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HOW TO USE THIS MANUAL

OVERVIEW

1. Summary

- (a). This manual supplies Overview for finishing maintenance service. Operation as per this manual is helpful for assurance of quality and efficiency of maintenance.
- (b). Common maintenance operation can be divided into three main working procedures:
 - Diagnosis
 - Dismantlement and installation, replacement, installation and check, debugging
 - Final inspection
- (c). This manual elaborates the first working procedure "Diagnosis" (see Chapter 04 Diagnosis), the second working procedure "Testing and adjustment, dismantlement and installation, disassemble and assemble, overhaul", but the third working procedure "Final inspection" isn't mentioned herein.

Hint:

Chapter 04 Diagnosis part only describes the electric part, the mechanical part can be referred to Fault List in every chapter.

- (d). This manual doesn't explain the following necessary key operation in practical maintenance:
 - Use jack or safety support platform to jack up vehicle
 - Wash dismantled parts as needed
 - Visual check

2. Preparations

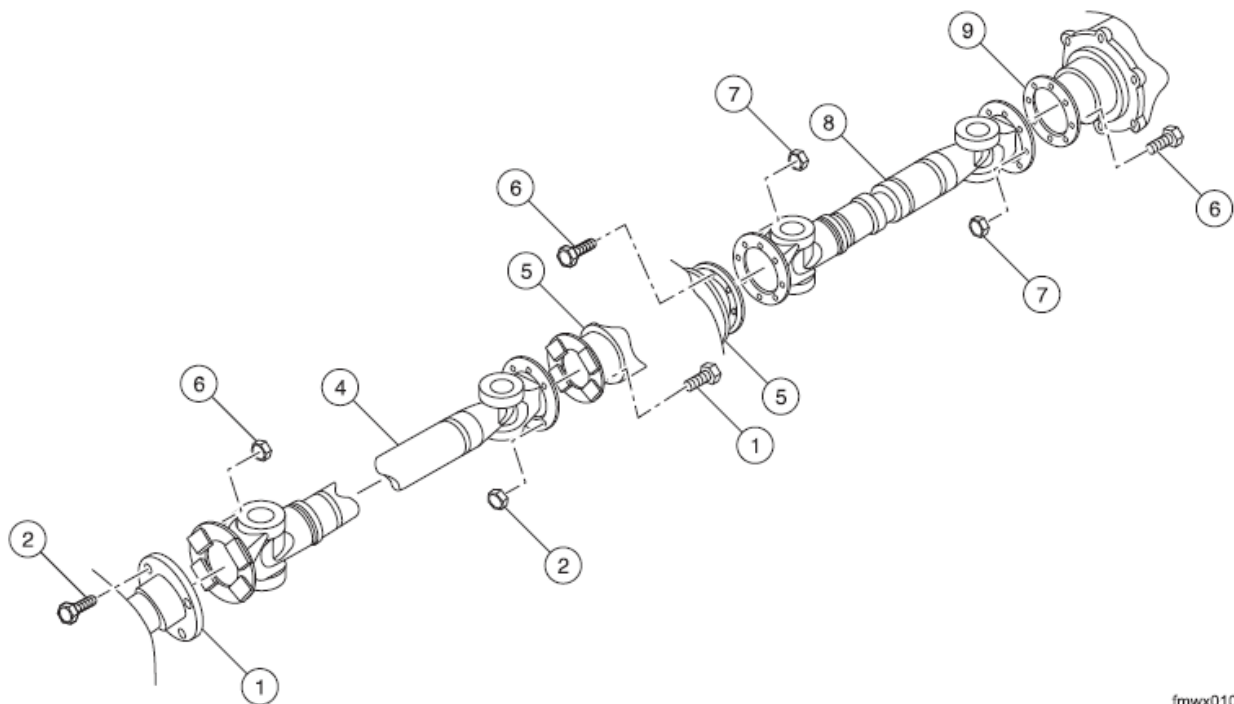
- (a). In this manual, Chapter 02 "Preparations" lists special tools, recommended tools, equipments and accessories needed for maintenance service, please correctly use them by strictly conforming to operating procedure.

3. Maintenance procedures

- (a). Illustration of component diagrams is inset to explain the system as needed by the chapter.
- (b). Component diagrams clearly describes the assembly relationship among components with the form of exploded view, and the names of components is listed and explained following the diagram.



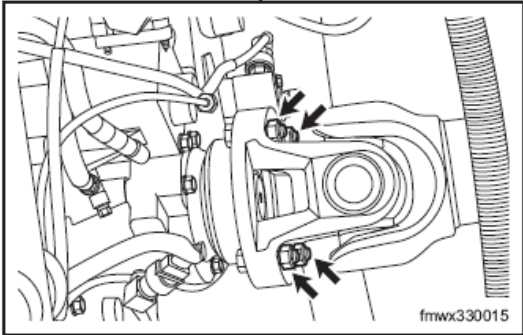
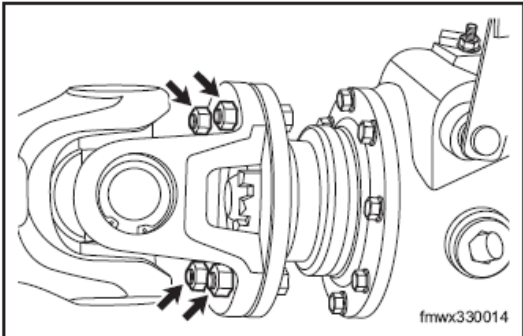
Example:



fmwx010032

- (a). If the installation procedure and dismantling procedure is just the opposite, only the key parts are described.
- (b). The manual uses illustrations to key parts and operating parts of working procedures, and gives detailed description to them, and lists method of operation, standard value and attentions.
- (c). The manual exists the situation that the same illustration is used for familiar model of vehicle. In such case, there maybe have some variations between the supplied data and practical situation.
- (d). Description of working procedures is made according to the following sequences:
- The operating steps explain "What to do" and "Where to do".
 - The title of operating steps explains: "What to do".
 - The operating steps explain how to "fulfill a task", and supply help and operating information, such as "hints" and "attentions".

Example:

Illustration of operating steps	Title of operating steps	Explanation of operating steps
 fmwx330015	4. Same drive shaft in installation.	(a) Put drive shaft assembly on hydraulic corner and lift the assembly to be flush with output flange of gear-box and input flange of intermediate axis. (b) The drive shaft shall be flush with output flange of gear-box, then screw down bolt. Torque: 178~218N.m Note: Ensure forward mark is forward, and installation marks are flush. (c) Connect drive shaft and input flange of intermediate axle, then screw down bolt. Torque: 178~218N.m
 fmwx330014		Note: Ensure installation marks are flush.
	Information of maintenance specification	Information of maintenance warning

fmwx010033

1 Maintenance specifications

- (a) In this manual, maintenance specification will be expressed by font bold, and you need not look for them by stopping your job in hand. Relevant contents also are listed in Chapter 03 "Maintenance specification" for fast searching.

2 Warning, attention and hints

Warning	Expressed by font bold, means it may injure you or others.
Attention	Expressed by font bold, means it may damage maintaining component or equipments
Hint	Supply additional explanation to help improving maintenance efficiency

3. International system of units (SI)

- (a). In this manual, "Unit" adopts international system of units (SI).

For example:

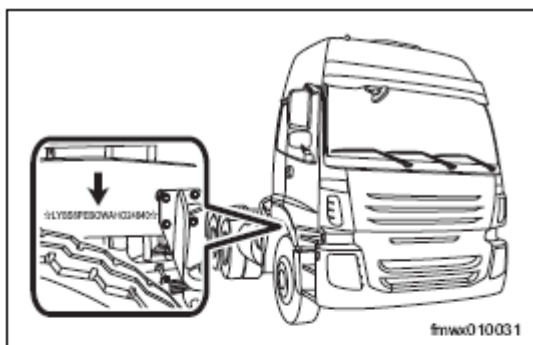
Torque: 180N.m

4. Vehicle applicable

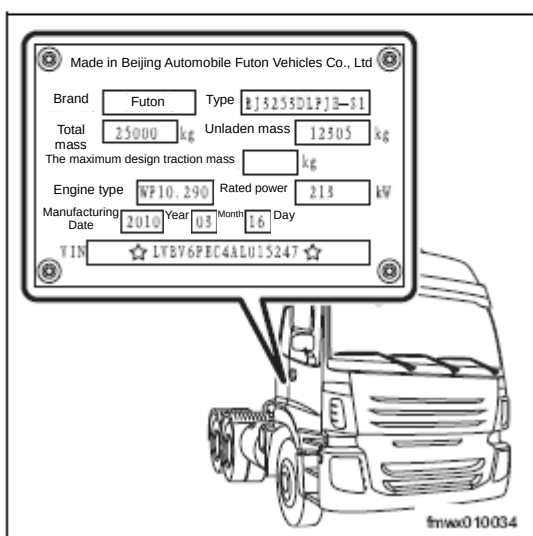
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4251SMFJB-06Z054	4251SMFKB-00ZA01	

VEHICLE IDENTIFICATION LOGO

VEHICLE IDENTIFICATION



1. **Vehicle identification number (VIN)**
 - (a). Vehicle identification number is engraved on the external side of right vertical beam of vehicle frame.

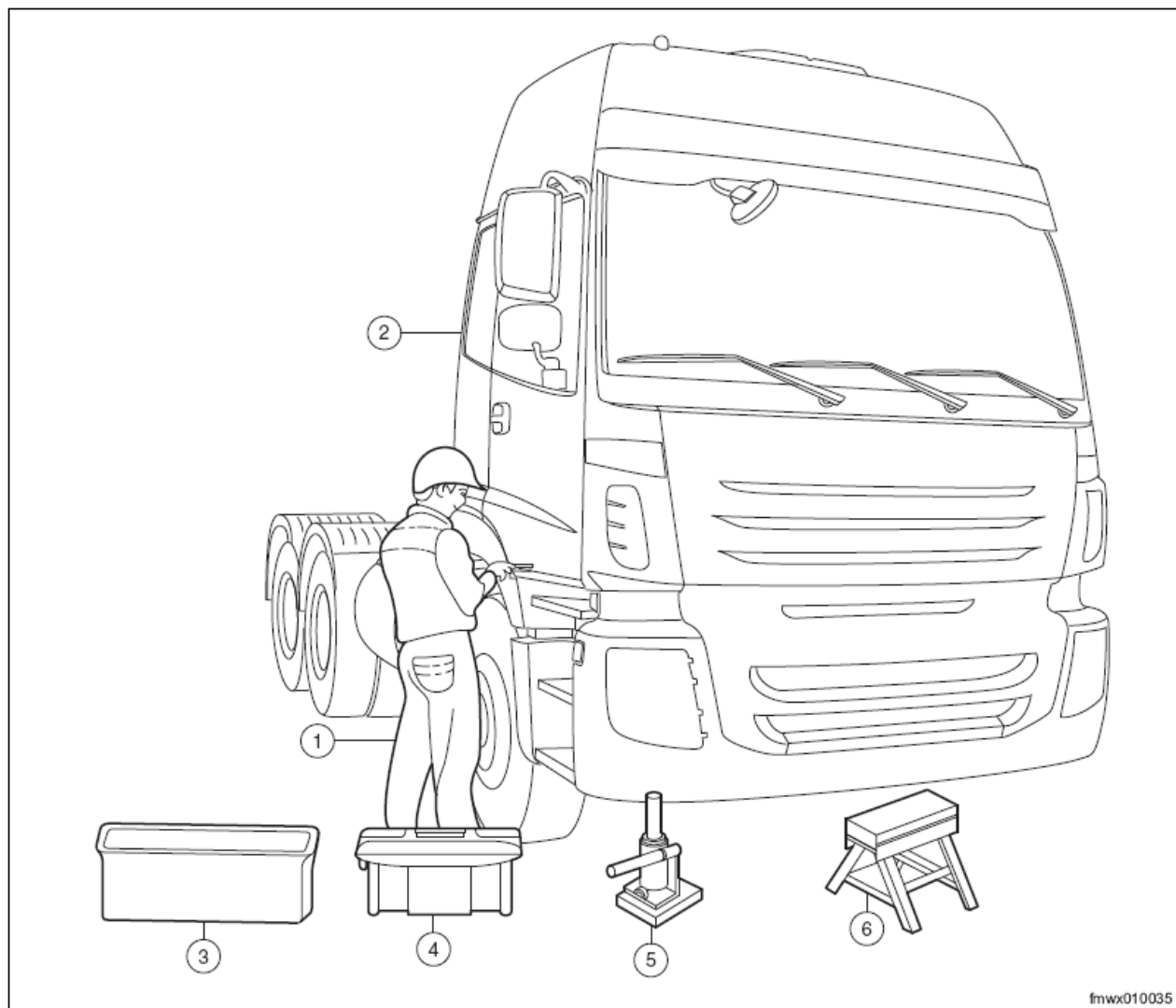


2. **VIN nameplate**
 - (a). VIN nameplate is on front pillar of right driver's cab door.

MAINTENANCE GUIDE

PREPARATIONS

1. Attentions for operation



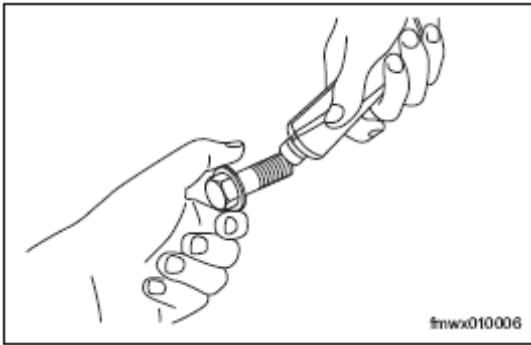
fmwx010035

1	Clothing	Must wear utility uniform and safety shoes and safety hats
2	Vehicle protection	Install grille, protective plate and flap before maintenance operation.
3	Dismantled parts	1. The dismantled parts shall be placed as per order to avoid confusion or contaminating parts. 2. The disposable parts, such as washer, O-ring seal and locknut, shall be replaced as per explanation of manual.
4	Toolkit	Before operation, prepare tool shelf, special tools for maintenance, meters, vehicle lube oil, cleaning rag and replacing parts

5	Maintenance	1. Take effective measures after analyze and diagnose the fault 2. Check the situation of complete machine, deformation and damage before dismantle the parts. 3. After completion of dismantlement, make mark to avoid damaging the performance of machine. 4. If it is necessary, wash the dismantled parts, test the parts before installation 5. Before work on electric appliance, negative cable shall be taken down from binding post of battery
6	Safe operation	1. When two or more persons work together, they must take others security into consideration. 2. When maintenance is made under operation of engine, the ventilation situation of the workshop must be checked. 3. When high-temperature, rotating, moving or vibrating part is operated, see to it that don't be burnt or injured. 4. When vehicle is jacked up, emergency seat must be set near the supporting point. 5. When vehicle is lifted up, it must adopt security equipment.



MAINTENANCE HINT

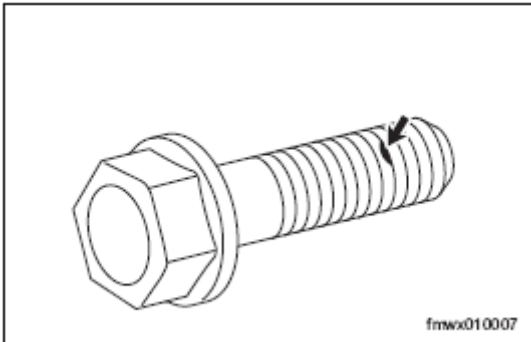


2. Precoating part

- (a). Precoating parts are the parts that have been coated with sealant at factory, such as bolt, nut, etc.
- (b). If precoating part needs to be tightened or loosened again, or it moves at any forms, the part shall be coated with stated sealant again.
- (c). When precoating part is re-used, the previous sealant shall be removed and be dried by compressed air. Then, the stated sealant shall be coated on bolt, nut or thread.
- (d). When sealant is used, a period of time may be needed to wait for solidification of sealant.

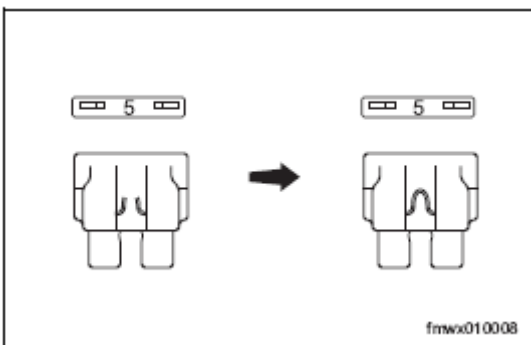
3. Washer

- (a). Seal ring shall be used in washer to prevent leakage if necessary.



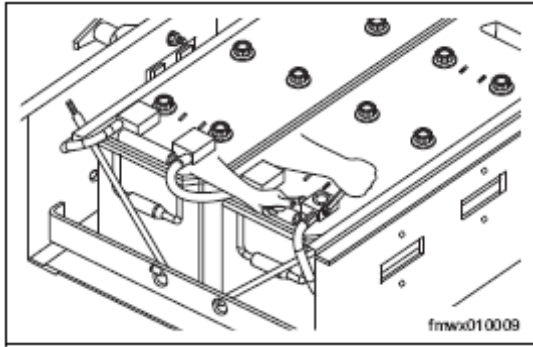
4. Stud, nut and screw

- (a). Carefully check the thread of bolt, stud and screw before usage whether damaged threads are more than three, if more than three threads are damaged, it must be replaced.
- (b). Carefully observe all specifications about fastening torque of bolt. Tension wrench must be used.



5. Fuse

- (a). When fuse is replaced, ensure rated value of current intensity of new fuse is correct. The fuse that is more than or less than the rated value is forbidden.



6. Battery

- (a). When check or repair, if it needs to disconnect battery, the cable must be disconnected from the negative (-) terminal of vehicle earthing.
- (b). In order to prevent damaging the binding post of battery, unscrew the nut of binding post, and take off cable by lifting it upward, the cable shouldn't be twisted or pried.
- (c). Clean the binding post of battery by cleaning rag in the shop, the binding post shouldn't be scraped by file or other milling tools.
- (d). Unscrew the nut, put cable terminal on binding post of battery, then screw down the nut, hammer shouldn't be used to hammer cable terminal on binding post.

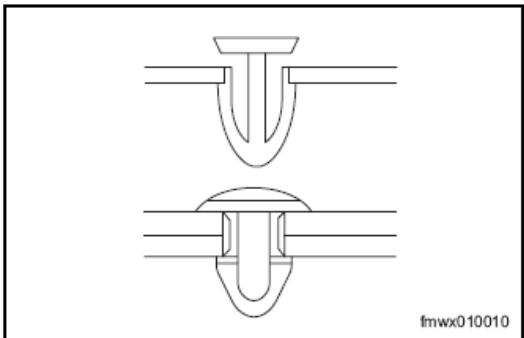
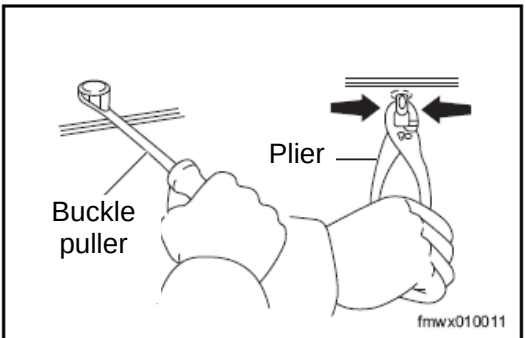
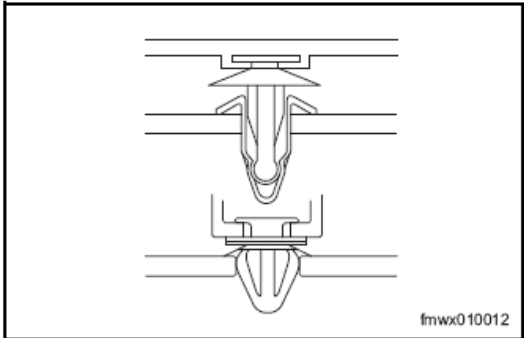
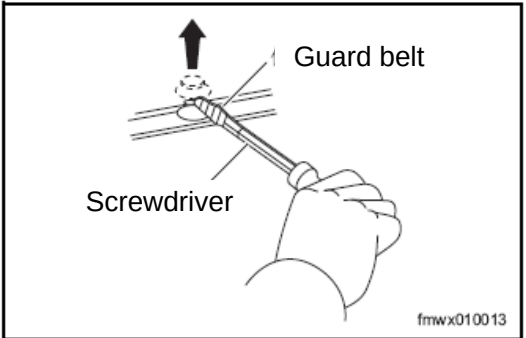
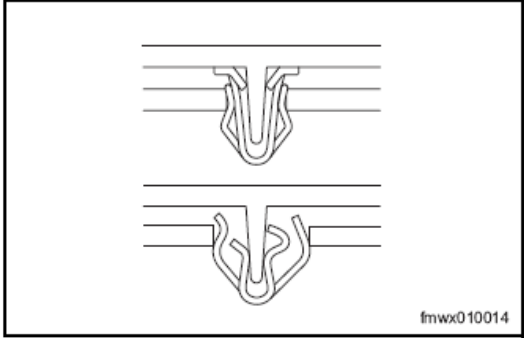
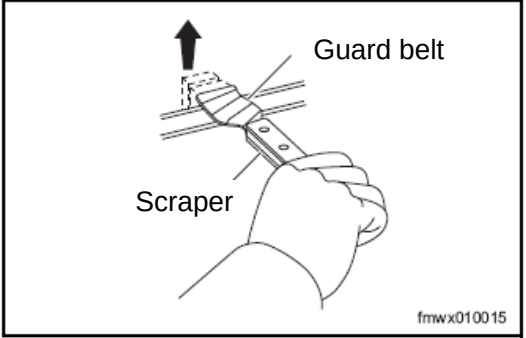
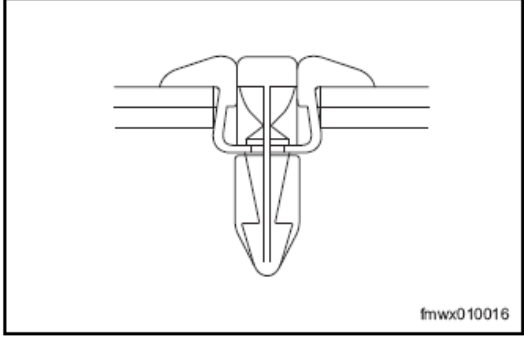
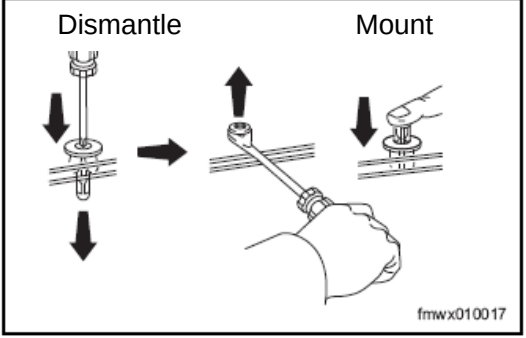
7. Clamp

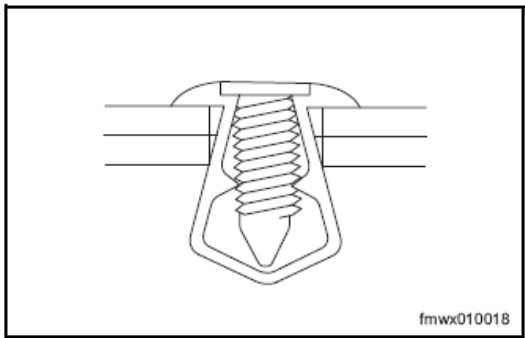
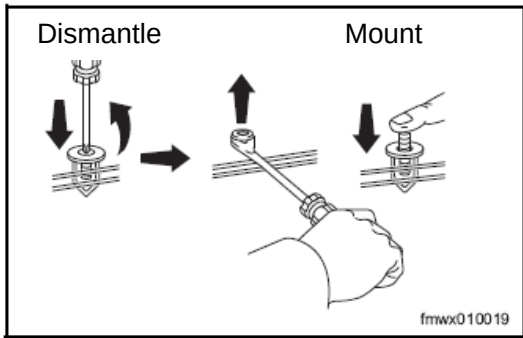
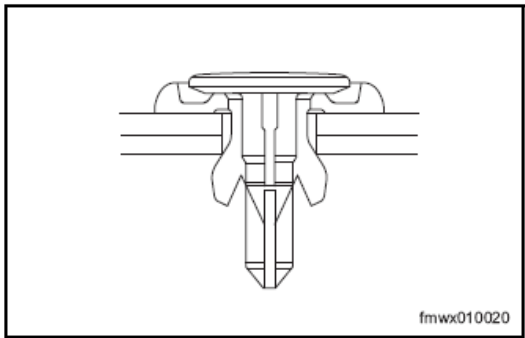
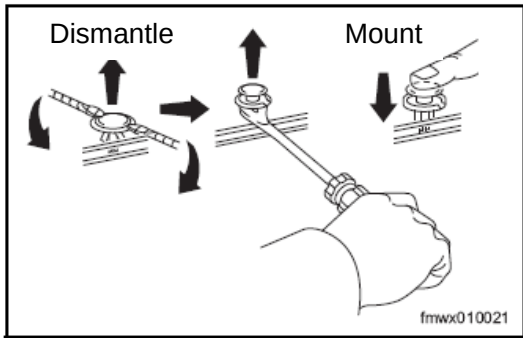
- (a). The operating method of clamp used for maintenance of vehicle as shown in the following figure.

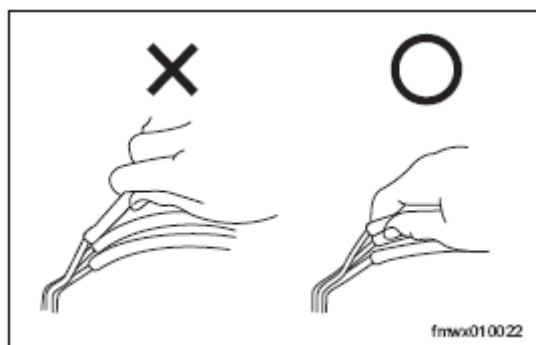
Hint:

If the clamp is damaged during process of maintenance, it must be replaced by new clamp.

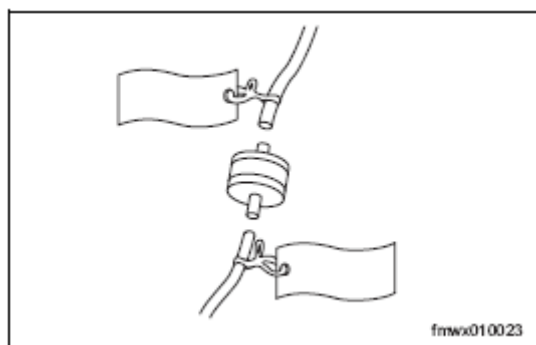


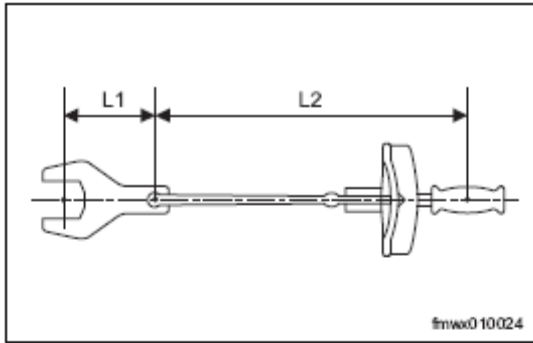
Shape (example)	Dismantle/mount
 fmwx010010	 Buckle puller Plier fmwx010011
 fmwx010012	 Guard belt Screwdriver fmwx010013
 fmwx010014	 Guard belt Scraper fmwx010015
 fmwx010016	 Dismantle Mount fmwx010017

Shape (example)	Dismantle/mount
	
	

**8****Dismantle and mount vacuum tube**

- (a). When vacuum tube is dismantled or mounted, it's necessary to catch hold of the end of tube, the middle part of tube must not be pulled.
- (b). When the connector of vacuum tube is disconnected, make mark by tag so that it can be identified when connect tube.
- (c). Every work shall be checked again after completion to ensure correct connection of vacuum tube.
- (d). When vacuum meter is used, oversize connector shouldn't be connected with tube, the size of connector must be adjusted gradually. Air leakage may be caused by extension of vacuum tube

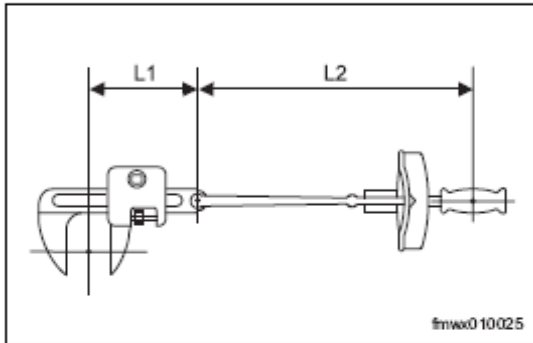




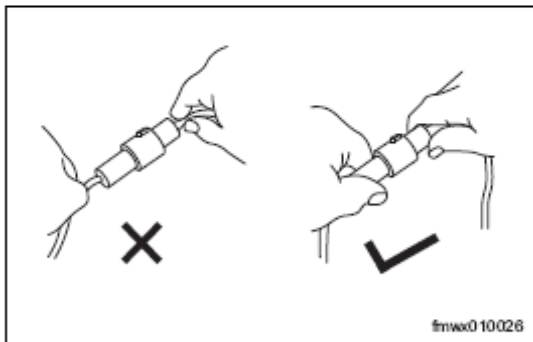
9. Use torque wrench with extension tool

- (a) When special maintenance tool or torque wrench with extension tool is used, if the numerical value shown on wrench reaches the scope of torque, that means actual torque is overload.
- (b) In this manual, only the size of special torque is marked. When special maintenance tool or extension tool is used, please calculate the size of torque as per the following formula.
- (c) Formula: $T' = T \times L2 / (L1 + L2)$

T'	Reading of torque wrench (N.m)
T	Actual torque (N.m)
L1	Special maintenance tool or lengthen the length of handle (mm)
L2	Length of torque wrench (mm)

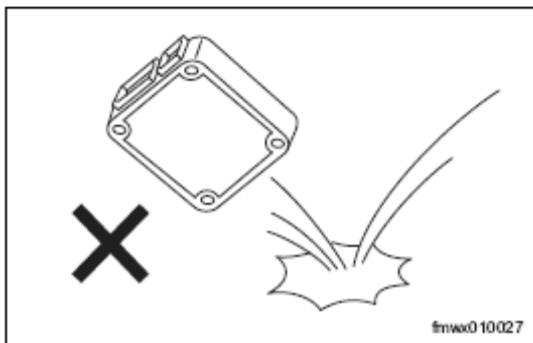


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10. Dismantle and mount the electric element

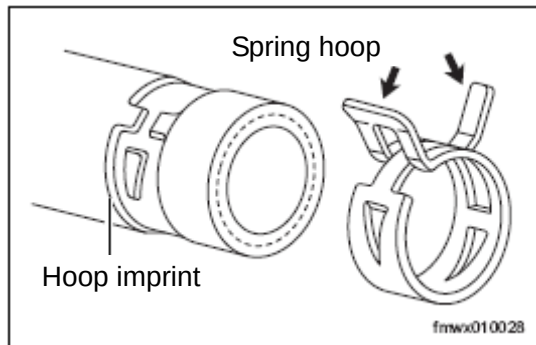
- (a) When pull away the connector of electric appliance, don't pull the wire, please pull the connector itself.
- (b) Be careful not to fall the electric elements, such as sensor or relay, if they fall on hard ground, please replace them.
- (c) Temperature detect switch or temperature sensor must not be dismantled or mounted by impact wrench.
- (d) When check continuity at wiring connector, insert probe of tester carefully to prevent bending of terminal.



11. Dismantle and mount parts of fuel control system

- (a) Notice of work site for dismantling and mounting parts of fuel system
- Be sure to select a place with good ventilation and without equipment or object around which may cause open flame, such as welding, grinding machine, electric drill, electric motor and oven, etc.
 - Be sure not to select a place like gas station or near it, because the evaporating fuel may be full of the space.
- (b) Dismantle and mount parts of fuel system.

- Be sure to prepare fire extinguisher before start operation.
- In order to prevent causing static electricity, be sure to earth the complete vehicle and fuel tank, and pay attention not to splash water on it for preventing slide of touch spot.
- Be sure not to use any electric appliance, such as electric motor or work light, to prevent causing sparkle or high temperature.
- Be sure not to use hammer to prevent causing sparkle.
- Be sure to separate cleaning rag from fuel when discarding.



12. Operation of hose hoop

- Before dismantle hose, check the depth of inserted coupler and position of hoop for correct re-mount.
- If there is deformation or dent on hoop, replace the hoop.
- If hose can be used again, be sure to clip the hoop on previous imprint.
- After completion of mounting, the clamping force of spring hoop can be adjusted as per direction of arrow.

13 Mounting method of key fastening piece

Hint:

The tightening torque of bolt that isn't stated scope shall be carried out as per deviation $\pm 10\%$.

- Nut of cylinder head: when screw down nut of cylinder head, it shall be screwed for several times and gradually until to the stated moment, and the principle of screwing is: the intermediate first, then the both sides, diagonal is crossover. When dismantle the cylinder, it shall be unscrewed gradually as per stated sequence. If the nut of cylinder head isn't screwed evenly or balanced, it will cause buckling deformation of plane of cylinder head. If the nut is screwed too tightly, the bolt will be tensile deformation, the engine block and thread will also be damaged. If the nut isn't screwed tightly enough, it will cause air leakage, water leakage and oil leakage of cylinder, and the high temperature gas inside the engine block will damage the head gasket, too.
- Flywheel nut: When install, the flywheel nut must be screwed tightly, and must be flanged and locked tightly by the thrust washer. If the nut of flywheel isn't screwed tightly, it will cause knocking noise when diesel engine works; and if it is serious, it will damage conical surface of crankshaft, shear key slot, twist off crankshaft, and result in serious accident. Furthermore, pay attention to thrust washer, its corner can be folded only once.
- Connecting rod bolt: connecting rod bolt, which is made by high quality steel material, will bear huge impact force during work, so it couldn't be replaced by ordinary bolt. The torque force shall be even when tightening; two connecting rod bolts shall be tightened to stated moment gradually by several times in turn, and shall be locked tightly by galvanized wire after. If the tightening torque of connecting rod bolt is oversize, it will cause tensile deformation of bolt., or even broken of bolt., and which may cause break block accidents; if the tightening torque of connecting rod bolt is undersize, the gap between bearing pads will increase, and cause knocking noise and impact load when work, or even cause bearing burnt and journal sticking, and broken accident of connecting rod bolt.
- Main bearing bolt: installation accuracy of the main bearing shall be ensured, and the bearing shouldn't be loosened. When tighten the main bearing bolt, the bolt shall be tightened evenly to



the stated moment by two or three times according to the sequence of intermediate first, then the two sides of the main bearing. At every time of tightening, the crankshaft shall be checked once for whether it is rotating normally or not. The hazard resulting from oversize or undersize of tightening torque of main bearing bolt is basically the same as the hazard caused by oversize or undersize of tightening torque of connecting rod bolt.

- (e). Balancing weight bolt: the balancing weight bolt shall be installed as per sequence, and shall be tightened to stated moment gradually by several times. The balancing weight shall be reassembled as per its original position; otherwise it will be out of balancing function.
- (f). Rocker seat nut: during service process of rocker seat nut, it shall be regularly checked and maintained. If the rocker seat nut loosens, it will increase valve clearance, valve opening will be put off and valve closing will be ahead of time, and perdurability of valve opening will be shortened, thus cause gas supply low, incomplete exhaust, power coast down and gasoline consumption increase.
- (g). Lock nut of oil injection nozzle: when oil injector is installed, its lock nut shall be tightened to stated moment. At the same time, it shall be tightened for several times, and it shouldn't be tightened in position for only once. If lock nut of oil injection nozzle is screwed too tightly, it will result in deformation of lock nut and pin valve blocked; if it is screwed too loose, it will result in oil leakage of injection nozzle, oil injection pressure drop, bad nebulization and oil consumption increase.

POSITION OF JACKING AND SUPPORTING VEHICLE

1. Pay attention to vehicle condition when it is jacked

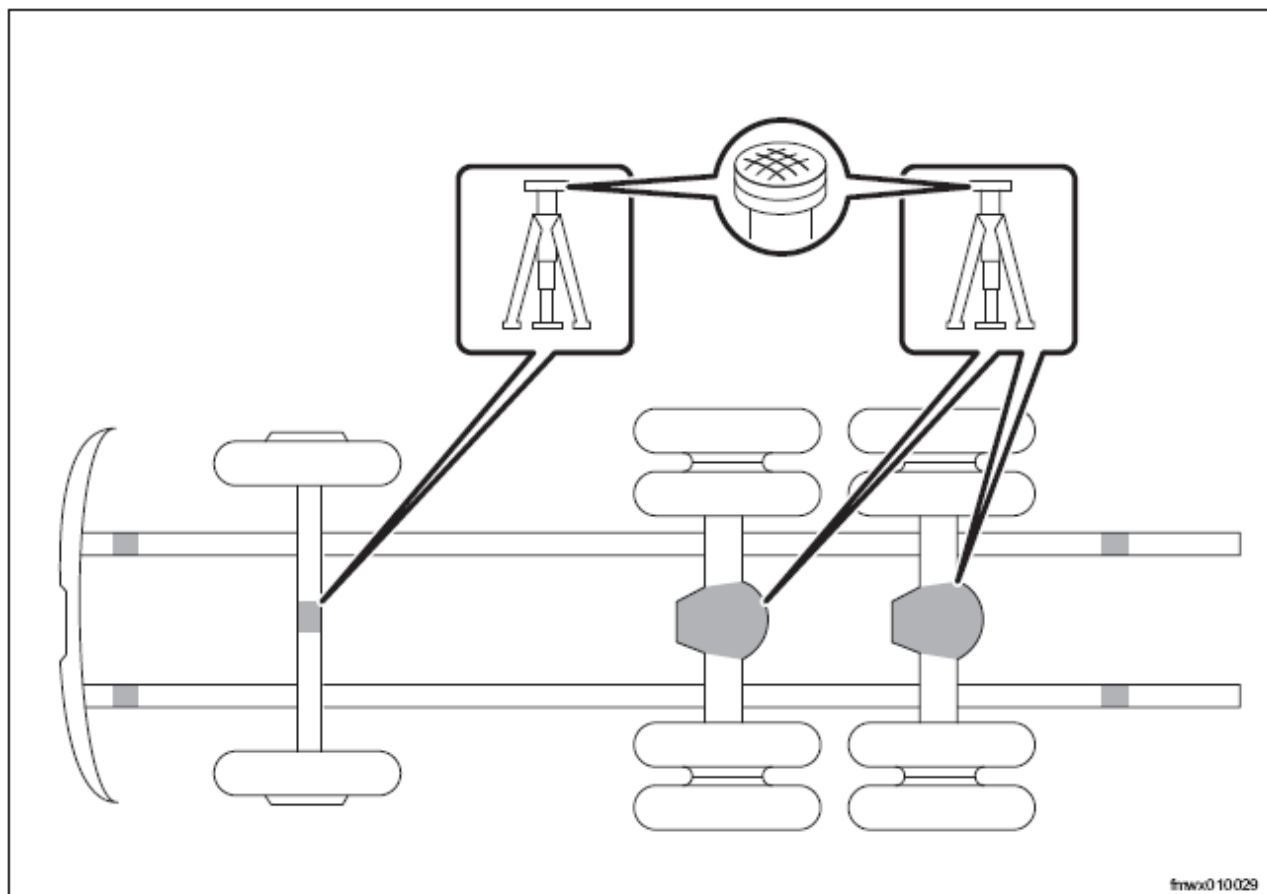
- (a). Principle: the vehicle must be jacked under no load condition; this operation must not be carried out under load condition.
- (b). The center of gravity of entire car will deviate after remove heavier parts, such as engine, and speed changer. Be sure to place balancing weight to prevent vehicle from capsizing, or jack shall be used to jack vehicle at appointed position for supporting.

2. Attentions for using jack and safety support platform

- (a). Be sure to proceed safe operation as per explanation of the manual
- (b). Be sure not to use tommy bar to raise tyre, in order to avoid damaging wheel and tyre.
- (c). The vehicle shall be parked on flat road, and parking brake shall be tightened.
- (d). Shift level shall be shifted to the position of reverse.
- (e). Be sure to block wheel at the diagonal of the position needed to be jacked by chock block.
- (f). The vehicle shall be jacked by jack that has rubber chock block.

Warning:

- Be sure not to jack up entire vehicle, in order to avoid damaging the vehicle, even endangering personnel safety.
- Be sure to jack up vehicle at stated jacking position.

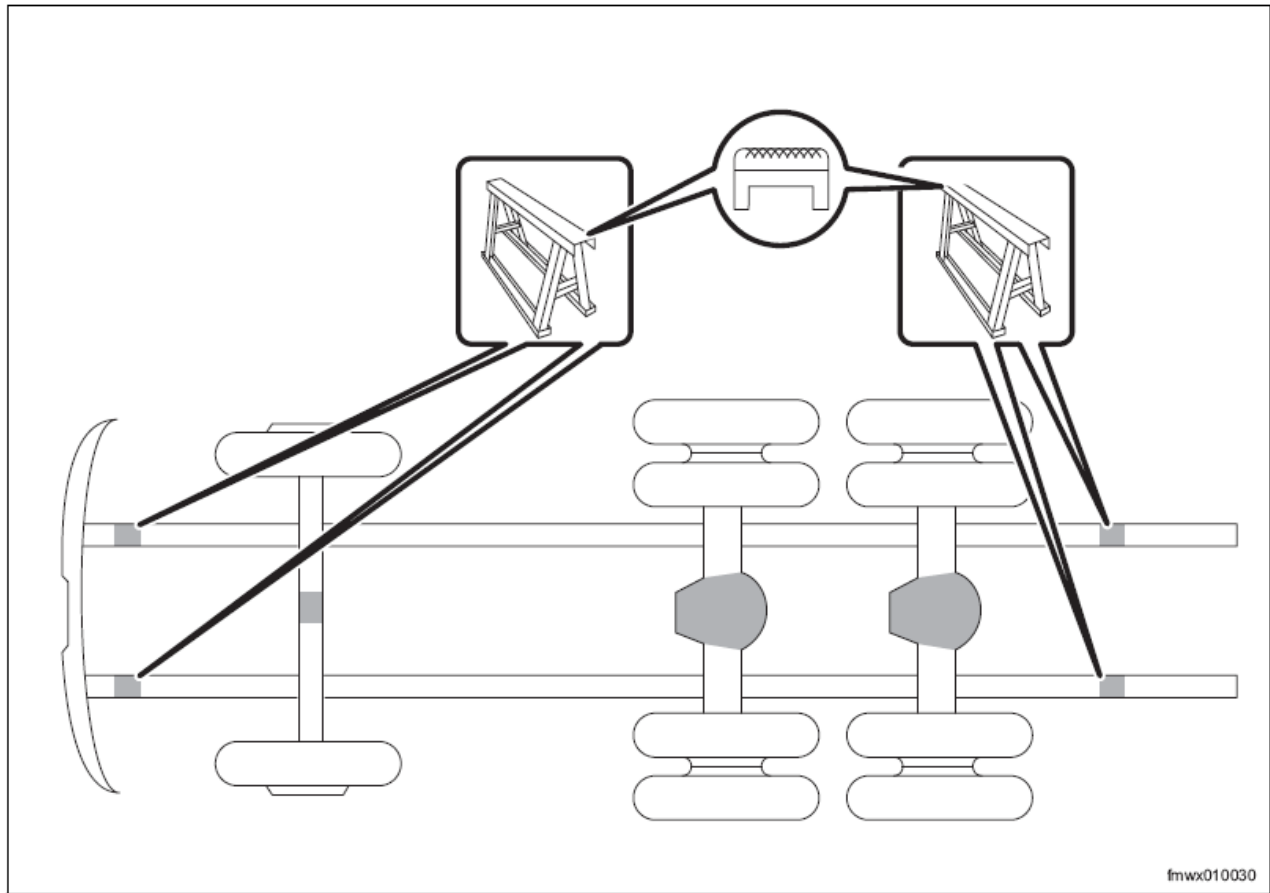


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- (g). After vehicle is jacked by jack, the vehicle may be supported by safety platform with rubber chock block if needed.

Warning:

- Be sure not to jack up entire vehicle, in order to avoid damaging the vehicle, even endangering personnel safety.
- Be sure to jack up vehicle at stated jacking position.



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TRANSMISSION (12JSD180TA)	02-23	CAB.....	02-43
PREPARATIONS	02-23	PREPARATIONS.....	02-43
TRANSMISSION (9JS180)	02-25	TRACTION SADDLE	02-44
PREPARATIONS	02-25	PREPARATIONS.....	02-44
CLUTCH.....	02-27		



FUEL (WD618)

PREPARATIONS

Special tools

	Fuel filter wrench	Fuel-water separator
	Fuel sensor wrench	Fuel sensor
	Fuel injector puller	Fuel injector

Recommended tools

	Air gun	
	Allen wrench	

Apparatus

Torque wrench	
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Accessories

Diesel	
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AIR INTAKE

PREPARATIONS

Recommended tools

	Air gun	Air filter
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EXHAUST SYSTEM AND TURBOCHARGER (WD618)

PREPARATIONS

Recommended tools

	Allen wrench	Turbocharger
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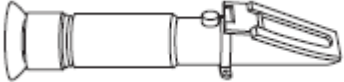
Apparatus

Torque wrench	
Torque wrench	

COOLING (WD618)

PREPARATIONS

Recommended tools

	Freezing point tester	Coolant
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Apparatus

Torque wrench	
Torque wrench	

LUBRICATION (WD618)

PREPARATIONS

Recommended tools

	Allen wrench	Engine oil cooler
	Engine oil filter wrench	Engine oil filter

Apparatus

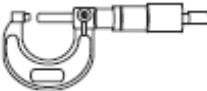
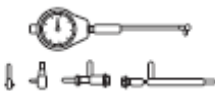
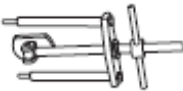
Torque wrench	
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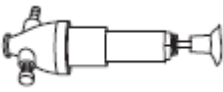
ENGINE MECHANIC SYSTEM (WD618)

PREPARATIONS

Recommended tools

	Engine tilting stand	Engine assembly
	Feeler gauge	Valve gap, piston ring opening gap, and cylinder head
	Plane meter	Cylinder head
	Outside micrometer	Crankshaft and camshaft
	Inside micrometer	Cylinder sleeve, crankshaft, and camshaft
	Magnetic stand	Crankshaft
	Crankshaft oil seal disassembling tool	Crankshaft oil seal
	Connecting rod bush reamer	Connecting rod
	Cylinder sleeve puller	Cylinder
	Cylinder pressure gauge	Cylinder
	Puller	Timing gear chamber

PREPARATIONS-ENGINE MECHANICAL PART (WD618)
02-9

	Valve disassembling tool	Valve
	Valve guide bar	Valve
	Valve seat reamer	Valve
	Valve guide reamer	Valve
	Valve grinder	Valve

Apparatus

Torque wrench	
Torque wrench	

02
Accessories

Engine oil	
Trichloroethylene detergent	
510 plane sealant	
Molybdenum dioxide powder	

STARTING AND PREHEATING SYSTEM (WD618)

PREPARATIONS

Recommended tools

	Inductive ammeter	Starter
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Apparatus

Torque wrench	
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CHARGING SYSTEM (WD618)

PREPARATIONS

Recommended tools

	Universal electric tester	Generator
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Apparatus

Torque wrench	
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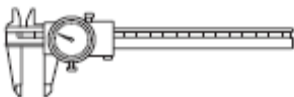
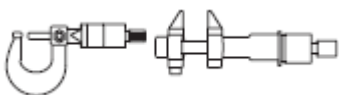
FRONT SUSPENSION

PREPARATIONS

Special tool

	Leaf spring hinge pin puller	Leaf spring hinge pin
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Recommended tools

	Hydraulic jack	Vehicle
		Front axle
	Tape measure	Plate spring
	Vernier caliper	Plate spring
	Torque wrench (200~1000 N·m)	
	Torque wrench (50~200 N·m)	
	Torque wrench (0~50 N·m)	
	Micrometer	Leaf spring hinge pin

Accessories

Lubricating grease	2# lithium base grease
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REAR SUSPENSION

PREPARATIONS

Recommended tools

	Hydraulic jack	Vehicle support
	Tape measure	Bumper block gap
	Torque wrench (200~1000N·m)	
	Torque wrench (50~200 N·m)	

Accessories

Lubricating grease	Gear oil SAE85W/90
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WHEELS AND TIRES

PREPARATIONS

Recommended tools

	Air pressure gauge	Tire
	Torque wrench (200~1000N·m)	Tire
	Hydraulic jack	Vehicle support

Apparatus

Inflator	
Dynamic balancing machine	
Tire puller	
Pneumatic wrench	

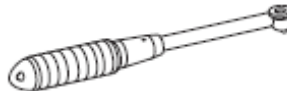
FRONT AXLE (ANKAI)

PREPARATIONS

Special tool

	Puller	Ball joint
	Bearing puller	Hub bearing

Recommended tools

	Hex key subassembly	Hub nuts
	Copper bar	Front hub bearing
	Spring balance	Bearing pre-tightening torque
	Torque wrench	Bolt
	Tape measure	Front wheel toe-in

Accessories

Lubricating grease	3# lithium base grease for summer
Lubricating grease	2# lithium base grease for winter
Plane sealant	598
Thread sealant	262

REAR AXLE

PREPARATIONS

Special tool

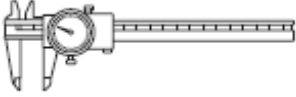
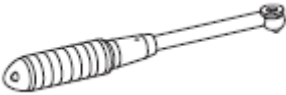
	Bolt sleeve	Wheel slotted nut
	Bearing puller	Bearing

Recommended tools

	Hex key subassembly	Flange nut
	Dial gauge with magnetic seat	Half shaft
		Rear wheel hub
		Drive gear
		Driven gear
		Planetary gear
		Half shaft gear
	Spring balance	Bearing pre-tightening torque
	Heating tool	Bearing inner ring
	Feeler gauge	
	Hydraulic jack	Main reducer assembly
		Rear axle assembly
	Tape measure	Half shaft gear

PREPARATIONS-REAR AXLE

02-17

	Vernier caliper	Rear axle housing
		Drive gear bearing block adjustment washer
		Drive gear bearing adjustment washer
		Planetary gear thrust washer
	Copper bar	Half shaft
		Rear wheel hub
		Rear wheel hub bearing
		Differential assembly
	Circlip pliers	Wheel
	Grease gun	Rear wheel hub
	Torque wrench (200~1000N·m)	Rear axle
	Torque wrench (50 ~ 200 N·m)	

02

Apparatus

V-bench	
Bench vice	
Bench vice	

Accessories

Lubricating grease	
Gear oil SAE85W/90	
598 plane sealant	
262 thread sealant	
Red lead powder	

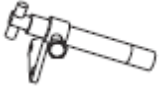


FOTON

SERVICE BRAKE

PREPARATIONS

Special tool

	Brake shoe polisher	Brake shoe
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Recommended tools

	Oil pipe wrench	Oil pipe
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Apparatus

Torque wrench	
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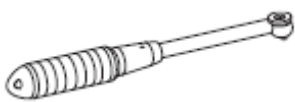
Accessories

Lubricating grease	Lithium base grease
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PARKING BRAKE

PREPARATIONS

Recommended tools

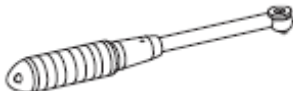
	Oil pipe wrench	Oil pipe
	Torque wrench	Bolt



FRAME

PREPARATIONS

Recommended tools

	Oil pipe wrench	Oil pipe
	Torque wrench	Bolt

Accessories

Low temperature anti-wear hydraulic oil	L-HV32 GB11118.1
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INTERMEDIATE AXLE (STEYR)

PREPARATIONS

Special tools

	Rear shaft bearing mounting socket	Rear shaft inner bearing
	Shaft head nut wrench	Hub

Recommended tools

	Input/output flange nut socket	Input/output flange nut
	Rear hub inner bearing puller	Rear wheel hub inner bearing
	Differential bearing and drive gear bearing puller bearing	Differential bearing and drive gear
	Copper bar	
	Spring balance	
	Torque wrench	

Apparatus

Torque wrench	
Torque wrench	

Accessories

Plane sealant	598 plane sealant
Plane sealant	262 Thread sealant
Gear oil	Grade AP1GL-5, SAE85W/90 viscosity



02-22

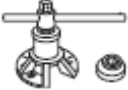
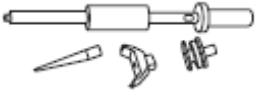
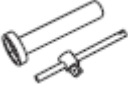
PREPARATIONS-INTERMEDIATE AXLE (STEYR)

Lubricant	3# lithium base grease for summer
Lubricating grease	2# lithium base grease for winter

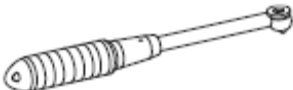
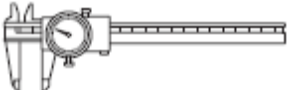
TRANSMISSION (12JSD180TA)

PREPARATIONS

Special tools

	Labor-saving wrench	Flange nut
	Hoisting tool	Secondary box
	Combined shaft puller	Reverse gear shaft
		Intermediate
	Flange nut special tool	Flange nut
	Rear bearing remover	Intermediate shaft rear bearing
	2nd shaft fixing seat	Installation of 2nd shaft
	1st shaft nut disassembling tool	1st shaft nut
	Intermediate shaft front bearing remover	Intermediate shaft front bearing

Recommended tools

	Torque wrench	
	Vernier caliper	Reverse gear shaft

PREPARATIONS-TRANSMISSION (12JSD180TA)

	Circlip pliers	2nd shaft brake ring
		1st shaft brake ring
		Intermediate brake ring
	Feeler gauge	Gear gap
	Hydraulic trolley	Transmission

Apparatus

Transmission disassembling tilting stand	
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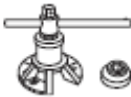
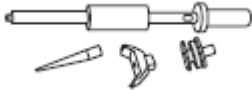
Accessories

Lubricating grease	
Gear oil SAE85W/90	17L
598 plane sealant	
262 thread sealant	

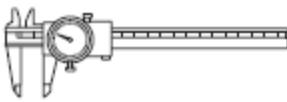
TRANSMISSION (9JS180)

PREPARATIONS

Special tools

	Labor-saving wrench	Flange nut
	Hoisting tool	Secondary box
	Combined shaft puller	Reverse gear shaft
		Intermediate
	Flange nut special tool	Flange nut
	Rear bearing remover	Intermediate shaft rear bearing
	2nd shaft fixing seat	Installation of 2nd shaft
	1st shaft nut disassembling tool	1st shaft nut
	Intermediate shaft front bearing remover	Intermediate shaft front bearing

Recommended tools

	Torque wrench	
	Vernier caliper	Reverse gear shaft

02-26

PREPARATIONS-TRANSMISSION (9JS180)

	Circlip pliers	2nd shaft brake ring
		1st shaft brake ring
		Intermediate brake ring
	Feeler gauge	Gear gap
	Hydraulic trolley	Transmission

Apparatus

Transmission disassembling tilting stand	
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Accessories

Lubricating grease	
Gear oil SAE85W/90	13L
598 plane sealant	
262 thread sealant	

02

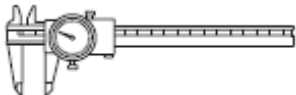
CLUTCH

PREPARATIONS

Special tools

	Clutch aligning bar	Clutch driven plate
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Recommended tools

	Dial gauge with magnetic seat	Driven plate
	Feeler gauge	Driven plate
		Pressure plate
	Tape measure	Clutch pedal
	Vernier caliper	Driven plate
		Pressure plate
	Grease gun	Clutch fork support bearing
	Torque wrench (50 ~ 200 N·m)	
	Torque wrench (50 ~ 200 N·m)	
	Oil cup	Drainage of clutch

Apparatus

V-bench	
Bench vice	

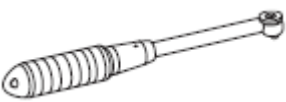
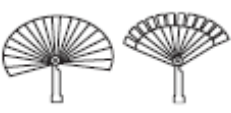
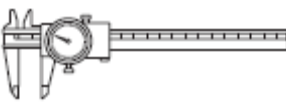
Accessories

2# lithium base grease	
Teflon tape	
V-3 clutch oil	

TRANSMISSION SHAFT

PREPARATIONS

Recommended tools

	Dial gauge	TRANSMISSION SHAFT
		Crossing shaft
	Torque wrench (200~ 1000N·m)	TRANSMISSION SHAFT connecting bolt
	Hydraulic jack	TRANSMISSION SHAFT
	Feeler gauge	TRANSMISSION SHAFT
	Vernier caliper	Joint cross
	Circlip pliers	Joint cross

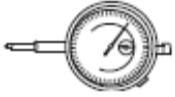
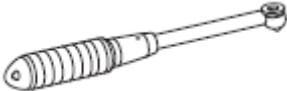
Apparatus

V-bench	
Bench vice	

STEERING WHEEL AND STEERING COLUMN

PREPARATIONS

Recommended tools

	Dial gauge with magnetic seat	Steering column TRANSMISSION SHAFT
	Spring balance	Steering force of steering wheel
	Puller	Steering wheel
	Torque wrench (200~1000 N·m)	
	Torque wrench (50~200 N·m)	

Apparatus

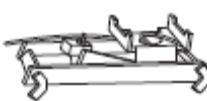
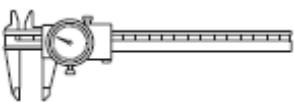
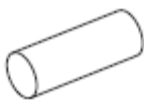
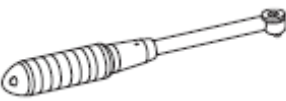
V-bench	
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POWER STEERING MECHANISM

PREPARATIONS

Recommended tools

	Oil pressure gauge	Steering oil pump
		Steering gear Steering drag link 02
	Puller	Steering drag link
	Spring balance	Steering force of steering wheel
	Hydraulic jack	Vehicle support and bleeding
	Vernier caliper	Drag link taper shaft
	Copper bar	Steering pitman arm
	Torque wrench (200~1000 N·m)	
	Torque wrench (50 ~ 200 N·m)	

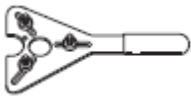
Accessories

Steering fluid	
Hydraulic circuit sealant	
Red lead powder	

AIR HEATER AND AIR CONDITIONER

PREPARATIONS

Special tools

	R-134a refrigerant recovery/ recycling/ refilling system	Refrigerant
	Drive plate bracket	Electromagnetic clutch

Apparatus

Torque wrench	
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Accessories

Refrigerant oil	PAG
Refrigerant	R-134a



SAFETY BELT

PREPARATIONS

Apparatus

Torque wrench	
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BATTERY

PREPARATIONS

Special tools

	Charger	Battery
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Recommended tools

	Gravimeter	Electrolyte
	Discharge tongs	Battery

Apparatus

Torque wrench	
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Accessories

Distilled water	
Concentrated sulfuric acid	



LIGHTING

PREPARATIONS

Recommended tools

	Torque wrench	Bolt
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WIPER AND WASHER

PREPARATIONS

Recommended tools

	Torque wrench	Bolt
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AUDIO SYSTEM

PREPARATIONS

Recommended tools

	Trim panel disassembling tool	Trim panel
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HORN

PREPARATIONS

Recommended tools

	Torque wrench	Bolt
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WINDOW REGULATOR REARVIEW MIRROR

PREPARATIONS

Recommended tools

	Glass sucker	Glass
	Allen wrench	Hexagon socket bolt
	Torque wrench	Bolt

Accessories

Sealant	CEMEDINE POS sealant
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INSTRUMENT CONSOLE, INSTRUMENTS, AND CIGARETTE LIGHTER

PREPARATIONS

Recommended tools

	Trim panel disassembling tool	Trim panel
	Torque wrench	Bolt

Accessories

Clamp	
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SEATS

PREPARATIONS

Recommended tools

	Oil pipe wrench	Oil pipe
	Torque wrench	Bolt

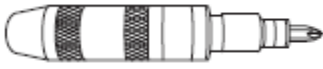
Accessories

Lubricating grease	Lithium base grease
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DOOR, DOOR LOCK AND DOOR HANDLE

PREPARATIONS

Recommended tools

	Clamp tool	Clamp
	Impact screwdriver	Countersunk screw
	Torque wrench	Bolt

Accessories

Clamp	
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INTERIOR AND EXTERIOR TRIMMINGS

PREPARATIONS

Recommended tools

	Torque wrench	Bolt
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Accessories

Clamp	
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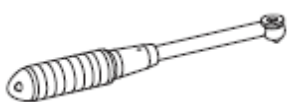
CAB

PREPARATIONS

Special tools

	CAB hoisting traveler	Hoisting of CAB
	CAB fixing bracket	Placement of CAB

Recommended tools

	Torque wrench	Bolt
	Hex socket subassembly	Bolt

TRACTION SADDLE

PREPARATIONS

Recommended tools

	Torque wrench	
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Accessories

Lubricating grease	Lithium base grease
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SERVICE SPECIFICATION

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Required tightening torque..... 03-41

**INSTRUMENT CONSOLE, INSTRUMENTS,
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03 INTERIOR AND EXTERIOR TRIMS..... 03-45

Required tightening torque..... 03-45

DRIVER CAB 03-46

Required tightening torque..... 03-46

TRACTION SADDLE 03-47

Required tightening torque..... 03-47

FUEL (WD618)

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Fuel tank clamping band fixing bolt	45±5
Accelerator pedal fixing bolt	25
Fuel injector fixing bolt	11±1
Fuel tank inlet and outlet pipe	46±6
Fuel-water separator seat fixing bolt	45±5
Fuel inlet and outlet pipe link bolt	45±5
Fuel injection pump fixing bolt	32
Fuel injection pump bracket fixing bolt	80
Drive flange fixing bolt	110

03



INTAKE

REQUIRED TIGHTENING TORQUE

Fastener	N.m
High intake pipe assembly fixing bolt	23±2
Safety filter element fixing nut	46±5
Main filter element fixing nut	46±5
Air cleaner assembly fixing bolt	97
Air cleaner intake hose bracket fixing bolt	23±2

EXHAUST AND TURBOCHARGER (WD618)

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Exhaust pipe clamp fixing bolt and nut	80±10
Exhaust pipe bracket fixing bolt and nut	45±5
Muffler bracket fixing nut	45±5
Muffler clamp fixing bolt	80±10
Turbine fixing bolt	45±5
Heat shield	25±5



COOLING (WD618)

SERVICE DATA

Item		Specification
Cooling mode		Water-cooling and forced recirculation
Radiator type		Corrugated radiator fins
Water pump	Type	Centrifugal type
	Nominal speed	3,648 r/min
Thermostat	Type	Wax type and core combined type
	Open temperature	80±2 °C
	Full open temperature	95 °C
Fan	Type	Annular fan
Inter-cooler	Type	Flat-pipe corrugated, air-cooling type

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Auxiliary water tank fixing bolt	20
Radiator slotted nut	70
Wind collecting cover fixing bolt	20
Inter-cooler fixing bracket	23±2
Inter-cooler fixing bolt	23±2
Cooling fan fixing bolt	20
Water pump fixing bolt	63



LUBRICATION (WD618)

SERVICE DATA

Item		Specification
Lubrication mode		Pressure lubrication
Lubricating oil capacity (Oil sump)		23L (25L at initial refilling)
Engine oil pressure		350~550kPa
Engine oil pressure under idling		≥ 100kPa
Engine oil filter	Type	Rotary paper filter element, double cartridge in parallel connection
Engine oil pump	Type	Gear pump (general single-stage pump, double-stage pump under special condition)
	Safety valve open pressure	1550±150kPa
Engine oil cooler	Type	Water cooling
	Bypass valve open pressure	600±36kPa
	Pressure for pressure resistance test	1,500kPa
Gap between drive/driven gears and inner wall of pump chamber		≤ 0.3mm
Meshing gap between drive and driven gears	Standard value	0.05mm
	Limit value	0.20mm

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Oil sump fixing bolt	25
Drainage bolt	25
Engine oil pump fixing bolt	62.5±2.5
Engine oil cooler fixing bolt	25



ENGINE MECHANICAL PART (WD618)

SERVICE DATA

Item		Standard value
Main bearing gap		0.099~0.166mm
Connecting rod bearing gap		0.084~0.104mm
Crankshaft axial gap		0.052~0.255mm
Connecting rod planar axial gap		0.15~0.35mm
Connecting rod smaller end bush × Piston pin gap		0.04~0.060mm
Piston pin seat × Piston pin gap		0.003~0.013mm
Piston ring opening gap under cold status	1 st ring	0.35~0.6mm
	2 nd ring	0.25~0.4mm
	Oil ring	0.35~0.55mm
Piston ring lateral gap under cold status	1 st ring	-
	2 nd ring	0.07 ~ 0.12 mm
	Oil ring	0.05 ~ 0.085 mm
Intake valve stem × Valve guide gap		0.02 ~ 0.048 mm
Exhaust valve stem × Valve guide gap		0.025 ~0.053 mm
Valve depression	Exhaust	1.08 ~ 1.48 mm
	Intake	0.75 ~ 1.15 mm
One-sided value of cylinder sleeve top above frame		0.05 ~ 0.10mm
Camshaft axial gap		0.1~0.4mm
Camshaft bearing gap		0.04 ~ 0.12 mm
Tappet × tappet hole gap		0.025~0.089mm
Cylinder sleeve outside diameter × Body cylinder sleeve bore interference and gap		-0.02~0.023mm
Rocker × rockshaft gap		0.04 ~ 0.119 mm
Timing gear × intermediate gear backlash		0.15 ~ 0.33 mm
Valve gap	Intake	0.35mm
	Exhaust	0.4mm
	EVB (cold status)	0.25mm

Name	Heating temperature	Recommended heating time
Crankshaft gear	Inductive heating, 180°C	-



SERVICE SPECIFICATION-ENGINE MECHANICAL PART (WD618)

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Piston	60 °C	10 min
Flywheel gear ring	150 °C	10 min
Crankshaft front flange	Inductive heating, 290°C	-
Note: It's recommended to use 3.6Kw 6A 380V 50Hz electric chamber furnace with maximum heating temperature at 400°C as the heating furnace.		

Loctite sealant trademark	Main applications	Application locations
242	It's applied onto the threads to prevent being vibrated to looseness, with moderate strength.	Timing gear chamber stud
		Camshaft thrust washer
		Camshaft timing gear stud
		Intermediate idler bolt
		Filter seat bolt
		Engine oil cooler seat bolt
		Air compressor shaft end thread
		Main oil way rear screw plug
		Safety valve screw plug
		Main oil way limiting valve thread
		Strainer bolt
262	It's applied onto the external threads to lock, seal, and prevent being vibrated to looseness	Cylinder head auxiliary bolt
271	Lock and tighten	Auxiliary oil way bowl plug
		Main oil way bowl plug
		Adjoining circumference between compressor outlet × connecting bend
277	Sealing between element × bore	Cylinder block water chamber bowl plug
		Camshaft bore bowl plug
		Cylinder head bowl plug
		Cylinder head copper sleeve
		Intake pipe bowl plug
		Segment of gas-oil separator breathe bend into cylinder block
		Exhaust valve spring lower base face
		Segment of pipe connector subassembly into water pipe connector

03



FOTON

03-10

SERVICE SPECIFICATION-ENGINE MECHANICAL PART (WD618)

510	It's applied onto shining metal surfaces for sealing purpose.	Mating face between cylinder block and crankcase
		Front and rear end faces of cylinder block
		Mating face between air compressor and timing gear chamber
		Mating face of filter seat × crankcase

03

REQUIRED TIGHTENING TORQUE

Fastener		N.m
Main bearing bolt	1 st time	Tighten as per specified sequence
	2 nd time	80
	3 rd time	275±25
Cylinder head bolt	1 st time	Tighten main and auxiliary bolts to 40±10 as per specified sequence
	2 nd time	Tighten auxiliary bolt to 100
	3 rd time	Tighten main bolt to 200
	4 th time	Tighten auxiliary bolt and nut by 90°
	5 th time	Tighten main bolt by 90°
Connecting rod bolt	1 st time	Pre-tighten in symmetrical manner
	2 nd time	120
	3 rd time	Tighten further by 90°±5° and check torque (210)
Flywheel bolt	1 st time	Tighten in symmetric manner
	2 nd time	70±10
	3 rd time	Tighten further by two 90°.
Flywheel housing bolt	1 st time	Tighten in symmetric manner (50±10)
	2 nd time	Tighten further by 120°±5° and check torque (255)
Intermediate gear bolt	1 st time	Pre-tighten to 60±5
	2 nd time	Tighten further by 90°±5° and check torque (112.5)
Engine oil pump intermediate gear shaft fixing bolt		62.5±2.5
Rocker seat bolt		105±5
Camshaft gear fixing bolt		Tighten in symmetric manner (34±2)
Fuel injector fixing bolt		Tighten in symmetric manner and notice the even gap (11±1)
Crankshaft shock absorber connecting bolt		Tighten in symmetric manner (65±5)
Air compressor gear fixing nut		210±10



FOTON

SERVICE SPECIFICATION-ENGINE MECHANICAL PART (WD618)

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High pressure oil pipe nut	Fuel injector end	22.5±2.5
	High pressure pump end	30±5
Crankshaft position sensor fixing bolt		8±2



START AND PREHEATING SYSTEM (WD618)

SERVICE DATA

Item		Specification
Start mode		Electric start
Starter	Power	6KW
	Voltage	24 V
Cold start	Without auxiliary starter	10℃
	With auxiliary starter	-30℃

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Ignition switch fixing bolt	25
Auxiliary starter switch fixing nut	25
Starter fixing nut	60



CHARGING SYSTEM (WD618)

SERVICE DATA

Item		Specification
Generator	Type	Integral rectification and voltage regulation
	Power	1,000 W
	Voltage output	28 V
	Current output	27A
	Allowable top speed	11,000r/min
	Rated load speed	6,000r/min

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Generator fixing bolt	60



FRONT SUSPENSION

SERVICE DATA

Item		Parameter
Front leaf spring hinge pin outside diameter	Standard value	φ30mm
	Limit value	φ29.93~29.97mm
Front leaf spring bush inside diameter	Standard value	φ30 mm
	Limit value	φ30.11~30.194mm
Height of leaf spring assembly under free status	Standard value	135 mm for left; 120mm for right
	Limit value	129~141mm for left; 114~126mm for right
Front leaf spring and front bumper block height (unloaded)	Standard value	124mm
	Limit value	118~130mm

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Front shock absorber upper fixing bolt	222±22
Front shock absorber lower fixing bolt	222±22
U-shaped connecting bolt fixing nut	280±20
Front leaf spring hinge pin fixing bolt	83±8
Stabilizer bar U-shaped connecting plate fixing bolt	83±8
Stabilizer bar and stabilizer bar link connecting bolt	140±14
Rear leaf spring hinge pin fixing bolt	83±8



REAR SUSPENSION

SERVICE DATA

Item		Parameter
Floating height of leaf spring under free status		60±6mm
Gap of bumper block	Standard value	145mm
	Limit value	145±12mm
Rear balance shaft leaf spring spacing		1040mm
Total length of rear balance shaft		< 1352mm

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Lower thrust rod fixing bolt	525±25
Limiting block fixing bolt	50±5
Plate spring thru bolt	100±20
U-shaped bolt fixing nut	510±20
Rear balance shaft fixing nut	312±24
Adjustment plate connecting bolt	83±8
Rear stabilizer bar and rear axle housing connecting bolt	222±22
Rear stabilizer bar U-shaped connecting plate fixing bolt	83±8



WHEELS AND TIRES

SERVICE DATA

Item		Parameter
Tire specification		12.00R20
Tire pressure	Front tire	830kPa
	Rear tire	830kPa
Tire wear limit		2mm

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Wheel nut	575±25



FRONT AXLE (ANKAI)

SERVICE DATA

Sizes and Fit Clearances for Various Portions of Front Axle (mm)

Portion	Standard Size	Fit Clearance	Wearing limit
Master pin upper end shaft diameter	42.975~42.991	0.018~0.059	0.16
Upper bush inside diameter	43.009~43.034		
Master pin lower end shaft diameter	46.975~46.991	0.018~0.059	0.16
Lower bush inside diameter	47.009~47.034		
Master pin middle shaft diameter	45.07~45.084	Interference	
Front shaft pin bore diameter	45.0~45.025	0.045~0.084	
Brake camshaft diameter	39.936~39.975	0.155~0.256	0.35
Bush inside diameter	40.130~40.192		
Brake shoe roller shaft outside diameter	20.040~20.092	0.08~0.165	
Roller inside diameter	19.927~19.96		

03

Basic specification of 7.5T-level front axle

Rated axle load (kg)	7500
Dead weight (exclusive of steel rim and tire) (KG)	Appr. 450
Maximum turning angle of front wheel (inner/outer)	45°/33°
Toe-in (Bias tire at outer edge of wheel rim) (KG)	0~2
Kingpin inclination angle	3°
Kingpin caster angle	1°
Front wheel camber angle	1°

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Steel rim fixing bolt	575±25
Brake adjustment arm seat fixing bolt	140
Brake shoe shaft fixing nut	300
Steering crankarm fixing nut	305±30
Shaft end bearing rotation torque	60-90N
Front leaf spring U-shaped bolt	280±20
Front shock absorber bracket fixing bolt	268



FOTON

REAR AXLE

SERVICE DATA

Item		Parameter
Rated axle load (kg)		13000
Maximum input speed (rpm)		3500
Wheel base		1800~1880mm
Axle housing thickness (mm)		16
		20
Speed ratio		Maximum input torque (N.m)
i=4.80		16680
i=5.73		13731
i=6.72		11770
Total rear axle weight (exclusive of lubricating oil and tire) (kg)		Appr. 780
Lubricating oil capacity	Main reducer (L)	8
	Left wheel reducer (L)	2
	Right wheel reducer (L)	2
Drive gear bearing pre-tightening force (N)		15±5
Meshing clearance between drive and driven gears		0.2~0.4
Differential bearing pre-tightening force (N)		29±13
Clearance between differential sun gear and planetary gear (mm)		0.18-0.5

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Brake base plate fixing bolt	300±20
Wheel slotted nut	350±50
Connecting bolt between left and right differential housings	195
Connecting bolt between driven gear and differential housing	325
Main reducer flange nut	775±25
Connecting bolt between drive gear bearing block and main reducer housing	110
Connecting bolt between main reducer and rear axle housing	125±15
Wheel cover and wheel assembly	60±15
Differential bearing cap nut	235±20
Differential lock round nut	200±20



SERVICE SPECIFICATION-REAR AXLE**03-19**

Connecting nut between upper thrust rod and rear axle upper bracket	500±25
Connecting nut between lower thrust rod and rear axle lower bracket	500±25
Connecting bolt between stabilizer bar and rear axle	221±22
Wheel oil drainage bolt	100 ±20
Wheel oil refilling bolt	100 ±20
Main reducer oil drainage bolt	235 ±35
Main reducer oil refilling bolt	235 ±35

03**FOTON**

SERVICE BRAKE

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Brake pedal fixing bolt	25
Master brake valve drive bolt	25
Drier base fixing bolt	60
Relay valve fixing nut	25
Differential valve fixing nut	25
Front brake air chamber fixing nut	97
Rear brake air chamber fixing nut	97
Brake shoe fixing nut	250
Exhaust brake butterfly valve fixing bolt	25
Trailer valve fixing bolt	25



PARKING BRAKE

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Handbrake valve fixing bolt	23



FRAME

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Rear suspension upper lock fixing bolt	63
Rear suspension lower lock fixing bolt	63
Tilting cylinder fixing bolt	160
Manual pump assembly fixing nut	97
Rear suspension lower frame weldment assembly fixing nut	97
Extension beam fixing bolt	63
Rocker assembly fixing bolt	97
Shock pad assembly fixing bolt	63



INTERMEDIATE AXLE (STEYR)

SERVICE DATA

Item		Parameter
Rated axle load (kg)		13,000
Maximum input speed (rpm)		3,500
Total speed ratio	i=4.80	23,540
	i=5.73	19,620
	i=6.72	17,170
Brake drum diameter × width (mm)		φ420X185
Brake type		Air chamber brake cam type
Braking air pressure (bar)		6.5
Braking friction plate and brake drum friction coefficient		0.39
Braking total efficiency		0.89
Parking brake type		Spring accumulated air cut-off brake
Total axle weight (exclusive of tire and lubricating oil) (kg)		
Intermediate axle		Appr. 860
Rear axle		Appr. 770
Refilling capacity of lubricating oil (L)	Intermediate axle main reducer	8.3
	Rear axle main reducer	8.0
	Wheel reducer	2.0 (each side)

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Left differential housing × Right differential housing	205±25
Driven bevel gear × wheel differential housing	320±20
Differential assembly × main reducer housing	235±20
Slotted nut	310±10
Bearing pressure plate × drive gear bearing	220±20
Front differential housing × rear differential housing	210
Flange nut	800±50
Bridge box × main reducer housing	100±20
Meshing sleeve	200±20



FOTON

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SERVICE SPECIFICATION-INTERMEDIATE AXLE (STEYR)

Main reducer assembly × axle housing	125±15
Oil baffle	60±15
Driving gear shaft baffle	180
Driving cylindrical gear shaft bush slotted nut	300
Differential lock fixing slotted nut	200
Bearing bush cover × bush seat	210

TRANSMISSION (12JSD180TA)

SERVICE DATA

Item		Parameter
Torque		1800N.m
Power output		298kw
Rated speed		2600rpm
Speed ratio	1 st gear	12.1
	2 nd gear	9.41
	3 rd gear	7.31
	4 th gear	5.71
	5 th gear	4.46
	6 th gear	3.48
	7 th gear	2.71
	8 th gear	2.11
	9 th gear	1.64
	10 th gear	1.28
	11 th gear	1
	12 th gear	0.78
	Reverse gear 1	11.56
	Reverse gear 2	2.59
Weight		350kg
Refilling capacity		15 L

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Clutch housing 6-M16×1.5	257±14
Clutch housing 4-M12	121±14
1st shaft bearing cap 6-M10	54±7
1st shaft gear M54×1.5 - Left	372±34
Single H control device 8-M10×1	54±7
Upper cap 16-M10	54±7
Fork lock screw 5-M12~1.2S	78±10



FOTON

03-26**SERVICE SPECIFICATION-TRANSMISSION (12JSD180TA)**

Secondary box fork 2-M12×1.5	78±10
Air cleaner bracket 2-M6	17±3
Output shaft M50×1.5	643±34
Secondary box rear cap 19--M10	54±7
Oil drainage port Z3 / 4	68±7
Oil filler port 21	91±10
Secondary box drive gear positioning disc 6-M10	54±6
Reverse gear camshaft 2-M16×1.5	74±7
Secondary box intermediate shaft rear cap 8-M10	54±6
Bottom power takeoff cap 8-M12	78±10
Intermediate shaft brake 8-M10	54±6
Transmission side window cap 6-M10	28±3
Main shaft rear bearing cap 6-M10	54±6
Gearshift cylinder housing 4-M10	54±6
Cylinder head 4-M10	54±6
Clutch housing bottom cap 4-M8	24±4
Intermediate shaft 2-M16×1.5	142±22
Flange nut	643±34



TRANSMISSION (9JS180)

SERVICE DATA

Item		Parameter
Torque		1,800N.m
Power output		331 kw
Rated speed		2600 rpm
Speed ratio	1 st gear	8.08
	2 nd gear	5.93
	3 rd gear	4.42
	4 th gear	3.36
	5 th gear	2.41
	6 th gear	1.76
	7 th gear	1.32
	8 th gear	1
	9 th gear	12.11
	Climbing gear	12.66
	Reverse gear	13.22
Weight		300 kg
Refilling capacity		13 L
2nd shaft low gear axial clearance		0.13~0.3mm
2nd shaft reverse gear axial clearance		0.13~0.3mm
2nd shaft 2nd gear axial clearance		0.13~0.3mm
2nd shaft 3rd gear axial clearance		0.13~0.3mm
Clearance between reverse gear and drive gear		0.3~0.9mm

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Clutch housing 6-M16×1.5	257±13
Clutch housing 4-M12	122±14
1st shaft bearing cap 6-M10	54±7
1st shaft gear M54×1.5 - Left	372±34
Double H control device 8-M10×1	54±7
Upper cap 16-M10	54±7
Fork lock screw 5-M12~1.2S	78±10
Secondary box fork 2-M12×1.5	78±10
Air cleaner bracket 2-M6	17±3



FOTON

03-28**SERVICE SPECIFICATION-TRANSMISSION (9JS180)**

Output shaft M50×1.5	643±34
Secondary box rear cap 19--M10	54±7
Oil drainage port Z3 /4"	68±7
Oil filler port 21	91±10
Secondary box drive gear positioning disc 6-M10	54±7
Reverse gear camshaft 2-M16×1.5	74±7
Secondary box intermediate shaft rear cap 8-M10	54±7
Intermediate shaft brake 8-M10	54±7
Transmission side window cap 6-M10	28±3
Main shaft rear bearing cap 6-M10	54±7
Gearshift cylinder housing 4-M10	54±7
Cylinder head 4-M10	54±7
Clutch housing bottom cap 4-M8	23.5±6.5
Intermediate shaft 2-M16×1.5	142±20



CLUTCH

SERVICE DATA

Item	Parameter
Clutch type	GF430
Clutch driven plate outside diameter (mm)	430
Maximum transmission torque (N.m)	2000
Number of driven plate	1
Pressing force of pressure plate	22500±1800
Friction area (cm)	2010
Release force (N)	7800
Overall thickness of driven plate (mm)	10±0.3
Thickness of release ring (mm)	9
Clutch control mechanism	Hydraulically controlled and pneumatically assisted
Clutch housing type	SAE1
Driven plate radial run-out (mm)	0.5

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Clutch oil cup fixing nut	12
Clutch master pump fixing bolt	64
Clutch master pump thrust rod fixing bolt	28
Connecting bolt between clutch bracket and compartment	28
Connecting bolt between clutch bracket and instrument console beam	28
Clutch bracket bottom connecting bolt	12
Clutch branch pump fixing bolt	28
Clutch pressure plate fixing bolt	28
Clutch fork support shaft fixing nut	160



DRIVE SHAFT

SERVICE DATA

Item		Parameter
Drive shaft type		Column type, with roller bearing constant angular speed crossing shaft universal joint
Outside diameter (mm)		Allowable max operation torque
Flange outside diameter 150		6200
Flange outside diameter 165		7000~15000
Flange outside diameter 180		17000
Modulus of drive shaft telescopic sleeve spline		2.5
Maximum angle of universal joint		35°
Drive shaft radial run-out (mm)	Standard value	0.6
	Limit value	1
Rolling spline fit clearance (mm)	Standard value	0.02~0.01
	Limit value	0.3
Universal joint and needle bearing clearance (mm)	Standard value	0.02~0.09
	Limit value	0.15
Wearing of crossing shaft diameter (mm)	Standard value	0.01
	Limit value	0.03
Intermediate support shaft axial clearance (mm)	Standard value	0.5
	Limit value	
Drive shaft sleeve diameter (mm)		89
		92
		104
		100
		110
		120
		140



SERVICE SPECIFICATION-DRIVE SHAFT

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Wall thickness of shaft tube (mm)	2.5
	5
	6

03

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Connecting bolt between transmission output flange and intermediate drive shaft	198±20
Connecting bolt between intermediate drive shaft and intermediate axle input flange	198±20
Connecting bolt between intermediate axle output flange and inter-axle drive shaft	Selecting contrary gear 198±20 and not reflecting 215±25
Connecting bolt between inter-axle drive shaft and rear axle flange	Selecting contrary gear 198±20 and not reflecting 215±25



FOTON

STEERING WHEEL AND STEERING COLUMN

SERVICE DATA

Item	Parameter
Steering wheel	
Diameter	480mm
Free travel	5°
Number of turns	2.5 turns in both left and right directions
Front and rear adjustable angle	±5°
Up and down adjustable height	20mm
Steering force	<32N
Steering Column	
Steering shaft linearity	0.5mm
Crossing shaft and shaft diameter gap	≤ 0.1mm
Crossing shaft specification (Diameter × length)	φ19x48

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Steering wheel fixing nut	70±10
Steering column fixing bolt	23±2
Connecting bolt between steering drive shaft and steering gear shaft	60±10
Ignition switch fixing bolt	10±1
Pipe protector fixing bolt	10±1



POWER STEERING MECHANISM

SERVICE DATA

Item	Parameter
Steering fluid	
Model	ATF-III
Steering fluid capacity	3.5L
Working temperature	-40~120°
Level raise Engine idling → stop	1~2mm
Steering oil pump	
Working pressure	170 bar
Steering gear	
Holding time of steering wheel at limit position	<5s
Number of screw rotation turns	6.68
Working pressure	150bar
Spiral direction of circulating raceway	Left
Diameter of circulating ball	8
Number of circulating ball	29
Diameter of circulating pair	38.1

03

REQUIRED TIGHTENING TORQUE

Item	N.m
Steering oil pump fixing bolt	23±2
High pressure oil tank connecting nut	120±10
Steering gear fixing bolt	565±15
Steering gear bracket fixing bolt	325±25
Steering gear oil return pipe (low pressure oil pipe) connecting nut	120±10
Connecting bolt between steering gear and steering drive shaft	60±10
Steering oil tank fixing bolt	23±2
Oil pipe clamp fixing bolt	23±2



HEATER AND AIR CONDITIONER

SERVICE DATA

Refrigerant pressure		Pressure value
Low pressure side	Idling	0.2~0.4MPa
High pressure side	Idling	1.6~2MPa

03

Replacement of pipes of entire system	750ml
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Refrigerant	Refilling capacity
R-134a	400 g

REQUIRED TIGHTENING TORQUE

Fastener	N.m
High pressure refrigerant pipe	22
Low pressure refrigerant pipe	31
Refrigerator × refrigerant pipe	10



SEAT BELT

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Seat belt retractor assembly	60
Seat belt	60
Driver seat buckle assembly	60
Middle seat buckle assembly	60
Passenger seat and middle seat buckle assembly	60

03



BATTERY

SERVICE DATA

03

Weather condition	Electrolyte specific gravity for fully charged battery at 15°C	
	Winter	Summer
Region with temperature lower than -40°C in winter	1.31	1.27
Region with temperature more than -40°C in winter	1.29	1.25
Region with temperature more than -30°C in winter	1.28	1.25
Region with temperature more than -20°C in winter	1.27	1.24
Region with temperature more than 0°C in winter	1.24	1.24

Discharge Level	Fully charged		25%		50%		75%		100%	
Specific gravity and freezing point of electrolyte	Specific Gravity	Freezing point	Specific Gravity	Freezing point	Specific Gravity	Freezing point	Specific Gravity	Freezing point	Specific Gravity	Freezing point
	15 °C	0 °C	15 °C	0 °C	15 °C	0 °C	15 °C	0 °C	15 °C	0 °C
	1.31	-76	1.27	-58	1.23	-36	1.19	-22	1.15	-14
	1.29	-70	1.25	-50	1.21	-28	1.17	-18	1.13	-10
	1.28	-69	1.24	-42	1.2	-25	1.16	-16	1.12	-9
	1.27	-58	1.23	-36	1.19	-22	1.15	-14	1.11	-8
	1.25	-50	1.21	-28	1.17	-18	1.13	-10	1.09	-6
	1.24	-42	1.2	-25	1.16	-16	1.12	-9	1.08	-5

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Battery switch fixing bolt	20
Battery switch × cable	20
Battery × cable	20



LIGHTING

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Front combination lamp fixing bolt	63
Interior lamp fixing bolt	23
Rear combination lamp assembly fixing nut	63

03



WIPER AND WASHER

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Linkage mechanism fixing bolt	23
Wiper motor fixing nut	63
Wiper motor × linkage mechanism	63
Washer fixing bolt	23

AUDIO SYSTEM

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Radio/audio player fixing screw	7



HORN

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Horn fixing bolt	23

GLASS LIFTER AND REAR VIEW MIRROR

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Door guide rail fixing bolt	9
Glass lifter fixing bolt	9
Rear view mirror hexagon socket head fixing screw	20
Front lower view mirror fixing bolt	20
Side lower view mirror fixing nut	24



03-42 SERVICE SPECIFICATION-INSTRUMENT CONSOLE, INSTRUMENTS, AND CIGARETTE LIGHTER

INSTRUMENT CONSOLE, INSTRUMENTS, AND CIGARETTE LIGHTER

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Instrument panel subassembly fixing bolt	40
Front pillar armrest fixing bolt	8

SEATS

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Driver seat fixing bolt and nut	40
Secondary driver seat fixing bolt and nut	40
Middle seat fixing bolt and nut	20
Angle adjuster assembly fixing bolt	63
Driver seat slideway assembly fixing nut	63
High top sleeper and sleeper air spring fixing nut	20
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Fixing bolt of driver cab wall sleeper hook	20



DOOR LOCK AND HANDLE

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Front door hinge fixing bolt	30

INTERIOR AND EXTERIOR TRIMS

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Front bumper support pipe fixing bolt	100
Front bumper fixing bolt	40
Front bumper × front crash beam	100
Front bumper × headlamp fixing bracket	40
Front tilting cover hinge fixing bolt	40
Left guard railing fixing bolt	97
Right guard railing fixing bolt	97

03

**FOTON**

DRIVER CAB

REQUIRED TIGHTENING TORQUE

Fastener	N.m
Front fixing seat fixing bolt	97
Gearshift lever lubricating oil pipe fixing bracket bolt	25
Master fuse case fixing bolt	25
Front cover harness fixing bolt	25
Front cover harness cover bolt	25



TRACTION SADDLE

REQUIRED TIGHTENING TORQUE

Fastener	N.m
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STARTING AND PREHEATING SYSTEM

PRECAUTIONS

1. Starter running time should be no more than 5 s; if several times of starting is necessary, starting interval should be over 10 s.
2. Perform the first time of motor maintenance after vehicle running 50,000 ~ 80,000 km, with dirt removed and lubricating oil changed.
3. Perform the second time of motor maintenance after vehicle running 40,000 ~ 50,000 km; during maintenance, please check the wear condition of carbon brush. In case of excess wear, please replace it. If the motor rotor and carbon brush are not replaced or cleaned timely, the contact surface shall be damaged easily, leading to the replacement of motor.
4. The carbon brush shall approach to the limit after the vehicle running about 100,000 ~ 150,000 km. If the vehicle is mostly applied to short distance running and more starting times are necessary, the motor shall be maintained before the vehicle running 80,000 km; if it is mostly applied to long distance running and less starting times are necessary, the motor can be maintained after the vehicle running 80,000 km.
5. Frequent maintenance and lubrication for starter can reduce the load and current consumption, so little damage shall be caused.

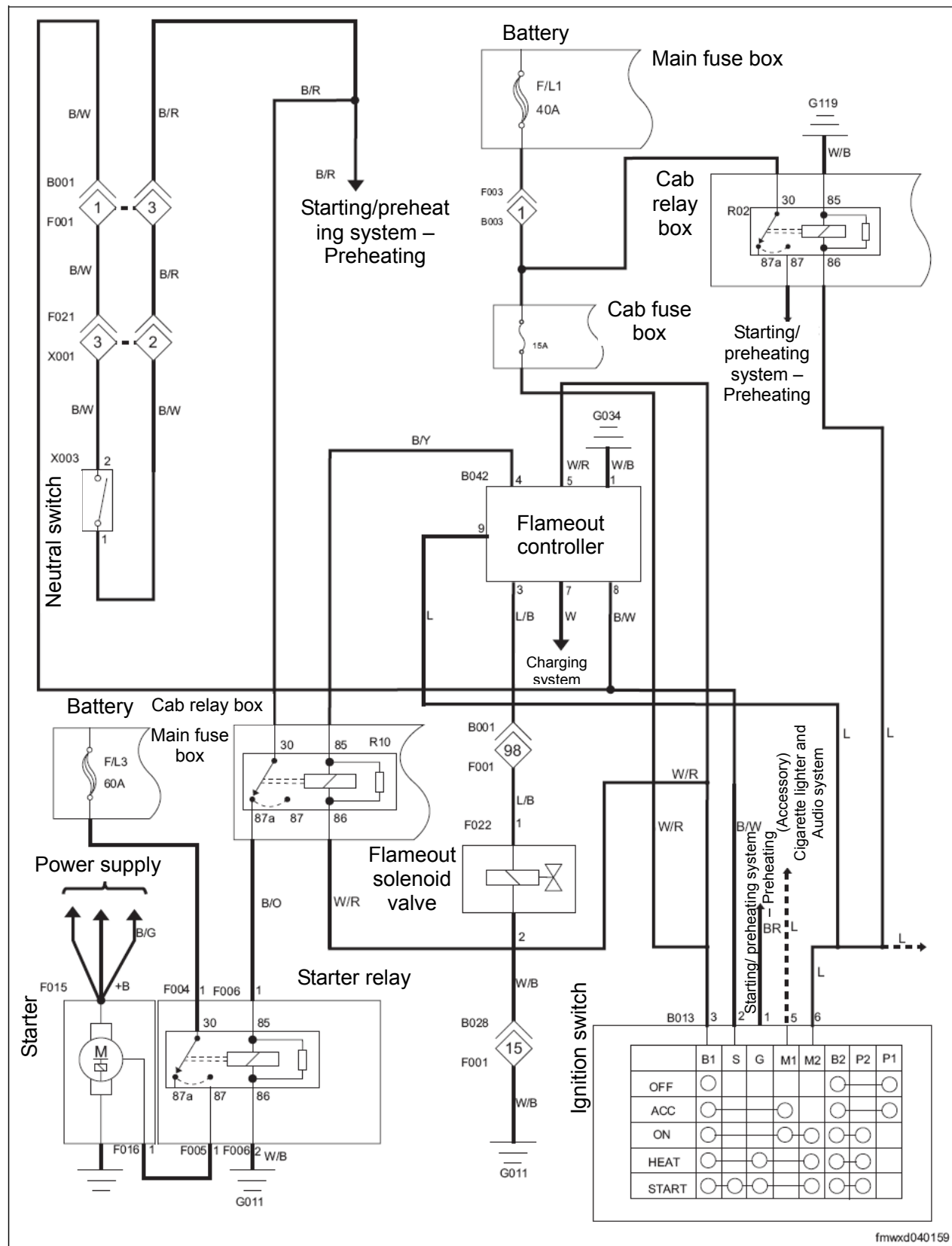
BASIC INSPECTION

Step	Inspection Item		Solution
1	Check battery voltage. • The battery voltage should be no less than 22V. Is the inspection result normal?	Yes	Go to Step 2.
		No	Refer to Table of Fault Phenomena.
2	Check the ignition switch. • Check the ignition switch for normal operation. Is the inspection result normal?	Yes	Go to Step 3.
		No	Refer to Table of Fault Phenomena.
3	Check neutral switch. • Check neutral switch for normal operation. Is the inspection result normal?	Yes	Go to Step 4.
		No	Refer to Table of Fault Phenomena.
4	Check engine flameout solenoid valve. • Check engine flameout solenoid valve for normal operation. Is the inspection result normal?	Yes	Go to Step 5.
		No	Refer to Table of Fault Phenomena.
5	Check engine auxiliary start switch. • Check engine start switch for normal operation. Is the inspection result normal?	Yes	Go to Step 6.
		No	Refer to Table of Fault Phenomena.
6	Check starting system circuit/ relay/ fuse. • Check starting system circuit/relay/fuse for normal operation. Is the inspection result normal?	Yes	Go to Step 7.
		No	Refer to Table of Fault Phenomena.
7	Check engine machinery. • Engine crankshaft is able to rotate. Is the inspection result normal?	Yes	Replace starter.
		No	Refer to Table of Fault Phenomena.

TABLE OF FAULT PHENOMENA

Fault Phenomena	Possible Cause	Solution
Starter failed to stop	1. Ignition switch (damaged)	Refer to Chapter 18 Starting and Preheating System - Replacement of Ignition switch.
	2. Relay (damaged)	Replace relay.
	3. Harness (short circuit to power supply)	Repair or replace harness.
Starter failed to start	1. Battery (undervoltage)	Refer to Chapter 53 Battery - Replacement of Battery.
	2. Ignition switch (damaged)	Refer to Chapter 18 Starting and Preheating System - Replacement of Ignition switch
	3. Neutral switch (damaged)	Replace neutral switch.
	4. Fuse (damaged)	Replace fuse.
	5. Harness (open circuit)	Repair or replace harness.
	6. Engine machinery (damaged)	Repair or replace engine machinery.
Starter noise	1. Starter (damaged)	Refer to Chapter 18 Starting and Preheating System - Replacement of Starter.
	2. Flywheel (damaged)	Refer to Chapter 16 Engine Machinery - Replacement of Flywheel and Flywheel Casing.

Circuit Diagram



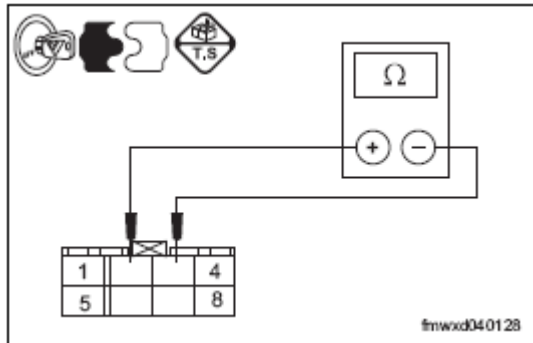
Diagnostic Procedures

Hint:

During conducting troubleshooting for starting and preheating system, please ensure transmission is shifted to Neutral position.

1. Check the ignition switch.

- (a). Shut off main power.
- (b). Remove ignition switch connector B013.



- (c). Check the ignition switch.

Standard value:

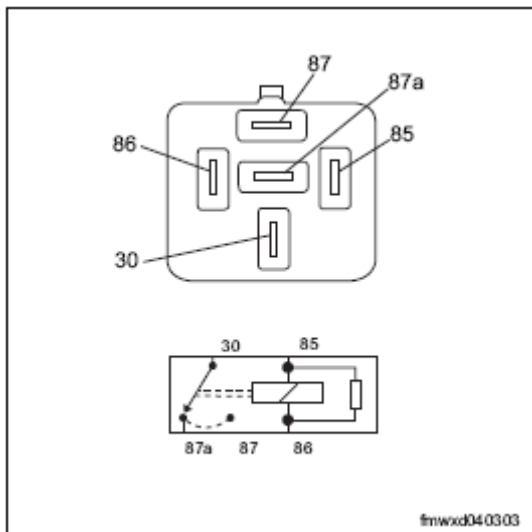
Condition	Multimeter Pin	Standard Value
Ignition switch turned to OFF	2-3	$> 10 \text{ M}\Omega$
Ignition switch turned to START	2-3	$\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 2.

No > Replace ignition switch.

2. Check start protection relay



- (a). Check relay in cab relay box: R10.

Standard value:

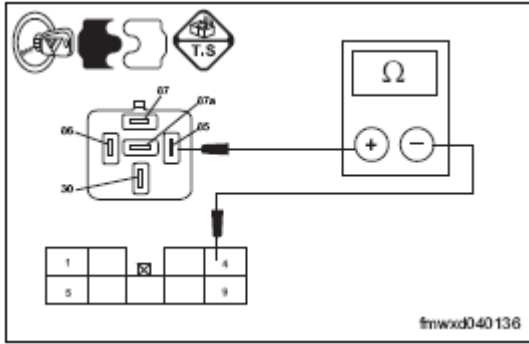
Condition	Multimeter Pin	Standard Value
Constant	85 - 86	Breakover
Power voltage applied between Pin 85 and Pin 86	30 - 87	Breakover
Constant	30 - 87a	Breakover

Is the inspection result normal?

Yes > Go to Step 3.

No > Replace start protection relay.

3. Check circuit between start protection relay and flameout controller.



- (a). Shut off main power.
- (b). Remove flameout controller connector B042.
- (c). Use multimeter to measure the resistance of the harness between Pin 85 of start protection relay R10 and Pin 4 of B042.

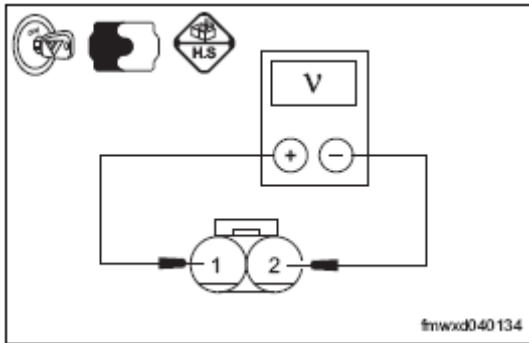
Resistance: $\leq 2\Omega$

Is the inspection result normal?

Yes > Go to Step 4.

No > Repair or replace harness.

4. Check flameout solenoid valve.



- (a). Turn on main power.
- (b). Use multimeter to measure the voltage of the circuit between Pin 1 and 2 of flameout solenoid valve connector F022.

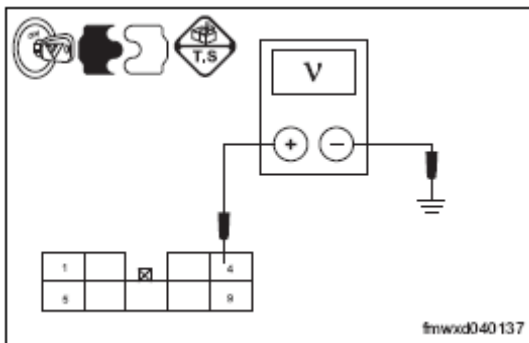
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 5.

No > Repair or replace harness, flameout solenoid valve.

5. Check flameout controller.



- (a). Turn on main power.
- (b). Use multimeter to measure the voltage of the circuit between Pin 4 of flameout controller connector B042 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace starter.

No > Replace flameout controller.

Circuit Diagram



Diagnostic Procedures

Hint:

During conducting troubleshooting for starting and preheating system, please ensure transmission is shifted to Neutral position.

1. Check battery.

- (a). Check battery voltage.

Standard voltage: Not below 22 V

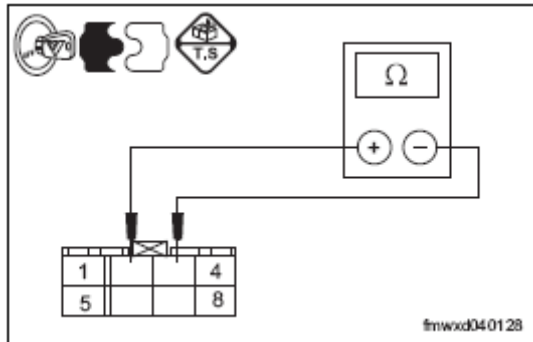
Is the inspection result normal?

Yes > Go to Step 2.

No > Replace battery.

2. Check the ignition switch.

- (a). Shut off main power.
(b). Remove ignition switch connector B013.



- (c). Check the ignition switch.

Standard value:

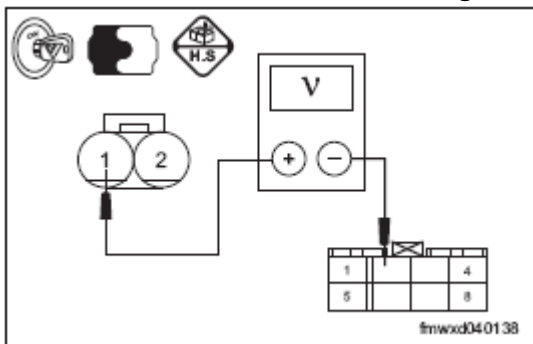
Condition	Multimeter Pin	Standard Value
Ignition switch turned to OFF	2-3	> 10 MΩ
Ignition switch turned to START	2-3	≤ 2 Ω

04

Is the inspection result normal?

Yes > Go to Step 3.

No > Replace ignition switch.

3. Check the circuit between ignition switch and neutral switch.

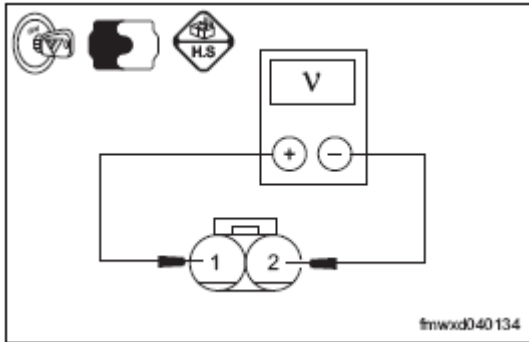
- (a). Turn on main power.
(b). With ignition switch placed at START, use multimeter to measure the voltage of the circuit between Pin 2 of ignition switch connector B013 and Pin 1 of neutral switch connector X003.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes> Go to Step 4.

No > Repair or replace harness.

4. Check neutral switch.

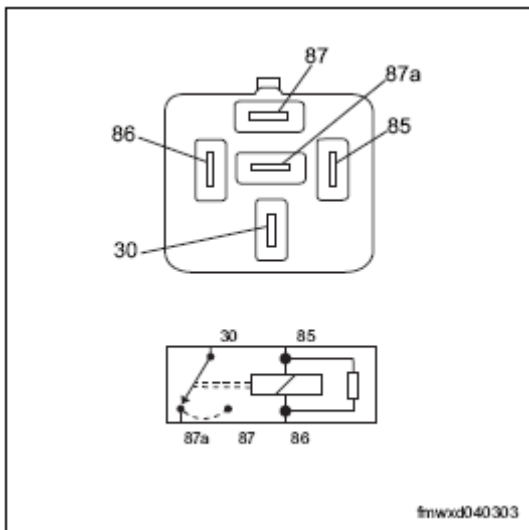
- (a). Turn on main power.
- (b). With ignition switch placed at START, use multimeter to measure the voltage of the circuit between Pin 1 and Pin 2 of neutral switch connector X003.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 5.

No > Replace neutral switch.

5. Check start protection relay.

- (a). Check relay in cab relay box: R10.

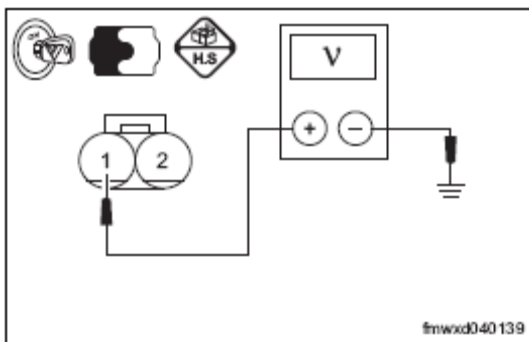
Standard value:

Condition	Multimeter Pin	Standard Value
Constant	85 -86	Breakover
Power voltage applied between Pin 85 and Pin 86	30 -87	Breakover
Constant	30 -87a	Breakover

Is the inspection result normal?

Yes > Go to Step 6.

No > Replace start protection relay.

6. Check starter control circuit.

- (a). With ignition switch placed at START, use multimeter to measure the voltage of the circuit between Pin 1 of starter connector F006 and ground point G011.

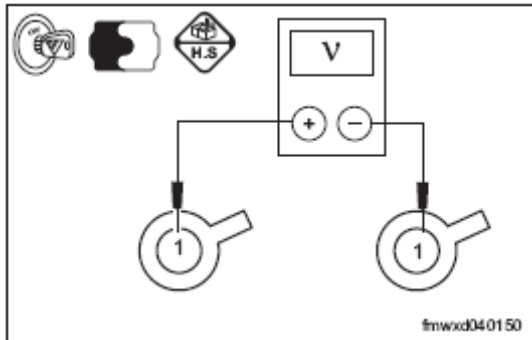
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 7.

No > Replace starter relay

7. Check starter relay power circuit.



- (a). With ignition switch placed at START, use multimeter to measure the voltage of the circuit between Pin 1 of starter connector F004 and Pin 1 of connector F005.

Standard voltage: Battery voltage

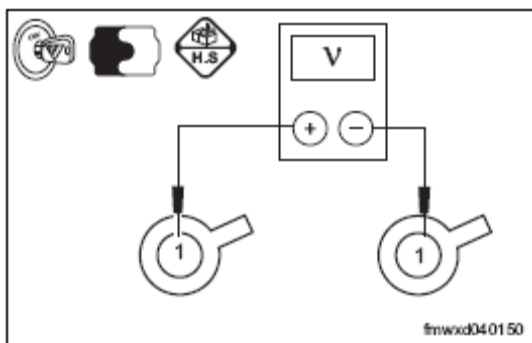
Is the inspection result normal?

Yes > Go to Step 8.

No > Repair or replace harness.

8. Check circuit between starter relay and starter electromagnetic clutch.

- (a). Shut off main power.



- (b). Use multimeter to measure the resistance of the circuit between Pin 1 of starter connector F005 and Pin 1 of starter electromagnetic clutch connector F016.

Resistance: $\leq 2\Omega$

Is the inspection result normal?

Yes > Go to Step 9.

No > Repair or replace harness.

9. Check circuit between starter and battery.

- (a). Use multimeter to measure the voltage of the circuit between starter terminal and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

04-16

DIAGNOSIS-STARTING AND PREHEATING SYSTEM

Yes > Go to Step 10.

No > Repair or replace harness.

10. Check engine machinery.

(a). Rotate crankshaft to check if it is able to rotate within effective torque.

Is the inspection result normal?

Yes > Replace starter assembly.

No > Repair faulty engine machinery.

STARTER NOISE

Diagnostic Procedures

1. With the engine started, check starting motor for normal operation.

- (a). With starter still engaged after engine start, check it for any loud “wheeze”(if the engine speed increases with the starter still engaged, it is sound like whistle).

Is the inspection result same as the above-mentioned?

Yes > Check flywheel ring gear for failures, such as crack, missing, wear or damage of gear tooth, flywheel bending. Replace flywheel when necessary.

No > Go to Step 2.

- 2. When the starter stops gradually after engine start, there is “rumble” or “roar” or “knock” under some condition.**

Is the inspection result same as the above-mentioned?

Yes > Go to Step 4.

No > Go to Step 3.

- 3. After engine crankshaft rotates and engine starts normally, is there any high-frequency whining sound?**

Is the inspection result same as the above-mentioned?

Yes > Replace starter.

No > Go to Step 4.

4. Service starter.

- (a). Check starter shaft sleeve for any wear and check clutch gear for crack or wear.

Yes > Replace starter motor.

No > Replace flywheel.



CHARGING SYSTEM

PRECAUTIONS

Alternator and governor are of simple structure that can be maintained easily. The correct operation may reduce fault probability and also extend service life, while improper operation may result in damage. Therefore, the following points should be observed during operation and maintenance.

1. **Battery should be grounded at negative pole. If it is reversed, the electronic elements of alternator or governor shall be burnt out.**
2. **Alternator and battery should be firmly connected, for accidental disconnection may cause damage of electronic elements of alternator or governor due to generation of overvoltage.**
3. **During alternator operation, it is prohibited to use fire trail method to check if the alternator operates normally; otherwise, the rectifier diode may be burnt out.**
4. **Please conduct service and troubleshooting once fault of alternator or governor is discovered; otherwise, more serious fault or battery power-lack may be caused, resulting in vehicle unable to run.**
5. **When install governor to match with alternator, their voltage degree and ground type should be the same and the power of governor should be no less than that of alternator; otherwise, the system may be unable to operate normally.**
6. **Circuit should be correctly connected. At present, different vehicle models are equipped with governors of different mounting positions and wiring types, so please be especially carefully during wiring.**
7. **Governor must be controlled by ignition switch. The ignition switch should be turned off when the alternator stops operation; otherwise, the field circuit of alternator is always ON, resulting in burnout of field coil and battery power-lack.**
8. **When the faulty alternator or governor should be removed from vehicle for service, please turn off ignition switch and all electrical equipments first, and then remove the negative cable of battery and then remove wire connector from alternator.**
9. **Warning:**
Batteries should be placed in areas that children can not reach. Batteries contain sulfuric acid, so please avoid contact with skin, eyes, or clothing. When working near the battery, please wear goggles to prevent acid dissolved liquid from being splashed into eyes. In case of any acid dissolved splashed onto skin or into eyes, rinse them immediately with fresh water for at least 15 min and then see a doctor right away. If one ingests the acid dissolved liquid, please send him/her to hospital immediately. Failure to follow these instructions shall cause serious injury or even death
10. **Warning:**
Batteries usually may produce explosive gases that leading to casualties. Therefore, do not let flame, spark or combustible material close to battery. During charging or operating close to the battery, please wear protective mask to protect face and eyes. Batteries should be kept in the well-ventilated position. Failure to follow these instructions may cause serious injury or even death.

-
11. **Warning:**
Please follow the operation instructions of relevant manufacturers when using any charging equipment. Failure to follow these instructions may cause serious injury or even death.
12. **Warning:**
Don't turn on the switch before connecting the charger to battery. Failure to follow these instructions may cause serious injury or even death.
Warning:
Please turn off the switch before disconnecting the charger from battery. Failure to follow these instructions may cause serious injury or even death.
13. **Attention:**
Don't place batteries inside vehicle for charging.
14. **Attention:**
Don't charge the fully discharged battery by relying on alternator, because the battery can only be fully charged after 8h continuous running of vehicle under no load condition of charging system.

04-BASIC INSPECTION

Step	Inspection Item		Solution
1	Battery appearance inspection. Battery surface free from leak trace, battery case free from crack or damage, electrode free from corrosion, electrode wiring reliably connected. Is the inspection result normal?	Yes	Go to Step 2.
		No	Refer to Table of Fault Phenomena.
2	Check with discharge detector. With relevant contacts pressed closely against positive and negative poles of battery, when the pointer of discharge detector is within green range and hold in this range for 2s, it is indicated that the battery has sufficient capacity for large current starting; when it is within red range and no other abnormality is detected, it is indicated that there is insufficient battery capacity and charging is required. Is the inspection result normal?	Yes	Go to Step 3.
		No	Refer to Table of Fault Phenomena.
3	Use voltmeter to check by using headlamps as load. Connect the voltmeter to battery by the method of measuring battery voltage and read out battery voltage; with headlamps turned on, if the voltage doesn't decrease rapidly and is hold above 22V, you can start vehicle after the battery is properly charged. If the voltage decreases rapidly, you should conduct charging to make the battery recover. As for battery that is unapplied for a long time, please extend charging time properly and conduct several times of charging and discharging to make it fully activated. Is the inspection result normal? Attention: It is inapplicable to use discharge detector to check the battery under charging or discharging status or right after being charged, because abundant oxyhydrogen is generated in the course of charging and the use of discharge detector for inspection may create sparks resulting in gas explosion, which may cause damage and personal injury.	Yes	Go to Step 4.
		No	Refer to Table of Fault Phenomena.



4	Alternator no-load test 1. Install the alternator onto the fixture of test bench, select proper sleeve and rubber connector, as well as adjust the fixture position to make the alternator is concentric with governor motor spindle on test bench. 2. Check for correct wiring and start the governor motor if it is correct. 3. Start the governor motor and the alternator exciting current is supplied by battery (or power supply on test bench). Increase motor speed gradually. The external power supply stop supplying exciting current when the motor speed is up to 500 ~ 800 r/min and the alternator should start self-excited power generation. 4. Continue to increase speed and observe voltmeter reading. • Record the alternator speed when the voltage reaches to the rated value. Turn off governor motor switch and the no-load test is finished. 5. Make analysis on no-load test data. • Compared with standard value, if the alternator speed is above no-load speed, it is indicated alternator failure; therefore, please disassemble and check the alternator. In case of no failure, start to conduct load test. Is the inspection result normal?	Yes	Go to Step 5.
		No	Refer to Table of Fault Phenomena.
5	Alternator load test 1. Adjust the rheostat to the maximum resistance position. 2. Start governor motor to make the alternator voltage reach to the rated value. 3. Maintain the voltage stable and increase alternator speed and output current to make speed reach to the rated value. At this time, record the output current. Turn off governor motor switch and the load test is finished. 4. Make analysis on load test data. • Compared with standard value, if the output current reaches to the rated value, it is indicated alternator is normal; otherwise, it has failure; therefore, please disassemble and check the alternator. Is the inspection result normal?	Yes	Refer to Table of Fault Phenomena.
		No	Refer to Chapter 19 Charging System - Service of Alternator to conduct repair or replacement.

TABLE OF FAULT PHENOMENA

Please refer to the following table for troubleshooting. The serial numbers indicate the order of fault possibility. Please check relevant parts in the order and conduct replacement when necessary.

Fault Phenomena	Possible Cause	Solution
Charging indicator always ON	Alternator belt (loosened)	Refer to Chapter 19 Charging System - Inspection and Adjustment of Charging System.
	Alternator governor (damaged)	Replace governor.
	Alternator (damaged)	Refer to Chapter 19 Charging System - Service of Alternator.
	Combination instrument (damaged)	Refer to Chapter 73 Instrument Panel and Cigarette Lighter - Replacement of Combination Instrument.
	Damage or poor contact of harness	Repair or replace harness, ammeter.
Battery undercharge	Alternator belt (loosened)	Refer to Chapter 19 Charging System - Inspection and Adjustment of Charging System.
	Alternator (damaged)	Refer to Chapter 19 Charging System - Service of Alternator.
	Alternator fuse (damaged)	Replace fuse.
	Battery (damaged)	Refer to Chapter 53 Battery - Replacement of Battery.
	Damage or poor contact of harness	Repair or replace harness, ammeter.
Battery overcharge	Alternator governor (damaged)	Replace alternator.
Charging current unstable	Alternator drive belt loosened	Refer to Chapter 19 Charging System - Inspection and Adjustment of Charging System.
	Stator coil nearly short circuit or open	Refer to Chapter 19 Charging System - Service of Alternator.
	Poor contact of harness terminal	Repair.
	Alternator governor (damaged)	Replace alternator.
	Governor terminal unconnected or loosened	Repair.
Abnormal noise generated in alternator	Belt loosened	Refer to Chapter 19 Charging System - Inspection and Adjustment of Charging System.
	Bearing damage	Refer to Chapter 19 Charging System - Service of Alternator.
	Rotor core contacted with stator core	Refer to Chapter 19 Charging System - Service of Alternator.
	Diode damage	Repair or replace.
	Stator coil nearly short circuit or open circuit	Refer to Chapter 19 Charging System - Service of Alternator.



DIAGNOSIS-CHARGING SYSTEM

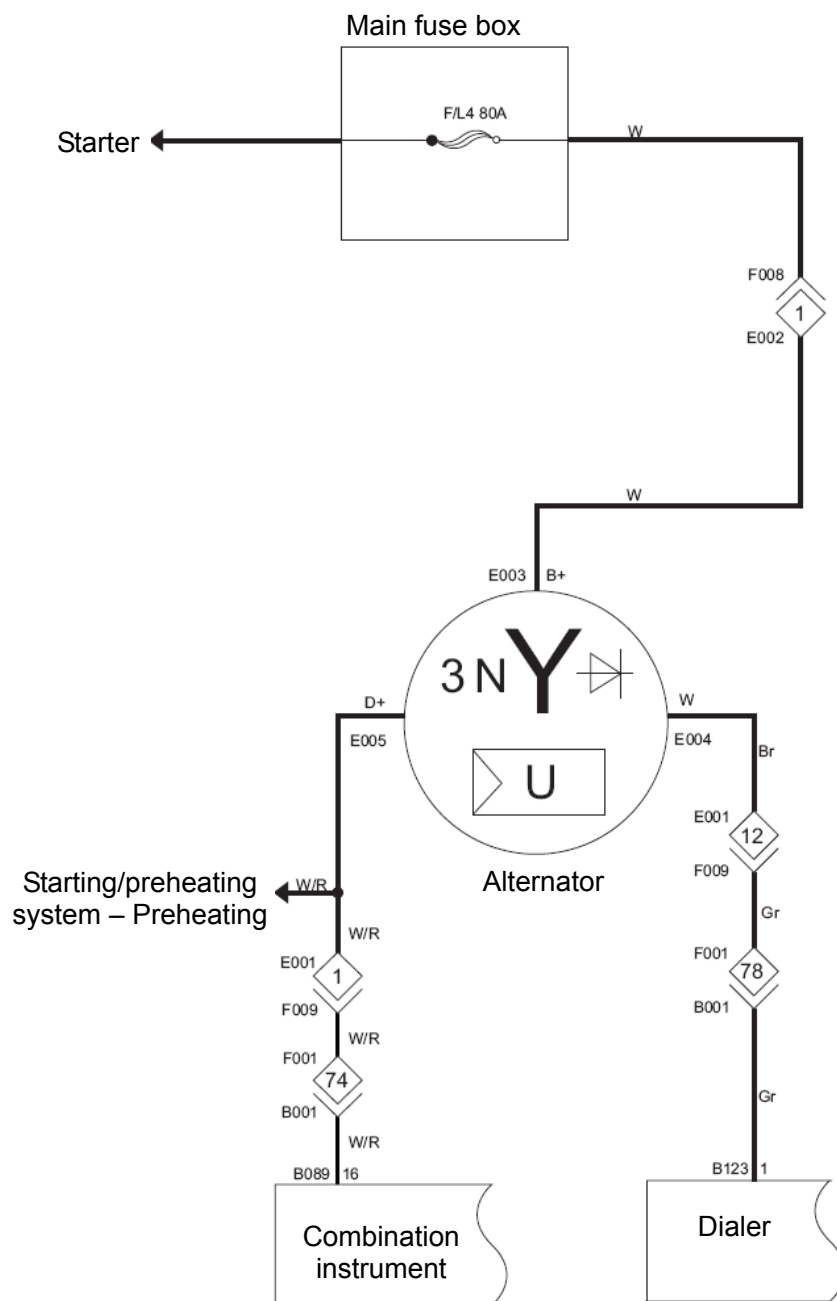
04-23

Fault Phenomena	Possible Cause	Solution
Battery discharge current, parasitic load	Battery (damaged)	Refer to Chapter 53 Battery - Replacement of Battery.
	Electrical equipment (discharged)	Repair or replace relevant electrical equipments.
	Harness (internal friction)	Repair or replace harness.



CHARGING INDICATOR ALWAYS ON

Circuit Diagram



fmwxw040135



Diagnostic Procedures**1. Check alternator capacity.**

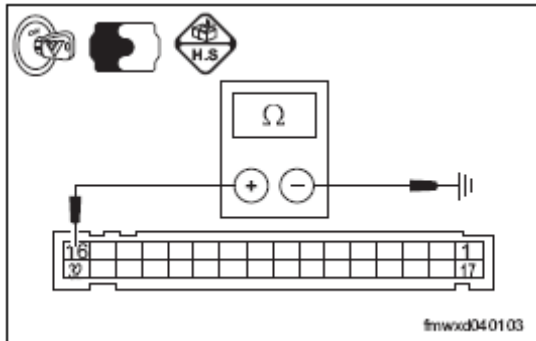
- (a). Start alternator.
- (b). Use multimeter to measure the voltage of the circuit between alternator connector E003 and the effective ground point of body.

Standard voltage: 27 ~ 29 V**Is the inspection result normal?****Yes > Go to Step 2.****No > Adjust alternator belt pretension and replace alternator.****2. Charging indicator emergency test**

- (a). Shut down engine.
- (b). Disconnect connection between alternator connector E005 and alternator.
- (c). Start engine to check if the charging indicator in combination instrument is always on.

Is the inspection result normal?**Yes > Go to Step 3.****No > Replace alternator.****3. Check harness.**

- (a). Shut down engine.
- (b). Remove combination instrument connector B089.



- (c). Use multimeter to measure the resistance of the circuit between Pin 16 of combination instrument connector B089 and the effective ground point of body.

Resistance: $\geq 10\text{ M}\Omega$ **Is the inspection result normal?****Yes > Replace combination instrument.****No > Repair or replace harness.**

BATTERY UNDERCHARGE

Circuit Diagram

Please refer to "Charging Indicator Always ON- Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check alternator capacity

- (a). Start alternator.
- (b). Use multimeter to measure the voltage of the circuit between alternator connector E003 and the effective ground point of body.

Standard voltage: 27 ~ 29 V

Is the inspection result normal?

Yes > Go to Step 2.

No > Replace alternator.

2. Check voltage at both terminals of battery

- (a). Use multimeter to check voltage at both terminals of battery.

Standard voltage: 27 ~ 29 V

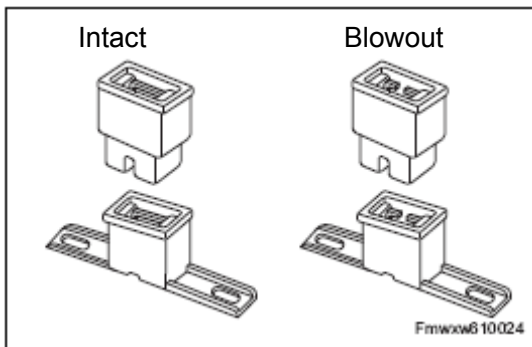
Is the inspection result normal?

Yes > Go to Step 3.

No > Replace battery.

3. Check alternator fuse.

- (a). Shut down engine.
- (b). Shut off main power.



- (c). Check fuse in front cover fuse box: F/L4 (80 A).

Is the inspection result normal?

Yes > Repair or replace harness.

No > Service charging system circuit and replace fuse of the same rating.

BATTERY OVERCHARGE

Circuit Diagram

Please refer to “Charging Indicator Always ON- Circuit Diagram” in this chapter.

Diagnostic Procedures

1. Check alternator capacity.

- (a). Start engine to let the engine speed increase to 2000 rpm from idling.
- (b). Use multimeter to measure the voltage of the circuit between battery positive cable and the ground.

Is the voltage above 29 V.

Yes > Replace alternator.

No > System is normal.



CHARGING CURRENT UNSTABLE

Circuit Diagram

Please refer to “Charging Indicator Always ON- Circuit Diagram” in this chapter.

Diagnostic Procedures

1. Check alternator capacity.

- (a). Start alternator.
- (b). Use multimeter to measure the voltage of the circuit between alternator connector E003 and the effective ground point of body.

Standard voltage: 27 ~ 29 V

Is the inspection result normal?

Yes > Repair or replace harness.

No > Adjust alternator belt tension or replace alternator.

ALTERNATOR NOISE

Diagnostic Procedures

1. Check alternator drive belt.

- (a). Check drive belt for teeth missing.

Hint:

Don't start alternator during checking alternator drive belt.

Is the inspection result normal?

Yes > Go to Step 2.

No > Replace drive belt.

2. Check alternator drive belt tension.

- (a). Check alternator drive belt tension.

Hint:

Don't start alternator during checking alternator drive belt tension.

Is the inspection result normal?

Yes > Go to Step 3.

No > Adjust alternator drive belt tension.

3. Check alternator.

- (a). Remove drive belt.
(b). Rotate alternator by hand.

Is there still noise in alternator?

Yes > Replace alternator.

No > Check accessory driving mechanism.



BATTERY DISCHARGE CURRENT, PARASITIC LOAD TEST

Test procedure

In case of continuous power-lack of battery, please conduct the following test procedures and also check battery for any parasitic current.

Attention:

Before conducting this procedure, please check if the vehicle is equipped with any after-sale installed device, such as DVD, amplifier, subwoofer. If any, please disconnect this system and then conduct test.

1. Battery discharge current, parasitic load test

- (a). Disconnect negative cable of battery.
- (b). Make the positive pen of multimeter connected to the negative cable of battery and negative pen connected to the negative pole of battery.
- (c). Ensure all electrical equipments and vehicle doors are closed.
- (d). Switch to mA position of multimeter for current measurement.
- (e). Measure parasitic current.

Standard parasitic current: 10mA~12mA

Is the inspection result normal?

Yes > System is normal.

No > Service electrical equipments and circuits for leakage of electricity.

JUMP STARTING PROCEDURES

Jump procedures

1. Park the vehicle with jump starting power provided properly and use jumper to connect batteries of two vehicles.
2. Turn ignition switches of both vehicle to “OFF” position and turn off headlamps and all accessory power equipments.
3. Press the hazard warning lamp switch to make the lamp lit.
4. Apply parking brakes of both vehicles.
5. Ensure transmissions are shifted to neutral position.

Warning:

The jumper should be intact without any bare wire; otherwise, possible personal injury or vehicle damage may be caused.

6. Connect one terminal of red cable with the positive terminal of battery with sufficient electric quantity and make sure it has no contact with other metal parts.
7. Connect the other terminal of red cable with the positive terminal of battery already discharged. Don't connect the red cable with the negative terminal of discharged battery.

Warning:

Don't connect the jumper directly with the negative terminal of discharged battery, in order to avoid spark generated possibly causing gas explosion.

8. Connect one terminal of black cable with the negative terminal of battery with sufficient electric quantity.
9. Connect the other terminal of black cable with the solid ground point of engine of battery already discharged and it is at least 500 mm distant from battery already discharged.
10. Start the engine of vehicle with its battery of sufficient electric quantity and let it run at medium speed for over 3 min.
11. Start the engine of vehicle equipped with discharged battery.
12. Remove jumper cable in the reverse order.

Attention:

If the other terminal of cable is not disconnected completely during removal, please prevent the cable clip from contacting any metal part.

13. The operation is finished.

ABS SYSTEM

PRECAUTIONS

1. Cut off power supply

- (a). In order to avoid personal injury or vehicle damage, please be sure to disconnect the negative cable of battery before removal/installation of any equipment and under the condition that certain tool or equipment is likely to contact with the bare electrical terminal.

Hint:

Please don't keep the key inside vehicle before disconnecting the negative cable of battery, in order to prevent vehicle doors from being locked.

- (b). Unless otherwise specified, the ignition switch must be turned off.

2. Disconnection of negative cable of battery shall make the odometer and clock reset.

Hint:

Odometer won't be reset.

3. Troubleshooting precautions

- (a). In case of failure of terminal contact or incorrect installation of parts, the removal and reinstallation of suspicious parts may make the system recover to the normal status completely or temporarily.
- (b). In order to determine the faulty part, be sure to check vehicle condition when the fault occurs. For example, check based on output of diagnostic trouble code (DTC) and record relevant data with each connector removed or before removal/installation of each part.
- (c). Unless otherwise specified in inspection procedures, ABS ECU, ABS solenoid valve and each sensor should be removed or installed with ignition switch turned off.
- (d). If ABS ECU, ABS solenoid valve and each sensor are required to be reinstalled, please check the system for normal operation after the installation. Please use special detector to check DTC or read DTC based on blink codes.
- (e). Don't use multimeter directly to measure ABS ECU terminals.

ABS DIAGNOSTIC INSTRUCTION

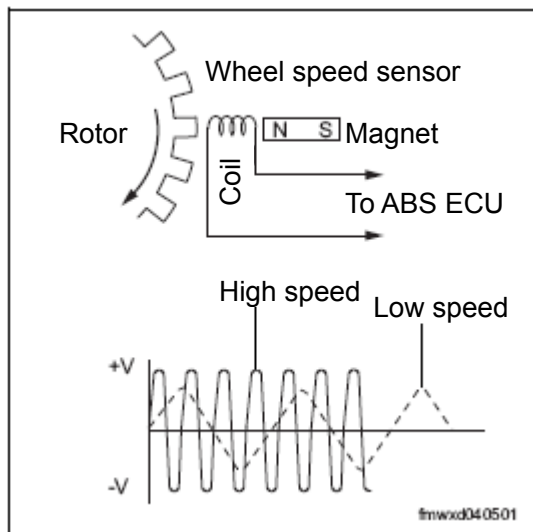
1. When fault cannot be determined based on DTC, please conduct troubleshooting for all relevant circuits that may result in failure.
2. In many cases, ABS system fault is caused by mechanical and gas circuit failure relevant to conventional brake system but not caused by electronic or circuit failure; under these circumstances, the ABS malfunction indicator lamp (MIL) is not lit.
3. The lighting of ABS MIL indicates electrical failure of ABS system generally. In case of any, please go to Foton Special Service Center for maintenance.

ABS MIL Working Status:

Status of Ignition Switch	ABS MIL Status	Explanation
Ignition Switch: ON	OFF after lighting for 3s	ABS system is normal.
	Always ON	The MIL is off when vehicle speed over 7 km/h, indicating ABS system is normal.
		The MIL is still on when vehicle speed over 7 km/h, indicating ABS system failure or MIL circuit failure.
	OFF	Indicate MIL circuit failure or ABS ECU failure.

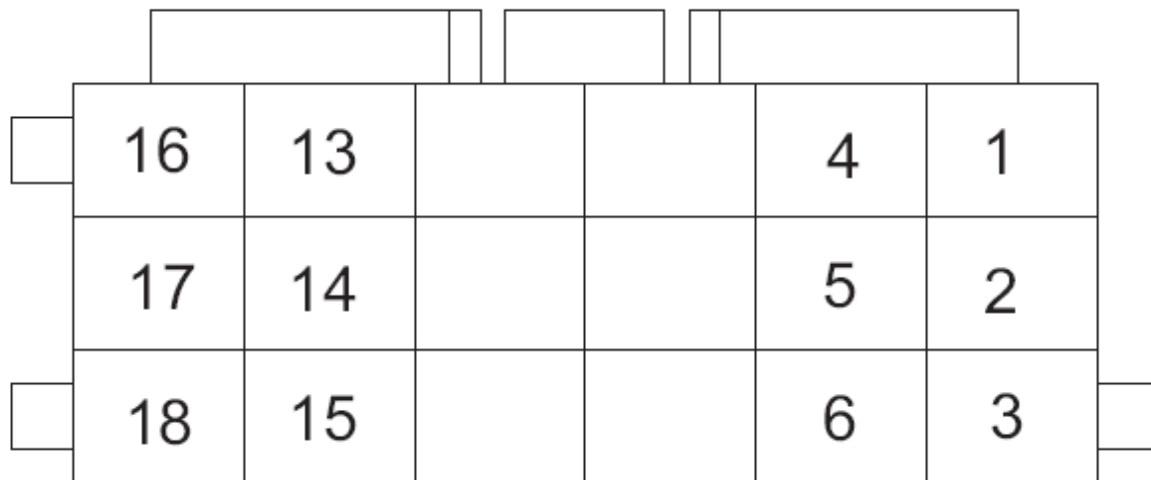
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System Description



1. Wheel speed sensor detects wheel speed and transmits signals that are used for controlling ABS control system to ABS ECU.
2. With the rotation of rotor, the permanent magnet on the speed sensor shall form magnetic field that producing alternating voltage.
3. As the alternating voltage frequency varies in proportion to rotor speed, the frequency is applied by ABS ECU for detecting each wheel speed.

ABS ECU TERMINALS

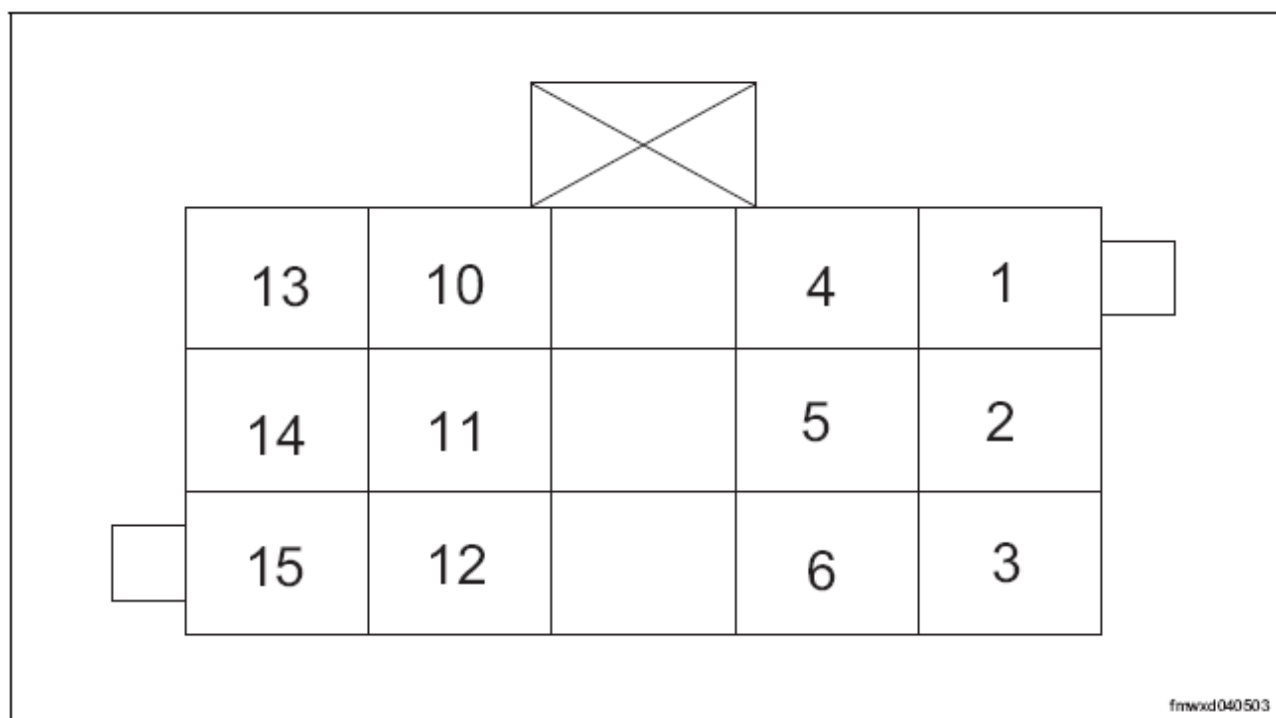


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Pin No.	Wire Color	Function
1	Br	ECU 18-1
2	Br	ECU 18-2
3	Br	ECU 18-3
4	L	ECU 18-4
5	L	ECU 18-5
6	L	ECU 18-6
7	Br	ASR solenoid valve
8	Br	ECU 18-8
9	L	ECU 18-9

Pin No.	Wire Color	Function
10	Br	ECU 18-10
11	Br	ECU 18-11
12	Br	ECU 18-12
13	B	ECU 18-13
14	B	ECU 18-14
15	B	ECU 18-15
16	L	ASR solenoid valve
17	Br	ECU 18-17
18	B	ECU 18-18





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Pin No.	Wire Color	Function
1	G	SAE J1939(B)
2		NC
3	W	SAE J1939(A)
4	W-B	ABS fuse (5A)
5		NC
6	G-L	ECU 14-6
7	R-W	ABS ECU(+)
8	B-Y	ABS ECU (UB)

Pin No.	Wire Color	Function
9	W-B	ABS ECU(0V)
10	Y	ECU 18-8
11	Y-R	ECU 18-9
12		NC
13	G-Y	ASR indicator
14	W-B	ABS ECU(DBR)
15	B-Y	ABS ECU(WL)

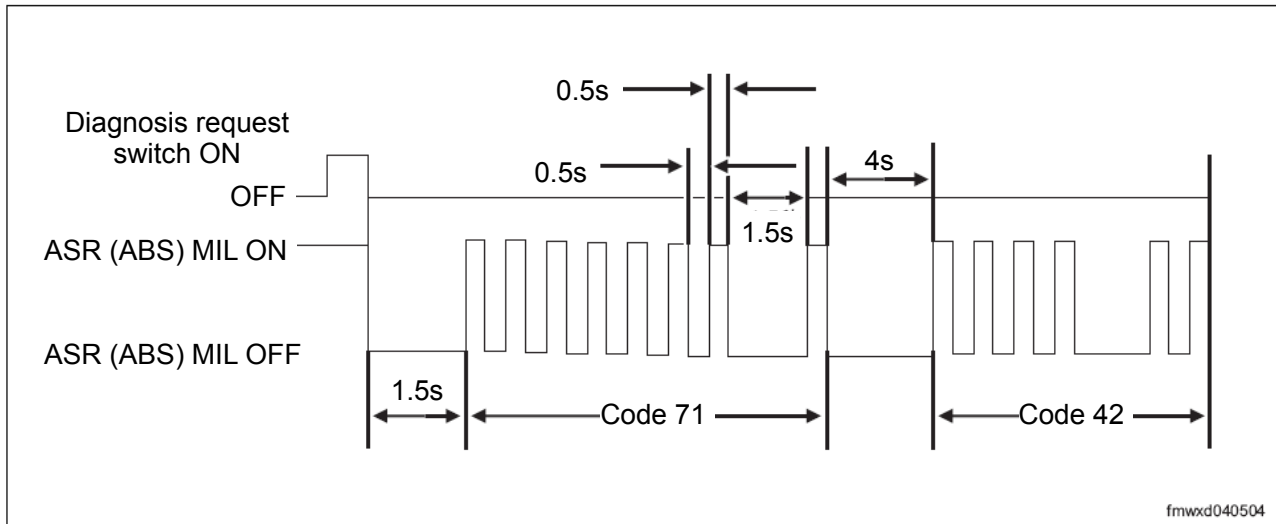
DTC READING/CLEARING

Blink code reading

There are two groups of blink codes: the first group represents failed parts and nature and the second one represents the faulty position. There are 1.5 seconds between the display of two groups of blink code. With ignition key turned on, if ABS MIL is always on, press the blink code switch for 1 second and observe the MIL Blinking times.

In case of two or more faults in ABS system, ABS MIL shows the first group of blink codes and then shows the second group in 4 seconds. The rest can be done in the same manner.

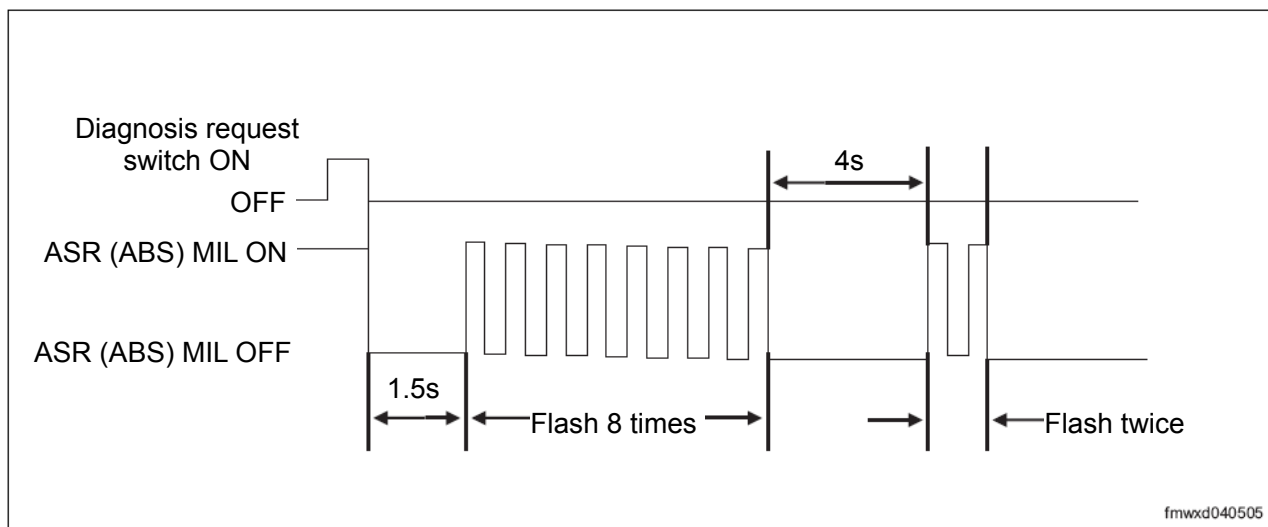
For example: The figure below shows the blinking type of DTC 7-1 and 4-2.



With Blink code switch on (for 1 seconds), MIL blinks repeatedly (which is off only after the switch is off), indicating this or these faults are present and in need of removed through maintenance, which is called “Current DTC”. MIL has another way of display, viz. each blink code presents once in sequence and then warning lamp is off, which is called “Memory DTC”. There are two kinds of “Memory DTC”: One kind refers to the occurred DTC that is removed but not cleared from ECU, the other kind refers to DTC once occurred but already not existed in ECU, such as poor contact of wire. “Memory DTC” only serves as record of once occurred fault, which is of no practical meaning. Therefore, it should be cleared after each time of maintenance.

DTC clearing

With Blink code switch pressed and released in 3 seconds, if MIL blinks 8 times and then twice, it is indicated that all fault memory is cleared and no current fault is existed; if MIL only blinks twice, it is indicated that there are current faults in ABS system in need of troubleshooting.



BASIC INSPECTION

With vehicle parked and ignition switch on, the ABS MIL is lit and you can hear six sounds in total from ABS solenoid valves: the first four sounds from “right front wheel - left rear wheel - left front wheel - right rear wheel”, then one sound from right front wheel and left rear wheel, finally one sound from left front wheel and right rear wheel. The sound type is “tap-tap” indicating solenoid valve actuation. If ABS MIL is off in 3 seconds, it is indicated that ABS system operates normally.

If the ECU is just installed into ABS system or is reinstalled into ABS system after removal, ABS MIL is always lit with the ignition switch turned on and is off when vehicle running speed over 7 km/h, it is indicated that ABS system is also normal.

If ABS MIL is not lit with ignition switch turned on, it is indicated ABS circuit failure or MIL bulb damage. At this time, please check bulb and circuit. If the MIL is always lit, it is indicated that there is one or more faults. At this time, diagnose faulty part and its nature by “blink code inspection method”.

Except for ABS system self-diagnosis, there is a more accurate and detailed diagnosis method. When the vehicle running at speed over 40 km/h on wide and flat hard road surface (asphalt or cement pavement), depress the brake pedal to the end to apply emergency brake and then observe if there is any drag marks on the pavement. If not, the ABS system operates normally. If all wheels or certain wheel has drag mark, it is indicated that ABS for all wheels or certain wheel fails and necessary inspection and maintenance should be conducted.

DTC LIST

Blink code meaning

1st Group of Blink Codes		2nd Group of Blink Codes	
Blinking times	Fault nature	Blinking times	Faulty part
1	No fault	1	No fault
2	ABS solenoid valve fault	1	Right front wheel
3	Excessive clearance of sensor	2	Left front wheel
4	Short or open circuit of sensor	3	Right rear wheel
5	Unstable sensor signal	4	Left rear wheel
6	Gear ring damage	5	Right wheel of the 3rd axle
		6	Left wheel of the 3rd axle
7	System functional fault	1	Data interface fault
		2	ASR differential valve fault
		3	Fault of the 3rd auxiliary brake relay
		4	ABS indicator fault
		5	ASR arrangement fault
		6	ASR proportional valve fault
8	ECU fault	1	Low voltage
		2	High voltage
		3	ECU internal fault
		4	System arrangement fault
		5	Ground fault

04

Fault Blink Code List

Fault Blink Code	Faulty Part and Cause
2-1	Right front wheel solenoid valve fault
2-2	Left front wheel solenoid valve fault
2-3	Right rear wheel solenoid valve fault
2-4	Left rear wheel solenoid valve fault
2-5	3rd axle right wheel solenoid valve fault
2-6	3rd axle left wheel solenoid valve fault
3-1	Excessive clearance, weak signal of right front wheel sensor
3-2	Excessive clearance, weak signal of left front wheel sensor



DIAGNOSIS-ABS SYSTEM

Fault Blink Code	Faulty Part and Cause
3-3	Excessive clearance, weak signal of right rear wheel sensor
3-4	Excessive clearance, weak signal of left rear wheel sensor
3-5	Excessive clearance, weak signal of 3rd axle right wheel sensor
3-6	Excessive clearance, weak signal of 3rd axle left wheel sensor
4-1	Short circuit or open circuit of right front wheel sensor
4-2	Short circuit or open circuit of left front wheel sensor
4-3	Short circuit or open circuit of right rear wheel sensor
4-4	Short circuit or open circuit of left rear wheel sensor
4-5	Short circuit or open circuit of 3rd axle right wheel sensor
4-6	Short circuit or open circuit of 3rd axle left wheel sensor
5-1	Unstable signal of right front wheel sensor
5-2	Unstable signal of left front wheel sensor
5-3	Unstable signal of right rear wheel sensor
5-4	Unstable signal of left rear wheel sensor
6-1	Right front wheel gear ring fault
6-2	Left front wheel gear ring fault
6-3	Right rear wheel gear ring fault
6-4	Left rear wheel gear ring fault
7-1	None or incorrect C3 signal
7-2	Differential brake valve open circuit or short circuit to ground, differential braking failure
7-3	Retarder open circuit or short circuit to ground
7-4	ABS warning lamp failure
7-5	ASR arrangement fault
7-6	Proportional valve short circuit or open circuit
8-1	Low ECU diagonal voltage
8-2	Overvoltage of ECU diagonal 1 or 2, all valves failure
8-3	ECU internal fault
8-4	Incorrect EEPROM wheel parameter
8-5	ECU diagonal 2 short circuit to power supply, diagonal ground wire open circuit or short circuit, ABS failure at left front wheel, right rear wheel and right 3rd axle



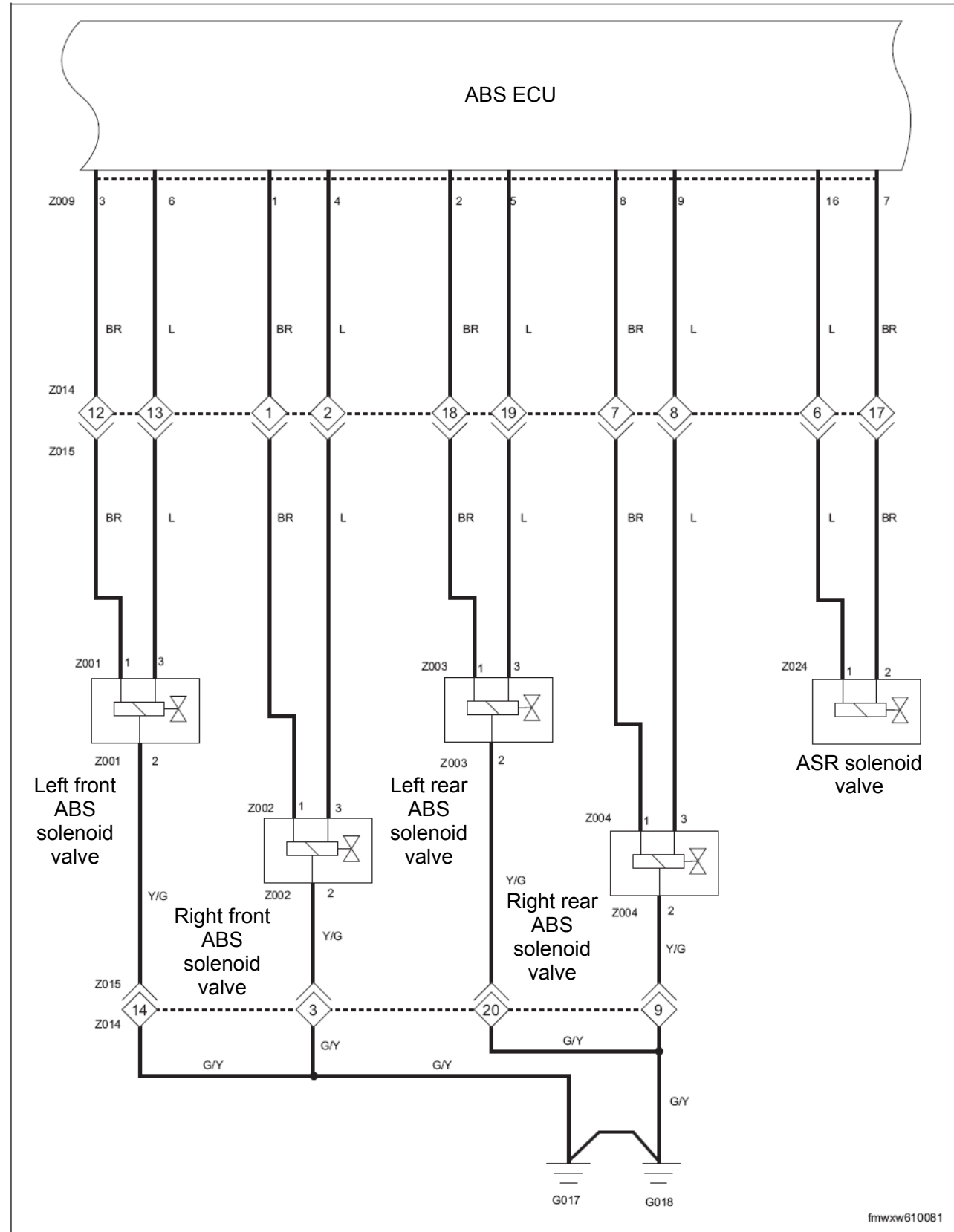
2-1 RIGHT FRONT WHEEL SOLENOID VALVE FAULT

2-2 LEFT FRONT WHEEL SOLENOID VALVE FAULT

2-3 RIGHT REAR WHEEL SOLENOID VALVE FAULT

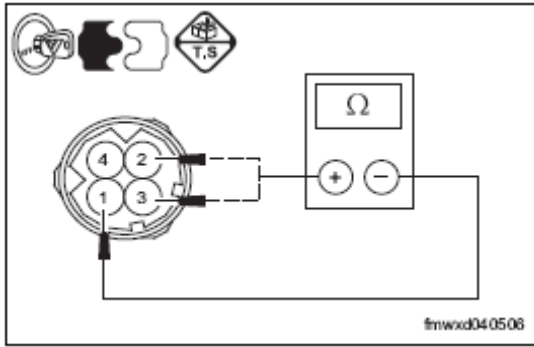
2-4 LEFT REAR WHEEL SOLENOID VALVE FAULT

Circuit Diagram



Diagnostic Procedures

1. Check right front wheel solenoid valve.



(a). With ABS solenoid valve connector removed, use multimeter to measure the resistance of the circuit between Pin 3 and Pin 1 of solenoid valve connector Z002.

(b). Use multimeter to measure the resistance of the circuit between Pin 2 and Pin 1 of solenoid valve connector Z002.

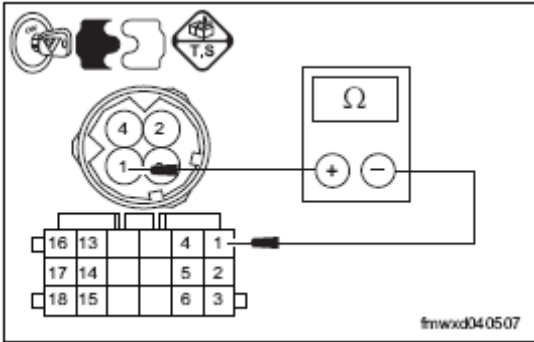
Resistance: $14.75 \pm 0.75 \Omega$

Is the inspection result normal?

Yes > Go to Step 2.

No > Replace right front wheel solenoid valve.

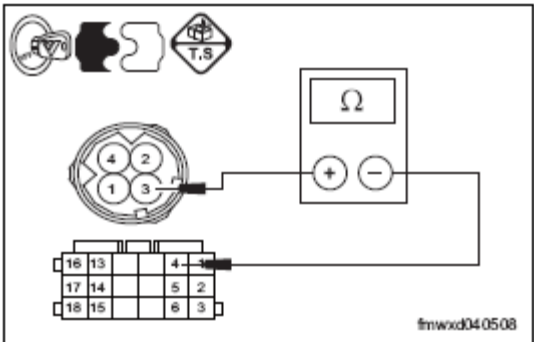
2. Check control circuit of right front wheel solenoid valve.



(a). Remove ABS ECU connector Z009 and right front ABS solenoid connector Z002.

(b). Measure the resistance of the circuit between Pin 1 of ABS ECU connector Z009 and Pin 3 of right front ABS solenoid valve connector Z002.

Resistance: $\leq 2 \Omega$



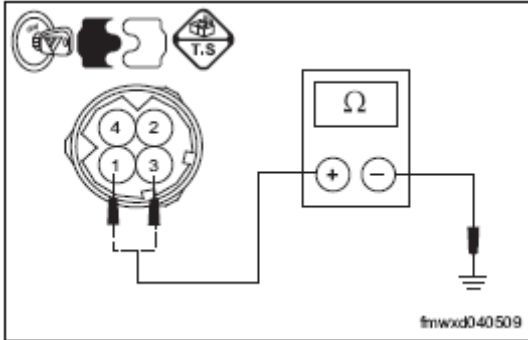
(c). Measure the resistance of the circuit between Pin 4 of ABS ECU connector Z009 and Pin 2 of right front ABS solenoid valve connector Z002.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 3.

No > Repair or replace harness.

3. Check control circuit of right front wheel solenoid valve.

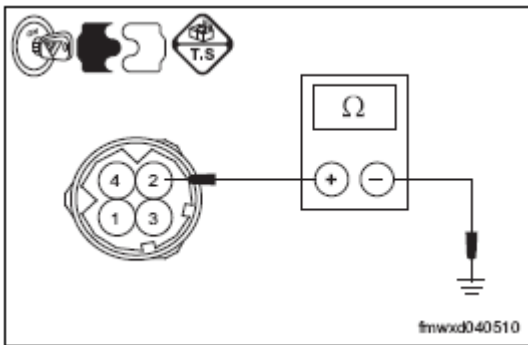
- (a). Remove ABS ECU connector Z009 and right front ABS solenoid connector Z002.
- (b). Measure the resistance of the circuit between Pin 2 / Pin 3 of right front ABS solenoid valve connector Z002 and the ground.

Resistance: $\geq 10 \text{ M}\Omega$

Is the inspection result normal?

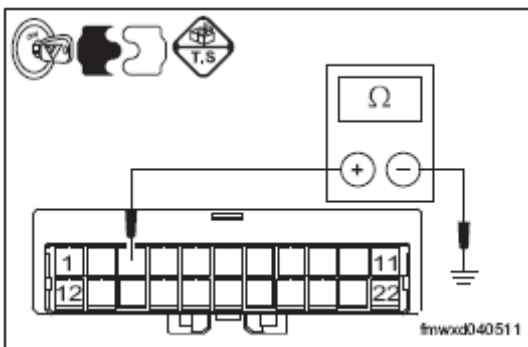
Yes > Go to Step 4.

No > Repair or replace harness.

4. Check ground wire of right front wheel solenoid valve.

- (a). Remove right front ABS solenoid connector Z002.
- (b). Measure the resistance of the circuit between Pin 1 of right front ABS solenoid valve connector Z002 and the ground.

Resistance: $\leq 2 \Omega$



- (c). Remove connectors Z015 and Z014.
- (d). Measure the resistance of the circuit between Pin 3 of connector Z014 and the ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace ABS ECU.

No > Repair or replace harness.

3-1 EXCESSIVE CLEARANCE, WEAK SIGNAL OF RIGHT FRONT WHEEL SENSOR

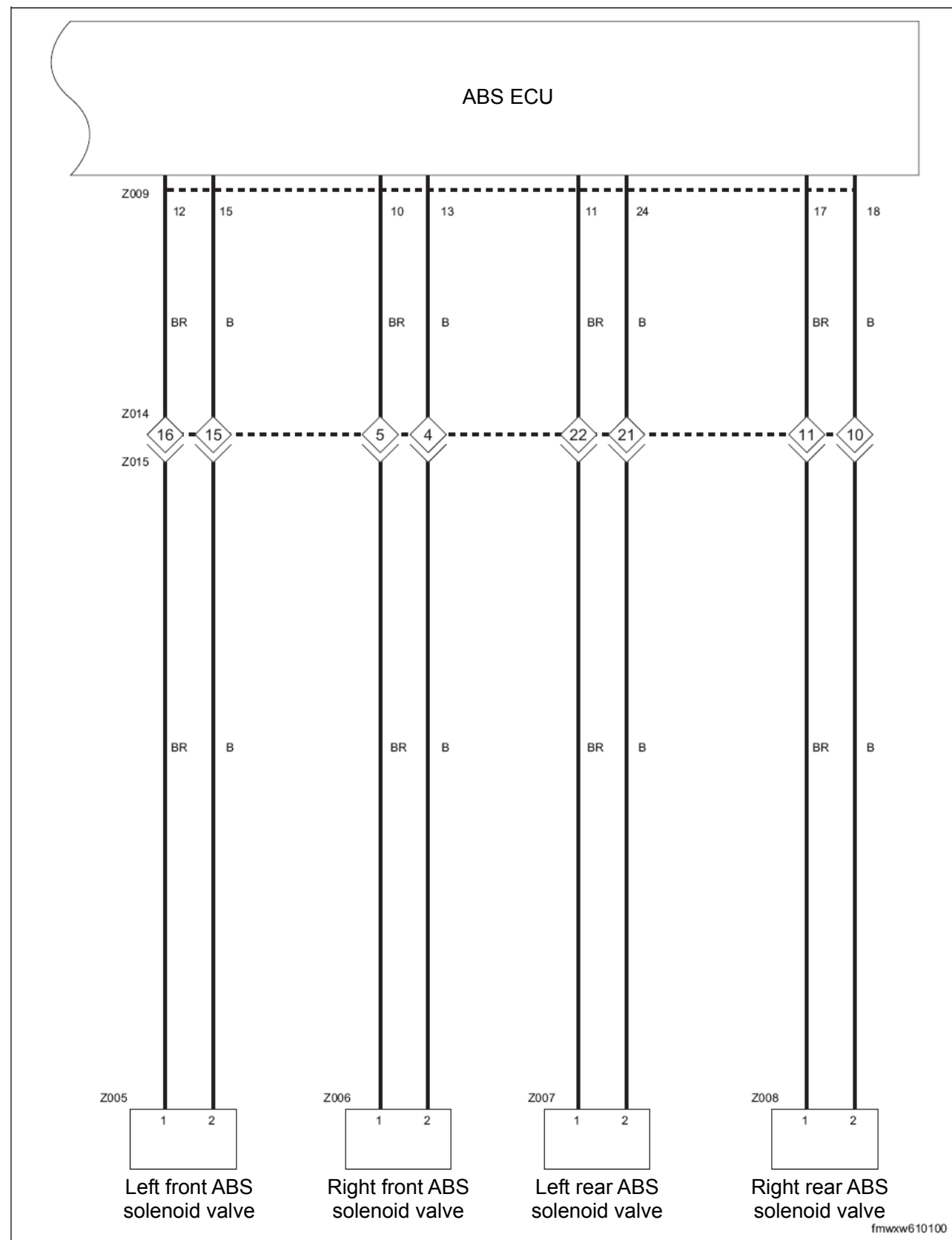
3-2 EXCESSIVE CLEARANCE, WEAK SIGNAL OF LEFT FRONT WHEEL SENSOR

3-3 EXCESSIVE CLEARANCE, WEAK SIGNAL OF RIGHT REAR WHEEL SENSOR

3-4 EXCESSIVE CLEARANCE, WEAK SIGNAL OF LEFT REAR WHEEL SENSOR



Circuit Diagram



Diagnostic Procedures**1. Check mounting position of sensor.**

- (a). Check if sensor is fitted in place.

Sensor axial direction is vertical to gear ring radial direction with maximum angle deviation less than $\pm 2.5^\circ$ and it head contacts the gear ring.

- (b). Check if the axial runout of gear ring is out of tolerance.

Locating surface contact ratio: $> 75\%$

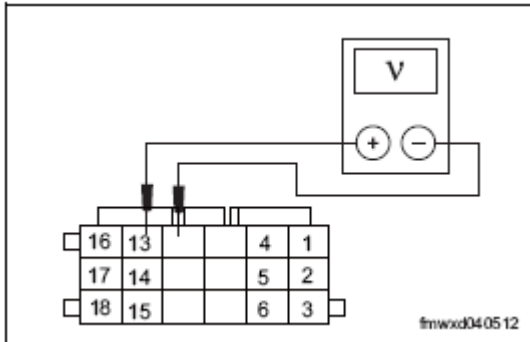
Tooth surface runout: $< 0.06 \text{ mm}$

- (c). Check hub bearing for looseness.

Is the inspection result normal?

Yes > Go to Step 2.

No > Reinstall or replace right front wheel sensor, gear ring, hub bearing.

2. Check right front wheel sensor harness.

- (a). Turn ignition switch to OFF.
 (b). Remove ABS ECU connector Z009.
 (c). Rotate wheel at speed over 30 r/min.

Voltage: $> 0.30 \text{ V}$

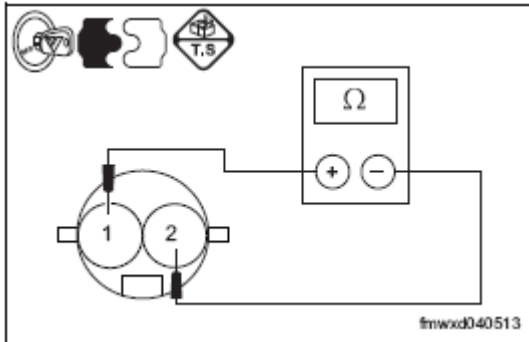
Is the inspection result normal?

Yes > Replace ABS ECU.

No > Repair or replace harness.

4-1 SHORT CIRCUIT OR OPEN CIRCUIT OF RIGHT FRONT WHEEL SENSOR**4-2 SHORT CIRCUIT OR OPEN CIRCUIT OF LEFT FRONT WHEEL SENSOR****4-3 SHORT CIRCUIT OR OPEN CIRCUIT OF RIGHT REAR WHEEL SENSOR****4-4 SHORT CIRCUIT OR OPEN CIRCUIT OF LEFT REAR WHEEL SENSOR****Circuit Diagram**

Refer to Circuit Diagram in “ABS System - 3-1 Excessive Clearance, Weak Signal of Right Front Wheel Sensor”.

Diagnostic Procedures**1. Check right front wheel sensor.**

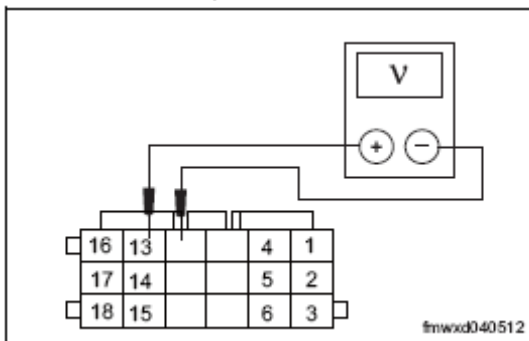
- (a). Turn ignition switch to OFF.
- (b). Remove right front wheel sensor connector Z006.
- (c). Measure resistance of right front wheel sensor.

Resistance: $1175 \pm 75 \Omega$

Is the inspection result normal?

Yes > Go to Step 2.

No > Replace sensor.

2. Check right front wheel sensor harness.

- (a). Turn ignition switch to OFF.
- (b). Remove ABS ECU connector Z009.
- (c). Rotate wheel at speed over 30 r/min.

Voltage: $> 0.30 \text{ V}$

Is the inspection result normal?

Yes > Replace ABS ECU.

No > Repair or replace harness.

5-1 UNSTABLE SIGNAL OF RIGHT FRONT WHEEL SENSOR**5-2 UNSTABLE SIGNAL OF LEFT FRONT WHEEL SENSOR****5-3 UNSTABLE SIGNAL OF RIGHT REAR WHEEL SENSOR****5-4 UNSTABLE SIGNAL OF LEFT REAR WHEEL SENSOR****Circuit Diagram**

Refer to Circuit Diagram in "ABS System - 3-1 Excessive Clearance, Weak Signal of Right Front Wheel Sensor".

Diagnostic Procedures**1. Check gear ring.**

- (a). Check if the axial runout of gear ring is out of tolerance.

Locating surface contact ratio: $> 75\%$

Tooth surface runout: $< 0.06 \text{ mm}$

- (b). Check if teeth number on each part of gear ring is the same.
(c). Check gear ring for any damage.

Is the inspection result normal?

Yes > Go to Step 2

No > Reinstall or replace gear ring.

2. Check mounting position of sensor.

- (a). Check if sensor is fitted in place.

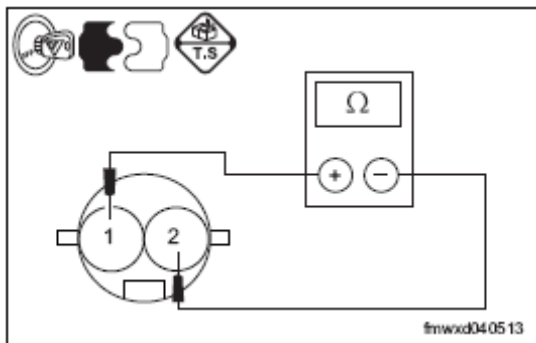
Sensor axial direction is vertical to gear ring radial direction with maximum angle deviation less than $\pm 2.5^\circ$ and it head contacts the gear ring.

- (b). Check if the sensor model is correct.
(c). Check hub bearing for looseness.

Is the inspection result normal?

Yes > Go to Step 3.

No > Reinstall or replace right front wheel sensor, hub bearing.

3. Check right front wheel sensor.

- (a). Turn ignition switch to OFF.
(b). Remove right front wheel sensor connector Z006.
(c). Measure resistance of right front wheel sensor.

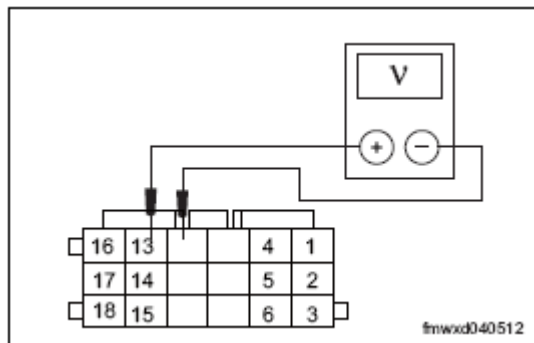
Resistance: $1175 \pm 75 \Omega$

Is the inspection result normal?

Yes > Go to Step 4.

No > Replace sensor.

4. Check right front wheel sensor harness.



(a). Turn ignition switch to OFF.

(b). Remove ABS ECU connector Z009.

(c). Rotate wheel at speed over 30 r/min.

Voltage: > 0.30 V

Is the inspection result normal?

Yes > Replace ABS ECU.

No > Repair or replace harness.

6-1 RIGHT FRONT WHEEL GEAR RING FAULT

6-2 LEFT FRONT WHEEL GEAR RING FAULT

6-3 RIGHT REAR WHEEL GEAR RING FAULT

6-4 LEFT REAR WHEEL GEAR RING FAULT

Diagnostic Procedures

1. Check gear ring.

- (a). Check if the axial runout of gear ring is out of tolerance.

Locating surface contact ratio: > 75%

Tooth surface runout: < 0.06 mm

- (b). Check if teeth number on each part of gear ring is the same.
(c). Check gear ring for any damage.

Is the inspection result normal?

Yes>Go to Step 2.

No > Reinstall or install gear ring.

2. Check mounting position of sensor.

- (a). Check if sensor is fitted in place.

Sensor axial direction is vertical to gear ring radial direction with maximum angle deviation less than $\pm 2.5^\circ$ and it head contacts the gear ring.

- (b). Check hub bearing for looseness.

Is the inspection result normal?

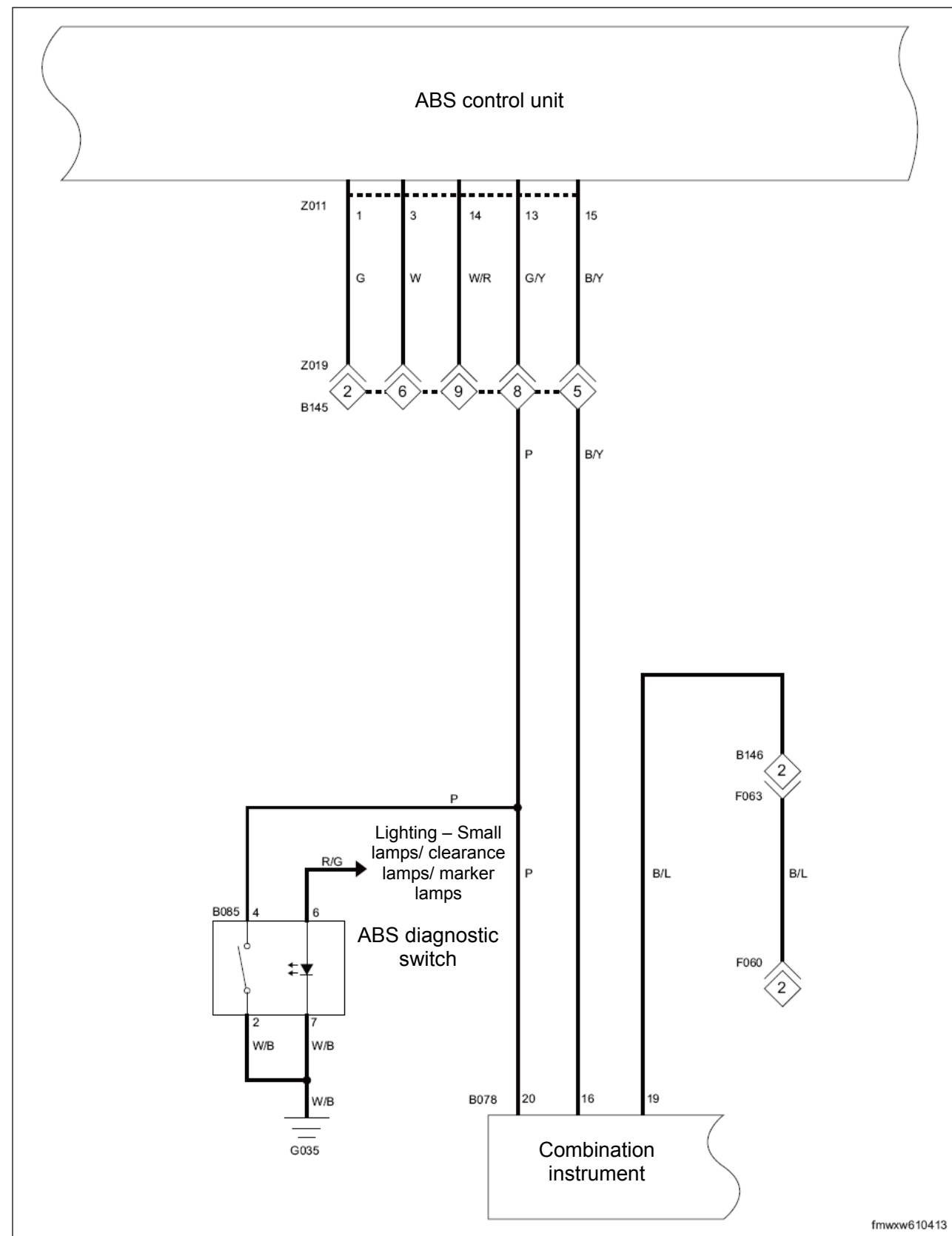
Yes>Replace ABS ECU.

No > Reinstall or replace right front wheel sensor, hub bearing.



7-4 ABS WARNING LAMP FAILURE

Circuit Diagram



Diagnostic Procedures**1. Check blink code switch.**

- (a). Is the blink code switch depressed for too long time.
Time: < 16 s
- (b). Check if blink code switch is able to return automatically.

Is the inspection result normal?

Yes > Go to Step 2.

No > Operate the blink code switch; repair or replace the switch

2. Check ABS warning lamp.

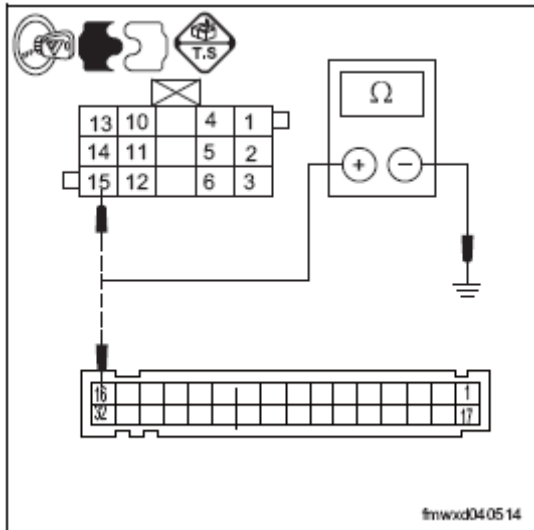
- (a). Switch ignition key from OFF to ON.
- (b). Check if ABS warning lamp is lit (always on or not lit).

Is ABS warning lamp lit?

Yes > Go to Step 3.

No > Go to Step 4.

04

3. Check ABS warning lamp harness for short circuit.

- (a). Turn ignition switch to OFF.
- (b). Remove combination instrument connector B078 and ABS ECU connector Z011.
- (c). Use multimeter to measure the resistance of the circuit between Pin 16 of combination instrument connector B078/Pin 15 of ABS ECU connector Z011 and the ground.

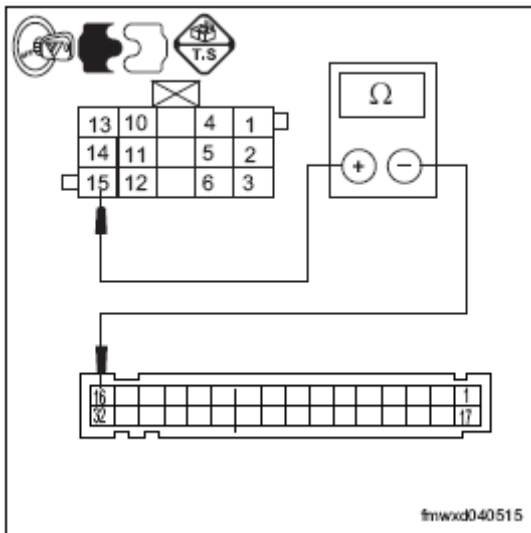
Resistance: > 10 MΩ

Is the inspection result normal?

Yes > Go to Step 5.

No > Repair or replace harness.

4. Check ABS warning lamp harness for open circuit.



- (a). Turn ignition switch to OFF.
- (b). Remove combination instrument connector B078 and ABS ECU connector Z011.
- (c). Use multimeter to measure the resistance of the circuit between Pin 16 of combination instrument connector B078 and Pin 15 of ABS ECU connector Z011.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 6.

No > Repair or replace harness.

5. Check warning lamp bulb

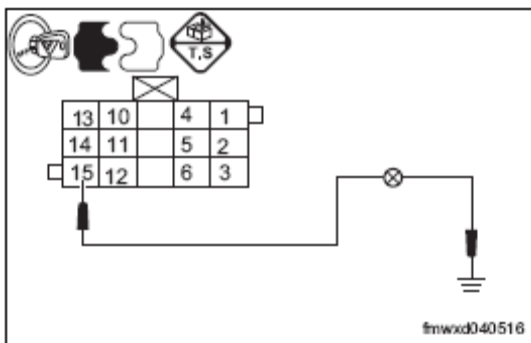
- (a). Remove combination instrument connector B078.
- (b). Check if ABS warning lamp is lit.

Check if ABS warning lamp is lit.

Yes > Replace warning lamp bulb.

No > Replace ABS ECU.

6. Check warning lamp bulb.



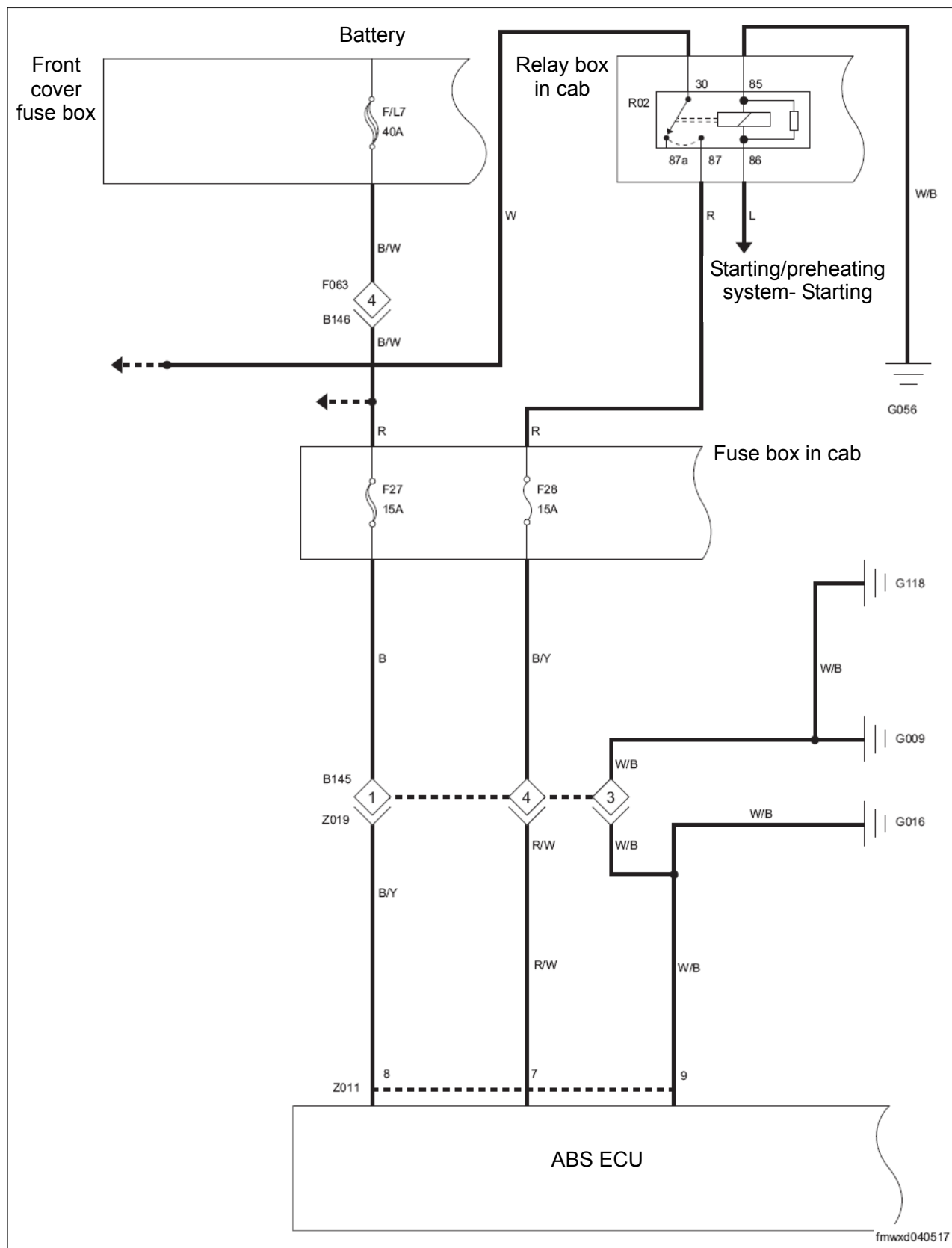
- (a). Turn ignition switch to OFF.
- (b). Remove ABS ECU connector Z011.
- (c). Connect a test lamp to Pin 15 of ABS ECU connector Z011.
- (d). With ignition switch turned ON, check if the test lamp is lit.

Is the test lamp lit?

Yes > Replace ABS ECU.

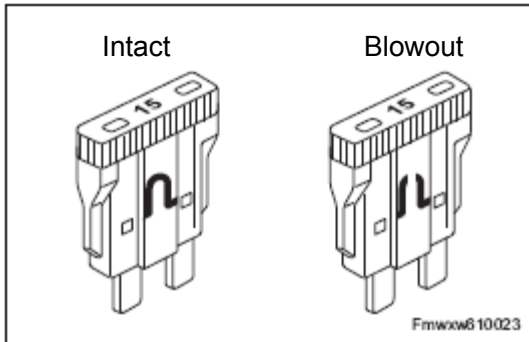
No > Replace warning lamp bulb.

Circuit Diagram



Diagnostic Procedures**1. Check fuses F27 and F28.**

(a). Shut off main power.



(b). Check fuses in cab fuse box: F27 (15A), F28 (5A).

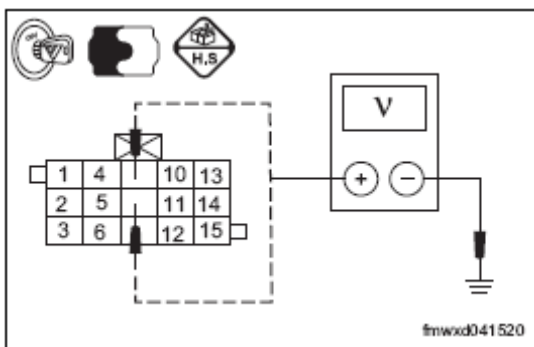
Is the inspection result normal?**Yes > Go to Step 2.****No > Service fuse circuit or replace fuse of the same rating.**

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2. Check battery voltage.

(a). Check battery voltage. Refer to Chapter 53, Battery - Inspection and Adjustment of Battery.

(b). Check charging voltage. Refer to Chapter 19, Charging System - Inspection and Adjustment of Charging System.

Is the inspection result normal?**Yes > Go to Step 3.****No > Replace battery or alternator.****3. Check ABS ECU power circuit.**

(a). Turn ignition switch to ON.

(b). Use multimeter to measure the voltage of the circuit between Pin 7 / Pin 8 of ABS ECU connector Z011 and the ground.

Standard voltage: Battery voltage**Is the inspection result normal?****Yes > Replace ABS ECU.****No > Service ABS ECU power circuit.**

8-2 OVERVOLTAGE OF ECU DIAGONAL 1 OR 2, ALL VALVES FAILURE

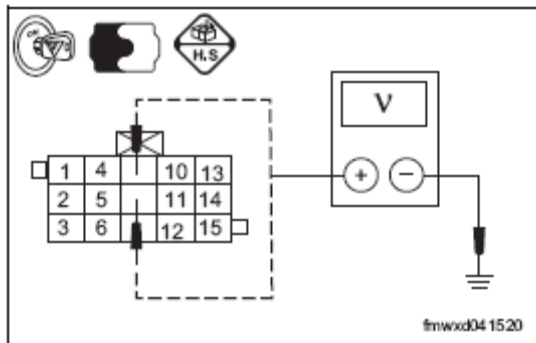
Circuit Diagram

Refer to "ABS System - Low ECU Diagonal Voltage, Circuit Diagram".

Diagnostic Procedures

1. Check ABS ECU power circuit.

(a). Start alternator.



(b). Use multimeter to measure the voltage of the circuit between Pin 7 / Pin 8 of ABS ECU connector Z011 and the ground.

Standard voltage: 24 V < charging voltage < 30 V

Is the inspection result normal?

Yes > Replace ABS ECU.

No > Service charging system. Refer to Chapter 19, Charging System - Inspection and Adjustment of Charging System.

8-3 ECU INTERNAL FAULT

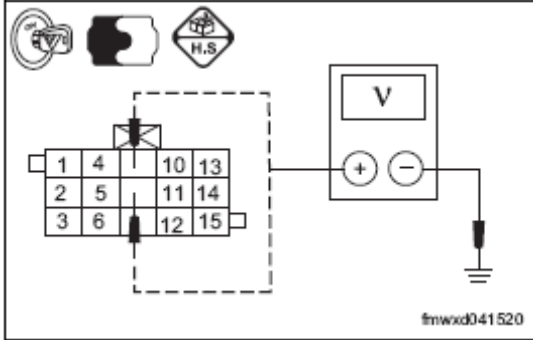
Circuit Diagram

Refer to "ABS System - Low ECU Diagonal Voltage, Circuit Diagram".

Diagnostic Procedures

1. Check ABS ECU power circuit.

(a). Start alternator.



(b). Use multimeter to measure the voltage of the circuit between Pin 7 / Pin 8 of ABS ECU connector Z011 and the ground.

Standard voltage: 24 V < charging voltage < 30 V

Is the inspection result normal?

Yes > Go to Step 2.

No > Service charging system. Refer to Chapter 19, Charging System - Inspection and Adjustment of Charging System.

2. Read out DTC.

(a). Clear DTC.

(b). Read out DTC.

Is DTC present repeatedly?

Yes > Replace ABS ECU.

No > The system is normal.

ABS SYSTEM FAILURE

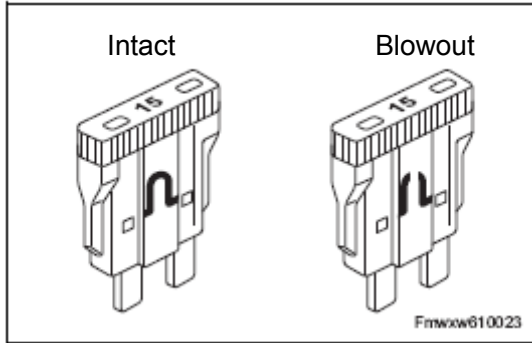
Circuit Diagram

Please refer to "ABS System - Low ECU Diagonal Voltage, Circuit Diagram".

Diagnostic Procedures

1. Check fuses F27 and F28.

(a). Shut off main power.



(b). Check fuses in cab fuse box: F27 (15A), F28 (5 A).
Standard voltage: 24 V < charging voltage < 30 V

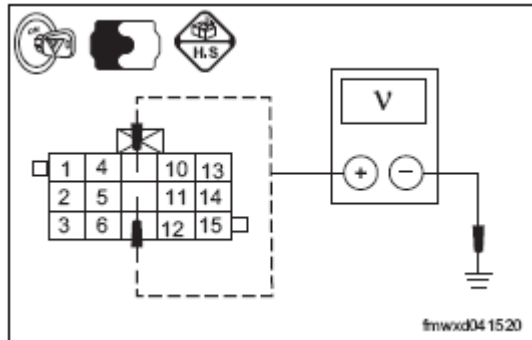
Is the inspection result normal?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check ABS ECU power circuit.

(a). Start alternator.



(b). Use multimeter to measure the voltage of the circuit between Pin 7 / Pin 8 of ABS ECU connector Z011 and the ground.

Standard voltage: 24 V < charging voltage < 30 V

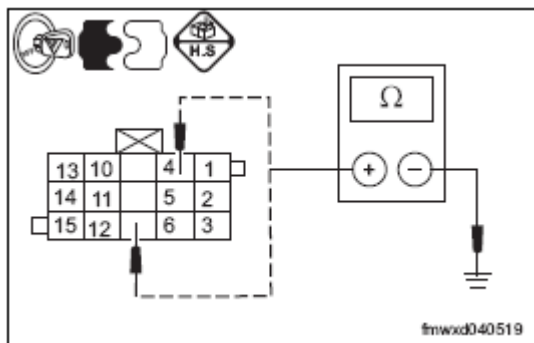
Is the inspection result normal?

Yes > Go to Step 3.

No > Repair or replace harness.

3. Check ABS ECU ground circuit

(a). Turn ignition switch to OFF.



- (b). Use multimeter to measure the voltage of the circuit between Pin 4 / Pin 9 of ABS ECU connector Z011 and the ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace ABS ECU.

No > Repair or replace harness.

AIR HEATER AND A/C

PRECAUTIONS

Please follow relevant regulations, rules and precautions during A/C system maintenance.

- Keep work areas clean.
- Please wear goggles and protective gloves during operating refrigerating system.
- Please keep away from harmful carbon monoxide fumes produced in the course of engine starting.
- Don't conduct refrigerant drainage in enclosed or poor-ventilated garage.
- In the course of maintaining A/C system, always keep the negative cable of battery removed, as well as drain and recover refrigerant.
- In the course of refrigerant drainage and recovery, don't make refrigerant drained too quickly; otherwise, compressor oil may be brought out along.
- Discharge moisture and dirt out of system. Please use plug or cap to cover relevant connectors once any pipeline or part is removed.
- Don't remove cap or plug before reconnection or installation.
- In the course of disconnecting or reconnecting lines, please use two wrenches to support line connector, in order to avoid torsion or other damages.
- Please install with new O-ring if the connector has been removed.
- Please apply the specified new compressor oil onto O-ring before connecting any hose or line.
- The applied compressor (PAG) oil varies with the compressor model. Be sure to apply the specified compressor oil for corresponding compressor model.
- During removal/replacement of parts that their refrigerant circuit should be drained, please conduct specified operation in the order listed below:
 1. Refrigerant recovery/recycle, refrigerant complete drainage and recovery for filling system or similar devices.
 2. Remove and replace damaged parts.
 3. After drainage, fill A/C system with refrigerant and check the system for leak.

Refrigerant is a kind of chemical compound, which requires special management, in order to avoid personal injury.

- Please always wear goggles and protective gloves during operation.
- Please operate in well-ventilated environment. Don't conduct welding or steam cleaning on any on-board A/C line or part (or in periphery).
- If R-134a contacts human body, please flush relevant part with cold water immediately and see a doctor.
- If R-134a container is required to be delivered or carried by vehicle, please don't place it inside carriage.
- Don't fill the container full when filling R-134a from a large container to a small container. Proper room should be always reserved for expansion.
- Please store R-134a container at temperature below 40°C (100°F).

Warning:

- If your eyes contact R-134a, please see a doctor right away.
- Don't rub your eyes. Flush relevant parts with abundant fresh water to make the temperature of refrigerant increase gradually to above freezing point.
- Go to doctor to have proper medical treatment. If the skin is exposed to R-134a, the skin must be treated by frostbite treatment method.

BASIC INSPECTION

Refrigerating system test

Step	Inspection Item		Solution
1	Check outer surfaces of radiator and condenser core. Check outer surfaces of radiator and condenser core to ensure air passage is not clogged by dirt, leaves or other foreign matters. Check outer surfaces between radiator and condenser and all relevant outer surfaces. Is the inspection result normal?	Yes	Go to Step 2.
		No	Refer to Table of Fault Phenomena.
2	Check condenser core and hose. Check condenser core, hose and connecting pipe for clogging or torsion. Is the inspection result normal?	Yes	Go to Step 3.
		No	Refer to Table of Fault Phenomena.
3	Check blower air volume. Check if blower air volume is normal. Is the inspection result normal?	Yes	Go to Step 4.
		No	Refer to Table of Fault Phenomena.
4	Check all air pipes for leak or clogging. Check all air pipes for leak or clogging. Small air flow may be caused by clogged evaporator core. Is the inspection result normal?	Yes	Go to Step 5.
		No	Refer to Table of Fault Phenomena.
5	Check compressor clutch. Check compressor clutch for slippage. Is the inspection result normal?	Yes	Go to Step 6.
		No	Refer to Table of Fault Phenomena.
6	Check accessory drive belt. Check the tension of accessory drive belt. Is the inspection result normal?	Yes	Refer to Table of Fault Phenomena.
		No	Adjust the tension of accessory drive belt.



TABLE OF FAULT PHENOMENA

Please refer to the following table for troubleshooting. The serial numbers indicate the order of fault possibility. Please check relevant parts in the order and conduct replacement when necessary.

Heater Fault

Fault Phenomena	Possible Cause	Solution
No heating	1. Engine coolant (low level)	Add coolant.
	2. Air mix damper (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Heater.
	3. Air mix damper motor (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Heater.
	4. Air duct (clogged)	Clean air duct.
	5. Blower (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Blower.
	6. Heater core and/or hose (clogged)	Refer to Chapter 51 Air Heater and A/C - Service of Heater.
	7. Engine (low water temperature)	Troubleshoot engine cooling system.
	8. Air duct/hose (misaligned)	Repair air duct/hose.
Overheating	1. Air mix damper (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Heater.
	2. Air mix damper motor (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Heater.
	3. Engine (overheated)	Troubleshoot engine cooling system.

04

Big Noise in Heating System

Fault Phenomena	Possible Cause	Solution
Gurgle	1. Engine coolant (low level)	Add coolant.
	2. Engine (overheated)	Troubleshoot engine cooling system.

Refrigerating System Fault

Fault Phenomena	Possible Cause	Solution
No or insufficient refrigerating	1. Electromagnetic clutch (failed to operate)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	2. Electromagnetic clutch disc (dirty, skidding)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	3. Drive belt (loose or fracture)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	4. Compressor (stuck)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	5. Refrigeration oil (leak)	Refer to Chapter 51 Air Heater and A/C - Service of Refrigerant.
	6. Refrigerant (insufficient or too much)	Refer to Chapter 51 Air Heater and A/C - Service of Refrigerant.
	7. Refrigerating system (leak)	Refer to Chapter 51 Air Heater and A/C - Service of A/C pipe.
	8. Condenser (clogged or inadequate heat dissipation)	Refer to Chapter 51 Air Heater and A/C - Service of Condenser.
	9. Temperature control knob (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of A/C Control Switch.
	10. Air mix damper motor (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Heater.
	11. Air mix damper (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Heater.
	12. Expansion valve (clogged)	Refer to Chapter 51 Air Heater and A/C - Service of Evaporator.
Inadequate air flow	1. Evaporator (clogged or frosted)	Refer to Chapter 51 Air Heater and A/C - Service of Evaporator.
	2. Air duct (air leak)	Repair air duct.
	3. Blower (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Blower.

Intermittent Refrigeration

Fault Phenomena	Possible Cause	Solution
Intermittent air flow	1. Blower (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Blower.
	2. Air duct (clogged)	Clean air duct.
Intermittent operation of compressor	1. Belt (slippage)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	2. Electromagnetic clutch(damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	3. Compressor (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	4. Dual-state pressure switch (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Fluid Reservoir.
Intermittent refrigeration under normal operation of blower and compressor	1. Temperature bulb (loose)	Refer to Chapter 51 Air Heater and A/C - Service of Evaporator.
	2. Expansion valve (clogged by ice)	Refer to Chapter 51 Air Heater and A/C - Service of Evaporator.
	3. System clogged intermittently by foreign matters	Repair A/C pipeline system.

Big Noise in Refrigerating System

Fault Phenomena	Possible Cause	Solution
Noise outside system	1. Belt (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	2. Compressor bracket (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	3. Compressor (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	4. Electromagnetic clutch (skidding)	Refer to Chapter 51 Air Heater and A/C - Service of Compressor.
	5. Refrigeration oil (inadequate or none)	Refer to Chapter 51 Air Heater and A/C - Service of Refrigeration Oil.
	6. Blower (damaged)	Refer to Chapter 51 Air Heater and A/C - Service of Blower.
Noise inside system	1. Refrigerant (too much or inadequate)	Refer to Chapter 51 Air Heater and A/C - Service of Refrigerant.
	2. Expansion valve (water vapor in system)	Refer to Chapter 51 Air Heater and A/C - Service of Evaporator.
	3. Compressor vibration (excessive high pressure)	Refer to Chapter 51 Air Heater and A/C - Service of Refrigerant.

INSUFFICIENT A/C REFRIGERATION

Diagnostic Procedures

1. Check air temperature at instrument panel air vent.

- (a). Start engine to let its speed up to 2000 rpm and measure air temperature at instrument panel air vent.

Is air temperature at instrument panel air vent too high?

Yes > Conduct maintenance and adjustment listed below and make sure the system is normal.

- Switch to internal circulation.
- Park the vehicle at shady and cool areas.
- Adjust external circulation damper mechanism and replace internal circulation damper mechanism and intake damper regulator motor when necessary.
- Service air mix damper motor and replace it when necessary.

No > Go to Step 2.

2. Check air volume at instrument panel air vent.

- (a). Check air volume at instrument panel air vent.

Is the air volume at instrument panel air vent too small?

Yes > Conduct maintenance and adjustment listed below and make sure the system is normal.

- Clean and service instrument panel air vent and replace it when necessary.
- Service relevant circuits.
- Service air direction control device and replace it when necessary.
- Service intake damper motor and replace it when necessary.
- Service blower motor and replace it when necessary.
- Replace blower speed control module.
- Service servo motor and replace it when necessary.
- Service air mix damper motor and replace it when necessary.
- Service air volume switch and replace it when necessary.

No > Go to Step 3.

3. Check refrigerant pressure.

- (a). Connect the A/C pressure gauge, start engine to let it run at 2000 rpm and measure A/C system high pressure and low pressure.

Is refrigerant pressure standard?

Yes > Go to Step 4.

No > Conduct maintenance and adjustment listed below and make sure the system is normal.

- If both high and low pressure of A/C is above the standard, please check the leakproofness of refrigerating system pipeline and refill the system with refrigerant; drain excessive refrigerant and refrigeration oil; replace expansion valve.
- If high pressure is above the standard but low pressure is below the standard, please wash or replace the clogged high pressure pipe; replace expansion valve.

- If high pressure is below the standard but low pressure is above the standard, please add refrigeration oil, service or replace compressor.
- If both high and low pressure of A/C is below the standard, please service or replace leaky A/C components and add refrigerant as required.
- If high pressure is below the standard but low pressure is in vacuum state, please replace receiver dryer, replace expansion valve, clean or replace the clogged low pressure pipe, extend vacuum pumping time, add refrigerant as required.

4. Check compressor operation condition

- (a). Operation condition of compressor belt.
- (b). Operation condition of compressor clutch.
- (c). Operation condition of compressor.

Does the system function normally?

Yes > Go to Step 5.

No > Conduct maintenance and adjustment listed below and make sure the system is normal.

- Adjust compressor belt and replace it when necessary.
- Check refrigerant, oil volume and add when necessary.
- Service compressor clutch circuit.
- Service compressor clutch and replace it when necessary.
- Service refrigerant pressure switch and replace it when necessary.
- Service compressor and replace it when necessary.
- Service A/C control panel and replace it when necessary.

5. Check condenser temperature.

- (a). Check heat dissipation of condenser.

Does the system function normally?

Yes > Go to Step 6.

No > Conduct maintenance and adjustment listed below and make sure the system is normal.

- Service and clean condenser and replace it when necessary.

6. Check engine coolant temperature.

- (a). Check the following items:
 - Engine idling time.
 - Heavy load operation time of engine.
 - Filling amount of coolant.
 - Coolant performance.
 - Thermostat performance.
 - Operation status of engine.
 - Operation status of cooling fan.

- Water tank radiation.
 - Cooling fan cowl status.
- (b). Conduct maintenance and adjustment listed below based on inspection results and make sure the system is normal.
- Shorten engine idling time.
 - Shorten heavy load operation time of engine.
 - Service coolant leakage and add coolant to the standard level.
 - Change with conforming coolant.
 - Replace thermostat.
 - Service cooling fan cowl and replace it when necessary.
 - Service and clean coolant tank and replace it when necessary.
 - Service cooling fan motor and circuit and replace it when necessary.
 - Service engine cooling system.
 - Service engine operation.



INADEQUATE HEATING

Diagnostic Procedures

1. Check engine coolant temperature.

- (a). Check engine coolant temperature.

Is engine coolant temperature up to 82 °C?

Yes > Go to Step 2.

No > Conduct maintenance and adjustment listed below and make sure the system is normal.

- Extend engine operation time.
- Discharge air out of cooling system.
- Service or replace thermostat.
- Service and adjust engine operation.
- Service condenser fan to ensure normal operation.

2. Check operation status of temperature damper.

- (a). Check operation status of temperature damper.

Does it operate normally?

Yes > Go to Step 3.

No > Conduct maintenance and adjustment listed below and make sure the system is normal.

- Adjust temperature damper mechanism and replace regulator motor and mechanism of air mix damper when necessary.
- Check air duct, service or replace the leaky air duct.
- Service temperature damper switch and replace it when necessary.
- Service circuit between temperature damper switch and air mix damper motor and replace it when necessary.

3. Check operation status of internal/external circulation air damper.

- (a). Check operation status of internal/external circulation air damper.

Is it normal?

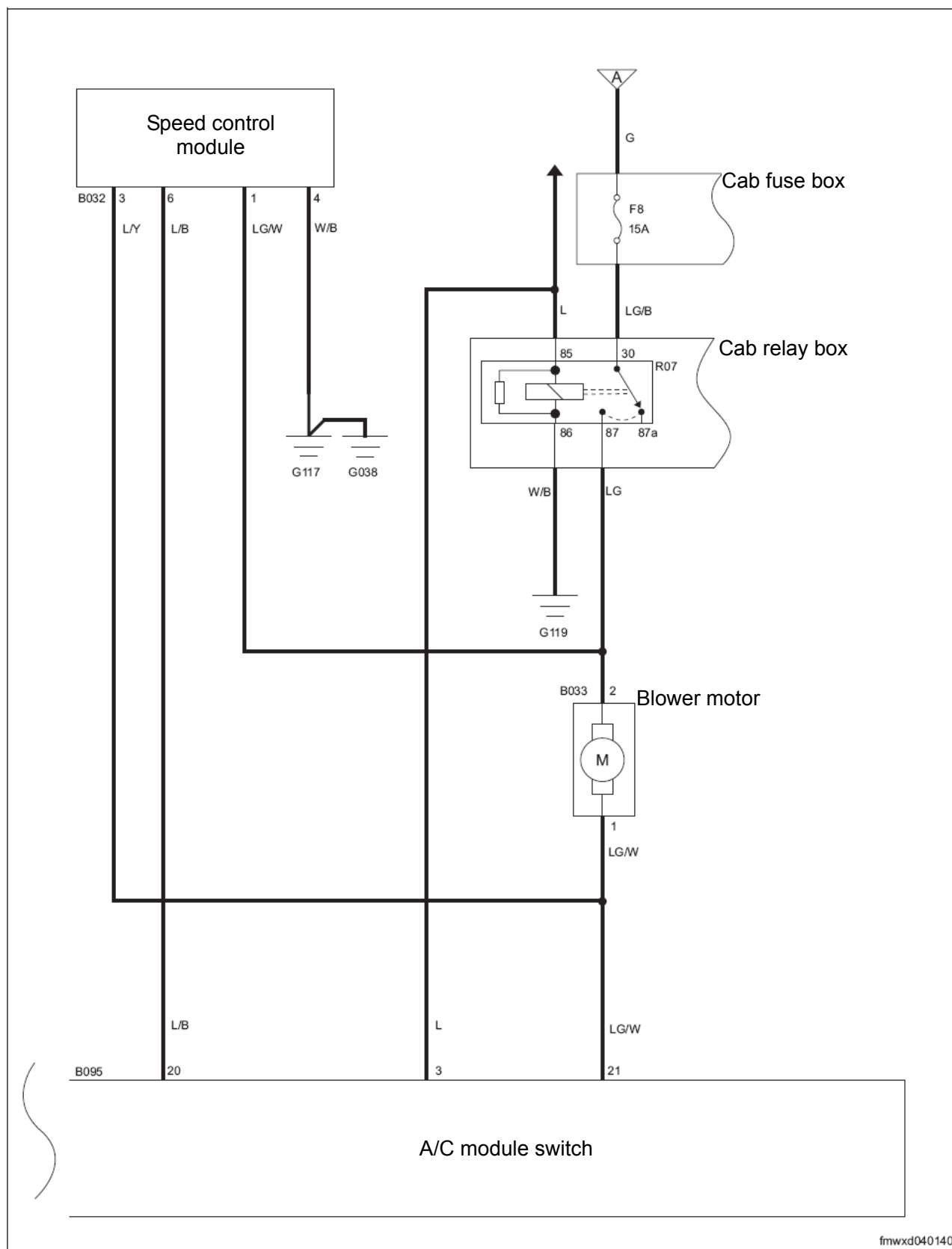
Yes > Confirm the system is normal.

No > Conduct maintenance and adjustment listed below and make sure the system is normal.

- Switch to internal circulation mode.
- Adjust internal/external circulation air damper mechanism.
- Service or replace intake air damper motor and mechanism.
- Service A/C control panel and replace it when necessary.

BLOWER FAILED TO OPERATE

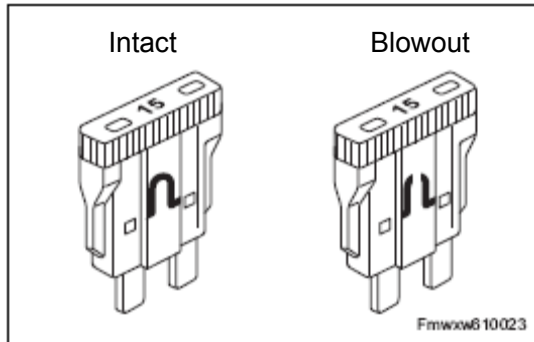
Circuit Diagram



Diagnostic Procedures

1. Check fuse.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F8 (15A).

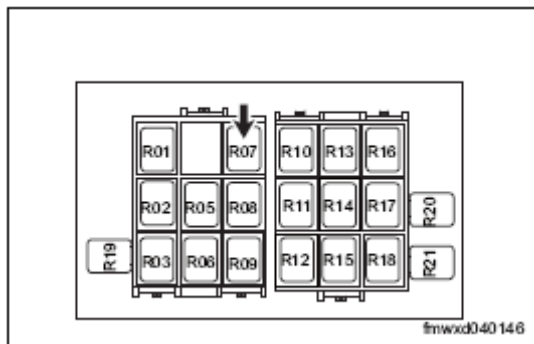
Is the structure normal?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check blower relay R07.

(a). Turn on main power.



(b). Turn on ignition switch repeatedly and check if the blower relay R07 in cab relay box is normal.

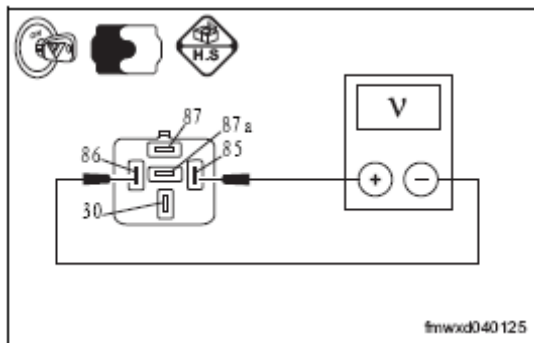
Is it normal?

Yes > Go to Step 4.

No > Go to Step 3.

3. Check relay R07 coil control circuit and contact circuit.

(a). Turn on main power and the ignition switch.



(b). Use multimeter to measure the voltage of the circuit between Pin 86 and Pin 85 of blower relay connector.

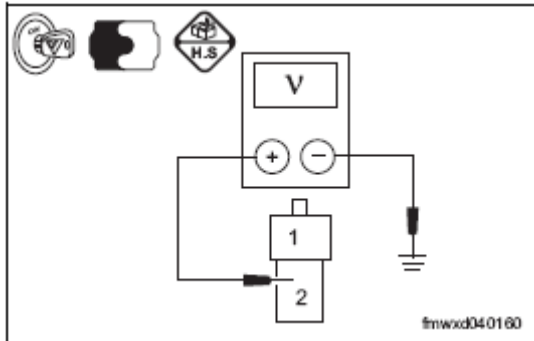
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace relay.

No > Repair or replace harness.

- 4. Check voltage of the circuit between Pin 2 of blower motor connector B033 and the ground.**



- (a). Use multimeter to measure the voltage of the circuit between Pin 2 of blower motor connector B033 and the ground.

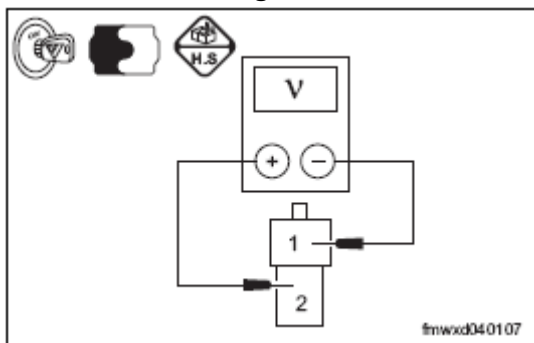
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 5.

No > Service circuit between R07 and blower.

- 5. Check voltage of the circuit between Pin 2 and Pin 1 of blower motor connector B033.**



- (a). Switch the A/C mode select switch and air volume switch to the maximum position.
- (b). Use multimeter to measure the voltage of the circuit between Pin 2 and Pin 1 of blower motor connector B033.

Standard voltage: Battery voltage

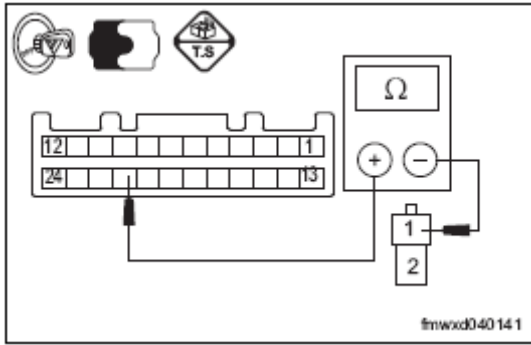
Is the inspection result normal?

Yes > Replace blower motor.

No > Go to Step 6.

- 6. Check circuit between blower and A/C mode select switch.**

- (a). Shut off main power.
- (b). Remove blower motor connector B033.
- (c). Remove A/C mode select switch connector B095.



- (d). Use multimeter to measure the resistance of the circuit between Pin 1 of blower motor connector B033 and Pin 21 of A/C mode select switch connector B095.

Resistance: $\leq 2 \Omega$

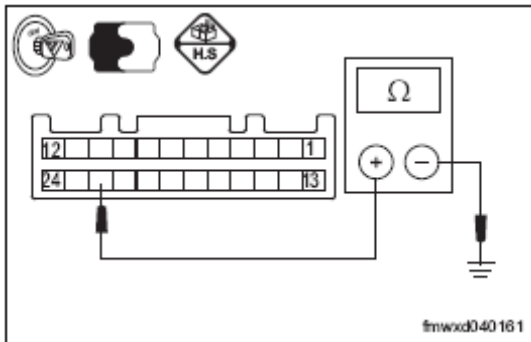
Is the inspection result normal?

Yes > Go to Step 7.

No > Repair or replace harness.

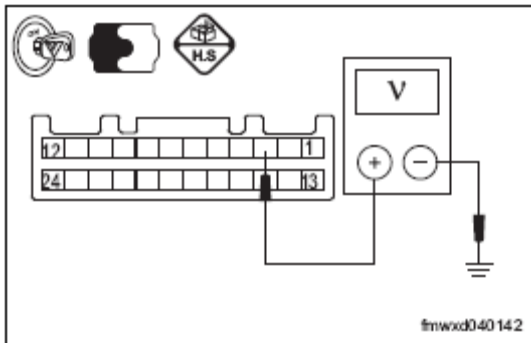
7. Check A/C mode select switch.

- (a). Turn on main power.



- (b). Use multimeter to measure the resistance of the circuit between Pin 22 of A/C mode select switch connector B095 and the effective ground point of body.

Resistance: $\leq 2 \Omega$



- (c). Use multimeter to measure the voltage of the circuit between Pin 3 of A/C mode select switch connector B095 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace A/C mode select switch.

No > Service A/C mode select switch power circuit and ground circuit.

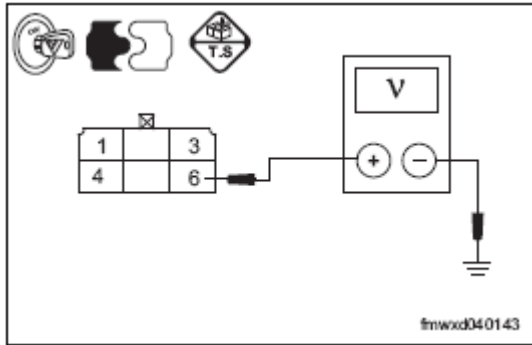
8. Check low speed operation of blower.

- (a). Turn the air volume switch to Low Speed position.

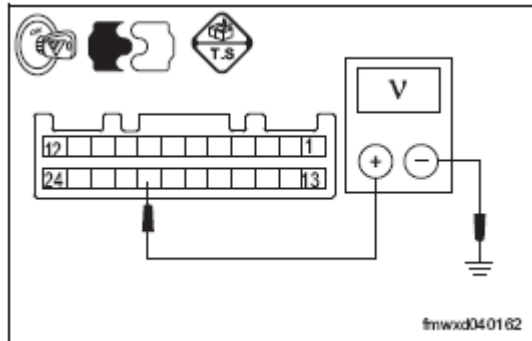
Does the blower operate?

Yes > System is normal.

No > Go to Step 9.

9. Check circuit between speed control module and A/C mode select switch.

- (a). Turn off ignition switch and remove harness connector B032 of speed control module.
- (b). Turn on ignition switch.
- (c). Use multimeter to measure the voltage of the circuit between Pin 6 of speed control module connector B032 and the effective ground point of body.



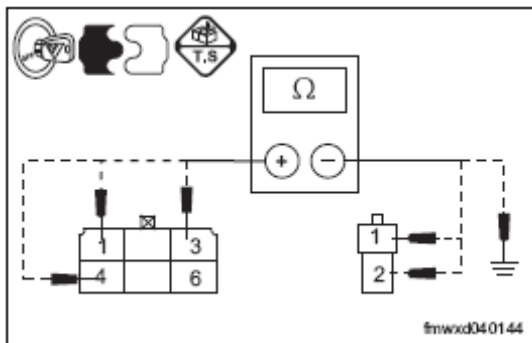
- (d). Use multimeter to measure the voltage of the circuit between Pin 20 of A/C mode select switch connector B095 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step10.

No > If the voltage of the circuit between Pin 20 of A/C mode select switch connector B095 and the effective ground point of body is normal, please repair or replace harness; if not, please replace the A/C mode select switch.

10. Check circuit between blower motor and speed control module.

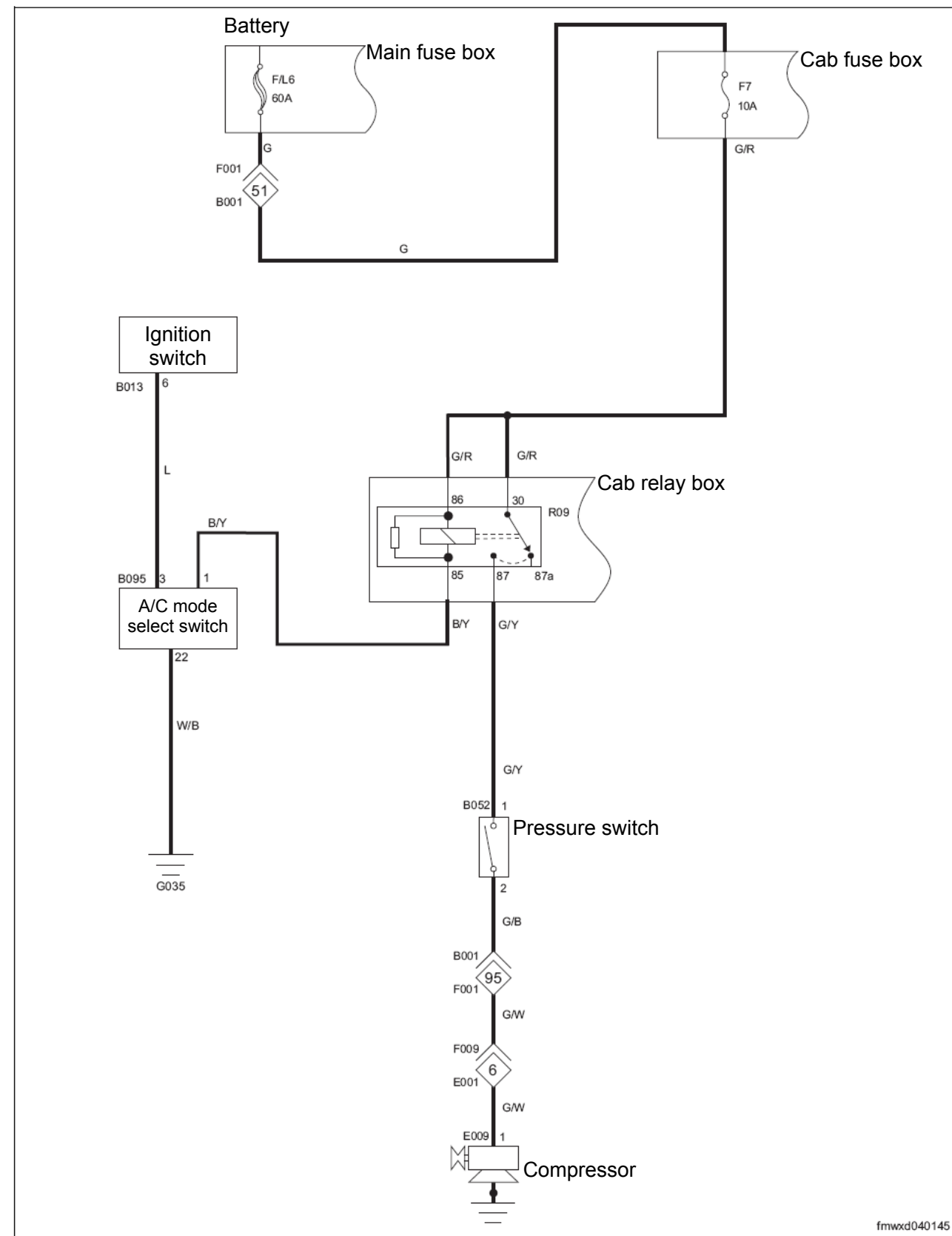
- (a). With ignition switch turned off, remove speed control module connector B032 and blower motor connector B033.
- (b). Use multimeter to measure the resistance of the circuit between Pin 4 of speed control module connector B032 and the ground.
- (c). Use multimeter to measure the resistance of the circuit between Pin 1 of speed control module connector B032 and Pin 2 of blower motor connector B033.
- (d). Use multimeter to measure the resistance of the circuit between Pin 3 of speed control module connector B032 and Pin 1 of blower motor connector B033.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace speed control module.

No > Repair or replace harness.

A/C COMPRESSOR CLUTCH FAILED TO OPERATE**Circuit Diagram**

Diagnostic Procedures**1. Check A/C system pressure.**

- (a). With A/C pressure gauge connected, measure high and low pressure of A/C system.

Standard system pressure:

Low pressure: 0.2~ 0.4MPa

High pressure: 1.6~ 2MPa

Is the refrigerant pressure standard?

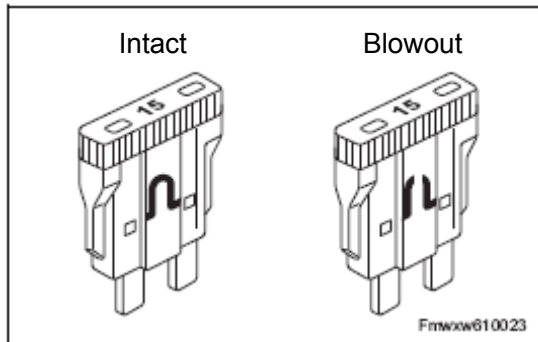
Yes > Go to Step 2.

No > Conduct maintenance and adjustment listed below and make sure the system is normal.

- If both high and low pressure of A/C is below the standard, please service or replace leaky A/C components and add refrigerant as required.

2. Check fuse.

- (a). Shut off main power.



- (b). Check fuse in cab fuse box: F7 (10A).

04

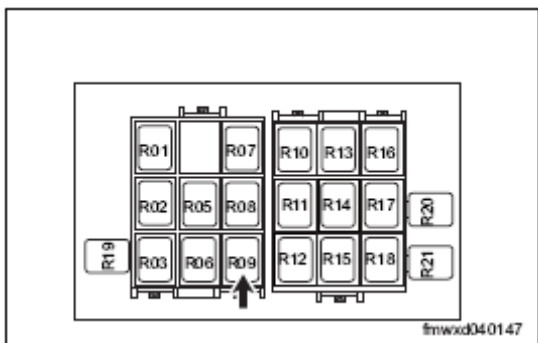
Is the inspection result normal?

Yes > Go to Step 3.

No > Service fuse circuit or replace fuse of the same rating.

3. Check compressor relay R09.

- (a). Turn on main power.



- (b). Turn on A/C switch repeatedly to check if compressor relay R09 is normal.

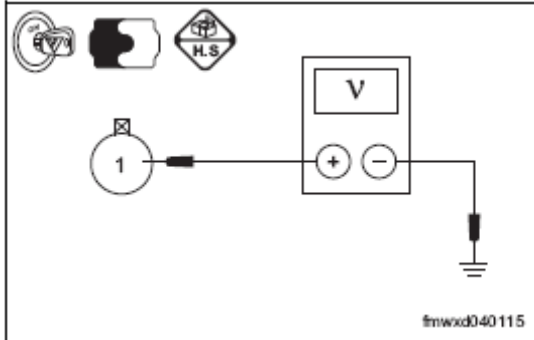
Is it normal?

Yes > Go to Step 4.

No > Go to Step 7.

4. Check compressor.

(a). Start engine and turn on A/C switch.



(b). Use multimeter to measure the voltage of the circuit between Pin 1 of compressor connector E009 and the effective ground point of body.

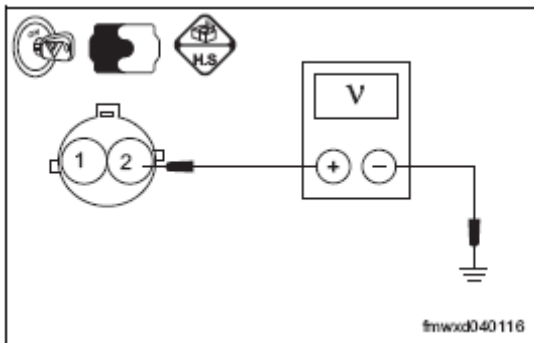
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace compressor.

No > Go to Step 5.

5. Check circuit between pressure switch and compressor.



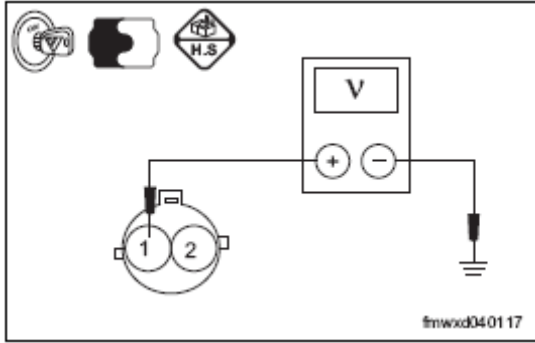
(a). Use multimeter to measure the voltage of the circuit between Pin 2 of pressure switch connector B052 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 6.

No > Repair or replace harness.

6. Check pressure switch power circuit.

- (a). Use multimeter to measure the voltage of the circuit between Pin 1 of pressure switch connector B052 and the effective ground point of body.

Standard voltage: Battery voltage

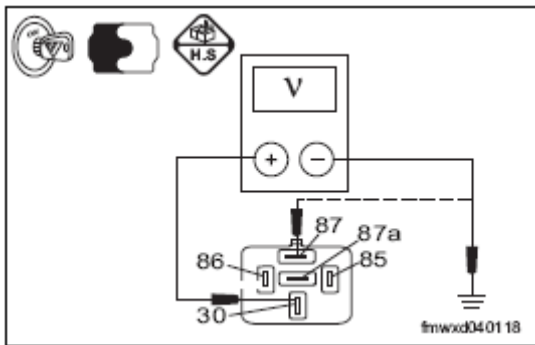
Is the inspection result normal?

Yes > Replace pressure switch.

No > Go to Step 7.

7. Check compressor relay R09 contact circuit.

- (a). Turn on main power.



- (b). Use multimeter to measure the voltage of the circuit between Pin 3 of compressor relay R09 connector and the effective ground point of body.
- (c). Use multimeter to measure the voltage of the circuit between Pin 30 and Pin 87 of compressor relay R09 connector.

Standard voltage: Battery voltage

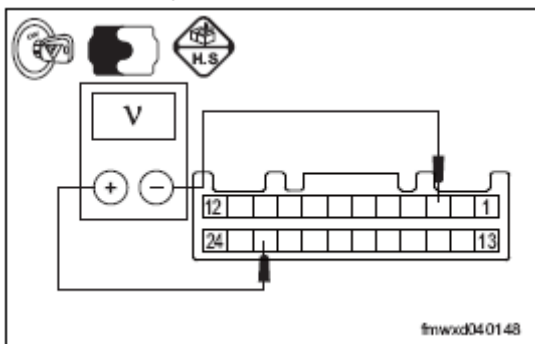
Is the inspection result normal?

Yes > Go to Step 8.

No > Repair or replace harness.

8. Check A/C panel power circuit and ground circuit.

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 3 and Pin 22 of A/C panel connector B095.

Standard voltage: Battery voltage

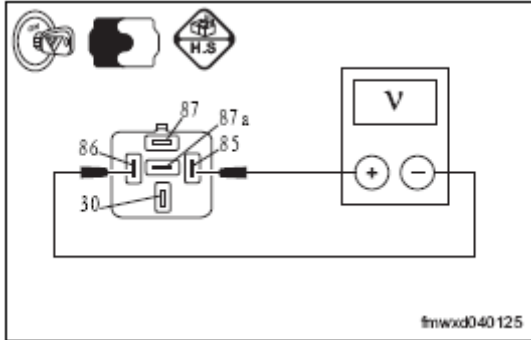
Is the inspection result normal?

Yes > Go to Step 9.

No > Repair or replace harness.

9. Check compressor relay R09 coil power circuit.

(a). Turn on main power and ignition switch.



(b). Use multimeter to measure the voltage of the circuit between Pin 86 and Pin 85 of compressor relay R09.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace relay R09.

No > Go to Step10.

10. Check harness.

(a). Check if the circuit between Pin 86 of compressor relay R09 and fuse F7 is short to ground.

(b). Check if the circuit between Pin 85 of compressor relay R09 and Pin 1 of A/C mode select switch connector B095 is open.

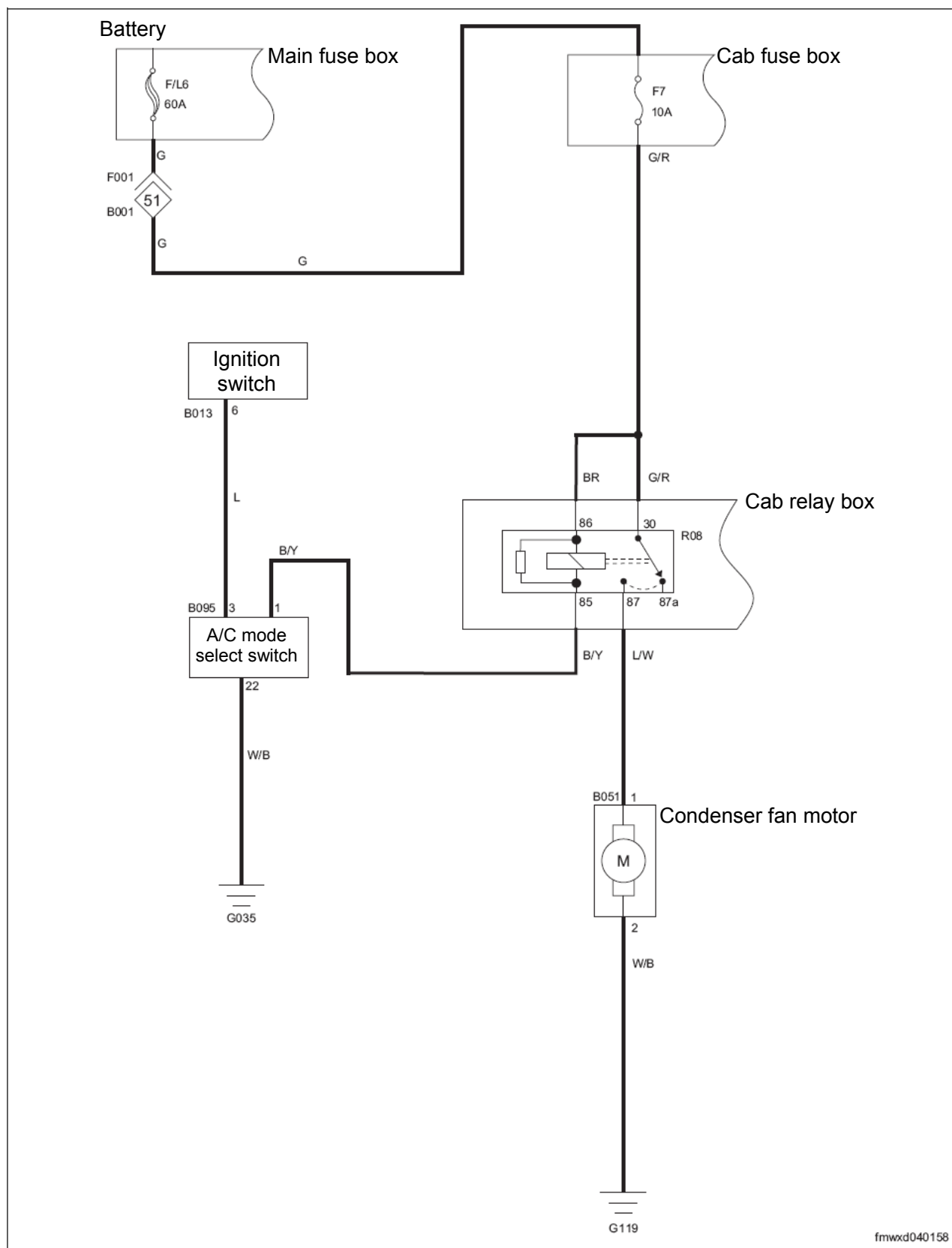
Is the inspection result normal?

Yes > Replace A/C mode select switch.

No > Repair or replace harness.

A/C COOLING FAN FAILED TO OPERATE

Circuit Diagram



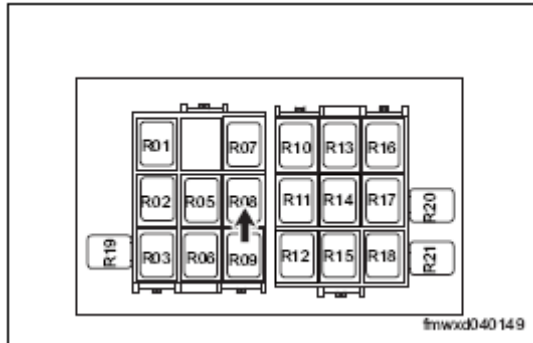
Diagnostic Procedures

Hint:

Before troubleshooting A/C cooling fan, please make sure A/C compressor clutch is able to operate normally. If not, please refer to "A/C Compressor Clutch Failed to Operate - Diagnostic Procedures" in this chapter.

1. Check condenser relay R08.

- (a). Turn ignition switch to ON.
- (b). Turn on A/C switch and air volume switch.



- (c). Check condenser relay R08 for normal operation.

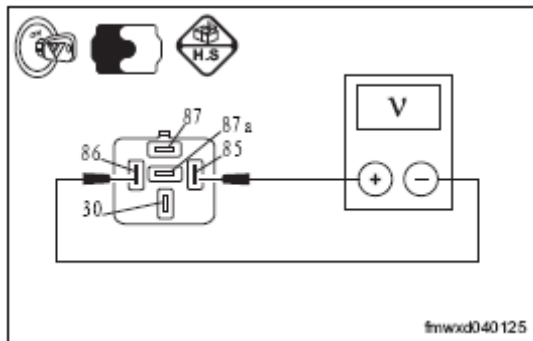
Is the inspection result normal?

Yes > Go to Step 5.

No > Go to Step 2.

2. Check condenser relay R08 coil circuit.

- (a). Turn on main power and ignition switch.



- (b). With A/C switch turned on, use multimeter to measure the voltage of the circuit between Pin 85 and Pin 86 of condenser relay R08 connector.

Standard voltage: Battery voltage

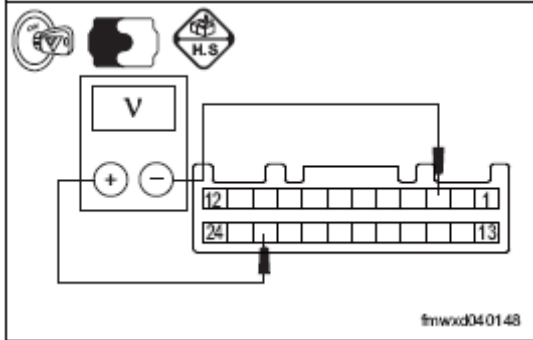
Is the inspection result normal?

Yes > Replace condenser relay R08.

No > Go to Step 3.

3. Check A/C mode select switch power and ground circuit

(a). Turn ignition switch to ON.



(b). Use multimeter to measure the voltage of the circuit between Pin 3 and Pin 22 of A/C mode select switch connector B095.

Standard voltage: Battery voltage

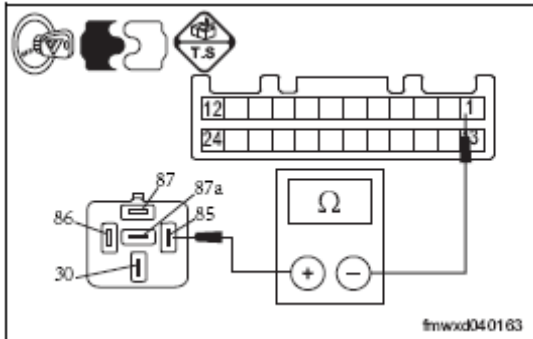
Is the inspection result normal?

Yes > Go to Step 4.

No > Repair or replace harness.

4. Check harness.

(a). Turn off ignition switch and remove A/C mode select switch connector B095.



(b). Use multimeter to measure the resistance of the circuit between Pin 85 of condenser relay R08 and Pin 1 of A/C mode select switch connector B095.

(c). Use multimeter to measure the resistance of the circuit between Pin 86 of condenser relay R08 and fuse F7.

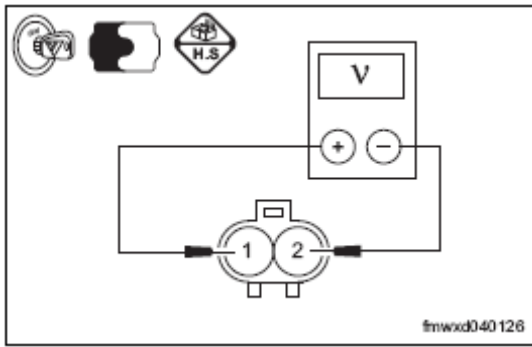
Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace A/C mode select switch.

No > Repair or replace harness.

5. Check voltage at both terminals of condenser fan motor.



- (a). Use multimeter to measure the voltage of the circuit between Pin 1 and Pin 2 of condenser fan motor connector B051.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace condenser fan.

No > Repair or replace harness.

LIGHTING SYSTEM

PRECAUTIONS

1. Cut off power supply.

- (a). Before removal or installation of any electrical device and if any tool or equipment may easily contact the bare electrical pin, please make sure the main power is cut off at first in order to avoid personal injury or vehicle damage.

Hint:

Please don't keep the key inside vehicle before cutting off main power supply, in order to prevent vehicle doors from being locked.

- (b). Unless otherwise specified, the ignition switch must be turned off.

2. Disconnection of negative cable of battery shall make the odometer and clock reset.

Hint:

Odometer won't be reset.

3. Disconnection of negative cable of battery shall make the stored settings in audio system lost.

Hint:

Please reset audio system before reconnecting negative cable of battery.

4. Replace bulbs carefully.

- (a). If any oil stain is retained on halogen bulb surface, service life of the bulb may be shortened and it may be burned out due to overheating.
- (b). Please be much attentive during handling halogen bulbs, for explosion or fracture may be caused due to high pressure inside bulb in case of any drop, knock or damage of bulb.
- (c). Please be sure to wear goggles during replacement of halogen bulb.
- (d). Please hold the lamp holder when handling bulb to avoid contact with glass.
- (e). Always keep a spare bulb for replacement. During replacement, if the removal time is too long, the reflector may absorb dust and moisture.
- (f). Replace the bulb with that of the same size.
- (g). After replacement, please install the lamp holder firmly. The reflector may become misty if any moisture around the lamp holder.

BASIC INSPECTION

Step	Inspection Item		Solution
1	Check battery voltage. Battery voltage should be no less than 22V. Is the inspection result normal?	Yes	Go to Step 2.
		No	Conduct battery charging or replacement. Refer to Chapter 53 Battery - Battery".
2	Check small lamps. Turn on the small lamps. Is the inspection result normal?	Yes	Go to Step 3.
		No	Refer to Table of Fault Phenomena.
3	Check low beams. - Turn on ignition switch. - Use combination switch to turn on low beams. Is the inspection result normal?	Yes	Go to Step 4.
		No	Refer to Table of Fault Phenomena.
4	Check high beams. Use combination switch to turn on high beams. Is the inspection result normal?	Yes	Go to Step 5.
		No	Refer to Table of Fault Phenomena.
5	Check turn signal lamps. Use combination switch to turn on turn signal lamps. Is the inspection result normal?	Yes	Go to Step 6.
		No	Refer to Table of Fault Phenomena.
6	Check hazard warning lamp Use hazard warning lamp switch to turn on hazard warning lamp. Is the inspection result normal?	Yes	Go to Step 7.
		No	Refer to Table of Fault Phenomena.
7	Check interior lamp. Use interior lamp switch to turn on interior lamp. Is the inspection result normal?	Yes	Check circuit.
		No	Refer to Table of Fault Phenomena.
8	Check reverse lamps. Shift the lever to R position and check reverse lamp. Is the inspection result normal?	Yes	Check circuit.
		No	Refer to Table of Fault Phenomena.
9	Check brake lamps. Depress brake pedal to check brake lamps. Is the inspection result normal?	Yes	Check circuit.
		No	Refer to Table of Fault Phenomena.



TABLE OF FAULT PHENOMENA

Please refer to the following table for troubleshooting. The serial numbers indicate the order of fault possibility. Please check relevant parts in the order and conduct replacement when necessary.

1. Headlamps

Fault Phenomena	Possible Cause	Solution
One side low beam not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Fuse (damaged)	Replace fuse.
	3. Harness (circuit open or short to ground)	Repair or replace harness.
Both side low beams not lit	1. Fuse (damaged)	Replace fuse.
	2. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	3. Low beam relay (damaged)	Replace relay.
	4. Harness (open or short circuit)	Repair or replace harness.
	5. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
One side low beam always ON	1. Fuse box	Replace fuse box.
	2. Harness (short circuit)	Repair or replace harness.
Both side low beams always ON	1. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	2. Low beam relay (damaged)	Replace fuse.
	3. Harness (open or short to power supply)	Repair or replace harness.
One side high beam not lit	1. Fuse (damaged)	Replace fuse.
	2. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	3. Harness (short circuit)	Repair or replace harness.
Both side high beams not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Fuse (damaged)	Replace fuse.
	3. High beam relay (damaged)	Replace high beam relay.
	4. Low beam relay (damaged)	Replace low beam relay.
	5. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	6. Harness (short circuit)	Repair or replace harness.

Fault Phenomena	Possible Cause	Solution
One side high beam always ON	1. Harness (short circuit to power supply)	Repair or replace harness.
	2. Fuse box (damaged)	Replace fuse.
Both side high beams always ON	1. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	2. High beam relay (damaged)	Replace high beam relay.
	3. Harness (short circuit)	Repair or replace harness.
Auxiliary high beam not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Fuse (damaged)	Replace fuse.
	3. High beam relay (damaged)	Replace high beam relay.
	4. Auxiliary high beam relay (damaged)	Replace auxiliary high beam relay.
	5. Auxiliary high beam switch (damaged)	Replace auxiliary high beam switch.
	6. Harness (short circuit)	Repair or replace harness.
Both side low and high beams not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Fuse (damaged)	Replace fuse.
	3. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	4. Harness (short circuit or short to ground)	Repair or replace harness.
Headlamps dark	1. Bulb (aged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Harness (poor contact)	Repair or replace harness.

2. Fog lamps

Fault Phenomena	Possible Cause	Solution
One side front fog lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Harness (short circuit)	Repair or replace harness.
Both side front fog lamps not lit	1. Fuse (damaged)	Replace fuse.
	2. Fog lamp relay (damaged)	Replace fog lamp relay.
	3. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	4. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	5. Harness (open circuit)	Repair or replace harness.
Front fog lamps always ON	1. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	2. Harness (short circuit to power supply)	Repair or replace harness.
One side rear fog lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Harness (open circuit)	Repair or replace harness.
Both side rear fog lamps not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Switch (damaged)	Replace rear fog lamp switch.
	3. Two-in-one controller (damaged)	Replace two-in-one controller.
	4. Harness (open circuit)	Repair or replace harness.
Rear fog lamps always ON	1. Switch (damaged)	Replace rear fog lamp switch.
	2. Two-in-one controller (damaged)	Replace two-in-one controller.
	3. Harness	Repair or replace harness.

3. Turn signal lamps

Fault Phenomena	Possible Cause	Solution
Turn signal lamps and warning lamp not flickering	1. Fuse (damaged)	Replace fuse.
	2. Relay (damaged)	Replace relay.
	3. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	4. Flasher (damaged)	Replace flasher.
	5. Harness (open circuit)	Repair or replace harness.
	6. Switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
One side turn signal lamp not flickering	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	3. Flasher (damaged)	Replace flasher.
	4. Harness (open circuit)	Repair or replace harness.
Warning lamp not flickering (turn signal lamp normal)	1. Combination switch	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	2. Flasher	Replace flasher.
One side turn signal lamp always flickering	1. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	2. Harness (short circuit to power supply)	Repair or replace harness.
	3. Flasher (damaged)	Replace flasher.
Both side turn signal lamps always flickering	1. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	2. Harness (short circuit to power supply)	Repair or replace harness.

4. Brake lamps

Fault Phenomena	Possible Cause	Solution
One side brake lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Rear Combination Lamp Bulb.
	2. Harness (open circuit)	Repair or replace harness.
Both side brake lamps not lit	1. Fuse (damaged)	Replace fuse.
	2. Relay (damaged)	Replace relay.
	3. Brake lamp switch (damaged)	Replace brake lamp switch.
	4. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Rear Combination Lamp Bulb.
	5. Brake lamp warning controller (damaged)	Replace brake lamp warning controller.
	6. Harness (open circuit)	Repair or replace harness.
Brake lamps always ON	1. Brake lamp switch (damaged)	Replace brake lamp switch.
	2. Harness (short circuit)	Repair or replace harness.



5. Reverse lamps

Fault Phenomena	Possible Cause	Solution
One side reverse lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Rear Combination Lamp Bulb.
	2. Harness (open circuit)	Repair or replace harness.
Reverse lamps not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Rear Combination Lamp Bulb.
	2. Fuse (damaged)	Replace fuse.
	3. Reverse gear relay (damaged)	Replace reverse gear relay.
	4. Reverse gear switch (damaged)	Replace reverse gear switch.
	5. Harness (open circuit)	Repair or replace harness.
Reverse lamps always ON	1. Reverse lamp switch (damaged)	Replace reverse lamp switch.
	2. Harness (short circuit)	Repair or replace harness.
Reverse buzzer failure	1. Buzzer (damaged)	Replace buzzer.
	2. Harness (open circuit)	Repair or replace harness.

6. Small lamps

Fault Phenomena	Possible Cause	Solution
One side small lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Combination Lamp Bulb.
	2. Harness (open circuit)	Repair or replace harness.
One side height lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Height Lamp Bulb
	2. Harness (open circuit)	Repair or replace harness.
One side marker lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Side Marker Lamp Bulb.
	2. Harness (open circuit)	Repair or replace harness.
One front marker lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Front Marker Lamp Bulb.
	2. Harness (open circuit)	Repair or replace harness.
One rear small lamp not lit	1. Bulb (damaged)	Refer to Chapter 54 Lighting - Replacement of Rear Combination Lamp Bulb.
	2. Harness (open circuit)	Repair or replace harness.
Interior lamp switch lamp not lit	1. Interior lamp switch assembly (damaged)	Refer to Chapter 54 Lighting - Replacement of Interior Lamp
	2. Harness (open circuit)	Repair or replace harness.
Cigarette lighter lamp not lit	1. Cigarette lighter (damaged)	Refer to Chapter 54 Instrument Panel and Cigarette Lighter - Replacement of Cigarette Lighter.
	2. Harness (open circuit)	Repair or replace harness.
Inter-shaft differential switch lamp not lit	1. Inter-shaft differential switch lamp (damaged)	Replace inter-shaft differential switch.
	2. Harness (open circuit)	Repair or replace harness.
Inter-wheel differential switch lamp not lit	1. Inter-wheel differential switch lamp (damaged)	Replace inter-wheel differential switch.
	2. Harness (open circuit)	Repair or replace harness.
Electric horn switch lamp not lit	1. Electric horn switch lamp (damaged)	Replace electric horn switch.
	2. Harness (open circuit)	Repair or replace harness.
ABS diagnostic switch lamp not lit	1. ABS diagnostic switch lamp (damaged)	Replace ABS diagnostic switch.
	2. Harness (open circuit)	Repair or replace harness.
Rear lamp switch lamp not lit	1. Rear lamp switch lamp (damaged)	Replace rear lamp switch.
	2. Harness (open circuit)	Repair or replace harness.
Rear fog lamp switch lamp not lit	1. Rear fog lamp switch lamp (damaged)	Replace rear fog lamp switch.
	2. Harness (open circuit)	Repair or replace harness.

DIAGNOSIS-LIGHTING SYSTEM

A/C mode select switch lamp not lit	1. A/C mode select switch lamp (damaged)	Replace A/C mode select switch.
	2. Harness (open circuit)	Repair or replace harness.
Combination instrument lamp not lit	1. Combination instrument lamp (damaged)	Replace combination instrument.
	2. Harness (open circuit)	Repair or replace harness.
Both rear small lamps and marker lamps not lit	1. Bulb (damaged)	Replace bulb.
	2. Fuse (damaged)	Replace fuse.
	3. Relay (damaged)	Replace relay.
	4. Harness (open circuit)	Repair or replace harness.
Marker lamps, clearance lamps and front and rear small lamps not lit	1. Bulb (damaged)	Replace bulb.
	2. Fuse (damaged)	Replace fuse.
	3. Relay (damaged)	Replace relay.
	4. Harness (open circuit)	Repair or replace harness.
	5. Combination switch	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
Marker lamps, clearance lamps and front and rear small lamps always ON	1. Combination switch (damaged)	Refer to Chapter 54 Wiper and Washer - Replacement of Combination Lamp.
	2. Harness (short circuit to power supply)	Repair or replace harness.

7. Step lamps

Fault Phenomena	Possible Cause	Solution
One side step lamp not lit	1. Bulb (damaged)	Replace bulb.
	2. Harness (open circuit)	Repair or replace harness.
Both side step lamps not lit	1. Fuse (damaged)	Replace fuse.
	2. Courtesy lamp switch (damaged)	Replace courtesy lamp switch.
	3. Bulb (damaged)	Replace bulb.
	4. Harness (open circuit)	Repair or replace harness.
Step lamps always ON	1. Switch (damaged)	Replace courtesy lamp switch.
	2. Harness (short circuit)	Repair or replace harness.



8. Interior lamp

Fault Phenomena	Possible Cause	Solution
Interior lamp switch lamp not lit	1. Fuse (damaged)	Replace fuse.
	2. Bulb (damaged)	Replace bulb.
	3. Switch (damaged)	Refer to Chapter 54 Lighting - Replacement of Interior Lamp.
	4. Harness (open circuit)	Repair or replace harness.
Reading lamp not lit	1. Bulb (damaged)	Replace bulb.
	2. Reading lamp	Refer to Chapter 54 Lighting - Replacement of Reading Lamp.
	3. Harness (open circuit)	Repair or replace harness.
Reading lamp always ON	1. Reading lamp	Refer to Chapter 54 Lighting - Replacement of Reading Lamp.
	2. Harness (open circuit)	Repair or replace harness.
Sleeper lamp not lit	1. Bulb (damaged)	Replace bulb.
	2. Sleeper lamp	Refer to Chapter 54 Lighting - Replacement of Sleeper Lamp.
	3. Harness (open circuit)	Repair or replace harness.
Sleeper lamp always ON	1. Sleeper lamp	Refer to Chapter 54 Lighting - Replacement of Sleeper Lamp.
	2. Harness (open circuit)	Repair or replace harness.

ONE SIDE LOW BEAM NOT LIT

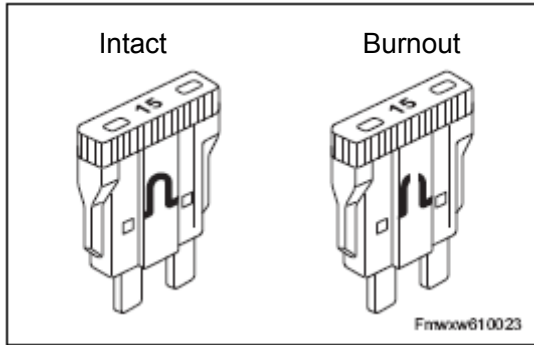
Circuit Diagram

Please refer to "Both Side Low Beams Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check fuse.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F22 (5A) or F23 (5A).

Is the fuse intact?

Yes > Go to Step 2.

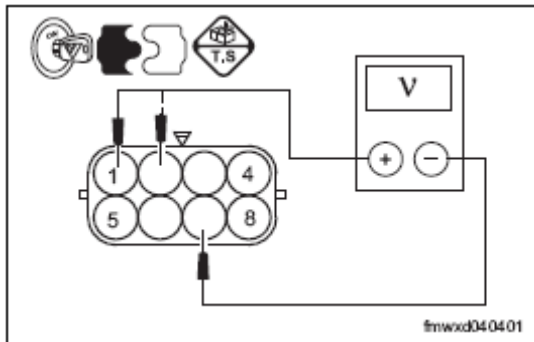
No > Service fuse circuit or replace fuse of the same rating.

2. Check voltage of the circuit between Pin 1 and Pin 4 of left front combination lamp connector B017 or between Pin 1 and Pin 7 of right front combination lamp connector B041.

(a). Remove left front combination lamp connector B017 or right front combination lamp connector B041.

(b). Turn on main power.

(c). Turn on low beams.



(d). Use multimeter to measure the voltage of the circuit between Pin 1 and Pin 4 of left front combination lamp connector B017 or between Pin 1 and Pin 7 of right front combination lamp connector B041.

Standard voltage: Battery voltage

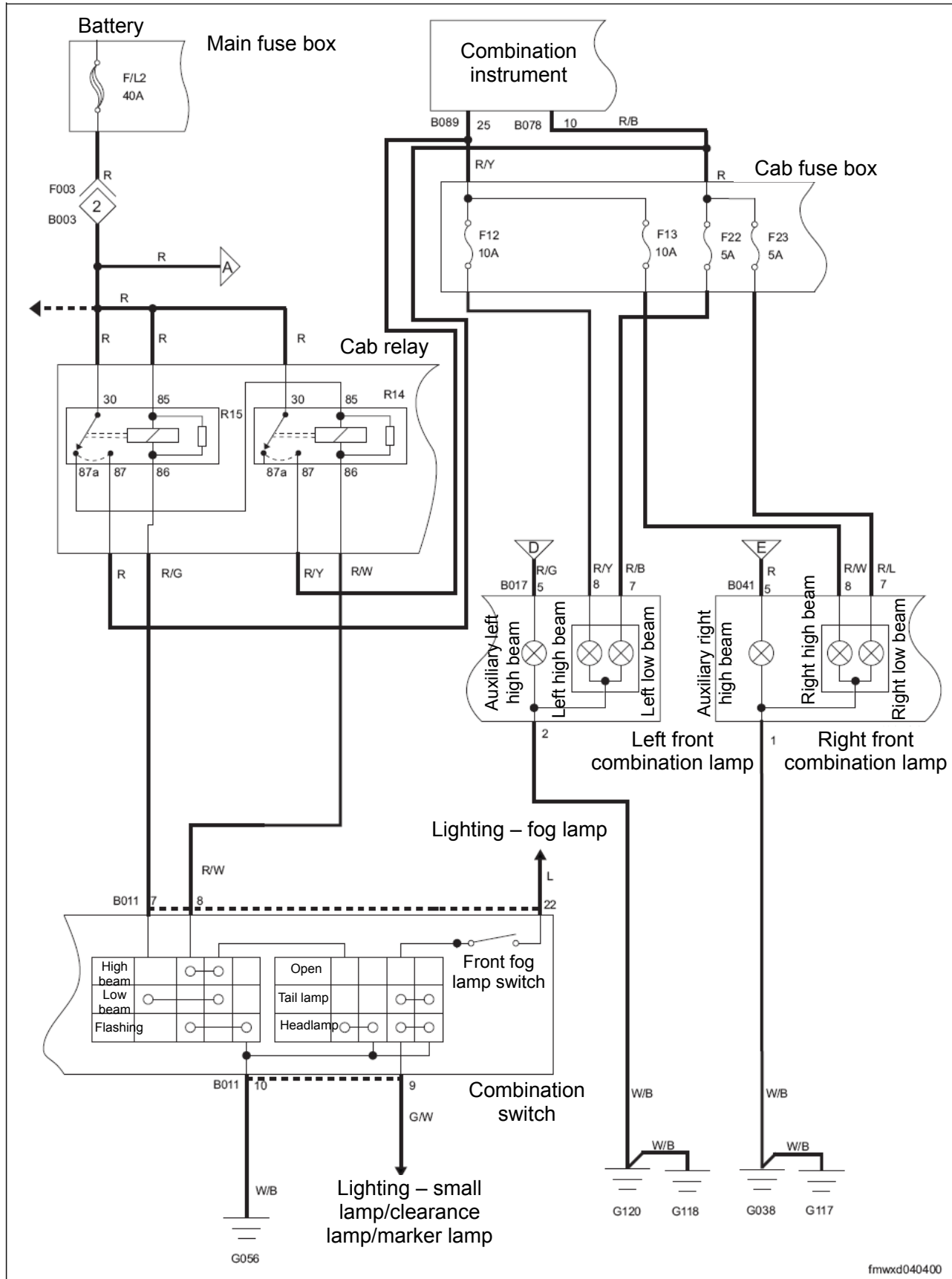
Is the inspection result normal?

Yes > Replace bulb.

No > Repair or replace harness.

BOTH SIDE LOW BEAMS NOT LIT

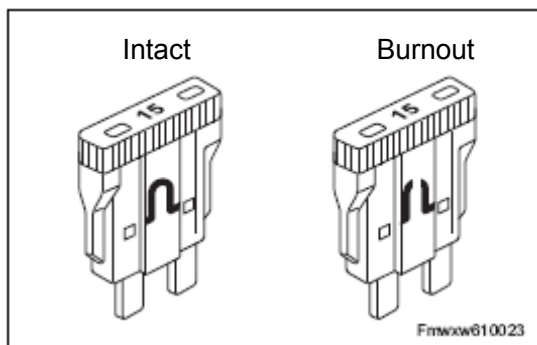
Circuit Diagram



fmwxd040400

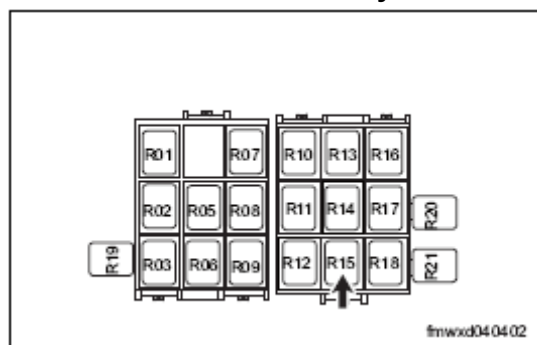
Diagnostic Procedures**1. Check fuse.**

(a). Shut off main power.



(b). Check fuses in cab fuse box: F22 (5A) and F23 (5A).

(c). Check fuse in front fuse box: F/L2 (40A).

Is the fuse intact?**Yes > Go to Step 2.****No > Service fuse circuit or replace fuse of the same rating.****2. Check low beam relay R15.**

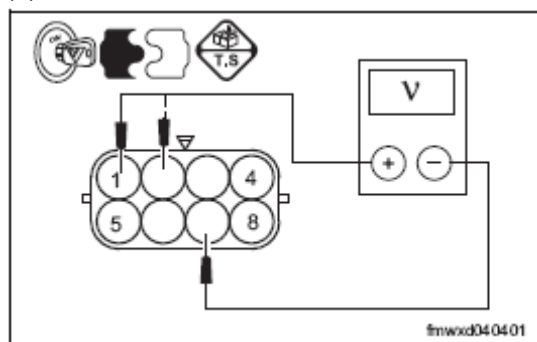
(a). Replace the low beam relay R15 with an intact relay of the same rating, turn on low beam and check if it is lit.

Are the low beams lit?**Yes > Replace low beam relay R15.****No > Go to Step 3.****3. Measure voltage of the circuit between Pin 2 and Pin 7 of left front combination lamp connector B017 or between Pin 1 and Pin 7 of right front combination lamp connector B041.**

(a). Remove left front combination lamp connector B017 or right front combination lamp connector B041.

(b). Turn on main power.

(c). Turn on low beams.



(d). Use multimeter to measure the voltage of the circuit between Pin 2 and Pin 7 of left front combination lamp connector B017 or between Pin 1 and Pin 7 of right front combination lamp connector B041.

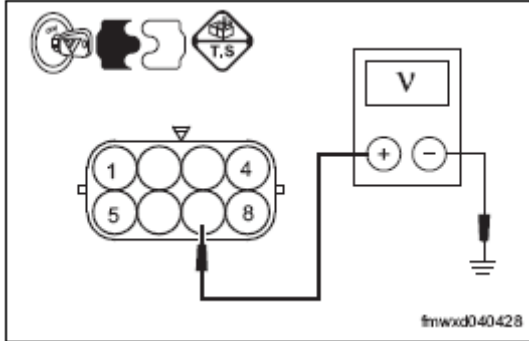
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 4.

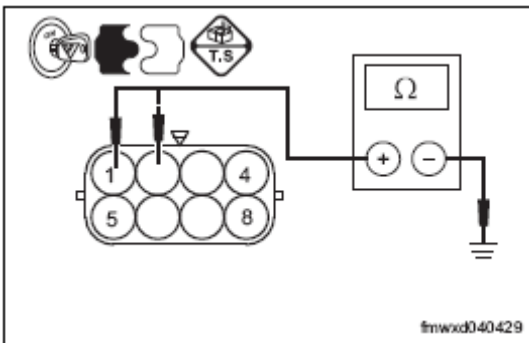
No > Replace bulb.

4. Check low beam power circuit and ground circuit



- (a). Use multimeter to measure the voltage of the circuit between Pin 7 of left front combination lamp connector B017 or Pin 7 of right front combination lamp connector B041 and the ground.

Standard voltage: Battery voltage



- (b). Use multimeter to measure the resistance of the circuit between Pin 2 of left front combination lamp connector B017 or Pin 1 of right front combination lamp connector B041 and the ground.

Resistance: $\leq 2 \Omega$

Are those circuits normal?

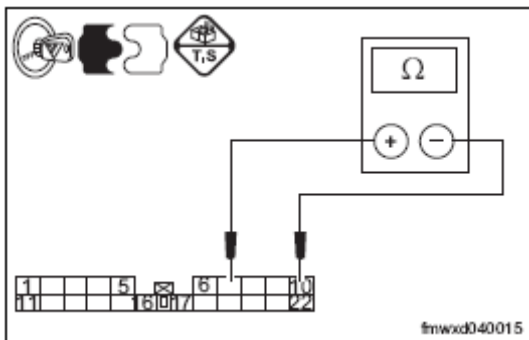
Yes > Go to Step 5.

No > Repair low beam power circuit and ground circuit.

5. Check combination switch.

- (a). Shut off main power.

- (b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

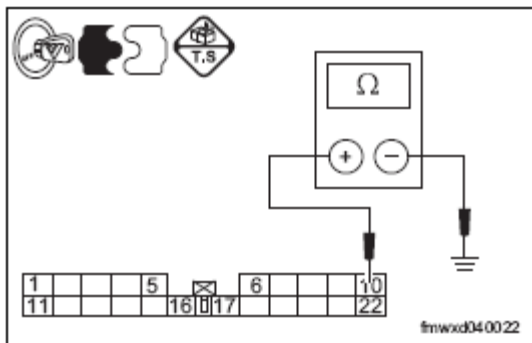
Condition	Multimeter Pin	Standard Value
Low beams turned OFF	7-10	$> 10 \text{ M}\Omega$
Low beams turned ON	7-10	$\leq 2 \Omega$

Is the inspection result normal?

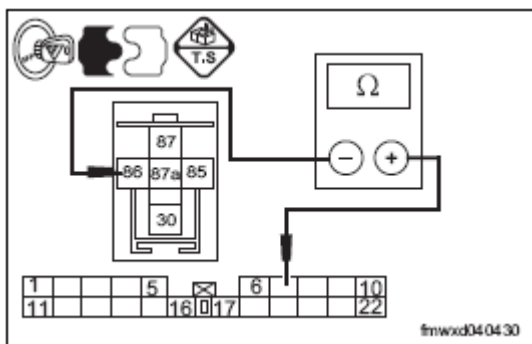
Yes > Repair or replace harness.

No > Replace combination switch.

6. Check coil control circuit for low beam relay R15 on combination switch.



- (a). Use multimeter to measure the resistance of the circuit between Pin 10 of combination switch connector B011 and the effective ground point of body.



- (b). Use multimeter to measure the resistance of the circuit between Pin 7 of combination switch connector B011 and Pin 86 of low beam relay R15.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Service power circuit of low beam relay R15.

No > Repair or replace harness.

ONE SIDE LOW BEAM ALWAYS ON

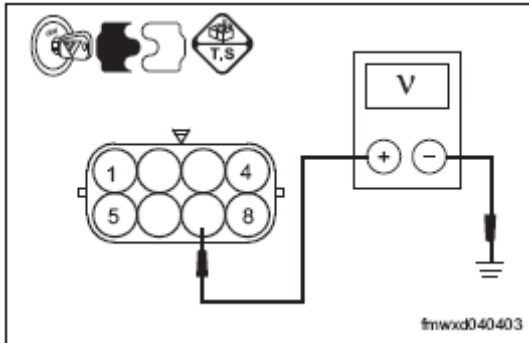
Circuit Diagram

Please refer to "Both Side Low Beams Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check power circuit of low beam bulb.

(a). Shut off main power.



- (b). Remove fuse in cab fuse box: F22 or F23.
- (c). Remove left front combination lamp connector B017 or right front combination lamp connector B041, and turn on main power and ignition switch.
- (d). Use multimeter to measure the voltage of the circuit between Pin 7 of connector B017 or B041 and the effective ground point of body.

Is the voltage equal to Zero?

Yes > Replace cab fuse box.

No > Repair or replace harness relevant to short circuit to power supply.

BOTH SIDE LOW BEAMS ALWAYS ON

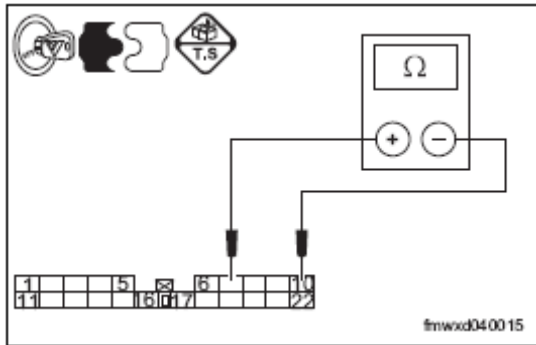
Circuit Diagram

Please refer to "Both Side Low Beams Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check combination switch.

- (a). Shut off main power.
- (b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Low beams turned OFF.	7-10	$> 10 \text{ M}\Omega$
Low beams turned ON.	7-10	$\leq 2 \Omega$

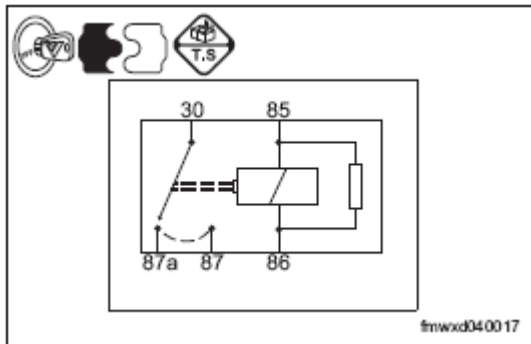
Is the inspection result normal?

Yes > Go to Step 2.

No > Replace combination switch.

2. Check if the low beam relay contact is normally closed.

- (a). Remove cab relay R15.



- (b). Use multimeter to measure the resistance of the circuit between Pin 30 and Pin 87 of low beam relay R15.

Resistance: $> 10 \text{ M}\Omega$

Is the inspection result normal?

Yes > Repair or replace harness.

No > Replace low beam relay R15.

ONE SIDE HIGH BEAM NOT LIT

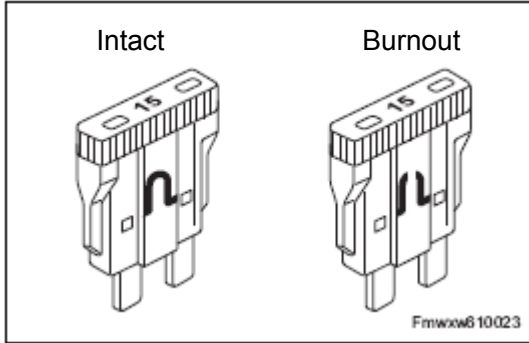
Circuit Diagram

Please refer to "Both Side High Beams Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check fuse.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F12 (10A) or F13 (10A).

Is the fuse intact?

Yes > Go to Step 2.

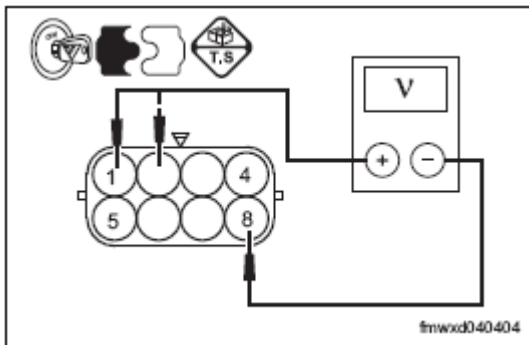
No > Service fuse circuit or replace fuse of the same rating.

2. Measure voltage of the circuit between Pin 2 and Pin 8 of left combination lamp connector B017 or between Pin 1 and Pin 8 of right combination lamp connector B041.

(a). Remove left combination lamp connector B017 or right combination lamp connector B041.

(b). Turn on main power.

(c). Turn on high beams.



(d). Use multimeter to measure the voltage of the circuit between Pin 2 and Pin 8 of left combination lamp connector B017 or between Pin 1 and Pin 8 of right combination lamp connector B041.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace bulb.

No > Repair or replace harness.

BOTH SIDE HIGH BEAMS NOT LIT

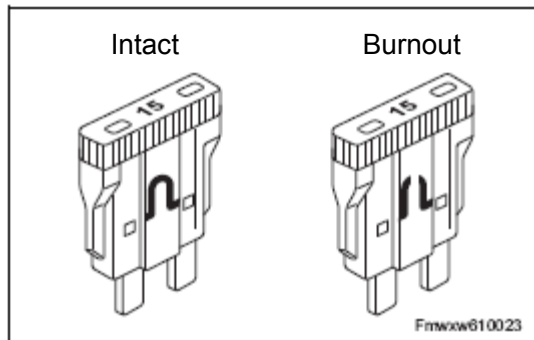
Circuit Diagram

Please refer to "Both Side Low Beams Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check fuse.

(a). Shut off main power.



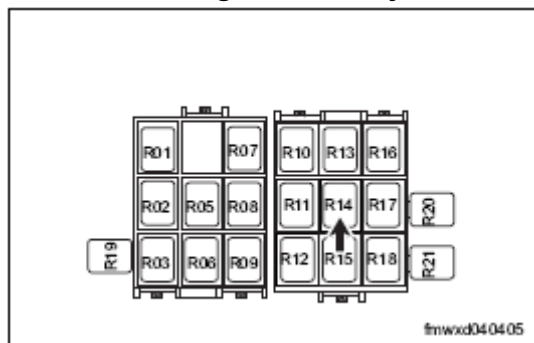
(b). Check fuses in cab fuse box: F12 (10A) and F13 (10A).

Is the fuse intact?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check high beam relay R14 in cab.



(a). Replace the high beam relay R14 with an intact relay of the same rating, turn on high beams and check if they are lit.

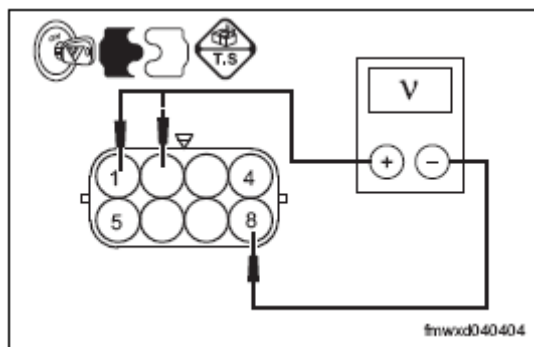
Are the high beams lit?

Yes > Replace high beam relay R14.

No > Go to Step 3.

3. Measure voltage of the circuit between Pin 2 and Pin 8 of left front combination lamp connector B017 or between Pin 1 and Pin 8 of right front combination lamp connector B041.

- (a). Remove left front combination lamp connector B017 or right front combination lamp connector B041.
- (b). Turn on main power.
- (c). Turn on high beams.



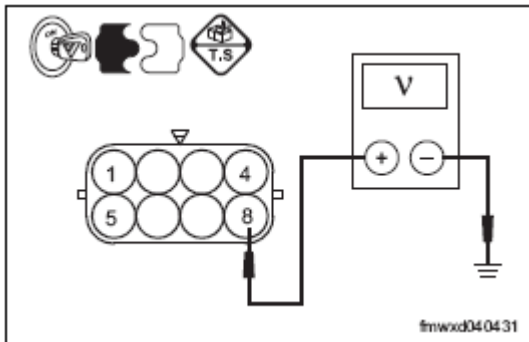
- (d). Use multimeter to measure the voltage of the circuit between Pin 2 and Pin 8 of left combination lamp connector B017 or between Pin 1 and Pin 8 of right combination lamp connector B041.

Standard voltage: Battery voltage

Is the inspection result normal?

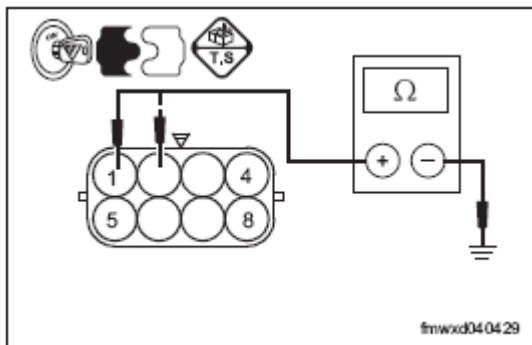
Yes > Replace bulb.

No > Go to Step 4.

4. Check high beam power circuit and ground circuit.

- (a). Use multimeter to measure the voltage of the circuit between Pin 8 of left front combination lamp connector B017 or Pin 8 of right front combination lamp connector B041 and the ground.

Standard voltage: Battery voltage



- (b). Use multimeter to measure the resistance of the circuit between Pin 2 of left front combination lamp connector B017 or Pin 1 of right front combination lamp connector B041 and the ground.

Resistance: $\leq 2 \Omega$

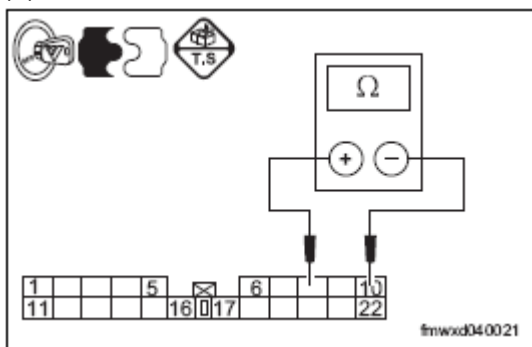
Are those circuits normal?

Yes > Repair high beam power circuit and ground circuit.

No > Go to Step 5.

5. Check combination switch.

- (a). Shut off main power.
(b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

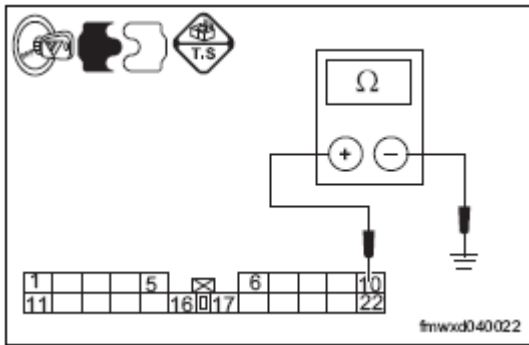
Condition	Multimeter Pin	Standard Value
High beams turned OFF	8-10	$> 10 \text{ M}\Omega$
High beams turned ON	8-10	$\leq 2 \Omega$

Is the inspection result normal?

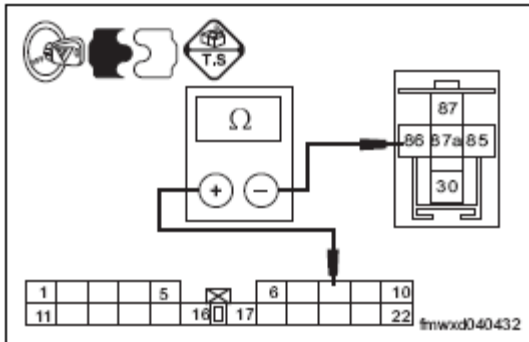
Yes > Go to Step 6.

No > Replace combination switch.

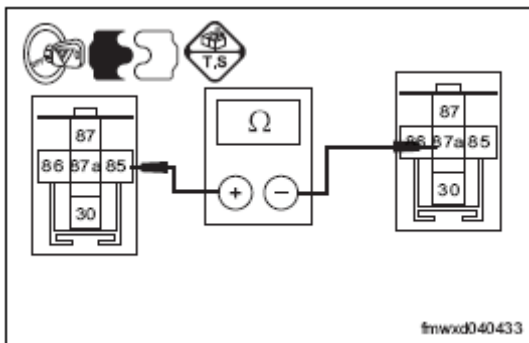
6. Check coil control circuit for high beam relay R14 on combination switch.



- (a). Use multimeter to measure the resistance of the circuit between Pin 10 of combination switch connector B011 and the effective ground point of body.



- (b). Use multimeter to measure the resistance of the circuit between Pin 8 of combination switch connector B011 and Pin 86 of high beam relay R14.



- (c). Use multimeter to measure the resistance of the circuit between Pin 87a of low beam relay R15 and Pin 85 of high beam relay R14.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Service power circuits of low beam relay R15 and high beam relay R14.

No > Repair or replace harness.

ONE SIDE HIGH BEAM ALWAYS ON

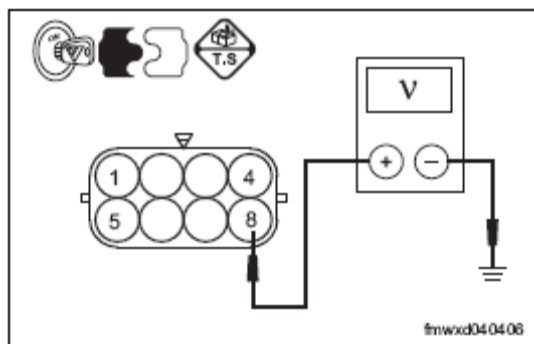
Circuit Diagram

Please refer to "Both Side Low Beams Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check power circuit of high beam bulb.

- (a). Shut off main power.
- (b). Remove high beam fuse in cab fuse box: F12 or F13.
- (c). Remove left front combination lamp connector B017 or right front combination lamp connector B041, and turn on main power and ignition switch.



- (d). Use multimeter to measure the voltage of the circuit between Pin 8 of left combination lamp connector B017 or Pin 8 of right combination lamp connector and the effective ground point of body.

Is the voltage equal to Zero?

Is the inspection result normal?

Yes > Replace cab fuse box.

No > Repair or replace harness relevant to short circuit to power supply.



BOTH SIDE HIGH BEAMS ALWAYS ON

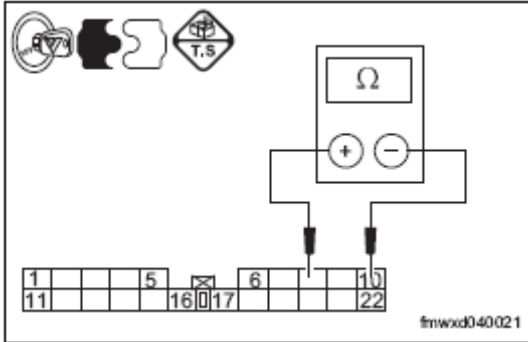
Circuit Diagram

Please refer to "Both Side Low Beams Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check combination switch.

- (a). Shut off main power.
- (b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
High beams turned OFF.	8-10	> 10 MΩ
High beams turned ON.	8-10	≤ 2 Ω

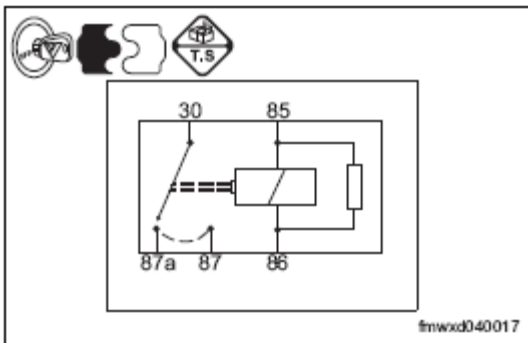
Is the inspection result normal?

Yes > Go to Step 2.

No > Replace combination switch.

2. Check if the high beam relay contact is normally closed.

- (a). Remove cab relay R14.



- (b). Use multimeter to measure the resistance of the circuit between Pin 30 and Pin 87 of high beam relay R14.

Resistance: > 10 MΩ

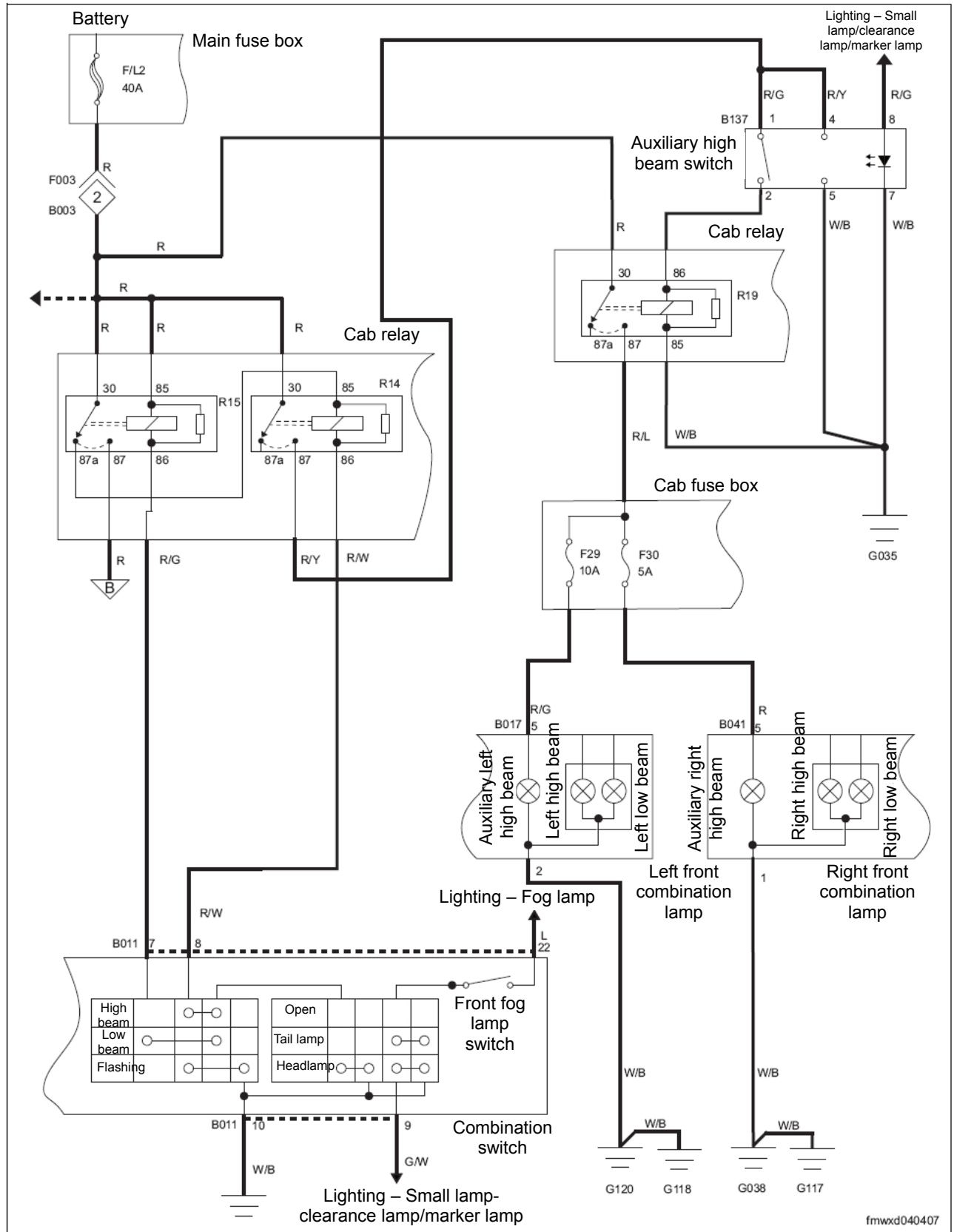
Is the inspection result normal?

Yes > Repair or replace harness.

No > Replace high beam relay R14.

AUXILIARY HIGH BEAM NOT LIT

Circuit Diagram



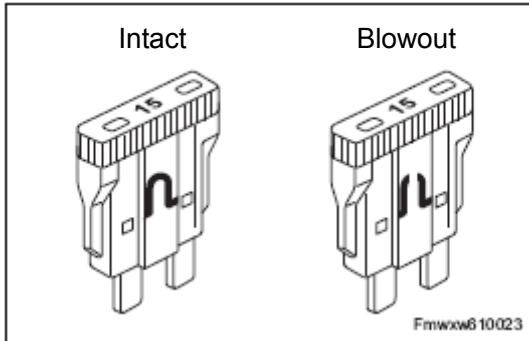
Diagnostic Procedures

Hint:

Check if high beam operates normally. If not, please refer to "Both High Beam not Lit" in this chapter.

1. Check fuse.

(a). Shut off main power.

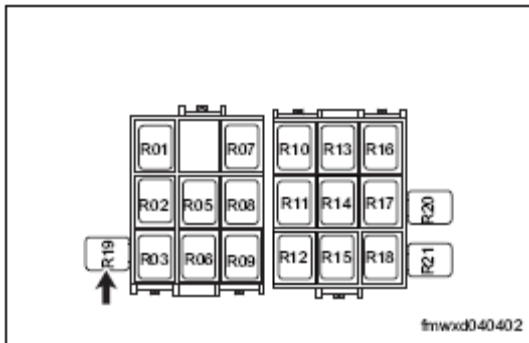


(b). Check fuses in cab fuse box: F29 (5A) and F30 (5A).

Is the fuse intact?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check cab relay R19 of auxiliary high beam.

(a). Replace the auxiliary high beam relay R19 with an intact relay of the same rating, turn on high beams and auxiliary high beams, and check if auxiliary high beams are lit.

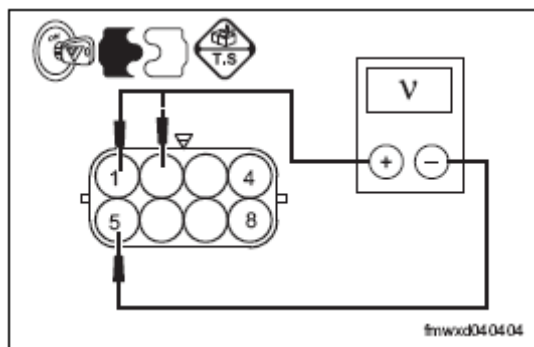
Are auxiliary high beams lit?

Yes > Replace auxiliary high beam relay R19.

No > Go to Step 3.

3. Measure voltage of the circuit between Pin 2 and Pin 5 of left front combination lamp connector B017 or between Pin 1 and Pin 5 of right front combination lamp connector B041.

- (a). Remove left front combination lamp connector B017 or right front combination lamp connector B041.
- (b). Turn on main power.
- (c). Turn on high beam and auxiliary high beam switch.



- (d). Use multimeter to measure the voltage of the circuit between Pin 2 and Pin 5 of left front combination lamp connector B017 or between Pin 1 and Pin 5 of right front combination lamp connector B041.

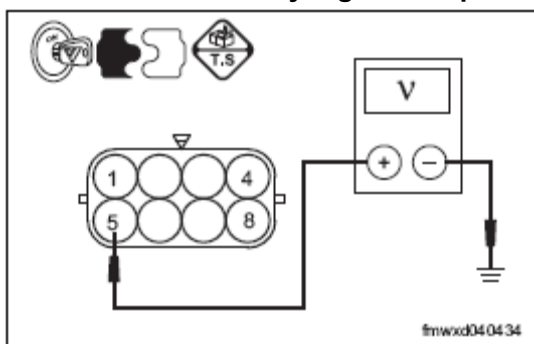
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace bulb.

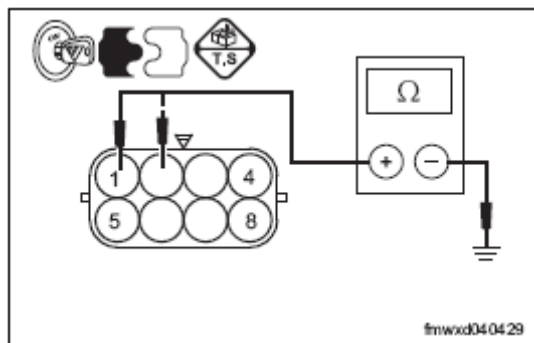
No > Go to Step 4.

4. Check auxiliary high beam power circuit and ground circuit.



- (a). Use multimeter to measure the voltage of the circuit between Pin 5 of left front combination lamp connector B017 or Pin 5 of right front combination lamp connector B041 and the ground.

Standard voltage: Battery voltage



- (b). Use multimeter to measure the resistance of the circuit between Pin 2 of left front combination lamp connector B017 or Pin 1 of right front combination lamp connector B041 and the ground.

Resistance: $\leq 2 \Omega$

Are those circuits normal?

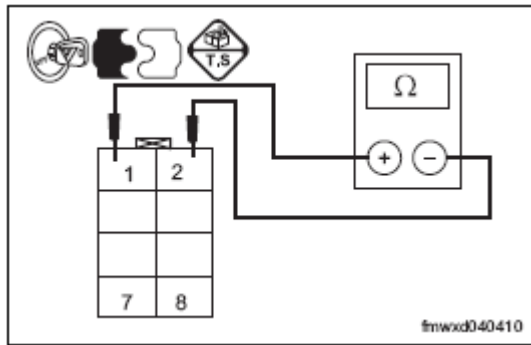
Yes > Go to Step 5.

No > Service auxiliary high beam power circuit and ground circuit.

5. Check auxiliary high beam switch.

- (a). Shut off main power.
- (b). Remove auxiliary high beam switch connector B137.





(c). Check auxiliary high beam switch.

Standard value:

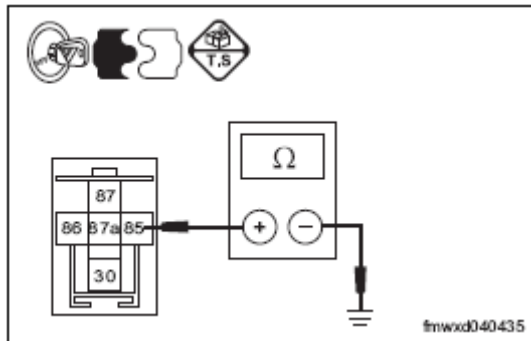
Condition	Multimeter Pin	Standard Value
Auxiliary high beams turned OFF	1 -2	$> 10 \text{ M}\Omega$
Auxiliary high beams turned ON	1 -2	$\leq 2 \Omega$

Is the inspection result normal?

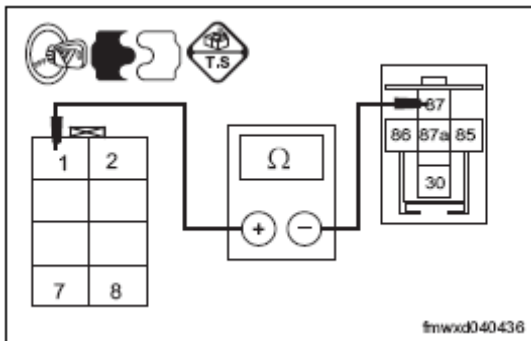
Yes > Go to Step 6.

No > Replace auxiliary high beam switch.

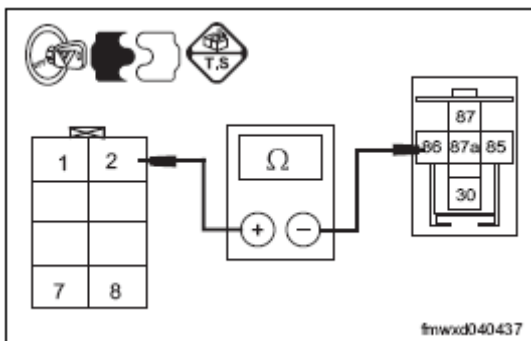
6. Check control circuit for auxiliary high beam R19 coil.



(a). Use multimeter to measure the resistance of the circuit between Pin 85 of auxiliary high beam relay R19 and the effective ground point of body.



(b). Use multimeter to measure the resistance of the circuit between Pin 1 of auxiliary high beam switch connector B137 and Pin 87 of high beam relay R14.



(c). Use multimeter to measure the resistance of the circuit between Pin 2 of auxiliary high beam switch connector B137 and Pin 86 of auxiliary high beam relay R19.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Confirm the system is normal.

No > Repair or replace harness.

BOTH SIDE LOW AND HIGH BEAMS NOT LIT

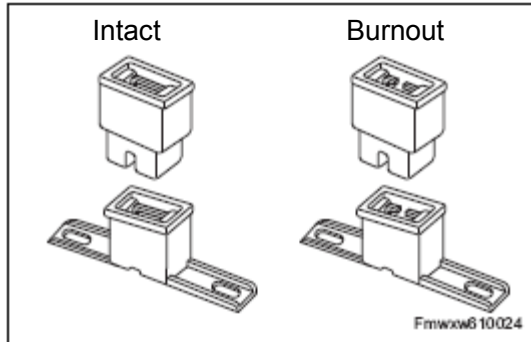
Circuit Diagram

Please refer to "Both Side Low Beams Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check fuse.

(a). Shut off main power.



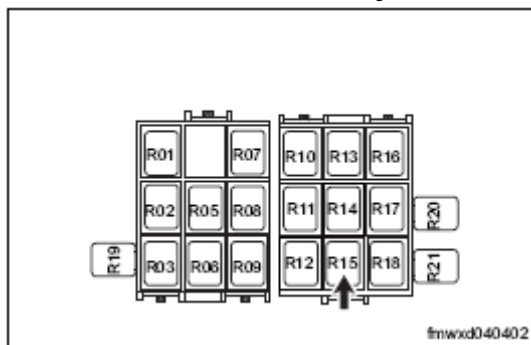
(b). Check fuse in front cover fuse box: F/L2 (40A).

Is the fuse intact?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check low beam relay R15.



(a). Replace the low beam relay R15 with an intact relay of the same rating, turn on low beams and check if both high and low beams are lit.

Are high and low beams lit?

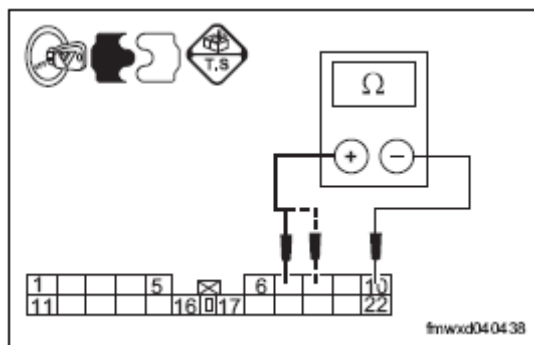
Yes > Replace low beam relay R15.

No > Go to Step 3.

3. Check combination switch.

(a). Shut off main power.

(b). Remove combination switch connector B011.



(c). Check combination switch.

Standard value:

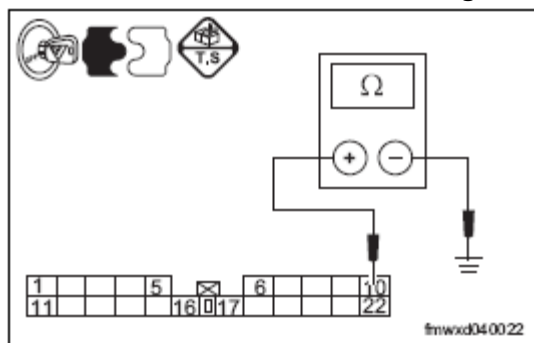
Condition	Multimeter Pin		Standard Value
Low and high beams turned OFF	8 -10	7 -10	$> 10 \text{ M}\Omega$
Low beams turned ON	-	7 -10	$\leq 2 \Omega$
	8 -10	-	$> 10 \text{ M}\Omega$
High beams turned ON	8 -10	-	$\leq 2 \Omega$
	-	7 -10	$> 10 \text{ M}\Omega$

Is the inspection result normal?

Yes > Go to Step 4.

No > Replace combination switch.

4. Check combination switch ground circuit.



(a). Use multimeter to measure the resistance of the circuit between Pin 10 of combination switch connector B011 and the effective ground point of body.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Service power circuits of low beam relay R15 and high beam relay R14.

No > Repair or replace harness.

ONE SIDE FRONT FOG LAMP NOT LIT

Circuit Diagram

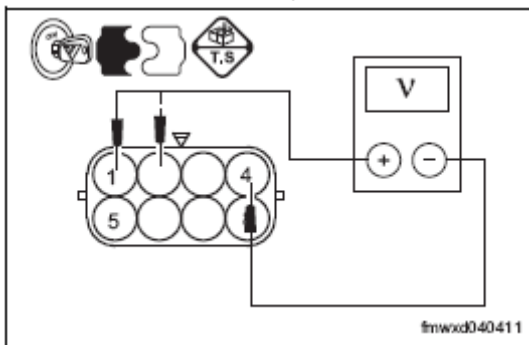
Please refer to "Both Side Front Fog Lamps Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

Hint:

Check if small lamps are normal before inspection of fog lamps. If not, please repair small lamps first.

1. **Check voltage of the circuit between Pin 1 and Pin 4 of left front combination lamp connector B017 or between Pin 2 and Pin 4 of right front combination lamp connector B041.**
 - (a). Remove left front combination lamp connector B017 or right front combination lamp connector B041.
 - (b). Turn on front fog lamps.



- -
 - (c). Use multimeter to measure the voltage of the circuit between Pin 1 and Pin 4 of left front combination lamp connector B017 or between Pin 2 and Pin 4 of right front combination lamp connector B041.

Standard voltage: Battery voltage

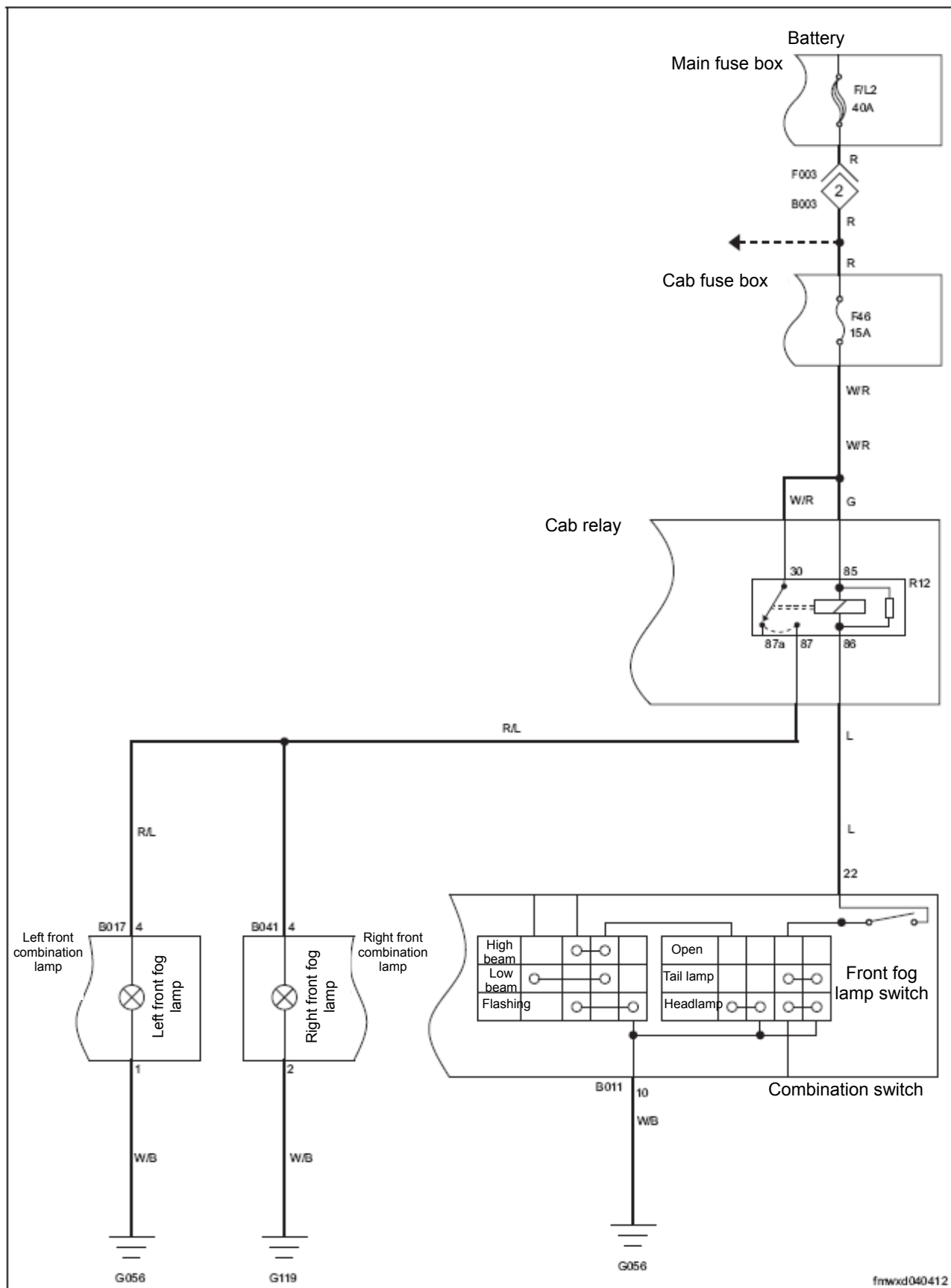
Is the inspection result normal?

Yes > Replace bulb.

No > Repair or replace harness.

BOTH SIDE FRONT FOG LAMPS NOT LIT

Circuit Diagram



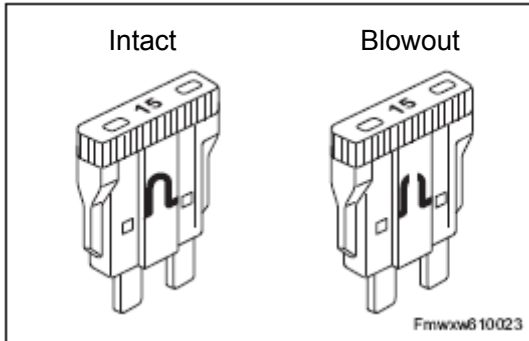
Diagnostic Procedures

Hint:

Check if small lamps are normal before inspection of fog lamps. If not, please repair small lamps first.

1. Check fuse F46.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F46 (15A).

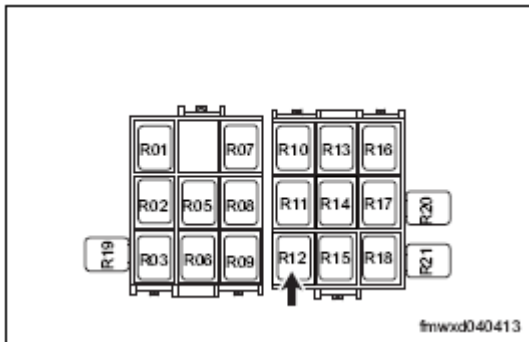
Is the inspection result normal?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check front fog lamp relay R12 in cab.

(a). Turn on main power.



(b). Replace the relay R15 with an intact relay of the same rating, turn on small lamps and front fog lamps, and check if they are lit.

Are front fog lamps lit?

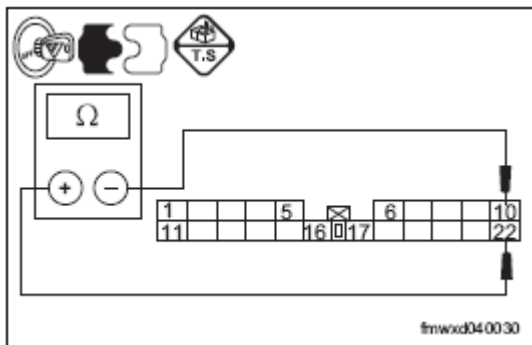
Yes > Replace front fog lamp relay R12.

No > Go to Step 3.

3. Check front fog lamp switch.

(a). Shut off main power.

(b). Remove combination switch connector B011.



(c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Front fog lamps turned OFF	22-10	$> 10 \text{ M}\Omega$
Front fog lamps turned ON	22-10	$\leq 2 \Omega$

Is the inspection result normal?

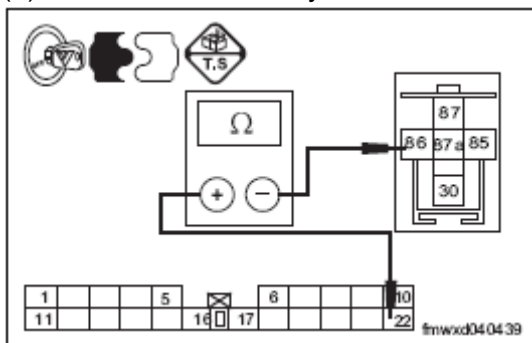
Yes > Go to Step 4.

No > Replace combination switch.

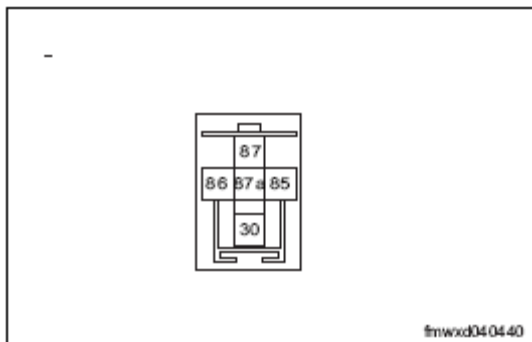
4. Check circuit.

(a). Remove combination switch connector B011.

(b). Remove cab relay R12.



(c). Use multimeter to measure the resistance of the harness between Pin 22 of combination switch connector B011 and Pin 85 of cab relay R12 connector.



(d). Use multimeter to measure the resistance of the harness between cab fuse F46 output terminal and Pin 86 of cab relay R12 connector.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 5.

No > Repair or replace harness.

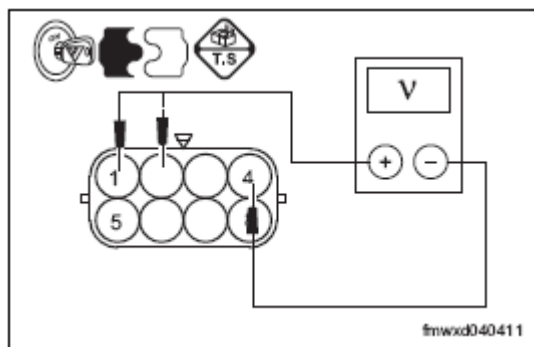
5. Measure voltage of the circuit between Pin 1 and Pin 4 of left combination lamp connector B017 or between Pin 2 and Pin 4 of right combination lamp connector B041.

(a). Remove combination lamp connector B017 or B041.

(b). Turn on main power.

(c). Turn on front fog lamps.





- (d). Use multimeter to measure the voltage of the circuit between Pin 1 and Pin 4 of left combination lamp connector B017 or between Pin 2 and Pin 4 of right combination lamp connector B041.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace bulb.

No > Repair or replace harness.

FRONT FOG LAMPS ALWAYS ON

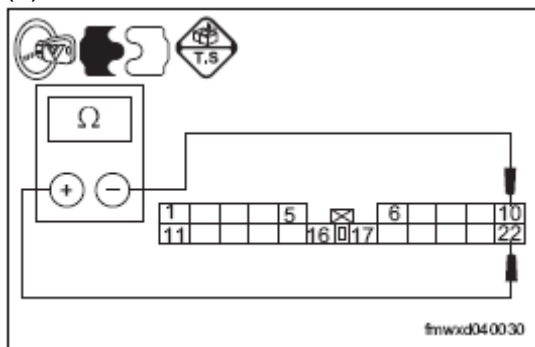
Circuit Diagram

Please refer to "Both Side Front Fog Lamps Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check combination switch.

- (a). Shut off main power.
- (b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Fog lamps turned OFF	22-10	> 10 MΩ
Fog lamps turned ON	22-10	≤ 2 Ω

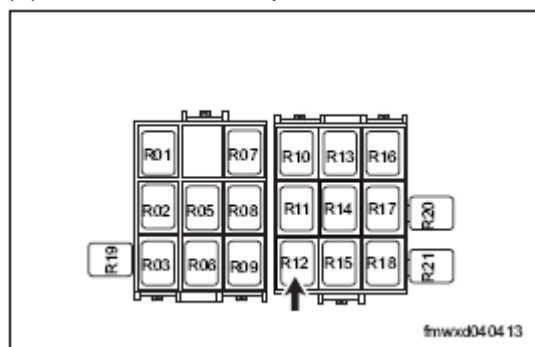
Is the inspection result normal?

Yes > Go to Step 2.

No > Replace combination switch.

2. Check front fog lamp relay R12 in cab.

- (a). Turn on main power.



- (b). Remove front fog lamp relay R12 and check if front fog lamps are always lit.

Are front fog lamps always lit?

Yes > Eliminate short circuit to power supply of harness between Pin 87 of front fog lamp relay R12 and Pin 4 of front combination lamp connector B017 or B041.

No > Replace front fog lamp relay R12.

ONE SIDE REAR FOG LAMP NOT LIT

Circuit Diagram

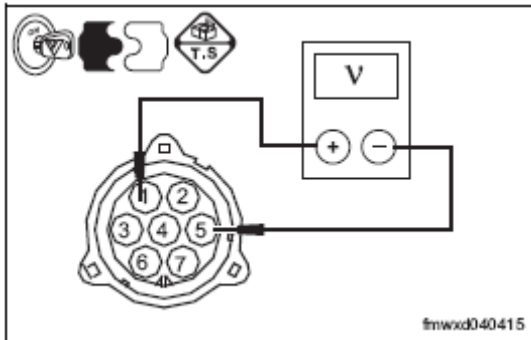
Please refer to "Both Side Rear Fog Lamps Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check voltage of the circuit between Pin 1 and Pin 5 of left rear combination lamp connector T013 or between Pin 1 and Pin 5 of right rear combination lamp connector T012.

- (a). Remove left rear combination lamp connector T013 or right rear combination lamp connector T012.

- (b). Turn on rear fog lamps.



- (c). Use multimeter to measure the voltage of the circuit between Pin 1 and Pin 5 of left rear combination lamp connector T013 or between Pin 1 and Pin 5 of right rear combination lamp connector T012.

Standard voltage: Battery voltage

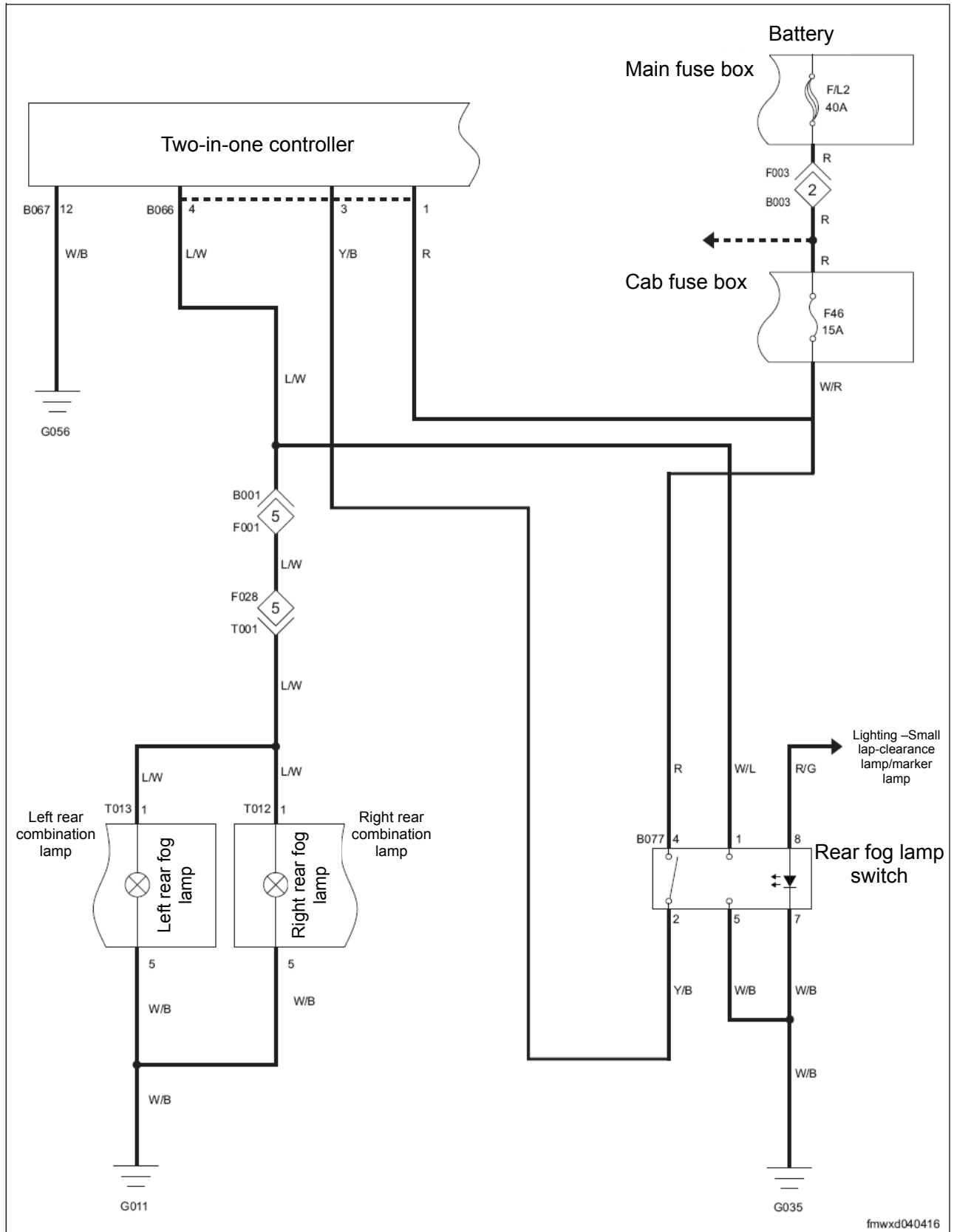
Is the inspection result normal?

Yes > Replace rear fog lamp bulb.

No > Repair or replace harness.

BOTH SIDE REAR FOG LAMPS NOT LIT

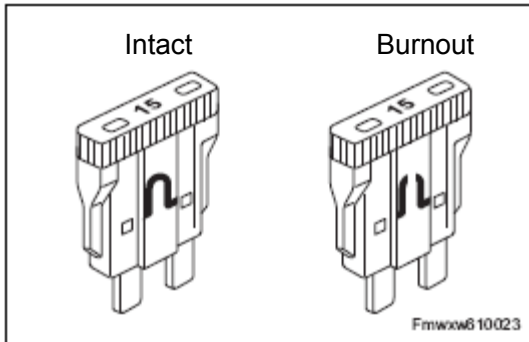
Circuit Diagram



Diagnostic Procedures

1. Check fuse F46.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F46 (15A).

Is the inspection result normal?

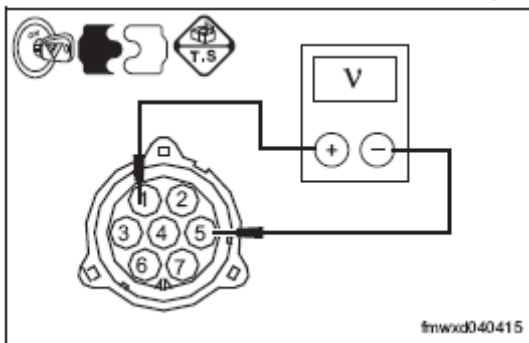
Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check voltage of the circuit between Pin 1 and Pin 5 of left rear combination lamp connector T013 or between Pin 1 and Pin 5 of right rear combination lamp connector T012.

(a). Remove left rear combination lamp connector T013 and right rear combination lamp connector T012.

(b). Turn on main power and rear fog lamps.



(c). Use multimeter to measure the voltage of the circuit between Pin 1 and Pin 5 of left rear combination lamp connector T013 or between Pin 1 and Pin 5 of right rear combination lamp connector T012.

Standard voltage: Battery voltage

Is the inspection result normal?

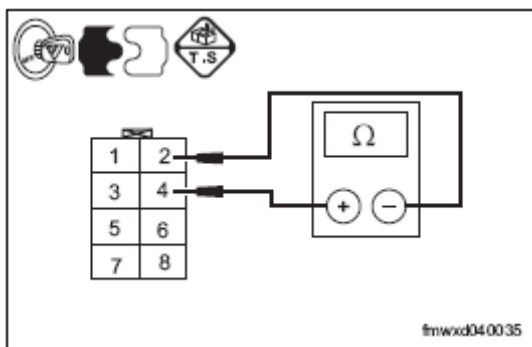
Yes > Go to Step 3.

No > Replace rear fog lamp bulb.

3. Check rear fog lamp switch.

(a). Shut off main power.

(b). Remove rear fog lamp switch connector B077.



(c). Check rear fog lamp switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Rear fog lamps turned OFF	4 -2	$\leq 2 \Omega$
Rear fog lamps turned ON	4 -2	$> 10 M\Omega$

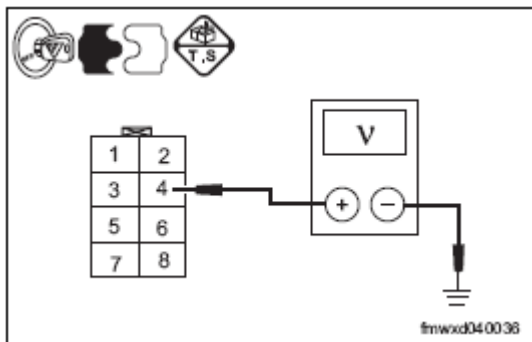
Is the inspection result normal?

Yes > Go to Step 4.

No > Replace rear fog lamp switch.

4. Check voltage of the circuit between Pin 4 of rear fog lamp switch connector B077 and the effective ground point of body.

(a). Turn on main power.



(b). Use multimeter to measure the voltage of the circuit between Pin 4 of rear fog lamp switch connector B077 and the effective ground point of body.

04

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 5.

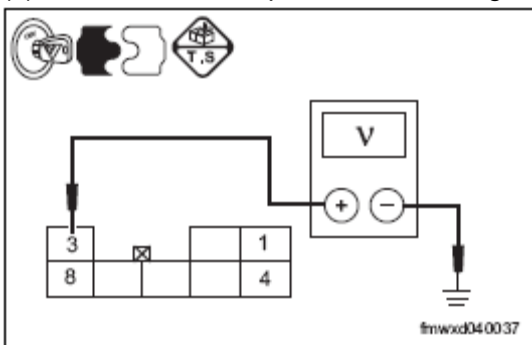
No > Repair or replace harness.

5. Check voltage of the circuit between Pin 3 of two-in-one controller connector B066 and the effective ground point of body.

(a). Shut off main power.

(b). Remove two-in-one controller connector B066.

(c). Turn on main power and rear fog lamps.



(d). Use multimeter to measure the voltage of the circuit between Pin 3 of two-in-one controller connector B066 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

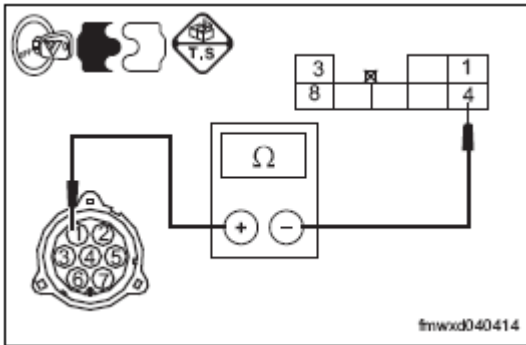
Yes > Go to Step 6.

No > Service harness between Pin 2 of rear fog lamp switch connector B077 and Pin 3 of two-in-one controller connector B066.

6. Check harness between Pin 4 of two-in-one controller connector B066 and Pin 1 of rear combination lamp connector T012 or T013.

(a). Shut off main power.

(b). Remove rear combination lamp connector T012 and T013.



(c). Use multimeter to measure the resistance of the circuit between Pin 4 of two-in-one controller connector B066 and Pin 1 of rear combination lamp connector T012 or T013.

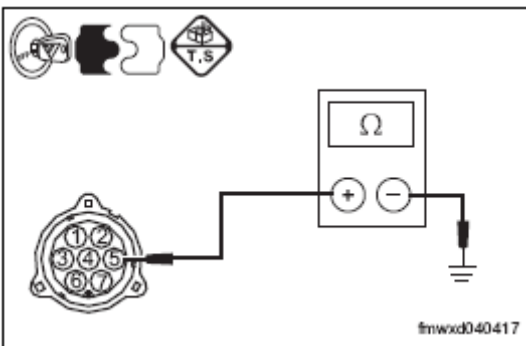
Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 7.

No > Repair or replace harness.

7. Check harness between Pin 5 of rear combination lamp connector T012 or T013 and the ground.



(a). Use multimeter to measure the resistance of the harness between Pin 5 of rear combination lamp connector T012 or T013 and the ground G011.

Resistance: $\leq 2 \Omega$

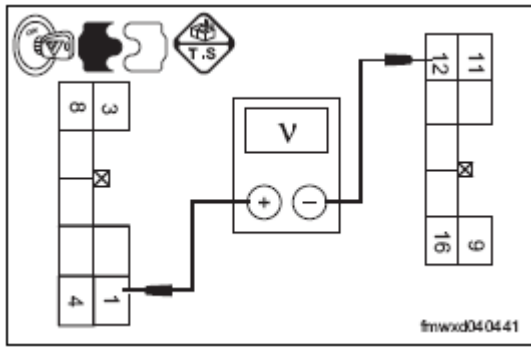
Is the inspection result normal?

Yes > Go to Step 8.

No > Repair or replace harness.

8. Check two-in-one controller power circuit and ground circuit.

(a). Remove two-in-one controller connector B066 or B067.



- (b). Use multimeter to measure the voltage of the circuit between Pin 1 of two-in-one controller connector B066 and Pin 12 of two-in-one controller B067.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace two-in-one controller.

No > Repair or replace harness.

REAR FOG LAMPS ALWAYS ON

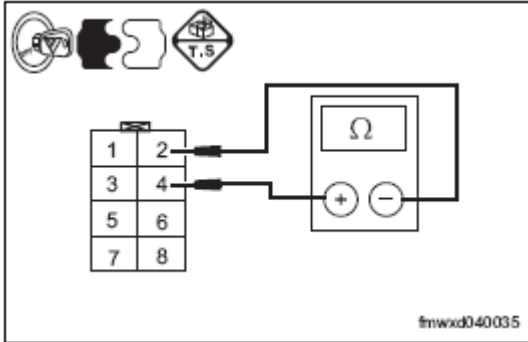
Circuit Diagram

Please refer to "Both Side Rear Fog Lamps Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check rear fog lamp switch.

- (a). Shut off main power.
- (b). Remove rear fog lamp switch connector B077.



- (c). Check rear fog lamp switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Rear fog lamps turned ON	4-2	$\leq 2 \Omega$
Rear fog lamps turned OFF	4-2	$> 10 M\Omega$

Resistance: $\leq 2 \Omega$

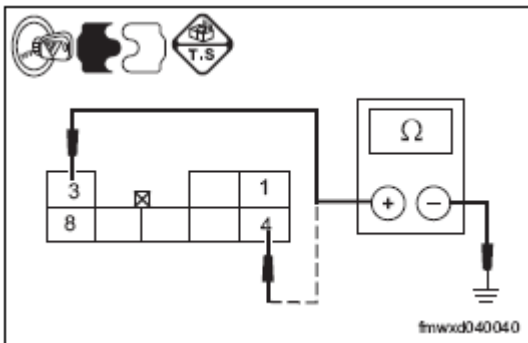
Is the inspection result normal?

Yes > Go to Step 2.

No > Replace rear fog lamp switch.

2. Check circuit.

- (a). Remove two-in-one controller connector B066.
- (b). Remove rear combination lamp connector T013 or T012.



- (c). Use multimeter to measure the resistance of the circuit between Pin 3 or 4 of two-in-one controller connector B066 and the effective ground point of body.

Resistance: $> 10 M\Omega$

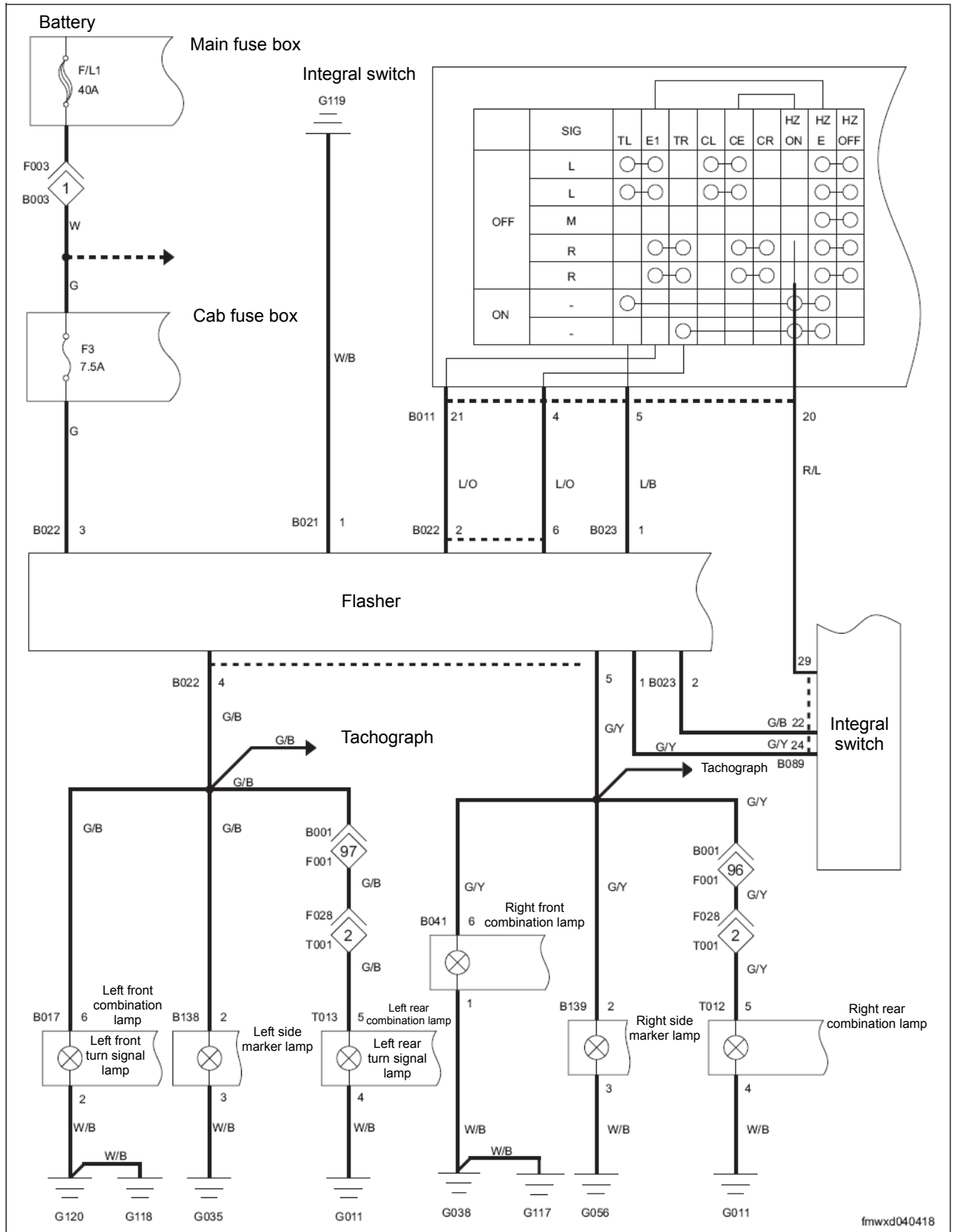
Is the inspection result normal?

Yes > Replace two-in-one controller.

No > Repair or replace harness.

TURN SIGNAL LAMPS AND WARNING LAMP NOT FLICKERING

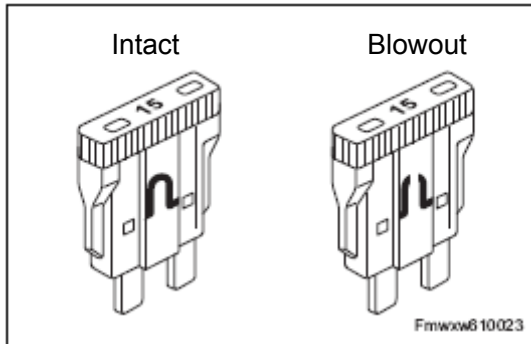
Circuit Diagram



Diagnostic Procedures

1. Check fuse.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F3 (7.5A).

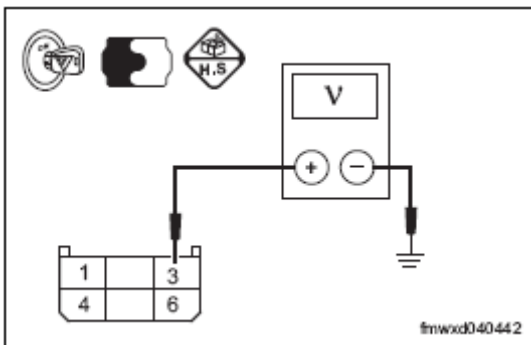
Is the fuse intact?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

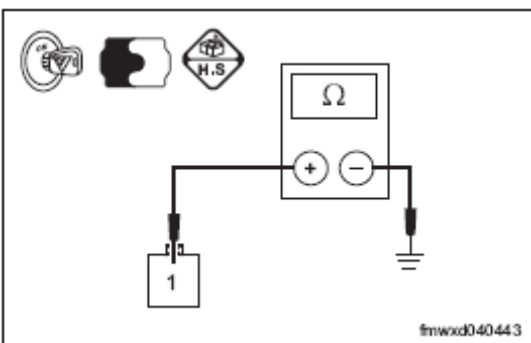
2. Check flasher power circuit and ground circuit.

(a). Turn ignition switch to ON.



(b). Use multimeter to measure the voltage of the circuit between Pin 3 of flasher connector B022 and the ground.

Standard voltage: Battery voltage



(c). Use multimeter to measure the resistance of the circuit between Pin 1 of flasher connector B021 and the ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

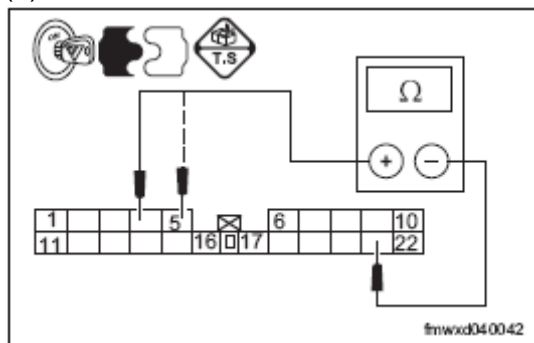
Yes > Go to Step 3.

No > Service flasher power circuit and ground circuit.

3. Check combination switch.

(a). Shut off main power.

(b). Remove combination switch connector B011.



(c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Left turn signal lamp turned ON	5-21	$\leq 2 \Omega$
Right turn signal lamp turned ON	4-21	$\leq 2 \Omega$
Turn signal lamp turned OFF	5-21 4-21	$> 10 \text{ M}\Omega$
Warning lamp turned ON	5-21 4-21	$\leq 2 \Omega$
Warning lamp turned OFF	5-21 4-21 21-22	$> 10 \text{ M}\Omega$

Is the inspection result normal?

Yes > Replace all turn signal lamp bulbs or flasher.

No > Replace combination switch.

ONE SIDE TURN SIGNAL LAMP NOT FLICKERING

Circuit Diagram

Please refer to "Turn Signal Lamps and Warning Lamp Not Flickering - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check bulb.

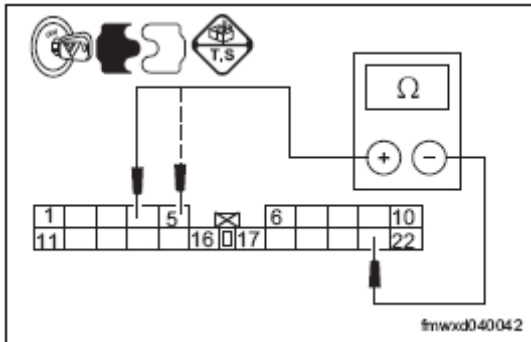
- (a). Check bulb for damage.

Yes > Replace bulb.

No > Go to Step 2.

2. Check combination switch.

- (a). Shut off main power.
(b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Left turn signal lamp turned ON	5-21	$\leq 2 \Omega$
Right turn signal lamp turned ON	4-21	$\leq 2 \Omega$
Turn signal lamp turned OFF	5-21 4-21	$> 10 M\Omega$

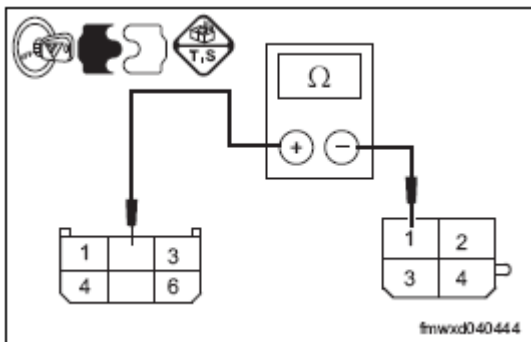
Is the inspection result normal?

Yes > Go to Step 3.

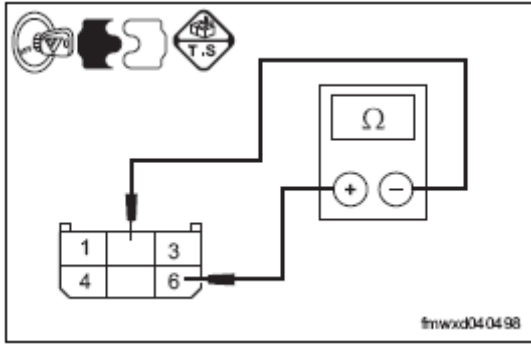
No > Replace combination switch.

3. Check flasher control circuit.

- (a). Connect combination switch connector B011 and remove flasher connectors B022 and B023.



- (b). With left turn signal lamp turned ON, use multimeter to measure the resistance of the circuit between Pin 1 of flasher connector B023 and Pin 2 of flasher connector B022.



- (c). Or, with right turn signal lamp turned ON, use multimeter to measure the resistance of the circuit between Pin 6 and Pin 2 of flasher connector B022.

Resistance: $\leq 2 \Omega$

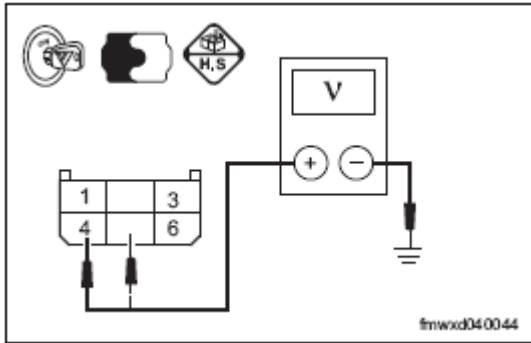
Is the inspection result normal?

Yes > Go to Step 4.

No > Service circuit between flasher and combination switch.

4. Check flasher output circuit.

- (a). Turn on main power and ignition switch.



- (b). With left turn signal lamp turned ON, use multimeter to measure the voltage of the circuit between Pin 4 of flasher connector B022 and the effective ground point of body.
- (c). Or, with right turn signal lamp turned ON, use multimeter to measure the voltage of the circuit between Pin 5 of flasher connector B022 and the effective ground point of body.

Is the battery voltage displayed on the multimeter intermittently?

Yes > Replace turn signal lamp bulbs at the failure side or replace relevant harness.

No > Replace flasher.

WARNING LAMP NOT FLICKERING (TURN SIGNAL LAMP NORMAL)

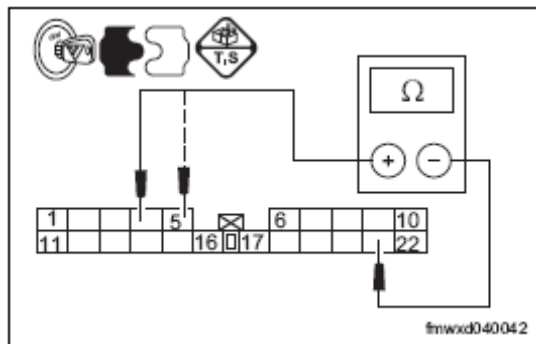
Circuit Diagram

Please refer to "Turn Signal Lamps and Warning Lamp Not Flickering - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check combination switch.

- (a). Shut off main power.
- (b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Warning lamp turned ON	4-21 5-21	$\leq 2 \Omega$
Warning lamp turned OFF	4-21 5-21	$> 10 M\Omega$

Is the inspection result normal?

Yes > Replace flasher.

No > Replace combination switch.



ONE SIDE TURN SIGNAL LAMP ALWAYS FLICKERING

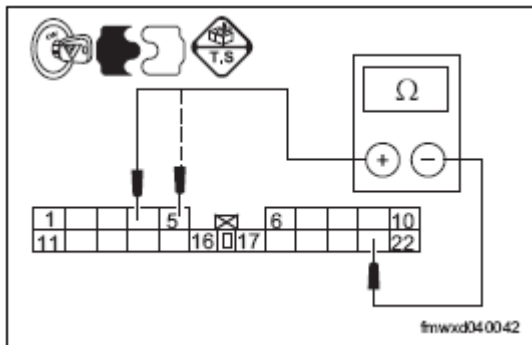
Circuit Diagram

Please refer to "Turn Signal Lamps and Warning Lamp Not Flickering - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check combination switch.

- (a). Shut off main power.
- (b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Left turn signal lamp turned ON	5-21	$\leq 2 \Omega$
Right turn signal lamp turned ON	4-21	$\leq 2 \Omega$
Turn signal lamp turned OFF	5-21 4-21	$> 10 M\Omega$

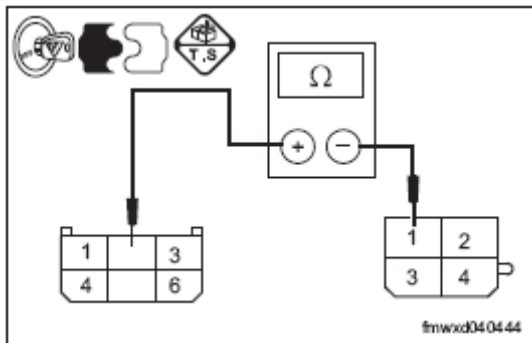
Is the inspection result normal?

Yes > Go to Step 2.

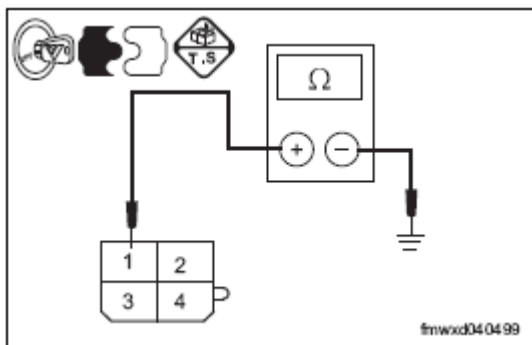
No > Replace combination switch.

2. Check flasher control circuit.

- (a). Connect combination switch connector B011, remove flasher connector B022 or B023, with combination switch OFF.

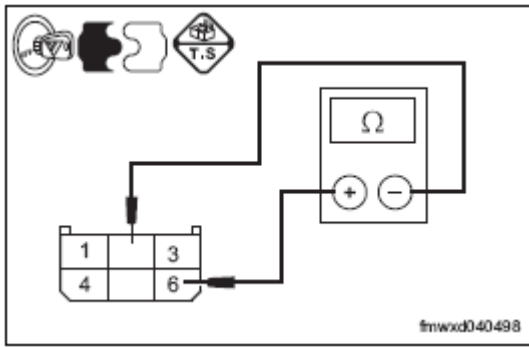


- (b). Use multimeter to measure the resistance of the circuit between Pin 1 of flasher connector B023 and Pin 2 of flasher connector B022.

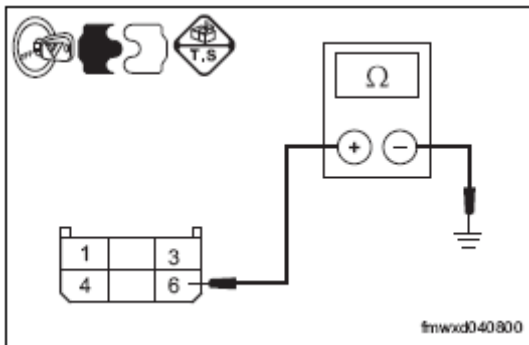


- (c). Use multimeter to measure the resistance of the circuit between Pin 1 of flasher connector B023 and the ground.





- (d). Or, use multimeter to measure the resistance of the circuit between Pin 6 and Pin 2 of flasher connector B022.



- (e). Or, use multimeter to measure the resistance of the circuit between Pin 6 of flasher connector B022 and the ground.

Resistance: > 10 MΩ

Is the inspection result normal?

Yes > Go to Step 3.

No > Service circuit between flasher and combination switch.

3. Check flasher.

- Turn on main power and ignition switch.
- Remove flasher connector B022 or B023 with combination switch OFF.

Is the fault still existed?

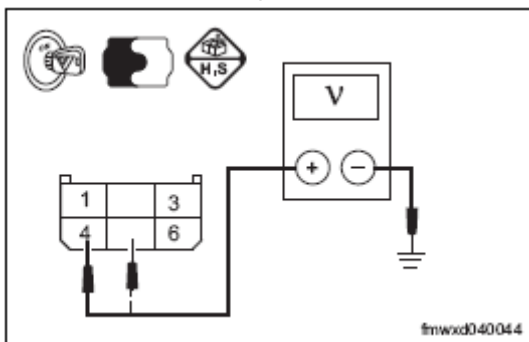
Yes > Go to Step 4.

No > Replace flasher.

4. Check flasher output circuit.

Hint:

Conduct the following procedures for troubleshooting.



- Use multimeter to measure the voltage of the circuit between Pin 4 of flasher connector B022 and the effective ground point of body.
- Use multimeter to measure the voltage of the circuit between Pin 5 of flasher connector B022 and the effective ground point of body.

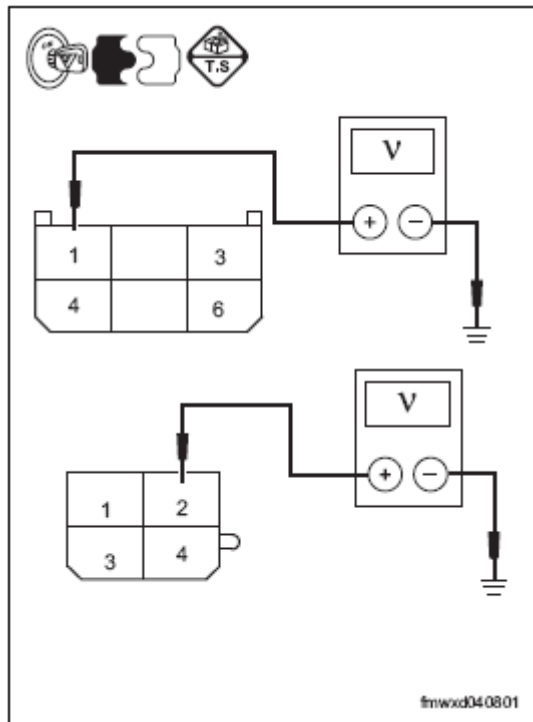
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 5.

No > Repair or replace one side turn signal lamp circuit for removal of short circuit to power supply.

5. Check turn signal lamp indicator circuit



- (a). Use multimeter to measure the voltage of the circuit between Pin 1 of flasher connector B022 and the effective ground point of body.
- (b). Use multimeter to measure the voltage of the circuit between Pin 2 of flasher connector B023 and the effective ground point of body.

Is the voltage equivalent to battery voltage?

Yes > Repair or replace turn signal lamp indicator circuit that is short to power supply.

No > System is normal.



BOTH SIDE TURN SIGNAL LAMPS ALWAYS FLICKERING

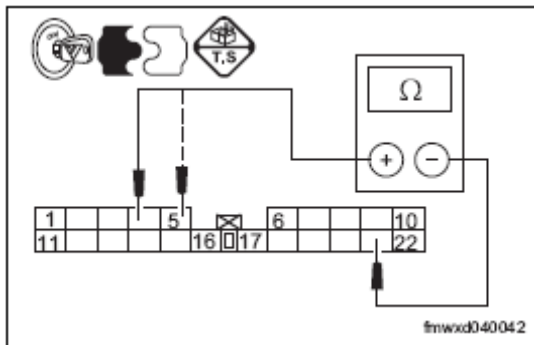
Circuit Diagram

Please refer to "Turn Signal Lamps and Warning Lamp Not Flickering - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check combination switch.

- (a). Shut off main power.
- (b). Remove combination switch connector B011.



- (c). Check combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Left turn signal lamp turned ON	5-21	$\leq 2 \Omega$
Right turn signal lamp turned ON	4-21	$\leq 2 \Omega$
Turn signal lamp turned OFF	5-21 4-21	$> 10 M\Omega$
Warning lamp turned ON	5-21 4-21	$\leq 2 \Omega$
Warning lamp turned OFF	5-21 4-21 21-20	$> 10 M\Omega$

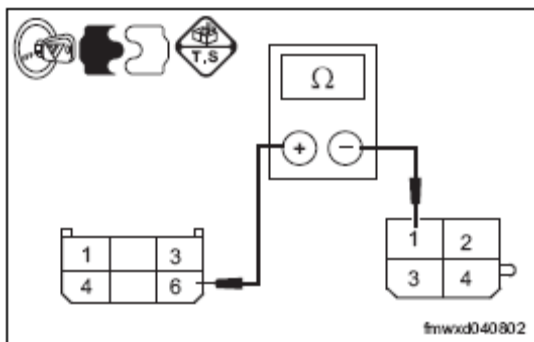
Is the inspection result normal?

Yes > Repair or replace harness.

No > Replace combination switch.

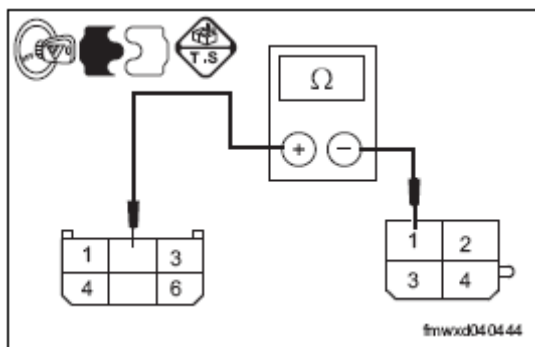
2. Check flasher control circuit.

- (a). Connect combination switch connector B011, remove flasher connector B022 and B023, with combination switch off.

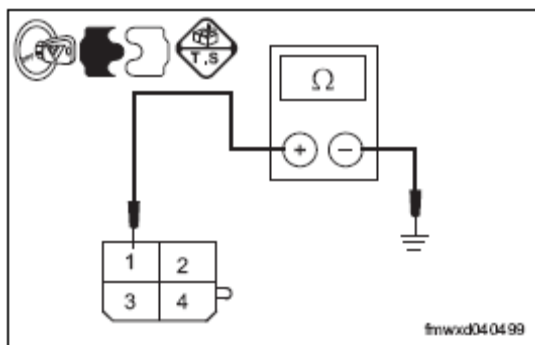


- (b). Use multimeter to measure the resistance of the circuit between Pin 1 of flasher connector B023 and Pin 6 of flasher connector B022.

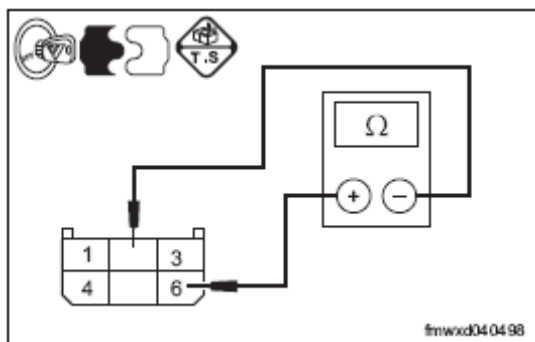




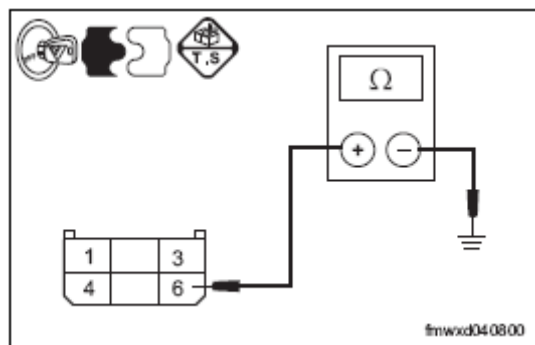
- (c). Use multimeter to measure the resistance of the circuit between Pin 1 of flasher connector B023 and Pin 2 of flasher connector B022.



- (d). Use multimeter to measure the resistance of the circuit between Pin 1 of flasher connector B023 and the ground.



- (e). Or, use multimeter to measure the voltage of the circuit between Pin 6 and Pin 2 of flasher connector B022.



- (f). Or, use multimeter to measure the resistance of the circuit between Pin 6 of flasher connector B022 and the ground.

Resistance: > 10 MΩ

Is the inspection result normal?

Yes > Replace flasher.

No > Service the circuit between flasher and combination switch.



ONE SIDE BRAKE LAMP NOT LIT

Circuit Diagram

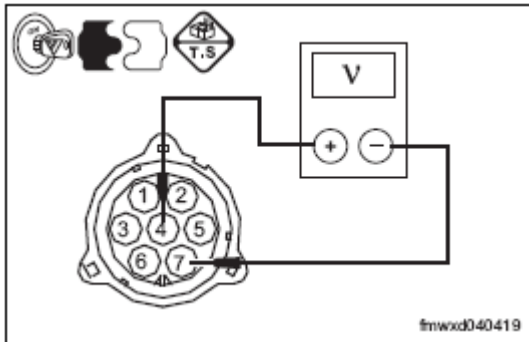
Please refer to "Both Side Brake Lamps Not Lit- Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check voltage of circuit between Pin 7 and Pin 4 of left rear combination lamp connector T013 or between Pin 7 and Pin 4 of right rear combination lamp connector T012.

(a). Remove left rear combination lamp connector T013 or right rear combination lamp connector T012.

(b). Turn ignition switch to ON.



(c). With brake pedal depressed, use multimeter to measure the voltage of the circuit between Pin 7 and Pin 4 of left rear combination lamp connector T013 or between Pin 7 and Pin 4 of right rear combination lamp connector T012.

Standard voltage: Battery voltage

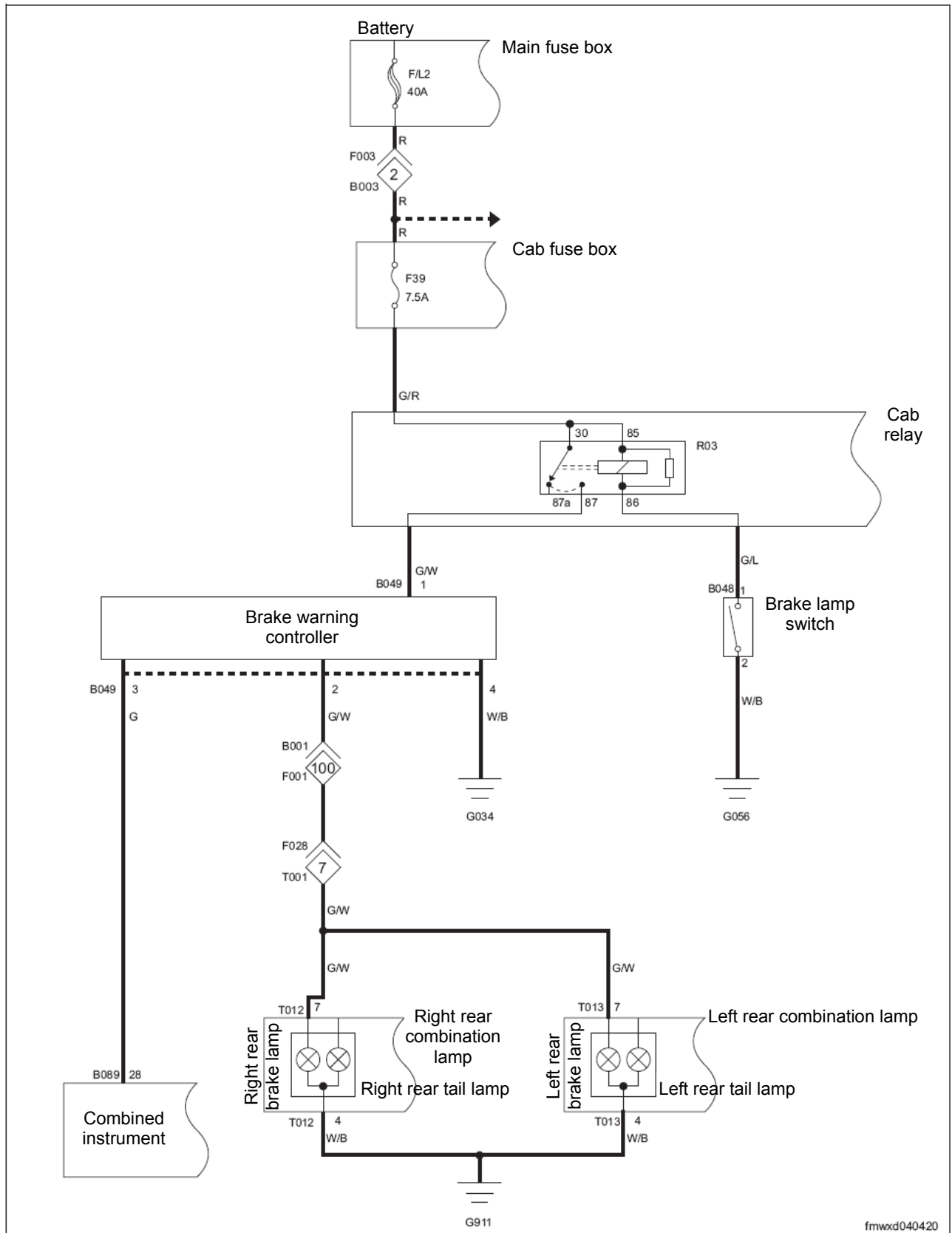
Is the inspection result normal?

Yes > Replace bulb.

No > Repair or replace harness.

BOTH SIDE BRAKE LAMPS NOT LIT

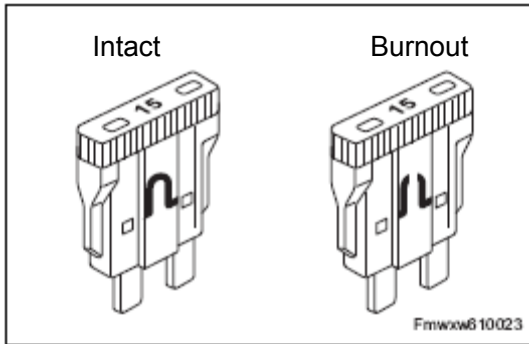
Circuit Diagram



Diagnostic Procedures

1. Check fuse.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F39 (7.5A).

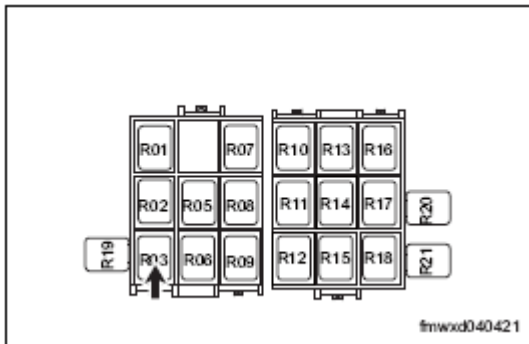
Is the fuse intact?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check brake lamp relay R03.

(a). Turn on main power and ignition switch.



(b). Replace the brake lamp relay R03 with an intact relay of the same rating and depress the brake pedal to check if the brake lamps operate normally.

Are brake lamps lit?

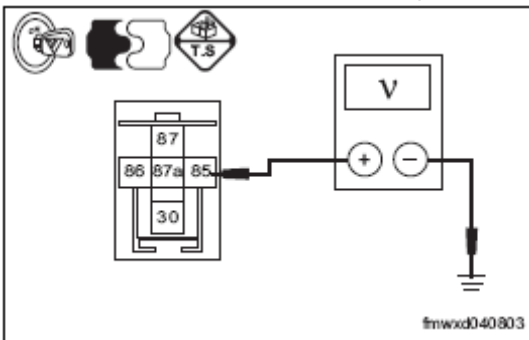
Yes > Replace brake lamp relay R03.

No > Go to Step 3.

3. Check power circuit of brake lamp relay R03 coil.

(a). Turn off the main power and remove brake lamp relay R03.

(b). Turn on main power and ignition switch.



(c). Use multimeter to measure the voltage of the circuit between Pin 85 of brake lamp relay R03 and the effective ground point of body.

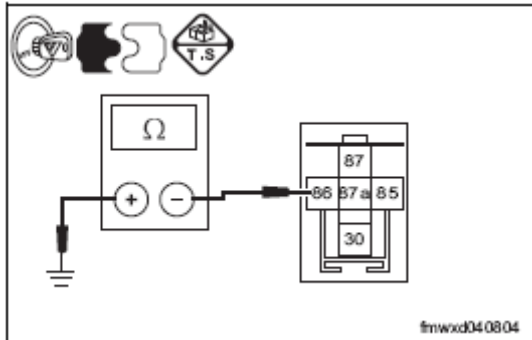
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 4.

No > Repair or replace harness.

4. Check ground circuit of brake lamp relay R03 coil.



- (a). With brake pedal depressed, use multimeter to measure the resistance of the circuit between Pin 86 of brake lamp relay R03 connector and the effective ground point of body.

Resistance: $\leq 2 \Omega$

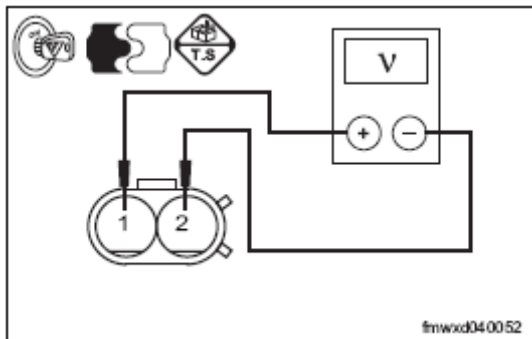
Is the inspection result normal?

Yes > Go to Step 6.

No > Go to Step 5.

5. Check brake lamp switch.

- (a). Turn ignition switch to OFF.
(b). Remove brake lamp switch connector B048.



- (c). Check brake lamp switch.

Standard value:

Condition	Multimeter Pin	Standard Value
With brake pedal depressed	1-2	$\leq 2 \Omega$
With brake pedal released	1-2	$> 10 M\Omega$

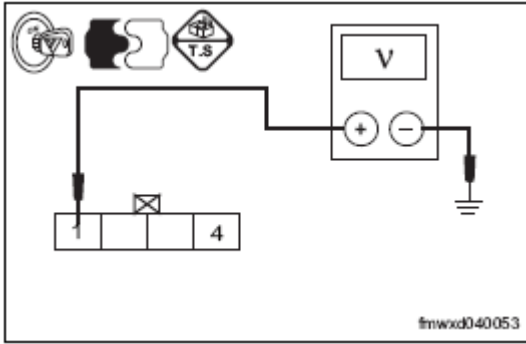
Is the inspection result normal?

Yes > Replace brake lamp switch or eliminate the open circuit fault of brake lamp switch.

No > Go to Step 6.

6. Check voltage of circuit between Pin 1 of brake warning controller connector B049 and the body ground.

- (a). Connect brake lamp switch connector B048, install relay R03 and remove brake warning controller connector B049.
(b). Turn ignition switch to ON.



- (c). With brake pedal depressed, use multimeter to measure the voltage of the circuit between Pin 1 of brake warning controller connector B049 and the effective ground point of body.

Standard voltage: Battery voltage

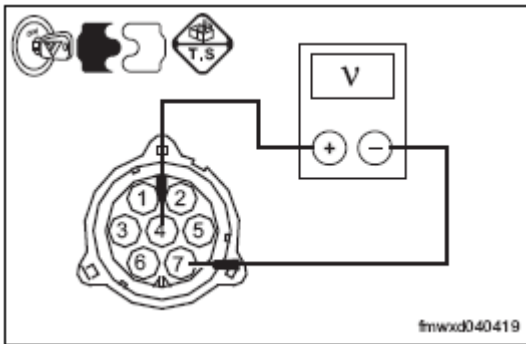
Is the inspection result normal?

Yes > Go to Step 7.

No > Repair or replace harness.

- 7. Check voltage of circuit between Pin 7 and Pin 4 of left rear combination lamp connector T013 or between Pin 7 and Pin 4 of right rear combination lamp connector T012.**

- (a). Remove left rear combination lamp connector T013 or right rear combination lamp connector T012.



- (b). With brake pedal depressed, use multimeter to measure the voltage of the circuit between Pin 7 and Pin 4 of left rear combination lamp connector T013 or between Pin 7 and Pin 4 of right rear combination lamp connector T012.

Standard voltage: Battery voltage

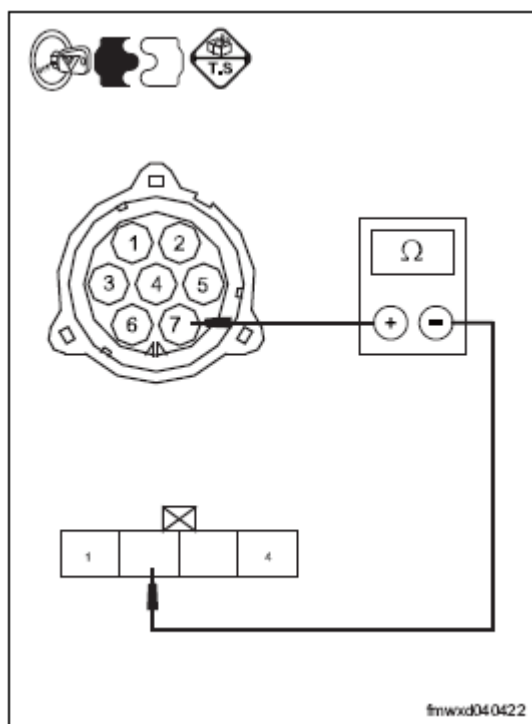
Is the inspection result normal?

Yes > Go to Step 8.

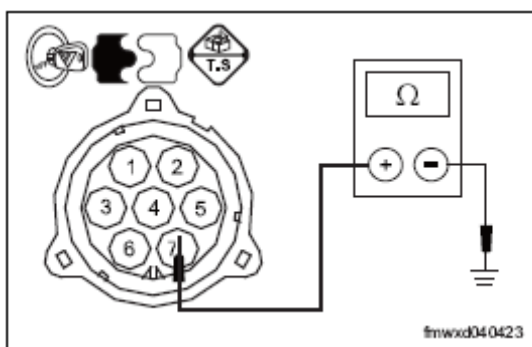
No > Replace bulb.

- 8. Check power circuit and ground circuit at both terminals of rear brake lamp bulbs.**

- (a). Remove brake warning controller connector B049.



- (b). Use multimeter to measure the resistance of the circuit between Pin 7 of rear combination lamp connector T013 or T012 and Pin 2 of brake warning controller connector B049.



- (c). Use multimeter to measure the voltage of the circuit between Pin 4 of rear combination lamp connector T013 or T012 and the effective ground point of body.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace brake warning controller.

No > Repair or replace harness.



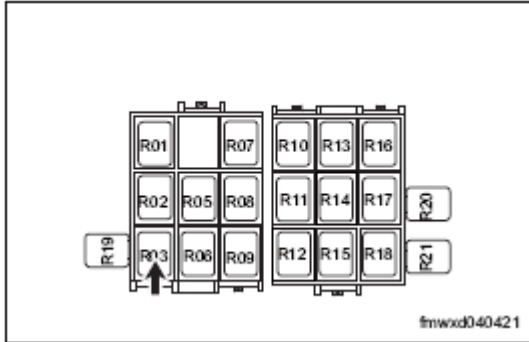
BRAKE LAMPS ALWAYS ON

Circuit Diagram

Please refer to "Both Side Brake Lamps Not Lit- Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check brake lamp relay R03.



- (a). Remove brake lamp relay R03.
- (b). Turn on main power and ignition switch.

04

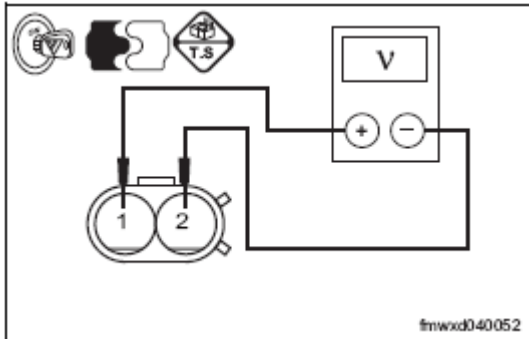
Are brake lamps still on?

Yes > Go to Step 4.

No > Go to Step 2.

2. Check brake lamp switch.

- (a). Turn ignition switch to OFF.
- (b). Remove brake lamp switch connector B048.



- (c). Check brake lamp switch.

Standard value:

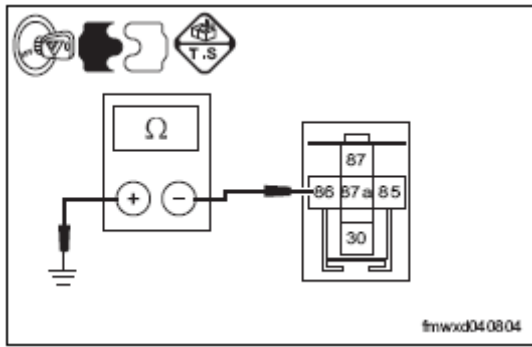
Condition	Multimeter Pin	Standard Value
With brake pedal depressed	1-2	$\leq 2 \Omega$
With brake pedal released	1-2	$> 10 M\Omega$

Is the inspection result normal?

Yes > Go to Step 3.

No > Replace brake lamp switch.

3. Check ground circuit of brake lamp relay R03 coil.



- (a). Remove brake lamp switch connector B048.
- (b). Use multimeter to measure the resistance of the circuit between Pin 86 of brake lamp relay R03 connector and the effective ground point of body.

Resistance: > 10 MΩ

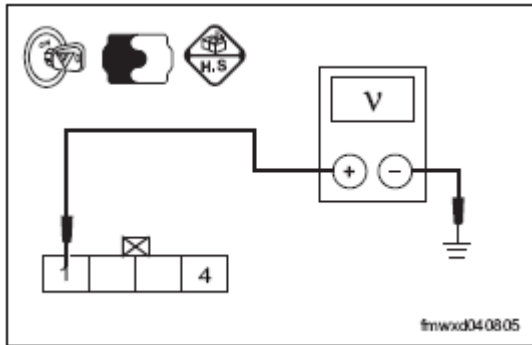
Is the inspection result normal?

Yes > Replace brake lamp relay R03

No > Check or service short circuit fault of brake lamp switch.

4. **Check voltage of circuit between Pin 1 of brake warning controller connector B049 and the body ground.**

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 1 of brake warning controller connector B049 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 5.

No > Eliminate short circuit fault or replace harness.

5. **Check brake warning controller.**

- (a). Remove brake warning controller connector B049.
- (b). Turn ignition switch to ON.

Are brake lamps off?

Yes > Replace brake warning controller.

No > Eliminate the short circuit to power supply between rear combination lamp and brake warning controller.

ONE SIDE REVERSE LAMP NOT LIT

Circuit Diagram

Please refer to "Reverse Lamps Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

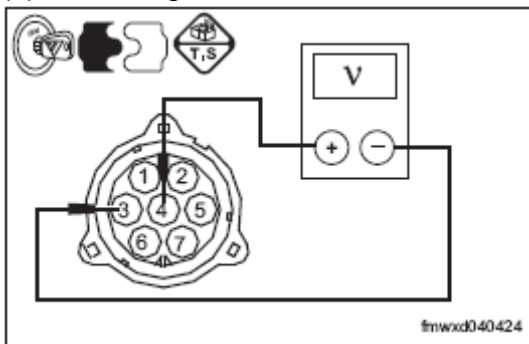
Warning:

Please shut down engine before inspection of reverse lamps.

1. Check voltage of circuit between Pin 3 and Pin 4 of left rear combination lamp connector T013 or between Pin 3 and Pin 4 of right rear combination lamp connector T012.

(a). Remove left rear combination lamp connector T013 or right rear combination lamp connector T012.

(b). Turn ignition switch to ON.



(c). With transmission shifted to reverse gear, use multimeter to measure the voltage of the circuit between Pin 3 and Pin 4 of left rear combination lamp connector T013 or between Pin 3 and Pin 4 of right rear combination lamp connector T012.

Standard voltage: Battery voltage

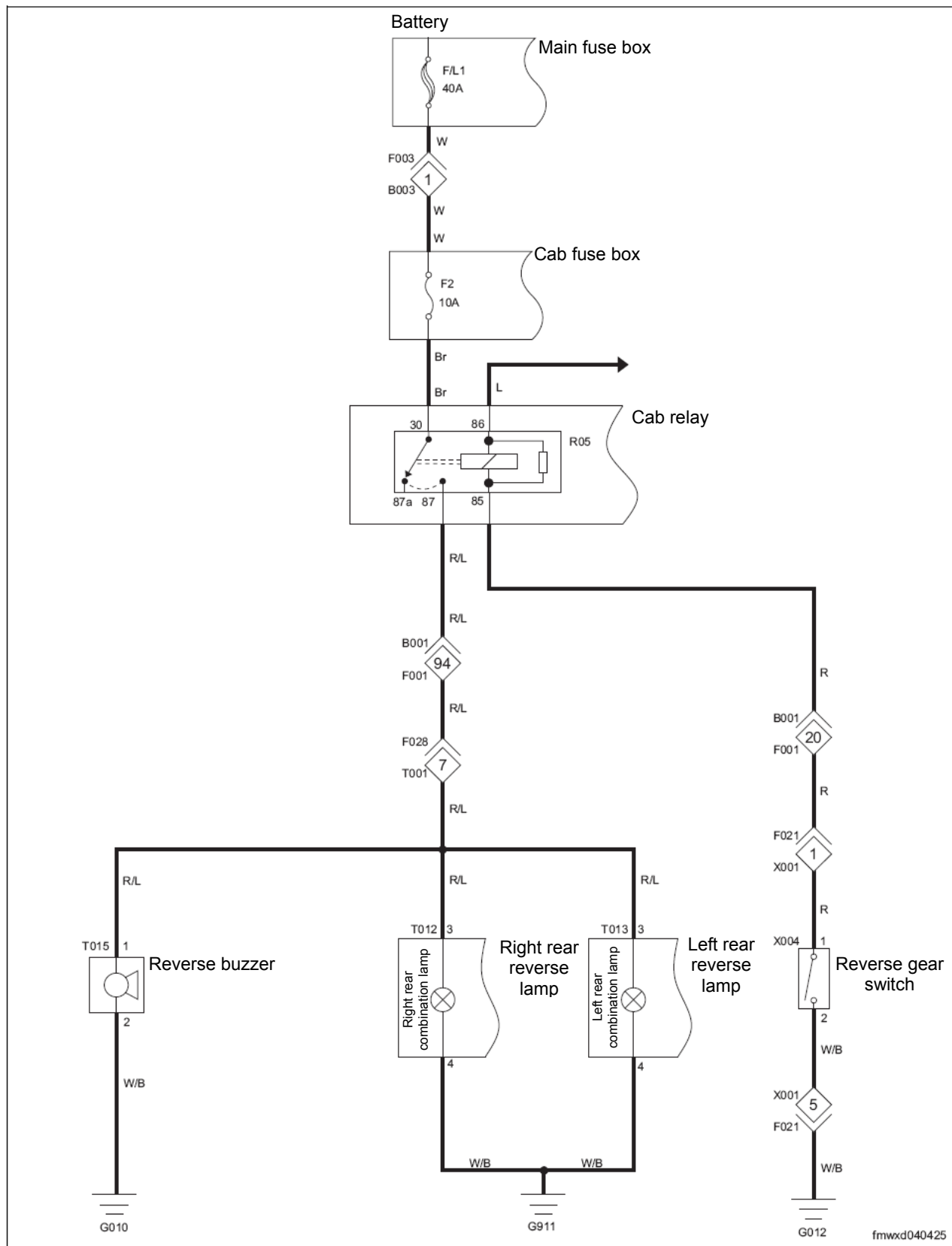
Is the inspection result normal?

Yes > Replace bulb.

No > Repair or replace harness.

REVERSE LAMPS NOT LIT

Circuit Diagram

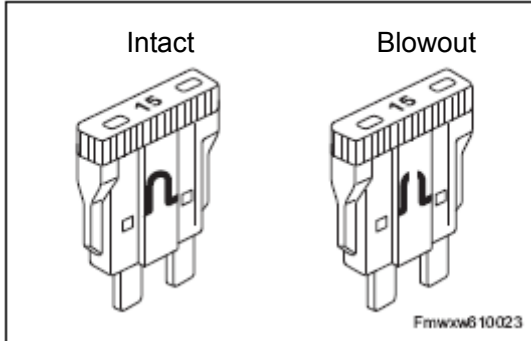


Diagnostic Procedures**Warning:**

Please shut down engine before inspection of reverse lamps.

1. Check fuse.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F2 (10A).

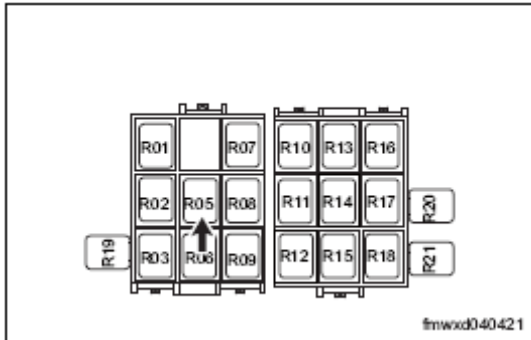
Is the fuse intact?

Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check reverse gear relay R05 in cab relay box.

(a). Turn on main power and ignition switch.



(b). Replace the relay R05 with an intact relay of the same rating, shift the transmission to reverse gear and check if reverse lamps are lit.

Are reverse lamps lit?

Yes > Replace reverse gear relay R05.

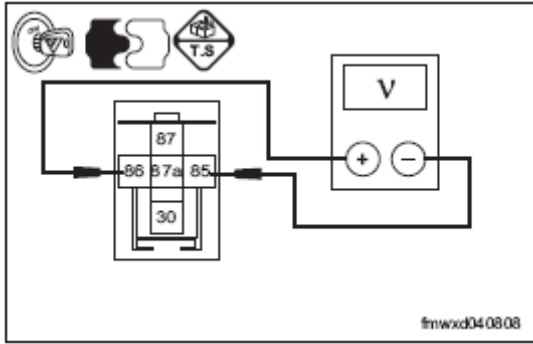
No > Go to Step 3.

3. Check control circuit of reverse lamp relay R05 coil.

(a). Shut off main power.

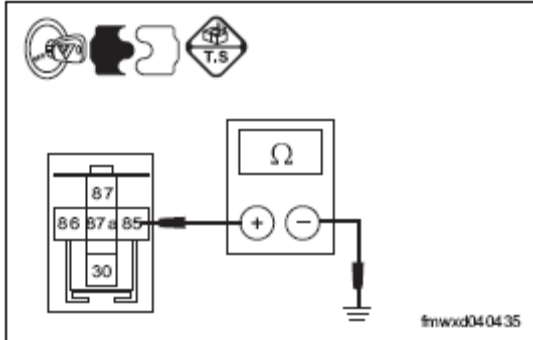
(b). Remove reverse lamp relay R05.

(c). Turn on main power and ignition switch.



- (d). With transmission shifted to reverse gear, use multimeter to measure the voltage of the circuit between Pin 86 and Pin 85 of reverse lamp relay R05 connector.

Standard voltage: Battery voltage



- (e). With transmission shifted to reverse gear, use multimeter to measure the resistance of the circuit between Pin 85 of reverse lamp relay R05 connector and the body ground.

Resistance: $\leq 2 \Omega$

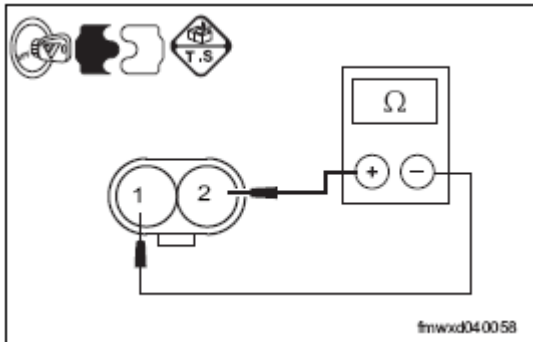
Is the inspection result normal?

Yes > Go to Step 5.

No > Go to Step 4.

4. Check reverse gear switch.

- (a). Remove reverse gear switch connector X004.



- (b). Check reverse gear switch.

Standard value:

Gear Position	Contact Resistance
Reverse gear	$\leq 1 \Omega$
Other gears	$> 10 M\Omega$

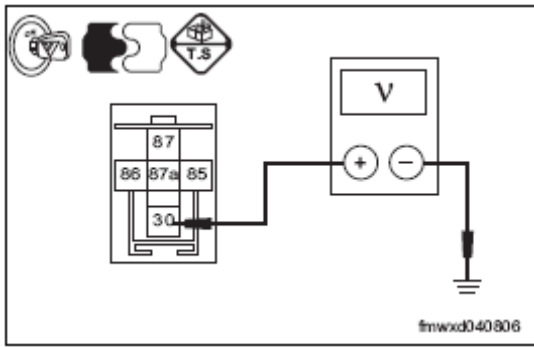
Is the inspection result normal?

Yes > Eliminate open circuit fault of reverse lamp relay R05 power circuit.

No > Replace reverse gear switch or service open circuit fault of reverse gear switch.

5. Check circuit between fuse F2 and relay R05.

- Shut off main power.
- Remove reverse lamp relay R05 in cab relay box.
- Turn on main power.



- (d). Use multimeter to measure the voltage of the circuit between Pin 30 of reverse lamp relay R05 connector and the effective ground point of body.

Standard voltage: Battery voltage

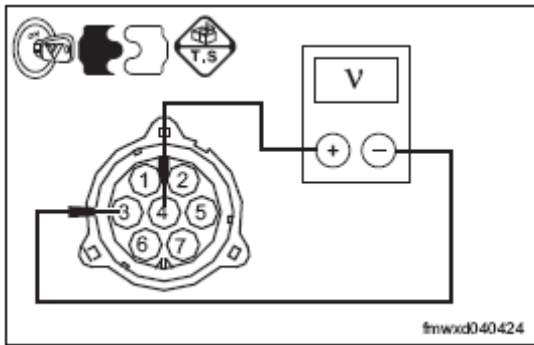
Is the inspection result normal?

Yes > Go to Step 6.

No > Repair or replace harness.

6. Check voltage at both terminals of reverse lamp bulbs.

- (a). Remove left rear combination lamp connector T013 or right rear combination lamp connector T012.
- (b). Turn ignition switch to ON.



- (c). With transmission shifted to reverse gear, use multimeter to measure the voltage of the circuit between Pin 3 and Pin 4 of left rear combination lamp connector T013 or between Pin 3 and Pin 4 of right rear combination lamp connector T012.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace bulb.

No > Repair or replace harness.

REVERSE LAMPS ALWAYS ON

Circuit Diagram

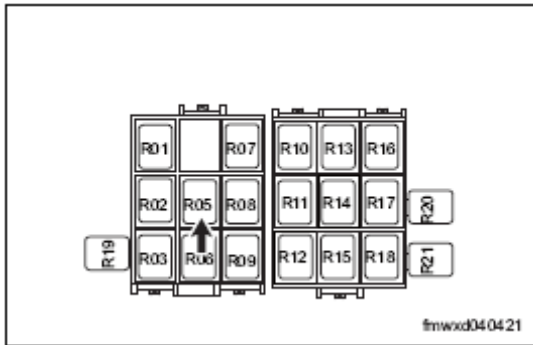
Please refer to "Reverse Lamps Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

Warning:

Please shut down engine before inspection of reverse lamps.

1. Check reverse lamp relay R05.



- (a). Remove reverse lamp relay R05.
- (b). Turn on main power and ignition switch.

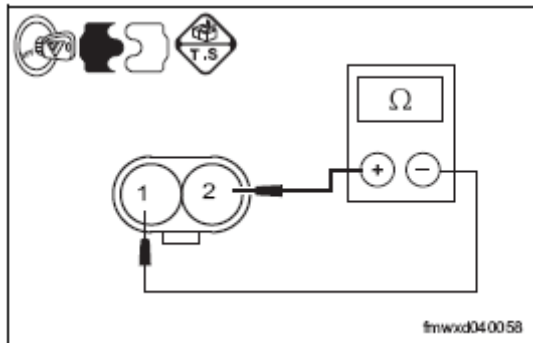
Are reverse lamp still lit?

Yes > Go to Step 4.

No > Go to Step 2.

2. Check reverse lamp switch.

- (a). Turn ignition switch to OFF.
- (b). Remove reverse gear switch connector X004.



- (c). Check reverse gear switch.

Standard value:

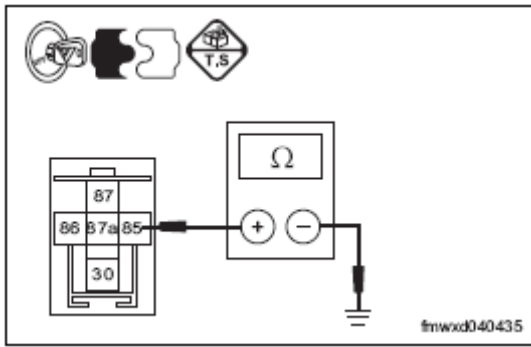
Gear Position	Contact Resistance
Reverse gear	$\leq 1 \Omega$
Other gears	$> 10 M\Omega$

Is the inspection result normal?

Yes > Go to Step 3.

No > Replace reverse lamp switch.

3. Check ground circuit of reverse lamp relay R05 coil.



- (a). Remove reverse lamp switch connector X004.
- (b). Use multimeter to measure the resistance of the circuit between Pin 85 of reverse lamp relay R05 connector and the effective ground point of body.

Resistance: > 10 MΩ

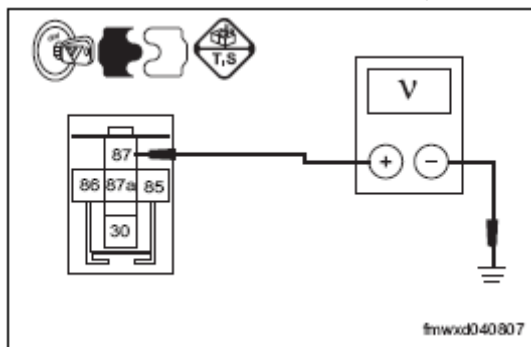
Is the inspection result normal?

Yes > Go to Step 4.

No > Eliminate short circuit fault of reverse lamp switch.

4. Check voltage of the circuit between Pin 87 of reverse lamp relay R05 and the body ground.

- (a). Remove reverse lamp relay R05.



- (b). Turn ignition switch to ON.
- (c). Use multimeter to measure the voltage of the circuit between Pin 87 of reverse lamp relay R05 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > System is normal.

No > Eliminate short circuit fault or replace harness.

REVERSE BUZZER FAILURE

Circuit Diagram

Please refer to "Reverse Lamps Not Lit - Circuit Diagram" in this chapter.

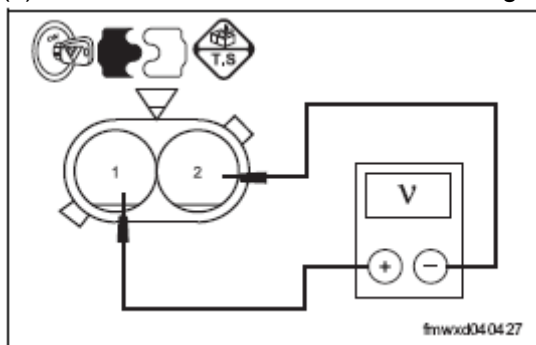
Diagnostic Procedures

Warning:

Please shut down engine before inspection of reverse buzzer.

1. Check circuit.

- (a). Remove reverse buzzer connector T015.
- (b). Turn ignition switch to ON.
- (c). Shift the transmission to reverse gear.



- (d). Use multimeter to measure the voltage of the circuit between Pin 1 and Pin 2 of reverse buzzer connector T015.

Standard voltage: Battery voltage

Is the inspection result normal?

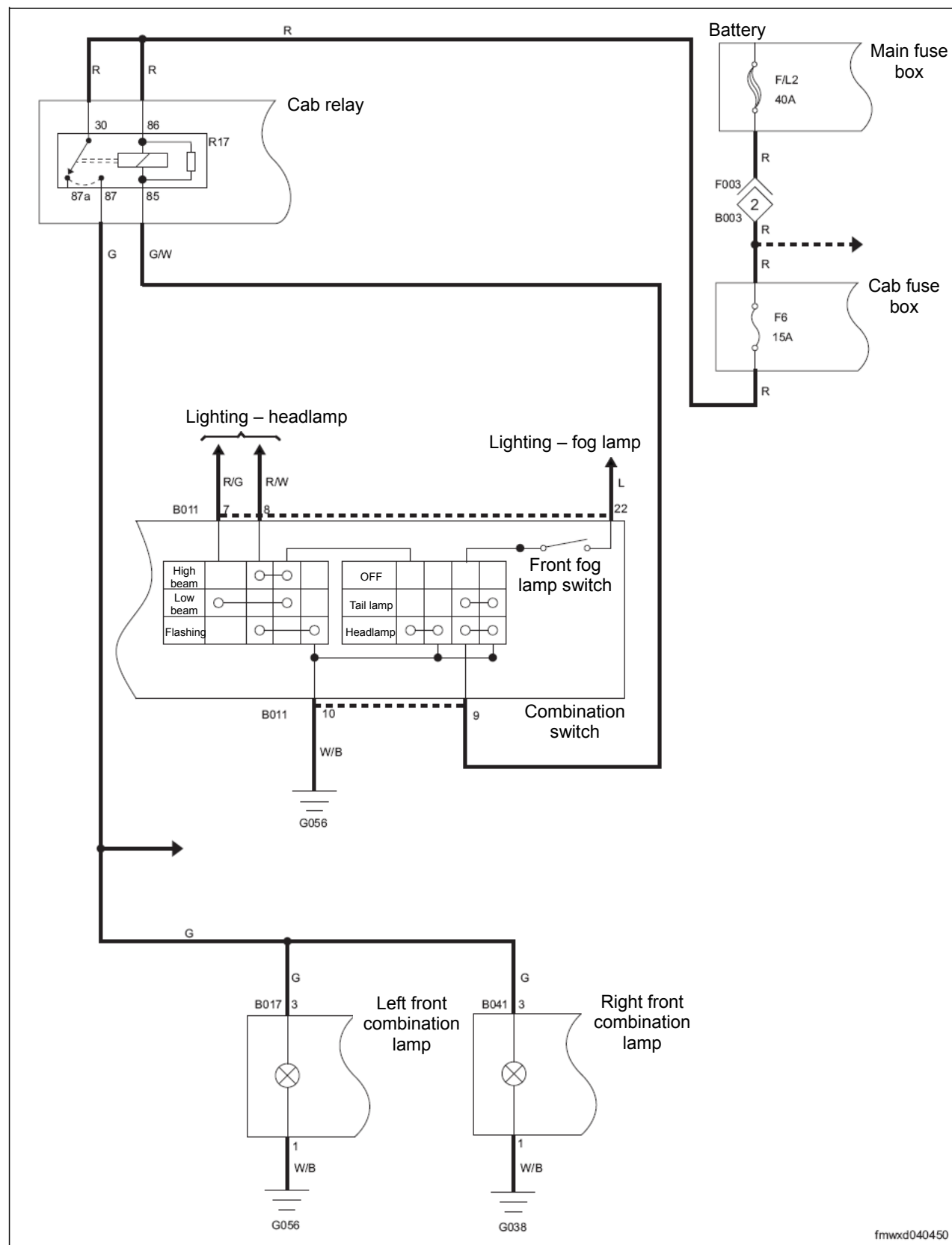
Yes > Replace reverse buzzer.

No > Repair or replace harness.



ONE SIDE SMALL LAMP NOT LIT

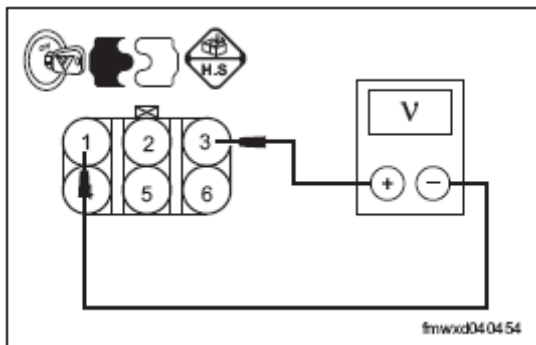
Circuit Diagram



Diagnostic Procedures

1. Check small lamp power circuit and ground circuit.

- (a). Remove front combination lamp connector B017 or B041.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 3 and Pin 1 of left front combination lamp connector B017 or between Pin 3 and Pin 1 of right front combination lamp connector B041.

Standard voltage: Battery voltage

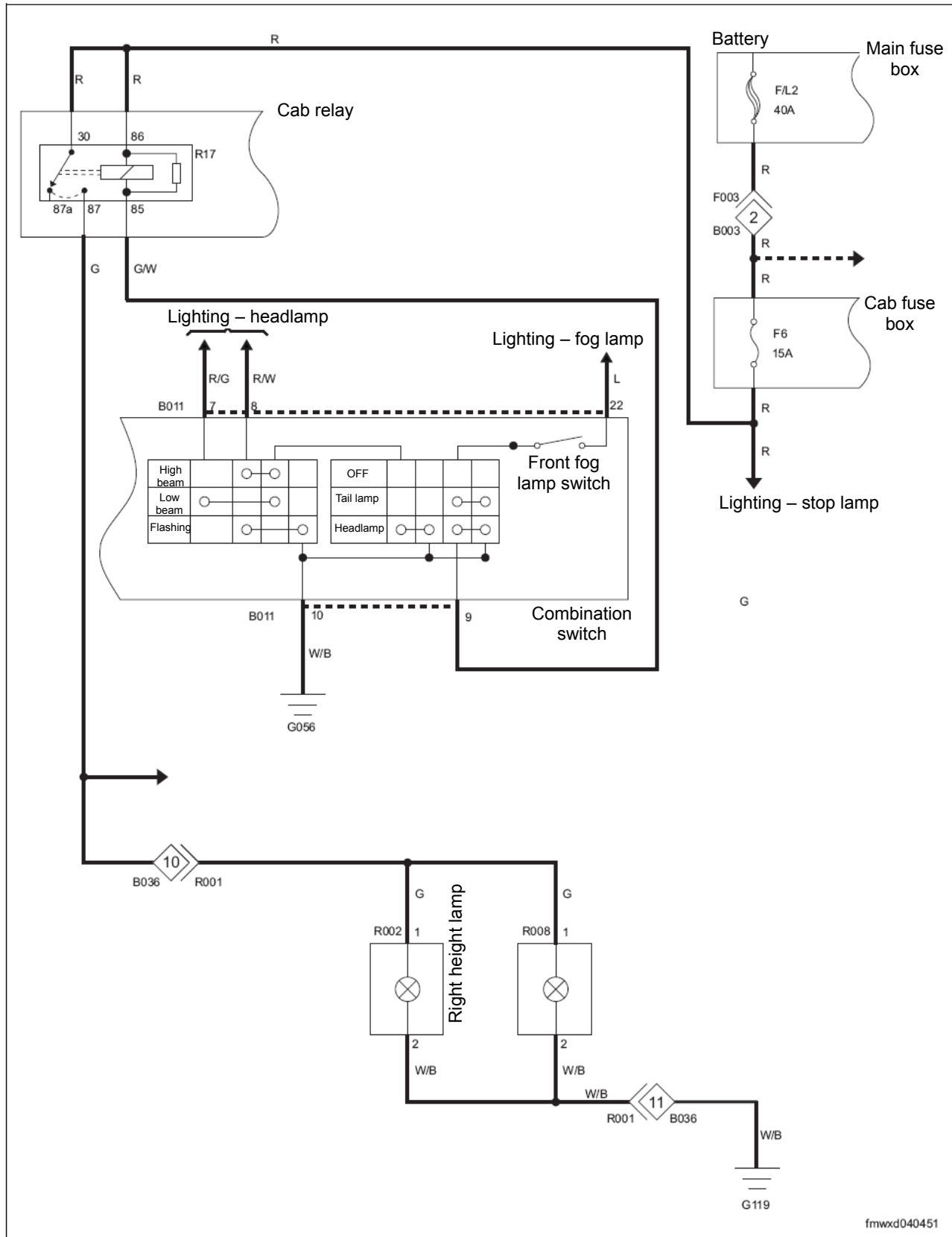
Is the inspection result normal?

Yes > Replace front small lamp bulbs.

No > Repair or replace harness.

ONE SIDE HEIGHT LAMP NOT LIT

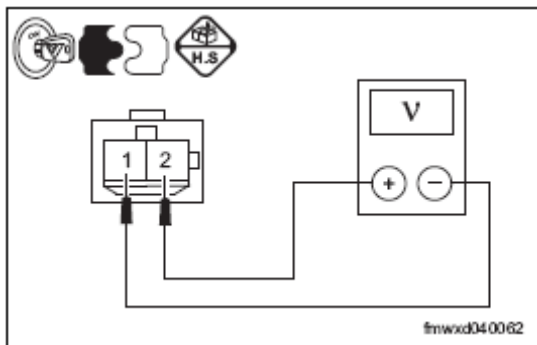
Circuit Diagram



Diagnostic Procedures

1. Check height lamp power circuit and ground circuit.

- (a). Remove height lamp connector R008 or R002.
- (b). Turn on small lamps.



- (c). Use multimeter to measure the voltage of the circuit between Pin 1 and Pin 2 of right height lamp connector R008 or between Pin 1 and Pin 2 of left height lamp connector R002.

Standard voltage: Battery voltage

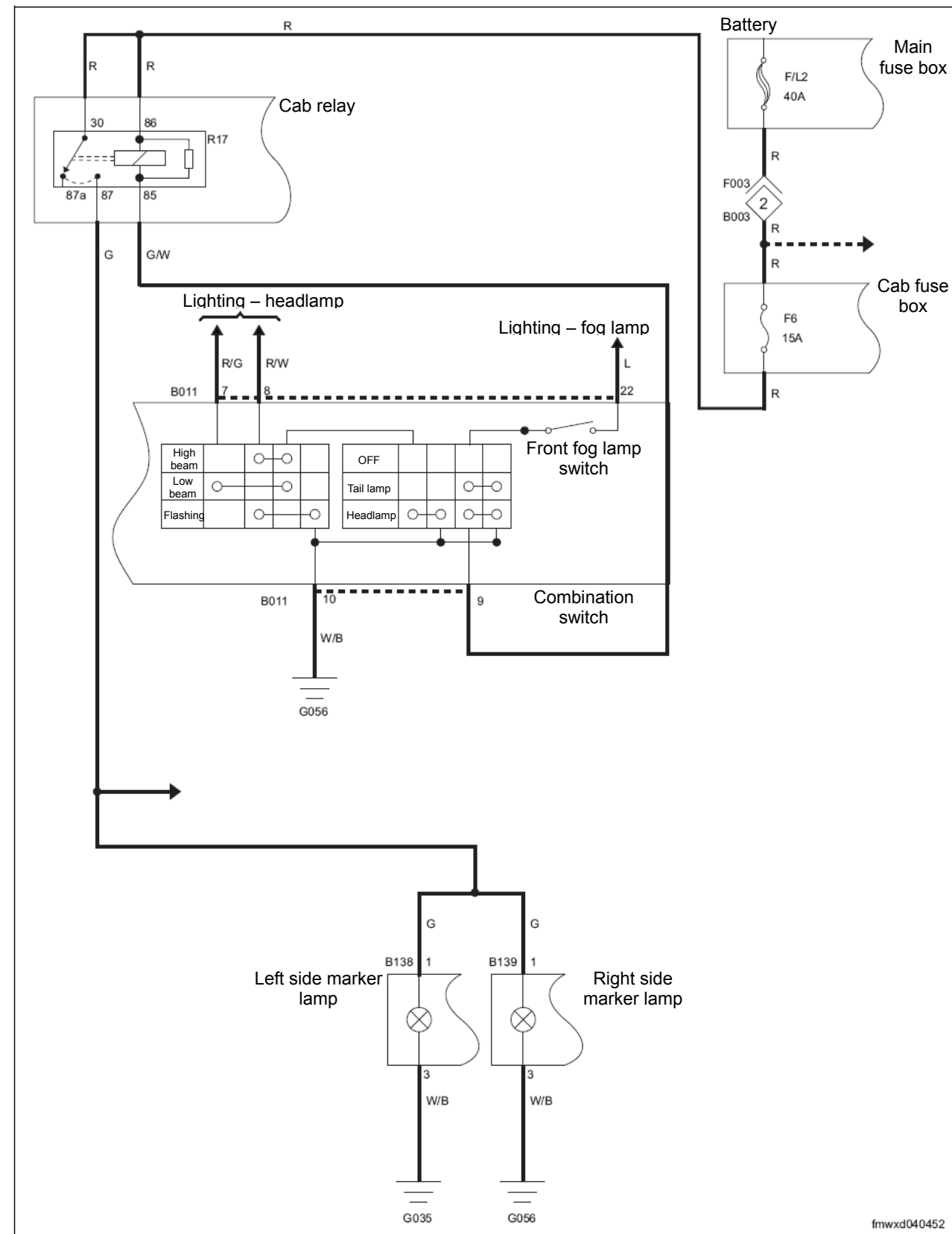
Is the inspection result normal?

Yes > Replace height lamp bulbs.

No > Repair or replace harness.

ONE SIDE MARKER LAMP NOT LIT

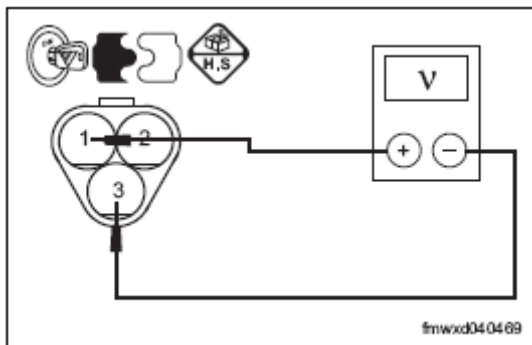
Circuit Diagram



Diagnostic Procedures

1. Check side marker lamp power circuit and ground circuit.

- (a). Remove side marker lamp connector B138 or B139.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 1 and Pin 3 of marker lamp connector B138 or between Pin 1 and Pin 3 of B139.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace side marker lamp bulbs.

No > Repair or replace harness.

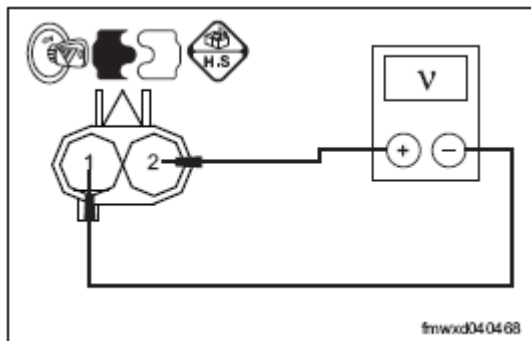
Circuit Diagram



Diagnostic Procedures

1. Check front marker lamp power circuit and ground circuit.

- (a). Remove front marker lamp connector T003 or T004.
- (b). Turn on main power.
- (c). Turn on small lamps.



- (d). Measure the voltage of the circuit between Pin 1 and Pin 2 of marker lamp connector T004 or between Pin 1 and Pin 2 of T003.

Standard voltage: Battery voltage

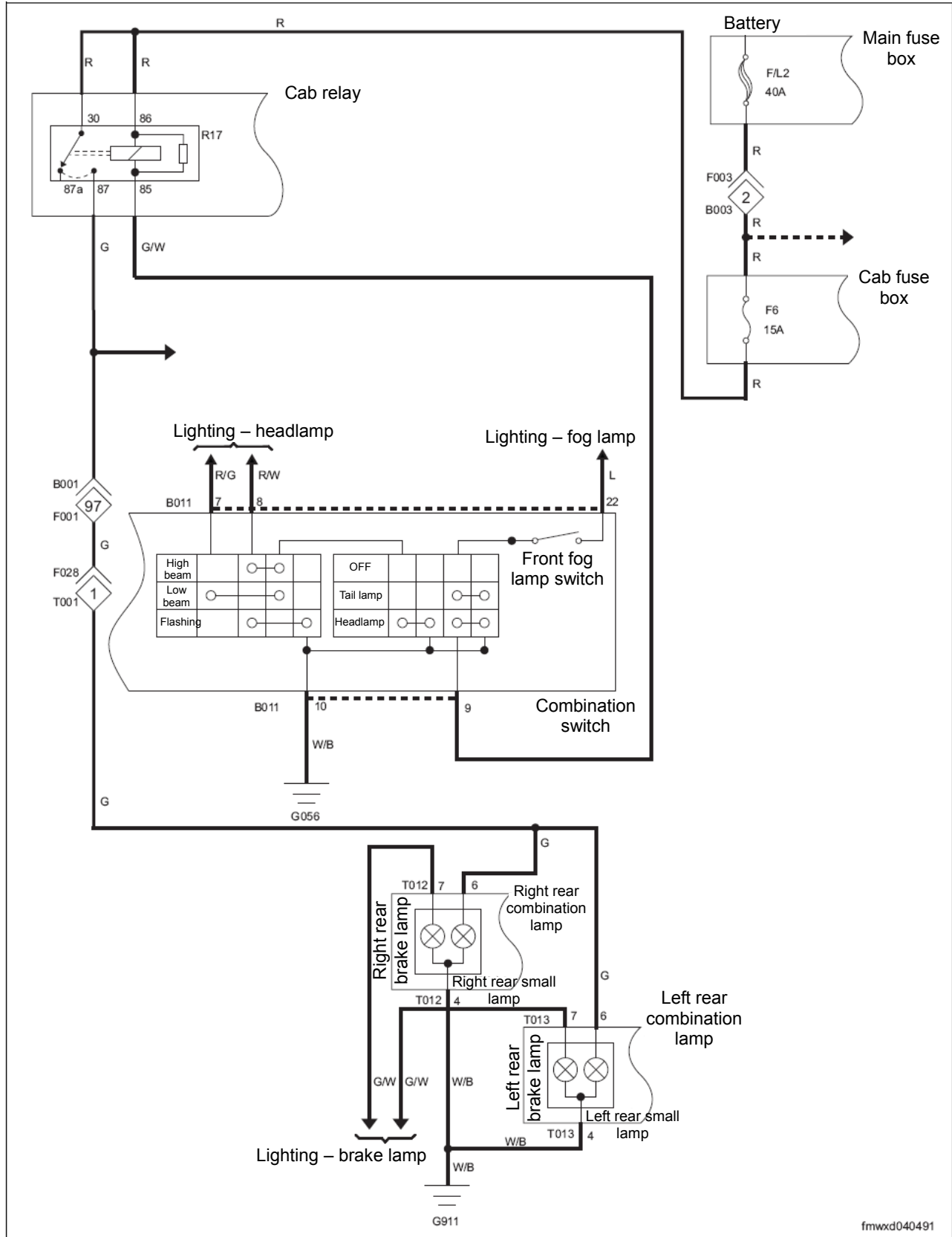
Is the inspection result normal?

Yes > Replace front marker lamp bulb.

No > Repair or replace harness.

ONE REAR SMALL LAMP NOT LIT

Circuit Diagram

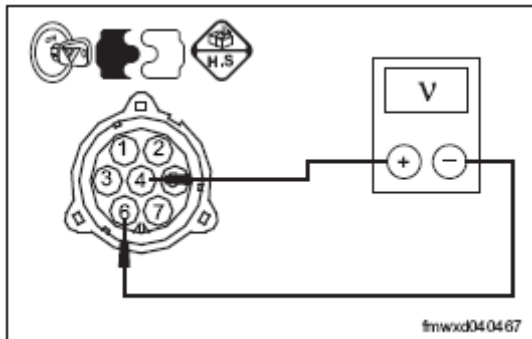


fmwxd040491

Diagnostic Procedures

1. Check rear small lamp power circuit and ground circuit.

- (a). Remove rear combination lamp connector T012 or T013.
- (b). Turn on main power.
- (c). Turn on small lamps.



- (d). Measure the voltage of the circuit between Pin 6 and Pin 4 of rear combination lamp connector T013 or between Pin 6 and Pin 4 of T012.

Standard voltage: Battery voltage

Is the inspection result normal?

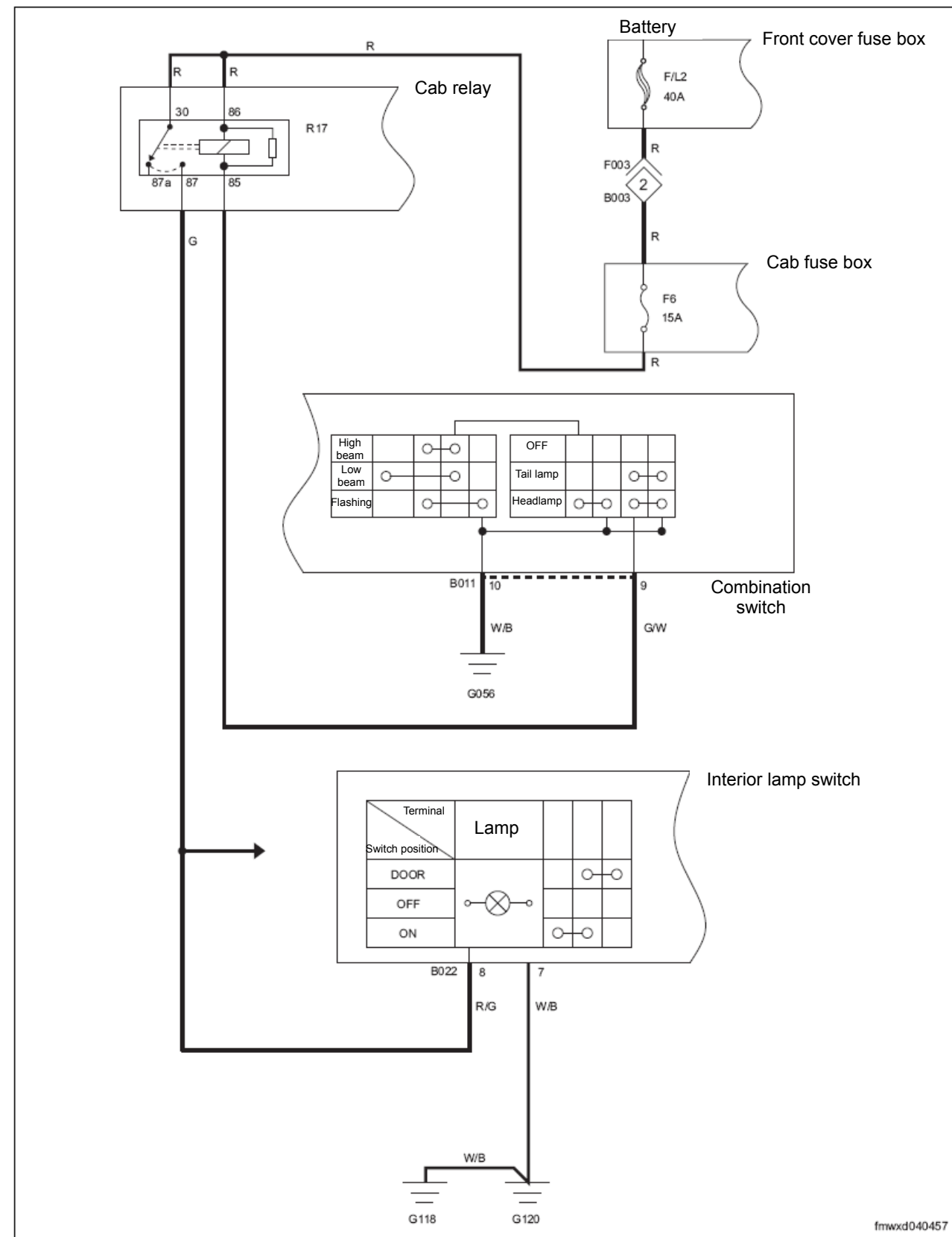
Yes > Replace rear small lamp bulbs.

No > Repair or replace harness.



INTERIOR LAMP SWITCH LAMP NOT LIT

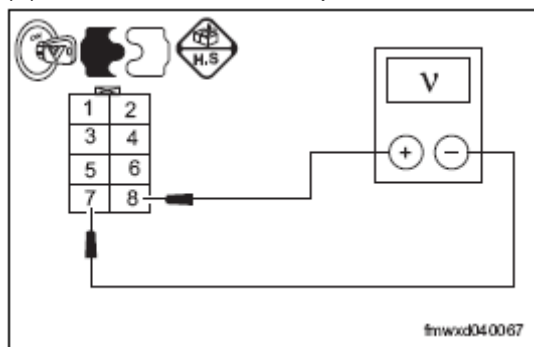
Circuit Diagram



Diagnostic Procedures

1. Check interior lamp switch lamp power circuit and ground circuit.

- (a). Remove interior lamp switch connector B202.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 8 and Pin 7 of interior lamp switch lamp connector B202.

Standard voltage: Battery voltage

Is the inspection result normal?

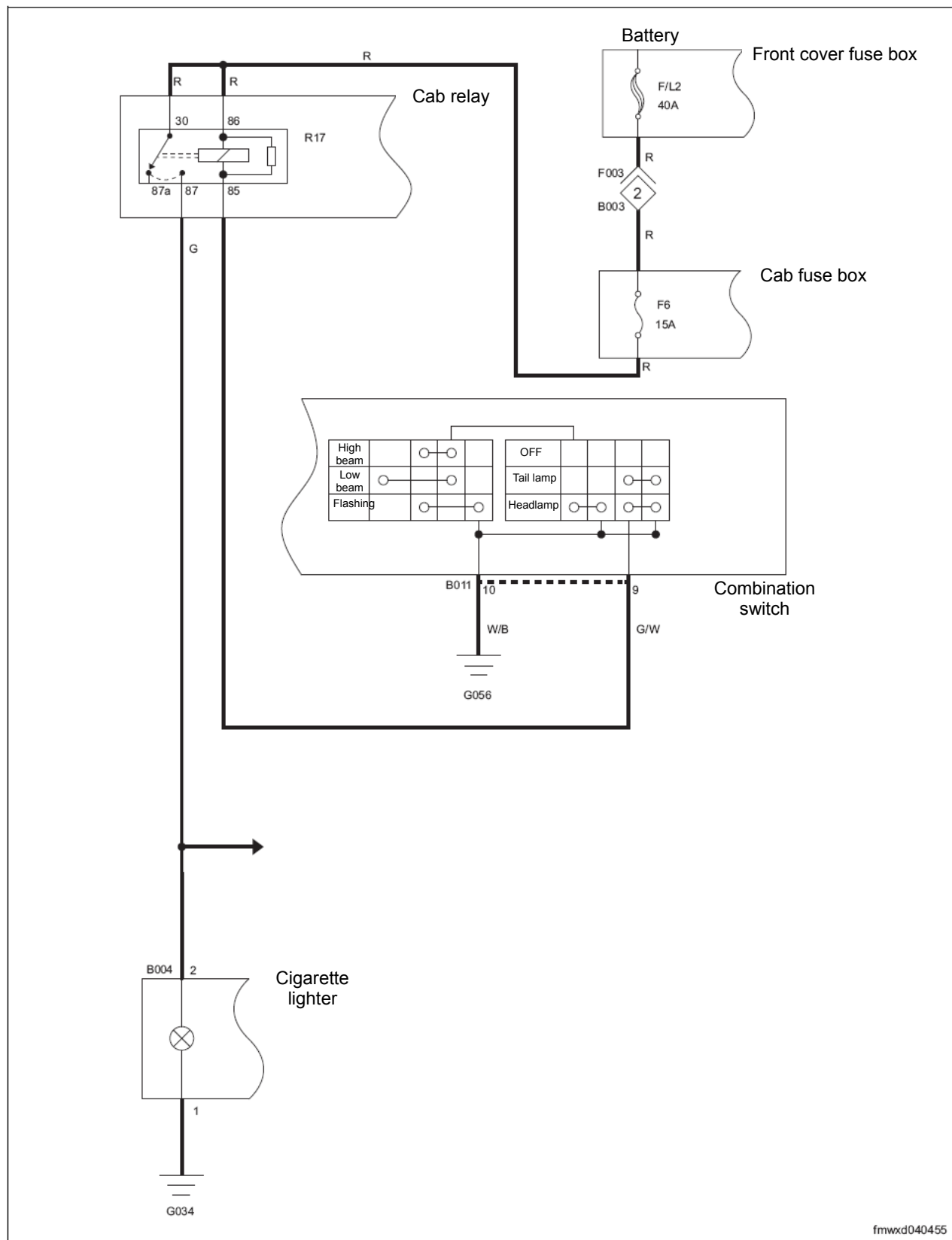
Yes > Replace interior lamp switch.

No > Repair or replace harness.



CIGARETTE LIGHTER LAMP NOT LIT

Circuit Diagram



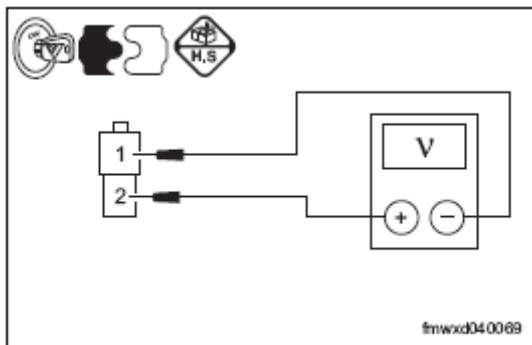
fmwxd040455



Diagnostic Procedures

1. Check cigarette lighter lamp power circuit and ground circuit.

- (a). Remove cigarette lighter connector B004.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 2 and Pin 1 of cigarette lighter lamp connector B004.

Standard voltage: Battery voltage

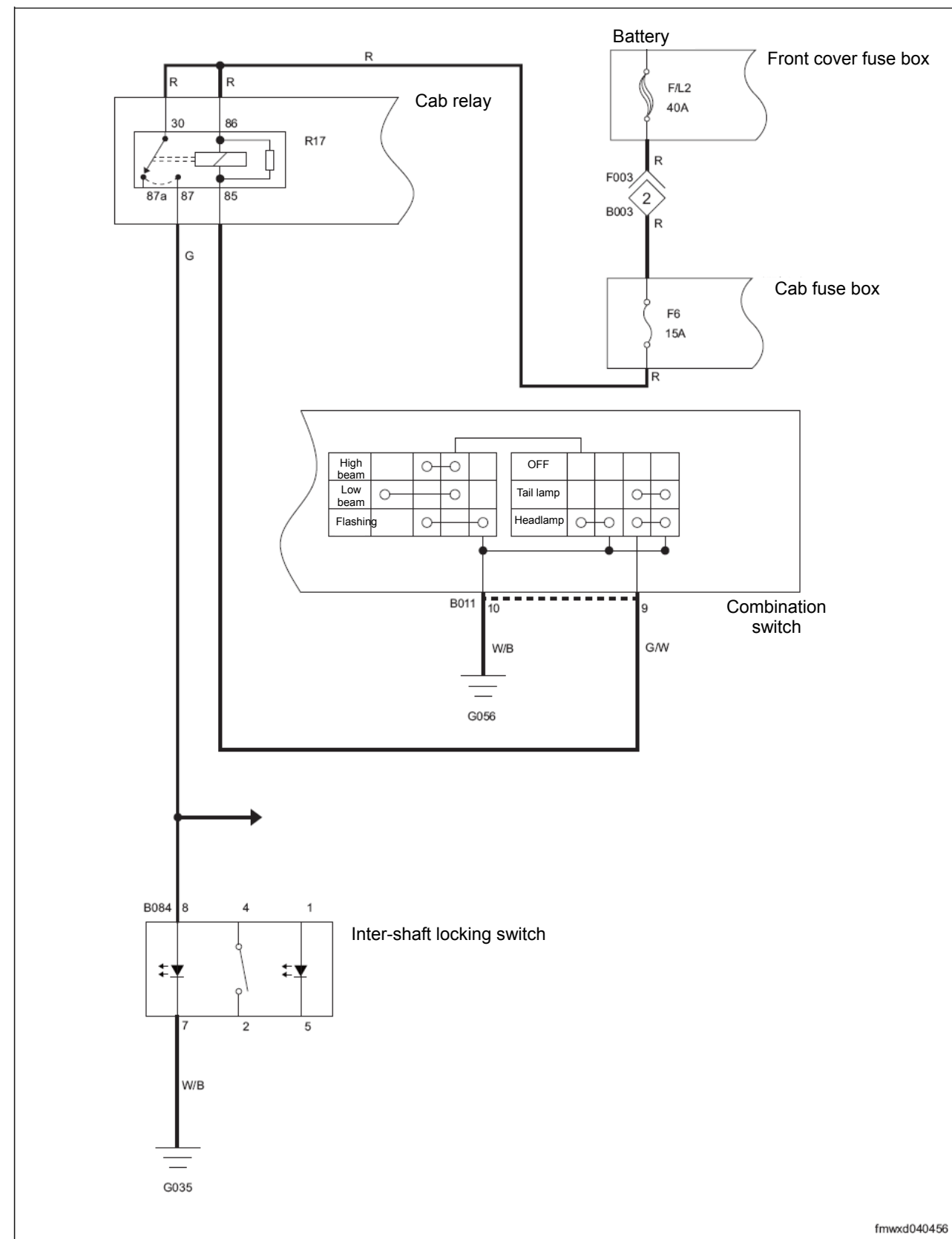
Is the inspection result normal?

Yes > Replace cigarette lighter holder lamp.

No > Repair or replace harness.

INTER-SHAFT DIFFERENTIAL SWITCH LAMP NOT LIT

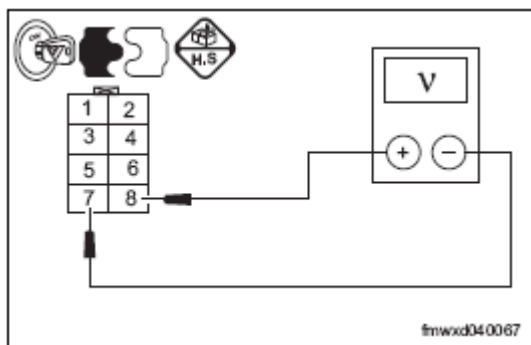
Circuit Diagram



Diagnostic Procedures

1. Check Inter-shaft differential switch lamp power circuit and ground circuit.

- (a). Remove inter-shaft differential switch connector B084.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 8 and Pin 7 of inter-shaft differential switch connector B084.

Standard voltage: Battery voltage

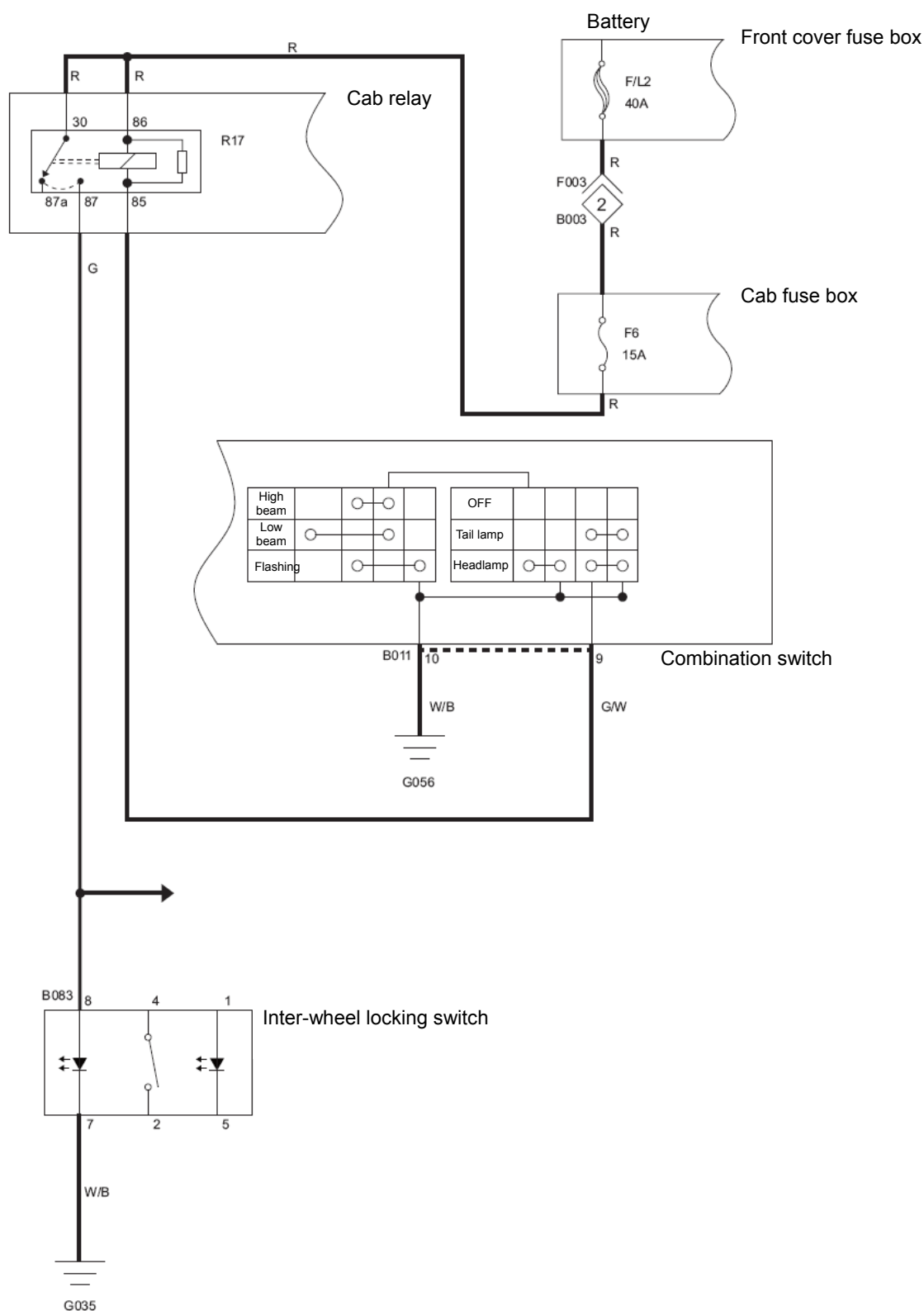
Is the inspection result normal?

Yes > Replace inter-shaft differential switch

No > Repair or replace harness.

INTER-WHEEL DIFFERENTIAL SWITCH LAMP NOT LIT

Circuit Diagram

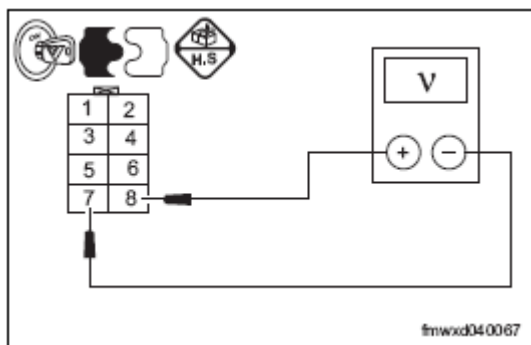


fmwxd040458

Diagnostic Procedures

1. Check Inter-wheel differential switch lamp power circuit and ground circuit.

- (a). Remove inter-wheel differential switch connector B083.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 8 and Pin 7 of inter- wheel differential switch connector B083.

Standard voltage: Battery voltage

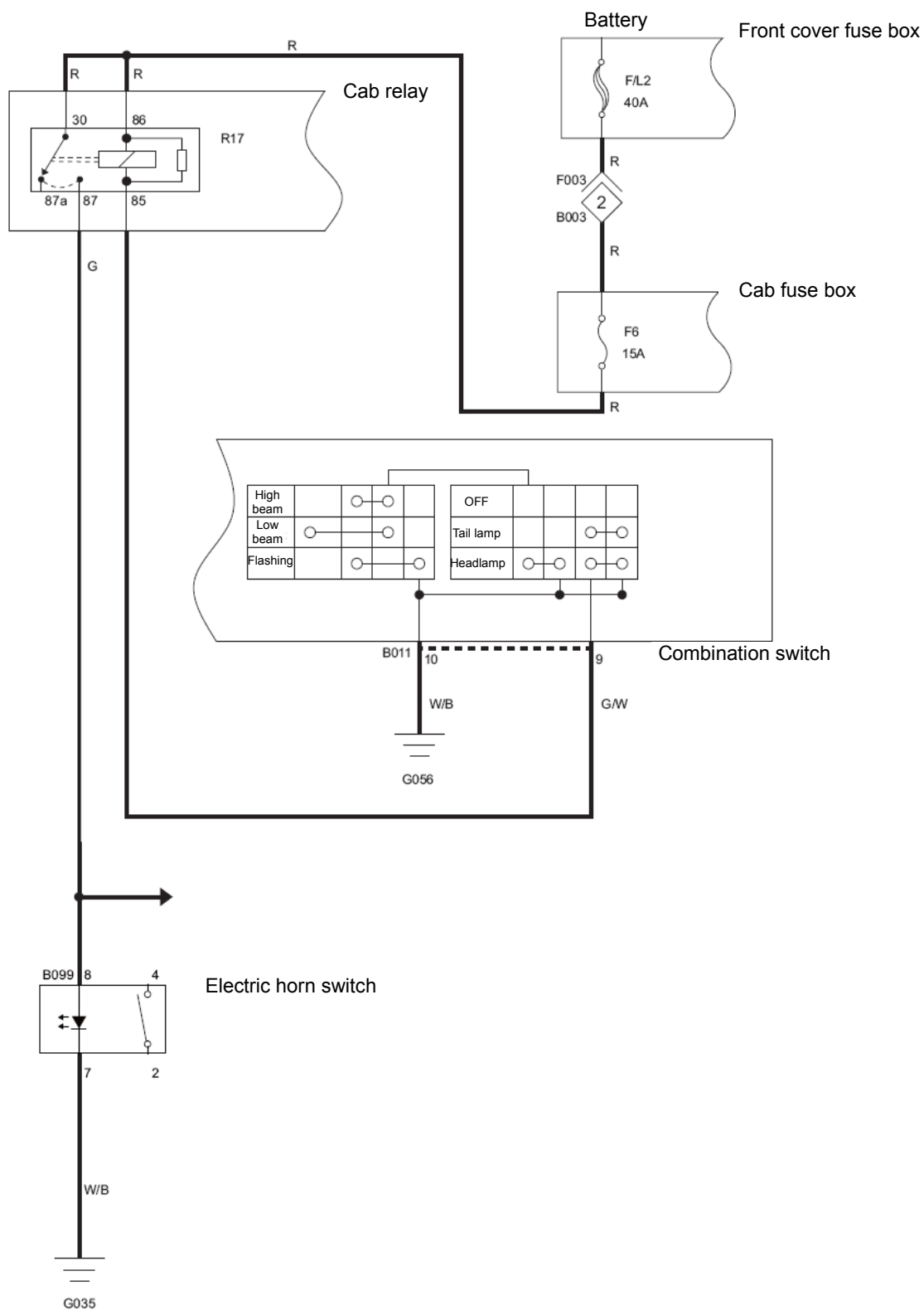
Is the inspection result normal?

Yes > Replace inter-wheel differential switch.

No > Repair or replace harness.

ELECTRIC HORN SWITCH LAMP NOT LIT

Circuit Diagram



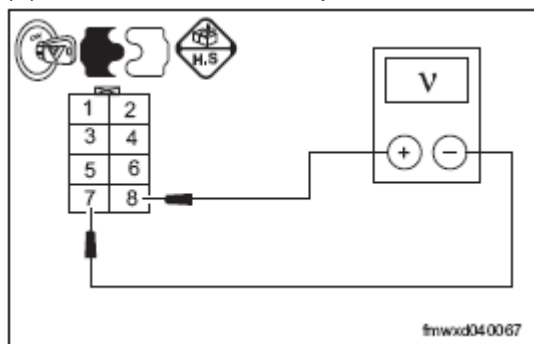
fmwxd040459



Diagnostic Procedures

1. Check electric horn switch lamp power circuit and ground circuit.

- (a). Remove electric horn switch connector B099.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 8 and Pin 7 of electric horn switch connector B099.

Standard voltage: Battery voltage

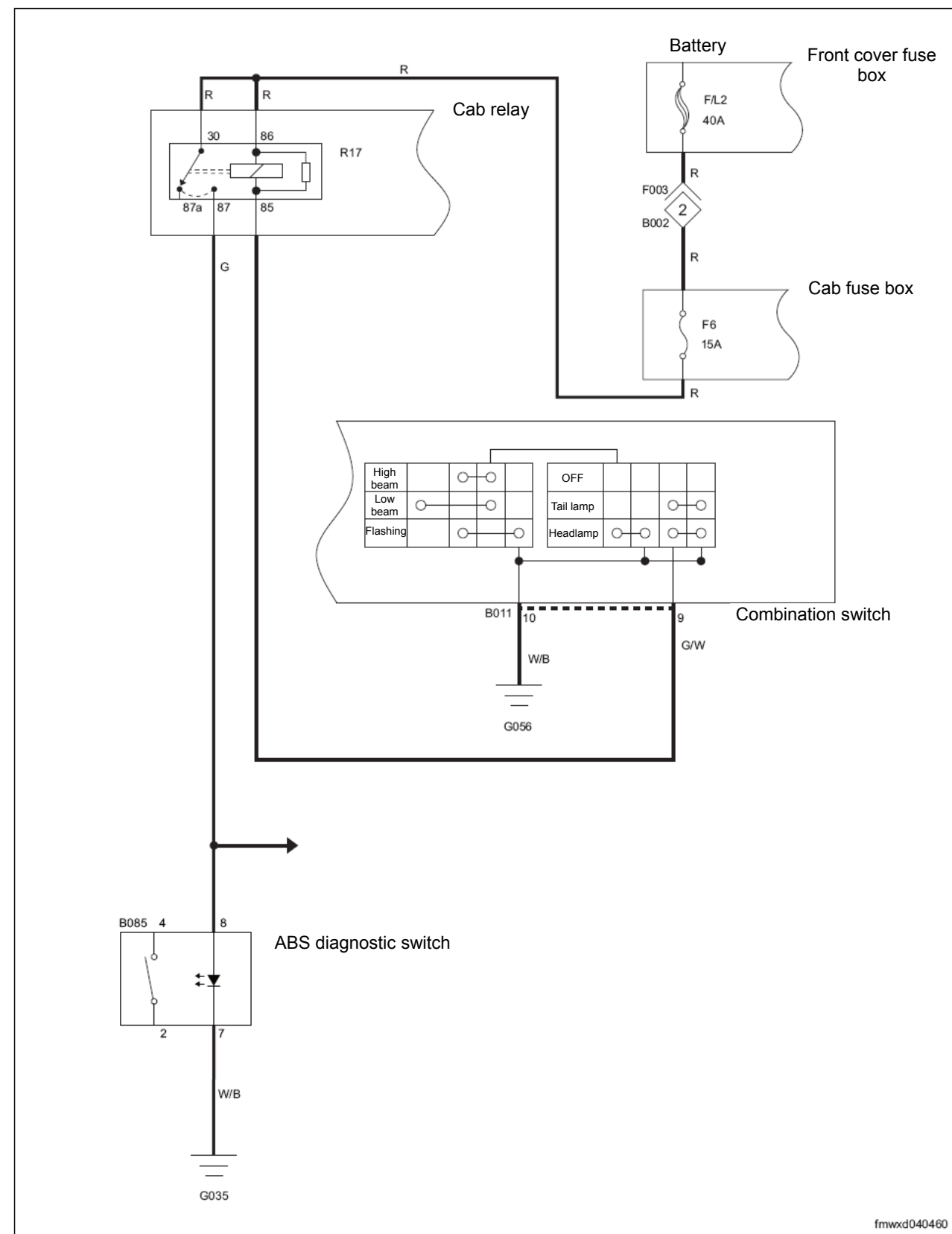
Is the inspection result normal?

Yes > Replace electric horn switch.

No > Repair or replace harness.

ABS DIAGNOSTIC SWITCH LAMP NOT LIT

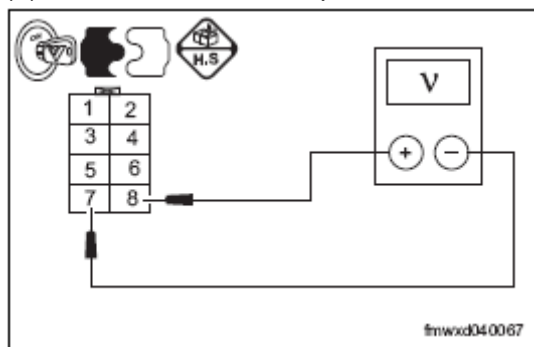
Circuit Diagram



Diagnostic Procedures

1. Check ABS diagnostic switch lamp power circuit and ground circuit.

- (a). Remove ABS diagnostic switch connector B085.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 8 and Pin 7 of ABS diagnostic switch connector B085.

Standard voltage: Battery voltage

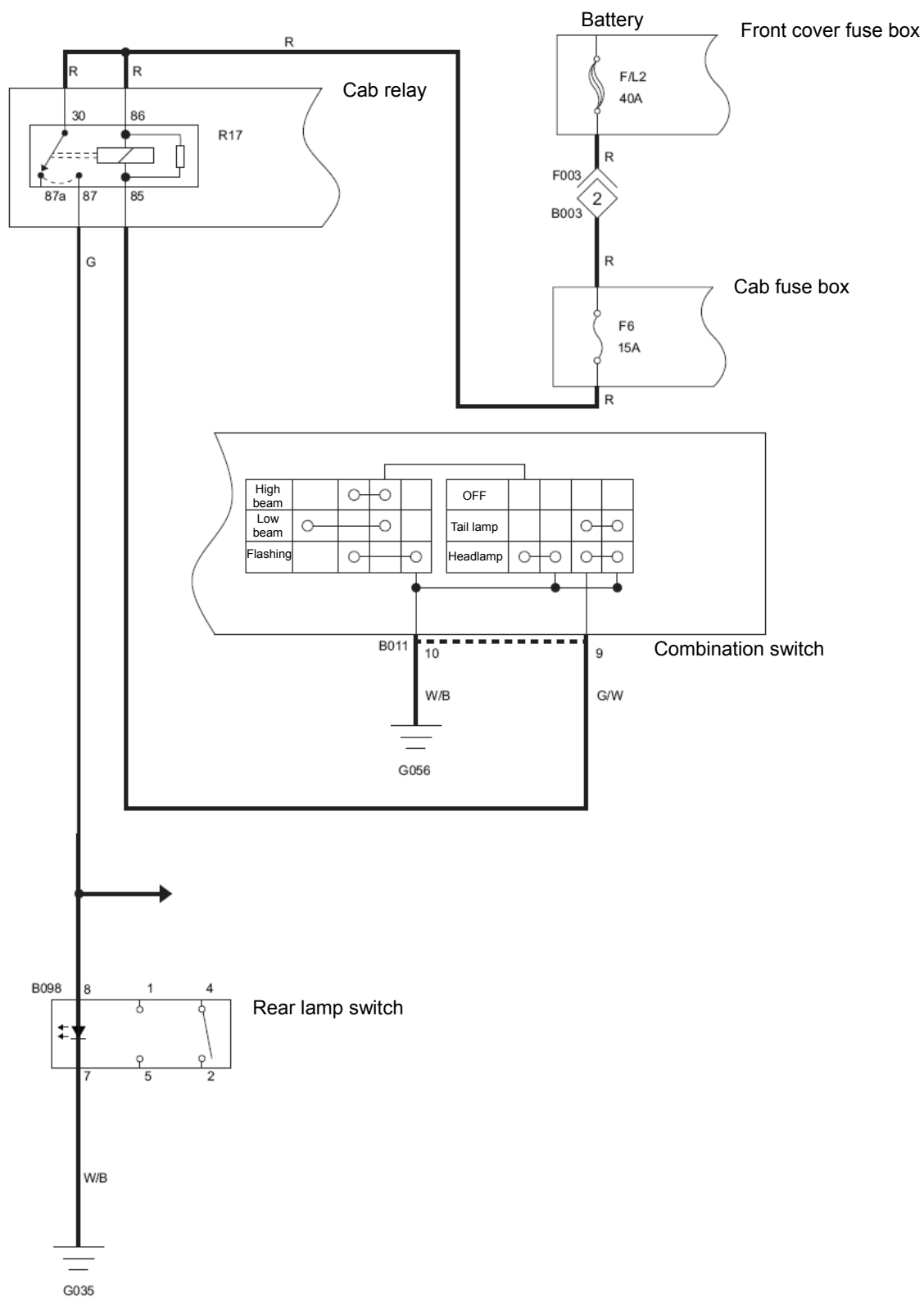
Is the inspection result normal?

Yes > Replace ABS diagnostic switch.

No > Repair or replace harness.

REAR LAMP SWITCH LAMP NOT LIT

Circuit Diagram



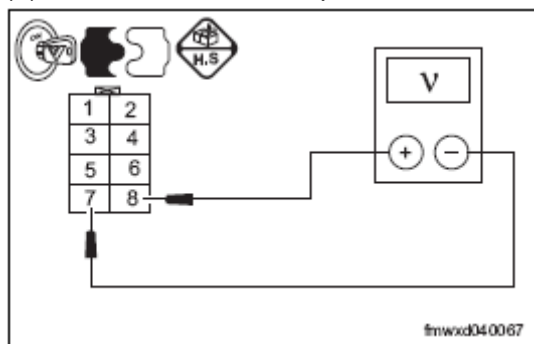
fmwxd040461



Diagnostic Procedures

1. Check rear lamp switch lamp power circuit and ground circuit.

- (a). Remove rear lamp switch connector B098.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 8 and Pin 7 of rear lamp switch connector B098.

Standard voltage: Battery voltage

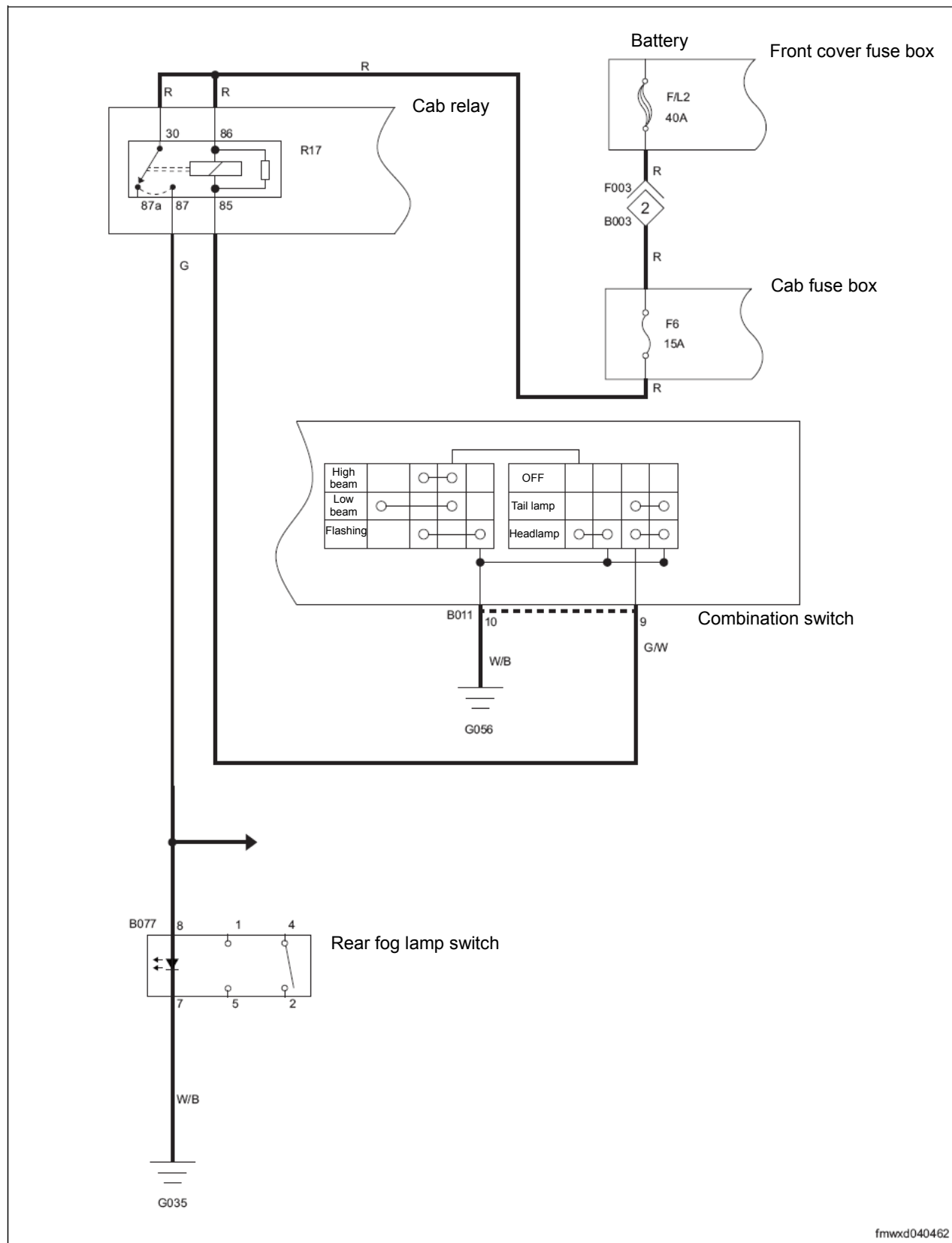
Is the inspection result normal?

Yes > Replace rear lamp switch.

No > Repair or replace harness.

REAR FOG LAMP SWITCH LAMP NOT LIT

Circuit Diagram

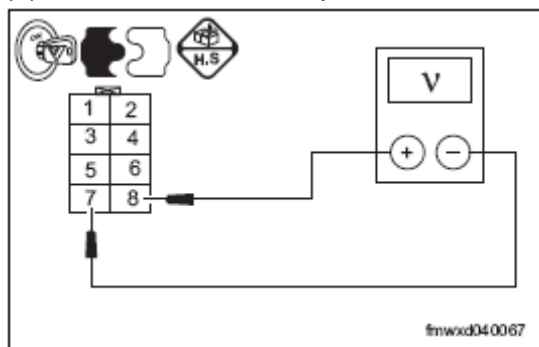


fmwxd040462

Diagnostic Procedures

1. Check power circuit and ground circuit of rear fog lamp switch lamp.

- (a). Remove rear fog lamp switch connector B077.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 8 and Pin 7 of rear fog lamp switch connector B077.

Standard voltage: Battery voltage

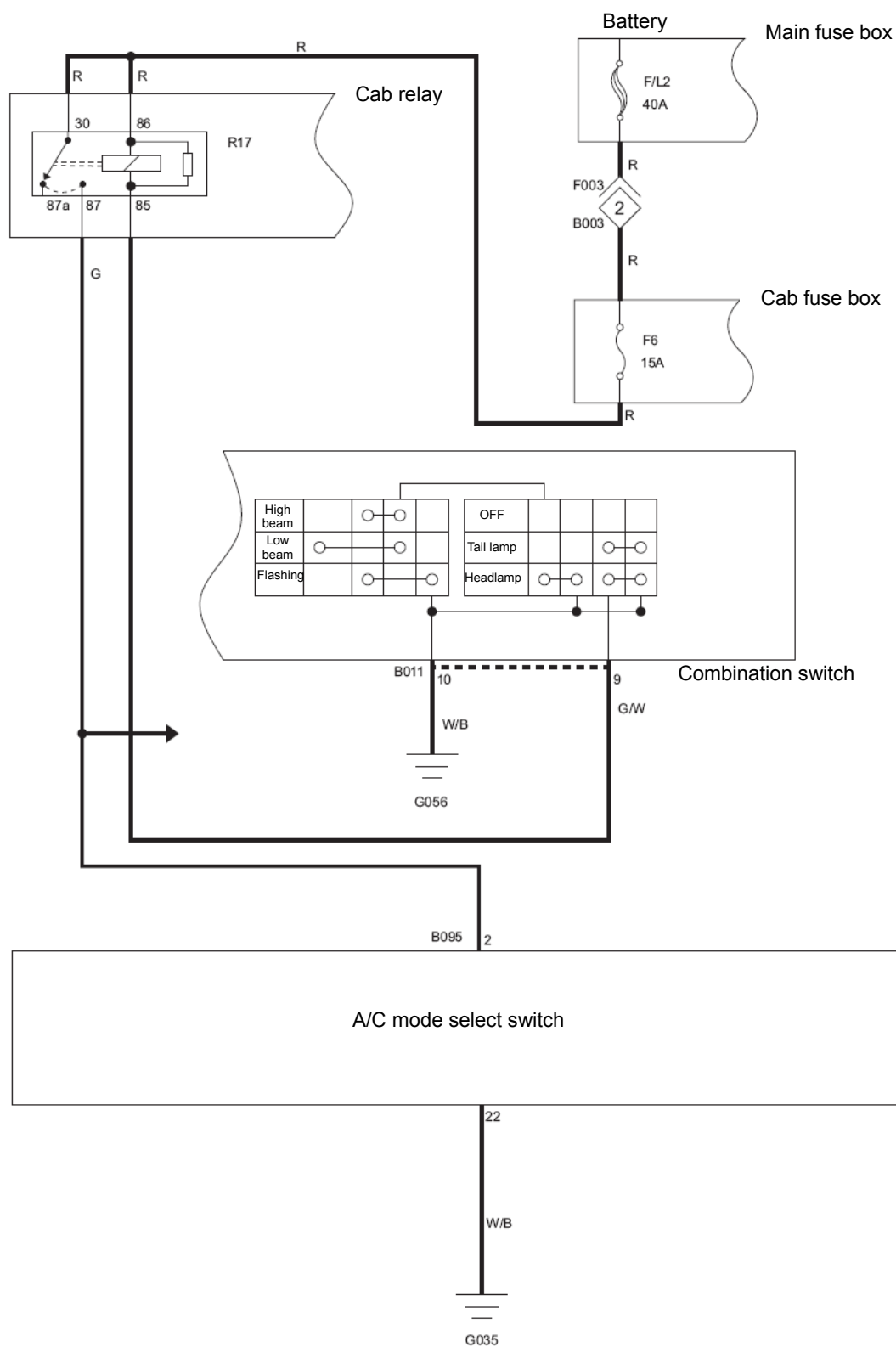
Is the inspection result normal?

Yes > Replace rear fog lamp switch.

No > Repair or replace harness.

A/C MODE SELECT SWITCH LAMP NOT LIT

Circuit Diagram

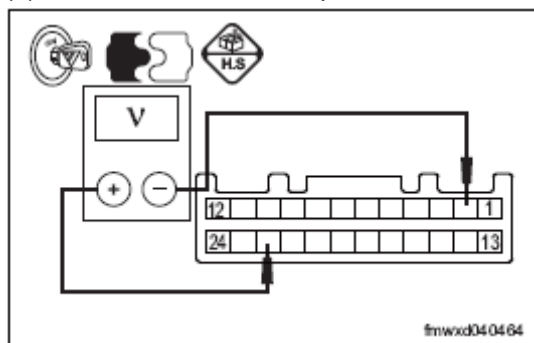


fmwxd040463

Diagnostic Procedures

1. Check power circuit and ground circuit of A/C mode select switch lamp.

- (a). Turn ignition switch to ON.
- (b). Remove A/C mode select switch connector B095.
- (c). Turn on small lamps.



- (d). Measure the voltage of the circuit between Pin 2 and Pin 22 of A/C control panel connector B095.

Standard voltage: Battery voltage

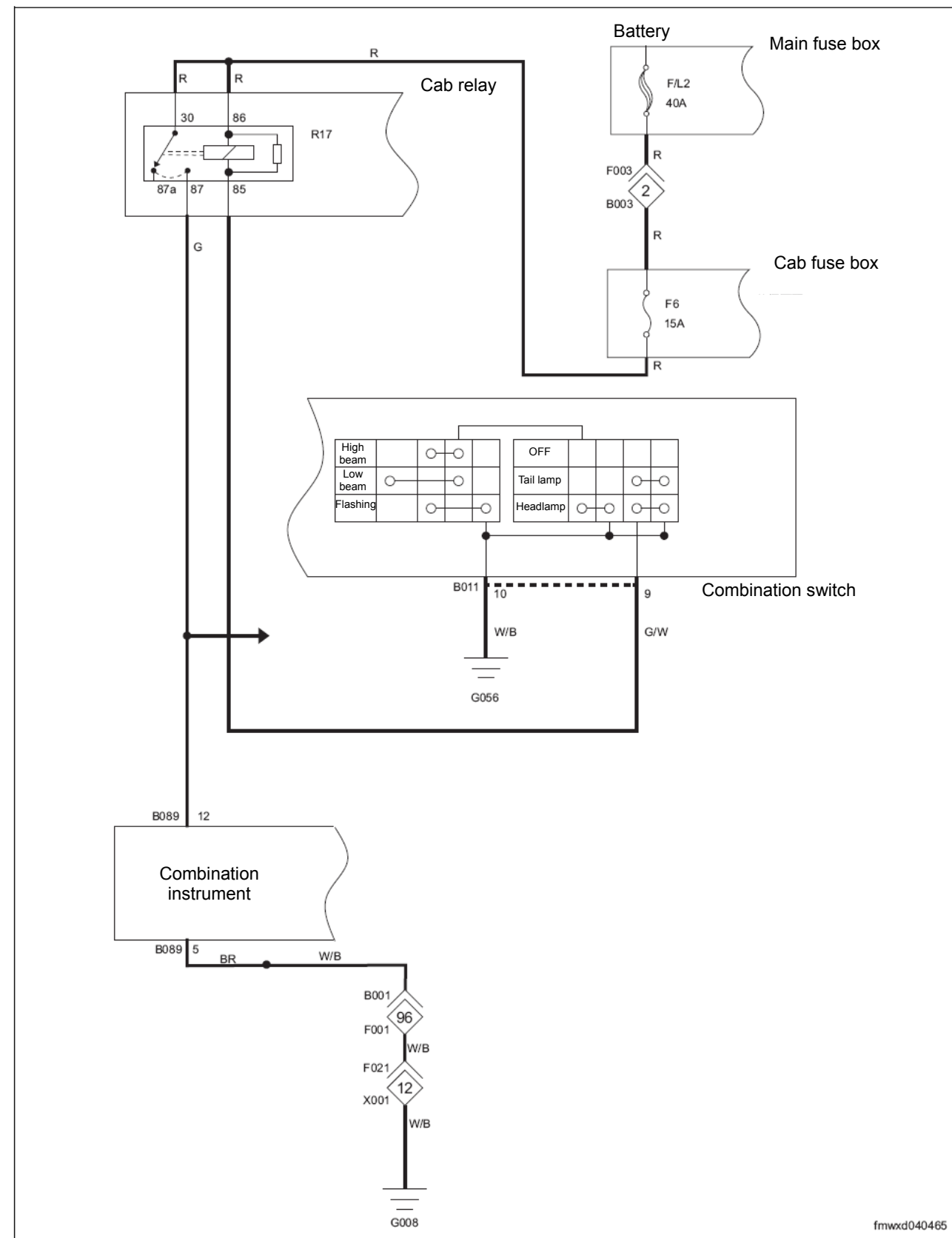
Is the inspection result normal?

Yes > Replace A/C mode select switch.

No > Repair or replace harness.

COMBINATION INSTRUMENT LAMP NOT LIT

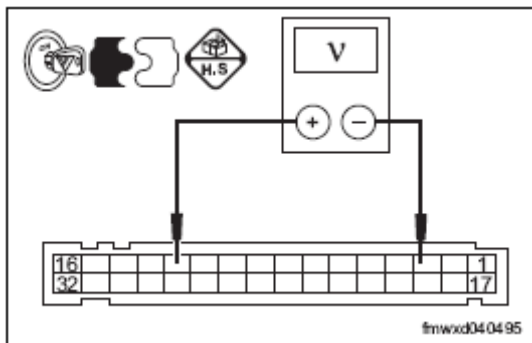
Circuit Diagram



Diagnostic Procedures

1. Check power circuit and ground circuit of combination instrument lamp.

- (a). Turn ignition switch to ON.
- (b). Disconnect combination instrument connector B089.
- (c). Turn on small lamps.



- (d). Measure the voltage of the circuit between Pin 12 and Pin 3 of combination instrument connector B089.

Standard voltage: Battery voltage

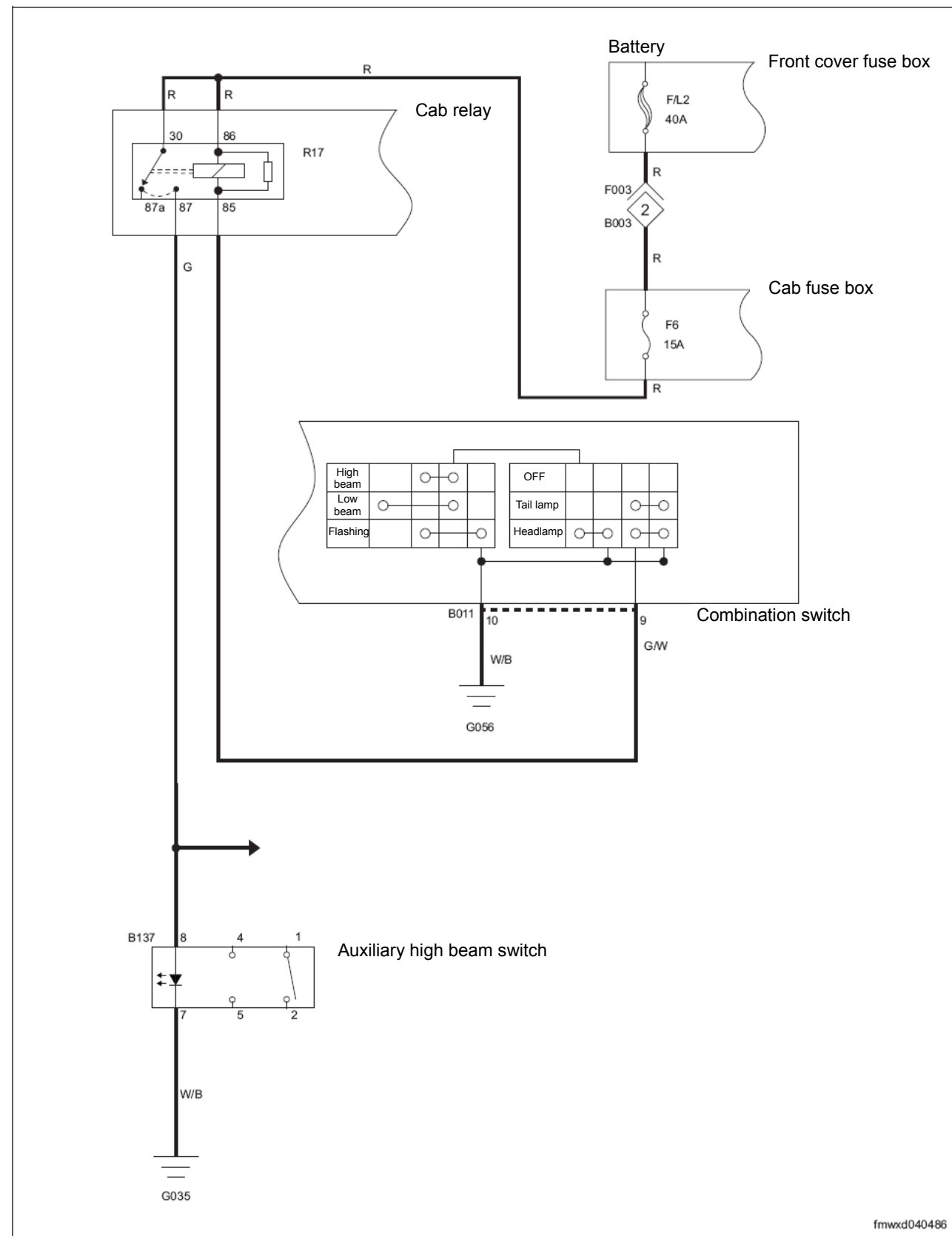
Is the inspection result normal?

Yes > Replace combination instrument.

No > Repair or replace harness.

AUXILIARY HIGH BEAM SWITCH LAMP NOT LIT

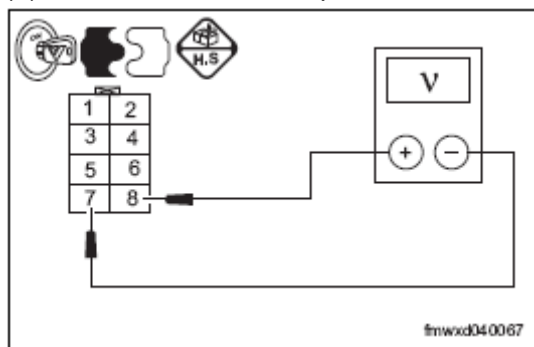
Circuit Diagram



Diagnostic Procedures

1. Check power circuit and ground circuit of auxiliary high beam switch lamp.

- (a). Remove auxiliary high beam switch connector B137.
- (b). Turn on small lamps.



- (c). Measure the voltage of the circuit between Pin 8 and Pin 7 of auxiliary high beam switch connector B137.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace auxiliary high beam switch.

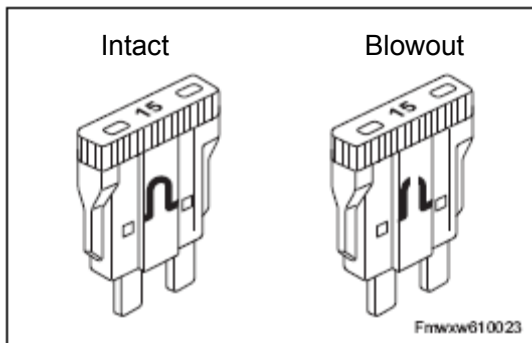
No > Repair or replace harness.

Circuit Diagram



Diagnostic Procedures**1. Check fuse.**

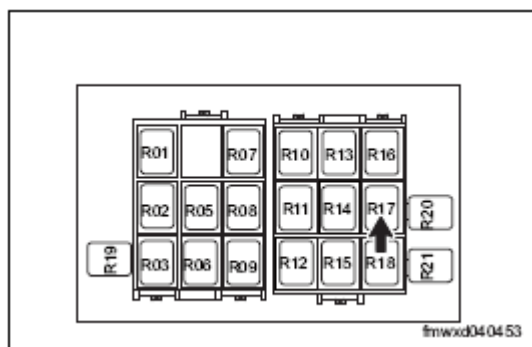
(a). Shut off main power.



(b). Check fuse in cab fuse box: F6 (15A).

Is the fuse intact?**Yes > Go to Step 2.****No > Service fuse circuit or replace fuse of the same rating.****2. Check small lamp relay R17 for normal operation.**

(a). Turn on main power.

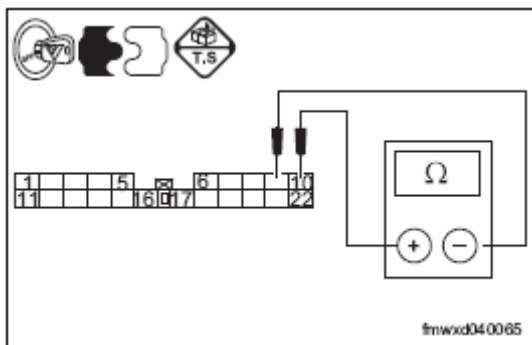


(b). Replace the small lamp relay R17 with an intact relay of the same rating.

Are small lamps, clearance lamps and marker lamps lit?**Yes > Replace small lamp relay R17.****No > Go to Step 3.****3. Check combination switch.**

(a). Shut off main power.

(b). Remove combination switch connector B011.



(c). Use multimeter to measure the voltage of the circuit between Pin 9 and Pin 10 of combination switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Small lamps turned ON	9-10	$\leq 2 \Omega$
Small lamps turned OFF	9-10	$> 10 \text{ M}\Omega$

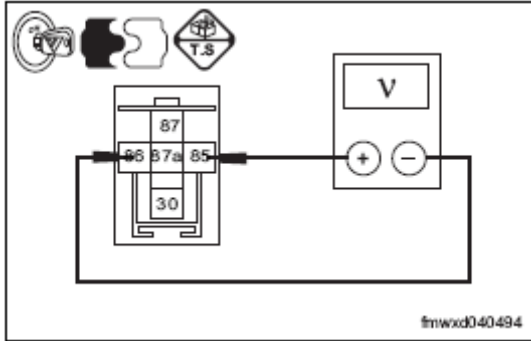
Is the inspection result normal?

Yes > Go to Step 4.

No > Replace combination switch.

4. Check small lamp relay R17 coil circuit in cab.

- (a). Turn on main power.
- (b). Remove relay R17.
- (c). Turn on small lamps.



- (d). Measure the voltage of the circuit between Pin 86 and Pin 85 of relay R17 connector.

Standard voltage: Battery voltage

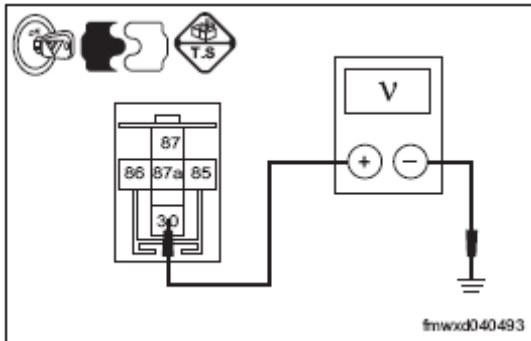
Is the inspection result normal?

Yes > Go to Step 5.

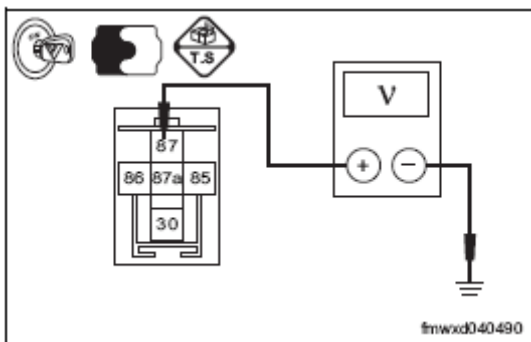
No > Repair power circuit of relay R17 connector Pin 86 or combination switch ground circuit.

5. Check relay R17 contact circuit.

- (a). Turn on main power.
- (b). Turn on small lamp switch.



- (c). Remove relay R17.
- (d). Measure the voltage of the circuit between Pin 30 of relay R17 connector and the effective ground point of body.



- (e). Install the relay R17.
- (f). Measure the voltage of the circuit between Pin 87 of relay R17 connector and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Service the output circuit of relay R17 connector Pin 87.

No > Service the power circuit of relay R17 connector Pin 30.

MARKER LAMPS, CLEARANCE LAMPS AND FRONT AND REAR SMALL LAMPS ALWAYS ON

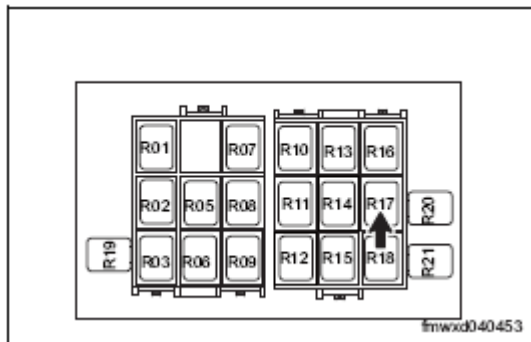
Circuit Diagram

Please refer to "Marker Lamps, Clearance Lamps and Front and Rear Small Lamps Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check tail lamp relay R17.

(a). Turn on main power and ignition switch.



(b). Replace the tail lamp relay R17 with an intact relay of the same rating, and turn on small lamps to check if they are lit.

Are small lamps still lit?

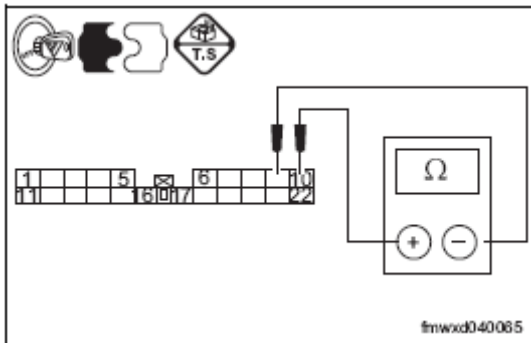
Yes > Go to Step 2.

No > Replace tail lamp relay R17.

2. Check combination switch.

(a). Shut off main power.

(b). Remove combination switch connector B011.



(c). Measure the resistance of the circuit between Pin 9 and Pin 10 of combination switch.

Standard value:

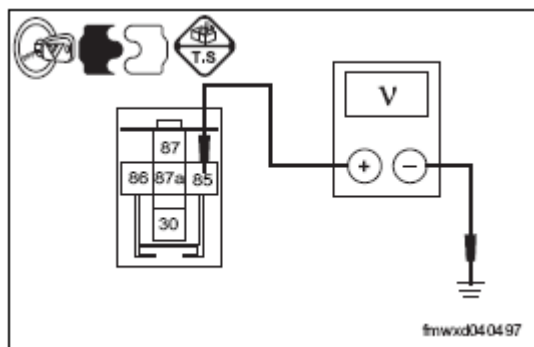
Condition	Multimeter Pin	Standard Value
Small lamps turned ON	9-10	$\leq 2 \Omega$
Small lamps turned OFF	9-10	$> 10 M\Omega$

Is the inspection result normal?

Yes > Go to Step 3.

No > Replace combination switch.

3. Check ground circuit of tail lamp relay R17 coil.



- (a). Remove combination switch connector B011.
- (b). Use multimeter to measure the resistance of the circuit between Pin 85 of tail lamp relay R17 connector and the effective ground point of body.

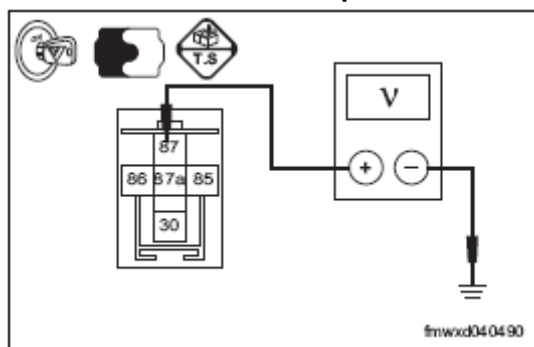
Resistance: > 10 MΩ

Is the inspection result normal?

Yes > Go to Step 4.

No > Eliminate short circuit between tail lamp relay R17 and combination switch.

4. Check contact output circuit of tail lamp relay R17.



- (a). Turn on ignition switch and turn off small lamps.
- (b). Use multimeter to measure the voltage of the circuit between Pin 87 of tail lamp relay R17 connector and the effective ground point of body.

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Is the voltage equivalent to battery voltage?

Yes > Eliminate short circuit of tail lamp relay R17 contact output circuit.

No > System is normal.



ONE SIDE STEP LAMP NOT LIT

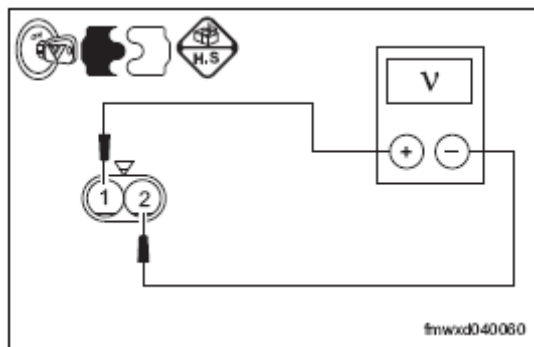
Circuit Diagram

Please refer to “Both Side Step Lamps Not Lit- Circuit Diagram” in this chapter.

Diagnostic Procedures

1. Check circuit.

- (a). Shut off main power.
- (b). Remove step lamp connector B302 or B303.



- (c). Measure the voltage of the circuit between Pin 1 and Pin 2 of step lamp connector B303 or B302.

Standard voltage: Battery voltage

Is the inspection result normal?

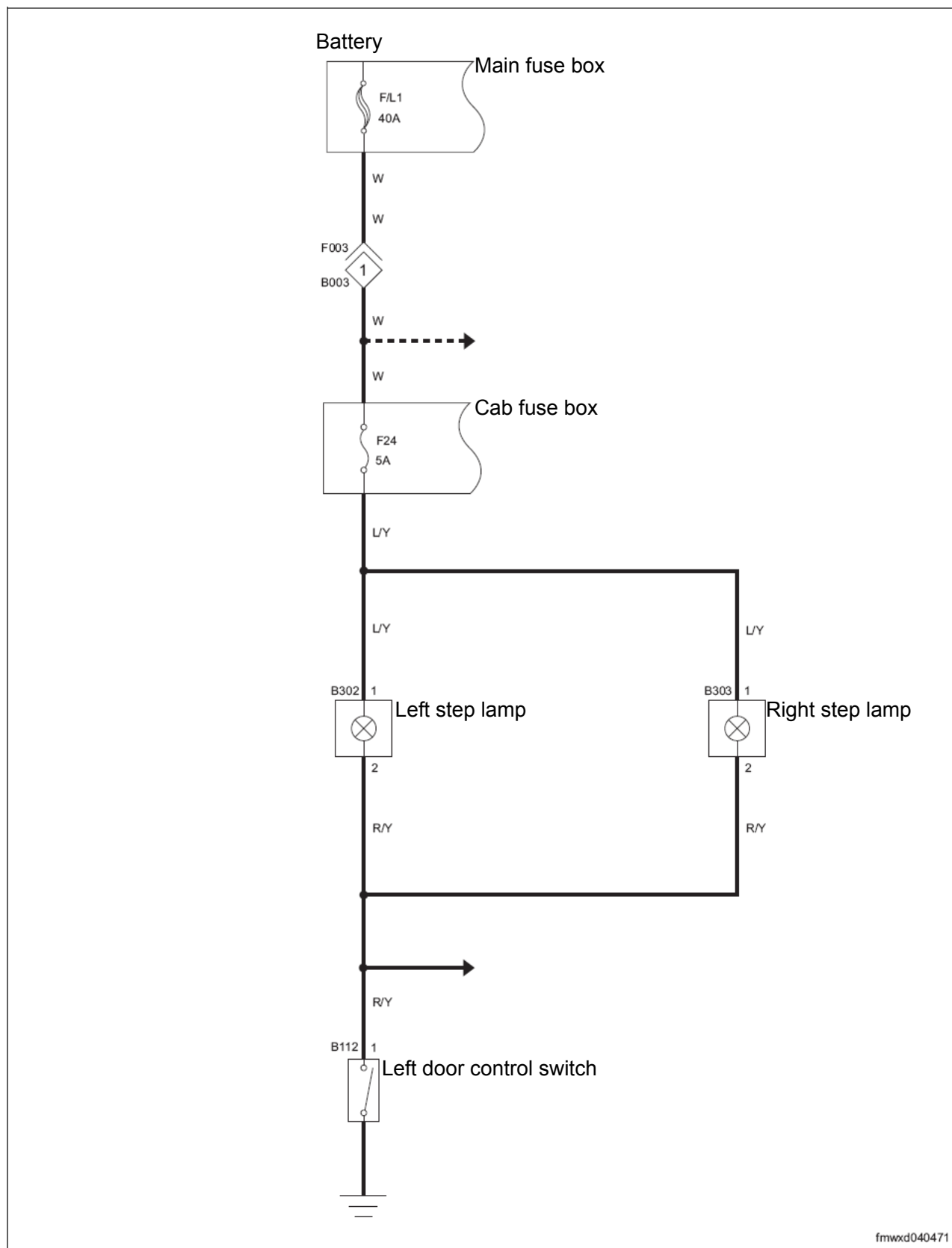
Yes > Replace step lamp bulbs.

No > Repair or replace harness.



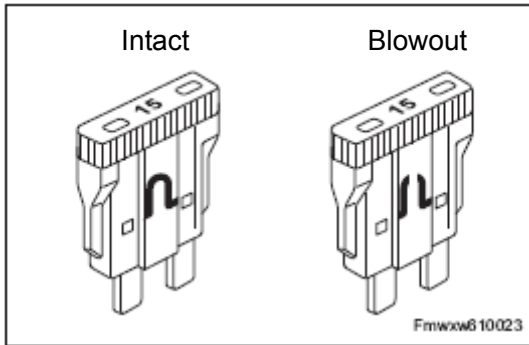
BOTH SIDE STEP LAMPS NOT LIT

Circuit Diagram



Diagnostic Procedures**1. Check fuse**

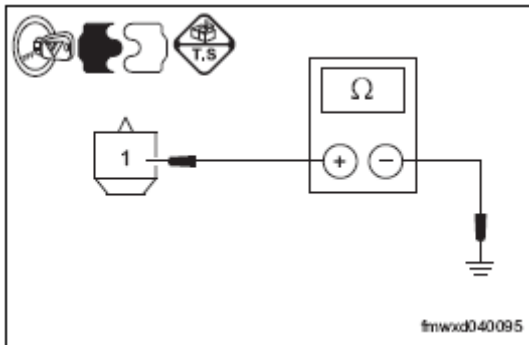
(a). Shut off main power.



(b). Check fuse in cab fuse box: F24 (5A).

Is the fuse intact?**Yes > Go to Step 2.****No > Service fuse circuit or replace fuse of the same rating.****2. Check left door control switch.**

(a). Remove left door control switch connector B112.



(b). Measure the resistance of left door control switch.

Standard value:

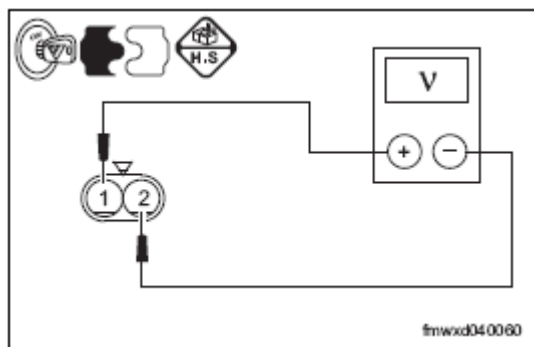
Condition	Multimeter Pin	Standard Value
Left door open	1-GND	$\leq 2 \Omega$
Left door closed	1-GND	$> 10 M\Omega$

Is the inspection result normal?**Yes > Go to Step 3.****No > Replace left door control switch.****3. Check step lamp power circuit and ground circuit.**

(a). Turn on main power.

(b). Open left door.

(c). Remove step lamp connector B302 or B303.



- (d). Measure the voltage of circuit between Pin 1 and Pin 2 of step lamp connector B302 or between Pin 1 and Pin 2 of B303. Does reverse lamp relay R05 operate normally?

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace step lamp bulbs.

No > Repair or replace harness.

STEP LAMPS ALWAYS ON

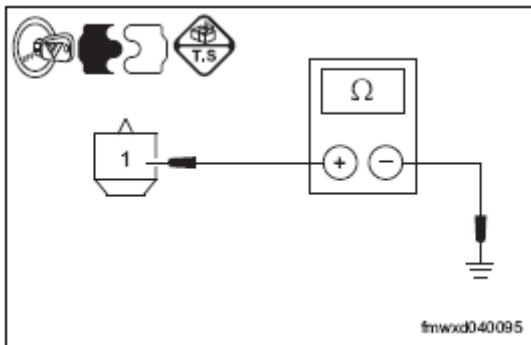
Circuit Diagram

Please refer to "Both Side Step Lamps Not Lit- Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check left door control switch.

- (a). Shut off main power.
- (b). Remove left door control switch connector B112.



- (c). Measure the resistance of left door control switch.

Standard value:

Condition	Multimeter Pin	Standard Value
Left door open	1-GND	$\leq 2 \Omega$
Left door closed	1-GND	$> 10 M\Omega$

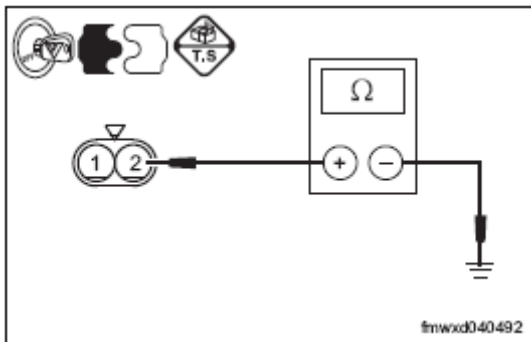
Is the inspection result normal?

Yes > Repair or replace harness.

No > Replace left door control switch.

2. Check step lamp ground circuit.

- (a). Shut off main power.
- (b). Open left door and remove step lamp connector B302 or B303.



- (c). Measure the resistance of circuit between Pin 2 of step lamp connector B302 or B303 and the effective ground point of body.

Resistance: $> 10 M\Omega$

Is the inspection result normal?

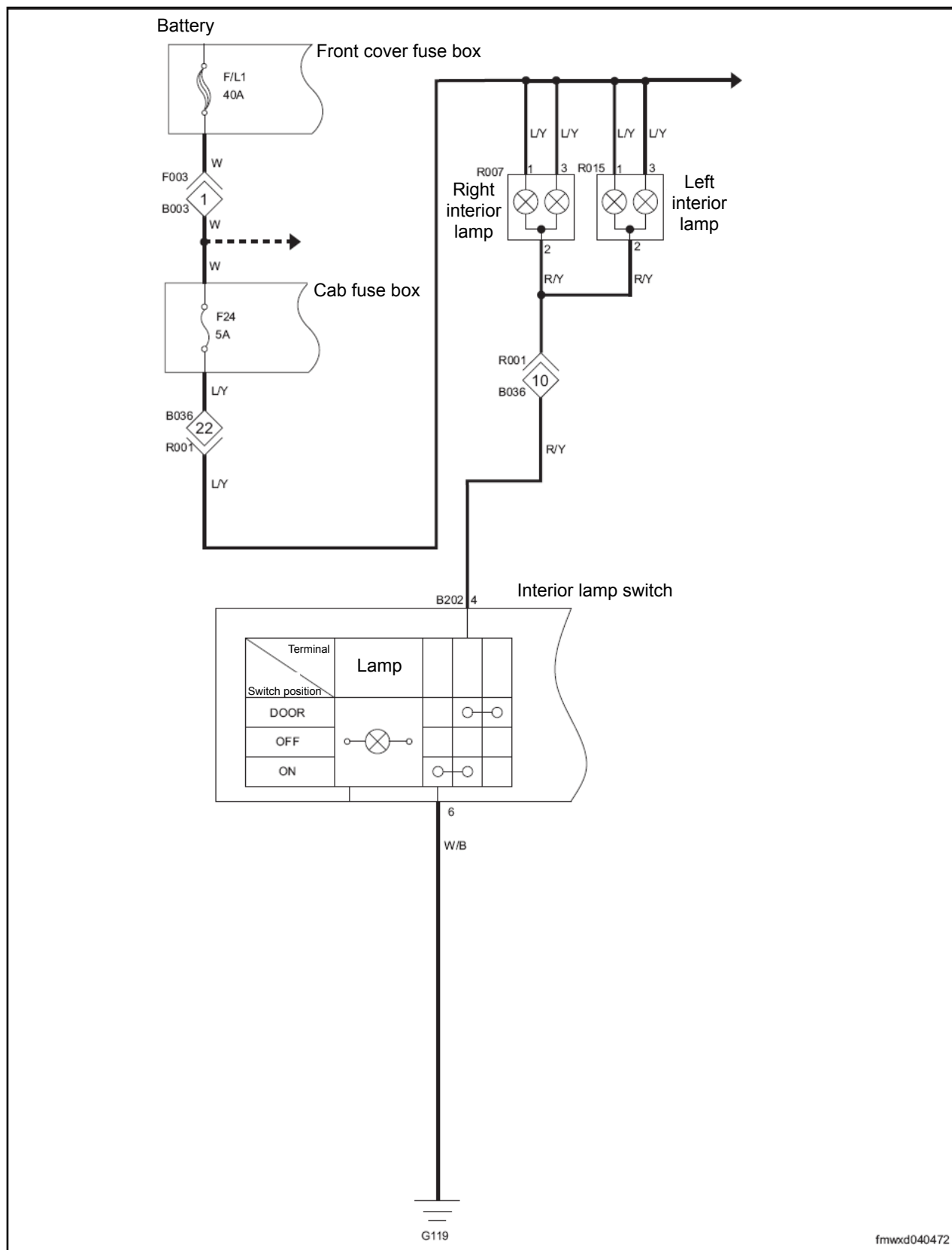
Yes > Repair or replace harness.

No > Replace step lamp.



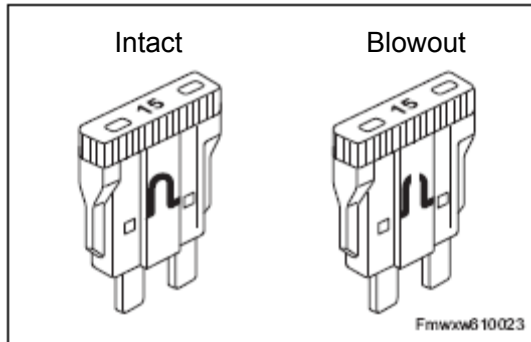
INTERIOR LAMP NOT LIT (WITH INTERIOR LAMP SWITCH ON)

Circuit Diagram



Diagnostic Procedures**1. Check fuse.**

(a). Shut off main power.

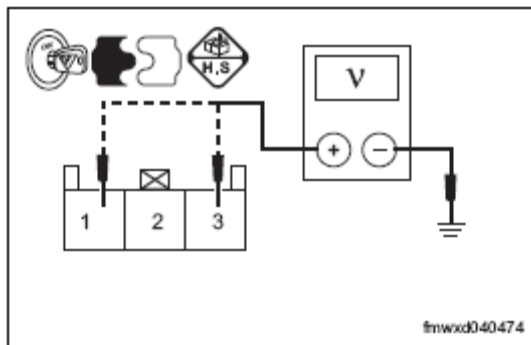


(b). Check fuse in cab fuse box: F24 (5A).

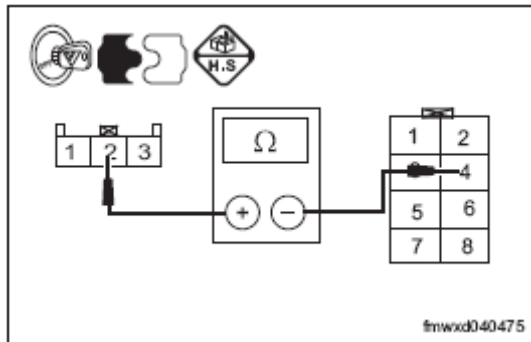
Is the fuse intact?**Yes > Go to Step 2.****No > Service fuse circuit or replace fuse of the same rating.****2. Check interior lamp power circuit.**

(a). Remove interior lamp connector R007 or R015.

(b). Turn on main power.



(c). Measure the voltage of the circuit between Pin 1 and Pin 3 of interior lamp connector R007 or R015 and the effective ground point of body.

Standard voltage: Battery voltage**Is the inspection result normal?****Yes > Go to Step 3.****No > Repair or replace harness.****3. Check interior lamp ground circuit.**

(a). Shut off main power.

(b). Measure the resistance of the circuit between Pin 2 of interior lamp connector R007 or R015 and Pin 4 of interior lamp switch connector B202.

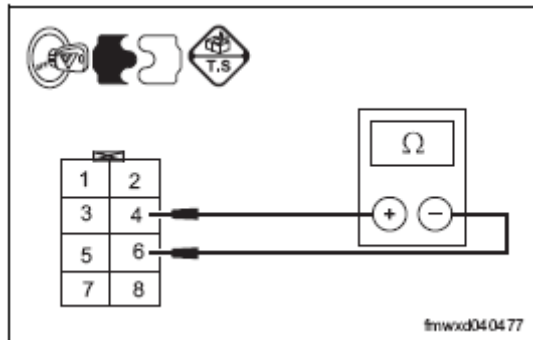
Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 4.

No > Repair or replace harness.

4. Check interior lamp switch



- Shut off main power.
- Turn interior lamp switch ON.
- Measure the resistance of the circuit between Pin 4 and Pin 6 of interior lamp switch connector B202.

Resistance: $\leq 2 \Omega$

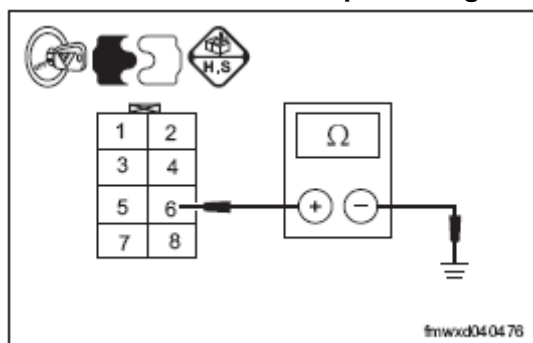
Is the inspection result normal?

Yes > Go to Step 5.

No > Replace interior lamp switch.

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5. Check interior lamp switch ground circuit.



- Shut off main power.
- Measure the resistance of the circuit between Pin 6 of interior lamp switch connector B202 and the ground point G119.

Resistance: $\leq 2 \Omega$

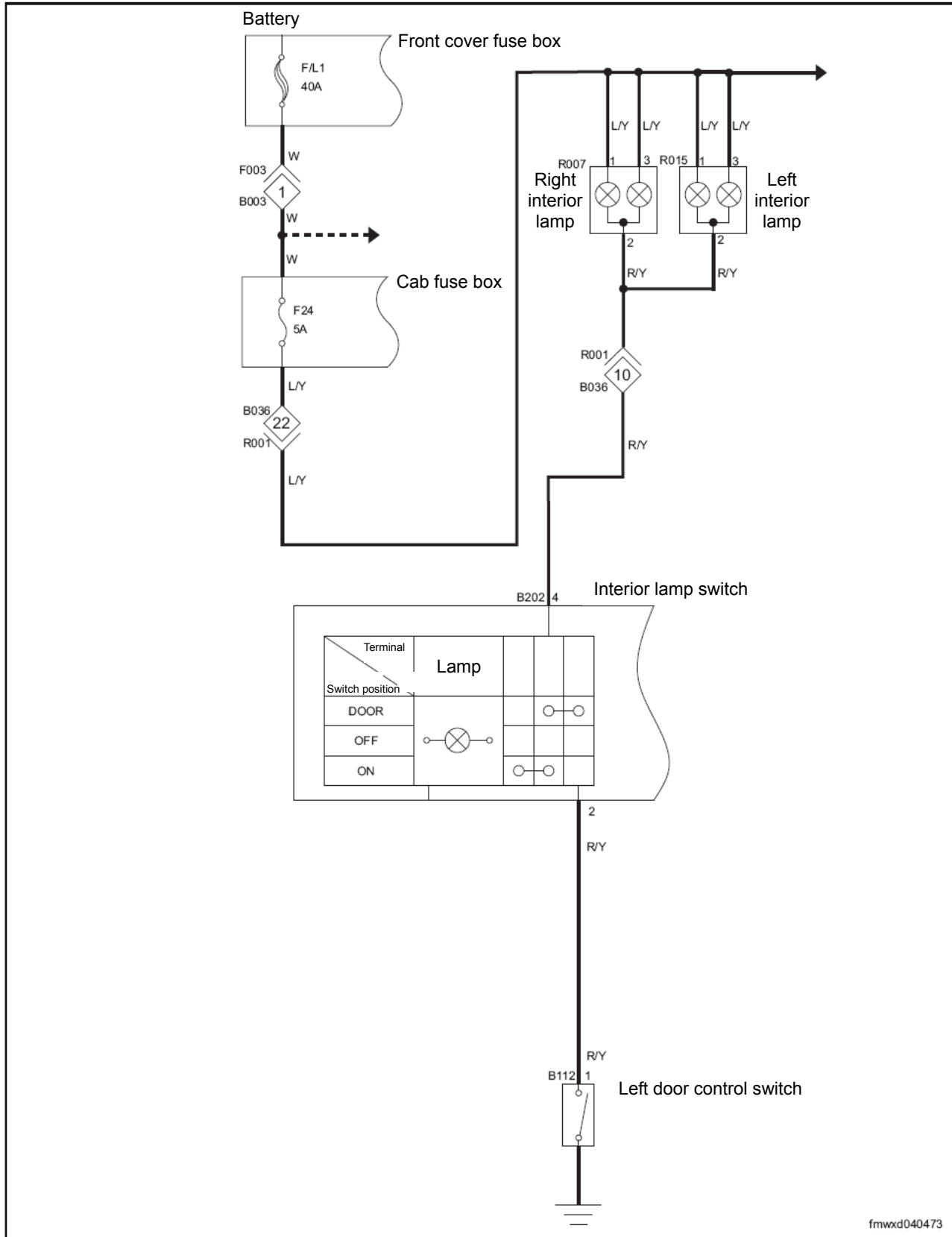
Is the inspection result normal?

Yes > Replace interior lamp bulb.

No > Repair or replace harness.

INTERIOR LAMP NOT LIT (WITH LEFT DOOR OPEN)

Circuit Diagram



Diagnostic Procedures

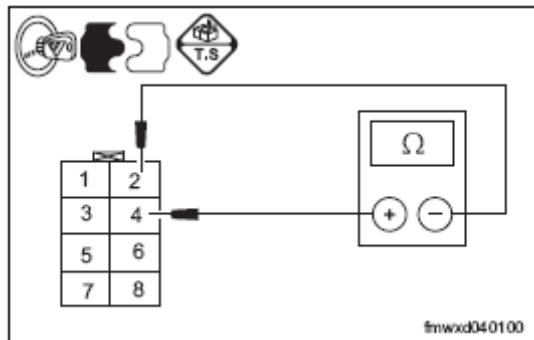
1. **Confirm the step lamp operates normally when the left door is open.**

2. **Check interior lamp switch**

(a). Shut off main power.

(b). Remove interior lamp switch connector B202.

(c). Turn interior lamp switch to DOOR position.



(d). Measure the resistance of the circuit between Pin 4 and Pin 2 of interior lamp connector B202.

Resistance: $\leq 2\ \Omega$

Is the inspection result normal?

Yes > Repair or replace harness.

No > Replace interior lamp switch.



INTERIOR LAMP ALWAYS ON

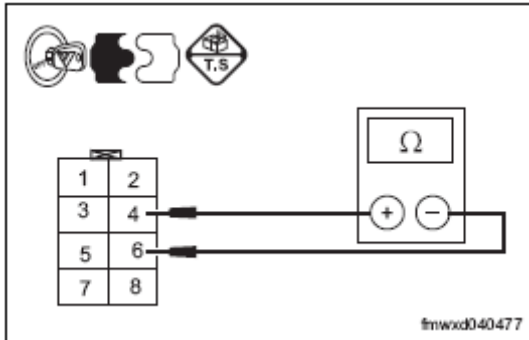
Circuit Diagram

Please refer to "Interior Lamp Not Lit (With Interior Lamp Switch ON) - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check interior lamp switch

- (a). Shut off main power.
- (b). Remove interior lamp switch connector R007 and R015.
- (c). Turn off interior lamp switch.



- (d). Measure the resistance of the circuit between Pin 4 and Pin 6 of interior lamp connector B202.

Resistance: > 10 MΩ

Is the inspection result normal?

Yes > Go to Step 2.

No > Replace interior lamp switch.

2. Check circuit.

- (a). Remove interior lamp harness connectors R007, R015 and B202.
- (b). Measure the resistance of the circuit between Pin 2 of R007 or R015 and the effective ground point of body.

Resistance: > 10 MΩ

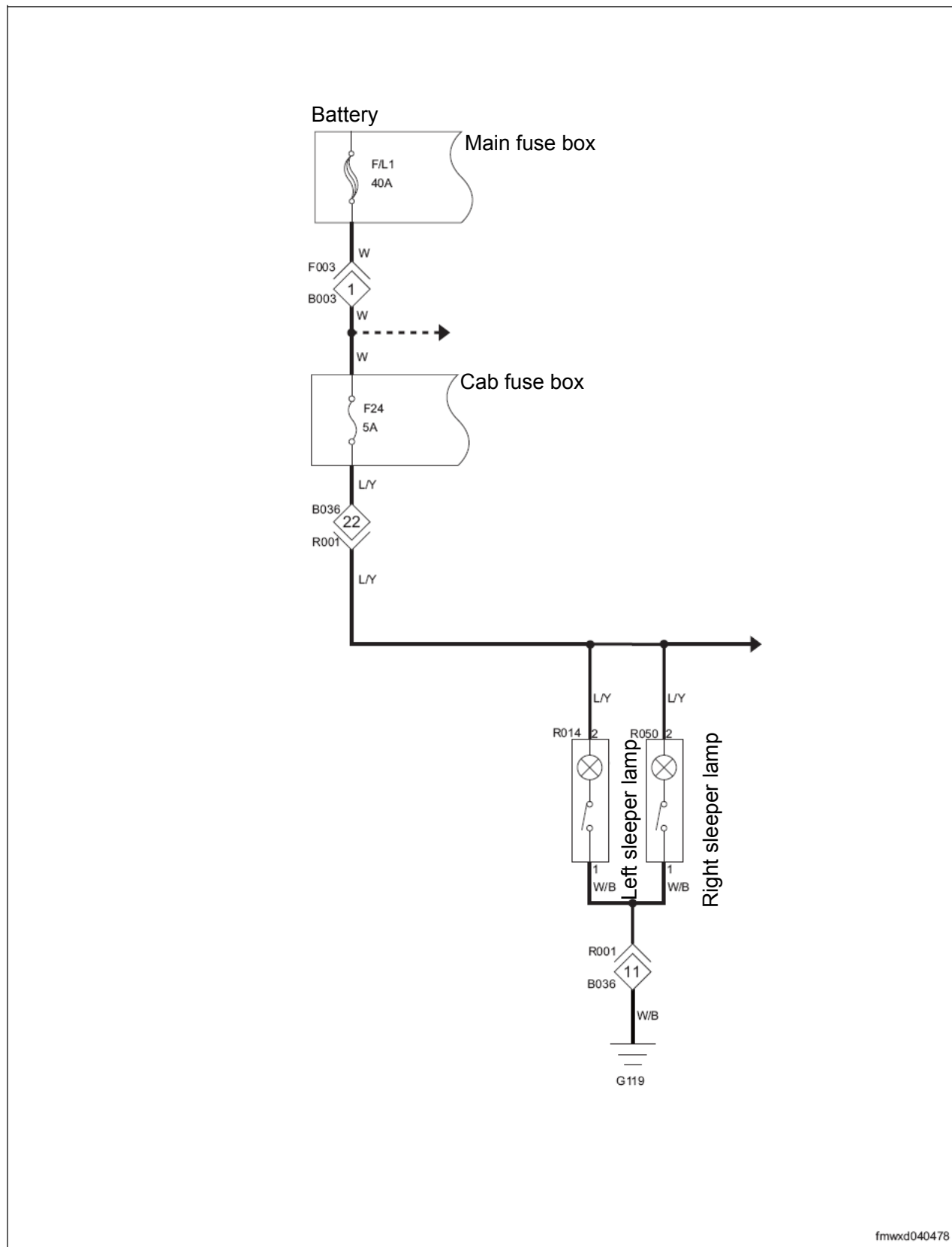
Is the inspection result normal?

Yes > Replace interior lamp switch.

No > Repair or replace harness.

SLEEPER LAMP NOT LIT

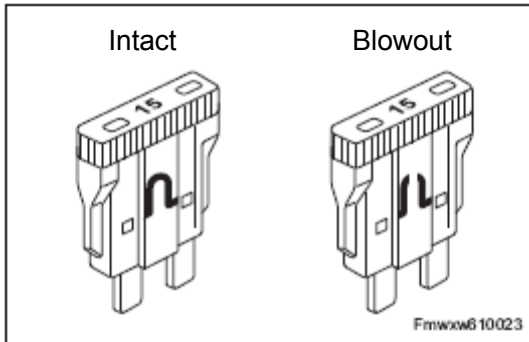
Circuit Diagram



Diagnostic Procedures

1. Check fuse.

(a). Shut off main power.



(b). Check fuse in cab fuse box: F24 (5A).

Is the fuse intact?

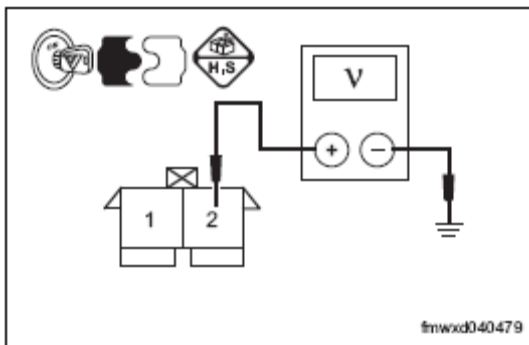
Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check sleeper lamp power circuit.

(a). Remove sleeper lamp connector R014 and R050.

(b). Turn on main power.



(c). Measure the voltage of the circuit between Pin 2 of interior lamp connector R014 or R050 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

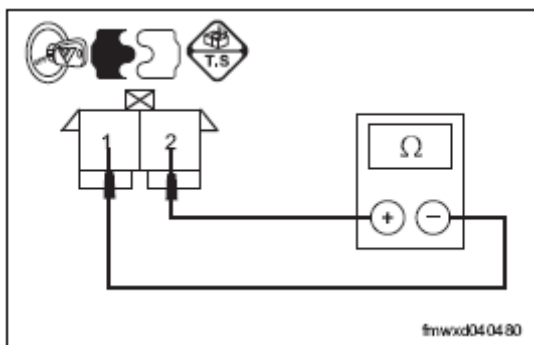
Yes > Go to Step 3.

No > Repair or replace harness.

3. Check sleeper lamp.

(a). Turn on sleeper lamp switch.

(b). Remove sleeper lamp connector R014 or R050.



- (c). Measure the resistance of the circuit between Pin 2 and Pin 1 of sleeper lamp connector R014 or R050.

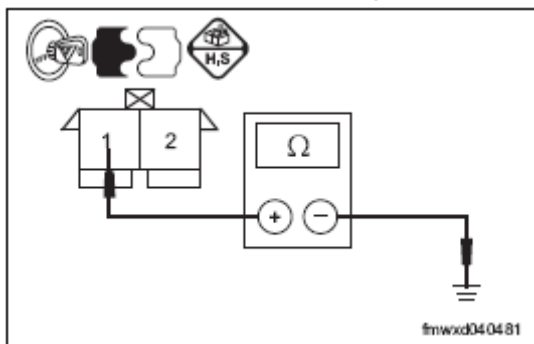
Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 4.

No > Replace sleeper lamp.

4. Check sleeper lamp ground circuit.



- (a). Shut off main power.
(b). Measure the resistance of the circuit between Pin 1 of sleeper lamp connector R014 or R050 and the body ground G119.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace sleeper lamp bulb.

No > Repair or replace harness.

SLEEPER LAMP ALWAYS ON

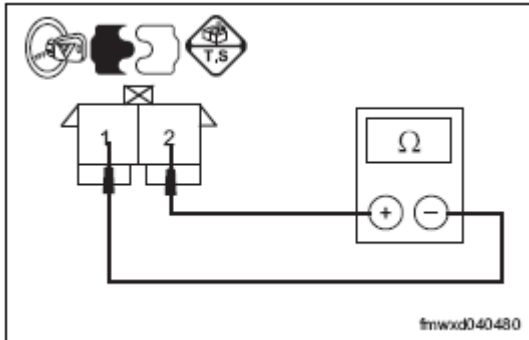
Circuit Diagram

Please refer to "Sleeper Lamp Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check sleeper lamp.

- (a). Shut off main power.
- (b). Remove sleeper lamp connector R014 or R050.
- (c). Turn off sleeper lamp switch.



- (d). Measure the resistance of the circuit between Pin 1 and Pin 2 of sleeper lamp connector R014 or R050.

Resistance: > 10 MΩ

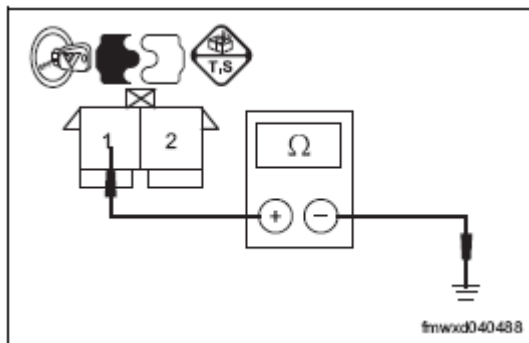
Is the inspection result normal?

Yes > Go to Step 2.

No > Replace sleeper lamp.

2. Check sleeper lamp ground circuit.

- (a). Shut off main power.
- (b). Remove sleeper lamp connector R014 or R050.
- (c). Turn off sleeper lamp switch.



- (d). Measure the resistance of the circuit between Pin 1 of sleeper lamp connector R014 or R050 and the effective ground point of body.

Resistance: > 10 MΩ

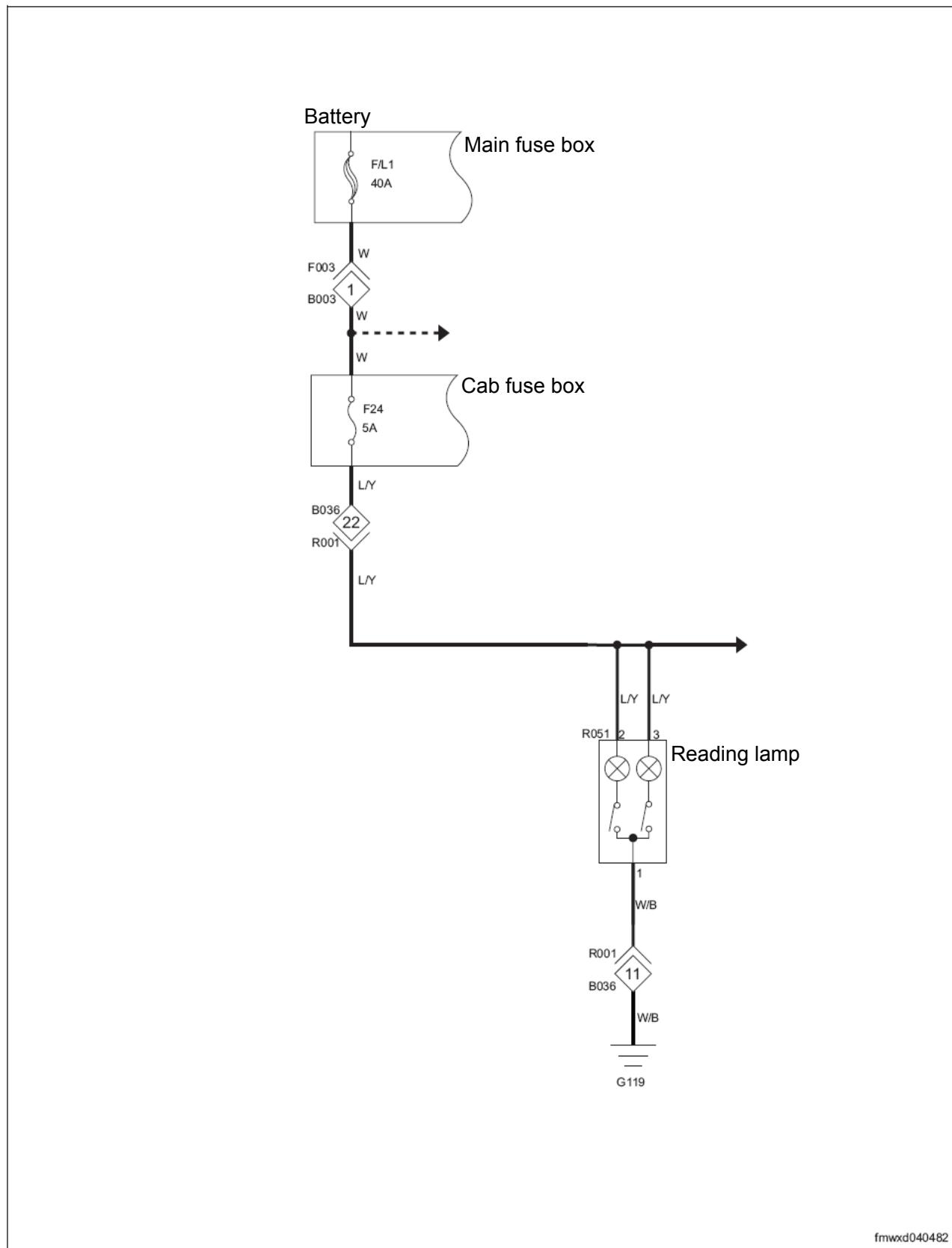
Is the inspection result normal?

Yes > System is normal.

No > Replace sleeper lamp.

READING LAMP NOT LIT

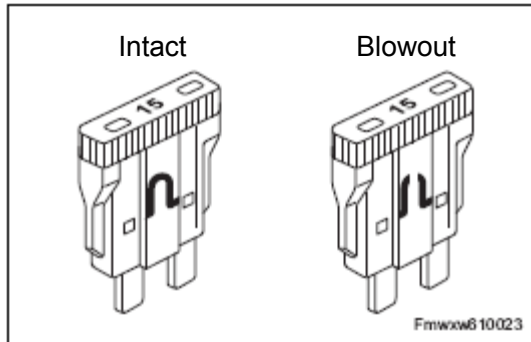
Circuit Diagram



Diagnostic Procedures

1. Check fuse

(a). Shut off main power.



(b). Check fuse in cab fuse box: F24 (5A).

Is the fuse intact?

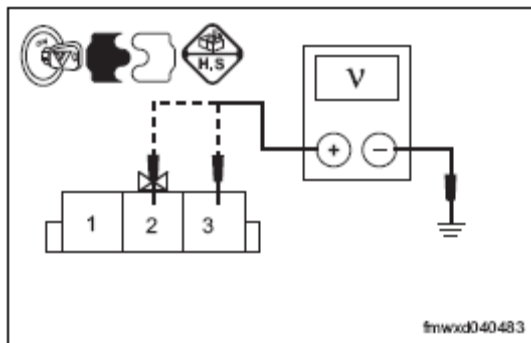
Yes > Go to Step 2.

No > Service fuse circuit or replace fuse of the same rating.

2. Check reading lamp power circuit.

(a). Remove reading lamp connector R051.

(b). Turn on main power.



(c). Measure the voltage of the circuit between Pin 2 or Pin 3 of interior lamp connector R050 and the effective ground point of body.

Standard voltage: Battery voltage

Is the inspection result normal?

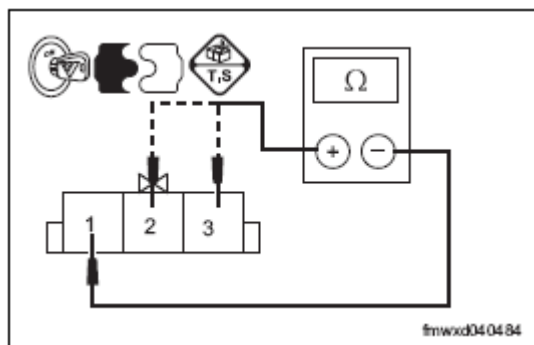
Yes > Go to Step 3.

No > Repair or replace harness.

3. Check reading lamp.

(a). Turn on reading lamp switch.

(b). Remove reading lamp connector R051.



- (c). Measure the resistance of the circuit between Pin 2/Pin 3 and Pin 1 of reading lamp connector R051.

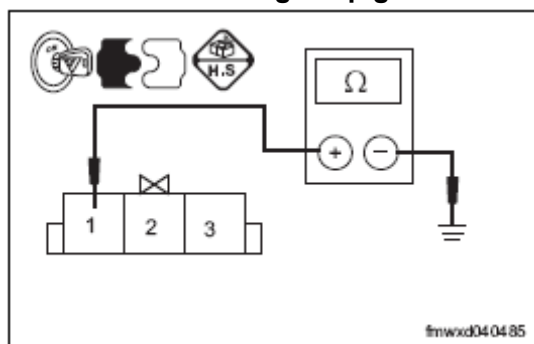
Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 4.

No > Replace reading lamp.

4. Check reading lamp ground circuit.



- (a). Shut off main power.
(b). Measure the resistance of the circuit between Pin 1 of reading lamp connector R051 and ground G119.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace reading lamp bulb.

No > Repair or replace harness.

READING LAMP ALWAYS ON

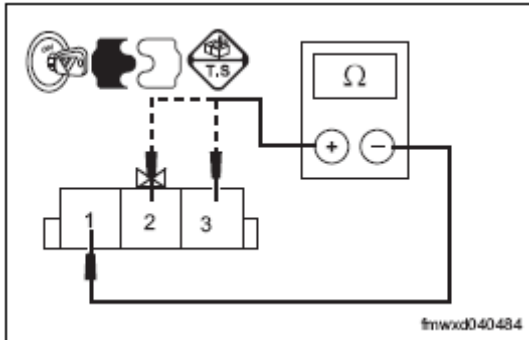
Circuit Diagram

Please refer to "Reading Lamp Not Lit - Circuit Diagram" in this chapter.

Diagnostic Procedures

1. Check reading lamp.

- (a). Shut off main power.
- (b). Remove reading lamp connector R051.
- (c). Turn on reading lamp switch.



- (d). Measure the resistance of the circuit between Pin 2/Pin 3 and Pin 1 of sleeper lamp connector R051.

Resistance: > 10 MΩ

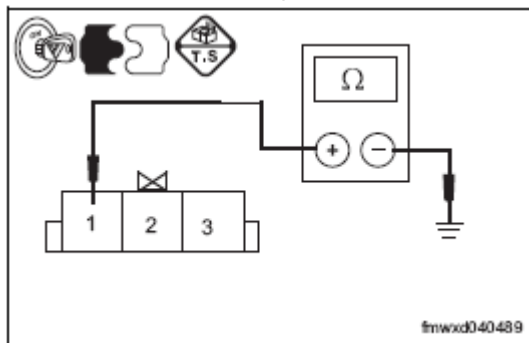
Is the inspection result normal?

Yes > Go to Step 2.

No > Replace reading lamp.

2. Check reading lamp ground circuit.

- (a). Shut off main power.
- (b). Remove reading lamp connector R051.
- (c). Turn off reading lamp switch.



- (d). Measure the resistance of the circuit between Pin 1 of reading lamp connector R051 and the effective ground point of body.

Resistance: > 10 MΩ

Is the inspection result normal?

Yes > System is normal.

No > Repair or replace harness.

WIPER AND WASHER

PRECAUTIONS

1. Shut off main power

- (a). In order to avoid personal injury or vehicle damage, please be sure to disconnect the negative cable of battery before removal/installation of any equipment and under the condition that certain tool or equipment is likely to contact with the bare electrical terminal.
- (b). Unless otherwise specified, the ignition switch must be turned off.

2. Disconnection of negative cable of battery shall make the odometer and clock reset.

Hint:

Odometer won't be reset.

3. Precautions for spray washer nozzle adjustment

- (a). It is not allowed to clean or adjust spray washer nozzle with a safety pin or the similar for the top of spray washer nozzle is made of resin and it is easily damaged.
- (b). In the case of blocked spray washer nozzle due to wax or the similar in it, remove the nozzle and clean it with soft resin brush or other cleaning tools.

BASIC INSPECTION

Step	Inspection Item		Measure
1	Check battery voltage. Battery voltage should not be lower than 22 V. Is the inspection result normal?	Yes	Go to Step 2
		No	Carry out battery charging or replacement. Refer to "Chapter 53 Battery- Replacement of Battery"
2	Check wiper intermittent gear Use combination switch to shift into wiper intermittent gear Is the inspection result normal?	Yes	Go to Step 3
		No	Refer to Table of Fault Phenomena.
3	Check wiper low-speed gear - Turn ignition switch to ON. - Use combination switch to shift into wiper low-speed gear. Is the inspection result normal?	Yes	Go to Step 4
		No	Refer to Table of Fault Phenomena.
4	Check wiper high-speed gear Use combination switch to shift into wiper high-speed gear. Is the inspection result normal?	Yes	Go to Step 5
		No	Refer to Table of Fault Phenomena.
5	Check washer Use combination switch to turn on washer. Is the inspection result normal?	Yes	Go to Step 6
		No	Refer to Table of Fault Phenomena.
6	Check washing liquid Is the inspection result normal?	Yes	Refer to Table of Fault Phenomena.
		No	Refill with washing liquid

TABLE OF FAULT PHENOMENA

Please refer to the following table for troubleshooting. The serial numbers indicate the order of fault possibility. Please check relevant parts in the order and conduct replacement when necessary.

Fault Phenomena	Possible Cause	Solution
Incapable working of wiper in any gear	1. Fuse (damaged)	Replace fuse
	2. Combination switch(damaged)	Chapter 55 Wiper and Washer- Replacement of Combination Switch
	3. Wiper motor(damaged)	Chapter 55 Wiper and Washer- Replacement of Wiper Motor
	4. Harness (Shorted or shorted to ground)	Replace harness
Motor rotation without wiper arm rotation	1. Wiper arm(loose)	Chapter 55 Wiper and Washer - Replacement of Wiper Arm Assembly
	2. Worm gear (loose)	Chapter 55 Wiper and Washer - Replacement of Wiper Motor
	3. Linkage mechanism(loose)	Chapter 55 Wiper and Washer - Replacement of Linkage Mechanism
Slow rotation of wiper	1. Battery(excessively low voltage)	Refer to Chapter 53 Battery- Replacement of Battery
	2. Harness (poor contact)	Repair harness
	3. Motor bearing and retarder gear(poor lubrication)	Chapter 55 Wiper and Washer - Replacement of Wiper Motor
	4. Wiper motor(damaged)	Chapter 55 Wiper and Washer - Replacement of Wiper Motor Assembly
Abnormal noise	1. Worm of worm gear(no lubrication)	Chapter 55 Wiper and Washer - Replacement of Wiper Motor Assembly
	2. Linkage mechanism(twisted and deformed)	Chapter 55 Wiper and Washer - Replacement of Linkage Mechanism
	3. Linkage connector(worn)	Chapter 55 Wiper and Washer - Replacement of Linkage Mechanism

Fault Phenomena	Possible Cause	Solution
Poor performance of wiper	1. Glass (with oil stains and wax)	Clean glass
	2. Wiper arm blade (wrong model)	Chapter 55 Wiper and Washer - Replacement of Wiper Arm Assembly
	3. Wiper arm blade(damaged rubber)	Chapter 55 Wiper and Washer - Replacement of Wiper Arm Assembly
	4. Wiper arm (damaged)	Chapter 55 Wiper and Washer - Replacement of Wiper Arm Assembly
	5. Wiper arm (degressive elasticity in spring)	Chapter 55 Wiper and Washer - Replacement of Wiper Arm Assembly
Incapable stop of wiper	1. Combination switch (damaged)	Chapter 55 Wiper and Washer - Replacement of Combination Switch
Incapable working of wiper in intermittent gear	1. Combination switch (damaged)	Chapter 55 Wiper and Washer - Replacement of Combination Switch
	2. Harness (Open circuit or shorted to ground)	Repair or replace harness
Incapable working of wiper in low-speed gear	1. Combination switch(damaged)	Chapter 55 Wiper and Washer - Replacement of Combination Switch
	2. Harness (Open circuit or shorted to ground)	Repair or replace harness
	3. Wiper motor (damaged)	Chapter 55 Wiper and Washer - Replacement of Wiper Motor Assembly
Incapable working of wiper in high-speed gear	1. Combination switch (damaged)	Chapter 55 Wiper and Washer - Replacement of Combination Switch
	2. Harness (Open circuit or shorted to ground)	Repair or replace harness
	3. Wiper motor (damaged)	Chapter 55 Wiper and Washer - Replacement of Wiper Motor Assembly
Incapable return of wiper when switch is turned off	1. Harness (Open circuit or shorted to ground)	Repair or replace harness
	2. Cam switch connection point (poor contact)	Chapter 55 Wiper and Washer - Replacement of Wiper Motor Assembly

DIAGNOSIS-WIPER AND WASHER
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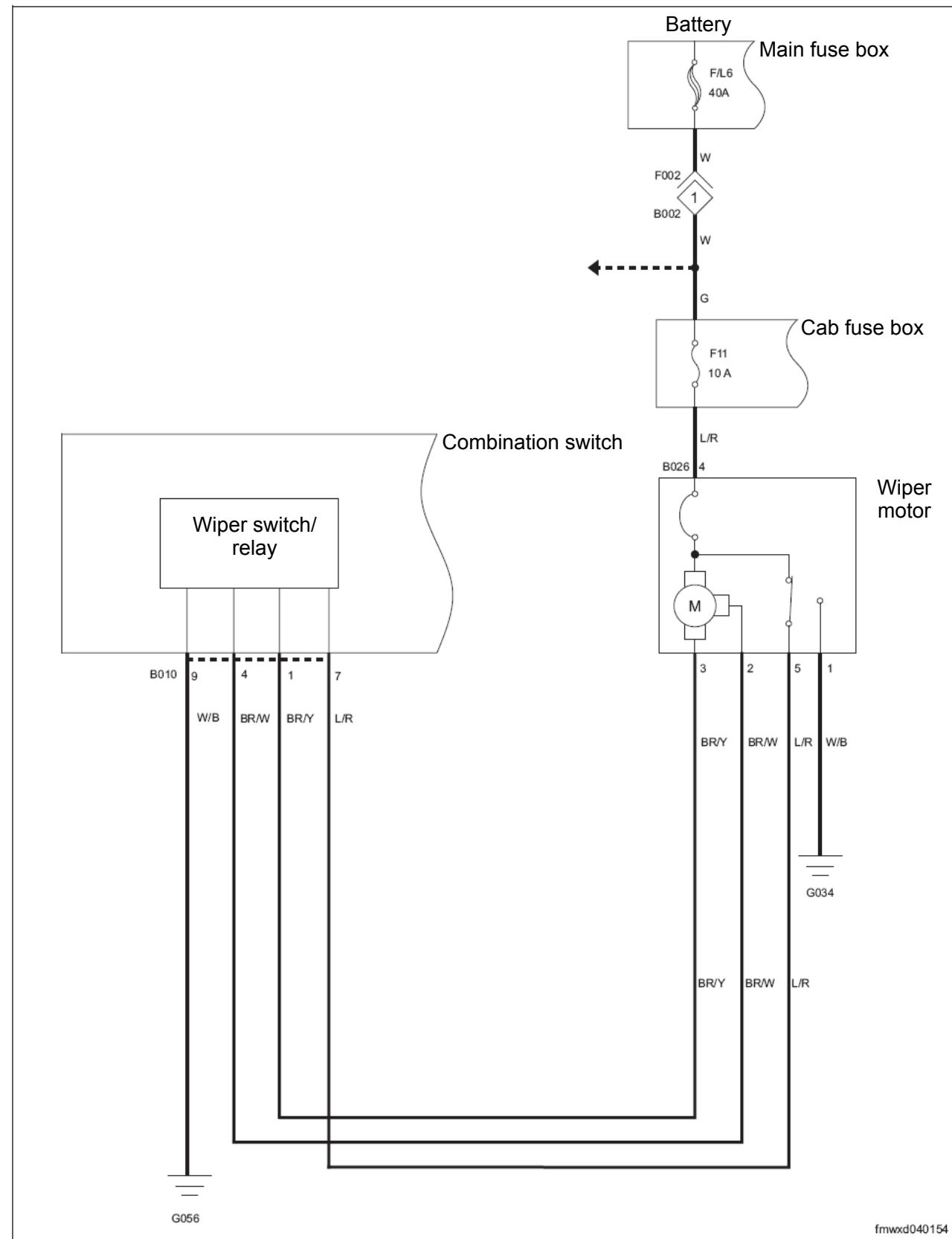
Fault Phenomena	Possible Cause	Solution
Incapable working of washer with normal operation of wiper	1. Washing liquid(insufficient)	Refill with washing liquid
	2. Nozzle(blocked)	Chapter 55 Wiper and Washer - Replacement of Wiper Arm Assembly
	3. Hose (damaged)	Replace hose
	4. Combination switch(damaged)	Chapter 55 Wiper and Washer - Replacement of Combination Switch
	5. Washer motor(damaged)	Chapter 55 Wiper and Washer - Replacement of Wiper Arm Assembly
	6. Harness	Repair or replace harness
Incapable washing liquid spraying	1. Nozzle(blocked)	Chapter 55 Wiper and Washer - Replacement of Wiper Arm Assembly
	2. Hose (damaged)	Replace hose
	3. Washer motor(damaged)	Chapter 55 Wiper and Washer - Replacement of Washer
	4. Combination switch(damaged)	Chapter 55 Wiper and Washer - Replacement of Combination Switch
	5. Harness (Open circuit or shorted to ground)	Repair or replace harness

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FOTON

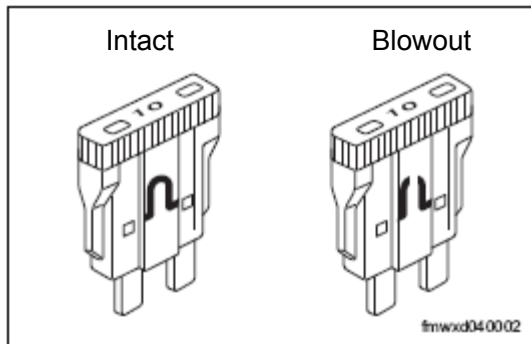
INCAPABLE WORKING OF WIPER IN ANY GEAR

Circuit Diagram



Diagnostic procedures**1. Check fuse F11**

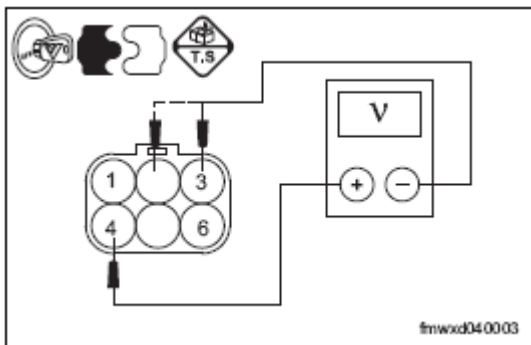
(a). Shut off main power.



(b). Check fuse in cab fuse box: F11 (10 A).

Is the inspection result normal?**Yes > Go to Step 2****No > Service fuse circuit, replace fuse of the same rating****2. Check voltage on both ends of wiper motor**

(a). Disconnect wiper motor connector B026 and turn on main power.



(b). Check wiper low-speed gear circuit.

- Shift wiper switch to low-speed gear "LO" and use multimeter to measure the voltage of the circuit between Pin 4 and Pin 2 of wiper motor connector B026 at the same time.

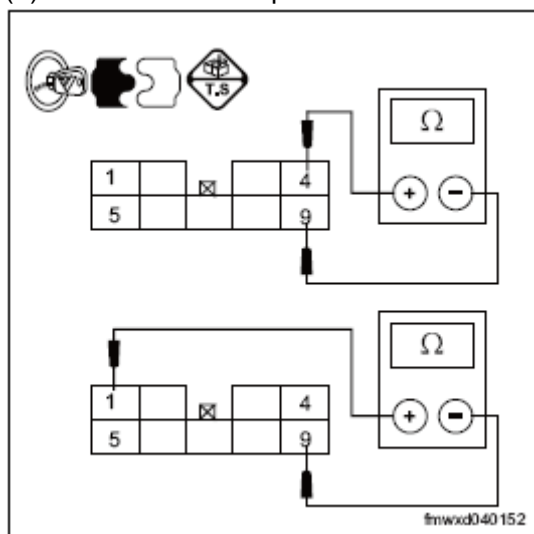
(c). Check wiper high-speed gear circuit.

- Shift wiper switch to how-speed gear "HI" and use multimeter to measure the voltage of the circuit between Pin 4 and Pin 3 of wiper motor connector B026 at the same time.

Standard voltage: battery voltage**Is the inspection result normal?****Yes > Replace wiper motor****No > Go to Step 3**

3. Check combination switch

(a). Shut off main power.



(b). Disconnect combination switch connector B010.

(c). Check combination switch.

Standard value:

Switch Position	Multimeter Pin	Standard Value
LO	4-9	$\leq 2 \Omega$
HI	1-9	$\leq 2 \Omega$

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Is the inspection result normal?

Yes > Repair or replace harness

No > Replace combination switch

SLOW ROTATION OF WIPER

Circuit Diagram

Refer to “This Chapter, Incapable Working of Wiper in Any Gear - Circuit Diagram”

Diagnostic procedures

1. Check battery voltage.

- (a). Use multimeter to measure battery voltage.

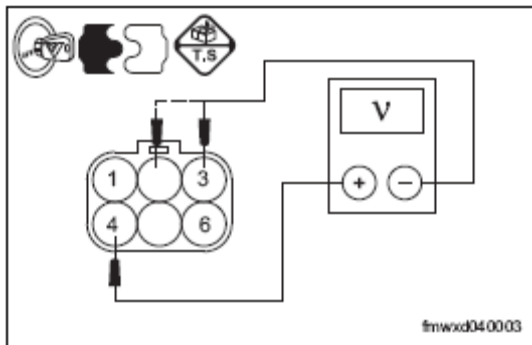
Is the inspection result normal?

Yes > Go to Step 2

No > Charge or replace battery

2. Check wiper motor

- (a). Shut off main power.
- (b). Disconnect wiper motor connector B026.



- (c). Check low-speed gear function.

- Connect positive pole(+) of battery to Pin 4 of wiper motor and negative pole(-) of battery to Pin 2 of wiper motor and check motor for its operation in low-speed gear.

- (d). Check high-speed gear function.

- Connect positive pole(+) of battery to Pin 4 of wiper motor and negative pole(-) of battery to Pin 3 of wiper motor and check motor for its operation in high-speed gear.

Is the inspection result normal?

Yes > Go to Step 3

No > Replace wiper motor

3. Check motor bearing and retarder gear

- (a). Remove wiper motor, refer to “Chapter 55 Wiper and Washer - Replacement of Wiper Motor Assembly”.
- (b). Check lubrication for motor bearing and retarder gear.

Is the inspection result normal?

Yes > Repair or replace harness

No > Refill with lubricating oil

INCAPABLE STOP OF WIPER

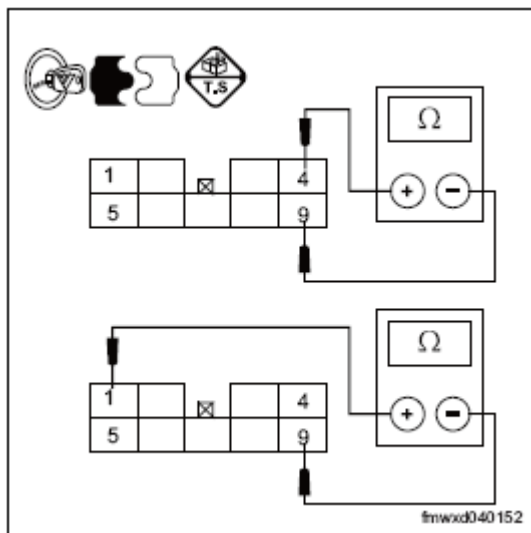
Circuit Diagram

Refer to "This Chapter, Incapable Working of Wiper in Any Gear, Circuit Diagram"

Diagnostic procedures

1. Check combination switch

- (a). Shut off main power.
- (b). Disconnect combination switch connector B010.



- (c). Check combination switch.

Standard value:

Switch Position	Multimeter Pin	Standard Value
LO	4-9	$\leq 2 \Omega$
HI	1-9	$\leq 2 \Omega$

Is the inspection result normal?

Yes > Repair or replace harness

No > Replace combination switch

INCAPABLE WORKING OF WIPER IN INTERMITTENT GEAR

Circuit Diagram

Refer to “This Chapter, Incapable Working of Wiper in Any Gear, Circuit Diagram”

Diagnostic procedures

1. Check harness

- (a). Disconnect wiper motor connector B026 and combination switch connector B010.
- (b). Use multimeter to measure the harness resistance between Pin 5 of wiper motor connector B026 and Pin 10 of combination switch connector B010.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace wiper motor

No > Repair or replace harness and combination switch

INCAPABLE WORKING OF WIPER IN HIGH-SPEED GEAR

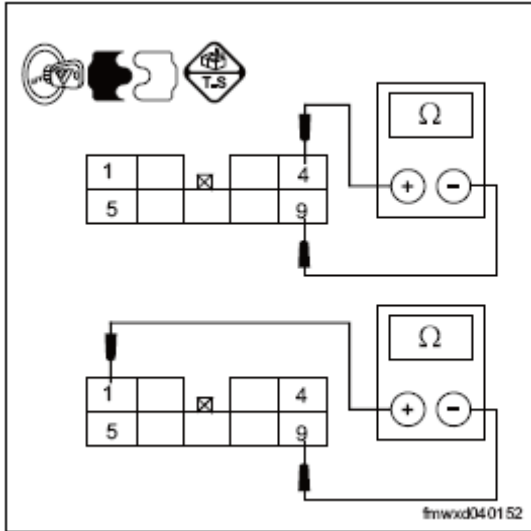
Circuit Diagram

Refer to "This Chapter, Incapable Working of Wiper in Any Gear, Circuit Diagram"

Diagnostic procedures

1. Check combination switch

- (a). Shut off main power.
- (b). Disconnect combination switch connector B010.



- (c). Check combination switch.

Standard value:

Switch Position	Multimeter Pin	Standard Value
LO	4-9	$\leq 2 \Omega$
HI	1-9	$\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 2

No > Replace combination switch

2. Check harness

- (a). Disconnect wiper motor connector B026 and combination switch connector B010.
- (b). Use multimeter to measure the harness resistance between Pin 3 of wiper motor connector B026 and Pin1 of combination switch connector B010.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace wiper motor

No > Repair or replace harness

INCAPABLE RETURN OF WIPER (WHEN SWITCH IS TURNED OFF)

Circuit Diagram

Refer to “This Chapter, Incapable Working of Wiper in Any Gear, Circuit Diagram”

Diagnostic procedures

1. Check harness

- (a). Shut off main power.
- (b). Disconnect wiper motor connector B026.
- (c). Use multimeter to measure the resistance of the circuit between Pin 1 of wiper motor connector B026 and vehicle body effective ground point.

Resistance: $\leq 2 \Omega$

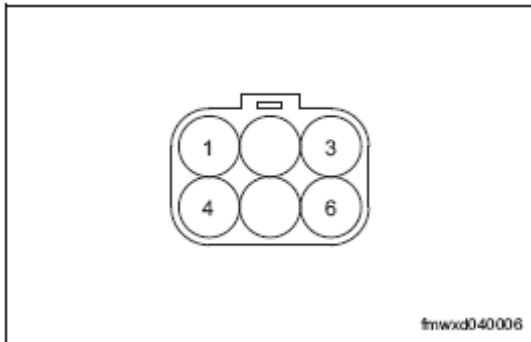
Is the inspection result normal?

Yes > Go to Step 2

No > Repair or replace harness

2. Check wiper motor

- (a). Remove wiper motor assembly and refer to “Chapter 55 Wiper and Washer -Replacement of Wiper Motor Assembly”.



- (b). Check automatic stop function.

- Connect positive pole(+) of battery to Pin 4 of wiper motor and negative pole(-) of battery to Pin 2 of wiper motor, when motor is operation in low-speed gear, disconnect connection with Pin 4 and let the motor automatically stop anywhere.
- Connect Pin 4 and 2 of wiper motor, connect positive pole (+) of battery to Pin 4 of wiper motor to restart motor and make the motor to operation in low-speed gear.
- Check whether automatic stop position is correct.

Is the inspection result normal?

Yes > Replace wiper motor

No > Repair or replace harness



Circuit Diagram



Diagnostic procedures**1. Check washing liquid**

- (a). Check washing liquid level.

Check whether washing liquid is sufficient?

Yes > Go to Step 2

No > Refill with washing liquid

2. Check nozzle

- (a). Check nozzle.

Check whether nozzle is unblocked?

Yes > Go to Step 3

No > Replace nozzle

3. Check hose

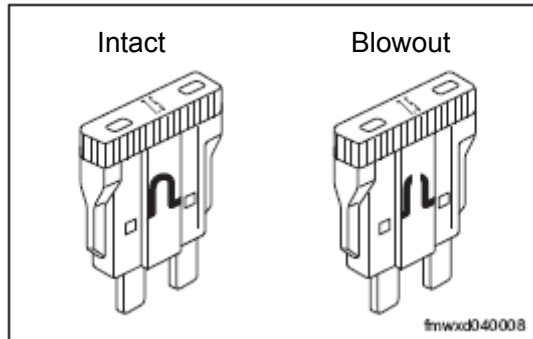
- (a). Check hose for leakage.

Yes > Replace hose

No > Go to Step 4

4. Check fuse

- (a). Turn ignition switch to OFF.



- (b). Check fuse in cab fuse box: F15 (7.5 A).

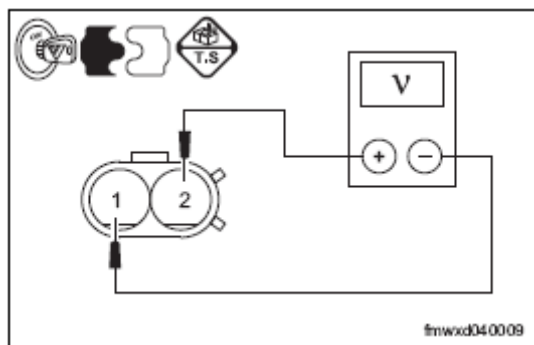
Is the inspection result normal?

Yes > Go to Step 5

No > Service fuse circuit, replace fuse of the same rating

5. Check voltage on both ends of washer motor

- (a). Disconnect washer motor connector B014.
(b). Turn ignition switch to ON.



- (c). Keep washer switch in liquid spraying position, Use multimeter to measure the voltage of the circuit between Pin 2 and Pin 1 of washer motor connector B014 at the same time.

Standard voltage: battery voltage

Is the inspection result normal?

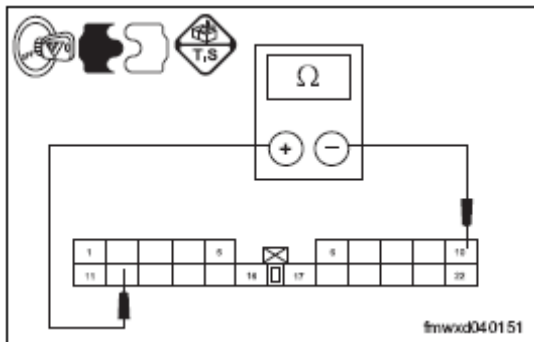
Yes > Replace washer motor

No > Go to Step 6

6. Check combination switch

- (a). Shut off main power.

- (b). Disconnect combination switch connector B011.



- (c). Check combination switch.

Standard value:

Switch Position	Multimeter Pin	Standard Value
OFF	-	-
ON (wash)	12-10	$\leq 2 \Omega$

Is the inspection result normal?

Yes > Repair or replace harness

No > Replace combination switch

AUDIO SYSTEM

PRECAUTIONS

1. Shut off main power

- (a). In order to avoid personal injury or vehicle damage, please be sure to disconnect the negative cable of battery before removal/installation of any equipment and under the condition that certain tool or equipment is likely to contact with the bare electrical terminal.
- (b). Unless otherwise specified, the ignition switch must be turned off.

2. Disconnection of negative cable of battery shall make the odometer and clock reset.

Hint:

Odometer won't be reset.

3. It is not allowed to retrofit audio system or add other audio equipments on it.

4. Following radio wave bands are applied in this audio system

Radio Wave	AM	FM
Modulation Method	Amplitude Modulation	Frequency Modulation
Tunning Range	522 ~ 1620kHz	87.5 ~ 108.0MHz

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5. Precautions for MP3

- (a). There is an USB interface of audio unit that equipped with MP3 for connection with external media sources.
- (b). Only files with postfixes of "mp3" can be recognized as MP3 files and be played.
- (c). In the case of storing non-MP3 files as files with postfixes of "mp3", these files may be mistakenly recognized as MP3 files and played. In this case, they are not recognizable and there will be sharp noise which may lead to loudspeaker damage.

Attention:

Any non-standard formatted files and virus files may lead to play failure and malfunction of this machine. Therefore, prior to application of removable storage media like USB, please check for correct file formation without virus.

BASIC INSPECTION

Step	Inspection Item		Measure
1	Check battery voltage. Battery voltage should not lower than 22V. Is the inspection result normal?	Yes	Go to Step 2
		No	Carry out battery charging or replacement. Refer to "Chapter 53 Battery-Battery"
2	Check antenna - Check antenna for its pull-out and pull-out with its fullest length - Check antenna for foreign matters on it. - Check antenna for its bending and deformation. Is the inspection result normal?	Yes	Go to Step 3
		No	Repair or replace antenna. Refer to "Chapter 56 Audio System-Antenna"
3	Check audio unit Press audio system power switch and check for the display of LCD. Is the inspection result normal?	Yes	Go to Step 4
		No	Refer to Table of Fault Phenomena.
4	Check audio unit Turn volume knob to make volume larger than 5 VOL and check whether there is sound coming out from the loudspeaker. Is the inspection result normal?	Yes	Go to Step 5
		No	Refer to Table of Fault Phenomena.
5	Check radio wave - There is a big difference between AM and FM in broadcasting coverage. Sometimes, AM programs can be received clearly but FM stereo can not. The coverage for FM stereo is the smallest and it is easy to be interfered by electromagnetic wave. - Check whether is high mountain or tall building around the vehicle. In the case of surrounded tall building or high mountain, parts of signals between the vehicle and transmitting tower will be blocked. - Check whether there is large transformer substation and transmission station around the vehicle for strong electromagnetic waves given off from them may lead to incapable broadcasting signal receiving. - Some buildings may reflect broadcasting signals due to their materials, which may lead to interference between the two received signals. Is the inspection result normal?	Yes	Refer to Table of Fault Phenomena.
		No	Move the vehicle to a place with better signal receiving effect.



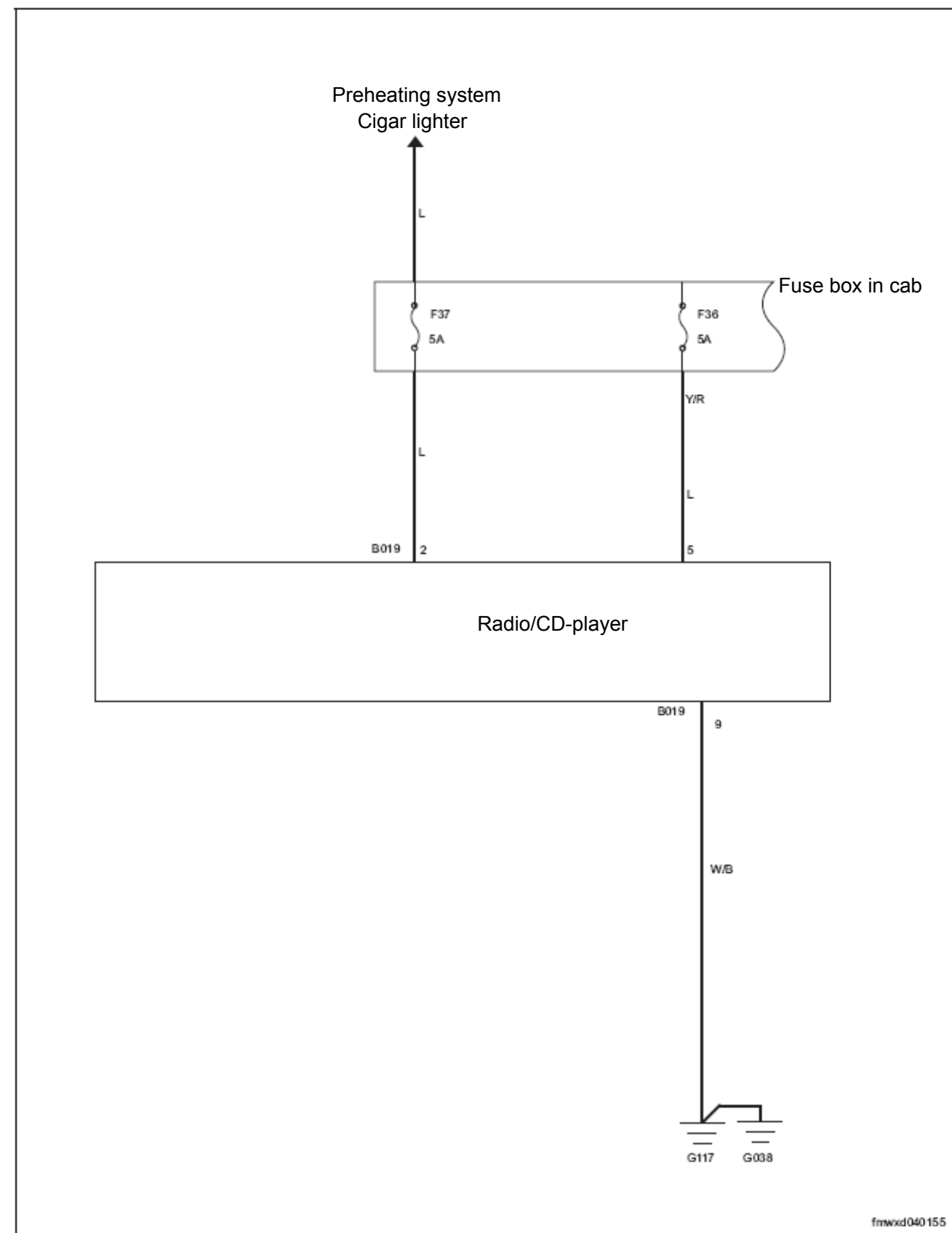
TABLE OF FAULT PHENOMENA

Please refer to the following table for troubleshooting. The serial numbers indicate the order of fault possibility. Please check relevant parts in the order and conduct replacement when necessary.

Fault Phenomena	Possible Cause	Solution
Incapable working of audio unit	1. Power supply and ground circuit	Chapter 04 Audio System-Incapable Working of Audio System
	2. Audio unit itself	
No sounds of electric loudspeaker (in any mode)	1. Mute mode	Relief mute mode.
	2. Loudspeaker circuit	Chapter 04 Audio System- No Sounds of Loudspeaker (in Any Mode)
	3. Loudspeaker	
	4. Audio unit itself	
Poor tone quality of loudspeaker (in any mode)	1. Improper setting of audio unit	Correctly set the audio unit
	2. Loudspeaker circuit	Chapter 04 Audio System- Poor Tone Quality of Loudspeaker (in Any Mode)
	3. Loudspeaker	
Low volume of loudspeaker (in any mode)	1. Improper setting of audio unit	Correctly set the audio unit
	2. Loudspeaker circuit	Chapter 04 Audio System- Low Volume of Loudspeaker (in Any Mode)
	3. Loudspeaker	
	4. Audio unit itself	
Incapable receiving of broadcasting program or poor aural reception effect	1. Strong electromagnetic interference around	Get far away from electromagnetic interference place
	2. Antenna	Chapter 04 Audio System- Incapable Receiving of Broadcasting Program or Poor Aural Reception Effect
	3. Audio unit itself	
Incapable insert/play of MP3	1. Incorrect file format of media source	Chapter 04 Audio System- Incapable Insert/Play of MP3
	2. Audio unit itself	
MP3 staccato	1. Poor tone quality of media source file	Chapter 04 Audio System-MP3 Staccato
	2. Audio unit itself	
No display of LCD with normal operation of audio system	1. Audio unit itself	Chapter 56 Audio System-Replacement of Radio and MP3 Player

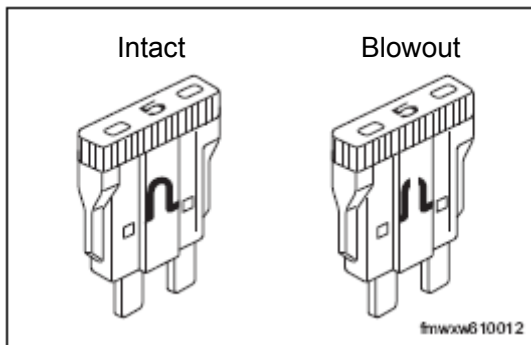
INCAPABLE WORK OR AUDIO UNIT

CIRCUIT DIAGRAM

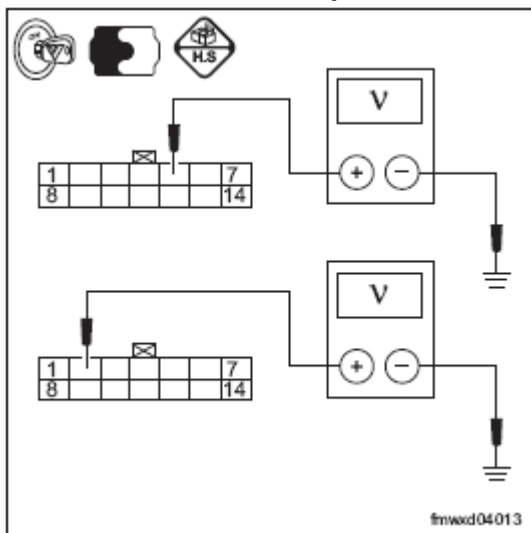


Diagnostic procedures**1. Check fuse F37**

(a). Turn ignition switch to OFF.



(b). Check fuse in cab fuse box: F37 (5A) and F36 (5A).

Is the inspection result normal?**Yes > Go to Step 2****No > Service fuse circuit and replace fuse of the same rating.****2. Check audio unit power circuit**

(a). Check audio unit constant power circuit.

- Use multimeter to measure the voltage of the circuit between Pin 5 of audio unit connector B019 and ground.

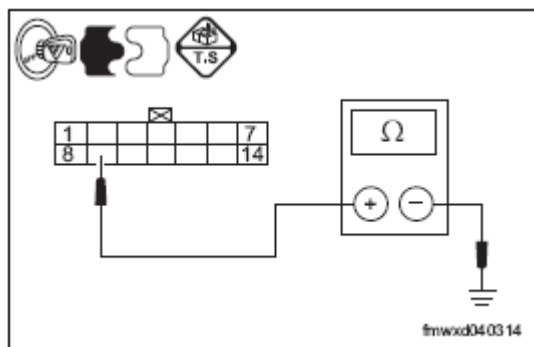
(b). Check audio unit power circuit.

- Turn ignition switch to ON.
- Use multimeter to measure the voltage of the circuit between Pin 2 of audio unit connector B019 and ground.

Standard voltage: Battery voltage**Is the inspection result normal?****Yes > Go to Step 3****No > Repair or replace harness****3. Check audio unit ground circuit**

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DIAGNOSIS-AUDIO SYSTEM



- (a). Turn ignition switch to OFF.
- (b). Disconnect audio unit connector B020.
- (c). Use multimeter to measure the resistance of the circuit between Pin 9 of audio unit connector B019 and ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

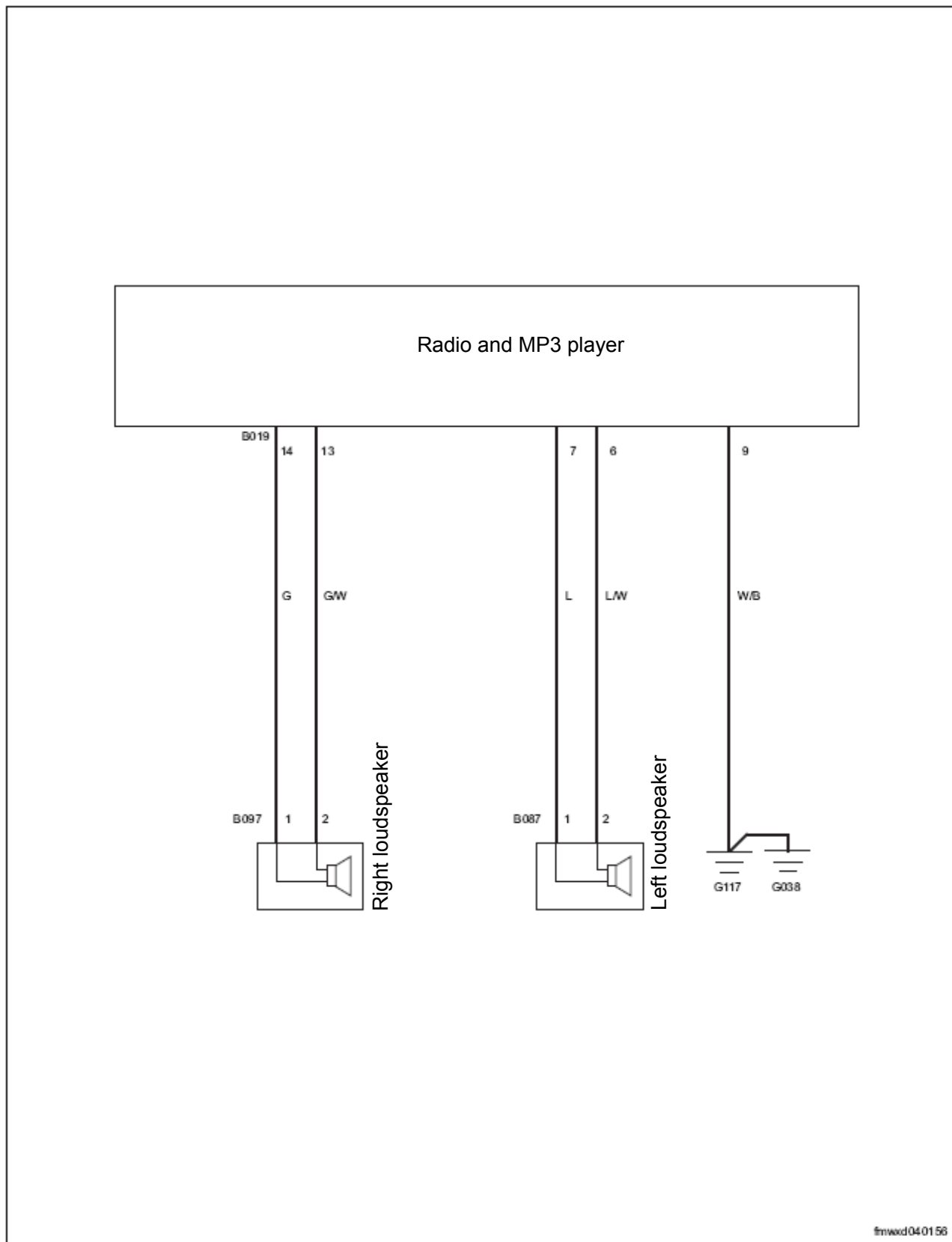
Yes > Replace audio unit

No > Repair or replace harness



NO SOUNDS OF LOUDSPEAKER (IN ANY MODE)

Circuit Diagram



Diagnostic procedures**1. Check audio unit setting**

- (a). Turn ignition switch to ON.
- (b). Press audio unit power switch.
- (c). Turn volume knob to make volume larger than 5 VOL.
- (d). Check and confirm that "MUTE (mute key)" is OFF.

Check whether there is sound coming out from loudspeaker?

Yes > Audio unit setting is incorrect.

No > Go to Step 2

2. Check loudspeaker

- (a). Turn ignition switch to OFF.
- (b). Remove left and right loudspeakers, refer to "Chapter 56 Audio System-Replacement of Loudspeaker"
- (c). Check whether loudspeaker paper cone is broken.
- (d). Install new loudspeaker, turn ignition switch to ON, turn on audio unit power switch and shift to FM mode.

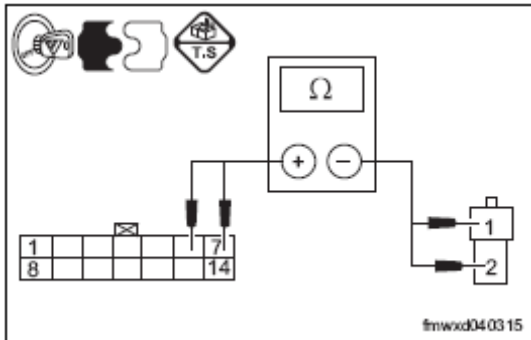
Check whether there is sound coming out from loudspeaker?

Yes > Replace loudspeaker

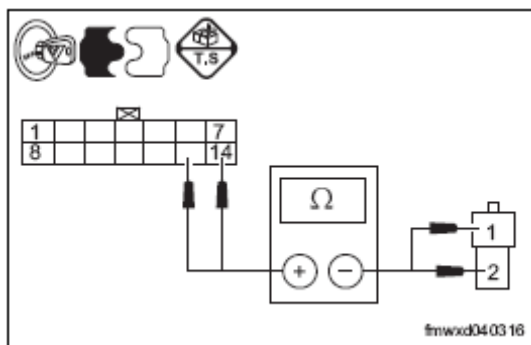
No > Go to Step 3

3. Check loudspeaker signal circuit

- (a). Turn ignition switch to OFF.
- (b). Disconnect audio unit connector.



- (c). Use multimeter to measure the resistance of the circuit between Pin 6 and 7 of audio unit B019 and Pin 2 and 1 of left loudspeaker B087.



- (d). Use multimeter to measure the resistance of the circuit between Pin 13 and 14 of audio unit B019 and Pin 2 and 1 of right loudspeaker B097.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace audio unit

No > Repair or replace harness

POOR TONE QUALITY OF LOUDSPEAKER (IN ANY MODE)

Diagnostic procedures

1. Check audio unit setting

- (a). Turn ignition switch to ON.
- (b). Press audio unit power switch.
- (c). Turn volume knob to make volume larger than 5 VOL.
- (d). Revert tremble and bass effect and track balance to their initial settings.

Check whether loudspeaker tone quality is normal?

Yes > Audio unit setting is incorrect.

No > Go to Step 2

2. Check loudspeaker

- (a). Turn ignition switch to OFF.
- (b). Remove left and right loudspeakers, refer to "Chapter 56 Audio System-Replacement of Loudspeaker"
- (c). Check left and right loudspeakers for foreign matter adsorption.
- (d). Check whether there is too much dust in left and right loudspeaker paper cones.
- (e). Check whether paper cones of left and right loudspeakers are broken.
- (f). Install new loudspeaker, turn ignition switch to ON, turn on audio unit power switch and shift to FM mode.

Is the inspection result normal?

Yes > Go to Step 3

No > Remove foreign matters and dust or replace loudspeaker.

3. Compare with that of the same vehicle model.

- (a). Set tremble and bass effect and track balance of audio unit to the same level.
- (b). Compare with that of the same vehicle model.

Check whether tone qualities of loudspeakers are the same?

Yes > Confirm normal operation of system

No > Replace audio unit

LOW VOLUME OF LOUDSPEAKER (IN ANY MODE)

Circuit Diagram

Refer to "This Chapter, No Sounds of Loudspeaker (in Any Mode) - Circuit Diagram"

Diagnostic procedures

1. Check audio unit setting

- (a). Turn ignition switch to ON.
- (b). Press audio unit power switch.
- (c). Turn volume knob to make volume larger than 5 VOL.
- (d). Turn volume balance to 0.

Check whether loudspeaker volume is normal?

Yes > Audio unit setting is incorrect.

No > Go to Step 2

2. Check loudspeaker

- (a). Turn ignition switch to OFF.
- (b). Remove left and right loudspeakers.
- (c). Check whether loudspeaker paper cone is broken.
- (d). Install new loudspeaker, turn ignition switch to ON, turn on audio unit power switch and shift to FM mode.

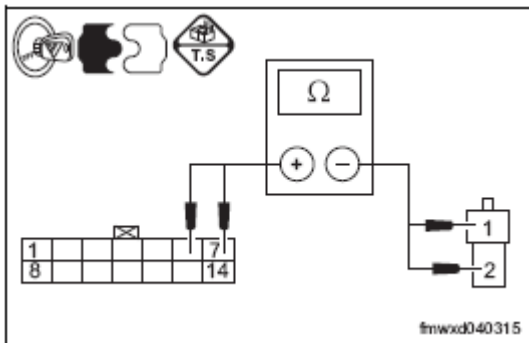
Check whether loudspeaker volume is normal?

Yes > Replace loudspeaker

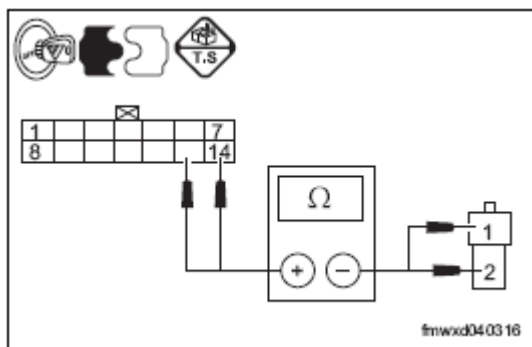
No > Go to Step 3

3. Check loudspeaker signal circuit

- (a). Turn ignition switch to OFF.
- (b). Disconnect audio unit connector.



- (c). Use multimeter to measure the resistance of the circuit between Pin 6 and 7 of audio unit B019 and Pin 2 and 1 of left loudspeaker B087.



- (d). Use multimeter to measure the resistance of the circuit between Pin 13 and 14 of audio unit B019 and Pin 2 and 1 of right loudspeaker B097.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Go to Step 4

No > Repair or replace harness

4. Compare with that of the same vehicle model.

- (a). Set tremble and bass effect and track balance of audio unit to the same level.
(b). Compare with that of the same vehicle model.

Check whether volumes for two loudspeakers are the same?

Yes > Confirm normal operation of system

No > Replace audio unit

INCAPABLE RECEIVING OF BROADCASTING PROGRAM OR POOR AURAL RECEPTION EFFECT

Diagnostic procedures

1. Check audio unit setting

- (a). Turn ignition switch to ON.
- (b). Press audio unit power switch.
- (c). Turn volume knob to make volume larger than 5 VOL.
- (d). Carry out automatic channel searching.

Whether automatic channel searching function of audio unit is normal?

Yes > Go to Step 2

No > Replace audio unit

2. Check audio unit antenna

- (a). Check whether antenna is pulled with its fullest length.
- (b). Whether there is foreign matter on antenna.
- (c). Whether antenna is bent and deformed.

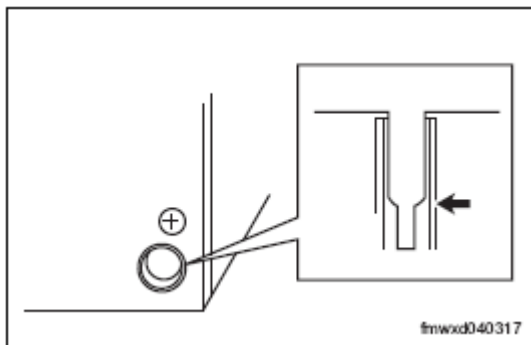
Is the inspection result normal?

Yes > Go to Step 3

No > Replace antenna

3. Check audio unit

- (a). Turn ignition switch to OFF.



- (b). Pull out audio antenna plug.
- (c). Turn ignition switch to ON.
- (d). Press audio unit power switch.
- (e). Turn volume knob to make volume larger than 5 VOL.
- (f). Select "FM1" frequency range, place a screwdriver, a thin lead or other metal objects on antenna socket of audio unit, check and confirm whether a broadcasting program can be heard.

Check whether audio unit can receive broadcasting program?

Yes > Replace antenna

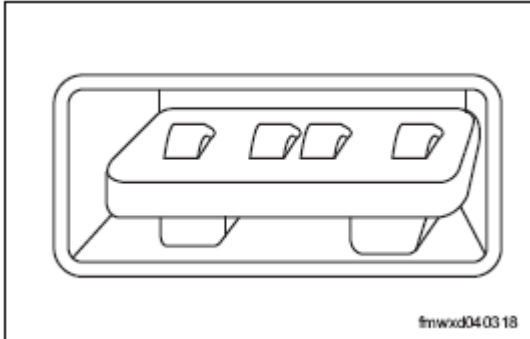
No > Replace audio unit

INCAPABLE INSERT/PLAY OF MP3

Diagnostic procedures

1. Check USB interface

(a). Check whether USB interface of U disk is deformed, damaged or oxidized.



(b). Check whether USB interface of audio unit is deformed, damaged or oxidized.

Is the inspection result normal?

Yes > Go to Step 2

No > In the case of U disk fault, replace U disk. In the case of deformed or damaged USB interface of audio unit, replace audio unit.

2. Check media source file of MP3

(a). Replace with known and confirmed "mp3" source files to play.

Check whether audio unit can play normally?

Yes > Use source files in correct formats

No > Go to Step 3

3. Check U disk

(a). Confirm that reading function of U disk is not locked.

(b). Replace with known U disk which can be normally used.

Check whether audio unit can play normally?

Yes > Replace U disk

No > Replace audio unit

MP3 STACCATO

Diagnostic procedures

Hint:

In the case of driving on rough road, interrupted MP3 playing is normal.

1. **Check and confirm whether there is staccato in the playing of all source files in the format of “mp3”.**

Is the inspection result same as the above-mentioned?

Yes > Go to Step 2.

No > Use authorized “mp3” source files with correct formats.

2. **Check U disk**

- (a). Check source files in U disk are “mp3” ones which can be played normally.
- (b). Replace with known U disk which can be normally used.

Check whether audio unit can be played normally?

Yes > Replace U disk

No > Replace audio unit



HORN

PRECAUTIONS

1. Shut off main power

- (a). In order to avoid personal injury or vehicle damage, please be sure to disconnect the negative cable of battery before removal/installation of any equipment and under the condition that certain tool or equipment is likely to contact with the bare electrical terminal.
- (b). Unless otherwise specified, the ignition switch must be turned off.

2. Disconnection of negative cable of battery shall make the odometer and clock reset.

Hint:

Odometer won't be reset.



BASIC INSPECTION

Step	Inspection Item	Measure
1	Check battery voltage. • Battery voltage should not be lower than 22 V. Is the inspection result normal?	Yes Go to Step 2
		No Carry out battery charging or replacement. Refer to "Chapter 53 Battery-Battery"
2	Check electric horn • Press horn switch. Check whether the horn beeps?	Yes Go to Step 3
		No Refer to Table of Fault Phenomena.
3	Check horn switch • Press horn switch. • Release horn switch. Check whether the horn keeps beeping?	Yes Refer to Table of Fault Phenomena.
		No Replace electric horn
4	Check air horn • Turn on electric/ air horn change over switch. • Press horn switch. Check whether air horn beeps?	Yes Confirm normal operation of system
		No Refer to Table of Fault Phenomena.



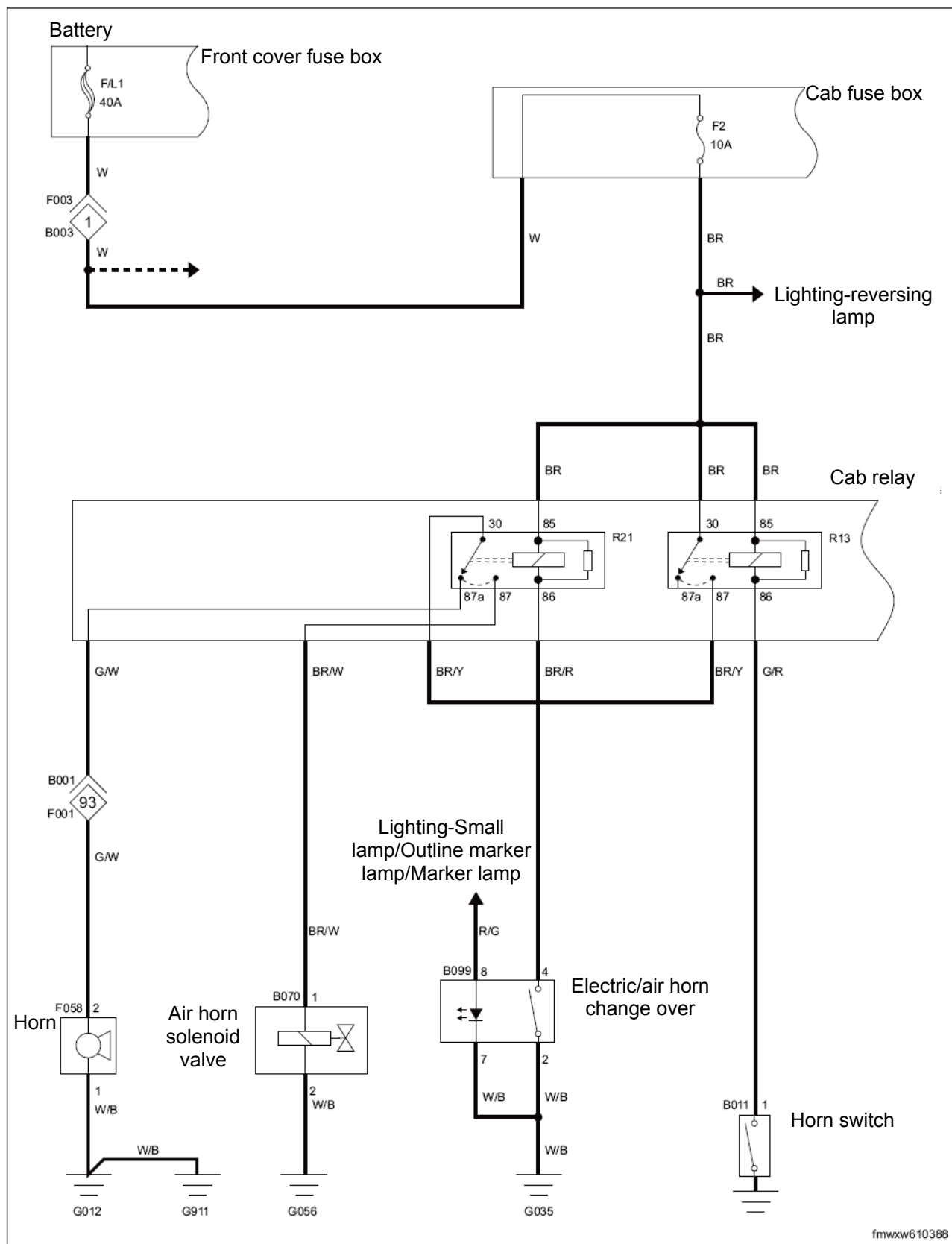
TABLE OF FAULT PHENOMENA

Please refer to the following table for troubleshooting. The serial numbers indicate the order of fault possibility. Please check relevant parts in the order and conduct replacement when necessary.

Fault Phenomena	Possible Cause	Solution
No beeps of electric horn	1. Electric horn(damaged)	Chapter 57 Horn-Replacement of Horn
	2. Horn switch(damaged)	Chapter 57 Horn- Replacement of Horn Switch
	3. Harness	Replace harness
Always beeping electric horn	1. Horn switch(damaged)	Chapter 57 Horn- Replacement of Horn Switch
	2. Harness	Replace harness
Abnormal horn beeping	1. Horn	Chapter 57 Horn- Replacement of Horn Switch
No beeps of air horn	1. Air horn(damaged)	Chapter 04 Diagnosis-Horn-No Beeps of Air Horn
	2. Horn switch(damaged)	Chapter 57 Horn- Replacement of Horn Switch
	3. Harness	Replace harness
	4. Electric/air horn change over switch	Chapter 04 Diagnosis-Horn-No Beeps of Air Horn
	5. Air horn solenoid valve	Chapter 04 Diagnosis-Horn-No Beeps of Air Horn
Always beeping air horn	1. Horn switch(damaged)	Chapter 57 Horn- Replacement of Horn Switch
	2. Harness	Replace harness
	3. Air horn solenoid valve	Chapter 04 Diagnosis-Horn-Always Beeping Air Horn

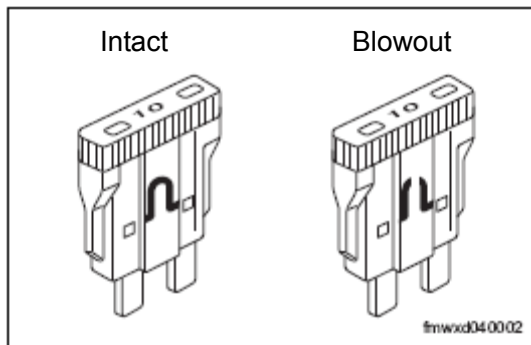
NO BEEPS OF ELECTRIC HORN

Circuit Diagram



Diagnostic procedures**1. Check Fuse F2**

(a). Turn ignition switch to OFF.

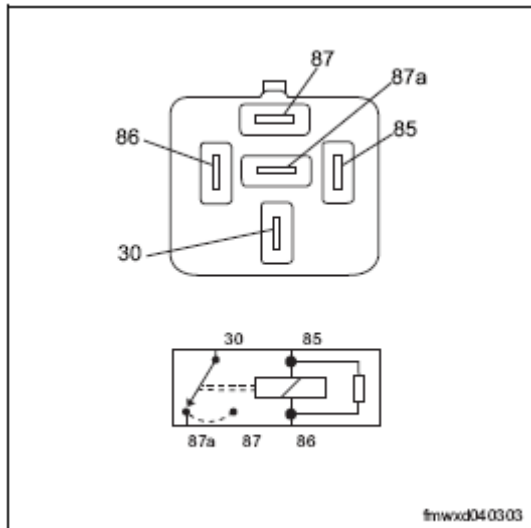


(b). Check fuse in cab fuse box: F2 (10A).

Is the inspection result normal?

Yes > Go to Step 2

No > Service fuse circuit, replace fuse of the same rating

2. Check horn relay R13 and electric/ air horn change over relay R21

(a). Check relay in cab relay box: R13 and R21.

Standard value:

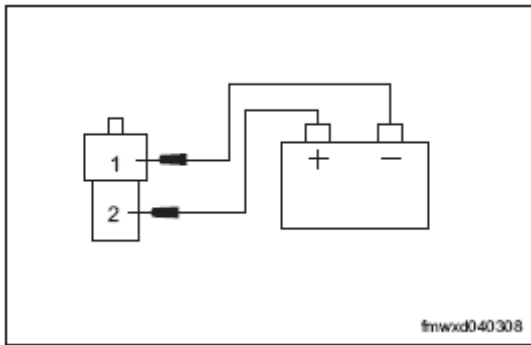
Switch Position	Multimeter Pin	Standard Value
Constant	85-86	Breakover
Power voltage applied between Pin 85 and Pin 86	30-87	Breakover
Constant	30-87a	Breakover

Is the inspection result normal?

Yes > Go to Step 3

No > Replace relay

3. Check electric horn



- (a). Remove horn and refer to "Chapter 57 Horn-Replacement of Horn"
- (b). Connect electric horn to battery.

Does the electric horn beep?

Yes > Go to Step 4

No > Replace electric horn

4. Check harness

- (a). Use multimeter to measure the harness resistance between F2 and Pin 30 and 85 of horn relay R13.
- (b). Use multimeter to measure the harness resistance between Pin 1 of B011 and Pin 86 of horn relay R13.
- (c). Use multimeter to measure the internal harness resistance of horn switch.
- (d). Use multimeter to measure the harness resistance between Pin 87 of horn relay R13 and Pin 30 of electric/ air horn change over relay R21.
- (e). Use multimeter to measure the harness resistance between Pin 87a of electric/air horn change over relay R21 and Pin 2 of F058.
- (f). Use multimeter to measure the harness resistance between Pin 1 of F058 and G012.

Resistance: $\leq 2\Omega$

Is the inspection result normal?

Yes > Repair horn switch or replace steering wheel

No > Repair or replace harness

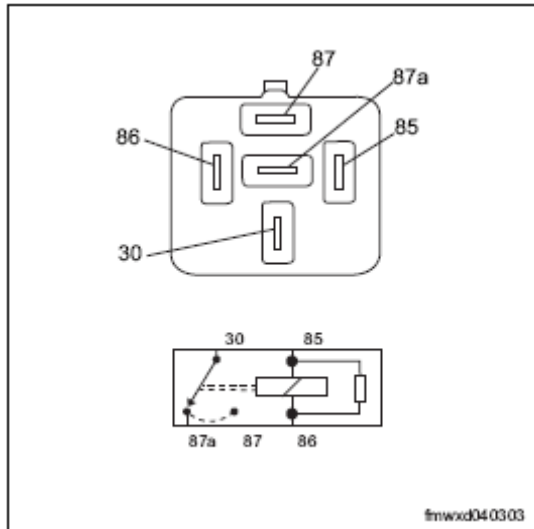
ALWAYS BEEPING ELECTRIC HORN

Circuit Diagram

Refer to "This Chapter, No Beeps of Electric Horn- Circuit Diagram"

Diagnostic procedures

1. Check horn relay R13



(a). Check relay in cab relay box: R13.

Standard value:

Switch Position	Multimeter Pin	Standard Value
Constant	85-86	Breakover
Power voltage applied between Pin 85 and Pin 86	30-87	Breakover
Constant	30-87a	Breakover

Is the inspection result normal?

Yes > Go to Step 2

No > Replace horn relay

2. Check harness

(a). Release horn switch.

(b). Use multimeter to measure the harness resistance between Pin 1 of horn switch and horn switch ground.

Resistance: $\geq 10 \text{ M}\Omega$

Is the inspection result normal?

Yes > Repair horn switch or replace steering wheel

No > Eliminate short circuit faults of electric horn or replace harness

NO BEEPS OF AIR HORN

Circuit Diagram

Refer to "This Chapter, No Beeps of Electric Horn- Circuit Diagram"

Diagnostic procedures

1. Check electric horn for its normal operation

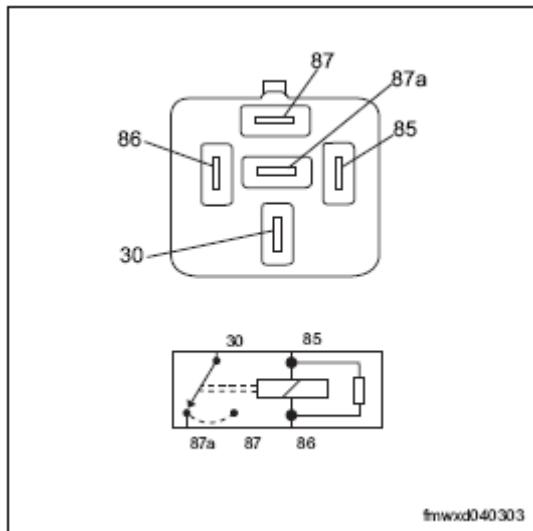
- (a). Change electric/air horn change over switch to electric horn position and check operation of electric horn.

Does electric horn operate normally?

Yes > Go to Step 2

No > Eliminate electric horn fault and refer to relevant contents in this Chapter.

2. Check electric/air horn change over relay R21



- (a). Check relay in cab relay box: R21.

Standard value:

Switch Position	Multimeter Pin	Standard Value
Constant	85-86	Breakover
Power voltage applied between Pin 85 and Pin 86	30-87	Breakover
Constant	30-87a	Breakover

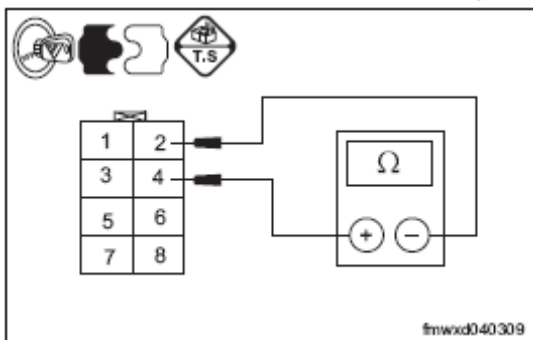
04

Is the inspection result normal?

Yes > Go to Step 3

No > Replace electric/air horn change over relay

3. Check electric/air horn change over switch



- (a). Shut off main power.
- (b). Disconnect electric/air horn change over switch connector B099.
- (c). Check electric/air horn change over switch.

Standard value:

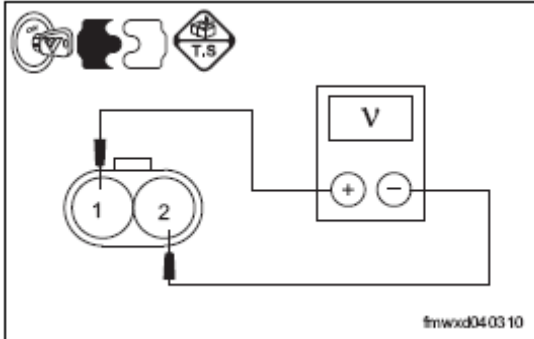
Switch Position	Multimeter Pin	Standard Value
ON	2-4	$\leq 2 \Omega$
OFF	2-4	$\geq 10M\Omega$

Is the inspection result normal?

Yes > Go to Step 4

No > Replace electric/air horn change over switch

4. Check voltage on two ends of air horn solenoid valve



- Disconnect air horn solenoid valve connector B070.
- Turn ignition switch to ON.
- Press horn switch and use multimeter to measure the voltage of the circuit between Pin 1 and Pin 2 of air horn solenoid valve connector B070 simultaneously.

Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Replace air horn solenoid valve

No > Go to Step 5

5. Check harness

- Use multimeter to measure the harness resistance between Pin 85 of electric/air horn change over relay R21 and F2.
- Use multimeter to measure the harness resistance between Pin 86 of electric/air horn change over relay R21 and Pin 4 of electric/air horn change over switch.
- Use multimeter to measure the harness resistance between Pin 2 of electric/air horn change over switch and G035.
- Use multimeter to measure the harness resistance between Pin 87 of electric/air horn change over relay and Pin 1 of B070.
- Use multimeter to measure the harness resistance between Pin 2 of B070 and G056.

Resistance: $\leq 2\Omega$

Is the inspection result normal?

Yes > Repair air horn and its air line

No > Repair or replace harness

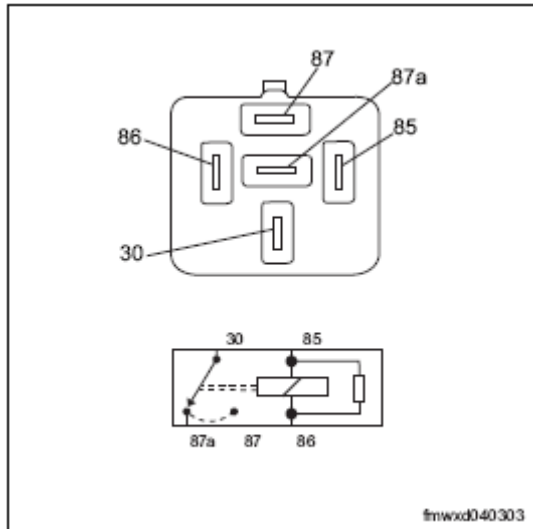
ALWAYS BEEPING AIR HORN

Circuit Diagram

Refer to "This Chapter, No Beeps of Electric Horn- Circuit Diagram"

Diagnostic procedures

1. Check horn relay R13



(a). Check relay in cab relay box: R13.

Standard value:

Switch Position	Multimeter Pin	Standard Value
Constant	85-86	Breakover
Power voltage applied between Pin 85 and Pin 86	30-87	Breakover
Constant	30-87a	Breakover

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Is the inspection result normal?

Yes > Go to Step 2

No > Replace horn relay

2. Check air horn solenoid valve

(a). Disconnect air horn solenoid valve connector and check air horn solenoid valve.

Check whether air horn always beeps?

Yes > Go to Step 3

No > Replace air horn solenoid valve

3. Check harness

(a). Release horn switch.

(b). Use multimeter to measure the harness resistance between Pin 1 of horn switch and horn switch ground.

Resistance: $\geq 10 \text{ M}\Omega$

Is the inspection result normal?

Yes > Repair horn switch or replace steering wheel

No > Eliminate short circuit fault of air horn or replace harness

COMBINATION INSTRUMENT

PRECAUTIONS

1. Shut off main power

- (a). In order to avoid personal injury or vehicle damage, please be sure to disconnect the negative cable of battery before removal/installation of any equipment and under the condition that certain tool or equipment is likely to contact with the bare electrical terminal.
- (b). Unless otherwise specified, the ignition switch must be turned off.

2. Disconnection of negative cable of battery shall make the odometer and clock reset.

Hint:

Odometer won't be reset.

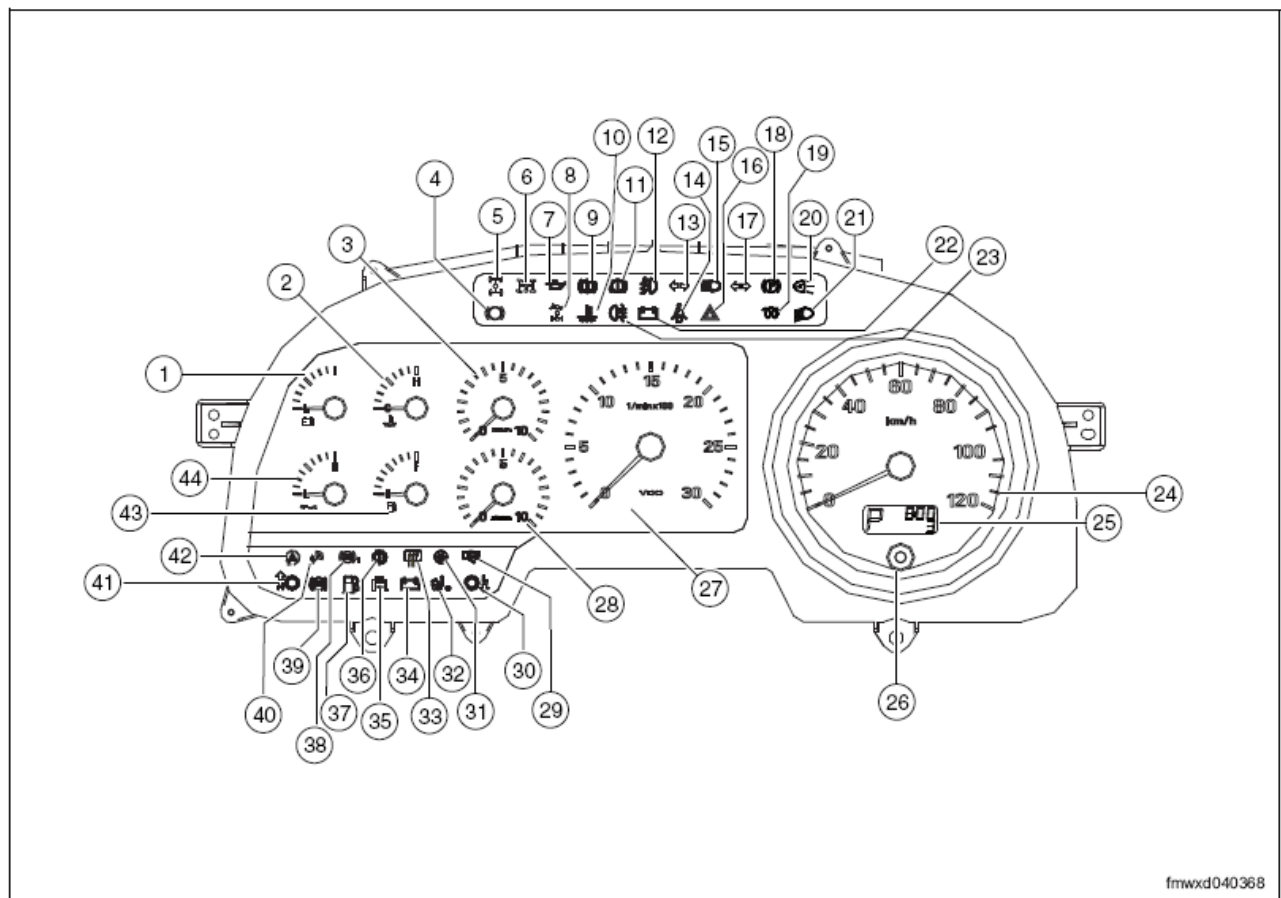
3. Disconnection of battery negative cable may lead to loss of stored audio system setting.

Hint:

After reconnection of battery negative cable, it is necessary to reset audio system.

- 4. Before performing welding and other relevant operations, please disconnect the negative cable of battery and remove connector of combination instrument, in order to avoid the impact failure caused by strong current to circuit board components of combination instrument.**

INSTRUMENT DESCRIPTION



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SN	Item	Description
1	Voltmeter	Voltmeter indicates the charging or discharging of battery. Check the reading on it in the case of engine operation.
2	Coolant temperature gauge	Coolant temperature gauge indicates coolant temperature of engine.
3	Front axle pressure gauge	It indicates air pressure in front axle brake air reservoir.
4	Inter-axle locking indicator lamp	In the case of inter-axle differential lock operation, this indicator lamp will be lit, indicating the rear axle is interlocked with the differential system directly.
5	Brake lining wear warning indicator lamp	In the case of serious brake lining wear, this indicator lamp will be lit.
6	Power take-off (PTO) indicator lamp	In the case of PTO operation, this indicator lamp will be lit, indicating PTO is in operation
7	Oil pressure warning lamp	In the case of starter operation without engine operation, this warning lamp will be lit. It is not allowed to use engine when the warning lamp will be lit.
8	Inter-wheel locking indicator lamp	In the case of inter-wheel differential lock operation, this indicator lamp will be lit, indicating left and right wheels are interlocked with the differential system directly.
9	Rear axle air pressure warning lamp	When air pressure of rear brake air reservoir is lower than limit value, this warning lamp will be lit.

SN	Item	Description
10	Coolant temperature warning lamp	In the case of overhigh coolant temperature, this indicator lamp will be lit.
11	Front axle air pressure warning lamp	When air pressure of front brake air reservoir is lower than limit value, this warning lamp will be lit.
12	Front fog lamp indicator lamp	In the case of fog lamp operation, this indicator lamp will be lit.
13	Tractor turn signal lamp	When turn signal switch is turned on, tractor turn signal lamp will flash, indicating that external turning signals are in operation.
14	Seatbelt indicator lamp	When driver does not fasten seatbelt firmly, this indicator lamp will be lit; and this indicator lamp will not be lit until the seatbelt is fastened firmly.
15	High beam indicator lamp	In the case of switch from headlamp to high beam, high beam indicator lamp will be lit.
16	Hazard warning lamp indicator lamp	When hazard warning lamp switch is turned on, this indicator lamp will flash, indicating abnormal operation of vehicle.
17	Trailer turn signal lamp	In the case of trailer, when turn signal switch is turned on, trailer turn signal lamp will flash, indicating that external turning signals are in operation.
18	Parking brake indicator lamp	When parking brake switch is turned on, parking brake indicator lamp will be lit.
19	Preheating indicator lamp	When key is turned to "Heat" position, preheating system of engine is in operation and this indicator lamp will be lit.
20	Brake lamp broken filament warning lamp	In the case of broken filament of brake lamp, this warning lamp will be lit.
21	Low beam indicator lamp	In the case of headlamp functioning as low beam, this indicator lamp will be lit.
22	Charging indicator lamp	In the case of charging system fault, charging indicator lamp will be lit.
23	Rear fog lamp indicator lamp	In the case of rear fog lamp operation, this indicator lamp will be lit.
24	Speedometer	It indicates current vehicle speed according to pulse signals received from vehicle speed sensor with unit as kilometer per hour (km/h).
25	Clock and Odometer display	Clock indicates current time and odometer records accumulated total mileages in kilometer.
26	Clock adjusting lever	Press clock adjusting lever for time adjustment.
27	Tachometer	It indicates engine speed.
28	Rear axle pressure gauge	It indicates air pressure in rear axle brake air reservoir.
29	Open door indicator lamp	When open door alarm switch is turned on, open door indicator lamp will be lit.
30	Transmission Low range indicator lamp	When transmission is in Low range position, this indicator lamp will be lit.
31	Blocked air filter warning lamp	In the case of blocked air filter, this warning lamp will be lit.



DIAGNOSIS-COMBINATION INSTRUMENT

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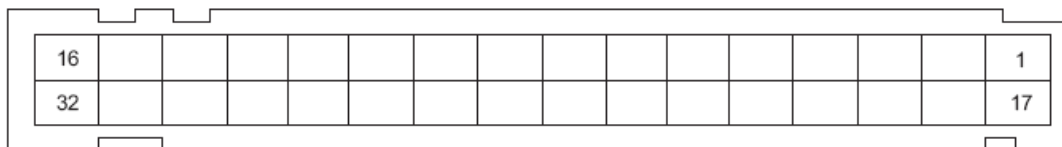
SN	Item	Description
32	Cab locking warning indicator lamp	In the case of cab tilt, this indicator lamp will be lit.
33	Rearview mirror heating indicator lamp	When rearview mirror switch is turned on, this indicator lamp will be lit.
34	Low voltage warning lamp	In the case of excessively low battery voltage, this warning lamp will be lit.
35	Exhaust brake indicator lamp	When exhaust brake switch is turned on, exhaust brake indicator lamp will be lit, indicating that exhaust braking device is in operation.
36	Transmission warning indicator lamp	In the case of overhigh fluid temperature in transmission fluid reservoir, this indicator lamp will be lit.
37	Low fuel level warning lamp	In the case of excessively low fuel level in fuel tank, this indicator lamp will be lit.
38	Trailer ABS indicator lamp	It indicates whether trailer ABS system is in normal operation and can be used as flash code indicator lamp.
39	Tractor ABS indicator lamp	It indicates whether ABS system is in normal operation and can be used as flash code indicator lamp. Turn on ignition switch and ABS system carries out self-inspection. In the case of no faults in the system, this lamp will be out within 3 seconds; In the case of faults in the system, this lamp will be lit.
40	Steering fluid level indicator lamp	In the case of excessively low steering fluid level, this indicator lamp will be lit to remind the driver of steering fluid refilling.
41	Transmission high range indicator lamp	When transmission is in high range position, this indicator lamp will be lit.
42	ASR flash code indicator lamp	In the case of faults in ASR system, this warning lamp will be lit as ABS fault flash code.
43	Fuel gauge	Fuel gauge indicates fuel level in fuel tank.
44	Oil pressure gauge	It indicates oil pressure in the case of engine operation.

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FOTON

INSTRUMENT TERMINALS

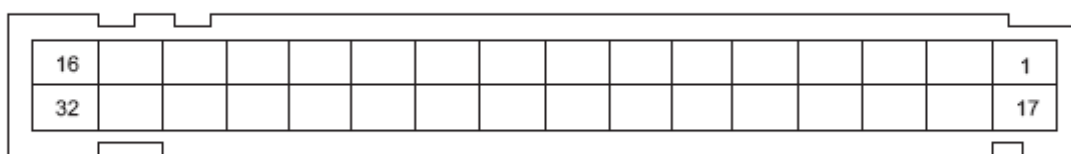


fmwxd040320

Pin No.	Wire Color	Function
1	-	-
2	Y-L	Instrument coolant level warning
3	BR	Instrument ground
4	-	-
5	BR	Instrument sensor ground
6	-	-
7	-	-
8	Y-B	Oil pressure indicator lamp
9	-	-
10	GR	Tachometer input
11	Y-R	Instrument power (+B)
12	R-G	Instrument lighting input
13	Y-B	Instrument power (IG)
14	-	-
15	-	-
16	W-R	Charging indicator lamp

Pin No.	Wire Color	Function
17	-	-
18	L-B	Parking indicator lamp
19	-	-
20	-	-
21	Y-R	Instrument fuel sensor input
22	G-Y	Tractor turn signal lamp
23	Y-G	Instrument coolant temperature indicator (+)
24	G-B	Trailer turn signal lamp
25	R-Y	High beam indicator lamp
26	-	-
27	GR-W	Instrument vehicle speed signal
28	G	Brake lamp broken filament warning lamp
29	R-L	Hazard warning lamp indicator lamp
30	GR	Instrument 12V output
31	-	-
32	-	-





fmwxd040320

Pin No.	Wire Color	Function
1	B-R	Instrument preheating indicator
2	B	Seatbelt pre-tensioner (+)
3	-	-
4	L	Rear axle air gauge
5	R	Front axle air gauge
6	-	-
7	R-L	Front fog lamp indicator lamp
8	-	-
9	-	-
10	R-B	Low beam indicator lamp
11	-	-
12	L-Y	Exhaust brake indicator lamp
13	B-W	CAB locking warning indicator lamp
14	W	Low range indicator lamp
15	-	-
16	B-Y	ABS diagnostic lamp

Pin No.	Wire Color	Function
17	B-L	Blocked air filter warning instrument indicator
18	R-Y	Door control instrument indicator lamp
19	B-L	Trailer ABS diagnostic lamp
20	P	ASR failure warning lamp
21	G-W	Instrument vehicle speed 20km/h
22	G-R	Instrument vehicle speed 60km/h
23	G-Y	Instrument vehicle speed 40km/h
24	LG	PTO indicator lamp (+)
25	-	-
26	-	-
27	-	-
28	-	-
29	-	-
30	-	-
31	-	-
32	-	-

BASIC INSPECTION

Attention:

In the implementation of Basic Inspection, it is necessary for the engine temperature to reach operating temperature. In the case of road test, there should be two or more people for the test.

Step	Inspection Item		Measure
1	Check air gauge - Air gauge pointer should point in the range of 750 ~ 830kPa - In the case of air pressure lower than 500kPa and in the red area, driving is not allowed. Is the inspection result normal?	Yes	Go to Step 2
		No	Refer to Table of Fault Phenomena.
2	Check tachometer - Start the vehicle and run the engine with idling speed. - Engine speed should be in the range of 550 ~ 600 r/min Is the inspection result normal?	Yes	Go to Step 3
		No	Refer to Table of Fault Phenomena.
3	Check coolant temperature gauge - Start the vehicle and run the engine with idling speed until cooling fan operation. - Indication of coolant temperature gauge should be in the range of 75 ~ 85 °C. Is the inspection result normal?	Yes	Confirm normal operation of system
		No	Refer to Table of Fault Phenomena.

TABLE OF FAULT PHENOMENA

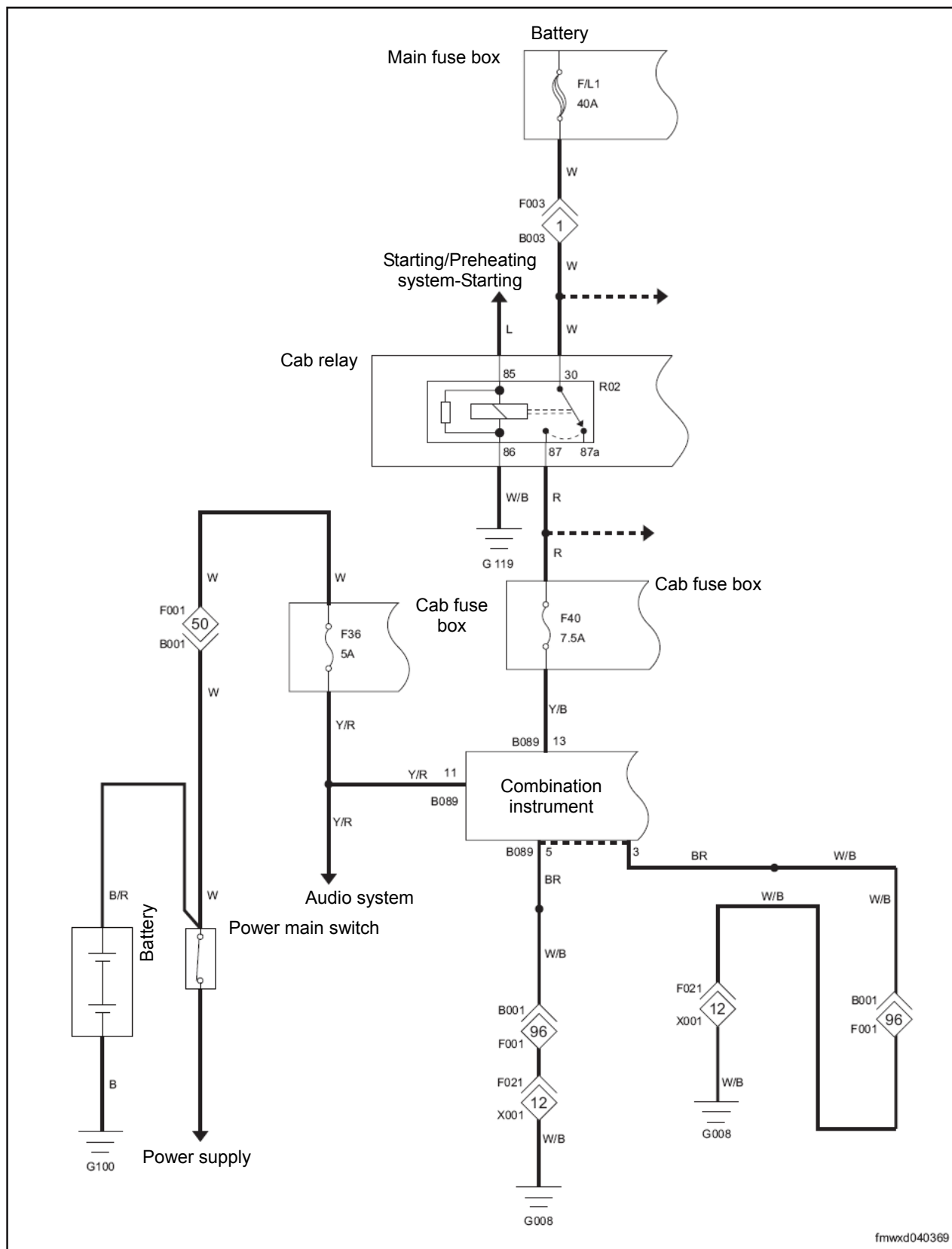
Please refer to the following table for troubleshooting. The serial numbers indicate the order of fault possibility. Please check relevant parts in the order and conduct replacement when necessary.

Fault Phenomena	Possible Cause	Solution
Incapable working of the whole combination instrument	1. Fuse	Replace fuse
	2. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	3. Harness	Repair or replace harness
	4. Relay	Replace relay
Speedometer failure	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Vehicle speed sensor	Replace vehicle speed sensor
	4. Dialer	Replace dialer
Tachometer failure	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Dialer	Replace dialer
Fuel gauge failure	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Fuel sensor	Replace fuel sensor
Coolant temperature gauge failure	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Coolant temperature sensor	Replace coolant temperature sensor
Oil pressure gauge failure	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Oil pressure sensor	Replace oil pressure sensor
Air gauge failure	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Air pressure sensor	Replace air pressure sensor

Fault Phenomena	Possible Cause	Solution
Always ON/OFF of coolant level indicator lamp	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Coolant level warning switch	Replace coolant level warning switch
Always ON/OFF of seatbelt indicator lamp	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Seatbelt pre-tensioner switch	Replace seatbelt pre-tensioner switch
Always ON/OFF of low range indicator lamp	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Combination switch	Replace gear select switch
Always ON/OFF of parking brake indicator lamp	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Gear select switch	Replace parking indicator switch
Always ON/OFF of blocked air filter warning indicator lamp	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. Blocked air filter warning indicator lamp switch	Replace blocked air filter warning indicator lamp switch
Always ON/OFF of cab locking warning indicator lamp	1. Combination instrument	Refer to Chapter 73 Instrument Panel and Cigar Lighter - Replacement of Combination Instrument
	2. Harness	Repair or replace harness
	3. CAB locking switch	Replace CAB locking switch

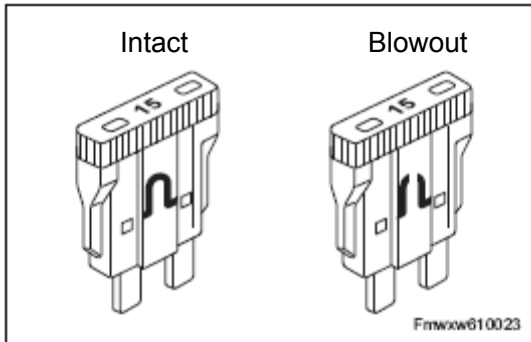
INCAPABLE WORKING OF THE WHOLE COMBINATION INSTRUMENT

Circuit Diagram



Diagnostic procedures**1. Check fuse**

- (a). Shut off main power.

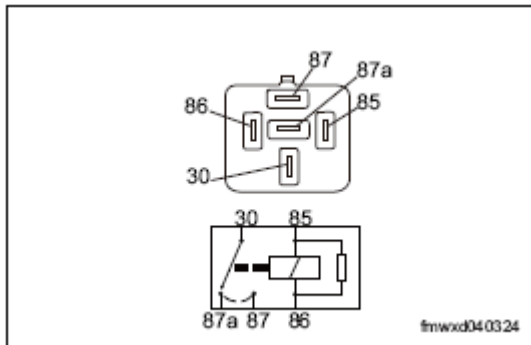


- (b). Check fuse in cab fuse box: F40 (7.5A) and F36 (5A).

Is the inspection result normal?

Yes > Go to Step 2

No > Service fuse circuit, replace fuse of the same rating

2. Check IG power relay R02

- (a). Check relay in cab relay box: R02.

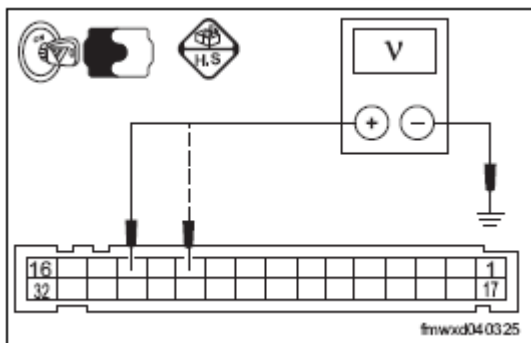
Standard value:

Switch Position	Multimeter Pin	Standard Value
Constant	85-86	Breakover
Power voltage applied between Pin 85 and Pin 86	30-87	Breakover
Constant	30-87a	Breakover

Is the inspection result normal?

Yes > Go to Step 3

No > Replace relay

3. Check combination instrument power circuit

- (a). Turn on main power.
 (b). Turn ignition switch to ON.
 (c). Use multimeter to measure the voltage of the circuit between Pin 11 and Pin 13 of combination instrument connector B089 and ground.

Standard voltage: Battery voltage

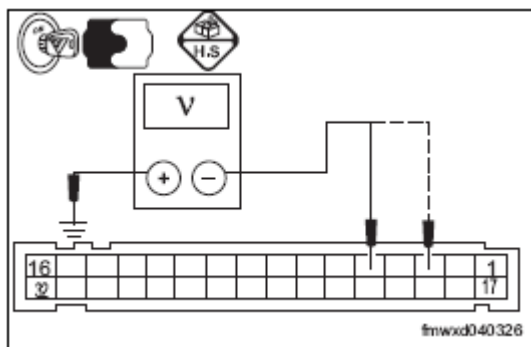
Is the inspection result normal?

Yes > Go to Step 4

No > Repair or replace harness

4. Check combination instrument ground circuit

(a). Shut off main power.



(b). Disconnect combination instrument connector B089.

(c). Use multimeter to measure the resistance of the circuit between Pin 3 and Pin 5 of combination instrument connector B089 and ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace combination instrument

No > Repair or replace harness

Circuit Diagram



Diagnostic procedures**1. Check vehicle speed sensor**

- (a). Remove vehicle speed sensor.
- (b). Turn ignition switch to ON and rapidly turn vehicle speed sensor pivot with hand.

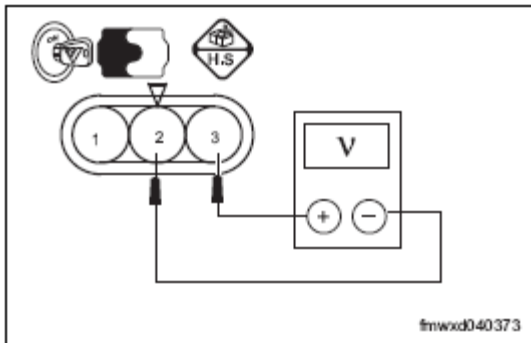
Is there any change in speedometer?

Yes > Reinstall or service transmission speed gear

No > Go to Step 2

2. Check vehicle speed sensor power input

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 3 and Pin 2 of vehicle speed sensor connector X006.

Standard voltage: 12v

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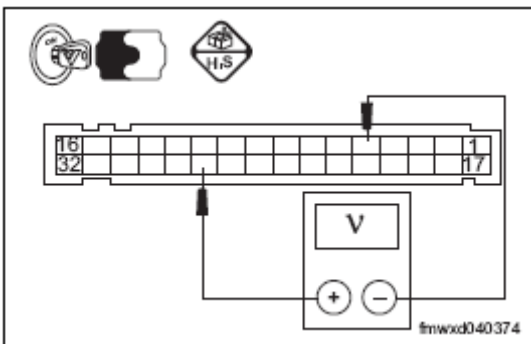
Is the voltage normal?

Yes > Go to Step 5

No > Go to Step 3

3. Check combination instrument power output

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 27 and Pin 5 of combination instrument connector B089.

Standard voltage: 12v

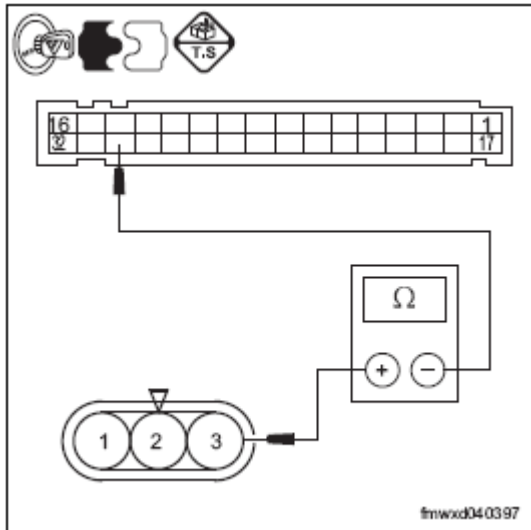
Is the voltage normal?

Yes > Go to Step 4

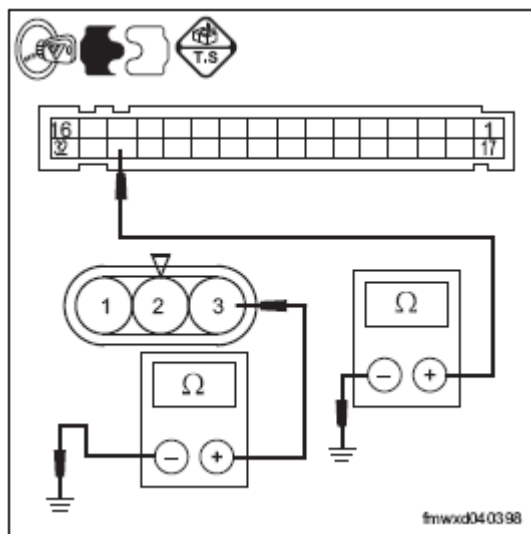
No > Service combination instrument power and ground circuit or replace combination instrument

4. Check the circuit between combination instrument power and vehicle speed sensor

- (a). Turn ignition switch to OFF.



- (b). Disconnect combination instrument connector B089 and vehicle speed sensor connector X006.
- (c). Use multimeter to measure the resistance of the circuit between Pin 30 of combination instrument connector B089 and Pin 3 of vehicle speed sensor connector X006.



- (d). Use multimeter to measure the resistance of the circuit between Pin 5 of combination instrument connector B089 and ground.
- (e). Use multimeter to measure the resistance of the circuit between Pin 2 of vehicle speed sensor connector X006 and ground.

Resistance: $\leq 2 \Omega$

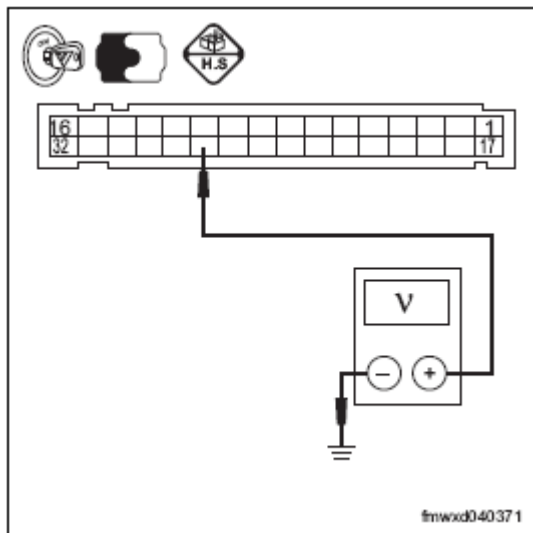
Is the resistance normal?

Yes > Go to Step 5

No > Repair or replace harness

5. Check speedometer input signal

- (a). Connect combination instrument connector B089 and vehicle speed sensor connector X006.
- (b). Turn ignition switch to ON and rapidly turn vehicle speed sensor pivot with hand.



- (c). Use multimeter to measure the voltage of the circuit between Pin 27 of combination instrument connector B089 and ground.

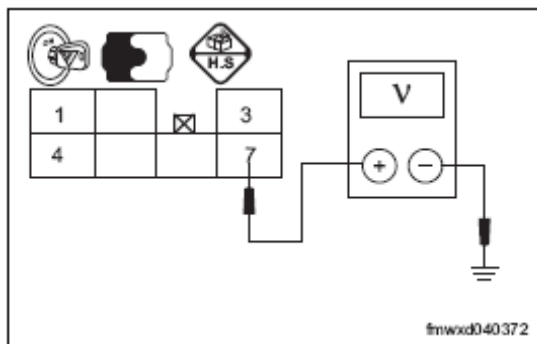
Is there any change in voltage?

Yes > Replace combination instrument

No > Go to Step6

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6. Check dialer signal output



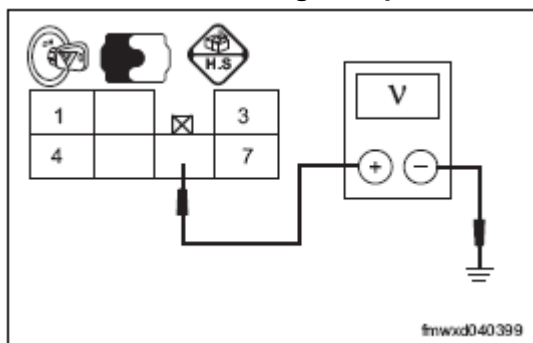
- (a). Turn ignition switch to ON and rapidly turn vehicle speed sensor pivot with hand.
(b). Use multimeter to measure the voltage of the circuit between Pin 7 of dialer connector B123 and ground.

Is there any change in voltage?

Yes > Repair or replace the harness between Pin 27 of combination instrument connector B089 and Pin 7 of dialer connector B123

No > Go to Step7

7. Check dialer signal input



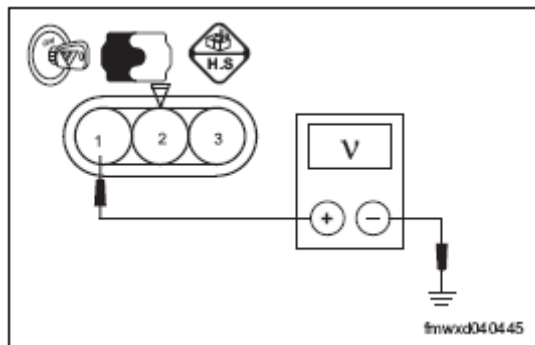
- (a). Turn ignition switch to ON and rapidly turn vehicle speed sensor pivot with hand.
(b). Use multimeter to measure the voltage of the circuit between Pin 6 of dialer connector B123 and ground.

Is there any change in voltage?

Yes > Service dialer power and ground circuit or replace dialer

No > Go to Step8

8. Check vehicle speed sensor signal output



- (a). Turn ignition switch to ON and rapidly turn vehicle speed sensor pivot with hand.
- (b). Use multimeter to measure the voltage of the circuit between Pin 1 of vehicle speed sensor connector X006 and ground.

Is there any change in voltage?

Yes > Repair or replace the harness between Pin 1 of vehicle speed sensor connector X006 and Pin 6 of dialer connector B123.

No > Replace vehicle speed sensor

TACHOMETER FAILURE

Circuit Diagram

Refer to "This Chapter, Tachometer Failure- Circuit Diagram"

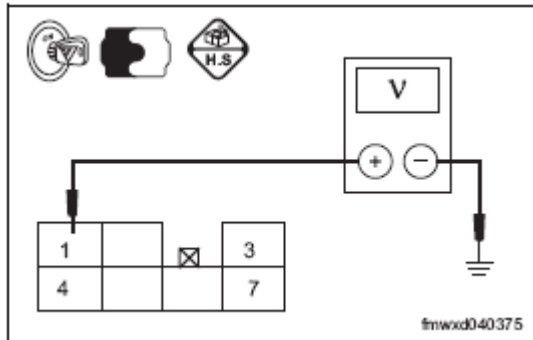
Diagnostic procedures

Hint:

Unsteady engine running may lead to jumps of tachometer pointer.

1. Check dialer input signal

(a). Start the engine and keep its idling running.



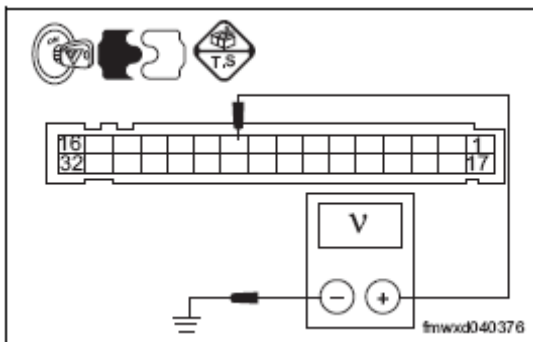
(b). Use multimeter to measure the voltage of the circuit between Pin 1 of dialer connector B123 and ground.

Is there any voltage output?

Yes > Go to Step 2

No > Repair or replace the harness between Pin 1 of dialer connector B123 and Pin W of generator connector E004

2. Check dialer output signal



(a). Turn ignition switch to OFF position and disconnect combination instrument connector B089.

(b). Start the engine and keep its idling running.

(c). Use multimeter to measure the voltage of the circuit between Pin 10 of combination instrument connector B089 and ground.

Voltage: 3-5V

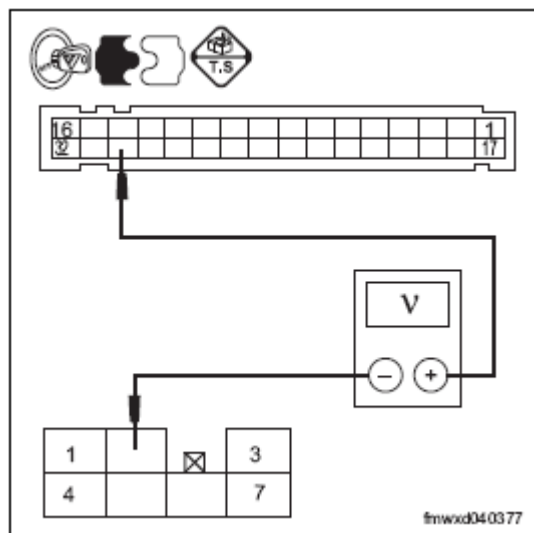
Is the inspection result normal?

Yes > Replace combination instrument

No > Go to Step 3

3. Check tachometer signal input circuit

(a). Turn ignition switch to OFF.



- (b). Disconnect combination instrument connector B089 and dialer connector B123.
- (c). Use multimeter to measure the resistance of the circuit between Pin 10 of combination instrument connector B089 and Pin 2 of dialer connector B123.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

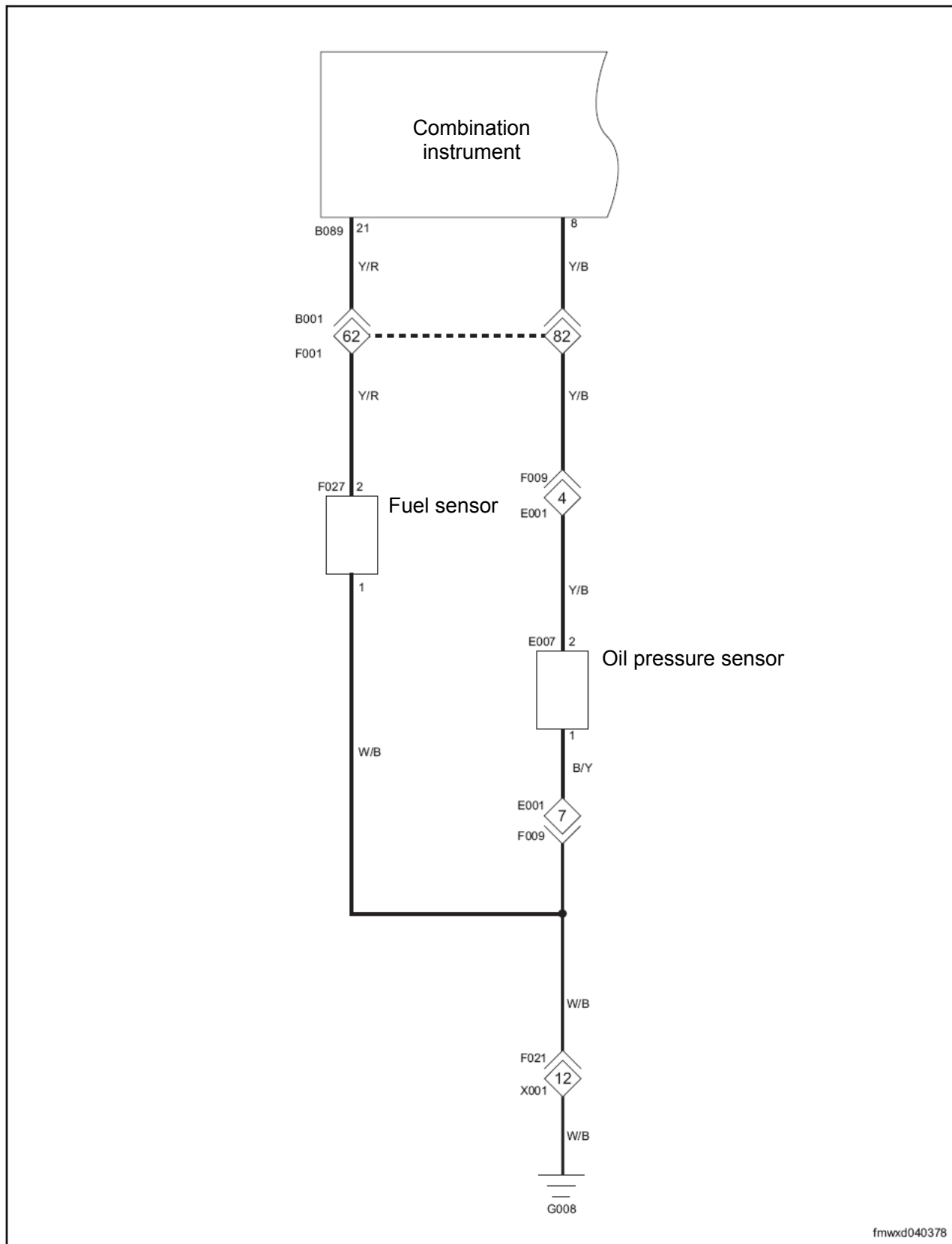
Yes > Service dialer power and ground circuit or replace dialer

No > Repair or replace harness



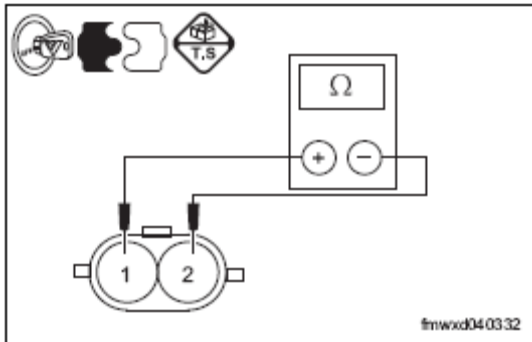
FUEL GAUGE FAILURE

Circuit Diagram



Diagnostic procedures**1. Check fuel sensor**

(a). Turn ignition switch to OFF.



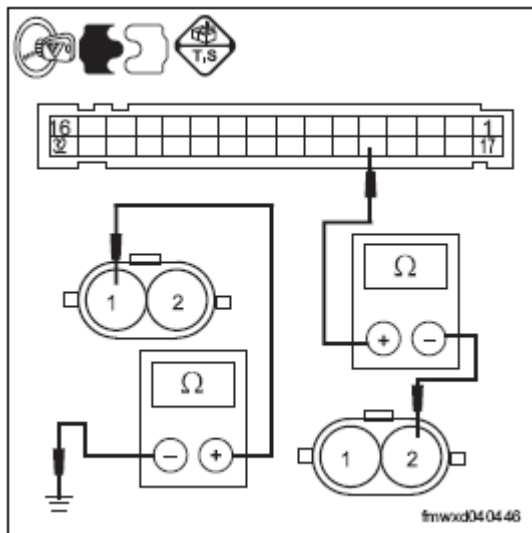
- (b). Disconnect fuel sensor connector F027.
 (c). Remove fuel sensor and simulate the conditions of empty, half-loaded and full fuel tank separately.
 (d). Use multimeter to measure the resistance of the circuit between Pin 1 and Pin 2 of fuel sensor connector F027.

Resistance: $3\pm3\Omega$, $76.8\pm10\Omega$, $180\pm10\Omega$

Is the inspection result normal?

Yes > Go to Step 2

No > Replace fuel sensor

2. Check fuel sensor harness

- (a). Disconnect combination instrument connector B089.
 (b). Use multimeter to measure the resistance of the harness between Pin 21 of combination instrument connector B089 and Pin 2 of fuel sensor connector F027.
 (c). Use multimeter to measure the resistance of the harness between Pin 1 of fuel sensor connector F027 and G008.

Resistance: $\leq 2\Omega$

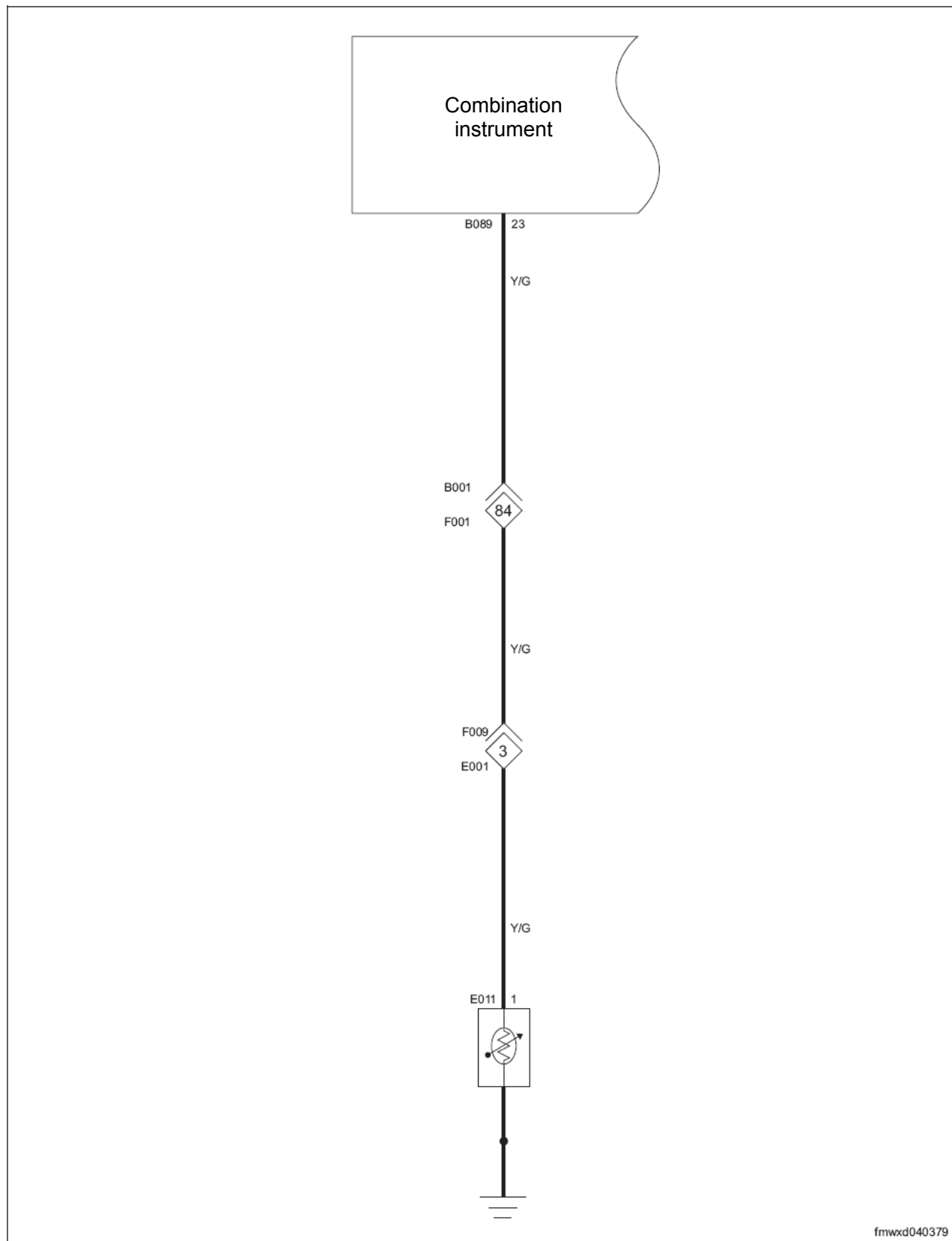
Is the inspection result normal?

Yes > Service combination instrument power and ground circuit or replace combination instrument

No > Repair or replace harness

COOLANT TEMPERATURE GAUGE FAILURE

Circuit Diagram

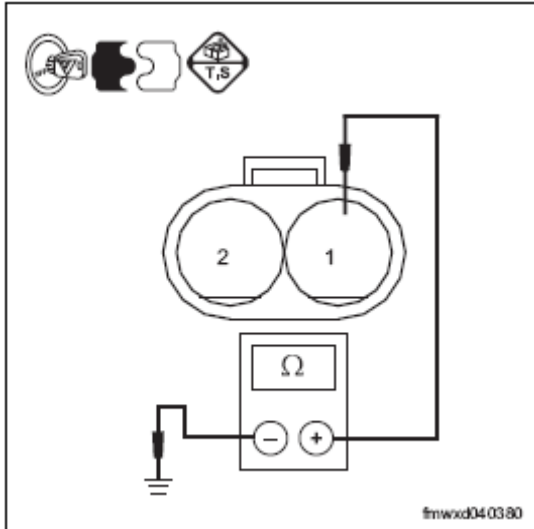


Diagnostic procedures**1. Check coolant temperature sensor**

- (a). Turn ignition switch to OFF.
- (b). Remove coolant temperature sensor.

Warning:

The removal of coolant temperature sensor should be carried out under cold vehicle condition.



- (c). Use multimeter to measure the resistance of the circuit between Pin 1 of coolant temperature sensor connector E010 and ground (the resistance varies according to coolant temperatures)

Range of resistance value: $38.5 \pm 4 \sim 287.4 \pm 30 \Omega$

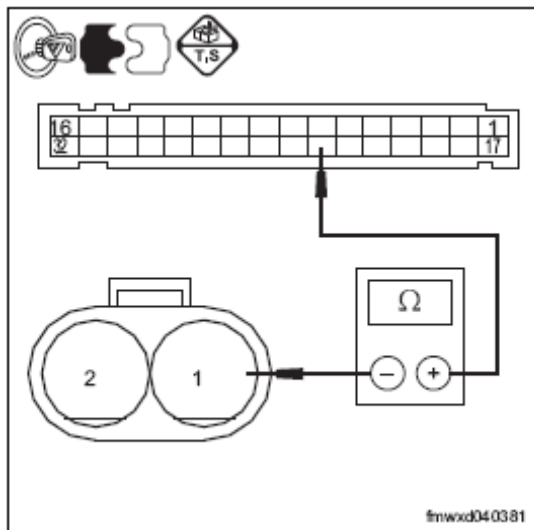
Is there any change in resistance value?

Yes > Go to Step 2

No > Replace coolant temperature sensor

2. Check coolant temperature sensor harness

- (a). Turn ignition switch to OFF.



- (b). Disconnect combination instrument connector B089 and coolant temperature sensor connector E011.
- (c). Use multimeter to measure the resistance of the harness between Pin 23 of combination instrument connector B089 and Pin 1 of coolant temperature sensor connector E011.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Service combination instrument power and ground circuit or replace combination instrument

No > Repair or replace harness

OIL PRESSURE GAUGE FAILURE

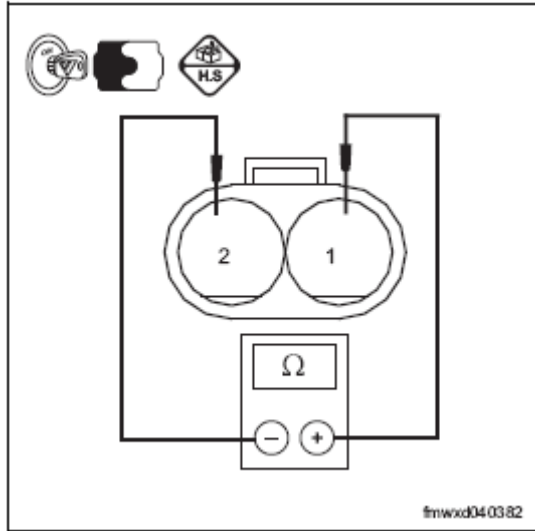
Circuit Diagram

Refer to "This Chapter, Fuel Gauge Failure- Circuit Diagram"

Diagnostic procedures

1. Check oil pressure sensor

- (a). Stop and start the engine and keep engine running with different speeds.



- (b). Use multimeter to measure the resistance of the circuit between Pin 1 and Pin 2 of oil pressure sensor connector E007.

Range of resistance value: $9\pm3 \sim 184\pm15\Omega$

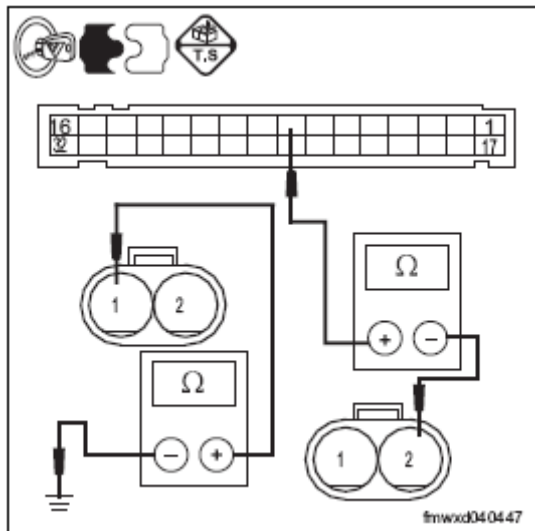
Is there any change in resistance value?

Yes > Go to Step 2

No > Replace oil pressure sensor and service engine lubricating system

2. Check oil pressure sensor harness

- (a). Turn ignition switch to OFF.



- (b). Disconnect combination instrument connector B089 and oil pressure sensor connector E007.
- (c). Use multimeter to measure the resistance of the harness between Pin 8 of combination instrument connector B089 and Pin 2 of oil pressure sensor connector E007.
- (d). Use multimeter to measure the resistance of the harness between Pin 1 of oil pressure sensor connector E007 and G008.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

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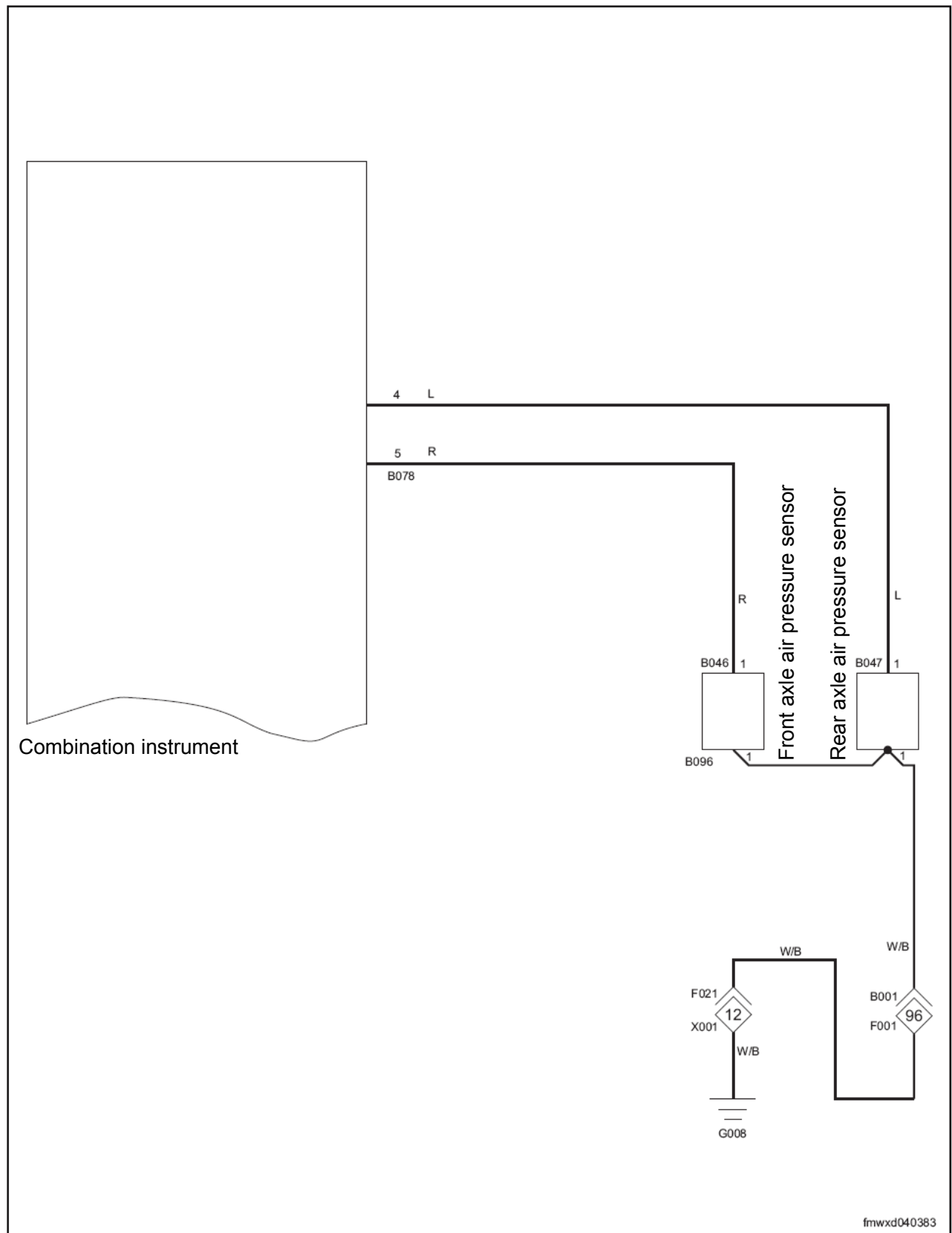
DIAGNOSIS-COMBINATION INSTRUMENT

Yes > Service combination instrument power and ground circuit or replace combination instrument

No > Repair or replace harness

AIR GAUGE FAILURE

Circuit Diagram

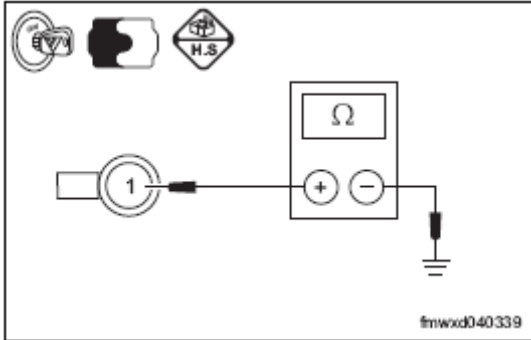


Diagnostic procedures**1. Check front and rear axle air pressure sensors**

- (a). Bleed air in air reservoir and start the engine to inflate the air reservoir for air pressure change in it.

Hint:

Check inflating pump for its normal operation and air reservoir for air leakage. In the case of faults in these devices, service faulty parts.



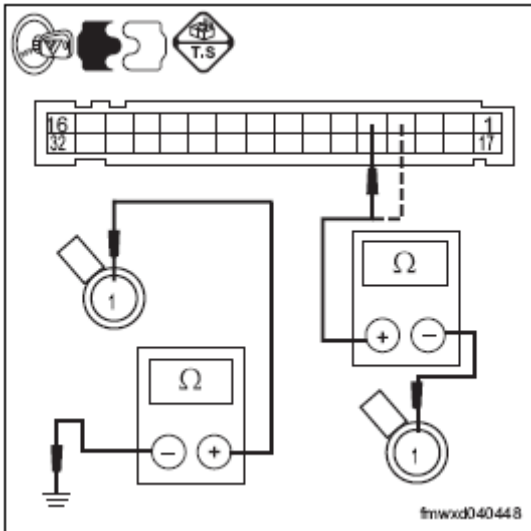
- (b). Use multimeter to measure the circuit resistance between Pin 1 of air pressure sensor connector B046 and B047 with ground respectively.

Range of resistance value: 10 ~ 184Ω

Is there any change in resistance value?

Yes > Go to Step 2

No > Replace air pressure sensor

2. Check air pressure sensor harness

- (a). Turn ignition switch to OFF.
- (b). Disconnect combination instrument connector B078, air pressure sensor connector B046, B047 and B096.
- (c). Use multimeter to measure the harness resistance between Pin 4 and 5 of combination instrument connector B078 with Pin 1 of air pressure sensor connector B047 and B046.
- (d). Use multimeter to measure the resistance of the harness between air pressure sensor ground point B096 and G008.

Resistance: $\leq 2 \Omega$

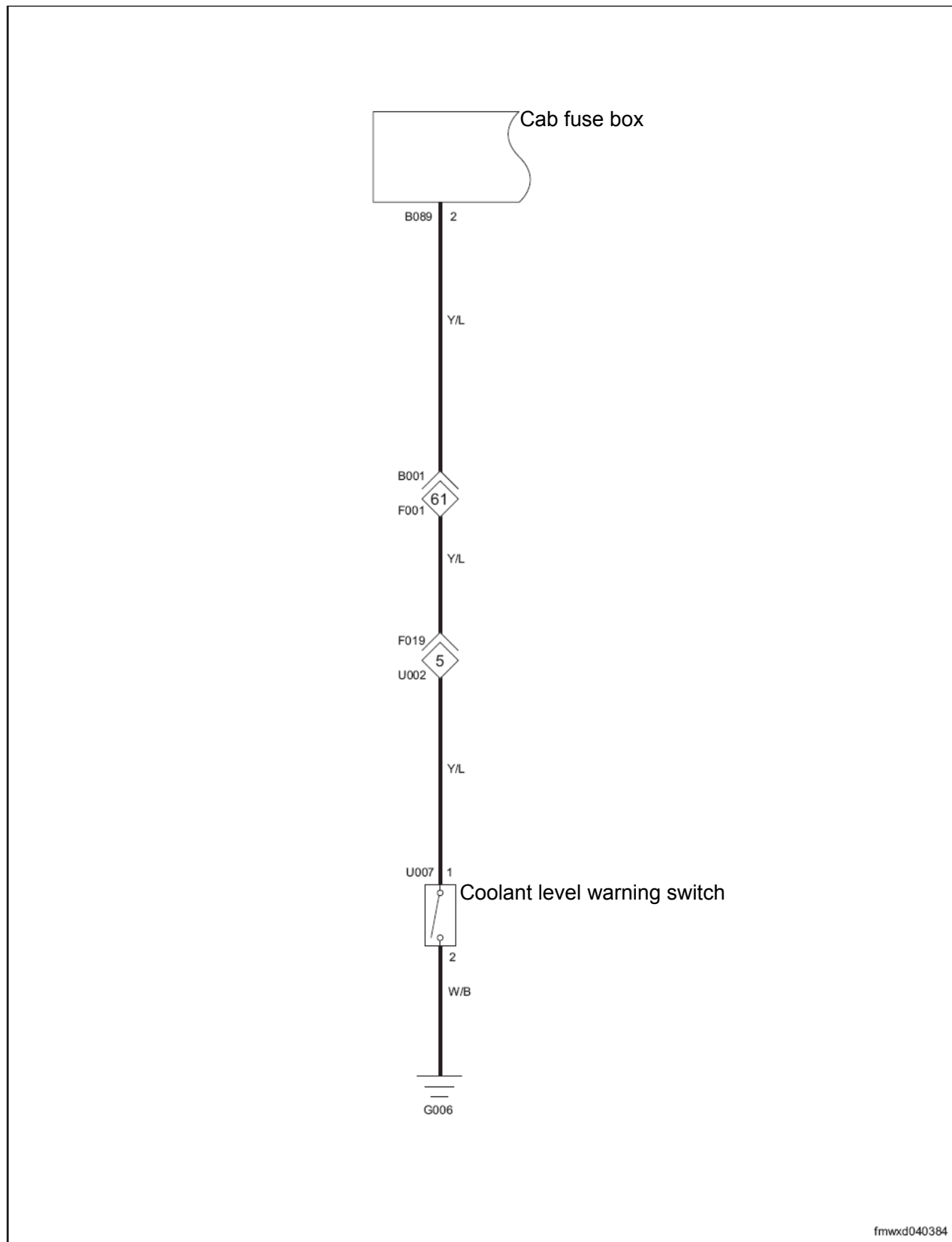
Is the inspection result normal?

Yes > Service combination instrument power and ground circuit or replace combination instrument

No > Repair or replace harness

ALWAYS ON/OFF OF COOLANT LEVEL INDICATOR LAMP

Circuit Diagram



Diagnostic procedures

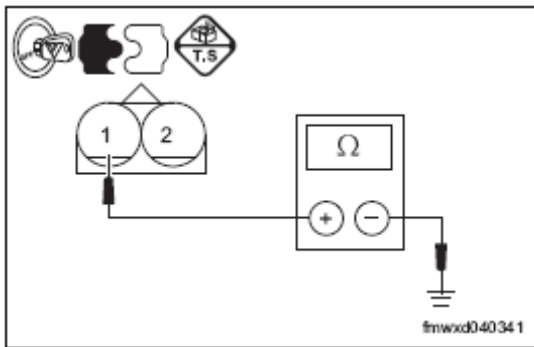
- Confirm that coolant level is in the range of standard scale.
- Turn ignition switch to ON.

Check whether coolant level indicator lamp is always ON or OFF?**Yes > (always ON) Go to Step 1.****No > (always OFF) Go to Step 3.****1. Check coolant level warning switch for short circuit**

- Turn ignition switch to OFF.
- Disconnect coolant level warning switch connector U007.
- Turn ignition switch to ON.

Check whether coolant level indicator lamp goes out?**Yes > Replace coolant level warning switch****No > Go to Step 2****2. Check coolant level indicator lamp signal circuit for short circuit**

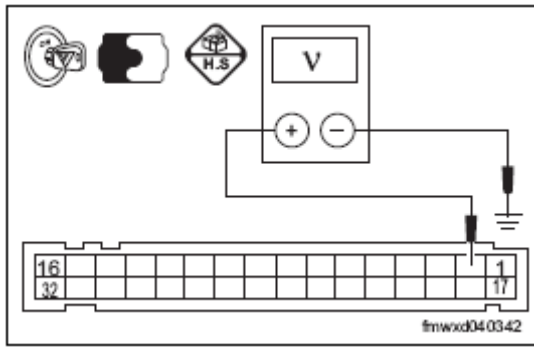
- Turn ignition switch to OFF.
- Disconnect combination instrument connector B089.



- Use multimeter to measure the resistance of the circuit between Pin 1 of coolant level warning switch connector U007 and ground.

Resistance: > 10MΩ**Is the inspection result normal?****Yes > Replace combination instrument****No > Repair or replace harness****3. Check coolant level indicator lamp signal circuit**

- Disconnect coolant level warning switch connector U007 and connect combination instrument connector B089.
- Turn ignition switch to ON.



- (c). Use multimeter to measure the voltage of the circuit between Pin 2 of combination instrument connector B089 and ground.

Standard voltage: Battery voltage

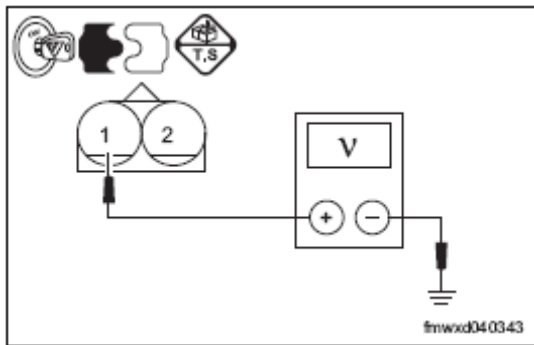
Is the inspection result normal?

Yes > Go to Step 4

No > Service combination instrument power circuit or replace combination instrument

4. Check coolant level indicator lamp signal circuit for open circuit

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 1 of coolant level warning switch connector U007 and ground.

Standard voltage: Battery voltage

04

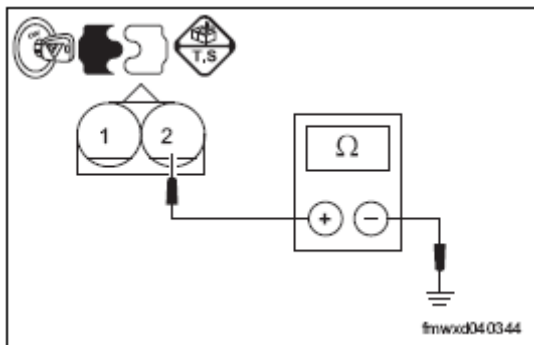
Is the inspection result normal?

Yes > Go to Step 5

No > Repair or replace harness

5. Check coolant level indicator lamp ground circuit

- (a). Turn ignition switch to OFF.



- (b). Use multimeter to measure the resistance of the circuit between Pin 2 of coolant level warning switch connector U007 and ground G006.

Resistance: $\leq 2 \Omega$

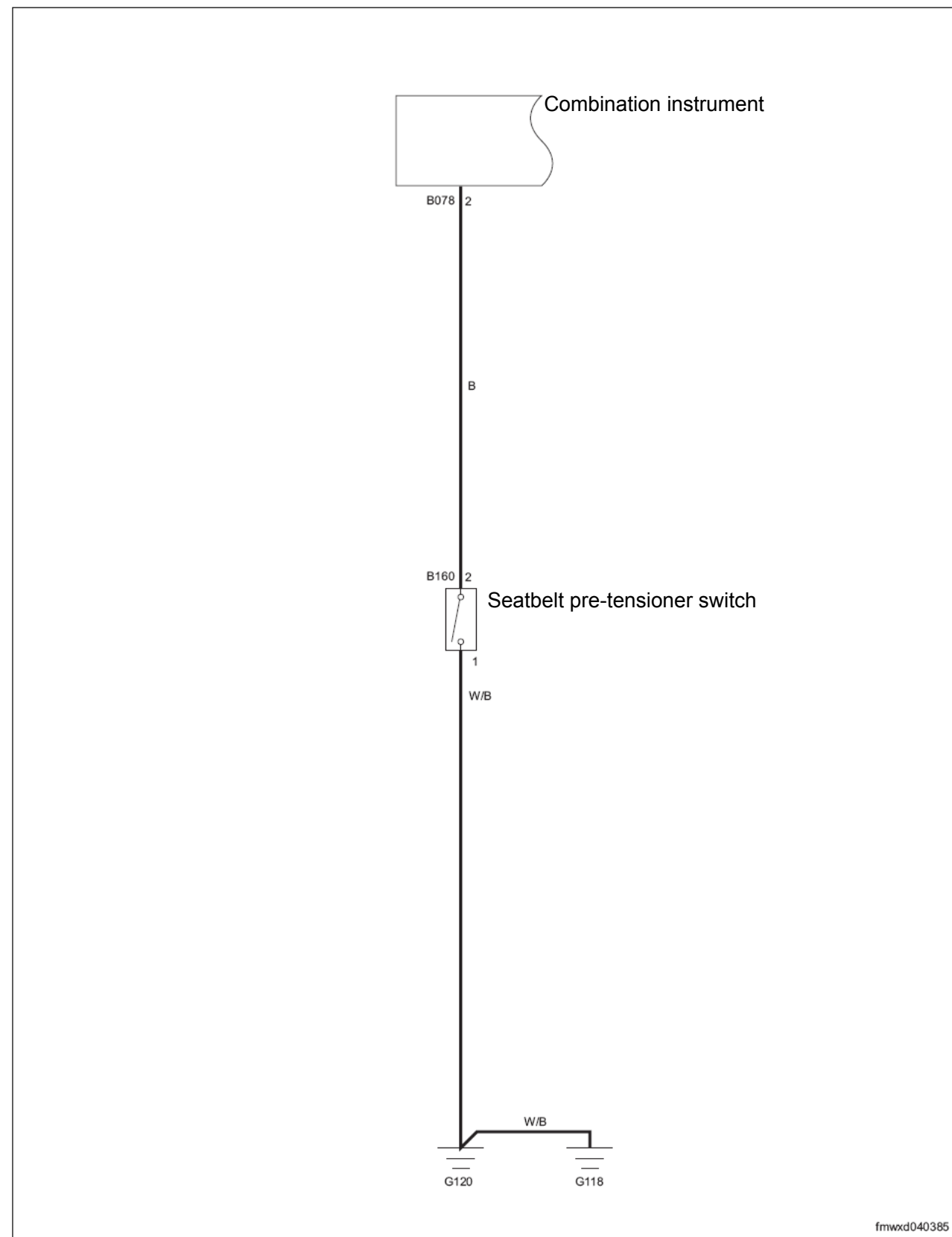
Is the inspection result normal?

Yes > Replace coolant level warning switch

No > Repair or replace harness

ALWAYS ON/OFF OF SEATBELT INDICATOR LAMP

Circuit Diagram



Diagnostic procedures

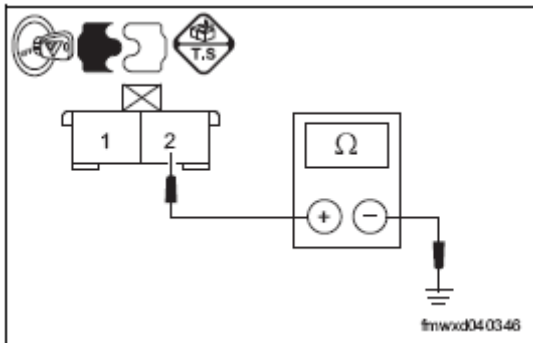
- Turn ignition switch to ON, in the case of non-fastened driver's seatbelt, this indicator lamp is lit.
- Turn ignition switch to ON, in the case of fastened driver's seatbelt, this indicator lamp goes out.

Check whether seatbelt indicator lamp is always ON or OFF?**Yes > (always ON) Go to Step 1.****No > (always OFF) Go to Step 3.****1. Check seatbelt pre-tensioner switch for short circuit**

- Turn ignition switch to OFF.
- Disconnect seatbelt pre-tensioner switch connector B160.
- Turn ignition switch to ON.

Check whether seatbelt indicator lamp goes out?**Yes > Replace seatbelt pre-tensioner switch****No > Go to Step 2****2. Check seatbelt indicator lamp signal circuit for short circuit**

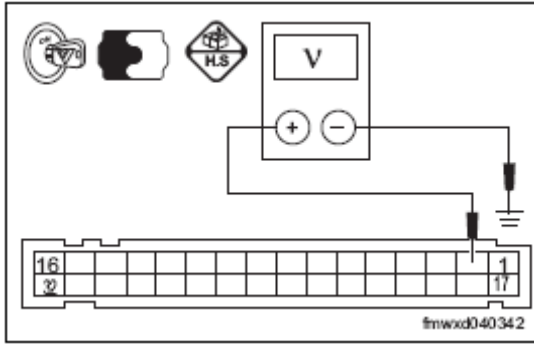
- Turn ignition switch to OFF.
- Disconnect combination instrument connector B078.



- Use multimeter to measure the resistance of the circuit between Pin 2 of seatbelt pre-tensioner switch connector B160 and ground.

Resistance: > 10MΩ**Is the inspection result normal?****Yes > Replace combination instrument****No > Repair or replace harness****3. Check seatbelt indicator lamp signal circuit**

- Connect combination instrument connector B078 and disconnect seatbelt pre-tensioner switch connector B160.
- Turn ignition switch to ON.



- (c). Use multimeter to measure the voltage of the circuit between Pin 2 of combination instrument connector B078 and ground.

Standard voltage: Battery voltage

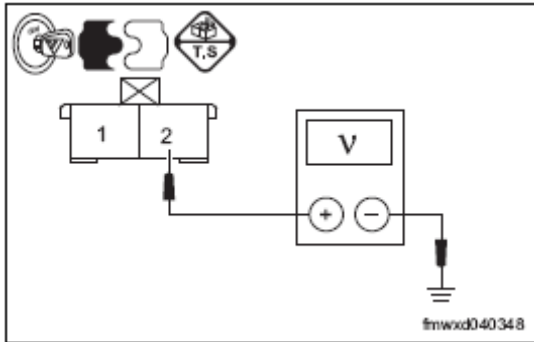
Is the inspection result normal?

Yes > Go to Step 4

No > Service combination instrument power circuit or replace combination instrument

4. Check seatbelt indicator lamp signal circuit for open circuit

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 2 of seatbelt pre-tensioner switch connector B160 and ground.

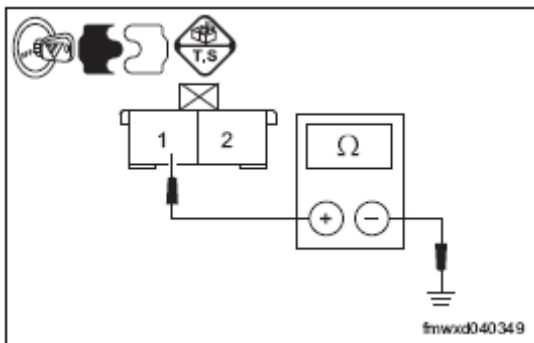
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 5

No > Repair or replace harness

5. Check seatbelt indicator lamp ground circuit



- (a). Use multimeter to measure the resistance of the circuit between Pin 1 of seatbelt pre-tensioner switch connector B160 and ground.

Resistance: $\leq 2 \Omega$

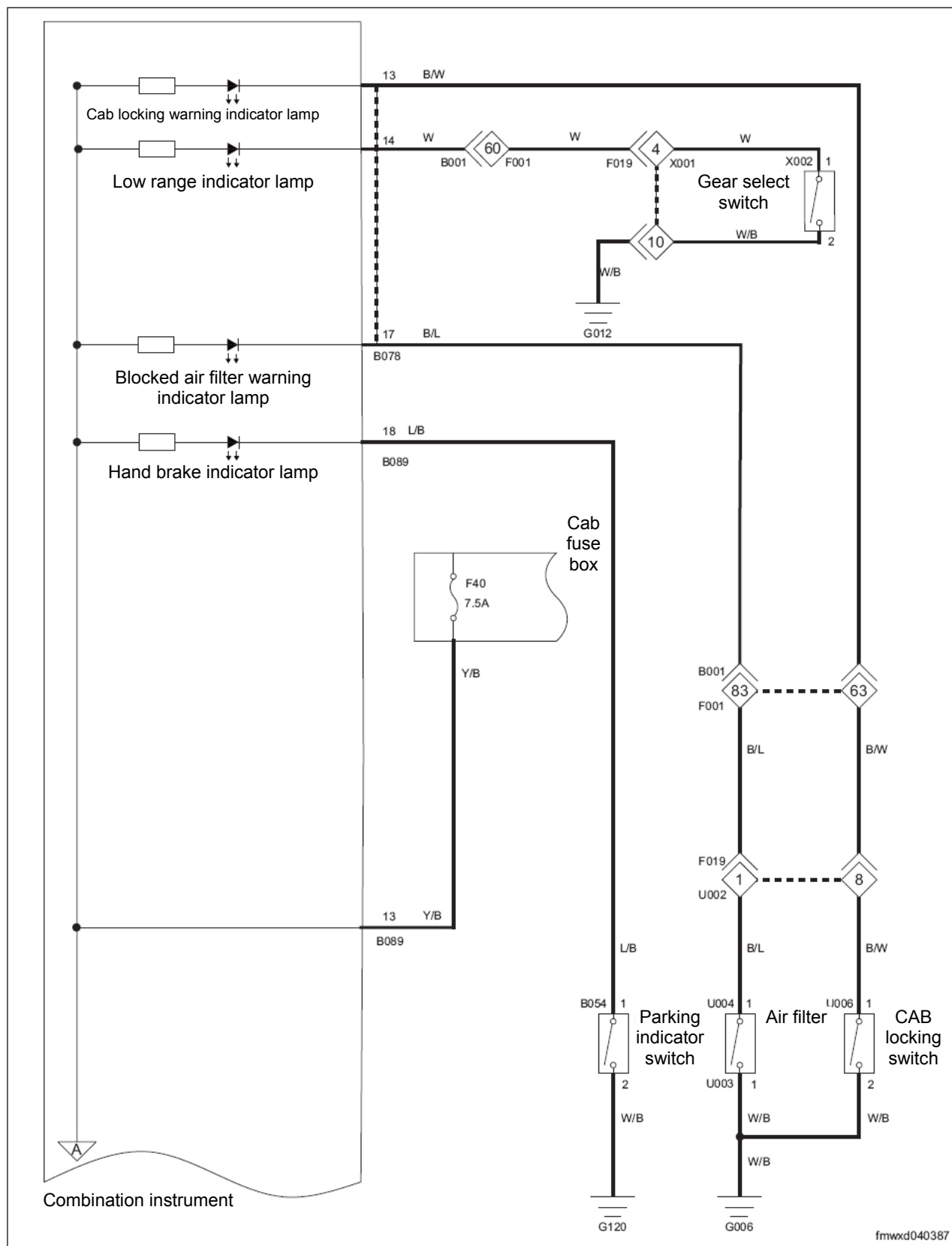
Is the inspection result normal?

Yes > Replace seatbelt pre-tensioner switch

No > Repair or replace harness

ALWAYS ON/OFF OF LOW RANGE INDICATOR LAMP

Circuit Diagram



Diagnostic procedures

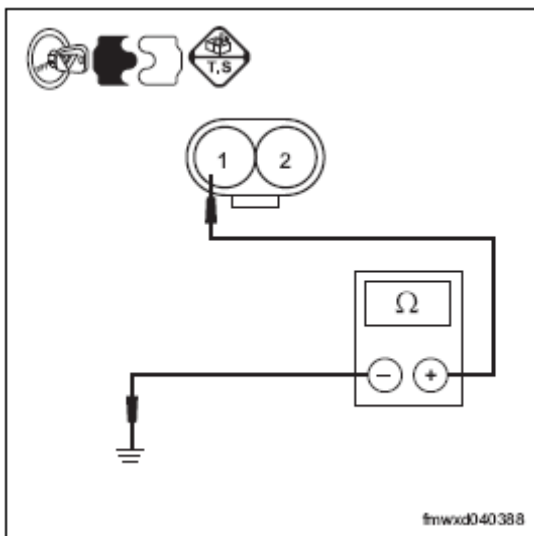
- Turn ignition switch to ON.
- Repeat gear shifts between low range and high range.

Check whether low range indicator lamp is always ON or OFF?**Yes > (always ON) Go to Step 1****No > (always OFF) Go to Step 3****1. Check gear select switch for short circuit**

- Turn ignition switch to OFF.
- Disconnect gear select switch connector X002.
- Turn ignition switch to ON.

Check whether low range indicator lamp goes out?**Yes > Replace gear select switch****No > Go to Step 2****2. Check low range indicator lamp signal circuit for short circuit**

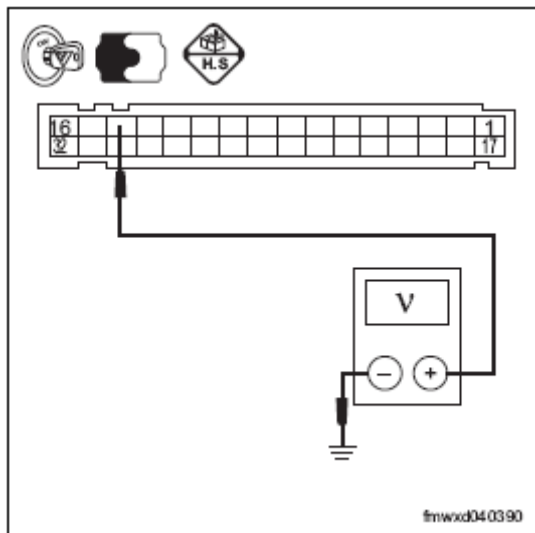
- Turn ignition switch to OFF.
- Disconnect combination instrument connector B078.



- Use multimeter to measure the resistance of the circuit between Pin 1 of combination switch connector X002 and ground.

Resistance: > 10MΩ**Is the inspection result normal?****Yes > Replace combination instrument****No > Repair or replace harness****3. Check low range indicator lamp signal circuit**

- Disconnect gear select switch connector X002 and connect combination instrument connector B078.
- Turn ignition switch to ON.



- (c). Use multimeter to measure the voltage of the circuit between Pin 14 of combination switch connector B078 and ground.

Standard voltage: Battery voltage

Is the inspection result normal?

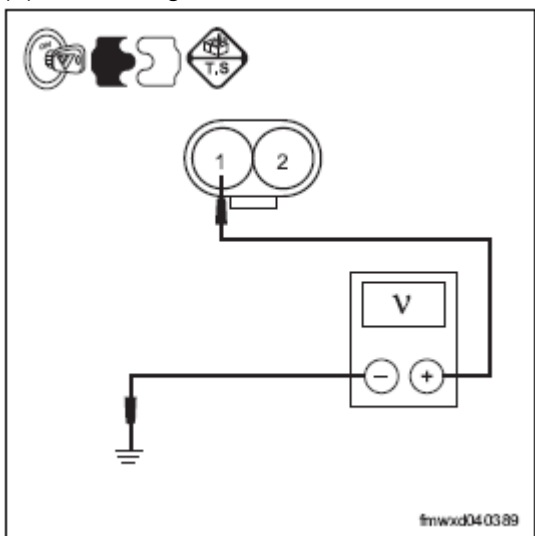
Yes > Go to Step 4

No > Service combination instrument power circuit or replace combination instrument

04

4. Check low range indicator lamp signal circuit for open circuit

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 1 of gear select switch connector X002 and ground.

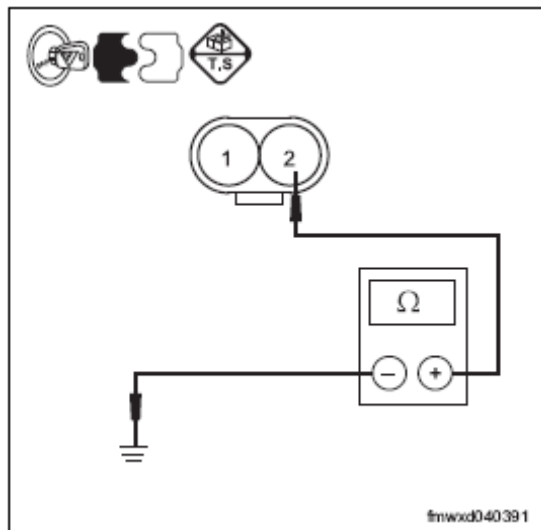
Standard voltage: Battery voltage

Is the inspection result normal?

Yes > Go to Step 5

No > Repair or replace harness

5. Check low range indicator lamp ground circuit



- (a). Use multimeter to measure the resistance of the circuit between Pin 2 of gear select switch connector X002 and ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace gear select switch

No > Repair or replace harness

ALWAYS ON/OFF OF PARKING BRAKE INDICATOR LAMP

Circuit Diagram

Refer to "This Chapter, Always ON/OFF of Low Range Indicator Lamp-Circuit Diagram"

Diagnostic procedures

- Turn ignition switch to ON, pull up hand brake handle, this indicator lamp is lit
- Turn ignition switch to ON, put down hand brake handle, this indicator lamp goes out.

Hint:

Abnormal air pressure of brake system may lead to abnormal operation of parking brake indicator lamp. In case of abnormal air pressure of brake system, eliminate faults in brake air line.

Check whether parking brake indicator lamp is always ON or OFF?

Yes > (always ON) Go to Step 1

No > (always OFF) Go to Step 3

1. Check parking brake indicator lamp switch for short circuit

- Turn ignition switch to OFF.
- Put down hand brake handle.

Warning:

Prior to putting down hand brake handle, chock four wheels with chock blocks to avoid vehicle slipping.

- Disconnect connector B054 of parking brake indicator lamp switch.
- Turn ignition switch to ON.

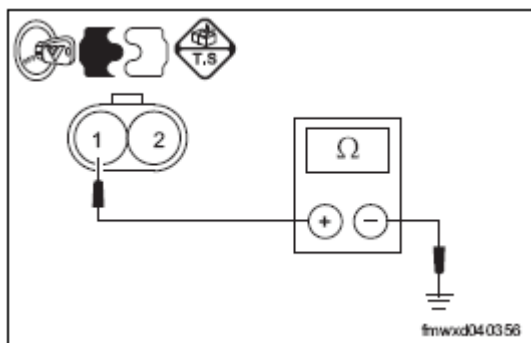
Check whether parking brake indicator lamp goes out?

Yes > Replace parking brake indicator lamp switch

No > Go to Step 2

2. Check parking brake indicator lamp signal circuit for short circuit

- Turn ignition switch to OFF.
- Disconnect combination instrument connector B089.



- Use multimeter to measure the resistance of the circuit between Pin 1 of parking brake indicator lamp switch connector B054 and ground.

Resistance: > 10MΩ

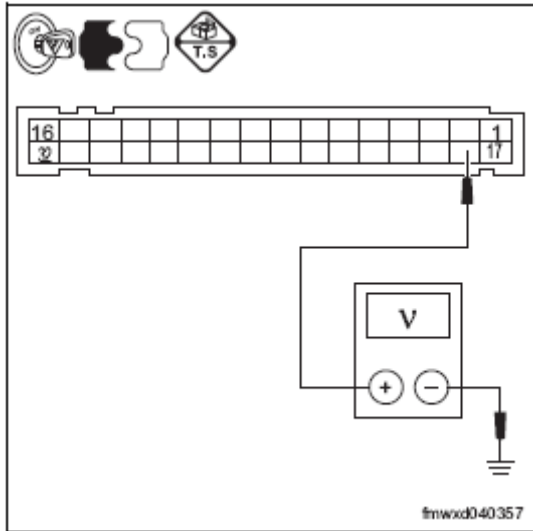
Is the inspection result normal?

Yes > Replace combination instrument

No > Repair or replace harness

3. Check parking brake indicator lamp signal circuit

- (a). Disconnect connector B054 of parking brake indicator lamp switch and connect combination instrument connector B089.
- (b). Turn ignition switch to ON.



- (c). Use multimeter to measure the voltage of the circuit between Pin 18 of combination instrument connector B089 and ground.

Standard voltage: battery voltage

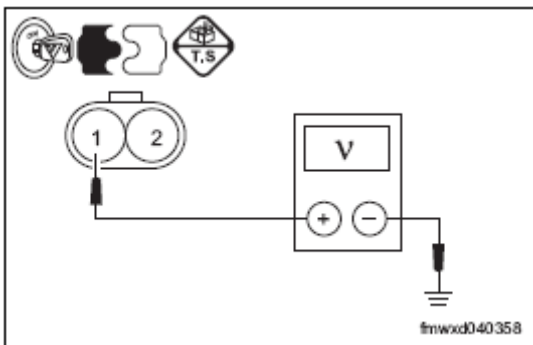
Is the inspection result normal?

Yes > Go to Step 4

No > Service combination instrument power circuit or replace combination instrument

4. Check parking brake indicator lamp signal circuit for open circuit

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 1 of parking brake indicator lamp switch connector B054 and ground.

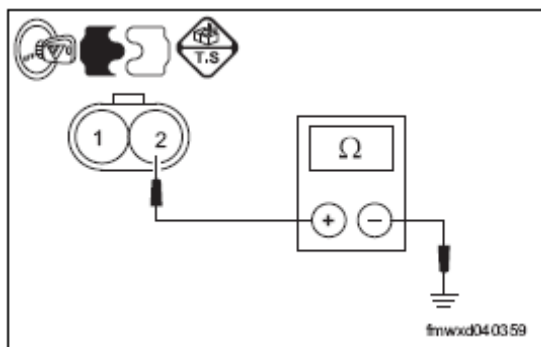
Standard voltage: battery voltage

Is the inspection result normal?

Yes > Go to Step 5

No > Repair or replace harness

5. Check parking brake indicator lamp ground circuit



- (a). Use multimeter to measure the resistance of the circuit between Pin 2 of parking brake indicator lamp switch connector B054 and ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace parking brake indicator lamp switch

No > Repair or replace harness

ALWAYS ON/OFF OF BLOCKED AIR FILTER WARNING INDICATOR LAMP

Circuit Diagram

Refer to "This Chapter, Always ON/OFF of Low Range Indicator Lamp- Circuit Diagram"

Diagnostic procedures

- Confirm whether air filter is too dirty. If so, replace with new air filter.
- Confirm whether there is excessively large resistance in air intake system. If so, eliminate this fault.
- Start alternator.

Check whether blocked air filter warning indicator lamp is always ON or OFF?

Yes > (always ON) Go to Step 1

No > (always OFF) Go to Step 3

04

1. Check blocked air filter warning indicator lamp signal circuit for short circuit

- Turn ignition switch to OFF.
- Disconnect connector U003 and U004 of blocked air filter warning indicator lamp switch.
- Turn ignition switch to ON.

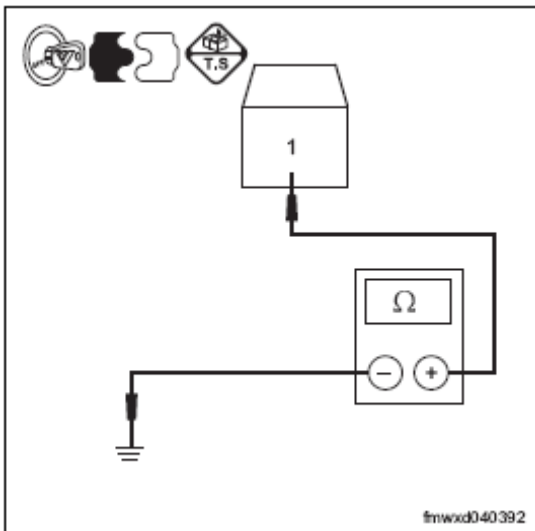
Check whether blocked air filter warning indicator lamp goes out?

Yes > Replace blocked air filter warning indicator lamp switch

No > Go to Step 2

2. Check parking brake indicator lamp signal circuit for short circuit

- Turn ignition switch to OFF.
- Disconnect combination instrument connector B078.



- Use multimeter to measure the resistance of the circuit between Pin 1 of blocked air filter warning indicator lamp switch connector U004 and ground.

Resistance: > 10MΩ

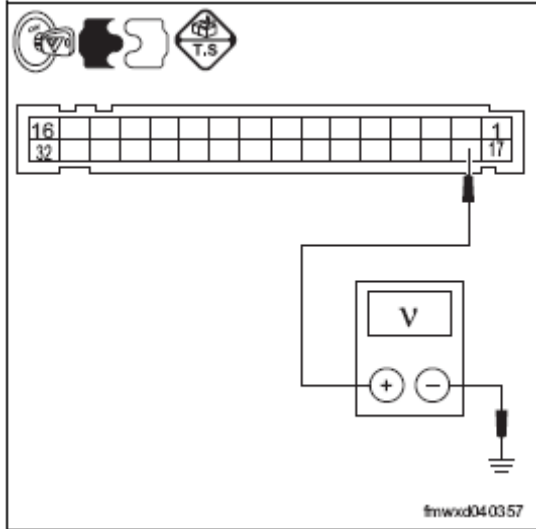
Is the inspection result normal?

Yes > Replace combination instrument

No > Repair or replace harness

3. Check blocked air filter warning indicator lamp signal circuit

- (a). Disconnect connector U003 and U004 of blocked air filter warning indicator lamp switch and connect combination instrument connector B078.
- (b). Turn ignition switch to ON.



- (c). Use multimeter to measure the voltage of the circuit between Pin 17 of combination instrument connector B078 and ground.

Standard voltage: battery voltage

04

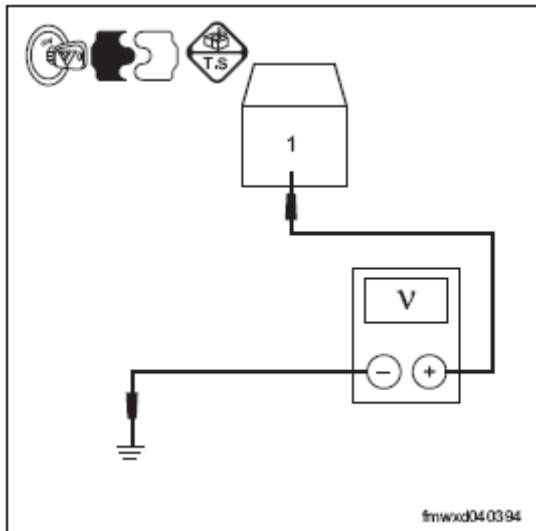
Is the inspection result normal?

Yes > Go to Step 4

No > Service combination instrument power circuit or replace combination instrument

4. Check blocked air filter warning indicator lamp signal circuit for open circuit

- (a). Turn ignition switch to ON.



- (b). Use multimeter to measure the voltage of the circuit between Pin 1 of blocked air filter warning indicator lamp switch connector U004 and ground.

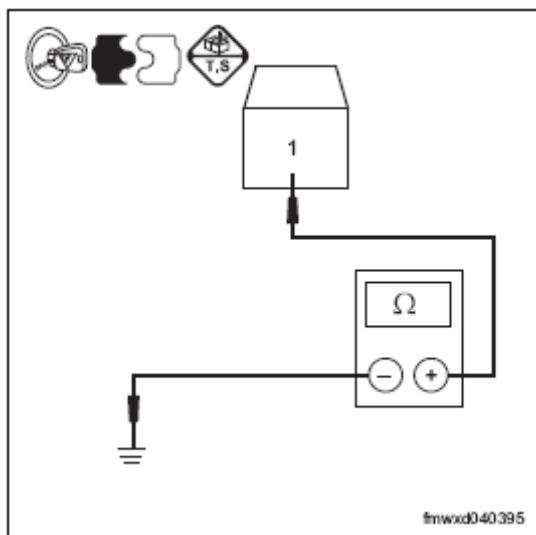
Standard voltage: battery voltage

Is the inspection result normal?

Yes > Go to Step 5

No > Repair or replace harness

5. Check blocked air filter warning indicator lamp ground circuit.



- (a). Use multimeter to measure the resistance of the circuit between Pin 1 of blocked air filter warning indicator lamp switch connector U003 and ground.
Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace blocked air filter warning indicator lamp switch

No > Repair or replace harness

ALWAYS ON/OFF OF CAB LOCKING WARNING INDICATOR LAMP

Circuit Diagram

Refer to "This Chapter, Always ON/OFF of Low Range Indicator Lamp-Circuit Diagram"

Diagnostic procedures

- Turn ignition switch to ON, in the case of cab tilt, this indicator lamp is lit.
- Turn ignition switch to ON, in the case of cab turning down, this indicator lamp goes out.

Check whether cab locking warning indicator lamp is always ON or OFF?

Yes > (always ON) Go to Step 1

No > (always OFF) Go to Step 3

1. Check CAB locking switch for short circuit

- Turn ignition switch to OFF.
- Turn down cab.
- Disconnect CAB locking switch connector U006.
- Turn ignition switch to ON.

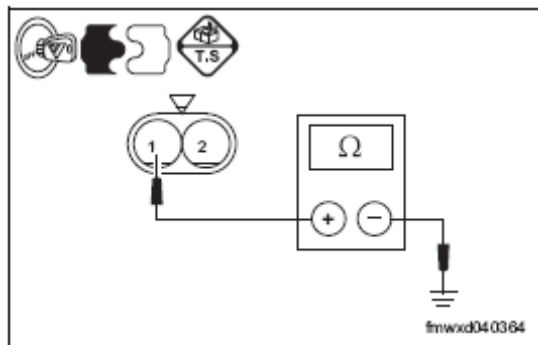
Check whether cab locking warning indicator lamp goes out?

Yes > Replace CAB locking switch

No > Go to Step 2

2. Check cab locking warning indicator lamp signal circuit for short circuit

- Turn ignition switch to OFF.
- Disconnect combination instrument connector B078.



- Use multimeter to measure the resistance of the circuit between Pin 1 of CAB locking switch connector U006 and ground.

Resistance: > 10MΩ

Is the inspection result normal?

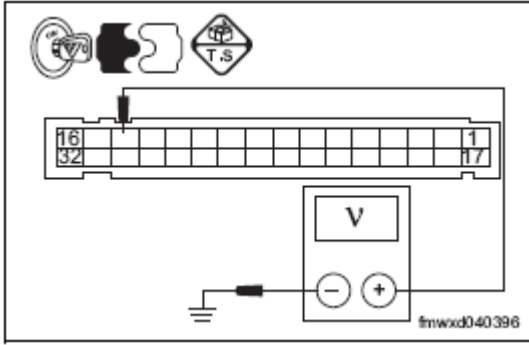
Yes > Replace combination instrument

No > Repair or replace harness

3. Check cab locking warning indicator lamp signal circuit

- Disconnect connector U006 of CAB locking switch and connect combination instrument connector B078.

(b). Turn ignition switch to ON.



(c). Use multimeter to measure the voltage of the circuit between Pin 13 of combination instrument connector B078 and ground.

Standard voltage: battery voltage

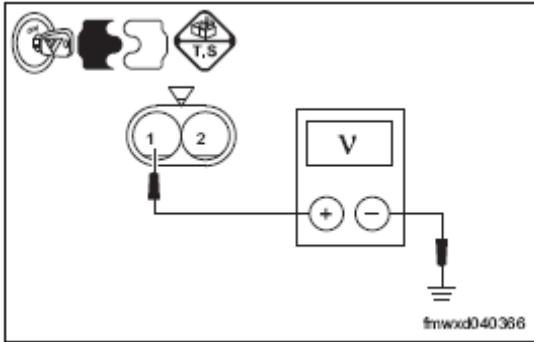
Is the inspection result normal?

Yes > Go to Step 4

No > Replace combination instrument

4. Check cab locking warning indicator lamp signal circuit for open circuit

(a). Turn ignition switch to ON.



(b). Use multimeter to measure the voltage of the circuit between Pin 1 of CAB locking switch connector U006 and ground.

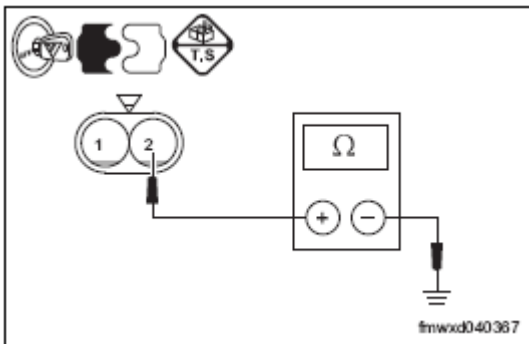
Standard voltage: battery voltage

Is the inspection result normal?

Yes > Go to Step 5

No > Repair or replace harness

5. Check cab locking warning indicator lamp ground circuit



(a). Use multimeter to measure the resistance of the circuit between Pin 2 of CAB locking switch connector U006 and ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace CAB locking switch

No > Repair or replace harness

CIGAR LIGHTER

PRECAUTIONS

1. Shut off main power

- (a). In order to avoid personal injury or vehicle damage, please be sure to disconnect the negative cable of battery before removal/installation of any equipment and under the condition that certain tool or equipment is likely to contact with the bare electrical terminal.

Hint:

Please don't keep the key inside vehicle before disconnecting the negative cable of battery, in order to prevent vehicle door from being locked.

- (b). Unless otherwise specified, the ignition switch must be turned off.

2. Disconnection of negative cable of battery shall make the odometer and clock reset.

Hint:

Odometer won't be reset.

3. Inspect the after-sale retrofitting devices which may affect the operation of cigar lighter.

4. In its application, press down the cigar lighter and wait for 15 seconds for its heating. When the temperature of it reaches usable temperature, the cigar lighter will return to original position automatically.

- (a). When pressing down the cigar lighter, it is necessary to press its handle knob with fingers and do not grip the cigar lighter to avoid burns.
- (b). After 18 seconds, the cigar lighter does not return to the original position. It is indicated that there is fault in it. Press down the handle knob again and make the cigar lighter to return.
- (c). In the case of pressed down cigar lighter, it is not allowed to leave the vehicle temporarily to avoid fires.
- (d). In the case of deformed cigar lighter, it can not return automatically. Carry out replacement with authorized cigar lighter fittings.

BASIC INSPECTION

Step	Inspection Item		Measure
1	Check battery voltage. Battery voltage should not be lower than 22 V. Is the inspection result normal?	Yes	Go to Step 2
		No	Carry out battery charging or replacement. Refer to "Chapter 53 Battery-Battery"
2	Check cigar lighter - Turn ignition switch to ON. - Press down cigar lighter and it will be heated and pop out in about 15 seconds Is the inspection result normal?	Yes	Confirm normal operation of system
		No	Go to Table of Fault Phenomena



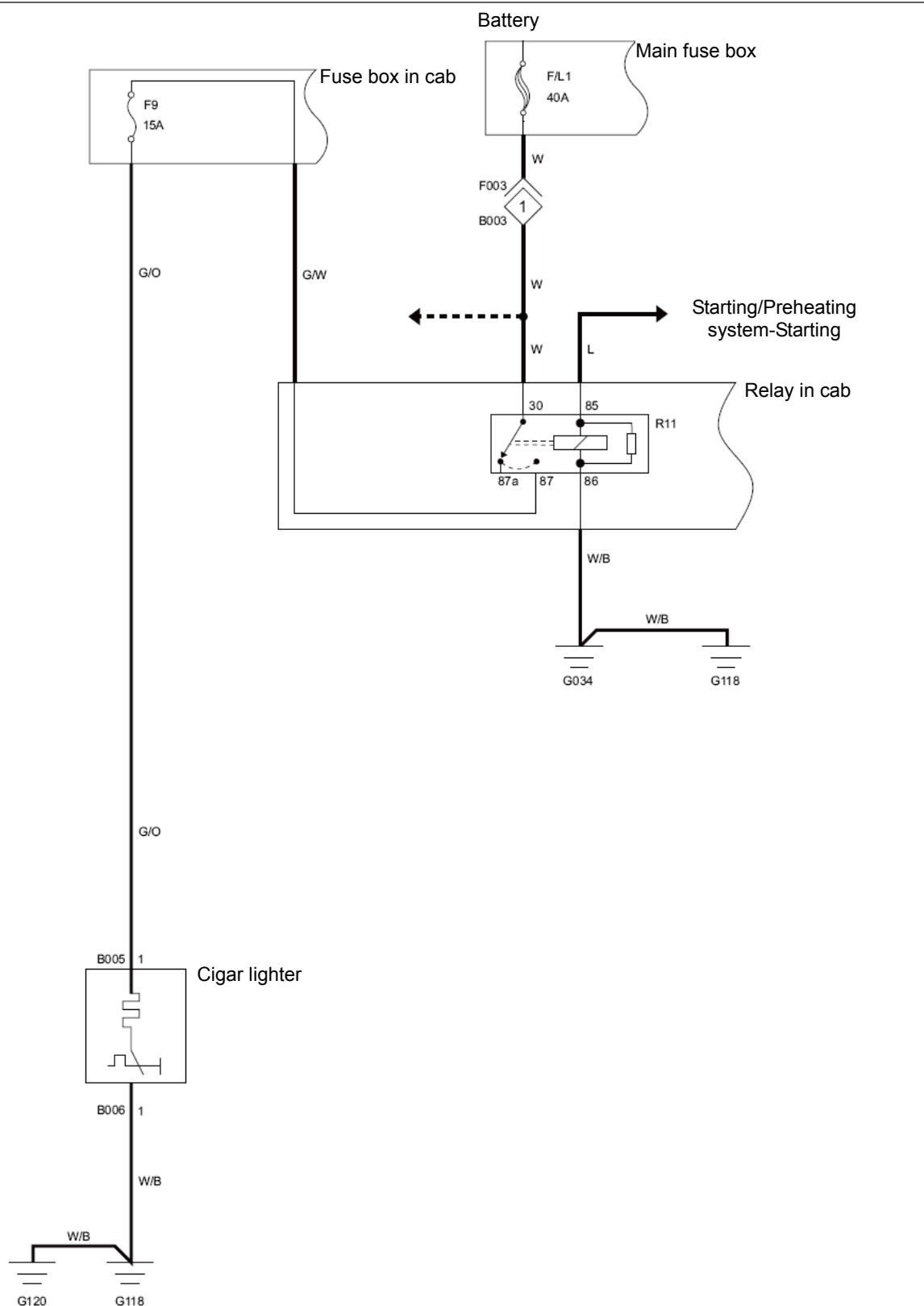
TABLE OF FAULT PHENOMENA

Please refer to the following table for troubleshooting. The serial numbers indicate the order of fault possibility. Please check relevant parts in the order and conduct replacement when necessary.

Fault Phenomena	Possible Cause	Solution
Incapable working of cigar lighter	1. Fuse (damaged)	Replace fuse
	2. Cigar lighter(damaged)	Chapter 04 Diagnosis- Cigar Lighter- Incapable Working of Cigar Lighter
	3. Harness (shorted or shorted to ground)	Replace harness
Incapable of automatic cigar lighter popping up	1. Cigar lighter (deformed)	Chapter 73 Instrument Panel and Cigar Lighter-Replacement of Cigar Lighter
	2. Cigar lighter seat (damaged)	Chapter 73 Instrument Panel and Cigar Lighter-Replacement of Cigar Lighter
Unlighted cigar lighter indicator lamp	1. Fuse and harness	Replace fuse and harness
	2. Lighting combination switch	Chapter 04 Diagnosis- Lightening- Unlighted Cigar Lighter Indicator Lamp
	3. Cigar lighter indicator lamp	Chapter 04 Diagnosis- Lightening- Unlighted Cigar Lighter Indicator Lamp

INCAPABLE WORKING OF CIGAR LIGHTER

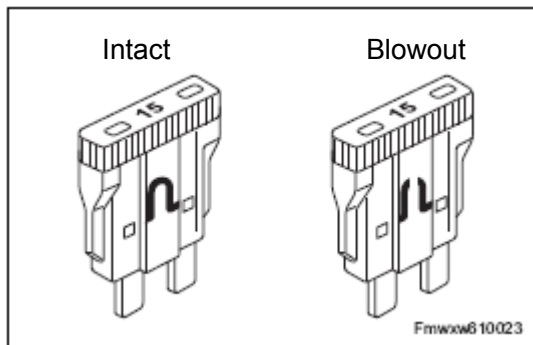
Circuit Diagram



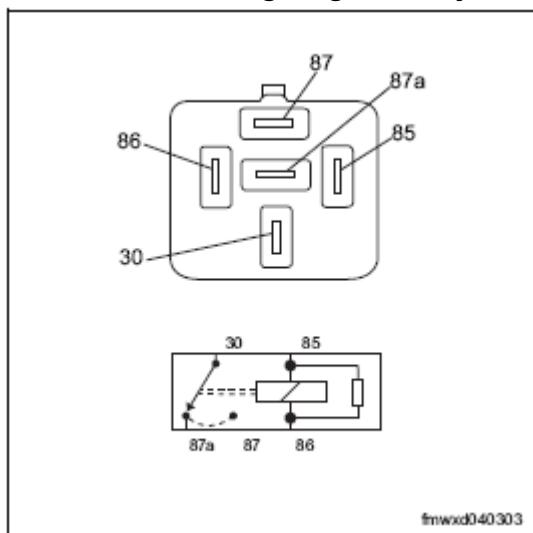
fmwxd040157

Diagnostic procedures**1. Check the fuse F9**

(a). Turn ignition switch to OFF.



(b). Check fuse in cab fuse box: F9(15A)

Is the inspection result normal?**Yes > Go to Step 2****No > Service fuse circuit, replace fuse of the same rating****2. Check the cigar lighter relay R11**

(a). Check relay in cab relay box: R11

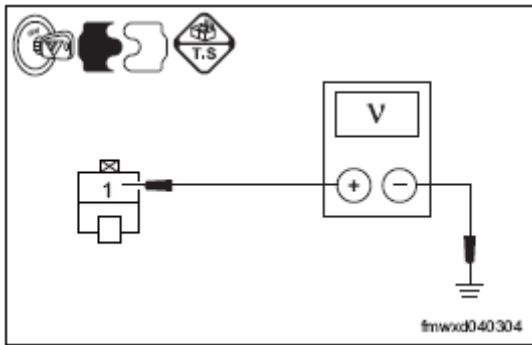
Standard value:

Switch Position	Multimeter Pin	Standard Value
Constant	85-86	Breakover
Power voltage applied between Pin 85 and Pin 86	30-87	Breakover
Constant	30-87a	Breakover

Is the inspection result normal?**Yes > Go to Step 3****No > Replace cigar lighter relay****3. Check cigar lighter power circuit**

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DIAGNOSIS-CIGAR LIGHTER



- (a). Disconnect cigar lighter connector B005 and turn ignition switch to ON.
- (b). Use multimeter to measure the voltage of the circuit between Pin 1 of cigar lighter connector B005 and ground.

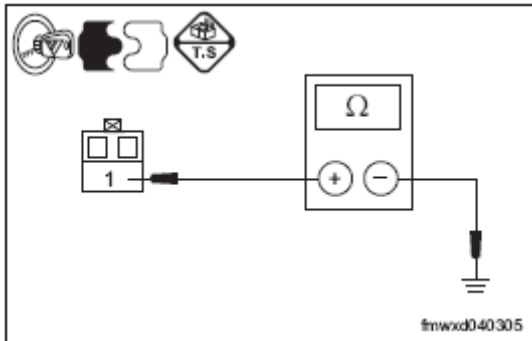
Standard voltage: battery voltage

Is the inspection result normal?

Yes > Go to Step 4

No > Repair or replace harness

4. Check cigar lighter grounded circuit



- (a). Disconnect cigar lighter connector B006 and turn ignition switch to OFF.
- (b). Use multimeter to measure the resistance of the circuit between Pin 1 of cigar lighter connector B006 and ground.

Resistance: $\leq 2 \Omega$

Is the inspection result normal?

Yes > Replace cigar lighter

No > Repair or replace harness

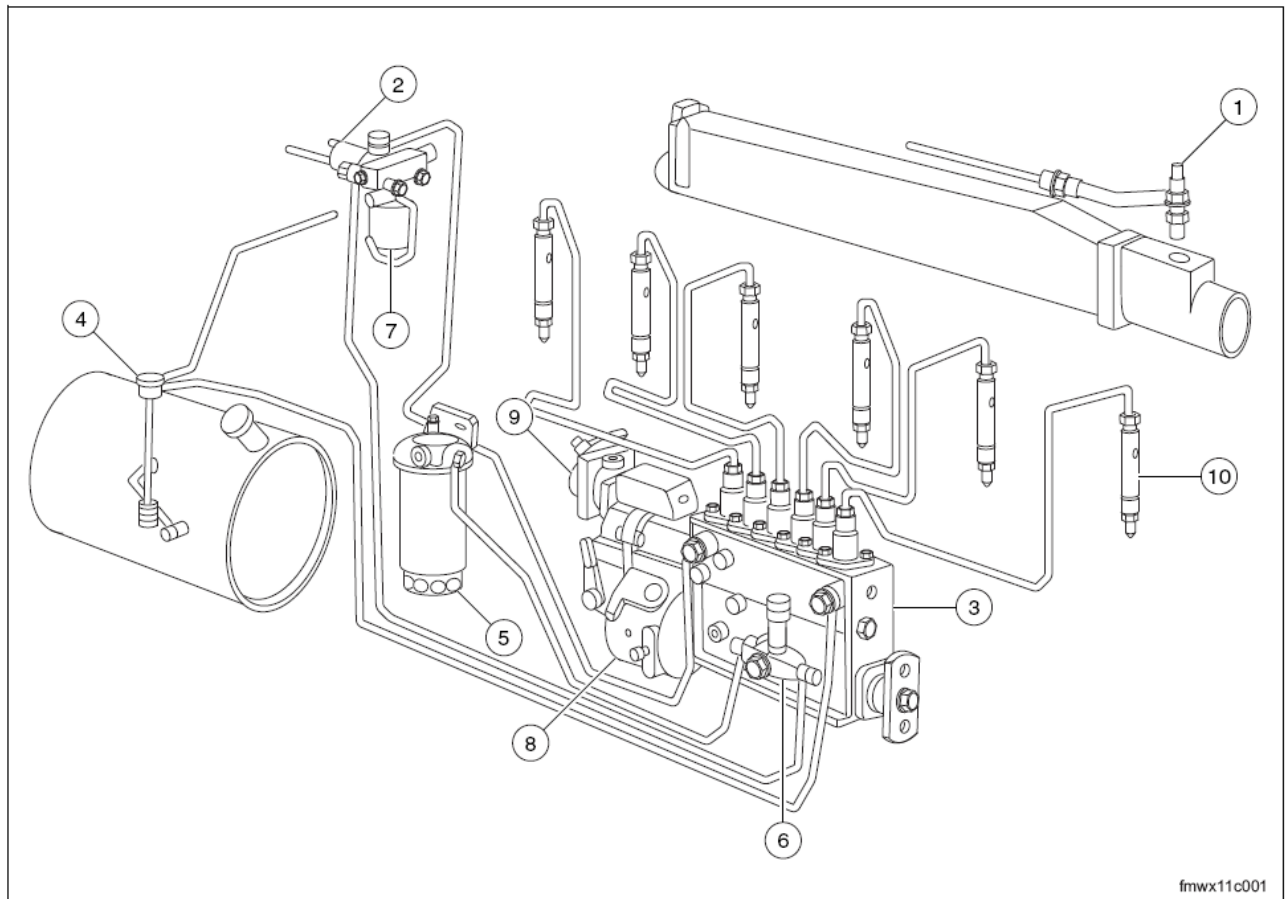
FUEL (WD618)

FUEL SYSTEM.....	11A-3
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FUEL TANK.....	11A-33
Replacement.....	11A-33
Cleaning	11A-36
FUEL-WATER SEPARATOR.....	11A-37
Replacement.....	11A-37
FUEL SECONDARY FILTER.....	11A-39
Replacement.....	11A-39
FUEL INJECTION PUMP	11A-41
Replacement.....	11A-41
FUEL INJECTOR.....	11A-46
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ACCELERATOR PEDAL.....	11A-50
Replacement.....	11A-50

FUEL SYSTEM

OVERVIEW

The WD618 diesel engine employs the typical plunger in-line pump type fuel injection system whose key parts include the RQV-K full-range regulator and the P type reinforced fuel injection pump of the rear-mounted smoke limiter



11A

1	Flame glow plug
2	Preheater solenoid valve
3	P type fuel injector pump
4	Fuel tank
5	Fuel filter

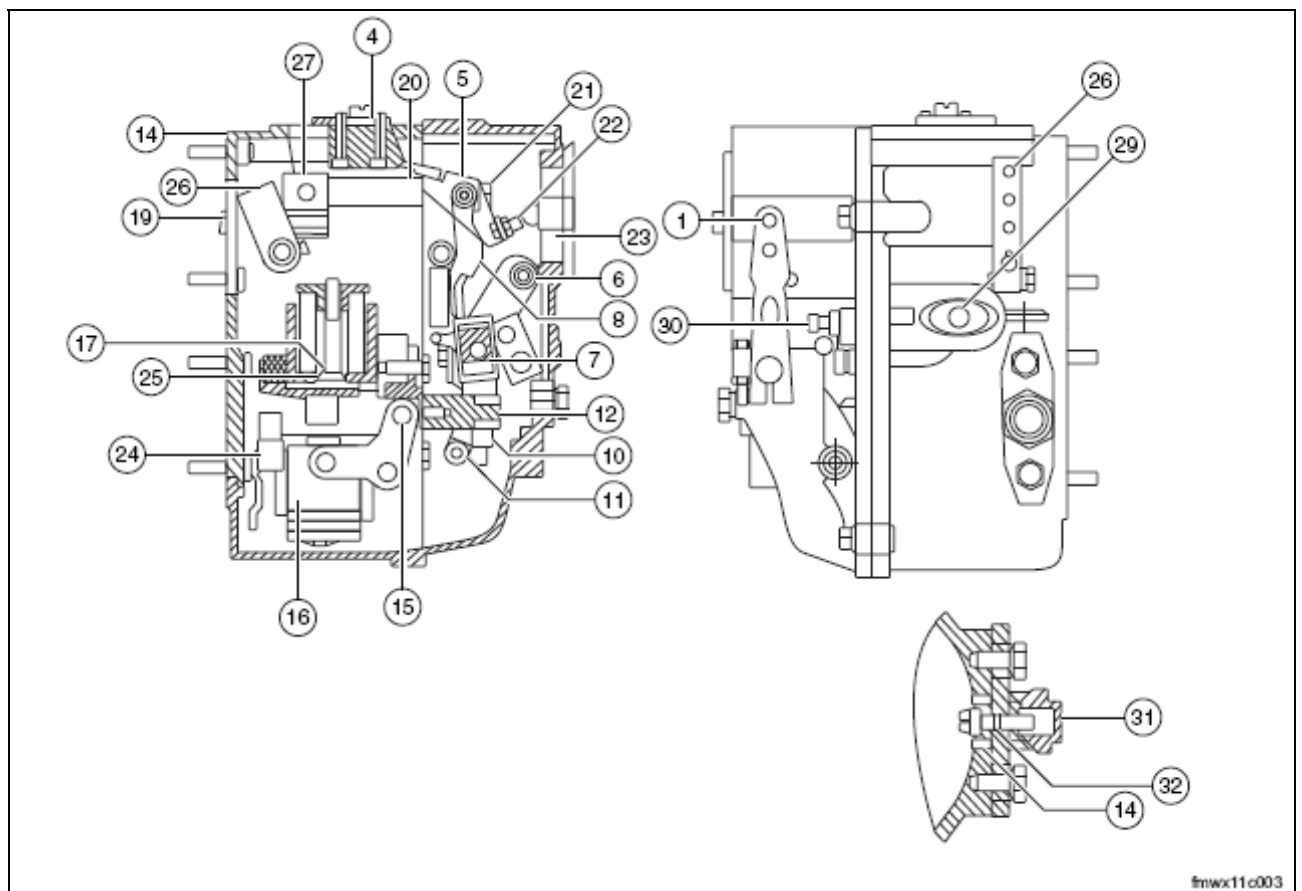
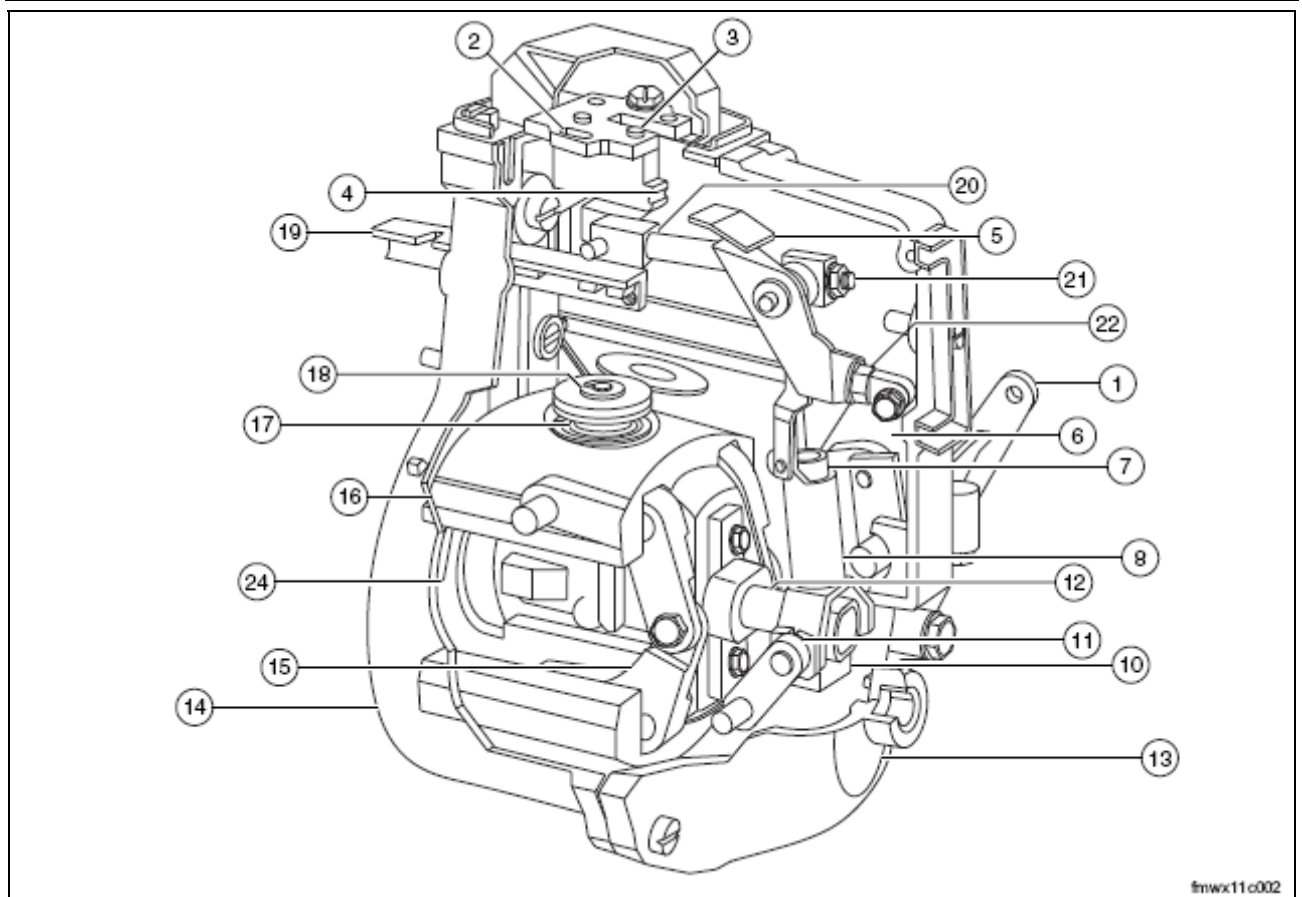
6	Fuel delivery pump
7	Preheater filter
8	Speed governor
9	Rear-mounted smoke limiter
10	Fuel injector

11A-4

FUEL (WD618)-FUEL SYSTEM

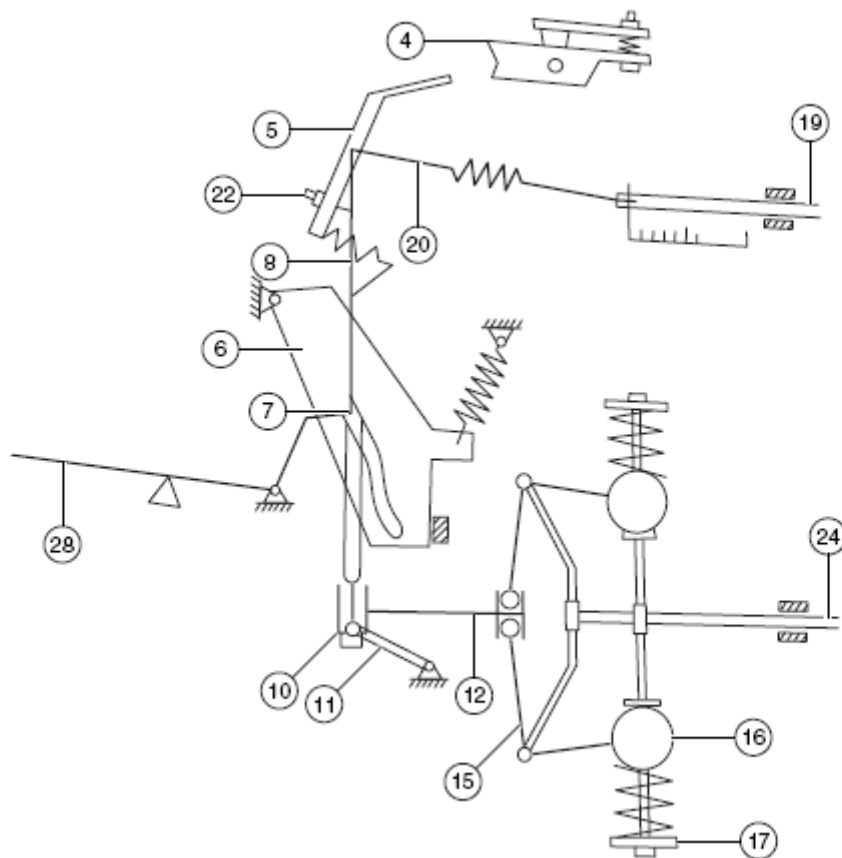
BOSCH P-type pump is typically a kind of reinforced pump, featuring the box type fully-enclosed structure employed in the pump body. The plunger coupler, fuel delivery valve and valve seat are all incorporated in one flange sleeve which is fitted in the pump. The pump has no side window, which thus has increased the pump rigidity. With a compact structure, this pump is suitable for those high injection volume and high fuel pressure applications of the high-power diesel engine. The advantageous control approach of this pump consists in the slotting of control lever, and the mechanism engaged with the rolling ball on the fuel control sleeve can realize the reliable control of fuel volume and sensitive speed regulation. The fuel supply from the pump is regulated by turning the mounting sleeve, while the injection timing is adjusted by adding or deleting shims of the mounting sleeve, easy and reliable. The injection pump cam and tappet mechanism are provided with forced lubrication, in which the engine oil from the engine secondary oil passage enters the injection pump body via the oil pipe and the engine oil used to lubricate and cool the injection pump is returned to the engine oil pan via the return pipe.





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fmwx1 1c004

1	Control lever (accelerator lever)
2	Fixing long hole for rectifying sliding block
3	Position groove of smoke limiter limiting block
4	Rectifying sliding block
5	Tongue-shaped swinging plate
6	Curved guide plate
7	Sliding block
8	Floating lever
9	Movable lever sliding block
10	Swinging rod
11	Movable rod
12	Rear housing of speed governor
13	Front cover of speed governor
14	Angled lever
15	Fly hammer
16	Speed-regulating spring

17	Speed-regulating spring
18	Speed-regulating spring adjusting screw
19	Fuel supply control rack
20	Connecting rod
21	Fuel volume adjusting screw
22	Tongue adjusting screw
23	Sight glass
24	Fuel injector camshaft
25	Adjusting shim
26	Fuel cutoff lever
27	Connecting plate
28	Control lever (accelerator lever)
29	Speed-regulating spring adjusting window
30	Rated speed limiting screw
31	Timing inspection hole cover
32	Timing pin

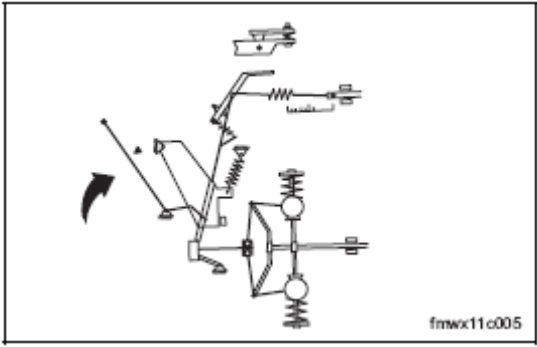
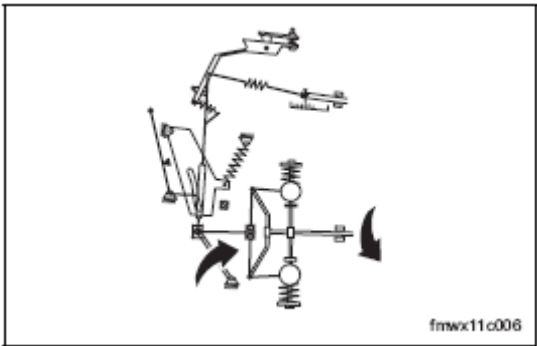


FOTON

The lower end of the speed governor floating lever is supported by the upper end of the swinging rod, and it can move up or down along the longitudinal groove of the movable sliding block. Therefore, the position of lower end of floating lever is determined by the movable rod. When the engine is stationary, the fly hammer will be closed up under the action of speed-regulating spring, and the angled lever will push the movable rod to the leftmost position as shown in the figure; at this moment, the floating lever is located at its lowest position, and the rectifying tongue-shaped swinging plate is also located at the lowest position separated from the sliding block. In such a case, if the engine is started, the control lever of speed governor accelerator lever will be pushed to the high-speed limiting screw position, and the floating lever will push the fuel supply control rack to the maximum supply position, to realize the start thickening purpose.

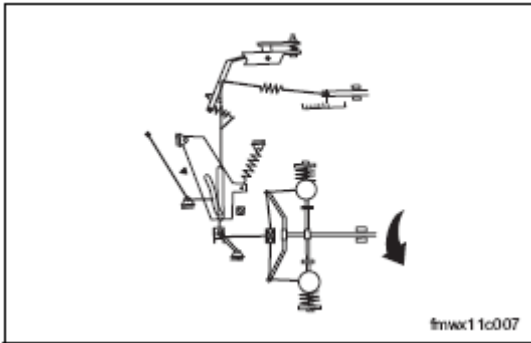
After the engine is started, the fly hammer will immediately offset the idling spring force to be extended. The fly hammer will push the movable rod to the right side as shown in the figure via the angled lever; in such a way, the swinging rod is driven to swing in the clockwise direction to move up the lower end of floating lever. In turn, the floating lever will wholly move up to raise the tongue swinging plate, used to rectify the fuel supply, to be in contact with the rectifying sliding block. Thereafter, the travel of fuel supply control rack will change regularly with the speed as per the shape set by the rectifying sliding block end face, thus to realize the regular change of fuel supply and satisfy demands of engine external characteristics.

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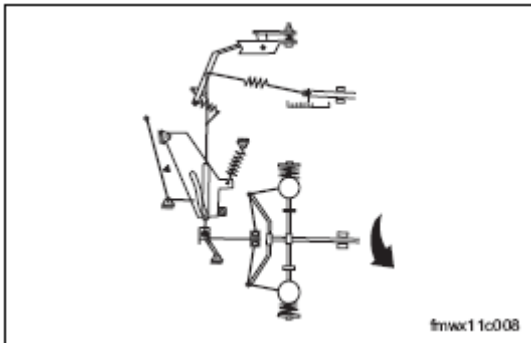
 fmwx11c005	Stop and starting conditions
 fmwx11c006	Post-start conditions

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FUEL (WD618)-FUEL SYSTEM



Intermediate speed conditions



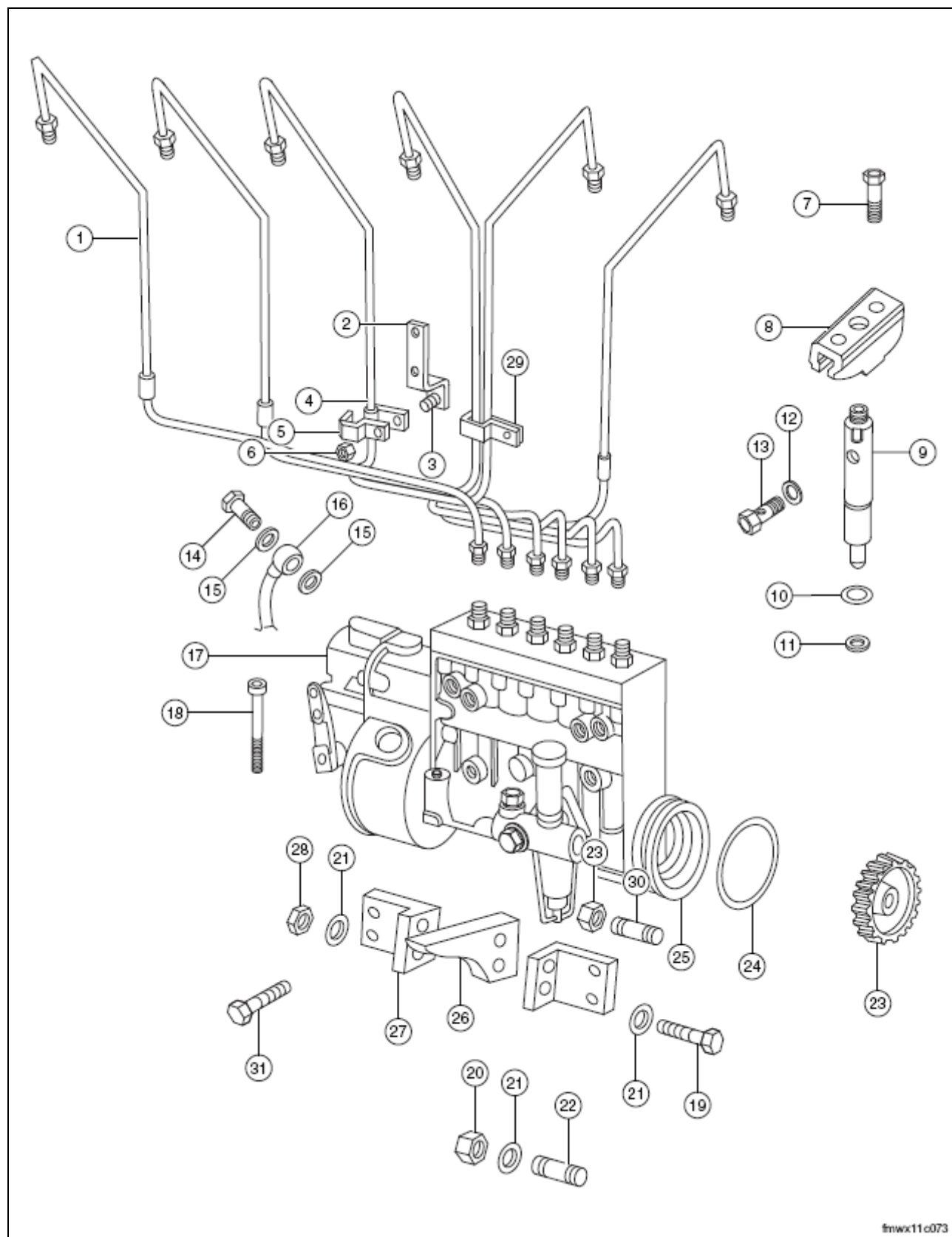
High-speed conditions

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PRECAUTIONS

1. Disconnect the battery negative cable before servicing the fuel supply system.
2. The fuel is flammable. When handling the fuel system, keep the cigarette, flame, indicator lamp, electric arc and switch far away from the working zone, and equip ventilating equipment to avoid injuries or even death.
3. To avoid injuries, never undo any fuel pipe union when the engine is running.
4. Keep the fuel far away from the rubber or leather parts.
5. The diesel oil injection device is manufactured as per the very accurate tolerance and clearance. Therefore, when handling the fuel system, an absolutely clean working environment is very important. All openings must be closed with dedicated caps.
6. Prior to the disconnection of the fuel system pipeline, check whether there is any dirt or foreign matters in the immediate area of the fuel pipe union; if any, clear them up, for the dirt or foreign matters may damage the fuel system or engine.
7. Do not bend or twist the fuel system pipe due to overexertion.
8. Prior to the connection of fuel system pipes, make sure all unions are intact; if any damage or crack is detected, replace the fuel pipe assembly and ensure that there is no oil on the pipe connecting surface.

DIAGRAM OF COMPONENTS



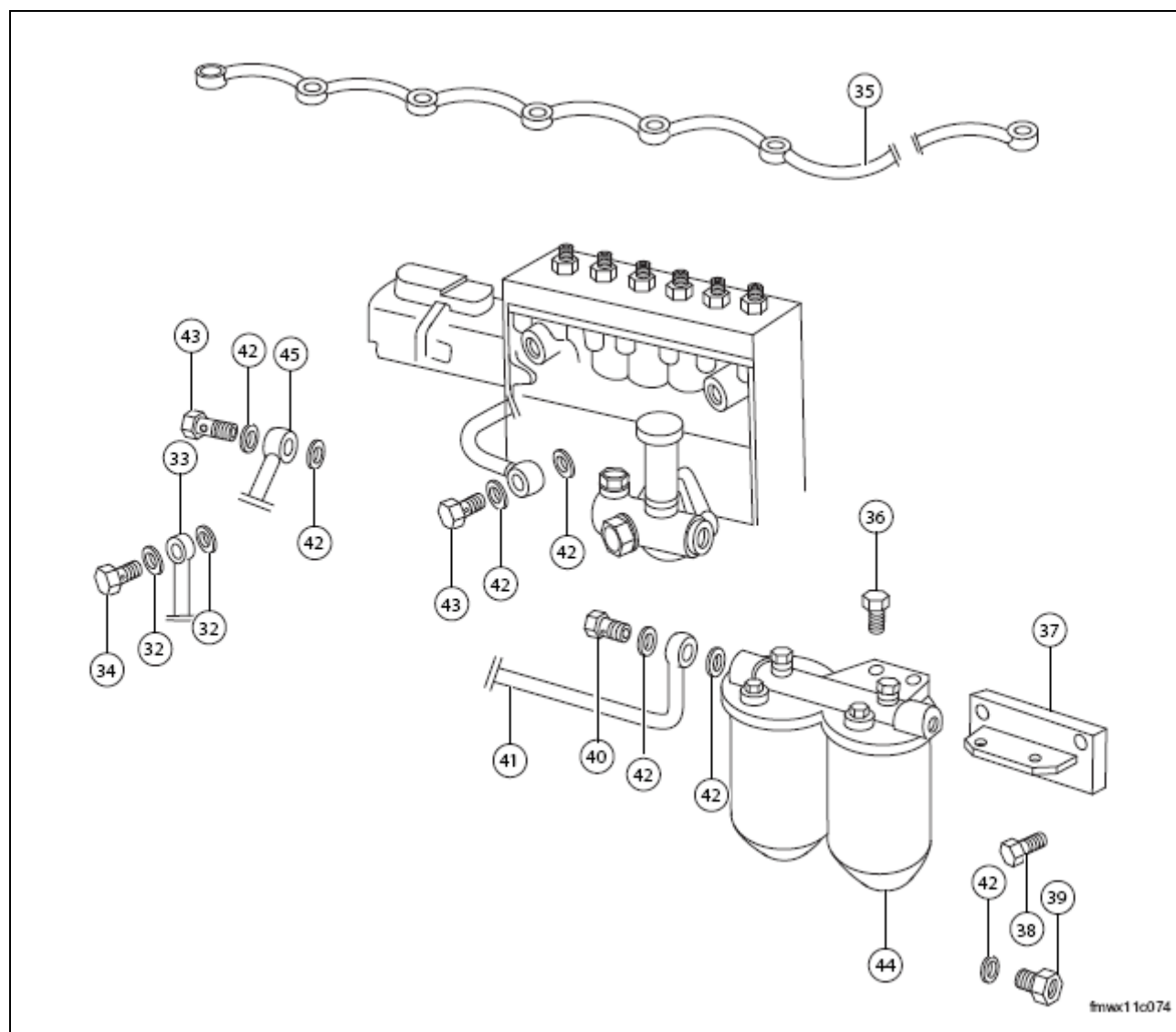
1	High-pressure fuel pipe assembly
2	Bearing bracket

17	P8500 high-pressure fuel pump
18	Hexagon bolt

3	Hexagon bolt
4	Pipe clip lower piece
5	Pipe clip upper piece
6	Type I hexagon nut
7	Hexagon bolt
8	Fastening pressure plate
9	Injector assembly
10	Gasket
11	Washer
12	Composite gasket
13	Hollow bolt
14	Hollow bolt
15	Gasket
16	Fuel pipe

19	Hexagon bolt
20	Type II fully-metallic hexagon lock nut
21	Plain washer
22	Stud
23	Gear
24	Sealing ring
25	Injection pump flange
26	Holder
27	Angle bracket
28	Type I hexagon nut
29	Pipe clip
30	Stud
31	Hexagon bolt





32	Gasket
33	Lubricating oil inlet pipe assembly
34	Hollow bolt
35	Oil return pipe assembly
36	Hexagon bolt
37	Holder assembly
38	Hexagon bolt

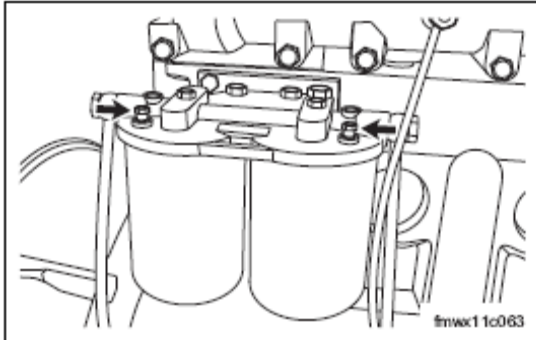
39	Ferrule type pipe union
40	Hollow bolt
41	Fuel pipe
42	Gasket
43	Hollow bolt
44	Fuel filter assembly
45	Fuel pipe

TESTING AND ADJUSTMENT

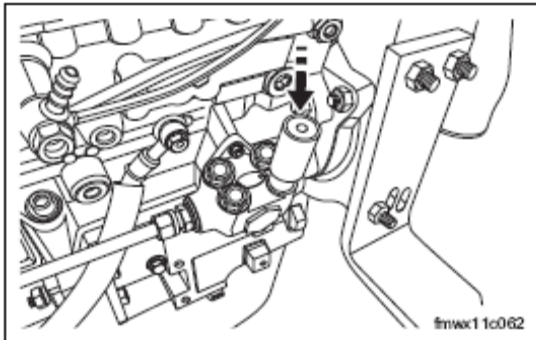
Air release of fuel system

When replacing the spinning primary filter or refitting the fuel delivery pipe or emptying the fuel tank, the air will enter the fuel system, and the fuel flow to the engine will be impeded. To avoid this, the air in the fuel system must be released.

1. Stop the engine.



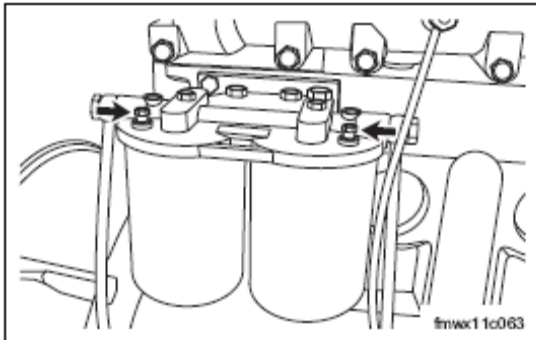
2. Undo the air bleeding bolt.



3. Use the hand fuel pump to pump the fuel.

- (a) Use the hand fuel pump to pump the fuel till only fuel flows from the air bleeding bolt.

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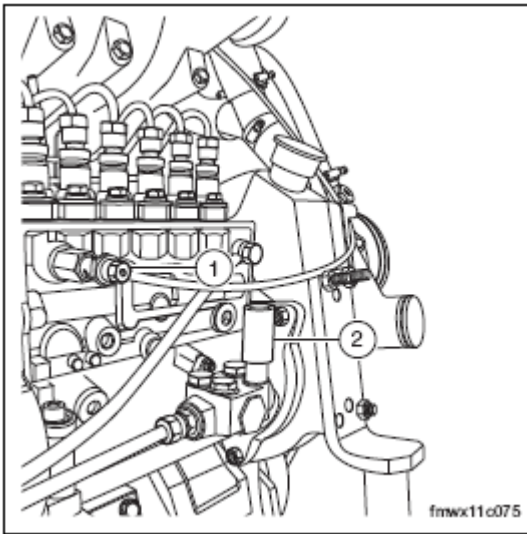
4. Fasten the air bleeding bolt.

Notice: Repeat Steps 2, 3 and 4 till no air bubble appears in the fuel from air bleeding hole; if bubbles remain in the fuel, check the fuel pipeline for air ingress.

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The fuel return pipe on the injection pump can be also used for air release. Where the fuel pipe from the filter to the fuel pump is replaced or removed, the low-pressure pipe on the pump side must be released from air. The return pipe of injection pump is located at the top of the pump, and a little of air bubbles in the fuel can be discharged via the return pipe.



1. Undo the lock screw 1 on the fuel pump return pipe.
2. Use the hand fuel pump 2 to pump fuel till no air bubbles appear in the fuel.
3. Fasten the lock crew 1.

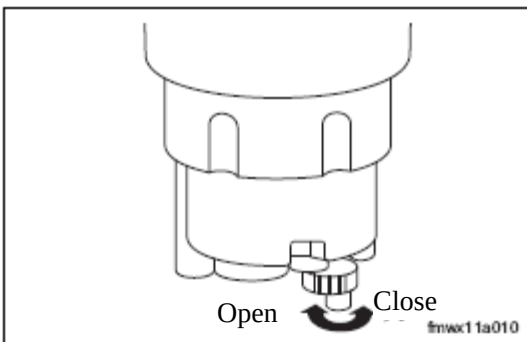
Discharge of water collector

If the water collector is full, the water in it must be discharged.

Warning:

There is a danger of icing. Discharge water before icing.

1. Stop the engine.



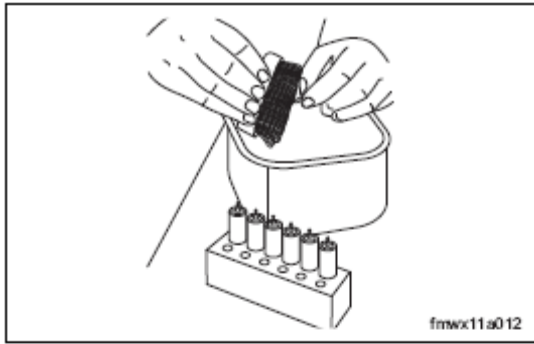
2. Remove the drain screw.
 - (a) Remove the drain screw at the bottom of collector to discharge the water.

3. Refit the drain screw.

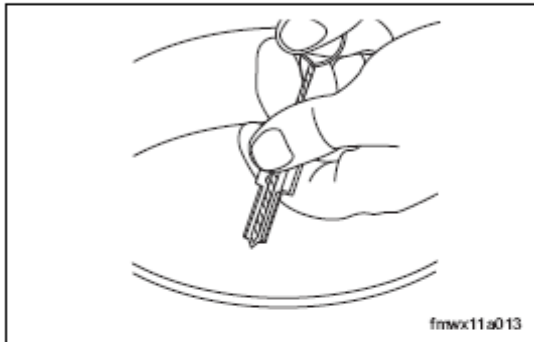
Check and adjustment of fuel injector



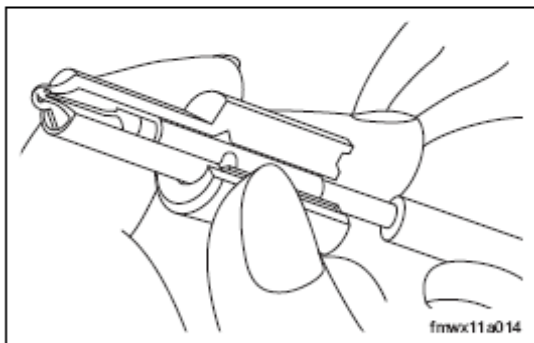
1. Prior to disassembly, the injector must be carefully cleaned to avoid scratching each refined mating surface by the pollutant or foreign matters in the disassembly and reassembly operation.



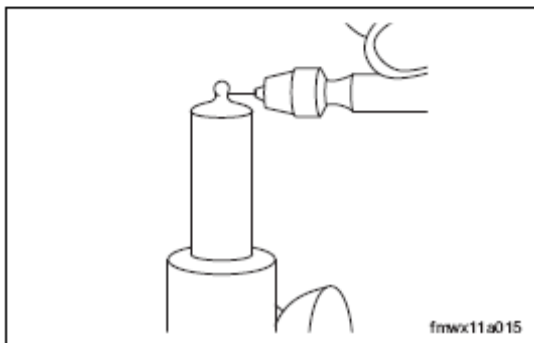
2. Pull the injector needle valve from the injector, clean the valve head in the kerosene with a brush, and then clear up the carbon deposit on the head of needle valve with a wood plate.



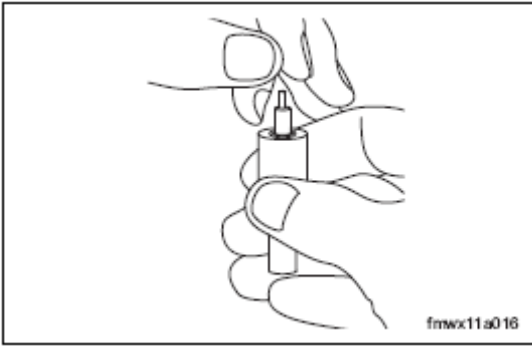
3. Use the dedicated brush to clear up the hole of needle valve on the injector valve seat.



4. Scrape off the carbon deposit on the head of needle valve hole on the injector valve seat with a dedicated scraper. The stem of scraper must be precisely matched with the needle valve hole. In the scraping operation, avoid scratching the valve hole mating surface.



5. Use a clean special cleaning steel needle to clear up the nozzle in the injector.
- (a) The diameter of steel needle is In general 0.02~0.03mm lower than the nozzle diameter. To avoid damaging the nozzle, firstly use a thin steel needle and then a thicker one.
- (b) To clear up the nozzle, insert the needle into the nozzle and rotate it. After the operation, clean the nozzle with kerosene again and use the compressed air to remove dirt in the needle valve hole.



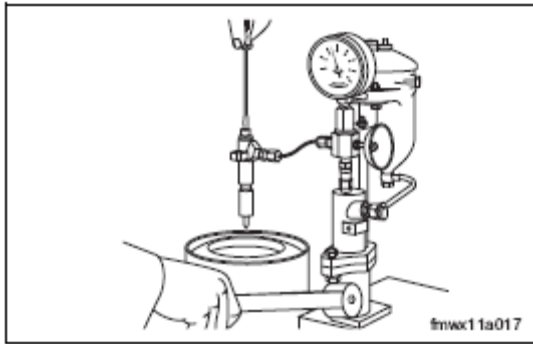
6. Sliding test of injector coupler

- (a) Lubricate the injector in the clean high-duty diesel oil, and repeatedly rotate slide the needle valve. Place the injector upright, pull out the needle valve by 1/3 of its length, and then release it; check whether the valve can be seated stably under its deadweight. If the valve can't be seated stably, apply a little high-level low-viscosity lubricating oil into the holes of needle valve and injector valve, and insert the needle valve into the injector hole for repeated rotation till the requirement on sliding performance is satisfied.
- (b) Check the sealing conditions of the conical surface of the needle valve and injector valve seats; if seriously worn, apply the precision alumina grinding agent (paste) onto the needle valve conical surface for grinding with the injector valve seat. After the grinding operation, clean the valve with kerosene. In the grinding operation, do remember not to apply the grinding agent onto the guide surface of the needle valve stem for precision match with fuel injection.
- (c) Check whether the contact surface between the fuel injector seat and injector is damaged, whether the injector spring is rusted or cracked, whether there is deviated wear in the needle valve and injector needle valve holes, and whether there is serious wear on the contact surface between the needle valve and push rod and that between the spring and push rod; if damaged or seriously worn, a replacement must be provided. Check the wearing degree of the injector positioning pin screw.

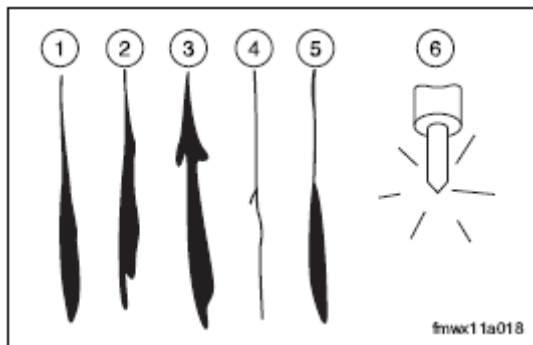
Notices:

When reassembling the injector assembly, the injector nozzle cap must be fastened with the required torque; otherwise the poor atomization of fuel will be caused.

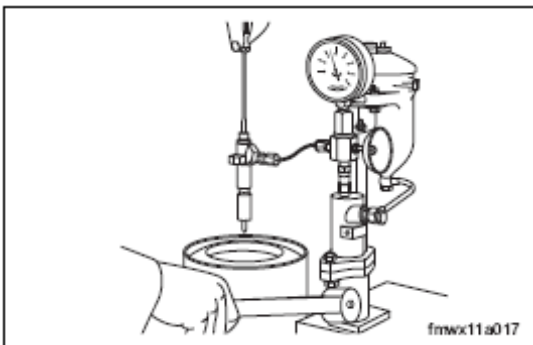
When replacing the new injection nozzle coupler, the coupler must be washed in the clean kerosene and the needle valve must move repeatedly in the injection nozzle needle valve hole to fully release the packaging oil in the nozzle.



7. **Check and adjust the injection pressure**
 - (a) Fit the injector onto the injector testing bench.
 - (b) Press the testing bench handle for several times by hand to eliminate the air in the fuel pipe and injector, and thoroughly flush the injector inside.
 - (c) Press the bench handle with hand, and check whether the pressure at initial injection is 30MPa.
 - (d) Use spring gaskets of different thicknesses to adjust the injection pressure.
 - (e) After the pressure is adjusted, fasten the injector lock nut and then check the opening pressure again; if unqualified, the readjustment is required.



8. **Check of atomization status**
 - (a) On the injector testing bench, press the bench handle at a rate of 40~80 times per minute and at a large travel, to check the state of atomization.
 - The fuel shall be injected in the form of fine spray which shall not contain fuel particle of a large size. The spray beam from each injector hole must be of the same length, and the continuous fuel column or uneven density is not permitted.
 - Fuel beams as indicated in ① through ⑤ are all unqualified.
 - At the starting and ending of injection, there shall be sensible sounds. After the injection, the injector head shall not drop any fuel or have any suspended fuel drop.



9. **Check the sealing performance of injector.**
 - (a) Press the injector testing bench handle by hand to gradually increase the pressure to 28~29MPa (1~2MPa lower than the injector opening pressure). Hold the handle for a period of time (In general 2~3s); if no fuel leaks from the injection nozzle head or there is no obvious pressure drop, the sealing performance is qualified.

RQV-K type speed governor

PQV-K type speed governor is provided with following adjustable parts:

1. Fuel volume adjusting screw

- Between the floating lever upper end and connecting rod, there is a fuel volume adjusting screw. By adjusting this screw, it is possible to change the length of connecting rod. If the connecting rod length is increased, the fuel supply of injection pump will be wholly increased; vice versa. That's to say, the fuel supply under various working conditions can be wholly increased or reduced by regulating this fuel volume adjusting screw.
- For certain RQV-K speed governors, their rectifying sliding block is attached onto the governor housing via long holes; that's to say, loosening the sliding block lock screw may enable the block to move forward or backward by a certain distance relative to the governor housing. As a result, the rectifying tongue swinging plate will press against the sliding block, and the initial position of the floating lever will be changed to alter the initial position of fuel supply control rack, which can also regulate the overall fuel supply. However, such an adjustment must be accompanied with the adjustment of the tongue adjusting screw to make the starting position to be rectified meet original requirements. This adjustment shall be performed by an experienced operator. Overview, it is not allowed to change the overall fuel supply by altering the position of rectifying sliding block. The preset position of sliding block prior to the product delivery should be kept unchanged preferably.

2. Tongue adjusting screw

- The tongue adjusting screw is used to adjust the relative position between the tongue and rectifying sliding block, thus to change the overall fuel supply and in turn, the engine characteristics. Therefore, under Overview conditions, the pre-delivery state must be ensured. It is only necessary to check and adjust this screw when refitting the sliding block.

3. Speed-regulating spring adjusting screw

- The speed-regulating spring adjusting screw is used to adjust the pre-tightening force of the speed-regulating spring. Adjusting this screw can alter the idle speed and rated speed.
- To adapt to charging characteristics of the exhaust turbine supercharger, a smoke limiter is also fitted on the injection pump. With charging characteristics of the supercharger, the charging efficiency of the supercharger will be dramatically increased as the speed rises. However, at the middle speed, the charging is not obvious. Therefore, if the fuel supply determined for the engine maximum torque and rated power conditions is applied, the black smoke will be produced due to the insufficient combustion as resulted from less air intake.

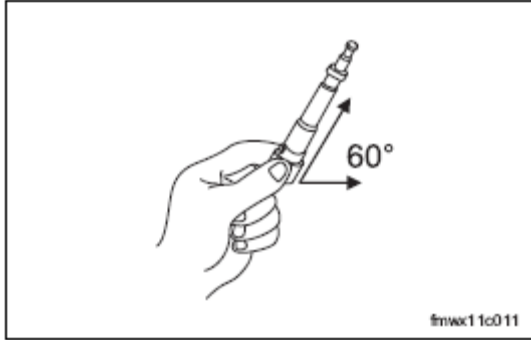
Check and adjustment of fuel injection pump

1. Check of plunger coupler

- (a) The plunger and plunger sleeve are a pair of precision coupler, with a fit clearance of 0.001~0.003mm. After the plunger coupler are worn, the injection starting time will be delayed while the fuel supply ending time will be advanced, accompanied by reduced fuel supply and engine power, difficult start, and unsteady idling to cause potential shutdown. When various slave cylinder plungers are unevenly worn, the fuel supply of each cylinder may be varied; therefore, the wear of plunger coupler has a direct bearing on the power efficiency of the diesel engine.

(b) Check of appearance

- Wash the plunger sleeve in the clean kerosene or light-duty diesel oil, check the mating part between the plunger and plunger sleeve, especially the upper guide portion at the plunger. If the plunger surface is seriously discolored (the worn part may become white), or presents spiral groove, straight groove or rusting in the form of groove edge scaling, crack, deformation or sleeve crack, the plunger couplers must be replaced in pairs.



(c) Plunger sliding test

- Incline the plunger coupler dipped with kerosene by 60°C, and pull out the plunger from its sleeve by 2/3 of this length. Upon releasing the plunger, it shall be able to fully slide into the sleeve by its deadweight. Rotate the plunger to different positions to repeat above tests. If the plunger is locally seized, apply the grinding paste onto the plunger, and insert the plunger into the sleeve for grinding. In the grinding operation, move the plunger up and down whilst rotating it.



(d) Plunger coupler sealing performance test

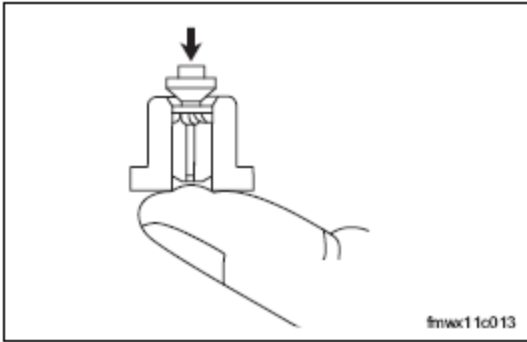
- Use the forefinger to block the upper end of plunger sleeve, and locate the plunger at the position corresponding to medium or maximum fuel supply. Pull down the plunger (do not pull the plunger over the position of inlet hole in the plunger sleeve). If, at this moment, the forefinger can feel the suction force from vacuum, and with the plunger released, the plunger can return to its original position, the plunger is qualified with respect to its sealing performance.

2. Check of fuel delivery valve

The fuel delivery valve is provided with two pairs of sealing contact surfaces, namely, the precision fit and sealing between the pressure reducing ring belt and valve seat hole. If the valve is seriously worn, the ring belt or conical surface seals will be disabled, resulting in post-combustion and fuel drop to worsen the combustion, cause white smoke, impair the engine power or even give rise to cylinder knock. Therefore, the sealing performance of fuel delivery valve must be tested.

(a) Check of appearance

- Wash the fuel delivery valve in clean kerosene or light-duty diesel oil, and observe the valve conical surface with eyes or a magnifying glass. If the pressure-reducing ring belt is seriously worn (there is clear wide or dark white wearing trace on the conical surface) or the belt shows noticeable longitudinal scratches, it shall be replaced. Meanwhile, check the valve and its seat for cracking and rusting.



(b) Sealing performance test

- With the fuel delivery valve fully seated, suction the valve seat bottom opening with mouth. If there is no leakage, lips will be stuck; otherwise the grinding operation is required. When grinding the valve conical surface, carefully apply the grinding paste onto the surface with a thin stick without covering the pressure reducing ring belt. As for the sealing performance test for the pressure reducing ring belt, block the valve seat bottom opening with the middle finger, and press the valve core down; when releasing the core, it will go up automatically, demonstrating that the ring belt is qualified with respect to the sealing performance, or a renewal is required.

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(c) The sealing performance test of the fuel delivery valve can be also performed on the fuel injector tester.

- Fit the fuel delivery valve and its seat onto the dedicated adapter (the seat of such an adapter has a valve seat with its diameter slightly less than that of the fuel delivery valve core, but the ring belt remains at the position of the seal in the valve seat hole). This adapter is connected to the injector tester. Undo the adjusting screw to fully seat the valve core, operate the tester to increase the pressure to 25MPa, and the elapse for the pressure to be reduced to 10MPa shall not be less than 60s. Raise the valve core by 0.3~0.5mm with the adjusting screw, increase the pressure to 25MPa, and the elapse for the pressure to be reduced to 10MPa shall not be less than 2s. During the sealing performance test, pay attention to the sealing performance of the tester itself, and the sealing ring of the tester must be checked prior to the test.

3. Check of other parts of the injection pump

(a) Check of plunger flange and control sleeve

- The gap between the plunger flange and fuel supply control sleeve is In general 0.02~0.08mm; if higher than 0.12mm, the sleeve must be replaced.

(b) Check of tappet assembly

- Check the tappet and roller for wear and rusting. Use the micrometer to measure the radial clearance between tappet roller and roller bush and that between roller bush and roller shaft; if higher than 0.2mm, the tappet assembly must be replaced. Check the gap between the tappet and pump; if higher than 0.2mm, the tappet or pump must be replaced.

(c) Check of camshaft

- Check the cam surface for wear, rust, crack and scaling. Grind with a honing stone or replace the cam depending on actual damages. If the cam is worn by more than 0.2mm, the camshaft is bent by more than 0.15mm or the cam height exceeds the service limit, the camshaft must be replaced.

(d) Check the plunger spring for crack, rust and scaling

- Check whether the free length of the spring conforms to relevant standards, and the maximum deviation of the spring center shall not exceed 1.5mm.

- (e) Check of fuel supply control mechanism
- The moving clearance between the control lever (or rack) and fuel supply control sleeve shall not exceed 0.25~0.30mm; otherwise the replacement is required.
- (f) Check of resistance of fuel supply control lever or (rack)
- The sliding resistance of the fuel supply control lever (or rack) along its full travel as measured on the injection pump testing bench shall not exceed the standard value.

Pump speed (r/min)	Sliding resistance (N)
0	1.3
600	0.5
1000	0.7

Adjustment of fuel injection pump on the testing bench

The purpose of adjusting the fuel injection pump on the testing bench is to satisfy technical standards of the pump, and the pump constitutes the basic component for the normal operation of fuel injection system.

Adjustment of fuel injection pump on testing bench should be carried out under specified conditions and it is preferable to completely simulate diesel engine operation condition during the procedure. However, due to the multiple varieties and models of engines, it is rather difficult to simulate the actual working conditions of each fuel injection system on the testing bench. To standardize the testing and adjustment procedure and provide a consistent basis for test data, all factors which may influence the test results have been identified in the testing and adjustment of fuel injection pumps of various kinds, and they have been testing conditions for the injection pump.

In Overview, testing conditions for adjustment of the injection pump on the testing bench include:

Models of the fuel injection nozzle and fuel injector: Under certain conditions, the type of fuel injection nozzle, and size and number of nozzles, and the opening pressure of injector may have a direct bearing on the fuel supply. In general, if the hole diameter and the number of nozzles are high, the fuel supply will be high. Similarly, if the opening pressure is low, the fuel supply will be also low. To eliminate influences exerted on the testing of injection pump under test by above-mentioned factors, during the test adjustment, the models of nozzles and injectors shall be standardized. To ensure the precise adjustment, the injection pressure must be checked and readjusted after the injector used on the testing bench has been used for the required time, and the nozzle which has been used for times as required shall be renewed.

Injection opening pressure: The opening pressure of fuel injector has a significant bearing on the fuel supply of the injection pump. Therefore, the standard opening pressure in the test must be stipulated. It must be noted that the injection pressure stipulated for the test may not be consistent with the one required in the actual operation.

Fuel supply pressure: The low fuel supply pressure of the injection pump may also exert an important influence on the fuel supply of the pump. In Overview, if the fuel supply pressure is high, the fuel supply will be high. So the fuel supply pressure must be stipulated in the test.

Testing fuel and fuel temperature: The testing fuel and fuel temperature will determine the fuel viscosity which in turn will bring a critical influence on the fuel supply of the pump. In Overview, if the fuel viscosity is high, the fuel supply will be high. So the designation and temperature of testing fuel shall be stipulated in the test.

Specifications of high-pressure fuel pipe: The high-pressure pipe between the injection pump and

injector is provided with a certain length, internal diameter and wall thickness. The high-pressure fuel pipe will cause pipe tubing effects in the pulse type operation, namely, the pipe will be subject to elastic expansion during the fuel supply, and the fuel injection by the injector will be later than the starting time of fuel supply by the pump. Therefore, high-pressure fuel pipes of different specifications may exert different influences on the fuel supply. In the test, the specifications of the high-pressure fuel pipe must be stipulated.

To ensure the precision of tests, the injection pump must be adjusted according to the testing conditions as required. If certain requirements can't be met, the test results must be rectified in the adjustment.

1. Preparations before test adjustment

- (a) Fit the injection pump on the test bench and connect it with the bench drive shaft. As the supercharger diesel engine is equipped with an smoke limiter on the injection pump, the test bench must be provided with a pressure-adjustable air source device to supply a required pressure to the limiter in the commissioning operation. Fill clean lubricating oil into the injection pump.

2. Check the sealing performance and opening pressure of various cylinders

- (a) Increase the pressure-regulating valve to 2~3MPa, and check whether there is fuel leakage in the fuel delivery valve seat of the cylinder; if any, remove the delivery valve and wash it in the clean diesel oil, or replace it.
- Connect the high-pressure fuel pipes of various cylinders of the pump, and open injector overflow valves in turn to check whether the opening pressure of delivery valve is between 1.4 and 1.8MPa; if not, add or delete valve shims for adjustment. For the same pump, the opening pressures of all fuel delivery pumps shall not differ each other by more than 0.2MPa.

3. Check and adjustment of zero position of fuel supply control rack

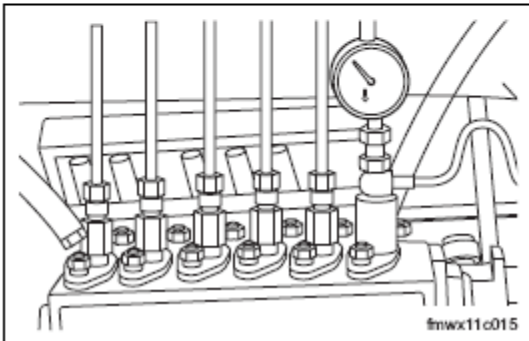
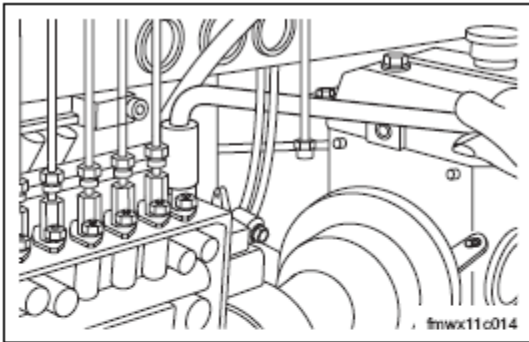
- (a) To keep the test adjustment in compliance with the standard requirements, in the test, a fuel supply control rack travel gauge (or rack travel ruler) is usually fitted at the front end of the pump. Before adjusting the pump, the "zero" position of the fuel supply control rack must be verified.
- The "zero" position of the rack should be preferably obtain when the pump speed corresponds to the value at the maximum torque (about half of the pump speed at the rated power). Locate the throttle control lever of the speed governor at the highest limiting screw, move the fuel cutoff lever to its extreme position, adjust the rack travel gauge to the "zero" position, and then fasten the lock nut.

Notice:

Do not move the cutoff lever to its extreme position in a forcible manner when the pump is stationary, for this may be liable to damage the speed governor.

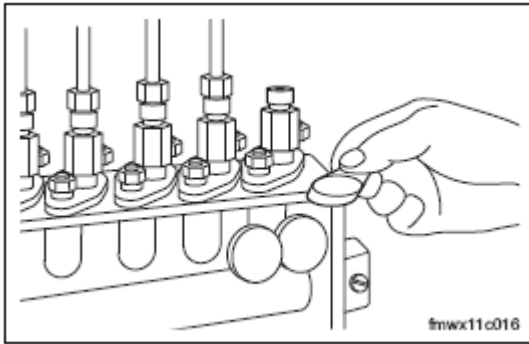
Adjustment of fuel supply timing

1. To ensure the accurate injection velocity (injection law) thus to enable the diesel engine to work under the best conditions, the plunger lift (pre-travel of plunger) at the beginning of fuel supply by various slave cylinders (when the plunger starts to close the fuel inlet) is limited, and to check and adjust the fuel supply timing of the injection pump itself is to check and adjust the pre-travel of the plunger. In another word, if the plunger pre-travel is correctly adjusted, the working area of the cam will be located in the designed routine of the pump, ensuring that the injection velocity is controlled within the design range and that the fuel supply timing of the pump is accurate. As for the injection timing of the whole engine, the above-mentioned adjustment shall be also performed on the engine.
2. The measurement of plunger pre-travel shall be realized with a dedicated measuring device. There are two types of plunger pre-travel measuring devices: one is to directly measure the plunger lift, and the other is to measure the tappet lift.

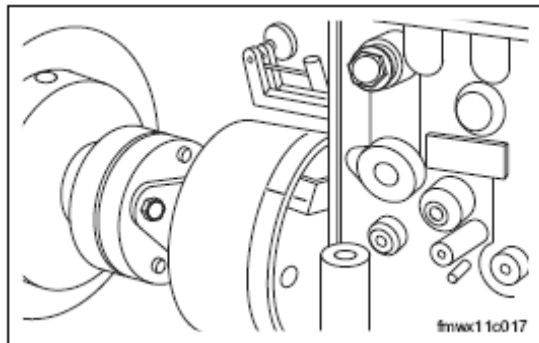


3. **Measure the plunger pre-travel by the overflow method**

- (a) Remove the union of high-pressure fuel pipe of the slave cylinder of the No.1 cylinder, take out the fuel delivery valve component and the gasket, and then fit the measuring device onto the union of the slave cylinder fuel delivery pipe. In fact, this measuring device is composed of the micrometer and overflow pipe on the fuel delivery pipe sleeve.
- (b) After the installation, bring the measuring probe of the micrometer in direct contact with the top end of the plunger. Start the low-pressure fuel supply line on the testing bench, rotate the camshaft to locate the plunger at the lower dead center (the lower dead center of the plunger can be read from the micrometer), move the micrometer pointer to zero position, and operate the injection pump load lever such that the pump is located at its maximum fuel supply position; at this moment, the fuel will slowly flow out of the overflow pipe. Thereafter, slowly rotate the camshaft in the working direction of the pump. If the measured value doesn't conform to the standard requirement, the readjustment must be provided.

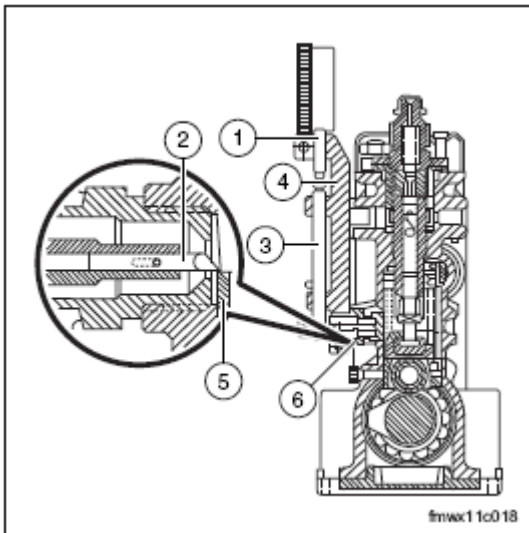


(c) The fuel supply timing is adjusted by adding or deleting timing shims. Remove the slave cylinder components. If the plunger pre-travel measured is lower than the standard value, add shims beneath the slave cylinder flange; if higher than the standard value, delete shims. When refitting the slave cylinder, note that its O-shaped sealing rings must be kept intact. After the fuel supply timing adjustment of the first cylinder slave cylinder is finished, locate the pump at the beginning position of the first cylinder slave cylinder for fuel supply (namely, locate the plunger at the pre-travel position), and check whether the injection pump timing marks are aligned.



(d) If the timing mark is disturbed, reprint the timing marks on the housings of timer and injection pump, used for timing purposes in the fuel injection check and adjustment.

Check and adjustment of spacing angle of fuel supply of various cylinders.



1	Micrometer
2	Testing needle
3	Guide rod

4	Testing frame
5	Tappet
6	Testing body

1. Check and adjust the beginning point of fuel supply of various slave cylinders as per the sequence of 1-5-3-6-2-4 by using the same method, to make their beginning points spaced by a cam rotating angle of $60^{\circ} \pm 0.5^{\circ}$; at this moment, the fuel supply timing of the injection pump is finished.

2. The pre-travel of the plunger can be also measured with the tappet lift measuring device. Fit the measuring device at the dedicated measuring hole on the injection pump (this hole is in general located at the position of No.1 cylinder tappet) in such a way that the measuring probe is on the tappet upper edge. Remove the fuel delivery valve component of the No.1 cylinder slave cylinder, start the test bench to supply fuel for the pump (or obtain a fuel supply pressure of $2.5\text{MPa} \pm 0.2\text{MPa}$ without removing the delivery valve), and locate the pump at its maximum supply position; at this moment, the fuel will flow from the slave cylinder. Rotate the camshaft to locate the plunger tappet at the lower dead center, zero the micrometer, and slowly turn the camshaft in the normal turning direction of the pump; when the slave cylinder stops supplying oil (namely, the plunger starts to close the fuel inlet), check whether the plunger lift indicated on the micrometer conforms to the standard pre-travel value. If unqualified, adjust it by adding or deleting timing shims. After the No.1 cylinder plunger pre-travel is adjusted, adjust the fuel supply timing of other slave cylinders as per the sequence of 1-5-3-6-2-4 in the same way above, and the beginning points of fuel supply of different slave cylinders shall be spaced by a cam shaft rotating angle of $60^\circ \pm 0.5^\circ$.

Check and adjustment of the travel of fuel supply control rack at the control point, maximum torque point and calibrated point

The control point refers to the point at which the engine speed increases such that the smoke limiter is disabled; namely, the speed governor tongue swinging plate has been separated from the smoke limiter limiting block and starts to contact the styling face of the rectifying sliding block. The maximum torque point refers to the position at which the engine obtains its highest torque. The change of the rack travel from the control point to the maximum torque point and then to the calibrated point is a reflection of the process of the tongue swinging plate crossing the styling face of the rectifying sliding block as the speed increases. The change of rack travel in such a process (change of fuel supply) is the simulated changes of engine characteristics. Therefore, this adjustment is essential to the engine performance.

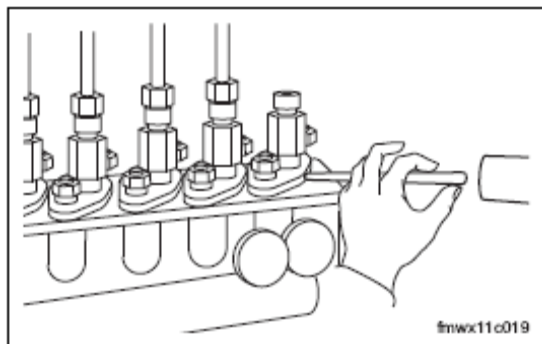
This adjustment is fulfilled by adjusting the fuel supply adjusting screw and tongue adjusting screw, with the purpose that the tongue swinging plate works within the standard routine locked by the rectifying sliding block within the corresponding speed range thus to obtain a better engine performance in actual operation.

1. Start the check and adjustment work from the calibrated point. Activate the testing bench, supply 120kPa air pressure to the smoke limiter (to deactivate it), and push the speed governor accelerator lever to the position limited by the high speed limiting screw. Set the pump speed at 1100rpm for the calibrated point, 750rpm for the maximum torque point and 600rpm for the control point respectively, and check whether the rack travel is within the standard range of $12.0 \sim 12.2\text{mm}$, $11.8 \sim 12.0\text{mm}$ and $11.3 \sim 11.5\text{mm}$ respectively.
2. The adjustment is realized by regulating the fuel supply adjusting screw and tongue swinging plate adjusting screw. The fuel supply adjusting screw is used to adjust the total travel of fuel supply control rack, i.e., the overall fuel supply, while the tongue swinging plate adjusting screw is used to adjust the relative positions of tongue swinging plate and rectifying sliding block. Therefore, the law of changes of the fuel supply control rack (or fuel supply) can be altered.

3. This adjustment is fulfilled via the fuel supply adjusting screw and tongue swinging plate adjusting screw. With the rack travels at the calibrated point, maximum torque point and control point within their standard ranges, it is obvious that such an adjustment aims to ensure that the engine characteristics meet design requirements to maximize the engine performance under qualified emission conditions. Check and adjustment of fuel supply at the calibrated point, maximum torque point and control point

Once the fuel supply of the rack at a certain travel is determined, the fuel supply at other travels are thus determined by the working route and precision of the plunger. For the adjustment, the fuel supply at the maximum torque point or the calibrated point at the rated power is used as the reference supply. The standard fuel supply under other working conditions is only used for inspection purposes in the pump adjustment.

1. Push the speed governor accelerator lever to the position as restricted by the high speed limiting screw. Activate the testing bench, supply 120kPa pressure to the smoke limiter, increase the pump speed to 750rpm, and check whether the fuel supply after 200 injection cycles reaches 37.2-38.4ml; if beyond this range, make adjustment and control the difference between fuel supplies of different cylinders within 2.5ml.



2. The fuel supply is adjusted by rotating the slave cylinder plunger.

- (a) Rotate the slave cylinder plunger sleeve by 10° relative to the pump body, which corresponds to a movement of 2.5mm of the fuel supply control rack. To adjust the fuel supply of slave cylinder, undo the set bolt of the slave cylinder flange, and knock it lightly with screwdriver or other tool to turn it. In the adjustment, pay attention to the direction in which the fuel supply is increased or deleted.

Due to the manufacturing error of the plunger, under reference conditions, the fuel supply of injection pump may be qualified and cylinders differ each other with respect to the fuel supply within the permitted range; however, under other conditions, the difference and uniformity of fuel supply of different cylinder may be significant. After the adjustment of fuel supply under reference conditions, it is also necessary to check the fuel supply and difference of fuel supply of slave cylinders under other working conditions. If the fuel supply of a certain slave cylinder and its difference from other cylinders meet requirements under reference conditions but there is a significant supply or difference of supplies from other cylinders under another certain condition, the slave cylinder plunger coupler concerned shall be replaced, in order to ensure that the fuel supply and difference among cylinders are qualified thus to realize the stable operation of the diesel engine under all conditions.

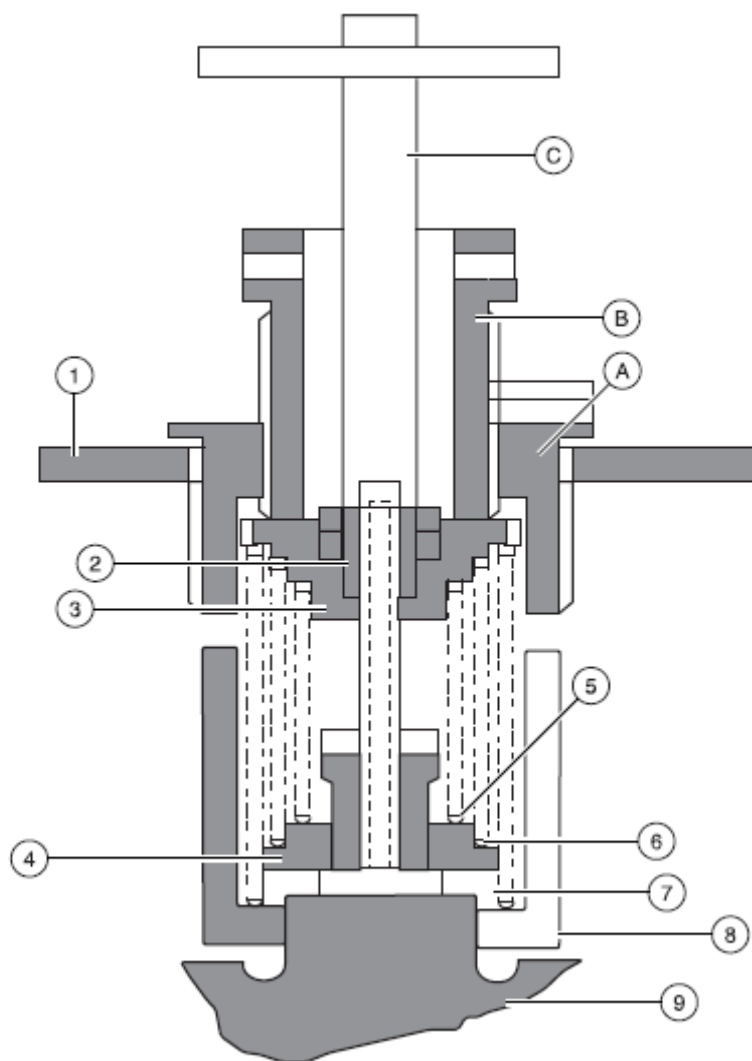
The fuel supply is in direct proportion with the rack travel; namely, if the rack travel is high, the fuel supply will be high. Due to the speed characteristic of the constant-pressure fuel delivery valve (i.e., the supply of fuel delivery valve changes with the speed at the same rack travel), when the fuel supply of the injection pump is increased with the rack travel, the fuel supply may not be increased. Therefore, interchanging fuel delivery valves may sometimes help to adjust the fuel supply and the uniformity of fuel supply of different cylinder.

Check of starting fuel supply

1. After the check and adjustment of fuel supply under normal conditions are finished, adjust the pump speed to 100rpm, move the speed governor control lever to the position of high speed limiting screw at full load (the throttle pushrod is located its maximum supply position), and check whether the starting fuel supply is higher than 16ml/100 cycles.
2. After all adjustments are fulfilled, check the fuel supply again under the reference conditions.
3. If the vehicle operates in the plateau area, rectify the fuel supply according to the altitude.



Adjustment of high-speed starting feature of speed governor and of fuel cutoff speed



1	Speed governor housing
2	Adjusting nut
3	Upper seat
4	Lower seat
5	Rectifying spring
6	High-speed spring

7	Idle speed spring
8	Fly hammer
9	Fly hammer body
A	-
B	Pressure sleeve
C	Sleeve wrench

1. Increase the pump speed to 1100rpm, and push the speed governor throttle control lever to the extreme position as restricted by the high speed screw.
2. Increase the pump speed to 1120~1140rpm. Confirm that the rack is stationary and continue to increase the speed; at this moment, the rack shall start to move in the direction of reducing oil supply. When the speed is increased to 1350rpm, the rack shall return to the fuel cutoff position at the travel of 0-1.0mm.
3. Use the dedicated tool to press the outer seat of adjusting spring, and adjust the speed adjusting nut with the sleeve wrench.
 - (a) If the starting speed is lower than the standard value, adjust the nut in the screw-in direction; otherwise adjust it in the screw-out direction.

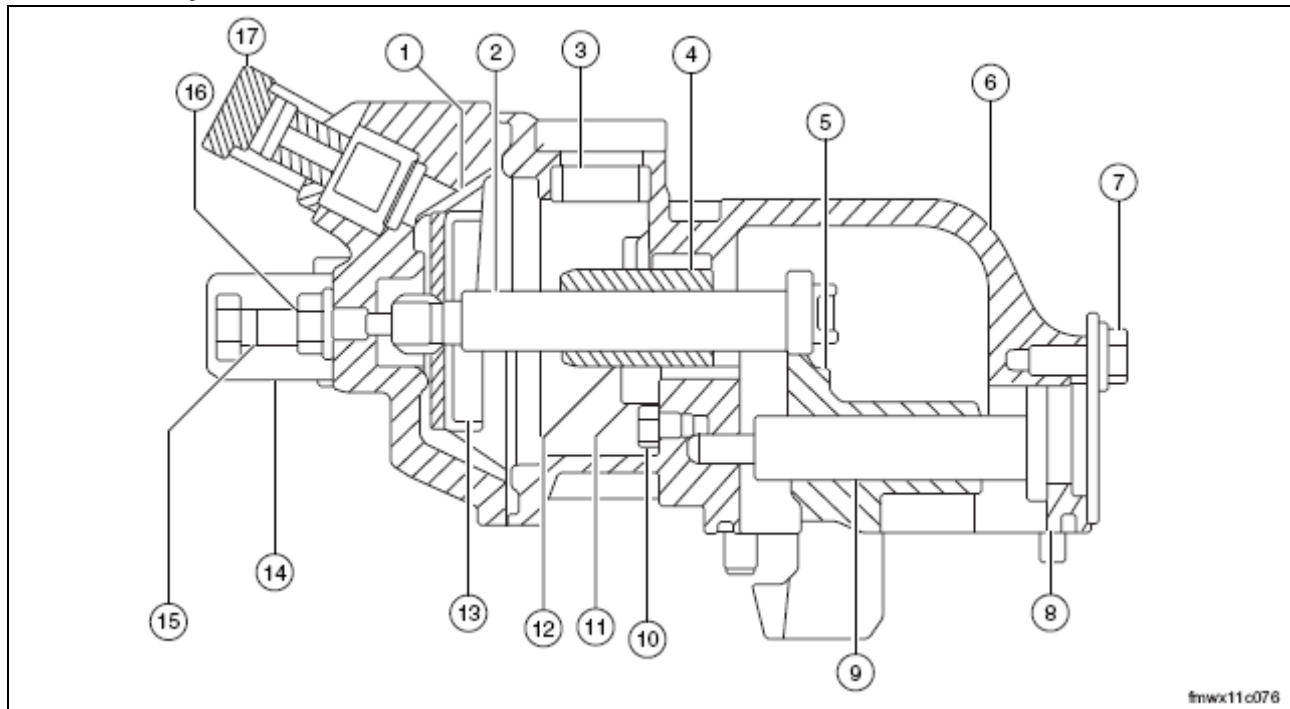
Notice:

In the adjustment, the adjusting nuts of both fly hammers shall be consistent, namely, the adjusting nuts of both fly hammer springs shall be screwed out or in by the same number of turns; otherwise the governor may be worn in a worse way due to the internal stress generated between fly hammer.

- (b) If the high-speed start works and the speed meets the requirement, but the adjustment rate is unqualified (when the pump speed reaches 1350rpm, the rack travel shall be higher than 1.0mm), the high-speed spring of the governor must be replaced.

Adjustment of idle speed control

1. Move the load control lever in the idle speed direction. When the pump speed reaches 300rpm, obtain the rack travel of 5.8~6.0mm, and fix the load control lever at this position.
2. Increase the pump speed. Make sure that the rack travel is less than 2.0mm when the pump speed reaches 405~445rpm. After the pump fully stops working, confirm that the rack travel is higher than 7.5mm. Where the test data is not in compliance with the standard values, make adjustment by adding or deleting idle speed spring shims or replacing the idle spring.
3. After the idle speed adjustment is ended, adjust the idle speed limiting screw in such a way that it is brought into contact with limiting block of the load control lever at this moment.

Check and adjustment of smoke limiter

fmwx11c076

1	Diaphragm
2	Push rod
3	Adjusting hole screw plug
4	Adjusting tooth
5	Limiting block
6	Smoke limiter body
7	Lock screw
8	Sealing ring
9	Supporting rod

10	Lock screw
11	Lock plate
12	Adjusting sleeve
13	Spring
14	Housing
15	Limiting adjusting screw
16	Lock nut
17	Air inlet union

1. Check the rack travel and fuel supply of the zero-boosting torque point.

- (a) Start the testing bench, but do not supply compressed air to the smoke limiter. Set the pump speed at 500rpm.
- (b) Adjust the zero boosting torque point of the smoke limiter, and control the rack travel within 9.4~9.6mm.
- (c) Check the fuel supply after 200 injection cycles, which shall be 29.6~31.0ml.

2. Check the starting air pressure and ending pressure.

- (a) At the pump speed of 750rpm, the starting pressure of the smoke limiter shall be 70~65kPa, and the ending pressure shall be 25~15kPa.
- (b) Start the testing bench, set the pump speed at 750rpm, and supply 100kPa air pressure to the smoke limiter. Then gradually reduce the pressure, and check whether the pressure is within 70~65kPa when the rack starts to move in the direction in which the fuel supply is reduced.
- (c) If unqualified, remove the inspection hole screw plug of the smoke limiter, use the screwdriver to operate the grooved tooth on the adjusting sleeve, and screw in the adjusting sleeve to reduce the starting pressure or screw out the sleeve to increase starting pressure.



- (d) Continue to reduce the pressure, and check whether the ending pressure of the rack is within 25-15kPa; if not, replace the smoke limiter spring.

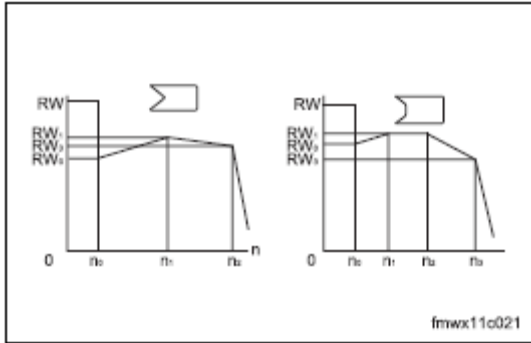
Check of low-speed torque control

The purpose is to check whether the smoke limiter can work normally.

1. **Start the testing bench, supply 30kPa pressure to the smoke limiter, and push the speed governor accelerator lever to the position as restricted by the high speed limiting screw at full load.**
2. **With the pump speed at 500rpm, check whether the rack travel is within 10.2~10.4mm, and check whether the fuel supply after 200 injection cycles reaches 31.0~32.4ml.**



Check and adjustment of smoke limiter (without parameters)



1. Supply 120~150kPa pressure to the smoke limiter, and push the speed governor accelerator lever to the position as restricted by the high speed limiting screw at full load
2. Start the testing bench, and increase the pump speed from 100rpm. Each 100rpm higher, record the travel of fuel supply control rack.
3. Reduce the input pressure of smoke limiter to 0, and push the speed governor accelerator lever to the position as restricted by the idle speed limiting screw.
4. Start the testing bench, and increase the pump speed from 100rpm. Each 100rpm higher, record the travel of fuel supply control rack.
5. Mark the pump speed and corresponding travel of fuel supply control rack under full load and idle speed conditions on the coordinate graph. The abscissa is the pump speed and the ordinate is the rack travel. Connect the full-load speed regulation characteristic curve and the idle speed regulation characteristic curve. Take the inflexion of the curve as the calibrating point for pump rectification.

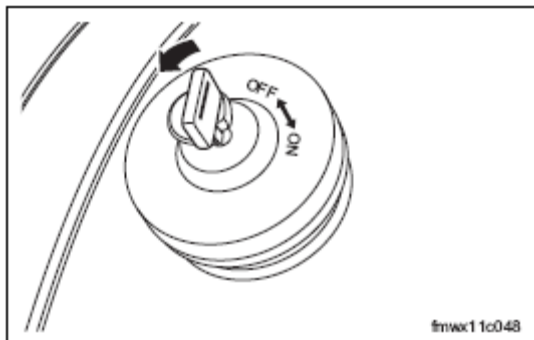
FUEL TANK

REPLACEMENT

Prompt:

As for the Diagram of Components, refer to Chapter 11A: Diagram of Components, Fuel-Fuel Tank.

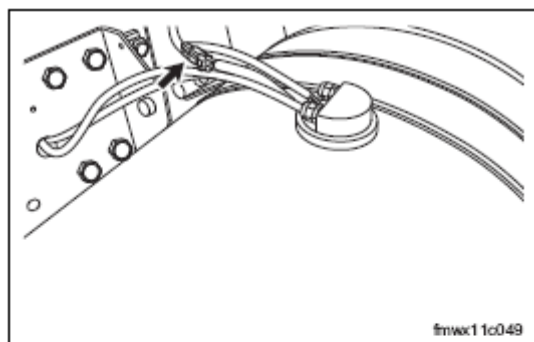
1. **Disconnect the negative cable of battery.**
2. **Remove the cargo box guardrail assembly. Refer to Chapter 77: Replacement, Internal/External Trimmings-Cargo Box Guardrail.**
3. **Release the fuel pressure.**



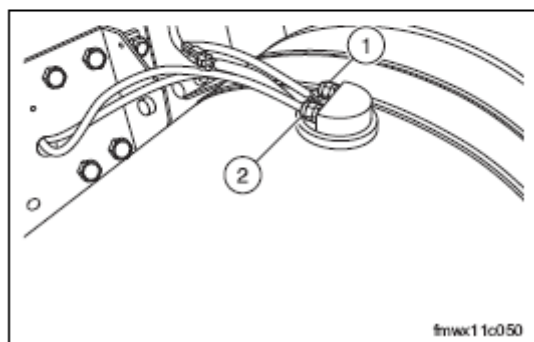
- (a) Insert the key, and unlock the fuel tank.
- (b) Undo the fuel tank lock assembly.

Notice:

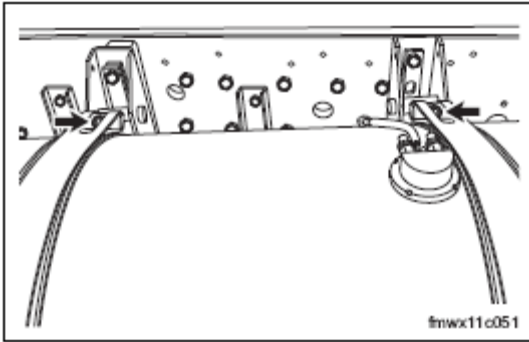
Do plug the fuel filler with a piece of clean and soft cloth.



4. **Disconnect the fuel sensor connector.**
- (a) Disconnect the fuel sensor connector.



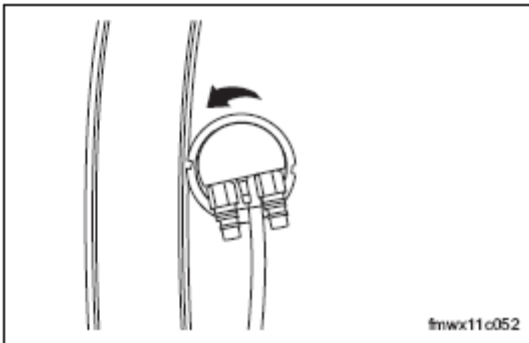
5. **Disconnect the fuel tank delivery pipe and return pipe.**
- (a) Disconnect the fuel tank delivery pipe union nut 1.
- (b) Disconnect the fuel tank delivery pipe union nut 2.



6. **Remove the fuel tank assembly.**
 - (a) Remove the set bolt for the binding strip.
 - (b) Remove the fuel tank binding strip.
 - (c) Remove the fuel tank assembly.

Notice:

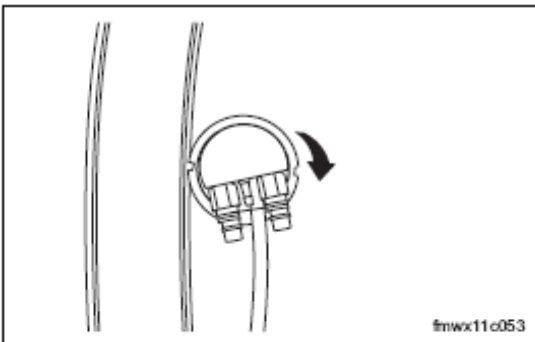
- Prior to the operation, check whether there are pipelines, wires or other foreign matters in the immediate area of the fuel tank, and if any, clear them up.
- Due to the massive volume of the tank, at handling the tank, proper tools or assistance from others is necessary.
- The fuel tank is made of aluminum alloy, so impacts shall be avoided during the removing, handling and refitting operation.



7. **Remove the fuel sensor.**
 - (a) Use the dedicated tool to undo the fuel sensor sealing cover.
 - (b) Rotate the fuel sensor to a proper angle and then knock it out lightly.

Notices:

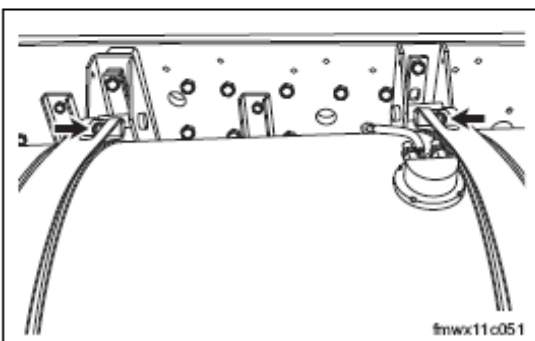
- Prior to this operation, check whether there is any dirt or other foreign matters in the immediate area of the fuel sensor; if any, clear them up.
- Take care not to damage the rubber sealing ring in the sealing cover of fuel sensor.



8. **Refit the fuel sensor.**

Notice:

When refitting the fuel sensor, start the operation by rotating the sensor to a proper angle, and avoid causing twisting or deformation.



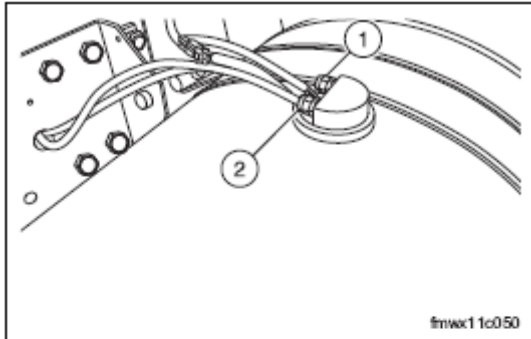
9. **Refit the fuel tank assembly.**
 - (a) Fit the fuel tank assembly onto the tank bracket, and attach it to the correct position.
 - (b) Fit the fuel tank binding strip set bolt.

Torque: 45±5N.m



Notice:

- Fasten the connecting nut between the tank binding strip and bracket to the required torque, and a higher torque may cause deformation of the fuel tank.
- The fuel tank shall be connected firmly and reliably without abnormal vibration.
- All rubber gaskets shall be fitted evenly.

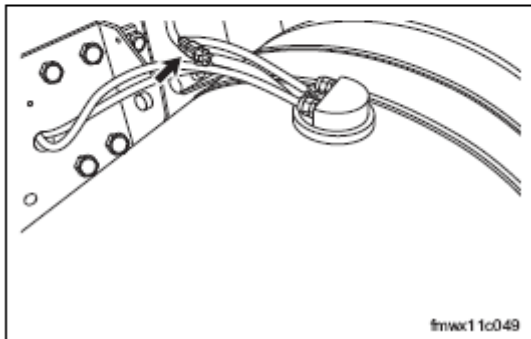
**10. Refit the fuel tank return pipe and delivery pipe.**

- (a) Refit the fuel tank return pipe union nut 2.

Torque: 46±5N.m

- (b) Refit the fuel tank delivery pipe union nut.

Torque: 46±5N.m

**11. Refit the fuel sensor connector.**

- (a) Refit the fuel sensor connector.

11A

12. Refit the fuel tank lock assembly.

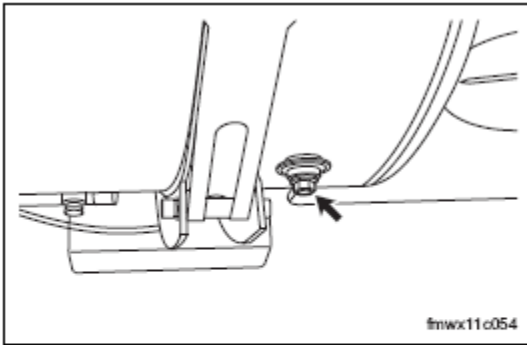
- (a) Check whether the fuel tank lock and pad are deformed or damaged; if necessary, replace the tank lock assembly.
- (b) Regularly lubricate movable parts.

13. Discharge the air in the fuel system. Refer to Chapter 11A: Testing and Adjustment, Fuel-Fuel System.**14. Refit the battery negative cable.****15. Check**

- (a) With all connectors properly fitted, turn on the ignition switch and check whether the fuel gauge works normally. Then start the engine, and check all fuel pipe unions of the fuel system for leakage.

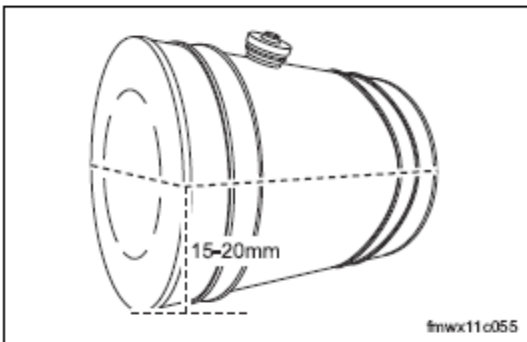
16. Refit the cargo box guardrail assembly. Refer to Chapter 77: Replacement, Internal/External Trimmings-Cargo Box Guardrail.

CLEANING



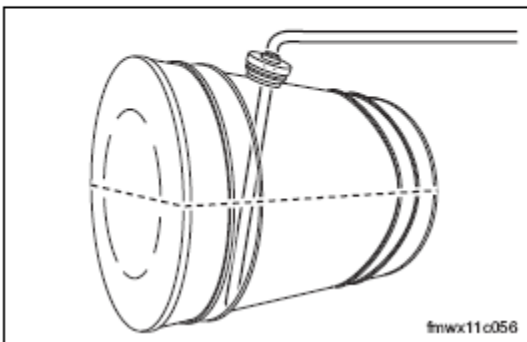
1. Discharge the fuel.

- (a) Disassemble the fuel tank lock assembly. Remove the drain plug, discharge the fuel, clean the plug, and then refit it.



2. Refill clean fuel.

- (a) Fill fuel into the tank until the fuel level is 15-20mm from the tank bottom.



3. Clean the fuel tank assembly.

- (a) Insert the hose with a nozzle into the tank bottom.
- (b) Connect the hose with the blowing gun.
- (c) Use a piece of clean and soft cloth to close the fuel filler, and turn on the blowing gun for purging.
- In the purging operation, the nozzle position must be changed to stir the deposit and adhesion with the fuel.

4. Clean the fuel tank assembly for several times.

- (a) After the whole tank is cleaned by the nozzle, remove the drain plug to release the old fuel, and repeat it for 2~3 times; thus the tank can be thoroughly cleaned.

5. Check the fuel tank assembly.

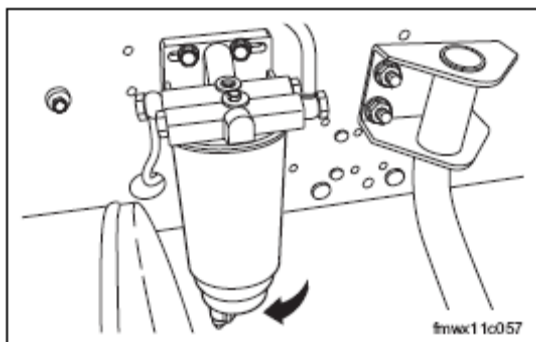
- (a) After the fuel tank is cleaned, check the tank for damages; if any, recover it immediately.

6. Refit the fuel tank lock assembly.

- (a) Check and clean the fuel tank filler strainer.

FUEL-WATER SEPARATOR

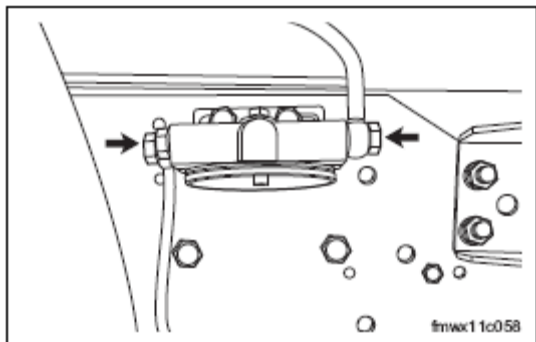
REPLACEMENT



1. **Remove the fuel-water separator.**
 - (a) Remove the separator with the fuel filter spanner.

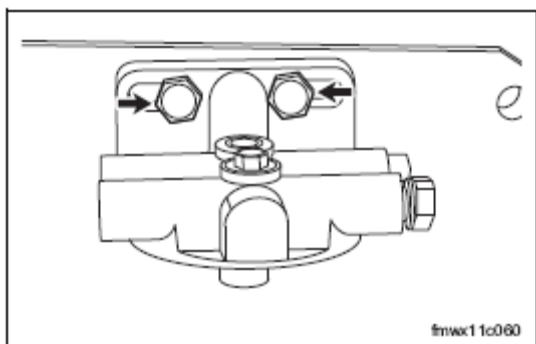
2. **Check the separator seat.**

- (a) Check the separator seat for cracks, scratches or noticeable damages; if any, replace the seat.

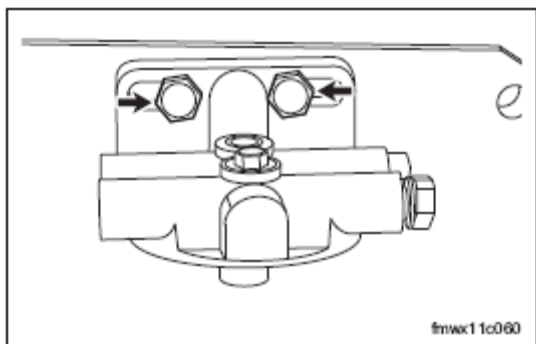


3. **Remove the separator seat.**
 - (a) Remove the hinging bolts for both inlet and outlet pipes.

11A

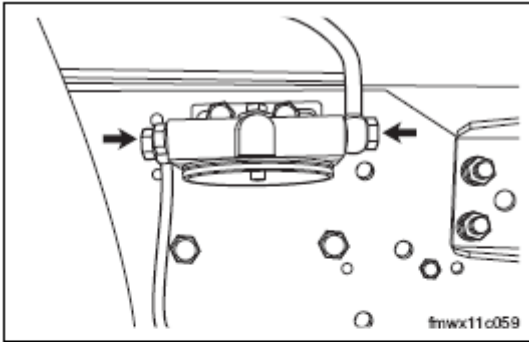


- (b) Remove the set bolt of the separator seat.



4. **Refit the separator seat.**
 - (a) Refit the set bolt of the separator seat.
Torque: 45±5N.m



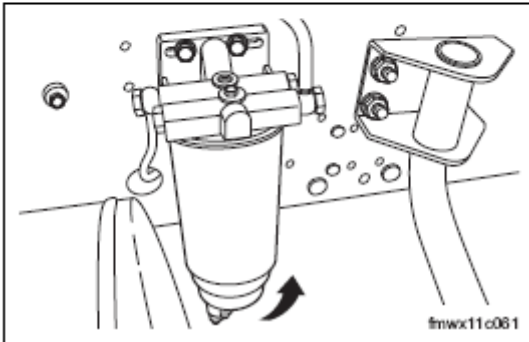


- (b) Refit the hinging bolts for both inlet and outlet pipes.

Torque: $45 \pm 5 \text{ N.m}$

Notice:

Check the washers for the inlet and outlet pipes, and if necessary, replace them.



5. Refit the fuel-water separator.

- (a) Apply a little of lubricating oil onto the separator sealing ring.
- (b) Fasten the separator till the sealing ring is engaged with the interface.
- (c) Use the fuel filter spanner to fasten the separator in the clockwise direction (by about 3/4 turn).

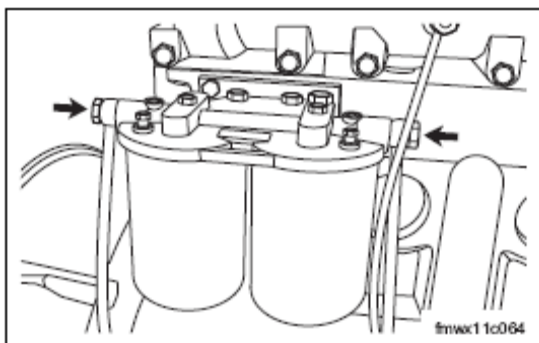
6. Discharge the air in the fuel system. Refer to Chapter 11A: Testing and Adjustment, Fuel-Fuel System.

7. Check

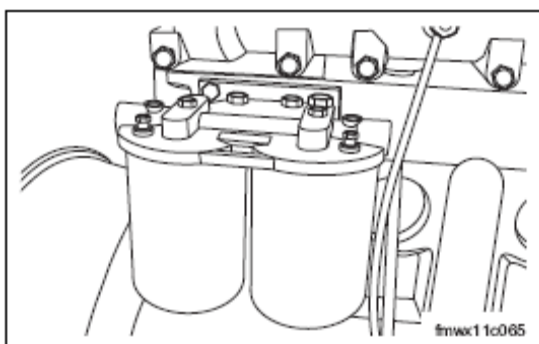
- (a) With all connectors properly fitted, turn on the ignition switch and check whether the fuel gauge works normally. Then start the engine, and check all fuel pipe unions of the fuel system for leakage.

FUEL SECONDARY FILTER

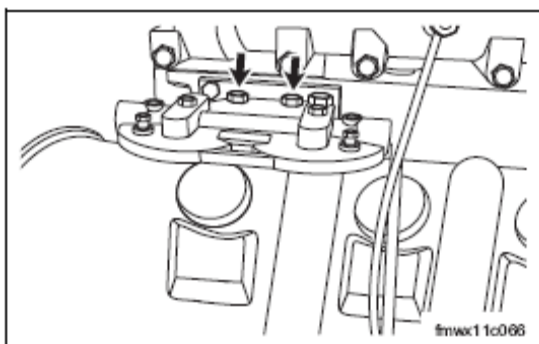
REPLACEMENT



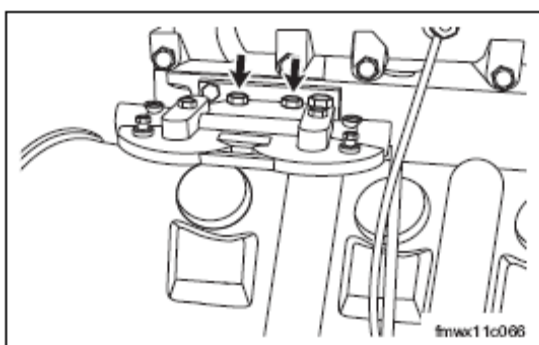
1. **Remove the fuel secondary filter.**
(a) Remove inlet and outlet pipes of the filter.



- (b) Use the fuel filter spanner to remove the secondary filter.



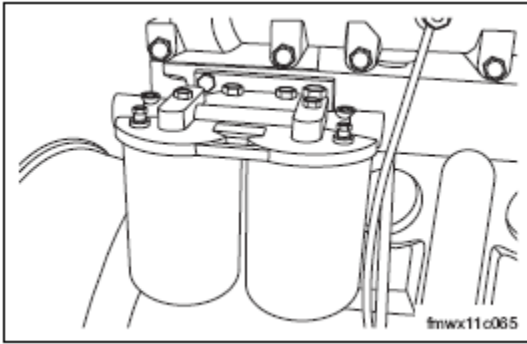
- (c) Remove the filter seat.



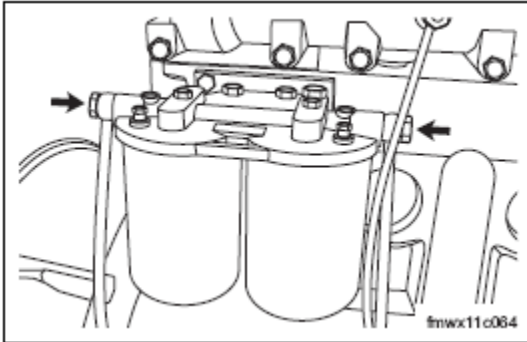
2. **Refit the secondary filter.**
(a) Refit the fuel secondary filter seat.

11A-40

FUEL (WD618)-FUEL SECONDARY FILTER



- (b) Use the filter spanner to refit the fuel secondary filter.

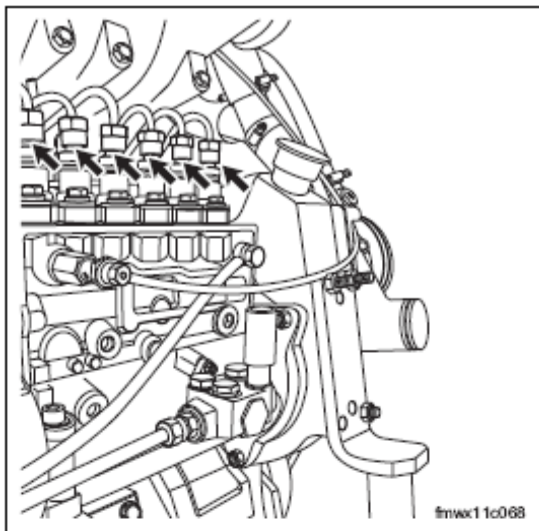


- (c) Refit the inlet and outlet pipes of the secondary filter.

11A

FUEL INJECTION PUMP

REPLACEMENT



1. Remove the fuel injection pump.

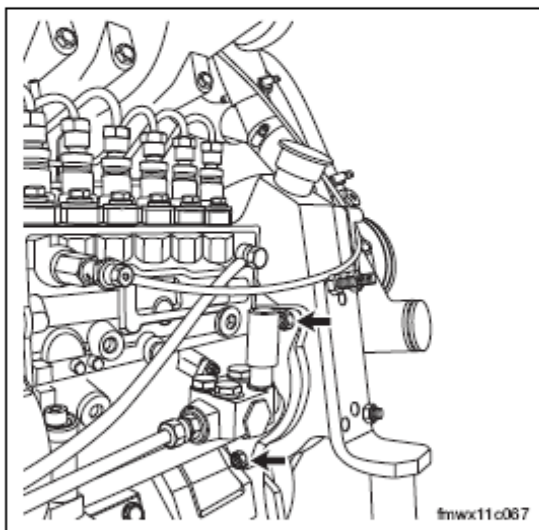
- (a) Remove the high-pressure fuel pipe of the fuel injection pump.

Notice:

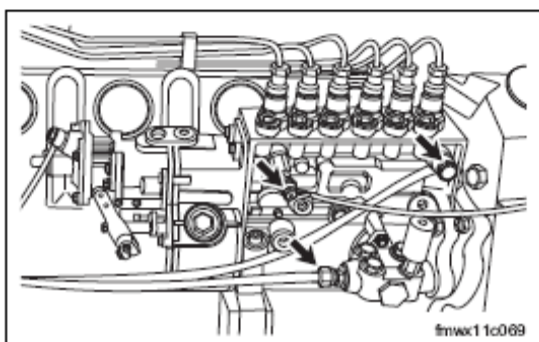
When undoing the high-pressure pipe nut, do use another spanner to fix the injection pump inlet pipe union. If this union is loosened unintentionally, it can be only fastened by once, and the inlet pipe union box gasket must be replaced.

Notice:

Recover the union cap to prevent pollution.



- (b) Remove these 3 bolts on the injection pump drive flange surface.

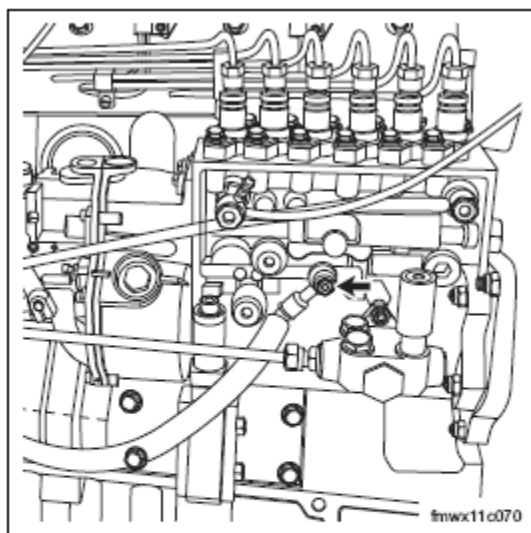


- (c) Remove the injection pump inlet and return pipes.

Notice:

Recover the union cap to prevent pollution.

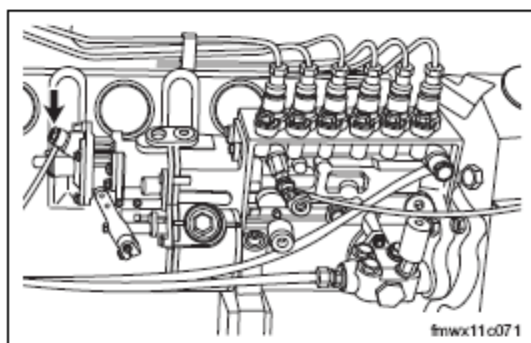




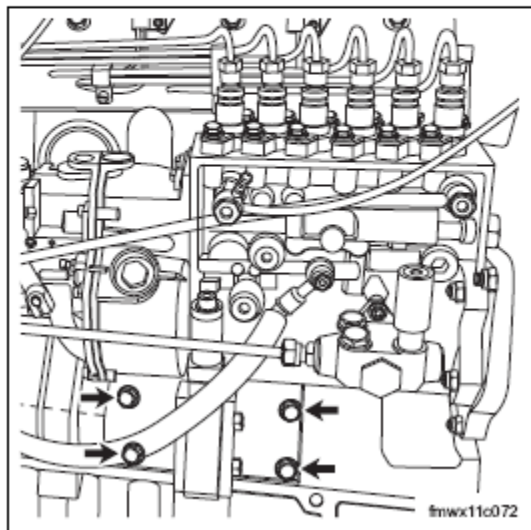
(d) Remove the pump engine oil pipe.

Notice:

Recover the union cap to prevent pollution.

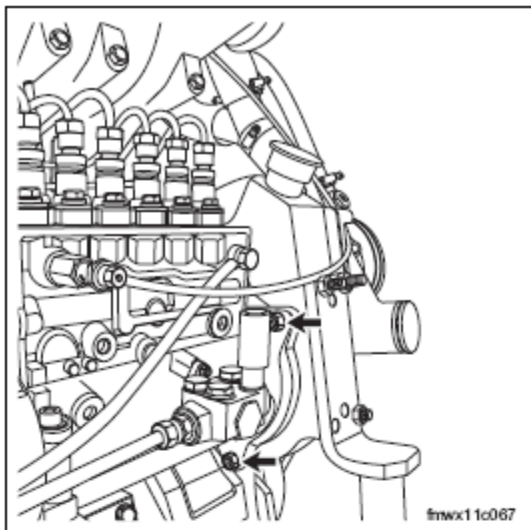


(e) Remove the smoke limiter air inlet pipe.



(f) Remove the set bolt of the injection pump bracket.



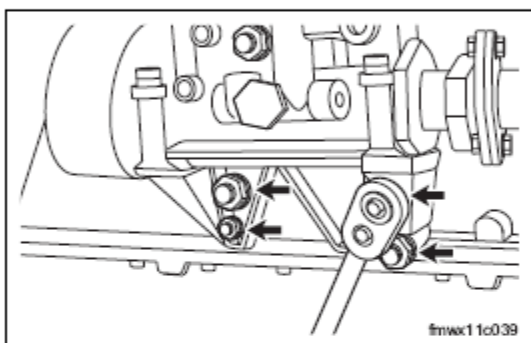


2. Refit the fuel injection pump.

- (a) Refit these 3 bolts on the pump flange surface.

Notice:

Turn the engine flywheel to the injection advance angle pre-tightening bolt as required in front of the compression upper dead center of the No.1 cylinder, and ensure that the pump is located at the upper dead center of the No.1 cylinder to localize the pump gear mark at the correct position.

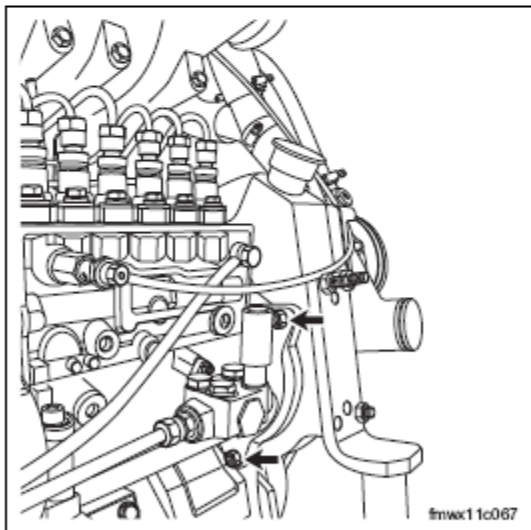


- (b) Refit the pump onto the bracket.

Torque: 32N.m

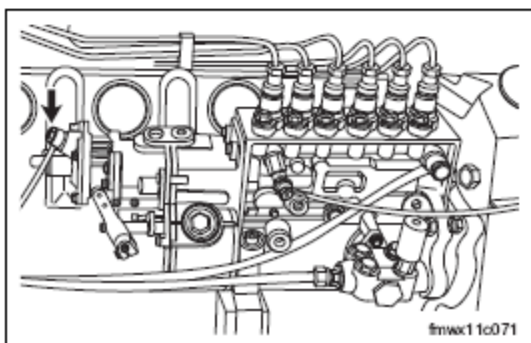
- (c) Refit the pump bracket.

Torque: 80N.m



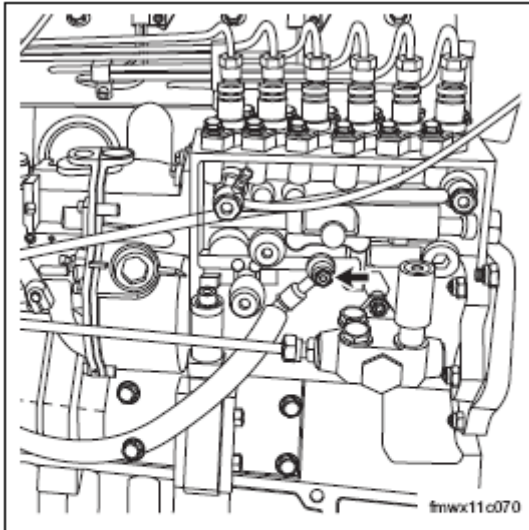
- (d) Fasten these 3 bolts on the injection pump flange surface with the required torque.

Torque: 80N.m

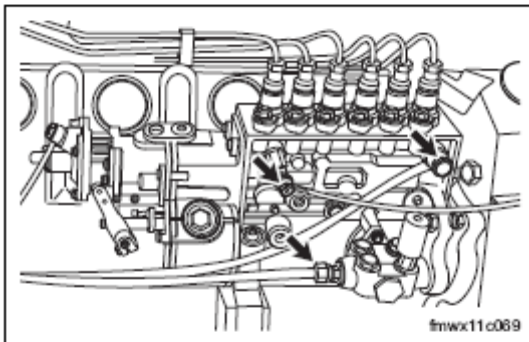


- (e) Refit the smoke limiter air inlet pipe.

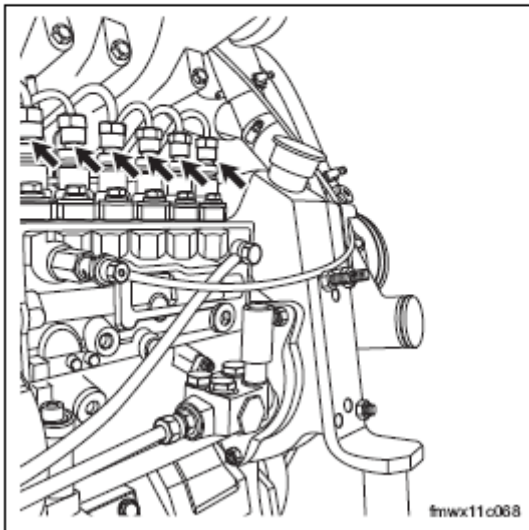




- (f) Refit the injection pump engine oil pipe.
Torque: 110N.m



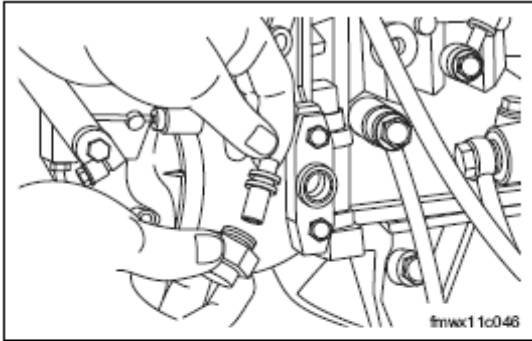
- (g) Refit the injection pump inlet pipe and return pipe.



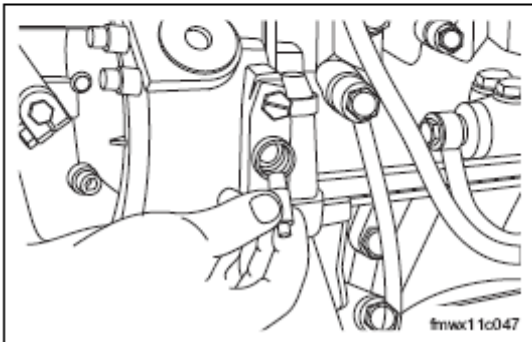
- (h) Refit the pump high-pressure pipe.

PS8500 series injection pump

This injection pump is provided with an injection timing testing device on the side face of the speed governor.



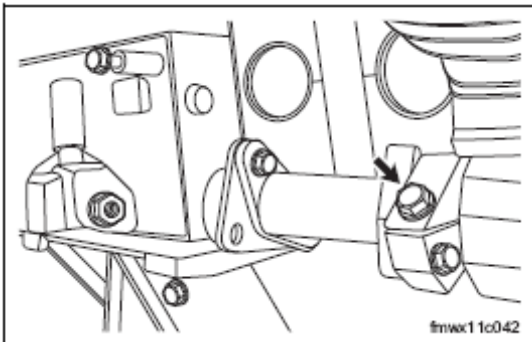
- (a) After the injection pump is fitted into the engine, remove the injection timing pin lock cap on the side face of the speed governor.



- (b) Remove the timing pin from the hole, reverse it and then insert it into the inspection hole. Rotate the connecting flange of the pump. When the timing gear groove is inserted into the positioning boss, it marks the start of fuel injection of the No.1 cylinder. At this moment, the injection pump connecting flange is connected with the pump drive shaft flange via the connecting steel plate. Fasten the flange lock nut.

Notice:

After the installation is finished, do remember to remove the timing pin, reverse it again and insert it into the inspection hole; finally, fasten the lock cap.



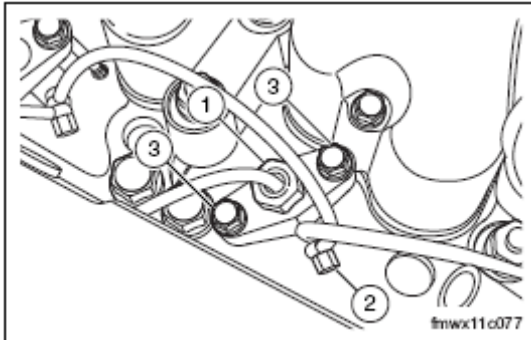
- (c) Set the pump to the injection starting position of the No.1 cylinder.
(d) Fasten the flange set bolt.

Torque: 110N.m

3. **Release the air in the low-pressure fuel line. Refer to Chapter 11A: Testing and Adjustment, Fuel-Fuel System.**
4. **Release the air in the high-pressure fuel line.**
 - (a) Undo the No.1 cylinder injector and high-pressure pipe union, and run the diesel engine with the starting motor till the diesel oil from the union contains no air bubbles, and then fasten the union nut.

FUEL INJECTOR

SERVICE



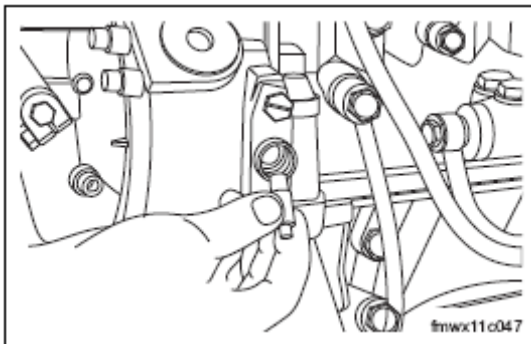
1. Remove the injector.

- (a) Remove the injector inlet pipe 1.
- (b) Remove the injector return pipe 2.

Notice:

Recover the union cap to prevent pollution.

- (c) Remove the injector set bolt 3.



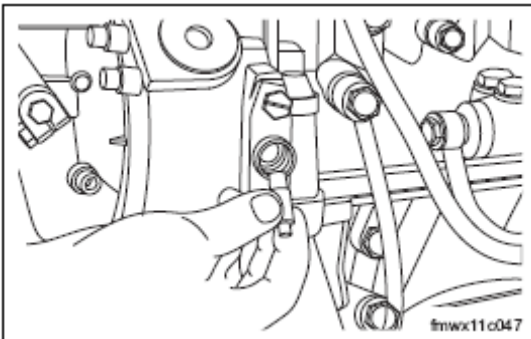
- (d) Remove the injector pressure plate.

- (e) Remove the injector.

Notice:

Do use the dedicated tool to remove the injector.

2. Test the injector. Refer to Chapter 11A: Testing and Adjustment, Fuel-Fuel System.



3. Refit the injector.

- (a) Insert the injector.
- (b) Refit the injector pressure plate.

Notice:

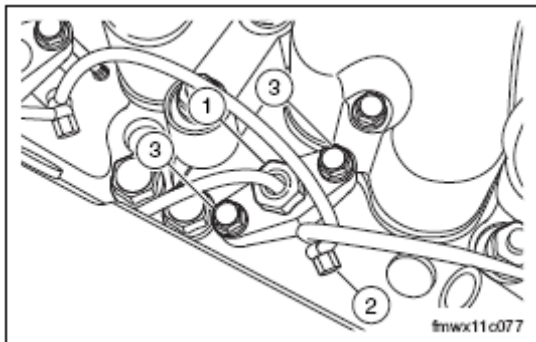
The injector can be only unpacked immediately prior to the installation.

Notice:

In the fitting operation of the injector, keep the injector body, O-shaped sealing ring and gasket clean and intact.

Notice:

The high-pressure union, O-shaped sealing ring and gasket can be only used for once.



- (c) Refit the injector set bolt.

Torque: $11\pm1\text{N.m}$

Fasten the bolt in a symmetrical way and pay attention to the consistence of side clearance.

- (d) Refit the injector inlet pipe 1.

- (e) Refit the injector return pipe 2.

Notice:

The protecting cap can be only removed immediately prior to the installation of fuel pipe.

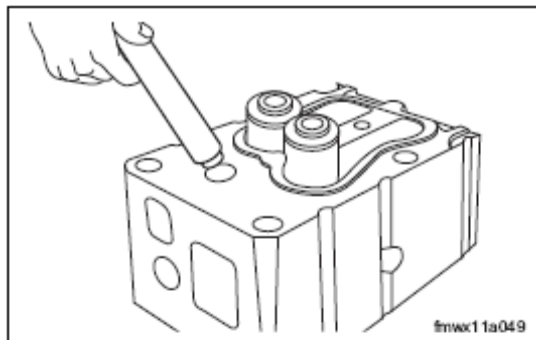
4. **Release the air in the low-pressure fuel line. Refer to Chapter 11A: Testing and Adjustment, Fuel-Fuel System.**
5. **Release the air in the high-pressure fuel line.**
 - (a) Undo the No.1 cylinder injector and high-pressure pipe union, and run the diesel engine with the starting motor till the diesel oil from the union contains no air bubbles, and then fasten the union nut.



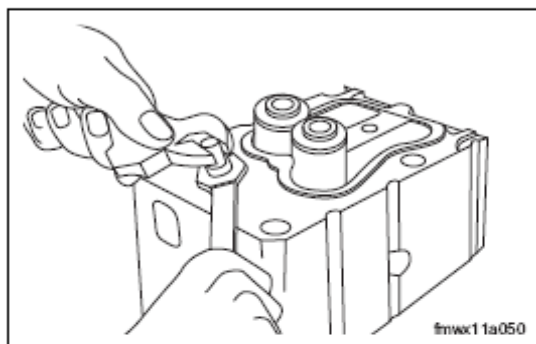
FUEL INJECTOR BUSH

REPLACEMENT

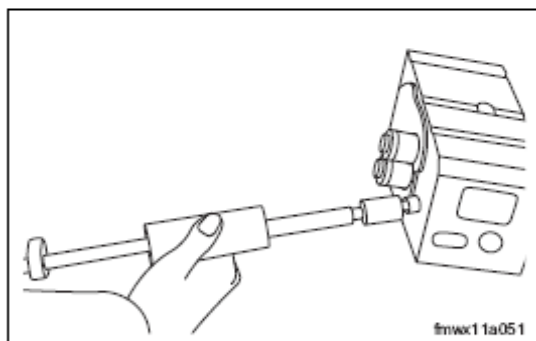
1. Remove the injector. Refer to Chapter 11A: Service, Fuel-Fuel Injector.



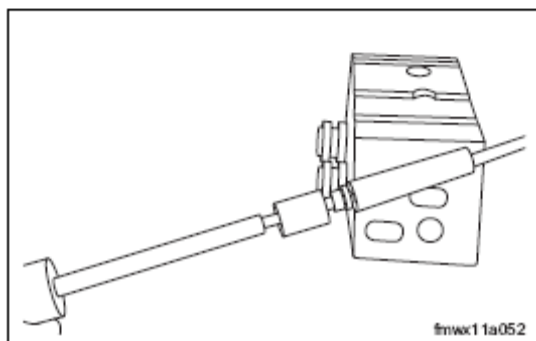
2. Insert the shifting block into the bush.



3. Fasten the shifting block expansion nut.



4. Use the puller hammer to pull the old bush.

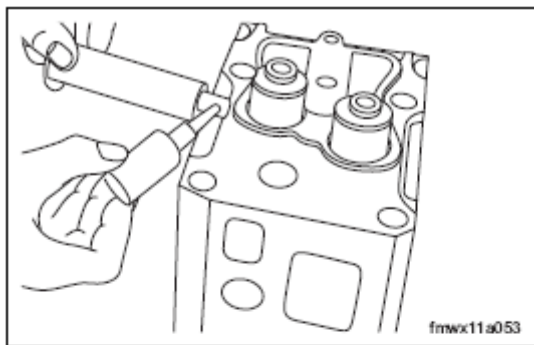


5. Pull out the old bush.

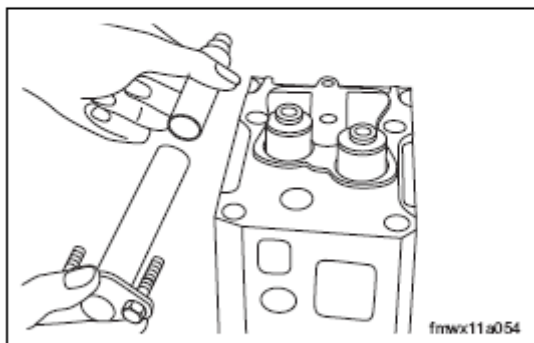
11A



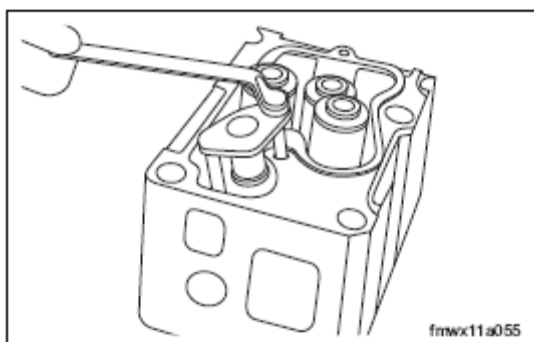
FOTON



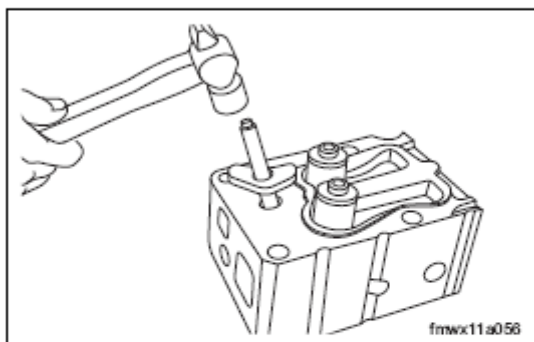
6. Apply 602 sealant onto the small head of the bush.



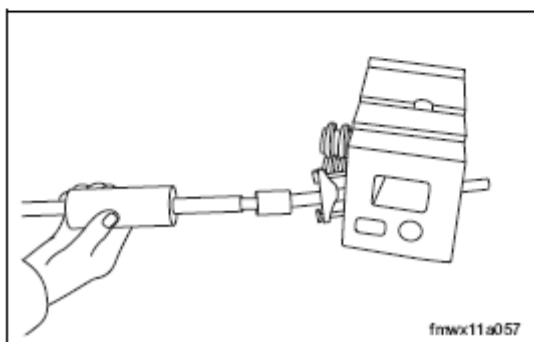
7. Insert the pressure sleeve into the new bush.



8. Use the injector pressure plate to press the pressure sleeve and new bush into the cylinder head.



9. Drive the expansion rod into the pressure sleeve.

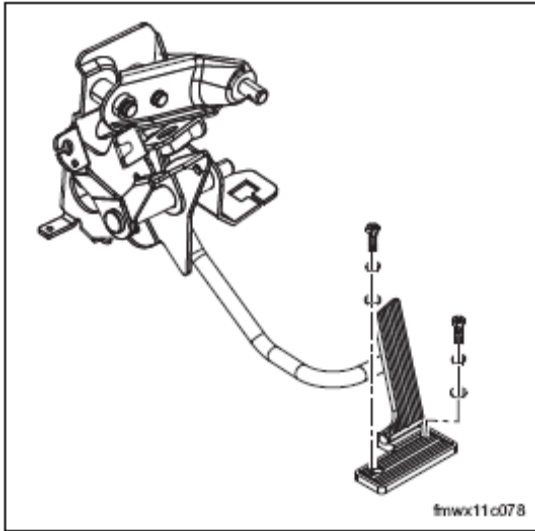


10. Use the puller to pull out the expansion rod.

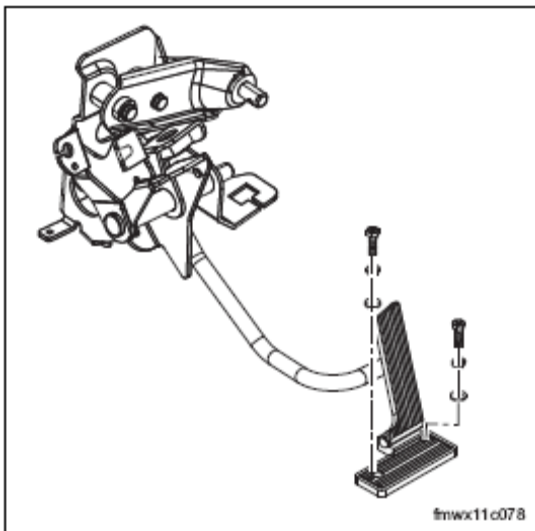


ACCELERATOR PEDAL

REPLACEMENT



1. Remove the accelerator pedal set bolt.



2. Refit the accelerator pedal set bolt.
Torque: 25N.m

AIR INTAKE

- AIR INTAKE SYSTEM 12-3**
 - Overview 12-3
 - Precautions 12-3
- HIGH-MOUNTED AIR INTAKE PIPE A 12-4**
 - Diagram of Components 12-4
 - Replacement 12-5
- HIGH-MOUNTED AIR INTAKE PIPE B 12-6**
 - Diagram of Components 12-6
 - Replacement 12-7
- AIR FILTER ASSEMBLY A 12-8**
 - Diagram of Components 12-8
 - Replacement 12-10
- AIR FILTER ASSEMBLY B 12-12**
 - Diagram of Components 12-12
 - Replacement 12-14
- AIR FILTER A 12-16**
 - Replacement 12-16
- AIR FILTER B 12-18**
 - Replacement 12-18

AIR INTAKE SYSTEM

OVERVIEW

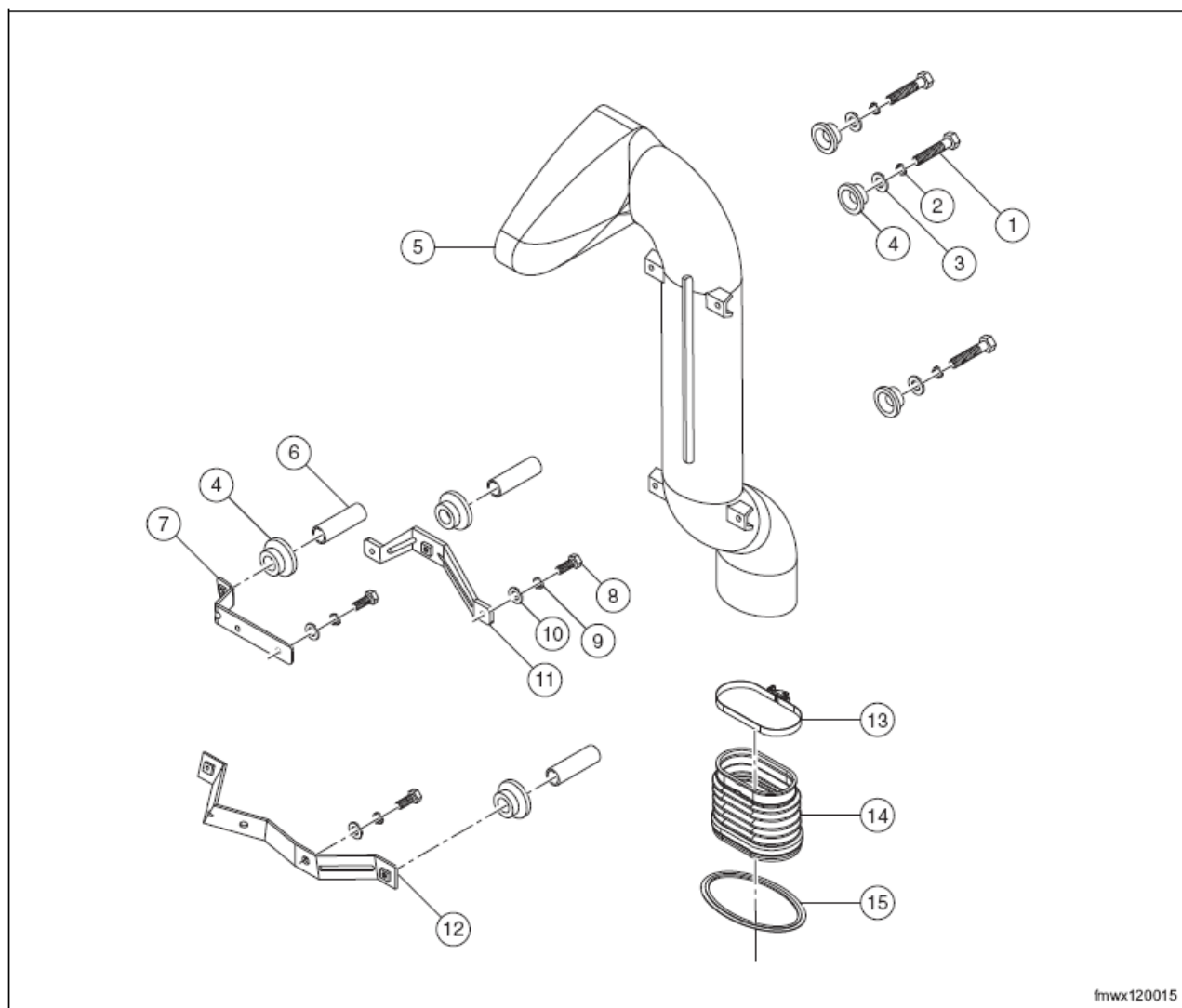
In this vehicle, the cyclone tube type desert dual-stage air filter is employed. This filter is composed of the housing, cyclone tube primary filter, paper type main filter insert and safety filter insert, provided with double filtering functions: the cyclone tube primary filter can remove most of dust, the paper main filter insert can fulfill the secondary filtering, and the safety filter insert can ensure the engine safety in the event of main filter insert damages. This filter is intended for vehicles operating in heavy dusty areas.

PRECAUTIONS

1. The engine intake air must be filtered to prevent the ingress of dust or scraps. If the air intake pipe is damaged or loosened, the unfiltered air will enter the engine to cause its premature wear.
2. The connector between the intake hose and high-mounted intake pipe must be fixed reliably without light leak or looseness.
3. The high-mounted intake pipe and the bracket must be connected reliably and the surface shall be free from fissures. The interface with the intake hose must present no air leakage.
4. In heavy sandy or dusty areas, the maintenance period must be properly shortened.
5. In the service and maintenance work, note that the filter insert outlet shall not be further contaminated.
6. If the filter insert not supplied by the original manufacturer is used or the required service method is not applied, the filtering quality of the filter will not be guaranteed.
7. Discharge the dust in the dust collecting bag every week and check the conditions of the bag.
8. Clean the filter regularly or when the filter clogging indicator lamp is lit. Replace the external insert every year or after 6 cleaning operations or whenever any damage is detected.
9. Check the cyclone tube primary filter every 500h (about two months).

HIGH-MOUNTED AIR INTAKE PIPE A

DIAGRAM OF COMPONENTS



fmwx120015

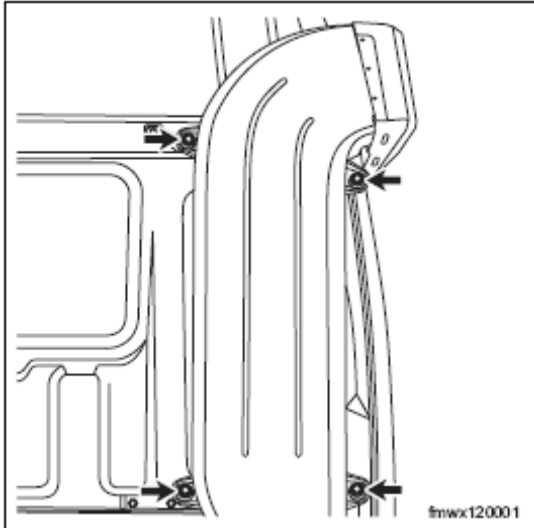
1	Hexagon bolt
2	Spring washer
3	Large washer
4	Rubber pad
5	High-mounted air intake pipe
6	Sleeve
7	High-mounted air intake pipe bracket 2
8	Hexagon bolt

9	Spring washer
10	Plain washer
11	High-mounted air intake pipe bracket 3
12	High-mounted air intake pipe bracket 1
13	A-type worm drive hose hoop
14	High-mounted air intake pipe connecting hose
15	Washer

REPLACEMENT

Hint:

As for the Diagram of Components, refer to Chapter 12: Diagram of Components, Air Intake-High-mounted Air Intake Pipe A.



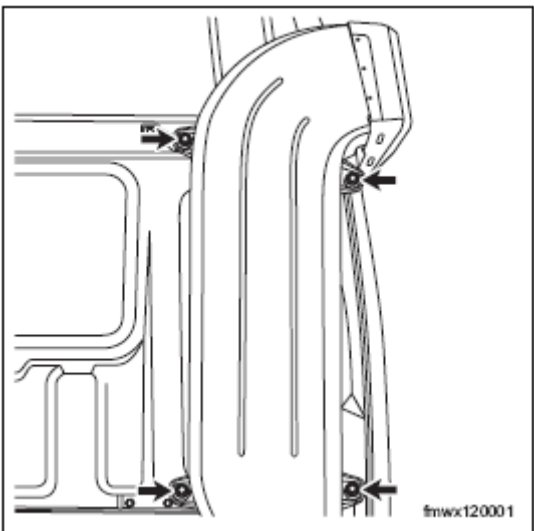
1. **Remove the high-mounted air intake pipe assembly.**
 - (a) Remove the intake pipe assembly lock bolt.

2. **Check the high-mounted air intake pipe.**

- (a) Clean the intake pipe and check whether there is any crack or air leakage.
 - (b) Check the connecting hose for aging, crack and air leakage.

Notice:

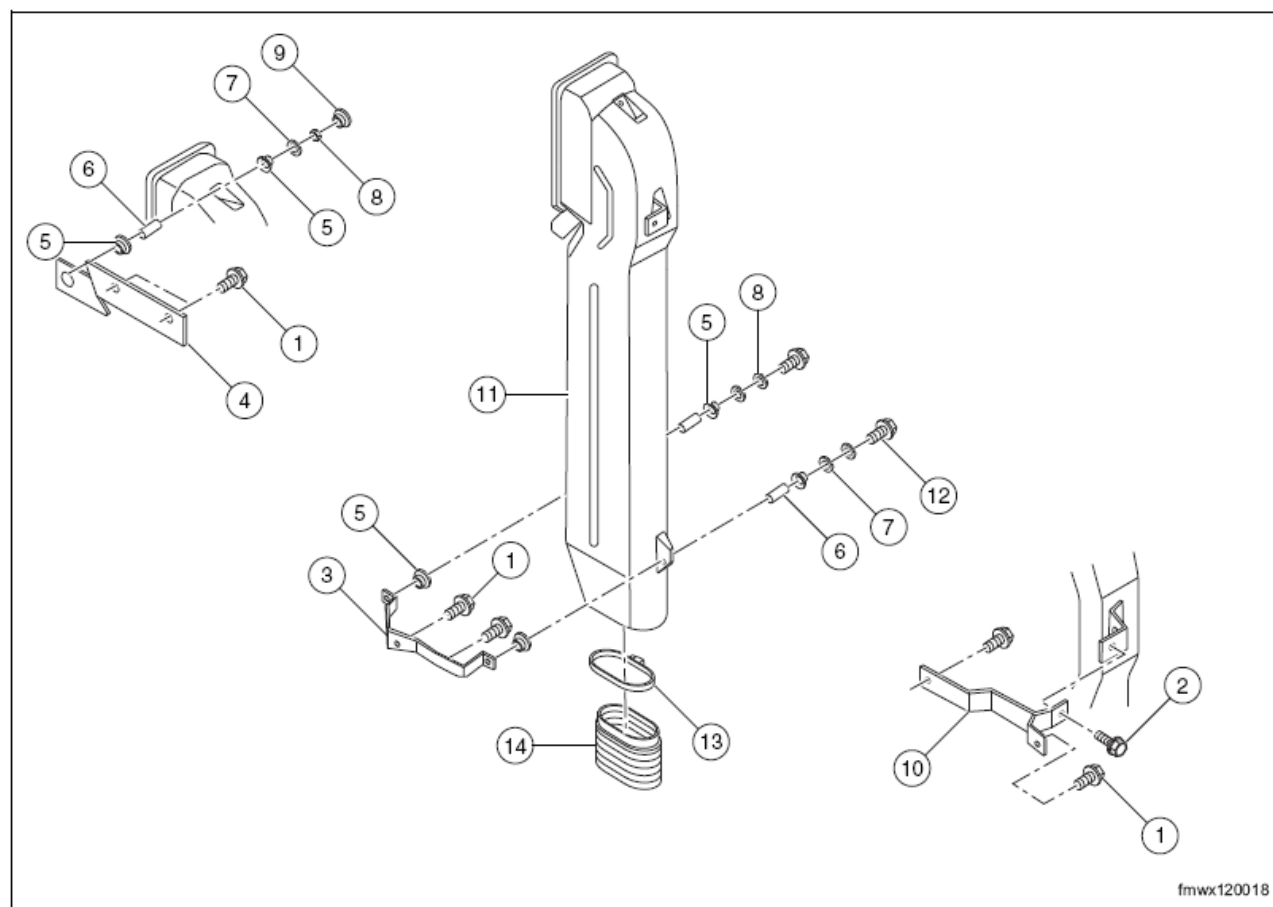
If any abnormality is detected, replace the intake pipe and connecting hose assembly.



3. **Refit the intake pipe assembly.**
 - (a) Refit the intake pipe assembly lock bolt and nut.
Torque: 23±2N.m

HIGH-MOUNTED AIR INTAKE PIPE B

DIAGRAM OF COMPONENTS



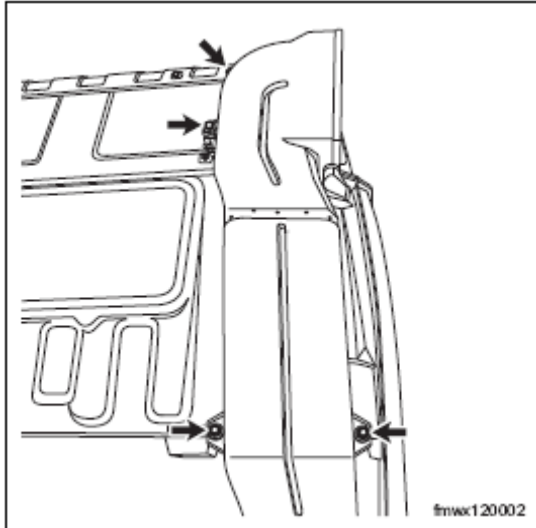
1	Hexagon bolt, spring washer and plain washer assembly
2	Hexagon bolt, spring washer and plain washer assembly
3	High-mounted air intake pipe bracket 2
4	High-mounted air intake pipe bracket 1
5	Rubber pad
6	Sleeve
7	Large washer

8	Spring washer
9	Type 1 hexagon nut
10	High-mounted air intake pipe bracket 3
11	cyclone tube high-mounted air intake pipe assembly
12	Hexagon bolt
13	A-type worm drive hose hoop
14	High-mounted air intake pipe connecting hose

REPLACEMENT

Hint:

As for the Diagram of Components, refer to Chapter 12: Diagram of Components, Air Intake-High-mounted Air Intake Pipe B.



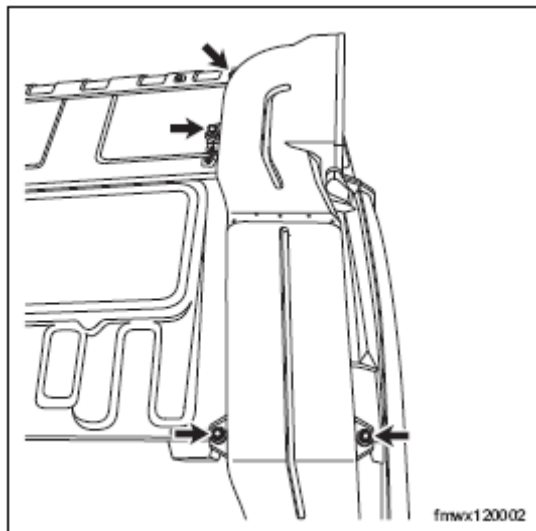
1. **Remove the high-mounted air intake pipe assembly.**
 - (a) Remove the intake pipe assembly lock bolt.

2. Check the high-mounted air intake pipe.

- (a) Clean the intake pipe and check whether there is any crack or air leakage.
- (b) Check the connecting hose for aging, crack and air leakage.

Notice:

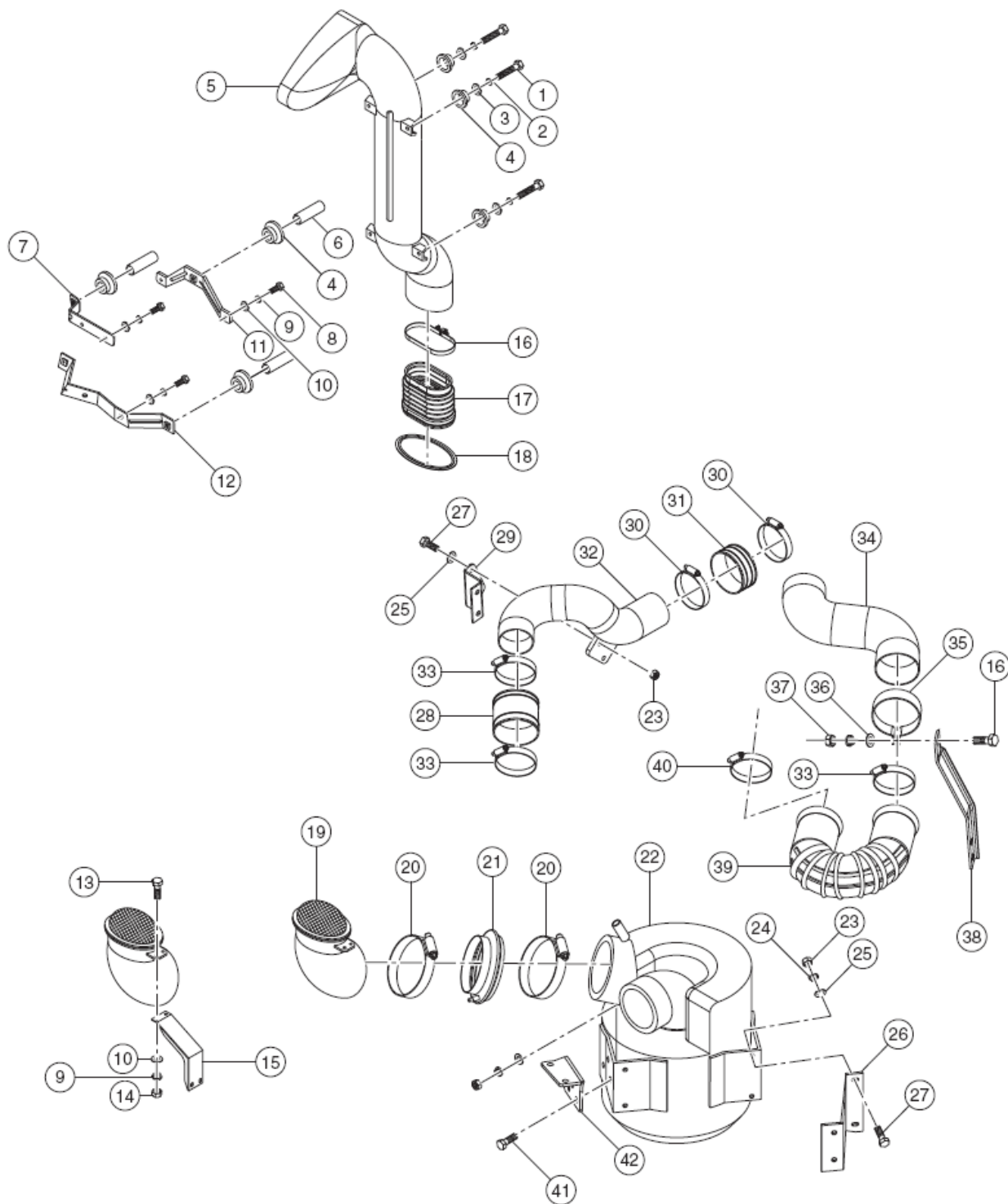
If any abnormality is detected, replace the intake pipe and connecting hose assembly.



3. **Refit the intake pipe assembly.**
 - (a) Refit the intake pipe assembly lock bolt and nut.
Torque: 23±2N.m

AIR FILTER ASSEMBLY A

DIAGRAM OF COMPONENTS



fmwx120016

AIR INTAKE-AIR FILTER ASSEMBLY A
12-9

1	Hexagon bolt	22	FD vertical filter assembly
2	Spring washer	23	Type 1 hexagon nut
3	Large washer	24	Spring washer
4	Rubber pad	25	Plain washer
5	High-mounted air intake pipe	26	Filter bracket
6	Sleeve	27	Hexagon bolt
7	High-mounted air intake pipe bracket 2	28	Air filter outlet pipe connecting hose 1
8	Hexagon bolt	29	Intake pipe fixture 2
9	Spring washer	30	A-type worm drive hose hoop
10	Plain washer	31	Air filter outlet pipe connecting hose 2
11	High-mounted air intake pipe bracket 3	32	Air filter outlet pipe 2
12	High-mounted air intake pipe bracket 1	33	A-type worm drive hose hoop
13	Hexagon bolt	34	Air filter inlet steel pipe
14	Type 1 hexagon nut	35	Clip
15	Elbow fixture	36	Plain washer
16	A-type worm drive hose hoop	37	Type 1 hexagon nut
17	High-mounted air intake pipe connecting hose	38	Outlet steel pipe bracket
18	Washer	39	Intake elbow
19	Connecting elbow	40	A-type worm drive hose hoop
20	A-type worm drive hose hoop	41	Hexagon bolt
21	Elbow connecting pipe	42	Air filter bracket

12

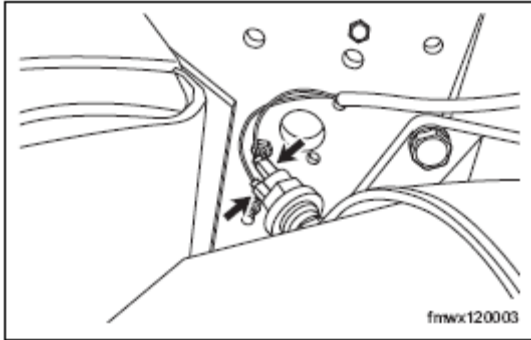
FOTON

REPLACEMENT

Hint:

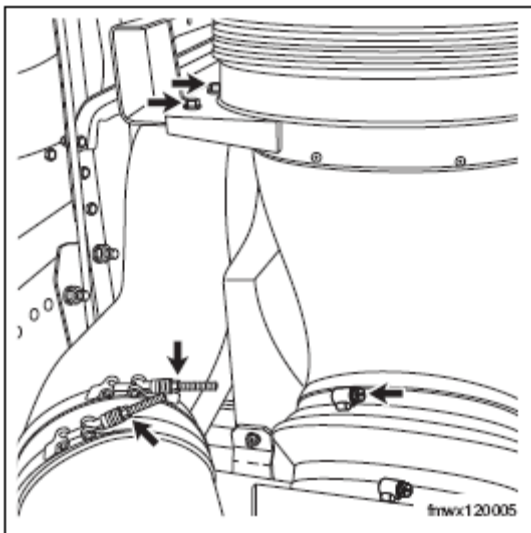
As for the Diagram of Components, refer to Chapter 12: Diagram of Components, Air Intake-Air Filter Assembly A.

1. Turn off the power master switch.



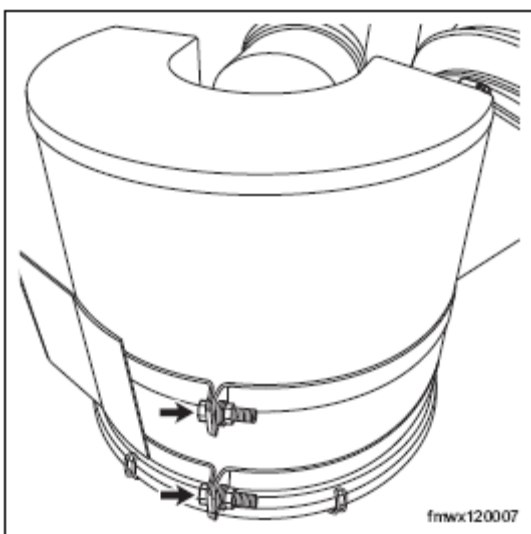
2. Remove the air filter assembly.

(a) Disconnect the filter clogging warning lamp switch connector.

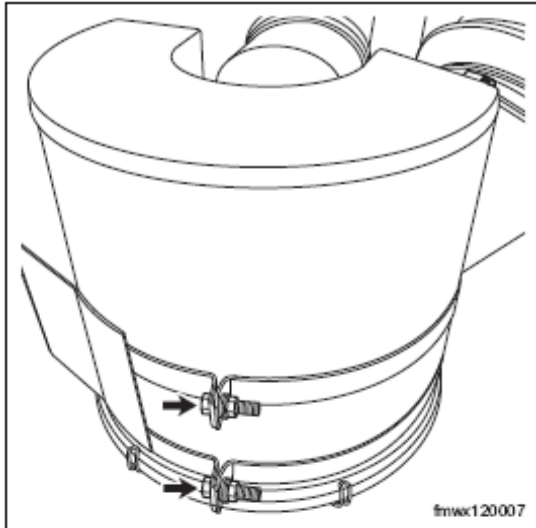


(b) Remove the filter inlet hose and outlet hose.

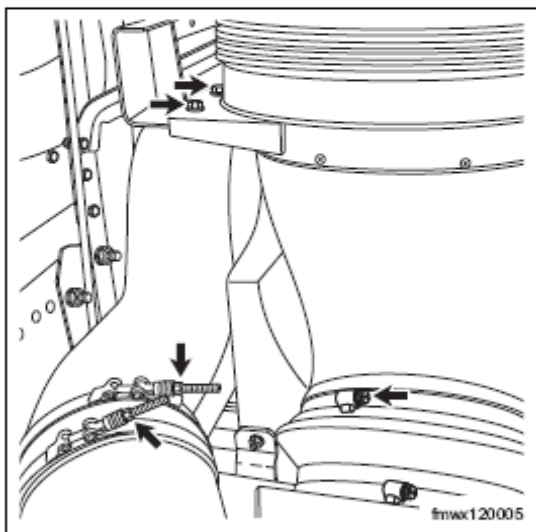
- Release the inlet hose hoop.
- Remove the inlet hose bracket lock nut.
- Undo the outlet hose hoop.



(c) Remove the air filter assembly lock bolt and nut.



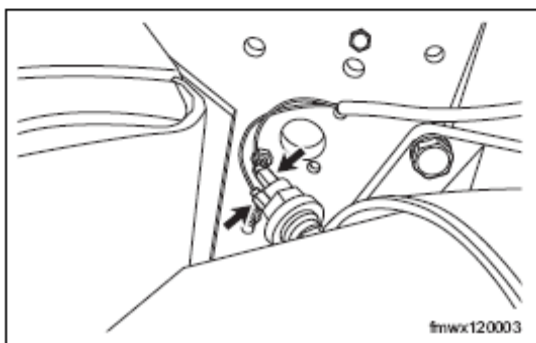
3. Refit the air filter assembly.
- (a) Refit the filter lock bolt and nut.
Torque: 97N.m



- (b) Refit the air filter inlet hose and outlet hose.
- Fasten the inlet hose hoop.
 - Refit the inlet hose bracket lock bolt.
- Torque: 23±2N.m**
- Fasten the outlet hose hoop.

Notice:

Refit the air filter inlet and outlet hoses and the filter connecting parts in place.



- (c) Refit the filter clogging warning lamp switch connector.

Notice:

Check whether the safety insert is contaminated or damaged; if contaminated or damaged, replace it.

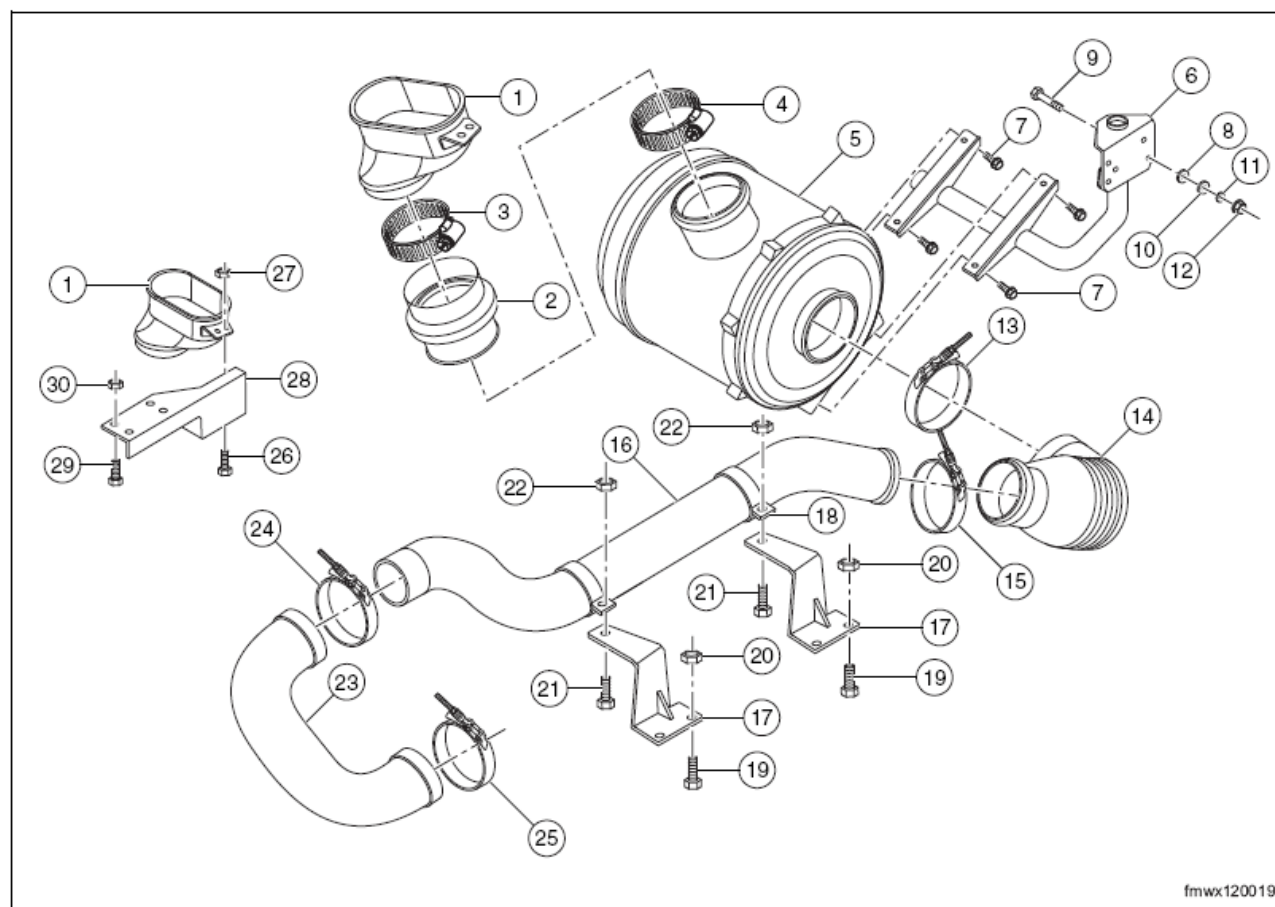
Notice:

Avoid the contamination of safety insert by dust. When using the compressed air, wear proper safety glasses and face shields, for the flying scraps or dirt may cause personal injuries.

4. Turn on the power master switch.

AIR FILTER ASSEMBLY B

DIAGRAM OF COMPONENTS



fmwx120019

1	Air inlet bend
2	Rubber drain pipe
3	A-type worm drive hose hoop
4	A-type worm drive hose hoop
5	Plastic-housing air filter assembly
6	Air filter bracket assembly
7	Hexagon bolt, spring washer and plain washer assembly
8	Pad
9	Hexagon bolt
10	Plain washer
11	Spring washer
12	Type 1 hexagon nut

16	Air filter steel outlet pipe
17	Bracket
18	Air filter outlet pipe clip
19	Hexagon bolt, spring washer and plain washer assembly
20	Hexagon flanged nut
21	Hexagon bolt, spring washer and plain washer assembly
22	Hexagon flanged nut
23	Air inlet bend
24	T-type spring reinforced clip (D136)
25	T-type spring reinforced clip (D190)
26	Hexagon bolt, spring washer and plain washer assembly
27	Hexagon flanged nut



AIR INTAKE-AIR FILTER ASSEMBLY B

12-13

13	T-type spring reinforced clip (D190)	28	Inlet bend bracket
14	Air filter outlet hose	29	Hexagon bolt, spring washer and plain washer assembly
15	T-type spring reinforced clip (D136)	30	Hexagon flanged nut

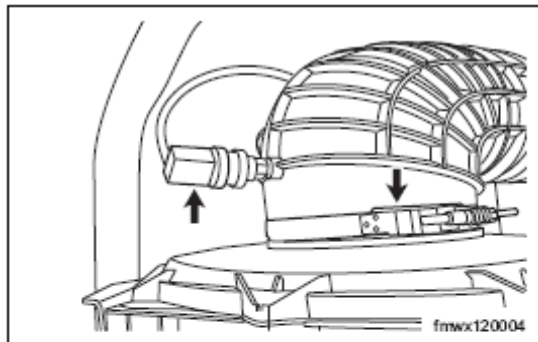


REPLACEMENT

Hint:

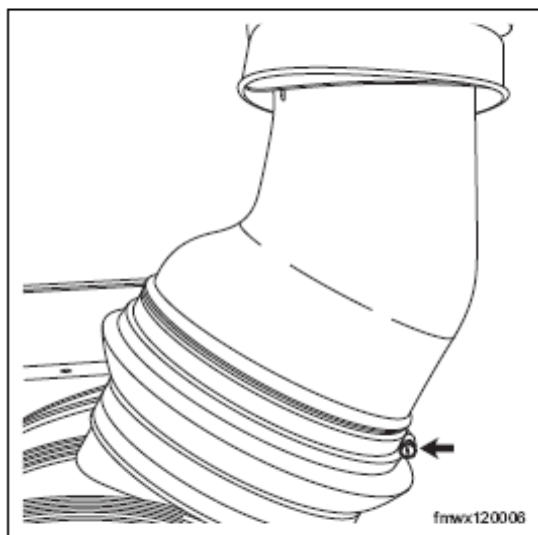
As for the Diagram of Components, refer to Chapter 12: Diagram of Components, Air Intake-Air Filter Assembly B.

1. Turn off the power master switch.

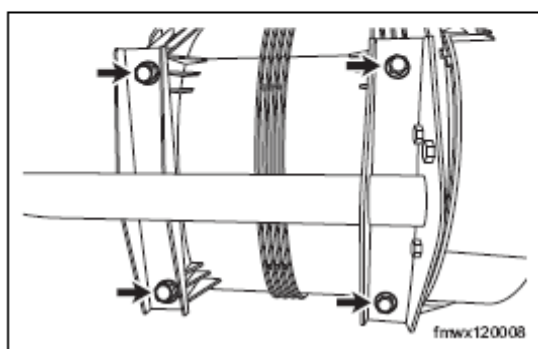


2. Remove the air filter assembly.

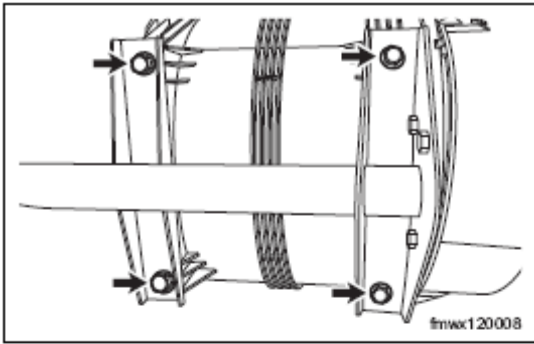
- (a) Disconnect the filter clogging warning lamp switch connector.
- (b) Remove the filter inlet hose and outlet hose.
 - Undo the filter outlet hose hoop.



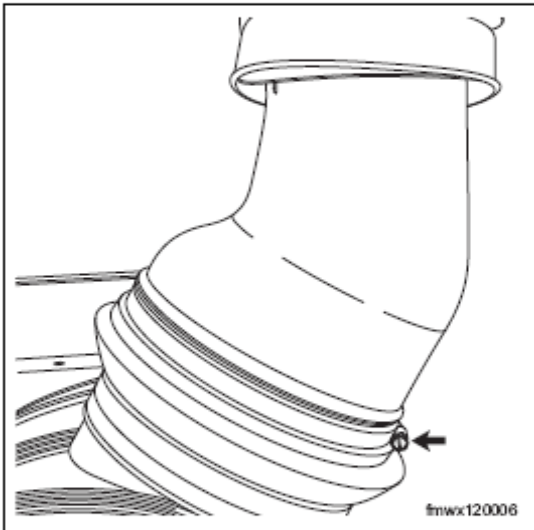
- (c) Remove the air filter inlet hose.
 - Undo the filter inlet hose hoop.



- (d) Remove the filter lock bolt and nut.



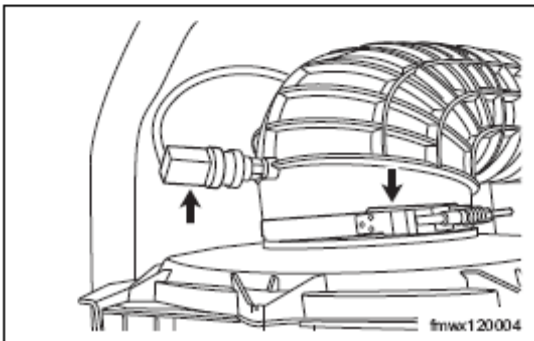
3. Refit the air filter assembly.
- (a) Refit the filter lock bolt and nut.
- Torque: 97N.m**



- (b) Refit the air filter inlet hose and outlet hose.
- Fasten the inlet hose hoop.
 - Fasten the outlet hose hoop.

Notice:

Refit the air filter inlet and outlet hoses and the filter connecting parts in place.



- (c) Refit the filter clogging warning lamp switch connector.

Notice:

Check whether the safety insert is contaminated or damaged; if contaminated or damaged, replace it.

Notice:

Avoid the contamination of safety insert by dust. When using the compressed air, wear proper safety glasses and face shields, for the flying scraps or dirt may cause personal injuries.

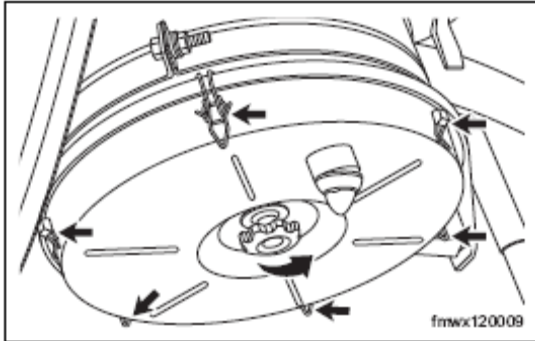
4. Turn on the power master switch.

AIR FILTER A

REPLACEMENT

Hint:

As for the Diagram of Components, refer to Chapter 12: Diagram of Components, Air Intake-Air Filter Assembly A.

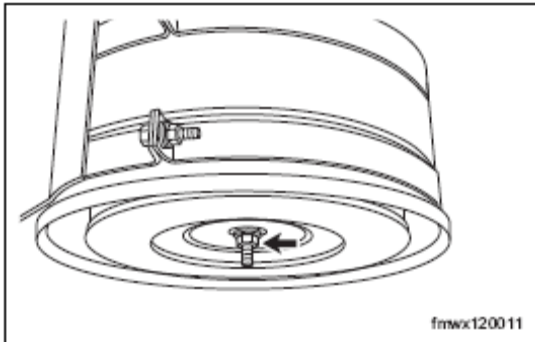


1. Remove the air cylinder assembly.

- (a) Undo clips around the round sealing cover.
- (b) Remove the filter round sealing cover handle.

Notice:

Plug the air outlet with clean materials. When using the compressed air, wear proper safety glasses and face shields, for the flying scraps or dirt may cause personal injuries.

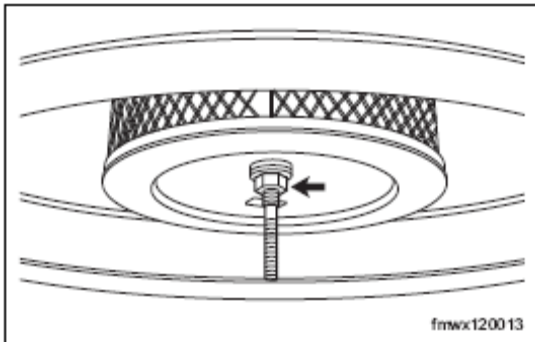


- (c) Remove the main filter insert lock nut.

- Use the compressed air to clean the main filter insert, and if necessary, replace it.

Notice

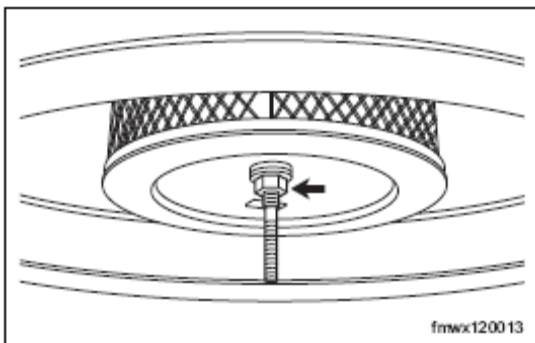
Avoid the contamination of safety insert by dust. When using the compressed air, wear proper safety glasses and face shields, for the flying scraps or dirt may cause personal injuries.



- (d) Remove the safety filter insert lock nut.

Notice:

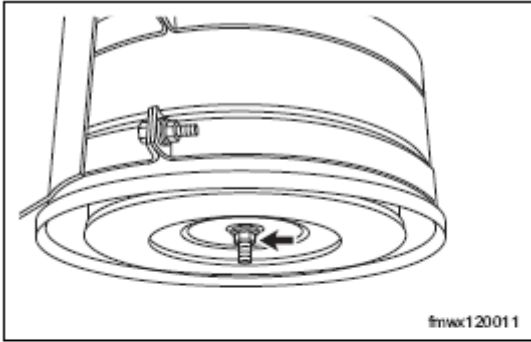
Check whether the safety insert is contaminated or damaged; if contaminated or damaged, replace it.



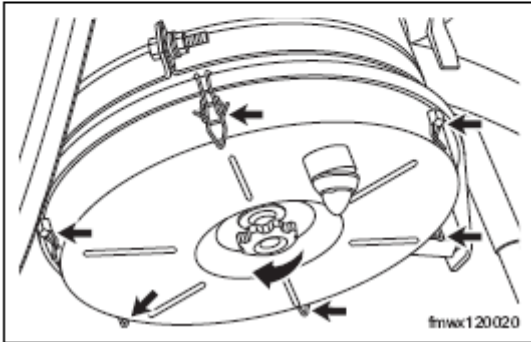
2. Refit the filter assembly.

- (a) Refit the safety filter insert lock nut.

Torque: 46±5N.m



- (b) Refit the main filter insert lock nut.
Torque: $46 \pm 5 \text{ N.m}$



- (c) Refit the filter round sealing cover handle.
(d) Fasten clips around the round cover.

Notice:

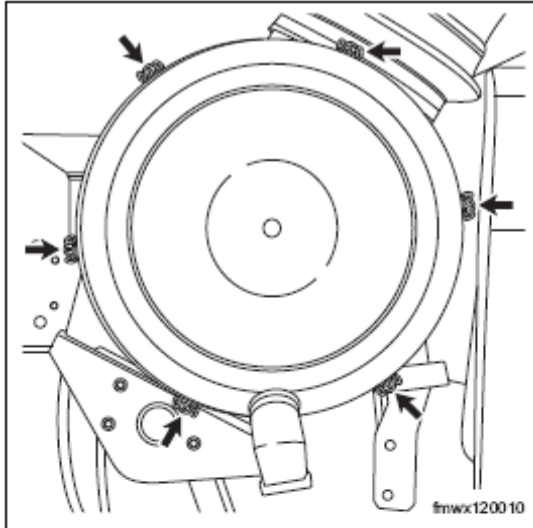
After the filter assembly is refitted, check whether it is properly sealed and free from looseness or leakage.

AIR FILTER B

REPLACEMENT

Hint:

As for the Diagram of Components, refer to Chapter 12: Diagram of Components, Air Intake-Air Filter Assembly B.

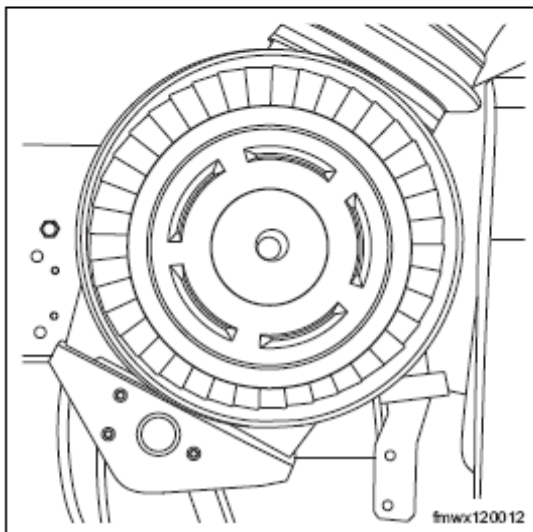


1. Remove the air cylinder assembly.

- (a) Undo clips around the round sealing cover.

Notice:

Plug the air outlet with clean materials. When using the compressed air, wear proper safety glasses and face shields, for the flying scraps or dirt may cause personal injuries.

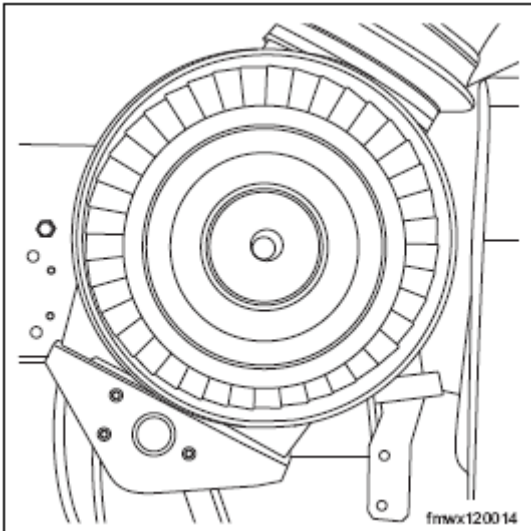


- (b) Remove the main filter insert.

- Use the compressed air to clean the main filter insert, and if necessary, replace it.

Notice

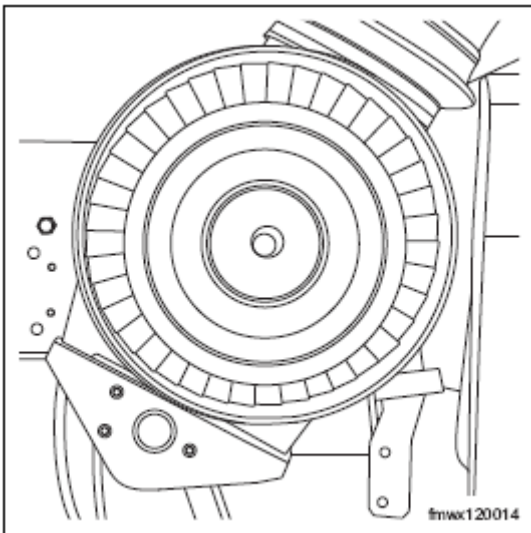
Avoid the contamination of safety insert by dust. When using the compressed air, wear proper safety glasses and face shields, for the flying scraps or dirt may cause personal injuries.



(c) Remove the safety filter insert.

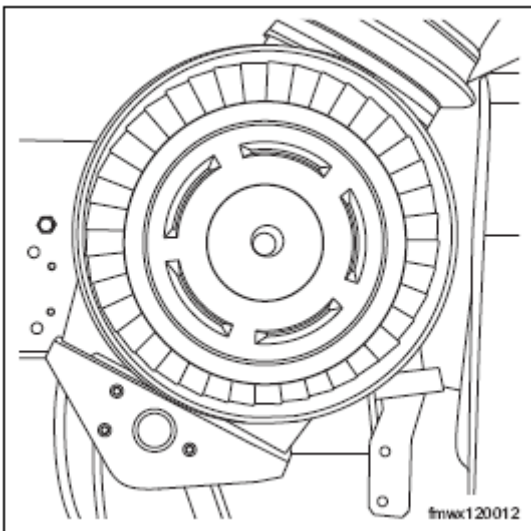
Notice:

Check whether the safety insert is contaminated or damaged; if contaminated or damaged, replace it.

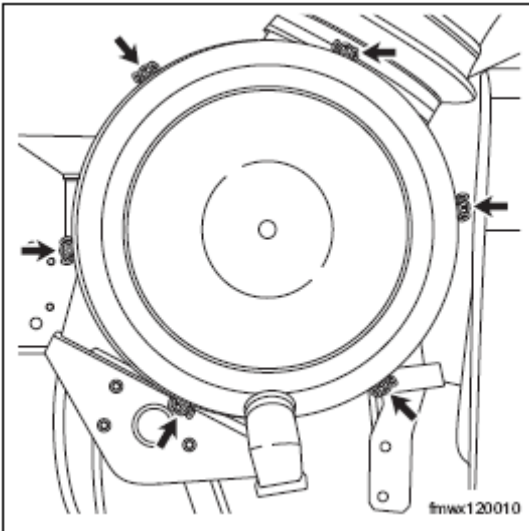


2. Refit the filter assembly.

(a) Refit the safety filter insert.



(b) Refit the main filter insert.



(c) Fasten clips around the round cover.

Notice:

After the filter assembly is refitted, check whether it is properly sealed and free from looseness or leakage.

EXHAUST SYSTEM AND TURBOCHARGER (WD618)

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13A



FOTON

EXHAUST SYSTEM

OVERVIEW

Turbocharger:

The WD618 diesel engine is of the turbocharger intercooler type. The exhaust turbocharger is employed. The engine power is originated from the combustion of fuel in the cylinder, and the fuel supply is subjected to the air supply to the cylinder so as to restrict the power output. If the engine is already in its best conditions, the additional output power can be only obtained by delivering more compressed air into the cylinder to increase fuel supply and improve the combustion capacity. Under current technological conditions, the turbocharger is the exclusive mechanic device which can increase the output power without affecting the engine working efficiency.

The most important advantage of the turbocharger consists in that the engine power and torque can be significantly improved without increasing the engine displacement. Overviewly, the engine equipped with a turbocharger will be additionally provided with 20-30% of power and torque. However, due to the inertia of the impeller, the engine will make a slow response to the instant change of the throttle thus to delay the increase or reduction of output power, which will cause a delay in the acceleration or overtaking operation.

The exhaust turbocharger is mainly composed of the pump wheel and turbine, as well as control elements. The pump wheel and turbine are connected via a shaft, namely, the rotor. The engine exhaust will drive the pump wheel which will in turn bring the turbine to rotate, thus pressurizing the intake system. The turbocharger is fitted on the engine exhaust side, so its working temperature is very high; furthermore, as the rotor speed in the operation is very high, more than 100,000rpm, this will disable the ordinary mechanic needle or roller bearing to work for the rotor. Therefore, the fully floating bearing is universally employed in the turbocharger, which is lubricated by the engine oil; in addition, the turbocharger is cooled by the cooling liquid.

Turbocharger intercooler:

The increased temperature will not only influence the charging efficiency but also is liable to cause deflagration. So it is necessary to equip a device to reduce the intake air temperature, and that's the intercooler. The intercooler is fitted between the turbocharger outlet and air intake pipe, used to cool the air delivered to the cylinder. The intercooler, just like the radiator, is cooled by air or water, and the air heat is dispersed in the atmosphere through cooling. According to the test, a high-quality intercooler will not only keep a rational engine compression ratio without causing deflagration, but also will reduce the temperature and increase the intake air pressure to further improve the engine effective power. In this vehicle, the air-air cooling is adopted, and the intercooler resistance shall be lower than 5kPa (under rated working conditions).



PRECAUTIONS

As the turbocharger usually works at high speed and high temperature, the maximum exhaust temperature at the exhaust turbine end may reach 600°C and the turbocharger rotor works at a high speed of 7000-100000rpm, to ensure the normal operation of the turbocharger, pay attention to following points in the operation:

1. Do not move up the vehicle upon the engine start.

- After the engine is started, especially in winter, run it at idle speed for a while to fully lubricate the bearing before the rotor works at high speed. Never apply the accelerator suddenly after the initial start of the engine to avoid damaging the turbocharger oil seal. After the startup, run the engine at idle speed properly (about 5min or shorter if the engine is stopped for a while) prior to the loading.

2. Do not immediately shut down the engine.

- After the engine works at high speed for long, do not immediately shut it down. When the engine is working, a portion of engine oil is supplied to turbocharger rotor for lubrication and cooling purposes. If the engine is suddenly stopped, the engine oil pressure will be reduced to zero rapidly, the high temperature of the turbine is transferred to the middle, while the heat in the bearing supporting housing can't be carried away immediately and the rotor still rotates quickly; in such a case, with the engine hot, the engine oil in the turbocharger will be over-hot to damage the bearing and shaft. Therefore, after the high-load and long-time operation of the engine, the engine must be idled for 3-5min before its shutdown to reduce the rotor speed. In particular, the sudden shutdown following the abrupt application of accelerator shall be avoided.

3. Keep clean.

- When removing the turbocharger, do keep it clean. All pipe unions must be plugged with clean cloth to avoid the entry of foreign matters thus to damage the rotor. In the servicing, take care not to damage the impeller. After the refitting operation is finished, remove the plug.

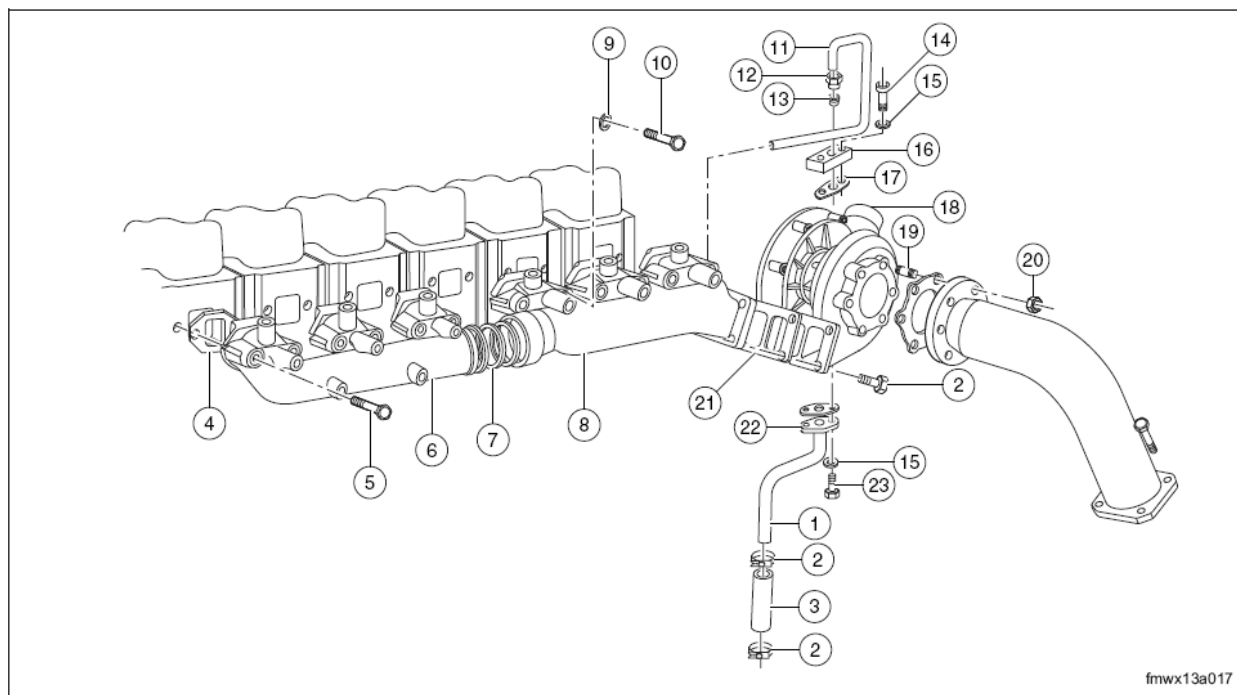
4. Clean the turbocharger.

- As the turbocharger usually works at high temperature, the oil in the lubricating oil pipe may be partially coked under the high temperature, which will cause the insufficient lubrication of the bearing thus to damage it. Therefore, the lubricating oil pipe must be cleaned as required after the operation.

5. Pay close attention to the operation of the turbocharger.

- Before and after the execution of tasks, check the connection conditions of all air pipes to avoid the failure of turbocharger and ingress of air into the cylinder due to the looseness and separation of pipe unions. The sealing performance of turbocharger pipeline system and components must be ensured to provide good cooling performance of the intercooler.

DIAGRAM OF COMPONENTS



13A

1	Oil return pipe
2	Hose clip
3	Turbocharger oil return hose
4	Bolt
5	Exhaust pipe gasket
6	Front exhaust manifold
7	Exhaust pipe sealing ring
8	Rear exhaust manifold
9	Thrust washer
10	Exhaust pipe lock bolt
11	Oil inlet pipe
12	Pipe union nut

13	Ferrule
14	Internal hexagon cylindrical head screw
15	Self-lock washer
16	Oil inlet pipe flange
17	Oil inlet pipe gasket
18	Exhaust turbocharger
19	Stud
20	Type 2 fully metallic hexagon lock nut
21	Turbocharger gasket
22	Oil return pipe flange gasket
23	Hexagon bolt

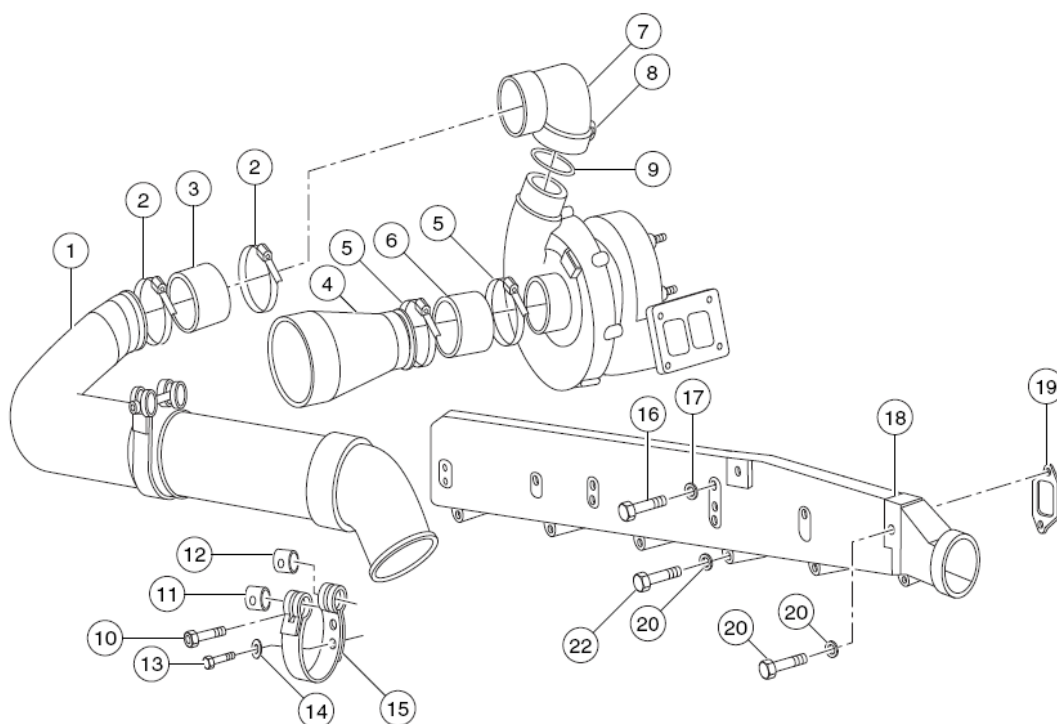


FOTON

13A-6

EXHAUST SYSTEM AND TURBOCHARGER (WD618)-EXHAUST SYSTEM

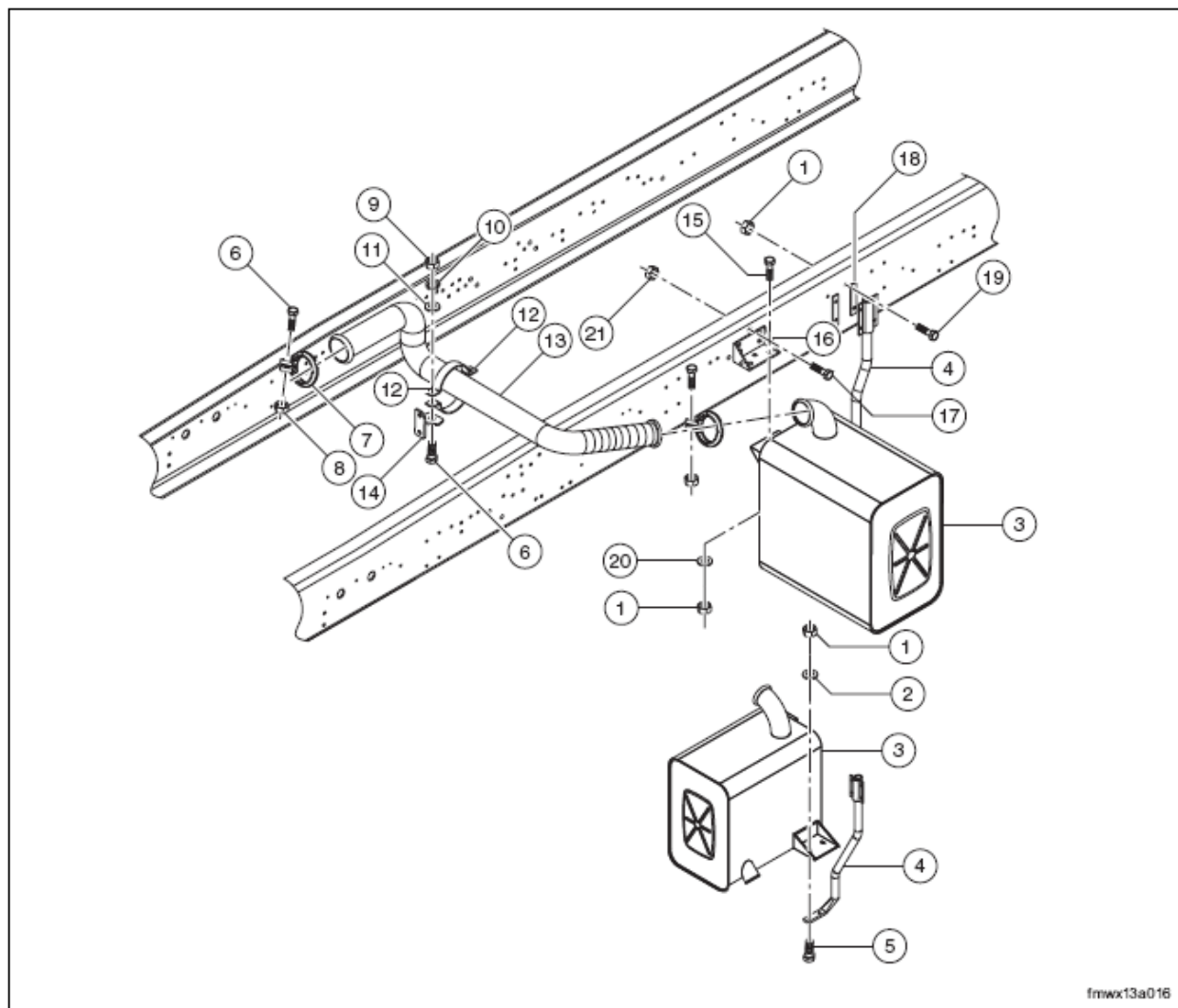
13A



fmwx13c002

1	Pipe assembly
2	Hose clip
3	Rubber hose with fiber interlayer
4	Air compressor inlet pipe
5	Hose clip
6	Rubber pipe
7	Connecting bend
8	Clamp
9	Sealing washer
10	Internal hexagon cylindrical screw
11	Tension pin

12	Tension pin
13	Hexagon bolt
14	Adjusting gasket
15	Clip strip
16	Hexagon screw plug
17	Sealing washer
18	Intake pipe assembly
19	Intake pipe gasket
20	Corrugated flexible washer
21	Intake pipe lock bolt
22	Hexagon bolt



13A

1	Type 2 fully metallic hexagon lock nut
2	Plain washer
3	PZK12-D002 exhaust silencer assembly
4	Silencer bracket 2
5	Hexagon bolt
6	Hexagon bolt
7	Exhaust pipe clip
8	Type 2 fully metallic hexagon lock nut
9	Type 1 hexagon nut
10	Spring washer
11	Plain washer

12	Exhaust pipe clip
13	Exhaust pipe welding assembly
14	Exhaust pipe bracket
15	Hexagon bolt
16	Silencer bracket 1
17	Hexagon bolt
18	Pad
19	Hexagon bolt
20	Plain washer
21	Type 2 fully metallic hexagon lock nut
22	Exhaust pipe clip



FOTON

TESTING AND ADJUSTMENT

The turbocharger is a critical component used to improve the engine power and reduce the emission. In the case of improper operation, service and maintenance, the turbocharger may be disabled to cause the abnormal operation of the engine. Herein some failures and countermeasures related to the turbocharger are described below:

Oil leakage of turbocharger

Symptom I: The engine oil consumption is significant, but the smoke is normal and the power is not reduced.

Cause: This is usually caused by the leakage of engine oil.

Countermeasures:

1. **Check the engine lubricating system external pipe (including the turbocharger oil inlet and return pipes) for leakage.**
2. **Check the presence of engine oil at the turbocharger exhaust outlet. If the engine oil is present, the sealing ring at the turbine end is damaged, and a renewal is required.**

13A

Symptom II: The engine oil consumption is significant and the smoke is blue, but the power is not reduced.

Causes: Due to the leakage at the turbocharger compressor end, the engine oil enters the combustion chamber via the engine intake pipe and is thus consumed. There are following potential cases:

1. **The turbocharger return pipe is not smooth. There is too much oil at the rotor middle bearing which flows into the compressor impeller along the rotor shaft.**
2. **With the damaged sealing ring or thrower ring close to the compressor impeller end, the engine oil enters the impeller chamber from here, and then into the combustion chamber together with the supercharged air via the intake pipe.**

Countermeasures:

1. **Open the compressor outlet or engine intake straight pipe (rubber hose), and check the pipe nozzle and pipe wall for the adhesion of engine oil. If the engine oil is present, check whether the turbocharger return pipe works smoothly. If not smoothly, there is too much oil at the middle bearing; in such a case, clear up the return pipe and refit it.**
2. **If the pipe works smoothly, the sealing ring or thrower ring at the compressor impeller end is damage; in such a case, disassemble the turbocharger for repairs.**

Symptom III: The engine oil consumption is significant, the smoke is blue or black, and the power is reduced.

Causes:

1. **The gap between the piston and cylinder is too large due to wear, and the engine oil enters into the combustion chamber to be consumed.**
2. **In the course of suction of air into the turbocharger, the air flow encounters a significant resistance. (If the air filter insert is clogged, the intake rubber pipe will be deformed or flattened). The pressure at the compressor inlet is low, and as a result, the engine oil enters the compressor to be consumed with the compressed air in the combustion chamber.**

Countermeasures:

1. **Check the straight intake pipe wall for the presence of engine oil and check whether the pipe is flattened, which are causes for the impedance of the air flow or clogging of the air filter insert.**



2. If there is engine oil at the nozzle or on the wall, clean or replace the air filter insert.

Sound arising out of friction between metals

Symptoms: Black smoke, reduced power, and strange noise in the turbocharger.

Causes:

1. If any sound arises out of the friction between metals, the turbocharger rotor bearing or thrust bearing is excessively worn to cause the friction between the impeller and turbocharger housing.
2. If the sound arises out of the air flow other than the friction between metals, the rotor rotates at high speed to generate rotating sounds, or the air leakage occurs at the intake and exhaust interfaces due to improper connection.

Countermeasures:

1. In the case of the former, replace or repair the damaged parts as the case may be.
2. In the case of the latter, solve the problem based on the correct identification.

The turbocharger bearing is damaged

Symptoms: The turbocharger bearing is damaged, the engine power is reduced, the engine oil consumption is significant, the black smoke is emitted, and even the turbocharger can't work.

Causes:

1. **The lubricating oil pressure and flow are insufficient.**
 - There is insufficient supply of lubricating oil to the turbocharger journal and thrust bearing.
 - There is insufficient supply of lubricating oil to keep the rotor journal and bearing floating.
 - The lubricating oil supply is delayed when the turbocharger is already working at high speed.
2. **There is ingress of foreign matters or sand into the lubricating system.**
3. **The engine oil is degraded due to oxidization.**
 - The diesel engine oil is too hot, and too much fuel gas moves through the piston and cylinder wall.
 - The cooling water leaks into the engine oil.
 - The improper engine oil is selected or is not replaced as scheduled.

Countermeasures:

1. **Check whether the lubricating oil pressure is normal and whether the engine oil conforms to the standard requirements.**
2. **Replace the lubricating oil as required and ensure that the oil is clean.**
3. **Use the lubricating oil as required and never mix oil products of different brands.**
4. **Avoid the operation of engine at high temperature, and keep the normal working temperature of the engine.**



13A-10

EXHAUST SYSTEM AND TURBOCHARGER (WD618)-EXHAUST SYSTEM

13A



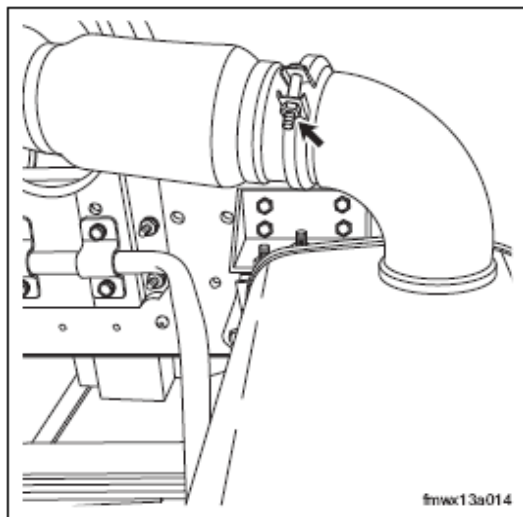
FOTON

EXHAUST PIPE

SERVICE

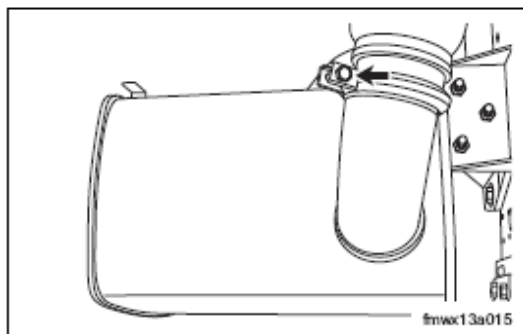
Hint:

As for the Diagram of Components, refer to Chapter 13A: Diagram of Components, Exhaust System and Turbocharger-Exhaust System.

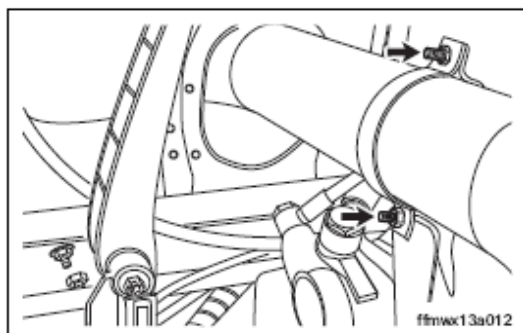


1. Remove the silencer.

- (a) Remove the lock bolt of the silencer clip.



- (b) Remove the lock nut of the silencer bracket.
(c) Take out the silencer.



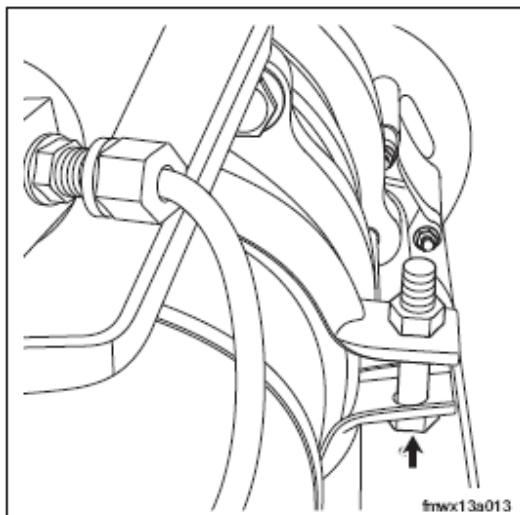
2. Remove the exhaust pipe.

- (a) Remove the lock nut of the exhaust pipe bracket.



13A-12

EXHAUST SYSTEM AND TURBOCHARGER (WD618)-EXHAUST PIPE



- (b) Remove the lock bolt of the exhaust pipe clip.
- (c) Pull out the exhaust pipe.

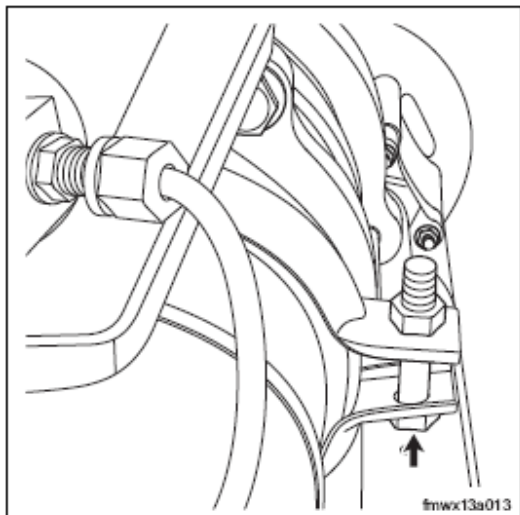
3. Check the exhaust pipe.

- (a) Check the exhaust pipe and silencer for excessive corrosion, cracks and air leakage.
- (b) Check the exhaust pipe and silencer.

13A

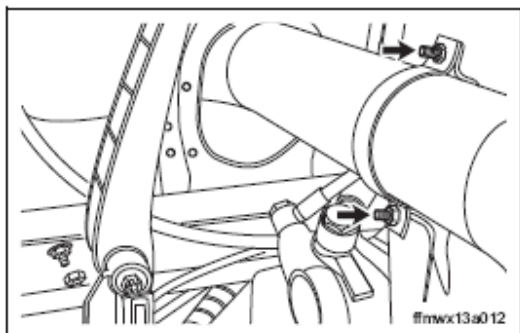
Notice:

If the exhaust pipe and silencer can't meet all requirements related to the performance, they shall be replaced.



4. Refit the exhaust pipe.

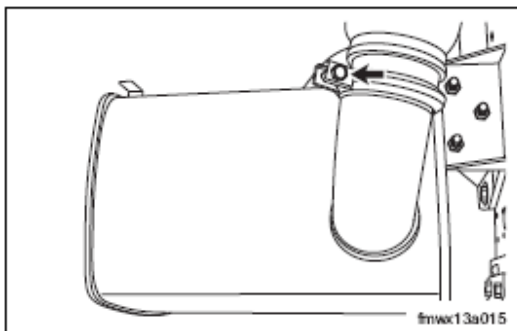
- (a) Refit the exhaust pipe.
 - (b) Refit the lock bolt and nut of the exhaust pipe clip.
- Torque: $80 \pm 10 \text{ N.m}$**



- (c) Refit the exhaust pipe bracket lock nut.
- Torque: $45 \pm 5 \text{ N.m}$**



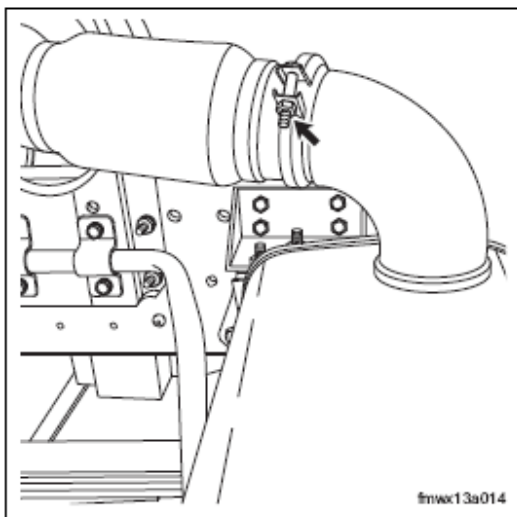
FOTON



5. Refit the silencer.

- (a) Refit the silencer.
- (b) Refit the bolt of silencer bracket.

Torque: $45 \pm 5 \text{ N.m}$



- (c) Refit the lock bolt of the silencer clip.

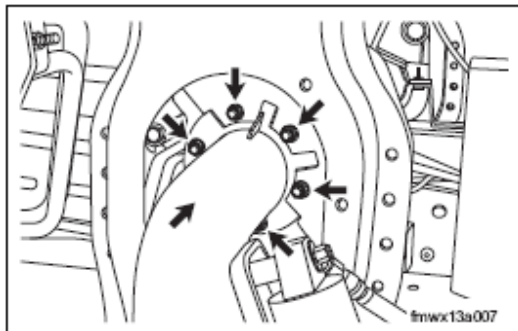
Torque: $80 \pm 10 \text{ N.m}$

TURBOCHARGER

SERVICE

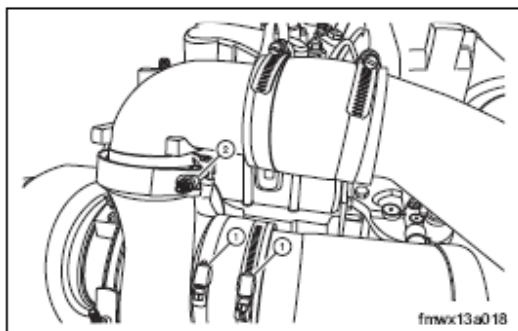
Hint:

As for the Diagram of Components, refer to Chapter 13A: Diagram of Components, Exhaust System and Turbocharger-Exhaust System.

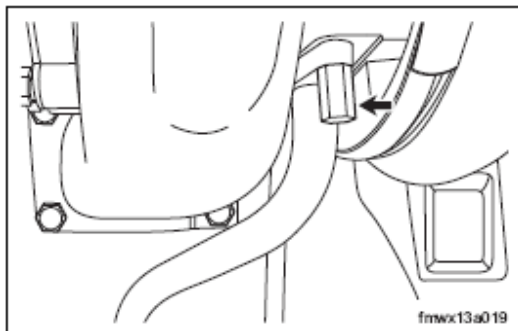


1. Remove the turbocharger.

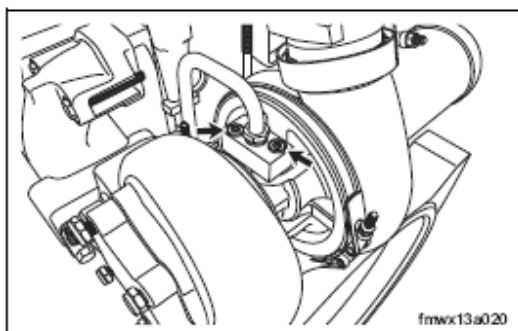
- (a) Remove the heat-insulating casing and exhaust pipe.



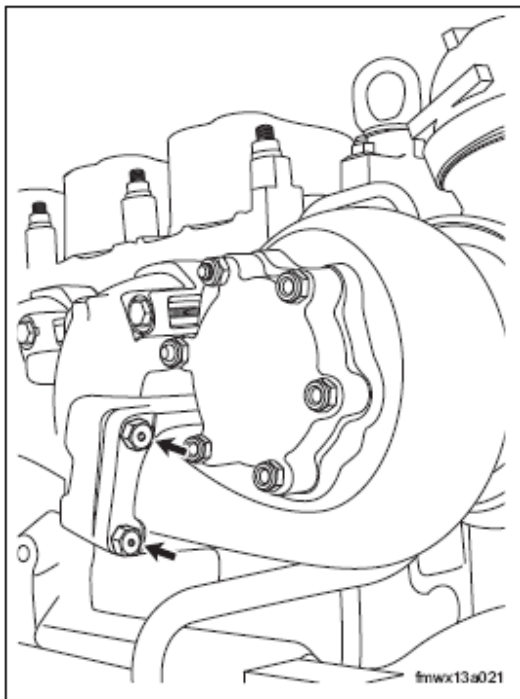
- (b) Remove the intercooler intake pipe 1 and connecting bend 2.



- (c) Remove the oil return pipe.
- Remove the return pipe bolt.



- (d) Remove the oil inlet pipe.
- Remove the internal hexagon bolt of the oil inlet pipe.



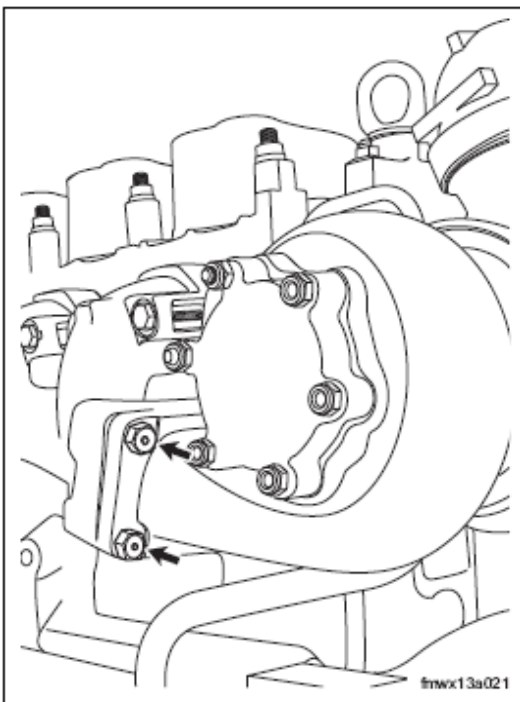
(e) Remove the lock bolt of the turbocharger.

Hint:

The turbocharger is fixed with four lock bolts.

13A

2. Check the turbocharger. Refer to Chapter 13A: Diagram of Components, Exhaust System and Turbocharger-Exhaust System.



3. Refit the turbocharger.

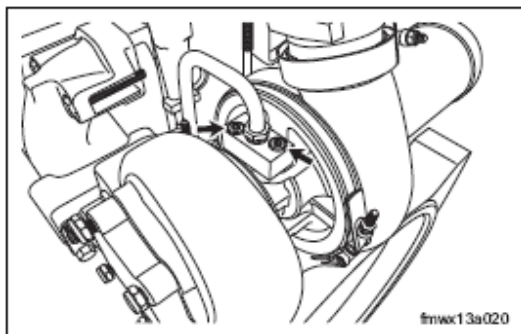
(a) Refit these four bolts of the turbocharger.

Torque: $45 \pm 5 \text{ N.m}$

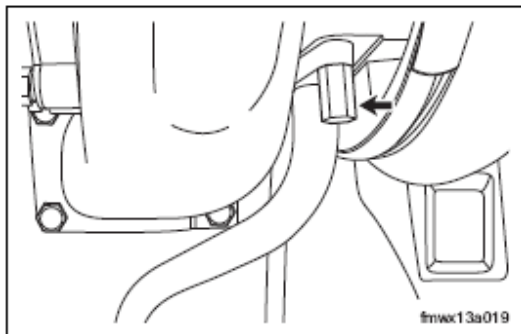


13A-16

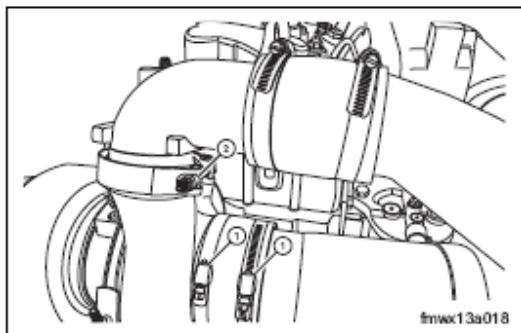
EXHAUST SYSTEM AND TURBOCHARGER (WD618)-TURBOCHARGER



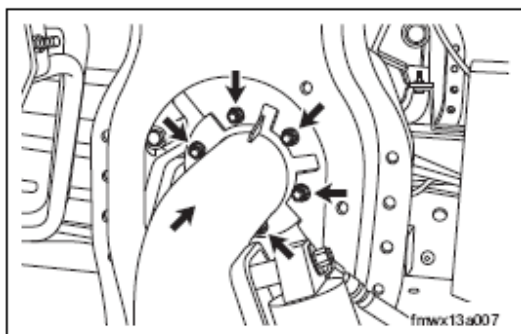
- (b) Refit the oil inlet pipe.
- Refit the oil inlet pipe internal hexagon bolt.



- (c) Refit the oil return pipe.
- Refit the oil return pipe bolt.



- (d) Refit the intercooler intake pipe 1 and connecting bend 2.



- (e) Refit the heat-insulating casing and exhaust pipe.
Torque: 25±5N.m

13A



FOTON

COOLING (WD618)

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COOLING FAN	14A-27
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Service	14A-34
THERMOSTAT.....	14A-38
Service	14A-38



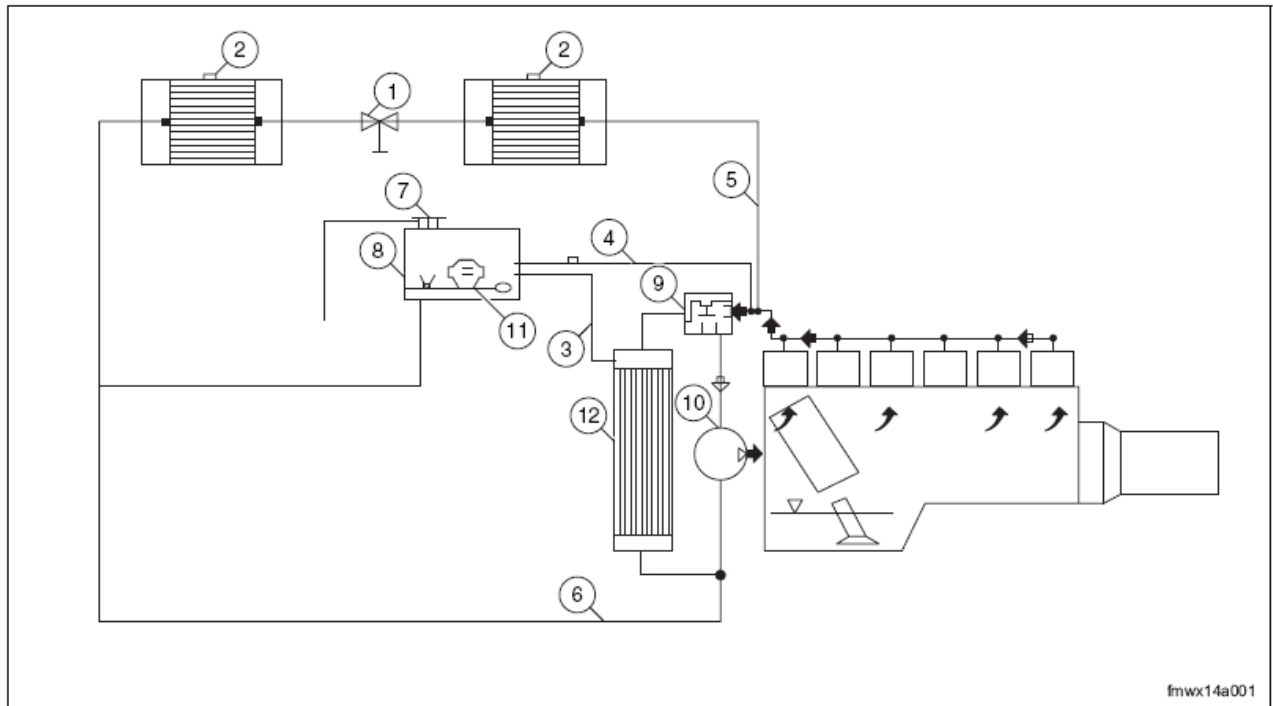
COOLING SYSTEM

OVERVIEW

The cooling system of the diesel engine is used to transfer the heat absorbed by the engine members being heated in good time by utilizing the cooling medium, namely, the cooling liquid, ensuring that such members can work normally under the permitted temperature conditions. As for the cooling of diesel engine, the proper cooling level other than the maximum cooling level is required, for the overcooling may exert adverse influences on the operation of the diesel engine as follows: firstly, the cylinder temperature may be too low thus to increase the ignition delay of the fuel, resulting in the reduction of combustion rate and increase of the heat loss; secondly, the engine may work in a rough manner to increase the fuel consumption; thirdly, the viscosity of lubricating oil will be increased to increase the friction power loss of moving parts, thus reducing the engine power. Therefore, only the proper cooling can ensure the correct and economic operation of the engine.

It is not allowed to use the ordinary water as cooling liquid, for the scale generated in the heating process of the water has a heat conduction rate 40 times lower than that of the cast iron, and the scaling on the water jacket wall will degrade the performance of engine cooling system. In particular, if the throttling hole on the cylinder liner is clogged by the scale, the rational water flow may be damaged to give rise to various failures and damages.

The engine cooling system is composed of the water pump, radiator, fan, thermostat, secondary water tank, cooling pipe and water pipe in the cylinder, and cooling water chamber of the crankcase.



14A-4**COOLING (WD618)-COOLING SYSTEM**

1	Switch	7	Pressure limiting valve cover
2	Air heater	8	Secondary water tank
3	Water tank air outlet pipe	9	Thermostat
4	Secondary water tank air inlet pipe	10	Water pump
5	Air heater water inlet pipe	11	Water filler cover
6	Water pipe	12	Water tank

The water pump is the power unit for the forced circulating water cooling system. It is mainly used to establish a certain pressure of the cooling liquid which will be then forced to flow into various cooling parts of the engine, thus ensuring the continuous circulation of the cooling liquid in the operation of diesel engine. In the WD618 diesel engine, the water pump is mounted at the front end of the engine, and the water flows into the right chamber of the body. The cooling water flows across the engine oil cooler and enters the cylinder water jacket through the right lower hole; after the cylinder block is cooled, the water will enter the cylinder head water chamber through the upper hole to cool the cylinder head and then flow into the water outlet pipe via the cylinder head water outlet. At the water outlet pipe, a thermostat is fitted. The thermostat has two outlets, one to the radiator, and the other to the water pump inlet, constituting a small circulation. When the cooling liquid temperature reaches $80\pm 2^{\circ}\text{C}$, the thermostat will be opened; when the temperature reaches 95°C , it will be fully opened. At this moment, the cooling liquid will be fully cooled by the radiator and delivered to the engine by the pump. If the cooling liquid temperature is lower than $80\pm 2^{\circ}\text{C}$, the thermostat will cut off the above-mentioned pass, and the cooling liquid directly flows into the pump inlet to increase the engine temperature quickly as necessary for operation, so as to prevent low-temperature abrasion and prolong the service life of engine.

The water pump oil chamber shall be filled with about 120cm^3 of automobile universal lithium-based grease on a regular basis.

Radiator

The radiator is used to transfer the heat absorbed by the cooling liquid from members being heated to the air to be dispersed in the atmosphere, thus reducing the cooling liquid temperature.

Fan

The working medium of the silicon oil fan clutch is silicon oil, which utilizes the high viscosity of silicon oil in the transfer the torque. Based on the temperature of air behind the radiator, the temperature sensor can automatically control the fan clutch for engagement and disengagement. When the temperature is low, the silicon oil will not flow, and the fan clutch is disengaged; at this moment, the fan speed is reduced, basically idle. When the temperature is high, the fan clutch will be engaged under the viscosity of the silicon oil, and the fan will rotate together with the water pump to regulate the engine temperature. Both the silicon oil fan clutch and temperature-sensing element are dual-metal spiral spring temperature sensors, with the working flow described as follows:

1. When the temperature of air passing the radiator increases, the dual-metal temperature sensor will be heated and thus deformed to rotate the valve disc shaft and open the oil inlet on the driven plate. Thus, the silicon oil stored between the driven plate and front cover will enter the working chamber between the drive plate and driven plate to engage the clutch and increase the fan speed. The higher the air temperature is, the wider the oil inlet is opened and the higher the fan speed is.
2. When the temperature of air passing the radiator decreases, the dual-metal temperature sensor will be recovered and the valve disc will close the oil inlet. Under the centrifugal force, the silicon oil will return to the oil chamber from the working chamber via the oil return hole to disengage the clutch and reduce the fan speed.

Thermostat

The thermostat is used to maintain the cooling liquid at a proper temperature, either ensuring the reliable cooling of the diesel engine, or avoiding impairing the power and cost efficiency of the diesel engine. When the cooling liquid temperature is low, the large circulating flap of the thermostat will be closed while the small flap will be opened. The cooling liquid in the engine water return pipe will be directly delivered to the pump inlet via the small flap, and the pump will supply the liquid into the cooling system again; at this moment, the water tank is disabled. After the engine water temperature rises to a certain temperature, the large flap of the thermostat will be opened while the small flap will be closed, and the cooling liquid will return into the water tank via the tank return pipe. After being cooled down, the liquid will be suctioned by the pump from the water tank and then delivered into the engine cooling circulation system. In this vehicle, the paraffin type core assembly thermostat is adopted. If the cooling liquid temperature is lower than the required value, the good-quality paraffin in the thermostat temperature sensor will be in its solid state, and the thermostat valve will close the passage between the engine and radiator under the action of the spring. The cooling liquid, which returns to the engine from the pump, will execute a small circulation in the engine. After the liquid temperature reaches the required value, the paraffin will be gradually melted to obtain its liquid state, accompanied with the volume expansion, and it will force the rubber pipe to be shrunk; in addition, the shrinkage of rubber pipe will exert an upward push on the push rod which will react on the valve to open it. At this moment, the cooling liquid will fulfill a large circulation by passing through the radiator and thermostat valve and then returning into the engine via the pump. Most of paraffin thermostats are located in the cylinder head water outlet pipeline, featuring simple structure and easy elimination of air bubbles in the cooling system, while the shortcoming of such an arrangement consists in that the thermostat will be normally closed in operation to cause oscillation.

14A

Secondary water tank

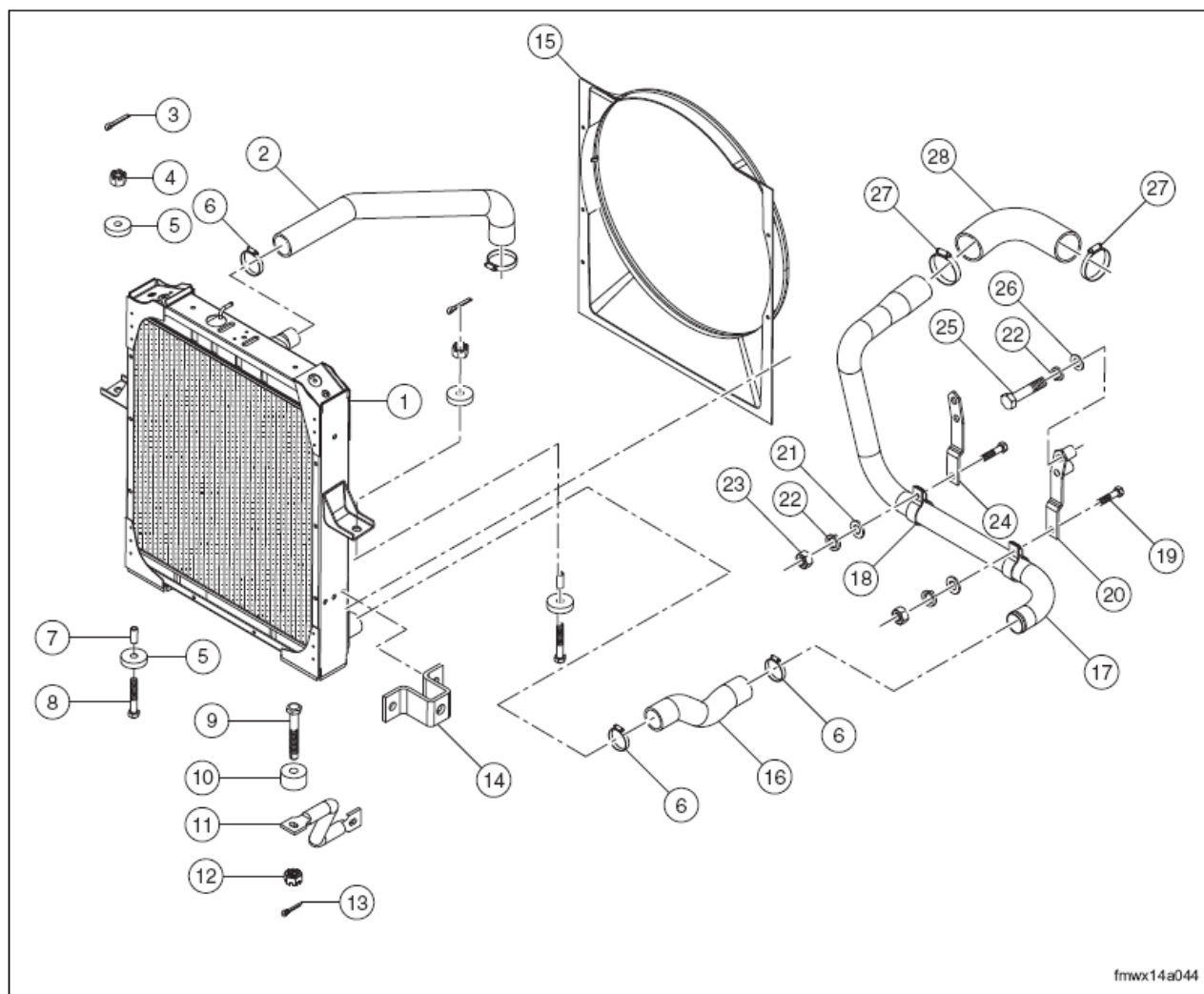
The secondary water tank is used to eliminate the steam of low-pressure portion of the cooling system, to avoid air lock and refilling of cooling liquid. The pressure in the secondary water tank shall be maintained at 50kPa, and the tank shall be located such that it is higher than the diesel engine and radiator by 400mm.

All water tank covers in the cooling system must be kept in good conditions and shall not remain opened. Maintaining a pressure of 50kPa in the cooling system will improve the cooling efficiency and prevent boiling.

PRECAUTIONS

1. Never open the pressure cover when the engine is hot, but do it after the cooling liquid temperature is reduced to 50°C below; otherwise the hot liquid or steam may be injected to cause injuries.
2. To disconnect the cooling system pipeline, use a dedicated vessel to receive the residual cooling liquid; if no further use is allowed, dispose the liquid as required.
3. At disconnecting the cooling system pipeline, prevent the entry of scraps into the pipeline, which otherwise may damage the cooling system and engine.
4. At disconnecting the cooling system pipeline union, to prevent the ingress of dirt or foreign matters, use the dedicated plug to close the nozzle.
5. The cooling liquid is poisonous. If no further use is permitted, keep it far from children and animals, and dispose it as required.
6. Anti-freezing liquids of different brands may differ each other with respect to their production formulae. If they are mixed, chemical reactions may occur among different additives to make them ineffective.
7. The valid term of anti-freezing liquid will last for two years, and the validity must be confirmed prior to the use.
8. The liquid must be replaced regularly, generally every two years or every 40,000km.
9. Prior to the replacement, the old liquid must be fully discharged and the cooling system shall be thoroughly cleaned.
10. Use qualified cooling liquids.
11. When the air temperature is lower than 0°C, check the density of cooling liquid on a regular basis.

DIAGRAM OF COMPONENTS



14A

1	Radiator assembly
2	Radiator water inlet hose
3	Split pin
4	Type 1 hexagon slotted nut-fine thread
5	Radiator mounting cushion
6	Type A worm drive type hose hoop
7	Sleeve
8	Hexagon bolt with holes on the shank
9	Hexagon bolt with holes on the shank
10	Hexagon pull rod cushion

15	Shroud assembly
16	Radiator water outlet hose
17	Engine water inlet pipe welding assembly
18	Pipe hoop
19	Hexagon bolt
20	Water inlet pipe bracket II
21	Plain washer
22	Spring washer
23	Type 1 hexagon nut
24	Water inlet pipe bracket



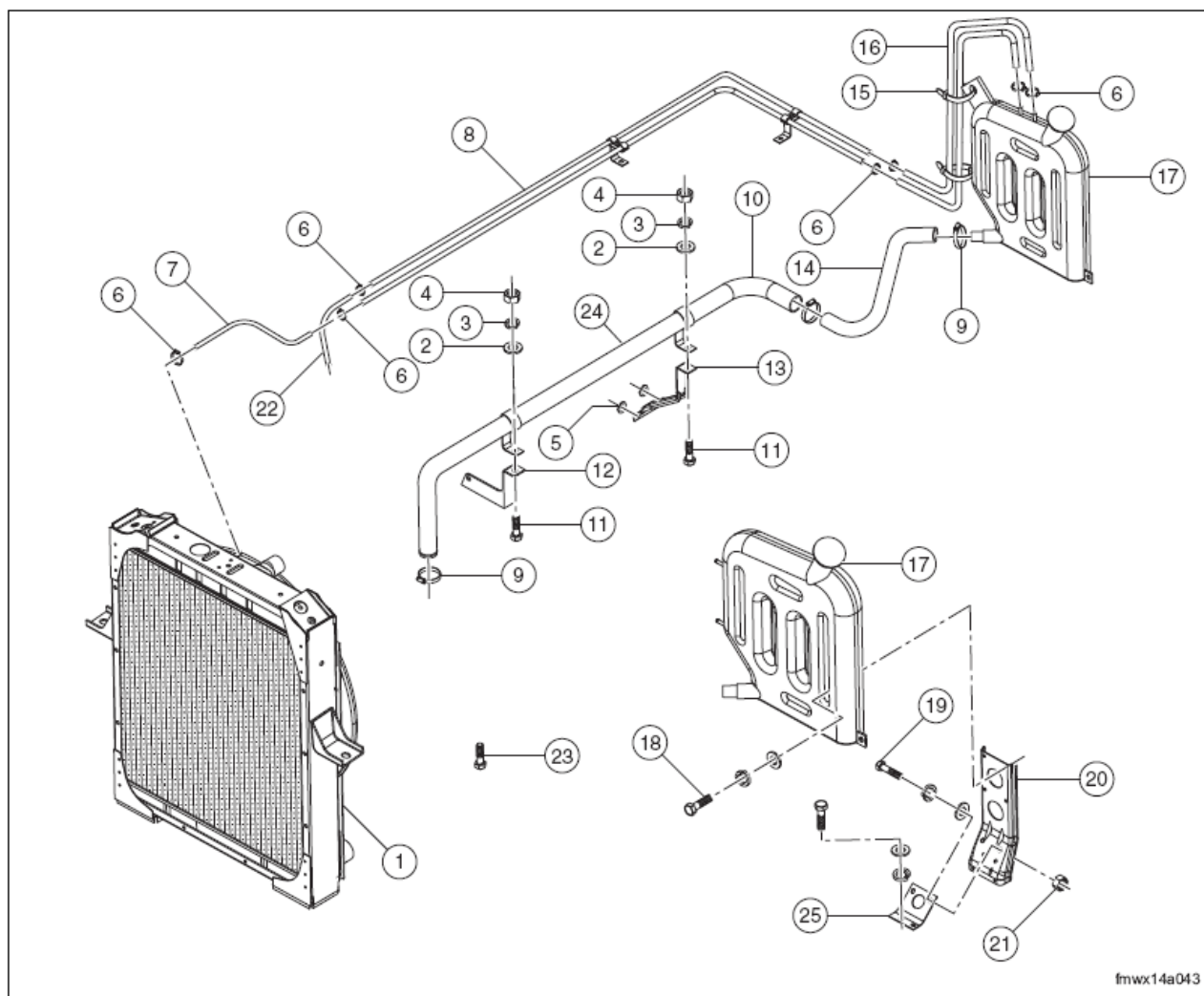
FOTON

14A-8**COOLING (WD618)-COOLING SYSTEM**

11	Radiator pull rod
12	Hexagon slotted thin nut
13	Split pin
14	Pull rod fixture

25	Hexagon bolt
26	Plain washer
27	Type A worm drive type hose hoop
28	Engine water inlet hose

14A**FOTON**



14A

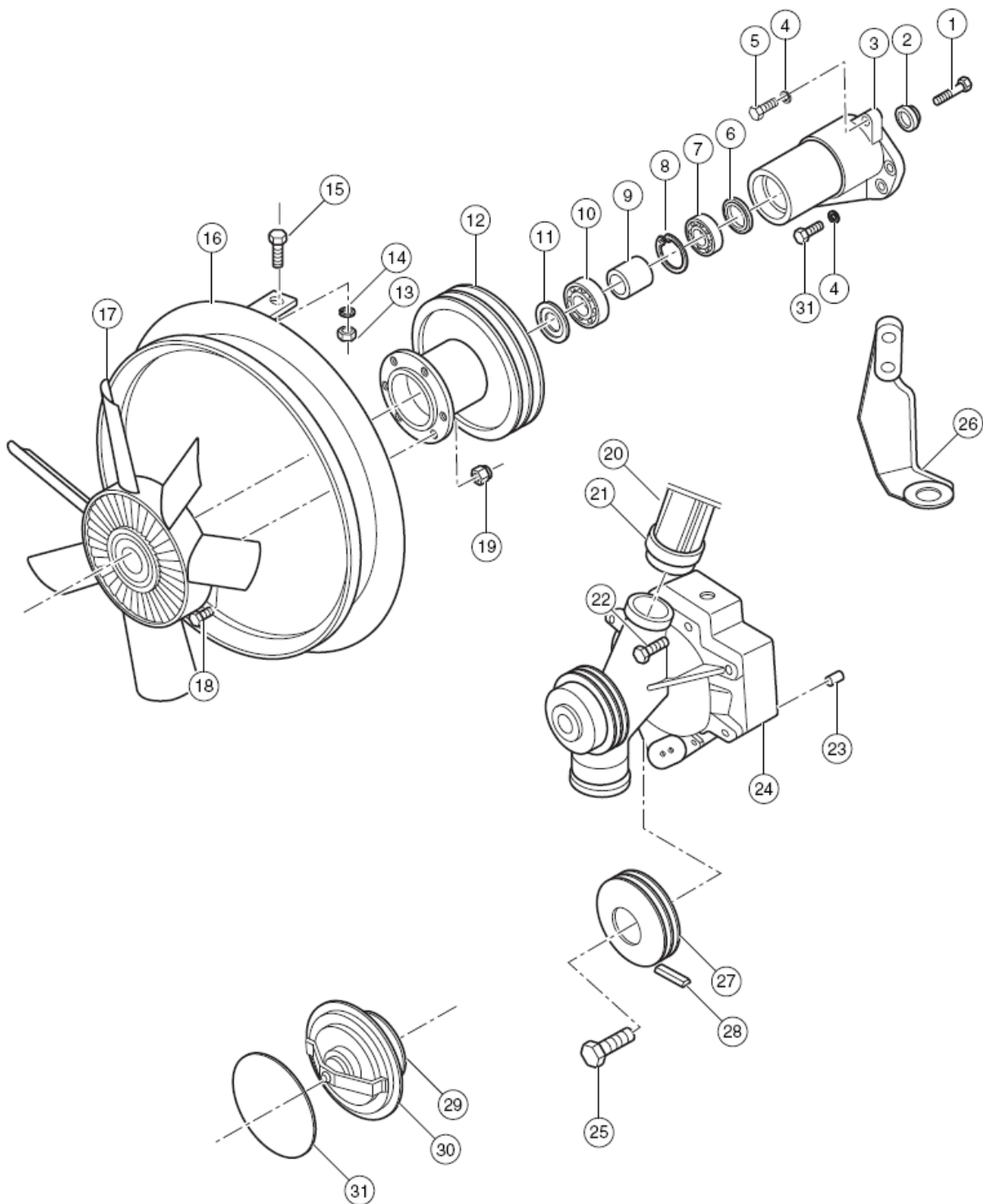
1	Radiator & shroud assembly
2	Plain washer
3	Spring washer
4	Type 1 hexagon nut
5	Plain washer
6	Type A worm drive type hose hoop
7	Radiator air outlet hose 1
8	Air outlet pipe assembly
9	Type A worm drive type hose hoop
10	Water filler steel pipe assembly
11	Hexagon bolt
12	Water filler steel pipe bracket 1
13	Water filler steel pipe bracket 2

14	Cooling water hose 2
15	Plastic binding strip
16	Air outlet hose
17	Plastic secondary water tank
18	Hexagon bolt
19	Hexagon bolt
20	Secondary water tank bracket
21	Hexagon bolt
22	Radiator air outlet hose
23	Hexagon bolt
24	Cooling water hose II
25	Secondary water tank supporting plate



14A-10

COOLING (WD618)-COOLING SYSTEM



fmwx14a045

1	Hexagon bolt
2	Pressing block
3	Fan bracket
4	Saddle-shaped flexible washer

17	Silicon oil clutch fan
18	Hexagon bolt
19	Type II hexagon lock nut
20	Shaped hose



FOTON

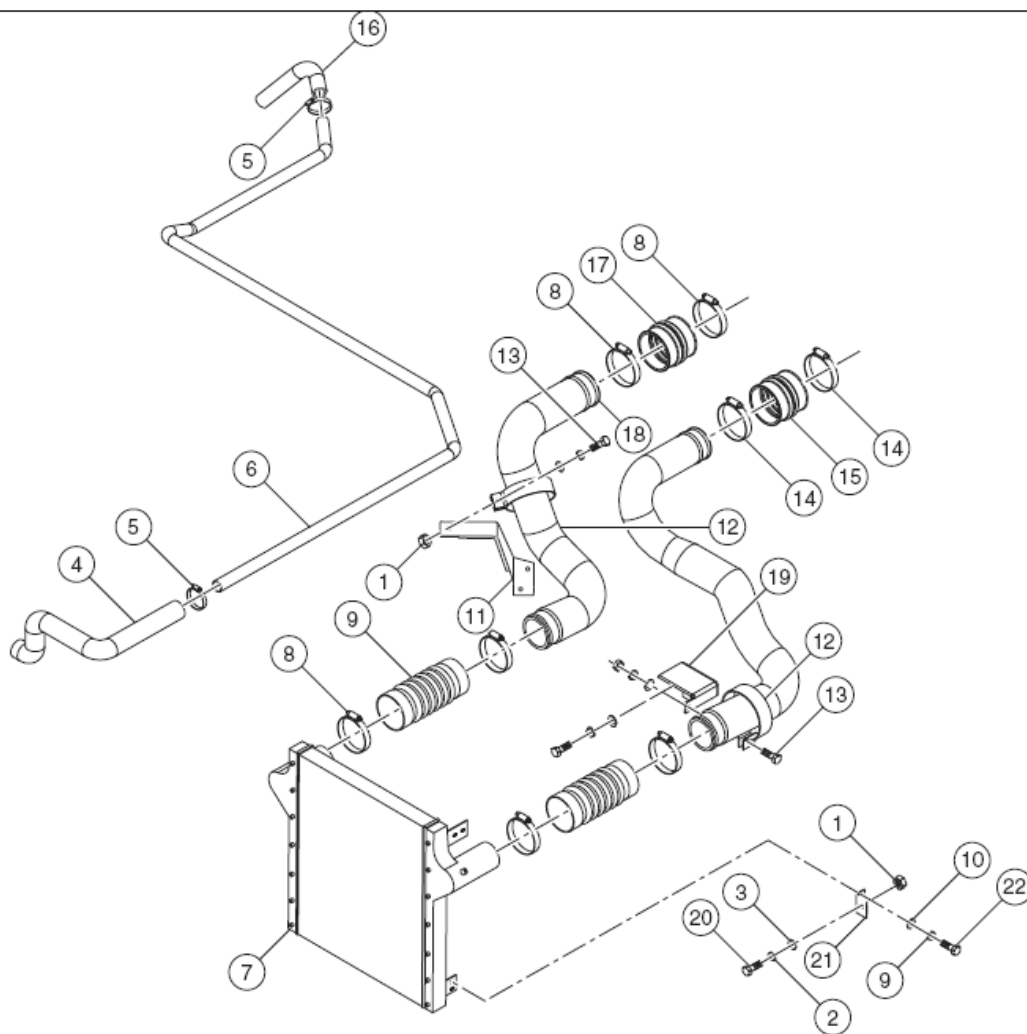
COOLING (WD618)-COOLING SYSTEM**14A-11**

5	Hexagon bolt	21	Hose hoop
6	Grommet	22	Hexagon bolt
7	Radial thrust ball bearing	23	Cylindrical pin
8	Flexible retaining ring for holes	24	Water pump assembly
9	Spacer	25	Hexagon bolt
10	Cylindrical roller bearing	26	Bracket
11	Grommet	27	Tensioner assembly
12	Pulley assembly	28	V-belt
13	Type I hexagon nut	29	Lining
14	Corrugated flexible washer	30	Thermostat
15	Hexagon bolt	31	Sealing ring
16	Shroud assembly	32	Hexagon bolt

14A**FOTON**

14A-12

COOLING (WD618)-COOLING SYSTEM



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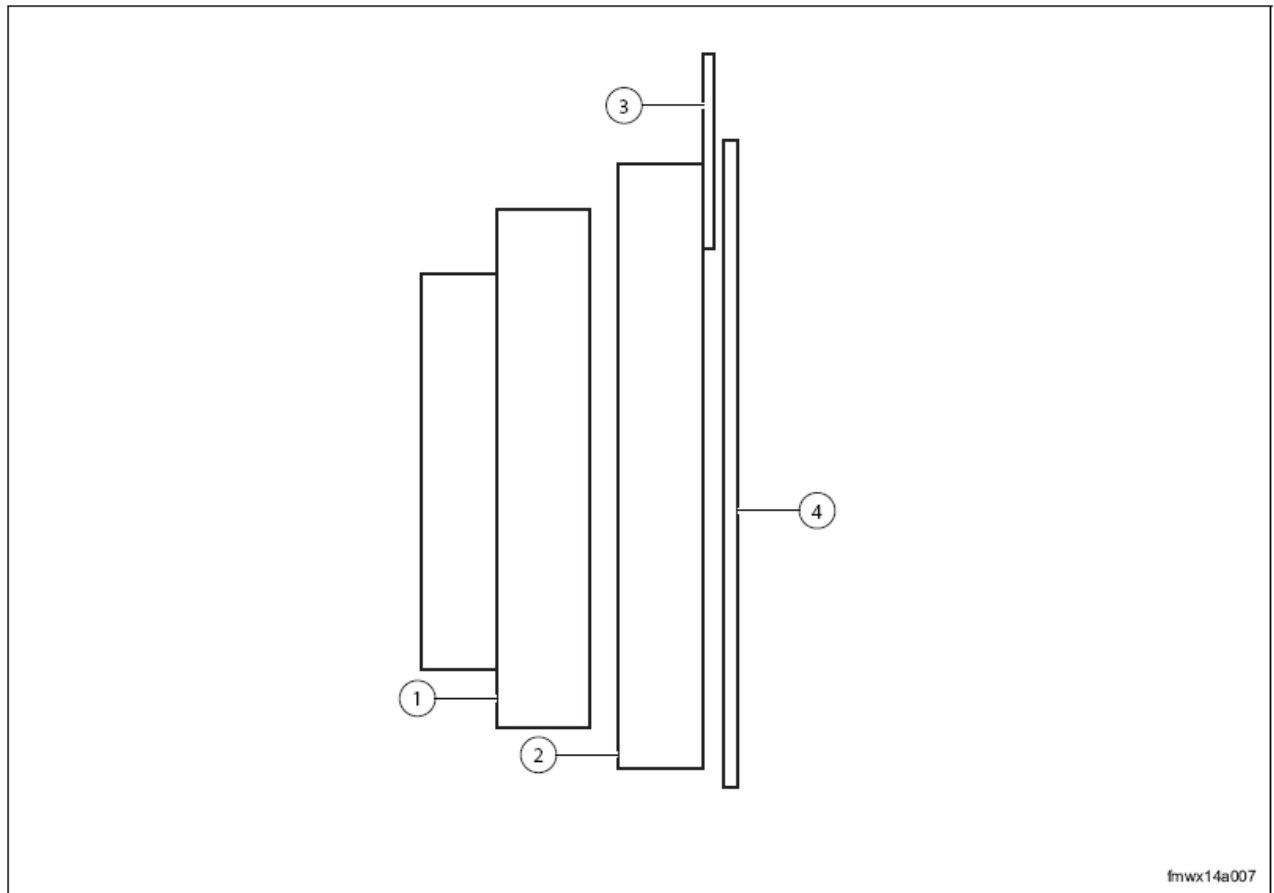
1	Type I hexagon nut
2	Spring washer
3	Plain washer
4	Air compressor inlet hose
5	Type A worm drive type hose hoop
6	Air compressor inlet steel pipe
7	Intercooler assembly
8	Clip
9	Connecting hose
10	Engine inlet steel pipe
11	Intercooler outlet steel pipe bracket

12	Clip
13	Hexagon bolt
14	Clip
15	Hose union
16	Air compressor inlet hose
17	Hose union
18	Intercooler inlet steel pipe
19	Intercooler inlet steel pipe bracket
20	Hexagon bolt
21	Intercooler fixture
22	Hexagon bolt

TESTING AND ADJUSTMENT

Fan

Manual test method: Start the engine and run it for several minutes. Then shut down the engine and move the fan by hand. If the clutch is separated and the fan can rotate, the silicon oil fan is in good conditions. Sometimes, the fan will not rotate if the temperature is low, and the silicon oil can't return quickly, which doesn't indicate any damage of the fan. In such a case, start the engine and try again; then stop engine after it works at middle speed and low temperature for 1-2 minutes. At this moment, move the fan by hand; if the fan can rotate freely, the fan is in good conditions. When the temperature reaches 88°C, stop the engine and move the fan by hand. If the fan can't be moved, the fan works normally; otherwise it is defective.



1	Fan	3	Thermometer
2	Radiator	4	Baffle

Dynamic test: Place the thermometer (range: -18-105°C) in front of the radiator. Fix a plastic plate before the radiator to prevent the air from passing the radiator. If the air conditioner is fitted, turn off its switch. Align the fan blade with a timing lamp, start the engine and run it at 2400r/min. The reading on the pointer thermometer shall reach 88°C within 10min. The fan clutch should be engaged before the temperature reaches 88°C. Observe the increase of fan speed. After the temperature reaches 88°C, remove the plastic plate, and the air temperature will start to drop. Ideally, the silicon oil fan clutch shall be able to reduce the air temperature by 11°C or more; meanwhile, the air flow noise shall be cut down by hearing. If the fan clutch can't meet all above-mentioned requirements, the clutch assembly shall be replaced.

Water pump

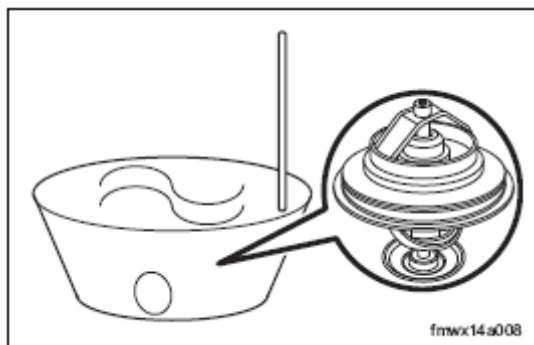
In the case of leakage in the cooling system, the smell of hot anti-freezing liquid can be felt. But it is necessary to check whether the water comes from the water pump shaft seal. To do this, use a mirror and light to check the leakage at the pump air bleeding hole. It is required to perform maintenance work and check the loss of cooling liquid on a regular basis.

Never underestimate the seriousness of leakage in the cooling system. The leakage will not only lead to the disorder of the preset cooling liquid flowing mode due to the absorbed air to cause hot points, but will also largely worsen the corrosion of water pump.

If the cooling liquid volume remains insufficient for long, the engine may be subject to over-heating in addition to the corrosion by the steam, which will damage the radiator and cause other pump problems. When the cooling liquid turns red, showing the color of iron rust, the impeller may have been corroded. In such a case, check the circulation conditions of the pump. To do this, discharge part of cooling liquid from the radiator to maintain the liquid level just above the water pipe; then preheat the engine, and operate the thermostat to be at the fully open position. When the engine speed reaches 3000rpm, a good water circulation shall be available.

Thermostat

The paraffin type thermostat has a service life of 50000km, and it shall be replaced as scheduled.

**1. Check the thermostat.**

- (a) The thermostat and thermometer can be placed in the hot water.
- (b) Check the opening temperature of the thermostat main valve.
- (c) Check the thermostat sealing ring.
- (d) If the thermostat can't meet all limit requirements, it shall be replaced.

Opening temperature	Fully opening temperature
80±2°C	95°C

Water pipe

Check whether the water pipe is clogged by foreign matters, or bulged, aged or cracked; check whether the pipe union is connected reliably.

Secondary water tank

Check whether the secondary water tank is cracked, and check whether the tank pipe is bulged, aged or cracked and whether the tank cover is intact.

Cooling liquid

After the engine runs at idle speed and is preheated to the normal working temperature, the level of cooling liquid in the reservoir shall be located between "MAX" mark and "MIN" mark, as shown on the reservoir. Use the freezing point tester to check the density of cooling liquid.

Radiator

Fill water into the radiator and check whether the water can flow smoothly; if not smoothly, the radiator inside is blocked. In such a case, flush the external radiator, and use hot water to clean the radiator inside. If this can't remove the scale in the radiator, use a soft metal strip to clear away the dirt and then clean the radiator by using the method described above. Remove damaged cooling fins of the radiator pipe with long-nose pliers, and cut off the damaged pipe. Thereafter, insert the said strip from the core end, thread it through upper and lower nozzles of the cut pipe, and straighten it. Take a piece of useful radiator pipe of the equivalent size from the old radiator, and weld both upper and lower nozzles with the soldering tin. Insert the resistor heater into the radiator pipe to be used, and switch on the 24V power supply. After the resistor is burnt red and the radiator pipe soldering tin is fused to separate the pipe, disconnect the power supply, and take out the radiator pipe together with the resistor heater and refit a new pipe which shall be welded reliably. Fit the radiator tester at the radiator cover opening to check the leakage of cooling system. Pressurize the radiator to 176kPa, and check the leakage of cooling liquid at normal working temperature. If there is leakage, the repair work shall be performed.

Intercooler

The supercharged intercooler is employed in this vehicle, fitted at the front end of the diesel engine, namely, the front end of water tank, to cool down the engine with the air draught fan and the adverse wind in the running order. The pipe in the intercooler is usually stuck with oil, adhesive matters etc, which will not only cut down the width of air passage to reduce the heat exchanging capacity, but will also decrease the air intake due to the blockage of air passage by the dirt, to reduce the engine power and cause white smoke in the emission, or even to impede the normal operation of the vehicle.

Fill water into the intercooler and check whether the water can flow smoothly; if not smoothly, the intercooler inside is blocked. In such a case, flush the intercooler with hot water; if this doesn't work, replace the intercooler.

14A

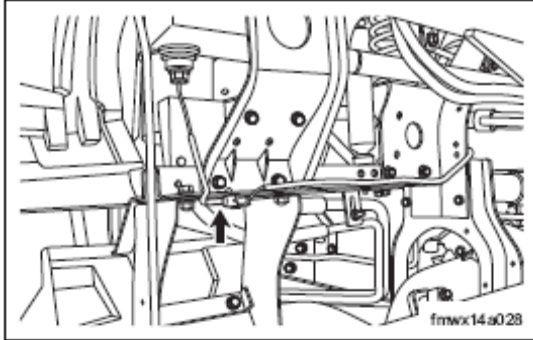
SECONDARY WATER TANK

SERVICE

Hint:

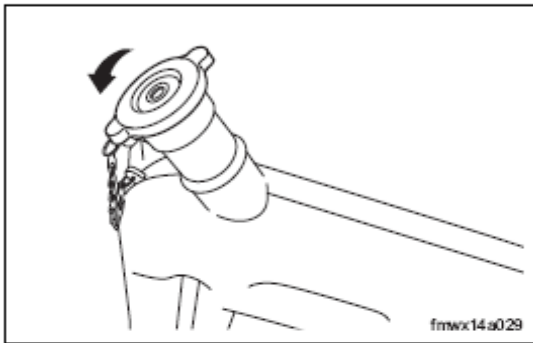
As for the Diagram of Components, refer to Chapter 14A: Diagram of Components, Cooling-Cooling System.

1. Discharge the cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.



2. Remove the secondary water tank.

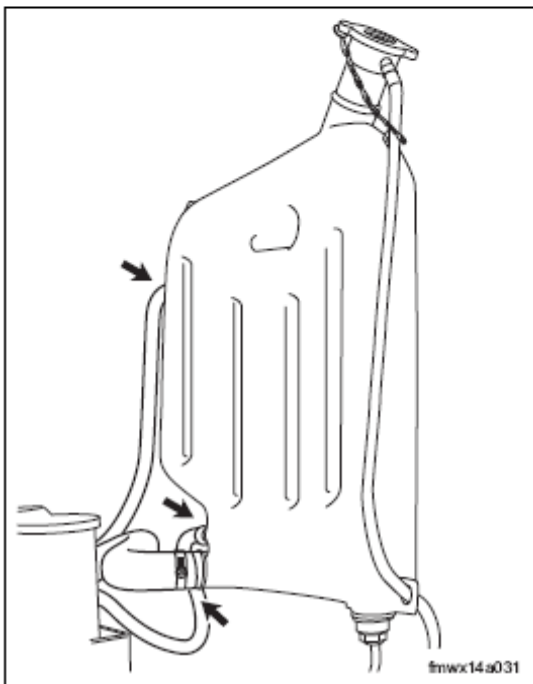
(a) Disconnect the wires of water tank.



(b) Open the tank cover.

Notice:

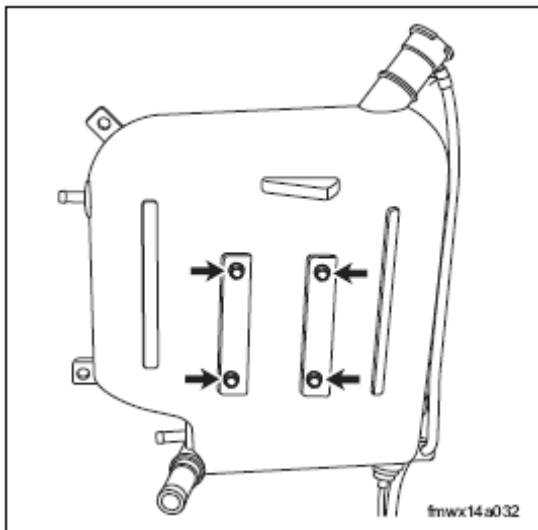
Never open the pressure cover when the engine is hot, but do it after the cooling liquid temperature is reduced to 50°C below; otherwise the hot liquid or steam may be ejected to cause injuries.



(c) Disconnect the secondary water tank pipe.

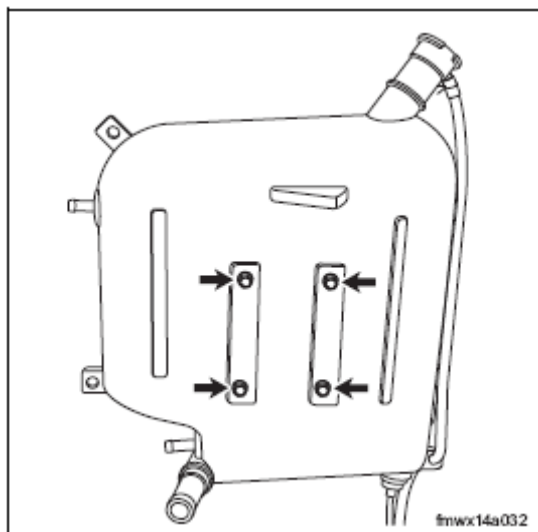
Notice:

When disconnecting the cooling system pipe union, to avoid the ingress of dirt or impurities, use the dedicated plug to close the nozzle.



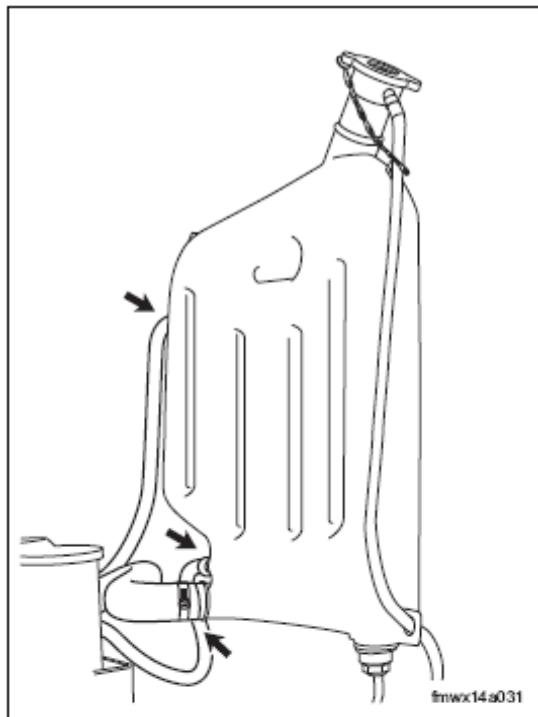
- (d) Remove the set bolt of secondary water tank.

3. Check the secondary water tank. Refer to Chapter 14A: Testing and Adjustment, Cooling-Cooling System.

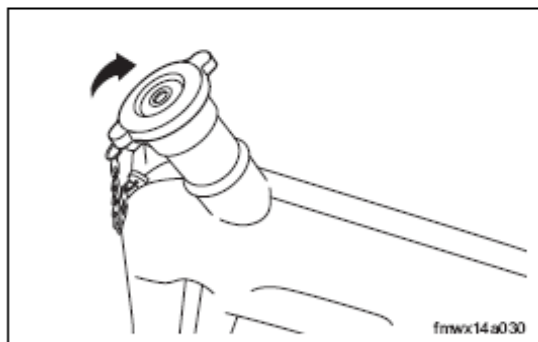


4. Refit the secondary water tank.
(a) Refit the set bolt of the tank.
Torque: 20N.m





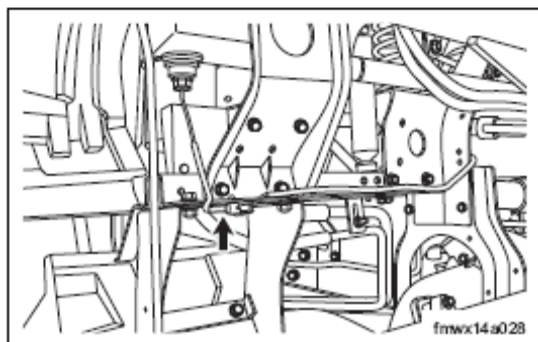
(b) Connect the tank pipe.



(c) Refill the cooling liquid.

Notice: The level of cooling liquid in the tank must be located between MIN and MAX marks, close to the MAX mark as much as possible.

(d) Fasten the tank cover.

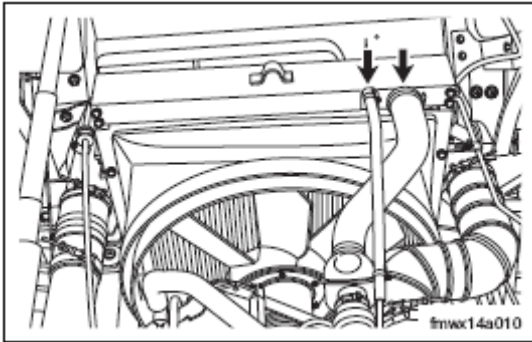


(e) Disconnect the wire connections of the tank.

Notice: After the tank is fitted, run the engine and check whether there is any leakage of cooling liquid.

COOLING LIQUID

REPLACEMENT



1. Discharge the cooling liquid.

- (a) Disconnect the radiator water inlet hose and air outlet pipe.

Notice:

Never open the pressure cover when the engine is hot, but do it after the cooling liquid temperature is reduced to 50°C below; otherwise the hot liquid or steam may be ejected to cause injuries.

Notice:

When disconnecting the cooling system pipe union, to avoid the ingress of dirt or impurities, use the dedicated plug to close the nozzle.

- (b) Disconnect the radiator water outlet hose.

Notice:

When disconnecting the cooling system pipe union, to avoid the ingress of dirt or impurities, use the dedicated plug to close the nozzle.

Notice:

The cooling liquid is poisonous. If no further use is permitted, keep it far from children and animals, and dispose it as required.

- (c) Undo the secondary water tank cover.

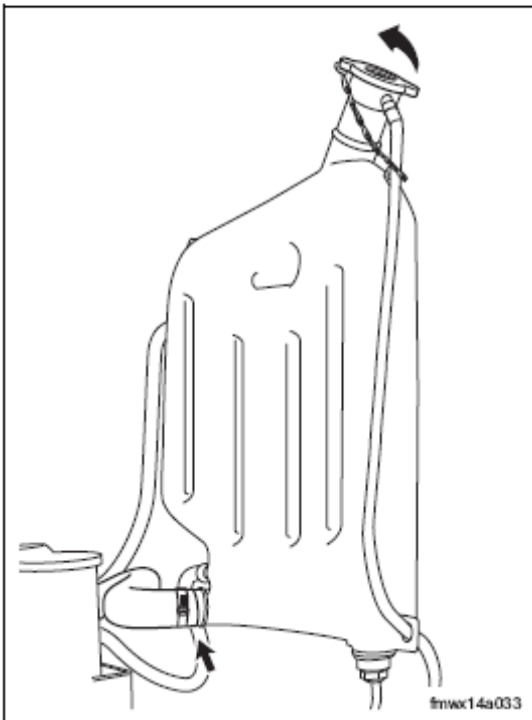
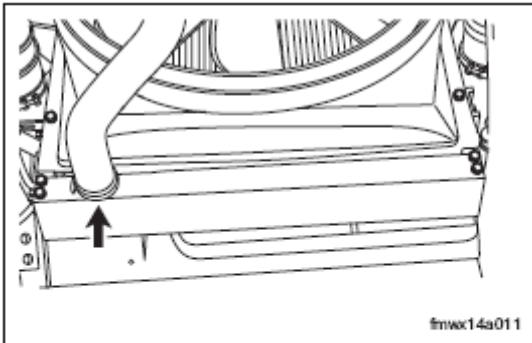
- (d) Disconnect the tank water pipe.

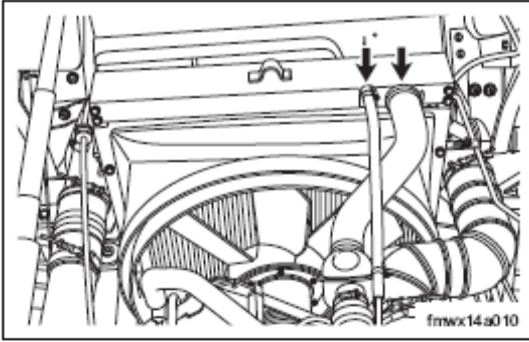
Notice:

When disconnecting the cooling system pipe union, to avoid the ingress of dirt or impurities, use the dedicated plug to close the nozzle.

Notice:

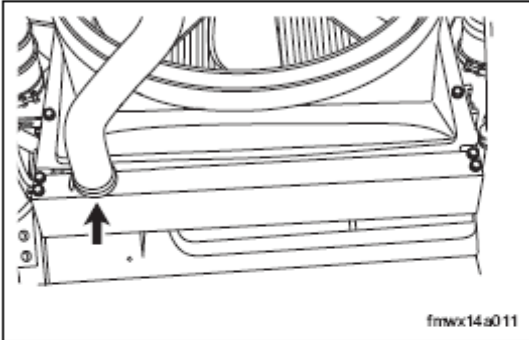
The cooling liquid is poisonous. If no further use is permitted, keep it far from children and animals, and dispose it as required.



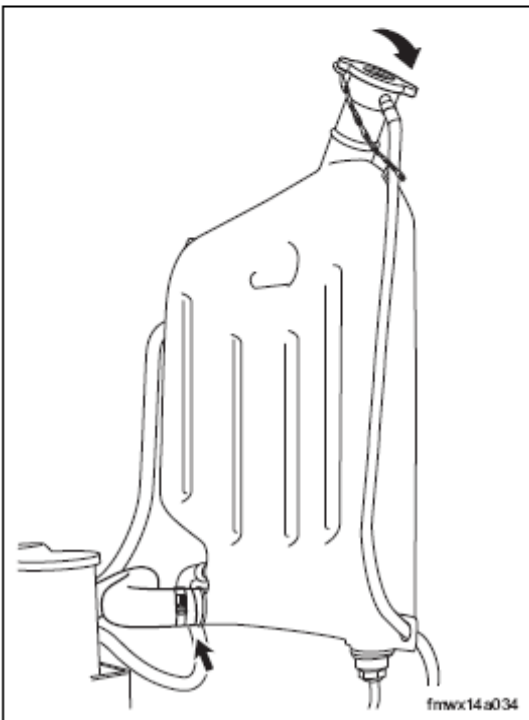


2. Fill the cooling liquid.

- (a) Connect the radiator water inlet hose and radiator air outlet pipe.



- (b) Connect the radiator water outlet hose.



- (c) Connect the secondary water tank pipe.

- (d) Fill cooling liquid.

Notice: The level of cooling liquid in the tank must be located between MIN and MAX marks, close to the MAX mark as much as possible.

- (e) Fasten the tank cover.

Notice:

Anti-freezing liquids of different brands may differ each other with respect to their production formulae. If they are mixed, chemical reactions may occur among different additives to make them ineffective. So anti-freezing liquids of different brands shall not be mixed.

Notice:

The valid term of anti-freezing liquid will last for two years, and the validity must be confirmed prior to the use.

3. Check the cooling liquid level.

- (a) Run the engine, and check the liquid level.
(b) If the level is too low, continue to fill the liquid.

Notice:

After the tank is fitted, run the engine, and check whether there is leakage of cooling liquid.

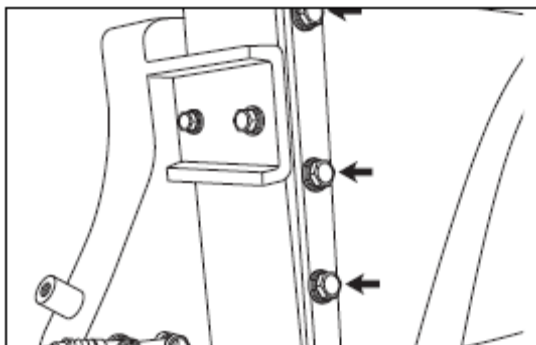
RADIATOR

SERVICE

Hint:

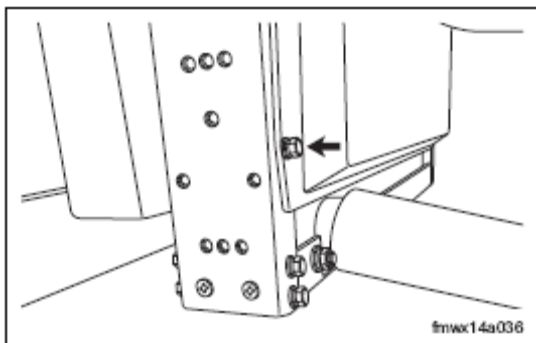
As for the Diagram of Components, refer to Chapter 14A: Diagram of Components, Cooling-Cooling System.

1. Discharge the cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.



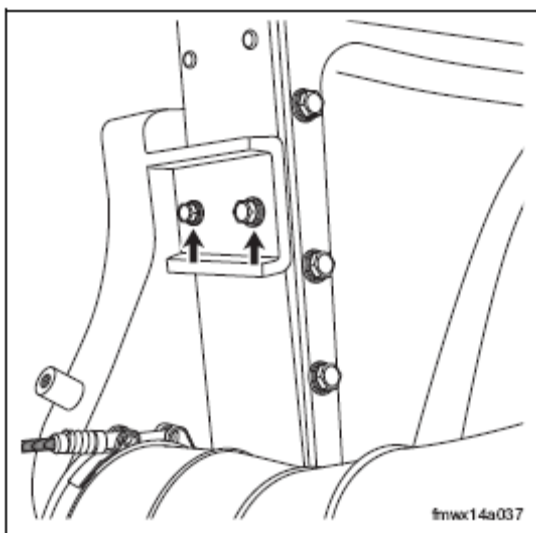
2. Remove the shroud.

(a) Remove the left upper set bolt of the shroud.



(b) Remove the left lower set bolt of the shroud.

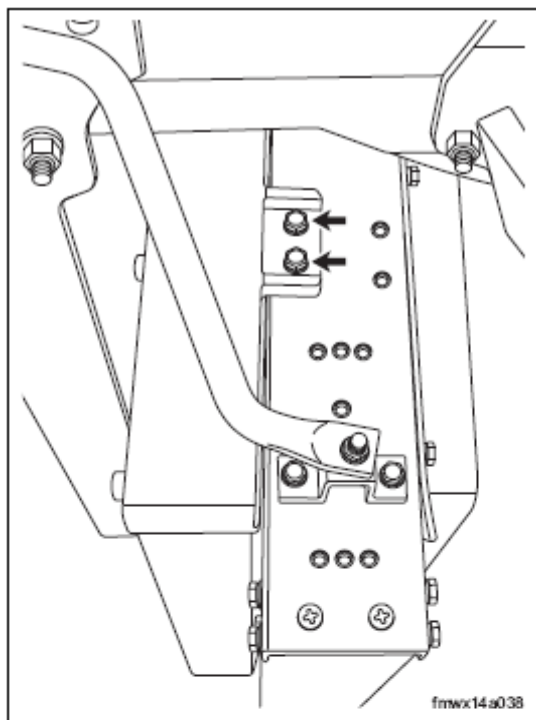
Hint: The right set bolts are removed in the same way with left ones.



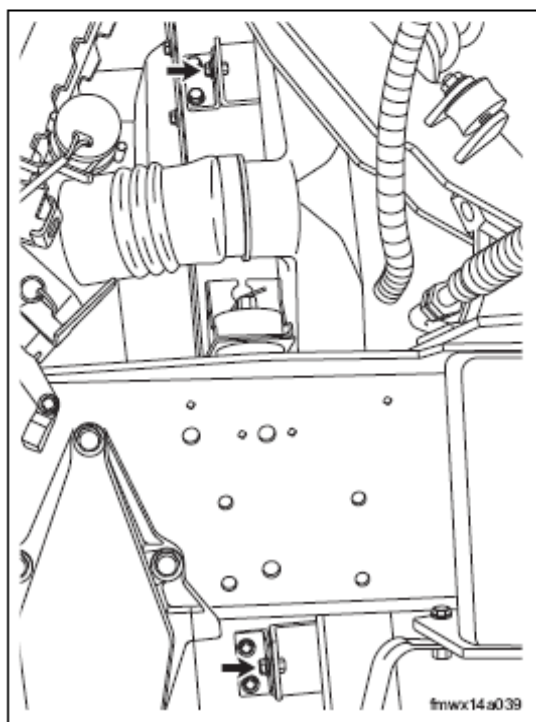
3. Remove the intercooler.

(a) Remove the left upper set bolt of intercooler.

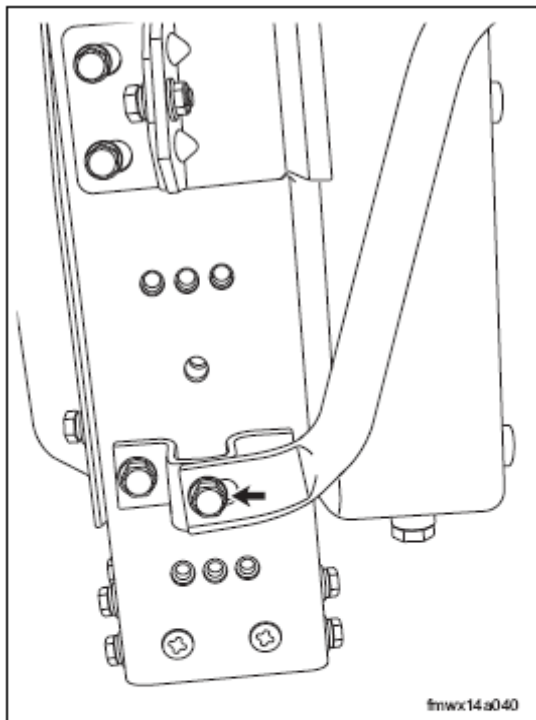
14A



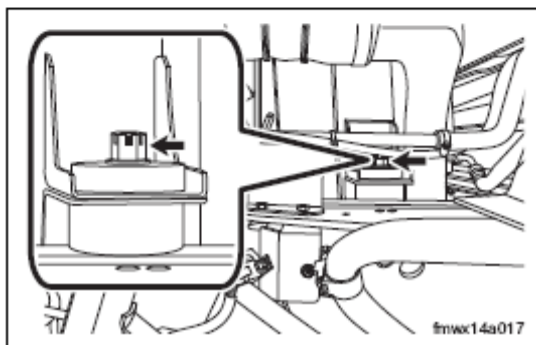
(b) Remove the left lower set bolt of intercooler.



(c) Remove the right set bolt of intercooler.

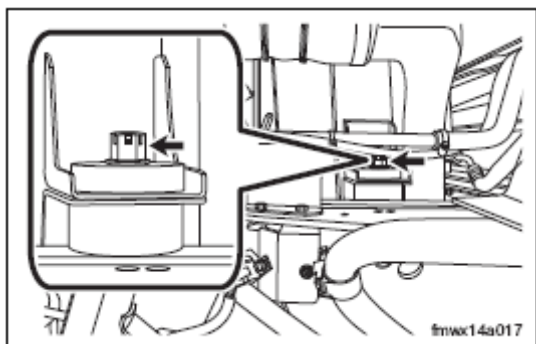


4. **Remove the radiator.**
(a) Remove the set bolt of radiator bracket.



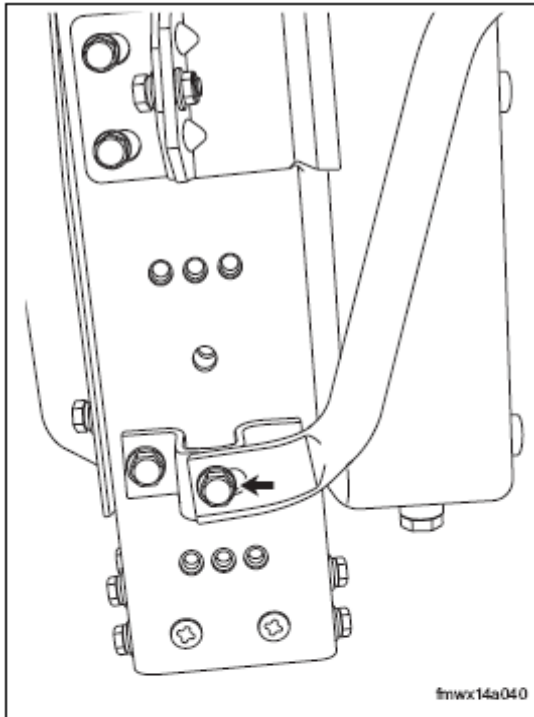
- (b) Remove the split pin.
(c) Remove the slotted nut of radiator.
(d) Pull out the radiator.

5. **Check the radiator. Refer to Chapter 14A: Testing and Adjustment, Cooling-Cooling System.**

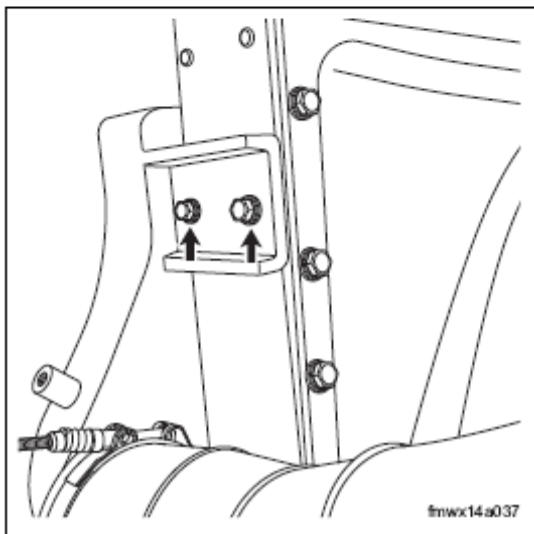


6. **Refit the radiator.**
(a) Refit the radiator.
 - Refit the radiator in the downward direction.
 - Refit the slotted nut of radiator.**Torque: 70N.m**
 - Refit the split pin.

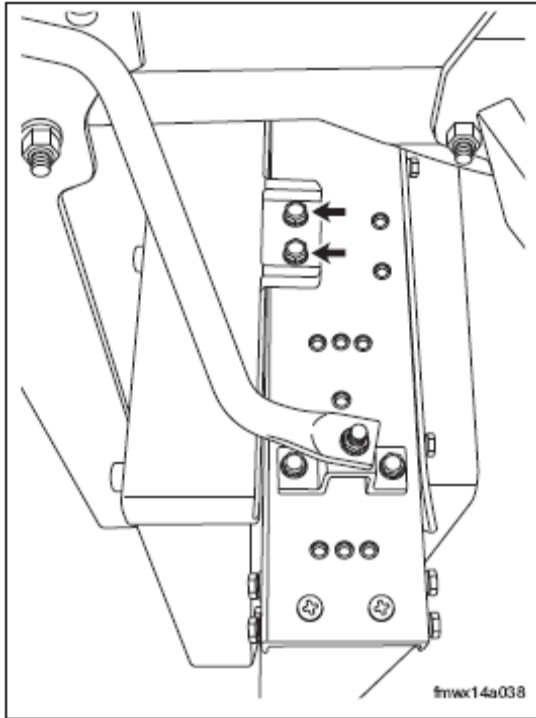
14A



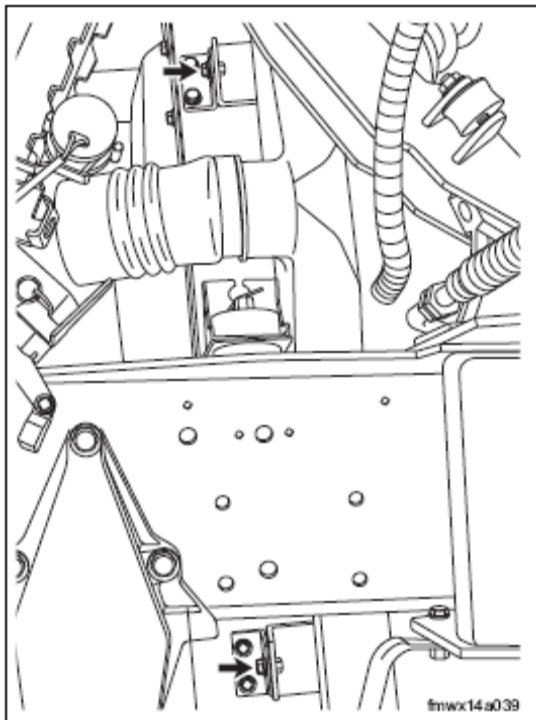
- Refit the set bolt of radiator bracket.
Torque: 23±2N.m



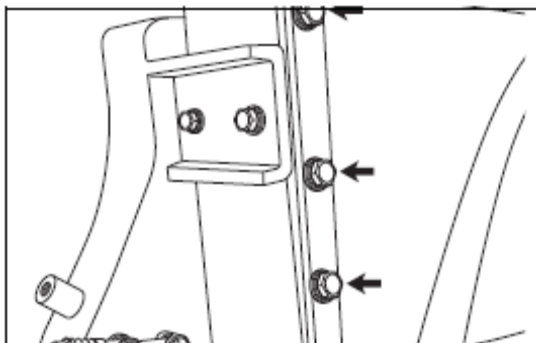
7. **Refit the intercooler.**
 - (a) Refit the left upper set bolt of intercooler.
Torque: 23±2N.m



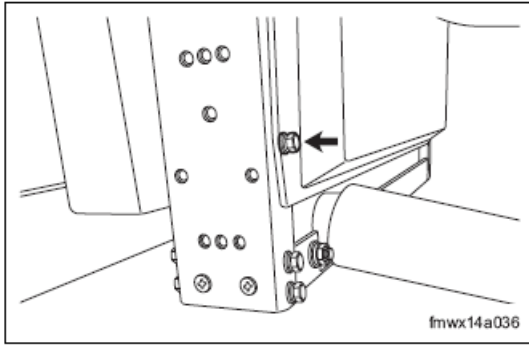
- (b) Refit the left lower set bolt of intercooler.
Torque: 23 ± 2 N.m



- (c) Refit the right set bolts of intercooler.
Torque: 23 ± 2 N.m



8. Refit the shroud.
(a) Refit the left upper set bolt of the shroud.
Torque: 20N.m



(b) Refit the left lower set bolt of the shroud.

Torque: 20N.m

Hint: Right set bolts of the shroud are refitted in the same manner with left ones.

9. Refill cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.

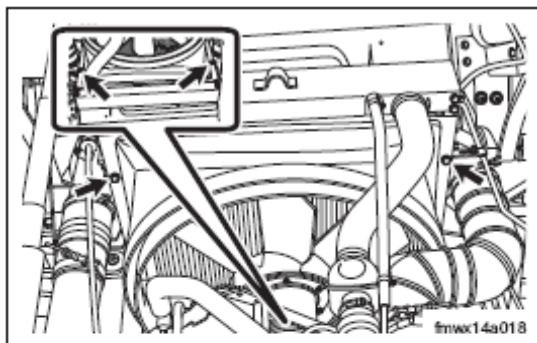
10. Cooling liquid degassing: Start engine for degassing (about 30 minutes at temperature of 90°C) after initially fast adding (or changing) anti-freezing liquid. As the liquid level in secondary water tank may decrease, it is necessary to stop engine to add anti-freezing liquid to the MAX scale and then perform degassing. Ensure the liquid level of secondary water tank won't decrease any more and then add anti-freezing liquid to the MAX scale again, and then you can use the vehicle. If not, the engine and radiator may be damaged.

COOLING FAN

SERVICE

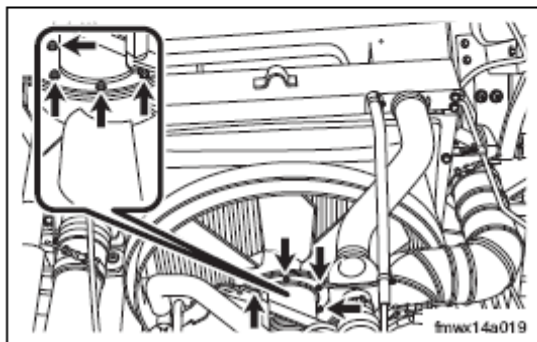
Hint:

As for the Diagram of Components, refer to Chapter 14A: Diagram of Components, Cooling-Cooling System.



1. Remove the cooling fan.

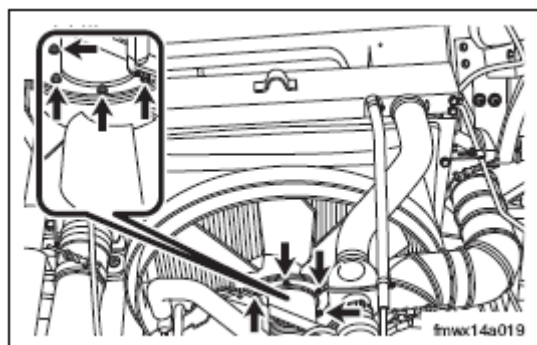
(a) Undo the shroud.



(b) Remove the cooling fan.

14A

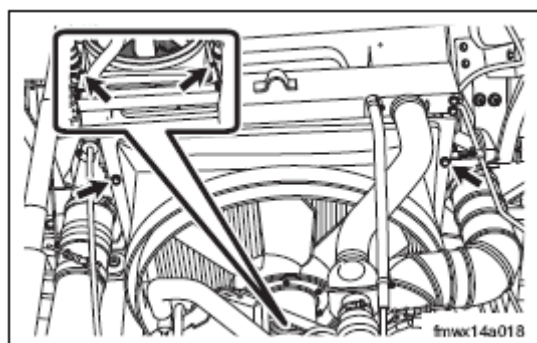
2. Check the cooling fan. Refer to Chapter 14A: Testing and Adjustment, Cooling-Cooling System.



3. Refit the cooling fan.

(a) Refit the cooling fan.

Torque: 20N.m



(b) Fasten the shroud.

Torque: 20N.m

(c) Connect the cooling fan silicon oil temperature sensor.



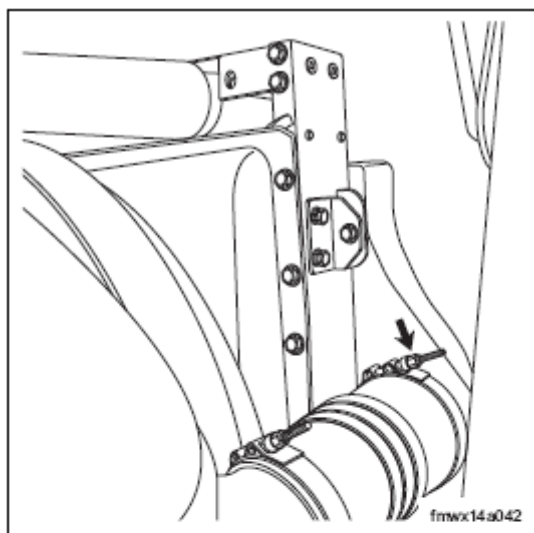
INTERCOOLER

SERVICE

Hint:

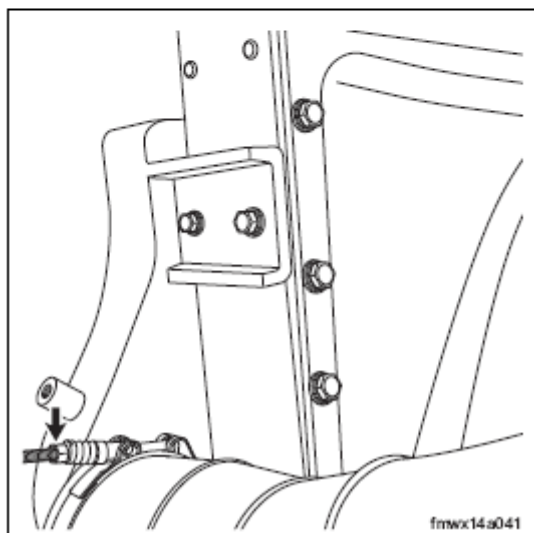
As for the Diagram of Components, refer to Chapter 14A: Diagram of Components, Cooling-Cooling System.

1. Remove the condenser. Refer to Chapter 51: Service, Air Heater and Air Conditioner-Condenser.

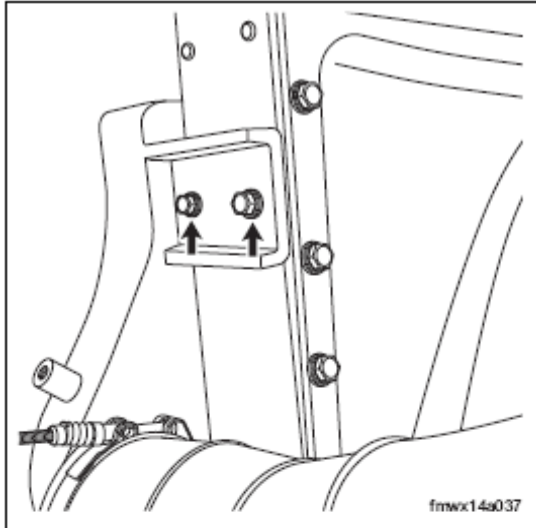


2. Remove the intercooler.

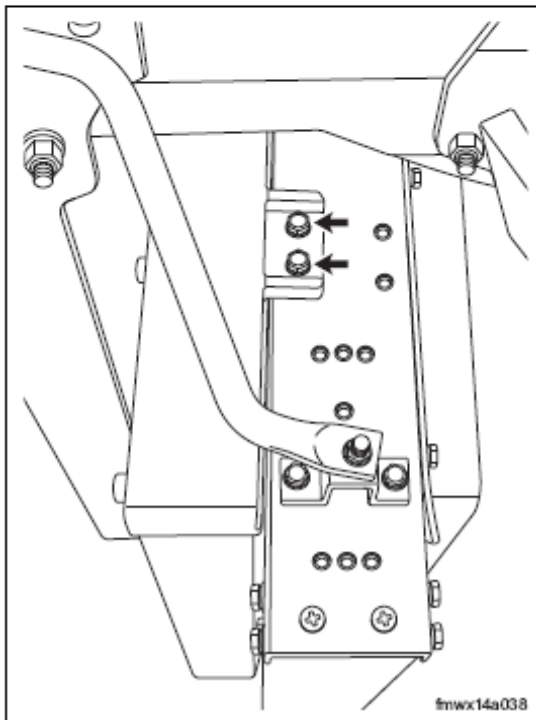
(a) Remove the intercooler air inlet pipe.



(b) Remove the intercooler air outlet pipe.

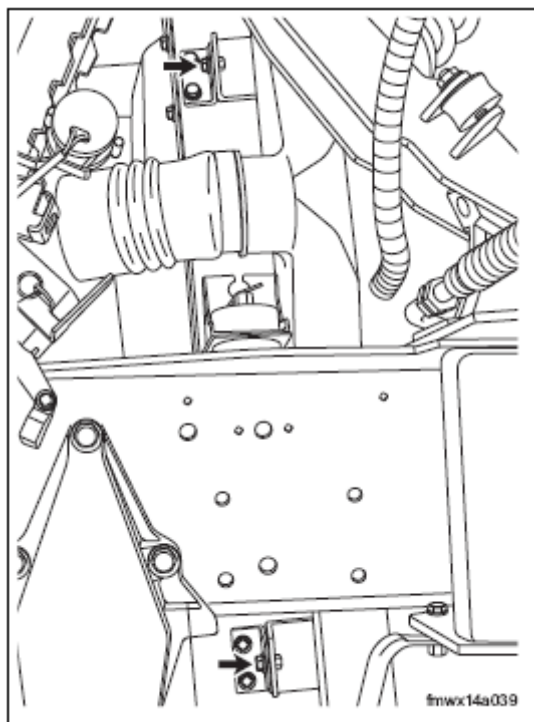


(c) Remove the left upper set bolt of the intercooler.



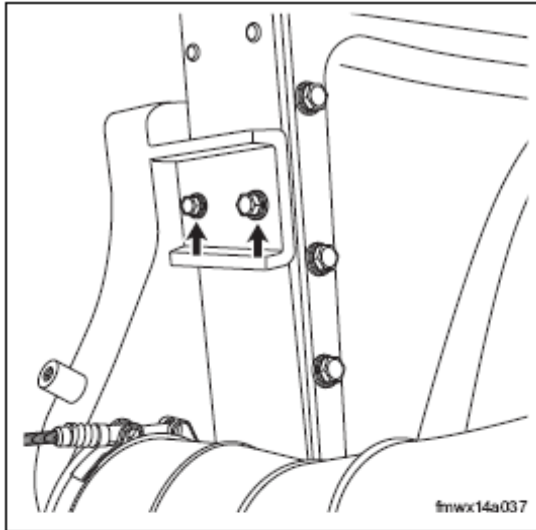
(d) Remove the left lower set bolt of the intercooler.

14A



- (e) Remove right set bolts of the intercooler.

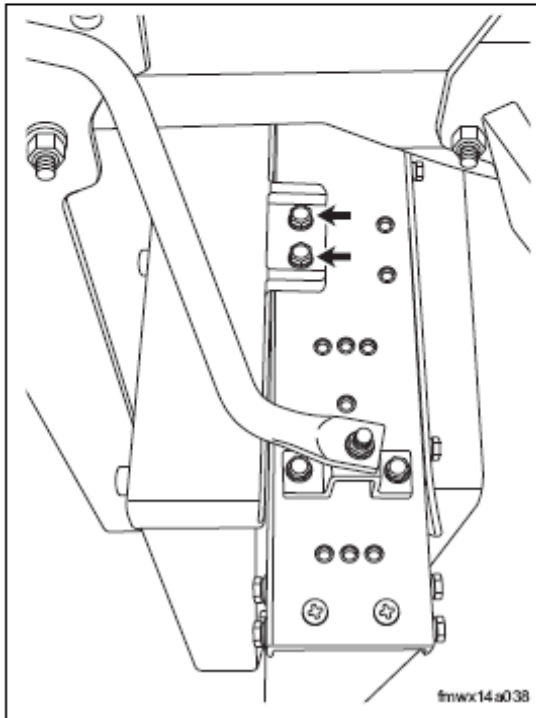
3. Check the intercooler. Refer to Chapter 14A: Testing and Adjustment, Cooling-Cooling System.

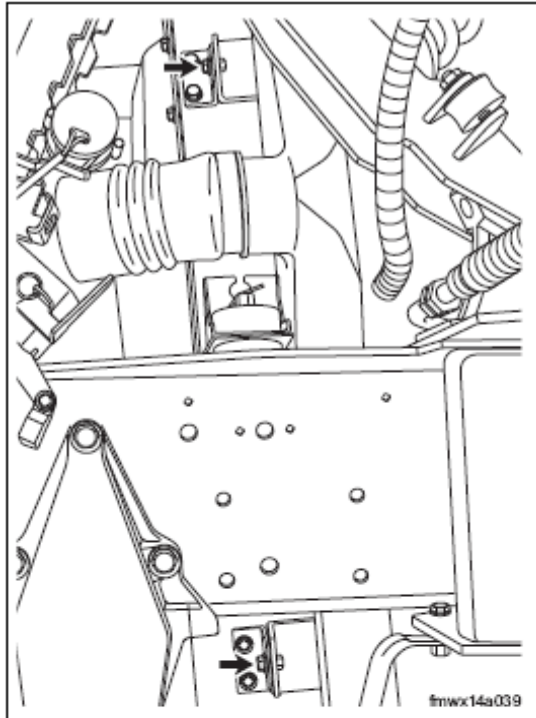


4. Refit the intercooler.

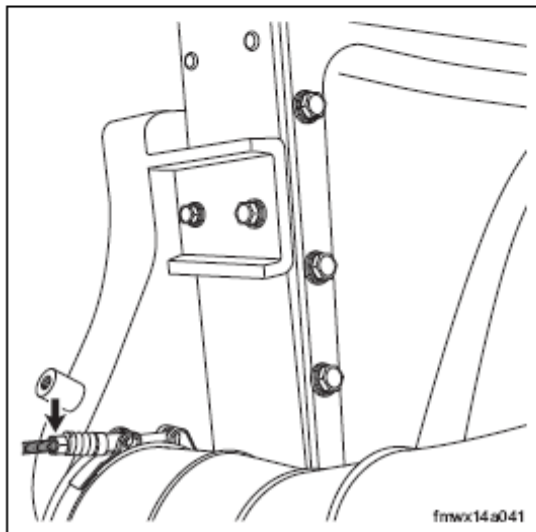
- (a) Refit the left upper set bolt of the intercooler.
(b) Refit the left lower set bolt of the intercooler.

Torque: 23 ± 2 N.m

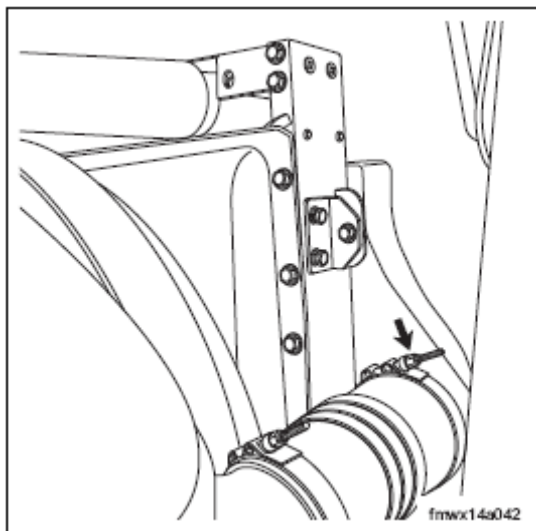




- (c) Refit right set bolts of the intercooler.
Torque: $23\pm2\text{N.m}$



- (d) Refit the intercooler air outlet pipe.



(e) Refit the intercooler air inlet pipe.

5. Refit the condenser. Refer to Chapter 51: Service, Air Heater and Air Conditioner-Condenser.

14A



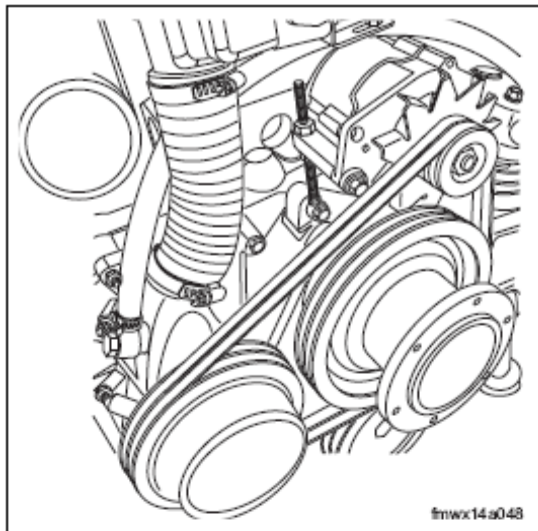
WATER PUMP

SERVICE

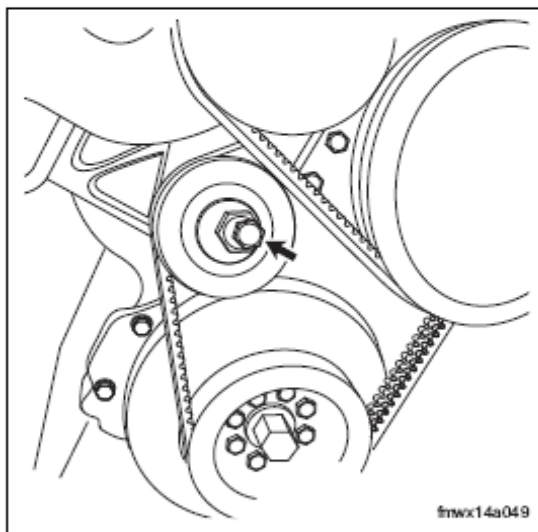
Hint:

As for the Diagram of Components, refer to Chapter 14A: Diagram of Components, Cooling-Cooling System.

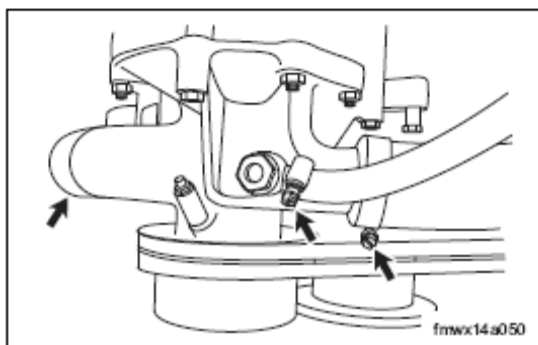
1. Discharge the cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.



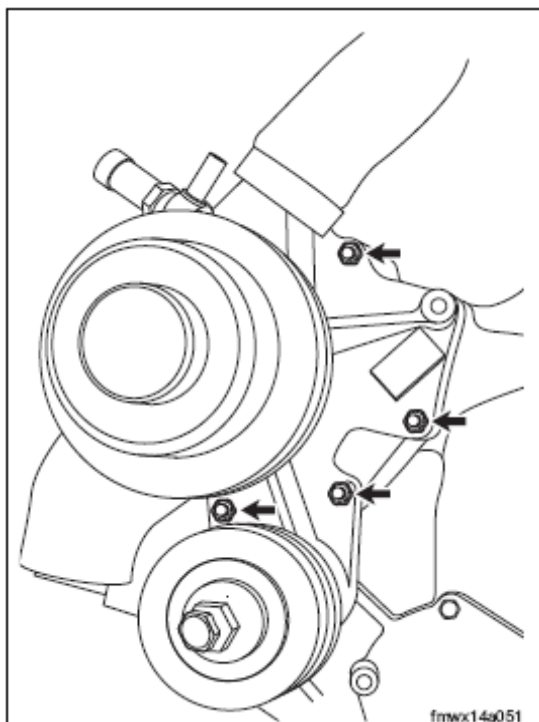
2. Remove the generator belt. Refer to Chapter 19A: Service, Charging System-Generator.



3. Remove the tensioner belt.
 - (a) Undo the tensioner.
 - (b) Remove the belt.

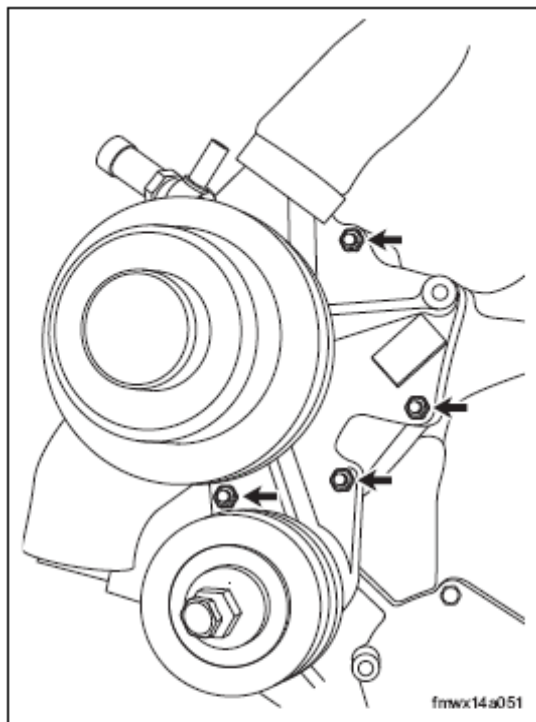


4. Remove the water pump.
 - (a) Remove accessories of water pump pipe.



- (b) Remove the lock nut of the pump.
Hint: There are 6 lock nuts on the pump.

5. Check the water pump. Refer to Chapter 14A: Diagram of Components, Cooling-Cooling System.

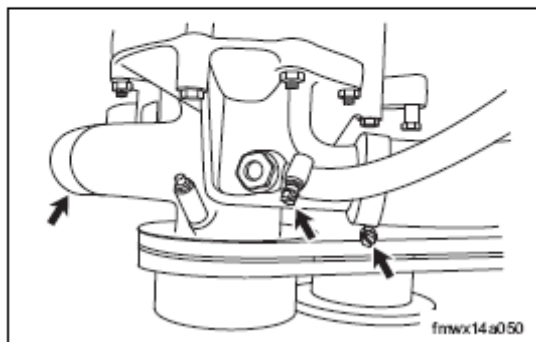


6. Refit the water pump.

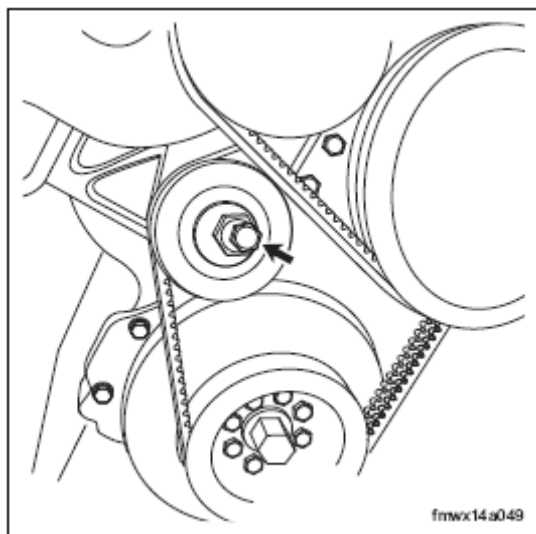
(a) Refit the water pump lock nut.

Torque: 63N.m

Hint: There are 6 lock nuts on the pump.



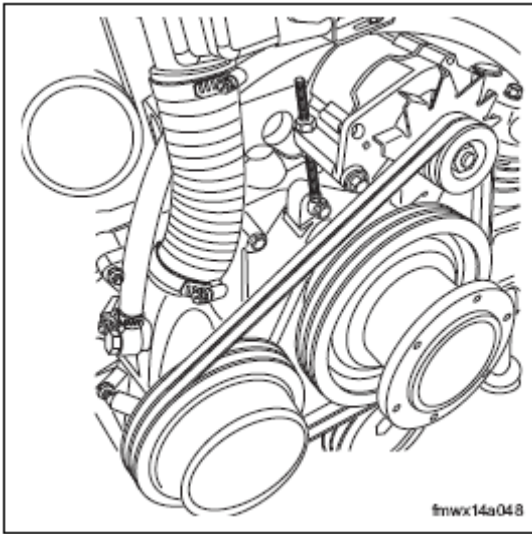
7. Refit accessories of the pump pipe.



8. Refit the tensioner belt.

(a) Put on the belt.

(b) Tighten the tensioner.



- 9. Refit the generator belt.**
- (a) Put on the belt.
 - (b) Fasten the generator tensioning nut.

- 10. Refill the cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.**

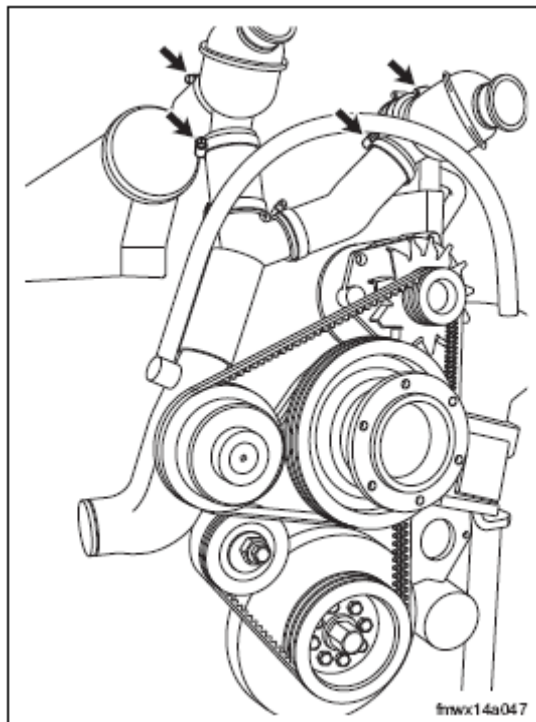
THERMOSTAT

SERVICE

Hint:

As for the Diagram of Components, refer to Chapter 14A: Diagram of Components, Cooling-Cooling System.

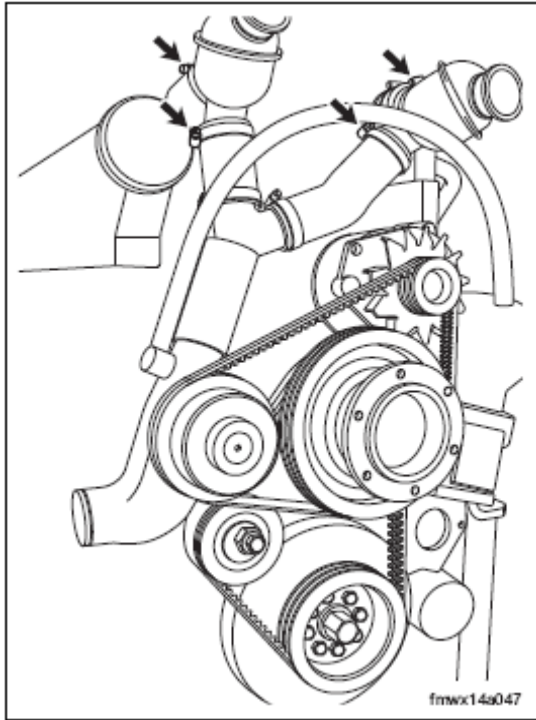
1. **Discharge the cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.**



2. **Remove the thermostat.**

- (a) Remove the cooling water pipe.
- (b) Remove the thermostat.

3. **Check the thermostat. Refer to Chapter 14A: Testing and Adjustment, Cooling-Cooling Liquid.**



4. **Refit the thermostat.**
 - (a) Refit the thermostat.
 - (b) Refit the cooling water pipe.

5. **Refill the cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.**

LUBRICATION (WD618)

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Precautions	15A-6
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OIL PUMP.....	15A-15
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Service	15A-16



15A

LUBRICATION SYSTEM

OVERVIEW

Function of lubrication system

Lubrication: lubricate the surface of moving components to reduce frictional resistance and abrasion and decrease the engine power consumption.

Cleaning: the engine oil circulating in the lubrication system continuously can rinse friction surface and wash away abrasive dust and other foreign matters.

Cooling: the engine oil circulating in the lubrication system can carry away the heat produced by combustion and friction, which plays an important role in cooling.

Sealing: oil film is formed between moving components to improve their leak tightness, which is helpful to prevent air and oil leakage.

Rust prevention: oil film is formed on the surface of components, which can protect component surface and prevent corrosion and rust.

Hydraulic function: lubricating oil can be used as hydraulic oil and enter to hydraulic tappet.

Cushioning and buffering effect: oil film is formed on the surface of moving components to absorb impact and reduce vibration.

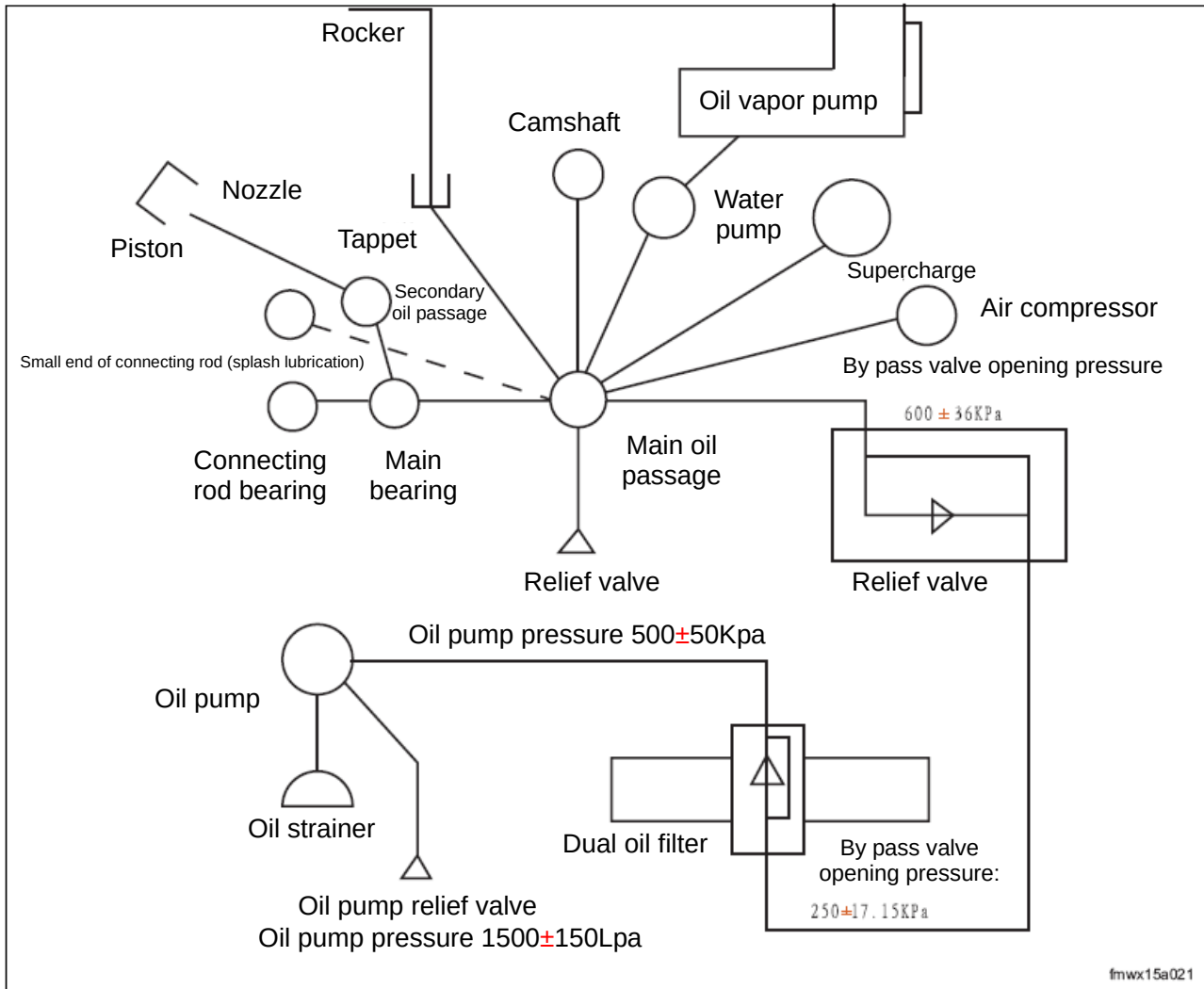
15A

Engine oil

The engine oil is chosen according to the company's requirements. Multigrade engine oil is favorable to cold-start, so it should be selected as the priority. The multigrade engine oil used throughout the year, such as 5W30, 10W40 and 15W40 can only be used within the specified temperature range. For occasional low temperature, take proper measures to preheat engine oil, or replace with the engine oil which is appropriate for environmental temperature.

The replacement time of engine oil should be determined according to the requirements of maintenance and service.

Pressure lubrication



Oil pump absorbs engine oil from crankcase sump through oil strainer and presses it to oil filter and oil cooler, and finally the engine oil reaches lubrication position through oil circuit system. Most oil reaches main bearing, passes through the oil hole on crankshaft and finally reaches connecting rod bearing. Cylinder sleeve surface and piston pin are lubricated by oil injection of nozzle. Valve control system, supercharger, high pressure oil pump, air compressor and intermediate gear bearing are also lubricated by oil pipe and oil sink. The bottom of piston is cooled by oil injection of nozzle. Engine oil is cooled by the coolant of oil cooler. The engine oil pressure of oil circulating system is adjusted by relief valve.

Diesel engine starts, oil has high viscosity for its low temperature. Oil pressure will increase within short time, however, oil temperature will go up with the rising of engine water temperature, the oil pressure will gradually decrease, when engine water temperature is at $80\sim 95\text{ }^{\circ}\text{C}$ under full load operation, normal oil pressure shall be $350\sim 550 \text{ kPa}$.

Oil pan

Oil pan is made of steel sheet by impact molding and its joint surface with crankcase has deep rolling edge, featuring with stiffness. It is equipped with concave oil pan gasket, 12 oil pan supporting blocks and M8 bolts tightly pressing on lower junction surface. Good sealing will not cause oil leakage.

Oil cooler

Oil cooler safety valve (bypass valve) is set in engine oil pipeline with opening pressure of $600 \pm 36 \text{ kPa}$ so as to prevent engine damage caused by oil cooler blocking or low oil temperature and high viscosity during starting in winter, high resistance of oil cooler etc.

Pressure limiting valve for main oil pipeline

Pressure limiting valve is located under crankcase right side, protruding in oil pan chamber with opening pressure of 500 kPa . Calibrated before installation, user cannot change voluntarily.

Oil filter

It uses two parallel spin-on filter cartridges, when maintenance is necessary, only removing old cartridge and installing new one shall be applicable.

Oil pump

Oil pump applies gear pump. Other vehicles apply single stage pump except that all-wheel driving road vehicles apply double stage pump.

Oil strainer

Oil strainer is a filter with metal mesh, installed on inlet pipe of oil pump to prevent large mechanical impurities from entering oil pump.

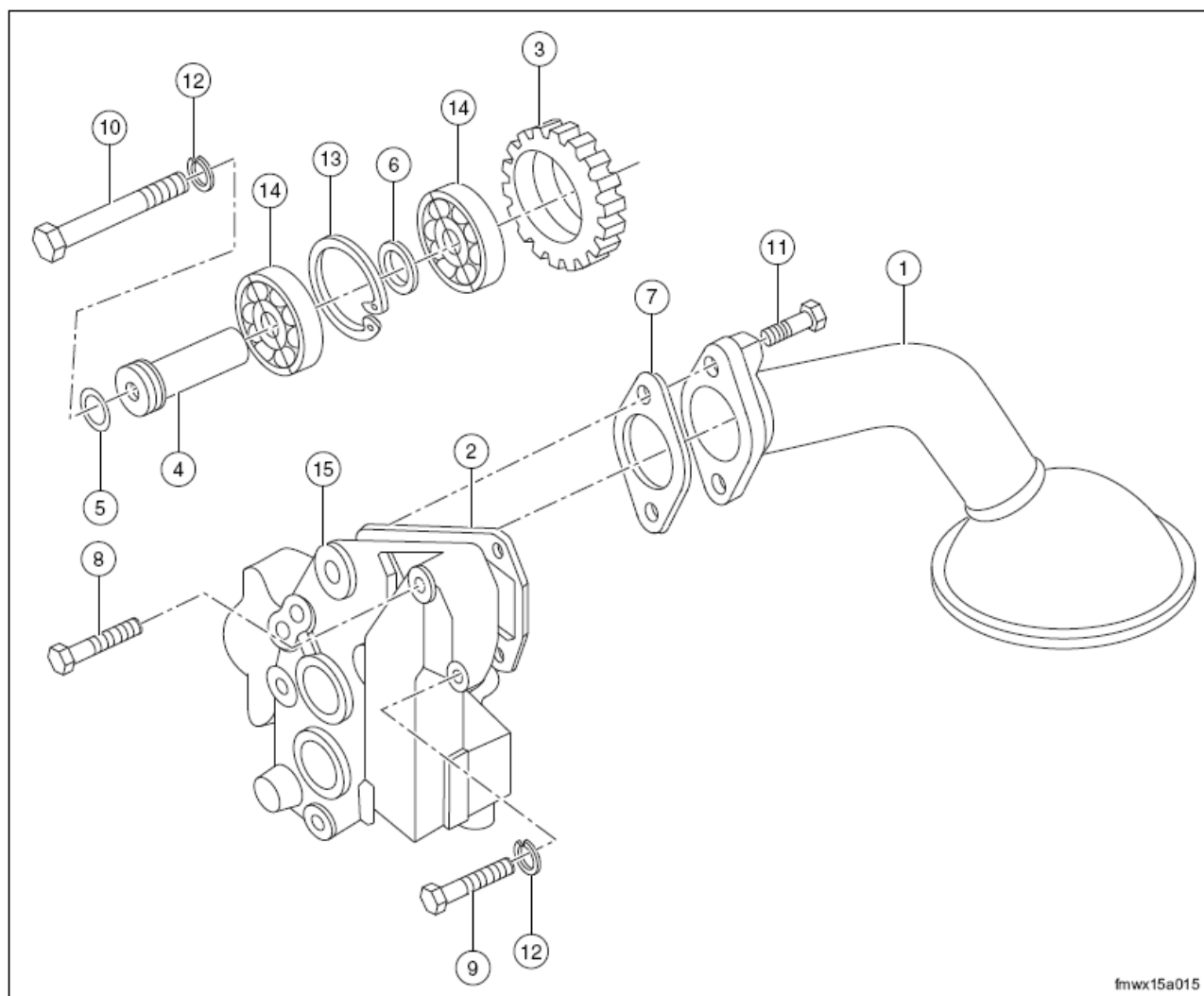
Primary oil filter

Primary oil filter is used to filter large size impurities in oil, normally connecting in series between oil pump and main oil pipeline, oil has small flowing resistance, and it is full-flow oil filter. Primary oil filter is a filter unit, its working principle is to keep impurities outside when oil passes through small mesh holes or apertures. It has various formations depending on different cartridges.

PRECAUTIONS

1. Prevent foreign objects and impurities from entering during dismantling and keep clean.
2. Regularly check oil level, too high oil level will cause not only engine running resistance and result in unnecessary power loss, but also cause oil leakage; too low oil level may damage engine for bad lubrication.
3. Apply oil with appropriate viscosity, too low oil viscosity can easily damage oil film so that parts may get stuck; too high viscosity can cause additional resistance for parts moving so that engine can start hard and power lose or increase.
 - Select oil depending on climate. Select low viscosity oil so as to facilitate engine starting when ambient temperature is low. Select high viscosity oil so as to facilitate moving and keeping oil film when ambient temperature is high.
 - Select oil depending on vehicle conditions, engine with good conditions, its mating clearance is small, which can use low viscosity oil, on the contrary, it can use high viscosity oil.
 - Diesel engine has high combustion pressure, furthermore, diesel will generate Sulfurous acid after combustion which will dilute oil, and therefore, diesel engine shall select special diesel engine oil which can neutralize Sulfurous acid.
4. Regularly replace engine oil.

DIAGRAM OF COMPONENTS



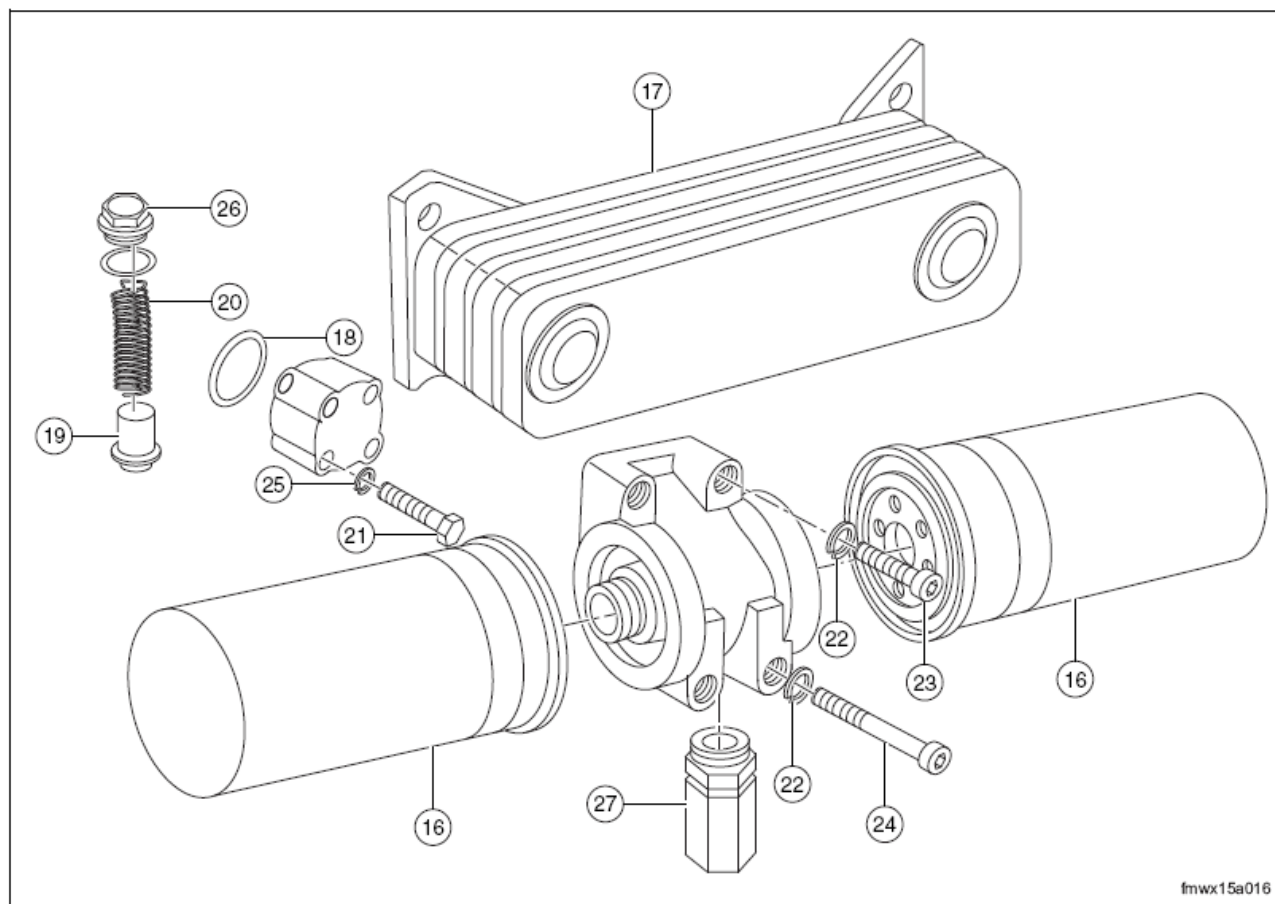
15A

1	Oil strainer assembly
2	Oil pump gasket
3	gear
4	middle gear shaft
5	Sealing ring
6	Intermediate space ring
7	gasket
8	Hexagon bolt

9	Hexagon bolt
10	Hexagon bolt
11	Hexagon bolt
12	Spring washer
13	Circlip with convex teeth for bore
14	Centripetal ball bearing
15	Oil pump assembly

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LUBRICATION (WD618)-LUBRICATION SYSTEM



16	Rotation oil filter cartridge assembly
17	Oil cooler filter cartridge assembly
18	Sealing ring
19	Safety valve
20	Safety valve spring
21	Hex socket head cap screws

22	Saddle elastic washer
23	Hex socket head cap screws
24	Hex socket head cap screws
25	Sealing ring
26	Plug
27	Main oil pipeline pressure limiting valve assembly

TESTING AND ADJUSTMENT

Engine oil pressure test

For engine in normal technical conditions within common rotation speed, the oil pressure shall be 350~550kPa. If oil pressure at medium rotation speed is lower than 300kPa, idling speed lower than 100kPa, engine shall stop running and check lubrication system. 15 Factors of influencing engine oil pressure:

1. **Engine oil pump performance, adjustment of pressure limiting valve and resistance of engine oil pipeline and engine oil filter etc.**
2. **Engine oil quality, temperature and viscosity**
 - For engine with low viscosity and high temperature, pressure decreases; on the contrary, oil pressure increases.
3. **Clearance of crankshaft main bearing, connecting rod bearing and camshaft bearing**
 - The clearance increases after bearing wear, and oil leakage at bearing clearance increases so that oil pressure decreases. Therefore, oil pressure is also an important parameter for diagnosing relevant bearing clearance.
 - If technical conditions of oil pump are normal, oil pressure decrease is mainly caused by excessive wear of crankshaft main journal and connecting rod journal. When crankshaft main bearing clearance increases in an increment of 0.01mm, the oil pressure shall decrease about 0.01Mpa.
4. **Oil manometer and oil pressure sensor**
 - Oil pressure value can be indicated on oil manometer of dashboard, however, oil manometer and oil pressure sensor cannot ensure the necessary measurement precision, so special test oil manometer shall be used during regular test.
 - When carrying out test, firstly remove oil pressure sensor and install oil manometer. Then start and run engine at specified rotation speed, the indicating value of oil manometer is oil pressure of lubrication system.

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Test on oil consumption

Factors of influencing oil consumption:

1. **Lubrication system leakage**
2. **Abnormal operation of air compressor**
3. **Improper selection of oil specification**
4. **Wear of cylinder piston sets**
 - Oil consumption can reflect the technical conditions of engine lubrication system, in addition, it can also be used to just the wear status of engine cylinder piston sets.
 - When oil brand is correct and other mechanisms are under normal conditions, the major reasons for oil consumption increase are excessive wear of cylinder piston sets, clearance increase and oil combustion entering combustion chamber.

Oil consumption shall not larger than 0.5% of fuel consumption.

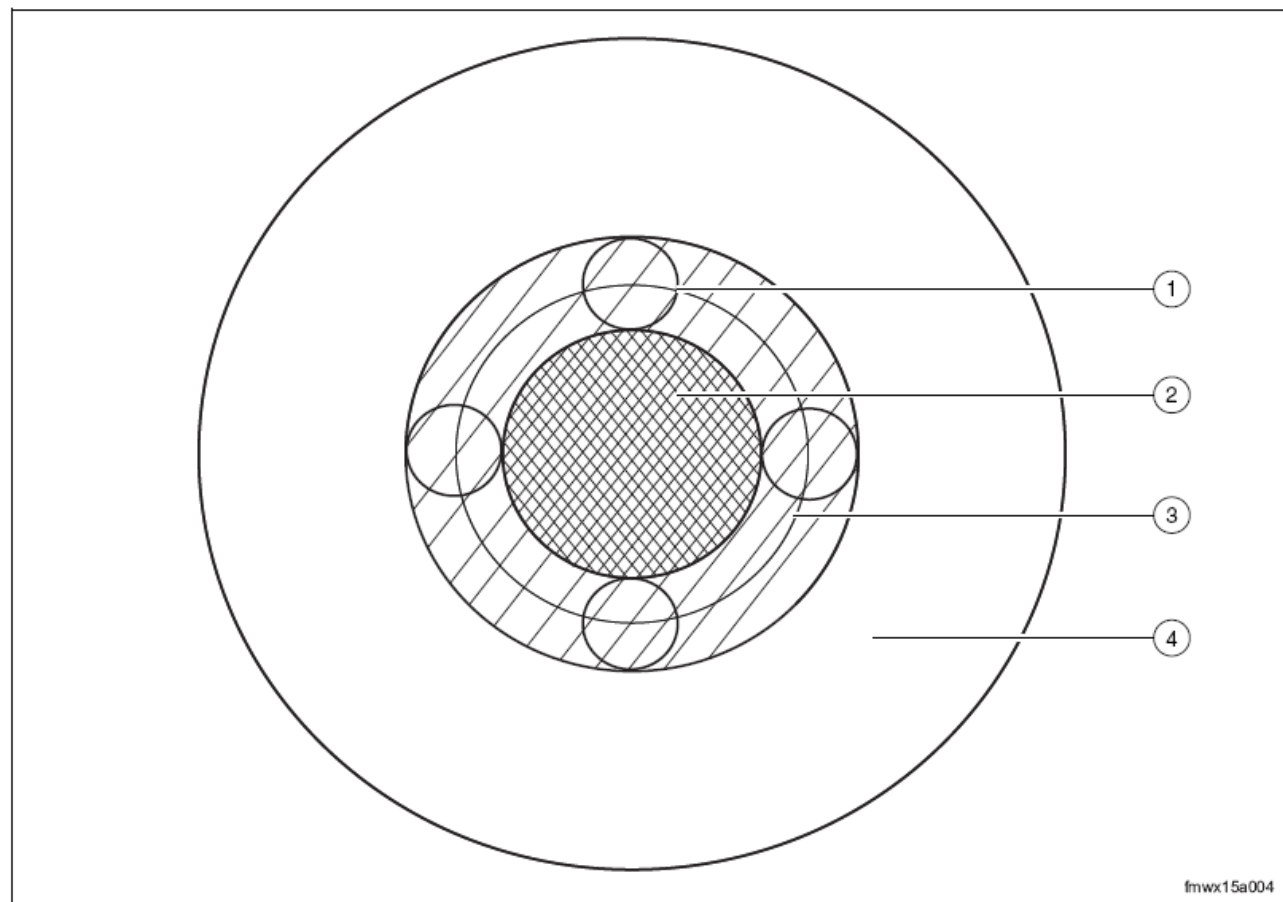
Test and analysis of oil quality

Oil quality shall deteriorate gradually during use for impurity contamination, fuel dilution, high temperature oxidation and addition consumption or property loss etc. It becomes dark, viscosity rising or declining in appearance.

15A-10**LUBRICATION (WD618)-LUBRICATION SYSTEM**

Impurity causing oil contamination is mainly from wear particles of fabrication surface, foreign dust and carbon deposition etc; unburned fuel for abnormal engine operation, inadequate combustion or loss of fire can flow into oil pan and dilute oil; high temperature generated from engine operation, especially when engine cylinder piston sets are worn excessively with increasing clearance, high temperature and high pressure gas enter crankcase during combustion stroke, it will intensity oil oxidization and generate oxides and oxidized polymers, thus deteriorate oil.

The detergent dispersant in oil is an important additive, which can disperse from engine surface and remove wear particles and carbon deposit so that they suspend in oil and do not deposit on the surface so as to reduce the abrasion of fabrication surface. The consumption and performance decrease of detergent dispersant during oil consumption will gradually lose cleaning and dispersing function.

Filter paper and oil spot test method**1. Test principle**

1	Dark circle
2	Central zone

3	Diffusion zone
4	Semitransparent zone

- If dropping used oil on special filter paper as per specification, oil drip shall gradually infiltrate and diffuse to the surrounding. Finally it forms multiple circular oil spots with dark centers and different color shades. If impurities in oil have different impurity contents and particle size with different cleanings and dispersing abilities, the color shade among each circular zone of formed oil spot is also different.

- If impurities in oil have small particle size with favorable cleaning and dispersing ability, impurity particles can diffuse farther, the difference of impurity concentration and color shade between central zone and diffusion is small; If impurities in oil have large particle size, losing cleaning and dispersing ability, impurity particles shall centralize in central zone, the difference of impurity concentration and color shade between central zone and diffusion is small; therefore, the impurity concentration in central zone of oil spot reflects total contamination degree of oil, the difference of unit area impurity concentration between central zone and diffusion zone can reflect the cleaning and dispersing ability of detergent dispersant in oil.

2. Test method

- Take a piece of 12cm×7cm organic glass (or cardboard, plastic plate and board) and cut into two, bore a hole with 5 cm diameter and bond with adhesive plaster at one side to avoid filter paper back contacting with table surface so as to influence the diffusion of oil spot.
- Take oil sample under heat working conditions of engine and put into test tube, use drop rod with specified size (a metal rod with smooth end, dia. 2 mm, L 150mm) and penetrate a certain depth under oil level in test tube, take out drop rod and drop the third drip on the filter paper and form oil spot.
- Place filter paper with oil spot together with frame evenly at point without wind and dust for 2-4 h, observe the diffusion status, compare with standard illustrations (national standard GB/T7607-2002 Test Method of Internal Combustion Oil Filter Paper Spot) and analyze to make judgments.

3. Rating criteria

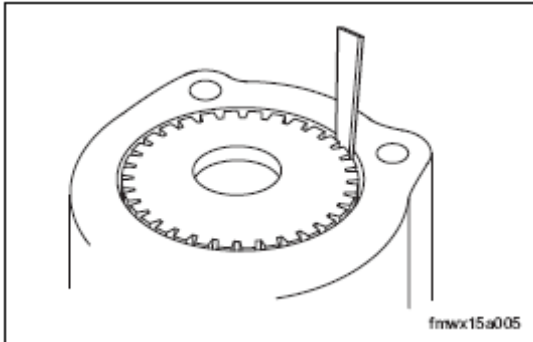
- Class 1: the central zone and diffusion circle of filter paper spot illustration appears bright and colorless or appears light color without obvious deposition circle. It indicates that the oil is new or used for a very short time without contamination and can be used furthermore.
- Class 2: the demarcation between deposit circle and diffusion circle of filter paper spot illustration is distinct with wide diffusion circles and bright oil circles. It indicates that the oil is used for a short time with slight contamination and favorable cleaning and dispersing ability, and it can be used furthermore.
- Class 3: the deposit circle of filter paper spot illustration appears dark with wide diffusion circles and bright oil circles. It indicates that the oil is used for a long time with heavy contamination, however with fair cleaning and dispersing ability, and it can be used furthermore.
- Class 4: the deposit circle of filter paper spot illustration appears dark black with narrowing diffusion circles and light yellow oil circles. It indicates that the oil is used for a long time with heavy contamination and increased deposit, cleaning and dispersing ability decreasing, and it can still be used.
- Class 5: the deposit circle of filter paper spot illustration appears dark black, even appears oil sludge, not easy drying with narrowing diffusion circles and widening light yellow oil circle. It indicates that the oil is heavily contaminated with bad cleaning and dispersing ability, the detergent dispersant is nearly consumed, and such oil can not be used furthermore and must be renewed.
- Class 6: only quite dark deposit circle and brown oil circle are left on filter spot illustration. Diffusion circle has completely disappeared. It indicates that the oil is heavily contaminated, contamination impurities fully condense in deposit circle, the detergent dispersant is

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LUBRICATION (WD618)-LUBRICATION SYSTEM

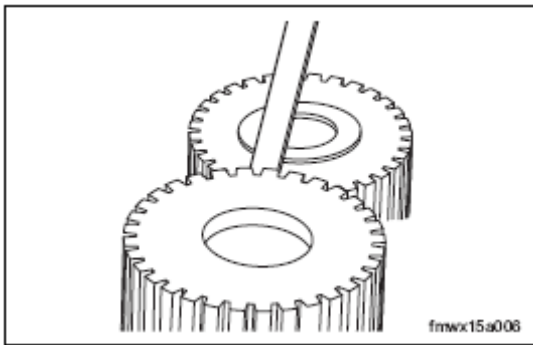
completely consumed without cleaning and dispersing ability, and such oil has surpassed oil renewing period.

Oil pump



1. Check the clearance between active/passive gear and inner wall of pump chamber

- Insert plug gauge into the space of the above two parts and measure, when the clearance exceeds 0.3mm, it shall be replaced with new parts.



2. Check the engaging clearance of active and passive gears:

- Insert plug gauge into the space of engaging gear teeth and measure 120° three-point tooth side, standard is 0.05mm, operating limit is 0.20mm.

Oil cooler

Immerse oil cooler into water and plug its outlet, blow compressed air to oil cooler and check if any air bubble occurs.

Selection of lubrication oil:

Please select 15W/40CF-4 or 20W/40CF-4 lubrication oil so as to operate your diesel engine safely and reliably. W here

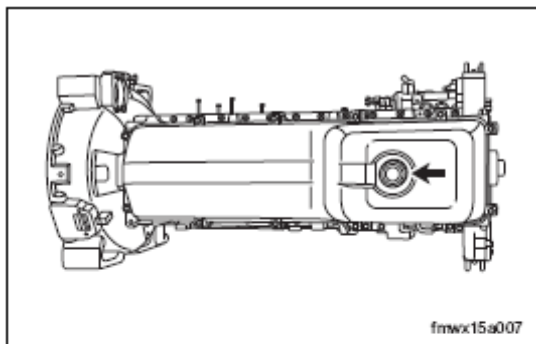
15W/40CF-4 can be used within $-15^{\circ}\text{C}\sim+30^{\circ}\text{C}$, 20W/40CF-4 can be used within $-10^{\circ}\text{C}\sim+30^{\circ}\text{C}$ (it is recommended to use Weichai special oil).

OIL PAN

REPLACEMENT

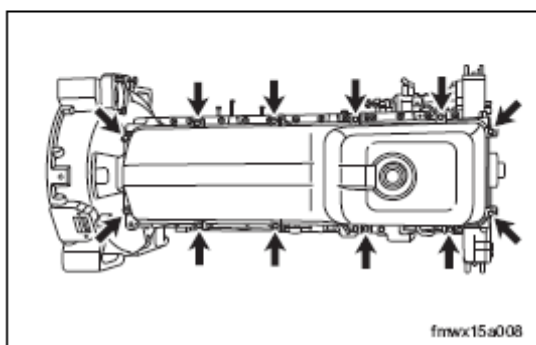
Suggestion:

Diagram of Components, see Chapter 15A Lubrication – lubricating system, Diagram of Components.



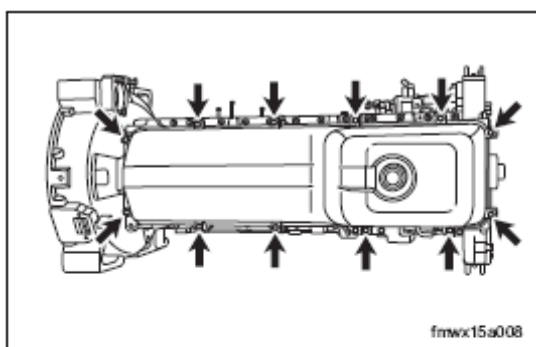
1. Drain lubrication oil

- (a). Dismantle oil draining bolts.
- (b). Hold drained oil from oil pan with clean container.



2. Dismantle oil pan

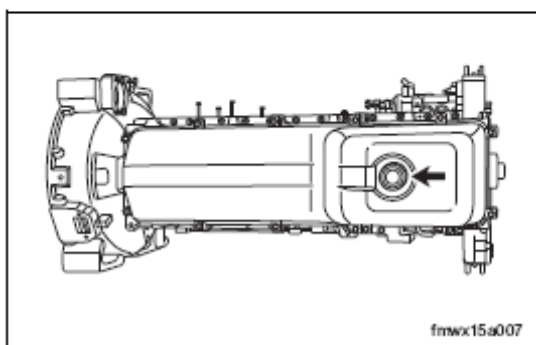
- (a). Dismantle 12 set bolts of oil pan supporting block.

15A

3. Install oil pan

- (a). Install 12 set bolts of oil pan supporting block.

Torque: 25 N.m



- (b). Install oil draining bolts.
- (c). Fill lubrication oil.

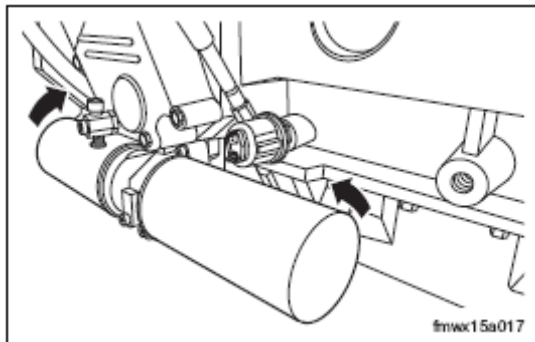
Torque: 25 N.m

OIL FILTER

REPLACEMENT

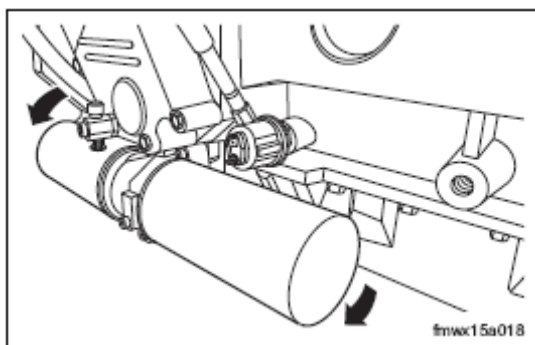
Suggestion:

Diagram of Components, see Chapter 15A Lubrication – lubricating system, Diagram of Components.



1. Dismantle oil filter

- (a). Remove oil filter.
- (b). Hold drained oil from oil pan with clean container.



2. Install oil filter

- (a). Tighten oil filter.
 - Apply clean oil on sealing ring before tightening.

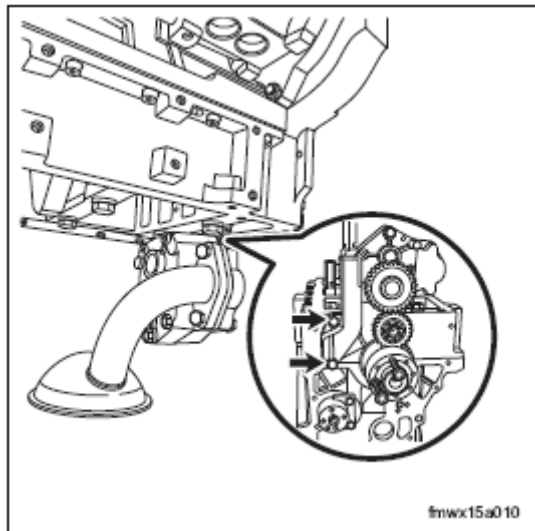
OIL PUMP

SERVICE

Suggestion:

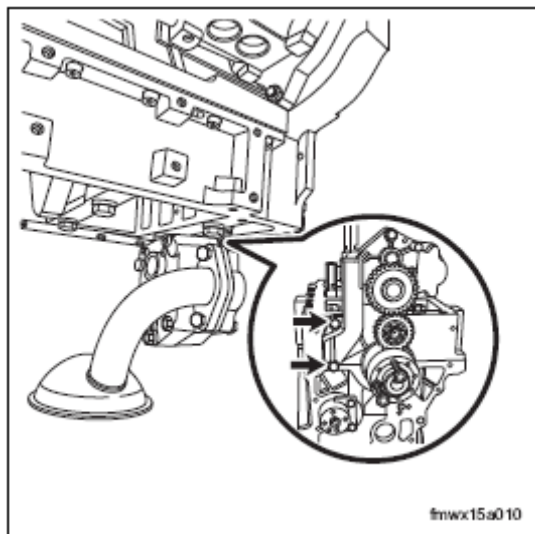
Diagram of Components, see Chapter 15A Lubrication – lubricating system, Diagram of Components.

1 Drain oil, see Chapter 15A Lubrication – oil pan, replacement



2. Dismantle oil pump

3 Check oil pump, Chapter 15A Lubrication – lubricating system, test and adjustment



4. Install oil pump

Torque: 62.5±2.5N.m



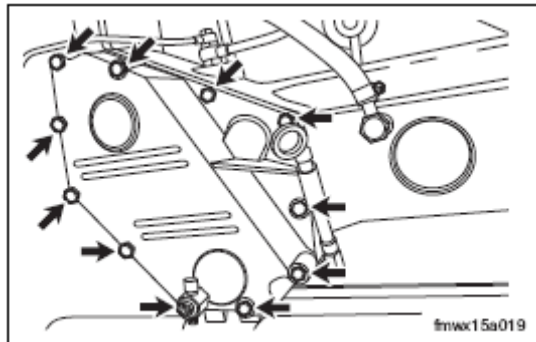
OIL COOLER

SERVICE

Suggestion:

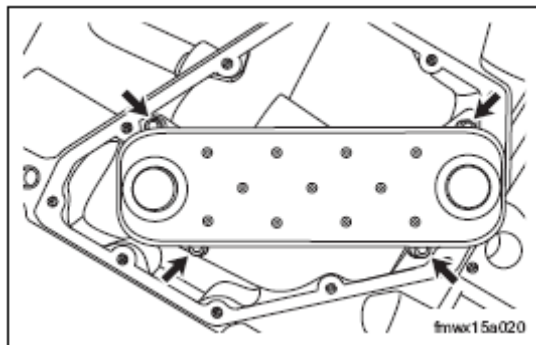
Diagram of Components, see Chapter 15A Lubrication – lubricating system, Diagram of Components.

1. **Drain oil, see Chapter 15A Lubrication – oil pan, replacement**
2. **Drain coolant, see Chapter 14A Cooling – coolant, replacement**

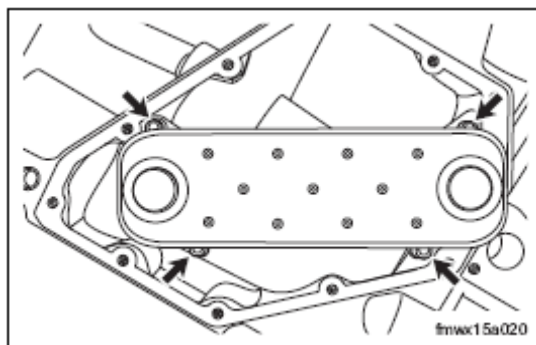


3. **Dismantle oil cooler**

(a). Dismantle water passage shield of engine.

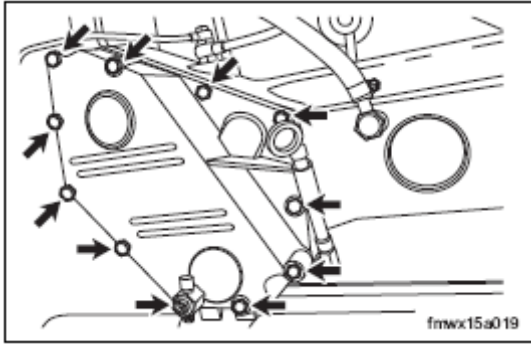


4. **Check oil cooler, see Chapter 15A Lubrication – lubricating system, test and adjustment**



- (a). **Install oil cooler**

Torque: 25 N.m



(b) Install water passage shield of engine.

Torque: 25 N.m

Notice:

Install oil cooler and replace new sealing ring.

- 6 Fill coolant, see Chapter 14A Cooling – coolant, replacement
7. Fill oil, see Chapter 15A Lubrication – oil pan, replacement

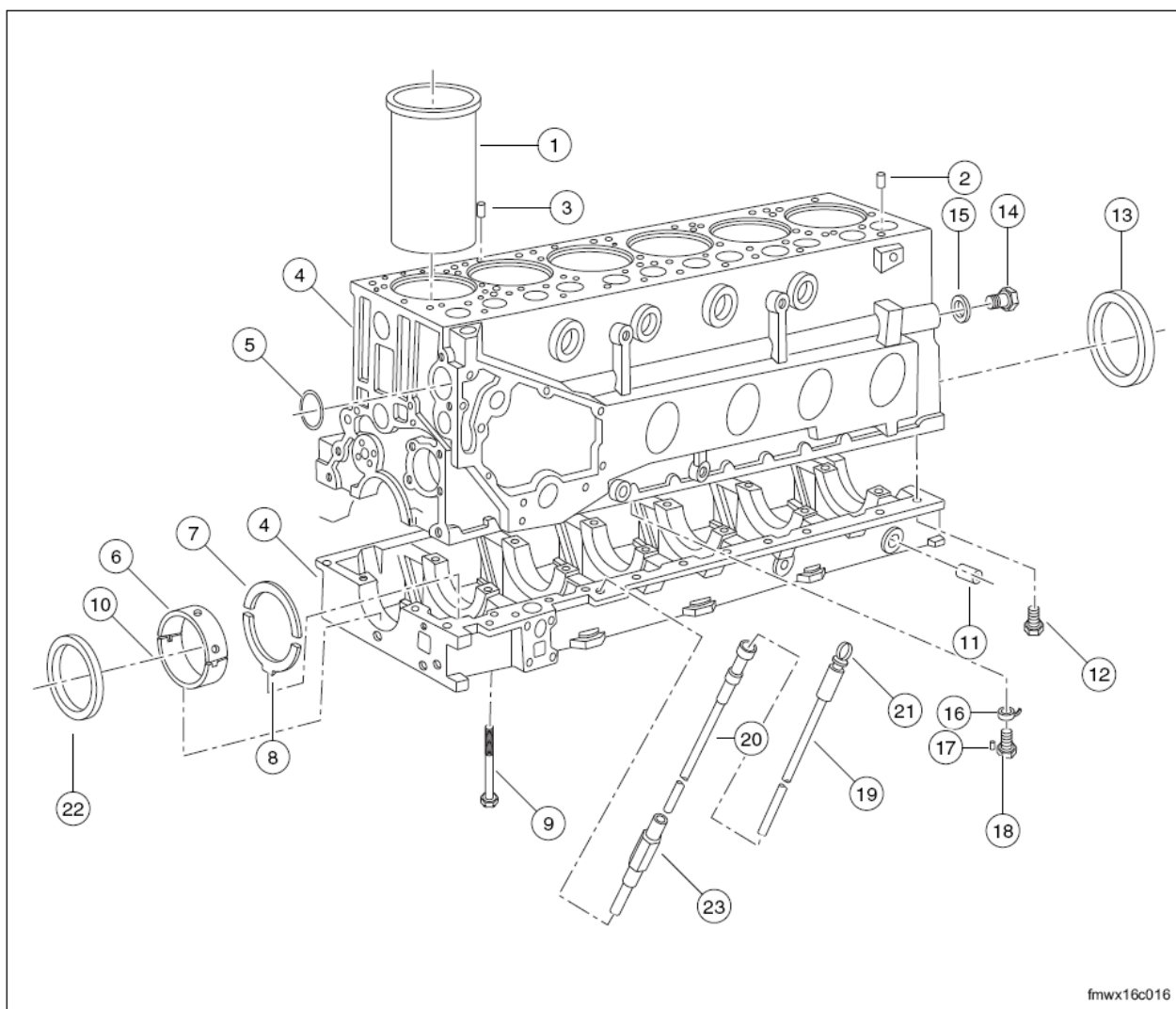
ENGINE MECHANIC SYSTEM (WD618)

ENGINE MECHANIC SYSTEM	16A-3
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Replacement	16A-17
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Replacement	16A-24
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Replacement	16A-34
CRANKSHAFT	16A-37
Replacement	16A-37
CYLINDER BLOCK	16A-41
Replacement	16A-41



ENGINE MECHANIC SYSTEM

DIAGRAM OF COMPONENTS



fmwx16c016

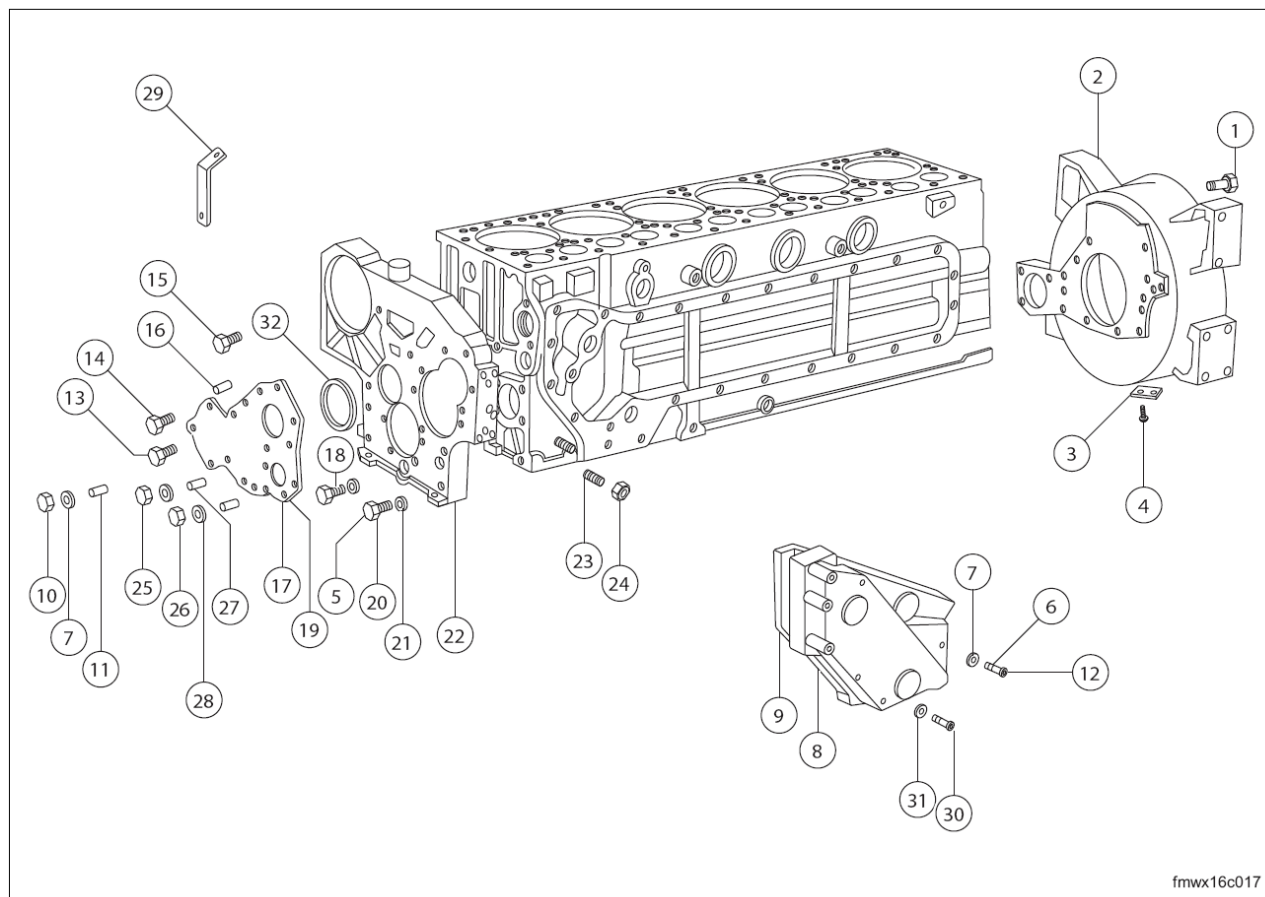
1	Cylinder liner
2	Cylindrical pin
3	Flexible cylindrical pin
4	Cylinder block assembly
5	Sealing ring
6	Upper main shaft bushing
7	Upper thrust plate
8	Lower thrust plate
9	Hexagon bolt
10	Lower main shaft bushing
11	Short fuel return pipe
12	Internal hexagon cylindrical head bolt

13	Rear oil seal
14	Main oil passage rear screw plug
15	Gasket
16	Nozzle subassembly
17	Flexible cylindrical pin
18	Hollow bolt
19	Oil dipstick guide pipe
20	Oil dipstick assembly
21	Oil dipstick subassembly
22	Sealing ring
23	Connecting pipe subassembly

16A

16A-4

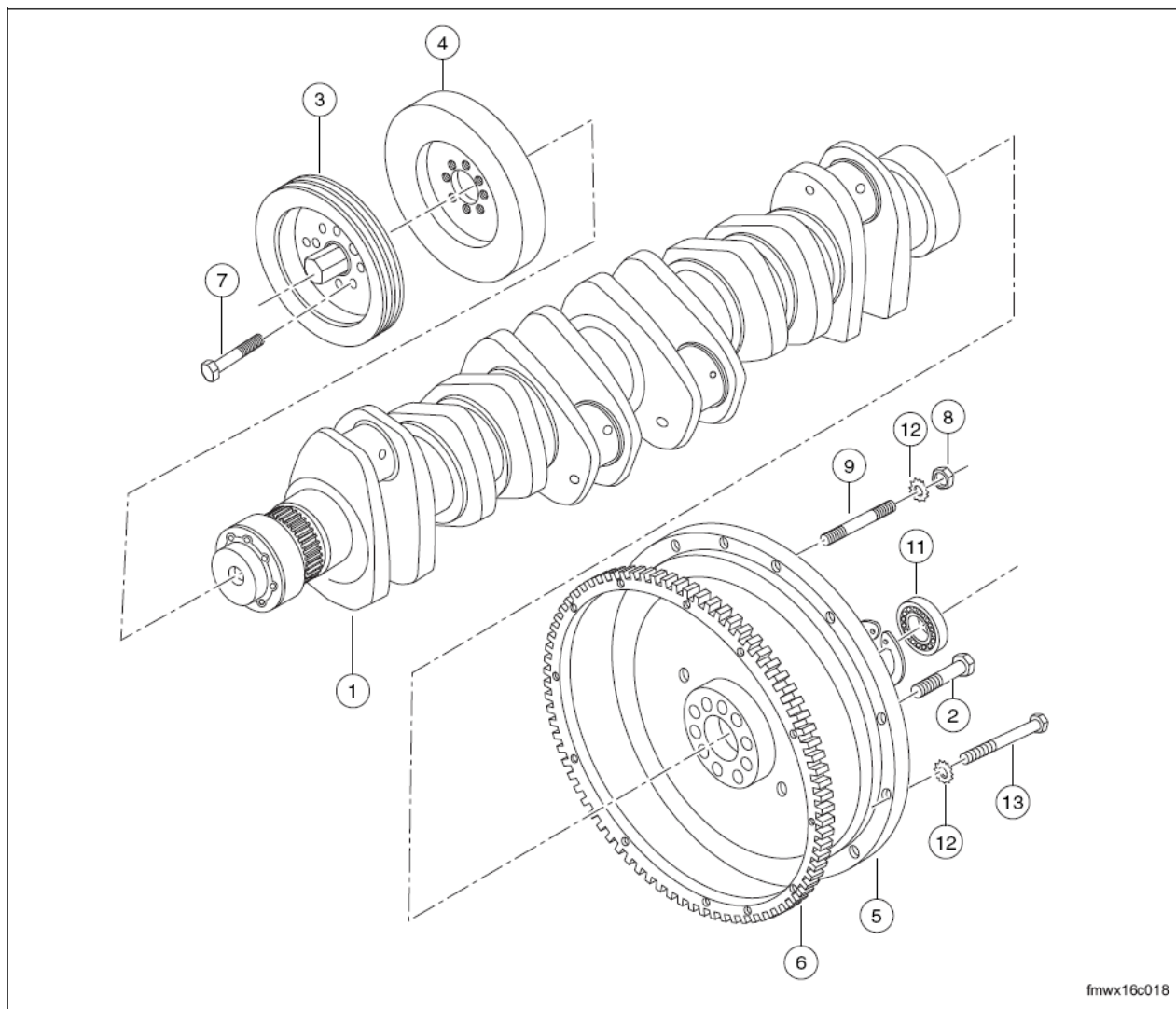
ENGINE MECHANIC SYSTEM (WD618)-ENGINE MECHANIC SYSTEM



fmwx16c017

1	Fly wheel housing bolt
2	Fly wheel housing
3	Inspection hole cover
4	Hexagon bolt
5	Hexagon bolt
6	Hexagon bolt
7	Corrugated flexible washer
8	Engine oil cooler cover
9	Engine oil cooler pad
10	Type I hexagon nut
11	Stud
12	Hexagon bolt
13	Hexagon bolt
14	Hexagon bolt
15	Hexagon bolt
16	Cylindrical pin

17	End cap
18	Hexagon bolt
19	Front oil seal
20	Hexagon bolt
21	Steel spring washer
22	Timing gear box assembly
23	Type I hexagon lock nut
24	Stud
25	Type I hexagon nut
26	Saddle-shaped flexible washer
27	Stud
28	Hexagon bolt
29	Bracket
30	Hexagon screw
31	Sealing ring
32	Sealing ring

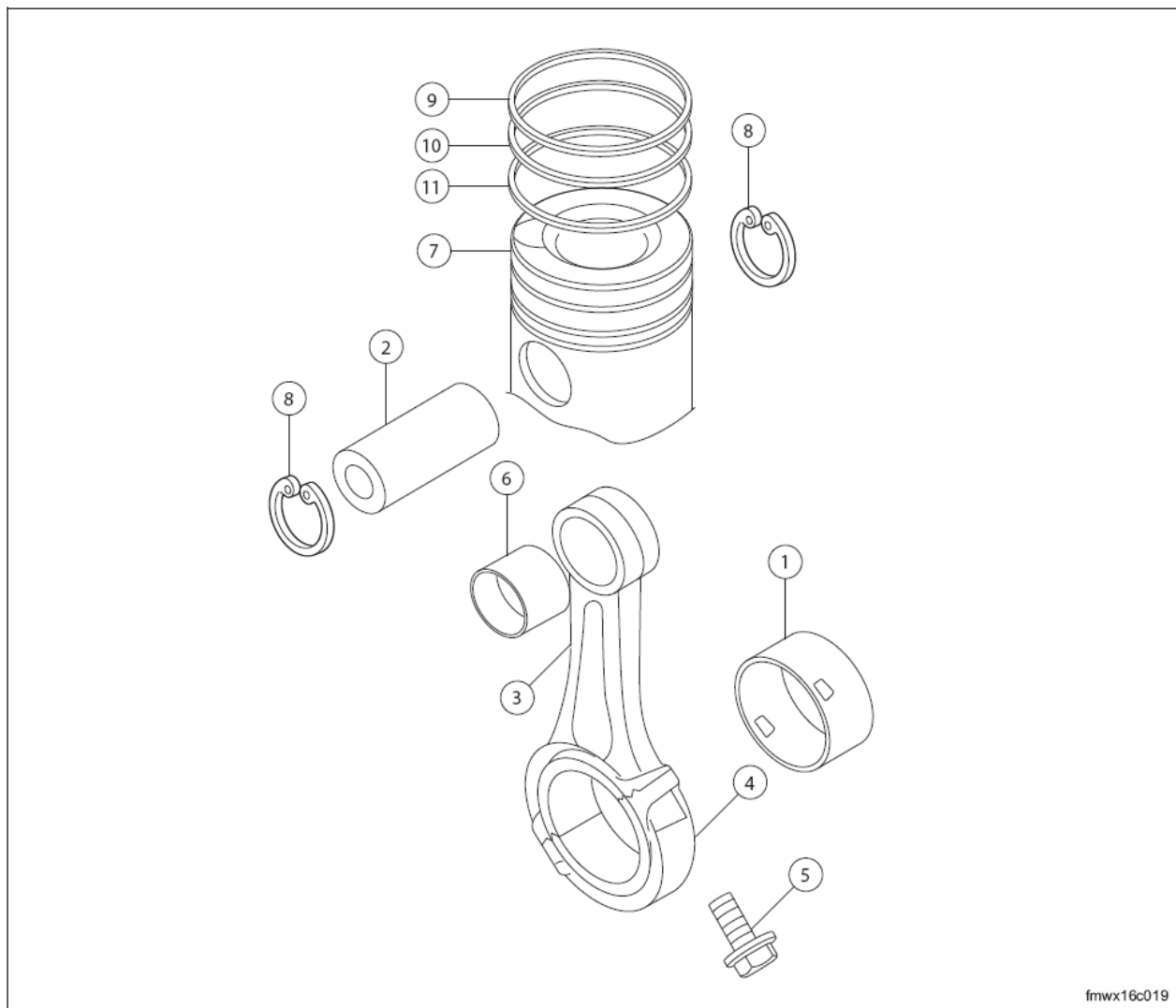


1	Crankshaft assembly
2	Hexagon bolt
3	Pulley
4	Shock absorber
5	Flywheel
6	Flywheel ring gear
7	Hexagon bolt

8	Type I hexagon nut
9	Stud
10	Radial ball bearing
11	Flexible retaining ring for holes
12	Corrugated pad
13	Hexagon bolt

16A-6

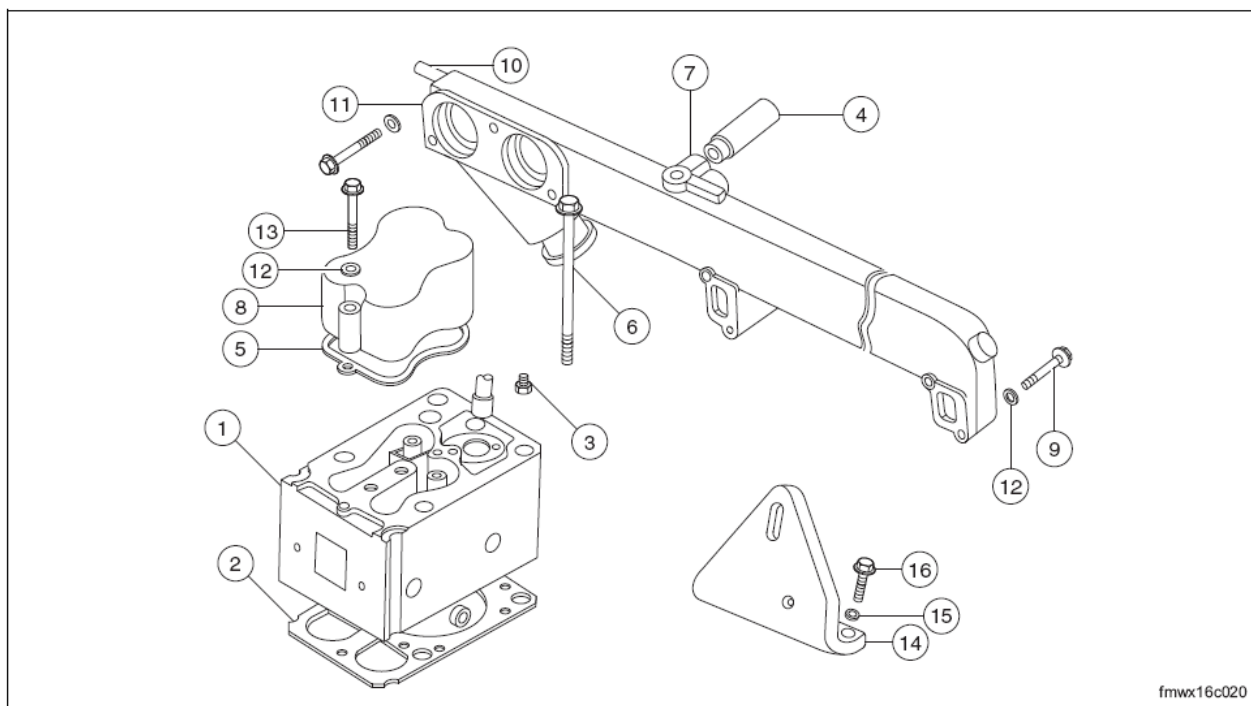
ENGINE MECHANIC SYSTEM (WD618)-ENGINE MECHANIC SYSTEM



fmwx16c019

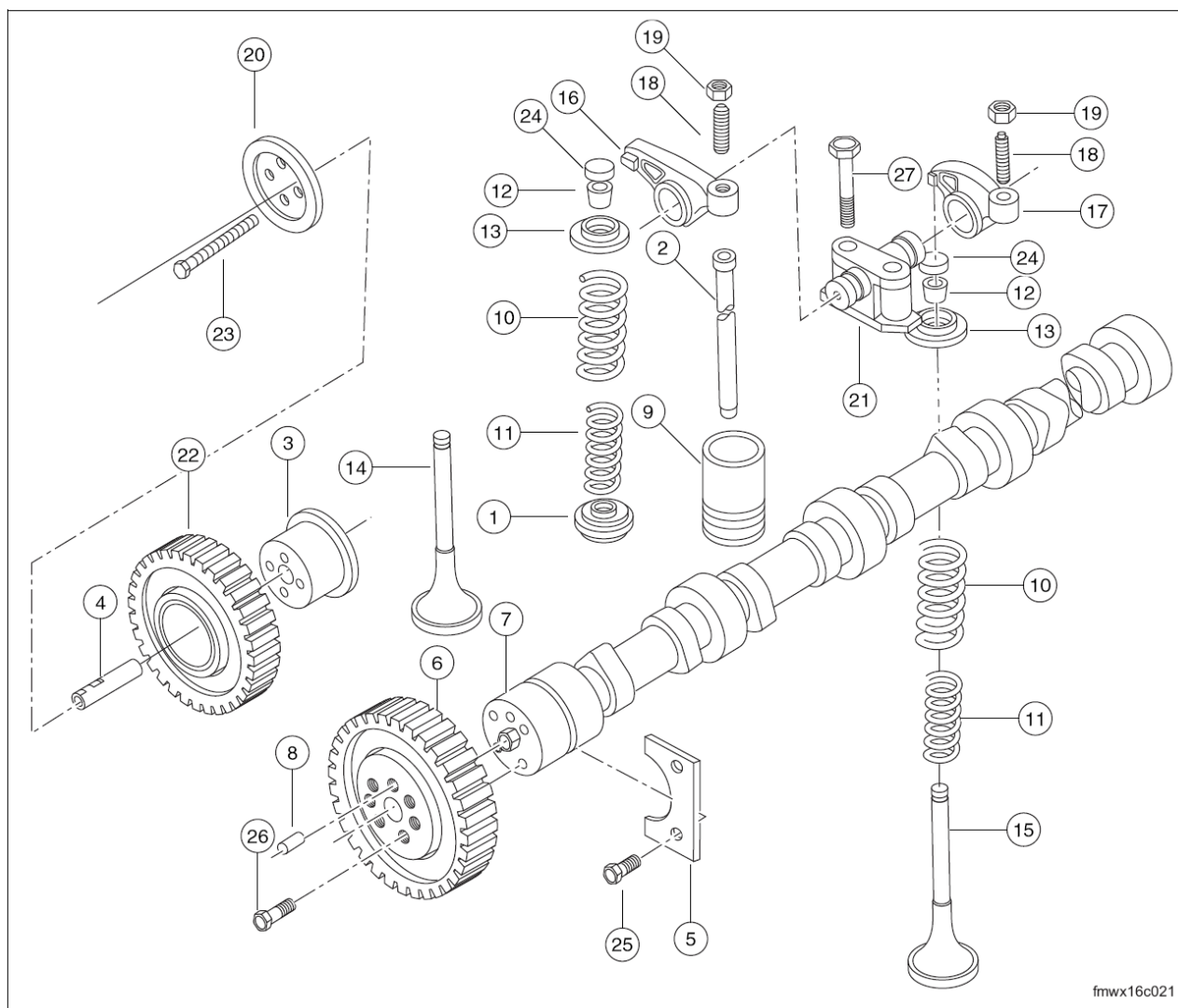
1	Connecting rod bush
2	Piston pin
3	Connecting rod body
4	Connecting rod cover
5	Connecting rod bolt
6	Connecting rod sleeve

7	Piston
8	Piston pin retaining ring
9	Trapezoid ring
10	Tapered ring
11	Grouped oil ring



1	Cylinder head assembly
2	Cylinder head lining
3	Valve rod sealing sleeve
4	Pipe
5	Cylinder head cover lining
6	Cylinder head main bolt
7	Water outlet pipe
8	Cylinder head cover

9	Hexagon bolt
10	Connecting pipe
11	Thermostat cover
12	Saddle-shaped flexible washer
13	Hexagon bolt
14	Suspended plate
15	Plain washer
16	Hexagon bolt full thread



fmwx16c021

1	Intake valve spring lower seat
2	Push rod assembly
3	Intermediate gear shaft
4	Intermediate gear shaft
5	Camshaft thrust plate
6	Camshaft gear
7	Camshaft
8	Cylindrical pin
9	Valve tappet
10	Valve outer spring
11	Valve inner spring
12	Valve lock clamp
13	Valve spring upper seat
14	Intake valve

15	Exhaust valve
16	Intake valve rocker arm
17	Exhaust valve rocker arm
18	Valve clearance adjusting screw
19	Valve clearance adjusting nut
20	Pad
21	Valve rocker arm seat
22	Intermediate gear assembly
23	Hexagon bolt
24	Valve cap
25	Hexagon bolt
26	Hexagon bolt
27	Hexagon bolt



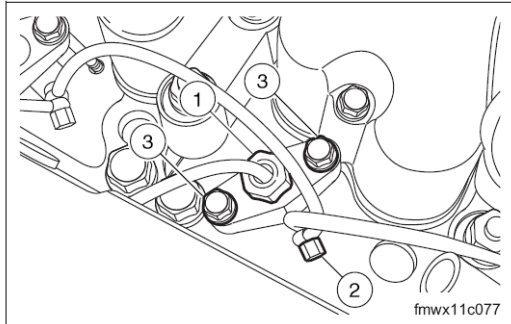
PRECAUTIONS

1. When lifting or supporting the engine, avoid the contact of the jack with the oil pan. When lowering the engine, use the engine supporting plate, wood frame or other similar tools to support the engine at the engine bearer and flywheel housing.
2. When removing the intake system, cover the intake to avoid the entry of foreign matters into the cylinder; otherwise the cylinder or other members may be seriously damaged in the engine operation.
3. When performing service work on the engine body, do ensure that the battery earthing cable is disconnected. If it is necessary to supply electric power to the engine when performing the service or similar work on it, take much care to avoid potential short circuits.
4. In order to protect and lubricate the sliding surface during the initial operation, apply a lot of engine oil onto the sliding surface.
5. When removing the valve system members, piston, piston ring, connecting rod, connecting rod bearing and crankshaft journal bearing, store them in sequence.
6. When installing parts, install the same parts onto the same positions prior to the removal.
7. Whenever the gasket, oil seal or other similar parts are removed, do ensure that the new parts are employed.
8. Prior to the application of any sealant, remove all old sealant, and remove the oil, grease, moisture and pollutants on parts concerned. After the application, refit the parts.
9. Apply the sealant pursuant to the requirements stipulated by the manufacturer.
10. During the assembling and fitting operation, fasten parts to the required torque, and then fit them correctly.

TESTING AND ADJUSTMENT

Compression pressure

With the engine stopped, after its temperature reduces to the normal value, measure the compression pressure with the battery and starter motor under failure-free conditions.



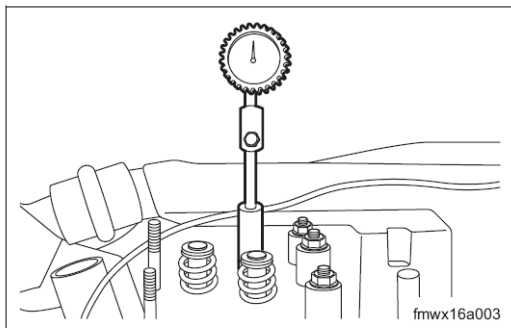
1. Remove the fuel injector.

- (a) Remove the injector inlet pipe 1.
- (b) Remove the injector return pipe 2.

Notice:

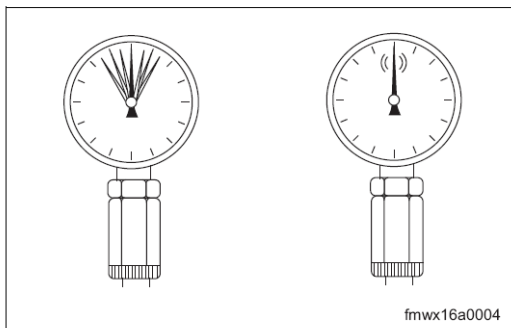
Recover the union cap to prevent pollution.

- (c) Remove the injector lock bolt 3.



2. Fit the pressure gauge.

- (a) Fit the pressure gauge into the injector hole.



3. Measure the compression pressure.

- (a) Start the starter motor, and read the compression pressure when the pressure gauge pointer is stabilized.

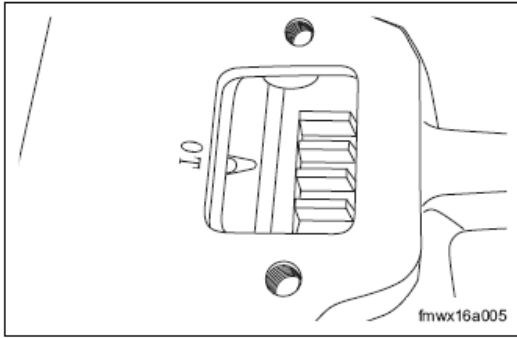
Notices:

- **Always remember that the air will be abruptly injected from the injector when the motor is working.**
- **Measure the pressure of all cylinders.**
- (b) Apply engine oil into the cylinder, and measure the compression pressure again.
 - If the pressure rises, the gap between the piston ring and cylinder liner is too large.

Item	Compression pressure	Pressure difference of air reservoirs
Standard value	2.6-2.8MPa	200kPa

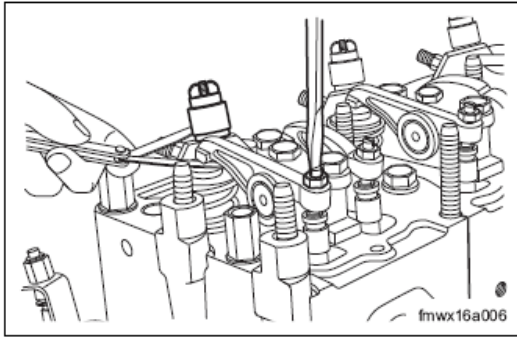
Adjustment of valve gap

Adjust the valve gap by two steps: firstly, set the No.1 cylinder at the upper dead center of compression; secondly, set the No.6 cylinder at the upper dead center of compression.



1. Set the No.1 (or No.6) cylinder at the upper dead center of compression.

- (a) Rotate the crankshaft forward, and align the OT regular line of the flywheel with the pointer. At this point, check whether there is any gap between the No.1 (or No.6) cylinder (upper dead center of compression) cam and the rocker arm.



2. Adjust the valve gap.

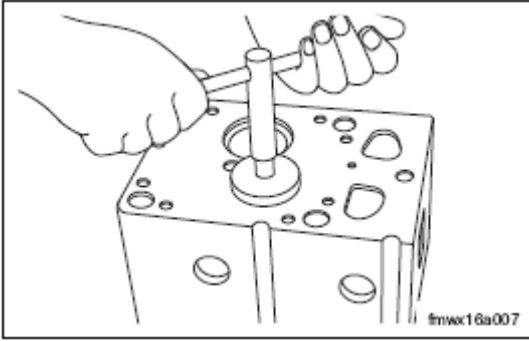
- (a) Fully undo the adjusting screw of the rocker arm.
 (b) Insert the thickness gauge into between the rocker arm and cam, make adjustment via the rocker arm adjusting screw, and then lock it with the lock nut.
 (c) When inserting the thickness gauge, fasten the screwing screw of the rocker arm till the gauge stops moving.
 (d) Gradually release the rocker arm adjusting screw, make readjustment till the gauge can be freely inserted and removed, and then fasten the lock nut of the rocker arm.

Item	Standard value
Intake valve gap	0.3mm
Exhaust valve gap	0.4mm

	Number of air reservoir	1		2		3		4		5		6	
Condition	Arrangement of valves	Exh.	Int.	Exh.	Int.	Exh.	Int.	Exh.	Int.	Exh.	Int.	Exh.	Int.
Valve to be adjusted	No.1 cylinder upper dead center	○	○		○	○			○	○			
	No.6 cylinder upper dead center			○			○	○			○	○	○



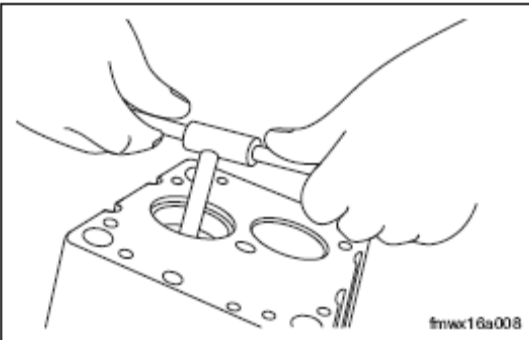
Reaming of valve seat



1. **Ream the valve seat.**
 - (a) Fit the reamer into the positioning bar.
 - (b) Insert the positioning bar into the valve guide pipe for localization.
 - (c) Slightly press the positioning bar and rotate it clockwise.
 - Firstly ream internal and external conical surfaces and finally the working conical surface.

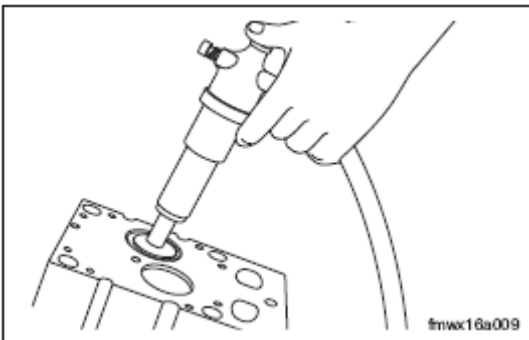
Item	Standard value
Width of working conical surface	1.5-1.8mm

Reaming of valve guide pipe



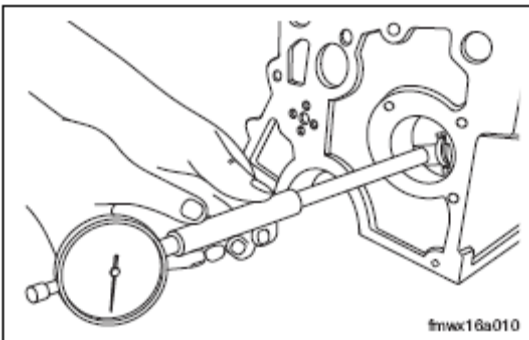
1. **Ream the valve guide pipe.**
 - (a) Rotate the reamer downward and clockwise with the reamer bar.
 - (b) Insert the positioning bar into the valve guide pipe for localization.
 - (c) Lightly press the positioning bar, and rotate it clockwise.
 - Firstly ream internal and external conical surfaces and finally the working conical surface.

Grinding of valve

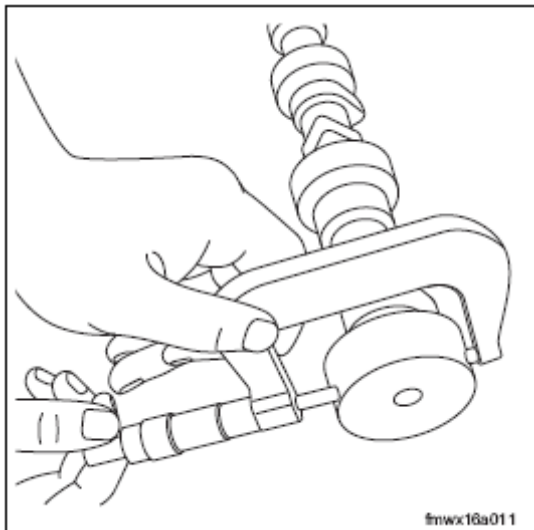


1. **Grind the valve**
 - (a) Use the grinding machine to grind the valve.
 - It is allowed to adjust the rotating and beating frequency of the grinding machine.
 - (b) After the grinding and cleaning work is finished, use the kerosene to check the valve sealing performance.

Check and adjustment of camshaft radial clearance



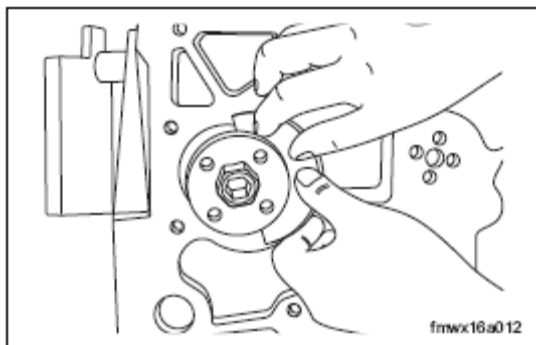
1. **Measure the internal diameter of the sleeve.**
 - (a) Check whether sleeves for various shaft holes are fitted reliably.
 - (b) Check whether the oil passage and oil holes are smooth.
 - (c) Use the internal diameter micrometer to measure internal diameters of various sleeves.



- (d) Use the external diameter micrometer to measure the external diameter of various cam shaft bearings.

Item	Standard value
Camshaft radial clearance	0.04-0.12mm

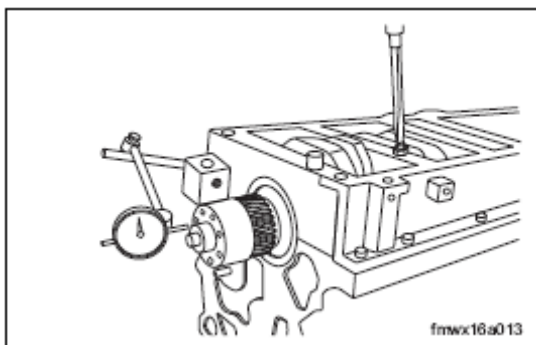
Check and adjustment of camshaft axial clearance



1. Axial clearance of camshaft

- Check the camshaft thrust groove, thrust baffle and their mating surface with the cylinder block for damages and burrs.
- Insert the thrust baffle into the thrust ring groove, and fix the baffle with two screws.
- Use the dial gauge to check the axial clearance of the camshaft.

Item	Standard value
Camshaft axial clearance	0.1-0.4mm



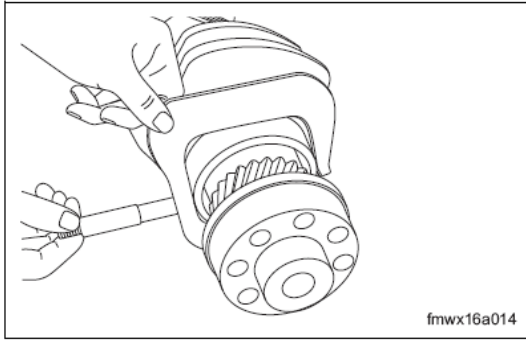
Check and adjustment of crankshaft axial clearance

1. Measure the crankshaft axial clearance.

- Use the magnetic dial gauge seat to fit the dial gauge at the crankshaft end.
- Pry the crankshaft fore and aft. Rotate the crankshaft, and it shall be able to turn freely without noticeable seizure.
- If the gap exceeds the required limit, replace the crankshaft pad.

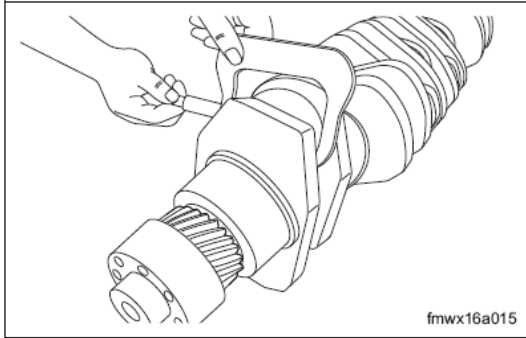
Item	Standard value
Crankshaft axial clearance	0.052-0.255mm

Check and adjustment of crankshaft radial clearance

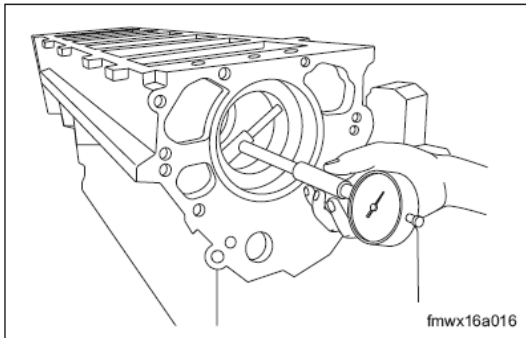


1. Measure the crankshaft radial clearance.

(a) Use the external diameter micrometer to measure dimensions of various main journals of the crankshaft.



(b) Use the external diameter micrometer to measure dimensions of various connecting rod journals of the crankshaft.



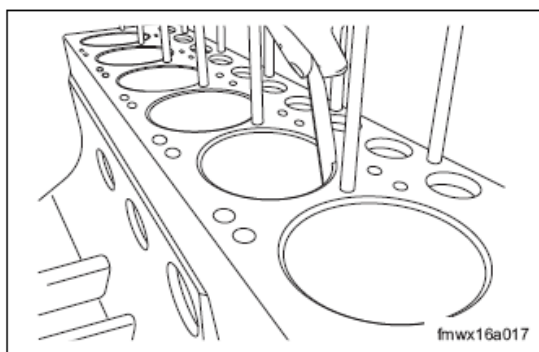
(c) Fit the crankshaft main bearing bushing onto the cylinder block and crankcase seat holes, and tighten it with the torque of 250N.m. Then use the internal diameter micrometer to measure internal diameters of various bushes.

Notice:

The main shaft bushing with an oil groove is the upper bushing, while the one without such a groove is the lower piece.

Item	Standard value
Crankshaft radial clearance	0.095-0.166mm

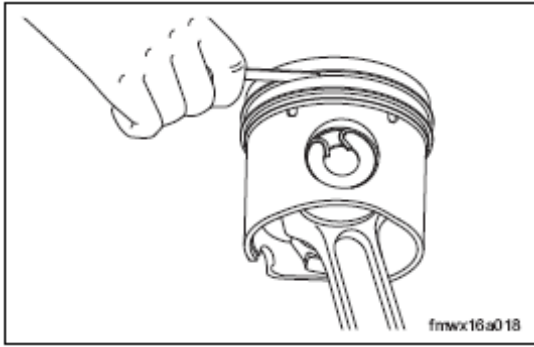
Check and adjustment of piston ring clearance



1. Measure the clearance of piston ring opening.

(a) Measure the clearance of piston ring opening.

(b) If the clearance exceeds the required limit, replace the piston ring.

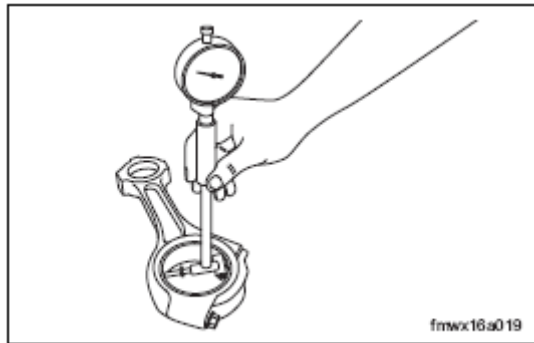


2. Measure the lateral clearance of the piston ring.

- (a) Use the thickness gauge to measure the lateral clearance of the piston ring.
- (b) If the clearance exceeds the required limit, replace the piston ring.

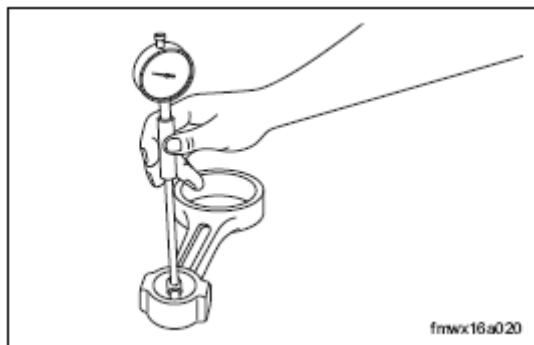
Item		Standard value
First air ring	Opening clearance	0.4-0.6mm
	Lateral clearance	-
Second air ring	Opening clearance	0.25-0.4mm
	Lateral clearance	0.07-0.102mm
Third oil ring	Opening clearance	0.35-0.55mm
	Lateral clearance	0.05-0.085mm

Check of fit clearance of connecting rod



1. Measure the connecting rod large end

- (a) Fit the connecting rod into the connecting rod large end, and fasten the connecting rod bolt.
- (b) Use the internal diameter micrometer to measure the diameter of connecting rod bush hole.



2. Measure the connecting rod small end.

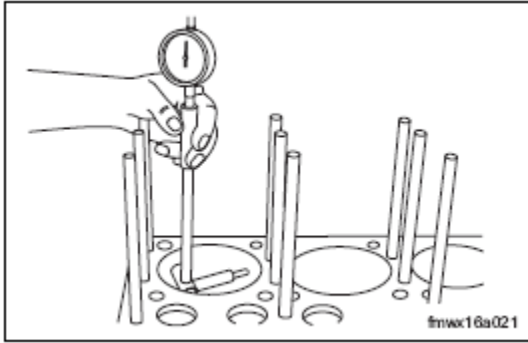
- (a) Press the connecting rod small end sleeve into the shaft hole.
- (b) Measure the internal diameter of the sleeve.
- (c) Measure the internal diameter of piston pin hole and external diameter of piston pin.

16A

Item	Standard value
Connecting rod large end face x crankshaft clearance	0.15-0.35mm
Connecting small end sleeve x piston pin fit clearance	0.040-0.060mm
Piston pin seat x piston pin fit clearance	0.003-0.013mm

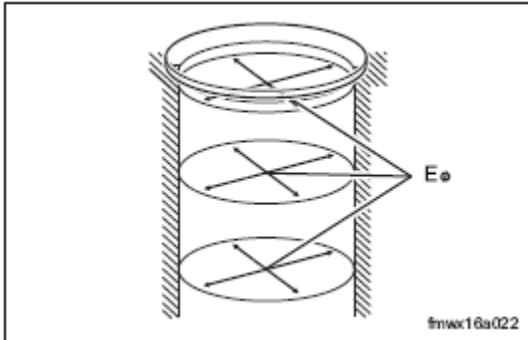


Check of cylinder liner roundness



1. Measure the cylinder liner roundness

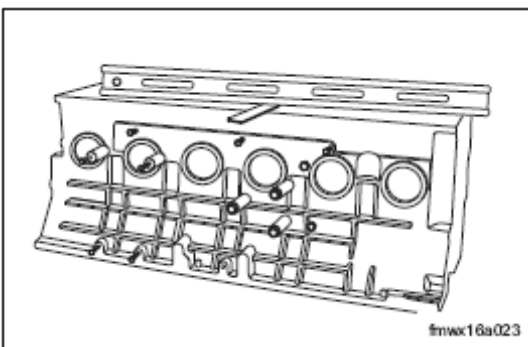
- Check the cylinder bore and spigot for cleanness, rusting and damages.
- Use the trichloroethylene cleaning agent to clean the bore and spigot.
- Use the internal diameter micrometer to measure the bore internal diameter.



- Measure on both sides at upper, middle and lower positions.

Item	Standard value
Out-of-roundness	Less than 0.04mm

Check of cylinder block planeness



1. Measure the cylinder block planeness.

- Place a horizontal ruler on the cylinder block upper surface.
- Use the thickness gauge to measure the clearance between the ruler and cylinder block upper surface.

Notice:

Measure at front, middle and rear positions on the cylinder block upper surface, as well as in the diagonal direction.

ENGINE ASSEMBLY

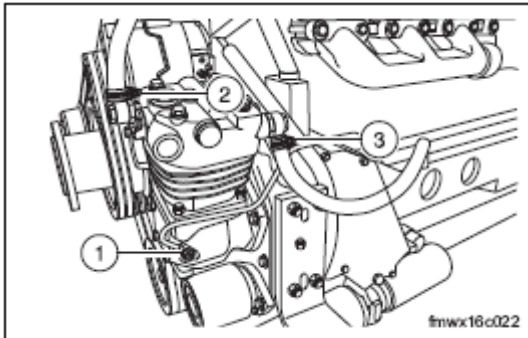
REPLACEMENT

1. Turn off the battery switch, and disconnect the battery negative cable.
2. Remove the engine inlet pipe. Refer to Chapter 11A: Replacement, Fuel-Fuel-water Separator.
3. Remove the intake pipe. Refer to Chapter 12: Replacement, Air Intake-High-mounted Air Intake Pipe A.
4. Remove the exhaust pipe. Refer to Chapter 13A: Replacement, Exhaust & Turbocharger-Exhaust Pipe.
5. Remove the transmission assembly. Refer to Chapter 31A: Replacement, Transmission-Transmission Assembly.
6. Discharge the cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.
7. Remove the intercooler hose. Refer to Chapter 14A: Overhaul, Cooling-Intercooler.
8. Remove the radiator hose. Refer to Chapter 14A: Overhaul, Cooling-Radiator.
9. Remove the secondary water tank hose. Refer to Chapter 14A: Replacement, Cooling-Secondary Water Tank.
10. Remove the air heater hose. Refer to Chapter 51: Overhaul, Air Heater & Air Conditioner- Air Heater Water Pipe.
11. Remove the air conditioner compressor pipeline. Refer to Chapter 51: Overhaul, Air Heater & Air Conditioner- Cooling Pipe.
12. Remove the air compressor pipeline. Refer to Chapter 16A: Overhaul, Engine Mechanic System-Engine Spare Parts.
13. Remove the engine lock bolts.
14. Install the engine lock bolts.
15. Install the air compressor pipeline. Refer to Chapter 16A: Overhaul, Engine Mechanic System-Engine Spare Parts.
16. Install the air conditioner compressor pipeline. Refer to Chapter 51: Overhaul, Air Heater & Air Conditioner- Cooling Pipe.
17. Install the air heater hose. Refer to Chapter 51: Overhaul, Air Heater & Air Conditioner- Air Heater Water Pipe.
18. Install the secondary water tank hose. Refer to Chapter 14A: Replacement, Cooling-Secondary Water Tank.
19. Install the radiator hose. Refer to Chapter 14A: Overhaul, Cooling-Radiator.
20. Install the intercooler hose. Refer to Chapter 14A: Overhaul, Cooling-Intercooler.
21. Refill the cooling liquid. Refer to Chapter 14A: Replacement, Cooling-Cooling Liquid.
22. Install the transmission assembly. Refer to Chapter 31A: Replacement, Transmission-Transmission Assembly.
23. Install the exhaust pipe. Refer to Chapter 13A: Replacement, Exhaust & Turbocharger-Exhaust Pipe.
24. Install the intake pipe. Refer to Chapter 12: Replacement, Air Intake-High-mounted Air Intake Pipe A.
25. Install the engine inlet pipe. Refer to Chapter 11A: Replacement, Fuel-Fuel-water Separator.
26. Connect the battery negative cable and turn on the battery switch,

ENGINE ACCESSORIES

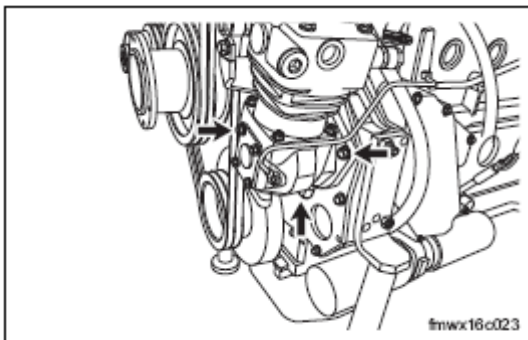
REPLACEMENT

1. Turn off the battery switch, and disconnect the battery negative cable.
2. Remove the generator. Refer to Chapter 19A: Overhaul, Charging System-Generator.
3. Remove the starter. Refer to Chapter 18A: Overhaul, Starting & Preheating System-Engine.
4. Remove the power steering pump. Refer to Chapter 42: Replacement, Power Steering Mechanism-Steering Oil Pump Assembly.
5. Remove the compressor. Refer to Chapter 51: Overhaul, Air Heater & Air Conditioner-Compressor.
6. Remove the water pump. Refer to Chapter 14A: Replacement, Cooling-Water pump.
7. Remove the cooling fan. Refer to Chapter 14A: Overhaul, Cooling-Cooling fan.
8. Remove the fuel injection pump. Refer to Chapter 11A: Replacement, Fuel-Injection Pump.
9. Remove the fuel secondary filter Refer to Chapter 11A: Replacement, Fuel-Fuel Secondary Filter.
10. Remove the oil pan. Refer to Chapter 15A: Replacement, Lubrication-Oil Pan.

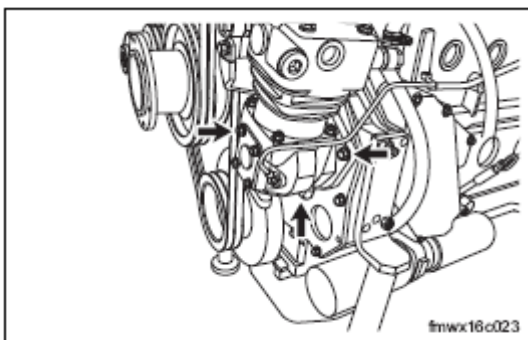


11. Remove the air compressor.

- (a) Remove the air compressor lubricating oil pipe 1.
- (b) Remove the compressor inlet pipe 2.
- (c) Remove the compressor outlet pipe 3.



- (d) Remove these 3 lock bolts on the compressor.



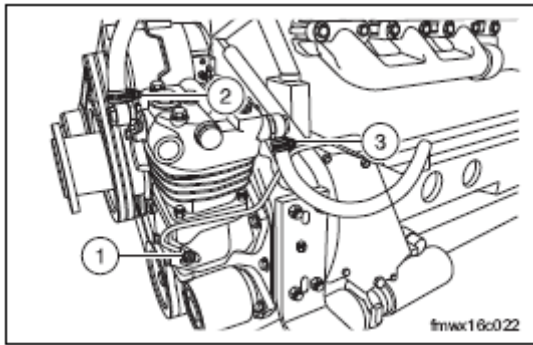
12. Install the air compressor.

- (a) Install these 3 lock bolts on the compressor.

Torque: 60N.m

Notice:

Pay attention to the compressor gasket in the installing operation.



- (b) Install the compressor lubricating oil pipe 1.
- (c) Install the compressor inlet pipe 2.
- (d) Install the compressor outlet pipe 3.

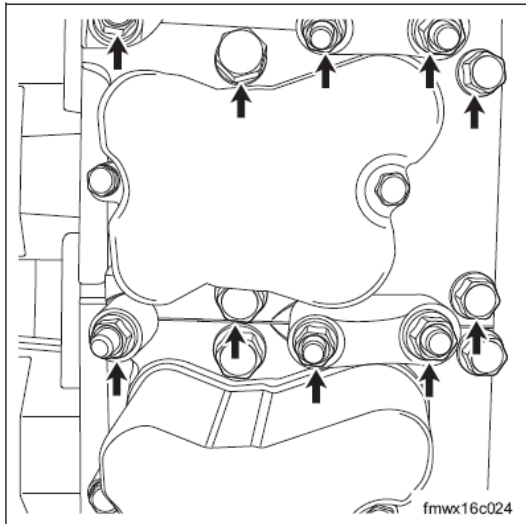
- 13. Install the oil pan. Refer to Chapter 15A: Replacement, Lubrication-Oil Pan.
- 14. Install the fuel secondary filter. Refer to Chapter 11A: Replacement, Fuel-Fuel Secondary Filter.
- 15. Install the fuel injection pump. Refer to Chapter 11A: Replacement, Fuel-Injection Pump.
- 16. Install the cooling fan. Refer to Chapter 14A: Overhaul, Cooling-Cooling fan.
- 17. Install the water pump. Refer to Chapter 14A: Replacement, Cooling-Water pump.
- 18. Install the compressor. Refer to Chapter 51: Overhaul, Air Heater & Air Conditioner-Compressor.
- 19. Install the power steering pump. Refer to Chapter 42: Replacement, Power Steering Mechanism-Steering Oil Pump Assembly.
- 20. Install the starter. Refer to Chapter 18A: Overhaul, Starting & Preheating System-Engine.
- 21. Install the generator. Refer to Chapter 19A: Overhaul, Charging System-Generator.
- 22. Connect the battery negative cable and turn on the battery switch.



CYLINDER HEAD

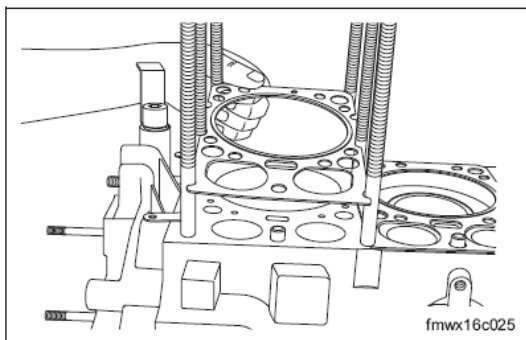
REPLACEMENT

1. Remove the fuel injector. Refer to Chapter 11A: Overhaul, Fuel-Fuel Injector.

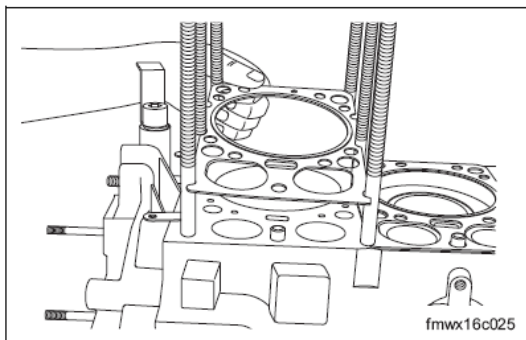


2. Remove the cylinder head.

- (a) Remove the cylinder head lock block.
- (b) Remove the cylinder head lock bolts and nuts.



- (c) Remove the cylinder gasket.
- (d) Remove the valve tappet.

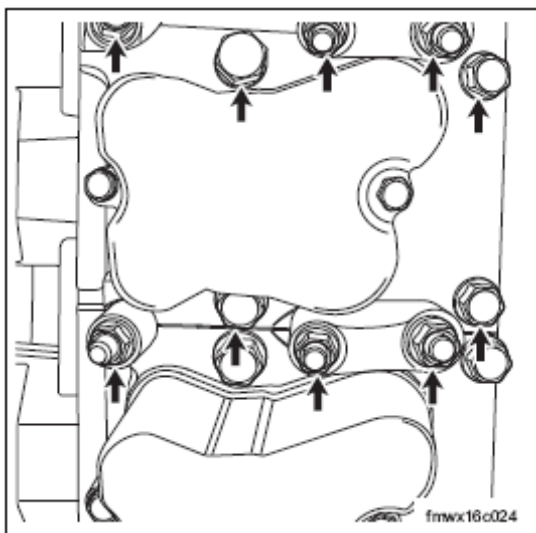


3. Install the cylinder head.

- (a) Install the valve tappet.
- (b) Install the cylinder gasket.

Notice:

Do not reverse the mounting direction.



- (c) Install the cylinder head lock block.
- (d) Install the cylinder head lock bolts and nuts.

Torque: Fasten the main and secondary bolts with the torque of $40 \pm 10 \text{ N.m}$ for the first time.

Fasten the secondary bolt with the torque of 100 N.m for the second time.

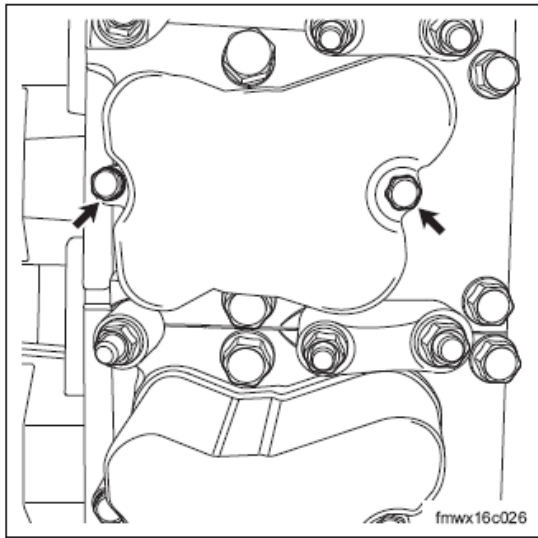
Fasten the main bolt with the torque of 200 N.m for the third time.

Screw in the secondary bolt and nut by 90° for the fourth time.

Screw in the main bolt by 90° for the fifth time.

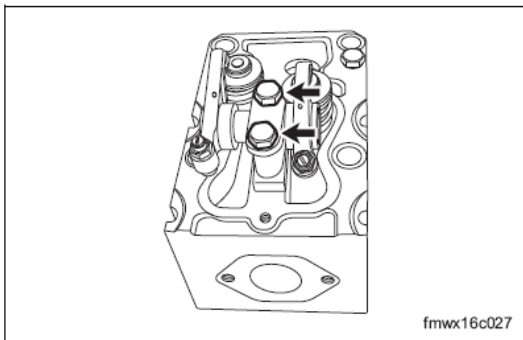
- 4. Install the fuel injector. Refer to Chapter 11A: Overhaul, Fuel-Fuel Injector.

ROCKER ARM & VALVE REPLACEMENT

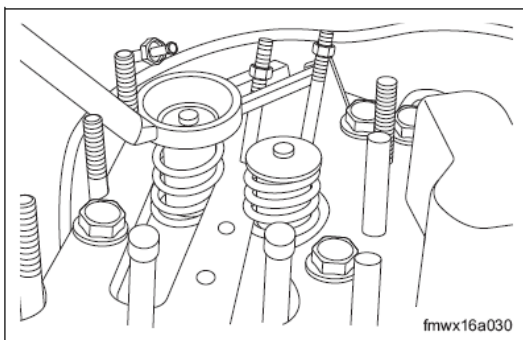


1. **Remove the valve chamber cover.**
 - (a) Remove the lock bolt of the valve chamber cover.

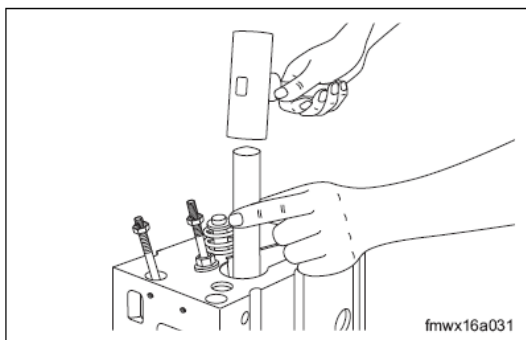
2. **Remove the cylinder head. Refer to Chapter 16A: Replacement, Engine Mechanic System-Cylinder Head.**



3. **Remove the rocker arm.**
 - (a) Remove the intake and exhaust valve rocker arms.
 - (b) Remove the rocker arm bracket.

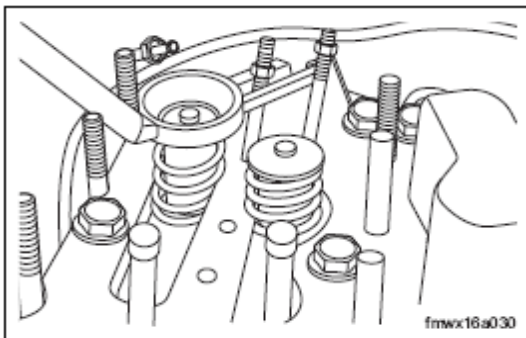


4. **Remove the valve.**
 - (a) Use the valve tools to remove the valve lock plate.
 - (b) Remove the valve spring and valve.
 - (c) Remove the valve guide pipe.

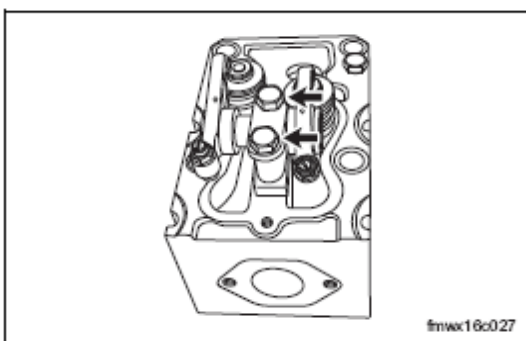


5. Install the valve.

- (a) Use the valve guide pipe stamping rod to install the valve guide pipe.
- (b) Install the valve spring.



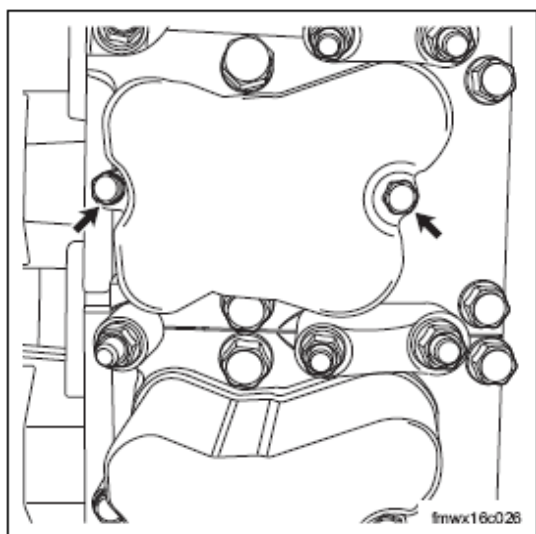
- (c) Use the valve tools to install the valve lock plate.



6. Install the rocker arm.

- (a) Install the rocker arm bracket.
Torque: 105±5N.m
- (b) Install the intake & exhaust valve rocker arms.

7. Install the cylinder head. Refer to Chapter 16A: Replacement, Engine Mechanic System-Cylinder Head.



8. Install the valve chamber cover.

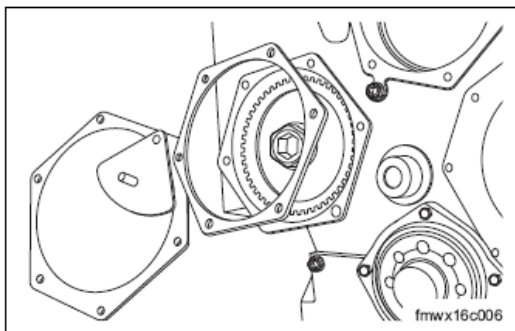
- (a) Install the lock bolt of the valve chamber cover.
Torque: 25N.m

TIMING GEAR REPLACEMENT

Hint:

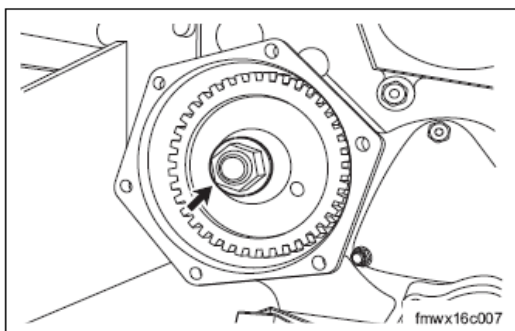
Prior to the removal of timing gear, provide timing marks to facilitate the installing operation.

1. **Remove the engine accessories. Refer to Chapter 16A: Replacement, Engine Mechanic System-Engine Accessories.**

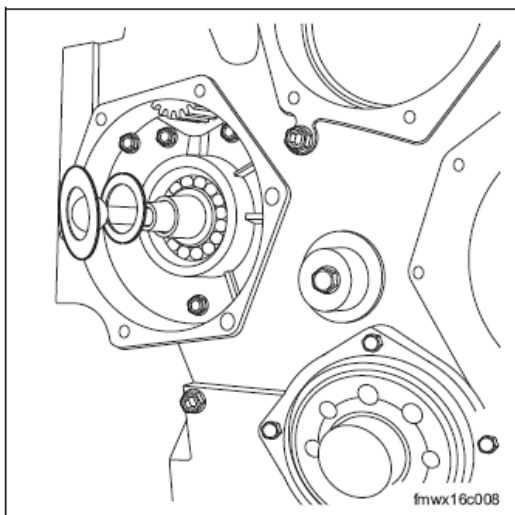


2. **Remove the timing gear box.**

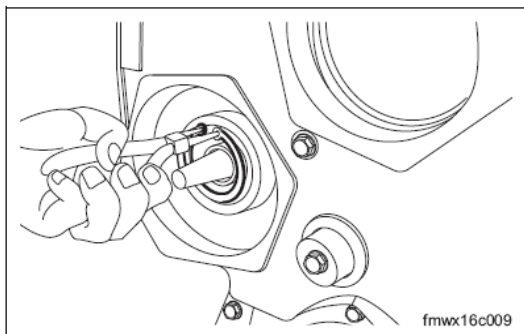
- (a) Remove the drive gear box gasket and cover plate.



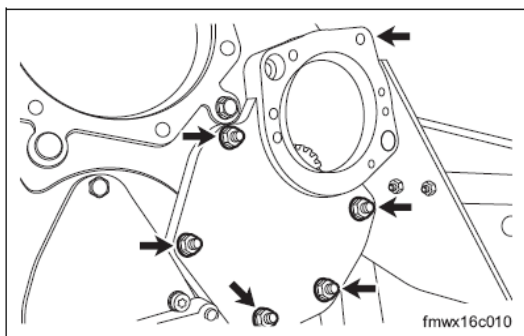
- (b) Remove the drive gear.



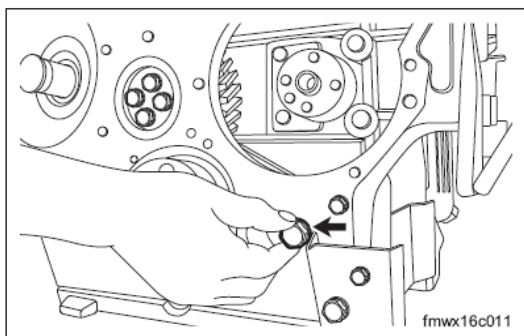
- (c) Remove the drive bearing inner ring positioning washer and butterfly-shaped flexible washer.



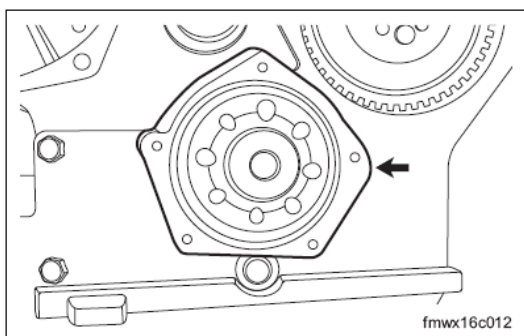
- (d) Remove the bearing outer ring positioning snap spring.



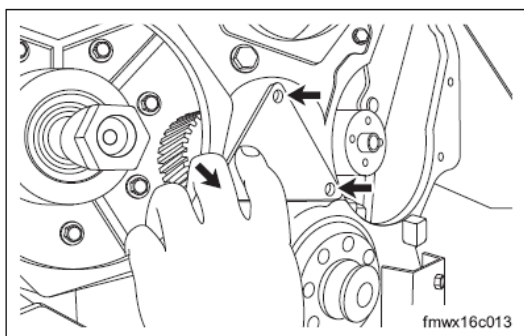
- (e) Remove the camshaft gear gasket and cover plate.



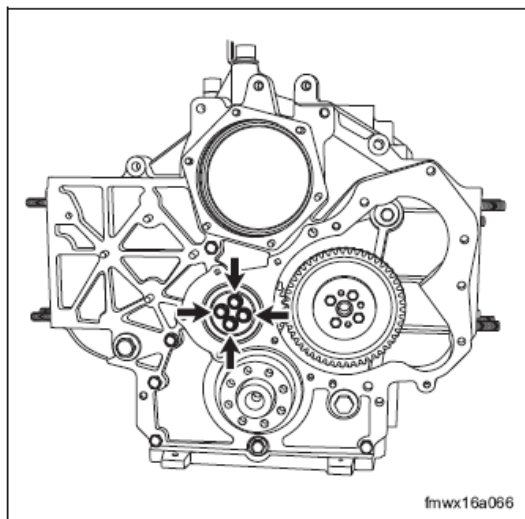
- (f) Remove the timing chamber screw plug.



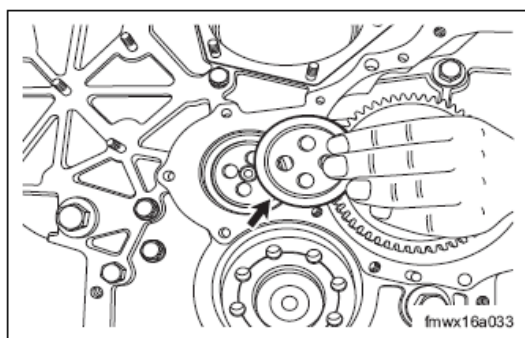
- (g) Remove the crankshaft oil seal seat pad.



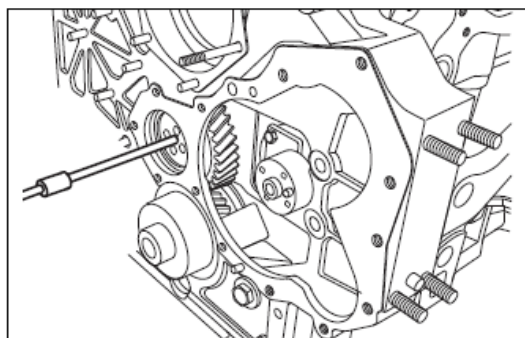
- (h) Remove the triangle cover plate.



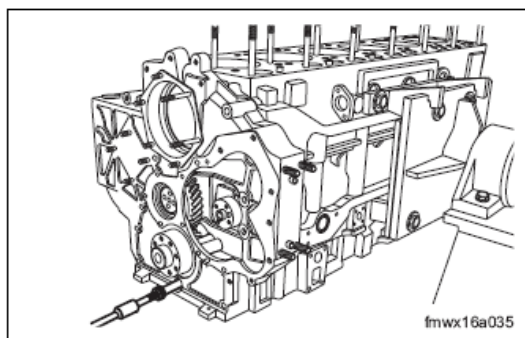
- (i) Remove the lock bolt for cover plate of timing intermediate gear shaft.



- (j) Remove the cover plate of timing intermediate gear shaft.

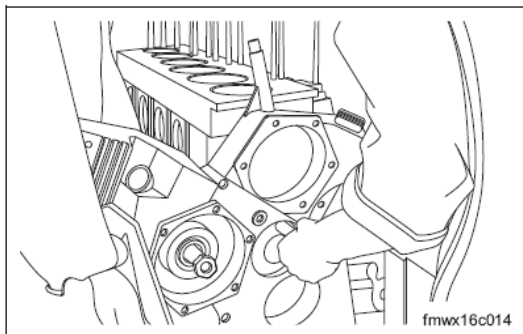


- (k) Remove the timing intermediate gear shaft.



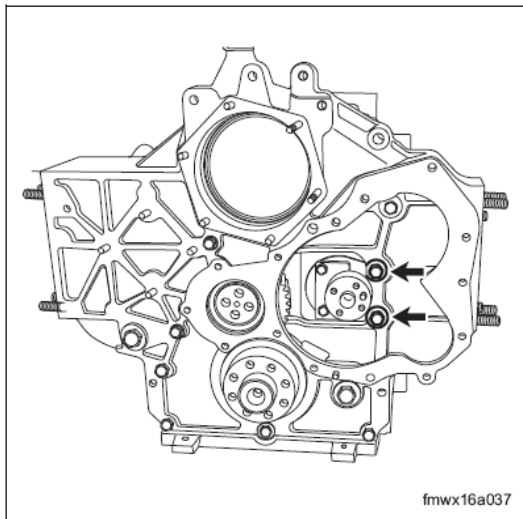
- (l) Remove the intermediate gear shaft of engine oil pump.

- (m) Remove the timing gear box.

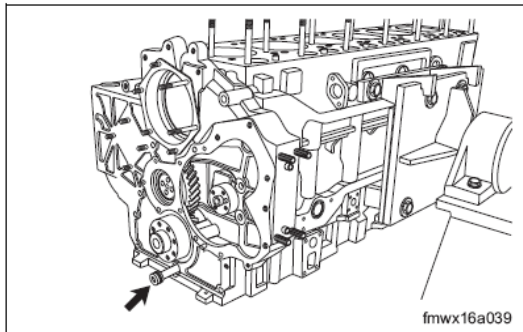


3. Install the timing gear.

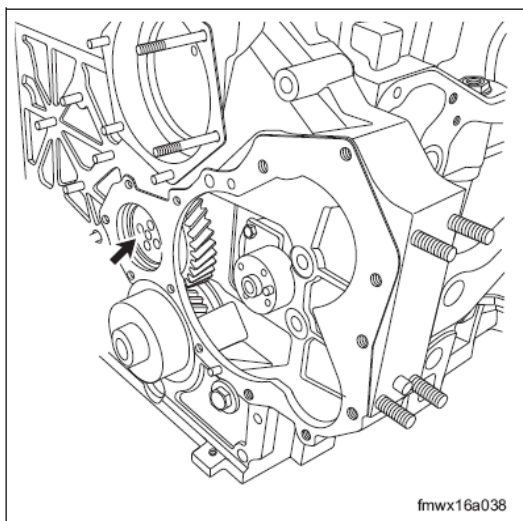
- (a) Install the timing gear box.



- (b) Install the engine oil pump intermediate gear shaft.

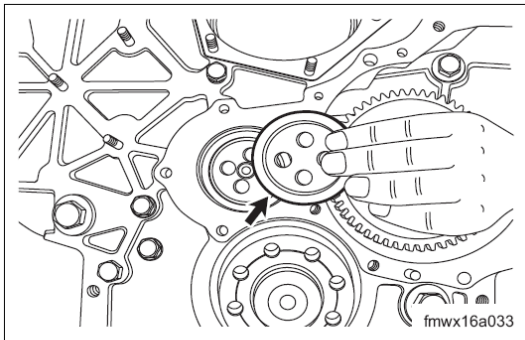


- (c) Install the timing intermediate gear shaft.



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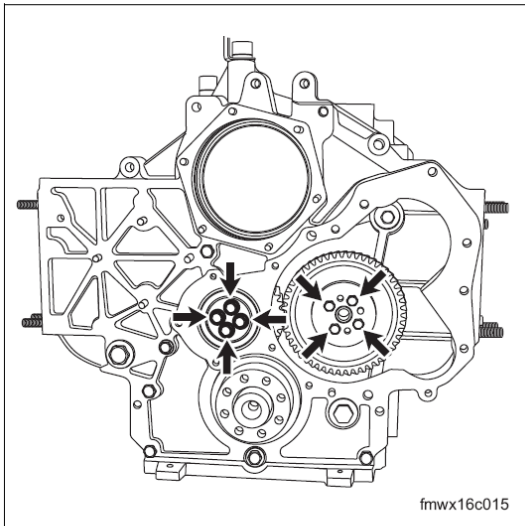
ENGINE MECHANIC SYSTEM (WD618)-TIMING GEAR



(d) Install the timing intermediate gear cover plate.

Notice:

Align the timing mark.



(e) Install the camshaft gear.

Torque: $34\pm 3\text{N.m}$, tightened in a symmetrical way;

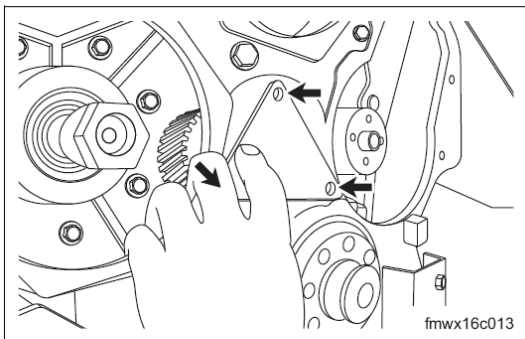
(f) Install the lock bolt of cover plate of the timing intermediate gear shaft.

Notice:

The length of one bolt is different from that of the remaining three ones.

Torque: $60\pm 5\text{N.m}$, pre-tightened.

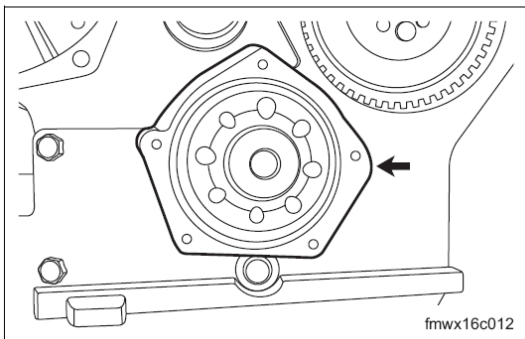
Further tightened by $90\pm 5^\circ$, with the testing torque of 112.5N.m



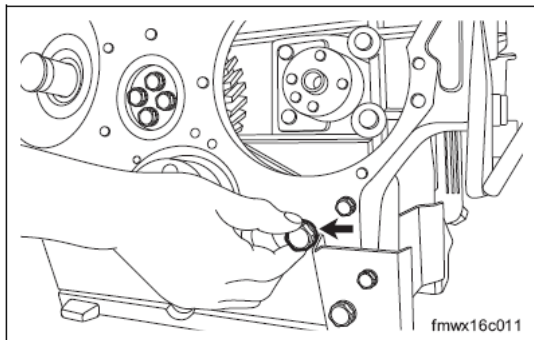
(g) Install the triangle cover plate.

Notice:

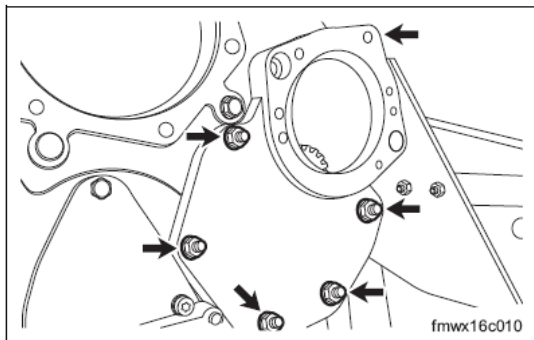
Apply the plane sealant.



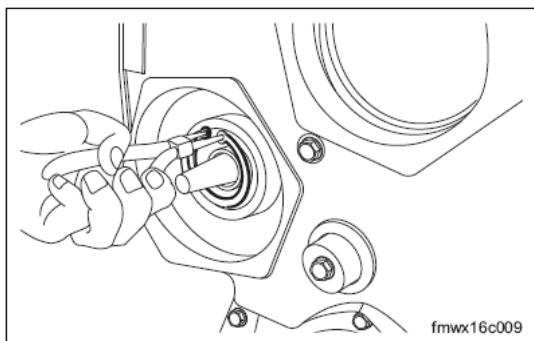
(h) Install the crankshaft oil seal seat pad.



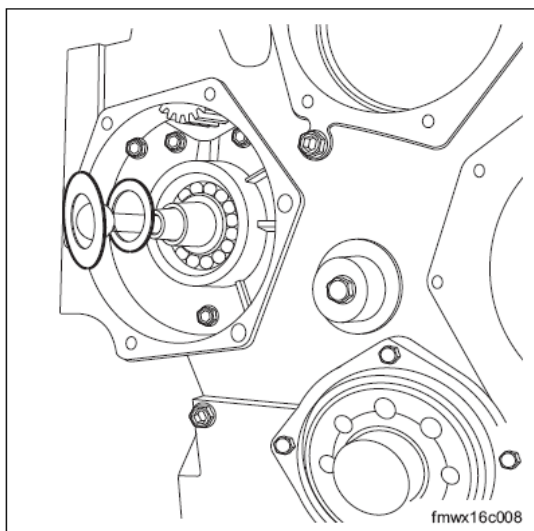
- (i) Install the timing gear screw plug.



- (j) Install the camshaft gear pad and cover plate.



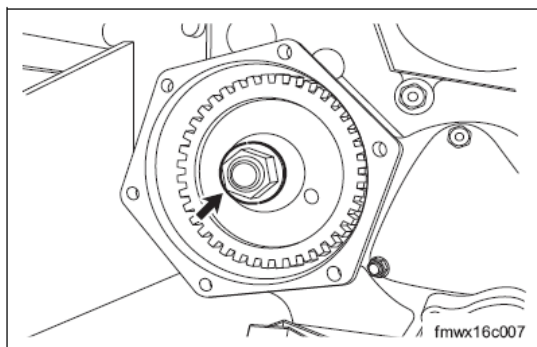
- (k) Install the bearing outer ring positioning snap spring.



- (l) Install the drive bearing inner ring positioning washer and butterfly-shaped flexible washer.

16A-30

ENGINE MECHANIC SYSTEM (WD618)-TIMING GEAR

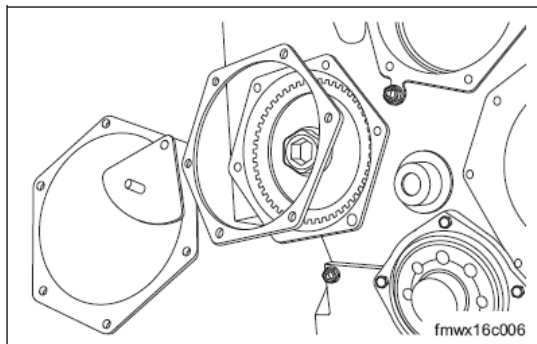


(m) Install the drive gear.

Torque: 200N.m

Notice:

Apply the 242 lock adhesive onto threads.



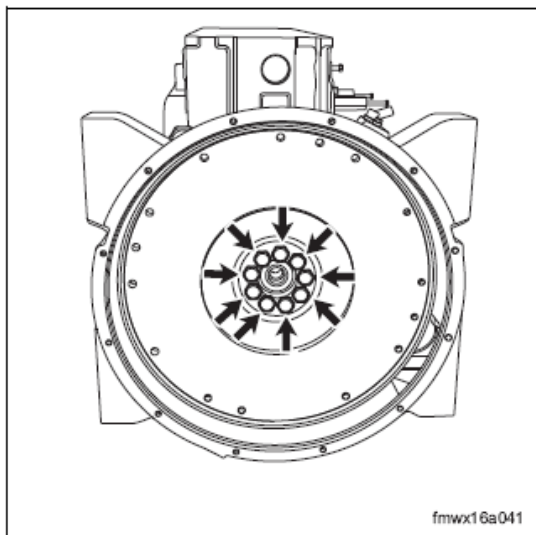
(n) Install the drive gear box gasket and cover plate.

4. Install engine accessories. Refer to Chapter 16A: Replacement, Engine Mechanic System-Engine Accessories.

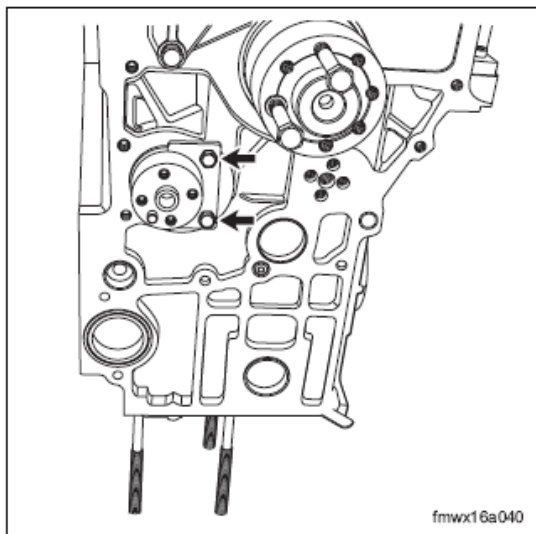
CAMSHAFT

REPLACEMENT

1. Remove the timing gear box. Refer to Chapter 16A: Replacement, Engine Mechanic System-Timing Gear Box.



2. Remove the camshaft.



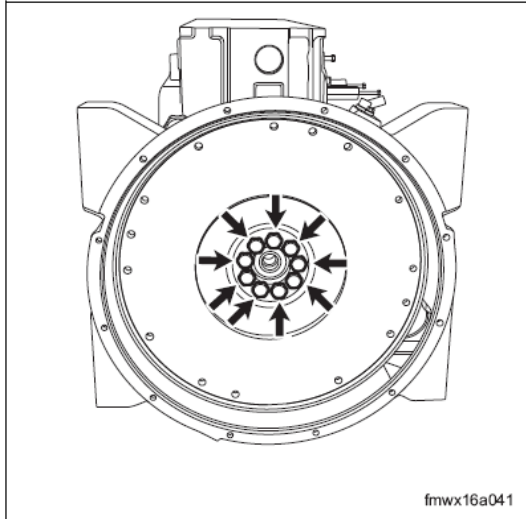
3. Install the camshaft.
 - (a) Install the camshaft.
 - (b) Install the lock bolt of camshaft.**Torque: 60N.m**

4. Install the timing gear box. Refer to Chapter 16A: Replacement, Engine Mechanic System-Timing Gear Box.

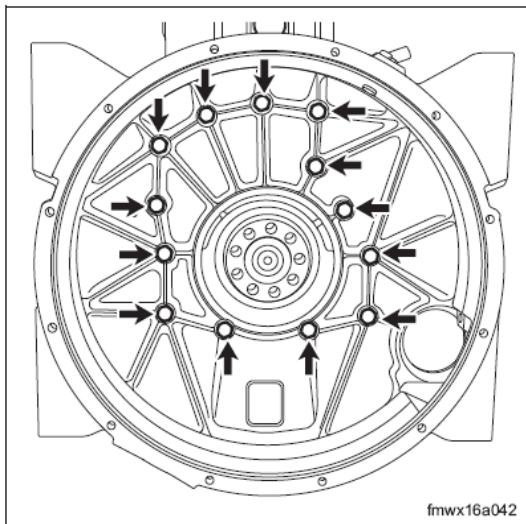
FLYWHEEL AND FLYWHEEL HOUSING

REPLACEMENT

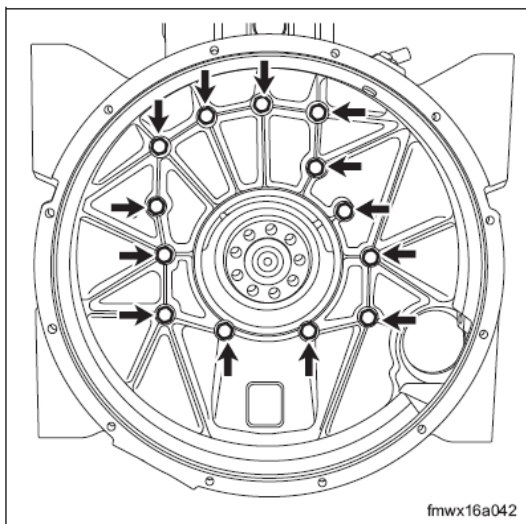
1. Remove the transmission. Refer to Chapter 31A: Replacement, Transmission - Transmission Assembly.



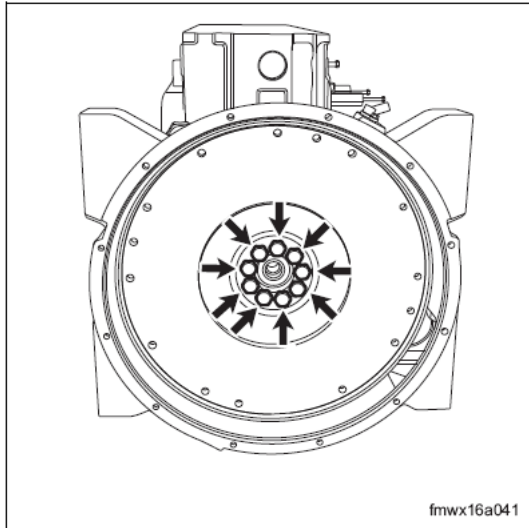
2. Remove the flywheel.
 - (a) Remove the flywheel lock bolt.



3. Remove the flywheel housing.
 - (a) Remove the flywheel housing lock bolt.



4. Install the flywheel housing.
 - (a) Install the flywheel housing lock bolt.
Torque: Initial $50\pm 10\text{N.m}$, applied symmetrically.
Further $120^\circ\pm 5^\circ$;
Testing torque: 255N.m



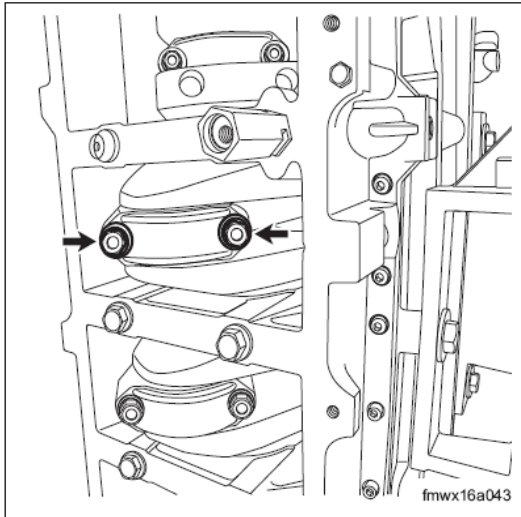
- 5. Install the flywheel.**
 - (a)** Install the flywheel lock bolt.
**Torque: Initially tightened symmetrically;
Further $70 \pm 10 \text{ N.m}$;
Further two 90° s;**

- 6. Install the transmission. Refer to Chapter 31A: Replacement, Transmission-Transmission Assembly.**

PISTON AND CONNECTING ROD

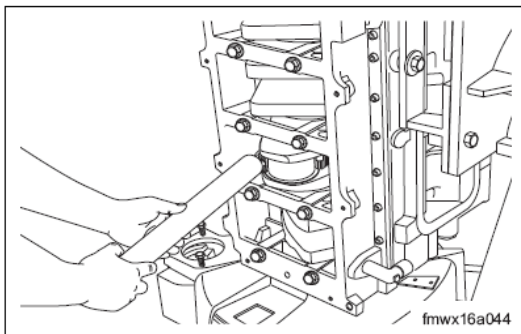
REPLACEMENT

1. Remove the cylinder head. Refer to Chapter 16A: Replacement, Engine Removing and Installing-Cylinder Head.
2. Remove the oil pan. Refer to Chapter 15A: Replacement, Lubrication-Oil Pan.



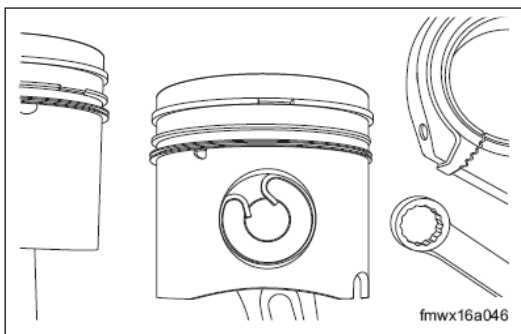
3. Remove the piston connecting rod mechanism.

(a) Remove the lock bolt of the connecting rod large end.



(b) Loosen the connecting rod by knocking it with a nylon rod.

(c) Pull out the connecting rod piston assembly.

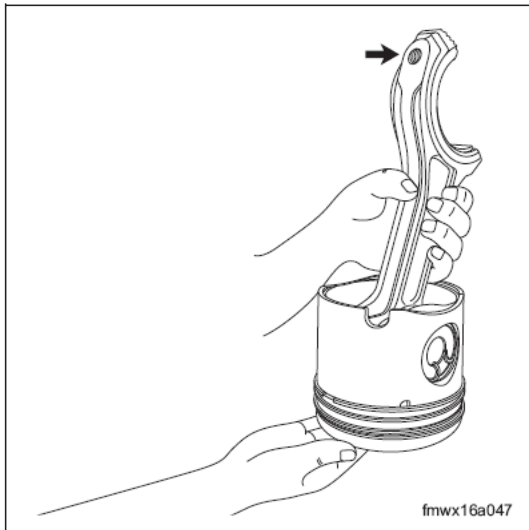


4. Remove the piston.

(a) Remove the piston ring.

(b) Remove the piston snap spring.

(c) Knock out the piston pin, and remove the piston.

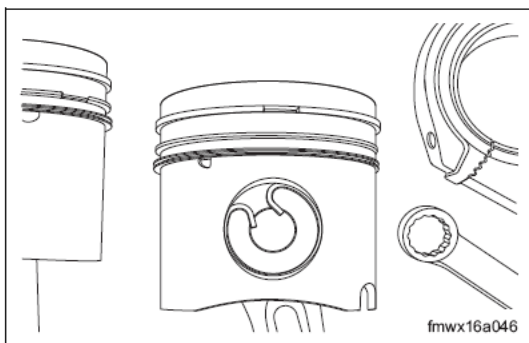


5. Install the piston.

- (a) Place the piston assembly in the 80°C thermostat for 10min, and immediately after it is taken out, install the piston pin and connecting rod.

Notice:

The 45° cutting surface of the connecting rod large end must be opposite to the gap of piston engine oil nozzle.

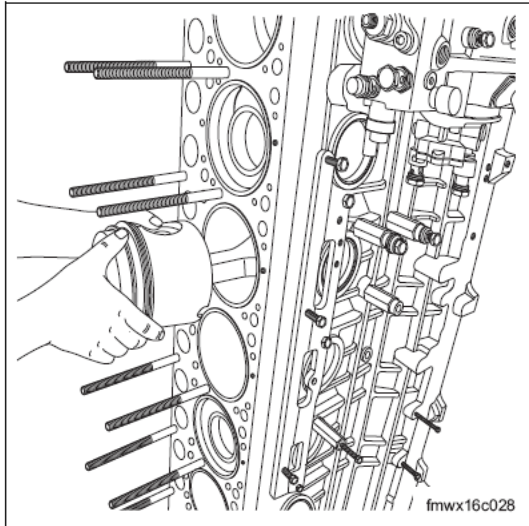


- (b) Fit the positioning snap spring into the positioning grooves on both sides of the piston pin hole.

- (c) Fit the piston ring.

Notice:

The air ring must be positioned such that the side marked with "TOP" faces up. As for the oil ring, there is no difference between upper and lower sides.



6. Fit the piston connecting rod mechanism.

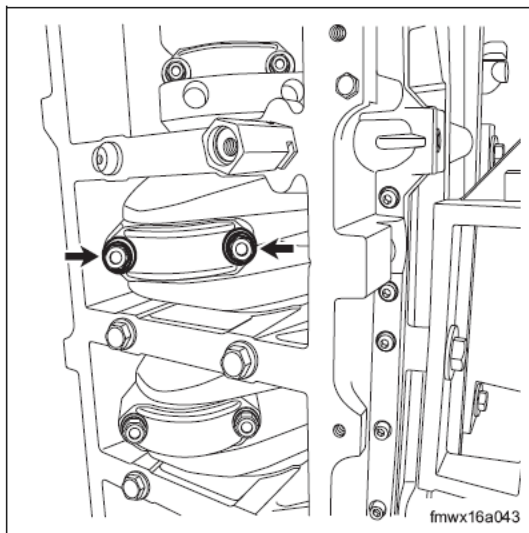
- (a) Use the piston pliers to fit the piston into the cylinder liner.

Notice:

The piston ring openings shall be staggered by 120°, and the opening shall be deviated from the piston pin axis by more than 30°. Apply the engine oil onto the piston external surface and cylinder liner inner surface.

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ENGINE MECHANIC SYSTEM (WD618)-PISTON AND CONNECTING ROD



- (b) Install the lock bolt of connecting rod large end.
- Tighten the connecting rod bolt symmetrically.

Torque: Initial 120N.m;

Further $90^{\circ} \pm 5^{\circ}$;

Check whether the torque reaches 210N.m.

Notice:

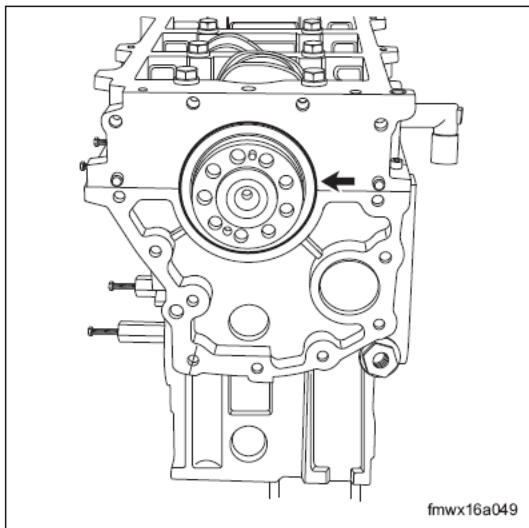
Once the connecting rod bolt is removed, no further use is allowed.

7. Install the oil pan. Refer to Chapter 15A: Replacement, Lubrication-Oil Pan.
8. Install the cylinder head. Refer to Chapter 16A: Replacement, Engine Removing and Installing-Cylinder Head.

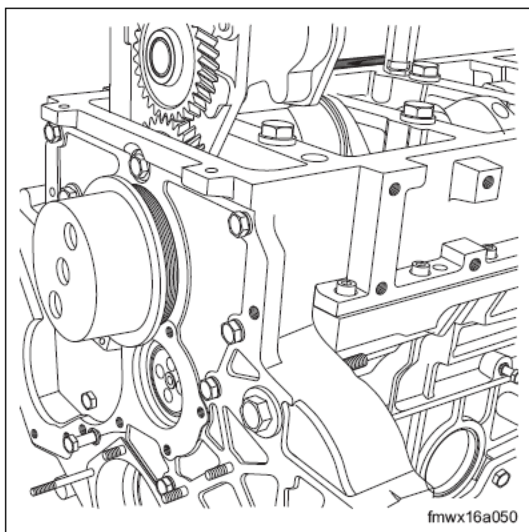
CRANKSHAFT

REPLACEMENT

1. Remove the piston and connecting rod. Refer to Chapter 16A: Replacement, Engine Mechanic System-Piston and Connecting Rod.
2. Remove the flywheel and flywheel housing. Refer to Chapter 16A: Replacement, Engine Mechanic System-Flywheel and Flywheel Housing.

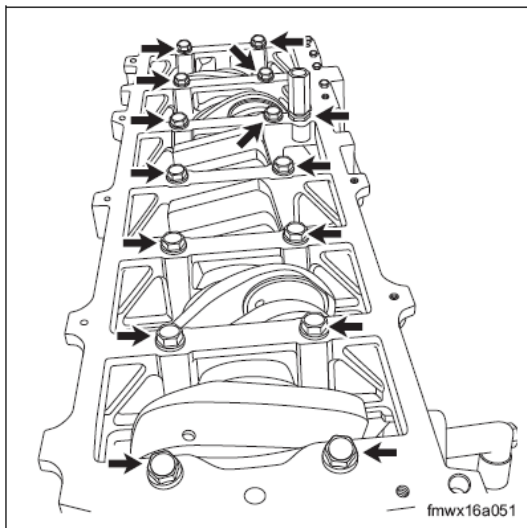


3. Remove the crankshaft oil seal.
 - (a) Remove the crankshaft front oil seal.



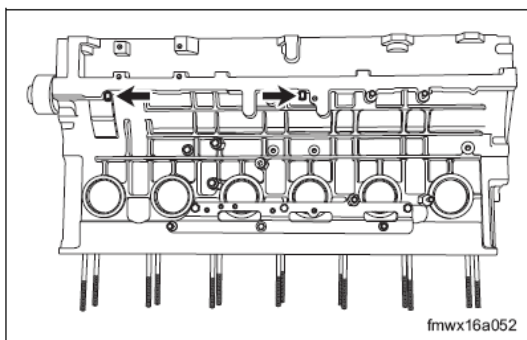
- (b) Remove the crankshaft rear oil seal.

4. Remove the timing gear. Refer to Chapter 16A: Replacement, Engine Mechanic System-Timing Gear.

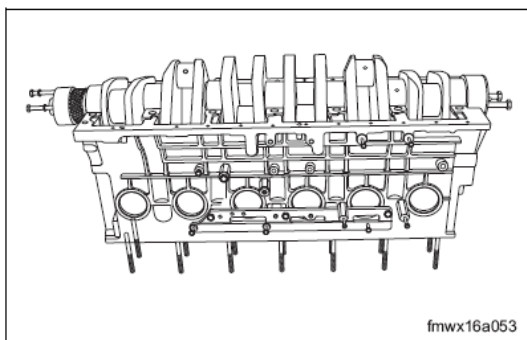


5. Remove the crankshaft.

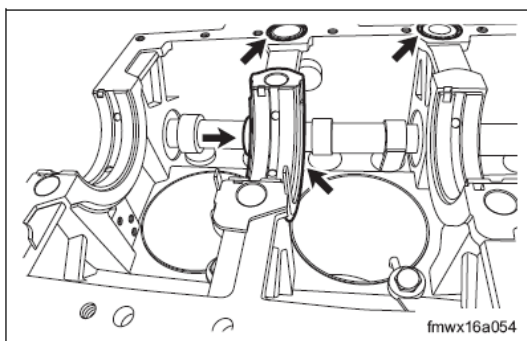
- (a) Remove the crankcase.
- Remove the engine oil pressure regulating valve.
 - Remove the crankcase lock bolt.



- Knock out the crankcase positioning pin.
- Remove the crankcase.

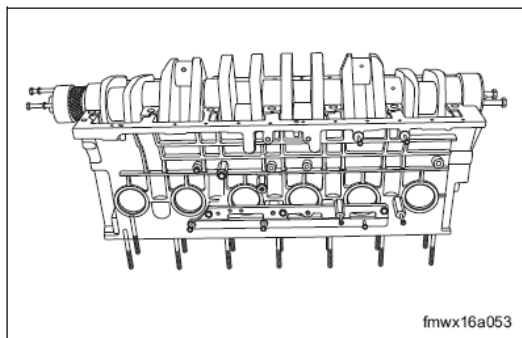


- (b) Remove the crankshaft.

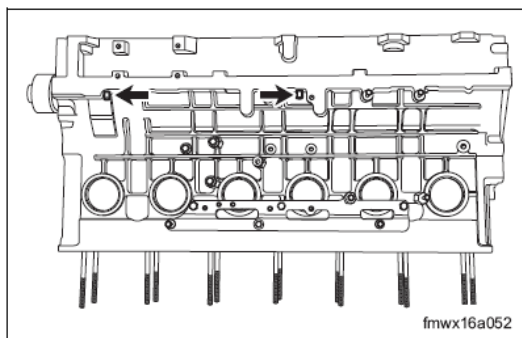


6. Install the crankshaft.

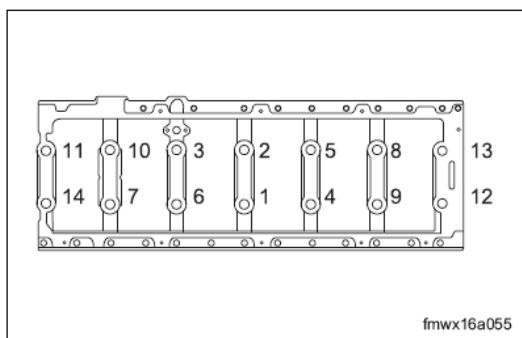
- (a) Fit the bushing.
- (b) Adjust the crankshaft radial clearance. Refer to Chapter 16A: Testing and Adjustment, Engine Mechanic System-Engine Mechanic System.
- (c) Fit the thrust gasket.
- (d) Fit the oil hole sealing ring.



- (e) Fit the crankshaft.
- (f) Adjust the crankshaft axial clearance. Refer to Chapter 16A: Testing and Adjustment, Engine Mechanic System-Engine Mechanic System.



- (g) Fit the crankcase.
 - Clean the contact surface between the cylinder block and crankcase, and apply 510 plane sealant.
 - Fit the crankcase.
 - Drive in the positioning pin of the crankcase.



- Fit the lock bolt of crankcase.

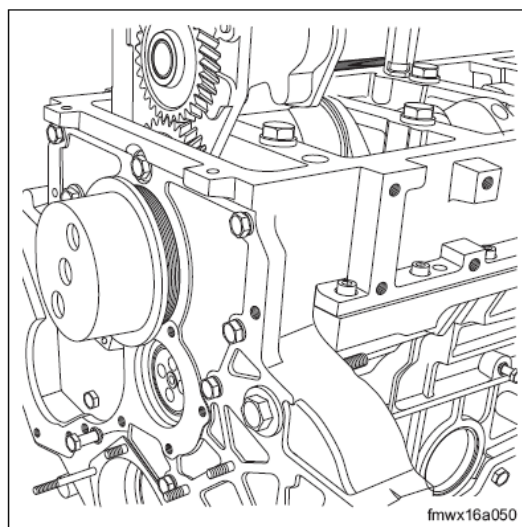
Torque: Initial 30N.m;

Further 80N.m;

Further 250±25N.m;

- Fit the engine oil pressure regulating valve.

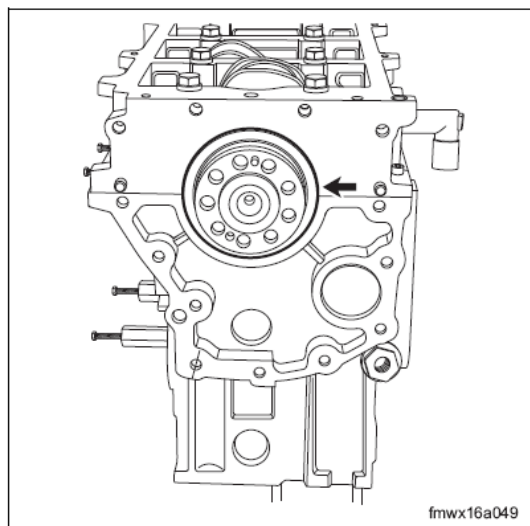
7. Install the timing gear. Refer to Chapter 16A: Replacement, Engine Mechanic System-Timing Gear.



8. Install the crankshaft oil seal.
 - (a) Install the crankshaft rear oil seal.

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ENGINE MECHANIC SYSTEM (WD618)-CRANKSHAFT



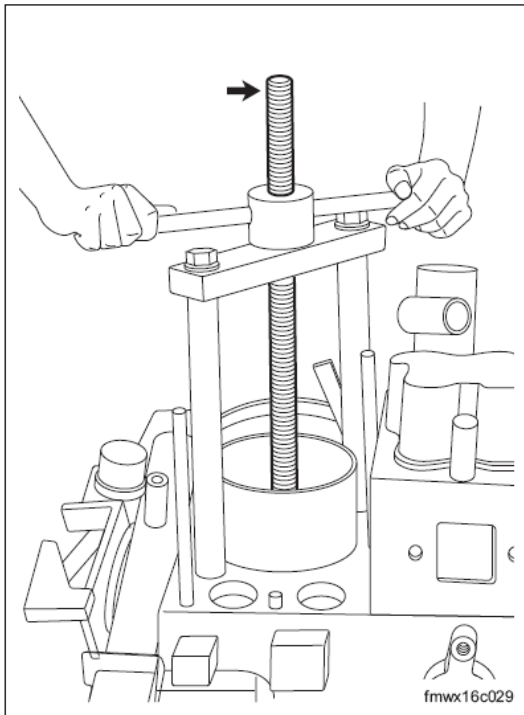
(b) Install the crankshaft front oil seal.

9. Install the flywheel and flywheel housing. Refer to Chapter 16A: Replacement, Engine Mechanic System-Flywheel and Flywheel Housing.
10. Install the piston and connecting rod. Refer to Chapter 16A: Replacement, Engine Mechanic System-Piston and Connecting Rod.

CYLINDER BLOCK

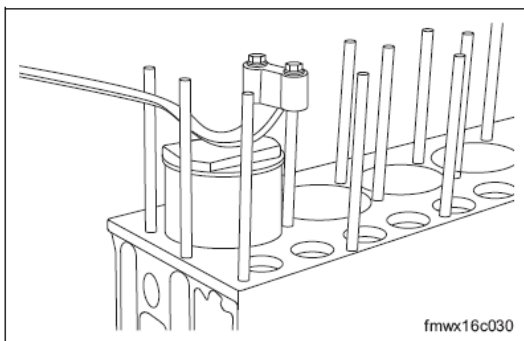
REPLACEMENT

1. Remove the engine accessories. Refer to Chapter 16A: Replacement, Engine Mechanic System-Engine Accessories.
2. Remove the crankshaft. Refer to Chapter 16A: Replacement, Engine Mechanic System-Crankshaft.



3. Remove the cylinder liner.

- (a) Use the cylinder liner puller to pull out the liner.



4. Install the cylinder liner.

- (a) Apply the molybdenum disulfide powder onto the external surface of the cylinder liner.

Notice:

Do not apply engine oil.

- (b) Lightly press in the cylinder liner.

Notice:

The cylinder liner shall project out of the cylinder block upper plane within 0.05-0.10mm.

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5. Install the crankshaft. Refer to Chapter 16A: Replacement, Engine Mechanic System-Crankshaft.
6. Install the engine accessories. Refer to Chapter 16A: Replacement, Engine Mechanic System-Engine Accessories.



- MEMO -

16A

STARTING AND PREHEATING SYSTEM (WD618)

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18A

STARTING AND PREHEATING SYSTEM

OVERVIEW

STARTER

To start the engine, the resistance of the compressed air in the cylinder and friction resistance between the engine itself and moving parts in its accessories must be overcome, and the torque necessary for offsetting such resistances is called the starting torque.

The crankshaft speed necessary for the smooth startup of the engine is called starting speed. To start the automobile diesel engine, a high starting speed is required, up to 150-300rpm, in order to prevent the air leakage and heat loss in the cylinder, and to ensure the sufficient pressure and temperature at the ending of the compression termination and also the establishment of sufficient injection pressure of the injection pump thus to formulate a strong air vortex in the cylinder. If the diesel oil is improperly atomized and the quality of air mixture is poor, the engine will be hard to be started. In addition, the compression ratio of the diesel engine is higher than that of the gasoline engine, so the starting torque is also higher. Thus, the starting power necessary for the startup of diesel engine is higher than that of the gasoline engine.

The DC starter is composed of the DC series motor, control mechanism and clutch mechanism, intended to start the engine, which requires a high torque, so the current needed is also very high, up to several hundred of amperes.

The DC electric motor has a high torque at low speed, while a lower one at the high speed, very suitable for the use as the starter.

The starter employs the series motor, and its rotor and stator are made of wound copper wires of a coarse rectangular cross section. The driving mechanism is provided with the reducer gear structure, and the control mechanism is provided with the electromagnetic suction approach.

The drive gear of the reducer gear structure is engaged with the engine flywheel to start the engine, and the single-way drive approach is employed. When the speed of pinion on the electric motor is higher than that of the flywheel ring gear, the motor will drive the engine to rotate; when the engine speed is higher than the motor speed, the power transfer relation between them is cancelled.

The reduction starter is mainly made up of the electromagnetic engaging switch, reducer gear, electric motor, starting gear (pinion) and single-way engaging device.

FLAME PREHEATER

To improve the engine starting performance, a flame preheater is equipped on the intake pipe of the engine, which will be electrified when the intake temperature or cooling water temperature is lower than a certain value to rapidly heat the air in the intake pipe thus to facilitate the engine start and combustion of gas mixture. The lowest working temperature of the flame preheater is -40°C, and the preheater is provided with automatic electronic control. The preheater is normally composed of the electronic controller, solenoid valve, temperature sensor, flame glow plug, fuel pipe and lead wires. Its working course is described as follows: with the glow plug heated to 850-950°C, the starter is activated and the solenoid valve will open the oil line to supply oil to the glow plug through the fuel pipe to start the engine by flame preheating.

The glow plug is a key actuator in the preheating system, fitted on the engine intake manifold. Its heater core surface will reach 950-1050°C after the preheating operation is finished, and the core will ignite the diesel oil at the post-heating to fulfill the preheating purpose.

18A-4 STARTING AND PREHEATING SYSTEM (WD618)-STARTING AND PREHEATING SYSTEM

The electronic controller is the core component of the flame preheating system, used for the control of the whole system, failure diagnosis, and failure warning.

PRECAUTIONS

1. Run the starter for no more than 15s; if many starts are needed, wait at least 120s between two starts.
2. Service the electric motor for the first time at 50000-80000km. Remove the dirt and refill lubricating oil.
3. Service the electric motor for the second time at 40000-50000km. Check the wear degree of carbon brush; if seriously worn, replace the brush. If the brush is not cleaned or replaced, the contact surface between the motor rotor and carbon brush is liable to be damaged, which may require the subsequent replacement of the motor.
4. The carbon brush may have been worn to its extreme limit at 100000-150000km. If the vehicle is mainly put into service for short trips, more starts are needed. If the mileage is less than 80000km, service the motor; if the vehicle is mainly put into service for long-distance trips, less starts are needed, and the motor can be serviced after 80000km.
5. Frequently servicing and lubricating the starter will help to avoid the increase of load and current, thus to minimize damages.
6. After the engine is started with the flame preheater, never increase the throttle openness significantly.
7. It is prohibited to use the flame preheater together with the starting liquid.
8. The glow plug shall be cleaned to remove the carbon deposit once each year, and connectors of the glow plug must be fixed reliably.

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TESTING AND ADJUSTMENT

IGNITION SWITCH

Use the multi-meter to check the controllability of each position of the ignition switch.

SECONDARY STARTING SWITCH

Use the multi-meter to check the controllability of each position of the secondary starting switch.

STARTER

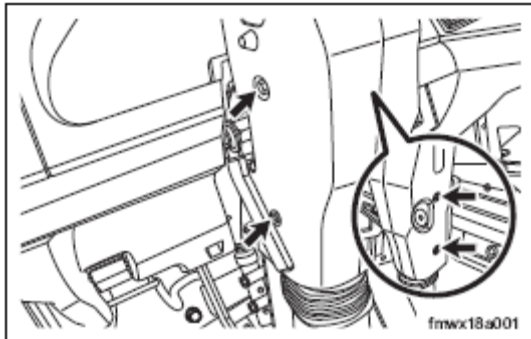
Test the starting current and measure the resistance of starting lead wire.



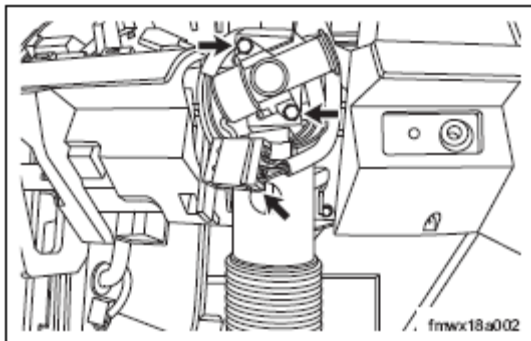
IGNITION SWITCH

REPLACEMENT

1. Turn off the power master switch.

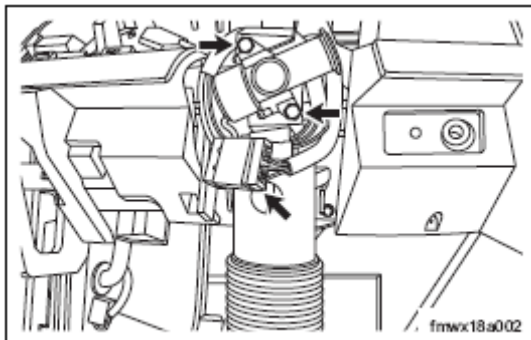


2. Remove the ignition switch.
- (a) Remove the trim plate of steering column.

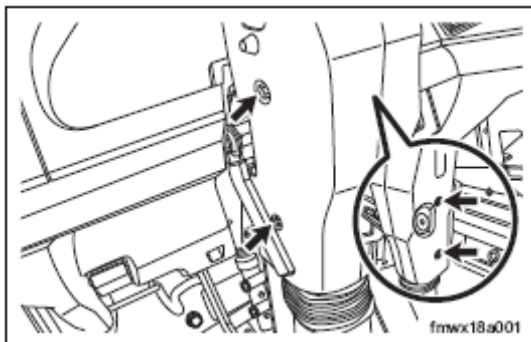


- (b) Remove the ignition switch.
- Disconnect the ignition switch wire.
 - Remove the ignition switch lock bolt.

3. Check the ignition switch. Refer to Chapter 18A: Testing and Adjustment, Starting and Preheating System-Starting and Preheating System.



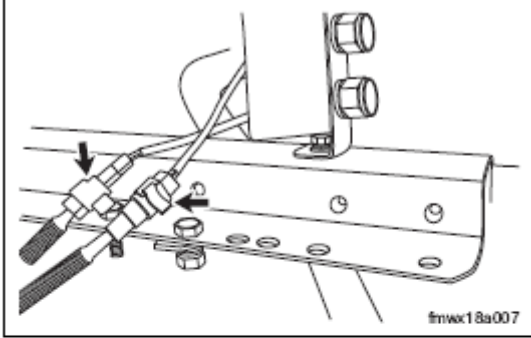
4. Refit the ignition switch.
- (a) Refit the ignition switch.
- Refit the ignition switch lock bolt.
- Torque: 25N.m**
- Reconnect the ignition switch wires.



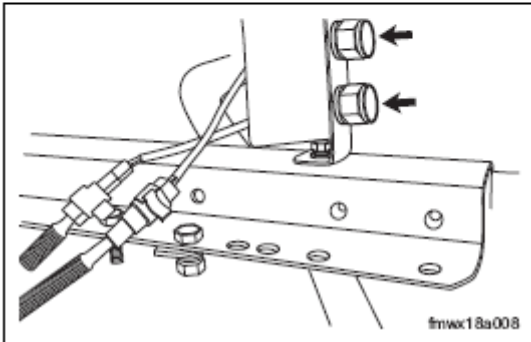
- (b) Refit the trim plate of steering column.

SECONDARY STARTING SWITCH AND SECONDARY SHUTDOWN SWITCH REPLACEMENT

1. Turn off the master power switch.

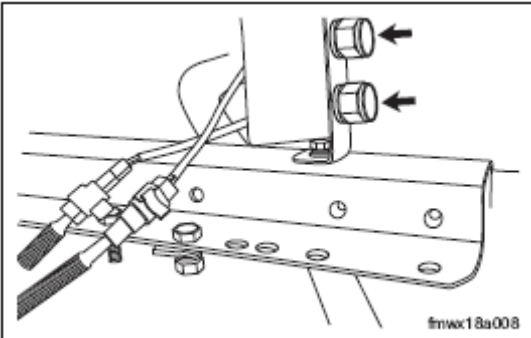


2. Remove the secondary starting switch and secondary shutdown switch.
 - (a) Disconnect wire connectors of the secondary starting switch and secondary shutdown switch.

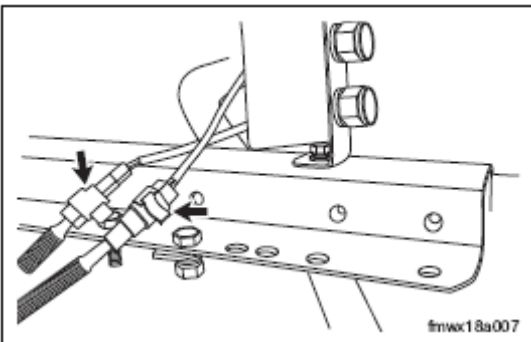


- (b) Remove the secondary starting switch and secondary shutdown switch.

3. Check the secondary starting switch. Refer to Chapter 18A: Testing and Adjustment, Starting and Preheating System- Starting and Preheating System.



4. Refit the secondary starting switch and secondary shutdown switch.
 - (a) Refit secondary starting switch and secondary shutdown switch.



- (b) Reconnect wire connectors of the secondary starting switch and secondary shutdown switch.

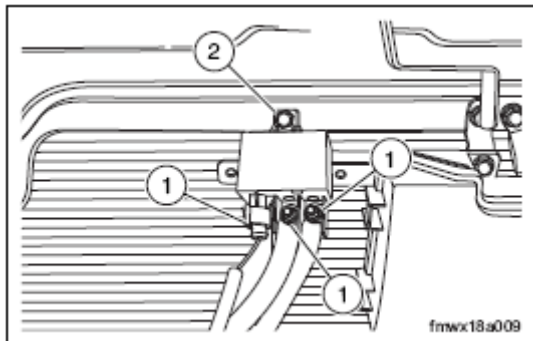
5. Turn on the power master switch.



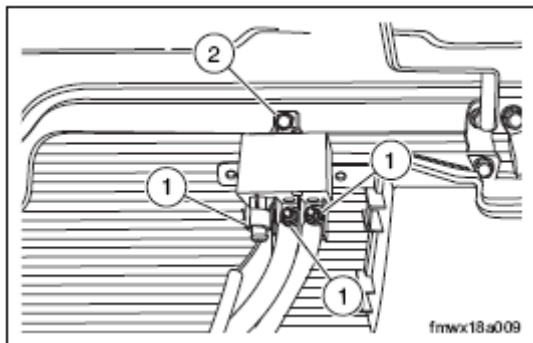
STARTER RELAY

REPLACEMENT

1. Turn off the power master switch.



2. Remove the starter relay.
- (a) Disconnect the starter relay wire connector 1.
 - (b) Remove the relay lock bolt 2.



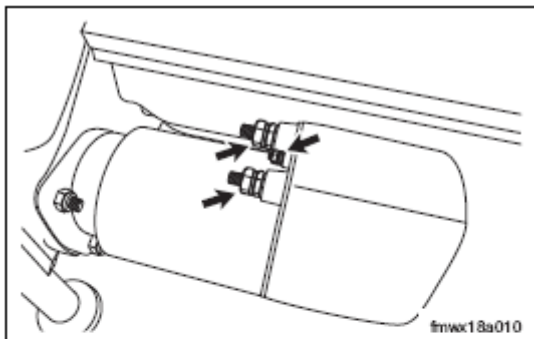
3. Refit the starter relay.
- (a) Refit the relay lock bolt 2.
- Turn on the power master switch.
- (b) Reconnect the wire connector 1 of the starter relay.

4. Turn on the power master switch.

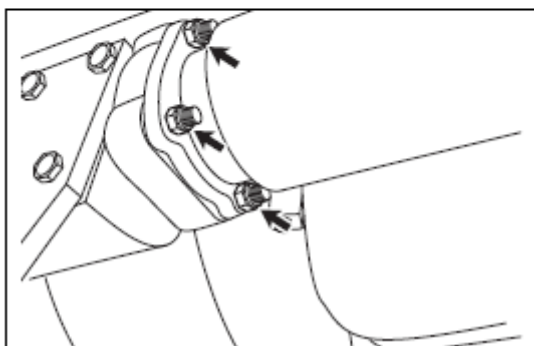
STARTER

REPLACEMENT

1. Turn off the power master switch.

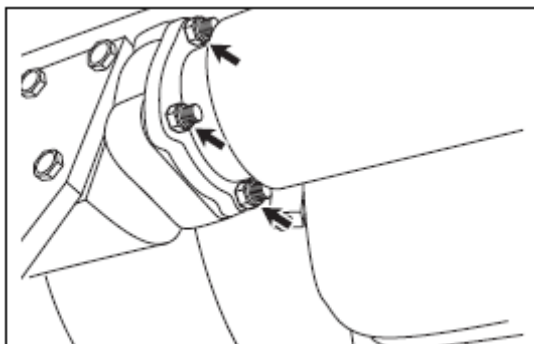


2. Remove the starter.
 - (a) Disconnect the starter wire connector.

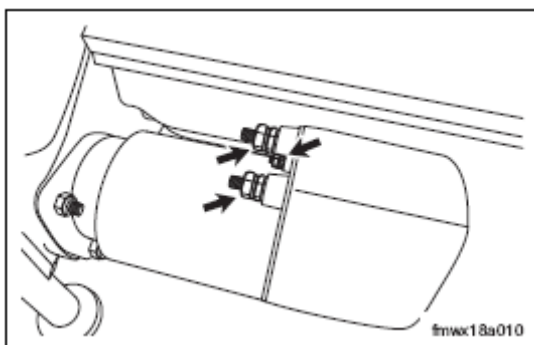


- (b) Remove the starter lock bolt.

3. Check the starter. Refer to Chapter 18A: Testing and Adjustment, Starting and Preheating System- Starting and Preheating System.



4. Refit the starter.
 - (a) Refit the starter lock bolt.
Torque: 60N.m

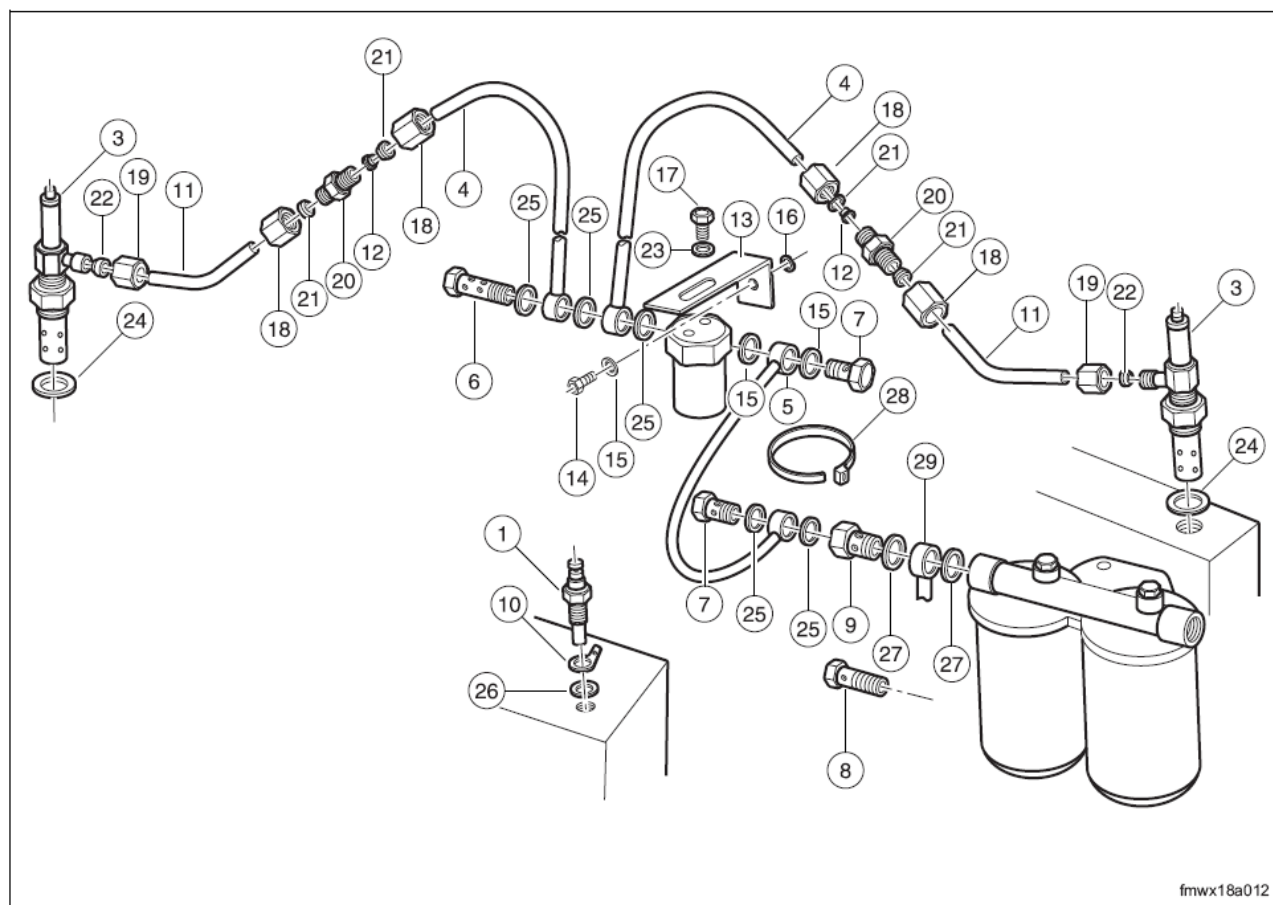


- (b) Reconnect the wire connector of the starter.

5. Turn on the power master switch.

FLAME PREHEATER

DIAGRAM OF COMPONENTS



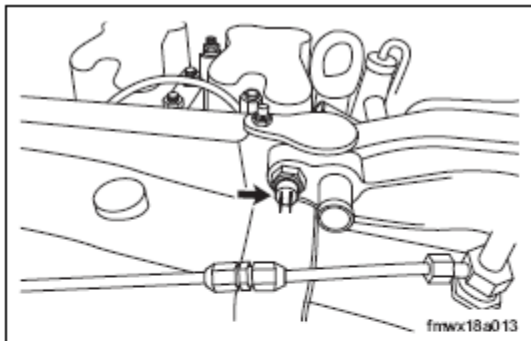
fmwx18a012

1	Temperature sensor
2	Solenoid valve
3	Flame preheater glow plug
4	Fuel pipe assembly
5	Fuel pipe assembly
6	Hollow bolt
7	Hollow bolt
8	Hollow bolt
9	Connecting bolt
10	Flat plug
11	Pipe
12	Sleeve
13	Angled bracket
14	Hexagon bolt
15	Corrugated flexible washer

16	Plain washer
17	Hexagon bolt
18	Pipe union nut
19	Connecting nut
20	Ferrule type straight union
21	Ferrule
22	Ferrule
23	Spring washer
24	Sealing washer
25	Sealing washer
26	Sealing washer
27	Sealing washer
28	Plastic binding strip
29	Hexagon bolt, spring washer and plain washer assembly

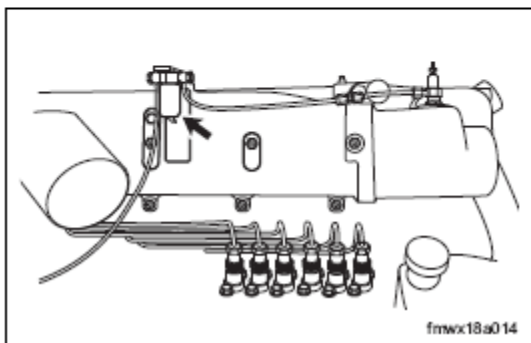
REPLACEMENT

1. Turn on the power master switch.

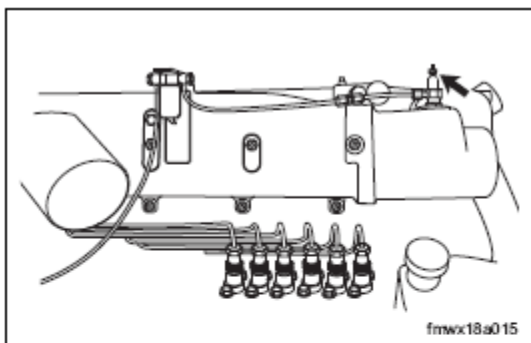


2. Disconnect the flame preheater wire connector.

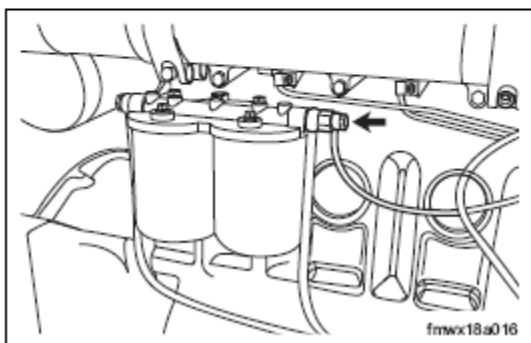
- (a) Disconnect the temperature sensor wire connector.



- (b) Disconnect the solenoid valve wire connector.



- (c) Disconnect the glow plug wire connector.



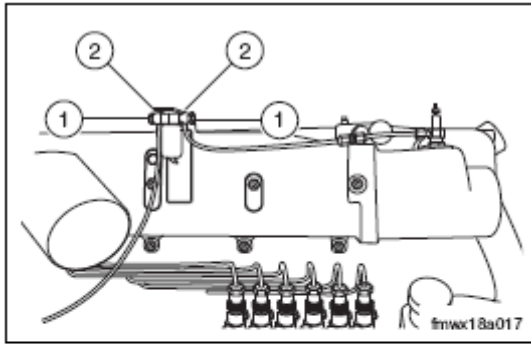
3. Remove the flame preheater.

- (a) Remove the secondary fuel filter oil pipe.

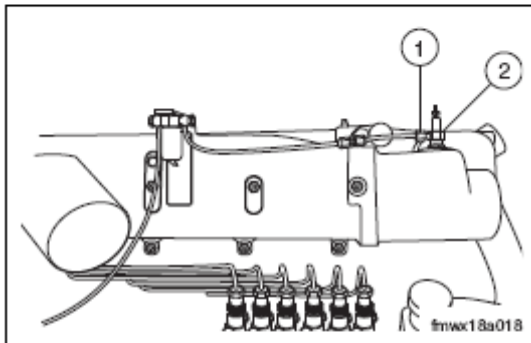


18A-12

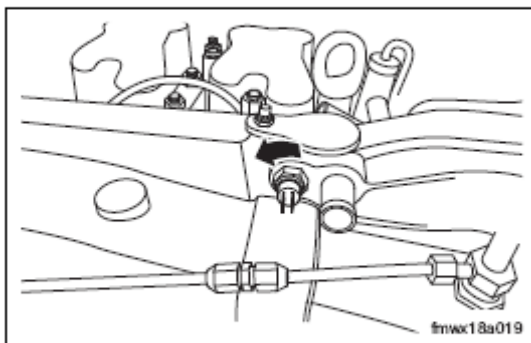
STARTING AND PREHEATING SYSTEM (WD618)-FLAME PREHEATER



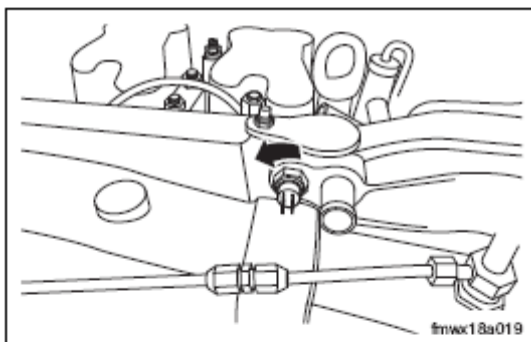
- (b) Remove the solenoid valve.
- Remove the solenoid valve oil pipe 1.
 - Remove the solenoid valve lock bolt 2.



- (c) Remove the flame glow plug.
- Remove the flame glow plug oil pipeline connecting nut 1.
 - Remove the glow plug lock nut 2.



- (d) Remove the temperature sensor.

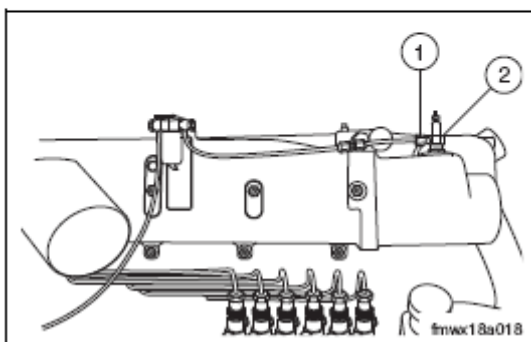


4. Refit the flame preheater.

- (a) Refit the temperature sensor.

Notice:

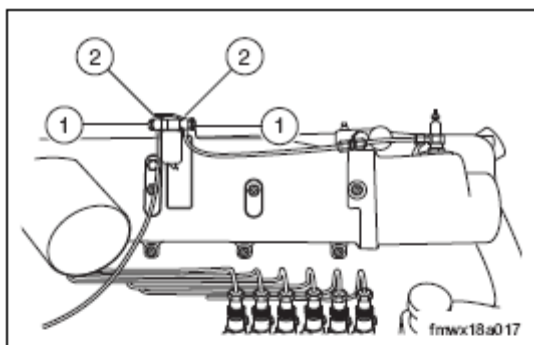
Ensure the sufficient contact between the sensor and cooling liquid.



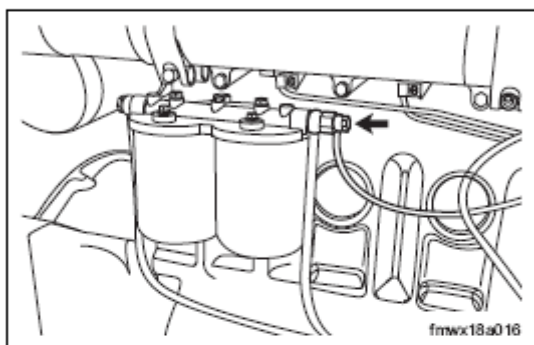
- (b) Refit the flame glow plug.
- Refit the plug oil pipe connecting nut 1.
 - Refit the plug lock nut 2.

Notice:

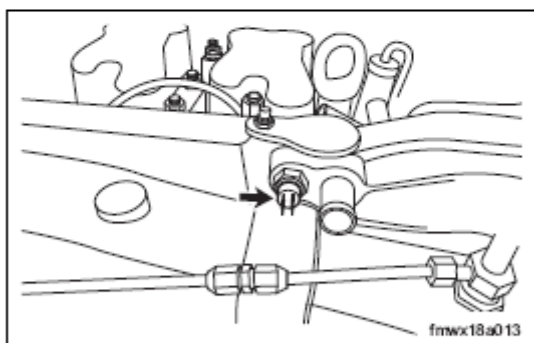
Ensure that the glow plug extends into the intake pipe by 20mm above. The angle between the glow plug and air flow shall be preferably between 45° and 90°.



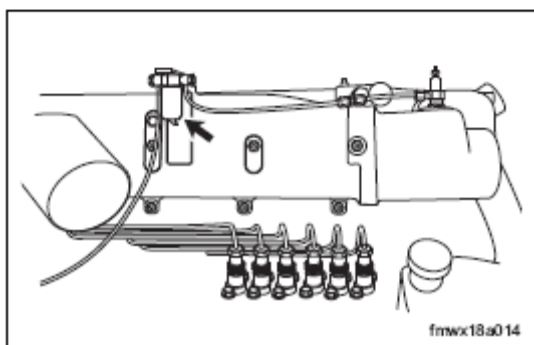
- (c) Refit the solenoid valve.
- Refit the solenoid valve oil pipe 1.
 - Refit the solenoid valve lock bolt 2.



- (d) Refit the secondary fuel filter pipe.



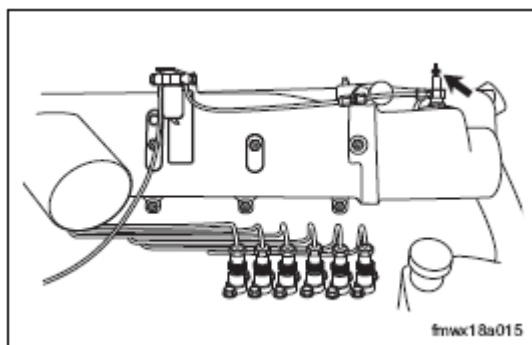
- 5. Reconnect the wires of the flame preheater.**
- (a) Connect wires of temperature sensor.



- (b) Connect wires of the solenoid valve.

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STARTING AND PREHEATING SYSTEM (WD618)-FLAME PREHEATER



(c) Connect wires of the glow plug.

6. Turn on the power master switch.

CHARGING SYSTEM (WD 618)

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Precautions	19A-5
Working principle.....	19A-6
Testing and adjustment	19A-8
ALTERNATOR.....	19A-9
Replacement.....	19A-9



19A

CHARGING SYSTEM

OVERVIEW

Alternator is main power supply of vehicle, its function is supplying power to all electric equipments(except for starter) and charging to battery simultaneously when the alternator is normal running.

Currently, vehicle adopts three-phase alternator, where there is diode rectifier circuit inside and which can rectify alternating current to direct current, therefore, what the output of the alternator of vehicle is direct current. The alternator must be equipped with voltage regulator, the voltage regulator controls the output voltage of alternator and makes it maintain basic constant to meet the requirement of automotive electrical appliance.

Rotor

The function of rotor is producing magnetic field.

The rotor is composed of claw pole, yoke, excitation winding, slip ring and rotor spindle, etc.

Two claw poles are press mounted on rotor spindle, and claw pole is processed as the shape of beak; excitation winding and yoke are equipped inside the cavity of claw pole.

The slip ring is composed of two separately insulated copper rings, and is press mounted on rotor spindle and is insulated with shaft. Two slip rings are connected with two ends of excitation winding respectively. When two slip rings are switched on, current flows through excitation winding and axial flux is produced which makes one piece of claw pole is magnetized as pole N and another is magnetized as pole S, thus six couples (or 8 couples) magnetic poles which are interlaced are formed.

Stator

Function of stator is producing alternating current.

Stator is mounted outside of rotor and fixed with covers at front end and rear end of alternator. When rotor is rotating inside the alternator, it can cause change of magnetic flux in stator winding, and alternating induced electromotive force is produced in stator winding.

Stator is composed of stator core and stator winding (coil).

Stator core is stacked by separately insulated silicon-steel plates whose inside track has groove.

Stator winding has three groups of coils, which are symmetrically embedded in the groove of stator core.

There are two kinds of connection method of three windings, they are Y connection and delta connection, and they all can produce three phase alternating current

Rectifier

It is used to transfer the three phase alternating current produced by stator winding into direct current.

Rectifier is composed of plate rectifier and rectifier diode. Rectifier of six-tube alternator is composed by press mounting(or welding) six silicon rectifier diodes on two separately insulated plates, among which, one is positive plate (with bolt at output terminal), and another is negative plate. The negative plate is connected (ground strap connection) with alternator casing, and the rear cover of alternator also can be used as negative plate. The six rectifier diodes are positive diodes and negative diodes. The diode that extracts positive electrode is called positive diode, three positive diodes are mounted on one same plate, so the plate is called positive plate; the diode that extracts negative electrode is called negative diode, three negative diodes are mounted on one same plate, and also can be mounted on rear cover directly.

End cover and brush discreteness

Generally, there are two end covers (front end cover and rear end cover), which have the functions of supporting rotor, stator, rectifier and brush discreteness. The end cover is usually casted by aluminium alloy. Firstly, it can effectively prevent magnetic leakage; secondly, the aluminium alloy has good performance of heat dispersion. Brush discreteness is mounted on rear end cover.

Brush discreteness is composed of carbon brush, brush carrier and brush spring.

The function of rotor is inducing power to excitation winding through slip ring. Two brushes are mounted in

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CHARGING SYSTEM (WD618)-CHARGING SYSTEM

holes of brush carrier respectively, and maintain contact with slip ring through spring pressure. Contact between brush and slip ring shall be good, otherwise insufficient power generation of alternator will result from undersize current of magnetic field.19A

19A

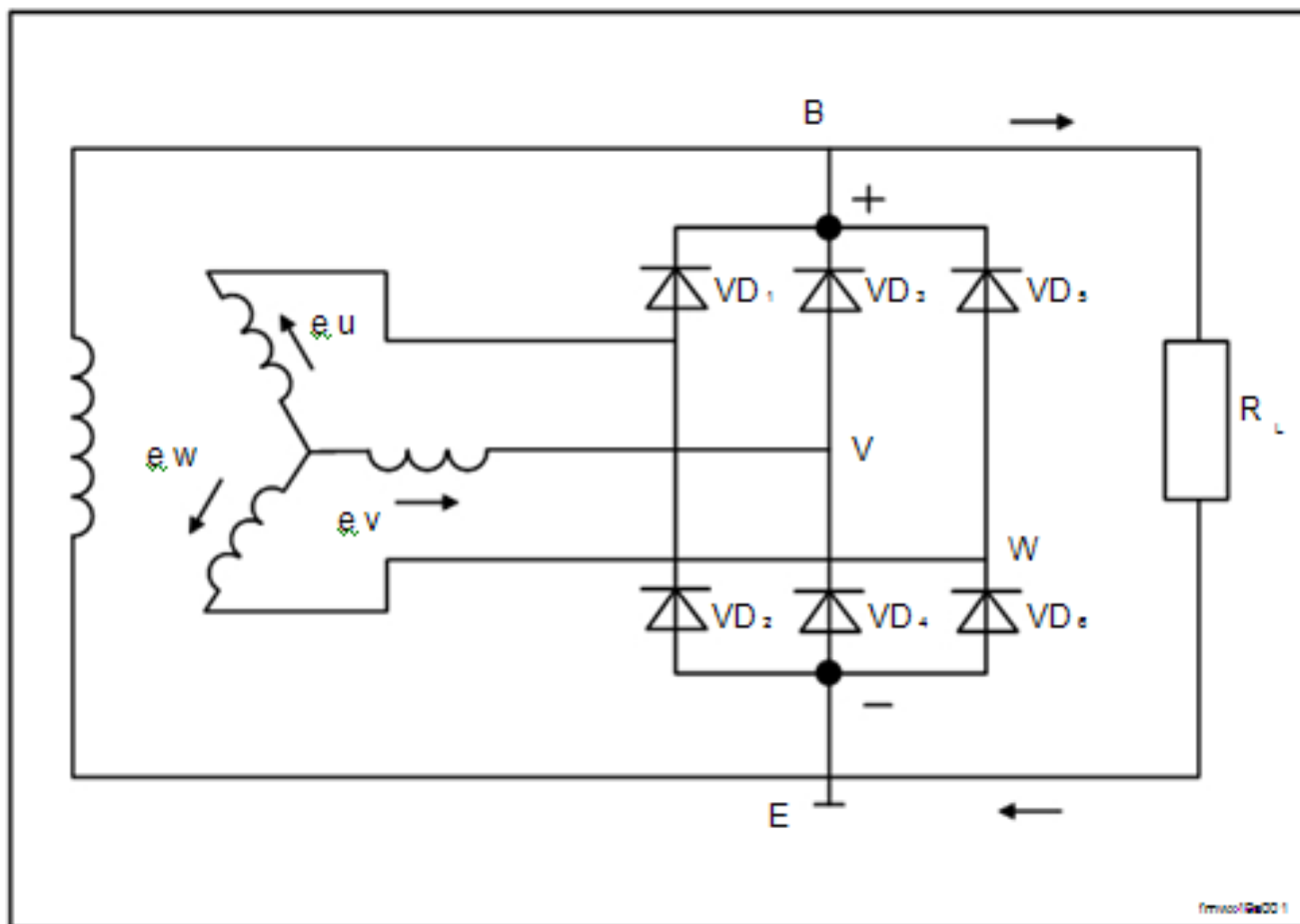
PRECAUTIONS

The alternator and regulator have simple structure and convenient maintenance. They will be free from failure and have long service life if they are correctly used. But will be damaged quickly if they are wrongly used. Therefore, the followings shall be paid attention to during usage and maintenance:

1. The battery polarity must be negative earth, the contrary is forbidden. Otherwise, the alternator or electronic components of regulator will be damaged.
2. Connection between alternator and battery shall be firm and reliable; if disconnect suddenly, overvoltage will be caused and will damage alternator or electronic components of regulator.
3. When alternator is operating, the method of test fire for checking whether the alternator is generating electricity is not allowed; otherwise the rectifier diode will be damaged.
4. Once failure is found on alternator or regulator, overhaul shall be made immediately to clear failure in time, otherwise will result in more severe failure or power shortage of battery and that the vehicle couldn't be driven.
5. When alternator is equipped with regulator, the voltage grade of alternator must be as same as the voltage grade of regulator. The earth type of alternator must be as same as earth type of regulator; the power of regulator shouldn't be less than power of alternator, otherwise, the system couldn't work normally.
6. Line connection must be correct. Currently, mounting positions and modes of connection of regulators in different types of vehicle are different, so special attention must be paid when wiring.
7. Regulator must be controlled by ignition switch, when alternator stops operating, ignition switch shall be switch off, otherwise the field circuit of alternator will keep on-state, but the field coil will not be damaged, and will result in power shortage of battery.
8. When failure is found in alternator or regulator and needs removal from vehicle for overhaul, firstly disconnect ignition switch and all electrical appliances, remove the negative cable of battery, then remove the conduit fitting from alternator.

19A

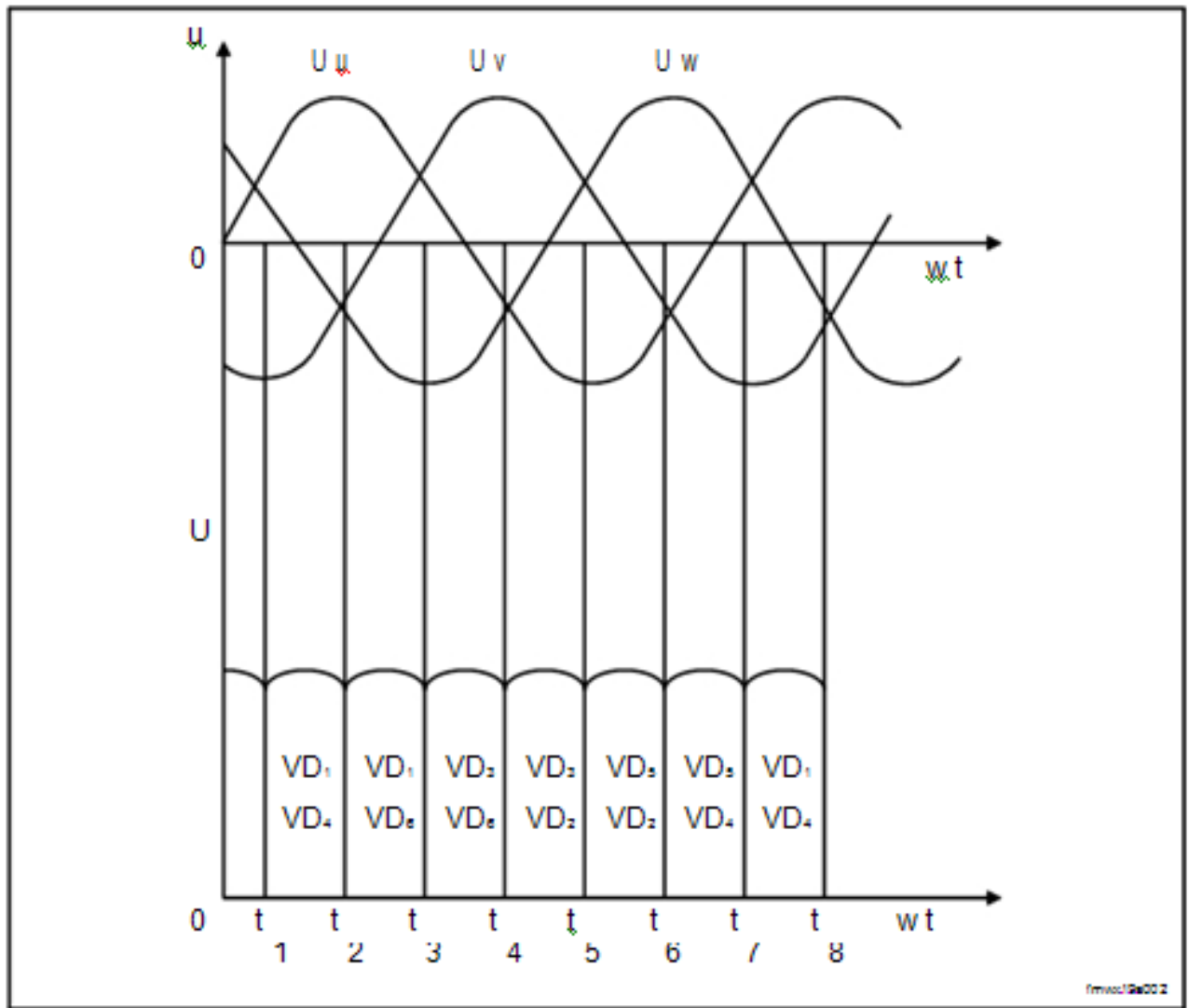
WORKING PRINCIPLE



Among three windings of stator of alternator, what produced from induction is alternating current, and direct current is rectified by three-phase bridge rectifier circuit which is composed of six diodes. Rectifier circuit is as shown in the figure.

Diode has one-way continuity. When forward voltage is in diode, diode flows current; when reverse voltage is in diode, diode is cut off.





Three-phase winding of stator and six rectifier diode shall be connected per circuit diagram, the output terminal B and E of alternator shall output one pulsating direct voltage, as shown in the figure, this is rectification principle of alternator.

TESTING AND ADJUSTMENT

Maintenance

1. Check the driving belt of alternator
2. Check connection of conducting wire
3. Check whether there is noise or not when operating
4. Check whether alternator is generating electricity normally or not
5. Check whether there is overcharging of battery or not

Overhaul

1. External cleaning
 - (a). After external cleaning, rotate rotor of alternator manually and check whether it is flexible, whether there is abnormal sound to judge whether there is failure in bearing or not.
2. Measurement of complete appliance
 - (a). Positive-going and reversed resistance value (earth terminal) between output terminal B of alternator and housing of alternator shall be measured. Compared them with standard value, if they couldn't meet the standard, which means there is fault in rectifier.
 - (b). Resistance values between terminals of positive brush and negative brush of alternator shall be measured, and compared with the standard value, if they couldn't meet the standard, that means there is fault in brush and excitation winding.

19A

No load test

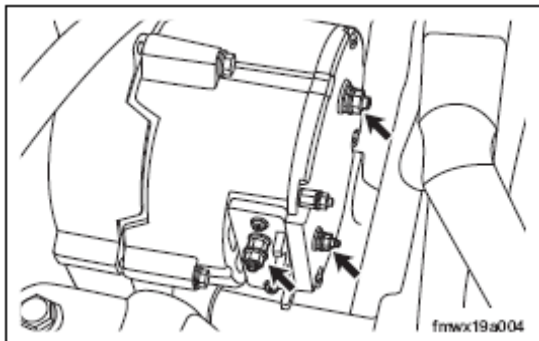
1. Mount alternator on fixture of test bed, select sleeve and rubber drive joint, adjust position of fixture and make the tested alternator has the same center as the main shaft of test bed.
2. Check whether the wiring is correct or not, then the regulating speed motor on the test bed can be started only after everything is correct.
3. Start the regulating speed motor on test bed, the battery (or power supply on the test bed) can supply field current to alternator. Gradually improve the rotating speed of motor. When rotating speed is increased to 500 ~ 800 r/min, then external power supply no longer supply field current to alternator. The alternator shall start self excited generating electricity.
4. Go on increasing rotating speed, at the same time, observe the reading of voltage meter.
 - When voltage reaches rated voltage, record rotating speed of alternator at this moment. Switch off the variable speed motor, then the no load test is finished.
5. Analyse the data of no load test.
 - Compared with the standard value, if the rotating speed is higher than no load rotating speed, that means the alternator has fault, and the alternator shall be dismantled and checked. If couldn't confirm the alternator has fault, go on making load test.

Load test

1. Regulate rheostat to ∞ position of resistance value.
2. Start regulating speed motor and make voltage of alternator reach the rated value.
3. Keep voltage unchanging and increase rotating speed and output current of alternator at the same time to make rotating speed reach rated value. Record the output current at this moment. Switch off the variable speed motor, then the load test is finished.
4. Analyse the data of load test.
 - Compared with the standard value, if the output current can reach the rated current, that means the alternator is good, otherwise, it means the alternator has fault, and the alternator shall be dismantled and checked. 19A

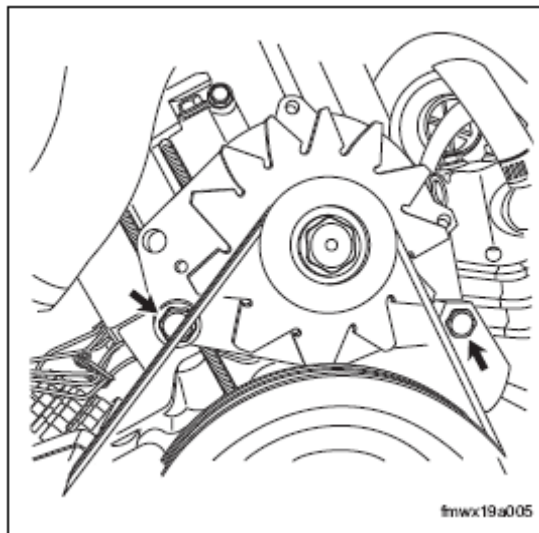
ALTERNATOR REPLACEMENT

1. Power-off main power

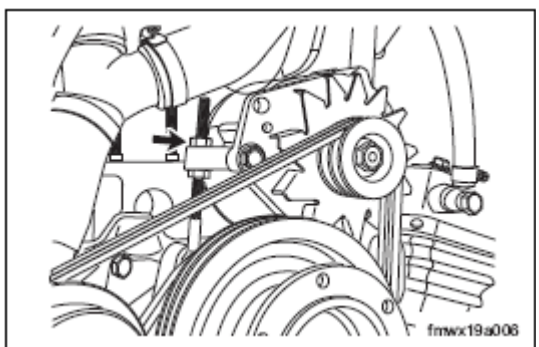


2. Dismount alternator

(a). Disconnect wiring harness of alternator



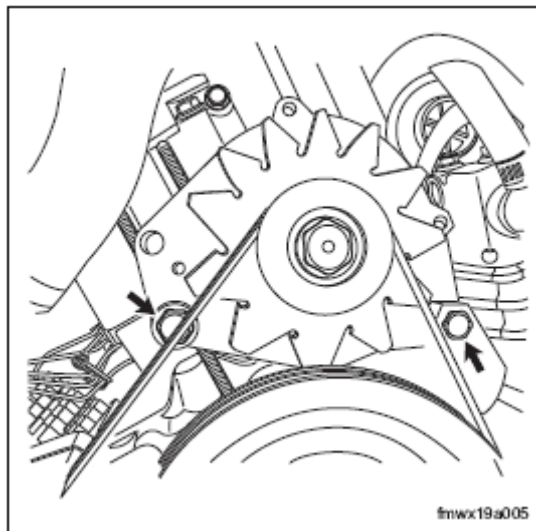
(b). Unlock fixing bolt of alternator



(c). Unlock tensioning nut of alternator, dismantle belt.

19A-10

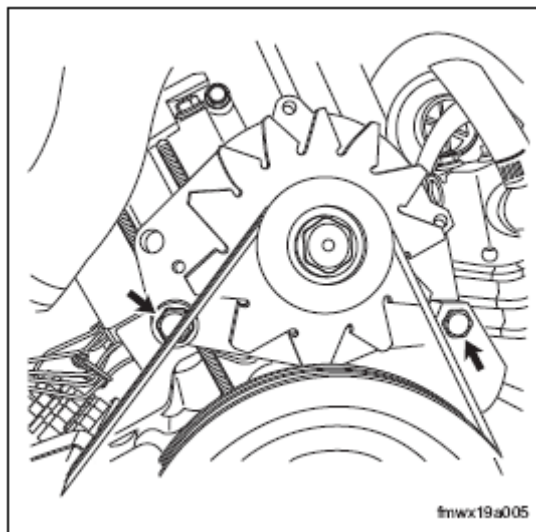
CHARGING SYSTEM (WD618)-CHARGING SYSTEM



- (d). Take down fixing bolt of alternator and take down assembly of alternator.

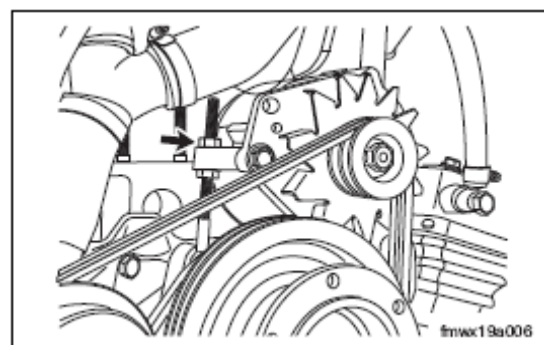
3. Check alternator, see Chapter 19A Charging system--charging system, testing and adjustment

19A



4. Install alternator

- (a). Mount fixing bolt of alternator.



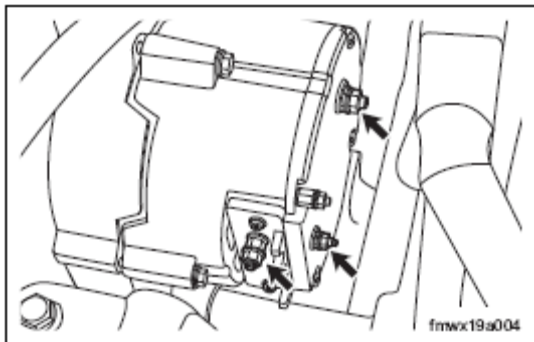
- (b). Mount belt, mount and adjust tensioning nut of alternator.



FOTON



- (c). Tighten fixing bolt of alternator
Torque: 60 N.m



- (d). Connect wire harness of alternator

5. Main power on



-MEMO-

19A

FRONT SUSPENSION

FRONT SUSPENSION ASSEMBLY.....	21-3
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FRONT LEAF SPRING.....	21-12
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FRONT SUSPENSION ASSEMBLY

OVERVIEW

The effect of the front suspension system is to increase the friction between the tire and the road surface to a large extent so as to provide good steering maneuverability and stability and ensure passengers' comfort. It can absorb energy perpendicular to acceleration of wheels to ensure that the frame and the body are free of interference when wheels bump up and down on the road surface. Front suspension consists of leaf spring, common coupling shaft, shock absorber, cushion rubber and stabilizer bar, among which, there are 9 leaf springs, the front end of which can be connected to spring bracket directly by means of spring pin and the rear end of which passes through shackle by means of shackle pin. The shackle is used to buffer gap change due to bend of the leaf spring. The leaf spring is connected to front axle by plywood (middle upper part) and the bracket (middle lower part). The shock absorber and stabilizer bar are installed between front axle and chassis frame to ensure more comfortable and steady driving.



PRECAUTIONS

1. Precautions for operation of suspension system

- (a). Instructions in this manual must be observed when replacing parts and be cautious.
- (b). Incorrect operation may affect performance of the steering system and can even endanger personal safety.
- (c). Operation should be conducted in strict accordance with the specifications at the position with special requirements.

WORKING PRINCIPLE OF THE SYSTEM

1. Shock absorber

The process known as damping is adopted by the shock absorber to control undesirable spring motion. The shock absorber converts kinetic energy produced by motion of the suspension to thermal energy which can be dissipated by hydraulic fluid to slow down and weaken vibrating motion. Upper support of the shock absorber is connected to the frame (namely sprung mass) and lower support is connected to the shaft (namely unsprung mass) and is near to wheels. For double-cylinder design of the shock absorber, one of common types is that upper support is connected to piston rod and then the piston rod is connected to the piston which is located in the cylinder full of hydraulic fluid. Inner cylinder is called as pressure cylinder and outer cylinder is called as oil storage cylinder in which hydraulic fluid in excess is stored. When wheels operate on uneven road and the spring is compressed tightly and stretched, spring energy is transmitted to the shock absorber by upper support firstly and then to the piston by piston rod. Holes are drilled on the piston, through which hydraulic fluid can seep when the piston moves up and down in the pressure cylinder. Only little hydraulic fluid can pass these holes even under big pressure for these holes are very small. In this way, movement velocity of the piston is reduced so as to slow down spring movement. The operation of the shock absorber includes two cycles, i.e. compression cycle and stretch cycle. Compression cycle refers to that the piston compresses hydraulic fluid under when it moves downward; stretch cycle refers to that the piston stretches hydraulic fluid above when it moves to the top of the pressure cylinder. As for typical vehicle, the resistance of stretch cycle is bigger than that of compression cycle. Besides, attention should be paid to the fact that compression cycle controls motion of unsprung mass of the vehicle while stretch cycle controls motion of relatively heavier sprung mass. All modern shock absorbers are of velocity sensing function—the faster the movement velocity of the suspension, the bigger the resistance of the shock absorber. This will enable the shock absorber to make adjustment according to road condition and control all undesired motions that may appear in the running vehicle, including bounce, side tilt, brake dive and acceleration crouch etc.

2. Stabilizer bar

The stabilizer bar is used with the shock absorber so as to provide additional stability for running vehicle. The stabilizer bar is a metal rod which traverses the entire axle and effectively connects two sides of the suspension together. When the suspension on one wheel moves up and down, the stabilizer bar transmits such movement to other wheels, which can make driving more stable and reduces gradient of the vehicle. In particular, it can counterbalance tendency to rollover of the vehicle on the suspension when the vehicle turns.

3. Leaf spring

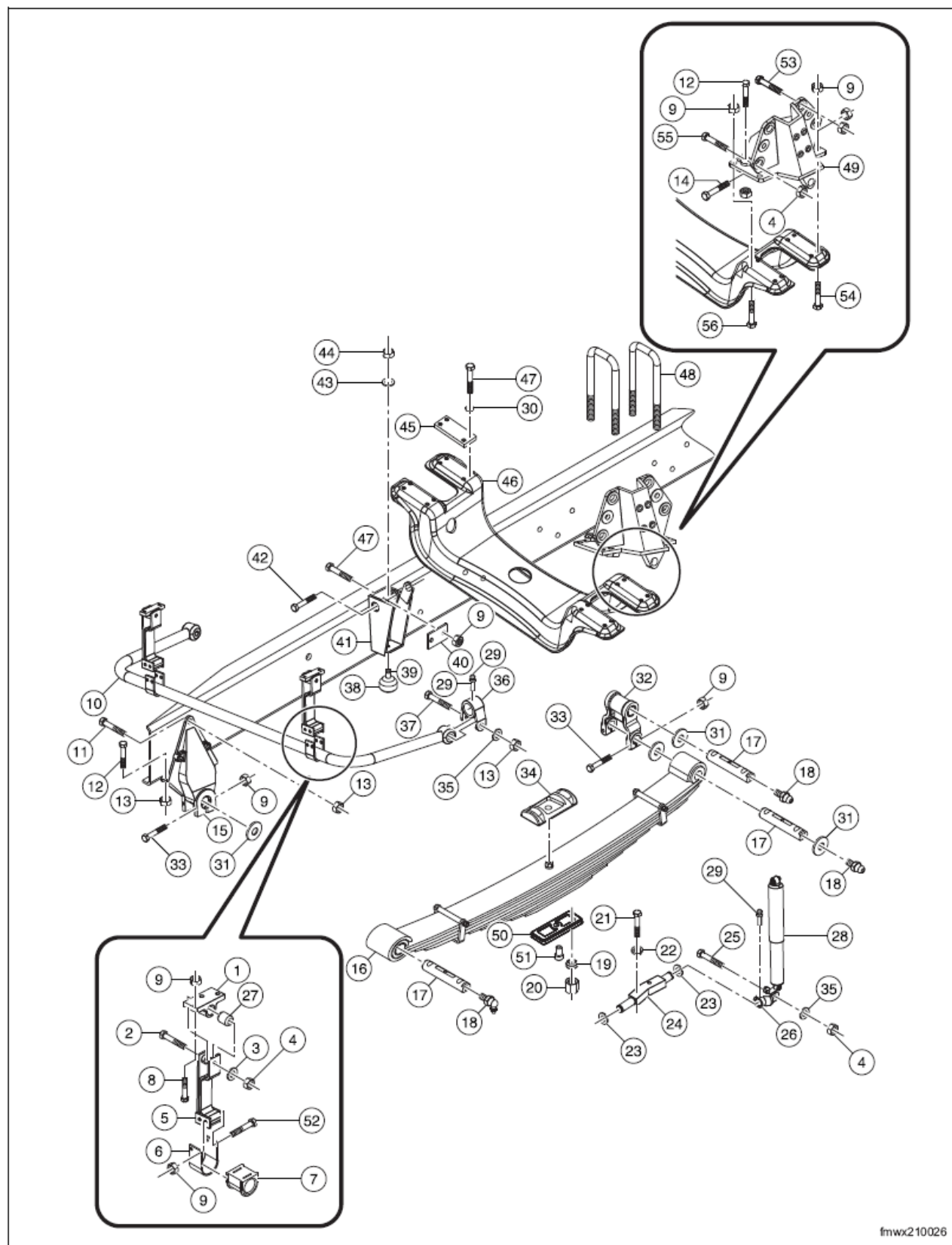
The middle part of leaf spring is fixed on the axle by U-bolt and spring eyes on both ends are articulated on the bracket of the frame. In this way, the axle and the body are connected by leaf spring for buffering, vibration reduction and transferring force. Each spring of multi-leaved leaf spring is superimposed to form shape of inverted triangle, with the longest steel plate at top and the shortest steel plate at bottom. Number of the spring relates to weight of the vehicle which it supports and shock absorption effect and the more, thicker and shorter the spring, the bigger the spring stiffness.

TABLE OF FAULT PHENOMENA

The following table can aid you to trace the fault. Serial number in the table indicates the sequence for the possibility of fault and each section should be checked in such sequence and replaced as needed.

Fault	Suspected component	Reference
The body subsides	1. Vehicle (overloaded) 2. Steel spring plate (weak) 3. Shock absorber (worn)	Loading of object based on carrying capacity of the vehicle Chapter 21 Front suspension-front leaf spring, Service Chapter 21 Front suspension-front shock absorber, Service
Swing / tilt	1. Tire (worn or improper inflation) 2. Wheel (imbalanced) 3. Shock absorber (worn) 4. Leaf spring pin, bushing, lug (excessive wear) 5. U-bolt (loose) 6. Leaf spring (inconsistent descending elasticity or rigidity)	Chapter 23 Tire and wheel-front tire and wheel assembly, Service Chapter 23 Tire and wheel-rear tire and wheel assembly, Service Chapter 23 Tire and wheel-rear tire and wheel assembly, check and adjustment Chapter 21 Front suspension-front shock absorber, Service Chapter 21 Front suspension- front leaf spring assembly, Service Chapter 21 Front suspension- front leaf spring, Service Chapter 21 Front suspension- front leaf spring, Service
The shock absorber leaks oil	1. Lubricating oil (excessive)	Adjustment of lubricating oil
	2. Sealing (ineffective or damaged)	Replacement of sealing
	3. Shock absorber (worn)	Chapter 21 Front suspension-front shock absorber, Service
Part of the suspension makes a noise	1. Shock absorber (ineffective) 2. Leaf spring (worn or damaged) 3. Bushing (worn or damaged) 4. Binding bolt and nut of shock absorber and leaf spring assembly (loose or damaged) 5. Stabilizer bar bushing (worn)	Chapter 21 Front suspension-front shock absorber, Service Chapter 21 Front suspension- front leaf spring, Service Chapter 21 Front suspension- front leaf spring, Service Chapter 21 Front suspension-front shock absorber, Service Chapter 21 Front suspension-front stabilizer bar, Service

DIAGRAM OF COMPONENTS



fmwx210026

1	Front stabilizer bar lifting socket	29	Direct lubricating nipple
2	Upper connecting bolt	30	Spring washer

21-8**FRONT SUSPENSION-FRONT SUSPENSION ASSEMBLY**

3	Plain washer
4	Self-locking nut
5	Front stabilizer bar hanger
6	U-shaped connecting plate
7	Front stabilizer bar rubber mat
8	Hexagon head bolts with fine pitch thread
9	Self-locking nut
10	Front stabilizer bar assembly
11	Hexagon head bolts with fine pitch thread
12	Hexagon head bolts with fine pitch thread
13	Self-locking nut
14	Hexagon head bolts with fine pitch thread
15	Front leaf spring front bracket
16	Front leaf spring assembly
17	Leaf spring pin shaft
18	Bent-neck grease nipple
19	Spherical washer
20	Self-locking nut
21	Hexagon head bolts with fine pitch thread
22	Spring washer
23	Circlip for axle
24	Common connecting shaft
25	Bolt
26	Shock absorber fork
27	Front stabilizer bar bushing
28	Front shock absorber assembly

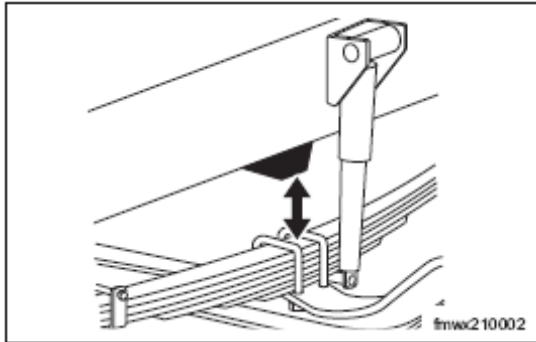
31	Adjusting gasket
32	Front leaf spring lug
33	Hexagon head bolts with fine pitch thread
34	Front leaf spring pressure plate
35	Plain washer
36	Stabilizer bar head connecting part
37	Head connecting bolt
38	Front bumper block
39	Connecting bolt
40	Reinforcing plate
41	Front shock absorber bracket
42	Bolt
43	Plain washer
44	All-metal hexagon lock nuts, style 2
45	Reinforcing plate
46	Cross sill (rebuilt)
47	Hexagon head bolts with fine pitch thread
48	Front U-bolt
49	Front leaf spring rear bracket
50	Front leaf spring
51	Locating pin
52	Hexagon head bolt
53	Hexagon head bolts with fine pitch thread
54	Hexagon head bolts with fine pitch thread
55	Hexagon head bolts with fine pitch thread
56	Hexagon head bolt



CHECK AND ADJUSTMENT

1. On-vehicle check

- (a). Visual check if the shock absorber leaks oil and the bushing cracks.
- (b). Check if U-bolt deforms or cracks and if its thread is damaged and replace them with new parts if necessary.
- (c). Tighten U-bolt using method of crossed tightening, increase tightening torque to specified value gradually. When the vehicle is fully loaded, it is required to re-tighten nut of U-bolt for leaf springs cling to each other tightly; when tightening nut, it is necessary to avoid false appearance of large torque which is caused by the phenomenon that leaf springs cannot be compressed tightly due to rusty bolt and nut and re-tap thread using screw tap to make the bolt and the nut fit properly.



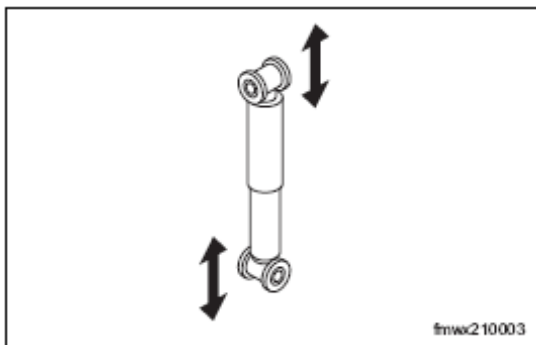
- (d). Measure buffer gap
Standard value: 124 mm
Limit value: 118 ~ 130 mm

Note:

Make a measurement when the vehicle is unloaded. Leaf spring and bumper block may be damaged (cracked or poor elasticity) if the buffer gap decreases significantly.

2. Check of shock absorber

- (a). Check if the shock absorber leak oil.



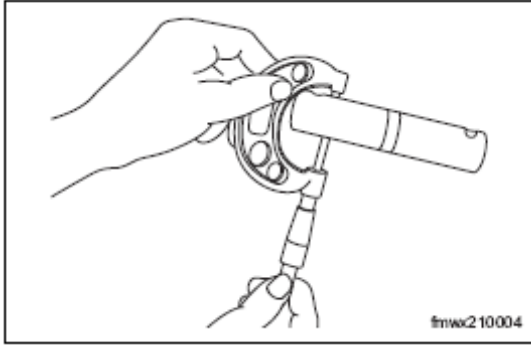
- (b). Check if connecting rod, rubber bushing and other connecting parts of the shock absorber are damaged and replace them with new parts if any.
- (c). Compress and stretch the shock absorber for 2-3 times to see if the stroke is normal and uniform in the whole process of reciprocation without idle stroke, jam and disequilibrium.
- (d). Stop the loaded vehicle after driving it on poorer road surface for about 10 Km and touch the surface of the shock absorber with hands; if temperature difference between two shock absorbers is bigger, the resistance difference between them is bigger and the shock absorber with low temperature is of low resistance; if surface temperature is not more than air temperature, the shock absorber is free of resistance and out of action.

Suggestion:

Replace the shock absorber if any fault exists, see chapter 21 Front suspension-front shock absorber, Service



3. Check of leaf spring pin shaft



- (a). Use micrometer to measure outside diameter of leaf spring pin shaft

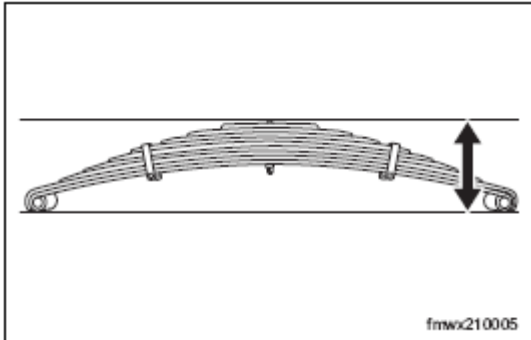
Standard value: $\phi 30\text{mm}$

Limit value: $\phi 29.93\text{-}29.97\text{mm}$

Note:

Replace leaf spring pin shaft if the limit value is exceeded.

4. Check of leaf spring assembly camber at free state



- (a). Use tape measure to measure leaf spring camber

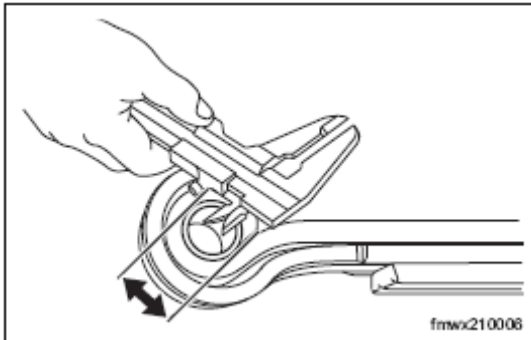
Standard value: 135 mm (left); 120mm (right)

Limit value: 129-141mm (left); 114-126mm (right)

Note:

Deviations between cambers of two front leaf springs should not be greater than 4mm, or else the vehicle will incline.

5. Measurement of inside diameter of front-end leaf spring pin shaft



- (a). Use vernier caliper to measure inside diameter of leaf spring pin shaft bushing

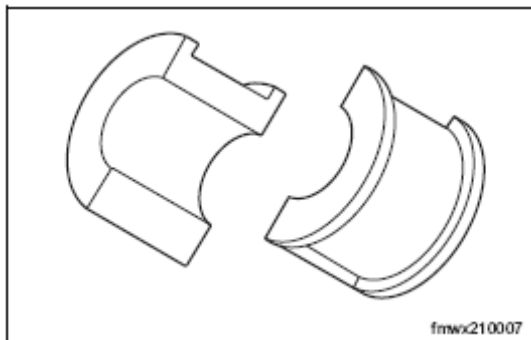
Standard value: $\phi 30\text{mm}$

Limit value: $\phi 30.11 \sim 30.194\text{mm}$

Note:

Take three positions for measurement

6. Check of stabilizer bar inner lining

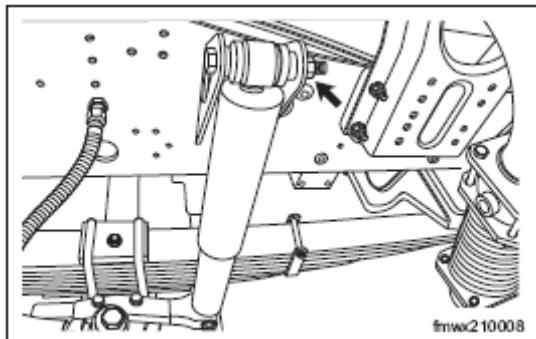


- (a). Check if the sleeve wears and cracks unduly.

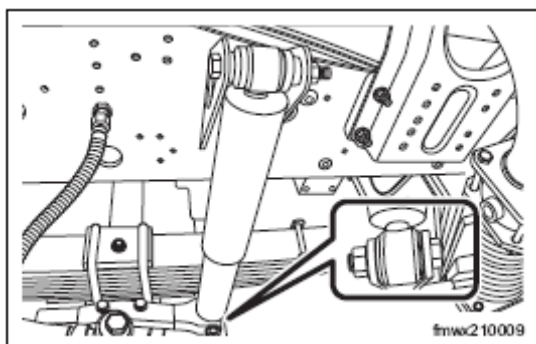
FRONT SHOCK ABSORBER

SERVICE

1. Dismantling of left front shock absorber assembly

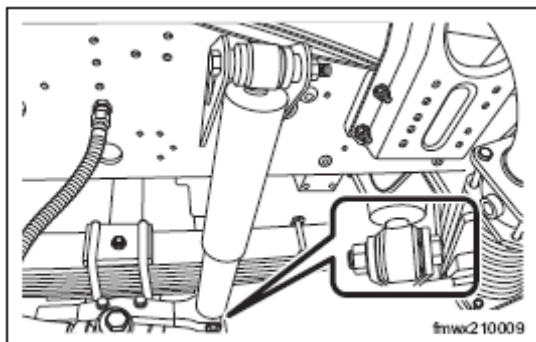


(a). Loosen binding bolt on the top.



(b). Loosen binding nut at the bottom and dismantle front shock absorber

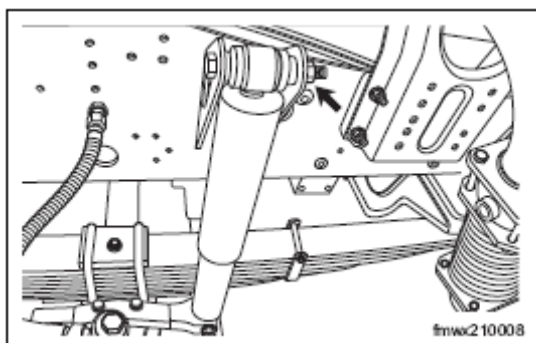
2 Check the shock absorber; see chapter 21 Front suspension-front suspension assembly, check and adjustment



3 Installation of left front shock absorber assembly

(a). Tighten binding nut at the bottom.

Torque: 221± 22N.m



(b). Tighten binding nut on the top.

Torque: 221± 22N.m

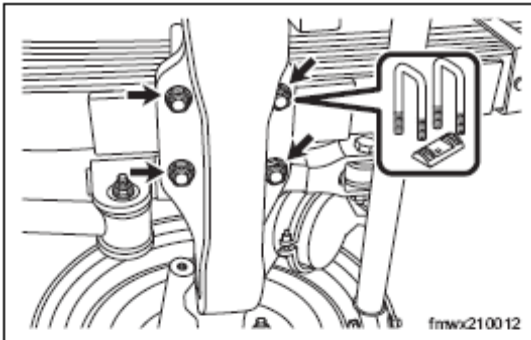
Suggestion:

Refer to Service of left front shock absorber for Service of right front shock absorber.

FRONT LEAF SPRING

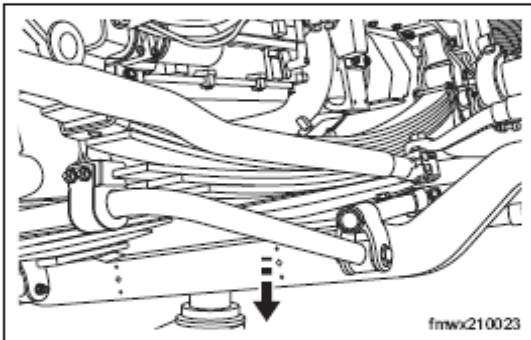
SERVICE

1. Jack left front beam with a jack and support it with stirrup; see chapter 01 Introduction-maintenance manual, jacking and supporting position of vehicle
2. Dismantling of tire, see chapter 23 Tire and wheel- front tire and wheel, Service
3. Disconnection of left front brake chamber air tube, see chapter 26 Service brake-front brake chamber, Service
4. Dismantling of left front shock absorber, see chapter 21 Front suspension—front shock absorber, Service



5. Dismantling of left front leaf spring assembly

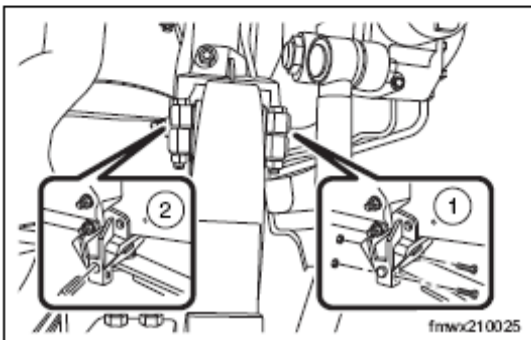
- (a). Jack front axle with a jack and remove U-shaped connecting nut of left front leaf spring and 4 connecting nuts from front axle.
- (b). Remove U-bolt and front spring pressure plate in turn.



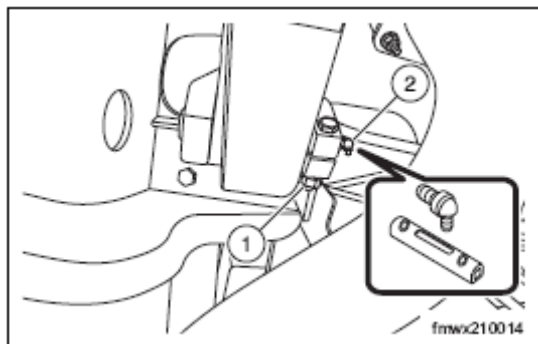
- (c). Release the jack slowly to drop front axle steadily.

Note:

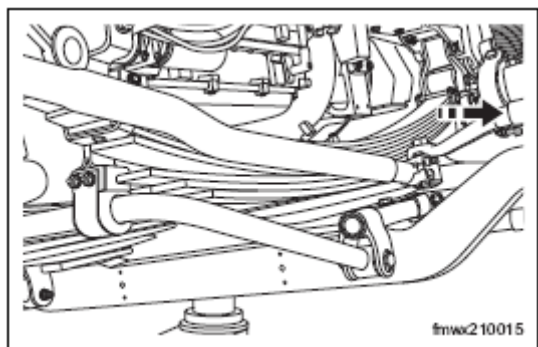
Ensure that the front of the vehicle has been jacked up when releasing the jack for front axle.



- (d). Dismantle set bolt 1 from front leaf spring pin shaft.
- (e). Pull out front leaf spring pin shaft 2 using puller.

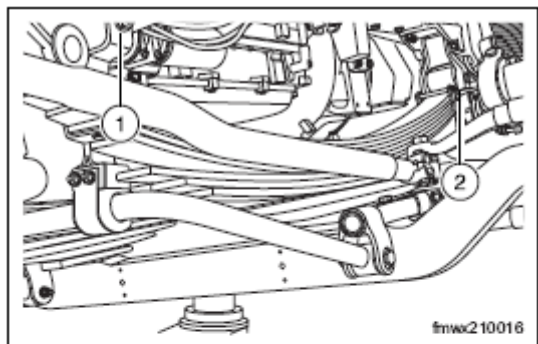


- (f). Dismantle binding bolt 1 from rear leaf spring pin shaft.
- (g). Pull out rear leaf spring pin shaft 2 using puller.



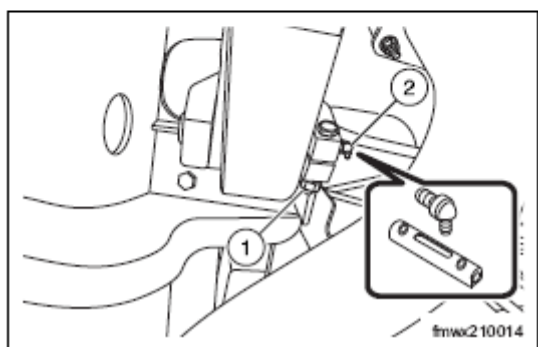
- (h). Remove left front leaf spring.

6. Check of front leaf spring assembly, see chapter 21 Front suspension-front suspension assembly, check and adjustment



7. Installation of left front leaf spring assembly

- (a). Install left front leaf spring onto front bracket 1 and left lug 2 of front leaf spring.

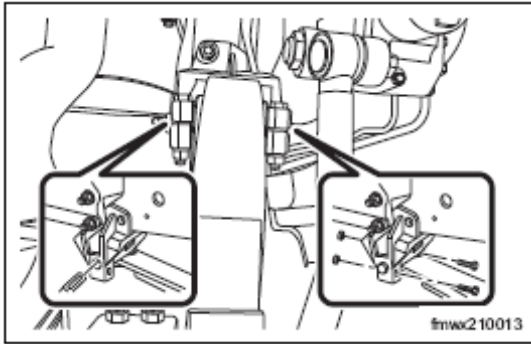


- (b). Install rear leaf spring pin shaft 2.
- (c). Install binding bolt 1 on rear leaf spring pin shaft.

Torque: 84±8 N.m

Suggestion:

Apply a layer of lubricating grease on leaf spring pin shaft.
Lubricating grease: lithium lubricating grease, No. 2

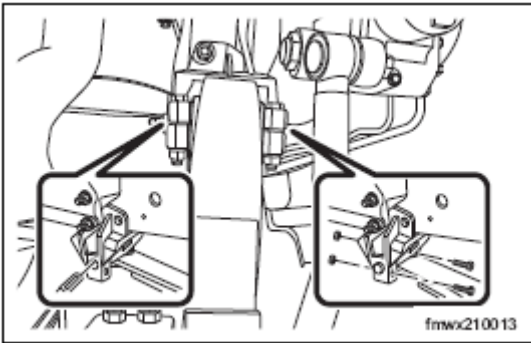


- (d) Install front leaf spring pin shaft 2.
- (e) Install 2 binding bolts 1 on front leaf spring shaft.

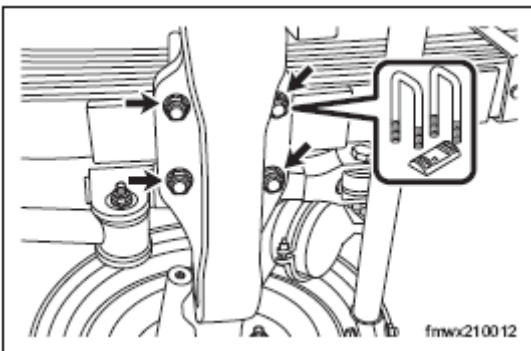
Torque: 84±8 N.m

Suggestion:

Apply a layer of lubricating grease on leaf spring pin shaft.
Lubricating grease: lithium lubricating grease, No. 2



- (f). Jack front axle with a jack slowly to push head of bolt in the center of leaf spring into locating hole of front axle.



- (g). Install front leaf spring pressure plate, U-bolt and U-nut in turn.

- Tighten 4 binding nuts.

Torque: 280±20 N.m

8. Installation of left front shock absorber assembly, see chapter 21 front suspension—front shock absorber, Service
9. Installation of left front brake chamber air tube, see chapter 26 Service brake-front brake chamber, Service
10. Installation of tire, see chapter 23 Tire and wheel—front tire and wheel, Service

Suggestion:

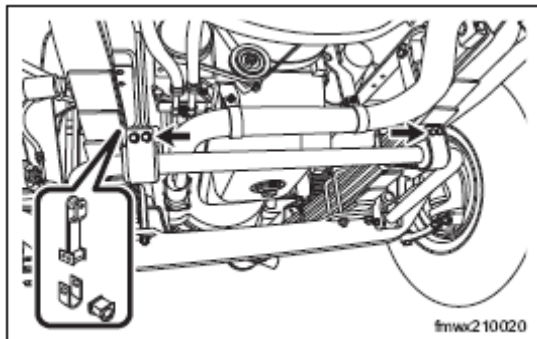
For Service of right front leaf spring assembly, see Service of left front leaf spring.



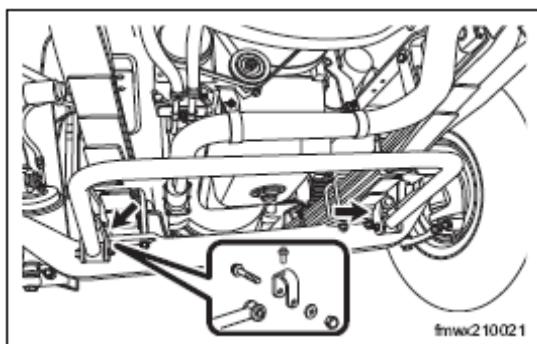
FRONT STABILIZER BAR

SERVICE

1. Dismantling of stabilizer bar assembly



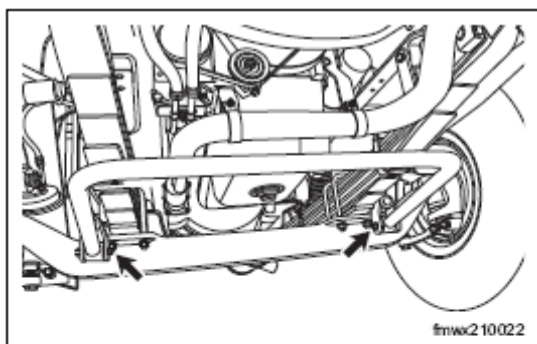
- (a) Dismantle U-shaped connecting plate.
 - Loosen binding nuts on both sides.
- (b) Remove U-shaped connecting plate and front stabilizer bar rubber pad in turn.



- (c) Disconnect stabilizer bar and stabilizer bar head connecting part.
 - Loosen binding nuts.
- (d) Remove stabilizer bar assembly.

2. Check of stabilizer bar assembly

- (a). Check if stabilizer bar deforms or wears.
- (b). Check if front stabilizer bar rubber pad wears or cracks.
- (c). Check if U-shaped and front stabilizer bar deform.



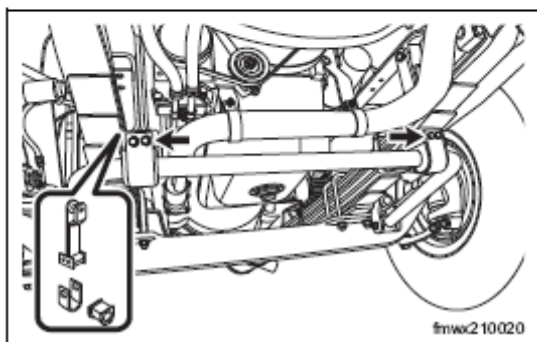
3 Installation of stabilizer bar assembly

- (a). Connect stabilizer bar with stabilizer bar connecting part and install bolts.

Torque: 140±14 N.m

Note:

Tighten the bolts after U-shaped connecting plate is properly and completely installed onto the stabilizer bar.



- (b). Install stabilizer bar rubber pad and U-shaped connecting plate into stabilizer bar assembly in turn.
- (c). Tighten the bolts.

Torque: 84±8 N.m



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REAR SUSPENSION

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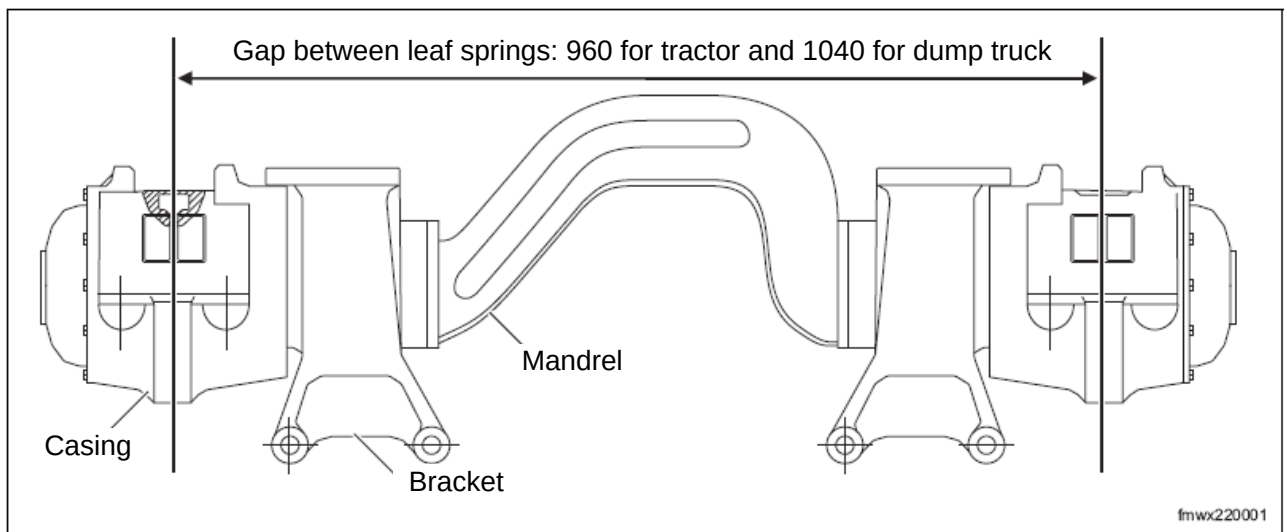


REAR SUSPENSION ASSEMBLY

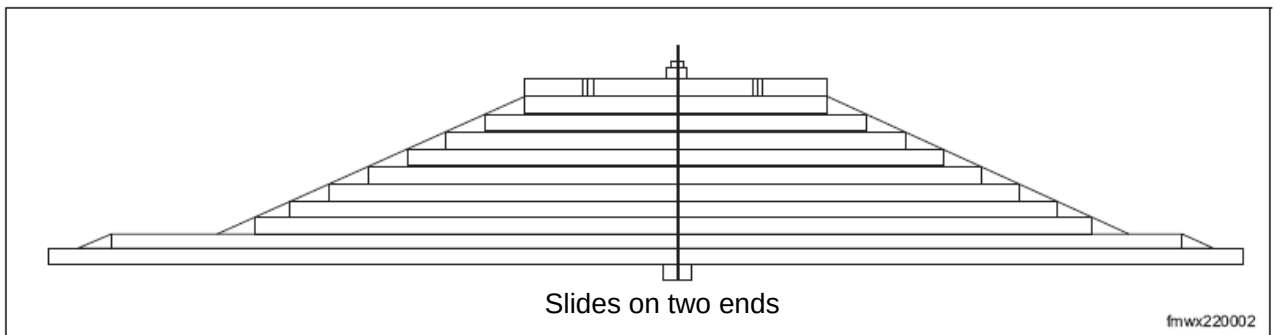
OVERVIEW

Rear suspension comprises leaf spring, balance shaft and cushion rubber, upper and lower thrust bars etc; bearings are installed into casings on two ends of balance shaft, which are tightened with king bolts and large nuts are tightened with screws, Two ends can rotate freely so as to reduce impact to the frame from road surface, which improves maneuverability of the vehicle.

Two ends of leaf spring can slide when the wheels are moving for they are supported only by rear axle housing. When the vehicle is running on rugged road, spring seat will reciprocate along balance shaft and thrust bar will also move with it. In this way, each rear axle can move up and down independently to ensure higher running performance of the vehicle. The structure of balance shaft is shown in the following diagram:



There are slides on two ends of rear leaf spring, as shown in following diagram:



PRECAUTIONS

1 Precautions for operation of rear suspension

- (a). Make sure to carefully and cautiously comply with Instructions in this manual when replacing parts.
- (b). Incorrect operation may affect performance of the steering system and can even endanger personal safety.
- (c). Operation should be conducted in strict accordance with the specifications.
- (d). Lubricating oil is filled into axle housing on two ends of balance shaft, please re-fill lubricating oil 85W/90 to standard position if any oil leakage is found to avoid damaging balance shaft assembly.
- (e). It is important that mark (left side/right side) on the spring should be taken down when it is removed so as to ensure that it can be reinstalled at its original position, for specifications and characteristics of the spring may vary with different vehicle sides.

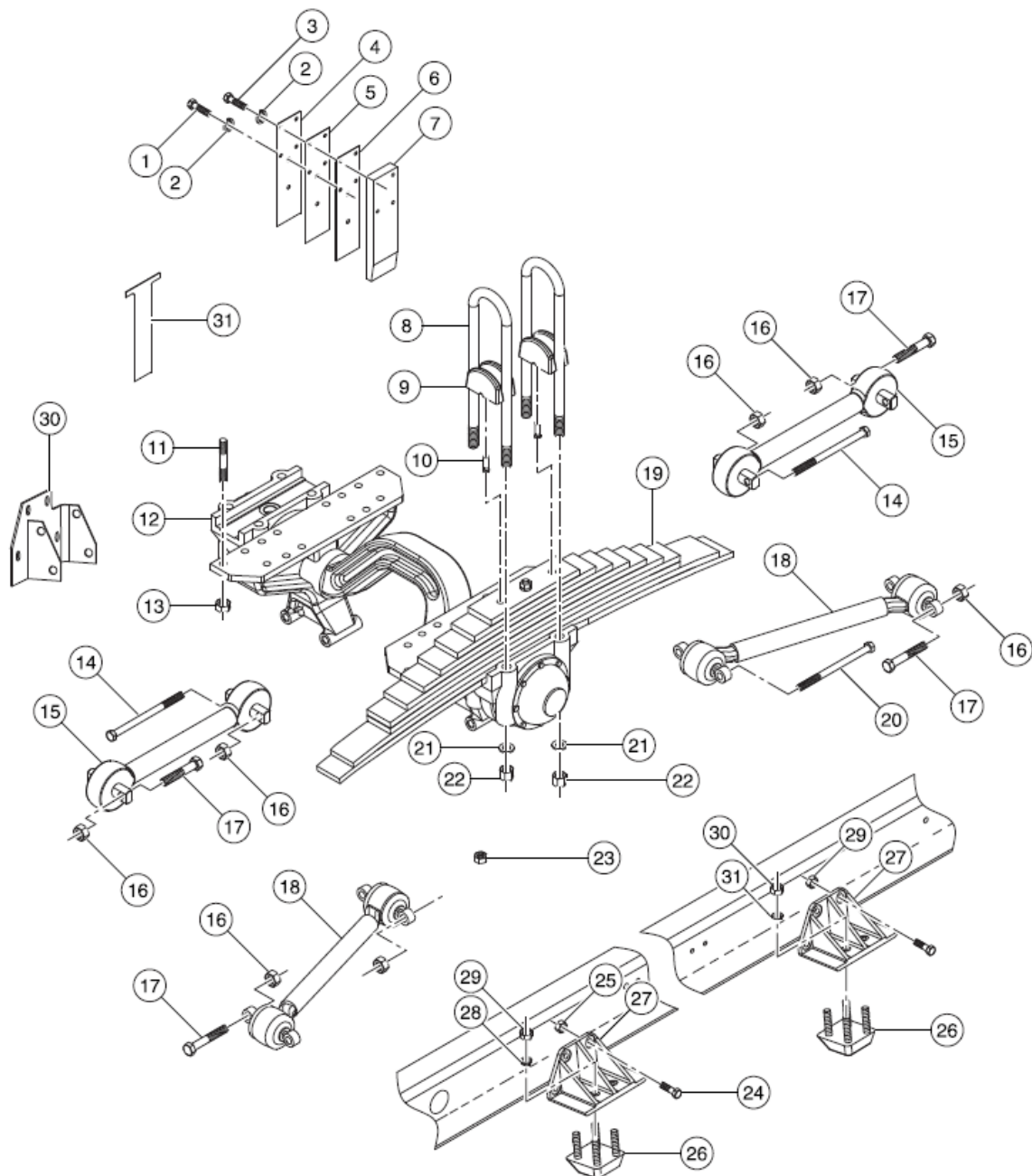
TABLE OF FAULT PHENOMENA

The following table can aid you to trace the fault. Serial number in the table indicates the sequence for the possibility of fault and each section should be checked in such sequence and replaced as needed

Fault	Suspected component	Reference
Part of the suspension makes a noise	1. Leaf spring (worn or damaged)	Chapter 22 Rear suspension-rear leaf spring, Service
	2. Leaf spring (loose)	Chapter 22 Rear suspension-rear leaf spring, Service
	3. Balance shaft (worn)	Chapter 22 Rear suspension-rear balance shaft assembly, Service
The body inclines when the vehicle is driven or parked	1. Leaf spring (worn or damaged)	Chapter 22 Rear suspension-rear leaf spring, Service
	2. Tire pressure (inconsistent)	Chapter 23 Tire and wheel - tire and wheel assembly, Testing and adjustment
	3. Balance shaft (worn or damaged)	Chapter 22 Rear suspension-rear balance shaft assembly, Service



DIAGRAM OF COMPONENTS



fmwx220028

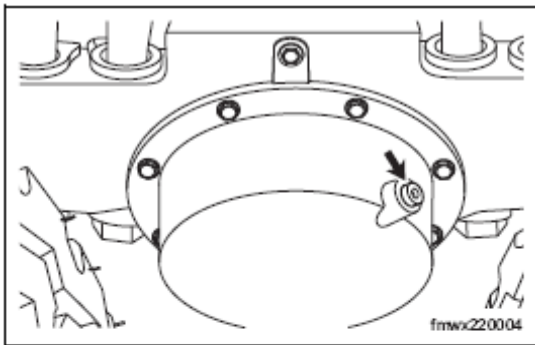
REAR SUSPENSION-REAR SUSPENSION ASSEMBLY**22-7**

1	Hexagon head bolts with fine pitch thread	17	Hexagon head bolts with fine pitch thread
2	Spring washer	18	Lower thrust bar assembly
3	Hexagonal bolt	19	Rear leaf spring assembly
4	Adjusting plate (I)	20	Hexagon head bolt
5	Adjusting plate (II)	21	Washer
6	Adjusting plate (III)	22	Self-locking nut
7	Guide plate	23	All-metal hexagon lock nuts, style 2
8	Rear U-bolt	24	Hexagon head bolts with fine pitch thread
9	Rear leaf spring pressure block	25	Self-locking nut
10	Location pin	26	Limit stop
11	Stud	27	Limit stop bracket
12	Balance shaft assembly	28	Spring washer
13	Hexagon nuts, style 1, with fine pitch thread	29	Hexagon nuts, style 1, with fine pitch thread2
14	Thrust bar connecting bolt	30	Middle axle limit stop bracket
15	Upper thrust bar assembly	31	T-shaped-adjusting plate
16	Self-locking nut		

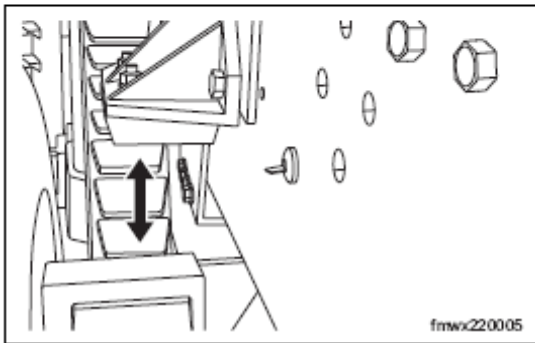


TESTING AND ADJUSTMENT

1. On-vehicle check
 - (a). Check if U-bolt deforms or cracks and if its thread is damaged and replace it with new part if necessary.
 - (b). Tighten U-bolt with the method of uniform crossed tightening and increase tightening torque to specified value gradually. When the vehicle is fully loaded, it is required to re-tighten nut of U-bolt for leaf springs cling to each other tightly; when tightening nut, it is necessary to avoid false appearance of large torque under the condition that leaf springs cannot be compressed tightly due to rusty bolt and nut and re-tap thread using screw tap to make the bolt and the nut fit properly if necessary.
 - (c). Check if thrust bar bushing is damaged and if the bolt loosens.
 - (d). Check if binding nut of balance shaft loosens.



- (e). Check liquid level on two ends of balance shaft frequently and re-fill lubricating oil 85W/90 to standard position if any shortage appears.



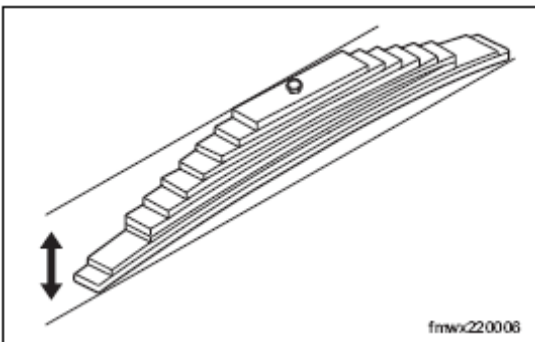
- (f). Measure buffer gap
 - Use tape measure to measure the gap.

Standard value: 145mm
Limit value: 139 - 151 mm

Suggestion:

The vehicle must be at unloaded state when making such measurement. Replace limit stop or rear leaf spring assembly if limit value is exceeded.

2. Check of leaf spring

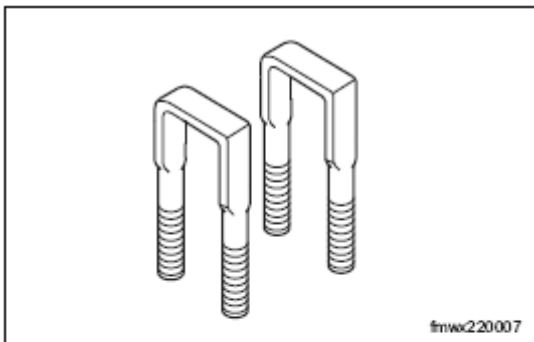


- (a). Use tape measure to measure leaf spring camber at free state.

Standard value: 54 - 66 mm

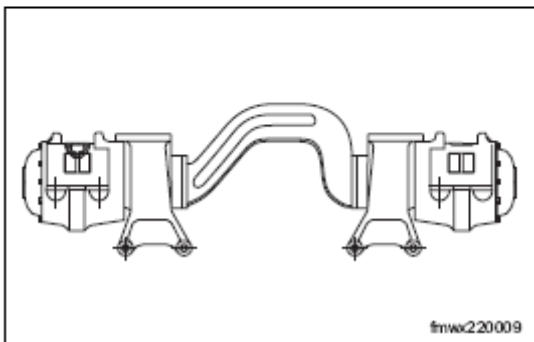
Suggestion:

Difference between left camber and right camber should not be greater than 4mm, or else the vehicle will incline.



3. U-bolt

- (a). Check if the bolt deforms and has any other damage and pay special attention to threaded portion.
- (b). Trim screw die with thread and remove any dust from threaded portion.



4. Check of balance shaft assembly

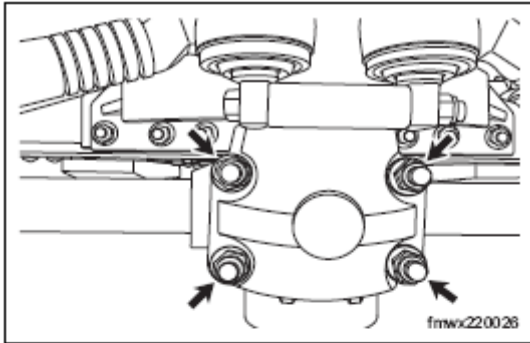
- (a). Check if any dragging and abnormal sound appear when rotating two sides of the balance shaft.
- (b). Use tape measure to measure length of balance shaft and check if there is any twist or deformation.

Standard value: 1040 mm

REAR LEAF SPRING

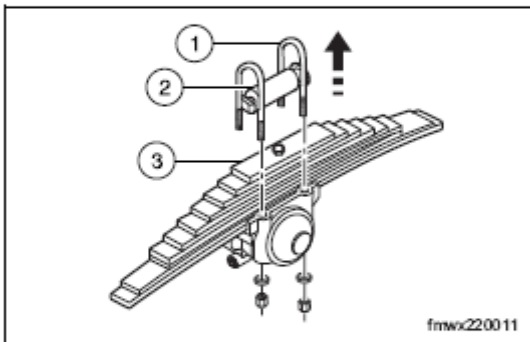
SERVICE

1. Lifting of the vehicle
2. Dismantling of rear tire



3. Dismantling of left rear leaf spring assembly

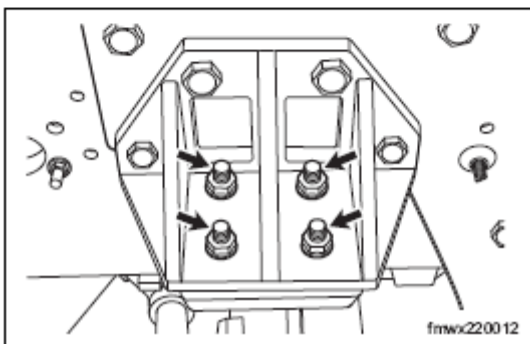
- (a). Dismantle U-bolt and 4 connecting nuts for stabilizing the axle.



- (b). Remove 2 U-shaped connecting bolts 1 and leaf spring pressure plate 2 in turn.
- (c). Loosen connecting nut 3 of the spring.
- (d). Remove 12 leaf springs in turn.

Suggestion:

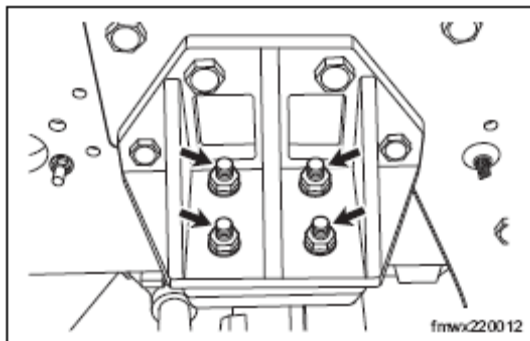
Make forward mark on the spring in order to recover original characteristics after assembly.



4. Dismantling of limit stop

- (a). Remove the limit stop after dismantling its 4 connecting nuts.

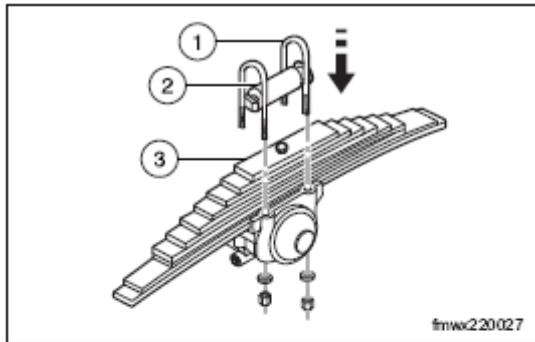
5. Check of leaf spring assembly; see chapter 22 Rear suspension-rear suspension assembly, Testing and adjustment



6. Installation of limit stop

- (a). Install limit stop and then tighten 4 connecting nuts.

Torque: 50±5N.m



7. Installation of leaf spring assembly

- (a). Install 12 springs into through bolt 3 and tighten connecting nut of springs.

Torque: $100 \pm 20 \text{ N.m}$

Note:

Be sure to conduct installation according to assembly mark made.

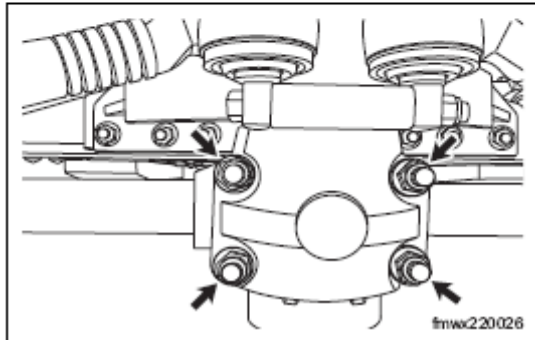
- (b). Install leaf spring pressure plate 2 and U-bolt 1 into the spring.
- (c). Tighten U-bolt and 4 connecting nuts of balance shaft

Torque: $510 \pm 20 \text{ N.m}$

Suggestion:

Right rear leaf spring can be serviced according to Service procedures for left rear leaf spring. It is important that mark (left side/right side) on the spring should be taken down when it is removed so as to ensure that it can be reinstalled at its original position, for specifications and characteristics of the spring may vary with different vehicle side.

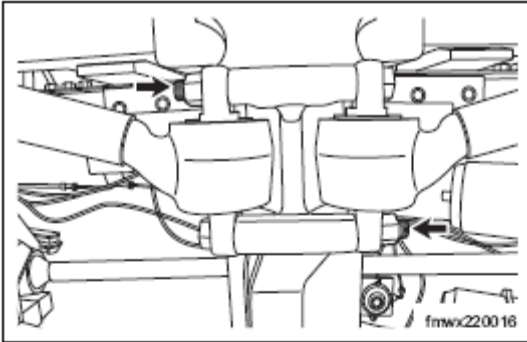
- 8. Installation of rear tire**
- 9. Lowering of the vehicle**



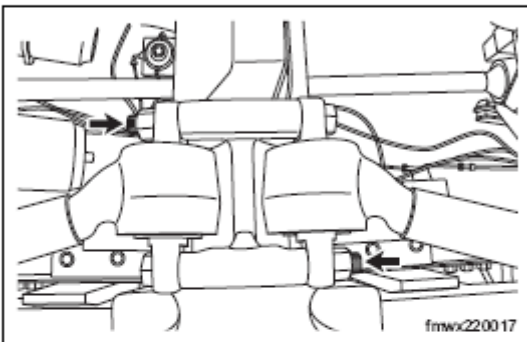
REAR BALANCE SHAFT ASSEMBLY

SERVICE

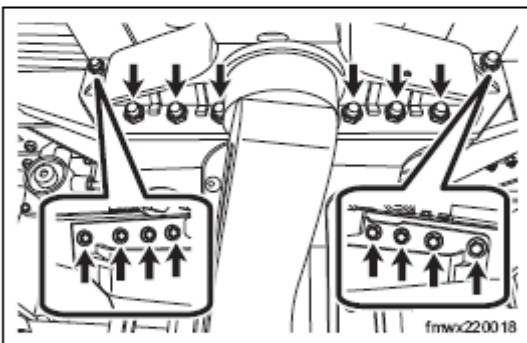
1. Dismantling of two rear leaf springs; see chapter 22 Rear suspension-rear leaf spring, Service
2. Dismantling of drive shaft between axles; see chapter 33 Drive shaft-drive shaft between axles, Service



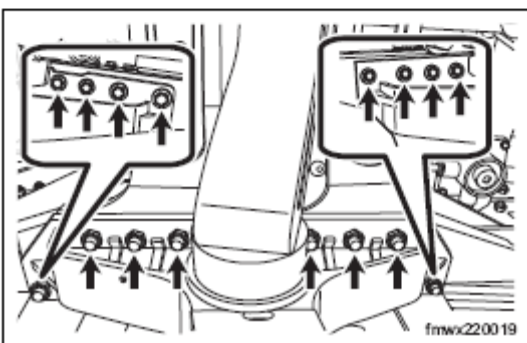
3. Dismantling of lower thrust bar assembly
 - (a). Dismantle bolt of lower thrust bar on the left side and remove left thrust bar assembly.



- (b). Dismantle bolt of lower thrust bar on the right side and remove right thrust bar assembly.

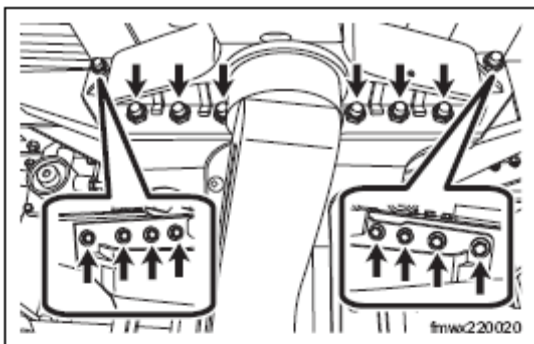


4. Dismantling of rear balance shaft assembly
 - (a). Dismantle 14 connecting bolts on the left side.



- (b). Dismantle 14 connecting bolts on the right side.
 - (c). Dismantle balance shaft assembly after propping balance shaft with hydraulic car.

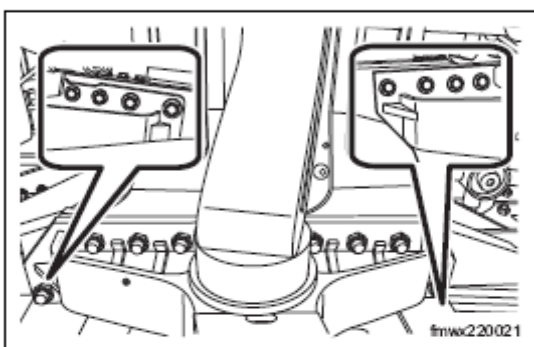
5. Check of balance shaft assembly; see chapter 22, Rear suspension-rear suspension assembly, Testing and adjustment



6. Installation of rear balance shaft assembly

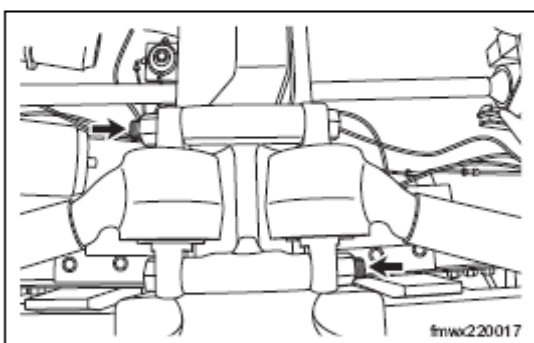
- (a). Prop rear balance shaft assembly with hydraulic car and align it with stud.
(b). Tighten 14 binding nuts on the left side.

Torque: $311.5 \pm 24.5 \text{ N.m}$



- (c). Tighten 14 binding nuts on the right side.

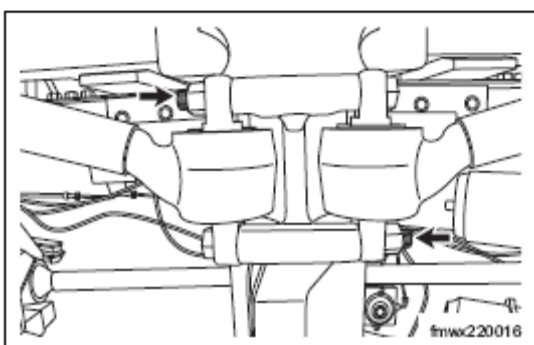
Torque: $311.5 \pm 24.5 \text{ N.m}$



7. Installation of lower thrust bar assembly

- (a). Install lower thrust bar on the right side and tighten the bolt. 2

Torque: $525 \pm 25 \text{ N.m}$



- (b). Install lower thrust bar on the left side and tighten the bolt.

Torque: $525 \pm 25 \text{ N.m}$

8. Installation of drive shaft between axles; see chapter 33 Drive shaft- drive shaft between axles, Service
9. Installation of two rear leaf springs; see chapter 22 Rear suspension- rear leaf spring, Service

WHEELS AND TIRES

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WHEEL AND TIRE ASSEMBLY

OVERVIEW

This vehicle is equipped with drive form of 6×4, including 10 tires in service and 1 spare tire. The tire assembly consists of tire, wheel, tire nuts, nut protective covers, air valve extension tube and protective cap. The vehicle is driven and stopped through the friction between tire and road. The tire should have good wear-resistance, prick-resistance, impact-resistance and thermal dissipation performances. Cord fabric body and main stressed member of the tire should be impact-resistant and have good flex-resistance in the running order. The wirecord fabric between wheel tread and tire body has the function of protecting tire body, guarding against the deformation of wheel tread, upholding the ground plane of tire tread and improving wearing resistance and driving stability. The special cord fabric body above the belt can inhibit the belt from moving in running order so as to prevent the belt from separating and maintain the stability of tire size at high speed. Rubberized steel wire is wound according to a certain shape (quadrangle or hexagon), which is helpful to install the tire on rim so as to fasten the tire. The filler material above wire loop can prevent the tire bead from scattering, reduce the impact of tire bead, protect tire bead and prevent the air from entering during forming.

PRECAUTIONS

1. Special tools should be used during the disassembly and assembly of tire. Sledge and other sharp tools are not allowed.
2. The tires with different specifications, different hierarchies, different patterns, different pressures or different loads should not be installed on the same shaft.
3. Pay attention to the rolling direction mark when installing the tire with directional patterns.
4. As for twin tires, pay attention to align the ventilating holes of the two wheels. In addition, the angle between the two inflating valves should be 180°, and the angle between the valves and shoe hub clearance inspection hole on the brake hub should be 90°.
5. Tire replacement should be carried out every 5000 ~ 6000 Km, so as to make the abrasion of various tires uniform.
6. Air pressure should be readjusted according to the tire position requirement after tire replacement.
7. Regularly check the toe-in of the front wheel to avoid unnecessary increase of running resistance, gasoline consumption and tire abrasion.

8. Precautions of tire inflation

- (a). Tire air pressure has a decisive influence on tire abrasion, gasoline consumption and fault. Therefore, the standard pressure must be maintained and checked regularly for the sake of safe driving.
- (b). The load capacity of tire is in proportion to its inflation pressure, so the desired air pressure should be determined according to the load capacity of the vehicle. Climatic and seasonal change should not be a reason for the adjustment of tire air pressure.
- (c). At the initial stage of new tire, the tire peripheral dimensions change due to the heat produced by flexing action, which decreases the tire air pressure, so the air pressure should be checked and adjusted after 24 hours or driving for 2000-3000km.
- (d). The tire air pressure should be increased by 10%-15% when driving at high speed for a long time.
- (e). Inflate the tire according to the standard air pressure as specified by Instructions of this vehicle type and measure the pressure with barometre at cold state; check whether the valve core fits neatly against the inflating valve and wipe out the dust; the inflated air should not contain moisture and oil mist. Check for air leakage after inflation and tighten the valve cap up.

9. The lack of air pressure for a long time is inadvisable.

The lack of air pressure for a long time will exacerbate tire sidewall deformation, increase heat generation and reduce tire service life. In addition, it will bring the following problems and potential safety hazards:

- (a). Excessive wear of tire shoulder.
- (b). A greater likelihood of protrusion of tire caused by impact.
- (c). The decrease of cohesive force between various parts of tire lead to delamination.
- (d). The serious lack of air pressure leads to the damage of tire wall side.
- (e). The excessive tire bounce leads to the abnormal abrasion between tire bead and rim, and damage on rim.
- (f). The increase of running resistance and gasoline consumption.

10. Excessive air pressure for a long time is inadvisable.

The excessive air pressure will reduce the ground contact area of tire tread, increase the rigidity of tire body and decrease resiliency. In addition, it will bring the following problems and potential safety hazards:

- (a). The excessive abrasion in the middle of tire tread.
- (b). The danger of breakage and tire burst increases when subject to external force impact.
- (c). The decrease of ground contact area leads to the loss of controllability, which is liable to cause drifting and sliding.
- (d). The decrease of riding quality.
- (e). Poor running smoothness. Excessive air pressure for a long time is liable to damage the chassis.



TABLE OF FAULT PHENOMENA

The following table can aid you to trace the fault. Serial number in the table indicates the sequence for the possibility of fault and each section should be checked in such sequence and replaced as needed.

Fault	Suspected component	Reference
Abnormal abrasion of tire	1. Toe-in (inconsistent with stipulations)	Chapter 24A: front axle (Ankai)-front axle assembly, Testing and adjustment
	2. Tire (air pressure does not meet the requirement)	Chapter 23: wheels and tires-wheel and tire assembly, Testing and adjustment
	3. Wheel (unbalanced)	Chapter 24A: front axle (Ankai)-front axle assembly, Service
	4. Front axle (deformed)	Chapter 24A: front axle (Ankai)-front axle assembly, Service
	5. Steering knuckle (deformed/abrasive)	Chapter 24A: front axle (Ankai)-steering knuckle, Service
Swing and shake of front wheel	1. Front wheel (different air pressures)	Chapter 23: wheels and tires-wheel and tire assembly, Testing and adjustment
	2. Wheel (unbalanced)	Chapter 23: wheels and tires-wheel and tire assembly Testing and adjustment
	3. Shock absorber (invalid)	Chapter 21: front suspension-front shock absorber, Service
	4. Steering mechanism (serious abrasion)	Chapter 42: power steering-steering mechanism assembly (left rudder), Service Chapter 42: power steering-steering drag link assembly, replacement
Front wheel sideslip	1. Tire toe-in (inconsistent with stipulations)	Chapter 24A: front axle (Ankai)-front axle assembly, Testing and adjustment
	2. Tire (air pressure does not meet the requirement)	Chapter 23: wheels and tires-wheel and tire assembly, Testing and adjustment
Poor riding quality	1. Tire (excessive air pressure)	Chapter 23: wheels and tires-wheel and tire assembly, Testing and adjustment
	2. Shock absorber (invalid)	Chapter 21: front suspension-front shock absorber, Service
	3. Leaf spring (invalid)	Chapter 21: front suspension-front leaf spring, Service Chapter 22: rear suspension-rear leaf spring, Service

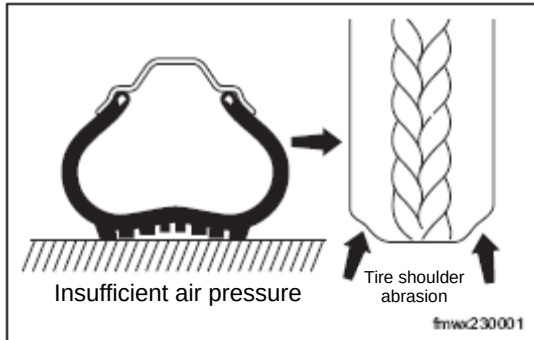
TESTING AND ADJUSTMENT

1. Check the depth of tire pattern

Depth: ≥ 2 mm

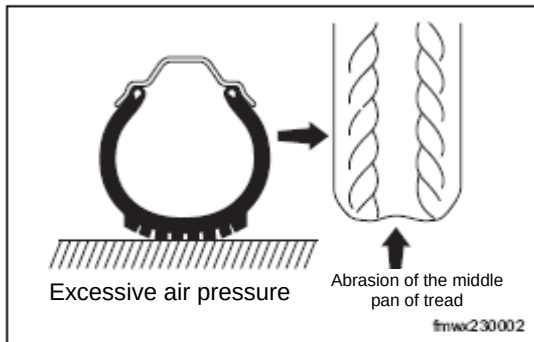
Note:

Replace it with new tire if the depth of tire pattern exceeds the limit; be sure to replace the right and left tires in pair.

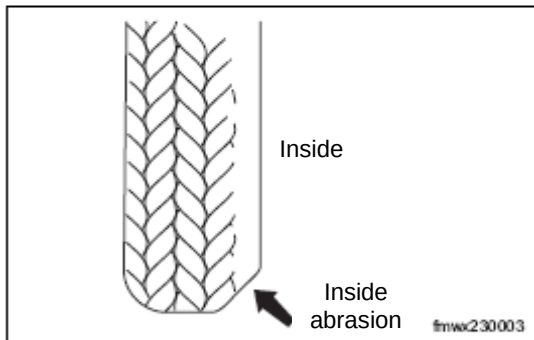


2. Check for the abnormal abrasion of tire

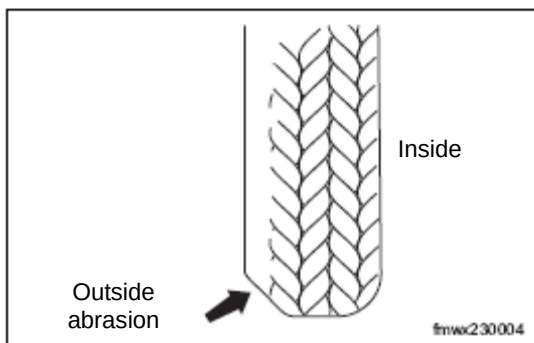
- (a). Check the tire shoulder for abrasion. If there is any abrasion, check whether the air pressure is insufficient and whether overloading occurs frequently and then carry out tire rotation after adjusting air pressure.



- (b). Check whether the middle part of tire tread is abrasive. If there is any abrasion, check whether the air pressure is excessive and then carry out tire rotation after adjusting air pressure.

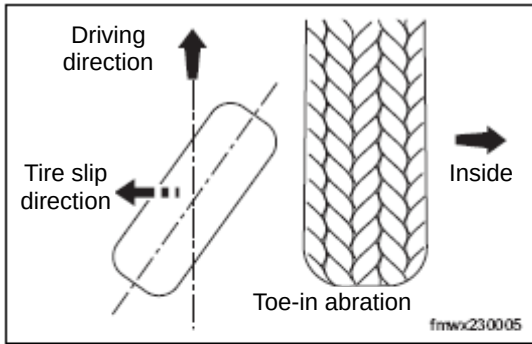


- (c). Check whether the tire inside is abrasive. If there is any abrasion, pay attention to avoid rolling at high speed, check whether suspension components are loose, whether the camber angle is normal and then carry out tire rotation after adjustment.

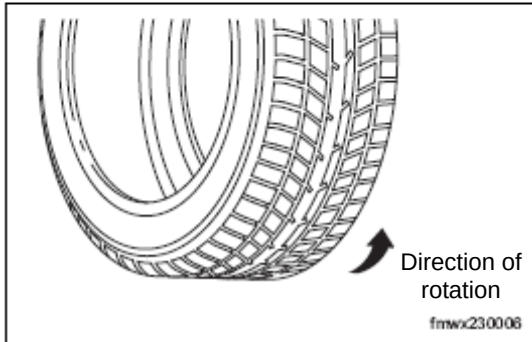


- (d). Check whether the tire outside is abrasive. If there is any abrasion, pay attention to avoid rolling at high speed, check whether suspension components are loose, whether the camber angle is normal and then carry out tire rotation after adjustment.





- (e) Check the tire for pinniform abrasion. If there is any abrasion, check toe-in value and then carry out tire rearrangement after adjustment.



- (f). Check the tire for corrugated abrasion. If there is any abrasion, check whether the tire inflation pressure is standard, whether the camber angle and toe-in are correct, whether the wheel bearings are loose or abrasive and then adjust them and carry out tire rotation.

3. Check cold-state tire inflation pressure

Tire specification	Inflation pressure
12.00R20	830kpa

Note: if necessary, adjust or replace the tire if tire specification or inflation pressure does not meet the requirements.

4. Check tire crown, shoulder and sidewall

Note: replace with new tire if there is internal damage, delamination, protrusion and deformation in tire crown, shoulder and sidewall.

5. Check inflating valve

Note: replace with new tire timely if valve core leaks air.

6. Check rim and check ring

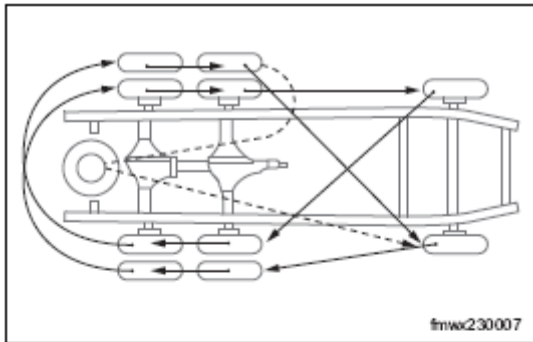
Note: replace with new tire timely if deformation, rust and damage are found.

7. Check tire bolt

Note: if these bolts are not secure, tighten up one by one again according to the requirements.

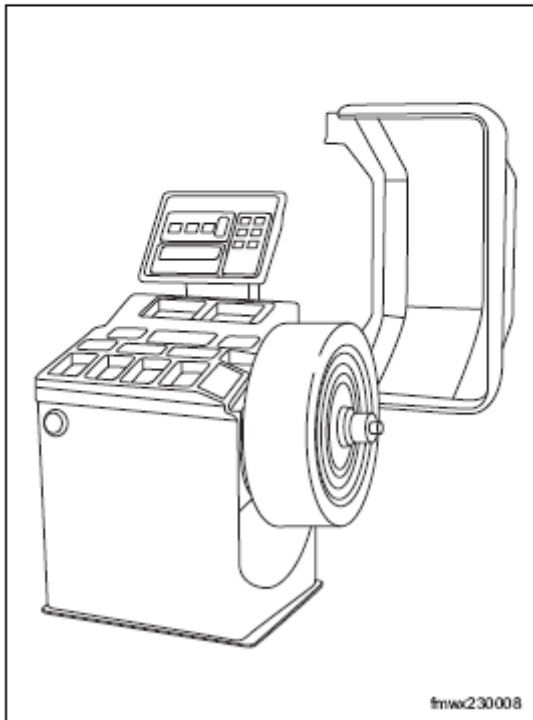
Front wheel torque: 575±25 N.m

Rear wheel torque: 575±25 N.m



8. Tire rearrangement

- (a). Circulating rearranging method



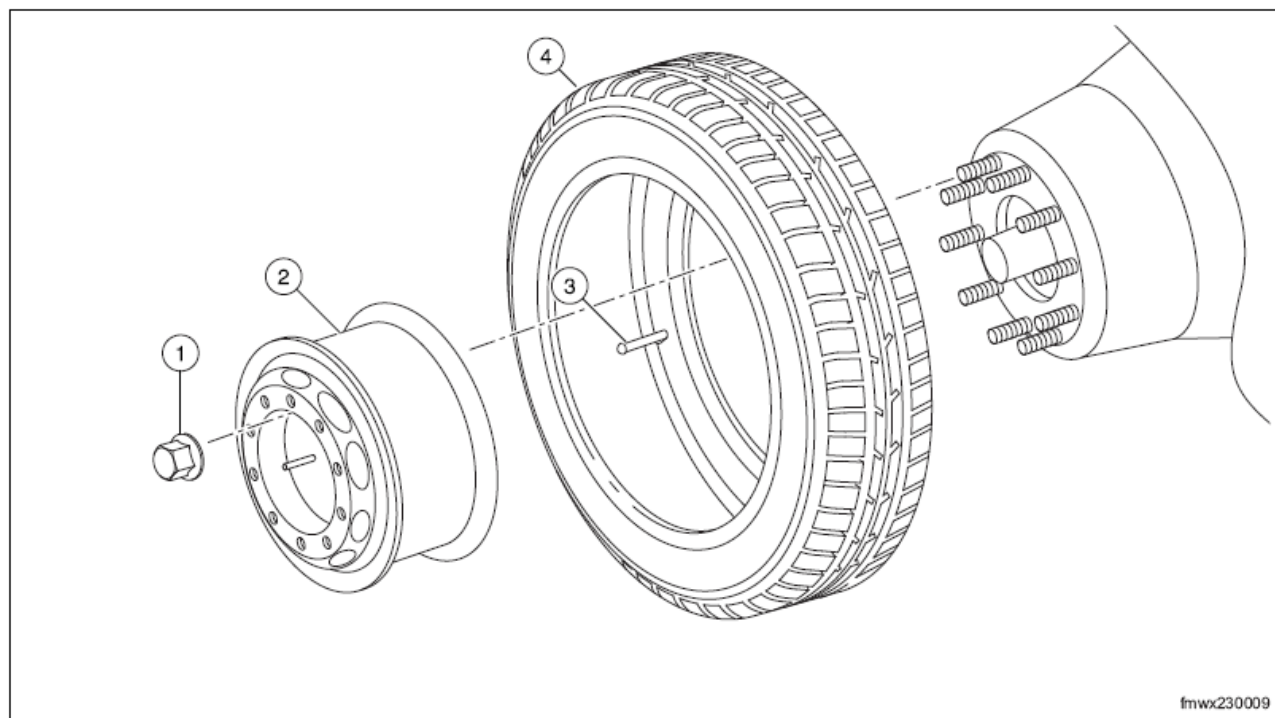
9. Tire dynamic balance

- (a). Wipe out the dust, carpolite and old counter balance on the wheel measured.
- (b). Check whether the tire air pressure meets the requirements of original manufacturer.
- (c). Choose pyramid according to the size of rim center hole to install the wheel and tighten them with fast nut.
- (d). Switch on the power of dynamic balance tester.
- (e). Measure the width of rim.
- (f). Measure the diameter of rim.
- (g). Measure the distance from edge of rim to dynamic balance tester.
- (h). Put down the wheel shield to start to check.
- (i). After the check, install the counter balance according to the unbalanced position and amount of unbalance instructed by the tester.
- (j). Check again and adjust the dynamic balance value till it meets the requirement.
- (k). Remove the tire.



FRONT WHEEL AND TIRE

DIAGRAM OF COMPONENTS



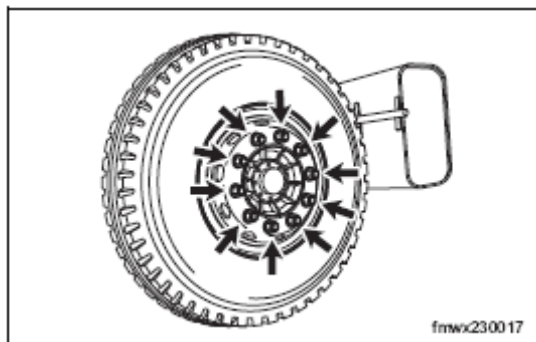
fmwx230009

1	Nut protective cover
2	Wheel assembly

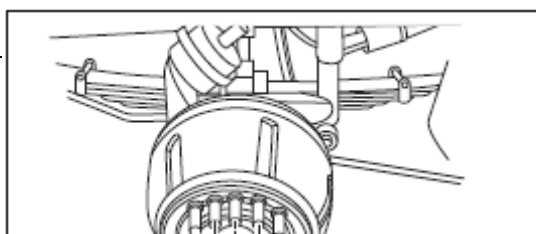
3	Valve and valve cap
4	Tire assembly

SERVICE

1. Apply the handbrake and wedge the rear wheel.
2. Jack the front of the car



3. Remove front tire
 - (a). Remove nut protective cover of the left front tire.
 - (b). Remove left front tire nut.



- (c). Remove left front wheel.

4. Install the front tires

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(a). Install the left front tire.

(b). Tighten up left front tire nut.

Torque: 575 ± 25 N.m

(c). Install the nut protective cover of left front tire

5. Remove right front tire; refer to the assembly and disassembly of left front tire.

23-12

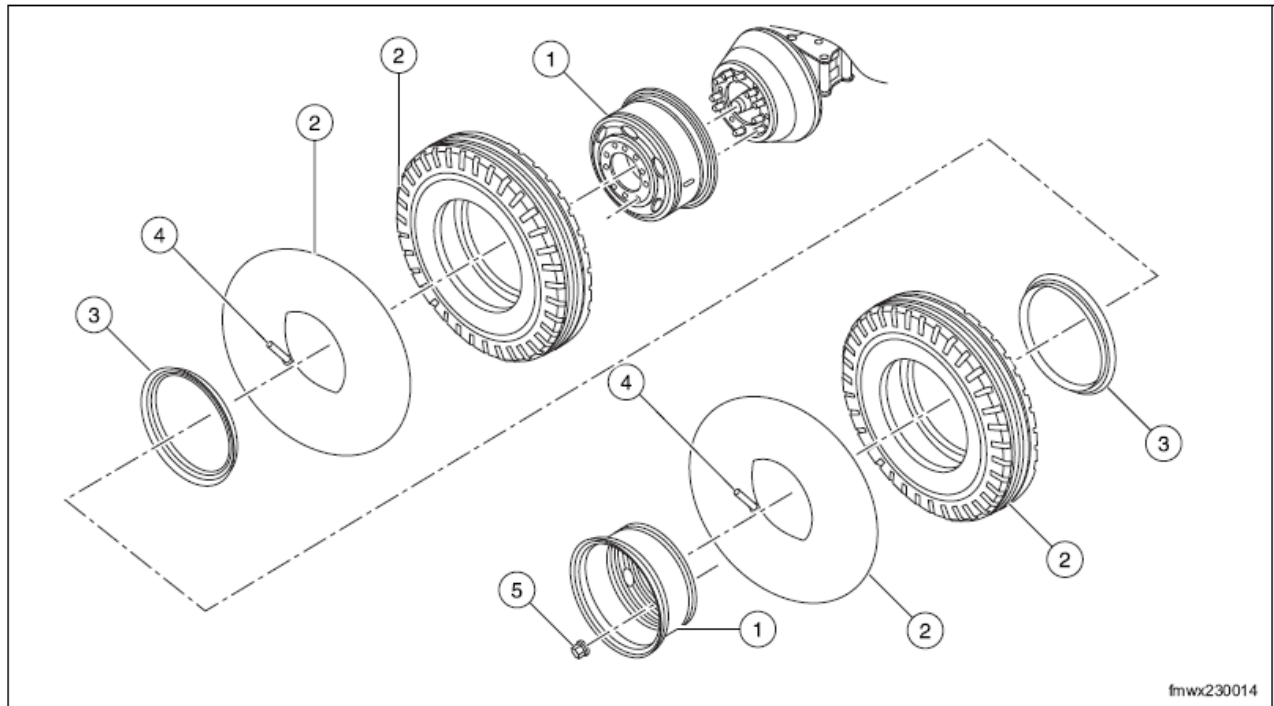
WHEELS AND TIRES-FRONT WHEEL AND TIRE

6. Remove the wedges.
7. Put the vehicle down.



REAR WHEEL AND TIRE

DIAGRAM OF COMPONENTS



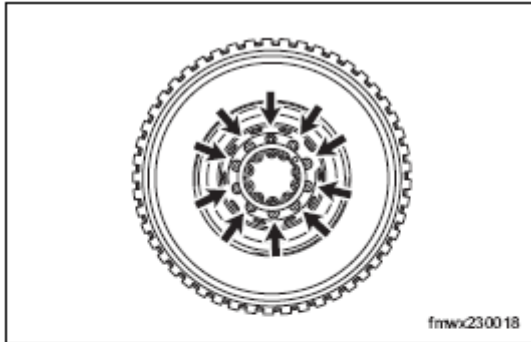
1	Rim assembly
2	Tire
3	Elastic check ring

4	Valve extension and protective cap
5	Tire nut

SERVICE

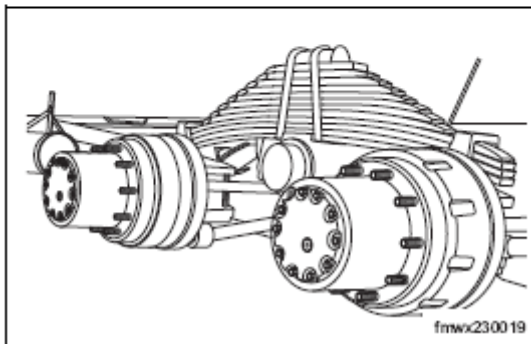
1 Apply the handbrake and wedge the front wheel.

2 Jack the rear of the car.

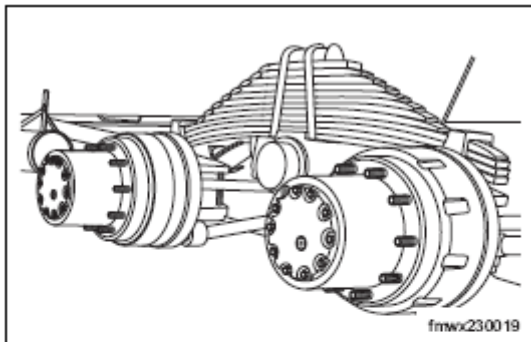


3 Remove rear tire.

(a) Unscrew the nuts of left rear outside tire; remove the left rear outside wheel.

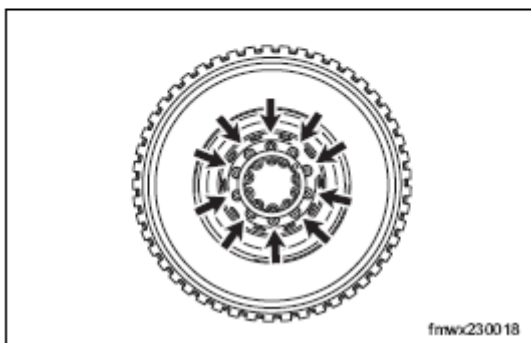


(b) Remove left rear inside wheel.



4 Install the left rear tire

(a) Install the left rear inside wheel.



(b) Install left rear outside wheel and tighten up left rear outside tire nut.

Torque: 575±25 N.m

5 Remove right rear tire; refer to the assembly and disassembly of left rear tire.

6 Remove the wedges.

7 Put the vehicle down.

Front Axle (Ankai)

FRONT AXLE ASSEMBLY	24A-3
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Overhaul.....	24A-12
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Overhaul.....	24A-17



24A

Front Axle Assembly

General

Since front axle is one important assembly component in vehicle running system, modern transport vehicles are stricter with its performance. Front axle of a 6.5T level not only meets performance requirements of auman heavy transport vehicles, but also enhances the bearing capacity of auman heavy transport vehicles by virtue of its excellent advantage of large axle load. Front axle of a 6.5T level has a rated load of 6.5T and can carry a load of 8T on a road in good condition



Precautions

1. Care shall be taken not to overload front axle in operation, and effect of shock load shall be avoided.
2. Inspection and maintenance shall be carried out on front axle in accordance with specified mileage. During maintenance, dismantle the hub to check hub bearing and fill lubricating grease, and check the matching of knuckle king pin and sleeve at the same time, if sintering or excessive clearance is detected, replace them. Attention must be paid to the concentricity while reaming the knuckle king pin and sleeve.
3. Front shaft is connected with the carriage by parabolic leaf spring. Attention shall be paid to the Testing & Adjustment of front wheel alignment dimensions while installing front shaft.
4. The initial tension of steering knuckle (without hub) is 10-50N (with the difference between two sides no more than 10N), and the rotation of knuckle shall be flexible without obvious blocking phenomena. Both clearance between bracket and gasket and surface bearing clearance shall be no more than 0.15 mm.
5. The involute direction of camshaft agrees with the bracket direction, namely "S" for the left, and inverse "S" for the right. The direction of adjusting arm agrees with the bracket direction, and hexagonal head of worm faces upward.
6. Prior to the use of a new axle, fill sufficient Lithium Grease No.2 into each butter nozzle, so that each member can be well lubricated.
7. After the axle is installed for use, forced maintenance and bearing pretightening force inspection shall be simultaneously carried out on it together with engine and gearbox after a complete-vehicle driving for 2000-4000 Km, at the same time, brake clearance must be adjusted and fastening of fasteners in every position must be rechecked before being formally put into use.
8. Regular inspection must be carried out on the air plug of axle housing, and the dirt and dust on it shall be cleaned to prevent oil leakage caused by the increase of oil pressure inside the axle as a result of blockage.
 - For every 2000 Km, fill Lithium Grease No.2 into each butter nozzle and clean air plug.
 - For every 5000 Km, check brake clearance.
 - For every 8000-10000 Km, check the fastening of brake base plate; check the loosening of hub bearing.
9. Parts may be stained with greasy dirt and mud. Cleaning of parts is an essential process. Some damaged parts may be detected in the cleaning process. Thus, care must be taken in the cleaning process. After cleaning of parts, use a specially prepared survey meter or tool to carry out inspection. Judge whether parts are suitable for use in accordance with the specified maintenance standard. Damaged parts shall be repaired or replaced as required. If one of mating parts is seriously worn and its fit-up gap is beyond the specified value, the parts or mating parts can be replaced as required.
10. In view of preventive maintenance, some parts within the repair or wear limit range shall be replaced before they go beyond the limit range.
11. For rubber parts, such as O-rings, oil seals, sealing washers, etc., when they are dismantled, judge whether to disuse them according to circumstances.

Front Axle (Ankai) - Front Axle Assembly

Fault Symptom Table

Use the table below to help you find the cause of the fault. If necessary, replace these parts.

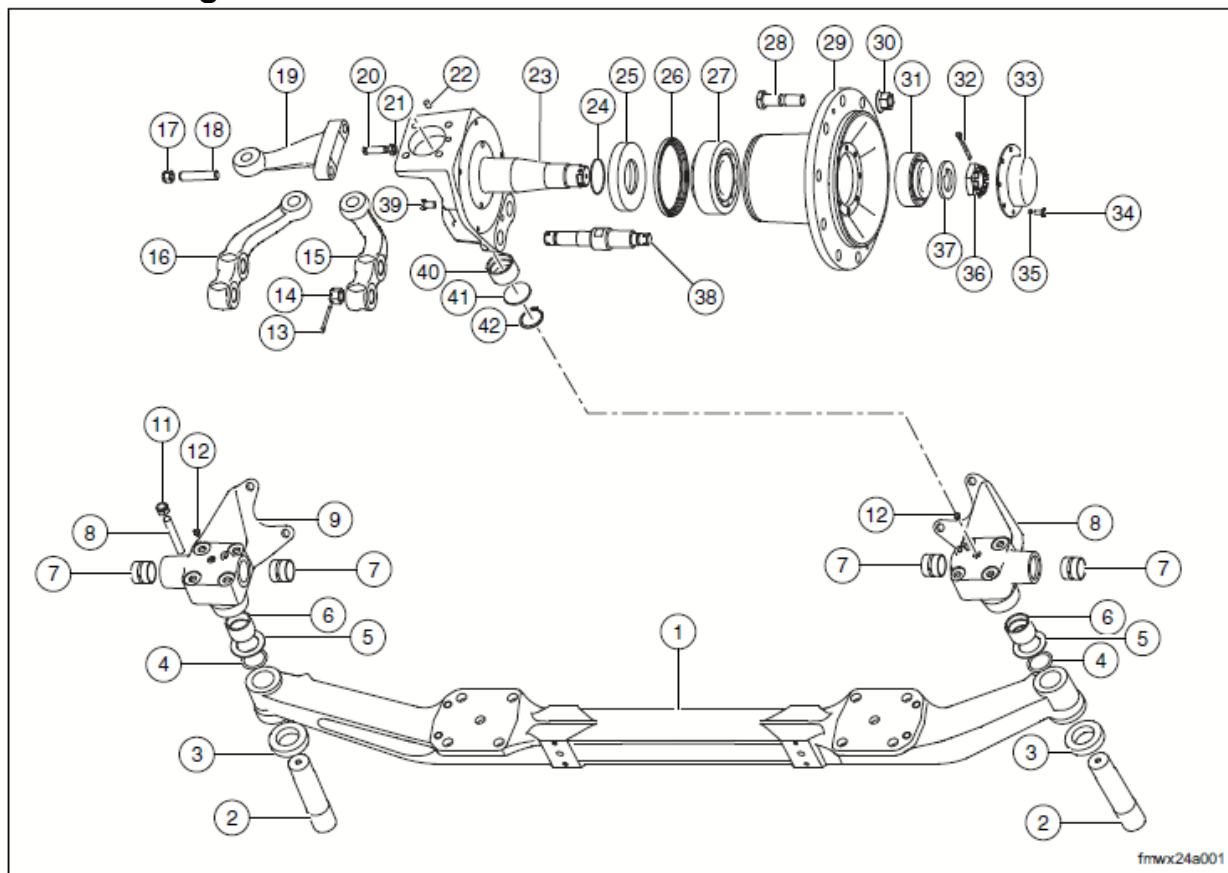
Symptom	Possible Cause	Reference
Heating of bearing	1. Hub bearing (Pretightening force is too big)	Chapter 24, Front Axle - Front Axle assembly - Front Wheel Bearing, Overhaul
	2. Hub bearing (Oil leakage)	Chapter 24, Front Axle - Front Axle assembly - Front Wheel Bearing, Overhaul
Heating of brake drum-	1. Brake chamber (Failing to return or slowly returns when brake process is finished)	Chapter 26, Service Brake - Front Brake Chamber, Overhaul
	2. Brake shoe and brake drum (No clearance therebetween)	Chapter 26, Service Brake System - Testing & Adjustment, Brake Clearance Adjustment
	3. Brake shoe return spring (Broken)	Chapter 26, Service Brake - Front Brake Shoe, Overhaul
Waddle or whipping of front wheels	1. Front wheels (Different pressures)	Chapter 23, Wheel & Tire - Wheels and Tire Assembly, Testing & Adjustment
	2. Wheels (Unbalanced)	Chapter 23, Wheel & Tire - Wheels and Tire Assembly, Testing & Adjustment
	3. Shock absorber (Failed)	Chapter 21, Front Mounting - Front Shock Absorber, Overhaul
	4. Steering mechanical (Severely worn)	Chapter 42, Power Steering Mechanism - Steering Gear Assembly, Overhaul Chapter 42, Power Steering Mechanism - Steering Drag Link, Replacement
Brake deviation	1. Friction plate (Worn out at one side)	Chapter 26, Service Brake - Front Brake Shoe, Replacement Chapter 26, Service Brake - Rear Brake Shoe, Replacement
	2. Friction plate (Used incorrectly)	Chapter 26, Service Brake - Front Brake Shoe, Replacement Chapter 26, Service Brake - Rear Brake Shoe, Replacement
	3. Brake clearance (Abnormal)	Chapter 26, Service Brake - Service Brake System, Testing & Adjustment
	4. Brake chamber (Different pressures)	Chapter 26, Service Brake - Front Brake Chamber, Replacement Chapter 26, Service Brake - Rear Brake Chamber, Replacement



Lack of braking force	1. Air compressor (Failing to work)	Chapter 16, Engine Machinery - Engine Accessories, Replacement
	2. Relay Valve (Damaged)	Chapter 26, Service Brake - Relay Valve, Replacement
	3. Brake friction plate (Hardened)	Chapter 26, Service Brake - Front Brake Shoe, Replacement Chapter 26, Service Brake - Rear Brake Shoe, Replacement
	4. Brake drum or brake friction plate (Oil stain)	Chapter 26, Service Brake - Front Brake Shoe, Replacement Chapter 26, Service Brake - Rear Brake Shoe, Replacement
	5. Brake chamber push rod (Distorted)	Chapter 26, Service Brake - Front Brake Chamber, Replacement Chapter 26, Service Brake - Rear Brake Chamber, Replacement

Front Axle (Ankai) - Front Axle Assembly

Part Drawing



1	FR Shaft
2	Knuckle Pin
3	Thrust Roller Bearing
4	O-Ring
5	Additional Washer
6	Sleeve
7	Sleeve
8	Bracket (LH)
9	Bracket (RH)
10	Stud Bolt
11	Full Metal Self-Locking Nut
12	Straight-Through Grease Nipple
13	Cotter Pin
14	Hex Slotted Flat Nut
15	Steering Tie Rod Arm (LH)

22	Cylindrical Pin
23	Knuckle
24	O-Ring
25	Spacer Ring
26	Shaft O-Ring
27	Tapered Roller Bearing
28	Wheel Bolt
29	FR Wheel Hub
30	Wheel Nut
31	Tapered Roller Bearing
32	Cotter Pin
33	Cover
34	Hex Head Bolt
35	Spring Washer
36	Hex Slotted Nut



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Front Axle (Ankai) - Front Axle Assembly

16	Steering Tie Rod Arm (RH)	37	Washer
17	Full Metal Self-Locking Nut	38	Backing Pin
18	Stud Bolt	39	Hex Bolt
19	Steering Drag Link Arm	40	Sleeve
20	Adjusting Screw	41	Cover
21	Hex Thin Nut	42	Circlip for Hole

Testing & Adjustment

Front Wheel Bearing

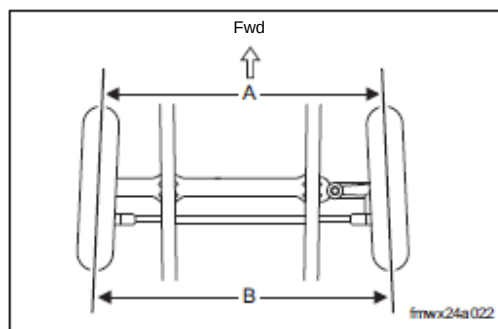
Having a regular structure, the hub is held on the knuckle spindle by two tapered roller bearings and is fixed on the knuckle spindle by slotted nut and baffle plate. After the installation of the hub, screw up the slotted nut in accordance with a torque of 250 N•m, then make a 1/6 - 1/3 back turn to ensure that the pretightening torque of bearing measured by dynamometer is 60-90 N•m and the difference between the two sides is no more than 10 N•m, align cotter pin hole of the shaft to any rabbet of the slotted nut, and lock up the cotter pin. During the installation, care must be taken of axle end oil seal, and the oil seal shall be aligned to oil seal seat so that edges of oil seal can not be damaged.

Toe-In of Front Wheel

Adjusting method for toe-in of front wheel is as follows:

1. Jack up the front axle to raise two wheels of this axle off the ground for 30 mm and enable the wheels at both sides to freely rotate and keep straight ahead.
2. Respectively make a mark in the tread center of the wheel at each side. Marking points shall be clear but not too big or too thick.
3. Rotate the marking points of the two wheels to positions in front of the wheel centers (the forward running direction of the vehicle), keep them in one horizontal plane, measure the distance between them with a measuring tape and record a data A. Respectively rotate the two wheels at both sides by 180° to keep the two marking points in one horizontal plane (which is the same with the plane for the first measurement), measure the distance between the two marking points with a measuring tape and record a data B.

Toe-in = data B - data A



4. If the result of the previous step is beyond the specified range (0~2 mm), adjust the length of the steering axle tie rod to meet the requirements.



Front Wheel Hub Overhaul

Hint:

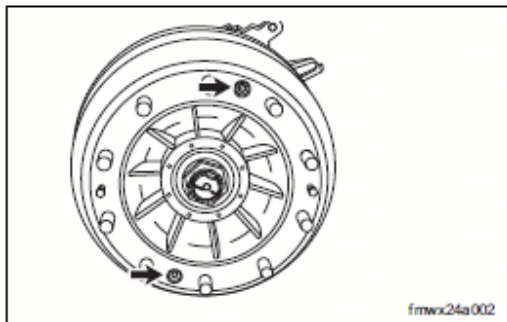
Part Drawing, refer to Chapter 24, Front Axle - Front Axle Assembly, Part Drawing.

1. **Jack up head of vehicle**

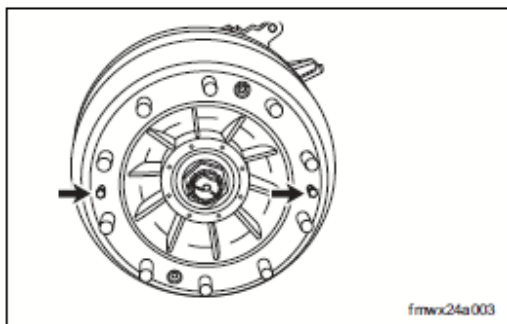
2. **Dismantle front wheels, refer to Chapter 23, Tire & Wheel - Front Tire & Wheel, Overhaul**

3. **Dismantle front brake drum**

(a). Dismantle two fixing screws of the brake drum with a cross screwdriver.

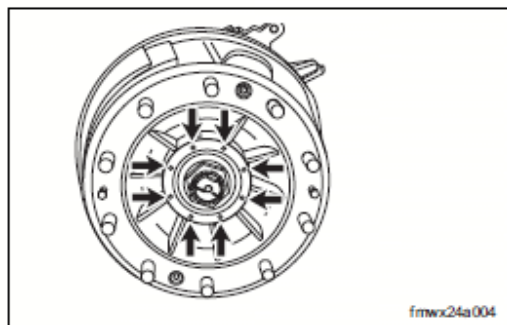


(b). Drive the brake drum out with two M10 bolts.



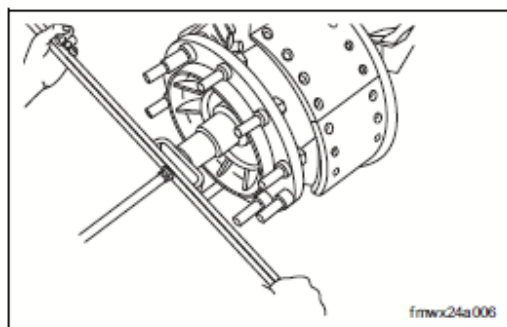
4. **Dismantle front wheel hub**

(a). Dismantle the axle end cover bolt.

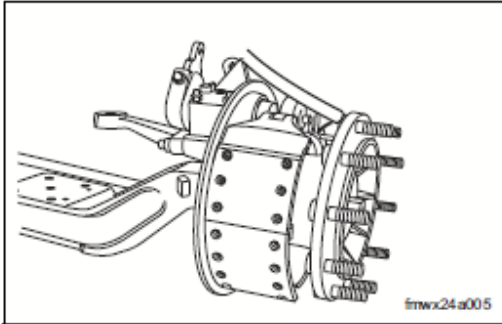


24A

(b). Remove the slotted nut cotter pin with a jaw vice, and dismantle the slotted nut.



Front Axle (Ankai) - Front Axle Assembly



- (c). Knock the hub with a copper rod until the hub is loosened, and remove the hub.

Caution:

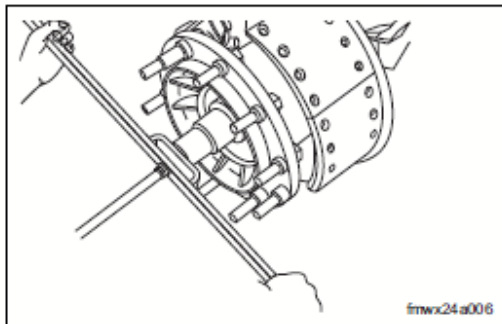
Do not use a hammer.

5. Check front wheel hub

- (a). Inspect whether the hub is cracked or worn, the oil seal is in good condition, the hub bearing is sintered or worn and the wheel bolt is broken. Replace them with new ones in case of the above-mentioned defects.

Caution:

Replace with new parts in case of any defect.

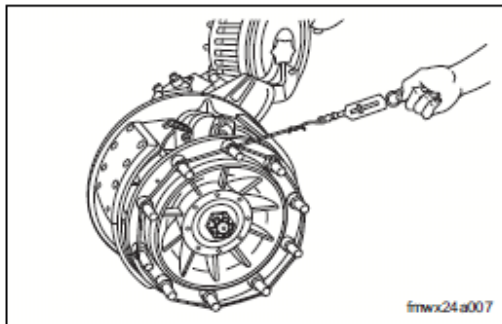
**6. Install front wheel hub**

- (a). Install the hub onto the axle end, screw down the slotted nut and then make a 1/6 - 1/3 back turn.

Torque: 250 N·m

Caution:

Fill the bearing chamber with lubricating grease.



- (b). Measure the pretightening torque of the bearing with a tension spring balance. Install the cotter pin.

Pretightening torque: 75 ± 15 N

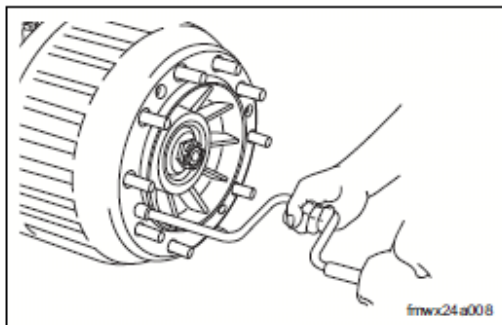
Caution:

The difference between both sides shall not be more than 10 N

- (c). Install the axle end cover bolt.

Caution:

Sealant shall be applied to the surface of the axle end cover.

**7. Install front brake drum**

- (a). Install two fixing screws of the brake drum with a cross screwdriver.

Caution:

During installation, the screw holes shall be aligned to. Attention shall be paid to the protection of the tire bolt.

- 8. Install front wheels, refer to Chapter 23, Tire & Wheel - Front Tire & Wheel, Overhaul**
9. Lay down head of vehicle

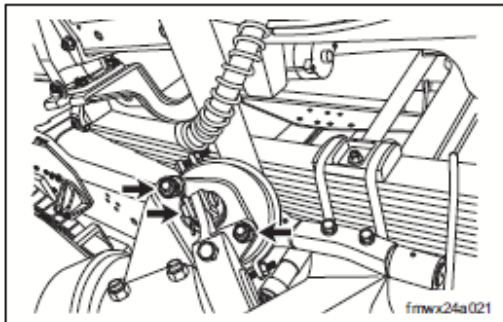


Knuckle Overhaul

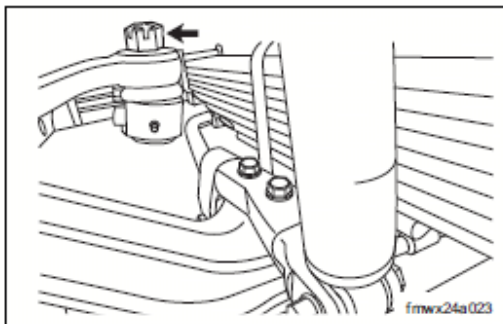
Hint:

Part Drawing, refer to Chapter 24, Front Axle - Front Axle Assembly, Part Drawing.

1. **Jack up head of vehicle**
2. **Open cab**
3. **Dismantle front wheels, refer to Chapter 23, Tire & Wheel - Front Tire & Wheel, Overhaul**
4. **Dismantle front ABS sensor plug**

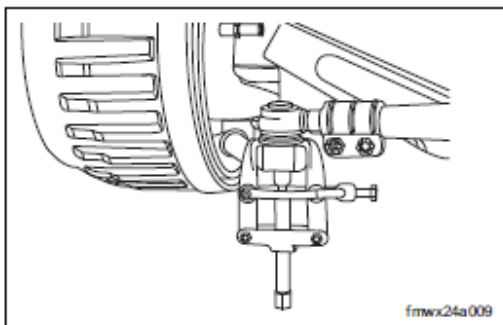


5. **Dismantle front brake chamber**
 - (a). Dismantle connecting pin of the brake chamber and adjusting arm.
 - (b). Dismantle fixing bolt of the brake chamber.



6. **Dismantle ball locking nut of steering linkage and steering crank**

Caution:
Special tools shall be used.

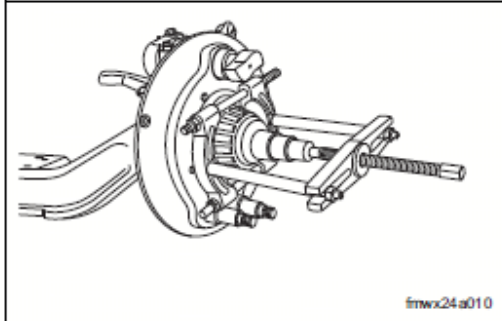


7. **Dismantle ball locking nut of tie rod and drag link**

Caution:
Special tools shall be used.

Front Axle (Ankai) - Front Axle Assembly

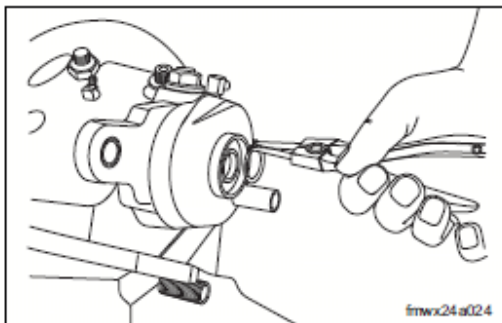
8. Dismantle front brake drum, refer to Chapter 24, Front Axle - Front Wheel Hub, Overhaul
9. Dismantle front wheel hub, refer to Chapter 24, Front Axle - Front Wheel Hub, Overhaul
10. Dismantle front brake shoe, refer to Chapter 26, Service Brake - Front Brake Shoe, Overhaul



11. Dismantle bearing in front wheel hub

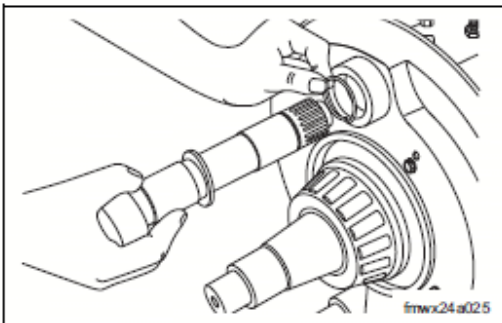
Caution:

Special tools shall be used.



12. Dismantle brake adjusting arm

- (a). Remove circlip and adjusting washer on the brake adjusting arm with circlip pliers.

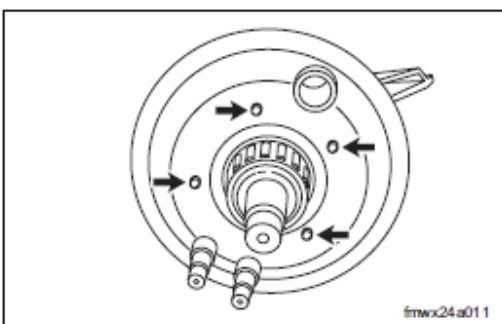


13. Dismantle brake camshaft

- (a). Draw out the brake camshaft from cam end, and remove O-ring and washer.

Caution:

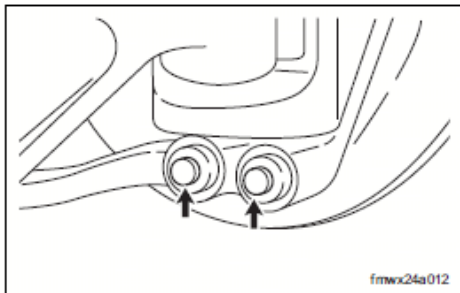
Check the O-ring, and replace it if damaged.



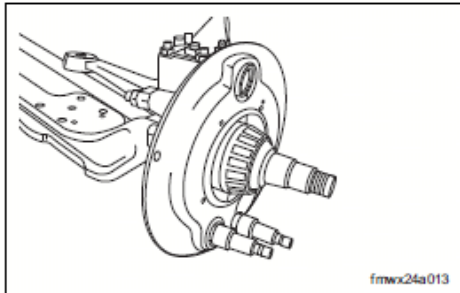
14. Dismantle brake dust cover

- (a). Dismantle fixing bolt of the brake dust cover.

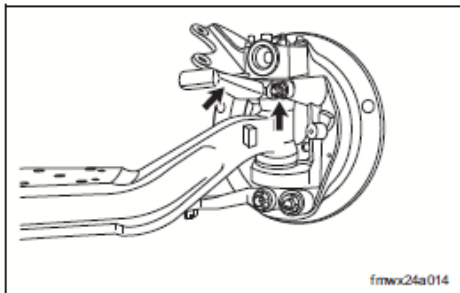




- (b). Dismantle fixing nut of the tie rod crank.

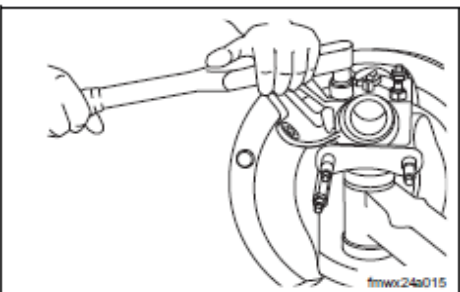


- (c). Knock the support pin shaft with a copper rod, and remove the support pin shaft and brake dust cover.



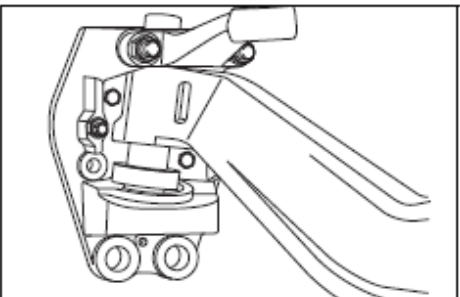
15. Dismantle steering drag link crank

- (a). Dismantle fixing bolt of the steering drag link crank.



16. Dismantle camshaft bracket

- (a). Dismantle fixing nut of the camshaft bracket.
(b). Remove the camshaft bracket together with upper sleeve of the king pin.



17. Dismantle knuckle

- (a). Hold up the lower end of the knuckle by hand, and draw it out to disconnect the lower end of the knuckle from the knuckle pin. Hold up the knuckle by hand to disconnect it from the knuckle pin, and remove the knuckle and thrust bearing.

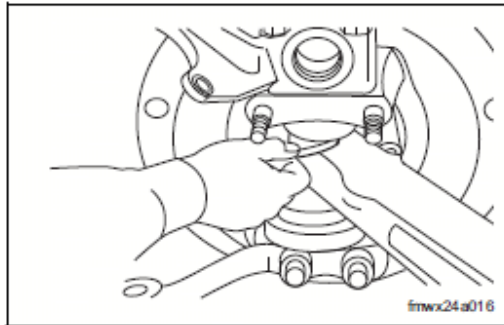
Front Axle (Ankai) - Front Axle Assembly

18. Check knuckle for crack, wear, sintering, etc., and replace it if any.**19. Install knuckle**

- (a). Sheath thrust roller bearing of the knuckle on the lower axle end of the king pin, and then push the knuckle upwards into the king pin. Install adjusting washer of the camshaft seat, and install the camshaft support in the upper end of the king pin.

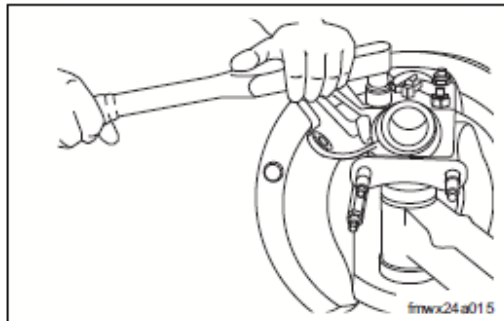
Caution:

The side of the thrust roller bearing having smaller hole size faces upward.



- (b). After installing fixing nut of the camshaft bracket, measure the axial clearance of the upper end of the king pin with a thickness gauge.

Clearance: 0.05~0.1 mm

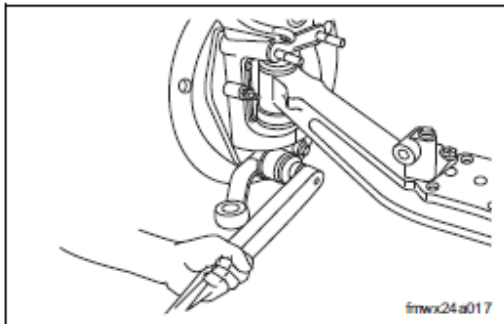


- (c). Tighten fixing nut of the camshaft bracket in accordance with the torque.

Torque: 140 N·m

Caution:

If the replacement of stud bolt is required, thread at the end from which the knuckle is put into needs to be spread with thread fastening glue.

20. Install brake dust cover and support pin shaft**21. Install tie rod crank**

Torque: 300 N·m

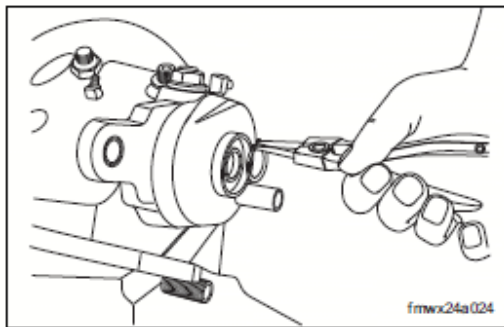
22. Install brake camshaft

- (a). Check the diameter of the camshaft and the size of the sleeve. Replacement shall be carried out if they do not meet the standard. The sleeves can be reamed with a reamer, and attention shall be paid to the concentricity of the two sleeves.

Caution:

The interchange of the left and right parts of the camshaft is not permitted, and lubricating grease shall be applied between two slide shaft diameters of the camshaft.



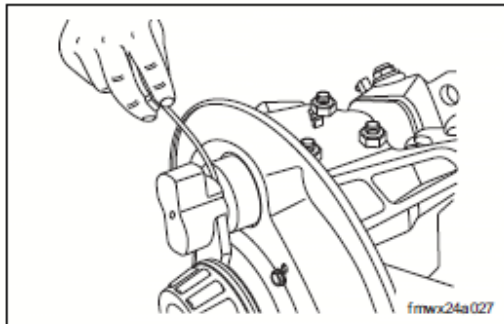


23. Install front brake adjusting arm

- (a). Install the axial adjusting gasket on the shaft, and then lock it up with a locating circlip.

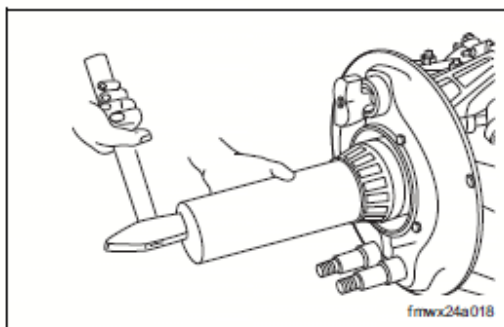
Caution:

Spline teeth at the end part of the camshaft shall be wholly put into the adjusting arm.



- (b). Measure the axial clearance of the camshaft with a thickness gauge. The thickness of the adjusting gasket shall be adjusted if it does not meet the standard.

Clearance: 0.1 mm



24. Install bearing in front wheel hub

- (a). Knock in the bearing inner ring with special tools.

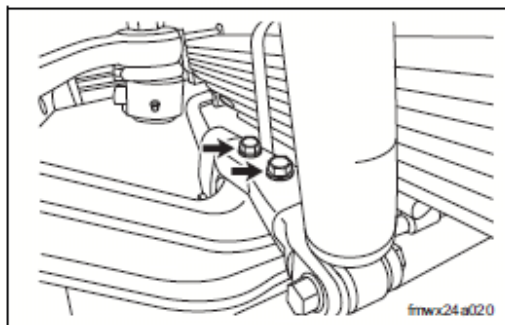
25. Install front brake shoe, refer to Chapter 26, Service Brake - Front Brake Shoe, Overhaul
26. Install front wheel hub, refer to Chapter 24, Front Axle - Front Wheel Hub, Overhaul
27. Install front brake drum, refer to Chapter 24, Front Axle - Front Wheel Hub, Overhaul
28. Adjust brake shoe clearance, refer to Chapter 26, Service Brake - Service Brake System, Testing & Adjustment
29. Install tie rod and drag link, and adjust toe-in. Refer to Chapter 24, Front Axle - Front Axle Assembly, Testing & Adjustment
30. Install ball locking nut of steering linkage and steering crank
Torque: 275~335 N•m
31. Install front brake chamber
32. Install ABS sensor
33. Install front wheels, refer to Chapter 23, Tire & Wheel - Front Tire & Wheel, Overhaul
34. Close cab
35. Lay down head of vehicle

Front Axle Overhaul

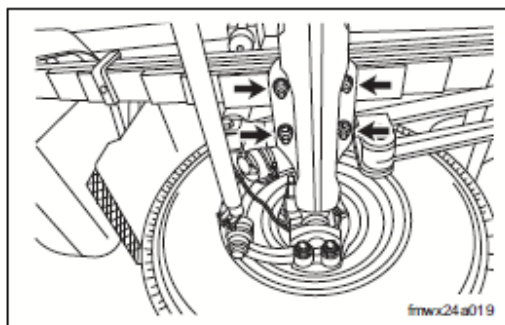
Hint:

Part Drawing, refer to Chapter 24, Front Axle A - Front Axle Assembly, Part Drawing.

1. **Jack up head of vehicle**
2. **Open cab**
3. **Dismantle front wheels, refer to Chapter 23, Tire & Wheel - Front Tire & Wheel, Overhaul**
4. **Dismantle front wheel hub, refer to Chapter 24, Front Axle - Front Wheel Hub, Overhaul**
5. **Dismantle knuckle, refer to Chapter 24, Front Axle - Knuckle, Overhaul**



6. **Dismantle front fixing bolt of front shock absorber support**
 - (a). Jack the front axle with a pneumatic hydraulic jack.
 - (b). Dismantle fixing bolt of the front shock absorber support.

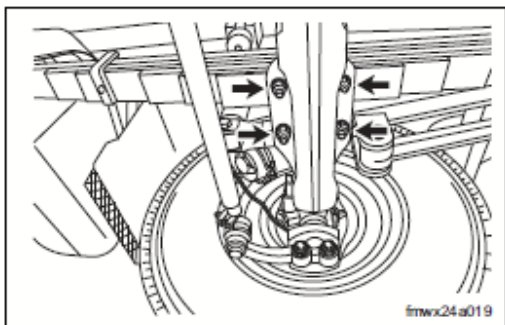


7. **Dismantle U-bolt of front leaf spring**
 - (a). Dismantle U-bolt of the front leaf spring.
 - (b). Lay down the pneumatic hydraulic jack, and draw out the front axle.

8. **Check front axle for crack, wear, bending, etc., and replace it if any.**

Caution:

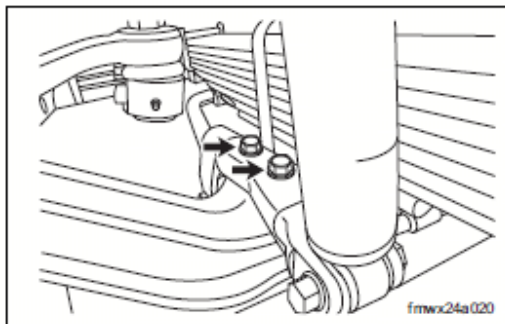
Since the king pin and H-beam hole of front axle form a tight fit, the king pin needs to be pressed downwards out by using a press.



9. **Install U-bolt of front leaf spring**
 - (a). Place the front axle under the head of vehicle, and jack the front axle by using a pneumatic hydraulic jack.
 - (b). Install U-bolt of the front leaf spring.

Torque: 260~300 N·m





- 10. Install fixing bolt of front shock absorber support**
Torque: 268 N•m

- 11. Install knuckle, refer to Chapter 24, Front Axle - Knuckle, Overhaul**
- 12. Install front wheel hub, refer to Chapter 24, Front Axle - Front Wheel Hub, Overhaul**
- 13. Install front wheels, refer to Chapter 23, Tire & Wheel - Front Tire & Wheel, Overhaul**
- 14. Close cab**
- 15. Lay down head of vehicle**

Rear Axle

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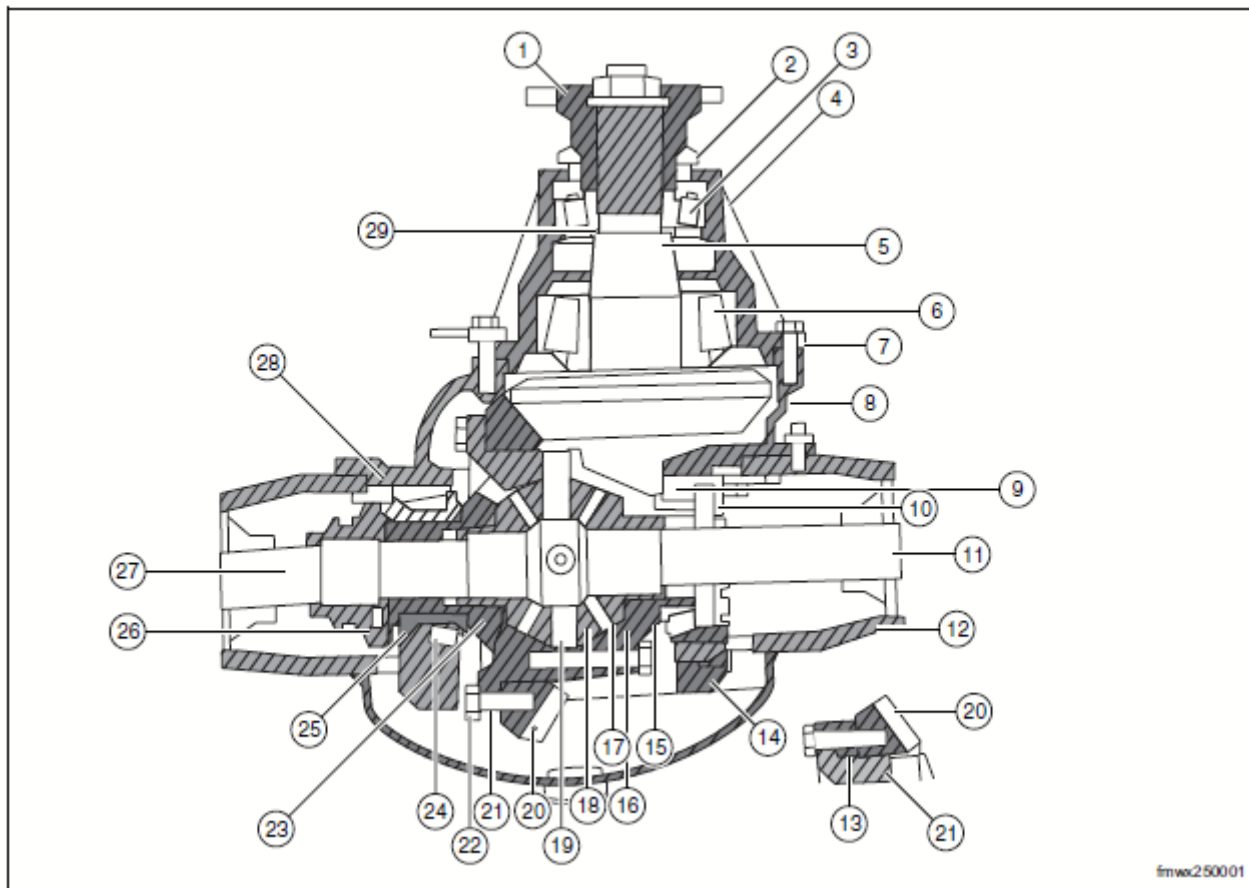
Rear Axle Assembly

General

The Kunlun heavy truck model adopts driving types of 4×2, 6×4 or 6×6. The driving rear axle is a common one with central single reduction plus wheel planet gear reduction. According to different service conditions, it is classified into a common version and an enhanced version which are the same in their structure and all other parts but different in the thickness of the axle housing. The thickness of the axle housing of the common type is 16 mm, while the thickness of the axle housing of the enhanced type is 20 mm. Generally, the axle housing of the enhanced type is used for an engineering truck for off-highway use.

The differential lock device is installed on the left axle shaft of the driving rear axle and the differential housing. The differential lock mesh sleeve is fixed on the differential housing with slotted nuts. The differential lock closing mesh sleeve is erected on the spline shaft of the left axle shaft. When the vehicle runs on a muddy road and wheels on one side slip, the control on the differential lock switch will introduce compressed air to the differential lock working cylinder through the electromagnetic valve, the piston push rod of the working cylinder will enable the mesh sleeves to be meshed with each other through the shift fork, so that the axle shafts and the differential housing are connected into a whole, in other words, the left and right axle shafts are integrated so as to smoothly drive the vehicle out of the muddy road. The driving rear axle adopts the wheel planet reduction mechanism to increase the speed ratio and reduce the size of the central main reducer, so that the ground clearance of the chassis is increased and the universality of the vehicle is improved. Power is sequentially transmitted to the driving flange 1 and driving gear shaft 5 through the drive shaft, and is then transmitted to the differential through the driven gear 20. The differential comprises the cross shaft 19, four planet gears 18, two axle shaft gears 17, 23 and two half differential housings 15, 21. The two half differential housings 15, 21 are connected into a whole by the connection bolt, and therefore, the cross shaft rotates simultaneously when the differential housing rotates, the planet gears revolve to simultaneously drive the left and right axle shaft gears 17, 23 to rotate, so that the left and right axle shafts transmit power to the left and right wheels at equal torque. When the vehicle makes a turn, the number of rotation turns of the steering inner wheels shall be less than that of the outer wheels, the planet gears revolve and rotate around the cross shaft as a result of the torque balance, so that the differential between the two axle shaft gears is generated, that is, the less turns the steering inner wheel rotate, the more turns the steering outer wheels synchronously rotate, thus realizing the differential effect to ensure the smoothness of the vehicle in the turning process. The driving rear axle is shown in the figure below.

Rear Axle- Rear Axle Assembly



1	Flange Assembly
2	Oil Seal
3	Driving Gear Outer Bearing
4	Driving Gear Bearing Seat
5	Driving Gear Shaft
6	Driving Gear Inner Bearing
7	Adjusting Gasket
8	Main Reducer Housing
9	Differential RH Bearing
10	Adjusting Nut of Differential RH Bearing
11	RH Axle Shaft
12	Axle Housing
13	Driven Gear Washer
14	Differential Bearing Cap
15	Differential RH Housing

16	Thrust Gasket of RH Axle Shaft Gear
17	RH Axle Shaft Gear
18	Planet Gear & Spherical Washer
19	Cross Shaft
20	Driven Gear
21	Differential LH Housing
22	Thrust Gasket of LH Axle Shaft Gear
23	LH Axle Shaft
24	Differential LH Bearing
25	Differential Mesh Sleeve
26	Differential Mesh Sleeve
27	LH Axle Shaft
28	Adjusting Nut of Differential LH Bearing
29	Adjusting Washer



Precautions

1. Prior to maintenance, be familiar with the system structure principle as well as the overhaul process specification on system maintenance to improve maintenance efficiency and accuracy of fault judgment; during lifting of the vehicle, pay attention to the support position of the vehicle, and avoid damage of vehicle parts and occurrence of safety accidents; inspect, dismantle and install the parts with special requirements by using special tools provided by the manufacturer.
2. During the disassembly and assembly of the differential, it shall be noted that: the differential bearing cap and bearing seat are machined in a mating way, so if there are no mating marks on the bearing cap and bearing seat, mating marks shall be printed prior to the dismantlement so as to avoid making mistakes in the reassembling process, (although the bearing cap and bearing seat are provided with pins, attention shall still be paid to the printing of mating marks). Generally, in order to ensure the well-adjusted bearing fit clearance, it is better to make mating marks on the planet gear and cross shaft in the disassembling process of the planet cross shaft, so that they can keep the original well-adjusted fit during the reassembly.
3. The rear axle main reducer and wheel reducers use gear oil of AP1GL-5 grade and SAE85W/90 viscosity; generally, the oil capacity of the main reducer is 6 L, and the oil capacity of each wheel reductor is 2 L or so; the drain interval of the driving rear axle gear oil is 40000 Km, and the gear oil shall be replaced during the forced maintenance for the first 2000~4000 Km. The oil level of wheel reductor preferably reaches such as a normal position that it can be touched by extending fingers straight into the threaded hole after opening the oil filler bolt when the filler hole is in the highest position.
4. Prior to the use of a new axle, the rear axle fills sulfur-phosphorous type, AP1 GL-5 grade, 85W/90 viscosity heavy-load gear oil of about 12 L into the main reducer from the rear cover oil filler hole; the intermediate axle fills gear oil of about 4 L into the intermediate axle main reducer from the gap bridge box cover oil filler hole, and then fills gear oil of 12 L into the main reducer from the rear cover oil filler hole; each wheel reductor is filled with gear oil of 3.5 L from each wheel oil filler hole. Caution: pipe thread sealant shall be spread prior to tightening of the oil filler/drain plug. Oil shall be so filled that the oil level can overflow; sufficient Lithium Grease No.2 shall be filled into each butter nozzle, so that each member can be well lubricated.
5. Regular inspection shall be carried out on the oil filler and oil drain plug of the intermediate axle and rear axle, the sealing gasket shall be tightened or replaced in time if oil leakage is detected, and the copper gasket for the oil filler and oil drain plug must be replaced after oil changing/filling twice, otherwise oil leakage may occur due to its deformation; dirt and dust on the air plug of axle housing shall be regularly inspected and cleaned to prevent oil leakage caused by the increase of oil pressure inside the axle as a result of blockage.
6. For every 2000 Km, fill Lithium Grease No.2 into each butter nozzle and clean air plug; check the axle housing inner gear for oil level (by opening the oil level plug).
7. During the maintenance of axle assembly with differential lock, the axle shaft with differential lock must be removed with the differential lock closed when it needs to be removed, otherwise the mesh sleeve will fall off accordingly, and the main reducer assembly has to be dismantled.
8. Use of differential lock: the vehicle must be at a speed of 10~15 km/h, the differential lock can not be closed until the clutch is released, then the indicator lamp is on, and meanwhile, the vehicle can run straight only. When the differential lock is used, it is forbidden to turn the vehicle by using the steering wheel, otherwise the differential gear will be broken; after the use of vehicle differential lock, the differential lock shall be removed immediately after the vehicle goes out of the fault road surface, otherwise serious accidents of severe tire wear and differential breaking will be resulted in.

Fault Symptom Table

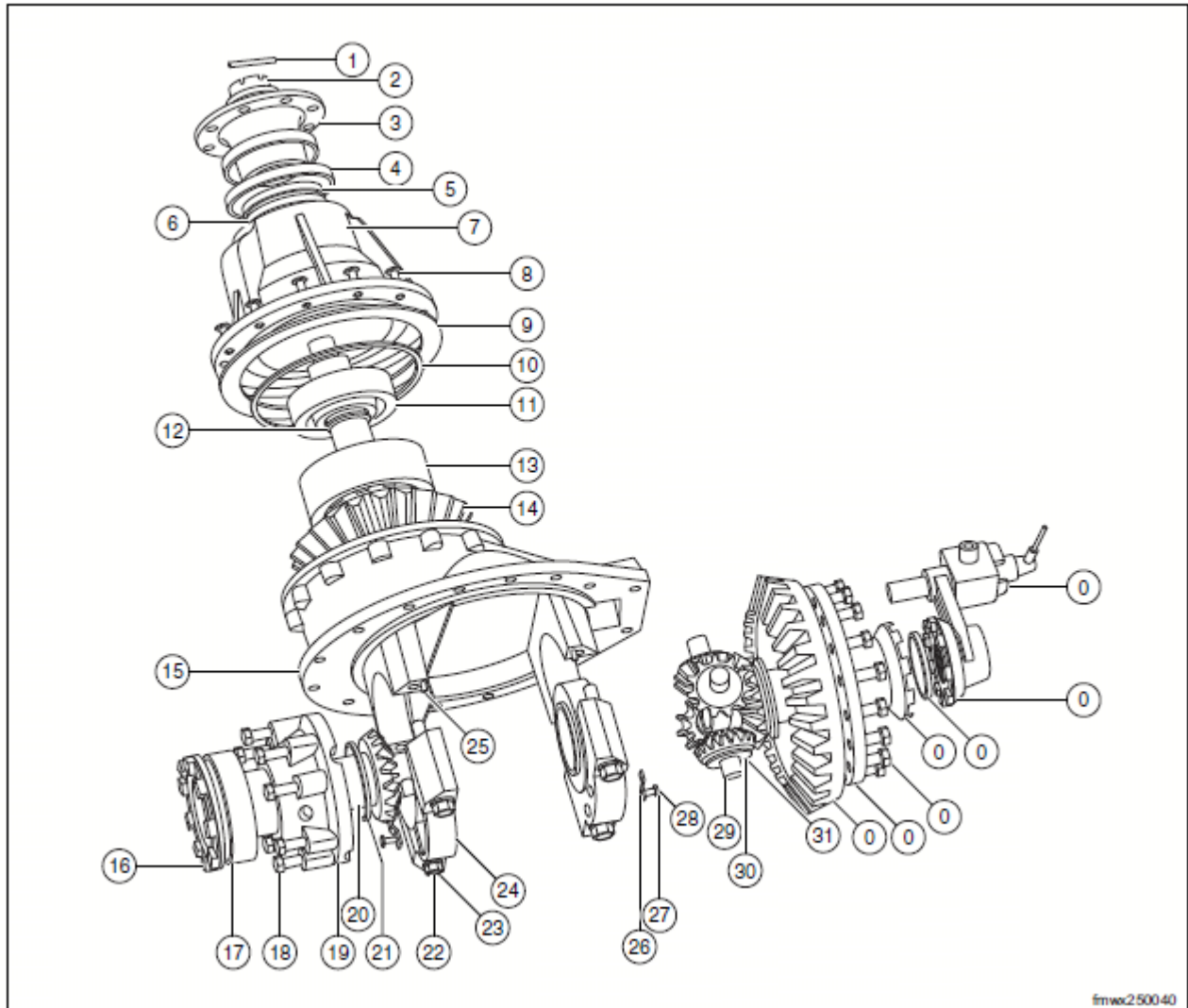
Use the table below to help you find the cause of the fault. Sequence number indicates the priority of possible causes of the fault. Check each part in order. If necessary, replace these parts.

Symptom	Possible Position	Reference
Oil leakage	1. Input shaft of central reducer	Chapter 25, Rear Axle - Driving Gear and Bearing, Overhaul
	2. O-ring between Hub and Planet Carrier Axle End	Chapter 25, Rear Axle - Axle Shaft, Overhaul
	3. O-ring between Hub Oil Seal Seat and Axle Housing Shaft Pipe	Chapter 25, Rear Axle - Hub Bearing and Oil Seal, Overhaul
	4. Hub Oil Seal	Chapter 25, Rear Axle - Hub Bearing and Oil Seal, Overhaul
Heating of Hub	1. Hub Bearing (Pretightening force is too strong)	Chapter 25, Rear Axle - Hub Bearing and Oil Seal, Overhaul
Overheating of Brake Drum	1. Brake Mechanical	Chapter 25, Rear Axle - Hub Bearing and Oil Seal, Overhaul
	2. Brake Control Air Circuit System	Chapter 26, Service Brake - Rear Brake Chamber, Overhaul
Abnormal Noises of Central Drive	1. Driving Shaft Bearing	Chapter 25, Rear Axle - Driving Gear and Bearing, Overhaul
	2. Differential Bearing	Chapter 25, Rear Axle - Differential Housing, Driven Gear and Planet Gear Assembly, Overhaul
	3. Drive Gear	Chapter 25, Rear Axle - Differential Housing, Driven Gear and Planet Gear Assembly, Overhaul
	4. Axle Housing (Deformed)	Chapter 25, Rear Axle - Rear Axle Assembly and Rear Axle Housing, Overhaul
Tires are worn by rear wheels	1. Tire Rim (Deformed)	Chapter 23, Tire & Wheel - Rear tires and Wheels, Overhaul
	2. Hub Bearing (Loosened)	Chapter 25, Rear Axle - Hub Bearing and Oil Seal, Overhaul
	3. Rear Axle (Displaced)	Chapter 25, Rear Axle - Rear Axle Assembly and Axle Housing, Overhaul



Rear Axle- Rear Axle Assembly

Part Drawing



25

1	Cotter Pin
2	Flange Nut
3	Flange Assembly
4	Oil Seal Plug
5	Shaft O-Ring
6	Shaft O-Ring
7	Main Reducer Bearing Seat
8	Hex Head Bolt
9	Adjusting Gasket
10	Adjusting Gasket
11	Tapered Needle Bearing
12	Adjusting Gasket

21	Axle Shaft Gear Gasket
22	Stud Bolt
23	Hex nut
24	Bearing Cap
25	Cylindrical Pin
26	Locking Plate
27	Hex Head Bolt
28	Spring Washer
29	Cross Shaft
30	Planet Gear
31	Planet Gear Gasket
32	Driven Bevel Gear



FOTON

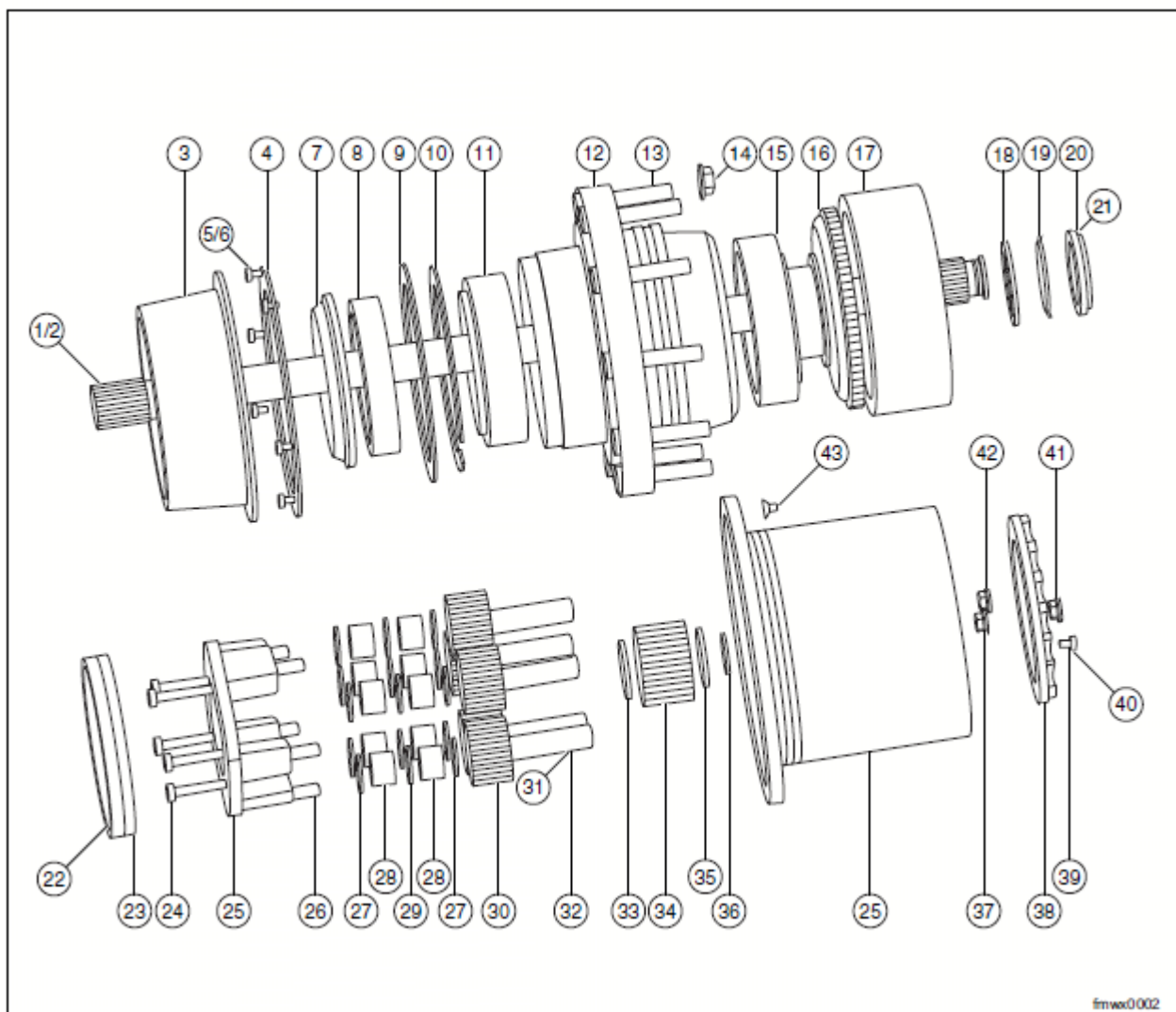
Rear Axle- Rear Axle Assembly

13	Tapered Needle Bearing
14	Driving Bevel Gear
15	Main Reducer Housing
16	Adjusting Nut
17	Tapered Roller Bearing
18	Hex Head Bolt
19	Differential Housing
20	Axle Shaft Gear

33	Differential Housing
34	Hex Head Bolt
35	Spring Gasket
36	Fixing Mesh Sleeve
37	Locking Gasket
38	Round Nut
39	Differential Lock Assembly



Rear Axle- Rear Axle Assembly



1	Axle Shaft (LH)
2	Axle Shaft (RH)
3	Oil Baffle Cover
4	Sealing Gasket
5	Hex Head Bolt
6	Spring Washer
7	Spacer Ring
8	Shaft O-Ring
9	Sealing Gasket
10	Circlip
11	Tapered Roller Bearing
12	RR Wheel Hub
13	Wheel Bolt

23	Planet Carrier Oil Baffle Disc
24	Hex Head Bolt
25	Planet Carrier Assembly
26	Cylindrical Pin
27	Washer
28	Needle Bearing
29	Washer
30	Planet Gear (Z-16)
31	Planet Gear Shaft
32	Steel Ball-8.0-GB308
33	Sun Gear Washer
34	Sun Gear
35	Washer

Rear Axle- Rear Axle Assembly

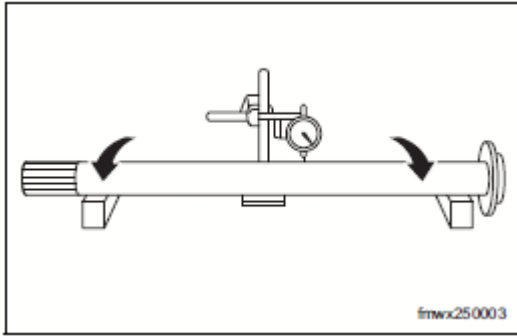
14	Wheel Nut
15	Tapered Roller Bearing
16	Ring Gear Bracket
17	Inner Ring Gear (Z-57)
18	Locking Nut
19	Axle End Locking Plate
20	Locking Nut
21	Adjusting Gasket
22	Oil Seal

36	Circlip for Shaft
37	End Cap Lifting Pin
38	End Cap
39	Hex Head Bolt (Full Thread)
40	Spring Washer
41	Oil Drain/Filler Plug
42	Oil Drain/Filler Plug
43	Cross Recessed Pan Head Screw



Testing & Adjustment

1. Check axle shaft



- (a). Measure radial runout in the middle of the axle shaft as well as runout of the inner end face of the flange with V-stage and dial indicator.

Radial runout: $\leq 1.0 \text{ mm}$

End-face runout: $\leq 0.15 \text{ mm}$

Caution:

If the radial runout and end-face runout exceed the limit values, correction shall be carried out, and the axle shaft may be replaced with a new one as required.

- (b). Check the axle shaft for crack by magnaflux.
(c). Check the spline at the axle shaft end for severe wear and obvious distortion and crack.

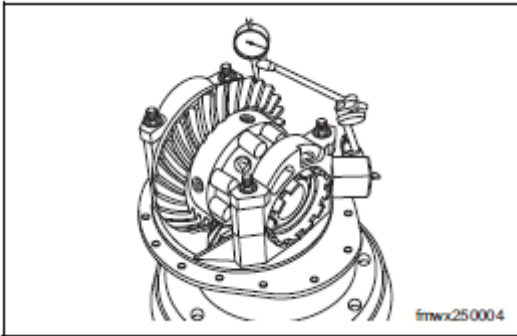
Wear of tooth thickness: $\leq 0.2 \text{ mm}$

Skew of tooth form: $\leq 1 \text{ mm}$

Caution:

If the tooth thickness wear of spline and the skew of tooth form exceed the limit values, the axle shaft shall be replaced with a new one.

2. Adjust clearance between mesh surfaces of driving gear and driven gear



- (a). Make the pointer of dial indicator perpendicular to the tooth face of the driven gear, fix the driving gear to disable its rotation, and gently rotate the driven gear. The swing range of the pointer is the flank clearance between the driving and driven gears.

Clearance: $0.2\sim0.4 \text{ mm}$

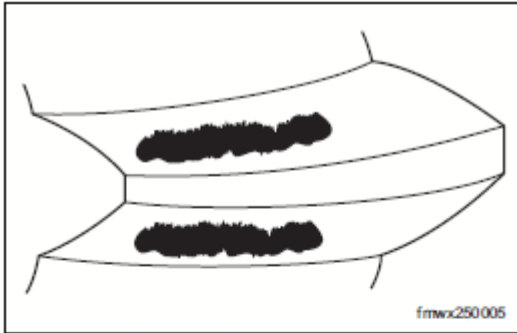
- (b). If the clearance is larger than the standard value, adjust the adjusting nuts to move the driven gear closer to the driving gear; if the clearance is smaller than the standard value, adjust the adjusting nuts to move the driven gear away from the driving gear. During the adjustment, the adjusting nuts at both ends shall be equally screwed in or out to keep the bearing pretightening force unchanged, at the same time, the slots of the adjusting nuts shall be aligned to M8 thread holes in the bearing cap to enable the locking plate to lock up the adjusting nuts.

Caution:

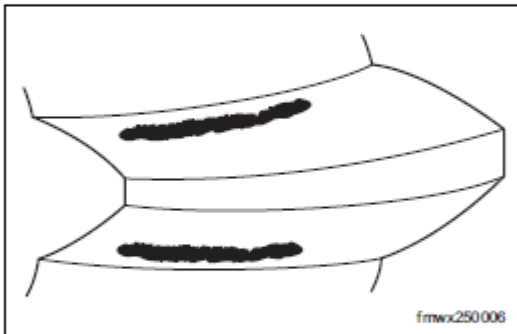
Three positions shall be selected for measurement, and three points shall be measured for each position.

3. Adjust meshing marks of driving and driven gears

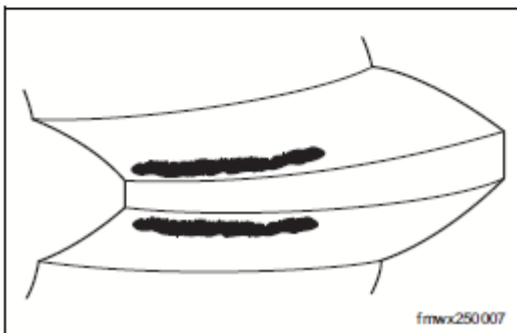
Evenly coat the driven gear with red lead powder in 2~3 positions with front and back sides of 2~3 teeth coated for each position, rotate the flange forward and backwards until contact marks are shown, and observe the contact marks of the driving and driven gears. The meshing marks of the driving and driven gears shall meet the following requirements: marks at front and back sides shall be more than 60% in both tooth length and tooth height directions, and the tooth length direction is positioned at the smaller end in the middle, while the tooth height direction is positioned in the middle. If the contact marks do not meet the requirements, adjust the adjusting gasket to satisfy its requirements. Increase the thickness of the bearing seat adjusting gasket if the marks are closer to the tooth bottom; decrease the thickness of the bearing seat adjusting gasket if the marks are closer to the small tooth top.



- (a). Correct the meshing marks.

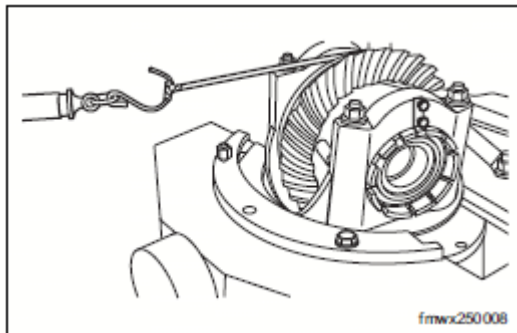


- (b). If the meshing marks are closer to the tooth top, the thickness X of adjusting gasket between the driving gear housing and the main reducer housing needs to be decreased.



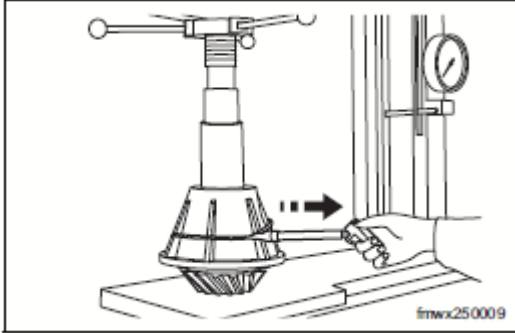
- (c). If the meshing marks are closer to the tooth root, the thickness X of adjusting gasket between the driving gear housing and the main reducer housing needs to be increased.

4. Inspect and adjust pretightening force of differential bearing



- (a). Install the differential assembly into the differential housing, sheathe the bearing cap on the bearing bolt in accordance with mating marks, and screw up connecting nuts. Torque: $235 \pm 20 \text{ N}\cdot\text{m}$.
- (b). Screw in the adjusting nuts into thread holes at both ends of the main reducer housing. Tie one end of a rope to the driven gear bolt, wind the rope around the differential for 1~2 turns, and measure the pretightening force of the differential bearing by hooking a dynamometer at the other end of the rope.
Pretightening force: $29 \pm 13 \text{ N}$.
- (c). If the measured value goes beyond the specified range, the adjusting nuts at both ends need to be adjusted to meeting the requirements. If the pretightening force is too big, the adjusting nuts at both ends shall be screwed out properly; if the pretightening force is too small, the adjusting nuts at both ends shall be screwed in properly.



5. Inspect and adjust pretightening force of driving gear bearing

- (a). Install the bearing sleeve with the bearing outer ring on the driving gear, put in the adjusting gasket and the tapered roller bearing, and knock the tapered roller bearing in place. Apply a pressure of 10~20 Mpa to the bearing.
- (b). Fix one end of a rope to the bearing seat by using the bolt, wind the rope around the outermost circle of the bearing seat for a turn, and measure the pretightening force of the main gear bearing by hooking a dynamometer at the other end of the rope.

Pretightening force: 15 ± 5 N

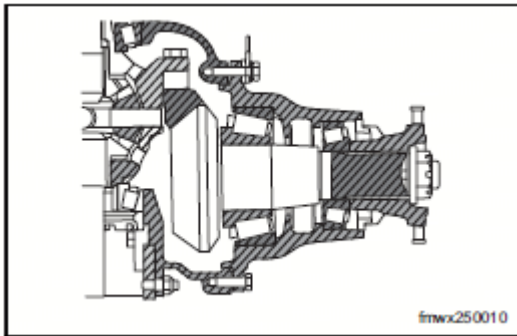
- (c). If the measured value goes beyond the specified range, the adjusting gasket shall be replaced to meet the requirements. If the pretightening force is too big, the thickness of the adjusting gasket shall be increased; if the pretightening force is too small, the thickness of the adjusting gasket shall be decreased. The standard thickness of the washer is 2.0, 2.05, 2.1, 2.15, 2.3, 2.35, 2.45, 2.5, 2.55, 3.0, 3.1, 3.3 and 3.4 mm.

6. Inspect and adjust gasket between driving gear bearing seat and main reducer housing

Hint:

The thickness X of the adjusting gasket between the driving gear housing and the main reducer can be calculated by the formula below:

$$X = (A \pm Z) + B - (L \pm Y)$$



Wherein, A -- theoretical value (mm) of distance from tooth-top end face of the driving gear to axis of the driven gear.

B -- Measured value (mm) of distance from end face of the driving gear to connecting face of the driving gear housing (measured with the adjusting gasket not installed).

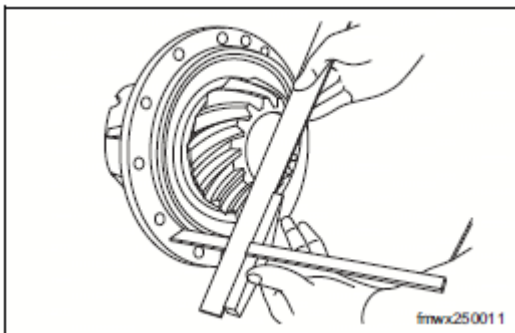
L -- Theoretical value of distance from connecting end face of the main reducer housing to central line of the driven gear.

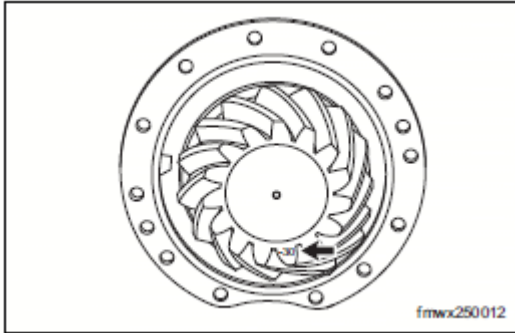
Z -- Actual deviation value (mm) of value A (printed on end face of the driving gear).

Y -- actual deviation value (mm) of value L (printed on connecting end face of the main reducer housing). For current Steyr series auman heavy trucks, the overall gear ratio $i = 4.38$

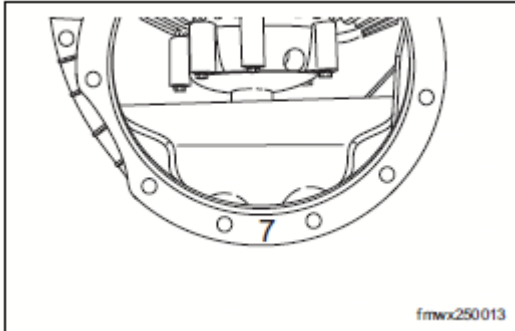
Wherein, $A = 102$ mm, $L = 170$ mm

- (a). With the adjusting gasket X not installed, actually measured $B = 70.2$ mm.





- (b). Observe value Z (1/100 mm) printed on end face of the driving gear. For example, if the print value on the end face is -30, $Z = -0.3$ mm.



- (c). Observe value Y (1/100 mm) printed on connecting end face of the main reducer housing. For example, if the print value on the end face is -7, $Y = -0.07$ mm.

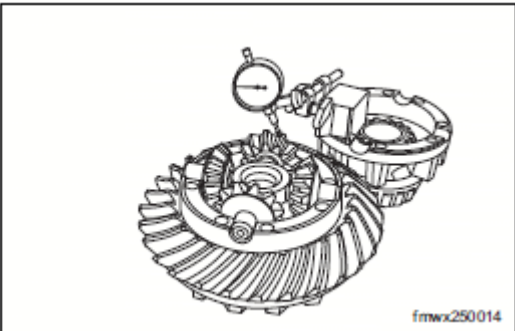
In accordance with the formula, the actual value of the gasket thickness:

$$X = (A \pm Z) + B - (L \pm Y) = (102 - 0.3) + 70.2 - (170 - 0.07) = 1.97 \text{ mm}$$

Hint:

The standard thickness of the adjusting gasket is 0.1, 0.15, 0.4 and 1.0 mm. Here, one 1.0 mm gasket, two 0.4 mm gaskets and one 0.15 mm gasket are selected for combination. During the dismantlement of an old main reducer, the original adjusting gasket shall be well kept for reassembly use.

7. Adjust clearance between differential sun gear and planet gear:

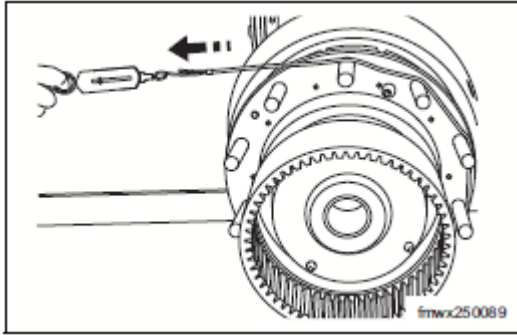


- (a). Respectively place cross shaft assemblies on left and right differential housings, and measure the clearance between the axle shaft gear and the planet gear. Clearance: 0.18~0.5 mm.
- (b). If the clearance is too big, replace with a thicker axle shaft gear gasket; if the clearance is too small, replace with a thinner axle shaft gear gasket. The adjustment shall not be finished until the clearance measured meets the requirements.

Hint:

The standard thickness of thrust gasket of the axle shaft gear is 4.9, 5.0, 5.1, 5.2 and 5.3 mm for selection, and clearance measurement shall be carried out on three points.

8. Adjust pretightening force of wheel bearing



- (a). Wind a rope around the hub bolt for several turns, connect a dynamometer to one end of the rope, and pull the dynamometer in the tangential direction of the wheel bolt circle to smoothly rotate the hub. Then, reading of dynamometer reflects pretightening conditions of the bearing.

Pretightening force: 4~5 kg

- (b). Adjust the axle end nut in accordance with the pretightening force. Unscrew the nut if the pretightening force is too big; screw up the nut to the standard value if the pretightening force is too small.

9. Clean and check parts

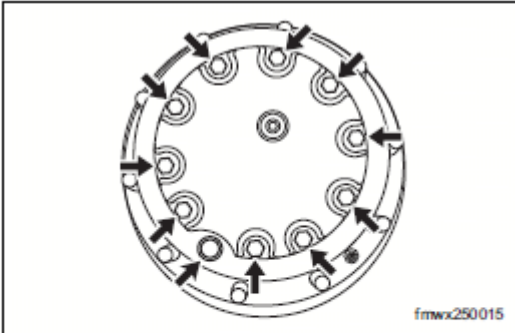
- (a). Parts may be stained with greasy dirt and mud. Cleaning of parts is an essential process. There are some common cleaning methods, such as steam cleaning, petrol cleaning, acid or alkali solution cleaning, neutral agent cleaning, trichloroethylene cleaning and magnetic cleaning. Some damaged parts may be detected in the cleaning process. Thus, care must be taken in the cleaning process.
- (b). After cleaning of parts, use a specially prepared survey meter or tool to carry out inspection. Judge whether parts are suitable for use in accordance with the specified maintenance standard. Damaged parts shall be repaired or replaced as required. If one of mating parts is seriously worn and its fit-up gap is beyond the specified value, the parts or mating parts can be replaced as required.
- (c). In view of preventive maintenance, some parts within the repair or wear limit range shall be replaced before they go beyond the limit range.
- (d). All the parts shall be carefully checked by visual observation or infra-red inspection. If any defect below is detected by visual observation, the part can be repaired or replaced as required.
- (e). For rubber parts, such as O-rings, oil seals, sealing washers, etc., when they are dismantled, judge whether to disuse them according to circumstances.

Axle shaft Overhaul

Hint:

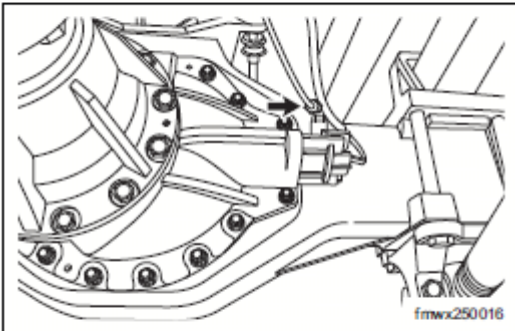
Part Drawing, refer to Chapter 25, Rear Axle - Rear Axle Assembly, Part Drawing.

1. **Lift vehicle, refer to Chapter 01, Introduction - Maintenance Guide, Vehicle Support Position**
2. **Dismantle tires, refer to Chapter 23, Tire & Wheel - Rear Tire & Wheel, Overhaul**

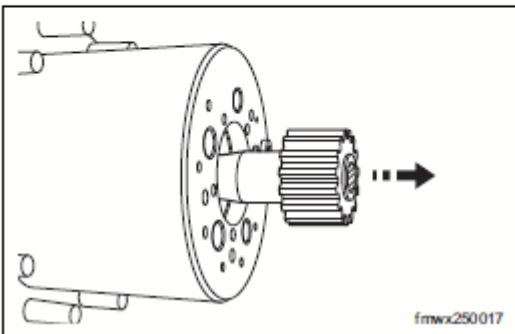


3. Dismantle axle shaft assembly

- (a). Loosen the wheel oil drain bolts at both sides.
 - Drain wheel gear oil to a container.
- (b). Loosen connecting bolt of the wheel reductor end cover.
 - Remove the wheel reductor end cover.



- (c). Enable the differential lock.
 - Ensure that the differential lock has already been closed.



- (d). Draw out the axle shaft assembly without differential lock.
- (e). Draw out the axle shaft assembly with differential lock.

Caution:

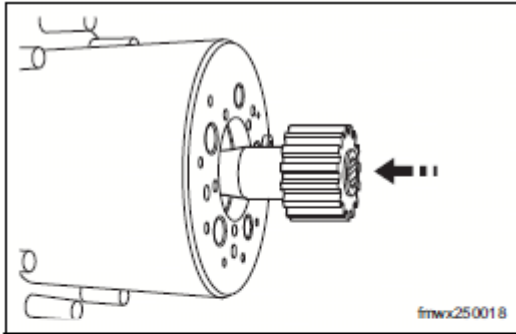
Prior to drawing out of the axle shaft with differential lock, the differential lock must be closed in advance, otherwise the differential lock mesh sleeve will fall into the differential housing, and the main reducer will fail to be disassembled in serious conditions.

4. Check axle shaft assembly

- Check the axle shaft for deformation.
- Check the spline tooth for breaking.
- Check the sun gear for wear and breaking.

Caution:

If any defect is detected, replace them with new ones.

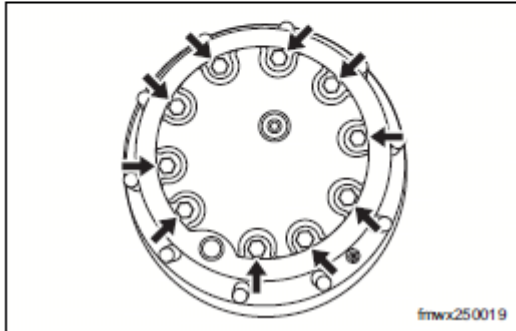


5. Install axle shaft assembly

- (a). Put the axle shaft into the axle housing.

Caution:

When the axle shaft is put in, take care not to damage the axle shaft oil seal, insert the left and right axle shafts into axle shaft gear spline holes in a rotating mode, and pay attention to the normal meshing of the sun gear and the planet gear.



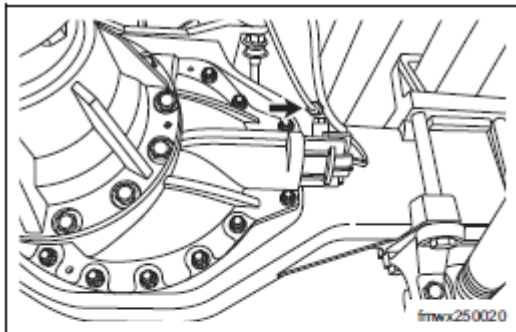
- (b). Fix the wheel reductor end cover onto the wheel reductor end cover.

- Screw up the connecting bolt.

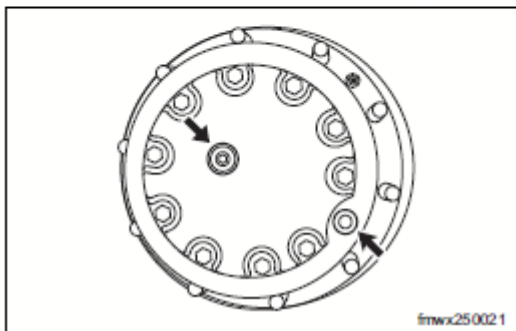
Torque: $60 \pm 15 \text{ N}\cdot\text{m}$

Caution:

Prior to sealant spreading, clean contact surface of the wheel reductor end cover and contact surface of the wheel reductor; the flange sealant must be continuous and uniform.



- (c). Cancel the work of the differential lock.



- (d). Fill the gear oil.

- Tighten the oil drain bolt.
- Tighten the oil filler bolt.

Torque: $100 \pm 20 \text{ N}\cdot\text{m}$

Caution:

The normal position for oil capacity of wheel reductor shall be the highest position of the oil filler plug, and the oil filler plug is preferably in such a position that the oil level can be touched by extending fingers straight into the threaded hole; the wheel reducers use gear oil of AP1GL-5 grade and SAE85W/90 viscosity, and the oil capacity of each wheel reductor is 2 L or so.

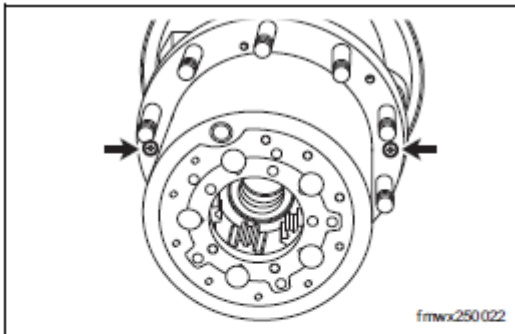
6. Install tires, refer to Chapter 23, Tire & Wheel - Rear Tire & Wheel, Overhaul
7. Let down vehicle, refer to Chapter 01, Introduction - Maintenance Guide, Vehicle Support Position

Wheel Hub Bearing and Oil Seal Overhaul

Hint:

Part Drawing, refer to Chapter 25, Rear Axle - Rear Axle Assembly, Part Drawing.

1. **Lift the vehicle**
2. **Dismantle the tires**
3. **Dismantle the axle shaft assembly. Refer to Chapter 25, Rear Axle - Axle Shaft, Overhaul**
4. **Dismantle the brake drum and brake shoe. Refer to Chapter 26, Service Brake - Rear Brake Shoe, Overhaul**

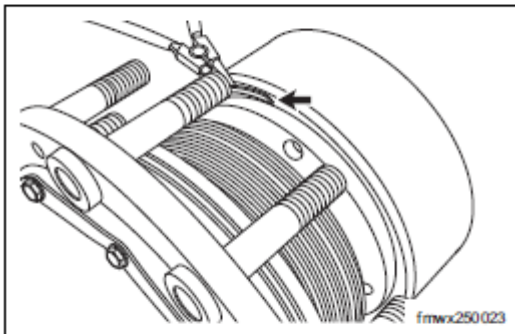


5. **Dismantle the wheel reductor assembly**

- (a). Dismantle the wheel reductor locating bolts.
- (b). Diagonally push the wheel reductor assembly out with two M10 stay bolts.

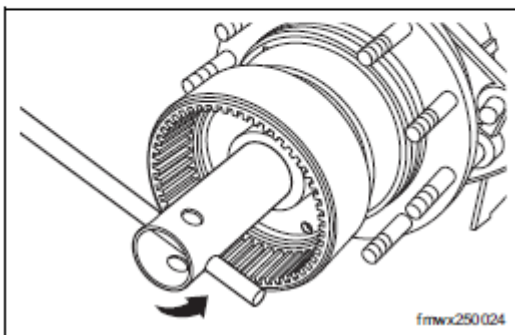
Caution:

Tighten the two bolts by turns, so that the two wheel parts are stressed evenly and symmetrically.



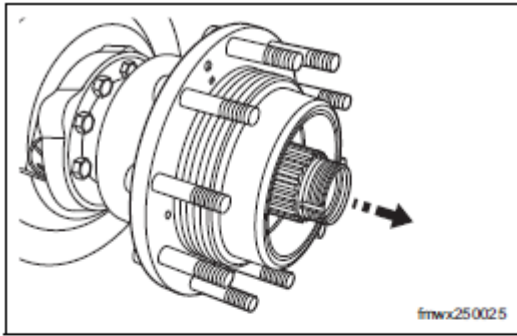
6. **Dismantle the hub assembly**

- (a). Dismantle the snap ring on the ring gear.

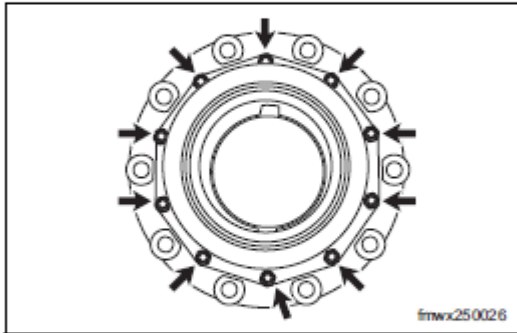


- (b). Flatten the locking plate, and dismantle the axle end slotted nuts with an axle end slotted nut wrench.
- (c). Remove the ring gear and ring gear shaft sleeve from the axle pipe.

Rear Axle- Rear Axle Assembly

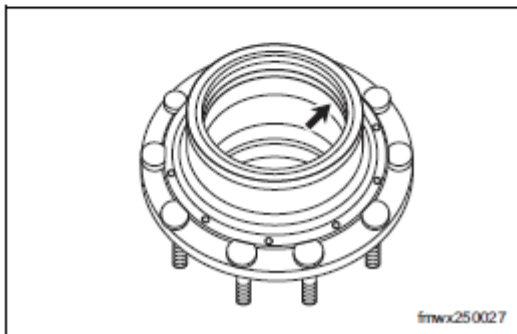


- (d). Take down the hub assembly together with the axle pipe shaft.



7. Dismantle the hub oil seal

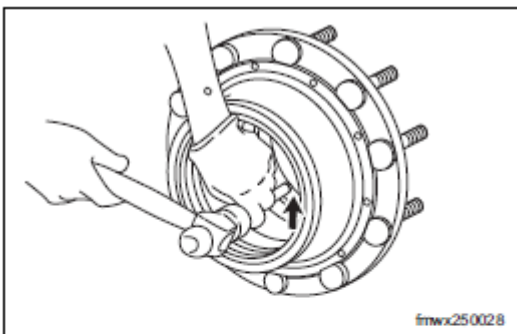
- (a). Dismantle the connecting bolts of the hub oil baffle cover.
- Take down the oil baffle cover.



- (b). Take out the hub oil seal.

Caution:

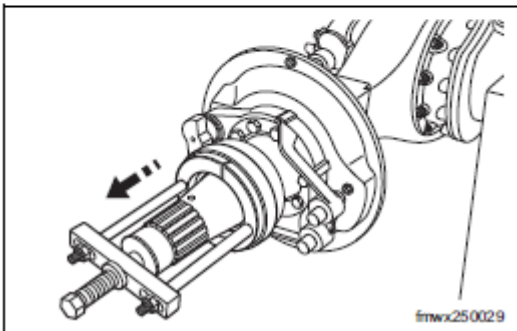
The oil seal, which is a wearing part, shall be replaced after dismantling, otherwise, that may result in oil leakage. Do not damage the hub inner ring while dismantling the oil seal.



- (c). Knock out the bearing outer ring with a thin copper rod.

Caution:

Do not damage the hub inner ring while knocking the bearing outer ring.

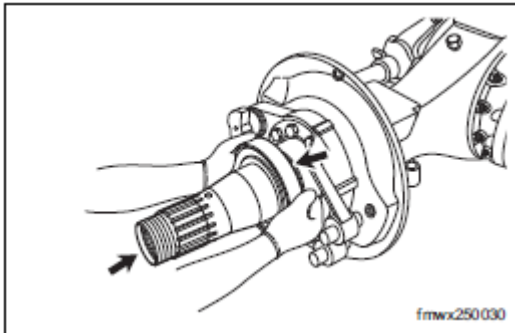


8. Dismantle the hub bearing

- (a). Pull the hub inner bearing out of the axle pipe with a bearing puller.

Caution:

The bearing forms an interference fit. It is suggested to pull out the inner bearing with the puller after heating to 80-100°C.



- (b). Take the axle shaft oil seal out of the axle pipe.
- (c). Take down the spacer ring.

Caution:

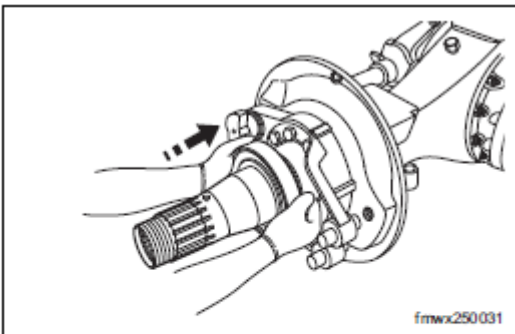
Do not scratch the outer side and inner side of the shaft pipe while dismantling the spacer ring and axle shaft oil seal.

9. Overhaul the hub assembly and wheel reductor assembly parts

- Check the snap ring for deformation;
- Check the hub seal ring for damage and aging;
- Check the wheel reductor for blister/crack;
- Check the planet carrier for damage; check the inner ring gear for rupture/wear;
- Check the sun gear and planet gear for rupture/wear, and check the planet gear shaft and needle bearing for damage.

Caution:

If damaged, a new part must be replaced.

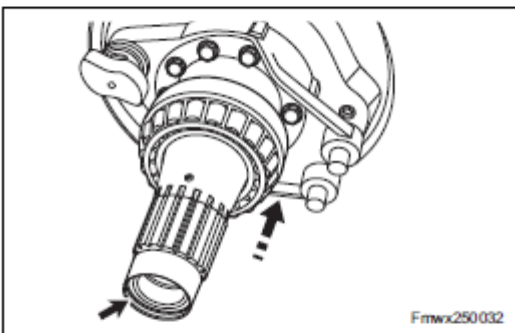


10. Install the hub bearing

- (a). Install the spacer ring on the axle pipe shaft.

Caution:

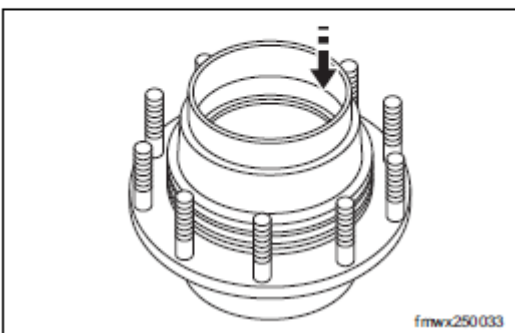
Make sure that the spacer ring closely abuts against the axle housing axle end.



- (b). Heat the bearing inner race to 80-100°C, and install the inner bearing to proper position with a press mold.
- (c). Install the axle shaft oil seal into the axle pipe.

Caution:

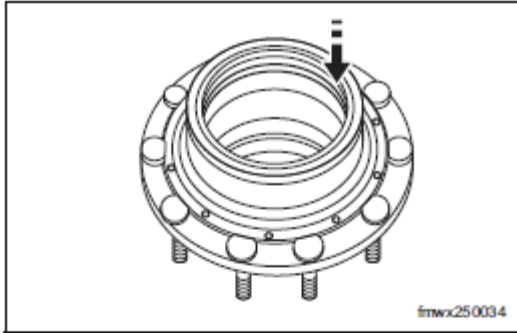
Make sure that there is no axial clearance to the oil seal spacer ring.



- (d). Install the bearing outer ring.
 - Smoothly press the bearing outer ring into the hub with a press mold.

Caution:

It is prohibited to knock the surface of the bearing outer ring. If replacing the hub bearing, smoothly press the across corners of the new bearing outer ring into the two ends of the hub with a dedicated presser.

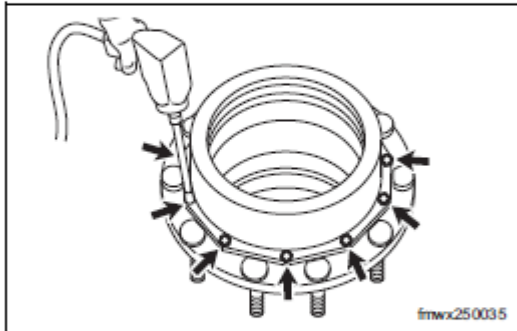


11. Install the hub oil seal

- (a). Press in the hub oil seal.

Caution:

Smoothly press the oil seal into the hub with a dedicated presser. It is not allowed to knock the surface of the oil seal. If replacing the hub bearing, press the new bearing outer ring into the two ends of the hub with a special presser, and orderly press the hub oil seals into the hub. If replacing the ABS ring gear, check the run-out quantity of the end face of ring gear shall not be greater than 0.15mm after pressing it into the ring gear.



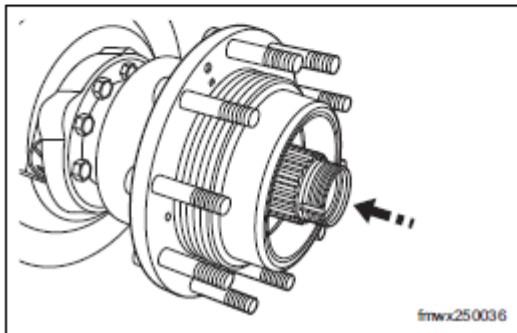
- (b). Install the oil baffle cover.

- Tighten the bolts.

Torque: 25 N•m

Caution:

The bolts shall be tightened diagonally. Do not use an impact wrench.



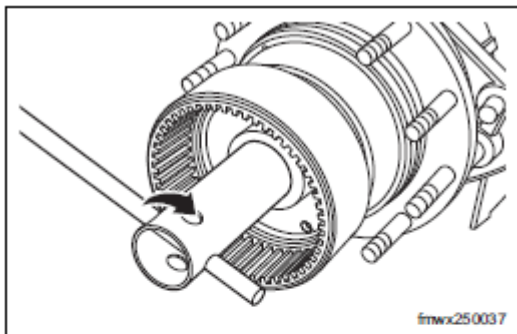
12. Install the hub assembly

- (a). Push the hub assembly into the axle end.

- Install the new seal ring in the hub.

Caution:

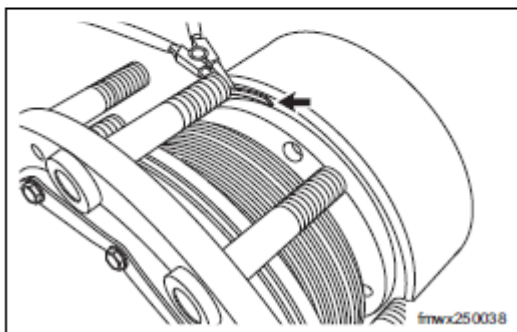
Take care not to damage the hub oil seal when pushing the hub in.



- (b). Install the ring gear assembly.

Caution:

Take care not to damage the bearing when installing the ring gear.

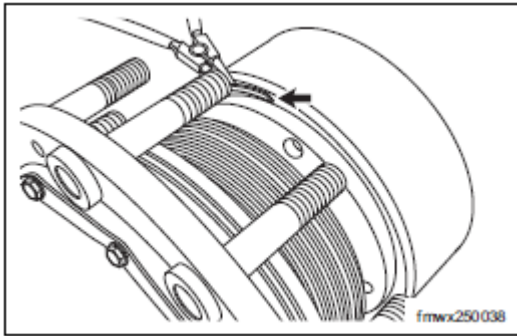


- (c). Orderly install the slotted nut, locking plate and slotted nut.

- Tighten the slotted nuts with an axle end slotted nut wrench.

Torque: 350±50 N•m

- 13. Inspect the pretightening force of the hub bearing. Refer to Chapter 25, Rear Axle - Rear Axle Assembly, Testing & Adjustment.**



- 14. Install the wheel reductor assembly**
(a). Install the wheel reductor to the ring gear.
• Tighten the bolts.

- 15. Install the hub and brake shoe. Refer to Chapter 26, Service Brake - Rear Brake Shoe, Overhaul**

- 16. Install the axle shaft assembly. Refer to Chapter 25, Rear Axle - Axle Shaft, Overhaul**

Caution:

When filling the wheel lubricating oil, check whether the lubricating oil level in the rear axle main reducer is normal. Refer to Chapter 25, Rear Axle - Main Reducer, Overhaul

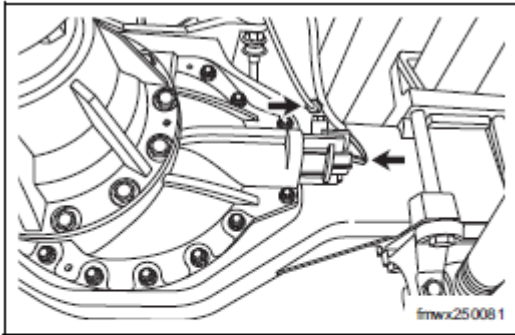
- 17. Install the tires.**
18. Put down the vehicle

Rear Axle Assembly and Rear Axle Housing Overhaul

Hint:

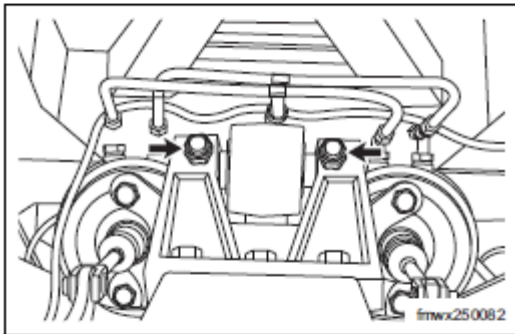
Part Drawing, refer to Chapter 25, Rear Axle - Rear Axle Assembly, Part Drawing.

1. **Lift the self-unloading container**
2. **Disconnect the battery negative cable. Refer to Chapter 53, Battery - Battery Assembly, Replacement**
3. **Lift the vehicle**
4. **Dismantle the rear brake chamber assembly. Refer to Chapter 26, Service Brake - Rear Brake Chamber, Overhaul**
5. **Dismantle the drive shaft. Refer to Chapter 33, Drive Shaft - Drive Shaft Assembly, Overhaul**

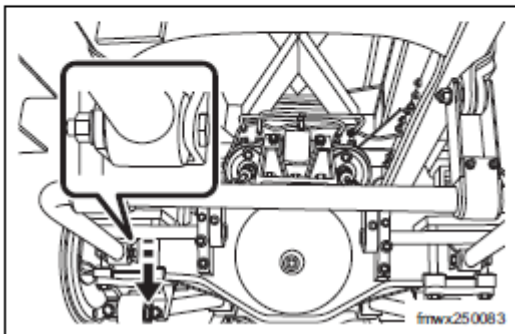


6. **Dismantle the rear axle assembly**

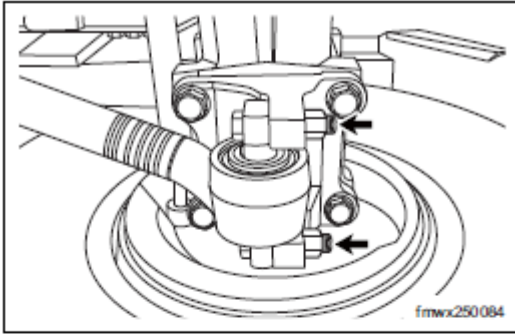
- (a). Disconnect the differential lock air pipe.
- (b). Disconnect the differential lock switching wiring harness connector.



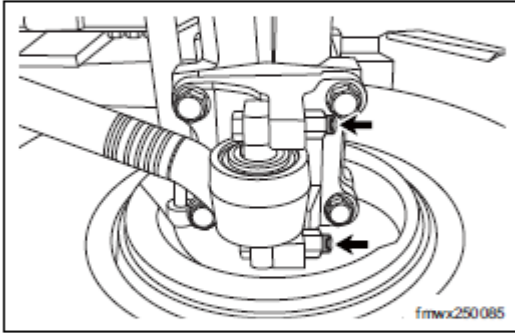
- (c). Dismantle the upper thrust rod.
 - Dismantle the upper thrust rod and the rear axle housing upper bracket connecting bolts.



- (d). Dismantle the stabilizer bar.
 - Dismantle the stabilizer bar connecting bolts on the two sides.
 - Rotate the stabilizer bar downwards.



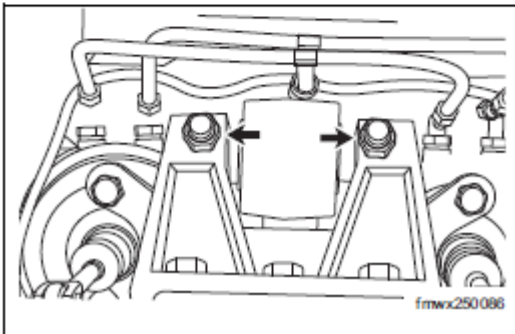
- (e). Lift the middle part of the rear axle with a hydraulic pusher.
- (f). Take down the lower thrust rod.
 - Dismantle the lower thrust rod and rear axle connecting bolts.
- (g). Disconnect the wheel speed sensor.
- (h). Push the rear axle assembly back until it is out.



7. Install the rear axle assembly

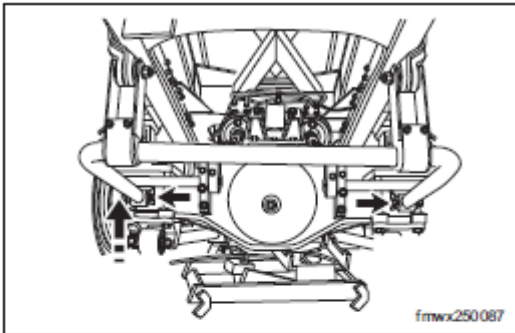
- (a). Push the rear axle to below the frame, and ensure that the leaf spring is installed in the rear axle bracket.
- (b). Install the lower thrust rod.
 - Tighten the lower thrust rod and rear axle connecting bolts.

Torque: $525 \pm 25 \text{ N}\cdot\text{m}$



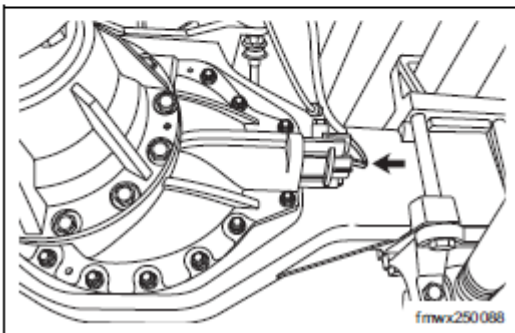
- (c). Install the upper thrust rod.
 - Fasten the upper thrust rod connecting bolts.

Torque: $525 \pm 25 \text{ N}\cdot\text{m}$



- (d). Install the stabilizer bar.
 - Rotate the stabilizer bar up into the stabilizer bar fixing bracket.
 - Tighten the stabilizer bar connecting bolts on the two sides.

Torque: $221 \pm 22 \text{ N}\cdot\text{m}$



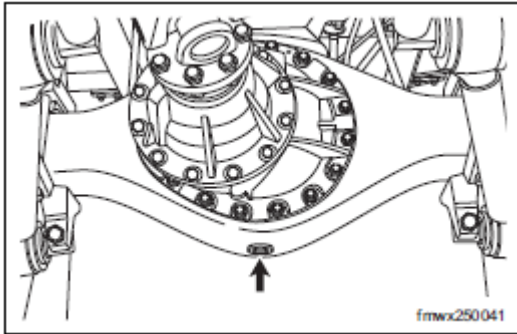
- (e). Connect the differential lock switching wiring harness connector.
- (f). Connect the differential lock air pipe.
- (g). Connect the ABS wiring harness connector.

Rear Axle- Rear Axle Assembly

8. Install the drive shaft. Refer to Chapter 33, Drive Shaft - Drive Shaft Assembly, Overhaul
9. Install the rear brake chamber assembly. Refer to Chapter 26, Service Brake - Rear Brake Chamber, Overhaul
10. Install the tires. Refer to Chapter 23, Tire & Wheel -Rear Tire and Wheel, Overhaul
11. Put down the vehicle. Refer to Chapter 01, Introduction - Maintenance Guide, Vehicle Support Position
12. Install the battery negative cable. Refer to Chapter 53, Battery - Battery Assembly, Replacement
13. Put down the self-unloading container



Main reducer Overhaul

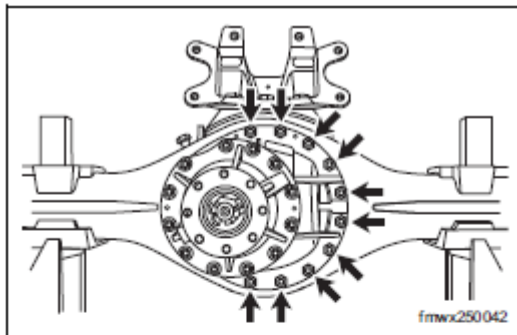


1. Drain oil

- (a). Dismantle the oil drain bolt.

2. Dismantle the axle shaft. Refer to Chapter 25, Rear Axle - Axle Shaft, Overhaul

3. Dismantle the drive shaft. Refer to Chapter 33, Drive Shaft - Drive Shaft Assembly, Overhaul

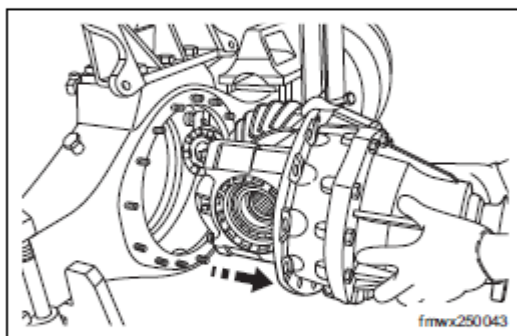


4. Dismantle the main reducer assembly

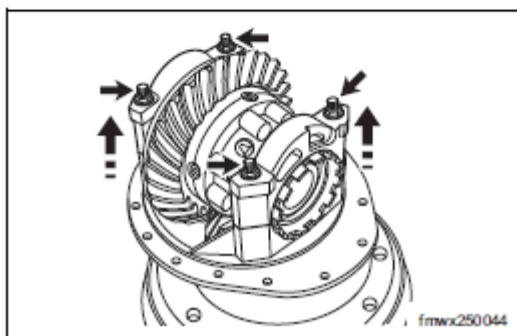
- (a). Loosen the connecting nuts of the main reducer and axle housing.
- (b). Push the main reducer out with two M10 long bolts.

Caution:

The two bolts shall be tightened diagonally.



- (c). Lift the main reducer assembly out with a hanger.



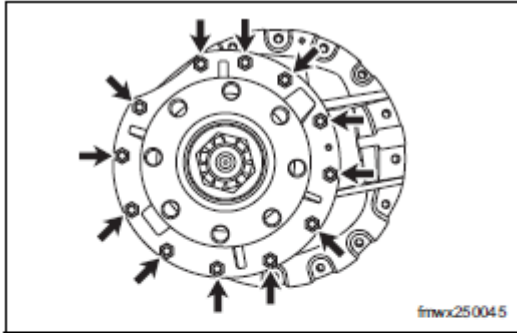
- (d). Dismantle the bearing cap fixing bolts of the main reducer.
- (e). Take down the bearing cap.

Caution:

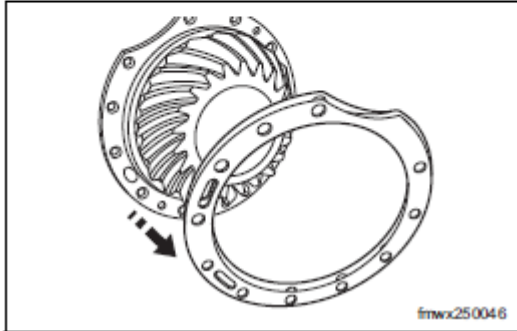
Before dismantling the bearing cap, the mating assembly marks shall be printed on the seat and the cap to avoid mistaken installation when reassembling.

- (f). Take down the differential assembly.
- (g). Dismantle the driven gear. Refer to Chapter 25, Rear Axle - Differential Housing, Driven Gear and Planet Gear Assembly, Overhaul.

Rear Axle- Rear Axle Assembly



- (h). Dismantle the connecting bolts of the driving gear bearing seat and main reducer housing.
- (i). Disconnect the driving gear bearing seat and main reducer housing.



- (j). Take down the gasket between the bearing seat and main reducer housing.

Caution:

If no part is replaced during reassembly, the original gasket shall be installed back. If any of the driving and driven gears, driving gear bearing or bearing seat housing is replaced, the thickness of the adjusting gasket must be remeasured and recalculated before reassembly.

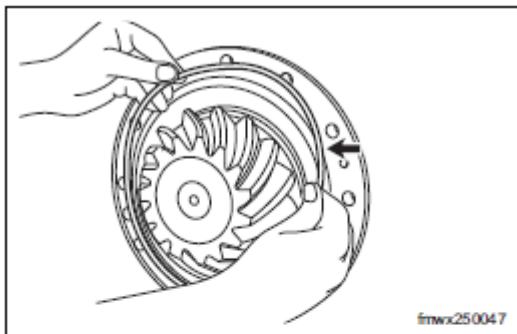
5. Dismantle the driving gear. Refer to Chapter 25, Rear Axle - Driving Gear and Bearing, Overhaul

6. Overhaul the main reducer parts

- Check the main reducer housing for rupture; check the gasket for damage.
- Check the driving and driven gears for rupture; check the bearings for wear and pitting.

Caution:

If damaged, replace them with new parts; and the driving and driven gears shall be replaced in pairs.

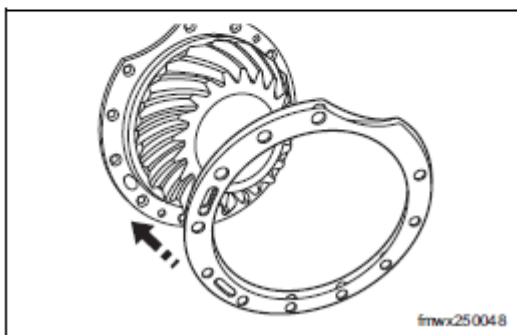


7. Install the main reducer assembly

- (a). Sheathe the O-ring on the driving gear shaft housing.

Caution:

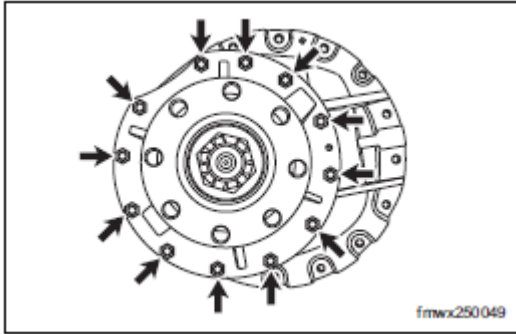
Clean the gear and contact surface before installation.



- (b). Install the adjusting gasket.
 - Select the adjusting gasket. Refer to Chapter 25, Rear Axle - Rear Axle Assembly, Testing & Adjustment.

Caution:

Spread flange sealant on the connecting surface of the driving gear bearing seat and main reducer housing before installing the gasket.



- (c). Install the driving gear bearing seat assembly in the main reducer housing.

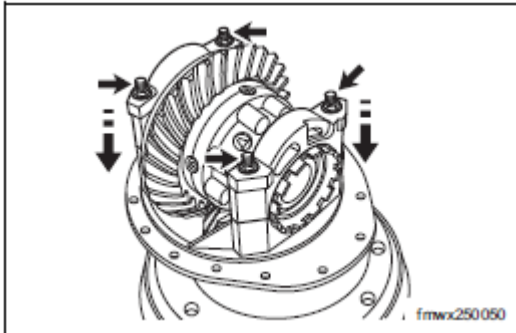
- Tighten the connecting bolts.

Torque: 110 N•m

Caution:

Tighten the bolts diagonally. Do not use an impact wrench.

- (d). Install the driven gear. Refer to Chapter 25, Rear Axle - Differential Housing, Driven Gear and Planet Gear Assembly, Overhaul.



- (e). Install the differential assembly in the main reducer housing.

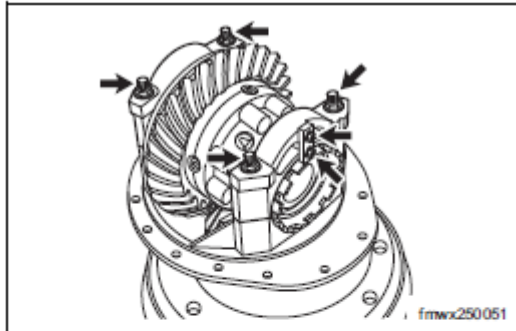
- (f). Install the bearing cap.

- Pretighten the bolts.

- (g). Adjust the mesh clearance of the driving and driven gears. Refer to Chapter 25, Rear Axle - Rear Axle Assembly, Testing & Adjustment.

- (h). Check and adjust the mesh traces of the driving and driven checks. Refer to Chapter 25, Rear Axle - Rear Axle Assembly, Testing & Adjustment.

- (i). Inspect the pretightening force of the differential bearing. Refer to Chapter 25, Rear Axle - Rear Axle Assembly, Testing & Adjustment.

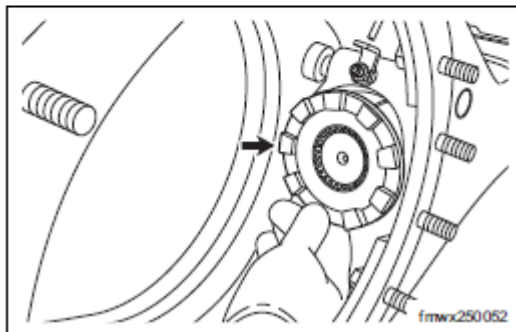


- (j). Tighten the nuts.

Torque: 235 ± 20 N•m

- Install the locking plate and tighten the bolts.

Torque: 25 N•m

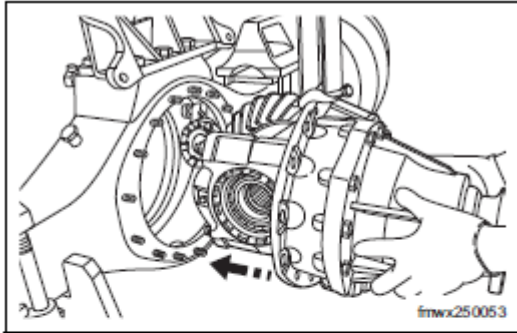


- (k). Slightly push the axle shaft in on one side of the axle differential lock. In the axle housing, firstly put the differential lock shift fork and the mesh sleeve on the axle shaft, and then push the axle shaft until it is aligned with the mesh sleeve.

Caution:

Do not damage the axle shaft oil seal while pushing the axle shaft.

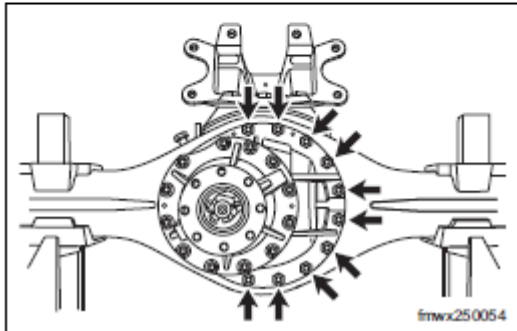
Rear Axle- Rear Axle Assembly



- (l). Install the central reducer assembly in the axle housing.

Caution:

Before installing the main reducer, clean the contact surface of the axle housing and main reducer housing, and uninterruptedly spread 598 flange sealant.

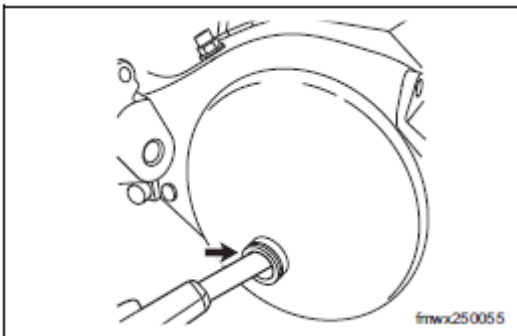


- (m). Tighten the connecting bolts of the axle housing and main reducer.

Torque: 210 N•m

8. Install the axle shaft. Refer to Chapter 25, Rear Axle - Axle Shaft, Overhaul

9. Install the drive shaft. Refer to Chapter 33 Drive Shaft-Drive Shaft Assembly, Overhaul



10. Refill oil

- (a). Refill lubricating oil, and tighten the bolts.

Torque: 200-270 N•m

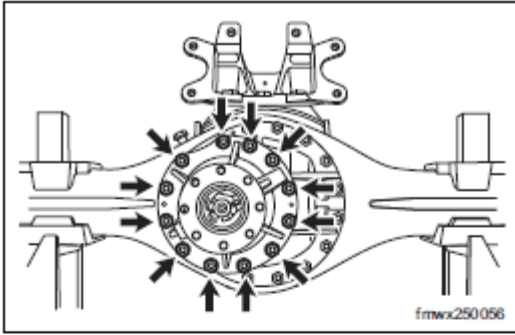
Caution: There is an oil filling hole in the middle of the rear part of the axle housing, and the normal liquid level shall be kept at the height of the oil filling hole all the time.

Driving Gear and Bearing Overhaul

Hint:

Part Drawing, refer to Chapter 25, Rear Axle - Main Reducer, Part Drawing.

1. **Drain oil**
2. **Disconnect the drive shaft and the main reducer flange. Refer to Chapter 33, Drive Shaft - Drive Shaft Assembly, Overhaul**

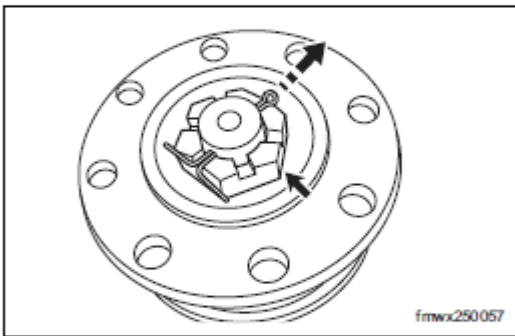


3. Dismantle the driving gear bearing seat.

- (a). Dismantle the connecting bolts of the driving gear bearing seat and main reducer housing.
- (b). Disconnect the driving gear bearing seat and main reducer housing with two M10 long bolts.

Caution:

The two M10 long bolts shall be loosened diagonally.

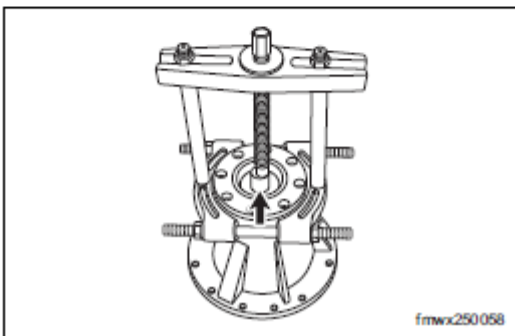


4. Dismantle the driving gear and bearing

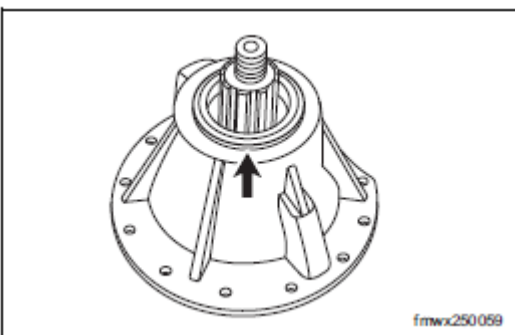
- (a). Dismantle the flange nuts.
 - Dismantle the cotter pin and flange nuts.

Caution:

The cotter pin is a worn part, and not suitable for repeated use.



- (b). Pull the flange out with a puller.



- (c). Take out the oil seal.

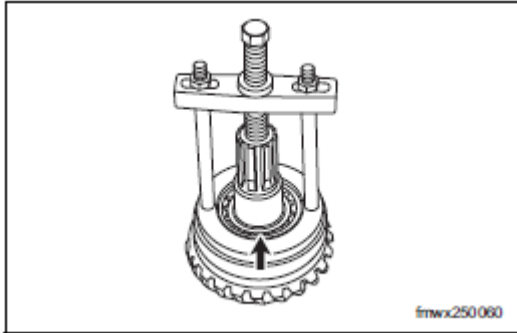
Caution:

Do not scratch the oil seal seat ring while taking out the oil seal.

- (a). Press the driving gear out of the driving gear bearing seat with a presser.

Caution:

Do not damage the threads while maintaining the driving gear.



- (b). Pull out the bearing on the driving gear with a puller.

Caution:

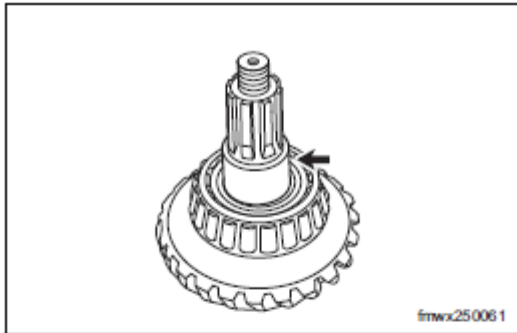
The bearing inner race and driving gear shaft form an interference fit. It is suggested to pull it out after heating to 80-100°C.

5. Check the driving gear assembly

- Check the driving gear bearing for wear and pitting.
- Check the driving gear for wear, rupture and distortion.
- Check the driving gear seat for cracking.

Caution:

If any defect is detected, replace with new parts.

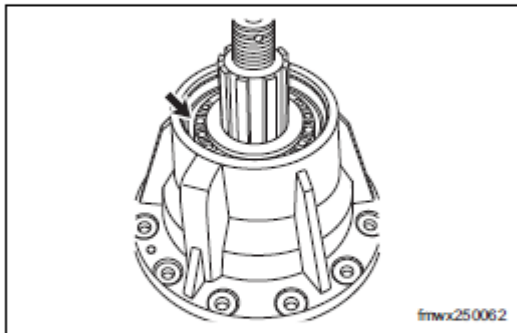


6. Install the driving gear and bearing

- (a). Press the bearing into the driving gear shaft.

Caution:

The bearing inner race and driving gear shaft form an interference fit. It is required to sheathe the tapered roller bearing on the driving gear after heating to 80-100°C.



- (b). Sheathe the driving gear bearing seat of the bearing outer ring on the driving gear.

- Press the driving gear to proper position with a press machine.

Caution:

It is required to put the proper gasket on the inner side of the bearing before pressing the bearing.

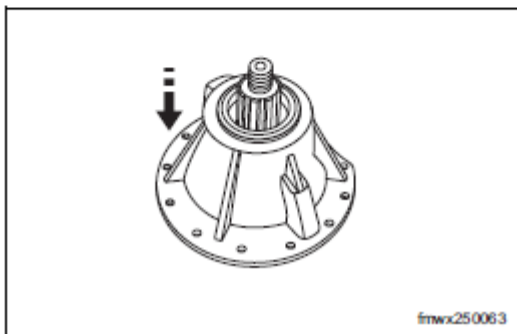
- (c). Measure the pretightening force of the driving gear bearing. Refer to Chapter 25, Rear Axle - Rear Axle Assembly, Testing & Adjustment.

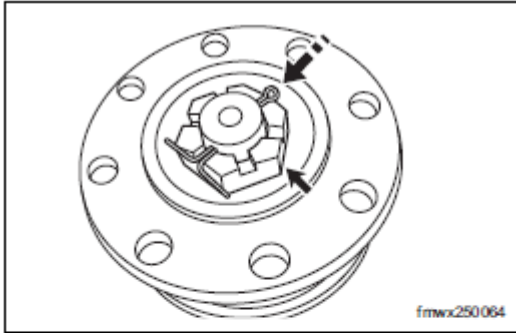
Pretightening force: $15 \pm 5N$

- (d). Install the oil seal in the oil seal seat.

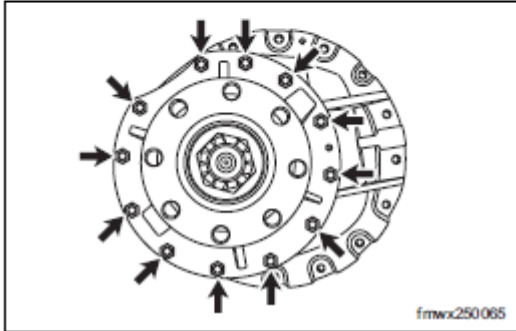
Caution:

Spread 262 thread lock on the outer ring of the oil seal seat.





- (e). Press the flange into the driving gear shaft.
 - (f). Tighten the nuts, and install the cotter pin.
- Torque: $800 \pm 50 \text{ N}\cdot\text{m}$**



- 7. Install the driving gear bearing seat assembly in the main reducer housing.**
- (a). Spread 598 flange sealant on the disk holes of the main reducer housing.
 - (b). Spread 262 thread lock on the connecting bolts.
 - (c). Tighten the bolts.
- Torque: $135 \pm 15 \text{ N}\cdot\text{m}$**

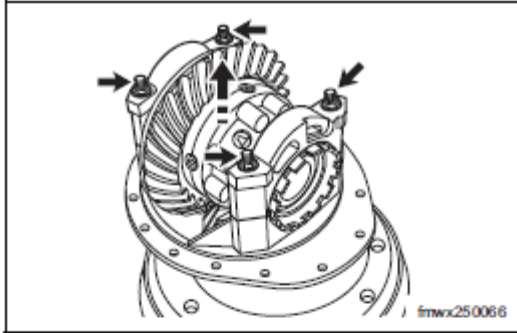
- 8. Install the drive shaft. Refer to Chapter 33, Drive Shaft - Drive Shaft Assembly, Overhaul.
- 9. Fill oil. Refer to Chapter 25, Rear Axle - Main Reducer, Overhaul.

Differential Housing, Driven Gear and Planet Gear Assembly Overhaul

Hint:

Part Drawing, refer to Chapter 25, Rear Axle - Main Reducer, Part Drawing.

1. Dismantle the main reducer assembly. Refer to Chapter 25, Rear Axle - Main Reducer, Overhaul

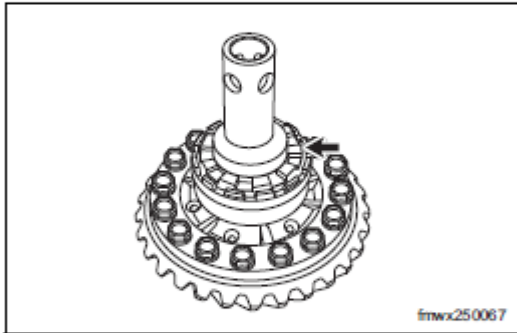


2. Dismantle the differential assembly

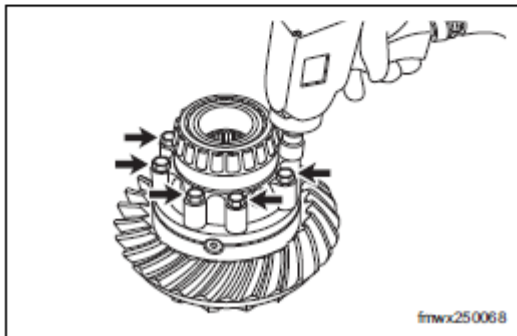
- (a). Dismantle the slotted nut locking plate of the differential bearing.
- (b). Dismantle the differential bearing cap.
 - Loosen the differential bearing cap nuts.
- (c). Take out the differential assembly.

Caution:

Before dismantling the cap, the cap and bearing seat shall be printed with mating marks to avoid mistaken installation when reassembling.



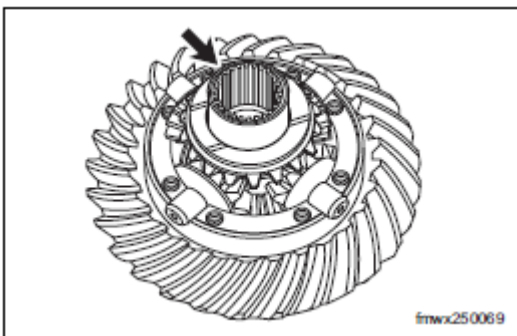
- (d). Dismantle the differential lock mesh sleeve.



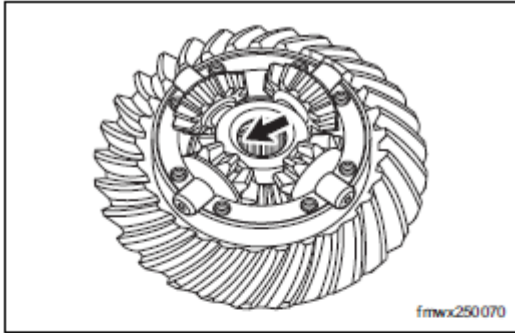
- (e). Dismantle the differential housing coupling bolts, and take down the differential housing.

Caution:

Before dismantling, observe whether there are assembly marks on the two differential housing halves. If there are no assembly marks, corresponding assembly marks shall be printed to avoid mistaken installation when reassembling.



- (f). Take out the axle shaft gear.



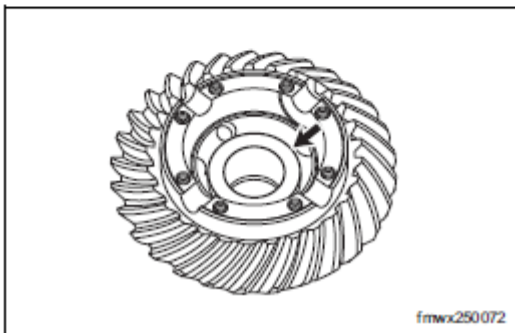
(g). Take out the planet gear and cross shaft.

Caution:

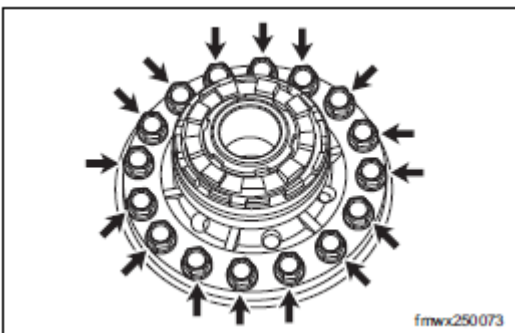
Do not lose planet gear spherical gasket.



(h). Take out the axle shaft gear.



(i). Take out the axle shaft thrust gasket



3. Dismantle the driven gear

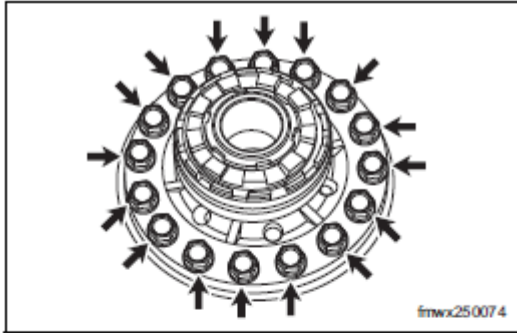
- (a). Dismantle the coupling bolts of the driven gear and differential housing.
- (b). Disconnect the driven gear, backing ring and differential.

4. Check the gear, bearing, gasket, cross shaft and axle shaft gear for wear or damage

Caution:

If any defect is detected, replace with new spares.

Rear Axle- Rear Axle Assembly

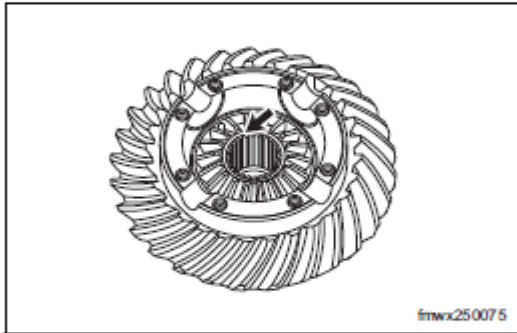
**5. Install the driven gear**

- (a). Connect the driven gear, backing ring and differential.
- (b). Tighten the coupling bolts of the driven gear and differential housing.

Torque: 325 N·m

Caution:

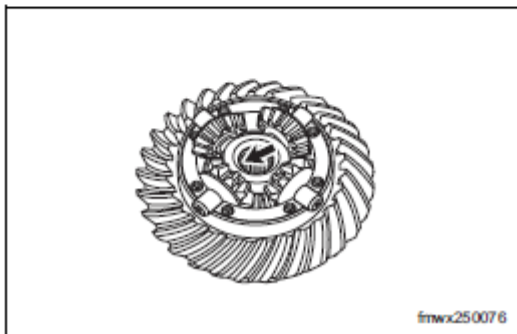
The bolts must be spread with Loctite 262 thread lock.

**6. Install the differential lock assembly**

- (a). Install the axle shaft thrust gasket and axle shaft gear. Standard thickness of axle shaft thrust gasket: 4.9mm, 5.0mm, 5.1mm, 5.2mm, 5.3mm

Caution:

The surface with the oil groove shall be faced with the axle shaft gear.

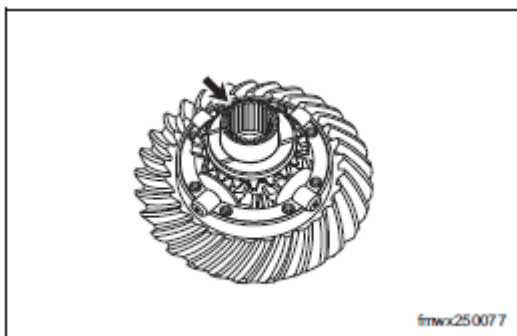


- (b). Install the planet gear and cross shaft.

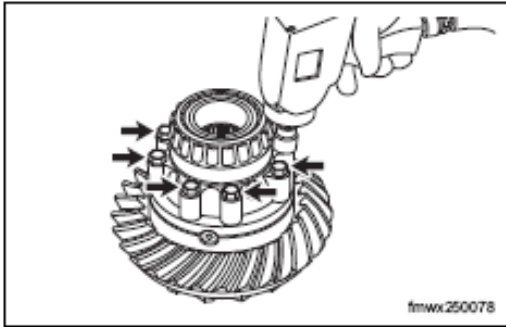
Caution:

Slightly knock the cross shaft to eliminate false clearance.

- (c). Measure and adjust the tooth side clearance. Refer to Chapter 25, Rear Axle - Rear Axle Assembly, Testing & Adjustment.



- (d). Install the axle shaft gear.

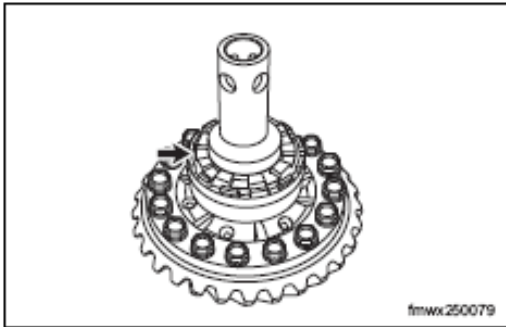


- (e). Install the differential housing, and tighten the coupling bolts of the differential housing.

Torque: 195 N•m

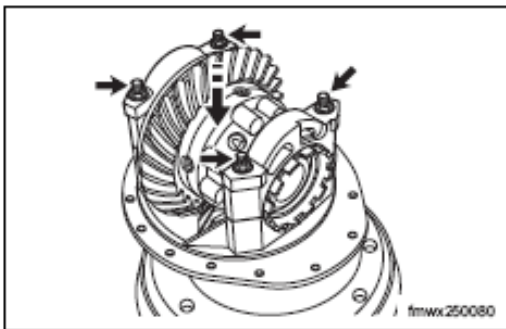
Caution:

Align the installation marks. The bolts must be spread with Loctite 262 thread lock.



- (f). Install the differential slotted nuts, differential lock mesh sleeve and slotted nut locking plate on the differential shaft sleeve, and tighten the differential slotted nuts.

Torque: 200 N•m



- (g). Install the differential assembly.
(h). Pretighten the differential bearing cap, and adjust the mesh clearance, mesh traces of driving and driven gears, and pretightening force of bearing. Refer to Chapter 25, Rear Axle - Rear Axle Assembly, Testing & Adjustment.
(i). Tighten the differential bearing cap.
Torque: 210 N•m
(j). Install the slotted nut locking plate of the differential bearing.

7. Install the main reducer assembly. Refer to Chapter 25, Rear Axle - Main Reducer, Overhaul

SERVICE BRAKE

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SERVICE BRAKE SYSTEM

OVERVIEW

The brake system of the Auman heavy duty truck adopts the typical design of world advanced level and adopts the master brake system of dual circuit pneumatic brake, parking brake system of spring accumulator bleeding brake, and the auxiliary brake system of engine exhaust brake.

Originated from the legal regulations, safety, and reliability, the requirements over the control mechanism and the actuator mechanism of the brake system are as below:

1. **The heavy duty truck must be equipped with three brake devices, namely the master brake (service brake), emergency brake, and parking brake, and may be additionally equipped with the auxiliary brake device, of which the master brake and the emergency brake must be adjustable and the parking brake may be non-adjustable. The emergency brake device refers to the backup brake device capable of substituting the master brake with completely equivalent performances, in event of the failure of the master brake control system.**

The Auman heavy duty truck adopts the dual circuit air brake system, in which the parking brake and the emergency brake adopts the spring accumulator bleeding brake and the auxiliary brake adopts the exhaust brake. The exhaust brake and the engine stop device share one same set of device.

2. **The master brake, the emergency brake, and the parking brake may share one same set of brake actuator. However, the control system of the master brake must be independent of that of parking brake. On this vehicle, the emergency brake control system and the parking brake control system share one same set of device.**
3. **The service brake must apply the braking to all wheels, with uniform braking effect. In case both control systems of master brake and emergency brake are failed, the parking brake must guarantee the 50% braking effect of the master brake.**
4. **In terms of the structure, the brake system must have the acoustic (or) light alarms. In event of failure of braking medium or if the pressure can't reach the specified value, the brake system must issue the warning signal. This vehicle has two warning indicators. When the air pressure of the master brake air circuit of the whole vehicle can't reach 4.5bar, the low pressure warning lamp lights up and at the same time the buzzer sounds. When the air pressure of the parking brake air circuit or the auxiliary air circuit is below 4.5bar, the parking brake indicator lamp lights up to indicate that the vehicle can't start up.**
5. **The parking brake must be capable of applying the brake by completely locking the working components with mechanical device, even without the presence of the driver, in order to guarantee the parking reliability on a slope.**
6. **The brake response duration from the moment that the brake master valve is opened to the moment that the air pressure of farthest brake branch chamber reaches the corresponding value shall not exceed 0.6s.**
7. **In addition to above requirements, in general the brake device of the vehicle must realize the shortest braking distance, on the premises of guaranteeing the driving stability and maneuverability.**

Color Comparison Table of Nylon Pipes for Preformed Air Pipeline

Differential relay valve	1# port			Red
	2# port backward			Red blue
	2# port			Hose
	41# port			Blue
	42# port			Apple green
Rear axle relay valve	1# port			Pink
	2# port backward	Φ8		Apple green
		Φ12		Red green
	4# port			Dark green
2# port			Hose	
Intermediate axle relay valve	1# port			White
	2# port backward			Light yellow
	2# port forward			Light yellow
	4# port	Φ8 nylon pipe		Light yellow
Solenoid valve	To inter-axle differntial			Purple
	To inter-wheel differential	Intermediate axle	To three-way connector/Orange Red	Orange blue
		Rear axle		Orange apple
	Exhaust brake butterfly valve			Yellow
	Stop cylinder			Orange
	Raise			Red
	Lower			Blue
	Neutral gear			RedPurple
	Power takeoff			Pink
Load sensing valve	1# port			Apple green
	2# port			Steel pipe
	3# port			Hose
	4# port			Dark green
Brake master pump	12# port			Apple green
	11# port			Pink
	21# port			Dark green
	22# port			Light yellow



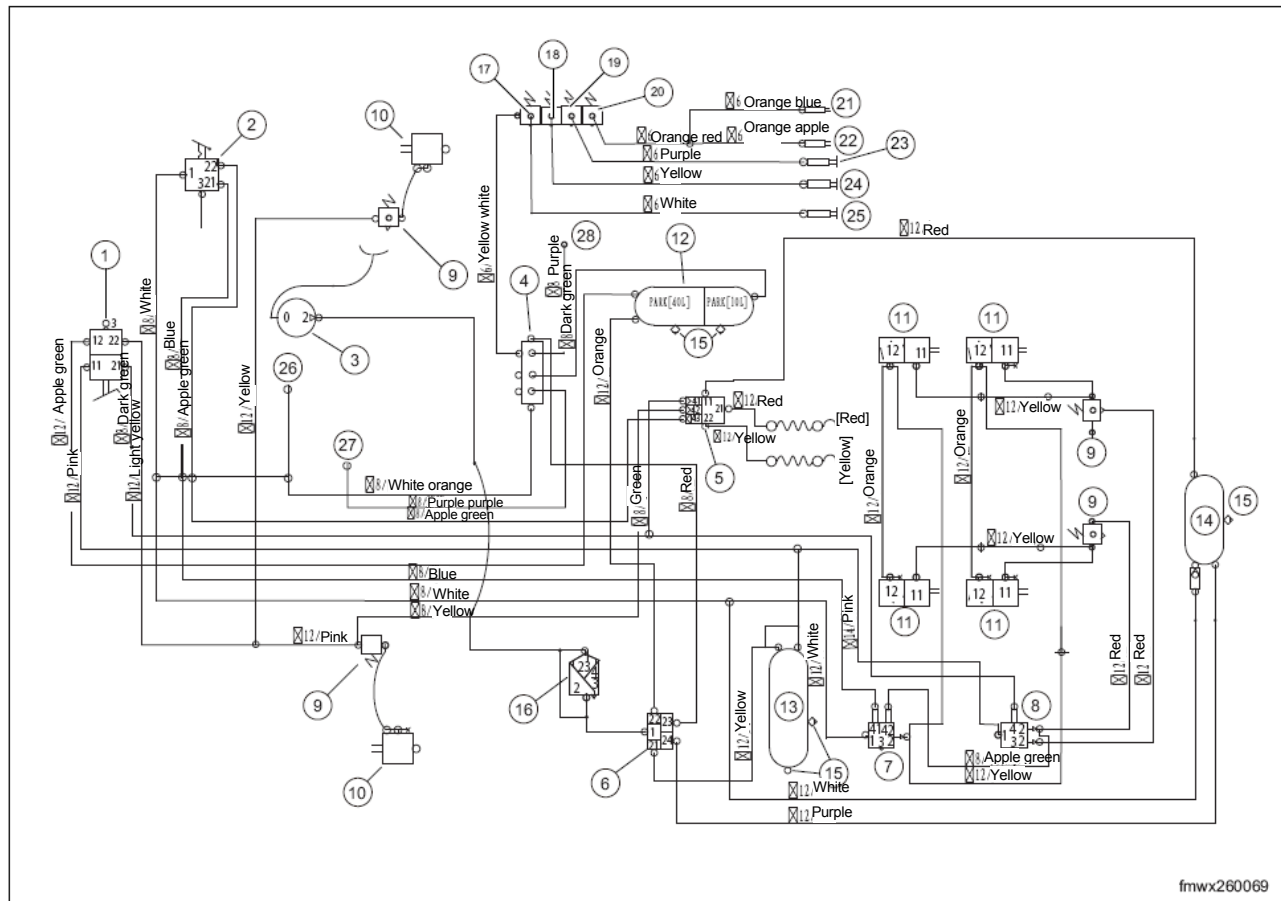
SERVICE BRAKE-SERVICE BRAKE SYSTEM

26-5

Handbrake master pump	11# port	White
	21# port	Blue
	22# port	Apple green
Seven-way connector	Clutch booster	PurplePurple
	Three-way stop connector	Orange
	Three-way stop connector to stop cylinder	Orange
	Transmission	Purple
	1# port	Red
	Left longitudinal beam solenoid valve 1# port	Yellow pink
	Right longitudinal beam solenoid valve 1# port	Yellow red
	Seats	White orange
Trailer Valve	2# port	Yellow
	41# port	Dark green
	43# port	Apple green
	42# port	Light yellow
	1# port	White
Air control switch	2# - Stop cylinder	Transparent
	Orange	
Driver cab three-way connector to solenoid valve		Yellow
Driver cab three-way connector to left adjoining elbow 950		Blue
Driver cab three-way connector to right adjoining elbow 3100		White
Adjoining elbow to air horn connector base		Orange
Connecting pipe among air chambers		Orange
Quick release valve	Left side of front brake elbow	Light yellow
	Right side of front brake elbow	Light yellow
Front ABS valve	Front axle adjoining elbow (or three-way connector) to ABS valve 1# port	Yellow
ASR valve	Multi-way connector to ASR valve	Red yellow
	ASR valve to differential valve 41	Red green

26

Schematic Diagram of Brake System (With ABS)

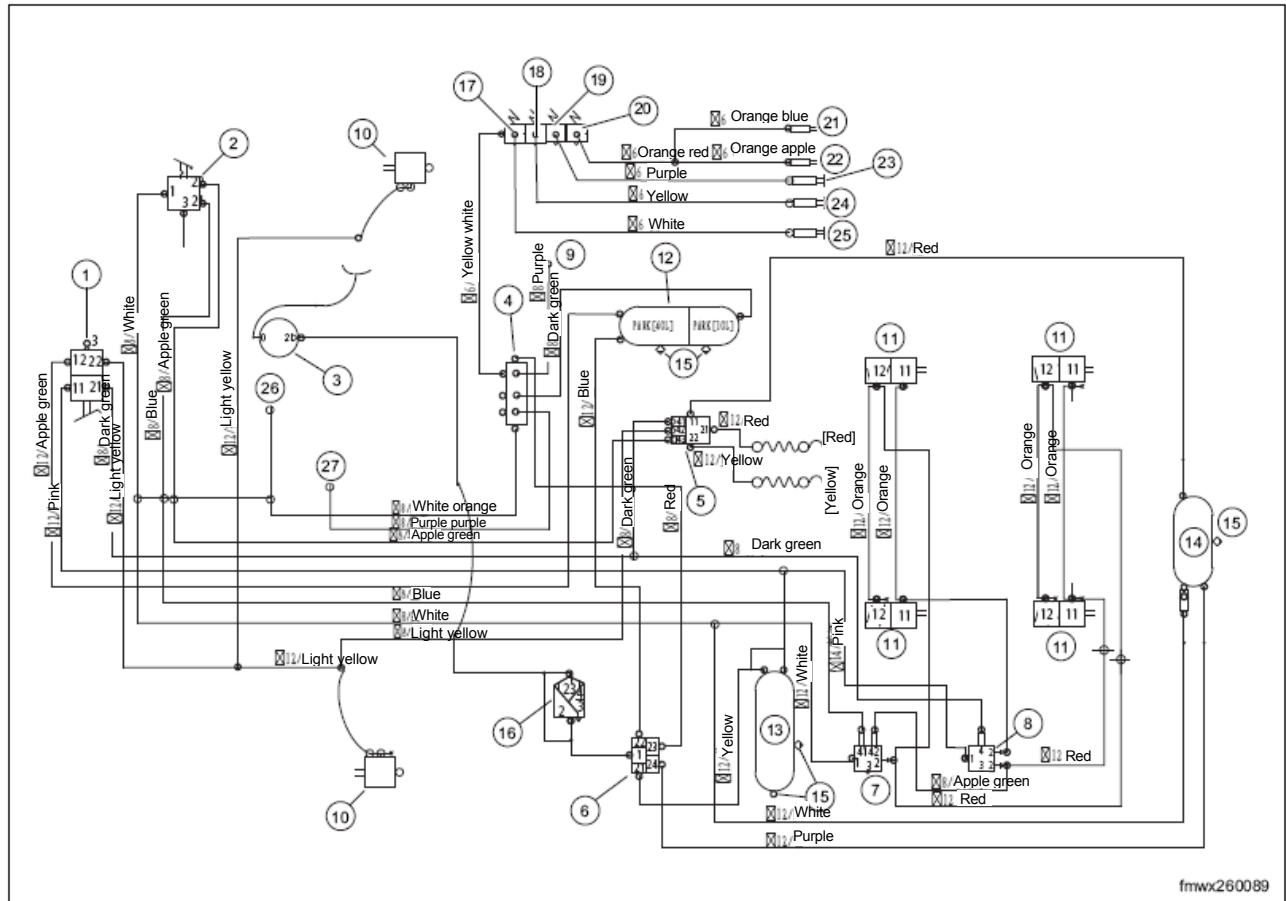


fmwx260069

1	Brake master valve
2	Handbrake valve
3	Air compressor
4	Multi-Way Connector
5	Trailer Valve
6	4-Circuit Protection Valve
7	Dual chamber relay valve
8	Relay Valve
9	ABS solenoid valve
10	Diaphragm brake air chamber
11	Spring brake air chamber
12	Combined Air Reservoir
13	30L Air Reservoir
14	Rear Air Reservoir

15	Manual water drainage valve
16	Drier
17	Stop cylinder solenoid valve
18	Exhaust brake butterfly valve solenoid valve
19	Inter-axle differential lock cylinder solenoid valve
20	Inter-wheel differential lock cylinder solenoid valve
21	Intermediate axle inter-wheel differential lock cylinder
22	Rear axle inter-wheel differential lock cylinder
23	Inter-axle differential lock cylinder
24	Exhaust Brake Butterfly Valve
25	Stop cylinder
26	Pneumatic seat assembly intake port
27	Clutch booster
28	Transmission intake port

Schematic Diagram of Brake System (Without ABS)

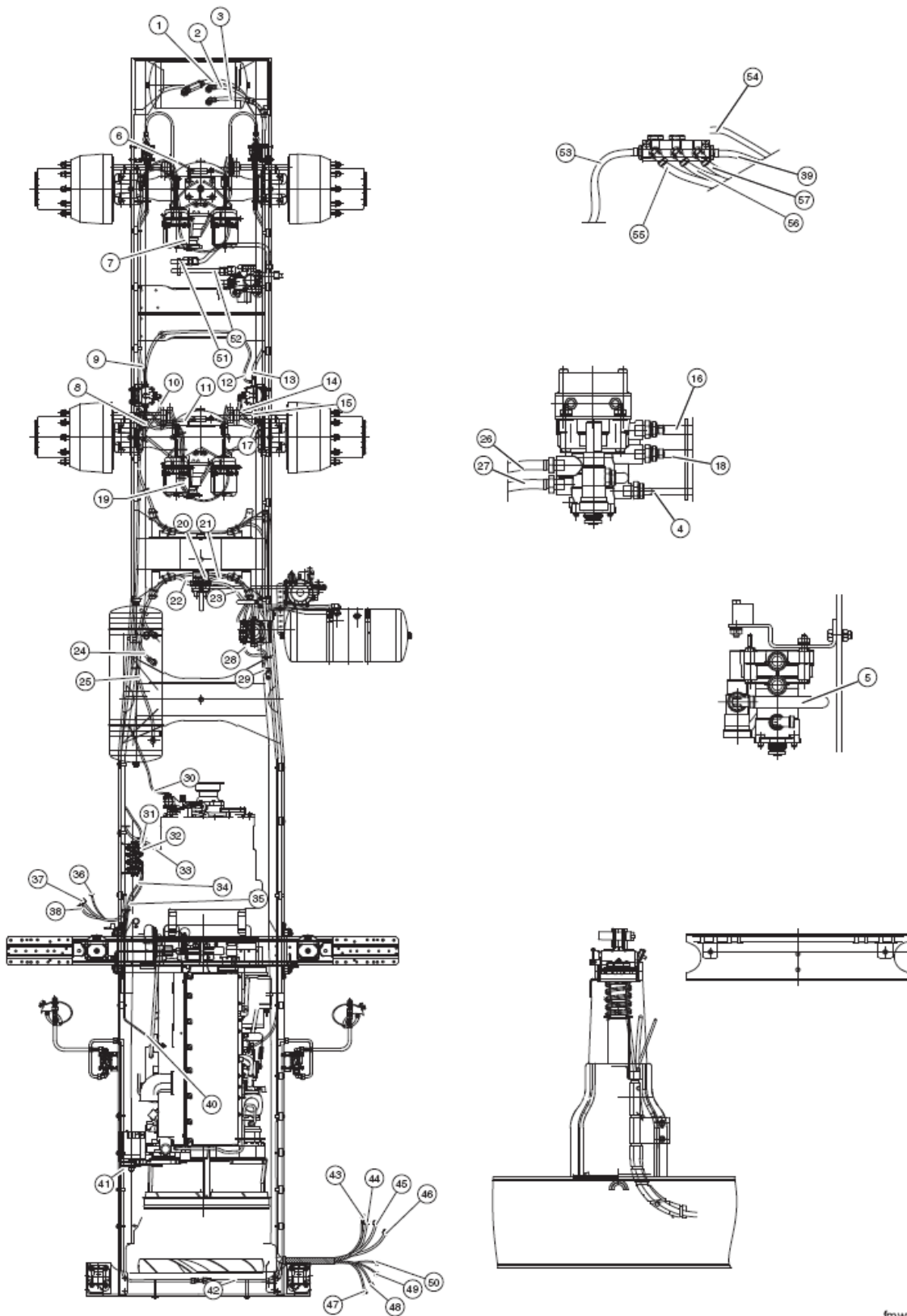


1	Brake master valve
2	Handbrake valve
3	Air compressor
4	Multi-Way Connector
5	Trailer Valve
6	4-Circuit Protection Valve
7	Dual chamber relay valve
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19	Inter-axle differential lock cylinder solenoid valve
20	Inter-wheel differential lock cylinder solenoid valve
21	Intermediate axle inter-wheel differential lock cylinder
22	Rear axle inter-wheel differential lock cylinder
23	Inter-axle differential lock cylinder
24	Exhaust Brake Butterfly Valve
25	Stop cylinder
26	Pneumatic seat assembly intake port
27	Clutch booster



Installation Diagram of Brake Pipeline



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SERVICE BRAKE-SERVICE BRAKE SYSTEM

26-9

No.	Color	Diameter	Description (mm)	No.	Color	Diameter	Description (mm)
1	White	12	Rear reservoir three-way connector to check valve	30	Apple green	8	Transmission
2	Red	12	Rear reservoir to trailer valve	31	Orange red	6	Inter-wheel differential
3	Purple	12	Rear reservoir to 4-circuit 24# port	32	Purple	6	Inter-axle differential
4	Apple green	8	Hand valve 2# port to trailer 43#	33	Purple	8	To clutch booster
5	Red	12	Rear reservoir to trailer 11# port	34	Yellow	6	Exhaust brake
6	Orange apple	6		35	Red	6	Stop cylinder
7	Orange	12		36	Yellow	8	To exhaust brake
8	Blue	8	Hand valve 21# port to differential valve 41#	37	Yellow	12	To yellow trailer connector
9	Red	12	Differential valve three-way connector 2# port to adjoining straight connector	38	Red	12	To red trailer connector
10	White	12		39	Red	8	Multi-way connector to 4-circuit 23# port
11	Orange blue	6	Inter-wheel differential	40	Yellow	6	Stop cylinder
12	Apple green	8	Relay valve three-way connector to differential valve 42# port	41	Yellow	12	Three-way connector to right ABS valve 1# port
13	Red	12	Relay valve 2# port three-way connector to left ABS valve 1# port	42	Light yellow	12	Foot valve 22# port to three-way connector
14	Dark green	8	To relay valve 4# port	43	Dark green	8	Brake 21# port to trailer three-way connector
15	Red	12	Relay valve 2# port to right ABS valve 1# port	44	Apple green	12	To brake 12# port
16	Dark green	8	Foot valve 21# circuit three-way connector to trailer 41# port	45	Pink	12	To brake 11# port
17	Pink	14	To relay valve 1# port	46	Light yellow	12	To brake 22# port
18	Light yellow	8	Foot valve 22# circuit three-way connector to trailer 42# port	47	White	8	To hand 1#



No.	Color	Diameter	Description (mm)	No.	Color	Diameter	Description (mm)
19	Purple	6	Inter-axle differential	48	Blue	8	To hand 21#
20	Purple	12	To 24# port	49	Apple green	8	Hand 22# to trailer 43#
21	Red	8	To brake 23# port	50	White orange	8	Multi-way connector to seat
22	Blue	12	To brake 22# port	51	Yellow	12	ABS valve 2# port to adjoining straight connector
23	Yellow	12	To brake 21# port	52	Dark green	12	Relay valve 2# port to right ABS valve 1# port
24	Apple green	12		53	White orange	8	Multi-way connector to seat
25	Red	8		54	Yellow	6	Multi-way connector to solenoid valve 1# port
26	Yellow	12	Trailer 22# port to trailer connector	55	Purple	8	Multi-way connector to clutch booster
27	Red	12	Trailer 21# port to trailer connector	56	Dark green	8	Multi-way connector to combined reservoir
28	White orange	8	To multi-way connector	57	Apple green	8	Multi-way connector to transmission
29	Dark green	8	To trailer 41# port				

Air Source Part

The air pump pumps the compressed air through the drier and the 4-circuit protection valve. The drier is equipped with one built-in pressure regulator valve, which restrains the maximum air pressure of the whole vehicle air circuit at 8.0~8.5bar. The drier contains the desiccant. When the compressed air from the air compressor passes through the drier, the water content in the compressed air is absorbed by the desiccant and the purified air is transmitted to the 4-circuit protection valve through the drier and to reverse-charge the air reservoir. When the air pressure of the whole vehicle reaches the rated value, the built-in pressure regulator valve of the drier opens to unload the air compressor and prevent the further rise of whole vehicle air pressure and at the same time open the reverse-charge passage of reverse-charging air reservoir to the drier. The compressed air within the reverse-charging air reservoir reversely flows through the drier through the throttle orifices within the drier to rapidly flush out the water content absorbed in the drier out of the drier and regenerate the desiccant. When the air pressure of the whole vehicle drops to the closing pressure of the pressure regulator valve, the pressure regulator valve closes, the compressed air from the air compressor is dried by the drier and then is supplied to the whole vehicle air circuit through the 4-circuit protection valve. During the driving of the vehicle, the drier will repeat above procedure to provide purified air to the circuit.

When the compressed air from the drier passes through the 4-circuit protection valve, the whole vehicle air circuit is divided into four circuits that are related and also separated. The 4-circuit protection valve is functioned to, in event of malfunction at any circuit (such as breakage or leakage), close the malfunctioned circuit immediately. In such case, the normal functioning and charging of other circuits will

not be influenced.

Front Axle Brake Circuit

The 21# port of the 4-circuit protection valve charges the air to the front brake air reservoir and then to the lower chamber 12# port of the master brake valve through the air reservoir. When the brake pedal is stepped down, the master brake valve opens so that the air is transmitted to the front axle brake branch chamber through the 22# port. During the braking, the air pressure of the brake branch chamber is in proportion to the pedal travel of the master brake valve.

(Intermediate) Rear Axle Brake Circuit

The (intermediate) rear brake air reservoir is charged through 22# port of 4-circuit protection valve. The air reservoir supplies the air to the upper chamber 11# port of master brake valve and leads to the master brake relay valve through the 21# port of the master brake valve. The relay valve is directly supplied by the air reservoir. When the master brake valve is actuated, the relay valve opens to supply brake air pressure to the intermediate master brake branch chamber and the rear axle master brake branch chamber. The air pressure of the brake branch chamber is in proportion to the pedal travel of the master brake valve. The relay valve is functioned to shorten the brake response time and exert the "quick charge" and "quick bleed" functions.

Parking Brake Circuit

The 24# port of the 4-circuit protection valve supplies the air to the parking brake. The parking brake valve controls the relay valve. When the parking brake is applied, the control air pressure of the relay valve bleeds the parking brake valve and the (intermediate) rear axle parking brake air chamber through the relay valve so that the spring of the air chamber drives the piston and ejector pin to extend and apply the braking effect, of which the size of the braking force depends on the pre-tightening force of the accumulator spring. When the parking brake valve is at "Drive" position, the parking brake valve transmits one control air pressure to the dual chamber relay valve to open the dual chamber relay valve so that the compressed air directly supplied by the air reservoir quickly enters into the (intermediate) rear axle parking brake air chamber, of which the pressure of the compressed air is above 550kPa to overcome the spring force and fully retract the piston and ejector rod to release the brake. The so-called "dual chamber relay valve" means that this valve can be controlled by the parking brake valve and the master brake valve respectively, namely, when the parking brake of the vehicle is applied, if the brake pedal is stepped down, the master brake valve outputs one braking air pressure to the master brake branch chamber as well as to the dual chamber spring accumulator branch chamber to release the parking brake so that the ejector rod of the brake branch chamber will not be overloaded.

Auxiliary Air Circuits

All air systems not related to the brake are connected to the auxiliary air circuits.

When the clutch pedal is stepped down, the clutch booster is actuated to generate the boosting effect.

The pressure reducing valve reduces the air pressure to 4.5bar and conveys to the gearshift valve of the transmission. When the valve is at high speed position, the air of the low speed cylinder is returned and the high speed cylinder is actuated. When the valve is at low speed position, the air of the high speed cylinder is returned and the low speed cylinder is actuated.

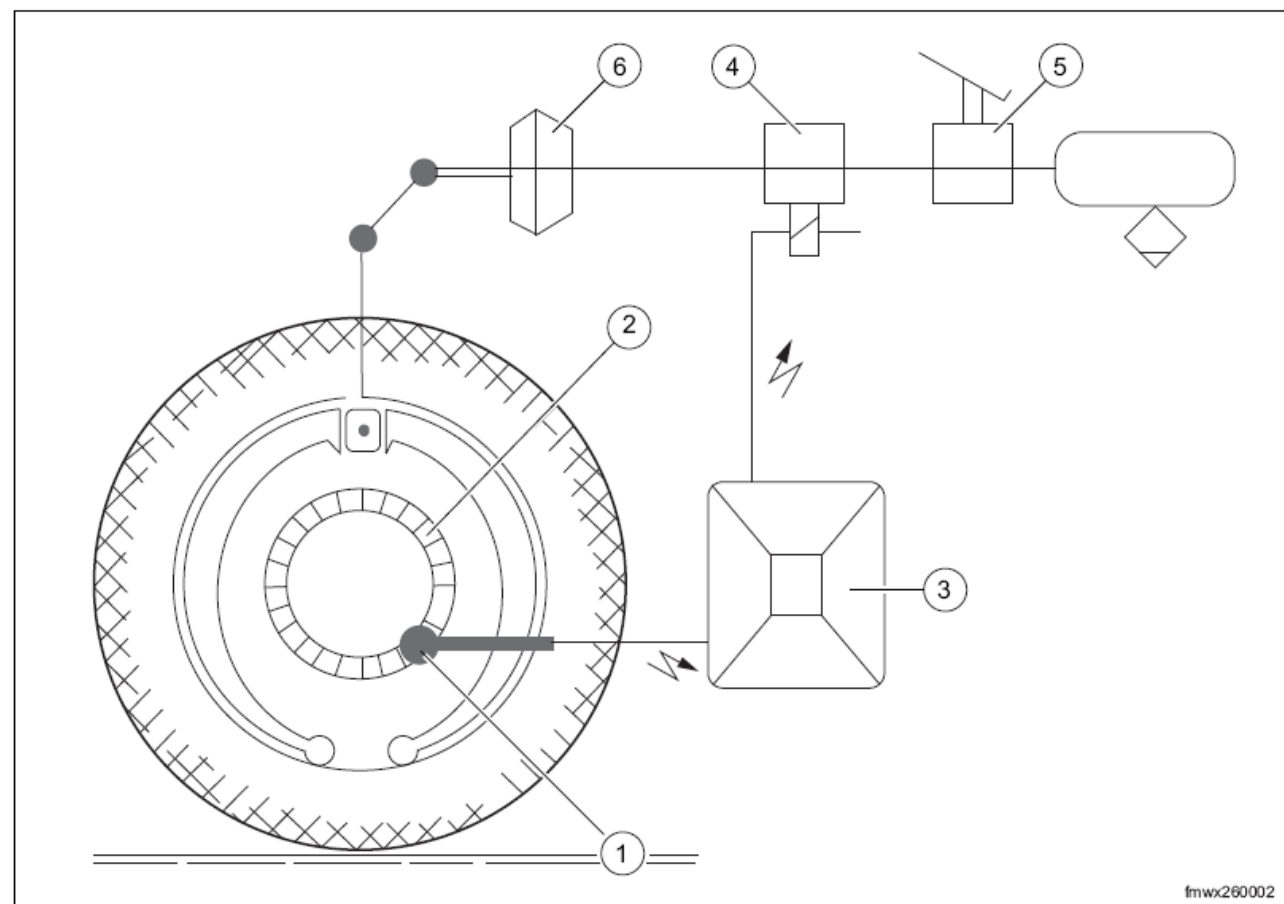
Meanwhile, the inter-wheel differential lock solenoid valve and the inter-axle differential lock solenoid valve are actuated to engage the differential locks.

Following the wearing of the brake shoe friction plate during the driving, the gap will increase continually. Therefore, it's necessary to frequently adjust the brake gap during the service.

Advantages of ABS System:

1. It maintains the maneuverability of vehicle direction at the braking.
2. It shortens and optimizes the braking distances and relieves the mental burden of the driver.
3. It reduces the wearing of tires and save the service costs.

Working Principle



1	Sensor
2	Gear ring
3	Electronic control unit (ECU)

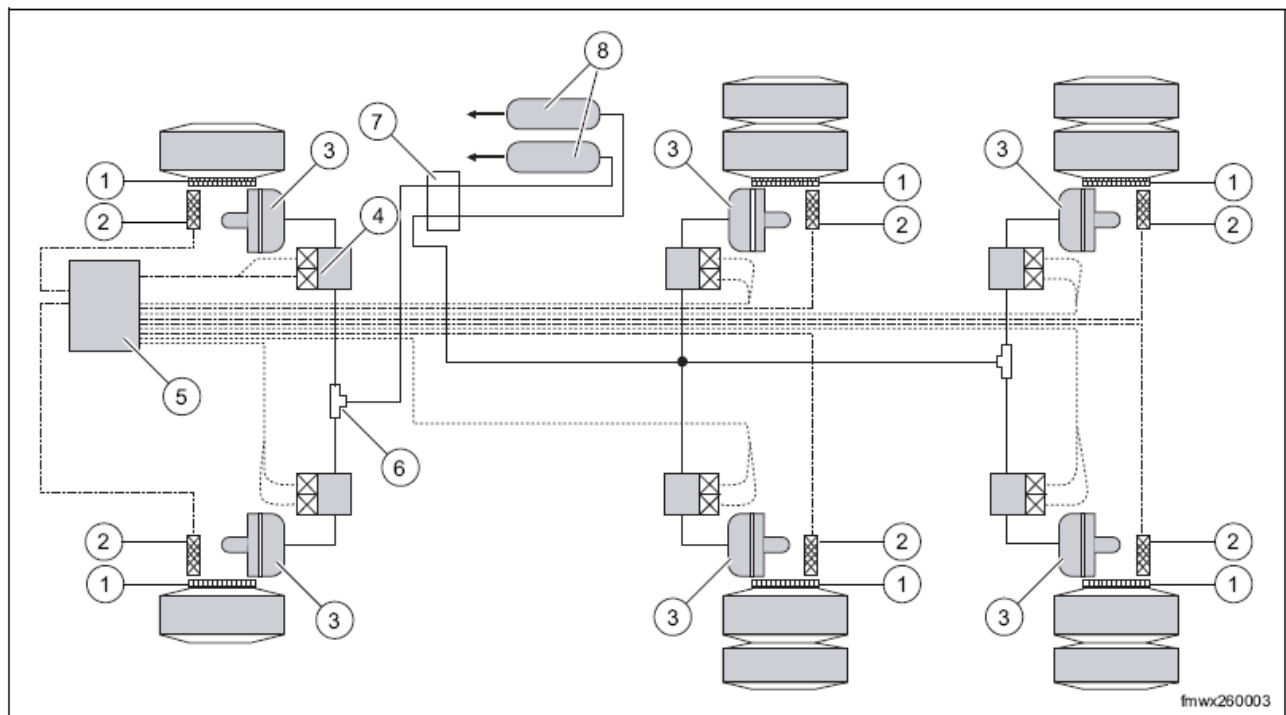
4	ABS solenoid valve
5	Master brake valve
6	Braking air chamber

The signal sensing system is composed of the gear ring, sensor, and wires that are fixed onto the wheel hub. The sensor is fixed onto the wheel hub bracket and works with gear ring to form one set of signal transmission system. When the wheel is rotating, the sensor real-time transmits the pulse signal that is synchronized with the wheel speed to the central control unit.

The central control unit processes the wheel speed signal inputted. At the braking of the vehicle, it real-time controls the ABS solenoid valve (actuator) and continually adjusts the pressure of the brake branch chamber via the ABS solenoid valve. When the wheels start to tend to be locked under high brake air pressure, the central control unit immediately bleeds the air via the solenoid valve and lowers the air pressure of the brake branch chambers so that the wheels are always maintained at the best braking status, namely at the borderline between slip and rolling.

The warning indicator system is composed of the central control unit and ABS warning indicator, which can not only indicate whether the ABS system functions normally, but also indicate the malfunction location of ABS via different flashing modes of the indicator lamp.

There are many arrangement modes for the ABS system. The basic configuration adopted in this vehicle is as below:



1	Gear ring
2	Sensor
3	Braking air chamber
4	ABS solenoid valve

5	ECU
6	Tee joint
7	Main brake valve
8	Air reservoir

PRECAUTIONS

1. Operation Precautions of Brake System

- (a). Replace each part in careful and correct manner, otherwise it will impair the performance of brake system and may endanger the personal safety.
- (b). Make sure to use the original genuine parts.
- (c). Keep clean the parts and the service site.
- (d). The brake pipeline is one critical safety part. Any leakage detected shall be serviced timely and replaced as required.
- (e). While operating the brake pipeline, seal the pipe openings with plugs to prevent the ingress of foreign materials (such as dust and mud) into the pipeline.
- (f). While disassembling or installing the brake pipeline, make sure not to bend or deform the brake pipeline.
- (g). All the buckles and cable ties removed shall not be reused.

2. Maintenance Precautions for Brake System

- (a). Perform the periodical checking at interval of 5,000km mileage.
 - Check the gap between brake shoe friction plate and brake drum.
 - Check the wearing status of the brake shoe friction plate.
 - Check the travel and free travel of the brake pedal.
 - Check the damage status of the brake pipeline.
 - Check various connections for looseness.
 - Check whether the brake system functions normally.

3. Installation precautions for the parts of brake system

- (a). The drier must be installed vertically and the temperature of the intake port shall not exceed + 65°C.
- (b). The exhaust port of trailer valve shall face downward and the maximum angle between valve body centerline and the vertical line is 90°.

TABLE OF FAULT PHENOMENON

The table below can be used to help find out the cause of the faults, in which the numerical sequence stands for the priority sequence of the faults. Check each part in order as per this sequence and as necessary replace with new one.

Table of Fault Phenomenon	Suspected Cause	Reference
Braking stagnation	1. Free travel of brake pedal (too small)	Chapter 26 Service Brake – Service Brake System, Testing and Adjustment
	2. Brake gap (too small)	Chapter 26 Service Brake - Service Brake System, Testing and Adjustment
	3. Master brake valve (Failed)	Chapter 26 Service Brake - Master Brake Valve, Service
	4. Brake pedal (distorted)	Chapter 26 Service Brake - Brake Pedal, Replacement
	5. Brake air chamber push rod (damaged)	Chapter 26 Service Brake - Front Brake Air Chamber, Service Chapter 26 Service Brake - Rear Brake Air Chamber, Service
	6. Wheel hub bearing (loose)	Chapter 24A Front Axle (Ankai) – Front Wheel Hub, Service Chapter 25 Rear Axle – Wheel Hub Bearing, Oil Seal, Service
	7. Brake shoe return spring (too soft or broken)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	8. Brake air chamber diaphragm (aged)	Chapter 26 Service Brake - Front Brake Air Chamber, Service Chapter 26 Service Brake - Rear Brake Air Chamber, Service

Abnormal braking noise	1. Brake shoe friction plate (exposed rivet)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	2. Brake shoe friction plate (hardened)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	3. Brake drum (abnormal wearing)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	4. Brake drum (distorted)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	5. Wheel hub bearing (excessive wearing)	Chapter 24A Front Axle (Ankai) - Front Wheel Hub, Service Chapter 25 Rear Axle - Wheel Hub Bearing, Oil Seal, Service
Braking out-of-control	1. Air compressor (damaged)	Chapter 16 Engine Mechanical Part - Engine Accessories, Replacement
	2. Brake pedal (loose)	Chapter 26 Service Brake - Brake Pedal, Replacement
	3. Brake air chamber (failed)	Chapter 26 Service Brake - Front Brake Air Chamber, Service Chapter 26 Service Brake - Rear Brake Air Chamber, Service

Unstable braking	1. Tire pressure (uneven)	Chapter 23 Tires and Wheels – Front Tire and Wheel, Service Chapter 23 Tires and Wheels – Rear Tire and Wheel, Service
	2. Left/right brakes (improper adjustment)	Chapter 26 Service Brake – Service Brake System, Testing and Adjustment
	3. Return spring (damaged)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	4. Brake friction plate (hardened)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	5. Brake base plate (damaged)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	6. Leaf spring U-shaped bolt (loose)	Chapter 21 Front Suspension – Front Leaf Spring, Service Chapter 22 Rear Suspension – Rear Leaf Spring, Service
Braking off-tracking	1. Friction plate (one-side polished)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake – Rear Brake Shoe, Service
	2. Friction plate (operation error)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake – Rear Brake Shoe, Service
	3. Brake gap (abnormal)	Chapter 26 Service Brake – Service Brake System, Testing and Adjustment
	4. Brake air chamber (uneven air pressure)	Chapter 26 Service Brake – Front Brake Air Chamber, Service Chapter 26 Service Brake - Rear Brake Air Chamber, Service

Insufficient braking force	1. Air compressor (failed)	Chapter 16 Engine Mechanical Part – Engine Accessories, Replacement
	2. Relay valve (damaged)	Chapter 26 Service Brake - Relay Valve, Service
	3. Brake friction plate (hardened)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	4. Brake drum or brake friction plate (oil stain)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake - Rear Brake Shoe, Service
	5. Brake air chamber push rod (distorted)	Chapter 26 Service Brake – Front Brake Air Chamber, Service Chapter 26 Service Brake - Rear Brake Air Chamber, Service
Smoking at braking	1. Half shaft oil seal (damaged)	Chapter 25 Rear Axle –Half Shaft, Service
	2. Brake gap (too small)	Chapter 26 Service Brake – Service Brake System, Testing and Adjustment
	3. Axle housing oil (excessive)	Drain the excessive oil
	4. Brake friction plate (operation error)	Chapter 26 Service Brake - Front Brake Shoe, Service Chapter 26 Service Brake – Rear Brake Shoe, Service

TESTING AND ADJUSTMENT

Service of Brake Valve

1. Checking of Air Leakage

- (a). Supply the compressed air to the air supply end.
- (b). Check the air supply end for presence of air leakage.

2. Measure the pedal angle at the start of the pedal.

- (a). Supply the compressed air to the air supply end.
- (b). Place one angle gauge and one pressure gauge at the air supply end and measure the pedal angle when the reading of the air pressure gauge is increased to 34.3kPa.
 - Pedal angle: $4^{\circ} \pm 0.5^{\circ}$

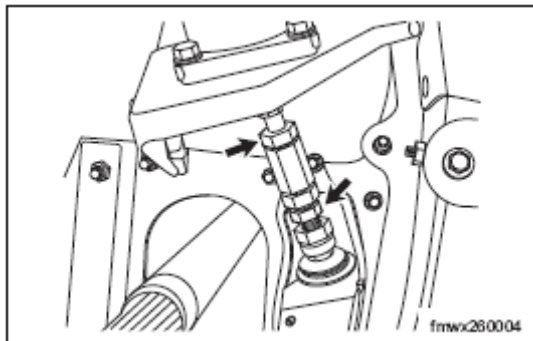
3. Measure the pressure of air supply end when the pedal is stepped down to the end.

- (a). Read out the pressure reading at the air supply end when the pedal is stepped down to the end.
 - Standard value: 368kPa

4. When the pedal is stepped down to the end, measure the pedal force at the location 150mm away from the pedal pivot.

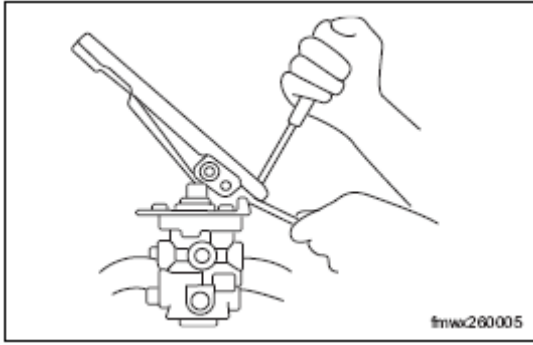
- (a). When the pedal is stepped down to the end, measure the pedal force at the location 150mm away from the pedal pivot.
 - Pedal force: 130N

Brake Pedal Gap



1. Adjust the connection between brake pedal and master brake valve.

- (a). Loosen the fixing nut.
- (b). Rotate the adjustment nut.
- (c). Tighten the fixing nut.



2. Adjust the adjustment screw on the brake pedal.

- (a). Adjust the free travel of pedal.
- (b). Use the adjustment screw at the lower end of pedal to adjust the free travel.
- (c). Lock the lock nut.

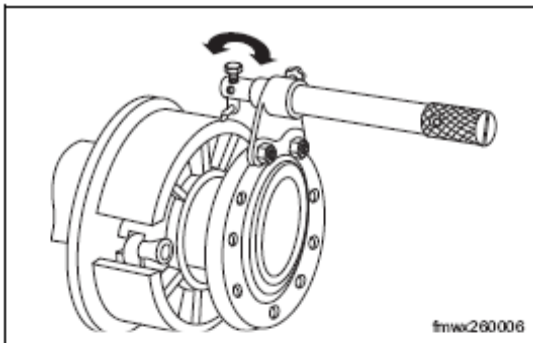
Polishing of Brake Shoe

Notice:

The feed for each polishing shall not exceed 1mm.

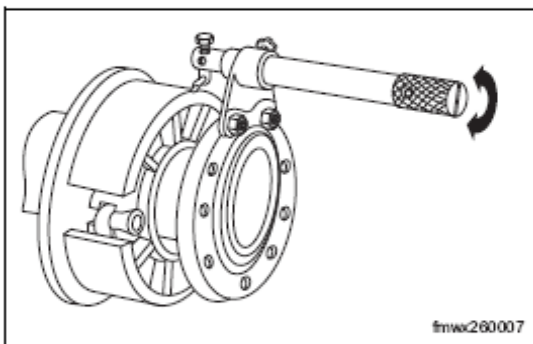
Notice:

The brake friction plate shall not be too close to the brake base plate. Once the polishing is completed, release the lever immediately. In such case, the polisher continues to rotate along with the wheel hub, however the lever will not rotate with respect to the polisher spindle so that the cutter bar stops feeding to prevent the polisher cutter bar from colliding with the brake base plate.



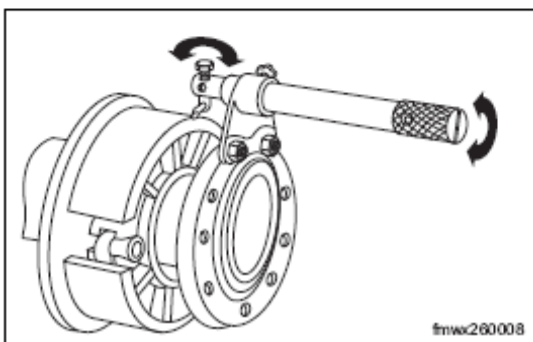
1. Install the polisher

- (a). Tighten the adjustment nut of the brake adjustment arm to completely cling the brake shoe friction plate onto the brake drum.
- (b). Loosen the adjustment nut by one turn.
- (c). Disassemble the brake drum.
- (d). Gotten the adjustment nut by one turn to completely cling the brake friction plate onto the brake drum again.
- (e). Fix the polisher onto the wheel hub.



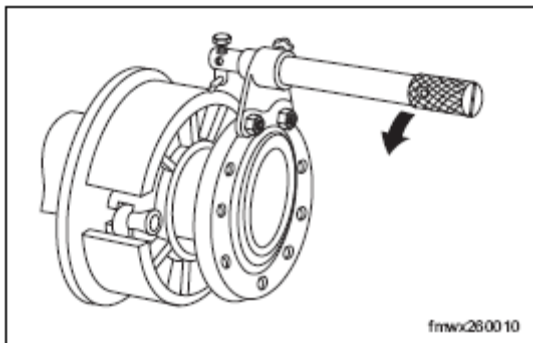
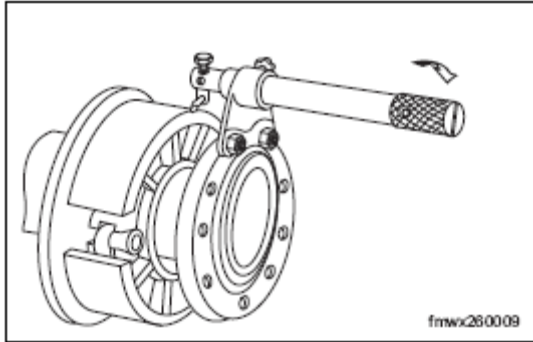
2. Position the main cutter bar

- (a). Loosen the spindle fixing hand wheel.
- (b). Adjust the spindle location, position the cutter bit to the edge of the friction plate.
- (c). Tighten the hand wheel to fix the spindle.



3. Setup the cutter

- (a). Turn up the quick feed handle of the spindle hand wheel.
- (b). Use the quick feed handle to move in the cutter bar so that the cutter bit is within the friction plate.
- (c). Rotate the cutter setting handle to align with surface of friction plate.



- (d). Then loosen by 1/5~1/4 turn to ensure that the outside diameter of the polished brake shoe friction plate is larger than the inside diameter of brake drum by 0.20~0.25mm.
- (e). Tighten the cutter setting handle.
- (f). Use the quick feed handle to withdraw the cutter bar to the edge position of the friction plate.

4. Polish the friction plate of front wheel brake shoe.

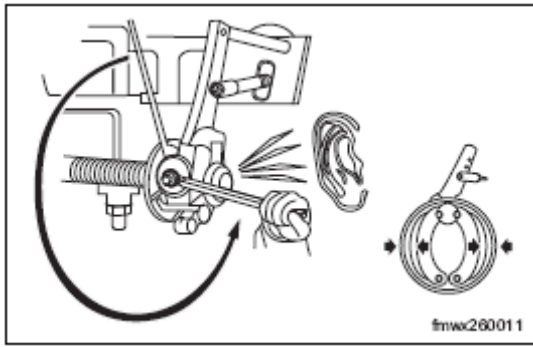
- (a). Adjust the brake adjustment arm to increase the diameter of brake shoe friction plate by 1~2mm.
- (b). Hold the spindle lever with hand and rotate the wheel hub clockwise.
 - The polisher automatically feeds along with the rotation of wheel hub.

5. Polish the friction plate of rear wheel brake shoe.

- (a). Polish the friction plate of left rear wheel brake shoe.
 - Shift the transmission to reverse gear and start the engine.
 - Use the clutch to control the rotation of rear wheel hub.
- (b). Polish the friction plate of right rear wheel brake shoe.
 - Shift the transmission to 3rd forward gear and start the engine.

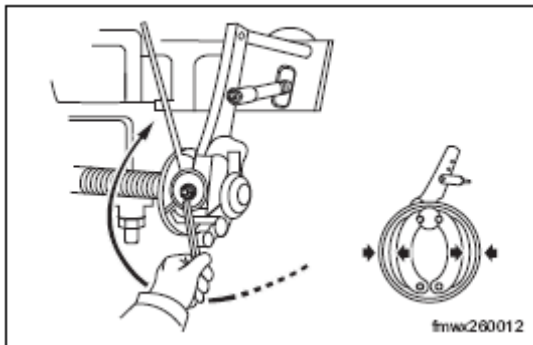
- 6. Disassemble the polisher.
- 7. Adjust the brake adjustment arm to reduce the brake shoe diameter and install into the brake drum.
- 8. Adjust the gap of the brake shoe.

Adjustment of Brake Gap



1. Partial Adjustment

- (a). Thoroughly clean the mud and oil stains from the adjustment arm.
 - If the locking sleeve can't be pressed, it's allowed to knock the wrench with hammer lightly.
- (b). Rotate clockwise the adjustment nut on the adjustment arm.
 - Till the nut can't be rotated further.
 - In such case, the brake gap is zero.
- (c). Rotate the adjustment nut counter-clockwise by 3/4 turn (270°).
 - One "click" sound can be heard.
- (d). Apply the brake for several times.



2. Complete Adjustment

- (a). Lift the axles to lift the wheels from the ground.
- (b). Loosen the split pin of brake air chamber push rod connecting fork and remove the hinge pin.
- (c). Adjust the adjustment nut of the adjustment arm by 3/4 turn to ensure that the brake drum can rotate freely, without any friction with the friction plate.
- (d). Check the brake gap.
- (e). Adjust the travel of brake air chamber push rod.
 - Loosen the lock nut of push rod connecting fork and adjust the travel of push rod.
 - Connect the split pin of brake air chamber push rod connecting fork and lock the split pin.

Adjustment of Brake Air Chamber

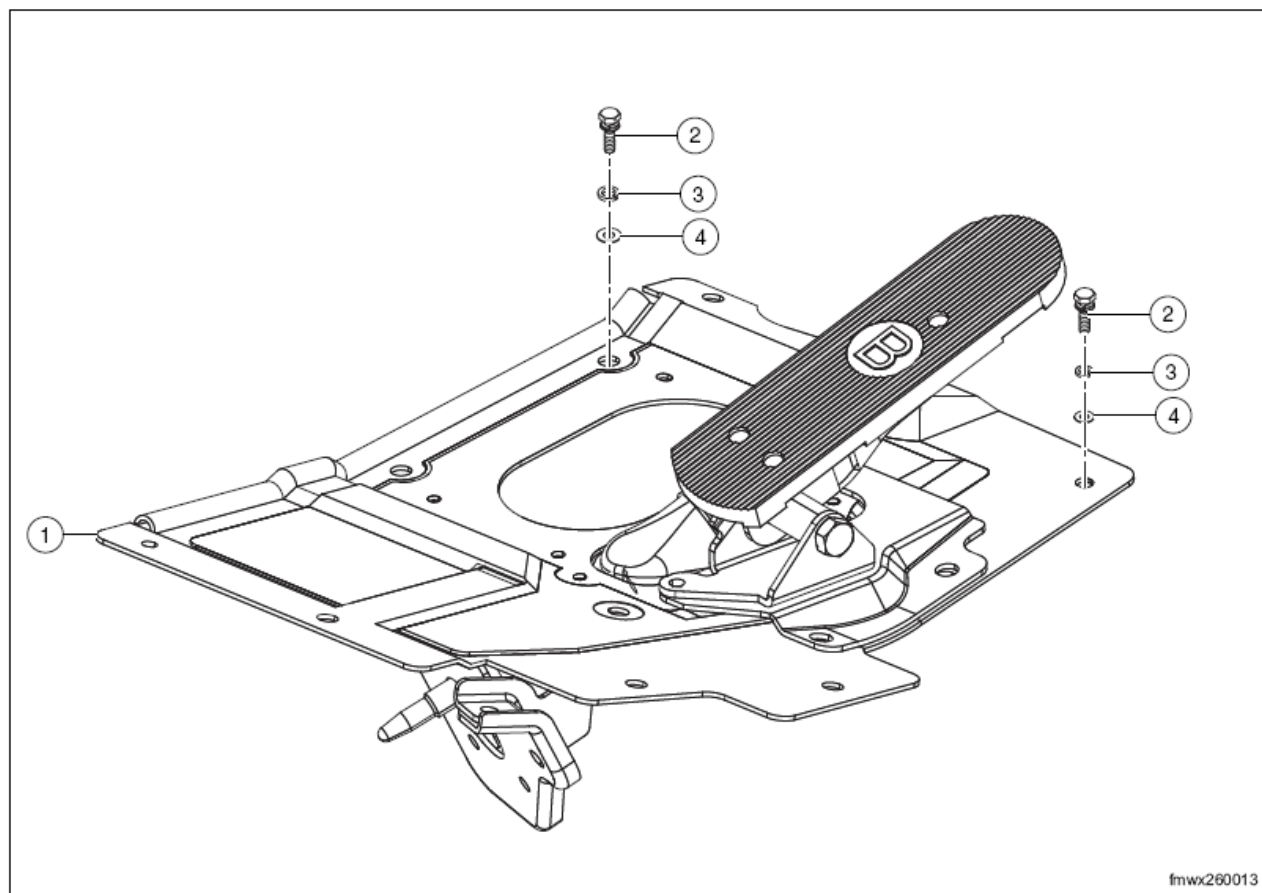
1. While installing the brake air chamber, determine the initial length of the push rod to ensure that the angle between the adjustment arm and the air chamber push rod shall not exceed $100^{\circ}\sim 105^{\circ}$, otherwise the initial force of the brake air chamber will be dropped.
2. Charge the compressed air into the diaphragm chamber of the brake air chamber and measure the travel of push rod with a height gauge.
3. After the adjustment, the travel of the brake air chamber shall not exceed the values given in the table below, otherwise the effective braking can't be guaranteed.

Item	Standard value	
	Front Brake Air Chamber	Rear Brake Air Chamber
Maximum travel of push rod	60mm	67mm

4. At the end of adjusted travel, the axis of the push rod shall be perpendicular to the centerline of the adjustment arm as far as possible, in order to ensure the maximum torque output. During the reciprocating movements of the push rod, the swing angle of the push rod shall vary within $\pm 3^{\circ}$, in order to reduce the wearing of air chamber parts.
5. Provided that the wheels are free of braking dragging, adjust the travel of adjustment arm to as minimum as possible, in order to reduce the consumption of compressed and guarantee the braking safety.
6. At completion of installation, charge the compressed air into the spring chamber and use a wrench to rotate the bolt back into the cylinder block, till the release nut comes into contact with the cylinder block nut.

BRAKE PEDAL

DIAGRAM OF COMPONENTS



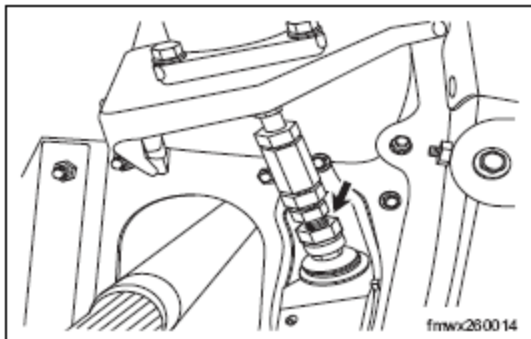
1	Brake pedal assembly
2	Hex head bolt, spring washer, and plain washer subassembly

3	Spring washer
4	Plain washer

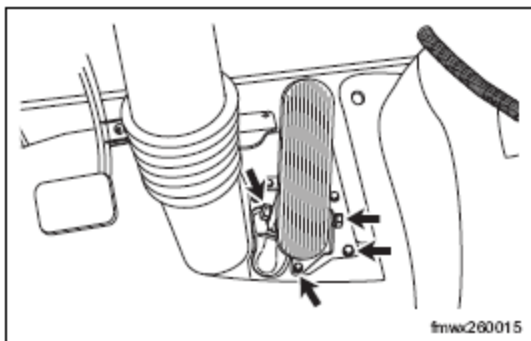
REPLACEMENT

Hint:

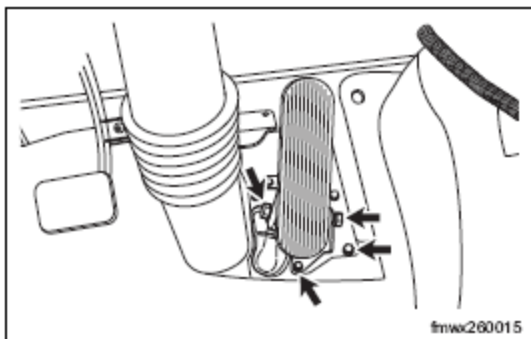
Please refer to Chapter 26 Service Brake - Brake Pedal, Diagram of Components for the diagram of components.



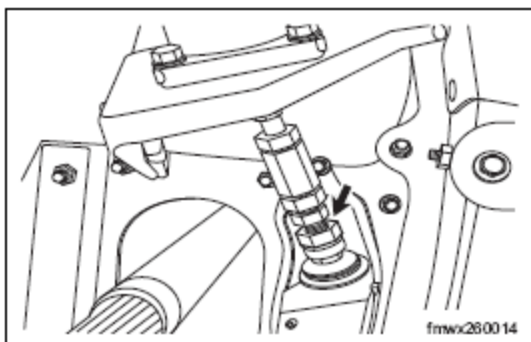
1. **Remove the brake pedal assembly.**
 - (a). Disassemble the master brake valve control lever.



- (b). Upturn the carpet.
 - (c). Disassemble the fixing bolts of brake pedal.



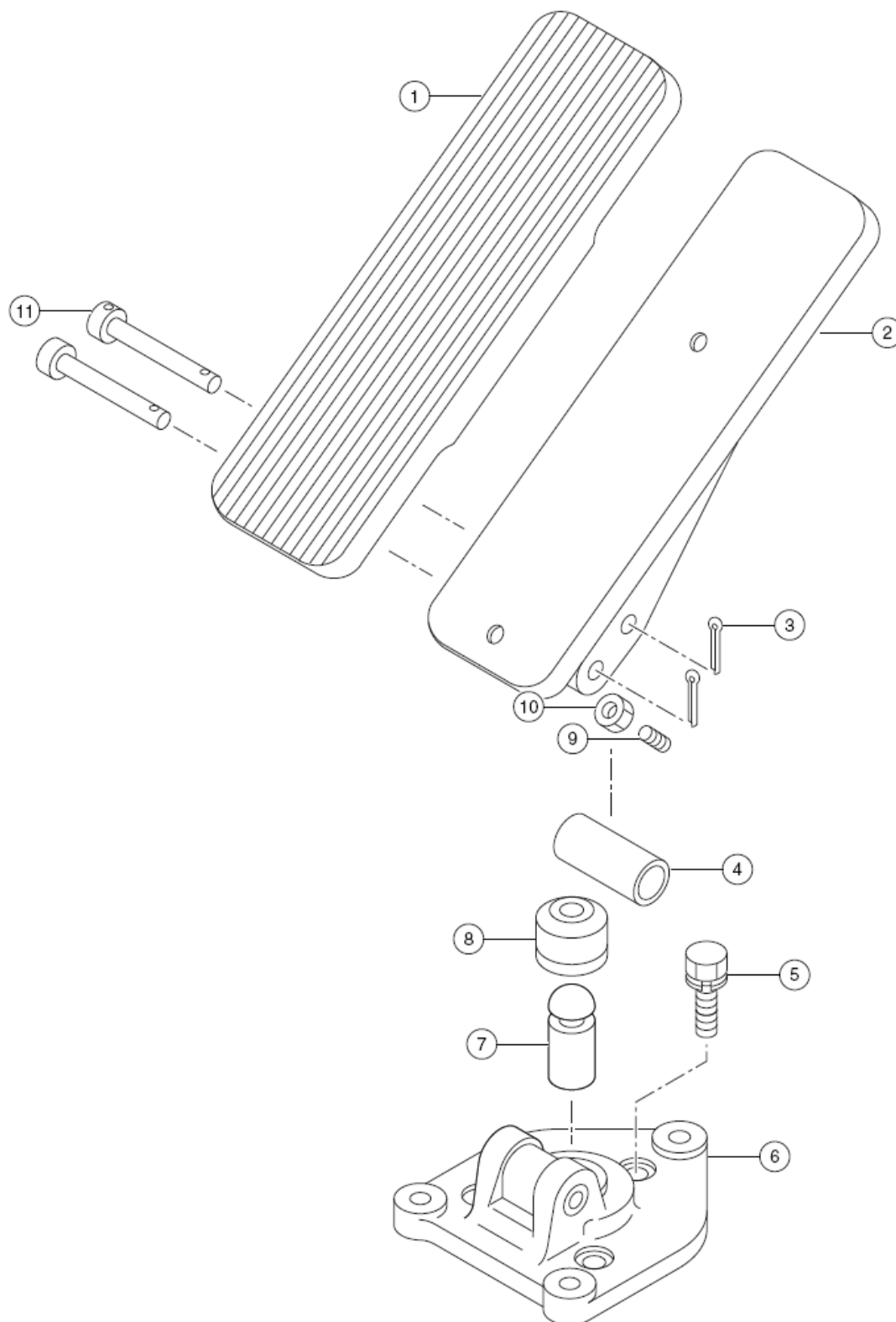
2. **Install the brake pedal assembly**
 - (a). Install the fixing bolts of brake pedal.
Torque: 25N·m
 - (b). Turn down the carpet.



- (c). Install the master brake valve control lever.
 - (d). Adjust the gap of brake pedal (Refer to Chapter 26 Service Brake – Service Brake System, Testing and Adjustment).

BRAKE PEDAL (RIGHT-HAND DRIVE)

DIAGRAM OF COMPONENTS



fmwx260016

1 Pedal cover

7 Electromagnetic core

SERVICE BRAKE-BRAKE PEDAL (RIGHT-HAND DRIVE)

26-27

2	Brake Pedal
3	Split pin
4	Roller
5	Bolt
6	Fixing plate

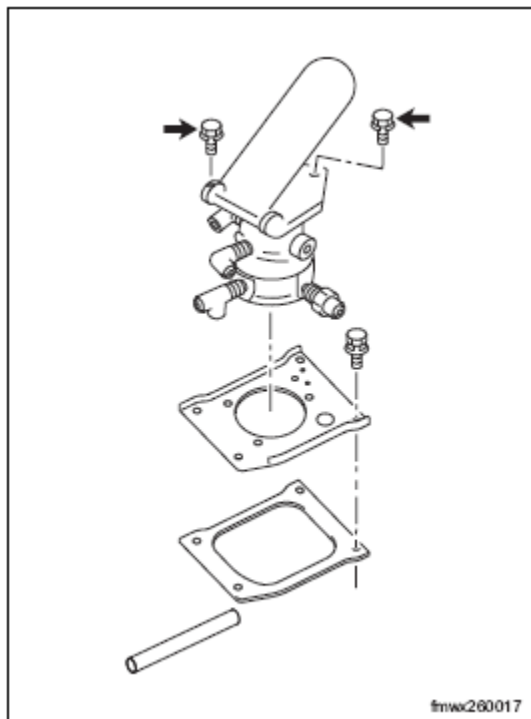
8	Electromagnetic core shield
9	Adjustment bolt
10	Nut
11	Straight pin



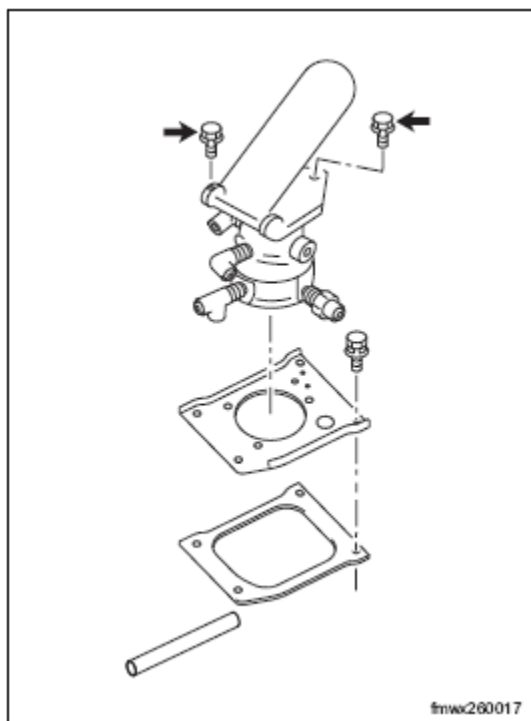
REPLACEMENT

Hint:

Please refer to Chapter 26 Service Brake - Brake Pedal Right-Hand Drive), Diagram of Components for the diagram of components.



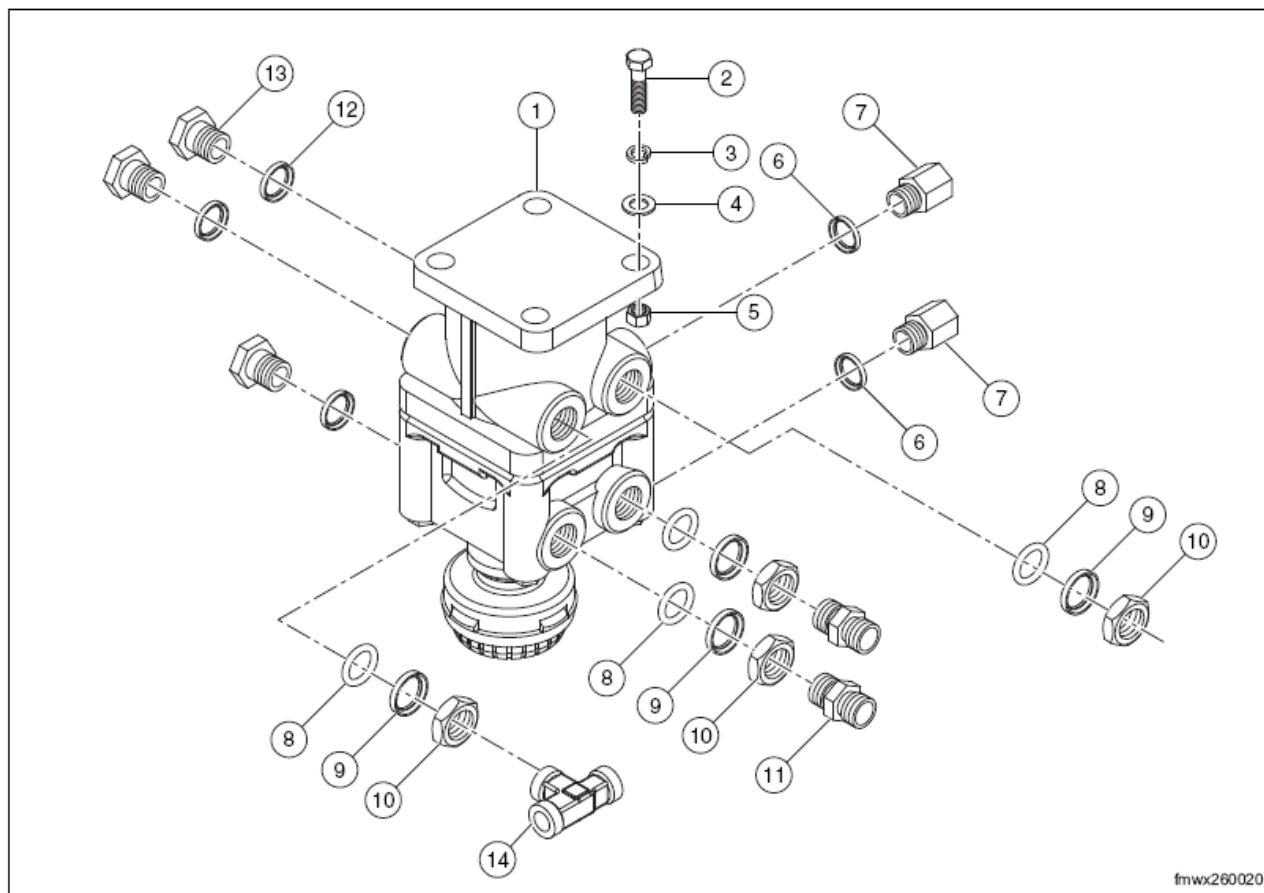
1. **Remove the brake pedal assembly.**
 - (a). Upturn the carpet.
 - (b). Disassemble the fixing bolts of brake pedal.



2. **Install the brake pedal assembly**
 - (a). Install the fixing bolts of brake pedal.
Torque: 25N·m
 - (b). Turn down the carpet.
 - (c). Adjust the gap of brake pedal (Refer to Chapter 26 Service Brake – Service Brake System, Testing and Adjustment).

MASTER BRAKE VALVE

DIAGRAM OF COMPONENTS



fmwx260020

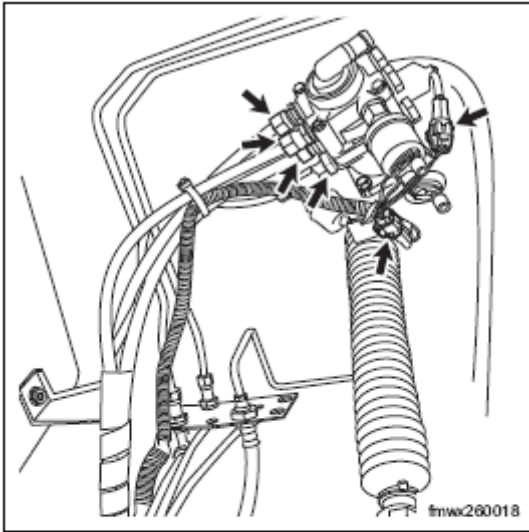
1	Brake valve assembly (with muffler)
2	Hexagon head bolt
3	Spring washer
4	Plain washer
5	1# hexagon nut
6	Sealing gasket
7	Transitional connector

8	Rubber O-ring
9	Sealing gasket
10	Hexagon thin nut – Fine thread
11	Clamping type thru reducing connector
12	Sealing gasket
13	Hexagon head screw plug
14	Transitional three-way connector



SERVICE

1. Relieve the pressure of brake system.
2. Upturn the vehicle head.



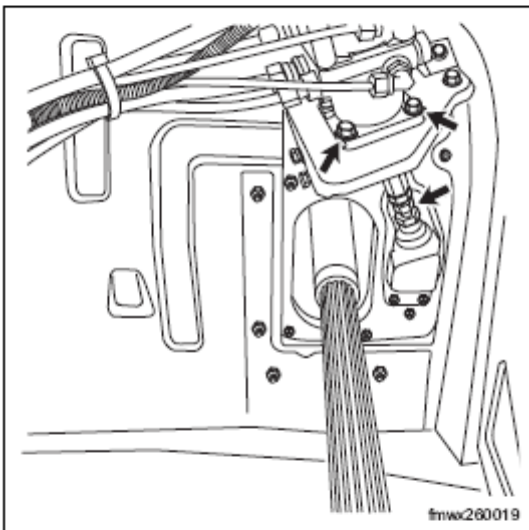
3. Disassemble the master brake valve.

- (a) Disconnect the master brake valve pipeline.

Notice:

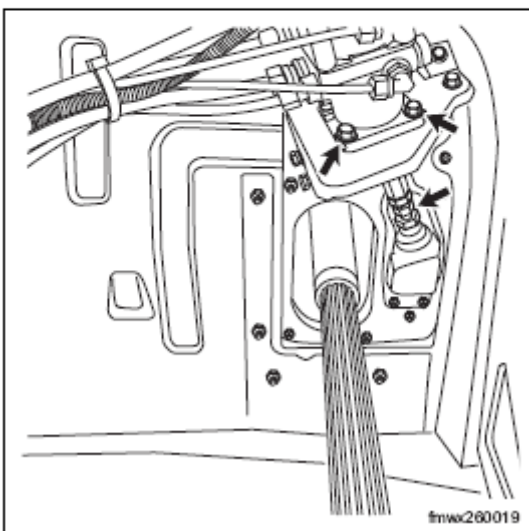
Add markings to the pipeline to prevent installation error.

- (b) Disconnect the connector of master brake valve.



- (c) Disassemble the connecting nuts between master brake valve and brake pedal.

- (d) Disassemble the fixing bolts of master brake valve.

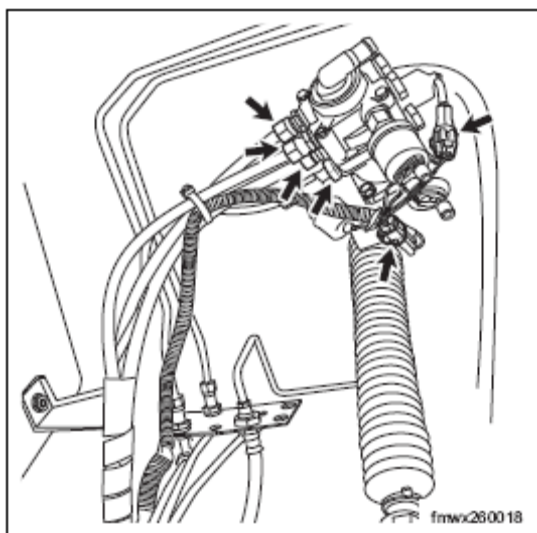


4. Install the master brake valve.

- (a) Install the fixing bolts of master brake valve.

Torque: 25N·m

- (b) Install the connecting nuts between master brake valve and brake pedal.

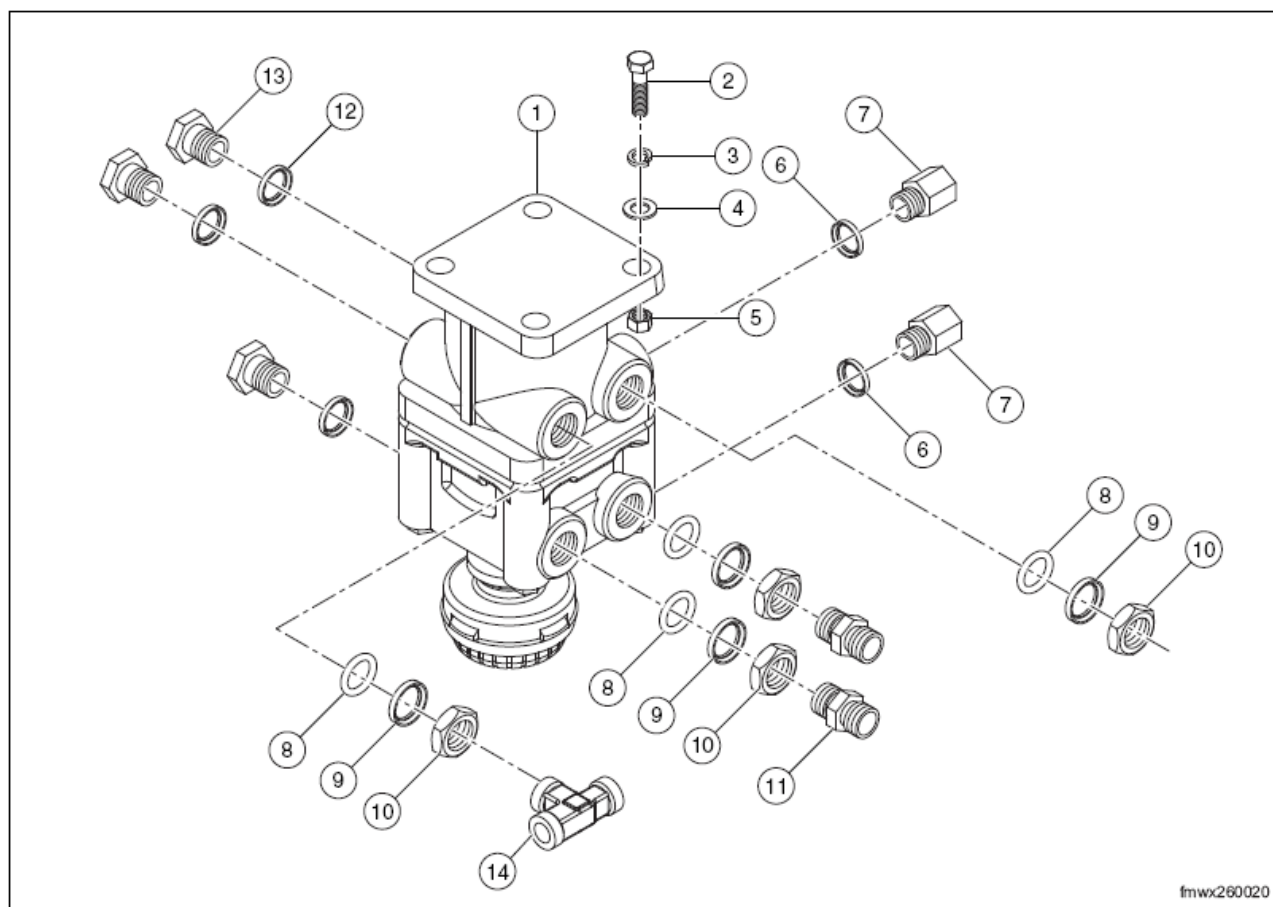


- (c). Connect the connector of master brake valve.
- (d). Connect the pipeline of master brake valve.
- (e). Adjust the gap of brake pedal (Refer to Chapter 26 Service Brake – Service Brake System, Testing and Adjustment).

5. Turn down the vehicle head.

MASTER BRAKE VALVE (RIGHT-HAND DRIVE)

DIAGRAM OF COMPONENTS



fmwx260020

1	Brake valve assembly (with muffler)
2	Hexagon head bolt
3	Spring washer
4	Plain washer
5	1# hexagon nut
6	Sealing gasket
7	Transitional connector

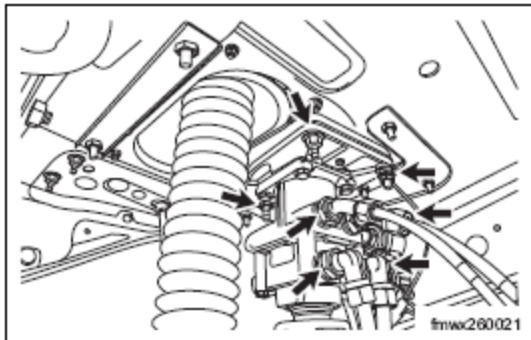
8	Rubber O-ring
9	Sealing gasket
10	Hexagon thin nut – Fine thread
11	Clamping type thru reducing connector
12	Sealing gasket
13	Hexagon head screw plug
14	Transitional three-way connector

SERVICE

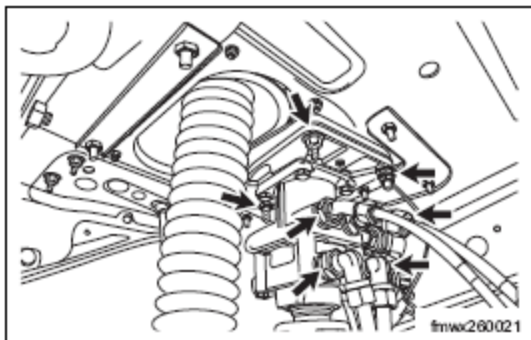
Hint:

Please refer to Chapter 26 Service Brake - Master Brake Valve, Diagram of Components for the diagram of components.

1. **Relieve the pressure of brake system.**
2. **Upturn the vehicle head.**



3. **Disassemble the master brake valve.**
 - (a). Disconnect the master brake valve pipeline.
 - (b). Disassemble the fixing bolts of master brake valve.

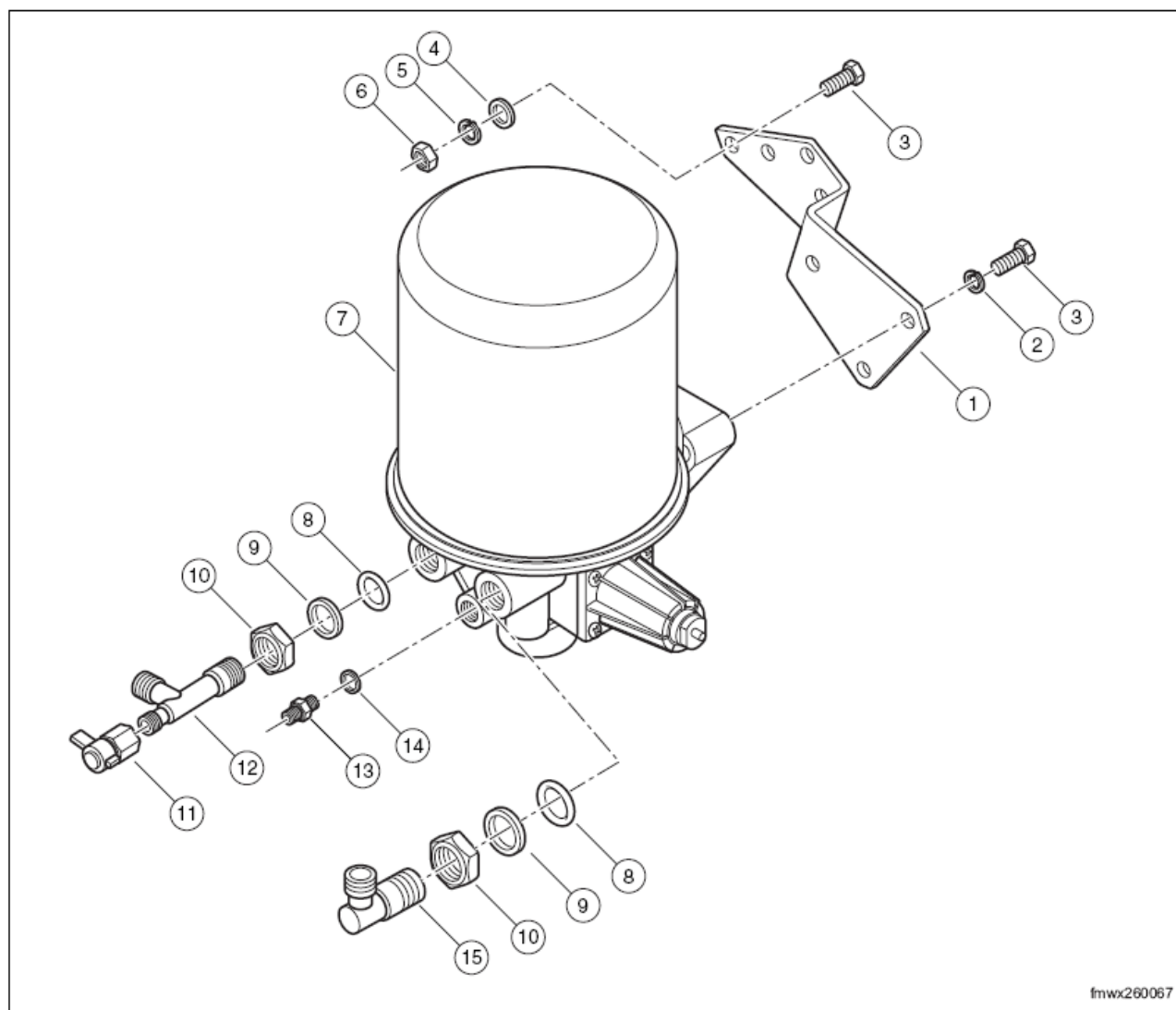


4. **Install the master brake valve.**
 - (a). Install the fixing bolts of master brake valve.
Torque: 25N·m
 - (b). Connect the pipeline of master brake valve.
 - (c). Adjust the gap of brake pedal (Refer to Chapter 26 Service Brake – Service Brake System, Testing and Adjustment).

5. **Turn down the vehicle head.**

DRIER

DIAGRAM OF COMPONENTS



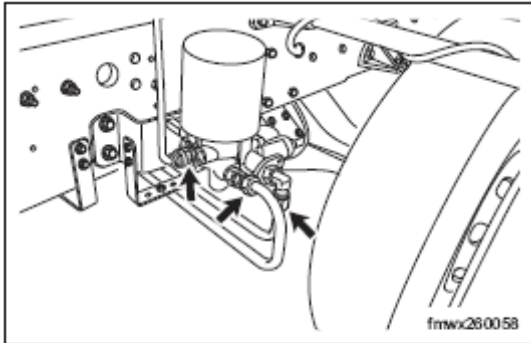
fmwx260067

1	Drier angle bracket
2	Spring washer
3	Hexagon thin nut – Fine thread
4	Plain washer
5	Heavy spring washer
6	1# hexagon nut
7	Combined air drier assembly
8	Rubber O-ring

9	Sealing gasket
10	Hexagon thin nut – Fine thread
11	Testing connector
12	Clamping type three-way connector
13	Clamping type thru reducing connector
14	Sealing gasket
15	Clamping type adjoining right angle connector

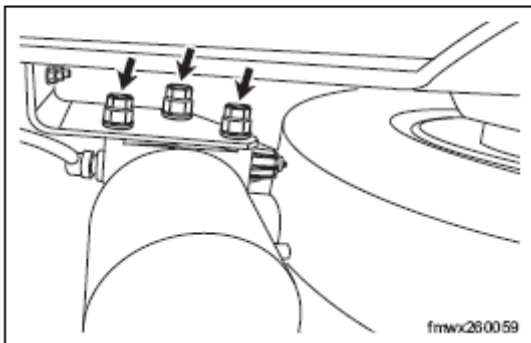
SERVICE

1. Relieve the pressure of brake system.



2. Disassemble the drier.

(a). Disconnect the drier pipeline.



(b). Disassemble the drier fixing bolts.

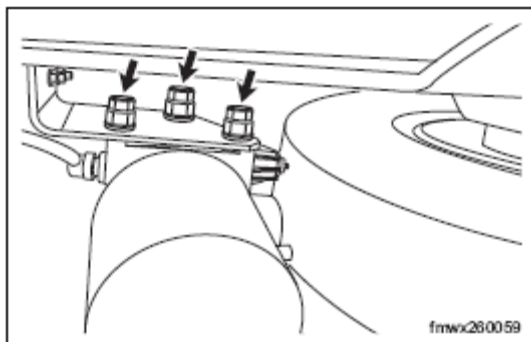
3. Check the drier.

(a). Check the pressure regulator valve.

- Check whether the check valve of the air vent is damaged.
- Check whether there is any foreign material between the check valve of air vent and the valve seat.
- Check whether the breathe hole on the top cover of the pressure regulator valve is blocked.
- Check whether the seals at the pressure regulator valve exhaust port are damaged.

(b). Check the exhaust valve.

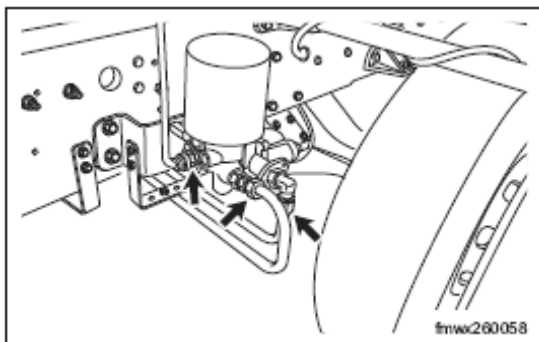
- Check whether the seals of exhaust valve are damaged.
- Check whether there is any foreign material between the exhaust valve body and the valve seat.



4. Install the driver.

(a) Install the drier fixing bolts.

Torque: 60N·m

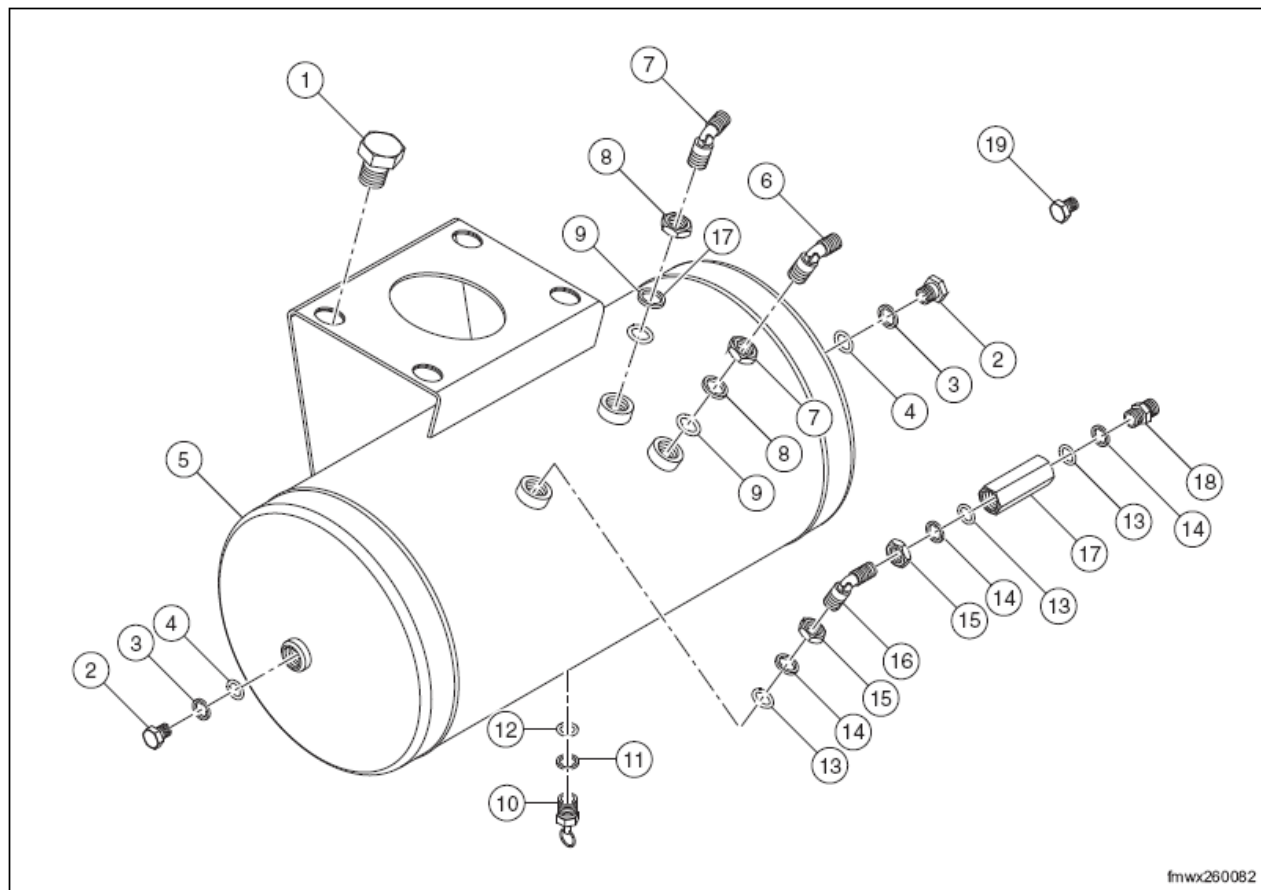


(b). Connect the drier pipeline.

AIR RESERVOIR

DIAGRAM OF COMPONENTS

Rear Air Reservoir



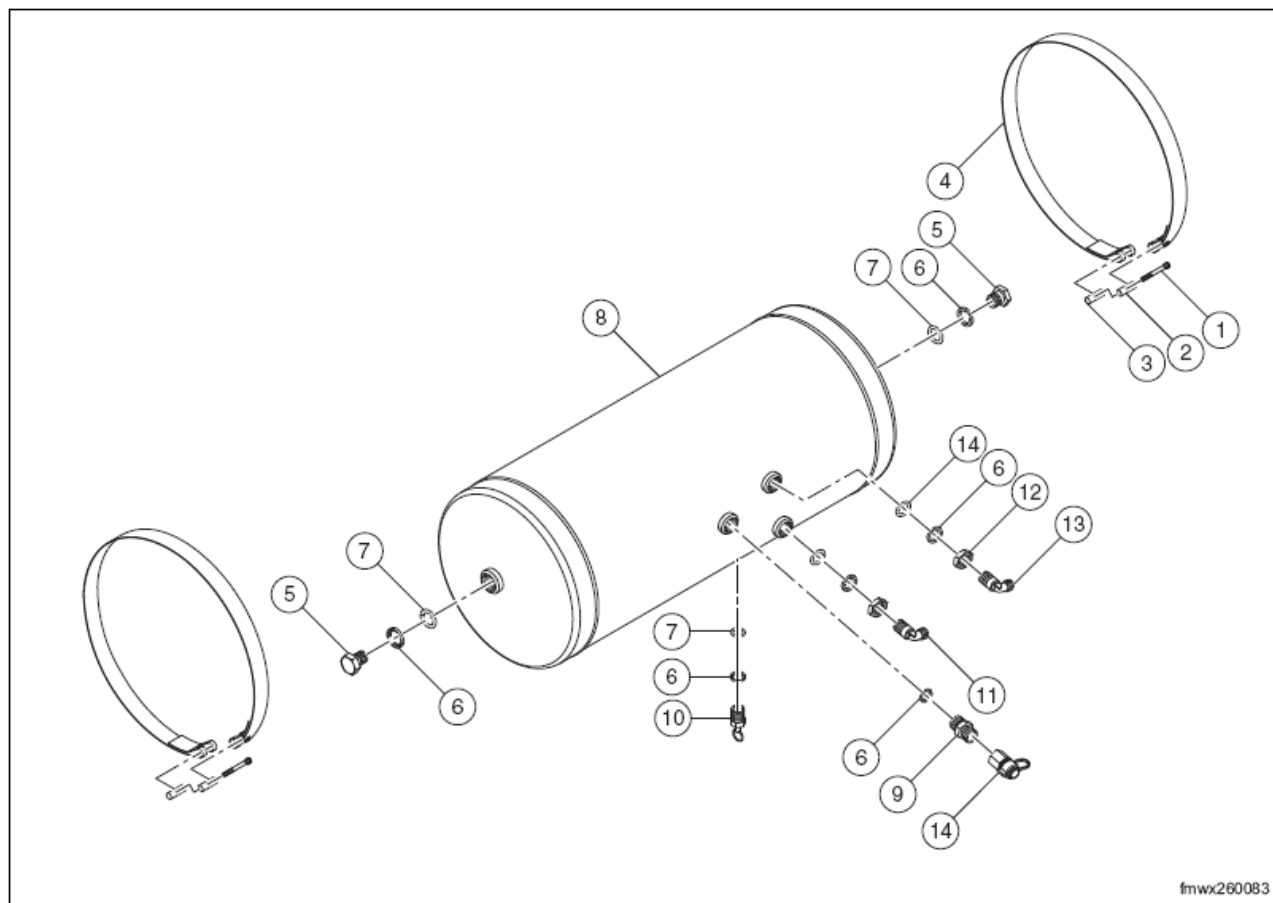
fmwx260082

1	Hexagon head bolt
2	Hexagon head screw plug
3	Sealing gasket
4	Rubber O-ring
5	Air reservoir assembly with bracket
6	Clamping type right angle reducing connector
7	Hexagon thin nut – Fine thread
8	Sealing gasket
9	Rubber O-ring
10	Manual water drainage valve

11	Sealing gasket
12	Rubber O-ring
13	Rubber O-ring
14	Sealing gasket
15	Hexagon thin nut – Fine thread
16	Clamping type right angle connector
17	Check valve
18	Clamping type thru reducing connector
19	All-metal hexagon flange bolt



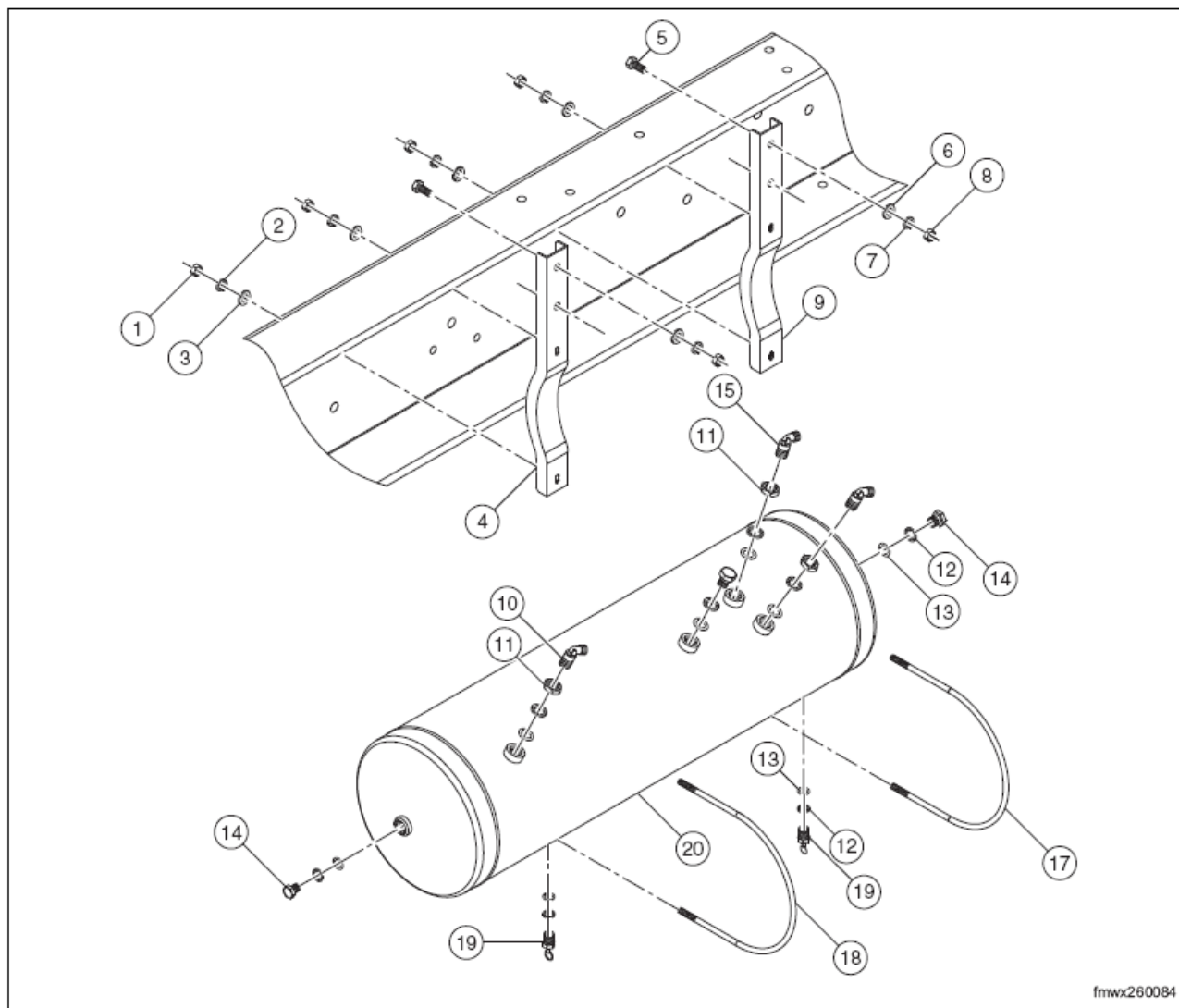
30L Air Reservoir



fmwx260083

1	Hexagon socket bolt
2	Strain pin
3	Tensioning pin
4	Air reservoir fixing band
5	Hexagon head screw plug
6	Sealing gasket
7	Rubber O-ring

8	30L Air Reservoir
9	Thru connector
10	Manual water drainage valve
11	Clamping type right angle reducing connector
12	Hexagon thin nut – Fine thread
13	Clamping type right angle connector
14	Testing connector

Combined Air Reservoir


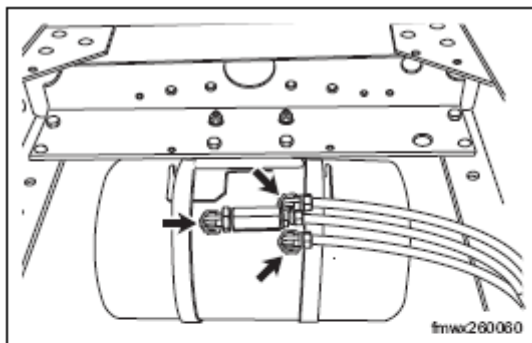
fmwx260084

1	1# hexagon nut
2	Spring washer
3	Plain washer
4	Combined air reservoir bracket
5	Hexagon head bolt
6	Plain washer
7	Spring washer
8	1# hexagon nut
9	Combined air reservoir bracket
10	Clamping type right angle connector

11	Hexagon thin nut – Fine thread
12	Sealing gasket
13	Hexagon head screw plug
14	Clamping type right angle reducing connector
15	Clamping type right angle reducing connector
16	Clamping type right angle connector
17	Combined air reservoir fixing band 1
18	Combined air reservoir fixing band
19	Manual water drainage valve
20	Combined air reservoir (40L/10L)

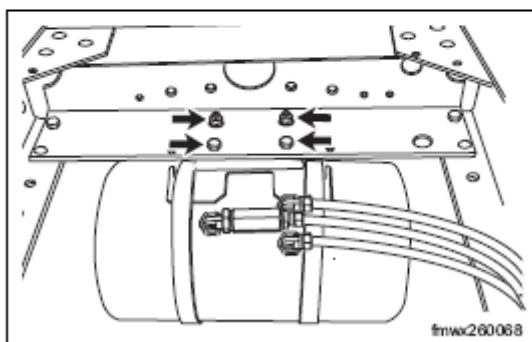
SERVICE

1. Relieve the pressure of brake system.

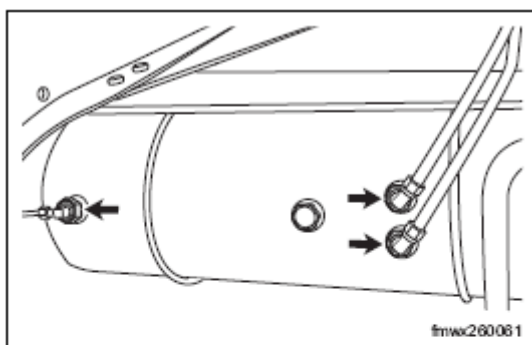


2. Disassemble the rear air reservoir.

(a). Disconnect the air pipe of rear air reservoir.

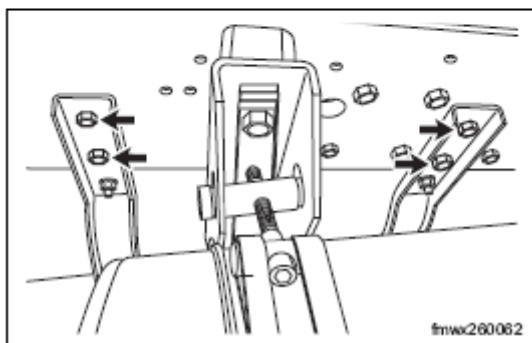


(b). Disassemble the fixing bolts of rear air reservoir fixing band and remove the rear air reservoir.

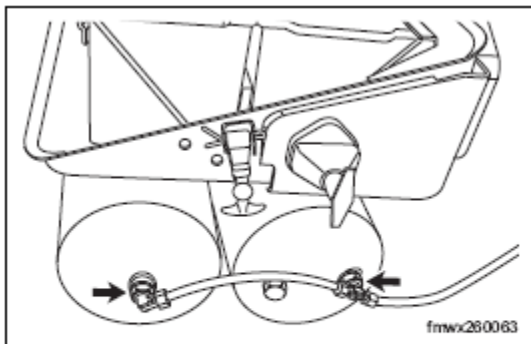


3. Disassemble the combined air reservoir.

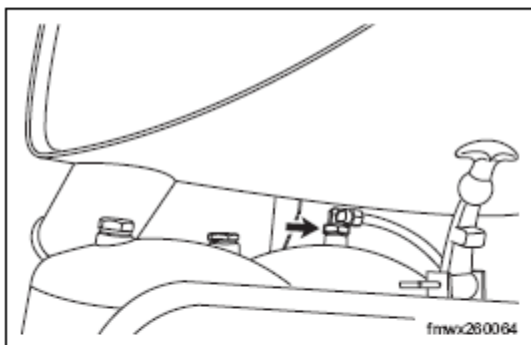
(a). Disconnect the air pipe of combined air reservoir.



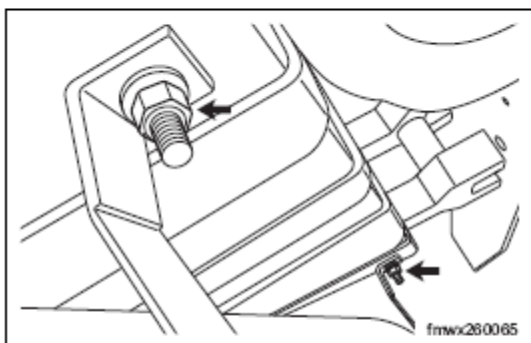
(b). Disassemble the fixing bolts of combined air reservoir fixing band and remove the combined air reservoir.



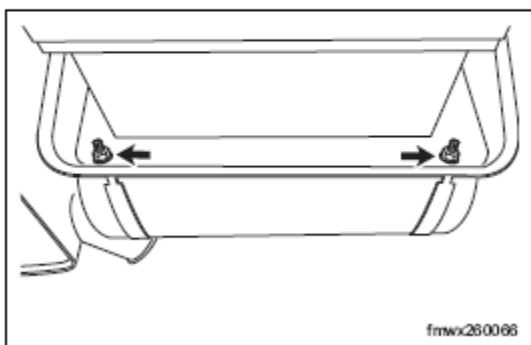
- 4. Disassemble the 30L air reservoir package.**
- (a). Disassemble the battery (Refer to Chapter 53 Battery – Battery, Replacement).
 - (b). Disconnect the air pipe on the rear side of the 30L air reservoir package.



- (c). Disconnect the air pipe on the front side of the 30L air reservoir package.



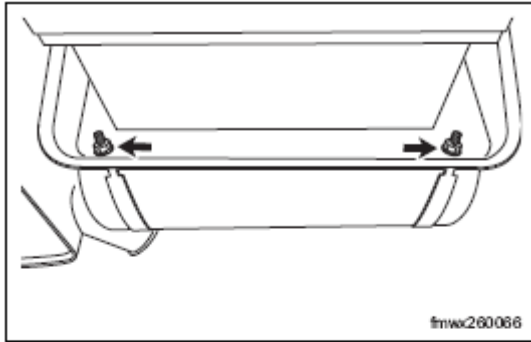
- (d). Disassemble the fixing nuts at the inner side of fixing band of the 30L air reservoir package.



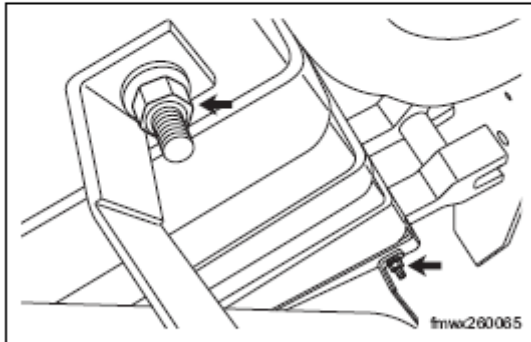
- (e). Disassemble the fixing nuts at the outer side of fixing band of 30L air reservoir package and remove the 30L air reservoir package.

5. Check the air reservoir.

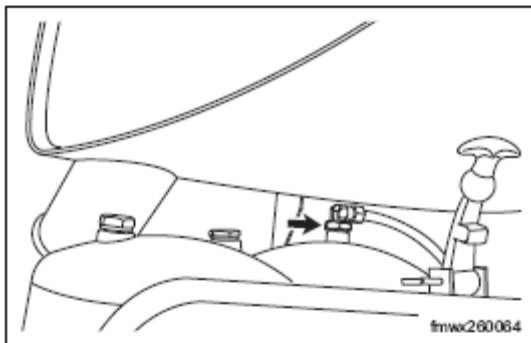
- (a). Check the air-tightness of air reservoir.
- (b). Check the air-tightness of water drainage valve.



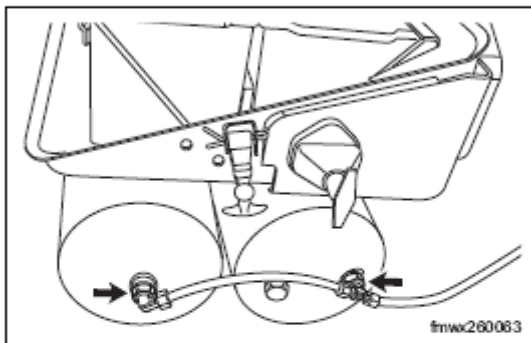
- 6. Install the 30L air reservoir package.**
- (a). Install the fixing nuts at the outer side of fixing band of 30L air reservoir package.
- Torque: 60N·m**



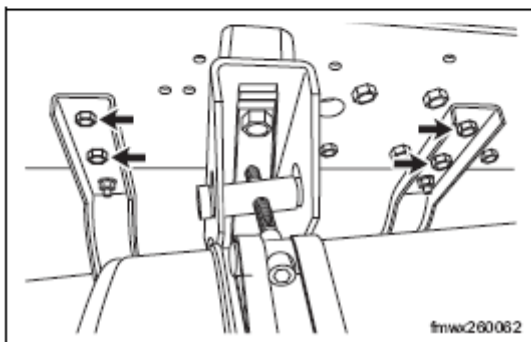
- (b). Install the fixing nuts at the inner side of fixing band of the 30L air reservoir package.
- Torque: 60N·m**



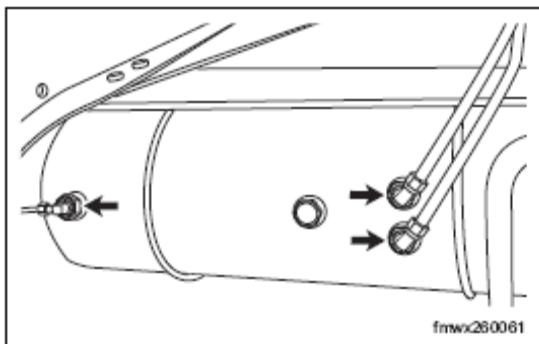
- (c). Connect the air pipe on the front side of the 30L air reservoir package.



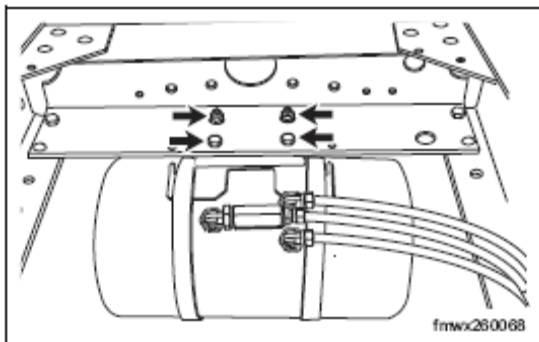
- (d). Connect the air pipe on the rear side of the 30L air reservoir package.
- (e). Install the battery (Refer to Chapter 53 Battery – Battery, Replacement).



- 7. Install the combined air reservoir.**
- (a). Install the fixing bolts of combined air reservoir fixing band.
- Torque: 60N·m**



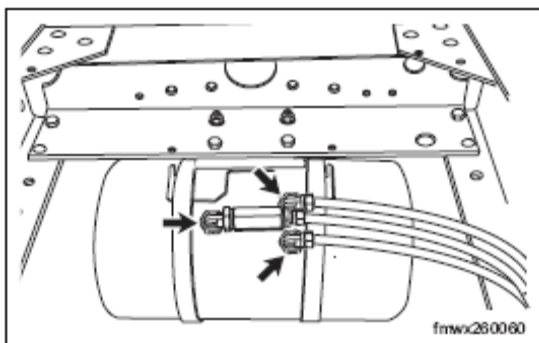
- (b). Connect the air pipes of combined air reservoir.



8. Install the rear air reservoir.

- (a). Install the fixing bolts of rear air reservoir fixing band.

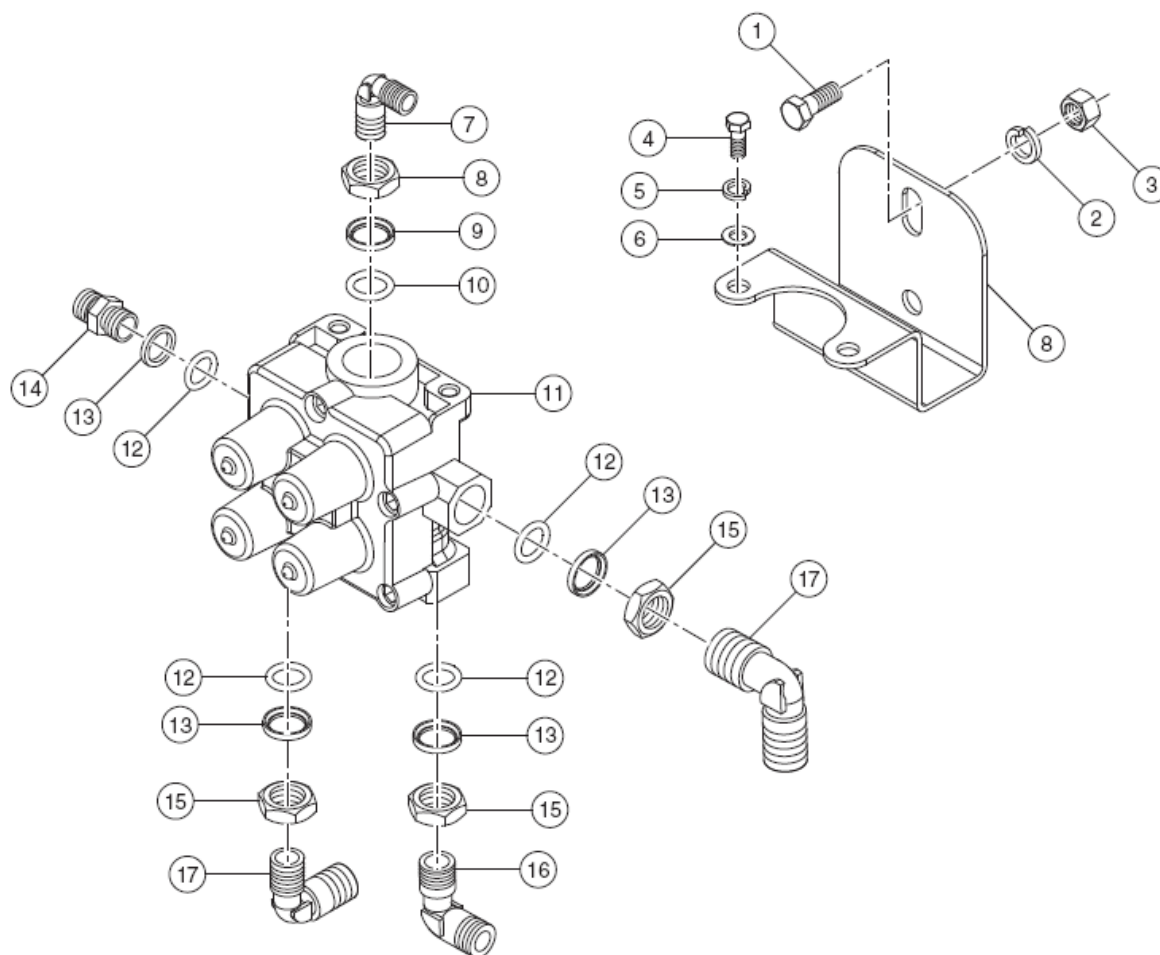
Torque: 60N·m



- (b). Connect the air pipes of rear air reservoir.

4-CIRCUIT PROTECTION VALVE

DIAGRAM OF COMPONENTS



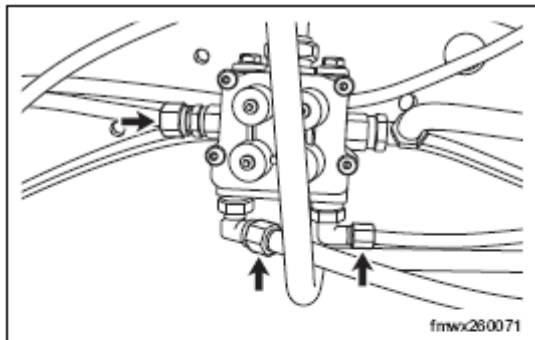
fmwx260085

1	Hexagon head bolt
2	Spring washer
3	1# hexagon nut
4	Hexagon head bolt
5	Spring washer
6	Plain washer
7	Clamping type adjoining right angle connector
8	Hexagon thin nut – Fine thread
9	Sealing gasket

10	Rubber O-ring
11	4-Circuit Protection Valve
12	Rubber O-ring
13	Sealing gasket
14	Clamping type thru reducing connector
15	Hexagon thin nut – Fine thread
16	Clamping type right angle connector
17	Clamping type right angle reducing connector
18	4-circuit valve bracket

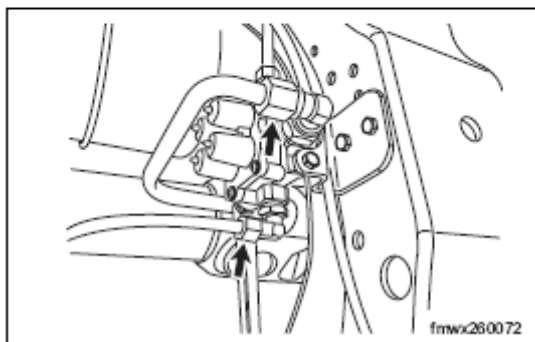
SERVICE

1. Relieve the pressure of brake system.



2. Disassemble the 4-circuit protection valve.

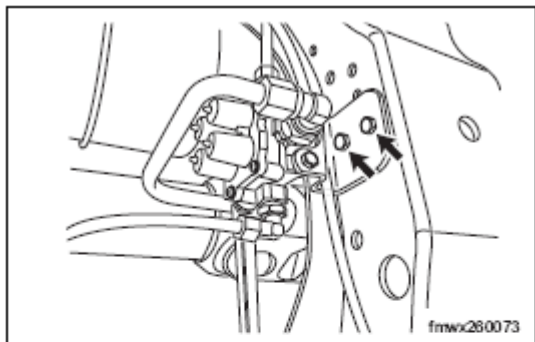
- (a). Disconnect the air pipes of 4-circuit protection valve.



- (b). Disconnect the air pipes of 4-circuit protection valve.

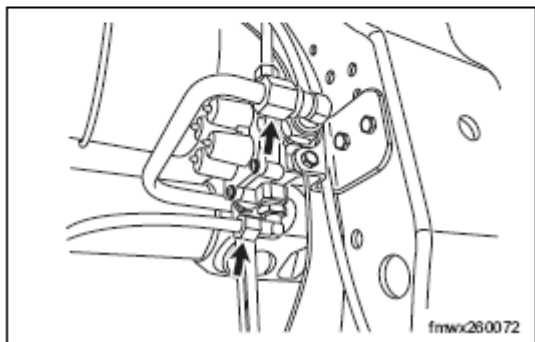
3. Service the 4-circuit protection valve.

- (a). Check whether the circuit valve core is blocked.
(b). Check whether the circuit valve core is frozen.
(c). Check the circuit for air leakage.

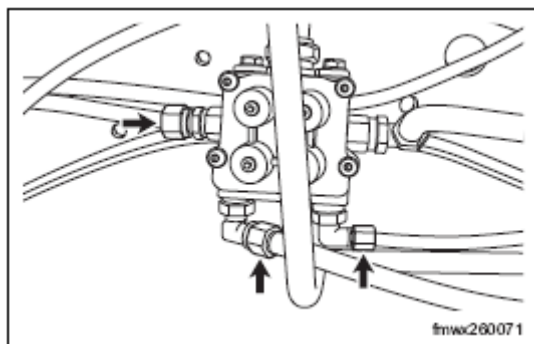


4. Install the 4-circuit protection valve.

- (a). Install the fixing bolts of 4-circuit protection valve.



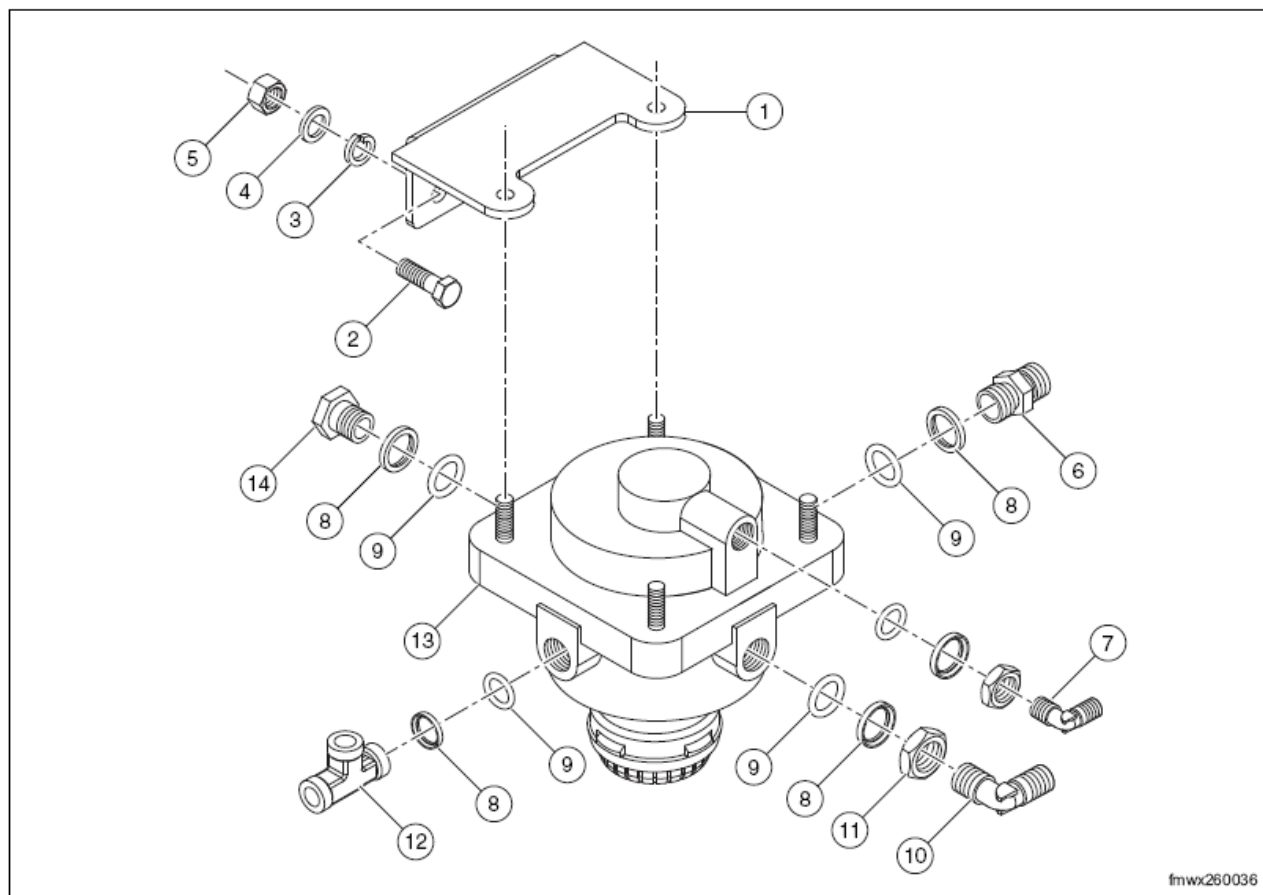
- (b). Connect the air pipes of 4-circuit protection valve.



(c). Connect the air pipes of 4-circuit protection valve.

RELAY VALVE

DIAGRAM OF COMPONENTS

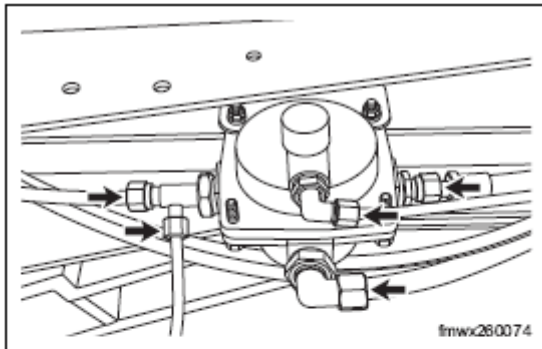


1	Relay valve bracket
2	Hexagon head bolt
3	Spring washer
4	Plain washer
5	1# hexagon nut
6	Clamping type thru reducing connector
7	Clamping type right angle connector

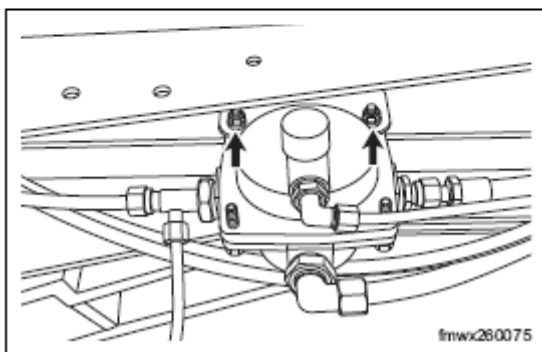
8	Sealing gasket
9	Rubber O-ring
10	Clamping type right angle connector
11	Hexagon thin nut – Fine thread
12	Clamping type three-way connector
13	Relay Valve
14	Hexagon head screw plug

SERVICE

1. Relieve the pressure of brake system.
2. Lift the cargo compartment.

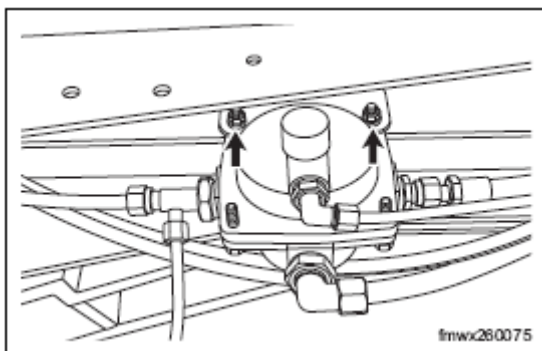


3. Disassemble the relay valve.
 - (a). Disconnect the air pipes of relay valve.

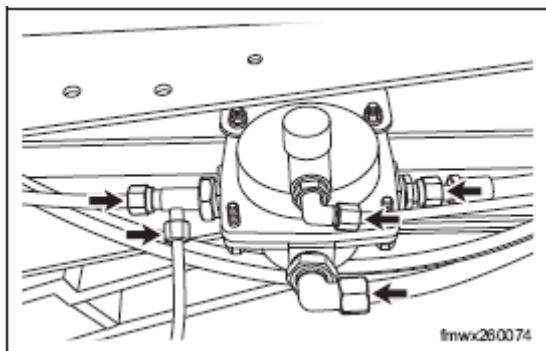


- (b). Disassemble the fixing nuts of relay valve.

4. Service the relay valve.
 - (a). Check whether the piston of the relay valve is blocked at the upper limit.
 - (b). Check whether the piston of the relay valve is blocked at the lower limit.
 - (c). Check the exhaust port of relay valve for air leakage.
 - (d). Check the intake port of relay valve for air leakage.
 - (e). Check whether the elastic force of the spring at the intake and exhaust ports of the relay valve is too high or too low.



5. Install the relay valve.
 - (a). Install the fixing nuts of relay valve. 26
Torque: 25N·m

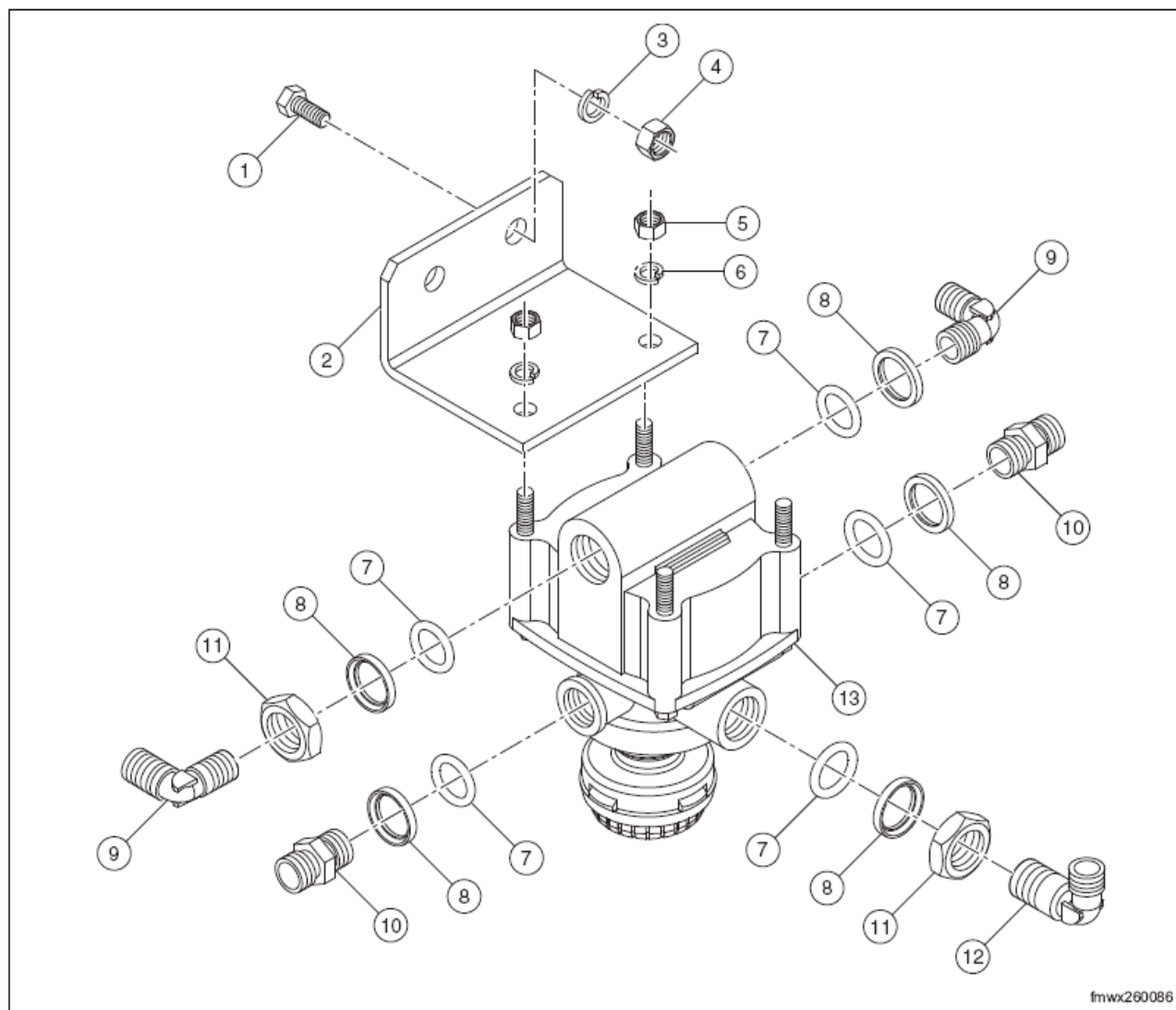


(b). Connect the air pipes of relay valve.

6. Lower the cargo compartment.

DIFFERENTIAL VALVE

DIAGRAM OF COMPONENTS

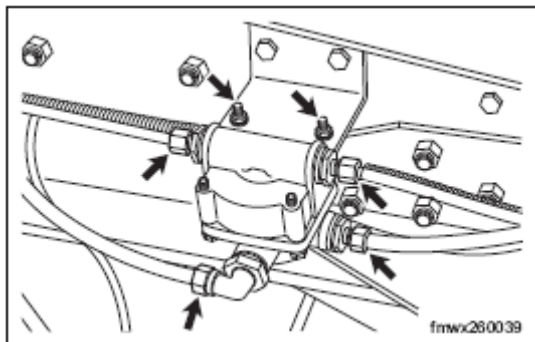


1	Hexagon head bolt
2	Differential valve bracket
3	Spring washer
4	Plain washer and 1# hexagon nut
5	1# hexagon nut
6	Spring washer
7	Rubber O-ring

8	Sealing gasket
9	Clamping type thru connector
10	Clamping type thru reducing connector
11	Hexagon thin nut – Fine thread
12	Clamping type right angle reducing connector
13	Two-direction relay valve

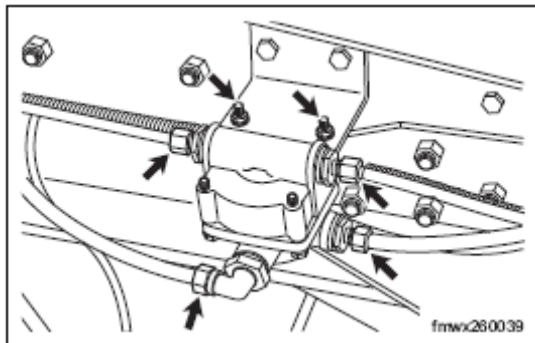
SERVICE

1. Relieve the pressure of brake system.
2. Lift the cargo compartment.



3. Disassemble the differential valve.
 - (a). Disconnect the air pipes of differential valve.
 - (b). Disassemble the fixing nuts of differential valve.

4. Service the differential valve.
 - (a). Check the air-tightness of the differential valve diaphragm and the valve body.
 - (b). Check the air-tightness between the valve assembly and the valve body and tappets.
 - (c). Check the exhaust port for leakage.



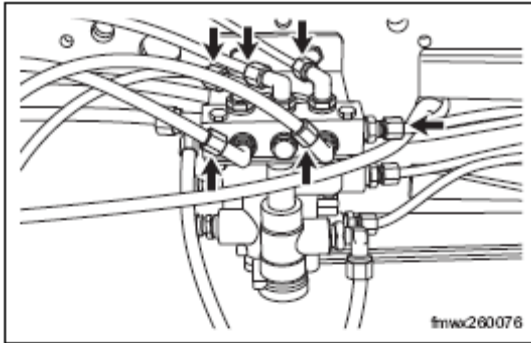
5. Install the differential valve.
 - (a). Install the fixing nuts of differential valve.
Torque 25N.m
 - (b). Connect the air pipes of differential valve.

6. Lower the cargo compartment.

MULTI-WAY CONNECTOR

REPLACEMENT

1. Relieve the pressure of brake system.
2. Lift the cargo compartment.

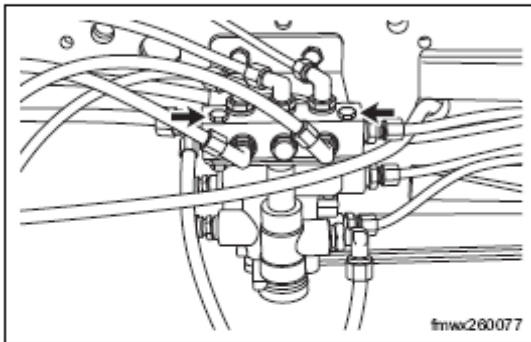


3. Disassemble the multi-way connector.

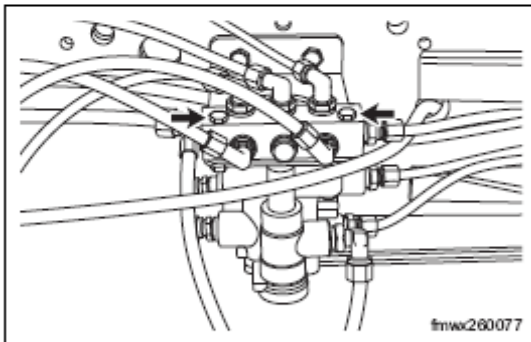
(a) Disconnect the pipeline of multi-way connector.

Notice:

Add markings to the pipeline to prevent installation error.



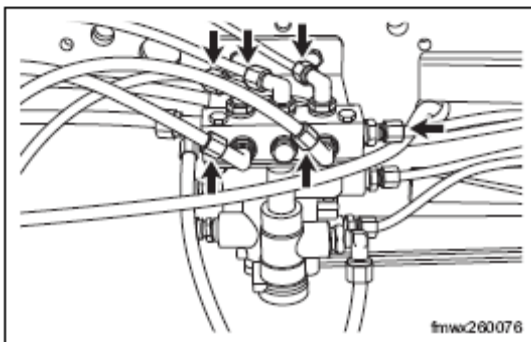
(b). Disassemble the fixing nuts of multi-way connector.



4. Install the multi-way connector.

(a). Install the fixing nuts of multi-way connector.

Torque: 25N·m

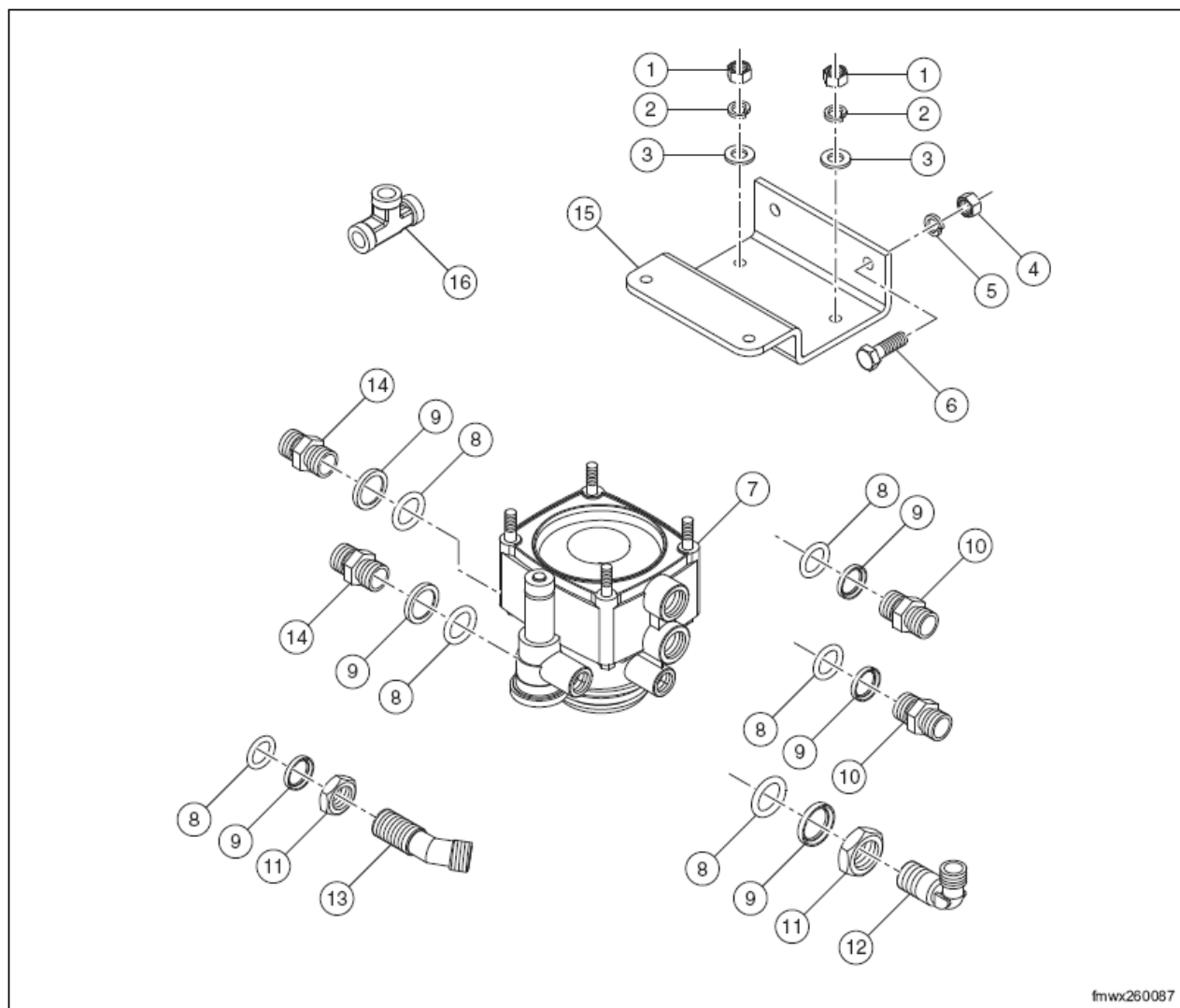


(b). Connect the pipeline of multi-way connector.

5. Lower the cargo compartment.

TRAILER VALVE

DIAGRAM OF COMPONENTS



26

1	1# hexagon nut
2	Spring washer
3	Plain washer
4	1# hexagon nut
5	Spring washer
6	Hexagon head bolt
7	Trailer brake valve assembly
8	Rubber O-ring

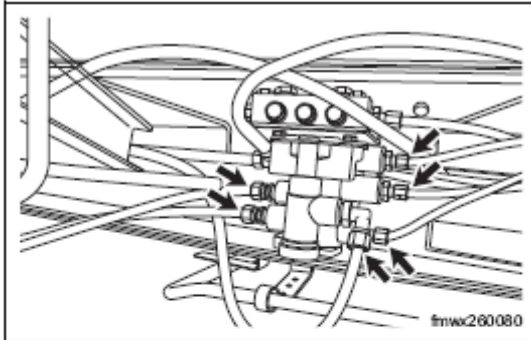
9	Sealing gasket
10	Clamping type thru reducing connector
11	Hexagon thin nut – Fine thread
12	Clamping type right angle connector
13	Air chamber connector
14	Clamping type thru reducing connector
15	Trailer valve multi-way combined bracket
16	Clamping type three-way connector



FOTON

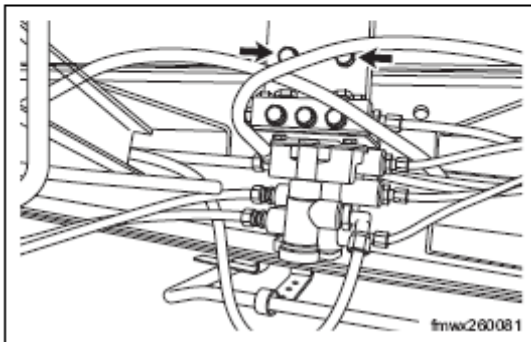
SERVICE

1. Relieve the pressure of brake system.
2. Lift the cargo compartment.
3. Disassemble the multi-way connector (Refer to Chapter 26 Service Brake – Multi-way Connector, Replacement).



4. Disassemble the trailer valve. 26

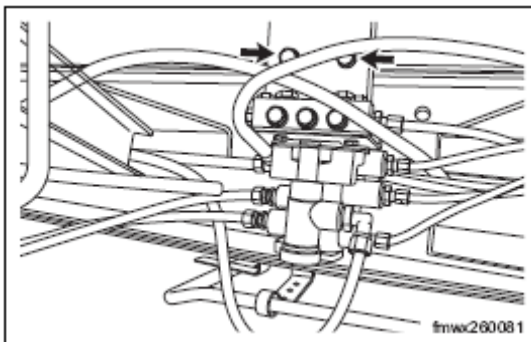
- (a). Disconnect the air pipes of trailer valve.



- (b). Disassemble the fixing nuts of trailer valve.

5. Service the trailer valve.

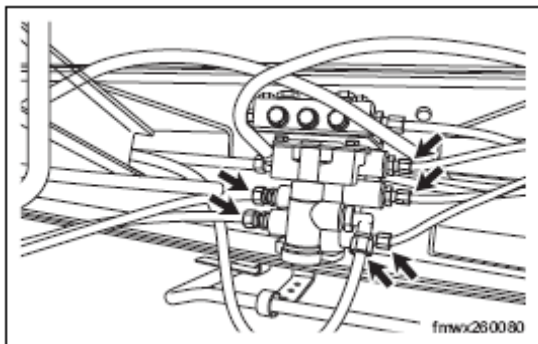
- (a). Check whether the piston of trailer valve is obstructed.
- (b). Check the air-tightness of valve, diaphragm, and tappets of the trailer valve.
- (c). Check the exhaust port of trailer valve for air leakage.
- (d). Check the intake port of trailer valve for air leakage.



6. Install the trailer valve.

- (a). Install the fixing nuts of trailer valve.

Torque: 25N·m



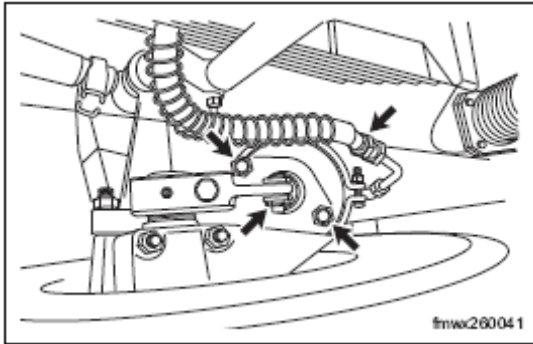
(b). Connect the air pipes of trailer valve.

7. Lower the cargo compartment.

FRONT BRAKE AIR CHAMBER

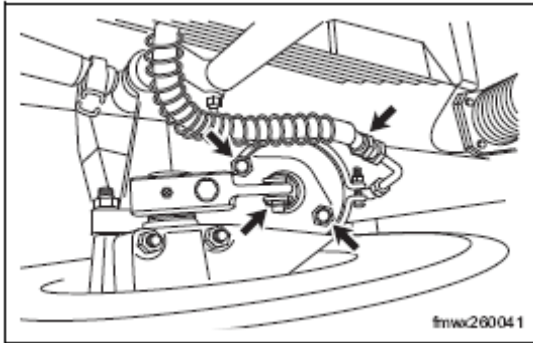
SERVICE

1. Relieve the pressure of brake system.
2. Lift the cargo compartment.



3. **Disassemble the front brake air chamber.**
 - (a). Disconnect the pipeline of front brake air chamber.
 - (b). Disassemble the connecting pin between front brake air chamber and brake adjustment arm.
 - (c). Disassemble the front brake air chamber fixing nut.

4. **Check the front brake air chamber.**
 - (a). Check the air-tightness of the front brake air chamber.



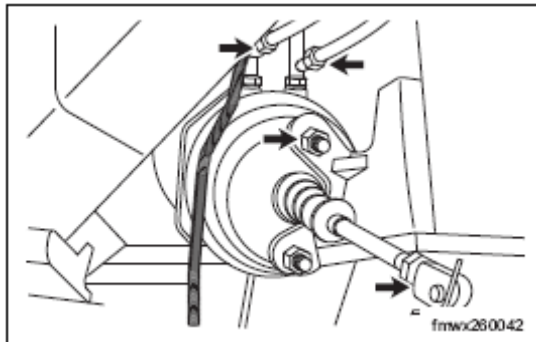
5. **Install the front brake air chamber.**
 - (a). Install the front brake air chamber fixing nut.
Torque: 97N·m
 - (b). Connect the connecting pin between front brake air chamber and brake adjustment arm.
 - (c). Connect the pipeline of front brake air chamber.

6. **Adjust the front brake air chamber (Refer to Chapter 26 Service Brake - Service Brake System, Testing and Adjustment).**
7. **Lower the cargo compartment.**

REAR BRAKE AIR CHAMBER

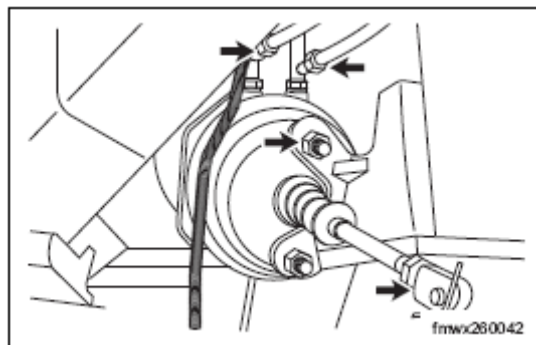
SERVICE

1. Relieve the pressure of brake system.
2. Lift the cargo compartment.



3. Disassemble the rear brake air chamber.
 - (a). Disconnect the pipeline of rear brake air chamber.
 - (b). Disassemble the connecting pin between rear brake air chamber and brake adjustment arm.
 - (c). Disassemble the rear brake air chamber fixing nut.

4. Check the rear brake air chamber.
 - (a). Check the air-tightness of the rear brake air chamber.

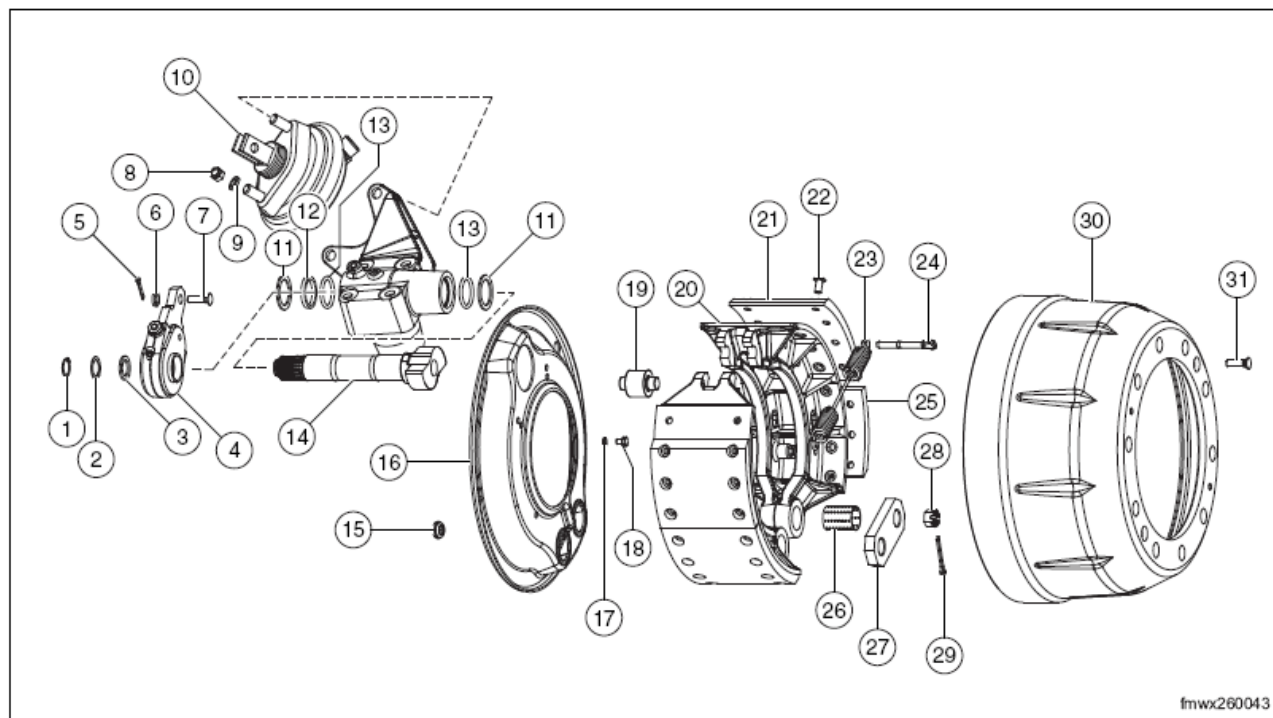


5. Install the rear brake air chamber.
 - (a). Install the rear brake air chamber fixing nut.
Torque: 97N·m
 - (b). Connect the connecting pin between rear brake air chamber and brake adjustment arm.
 - (c). Connect the pipeline of rear brake air chamber.

6. Adjust the rear brake air chamber (Refer to Chapter 26 Service Brake - Service Brake System, Testing and Adjustment).
7. Lower the cargo compartment.

FRONT BRAKE SHOE

DIAGRAM OF COMPONENTS

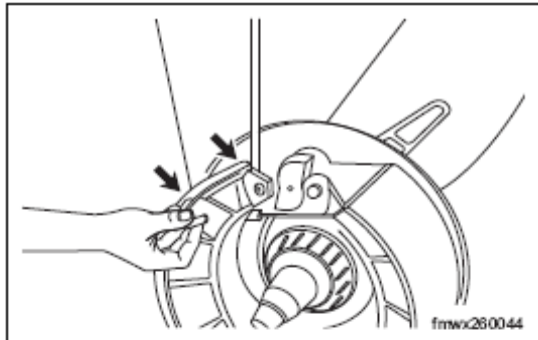


1	Circlip for shaft
2	Adjustment washer
3	Washer
4	Brake adjustment arm
5	Split pin
6	Plain washer
7	Hinge pin
8	Hexagon nut
9	External tooth lock nut
10	Diaphragm brake air chamber
11	Additional washer
12	Spacer bush
13	O-ring
14	Brake camshaft
15	Seal plug
16	Brake dust cover

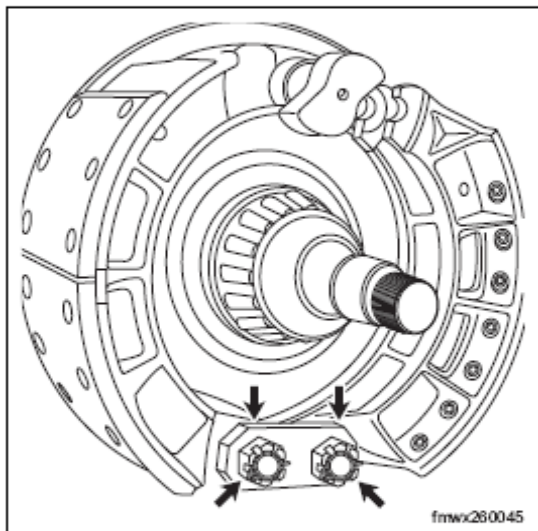
17	Spring washer
18	Hexagon head bolt
19	Roller
20	Brake shoe
21	Brake friction plate
22	Rivet
23	Return spring
24	Return spring pin
25	Brake friction plate
26	Bush
27	Limit plate
28	Hexagon slotted flat nut
29	Split pin
30	Brake drum
31	Countersunk screw

SERVICE

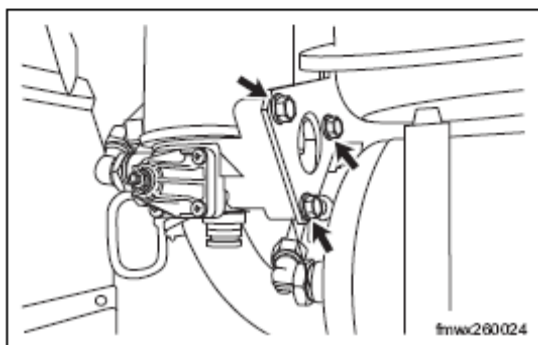
1. Relieve the pressure of brake system.
2. Lift the cargo compartment.
3. Disassemble the front brake drum (Refer to Chapter 24A Front Axle (Ankai) – Front Wheel Hub, Service).
4. Disassemble the hub (Refer to Chapter 24A Front Axle (Ankai) – Front Wheel Hub, Service).



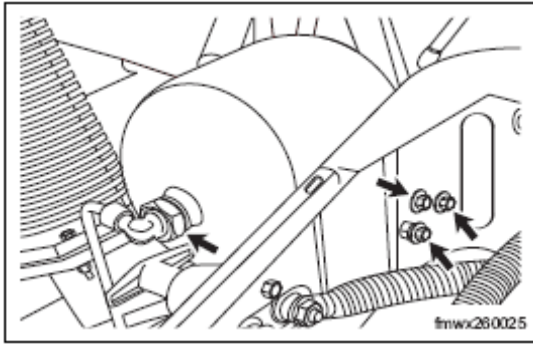
5. Disassemble the front brake shoe.
 - (a). Tension the return spring with a long lever and remove the roller.
 - (b). Unplug the spring fixing pin and remove the return spring.



- (c). Disassemble the split pin from the brake shoe base.
 - (d). Disassemble the fixing nuts of brake shoe base.



6. Disassemble the front brake adjustment arm.
 - (a). Use a pair of circlip pliers to remove the circlip and adjustment washer from the brake adjustment arm.
 - (b). Remove the front brake adjustment arm.

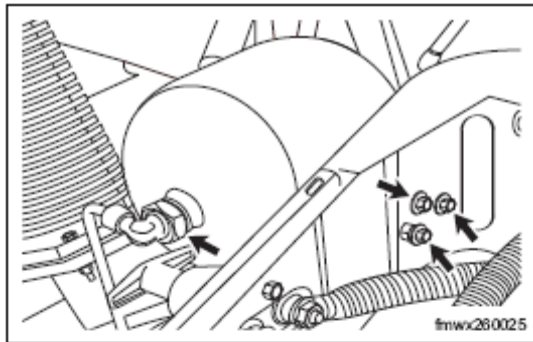


7. Disassemble the brake camshaft.

- (a). Pull out the brake camshaft from the cam end.
- (b). Remove the sealing O-ring and washer.

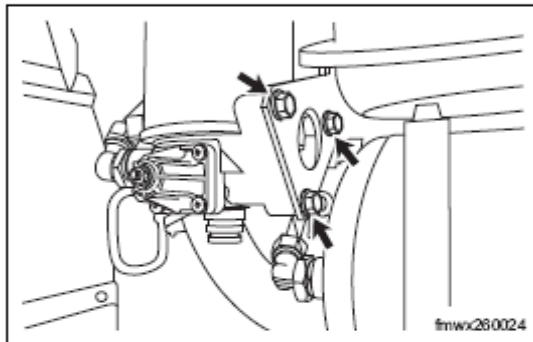
8. Check the brake shoe.

- (a). Check the brake shoe for wearing, cracking, ablation, and vibration.



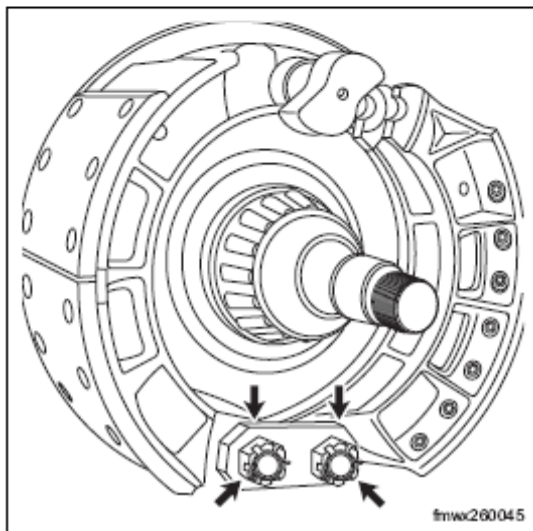
9. Install the brake camshaft.

- (a). Insert the brake camshaft into the cam end.
- (b). Install the sealing O-ring and washer.



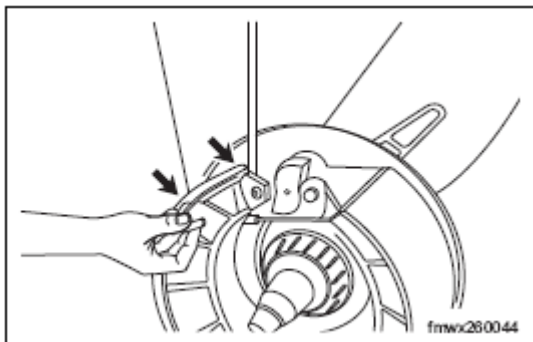
10. Install the front brake adjustment arm.

- (a). Install the front brake adjustment arm.
- (b). Use a pair of circlip pliers to install the circlip and adjustment washer on the brake adjustment arm.



11. Install the front brake shoe.

- (a). Install the fixing nuts of brake shoe base.
Torque: 250N·m
- (b). Install the split pin on the brake shoe base.

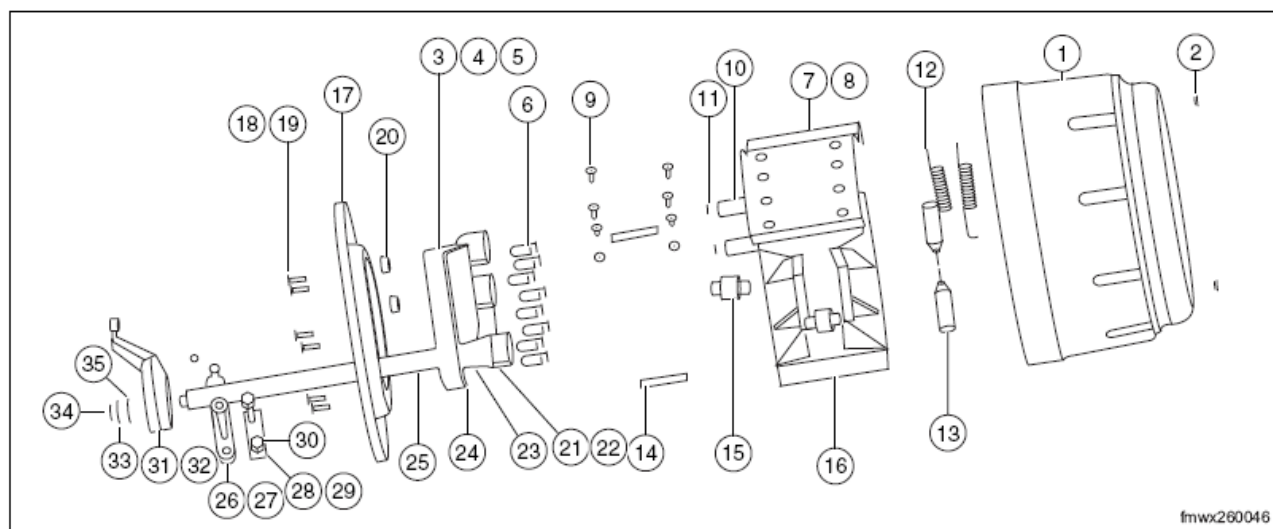


- (c). Install the return spring and the spring fixing pin.
- (d). Tension the return spring with a long lever and install the roller.

- 12. Install the hub (Refer to Chapter 24A Front Axle (Ankai) – Front Wheel Hub, Service.
- 13. Install the front brake drum (Refer to Chapter 24A Front Axle (Ankai) – Front Wheel Hub, Service.
- 14. Adjust the brake gap (Refer to Chapter 26 Service Brake - Service Brake System, Testing and Adjustment).
- 15. Lower the cargo compartment.

REAR BRAKE SHOE

DIAGRAM OF COMPONENTS



fmwx260046

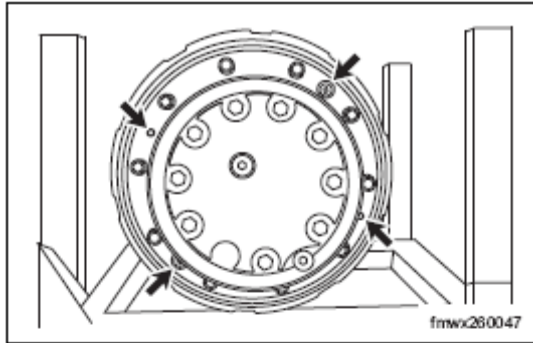
26

1	Brake drum
2	Flat head bolt
3	Brake base plate
4	Brake base plate
5	Brake base plate
6	Hinge pin
7	Brake shoe
8	Brake shoe
9	Rivet
10	Positioning hinge pin
11	Gasket
12	Return spring
13	Return spring
14	Hinge pin
15	Roller
16	Brake shoe liner
17	Brake base plate
18	Hinge pin

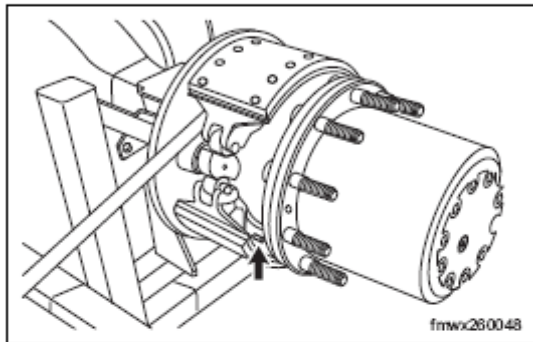
19	Hinge pin
20	Cap
21	Camshaft
22	Camshaft
23	Gasket
24	O-ring
25	Gasket
26	Fixing bracket
27	Fixing bracket
28	Bracket upper cap
29	Bolt
30	Bolt
31	Adjustment arm
32	Adjustment arm
33	Sealing gasket
34	Gasket
35	Clamp

SERVICE

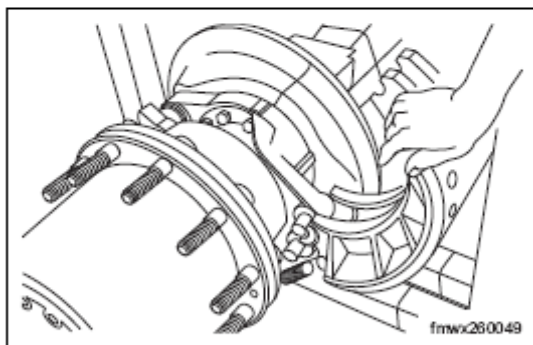
1. Relieve the pressure of brake system.
2. Lift the cargo compartment.
3. Disassemble the rear tire (Refer to Chapter 23 Wheels and Tires – Rear Tire and Wheel, Service).



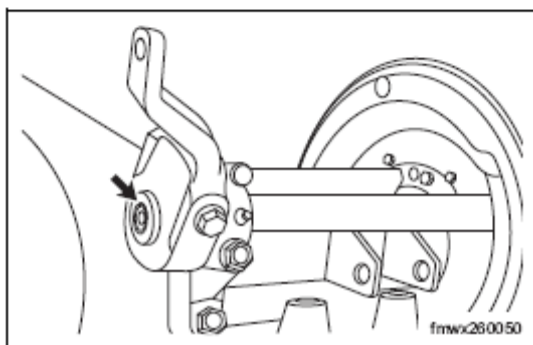
4. Disassemble the rear brake drum.
 - (a). Disassemble the Phillips fixing screws.
 - (b). Use bolts to push out the rear brake drum.



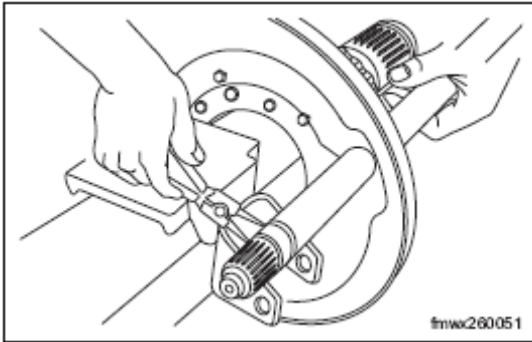
5. Disassemble the rear brake shoe.
 - (a). Tension the return spring with a long lever and remove the roller.
 - (b). Unplug the spring fixing pin and remove the return spring.



- (c). Disassemble the brake shoe base.



6. Disassemble the rear brake adjustment arm.
 - (a). Use a pair of circlip pliers to remove the circlip and adjustment washer from the brake adjustment arm.
 - (b). Remove the rear brake adjustment arm.

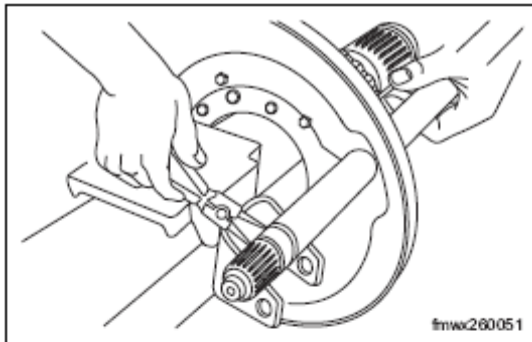


7. Disassemble the brake camshaft.

- (a). Pull out the brake camshaft from the cam end.
- (b). Remove the sealing O-ring and washer.

8. Check the brake shoe.

- (a). Check the brake shoe for wearing, cracking, ablation, and vibration.

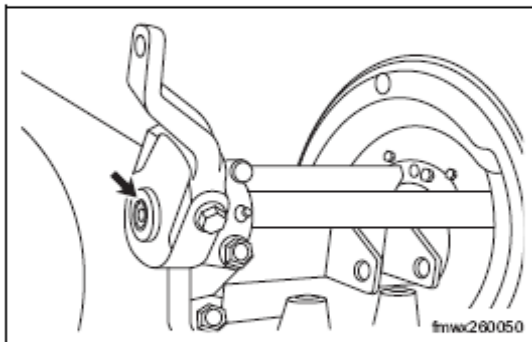


9. Install the brake camshaft.

- (a). Insert the brake camshaft into the cam end.
- (b). Install the sealing O-ring and washer.

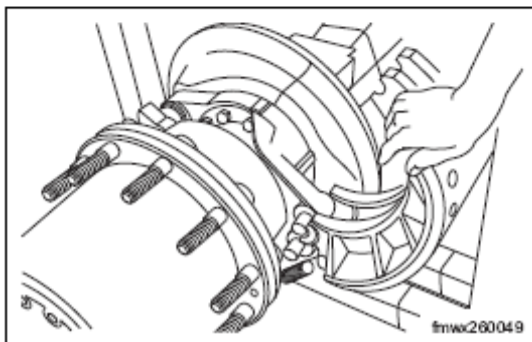
10. Install the rear brake adjustment arm.

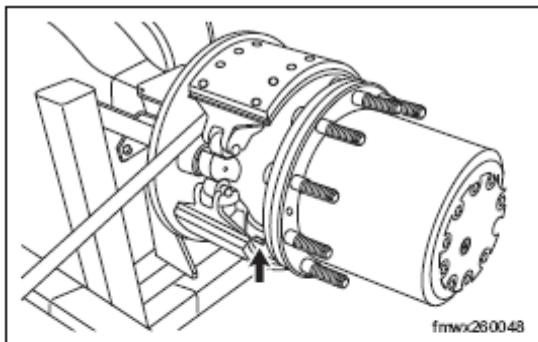
- (a). Install the rear brake adjustment arm.
- (b). Use a pair of circlip pliers to install the circlip and adjustment washer on the brake adjustment arm.



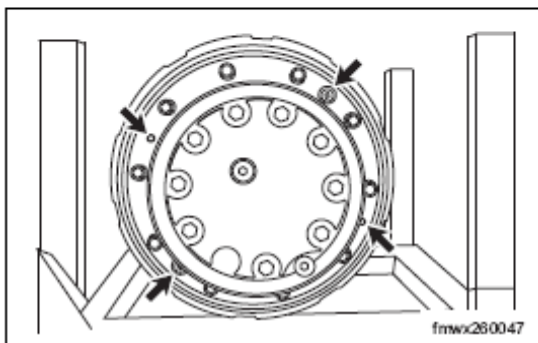
11. Install the rear brake shoe.

- (a). Install the brake shoe base.





- (b) Install the return spring and the spring fixing pin.
- (c). Tension the return spring with a long lever and install the roller.



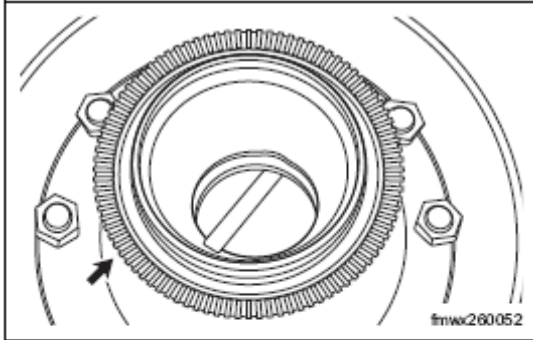
- 12. Install the rear brake drum.**
- (a). Install the rear brake drum.
 - (b). Install the Phillips fixing screws.

- 13. Install the rear tire (Refer to Chapter 23 Wheels and Tires – Rear Tire and Wheel, Service).
- 14. Adjust the brake gap (Refer to Chapter 26 Service Brake - Service Brake System, Testing and Adjustment).
- 15. Lower the cargo compartment.

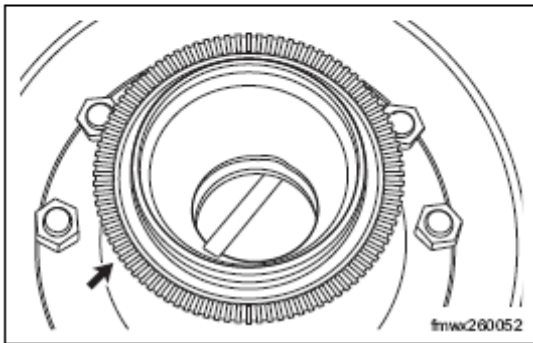
ABS GEAR RING

REPLACEMENT

1. Disassemble the hub (Refer to Chapter 24A Front Axle (Ankai) – Front Wheel Hub, Service.
2. Disassemble the hub (Refer to Chapter 25 Rear Axle – Wheel Hub Bearing and Oil Seal, Service.



3. Disassemble the ABS gear ring.
 - (a). Disassemble the ABS gear ring.



4. Install the ABS gear ring.
 - (a). Install the ABS gear ring.
 - Heat the gear ring to 150°C~200°C and maintain for 5~10min.
 - Press the gear ring into the hub.

Notice:

This installation step is one-time installation and do not install repeatedly.

5. Measurement after installation

- (a). Measure the run-out of tooth face.
 - Measure the tooth face run-out with a micrometer.
 - Tooth face run-out: <0.2mm Height difference between adjacent teeth: <0.04mm

6. Measurement after being installed on vehicle

- (a). Measure the signal with a hand-hold sensor tester.
 - When the wheel hub is rotating at 30r/min, the signal lamp must flash uniformly without any interruption and its brightness shall be legible and clear.
- (b). Measure the voltage output of sensor with a multimeter.
 - When the speed is above 30r/min, the voltage output shall be above 0.30V.

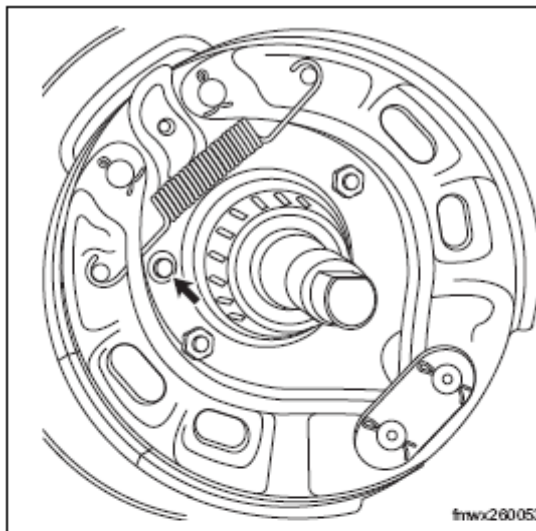
Notice:

Before the installation of gear ring, thoroughly clean the axial positioning face of the wheel hub to prevent the ingress of foreign materials and eliminate any possible bias swing of gear ring. Make sure that the joining rate of the positioning face shall be above 75% during installation. Measure the tooth face run-out of the gearing with a micrometer. The measurement shall be less than 0.06mm.

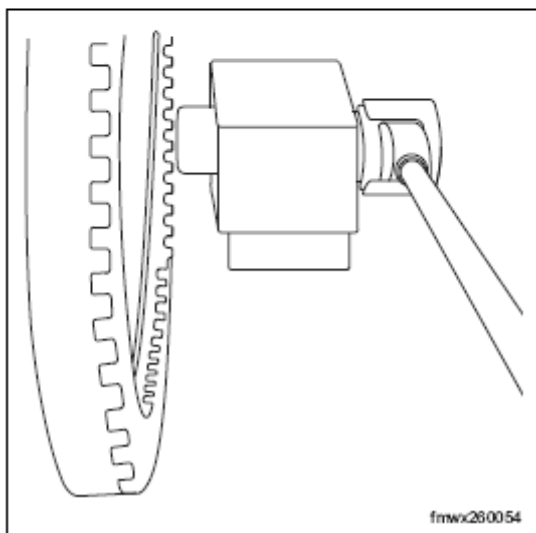
7. Install the hub (Refer to Chapter 25 Rear Axle – Wheel Hub Bearing and Oil Seal, Service.
8. Install the hub (Refer to Chapter 24A Front Axle (Ankai) – Front Wheel Hub, Service.

WHEEL SPEED SENSOR

REPLACEMENT



1. **Install the wheel speed sensor.**
 - (a). Install the elastic bush and sensor into the steel bush in turn.
 - (b). After the wire direction is properly adjusted, securely tie the wire.
 - (c). Push in with hand or lightly knock in with a hammer.

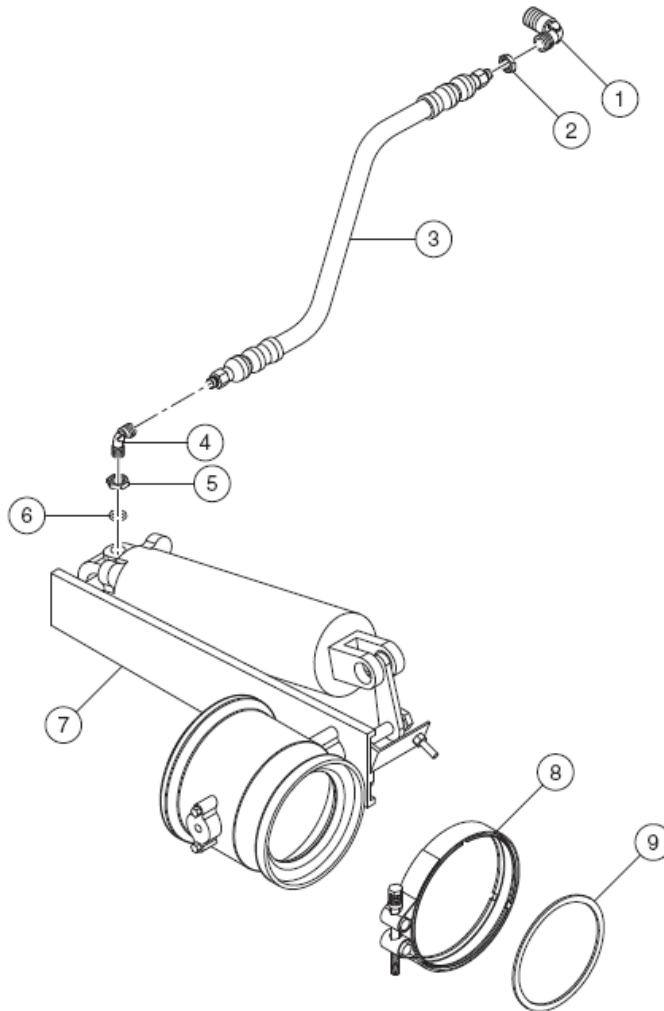


- (d). Make sure that the front center of the sensor is aligned with the tooth face of the gear ring. Otherwise, adjust the bracket position and push the sensor to the end.
 - (e). Insert the sensor into the bracket or bush bore, with the insertion and pulling force above 50N.

2. **Install the hub (Refer to Chapter 25 Rear Axle – Wheel Hub Bearing and Oil Seal, Service.**
3. **Install the hub (Refer to Chapter 24A Front Axle (Ankai) – Front Wheel Hub, Service.**

AUXILIARY BRAKE

DIAGRAM OF COMPONENTS



fmwx260088

1	Clamping type adjoining right angle connector
2	Thin hexagon nut
3	Butterfly valve rubber hose assembly
4	Clamping type right angle connector
5	Gland nut

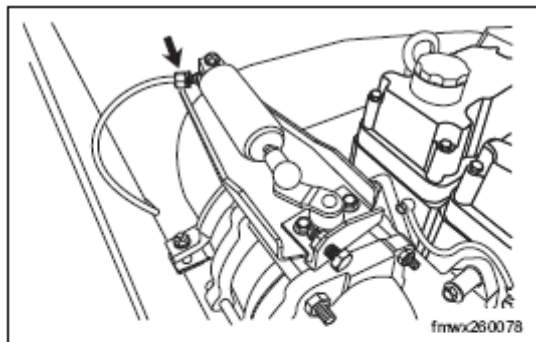
6	Rubber O-ring
7	Exhaust brake butterfly valve assembly
8	Clamp
9	Sealing gasket

EXHAUST BRAKE BUTTERFLY VALVE

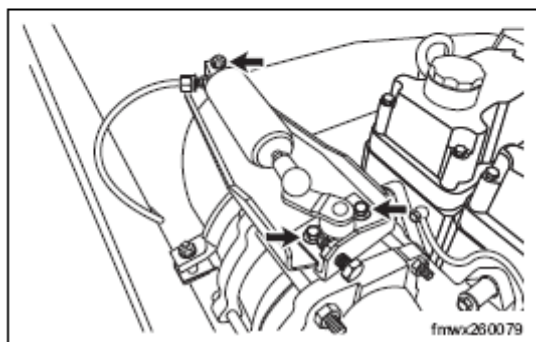
SERVICE

Hint:

Please refer to Chapter 26 Service Brake – Auxiliary Brake, Diagram of Components for the diagram of components.



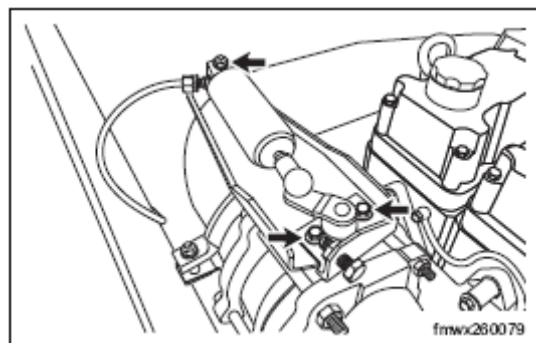
1. **Disassemble the exhaust brake butterfly valve.**
 - (a). Disassemble the air pipe of exhaust brake butterfly valve.



- (b). Disassemble the fixing bolts of exhaust brake butterfly valve.

2. **Check the exhaust brake butterfly valve.**

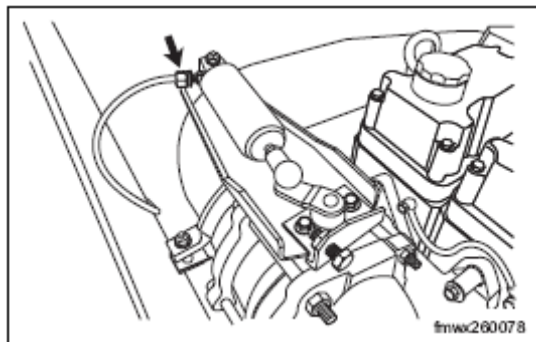
- (a). Check the lubrication status of butterfly valve thrush rod.
 - (b). Check the butterfly valve for presence of contamination.
 - (c). Check the leakage of butterfly valve working cylinder.
 - (d). Check the normal position of butterfly valve linkage mechanism.



3. **Install the exhaust brake butterfly valve.**

- (a). Install the fixing bolts of exhaust brake butterfly valve.

Torque: 25N·m



- (b). Install the air pipe of exhaust brake butterfly valve.

PARKING BRAKE

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Fault Phenomena.....	27-4
Function Checking	27-5
HANDBRAKE VALVE	27-6
Component diagram	27-6
Replacement.....	27-8

PARKING BRAKE SYSTEM

PRECAUTIONS

1. Operation Precautions of Parking Brake System

- (a). Replace each part in careful and correct manner, otherwise it will impair the performance of parking brake system and may endanger the personal safety.
- (b). Make sure to use the original genuine parts.
- (c). Keep clean the parts and the service site.
- (d). Make sure to perform the periodical checking. Make sure to check whether the parking brake system functions normally at interval of 10,000km.



FAULT PHENOMENA

The table below can be used to help find out the cause of the faults, in which the numerical sequence stands for the priority sequence of the faults. Check each part in order as per this sequence and as necessary replace with new one.

Fault Phenomenon	Possible Cause	Reference
“Clamping” of rear axle wheels during driving	1. Handbrake valve	Chapter 27 Parking Brake – Handbrake Valve, Replacement
	2. Differential valve	Chapter 26 Service Brake – Differential Valve, Service
	3. Braking air chamber	Chapter 26 Service Brake – Rear Braking Air Chamber, Service

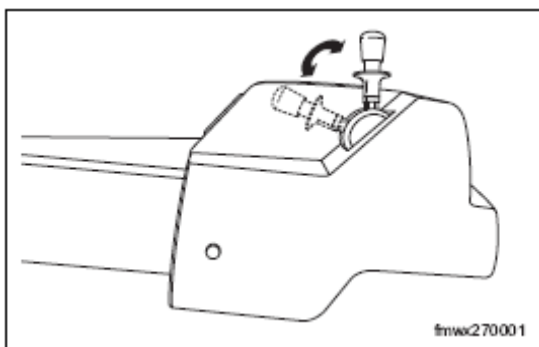


FUNCTION CHECKING

1. Check the parking brake:

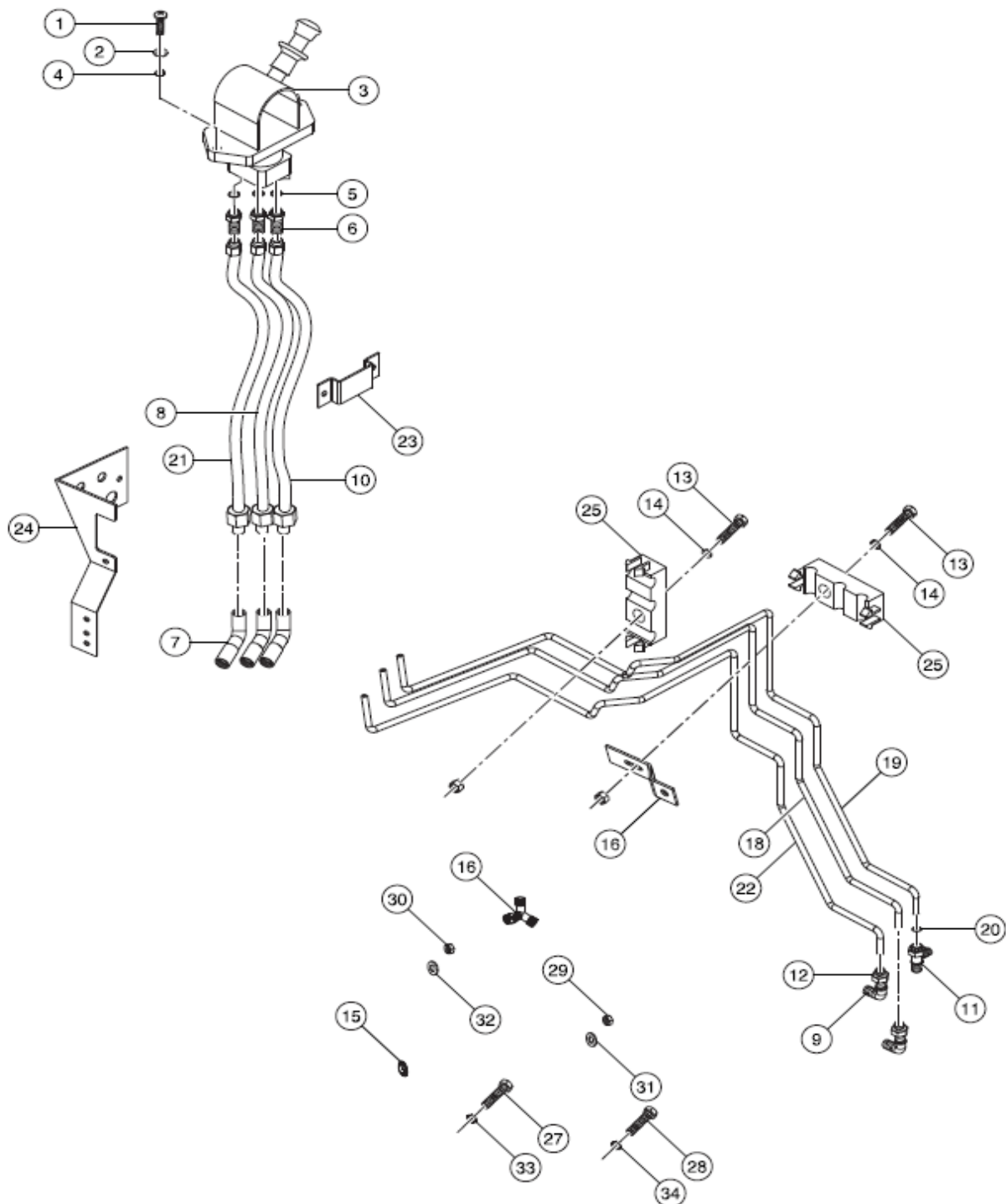
(a). Operation Checking

- Park the vehicle on a dry slope and apply the parking brake. The parking brake must be capable of keeping still the vehicle.
- Lift the brake lever. Check whether there is exhaust sound while the spring chamber is functioning (The braking force is applied onto the rear wheels).
- Push the release lever towards the lever on the top of the brake lever and lower the brake lever.
- Check the working status of the alarm lamp.



HANDBRAKE VALVE

COMPONENT DIAGRAM



1

Hexagon bolt with indentation

18

Steel pipe assembly – 21# port of handbrake valve to bracket



FOTON

PARKING BRAKE- HANDBRAKE VALVE**27-7**

2	Small washer
3	Handbrake valve assembly
4	Spring washer
5	Sealing gasket
6	Bite type thru reducing union
7	Bite type adjoining right angle connector
8	Nylon pipe assembly – Adjoining right angle connector to 1# port of handbrake valve
9	Bite type adjoining right angle connector
10	Nylon pipe assembly – Adjoining right angle connector to 21# port of handbrake valve
11	Bite type adjoining three-way connector
12	Hexagon thin nut – Fine thread
13	Hexagon head bolt
14	Spring washer
15	Plug
16	Bite type adjoining three-way connector
17	Bracket plate

19	Steel pipe assembly – Hose bracket to 1# port of handbrake valve
20	Sealing gasket
21	Nylon pipe assembly – Adjoining right angle connector to 22# port of handbrake valve
22	Steel pipe assembly – 22# port of handbrake valve to bracket
23	Bracket plate
24	Bracket plate
25	Three-pipe lower bracket
26	Nylon pipe assembly – Bracket to four-way connector
27	Hexagon head bolt
28	Hexagon head bolt
29	1# hexagon nut
30	1# hexagon nut
31	Plain washer
32	Plain washer
33	Spring washer
34	Spring washer

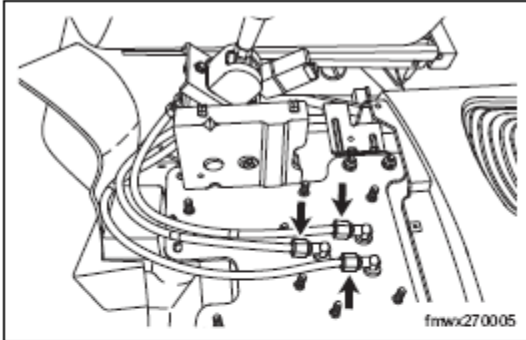


REPLACEMENT

Hint:

Please refer to Chapter 27 Parking Brake – Handbrake Valve, Component diagram for the Component diagram.

1. **Relieve the pressure of brake system.**
2. **Disassemble the middle platform rear assembly (Refer to Chapter 73 Instrument Console Instrument Cigarette Lighter – Cigarette Lighter, Replacement).**



3. **Disassemble the handbrake valve assembly.**

- (a). Disassemble the nut of handbrake valve air pipe connector and separate the handbrake valve air pipe.

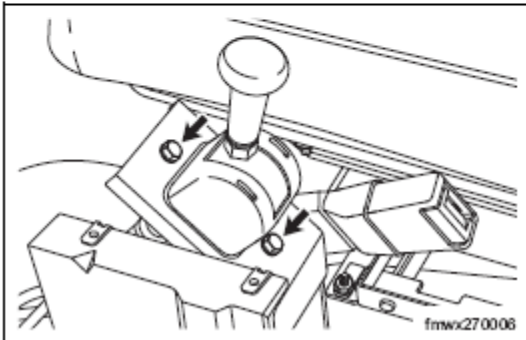
Attention:

Use the oil pipe wrench for disassembly.

Hint:

Before disconnecting the air pipe, add the markings onto the air pipe to help the identification during the installation.

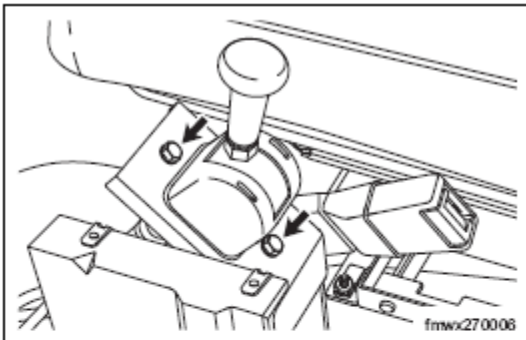
- (b). Disassemble the fixing bolts of handbrake valve and remove the handbrake valve assembly.



4. **Install the handbrake valve assembly.**

- (a). Install the handbrake valve fixing bolts.

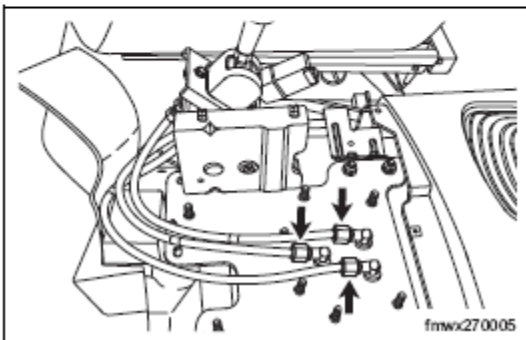
Torque: 23 N.m



- (b). Connect the handbrake valve air pipe and install the nut of handbrake valve air pipe connector.

Attention:

Use the oil pipe wrench for installation.



5. **Install the middle platform rear assembly (Refer to Chapter 73 Instrument Console, Instruments, and Cigarette Lighter – Cigarette Lighter, Replacement).**

FRAME

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REAR SUSPENSION ASSEMBLY	28-18
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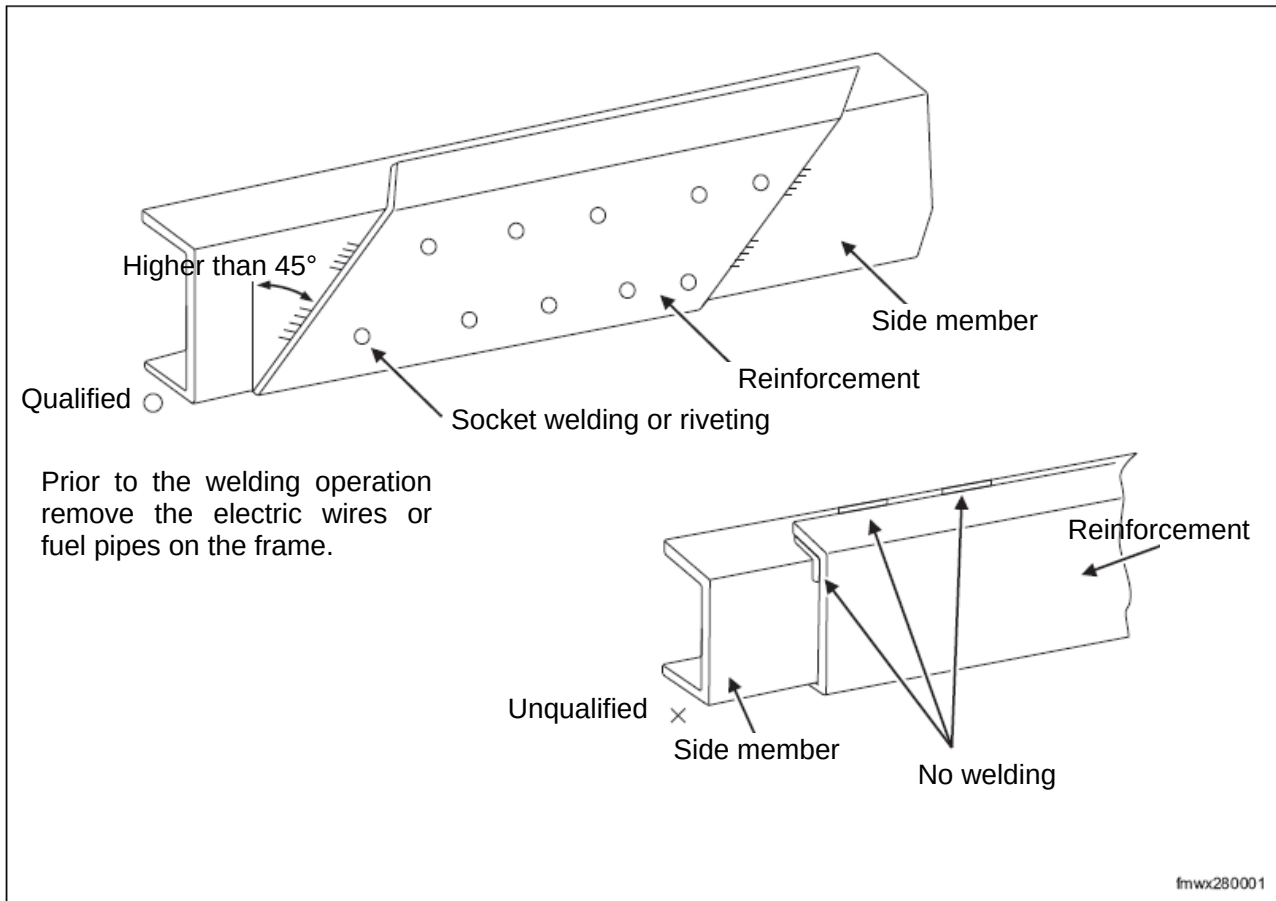
FRAME ASSEMBLY

PRECAUTIONS

1. Minimize the servicing work on the frame as much as possible.

Generally, the servicing work on the frame can be minimized or cancelled by minimizing the concentration of stress at a certain part of the frame.

- (a) The vehicle can be only used for the design purpose.
 - The overloading is not permitted.
 - The vehicle shall be loaded evenly to avoid local overloading.
 - The dump truck shall not be subject to disperse loading.
 - The baffle on the box truck must be used.
 - Do not operate the vehicle under the extremely uneven road conditions.
 - Where a new frame is used, take the load to be received into account prior to the operation, or reinforce the frame.
- (b) Repair the frame or attach the body or equipment onto the frame as per the method recommended.
 - Avoid the sudden change of various modules.
 - Do not drill the flange of the frame track.
 - Holes on the web plate of the track shall be spaced by at least 40mm.
 - Use the existing holes as much as possible.
 - Never cut the hole by welding torch.
 - Never slot the track.
 - Never overheat the frame track.
 - Avoid welding any part onto the flange.
 - The number of holes on the same vertical line of the web plate shall not exceed four.
 - The distance between the hole on the reinforced bar and the bar edge shall be at least twice of the material thickness.
- (c). Frame alignment and inspection:
 - In case of bending or excessive torsion, please make alignment.
 - In case of slight partial bending of side member and cross member, movable hydraulic machine can be applied for alignment after the frame is assembled or use jack to properly push the member when both ends of the member are locked with chain.
 - Cold pressing alignment is generally applied, in order to avoid affecting the mechanical strength of frame.
 - In case of large bending that is hardly to be aligned by the cold pressing method, partial heating can be adopted, with minimum scope of heating and the temperature no more than 700°C, and then cool relevant part slowly (water cooling is not allowed) to avoid increase of material brittleness.
 - After frame alignment, check rivets on the frame for any looseness.
 - In case of serious bending and torsion of frame, please disassemble it and make alignment for side member and cross member as per sample requirements and rivet them again.
 - If it is difficult to rivet them, special screws can be applied for tightening.



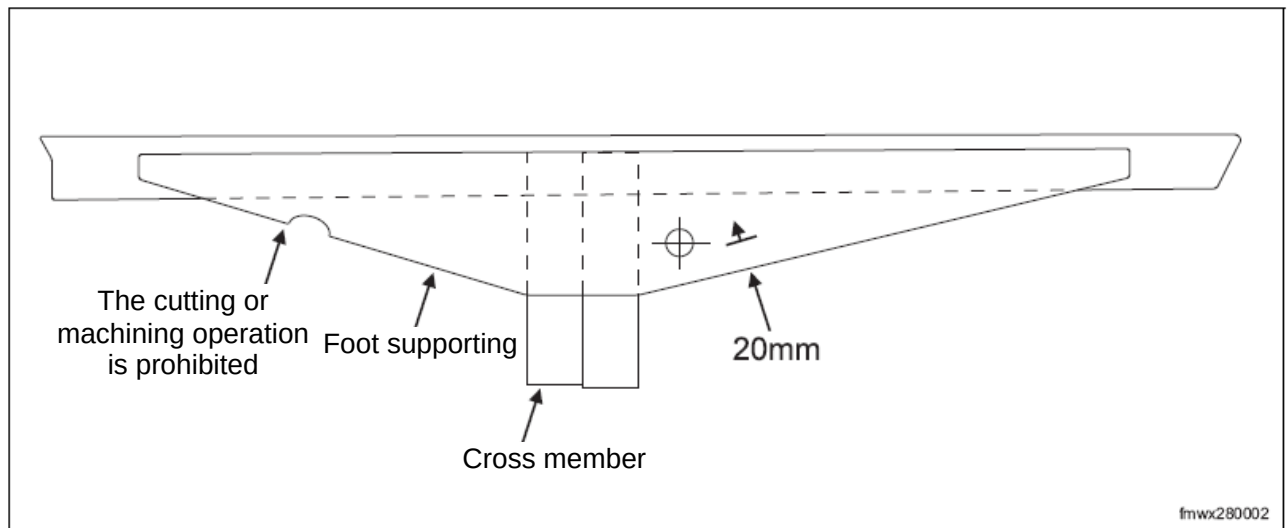
2. Reinforcement

When fitting the reinforcing materials onto the chassis frame, specially pay attention to following points:

- (a) When fitting the reinforcing materials, prevent the significant change of various modules, and in the welding operation, avoid causing over-high local stress.
- (b) Major frame components shall be made of reinforced steel plates of high tensile strength. The steel plate shall be made of the steel with high tensile strength.

3. Drilling

- (a) In the drilling operation, do not use the flame, but use the drilling tool.
- (b) After the drilling operation, the hole edge must be finished.
- (c) If the riveting is to be used for fixing purpose, the cold riveting must be applied.
- (d) It is prohibited to cut the chassis frame flange.
- (e) Where the sub-frame is to be attached onto the chassis frame, fix it with bolts.
- (f) On the dual-rear-axle vehicle (spider type rear suspension), it is prohibited to cut or machine the gusset.



4. Welding

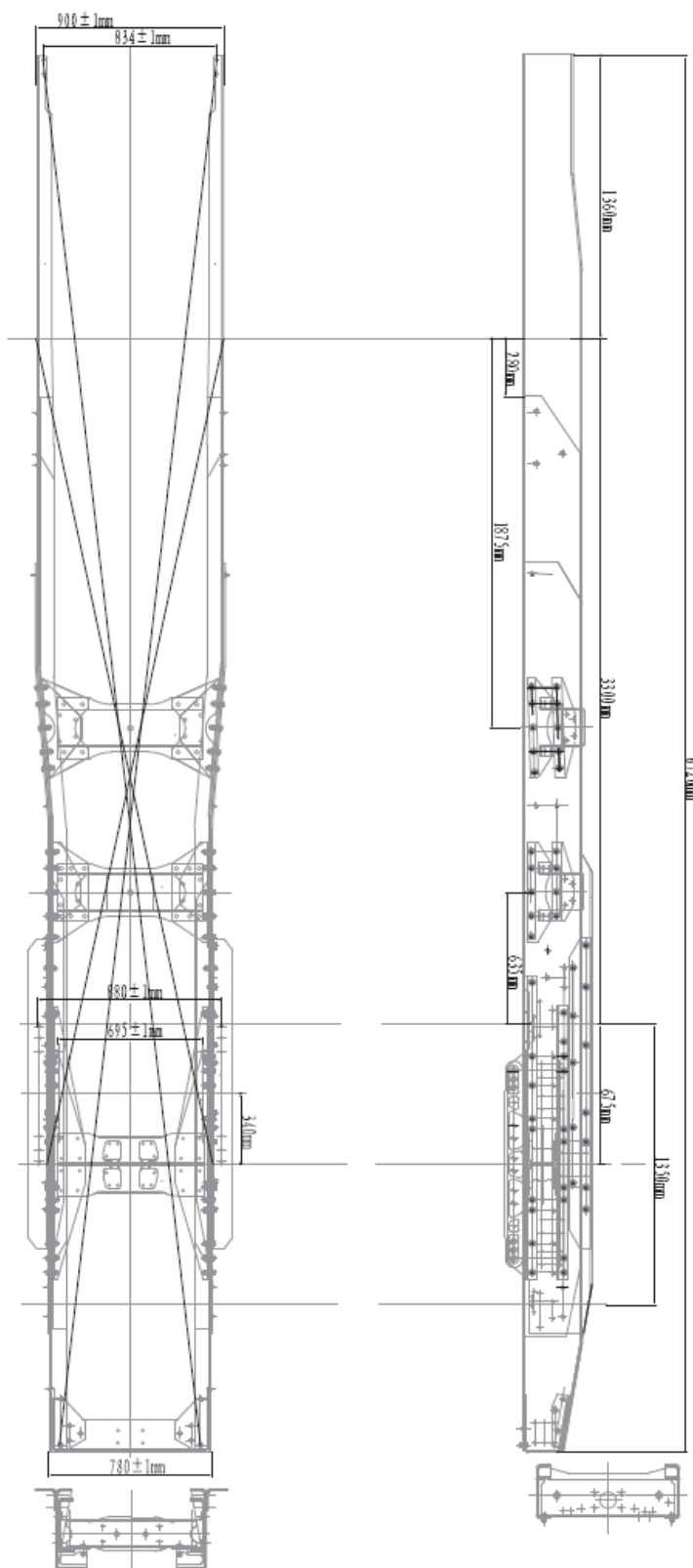
(a) Notices

- Prior to the welding operation, disconnect the battery negative cable; otherwise electric members may be damaged.
- Connect the earthing cable of welding machine close to the working zone as much as possible.
- Keep the reinforced plate and chassis frame components dry.
- After the welding operation, avoid cooling by water.
- Protect the pipe, electric wires, rubber parts and springs with proper methods, to prevent them from being adversely affected by the heat and welding sparks.
- When the part to be welded is close to the fuel tank, remove the fuel tank assembly.
- For the painted part to be welded, fully remove the paint layer.

(b) When welding the chassis frame component made of the high-strength steel, pay attention to following points:

- Take much care to avoid cracking in the operation.
- Control the material hardness within the required range (no higher than 350 Vickers hardness).
- The welding ball surface shall be smooth, for the notch effect of the steel of a high tensile strength are stronger than those of the ordinary neutral steel.

FRAME DIMENSION DRAWING



fmwx280049

TILTING CONTROL MECHANISM ASSEMBLY

PRECAUTIONS

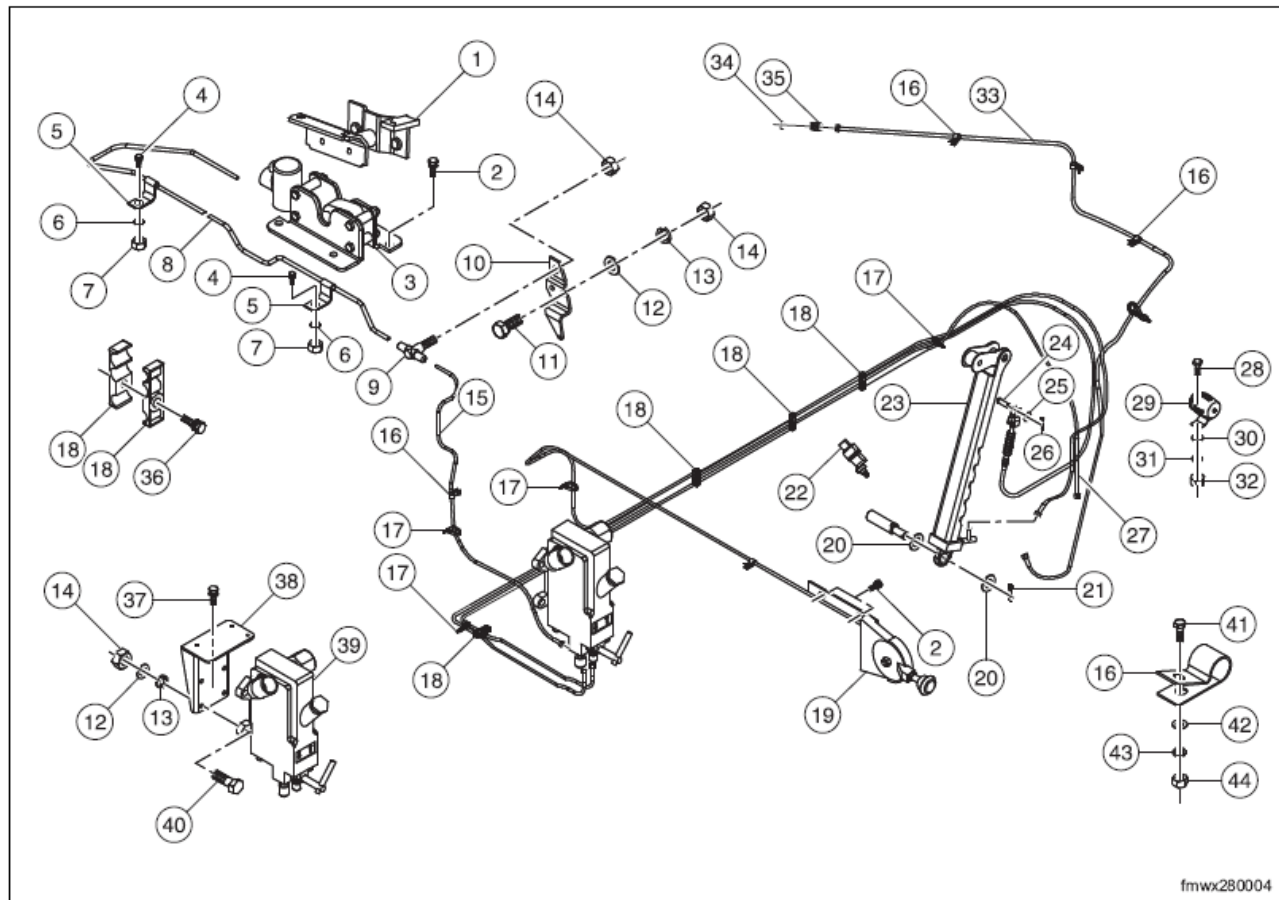
1. When lifting the cab, park the vehicle on a level ground, open the front shield, and stop the engine.
2. Before starting the engine with the secondary starting switch, be sure to check and confirm that the transmission is at the neutral position.
3. When lowering the cab, locate the control cable handle at the lower position, lower the cab to the bottom, and ensure the locking body is locked. Continue to operate the oil pump, and ensure that the cylinder is reset and that the buzzer will no longer ring. At this moment, push the control cable handle to the upper end.
4. Oil pump working oil: Low-temperature anti-wear hydraulic oil L-HV32 GB11118.1
5. With the system properly installed and adjusted, after the oil pump is filled up for the first time, raise the cab by 2~3 times to imbue the system with oil and release the air in it. After the final commissioning is finished, the oil level shall be lower than the filler by 15~20mm. With the cylinder upper chamber filled up with oil, add 280 ± 20 ml of oil.
6. The overflow of oil from the pump upper vent is tolerated.

Warning: The rear locking body must be locked reliably.

Locking criteria: The lock piston on the left side of the locking body is located at its lowest position, and the lifting warning lamp in the cab is off.

DIAGRAM OF COMPONENTS

Notice: applicable for left-hand drive vehicles



1	Rear suspension upper locking body assembly
2	Hexagon bolt, spring washer and plain washer assembly
3	Rear mounting lower locking body assembly
4	Hexagon bolt assembly
5	Oil pipe clip
6	Spring washer
7	Type 1 hexagon nut
8	Hard pipe
9	Two-way union
10	Two-way union fixing plate
11	Hexagon bolt
12	Plain washer
13	Spring washer

23	Tilting cylinder assembly H3 series
24	Pin shaft
25	Plain washer
26	Split pin
27	Cylinder oil inlet & outlet pipe
28	Hexagon bolt
29	Tilting buzzer
30	Plain washer
31	Spring washer
32	Type 1 hexagon nut
33	Unhooking cylinder connecting oil pipe
34	Sealing washer
35	Unhooking cylinder straight union

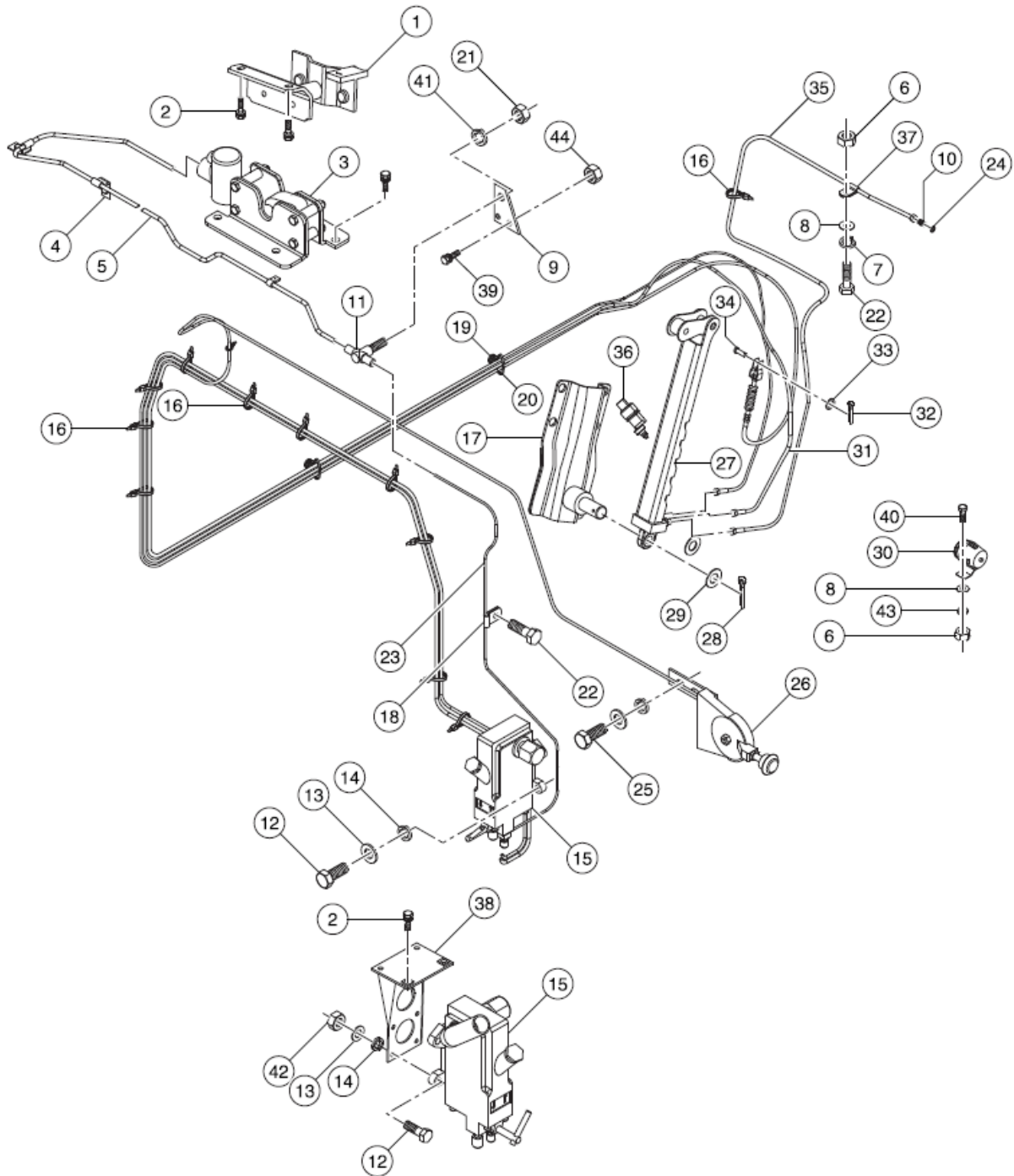


FRAME-TILTING CONTROL MECHANISM ASSEMBLY**28-9**

14	Type 1 hexagon nut	36	Hexagon bolt, spring washer and plain washer assembly
15	Connecting hose	37	Hexagon bolt, spring washer and plain washer assembly
16	Lifting oil pipe clip	38	Hand oil pump bracket
17	Plastic binding strip	39	Hand oil pump assembly
18	Oil pipe clip	40	Hexagon bolt
19	Cylinder control cable assembly	41	Hexagon bolt
20	Plain washer	42	Plain washer
21	Split pin	43	Spring washer
22	Lower dead center switch	44	Type 1 hexagon nut



Notice: Applicable for right-hand drive vehicles



fmwx280050

1

Rear mounting upper locking body assembly

23

Connecting hose

FRAME-TILTING CONTROL MECHANISM ASSEMBLY**28-11**

2	Hexagon bolt, spring washer and plain washer assembly	24	Sealing washer
3	Rear mounting lower locking body assembly	25	Hexagon bolt, spring washer and plain washer assembly
4	Oil pipe clip	26	Cylinder control cable assembly
5	Hard pipe	27	Tilting cylinder assembly H3 series
6	Type 1 hexagon nut	28	Split pin
7	Spring washer	29	Plain washer
8	Plain washer	30	Tilting buzzer
9	Two-way union fixing plate	31	Cylinder oil inlet & outlet pipe
10	Unhooking cylinder straight union	32	Split pin
11	Two-way union	33	Plain washer
12	Hexagon bolt	34	Pin shaft
13	Plain washer	35	Unhooking cylinder connecting oil pipe
14	Spring washer	36	Lower dead center switch
15	Hand pump assembly	37	Lifting oil pipe clip
16	Plastic binding strip	38	Oil pump bracket
17	Cylinder bracket assembly	39	Hexagon bolt, spring washer and plain washer assembly
18	Single pipe clip	40	Hexagon bolt
19	Pipe bundle pad	41	Spring washer
20	Round-head binding strip	42	Type 1 hexagon nut
21	Type 1 hexagon nut	43	Spring washer
22	Hexagon bolt	44	Type 1 hexagon nut

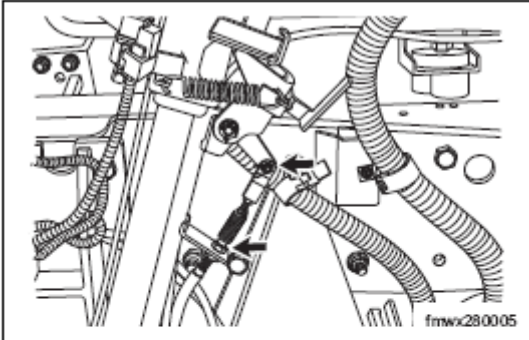


REPLACEMENT

Hint:

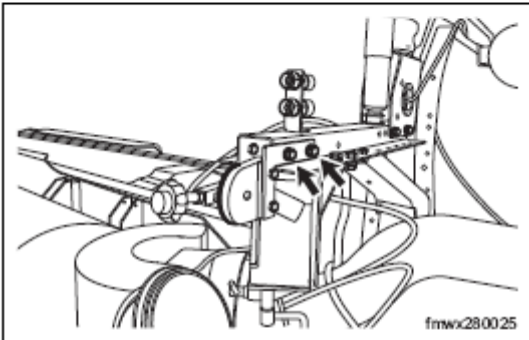
As for the Diagram of Components, refer to Chapter 28: Diagram of Components, Frame-Tilting Control Mechanism Assembly.

1. Turn up the cab.
2. Lower the left and right front window glass, and place the cab sling at the middle rear cab.
Slowly raise the sling till the cab is supported.

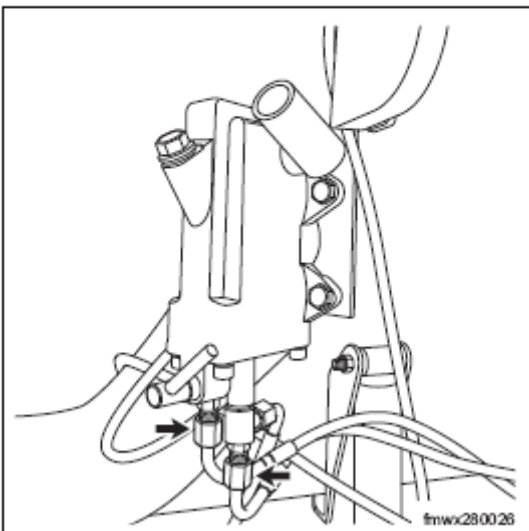


3. Remove the cylinder control cable assembly.

- (a) Remove the split pin and the control cable pin shaft.
- (b) Undo the cylinder control cable lock nut.



- (c) Remove the cylinder control cable assembly lock nut, and then remove the cylinder control cable assembly.

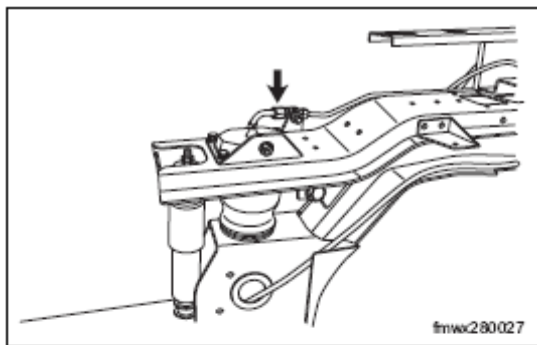


4. Remove the hand pump assembly.

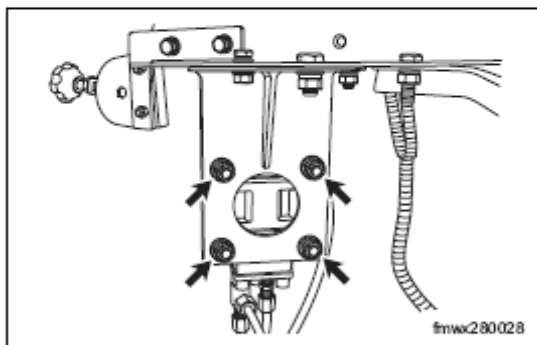
- (a) Remove the hand pump oil inlet & outlet pipes, and discharge the hydraulic oil.

Notice:

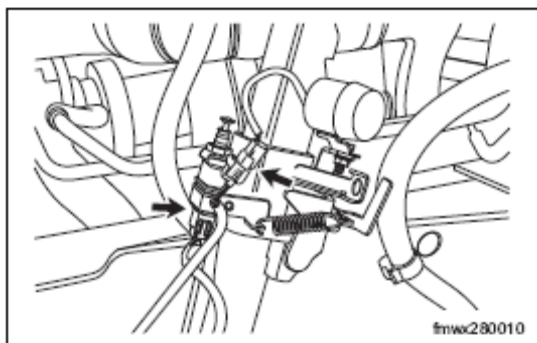
Use the oil pipe spanner to remove the oil pipe.



- (b) Remove the union at the connecting hose two-way union.

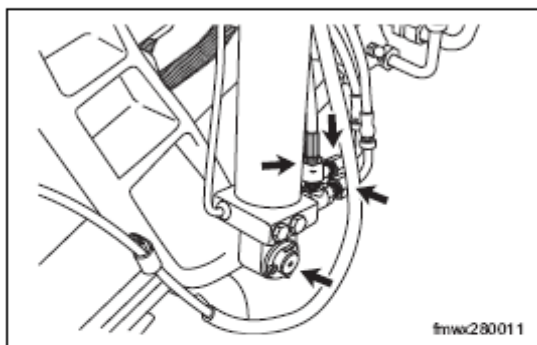


- (c) Remove the hand pump assembly lock nut, and then remove the hand pump assembly.



5. Remove the tilting cylinder assembly.

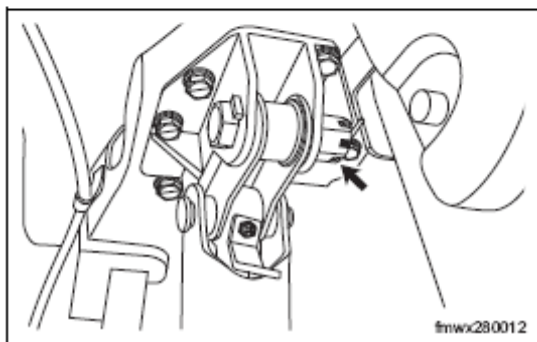
- (a) Disconnect the reversing buzzer and lower dead center switch connector.



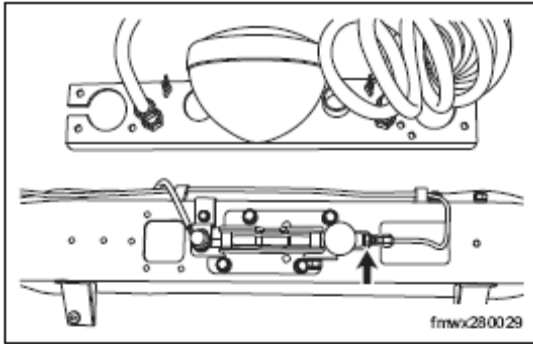
- (b) Remove the tilting cylinder oil inlet & outlet pipe and unhooking cylinder connecting oil pipe.
(c) Remove the tilting cylinder pin shaft.

Notice:

Use the oil pipe spanner to remove the oil pipe.

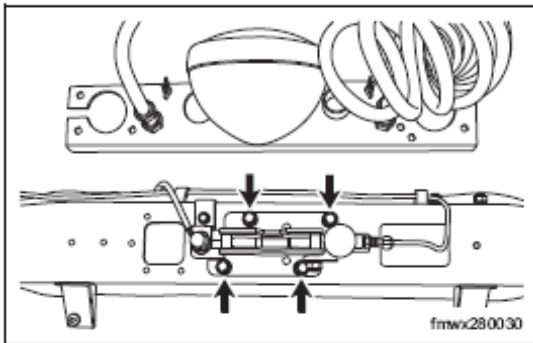


- (d) Remove the tilting cylinder lock bolt, and take out the tilting cylinder assembly.

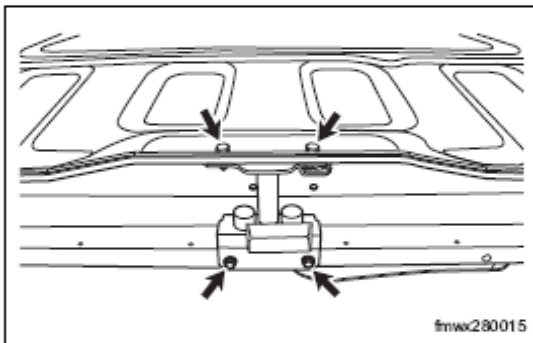


6. Remove the rear mounting lower locking body assembly.

- (a) Remove the rear mounting lower locking body oil pipe union.

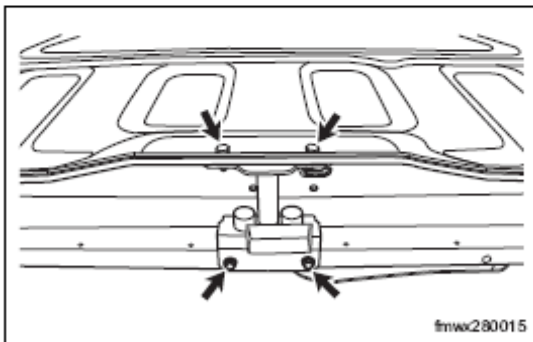


- (b) Remove the rear mounting lower locking body lock bolt, and remove the lower locking body assembly.



7. Remove the rear mounting upper locking body assembly.

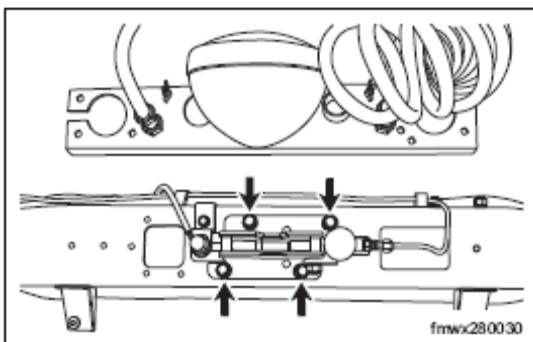
- (a) Remove the rear mounting upper lock body lock bolt, and then remove the upper locking body assembly.



8. Refit the rear mounting upper locking body assembly.

- (a) Refit the lock bolt of the rear mounting upper locking body.

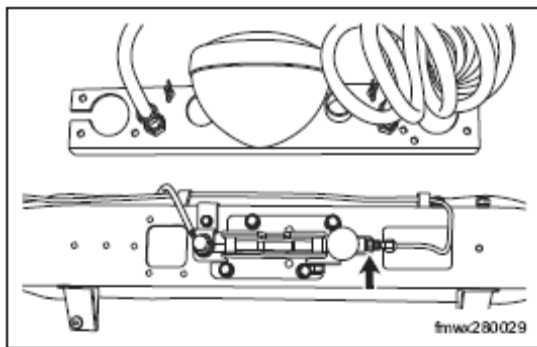
Torque: 63N.m



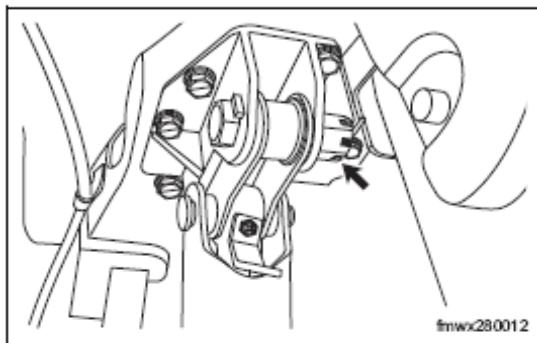
9. Refit the rear mounting lower locking body assembly.

- (a) Refit the lock bolt of the rear mounting lower locking body.

Torque: 63N.m



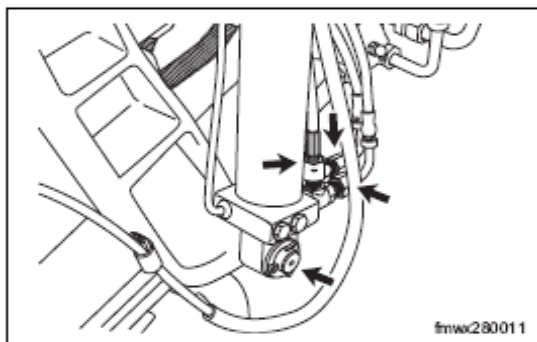
- (b) Refit the rear mounting lower locking body oil pipe union.



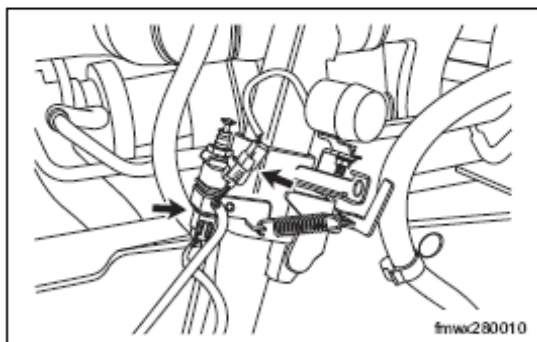
10. Refit the tilting cylinder assembly.

- (a) Refit the tilting cylinder lock bolt.

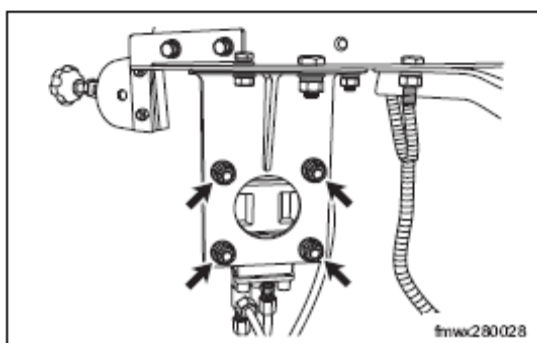
Torque: 160N.m



- (b) Refit the tilting cylinder pin shaft.
(c) Refit the tilting cylinder oil inlet & outlet pipes and unhooking cylinder connecting oil pipe.



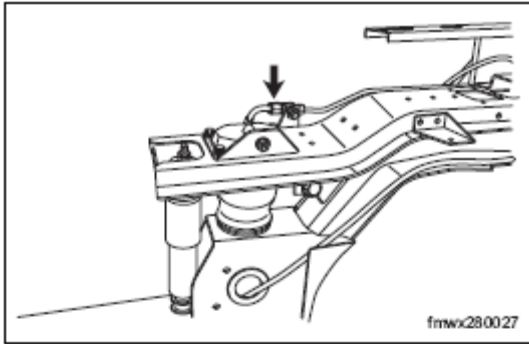
- (d) Connect the reversing buzzer and lower dead center switch connector.



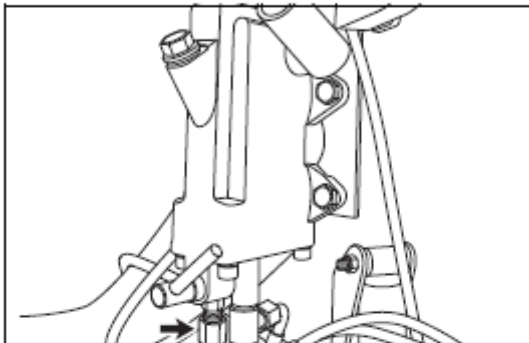
11. Refit the hand pump assembly.

- (a) Remove the lock nut of hand pump assembly.

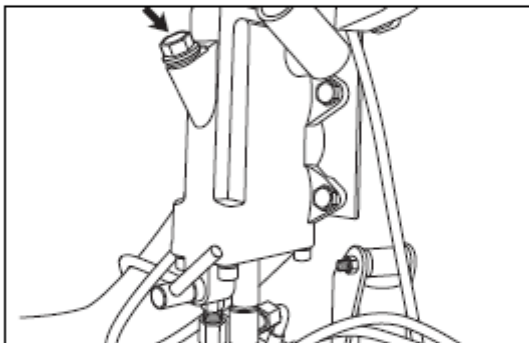
Torque: 97N.m



- (b) Refit the union at the connecting hose two-way union.



- (c) Refit the hand pump oil inlet & outlet pipes.

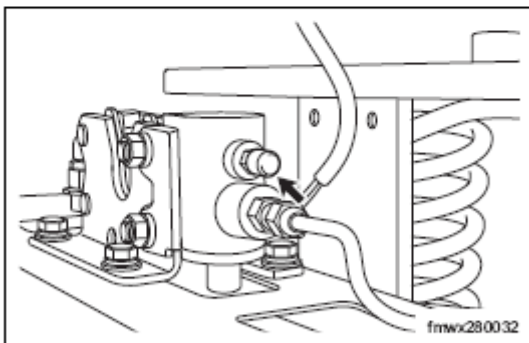


12. Fill the hand pump with hydraulic oil.

- (a) Remove the filler bolt, and fill hydraulic oil.

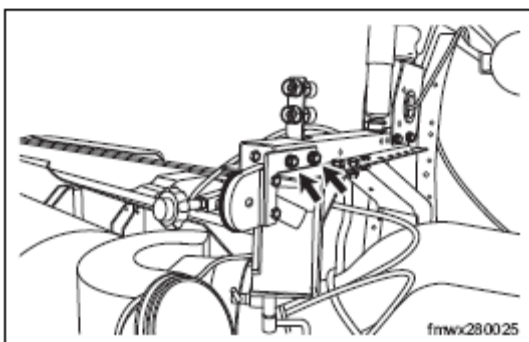
Hint:

After the oil pump is initially filled up, lift the cab for 2~3 times to imbue the system with oil.



- (b) Undo the system air bleeding screw to release the air in the system. After the final commissioning, the oil level shall be 15~20mm lower than the filler. With the cylinder upper chamber filled up with oil, add 280 ± 20 ml oil.

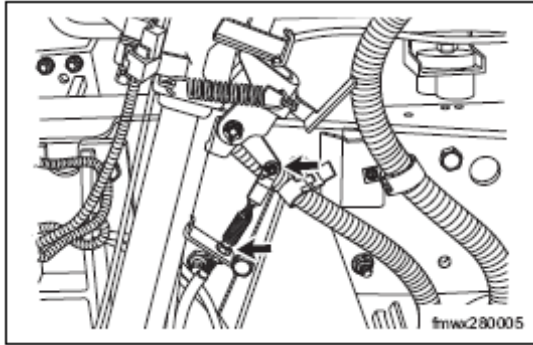
- (c) Fasten the air bleeding screw, fit the filler bolt, and check the system for leakage.



13. Refit the cylinder control cable assembly.

- (a) Refit the lock nut of the cylinder control cable.

Torque: 97N.m

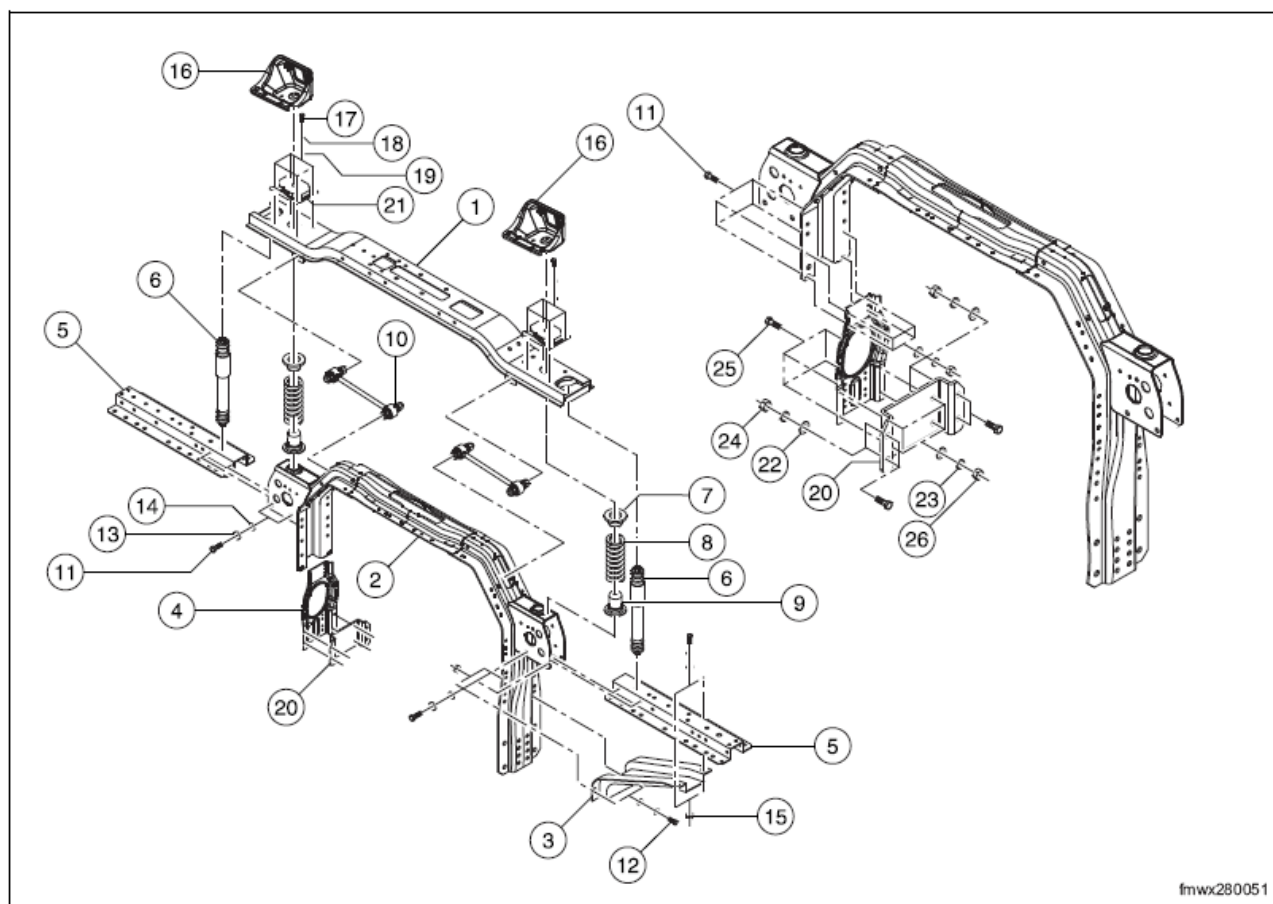


- (b) Fasten the lock nut of the cylinder control cable.
- (c) Refit the control cable pin shaft and split pin.

- 14. Lower the cab sling.
- 15. Lower the cab.

REAR SUSPENSION ASSEMBLY

DIAGRAM OF COMPONENTS



fmwx280051

1	Rear mounting upper frame assembly
2	Rear mounting lower frame welding assembly
3	Reinforced plate
4	Rear mounting connecting plate
5	Extension beam assembly
6	Rear shock absorber assembly
7	Upper buffer assembly
8	Rear spiral spring
9	Lower buffer assembly
10	Rocker arm assembly
11	Hexagon bolt
12	Hexagon bolt
13	Spring washer
14	Extension beam assembly

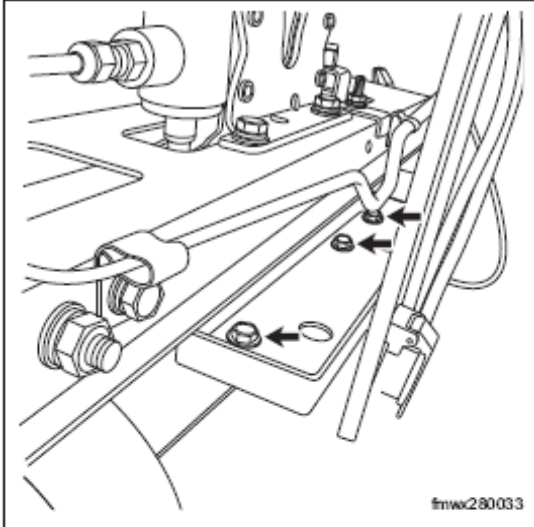
14	Plain washer
15	Type 1 hexagon nut
16	Rear supporting seat assembly
17	Hexagon bolt
18	Spring washer
19	Plain washer
20	Transition bracket
21	Shock absorber assembly
22	Plain washer
23	Spring washer
24	Type 1 hexagon nut
25	Hexagon bolt
26	Type 1 hexagon nut

REPLACEMENT

Hint:

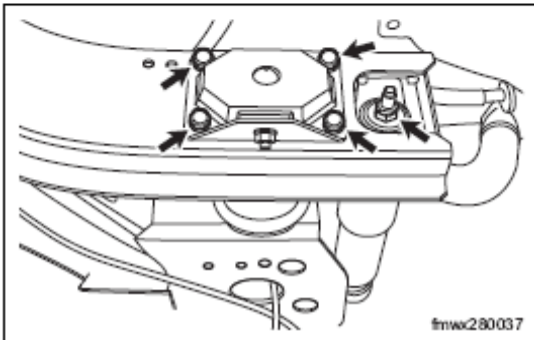
As for the Diagram of Components, refer to Chapter 28: Diagram of Components, Frame-Rear suspension assembly.

1. **Tilt up the cab.**
2. **Remove the rear mounting lower locking body assembly and its pipe unions.**



3. **Remove the braking pipeline trailer union bracket assembly.**

- (a) Remove the lock bolt of the braking pipeline trailer union bracket assembly, and then remove the union bracket.



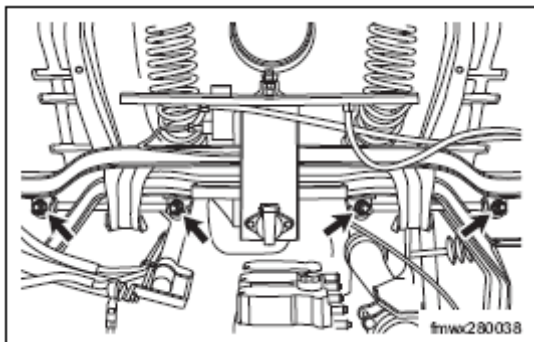
4. **Remove the rear mounting upper frame welding assembly.**

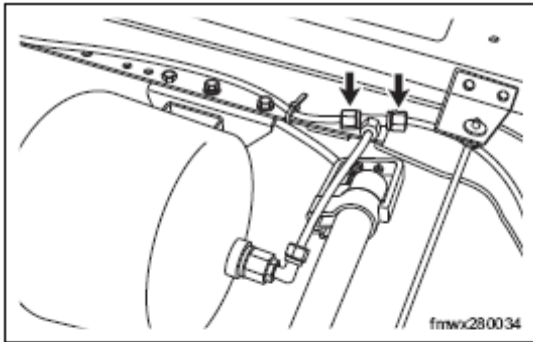
- (a) Remove the lock bolt of the left shock-absorbing air bag assembly, and then remove both upper and lower buffers, and left shock-absorbing air bag.
- (b) Remove the locking seat nut of the right rear shock absorber.

Hint:

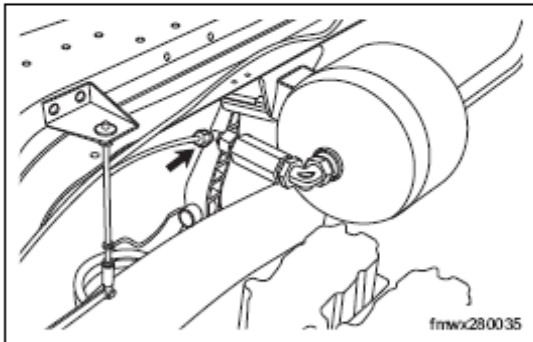
The left part is removed as per the same procedure with the right one.

- (c) Remove the rocker arm assembly lock bolt, and then remove the rocker arm assembly.
- (d) Remove the rear mounting upper frame welding assembly.

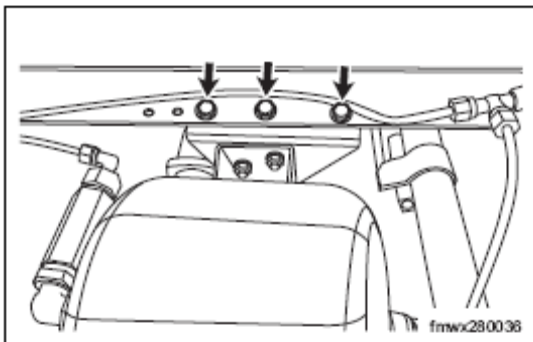




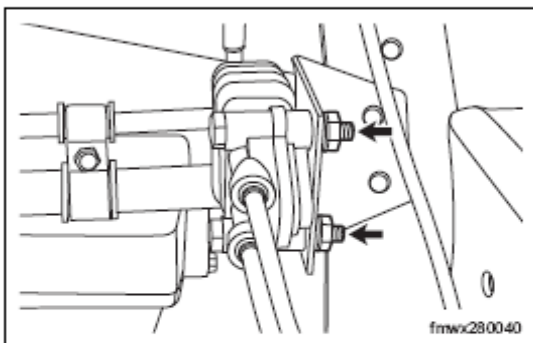
5. **Remove the rear mounting air pump assembly.**
(a) Remove the union at the air pump outlet hose tee valve union.



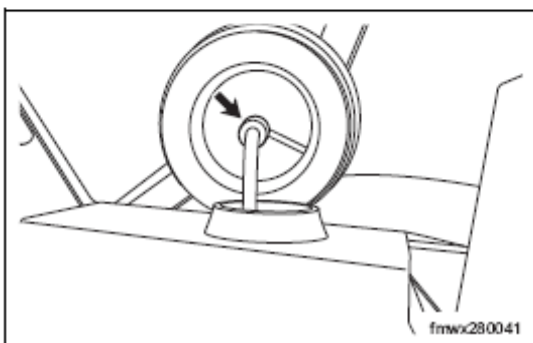
- (b) Remove the nut at the air pump inlet hose union.



- (c) Remove the air pump lock bolt and then the pump.



- (d) Remove the lock bolt of the left air chamber.

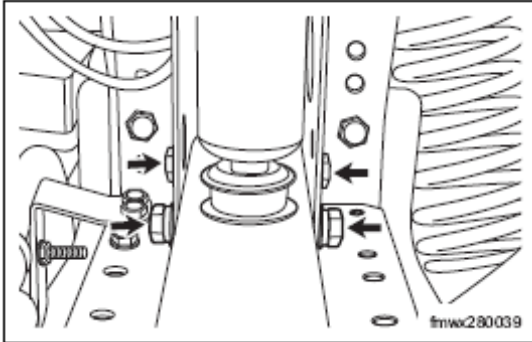


- (e) Remove the connecting hose of the left shock-absorbing air bag, and then remove the left air chamber and left shock-absorbing air bag.

Hint:

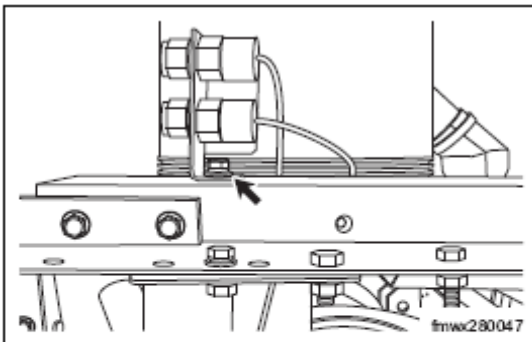
The right part is removed as per the same procedure with the left one.

6. Remove the steering oil tank assembly. Refer to Chapter 42: Replacement, Power Steering Mechanism-Power Steering Oil Tank Assembly.
7. Remove the secondary water tank assembly. Refer to Chapter 14A: Service, Cooling-Secondary Water Tank.
8. Remove the left mudguard bracket, and then remove various wire binding strips and brackets.

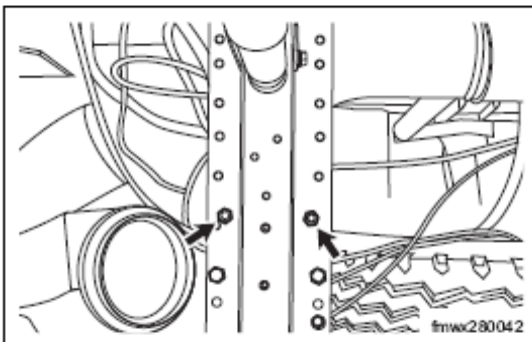


9. Remove the left extension beam assembly.
 - (a) Remove the extension beam lock bolt and then remove the extension beam assembly.

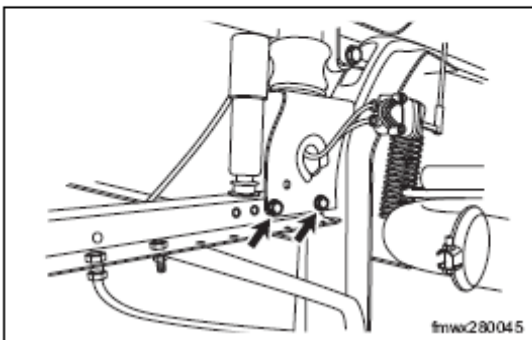
10. Remove the right mudguard bracket and then various wire binding strips and brackets.
11. Remove the cylinder control cable assembly lock nut. Refer to Chapter 28: Replacement, Frame-Tilting Control Mechanism Assembly.



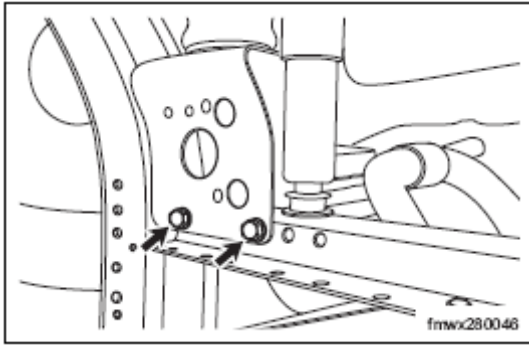
12. Remove the right extension beam assembly.
 - (a) Remove the lock bolt of the engine secondary starting switch bracket, and then remove the switch bracket.



- (b) Remove the right extension beam triangle bracket lock bolt.

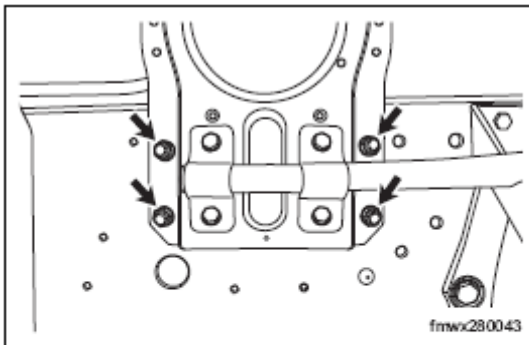


- (c) Remove the right extension beam right lock bolt.



- (d) Remove the right extension beam left lock bolt, and then remove the extension beam assembly.

13. Remove the exhaust pipe assembly. Refer to Chapter 13A: Service, Exhaust and Turbo-charging-Exhaust Pipe.



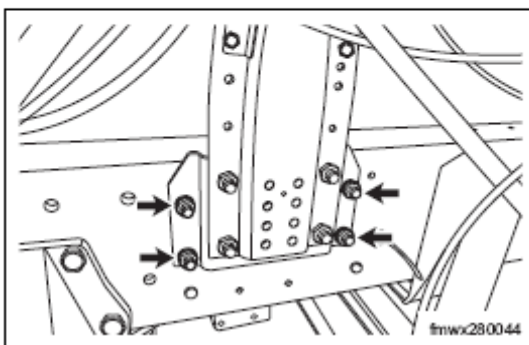
14. Remove the left rear mounting lower frame welding assembly.

- (a) Remove the lock nut of the left rear mounting lower frame welding assembly.

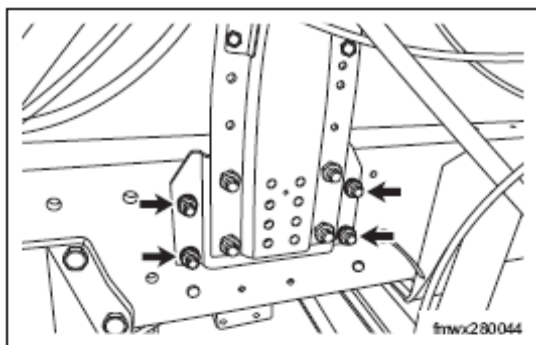


15. Remove the right rear mounting lower frame welding assembly.

- (a) Remove the right rear mounting lower frame upper earthing bolt.



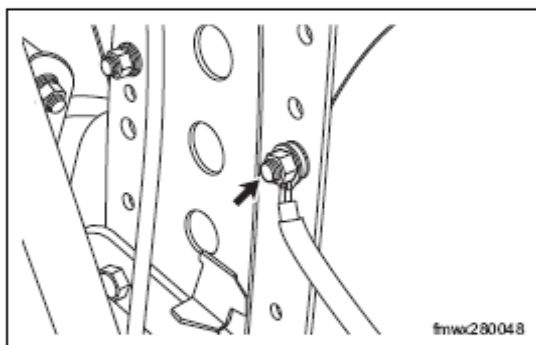
- (b) Remove the lock nut of the right rear mounting lower frame welding assembly.
(c) Remove the Rear suspension assembly.



16. Refit the rear mounting lower frame welding assembly.

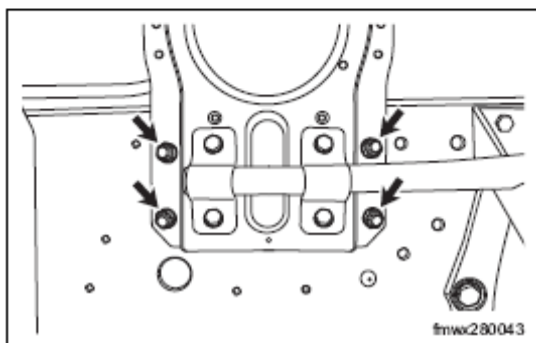
- (a) Refit the lock nut of the right rear mounting lower frame welding assembly.

Torque: 97N.m



- (b) Refit the right rear mounting upper frame upper earthing bolt.

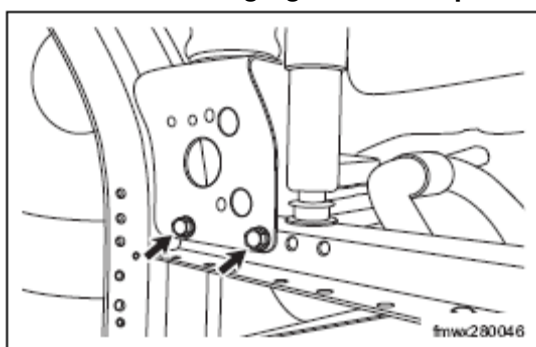
Torque: 63N.m



- (c) Refit the lock nut of the left rear mounting lower frame welding assembly.

Torque: 97N.m

17. Refit the exhaust pipe assembly. Refer to Chapter 13A: Service, Exhaust and Turbo-charging-Exhaust Pipe.

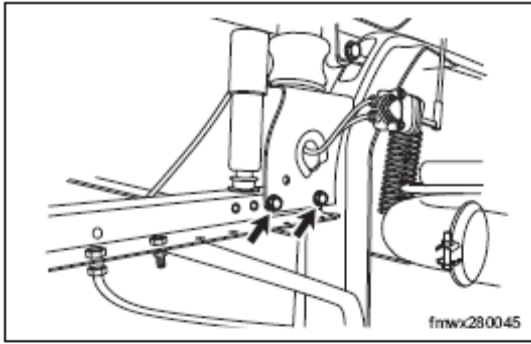


18. Refit the right extension beam assembly.

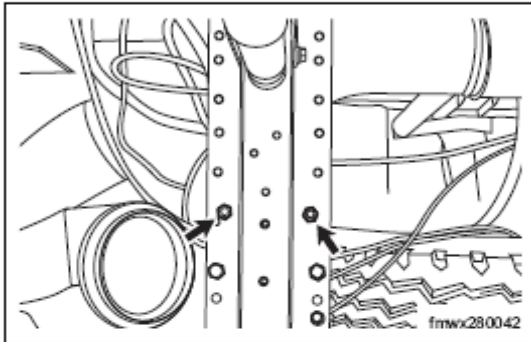
- (a) Refit the right extension beam left lock bolt.

Torque: 63N.m

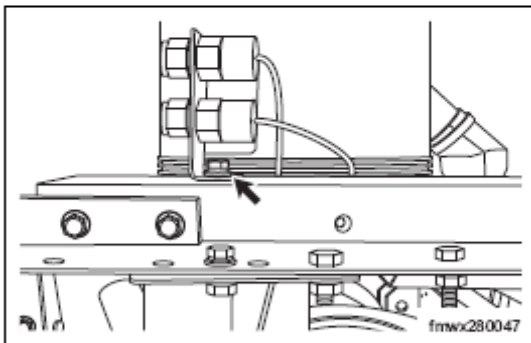




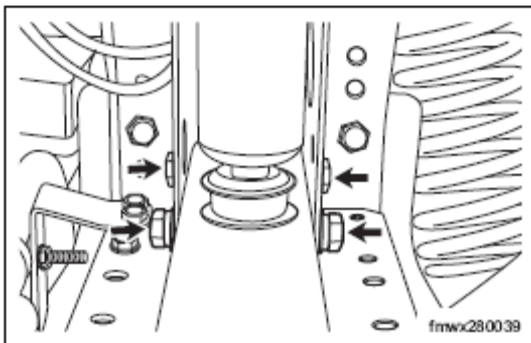
- (b) Refit the right lock bolt of right extension beam.
Torque: 63N.m



- (c) Refit the lock bolt of the triangle bracket of right extension beam.
Torque: 63N.m

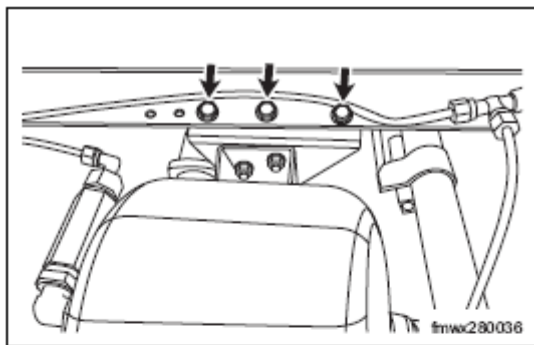


- (d) Refit the lock bolt of the secondary starting switch bracket of the engine.
Torque: 63N.m



19. Refit the left extension beam assembly.
(a) Refit the left extension beam lock bolt.
Torque: 63N.m

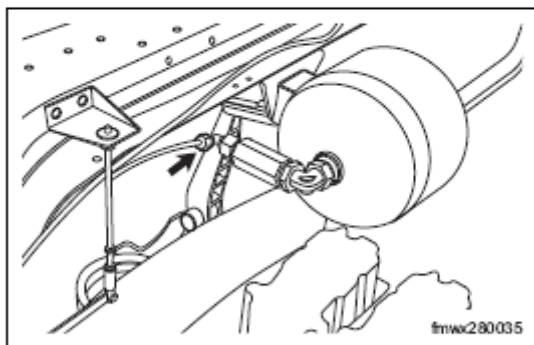
20. Refit the left mudguard bracket and various wire binding strips and brackets.
21. Refit the secondary water tank assembly. Refer to Chapter 14A: Service, Cooling-Secondary Water Tank.
22. Refit the steering oil reservoir assembly. Refer to Chapter 42: Replacement, Power Steering Mechanism-Power Steering Oil Reservoir Assembly.
23. Refit the lock nut of cylinder control cable. Refer to Chapter 28: Replacement, Frame-Tilting Control Mechanism Assembly.
24. Refit the right mudguard bracket and various wire binding strips and brackets.



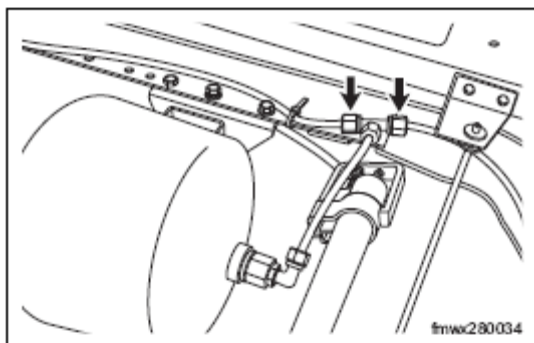
25. Refit the rear mounting air pump assembly.

- (a) Refit the air pump lock bolt.

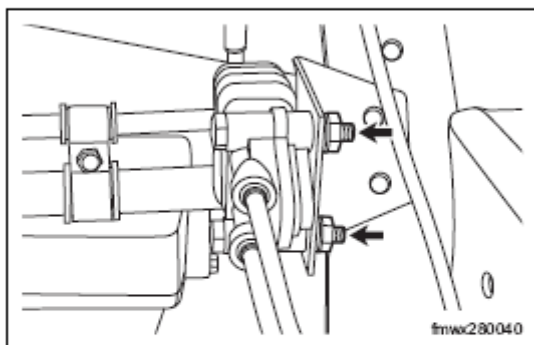
Torque: 63N.m



- (b) Refit the nut at the air pump inlet pipe hose.

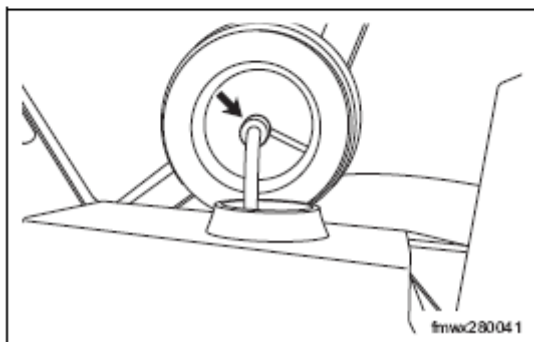


- (c) Refit the union at the air pump outlet hose tee valve union.



- (d) Refit the left air chamber lock bolt.

Torque: 63N.m

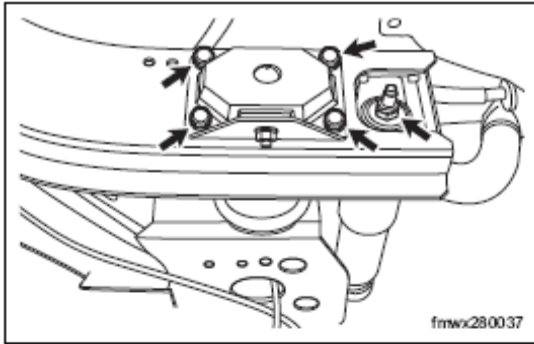


- (e) Insert the connecting hose of the left shock-absorbing air bag.

Hint:

The right part is refitted as per the same procedure with the left one.





26. Refit the rear mounting upper frame welding assembly.

- (a) Refit the left rear shock absorber lock seat nut.
- (b) Refit the upper and lower buffers and left shock-absorbing air bag, and refit the left air bag lock bolt.

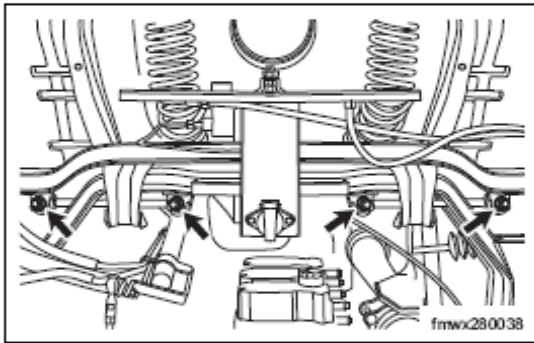
Torque: 63N.m

Hint:

The right part is refitted as per the same procedure with the left one.

- (c) Refit the lock bolt of rocker arm assembly.

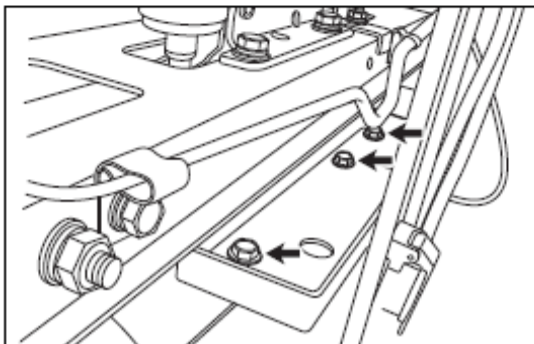
Torque: 97N.m



27. Refit the braking pipeline trailer union bracket assembly.

- (a) Refit the lock bolt of the braking pipeline trailer union bracket assembly.

Torque: 63N.m



28. Refit the rear mounting lower locking body assembly and its pipeline unions.

29. Tilt down the cab.

Intermediate Axle (Steyr)

Intermediate Axle Assembly	29A-3
General	29A-3
Precautions	29A-4
Fault Symptom Table	29A-6
Part Drawing	29A-8
Testing and Adjustment	29A-12
Axle Shaft	29A-19
Overhaul	29A-19
Hub Bearing & Oil Seal	29A-20
Overhaul	29A-20
Intermediate Axle Assembly and Intermediate Axle Housing	29A-21
Overhaul	29A-21
Through Shaft	29A-23
Overhaul	29A-23
Inter-axial Differential	29A-25
Overhaul	29A-25
Main Reducer	29A-31
Overhaul	29A-31
Driving Gear and Bearing	29A-32
Overhaul	29A-32



Intermediate Axle Assembly

General

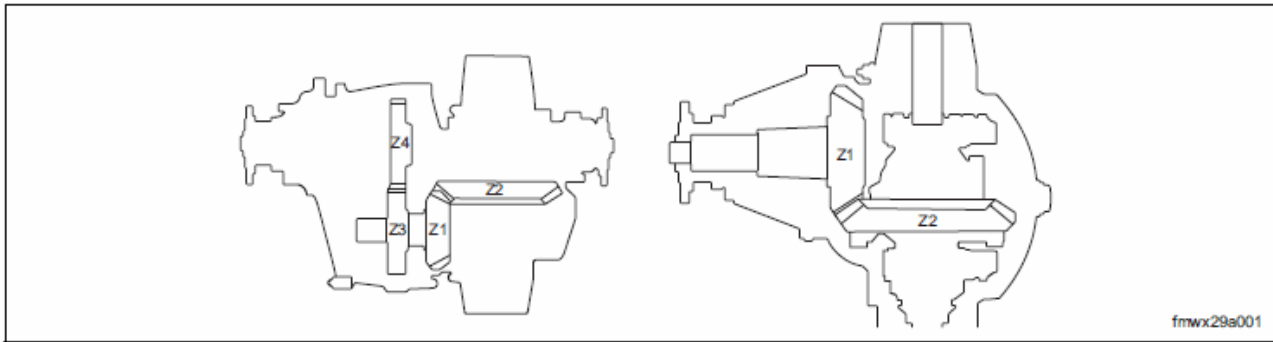
Power is transferred to the input driving flange by the drive shaft, and the spline shaft drives the input shaft to rotate. The input shaft is actually the front housing of the inter-axial differential, and is integrated with the rear housing of the differential through coupling bolts. Identical cross shaft planet gears in the inter-axial differential mesh with two axle shaft gears to drive the two axle shaft gears to rotate. The front axle shaft gear is connected with the through shaft of the driving rear axle through splines, so as to transfer power to the rear driving axle. The rear axle shaft gear is linked with the intermediate axle driving sleeve through splines. The shaft sleeve is linked with a driving cylindrical gear through splines, so that power is transferred to the driving bevel gear shaft via the driven cylindrical gear, and transferred to the left and right axle shafts of the intermediate axle via the inter-wheel differential through the driving and driven bevel gears.

There are two differentials in the driving intermediate axle. One is an inter-wheel differential, and it performs the function of automatic differential of the left and right wheels when the car is turning around. The other is an inter-axial differential, and it performs the function of automatic differential between the intermediate axle and rear axle when the vehicle is running on an uneven road. When the vehicle is running on an uneven road, it usually requires different instantaneous speeds between the intermediate axle and rear axle (at a certain moment, the intermediate axle rotates a little more than the rear axle wheel, while at another moment, the intermediate axle rotates a little less than the rear axle wheel) to meet the requirements of road for wheel rotation. If the intermediate axle and the rear axle form a completely positive drive, the wheels of the intermediate axle and rear axle rotate at the same speed at any moment so as to generate the phenomenon of incoordination. This consumes power, and may result in failure of wheel abrasion in less serious cases or even part damage in serious cases. The inter-axial differential can automatically adjust the speed of the intermediate and rear axles to completely adapt to the road surface.

Similar to the driving rear axle, the inter-wheel differential is provided with a differential lock. When the left and right wheels of the intermediate wheels skid on one side, causing failure to run, the inter-wheel differential lock can be closed. At this time, the mesh sleeve linked with the right axle shaft shall mesh with mesh teeth on the differential, so that the differential housing is locked with the right axle shaft into an integral body. The differential no longer performs the differential function, the left and right axle shafts shall become a positive driving shaft, and the vehicle shall smoothly run out of the fault road surface.

If the inter-wheel differential lock is closed, both the left and right wheels of the intermediate axle skid while the wheels of the rear axle keep still, or both the wheels of the rear axle skid while the wheels of the intermediate axle keep still (which indicates that the inter-axial differential is working), but the vehicle still can not run, then it is necessary to close the inter-axial differential lock. After pressing the inter-axial differential lock button, the electromagnetic valve is opened, and compressed air enters the operating cylinder of the inter-axial differential lock to drive the piston push rod, so that the shift fork of the differential lock drives the differential lock pin into the pinhole of the gear at the front axle shaft. Thus, the differential housing is locked with the axle shaft gear, the differential no longer performs the differential function, and the through shaft and drive gear sleeve completely form a positive linkage. At this time, the intermediate axle, rear axle, left axle shaft and right axle shaft completely form an integrated connection, and the vehicle smoothly runs out of the fault road surface. After the vehicle runs out of the fault road surface, the center and inter-wheel differential locks shall be immediately disengaged and removed.

Precautions



Total Speed Ratio i		4.38	4.8	5.73	6.72	7.49	8.4	9.49
Rear axle	Driving cylindrical bevel gear Z1	23	21	17	15	13	12	21
	Driven cylindrical bevel gear Z2	29	29	28	29	28	29	30
Intermediate axle	Driving cylindrical bevel gear Z1	17	17	17	15	13	12	11
	Driven cylindrical bevel gear Z2	28	28	28	29	28	29	30
	Driving cylindrical bevel gear Z3	34	31	35	35	35	35	35
	Driven cylindrical bevel gear Z4	26	26	35	35	35	35	35

As for the dual axle of which the speed ratio $i=6.72$, the intermediate axles and rear axles of the driving and driven bevel gears are identical. As for the dual axle of which the speed ratio $i=5.73$, the intermediate axles and rear axles of the driving and driven bevel gears are also identical. The driving and driven cylindrical drive gears in the gap bridge boxes of the intermediate axles $i=5.73$ and $i=6.72$ are identical. In other words, in the dual axles $i=5.73$ and $i=6.72$, only the numbers of teeth of the driving and driven bevel gears are different, and other parts are basically identical. Therefore, when it is necessary to replace the driving and driven bevel gears in maintenance, pay special attention to the speed ratio of the original vehicle. Otherwise, replacement of a wrong gear shall lead to different speed ratios of the intermediate axle and rear axle, resulting in the fault of burning loss of inter-axial differential. It should be worth noting that the driving and driven bevel gears of the intermediate axle $i=4.8$ are identical to those of the intermediate axle $i=5.73$, but the numbers of teeth of the driving and driven cylindrical gears in the gap bridge boxes. Therefore, the appearances of the gap bridge boxes of the intermediate axles look are identical, and can be interchangeably connected with the axle housing. Thus, do pay special attention to whether the speed ratio of the intermediate axle interruption assembly to be replaced is identical to that of the original vehicle speed ratio. Otherwise, different speed ratios shall result in different speed ratios of the intermediate axle and rear axle, resulting in burning loss of the inter-axial differential. Special attention shall also be paid to this in maintenance, when mounting the intermediate axle $i=4.38$.

The gap bridge transmission case of the intermediate axle and the main reducer adopt splash lubrication. There is a refill plug above the gap bridge box inter-axial differential, and the bottom of the gap bridge box is provided with an oil drain plug. A refill plug and an oil drain plug are also arranged on the intermediate axle tooth pit.

An oil baffle plate is arranged above the intermediate axle gap bridge box housing, so that the splashing lubricating oil flows into the lubrication differential of the inter-axial differential. The position of the inter-axial differential is higher, and its lubrication conditions are severe, so pay special attention to the amount of lubricating oil in the intermediate axle.



In use and maintenance of the dual axle, pay attention to:**1. Operation of differential lock**

The dual axle is provided with an inter-wheel differential lock and an inter-axial differential lock. So that the vehicle can smoothly pull out of the fault road surface by using the differential locks when it runs into the muddy and smooth road surface and fails to pull out.

The cab dashboard is provided with two differential lock buttons, an inter-wheel differential lock button and an inter-axial differential lock button. When the vehicle runs into a muddy road and the wheel of a certain axle skid on one side, it is required to step on the clutch and press down the inter-wheel differential lock button. When the indicator lamp is on, the inter-wheel differential locks of the intermediate and rear axles are closed at the same time. When releasing the clutch pedal, the left and right wheels of a certain axle skid and idle at the same time, and the wheels of the other axle keep still, but the vehicle still can not pull out. At this time, step on the clutch and press down the inter-axial differential lock button; and after the indicator lamp is on, engage a gear, and release the clutch, so the vehicle must pull out of the fault road surface. After the vehicle pulls out of the fault road surface, immediately remove the differential locks.

- 2. In repair and maintenance, when it is necessary to draw the axle shaft, it should be noted that: the axle shaft on the side without a differential lock can be drawn freely. As for the axle shaft on the side with a differential lock, the differential shall be closed before drawing the axle shaft. In order to ensure the mesh sleeve of the differential lock not to disengage, the operating cylinder push rod of the differential lock shall also be fixed with an iron wire to avoid mesh sleeve disengagement caused by air leakage at the operating cylinder.**
- 3. A new vehicle shall be provided with forced maintenance after running 2,000-4,000km. At this time, gear grease at the center transmission and the wheel reductor shall be replaced. When refilling lubricating oil into the intermediate axle interruption, the lubricating oil shall be refilled from the refilling plug on the inter-axial differential housing. The center transmission and wheel reductor of the dual axle shall be filled with gear oil, AP1GL-5, Viscosity SAE85W/90.**



Fault Symptom Table

Use the table below to help you find the cause of the malfunction. Sequence number indicates the probability of the cause of the malfunction. Inspect each part in order. If necessary, replace these parts.

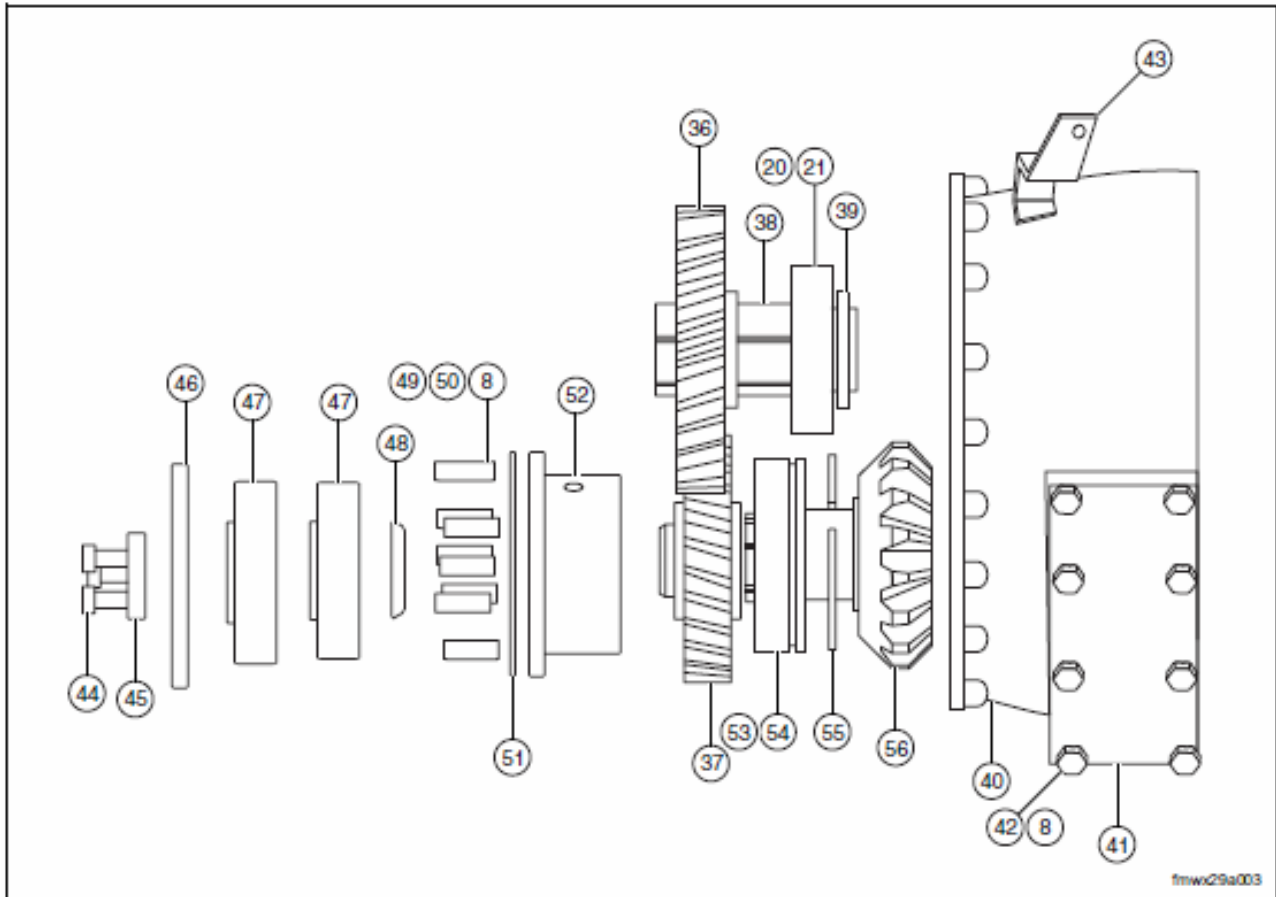
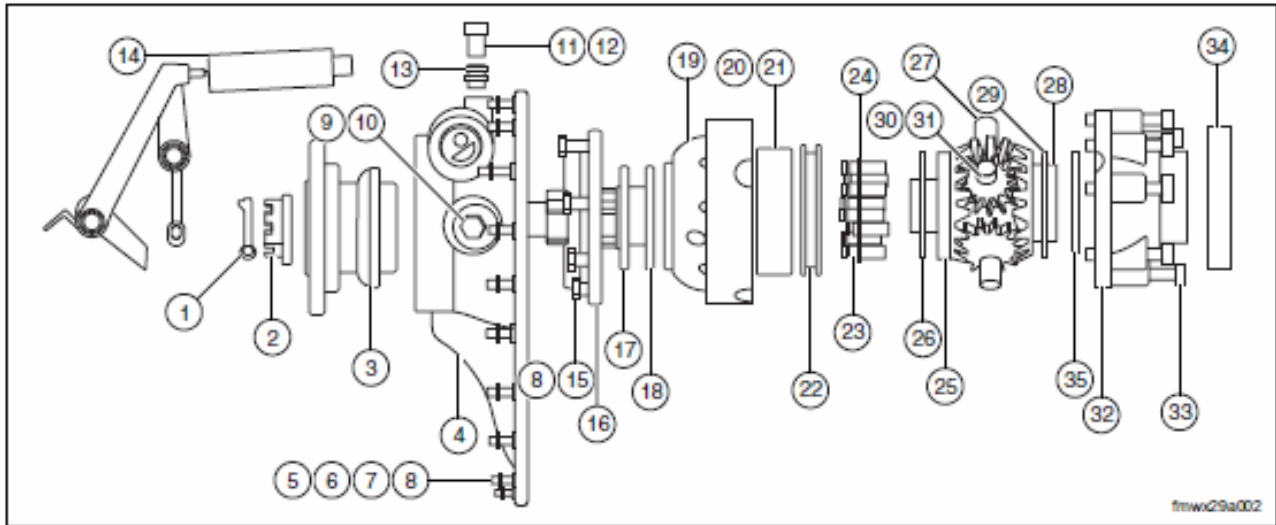
Symptom	Possible Position	Reference
Burn-out of inter-axial differential	1. Lack of oil	Add proper lubricating oil
	2. Different speed ratios of intermediate axle and rear axle	Select intermediate axle and rear axle at proper speed ratio
Abnormal sound of axle	1. Fixing bolt of driven cylindrical bevel gear (falling off or loosening)	Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Main Reducer, Overhaul
	2. Gear (damaged, the gap is too big or small)	Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Assembly, Test and Adjustment
	3. Tooth back (strain or pitting)	Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Main Reducer, Overhaul
	4. Bearing (falling apart, pitting)	Chapter 29A, Intermediate Axle (Steyr) – Gap Bridge Box Assembly, Overhaul Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Main Reducer, Overhaul
	5. Differential lock mesh sleeve (shift)	Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Main Reducer, Overhaul
	6. Differential gear (burn-out)	Chapter 29A, Intermediate Axle (Steyr) – Gap Bridge Box Assembly, Overhaul
	7. Cylindrical bevel gear (deviation of contact site of tooth surface)	Chapter 29A, Intermediate Axle – Intermediate Axle Main Reducer, Overhaul
	8. Spline shaft, hole (loosening)	Chapter 29A, Intermediate Axle (Steyr) – Gap Bridge Box Assembly, Overhaul
Heating of axle	1. Lack of oil	Add proper lubricating oil
	2. Too much lubricating oil	Discharge excessive lubricating oil
	3. Excessive pretightening of bearing	Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Assembly, Test and Adjustment
Oil leakage	1. Oil seal (damaged)	Chapter 25A, Rear Axle – Hub Bearing and Oil Seal, Overhaul
	2. Oil seal outer ring (loosening)	Chapter 25A, Rear Axle – Hub Bearing and Oil Seal, Overhaul
	3. Vent hole (blocked)	Dredge the vent hole



Symptom	Possible Position	Reference
Wear of tire	1. Steel ring (deformed)	Chapter 23A, Tire and Wheel –Rear Tire and Wheel, Overhaul
	2. Axle end bearing (loosening)	Chapter 25A, Rear Axle – Hub Bearing and Oil Seal, Overhaul
	3. Gas pressures of double rows of tires (too much difference)	Check the tire pressure, and inflate or deflate
	4. Balance shaft sleeve (wear, loosening)	Replace the balance shaft sleeve
	5. Rubber support of balance suspension push rod (damaged)	Chapter 25A, Rear Axle – Rear Axle Assembly and Rear Axle Housing, Overhaul
	6. Balance shaft push rod bracket and axle housing (snap of welding)	Replace the connection of balance shaft push rod bracket and axle housing

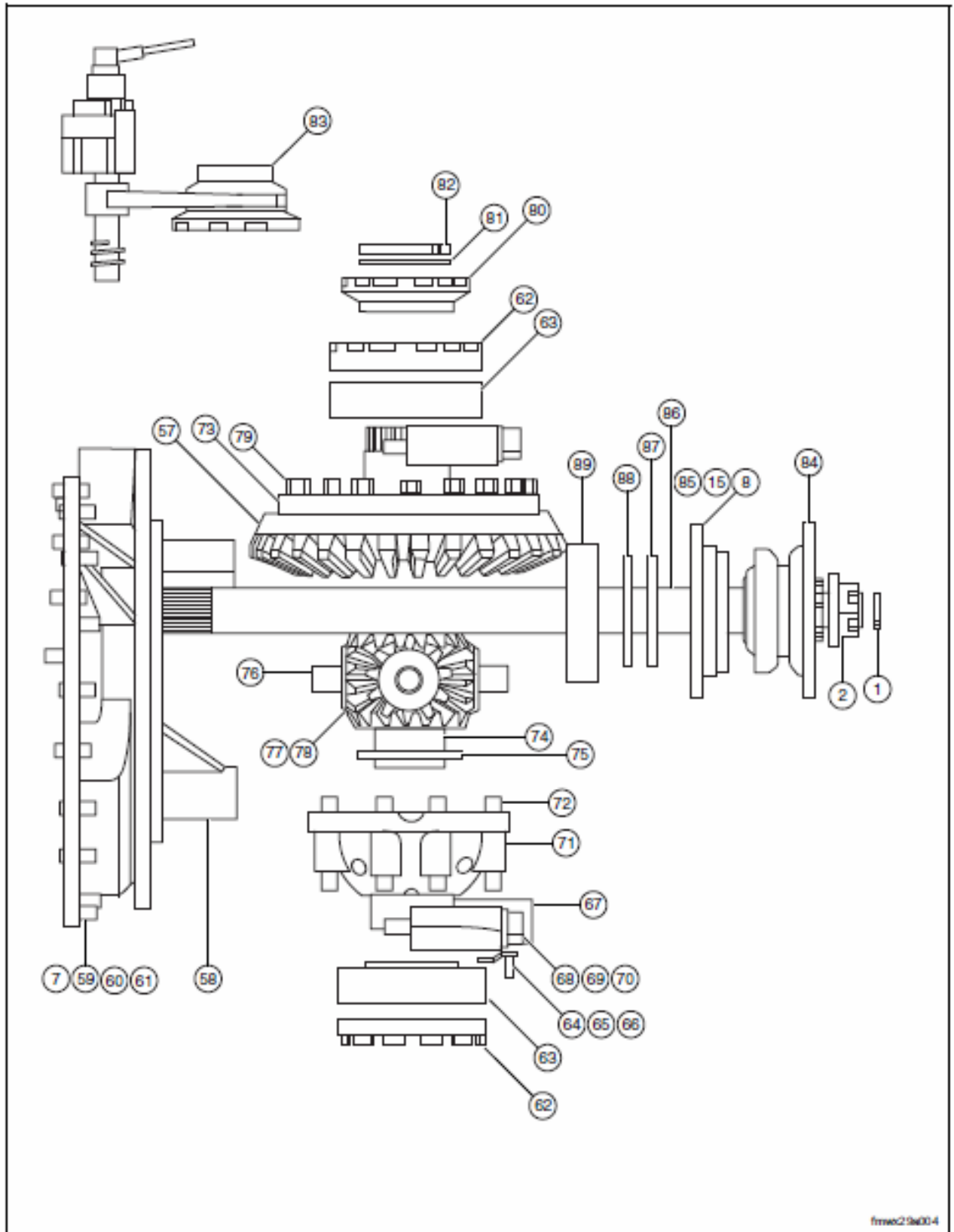


Part Drawing



29A

Intermediate Axle (Steyr) – Intermediate Axle Assembly



1	Cotter Pin
2	Flange Nut
3	Middle Front Flange Assy.
4	Gap Bridge Box Cover
5	Stud Bolt
6	Hex Nut, Style I
7	Cylindrical Pin
8	Spring Washer
9	Oil Filler Plug
10	Sealing Washer
11	Hex Head Bolt
12	Hex Nut, Style II
13	Pressure Switch
14	Differential Lock Assy.
15	Hex Head Bolt
16	End Cover, Bearing Cover
17	Shaft O-ring
18	Shaft O-ring
19	Front Differential Housing
20	Radial Ball Bearing
21	Steel Wire Circlip
22	Inter-axial Differential Gasket
23	Differential Lock Pin
24	Differential Lock Ring
25	Front Axle Shaft Gear
26	Front Gasket, Axle Shaft Gear
27	Differential Cross Shaft
28	Rear Axle Shaft Gear
29	Rear Gasket, Axle Shaft Gear
30	Planet Gear
31	Planet Gear Gasket
32	Rear Differential Housing
33	Hex Head Bolt

46	Pressure Plate, Bearing Outer Ring
47	Tapered Roller Bearing
48	Spacer
49	Stud Bolt
50	Hex Nut
51	Adjusting Gasket
52	Bearing Seat
53	Roller Bearing
54	Round Wire Snap Ring
55	Oil Retainer
56	Driving Bevel Gear
57	Driven Bevel Gear
58	Main Reducer Housing
59	Stud Bolt
60	Hex Nut, Style II
61	Spring Washer
62	Adjusting Nut
63	Single-Row Tapered Roller Bearing
64	Locking Plate
65	Hex Head Bolt
66	Spring Washer
67	Differential Bearing Cover
68	Stud Bolt
69	Hex Nut, Style I
70	Cylindrical Pin
71	RH Differential Housing
72	Hex Head Bolt
73	LH Differential Housing
74	Axle Shaft Gear
75	Washer, Axle Shaft Gear
76	Cross Shaft
77	Planet Gear
78	Planet Gear Gasket



Intermediate Axle (Steyr) – Intermediate Axle Assembly

34	Radial Ball Bearing
35	Round Wire Snap Ring for Shaft
36	Driving Cylindrical Gear
37	Driven Cylindrical Gear
38	Hollow Shaft
39	Slotted Nut
40	Gap Bridge Box
41	Oil Baffle Plate Assy.
42	Hex Head Bolt
43	Bracket Assy.
44	Hex Head Bolt
45	Bearing Pressure Plate

79	Hex Head Bolt
80	Fixing Mesh Sleeve
81	Locking Gasket
82	Round Nut
83	Differential Lock Assy.
84	Middle Rear Flange Assy.
85	Oil Seal Seat
86	Through Shaft
87	Sealing Ring
88	Sealing Ring
89	Deep Groove Ball Bearing



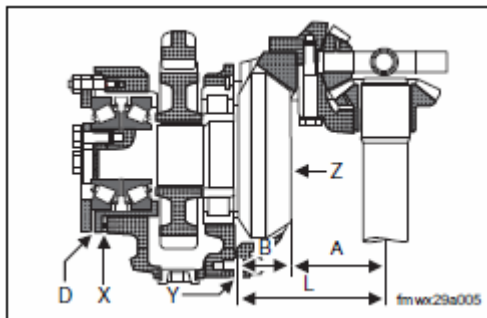
Testing and Adjustment

Adjustment of pretightening degree of driving gear bearing

When reassembling, check and adjust the pretightening degree of the driving gear bearing, the mounting distance adjusting washer of the driving gear bearing housing, the differential gear clearance, the driving and driven gear clearances, and the pretightening degree of the inter-wheel differential bearing.

The thickness calculation formula of the mounting distance adjusting washer X of the driving gear:

$$X = (A \pm Z) + B - (L \pm Y)$$



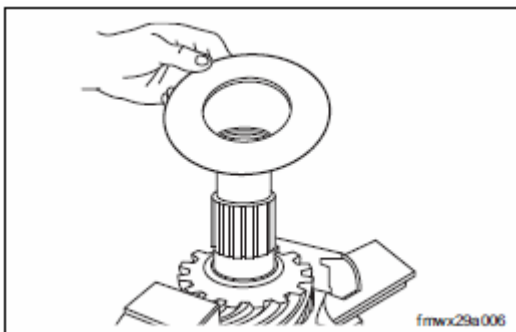
A	Theoretical value of distance between end face of driving gear and axis of driven gear (mm)
B	Measured value of distance between end face of driving gear and connecting surface of transition box (mm) (before adjusting gasket is mounted)
L	Theoretical value of distance between connecting surface of main reducer housing and axis of driven gear (mm)
Z	Actual deviation of A (printed on the end face of driving gear)
Y	Deviation of L (printed on connecting surface of main reducer housing)

29A

When installing the two tapered roller bearings of the driving gear shaft, select the gasket D with proper thickness. After tightening the pressure cover, the rotational resistance torque of the driving shaft is 0.5-2.5 N.m. This can be measured by pulling the string around the bearing housing with a spring balance. In normal cases, the reading on the spring balance shall be 0.6-2.9kg. If the tensile force is too large, it is required to thicken the gasket; if the tensile force is too small, it is required to thin the gasket.

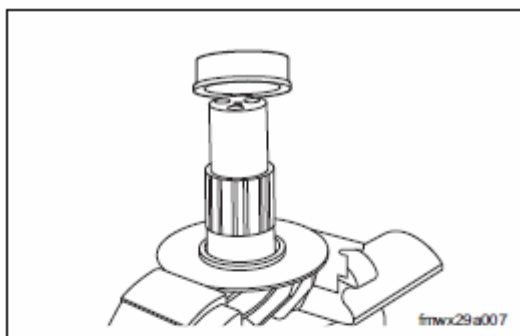
As for the intermediate axles, whose total speed ratio $i=4.38, 4.8, 5.79$ and 6.72 , $A=102\text{mm}$, $L=160\text{mm}$.

Caution: When dismantling and checking the old gap bridge box of intermediate axle, take care to keep the gaskets D and X for reassembling. Take care not to confuse the gaskets D and X, for the two gaskets are identical.

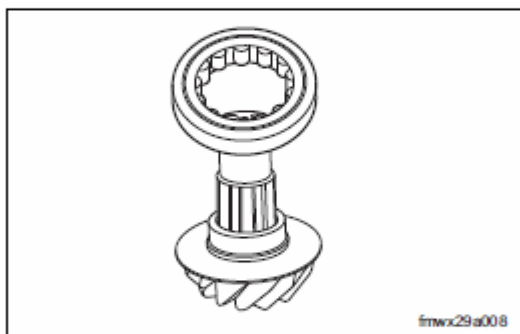


1. Put the oil baffle disc in the driving gear

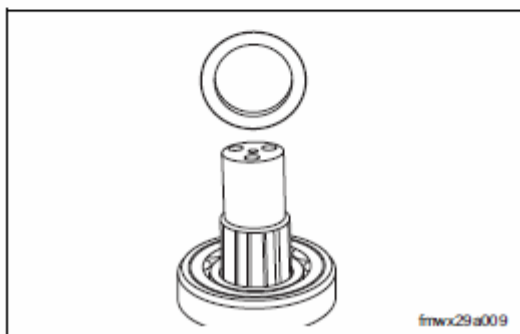




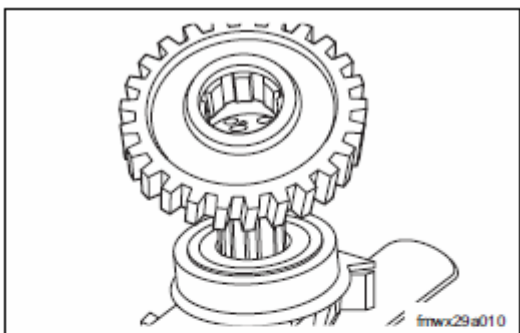
2. Heat the bearing inner ring to 80-100°C, and press it into the driving gear shaft



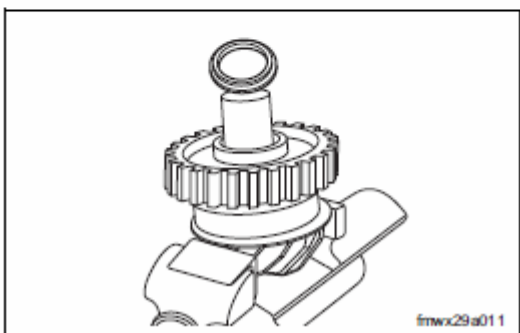
3. After cooling the bearing inner ring, put the outer ring and rollers in



4. Put the gasket into the driving bevel gear shaft

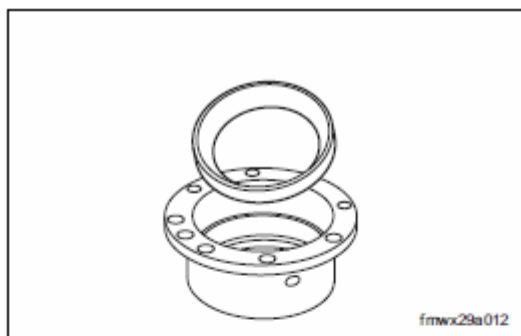


5. Preinstall the driving bevel gear shaft into the driven cylindrical drive gear

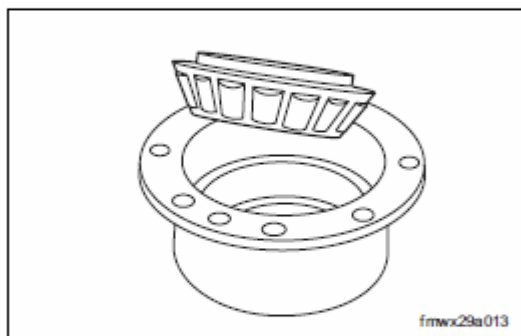


6. Put the spacer ring in the driving gear shaft

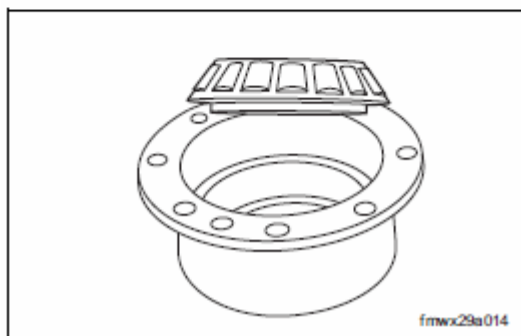




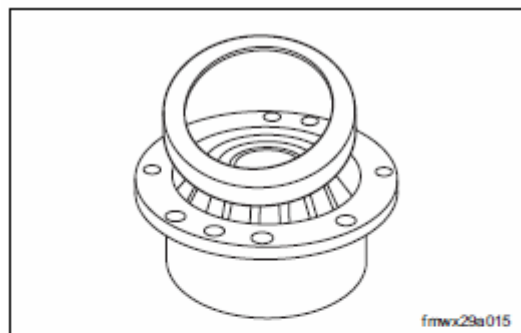
7. Press the bearing outer ring of the driving shaft in the bearing housing



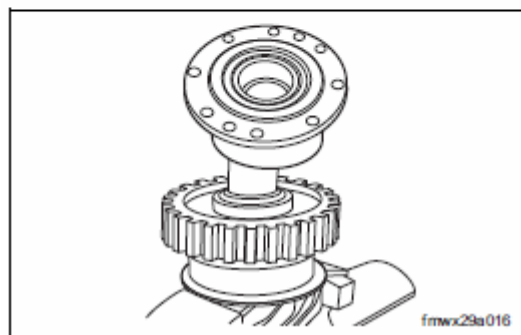
8. Install the inner bearing inner ring of the driving bevel gear



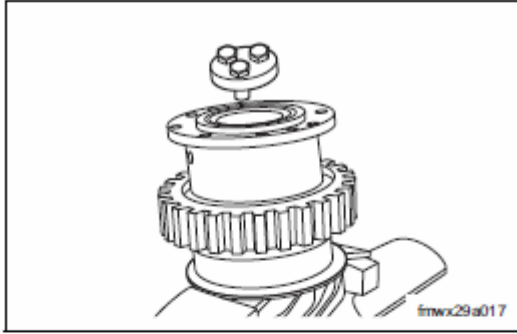
9. Install the outer bearing inner ring of the driving bevel gear



10. Press the outer bearing outer ring into the bearing seat

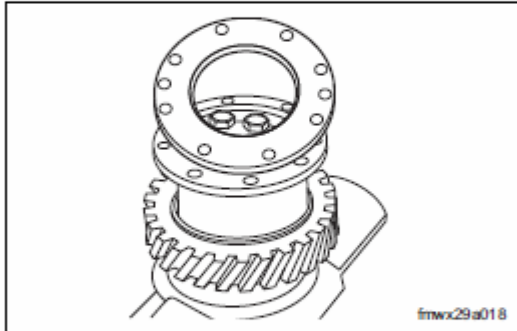


11. Install the bearing seat in the driving bevel gear shaft

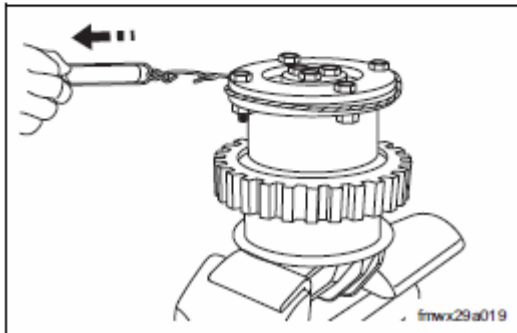


- 12. Install the driving gear shaft baffle plate, and pretighten 3 fixing bolts**

Torque: 195N.m



- 13. Preinstall the cover plate on the bearing seat**

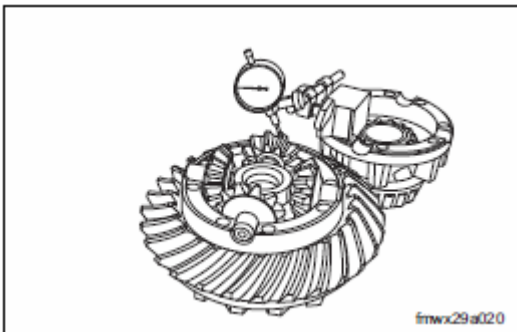


- 14. Measure the rotational resistance torque with spring balance**

- (a). The resistance torque shall be 0.5-2.5N.m, the reading of tensile force of the spring balance is 0.6-2.9kg. If not conforming to the standard, it is required to readjust the thickness of the gasket. If the resistance torque is too large, the gasket shall be thickened, and vice versa.

Adjustment tooth side clearance between planet gear and axle shaft gear of inter-axial differential and inter-wheel differential

It can be measured by measuring the left and right flexible clearance of big tapered surface tooth top of the planet gear by using a dial indicator. The clearance is realized by measuring the each differential housing and adjusting the thickness of the axle shaft gear thrust gasket.

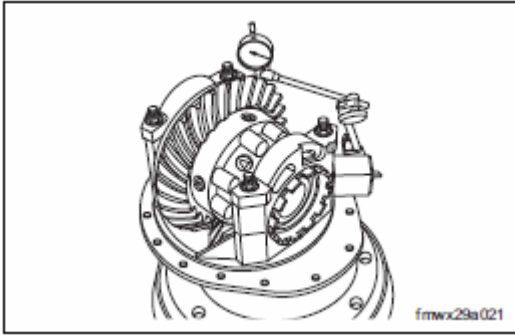


The tooth side clearance between the inter-axial differential planet gear and the axle shaft gear shall be 0.18-0.5mm.

The tooth side clearance between the inter-wheel differential planet gear and the axle shaft gear shall be 0.1-0.5mm.

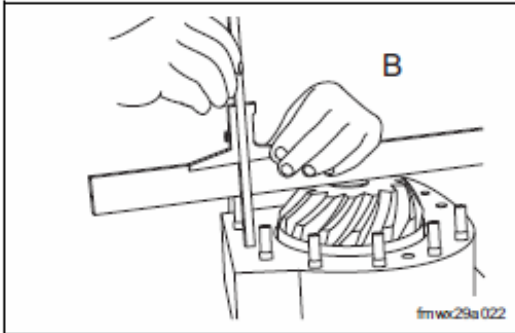


Adjustment of installation pretightening degree of inter-wheel differential

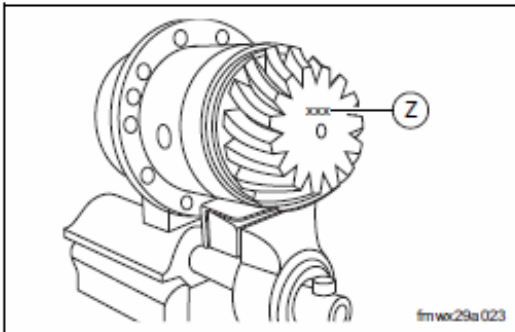


The installation pretightening of the inter-wheel differential bearing in the housing shall be realized by adjusting the torque of the slotted nut. Proper pretightening degree shall make the rotational resistance torque of the inter-wheel differential range 0.5-4.0N.m. This can be measured by pulling the string around the differential housing with a spring balance and observing the tensile force of the spring. This tensile force shall be 1.2-3.2kg.

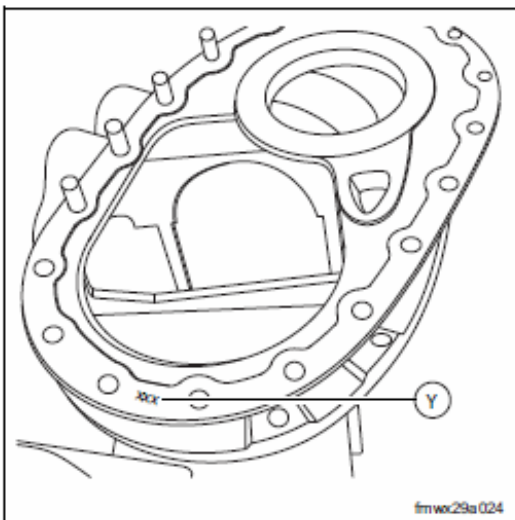
Adjustment of driving gear adjusting gasket



1. Actually measure the distance between the driving gear end face and the connecting plane with a depth indicator. For example, B=60mm



2. Observe that the driving gear end face is printed with Z=+0.2mm

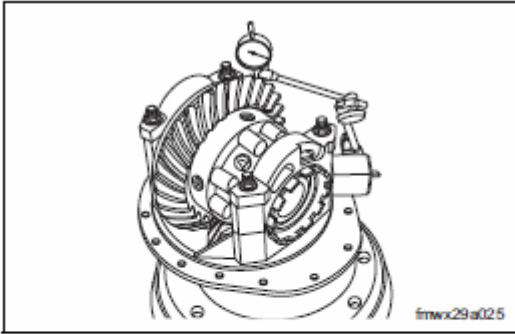


3. The connecting end face of the main reducer is printed with Y=-0.07mm

4. Work out the gasket thickness X= (A±Z) +B-(L±Y) =102+0.2+60-(160-0.07) =2.27mm

Adjustment of installation distance of driving gear and driven gear

The actual installation distance of the driving gear and the driven gear is realized by adjusting the connecting surface adjusting gasket between the bearing housing and the gap bridge box.

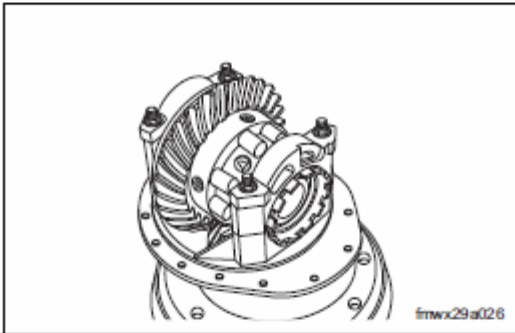


1. Measure the clearance of between the driving bevel gear and the driven bevel gear

Nominal value: 0.3-0.4mm

2. Adjust the bearing slotted nuts

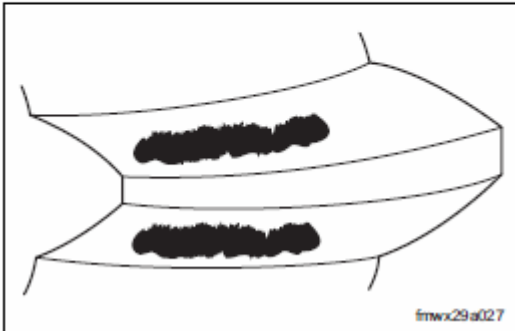
Caution: In order to ensure the pretightening degree of the adjusted bearing, take care that the left and right adjusting slotted nuts shall be adjusted synchronously and equally, i.e. the left slotted nut and the right slotted nut shall be loosened by the same angle (or number of turns). Thus, the left and right slotted nuts shall be marked before adjustment.



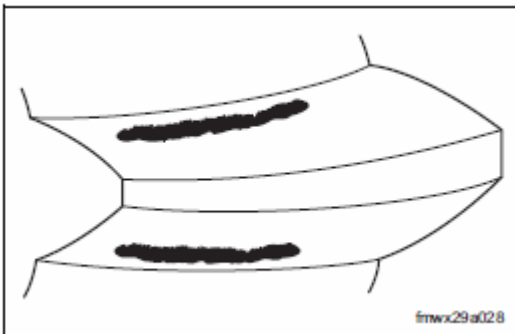
3. Check the tooth surface contact traces

- (a). Coat red lead oil or pigment on the tooth surface. Repeatedly rotate the driving and driven gears, and observe the tooth surface traces.

Caution: The test shall be carried out at 3 sites.

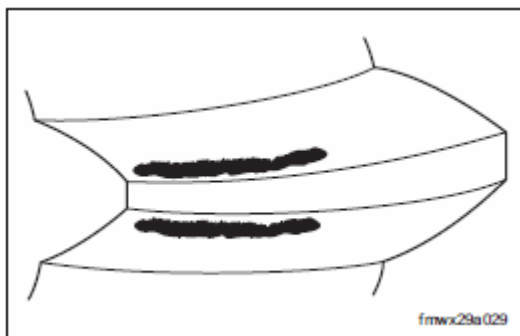


- The tooth surface contact traces are correct.



- If the tooth top contacts, the adjusting gasket X shall be thinned.





- If the tooth root contacts, the adjusting gasket X shall be thickened.

Axle Shaft Overhaul

Hint:

Part Drawing, refer to Chapter 25, Rear Axle – Rear Axle Assembly, Part Drawing.

Refer to Chapter 25, Rear Axle – Axle Shaft, Overhaul



Hub Bearing & Oil Seal Overhaul

Hint:

Part Drawing, refer to Chapter 25, Rear Axle – Rear Axle Assembly, Part Drawing.

Refer to Chapter 25, Rear Axle – Hub Bearing and Oil Seal, Overhaul

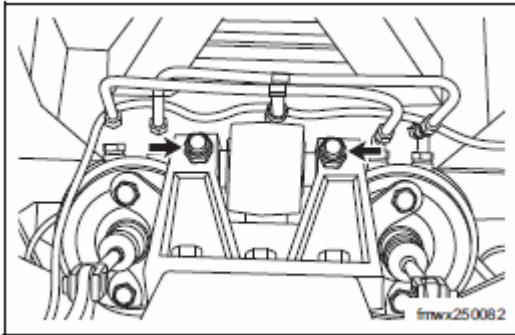


Intermediate Axle Assembly and Intermediate Axle Housing Overhaul

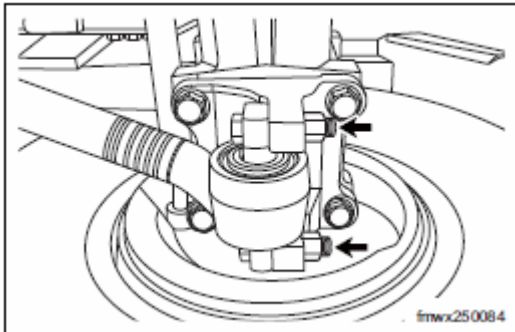
Hint:

Part Drawing, refer to Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Assembly, Part Drawing.

1. **Lift the vehicle. Refer to Chapter 01, Introduction - Maintenance Guide, Vehicle Support Position**
2. **Disconnect the intermediate drive shaft. Refer to Chapter 33, Drive Shaft - Intermediate Drive Shaft, Overhaul**
3. **Disconnect the inter-axial drive shaft. Refer to Chapter 33, Drive Shaft - Inter-axial Drive Shaft, Overhaul**
4. **Dismantle tires. Refer to Chapter 23 Wheel & Tire - Rear Wheel and Tire, Overhaul**
5. **Dismantle the rear brake chamber assembly. Refer to Chapter 26, Service Brake - Rear Brake Chamber, Overhaul**



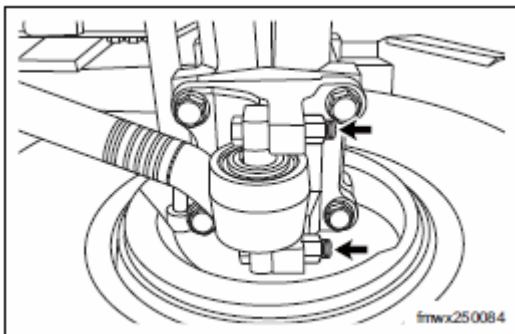
6. **Dismantle the intermediate axle assembly**
 - (a). Disconnect the differential lock air pipe.
 - (b). Disconnect the differential lock switching wiring harness connector.
 - (c). Dismantle the upper thrust rod.



- (d). Dismantle the lower thrust rod.
- (e). Dismantle the leaf spring U-bolt.
- (f). Put down the intermediate axle assembly with a jack, and draw it out.

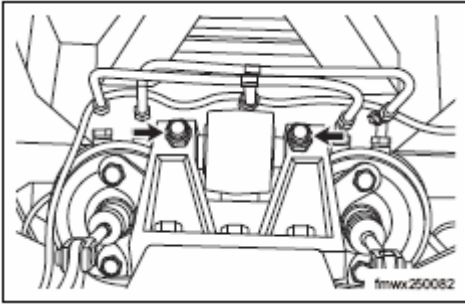
29A

7. **Check the intermediate axle housing for crack, wear and corrosion**



6. **Install the intermediate axle assembly**
 - (a). Put the intermediate axle assembly below the vehicle and lift it with a jack.
 - (b). Install the leaf spring U-bolt.
 - (c). Install the lower thrust rod.





- (d). Install the upper thrust rod.
- (e). Connect the differential lock switching wiring harness connector.
- (f). Connect the differential lock air pipe.

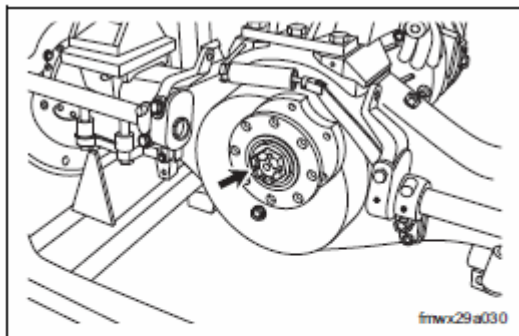
- 9. Install the rear brake chamber assembly. Refer to Chapter 26, Service Brake - Rear Brake Chamber, Overhaul
- 10. Install the tires. Refer to Chapter 23 Wheel & Tire - Rear Wheel and Tire, Overhaul
- 11. Connect the inter-axial drive shaft. Refer to Chapter 33, Drive Shaft - Inter-axial Drive Shaft, Overhaul
- 12. Connect the intermediate drive shaft. Refer to Chapter 33, Drive Shaft - Intermediate Drive Shaft, Overhaul

Through Shaft Overhaul

Hint:

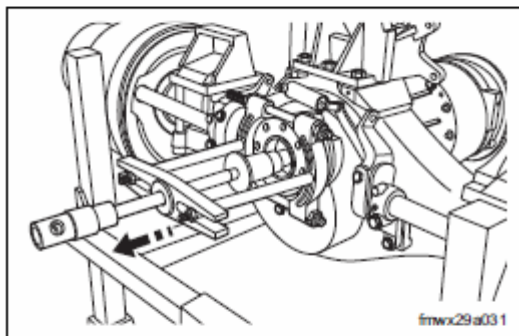
Part Drawing, refer to Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Assembly, Part Drawing.

1. **Disconnect the inter-axial drive shaft. Refer to Chapter 33, Drive Shaft - Inter-axial Drive Shaft, Overhaul**

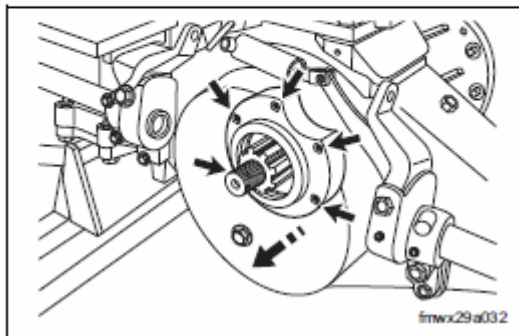


2. **Dismantle the through shaft**

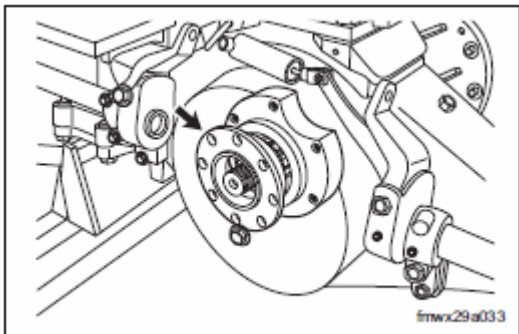
- (a). Dismantle the through shaft output flange.
 - Dismantle the flange nut.



- (b). Pull out the driving flange with a puller.

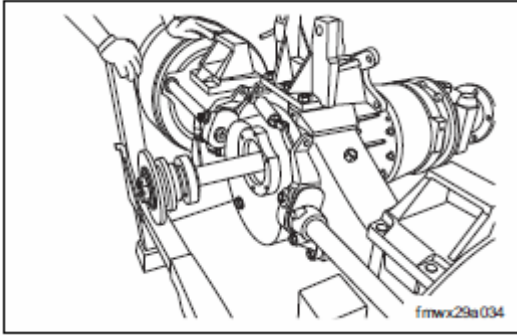


- (c). Dismantle the through shaft bearing end cover.



- (d). Install the through shaft output flange.





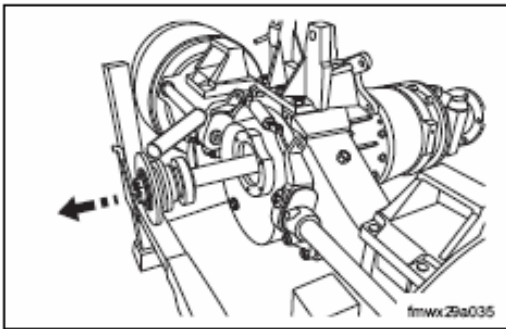
- (e). Knock the through shaft and block bearing out of the axle housing with a copper rod.
- Draw the through shaft out.

3. Check the through shaft

- Check the spline for damage.
- Check the bearing for damage.

Caution:

If damaged, replace with a new axle shaft or bearing.

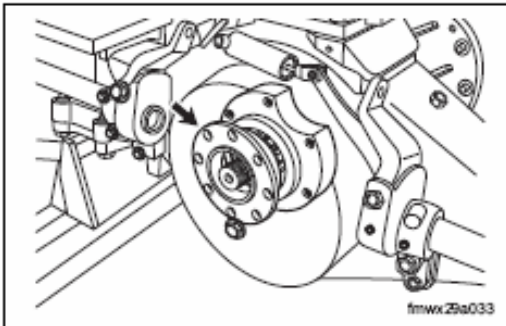


4. Install the through shaft

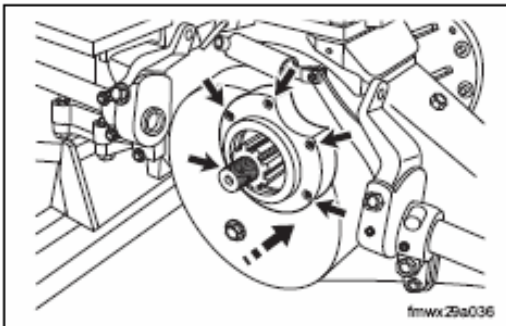
- (a). Knock the through shaft and block bearing into the axle housing with a copper rod.
- Insert the through shaft.

Caution:

Do not use a hammer.



- (b). Dismantle the through shaft output flange.



- (c). Install the through shaft bearing end cover.

Caution:

Before installation, clean the contact surface, and spread 598 flange sealant.

- Install the flange nut.

Torque: 210N.m

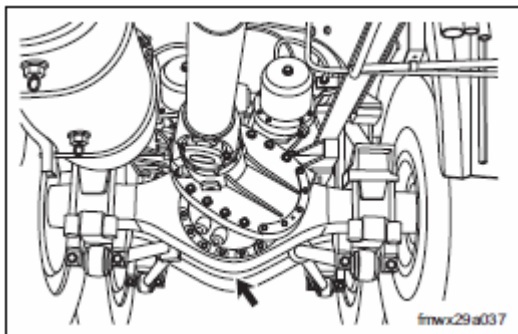
5. Connect the inter-axial drive shaft. Refer to Chapter 33, Drive Shaft - Inter-axial Drive Shaft, Overhaul

Inter-axial Differential

Overhaul

Hint:

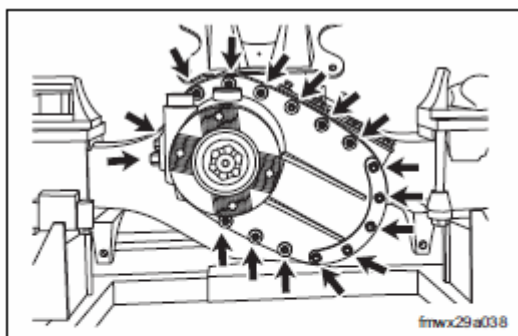
Part Drawing, refer to Chapter 29A, Intermediate Axle (Steyr) – Intermediate Axle Assembly, Part Drawing.



1. Drain the gear oil

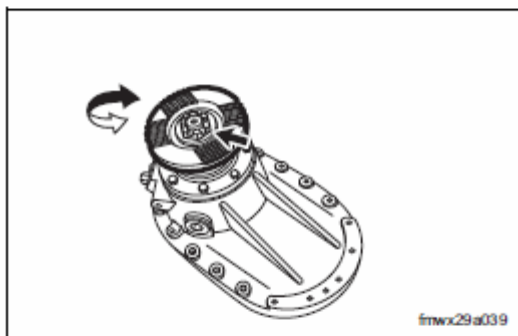
- (a). Loosen the bottom oil drain bolt.

2. Disconnect the intermediate drive shaft. Refer to Chapter 33, Drive Shaft - Intermediate Drive Shaft, Overhaul



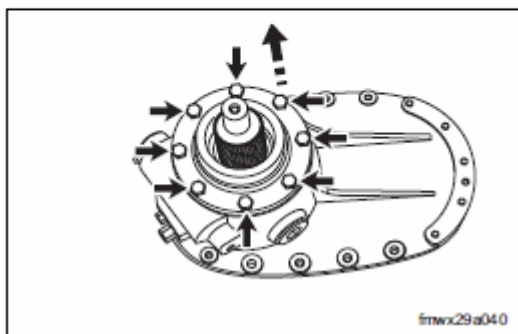
3. Dismantle the input shaft housing

- (a). Dismantle the input shaft housing fixing nut.
- (b). Dismantle the input shaft housing.



4. Dismantle the flange

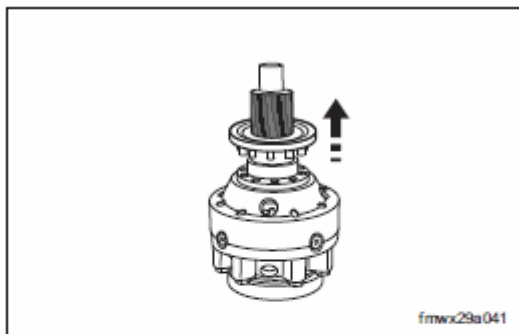
- (a). Dismantle the flange nut cotter pin.
- (b). Loosen the flange nut.



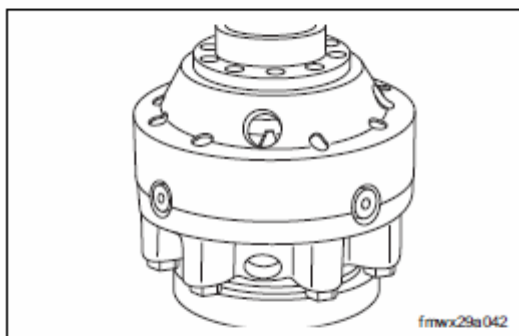
5. Dismantle the inter-axial differential

- Dismantle the bearing end cover

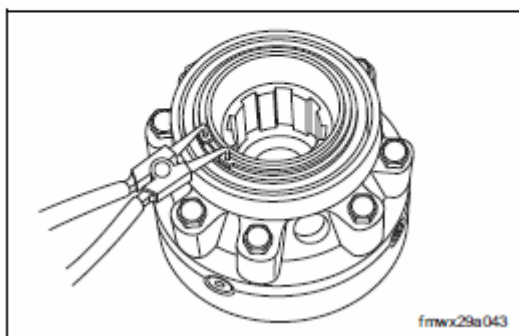




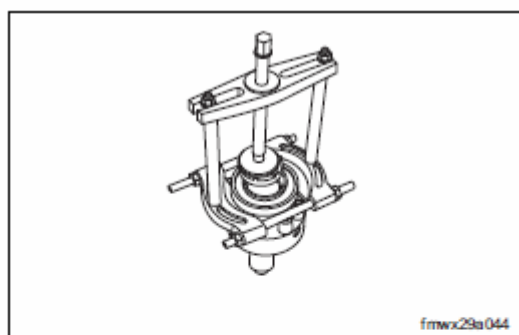
6. **Dismantle the differential lock pin slide sleeve**



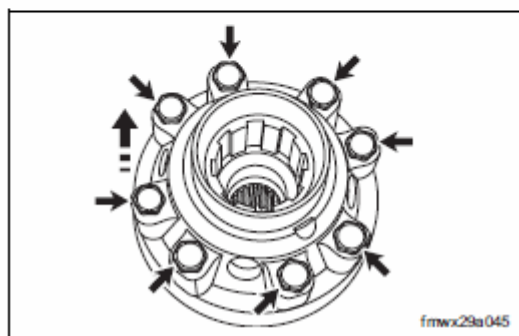
7. **Check the differential housing for assembling mark. If there is no assembling mark, reprint the assembling mark on the two differential housing halves.**



8. **Dismantle the bearing**
(a). Dismantle the rear bearing locating snap ring of the inter-axial differential.

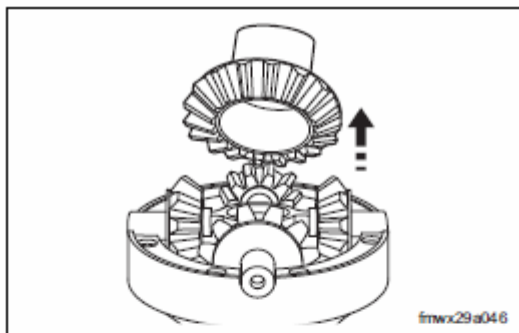


- (b). Dismantle the rear bearing of the inter-axial differential with a puller.

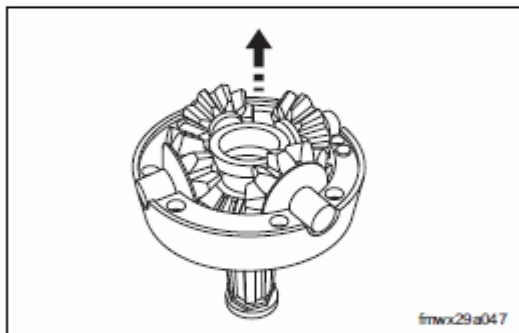


9. **Dismantle the differential housing**
(a). Dismantle the differential housing connecting bolts.

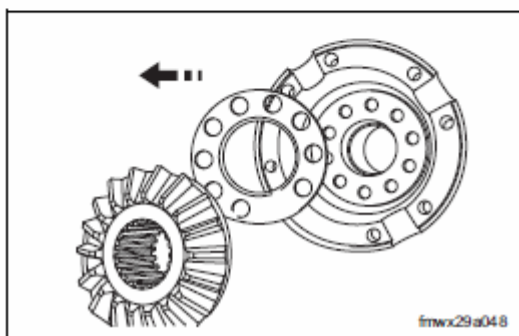




10. Take out the axle shaft gear



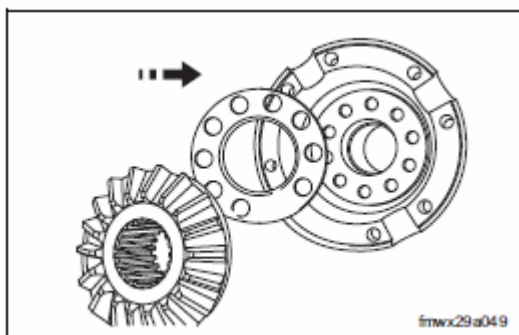
11. Take out the planet gear



12. Dismantle the axle shaft gear and adjusting gasket

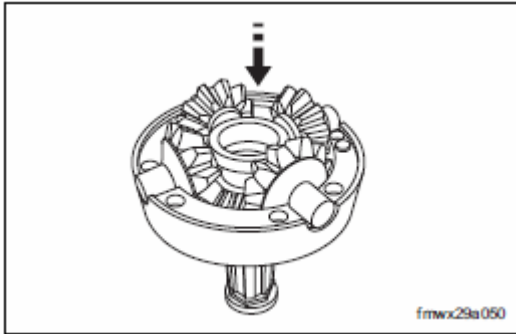
13. Check the differential housing, axle shaft gear and planet gear

- Check the differential housing for crack.
- Check the axle shaft gear for rupture, wear, pitting, gluing and plastic deformation.
- Check the planet gear for rupture, wear, pitting, gluing and plastic deformation.



14. Install the axle shaft gear and adjusting gasket

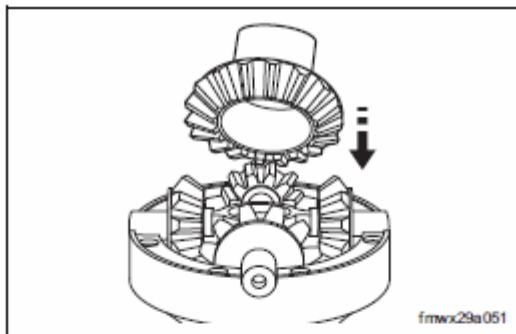




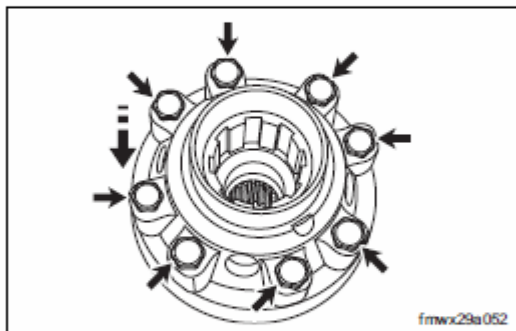
15. Install the planet gear

Caution: slightly knock the cross shaft with a copper rod to eliminate false clearance.

16. Measure the tooth side clearance. Refer to Chapter 29A, Intermediate Axle (Steyr) - Intermediate Axle Assembly, Test and Adjustment

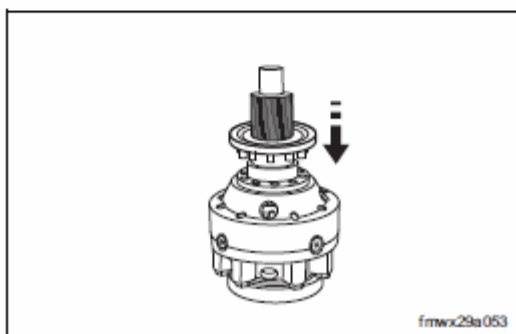


17. Install the axle shaft gear



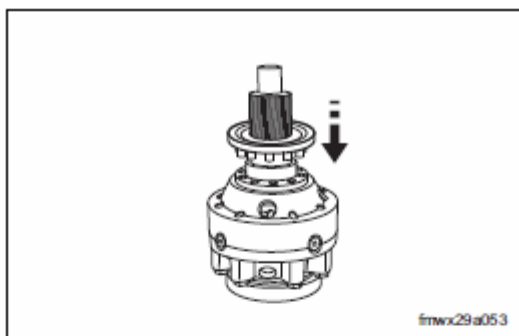
18. Install the differential housing connecting bolts

Caution: Before tightening the bolts, apply 262 thread lock on the bolts, and the bolts shall be tightened diagonally.

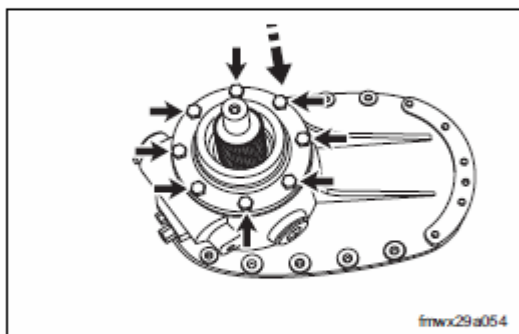


19. Install the bearing

- (a). Install the inter-axial differential rear bearing.
- (b). Install the rear bearing locating snap ring of the inter-axial differential.



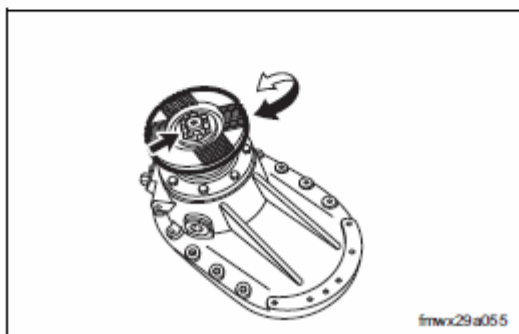
20. Install the differential lock pin slide sleeve



21. Install the inter-axial differential

- Install the bearing end cover

Caution: Apply 598 flange sealant on the end face of the bearing cap.

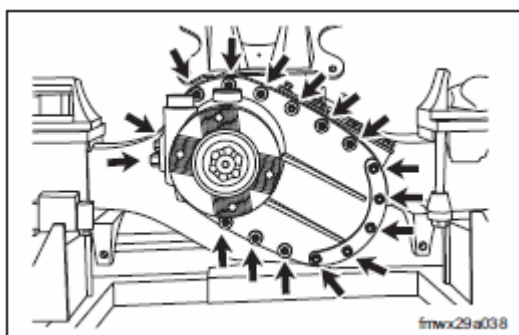


22. Install the flange

- Install the flange nut.

Torque: 775±25N.m

- Install the flange nut cotter pin.



23. Install the input shaft housing

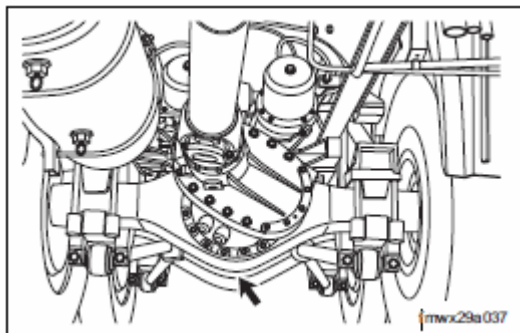
- Install the input shaft housing.
- Install the input shaft housing fixing nut.

Caution:

Apply 598 flange sealant on the connecting plane of the gap bridge box.

24. Connect the intermediate drive shaft. Refer to Chapter 33, Drive Shaft - Intermediate Drive Shaft, Overhaul





- 25. Add gear oil**
(a). Tighten the bottom oil drain bolt.

Main Reducer

Overhaul

Hint:

Part Drawing, refer to Chapter 29A, Intermediate Axle (Steyr) – Front Mounting Assembly, Part Drawing.

1. **Dismantle the inter-axial differential. Refer to Chapter 29A, Intermediate Axle (Steyr) - Inter-axial Differential, Overhaul**
2. **Dismantle the gap bridge box assembly. Refer to Chapter 29A, Intermediate Axle (Steyr) - Driving Gear and Bearing, Overhaul**
3. **Dismantle the driving gear. Refer to Chapter 29A, Intermediate Axle (Steyr) - Driving Gear and Bearing, Overhaul**
4. **Dismantle the driven gear. Refer to Chapter 29A Intermediate Axle (Steyr) - Inter-wheel Differential Housing, Driven Gear and Planet Gear Assembly, Overhaul**
5. **Check the main reducer**
 - Check the driving gear for rupture, wear, pitting, gluing and plastic deformation.
 - Check the driven gear for rupture, wear, pitting, gluing and plastic deformation.
6. **Install the driven gear. Refer to Chapter 29A Intermediate Axle (Steyr) - Inter-wheel Differential Housing, Driven Gear and Planet Gear Assembly, Overhaul**
7. **Install the driving gear. Refer to Chapter 29A, Intermediate Axle (Steyr) - Driving Gear and Bearing, Overhaul**
8. **Install the gap bridge box assembly. Refer to Chapter 29A, Intermediate Axle (Steyr) - Driving Gear and Bearing, Overhaul**
9. **Install the inter-axial differential. Refer to Chapter 29A, Intermediate Axle (Steyr) - Inter-axial Differential, Overhaul**



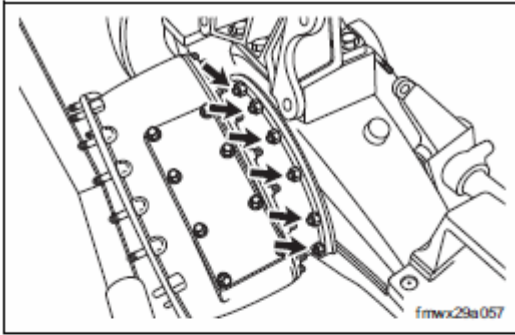
Driving Gear and Bearing

Overhaul

Hint:

Part Drawing, refer to Chapter 29A, Intermediate Axle (Steyr) - Intermediate Axle Assembly, Part Drawing.

1. Dismantle the inter-axial differential. Refer to Chapter 29A, Intermediate Axle (Steyr) - Inter-axial Differential, Overhaul



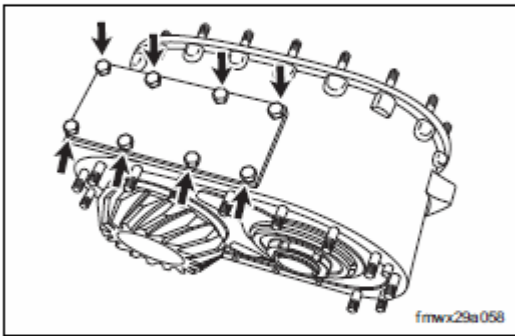
2. Dismantle the gap bridge box assembly

- (a). Draw out the axle shaft. Refer to Chapter 25 Rear Axle - Axle Shaft, Overhaul

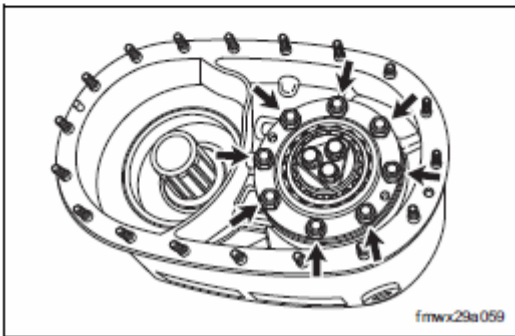
Caution: Before dismantling the intermediate axle gap bridge box, do not draw out the whole axle shaft on the end provided with the differential lock, otherwise, the falling mesh sleeve may check the differential, so that the intermediate axle gap bridge box can not be drawn out of the axle housing.

- (b). Loosen the connecting bolts of the gap bridge box assembly and axle housing.

3. Dismantle the oil baffle plate

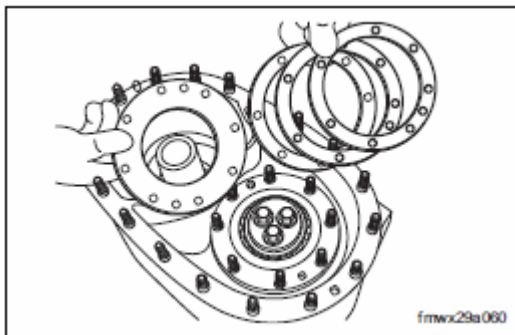


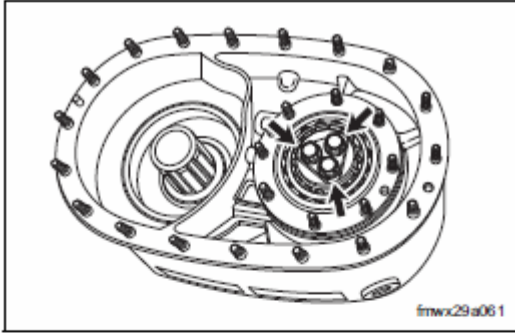
4. Dismantle the fixing bolts and nuts of the gap bridge box driving gear bearing seat



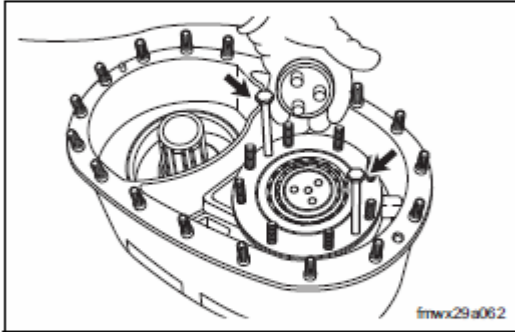
5. Take out the bearing seat end cover and end cover adjusting gasket

Caution: Keep the adjusting gasket. The adjusting gasket is installed on the connecting surface between the end cover and the bearing seat, and can adjust the pretightening degree of the driving gear bearing. Before reassembling, if there is no part for replacement, the original gasket can be installed. The thickest gasket shall be put at the bottom.

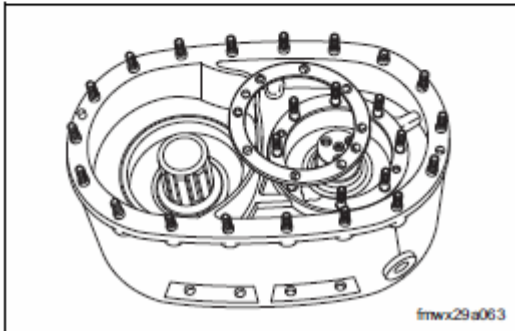




6. **Dismantle the baffle plate of the driving bevel gear bearing**
 - (a). Loosen the baffle plate locking plate of the driving bevel gear bearing.

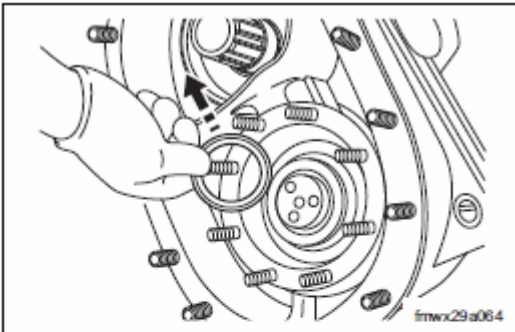


7. **Push out the bearing seat with two bolts, and take out the bearing seat.**

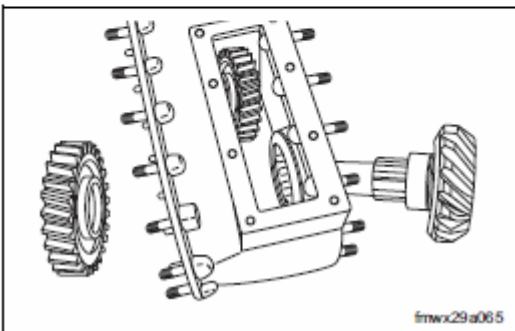


8. **Take out the adjusting gasket of the driving gear**

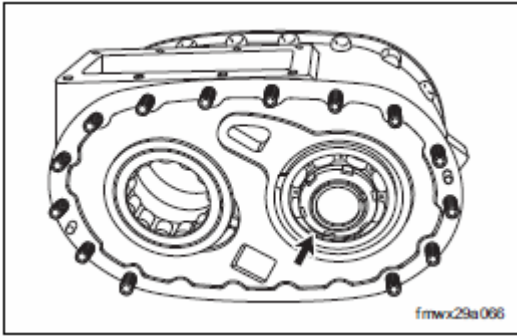
Caution: The gasket is installed on the connecting surface of the bearing seat and the gap bridge box, and can adjust the installation distance of the driving gear. If no part is replaced during reinstallation, the old adjusting gasket is still available. If any of the driving gear shaft, bearing, bearing seat or gap bridge box housing is replaced during reassembly, the thickness of the gasket must be recalculated and readjusted to determine the correct installation distance of the driving gear, thereby ensuring the mesh quality of the driving and driven bevel gears.



9. **Dismantle the spacer**



10. **Dismantle the driving bevel gear shaft, and take out the driven cylindrical gear and spacer**



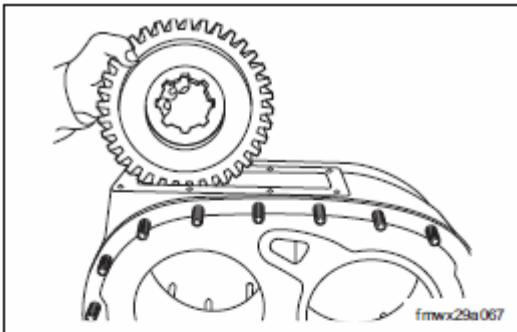
11. Take out the hollow shaft and gear

- (a). Dismantle the hollow shaft locking plate.
- (b). Dismantle the slotted nut.

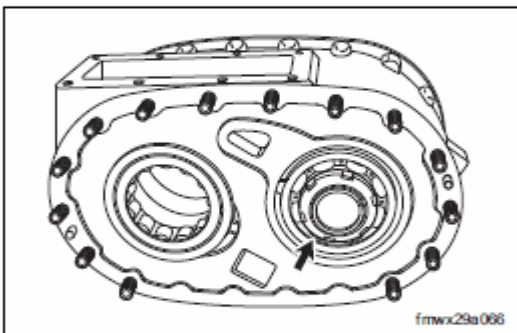
12. Check the driving gear and bearing

- Check the driving gear for rupture, wear, pitting, gluing and plastic deformation.
- Check the bearing for wear, deformation and ablation.

13. Redismantle the driving gear shaft



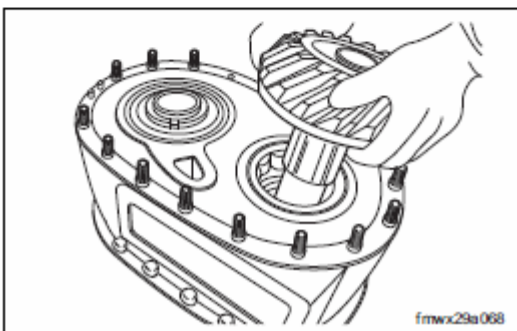
14. Put the driving cylindrical gear in the gap bridge box, and insert the hollow shaft



15. Put the driven cylindrical gear in the gap bridge box

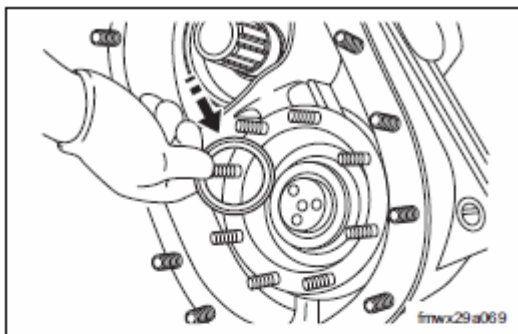
- (a). Tighten the slotted nut of the driving cylindrical gear.
- (b). Lock the slotted nut with a locking gasket.

Torque: 300N.m

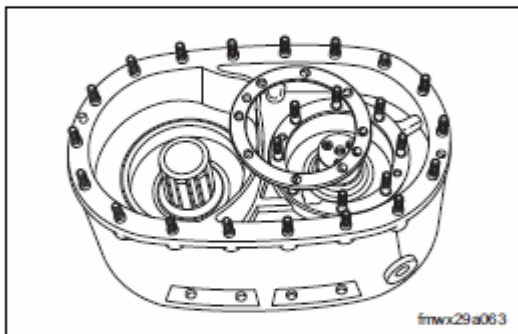


16. Clamp the snap ring with hand tongs, and slightly knock the driving bevel gear assembly into the gap bridge box.

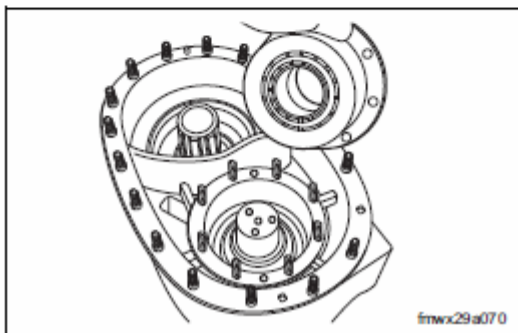
- (a). Put the bearing locating snap ring into the bearing groove.



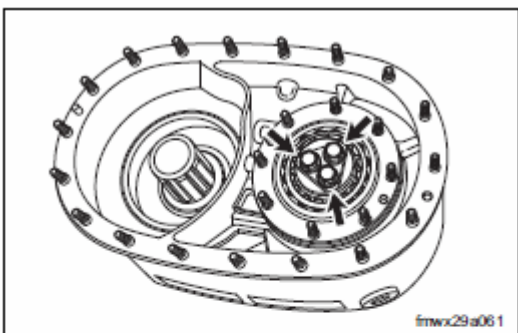
17. Install the spacer



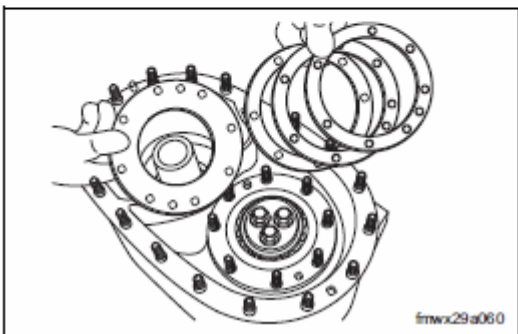
18. Install the adjusting gasket



19. Install the driving bevel gear bearing seat

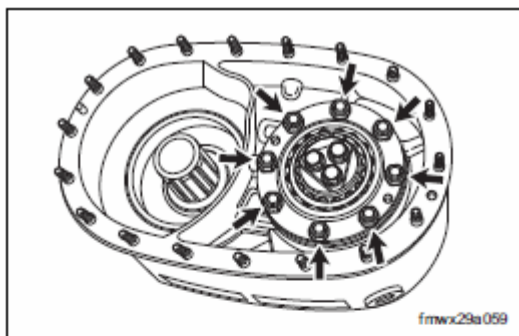


20. Install the baffle plate of the driving bevel gear shaft to lock the locking plate
Torque: 180N.m

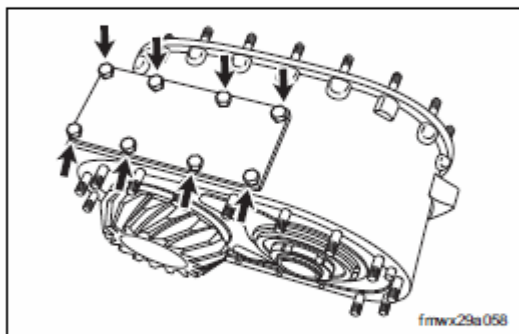


21. Install the adjusted bearing cover plate adjusting gasket

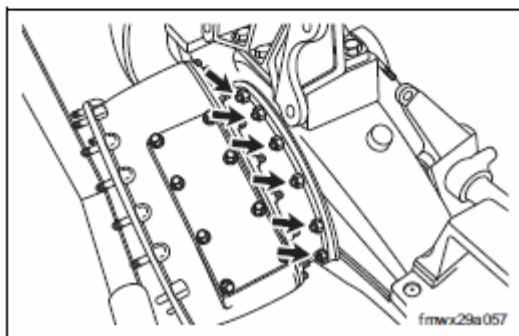




22. Install the bearing cover plate, and tighten the fixing bolts.



23. Install the oil baffle plate



24. Install the gap bridge box assembly

25. Install the inter-axial differential. Refer to Chapter 29A, Intermediate Axle (Steyr) - Inter-axial Differential, Overhaul

TRANSMISSION (12JS180TA)

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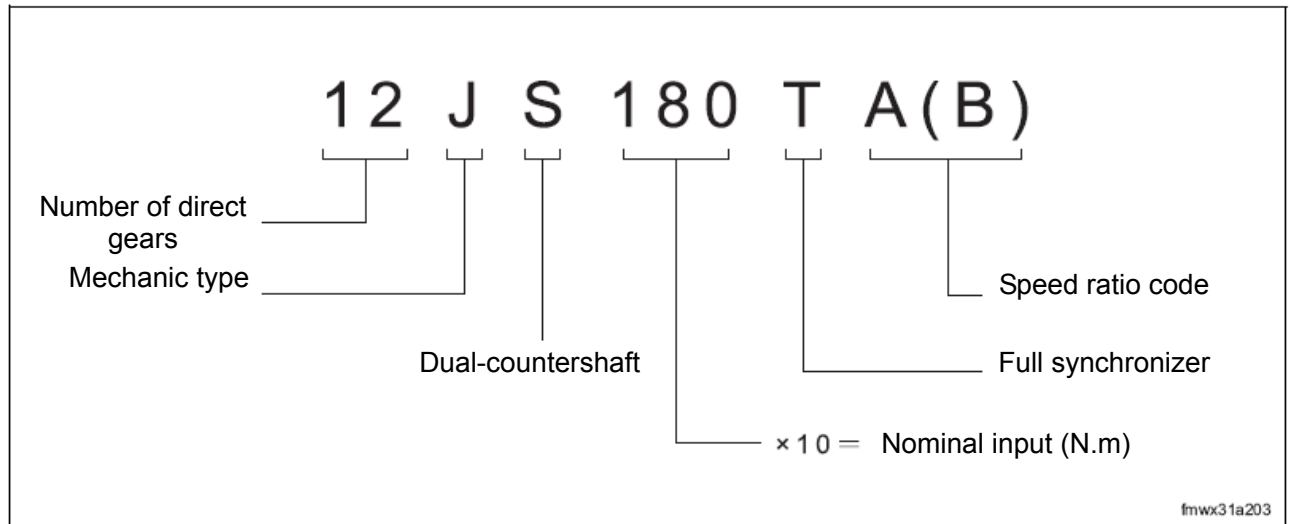


TRANSMISSION

OVERVIEW

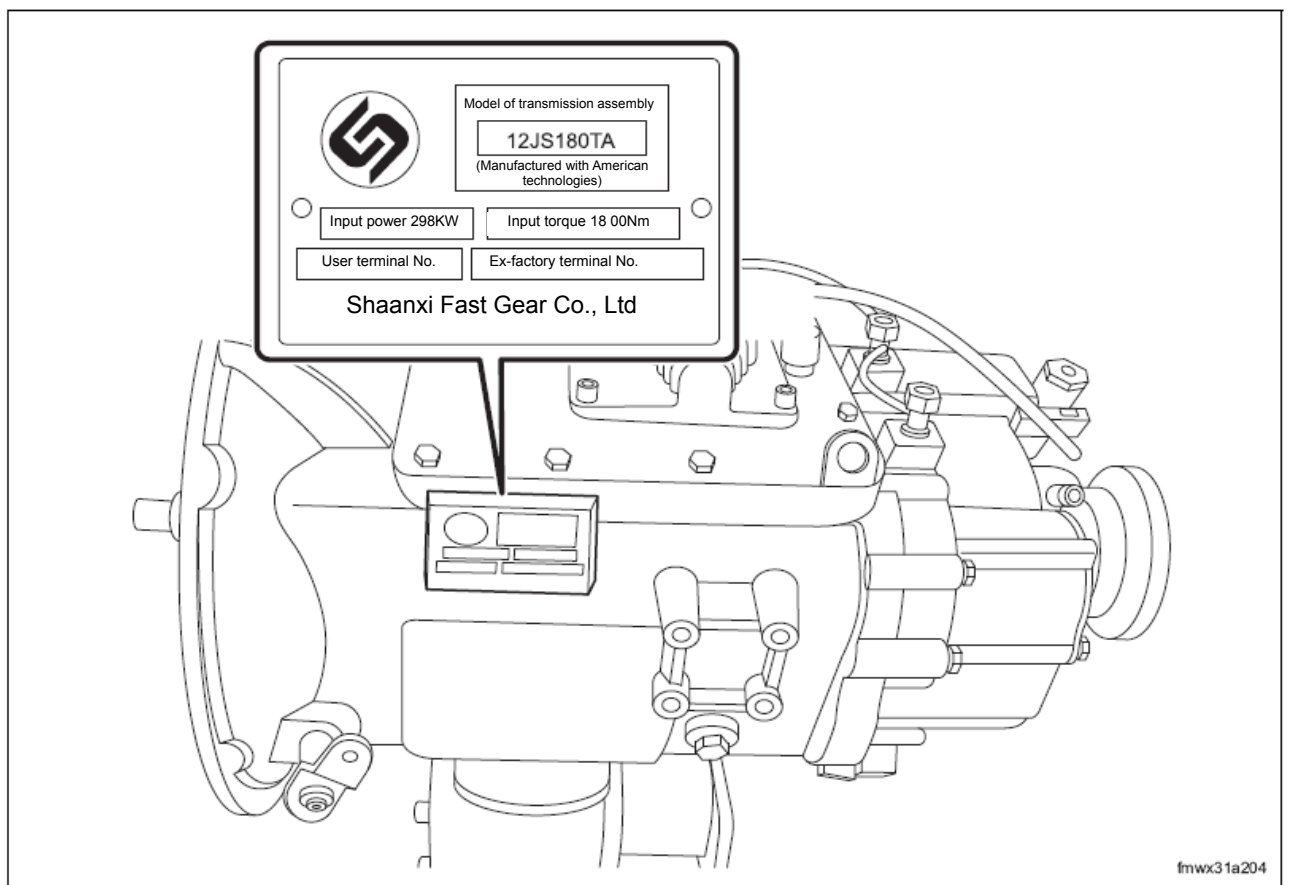
The major characteristic of Fast dual-shaft transmission consists in that another countershaft is provided in addition to the countershaft equipped in an ordinary transmission, to constitute the dual-countershaft transmission. With this second countershaft, the symmetrical transfer of power is obtained thus to realize the steady transmission and lower noise. All gears are optimized through the large-arc design at the tooth foundation, and all direct gears are provided with dual-cone lock ring type synchronizers.

Meaning of transmission model:



31A

Nameplate of transmission:



PRECAUTIONS

I. Precautions in operation of transmission

To correctly and properly operate the transmission and provide regular service are critical for ensuring the safe and reliable operation of the vehicle and prolonging the service life of the transmission. You are kindly required to observe following requirements:

1. **Before move-up, release the parking brake. For vehicles with air cutoff brake, engage any gear after the air pressure rises to the value necessary for releasing the brake.**
2. **Engage the third or fourth gear at move-up depending on the road conditions.**
3. **Where the gearshift lever is located in the high-speed range, the neutral gear is located between the 9th and 10th gear; where the lever is in the low-speed range, the neutral gear is located between the 3rd and 4th gear. At parking, the transmission shall be located in the low-speed neutral gear zone, i.e., the changeover switch on the control handle is moved to the low-speed position.**
4. **In the shifting operation, the clutch must be disengaged thoroughly; otherwise the useful life of basic transmission will be adversely affected. Furthermore, the gearshift lever shall be engaged in place.**
5. **To engage the reverse gear, firstly stop the engine and then engage the gear to avoid damage parts inside the transmission. At engaging the reverse gear, a high gear-selecting force shall be applied to offset the resistance from the reverse gear lock.**
6. **To shift from the 6th gear to the 7th gear (or from 7th gear to 6th gear), a short pause is required intentionally to enable the splitter to fulfill the change between high-speed and low-speed ranges. Before disengaging the gear, operate the control handle to the target range, and then change between different ranges.**
7. **At changing from low-speed range to high-speed range (vice versa), do not skip any gear otherwise the useful life of the splitter synchronizer may be adversely affected.**
8. **Frequently check the ventilating plug, and if any dirt is found, remove it immediately.**
9. **When the vehicle moves downhill, avoid the changeover between high-speed and low-speed ranges as much as possible.**
10. **If any abnormal noise or heavy operation in the transmission is detected, stop the vehicle immediately for troubleshooting.**

Warning:

1. **Avoid skipping when the transmission is shifted between high and low gears.**
2. **When the vehicle is moving downhill, avoid any shifting operation.**
3. **Never coast at the neutral gear.**
4. **Never tow the vehicle with the drive wheel in contact with the ground.**
5. **If any abnormal noise or heavy operation in the transmission is detected, stop the vehicle immediately for troubleshooting. Drive on until the faults are removed.**

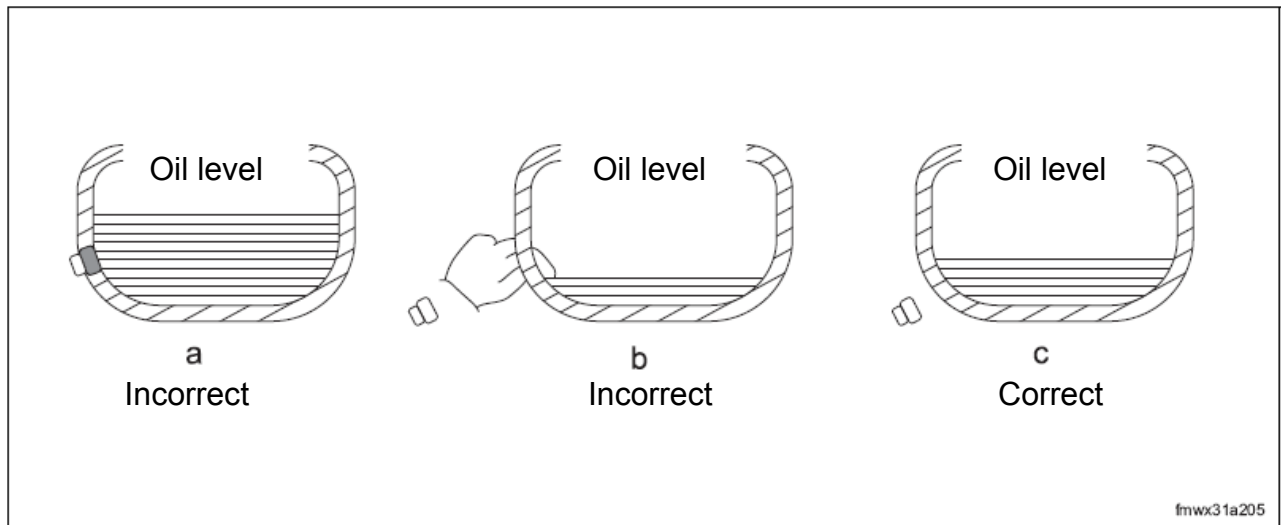
II. Service of transmission

Each time the required interval for maintenance is expired, all previous maintenance and service work shall be performed pursuant to the service and maintenance schedule.

1. Day-to-day inspection

- 1-1 Inspection on lubricating oil level

Each day check the transmission lubricating oil level and leakage, and add the oil if necessary. If any leakage is found, repair the transmission immediately to avoid any failure due to the loss of lubricating oil.



1-2 Pneumatic system

- 1) Each day remove the water in the vehicle pneumatic system.
- 2) Each day check whether there is air leakage by hearing, and provide repairs if necessary.
- 3) Confirm whether the air dryer works normally, and provide repairs if necessary. Service the air compressor as required to prevent the entry of lubricating oil into the pneumatic system.

2. Every 2000-5000km's travel of the new transmission

- 2-1 Replacement of lubricating oil
- 2-2 Check the transmission fixing bolts and fasteners for looseness and loss, especially those bolts used to attach the transmission onto the engine.
- 2-3 Lubricate the throw-out bearing.
- 2-4 Lubricate the clutch fork shaft;
- 2-5 Wash the air filter insert;
- 2-6 Check and clean the transmission vents;
- 2-7 Check the transmission control mechanism for normal operation.

3. Every 10000km or two months

- 3-1 Check the transmission fixing bolts and fasteners for looseness and loss, especially those bolts used to attach the transmission onto the engine.
- 3-2 Lubricate the throw-out bearing.
- 3-3 Lubricate the clutch fork shaft;
- 3-4 Wash the air filter insert;
- 3-5 Check and clean the transmission vents;
- 3-6 Check the transmission control mechanism for normal operation.

4. Replacement of oil

- 4-1 The use of correct lubricating oil is essential for the service and maintenance of the transmission. You are kindly required to strictly observe following service and maintenance procedure:
 - 1) Procure lubricating oil from a qualified supplier;

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- 2) Use the lubricating oil of the correct type and class: 85W-90GL-5;
- 3) Replace the oil as per the proper interval;
- 4) Maintain a correct oil level.
- 4-2 The interval for replacement of lubricating oil shall not be longer than the time stipulated in the table below.

Road conditions	Off-road conditions	Rigorous conditions
One year (at most) or 50000km	Every 1000h	Every 500h

Precautions:

Rigorous conditions refer to those circumstances where components are required to work at high load or in seriously contaminated environment or to constantly work on a steep slope. Under these circumstances, abide by the replacement cycle of lubricating oil required by the rigorous conditions.

III. Precautions in removal of the transmission

1. Service the transmission in a clean place to avoid the entry of dust or other impurities into the transmission. Prior to the removal operation, carefully clean the external surface of the transmission.
2. To remove various assemblies, store all parts on a clean work bench in the sequence of the removal operation, thus to make the steps of the reinstallation convenient and minimize the possibility of loss of parts.
3. At removing the first shaft, it is unnecessary to remove the countershaft, second shaft and first shaft gear.
4. At removing the bearing, use the dedicated tools. Carefully clean the bearing and check whether its rolling way shows pit corrosion and whether the roller is in good conditions.

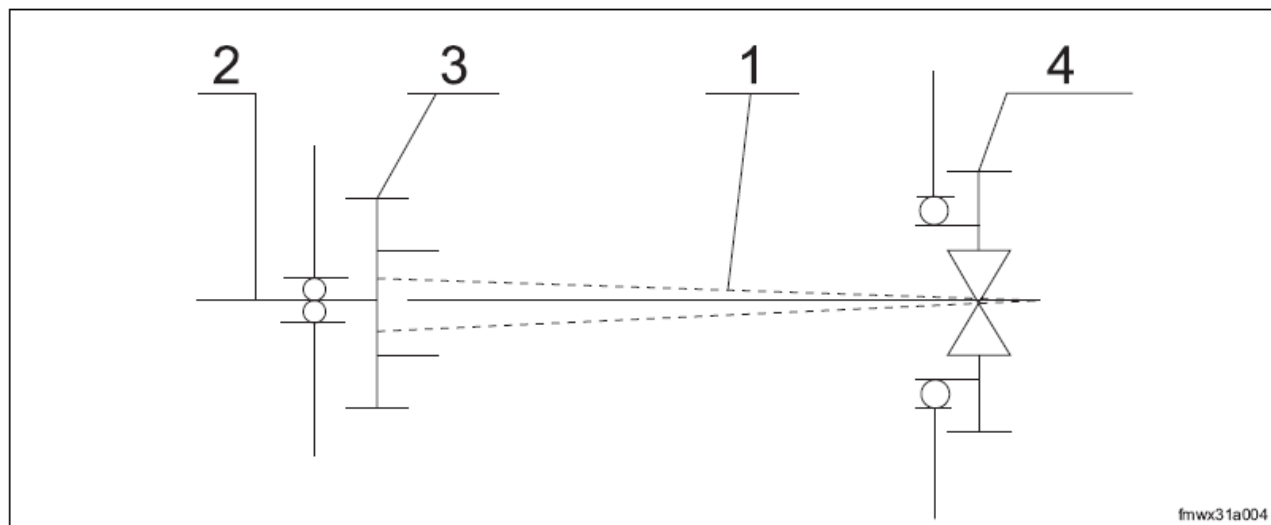
IV. Precautions in refitting operation

Before the refitting operation, thoroughly clean all parts to be refitted and avoid the entry of dust and foreign matters into the transmission; otherwise the unwanted damages may be invited.

1. **Lining:** In the refitting operation of the transmission, all linings must be renewed.
2. **Bolts:** To prevent oil leakage, all bolts must be coated with thread sealant and tightened with the standard torque.
3. **O-shaped ring:** Use the silicon-grease lubricant to lubricate all O-shaped rings.
4. **Initial lubrication:** In the refitting operation, all thrust washers shall be coated with the grease for initial lubrication to avoid scratches or wear.
5. Tighten the output shaft flange disc nuts, and use standard torque to fasten output shaft nuts; otherwise serious consequences may be aroused.

STRUCTURE AND PRINCIPLE OF TRANSMISSION

I. Power transfer line



1	Main shaft	3	Input shaft gear
2	Input shaft	4	Splitter drive gear

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As to the 12-speed transmission with synchronizer, the main and auxiliary transmissions adopt the intermediate shaft, of which structure are completely same. The interval of 180° power is transferred to the input shaft, then shunt to two intermediate shafts. At last, the power is output from the main shaft. As to the auxiliary transmission, its principle is same with that of main transmission. Theoretically, each intermediate shaft only transfer 1/2 torque. Therefore, the double-intermediate shaft could reduce the center distance of transmission, thin the thickness of gear, shorten the axial dimension and decrease the mass. If the double-axial shaft is adopted, each-speed gear on the main shaft should simultaneously engage the gears of two intermediate shafts.

To satisfy the correct engagement and distribute the load as uniformly as possible, the main shaft gear floats in a radial direction on the main shaft which is provided with a hinged floating structure. The main shaft journal is inserted into a hole on the input shaft. In this hole, an oil-bearing guide sleeve is accommodated, with a sufficient radial clearance between the said journal and the guide sleeve. The rear end of the main shaft is inserted into the splitter driving gear hole via an involute spline, and the splitter driving gear journal is supported on the ball bearing.

As all gears on the main shaft float along the main shaft, the conventional needle bearing is thus cancelled to simplify the structure of the main shaft assembly. In the operation, both countershaft gears exert the same radial force on the main shaft gear in opposite directions to offset each other; in such a way, the main shaft will only receive the torsional moment, but no bending moment, which has largely relieved the load of both the main shaft and the bearing, and has also significantly improved the transmission's reliability and durability.

II. Power transfer line

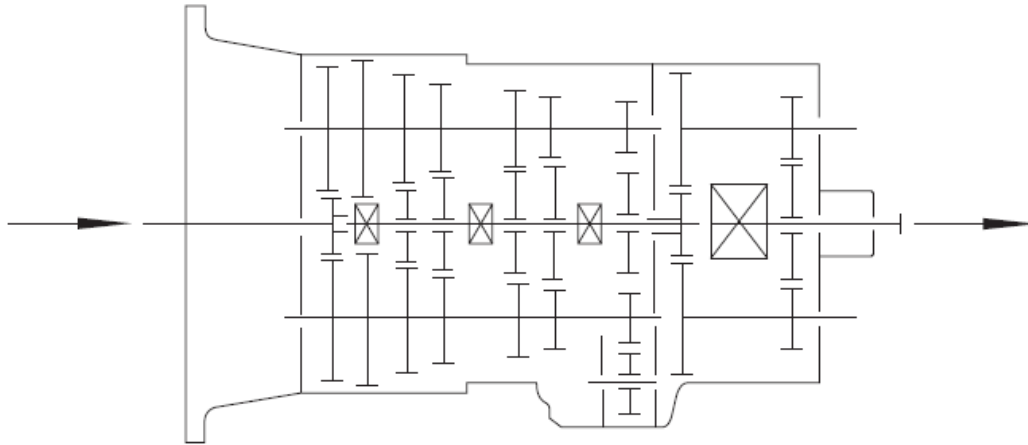
To understand the engine power transfer line of a specific gear of the transmission can assist the technician to service and maintenance the transmission in a better manner. In general, it is considered that the Fast transmission is an integral body consisting of two separate transmissions. The first transmission (or called transmission front box) is composed of six gear pairs controlled by the gearshift lever, while the second transmission is called splitter, used to realize the shift between range gears under the pneumatic control.

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TRANSMISSION (12JS180TA)-TRANSMISSION

Hint:

This transmission is a normally-on transmission. In the working process, although only part of gears will transfer the power, all gears are rotating.

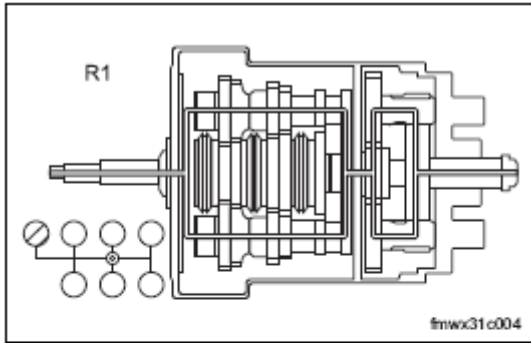


Gear

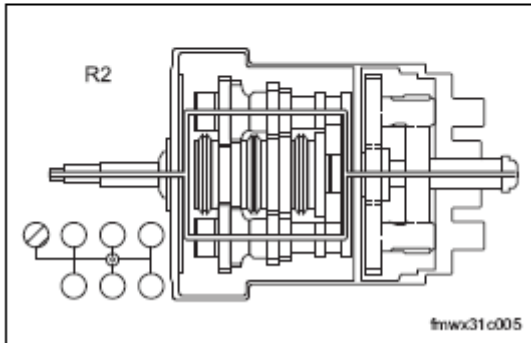
12JS160TA	12JS160T
12JS180TA	12JS180T
12JS200TA	12JS200T
1	1
2	2
3	3
4	4
6	5
5	6
7	7
8	8
9	9
10	10
12	11
11	12
Reverse gear 1 (R)	Reverse gear 1 (R)
Reverse gear 2 (R)	Reverse gear 2 (R)

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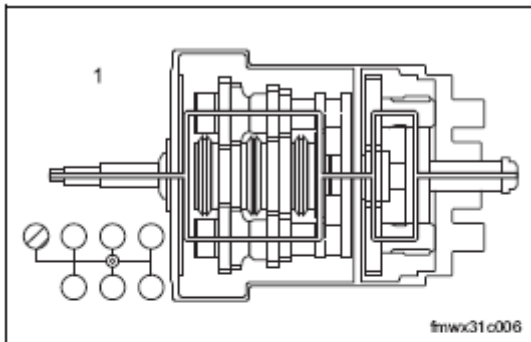
1. Basic transmission power transfer line



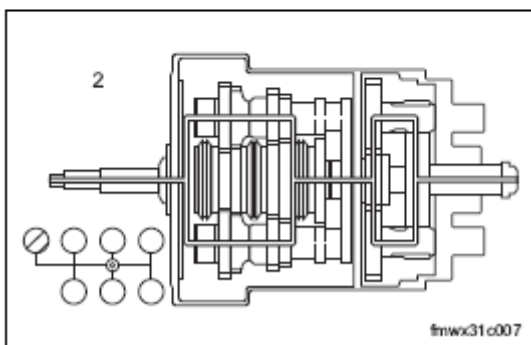
(a) Transfer line of the reverse gear 1



(b) Transfer line of the reverse gear 2



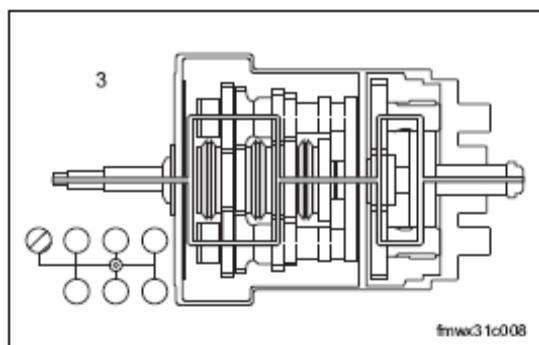
(c) Transfer line of the first gear



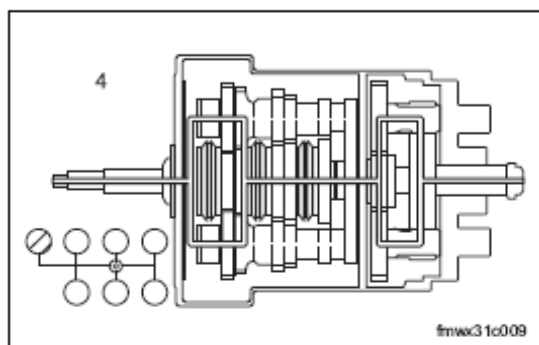
(d) Transfer line of the second gear

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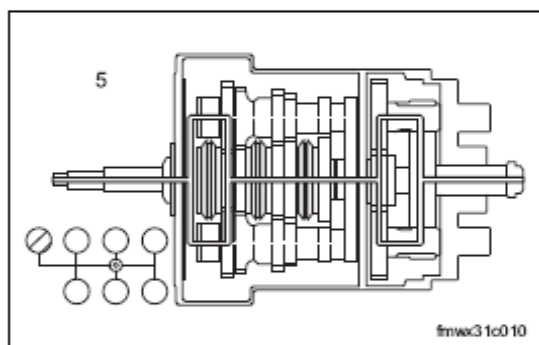
TRANSMISSION (12JS180TA)-TRANSMISSION



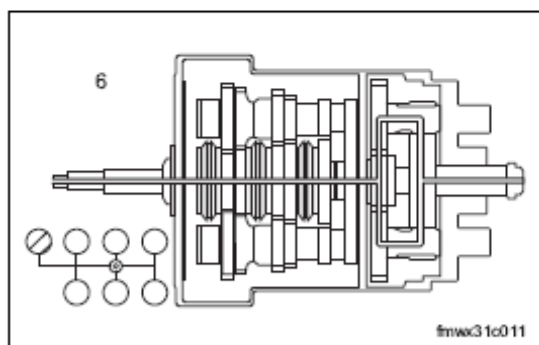
(e) Transfer line of the third gear



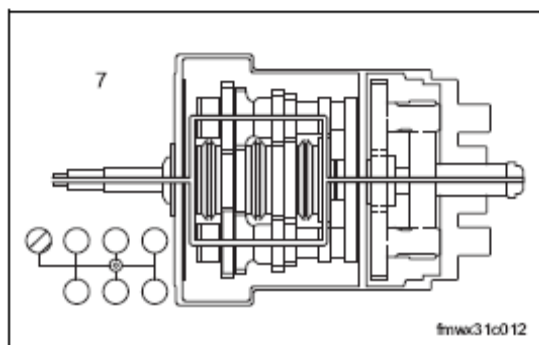
(f) Transfer line of the fourth gear



(g) Transfer line of the fifth gear

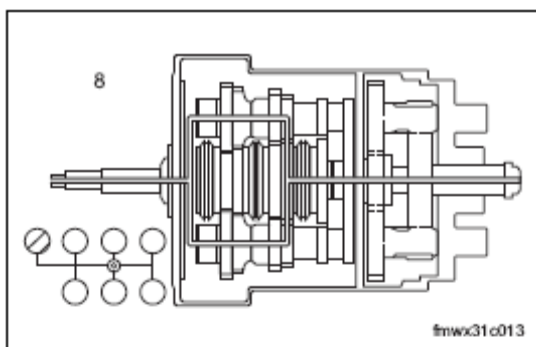


(h) Transfer line of the sixth gear

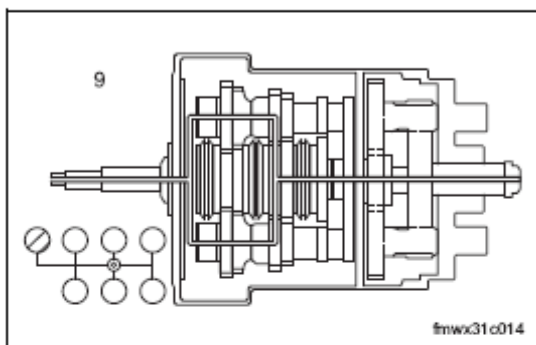


(i) Transfer line of the seventh gear

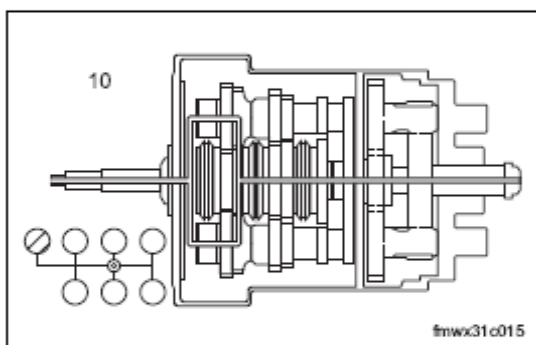




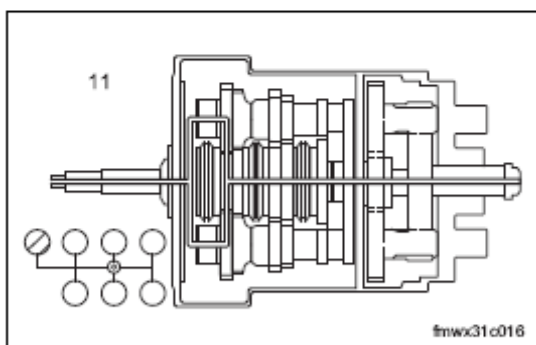
(j) Transfer line of the eighth gear



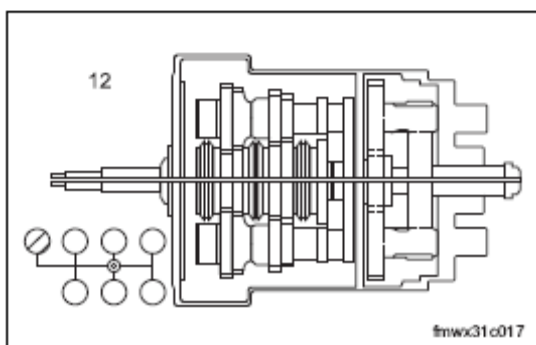
(k) Transfer line of the ninth gear



(l) Transfer line of the tenth gear

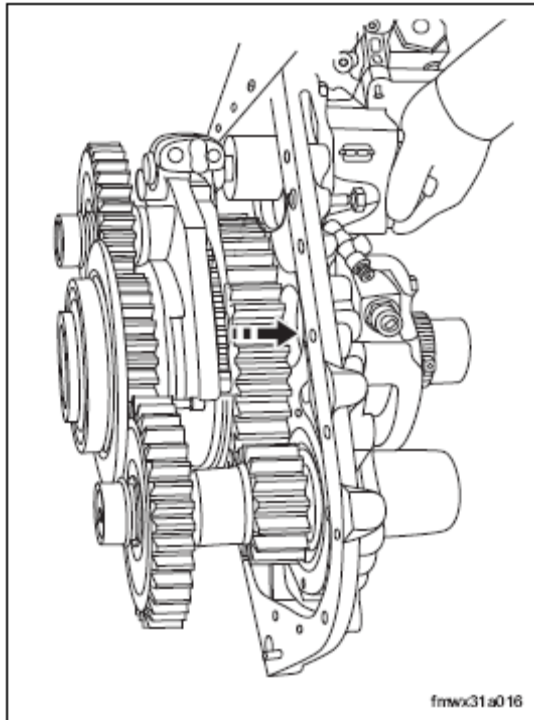


(m) Transfer line of the eleventh gear



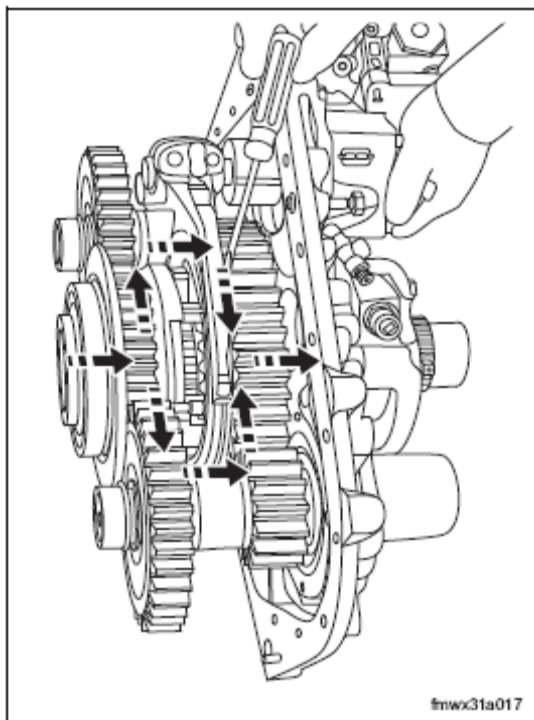
(n) Transfer line of the twelfth gear





2. Power transfer line of the splitter

(a) High-speed gear



(b) Low-speed gear

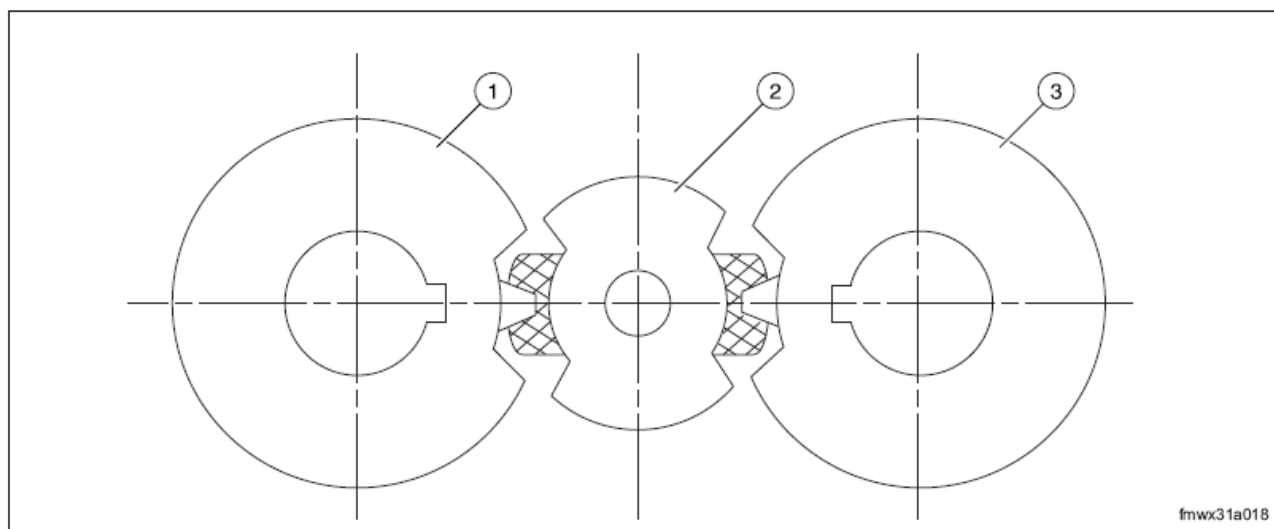
III. Tooth alignment and tooth alignment procedure

To ensure the correct engagement between the countershaft gear and main shaft gear, the tooth alignment must be performed.

1. At first, mark two adjacent teeth of the input shaft gear, and then mark the other side symmetrical to it. (The number of teeth of both groups of marks shall be equal.)
2. Mark the tooth on each countershaft driven gear opposite to the gear key groove.
3. In the installation, engage the marked teeth on both countershaft driven gears into both marked teeth on left and right sides of the input shaft gear.

4. At installing the splitter, use the reducer gear and splitter countershaft pinion for tooth alignment.

Tooth alignment procedure:



1	Left countershaft gear
2	First shaft gear

3	Right countershaft gear

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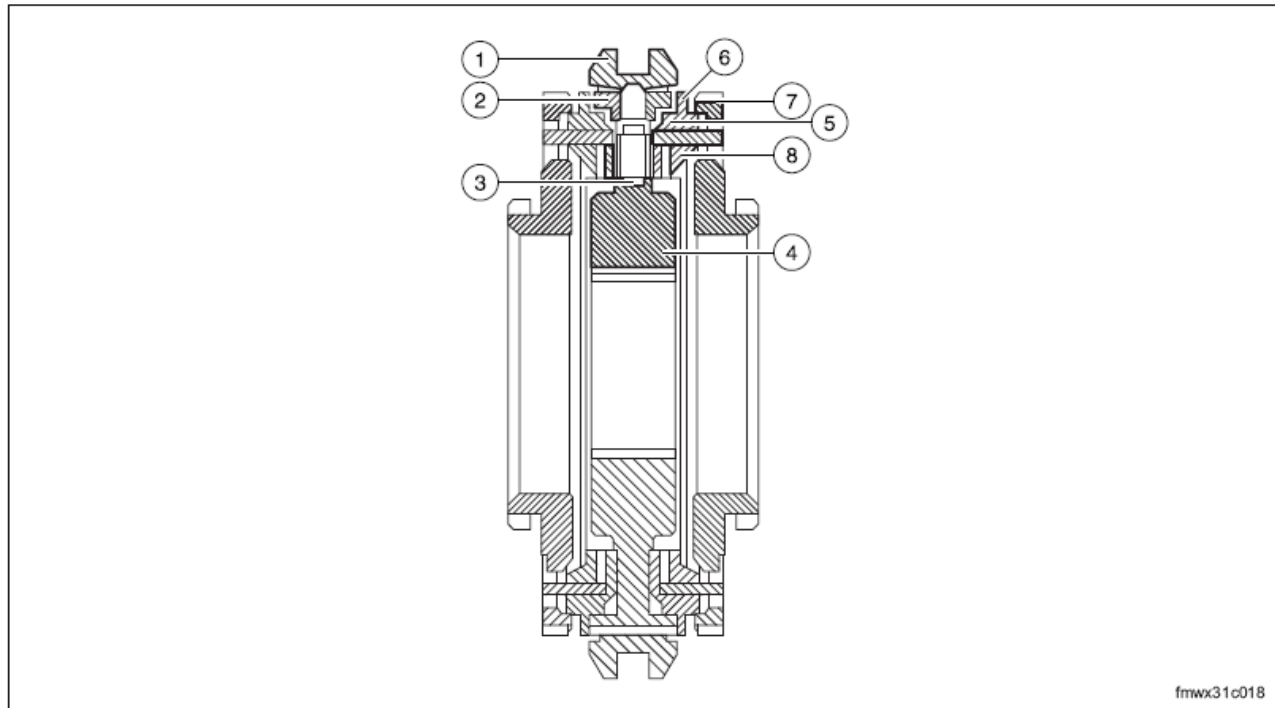
Tooth alignment of basic transmission

- At first, mark any two adjacent teeth with paint on the first shaft gear, and then mark another two adjacent teeth on the other side in the corresponding 180° direction. The number of teeth between marks in both groups must be equal.
- Separately mark the external tooth top opposite to both countershaft normally engaged gear inner hole key groove with paint, and such a mark shall be exclusive.
- In the refitting operation, insert the marked teeth of both countershaft normally engaged gears into the marked tooth groove on the first shaft gear. If the correct mounting is done, the first shaft will be able to rotate freely; if the shaft can't rotate or rotates heavily, check whether the tooth alignment marks are correct.

Tooth alignment of splitter

- At first, mark any two adjacent teeth with paint on the splitter reducer gear, and then mark another two adjacent teeth on the other side in the corresponding 180° direction. The number of teeth between marks in both groups must be equal.
- Separately paint the tooth crown top marked with "O" on the splitter countershaft gear, and such a mark shall be exclusive.
- In the refitting operation, insert the marked teeth of both splitter countershaft gear into the marked tooth groove on the reducer gear. Before the installation of the splitter assembly onto the basic transmission, carefully check the tooth alignment marks.

IV. Structure and working principle of basic transmission synchronizer



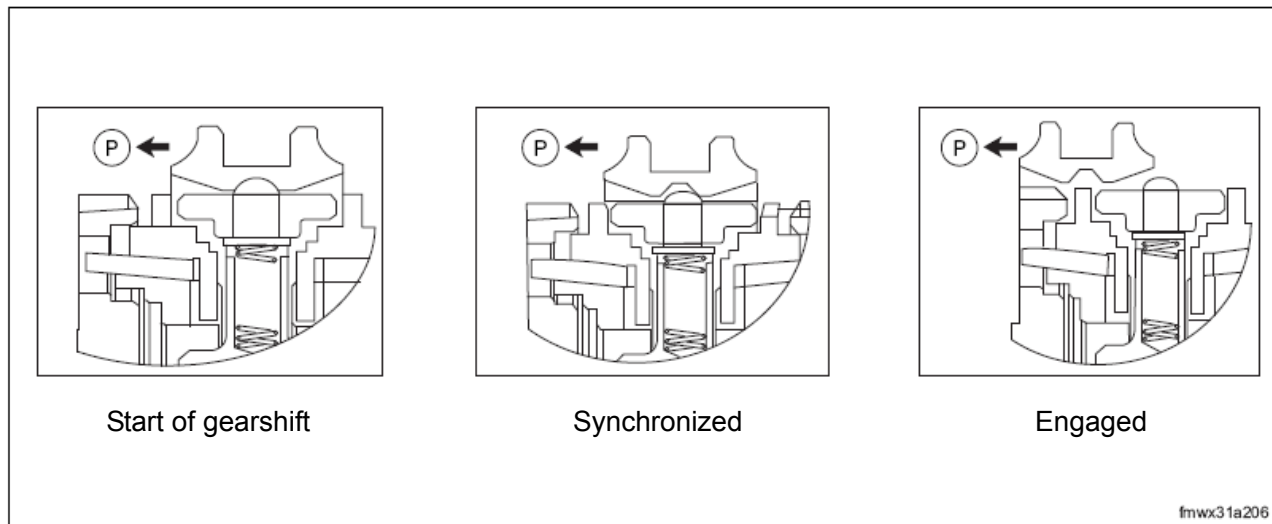
1	Synchronizer tooth sleeve
2	Positioning block
3	Spring
4	Synchronizer gear hub

5	Synchronizer external cone
6	Synchronizer double cone
7	Synchronizer engaging tooth
8	Synchronizer inner cone

The transmission synchronizer can fulfill the easy and rapid gearshift without causing impact or noise, so as to prolong the gear's useful life, and improve the vehicle's accelerating performance and save fuel. Therefore, except for the reverse gear, the transmission can be applied at all gears. The transmission is required to provide a wide torque range, reliable performance and long service life. The inertia synchronizer can ensure the gearshift with the synchronizer engaged, being stable and reliable. It is divided into the inertia lock type and inertia servo type, and those of the most widespread use are inertia lock synchronizers of the locking ring type, locking pin type etc.

The lock ring synchronizer is widely used at present because of its compact structure, good performance, reliable use and low cost. Its defect lies in that the friction torque is too small. Double-cone lock ring synchronizer is a new synchronizer device developed and designed on the base of the similar working principle and structural arrangement to the lock ring synchronizer. It not only inherits the merits of the lock ring synchronizer but also covers the shortage by improving the friction torque of the synchronizer. In the figure above, a 5-6 synchronizer is shown, in which both the 5th gear and the 6th gear are provided with a double cone, with the synchronizer gear sleeve, gear hub, sliding block, spring etc. shared by them. In addition, three conical members (5, 6, 8) are provided for these two gears. For the synchronizer outer cone (5), 6 single keys are connected with these 6 key grooves on the inner cone (8); therefore, the outer cone (5) and inner cone (8) can rotate synchronously with the transmission second shaft, while these 6 lugs on the synchronizing cone (6) are engaged without these 6 holes on the combining ring (7), so the cone (6) rotates with the 5th gear. As a result, when the gear is shifted from 4th to 5th or from 6th to 5th, a relative angular speed difference is produced between the 5th gear and the second shaft; at this moment, two pairs of sliding friction cones will start to work in the 5th gear

synchronizer cone structure. Consequently, the synchronous frictional torque produced on the friction cone due to the axial thrust exerted on the synchronizer gear sleeve is equal to the sum of frictional torques between these two pairs of cones, provided that the overall sizes are the same, that's to say, the synchronous frictional torque produced at the shift to the 5th gear is about 2 times of that of a single-cone synchronizer, thus deducting the gear shifting force by approximately 50%.

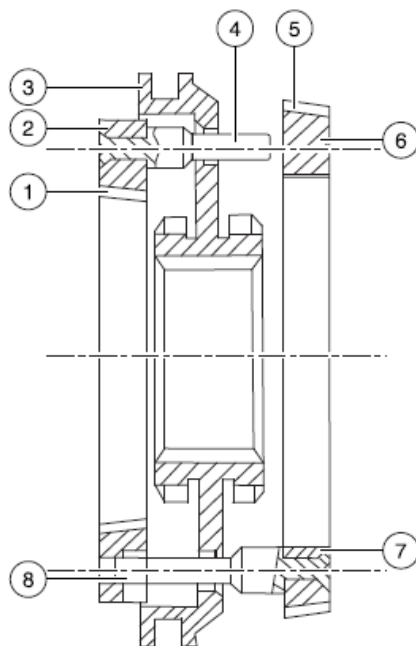


The figure above has shown these three major processes of the gearshift operation of the synchronizer. To start the gearshift, the synchronizer tooth sleeve will bring the sliding block, pressed with the spring, to push the synchronizing ring to press against the synchronizing cone surface of the gear via the sliding block groove. Next, the synchronizer tooth sleeve, by overcoming the spring force, will be separated from the sliding block to continue to move forward, thus to enable the inclined face of the locking corner at the tooth sleeve tooth end to press against the inclined face of the locking corner at the synchronizing ring tooth end. Due to that there is a difference of revolution between both cone surfaces, the friction torque will be generated on the cone surface under the axial component of the inclined face of locking corner of synchronizing ring tooth end. As the gearshift power P is gradually increased, when the angular speeds of both engaging members are equal, the friction torque will be reduced to zero. Under the continuous action of the gearshift power P , the locking inclined face is separated; at this moment, the synchronizer tooth sleeve can be engaged with the engaging tooth on the gear.

V. Structure and working principle of the splitter

The splitter of the 12JS10TA dual-countershaft transmission is equipped with the locking pin type inertia synchronizer, which is controlled by the splitter gear shifting cylinder and will only work at the changeover from high gear to low gear. Its action is controlled by the lateral gearshift lever and the single-H pneumatic valve.

Both the high-gear synchronizing ring 2 and low-gear synchronizing ring 6 are riveted with three locking pins 4 and 7. The sliding tooth sleeve 3 is engaged with the splitter output shaft via the spline. The basic unit of the high-gear synchronizing ring and low-gear cone ring are made of powder through sintering. On the internal and external cone face of the high-gear synchronizing ring, the non-metal materials with high anti-friction performance are adhered, and on the splitter drive gear and reducer gear, the corresponding external and internal cone surfaces are respectively provided, as shown in the figure below:



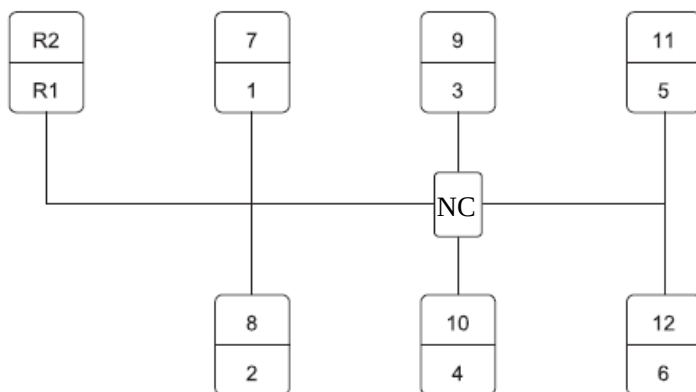
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1	High gear friction belt
2	High gear synchronizing ring
3	Sliding tooth sleeve
4	High-speed gear locking pin

5	Low gear friction belt
6	Low gear cone ring
7	Low gear locking pin
8	Spring

VI. Control mechanism

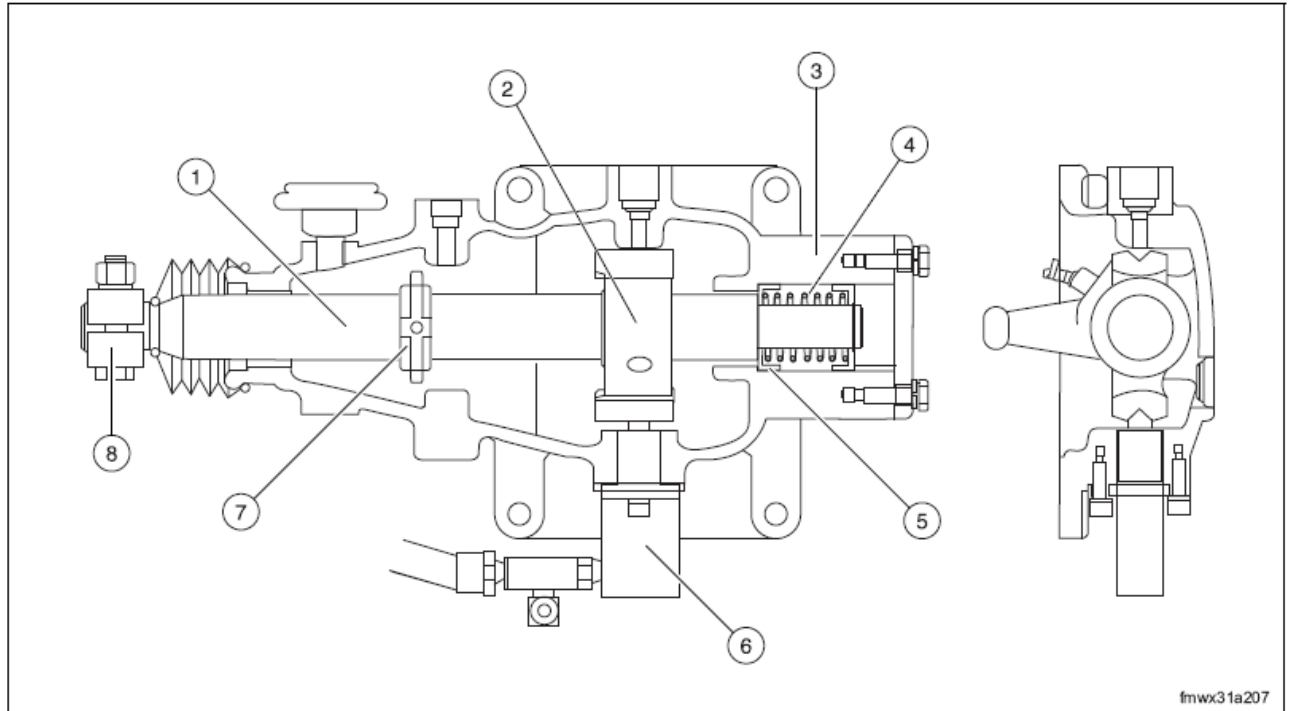
In the 12-gear all synchromesh transmission, the basic control mechanism takes the form of a single H-shaped remote control, characterized by a compact structure, clearly-defined gears and good hand feeling, of which gears R1, 2, 3, 4, 5 and 6 are arranged in the low-speed zone, and R2, 7, 8, 9, 10, 11 and 12 in high-speed zone, and the neutral position of the low-speed zone is located at the 3-4 gear while that of the high-speed zone at 9-10 gear.



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The external gearshift arm, reverse gear switch control block, gear shifting block and spring seat are all fitted on the lateral gearshift lever. The gear selection is realized via the lateral movement of the lateral gearshift lever under the control of external gearshift arm, and the fore-and-aft movement of the lever can fulfill the engagement and disengagement of gears. When the shifting block of the control hand ball is moved into the high-speed range, the air supply pipe will not supply air, and the compressed air will enter the splitter cylinder via the high-speed air pipe to engage the high gear; when the shifting block is moved into the low-speed range, the pipe will supply air and the compressed air will enter the splitter cylinder via the low-speed air pipe to engage the low gear. Thus, the automatic gearshift of the transmission is actualized.



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1	Lateral gearshift lever
2	Shifting block
3	Control device housing
4	Compression spring

5	Spring seat
6	Pneumatic line control valve
7	Low and reverse gear switch control block
8	External gearshift arm

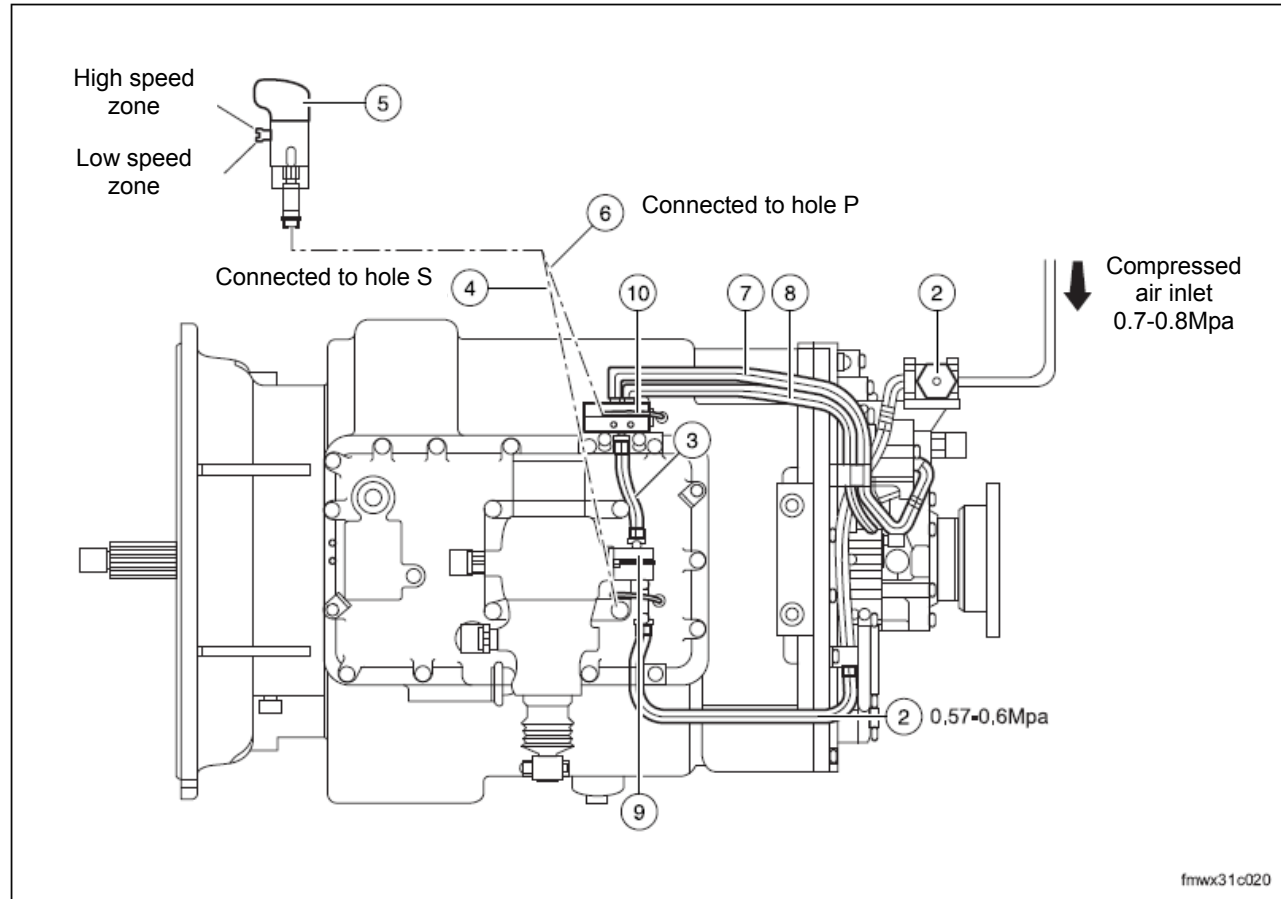
VII Working principle of the 12-gear transmission pneumatic line

The 0.7-0.8Mpa compressed air from the vehicle is adjusted to 0.57-0.6MPa by the air filter regulator and then enters the main air pipe and control air pipe. When the basic transmission is located at the neutral position, the pneumatic line control valve is turned on, and the compressed air will enter the redirection valve. With the preselection switch handle at low gear position and its shifting block at low position, the air pipe is supplied with air to push the redirection valve to open the pneumatic line for the low gear. The compressed air enters the low-gear air inlet of the gear shifting cylinder through the low-gear air pipe, and the gear shifting cylinder piston will engage the teeth of splitter synchronizer sliding sleeve and reducer gear; at this moment, the transmission is fully located at the low gear, i.e., R1, 1, 2, 3, 4, 5 and 6 respectively. With the preselection switch handle at high gear position and its shifting block at high position, the air pipe is disconnected from air supply, the compressed air enters the high-gear air inlet of the splitter gear shifting cylinder from the high-gear air pipe via the high-gear air

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outlet of the redirection valve, and then the high-gear cylinder piston will engage the teeth of splitter synchronizer sliding sleeve and drive gear; at this moment, the transmission is fully located at the high gear, i.e., R2, 7, 8, 9, 10, 11 and 12 respectively. The neutral position of low-speed range is located between the 3rd and 4th gears, while that of high-speed range is located between the 9th and 10th gears.



1	Air filter regulator
2	Main air pipe
3	Intermediate air pipe
4	Control air inlet pipe
5	Gearshift handle (preselection valve)

6	Control air outlet pipe
7	High-gear air pipe
8	Low-gear air pipe
9	Pneumatic line control valve
10	Pneumatic line redirection valve

Precautions:

1. The pneumatic line control valve can be only turned on at the neutral gear. To disengage any gear, the pneumatic line will be cut off at the control valve; that's to say, the shifting operation can be only performed at neutral gear.
2. At low gear, the air outlet pipe of the control pneumatic line (preselection valve) is supplied with air; at high gear, the pipe is disconnected from air supply (preselection valve).

TABLE OF FAULT PHENOMENA

The table below can assist you to find the failure. The number represents the sequence of occurrence of possible failures. Check each part as per this sequence, and provide replacement if necessary.

Symptoms of failure	Possible causes	Reference
Strange sound or noise	1. Poor quality of lubricating oil	Use the 85W-90 GL5 lubricating as required by the manufacturer
	2. Insufficient lubricating oil	Add oil
	3. Damages or excessive wear of gear tooth face to generate a large gap	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transmission
	4. Damages or crack of bearing	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transmission
	5. Improper engaging position between gearshift fork and gears	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transmission Control Mechanism
	6. Wear or damages of synchronizer	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transmission
	7. Damages of gear	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transmission
Difficult or failed gearshift of basic transmission	1. Wear or damages of bearing	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Basic Transmission
	2. Bending or burrs of fork and shaft	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transmission Upper Cover
	3. Looseness of retaining screw of fork	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transmission Upper Cover
	4. Abnormal disengagement of clutch	Chapter 32A: Testing and Adjustment, Clutch Assembly
	5. High viscosity of lubricating oil	Use the 85W-90 GL5 lubricating as required by the manufacturer
	6. Twisting of main shaft	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Second Shaft Assembly

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TRANSMISSION (12JS180TA)-TRANSMISSION

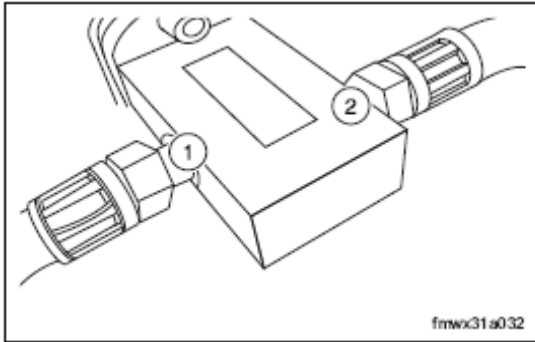
Symptoms of failure	Possible causes	Reference
Delayed or failed shifting operation in high and low gear ranges of splitter	1. Defects of pressure regulating valve	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transmission
	2. Failure of air pipe or union	Chapter 31A: Removal and installation, Transmission 12JS180TA- Single-H Control Mechanism,
	3. Seizure of single-H air valve plunger	Chapter 31A: Removal and installation, Transmission 12JS180TA- Single-H Control Mechanism,
	4. Poor lubrication or damages of gear shifting cylinder O-shaped ring	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Splitter
	5. Looseness of cylinder piston nut	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Splitter
	6. Damages of cylinder piston	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Splitter
	7. Damages of synchronizer or spring	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Splitter
Disengagement or skipshift of basic transmission	1. Deformation or wear of gearshift fork	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transission Upper Cover
	2. Wear of locking roller or of roller groove on gearshift fork shaft	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transission Upper Cover
	3. Breakage or fatigue of locking spring	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transission Upper Cover
	4. Over-large gap of gear	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transission
	5. Failure of engaging tooth or tooth sleeve reverse cone	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transission
	6. Wear of sliding part or end face of sliding shaft sleeve	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transission
	7. Axial runout due to the wear of bearing	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transission
	8. Looseness of flange lock nut	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Splitter
Section between auxiliary transmission high and low gear out of gear	1. Defects of pressure regulating valve	Replace the valve.
	2. Failure of air pipe or union	Chapter 31A: Removal and installation, Transmission 12JS180TA- Single-H Control Mechanism,
	3. Twisting of shaft; the gear is not located at the synchronized position	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transission
	4. Failure of engaging tooth or tooth sleeve reverse cone	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transission

TRANSMISSION (12JS180TA)-TRANSMISSION**31A-21**

Symptoms of failure	Possible causes	Reference
Disorder of gears	1. Missing or worn interlock steel ball or interlock pin	Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transmission Upper Cover
Leakage of oil or air	1. Too much lubricating oil	Adjust the lubricating oil level to the standard value
	2. Damages or failures of seal parts	Chapter 31A: Testing and Adjustment, Transmission 12JS180TA-Transission
	3. Looseness of fasteners	Tighten fasteners
	4. Clogging of ventilating plug	Clean or replace the plug
	5. Absence of sealant on bolts	Apply the sealant, and refit mounting bolts

31A

TESTING AND ADJUSTMENT



1. Testing of single-H air valve

- (a) Testing of appearance: The housing shall be in good conditions, and the plunger shall be able to move freely without significant wear.
- (b) Testing of passage: With the plunger at its original position, supply the compressed air, and it shall only flow from the outlet 1; with the plunger load reversed to the lowest position, supply the compressed air, and it shall only flow from the outlet 2.

Hint:

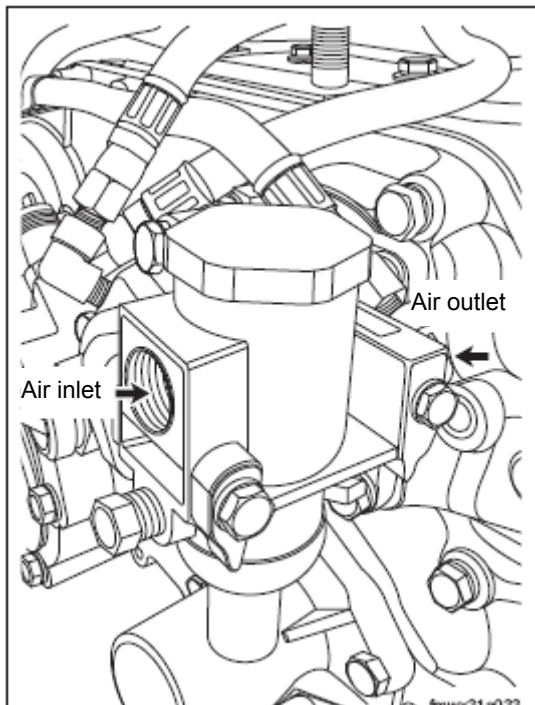
If any above-mentioned failure occurs, the air valve must be replaced.

2. Testing of double-H air valve

- (a) Testing of appearance: The housing shall be in good conditions, and the plunger shall be able to move freely without significant wear.
- (b) Test inspection: when the air pressure of vehicle reaches 0.7-0.8Mpa, install a barometer on the outlet. Then the measured pressure value should be 0.57-0.6Mpa.

Hint:

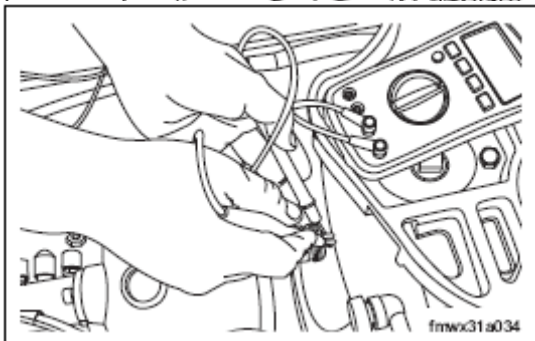
If any above-mentioned failure occurs, the air valve must be replaced.

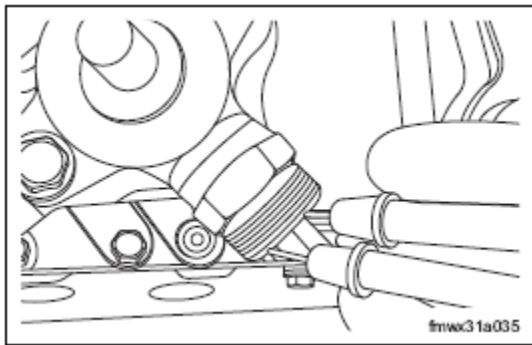


3. Testing of neutral gear switch

- (a) Testing of appearance: There shall be no such defects as deformation, damages or looseness of contact.
- (b) Testing of resistance: Use the multi-meter to test the resistance between both terminals of the switch.

Gear	Contact resistance (Ω)
Neutral	<1
Others	∞

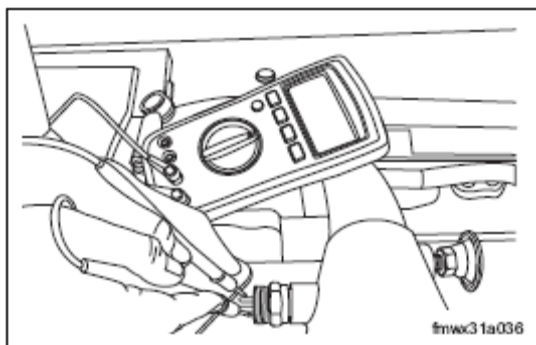




4. Testing of range gear switch

- (a) Testing of appearance: There shall be no such defects as deformation, damages or looseness of contact.
- (b) Testing of resistance: Use the multi-meter to test the resistance between both terminals of the switch.

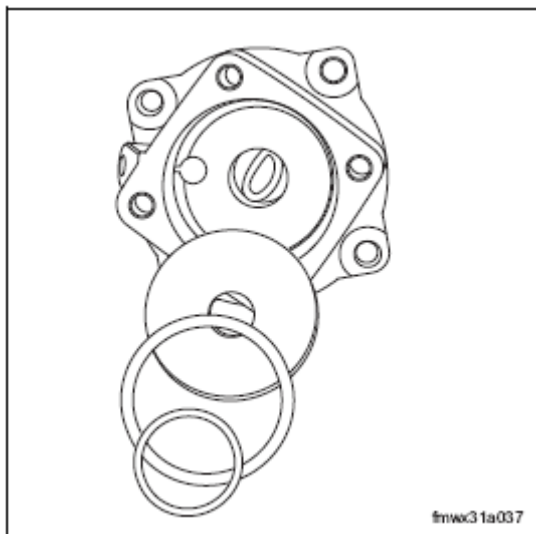
Gear	Contact resistance (Ω)
Low gear	<1
High gear	∞



5. Testing of reverse gear switch

- (a) Testing of appearance: There shall be no such defects as deformation, damages or looseness of contact.
- (b) Testing of resistance: Use the multi-meter to test the resistance between both terminals of the switch.

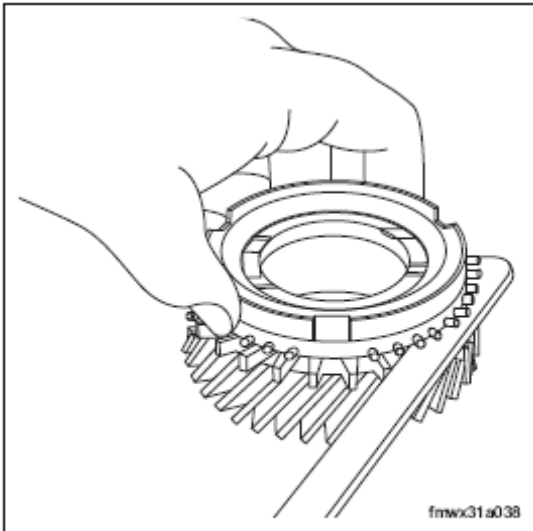
Gear	Contact resistance (Ω)
Reverse gear	<1
Other gear	∞



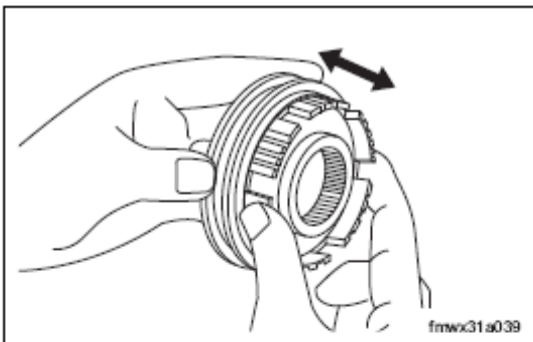
6. Testing of splitter gear shifting cylinder

- (a) Check the O-shaped ring or other seals for damages, deformation, poor lubrication or improper installation.

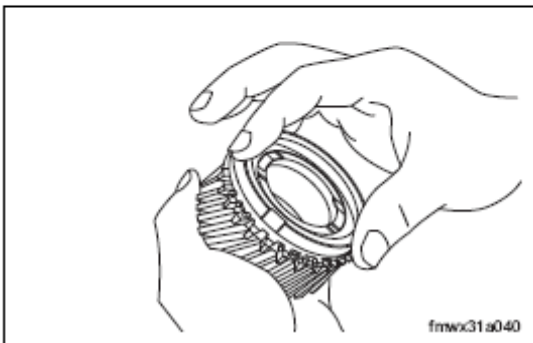




7. **Check of high and low gear synchronizer**
- (a) Use the thickness gauge to measure the gap between the gear and synchronizing ring.
 - (b) If the measured value exceeds the required value, replace the synchronizing ring or synchronizer.



- (c) Check of synchronizer ring gear and gear seat
 - Check sliding conditions of ring gear and gear seat.

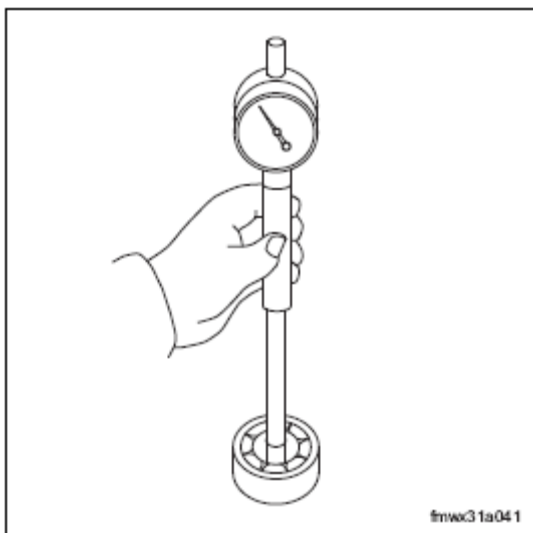


- (d) Check of synchronizing ring
 - Press the synchronizing ring toward the gear, and rotate it toward the same direction. Check locking effects of the ring. If the ring can't be locked efficiently, apply the high-quality grinding paste on the mating surface between the ring and gear, and grind it slightly.

Notices:

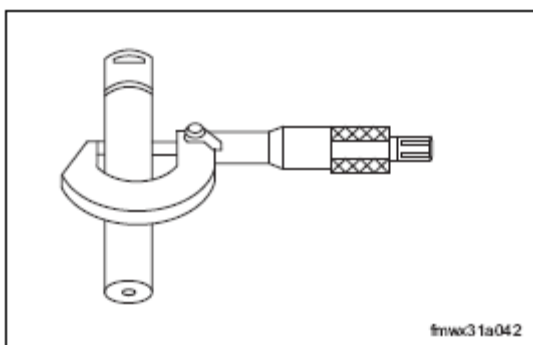
Ensure that the grinding paste is removed after the grinding operation.

- Check locking effects of the synchronizing ring again.
- If the ring can't be locked efficiently again, check the gap between the gear and ring.



8. Check of bearing

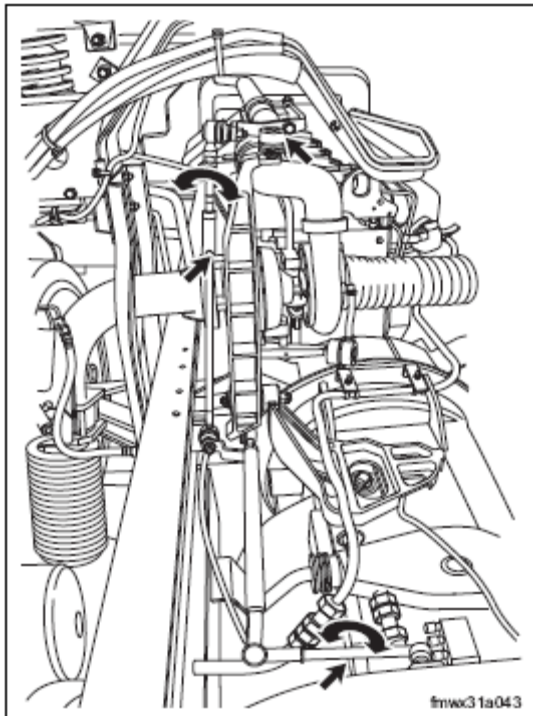
- (a) Wash all bearings in the clean solution, and check the steel ball, roller and bearing rolling way for pits or scaling.
- (b) Measure the internal diameter of the bearing.
- (c) The wear of bearing seat hole and housing bearing seat hole may damage their mounting relation with the bearing, and have a direct bearing on the relative position between the input shaft and output shaft. The clearance between the bearing and seat hole shall be 0-0.03mm, with the maximum limit of 0.10mm; otherwise the housing shall be replaced or the hole inlay bush repaired.



9. Measurement of reverse gear shaft diameter

- (a) Use the micrometer to measure the reverse gear shaft diameter.
- (b) If the measurement exceeds the limit, replace the reverse gear shaft.

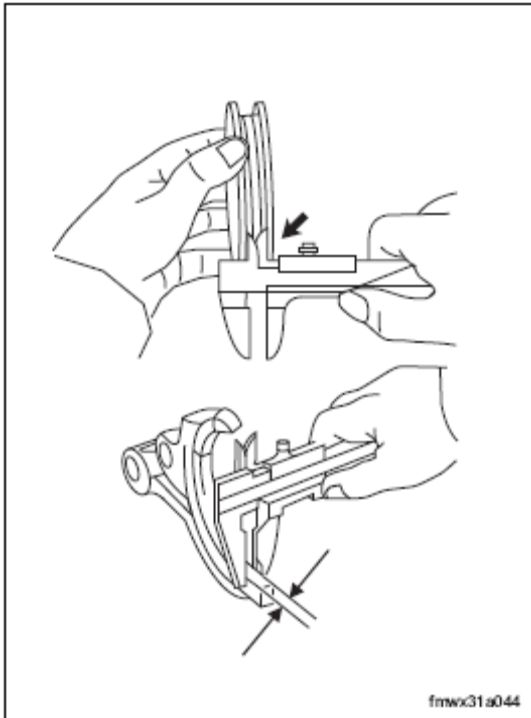
31A



10. Adjustment of transmission gearshift control mechanism

- (a) The technician A holds the gearshift handle at the central position in the cab.
- (b) The technician B undoes the telescopic rod assembly or gearshift lever assembly adjusting nut, and adjust the gear to the best position.
- (c) Tighten the nut.





11. Measurement of clearance between ring gear and fork

- (a) Use the micrometer to measure the ring gear dimensions.
- (b) Use the micrometer to measure the fork dimensions.

Hint:

If the clearance exceeds the limit, replace the corresponding ring gear and fork.

12. Check of gears

- (a) Check the gear tooth face for pit corrosion; if any, replace the gear concerned.
- (b) Under normal working conditions, the tooth face of transmission gear will present the even wear, and the wear along the length direction of the tooth shall not exceed 30% of the original tooth length; the tooth thickness shall be no higher than 0.40; the gear meshing area shall be no lower than 2/3 of the tooth area; In general, the meshing gap of the rotating gear shall be 0.15~0.26mm, with the service limit of 0.80mm; the meshing gap of the engaged gear shall be 0.10~0.15mm, with the service limit of 0.60mm, which can be measured by the dial gauge or soft metal rolling method. If the gap limit is exceeded, parts concerned shall be replaced in pairs.
- (c) The breakage of gear tooth is caused by the improper meshing part of the gear tooth or high impact load received in operation due to the unqualified meshing gap of the gear. If the tooth edge presents a minor breakage with a size of no more than 2mm, the further use is allowed after it is repaired by finishing with honing stone; if more than 2mm or there are at least 3 parts with minor breakage, parts shall be replaced in pairs.
- (d) Wear of end face of normally engaged gear: There shall be an axial clearance of 0.10~0.30mm on the normally engaged inclined tooth end face to ensure the proper working of the gear; if the tooth end is slotted, the finishing work can be done, but it shall not be ground by more than 50mm.

13. Check of spline

- (a) Check the wear degree of splines on all shafts. If the sliding tooth sleeve and output flange disc inclines toward the spline due to wear, it shall be replaced. The spline tooth may be seriously worn on the loading side, and it can be checked together with the spline sleeve. If the spline tooth is worn by more than 0.25mm or the mating clearance of original key groove is more than 0.40mm, or if the clearance between the engaging ring gear & engaging sleeve and key tooth exceeds 0.30mm, or if the clearance between the woodruff key and shaft journal key grooves exceeds 0.08mm, the key tooth shaft or those shafts with key groove must be repaired or replaced.

14. Check of thrust washer

- (a) Check the conditions of surfaces of all thrust washers, and replace those which are scratched or have reduced thicknesses.

15. Service of transmission shaft

- (a) Use the thimble to press against the thimbles holes at both ends of the transmission shaft, and use the dial gauge to check the radial runout of the shaft; the deviation shall be less than 0.10mm. If more than 0.10mm, the pressure rectification shall be performed for repairs or the replacement shall be done.
- (b) Wear of normally engaged gear journal, needle bearing and seat hole: The clearance between the normally engaged gear seat hole, needle bearing and journal shall be 0.01~0.08mm; otherwise the replacement shall be provided.

16. Check of grey cast iron parts

- (a) Check all grey cast iron parts for crack or damages. Large castings can be provided with fusion welding or brazing, but the thermal crack shall not extend to the bearing hole or bolt connecting surface.

17. Check of bearing cover

- (a) Check the wear conditions of the spigot.
- (b) Check the oil seals in both the first shaft bearing cover and in the odometer housing; if the lip becomes ineffective with respect to the sealing performance, seals must be replaced.

18. Check of sliding sleeve

- (a) Check all forks and fork grooves of sliding sleeve for excessive wear or discoloring due to overheating.
- (b) Check the meshing tooth of the sliding sleeve for any inclination of the contact zone.

19. Check of O-shaped rings

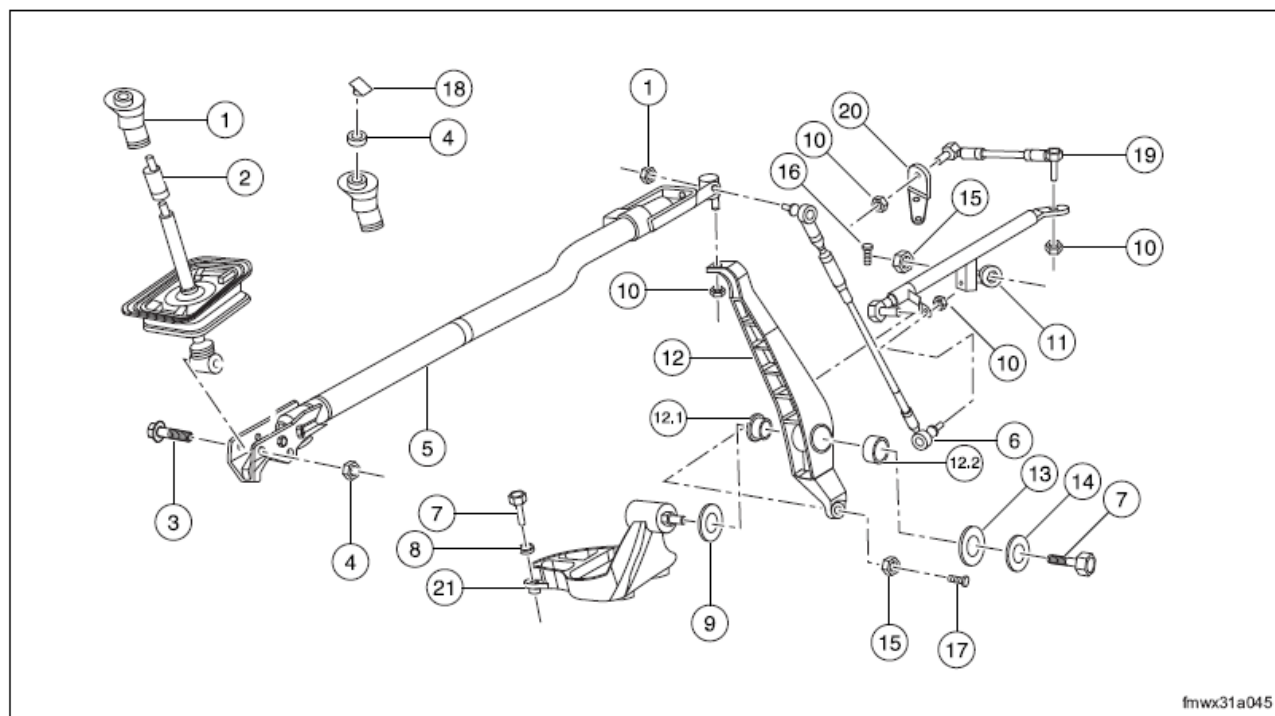
- (a) Check all O-shaped rings for breakage and deformation; if worn or aged, the replacement shall be provided.

20. Check of journal wear

- (a) If the journal is excessively worn, this will not only give rise to the deviation of gear axis, but also will change the gear meshing clearance to cause noise in transmission, and meanwhile it may damage the mating relation between the journal and bearing to cause burnout in operation. Therefore, the wear of journal at the interference fit of roller bearing shall be no higher than 0.02mm, and that at the joint of needle bearing shall be no higher than 0.07mm; otherwise it shall be replaced or repaired by chrome plating.

TRANSMISSION CONTROL MECHANISM

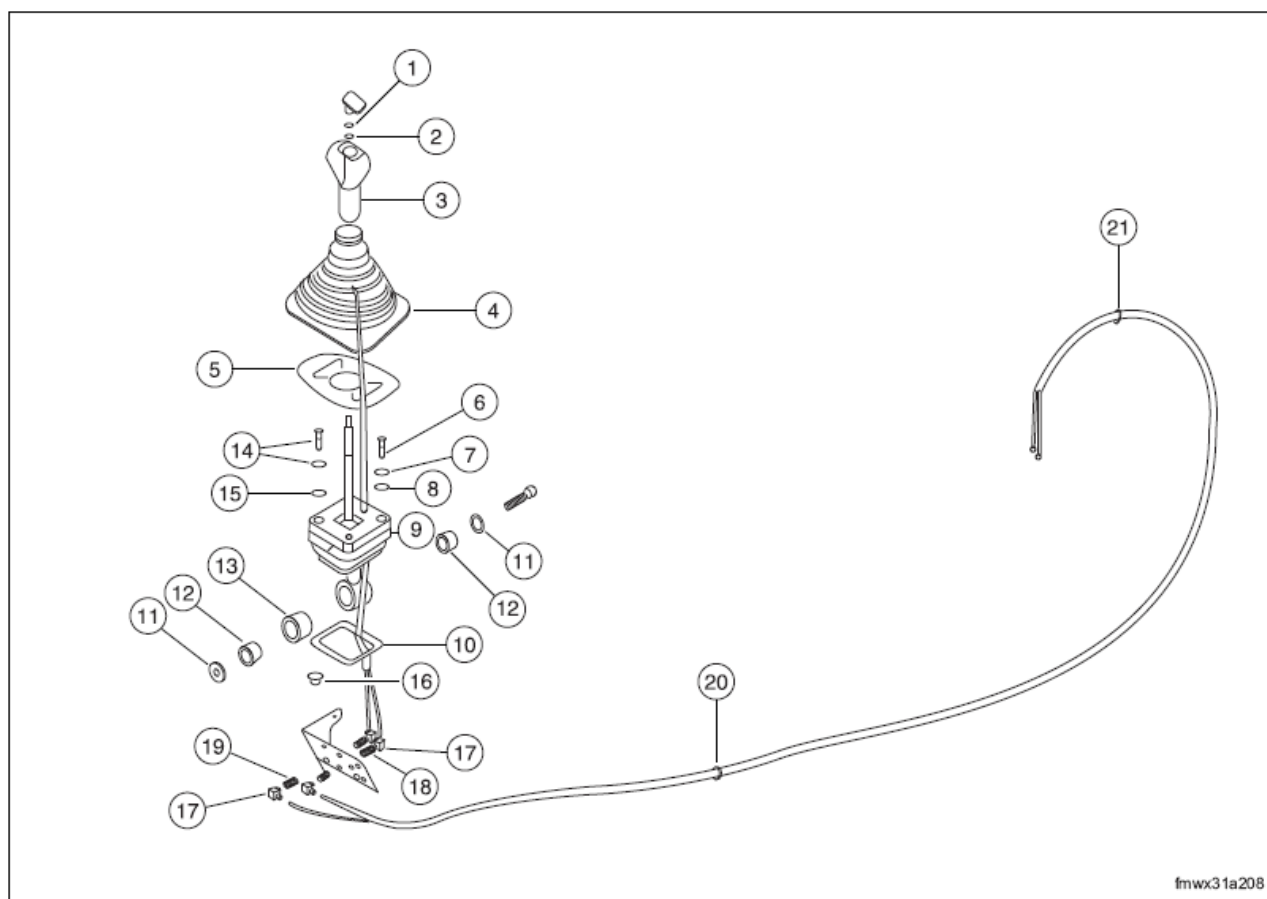
DIAGRAM OF COMPONENTS



fmwx31a045

1	Handle ball assembly
2	Locking ring
3	Hexagon flange bolt
4	Fully-metallic hexagon flanged lock nut
5	Telescopic rod assembly
6	Gear selector lever assembly
7	Hexagon head bolt
8	Spring washer
9	Noise-reducing washer
10	Type 1 fully-metallic hexagon lock nut
11	Gear selector lever assembly
12	Gear selector rocker arm assembly

12.1	Straight lining
12.2	L-shaped lining
13	Sealing gasket
14	Thick washer
15	Hexagon slotted thin nut
16	Slotted pin
17	Slotted pin
18	Gear plate
19	Gear selector rear strut assembly
20	Gear selector bracket
21	Tetragonal bracket assembly


31A

fmwx31a208

1	Type 1 hexagon nut
2	Spring washer
3	Handle & air valve assembly
4	Upper dustproof cover
5	Upper pressure plate
6	Hexagon head bolt
7	Plain washer
8	Spring washer
9	Controller assembly
10	Lower pressure plate
11	Sealing gasket

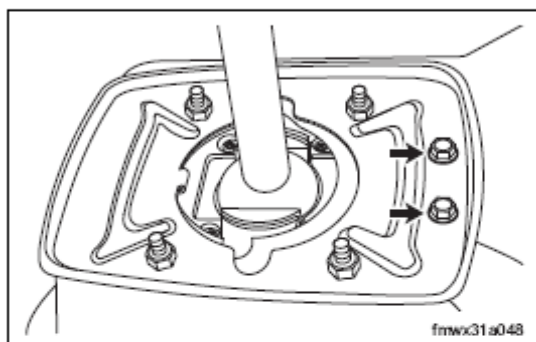
12	Composite lining
13	Intermediate spacer
14	Hexagon head bolt & external toothed lock washer assembly
15	Plain washer
16	Fully-metallic hexagon flanged lock nut
17	90° quick-change union
18	Type 1 hexagon nut
19	Air pipe union
20	Binding strip
21	Binding strip
22	Bracket

REMOVAL AND INSTALLATION

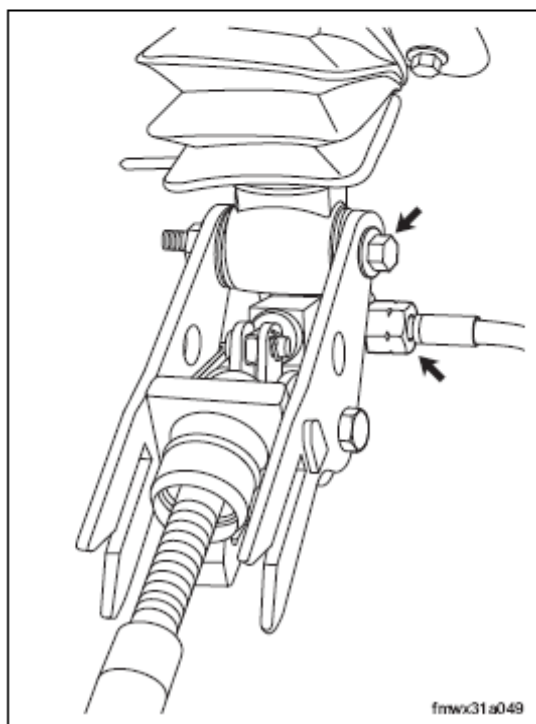
1. Removal of gearshift control mechanism



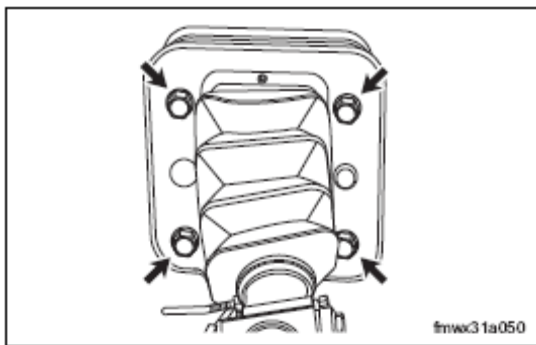
- (a) Remove the gear plate, and undo the lock nut.
- (b) Remove the dustproof cover.



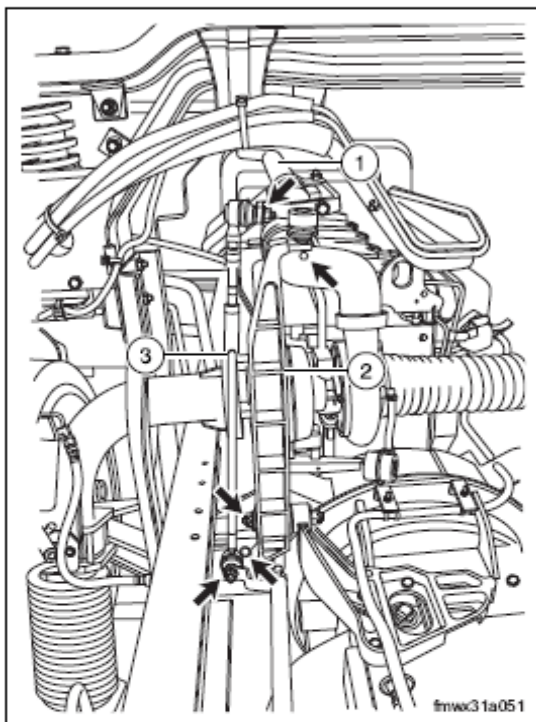
- (c) Remove the upper pressure plate lock bolt.



- (d) Disconnect the lubricating oil pipe.
- (e) Disconnect the connecting bolt between the controller and telescopic rod.

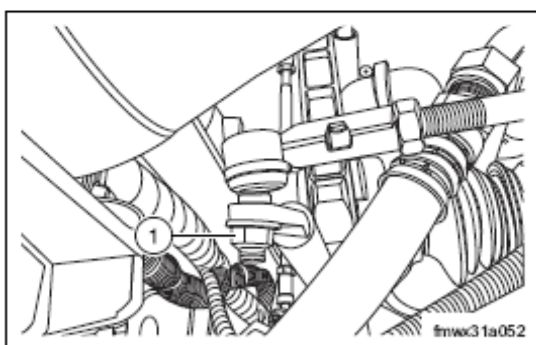


- (f) Remove those 4 lock bolts of the lower pressure plate.
- (g) Remove the lower pressure plate and lower dustproof cover in order.
- (h) Remove the gearshift controller assembly.

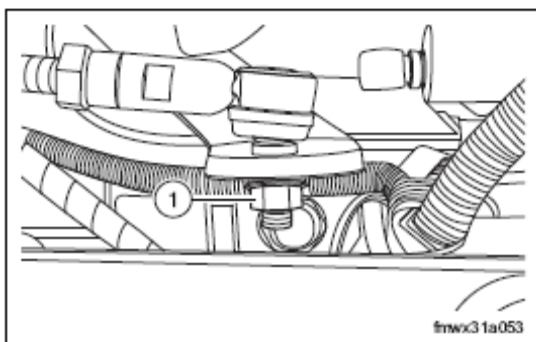


- (i) Remove the gearshift telescopic rod 1.
 - Remove the connecting nut and then the telescopic rod.
- (j) Remove the gear selector lever assembly 3.
 - Remove the connecting nut, and remove the gear selector lever assembly.
- (k) Remove the gearshift rocker arm assembly 2.
 - Remove the slotted pin and connecting nut, and then the gearshift rocker arm assembly.

31A

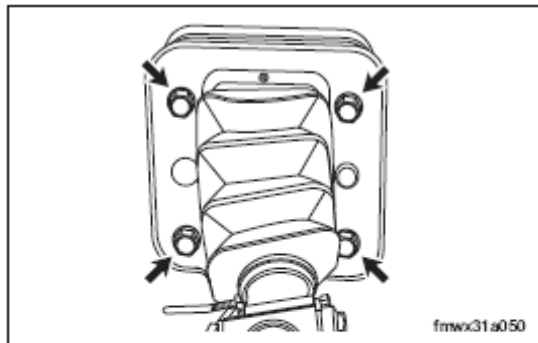


- (l) Remove the gearshift lever assembly.
 - Remove the gearshift lever assembly connecting nut 1 and then the gearshift lever assembly.



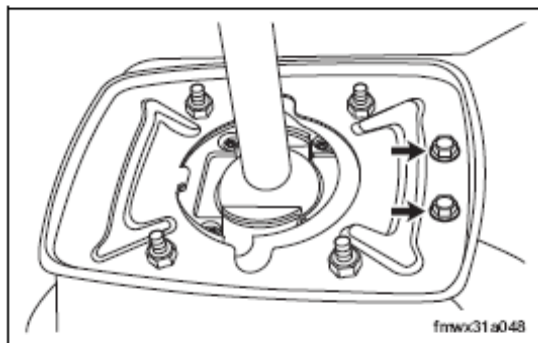
- (m) Remove the gear selector rear strut assembly.
 - Remove the gear selector rear strut assembly connecting nut 1 and then the rear strut assembly.

2. Installation of gearshift control mechanism



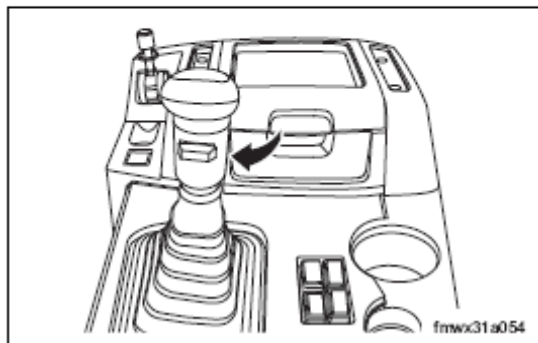
- (a) Refit the gearshift controller assembly
- Install the dustproof cover and both upper and lower pressure plates, and tighten these 4 bolts.

Torque: $21 \pm 5 \text{ N.m}$

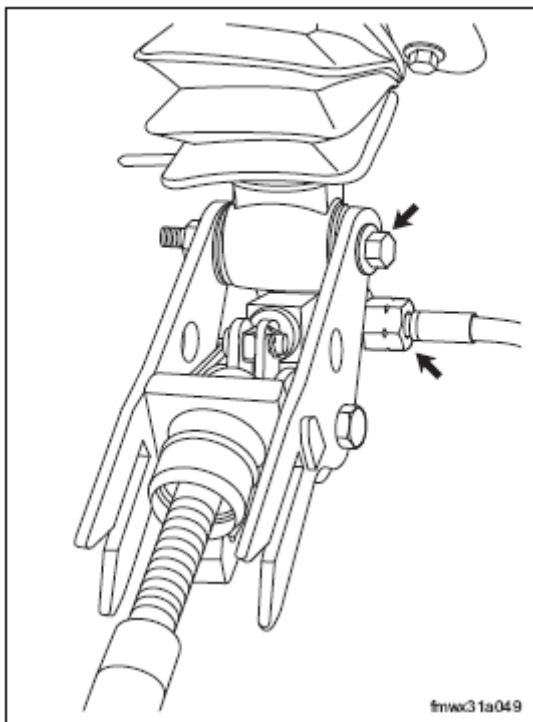


- (b) Refit these 2 bolts of the upper pressure plate.

Torque: $9 \pm 3 \text{ N.m}$



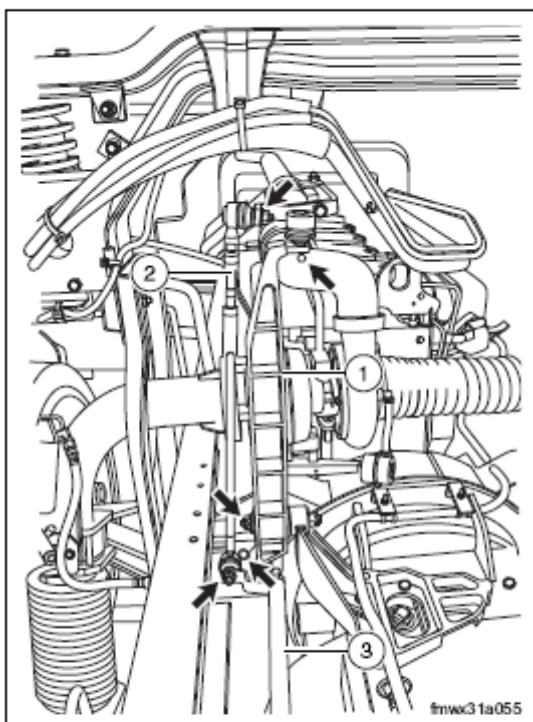
- (c) Refit the dustproof cover, handle ball, lock nut and gear plate in order.



- (d) Refit the telescopic rod assembly.
- Connect the telescopic rod and gearshift controller, and tighten the connecting bolt.

Torque: 64N.m

- Connect the lubricating oil pipe.



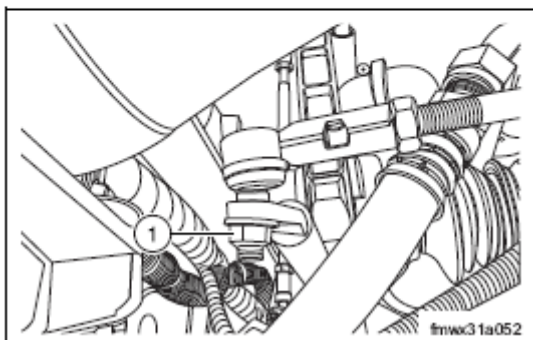
- (e) Refit the gearshift rocker arm assembly 1.
- Attach the gearshift rocker arm assembly 1 onto the tetragonal bracket assembly, tighten the nut, and put on the slotted pin.
 - Connect the telescopic rod and gearshift rocker arm assembly, and tighten connecting nuts.

Torque: 95N.m

- (f) Refit the gearshift lever assembly 2.
- Connect the gear selector lever 2 and the telescopic rod, and tighten connecting nuts.

Torque: 95N.m

- (g) Refit the gearshift lever assembly 3.
- Connect the gear selector lever assembly 2 and gearshift lever assembly 3, and tighten connecting nuts.
 - Connect the gearshift lever assembly 3 and gearshift rocker arm assembly 1, tighten connecting nuts, and put on the slotted pin.



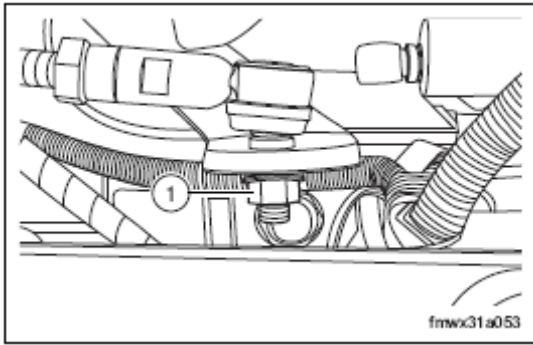
- (h) Refit the gear selector rear strut assembly
- Connect the gear selector rear strut assembly and gearshift lever assembly, and tighten nuts.

Torque: 95N.m



31A-34

TRANSMISSION (12JS180TA)-TRANSMISSION CONTROL MECHANISM



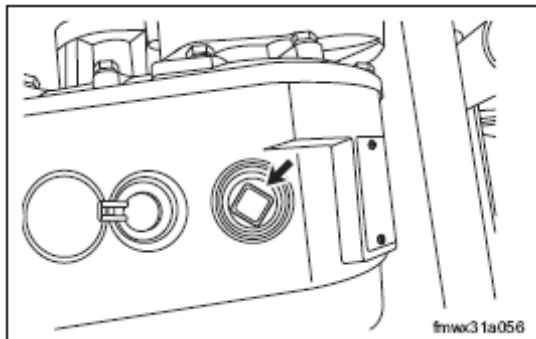
- (i) Refit the gear selector lever assembly onto the gear selector bracket, and tighten connecting nuts.
Torque: 95N.m

31A

TRANSMISSION ASSEMBLY

REPLACEMENT

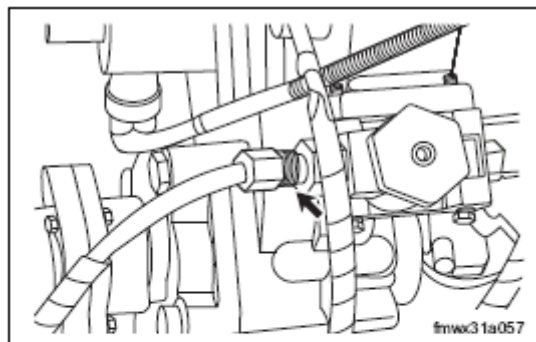
1. Disconnect the battery negative cable.



2. Remove the drain plug at the bottom of transmission to discharge all transmission oil, and then fasten the drain bolt.

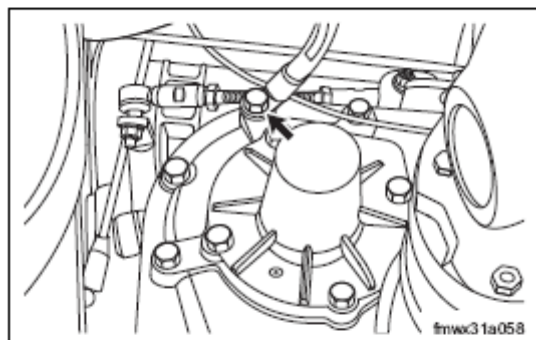
Torque: $68 \pm 7 \text{ N.m}$

3. Remove the intermediate drive shaft. Refer to Chapter 33 Service, Drive Shaft-Intermediate Drive shaft.

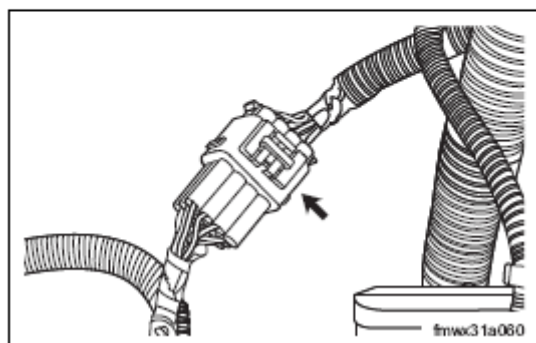


4. Disconnect the transmission from other components.

- (a) Remove the air filter regulator air pipe assembly.



- (b) Remove the transmission earthing cable.



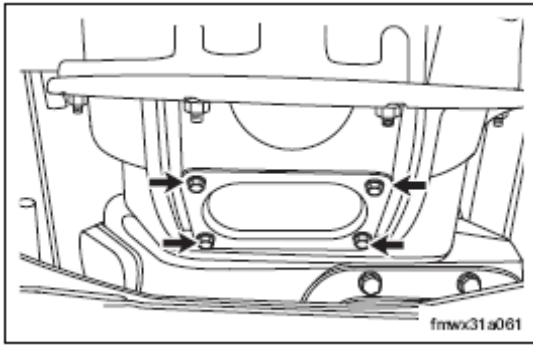
- (c) Disconnect the transmission grouped plug.

31A

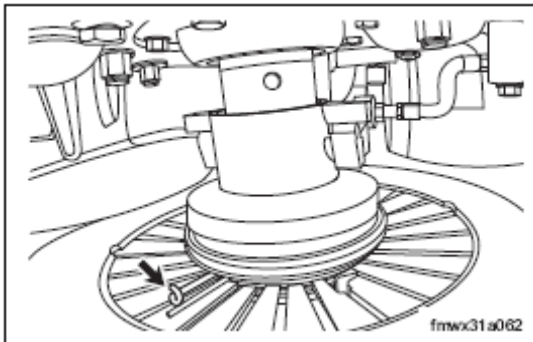
31A-36

TRANSMISSION (12JS180TA)-TRANSMISSION ASSEMBLY

5. Remove the transmission gearshift control mechanism assembly. Refer to Chapter 31A Disassembly and assembly, Transmission 12JS180TA-Transmission Control Mechanism.

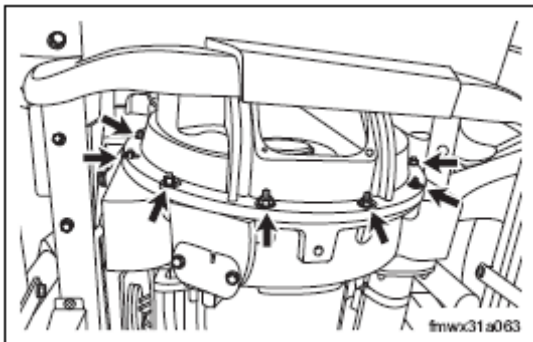


6. Remove the clutch inspection hole cover plate.
(a) Remove these 4 bolts and then the cover plate.

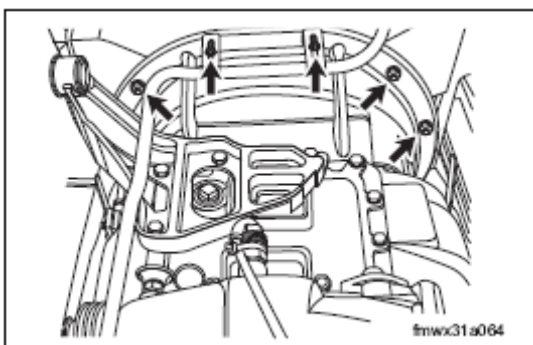


7. Disconnect the hook of spring retainer of the clutch throw-out bearing.

8. Remove the clutch slave cylinder. Refer to Chapter 32: Service, Clutch-Clutch Slave Cylinder.

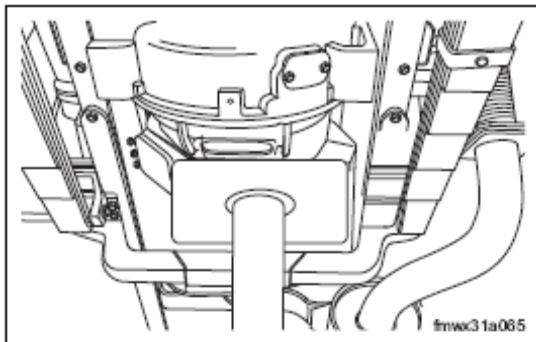


9. Disconnect the transmission from the engine.
(a) Remove the lower connecting bolts between the transmission and engine.



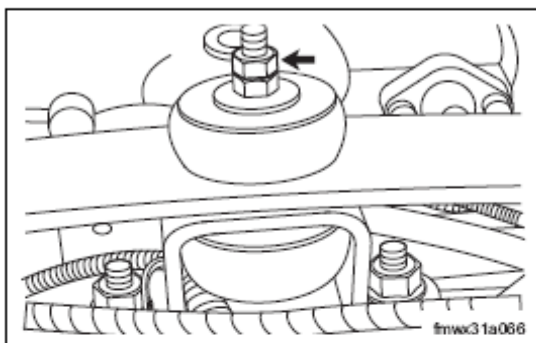
- (b) Remove the upper connecting bolts between the transmission and engine.

10. Remove the sub-frame.

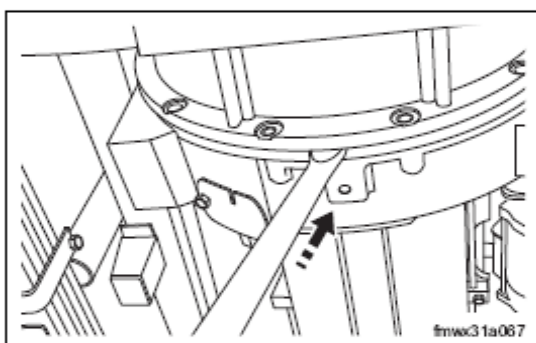


11. Remove the transmission assembly.

- (a) Use the transmission hydraulic jack to raise the transmission assembly.

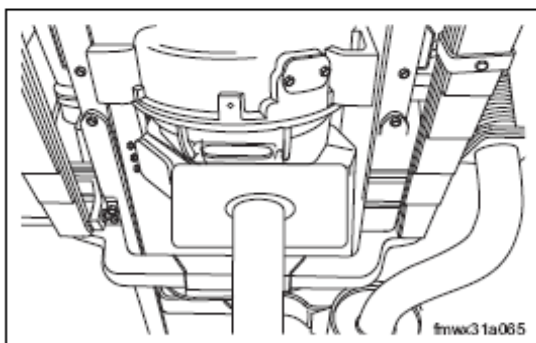


- (b) Remove the connecting nut of the transmission mounting and then the spring beam.



- (c) Use the flat pry bar to separate the transmission assembly from the engine.

- (d) Lower the transmission assembly.

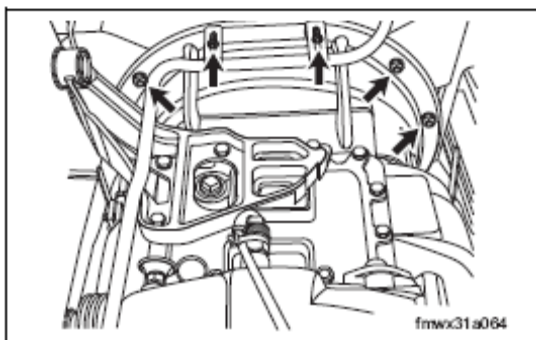


12. Refit the transmission assembly.

- (a) Connect the transmission assembly and engine assembly.

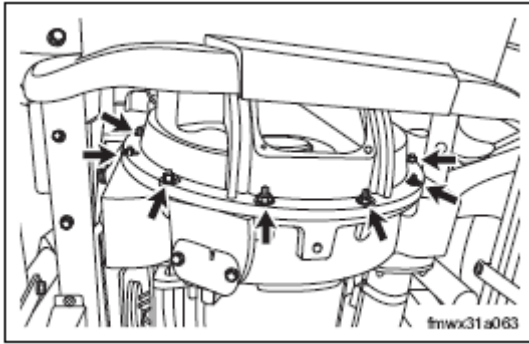
Hint:

Prior to the refitting operation of transmission assembly, the hook of spring retainer of the clutch must be engaged. Move the spring retainer and check whether it can move flexibly on the throw-out ring; if not flexible, refit it again; otherwise it may be not allowed to install the throw-out bearing.

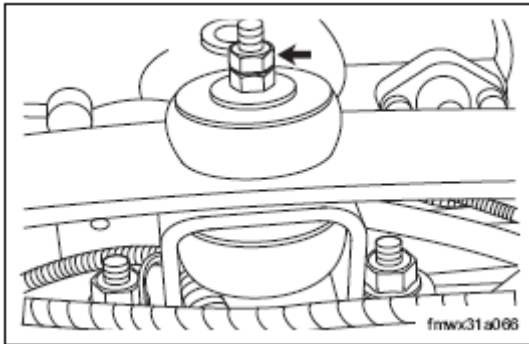


13. Refit connectors between the transmission and engine.

- (a) Tighten upper connecting bolts of the transmission.

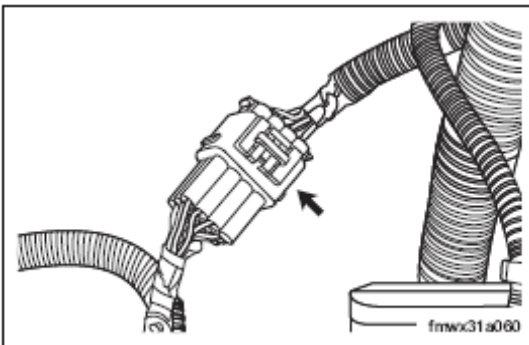


- (b) Tighten lower connecting bolts of the transmission.

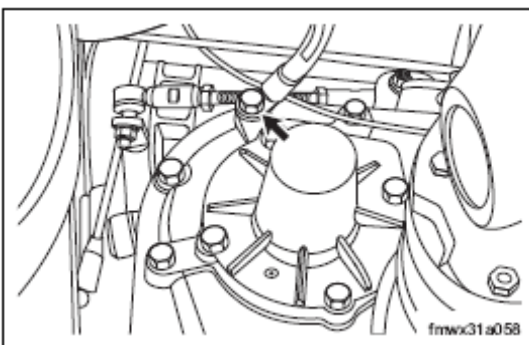


14. Refit the transmission spring beam, and tighten the mounting connecting nuts.
Torque: 240N.m

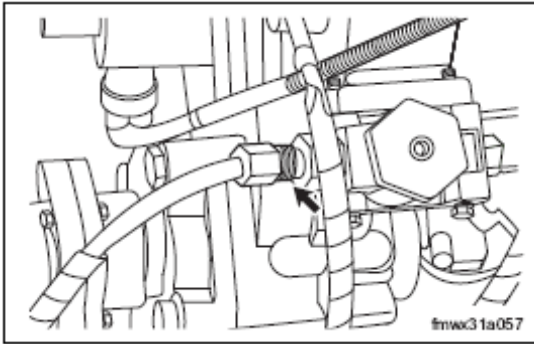
15. Refit the transmission gearshift control components. Refer to Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transmission Control Mechanism.



16. Refit the transmission accessories.
(a) Connect the transmission grouped plug.



- (b) Refit the transmission earthing cable, and tighten the bolt.
Torque: 54.5±7N.m

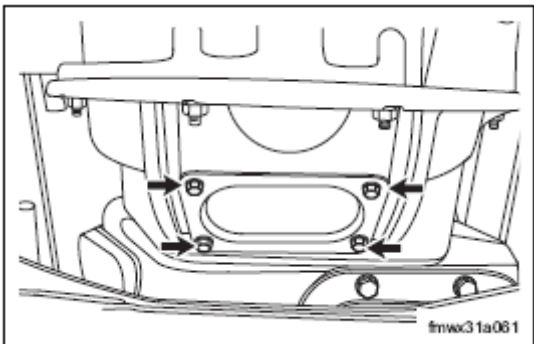


- (c) Refit the air filter regulator air pipe assembly.

17. Refit the clutch slave cylinder. Refer to Chapter 32: Service, Clutch-Clutch Slave Cylinder.

Hint:

Prior to the refitting operation of clutch slave cylinder, use the rope to hold the throw-out bearing elbow end via the window of the clutch slave cylinder and then drag the elbow outward by applying a significant force to push the throw-out bearing into the throw-out ring and seize it with the spring retainer; in such a way, the throw-out bearing can be fitted in place.



18. Refit the clutch inspection hole cover plate.

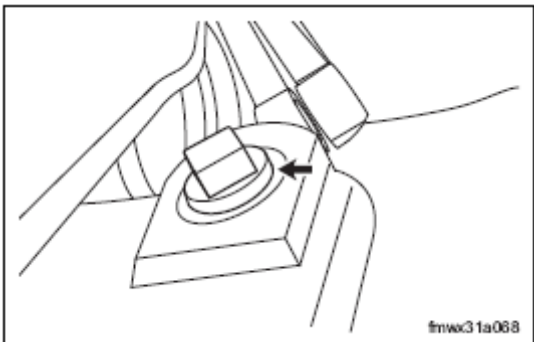
- (a) Refit the clutch inspection hole cover plate, and tighten 4 bolts.

Torque: 23.5±3.5Nm

31A

19. Refit the intermediate drive shaft. Refer to Chapter 33: Service, Drive Shaft-Intermediate Drive shaft.

20. Refit the battery negative cable.



- 21. Remove the transmission middle filler plug, fill the transmission oil 85W/90GL-5, and tighten the filler bolt.**

Amount of transmission oil: 15L

Notices:

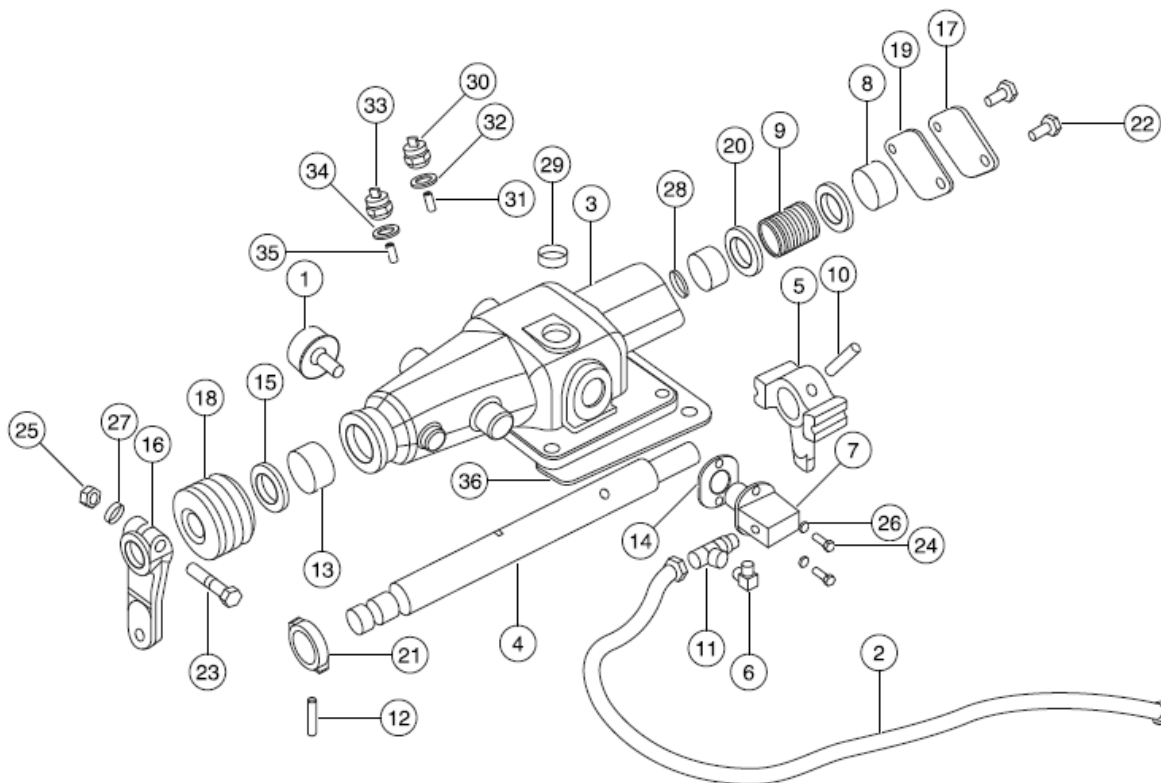
After the refilling operation is finished, run the transmission for several minutes, and then check the transmission oil level again.

22. Transmission running-in specification and tests

- (a) The speed shall be 1500r/min or so, with the oil temperature no lower than 15°C, at zero load; run the engine at neutral gear for at least 15min and at other gears for at least 20min.
- (b) Check whether the gearshift operation is easy and whether the gear can be fully engaged. In the gearshift operation, there shall be no impact noise from the gear.
- (c) The transmission gearshift lever shall not shake noticeably.
- (d) In the transmission test, there shall be no abnormal friction or impact noise.
- (e) There shall be no oil leakage in the transmission.
- (f) After the running-in, discharge the transmission oil, and thoroughly clean the transmission inside, and fill the oil as required.

SINGLE-H CONTROL MECHANISM

DIAGRAM OF COMPONENTS



fmwx31c025

1	Ventilating plug
2	Air pipe assembly
3	Control device housing
4	Lateral gearshift lever
5	Shifting block
6	90°quick-change union
7	Pneumatic line control valve
8	Limiting sleeve
9	Compression spring
10	Cylindrical pin
11	Tee pipe union
12	Flexible cylindrical pin
13	Lateral gearshift lever bush
14	Single-H air valve lining

19	End gasket
20	Spring seat
21	Reverse and low gear switch control valve
22	Hexagon head bolt & spring washer assembly
23	Hexagon bolt-Fine thread
24	Internal hexagon cylindrical head screw
25	Type 1 hexagon nut
26	Spring washer
27	Spring washer
28	Flexible retaining ring for shaft
29	Cup-shaped insert
30	Pressure switch
31	Switch starting pin
32	Sealing washer



TRANSMISSION (12JS180TA)-SINGLE-H CONTROL MECHANISM

31A-41

15	Oil seal
16	LRC external gearshift arm
17	Side plate
18	sleeve

33	Pressure switch
34	Sealing ring
35	Swithec starting pin
36	Control window lining

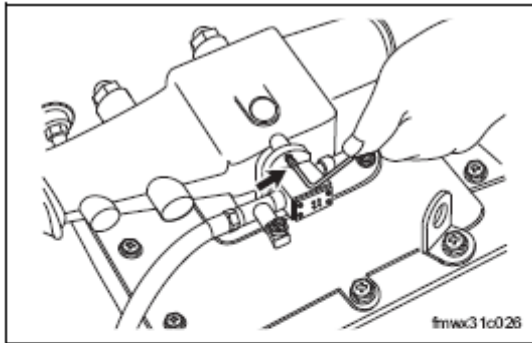
31A



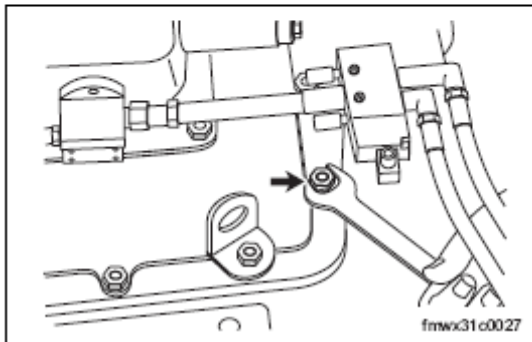
FOTON

REMOVAL AND INSTALLATION

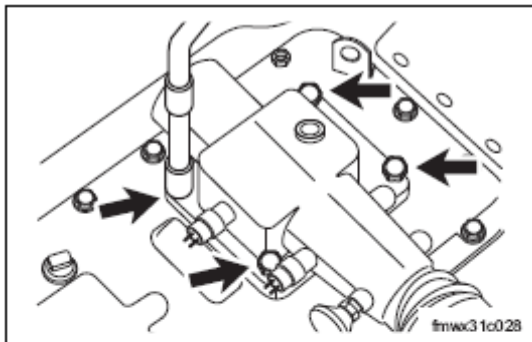
1. Removal of single-H control mechanism



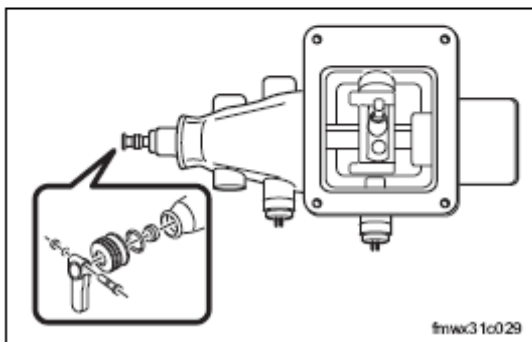
- (a) Remove the internal hexagon bolt of pneumatic line cutoff valve on the single-H assembly.



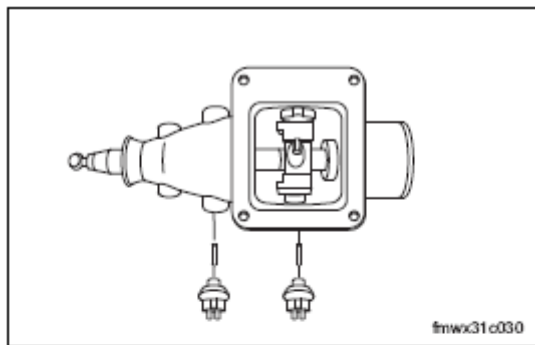
- (b) Remove the bracket bolt of right pneumatic line redirection valve of upper cover.



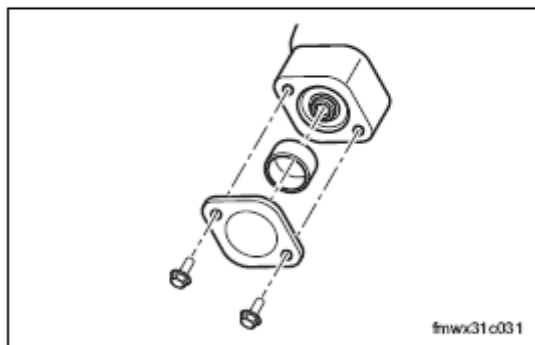
- (c) Remove these 4 positioning nuts on the single-H assembly.
(d) Use the copper rod to lightly knock the single-H control mechanism housing, and remove the single-H assembly.



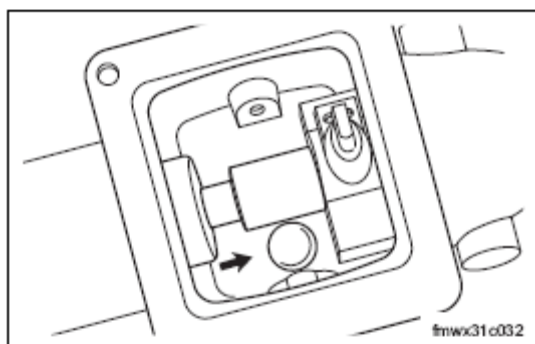
- (e) Remove the gearshift rocker arm, dustproof sleeve and ventilating plug in order.



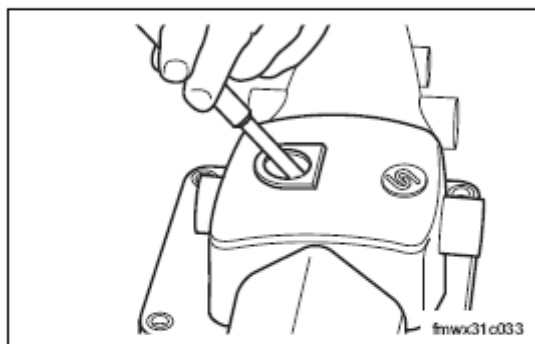
- (f) Remove the reverse and neutral gear switch and plunger.



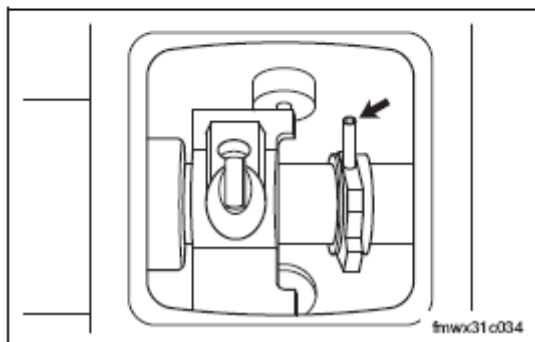
- (g) Remove these two bolts and limiting sleeve on the side board of single-H assembly as well as the snap ring on the lateral gearshift shaft.



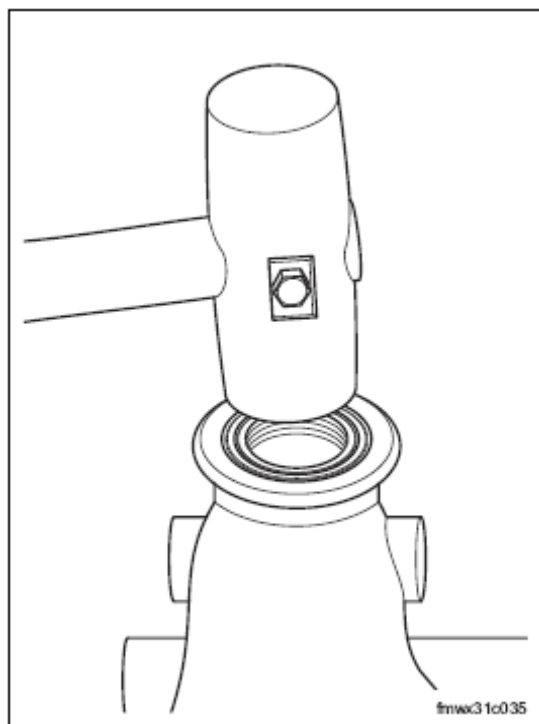
- (h) Rotate the single-H housing, and remove the cup-shaped insert and iron wire on the gearshift block.



- (i) Remove the cylindrical pin on the gearshift block.

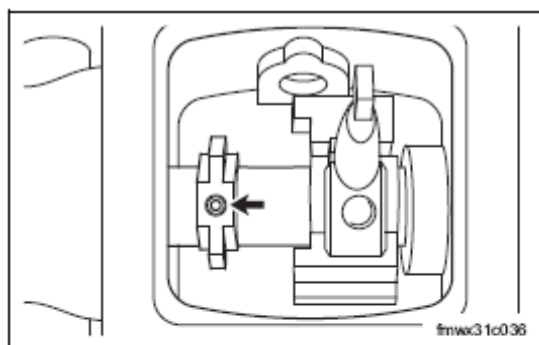


- (j) Remove the flexible cylindrical pin on the reverse gear control block, and pull out the lateral gearshift shaft.

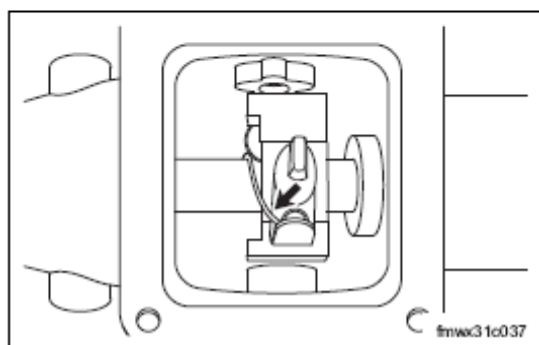


2. Refitting of single-H control mechanism

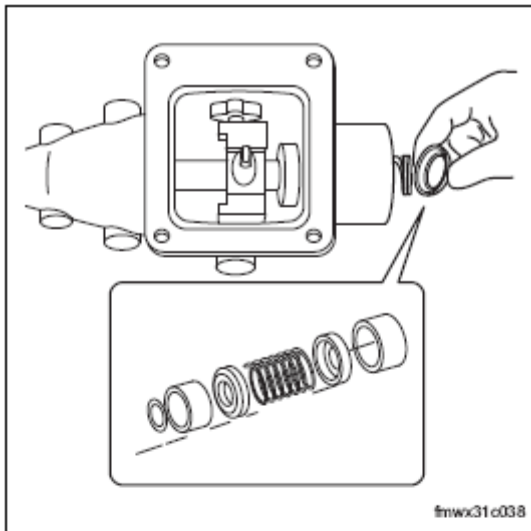
- (a) Place the single-H assembly upright and fit the oil seal.



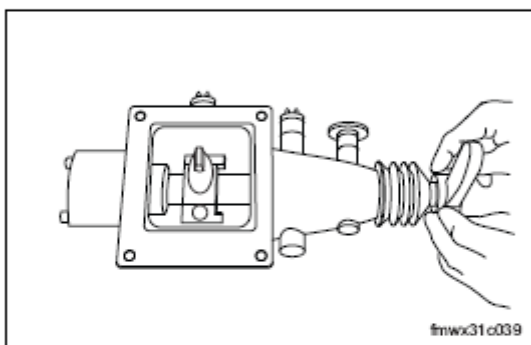
- (b) Fit the lateral gearshift shaft and the reverse gear control block cylindrical pin with the smaller head facing up.



- (c) Fit the cylindrical pin of the gearshift block, and bind it with iron wire.



- (d) Fit the spring, spring seat and snap ring in order.



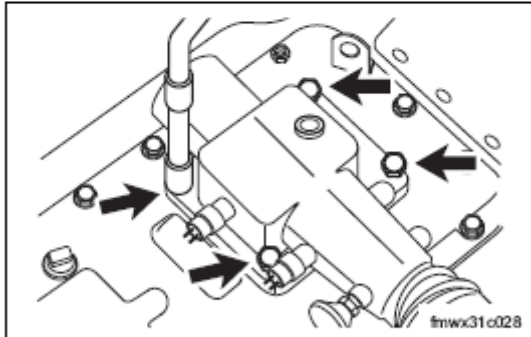
- (e) Fit the limiting sleeve and side board.
(f) Fit the switch starting pin and reverse & neutral gear switch.

Torque: $23 \pm 3 \text{ N.m}$

- (g). Fit the dustproof sleeve and gearshift rocker arm.

Notice:

Ensure that the rocker arm and gearshift block are located on the same line.

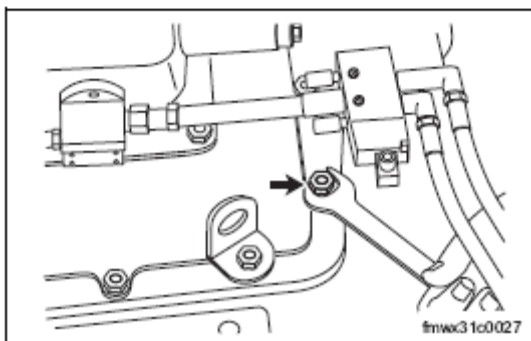


- (h) Fit these four positioning nuts of the single-H assembly.

Torque: $17 \pm 3 \text{ N.m}$

Notice:

The mating surface must be coated with sealant evenly.

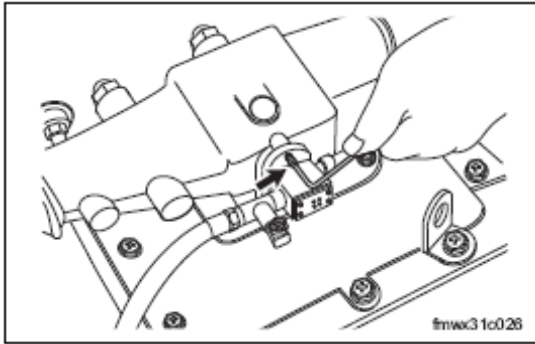


- (i) Fit the bracket bolt of the upper cover right pneumatic line redirection valve.

Torque: $54 \pm 7 \text{ N.m}$

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TRANSMISSION (12JS180TA)-SINGLE-H CONTROL MECHANISM



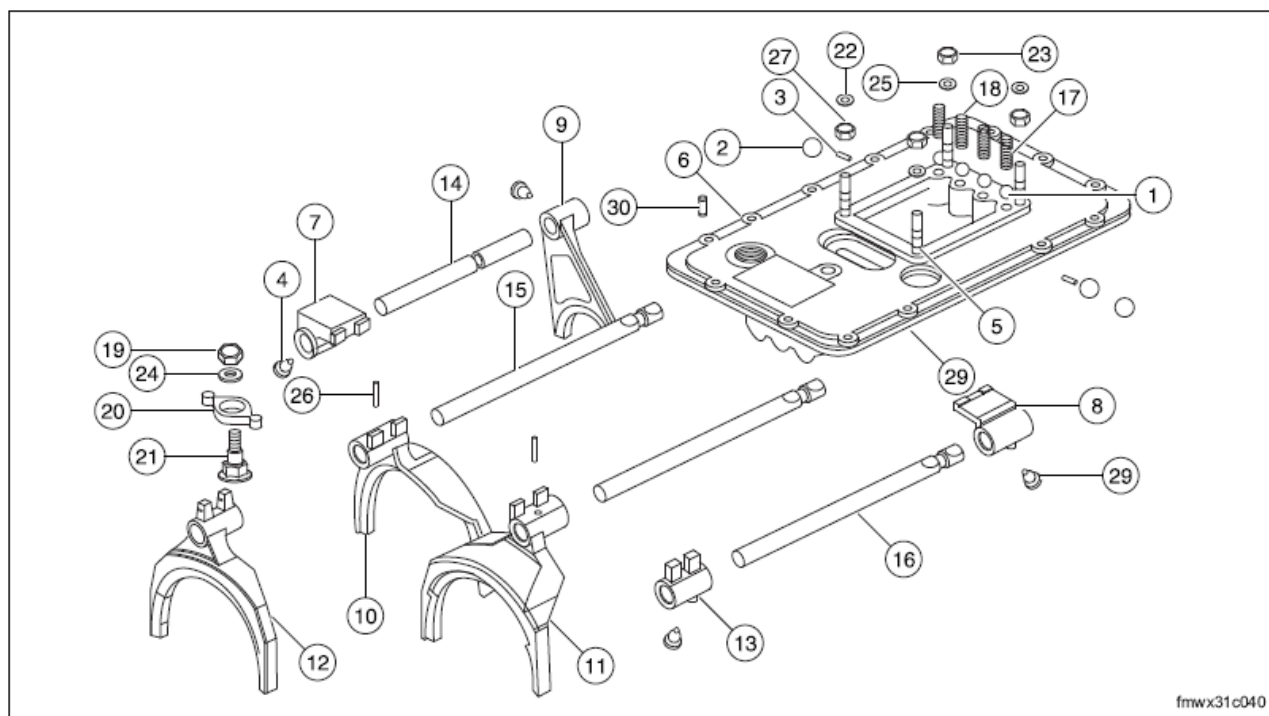
- (j) Fit the internal hexagon screw of pneumatic line cutoff valve on the single-H assembly.

Notice:

The mating surface must be coated with sealant evenly.

TRANSMISSION UPPER COVER

DIAGRAM OF COMPONENTS



31A

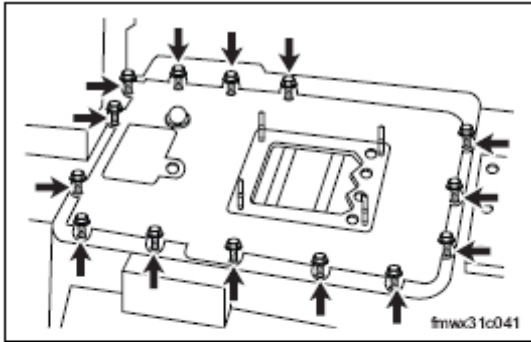
fmwx31c040

1	Steel ball
2	Steel ball
3	Fork shaft interlock pin
4	Gearshift fork lock bolt
5	Stud
6	Upper cover
7	Reverse gear guide block assembly
8	Fifth & sixth gear guide block
9	Reverse gear fork
10	First & second gear fork
11	Third & fourth gear fork
12	Fifth & sixth gear fork
13	Fifth & sixth gear fork shaft
14	Low & reverse gear fork shaft
15	First, second, third and fourth gear fork shaft

16	Fifth & sixth gear fork shaft
17	Compression spring
18	Compression spring
19	Hexagon nylon ring lock nut
20	Swinging puller
21	Bearing shaft pin
22	Hexagon thin nut
23	Type 2 hexagon nut
24	Plain washer
25	Spring washer
26	Flexible cylindrical pin
27	Hexagon nut
28	Gearshift fork lock bolt
29	Upper cover lining
30	Cylindrical pin

DISASSEMBLY AND ASSEMBLY

1. Remove the transmission single-H control mechanism. Refer to Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Single-H Control Mechanism.



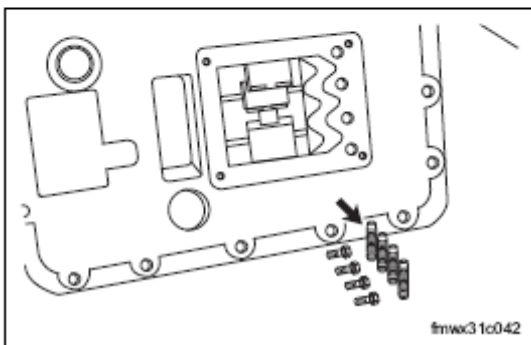
2. Remove the upper cover assembly.

- (a) Remove the upper cover lock bolt.
- (b) Remove these four studs on the upper cover housing.
- (c) Use the copper rod to knock the upper cover and separate it from the lining.

Notices:

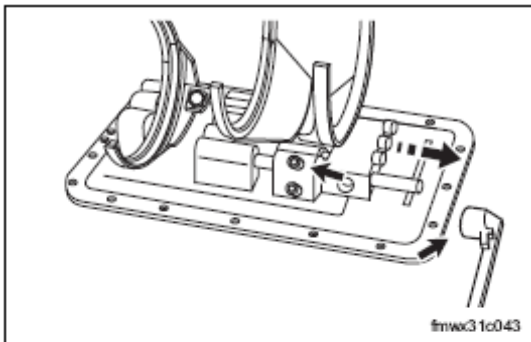
Use the hand to keep out the spring hole while knocking the cover, to avoid the fall of spring into the basic transmission.

- (d) Remove the upper cover assembly and then the spring and steel ball in the upper cover hole.



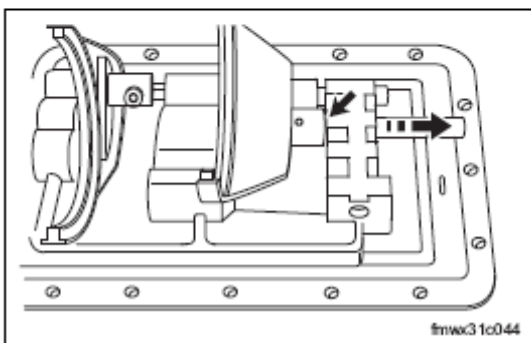
- (e) Turn over the upper cover assembly, and remove the reverse gear fork, fork shaft and guide block.

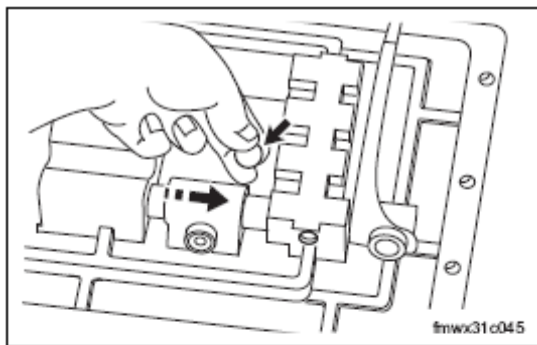
- (f) Remove the flexible cylindrical pin on the 1st/2nd gear fork, and then the 1st/2nd gear fork and fork shaft, as well as interlock pin on the shaft and interlock steel ball in the hole.



- (g) Remove the flexible cylindrical pin on the 3rd /4th gear fork, and then the 3rd /4th gear fork and fork shaft, as well as interlock pin on the shaft and interlock steel ball in the hole.

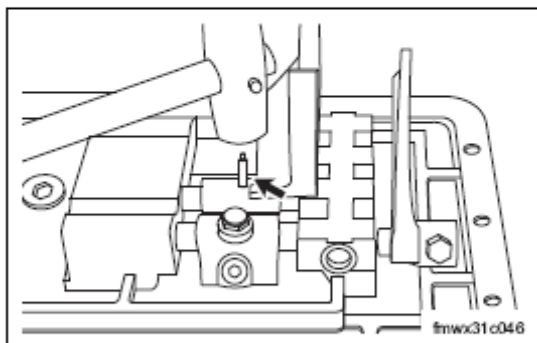
- (h) Remove the positioning bolt on the 5th/6th gear fork shaft, and take out the fork shaft and 5th/6th gear fork and guide block.





3. Refit the upper cover assembly.

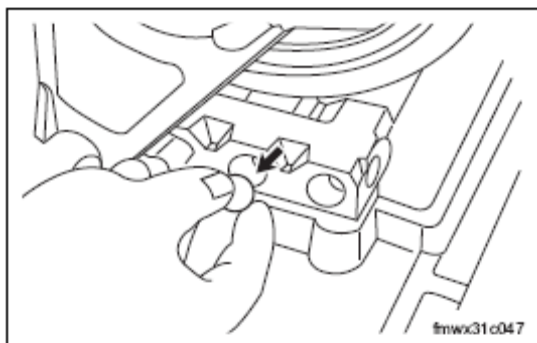
- (a) Put on the low-gear guide block and fork onto the reverse gear fork shaft, fasten it with taper bolt, fix the locking iron wire, and fit an interlock steel ball.



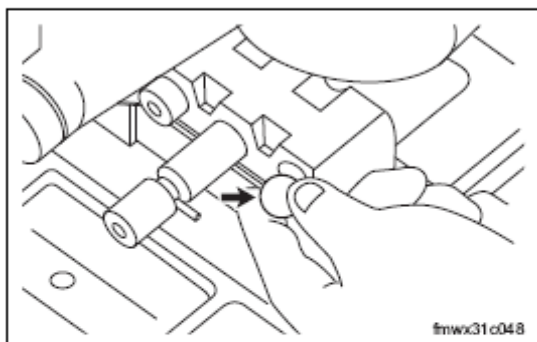
- (b) Refit the 1st/2nd gear fork shaft and then the flexible cylindrical pin on the fork.

Notice:

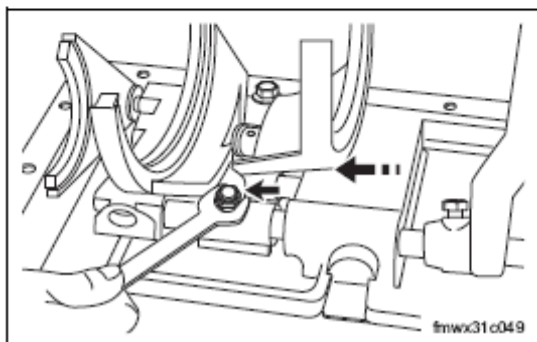
Do not miss the interlock pin on the 1st/2nd gear fork shaft.



- (c) Fit an interlock steel ball.



- (d) Refit the 3rd/4th gear fork shaft and then the flexible cylindrical pin on the fork. Refit the interlock pin and interlock steel ball.

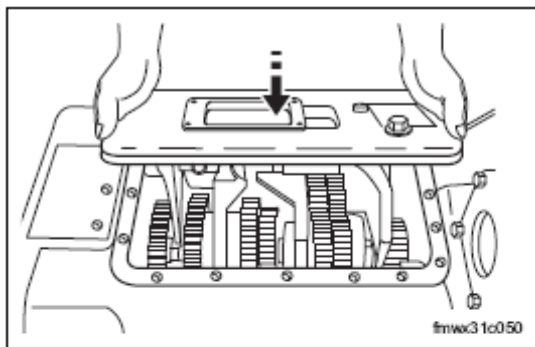


- (e) Refit the 5th/6th gear fork shaft and then the 5th/6th gear guide block and fork. Use the bolt to fasten the locking iron wire.

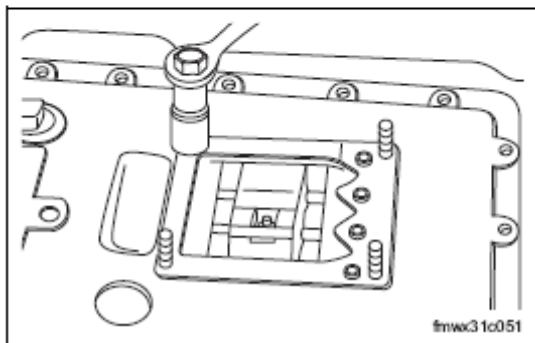
Torque: 78±10N.m

31A-50

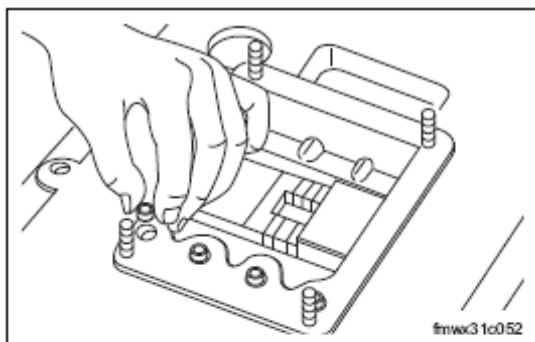
TRANSMISSION (12JS180TA)-TRANSMISSION UPPER COVER



- (f) Fit the upper cover into the basic transmission.
Torque: $54.5 \pm 7 \text{ N.m}$



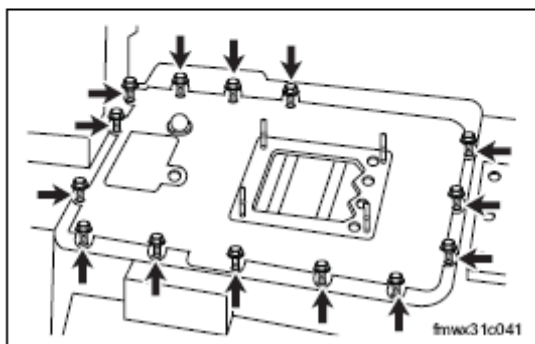
- (g) Fit these four studs on the upper cover housing.
Torque: $54.5 \pm 7 \text{ N.m}$



- (h) Fit these four studs, positioning spring and steel ball on the upper cover.

Notice:

The spring in the 5th/6th fork shaft hole is coarse.



- (i) Fit the upper cover lock bolt.
Torque: $54.5 \pm 7 \text{ N.m}$

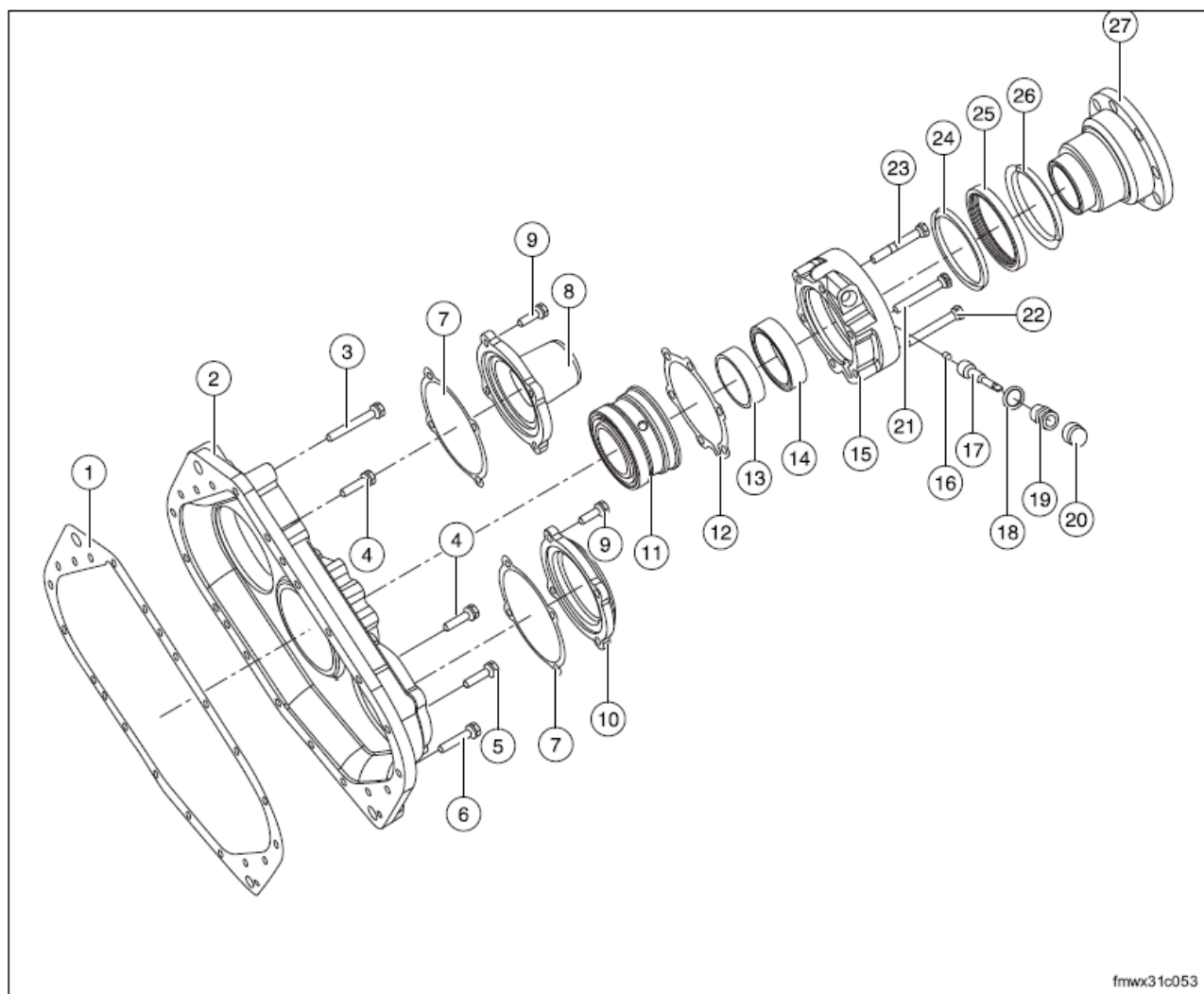
Notice:

The mating surface shall be coated with sealant.

4. Fit the transmission single-H control mechanism. Refer to Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Single-H Control Mechanism.

SPLITTER

DIAGRAM OF COMPONENTS



31A

fmwx31c053

1	Rear cover lining
2	Rear cover housing
3	Hexagon head bolt & spring washer assembly
4	Hexagon bolt & spring washer and plain washer assembly
5	Hexagon bolt & spring washer assembly
6	Hexagon bolt & spring washer assembly
7	Countershaft bearing cover lining
8	Extra-long countershaft cover

15	Output shaft rear bearing cover
16	Odometer driven gear bushing
17	Odometer driven gear
18	Pad
19	Odometer union
20	Odometer casing
21	Hexagon head bolt with hole & spring washer assembly
22	Hexagon head bolt & spring washer assembly



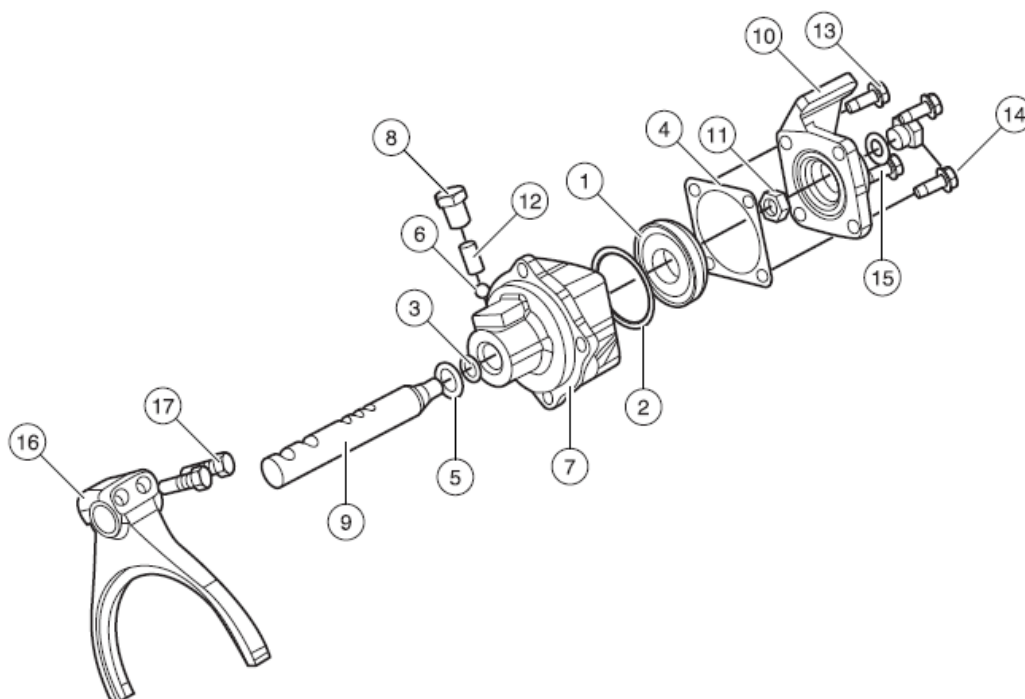
FOTON

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TRANSMISSION (12JS180TA)-SPLITTER

9	Bolt assembly
10	Splitter countershaft bearing cover
11	Conical roller bearing
12	Main shaft rear bearing cover lining
13	Odometer drive gear bush
14	Odometer drive gear

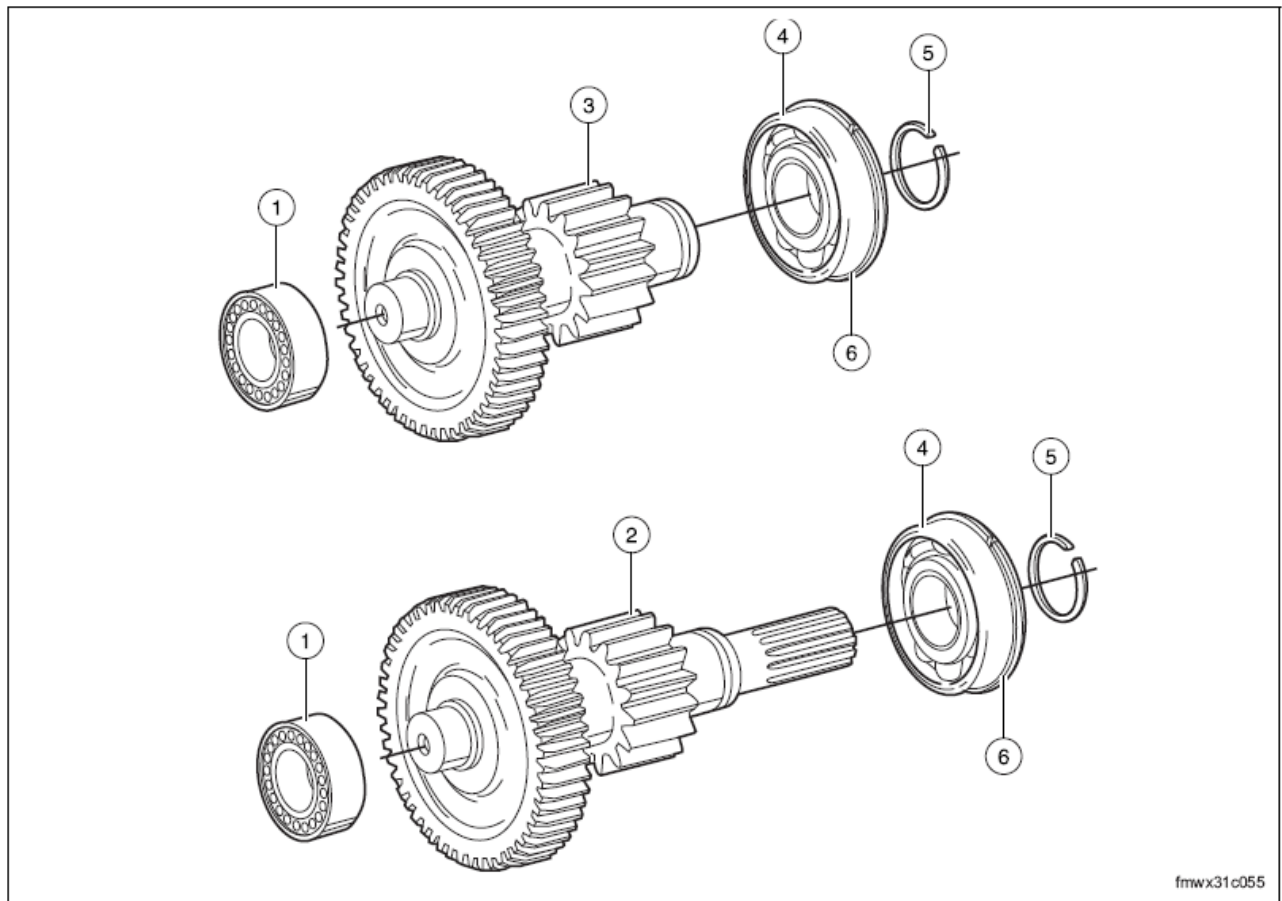
23	Bolt assembly
24	Main shaft rear bearing cover oil seal
25	Oil seal
26	Dustproof cover
27	Output flange disc



fmwx31c054

1	Range gear cylinder piston
2	O-shaped sealing ring
3	O-shaped sealing ring
4	Cylinder cover gasket
5	O-shaped sealing ring
6	Steel ball
7	Range gear cylinder
8	Screw
9	Range gear fork shaft

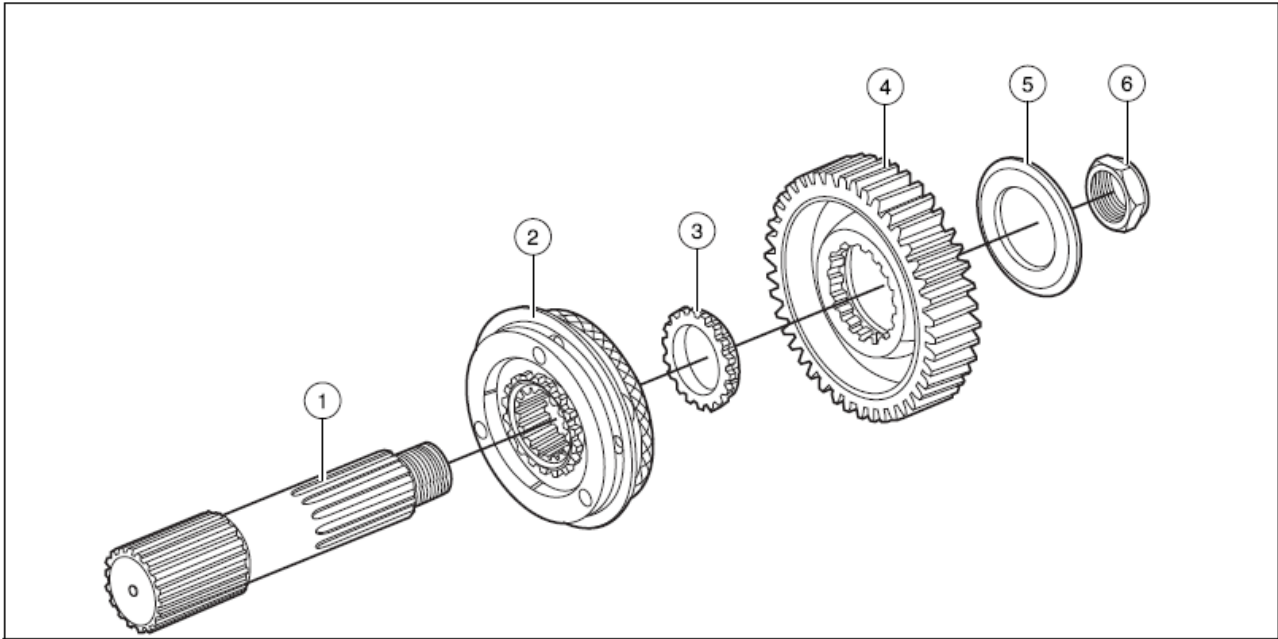
10	Splitter gear shifting cylinder cover
11	Hexagon nylon lock nut
12	Positioning spring
13	Hexagon bolt
14	Pressure copper washer switch
15	Copper washer
16	Splitter fork
17	Hexagon bolt with hole



31A

1	Short cylindrical roller bearing
2	Splitter extra-long countershaft welding assembly
3	Splitter countershaft welding assembly

4	Short cylindrical roller bearing2
5	Retaining ring
6	Retaining ring



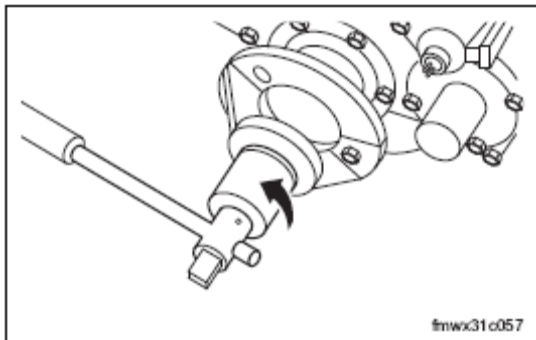
31A

1	Splitter main shaft
2	High and low gear synchronizer assembly
3	Splitter main shaft lining

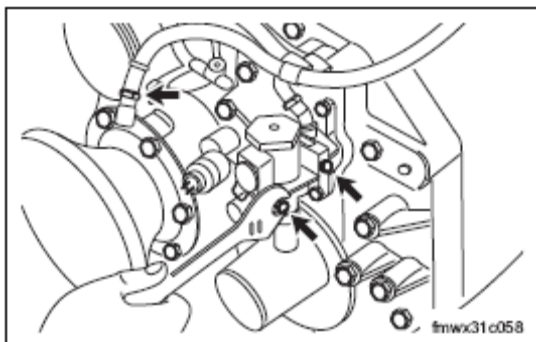
4	Splitter main shaft reducer gear
5	Splitter main shaft gear pressure plate
6	Flange nut

DISASSEMBLY AND ASSEMBLY

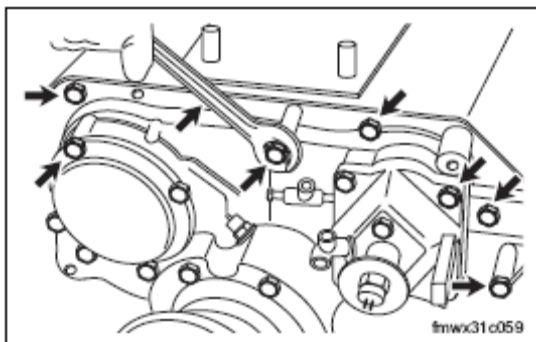
1. Disassembly of splitter assembly



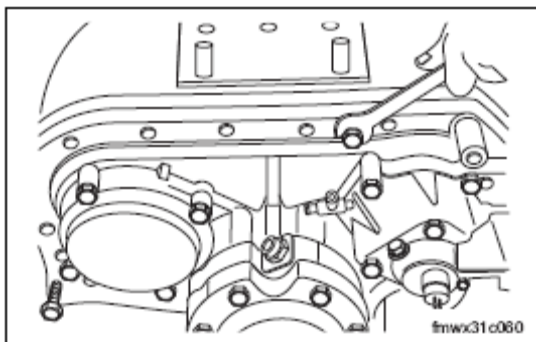
- (a) Engage both synchronizers in the basic transmission with gears respectively.
- (b) Use the dedicated spanner to remove the flange disc flange nut.



- (c) Remove these three air pipes on the splitter cylinder and these two bolts on the air filter.



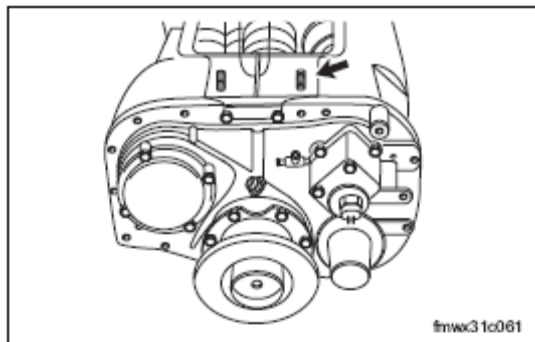
- (d) Remove the connecting bolt between the rear cover housing and basic transmission.



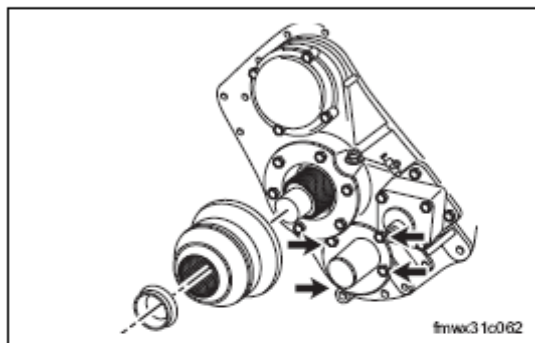
- (e) Use these three bolts to move back the splitter assembly by about 10mm.

Notice:

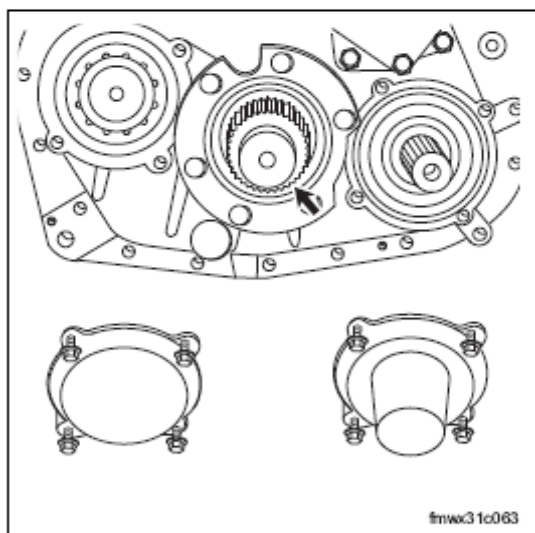
These three bolts must be screwed in evenly.



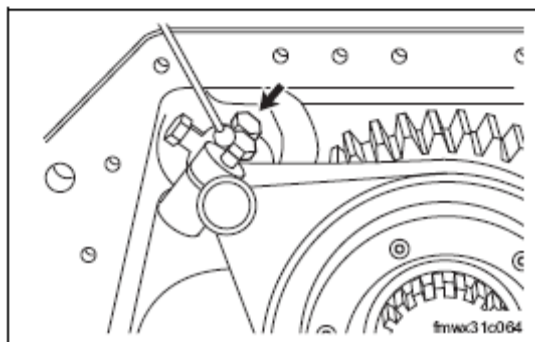
- (f) Use the hoist to lower the splitter assembly.



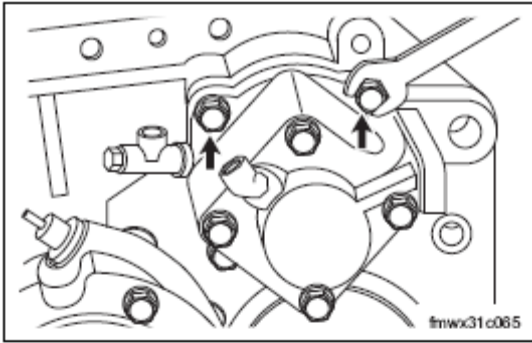
- (g) Remove the flange disc.



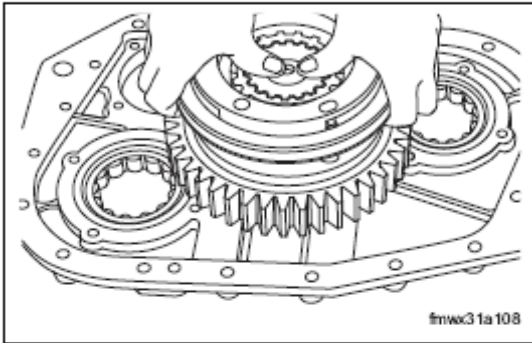
- (h) Remove these two output bearing covers, and use the snap ring pliers to remove the snap ring in the splitter countershaft.
- (i) Knock the output shaft in the rearward direction to separate it from the bearing, and take out the countershaft bearing.



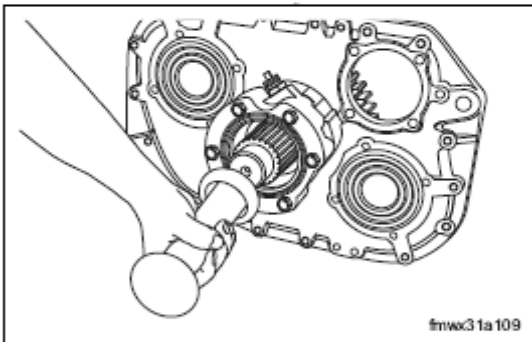
- (j) Remove the connecting bolt between the splitter gear shifting cylinder and splitter gearshift fork.



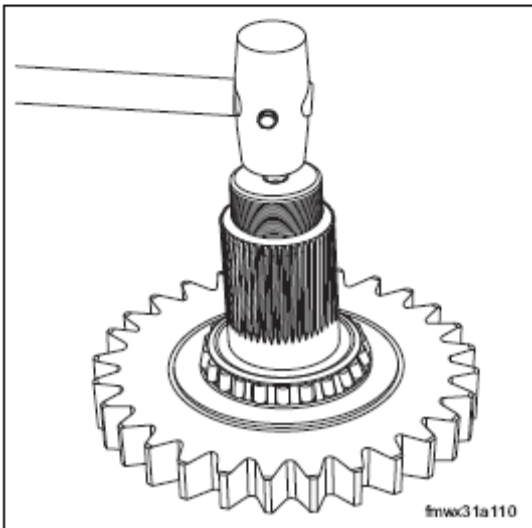
- (k) Remove these four bolts of splitter gear shifting cylinder, and take out the cylinder assembly.



- (l) Remove the synchronizer assembly from the output shaft.



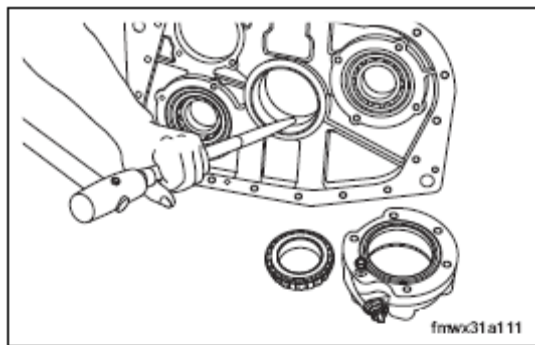
- (m) Remove the output shaft and separate it from the splitter.



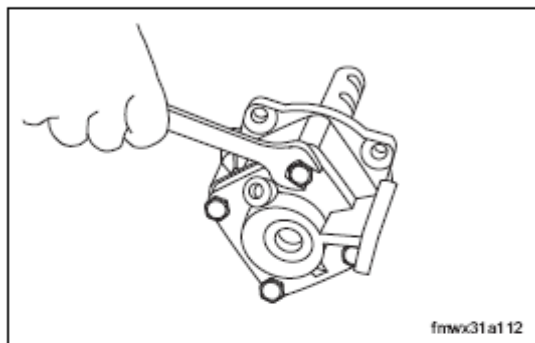
- (n) Remove the output shaft and separate it from the bearing.

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TRANSMISSION (12JS180TA)-SPLITTER

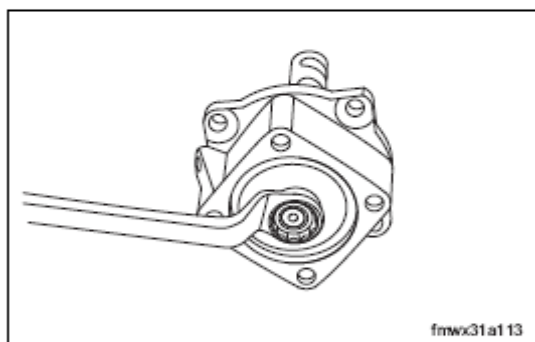


- (o) Remove the output bearing cover, and use the soft rod to remove the bearing outer ring in the rear cover housing hole by knocking.

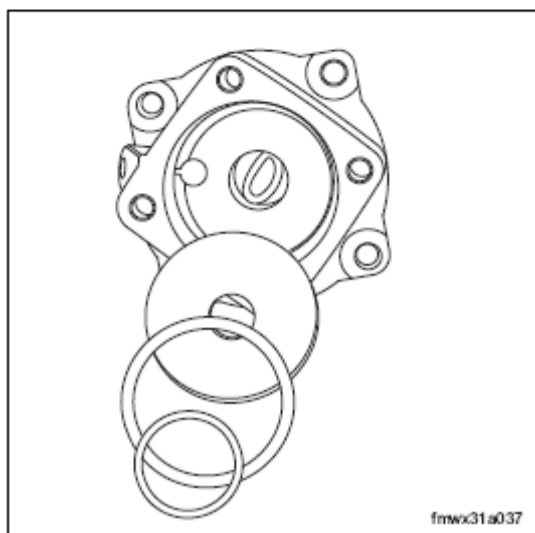


Disassembly of splitter gear shifting cylinder

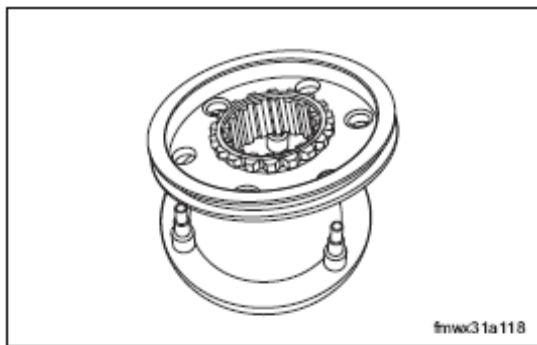
- (a) Remove these four bolts on the cylinder cover, and take out the cylinder head.



- (b) Remove the self-lock nut on the piston.

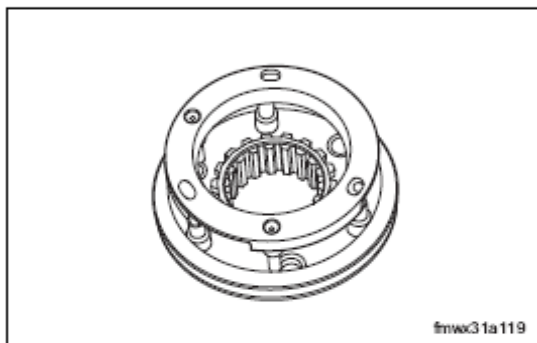


- (c) Remove the gear shifting cylinder piston and these three O-shaped sealing rings.

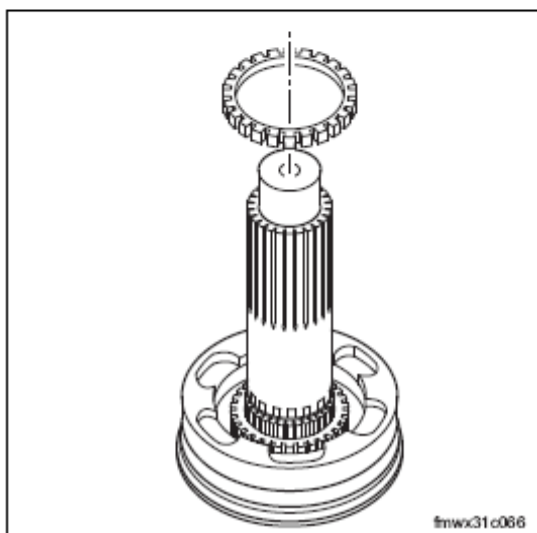


2. Assembly of splitter

- (a) Clean the splitter synchronizer and its components.
- (b) Place the splitter synchronizer low-gear ring into the synchronizer sliding sleeve.



- (c) Put these three springs into the high-gear ring hole, and apply a rotating force to coordinate them with remaining parts of the synchronizer.

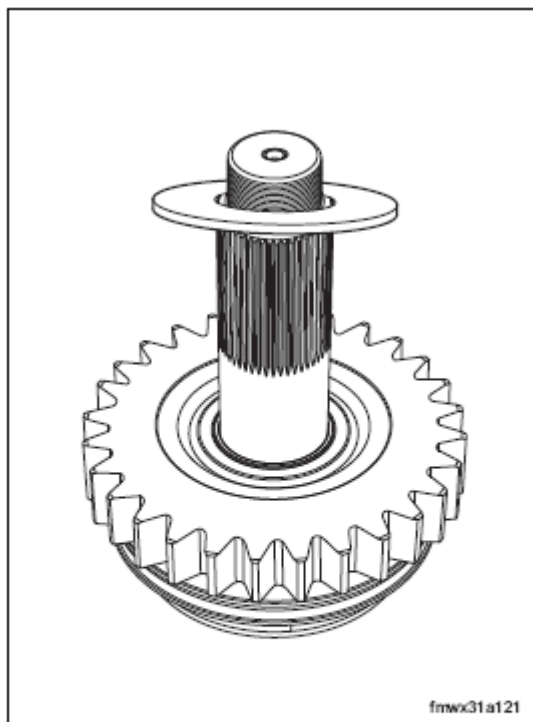


- (d) Place the synchronizer low-gear ring on a 50mm-high wooden block, and insert the output shaft.
- (e) Fit the splitter main shaft washer with the spigot side facing downward.



31A-60

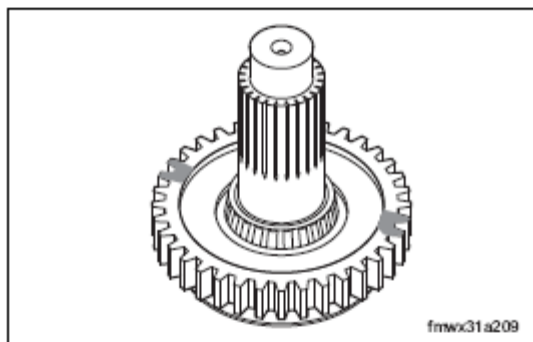
TRANSMISSION (12JS180TA)-SPLITTER



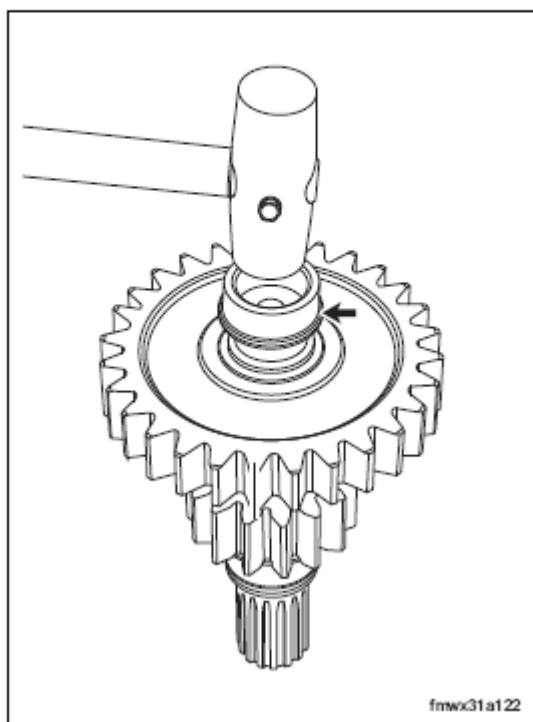
- (f) Put the splitter reducer gear onto the output shaft, and then fit the splitter main shaft gear pressure plate.

Notice:

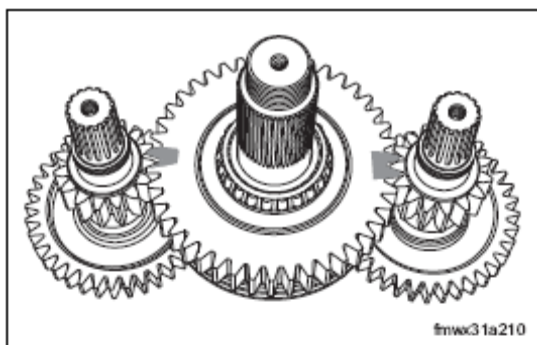
The pressure plate shall be initially lubricated.



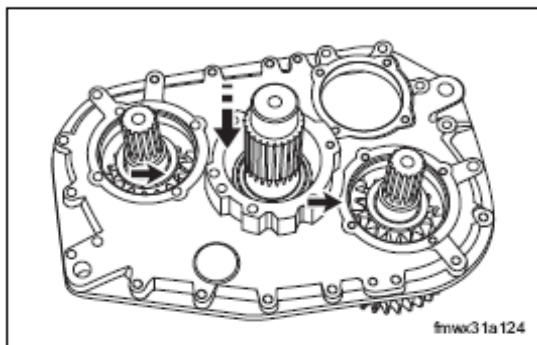
- (g) Fit the bearing side into the output shaft, and mark the splitter reducer gear in the 180° direction for tooth alignment.



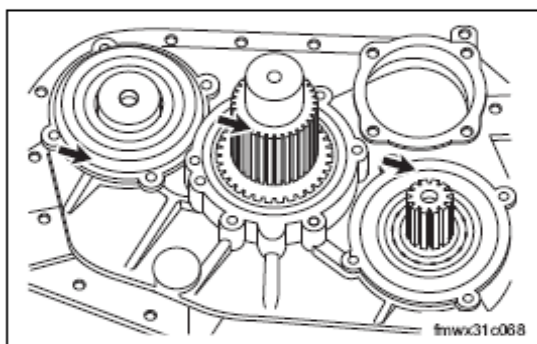
- (h) If the splitter countershaft bearing inner ring is removed, refit it.



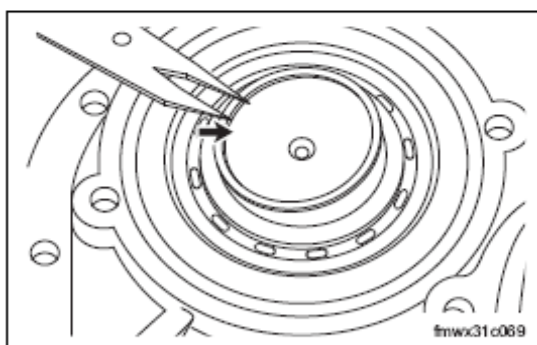
- (i) Insert both marked teeth of the countershaft into both marked grooves of the reducer gear.



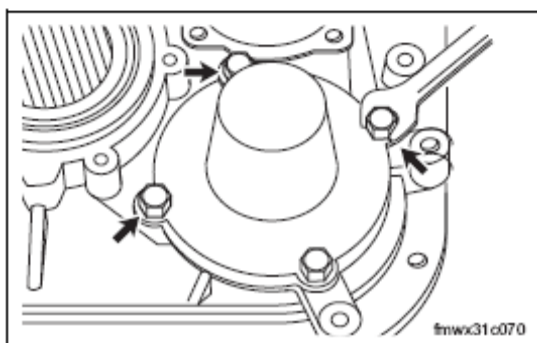
- (j) Fit the rear cover housing.



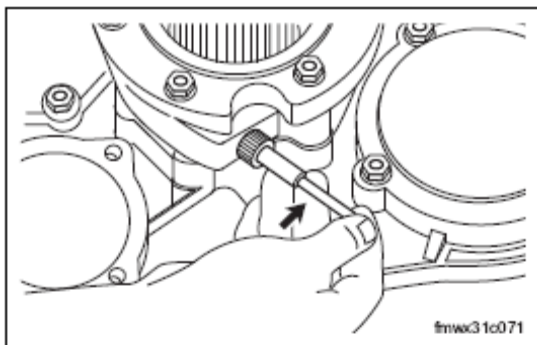
- (k) Fit the assembled bearing and roller bearings on both extra-long countershafts.



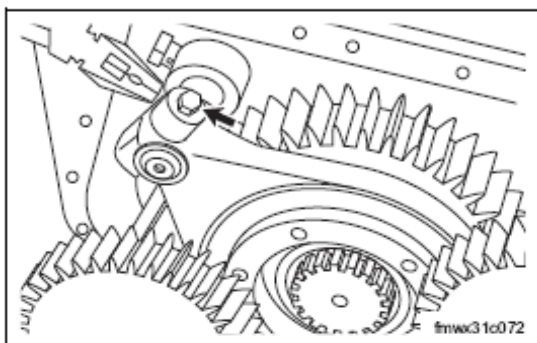
- (l) Fit snap ring onto both extra-long countershafts.



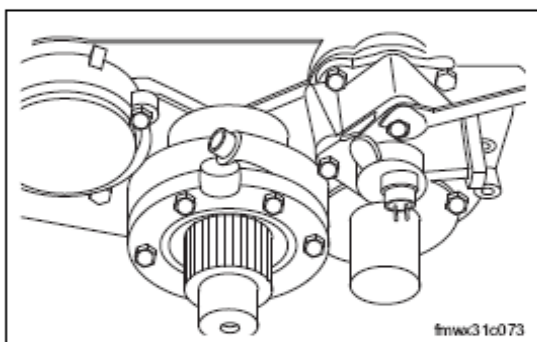
- (m) Fit these two countershaft covers.
Torque: 54±7N.m



- (n) Fit the output bearing cover and the odometer drive and driven gears and unions.

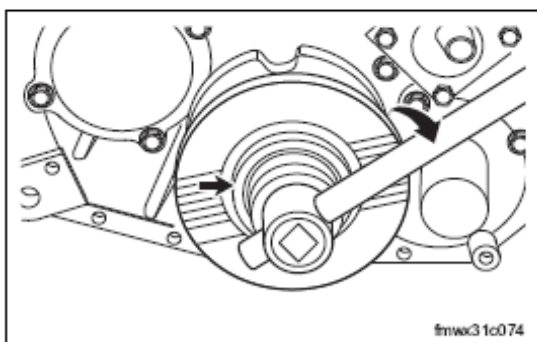


- (o) Insert the splitter gearshift fork into the synchronizer sliding sleeve in the horizontal and outward direction. Fit the fork and gear shifting cylinder connecting bolt and fasten it with iron wire.



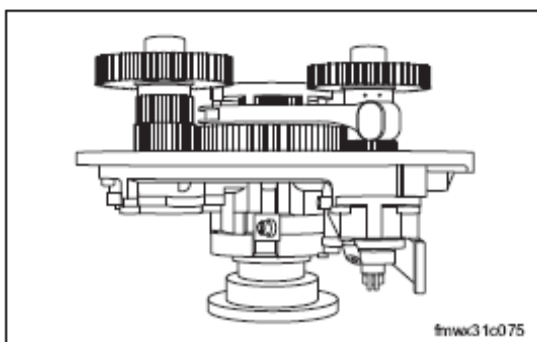
- (p) Fit the splitter gear shifting cylinder and fasten these 4 bolts.

Torque: 54±7N.m

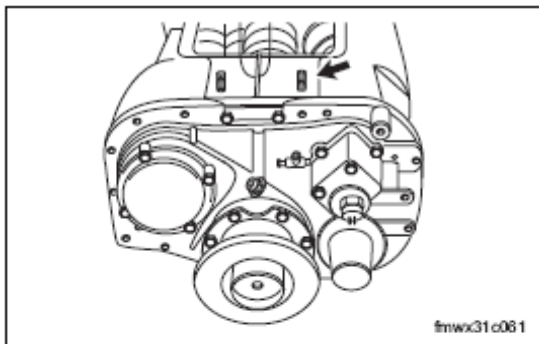


- (q) Use the dedicated sleeve to fasten the flange nut.

Torque: 643±34N.m



- (r) Locate the splitter synchronizer in the low-speed range.

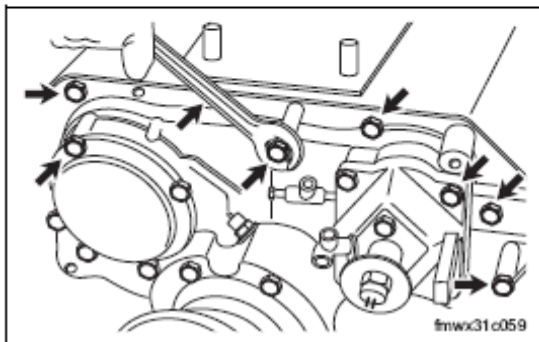


- (s) Apply grease into both bearing holes of the basic transmission.

Hint:

This step is very critical in the installation of splitter.

- (t) Use the dedicated tool to hoist the splitter assembly, and move the splitter forward and rotate the flange disc by hand.



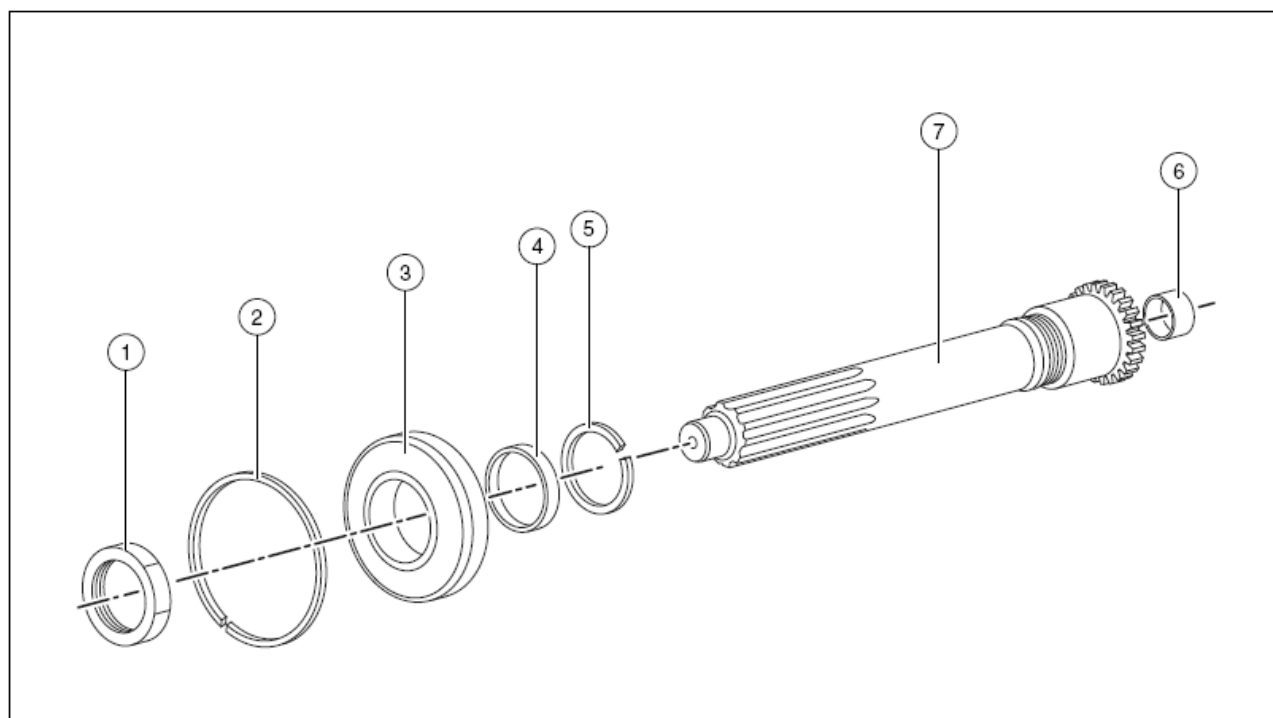
- (u) Install the splitter assembly in place, and tighten the rear cover bolt.

Torque: 54 ± 7 N.m



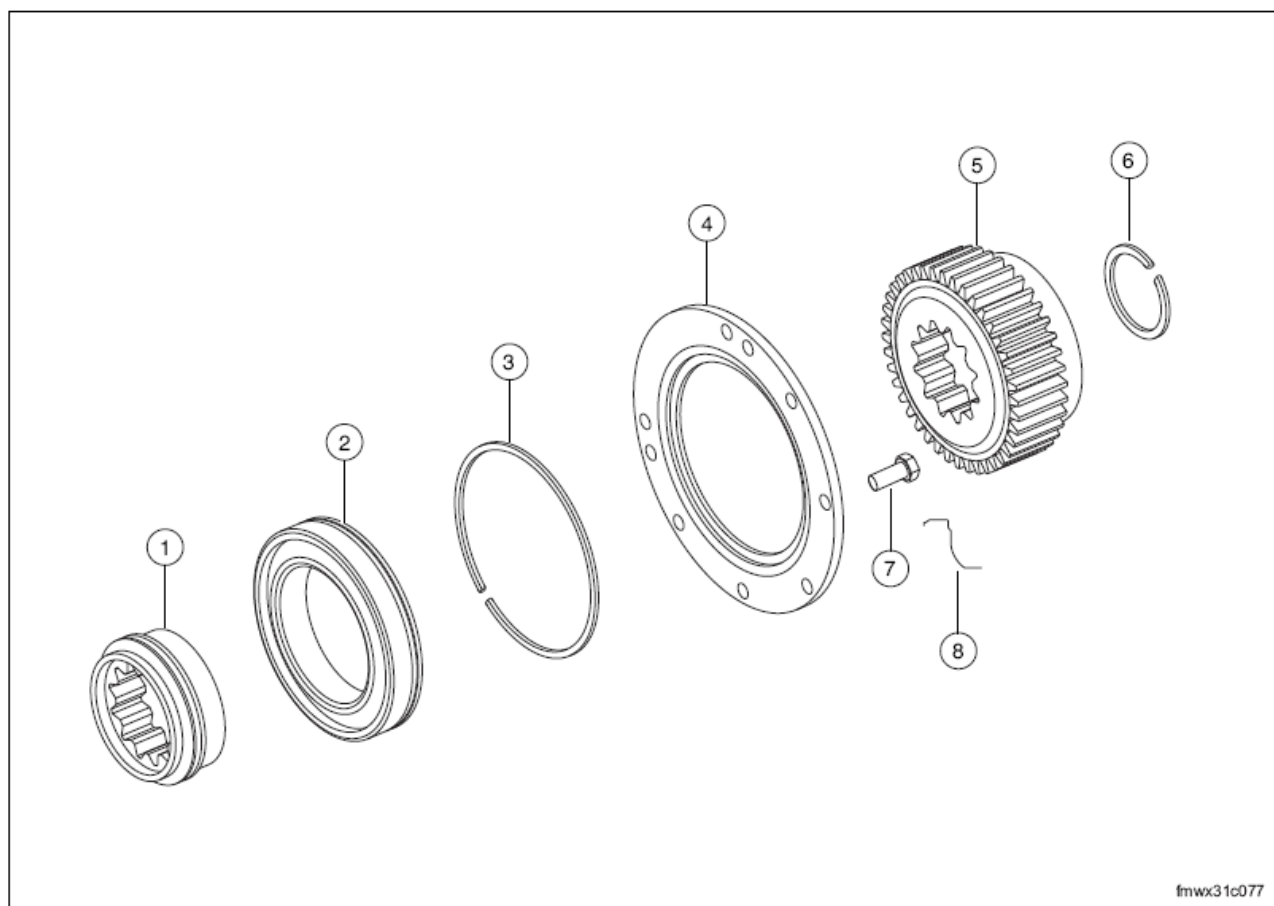
BASIC TRANSMISSION

DIAGRAM OF COMPONENTS



1	First shaft nut
2	Retaining ring
3	Single-row centripetal bearing
4	Gear spacer

5	Retaining ring
6	Second shaft guide sleeve
7	First shaft

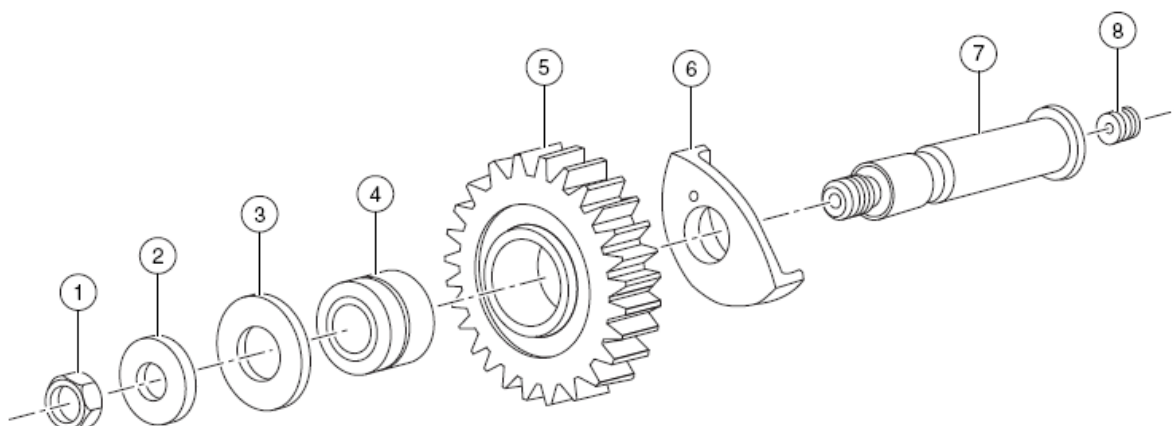


31A

1	Bearing support
2	Single-row centripetal bearing with retaining groove
3	Retaining ring
4	Splitter bearing positioning disc

5	Splitter drive gear
6	Retaining ring
7	Hexagon bolt with a hole in the head
8	Iron wire

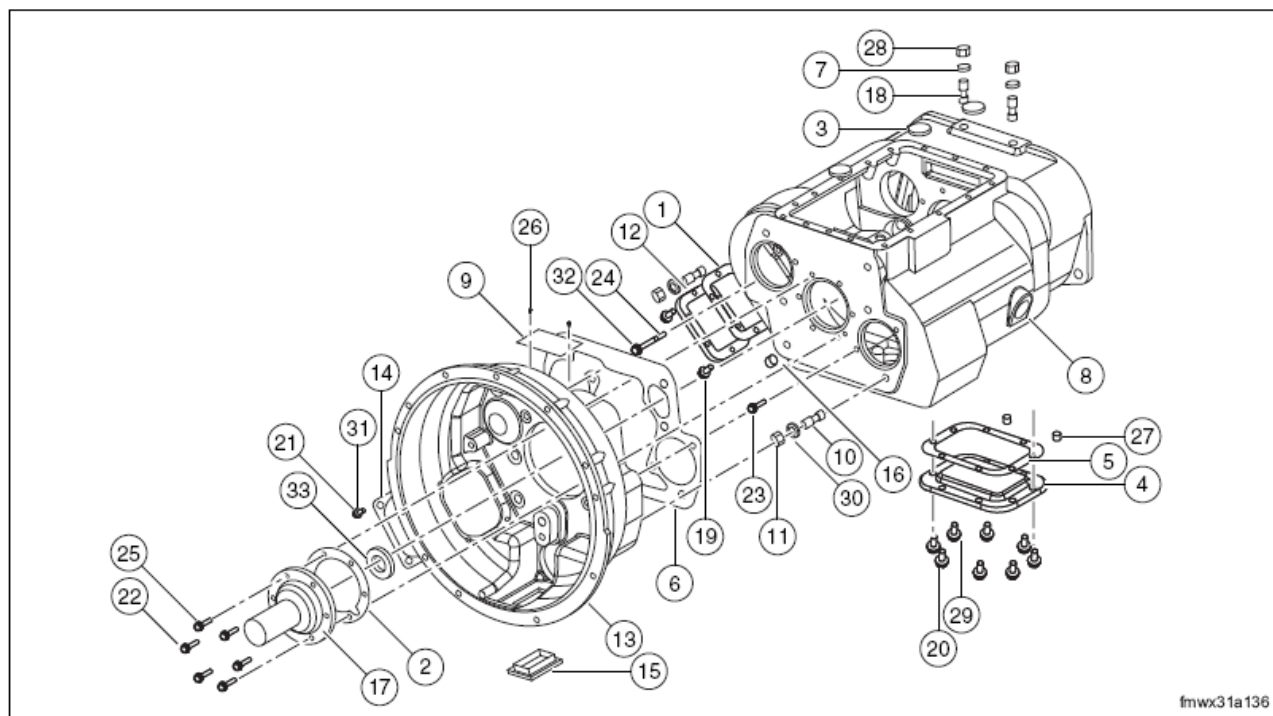




fmwx31a135

1	Hexagon nylon ring lock nut (M16x1.5)
2	Reverse gear countershaft washer
3	Reverse gear thrust washer
4	Needle bearing

5	Reverse gear intermediate gear
6	Cup-shaped reverse gear washer
7	Reverse gear countershaft
8	Flat-end lock bolt (M12x12)



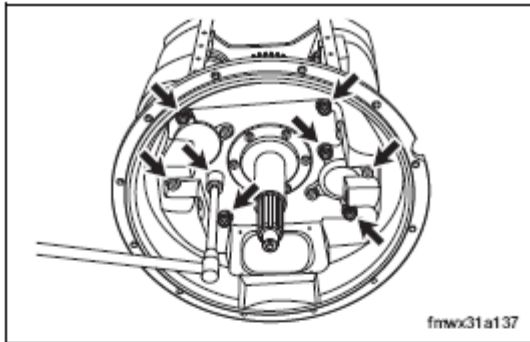
31A

1	Lateral power takeoff window lining
2	First shaft bearing lining
3	Round magnet
4	Bottom power takeoff window cover
5	Bottom power takeoff window lining
6	Clutch housing lining
7	Spring washer
8	Transmission housing
9	Nameplate
10	Stud
11	Hexagon nylon ring lock nut
12	Lateral power takeoff window cover
13	Clutch housing
14	Hand hole cover
15	Hand hole cover
16	Slotted taper nut
17	First shaft bearing cover

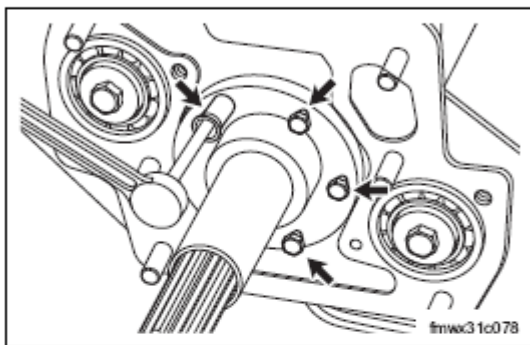
18	Stud
19	Hexagon bolt & spring washer assembly
20	Hexagon bolt
21	Hexagon bolt
22	Hexagon bolt
23	Hexagon bolt
24	Hexagon bolt
25	Hexagon bolt with a hole in the head
26	Cross-recessed pan head self-tapping screw
27	Slotted flat-end lock screw
28	Type 1 hexagon nut
29	Plain washer
30	Plain washer
31	Spring washer
32	Spring washer
33	Framework oil seal

DISASSEMBLY AND ASSEMBLY

1. Remove the upper cover assembly. Refer to Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transmission Upper Cover.



2. Remove the clutch housing assembly.
 - (a) Undo the connecting bolt, and remove the clutch housing.

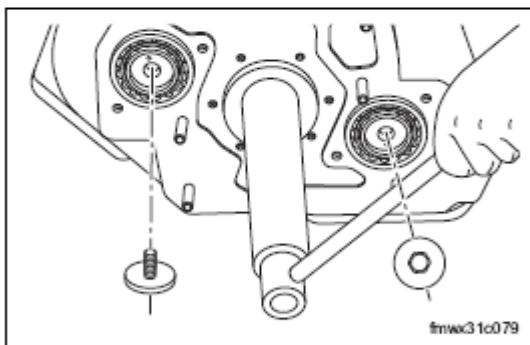


3. Remove the first shaft assembly.

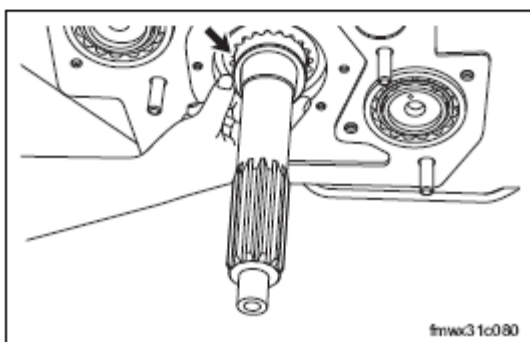
Hint:

This method is also available for the replacement of first shaft without removing the basic transmission.

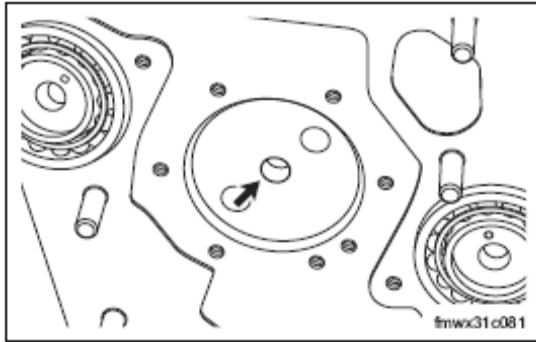
- (a) Remove the bolt of first shaft cover, and take out the first shaft cover by knocking it lightly.
- (b) Engage basic transmission synchronizers with both groups of gears respectively.



- (c) Remove the bearing pressure plates at front ends of both basic transmission countershafts, and use the dedicated tool to remove the first shaft nut.



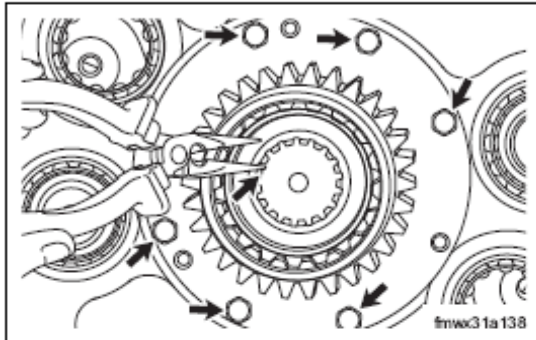
- (d) Knock the first shaft with a copper rod.
- (e) Knock the first shaft on both left and right sides to separate the bearing from the housing hole.
- (f) Take out the first shaft gear spacer.
- (g) Remove the snap ring in the first shaft gear.



- (h) Use the pressure plate and one bolt (M10x1) to hold the first shaft gear.

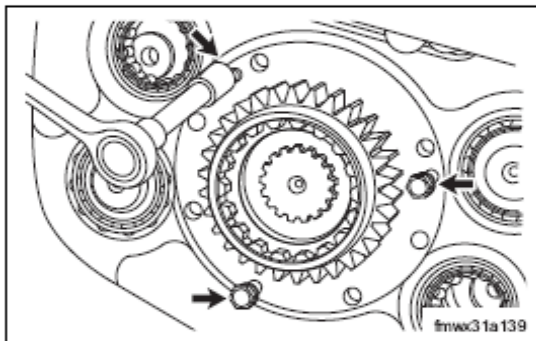
Hint:

To avoid damaging the 5th/6th gear synchronizer in the Removal and installation operation, use the pressure plate and bolt to attach the first shaft gear onto the second shaft assembly when removing the main shaft assembly.

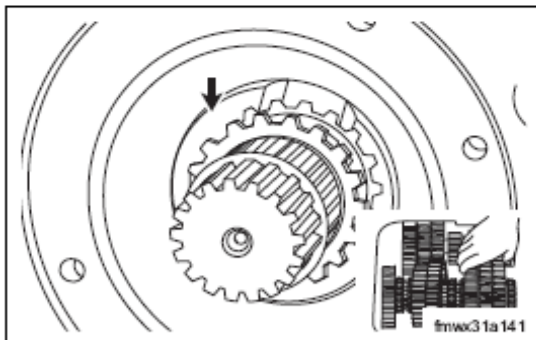


4. Remove the drive gear assembly.

- (a) Cut off the lock wire of drive gear assembly, and remove these six bolts with holes.
(b) Remove the retaining ring.

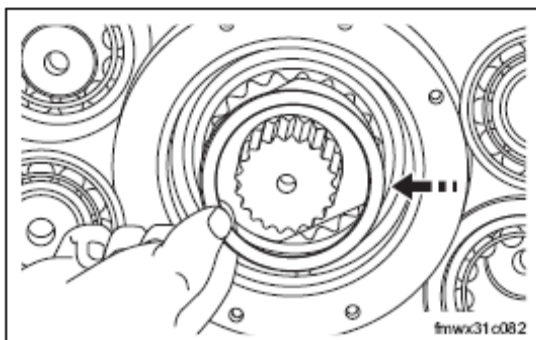


- (c) Use three bolts to squeeze out the drive gear assembly.



5. Remove the reverse gear assembly.

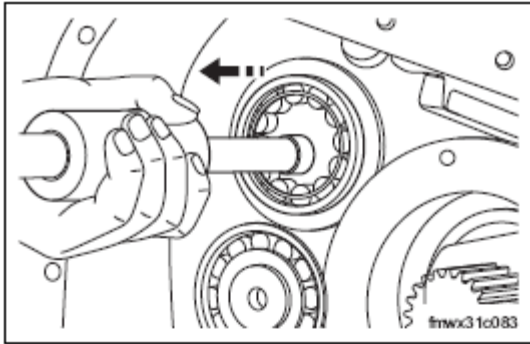
- (a) Remove the snap ring in the second shaft reverse gear.



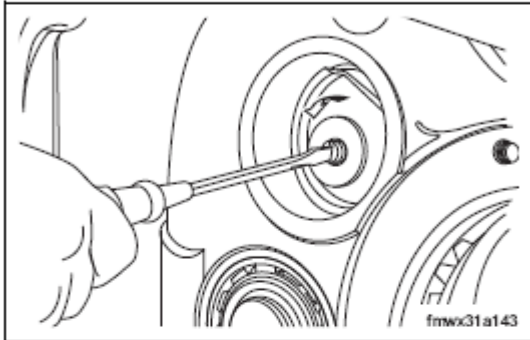
- (b) Take out the main shaft gear washer in the second shaft reverse gear.

31A-70

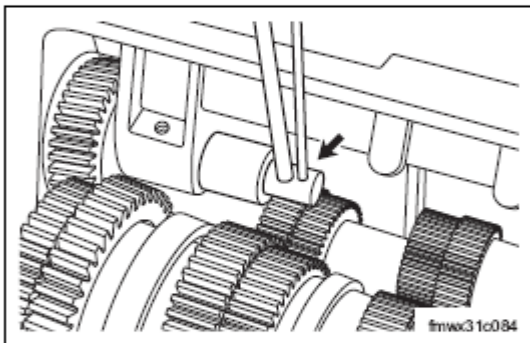
TRANSMISSION (12JS180TA)-BASIC TRANSMISSION



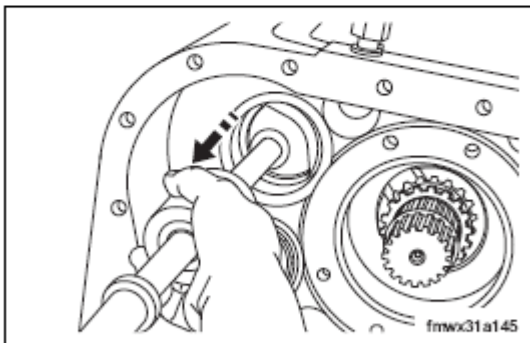
- (c) Use the dedicated tool to remove the bearing at the rear end of reverse gear intermediate wheel shaft.



- (d) Remove the screw in the reverse gear shaft intermediate wheel shaft.



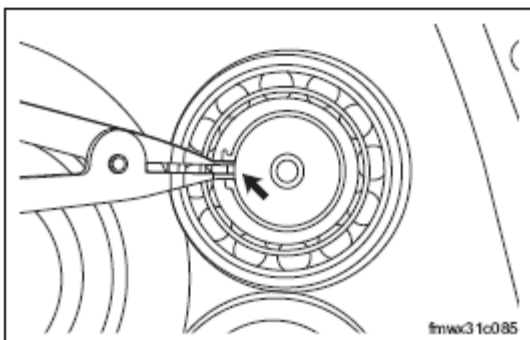
- (e) Remove the self-lock nut in the reverse gear shaft intermediate wheel shaft.



- (f) Use the dedicated bearing puller to remove the reverse gear shaft intermediate wheel shaft.

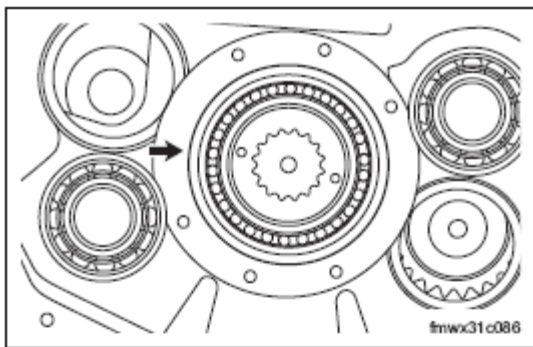
Notice:

Prevent the reverse gear idler from falling to cause damages.

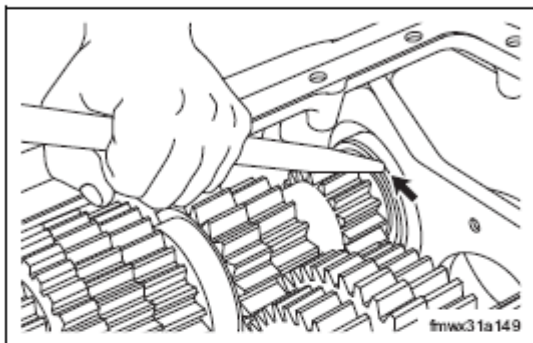


6. Remove the basic transmission assembly.

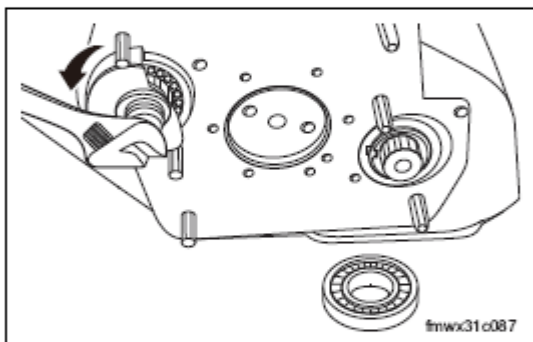
- (a) Remove the snap ring at the rear end of basic transmission countershaft.



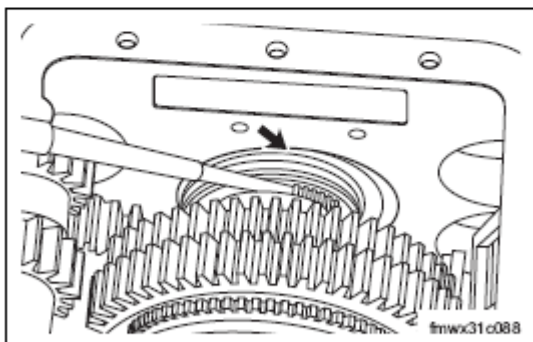
- (b) Fit the drive gear bearing to localize the second shaft rear end.



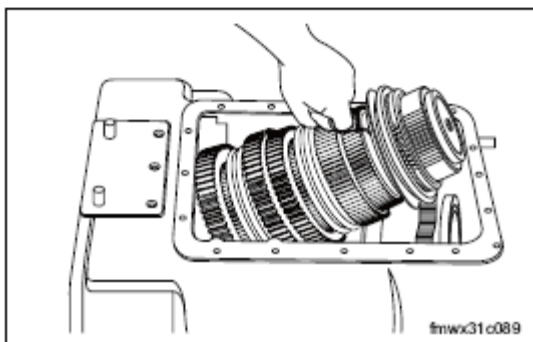
- (c) Use a soft rod to remove the countershaft rear bearing.



- (d) Knock the countershaft with a copper rod and have it move back by about 100mm. Use dedicated tools to remove both countershaft front bearings.

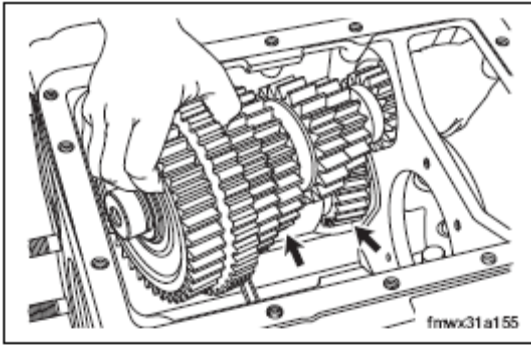


- (e) Refit the drive gear bearing which has been removed.

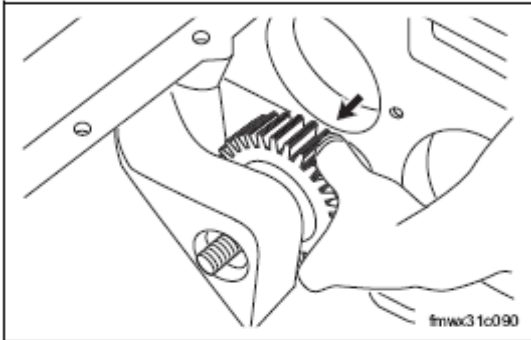


- (f) Take out the second shaft assembly from the basic transmission.



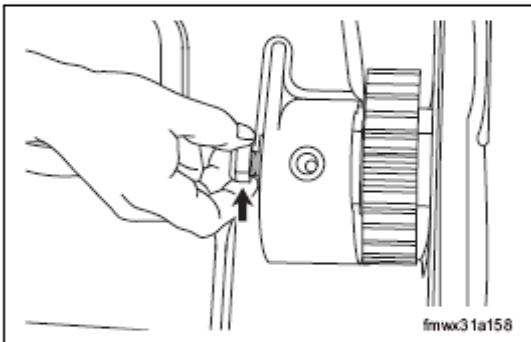


- (g) Remove the countershaft assembly and reverse gear idler from the basic transmission housing.



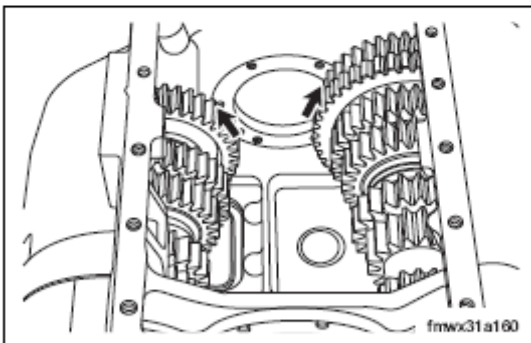
7. Reassemble the basic transmission.

- (a) Fit the reverse gear intermediate wheel into the housing with the convex side facing forward.
(b) Fit the reverse gear intermediate wheel shaft.

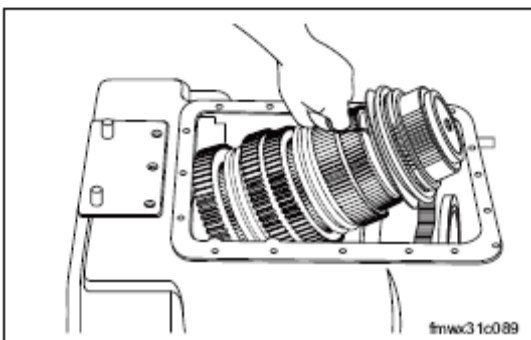


- (c) Tighten the self-lock nut on the front end of right reverse gear intermediate wheel shaft.

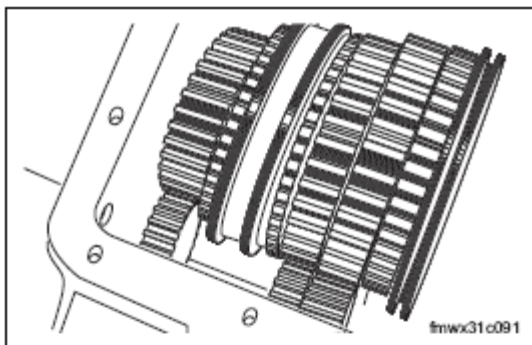
Torque: 78±10N.m



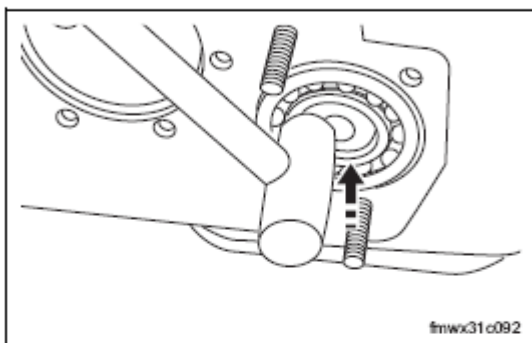
- (d) Provide tooth alignment marks on the teeth opposite to both countershaft key grooves.
(e) Fit both countershaft assemblies into the basic transmission housing.



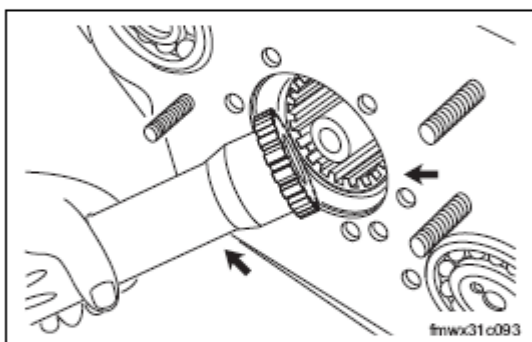
- (f) Respectively select a group of teeth, spaced by 180°, from the first shaft gear to be marked for tooth alignment. Fit the second shaft assembly into the basic transmission and then the drive gear bearing to position the rear end of second shaft.



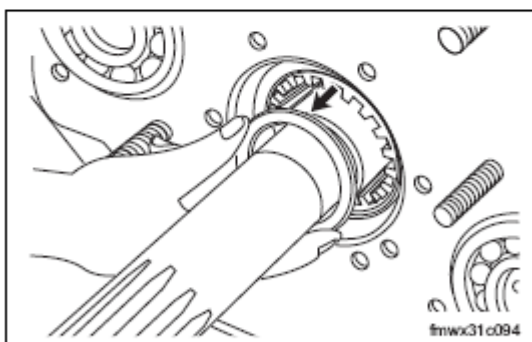
- (g) Insert the marked teeth on the countershaft into the marked groove on the first shaft gear, and fit the countershaft rear bearing.



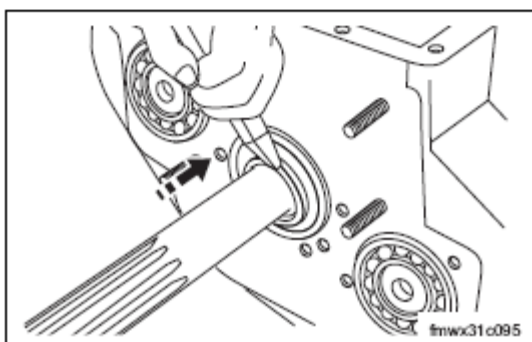
- (h) Fit the countershaft front bearings on both sides.



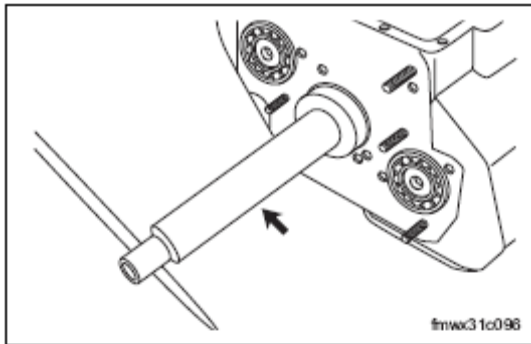
- (i) Remove the pressure plate in front of the first shaft gear, apply the first shaft hole with grease, and fit the first shaft into the spline in the first shaft gear.



- (j) Fit the snap ring of first shaft gear.
(k) Fit the first shaft gear spacer.



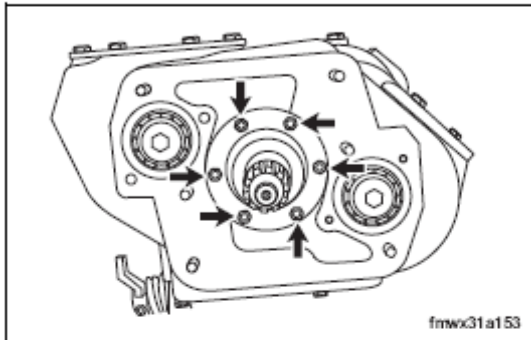
- (l) Fit the first shaft bearing.



- (m) Apply the sealant onto the first shaft nut, and use the dedicated tool to fit the first shaft nut.

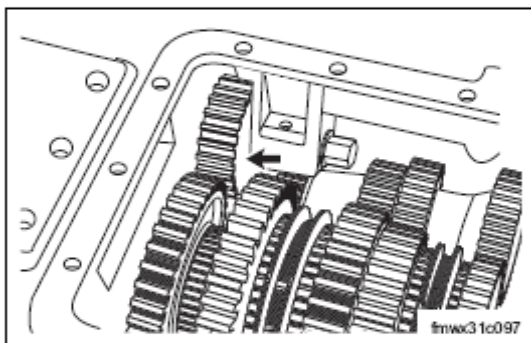
Torque: $372 \pm 34 \text{ N.m}$

- (n) Rivet the thread belt groove of first shaft nut at the first shaft.

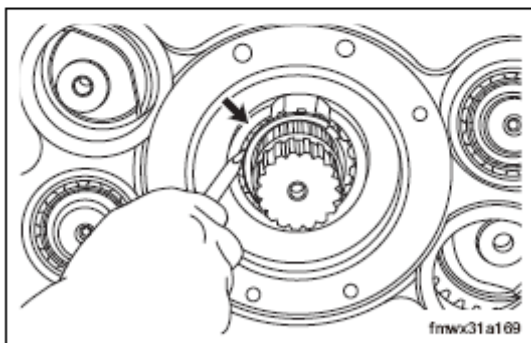


- (o) Fit both countershaft front baffles, and then the first shaft cover.

Torque: $54 \pm 7 \text{ N.m}$

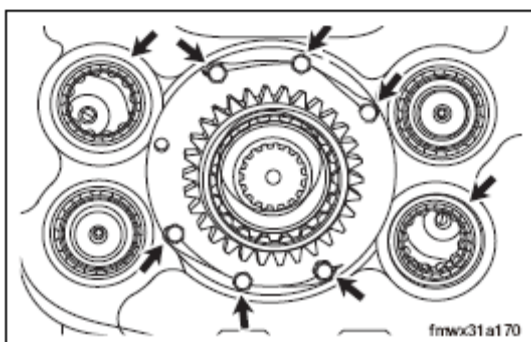


- (p) Fit the reverse gear intermediate wheel assembly, remove the drive gear bearing, and pull the second shaft reverse gear backward to be engaged with the reverse gear intermediate wheel.



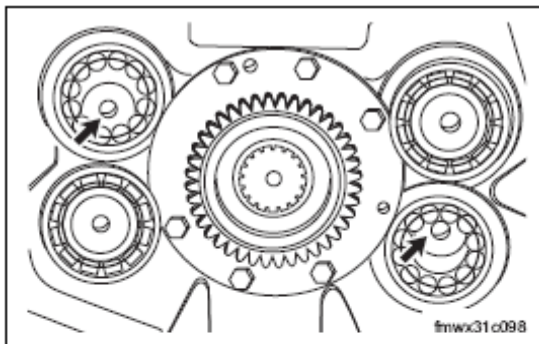
- (q) Fit the main shaft gear washer in the second shaft reverse gear.

- (r) Fit the snap ring in the second shaft reverse gear.

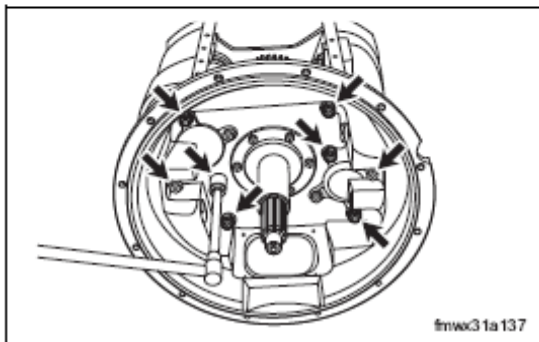


- (s) Fit the drive gear bearing and drive gear positioning disc, and use the bolt to fasten the locking wire,

Torque: $54 \pm 7 \text{ N.m}$



- (t) Fit the splitter drive gear and the snap ring at the rear end.
- (u) Fit both extra-long countershaft front bearings and then snap ring at the rear end of both countershafts of the basic transmission.

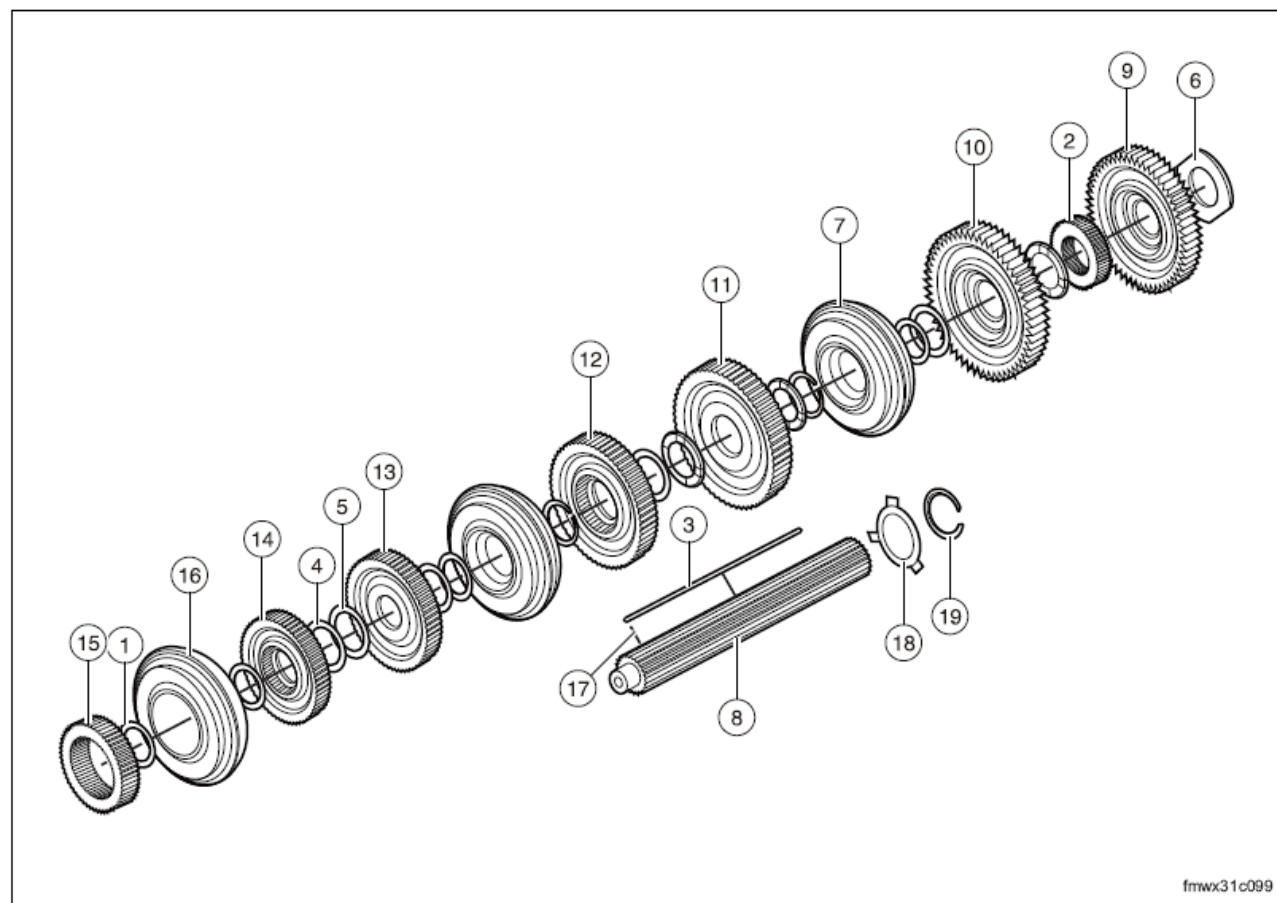


- (v) Fit the clutch housing assembly.
Torque: 257.5±13.5N.m(M16)
Torque: 121.5±13.5N.m(M12)

8. Fit the transmission upper cover. Refer to Chapter 31A: Disassembly and assembly, Transmission 12JS180TA-Transmission Upper Cover.

SECOND SHAFT ASSEMBLY

DIAGRAM OF COMPONENTS



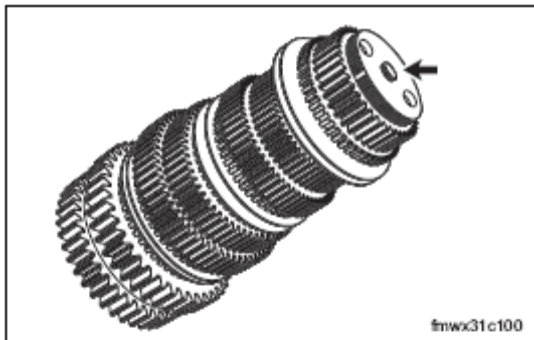
fmwx31c099

1	Retaining ring
2	Sliding sleeve
3	Second shaft hexagon key
4	Second shaft gear spline
5	Gear spacer
6	Reverse gear gasket
7	1/2 gear synchronizer
8	Second shaft
9	Second shaft reverse gear
10	First-speed gear

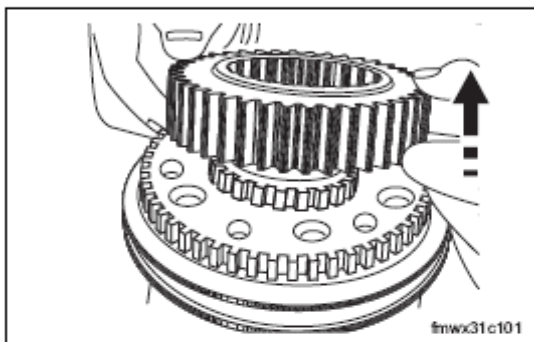
11	Second-speed gear
12	Third-speed gear
13	Fourth-speed gear
14	Fifth-speed gear
15	First shaft gear
16	3/4 gear synchronizer
17	Flexible cylindrical pin
18	Drive gear washer
19	Second shaft low-speed gear

DISASSEMBLY AND ASSEMBLY

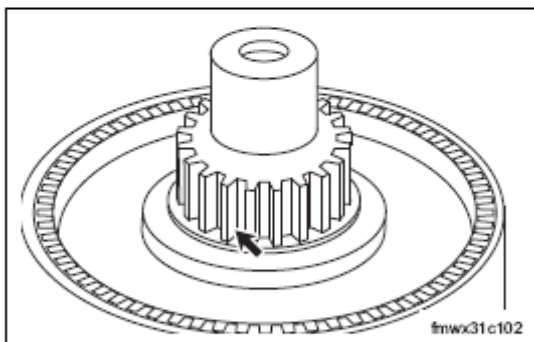
1. Disassemble the second shaft assembly.



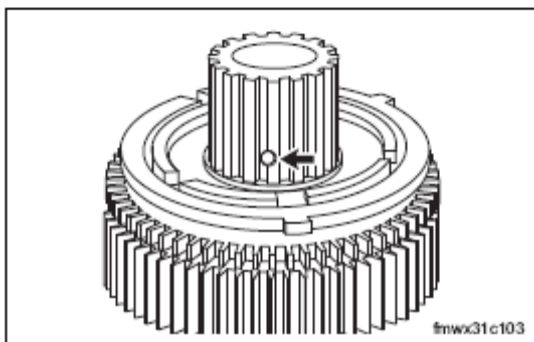
- (a) Remove the pressure plate on the second shaft.



- (b) Remove the first shaft gear and 5/6 gear synchronizer components.

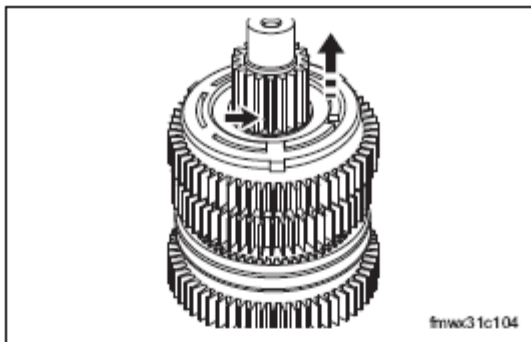


- (c) Remove the snap ring and 5/6 gear synchronizer gear hub.

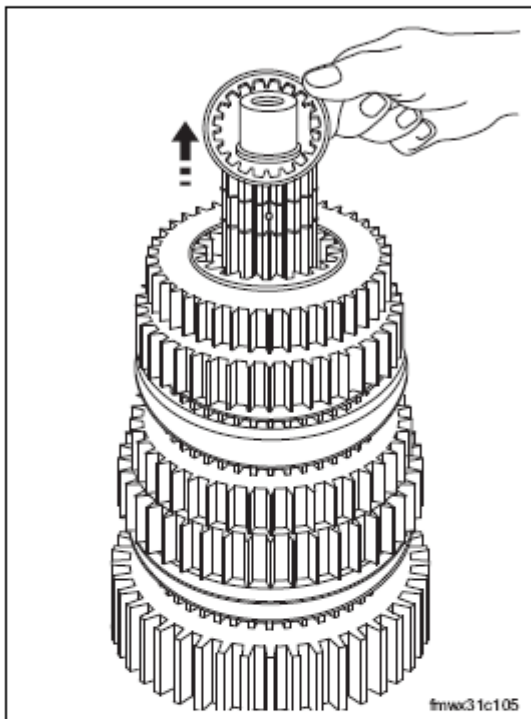


- (d) Remove the flexible pin on the second shaft and pull out the long key.

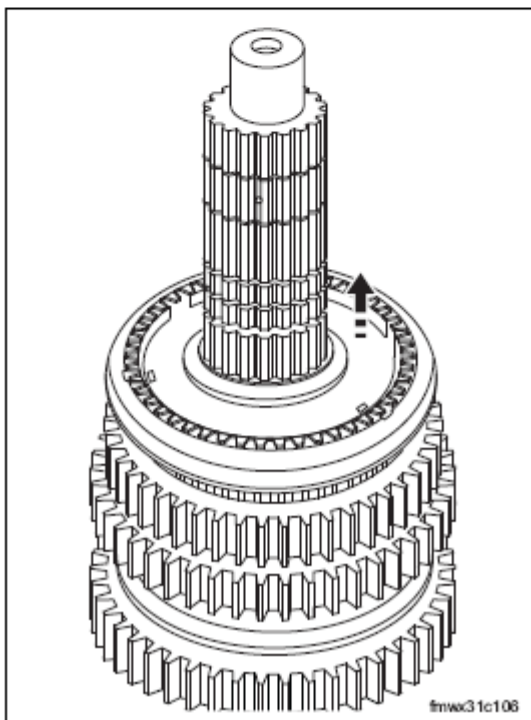
31A



- (e) Remove the snap ring and components on the other side of the 5/6 gear synchronizer.

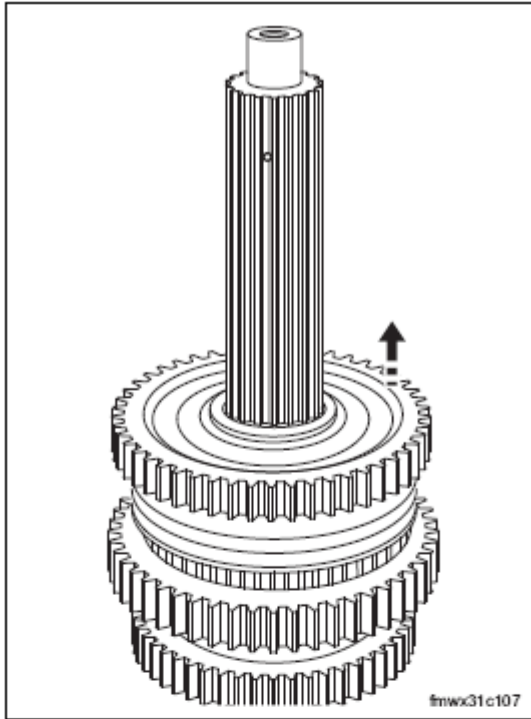


- (f) Remove the spline gasket and fifth-speed gear.
(g) Remove the gear spacer and fourth-speed gear engaging teeth.
(h) Remove the spline gasket and components on the other side of the 3/4 gear synchronizer.

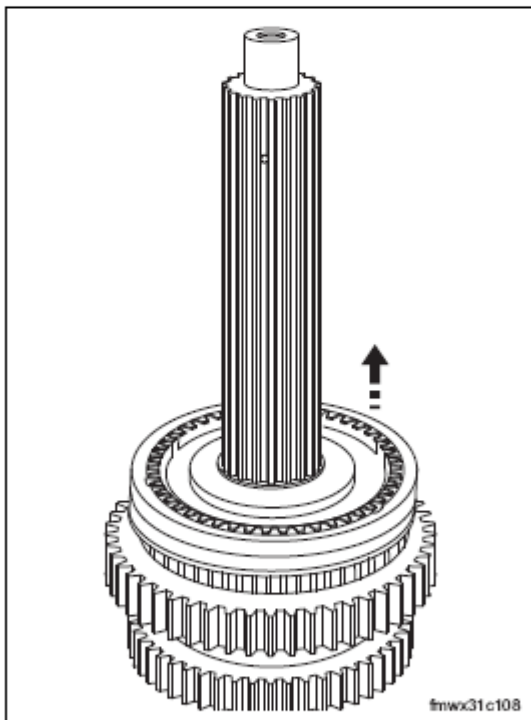


- (i) Remove the snap ring and then the 3/4 synchronizer gear hub.
(j) Remove the snap ring and then components on the other side of the 3/4 synchronizer.
(k) Remove the spline gasket and third-speed gear.

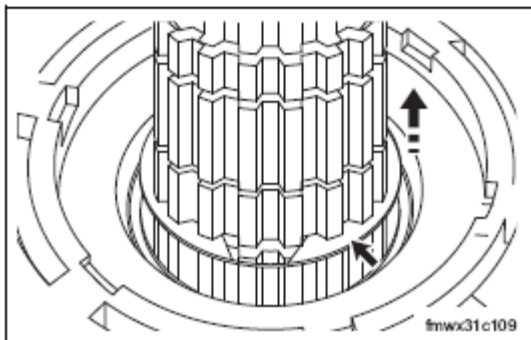




- (l) Remove the gear spacer, and then the second-speed gear.
- (m) Remove the gear spacer and then components on the other side of the 1/2 synchronizer.



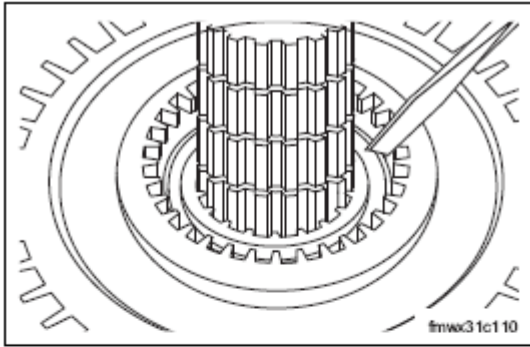
- (n) Remove the snap ring and then the 1/2 synchronizer gear hub.



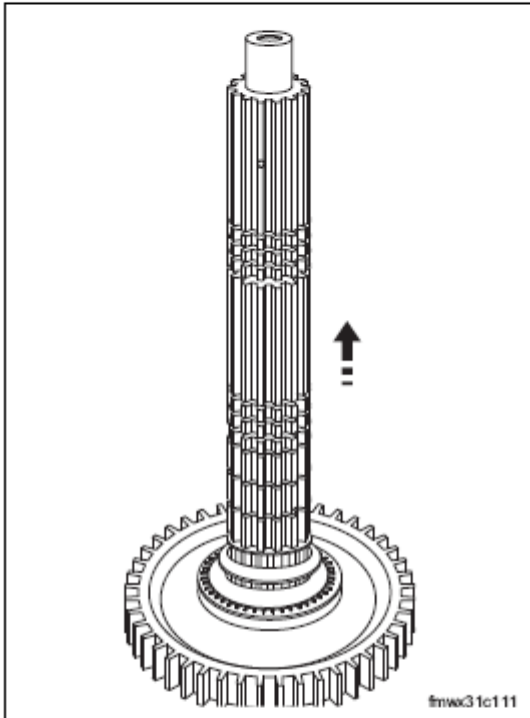
- (o) Remove the snap ring and then components on the other side of the 1/2 synchronizer.

31A-80

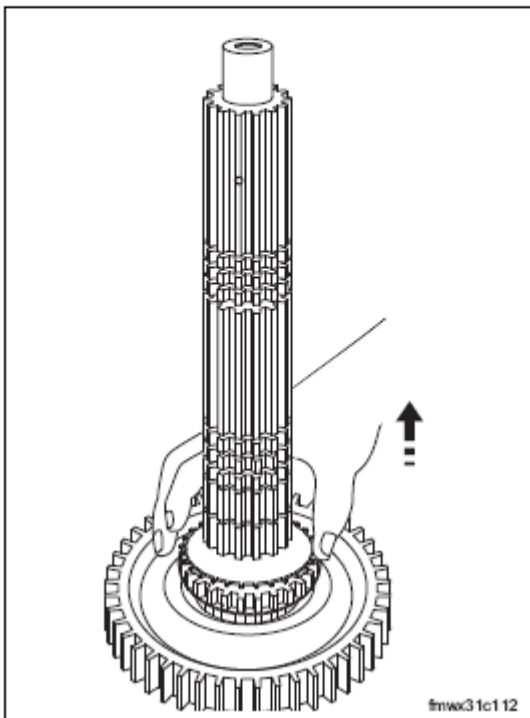
TRANSMISSION (12JS180TA)-SECOND SHAFT ASSEMBLY



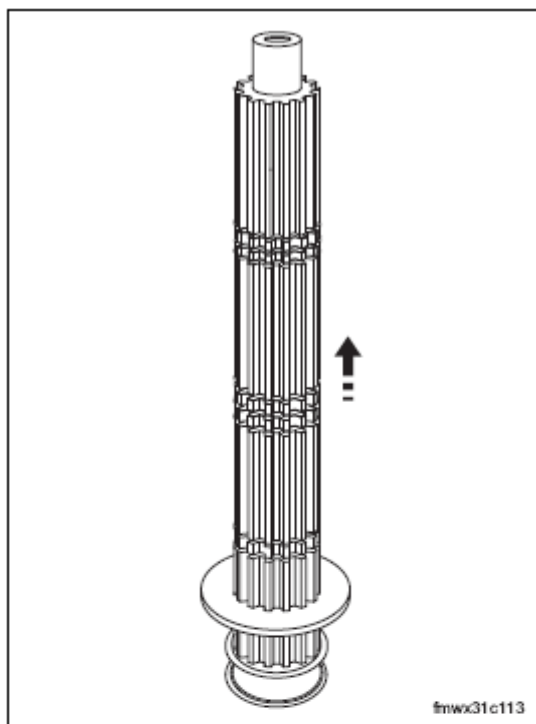
(p) Remove the spline gasket and first-speed gear.



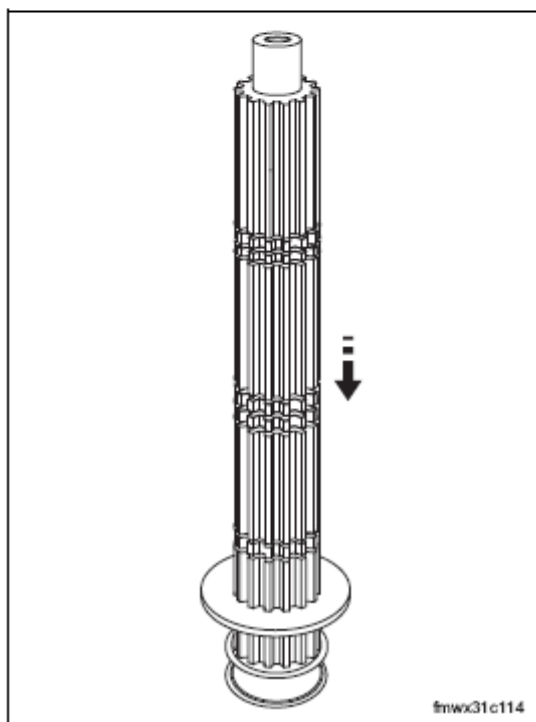
(q) Remove the spacer.



(r) Remove the sliding sleeve and reverse gear.



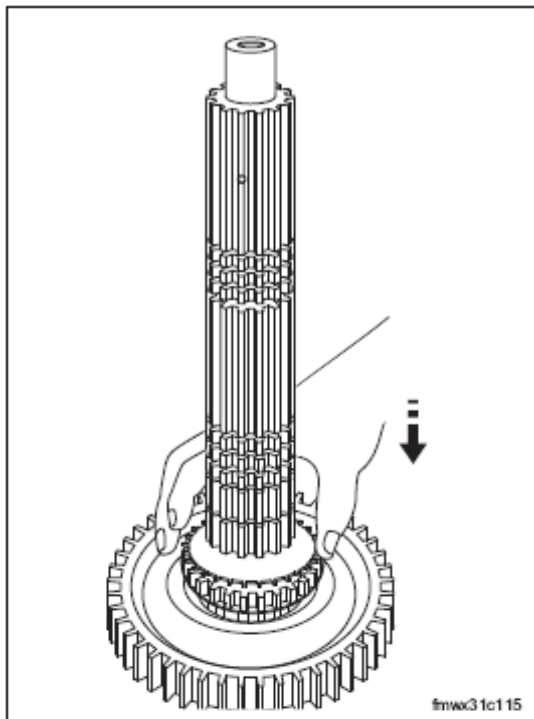
- (s) Remove the reverse gear gasket.



2. **Reassemble the second shaft.**
(a) Place the smaller end of the second shaft on the work bench vertically, fit the second shaft reverse gear gasket and then put on the long key after the gear has been turned by one tooth pitch.

31A

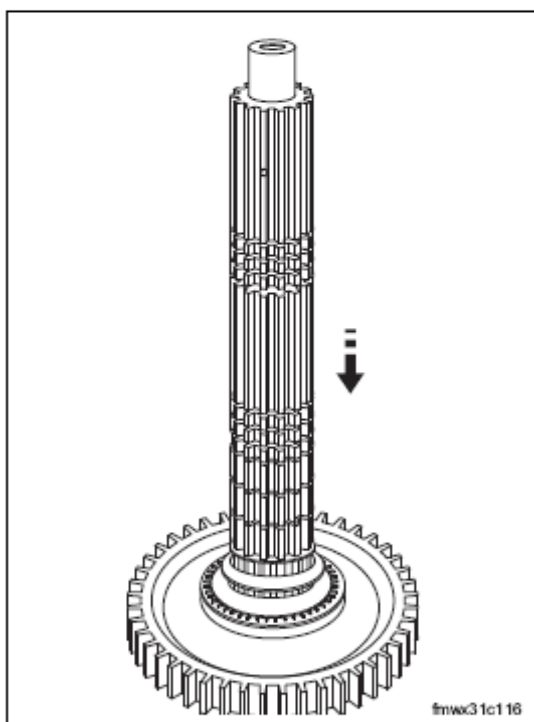




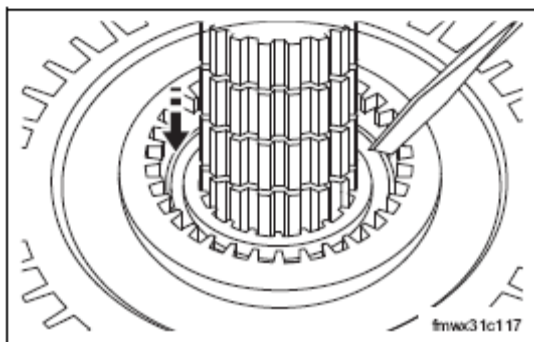
- (b) Fit the second shaft reverse gear and reverse gear sliding sleeve.

Notice:

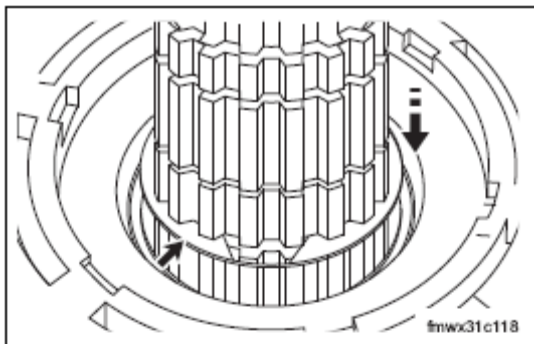
The portion without teeth shall be aligned with the groove on the second shaft with holes, and the side with short tooth shall face upward.



- (c) Fit the second shaft gear spacer. After the gear is turned by one tooth pitch, put on the long key.



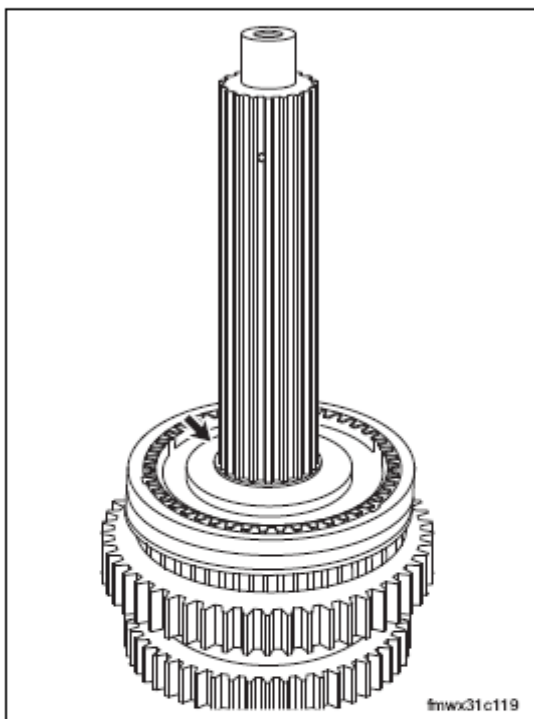
- (d) Fit the second shaft first gear engaging tooth into the second shaft, insert the spline gasket with the convex side facing up, and after the gear is turned by one tooth pitch, put on the long key.



- (e) Fit the components on the other side of the 1/2 synchronizer and then the snap ring.

Notice:

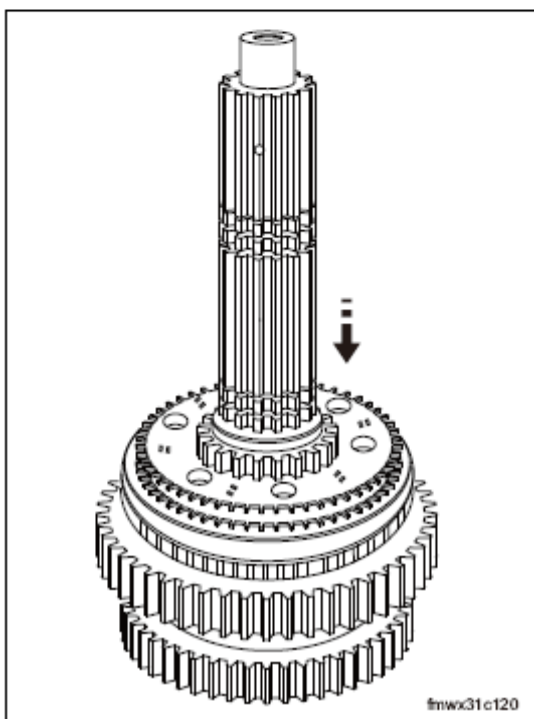
The opening of snap ring shall face to the groove with holes on the second shaft.



- (f) Fit the 1/2 synchronizer gear hub and one snap ring.

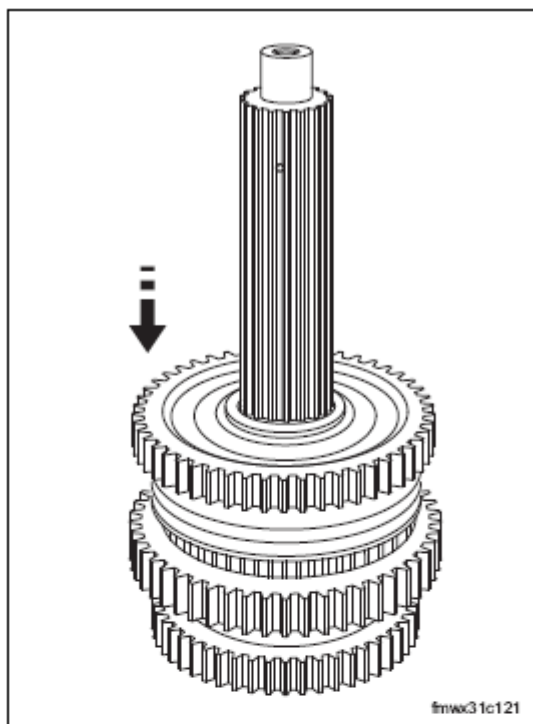
Notice:

The opening of snap ring shall face to the groove with holes on the second shaft.

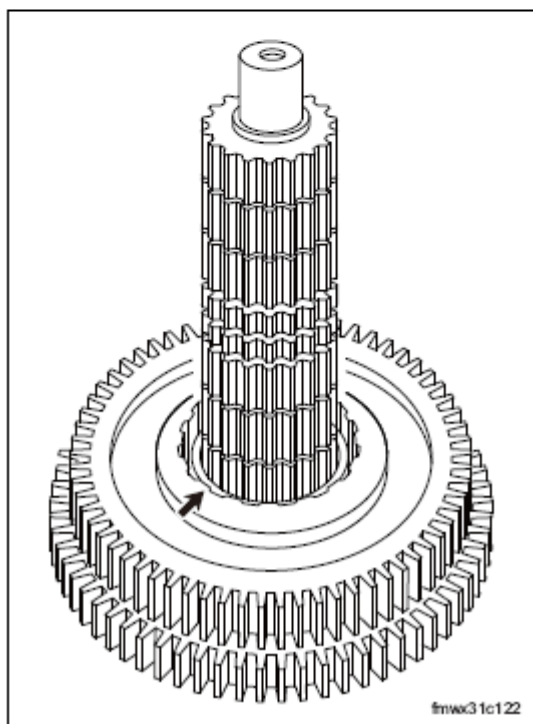


- (g) Fit components on the other side of 1/1 synchronizer, insert the second shaft spline gasket with the convex side facing down and after the gear is turned by one tooth pitch, put on the long key.

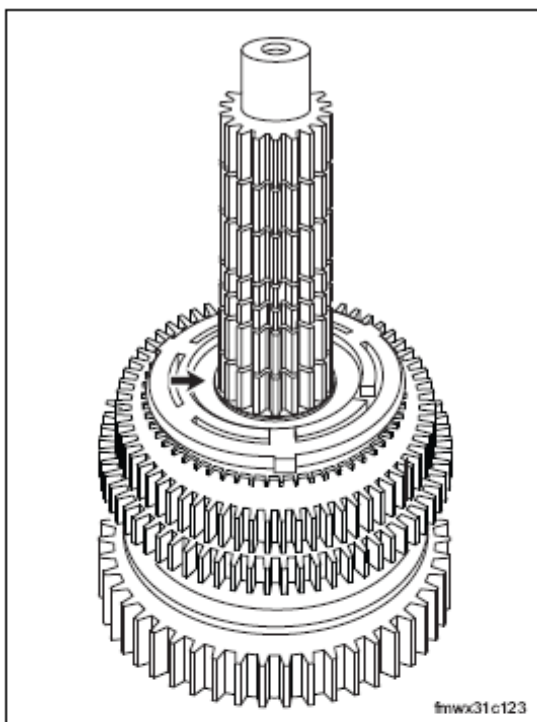




- (h) Fit the second shaft with the second shaft second gear engaging tooth facing down, fit the second shaft gear spacer and after the gear is turned by one tooth pitch, put on the long key.



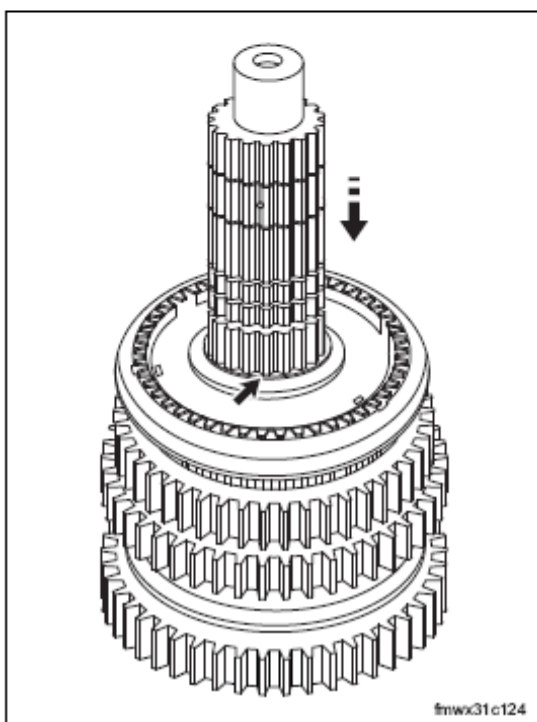
- (i) Fit the second shaft third-speed gear engaging tooth into the second shaft, insert the spline gasket with the convex side facing up and after the gear is turned by one tooth pitch, put on the long key.



- (j) Fit the components on the other side of the 3/4 synchronizer and then the snap ring.

Notice:

The opening of snap ring shall face to the groove with holes on the second shaft.

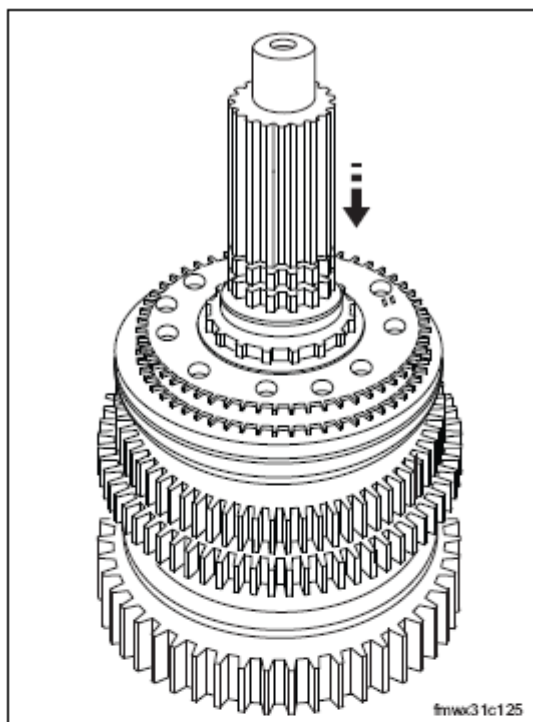


- (k) Fit the 3/4 synchronizer gear hub and then the snap ring.

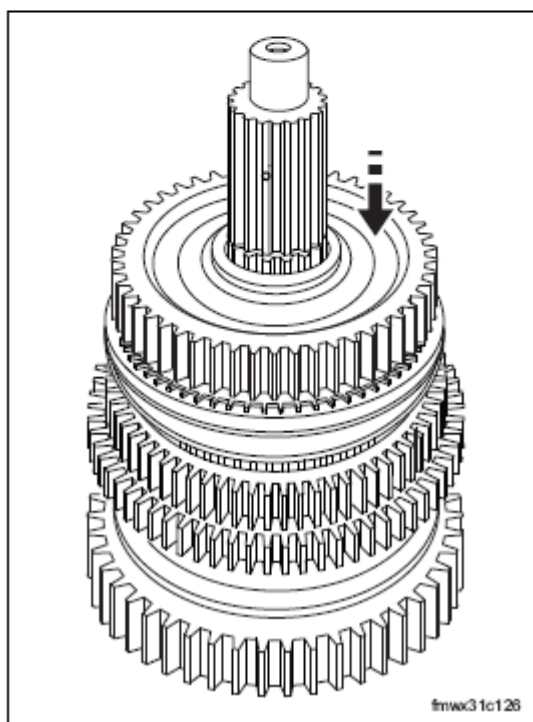
Notice:

The opening of snap ring shall face to the groove with holes on the second shaft.

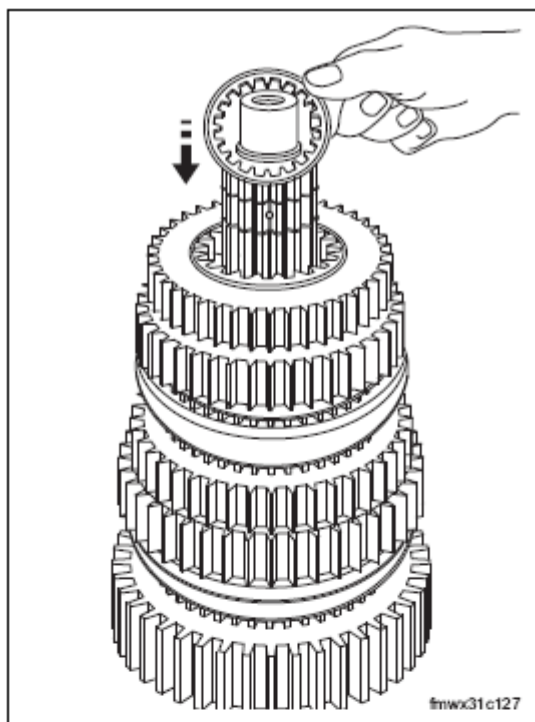




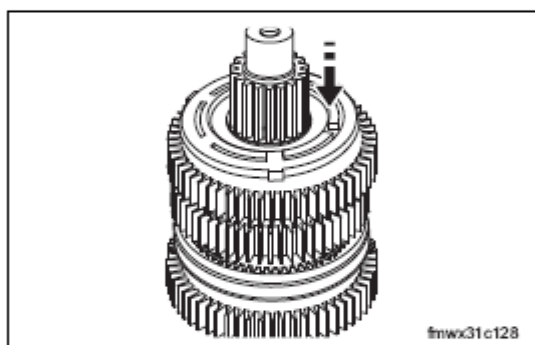
- (l) Fit components on the other side of the 3/4 synchronizer, insert the second shaft spline gasket with the convex side facing down and after the gear is turned by one tooth pitch, put on the long key.



- (m) Fit the second shaft fourth-speed gear engaging tooth into the second shaft, insert the second shaft gear spacer, and after the gear is turned by one tooth pitch, put on the long key.



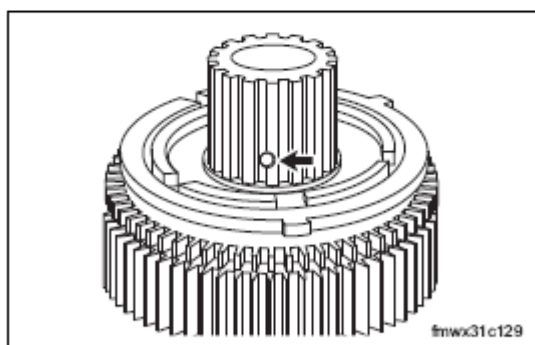
- (n) Fit the second shaft fifth-speed gear engaging tooth into the second shaft, insert the second shaft spline gasket with the convex side facing up and after the gear is turned by one tooth pitch, put on the long key.



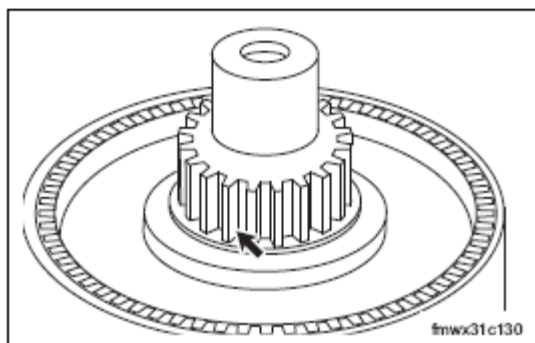
- (o) Fit the components on one side of the 5/6 synchronizer and then the snap ring.

Notice:

The opening of snap ring shall face to the groove with holes on the second shaft.



- (p) Fit the flexible pin on the second shaft, and push the long key in place.



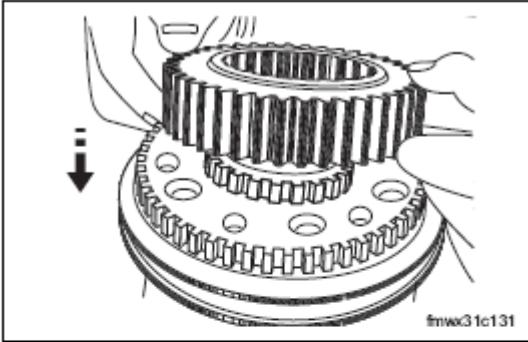
- (q) Fit the 5/6 synchronizer gear hub and then the snap ring.

Notice:

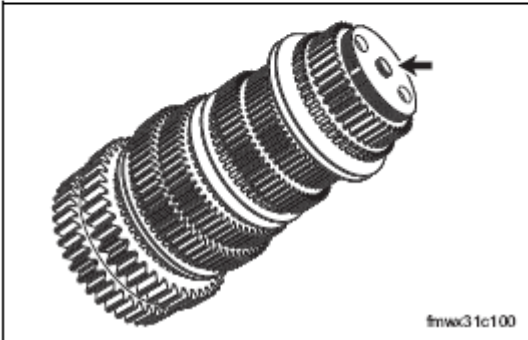
The opening of snap ring shall face to the groove with holes on the second shaft.

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TRANSMISSION (12JS180TA)-SECOND SHAFT ASSEMBLY



- (r) Fit components on the other side of the 5/6 synchronizer, and then the first shaft gear.

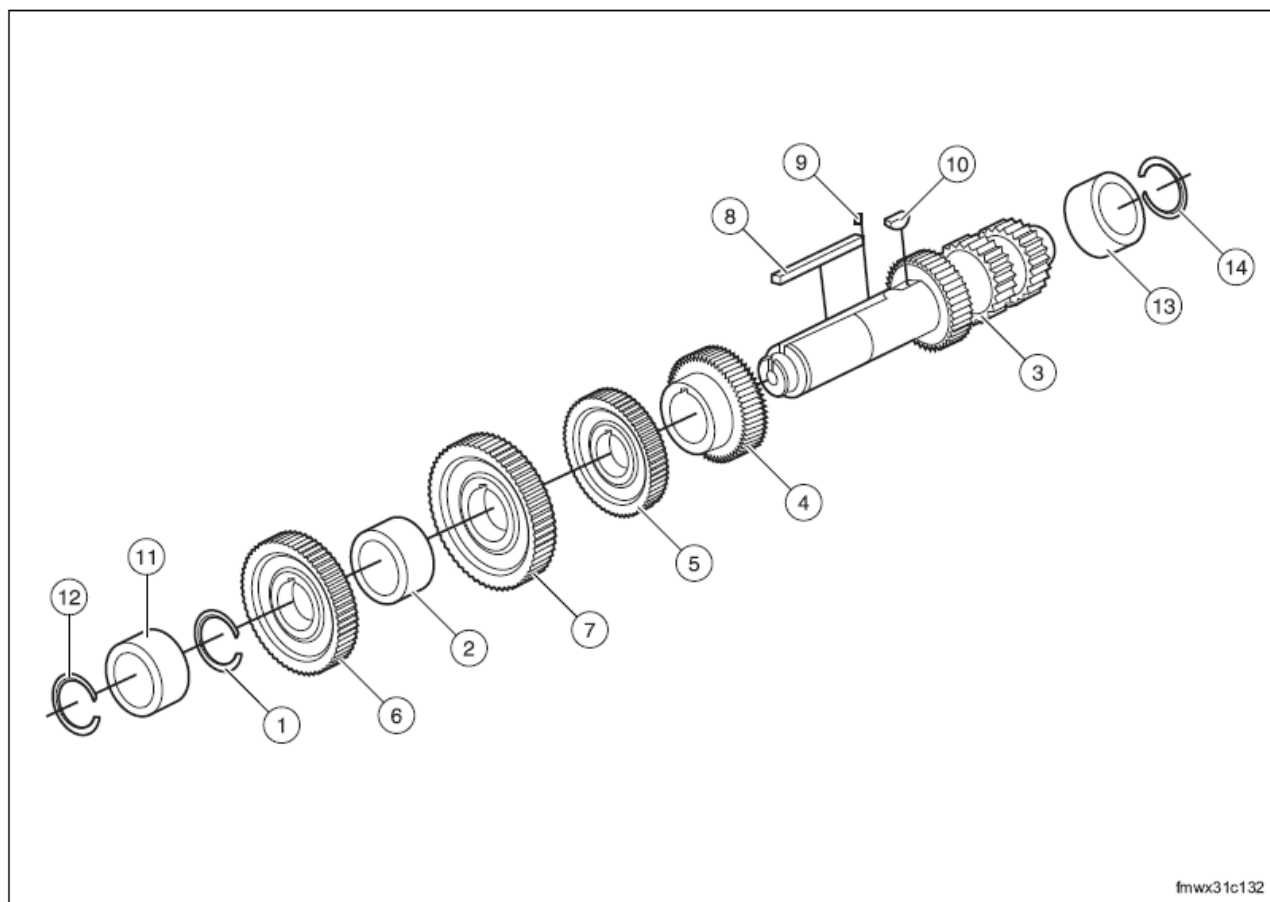


- (s) Use the pressure plate to attach the first shaft gear onto the second shaft.

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BASIC TRANSMISSION COUNTERSHAFT

DIAGRAM OF COMPONENTS



31A

1	Countershaft retaining ring
2	Spacer
3	Countershaft
4	Countershaft third-speed gear
5	Countershaft fourth-speed gear
6	Countershaft driven gear
7	Countershaft fifth-speed gear

8	Countershaft square key
9	Flexible cylindrical pin
10	Woodruff key
11	Short cylindrical roller bearing
12	Retaining ring
13	Short cylindrical roller bearing
14	Flexible retaining ring for shaft

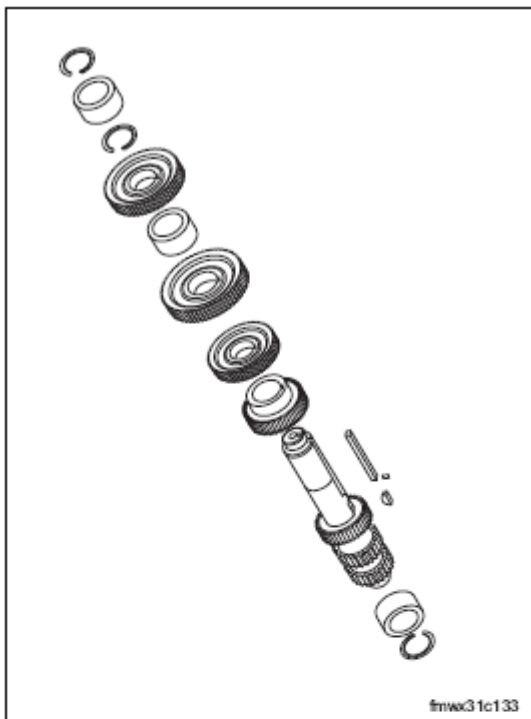
DISASSEMBLY AND ASSEMBLY

Hint:

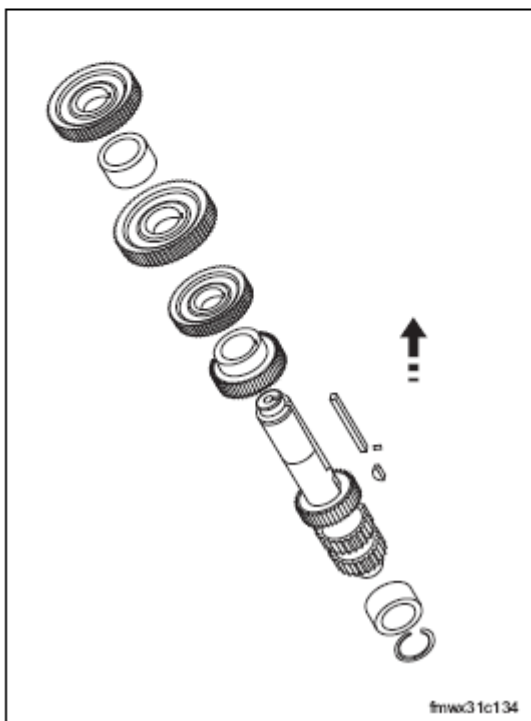
Except for serious wear or tooth collision, do not remove the countershaft gear.

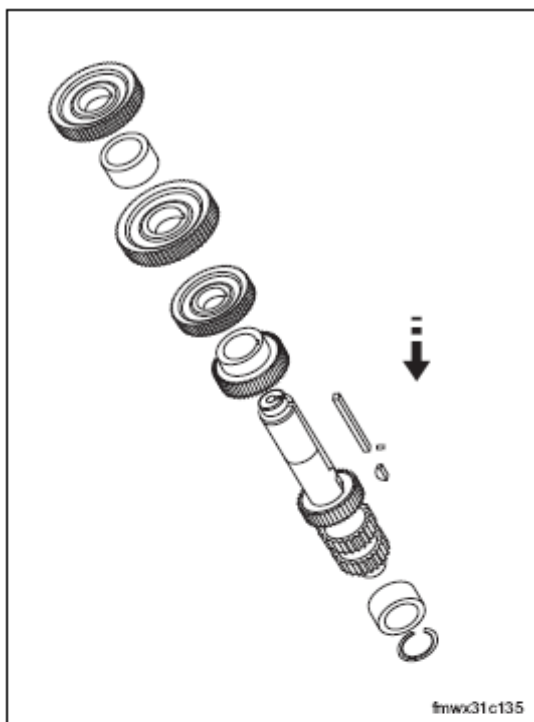
1. Disassemble the left countershaft.

- (a) Remove the left countershaft retaining ring.



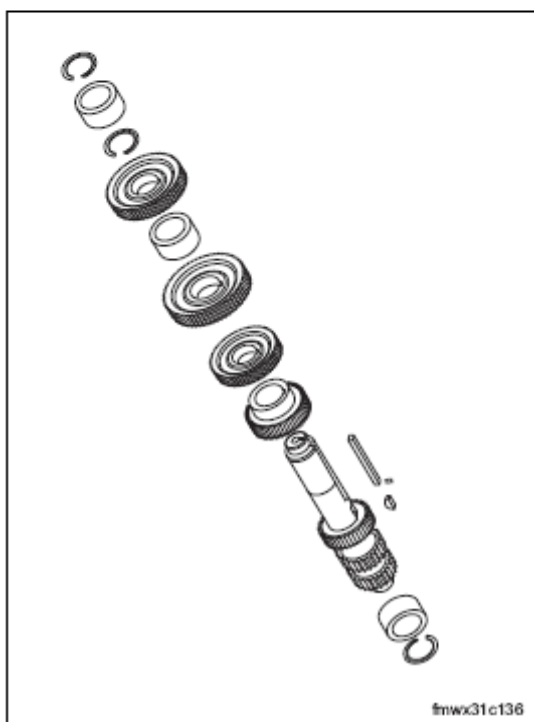
- (b) Remove the countershaft driven gear, spacer, countershaft fifth-speed gear, countershaft fourth-speed gear, countershaft third-speed gear, countershaft square key and woodruff key in order.





2. Reassemble the left countershaft.

- (a) Refit the woodruff key, countershaft square key, countershaft third-speed gear, countershaft fourth-speed gear, countershaft fifth-speed gear, spacer, friction wheel and countershaft driven gear onto the countershaft.



- (b) Fit the countershaft retaining ring.

Hint:

As for the Disassembly and assembly of the right countershaft, refer to the Disassembly and assembly of the left one.

TRANSMISSION (9JS180)

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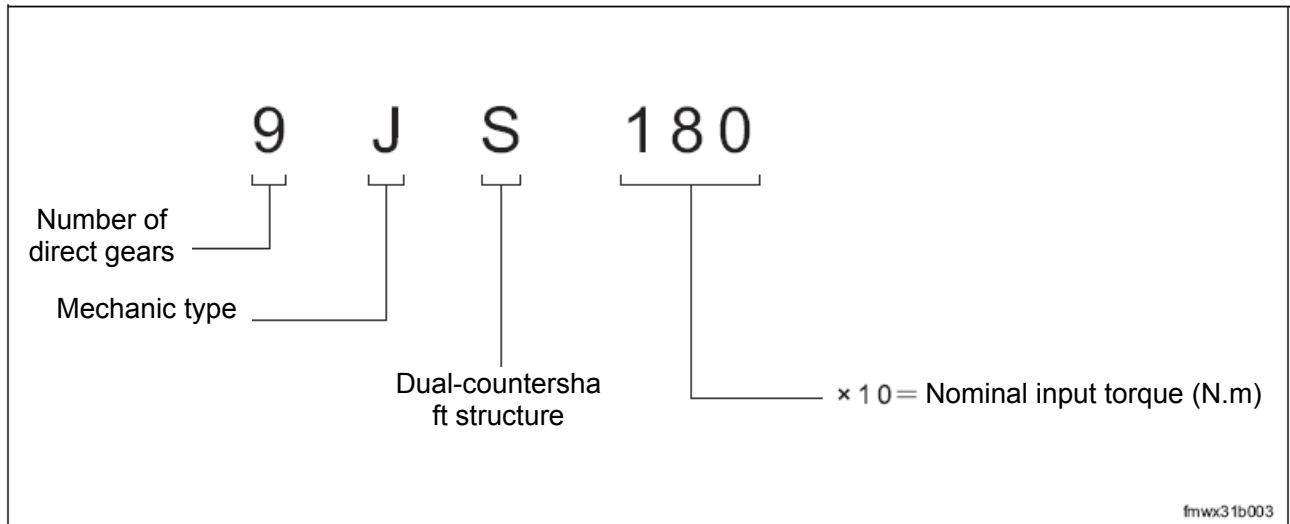


TRANSMISSION

OVERVIEW

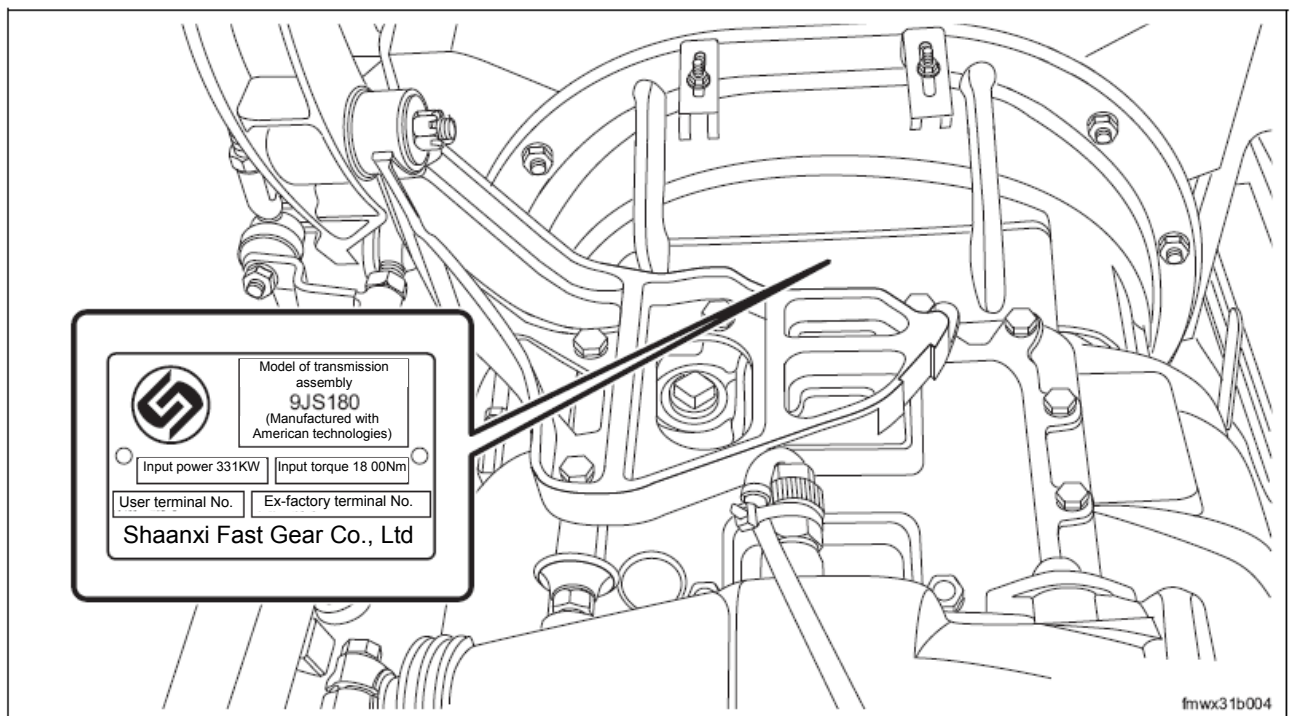
The major characteristic of Fast dual-shaft transmission consists in that another countershaft is provided in addition to the countershaft equipped in an ordinary transmission, to constitute the dual-countershaft transmission. With this second countershaft, the symmetrical transfer of power is obtained thus to realize the steady transmission and lower noise.

Meaning of transmission model:



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Nameplate of transmission:



PRECAUTIONS

I. Precautions in operation of transmission

To correctly and properly operate the transmission and provide regular service are critical for ensuring the safe and reliable operation of the vehicle and prolonging the service life of the transmission. You are kindly required to observe following requirements:

1. **Before move-up, release the parking brake. For vehicles with air cutoff brake, engage any gear after the air pressure rises to the value necessary for releasing the brake.**
2. **Engage the first or second gear at move-up depending on the road conditions.**
3. **In the shifting operation, the clutch must be disengaged thoroughly and the gearshift lever shall be engaged in place.**
4. **The gearshift lever is provided with two neutral positions, namely, the 3/4 position of low gear range and 5/6 position of high gear range. To park the vehicle, the gearshift lever must be located in the low gear range.**
5. **To engage the reverse gear or low gear (creeper gear), the engine must be stopped before the engagement to avoid damaging parts in the transmission. To engage the reverse gear, a significant force exerted by the hand must be used to offset the resistance from the reverse gear lock.**
6. **To shift between high and low gears (gears 4 and 5), a short pause of 1 or 2 seconds is required intentionally to enable the splitter to fulfill the change between high-speed and low-speed ranges.**
7. **When the transmission works continuously, the maximum temperature shall not exceed 120°C, and the minimum temperature shall be no lower than -40°C. Where the working temperature is higher than 120°C, the lubricating oil will be decomposed and the service life of transmission will be reduced.**

Warning:

1. **Avoid skipping when the transmission is shifted between high and low gears.**
2. **To shift the gear in running order, do not use the countershaft brake.**
3. **When the vehicle is moving downhill, avoid any shifting operation.**
4. **Never coast at the neutral gear.**
5. **Never tow the vehicle with the drive wheel in contact with the ground.**
6. **If any abnormal noise or heavy operation in the transmission is detected, stop the vehicle immediately for troubleshooting. Drive on until the faults are removed.**

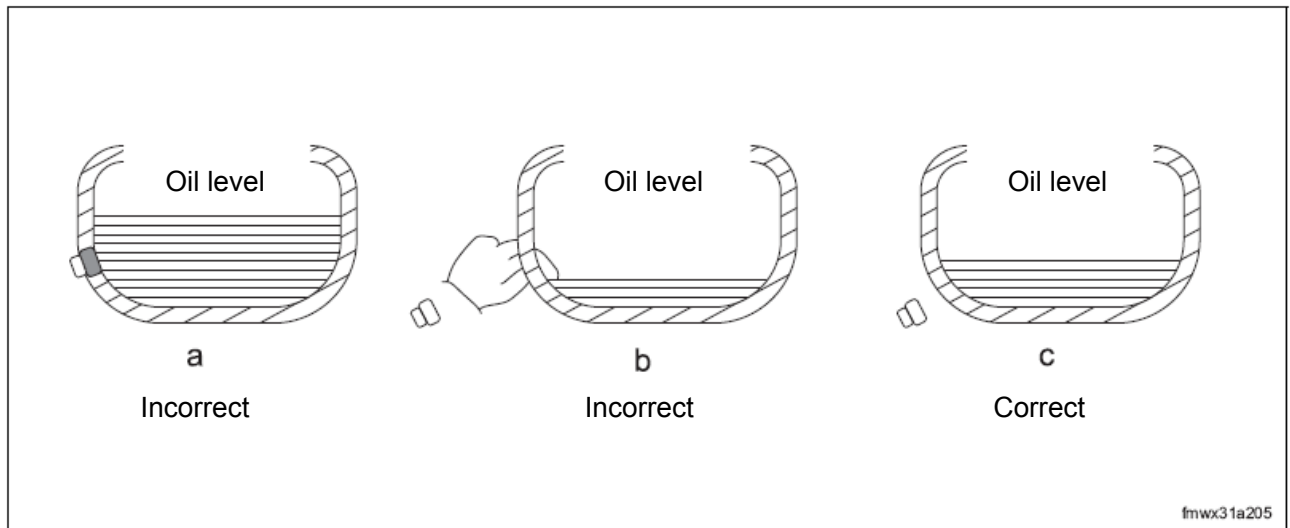
II. Service of transmission

Each time the required interval for maintenance is expired, all previous maintenance and service work shall be performed pursuant to the service and maintenance schedule.

1. Day-to-day inspection

1-1 Inspection on lubricating oil level

Each day check the transmission lubricating oil level and leakage, and add the oil if necessary. If any leakage is found, repair the transmission immediately to avoid any failure due to the loss of lubricating oil.



1-2 Pneumatic system

- 1) Each day remove the water in the vehicle pneumatic system.
- 2) Each day check whether there is air leakage by hearing, and provide repairs if necessary.
- 3) Confirm whether the air dryer works normally, and provide repairs if necessary. Service the air compressor as required to prevent the entry of lubricating oil into the pneumatic system.

2. Every 2000-5000km's travel of the new transmission

2-1 Replacement of lubricating oil

- 2-2 Check the transmission fixing bolts and fasteners for looseness and loss, especially those bolts used to attach the transmission onto the engine.
- 2-3 Lubricate the throw-out bearing.
- 2-4 Lubricate the clutch fork shaft;
- 2-5 Wash the air filter insert;
- 2-6 Check and clean the transmission vents;
- 2-7 Check the transmission control mechanism for normal operation.

3. Every 10000km or two months

- 3-1 Check the transmission fixing bolts and fasteners for looseness and loss, especially those bolts used to attach the transmission onto the engine.
- 3-2 Lubricate the throw-out bearing.
- 3-3 Lubricate the clutch fork shaft;
- 3-4 Wash the air filter insert;
- 3-5 Check and clean the transmission vents;
- 3-6 Check the transmission control mechanism for normal operation.

4. Replacement of oil

- 4-1 The use of correct lubricating oil is essential for the service and maintenance of the transmission. You are kindly required to strictly observe following service and maintenance procedure:
 - 1) Procure lubricating oil from a qualified supplier;
 - 2) Use the lubricating oil of the correct type and class: 85W-90 GL5;
 - 3) Replace the oil as per the proper interval;
 - 4) Maintain a correct oil level.
- 4-2 The interval for replacement of lubricating oil shall not be longer than the time stipulated in the table below.

31B-6**TRANSMISSION (9JS180)-TRANSMISSION**

Road conditions	Off-road conditions	Rigorous conditions
One year (at most) or 50000km	Every 1000h	Every 500h

Precautions:

Rigorous conditions refer to those circumstances where components are required to work at high load or in seriously contaminated environment or to constantly work on a steep slope. Under these circumstances, abide by the replacement cycle of lubricating oil required by the rigorous conditions.

III. Notices in removal of the transmission

1. Service the transmission in a clean place to avoid the entry of dust or other impurities into the transmission. Prior to the removal operation, carefully clean the external surface of the transmission.
2. To remove various assemblies, store all parts on a clean work bench in the sequence of the removal operation, thus to make the steps of the reinstallation convenient and minimize the possibility of loss of parts in the refitting operation.
3. At removing the first shaft, it is unnecessarily to remove the countershaft, second shaft and first shaft gear.
4. At removing the bearing, use the dedicated tools. Carefully clean the bearing and check whether its rolling way shows pit corrosion and whether the roller is in good conditions.

31B

IV. Precautions in refitting operation

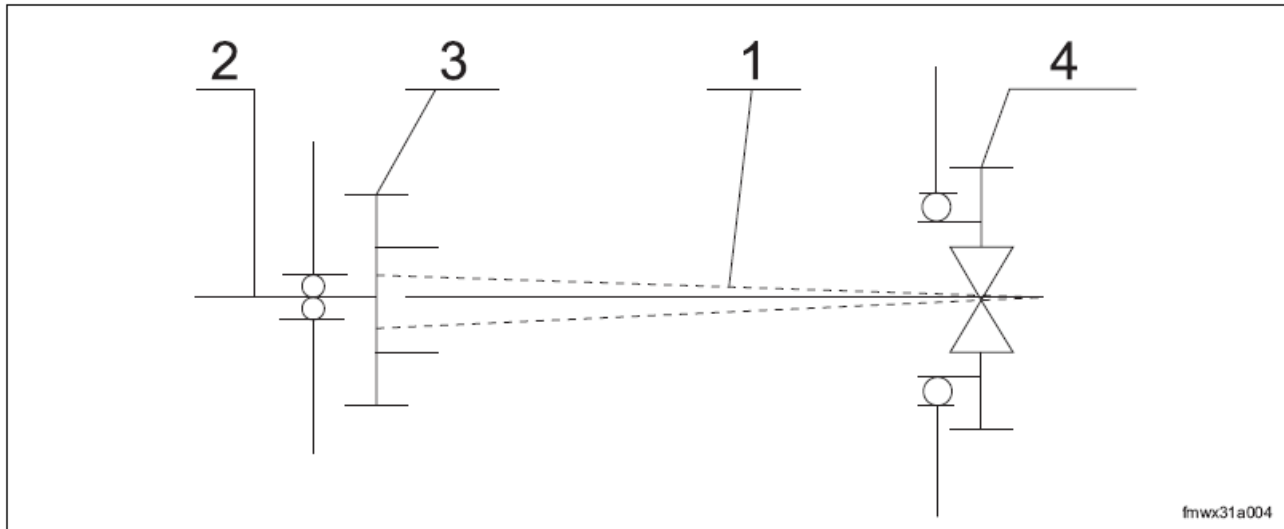
Before the refitting operation, thoroughly clean all parts to be refitted and avoid the entry of dust and foreign matters into the transmission; otherwise the unwanted damages may be invited.

1. **Lining:** In the refitting operation of the transmission, all linings must be renewed.
2. **Bolts:** To prevent oil leakage, all bolts must be coated with thread sealant and tightened with the standard torque.
3. **O-shaped ring:** Use the silicon-grease lubricant to lubricate all O-shaped rings.
4. **Initial lubrication:** In the refitting operation, all thrust washers shall be coated with the grease for initial lubrication to avoid scratches or wear.
5. **Axial clearance:** It must be ensured that the axial clearance of the second shaft direct gear is 0.13~0.30mm and that the axial clearance of the reverse gear is 0.30~0.90mm.
6. **Tighten the output shaft flange disc nuts,** and use a torque of 610~680N.m to fasten output shaft nuts; otherwise serious consequences may be aroused.



STRUCTURE AND PRINCIPLE OF TRANSMISSION

I. Dual-countershaft floating structure



1	Main shaft
2	Input shaft

3	Input shaft gear
4	Splitter drive gear

In the Fast dual-countershaft transmission, both the basic transmission and the splitter are provided with countershafts of completely the same structure, spaced by 180°. The power from the input shaft is transferred to these two countershafts and then collected in the main shaft for output, so does the splitter.

Theoretically, each countershaft is only allowed to transfer 1/2 of the torsional moment, so the use of double countershafts can reduce the center-to-center distance of the transmission and cut down the thickness of gears to obtain a smaller axial size and weight. By adopting the double countershafts, all gears on the main shaft must be engaged with both countershaft gears synchronously.

To satisfy the correct engagement and distribute the load as uniformly as possible, the main shaft gear floats in a radial direction on the main shaft which is provided with a hinged floating structure. The main shaft journal is inserted into a hole on the input shaft. In this hole, an oil-bearing guide sleeve is accommodated, with a sufficient radial clearance between the said journal and the guide sleeve. The rear end of the main shaft is inserted into the splitter driving gear hole via an involute spline, and the splitter driving gear journal is supported on the ball bearing.

In the fine-tooth transmission, the splitter drive gear journal is provided with two grooves in which O-shaped sealing rings are fitted to constitute an elastic support with the bearing.

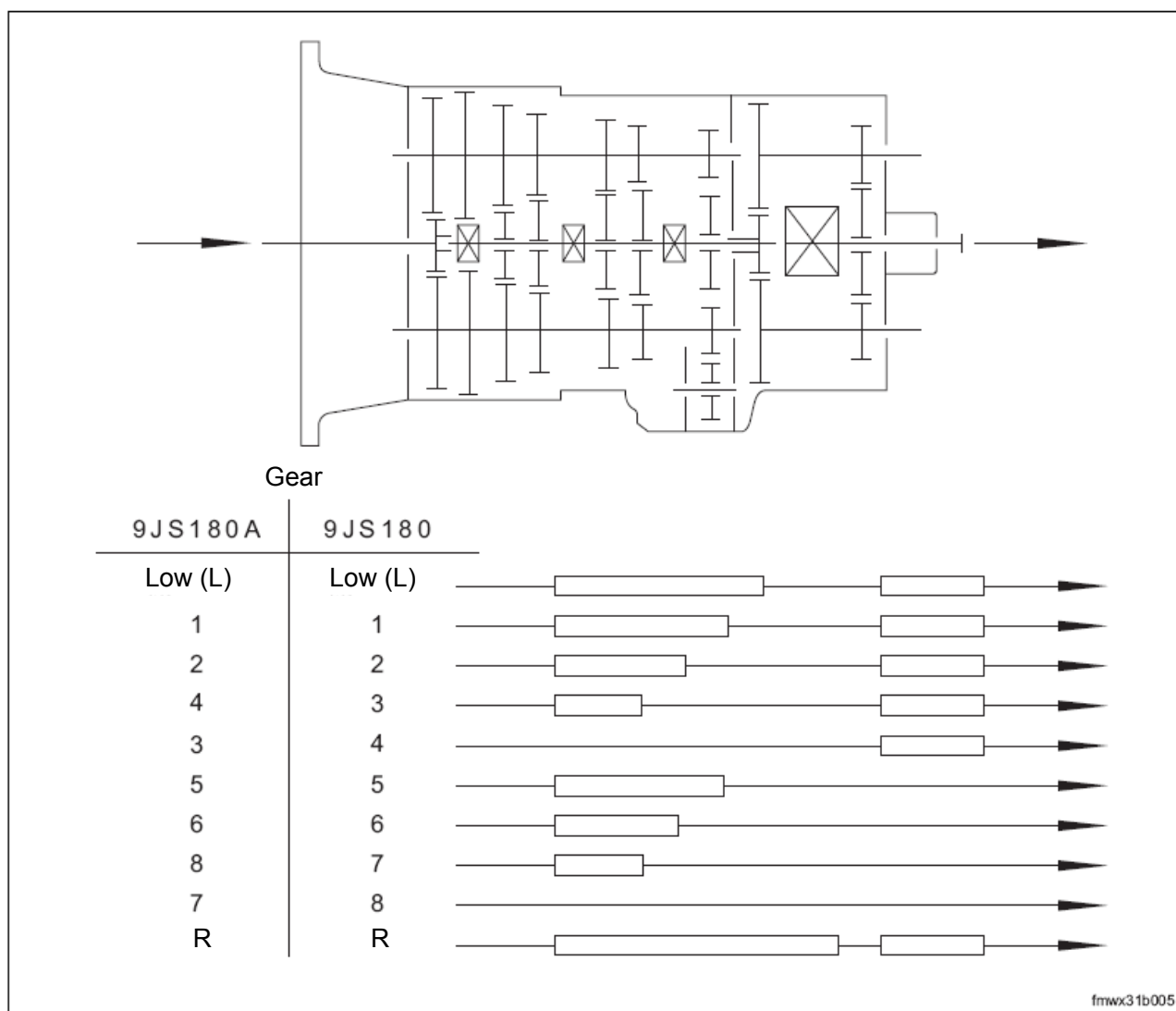
As all gears float along the main shaft, the conventional needle bearing is thus cancelled to simplify the structure of the main shaft assembly. In the operation, both countershaft gears exert the same radial force on the main shaft gear in opposite directions to offset each other; in such a way, the main shaft will only receive the torsional moment, but no bending moment, which has largely relieved the load of both the main shaft and the bearing, and has also significantly improved the transmission's reliability and durability.

II. Power transfer line

To understand the engine power transfer line of a specific gear of the transmission can assist the technician to service and maintenance the transmission in a better manner. Generally, it is considered that the Fast transmission is an integral body consisting of two separate transmissions. The first transmission (or called transmission front box) is composed of six gear pairs controlled by the gearshift lever, while the second transmission is called splitter, used to realize the shift between range gears under the pneumatic control.

Hint:

This transmission is a normally-on transmission. In the working process, although only part of gears will transfer the power, all gears are rotating.

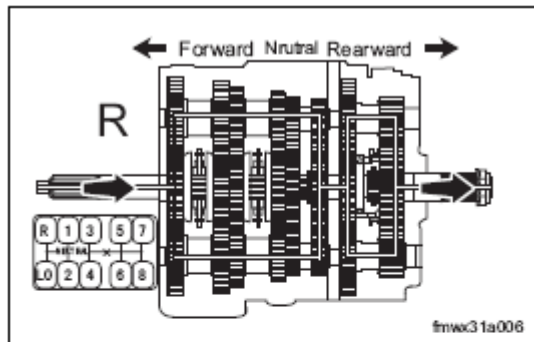


31B

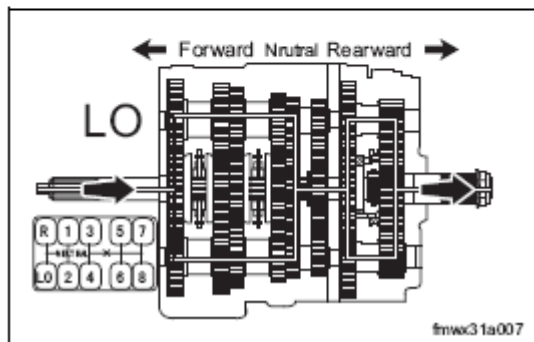
31B-10

TRANSMISSION (9JS180)-TRANSMISSION

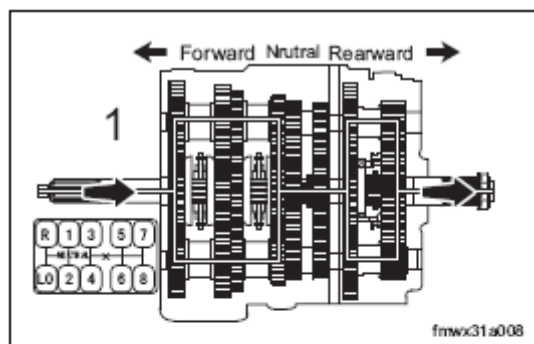
1. Basic transmission power transfer line



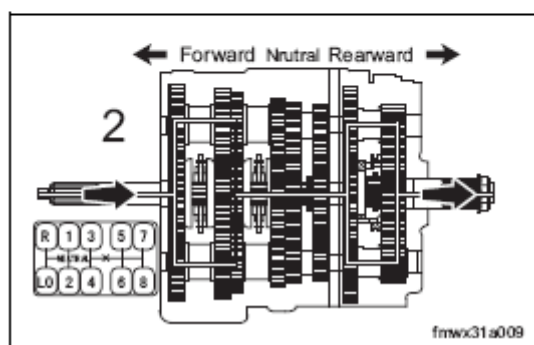
(a) Transfer line of the reverse gear



(b) Transfer line of the climbing gear

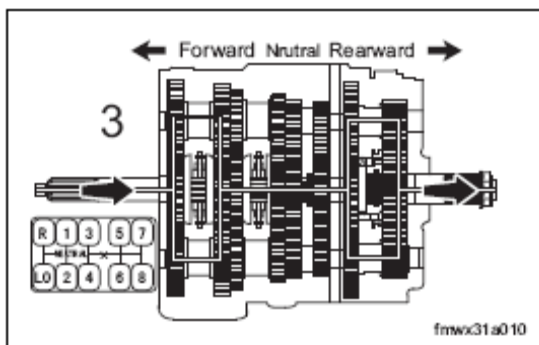


(c) Transfer line of the first gear

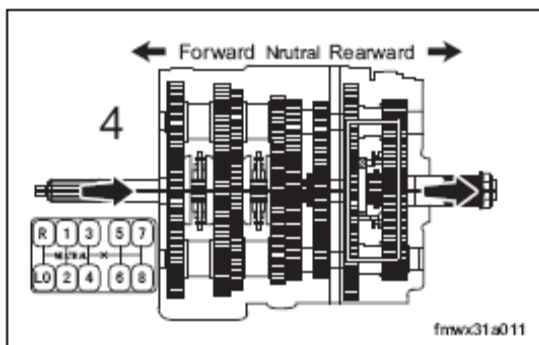


(d) Transfer line of the second gear

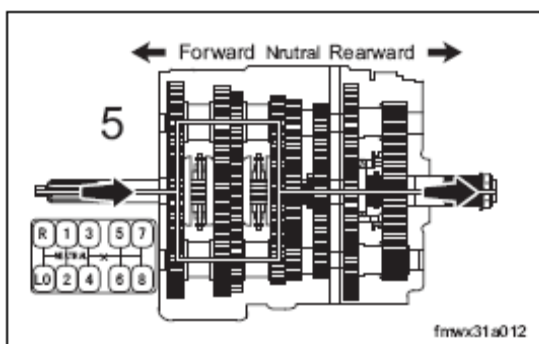




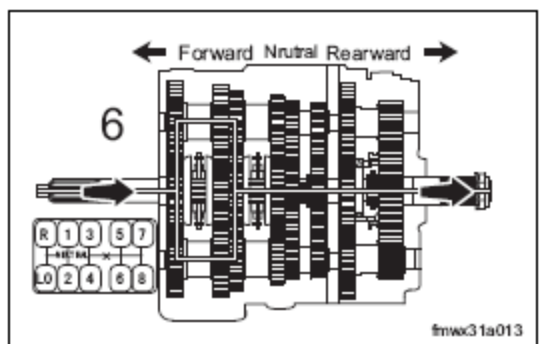
(e) Transfer line of the third gear



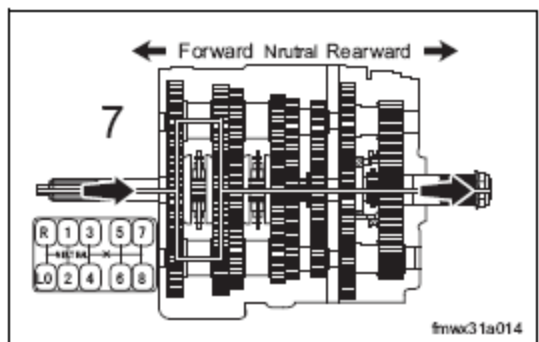
(f) Transfer line of the fourth gear



(g) Transfer line of the fifth gear



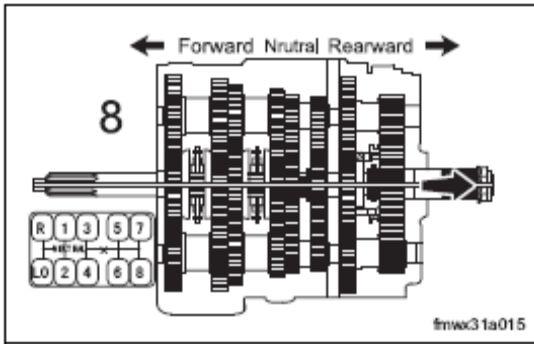
(h) Transfer line of the sixth gear



(i) Transfer line of the seventh gear

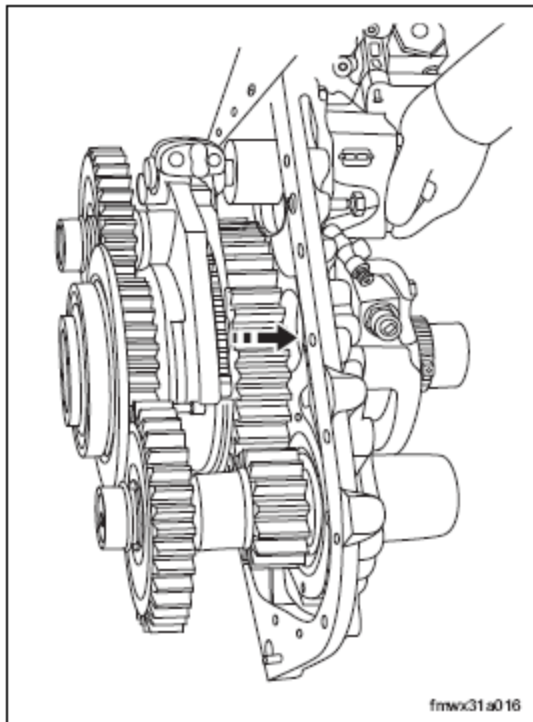
31B-12

TRANSMISSION (9JS180)-TRANSMISSION

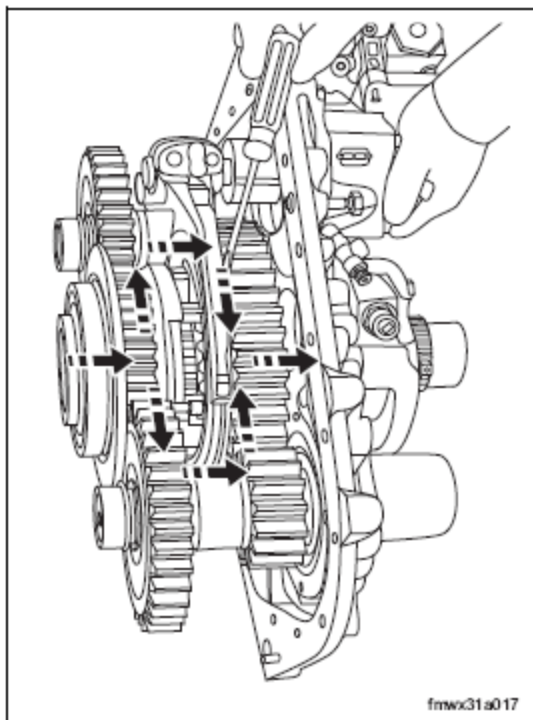


(j) Transfer line of the eighth gear

2. Power transfer line of the splitter



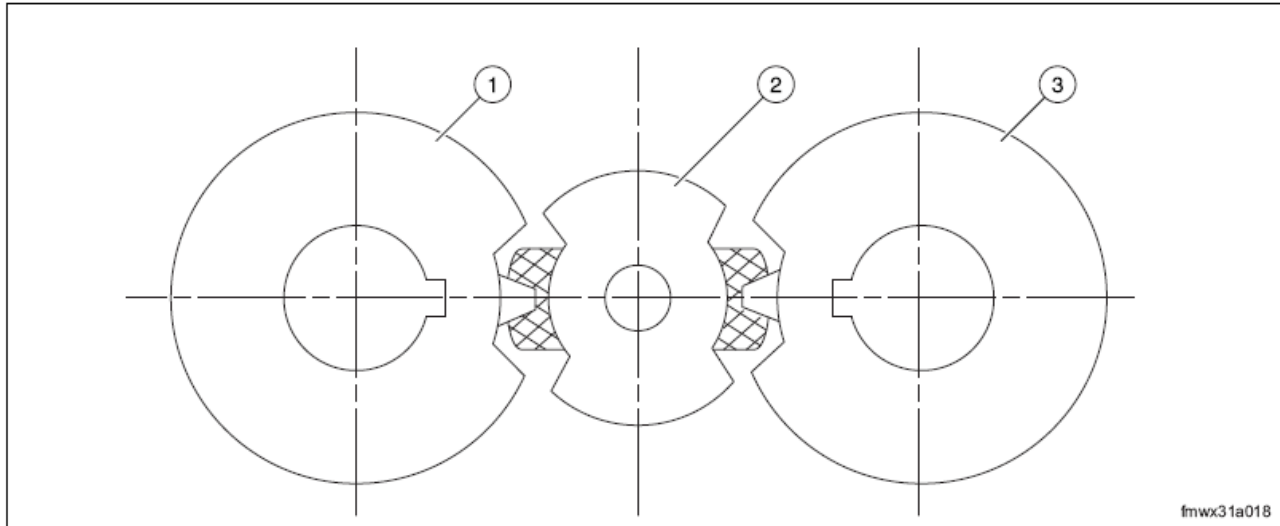
(a) High-speed gear



(b) Low-speed gear

III. Tooth alignment and tooth alignment procedure

To ensure the correct engagement between dual-countershaft gear and main shaft gear and the identical angle of both countershafts, either the basic transmission or splitter must be synchronized. Generally, in the installation of basic transmission, the first shaft gear and countershaft normally engaged gear are selected for tooth alignment; in the installation of splitter, the splitter reducer gear and splitter countershaft gear are selected for tooth alignment.

Tooth alignment procedure:

1	Left countershaft gear
2	First shaft gear

3	Right countershaft gear
---	-------------------------

Tooth alignment of basic transmission

- At first, mark any two adjacent teeth with paint on the first shaft gear, and then mark another two adjacent teeth on the other side in the corresponding 180° direction. The number of teeth between marks in both groups must be equal.
- Separately mark the external tooth top opposite to both countershaft normally engaged gear inner hole key groove with paint, and such a mark shall be exclusive.
- In the refitting operation, insert the marked teeth of both countershaft normally engaged gears into the marked tooth groove on the first shaft gear. If the correct mounting is done, the first shaft will be able to rotate freely; if the shaft can't rotate or rotates heavily, check whether the tooth alignment marks are correct.

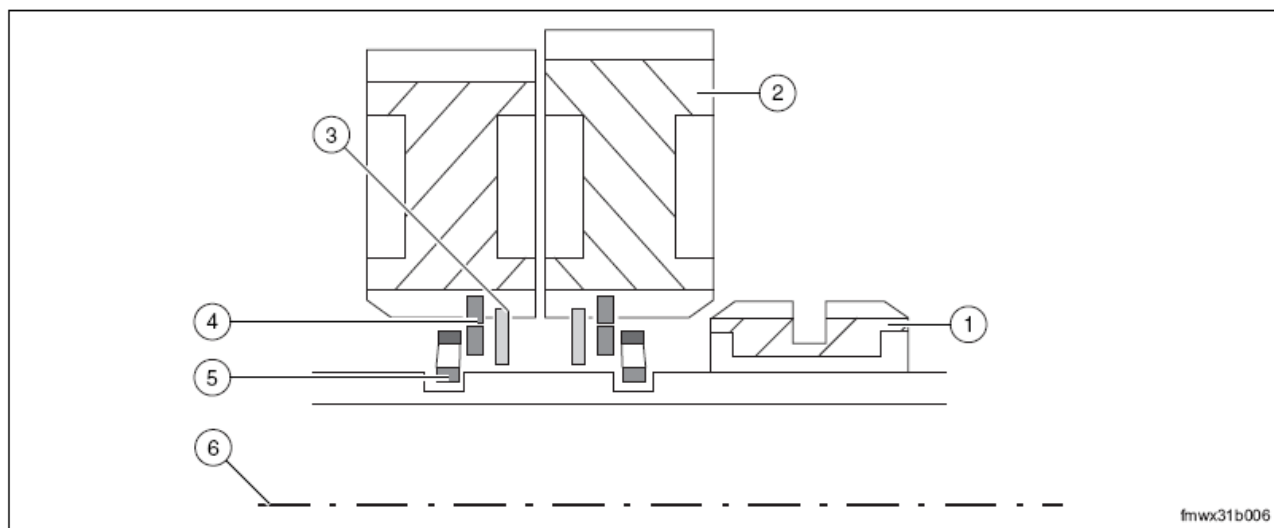
Tooth alignment of splitter

- At first, mark any two adjacent teeth with paint on the splitter reducer gear, and then mark another two adjacent teeth on the other side in the corresponding 180° direction. The number of teeth between marks in both groups must be equal.
- Separately paint the tooth crown top marked with "O" on the splitter countershaft gear, and such a mark shall be exclusive.
- In the refitting operation, insert the marked teeth of both splitter countershaft gear into the marked tooth groove on the reducer gear. Before the installation of the splitter assembly onto the basic transmission, carefully check the tooth alignment marks.

VI. Gearshift mechanism

The basic transmission of the 9JS180 dual-countershaft transmission is provided with no synchronizer. The main shaft sliding sleeve is threaded on the main shaft via the involute spline. By moving the sliding sleeve, its engaging tooth will be engaged with the one in the main shaft gear to transfer power. At the ends of both engaging teeth of the sleeve and main shaft gear, the same cone angle $\alpha=35^\circ$ is present. As the main shaft and its gear are floating, these two conical surfaces will provide the automatic centering and tooth alignment to some extent.

The 9JS180 dual-countershaft transmission has a great number of gears which don't differ significantly each other with respect to the speed ratio; therefore, in the operation, the speed difference between two adjacent gears is also minor to realize the steady gearshift operation of the transmission.



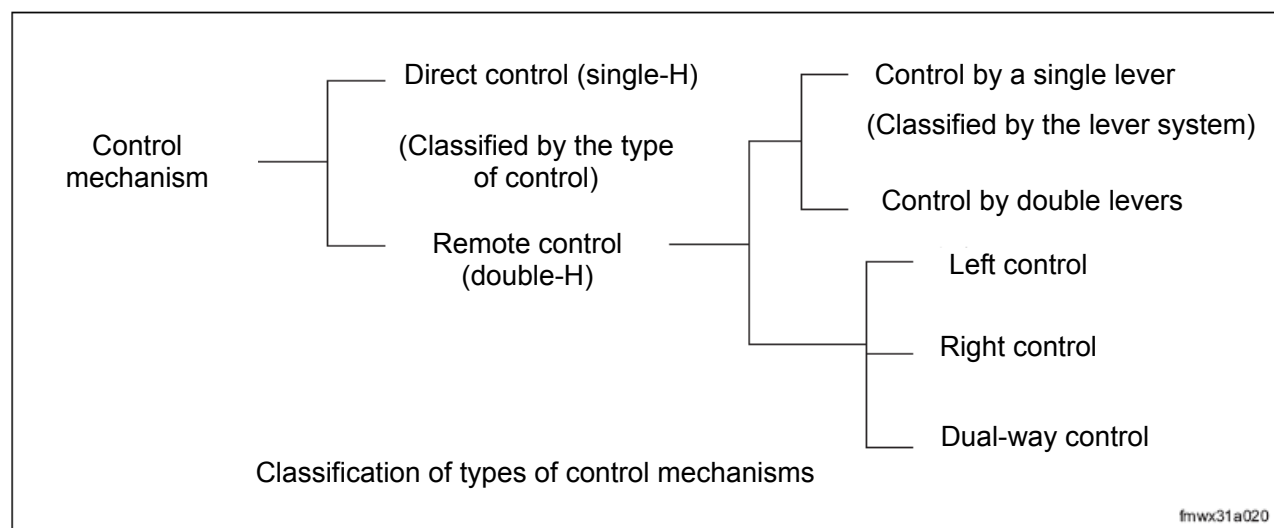
1	Sliding sleeve
2	Second shaft gear
3	Snap ring

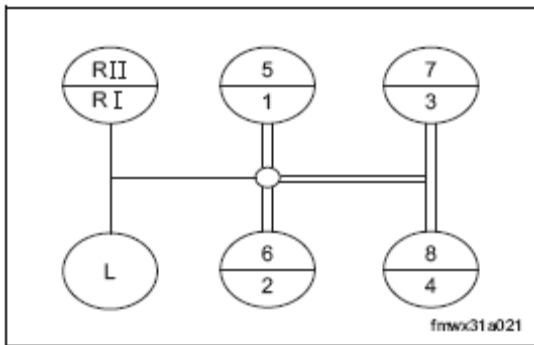
4	Spline gasket
5	Adjusting shim
6	Main shaft

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V. Control mechanism

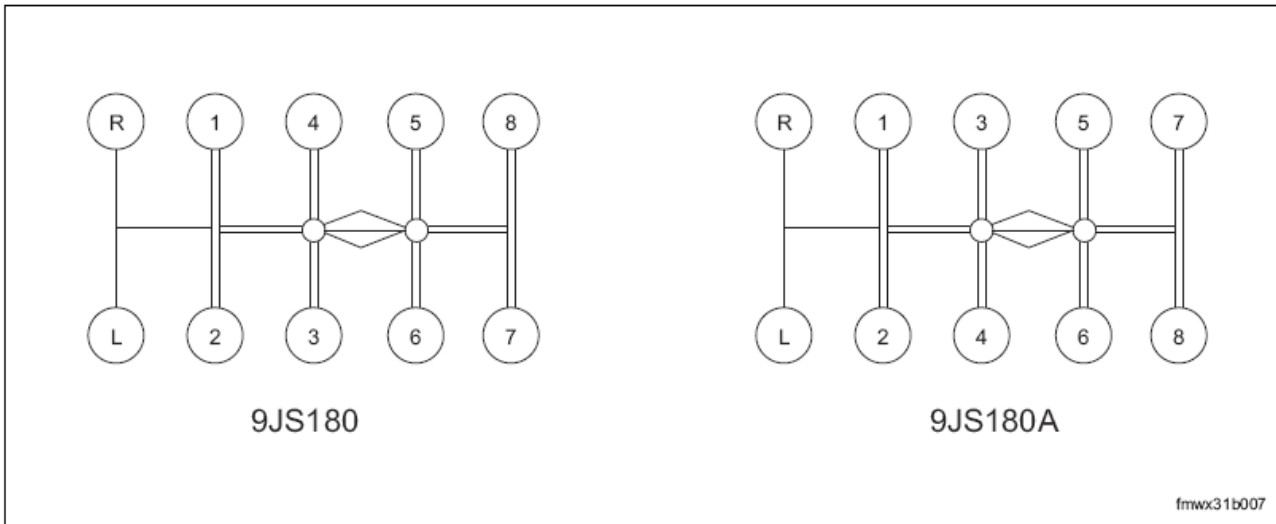
The 9JS180 dual-countershaft transmission control mechanism is classified into the direct control (single-H) and remote control (double-H). Most vehicles employ the remote control mechanism.





1. Diagram for single-H control hand ball position

2. Diagram for double-H remote control position

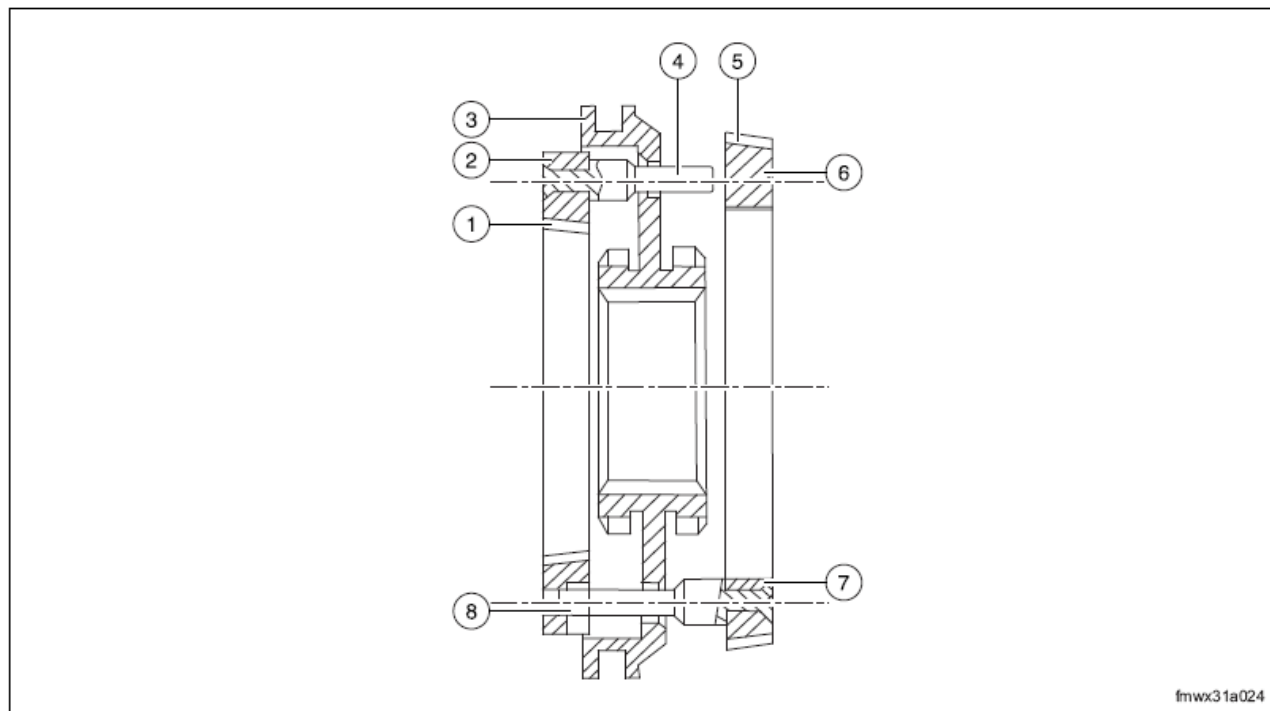


In the double-H control mechanism, 1-2-3-4 and R-L gears are located in the low-speed range, while 5-6-7-8 gears are located in the high-speed range. The double-H mechanism is provided with two neutral positions, one at 3/4 in low-speed range and the other at 5/6 in the high-speed range.

VI. Structure and working principle of the synchronizer

The splitter of the 9JS180 dual-countershaft transmission is equipped with the locking pin type inertia synchronizer, which is controlled by the splitter gear shifting cylinder and will only work at the changeover from high gear to low gear. Its action is controlled by the lateral gearshift lever and the double-H pneumatic valve.

In the 9JS180 transmission, both the high-gear synchronizing ring 2 and low-gear synchronizing ring 6 are riveted with three locking pins 4 and 7. The sliding tooth sleeve 3 is engaged with the splitter output shaft via the spline. The basic unit of the high-gear synchronizing ring and low-gear cone ring are made of powder through sintering. On the internal and external cone face of the high-gear synchronizing ring, the non-metal materials with high anti-friction performance are adhered, and on the splitter drive gear and reducer gear, the corresponding external and internal cone surfaces are respectively provided, as shown in the figure below:



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1	High gear friction belt
2	High gear synchronizing ring
3	Sliding tooth sleeve
4	High-speed gear locking pin

5	Low gear friction belt
6	Low gear cone ring
7	Low gear locking pin
8	Spring

VII. Working principle of pneumatic line system

- The gearshift control of splitter of the dual-countershaft transmission is realized by regulating the pressure of pneumatic line.
- The pneumatic line system consists of the air filter regulator, double-H air valve, splitter gear shifting cylinder and connecting pipeline.
- The failure of pneumatic line may give rise to the failure or delay of the gearshift operation or damages of transmission components. With a good knowledge about the working principle of the pneumatic line, it may be possible to find the problem and solve it quickly by performing simple service work.

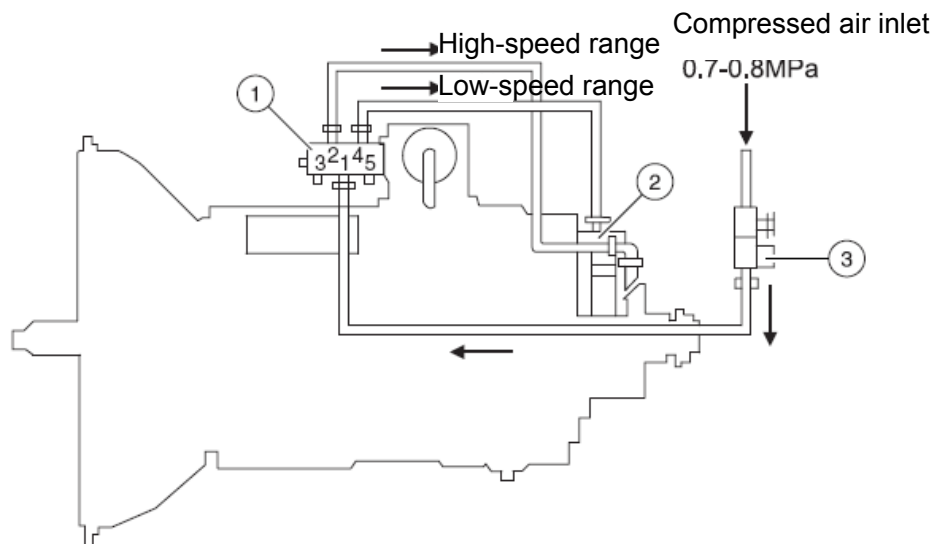
Working principle:

The 0.7-0.8Mpa compressed air from the vehicle's air reservoir is adjusted to 0.41-0.44MPa by the air filter regulator and then enters the air inlet of the double-H air valve through the air pipe. With a low gear engaged, the double-H air valve probe will be ejected to connect the low-speed range air line, and the compressed air will enter the air inlet for the low-speed range of the gear shifting cylinder via the double-H air valve low-speed air pipe to push the gear shifting cylinder piston to move back, thus the gear shifting cylinder fork shaft brings engaging teeth in synchronizer sliding sleeve and splitter reducer gear to be engaged; in such a way, the transmission will only work in low-speed range. With a high gear engaged, the double-H air valve probe will be compressed to connect the high-speed range air line, and the compressed air will enter the air inlet for the high-speed range of the gear shifting cylinder via the double-H air valve high-speed air pipe to push the gear shifting cylinder piston to move forward, thus the gear shifting cylinder fork shaft brings engaging teeth in synchronizer sliding sleeve and splitter reducer

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TRANSMISSION (9JS180)-TRANSMISSION

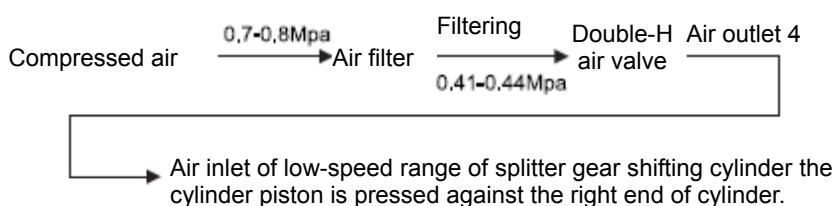
gear to be engaged; in such a way, the transmission will only work in high-speed range. When the gearshift lever is moved between low speed range and high speed rang, the residual air in the cylinder will be discharged from the vent of the double-H air valve through the connecting air pipe.



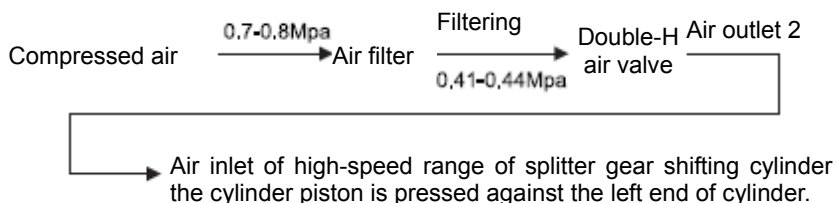
1	Double-H gearshift air valve
2	Range gear cylinder

3	Air filter regulator
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When the gearshift lever works in the low-speed range, the working line of the compressed air is as follows:



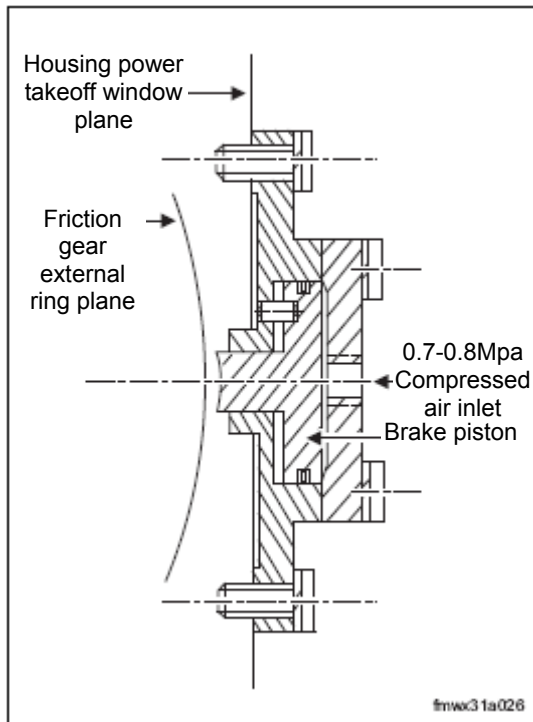
When the gearshift lever works in the high-speed range, the working line of the compressed air is as follows:



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VIII. Countershaft brake

The countershaft brake is also called clutch brake, fitted on the right side of the basic transmission housing. The countershaft brake is a brake control device, and the control air valve is mounted below the clutch pedal. In the operation, with the pedal fully depressed, the countershaft brake air line will be connected and the compressed air will push the brake piston to the countershaft power takeoff gear crown to realize the rapid deceleration of countershaft, main shaft gear and clutch driven members.



The countershaft brake is used in the transmission system equipped with the push type clutch. Prior to the move-up, the transmission is located at the neutral position, and the engine will bring the clutch, input shaft and basic transmission gears to rotate together whilst the main shaft doesn't rotate. When any gear is engaged for move-up, the clutch will be firstly disengaged. With the clutch pedal fully depressed, the countershaft brake air line is connected to rapidly reduce the speed of driven members of the clutch as well as the transmission input shaft, countershaft gear and main shaft gear connected to it; after the gear is engaged, the vehicle will move up steadily. For vehicles without a countershaft brake, strange noise may be generated in the gear engagement; to realize the steady move-up, after the clutch pedal is depressed, wait for a further 3-5s and then engage any gear.

Hint:

The countershaft brake can be only applied at the move-up.

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TABLE OF FAULT PHENOMENA

The table below can assist you to find the failure. The number represents the sequence of occurrence of possible failures. Check each part as per this sequence, and provide replacement if necessary.

Symptoms of failure	Possible causes	Reference
Strange sound or noise	1. Poor quality of lubricating oil	Use the 85W-90 GL5 lubricating as required by the manufacturer
	2. Insufficient lubricating oil	Add oil
	3. Damages or excessive wear of gear tooth face to generate a large gap	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transmission
	4. Damages or crack of bearing	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transmission
	5. Improper engaging position between gearshift fork and gears	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transmission Control Mechanism
	6. Wear or damages of synchronizer	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transmission
	7. Damages of gear	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transmission
Difficult or failed gearshift of basic transmission	1. Wear or damages of bearing	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Basic Transmission
	2. Bending or burrs of fork and shaft	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transmission Upper Cover
	3. Looseness of retaining screw of fork	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transmission Upper Cover
	4. Abnormal disengagement of clutch	Chapter 32A: Testing and Adjustment, Clutch Assembly
	5. High viscosity of lubricating oil	Use the 85W-90 GL5 lubricating as required by the manufacturer
	6. Twisting of main shaft	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Second Shaft Assembly

TRANSMISSION (9JS180)-TRANSMISSION

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Symptoms of failure	Possible causes	Reference
Delayed or failed shifting operation in high and low gear ranges of splitter	1. Defects of pressure regulating valve	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transmission
	2. Failure of air pipe or union	Chapter 31B: Removal and Refitting, Transmission 9JS180-Double-H Control Mechanism
	3. Seizure of double-H air valve plunger	Chapter 31B: Removal and Refitting, Transmission 9JS180- Double-H Control Mechanism,
	4. Poor lubrication or damages of gear shifting cylinder O-shaped ring	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Splitter
	5. Looseness of cylinder piston nut	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Splitter
	6. Damages of cylinder piston	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Splitter
	7. Damages of synchronizer or spring	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Splitter
Disengagement or shift skipping of basic transmission	1. Deformation or wear of gearshift fork	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transission Upper Cover
	2. Wear of locking roller or of roller groove on gearshift fork shaft	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transission Upper Cover
	3. Breakage or fatigue of locking spring	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transission Upper Cover
	4. Over-large gap of gear	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transission
	5. Failure of engaging tooth or tooth sleeve reverse cone	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transission
	6. Wear of sliding part or end face of sliding shaft sleeve	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transission
	7. Axial runout due to the wear of bearing	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transission
	8. Looseness of flange lock nut	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Splitter
Section between auxiliary transmission high and low gear out of gear	1. Defects of pressure regulating valve	Replace the valve.
	2. Failure of air pipe or union	Chapter 31B: Removal and Refitting, Transmission 9JS180- Single-H Control Mechanism,
	3. Twisting of shaft; the gear is not located at the synchronized position	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transission
	4. Failure of engaging tooth or tooth sleeve reverse cone	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transission

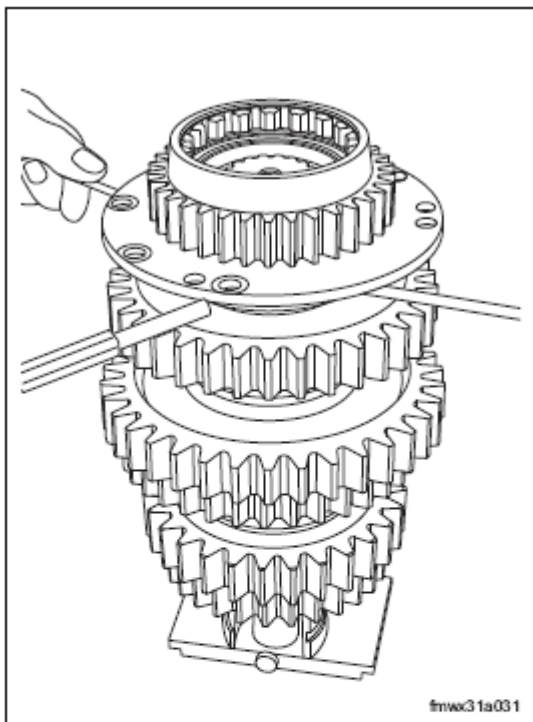
31B

31B-22**TRANSMISSION (9JS180)-TRANSMISSION**

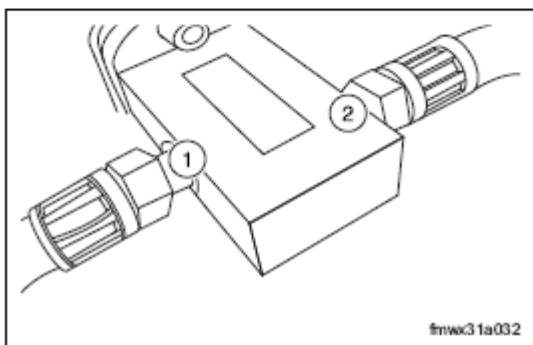
Symptoms of failure	Possible causes	Reference
Disorder of gears	1. Missing or worn interlock steel ball or interlock pin	Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transmission Upper Cover
Leakage of oil or air	1. Too much lubricating oil	Adjust the lubricating oil level to the standard value
	2. Damages or failures of seal parts	Chapter 31B: Testing and Adjustment, Transmission 9JS180-Transission
	3. Looseness of fasteners	Tighten fasteners
	4. Clogging of ventilating plug	Clean or replace the plug
	5. Absence of sealant on bolts	Apply the sealant, and refit mounting bolts

TESTING AND ADJUSTMENT

1. Check axial clearances of various gears of the second shaft



- (a) Place the second shaft vertically, and fit the reverse gear snap ring, the splitter drive gear assembly and its snap ring.
- (b) Use the thickness gauge to check the clearance between the reverse gear and drive gear.
Standard clearance: 0.3~0.9mm.
- (c) Check the axial clearance of second shaft low and reverse gears and second and third gears.
Standard clearance: 0.13~0.3mm.

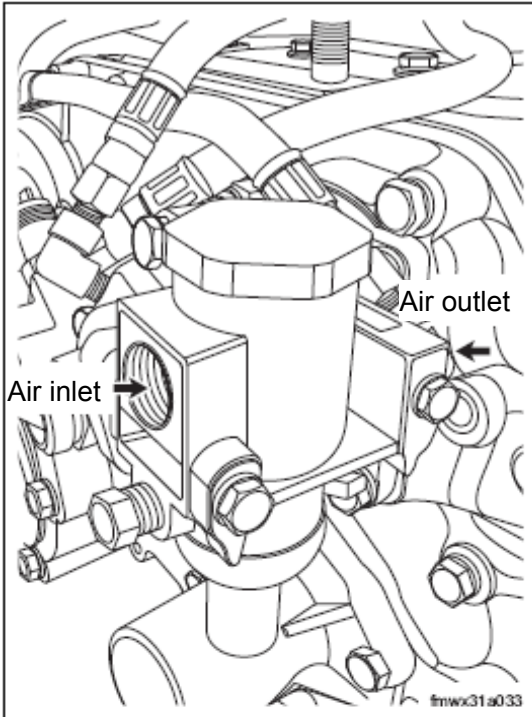


2. Testing of double-H air valve

- (a) Testing of appearance: The housing shall be in good conditions, and the plunger shall be able to move freely without significant wear.
- (b) Testing of passage: With the plunger at its original position, supply the compressed air, and it shall only flow from the outlet 4; with the plunger load reversed to the lowest position, supply the compressed air, and it shall only flow from the outlet 2.

Hint:

If any above-mentioned failure occurs, the air valve must be replaced.

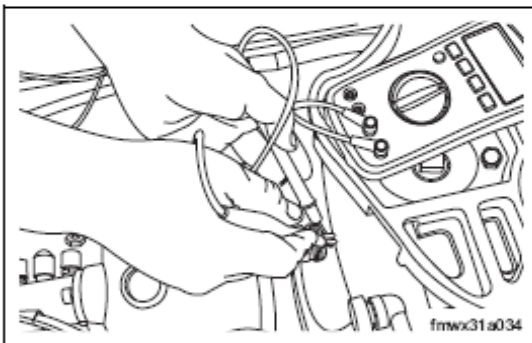


3. Testing of air filter regulator

- (a) Testing of appearance: Parts shall be free from defects or leakage.
- (b) Testing of pressure: With the vehicle pressure at 0.7-0.8Mpa, fit a pressure gauge at the outlet, and the reading on the gauge shall be 0.41-0.44Mpa.

Hint:

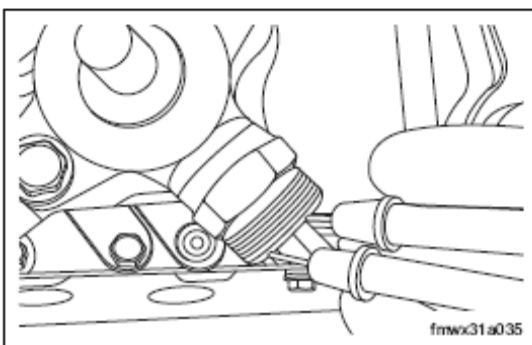
If the reading is not qualified, the air filter regulator must be replaced.



4. Testing of neutral gear switch

- (a) Testing of appearance: There shall be no such defects as deformation, damages or looseness of contact.
- (b) Testing of resistance: Use the multi-meter to test the resistance between both terminals of the switch.

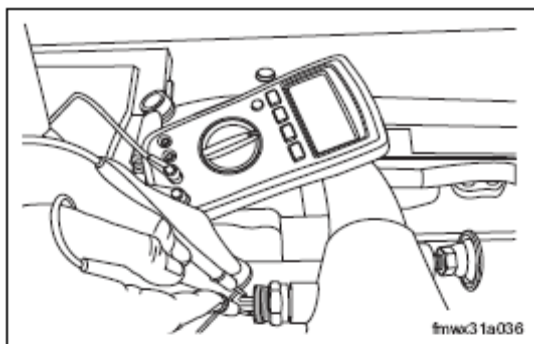
Gear	Contact resistance (Ω)
Neutral	<1
Others	∞



5. Testing of range gear switch

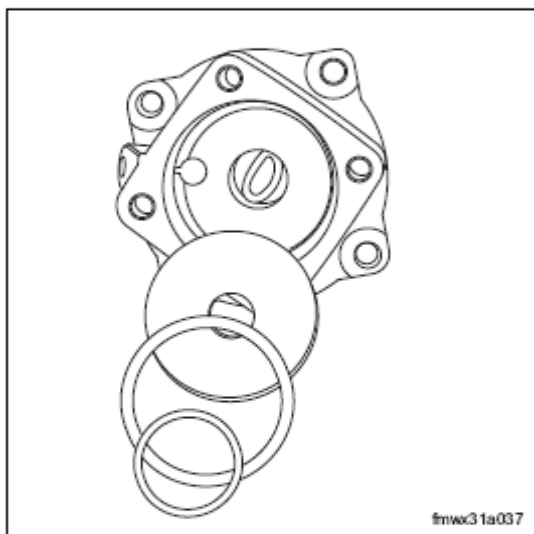
- (a) Testing of appearance: There shall be no such defects as deformation, damages or looseness of contact.
- (b) Testing of resistance: Use the multi-meter to test the resistance between both terminals of the switch.

Gear	Contact resistance (Ω)
Low gear	<1
High gear	∞



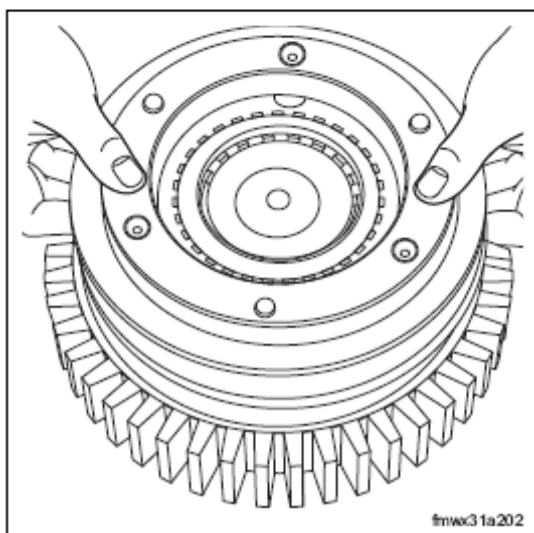
6. Testing of reverse gear switch
- (a) Testing of appearance: There shall be no such defects as deformation, damages or looseness of contact.
- (b) Testing of resistance: Use the multi-meter to test the resistance between both terminals of the switch.

Gear	Contact resistance (Ω)
Reverse gear	<1
Other gear	∞



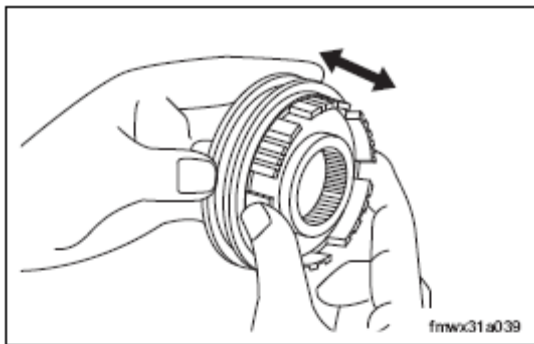
7. **Testing of splitter gear shifting cylinder**
- (a) Check the O-shaped ring or other seals for damages, deformation, poor lubrication or improper installation.

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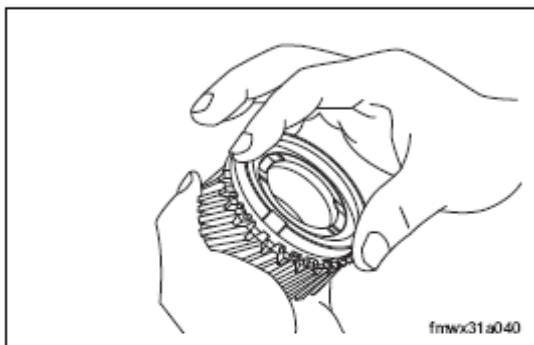


8. **Check of high and low gear synchronizer**
- (a) Check the coordination between the synchronizer and splitter output shaft.

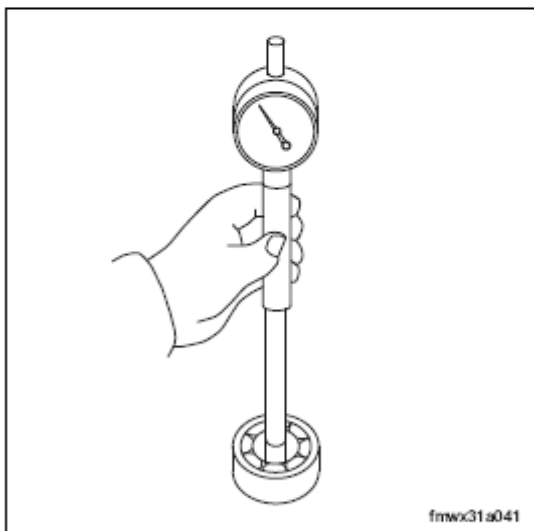




- (b) Check the synchronizer key groove and locking pin for wear.

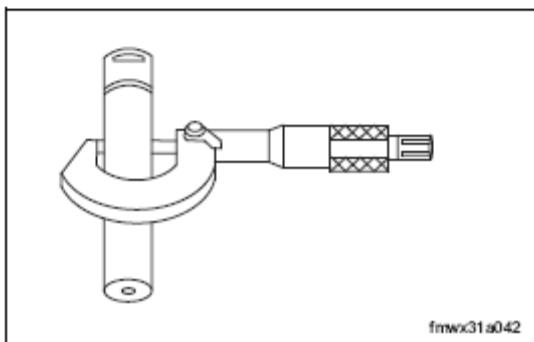


- (c) Check the synchronizer ring gear for crack and deformation.



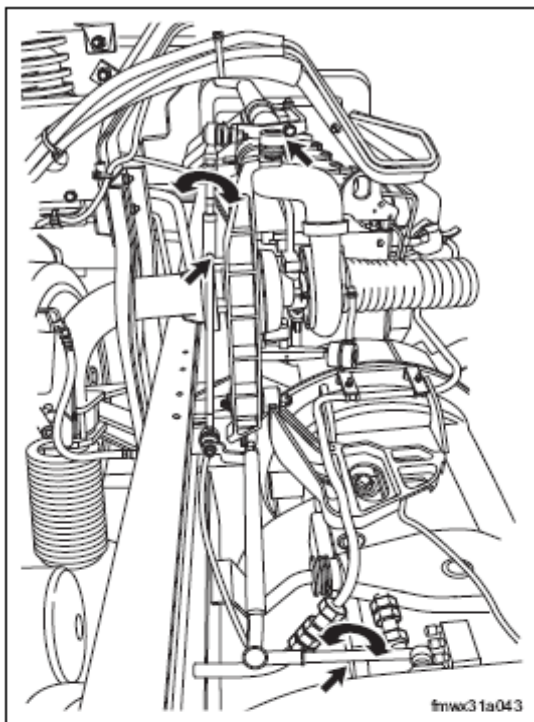
9. Check of bearing

- (a) Wash all bearings in the clean solution, and check the steel ball, roller and bearing rolling way for pit corrosion or scaling.
- (b) Measure the internal diameter of the bearing.
- (c) If the measurement exceeds limits, replace the bearing.



10. Measurement of reverse gear shaft diameter

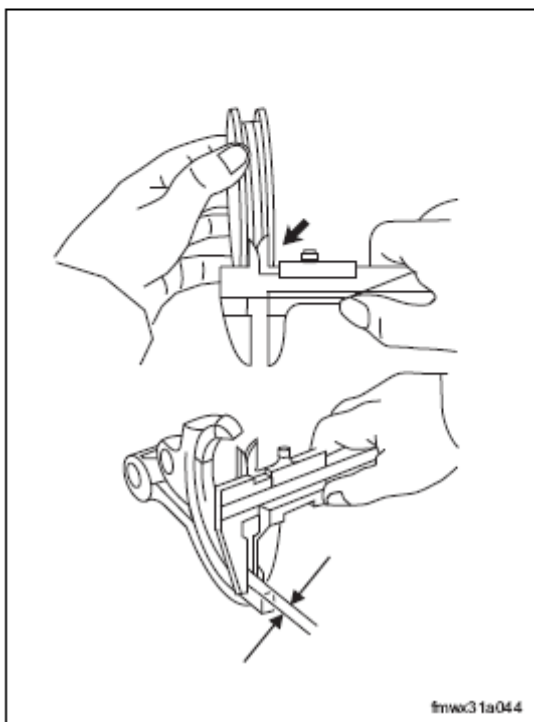
- (a) Use the micrometer to measure the reverse gear shaft diameter.
- (b) If the measurement exceeds the limit, replace the reverse gear shaft.



11. Adjustment of transmission gearshift control mechanism

- (a) The technician A holds the gearshift handle at the central position in the cab.
- (b) The technician B undoes the telescopic rod assembly or gearshift lever assembly adjusting nut, and adjust the gear to the best position.
- (c) Tighten the nut.

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12. Measurement of clearance between ring gear and fork

- (a) Use the micrometer to measure the ring gear dimensions.
- (b) Use the micrometer to measure the fork dimensions.

Hint:

If the clearance exceeds the limit, replace the corresponding ring gear and fork.

13. Check of gears

- (a) Check the gear tooth face for pit corrosion; if any, replace the gear concerned.
- (b) Check all engaging teeth. If the gear is such worn that it tapers off or its engaging length is reduced due to impacts in the shifting operation, the gear shall be replaced.
- (c) Check axial clearance of the gear. For parts with an excessive clearance, check the gear split ring, washer, adjusting shim and gear flange for excessive wear. The axial clearance for the second shaft direct gear shall be 0.13~0.30mm and that of the reverse gear shall be 0.30~0.90mm.

14. Check of spline

- (a) Check the wear degree of splines on all shafts. If the sliding tooth sleeve and output flange disc inclines toward the spline due to wear, it shall be replaced.

15. Check of thrust washer

- (a) Check the conditions of surfaces of all thrust washers, and replace those which are scratched or have reduced thicknesses.

16. Check of grey cast iron parts

- (a) Check all grey cast iron parts for crack or damages. Large castings can be provided with fusion welding or brazing, but the thermal crack shall not extend to the bearing hole or bolt connecting surface.

17. Check of bearing cover

- (a) Check the wear conditions of the spigot.
- (b) Check the oil seals in both the first shaft bearing cover and in the odometer housing; if the lip becomes ineffective with respect to the sealing performance, seals must be replaced.

18. Check of sliding sleeve

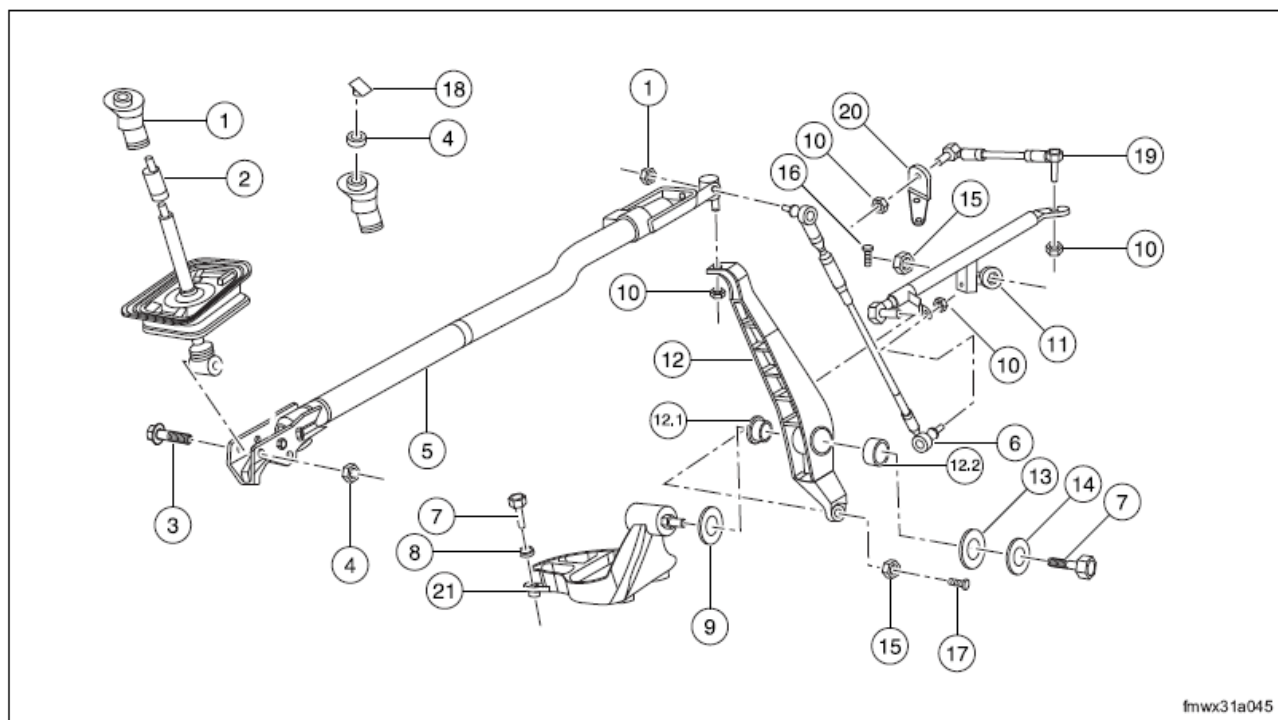
- (a) Check all forks and fork grooves of sliding sleeve for excessive wear or discoloring due to overheating.
- (b) Check the meshing tooth of the sliding sleeve for any inclination of the contact zone.

19. Check of O-shaped rings

- (a) Check all O-shaped rings for breakage and deformation; if worn or aged, the replacement shall be provided.

TRANSMISSION CONTROL MECHANISM

DIAGRAM OF COMPONENTS



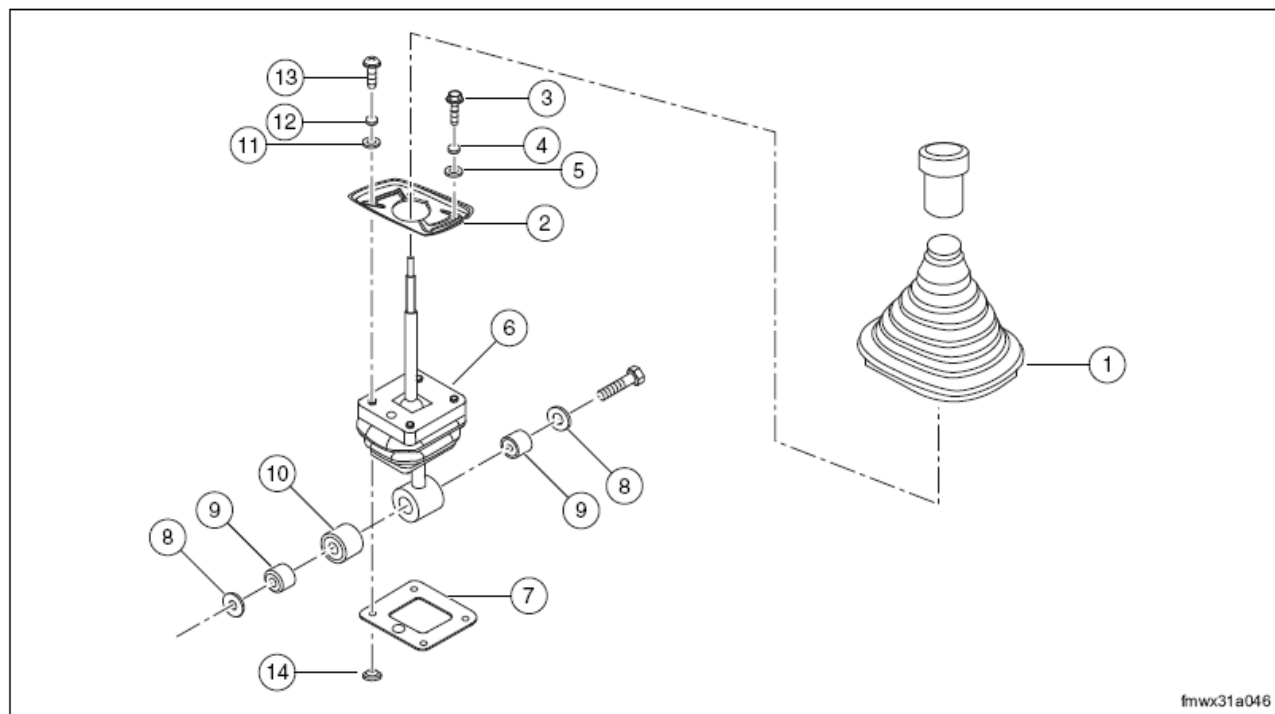
31B

1	Handle ball assembly
2	Locking ring
3	Hexagon flange bolt
4	Fully-metallic hexagon flanged lock nut
5	Telescopic rod assembly
6	Gear selector lever assembly
7	Hexagon head bolt
8	Spring washer
9	Noise-reducing washer
10	Type 1 fully-metallic hexagon lock nut
11	Gear selector lever assembly
12	Gear selector rocker arm assembly

12.1	Straight lining
12.2	L-shaped lining
13	Sealing gasket
14	Thick washer
15	Hexagon slotted thin nut
16	Slotted pin
17	Slotted pin
18	Gear plate
19	Gear selector rear strut assembly
20	Gear selector bracket
21	Tetragonal bracket assembly

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TRANSMISSION (9JS180)-TRANSMISSION CONTROL MECHANISM

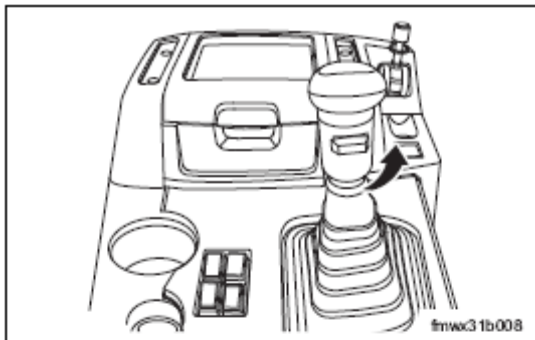


1	Upper dustproof cover
2	Upper pressure plate
3	Hexagon bolt
4	Plain washer
5	Spring washer
6	Controller assembly
7	Lower pressure plate

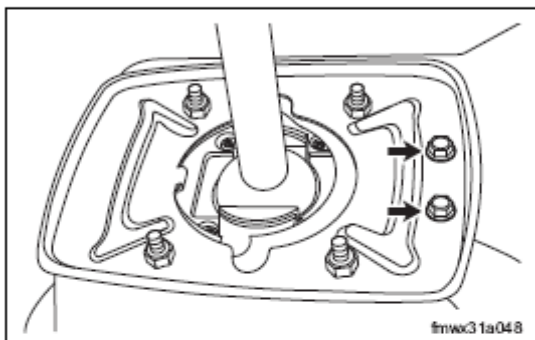
8	Sealing gasket
9	Composite bushing
10	Intermediate spacer
11	Spring washer
12	Plain washer
13	Hexagon bolt & external toothed lock washer assembly
14	Fully-metallic hexagon flanged lock nut

REMOVAL AND INSTALLATION

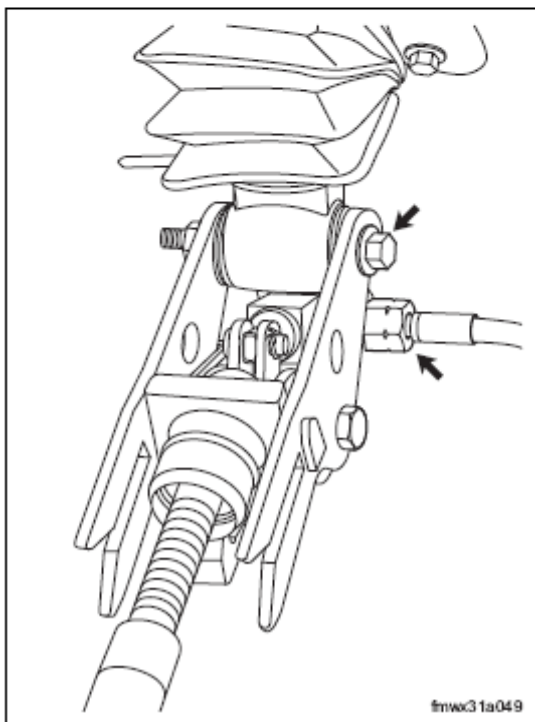
1. Removal of gearshift control mechanism



- (a) Remove the gear plate, and undo the lock nut.
- (b) Remove the dustproof cover.



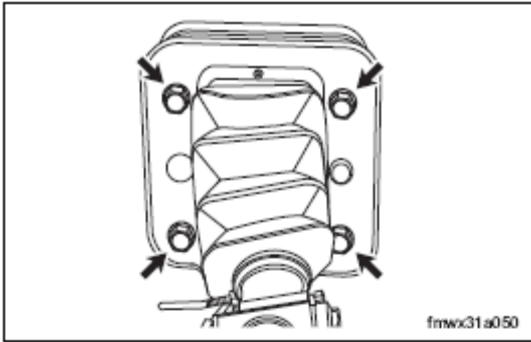
- (c) Remove the upper pressure plate lock bolt.



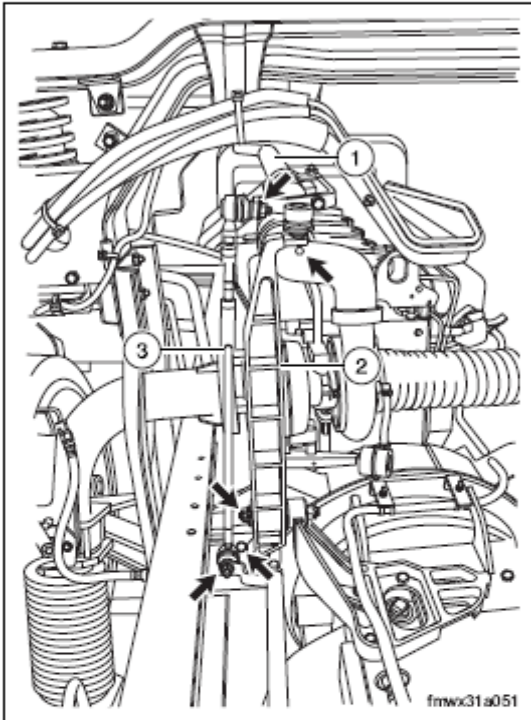
- (d) Disconnect the lubricating oil pipe.
- (e) Disconnect the connecting bolt between the controller and telescopic rod.

31B-32

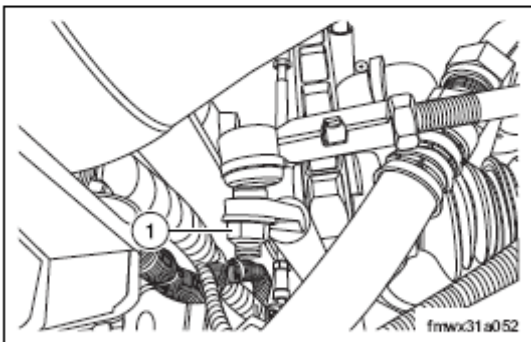
TRANSMISSION (9JS180)-TRANSMISSION CONTROL MECHANISM



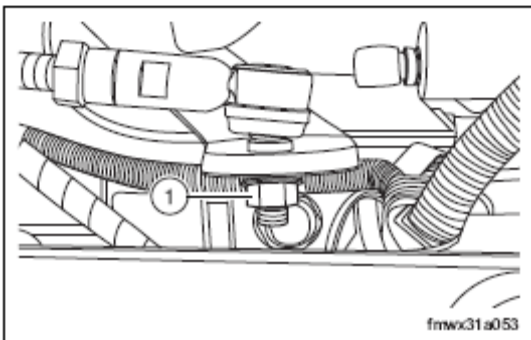
- (f) Remove those 4 lock bolts of the lower pressure plate.
- (g) Remove the lower pressure plate and lower dustproof cover in order.
- (h) Remove the gearshift controller assembly.



- (i) Remove the gearshift telescopic rod 1.
 - Remove the connecting nut and then the telescopic rod.
- (j) Remove the gear selector lever assembly 3.
 - Remove the connecting nut, and remove the gear selector lever assembly.
- (k) Remove the gearshift rocker arm assembly 2.
 - Remove the slotted pin and connecting nut, and then the gearshift rocker arm assembly.

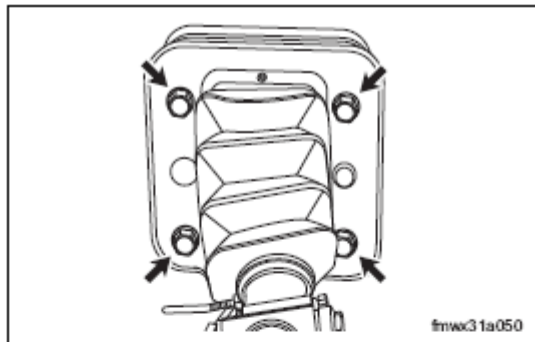


- (l) Remove the gearshift lever assembly.
 - Remove the gearshift lever assembly connecting nut 1 and then the gearshift lever assembly.



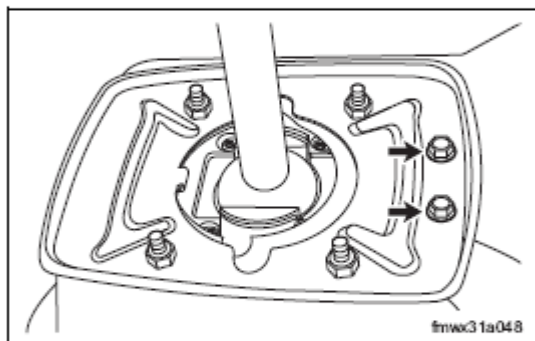
- (m) Remove the gear selector rear strut assembly.
 - Remove the gear selector rear strut assembly connecting nut 1 and then the rear strut assembly.

2. Installation of gearshift control mechanism



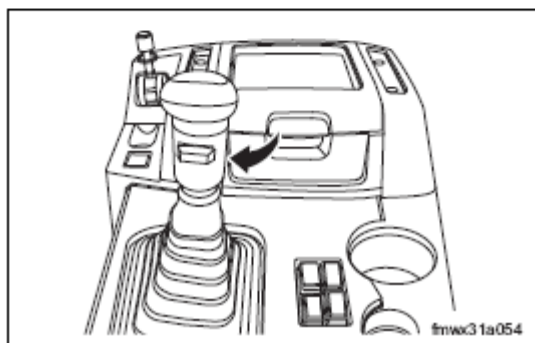
- (a) Refit the gearshift controller assembly
- Install the dustproof cover and both upper and lower pressure plates, and tighten these 4 bolts.

Torque: $21 \pm 5 \text{ N.m}$



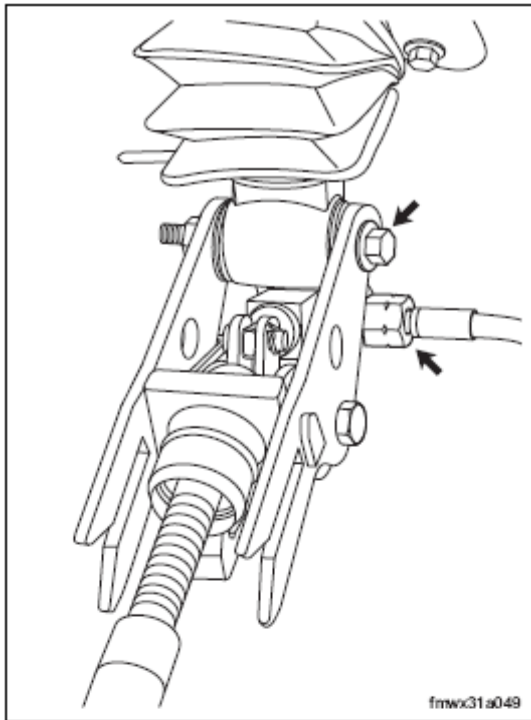
- (b) Refit these 2 bolts of the upper pressure plate.

Torque: $9 \pm 3 \text{ N.m}$



- (c) Refit the dustproof cover, handle ball, lock nut and gear plate in order.

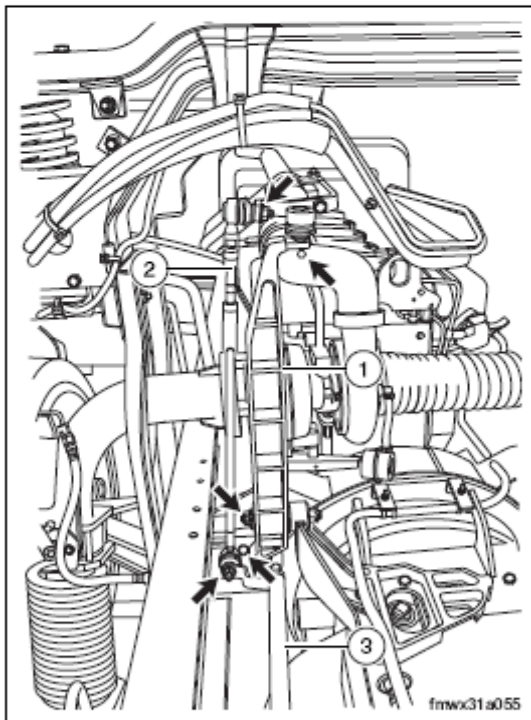




- (d) Refit the telescopic rod assembly.
- Connect the telescopic rod and gearshift controller, and tighten the connecting bolt.

Torque: 64N.m

- Connect the lubricating oil pipe.



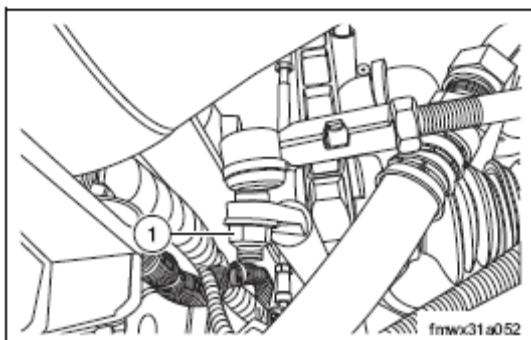
- (e) Refit the gearshift rocker arm assembly 1.
- Attach the gearshift rocker arm assembly 1 onto the tetragonal bracket assembly, tighten the nut, and put on the slotted pin.
 - Connect the telescopic rod and gearshift rocker arm assembly, and tighten connecting nuts.

Torque: 95N.m

- (f) Refit the gearshift lever assembly 2.
- Connect the gear selector lever 2 and the telescopic rod, and tighten connecting nuts.

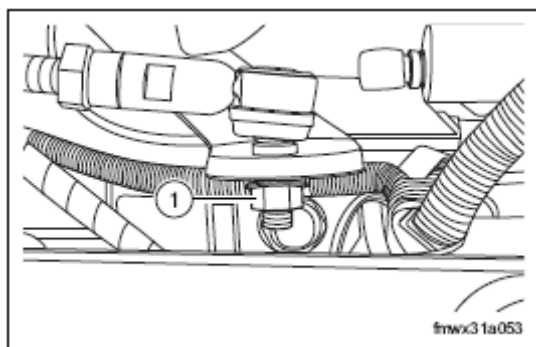
Torque: 95N.m

- (g) Refit the gearshift lever assembly 3.
- Connect the gear selector lever assembly 2 and gearshift lever assembly 3, and tighten connecting nuts.
 - Connect the gearshift lever assembly 3 and gearshift rocker arm assembly 1, tighten connecting nuts, and put on the slotted pin.



- (h) Refit the gear selector rear strut assembly
- Connect the gear selector rear strut assembly and gearshift lever assembly, and tighten nuts.

Torque: 95N.m

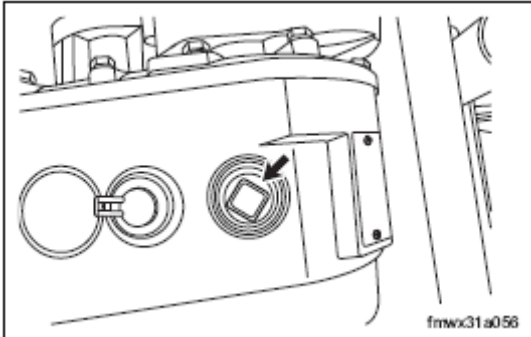


- (i) Refit the gear selector lever assembly onto the gear selector bracket, and tighten connecting nuts.
Torque: 95N.m

TRANSMISSION ASSEMBLY

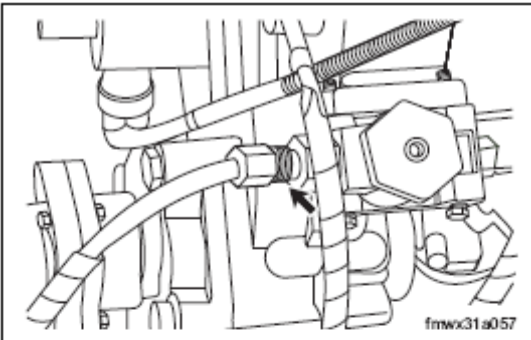
REPLACEMENT

1. Disconnect the battery negative cable.



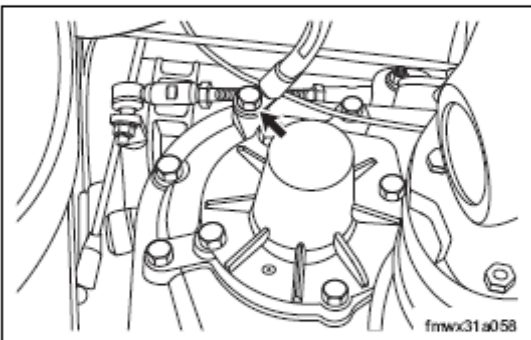
2. Remove the drain plug at the bottom of transmission to discharge all transmission oil, and then fasten the drain bolt.
Torque: $68 \pm 7 \text{ N.m}$

3. Remove the intermediate drive shaft. Refer to Chapter 33 Service, Drive Shaft-Intermediate Drive shaft.

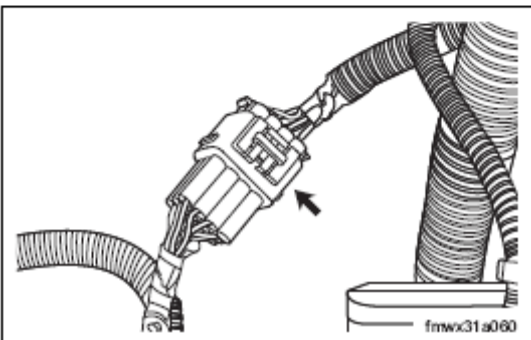


4. Disconnect the transmission from other components.

- (a) Remove the air filter regulator air pipe assembly.

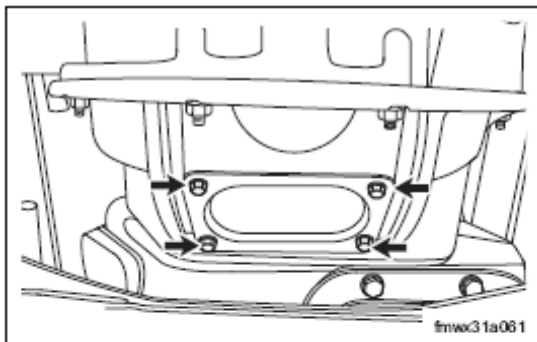


- (b) Remove the transmission earthing cable.

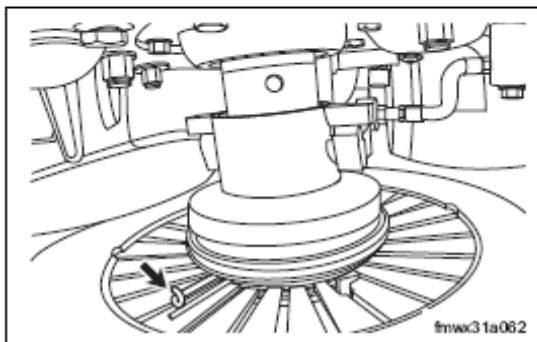


- (c) Disconnect the transmission grouped plug.

5. Remove the transmission gearshift control mechanism assembly. Refer to Chapter 31B Disassembly and assembly, Transmission 9JS180-Transmission Control Mechanism.

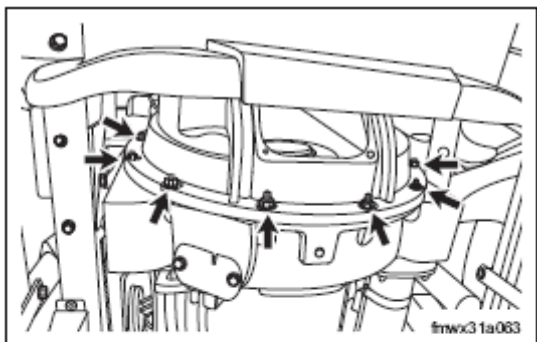


6. **Remove the clutch inspection hole cover plate.**
(a) Remove these 4 bolts and then the cover plate.

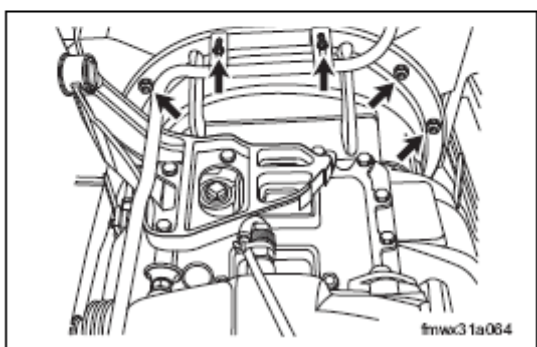


7. **Disconnect the hook of spring retainer of the clutch throw-out bearing.**

8. **Remove the clutch slave cylinder. Refer to Chapter 32: Service, Clutch-Clutch Slave Cylinder.**

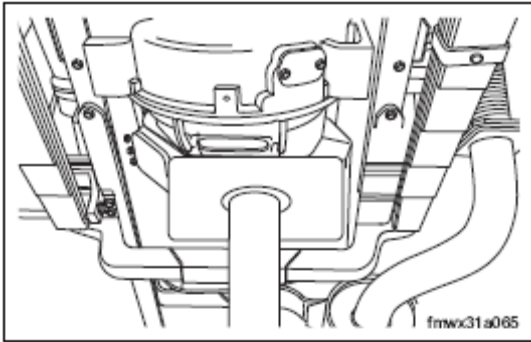


9. **Disconnect the transmission from the engine.**
(a) Remove the lower connecting bolts between the transmission and engine.



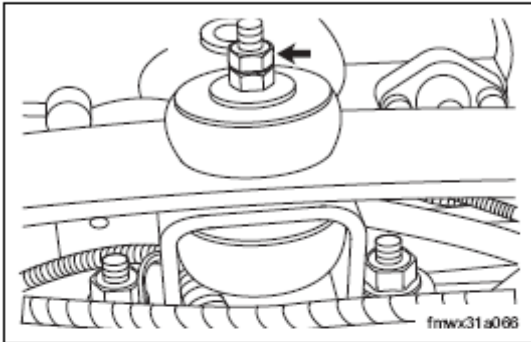
- (b) Remove the upper connecting bolts between the transmission and engine.

10. **Remove the sub-frame.**

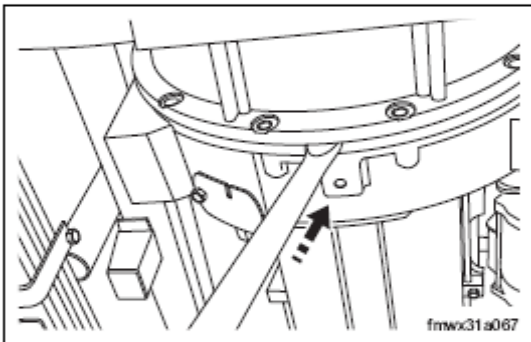


11. Remove the transmission assembly.

- (a) Use the transmission hydraulic jack to raise the transmission assembly.

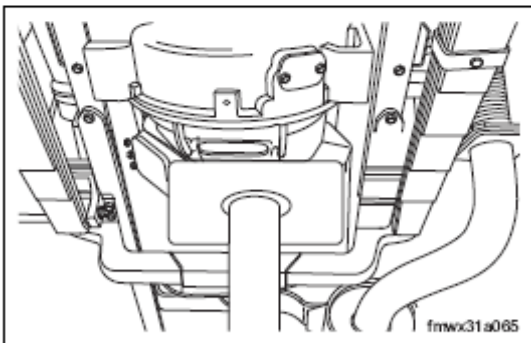


- (b) Remove the connecting nut of the transmission mounting and then the spring beam.



- (c) Use the flat pry bar to separate the transmission assembly from the engine.

- (d) Lower the transmission assembly.

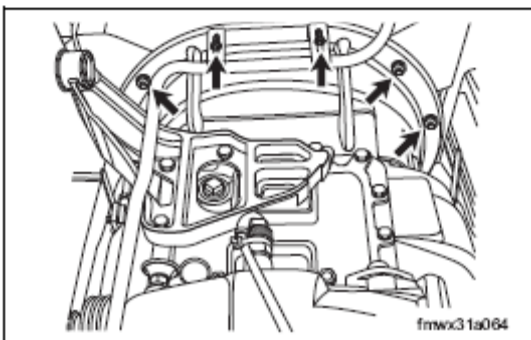


12. Refit the transmission assembly.

- (a) Connect the transmission assembly and engine assembly.

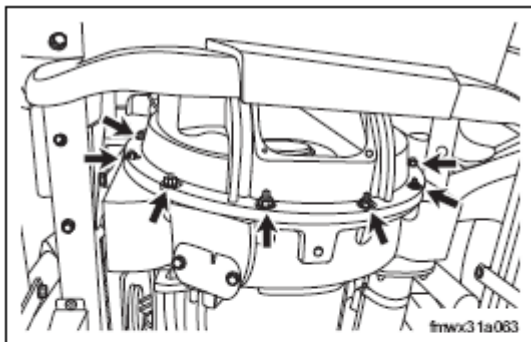
Hint:

Prior to the refitting operation of transmission assembly, the hook of spring retainer of the clutch must be engaged. Move the spring retainer and check whether it can move flexibly on the throw-out ring; if not flexible, refit it again; otherwise it may be not allowed to install the throw-out bearing.

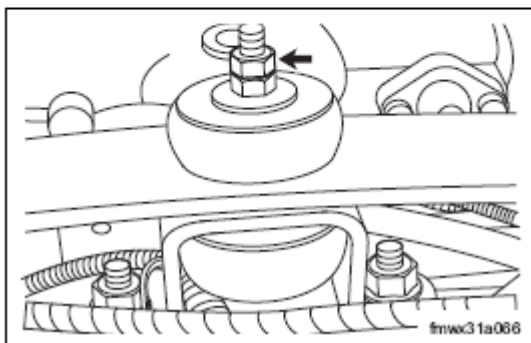


13. Refit connectors between the transmission and engine.

- (a) Tighten upper connecting bolts of the transmission.

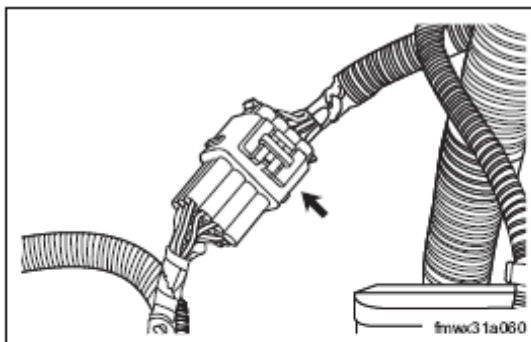


- (b) Tighten lower connecting bolts of the transmission.

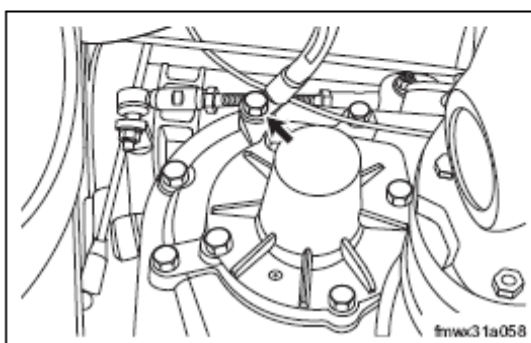


14. Refit the transmission spring beam, and tighten the mounting connecting nuts.
Torque: 240N.m

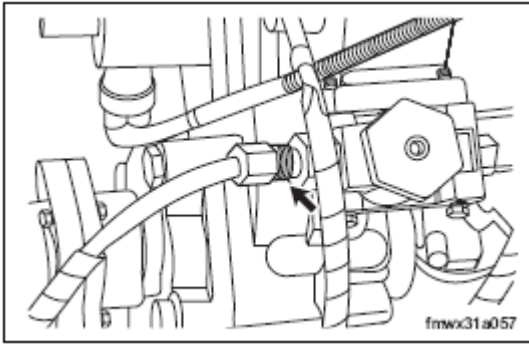
15. Refit the transmission gearshift control components. Refer to Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transmission Control Mechanism.



16. Refit the transmission accessories.
(a) Connect the transmission grouped plug.

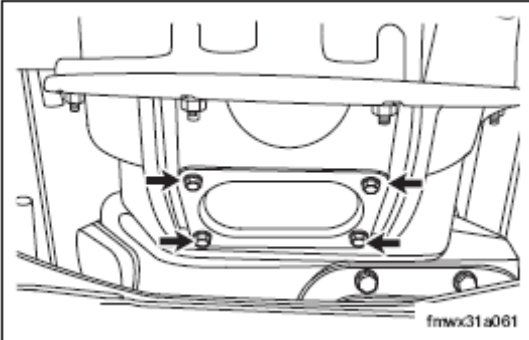


- (b) Refit the transmission earthing cable, and tighten the bolt.
Torque: 54.5±7N.m



- (c) Refit the air filter regulator air pipe assembly.

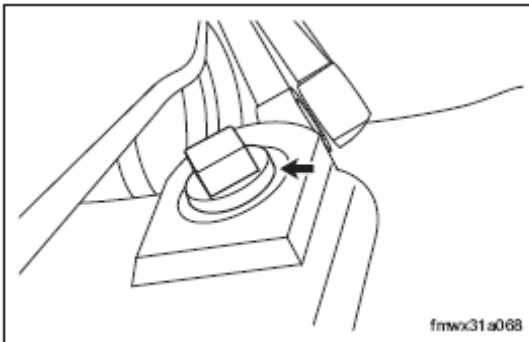
17. Refit the clutch slave cylinder. Refer to Chapter 32: Service, Clutch-Clutch Slave Cylinder.



18. Refit the clutch inspection hole cover plate.
(a) Refit the clutch inspection hole cover plate, and tighten 4 bolts.
Torque: 23.5±3.5Nm.

19. Refit the intermediate drive shaft. Refer to Chapter 33: Service, Drive Shaft-Intermediate Drive shaft.

20. Refit the battery negative cable.



21. Remove the transmission middle filler plug, fill the transmission oil 85W/90GL-5, and tighten the filler bolt.

Amount of transmission oil: 13L

Precautions:

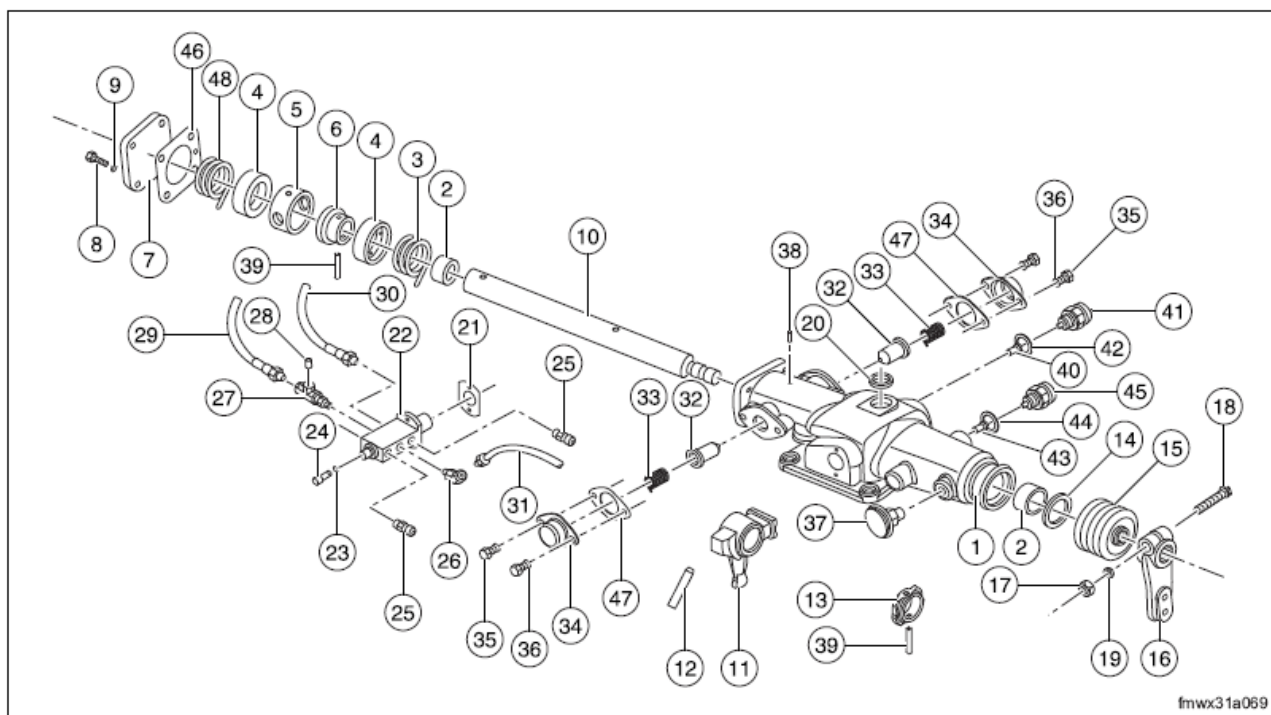
After the refilling operation is finished, run the transmission for several minutes, and then check the transmission oil level again.

22. **Transmission running-in specification and tests**

- (a) The speed shall be 1500r/min or so, with the oil temperature no lower than 15°C, at zero load; run the engine at neutral gear for at least 15min and at other gears for at least 20min.
(b) Check whether the gearshift operation is easy and whether the gear can be fully engaged. In the gearshift operation, there shall be no impact noise from the gear.
(c) The transmission gearshift lever shall not shake noticeably.
(d) In the transmission test, there shall be no abnormal friction or impact noise.
(e) There shall be no oil leakage in the transmission.
(f) After the running-in, discharge the transmission oil, and thoroughly clean the transmission inside, and fill the oil as required.

DOUBLE-H CONTROL MECHANISM

DIAGRAM OF COMPONENTS



31B

1	Double-H control device housing
2	Lateral gearshift lever sleeve
3	Compression spring
4	Spring seat
5	Spring spacer
6	Positioning ring
7	Side board
8	Small hexagon bolt M8x22
9	Spring washer
10	Lateral gearshift lever
11	Shifting block
12	Cylindrical pin
13	Low and reverse gear switch control block
14	Oil seal
15	Sleeve
16	LRC external gearshift arm
17	Small hexagon nut M10x1

25	Ventilating plug
26	45° bend union
27	Tee pipe union
28	Hexagon conic screw plug
29	Air pipe assembly
30	Air pipe assembly
31	Air pipe assembly
32	Positioning plunger
33	Compression spring
34	Spring pressure cover
35	Small hexagon bolt M8x12
36	Spring washer
37	Ventilating plug
38	Retaining screw
39	Pin 6x36.5
40	Neutral gear switch plunger
41	Pressure switch

31B-42**TRANSMISSION (9JS180)-SINGLE-H CONTROL MECHANISM**

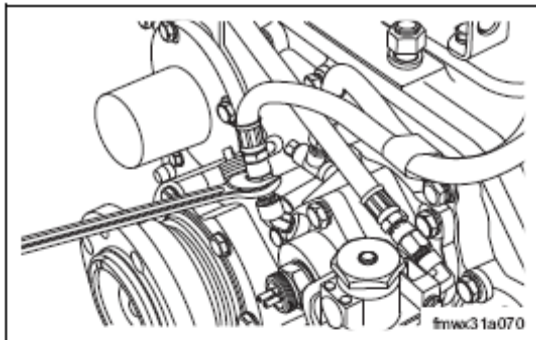
18	Small hexagon bolt M10x50
19	Washer
20	Cup-shaped insert
21	Double-H air valve lining
22	Double-H air valve
23	Spring washer
24	Internal hexagon screw

42	Gasket
43	Switch starting pin
44	Gasket
45	Pressure switch
46	End pad
47	Lining
48	Compression spring

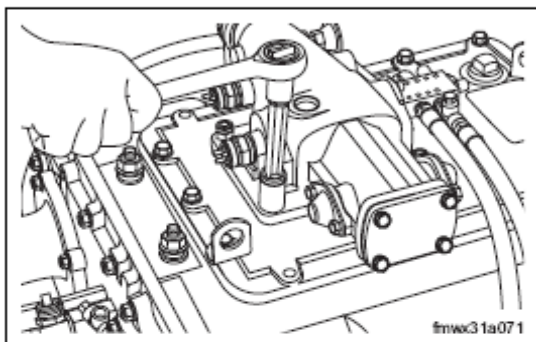
31B**FOTON**

REMOVAL AND INSTALLATION

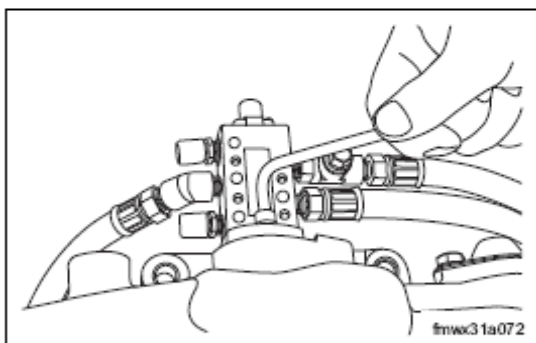
1. Remove the double-H control mechanism



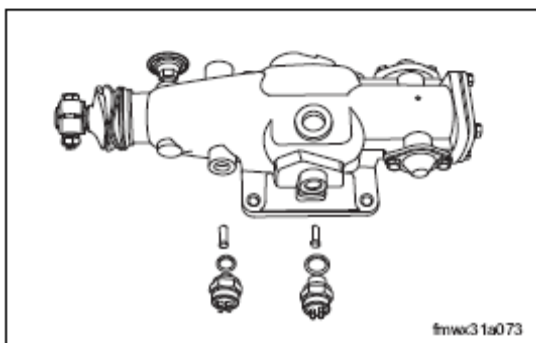
- (a) Remove these three air pipes and two air filter bolts.



- (b) Remove these four nuts on the double-H assembly.
(c) Loosen the double-H assembly housing by knocking it with a copper rod.



- (d) Remove the double-H control assembly from the transmission, and use the internal hexagon spanner to remove the double-H air valve and air pipe.

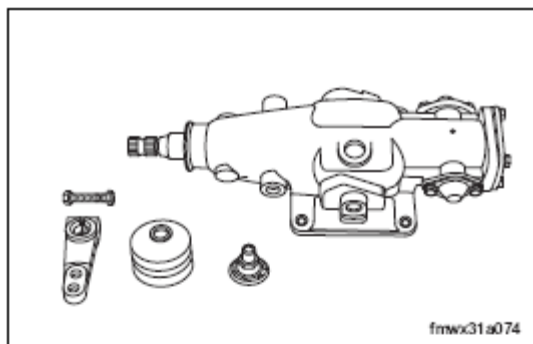


- (e) Remove the reverse & neutral gear switch and plunger.

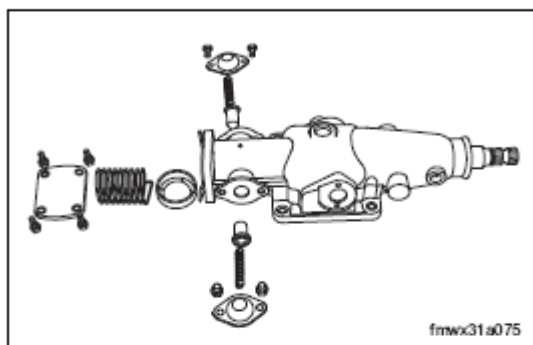
31B

31B-44

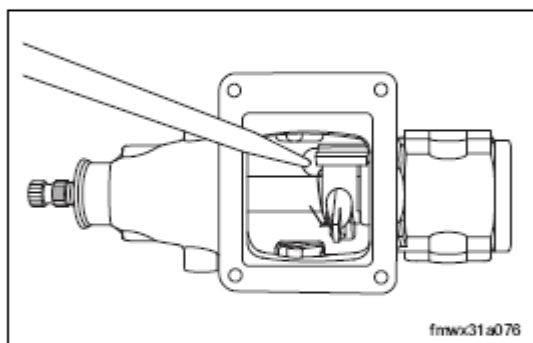
TRANSMISSION (9JS180)-SINGLE-H CONTROL MECHANISM



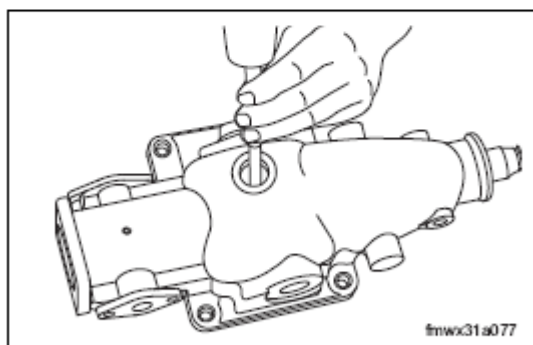
- (f) Remove the gearshift rocker arm, dustproof cover and ventilating plug in order.



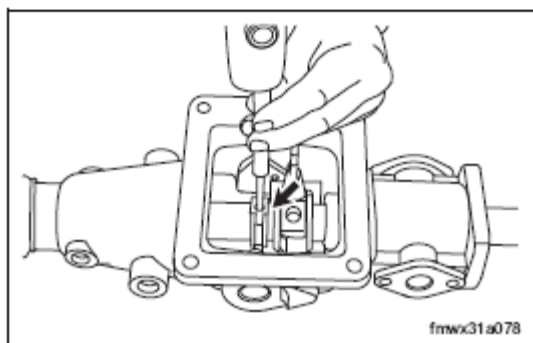
- (g) Remove the side board and spring seats on both sides, and take out the spring, positioning plunger etc.



- (h) Remove the cup-shaped insert and the lock wire on the shifting block.

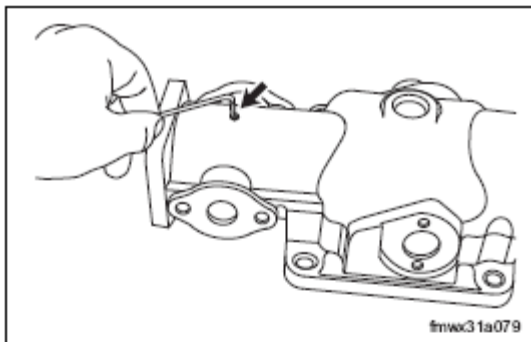


- (i) Remove the cylindrical pin by knocking it with a proper tool.



- (j) Remove the flexible pin on the lateral gearshift lever.

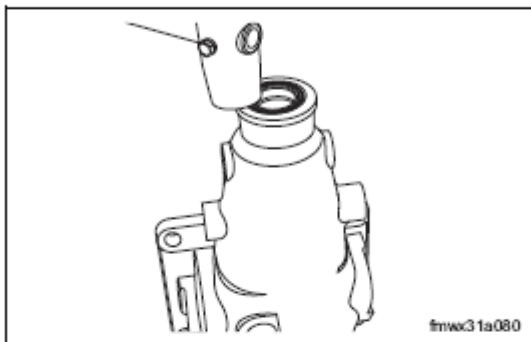




- (k) Remove the retaining screw, and take out another set of springs and spring seats in the double-H housing.

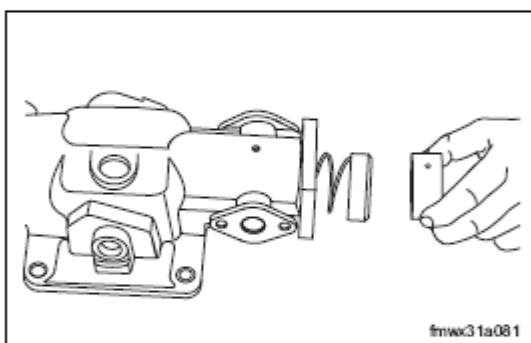
Hint:

Of these two springs, the one closer to the housing insider is shorter.

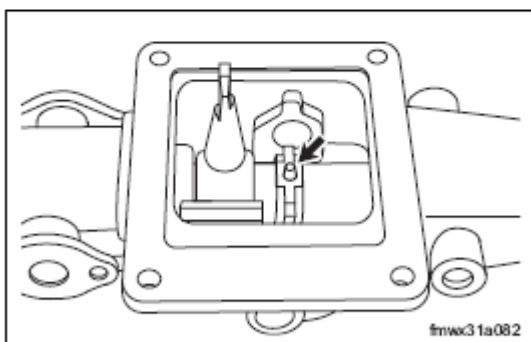


2. Refitting of double-H control mechanism

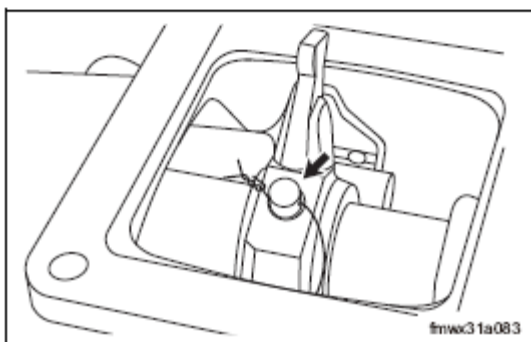
- (a) Fit the oil seal, and apply grease onto the edge.



- (b) Fit the spring, spring seat and spacer into the double-H housing and lock them with retaining screws.
- (c) Fit the flexible pin on the positioning ring. Pay attention to the direction of this ring.



- (d) Fit the lateral gearshift lever into the housing, and mount the flexible pin on the reverse gear control block.

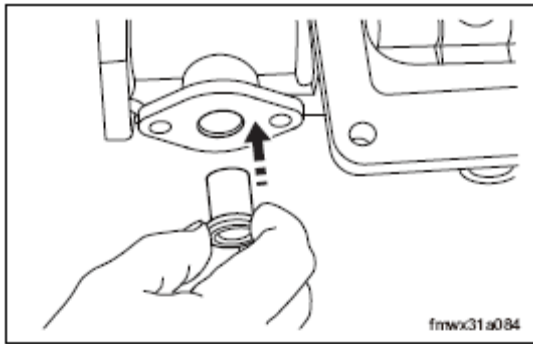


- (e) Fit the cylindrical pin on the shifting block, and fix it with iron wire.

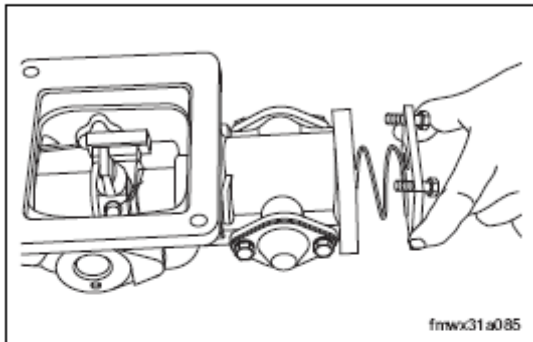


31B-46

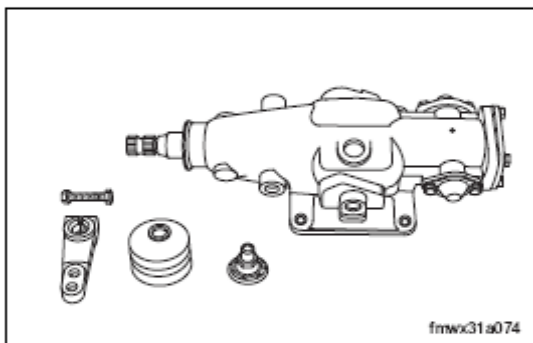
TRANSMISSION (9JS180)-SINGLE-H CONTROL MECHANISM



- (f) Fit plungers, springs and spring seats on both sides, and initially lubricate the plunger.



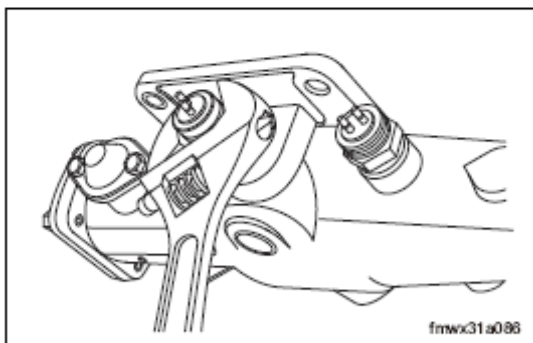
- (g) Fit the spring seats and springs, and install the side board.



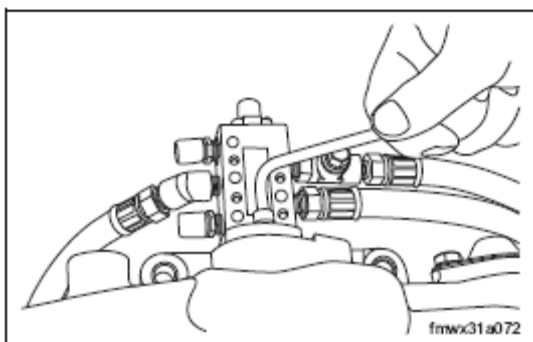
- (h) Fit the dustproof cover and gearshift rocker arm.

Notice:

Ensure that the rocker arm is located on the same line with the shifting block.



- (i) Fit the reverse & neutral gear switch and plunger.
Torque: $23 \pm 3 \text{ N.m}$

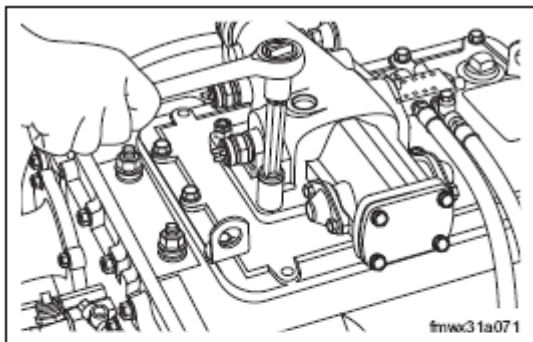


- (j) Use the internal hexagon spanner to fit these two positioning bolts of the double-H valve.

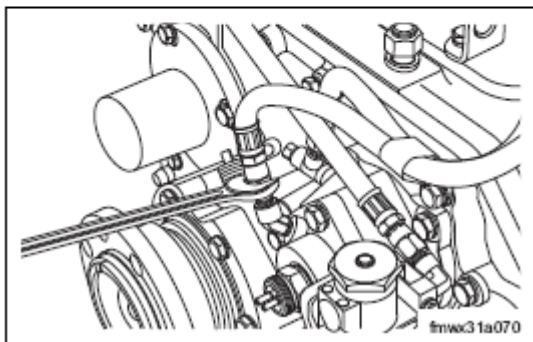
Torque: $17 \pm 3 \text{ N.m}$

Notice:

The mating surface shall be coated with sealant.



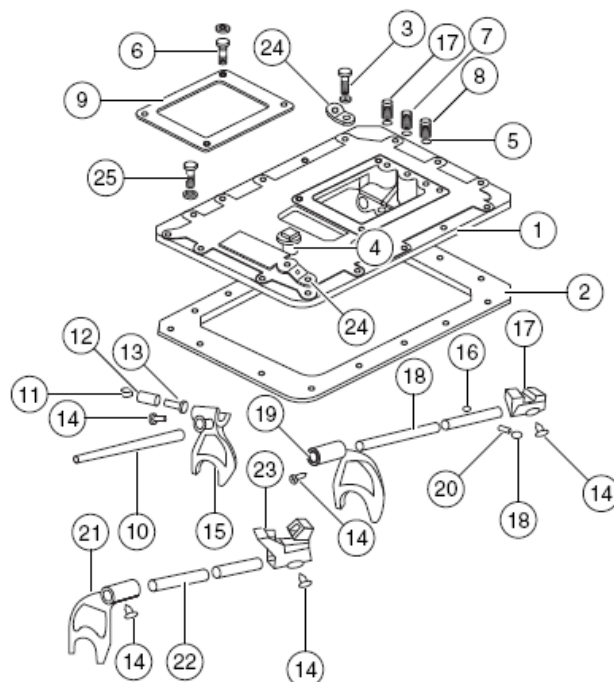
(k) Fit these four nuts on the double-H assembly.



(l) Fit these three air pipes and two air filter bolts.

TRANSMISSION UPPER COVER

DIAGRAM OF COMPONENTS



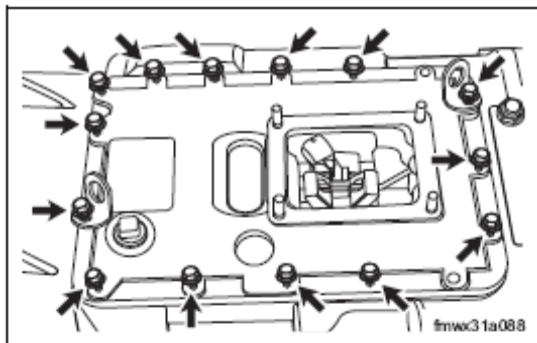
fmwx31a087

1	Upper cover
2	Upper cover lining
3	Small hexagon bolt (M10x38)
4	Square head taper screw plug
5	Steel ball (12.7000G1000b)
6	Stud
7	Compression spring
8	Compression spring
9	Control window lining
10	Low & reverse gear fork shaft
11	Reverse gear lock screw plug
12	Reverse gear lock spring
13	Reverse gear lock plunger

14	Gearshift fork lock screw
15	Low & reverse gear fork
16	Stall ball (19.0500G1000b)
17	1/2 and 5/6 guide block
18	1/2 fork shaft
19	1/2 fork
20	Fork shaft interlock pin
21	3/4 fork
22	3/4 fork shaft
23	3/4 and 7/8 guide block
24	Hoisting bent plate
25	Small hexagon bolt (M10x32)

DISASSEMBLY AND ASSEMBLY

1. Remove the transmission double-H control mechanism. Refer to Chapter 31B: Disassembly and assembly, Transmission 9JS180-Double-H Control Mechanism.

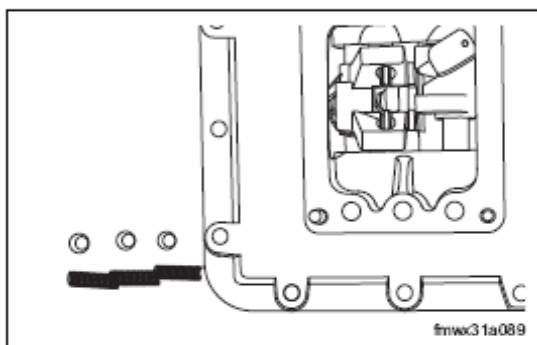


2. Remove the upper cover assembly.

- (a) Remove the upper cover lock bolt.
- (b) Separate the upper cover from the lining by knocking it with a copper rod.

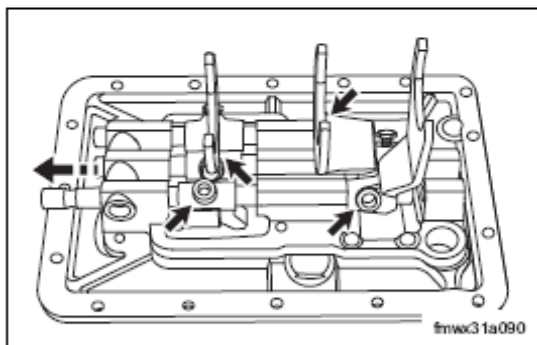
Notice:

Avoid overexertion when knocking the upper cover, and do knock the perimeter evenly.

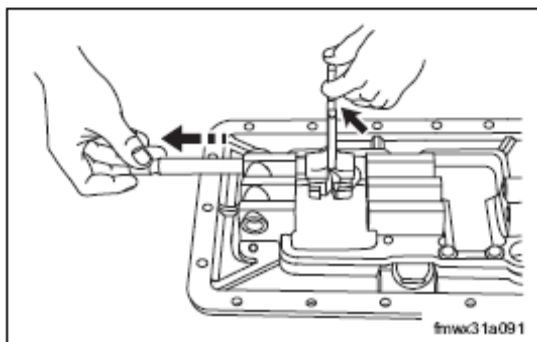


- (c) Remove the upper cover from the transmission, and take out the gearshift self-lock steel ball and spring.
- (d) Remove these four studs.

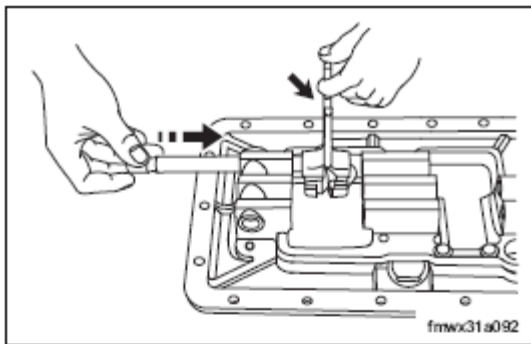
31B



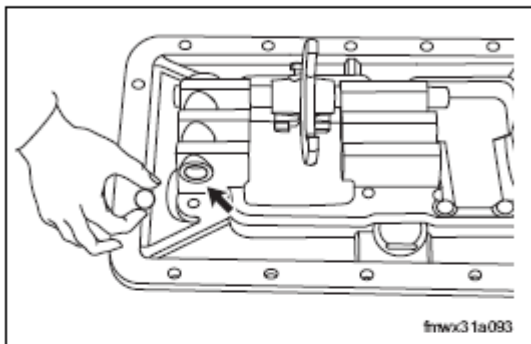
- (e) Turn over the upper cover assembly, and remove the 3/4 fork shaft, guide block and 3/4 fork.
- (f) Remove the 1/2 fork shaft, guide block, 1/2 fork and interlock pin.



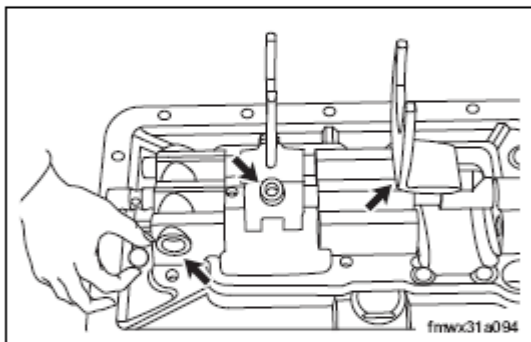
- (g) Remove the low & reverse gear fork shaft and fork.



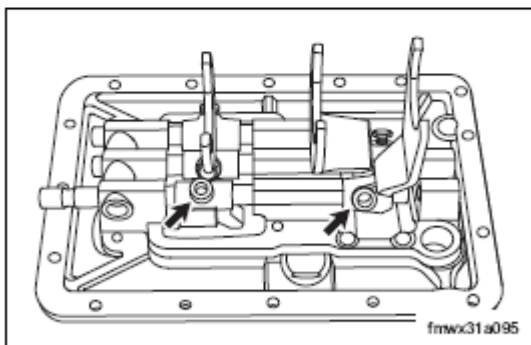
- 3. Reassemble the upper cover assembly.**
(a) Fit the low & reverse gear fork and fork shaft.



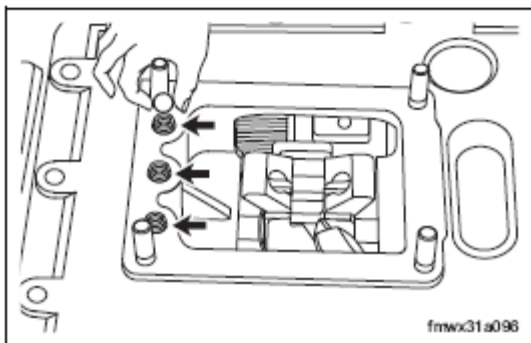
- (b) Fit one interlock steel ball.



- (c) Fit the 1/2 fork shaft, guide block and 1/2 fork, and fit the interlock pin and interlock steel ball.



- (d) Fit the 3/4 fork shaft, guide block, fork, fasten the bolt and bind it with iron wire.

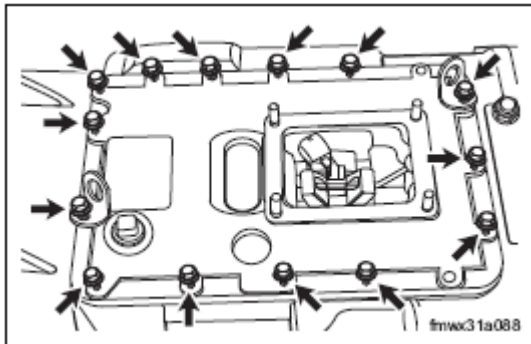


- (e) Fit these 4 studs and self-lock steel ball and spring.

Notice:

The spring in the 3/4 fork shaft hole is coarser.





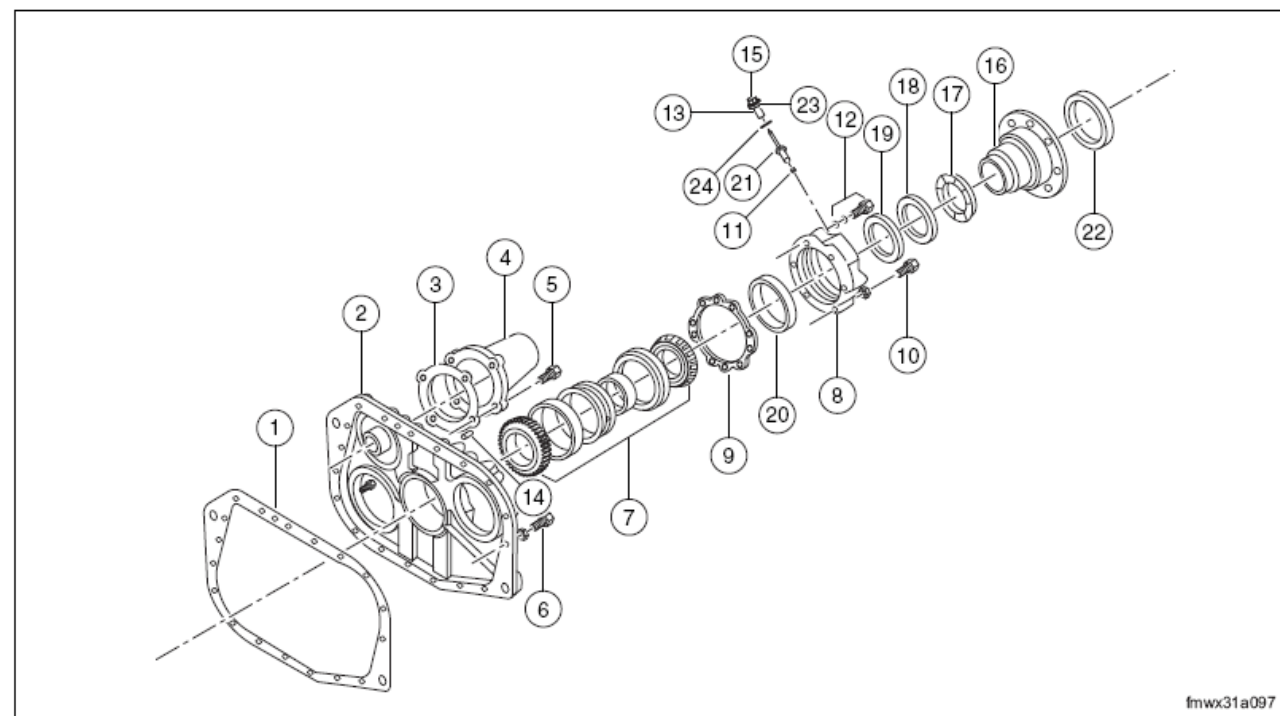
(f) Fasten the upper cover bolt.

Torque: $54.5 \pm 7 \text{ N.m}$

4. **Fit the transmission double-H control mechanism. Refer to Chapter 31B: Disassembly and assembly, Transmission 9JS180-Double-H Control Mechanism.**

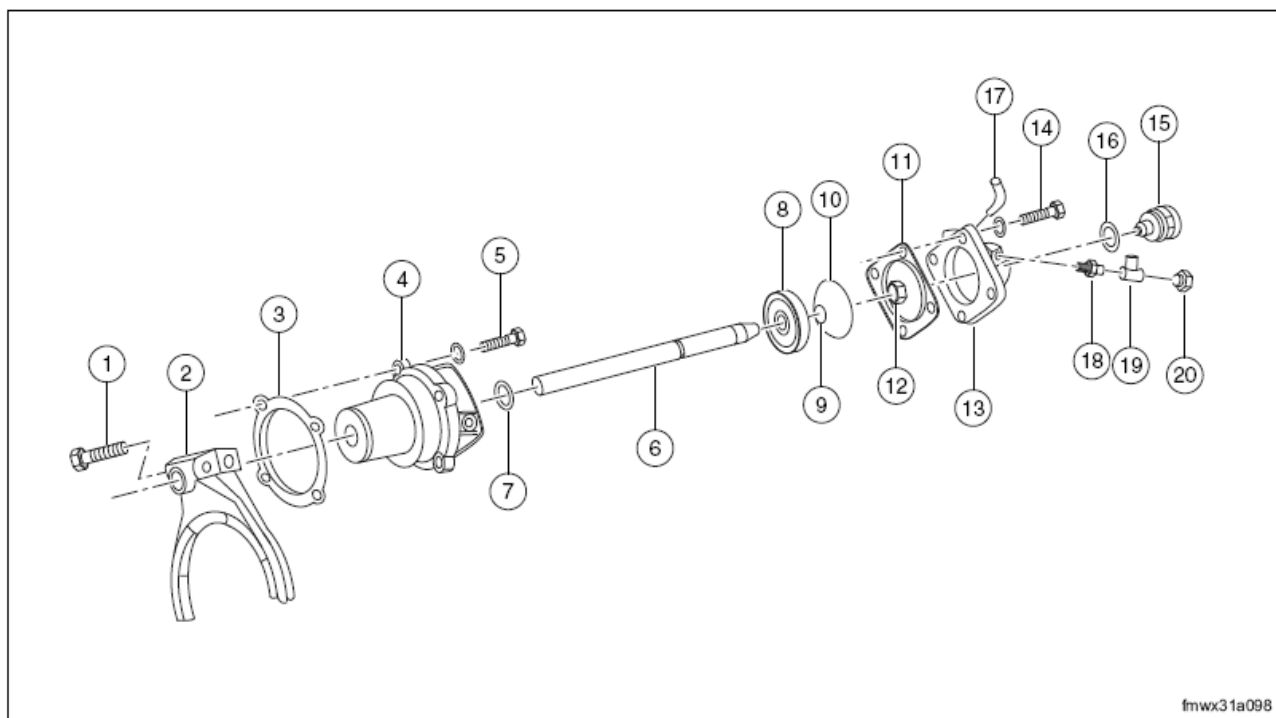
SPLITTER

DIAGRAM OF COMPONENTS



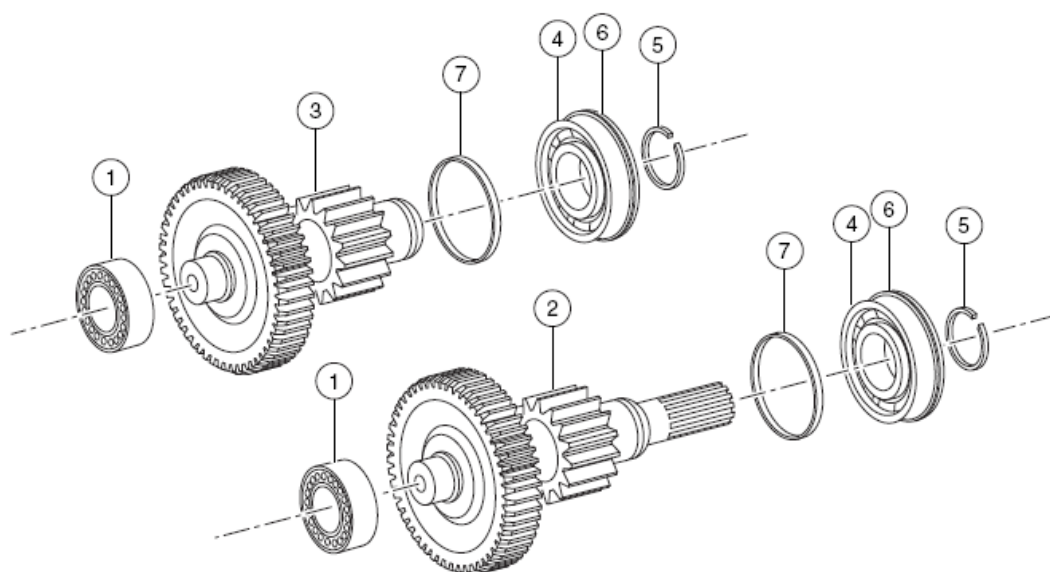
1	Rear cover lining
2	Rear cover housing
3	Splitter countershaft bearing cover lining
4	Extra-long intermediate shaft cover
5	Bolt assembly
6	Hexagon bolt M10
7	Cylindrical roller bearing
8	Output shaft rear bearing cover
9	Splitter main shaft rear bearing cover lining
10	Hexagon bolt (M10x75)
11	Odometer driven gear bush
12	Bolt assembly

13	Odometer union
14	Rear cover positioning pin
15	Odometer casing
16	Output flange disc
17	Dustproof cover
18	Oil seal
19	Main shaft rear bearing cover oil seal
20	Odometer drive gear
21	Odometer driven gear
22	Positioning ring
23	O-shaped ring (φ12x1.9)
24	Gasket


31B

1	Hexagon bolt with a hole in the head
2	Splitter fork
3	Gasket
4	Range gear cylinder
5	Hexagon bolt
6	Range gear fork shaft
7	O-shaped sealing ring
8	Range gear cylinder piston
9	O-shaped sealing ring
10	O-shaped sealing ring

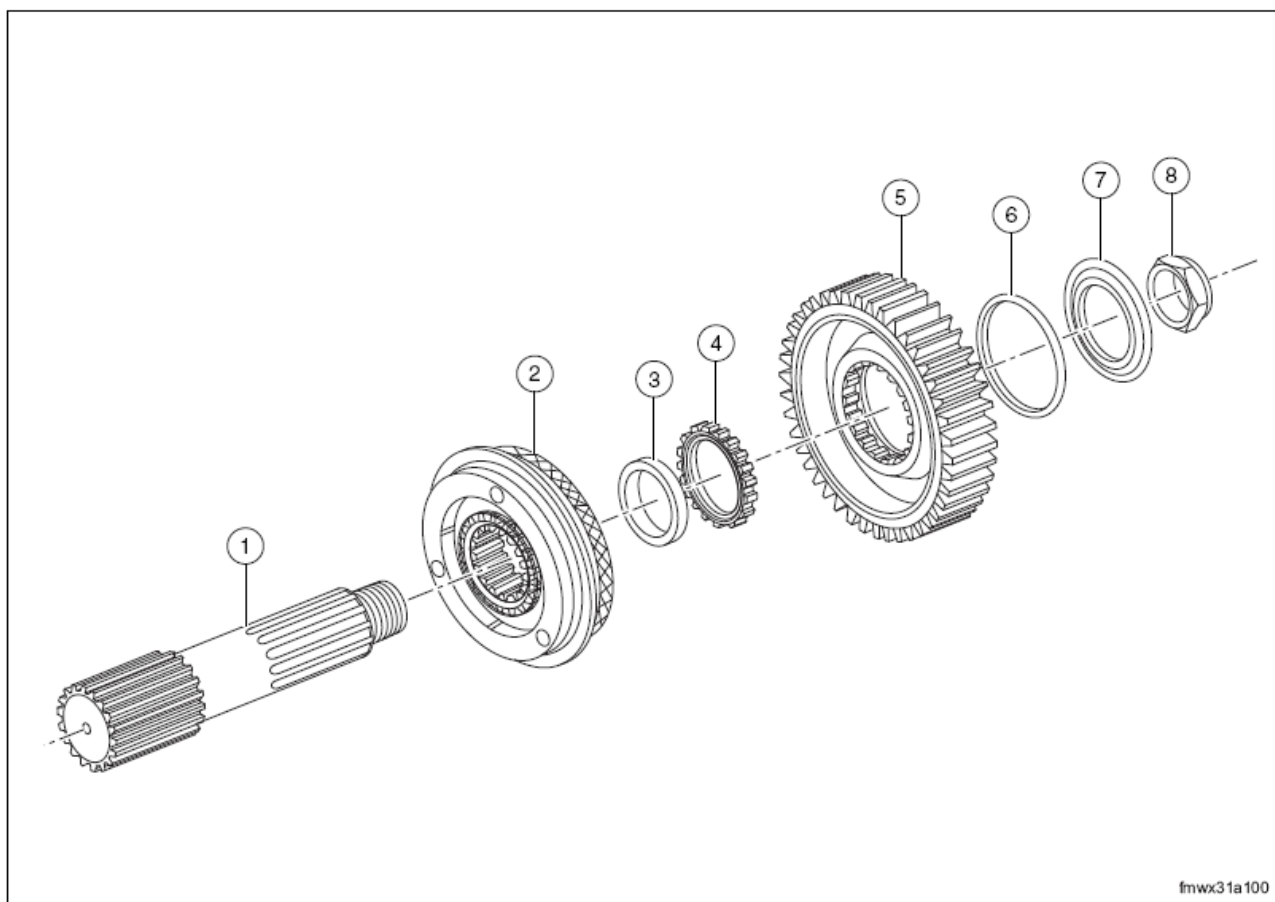
11	Cylinder head gasket
12	Hexagon nylon ring lock nut (M16x1.5)
13	Splitter gear shifting cylinder head
14	Hexagon bolt (M10x32)
15	Pressure switch
16	Wrinkled copper gasket
17	45° bend union
18	Tee pipe union
19	Tee pipe union
20	Hexagon taper screw plug



fmwx31a099

1	Short cylindrical roller bearing
2	Splitter extra-long countershaft welding assembly
3	Splitter countershaft welding assembly
4	Short cylindrical roller bearing

5	Retaining ring
6	(Bearing) retaining ring
7	Bearing gasket



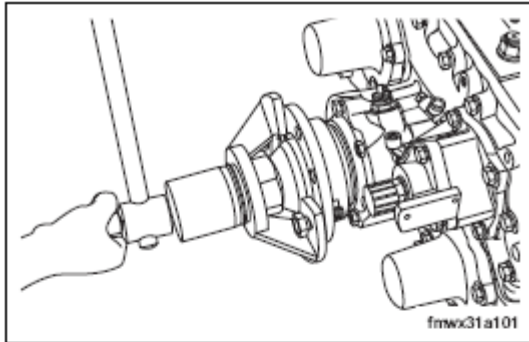
31B

1	Splitter main shaft
2	High & low gear synchronizer assembly
3	Splitter main shaft gasket
4	Splitter main shaft gear gasket

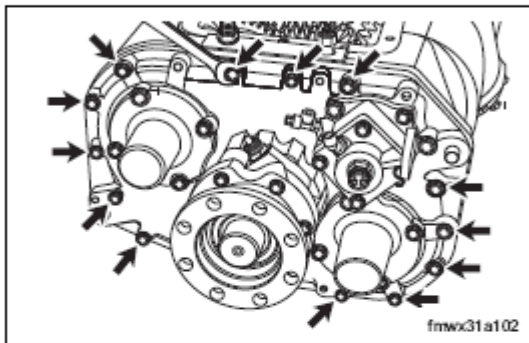
5	Splitter main shaft reducer gear
6	Retaining ring
7	Splitter reducer gear gasket
8	Flange nut

DISASSEMBLY AND ASSEMBLY

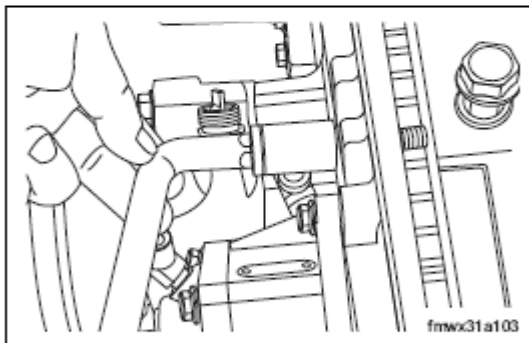
1. Disassembly of splitter assembly



- (a) Engage both sliding sleeves with the basic transmission gears.
- (b) Use the dedicated spanner to remove the flange nut of flange disc.



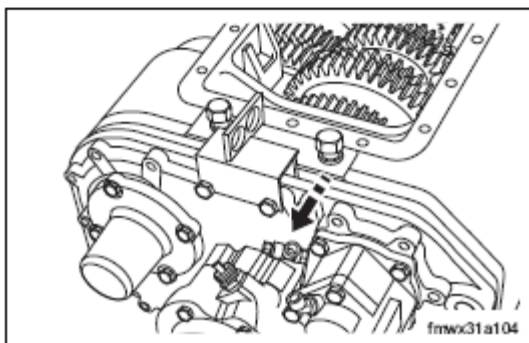
- (c) Remove the bolt on the rear cover housing.



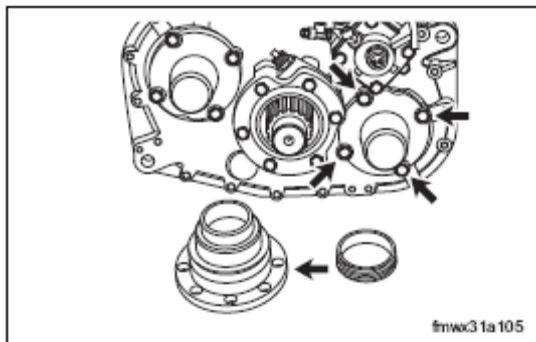
- (d) Use these three bolts to squeeze out the splitter assembly by about 10mm.

Notice:

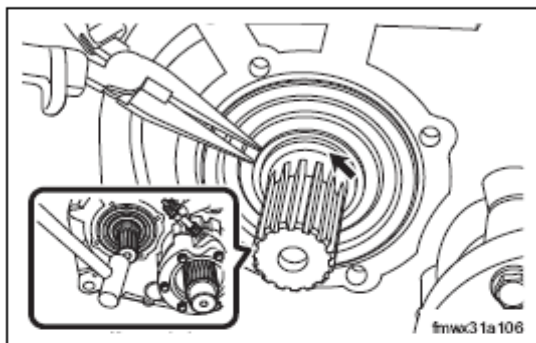
These three bolts must be screwed in evenly.



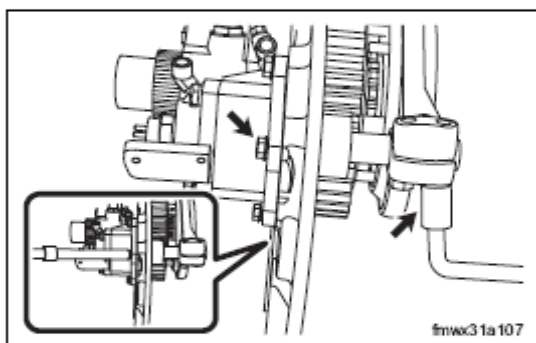
- (e) Fit the dedicated tool and hoist the splitter assembly to move it backward, thus to separate it from the basic transmission.



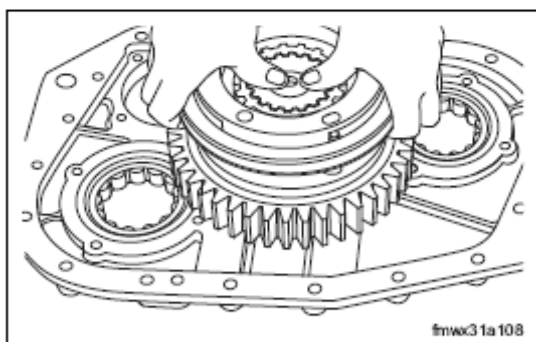
- (f) Remove the output flange disc and odometer drive gear.
- (g) Remove the extra-long countershaft cover.



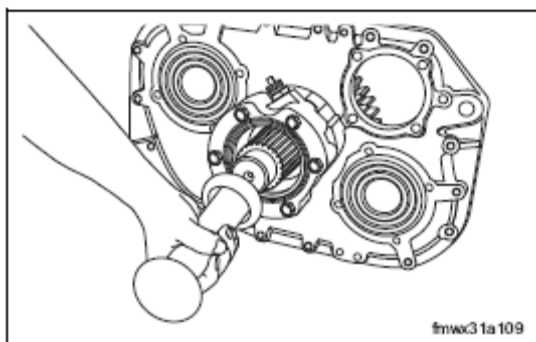
- (h) Remove the snap ring on the extra-long countershaft.
- (i) Separate the extra-long countershaft from the bearing by knocking it with a copper rod.



- (j) Cut off the iron wire, and remove bolts on the splitter fork.
- (k) Remove the bolt used to connect the gear shifting cylinder and rear cover.

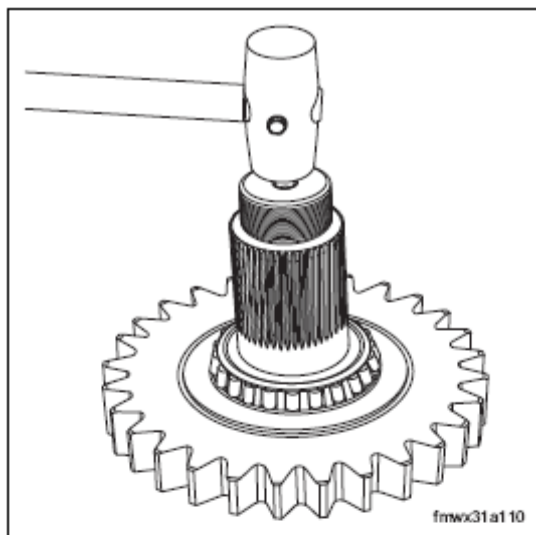


- (l) Remove the splitter synchronizer.

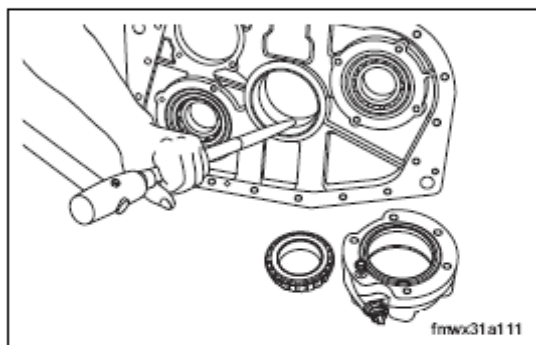


- (m) Separate the output shaft from the rear cover housing by knocking it.

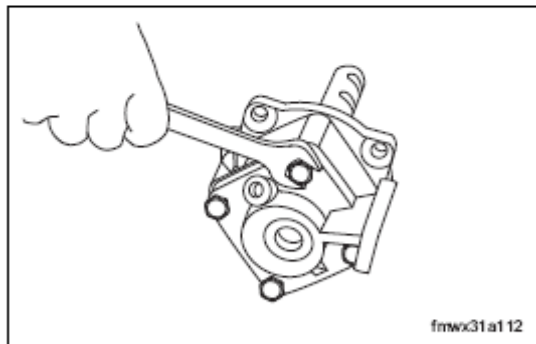




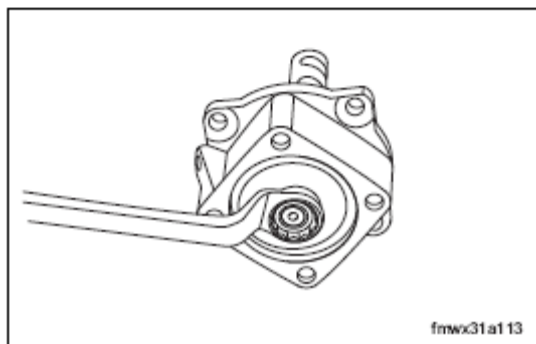
- (n) Squeeze out the output shaft to separate it from the bearing.



- (o) Remove the output bearing cover, and remove the bearing outer ring in the rear cover housing hole by knocking it with a soft rod.

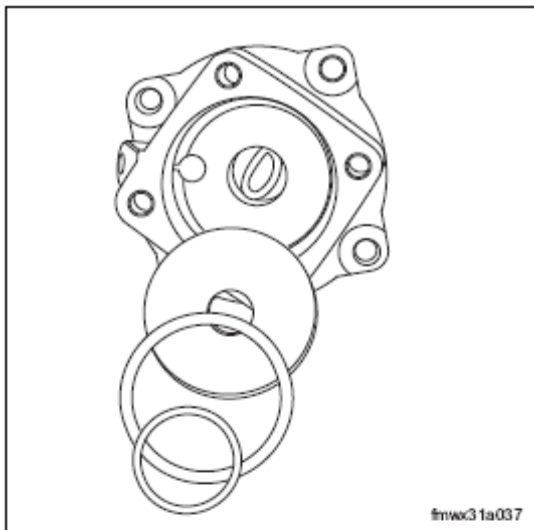


2. **Disassemble the splitter gear shifting cylinder.**
(a) Remove these four bolts on the cylinder head, and take out the cylinder head.

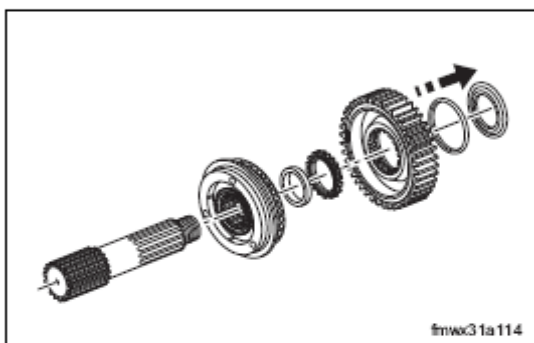


- (b) Remove the self-lock nut on the piston.





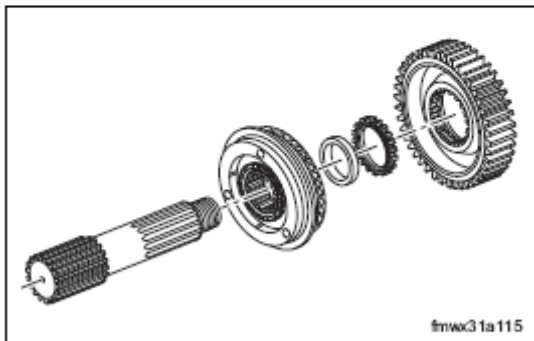
- (c) Remove the piston and these three O-shaped sealing rings on the gear shifting cylinder.



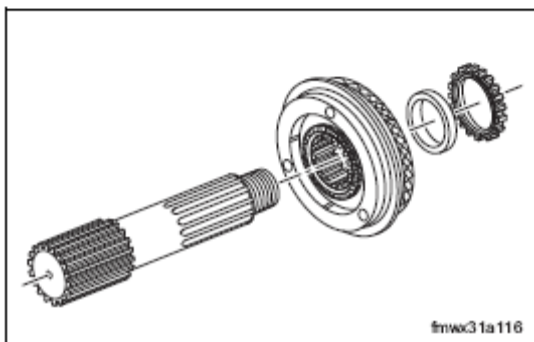
3. Disassemble the splitter main shaft component.

- (a) Remove the gasket and retaining ring in order.

31B



- (b) Remove the splitter main shaft reducer gear.
(c) Remove the splitter main shaft gear gasket, splitter main shaft gear ring, and high & low gear synchronizer assembly in order.

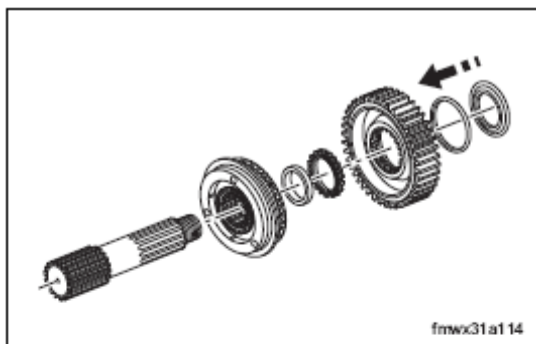


4. Reassemble the splitter main shaft component.

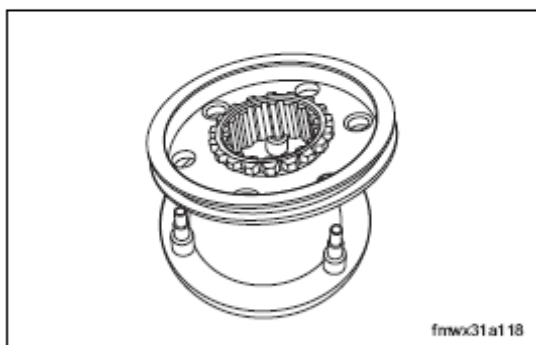
- (a) Refit the high & low gear synchronizer assembly, splitter main shaft gear ring and splitter main shaft gear gasket in order.

31B-60

TRANSMISSION (9JS180)-SPLITTER

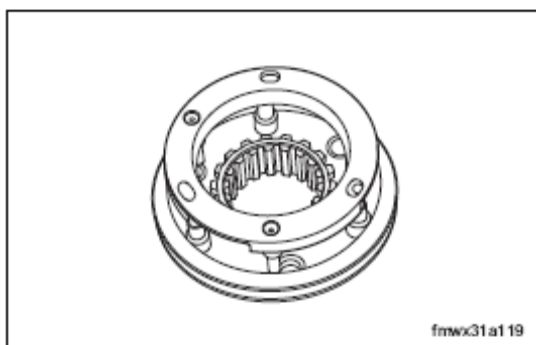


- (b) Fit the splitter main shaft reducer gear.
- (c) Remove the retaining ring and gasket in order.

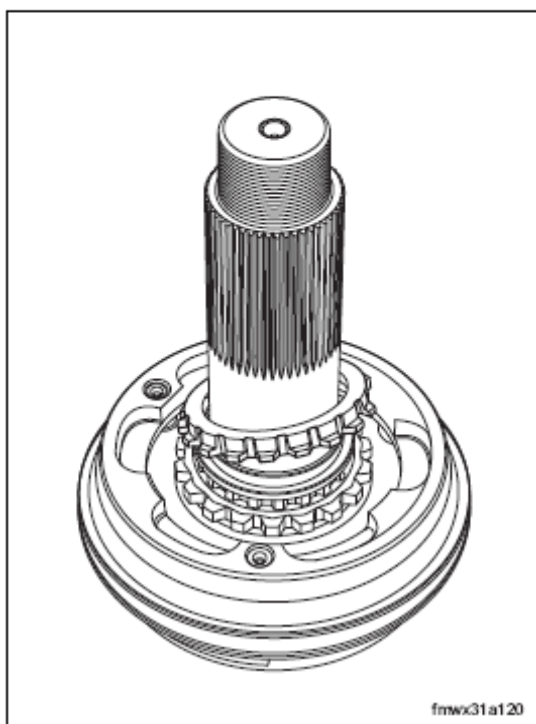


5. Reassemble the splitter.

- (a) Clean the splitter synchronizer and its component.
- (b) Place the splitter synchronizer low-gear ring horizontally, and fit the synchronizer sliding sleeve.



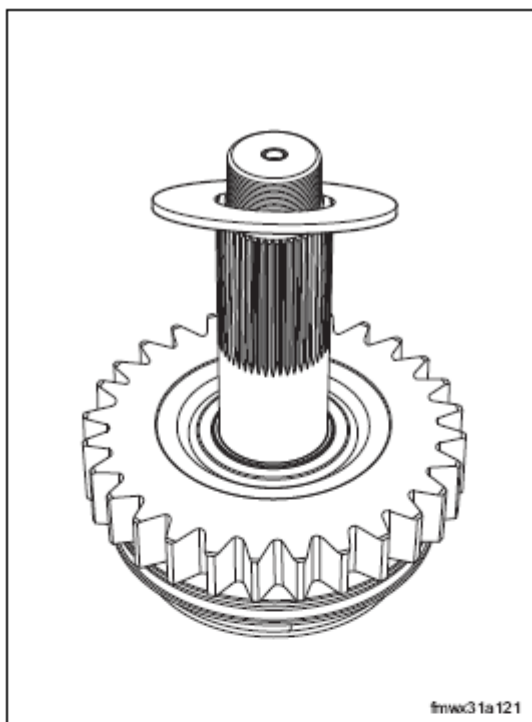
- (c) Put these three springs into the high-gear ring hole, and apply a rotating force to coordinate it with other parts of the synchronizer.



- (d) Put the synchronizer low-gear ring on a 50mm-high wood block, and insert the input shaft.
- (e) Fit the splitter main shaft gear gasket and splitter main shaft washer.



FOTON

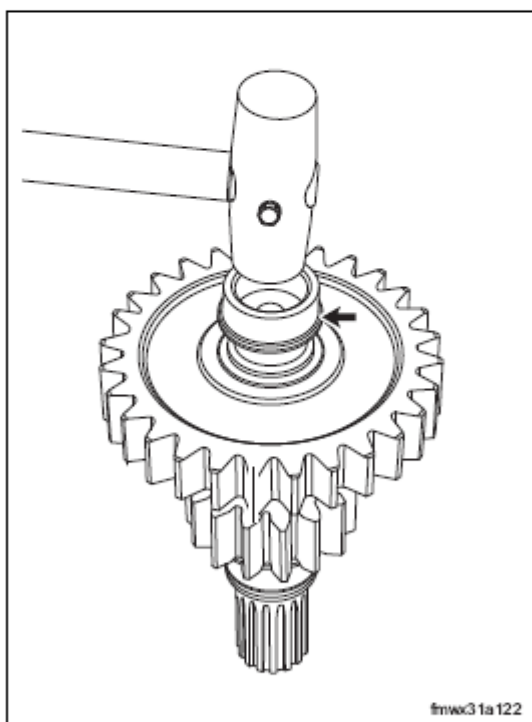


- (f) Insert the gear and gasket into the output shaft with the convex side facing down.

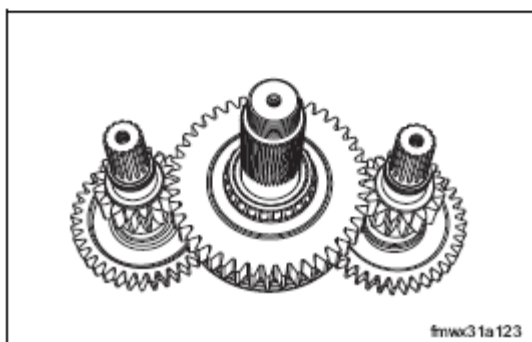
Notice:

The gasket must be initially lubricated.

31B

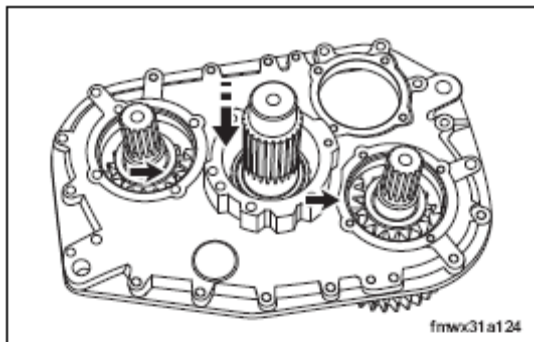


- (g) Fit the bearing inner ring into the splitter extra-long countershaft.
(h) Mark the splitter extra-long countershaft for tooth alignment.

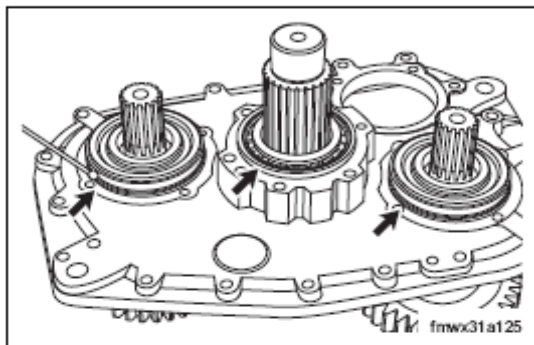


- (i) Mark the splitter reducer gear, spaced by 180°, for tooth alignment, as shown in the figure.





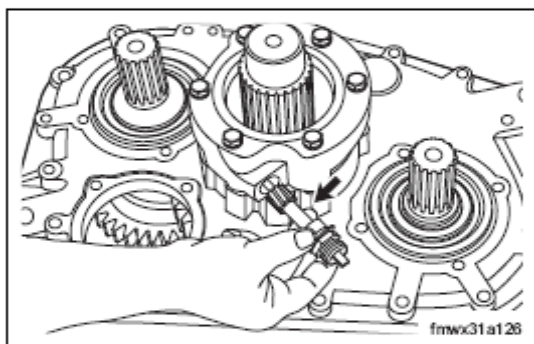
- (j) Fit the rear cover housing.



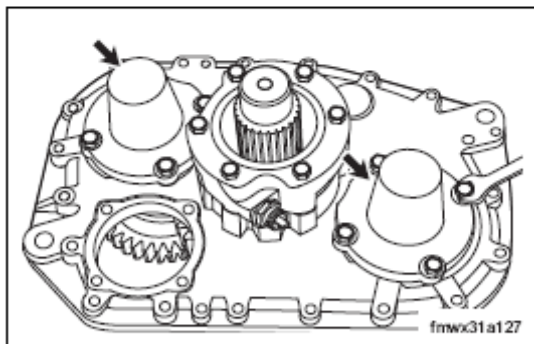
- (k) Fit the assembled bearing and the roller bearing on both extra-long countershafts.

Notice:

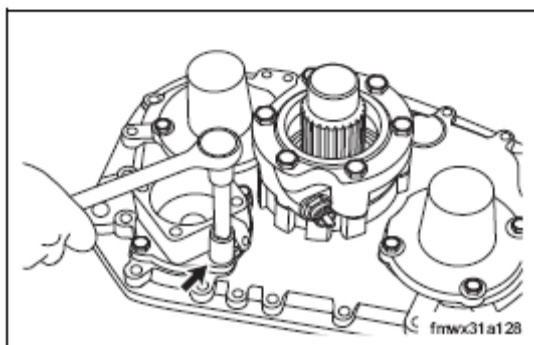
The bearing is provided with a lined ring in addition to a snap ring.



- (l) Fit snaps on both extra-long countershafts.
(m) Fit the output bearing cover and odometer driven gear and odometer union.

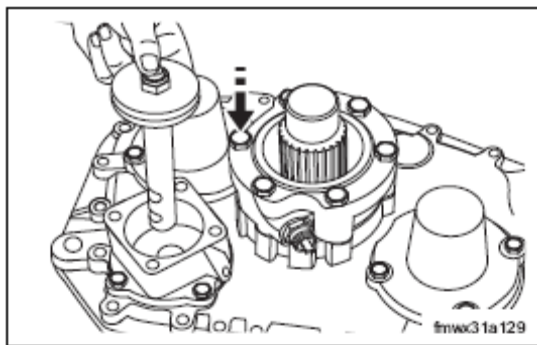


- (n) Fit both extra-long countershafts.
Torque: 54.5±7N.m



- (o) Fit the cylinder housing.
Torque: 54.5±7N.m

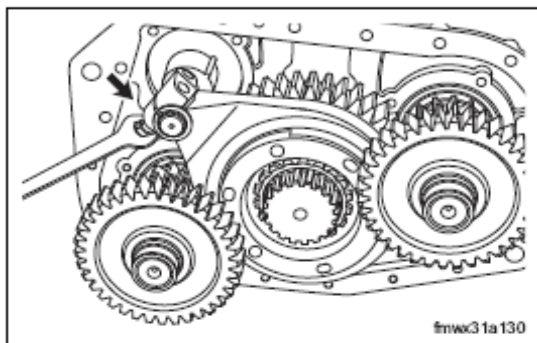




(p) Fit the sealing ring and cylinder piston in order.

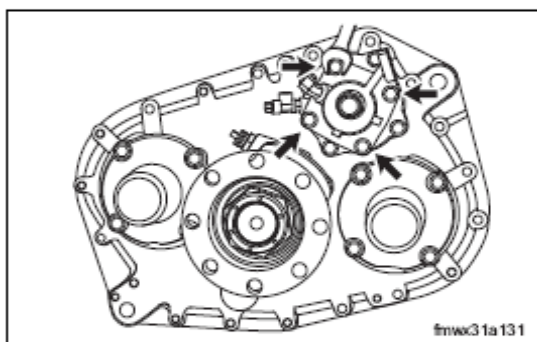
Notice:

The flat side of the piston shall face up.



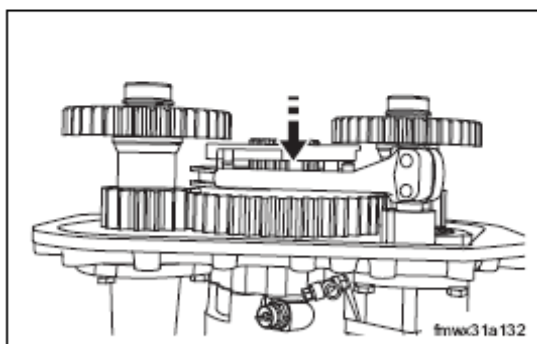
(q) Insert the splitter gearshift fork into the synchronizer sliding sleeve, fit the bolt on the fork shaft and lock with iron wire.

Torque: $78 \pm 10 \text{ N.m}$



(r) Fit the gear shifting cylinder head and flange disc.

Cylinder head tightening torque: $54.5 \pm 7 \text{ N.m}$

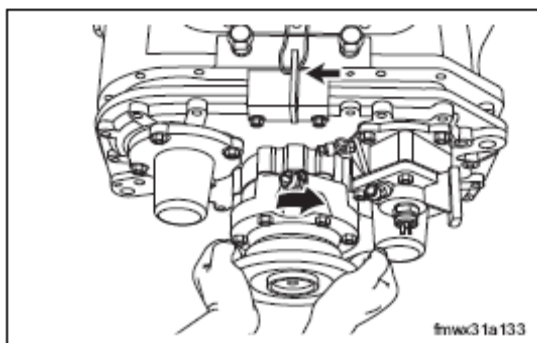


(s) Put the splitter synchronizer in the low-speed range.

(t) Apply grease into both bearing holes of the basic transmission.

Hint:

This step is very critical in the installation of splitter.

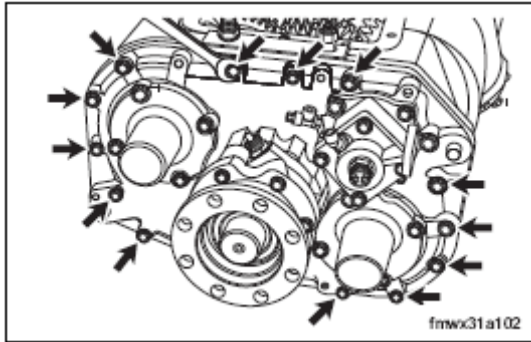


(u) Use the dedicated tool to hoist the splitter assembly, move the splitter forward, and rotate the flange disc by hand.



31B-64

TRANSMISSION (9JS180)-SPLITTER



- (v) Fit the splitter assembly in place, and fasten the rear cover bolt and flange nut.

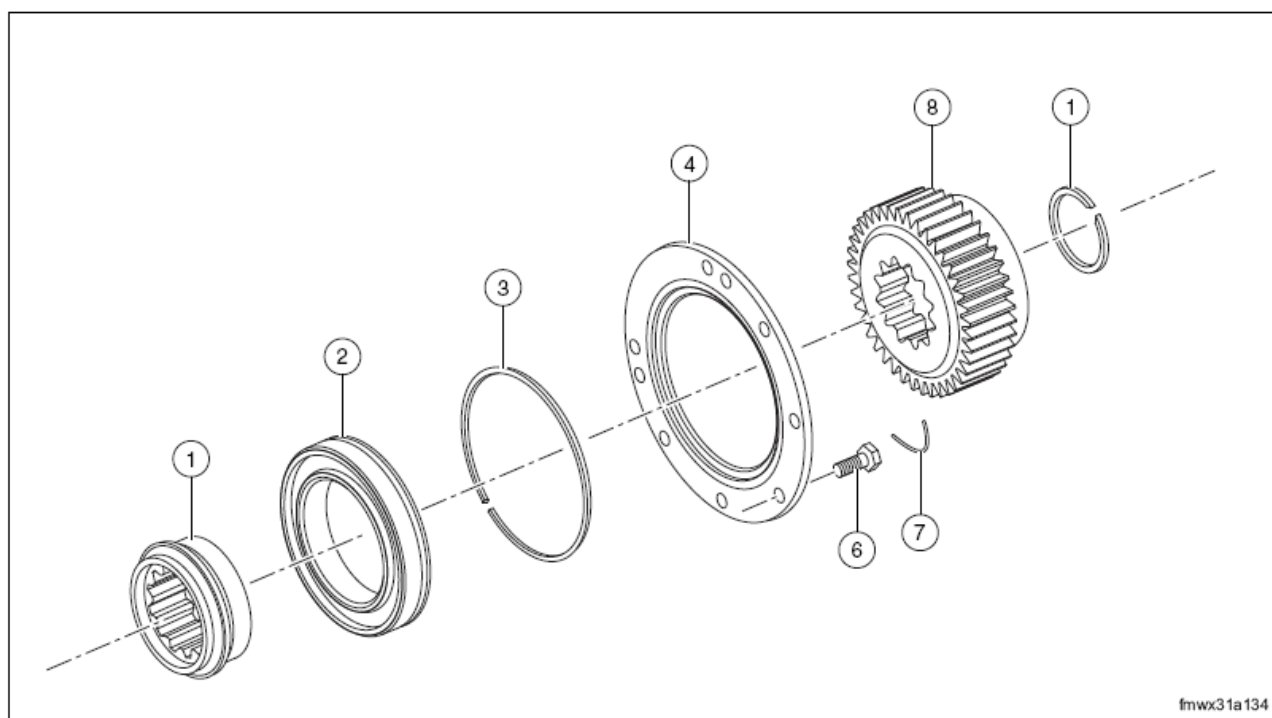
Tightening torque: $54.5 \pm 7 \text{ N.m}$

Flange nut tightening torque: $654 \pm 45 \text{ N.m}$

31B

BASIC TRANSMISSION

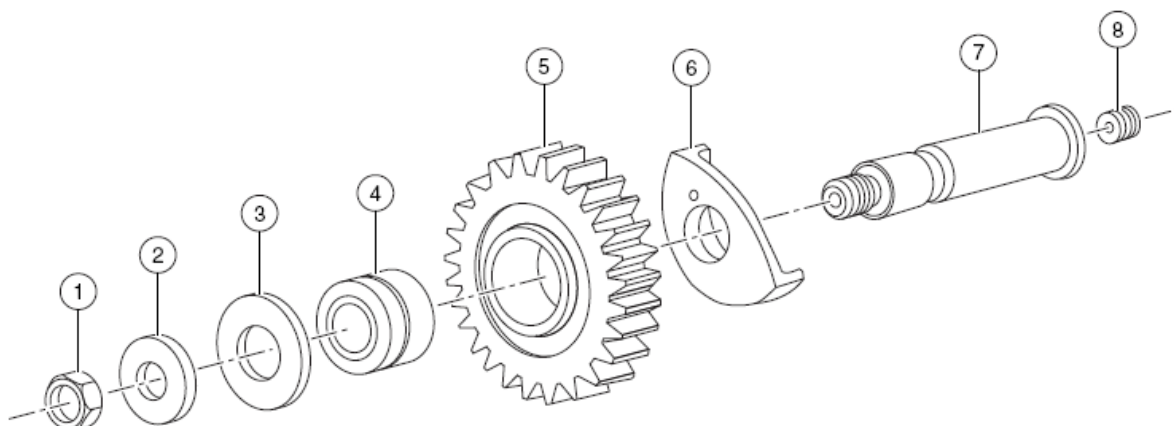
DIAGRAM OF COMPONENTS



31B

1	Retaining ring
2	Retaining ring
3	Bearing
4	(Bearing) retaining ring

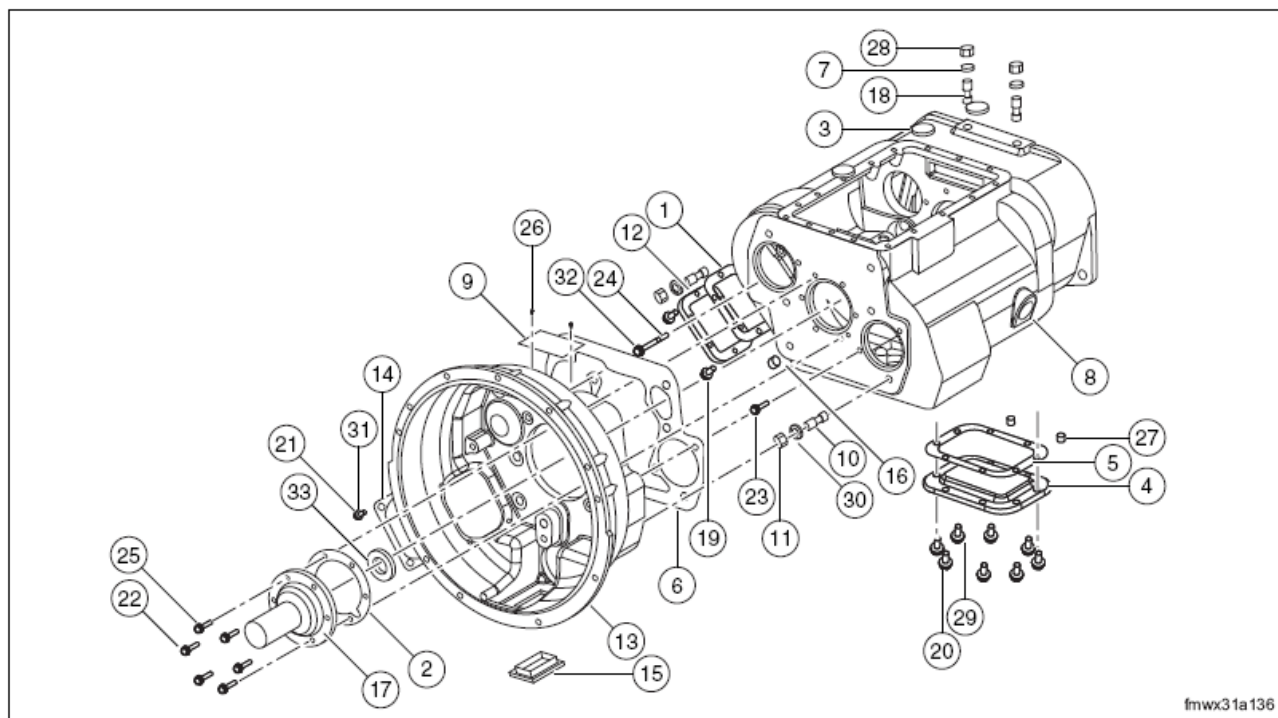
5	Splitter bearing positioning disc
6	Small hexagon nut with a hole in the head (M10x22)
7	Iron wire
8	Splitter drive gear



fmwx31a135

1	Hexagon nylon ring lock nut (M16x1.5)
2	Reverse gear countershaft washer
3	Reverse gear thrust washer
4	Needle bearing

5	Reverse gear intermediate gear
6	Cup-shaped reverse gear washer
7	Reverse gear countershaft
8	Flat-end lock screw (M12x12)



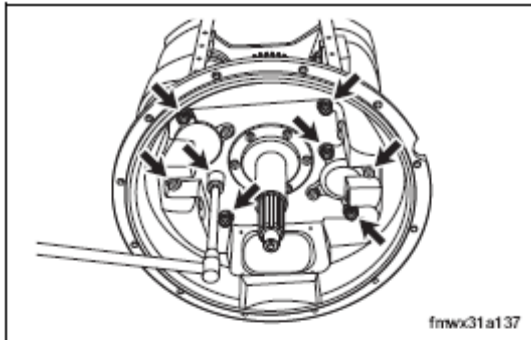
31B

1	Side power takeoff window lining
2	First shaft bearing lining
3	Round magnet
4	Bottom power takeoff window cover
5	Bottom power takeoff window lining
6	Clutch housing lining
7	Spring washer
8	Transmission housing
9	Nameplate
10	Stud
11	Hexagon nylon ring lock nut
12	Side power takeoff window cover
13	Clutch housing
14	Hand hole cover
15	Hand hole cover
16	Slotted conic nut
17	First shaft bearing cover

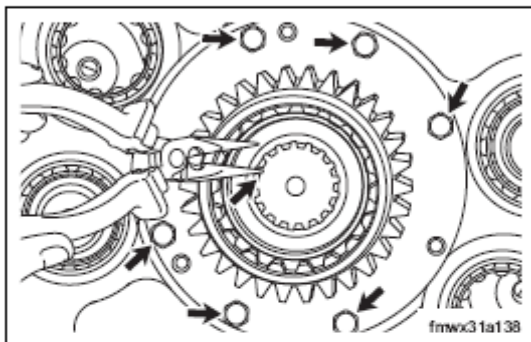
18	Stud
19	Hexagon bolt & spring washer assembly
20	Hexagon bolt
21	Hexagon bolt
22	Hexagon bolt
23	Hexagon bolt
24	Hexagon bolt
25	Hexagon bolt with a hole in the head
26	Cross-recessed pan-head self-tapping screw
27	Slotted flat-end lock screw
28	Type 1 hexagon nut
29	Plain washer
30	Plain washer
31	Spring washer
32	Spring washer
33	Framework oil seal

DISASSEMBLY AND ASSEMBLY

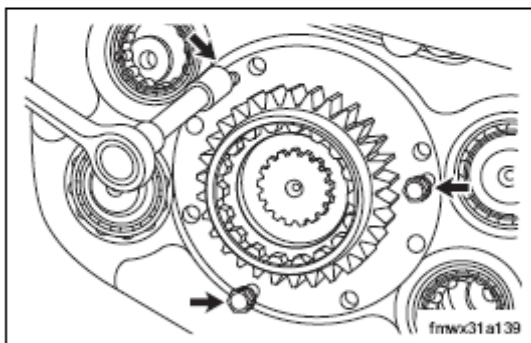
1. Remove the upper cover assembly. Refer to Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transmission Upper Cover.



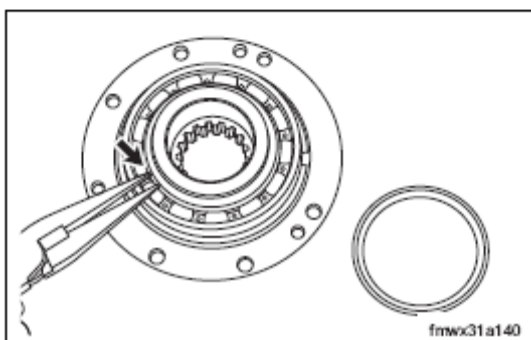
2. Remove the clutch housing assembly.
 - (a) Undo the connecting bolt and remove the clutch housing.



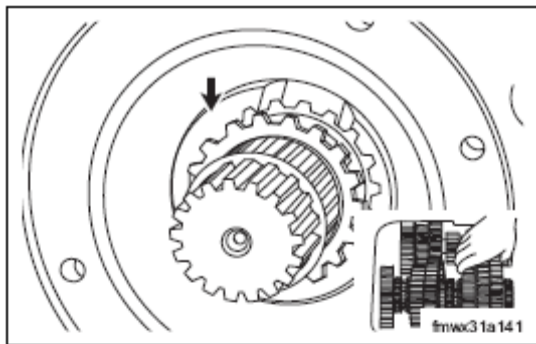
3. Disassemble the splitter drive gear assembly.
 - (a) Remove the snap ring at the rear end of splitter drive gear and these six bolts of the positioning disc.
 - (b) Remove the retaining ring.



- (c) Use three bolts to squeeze out the drive gear assembly.

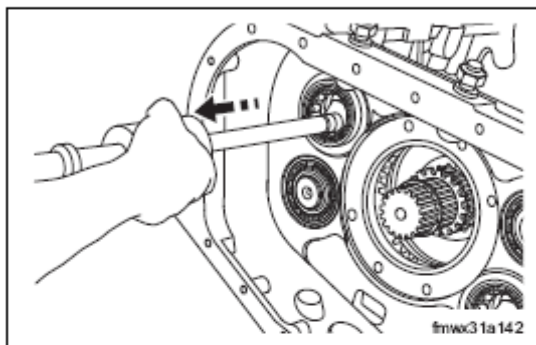


- (d) Remove the retaining ring fixing ring and slotted ring on the splitter drive gear.

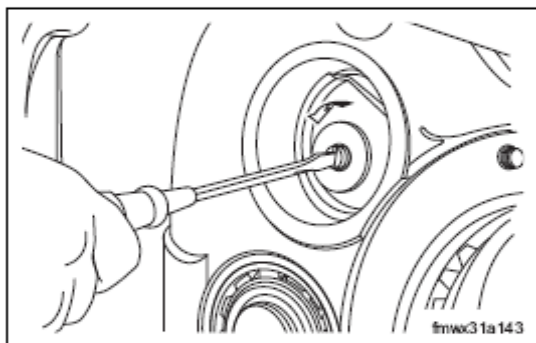


4. **Disassemble the reverse gear intermediate wheel assembly.**

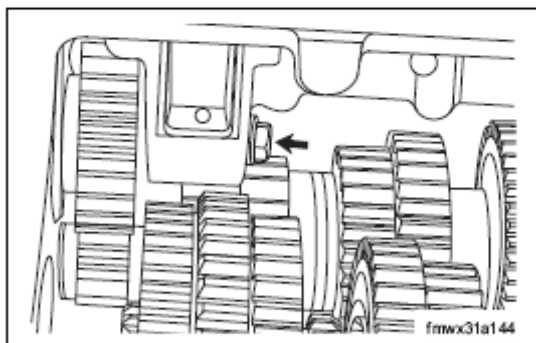
- (a) Remove the snap ring in the second shaft reverse gear.
- (b) Move the reverse gear forward till it presses against the second shaft low-speed gear.



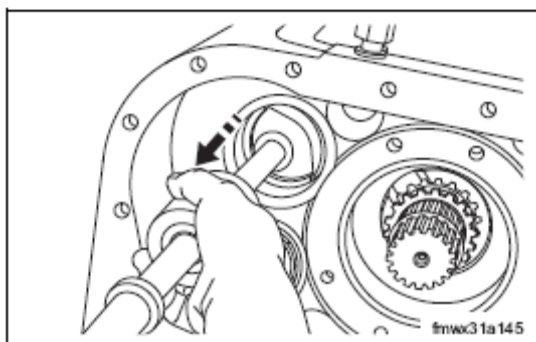
- (c) Use the dedicated tool to remove the bearing at the rear end of reverse gear intermediate wheel shaft.



- (d) Remove the screw plug in the reverse gear intermediate wheel shaft.



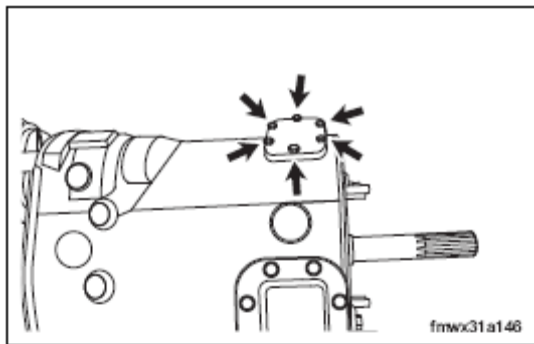
- (e) Remove the self-lock nut on the reverse gear intermediate wheel shaft.



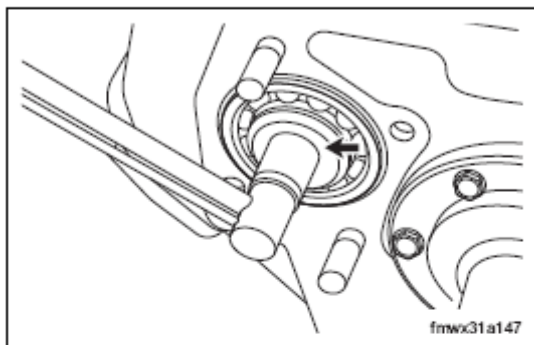
- (f) Use the dedicated tool to remove the reverse gear intermediate wheel shaft.

Notice:

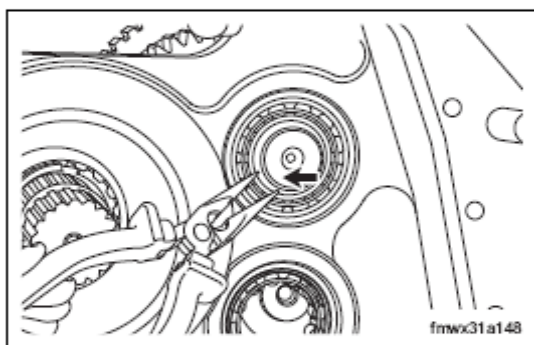
Prevent the reverse gear idler from falling to cause damages.



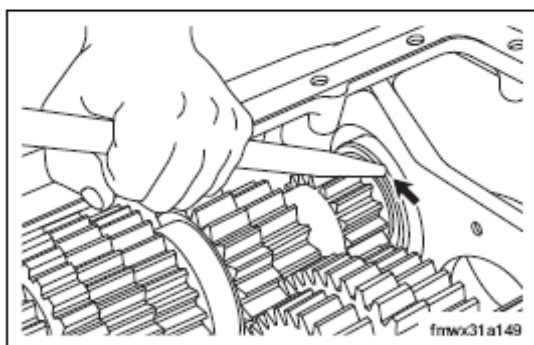
5. **Remove the second shaft assembly.**
(a) Remove the countershaft brake assembly.



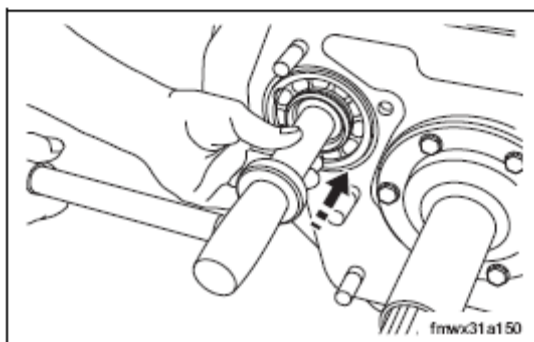
- (b) Remove the bearing baffle at the front end of basic transmission countershaft.



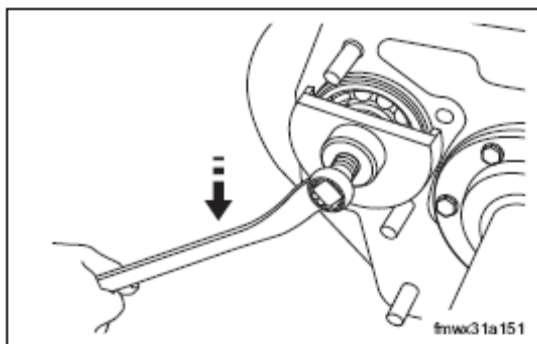
- (c) Remove the snap ring on the bearing at the rear end of basic transmission countershaft.



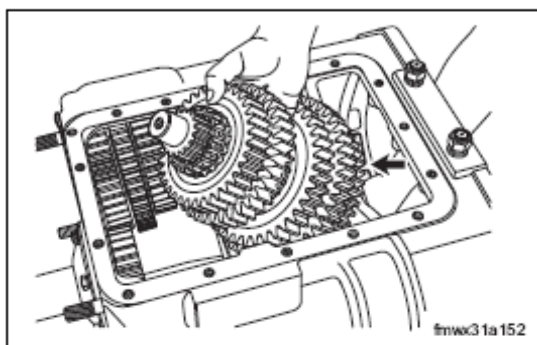
- (d) Use the soft rod to remove the rear bearing of countershaft.



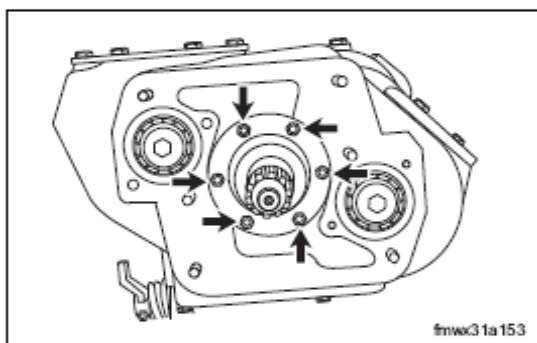
- (e) Use the copper rod to knock the countershaft and move it back by about 10mm.



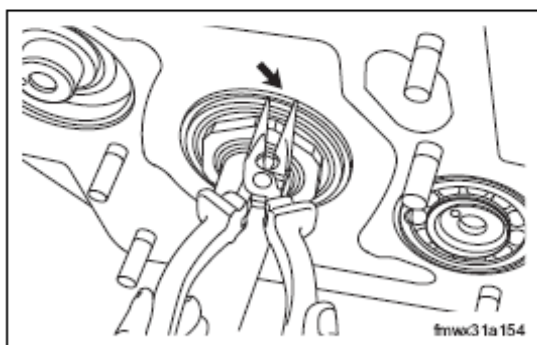
- (f) Use the dedicated tool to remove the front bearing of countershaft.



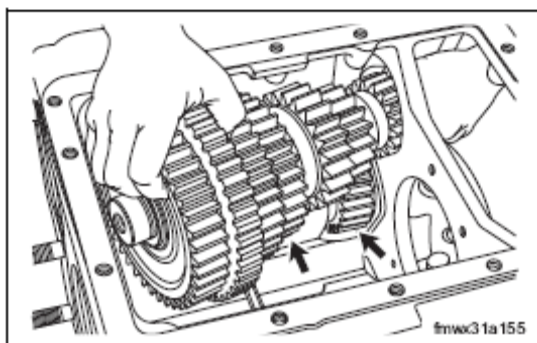
- (g) Remove the second shaft from the basic transmission housing.



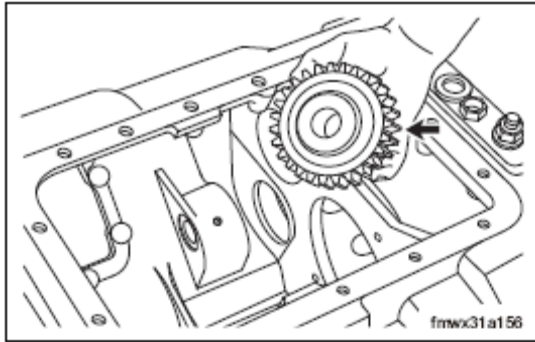
6. **Remove the first shaft assembly.**
(a) Undo these six bolts on the first shaft bearing cover and remove the first shaft cover.



- (b) Remove the snap ring on the first shaft bearing, impact the shaft head and remove the first shaft assembly.

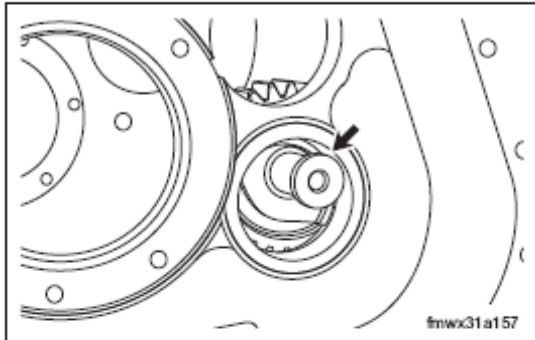


7. **Remove the countershaft assembly and reverse gear intermediate wheel from the basic transmission housing.**

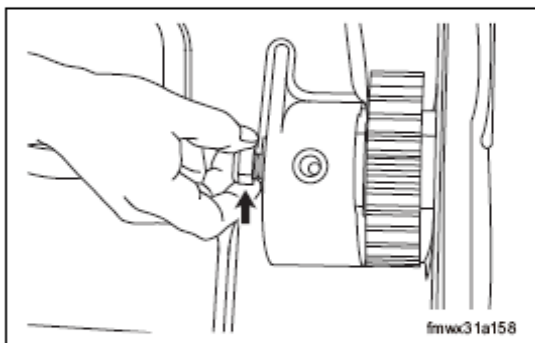


8. Fit the reverse gear intermediate wheel.

- (a) Fit the reverse gear intermediate wheel into the housing with the convex side facing forward.

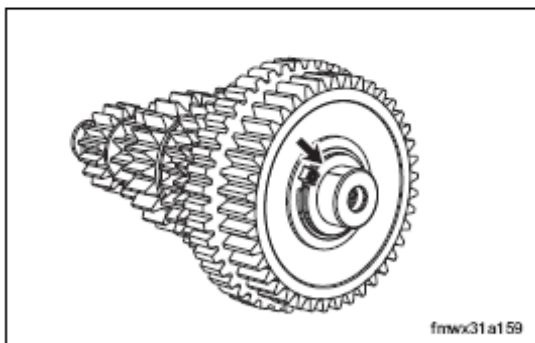


- (b) Fit the reverse gear intermediate wheel shaft.



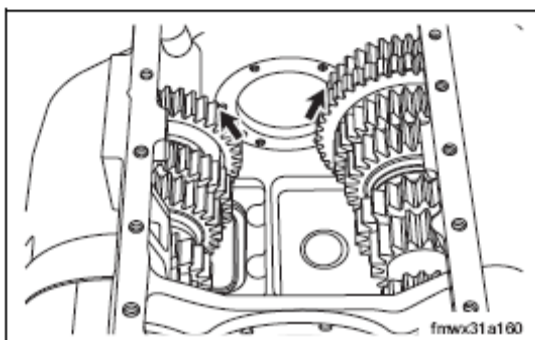
- (c) Tighten the self-lock nut at the front end of right reverse gear intermediate wheel shaft.

Torque: $74.5 \pm 6.5 \text{ N.m}$

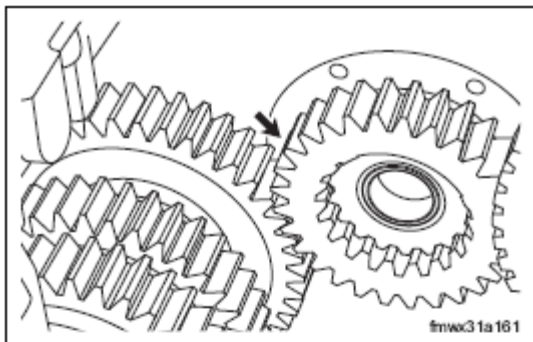


9. Fit the countershaft.

- (a) Mark the tooth for tooth alignment opposite to the key groove of normally engaged gear of the countershaft assembly.

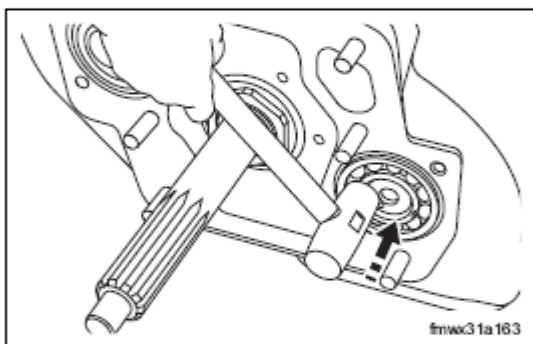
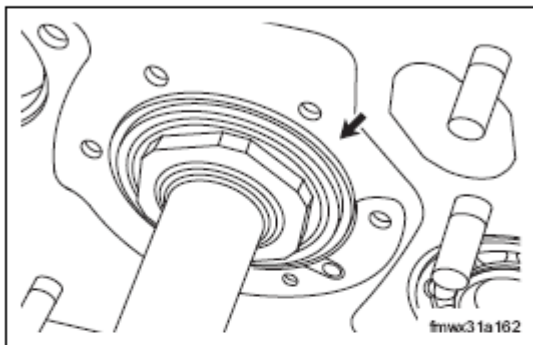


- (b) Fit both countershaft assemblies into the basic transmission housing.



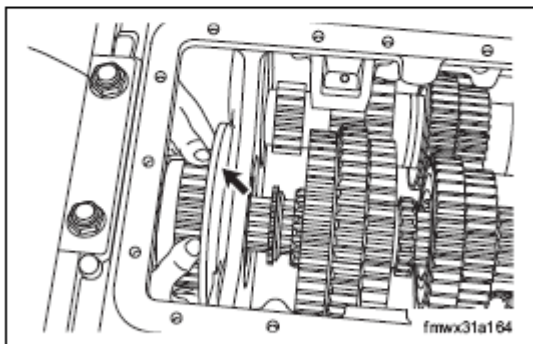
10. Fit the first shaft assembly.

- (a) Select two groups of teeth at random from the first shaft gear in the 180° direction to be marked for tooth alignment.
- (b) Fit the first shaft assembly into the basic transmission assembly, and insert the marked tooth of the left countershaft into the marked groove of first shaft gear. Fit the countershaft rear bearing and fix it with a snap ring.
- (c) Fit the snap ring on the first shaft bearing.



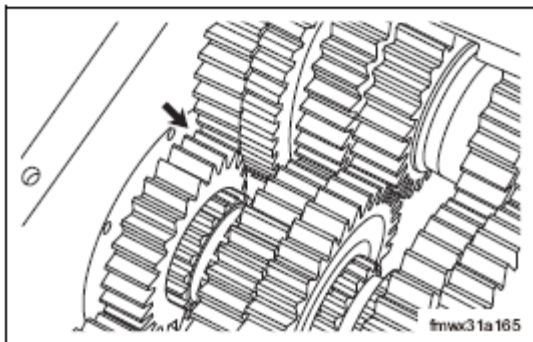
11. Fit the countershaft front bearing.

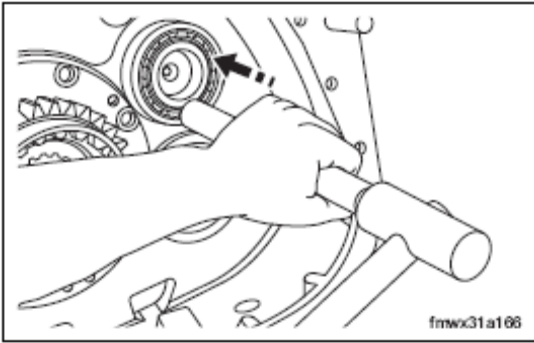
- (a) Fit the countershaft front bearing.



12. Fit the second shaft assembly.

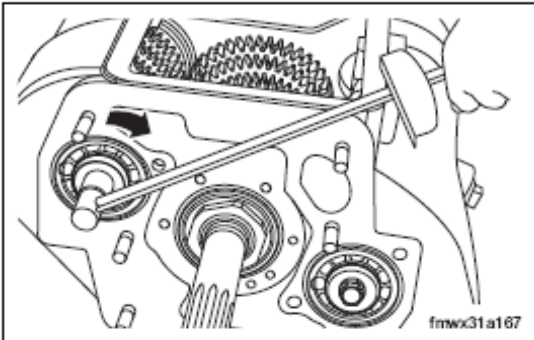
- (a) Apply grease into the first shaft hole (initial lubrication).
- (b) Put the second shaft assembly into the basic transmission, and position the rear end with drive gear.
- (c) Insert the marked tooth of right countershaft into the marked groove of first shaft gear.





13. Fit the countershaft rear end bearing.

- (a) Fit the countershaft rear bearing, and position with a snap ring.



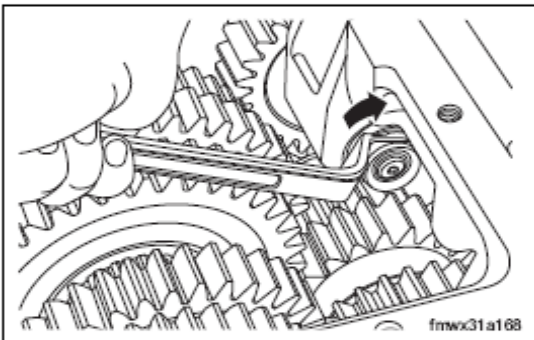
14. Fit the countershaft front bearing.

- (a) Fit the countershaft front bearing, and then the countershaft pressure plate.

Torque: $142 \pm 20 \text{ N.m}$

Notice:

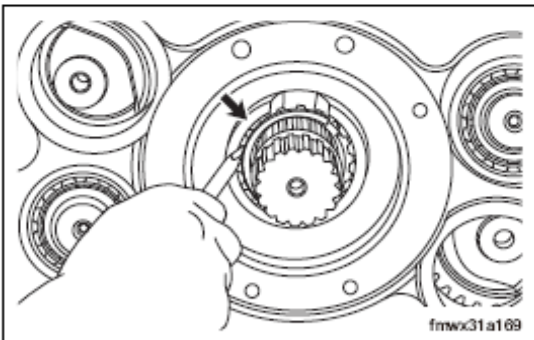
The pressure plate bolt shall be coated with anaerobic adhesive.



15. Fit the left reverse gear intermediate wheel assembly.

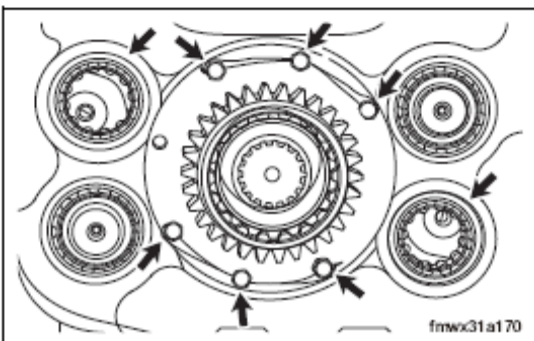
- (a) Fit the left reverse gear intermediate wheel assembly, and fasten the self-lock nut.

Torque: $74.5 \pm 6.5 \text{ N.m}$



16. Fit the reverse gear snap ring.

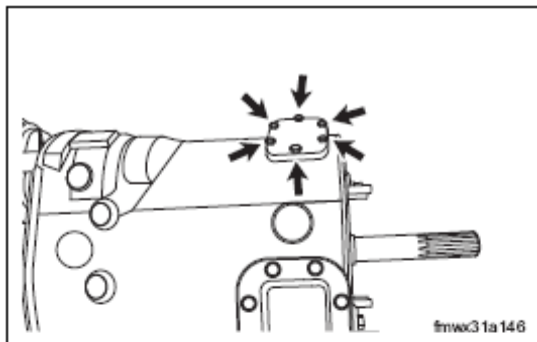
- (a) Pull back the second shaft reverse gear to be engaged with the left reverse gear intermediate wheel, and fit the reverse gear snap ring.



17. Fit the drive gear assembly and bearing.

- (a) Fit the drive gear assembly and both bearings.
(b) Fasten these six bolts.

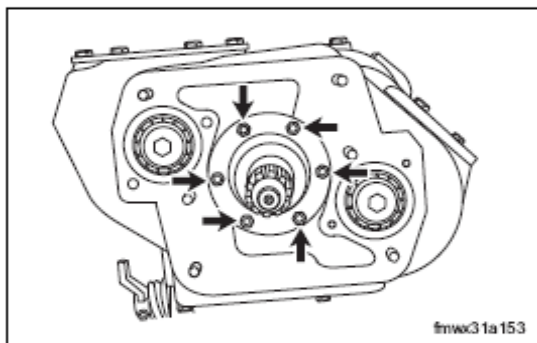
Torque: $54 \pm 7 \text{ N.m}$



18. Fit the countershaft brake assembly.

- (a) Fit the countershaft brake assembly.

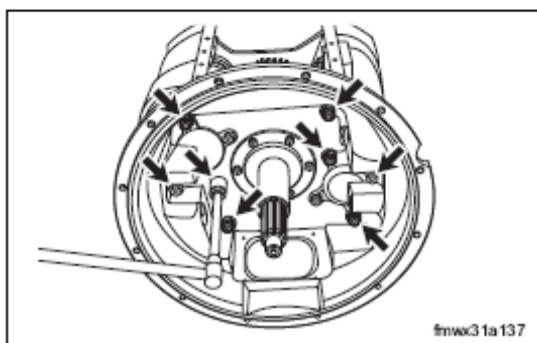
Torque: $54 \pm 7 \text{ N.m}$



19. Fit the first shaft bearing cover.

- (a) Fit the first shaft bearing cover, and fasten the bolt.

Torque: $54 \pm 7 \text{ N.m}$



20. Fit the clutch housing assembly.

- (a) Fit the clutch housing assembly, and tighten the bolt.

Tightening torque of M16: $257.5 \pm 13.5 \text{ N.m}$

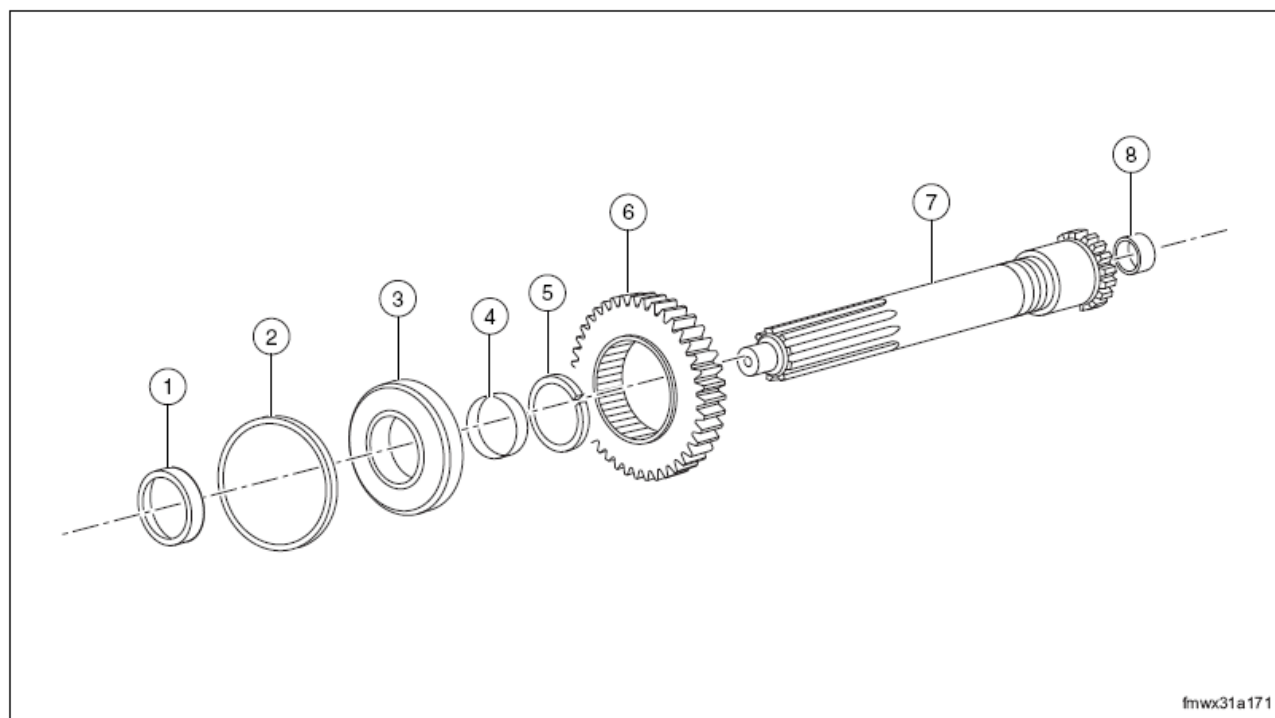
Tightening torque of M12: $121.5 \pm 13.5 \text{ N.m}$

- 21. Fit the transmission upper cover. Refer to Chapter 31B: Disassembly and assembly, Transmission 9JS180-Transssion Upper Cover.**



FIRST SHAFT ASSEMBLY

DIAGRAM OF COMPONENTS



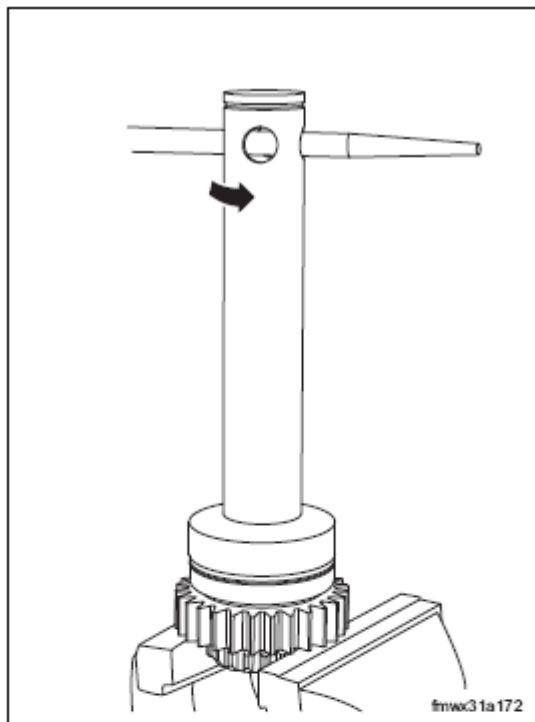
fmwx31a171

1	First shaft nut
2	(Bearing) retaining ring
3	Single-row centripetal ball bearing with one side having retaining groove and dustproof cover (φ60×φ110×22)
4	Gear spacer

5	Retaining ring
6	First shaft gear
7	First shaft
8	Second shaft guide sleeve

DISASSEMBLY AND ASSEMBLY

1. Disassemble the first shaft.

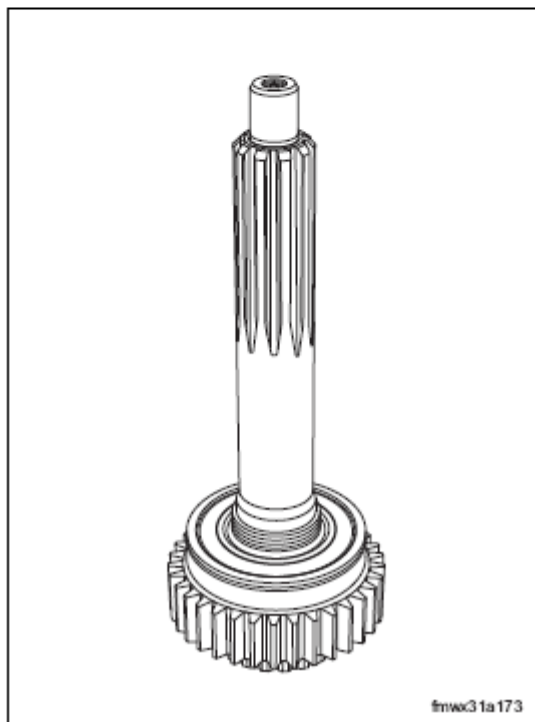


- (a) Clamp the first shaft assembly onto the vice bench.

Notice:

Wrap the first shaft with cloth, and take care to avoid damaging the first shaft by the vice bench.

- (b) Use the dedicated tool to remove the first shaft nut.

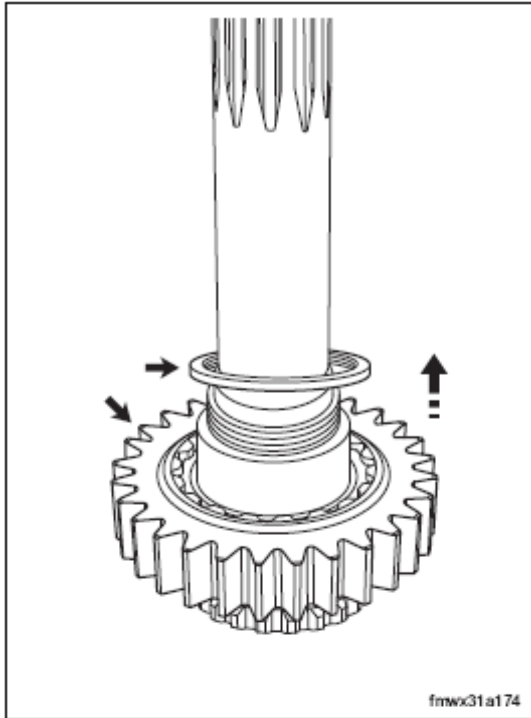


- (c) Use a puller to remove the first shaft bearing.

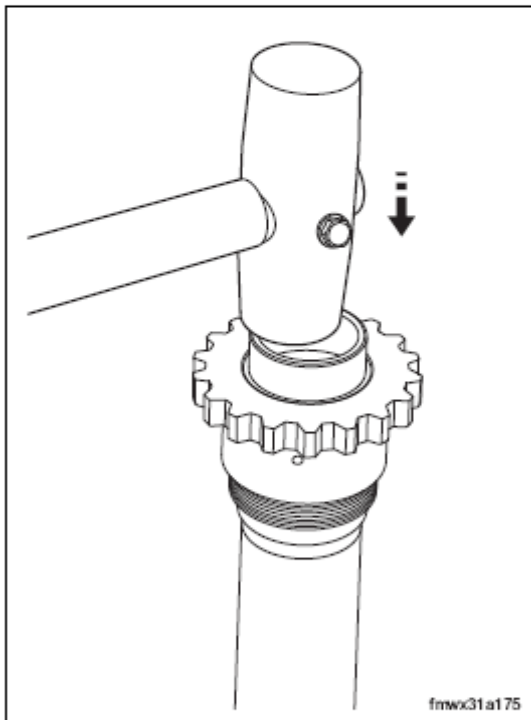


31B-78

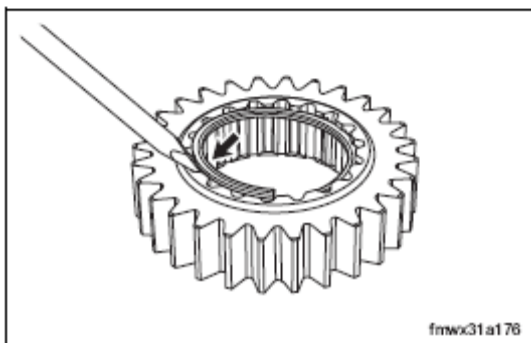
TRANSMISSION (9JS180)-FIRST SHAFT ASSEMBLY



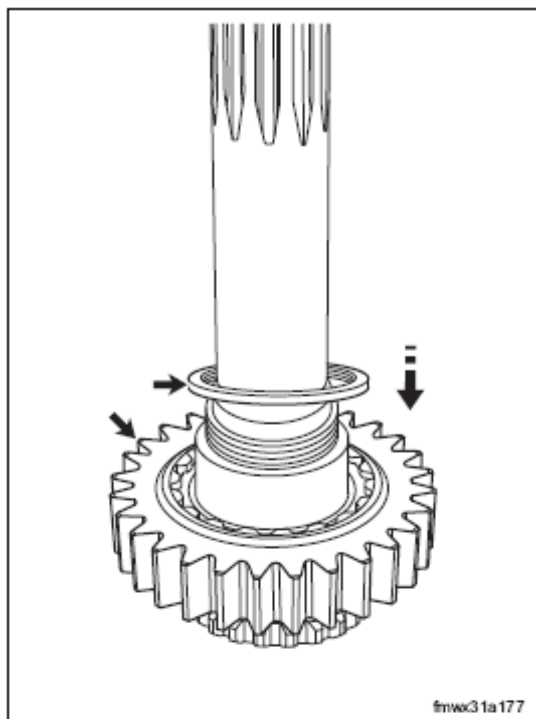
- (d) Remove the first shaft gear spacer and first shaft gear in order.



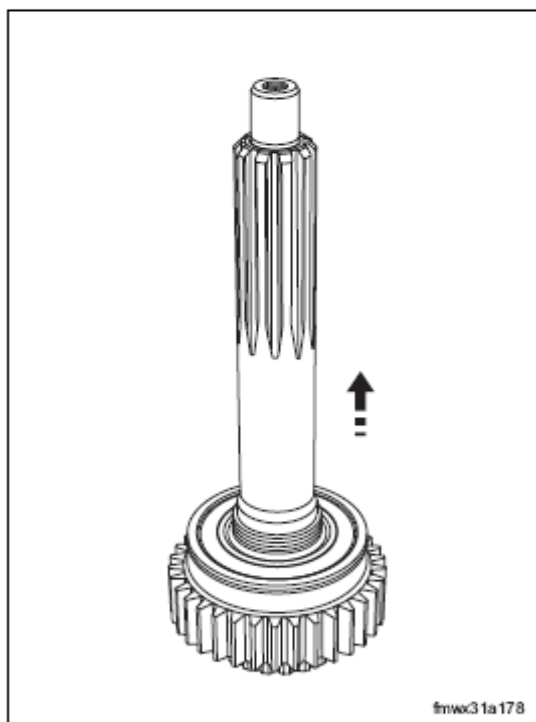
- 2. Reassemble the first shaft assembly.**
(a) Fit the second shaft guide sleeve into the first shaft hole.



- (b) Fit the snap ring.



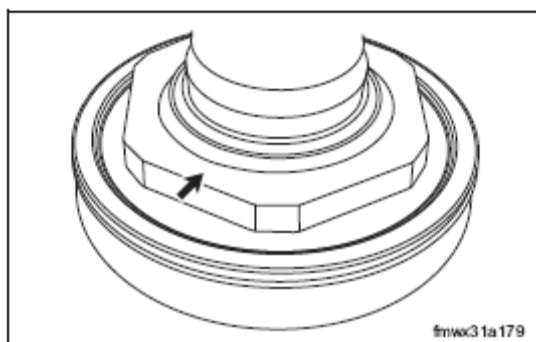
- (c) Fit the first shaft gear and first shaft gear spacer into the first shaft in order.



- (d) Fit the first shaft bearing.

Notice:

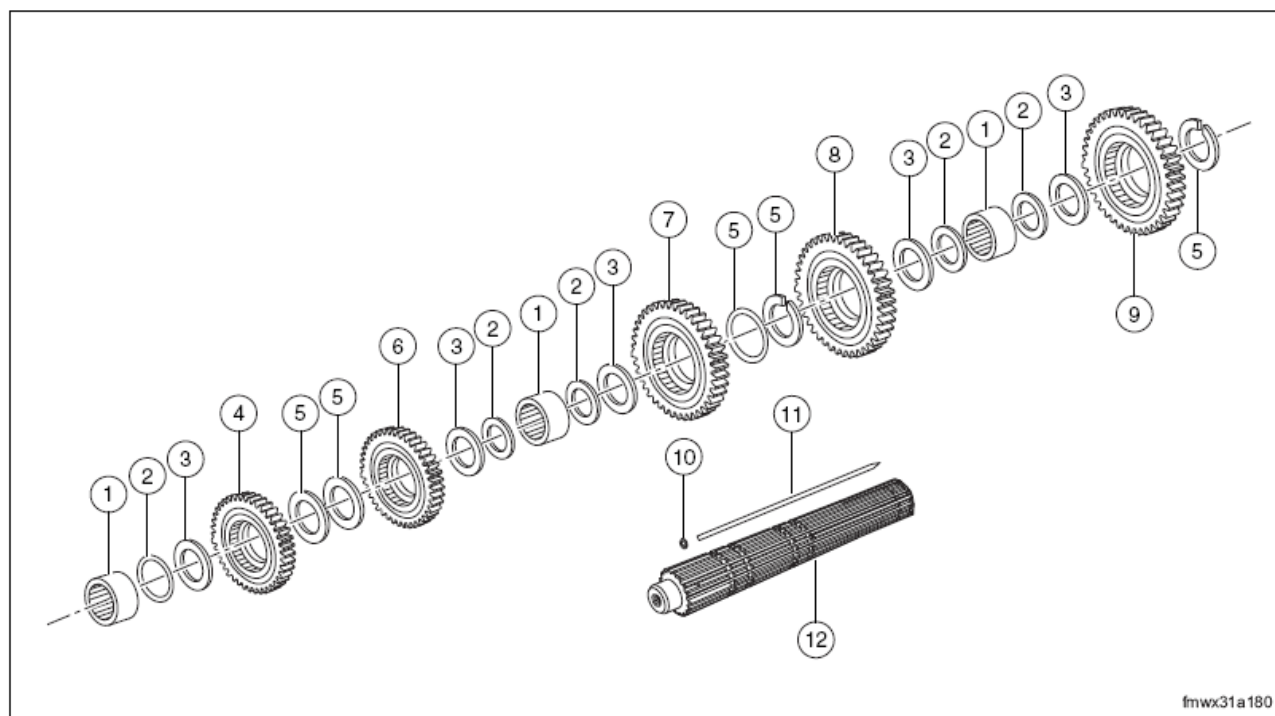
The side with the oil retaining disk must face up.



- (e) Tighten the first shaft nut, and rivet it reliably.
Torque: $372 \pm 34 \text{ N.m}$

SECOND SHAFT ASSEMBLY

DIAGRAM OF COMPONENTS

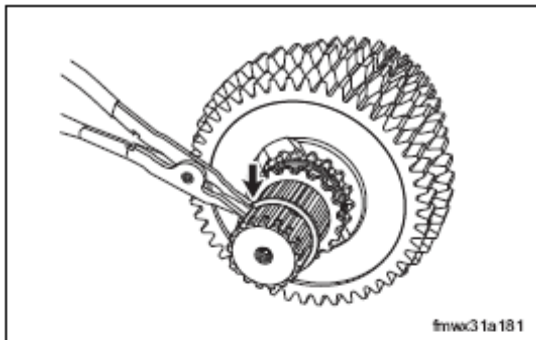


1	Second shaft sliding sleeve
2	Second shaft gear adjusting shim
3	Second shaft gear spline gasket
4	Second shaft third-speed gear
5	Retaining ring
6	Second shaft second-speed gear

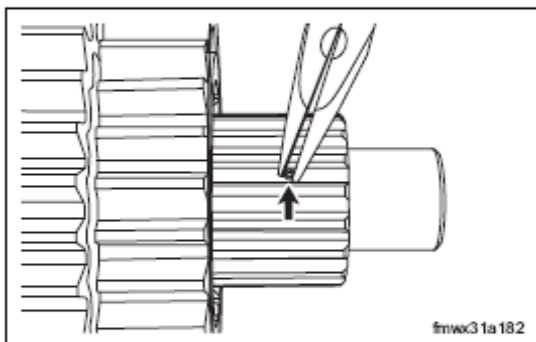
7	Second shaft first-speed gear
8	Second shaft low-speed gear
9	Second shaft reverse gear
10	Flexible cylindrical pin (Pin 3x10)
11	Second shaft hexagon key
12	Second shaft

DISASSEMBLY AND ASSEMBLY

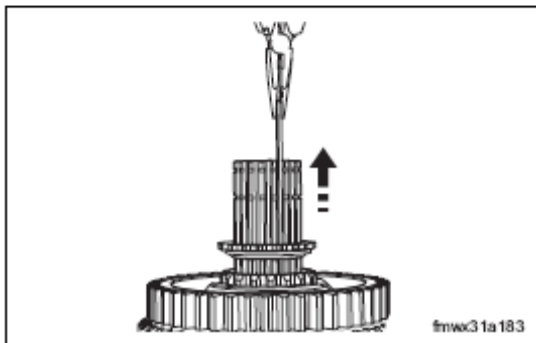
1. Disassemble the second shaft assembly.



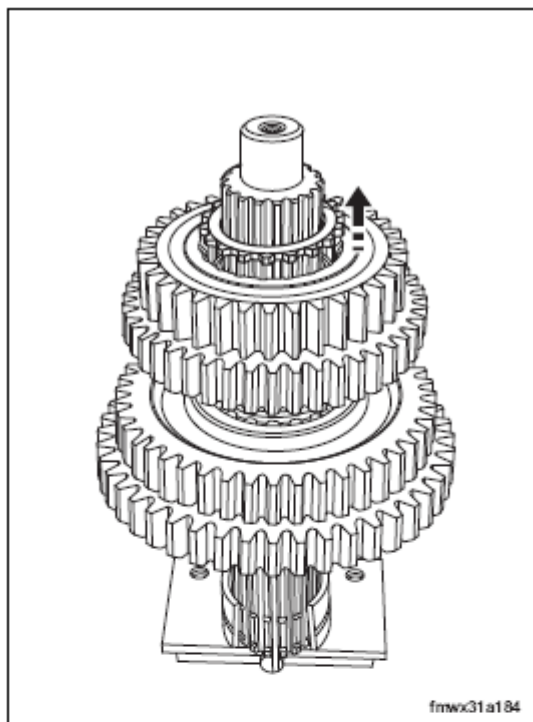
- (a) Remove the snap ring at the rear end of second shaft, and remove the spline gasket and second shaft reverse gear in order.



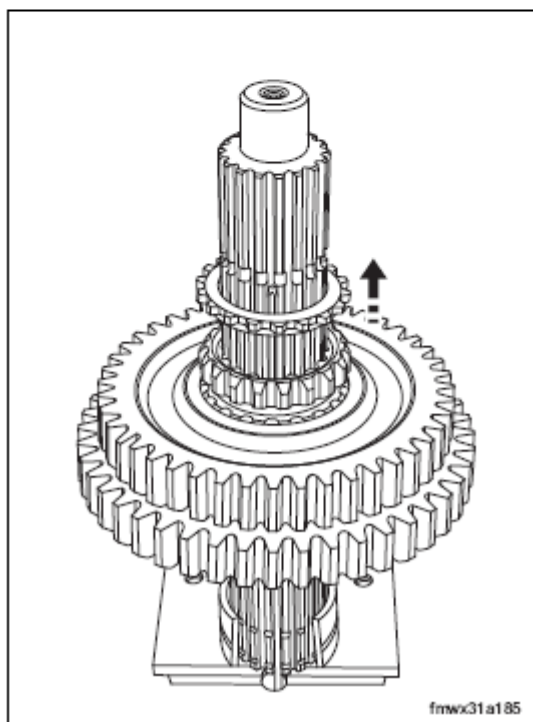
- (b) Remove the flexible pin on the second shaft.



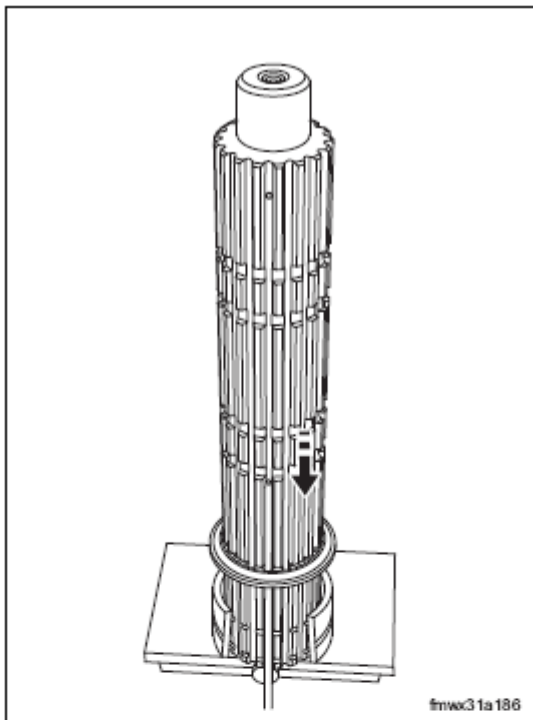
- (c) Remove the long key.



- (d) Remove the second shaft sliding sleeve, adjusting shim, spline gasket and second shaft third-speed gear.
- (e) Remove the second shaft second-speed gear.

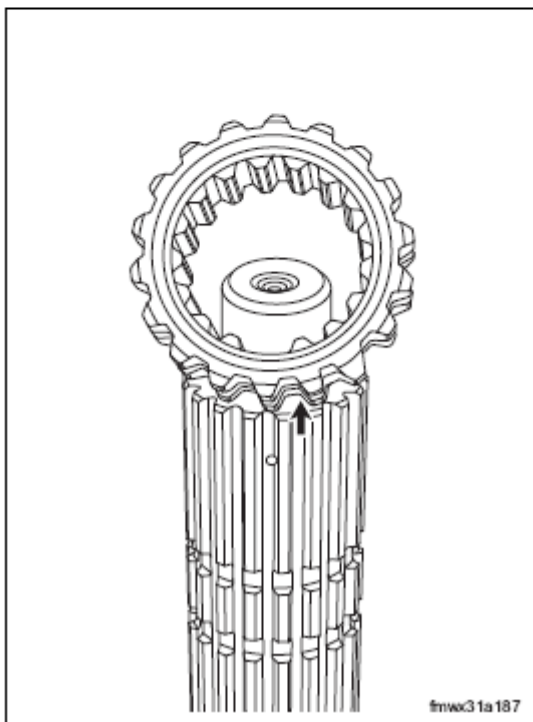


- (f) Remove the spline gasket, gear adjusting shim, sliding sleeve and second shaft first-speed gear in order.
- (g) Remove the second shaft low-speed gear.



2. Reassemble the second shaft assembly.

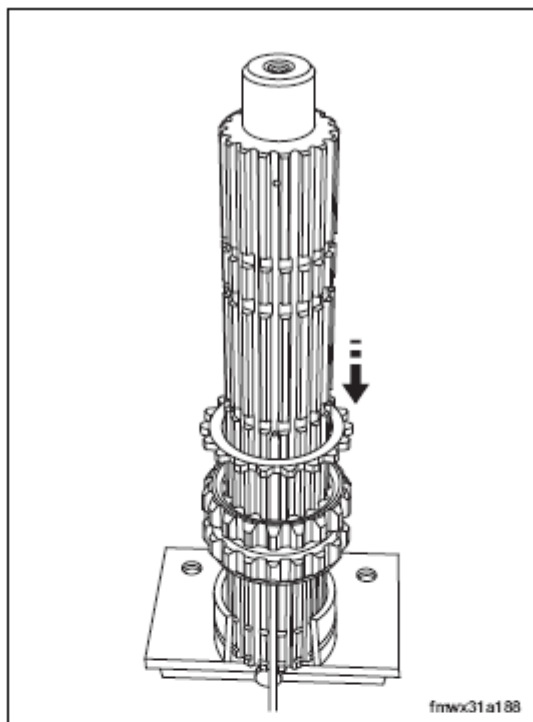
- (a) Put the second shaft vertically into the mounting tool, fit the adjusting shim into the second shaft with the convex side facing up, and after the gear is turned by one tooth pitch, put on the long key.



- (b) Fit the low/reverse gear sliding sleeve.

Hint:

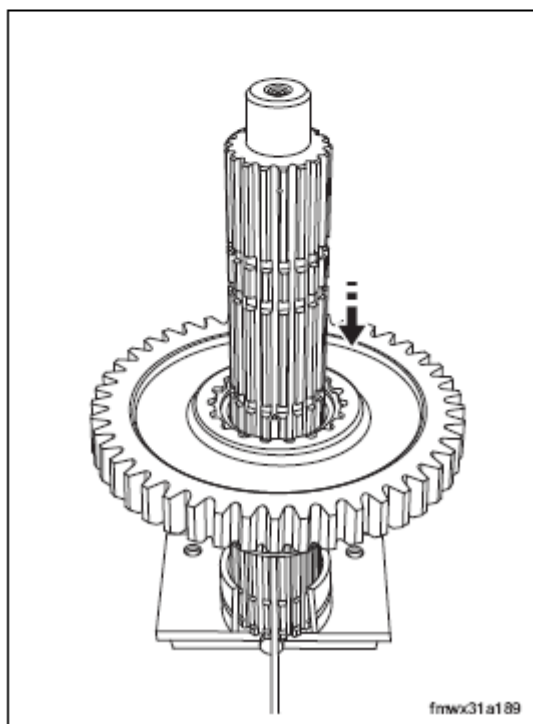
These three sliding sleeves on the second shaft are interchangeable, and the portion without tooth shall face to the groove with a hole on the second shaft.



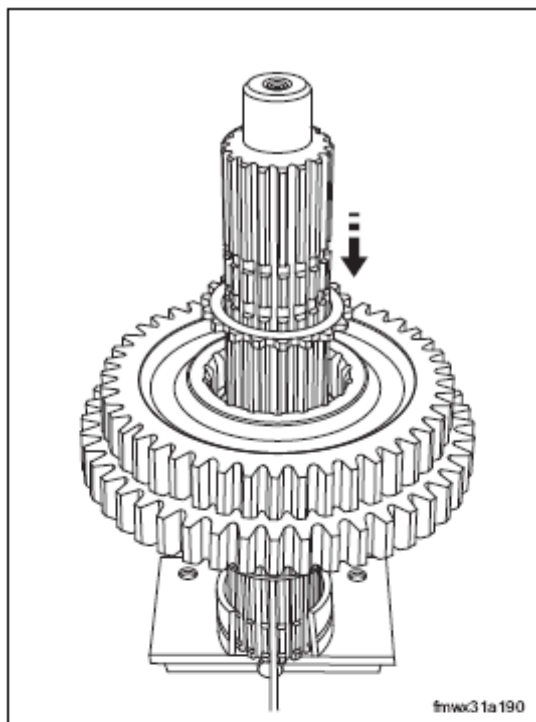
- (c) Fit one adjusting shim with the convex side facing down, and after the gear is turned by one tooth pitch, move on the long key, and fit a spline gasket.

Notice:

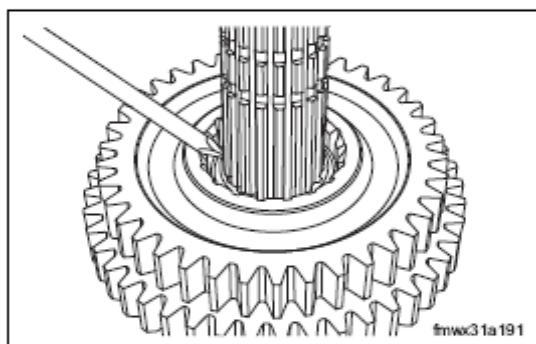
Spline gaskets are interchangeable, having the same thickness. Adjusting shims are provided with different thickness for selection.



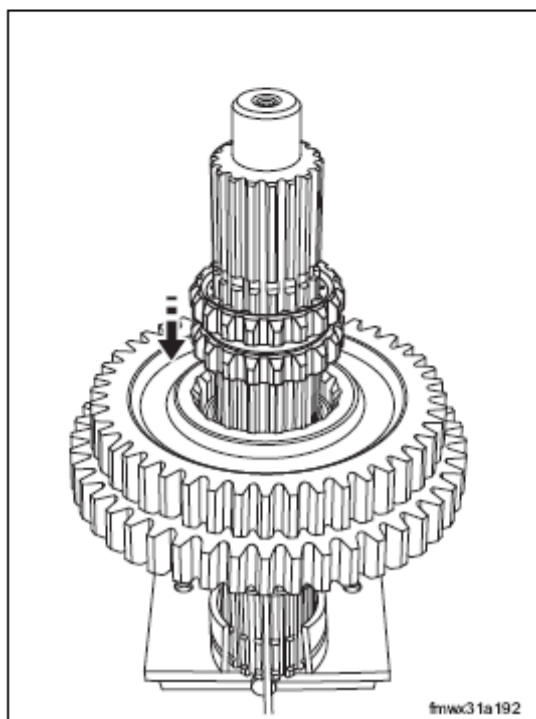
- (d) Fit the second shaft low-speed gear engaging tooth into the second shaft.



- (e) Fit the second shaft first-speed gear engaging tooth into the second shaft, and insert one spline gasket.



- (f) Fit an adjusting shim with the convex side facing up, and by turning it by a certain angle, move on the long key.



- (g) Fit the 1/2 sliding sleeve.

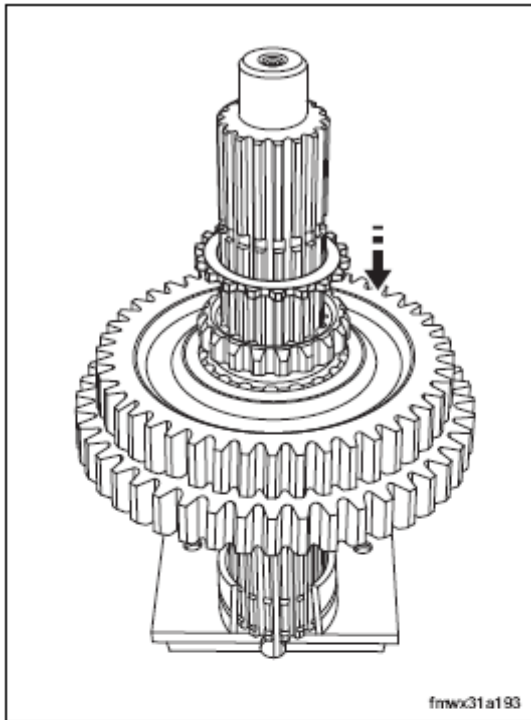
Notice:

The portion without tooth shall face to the groove with a hole on the second shaft.

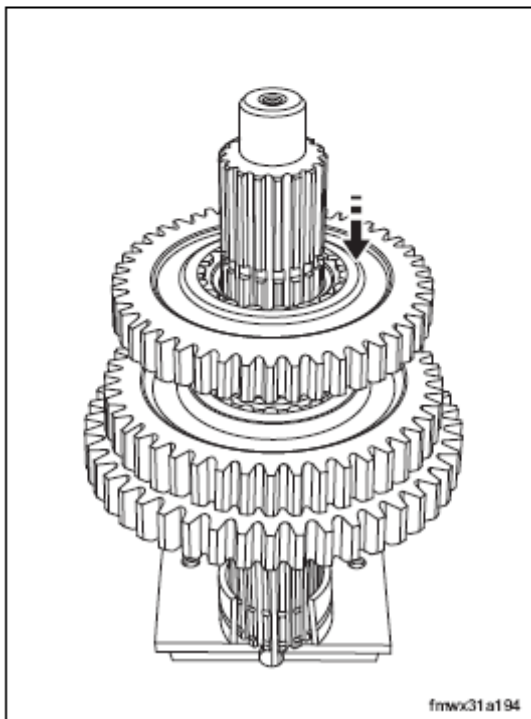


31B-86

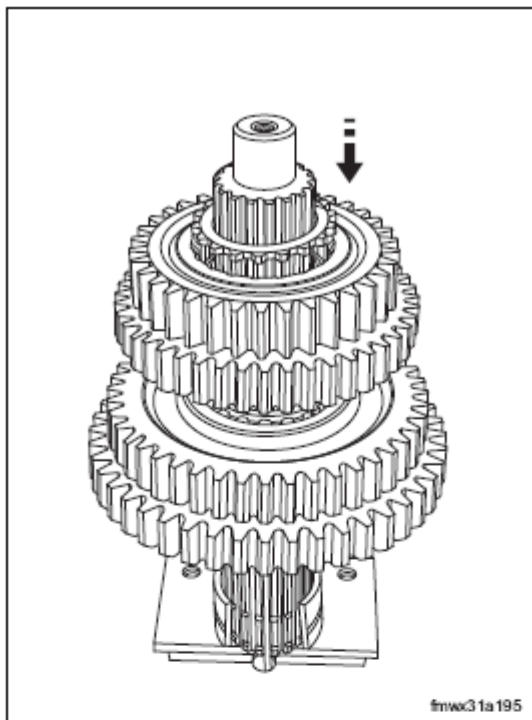
TRANSMISSION (9JS180)-SECOND SHAFT ASSEMBLY



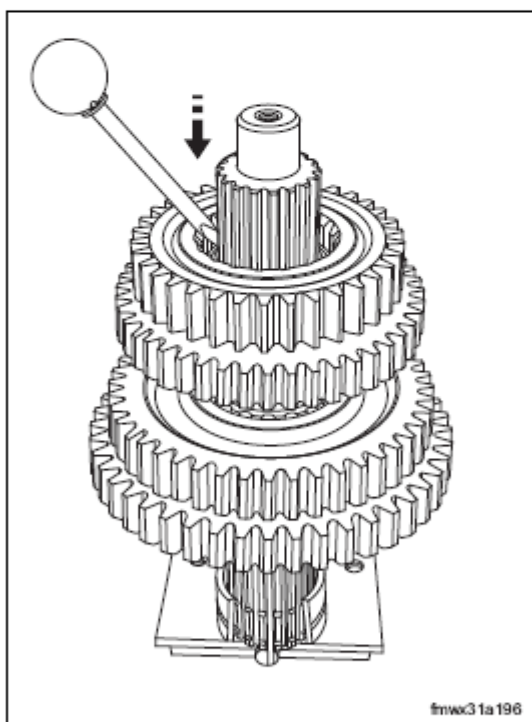
- (h) Fit an adjusting shim with the convex side facing down. By turning it by one tooth pitch, move on the long key and fit a spline gasket.



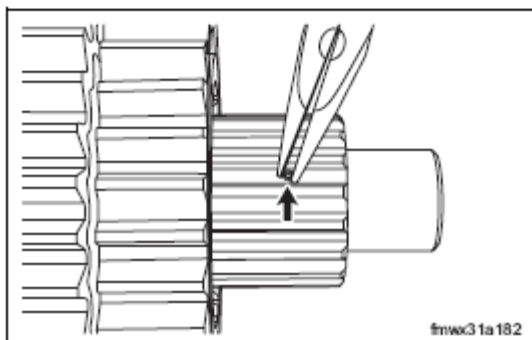
- (i) Fit the second shaft second-speed gear engaging tooth into the second shaft.



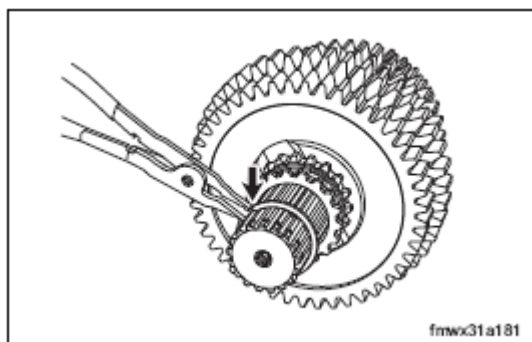
- (j) Fit the second shaft third-speed gear engaging tooth into the second shaft, and fit one spline gasket.



- (k) Fit an adjusting shim with the convex side facing up. By turning it by one tooth pitch, move on the long key.



- (l) Knock the flexible pin into the small hole on the second shaft, and fit the 3/4 sliding sleeve.



- (m) Knock the flexible pin into the small hole on the second shaft, and fit the 3/4 sliding sleeve. Horizontally place the second shaft, and fit the second shaft reverses gear and spline gasket. Then fit a snap ring at the rear end of second shaft.

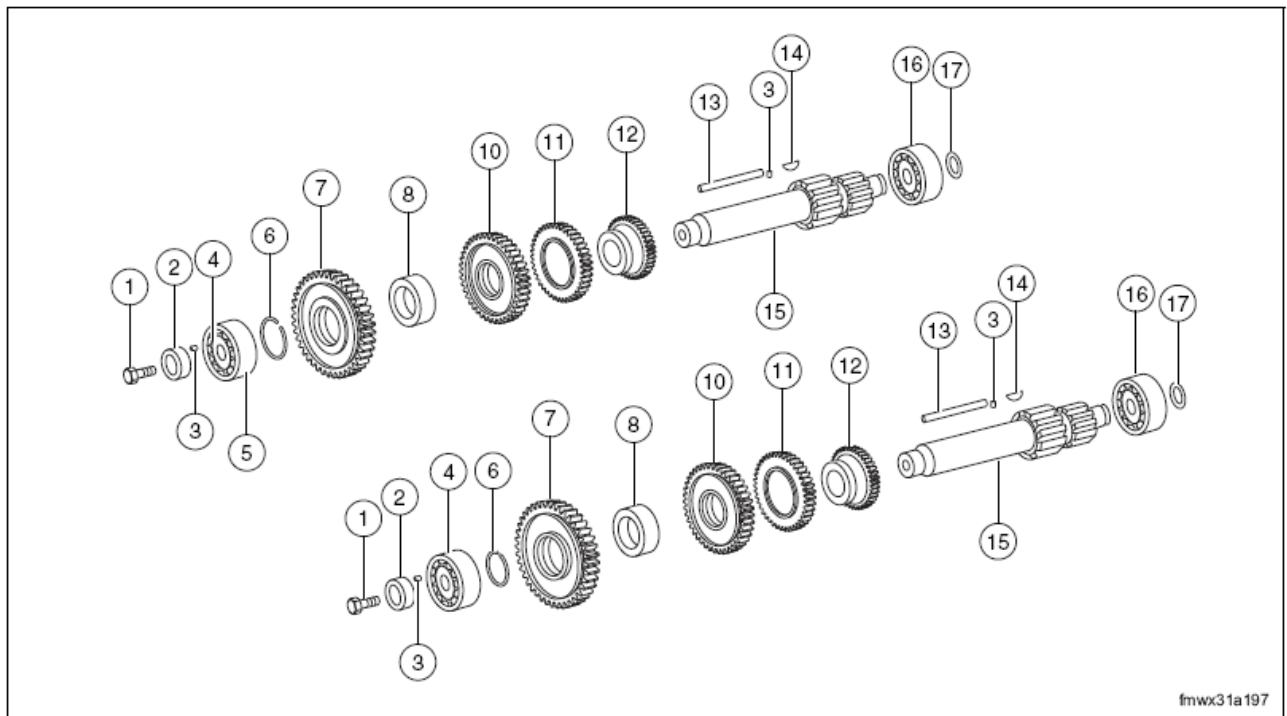
Notice:

To assemble the shaft, it is required to adjust the gear clearance by using shims of different thickness. The thickness and color of shims are indicated in the table below:

Range of thickness (mm)	Color
6.30-6.35	White
6.45-6.48	Green
6.55-6.60	Orange
6.68-6.73	Purple
6.80-6.86	Yellow
6.93-6.99	Black

TRANSMISSION COUNTERSHAFT ASSEMBLY

DIAGRAM OF COMPONENTS



1	Small hexagon bolt (M16x1.5x4.5)
2	Countershaft bearing baffle
3	Flexible cylindrical pin (Pin 5x14)
4	Single-row centripetal ball bearing
5	Retaining ring
6	Countershaft retaining ring
7	Countershaft retaining ring
8	Spacer (left countershaft assembly)
9	Friction wheel (right countershaft assembly)

10	Countershaft third-speed gear
11	Countershaft second-speed gear
12	Countershaft first-speed gear
13	Countershaft square key
14	Woodruff key
15	Countershaft
16	Bearing
17	Retaining ring

31B

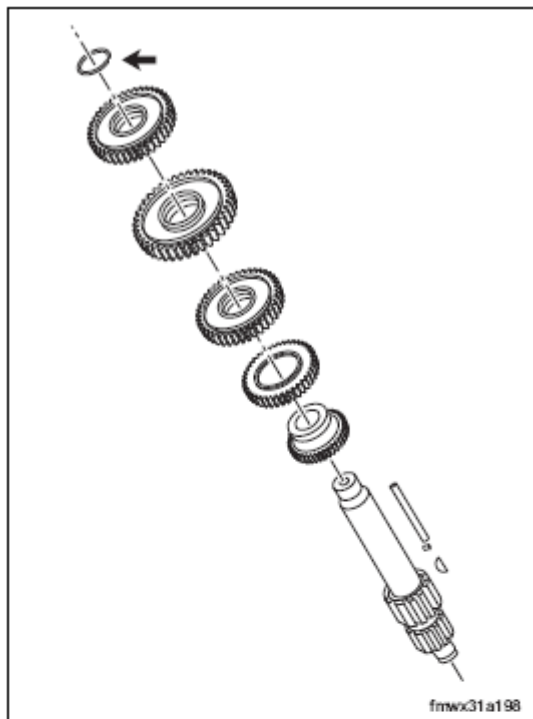
DISASSEMBLY AND ASSEMBLY

Hint:

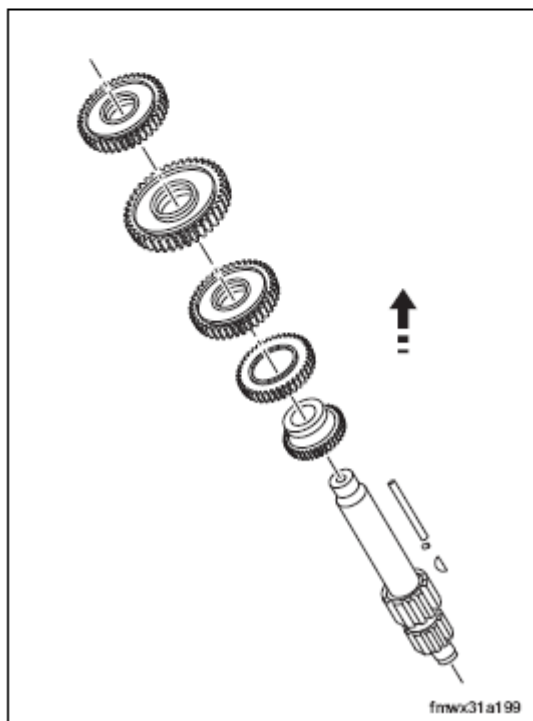
Except for serious wear or tooth collision, do not remove the countershaft gear.

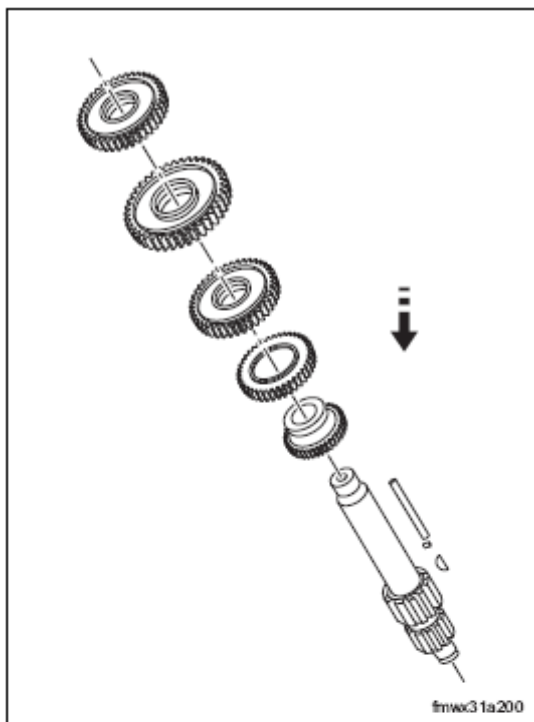
1. Disassemble the right countershaft.

- (a) Remove the countershaft retaining ring.



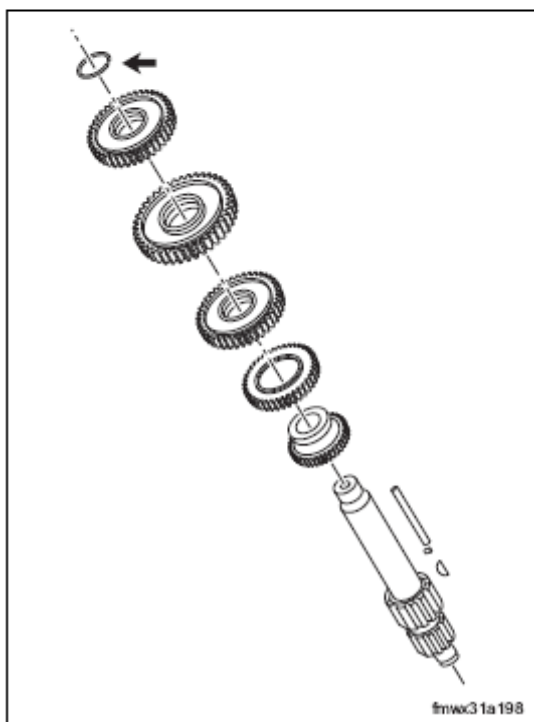
- (b) Remove the countershaft driven gear, friction wheel, spacer, countershaft third-speed gear, countershaft second-speed gear, countershaft first-speed gear, countershaft square key and woodruff key in order.





2. Reassemble the right countershaft.

- (a) Fit the woodruff key, countershaft square key, countershaft first-speed gear, countershaft second-speed gear, countershaft third-speed gear, friction wheel and countershaft driven gear onto the countershaft.



- (b) Fit the countershaft retaining ring.

Hint:

As for the Disassembly and assembly of the left countershaft, refer to the Disassembly and assembly of the right one. Both countershafts differ each other in following aspects: In the left countershaft, the spacer is fitted at the position where the friction wheel is fitted in the right countershaft.

CLUTCH

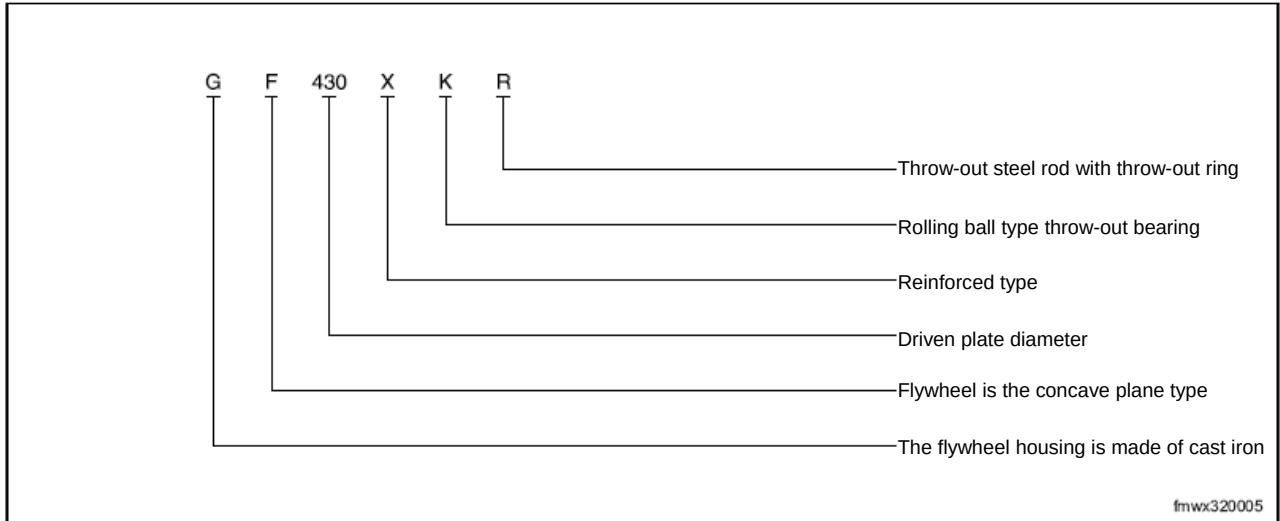
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Diagram of Components	32-26
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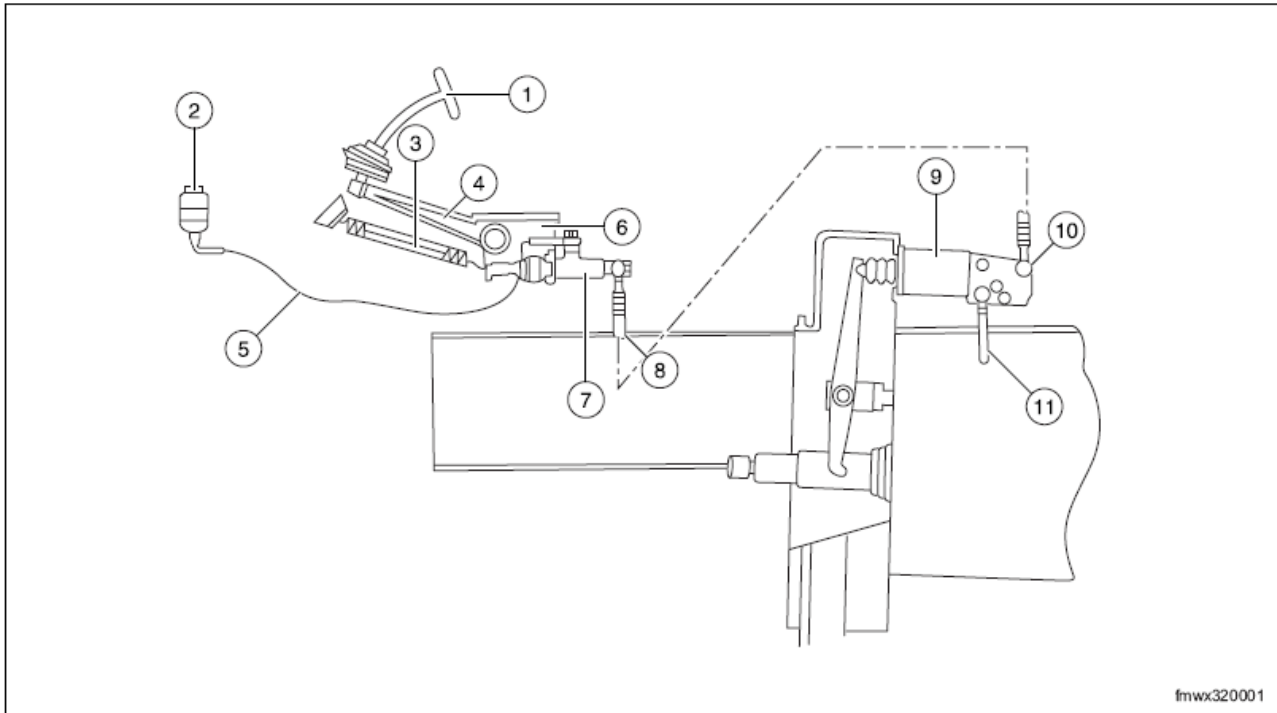
CLUTCH ASSEMBLY

OVERVIEW

This vehicle is equipped with the conventional single-plate dry membrane clutch GF430 and SAE1 clutch housing. The meaning of clutch model is described below:



The clutch assembly is fitted between the engine and gearbox, attached onto the rear plane of the flywheel with bolts. The clutch spline hub and gearbox input shaft are rigidly connected. In the driving, the driver can depress or release the clutch pedal to temporarily disengage and gradually engage the engine and gearbox thus to disconnect or connect the power supply for transmission. The clutch system mainly comprises of the clutch plate, driven plate, throw-out bearing, fork, and clutch housing. There are two types of membrane spring clutches, i.e., push type and pull type. In the case of the push type clutch, the membrane spring is pushed forward by the throw-out bearing to disengage the clutch; in the case of the pull type clutch, the membrane spring is pulled backward by the throw-out bearing to disengage the clutch. In this vehicle, the pull type clutch is employed. With the clutch pedal depressed by the driver, the clutch master cylinder will push the pushrod forward via the boosted slave cylinder to enable the fork to pull the throw-out bearing backward (in the direction of the transmission) through the pivot. As the separator of the membrane spring is fixed on the throw-out bearing by the spring clip, the separator is also pulled backward (in the direction of the transmission) to release the pressure plate thus to thoroughly disengage the clutch. With the clutch pedal slowly released by the driver, the throw-out bearing will move forward as the throw-out pushrod is retracted, and the membrane spring separator will move forward and apply an increasingly higher pressure on the pressure plate to realize the stable engagement of the clutch. The push type clutch throw-out bearing is always integrated with the membrane separator without causing any gap. Therefore, the throw-out bearing is normally engaged. As long as the engine is in operation, the throw-out bearing will work together with the clutch pressure plate assembly, as shown in the figure below:



fmwx320001

1	Clutch pedal
2	Oil reservoir
3	Pedal return spring
4	Pedal crank
5	Oil pipe
6	Clutch bracket

7	Clutch master cylinder
8	Connecting oil pipe
9	Clutch boosted slave cylinder
10	Slave cylinder oil pipe union
11	Clutch slave cylinder air pipe union

WORKING PRINCIPLE

1. Ensure the steady move-up of the vehicle:

Prior to the move-up, keep the vehicle stationary. If the engine is rigidly connected with the gearbox, once the gear is engaged, the vehicle will move forward suddenly due to the abrupt supply of power, which will not only damage members, but also generate enormous inertia force due to that the driving power is not high enough to offset the forward movement of the vehicle, thus to shut down the engine because of the dramatic drop of engine speed. Where the engine and gearbox are temporarily disengaged with the clutch which is then gradually engaged, with the slipping between the drive part and driven part, the torque from clutch will be increased from zero, and the vehicle driving power will be also increased to realize the steady move-up.

2. Facilitate the gearshift:

In the driving, it is necessary to shift to different gears to adapt to continuously-changing operation conditions. If no clutch is provided to disengage the engine and gearbox, the engaged power-transferring gear in the gearbox will remain unloaded to establish a significantly high pressure between engaging surfaces to cause the difficult disengagement. In addition, the gears to be engaged will be hard to be engaged due to the different circumferential speeds. Even if the gear is forcibly engaged, a massive impact will occur at the tooth end, which is liable to damage members. Whenever the clutch is employed to disengage the engine and gearbox temporarily for gear shifting operation, the originally engaged gear pairs will be unloaded to largely reduce the pressure between the engaging surfaces to make the disengagement easier. As for another pairs of gears to be engaged, as the drive gear is provided with a low rotating inertia after it is separated from the engine, the adoption of a proper gear shifting action will equalize or approximately equalize the circumferential speed of gears to be engaged, thus to avoid or minimize the collision between gears.

3. Prevent the overloading of transmission system

In the case of emergency braking of the vehicle, the wheel speed will be reduced abruptly, but the transmission system connected to the engine will remain its original speed due to the rotating inertia, which will usually produce an inertia torque in the transmission system much higher than the engine torque to damage members of the transmission system. As the clutch transfers the torque via the friction force, when the overload in the transmission system exceeds the torque which can be transferred by the friction force, the clutch drive and driven parts will slip automatically to prevent the system overloading.

PRECAUTIONS

1. Precautions in operation of the clutch system

- (a) When servicing the clutch system, do observe instructions provided in this manual.
- (b) The incorrect operation may impair the performance of the clutch system and vehicle.
- (c) Before disconnecting the clutch system pipeline, all openings must be enclosed with the dedicated caps to avoid the adhesion of clutch oil onto the paint surface.

2. Precautions in maintenance of the clutch system

- (a) The designated clutch oil must be used. Never mix the clutch oil products of different brands. Furthermore, it is necessary to check and replace the clutch oil on a regular basis.

Clutch oil: DOT3 brake liquid

- (b) Check the clutch oil every 5000km. After the initial 40000km, the clutch oil must be replaced, and subsequent replacements shall be provided every 40000km. After 8000km, replace the clutch oil every 20000km.
- (c) Check the clutch every 5000km as described below:
 - Check the clutch pedal travel and free travel;
 - Check the clutch hydraulic system for leakage;
 - Check the clutch pneumatic system for leakage;
 - Check the clutch slave cylinder booster pushrod travel and sealing performance;
 - Check all connections for looseness;
 - Check whether the clutch system can work normally.

3. Precautions in removal and refitting operation of the clutch

- (a) When removing or refitting the clutch, take care not to subject the drive plate to impact load. The pressure plate shall be fixed relative to the pressure plate housing to avoid damaging the drive plate; if the plate is deformed, this will significantly impair the clutch performance.
- (b) When fitting a new pressure plate assembly, fix the assembly onto the flywheel, and then the flexible U-shaped clip will be loosened; at this moment, remove the clip; otherwise serious failures and consequences will be caused if the clip falls into the clutch in operation.
- (c) When fitting the pressure plate assembly, use two positioning bolts to position the plate and flywheel. Position the driven plate on the flywheel central hole with the positioning rod, and then pre-tighten 12 bolts on the plate housing. Thereafter, tighten them with a torque of 50-60N.m in the diagonal sequence.

TABLE OF FAULT PHENOMENA

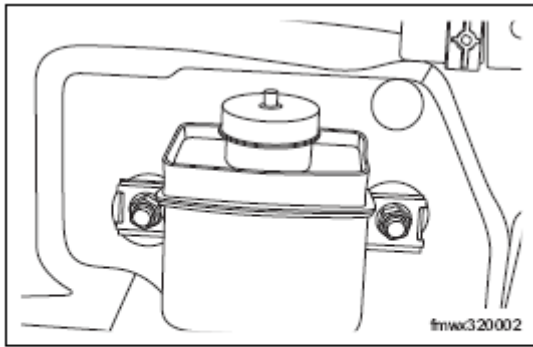
The table below can assist you to find the failure. The number represents the sequence of occurrence of possible failures. Check each part as per this sequence, and provide replacement if necessary.

Symptoms of failure	Possible causes	Reference made to
The clutch slips.	1. Clutch pedal free travel (too small)	Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly
	2. Driven plate (excessively worn)	Chapter 32: Service, Clutch-Clutch Assembly
	3. Flywheel (warped)	Chapter 16: Replacement, Engine Mechanic System-Flywheel and Flywheel Housing
	4. Pressure plate (deformed)	Chapter 32: Service, Clutch-Clutch Assembly
	5. Pressure plate membrane spring (disabled)	Chapter 32: Service, Clutch-Clutch Assembly
The clutch is disengaged incompletely	1. Clutch pedal free travel (too large)	Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly
	2. Pressure plate membrane spring (disabled)	Chapter 32: Service, Clutch-Clutch Assembly
	3. Clutch master cylinder (leakage)	Chapter 32: Service, Clutch-Clutch Assembly
	4. Clutch slave cylinder booster (leakage)	Chapter 32: Service, Clutch-Clutch Assembly
	5. Hydraulic system (ingress of air)	Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly
	6. Driven plate (abnormal wear)	Chapter 32: Service, Clutch-Clutch Assembly
	7. Pressure plate (abnormal wear)	Chapter 32: Service, Clutch-Clutch Assembly
	8. Throw-out bearing (excessive wear)	Chapter 32: Service, Clutch-Clutch Assembly
	9. Clutch throw-out fork (abnormal wear)	Chapter 32: Service, Clutch-Clutch Assembly
	10. Improper adjustment of clutch working travel	Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly
Abnormal noise in the clutch	1. Shock-absorbing spring (broken)	Chapter 32: Service, Clutch-Clutch Assembly
	2. Driven plate (excessively worn)	Chapter 32: Service, Clutch-Clutch Assembly
	3. Throw-out bearing (slack)	Chapter 32: Service, Clutch-Clutch Assembly
	4. Clutch pedal (deformed)	Chapter 32: Service, Clutch-Clutch Pedal Assembly

CLUTCH-CLUTCH ASSEMBLY

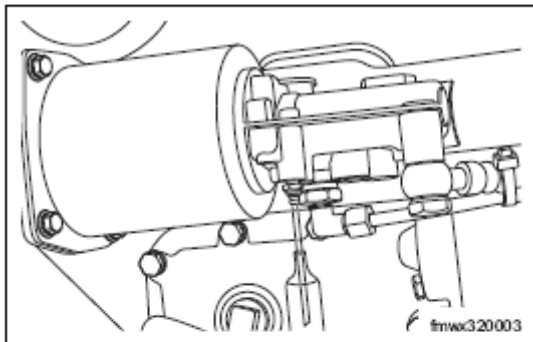
Symptoms of failure	Possible causes	Reference made to
The clutch shivers.	1. Driven plate (deformed or abnormally worn)	Chapter 32: Service, Clutch-Clutch Assembly
	2. Flywheel (abnormally worn)	Chapter 16: Replacement, Engine Mechanic System-Flywheel and Flywheel Housing
	3. Pressure plate (abnormally worn)	Chapter 32: Service, Clutch-Clutch Assembly
	4. Shock-absorbing spring (broken or deformed due to fatigue)	Chapter 32: Service, Clutch-Clutch Assembly
	5. Pressure plate membrane spring (deformed)	Chapter 32: Service, Clutch-Clutch Assembly
	6. Engine mounting (slack or rubber pad damaged)	Fasten, repair or replace the rubber pad
	7. Transmission mounting ((slack or rubber pad damaged)	Fasten, repair or replace the rubber pad

TESTING AND ADJUSTMENT

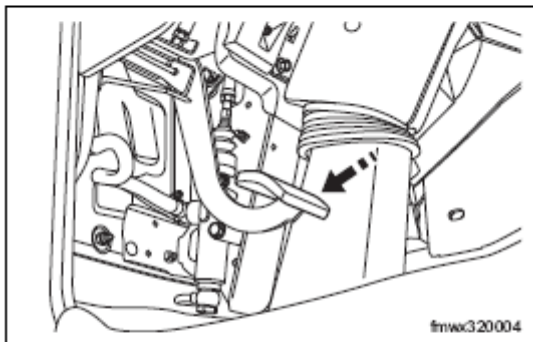


1. Refilling and air discharge of clutch oil

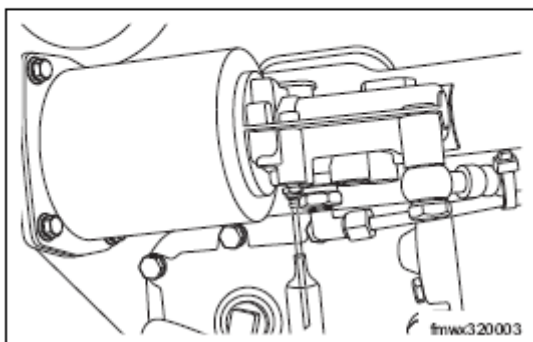
- (a) Fill up the oil cup with clutch oil.



- (b) Fit a rubber pipe of a suitable length onto the air bleed valve on the clutch slave cylinder booster.
- (c) Place a suitable vessel at the lower end of the rubber pipe to receive the clutch oil.

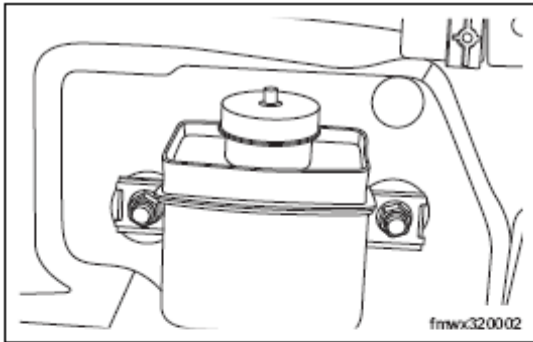


- (d) Depress the clutch pedal for several times; then depress it to its lowest position and hold it.

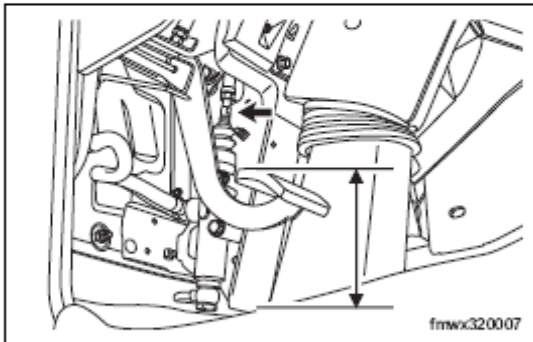


- (e) Undo the drain plug on the air bleed valve to release the bubble-bearing or turbid clutch oil. When the clutch oil stops flowing out, fasten the drain plug.
- (f) Repeat the above-mentioned procedure till no bubble appears in the clutch oil or the oil color is corrected. Then fasten the drain plug.

Torque: 12N.m

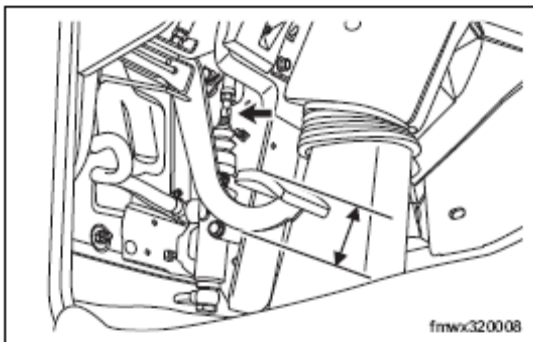


- (g) Check the level of clutch oil in the cup, which shall be between "MAX" and "MIN"; if necessary, refill the oil.

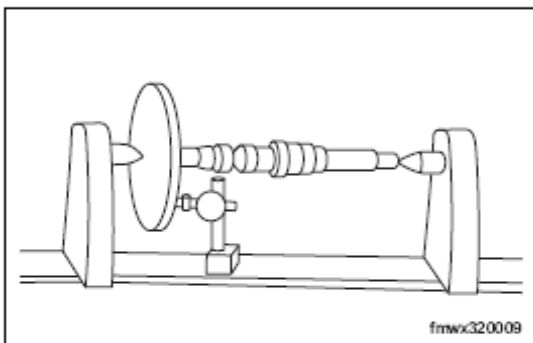


2. Adjustment of clutch pedal

- (a) Measure the clutch pedal travel, and depress the pedal to its lowest position; measure the distance from the starting position to the ending position.
- (b) Adjust the pedal travel, undo the lock nut and rotate the bolt.

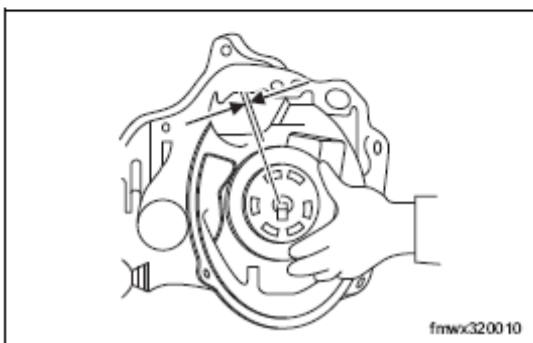


- (c) Determine the pedal free travel, lightly press the pedal with hand, and measure the declining distance when a resistance is detected.
- (d) Adjust the free travel, undo the lock nut and rotate the pushrod. The free travel shall be between 35mm and 40mm. After the adjustment, fasten the lock nut.



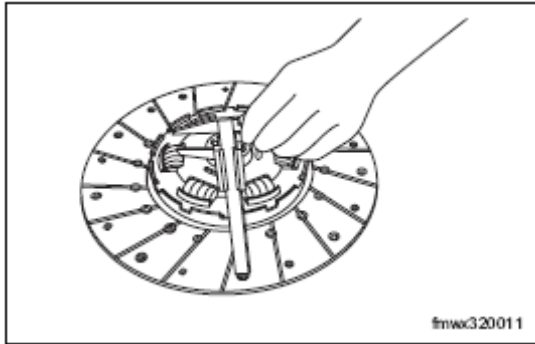
3. Check of clutch driven plate

- (a) Check the clutch driven plate for warping and deformation.
- (b) If the required value is exceeded, replace the clutch driven plate.

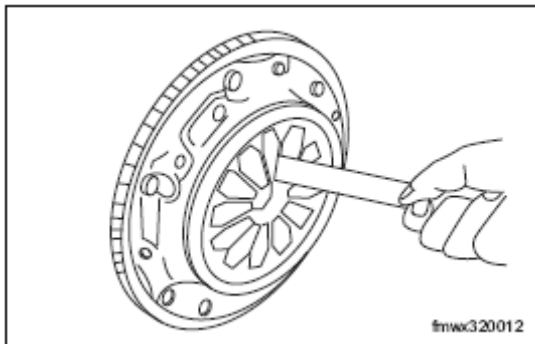


- (c) Check the spline lateral fit clearance. With the spline fitted on the transmission input shaft, rotate the friction plate assembly fore and aft to check the lateral clearance. If the clearance exceeds the limit (0.5mm), replace the friction plate assembly. This clearance is the moving clearance in the circumferential direction when measured with the micrometer.

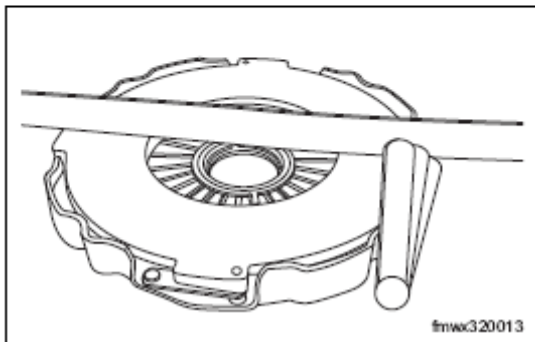
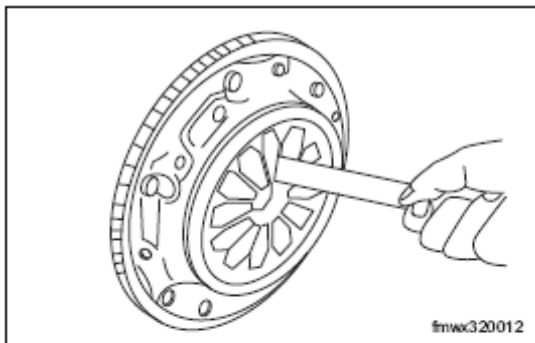




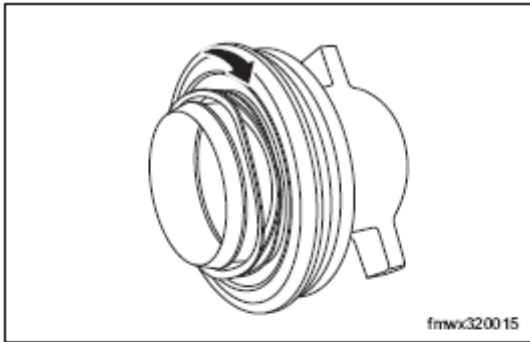
- (d) Check the wearing conditions of the friction plate. Measure the depth of various rivet heads, i.e., the distance between the rivet head and friction plate surface, to check the wear conditions of the friction plate. If the distance at any hole reaches the serviceability limit (0.5m), replace the friction plate assembly.
- (e) Check the status of the friction plate surface. If the friction plate is lightly damaged or worn (mirror-like), refinish it with the No.120-200 emery paper; if seriously damaged or the cracks on the surface are hard to be recovered, replace the friction plate assembly.



4. **Check of clutch pressure plate assembly**
 - (a) Check whether the membrane spring rivet of the pressure plate assembly is loosened; if loosened or being loosened, replace the pressure plate assembly, for a loose plate will make a clattering sound when the clutch pedal is being depressed.
 - (b) Check whether the height of the membrane spring at the throw-out claw is identical, and the permissible maximum height variance is 0.7mm. If higher than 0.7mm, the adjustment is required. The adjustment shall be such that the number of claws to be adjusted is minimized.
 - (c) Check the planeness of the clutch pressure plate.
 - (d) If the limit is exceeded, replace the pressure plate.

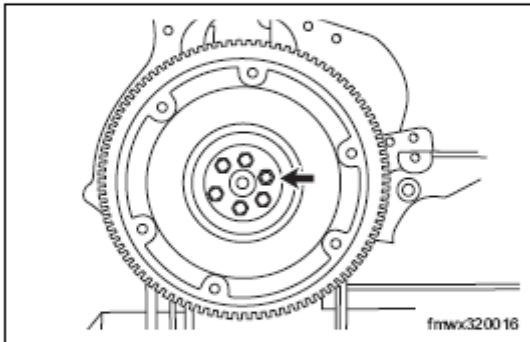


- (e) Check the wearing conditions of the pressure plate.
- (f) If the limit is exceeded, replace the pressure plate.



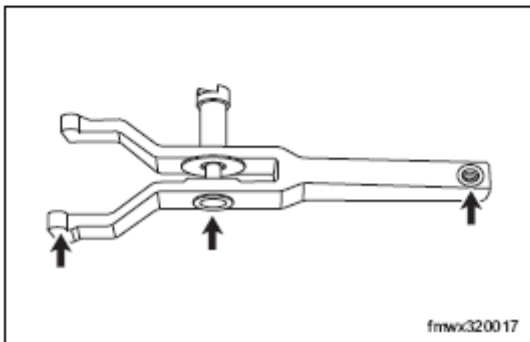
5. Check of throw-out bearing

- (a) Rotate the throw-out bearing by hand; if any seizure, or clattering sound or strange noise is detected, replace the throw-out bearing.



6. Check of flywheel friction surface

- (a) Check whether the flywheel surface in contact with the clutch friction plate is damaged or worn.
- (b) Check whether the guide bearing is slack.



7. Check of fork shaft assembly

- (a) Check whether the fork shaft is deformed or worn, whether the shaft end thread is seriously damaged and whether the fork is seriously worn; if the fork is damaged, replace it.

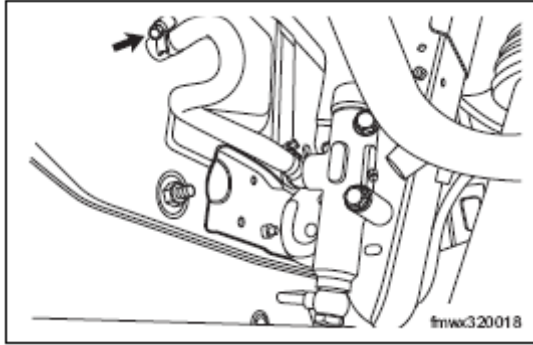
CLUTCH OIL RESERVOIR ASSEMBLY

SERVICE

Hint:

As for the Diagram of Components, refer to Chapter 32: Diagram of Components, Clutch-Clutch Master Cylinder.

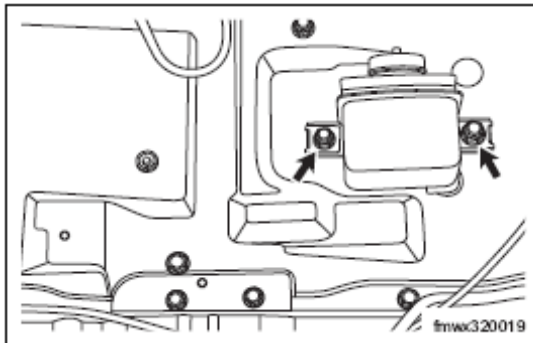
1. Discharge the clutch oil.



2. Disconnect the clutch front hose and clutch oil reservoir.

- (a) Undo the hoop, and disconnect the clutch master cylinder inlet hose and the oil reservoir.

3. Remove the wiper water reservoir. Refer to Chapter 55: Service, Wiper and Washer-Washer.



4. Remove the clutch oil reservoir assembly.

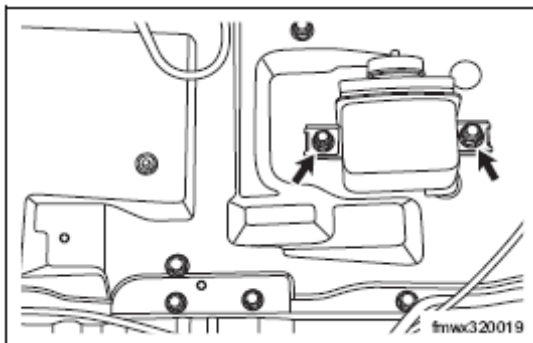
- (a) Remove these 2 lock nuts of the reservoir.
(b) Remove the reservoir assembly.

5. Check the clutch oil reservoir assembly.

- (a) Check whether the reservoir is cracked, whether the strainer is contaminated, and whether the reservoir cover is broken.

Hint:

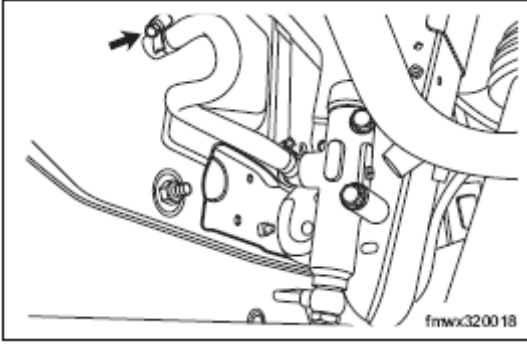
Repair or replace the reservoir as the case may be.



6. Refit the clutch oil reservoir assembly.

- (a) Refit the clutch oil reservoir.
(b) Fasten the lock nut.

Torque: 12N.m

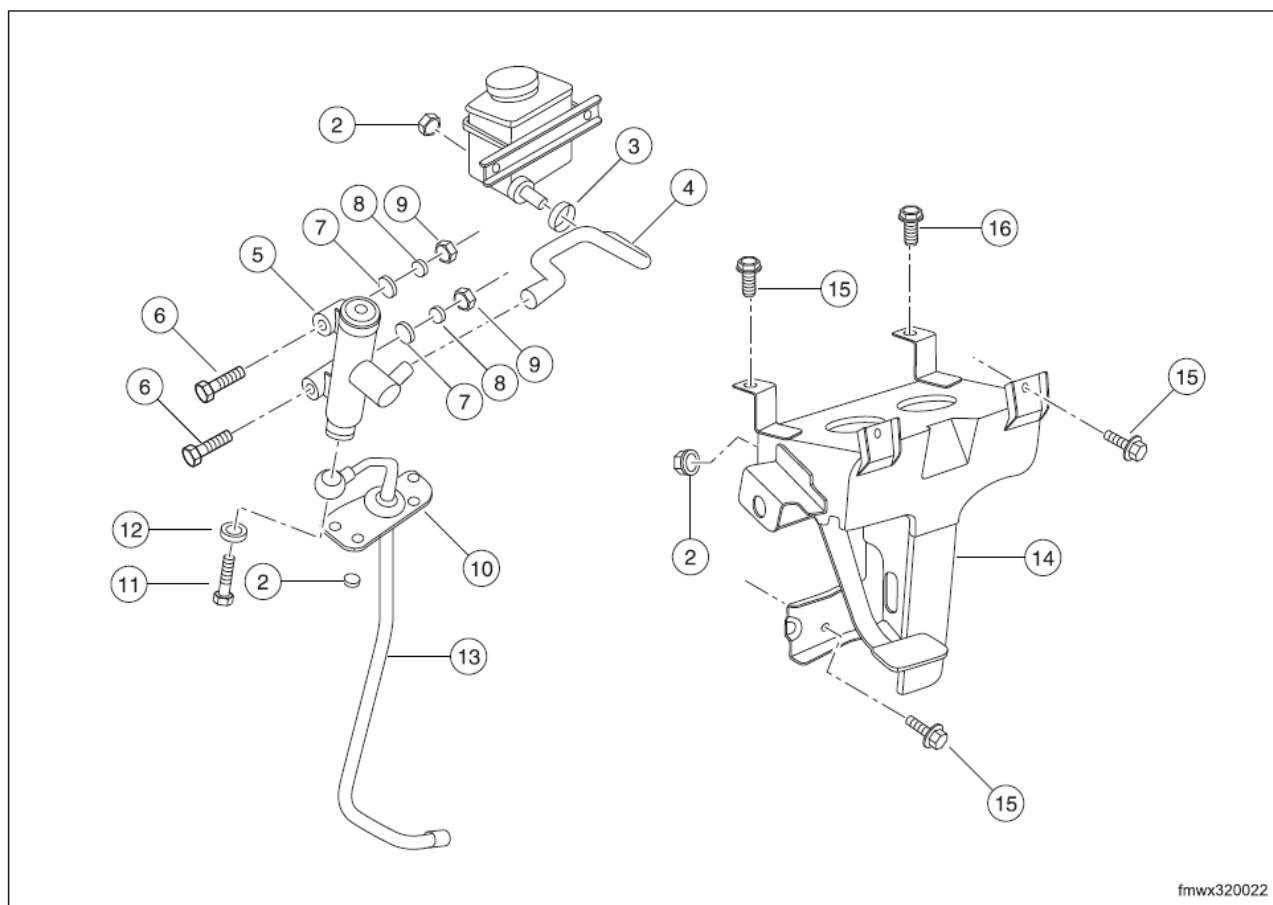


- (c) Connect the clutch master cylinder inlet hose to the oil reservoir, and fasten the hoop.

7. Refill the clutch oil and release the air. Refer to Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly.

CLUTCH MASTER CYLINDER

DIAGRAM OF COMPONENTS



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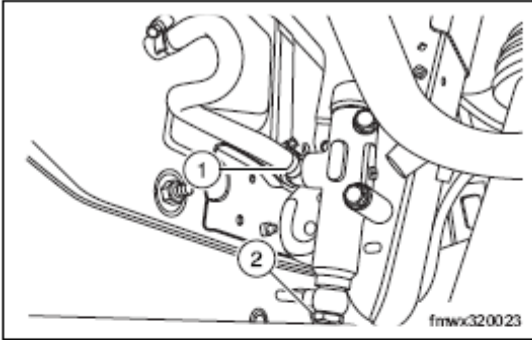
1	Oil reservoir
2	Fully-metallic hexagon flanged lock nut
3	A-type worm drive hose hoop
4	Clutch master cylinder inlet hose
5	Clutch master cylinder assembly
6	Hexagon bolt
7	Plain washer
8	Spring washer

9	Type 1 hexagon nut
10	Dustproof plate
11	Ferrule type hinged hexagon bolt
12	Sealing washer
13	Clutch master cylinder outlet pipe
14	Clutch pedal assembly
15	Hexagon bolt, spring washer and plain washer assembly
16	Hexagon bolt assembly



SERVICE

1. Discharge the clutch oil.
2. Turn up the vehicle front end.



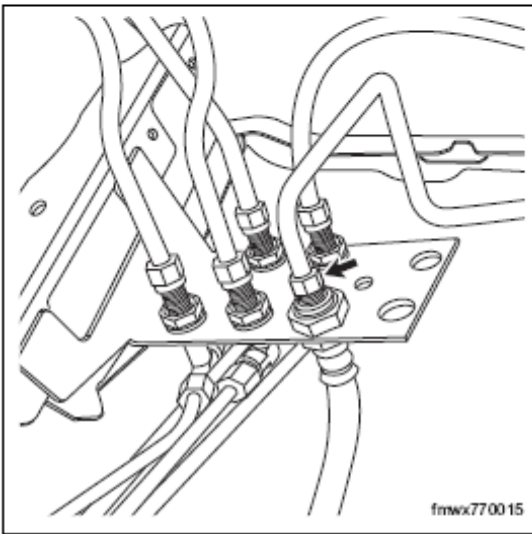
3. Disconnect the clutch master cylinder inlet pipe and outlet pipe.

- (a) Undo the inlet pipe hoop 1, and separate the inlet pipe.
- (b) Undo the bolt 2, and separate the outlet pipe.

Notice:

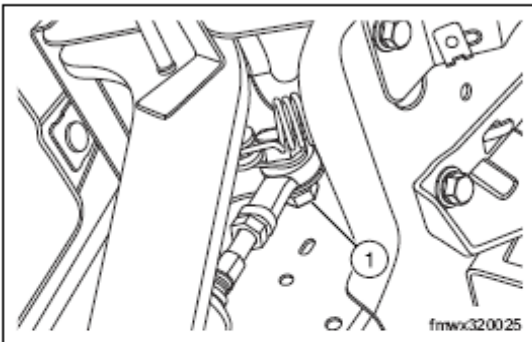
Use a dedicated vessel to receive the residual clutch oil. Avoid the contact between clutch oil and paint surface. If the skin is contaminated by the clutch oil, wash it with water.

- (c) Disconnect the clutch master cylinder outlet pipe and front connecting hose assembly.
- (d) Remove the clutch master cylinder outlet pipe.



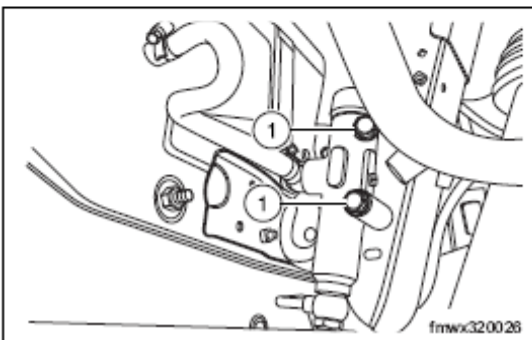
4. Remove the clutch master cylinder pushrod.

- (a) Remove the clutch master cylinder pushrod pin shaft bolt 1.



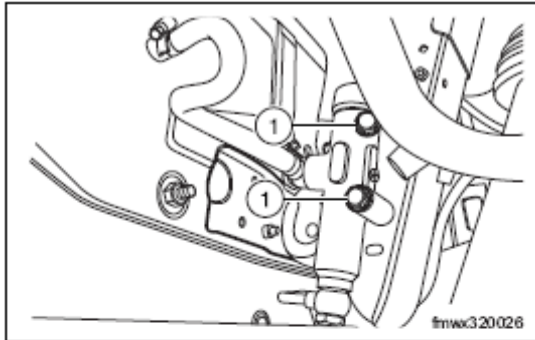
5. Remove the clutch master cylinder.

- (a) Undo these two lock bolts 1 on the master cylinder.
- (b) Remove the master cylinder assembly.



6. Check the clutch master cylinder.

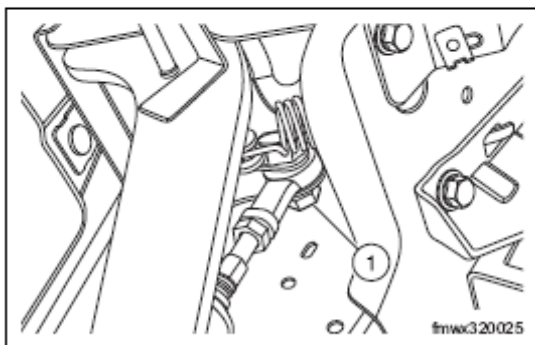
- (a) Check whether the master cylinder inlet pipe union is loosened.
- (b) Check whether the cylinder dustproof casing is aged or cracked.
- (c) Check whether there is leakage in the master cylinder pushrod oil seal.



7. Refit the clutch master cylinder.

- (a) Refit the clutch master cylinder, and fasten these two lock bolts 1.

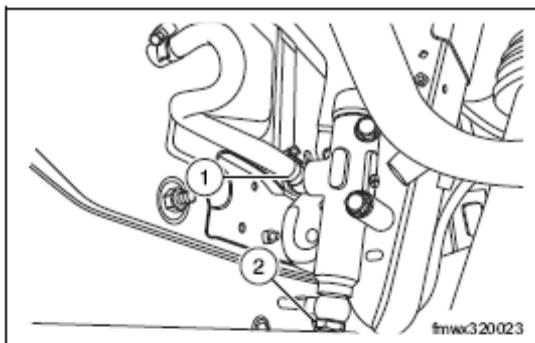
Torque: 64N.m



8. Refit the clutch master cylinder pushrod.

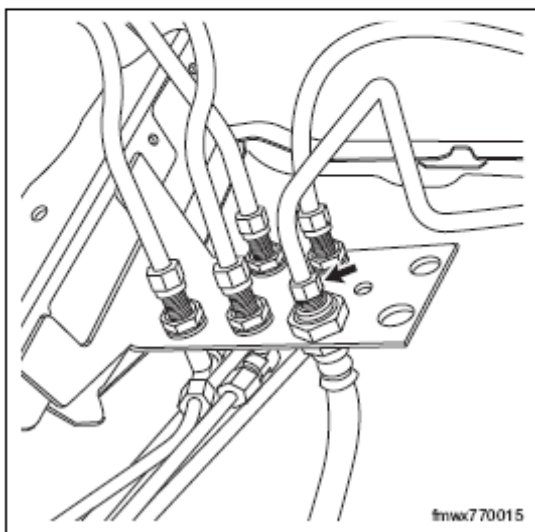
- (a) Refit the clutch master cylinder pushrod, and fasten the pin shaft bolt 1.

Torque: 28N.m



9. Refit the clutch master cylinder inlet pipe and outlet pipe.

- (a) Connect the cylinder inlet pipe and fasten the hoop 1.
- (b) Connect the outlet pipe, and fasten the bolt 2.



- (c) Connect the clutch master cylinder outlet pipe and front connecting hose assembly.

Notice:

The pipe union must be wrapped with the seal tape.

10. Refill the clutch oil and release the air. Refer to Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly.

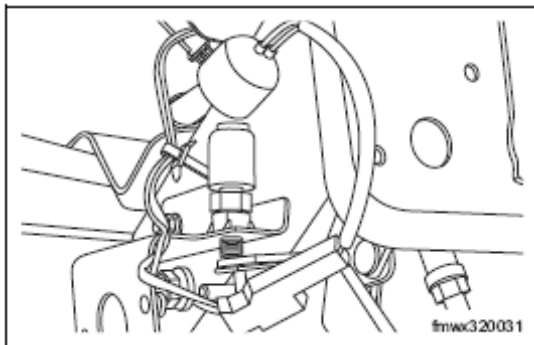
CLUTCH PEDAL ASSEMBLY

SERVICE

Hint:

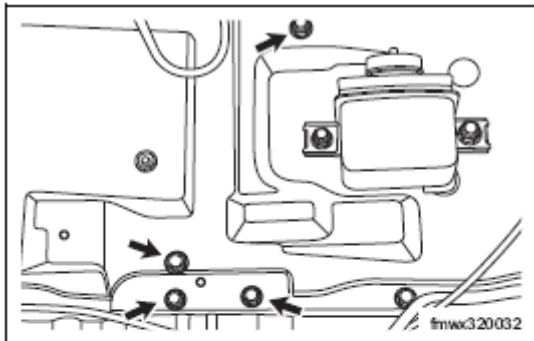
As for the Diagram of Components, refer to Chapter 32: Diagram of Components, Clutch-Clutch Master Cylinder.

1. **Disconnect the battery negative cable.**
2. **Discharge the clutch oil.**
3. **Remove the steering column. Refer to Chapter 41: Removal and Refitting, Steering Wheel and Steering Column-Steering Column (Right-hand Drive).**
4. **Remove the dashboard. Refer to Chapter 73: Replacement, Dashboard/Instrument/Cigarette Igniter.**

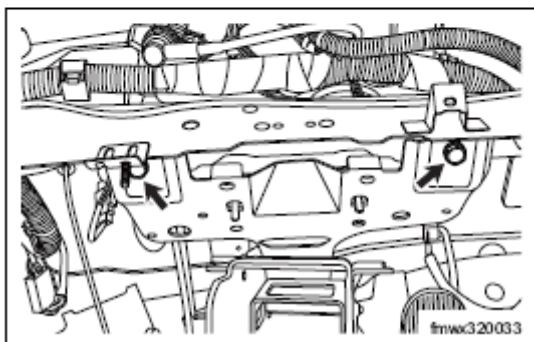


5. **Remove the clutch pedal switch.**
 - (a) Disconnect the clutch switch wire connector.
 - (b) Undo the clutch switch lock nut, and remove the switch assembly.

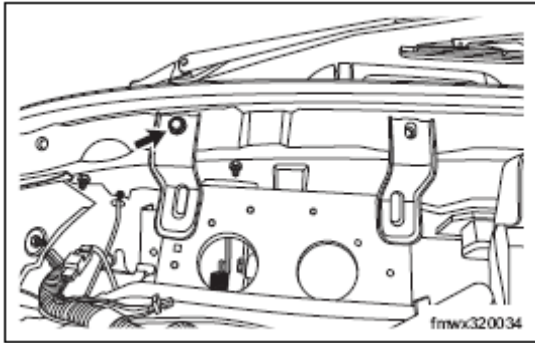
6. **Remove the clutch master cylinder. Refer to Chapter 32: Service, Clutch-Clutch Master Cylinder.**
7. **Remove the wiper water reservoir. Refer to Chapter 55: Replacement, Wiper and Washer-Washer.**



8. **Remove the clutch pedal assembly.**
 - (a) Remove these four lock bolts at the front clutch.



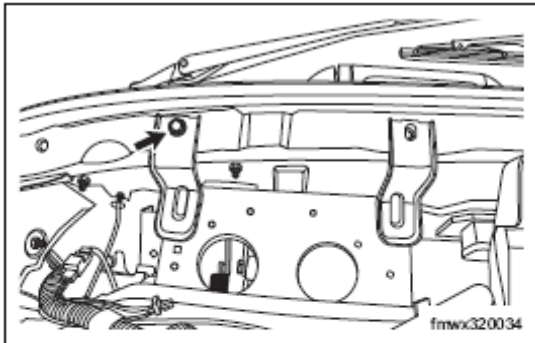
- (b) Remove these two connecting bolts between the clutch pedal and the dashboard cross member.



- (c) Remove the connecting bolt between the clutch pedal and cabin.
- (d) Remove the clutch pedal assembly.

9. Check the clutch pedal assembly.

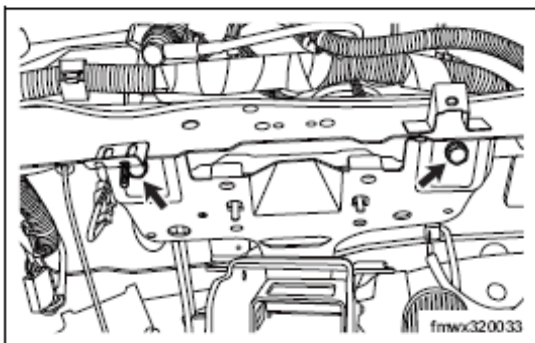
- (a) Check whether the pedal assembly is twisted.
- (b) Check whether the return spring is permanently deformed.
- (c) Check whether the pedal rubber pad is worn.
- (d) Check whether the pedal limiting rubber is worn and aged.



10. Refit the clutch pedal assembly.

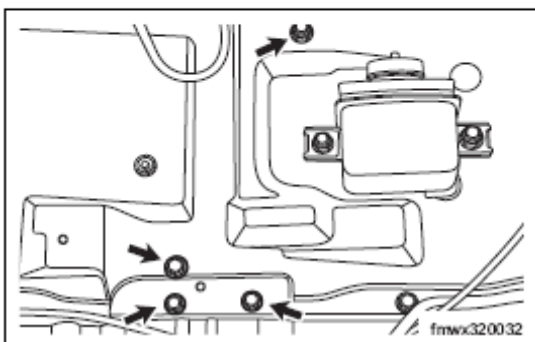
- (a) Fit the clutch pedal assembly, and align the screw hole.
- (b) Fit and fasten the connecting bolt between the clutch pedal and cabin.

Torque: 28N.m



- (c) Fit and fasten these two connecting bolts between the clutch pedal and dashboard.

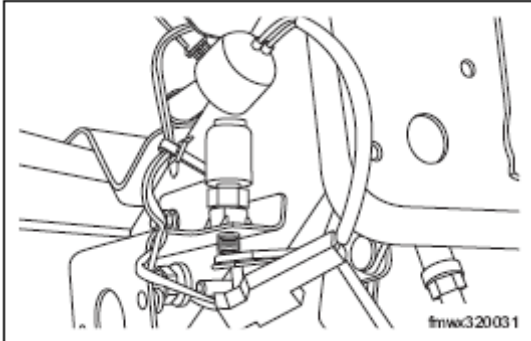
Torque: 12N.m



- (d) Fit and fasten these four lock bolts of the front clutch.

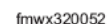
Torque: 12N.m

11. Fit the wiper water reservoir assembly. Refer to Chapter 55: Replacement, Wiper and Washer-Washer.
12. Fit the clutch master cylinder. Refer to Chapter 32: Service, Clutch-Clutch Master Cylinder.



13. Fit the clutch pedal switch.
 - (a) Fit the clutch switch assembly.
 - (b) Adjust the clutch switch to the correct position, and fasten the lock nut.
 - (c) Connect the clutch switch wire connector.
14. Refit the dashboard. Refer to Chapter 73: Replacement, Dashboard/Instrument/Cigarette Igniter.
15. Refit the steering column. Refer to Chapter 41: Removal and Refitting, Steering Wheel and Steering Column-Steering Column (Left-hand Drive).
16. Connect the battery negative cable.
17. Refill the clutch oil and discharge the air. Refer to Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly.

DIAGRAM OF COMPONENTS



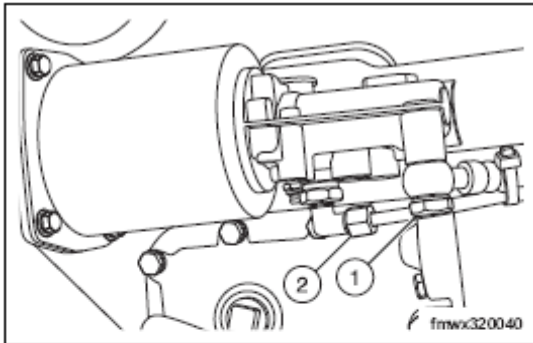
CLUTCH-CLUTCH SLAVE CYLINDER**32-23**

2	Spring washer	10	Hexagon bolt
3	Plain washer	11	Plain washer
4	Single pipe clip	12	Spring washer
5	Hexagon bolt	13	Clutch booster assembly
6	Rear hose bracket	14	Sealing washer
7	Ferrule type pipe union hexagon thin nut	15	Rear connecting hose assembly
8	Front connecting hose assembly	16	Ferrule type hinged hexagon bolt



SERVICE

1. Discharge the clutch oil.



2. Disconnect the clutch slave cylinder oil pipe and air pipe.

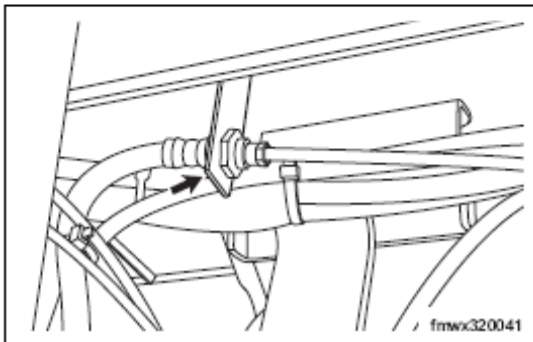
- Undo the bolt 1, and disconnect the clutch slave cylinder and rear connecting hose.
- Undo the bolt 2, and disconnect the clutch slave cylinder and booster air pipe.

Notice:

Use a dedicated vessel to receive the residual clutch oil. Avoid the contact between clutch oil and paint surface. If the skin is contaminated by the clutch oil, wash it with water.

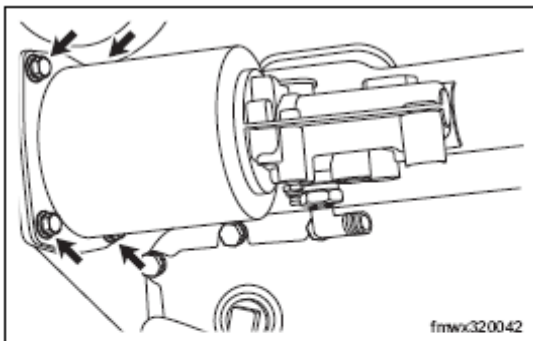
3. Remove the rear connecting hose.

- Disconnect the rear connecting hose and slave cylinder oil pipe assembly.
- Remove the clutch slave cylinder oil pipe assembly.



4. Remove the clutch slave cylinder assembly.

- Undo these 4 lock bolts of the clutch slave cylinder.
- Remove the clutch slave cylinder assembly.



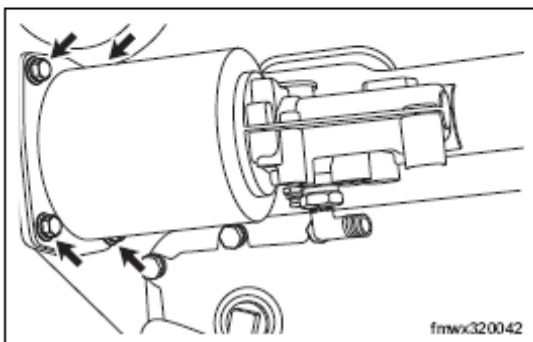
5. Fit the clutch slave cylinder.

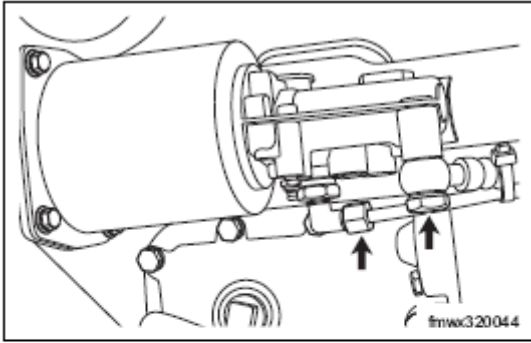
- Fit the clutch master cylinder, and fasten the lock bolt.

Torque: 28N.m

Hint:

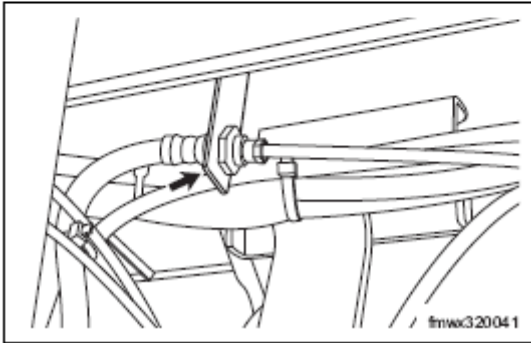
There is an arrow mark which points up on the slave cylinder housing, indicating the upward position.





6. Fit the clutch air inlet pipe and oil inlet pipe.

- (a) Fit the clutch air inlet pipe.
- (b) Fit the clutch oil inlet pipe.

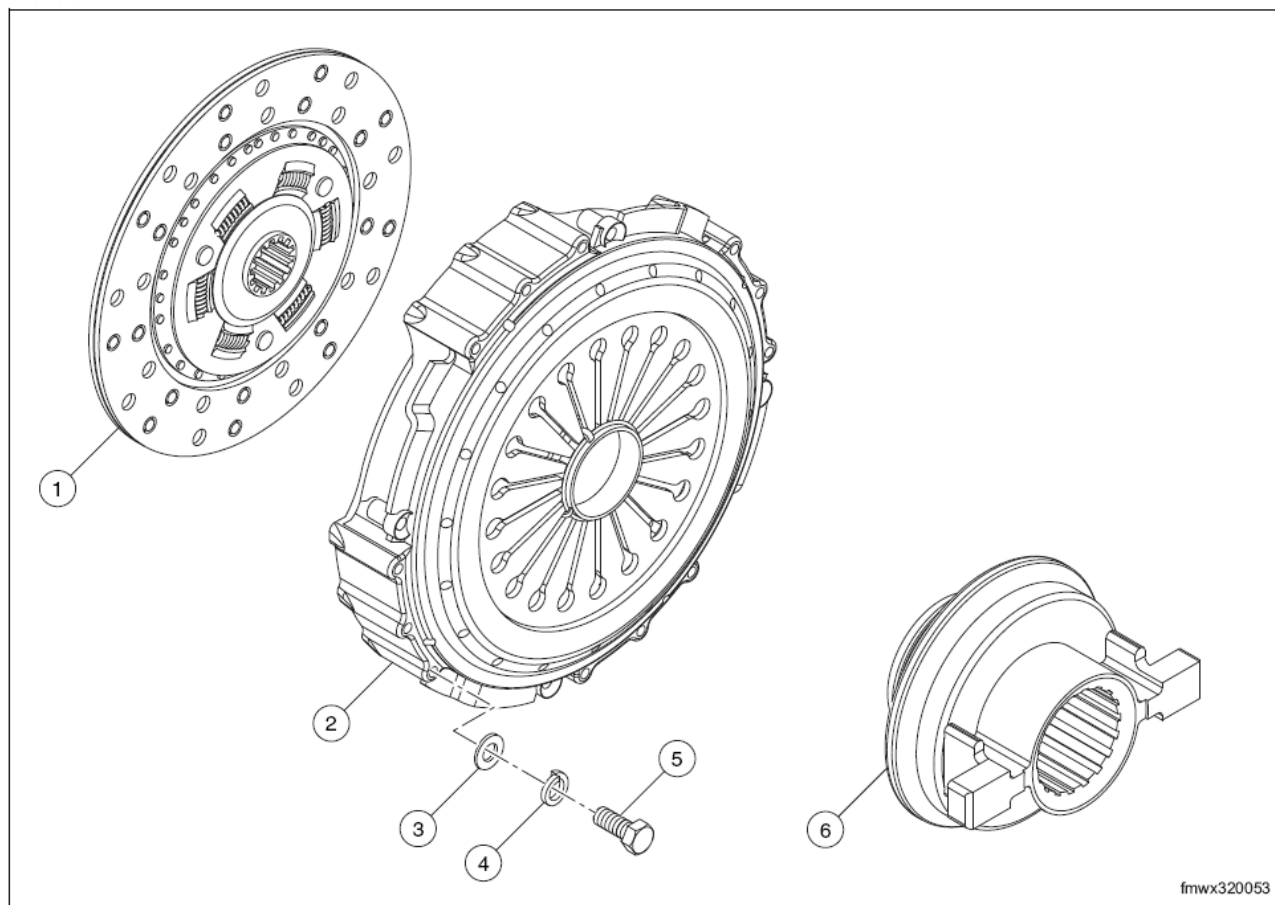


7. Fit the rear connecting hose.

- 8. Refill the clutch oil and discharge the air. Refer to Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly.**

CLUTCH SUBASSEMBLY

DIAGRAM OF COMPONENTS



fmwx320053

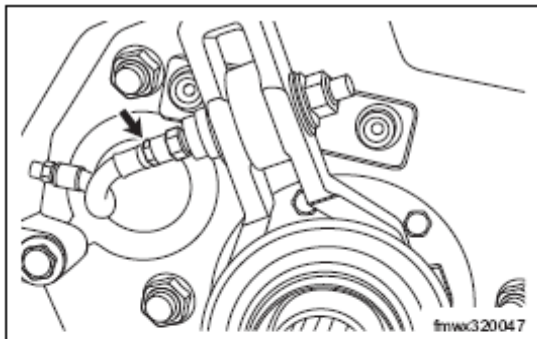
1	Driven plate assembly
2	Clutch pressure plate assembly
3	Plain washer

4	Spring washer
5	Hexagon bolt
6	Throw-out bearing

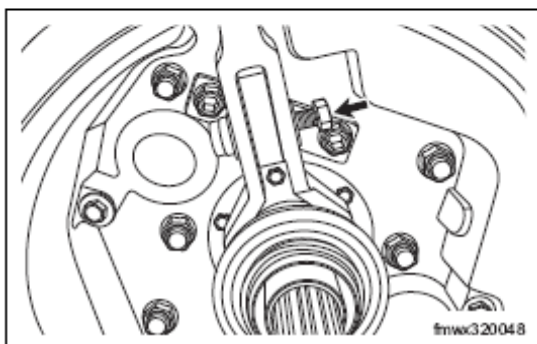


SERVICE

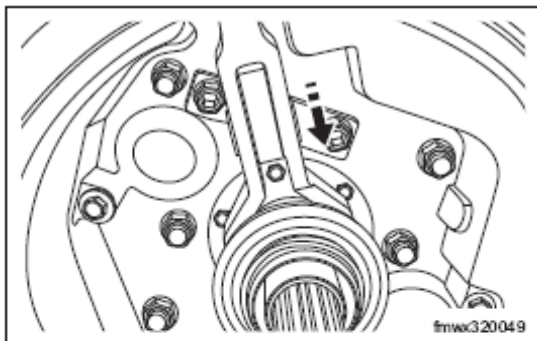
1. Disconnect the battery negative cable.
2. Remove the transmission assembly. Refer to Chapter 31A: Replacement, Transmission (12JS180TA)-Transmission Assembly.



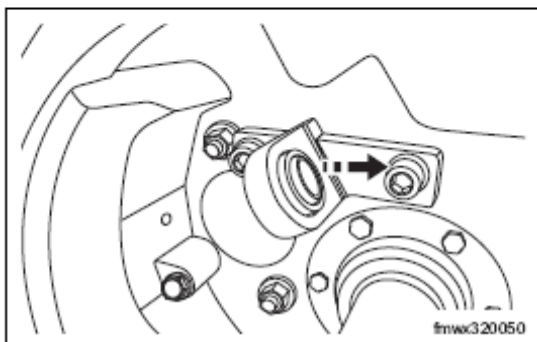
3. Remove the lubricating oil pipe.
 - (a) Remove bolts at the both ends of the lubricating oil pipe, and then remove the lubricating oil pipe.



4. Remove the clutch fork and throw-out bearing subassembly.
 - (a) Remove the lock nut.
 - (b) Remove the supporting shaft of clutch fork.

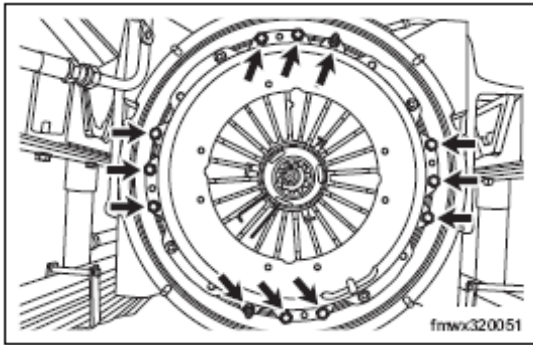


- (c) Remove the clutch fork and throw-out bearing subassembly.



- (d) Remove the fork supporting shaft sleeve.





5. Remove the pressure plate assembly and driven plate assembly.

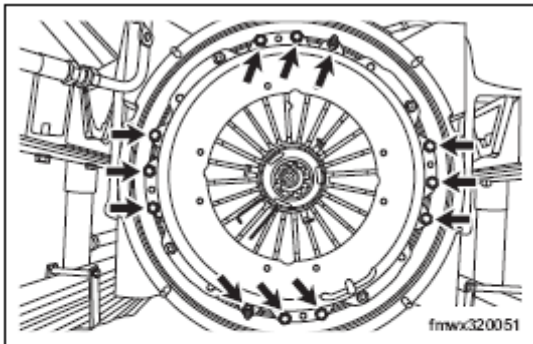
- (a) Remove these 12 lock bolts of the clutch pressure plate.

Notice:

When removing lock bolts, undo bolts evenly and crosswise.

- (b) Remove the clutch pressure plate assembly and driven plate assembly in order.

6. Check the clutch assembly. Refer to Chapter 32: Testing and Adjustment, Clutch-Clutch Assembly.



7. Refit the clutch pressure plate assembly and driven plate assembly.

- (a) Use the centripetal pump to fit the pressure plate and driven plate onto the flywheel.

- (b) Fasten the pressure plate lock bolt.

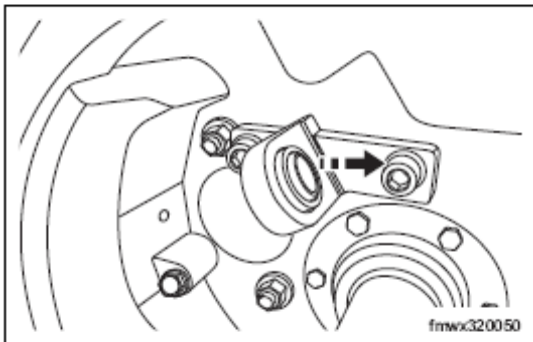
Torque: 28N.m

Notice:

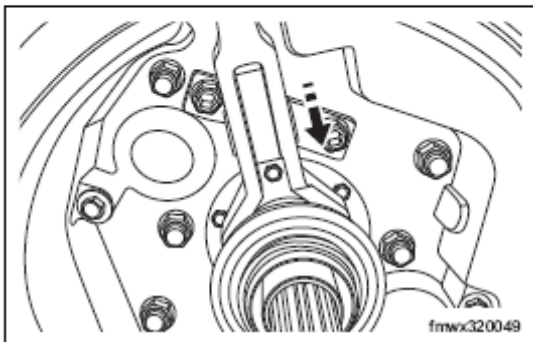
Fasten the lock bolts evenly and crosswise.

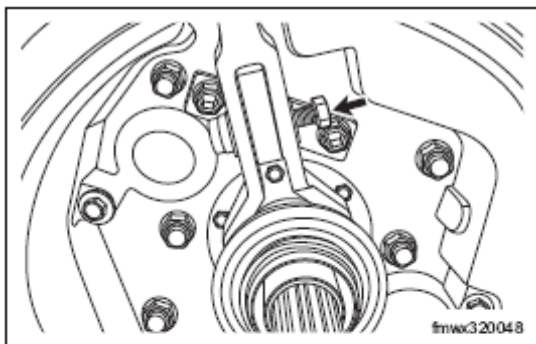
8. Refit the clutch fork and throw-out bearing subassembly.

- (a) Refit the fork supporting shaft sleeve.

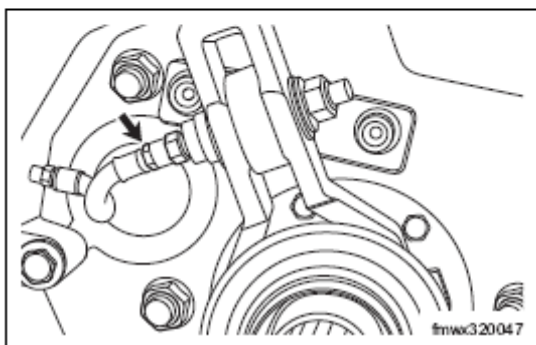


- (b) Refit the fork and throw-out bearing.





- (c) Refit the clutch fork supporting shaft.
 - (d) Fasten the nut.
- Torque: 160N.m**



- 9. Refit the lubricating oil pipe.**
- (a) Refit the lubrication oil pipe onto the clutch fork supporting shaft and lubricating oil filler.
 - (b) Fasten the union nut.

- 10. Refit the transmission assembly. Refer to Chapter 31A: Replacement, Transmission (12JS180TA)-Transmission Assembly.
- 11. Connect the battery negative cable.

TRANSMISSION SHAFT

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TRANSMISSION SHAFT

OVERVIEW

The drive model of this vehicle is 6×4. The transmission shaft mainly consists of shaft tube, telescopic tube and universal joint. Telescopic tube can automatically adjust the distance between gearbox and intermediate axle, and the distance between intermediate axle and rear axle; the universal joint can control the variation of shaft angle between gearbox output shaft and drive axle input shaft, and make these two shafts rotate with same angular velocity; universal joint comprises cross shaft, cross shaft, bearing and flange yoke. Both end-surfaces of cross shaft, bearing are equipped with belleville spring to compact the roller; reinforced nylon pad with spiral groove is added on the cross shaft, surface, to prevent any sintering phenomena during the power-transmission process with large included angle and large torque.

The spline sleeve of transmission shaft can be integrally welded with transmission shaft tube, the spline shaft can be welded together with the flange yoke; the spline has such features: large pressure angle, involute and short tooth spline. Apply a layer of nylon material on the entire surface of the teeth of telescopic tube and spline shaft, which can not only improve the abrasion resistance and self-lubricating property of these two components, but also reduce the damage of transmission shaft from impact load, and meanwhile improve the buffer ability. Transmission shaft is a rotating body with high rotation speed but little support, thus it is very important to keep the dynamic balance of transmission shaft.

PRECAUTIONS:

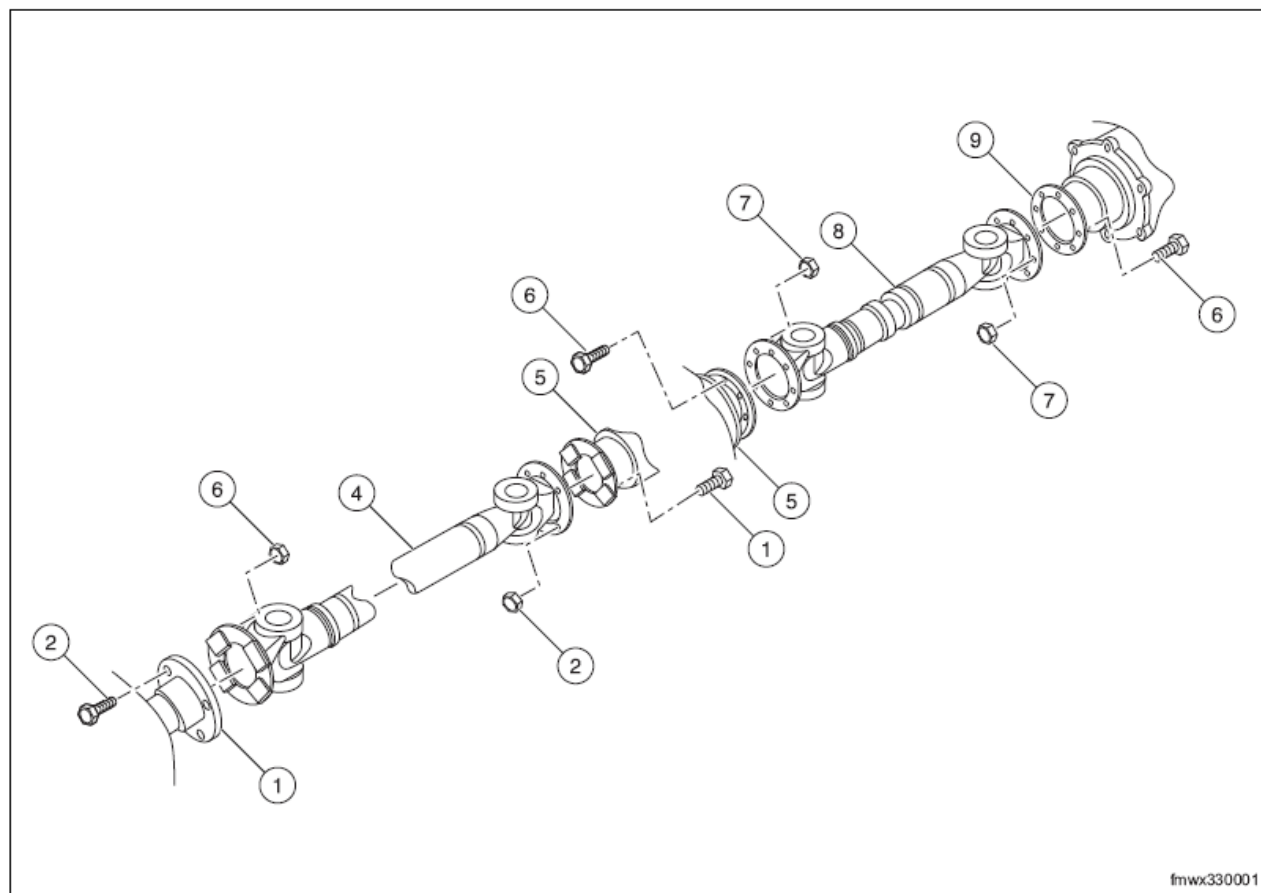
1. It is strictly prohibited to start the car with high gear.
2. It is strictly prohibited to suddenly lift the clutch pedal.
3. It is strictly prohibited to drive under overload and overspeed conditions.
4. Frequently check the working status of transmission shaft, to avoid any relaxation at various connecting parts and any deformation of transmission shafts.
5. In order to keep the dynamic balance of transmission shaft, it is necessary to check if the balance block is sealing-off and the new transmission shaft components are provided in match; pay attention to the assembly mark of telescopic tube when assembling the transmission shaft, and assure the flange yokes are installed in the same plane; print assembly marks on the telescopic tube and flange shaft when repairing/dismantling transmission shafts, for the purpose of keeping original assembly relations invariable during reassembly.
6. Fill lubricant greases for the cross shaft bearing and spline shaft of universal joint before using transmission shafts & after running for 2000km, fill lithium base grease # 3 in summer and grease # 2 in winter.
7. When repairing transmission shafts, the disassembly sequence is from back to front, and the assembly sequence shall be inverse.

TABLE OF FAULT PHENOMENA

The following table can aid you to trace the fault. Serial number in the table indicates the sequence for the possibility of fault and each section shall be checked in such sequence and replaced as needed.

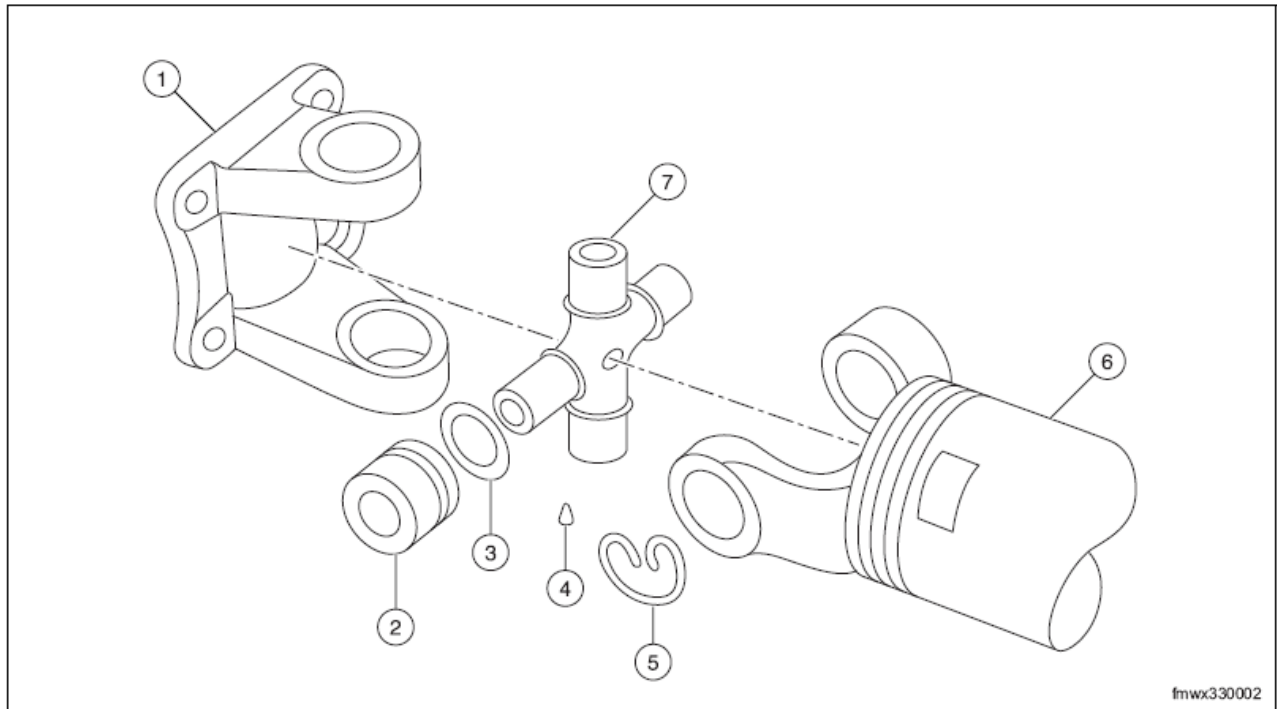
Fault	Suspected cause	Reference
Abnormal noise of transmission shaft	1. Transmission shaft (loose)	Chapter 33 Transmission shaft -intermediate transmission shaft, overhaul
		Chapter 33 Transmission shaft -inter-axle transmission shaft , overhaul
	2. Lubrication (Not good)	Lubricate or replace the transmission shaft
	3. Universal joint (worn or damaged)	Chapter 33 Transmission shaft –universal joint, overhaul
	4. Sliding spline (worn)	Chapter 33 Transmission shaft -transmission shaft assembly, check and adjustment
Vibration of transmission shaft	1. Transmission shaft (loose)	Chapter 33 Transmission shaft -intermediate transmission shaft, overhaul
		Chapter 33 Transmission shaft -inter-axle transmission shaft , overhaul
	2. Transmission shaft (misaligned marks)	Chapter 33 Transmission shaft -intermediate transmission shaft, overhaul
		Chapter 33 Transmission shaft -intermediate transmission shaft, overhaul
	3.. Transmission shaft (twisty or tortuous)	Chapter 33 Transmission shaft-transmission shaft assembly, check and adjustment
	4. Transmission shaft (unbalanced)	Chapter 33 Transmission shaft-transmission shaft assembly, check and adjustment

DIAGRAM OF COMPONENTS



1	Gearbox output flange
2	Bolt
3	Nut
4	Intermediate transmission shaft
5	Intermediate-axle flange

6	Bolt
7	Nut
8	Inter-axle transmission shaft
9	Rear axle flange



1	Flange yoke
2	Needle bearing
3	Rubber bush
4	Grease fitting

5	Retaining ring
6	Shaft fork
7	Cross shaft bearing



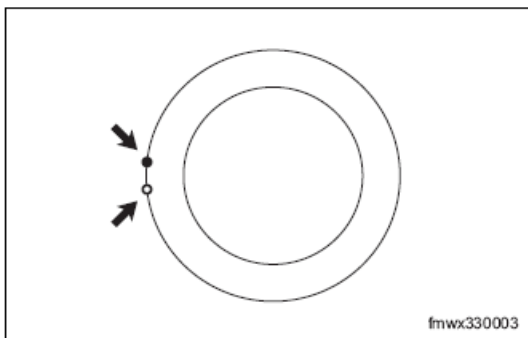
TESTING AND ADJUSTMENT

1. Vibration of transmission system (real vehicle inspection)

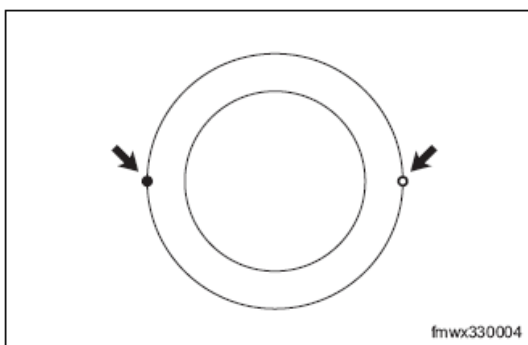
- (a). Inspect the balance status of moving wheels, adjust it if required; see Chapter 23 Wheel and tire –Wheel & Tire Assembly , check and adjustment
- (b). Conduct road test, and check whether the transmission system is vibrating during the running process of vehicle.

2. Inspect the dynamic balance of transmission shaft (real vehicle inspection)

- (a). Turn around the wheel to rotate transmission shafts, and measure the radial runout of front, intermediate and back ends of transmission shafts.
 - If the radial runout of front and intermediate ends exceeds the limit value, then it is needed to replace with new transmission shafts.
 - If the radial runout of front and intermediate ends are within the limited range, but the runout of back end exceeds the limit value, then mark out the top pulsating point of back end and conduct the next step;
 - If all the radial pulsations are within the limited range, conduct the next step as well.
- (b). Rotate transmission shaft around the main reduction gear oppositely for 1/2 circle.
See Chapter 33 Transmission shaft -intermediate transmission shaft, overhaul
See to Chapter 33 Transmission shaft – interaxial transmission shaft, overhaul
 - If only rotates for 1/4 circle, then more precise check and adjustment shall be executed.
- (c). Inspect the radial runout of the back end of transmission shaft.
 - If the radial runout of back end exceeds limit value, then mark out the top point and execute the next step;
 - If the radial runout of back end is within limited range, then conduct road test and check that if the transmission system is vibrating during the running process of vehicle. If yes, then mark out the top point and execute the next step.
- (d). Compare two top points marked in the steps above.

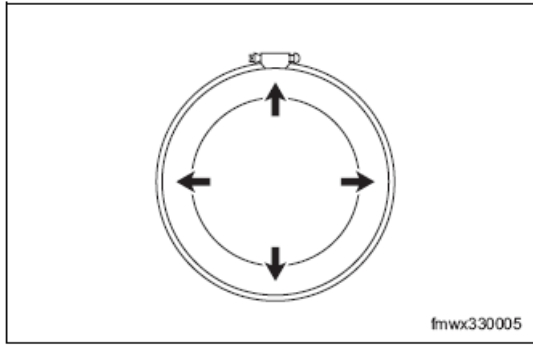


- If the two marked points are closing up with each other, with a space of 20mm or less, then it is needed to replace with new transmission shafts.

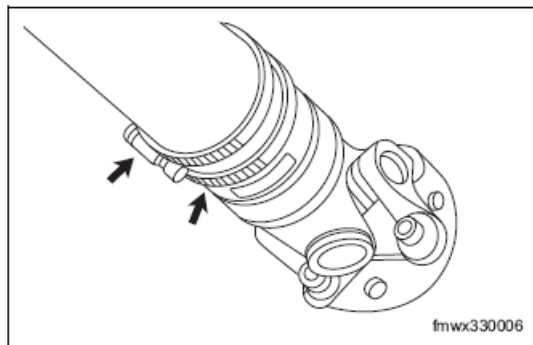


- If the two marked points (top points) are located on two opposite sides of the transmission shafts, this indicates that main reduction flange is the essential factor which causes vibration. See Chapter 25 Rear axle-- driving gear and bearing, overhaul
- Conduct road test to check if there still exists vibration or not. If yes, it is needed to balance the transmission shaft.

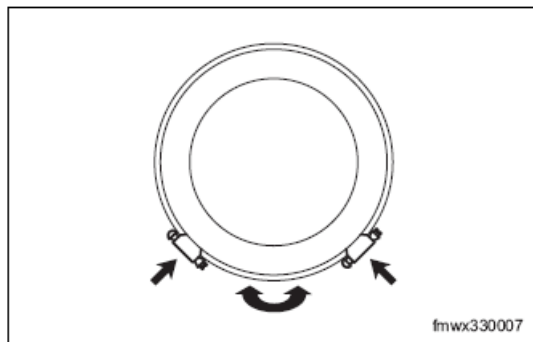
3. Balance the transmission shaft (real vehicle inspection)



- (a) Assemble 1 or 2 hoops on the back end of transmission shaft
- Divide the circle area at the back end of transmission shaft into 4 uniform parts and put the hoop chuck on one of them.
 - Conduct road test to check if there is vibration or not. Change the direction of hoops and confirm the position with least vibration. If the vibration effects at two adjacent positions are quite near, then the hoop should be placed in the middle of two positions.

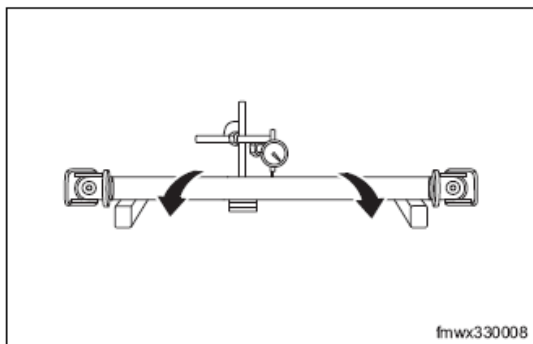


- (b) If the vibration still exists, then add one hoop on the same position, and conduct road rest again to check if there is vibration or not.



- Rotate the hoop inversely in case of unimproved vibration; the distance shall be the same as that of the former confirmed position which minimizes vibration. Detach the two hoop chucks for about 10 cm, conduct road test again to check if there is vibration.
- Enlarge the space and repeat the steps above, to finally find out the best positions or reduce vibration to the acceptable degree.

4. Inspect the radial runout of the transmission shaft

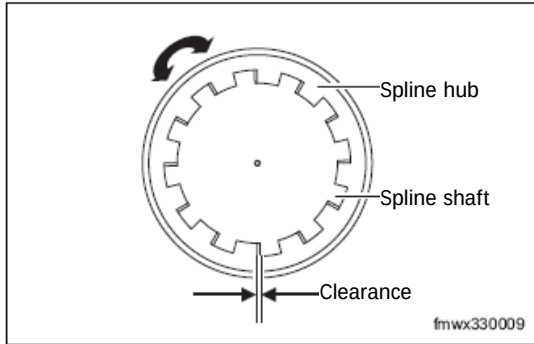


- (a) Use V-shaped bench and dial gauge to measure the radial play eccentricity of transmission shaft.

Standard value: 0.6mm

Limit value: 1.0mm

5. Inspect the sliding spline teeth clearance of transmission shaft



- (a). Use feeler to measure the fit clearance of spline shaft and spline sleeve in normal rotating directions.

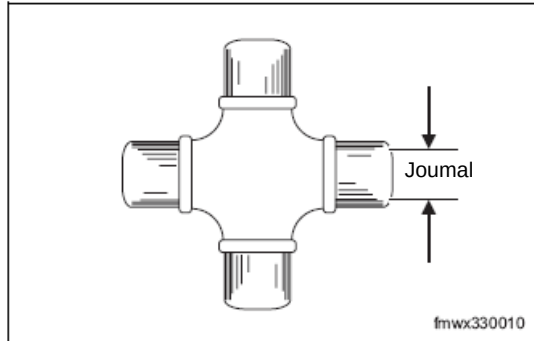
Standard value: 0.02~0.01mm

Limit value: 0.3mm

Hint:

If the clearance of sliding spline teeth exceeds limit value, then replace with new transmission shaft

6. Inspect the cross shaft



- (a). Inspect the abrasion status of the cross shaft journal surface.

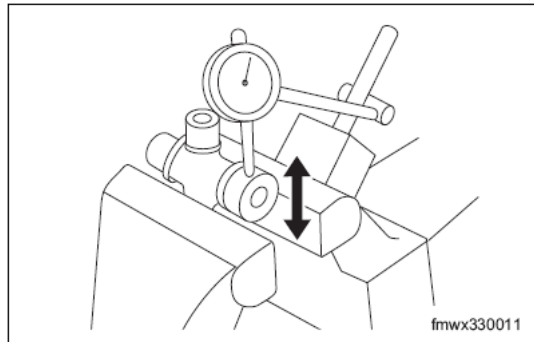
- (b). Use vernier caliper to measure journal of the cross shaft.

Standard value: 0.01mm

Limit value: 0.03mm

Hint:

If the abrasion status exceeds limit value, then replace with new cross shafts.



- (c). Use bench vice and dial gauge to inspect the clearance between cross shaft and needle bearing.

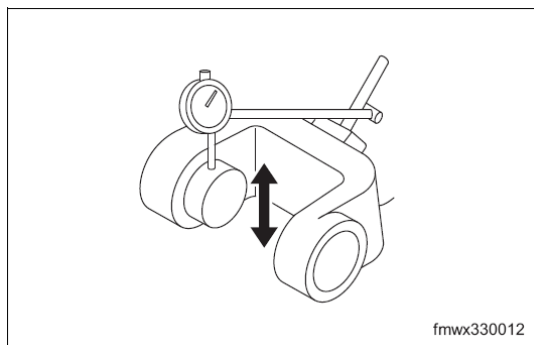
Standard value: 0.02~0.09mm

Limit value: 0.15mm

- Do not use bench vice to directly clamp the cross shaft, put a layer of mull at the clamping place to avoid any damage of cross shaft.
- When inspecting, do use new needle bearing.
- Attach needle bearing to the cross shaft and move needle bearing along the axial direction, to measure the clearance of cross shaft and needle bearing.

Hint:

If the clearance exceeds limit value, then replace with new cross shafts.



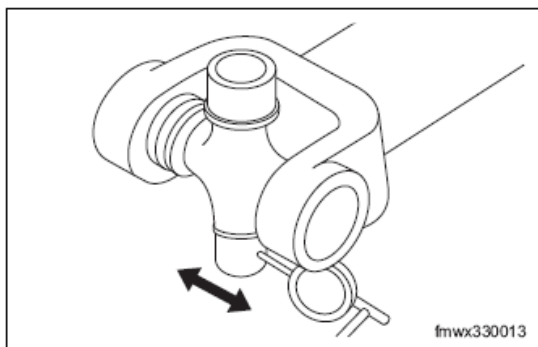
- (d). Use dial gauge to inspect the clearance between needle bearing and universal joint fork

Limit value: 0.50mm

- Put needle bearing into the installing hole of universal joint and move the bearing along the axial direction, to measure the clearance of needle bearing and universal joint fork.

Hint:

If the clearance exceeds limit value, then replace with new needle bearing.



- (e). Use dial gauge to inspect the axial clearance of cross shafts.
- The needle bearing shall be sleeved with cross shaft, and be inserted into the installing hole of universal joint, move the cross shaft along axial direction to measure its axial clearance.

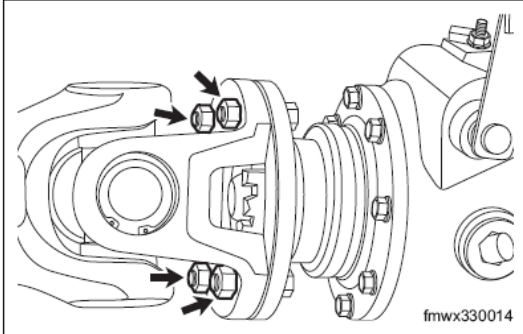
Hint:

If the clearance exceeds limit value, then replace with new and cross shaft needle bearing.

INTERMEDIATE TRANSMISSION SHAFT

SERVICE

1. Turn up the cargo tank by the automatic unload function.



2. Dismantling of the intermediate transmission shaft assembly.

- (a). Lift up the transmission shaft by hydraulic crane.
(b). Disconnect the transmission shaft from intermediate axle.
- Dismantle the joint bolt between transmission shaft and intermediate axle input flange.

- (c). Break the connection between transmission shaft and gear box.

- Dismantle the joint bolt between transmission shaft and gearbox output flange.

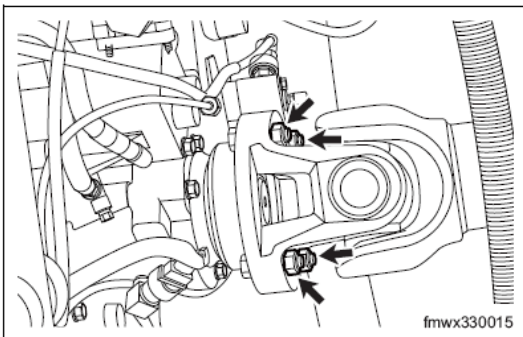
Hint:

Observe that whether there are assembly marks, if not, it is needed to add on.

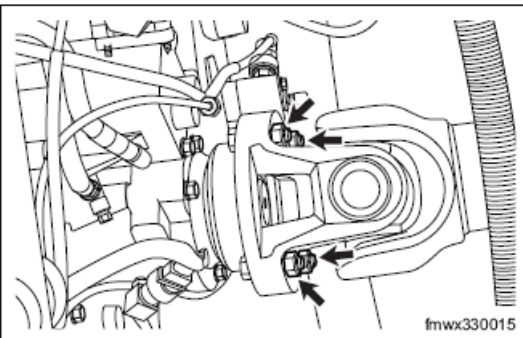
- (d). Dismantle the intermediate transmission shaft assembly.

Hint:

Observe that if there are frontward marks, if not, it is needed to add on



3. Inspection of transmission shaft; see Chapter 333 Transmission shaft - transmission shaft assembly, check and adjustment



4. Installation of intermediate transmission shaft

- (a). Place transmission shaft assembly on the hydraulic crane, to jack up the gearbox output flange and intermediate-axle input flange.
(b). Align the transmission shaft and gearbox output flange, meanwhile screw the bolt.

Torque: 198±20N.m

Note:

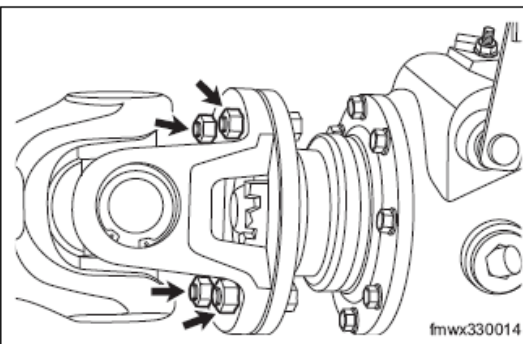
Make sure that the frontward mark shall be faced front and the assembly mark shall be aligned;

- (c). Connect the transmission shaft with intermediate input flange, meanwhile screw the bolt.

Torque: 198±20N.m

Note:

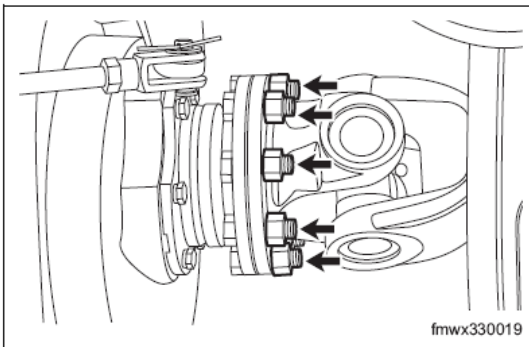
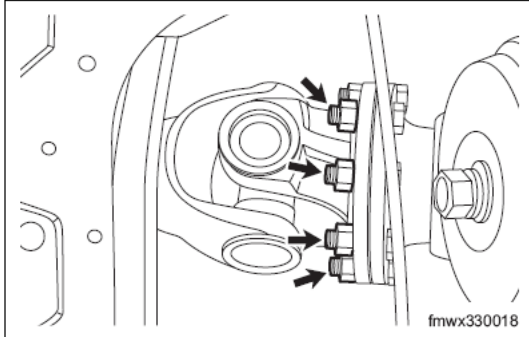
Make sure that the assembly marks are aligned.



INTER-AXLE TRANSMISSION SHAFT

SERVICE

1. Turn up the cargo tank by the automatic unload function.



2. Dismantle the inter-axle transmission shaft assembly (a). Disconnect the inter-axle transmission shaft from the rear axle.

- Dismantle the joint bolt of inter-axle transmission shaft and rear axle input flange.

Hint:

Observe that if there are assembly marks, if not, it is needed to add on.

- (b). Disconnect inter-axle transmission shaft from intermediate axle.

- Dismantle the joint bolt of inter-axle transmission shaft and intermediate axle output flange.

Hint:

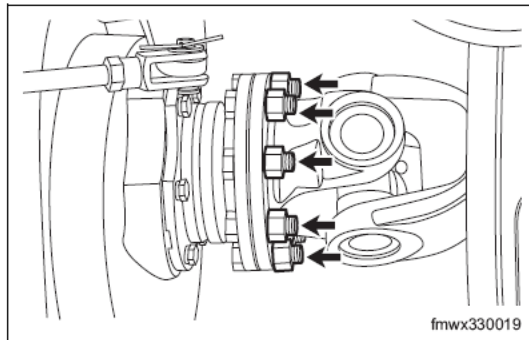
Observe that if there are assembly marks, if not, it is needed to add on.

- (c). Dismantle the inter-axle transmission shaft assembly.

Hint:

Observe that if there are frontward marks, if not, it is needed to add on

3. Inspection of inter-axle transmission shaft; see Chapter 33 Transmission shaft-transmission shaft assembly, check and adjustment



4. Install the inter-axle transmission shaft assembly

- (a). Align inter-axle transmission shaft and intermediate axle output flange, meanwhile screw the bolt.

Torque: 198±20N.m

Note:

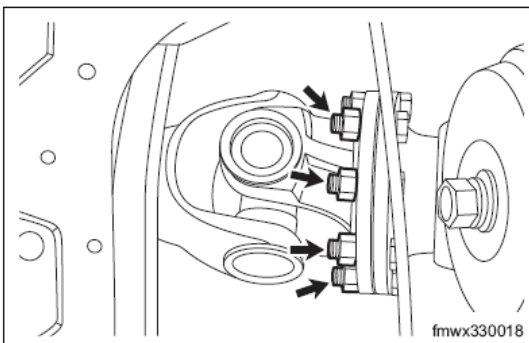
Make sure that the frontward mark shall be faced front and the assembly mark shall be aligned.

- (b). Align the inter-axle transmission shaft and the rear axle flange, meanwhile screw the bolt.

Torque: 198±20N.

Note:

Make sure that the assembling marks are aligned.



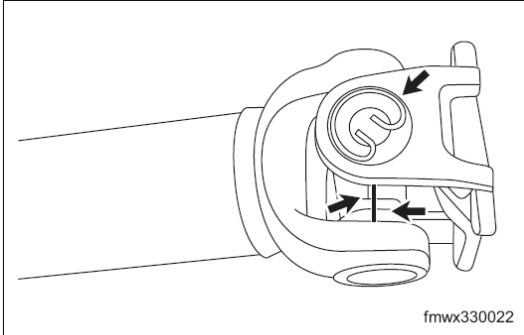
UNIVERSAL JOINT

SERVICE

1. Dismantle the transmission shaft

See Chapter 33 Transmission shaft – intermediate transmission shaft, overhaul

See Chapter 33 Transmission shaft - inter-axle transmission shaft, overhaul



2. Disassemble the sliding universal joint fork

(a). Add assembly mark on flange yoke, cross shaft and slide fork.

(b). Dismantle the grease fitting.

Note:

Do be careful when dismantling; do not damage the grease fitting.

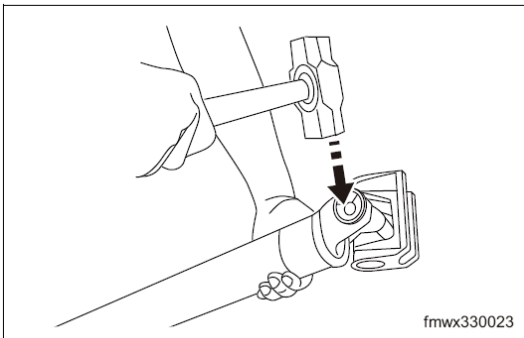
(c). Use spring pliers to dismantle retaining rings.

(d). Use hammer and copper rod, to lightly knock the slide fork, so that the needle bearing and dustproof cover can be knocked out from the slide fork and flange yoke, and the cross shaft can be finally dismantled.

Note:

Do not use hammer to knock directly or use copper rod to clamp the transmission shaft directly.

(e). Detach the slide fork and flange yoke.

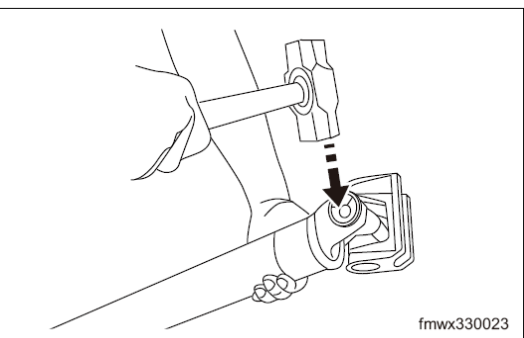


3. Inspection of universal- joint components; see chapter 33 Transmission shaft – transmission shaft assembly, check and adjustment

4. Assemble the sliding universal joint fork

(a). Apply certain amount of lithium base grease #2 on the surface of cross shaft and needle bearing.

- Superfluous grease will increase the assembling difficulty.

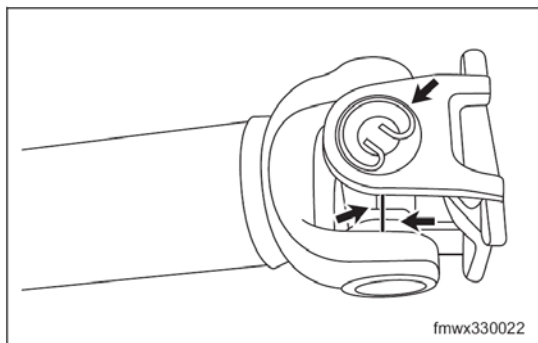


(b). Use rubber mallet to lightly knock the needle bearing, install it into holes from the outside of flange yoke and slide fork. Install the cross shaft simultaneously.

- Do replace with new needle bearing.
- Install the dustproof cover simultaneously.

Note:

Carry out the installing procedures as per the assembly mark. Make sure the direction of cross shaft grease fitting during installing course consistent with other cross shaft grease fittings, so as to facilitate the filling of lubricating grease.



- (c). Use spring pliers to install the retaining ring.
 - Do replace with new retaining ring.
- (d). Install the grease fitting
 - Do replace with new grease nozzle.

5. Installation of transmission shaft

See Chapter 33 Transmission shaft – intermediate transmission shaft, overhaul

See Chapter 33 Transmission shaft –inter-axle transmission shaft , overhaul

STEERING WHEEL AND STEERING COLUMN

STEERING WHEEL AND STEERING COLUMN

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STEERING WHEEL AND STEERING COLUMN

OVERVIEW

The steering system mainly comprises the steering wheel, and steering column assembly with adjustable mechanism, steering drive shaft, jacket assembly and dustproof cover. This system is also capable of transferring the steering power adhered onto the steering wheel from the driver to the steering gear assembly.

PRECAUTIONS

1. Precautions in operation of the steering wheel and steering column

- (a) When replacing any component, do carefully observe instructions in this manual.
- (b) The incorrect operation may impair the performance of the steering system, or even cause injuries.

Warning:

If the power steering system has been serviced, the air in the system must be released; otherwise the correct steering oil level will not be obtained. The air in the steering liquid may cause noises in the power steering pump, and may subsequently damage the pump.

Never start the engine when any power steering gear inlet or outlet hose is disconnected. If the hose is disconnected, plug or cover all hose nozzles; otherwise the steering liquid may be contaminated or consumed to damage the system.

The steering wheel shall not be located at its extreme position for more than 5s; otherwise the steering pump may be damaged.

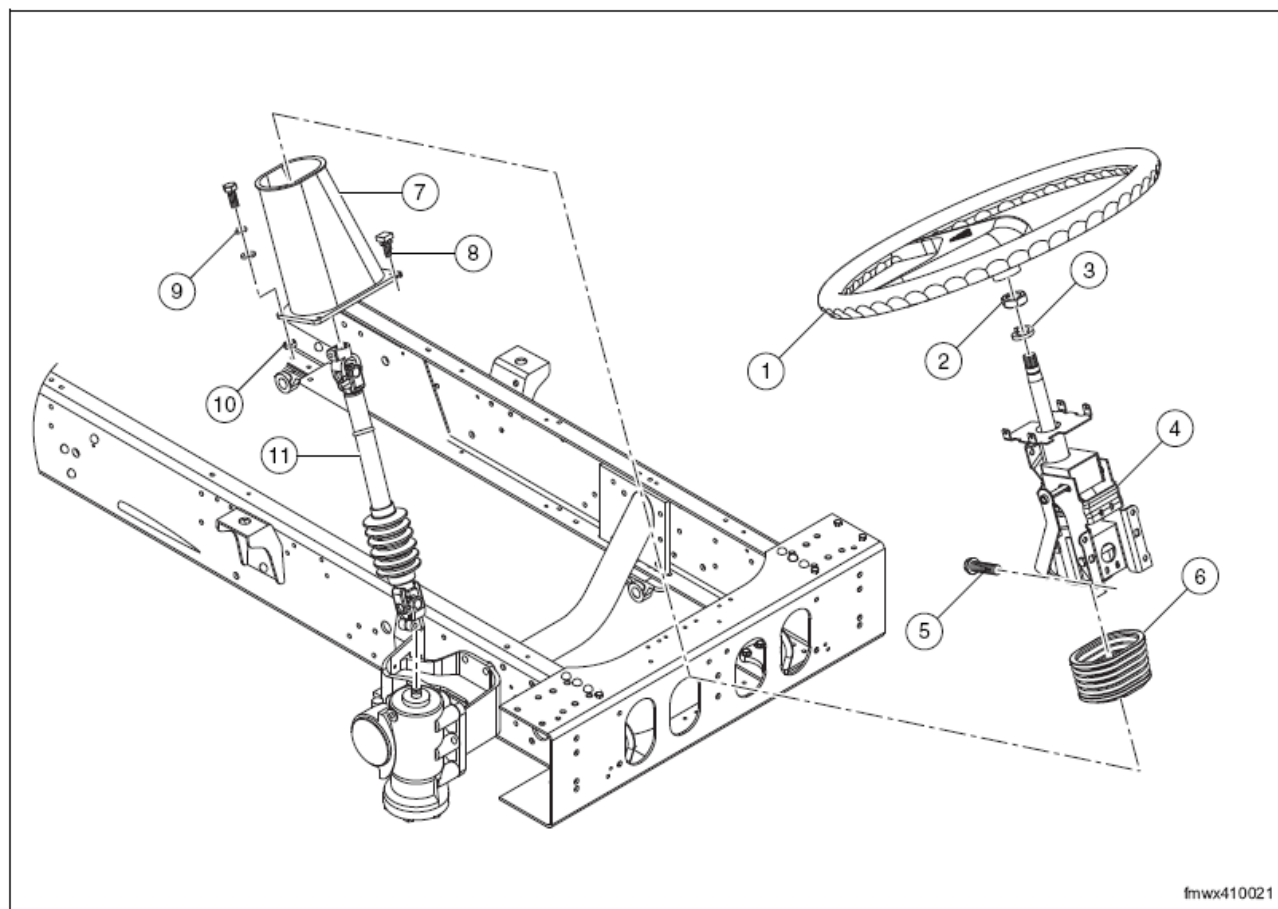
When refilling or thoroughly replacing the liquid, use the correct steering liquid. If the wrong liquid is selected, the hose and seals may be damaged to cause leakage.

TABLE OF FAULT PHENOMENA

The table below can assist you to find the failure. The number represents the sequence of occurrence of possible failures. Check each part as per this sequence, and provide replacement if necessary.

Symptoms of failure	Possible causes	Reference made to
The free travel of the steering wheel is too large.	1. Steering drive shaft lock bolt (loosened)	Chapter 41: Removal and installation, Steering Wheel and Steering Column-Steering Column (Left-hand Drive)
	2. Steering drive shaft (worn)	Chapter 41: Testing and Adjustment, Steering Wheel and Steering Column-Steering Column (Left-hand Drive)
	3. Steering tie bar (loosened)	Chapter 24A: Service, Front Axle (Ankai)-Steering Knuckle
	4. Steering drag link (loosened)	Chapter 42: Service, Power Steering Mechanism-Steering Drag Link Assembly
	5. Steering gear (loosened)	Chapter 42: Service, Power Steering Mechanism-Steering Gear Assembly (Left-hand Drive)
	6. Steering gear (worn or incorrectly adjusted)	Chapter 42: Service, Power Steering Mechanism-Steering Gear Assembly (Left-hand Drive)

DIAGRAM OF COMPONENTS

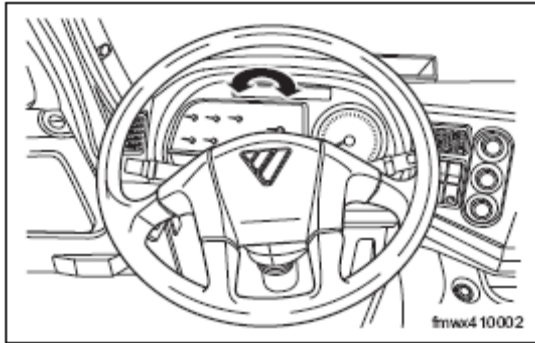


1	Steering wheel assembly
2	Hexagon thin nut
3	Spring washer
4	Steering column & adjustable mechanism assembly
5	Hexagon flanged bolt
6	Boot

7	Jacket assembly
8	Jacket connecting bolt
9	Hexagon bolt, spring washer and plain washer assembly
10	Fully metallic hexagon flanged lock nut
11	Steering drive shaft assembly

TESTING AND ADJUSTMENT

1. Free travel of steering wheel



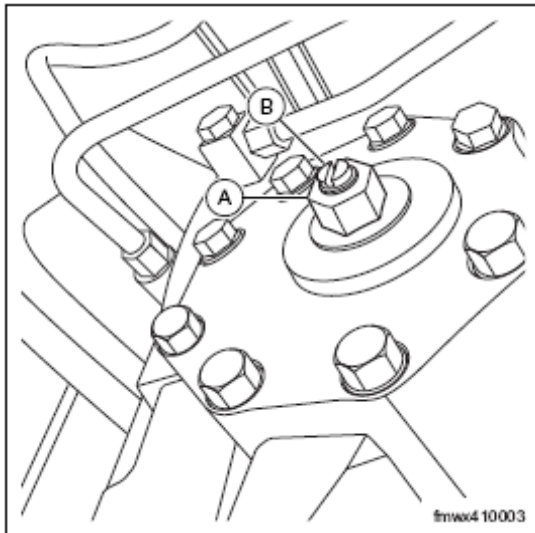
(a) Testing

- Align the steering wheel, and localize the front wheel in forward direction. Connect the steering power tester onto the steering pump outlet and steering gear inlet in series. Start the engine and run it at idle speed. At this moment, the circulating pressure of the system at no load as measured shall be about 5bar. Turn the steering wheel to the right slowly till the pressure as indicated on the pressure gauge rises to 6 bar, and the right movement of the steering wheel measured shall be less than 20mm. Turn the steering wheel to the left slowly till the pressure indicated rises to 6 bar, and the left movement of the steering wheel measured shall be less than 20mm.

Free travel: $\leq 40\text{mm}$

(b) Adjustment

- Undo the hexagon nut A. Rotate the slotted screw B clockwise, and the free travel will be reduced; vice versa. After the correct value is obtained, fasten the nut A.



Attention

Prior to the adjustment, check relevant components. (Refer to "Chapter 41: Table of Fault Phenomena, Steering Wheel and Steering Column- Steering Wheel and Steering Column"). Then check the front wheel maximum turning angle, and make adjustment if necessary. (Refer to "Chapter 24A: Front Wheel Toe-in, Front Axle-Front Axle Assembly").

2. Check the steering column assembly.

(a) Check the steering shaft.

- Check the linearity of the steering shaft.

Linearity: 0.5mm

If the linearity of the steering shaft exceeds the limit value, replace the steering column assembly.

(b) Check the spline shaft, spline sleeve and universal joint fork.

- Check the spline shaft, spline sleeve and universal joint fork spline for rusting, damage and cracking.

41-8

STEERING WHEEL AND STEERING COLUMN-STEERING WHEEL AND STEERING COLUMN

- Check whether there are two or more damaged or deformed teeth on the spline. If it is in such a case, replace the steering column assembly.

(c) Check the steering column universal joint.

- Check the universal joint bearing surface for scaling, breakage or missing needles.
- Check whether the bearing gasket and sealing cover are disabled.
- Check the universal joint spider journal for impress, scaling, partial wear, crack etc.
- Check whether the universal joint can rotate smoothly. If the above-mentioned defect is found, replace the steering column assembly.
- Check the gap between the spider bearing and journal.

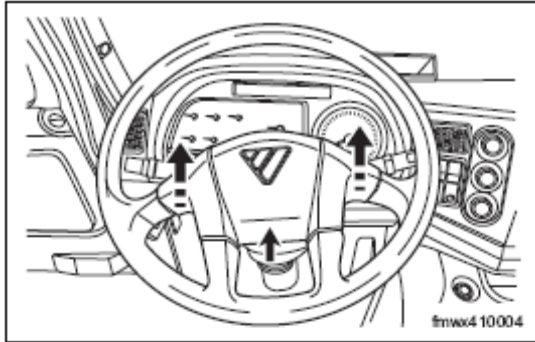
Gap: $\leq 0.1\text{mm}$.

If the gap between the spider bearing and journal exceeds the extreme value, replace the steering column assembly.

STEERING WHEEL (LEFT-HAND DRIVE)

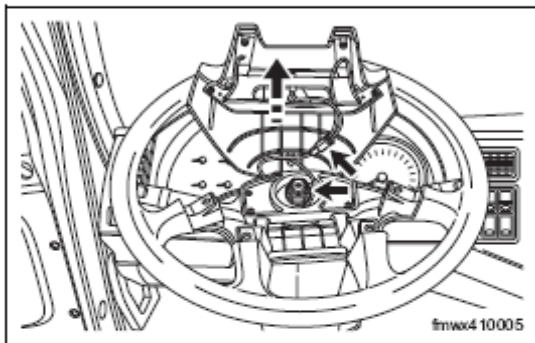
REPLACEMENT

1. As for the notices in the operation of steering wheel, refer to Chapter 41: Notices, Steering Wheel and Steering Column- Steering Wheel and Steering Column.

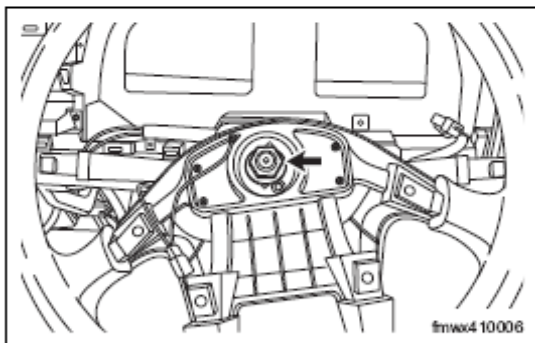


2. **Remove the horn button.**

- (a) Align the steering wheel, and localize the front wheel in forward direction.
- (b) Respectively press left and right sides of the horn button, and remove it from the steering wheel.



- (c) Reverse the horn button, and pull out these two wire connectors connected with the steering wheel.

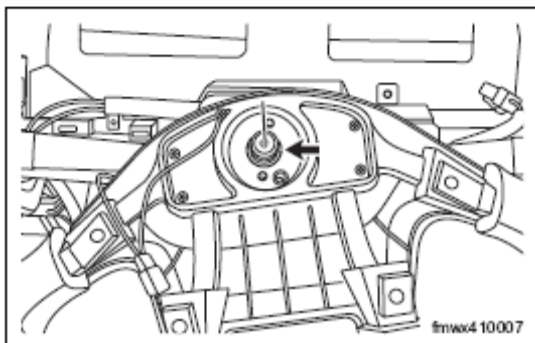


3. **Remove the steering wheel.**

- (a) Undo and remove the lock nut of the steering wheel.
- (b) Remove the spring washer.

Attention

Store the steering wheel properly to avoid damaging the wheel surface.



- (c) Mark the steering shaft and steering wheel to facilitate the refitting operation.

Attention

Ensure that marks are clear.

- (d) Use the steering wheel puller to pull out the steering wheel from the steering shaft.

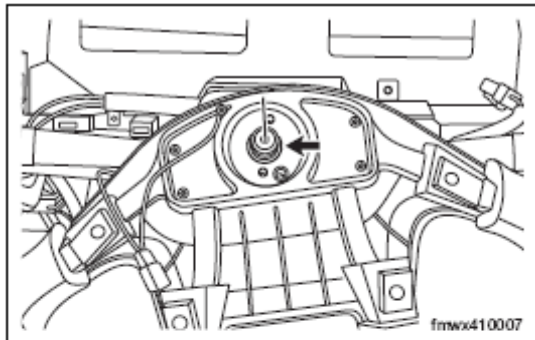
41-10 STEERING WHEEL AND STEERING COLUMN-STEERING WHEEL (LEFT-HAND DRIVE)

4. Check the steering wheel.

- (a) Check whether the steering wheel rim is warped, impressed or broken.

Attention

If it is in such a case, replace the steering wheel.

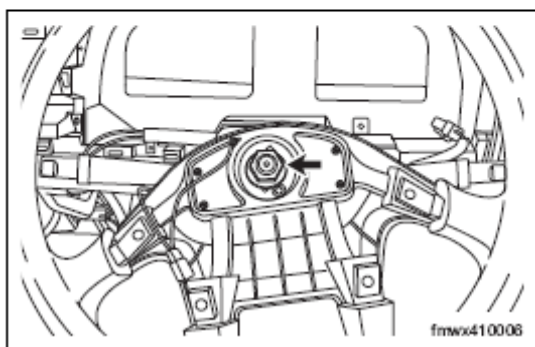


5. Refit the steering wheel.

- (a) Fit the steering wheel onto the steering shaft as per the refitting marks.

Attention

Do refit the steering wheel as per the marks.

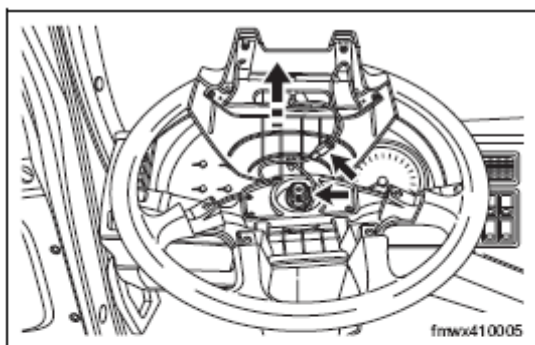


- (b) Refit the spring washer, and fasten the lock nut of the steering wheel.

Torque: $70 \pm 10 \text{ N.m}$

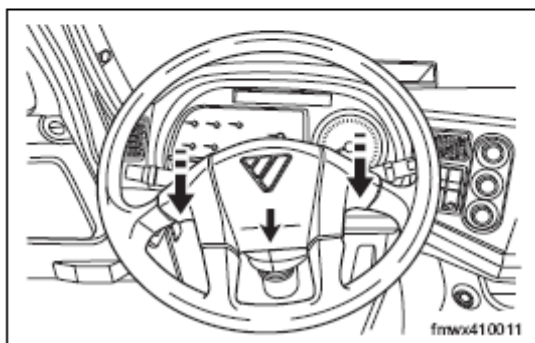
Attention

Do not use the impact spanner.



6. Refit the horn button.

- (a) Connect both wire connectors.



- (b) Lightly press the horn button by hand, and fit it onto the steering wheel.

STEERING WHEEL (RIGHT-HAND DRIVE)

REPLACEMENT

Hint:

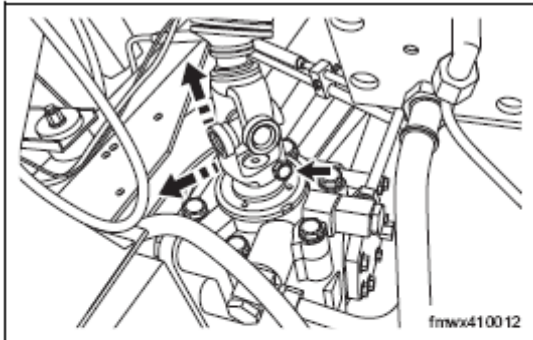
As for the replacement of right-hand steering wheel, refer to Chapter 41: Replacement, Steering Wheel and Steering Column-Steering Wheel (Right-hand Drive).



STEERING COLUMN (LEFT-HAND DRIVE)

REMOVAL AND INSTALLATION

1. As for the notices in operation of the steering column, refer to Chapter 41: Notices, Steering Wheel and Steering Column- Steering Wheel and Steering Column.
2. Remove the steering wheel. Refer to Chapter 41: Replacement, Steering Wheel and Steering Column-Steering Wheel (Left-hand Drive).
3. Remove the multi-function switch assembly. Refer to Chapter 55: Replacement, Wiper and Washer-Multi-function Switch.
4. Remove the ignition switch assembly. Refer to Chapter 18: Replacement, Starting/Preheating System-Ignition Switch.

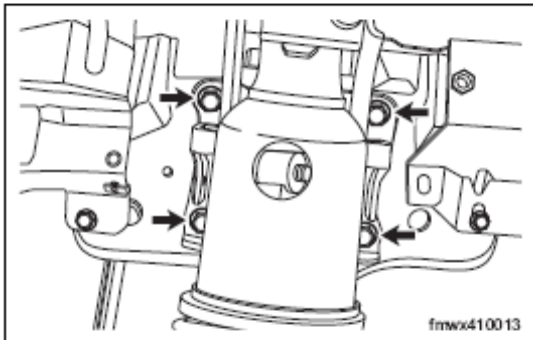


5. Remove the steering column & adjustable mechanism assembly.

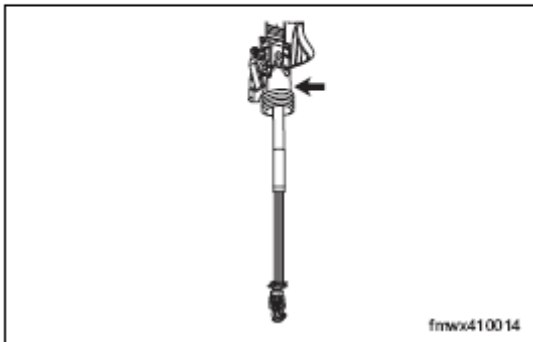
- (a) Undo the bolt, and pull out the drive shaft spline sleeve universal joint fork from the spline shaft at the steering worm top end of the steering gear.

Attention

Mark the universal joint fork and steering worm.



- (b) Remove these 4 lock bolts of the steering column.



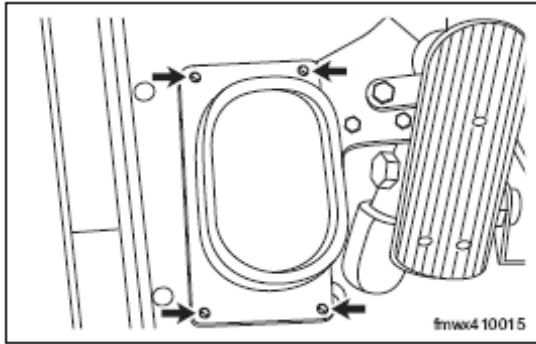
- (c) Remove the steering column & adjustable mechanism assembly.

- (d) Remove the boot and steering drive shaft assembly in order.

Attention

Mark the steering drive shaft outer spline and steering column.

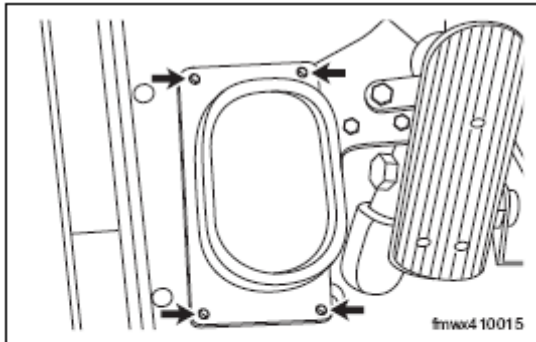
STEERING WHEEL AND STEERING COLUMN-STEERING COLUMN (LEFT-HAND DRIVE) 41-13



6. Remove the jacket assembly.

- (a) Remove the jacket lock bolt.
- (b) Remove the jacket .

7. Check the steering column assembly. Refer to Chapter 41: Testing and Adjustment, Steering Wheel and Steering Column- Steering Wheel and Steering Column.



8. Refit the jacket assembly.

- (a) Refit the jacket assembly onto the cab floor.
- (b) Fasten the lock bolt of the jacket .

Torque: $10 \pm 1 \text{ N.m}$

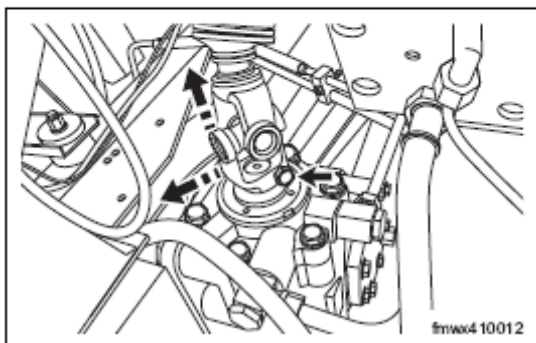


9. Refit the steering column assembly.

- (a) Refit the steering shaft and boot into the steering column in order.

Attention

Perform the refitting operation as per the marks.



- (b) Put the steering column assembly through the jacket , and fully put the steering column spline sleeve universal joint onto the spline shaft at the top end of steering gear worm.

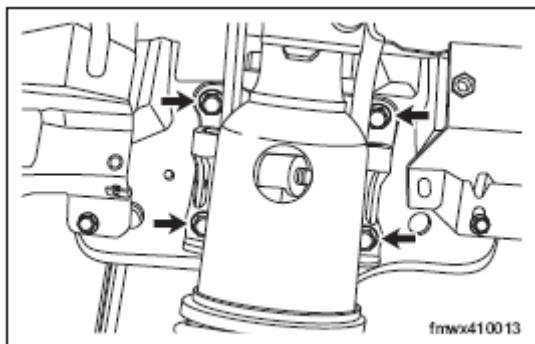
- Fasten the bolt.

Torque: $60 \pm 10 \text{ N.m}$

Attention

Perform the refitting operation as per the marks.

41-14 STEERING WHEEL AND STEERING COLUMN-STEERING COLUMN (LEFT-HAND DRIVE)



(c) Refit the lock bolt of steering column.

- Fasten the bolt.

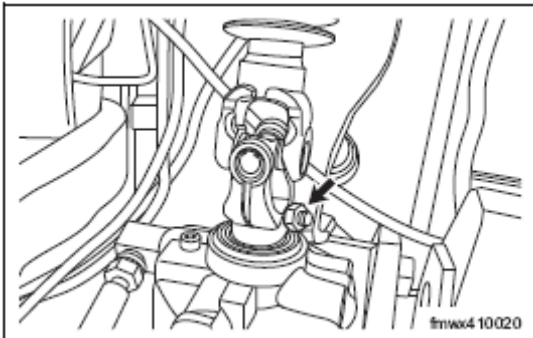
Torque: 23 ± 2 N.m

10. Refit the ignition switch assembly. Refer to Chapter 18: Replacement, Starting/Preheating System-Ignition Switch.
11. Refit the multi-function switch assembly. Refer to Chapter 55: Replacement, Wiper and Washer-Multi-function Switch.
12. Refit the steering wheel. Refer to Chapter 41: Replacement, Steering Wheel and Steering Column-Steering Wheel (Left-hand Drive).

STEERING COLUMN (RIGHT-HAND DRIVE)

REMOVAL AND INSTALLATION

1. As for the notices in operation of the steering column, refer to Chapter 41: Notices, Steering Wheel and Steering Column- Steering Wheel and Steering Column.
2. Remove the steering wheel. Refer to Chapter 41: Replacement, Steering Wheel and Steering Column-Steering Wheel (Left-hand Drive).
3. Remove the multi-function switch assembly. Refer to Chapter 55: Replacement, Wiper and Washer-Multi-function Switch.
4. Remove the ignition switch assembly. Refer to Chapter 18: Replacement, Starting/Preheating System-Ignition Switch.



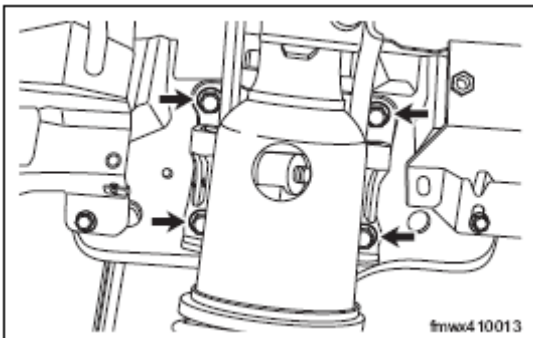
5. Remove the steering column & adjustable mechanism assembly.

- (a) Undo the bolt, and pull out the drive shaft spline sleeve universal joint fork from the spline shaft at the steering worm top end of the steering gear.

Attention

Mark the universal joint fork and steering worm.

- (b) Remove these 4 lock bolts of the steering column.



- (c) Remove the steering column & adjustable mechanism assembly.
- (d) Remove the boot and steering drive shaft assembly in order.

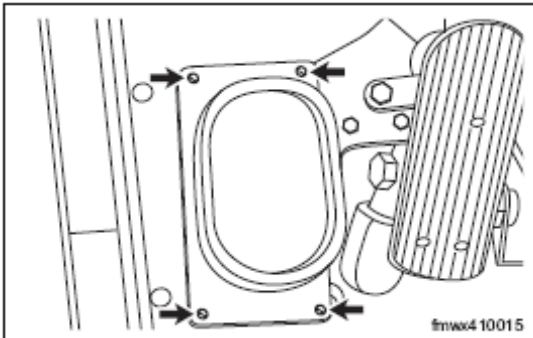
Attention

Mark the steering drive shaft outer spline and steering column.



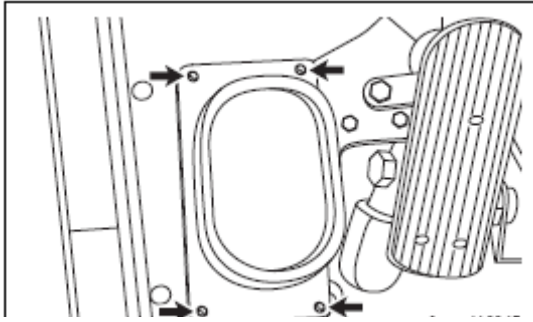
6. Remove the jacket assembly.

- (a) Remove the jacket lock bolt.
- (b) Remove the jacket .



41-16 STEERING WHEEL AND STEERING COLUMN-STEERING COLUMN (RIGHT-HAND DRIVE)

7. Check the steering column assembly. Refer to Chapter 41: Testing and Adjustment, Steering Wheel and Steering Column- Steering Wheel and Steering Column.



8. Refit the jacket assembly.

- (a) Refit the jacket assembly onto the cab floor.
- (b) Fasten the lock bolt of the jacket .

Torque: $10 \pm 1 \text{ N.m}$

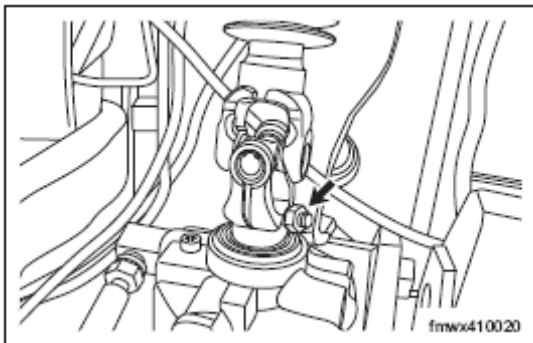


9. Refit the steering column assembly.

- (a) Refit the steering shaft and boot into the steering column in order.

Attention

Perform the refitting operation as per the marks.



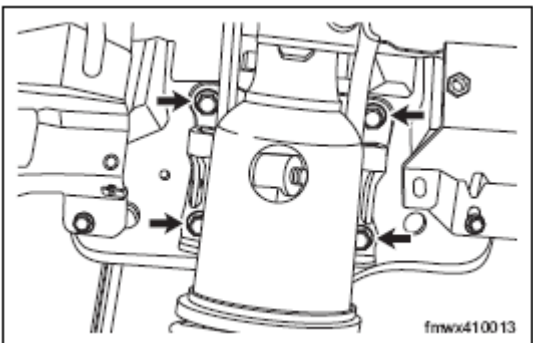
- (b) Put the steering column assembly through the jacket, and fully put the steering column spline sleeve universal joint onto the spline shaft at the top end of steering gear worm.

- Fasten the bolt.

Torque: $60 \pm 10 \text{ N.m}$

Attention

Perform the refitting operation as per the marks.



- (c) Refit the lock bolt of steering column.

- Fasten the bolt.

Torque: $23 \pm 2 \text{ N.m}$

- 10. Refit the ignition switch assembly. Refer to Chapter 18: Replacement, Starting/Preheating System-Ignition Switch.
- 11. Refit the multi-function switch assembly. Refer to Chapter 55: Replacement, Wiper and Washer-Multi-function Switch.
- 12. Refit the steering wheel. Refer to Chapter 41: Replacement, Steering Wheel and Steering Column-Steering Wheel (Left-hand Drive).

POWER STEERING GEAR

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POWER STEERING SYSTEM

OVERVIEW

Hydraulic boosting steering system is adopted for most heavy duty cars; working states installed with boosting medium could be divided into constant flow type and constant pressure type. In case of constant flow power steering gear, the boosting medium is in constant circulating flow state in this dynamic hydraulic system; in case of constant pressure power steering gear, it is boosted through the static hydraulic pressure of accumulator. As by the composition of boosting gear, power steering could be divided into integral type and split type. In case of integral type, the control gear (distribution valve), actuating gear (cylinder) and steering gear are combined together; in case of split type, they are separately arranged. The power steering system adopted in the car discussed here is integral hydraulic constant flow type. The boosting steering system is composed by steering pump assembly, CQ8111d steering gear assembly, steering pitman arm, drag link, steering tank and hydraulic circuit etc.

PRECAUTIONS

1. Operational precautions on steering system

- (a) The instructions in this manual shall be strictly and carefully followed for components replacement.
- (b) Incorrect operation might affect the performance of steering system or even endanger the safety of people.
- (c) The steering fluid of different types can't be mixed, otherwise it might reduce the service life of systematic components.
- (d) Return oil filtering approach is adopted for the hydraulic circuit of this vehicle model (that is, the steering oil filter in oil tank is installed on return oil end of steering gear instead of the oil-absorbing end of steering pump); so, when replace or supplement steering fluids, we shall clean the oil tank, operate in the field free of dust, and especially avoid the contamination dropping in to protect the components from damage.
- (e) When separating steering gear and mechanical part, keep the front wheels in the straight position of the vehicle, and fix the steering pitman arm in vertical position; random steering might cause positional change in the limit adjusting valve of steering gear and further result in overload in limit position which might damage mechanical parts.

TABLE OF FAULT PHENOMENA

You can find common failures in the following table. The no. represents the priorities of possible failures. Inspect separate parts in this order and conduct necessary replacements.

Failures	Possible causes	References
Excessive free travel for steering wheel	1. Steering rotation axis universal joint locking bolt (loose)	Chap.41 Steering wheel and steering column-steering column (left-hand drive), disassembly and installation
	2. Steering gear (loose)	Chap.42 Power steering gear-steering gear assembly (left-hand drive), overhauling
	3. Steering gear (abrasion or incorrect adjustment)	Chap.42 Power steering gear-steering gear assembly (left-hand drive), overhauling
	4. Drag link connecting rod (loose)	Chap.41 Steering wheel and steering column-steering column (left-hand drive), disassembly and installation
	5. Tie rod connecting rod (loose)	Chap.24A front axle (Anyka)-steering knuckle, overhauling
Heavy steering wheel	1. Front shaft (overload)	Chap.24A front axle (Anyka)- front shaft, overhauling
	2. Tire (abrasion)	Chap.23 Tire and wheel-tire and wheel assembly, inspection and adjustment
	3. Tire (low air pressure)	Chap.23 Tire and wheel-tire and wheel assembly, inspection and adjustment
	4. Front wheel positioning (incorrect)	Chap.24A front axle (Anyka)-front axle assembly, inspection and adjustment
	5. Steering fluid (inlet air) (lack)	Chap.42 Power steering-power steering system, inspection and adjustment Chap.42 Power steering-steering fluid (left-hand drive), replacement
	6. Steering rotation axis (bend or over-intense bearing)	Chap.41 Steering wheel and steering column-steering column, inspection and adjustment
	7. Steering gear (abrasion or damage)	Chap.42 Power steering-steering assembly (left-hand drive), overhauling
	8. Steering pump (abrasion or damage)	Chap.42 Power steering-steering pump assembly, replacement
	9. Steering pin (too small clearance)	Chap.24A front axle-(Anyka) steering knuckle, overhauling
	10. Steering tank (block)	Chap.42 Power steering gear-steering tank assembly, replacement

Failures	Possible causes	References
Incorrect steering numbers of steering wheel	1. Drag link (Deformation)	Chap.42 Power steering gear-drag link assembly, replacement
	2. Steering upright arm (incorrect angle)	Chap.42 Power steering gear-steering gear assembly (left-hand drive), overhauling
	3. Steering gear (abrasion or damage)	Chap.42 Power steering gear-steering gear assembly (left-hand drive), overhauling
	4. Steering knuckle limit bolt (incorrect adjustment)	Chap.24A front axle-(Anyka) steering knuckle, overhauling
Shaking of steering wheel	1. Tire (different air pressures)	Chap.23 Tire and wheel-tire and wheel assembly, inspection and adjustment
	2. Front wheel positioning (incorrect)	Chap. 24A front axle (Anyka)-front axle assembly, inspection and adjustment
	3. Shock absorber (damage)	Chap.21 Front suspension-front shock absorber, overhauling Chap.22 Rear suspension-rear shock absorber, overhauling
	4. Leaf spring (loose or damage)	Chap.21 Front suspension-front leaf spring, overhauling Chap.22 Rear suspension-rear leaf spring, overhauling
	5. Tire and wheel assembly (unbalanced abrasion)	Chap.23 Tire and wheel-tire and wheel assembly, inspection and adjustment Chap.23 Tire and wheel-tire and wheel assembly, inspection and adjustment
	6. Steering gear (loose or damage)	Chap. 42 Power steering-steering gear assembly (left-hand drive), overhauling
	7. Brake drum (unbalanced)	Chap. 26 Travel brake-front brake shoes, overhauling
	8. Front wheel bearing (abrasion)	Chap. 24A front axle (Anyka)-front wheel hub, overhauling
	9. Steering knuckle pin (over-intense)	Chap.24A front axle (Anyka)-steering knuckle, overhauling
	10. Steering knuckle (deformation)	Chap. 24A front axle (Anyka)-steering knuckle, overhauling
	11. Frame (deformation)	Chap.28 Frame-frame assembly, notices

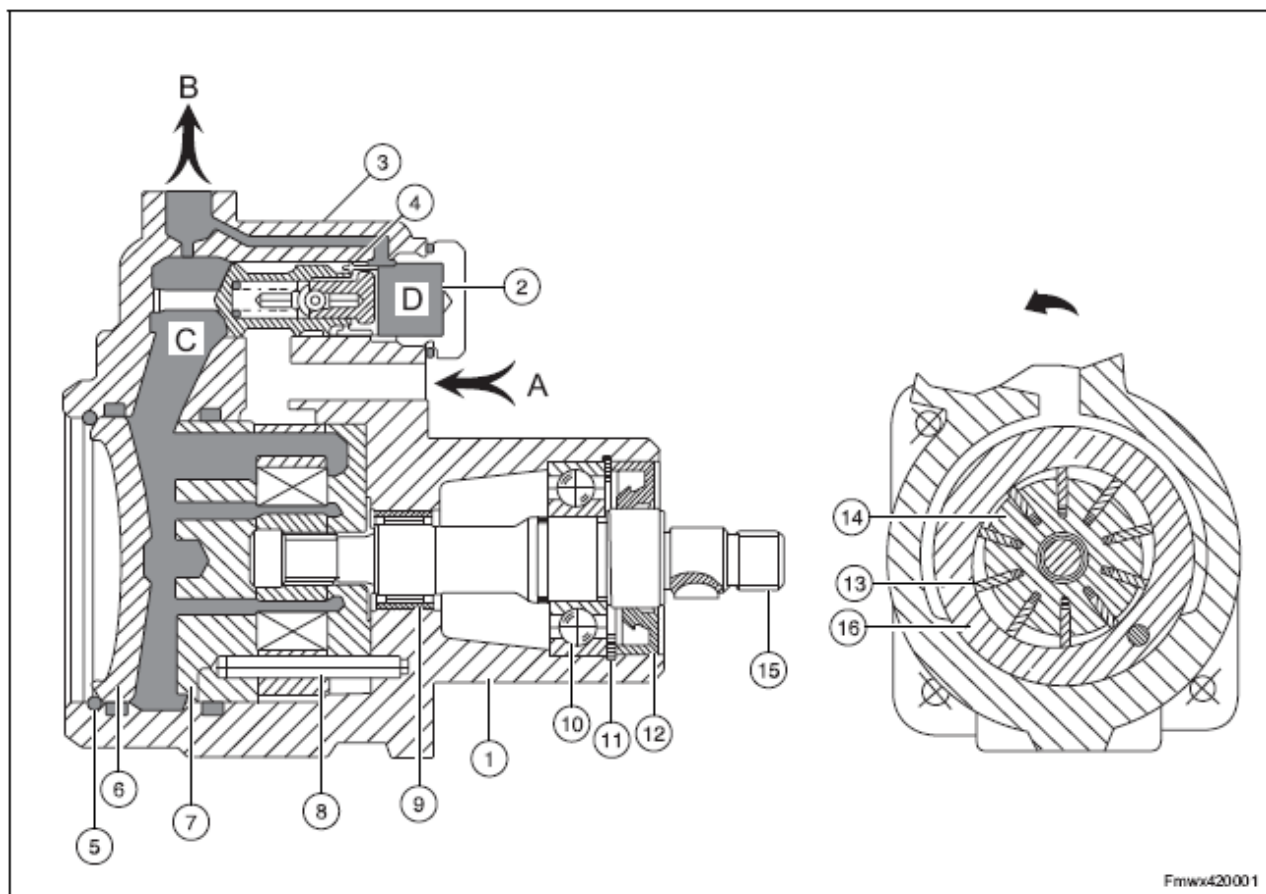


Failures	Possible causes	References
Abnormal steering noise	1. Steering fluid (incorrect model)	Chap.42 Power steering gear-power steering system, notices
	2. Steering hydraulic system (foreign air)	Chapter42 Power steering gear-power steering system, inspection and adjustment
	3. Steering gear (loose or damage)	Chapter42 Power steering gear-steering gear assembly (left-hand drive), overhauling
	4. Steering pump (abrasion or damage)	Chapter42 Power steering gear-steering pump assembly, replacement
	5. Drag link ball joint (abrasion or damage)	Chapter42 Power steering gear- drag link assembly, replacement
	6. Steering column universal joint (loose)	Chap.41 Steering wheel and steering column-steering column (left-hand drive), installation and assembly
	7. Tie rod ball joint (abrasion or damage)	Chap. 24A front axle (Anyka)-steering knuckle, overhauling
Insufficient steering boost	1. Steering fluid (insufficient)	Chapter42 Power steering gear-power steering system, inspection and adjustment
	2. Steering hydraulic system (foreign air)	Chapter42 Power steering gear-power steering system, inspection and adjustment
	3. Steering tank (filter blocked)	Chapter42 Power steering gear-steering tank assembly, replacement
	4. Steering pump (abrasion or damage)	Chapter42 Power steering gear-steering pump assembly, replacement
	5. Steering column universal joint (not smooth)	Chap.41 Steering wheel and steering column-steering column (left-hand drive), installation and assembly

WORKING PRINCIPLE

1. The operational principle of steering pump

The steering pump is mainly composed by pump shell (1), steering shaft (15), vane (13), rotor (14) and outer circle of rotor (16). To ensure the fundamentally stable output displacement of rotor oil pump and the maximum value of rated output pressure, flow control valve (3) and safety valve (4) are installed at the output end of pump. Steering pump is installed on the timing gear housing of the motor; the pump is led by camshaft gear to drive the rotation of gear. When the motor is in motion, the vane pump rotates, and the vanes installed in the rotor wedge of the pump start to rotate closely against the internal curved surface the pump body under the actions of centrifugal force and oil pressure. Sealed working channels form among different vanes. Oil absorbing channels occur where the volumes of sealed working channels are progressively enlarged. For every rotation of the pump, oil absorbing and pressing actions are completed twice. Given the symmetric distribution of oil absorbing and oil pressing channels, the hydraulic radial force acted on the shaft is balanced. The displacement of the pump is determined by the width and rotating speed of rotor vane; the output pressure of the pump is determined by the resistance of steering system. To restrict maximum pump pressure, safety valve (4) is designed inside the pump. When the external load of power steering system is so enlarged that pump pressure has reached 130bar, safety valve is opened to unload. To ensure fundamentally stable pump displacement, flow control mechanism is also designed inside pump body which is composed by safety valve (4) and flow control valve (3). When the pump is rotating in relatively slow speed, valve (3) will seal oil outlet and inlet channels under the action of return spring. With the speeding up of the pump, pump displacement is increased as well. By the choking effect of safety valve (4), a pressure difference $\Delta P = P_c - p_d$ (P_c : pressure of C channel; p_d : pressure of D channel) is formed between the front channel C and rear channel D of safety valve (4). The pressure difference is increased with the increasing of pump displacement. When pump speed is increased to set-speed (that is, pump displacement has reached a certain value), the pressure difference ΔP formed between the front channel C and rear channel D is sufficient to overcome the pretightening force of return spring. Meanwhile, the flow control valve (3) will move left under the action of pressure difference, therefore opening the passages of oil outlet and inlet channels and resulting in internal circulation in part of the oil. The larger the pump displacement is, the larger the pressure difference ΔP ; so are the opening of the flow control valve (3) and internal discharge capacity. Therefore, the fundamentally stable output displacement of rotor oil pump is ensured. See details in the following chart:

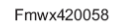


1	Pump shell
2	Spring
3	Flow control valve
4	Safety valve
5	End cover clamp spring
6	End cover
7	Oil distributor
8	Positioning pin
9	Needle bearing

10	Bearing
11	Bearing clamp spring
12	Oil seal
13	Rotor vane
14	Rotor
15	Rotor shaft
16	Outer circle of rotor
A	Oil inlet (low pressure)
B	Oil outlet (high pressure)



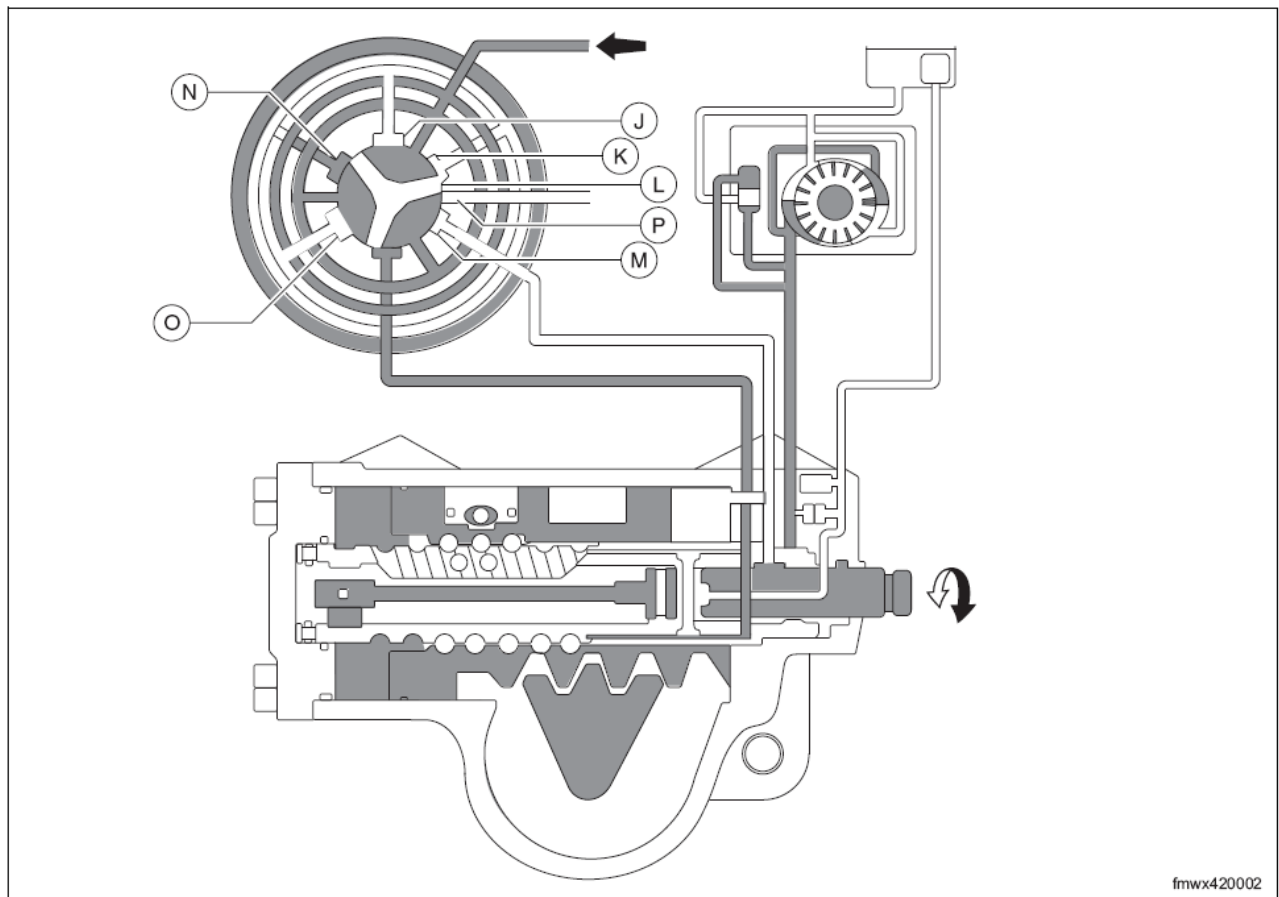
Steering pump is the power source of steering system. The steering tank receives the low pressure oil returned from steering gear and supply oil to steering pump at the same time. In the steering gear a cylinder is composed by shell A and piston B, the latter of which will convert the steering motion of steering axis C into linear motion and rotate the fan-shaped rocker axis F simultaneously. By means of a circle of steel balls, piston B and worm gear D correspondingly move. When worm gear rotates, steel balls enter into worm gear surface in sequence and make reciprocating motion on worm gear through circulating pipe. The safety valve is composed by steering valve C and valve sleeve D, for which 6 grooves are designed respectively on the cylindrical surface. The torque rod E is separately connected to steering valve C and valve sleeve D by fixing pins and set the control valve at the neutral position when the steering wheel is motionless. The safety valve G could limit abnormal oil pressure in the steering gear. When the steering is in motion but the steering pump is motionless, oil charge valve H could recharge steering engine through return oil pipe. The control slot on the rotor and the control slot on the valve sleeve are in opposing position. After gone through oil inlet channel J and K, the oil goes to the curved axial groove N and O on the valve sleeve and reaches one side and both sides of boosting piston through axial oil duct. When the control valve is at the neutral position, the oil returns to the oil tank through three return oil slots P of the rotor after reaching both sides of boosting piston. See details in the following drawing:



G	Safety valve
H	Oil charge valve
Q	Oil tank
R	Rotor vane

E	Torque rod	S	Constant flow valve
F	Fan-shaped rocker axis		

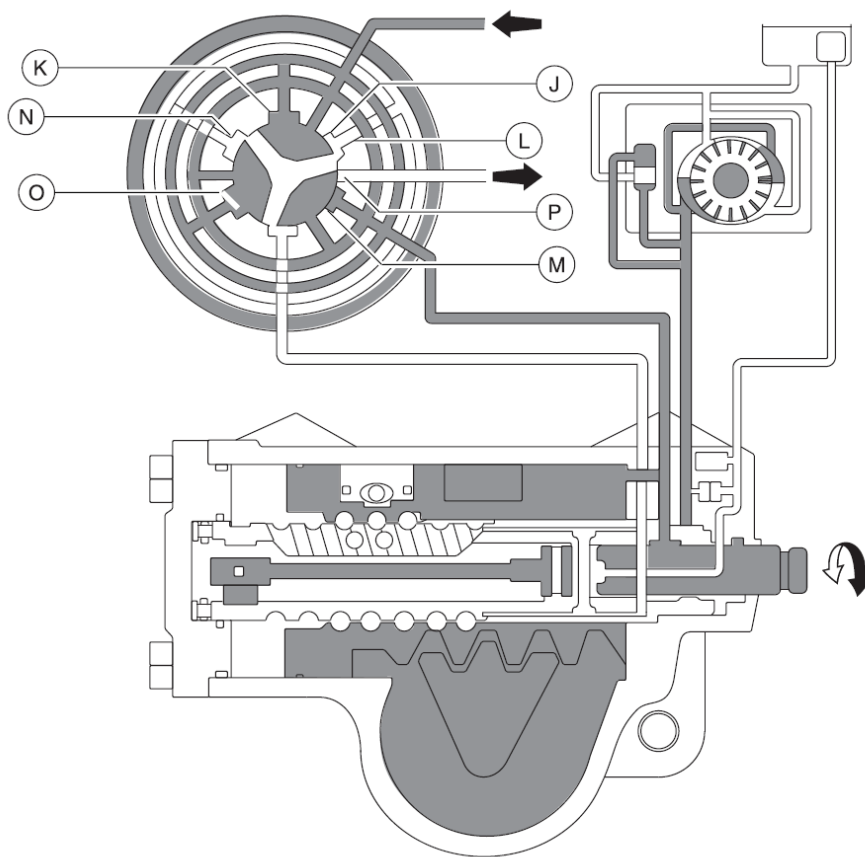
When the steering wheel turns right and the control groove on control valve motor deflects in clockwise direction, the oil inlet channel K is relatively largely opened to let the oil go through; the other oil inlet channel J is closed to prevent the oil from flowing to the axial slot O on the valve sleeve. Thus the oil has to flow to the guide slot N on the valve sleeve through oil inlet channel K and further flow to the left side of the piston through steel ball raceway. The other oil inlet channel J is closed to prevent the oil from flowing back to the oil tank which might result in high oil pressure. At this moment the oil at the right side of the piston is discharged and flow back to the oil tank after going through the opened return oil channel M and return oil slot and the oil duct inside the rotor. While the pressure in the left side oil chamber of the piston is raised up, the right side oil chamber is unloaded, therefore the piston is pushed to move right by hydraulic oil. See details in the following drawing:



J	Oil inlet channel
K	Oil inlet channel
L	Return oil channel
M	Return oil channel

N	Steering slot
O	Steering slot
P	Return oil slot

When the steering wheel turns left and the control groove on control valve motor deflects in counter-clockwise direction, the oil flows to the right side of the piston through opened oil inlet channel J and axial slot O. At this moment the oil at the left side of the piston is discharged and flow back to the oil tank after going through the opened return oil channel P, steel ball raceway and return oil slot and the oil duct inside the rotor. Given that the pressure at the right side of the piston is raised up, the piston will move left, therefore achieving boost. See details in the following drawing:

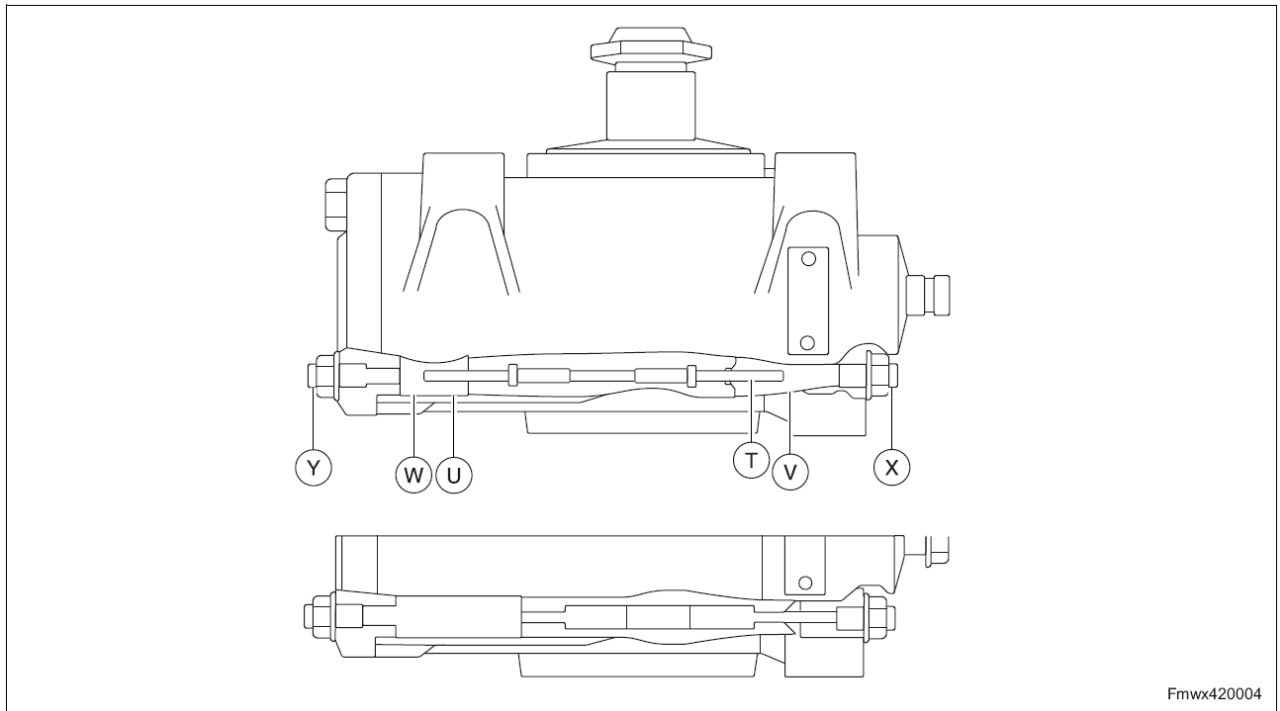


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J	Oil inlet channel
K	Oil inlet channel
L	Return oil channel
M	Return oil channel

N	Steering slot
O	Steering slot
P	Return oil slot

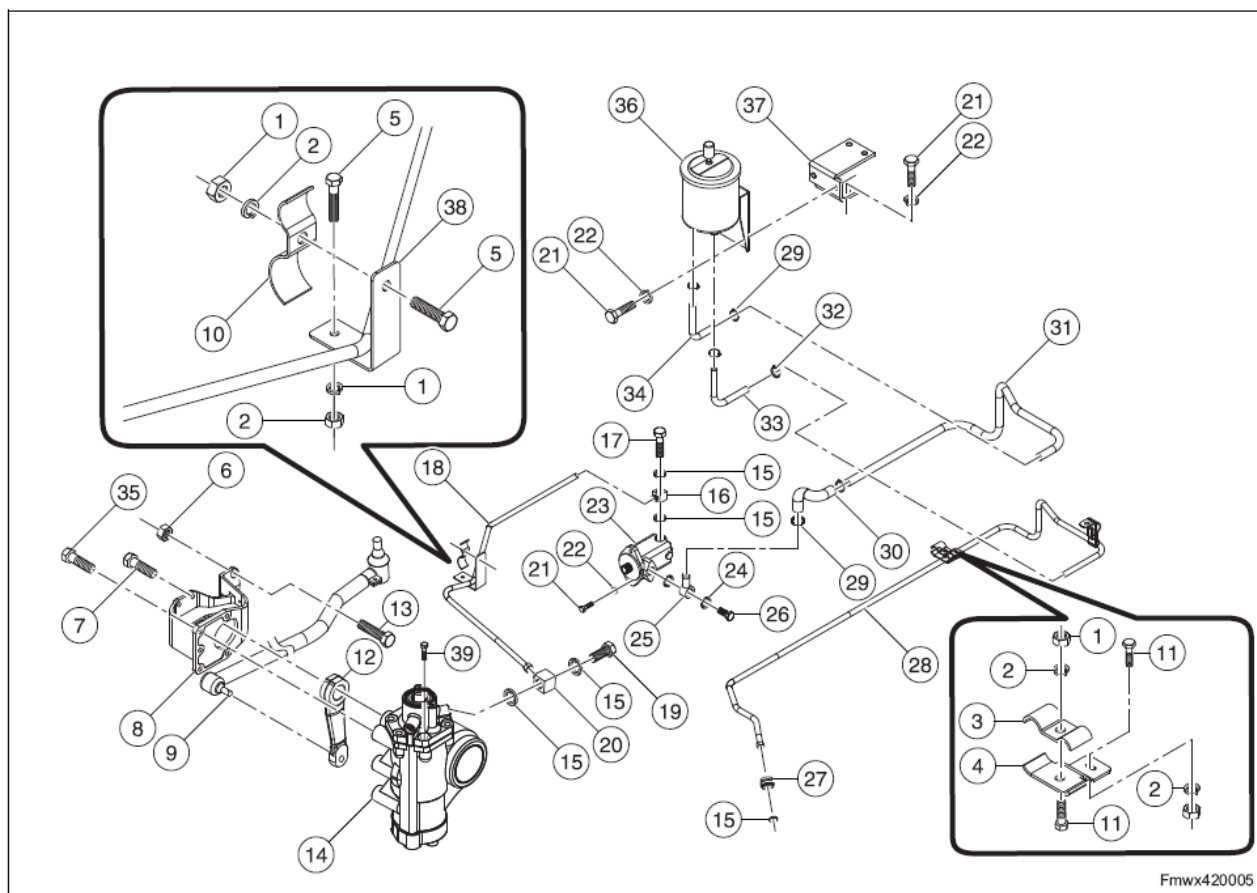
There are two limit valves installed on both sides of the steering gear. The steering limit valve could prevent maximum working pressure from pushing the steering gear to the limit position and therefore protect the steering gear and steering pump from being damaged by extreme pressure; it could also prevent over-high oil pressure. The double acting hydraulic steering limit valve is composed by two valve disks T and U (with springs) which are installed on the piston, protruding the piston on both sides. When the piston move right to near the limit position, the right-side valve disk T is jacked into the piston by right-side adjusting screw, and the left-side valve U is pushed into the piston under the action of pressure. The oil in the left chamber of the piston flows the oil chamber of the piston after relieving pressure by limit valve port and connects with low pressure, therefore completing unloading. When the piston move left to near the limit position, both valve disks are opened to unload, therefore ensuring the safety of mechanical parts at limit position. When the hydraulic steering limit valve is opened, the steering gear could still steer outward. However, given the dramatic decrease in hydraulic boosting action, the steering force necessary for the steering wheel is increased until reaching its mechanical limit position. See details in the following drawing:



T	Right-side valve disk
U	Left-side valve disk
V	Oil chamber of piston

W	Left piston chamber
X	Right-side adjusting screw
Y	Left-side adjusting screw

DIAGRAM OF COMPONENTS



1	1-type hexagonal nut
2	Spring washer
3	Pipe clamp
4	Oil pipe supporter
5	Hexagon headed bolt
6	Self-locking nut
7	Hexagon headed bolt-fine thread
8	Steering gear supporter
9	Drag link assembly
10	Pipe clamp 2
11	Hexagon headed bolt-fine thread
12	Steering pitman arm
13	Hexagon headed bolt-fine thread
14	Steering gear assembly
15	Sealing washer
16	Clip set hinged fitting body
17	Clip set hinged bolt

21	Hexagon headed bolt
22	Spring washer
23	Steering pump assembly
24	Sealing washer
25	Annular joint
26	Clip set hinged hexagonal bolt
27	Hinged fitting body
28	Oil return pipe assembly
29	B-type worm transmission flexible-pipe hoop
30	Flexible oil-absorbing pipe
31	Oil-absorbing pipe
32	B-type worm transmission flexible-pipe hoop
33	Flexible oil-absorbing pipe
34	Flexible oil-absorbing pipe 1
35	Hexagon headed bolt
36	Steering tank assembly
37	Steering tank supporter



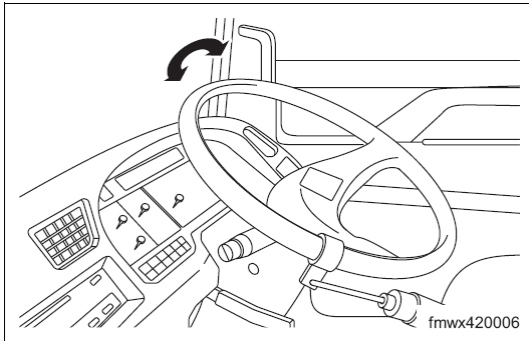
POWER STEERING GEAR-POWER STEERING SYSTEM

42-15

18	High pressure oil pipe assembly	38	Oil pipe supporter
19	Hinged bolt	39	Hexagon headed bolt
20	Pipe fitting		

TESTING AND ADJUSTMENT

1. Measurement of required acting force



- (a). For measurement, the vehicle is required to be stopped on dry leveled road, with parking brake firmly set. Start the motor for idle running until the temperature of the liquid reaches 50 to 60°C (122 to 140°F), then inspect the acting force required by the steering wheel by the tie rod.

Acting force of the steering wheel:

Standard value: 32N

2 Inspection of steering fluid level

Attention:

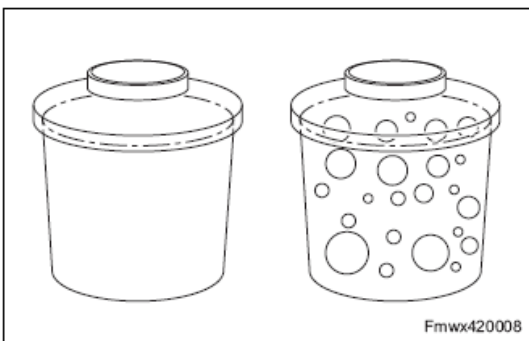
- Park the car on leveled road;
- If liquid level is low, it represents that there might be leakage in braking system components. Inspect and repair the system when necessary;
- Regular inspection of liquid level must be conducted at least once per 5000km travel (or 1 month):

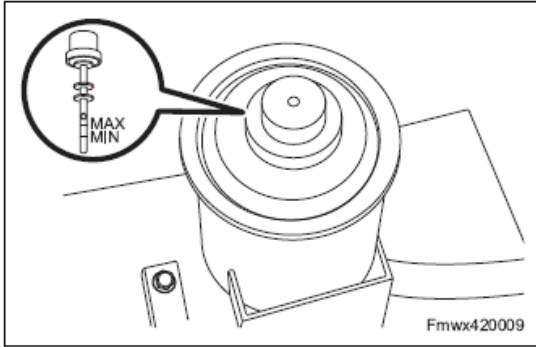
- (a). Keep the motor in idle running;
- (b). Steer the steering wheel several times between both sides of limit position and raise steering fluid temperature. Steering fluid temperature: 60 to 80°C.

Attention:

Prevent the steering wheel from staying at limit position for more than 5s to avoid damaging steering gear;

- (c). Inspect whether there are turbidness or air bubbles in steering fluid. If there are any turbidness or air bubbles, conduct air bleeding treatment on steering fluid.

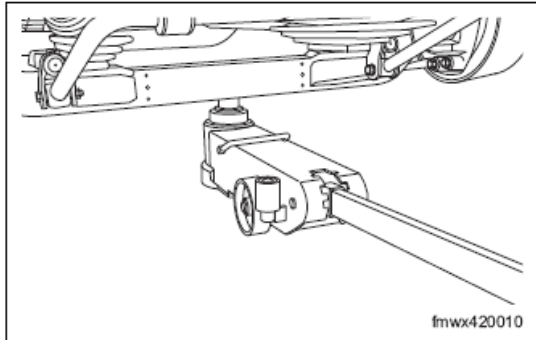




- (d). Observe the steering fluid level, which should be at the max mark position on the oil level indicator.

Attention:

When the diesel engine is in operation, the steering fluid level 1 to 2mm higher than normal position is normal.



3. Hydraulic circuit venting

- (a). Elevate the front wheels with jack until it is higher than the ground;
 (b). Unscrew the cover of steering tank;
 (c). Stop the operation of the motor and carefully steer the steering wheel in both clockwise and counter-clockwise directions until it touches steering knuckle arm check block.

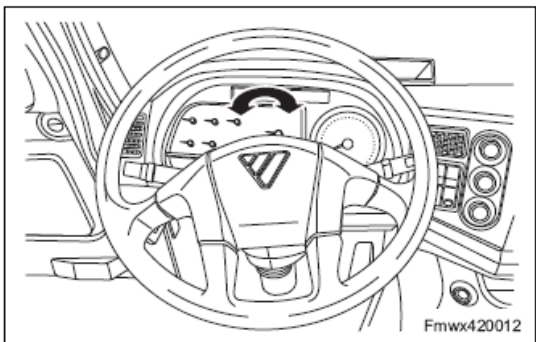
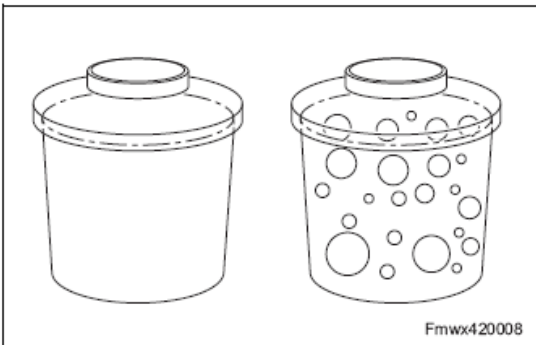
Attention:

Prevent the steering wheel from staying at limit position for more than 5s to avoid damaging steering gear;

- (d). Start the motor for idle running, and then steer the steering wheel several times between both sides of limit position until the steering fluid level in steering tank stop declining and there is no bubble generated. Fasten the cover of steering tank.

Attention:

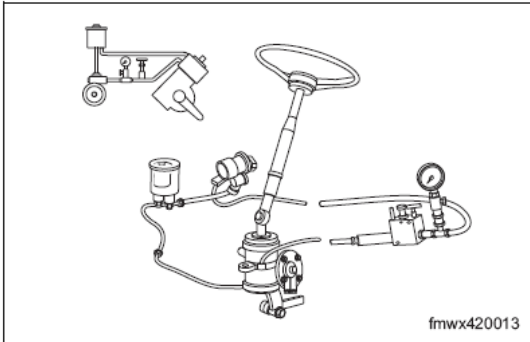
Timely observe the steering fluid level and recharge steering oil.



- (e). Lower the front wheels with jack, and then steer the steering wheel several times between both sides of limit position during the idle operation of the motor.

Attention: Prevent the steering wheel from staying at limit position for more than 5s to avoid damaging steering gear;

- (f). When testing the vehicles on the road, ensure successful steering operation and ensure that there is no abnormal noise heard when steering the steering wheel.
 (g). Observe steering fluid level and recharge it to the marked position on the oil level indicator



4. Inspection of steering pump

- (a). Disconnect high pressure oil pipe with steering gear and steering pump. Refer to Chapter 42 Power steering gear-hydraulic circuit, disassembly and installation.
- (b). Cascade a pressure gauge (150bar in measuring range) and a switch between steering gear and steering pump.
- (c). Widely open the switch, start the motor and keep it operating within slow speed range;
- (d). Gradually close the switch, the pressure gauge should have reach 117 to 143bar, which means the pump is in normal state; refer to Chapter 42 Power steering gear-steering pump assembly, replacement.

Attention:

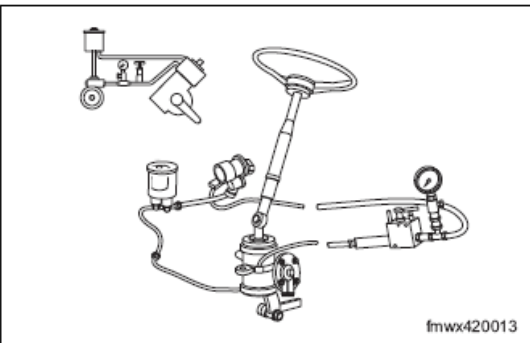
Gradually close the switch within 5s, and the motor should be kept operating within slow speed range.

5. Adjustment of steering limit valve

- (a). Elevate front axle I-beam with jack until the front wheels are off ground;
- (b). First steer the steering wheel in one direction to the limit position, then steer it in opposing direction to the limit position, and then the adjustment of steering limit valve is completed.

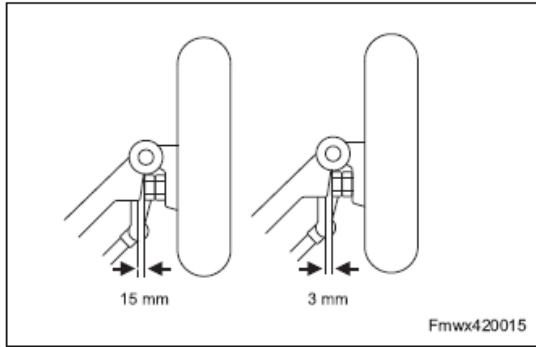
Attention:

The adjustment of steering limit valve is automatic without needing any disassembled adjustments on steering gear. Pay attention that this operation could only be conducted after connecting steering gear with steering mechanical parts.



6. Sealing quality inspection

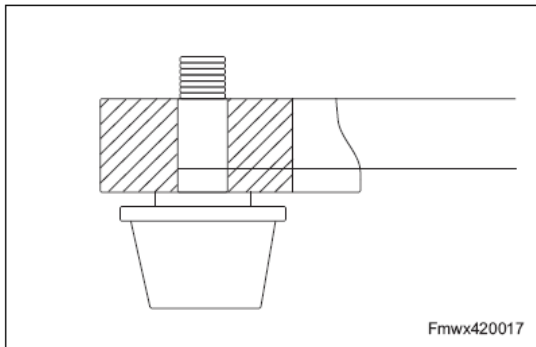
- (a). Disconnect high pressure oil pipe with steering gear and steering pump. Refer to Chapter 42 Power steering gear-hydraulic circuit, disassembly and installation.



- (b). Elevate front axle I-beam with jack until the front wheels are off ground;
- (c). Put a steel plate (15mm in thickness) between front wheel limit screw and convex plate;
- (d). Start the motor and keep it operating within slow speed range; steer the front wheel to one-side limit position and continue to pull the steering wheel in steering direction; repeat the operation in opposing direction.

Attention:

The pressures on both sides should have reached 117-143bar, otherwise the steering gear assembly should be replaced; Chapter 42 Power steering gear-steering gear assembly (left-hand drive), overhauling.

**7. Inspection of various connecting parts of drag link**

- (a). Inspect the contact areas of front ball joint of drag link and tie rod with steering pitman arm.
 - Uniformly apply red lead powder on the internal surfaces of mounting holes of drag link front tapered shaft and steering pitman arm;
 - Insert the tapered shaft of drag link left joint assembly into mounting holes steering pitman arm and then take it out, therefore completing inspecting contact indentations.

Standard:

Uniform contact, with contact area no bigger than 3/4 of the total tapered shaft length

Attention:

In case of nonuniform contact or contact area bigger than 3/4 of the total tapered shaft length, the drag link and tie rod assembly and steering pitman arm will be replaced. Refer to Chapter 42 Power steering gear-drag link assembly, placement; Chapter 41 Power steering gear-steering gear assembly (left-hand drive), overhauling.

- (b) Inspect the contact areas of rear ball joint of drag link and tie rod with steering knuckle arm.

Hint:

For the operational steps of inspecting the contact areas of rear ball joint of drag link and tie rod with steering knuckle arm, refer to the descriptions on inspecting the contact areas of front ball joint of drag link and tie rod with steering pitman arm.

Standard:

Uniform contact, with contact area no bigger than 3/4 of the total tapered shaft length.

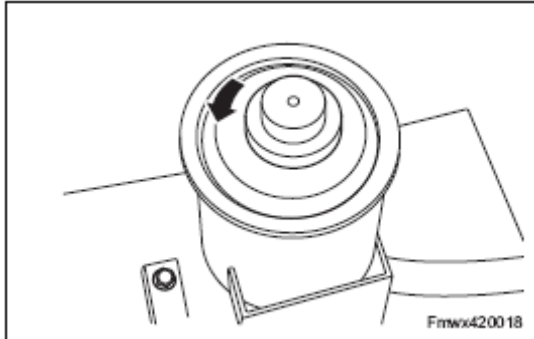
Attention:

In case of nonuniform contact or contact area bigger than 3/4 of the total tapered shaft length, the drag link and tie rod assembly and steering knuckle arm will be replaced. Refer to Chapter 42 Power steering gear-drag link assembly, placement; Chapter 24 Front axle-steering knuckle, overhauling.

STEERING FLUID (LEFT-HAND DRIVE)

REPLACEMENT

1. Turn up the vehicle head.



2. Oil outlet

- (a). Support it with safety scaffolding, with front wheels on both sides off the ground at the same time;
- (b). Rotate the cover of steering tank in counter-clockwise direction to remove it.

- (c). Loose the nut, and pull out the low pressure oil pipe assembly 1 from steering gear return oil port;
- (d). Start the motor and keep it in idle running;
- (e). Discharge the steering fluid in steering pump and steering tank.
- (f). Steer the steering wheel several times between both sides of limit position until there is no steering fluid flowing out.

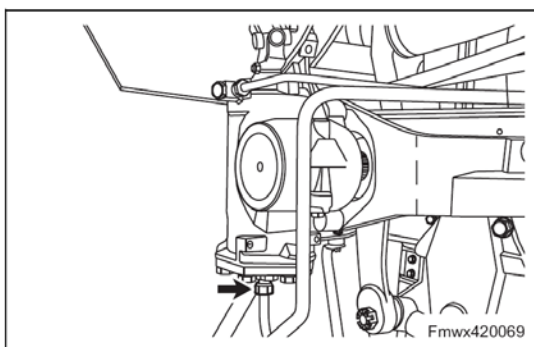
Attention:

Prevent the steering wheel from staying at limit position for more than 5s to avoid damaging steering gear.

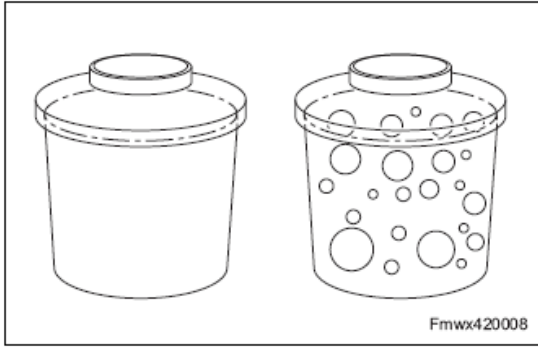
3. Filling

- (a). Paint sealing gum on the pipe orifice of low pressure oil pipe assembly.

Sealing gum: Loctite 567 sealing gum;



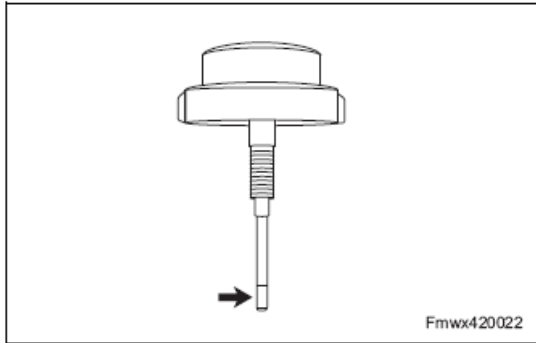
- b). Insert the low pressure oil pipe assembly 1 into steering gear return oil port, and fasten the screw;
Torque: 120±10N·m



- (c). Inject steering fluid into steering tank.
Steering fluid: ATF-III;
- (d). Keep the motor in idle running;
- (e). Steer the steering wheel several times between both sides of limit position until the steering fluid level in steering tank stop declining and there is no bubble generated.

Attention:

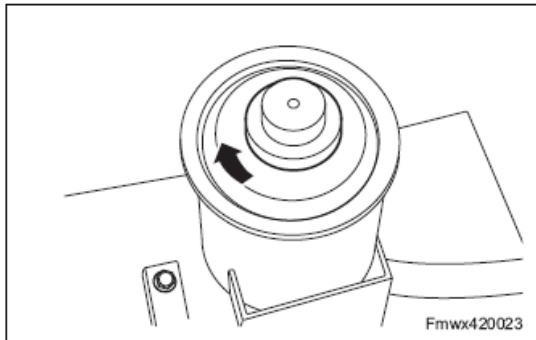
Prevent the steering wheel from staying at limit position for more than 5s to avoid damaging steering gear;



- (f). Inspect steering fluid level
 - When the diesel engine is not in operation, the oil volume is required to be at the upper limit of oil gauge.

Attention:

When the diesel engine is in operation, the oil volume 1 to 2mm higher than the upper limit is normal.



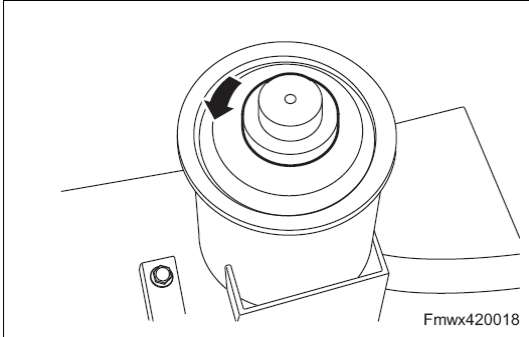
- (g). Rotate the cover of oil tank in clockwise direction to fasten it.
- (h). Close the motor.
- (i). Set down the vehicle.

4. Turn down the vehicle.

STEERING FLUID (RIGHT-HAND DRIVE)

REPLACEMENT

1. Turn up the vehicle.



2. Oil outlet

- (a). Support it with safety scaffolding, with front wheels on both sides off the ground at the same time;
- (b). Rotate the cover of steering tank in counter-clockwise direction to remove it.

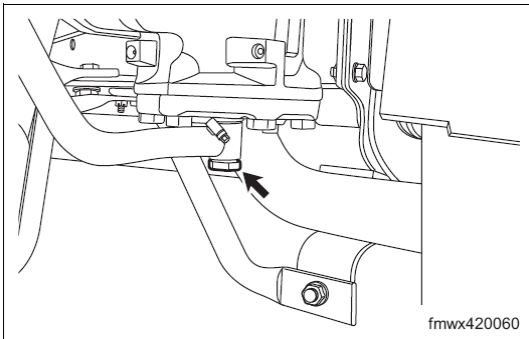
- (c). Loose the nut, and pull out the low pressure oil pipe assembly from steering gear return oil port;
- (d). Start the motor and keep it in idle running;
- (e). Discharge the steering fluid in steering pump and steering tank.
- (f). Steer the steering wheel several times between both sides of limit position until there is no steering fluid flowing out.

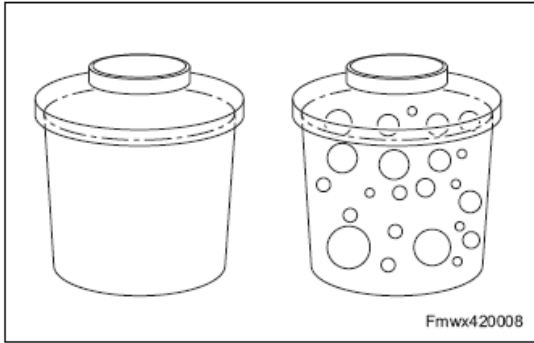
Attention:

Prevent the steering wheel from staying at limit position for more than 5s to avoid damaging steering gear.

3. Filling

- (a). Paint sealing gum on the pipe orifice of low pressure oil pipe assembly.
Sealing gum: Loctite 567 sealing gum;
- (b). Insert the low pressure oil pipe assembly into steering gear return oil port, and fasten the screw;





- (c). Inject steering fluid into steering tank.
Steering fluid: ATF-III;
- (d). Keep the motor in idle running;
- (e). Steer the steering wheel several times between both sides of limit position until the steering fluid level in steering tank stop declining and there is no bubble generated.

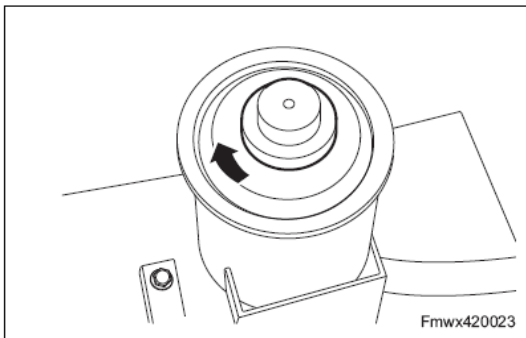
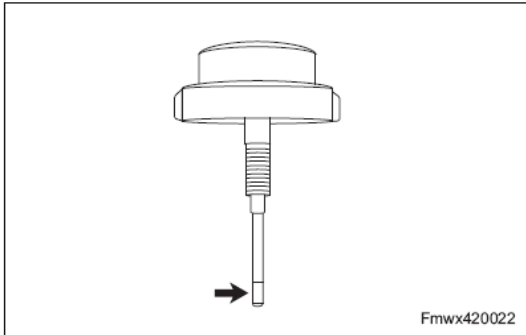
Attention:

Prevent the steering wheel from staying at limit position for more than 5s to avoid damaging steering gear;

- (f). Inspect steering fluid level
 - When the diesel engine is not in operation, the oil volume is required to be at the upper limit of oil gauge.

Attention:

When the diesel engine is in operation, the oil volume 1 to 2mm higher than the upper limit is normal.



- (g). Rotate the cover of oil tank in clockwise direction to fasten it.
- (h). Close the motor.
- (i). Set down the vehicle.

4. Turn down the vehicle head.

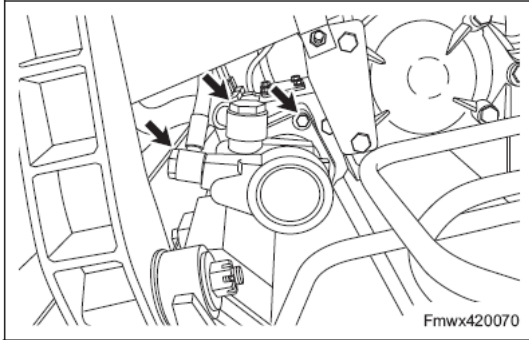
STEERING PUMP ASSEMBLY

REPLACEMENT

Hint:

- As precision component, the steering pump assembly can not be disassembled for overhauling.
- If damaged, the steering pump assembly has to be replaced.

1. Oil outlet: refer to Chapter 42 Power steering-steering fluid (left-hand drive), replacement



2. Disassemble steering pump assembly

- (a). Loose terminal nut, and pull out high pressure oil pipe assembly from the oil outlet of steering pump assembly;
- (b). Loose the hoop, and pull out pump oil-absorbing pipe assembly from the oil inlet of steering pump assembly;
- (c). Loose two bolts and remove steering pump assembly.

3. Install steering pump assembly

- (a). Put steering pump assembly on a flat surface and fasten two bolts;
- (b). Set pump oil-absorbing pipe assembly on the oil inlet of steering pump assembly, and fasten the hoop;
- (c). Paint sealing gum on the pipe orifice of high pressure oil pipe assembly.

Sealing gum: Loctite 567 sealing gum;

- (d). Set pump oil-absorbing pipe assembly on the oil outlet of steering pump assembly, and fasten the terminal nut.

Torque: $23 \pm 2 \text{ N} \cdot \text{m}$

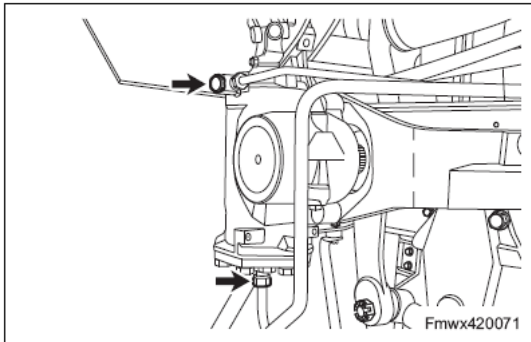
4. Fulfill steering fluid; refer to Chapter 42 Power steering-steering fluid (left-hand drive), replacement

STEERING GEAR ASSEMBLY (LEFT-HAND DRIVE)

SERVICE

Hint:

- As precision component and safety component, the steering gear assembly can not be disassembled for overhauling.
 - if damaged, the steering pump assembly has to be replaced.
1. **Steering fluid oil outlet: refer to Chapter 42 Power steering-steering fluid (left liquid), replacement;**
 2. **Separate steering column splined sleeve universal joint with steering gear; refer to Chapter 41 Steering wheel and steering column-steering column (left-hand drive), disassembly and installation;**
 3. **Separate drag link and steering pitman arm; refer to Chapter 42 Power steering-drag link assembly, replacement;**



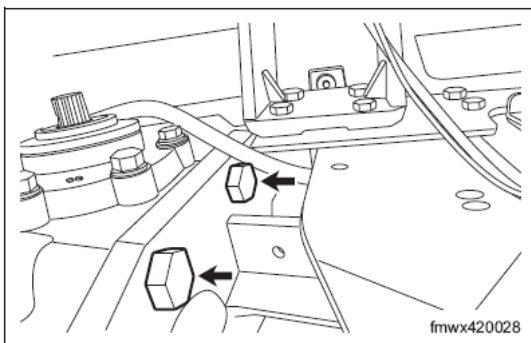
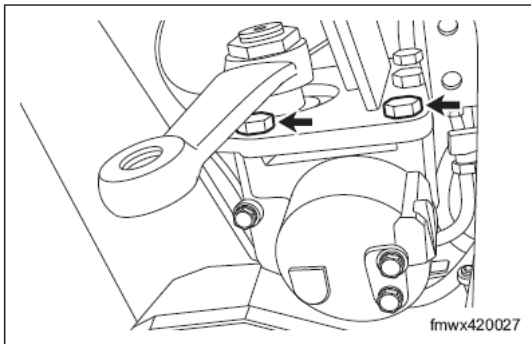
4. Disassemble steering gear assembly

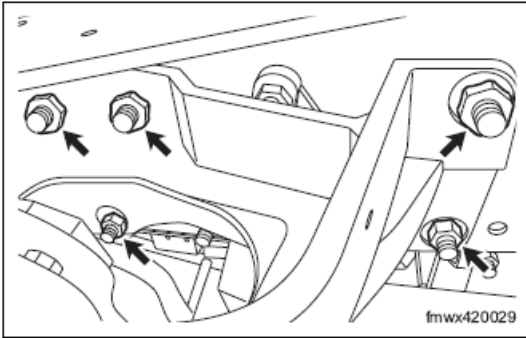
- (a). Loose terminal nut, and pull out high pressure oil pipe assembly from the oil inlet of steering pump assembly;
- (b). Loose terminal nut, and pull out low pressure oil pipe assembly from the return oil port of steering pump assembly;
- (c). Disconnect steering pitman arm and steering gear;
 - Disassemble the fastening nut of steering pitman arm.

Attention:

Make assembly marks on steering pitman arm and steering gear pitman axis.

- (d). Disassemble the four fastening bolts at the bottom of the steering gear;
- (e). Disassemble the two fastening bolts at the top of the steering gear;
- (f). Separate steering gear and steering gear supporter;





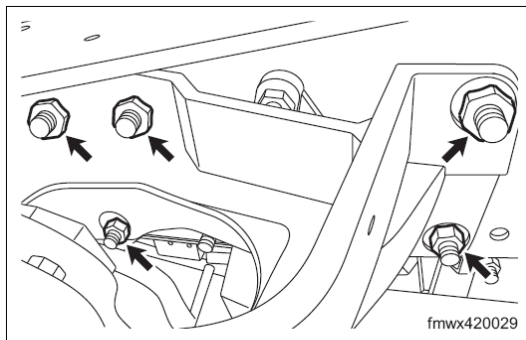
5. Disassemble steering gear supporter

- (a). Disassemble the five fastening nuts of the steering gear supporter;
- (b). Remove the steering gear supporter.

6. Inspecting steering gear and steering pitman arm

- (a). Inspect steering gear shell and steering pitman arm axis to see if there are any cracks by means of magnetic crack detection;
- (b). Inspect steering pitman arm axis spline to see if there are any cracks or damages;
- (c). Inspect steering pitman arm.
 - Inspect steering pitman arm to see if there are any deformations or cracks;
 - Inspect steering pitman arm splined holes and spline tooth to see if there are any serious abrasions.

If there are any of the above flaws detected, the steering gear and steering pitman arm will be replaced.

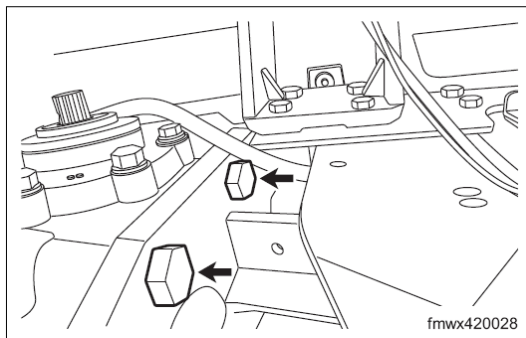


7. Install steering gear supporter

- (a). Install the steering gear supporter on the frame of vehicle.

- Fastening nut.

Torque: $325 \pm 25 \text{ N} \cdot \text{m}$



8. Install steering gear assembly

- (a). Install steering gear assembly onto steering gear supporter;
- (b). Install the two fastening bolts on the top of steering gear;

- (c). Install the two fastening bolts on the bottom of steering gear.

- screw the four fastening bolts of steering gear.

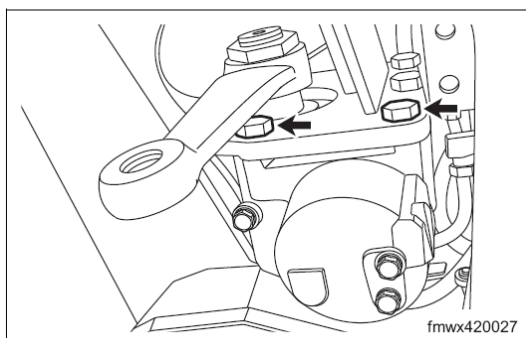
Torque: $565 \pm 15 \text{ N} \cdot \text{m}$

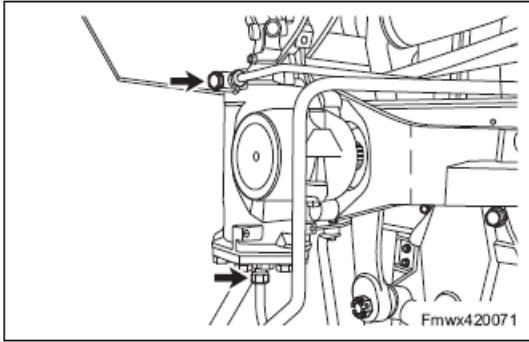
- (d). Install the pitman arm

- Screw the fastening bolts of pitman arm.

Attention:

Install according to the assembly marks made.





- (e). Set high pressure oil pipe assembly on the oil inlet of steering gear, and fasten the terminal nut;
Torque: 120±10N·m
- (f). Set low pressure oil pipe assembly on the return oil port of steering gear, and fasten the terminal nut;

Torque: 120±10N·m

- 9. Connect drag link and steering pitman arm; refer to Chapter 42 Power steering gear-drag link assembly, replacement;
- 10. Connect steering column splined sleeve universal joint with steering gear; refer to Chapter 41 Steering wheel and steering column-steering column (left-hand drive), disassembly and installation;
- 11. Fulfill steering fluid; refer to Chapter 42 Power steering gear-steering fluid (left-hand drive), replacement.

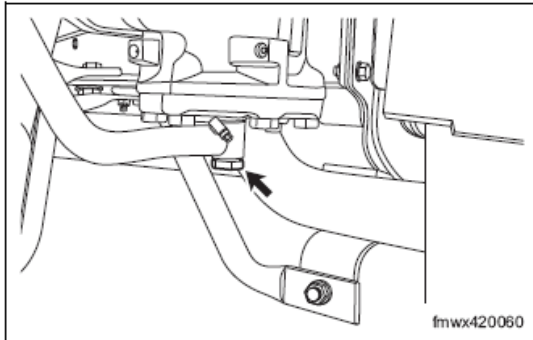
STEERING GEAR ASSEMBLY (RIGHT-HAND DRIVE)

SERVICE

Hint:

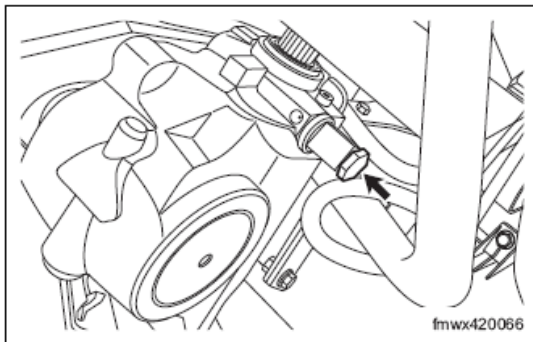
- As precision component and safety component, the steering gear assembly can not be disassembled for overhauling.
- If damaged, the steering pump assembly has to be replaced.

1. **Steering fluid oil outlet: refer to Chapter 42 Power steering-steering fluid (right-hand drive), replacement;**
2. **Separate steering column splined sleeve universal joint with steering gear; refer to Chapter 41 Steering wheel and steering column-steering column (right-hand drive), disassembly and installation;**
3. **Separate drag link and steering pitman arm; refer to Chapter 42 Power steering-drag link assembly, replacement;**

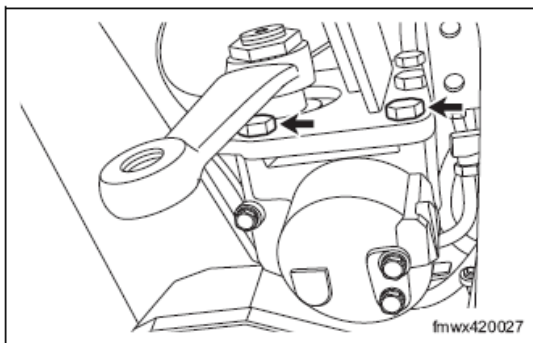


4. Disassemble steering gear assembly

- (a). Loose terminal nut, and pull out low pressure oil pipe assembly from the oil inlet of steering gear;



- (b). Loose terminal nut, and pull out high pressure oil pipe assembly from the return oil port of steering gear;

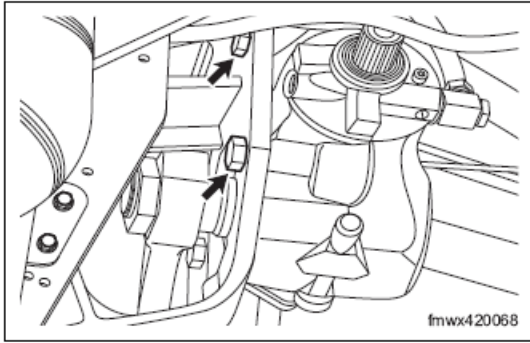


- (c). Disconnect steering pitman arm and steering gear;
 - Disassemble the fastening nut of steering pitman arm.

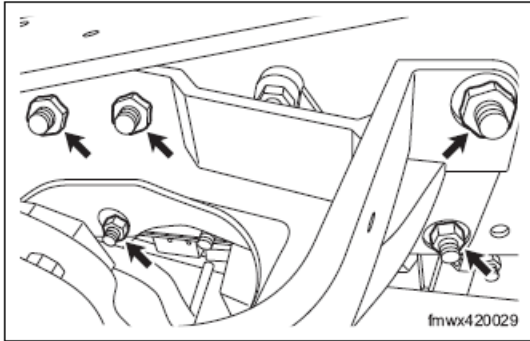
Attention:

Make assembly marks on steering pitman arm and steering gear pitman axis.

- (d). Disassemble the two fastening bolts at the bottom of the steering gear;



- (e). Disassemble the two fastening bolts at the top of the steering gear;
- (f). Separate steering gear and steering gear supporter.



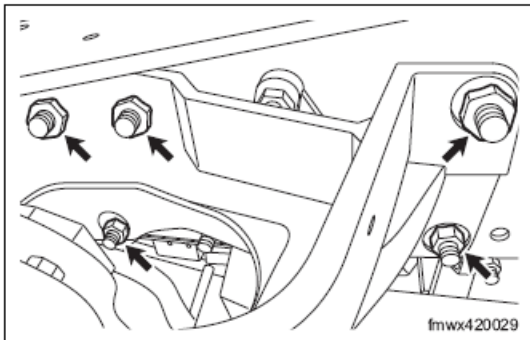
5. Disassemble steering gear supporter

- (a). Disassemble the five fastening nuts of the steering gear supporter;
- (b). Remove the steering gear supporter.

6. Inspecting steering gear and steering pitman arm

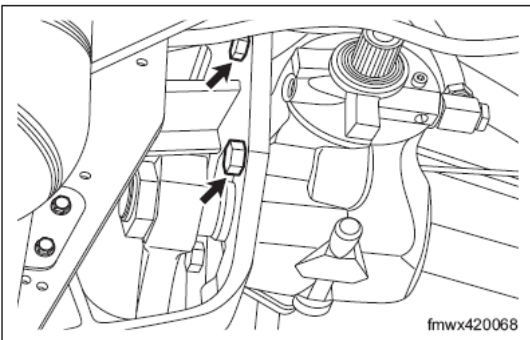
- (a). Inspect steering gear shell and steering pitman arm axis to see if there are any cracks by means of magnetic crack detection;
- (b). Inspect steering pitman arm axis spline to see if there are any cracks or damages;
- (c). Inspect steering pitman arm.
 - Inspect steering pitman arm to see if there are any deformations or cracks;
 - Inspect steering pitman arm splined holes and spline tooth to see if there are any serious abrasions.

If there are any of the above flaws detected, the steering gear and steering pitman arm will be replaced.



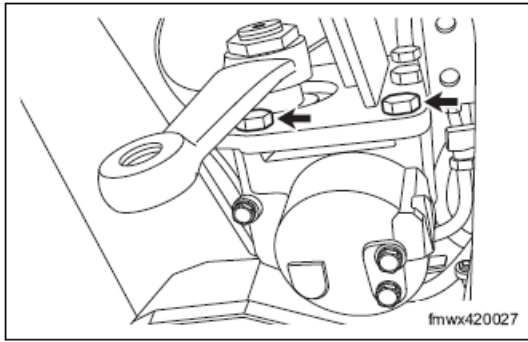
7. Install steering gear supporter

- (a). Install the steering gear supporter on the frame of vehicle.
 - Fastening nut.
- Torque: 325±25N·m**



8. Install steering gear assembly

- (a). Install steering gear assembly onto steering gear supporter;
- (b). Install the two fastening bolts on the top of steering gear;



- (c). Install the two fastening bolts on the bottom of steering gear.
- Screw the four fastening bolts of steering gear.

Torque: $565 \pm 15 \text{ N} \cdot \text{m}$

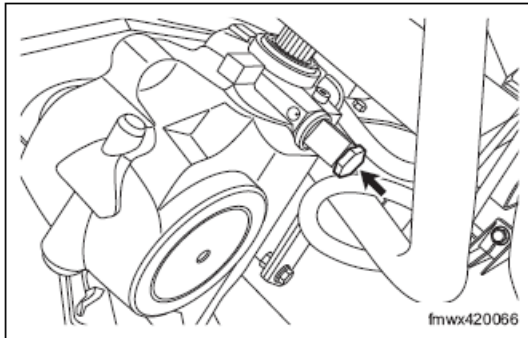
- (d). Install the pitman arm
- screw the fastening bolts of pitman arm.

Attention:

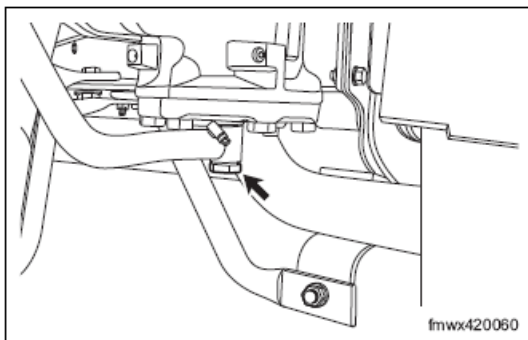
Install according to the assembly marks made.

- (e). Set high pressure oil pipe assembly on the oil inlet of steering gear, and fasten the terminal nut;

Torque: $120 \pm 10 \text{ N} \cdot \text{m}$



- (f). Set low pressure oil pipe assembly on the return oil port of steering gear, and fasten the terminal nut;

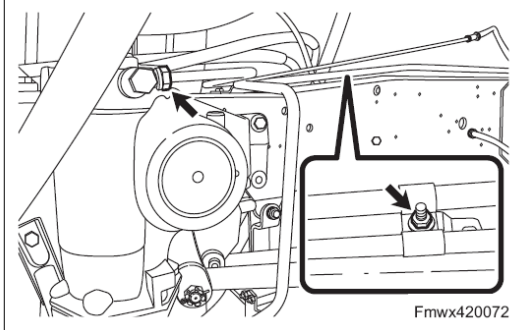


9. Connect drag link and steering pitman arm; refer to Chapter 42 Power steering gear-drag link assembly, replacement;
10. Connect steering column splined sleeve universal joint with steering gear; refer to Chapter 41 Steering wheel and steering column-steering column (right-hand drive), disassembly and installation;
11. Fulfill steering fluid; refer to Chapter 42 Power steering gear-steering fluid (right-hand drive), replacement.

HYDRAULIC CIRCUIT

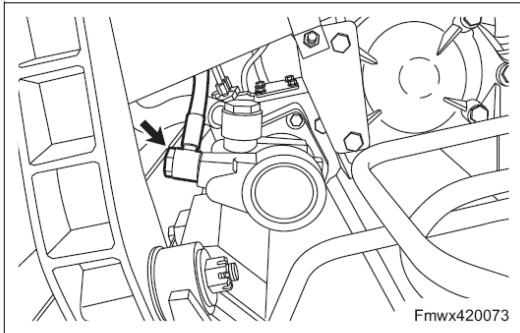
REMOVAL AND INSTALLATION

1. Oil outlet: Chapter 42 Power steering gear-steering fluid (right-hand drive), replacement.



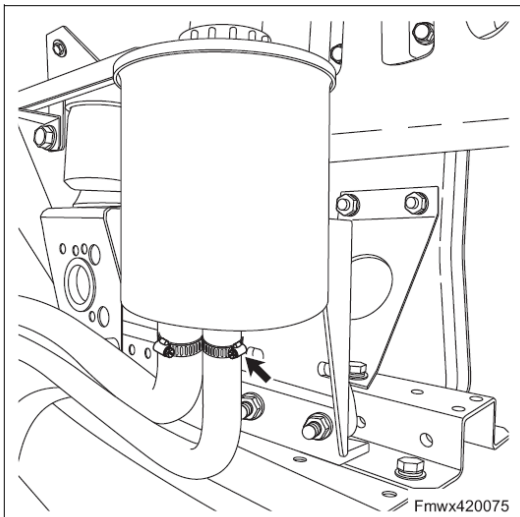
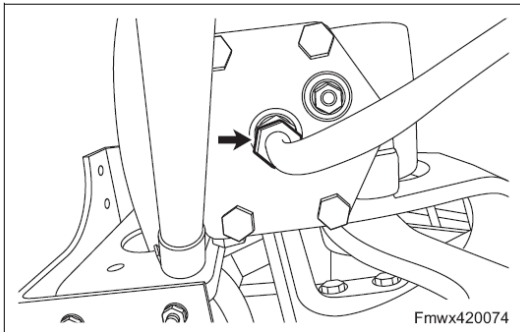
2. Disassemble high pressure oil pipe assembly

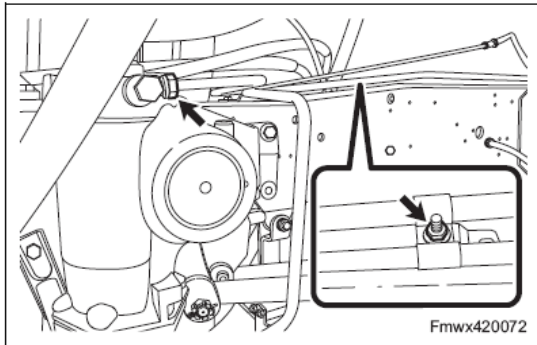
- (a). Loose terminal nut, and pull out high pressure oil pipe assembly from the oil inlet of steering pump assembly;
- (b). Loose the bolts of oil pipe clamp assembly,, and remove oil pipe clamp assembly;
- (c). Loose terminal nut, and pull out and remove high pressure oil pipe assembly from the oil outlet of steering pump assembly;



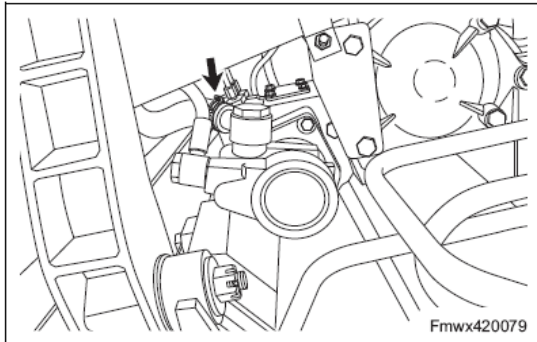
3. Disassemble low pressure pipe

- (a). Loose terminal nut, and pull out low pressure oil pipe assembly from the return oil port of steering gear;
- (b). Loose the hoop, and pull out low pressure oil pipe assembly from the oil inlet port of steering tank;

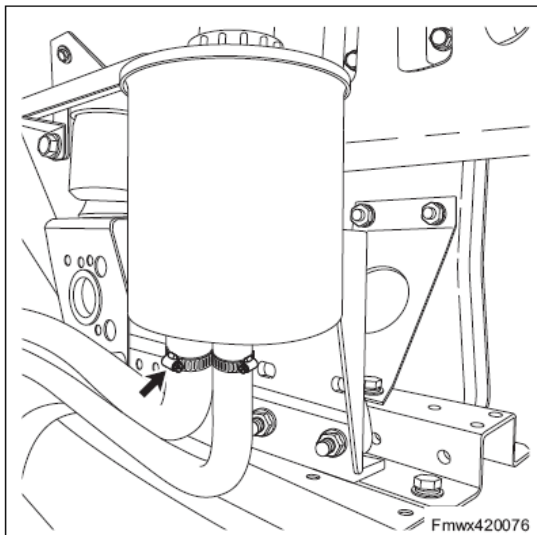




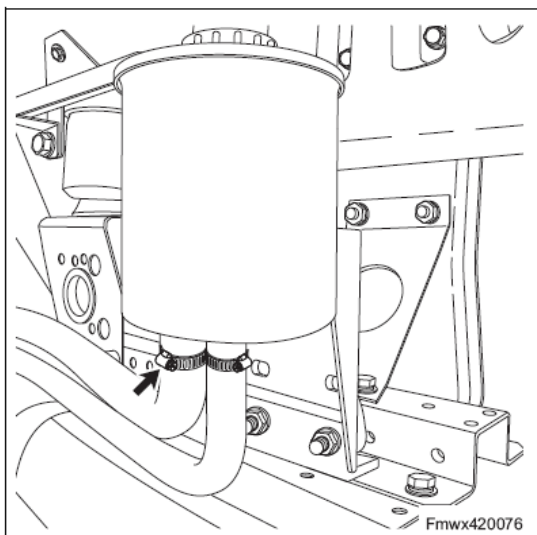
- (c). Loose oil pipe clamp bolt, and remove low pressure oil pipe assembly;



4. Disassemble steering pump oil inlet assembly
(a). Loose the hoop, and pull out steering pump oil inlet assembly from the oil inlet of steering pump assembly;

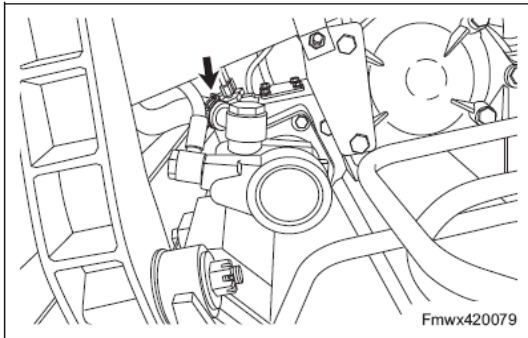


- (b). Loose the hoop, and pull out steering pump oil inlet assembly from the oil outlet of steering tank;
(c). Remove steering pump oil inlet assembly.

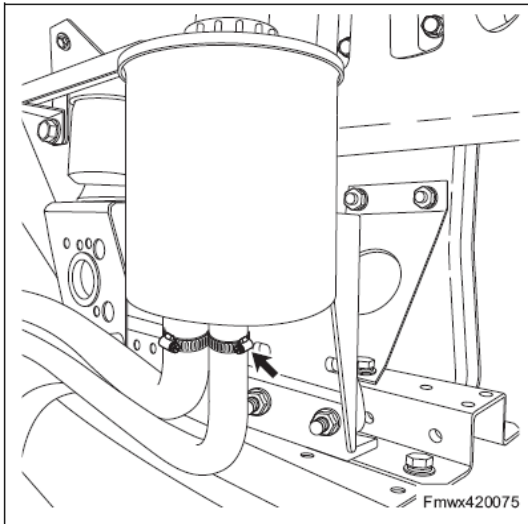


5. **Install steering pump oil inlet assembly**
(a). Install steering pump oil inlet pipe onto the oil outlet of steering tank, and fasten the hoop;





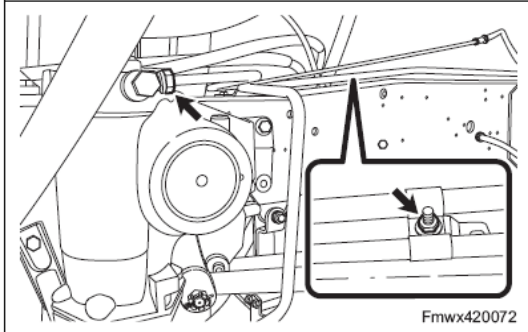
- (b). Install steering pump oil inlet pipe onto the oil inlet of steering pump assembly, and fasten the hoop;



6. Install low pressure oil pipe

- (a). Install low pressure oil pipe assembly onto the oil inlet of steering tank, and fasten the hoop;

42



- (b). Paint sealing gum on the pipe orifice of low pressure oil pipe assembly.

Sealing gum: Loctite 567 sealing gum;

- (c). Insert the low pressure oil pipe assembly into steering gear return oil port, and fasten the terminal nut;

Torque: $120 \pm 10 \text{ N} \cdot \text{m}$

- (d). Install oil pipe clamp component, and fasten the bolt.

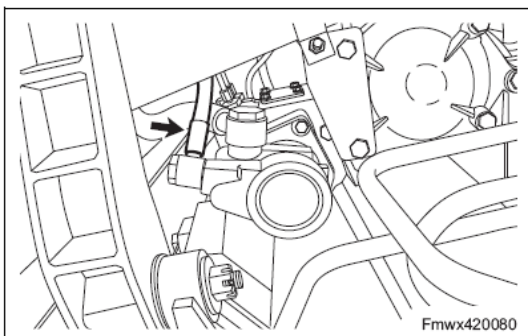
Torque: $23 \pm 2 \text{ N} \cdot \text{m}$

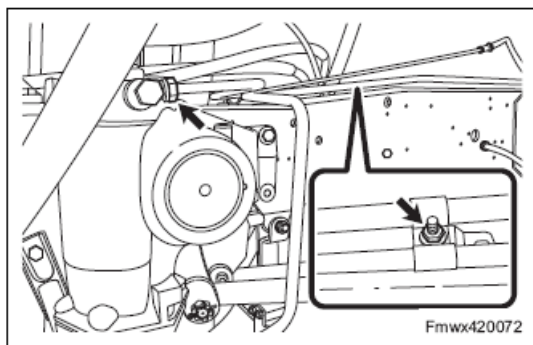
7. Install high pressure oil pipe

- (a). Paint sealing gum on high pressure oil pipe assembly and the pipe orifice of high pressure oil pipe assembly;

Sealing gum: Loctite 567 sealing gum;

- (b). Set the high pressure oil pipe assembly onto the oil outlet of steering pump, and fasten the terminal nut;





- (c). Insert the high pressure oil pipe assembly onto the oil inlet of steering gear, and fasten the terminal nut;

Torque: $120 \pm 10 \text{ N} \cdot \text{m}$

- (d). Install oil pipe clamp component, and fasten the bolt.

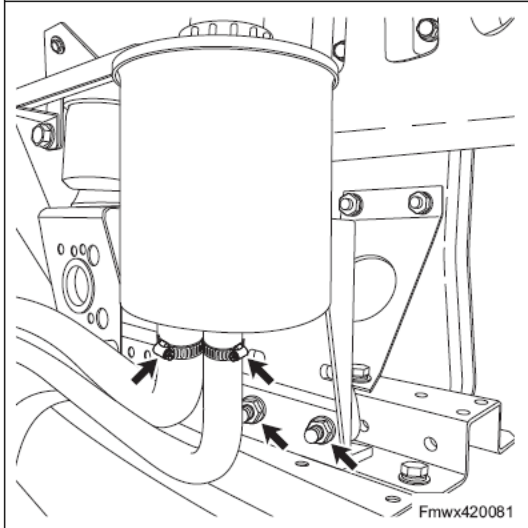
Torque: $120 \pm 10 \text{ N} \cdot \text{m}$

8. Fulfill steering fluid; refer to Chapter 42 Power steering gear-steering fluid (right-hand drive), replacement.

STEERING TANK ASSEMBLY

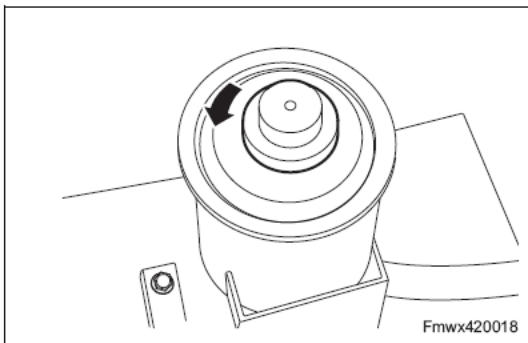
REMOVAL AND INSTALLATION

1. Oil outlet: refer to Chapter 42 Power steering-steering fluid (left-hand drive), replacement



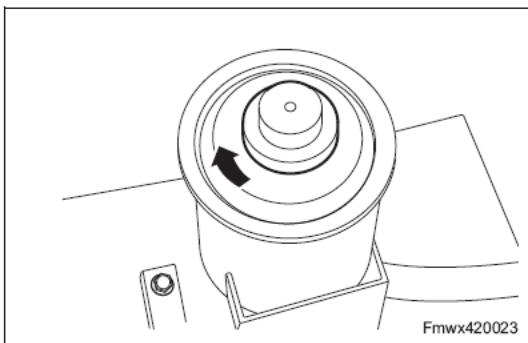
2. Disassemble steering tank assembly

- (a). Loose the hoop, and pull out low pressure oil pipe assembly from the oil inlet of steering tank;
- (b). Loose the hoop, and pull out oil pump inlet pipe assembly from the oil outlet of steering tank;
- (c). Loose the bolts of steering tank and the supporter.



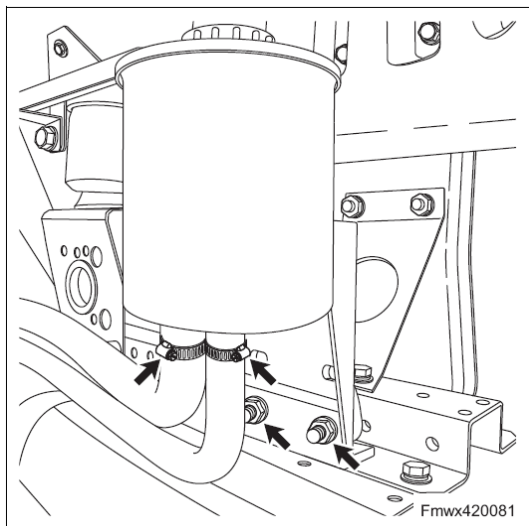
3. Disassemble the cover of steering tank

- (a). Rotate the cover of steering tank in counter-clockwise direction to remove it.



4. Install the cover of steering tank

- (a). Rotate the cover of steering tank in clockwise direction to fasten it.



5. Install the steering tank assembly

- (a). Install the steering tank assembly onto the supporter, and fasten the bolts;

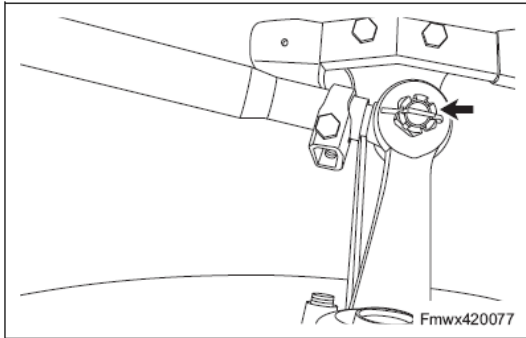
Torque: $23 \pm 2 \text{ N} \cdot \text{m}$

- (b). Set the oil pump inlet pipe assembly onto the oil inlet of steering tank, and fasten the hoop;
- (c). Set the low pressure oil pipe assembly onto the oil inlet of steering tank, and fasten the hoop.

6. Fulfill steering fluid; refer to Chapter 42 Power steering gear-steering fluid (left-hand drive), replacement.

DRAG LINK ASSEMBLY

SERVICE

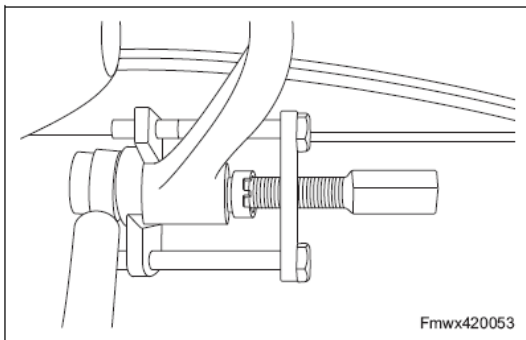


1. **Disconnect drag link and steering knuckle arm.**

(a). Pull out the split pin and loose hex slotted nut;

Attention:

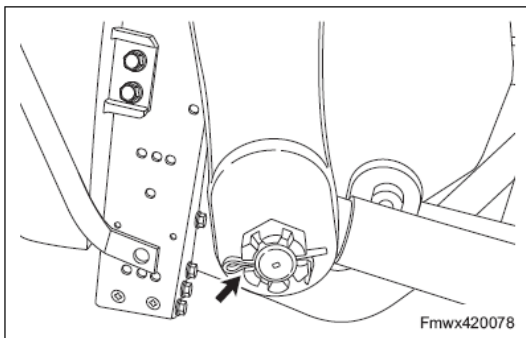
The split pin pulled out could not be used again.



- (b). Separate drag link and steering knuckle arm by ball joint clamp.

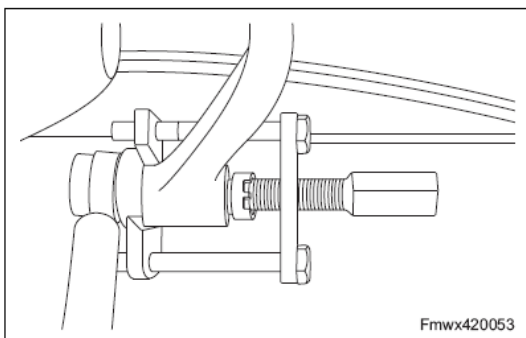
Attention:

Do not damage the dust cover of the ball joint when using ball joint clamp.



2. **Disconnect drag link and steering pitman arm.**

(a). Pull out the split pin and loose hex slotted nut;



- (b). Separate drag link and steering pitman arm by ball joint clamp.

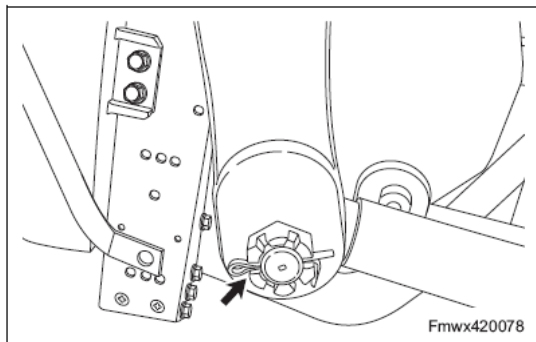
Attention:

Make front marks for drag link facing the front of the vehicle; do not damage the dust cover of the ball joint when using ball joint clamp.

3. **Inspect drag link .**

(a). Inspect the ball joint to see if it is loose;

(b). Inspect the contact areas of tapered shaft with steering pitman arm and steering knuckle arm; refer to Power steering gear-power steering system, inspection and adjustment.



4. Install drag link assembly

- (a). Install drag link into steering pitman arm, fasten hex slotted nut and install split pin;

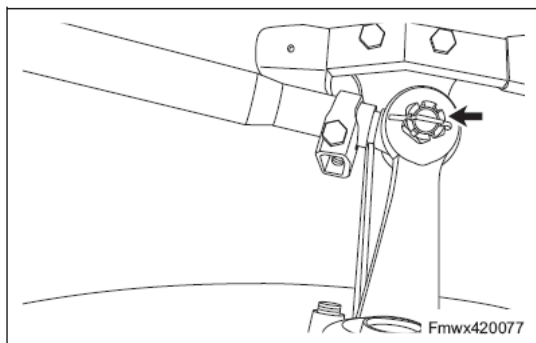
Attention:

Ensure that the anterior part of drag link is installed into the side of steering pitman arm; ensure that new split pin is used.

- (b). Install drag link into steering knuckle arm, fasten hex slotted nut and install split pin;

Torque: 180N·m

Attention: ensure that new split pin is used.



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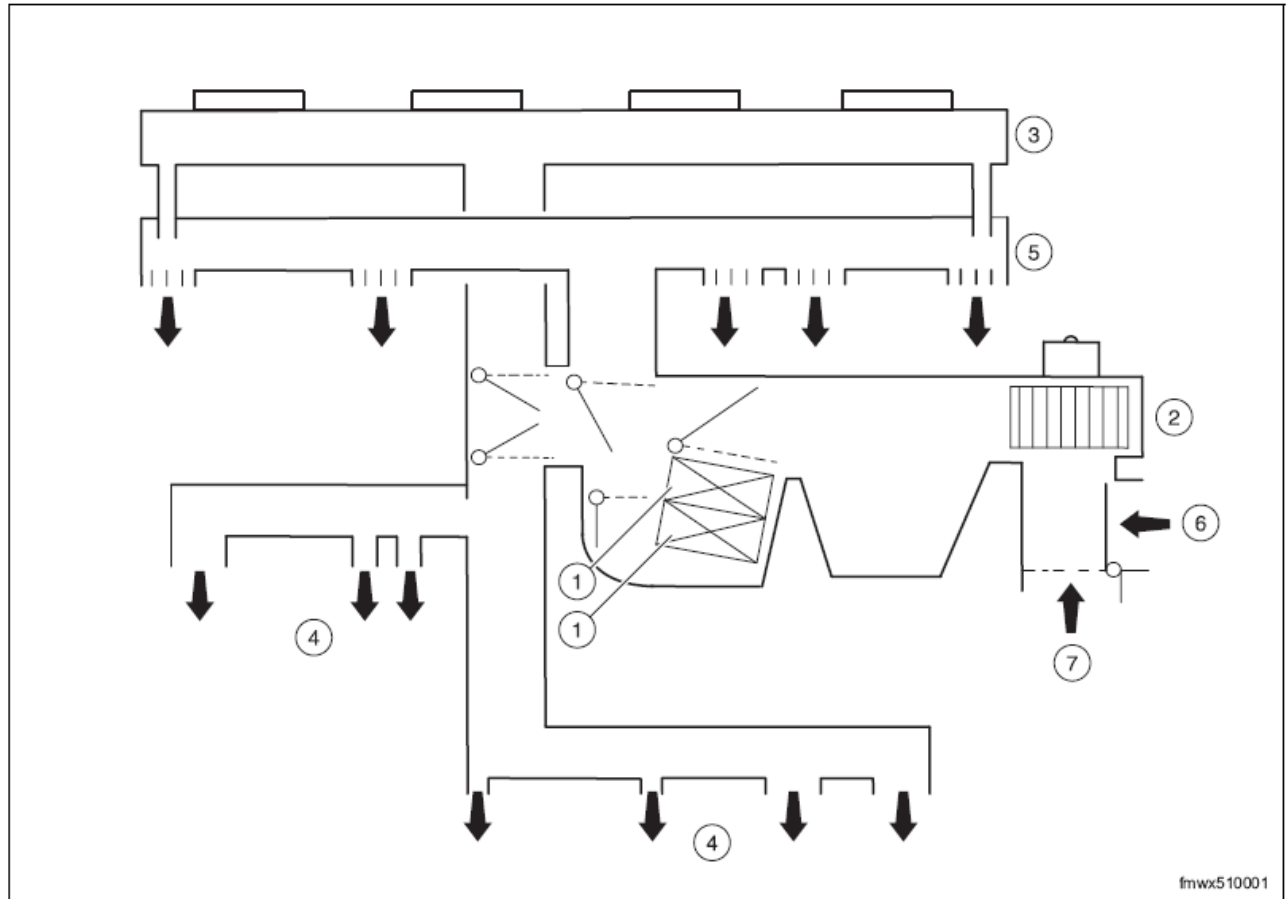


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AIR HEATER AND AIR CONDITIONER

OVERVIEW

Heater



1	Heater core
2	Blower
3	Defroster
4	Floor outlet

5	Instrument panel outlet
6	Internal air
7	External air

When the engine is being heated, the heated engine cooling liquid will be delivered into the heater core. The heating system will supply hot air into the cabin to preheat it. Thus, the external air can be circulated via the heater of the heating device and then delivered to the cabin. By controlling the external air and heater core, the most comfortable cabin temperature can be selected and maintained. The temperature of hot air delivered to the cabin is controlled by the temperature control knob which is used to open and close the air mixture door, thus to control the air flow passing through the heater core.

Meanwhile, the most comfortable cabin temperature can be also selected and maintained via the internal and external circulation switch of different control modes. This switch is used to select the external air circulation or internal air circulation. Where the switch is turned to "External Circulation", the external air will be always introduced into the cabin; where the switch is turned to "Internal Circulation", only the internal air, other than the external air, will be circulated and the air temperature inside will be increased quickly. However, the switch is normally set at "External Circulation" to avoid fogging of the windshield.

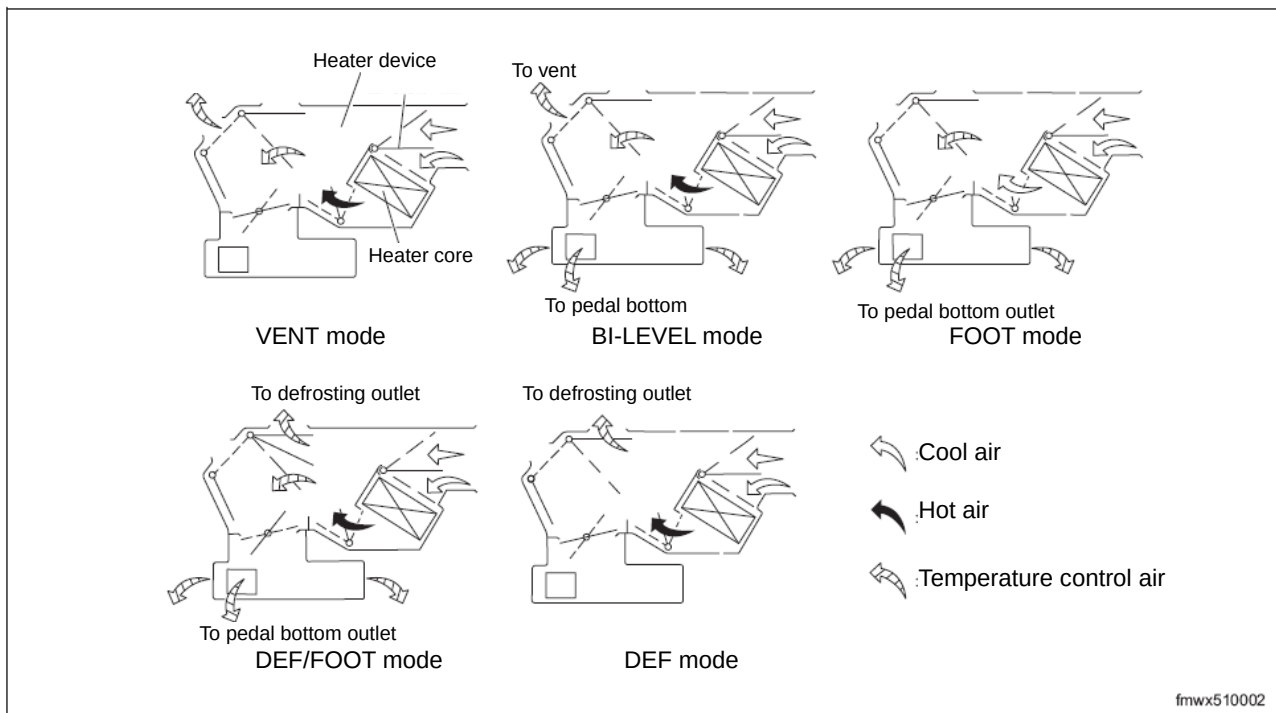
Control switch assembly

This vehicle is equipped with an electric switch assembly, which is used to control the air mixture door and mode air door of the heating device and internal & external circulation air door of the blower via the electric motor. The fan control device is used to control the air volume by adjusting four resistors from “1” (low) to “4” (high).

Ventilation

Set the internal and external circulation switch to “External Circulation” and start the blower fan. At this position, the air will be heated while fresh air will be introduced. The blower fan can deliver outside fresh air into the vehicle to ensue the sufficient ventilation.

Mode switch



The mode switch can be used to deliver the hot air from various outlets into the cabin.

- 1. Ventilation:** With the switch at this position, the air will be released from the upper vent. The air flow is controlled via the fan control knob.
- 2. Dual-level positive pressure ventilation:** With the switch at this position, the air flow will be divided between the upper outlet and pedal bottom outlet. The hot air is delivered to the floor outlet, while the cool air is delivered to the upper outlet.
- 3. Pedal bottom ventilation:** With the switch at this position, the air is only delivered to the pedal bottom.
- 4. Defrosting/Pedal bottom ventilation:** With the switch at this position, the air will be delivered to the pedal bottom, and about 30% of the total air flow will be delivered to the windshield.
- 5. Defrosting:** With the switch at this position, most of air is delivered to the windshield while the remaining air is delivered to the side window.

Internal and external circulation switch

This switch is used to control the introduction of external air and circulation of internal air. At pressing this switch, the air will be heated as quickly as possible with the blower mode door control deactivated. At this position, no external air will be delivered into the cabin.

Fan switch

This switch is used to control the speed of blower motor, and to regulate the air flow delivered to the defroster, pedal bottom and ventilating pipeline.

1. Low	2. Low-middle	3.Middle-high	4.High
--------	---------------	---------------	--------

Temperature control knob

With the temperature control knob at "Cool" (blue), the air mixture door will be closed to prevent the air from flowing to the heater core. With the knob at "Hot" (red), the mixture door will be opened to deliver the air to the heater core and heat the cabin. With the knob at the middle position, less or more air will be delivered to the heater core. Under this mode, it is allowed to adjust the cabin temperature.

Compressor

The compressor is mainly used to execute two functions:

It can compress the low-pressure and low-temperature coolant steam from the evaporator into high-pressure and high-temperature coolant steam and then deliver it to the condenser. In addition, it can be also used to pump coolant and coolant oil via the air conditioning system.

This vehicle is equipped with the rotating scroll type compressor (10S15C).

The rotating scroll of this type of compressor is fitted on the shaft. When the shaft is rotating, the rotating force of the plate will be turned into the reciprocating movement of the piston thus to suction and compress the coolant air.

The shaft seal (lip seal type) is fitted between the valve plate and shaft and cylinder head to avoid the leakage of coolant air. The compressor oil of a fixed volume is stored in the oil disc.

The compressor oil is delivered to the cylinder and bearing via the pump connected to the rotating scroll shaft.

As for certain compressors, the pressure difference generated between the suction and release in the operation, in lieu of the oil pump, will be utilized to fulfill the lubrication.

Furthermore, the compressor oil will be changed depending on the compressor model.

As for 10S15C, the required compressor oil volume is 120ml.

Never mix two or more kinds of oil products.

If the incorrect oil is used, the lubrication will be degraded to cause seizure or failure of the compressor.

The electromagnetic clutch adapter is waterproof.

Electromagnetic clutch

The compressor is driven via the drive belt of the engine crankshaft pulley. If the compressor is started each time the engine is started, the engine will be overloaded. The electromagnetic clutch transfers the engine power to the compressor, and will be started upon the activation of air conditioner while disconnected from the power supply upon the deactivation of air conditioner.

Condenser assembly

The condenser is located behind the headlamp, which is used to deliver the coolant to the cooling fin thus to realize the quick heat transfer.

In addition, it can also cool and liquidize the high-pressure and high-temperature steam from the compressor via the radiator fan or external air. The condenser failures include the leakage and clogging. In the case of clogging, the compressor discharge pressure will be increased; in the case of local clogging, the coolant will be rapidly expanded after it passes the position being clogged.

Therefore, immediately after the clogging, the icing or frosting will be invited. If the air flowing through the condenser or radiator is impeded, the high discharge pressure will be produced. During the normal operation of the condenser, the coolant outlet pipeline will be slightly cooler than the inlet pipeline.

This vehicle is provided with a parallel-flow type condenser. The large heat transfer zone on the inner surface of the pipeline may increase the radiant heat, while the air supply resistance will be correspondingly reduced.

Pressure switch

The pressure switch is fitted on the coolant pipeline, used to turn on or turn off the electromagnetic clutch where there is an irregular fluctuation of the coolant high or low pressure.

- Pressure on the low-pressure side: 0.2-0.4MPa;
- Pressure on the high-pressure side: 1.6-2MPa;

Evaporator

The evaporator is used to cool and dehumidify the air before it enters the air conditioner outlet. The high-pressure liquid coolant will enter the evaporator low pressure zone via the expansion valve. The heat of air flowing through the evaporator core will be lost on the surface of cooling device at the core thus to cool down the air. With the loss of heat between the air and evaporator core surface, the moisture inside the vehicle will be condensed on the evaporator core external surface and discharged in the form of water. In the case of evaporator failure, the supply of cool air will be reduced, which is usually caused by the local clogging due to pollution or by the failure of blower motor.

The evaporator with a multi-layer shutter is a single-layer box, and only one box is fitted beneath the core.

Expansion valve

The external pressure type expansion valve is adopted, located at the suction end of the evaporator.

Before the liquid coolant is delivered to the evaporator, the expansion valve will force the high-pressure coolant liquid to pass a small hole thus to transform the high-pressure coolant liquid from the receiver/dryer into the low-pressure gas coolant.

This expansion valve is composed of the temperature sensor, diaphragm, ball valve, valve seat, and spring adjusting screw.

The temperature sensor is in contact with the outlet pipeline of the evaporator, used to transform the temperature change into pressure and then transfer the pressure to the diaphragm upper chamber.

The coolant pressure is transferred to the diaphragm upper chamber via the external pressure equalizing pipe.

The ball valve is connected with the diaphragm. The openness of expansion valve is determined by the diaphragm pressure and spring pressure.

The expansion valve is used to regulate the coolant flow. Correspondingly, in the case of failures of the expansion valve, both the discharge and suction pressures will be reduced thus to degrade the cooling capacity of the evaporator.

Electronic thermostat

The thermostat is composed of the temperature sensor, and the thermostat device used to attenuate the system working noise via the electric circuits.

The electronic thermostat is located at the outlet of evaporator core, used to test the temperature of evaporator cool air. The temperature signal will be transferred to the thermostat device and then to the output terminal after the comparison with the thermostat, thus to activate the compressor relay and change the electromagnetic clutch switch to "ON" or "OFF" position to prevent defrosting of the evaporator.

The characteristic of the sensor consists in that the resistance will be reduced when the temperature is increased, vice versa.

Coolant pipeline

In the case of following conditions, the coolant pipeline is clogged:

1. **Suction pipeline: If the suction pipeline is clogged, the compressor suction and discharge pressures will be reduced to degrade the cooling capacity or disable the cooling device.**
2. **Discharge pipeline: If the discharge pipeline is clogged, the leakage will be In general caused.**
3. **Liquid pipeline: If the discharge or suction pressure is low and the cooling capacity is insufficient, the liquid pipeline is clogged.**

The coolant hose exhibiting low infiltration rate of coolant and water can be applied. On the inside surface of such hoses, a special nylon layer is provided.

PRECAUTIONS

When servicing the air conditioning system, relevant specifications, rules and Precautions must be observed.

- Keep the working zone clean.
- Do wear safety glasses and gloves when handling the cooling system.
- Pay attention to CO smoke at the engine start.
- Pay attention to the coolant from the enclosed or poorly ventilated garage.
- Always turn off the master power supply, and discharge and collect the coolant when servicing the air conditioning system.
- When discharging and collecting the coolant, do not release the coolant too quickly; otherwise the compressor oil may be removed from the system.
- Release the moisture and pollutant in the system. Immediately after any pipeline or component is removed, close the union with plug or cap.
- Do not remove the cap or plug prior to the reconnection or refitting operation.
- When disconnecting or reconnecting the pipeline, use two spanners to support the pipeline union to avoid twisting or other damages.
- Each time the union is removed, the new O-shaped ring must be always fitted.
- Prior to the connection of any hose or pipe, apply the O-shaped ring with the required new compressor oil.
- The compressor oil (PAG) used will be changed depending on the compressor model. Do apply the oil designated for the compressor model.
- When removing and replacing the component which requires the full discharge of coolant circuit, perform the operations stipulated in this chapter as per the following sequence:
 1. **Fully discharge and collect the coolant in the coolant recycling/reutilizing/refilling system or similar device.**
 2. **Remove and replaced damaged parts.**
 3. **After the discharge, refill coolant into the air conditioning system and check the leakage.**

The coolant is a chemical compound and requires special management to avoid personal injuries.

- Always wear safety glasses and gloves.
- Always work in well-ventilated environments. Never perform any welding or steam cleaning operations on the on-board air conditioner pipeline or components (or within their immediate areas).
- In the case of contact between R-134a and human body, immediately wash the body part concerned with cold water and seek for medical service.
- Where the R-134a vessel is to be transported or handled by the vehicle, do not store it in the cabin.
- Where the R-134a is to be transferred from a large vessel into a small one, never fill up the latter, but an expansion space shall be reserved above the level.
- Store the R-134a vessel at the temperature lower than 40°.

Warning:

- **When your eyes are in contact with R-134a, see the doctor immediately.**
- **Do not touch the eye contaminated by R-134a, but wash it with a lot of clean cool water to increase the coolant temperature to the value above the freezing point.**
- **Seek for correct medical service as much as possible. If your skin is contaminated by R-134a, provide medical treatment in the same way with the frostbite.**



TABLE OF FAULT PHENOMENA

The table below can assist you to find the failure. The number represents the sequence of occurrence of possible failures. Check each part as per this sequence, and provide replacement if necessary.

The heater doesn't heat the air.

Symptoms of failure	Possible causes	Reference made to
No heating	1. Engine cooling liquid (low level)	Refill the coolant.
	2. Air mixture door (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Heater
	3. Air mixture door motor (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Heater
	4. Air duct (clogged)	Clear up the duct
	5. Blower (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Blower
	6. Heater core and/or hose (clogged)	Chapter 51: Service, Air Heater and Air Conditioner- Heater
	7. Engine (low water temperature)	Service the engine cooling system
	8. Air duct/hose (not aligned)	Refit the air duct/hose
Over-heating	1. Air mixture door (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Heater
	2. Air mixture door motor (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Heater
	3. Engine (over-heat)	Service the engine cooling system

The noise of heating system is high.

Symptoms of failure	Possible causes	Reference made to
Clucking	1. Engine liquid (low level)	Chapter 51: Service, Air Heater and Air Conditioner- Coolant
	2. Engine (over-heat)	Service the engine cooling system

The cooling system doesn't cool the air.

Symptoms of failure	Possible causes	Reference made to
No or insufficient cooling capacity	1. Electromagnetic clutch (no working)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	2. Electromagnetic clutch plate (contaminated and skidding)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	3. Drive belt (loosened or broken)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	4. Compressor (seized)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	5. Freezing oil (leakage)	Chapter 51: Service, Air Heater and Air Conditioner- Coolant
	6. Coolant (too little or too much)	Chapter 51: Service, Air Heater and Air Conditioner- Coolant
	7. Cooling system (leakage)	Chapter 51: Service, Air Heater and Air Conditioner- Air Conditioner Pipe
	8. Condenser (clogged or insufficient heat dispersion)	Chapter 51: Service, Air Heater and Air Conditioner- Condenser
	9. Temperature control knob (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Air Conditioner Control Switch
	10. Air mixture door motor (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Heater
	11. Air mixture door (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Heater
	12. Expansion valve (clogged)	Chapter 51: Service, Air Heater and Air Conditioner- Evaporator
Low air flow rate	1. Evaporator (clogged or frosted)	Chapter 51: Service, Air Heater and Air Conditioner- Evaporator
	2. Air duct (air leakage)	Replace the air duct
	3. Blower (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Blower

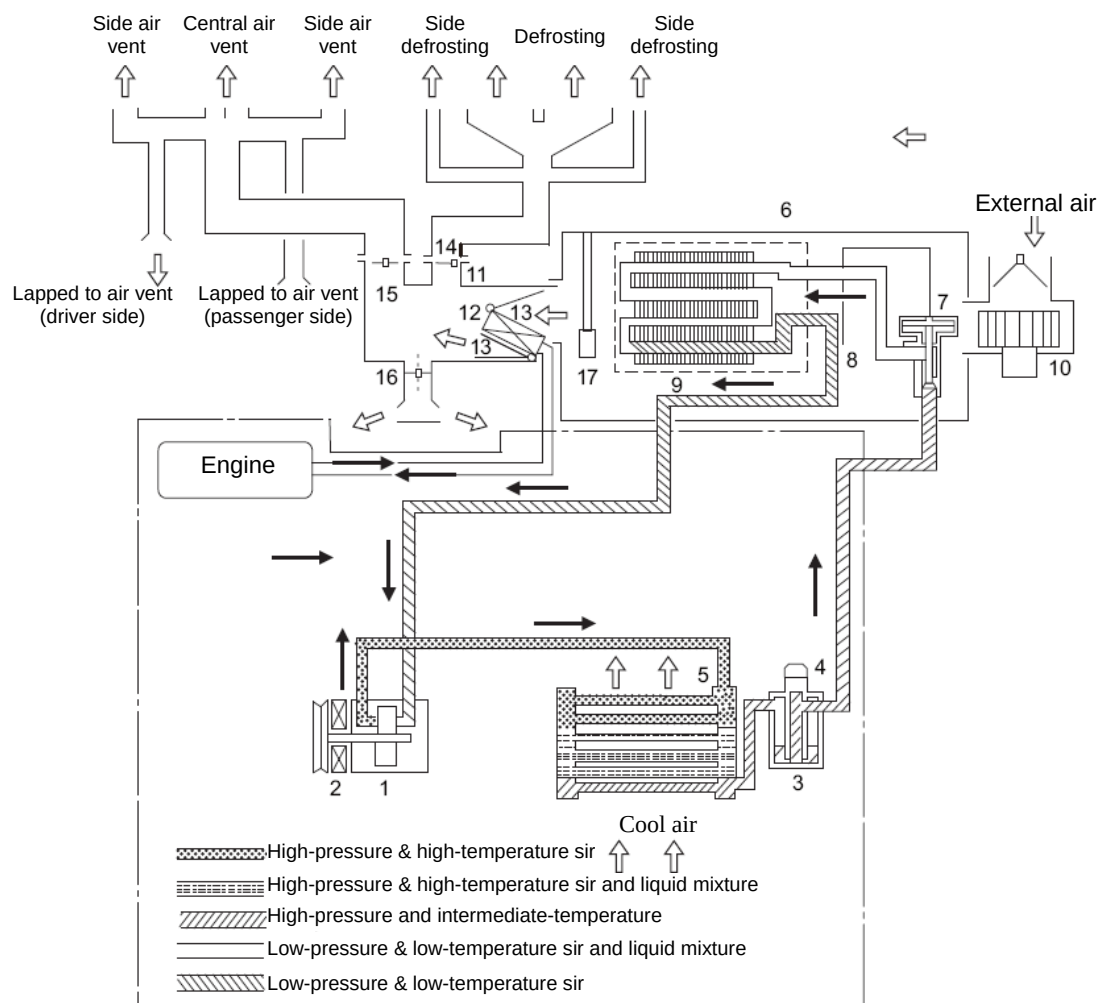
The cool air is supplied discontinuously.

Symptoms of failure	Possible causes	Reference made to
The air is supplied discontinuously	1. Blower (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Blower
	2. Air duct (clogged)	Clear up the air duct
The compressor works discontinuously	1. Belt (skidding)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	2. Electromagnetic clutch (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	3. Compressor (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	4. Three-state pressure switch (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Liquid Reservoir
The blower and compressor work normally but the cool air is supplied discontinuously	1. Temperature sensing probe (loosened)	Chapter 51: Service, Air Heater and Air Conditioner- Evaporator
	2. Expansion valve (clogged by ice)	Chapter 51: Service, Air Heater and Air Conditioner- Evaporator
	3. The system is clogged by the foreign matter in an intermittent way	Clear up or replace the pipeline in question

The noise of cooling system is high

Symptoms of failure	Possible causes	Reference made to
External noise of the system	1. Belt (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	2. Compressor bracket (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	3. Compressor (damaged)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	4. Electromagnetic clutch (skidding)	Chapter 51: Service, Air Heater and Air Conditioner- Compressor
	5. Freezing oil (too little or none)	Chapter 51: Service, Air Heater and Air Conditioner- Freezing oil
	6. Blower (damaged)	Chapter 51: Service, Air Heater and Air Conditioner-Blower
Internal noise of the system	1. Coolant (too much or too little)	Chapter 51: Service, Air Heater and Air Conditioner-Coolant
	2. Expansion valve (water in the system)	Chapter 51: Service, Air Heater and Air Conditioner-Evaporator
	3. Compressor vibration (the high pressure is too high)	Chapter 51: Service, Air Heater and Air Conditioner-Coolant

WORKING PRINCIPLE



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1	Compressor
2	Electromagnetic clutch
3	Receiver/dryer
4	Pressure switch
5	Condenser
6	Evaporator assembly
7	Expansion valve
8	Temperature sensor
9	Evaporator core

10	Blower motor
11	Heater
12	Heater core
13	air mixture door
14	Defrosting mode air door
15	Ventilating mode air door
16	Heating mode air door
17	Electronic thermostat

With the repeated transformation between liquid and gas in the circulation, the coolant will undergo the following four courses:

Evaporation

The coolant is transformed into gas from liquid in the evaporator. The coolant in the evaporator will be evaporated quickly, and the liquid coolant will remove a certain amount of heat (potential heat) from the air in the immediate area of the evaporator cooling fin and be evaporated rapidly. The elimination of heat will cool down the air and the cooled air will in turn give off from the cooling fin to cool down the inside temperature.

Both coolant liquid and gas from the expansion valve will be delivered into the evaporator, and the liquid is then transformed into gas.

With the change from liquid to gas, the pressure in the evaporator must be maintained as low as possible to satisfy requirements for evaporation at low temperature. Thus, the evaporated coolant will be absorbed into the compressor.

Compression

The coolant is compressed in the compressor to become high-temperature & high-pressure gas coolant. The coolant evaporated in the evaporator is suctioned into the compressor, which can maintain the coolant in the evaporator at low pressure to facilitate the evaporation, even if the temperature is approximately 0°C.

In addition, the coolant absorbed by the compressor will be also compressed in the compressor cylinder to increase the pressure and temperature such that the coolant can be liquidized at the room temperature.

Condensation

The coolant in the condenser is cooled down via the external air and gas-liquid transformation. The high-temperature & high-pressure gas from the compressor is gradually cooled and liquidized under the action of the external air and then output in the form of intermediate-temperature & high-pressure gas-liquid mixture and stored in the dryer. The heat generated in the process during which the high-temperature & high-pressure air in the compressor is dispersed in the external air is called condensation heat. That is all of the heat removed from the vehicle inside by the coolant via the evaporator and compressor.

Expansion

The expansion can reduce the pressure of coolant liquid to facilitate the evaporation. The expansion is such a process that the pressure of the liquid coolant is reduced before its delivery to the evaporator thus to accelerate the evaporation. Furthermore, the expansion valve can also control the coolant flow rate whilst reducing the coolant pressure.

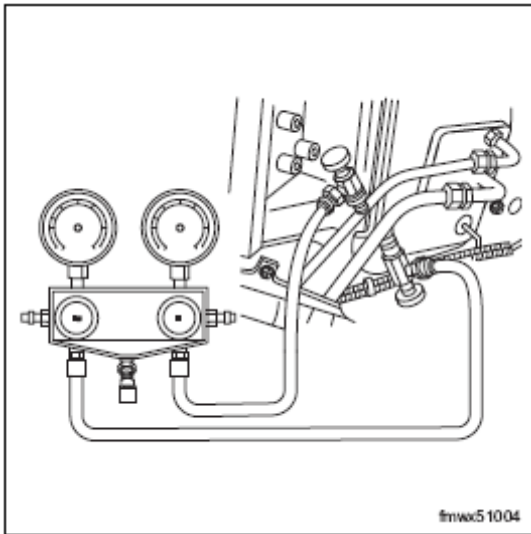
In another word, the volume of coolant as evaporated in the evaporator is determined by the heat which must be removed at the required evaporation temperature. It is important that the coolant volume must be correctly and precisely controlled.

TESTING AND ADJUSTMENT

Use the manifold pressure gauge to test the cooling system.

Testing conditions:

- Ambient temperature: 25-30°C
- The engine runs at idle speed.
- The air conditioner switch is at ON.
- The blower motor runs at "4" (high).
- The temperature control knob is set at "coolest" position.
- The internal and external circulation switch is located at "Internal Circulation" position.
- All air doors are closed.



Connect the manifold pressure gauge

Low-pressure side:

About 20-40MPa

High-pressure side:

About 160-200MPa

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Results	Symptoms	Causes	Remedies
The reading from the high-pressure side pressure gauge is abnormally high.	The air flow passing through the condenser is reduced or eliminated.	• The condenser is clogged or contaminated.	• Clean the condenser.
	After the condenser is cooled, no air bubbles are found via the sight glass (the cooling efficiency is low).	• There is too much coolant in the system.	• Check the sight glass. • Release and collect the coolant, and then refill the coolant to the required level.
	After the air conditioner is stopped, the pressure drops quickly.	• There is air in the system.	• Release and refill the coolant.
The reading from the high-pressure side pressure gauge is abnormally low.	The cooling efficiency is low and too many air bubbles are found via the sight glass.	• There is insufficient coolant in the system.	• Check the sight glass. • Check leakage. • Release and collect the coolant, and then refill the coolant to the required level.
	The low-pressure gauge indicates the vacuum.	• The expansion valve is clogged or damaged.	• Replace the expansion valve.

Results	Symptoms	Causes	Remedies
	The frost or dew is found on the coolant pipe in front of and behind the dryer or expansion valve, and the low-pressure gauge indicates the vacuum.	The impurities or moisture in the dryer cause clogging.	Check the system for clogging and if necessary replace it.
	Immediately after the air condition is stopped, the high-pressure gauge is balanced.	- The compressor seal is damaged. - The compressor gasket is damaged to cause the insufficient compression.	Replace the compressor.
The reading from the low-pressure side pressure gauge is abnormally high.	When the condenser is cooled with water, the reading on the low-pressure gauge is reduced.	There is too much coolant in the system.	Release and collect the coolant, and then refill the coolant to the required level.
	The temperature of the low-pressure hose close to the union of compressor coolant pipe is lower than that of the low-pressure hose.	The valve works inefficiently due to damages of the expansion valve temperature sensor.	Replace the expansion valve.
	After the air conditioner is stopped, the high-pressure gauge is soon balanced.	The compressor gasket is damaged.	Place the compressor.
	The air conditioner stops working before the cabin is sufficiently cooled down.	The electronic thermostat is damaged.	Check the thermostat, and if necessary, replace it.
The low-pressure side pressure is abnormally low.	The condenser is not hot, and too many bubbles are found via the sight glass.	There is insufficient coolant.	- Check the sight glass. - Check leakage. - Release and collect the coolant, and then refill the coolant to the required level.
	The frost or dew is found at the expansion valve inlet pipeline.	The expansion valve is clogged.	Replace the expansion valve.
	There is a significant temperature difference between coolant inlet and outlet pipes of the dryer.	The dryer is clogged.	Replace the dryer.
The low-pressure side pressure is abnormally low.	The coolant pipe of expansion valve outlet fails to cool the air, and the low-pressure gauge indicates the vacuum.	The expansion temperature sensor is damaged, and the valve can't regulate the coolant flow correctly.	Replace the expansion valve.
	The discharge temperature is low and the air at the vent is impeded.	The evaporator core is frozen.	Check the electronic thermostat, and if necessary, replace it.

Results	Symptoms	Causes	Remedies
	The low-pressure gauge indicates low value or vacuum.	The coolant pipeline is clogged.	Replace the coolant pipe.
The pressures on both low-pressure side and high-pressure side are abnormally high.	After the condenser is cooled with water, no air bubbles are found via the sight glass (the cooling is inefficient).	There is too much coolant in the system.	- Check the sight glass. - Release and collect the coolant, and then refill the coolant to the required level.
	The air flowing through the condenser is reduced.	The air passing through the condenser is reduced.	Clean the condenser.
	The hose on the suction (low-pressure) side is not cool.	There is air in the system.	Release and collect the coolant, and then refill the coolant to the required level.
The pressures on both low-pressure side and high-pressure side are abnormally low.	The cooling is inefficient and too many bubbles are found via the sight glass.	There is insufficient coolant in the system.	- Check the sight glass. - Release and collect the coolant, and then refill the coolant to the required level.

Read the sight glass

Temperature of high and low pressure pipe	Status of sight glass	State of air conditioning cycle
The high-pressure pipeline is hot while the low-pressure pipeline is cold, showing a significant temperature difference.	Nearly transparent; the flowing air bubbles are visible, but they disappear after the throttling valve is turned on. 	Qualified
The high-pressure pipeline is hot while the low-pressure pipeline is cold, showing a minor temperature difference.	Flowing air bubbles are always visible. They are sometimes transparent and sometimes numerous. 	Unqualified (insufficient coolant)
There is almost no temperature difference between the high-pressure pipe and low-pressure pipe.	The mist is indistinctly visible. 	Unqualified (nearly no coolant)
The high-pressure pipeline is very hot and the low-pressure pipeline is slightly hot, showing a significant temperature difference.	Even if the fan is turned to "4" (all windows are opened) at idle speed, bubbles are transparent. 	Unqualified (too much coolant)

The sight glass can only provide an accurate diagnosis under following conditions. If the vehicle is tested under such conditions, check the appearance of sight glass and compare it with the graph.

- The engine runs at idle speed.
- The air conditioner switch is turned on.
- The blower fan works at the max speed.
- The internal and external circulation switch is set at "Internal Circulation".
- The temperature control knob is set at the max. cool position.
- The ambient temperature is lower than 30°C and the relative humidity is lower than 70%.

Notice:

If it is not allowed to move the vehicle to the testing position satisfying those conditions described above, the sight glass can't be used for diagnosis. In such a case, the coolant must be discharged and collected, and then the system shall be refilled with the coolant to the required level. Thereafter, the testing of system performance can be continued.

- The pressure on the high-pressure side is lower than 1.6MPa.

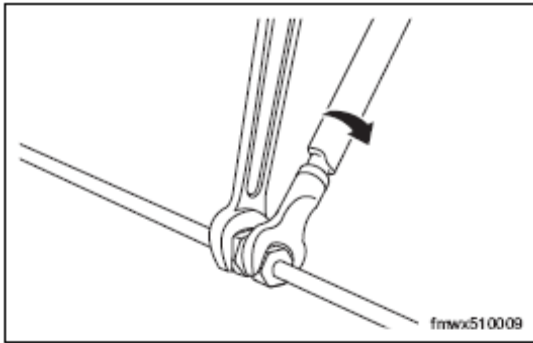
Notice:

If the pressure on the high-pressure side is higher than the designated value, the sight glass can't be used for diagnosis. In such a case, the coolant must be discharged and collected, and then the system shall be refilled with the coolant to the required level. Thereafter, the testing of system performance can be continued.

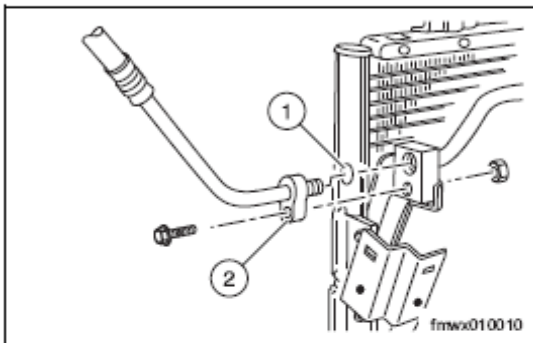


Servicing of coolant leakage

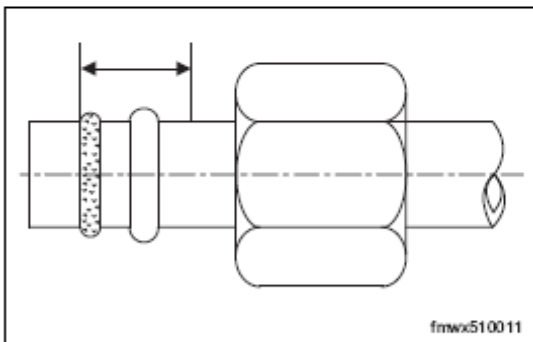
Connection of coolant pipeline



If necessary, fit a new O-shaped ring. When connecting or disconnecting the pipeline, use two spanners to prevent twisting or damages of connectors.



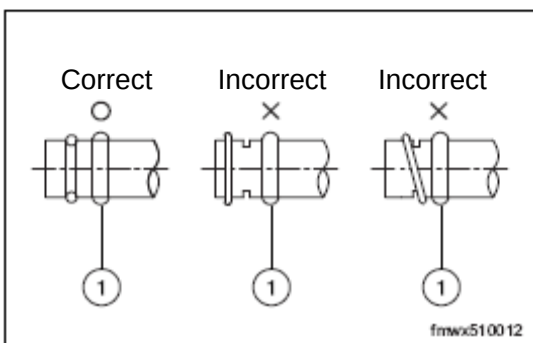
When connecting the coolant pipe at the section union, insert the projection of the part to be connected into the connecting hole on the device side, and fasten it with bolts.



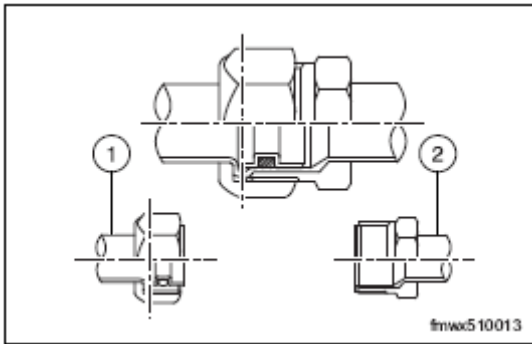
Prior to connection, apply the dedicated compressor oil onto the O-shaped ring.

Notice:

The compressor (PAG) oil used will be changed depending on the compressor model. The compressor oil designated for the compressor model in question must be applied.



The O-shaped ring (1) must be aligned with the raised part of the coolant pipeline.



Insert the nut (2) into the union (1). At first, use the hand to fasten the nut as much as possible, and then fasten the nut with the required torque.

Leakage of coolant pipeline union

1. Check the torque of coolant pipeline union; if too loose, fasten it to the required torque.

Notice:

Use two spanners to avoid twisting or damaging the pipeline.

Notice:

Do not fasten the union too tightly.

2. Perform a leakage test at the union of the coolant pipeline.
3. If the leakage remains there, release and collect the coolant in the system.
4. Replace the O-shaped ring.

Notice:

Once the O-shaped ring is removed, no further use is allowed.

Notice:

Do apply the designated compressor oil onto the new O-shaped ring.

5. Fasten the coolant pipeline union to the required torque.

Notice:

Use two spanners to avoid twisting or damaging the pipeline.

6. Discharge, refill and re-test the system.

Leakage of hose

If the leakage occurs at the inlet or outlet hose of the compressor, the whole hose must be renewed. It is not allowed to cut or divide the coolant hose for servicing purposes.

1. Find out the leakage position.
2. Discharge and collect the coolant.
3. Remove the hose assembly.

Notice:

Immediately cover the union opening.

4. Connect the new hose assembly.

Notice:

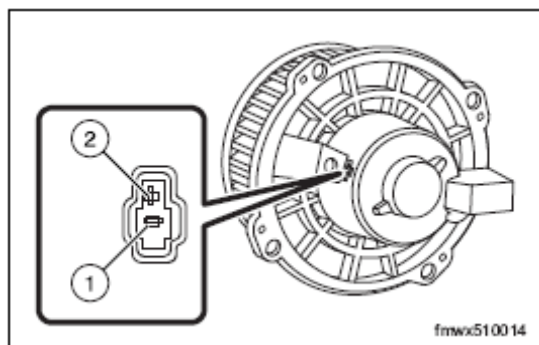
Use two spanners to avoid twisting or damaging the pipeline.

5. Discharge, refill and test the system.

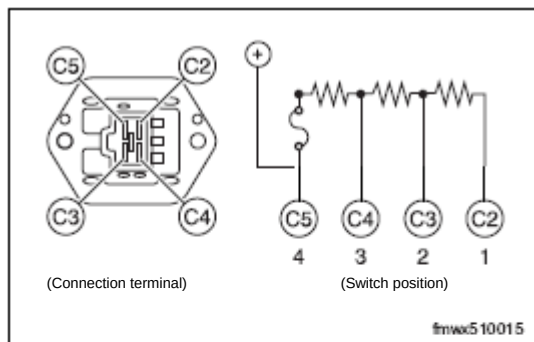
Leakage of compressor

If the leakage is close to the compressor oil seal or housing, the compressor shall be replaced.

Blower motor



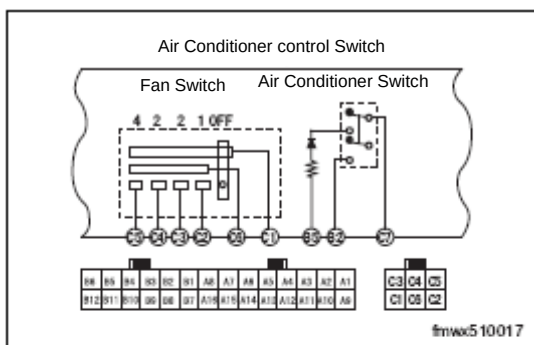
1. **Disconnect the connector of blower motor from the blower motor.**
2. **Connect the battery positive terminal to the blower motor terminal 1, and the negative terminal to the motor terminal 2.**
3. **Do check whether the blower motor works normally.**

Resistor

1. Disconnect the resistor union.
2. Check the connection and resistance between resistor terminals.

Terminal Switch position	C1	C2	C3	C4	C5	Resistance 24V
1	○	○				Connected
2	○		○			Connected
3	○			○		Connected
4	○				○	Connected

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Fan control knob and air conditioner switch

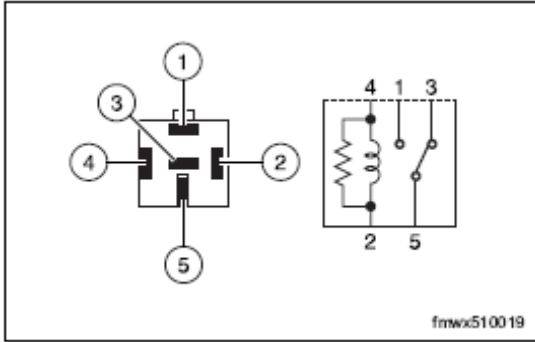
1. Check the connection between connecting terminals on the side of the fan switch and air conditioner.

Terminal Switch position	C1	C2	C4	C6	C3	C5	B3	B3	B7
OFF									
1	○	○							
2	○		○						
3	○			○					
4	○				○				
Air Conditioner Switch									
OFF									
ON							○	○	○

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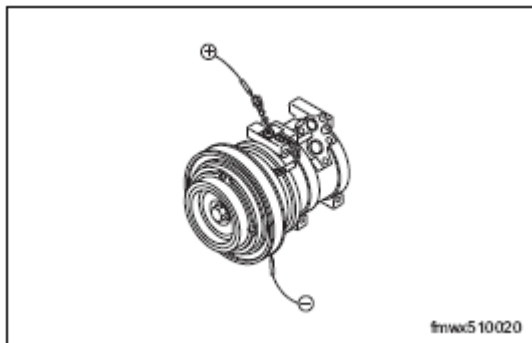
Air conditioner compressor and condenser relay



1. Check the connection between connecting terminals on the relay side.

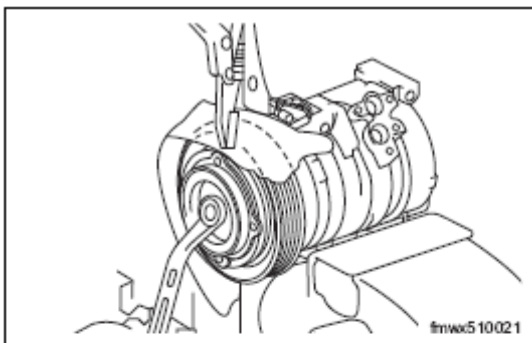
Terminal measured	Whether the battery voltage is applied between 2 and 4	Whether connected
3-5	No	Yes
1-5	No	No
3-5	Yes	No
1-5	Yes	Yes

Electromagnetic clutch

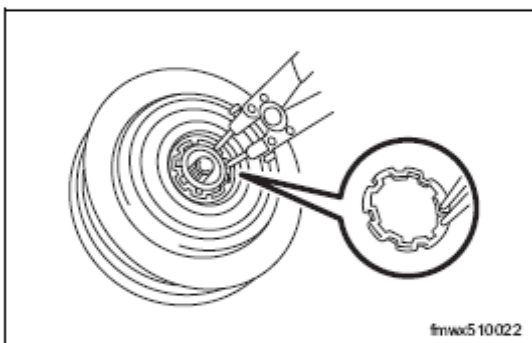


1. Disconnect the connector of electromagnetic clutch wires.
2. Apply the battery voltage onto the connecting terminal on the clutch side, and check whether the electromagnetic clutch is suctioned on the pulley.

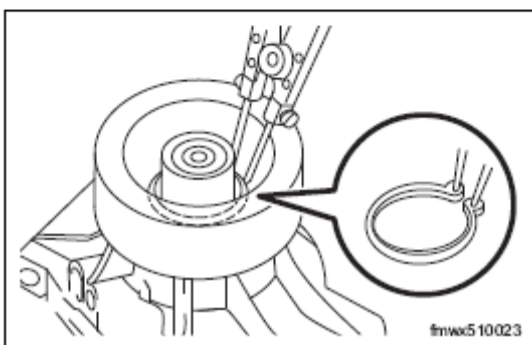
Adjustment of clearance of electromagnetic clutch



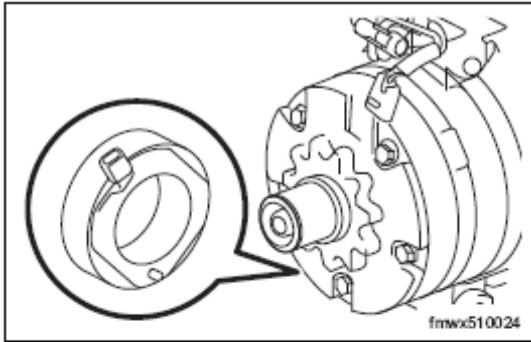
1. Place the clutch on the bench vice.
2. Use the vice to fix the clutch.
3. Remove the bolt and pressure plate.



4. Use the clip pliers to remove the clip, and remove the pulley.



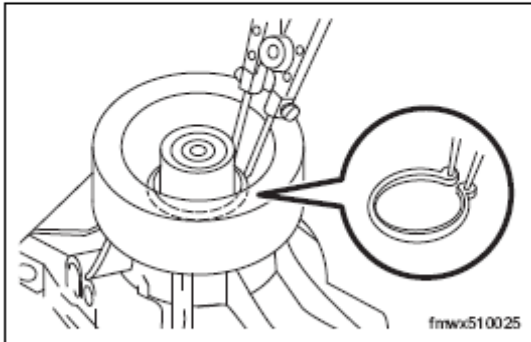
5. Use the clip pliers to remove the clip, and remove the magnet.



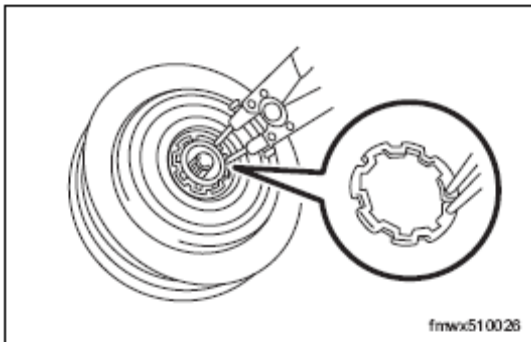
6. Fit the magnet.

Notice:

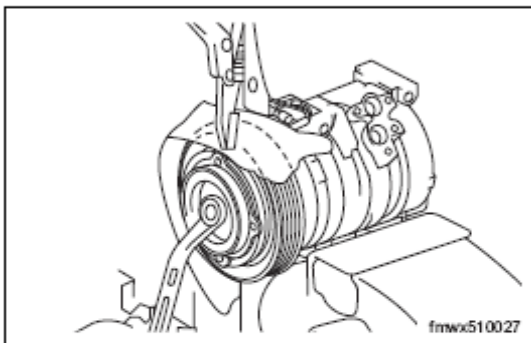
Align the mounting marks.



7. Fit a new clip.

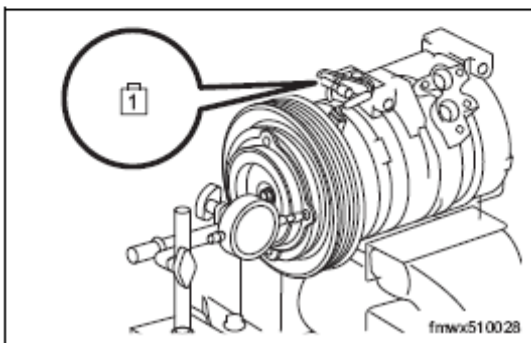


8. Fit the pulley, and install a new clip.



9. Fit the compressor onto the bench vice.

10. Use the vice to fix the clutch and then fasten the bolt.



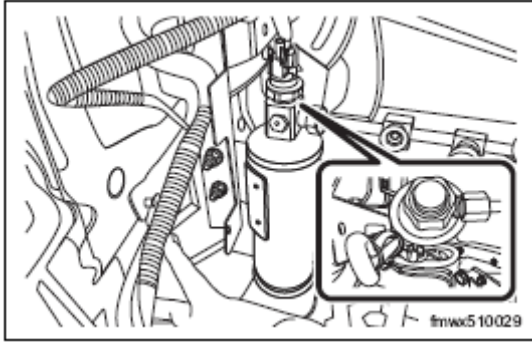
11. Measure the clearance by connecting and disconnecting the clutch, and align the mounting mark.

Standard value: 0.35-0.60mm.

If the measured value is beyond the standard range, remove the pressure plate and adjust the pulley.

Notice:

At least 3 measurements must be performed.

Pressure switch

1. Fit a manifold pressure gauge onto the pipeline.
2. Connect the multi-meter (at ohm position) to the pressure switch. When the cooling system pressure changes, check the connection between pins as indicated in the figure.
3. If the operation doesn't conform to relevant standard, replace the pressure switch.

Pressure on the high-pressure side, at idle speed	1.6-2MPa
Pressure on the low-pressure side, at idle speed	0.2-0.4MPa

Electronic thermostat

1. Turn the mode switch to "Vent" and the internal and external circulation switch to "Internal Circulation", thus to start the air conditioner.
2. When turning the temperature control knob from "Coolest" to "Hottest", check whether the electromagnetic is opened or closed.

Notice:

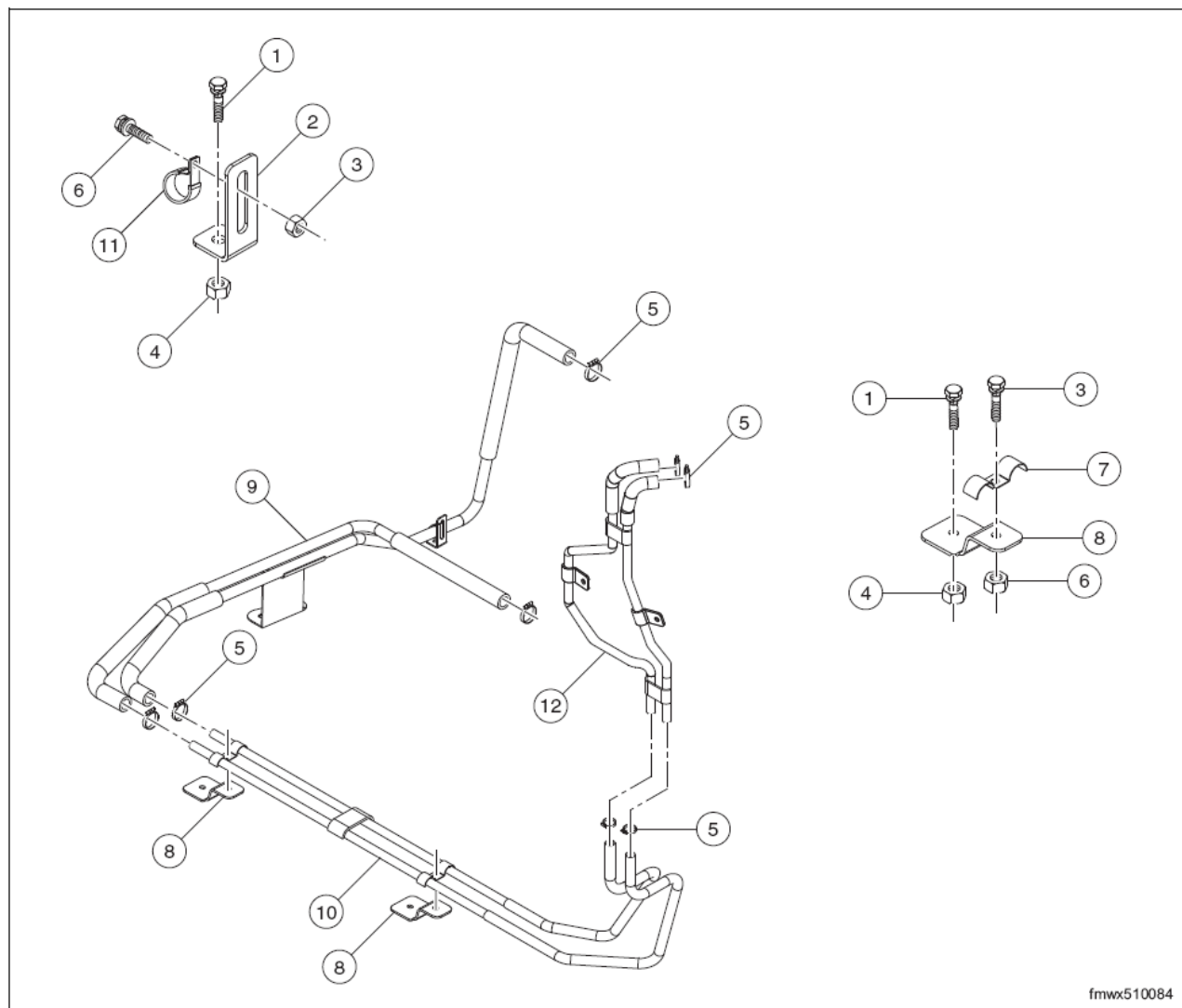
The time elapse to reach "closing" point depends on the $35\pm0.5^{\circ}\text{C}$ cool or hot air detected by the temperature sensor of the electromagnetic thermostat.

3. When the clutch is opened or closed, measure the voltage between terminals 1 and 2 on the chassis side.

Terminal No.	Electromagnetic clutch	Voltage
1-2	Opened	0V
	Closed	Battery voltage

AIR HEATER WATER PIPE

DIAGRAM OF COMPONENTS



1	Hexagon bolt, spring washer and plain washer assembly
2	Pipeline bracket
3	Hexagon bolt, spring washer and plain washer assembly
4	Hexagon flanged nut
5	C-shaped worm drive type hose clip
6	Hexagon flanged nut

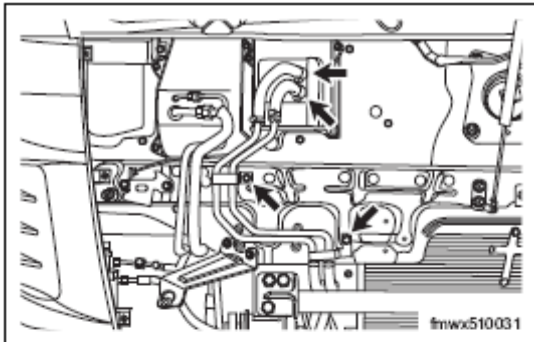
7	Bracket
8	Bracket
9	Chassis air heater pipeline assembly
10	Chassis air heater pipeline assembly
11	Single pipe clamping plate
12	Hexagon bolt, spring washer and plain washer assembly

SERVICE

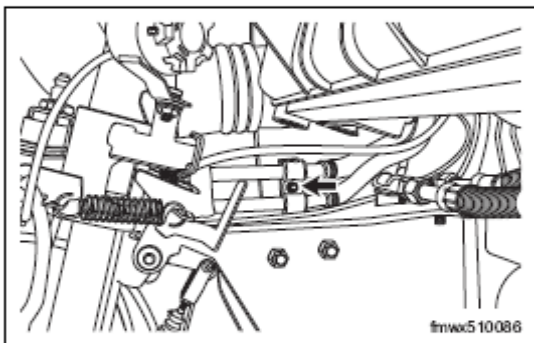
Hint:

As for the Diagram of Components, refer to Chapter 51: Diagram of Components, Front Suspension-Air Heater Water Pipe.

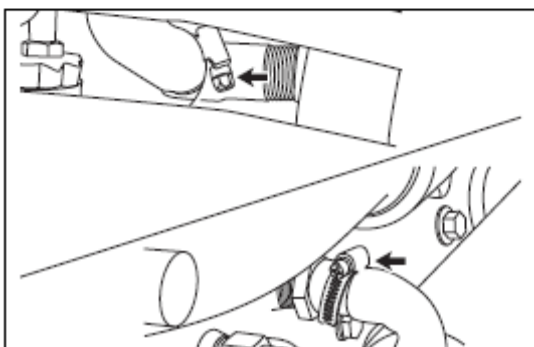
1. **Discharge the anti-freezing liquid. Refer to Chapter 14: Testing and Adjustment, Cooling-Cooling System.**
2. **Open the front cover.**



3. **Remove the air heater water pipe.**
 - (a) Remove the air heater water pipe hoop.
 - (b) Remove the water pipe lock bolt.



- (c) Remove the lock bolt of engine compartment air heater water pipe.

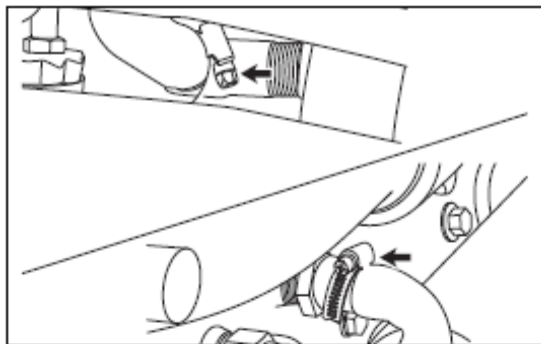


- (d) Disconnect the air heater water pipe on the engine, and remove the front shock absorber.

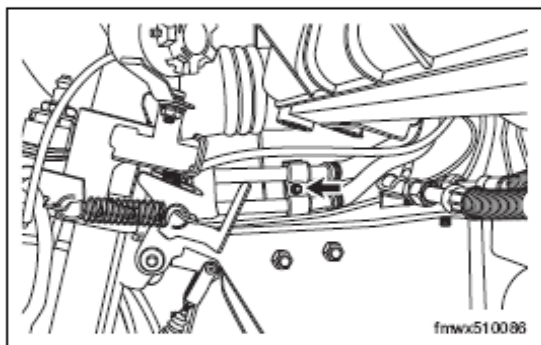
4. **Check the air heater water pipe.**
 - (a) Check whether the hose is cracked, damaged or aged.
 - (b) Check whether the pipe is rusted or damaged.

Notice:

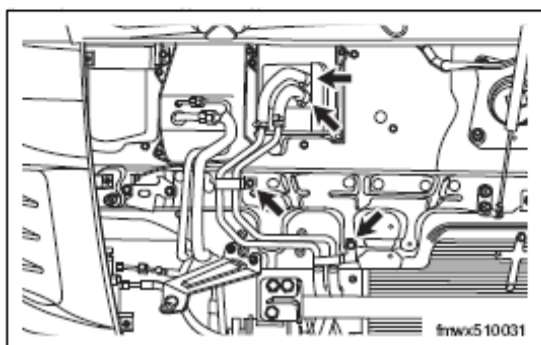
If any abnormality is detected, replace the pipe.



- 5. Fit the air heater water pipe.**
(a) Fit the water pipe onto the engine.



- (b) Fit the lock bolt of engine compartment air heater water pipe.



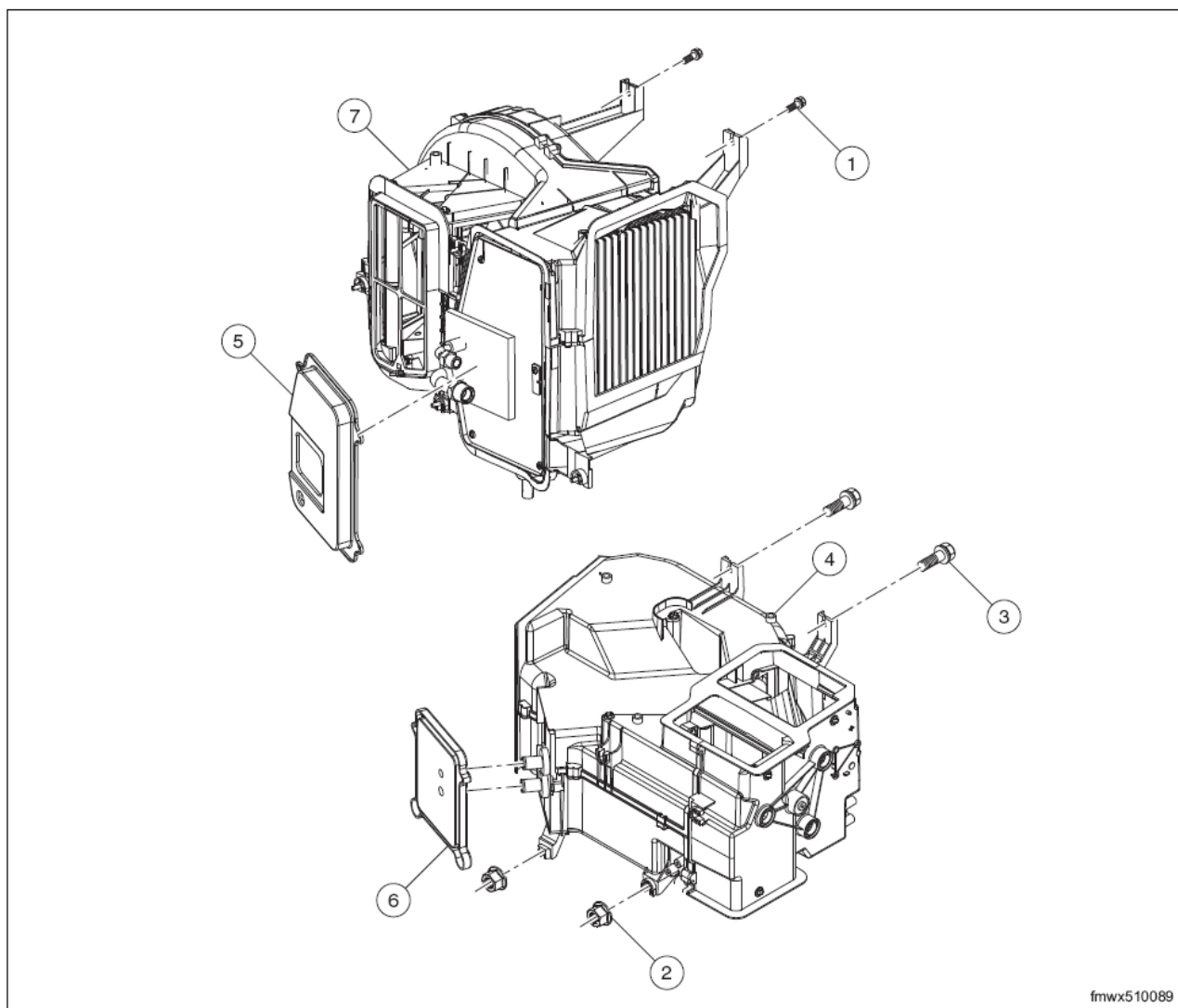
- (c) Fit the lock bolt of air heater water pipe.
(d) Fit the air heater water pipe hoop.

- 6. Close the front cover.**
7. Fill anti-freezing liquid. Refer to Chapter 14: Testing and Adjustment, Cooling-Cooling System.



HEATER

DIAGRAM OF COMPONENTS



1	Hexagon bolt, spring washer and plain washer assembly
2	Hexagon flanged nut
3	Hexagon bolt, spring washer and plain washer assembly
4	Air heater assembly

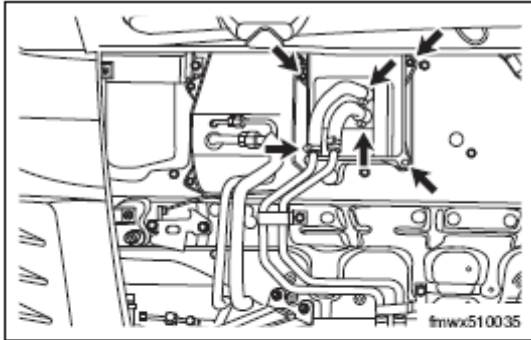
5	Evaporator pipeline shield
6	Air heater water pipe shield
7	Blower assembly

SERVICE

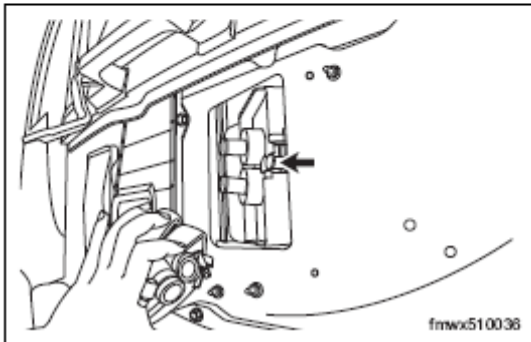
Hint:

As for the Diagram of Components, refer to Chapter 51: Diagram of Components, Air Heater and Air Conditioner-Heater.

1. Turn off the power master switch.
2. Discharge the anti-freezing liquid. Refer to Chapter 14: Testing and Adjustment, Cooling-Cooling System.
3. Open the front cover.

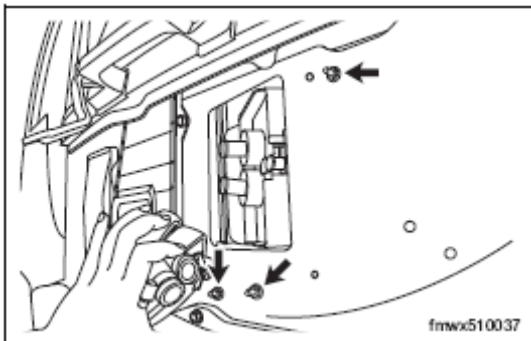


4. Remove the heater core.
 - (a) Disconnect the air heater pipe.
 - (b) Remove the heater core cover plate.

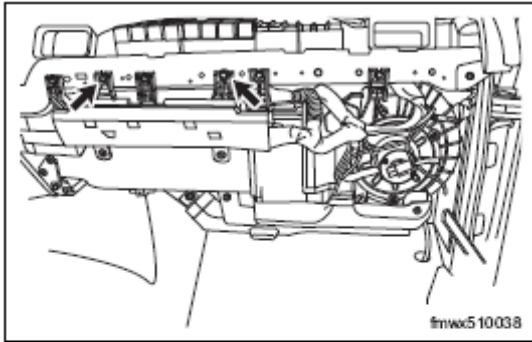


- (c) Remove the heater core lock bolt.
 - (d) Remove the heater core.

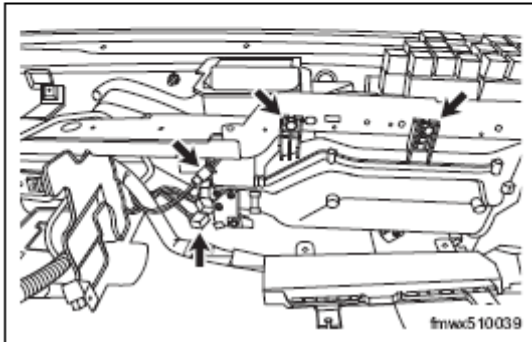
5. Check the heater core.
 - (a) Check whether the heater core fin is damaged.
 - (b) Check whether the heater core is clogged by foreign matters.
 - (c) Fill cooling liquid into the heater core, and check the core for leakage.



6. Remove the heater assembly.
 - (a) Remove the lock nut of heater.



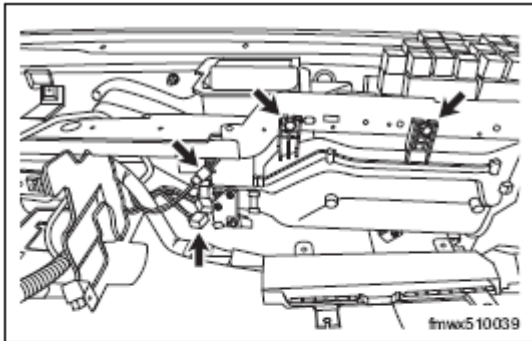
- (b) Remove the wires.
- Remove the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.
 - Remove the lock bolt for wires.



- (c) Remove the heater lock bolt.
- (d) Disconnect the connector of air mixture door motor wires.
- (e) Remove the heater.

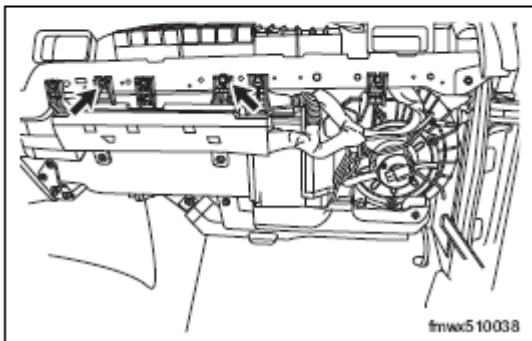
7. Check the heater housing.

- (a) Check whether the heater housing is damaged.
- (b) Check whether the heater air mixture door is damaged.
- (c) Check whether the door pivot is displaced.
- (d) Check whether the heater air door motor is damaged.

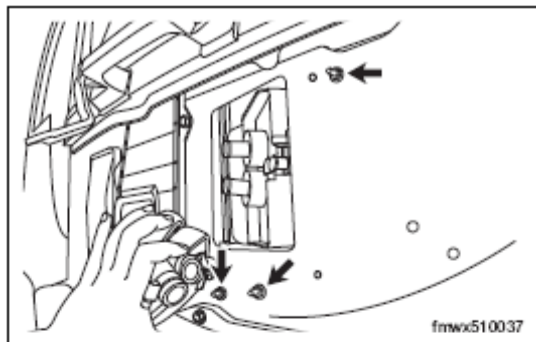


8. Fit the heater assembly.

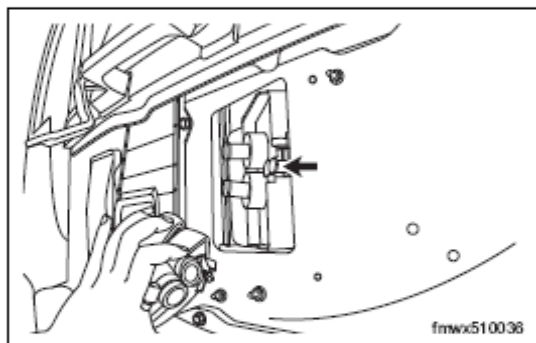
- (a) Fit the heater lock bolt.
- (b) Connect the connector of air mixture door motor wires.



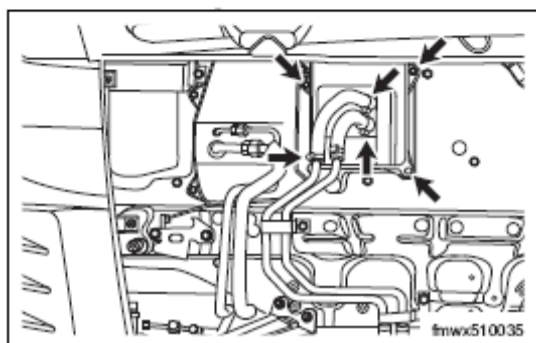
- (c) Fit wires.
- Fit the wire lock bolt.
 - Fit the instrument panel. Refer to Chapter 73: Service, Dashboard/ Instrument Panel/ Cigarette Igniter- Dashboard.



9. Fit the heater assembly.
- (a) Fit the heater assembly lock bolt.



- (b) Fit the heater core.
- (c) Fit the heater core lock bolt.



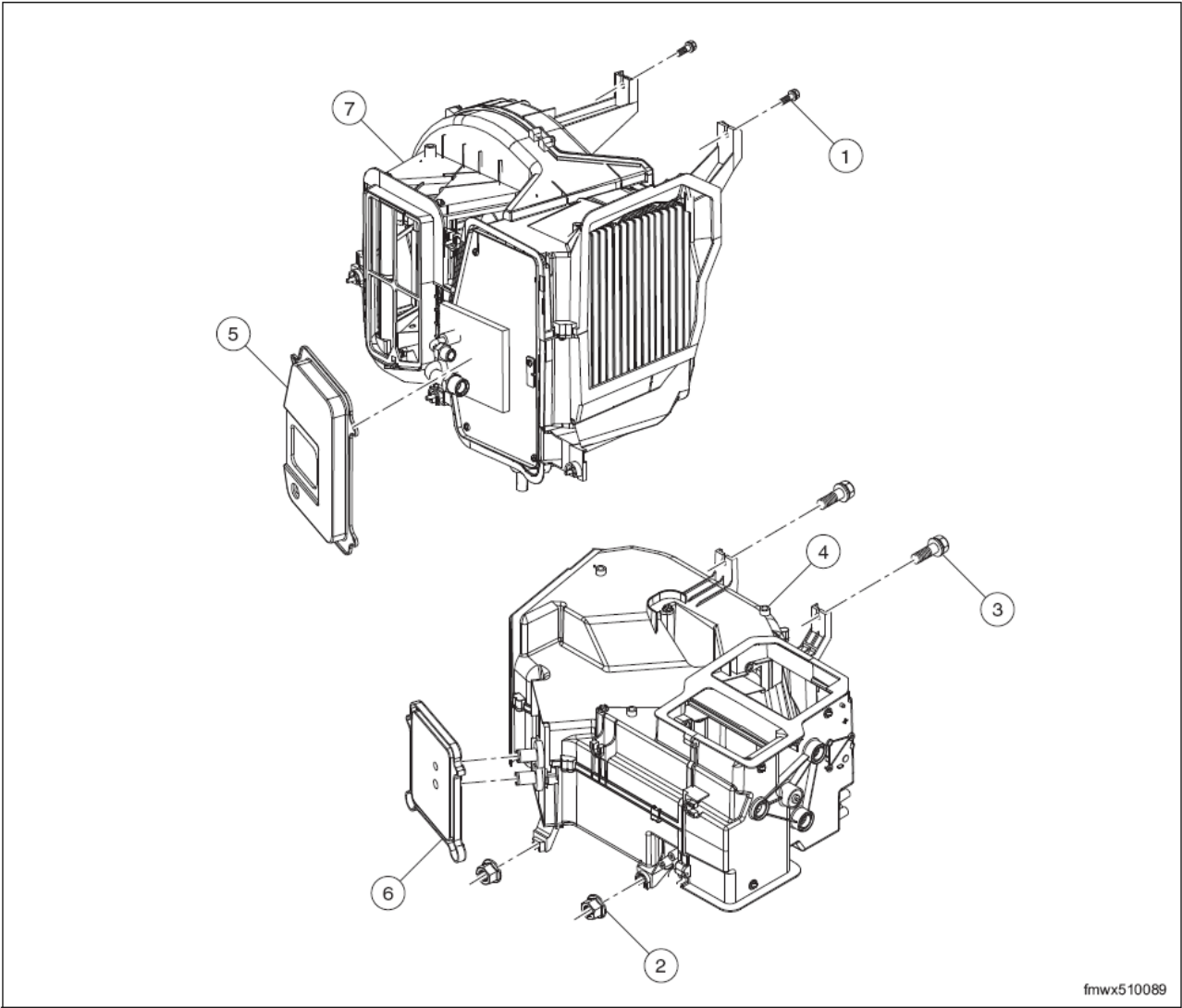
- (d) Fit the heater core cover plate.
- (e) Connect the heater water pipe.

10. Close the front cover.
11. Fill the anti-freezing liquid. Refer to Chapter 14: Testing and Adjustment, Cooling-Cooling System.
12. Turn on the power master switch.



HEATER (RIGHT-HAND DRIVE)

DIAGRAM OF COMPONENTS



1	Hexagon bolt, spring washer and plain washer assembly
2	Hexagon flanged nut
3	Hexagon bolt, spring washer and plain washer assembly
4	Air heater assembly

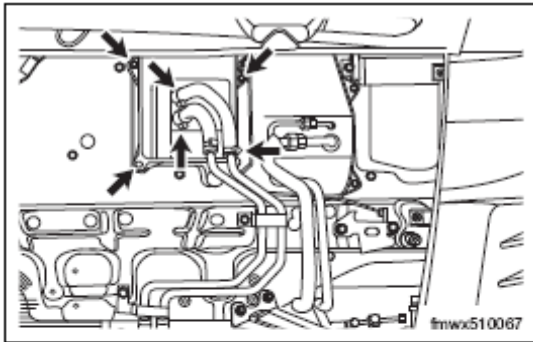
5	Evaporator pipeline shield assembly
6	Air heater water pipe shield
7	Blower assembly

SERVICE

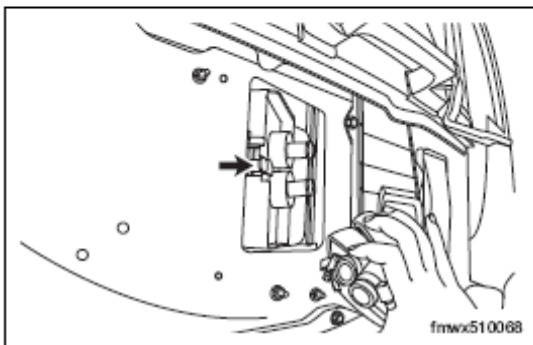
Hint:

As for the Diagram of Components, refer to Chapter 51: Diagram of Components, Air Heater and Air Conditioner-Heater.

1. Turn off the power master switch.
2. Discharge the anti-freezing liquid. Refer to Chapter 14: Testing and Adjustment, Cooling-Cooling System.
3. Open the front cover.

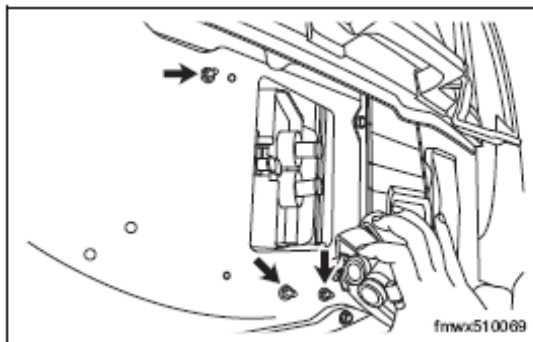


4. Remove the heater core.
 - (a) Disconnect the air heater pipe.
 - (b) Remove the heater core cover plate.

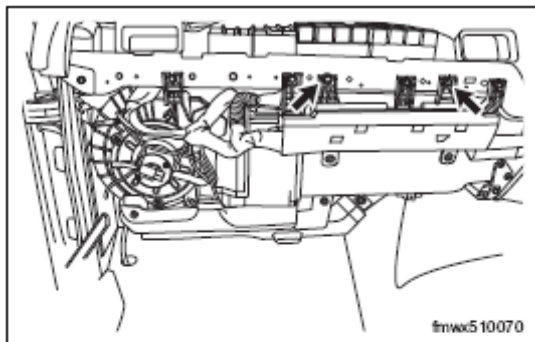


- (c) Remove the heater core lock bolt.
 - (d) Remove the heater core.

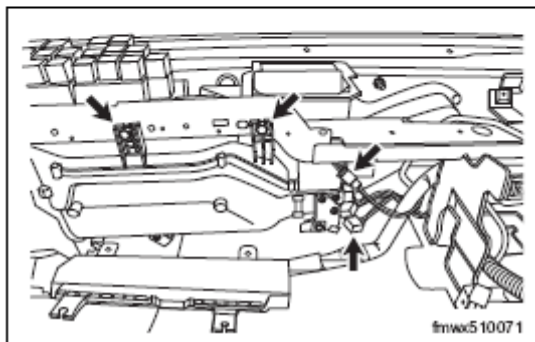
5. Check the heater core.
 - (a) Check whether the heater core fin is damaged.
 - (b) Check whether the heater core is clogged by foreign matters.
 - (c) Fill cooling liquid into the heater core, and check the core for leakage.



6. Remove the heater assembly.
 - (a) Remove the lock nut of heater.



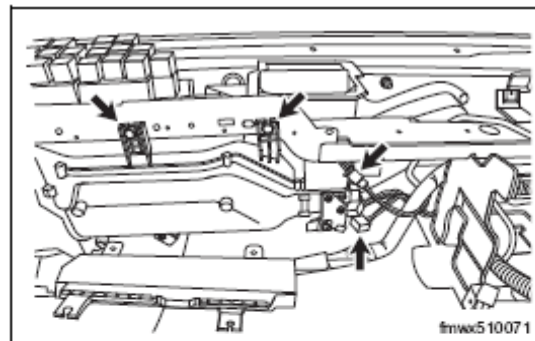
- (b) Remove the wires.
- Remove the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.
 - Remove the lock bolt for wires.



- (c) Remove the heater lock bolt.
- (d) Disconnect the connector of air mixture door motor wires.
- (e) Remove the heater.

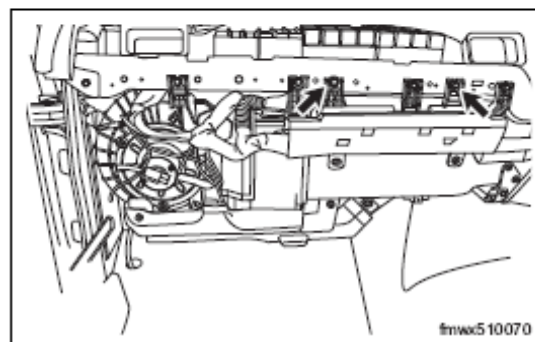
7. Check the heater housing.

- (a) Check whether the heater housing is damaged.
- (b) Check whether the heater air mixture door is damaged.
- (c) Check whether the door pivot is displaced.
- (d) Check whether the heater air door motor is damaged.

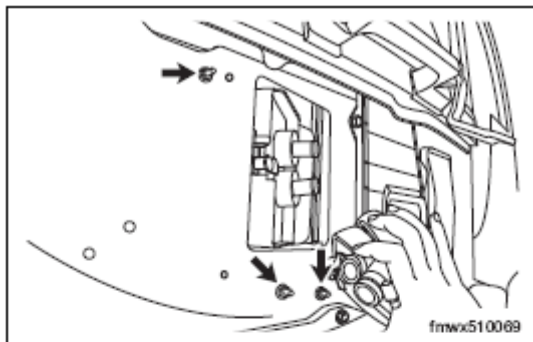


8. Fit the heater assembly.

- (a) Fit the heater lock bolt.
- (b) Connect the connector of air mixture door motor wires.

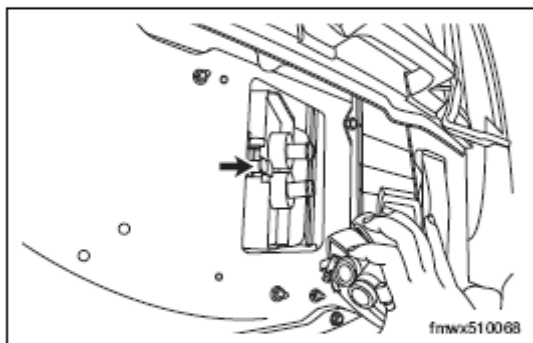


- (c) Fit wires.
- Fit the wire lock bolt.
 - Fit the instrument panel. Refer to Chapter 73: Service, Dashboard/ Instrument Panel/ Cigarette Igniter-Dashboard.



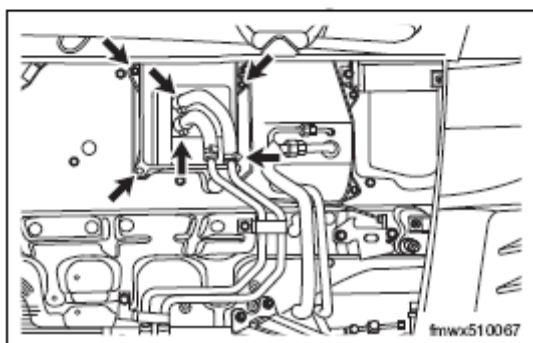
9. Fit the heater assembly.

(a) Fit the heater assembly lock bolt.



(b) Fit the heater core.

(c) Fit the heater core lock bolt.



(d) Fit the heater core cover plate.

(e) Connect the heater water pipe.

10. Close the front cover.

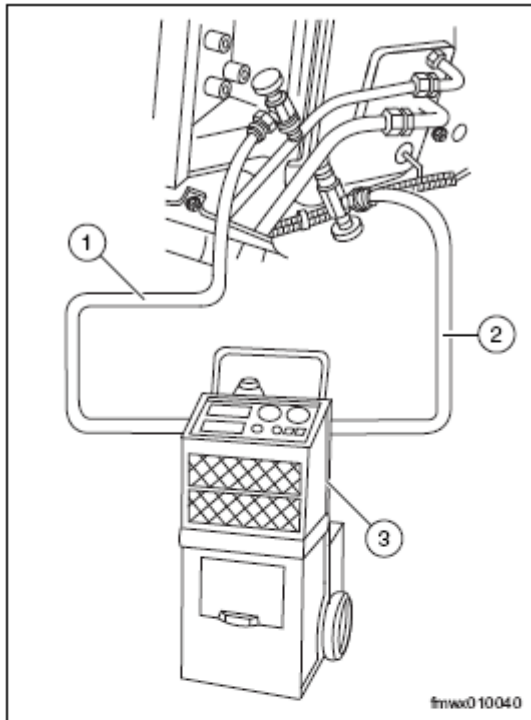
11. Fill the anti-freezing liquid. Refer to Chapter 14: Testing and Adjustment, Cooling-Cooling System.

12. Turn on the power master switch.



COOLANT

REPLACEMENT



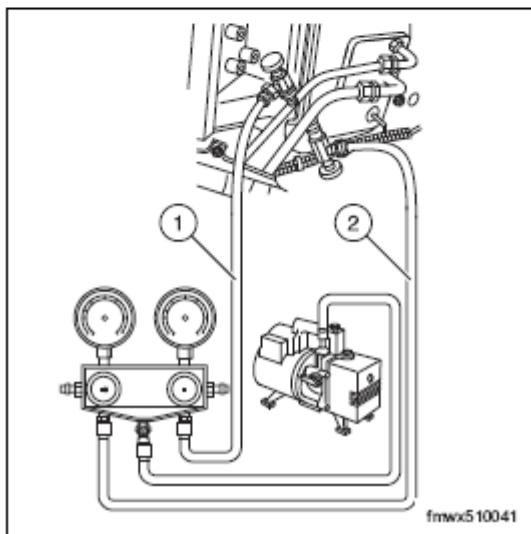
1. Discharge the coolant.

- Turn on the air conditioner switch.
- Run the engine at idle speed for 5-6 minutes to circulate the coolant, and try to collect the freezing oil of each part into the compressor.
- Stop the engine.
- Collect the coolant.

Warning:

The coolant may pollute the environment, and never discharge the coolant into the atmosphere.

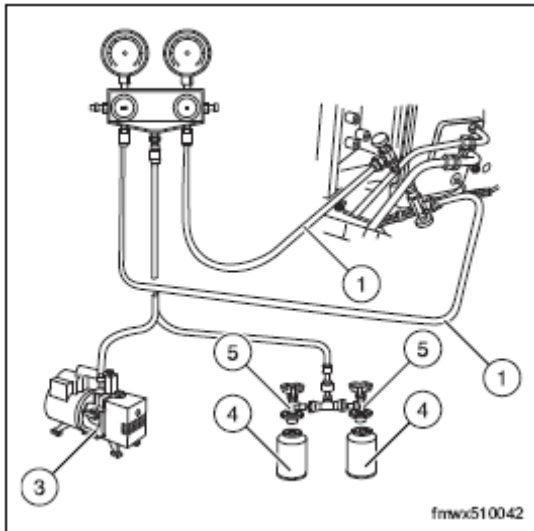
51



2. Vacuumize the system.

- Connect the pressure gauge manifold.
 - Connect the central hose of the pressure gauge manifold fitted at the vacuum pump inlet.
 - Operate the vacuum pump, turn on the shutoff valve, and turn on both manual valves.
 - When the low-pressure gauge indicates 100kPa, continue vacuumize the system for 5 minutes or longer.
 - Turn off both manual valves and stop the vacuum pump.
- Ensure that the pressure remains unchanged after 10 minutes.
 - If the pressure changes, check the system for leakage.
 - If the leakage occurs, refasten the coolant pipeline union and repeat the vacuumization.
 - If no leakage is found, operate the vacuum pump for another 20 minutes or longer. When the pressure gauge manifold pressure reaches 100kPa, stop both manual valves.
 - Close the positive shutoff valve, stop the vacuum pump and disconnect the central hose at the vacuum pump.





3. Refill the coolant.

- (a) Fit the filling valve in front of the coolant vessel, and rotate the valve handle counterclockwise till the valve needle is fully retracted.
- (b) Rotate the riveted flange nut counterclockwise till it reaches the highest position (relative to the filling valve).
- (c) Fit the filling valve into the coolant vessel.
- (d) Rotate the riveted flange nut clockwise, and connect the manifold pressure gauge central hose onto the filling valve.
- (e) Fasten the flange nut with hand, rotate the valve handle clockwise to lower the valve needle, and drill the coolant vessel.
- (f) Rotate the valve handle counterclockwise to raise the valve needle. Operate the manifold pressure gauge and fill the coolant in the vessel into the air conditioning system.

Notice:

Absolutely ensure that the old coolant vessel will not be further used.

- (g) Ensure the correct discharge.
- (h) Connect the manifold pressure gauge central hose to the coolant vessel.
 - Rotate the valve handle counterclockwise, discharge the filling pipeline, and release all air in the manifold pressure gauge central hose.
- (i) Open the low pressure manual valve, and fill about 200g of coolant.
 - Ensure that the high-pressure manual valve is closed.
 - Never fill the coolant by reversing the coolant vessel.
- (j) Close the low pressure manual valve of the manifold pressure gauge.
 - Ensure that the pressure class is not reached.
- (k) Use the R-134a leakage detector to check the coolant leakage.
 - In the case of leakage, repair the union concerned and discharge the system again.
- (l) If no leakage occurs, open the low pressure hand valve of the manifold pressure gauge, and then continue to fill the coolant into the system.
- (m) When it is difficult to fill the system, execute following steps:
 - Run the engine at idle speed, and close all doors.
 - Turn on the air conditioner switch.
 - Turn the fan control knob (fan switch) to the highest position.

Warning:

Absolutely ensure that the high-pressure manual valve is not opened. If this valve is opened, the high-pressure coolant air flow will be reversed to cause breakage of the coolant vessel.

- (n) When discharging the coolant vessel, replace the vessel as per following procedures:
 - Close the low pressure manual valve.
 - Raise the valve needle and remove the filling valve.
 - Refit the filling valve onto the new coolant vessel.

- Release all residual air in the manifold pressure gauge central hose.
- (o) Fill the coolant into the system as required, and then close the low pressure manual valve. If the coolant volume is not required, estimate the time to stop filling operation by reading values on the high and low pressure gauges and observing the coolant flowing status via the sight glass (transparent, bubbling, turbid).
 - Radiator water temperature: keep steady;
 - Air conditioner switch: ON
 - Temperature regulator: Adjust the temperature of air from internal circulation to 25-30°C;
 - Fan switch: at "4" position;
 - Changeover of internal and external air: Internal circulation;
 - Door: Fully opened;
 - Window: Fully opened;
 - Estimate the coolant volume to be filled;
- (p) After the above-mentioned filling operation is finished, turn the air conditioner switch to OFF; after its pressure is balanced, turn the switch to ON again for judgment.
- (q) Turn off the coolant vessel low pressure manual valve and filling valve.
- (r) Stop the air conditioner and engine.
- (s) Disconnect the high and low pressure hoses at the connector of manifold pressure gauge.
- 4. **Check the air conditioning system.**
 - When no bubbles are found via the sight glass, the system is filled up. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner-Air Conditioning System.
 - Read the high and low pressure values on the manifold pressure gauge. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner-Air Conditioning System.
 - Use the R-134a leakage detector to check the coolant leakage. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner-Air Conditioning System.

Notice:

Immediately after the coolant is filled, both high and low pressures will be high and the pointer will deviate to the left side of the pressure gauge. However, the pressure will be stabilized at last and indicated on the pressure guide valve as follows:

- Ambient temperature: 25-30°C;
- Pressure on the high-pressure side: 1.6-2MPa;
- Pressure on the low-pressure side: 0.2-0.4MPa;

FREEZING OIL

SERVICE

1. **Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.**
2. **Discharge the freezing oil.**
 - (a) Remove the compressor. Refer to Chapter 51: Service, Air Heater and Air Conditioner-Compressor.
 - (b) Discharge the freezing oil from the compressor.
3. **Check the freezing oil.**
 - (a) Comparison method: Fill standard freezing oil into a test tube as the reference oil, and then fill the freezing oil to be tested into another test tube of the same size for comparison. If the oil to be tested is light yellow or orange, the further use is allowed; if the oil turns rufous and turbid, no further use is allowed.
 - (b) Dropping-onto-the-paper method: Take one drop of freezing oil to be tested onto a piece of clean white paper, and after a while, observe the color of the oil. If it is light-colored and uniformly distributed, there is no impurity in the oil and the further use is allowed; if there is black spot in the oil drop center, the oil has been degraded and no further use is allowed.
4. **Fill freezing oil.**
 - (a) Fit the compressor. Refer to Chapter 51: Service, Air Heater and Air Conditioner-Compressor.
 - (b) Fill the freezing oil as required.

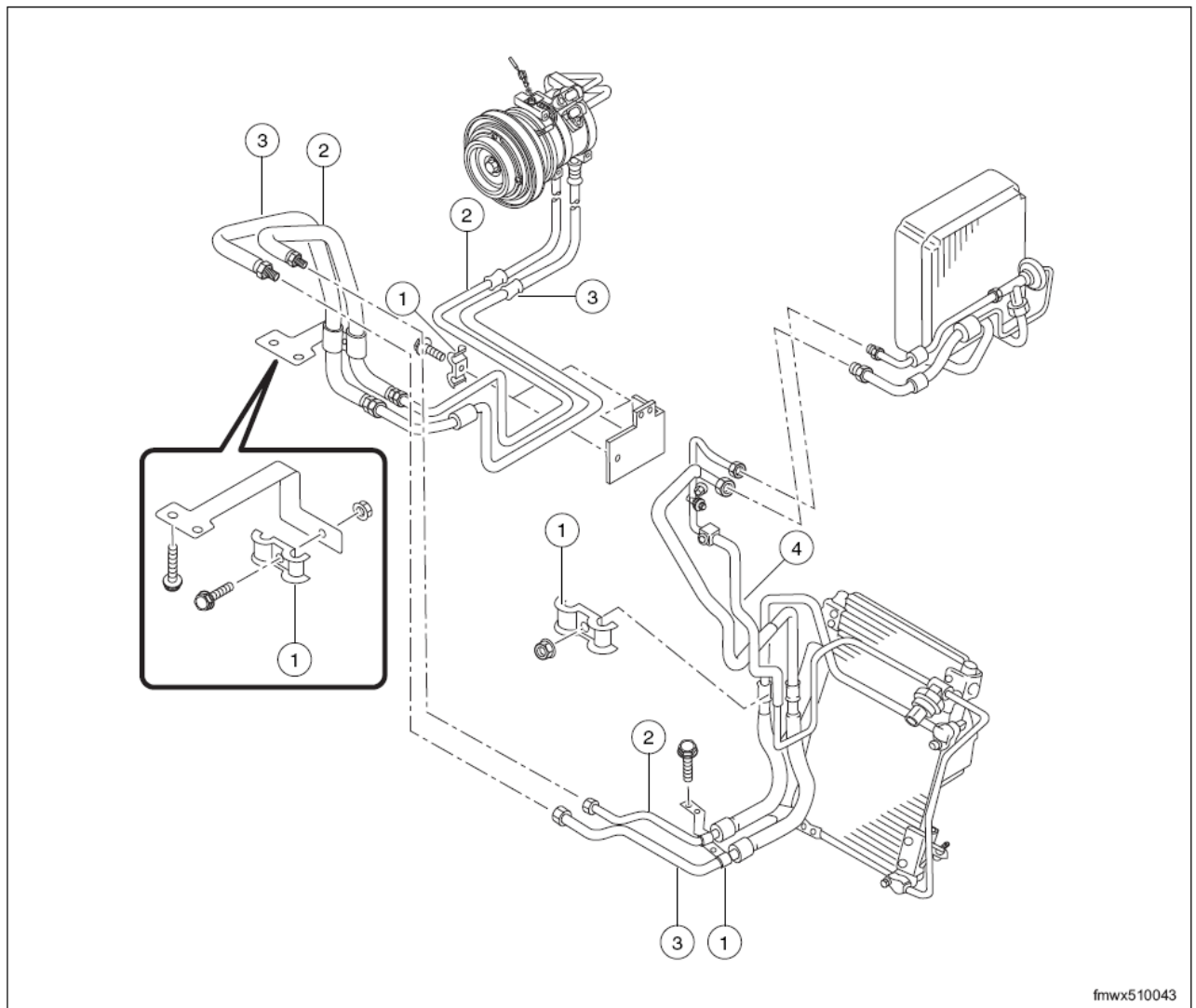
Notice:

In general, the new air conditioning system requires no additional freezing oil, for the new compressor is provided with the freezing oil necessary for the operation of the whole system (take account of 14%-18% of the coolant of air conditioning system). If the air conditioning system has been serviced by twice or more, or the freezing oil becomes insufficient due to other reasons, the freezing oil must be refilled. After the system is replaced, add the freezing oil.

5. **Fill the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.**
6. **Heat the engine to the normal working temperature.**
7. **Check the coolant leakage. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.**

COOLING PIPE

DIAGRAM OF COMPONENTS

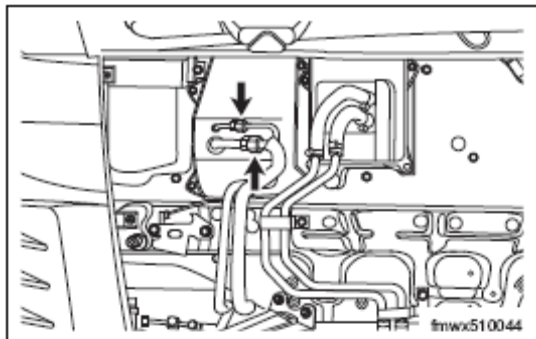


1	Clamp/clip
2	Cooling pump (compressor-condenser)

3	Cooling pipe (compressor-evaporator)
4	Cooling pipe (condenser-evaporator)

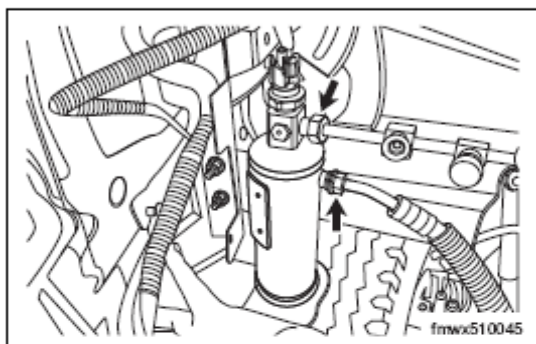
SERVICE

1. Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.
2. Open the front cover.

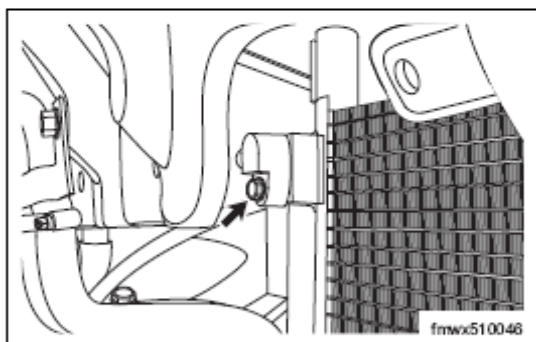


3. Remove the coolant.

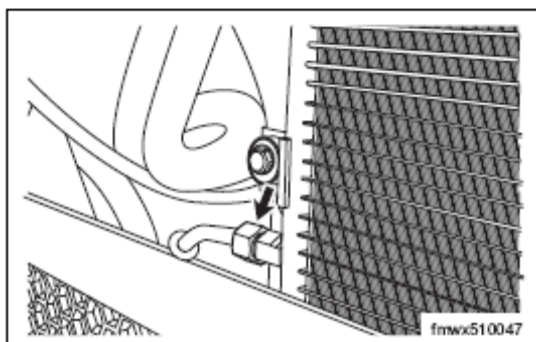
- (a) Disconnect the evaporator cooling pipe.



- (b) Disconnect the dryer cooling pipe.

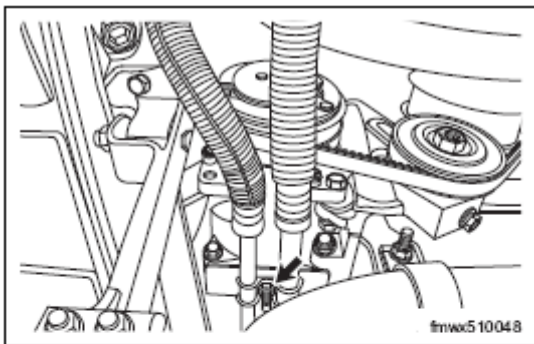


- (c) Disconnect the condenser cooling pipe.

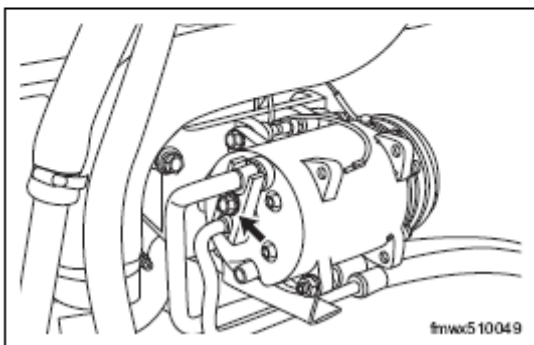


- (d) Disconnect the condenser cooling pipe.



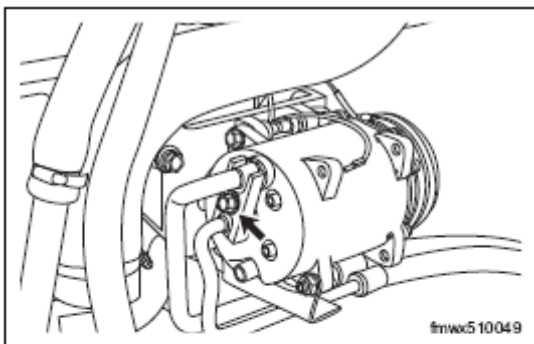


- (e) Remove the compressor cooling pipe clip.



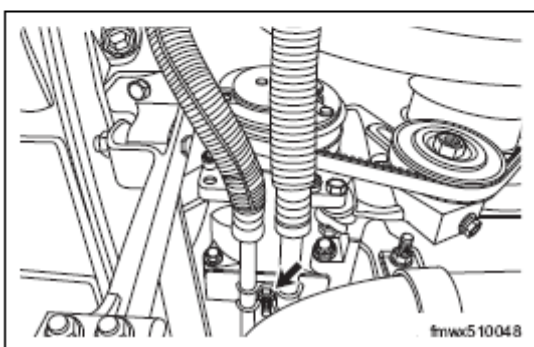
- (f) Disconnect the compressor cooling pipe.

4. Check the cooling pipe. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.

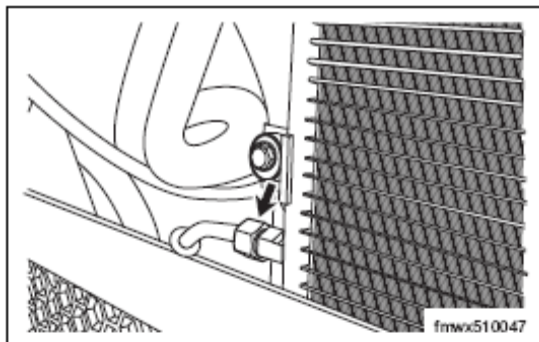


5. Refit the cooling pipe.

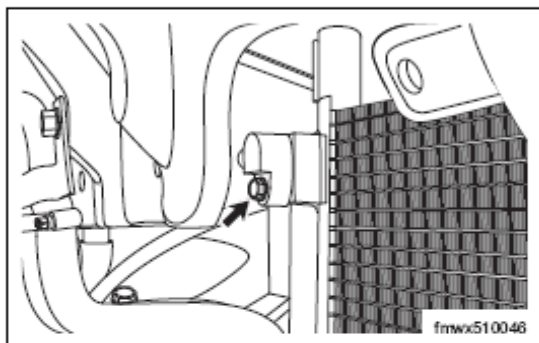
- (a) Connect the compressor cooling pipe.



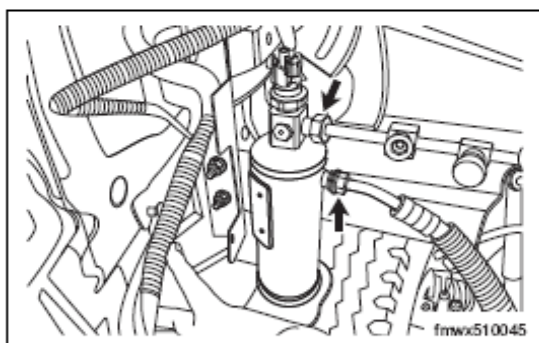
- (b) Refit the compressor cooling pipe clip.



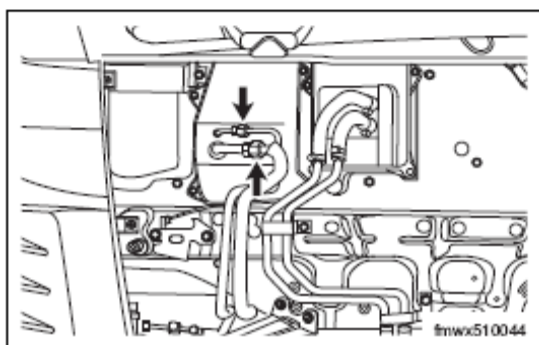
(c) Connect the condenser cooling pipe.



(d) Connect the condenser cooling pipe.



(e) Connect the dryer cooling pipe.



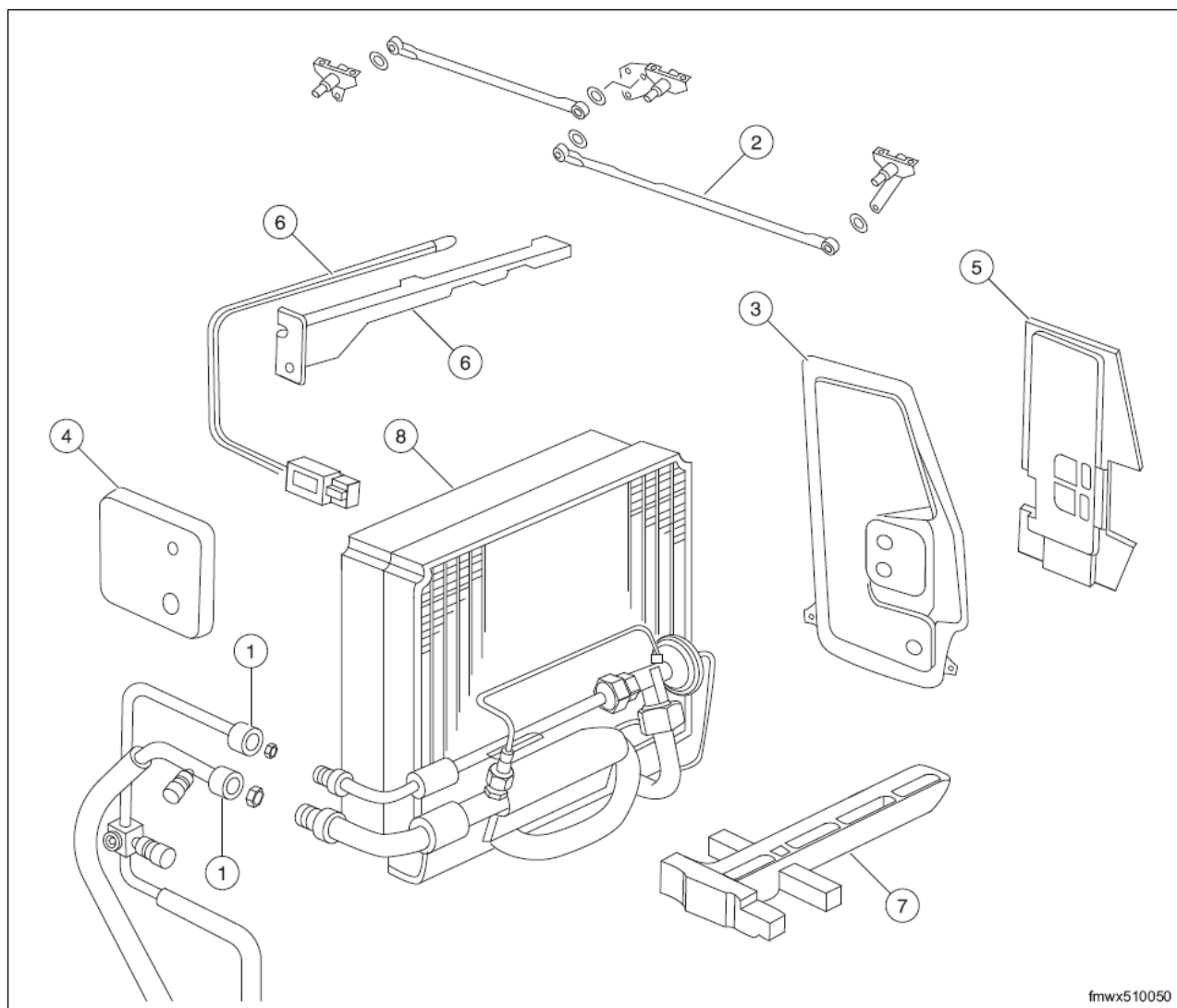
(f) Connect the evaporator cooling pipe.

6. Close the front cover.
7. Refill the coolant. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Coolant.
8. Refill the freezing oil. Refer to Chapter 51: Service, Air Heater and Air Conditioner-Freezing oil.



EVAPORATOR

DIAGRAM OF COMPONENTS



51

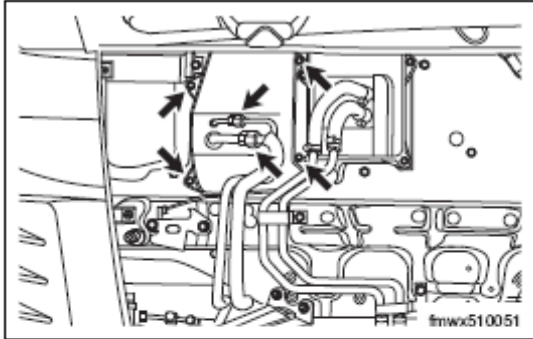
1	Cooling pipe
2	Windshield wiper connecting rod
3	Evaporator outer cover
4	Insulator

5	Evaporator inner cover
6	Electronic thermostat
7	Bottom plate
8	Evaporator core assembly



SERVICE

1. Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.
2. Open the front cover.

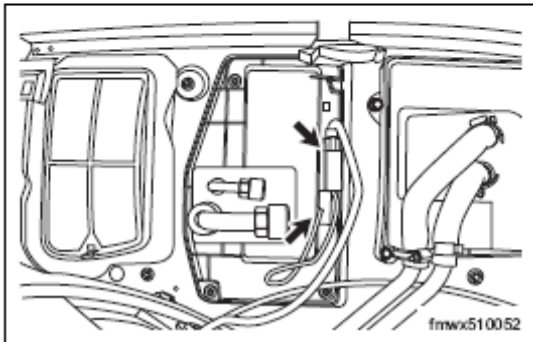


3. Remove the evaporator cooling pipe.

Notice:

The sealing cover must be immediately recovered after the pipeline is opened.

4. Remove the evaporator cover plate.

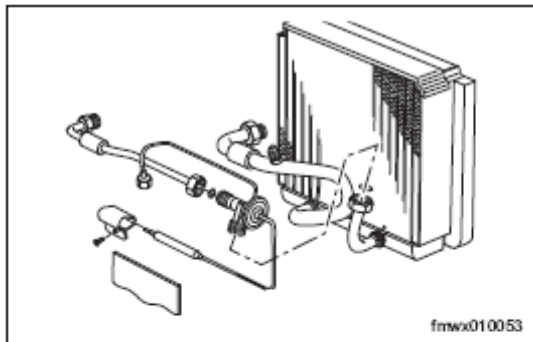


5. Remove the evaporator core.

- (a) Disconnect the electronic thermostat wire connector.
- (b) Disconnect the dryer cooling pipe.
- (c) Take out the evaporator core.

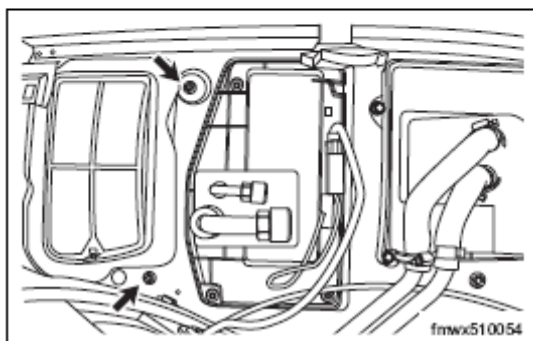
6. Check the evaporator core.

- (a) Check the evaporator core surface for contamination, damages and deformation.
- (b) Soaking method: Enclose a 1.67MPa pressure in the evaporator, soak the evaporator in the water for 5 minutes, and check whether there are air bubbles on its surface.

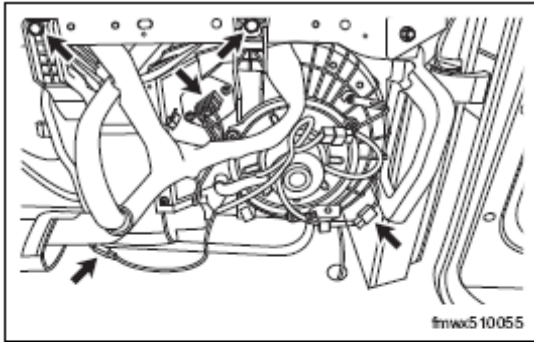


7. Remove the expansion valve.

- (a) Carefully take out the insulator.
- (b) Remove the sensor clip.
- (c) When disconnecting all coolant pipes, use the standby spanner and then remove the expansion valve.

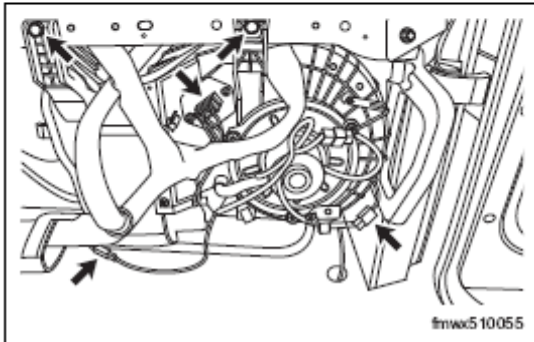


8. Remove the evaporator lock bolt.



9. Remove the evaporator.

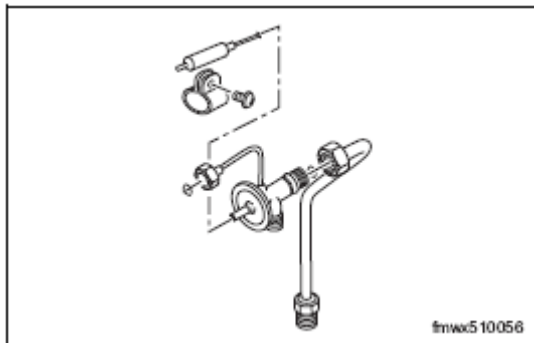
- (a) Remove the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.
- (b) Remove the wire.
- (c) Remove the lower air duct.
- (d) Disconnect the blower wire connector.
- (e) Disconnect the internal and external circulation air door motor wire connector.



10. Refit the evaporator.

- (a) Connect the internal and external circulation air door motor wire connector.
- (b) Connect the blower wire connector.
- (c) Refit the lower air duct.
- (d) Refit wires.
- (e) Refit the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.

11. Refit the evaporator lock bolt.



12. Fit expansion valve.

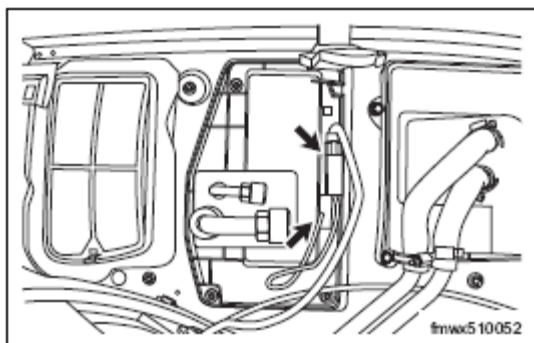
- (a) Fit the expansion valve. Use the standby spanner when connecting all coolant pipes.
- (b) Fit the sensor clip.
- (c) Carefully take out the insulator.

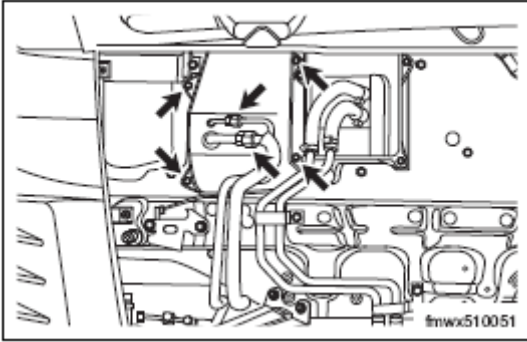
Notice:

- The O-shaped ring shall not be reused. Always use a new ring.
- When connecting the pipeline, do apply the designated new freezing oil onto the O-shaped ring.
- Do fit the expansion valve sensor and insulator at the original position.
- To refit the evaporator core, fill 50ml of new freezing oil as required into the core.

13. Fit the evaporator core.

- (a) Fit the evaporator core.
- (b) Fit the evaporator core baffle.
- (c) Connect the connector of electronic thermostat wire.



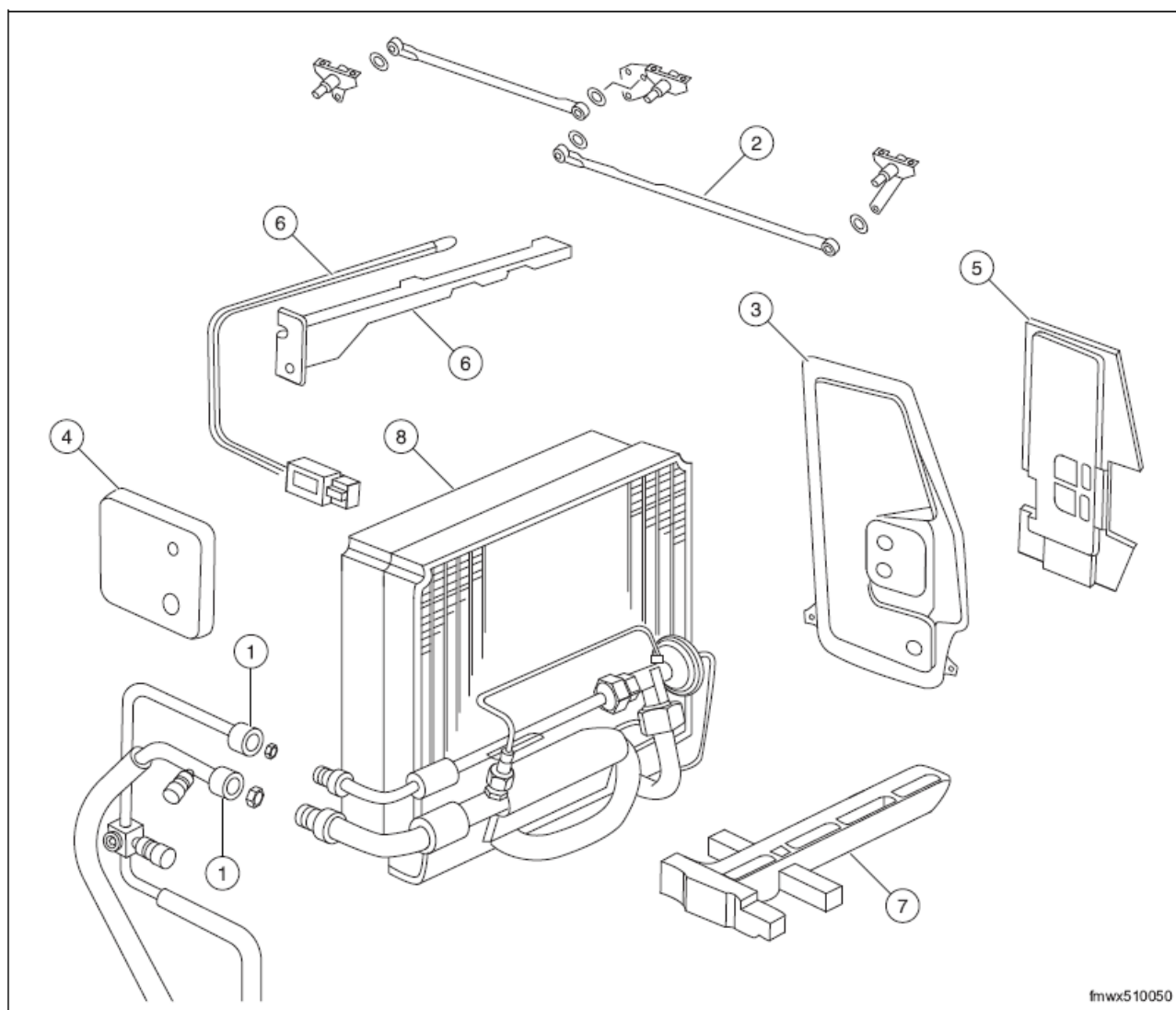


- 14. Fit the evaporator cover plate.**
- 15. Fit the evaporator cooling pipe.**

- 16. Fill the coolant. Refer to Chapter 51: Service, Air Heater and Air Conditioner-Coolant.**
- 17. Close front cover.**

EVAPORATOR (RIGHT-HAND DRIVE)

DIAGRAM OF COMPONENTS



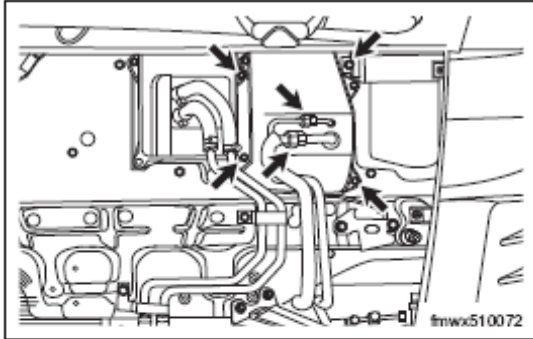
1	Cooling pipe
2	Windshield wiper connecting rod
3	Evaporator outer cover
4	Insulator

5	Evaporator inner cover
6	Electronic thermostat
7	Bottom plate
8	Evaporator core assembly



SERVICE

1. Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.
2. Open the front cover.

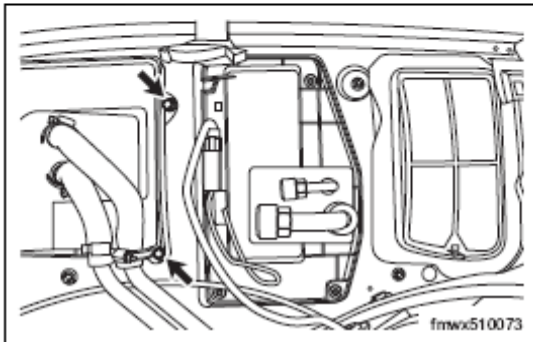


3. Remove the evaporator cooling pipe.

Notice:

The sealing cover must be immediately recovered after the pipeline is opened.

4. Remove the evaporator cover plate.

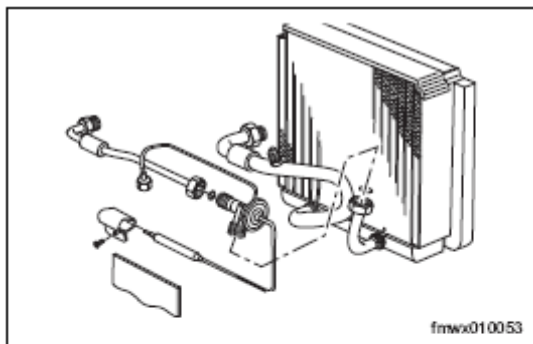


5. Remove the evaporator core.

- (a) Disconnect the electronic thermostat wire connector.
- (b) Disconnect the dryer cooling pipe.
- (c) Take out the evaporator core.

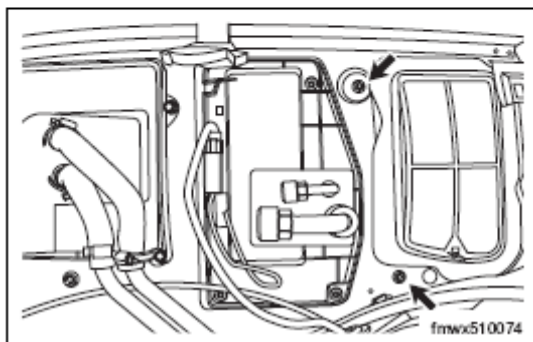
6. Check the evaporator core.

- (a) Check the evaporator core surface for contamination, damages and deformation.
- (b) Soaking method: Enclose a 1.67MPa pressure in the evaporator, soak the evaporator in the water for 5 minutes, and check whether there are air bubbles on its surface.

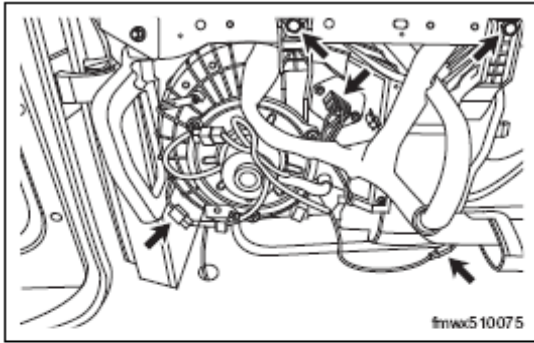


7. Remove the expansion valve.

- (a) Carefully take out the insulator.
- (b) Remove the sensor clip.
- (c) When disconnecting all coolant pipes, use the standby spanner and then remove the expansion valve.

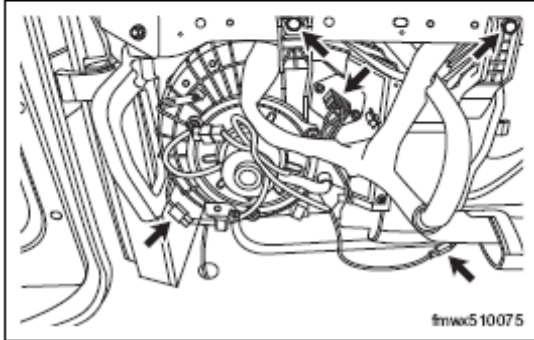


8. Remove the evaporator lock bolt.



9. Remove the evaporator.

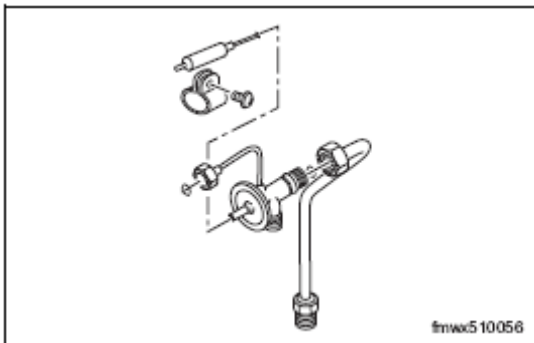
- (a) Remove the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.
- (b) Remove the wire.
- (c) Remove the lower air duct.
- (d) Disconnect the blower wire connector.
- (e) Disconnect the internal and external circulation air door motor wire connector.



10. Refit the evaporator.

- (a) Connect the internal and external circulation air door motor wire connector.
- (b) Connect the blower wire connector.
- (c) Refit the lower air duct.
- (d) Refit wires.
- (e) Refit the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.

11. Refit the evaporator lock bolt.



12. Fit expansion valve.

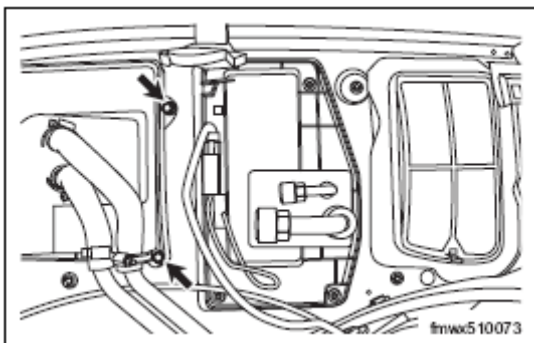
- (a) Fit the expansion valve. Use the standby spanner when connecting all coolant pipes.
- (b) Fit the sensor clip.
- (c) Carefully take out the insulator.

Notice:

- The O-shaped ring shall not be reused. Always use a new ring.
- When connecting the pipeline, do apply the designated new freezing oil onto the O-shaped ring.
- Do fit the expansion valve sensor and insulator at the original position.
- To refit the evaporator core, fill 50ml of new freezing oil as required into the core.

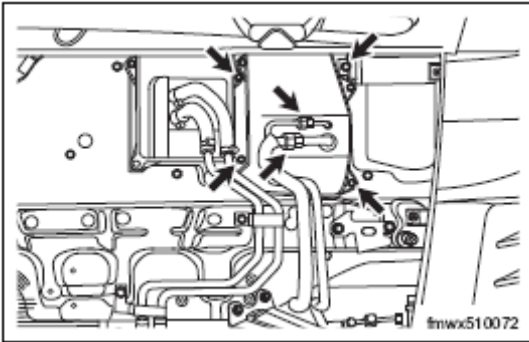
13. Fit the evaporator core.

- (a) Fit the evaporator core.
- (b) Fit the evaporator core baffle.
- (c) Connect the connector of electronic thermostat wire.



51-52

AIR HEATER AND AIR CONDITIONER-EVAPORATOR (RIGHT-HAND DRIVE)



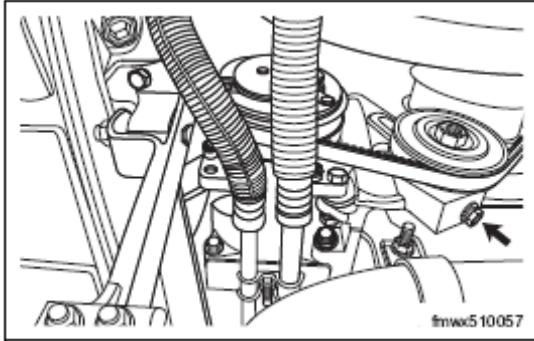
- 14. Fit the evaporator cover plate.**
- 15. Fit the evaporator cooling pipe.**

- 16. Fill the coolant. Refer to Chapter 51: Service, Air Heater and Air Conditioner-Coolant.**
- 17. Close front cover.**

COMPRESSOR

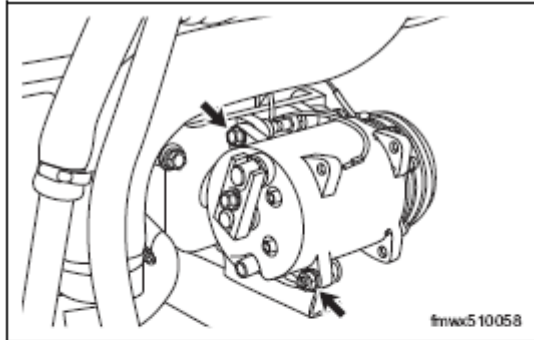
SERVICE

1. Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.

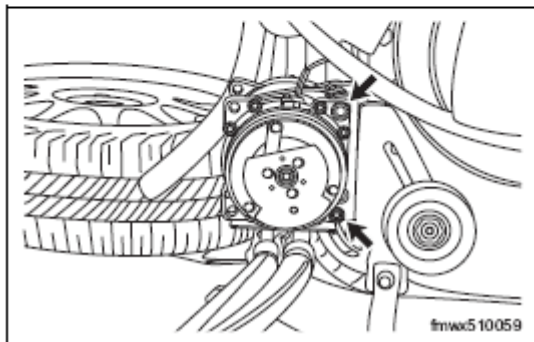


2. Remove the compressor belt.
 - (a) Remove the tensioner.

3. Remove the compressor cooling pipe. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Cooling Pipe.

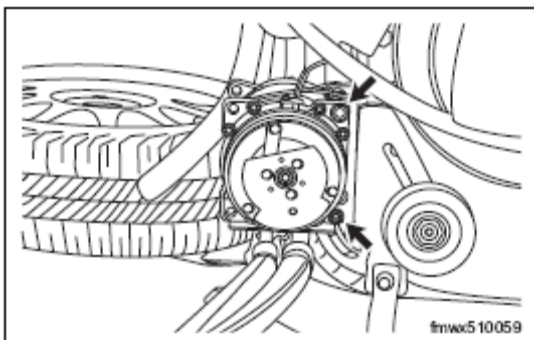


4. Remove the compressor.
 - (a) Disconnect the compressor wire connector.

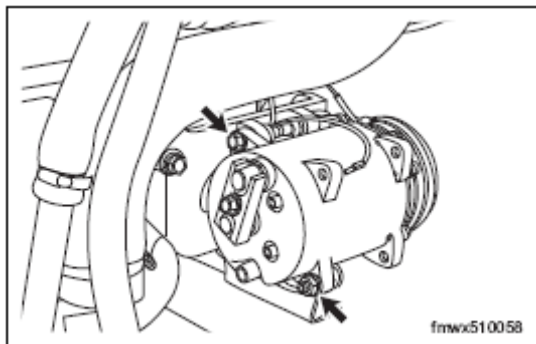


- (b) Remove the compressor lock bolt.

5. Check the compressor. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.

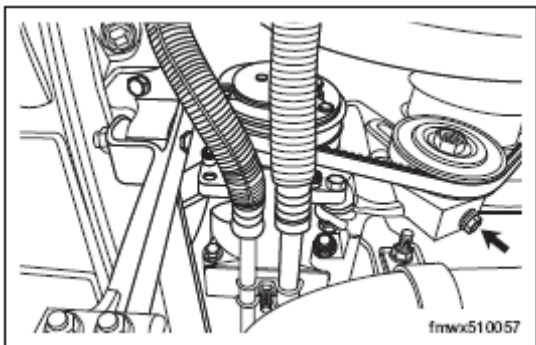


6. Refit the compressor.
 - (a) Refit the compressor lock bolt.



- (b) Connect the connector of compressor wire.

7. Refit the compressor cooling pipe. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Cooling Pipe.



8. Refit the compressor belt.

- (a) Refit the tensioner.

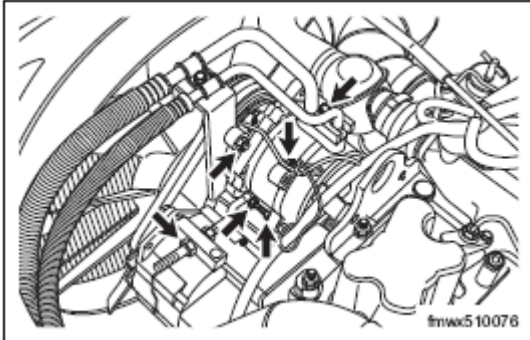
9. Fill the coolant. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Coolant.
10. Check the freezing oil. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Freezing oil.

COMPRESSOR (RIGHT-HAND DRIVE)

SERVICE

1. Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner- Coolant.

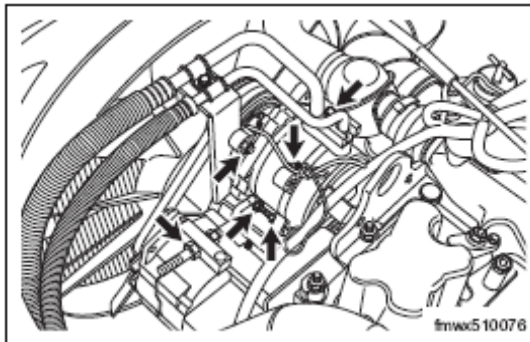
2. Remove the compressor belt.



3. Remove the compressor.

- (a) Disconnect the compressor wire connector.
- (b) Remove the compressor air conditioner pipe.
- (c) Remove the compressor tensioner.
- (d) Remove the compressor lock bolt.

4. Check the compressor. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.



5. Refit the compressor.

- (a) Refit the compressor lock bolt.
- (b) Refit the compressor tensioner.
- (c) Refit the compressor air conditioner pipe.
- (d) Refit the compressor wire connector.

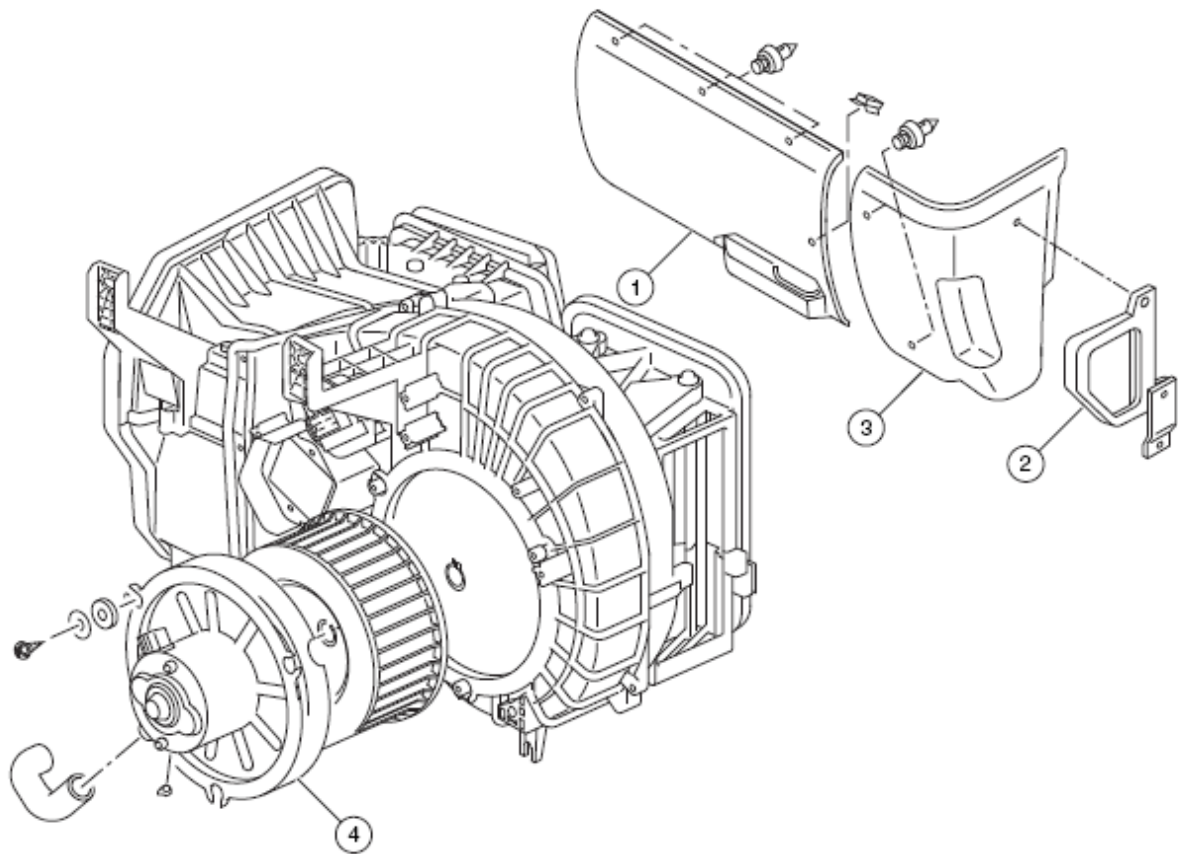
6. Fit the compressor belt.

7. Fill the coolant. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Coolant.

8. Check the freezing oil. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Freezing oil.

BLOWER

DIAGRAM OF COMPONENTS



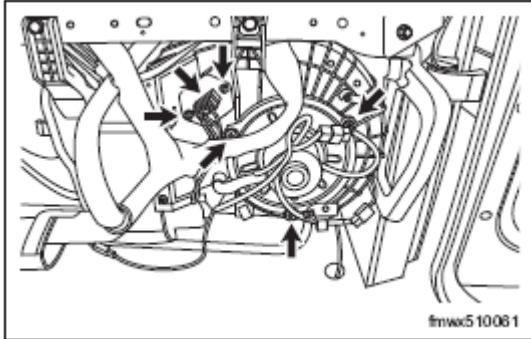
fmwx510080

1	Dashboard
2	Handrail

3	Dashboard
4	Blower motor

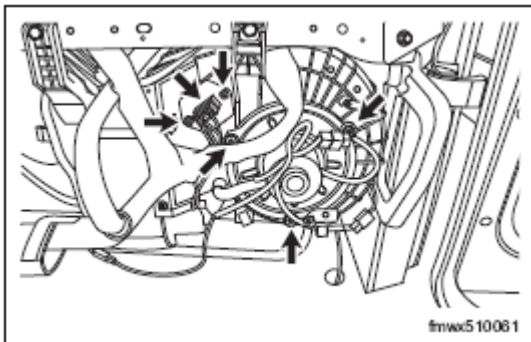
SERVICE

1. Turn off the power master switch.
2. Remove the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.



3. Remove the blower motor and resistor.
 - (a) Disconnect the blower motor wire connector.
 - (b) Remove the lock bolt of blower motor.
 - (c) Disconnect the resistor wire connector.
 - (d) Remove the lock bolt of the resistor.

4. Check the blower motor. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.
5. Check the resistor. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.
6. Check the air door motor. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.

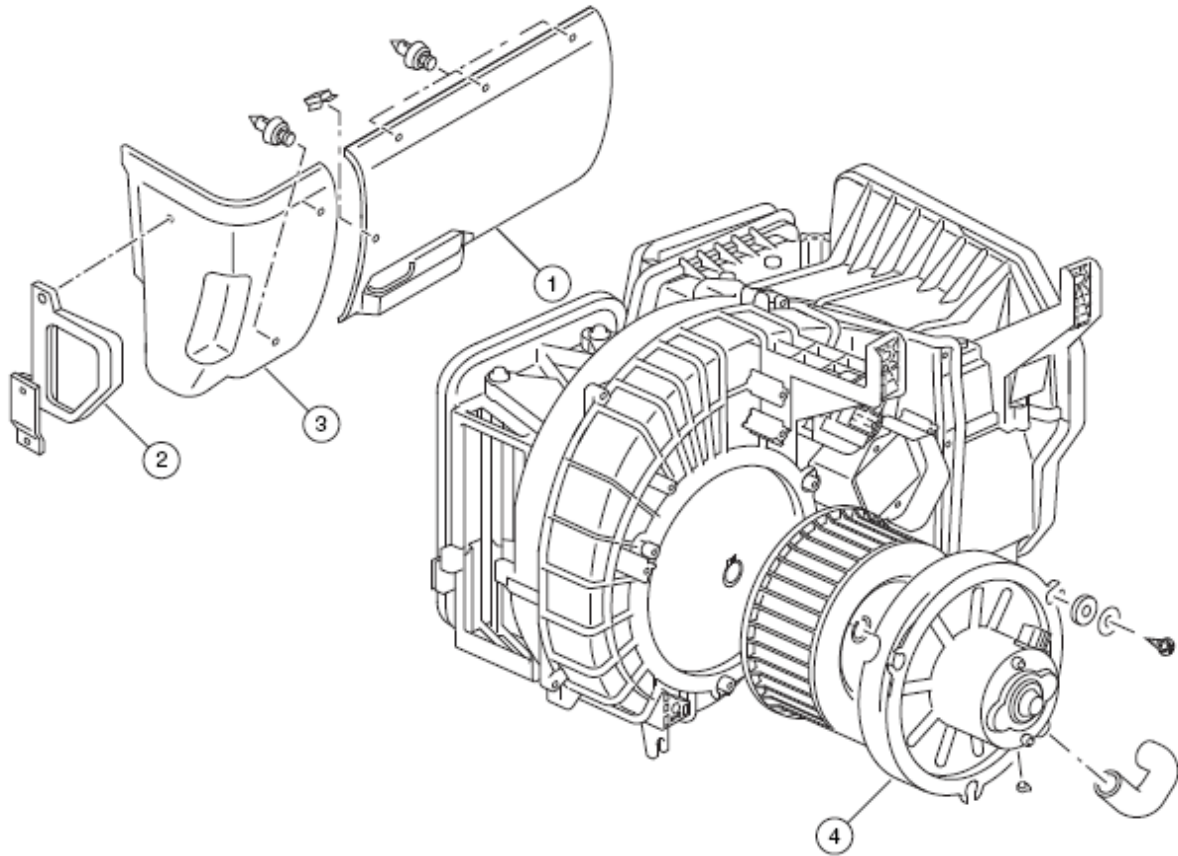


7. Refit the blower motor and resistor.
 - (a) Refit the resistor lock bolt.
 - (b) Connect the resistor wire connector.
 - (c) Refit the blower motor lock bolt.
 - (d) Connect the blower motor wire connector.

8. Refit the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.
9. Turn on the power master switch.

BLOWER (RIGHT-HAND DRIVE)

DIAGRAM OF COMPONENTS



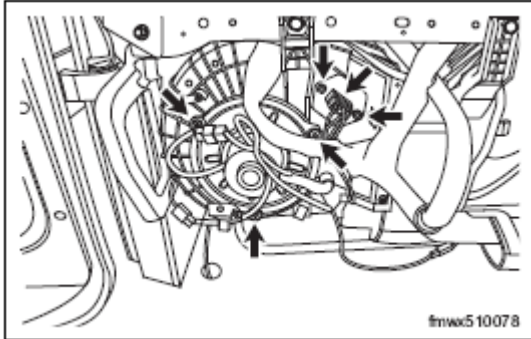
fmwx510077

1	Dashboard
2	Handrail

3	Dashboard
4	Blower motor

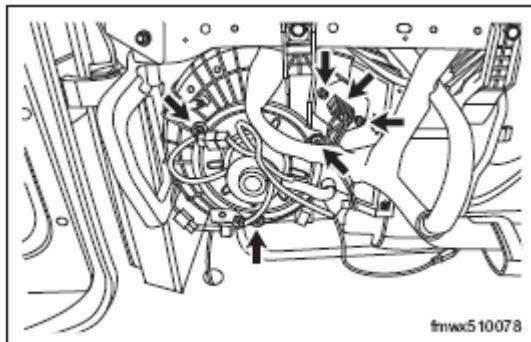
SERVICE

1. Turn off the power master switch.
2. Remove the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.



3. Remove the blower motor and resistor.
 - (a) Disconnect the blower motor wire connector.
 - (b) Remove the lock bolt of blower motor.
 - (c) Disconnect the resistor wire connector.
 - (d) Remove the lock bolt of the resistor.

4. Check the blower motor. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.
5. Check the resistor. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.
6. Check the air door motor. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.



7. Refit the blower motor and resistor.
 - (a) Refit the resistor lock bolt.
 - (b) Connect the resistor wire connector.
 - (c) Refit the blower motor lock bolt.
 - (d) Connect the blower motor wire connector.

8. Refit the instrument panel. Refer to Chapter 73: Service, Dashboard/Instrument Panel/Cigarette Igniter-Dashboard.
9. Turn on the power master switch.

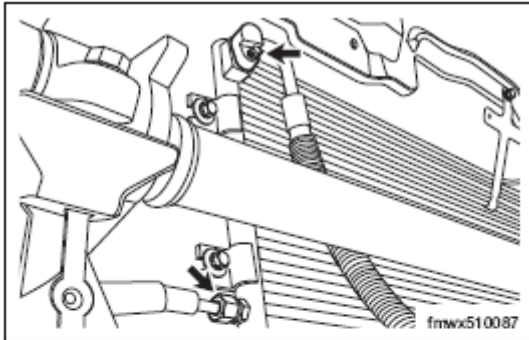
CONDENSER

SERVICE

Notice:

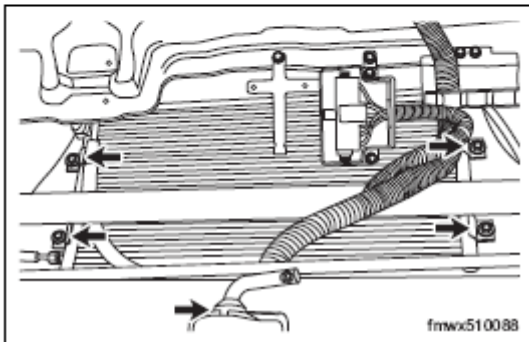
The condenser is a heat exchanger, provided with many precision and fragile structures and materials (especially the cooling members). When handling the condenser, avoid dropping, hitting and scratching.

1. Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.
2. Open the front cover.



3. Remove the condenser.

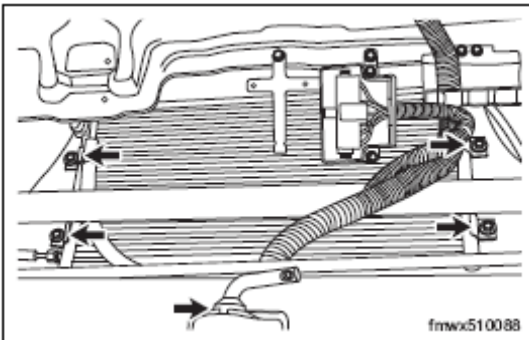
- (a) Remove the condenser cooling pipe. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Cooling pipe.



- (b) Remove the condenser lock bolt, and take out the condenser.

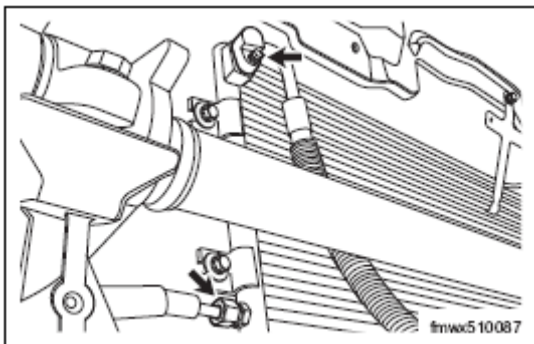
4. Check the condenser.

- (a) Check the condense surface for contamination, deformation and damages.
 - If the condenser fin is contaminated, clean it with water, and then dry it with compressed air.
 - If the fin is bent or deformed, use the fin comb to refit it.
- (b) Check the condenser for leakage.
 - Use the leakage tester to check the pipeline union for gas leakage.



5. Refit the condenser.

- (a) Refit the condenser lock bolt.



- (b) Refit the condenser cooling pipe. Refer to Chapter 51: Service, Air Heater and Air Conditioner-Cooling pipe.

6. Fill the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.
7. Heat the engine to its normal working temperature.
8. Check the freezing oil leakage. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.

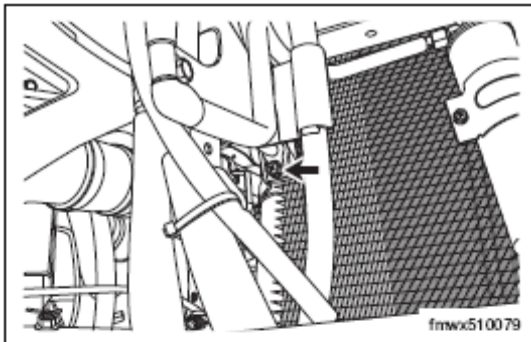
CONDENSER (RIGHT-HAND DRIVE)

SERVICE

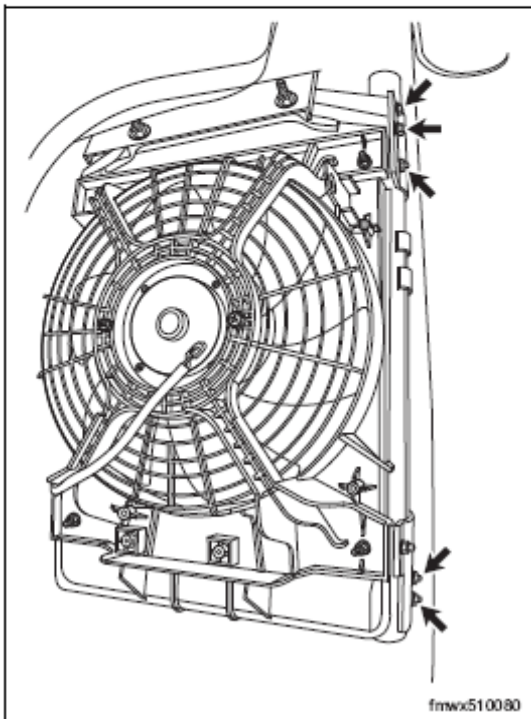
Notice:

The condenser is a heat exchanger, provided with many precision and fragile structures and materials (especially the cooling members). When handling the condenser, avoid dropping, hitting and scratching.

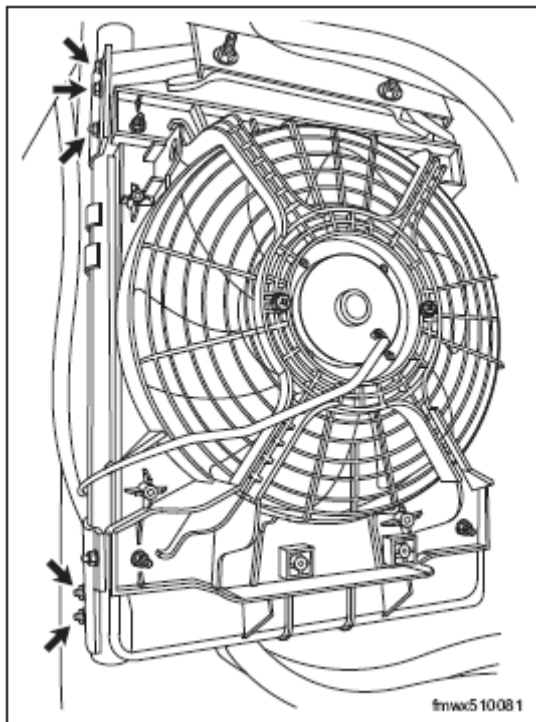
1. Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.
2. Open the front cover.



3. Remove the condenser.
 - (a) Remove the condenser cooling pipe.



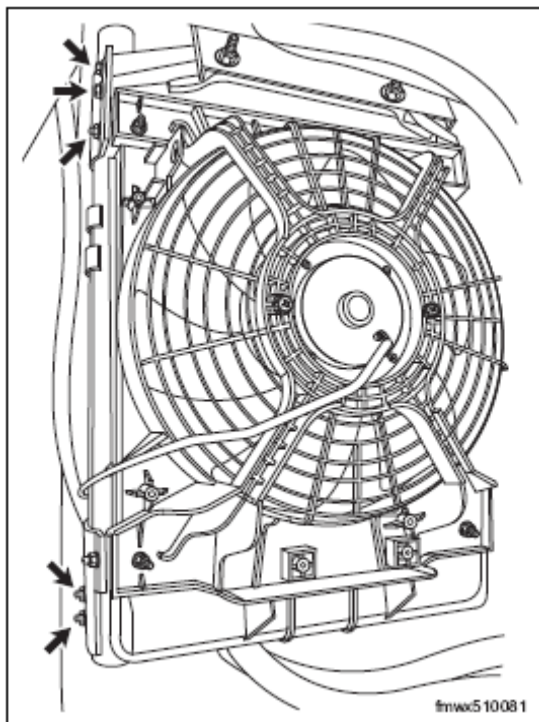
- (b) Remove the condenser lock bolt and nut.



- (c) Remove the condenser cooling pipe.
- (d) Remove the condenser lock bolt and nut.

4. Check the condenser.

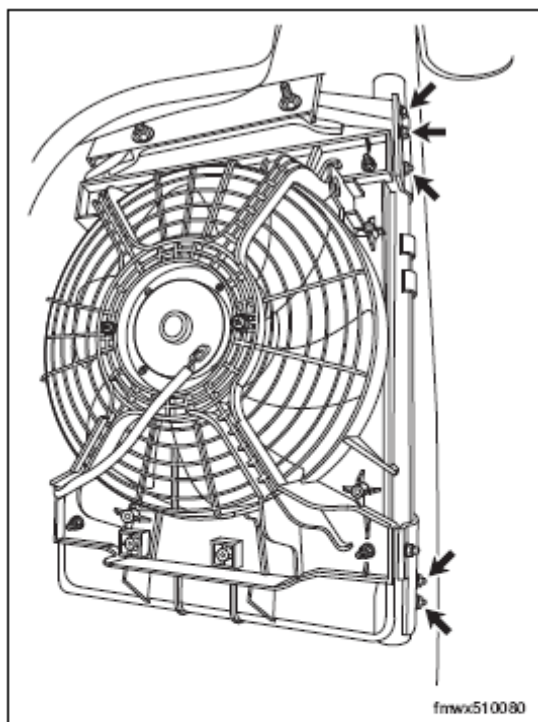
- (a) Check the condense surface for contamination, deformation and damages.
 - If the condenser fin is contaminated, clean it with water, and then dry it with compressed air.
 - If the fin is bent or deformed, use the fin comb to refit it.
- (b) Check the condenser for leakage.
 - Use the leakage tester to check the pipeline union for gas leakage.



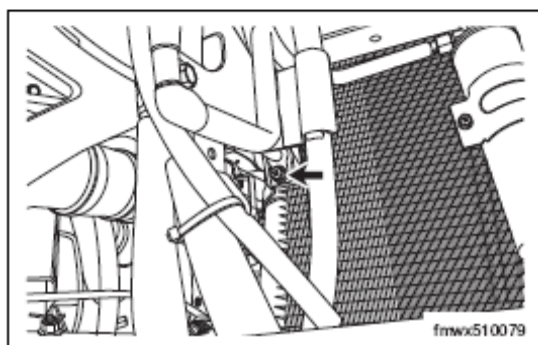
5. Refit the condenser.

- (a) Refit the condenser lock bolt.
- (b) Refit the condenser cooling pipe.





(c) Refit the condenser lock bolt and nut.



(d) Refit the condenser cooling pipe.

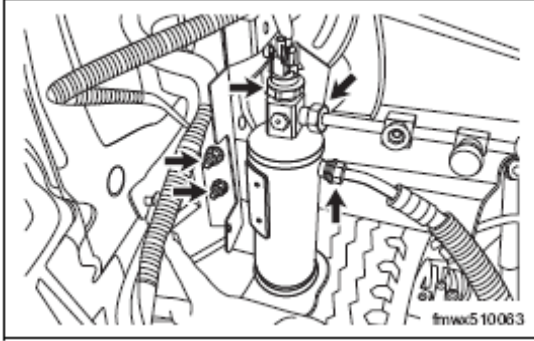
6. Fill the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.
7. Heat the engine to its normal working temperature.
8. Check the freezing oil leakage. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.



LIQUID RESERVOIR

SERVICE

1. **Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.**



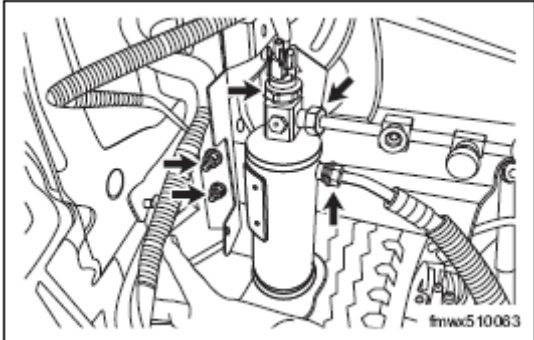
2. **Remove the liquid reservoir.**

Sealant: Loctite 567 sealant

- (a) Remove the liquid reservoir cooling pipe. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Cooling Pipe.
- (b) Disconnect the dual-pressure switch wire connector.
- (c) Remove the liquid reservoir lock nut.

3. **Check the liquid reservoir.**

- (a) Check whether the liquid reservoir housing is damaged.



4. **Refit the reservoir.**

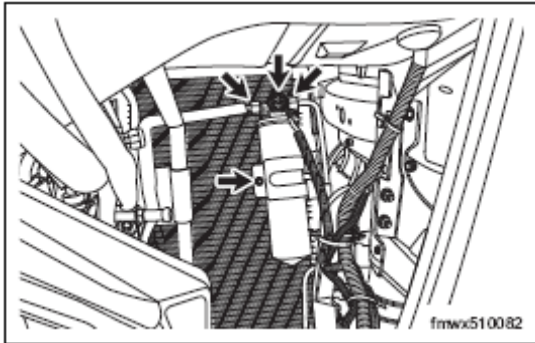
- (a) Refit the reservoir lock nut.
- (b) Connect the dual-pressure switch wire connector.
- (c) Refit the liquid reservoir cooling pipe. Refer to Chapter 51: Service, Air Heater and Air Conditioner- Cooling Pipe.

5. **Fill the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.**
6. **Heat the engine to its normal working temperature.**
7. **Check the freezing oil leakage. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.**

LIQUID RESERVOIR (RIGHT-HAND DRIVE)

SERVICE

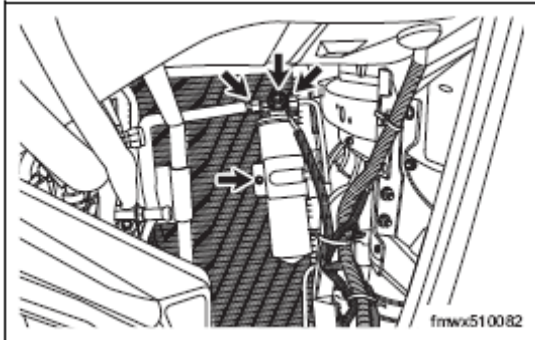
1. Discharge the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.



2. Remove the liquid reservoir.
 - (a) Remove the liquid reservoir cooling pipe.
 - (b) Disconnect the dual-pressure switch wire connector.
 - (c) Remove the liquid reservoir lock nut.

3. Check the liquid reservoir.

- (a) Check whether the liquid reservoir housing is damaged.



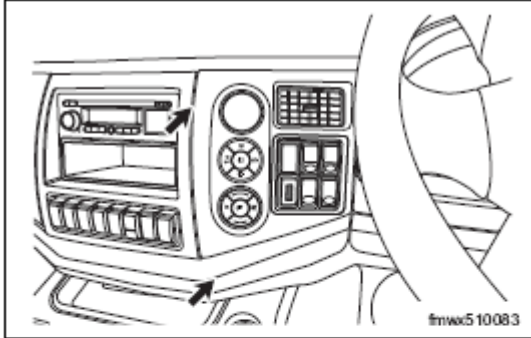
4. Refit the reservoir.
 - (a) Refit the reservoir lock nut.
 - (b) Connect the dual-pressure switch wire connector.
 - (c) Refit the liquid reservoir cooling pipe.

5. Fill the coolant. Refer to Chapter 51: Replacement, Air Heater and Air Conditioner-Coolant.
6. Heat the engine to its normal working temperature.
7. Check the freezing oil leakage. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.

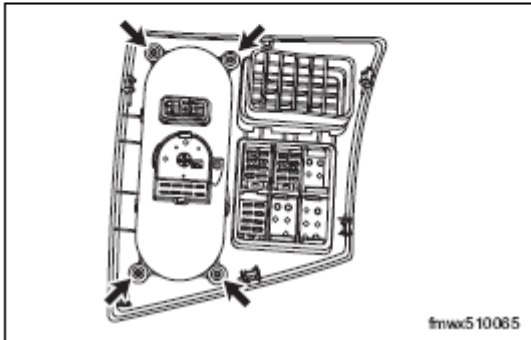
AIR CONDITIONER CONTROL SWITCH (RIGHT-HAND DRIVE)

SERVICE

1. Turn off the master power switch.

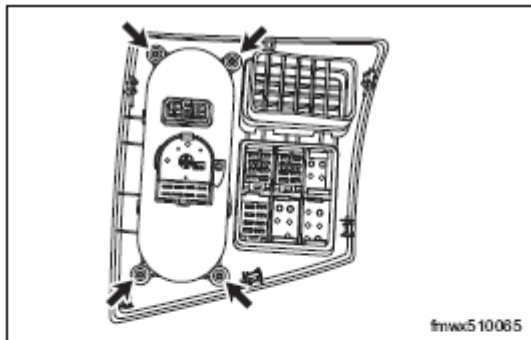


2. Remove the air conditioner control switch.
- (a) Remove the trim strip.
 - (b) Remove the air conditioner control switch panel.
 - (c) Disconnect the connector of control switch wire.

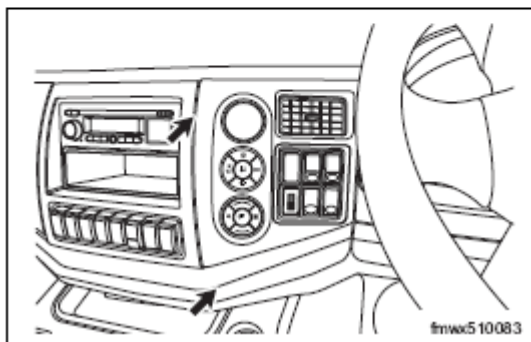


- (d) Remove the control switch lock bolt.

3. Check the air conditioner control switch. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.



4. Refit the control switch.
- (a) Refit the switch lock bolt.

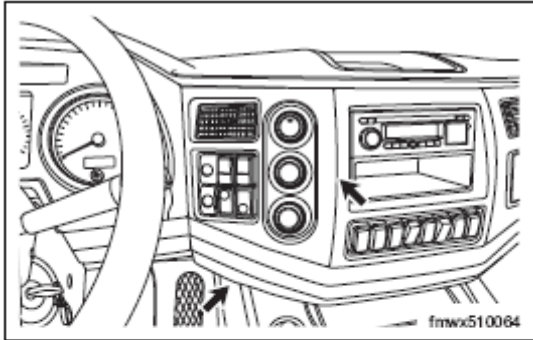


- (b) Connect the control switch wire connector.
- (c) Connect the switch panel.
- (d) Refit the trim strip.

AIR CONDITIONER CONTROL SWITCH

SERVICE

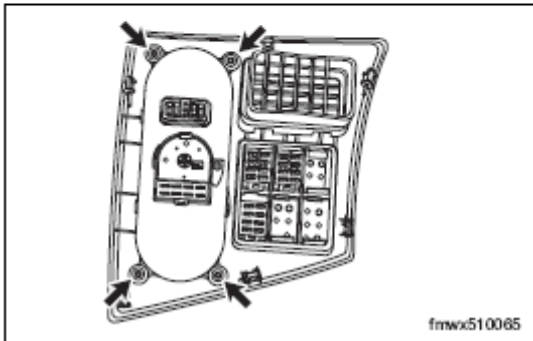
1. Turn off the master power switch.



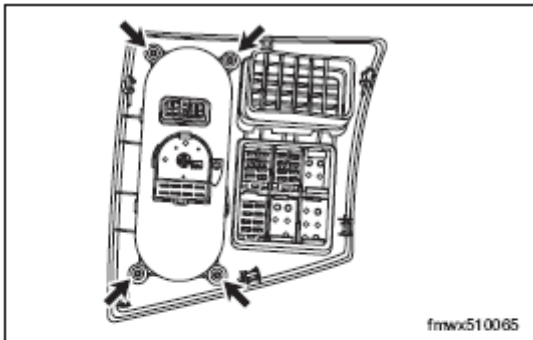
2. Remove the air conditioner control switch.

- (a) Remove the trim strip.
- (b) Remove the air conditioner control switch panel.
- (c) Disconnect the connector of control switch wire.

- (d) Remove the control switch lock bolt.



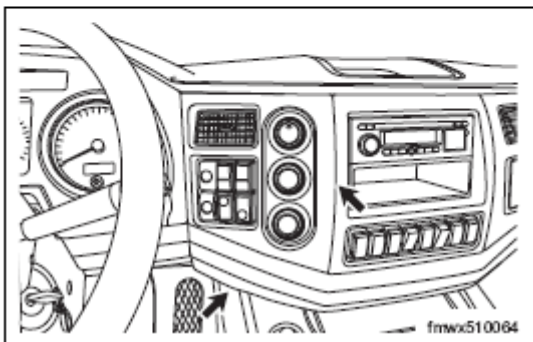
3. Check the air conditioner control switch. Refer to Chapter 51: Testing and Adjustment, Air Heater and Air Conditioner- Air Heater and Air Conditioner.



4. Refit the control switch.

- (a) Refit the switch lock bolt.

- (b) Connect the control switch wire connector.
- (c) Connect the switch panel.
- (d) Refit the trim strip.



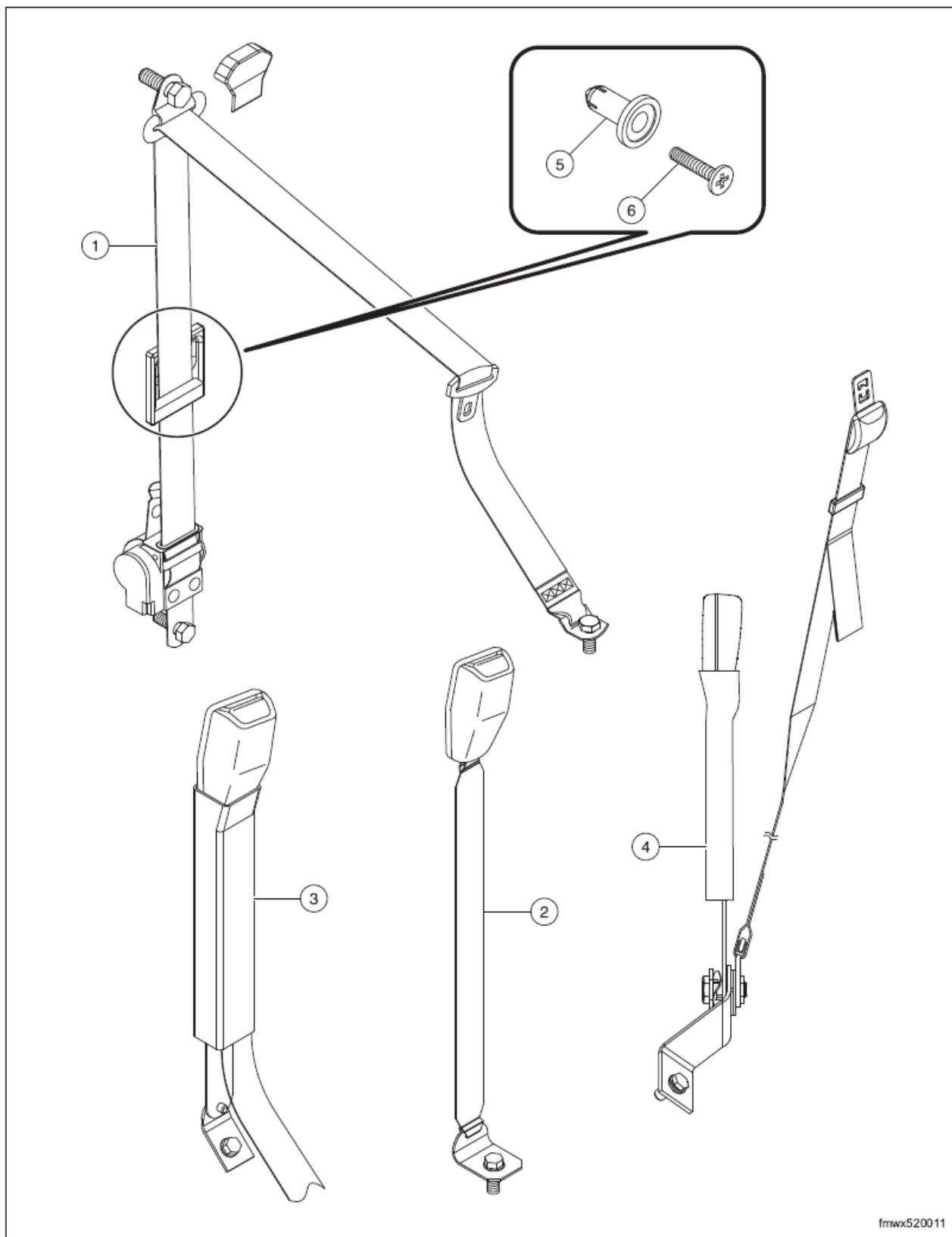
5. Turn on the power master switch.

SAFETY BELT

SAFETY BELT ASSEMBLY	52-3
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SAFETY BELT ASSEMBLY DIAGRAM OF COMPONENTS



52-4

SAFETY BELT-SAFETY BELT ASSEMBLY

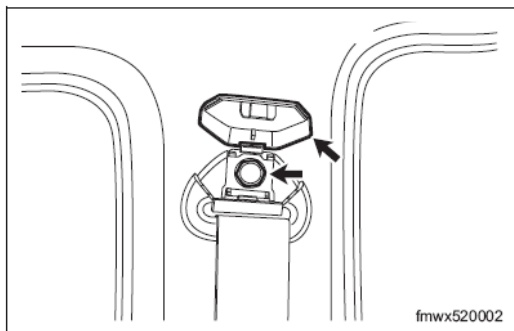
1	Safety belt retractor assembly	4	Passenger seat and middle seat buckle assembly
2	Middle seat buckle assembly	5	Plastic screw -Safety belt
3	Drive seat buckle assembly	6	Plastic bolt-Safety belt

DRIVER SEAT SAFETY BELT

SERVICE

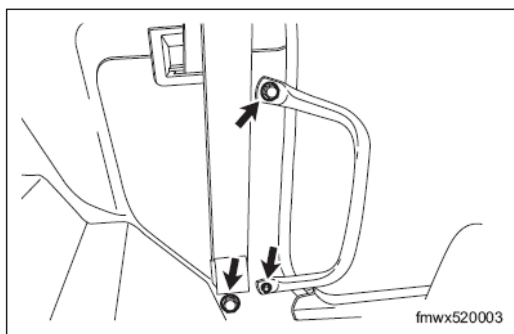
Hint:

Refer to Chapter 52: Component Drawing, Safety Belt-Safety Belt Assembly.



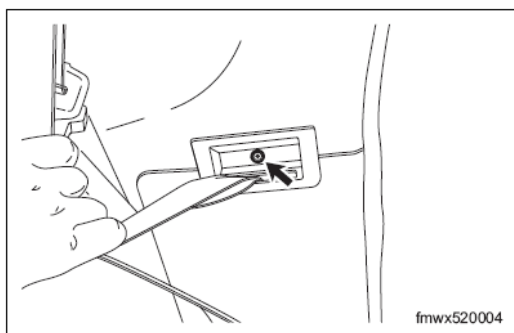
1. Remove the driver seat safety belt.

- (a) Turn up the driver seat safety belt trim cover.
- (b) Remove the set bolt on the top of safety belt.

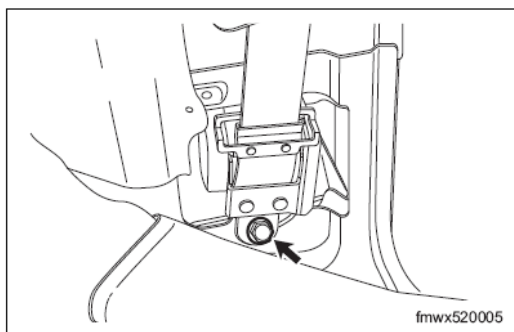


- (c) Remove the door handrail.
- (d) Remove the set bolt at the bottom of safety belt.

52



- (e) Remove the safety belt plastic bolt and plastic screw
- (f) Remove the left side wall lower baffle.



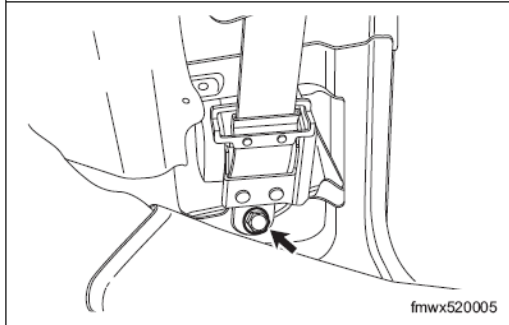
- (g) Remove the set bolt for safety belt retractor.

2. Check the safety belt assembly.

- (a) Requirements on the strap: The strap surface shall be clean and smooth, weaved evenly, free from spots, crack, overlap, burr or other defects.
- (b) Requirements on the retractor: The retractor can be retracted automatically at the mounting angle.

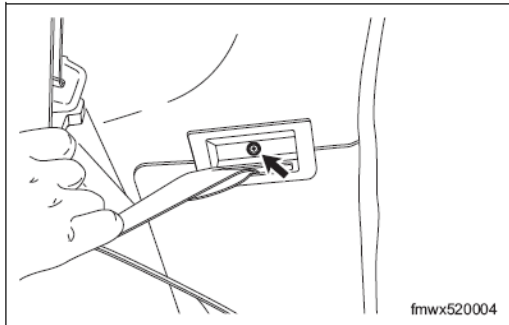
Notice:

If the safety belt can't meet all performance requirements, it shall be replaced.

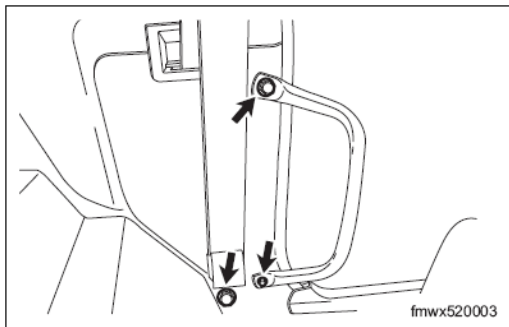


3. Fit the driver seat assembly.

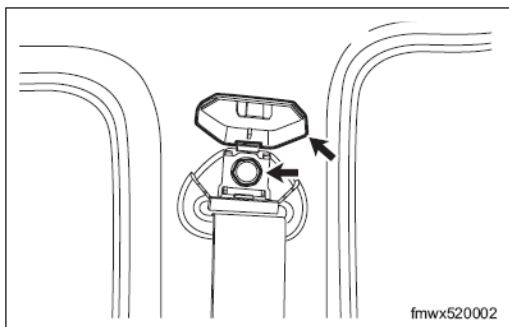
- (a) Tighten the safety belt retractor set bolt.
Torque: 60N.m



- (b) Fit the left side wall lower baffle.
- (c) Fit the safety belt plastic bolt and screw.



- (d) Fit the belt bottom set bolt.
- (e) Fit the door handrail.



4. Fit the driver seat safety belt.

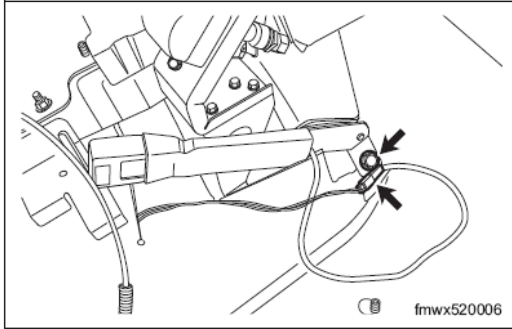
- (a) Fit the belt top set bolt.
- (b) Recover the driver seat safety belt trim cover.

DRIVER SEAT BUCKLE

SERVICE

Hint:

Refer to Chapter 52: Component Drawing, Safety Belt-Safety Belt Assembly.



1. Remove the driver seat buckle.

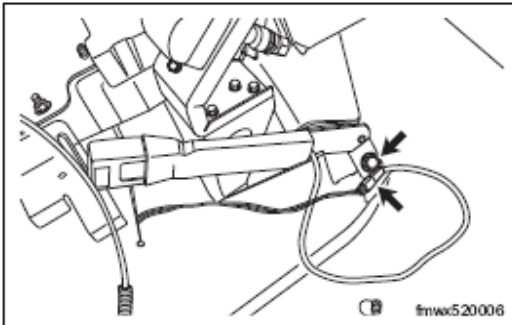
- (a) Turn up the carpet.
- (b) Disconnect the safety belt indicator lamp wire connector.
- (c) Remove the buckle set bolt.

2. Check the driver seat buckle.

- (a) Requirements on the buckle: It must be sensible when the lock tongue is inserted and the buckle unlocked correctly. The buckle shall not be unlocked by itself, and the assembly shall not become ineffective.
- (b) Fasten the safety belt and check whether the safety belt indicator lamp works normally.

Notice:

If the driver seat buckle can't meet all performance requirements, it shall be replaced.



3. Fit the driver seat buckle.

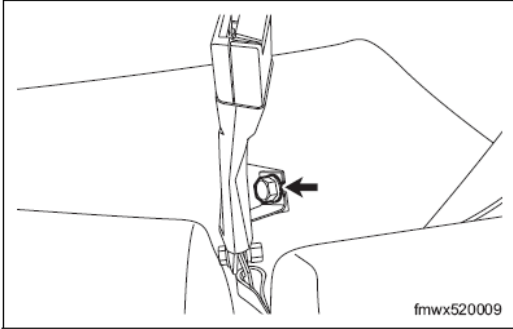
- (a) Fit the buckle set bolt.
Torque: 60N.m
- (b) Connect the safety belt indicator lamp wire connector.
- (c) Recover the carpet.

CO-DRIVER SEAT BUCKLE AND MIDDLE SEAT SAFETY BELT

SERVICE

Hint:

Refer to Chapter 52: Component Drawing, Safety Belt-Safety Belt Assembly.



1. Remove the middle seat safety belt and co-driver seat safety belt buckle.

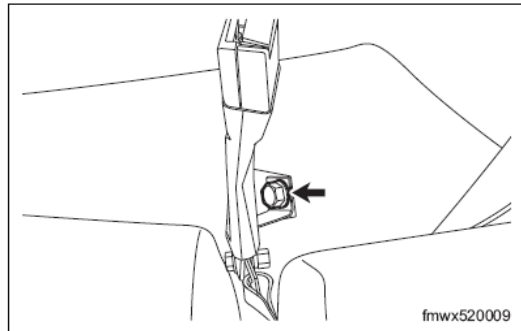
- (a) Turn up the carpet.
- (b) Remove the safety belt and buckle set bolt.

2. Check the middle seat safety belt and co-driver seat buckle.

- (a) Requirements on the strap: The strap surface shall be clean and smooth, weaved evenly, free from spots, crack, overlap, burr or other defects.
- (b) Requirements on the buckle: It must be sensible when the lock tongue is inserted and the buckle unlocked correctly. The buckle shall not be unlocked by itself, and the assembly shall not become ineffective.

Notice:

If the middle seat safety belt and co-driver seat buckle can't meet all performance requirements, they shall be replaced.



3. Fit the middle seat safety belt and co-driver seat buckle.

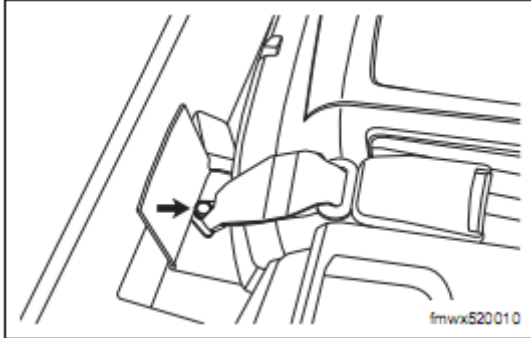
- (a) Fit the safety belt and buckle set bolt.
Torque: 60N.m
- (b) Recover the carpet.

MIDDLE SEAT SAFETY BELT BUCKLE

SERVICE

Hint:

Refer to Chapter 52: Component Drawing, Safety Belt-Safety Belt Assembly.



1. Remove the middle seat safety belt buckle.

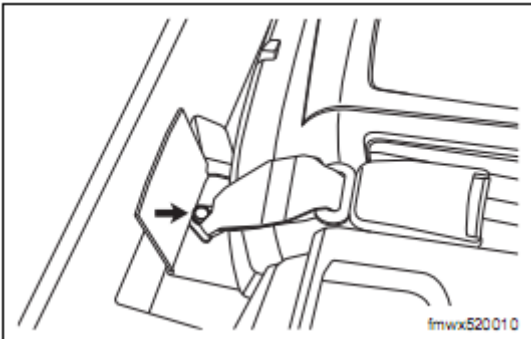
- (a) Turn up the carpet.
- (b) Remove the middle seat buckle set bolt.

2. Check the middle seat safety belt buckle.

- (a) Requirements on the strap: The strap surface shall be clean and smooth, weaved evenly, free from spots, crack, overlap, burr or other defects.
- (b) Requirements on the buckle: It must be sensible when the lock tongue is inserted and the buckle unlocked correctly. The buckle shall not be unlocked by itself, and the assembly shall not become ineffective.

Notice:

If the middle seat buckle can't meet all performance requirements, the middle seat safety belt buckle assembly shall be replaced.



3. Fit the middle seat safety belt buckle.

- (a) Fit the middle seat safety belt buckle set bolt.
Torque: 60N.m
- (b) Recover the carpet.



BATTERY

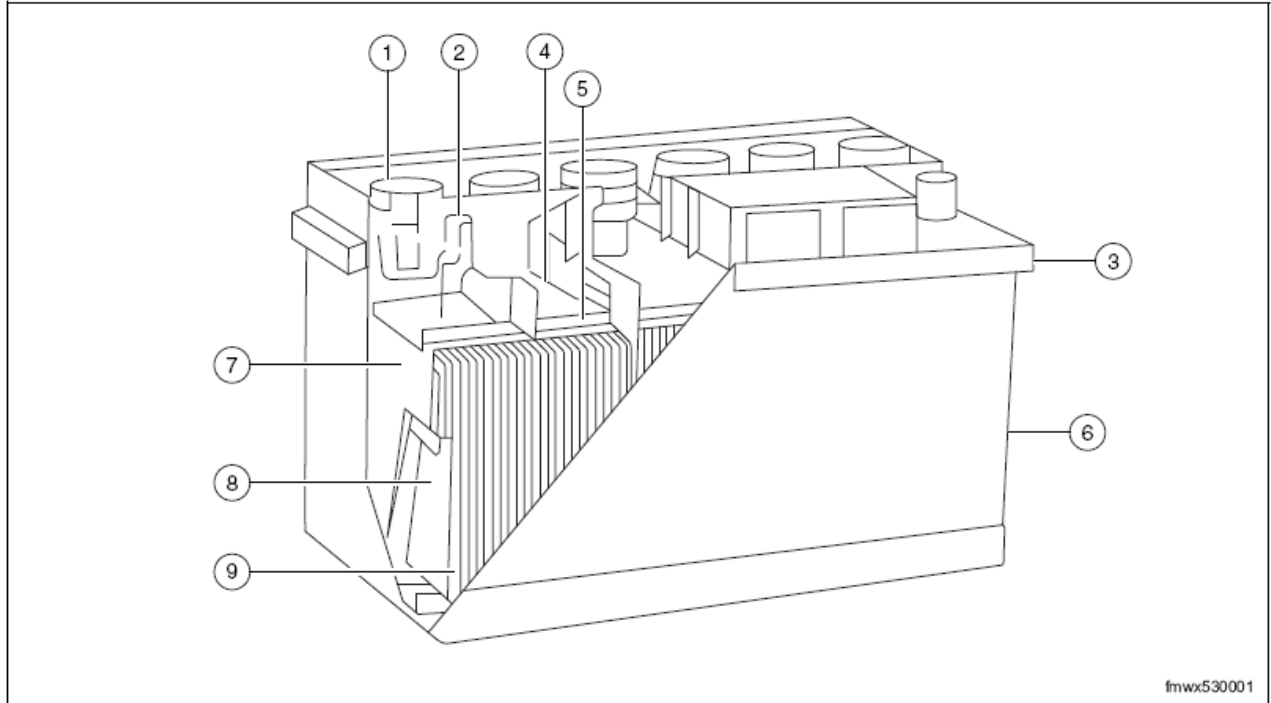
BATTERY ASSEMBLY	53-3
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BATTERY ASSEMBLY

OVERVIEW

Structure



1	Exhaust valve
2	Cathode post
3	Battery cover
4	Bridge connection
5	Bus bar

6	Integral tank
7	Cathode plate
8	Separator
9	Anode plate

1. The grille is functioned to bear the active substance, conduct the current, and guarantee the uniform distribution of current. The grille is generally fabricated from lead-stibium alloy. The stibium can promote the mechanical strength and casting performance, however it can accelerate the separation out of hydrogen, speed up the consumption of electrolyte, lead to self-discharging of battery and corrosion of grille, and shorten the service life of battery. At present, most batteries adopt lead-low stibium alloy grille or lead-calcium-tin alloy grille. The maintenance-free battery adopts the lead-calcium alloy.
2. The separator for battery is made of materials such as porous rubber and plastic glass fiber and must feature high porosity, small pore diameter, acid resistance, secretion-free of hazardous substance, certain strength, low resistance within electrolyte, and chemical stability. The main functions are as below:
 - (a). It prevents the short-circuit of anode and cathode polarity plates.
 - (b). It guarantees the smooth penetration of anode and negative ions within electrolyte.
 - (c). It restrains the fall-off of active substances on anode and cathode polarity plates and prevents the damage of anode and cathode polarity plates due to vibration.

3. The electrolyte is mainly functioned to conduct the current and take part in the electric-chemical reaction. The electrolyte is prepared from concentrated sulphur acid and purified water. The purity and density of the electrolyte are of great importance to the capacity and service life of the battery. The automotive battery adopts the diluted sulphur acid electrolyte with a density of $1.280 \pm 0.005 \text{g/cm}^3$ (25 °C).
4. Cover is the containers for accommodation of anode and cathode polarity plates and electrolyte and are mainly fabricated from plastic and rubber materials.
5. The exhaust valve is fabricated from plastic and is functioned to seal the battery, restrain the ingress of air, and prevent the oxidation of polarity plates. Before use, make sure to penetrate the blind hole of the exhaust valve with nail, in order to guarantee the smooth escape of air.
6. In addition the above mentioned main components, the battery is also composed of the links, terminals, polarity , and level indicator.

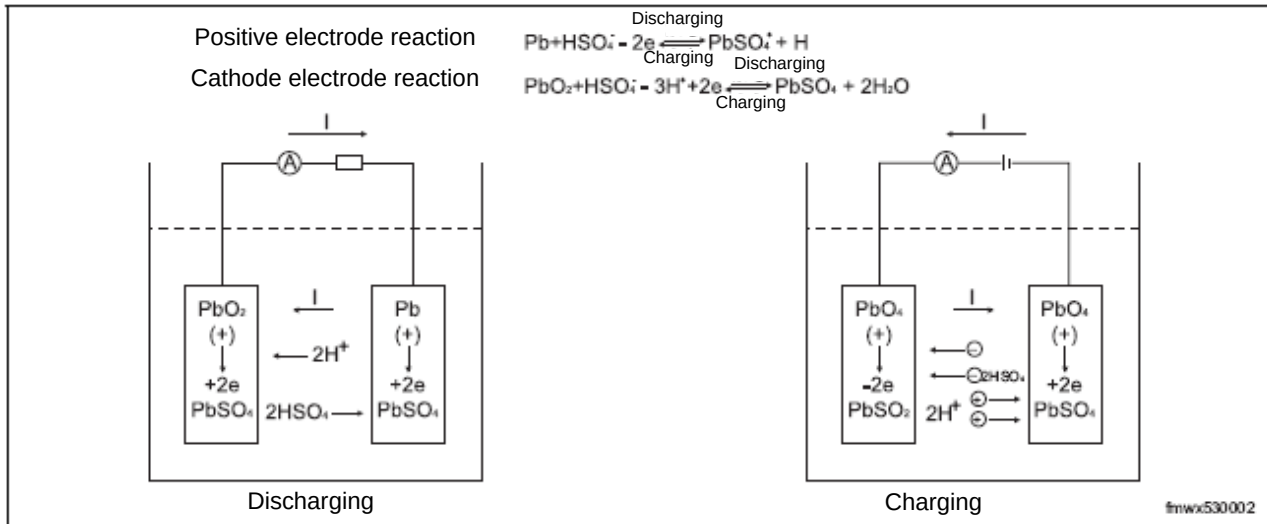
PRECAUTIONS

1. Charge the battery within a dry and well-ventilated room, with the room temperature preferably at 5~40°C.
2. Do not overlap the batteries nor directly place the battery onto the ground. Place the battery on wooden frame and do not place along with the alkaline battery or other chemicals.
3. Keep the area in which the battery is charged away from fire source and heat source.
4. The temperature of the electrolyte shall not exceed 45°C, or the cooling measure shall be taken (by lowering the charging current, stopping the charging, or immersing the battery into water bath for cooling).



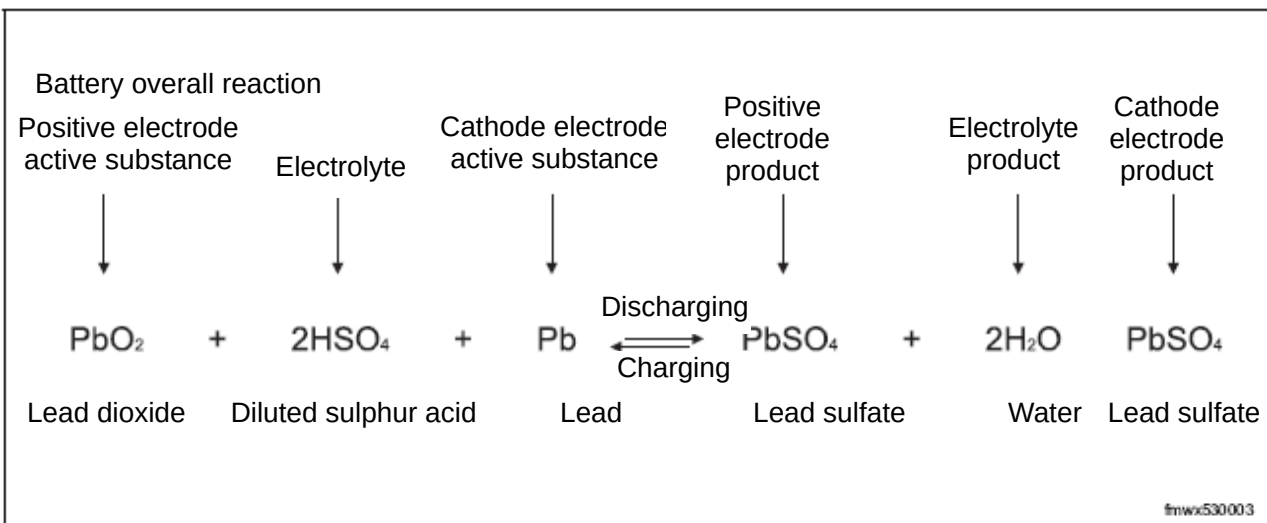
WORKING PRINCIPLE

In a lead-acid battery, the anode active substance is lead dioxide and the cathode active substance is spongy lead, with the diluted sulphur acid as conductive medium (electrolyte). During the charging and discharging of the battery, the following chemical action occurs in the anode and cathode polarity to convert the electrical energy into chemical energy for storage in the battery or convert the chemical energy to electric energy for outputting to outside world.



Discharging: The concentration of H₂SO₄ is reduced and the PbSO₄ on anode and cathode polarity is increased so that the internal resistance is increased, the concentration of electrolyte is reduced, and the electro-dynamic potential of battery is reduced.

Charging: The concentration of electrolyte is increased and the internal resistance is reduced so that the electro-dynamic potential of battery is increased. At the later stage of charging, a large amount of air bubbles appears due to the electrolysis of water.



After the battery is discharged, the active substances on two polarity are converted into lead sulfate, for which the theory explaining the streaming reaction of lead-acid battery is referred to as "Double sulphating" Theory.

TABLE OF FAULT PHENOMENA

The table below can be used to help find out the cause of the faults, in which the numerical sequence stands for the priority sequence of the faults. Check each part in order as per this sequence and as necessary replace with new one.

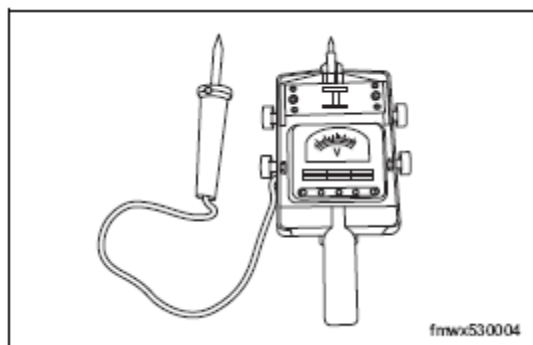
Fault	Suspected component	Reference
Low battery power	1. Long term storage of battery	Chapter 53 Battery – Battery, Checking and Adjustment
	2. Battery polarity plate (vulcanization)	Chapter 53 Battery – Battery, Checking and Adjustment
	3. Battery (internal short-circuit)	Chapter 53 Battery – Battery, Checking and Adjustment
	4. Battery electrolyte plate (bending)	Chapter 53 Battery – Battery, Checking and Adjustment
	5. Polarity plate (break-off of active substances)	Chapter 53 Battery – Battery, Checking and Adjustment
	6. Reverse polarity of one battery cell	Chapter 53 Battery – Battery, Checking and Adjustment
Explosion	1. Battery (over-charged)	Chapter 53 Battery – Battery, Checking and Adjustment
	2. Battery (internal short-circuit, vulcanization)	Chapter 53 Battery – Battery, Checking and Adjustment
	3. Encountering fire source	Chapter 53 Battery – Battery, Checking and Adjustment
Quick drop of electrolyte level	1. High charging current	Chapter 53 Battery – Battery, Checking and Adjustment
	2. Housing leakage	Chapter 53 Battery – Battery, Checking and Adjustment
	3. Vulcanization or short-circuit of one battery cell	Chapter 53 Battery – Battery, Checking and Adjustment
Yellow and white substances on battery cover and polarity	1. Housing leakage	Chapter 53 Battery – Battery, Checking and Adjustment
Freezing of battery	2. Low electrolyte specific gravity	Chapter 53 Battery – Battery, Checking and Adjustment

CHECKING AND ADJUSTMENT

Appearance Checking

1. Check whether the battery appearance is intact and whether the connections of fixing tie rod and wires are secure.
2. Observe the electrolyte level of the battery. The required level shall be above the polarity plate by 10~15mm. If the electrolyte level is lower than the required level, refill the distilled water.
3. Observe the casing and central separator of the battery for presence of cracking. Knock the casing and central separator with wood rod and listen for the rupture sound. The cracking is vulnerable to appear on the central separator and the four casing walls. Carefully check these areas.
4. If a observation glass is equipped, the green color indicates that the battery power is sufficient and the red color and white color indicate that the battery power is insufficient and depleted respectively.

Capacity Checking



1. The high rate discharge gauge is also referred to as discharge tongs and is composed of one DC voltmeter and one load resistor.
2. During measurement, tightly press two probes to the anode and cathode polarity of the battery respectively and hold for 5S and then observe the voltage of the battery that can be sustained under high discharge condition. This can correctly judge the discharge extent and the start capability of the battery.
3. For the high rate discharge gauges from different manufacturers, please operate as per the values specified in the corresponding operation instruction. Generally, for a battery under good technical condition, the voltage of any battery cell shall be higher than 1.5V and shall maintain constant within 5s. If the voltage drops rapidly within 5s or the voltage of any battery cell is lower than others by more than 0.1V, it indicates that the battery is malfunctioned.

The comparison table measured by using the high rate discharge gauge is as below.

Display area	Determination	Disposal Method
White zone	Sufficient	Continue to use
Green zone	Normal	Continue to use
Yellow zone	Insufficient	Charge the battery
Red zone	Depleted	Charge the battery

Charging of Battery

Attention:

- Charge the battery within a dry and well-ventilated room, with the room temperature preferably at 5~40°C.
- Do not overlap the batteries nor directly place the battery onto the ground. Place the battery on wooden frame and do not place along with the alkaline battery or other chemicals.
- Keep the area in which the battery is charged away from fire source and heat source.
- The temperature of the electrolyte shall not exceed 45°C, or the cooling measure shall be taken (by lowering the charging current, stopping the charging, or immersing the battery into water bath for cooling).

Constant Current Charging

The constant current charging also includes the initial charging, supplementary charging, common charging, and equalizing charging.

- The initial charging refers to the first charging before the non-dry charged battery is put in use. After the non-dry charged battery is filled with electrolyte, position under still condition for 1~6h and wait till the temperature drops to below 35°C before starting the charging.
- The charging current for the initial charging is generally 0.07C20A (namely $0.07 \times 20 = 1.4A$ current). After the voltage of single cell is charged to 2.4V, halve the charging current and continue the charging.
- The supplementary charging is only applicable for the dry charged battery with poor dry charging performance that is under storage for a long period or the fully charged battery that is unused for approximate one month. For the supplementary charging, the charging current is 0.1C20A and the charging duration is approximate 5 hours or is determined based on the storage period.
- The common charging refers to the charging after the battery is put in use. In the first phase of the common charging, the charging current is 0.1C20A and the battery is charged for 8~12h, till the voltage reaches 2.4V/cell. Next, halve the charging current and charge for approximate further 10h. The charging amount is generally above 1.5 times of the discharging amount or is 1.3~1.5 times of the rated capacity.
- The equalizing charging is to, after the battery is fully charged by common charging method, further charge the battery with 0.035C20A current. When the uniform air bubbles emerge in the battery and the temperature is increased, stop the charging for 1h. Repeat above step for 3~4 times. In such case, after one battery generates a large amount of air bubbles and the voltage and the electrolyte density tend to become constant, stop the charging.

Constant Voltage Charging

The constant voltage charging is to charge the battery with one constant charging voltage, during which the charging current is high at the beginning and then reduces gradually. The constant voltage charging voltage is generally 2.4~2.4V. Under this charging mode, it can generate tiny gas and consume tiny water. Therefore, the constant voltage charging is generally used for maintenance-free sealed lead-acid battery.

Quick Charging

The quick charging is to charge the battery by means of the intermittent charging method with high current, pulse charging, and short discharging. The quick charging generally uses 1~2 times of C20A high current to charge the battery. The quick charging is fulfilled by means of the specially fabricated quick charger.

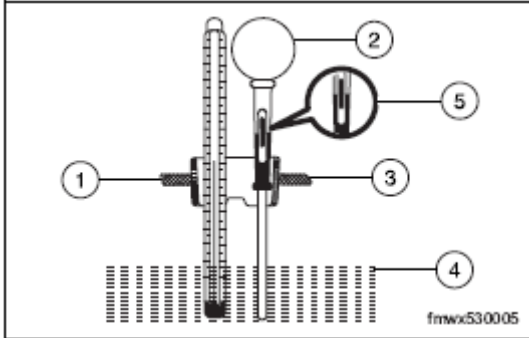
The signs to judge whether the battery is fully charged are as below:

- (a). A large amount of air bubble is generated in one battery cell.
- (b). The voltage of one battery cell is 2.6~2.8V and remains unchanged while being measured for more than 2 hours.
- (c). The specific gravity of electrolyte is $1.280 \pm 0.01g/cm^3$ (25 °C) and remains unchanged while being measured for more than 2 hours.

Refilling Water to Battery**Attention:**

The operation personnel shall wear the protective goggles, acid-resistant gloves, rubber shoes or boots, and rubber apron. The container for containment of electrolyte shall be made of acid-resistant and thermal-resistant plastic, glass, ceramic, or lead.

1. Screw off the cap of the filler port and check the electrolyte level. The minimum level shall be the top of the polarity plate.

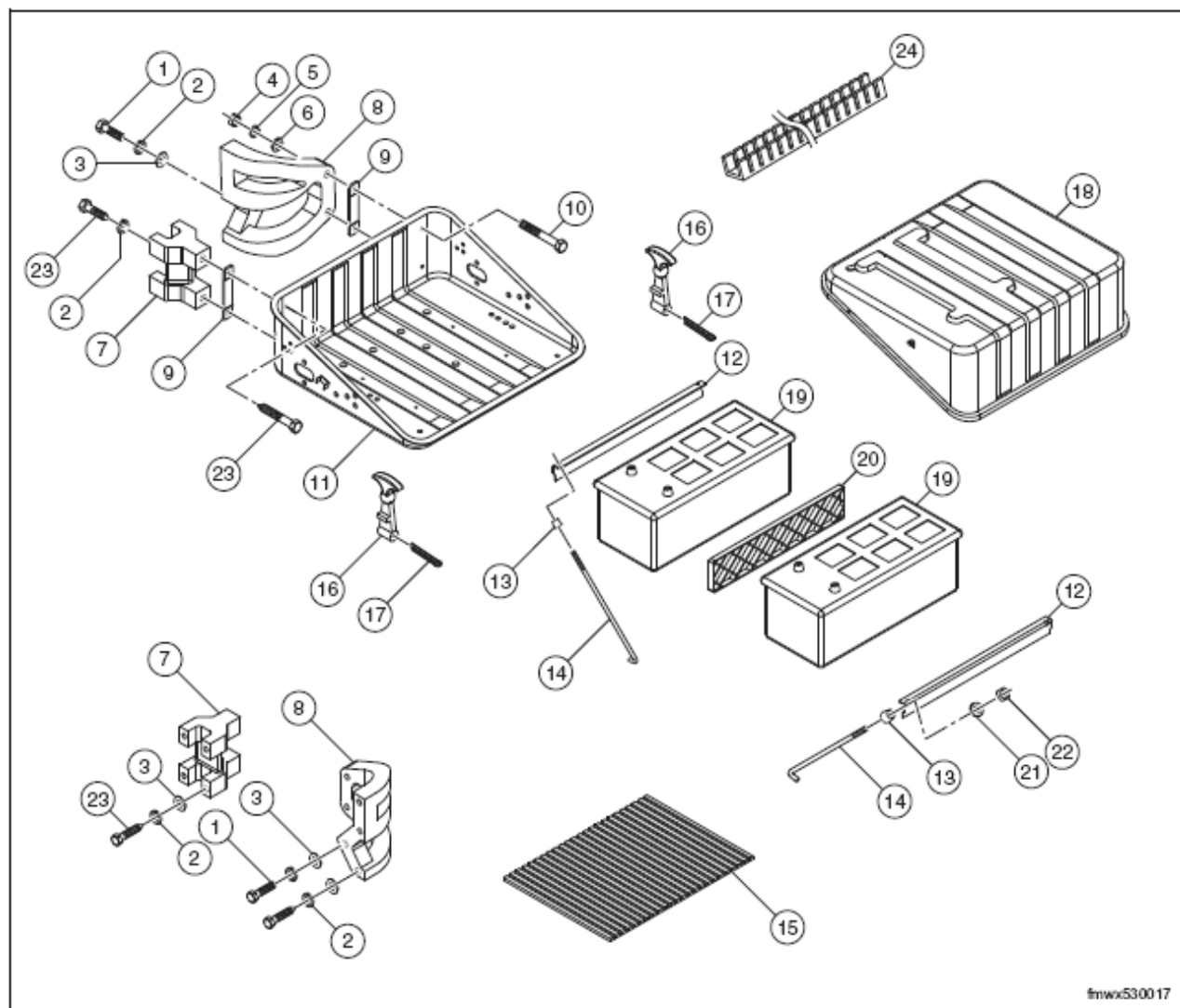


2. Check the electrolyte density.

3. If the electrolyte is invisible, refill the water, till the polarity plate is immersed.
4. Attach the cap and tighten.
5. Fully charge the battery before refilling the water.
6. At completion of charging, screw off the cap and check the electrolyte level and density.

Specific gravity value	Determination	Disposal Method
Above 1.300	Excessive electrolyte concentration or refilling error	Refill distilled water or deionized water
1.250~1.280	Good	Continue to use
1.220~1.250	Insufficient	Charge the battery
Below 1.100~1.220	Over-discharged, with low concentration	Charge and re-check
Difference of specific gravity is above 0.04 amongst all battery cells	One battery cell is probably malfunctioned	Charge and re-check

DIAGRAM OF COMPONENTS



1	Hexagon bolt
2	Spring washer
3	Plain washer
4	1# hexagon nut
5	Spring washer
6	Plain washer
7	Battery box front bracket
8	Battery box rear bracket
9	Battery box mounting plate
10	Hex head bolt
11	Battery box body
12	Clamping bracket

13	Rubber damper
14	Fixing tie rod
15	Rubber pad
16	Hook
17	Split pin
18	Battery box cover
19	Battery
20	Separator
21	Small washer
22	1# all-metal hexagon lock nut
23	Hex head bolt
24	Wiring sheath

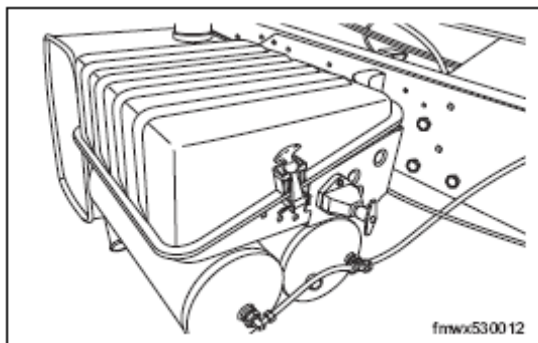
BATTERY

REPLACEMENT

Hint:

Please refer to Chapter 53 Battery – Battery, Diagram of Components for the diagram of components.

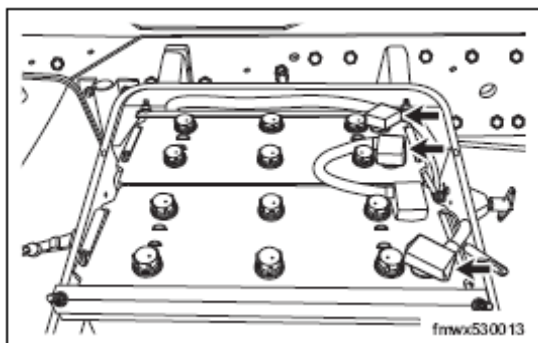
1. Turn off the battery

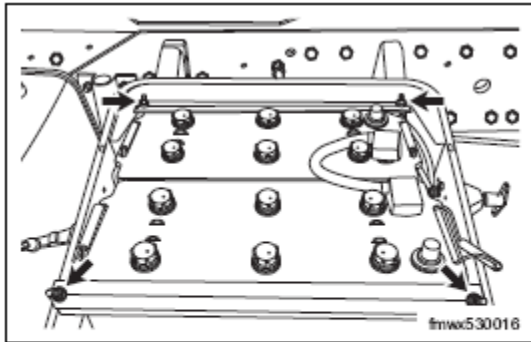


2. Open the battery box cover.

3. Disassemble the battery.

(a). Upturn the protective sleeve of battery polarity .





(b). Disconnect the battery cables.

Attention:

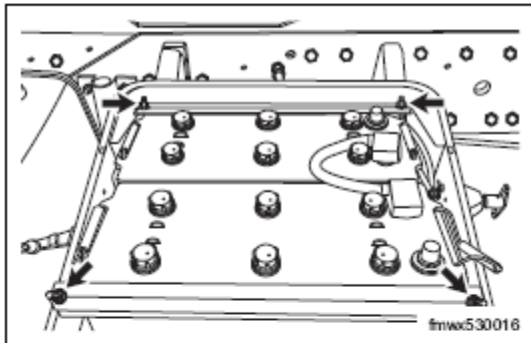
Disconnect the cathode cable first.

(c). Disassemble the clamping bracket.

(d). Take out the battery and separator.

Attention:

Lift the battery out steadily by two operators and prevent tilting the battery, which will lead to leakage of electrolyte.



4. Install the battery.

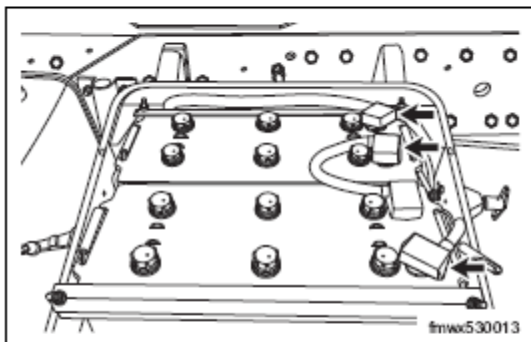
(a). Install the battery and separator.

(b). Install the clamping bracket.

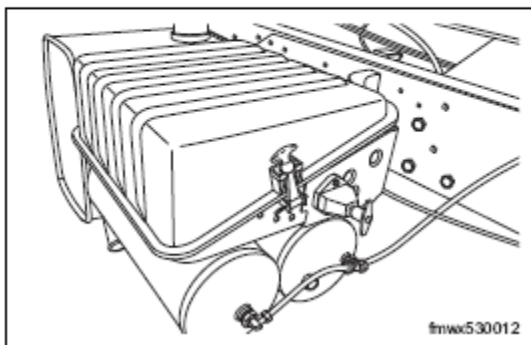
(c). Install the battery cables.

Attention:

Clean the polarity and apply the grease. Install the anode cable first.



(d). Turn down the protective sleeve of battery polarity.



5. Close the battery box cover.



MAINTENANCE

1. Use and Maintenance of Battery in winter

- (a). Frequently maintain the battery under fully charged status, in order to prevent the freeing of electrolyte due to reduction of electrolyte specific gravity, which will lead to the malfunctions such as container rupture, bending of electrolyte plate, and break-off of active substances.
- (b). In winter, refill the electrolyte with specific gravity at 1.40 for adjustment, as defined in the table below.

Measured electrolyte temperature	+ 45	+ 30	+ 15	0	− 15	− 30	− 45
Corrected value of hydrometer reading	+ 0.02	+ 0.01	0	− 0.01	− 0.02	− 0.03	− 0.04

- (c). In winter, refill the water only when the engine is running and the generator is charging the battery, in order to prevent freezing of electrolyte due to uneven mixture between water and electrolyte.
- (d). As the battery capacity drops in winter, it's necessary to preheat the engine under the cold start of engine. Meanwhile, the starter can't be turned on for more than 15s each time and the interval between any two consecutive starts shall be 2~3min. If the engine can't start from three start tries, check for engine malfunction and restart the engine after the malfunction is resolved.

2. Use of newly replaced battery

- (a). For dry charged battery, mainly refill the electrolyte meeting the required specification into the battery (Refer to Chapter 53 Battery – Electrolyte, Refilling) and wait for half hour before use. No initial charging is required, but it's preferable to charge the battery for 3~4h, which is more beneficial to the service performance of the battery.
- (b). For non-dry charged battery, make sure to fulfill the initial charging before use.

ELECTROLYTE

ADDING

1. Preparation of Electrolyte

Attention:

While preparing the electrolyte, the operation personnel must wear the protective goggles, rubber gloves, plastic apron, and high rubber boots, in order to prevent scalding.

If the clothing is contaminated by sulphur acid, immerse the clothing with 10% soda water solution immediately and then wash with clean water.

Attention:

The containers for preparation of electrolyte must be acid-resistant and thermal-resistant glazed ceramic container, glass jar, plastic tank, or lead lined wood tank.

- (a). Before the preparation, thoroughly clean the containers and clean with pure water.
- (b). While preparing the electrolyte, firstly pour the pure water needed into the container and then slowly inject the concentrated sulphur acid into the pure water and stir continually. It's strictly prohibited to pour the water into the concentrated sulphur acid, in order to prevent the splashing scalding.
- (c). The electrolyte of lead-acid battery is prepared from pure water and concentrated sulphur acid, with a density at $1.280 \pm 0.005 \text{ g/cm}^3$ (25 °C).
- (d). The conversion equation for electrolyte density is as below: $d_{25} = d_t + 0.007 (t - 25)$
 - d_{25} : Electrolyte density at 25°C
 - d_t : Electrolyte density when the temperature is at t.
 - 0.007: Temperature coefficient
 - t: Measured electrolyte temperature
- (e). While measuring the specific gravity, measure the electrolyte temperature as well and then convert the measured specific gravity to the value at 15°C. This is because that the specific gravity of the electrolyte is reduced by 0.007 g/cm^3 when the temperature is increased by 1°C and our national standard defines 15°C as the benchmark temperature. Therefore, after the measurement, it's necessary to correct the temperature, namely adding the correction value for above 15°C and deducting the correction value for below 15°C.

2. Choice of Electrolyte Specific Gravity

When the specific gravity of the electrolyte is increased, the freezing point of the electrolyte is reduced, which can reduce the freezing hazard and promote the battery capacity. However, when the specific gravity is too high, due to the increased viscosity of electrolyte and difficult penetration, the battery capacity is on the contrary reduced and the carbonization of wood separator is accelerated and the polarity plate is vulnerable to vulcanization, which will greatly reduce the battery life. Therefore, choose the different specific gravity of electrolyte depending on the different operating conditions. Please refer to the table below for the choice of electrolyte specific gravity under different regions and weather conditions.

Climatic condition	Electrolyte specific gravity of completely-charged battery under 15°C	
	Winter	Summer
Region with temperature lower than -40°C in winter	1.31	1.27

BATTERY-ELECTROLYTE

Climatic condition	Electrolyte specific gravity of completely-charged battery under 15°C	
	Winter	Summer
Region with temperature more than -40°C in winter	1.29	1.25
Region with temperature more than -30°C in winter	1.28	1.25
Region with temperature more than -20°C in winter	1.27	1.24
Region with temperature more than 0°C in winter	1.24	1.24

3. Choice of Electrolyte Specific Gravity

When it's necessary to adjust the specific gravity of electrolyte at the change of seasons, fully charge the battery and measure the specific gravity. If the specific gravity is not appropriate, such out some electrolyte with suction pipe. If the measured specific gravity is higher than the required value, refill the distilled water. If the measured specific gravity is lower than required value, refill the 1.40 g / cm³ electrolyte, charge for a while to mix uniformly, and re-measure the specific gravity, till the specific gravity is appropriate.

The adjustment of battery electrolyte specific gravity in winter shall comply with the table below.

Discharging degree	Complete charging		25 %		50 %		75 %		100 %	
	Specific gravity 15 °C	Freezing point 0 °C	Specific gravity 15 °C	Freezing point 0 °C	Specific gravity 15 °C	Freezing point 0 °C	Specific gravity 15 °C	Freezing point 0 °C	Specific gravity 15 °C	Freezing point 0 °C
specific gravity and freezing point of electrolyte	1.310	-76	1.270	-58	1.230	-36	1.190	-22	1.150	-14
	1.290	-70	1.250	-50	1.210	-28	1.170	-18	1.130	-10
	1.280	-69	1.240	-42	1.200	-25	1.160	-16	1.120	-9
	1.270	-58	1.230	-36	1.190	-22	1.150	-14	1.110	-8
	1.250	-50	1.210	-28	1.170	-18	1.130	-10	1.090	-6
	1.240	-42	1.200	-25	1.160	-16	1.120	-9	1.080	-5

4. Refilling of Electrolyte

Attention:

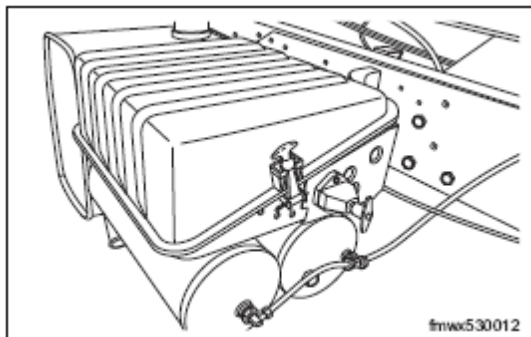
Before refilling the electrolyte, make sure to wear the protective articles. If the clothing is contaminated by sulphur acid, immerse the clothing with 10% soda water solution immediately and then wash with clean water.

- Screw off the exhaust valve and make sure to penetrate the breathe hole of the exhaust valve. There are a sealing gasket and sealing paper beneath the exhaust valve, which shall be removed after refilling with electrolyte.
- Make sure to cool down the electrolyte to below 30°C before pouring into the battery.
- Pour the prepared electrolyte into each battery cell. The electrolyte level shall be level with the highest position marking of the housing and the electrolyte level of the rubber cell shall be higher than the separator by 10~15mm.
- Tighten the exhaust valve to prevent the electrolyte leakage.

BATTERY SWITCH

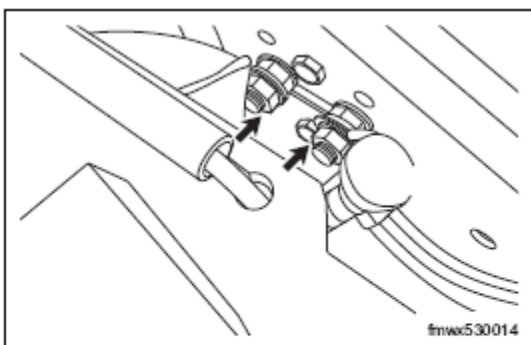
REPLACEMENT

1. Turn off the battery switch.



2. Open the battery box cover.

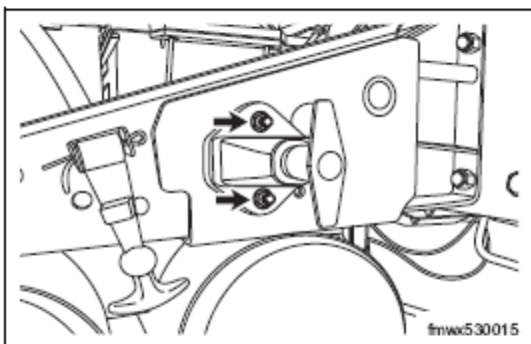
3. Disconnect the cathode cable of battery.



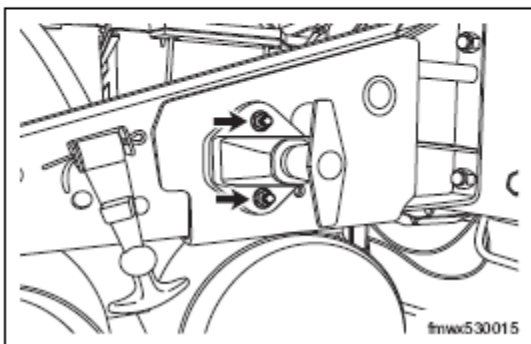
4. Disassemble the battery switch.

(a). Upturn the binding post cover of the battery switch.

(b). Disassemble the wiring polarity of the battery switch.

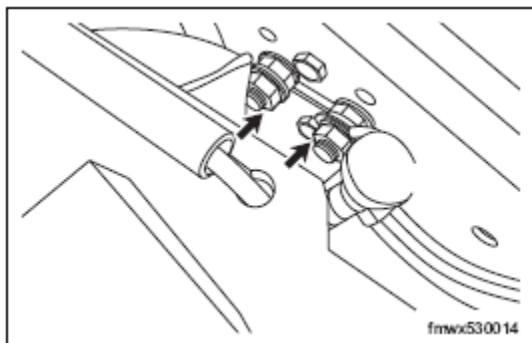


(c). Disassemble the fixing bolts of battery switch.



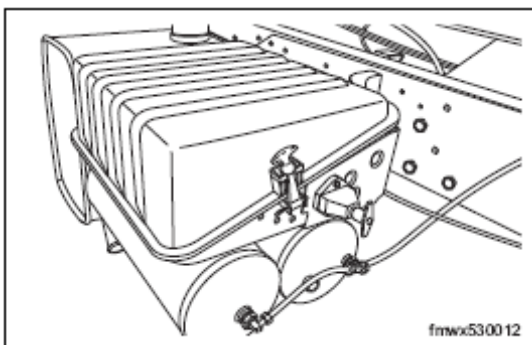
5. Install the battery switch.

(a) Install the fixing bolts of battery switch.



- (b) Install the wiring polarity of battery switch.
- (c) Turn down the binding post cover of the battery switch.

6. Connect the cathode cable of battery.



7. Close the battery box cover.

LIGHTING

LIGHTING SYSTEM	54-3
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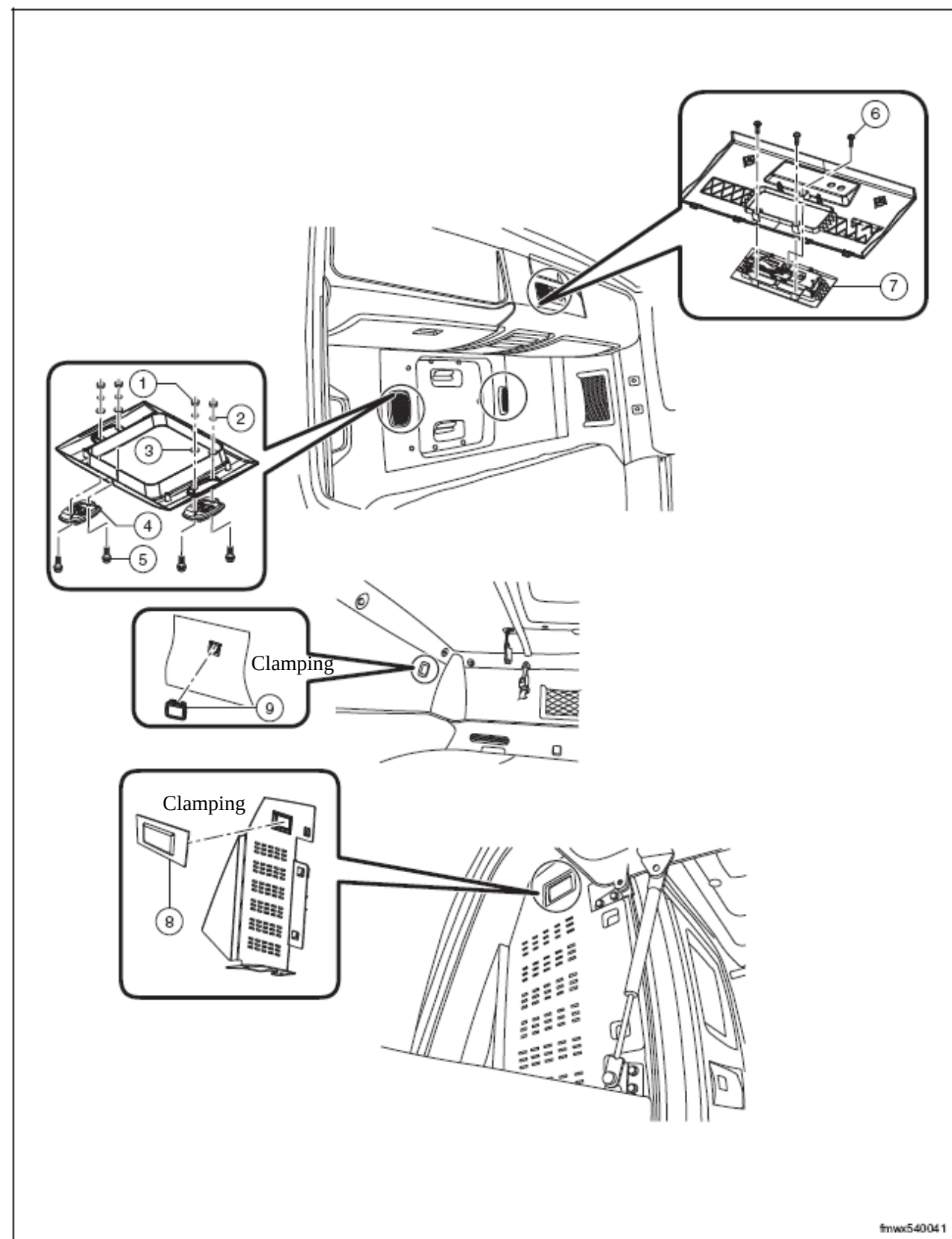
LIGHTING SYSTEM

PRECAUTIONS

1. **Cut off the power.**
 - (a). Before disassembling or installing any electric device or when any tool or equipment will easily come into contact with any exposed electric terminal, make sure to disconnect the cathode cable of the battery, in order to prevent injuring the personnel or damaging the vehicle.
 - (b). Make sure to turn off the ignition switch, unless otherwise specified.
2. **If the surfaces of the halogen bulb are contaminated by oil stains, the service life of the bulb will be shortened and the bulb will be burnt out due to overheating.**
3. **Extreme care shall be taken while handling the halogen bulb. Because the inside of bulb contains high pressure, the drop-off, knocking, or damage of the bulb may lead to explosion and burst.**
4. **Make sure to wear the protective goggles before the replacement of halogen bulb.**
5. **While handling the bulb, hold the bulb holder only and do not contact the bulb glass.**
6. **Prepare one bulb immediately ready for replacement. During the replacement of bulb, if the bulb is position for a long period after being disassembled from the vehicle, the reflector will be contaminated by dust and moisture.**
7. **Replace with the bulb with same nominal power.**
8. **After the replacement of bulb, re-secure the lamp holder. The ingress of the moisture surrounding the lamp holder may blur the reflector.**



DIAGRAM OF COMPONENTS



fmwx540041

1	2# hexagon nut
2	Spring washer

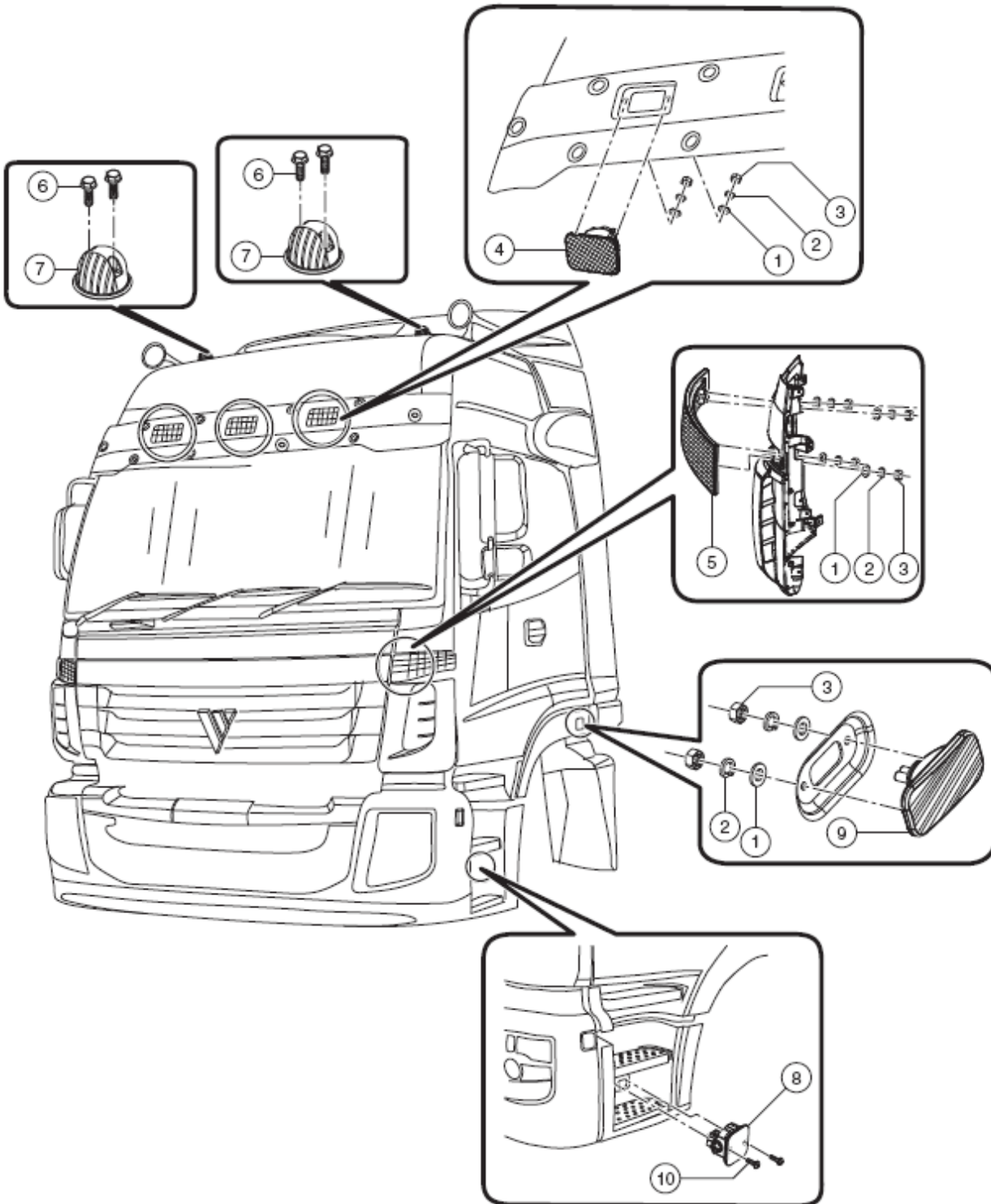
6	Phillips pan head self-tapping screw
7	Reading lamp assembly

LIGHTING- LIGHTING SYSTEM

54-5

3	Plain washer
4	Interior lamp assembly
5	Hex head bolt, spring washer, and plain washer subassembly

8	Overhead cabinet lamp assembly
9	Sleeper lamp assembly



fmx540040

1	Plain washer
2	Spring washer
3	Hexagon nut

6	Hexagon flange bolt
7	Clearance lamp
8	Courtesy lamp

LIGHTING- LIGHTING SYSTEM

54-7

4	Vehicle speed lamp assembly	9	Marker lamp assembly
5	Decorative lamp assembly	10	Phillips pan head self-tapping screw

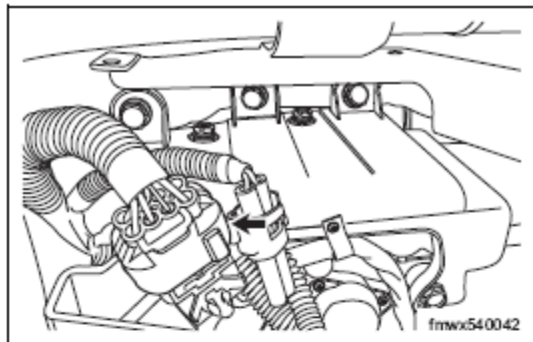
FRONT COMBINATION LAMP

REPLACEMENT

Hint:

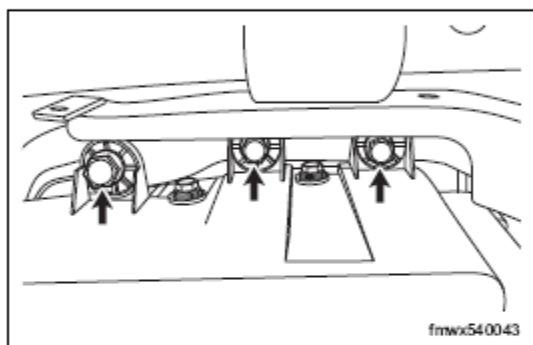
Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Cut off the main power.
2. Upturn the driver cab.

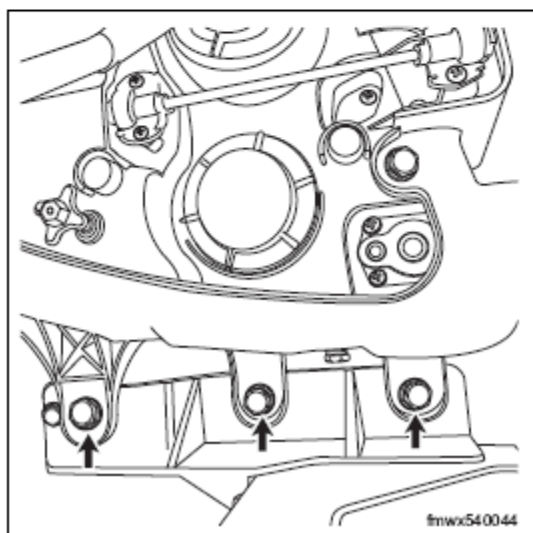


3. Disassemble the left front combination lamp assembly.

(a). Unplug the connector of front combination lamp.

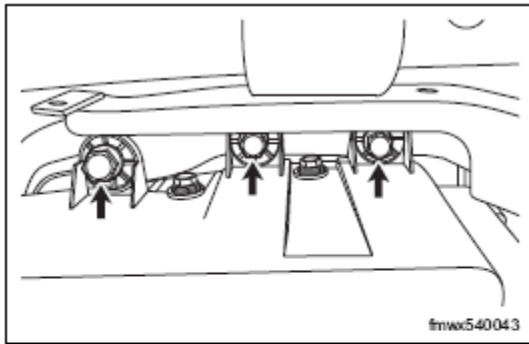


- (b). Disassemble the fixing bolts of left front combination lamp and remove the left front combination lamp assembly.



Hint:

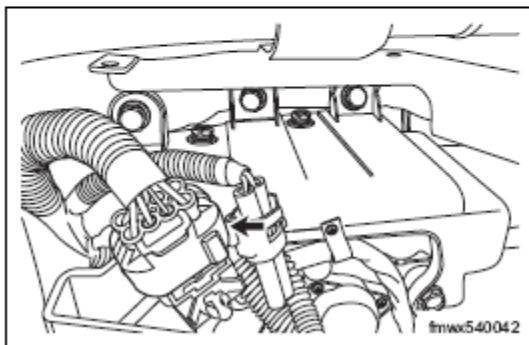
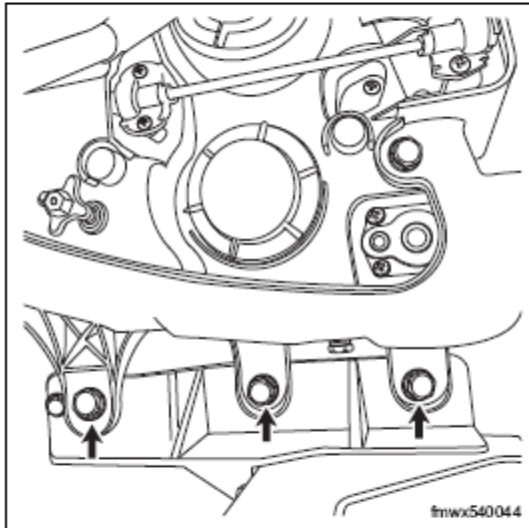
The disassembly procedure for right front combination lamp assembly is same with that for left front combination lamp assembly.



4. Install the left front combination lamp assembly.

(a). Install the fixing bolts of left front combination lamp.

Torque: 63N•m

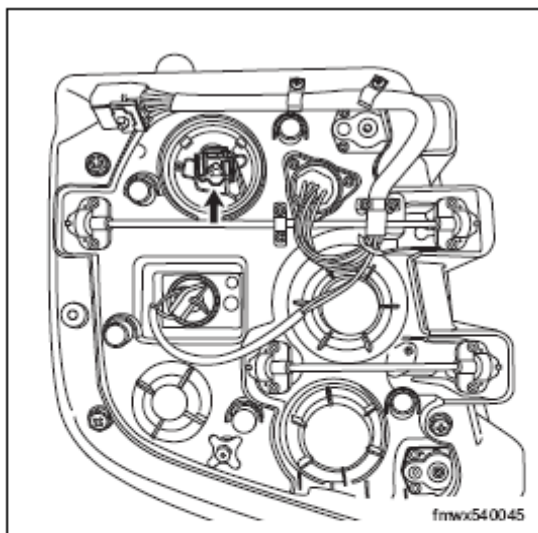


(b). Connect the connector of front combination lamp.

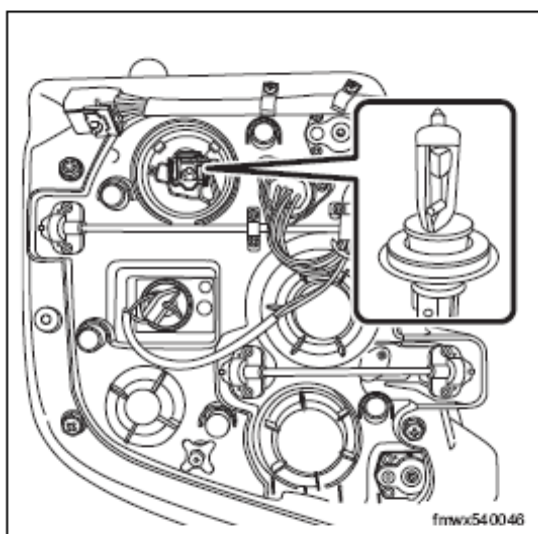
Hint:

The installation procedure for right front combination lamp assembly is same with that for left front combination lamp assembly.

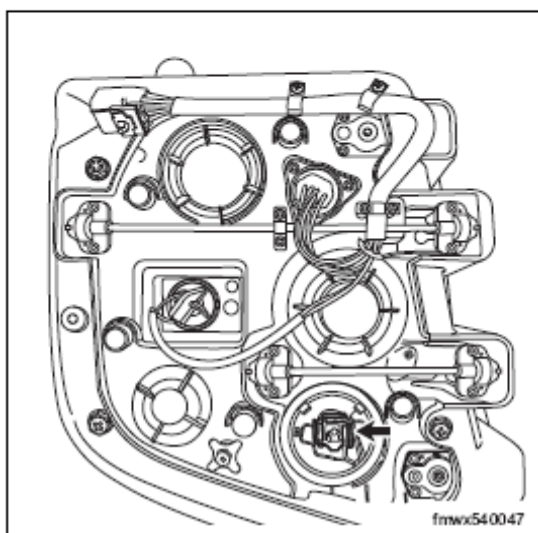
5. Turn down the driver cab.
6. Adjust the front combination lamp assembly (Refer to Chapter 54 Lighting – Front Combination Lamp, Adjustment).
7. Turn on the main power.



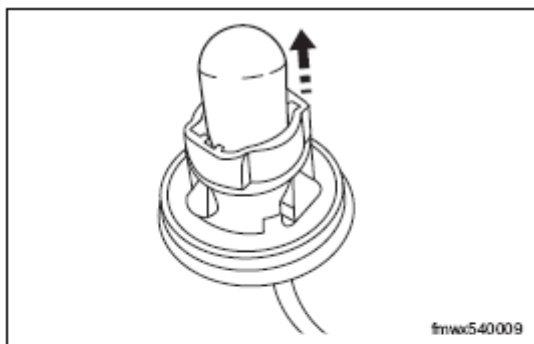
1. **Disassemble the bulb of left front low beam.**
 - (a). Disassemble the cover and disconnect the connector of left front low beam.



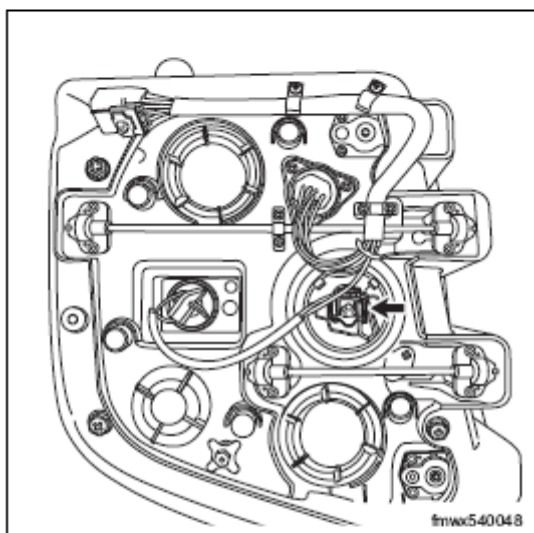
- (b). Loosen the fixing wire clamp and remove the low beam bulb.



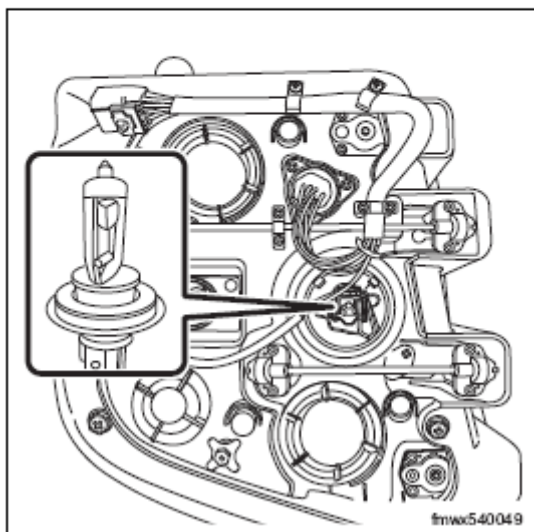
2. **Disassemble the bulb of left front small lamp.**
 - (a). Disassemble the cover and screw off the small lamp holder.



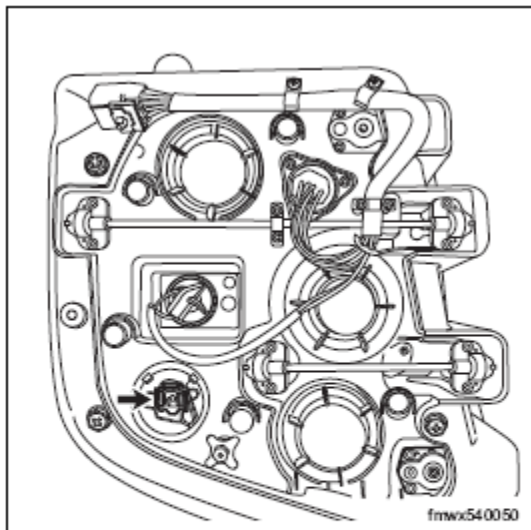
- (b). Disassemble the small lamp bulb.



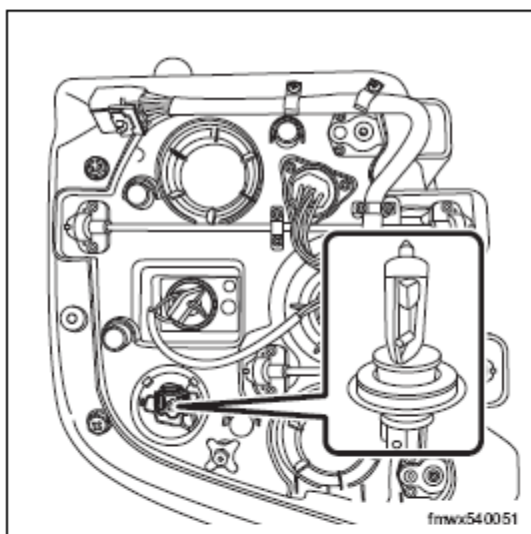
3. **Disassemble the bulb of left front high beam.**
(a). Disassemble the cover and disconnect the connector of left front high beam.



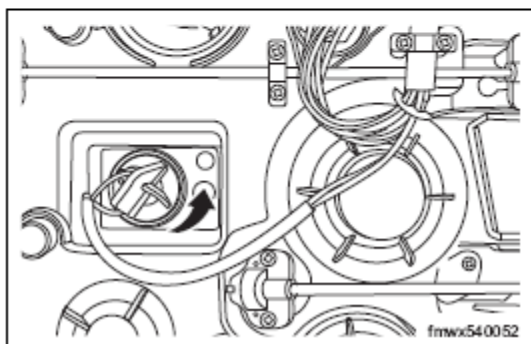
- (b). Loosen the fixing wire clamp and remove the high beam bulb.



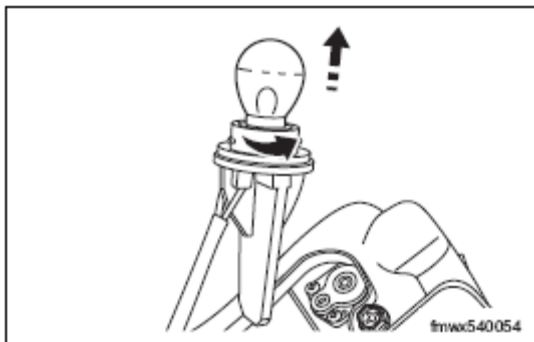
- 4. Disassemble the bulb of left front fog lamp.**
- (a). Disassemble the cover and disconnect the connector of left front fog lamp.



- (b). Loosen the fixing wire clamp and remove the fog lamp bulb.



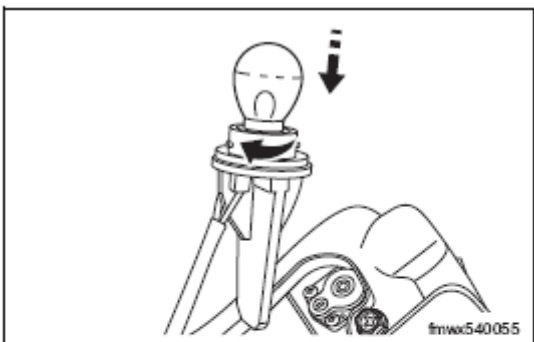
- 5. Disassemble the bulb of left front turn lamp.**
- (a). Screw off the turn lamp holder.



- (b). Disassemble the turn lamp bulb.

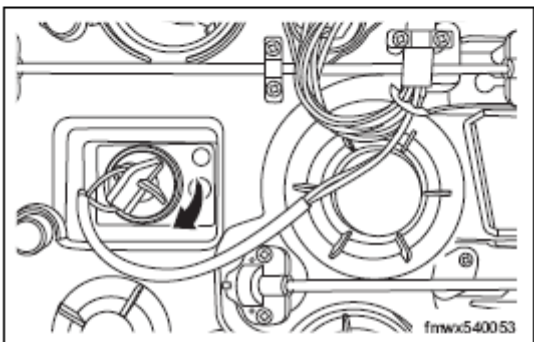
Hint:

The disassembly procedure for the bulbs of right front combination lamp is same with that for the bulbs of left front combination lamp.

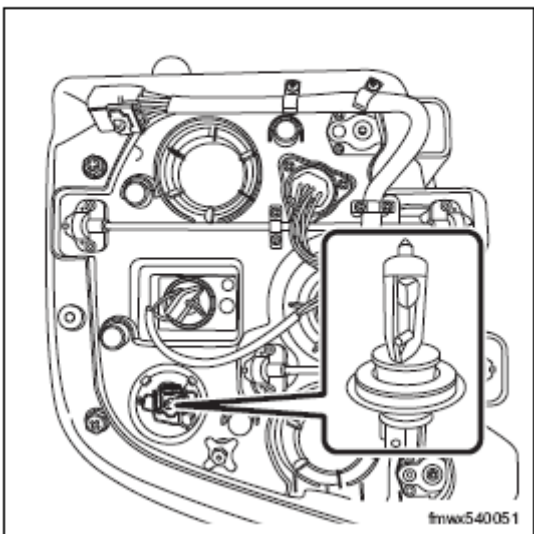


6. Install the bulb of left front turn lamp.

- (a). Install the turn lamp bulb.

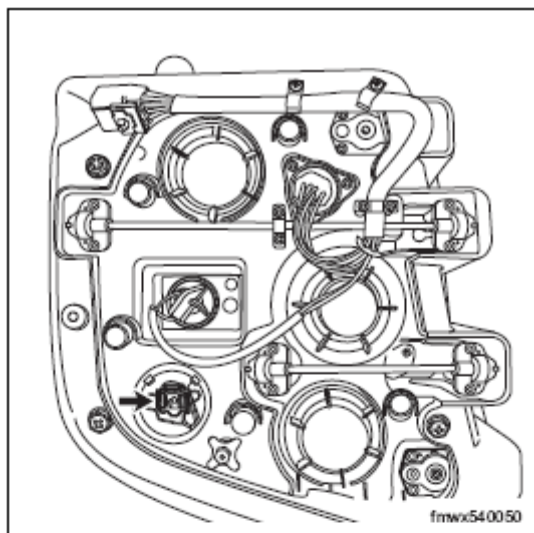


- (b). Screw in the turn lamp holder.

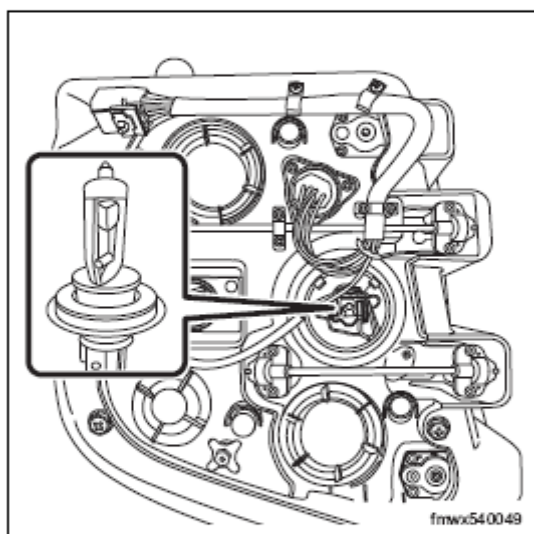


7. Install the bulb of left front fog lamp.

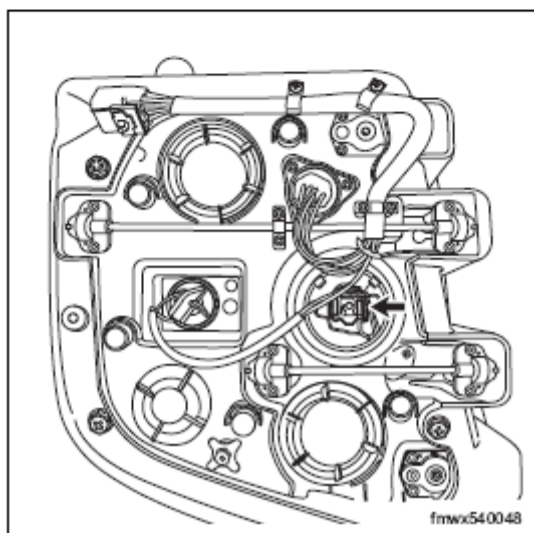
- (a). Install the fog lamp bulb and secure the fixing wire clamp.



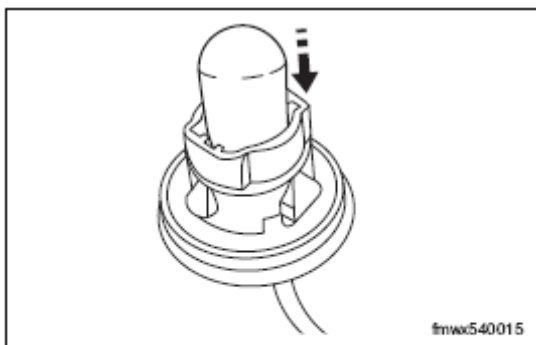
- (b). Connect the connector of left front fog lamp and install the cover.



- 8. Install the bulb of left front high beam.**
(a). Install the high beam bulb and secure the fixing wire clamp.

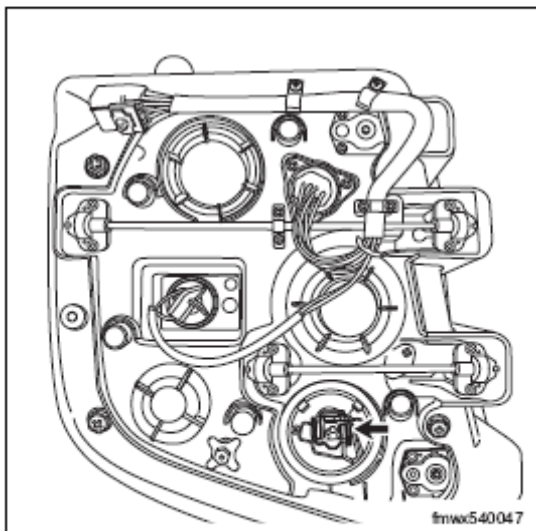


- (b). Connect the connector of left front high beam and install the cover.

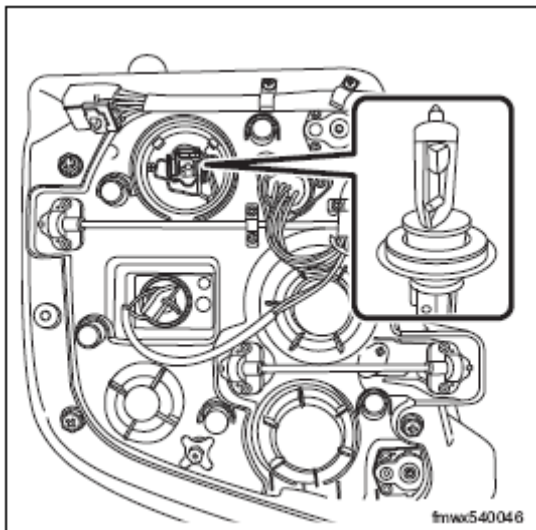


9. Install the bulb of left front small lamp.

- (a). Install the small lamp bulb.

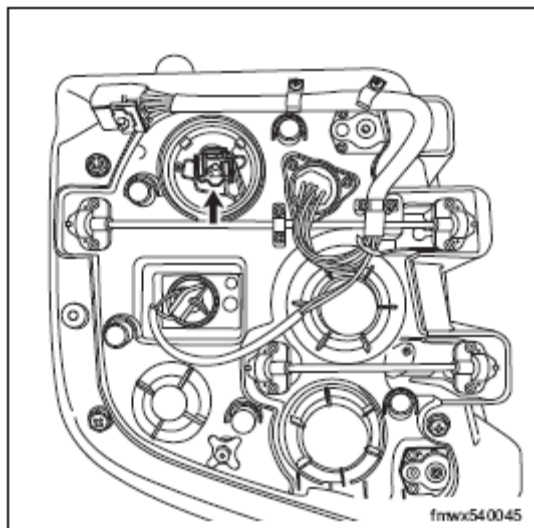


- (b). Screw in the small lamp holder.



10. Install the bulb of left front low beam.

- (a). Install the low beam bulb and secure the fixing wire clamp.



- (b). Connect the connector of left front low beam and install the cover.

Hint:

The installation procedure for the bulbs of right front combination lamp is same with that for the bulbs of left front combination lamp.

- 11. Adjust the front combination lamp assembly (Refer to Chapter 54 Lighting – Front Combination Lamp, Adjustment).**

ADJUSTMENT

1. Adjustment of headlamp range

(a). Position the vehicle to the following conditions:

- No distortion in the surroundings of front combination lamp.
- Park the vehicle on a level ground.
- Ensure that the pressure of the tires is at standard value (Refer to Chapter 23 Tires and Wheels – Tire and Wheel Assembly, Checking and Adjustment).
- The driver sits within the vehicle and the vehicle is under all-ready status (full fuel tank).

(b). Check the headlamp range.

- Prepare one thick white paper.
- Position the white paper at a location 3m away from the front combination lamp, perpendicular to the ground.
- Make sure that the longitudinal centerline of the vehicle is perpendicular to the white paper.
- Draw a horizontal line on the white paper, indicating the location that should be illuminated by the headlamp.
- Draw one vertical line on the white paper, indicating the location of the vehicle longitudinal centerline.
- Draw two vertical lines, indicating the locations that should be illuminated by two headlamps (right headlamp vertical line and left headlamp vertical line).
- Draw one horizontal line (connecting the center marks of two low beams, indicating the locations that should be illuminated by headlamps (right front combination lamp horizontal line and left front combination lamp horizontal line)).
- Be noted to use an appropriate measurement means, in order to prevent influencing other lamps.
- Adjust the horizontal level of the headlamps to position "0" and then adjust the angle of front combination lamp axis.

Hint:

Both horizontal lines of right front combination lamp and left front combination lamp shall be lower than the horizontal line by 0.4° .

- Start the engine.
- Turn on the front combination lamp.
- Check whether the headlamp range complies with the requirement.
- If not, adjust along the vertical direction of headlamp.

(c). Adjust the headlamp range along the vertical direction: Rotate the adjustment bolt to adjust the headlamp range to the standard range.

Hint:

Rotate the screwdriver clockwise to move upward the headlamp range and rotate counter-clockwise to move downward the headlamp range.

2. Adjustment of front fog lamp range

(a). The fog lamp range can be vertically adjusted by rotating the adjustment bolt.

Hint:

Rotate the screwdriver clockwise to move upward the fog lamp range and rotate counter-clockwise to move downward the fog lamp range.

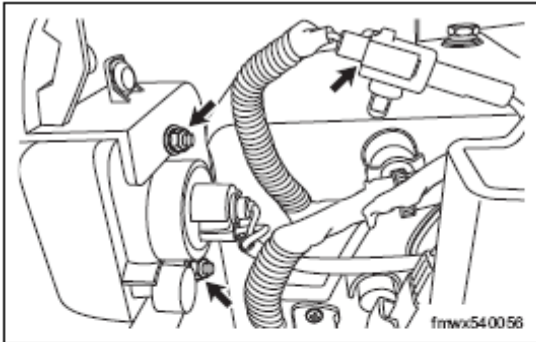
TURN LAMP

REPLACEMENT

Hint:

Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Cut off the main power.



2. Disassemble the left turn lamp assembly.

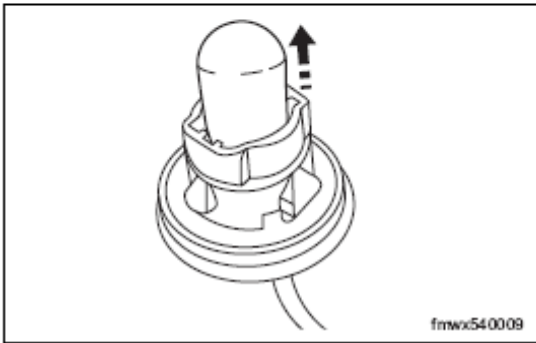
- (a). Disconnect the connector of left turn lamp.
- (b). Disassemble the fixing nuts of left turn lamp assembly and remove the turn lamp assembly.

Hint:

The disassembly procedure for right turn lamp assembly is the same with that for left turn lamp assembly.

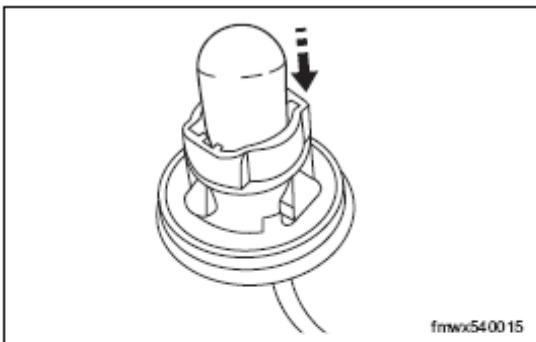
3. Disassemble the turn lamp bulb.

- (a). Screw off the turn lamp holder.
- (b). Disassemble the turn lamp bulb.



4. Install the turn lamp bulb.

- (a). Install the turn lamp bulb.
- (b). Screw in the turn lamp holder.

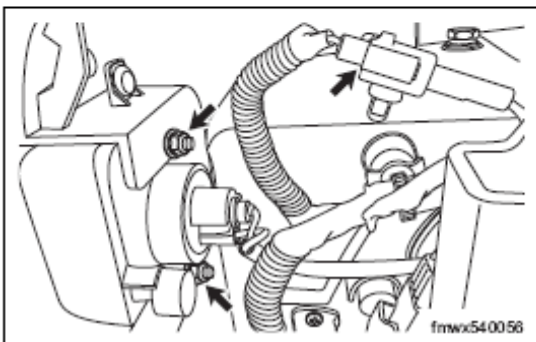


5. Install the left turn lamp assembly.

- (a). Install the fixing nuts of left turn lamp assembly.
- (b). Connect the connector of left turn lamp.

Hint:

The installation procedure for right turn lamp assembly is the same with that for left turn lamp assembly.



6. Turn on the main power.

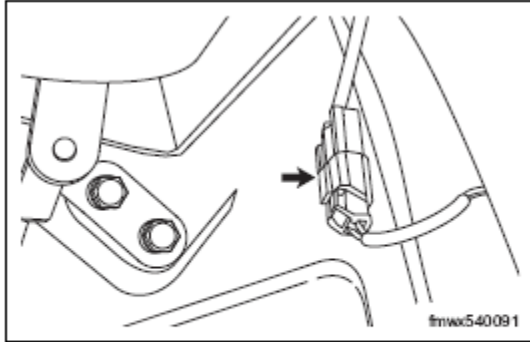
CLEARANCE LAMP

REPLACEMENT

Hint:

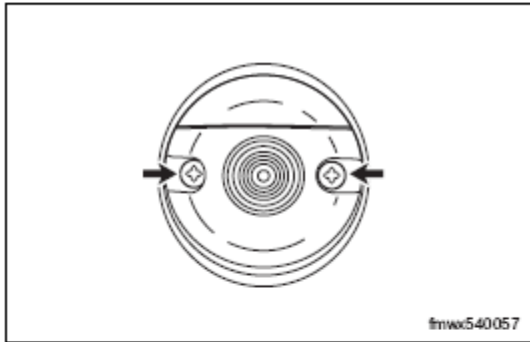
Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Cut off the main power.



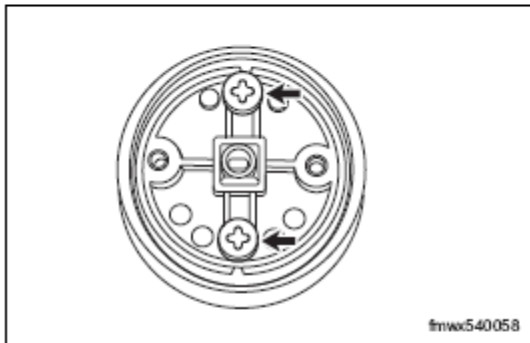
2. Disassemble the left clearance lamp assembly.

(a). Open the left overhead cabinet within the driver cab and disconnect the connector of clearance lamp.



(b). Disassemble the fixing screws of left clearance lamp cover and remove the lamp cover.

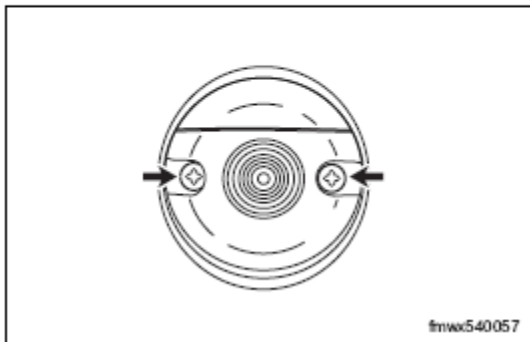
54



(c). Disassemble the fixing screws of left clearance lamp and remove the clearance lamp assembly.

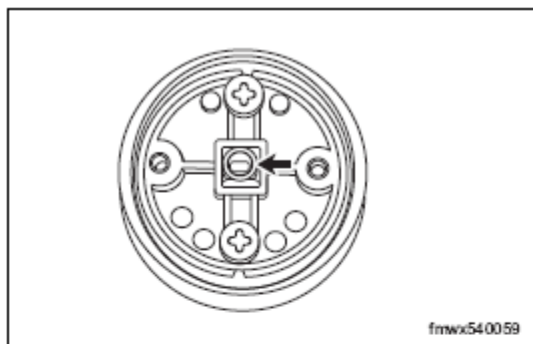
Hint:

The disassembly procedure for right clearance lamp assembly is same with that for left clearance lamp assembly.

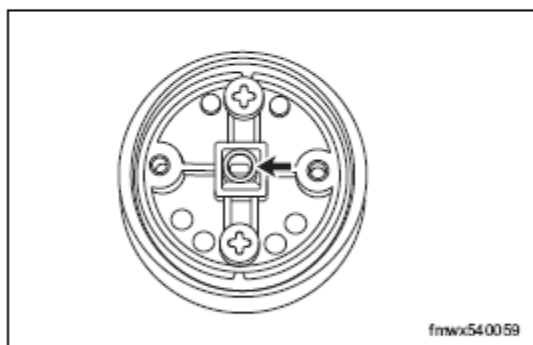


3. Disassemble the bulb of clearance lamp.

(a). Disassemble the fixing screws of clearance lamp cover and remove the lamp cover.

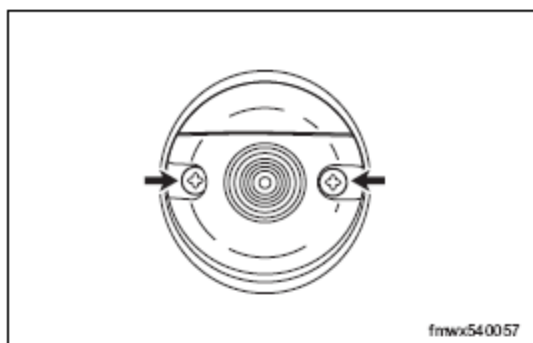


- (b). Unplug the clearance lamp bulb.

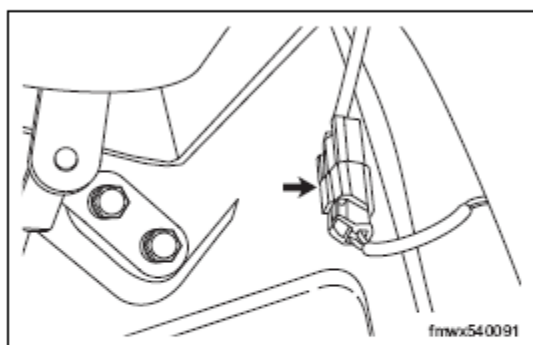


4. Install the clearance lamp bulb.

- (a). Insert the clearance lamp bulb.

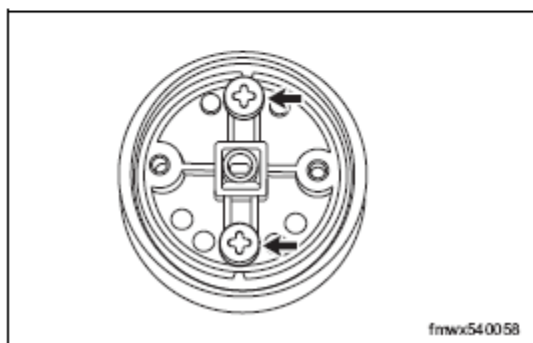


- (b). Install the fixing screws of the clearance lamp cover.

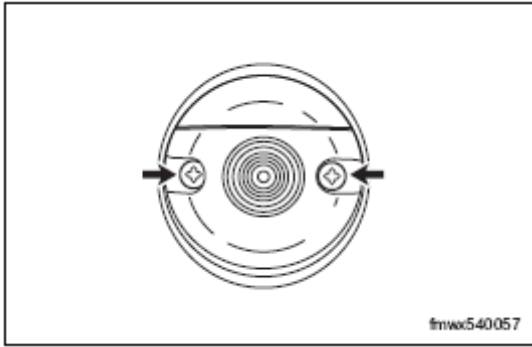


5. Install the left clearance lamp assembly.

- (a). Connect the connector of clearance lamp.



- (b). Install the fixing screws of left clearance lamp.



- (c). Install the fixing screws of the left clearance lamp cover.

Hint:

The installation procedure for right clearance lamp assembly is same with that for left clearance lamp assembly.

6. Turn on the main power.

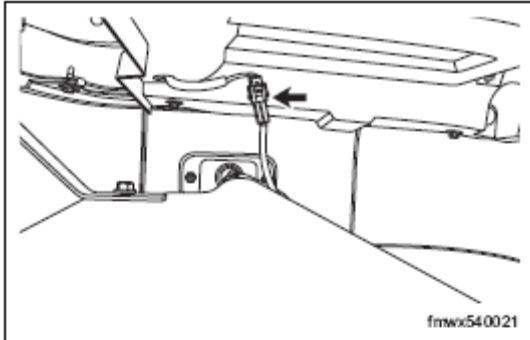
MARKER LAMP

REPLACEMENT

Hint:

Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Turn off the main power.



2. Disassemble the left front marker lamp assembly.

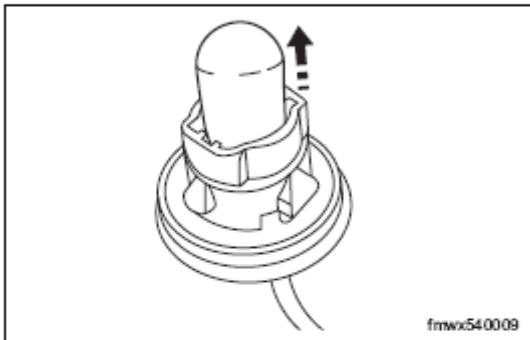
- (a). Disconnect the connector of left front marker lamp.
- (b). Disassemble the fixing nuts of left front marker lamp assembly and remove the marker lamp assembly.

Hint:

The disassembly procedure for right front marker lamp assembly is same with that for left front marker lamp assembly.

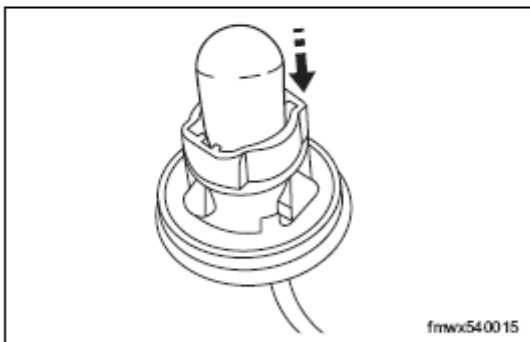
3. Disassemble the bulb of marker lamp.

- (a). Screw off the marker lamp holder.
- (b). Disassemble the bulb of marker lamp.



4. Install the marker lamp bulb.

- (a). Install the marker lamp bulb.
- (b). Screw in the marker lamp holder.

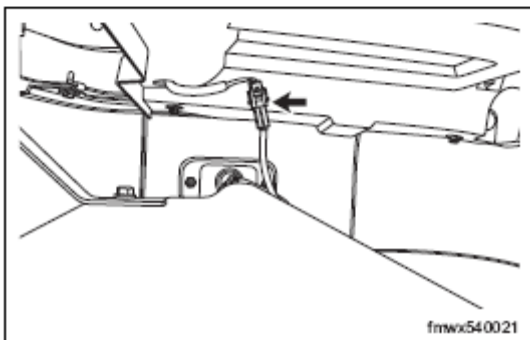


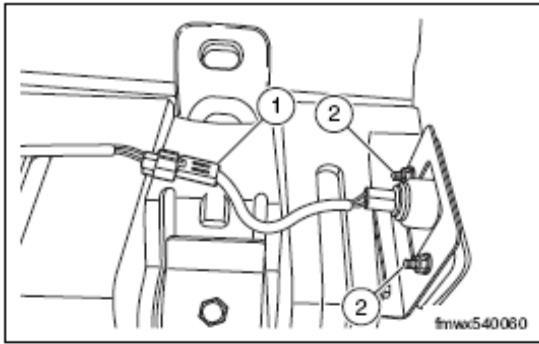
5. Install the left front marker lamp assembly.

- (a). Install the fixing nuts of left front marker lamp assembly.
- (b). Connect the connector of left front marker lamp.

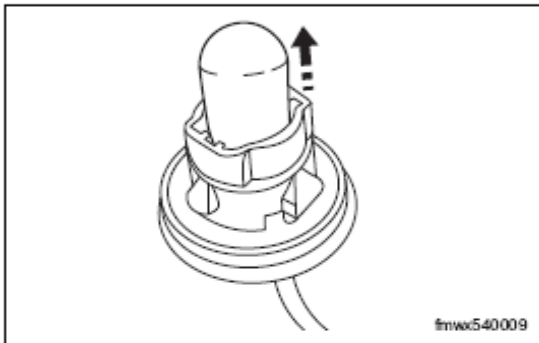
Hint:

The installation procedure for right front marker lamp assembly is same with that for left front marker lamp assembly.





- 6. Disassemble the bulb of left rear marker lamp.**
- (a). Disconnect the connector 1 of left rear marker lamp.
 - (b). Disassemble the fixing nuts 2 of left rear marker lamp.

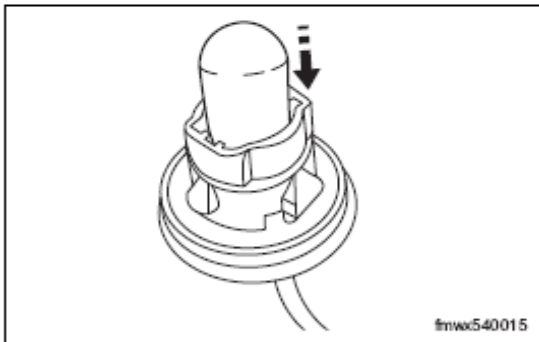


7. Disassemble the bulb of marker lamp.

- (a). Screw off the marker lamp holder.
- (b). Disassemble the bulb of marker lamp.

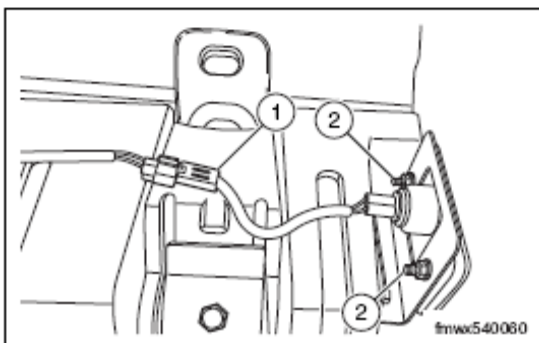
Hint:

The disassembly procedure for the bulb of right rear marker lamp is same with that for the bulb of left rear marker lamp.



8. Install the left rear marker lamp bulb.

- (a). Install the marker lamp bulb.
- (b). Screw in the marker lamp holder.



9. Install the left rear marker lamp assembly.

- (a). Install the fixing nuts 2 of left rear marker lamp assembly.
- (b). Connect the connector 1 of left rear marker lamp.

Hint:

The installation procedure for the bulb of right rear marker lamp is same with that for the bulb of left rear marker lamp.

- 10. Turn on the main power.**

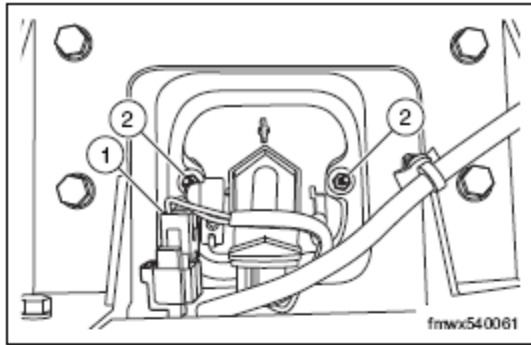
COURTESY LAMP

REPLACEMENT

Hint:

Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Cut off the main power.



2. Disassemble the left courtesy lamp assembly.

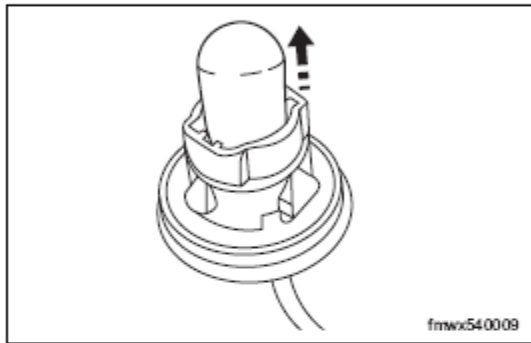
- (a). Disconnect the connector 1 of courtesy lamp.
- (b). Disassemble the fixing nuts 2 of courtesy lamp assembly and remove the courtesy lamp assembly.

Hint:

The disassembly procedure for right courtesy lamp assembly is same with that for left courtesy lamp assembly.

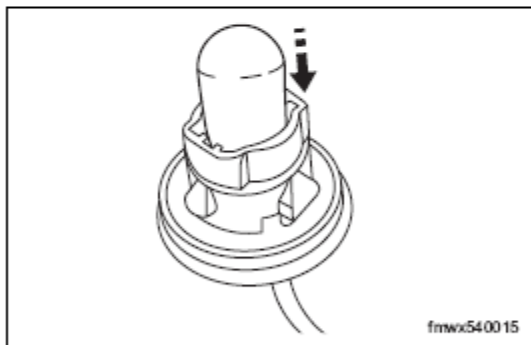
3. Disassemble the left courtesy lamp bulb.

- (a). Screw off the left courtesy lamp holder.
- (b). Disassemble the left courtesy lamp bulb.



4. Install the left courtesy lamp bulb.

- (a). Install the left courtesy lamp bulb.
- (b). Screw in the left courtesy lamp holder.

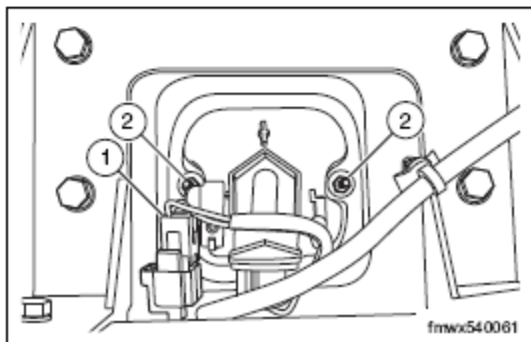


5. Install the left courtesy lamp assembly.

- (a). Install the fixing nuts 2 of left courtesy lamp assembly.
- (b). Connect the connector 1 of left courtesy lamp.

Hint:

The installation procedure for right courtesy lamp assembly is same with that for left courtesy lamp assembly.



6. Turn on the main power.

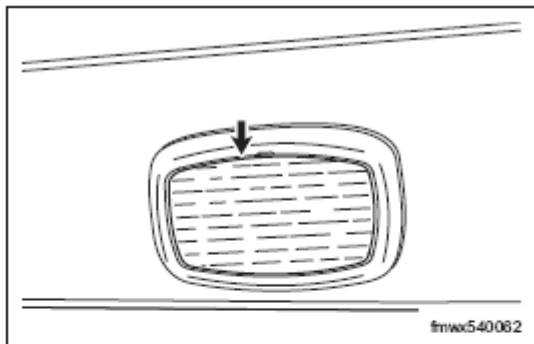
INTERIOR LAMP

REPLACEMENT

Hint:

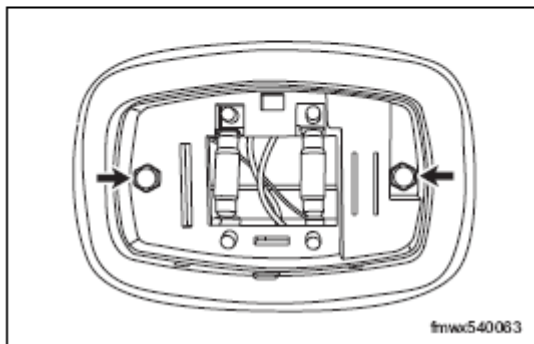
Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Turn off the main power.

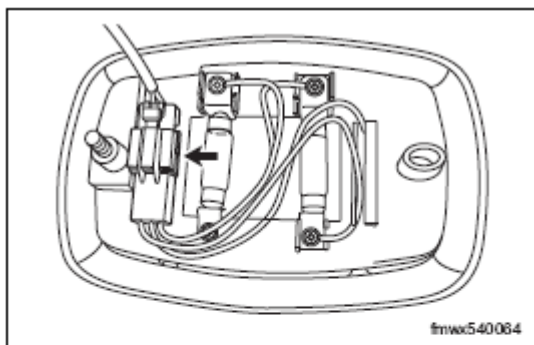


2. Disassemble the interior lamp assembly.

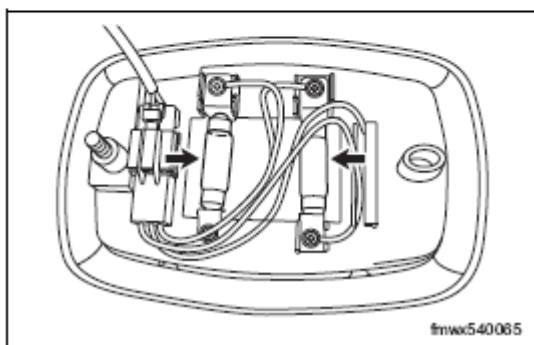
(a). Pry out the lamp cover.



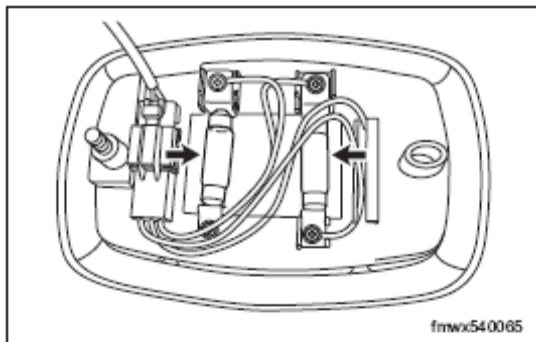
(b). Disassemble the fixing screws of interior lamp assembly.



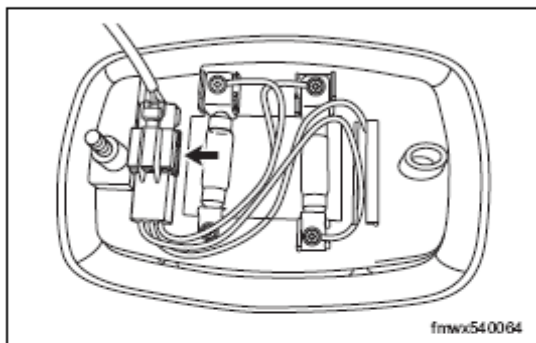
(c). Disconnect the connector of interior lamp and remove the interior lamp assembly.



3. Disassemble the interior lamp bulb.

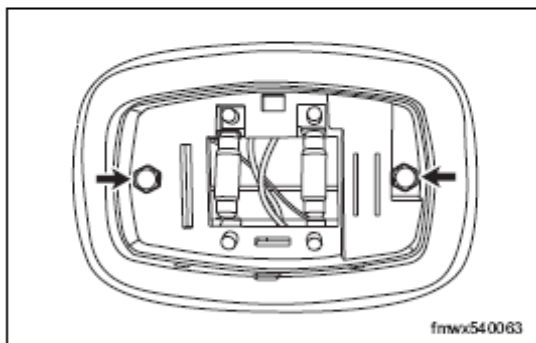


4. Install the interior lamp bulb.



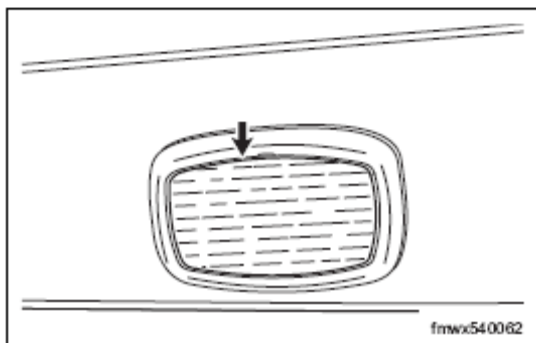
5. Install the interior lamp assembly.

(a). Connect the connector of interior lamp.



(b). Install the fixing bolts of interior lamp.

Torque: 23N•m



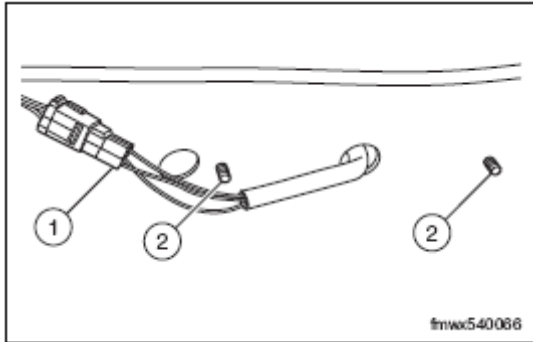
(c). Install the lamp cover.

6. Turn on the main power.

REAR COMBINATION LAMP

REPLACEMENT

1. Cut off the main power



2. Disassemble the left rear combination lamp assembly.

- (a). Disconnect the connector 1 of left rear combination lamp assembly.
- (b). Disassemble the fixing nuts 2 of left rear combination lamp assembly and remove the left rear combination lamp assembly.

Hint:

The disassembly procedure for right rear combination lamp assembly is same with that for left rear combination lamp assembly.

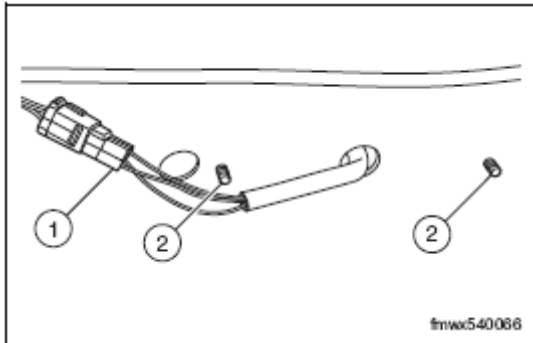
3. Install the left rear combination lamp assembly.

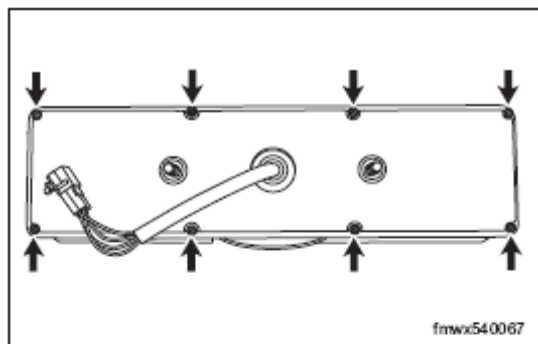
- (a). Install the fixing nuts 2 of left rear combination lamp assembly.
- (b). Connect the connector 1 of left rear combination lamp assembly.

Hint:

The installation procedure for right rear combination lamp assembly is same with that for left rear combination lamp assembly.

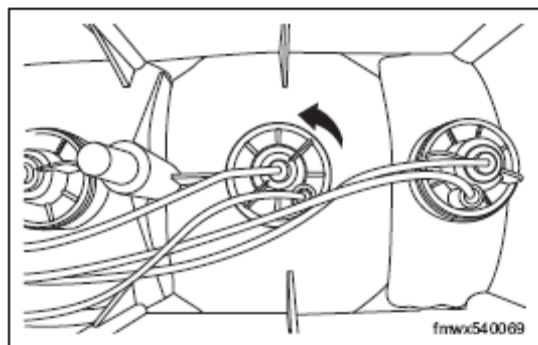
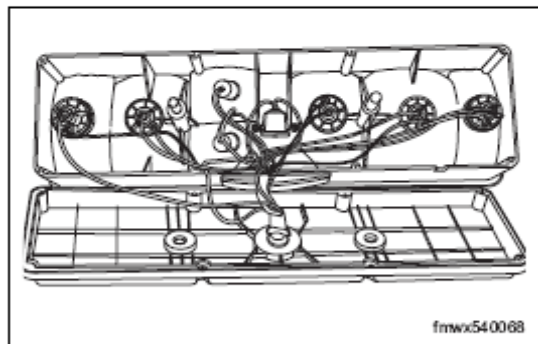
4. Turn on the main power.



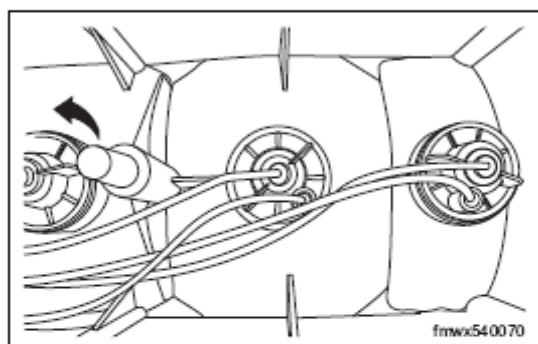


1. **Disassemble the bulbs of left rear combination lamp.**

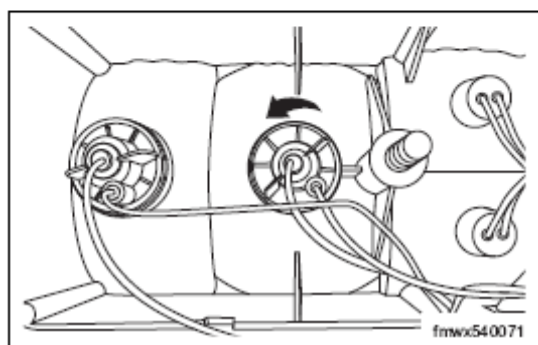
(a). Disassemble the fixing screws of the left rear combination lamp cover.



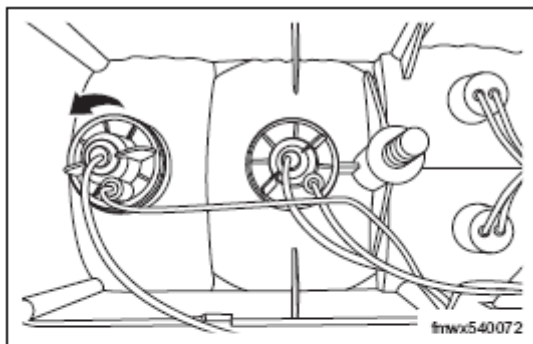
(b). Screw off the left rear turn lamp holder and remove the left rear turn lamp bulb.



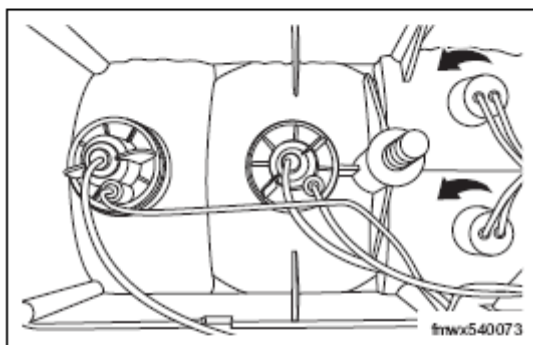
(c). Screw off the left rear brake lamp holder and remove the left rear brake lamp bulb.



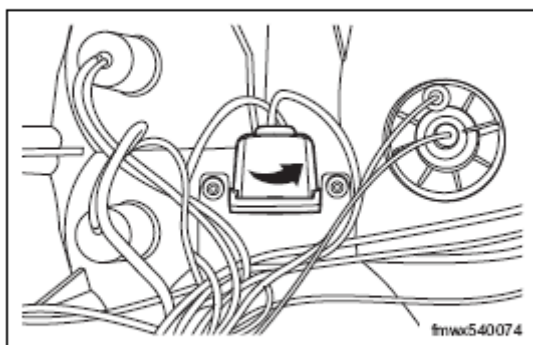
(d). Screw off the left rear fog lamp holder and remove the left rear fog lamp bulb.



- (e). Screw off the left rear backup lamp holder and remove the left rear backup lamp bulb.



- (f). Screw off the left rear small lamp holder and remove the left rear small lamp bulb.



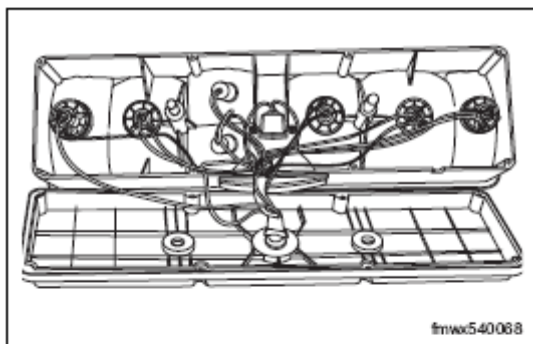
- (g). Screw off the left rear license plate lamp holder and remove the left rear license plate lamp bulb.

Hint:

Only the left rear combination lamp contains the license plate lamp.

Hint:

The disassembly procedure for bulbs of right rear combination lamp is same with that for bulbs of left rear combination lamp.

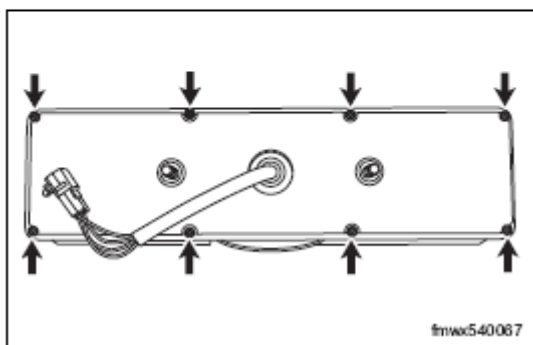


2. Install the bulbs of left rear combination lamp and screw in the lamp holder.

- (a). Install the bulbs of left rear combination lamp and screw in the lamp holder.

Hint:

Install the bulbs one by one.



- (b). Install the fixing screws of the left rear combination lamp cover.

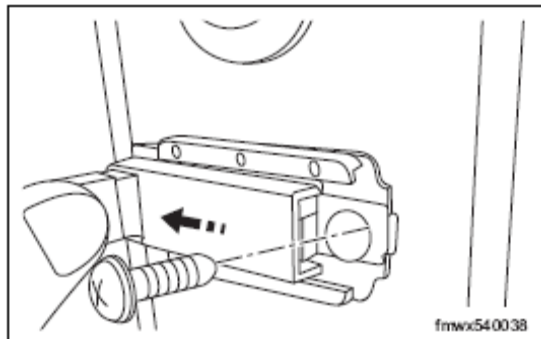
Hint:

The installation procedure for bulbs of right rear combination lamp is same with that for bulbs of left rear combination lamp.

DOOR LAMP SWITCH

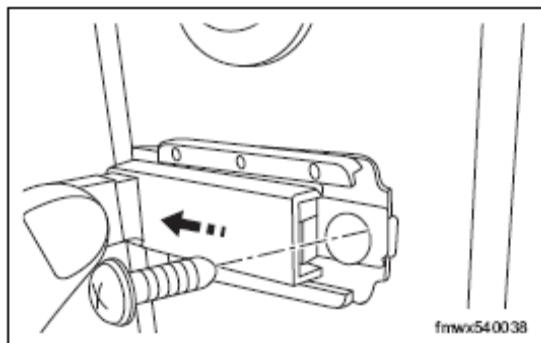
REPLACEMENT

1. Cut off the main power.



2. Disassemble the left door lamp switch.

- (a). Hold the door lamp switch with hand, and disassemble the fixing screws of door lamp switch.
- (b). Disconnect the connector, and disassemble the door lamp switch.



3. Install the left door lamp switch.

- (a). Connect the connector of door lamp switch.
- (b). Hold the door lamp switch with hand and install the fixing screws of door lamp switch.

4. Turn on the main power.

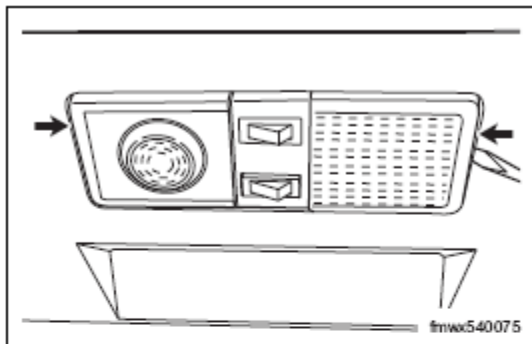
READING LAMP

REPLACEMENT

Hint:

Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Cut off the main power.

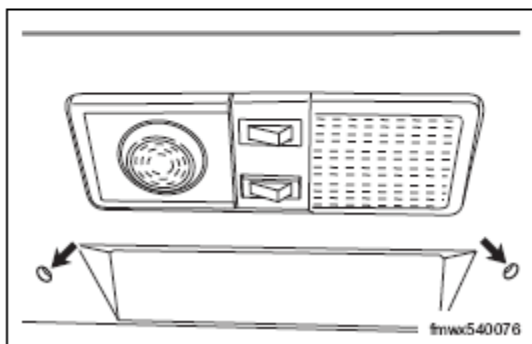


2. Disassemble the reading lamp assembly.

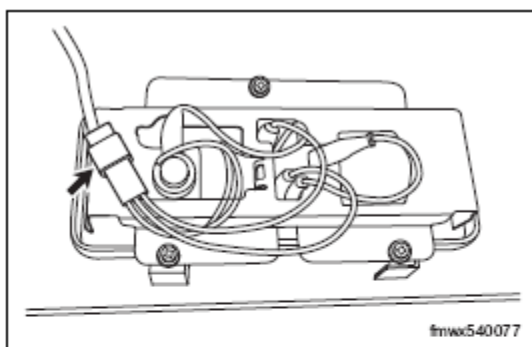
(a). Pry out the lamp cover.

Notice:

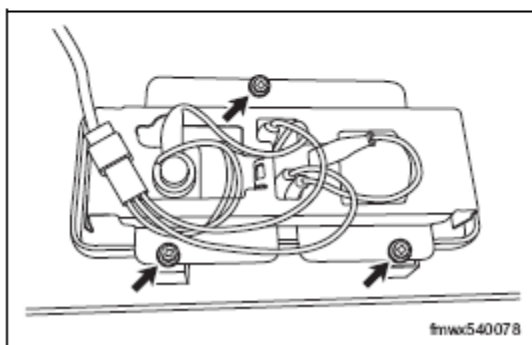
Be cautions to handle the clips in the lamp cover and do not handle with large force, in order to prevent damaging the parts.



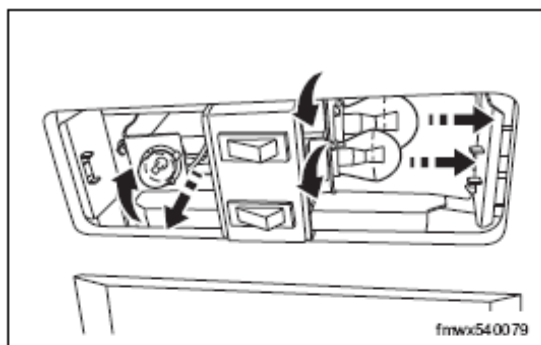
(b). Disassemble the inner trim panel.



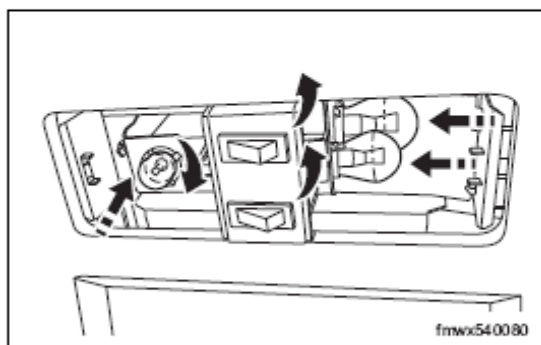
(c). Disconnect the connector of reading lamp assembly.



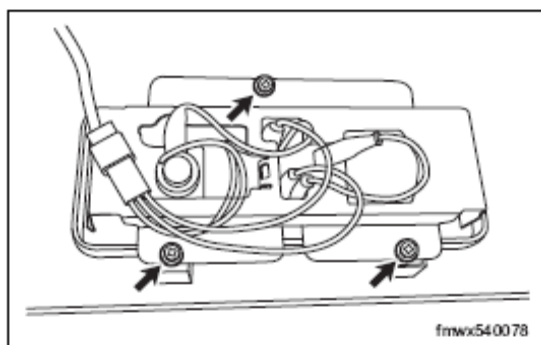
(d). Disassemble the fixing screws of reading lamp assembly and remove the reading lamp assembly.



3. Disassemble the reading lamp bulb.

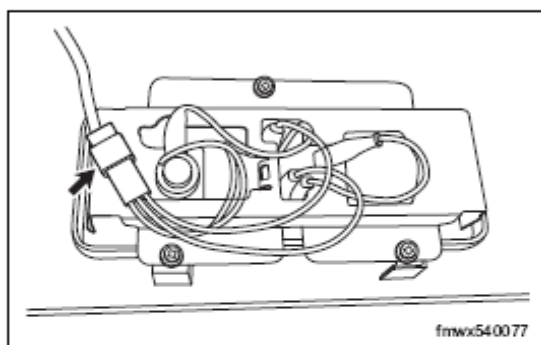


4. Install the reading lamp bulb.

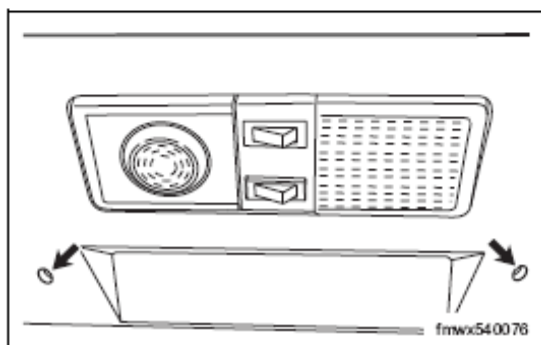


5. Install the reading lamp assembly.

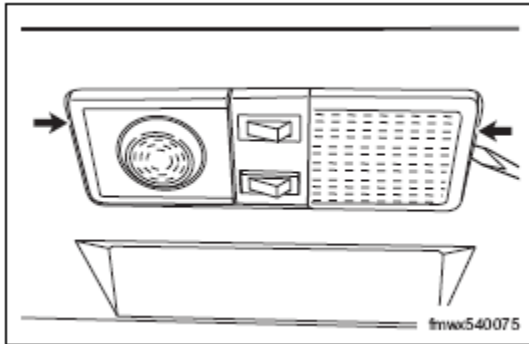
(a). Install the fixing screws of reading lamp assembly.



(b). Install the connector.



(c). Install the inner trim panel.



(d). Install the reading lamp cover.

6. Turn on the main power.

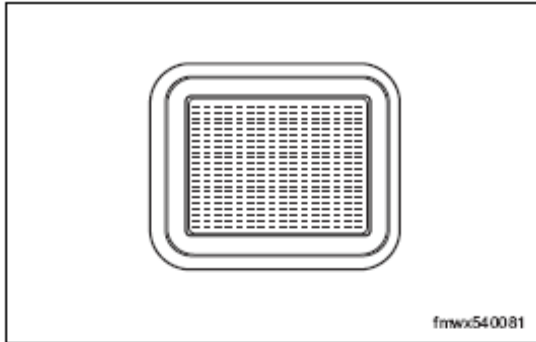
SLEEPER LAMP

REPLACEMENT

Hint:

Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Cut off the main power.

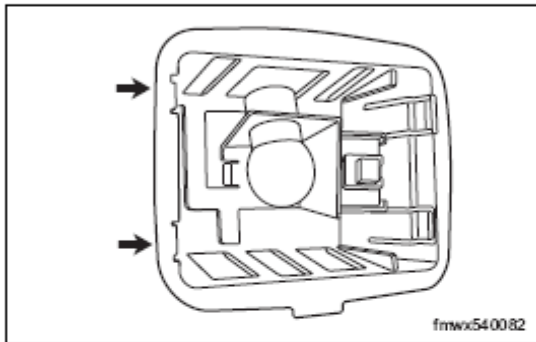


2. Disassemble the sleeper lamp assembly.

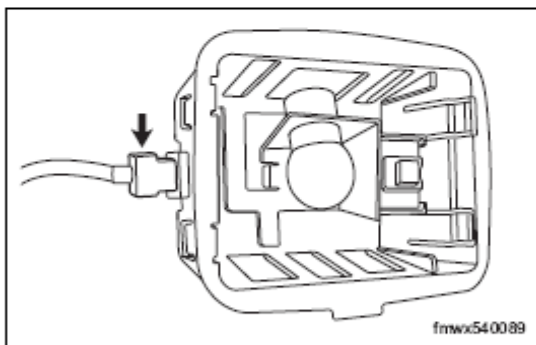
(a) Pry out the lamp cover.

Notice:

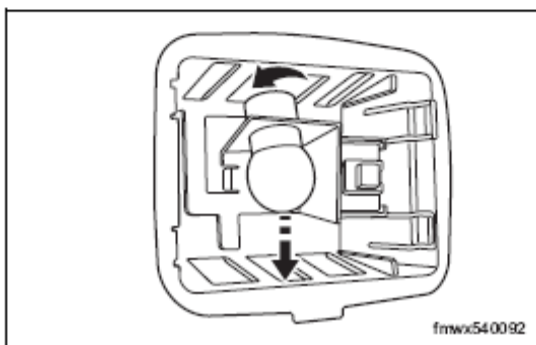
Be cautions to handle the clips in the lamp cover and do not handle with large force, in order to prevent damaging the parts.



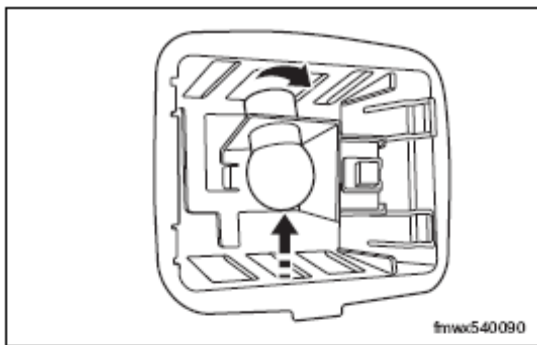
(b). Disassemble the sleeper lamp holder.



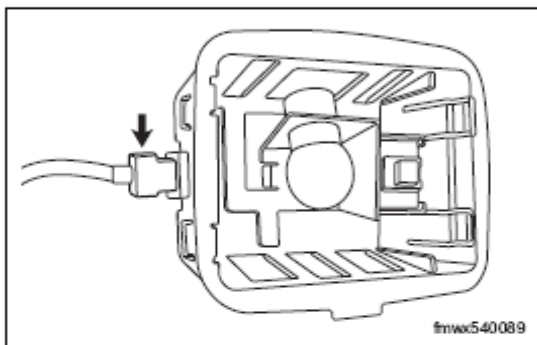
(c). Disconnect the connector of sleeper lamp assembly.



3. Disassemble the sleeper lamp bulb.

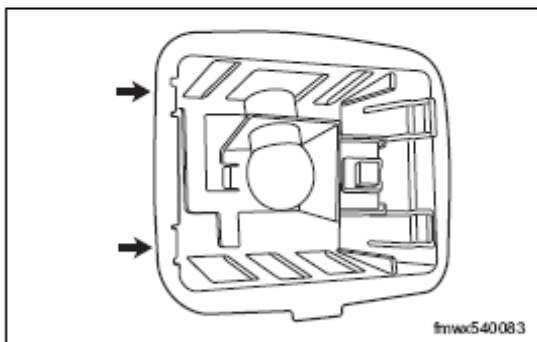


4. Install the sleeper lamp bulb.

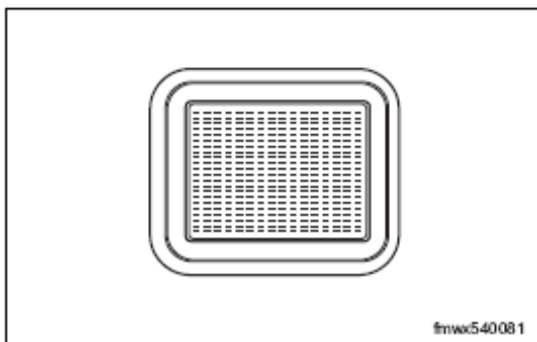


5. Install the sleeper lamp assembly.

(a). Connect the connector.



(b). Install the sleeper lamp holder.



(c). Install the lamp cover.

6. Turn on the main power.

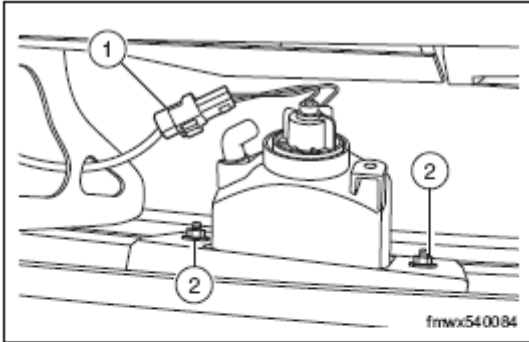
VEHICLE SPEED LAMP

REPLACEMENT

Hint:

Please refer to Chapter 54 Lighting – Lighting System, Diagram of Components for the diagram of components.

1. Cut off the main power.



2. Disassemble the left vehicle speed lamp assembly.

- (a). Disconnect the connector 1 of left vehicle speed lamp.
- (b). Disassemble the fixing nuts 2 of left vehicle speed lamp assembly.

3. Install the left vehicle speed lamp assembly.

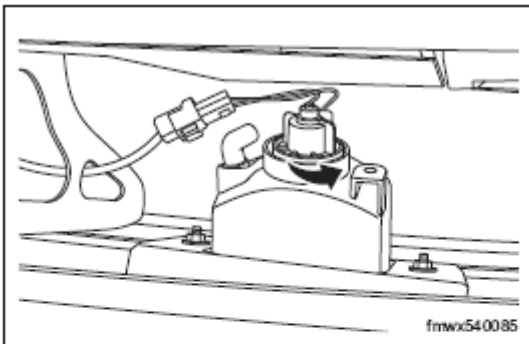
- (a). Connect the connector 1 of left vehicle speed lamp.
- (b). Install the fixing nuts 2 of left vehicle speed lamp assembly.

Hint:

The disassembly and installation procedures for the right vehicle speed lamp assembly and the middle vehicle speed lamp assembly are the same with those for left vehicle speed lamp assembly.

4. Disassemble the left vehicle speed lamp bulb.

- (a). Screw off the left vehicle speed lamp holder and remove the bulb.

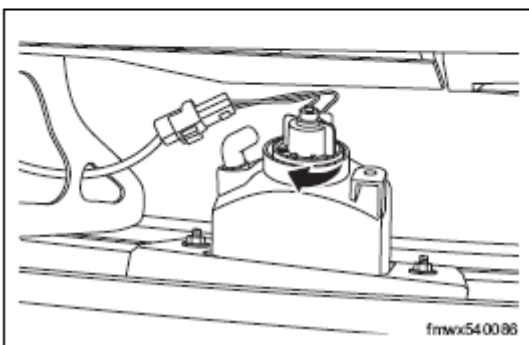


5. Install the left vehicle speed lamp bulb.

- (a). Install the bulb and screw in the left vehicle speed lamp holder.

Hint:

The installation procedure for the right vehicle speed lamp bulb and the middle vehicle speed lamp bulb is the same with that for left vehicle speed lamp bulb.

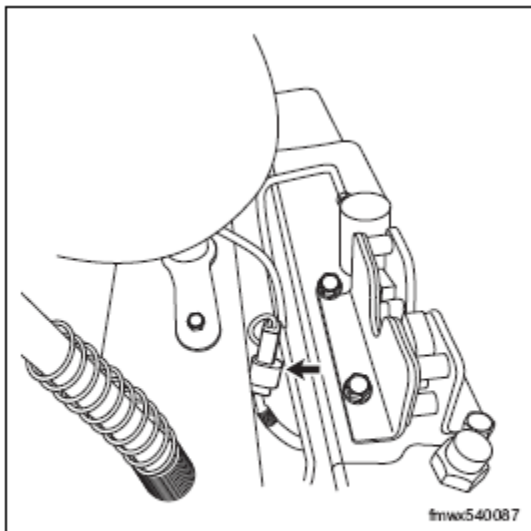


6. Turn on the main power.

REAR ILLUMINATION LAMP

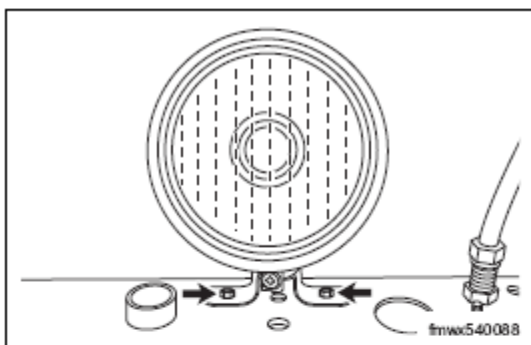
REPLACEMENT

1. Cut off the main power.

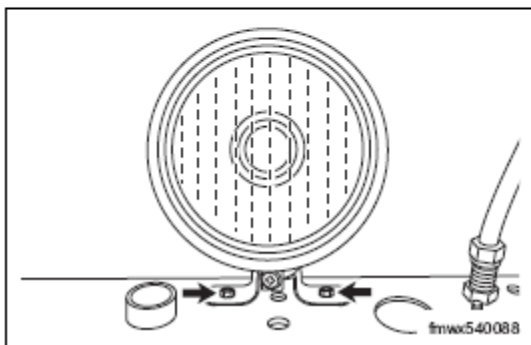


2. Disassemble the rear illumination lamp assembly.

- (a). Disconnect the connector of rear illumination lamp assembly.



- (b). Disassemble the fixing bolts of rear illumination lamp assembly.

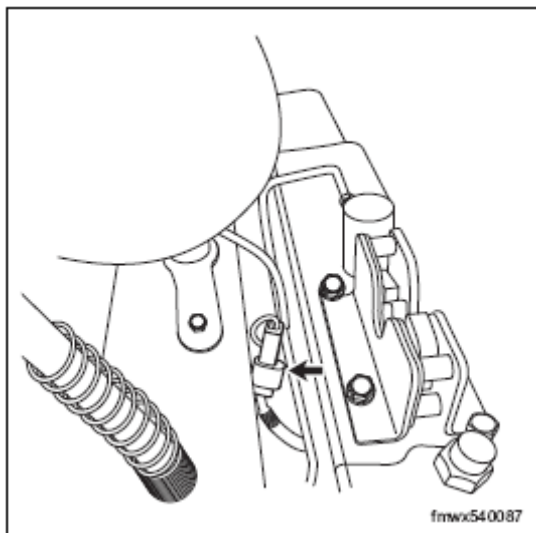


3. Install the rear illumination lamp assembly.

- (a). Install the fixing nuts of rear illumination lamp assembly.

54-38

LIGHTING-TAIL LAMP



- (b). Connect the connector of rear illumination lamp assembly.

4. Turn on the main power.

WIPER AND WASHER

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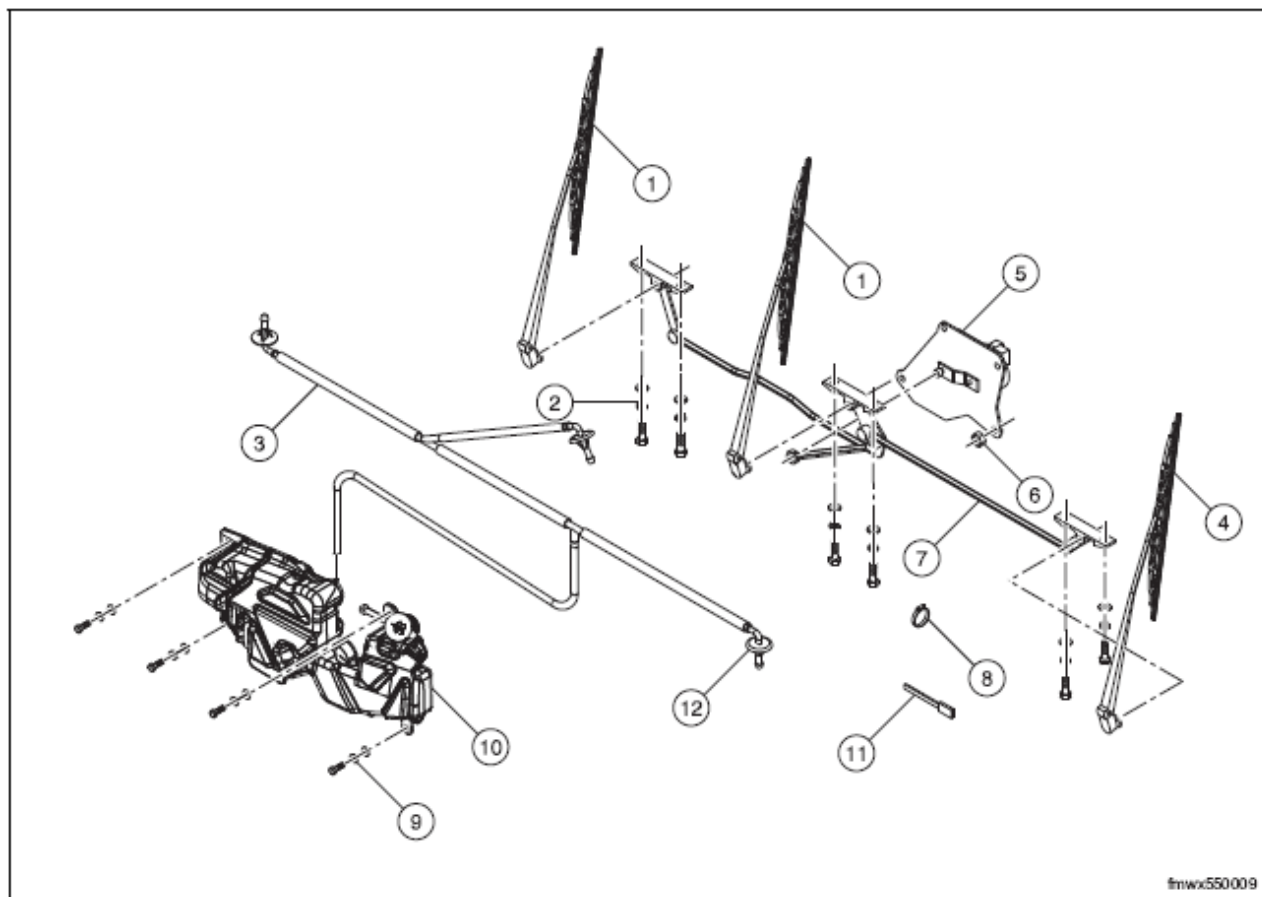
WIPER AND WASHER

PRECAUTIONS

1. While the windshield is dry, do not operate the wiper in order to prevent scratching the windshield .
2. If the wiper is bonded or frozen by snow, do not operate the wiper in order to prevent damaging the wiper system.
3. The washing fluid reservoir shall be refilled with washing fluid. If there is no washing fluid within the reservoir, do not operate the washer, or it may damage the washer motor.
4. Cut off the power.
 - (a). Before disassembling or installing any electric device or when any tool or equipment will easily come into contact with any exposed electric terminal, make sure to disconnect the cathode cable of the battery, in order to prevent injuring the personnel or damaging the vehicle.
 - (b). Make sure to turn off the ignition switch, unless otherwise specified.



DIAGRAM OF COMPONENTS



fmwx550009

1	Left wiper arm blade assembly
2	Hex head bolt, spring washer, and plain washer subassembly
3	Water pipe assembly
4	Right wiper arm blade assembly
5	Wiper motor assembly
6	All-metal hexagon flange lock nut

7	Wiper linkage mechanism assembly
8	Pipe clamp
9	Hex head bolt, spring washer, and plain washer subassembly
10	Washing fluid reservoir assembly
11	Cable tie
12	Right angle two-way valve

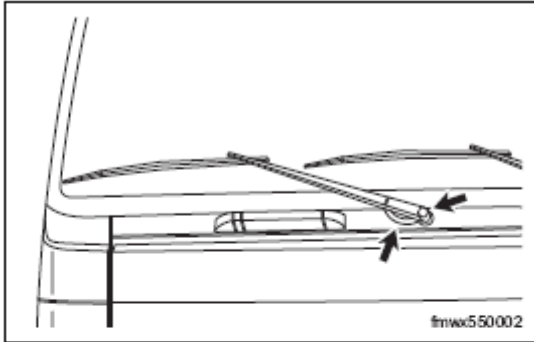
WIPER ARM ASSEMBLY

REPLACEMENT

Hint:

Please refer to Chapter 55 Wiper and Washer – Wiper and Washer Assembly, Diagram of Components for the diagram of the components.

1. Operate the wiper arm to automatic stop position

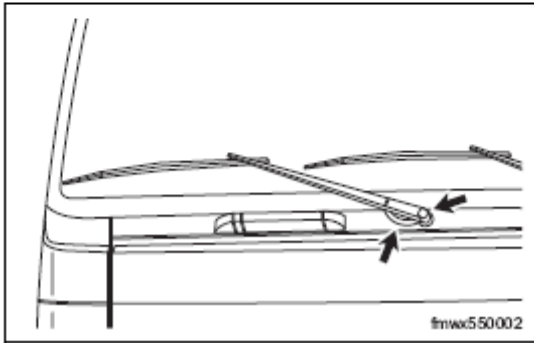


2. Disassemble the right wiper arm assembly.

- Disconnect the water spray nozzle hose.
- Pry up the end cover of the wiper arm.
- Disassemble the fixing nuts of the wiper arm assembly.

Hint:

The disassembly procedure for left and middle wiper arm assemblies is same with that for right wiper arm assembly.



3. Install the right wiper arm assembly.

- Install the fixing nuts of wiper arm assembly.
- Install the end cover of the wiper arm.
- Connect the water spray nozzle hose.

Hint:

The installation procedure for left and middle wiper arm assemblies is same with that for right wiper arm assembly.

4. Check whether the wiper arm functions smoothly and returns normally.

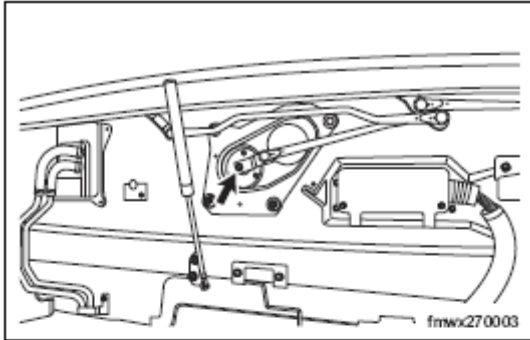
LINKAGE MECHANISM

REPLACEMENT

Hint:

Please refer to Chapter 55 Wiper and Washer – Wiper and Washer Assembly, Diagram of Components for the diagram of the components.

1. **Disassemble the wiper arm assembly (Refer to Chapter 55 Wiper and Washer – Wiper Arm Assembly, Replacement).**
2. **Open the front tilting cover.**

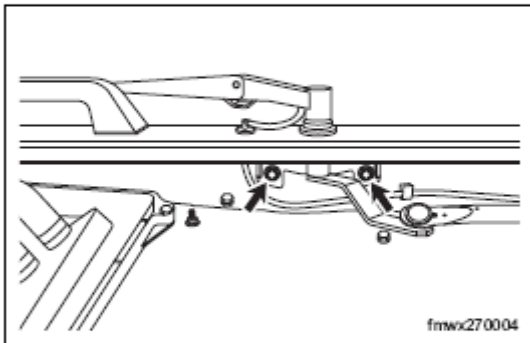


3. **Disassemble the linkage mechanism assembly.**

- (a). Disassemble the connecting nuts between wiper motor and linkage mechanism.

Notice:

During the disassembly, add markings to help the correct positioning during re-installation.

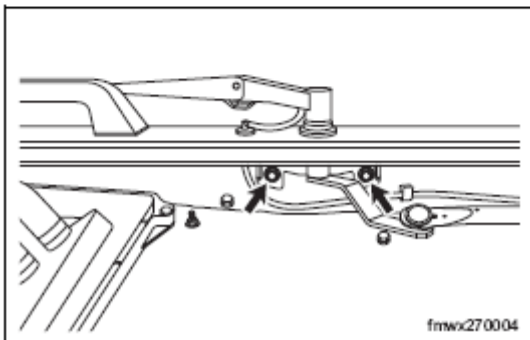


- (b). Disassemble the fixing bolts of the right linkage mechanism.

Hint:

The procedure to disassemble the left and middle fixing bolts is the same with that to disassemble the right fixing bolts.

- (c). Remove the linkage mechanism assembly.



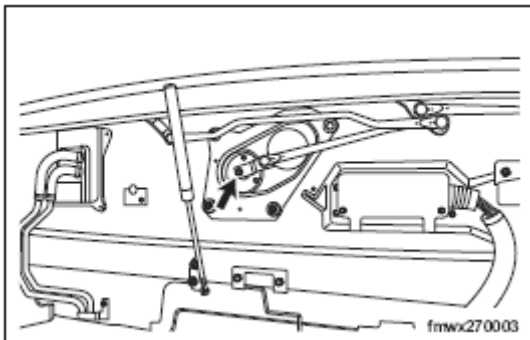
4. **Install the linkage mechanism assembly.**

- (a). Install the fixing bolts of the right linkage mechanism.

Hint:

The procedure to install the left and middle fixing bolts is the same with that to install the right fixing bolts.

Torque: 23N•m



- (b). Install the connecting nuts between wiper motor and linkage mechanism.

Torque: 63N•m

Notice:

Align the positioning markings during installation, in order to ensure the correct positioning of the parts.

5. Close the front tilting cover.
6. Install the wiper arm assembly (Refer to Chapter 55 Wiper and Washer – Wiper Arm Assembly, Replacement).



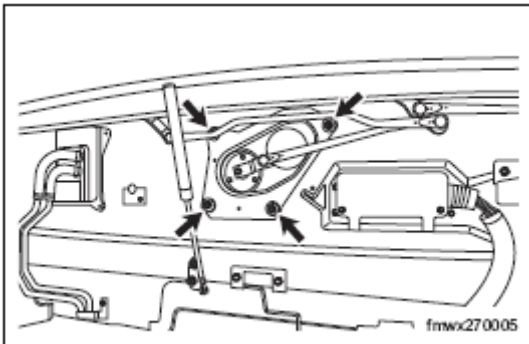
WIPER MOTOR

REPLACEMENT

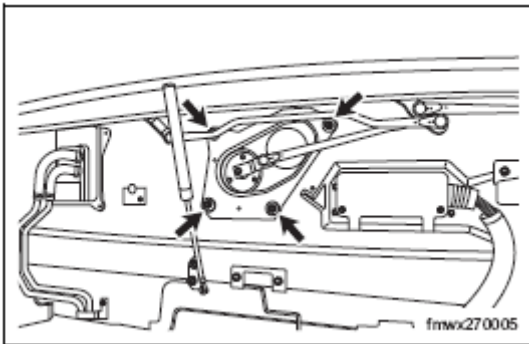
Hint:

Please refer to Chapter 55 Wiper and Washer – Wiper and Washer Assembly, Diagram of Components for the diagram of the components.

1. **Disassemble the wiper arm assembly (Refer to Chapter 55 Wiper and Washer – Wiper Arm Assembly, Replacement).**
2. **Open the front tilting cover.**
3. **Disassemble the linkage mechanism assembly (Please refer to Chapter 55 Wiper and Washer – Linkage Mechanism, Replacement).**



4. **Disassemble the wiper motor assembly.**
 - (a). Disassemble the fixing nuts of wiper motor.
 - (b). Disconnect the connector of wiper motor.



5. **Install the wiper motor assembly.**
 - (a). Connect the connector of wiper motor.
 - (b). Install the fixing nuts of wiper motor.

Torque: 63N•m

6. **Install the linkage mechanism assembly (Please refer to Chapter 55 Wiper and Washer – Linkage Mechanism, Replacement).**
7. **Close the front tilting cover.**
8. **Install the wiper arm assembly (Refer to Chapter 55 Wiper and Washer – Wiper Arm Assembly, Replacement).**

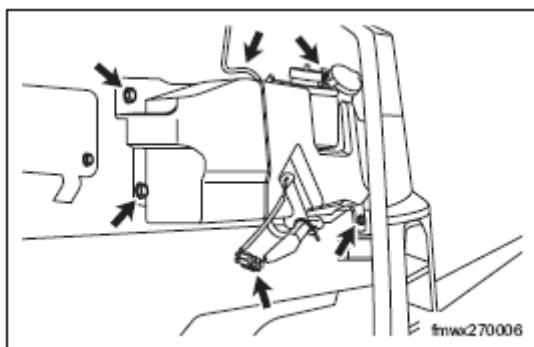
WASHER

REPLACEMENT

Hint:

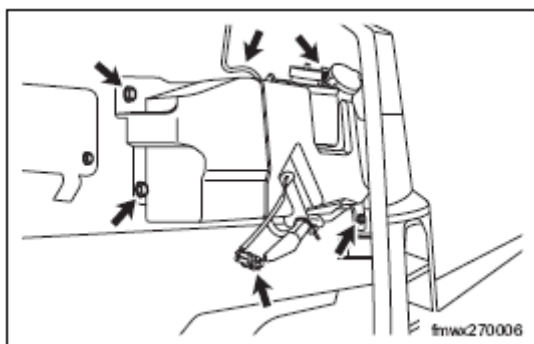
Please refer to Chapter 55 Wiper and Washer – Wiper and Washer Assembly, Diagram of Components for the diagram of the components.

1. Open the front tilting cover.



2. Disassemble the washer assembly.

- (a). Disconnect the washer hose and the washer motor connector.
- (b). Disassemble the fixing bolts of washer.



3. Install the washer assembly.

- (a). Install the fixing bolts of washer.
- (b). Connect the washer hose and washer motor connector.

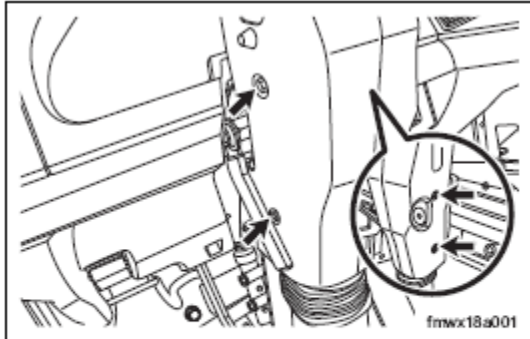
Torque: 23N•m

4. Close the front tilting cover.

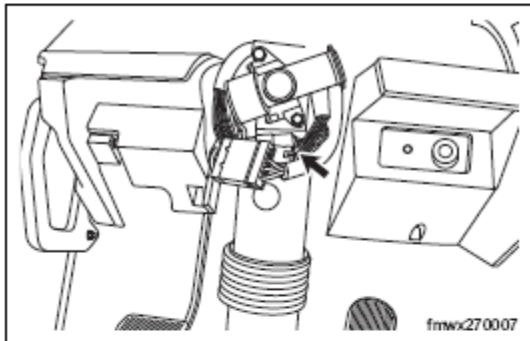
COMBINATION SWITCH

REPLACEMENT

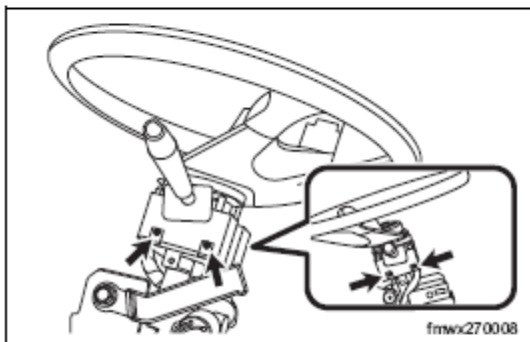
1. Turn off the main power.



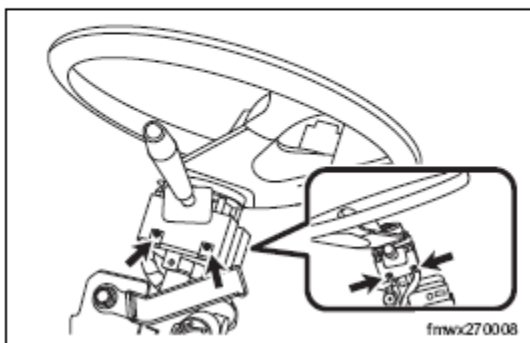
2. **Disassemble the steering column trim panel**
(a). Disassemble the fixing bolts of steering column trim panel.



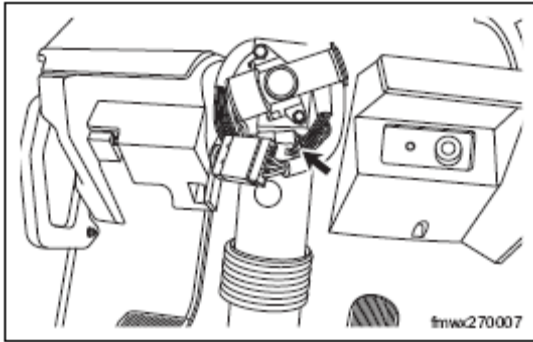
3. **Disassemble the combination switch assembly.**
(a). Disconnect the connector of combination switch.



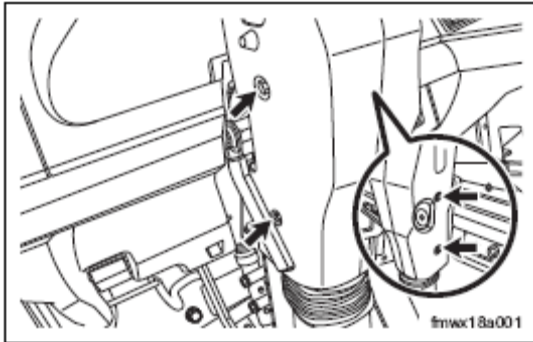
- (b). Disassemble the fixing screws of the combination switch.



4. **Install the combination switch assembly.**
(a). Install the fixing screws of the combination switch.



(b). Connect the connector of the combination switch.



5. Install the steering column trim panel.

(a). Install the fixing bolts of steering column trim panel.

6. Turn on the main power.

AUDIO SYSTEM

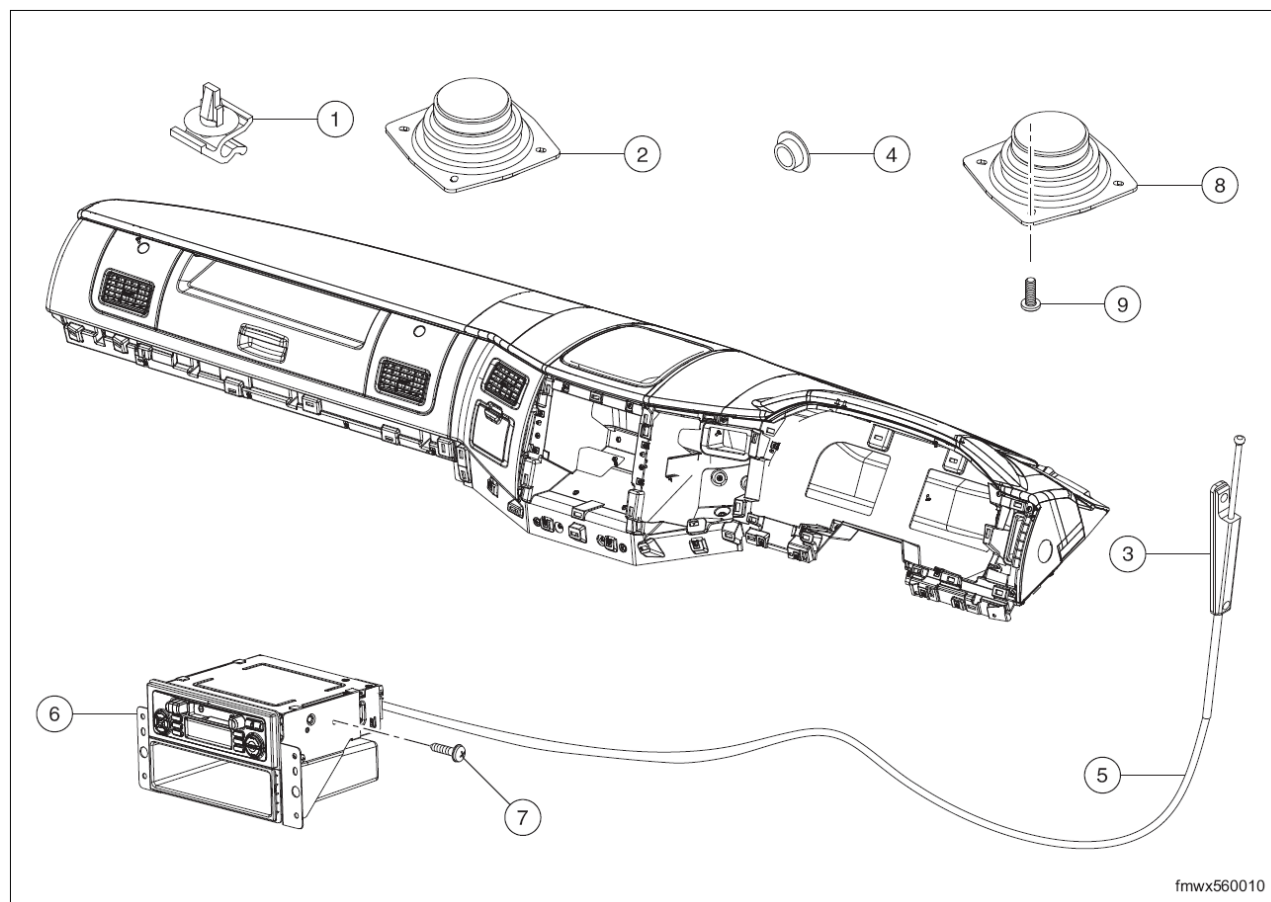
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LOUDSPEAKERS	56-7
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AUDIO SYSTEM

PRECAUTIONS

1. **Cut off the power.**
 - (a). Before disassembling or installing any electric device or when any tool or equipment will easily come into contact with any exposed electric terminal, make sure to disconnect the negative cable of the battery, in order to prevent injuring the personnel or damaging the vehicle.
 - (b). Make sure to turn off the ignition switch, unless otherwise specified.
2. **Disconnection the negative cable of battery will reset the clock on the combination instrument, however the total mileage will not be reset.**
3. **Disconnection the negative cable of battery will lead to loss of all saved settings of the audio system.**
 - (a). Re-setup the audio system after the negative cable of the battery is re-connected.
4. **While inserting a U-disk into the connector, maintain it at level position and do not push with high force, or the use of high force will easily lead to the distortion or damage of the mechanism.**
5. **Do not use any poor quality or non-standard external connector, as the non-regular shape of such connector will easily lead to distortion of jack and thus lead to fault of signal input mechanism. Under worse condition, it will lead to damage of grille and other components to cause function failure.**
6. **Power on the on-board radio/CD-player only after the external harness of the on-board radio/CD-player is correctly secured and the voltage meets the required value, in order to prevent damaging the internal circuit of the on-board radio/CD-player and the external loudspeakers and fuses (fuse cases).**
7. **Do not put any foreign material into the on-board radio/CD-player, in order to prevent damaging the on-board radio/CD-player.**

DIAGRAM OF COMPONENTS



fmwx560010

1	Tensioning clip
2	Loud speakers
3	Antenna assembly
4	Grommet
5	Antenna cable

6	Radio/CD-player assembly
7	Phillips pan head self-tapping screw and plain washer subassembly
8	Rear loudspeaker
9	Phillips self-tapping screw

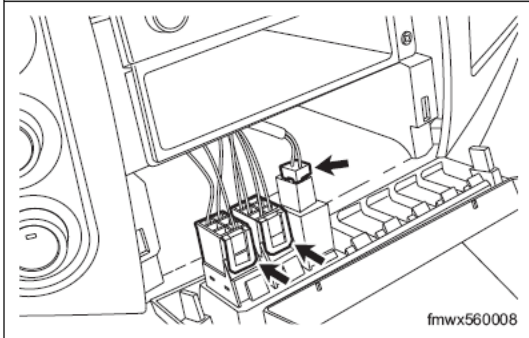
RADIO/CD-PLAYER

REPLACEMENT

Hint:

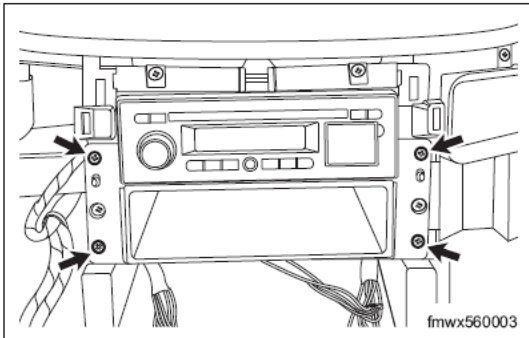
Please refer to Chapter 56 Audio System – Audio System, Diagram of Components for the diagram of the components.

1. Turn off the main power.



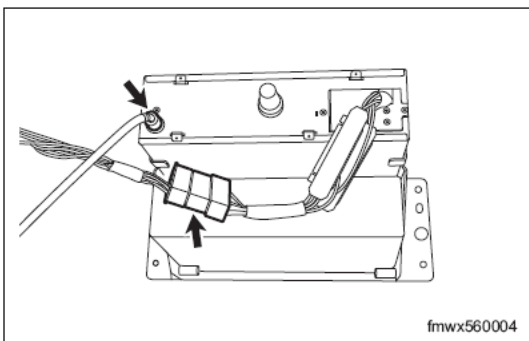
2. Disassemble the middle panel assembly.

- (a). Slowly pry out the middle panel with special tool.
- (b). Disconnect the connector of the middle panel.

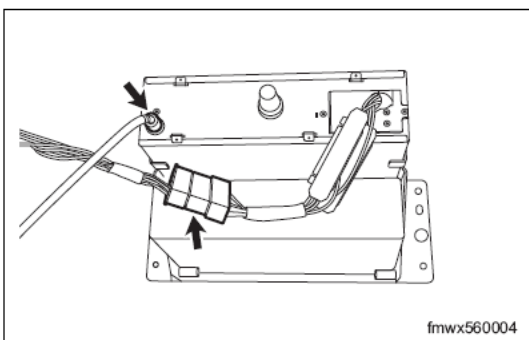


3. Disassemble the radio/CD-player assembly.

- (a). Disassemble the fixing screws of the radio/CD-player.

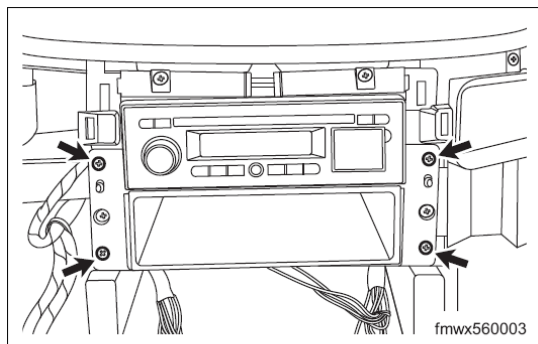


- (b). Disconnect the radio/CD-player connector and the antenna connector.



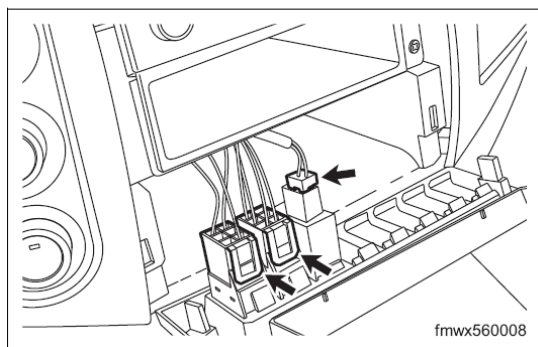
4. Install the radio/CD-player assembly.

- (a). Connect the radio/CD-player connector and the antenna connector.



- (b). Install the fixing screws of radio/CD-player.

Torque: 7 N.m



5. Install the middle panel assembly.

- (a). Connect the connector of the middle panel.
(b). Install the middle panel.

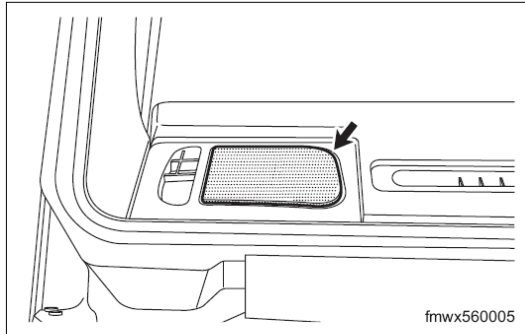
6. Turn on the main power.

LOUDLOUDSPEAKERS

REPLACEMENT

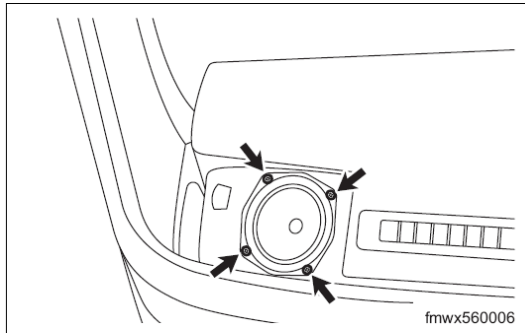
Hint:

Please refer to Chapter 56 Audio System – Audio System, Diagram of Components for the diagram of the components.



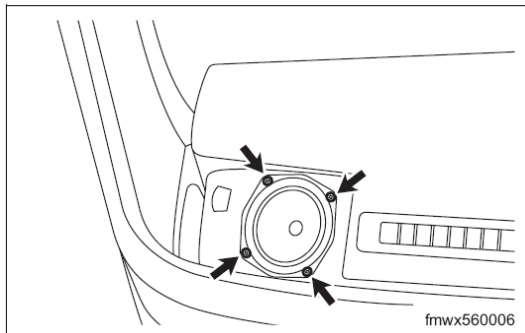
1. Disassemble the loud speaker grille.

- (a). Use special tool to slowly pry out the loud speaker grille. Do not scratch the trim panel.



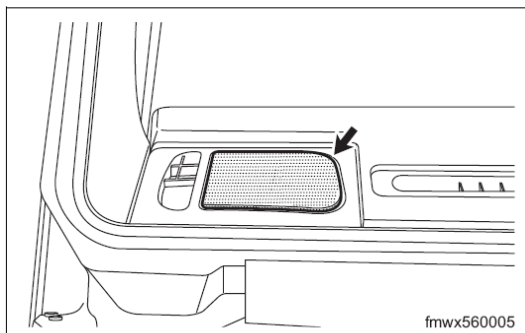
2. Disassemble the loud speaker assembly.

- (a). Disassemble the fixing screws of the loud speaker.
- (b). Disconnect the connector of loud speaker.



3. Install the loudspeaker assembly.

- (a). Connect the loudspeaker connector.
- (b). Install the fixing screws of the loudspeaker.



4. Install the loudspeaker grille.

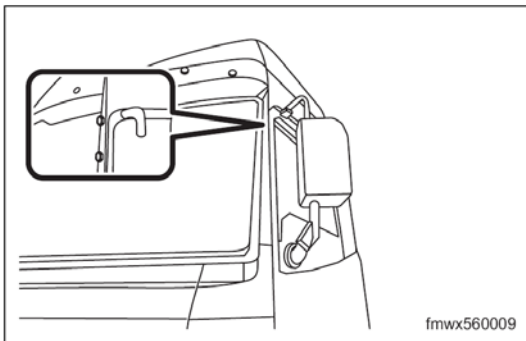
ANTENNA

REPLACEMENT

Hint:

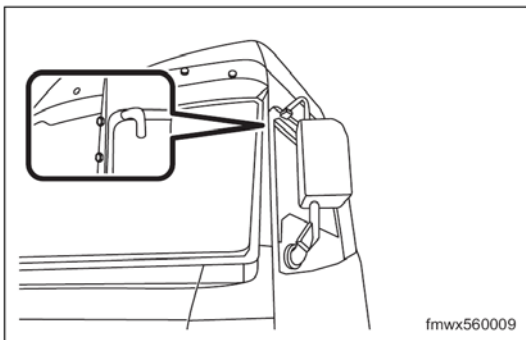
Please refer to Chapter 56 Audio System – Audio System, Diagram of Components for the diagram of the components.

1. **Disconnect the radio/CD-player antenna connector (Please refer to Chapter 56 Audio System – Radio/CD-player, Replacement).**



2. **Disassemble the antenna assembly.**

- (a). Disassemble the fixing screws of the antenna assembly.
- (b). Take out the antenna assembly.



3. **Install the antenna assembly.**

- (a). Install the fixing screws of the antenna assembly.

4. **Connect the radio/CD-player antenna connector (Please refer to Chapter 56 Audio System – Radio/CD-player, Replacement).**

HORN

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HORN

TABLE OF FAULT PHENOMENA

The following table can aid you to trace the fault. Serial number in the table indicates the sequence for the possibility of fault and each section should be checked in such sequence and replaced as needed.

Fault	Suspected cause	Reference
The horn does not blow.	1. Horn (damaged)	Chapter 57 Horn-horn, replacement
	2. Horn switch (damaged)	Chapter 57 Horn-horn switch, replacement
	3. Harness	Chapter 04 Horn-electric horn does not blow
	4. Relay	Chapter 4 Horn-electric horn does not blow
	5. Fuse	Chapter 04 Horn-electric horn does not blow
The horn blows frequently.	1. Horn switch (damaged)	Chapter 57 Horn-horn switch, replacement
	2. Harness	Chapter 04 Horn-electric horn blows frequently
	3. Relay	Chapter 04 Horn-electric horn blows frequently

CHECK

1. Horn assembly

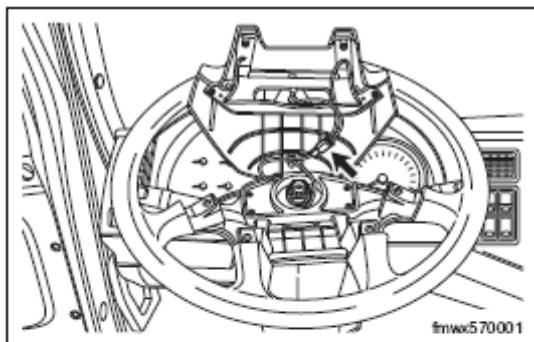
- (a). Apply storage battery voltage between horn terminals.
If the horn does not blow, replace horn assembly.

2. Horn switch

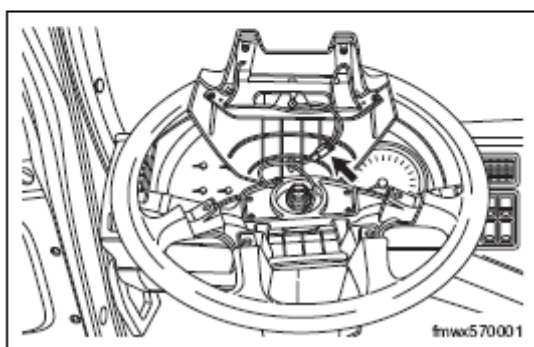
- (a). Press the horn switch and check if the hoot can be heard.
(b). Release the horn switch and check if the horn button returns to its original position and the hoot stops.
If the condition fails to conform to the standard, repair the horn switch or replace steering wheel assembly.

HORN SWITCH

REPLACEMENT



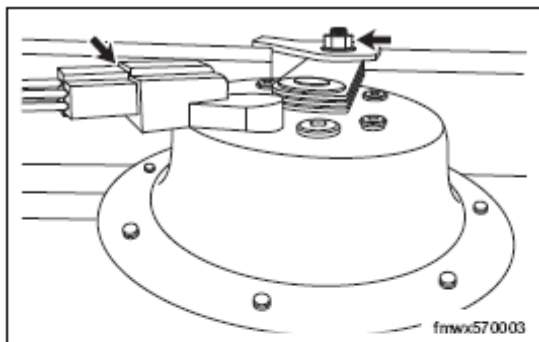
- 1. Dismantling of horn switch**
 - (a). Open horn switch cover plate.
 - (b). Disconnect horn switch connector.



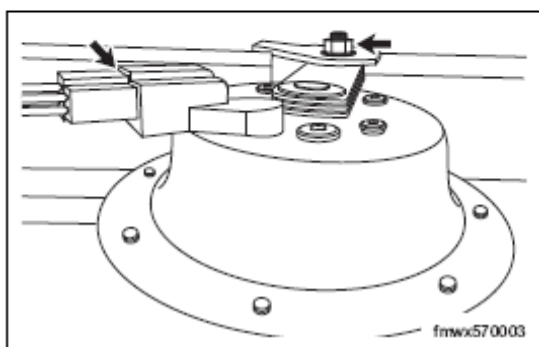
- 2. Installation of horn switch**
 - (a). Connect horn switch connector .
 - (b). Install horn switch cover plate.

ELECTRIC HORN

REPLACEMENT



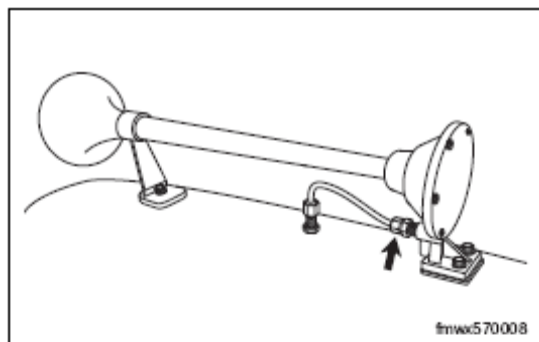
- 1 Dismantling of electric horn assembly
 - (a) Dismantle the plug of the electric horn
 - (b) Remove set bolt from the electric horn.



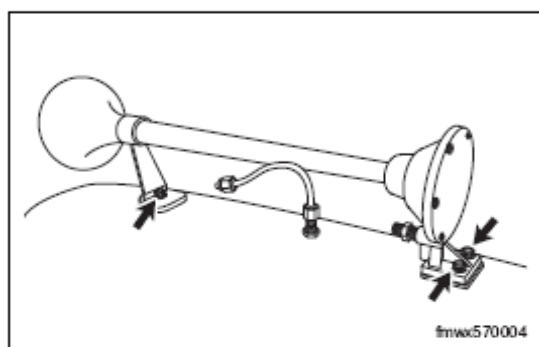
- 2 Installation of electric horn assembly
 - (a) Fit set bolt on the electric horn.
Torque: 23N.m
 - (b) Connect the plug of the electric horn.

PNEUMATIC HORN

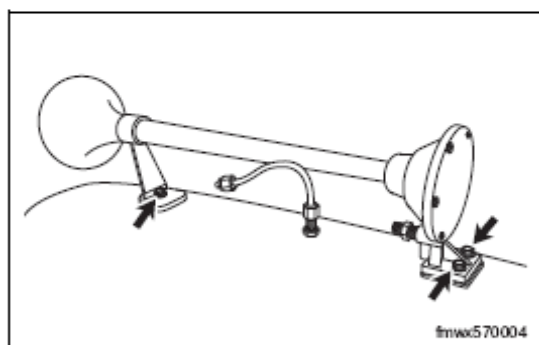
REPLACEMENT



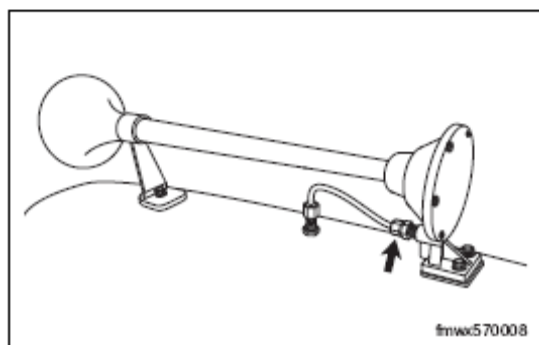
- 1 Dismantling of pneumatic horn assembly**
(a) Disconnect the air tube of the pneumatic horn.



- (b) Remove set bolt from the pneumatic horn.



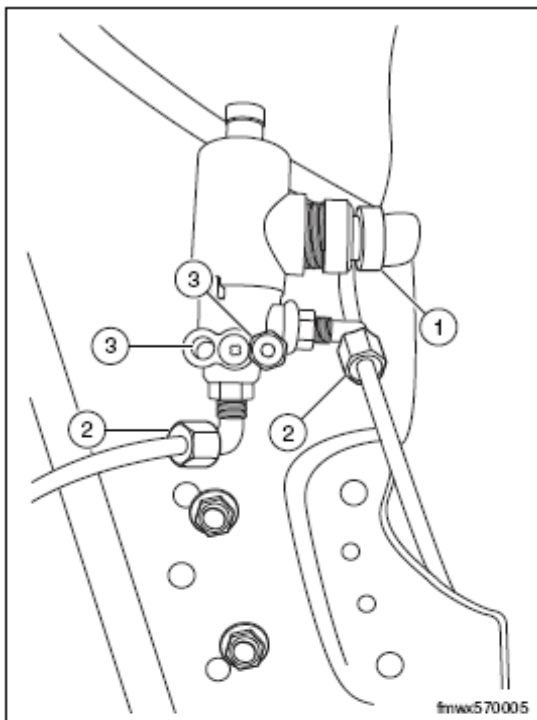
- 2 Installation of pneumatic horn assembly**
(a) Fit set bolt on the pneumatic horn.
Torque: 23N.m



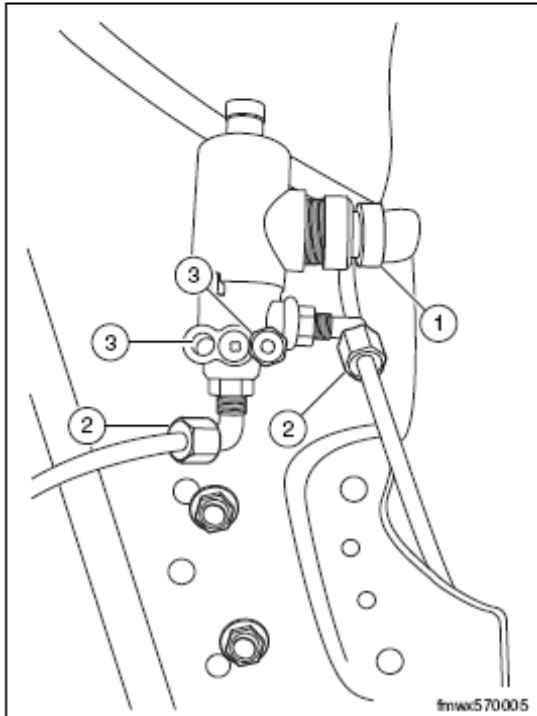
- (b) Connect the air tube of the pneumatic horn.

PNEUMATIC HORN SOLENOID VALVE

REPLACEMENT



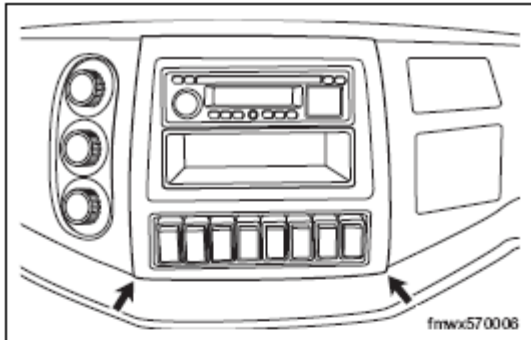
- 1 Dismantling of pneumatic horn solenoid valve**
- (a) Shut off main power.
 - (b) Disconnect plug 1 of the solenoid valve
 - (c) Disconnect inlet/outlet pipe 2 of the pneumatic horn solenoid valve.
 - (d) Remove set bolt 3 from the pneumatic horn solenoid valve.



- 2 Installation of pneumatic horn solenoid valve**
- (a) Fit set bolt 3 of the pneumatic horn solenoid valve.
 - (b) Connect inlet/outlet pipes 2 of pneumatic horn solenoid valve.
 - (c) Connect plug 1 of the solenoid valve.

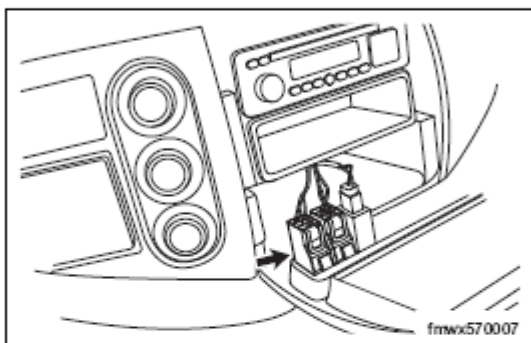
ELECTRIC/PNEUMATIC HORN CHANGEOVER SWITCH

REPLACEMENT

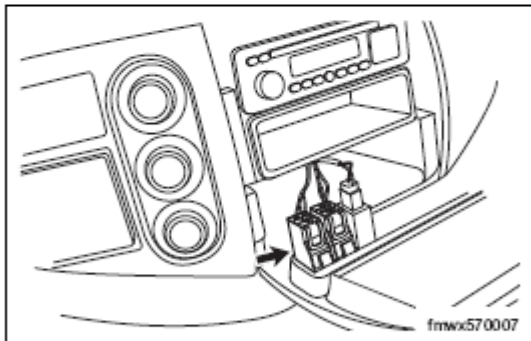


1 Dismantling of electric/pneumatic horn changeover switch

- (a) Shut off main power.
- (b) Dismantle middle panel assembly.

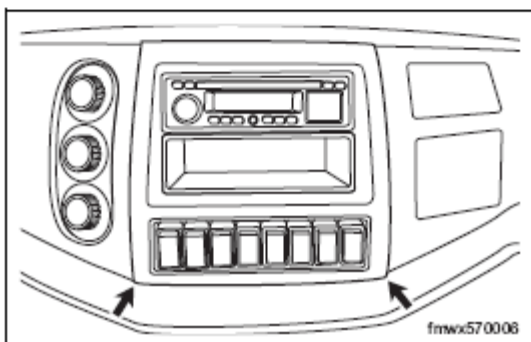


- (c) Disconnect the plug of electric/pneumatic horn changeover switch.
- (d) Remove electric/pneumatic horn changeover switch.



2 Installation of electric/pneumatic horn changeover switch assembly

- (a) Install electric/pneumatic horn changeover switch.
- (b) Connect the plug of electric/pneumatic horn changeover switch.
- (c) Install middle panel assembly.



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INTRODUCTION

REMARK

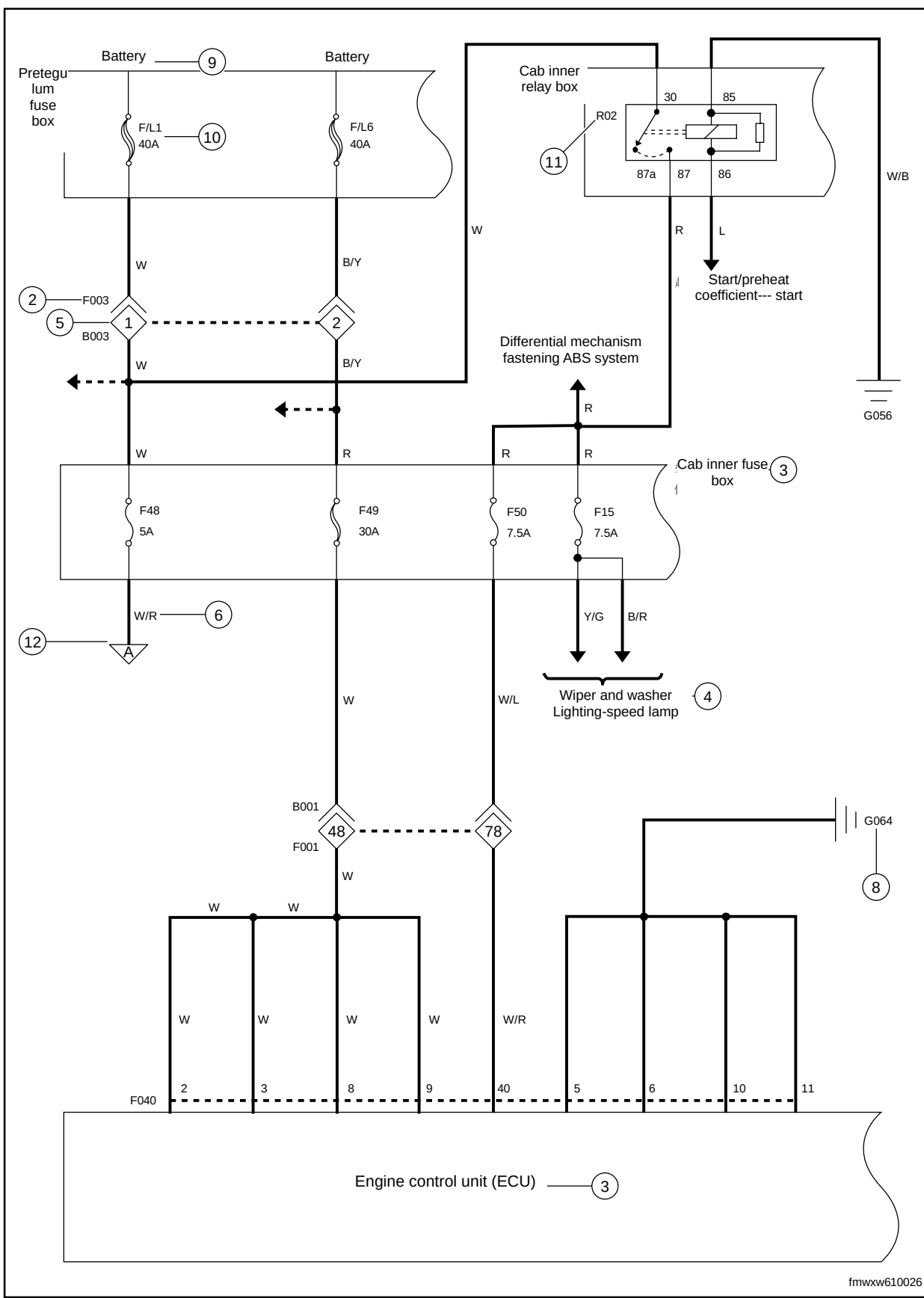
Notice: Always reinstall the fasteners to their original positions after removing them. If it's needed to replace the fasteners, the replacing fasteners' unit codes must be correct. If there's no correct match, fasteners with the same size and strength (or more strong) can be the replacement. For the non-reusable fasteners should be replaced by new fasteners. For the fasteners which need screw agent, add the agent while installing. Adopt correct torque values while installing. Any disobedience of above condition will lead to components or system damage.

Notice: Use the components of the same capacity and load to replace fuse, relay and load components. Any disobedience of above condition will lead to component or system damage and cause fire.

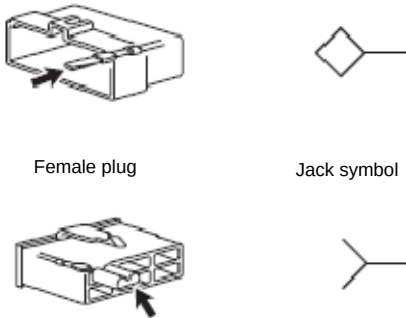
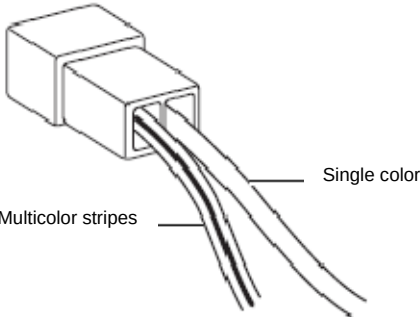
The specifications of the underpan electrical system is 24 v, negative grounding. The wire diameter must match the corresponding circuit requirements, and with colored classification (for easy identification in the circuit diagram). The wire diameter is decided by load capacity and needed wire length. Automotive wire connector includes: automobile body major connector, front frame major connector, back frame major connector, transmission connector, and engine connector, dumping gear connector, ceiling connector and battery cable. According to different connector positions, the connectors will be protected by insulating tape or bellows. Each system circuit has power supply, circuit, fuse, relays, switches, load components and grounding, and all of these are displayed in the circuit diagram. The manual catalogs each electrical equipment by systems. It has detailed specification for the major components of every system in the circuit diagram, including summary, failure diagnosis, inspection, disassemble and installation steps. Please refer to the diagnosis chapter to make necessary replacement.

USER GUIDE

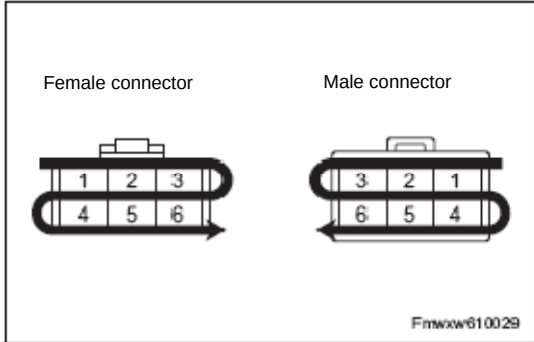
① Engine control system—ECU power supply/grounding



Code	Name	Description																																				
1	system name																																					
2	wiring harness connector code	The coding rules of the wiring harness connector in this circuit diagram are based on the wiring harness. For example: the code of engine wiring harness in the engine control unit (ECU) is E01 in which E stands for the code of the wiring harness, and 01 is the plug serial number. The coding specifications of wiring harness and wiring harness connectors are as follows: <table><tr><th>Definition</th><th>Name</th></tr><tr><td>BM</td><td>The main body wiring harness</td></tr><tr><td>B--</td><td>The main body wiring harness connector</td></tr><tr><td>EN</td><td>Engine wiring harness</td></tr><tr><td>E--</td><td>Engine wiring harness plug</td></tr><tr><td>EC</td><td>ECU wiring harness</td></tr><tr><td>C--</td><td>ECU wiring harness connector</td></tr><tr><td>GX</td><td>Transmission wiring harness</td></tr><tr><td>X--</td><td>Transmission wiring harness connector</td></tr><tr><td>RF</td><td>Roof wiring harness</td></tr><tr><td>R--</td><td>Roof wiring harness connector</td></tr><tr><td>UT</td><td>Flip institutions wiring harness</td></tr><tr><td>U--</td><td>Flip institutions wiring harness connector</td></tr><tr><td>FF</td><td>Front frame wiring harness</td></tr><tr><td>F--</td><td>Front frame wiring harness connector</td></tr><tr><td>TF</td><td>Rear frame wiring harness</td></tr><tr><td>T--</td><td>Rear frame wiring harness connector</td></tr><tr><td>Z--</td><td>other connectors</td></tr></table>	Definition	Name	BM	The main body wiring harness	B--	The main body wiring harness connector	EN	Engine wiring harness	E--	Engine wiring harness plug	EC	ECU wiring harness	C--	ECU wiring harness connector	GX	Transmission wiring harness	X--	Transmission wiring harness connector	RF	Roof wiring harness	R--	Roof wiring harness connector	UT	Flip institutions wiring harness	U--	Flip institutions wiring harness connector	FF	Front frame wiring harness	F--	Front frame wiring harness connector	TF	Rear frame wiring harness	T--	Rear frame wiring harness connector	Z--	other connectors
		Definition	Name																																			
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		RF	Roof wiring harness																																			
		R--	Roof wiring harness connector																																			
		UT	Flip institutions wiring harness																																			
		U--	Flip institutions wiring harness connector																																			
		FF	Front frame wiring harness																																			
		F--	Front frame wiring harness connector																																			
		TF	Rear frame wiring harness																																			
		T--	Rear frame wiring harness connector																																			
Z--	other connectors																																					
3	Parts Name																																					
4	Information connecting other systems regarding to																																					

Code	Name	Description																								
5	Wiring harness connectors	In terms of wiring harness and wiring harness connector, diamond graphs represent male plugs, and the numeric codes in the diamond graphs represent pin number while arrow graphs represent the female jack.  Male plug Plug symbol  Female plug Jack symbol Fm1wxx6 10027																								
6	Wiring color	If the wiring is a double-color wiring, then the first letter shows the grounding of the wiring, and the second letter shows the color of the stripes, separated in the middle with "/" separator.  Single color Multicolor stripes For example: G / R Red color (stripe color) Green color (grounding) <table><tr><td>Black</td><td>White</td><td>Red</td><td>Green</td><td>Yellow</td><td>Brown</td></tr><tr><td>B</td><td>W</td><td>R</td><td>G</td><td>Y</td><td>Br</td></tr><tr><td>Pink</td><td>Blue</td><td>Gray</td><td>Violet</td><td>Orange</td><td>Light green</td></tr><tr><td>P</td><td>L</td><td>Gr</td><td>V</td><td>O</td><td>Lg</td></tr></table> Fm1wxx6 10028	Black	White	Red	Green	Yellow	Brown	B	W	R	G	Y	Br	Pink	Blue	Gray	Violet	Orange	Light green	P	L	Gr	V	O	Lg
Black	White	Red	Green	Yellow	Brown																					
B	W	R	G	Y	Br																					
Pink	Blue	Gray	Violet	Orange	Light green																					
P	L	Gr	V	O	Lg																					



Code	Name	Description
7	Pin coding	Display the pin coding of the connectors, and pay attention to the wiring harness connected with each other. Connectors' pin coding sequence are mirror images, as shown below: 
8	Grounding points	Ground point coding is identified by the serial number coding beginning with G, and please refers to the distribution graph of grounding for the details of the locations of the grounding points.
9	Power supply type	In terms of the power supply type for the fuse, the storage battery represents the storage battery power, and ACC represents the power output when the ignition switch is set at the "ACC", and ON represents the power output when the ignition switch is set at "ON", and ST represents the power output when the ignition switch is set at the "START / HEAT".
10	Fuse coding	Fuse coding is comprised of the fuse code and serial number. The fuse code of the fuse located at the front flip cover of the cab is F / L, and that one located inside the cab is F. Please refer to the relay and fuse box for the detailed fuse codes.
11	Relay	Indoor relay code is R. Please refer to the relay and fuse box for details.
12	Connecting to the next page	If a system has comparatively more content, and more pages are needed to denote the wiring, then the start of the wiring is shown and denoted with a triangular arrow pointing out and the end of the wiring with a triangular arrow pointing in. If there is more than one wiring extended to the next page, they shall be denoted by the letters such as A, B, C, and so on.

SYMBOLS REPRESENTING PARTS

Symbols	Meaning of symbols	Symbols	Meaning of symbols	Symbols	Meaning of symbols
	Storage battery		Strand wire		Speaker / Buzzer
	Grounding		Filament bulb		Cross-connected wirings
	Small load fuses		Relay		Non cross-connected wirings
	Medium load fuses		Single speed motor		Normally open switch
	Large load fuses		Speed motor		Normally closed switch
	Resistors		Dual filament lamp		Double-throw switch
	Adjustable resistors		Connectors		Reed switch
	Temperature sensor		Diodes		Capacitance
	Coil sensor		LED		Cigarette lighter
	Solenoid valve		Loudspeaker		Preheater / heater

FAILURE DIAGNOSIS AND MAINTENANCE

FAILURE DIAGNOSIS PROCEDURE

Inspect the fault as per the following procedure:

1. Confirm the client's complaint

To make correct maintenance, confirm client's description of the failure. Carefully check relevant parts to confirm the failure and make notes. Decomposition of the units is not allowed while fault coverage and causes haven't been confirmed.

2. Circuit diagram specification and cause analysis

Analyze and judge the entire circuit from power supply to grounding of the failure part as per subsystem circuit diagram, and confirm maintenance policy. If it's impossible to confirm the maintenance operation policy, please refer to relevant chapter of the system description in maintenance manual to get a general understanding of the operating principle. At the same time check other shared circuits with the fault circuit, such as the system circuits shared by the reference fuse, grounding and switching on the circuit map. The detection is at Step 1: unchecked shared circuit. If other parts function normally in the shared circuit, then the failure is at the circuit itself. If other components also perform function problem, then it's the fuse or grounding failure.

3. Circuit and component inspection

Any circuit diagram should be applied with its maintenance manual. Refer to the inspection procedure of the diagnosis part in the maintenance manual. For the circuit with module control, the component inspection should be combined with diagnostic apparatus. An effective failure diagnosis should be a reasonable operating procedure with logicity. Combine with the failure diagnosis procedure of diagnosis part in the maintenance manual fully, and start from the most possible reasons and components that are easy to check.

4. Failure maintenance

Once the failure is found, refer to the failure processing method description in the circuit diagram as well as the maintenance manual. For example: bad grounding processing procedure, wiring connector processing method.

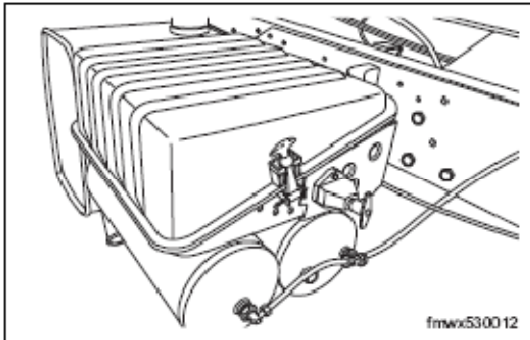
5. Confirm circuit working condition

When the maintenance is over, confirm the failure is eliminated. All the functions should be detected to be normal condition. If it's the fusing failure, all the sharing circuits should be checked.

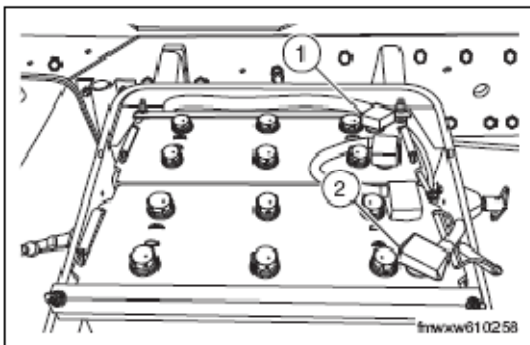
ELECTRICAL FAILURE MAINTENANCE AND ANNOUNCEMENTS

Disconnecting of the storage battery

1. Make sure that all electrical equipment is turned off



2. Close the battery breaker switch



3. Disconnect the storage battery cable

- (a). Disconnect the ground cable of the storage battery 1.
- (b). Disconnect the positive cable of the storage battery 2.

Notice:

You should first disconnect the ground cable of the storage battery as disconnecting the positive cable of the storage battery could result in a short circuit.

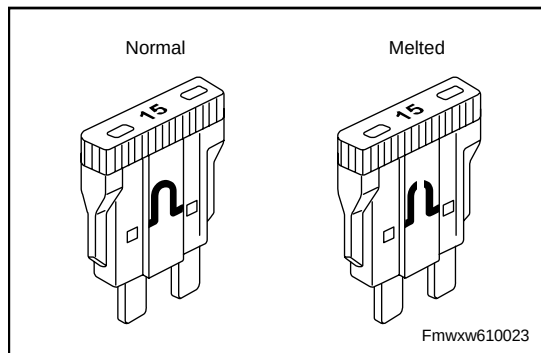
4. Connect the cable of the storage battery in the reverse order of disconnecting it

Notice:

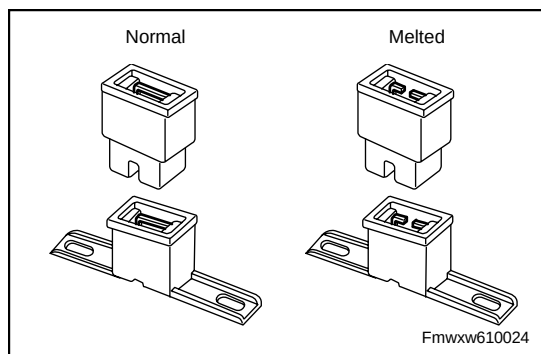
Please clean the armature and cable connectors of the storage battery. Please apply a thin layer of lubricating grease on the armature of the storage cable to prevent corrosion of the armature and connectors after the installation is complete,

Check the fuse**Notice:**

Please do not use a fuse of different rated current value for the replacement of the melted fuse. Doing so will result in electrical fire or other serious damages to the circuit.

**1. Small or Medium loaded fuses**

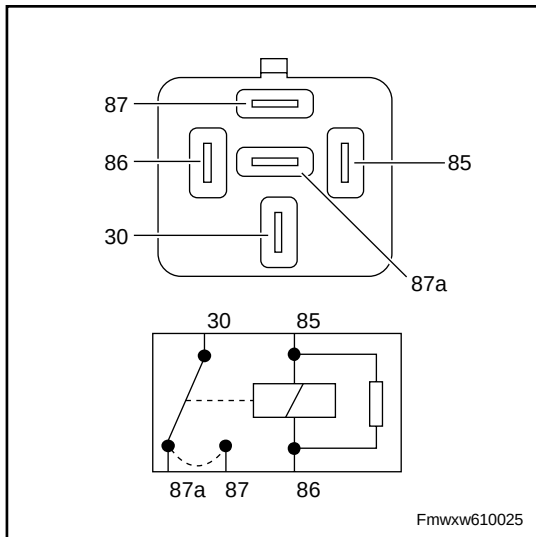
- Fuse is the most common circuit protection in automobile circuit. It is series connected in protective circuit. When the electricity current is overloaded in the circuit(for example, the grounding wire is too short), according to the design, such thin wire or metal wire will be burned out, therefore the electricity current is cut off. This can prevent high strength current reaching to other parts of the circuit and causing damage. Before replacing the fuse, be sure of the causes of the overload. New fuse must with the same rated current value of the original fuses. It is easy to identify the melted fuse, see the picture.

**2. Large loaded fuses**

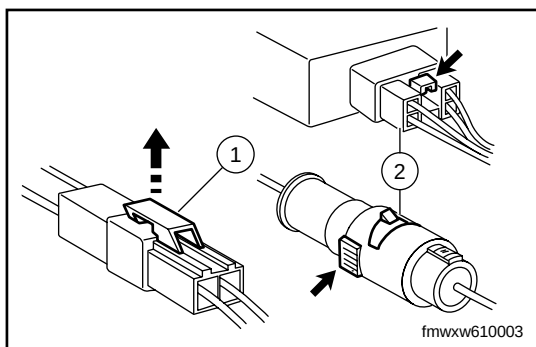
- Large loaded fuse is used for large current circuit (starter) or when common fuse is not practical. Too much current will make the fuse melt, and the electricity is cut off to avoid circuit damage caused by fire or heat. Before replacing the fuse, be sure of the causes of the overload. New fuse must with the same rated current value of the original fuses. It is easy to identify the broken fuse, see the picture.

Check the relay

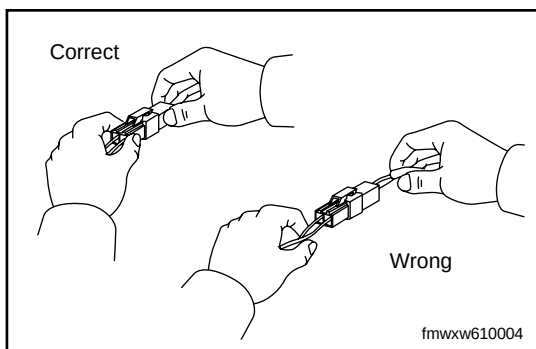
Notice: please do not use a relay of different rated current value for the replacement of the damaged relay.

**1. 24V relay**

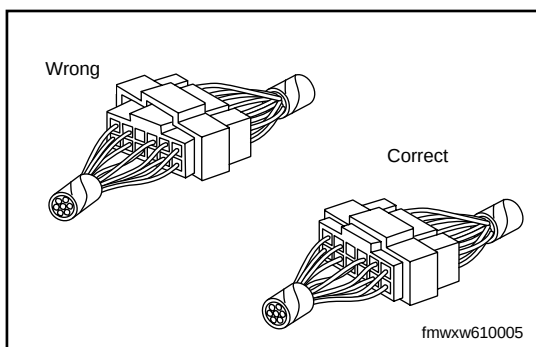
- Due to the power supply and load need a switch which has a certain distance away from them. This means that wire will be longer, and the voltage will be higher, and the relay can reduce the length between the power and the load, thus reduces the voltage between. Most of the switches cannot stand such large current, using switch to control relay and control the loads, then the current that passes the switch will be smaller.
- Model: 24V 30/20A.

Operation of connectors**1. Disconnecting the connectors**

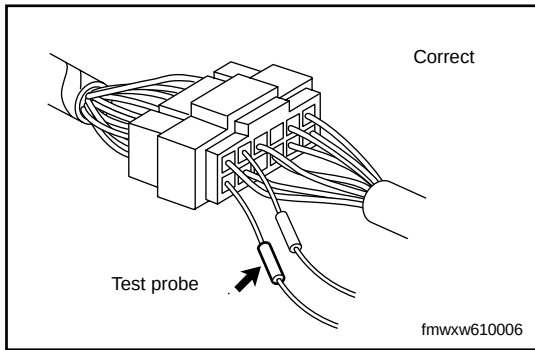
- (a). Some connectors have retainers for connecting the connectors firmly together when the vehicle is in motion. Some retainers can be released by being pulled towards your direction 1. Some retainers can be released by pressing forward 2.



- (b). Make sure the type of the retainers being operated. Firmly grasp the connector on both sides (plug and jack). Release the retainer and carefully pull apart both ends of the connector. Please do not detach the connectors by pulling on the wiring, or the wiring will be broken.

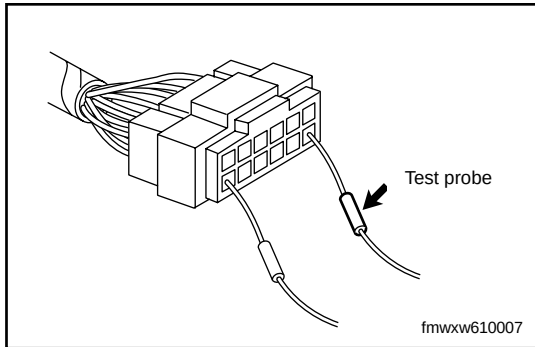
**2. Connecting the connectors**

- (a). Please firmly grasp the connector on both sides (plug and jack). Make sure that the connector pin and pin-hole matches. Make sure that the connector is aligned on both sides. Carefully push together tightly both sides of the connector until you hear a clear clicking sound.



3. Check the wiring on the connectors

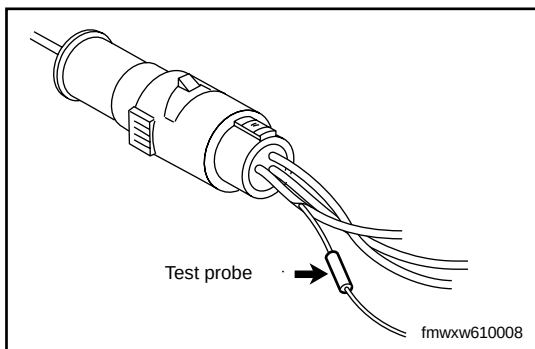
- (a). Check the wiring with a multimeter. Insert the test probe on one side of the wiring of the connector.



- (b). Test the wiring from the open end of the connector, and use a thinner test probe.

Notice:

Please do not insert a test probe thicker than the pin-hole test probe into the open end of the connector to test the wiring. Doing this will result in the rupture or cracking of the connector ends and expansion of the pin-hole.



- (c). Under the circumstances of not disconnecting the connector, while the test probe is unable to be inserted into the waterproof connector, insert a test probe clip of fine steel needle type into the wire to check the wiring.

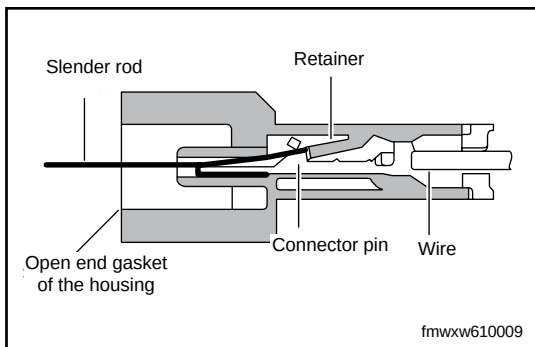
Notice:

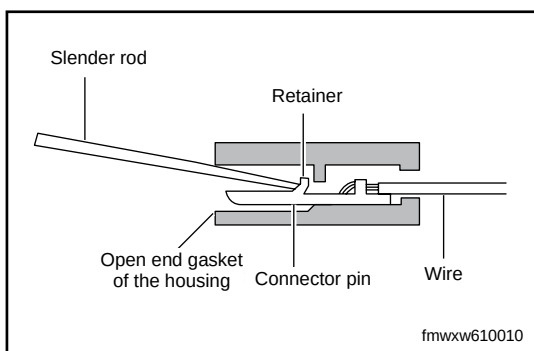
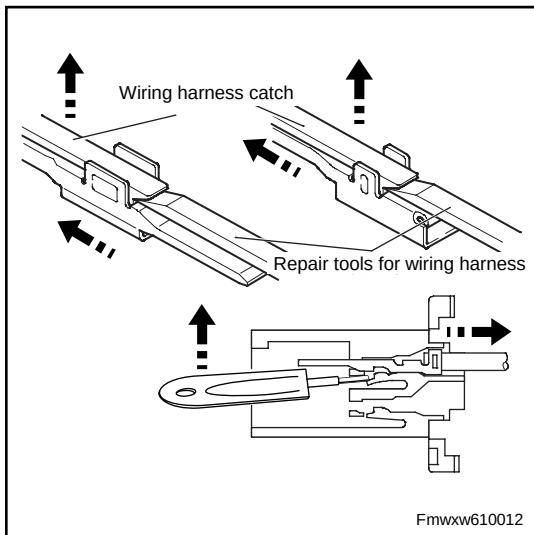
Use a dedicated tool of test probe clip for the wiring inspection and test, or it would be easy to damage the wires.

4. Detach the connector pins

- (a). Housing retainer type:

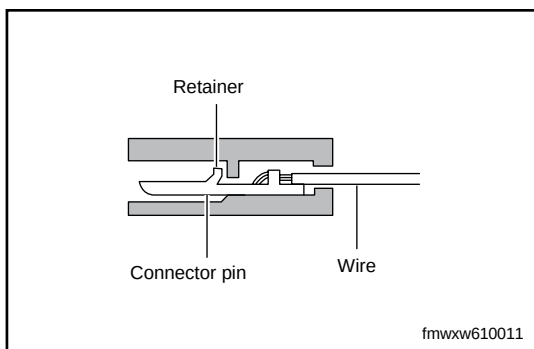
- Insert the slender rod into the open end of the connector housing.
- Push the retainer upward (following the direction of the arrow in the graph). Pull out the wire and connector pin from the wire side of the connectors.





(b). Connector pin retainer type

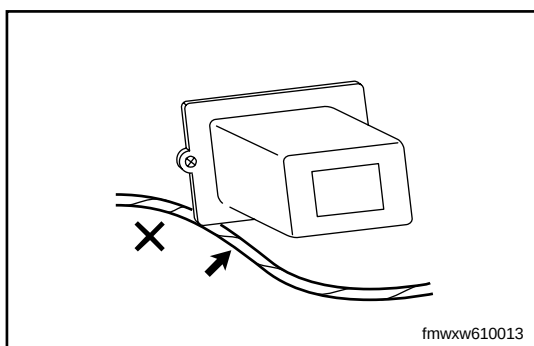
- Insert the slender rod into the open end of the connector housing.
- Flatten the retainer (towards the connector wire side). Pull out the wire and pin from the wire side of the connector.



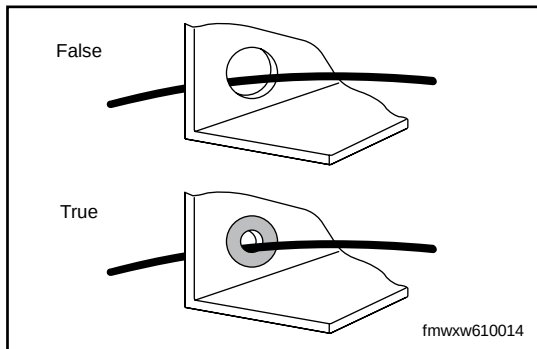
5. Install the connector pins

- Check if the retainer is fully up.
- Insert into the connector pin from the wire side of the connector and push the pin in until the retainer snaps into place.
- Gently pull the wire to confirm the connector pin is securely installed in place.

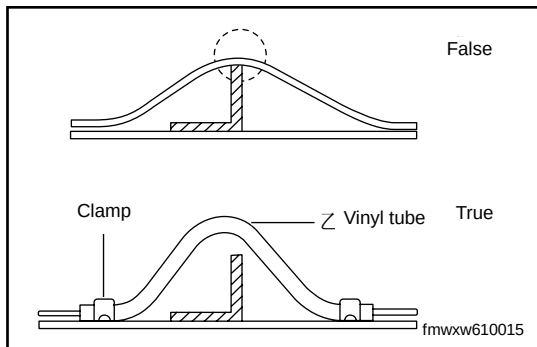
Fixing of the wiring harness



- Please pay attention not to clamping or crushing wire harness when assemble parts. All electric joints should be kept clean and firm.



2. Using grommet or protective pipe can prevent wire harness from touching sharp edges and surface.



3. Wire harness should be laid over other parts with enough margin and protected by vinyl tube from contacting directly

4. Wire harness between motor and underpan should be long enough to prevent abrasion or damage caused by various vibrating.

Wire repairing

1. Open wire harness

- If wires were stuck by adhesive tapes, please remove them. To avoid the damage to wire insulation lagging, cutting must be careful. If there were plastic sleeve around wire harness, just pull out wires.

2. Wire cutting

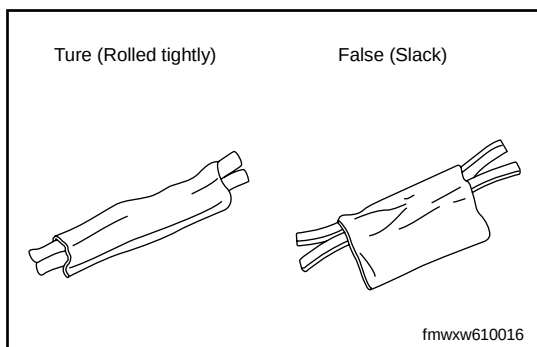
- In the beginning, cut wires as little as possible. While in the future, if more wires were decided to cut to change connection position, it may be necessary to set extra length aside for adjusting connection position to ensure appropriate distance between each junction with others and wiring branches or joint.

3. Strip insulation layers

- Please use wires with the same diameter as original one when replace them. Check stripped wires if there were crack or cut strand and replace them with new ones if damage. The length of tail end of two stripped wires should be the same.

4. Wires connecting

- Superpose the naked parts of the two wires and then screw them together or clamp them with connector. The screwing or clamping must be firm



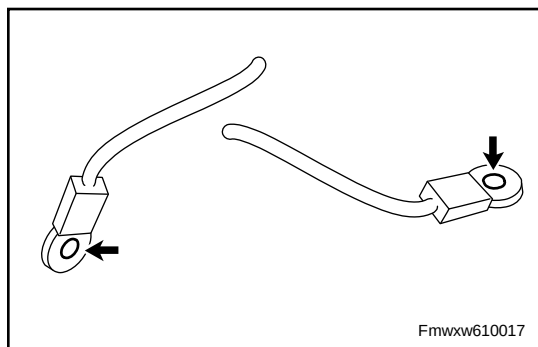
5. Wires wrapping

- (a). Place joints tapes in the middle and roll them tightly. The insulation tape should cover the whole joint. Tangle enough tapes to double current thick of insulation layers. The tapes should not be slack in that slack insulation tape may not afford to provide sufficient insulating ability and the slack end may get entangled in other wires of harness.

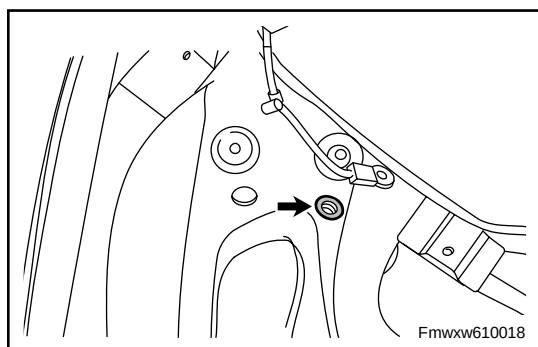


Ground handling

1. Dismantle bolts at ground point



- 2. Clear the contact surface of the two ground rings of wire harness side (including body side and bolt side) by abrasive cloth until all the oxide cleared.**

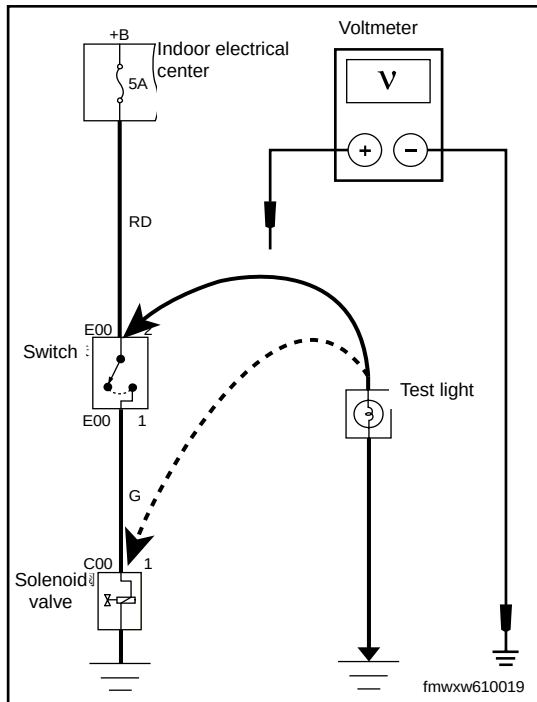


- 3. Clear the ground point of body side by abrasive cloth until the surface completely cleared.**

- 4. Remount wire harness and fixing bolt of ground point and screw them tightly following given moment.**

FAILURE DETECTION

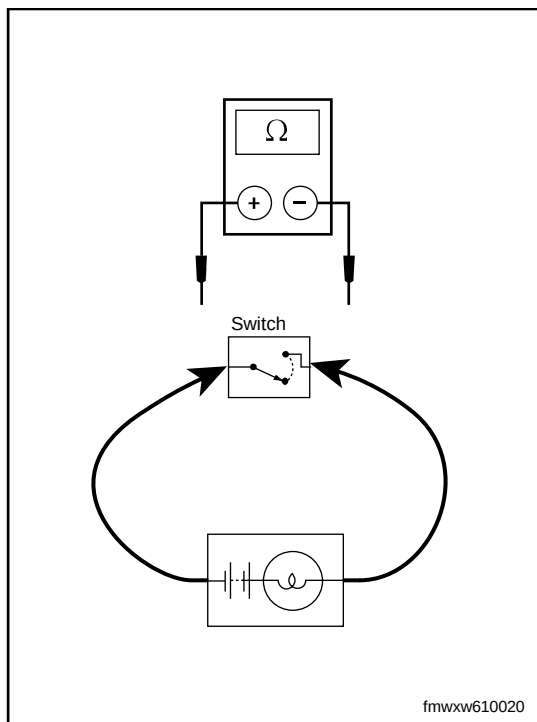
Voltage detection



Hint: Voltage detection is to detect a certain point if there is a voltage. Detecting a certain terminal of wire connector could use a positive wire probe of circuit detecting tool plugging back of the connector without decomposing wire connectors.

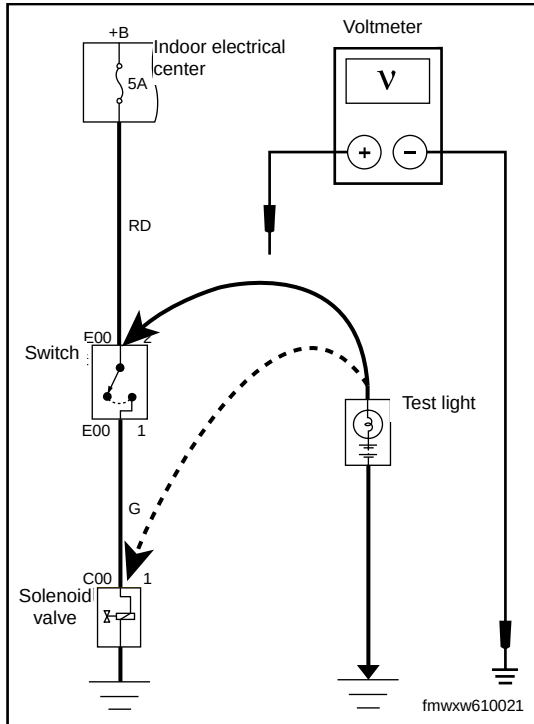
1. When use a test light or voltmeter checking voltage, negative pole of detecting tool should be connected to that of battery first.
2. Then connect the wire of the other end of test light or voltmeter to the position to be checked.
3. If voltmeter used, the circuit would be found in trouble when displayed value is more than 1V less than specified value. While test light, the circuit would have faults if the light unable to illumine normally.

Open circuit testing



1. Break wire harness of negative pole of storage cell
2. Connect a lead of self-powered test light or ohmmeter to the parts to be checked. In the utilization of ohmmeter, it's two leads would be shorted first, then zeroed
3. Connect the other wire of detector to the other terminal of load to be checked.
4. The lighting of self-powered test light represents the circuit is conducted. If using a ohmmeter, the unit would be conducted well when resistance is very small or close to 0Ω

Short circuit testing



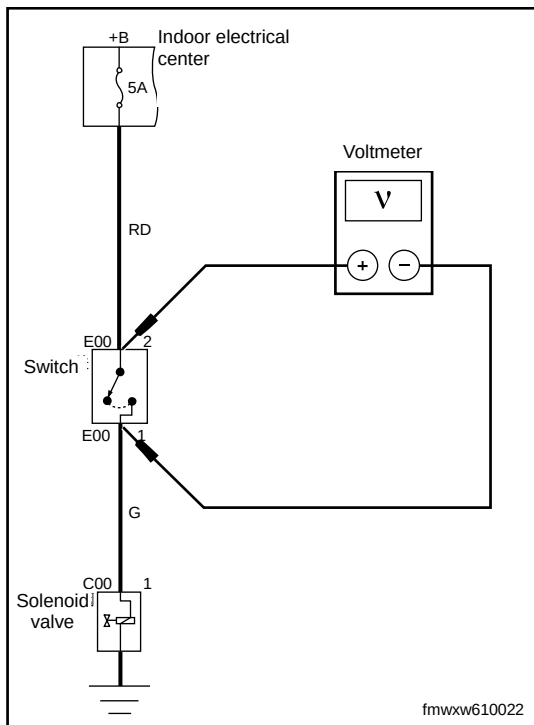
1. Disconnect negative wires of storage cell.
2. Connect one wire of self-powered test light or ohmmeter to the leading-out terminal of fuse.
3. Ground the other wire of self-powered test light or ohmmeter
4. Disconnect all the associated electrical loads on fuse.

Notice:

If all the electrical loads of fuse were not disconnected, ohmmeter would always display low resistance when checking low resistance loads circuits such as light and so on, which may lead to misjudgment.

5. Check circuits in turn from the nearest position around fuse.
6. The light of self-powered test light or resistance of less than 5Ω represent this part is ground shorted

Voltage drop testing

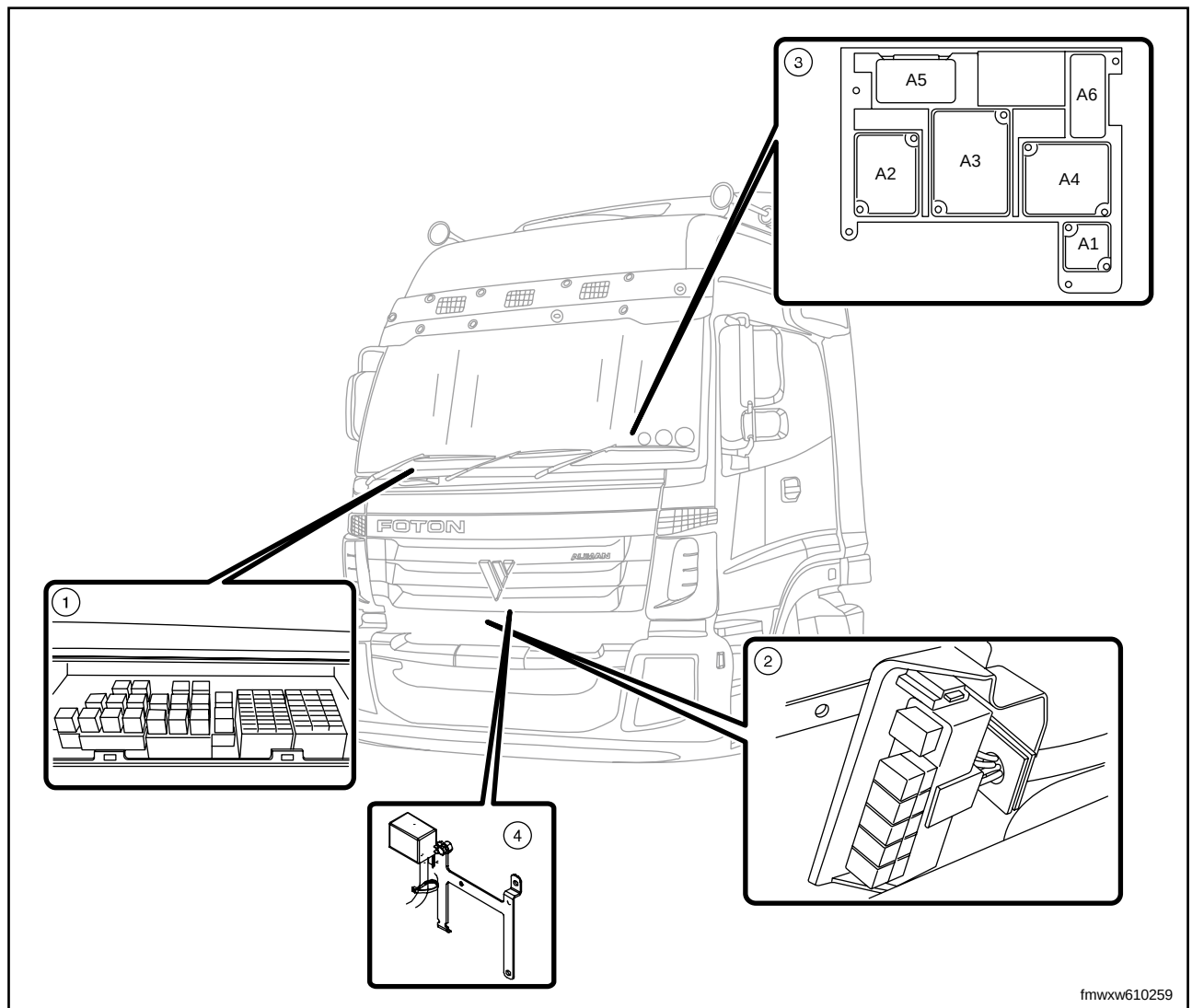


Hint: Test along wires, joints or switches to check voltage drop

1. Connect positive wire of voltmeter to the end of wire near storage cell (Joint side or switch side)
2. Connect negative wire to the other end (The other side of joint or switch)
3. Open or close switch to make circuit work.
4. The voltmeter would display the voltage between the two points.
5. If voltage exceeds 0.1V (the voltage of 5V circuit should be less than 50mV), the circuit is found in trouble, then check the slack, oxidized or corrosive circuits.

RELAY AND FUSE BOX

LOCATION OF RELAY AND FUSE BOX

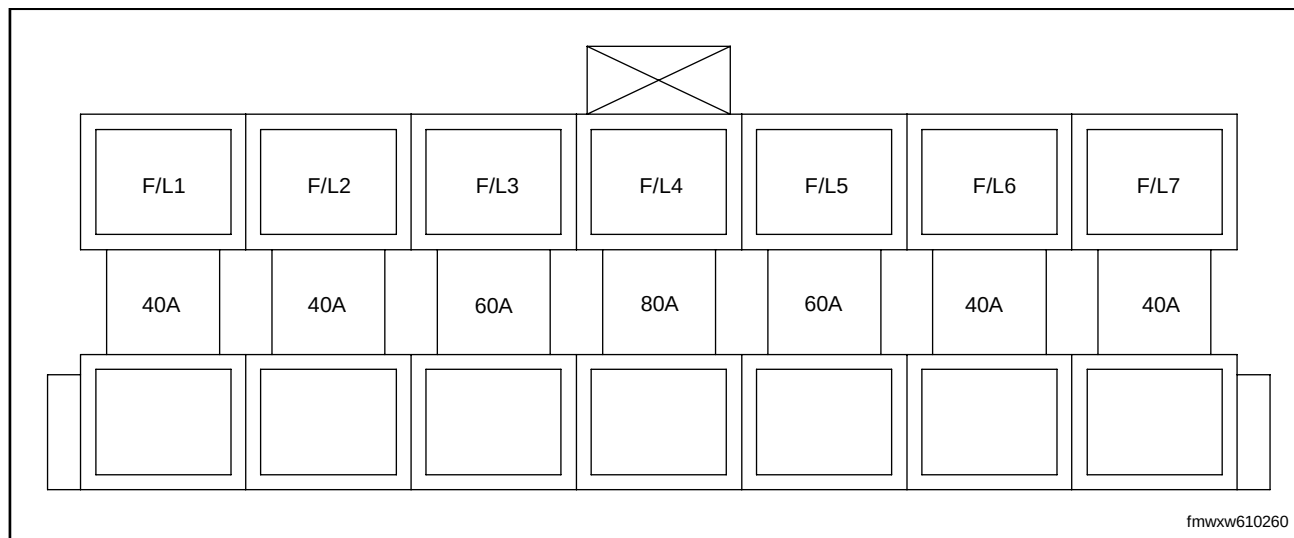


fmwxw610259

1	Relay and fuse box in cab
2	Fuse box of front cover

3	Relay and fuse box in cab
4	Starting relay

FUSE BOX OF FRONT COVER

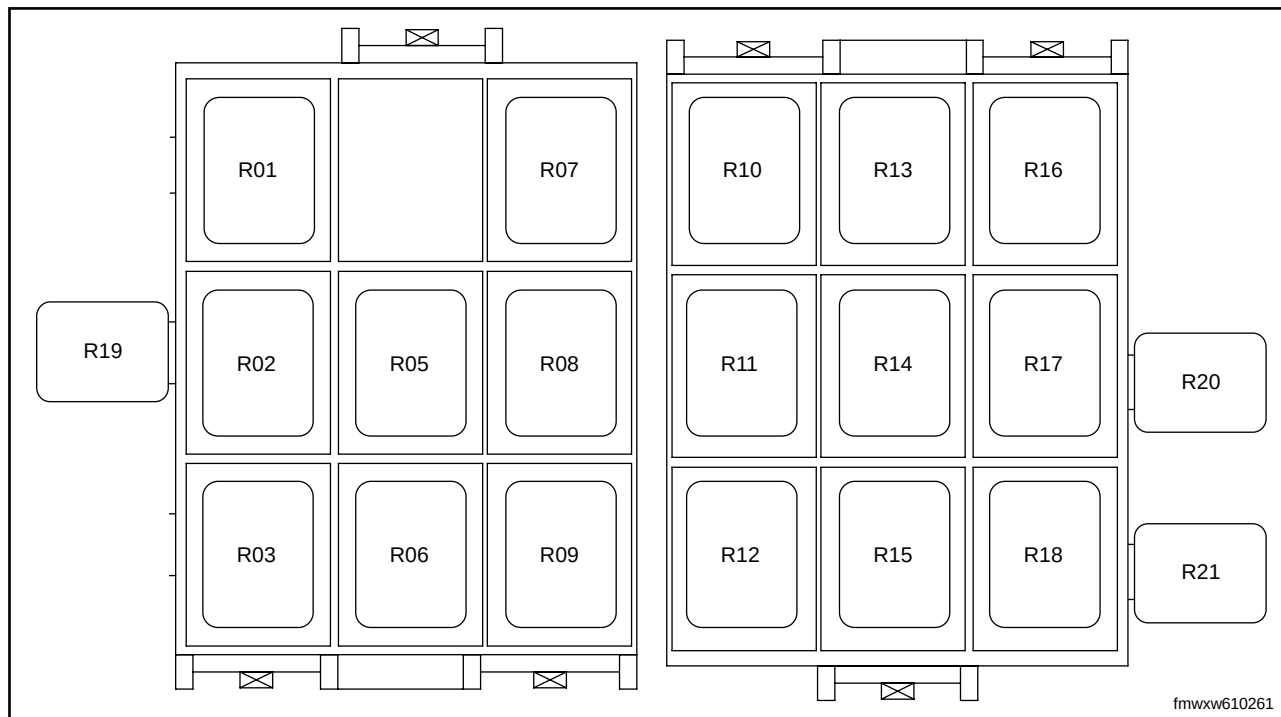


No.	Rated current	Name
F/L1	40A	—
F/L2	40A	—
F/L3	60A	—
F/L4	80A	Generator fuse

No.	Rated current	Name
F/L5	60A	—
F/L6	40A	—
F/L7	40A	—

RELAY, FUSE BOX AND CONTROLLER IN CAB

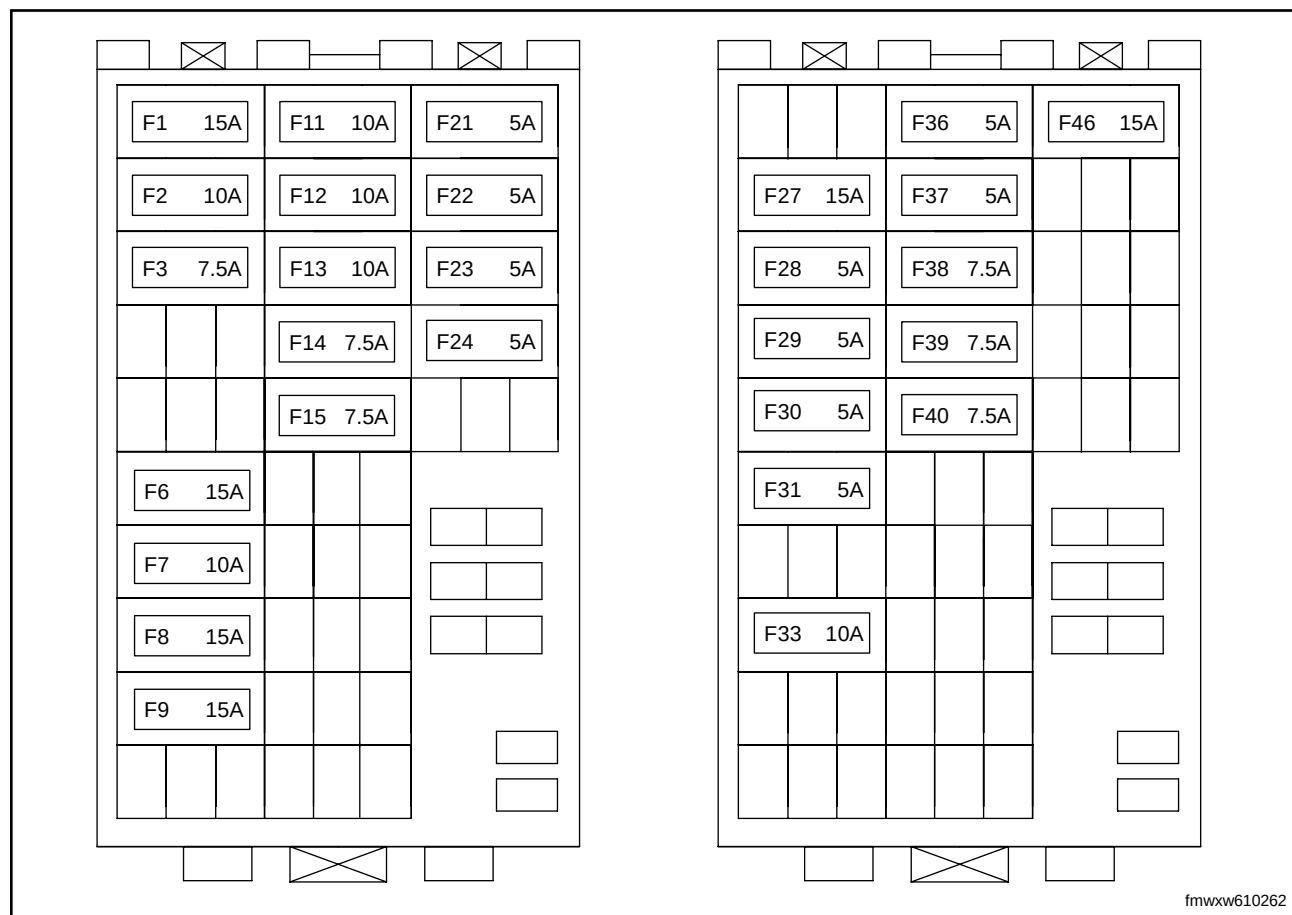
Relay box



No.	Type	Name
R01	24V 30/20A	Exhaust brake relay
R02	24V 30/20A	IG power relay
R03	24V 30/20A	Brake lamp relay
R04	—	—
R05	24V 30/20A	Reversing light relay
R06	24V 30/20A	Power takeoff relay
R07	24V 30/20A	Blower relay
R08	24V 30/20A	Condenser relay
R09	24V 30/20A	Compressor relay
R10	24V 30/20A	Start protection relay
R11	24V 30/20A	Cigar lighter relay

No	Type	Name
R12	24V 30/20A	Foglight relay
R13	24V 30/20A	Horn relay
R14	24V 30/20A	High beam relay
R15	24V 30/20A	Low beam relay
R16	24V 30/20A	Speed light B relay
R17	24V 30/20A	Tail light relay
R18	24V 30/20A	Speed light A relay
R19	24V 30/20A	Auxiliary high beam relay
R20	24V 30/20A	Speed light A relay
R21	24V 30/20A	Electric/pneumatic horn switching relay

Fuse box



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No.	Rated current	Name
F1	15A	Ignition lock fuse (AM)
F2	10A	Backup light fuse
F3	7.5A	Steering light fuse
F4	—	—
F5	—	—
F6	10A	Body small light fuse
F7	10A	Condenser and compressor fuse
F8	15A	Blower fuse
F9	15A	Cigar lighter fuse
F10	—	—
F11	10A	Wiper motor fuse
F12	10A	Left high beam fuse
F13	10A	Right high beam fuse
F14	7.5A	Heater/drying fuse
F15	7.5A	Washing fuse
F16	—	—

No.	Rated current	Name
F26	—	—
F27	15A	ABS ECU fuse
F28	5A	ABS fuse
F29	5A	Auxiliary high beam
F30	5A	Auxiliary high beam
F31	5A	Black box fuse
F32	—	—
F33	10A	Power converter fuse
F34	—	—
F35	—	—
F36	5A	Memory fuse
F37	5A	Radio cassette player
F38	7.5A	Exhaust brake fuse
F39	7.5A	Brake light fuse
F40	7.5A	Instrument cluster fuse
F41	—	—

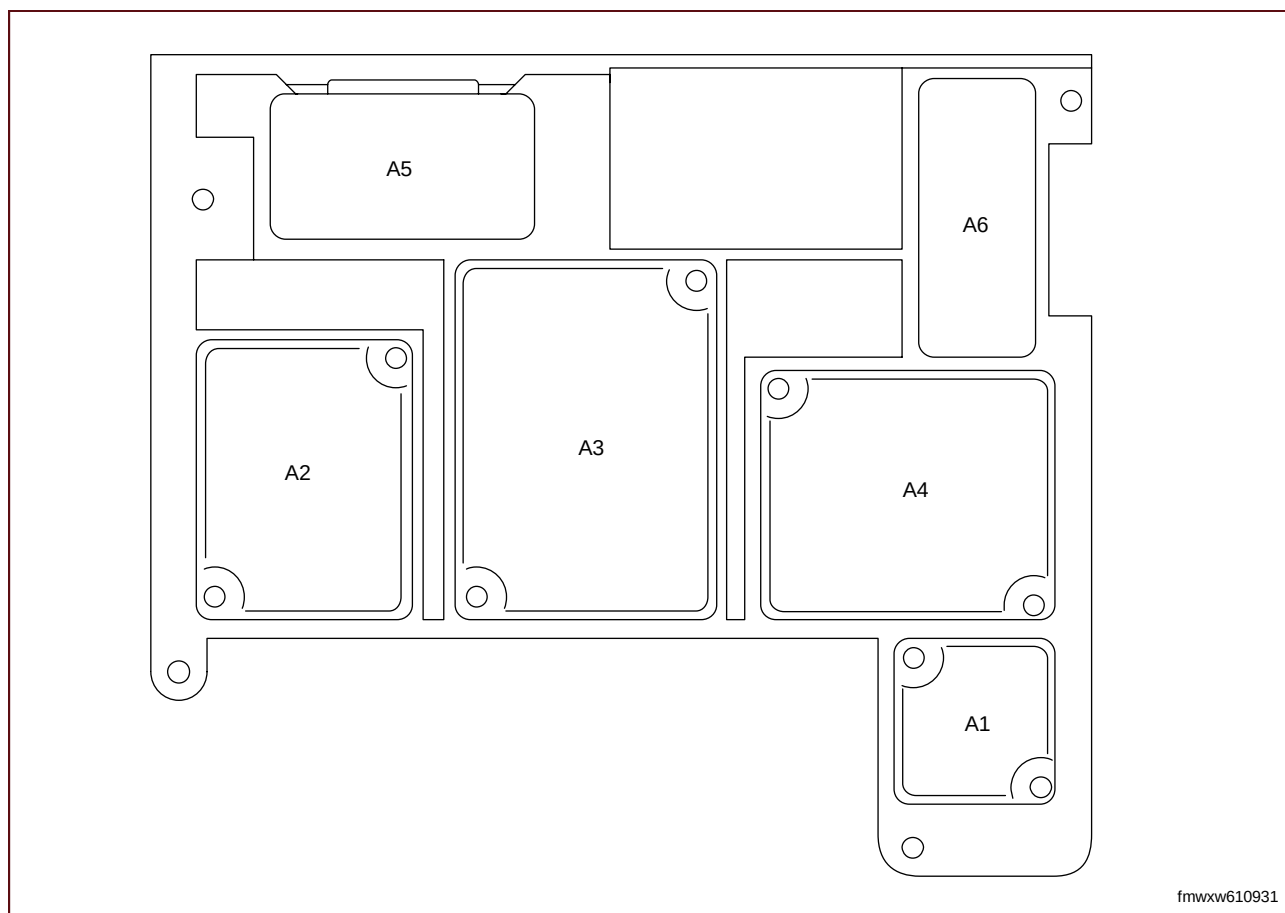


FOTON

CIRCUIT DIAGRAM-RELAY AND FUSE BOX**61-23**

No.	Rated current	Name
F17	—	—
F18	—	—
F19	—	—
F20	—	—
F21	5A	Rear-view mirror fuse
F22	5A	Left low beam fuse
F23	5A	Right low beam fuse
F24	5A	Room light
F25	—	—

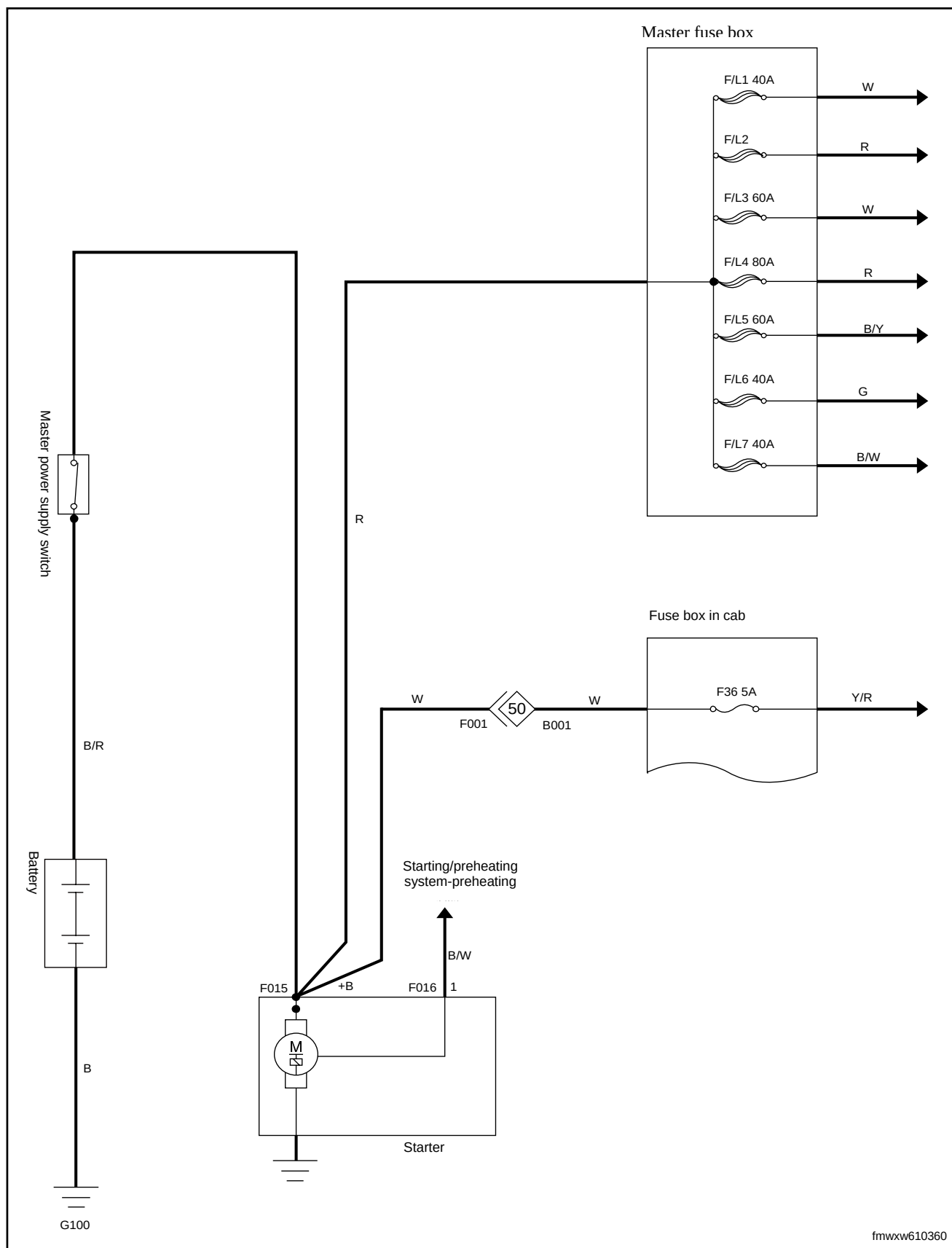
No.	Rated current	Name
F42	—	—
F43	—	—
F44	—	—
F45	—	—
F46	15A	Fog light fuse
F47	—	—
F48	—	—
F49	—	—
F50	—	—

CONTROLLER GROUP IN CAB

No.	Rated current	Name
A1	—	Fuse warning controller
A2	—	Flame-out controller(Second)
A3	—	Heater controller

No.	Rated current	Name
A4	—	Dialer
A5	—	Flash relay
A6	—	2 in 1 controller

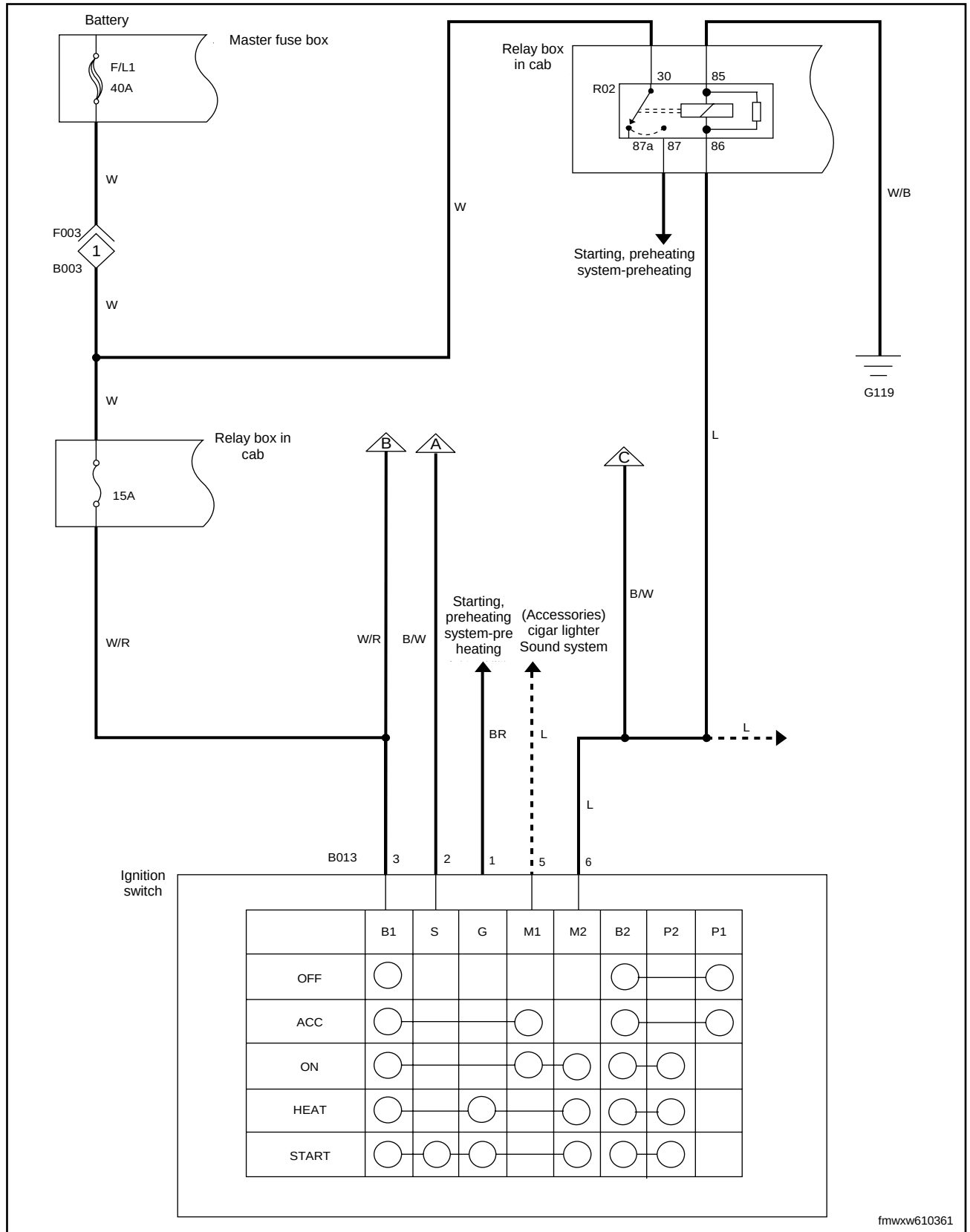
POWER



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STARTING AND PREHEATING SYSTEM

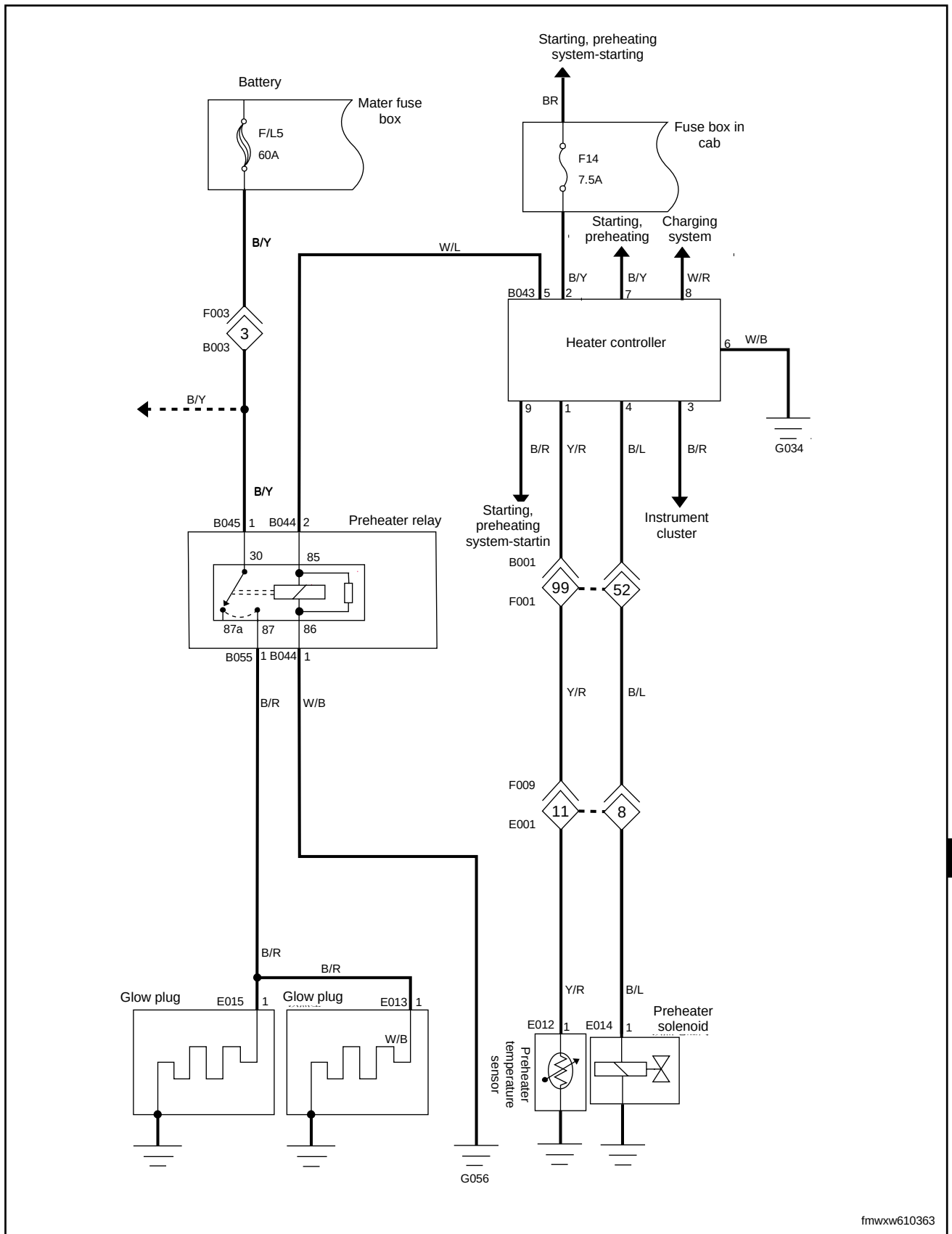
STARTING



61

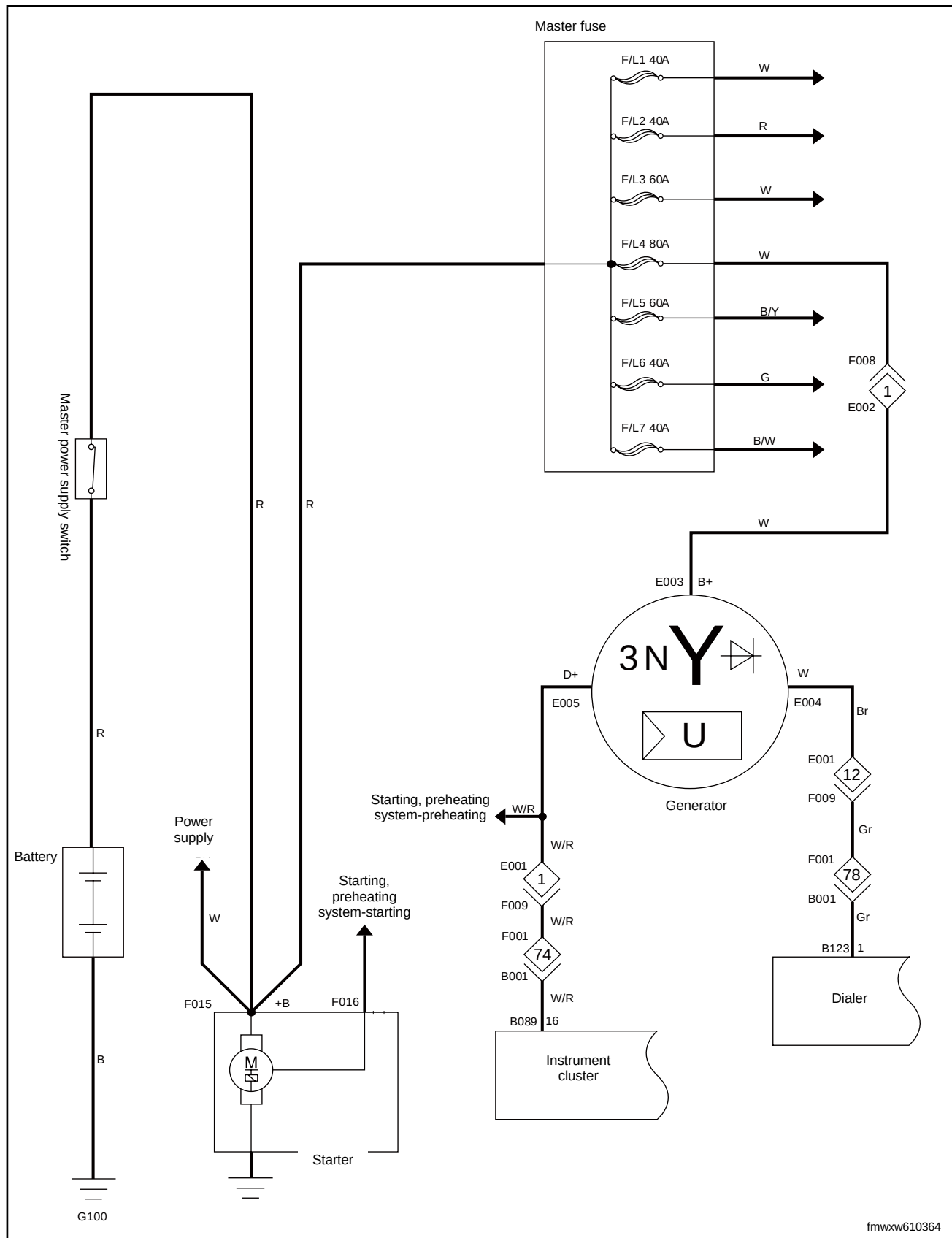


PREHEATING

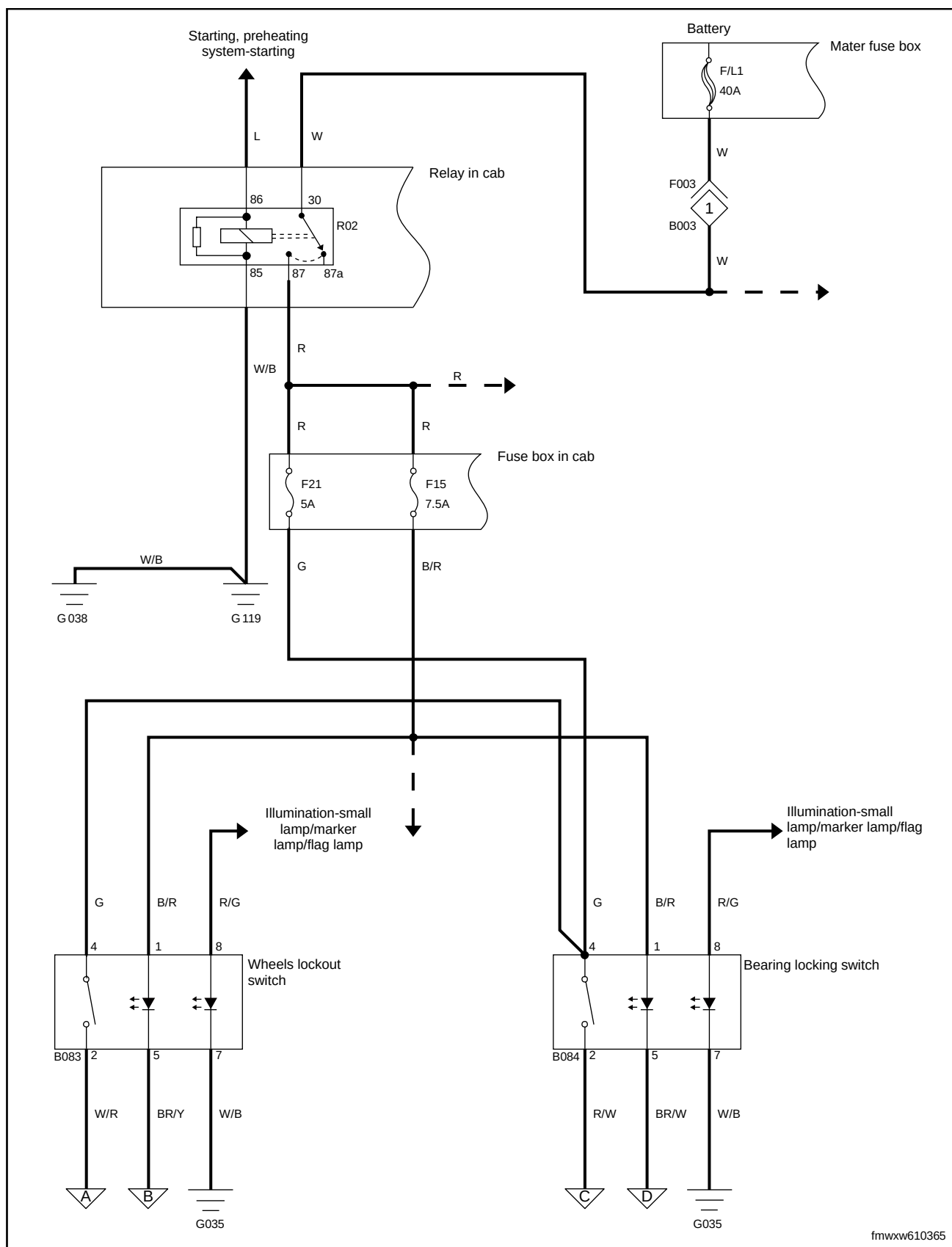


fmwxw610363

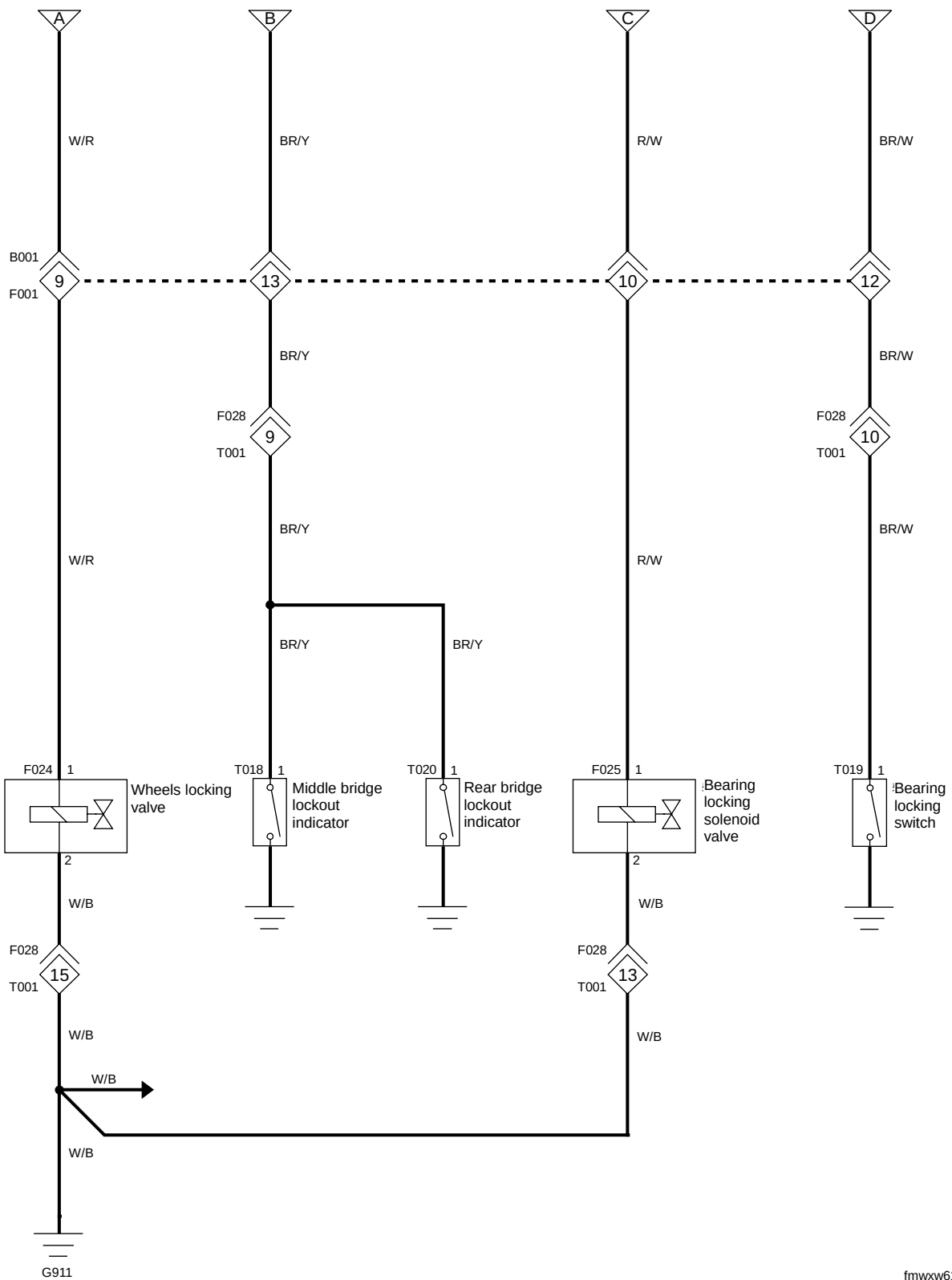
CHARGING SYSTEM



DIFFERENTIAL LOCK

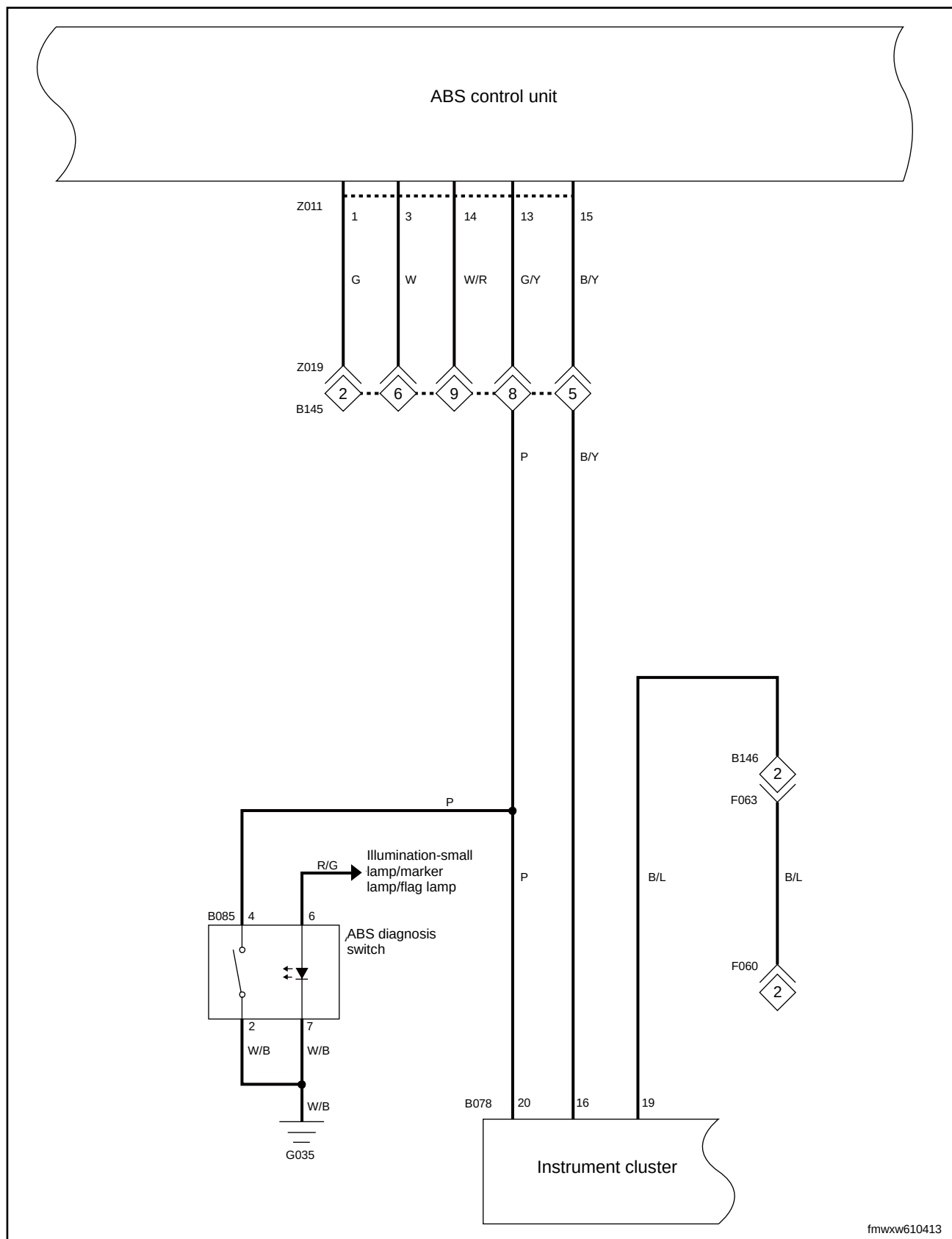


DIFFERENTIAL LOCK (Cont.)



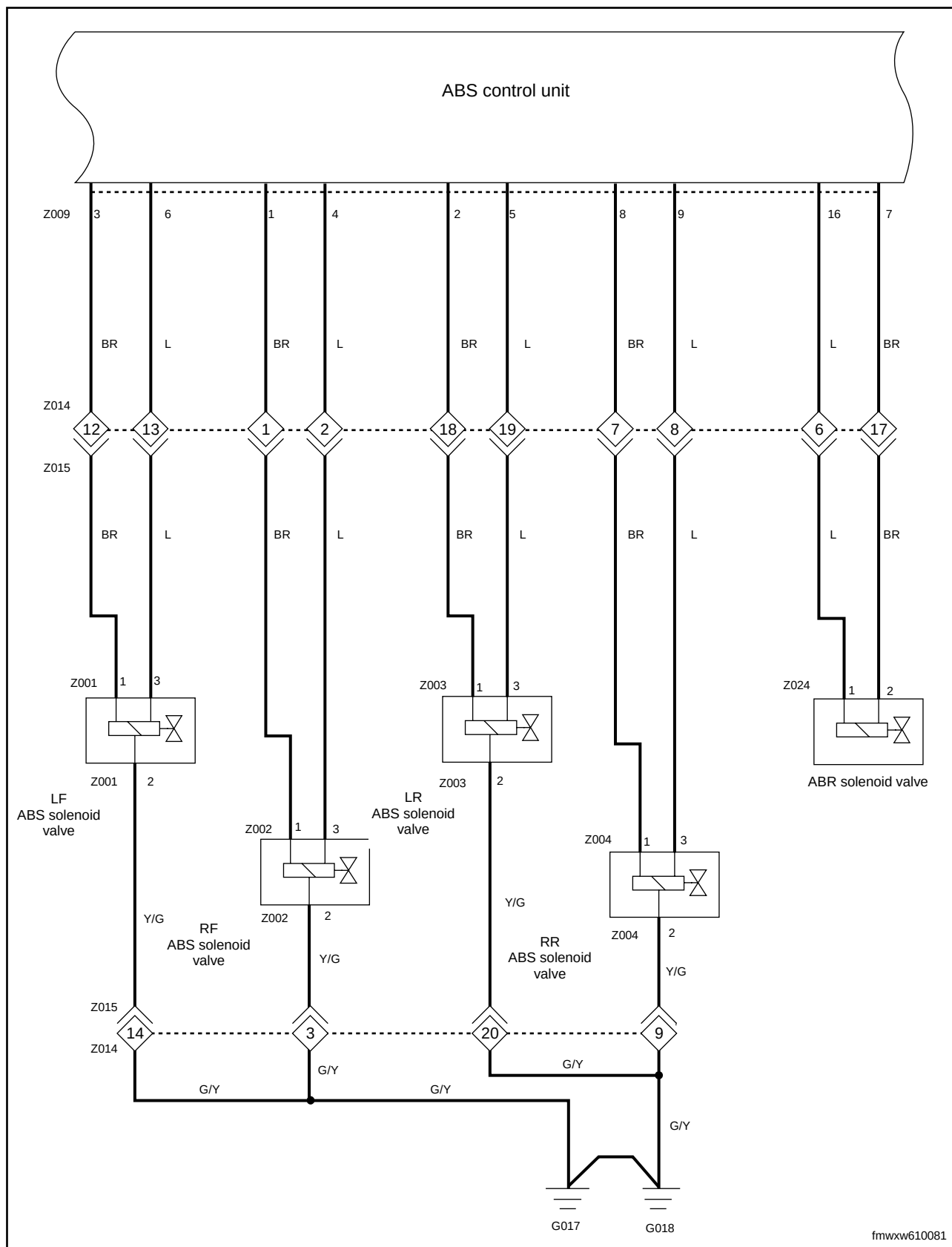


ABS SYSTEM (Cont.)

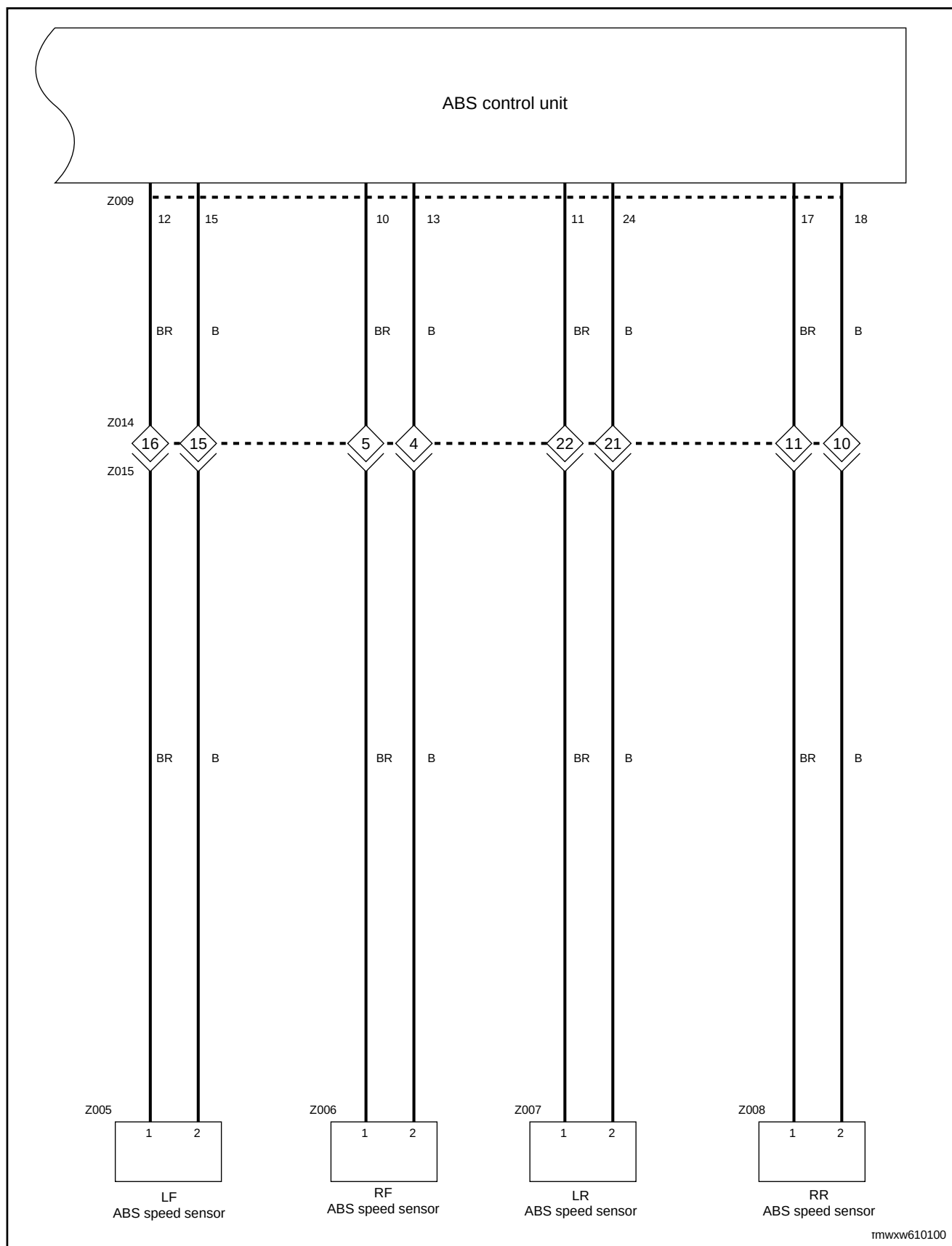


fmwxw610413

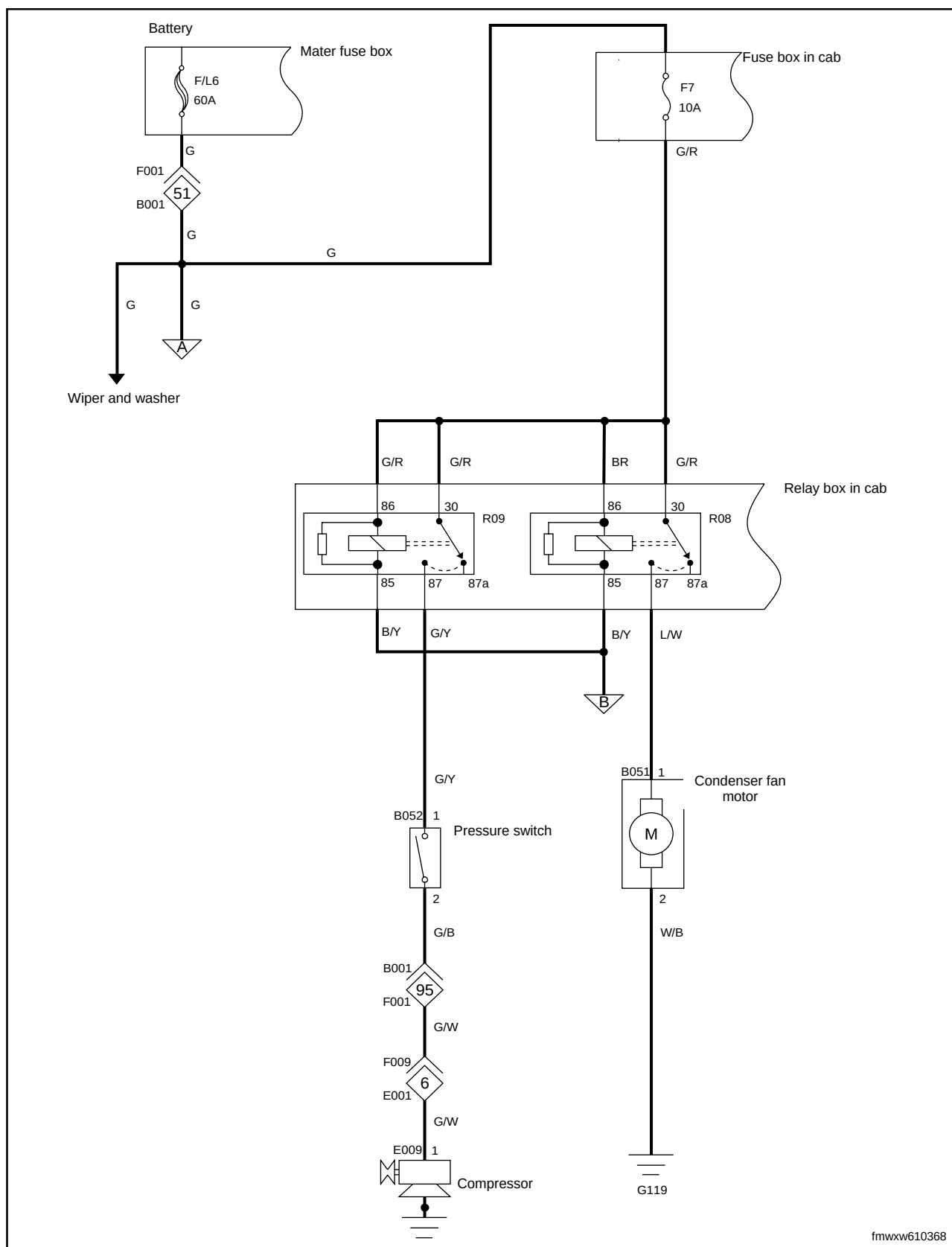
ABS SYSTEM (Cont.)



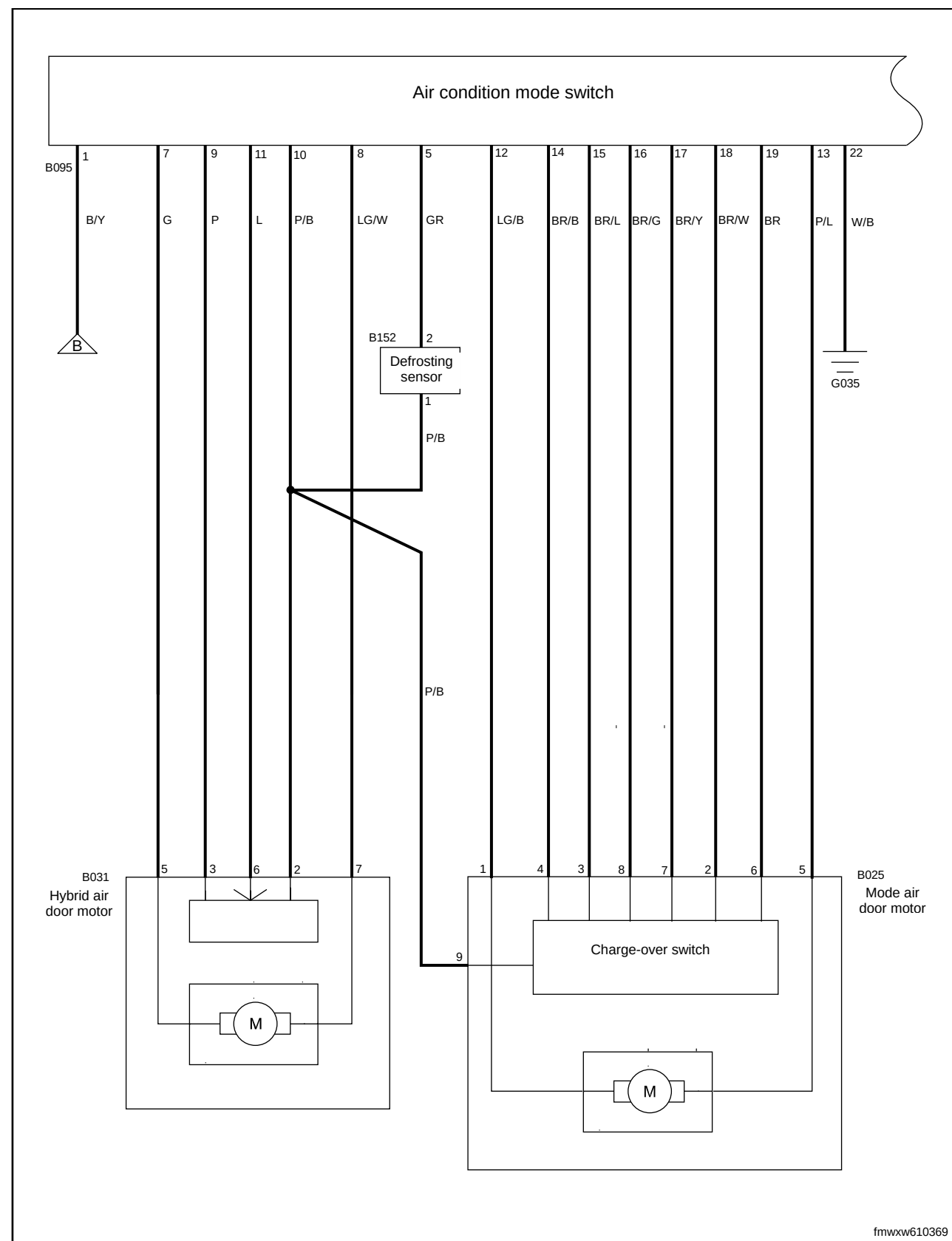
ABS SYSTEM (Cont.)



HEATER UNIT AND AIR CONDITIONER

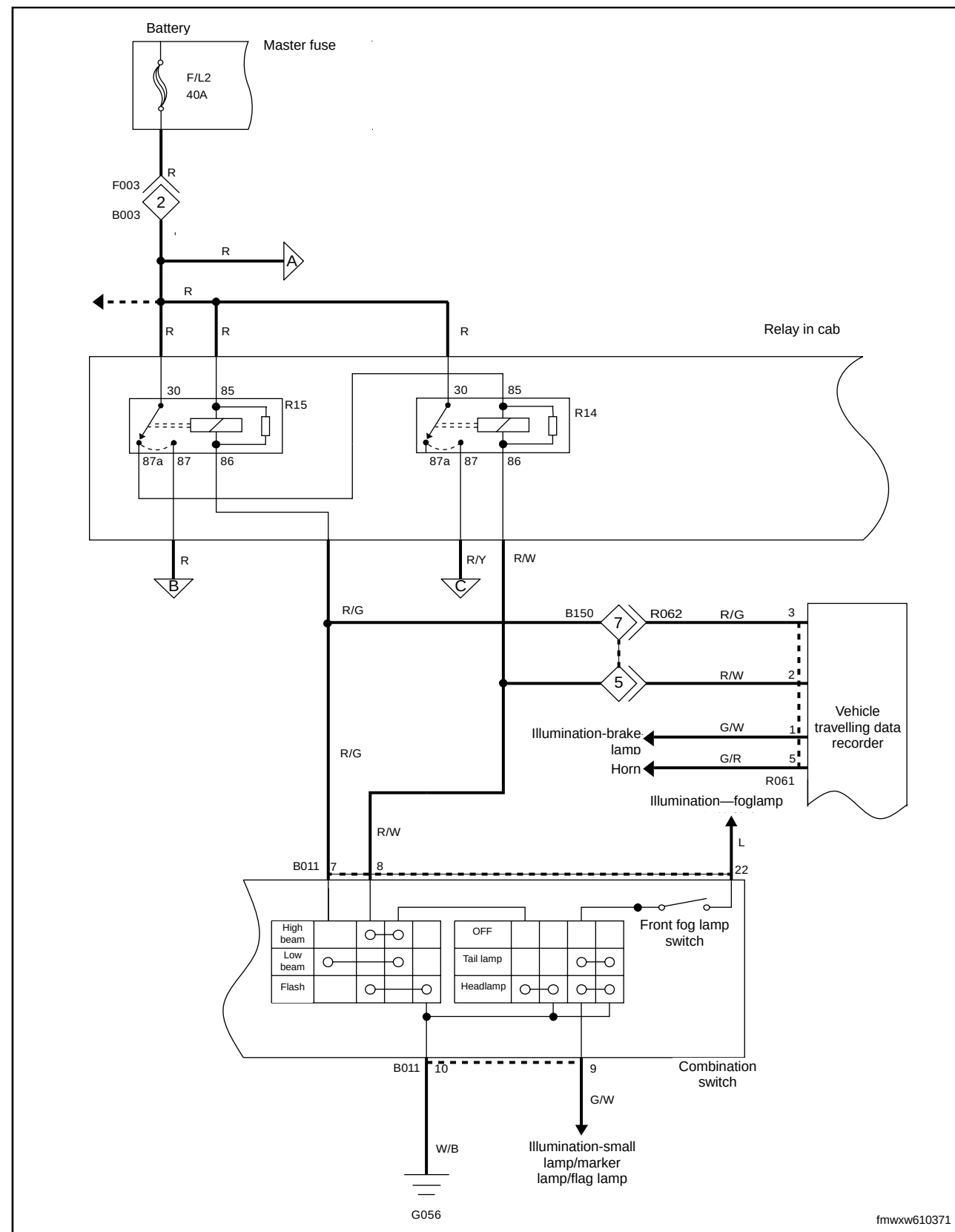


HEATER UNIT AND AIR CONDITION (Cont.)

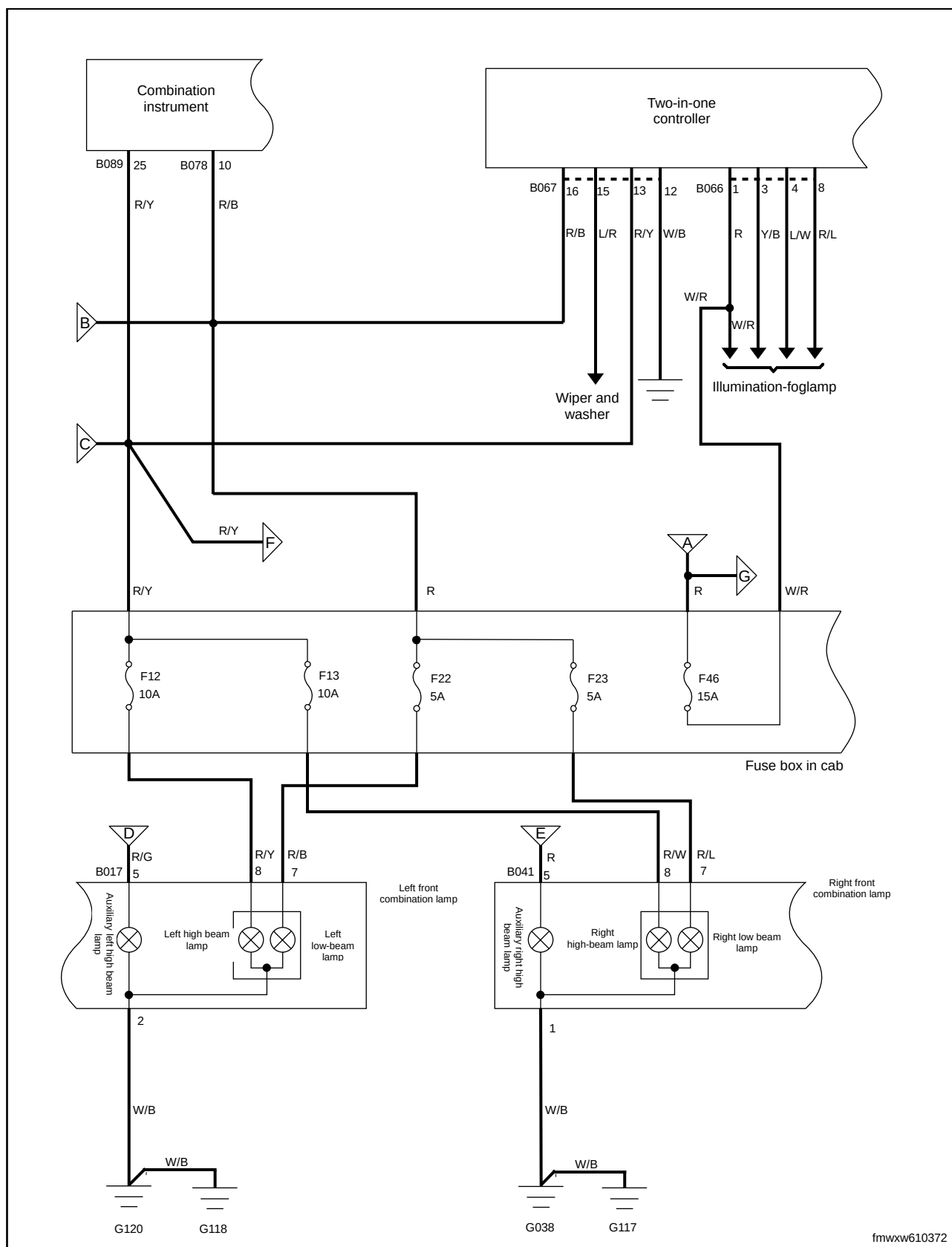


ILLUMINATION

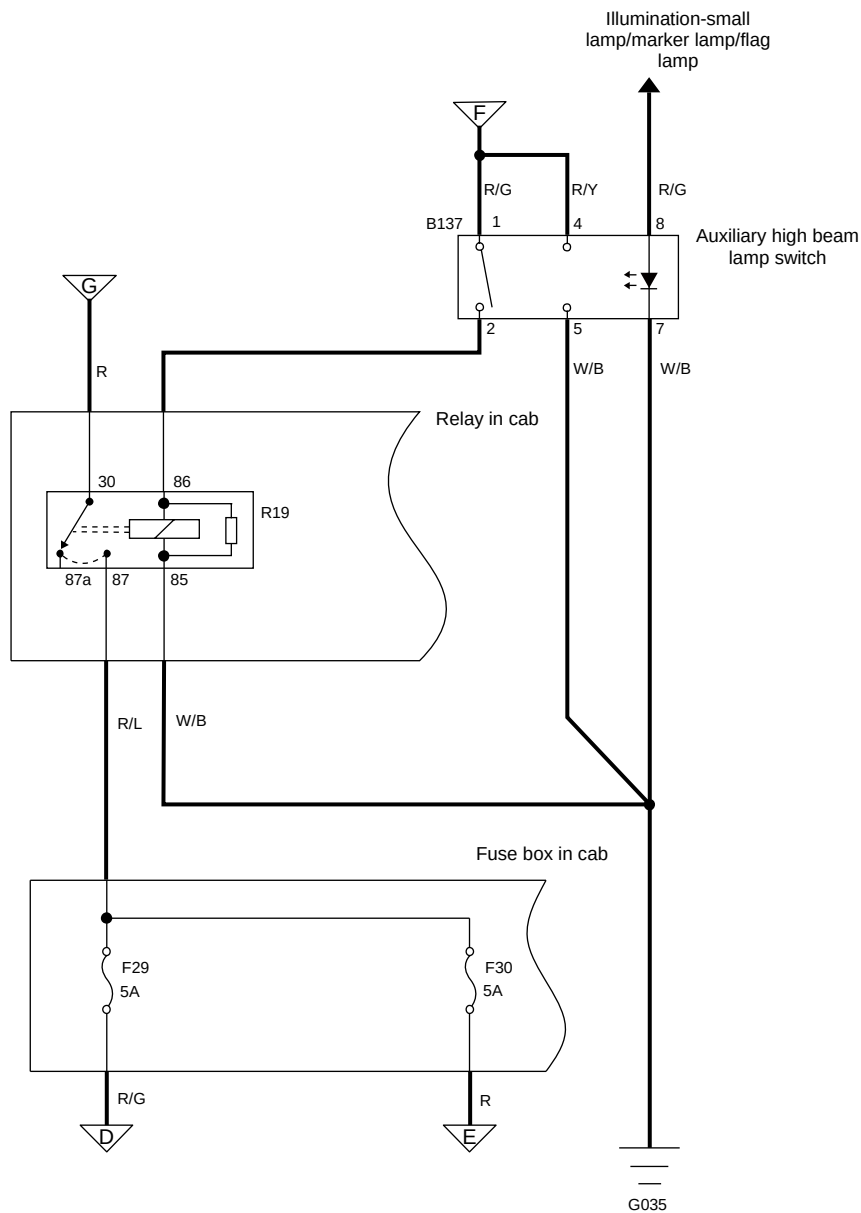
HEADLAMP



HEADLAMP (Cont.)

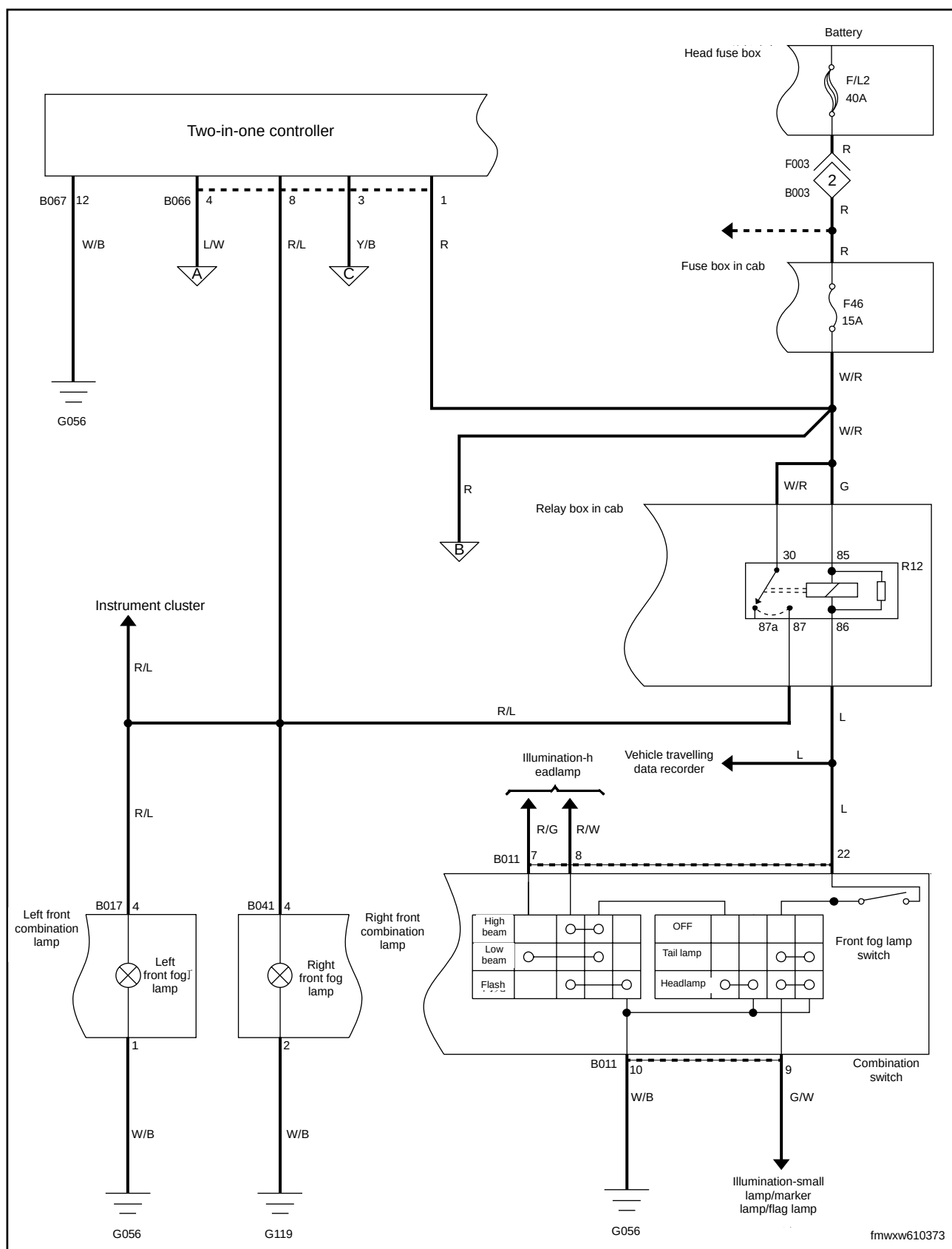


HEADLAMP (Cont.)

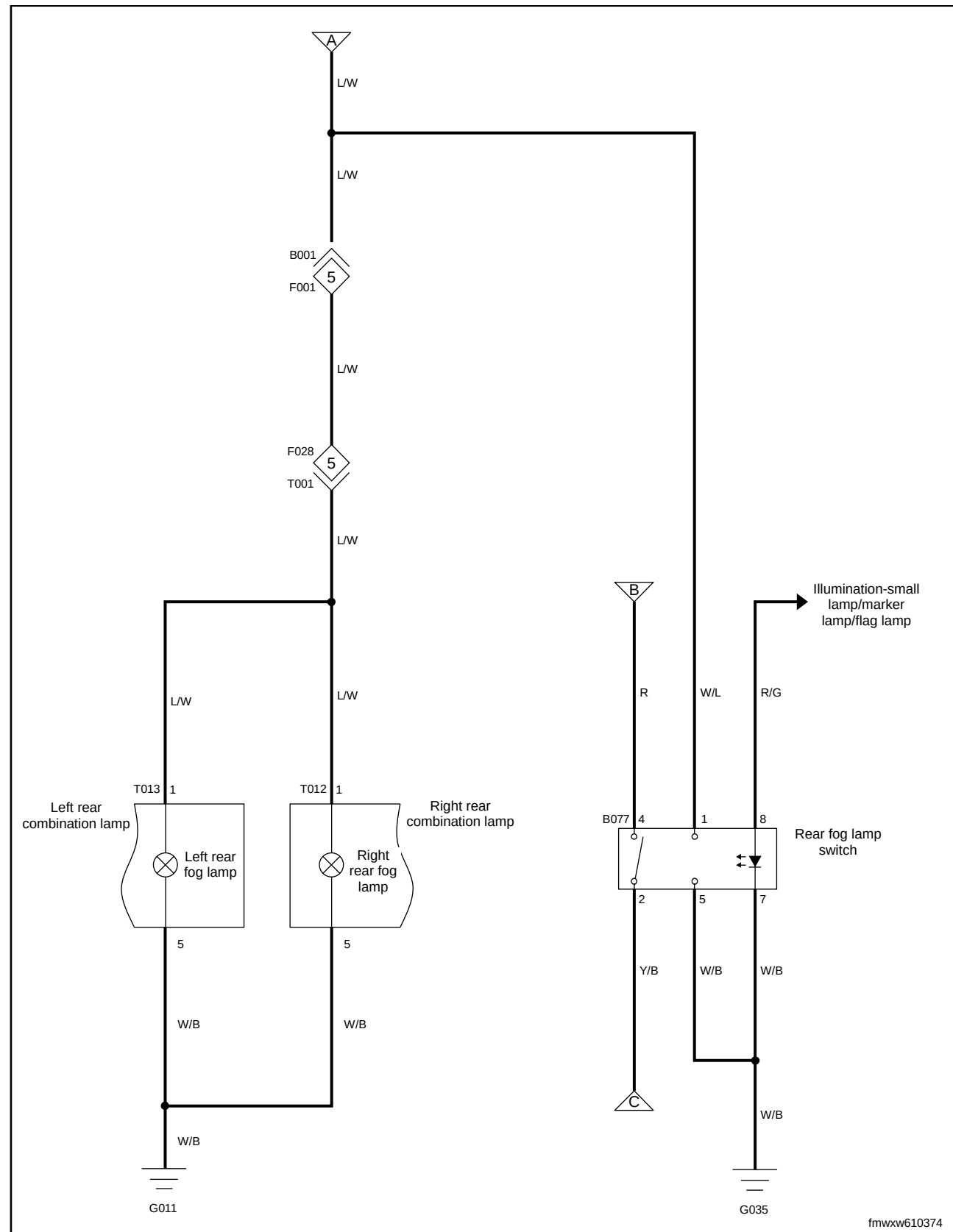


fmwxw610414

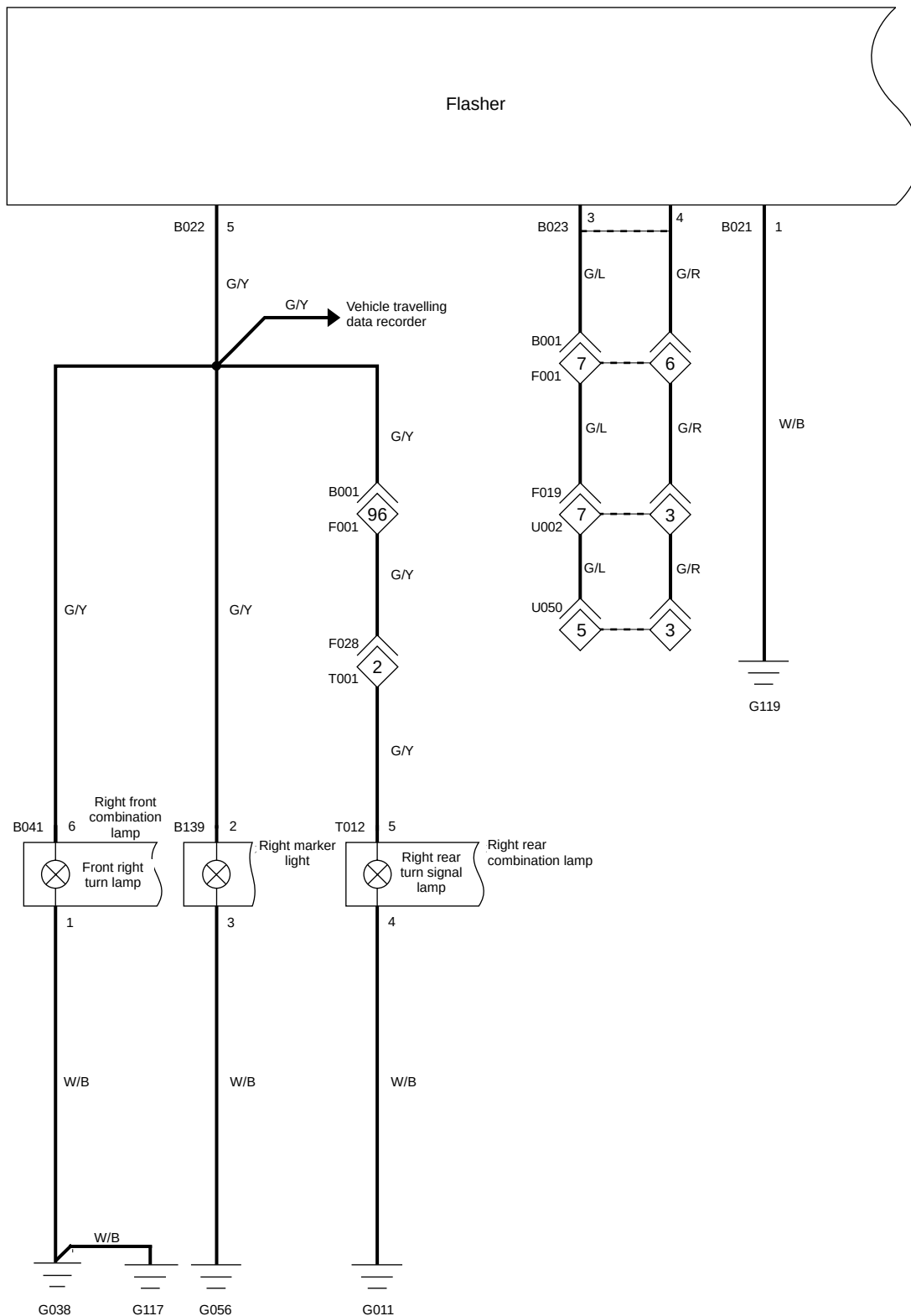
FOG LAMP



FOG LAMP (Cont.)

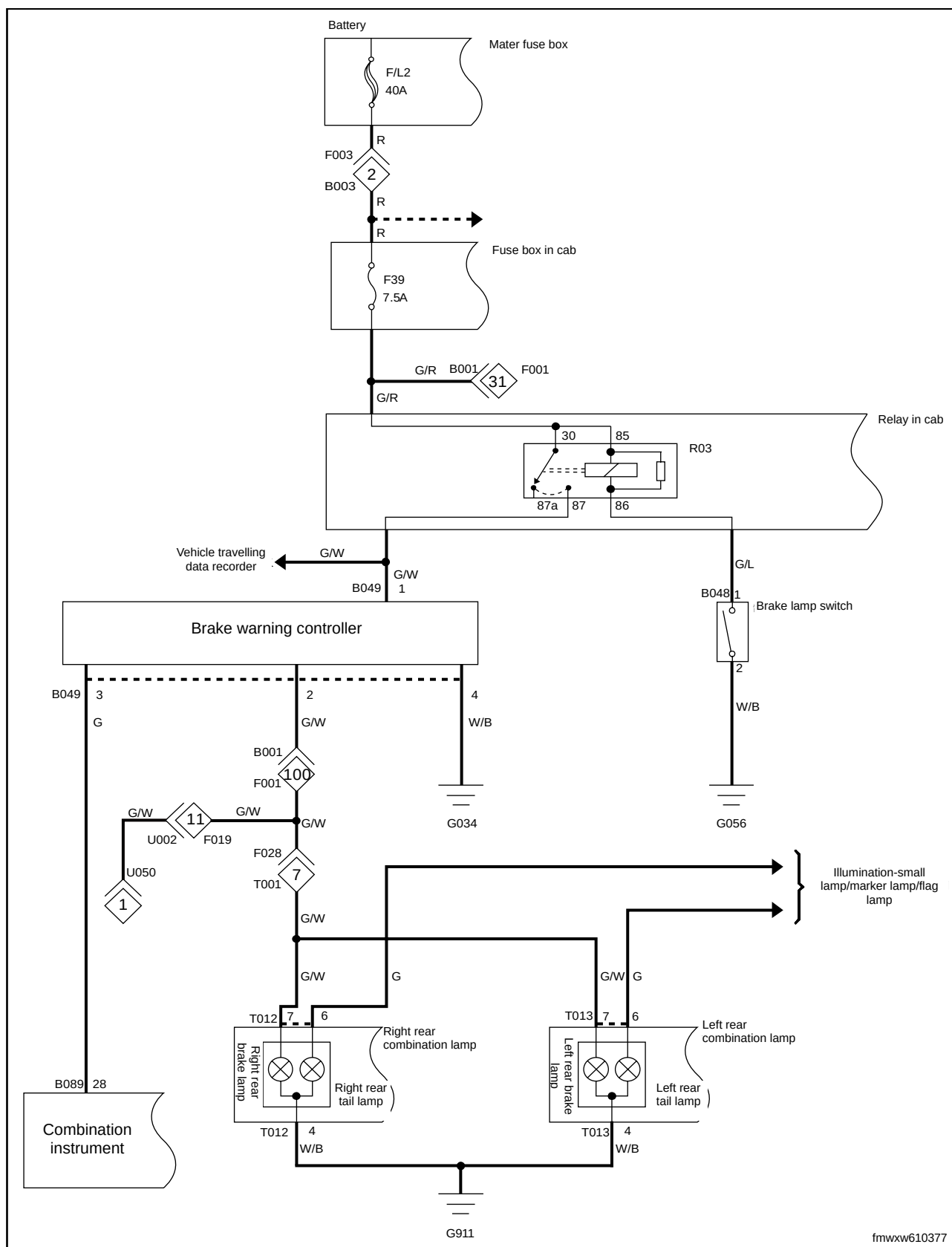


TURN SIGNAL LAMP, HAZARD WARNING LAMP (Cont.)

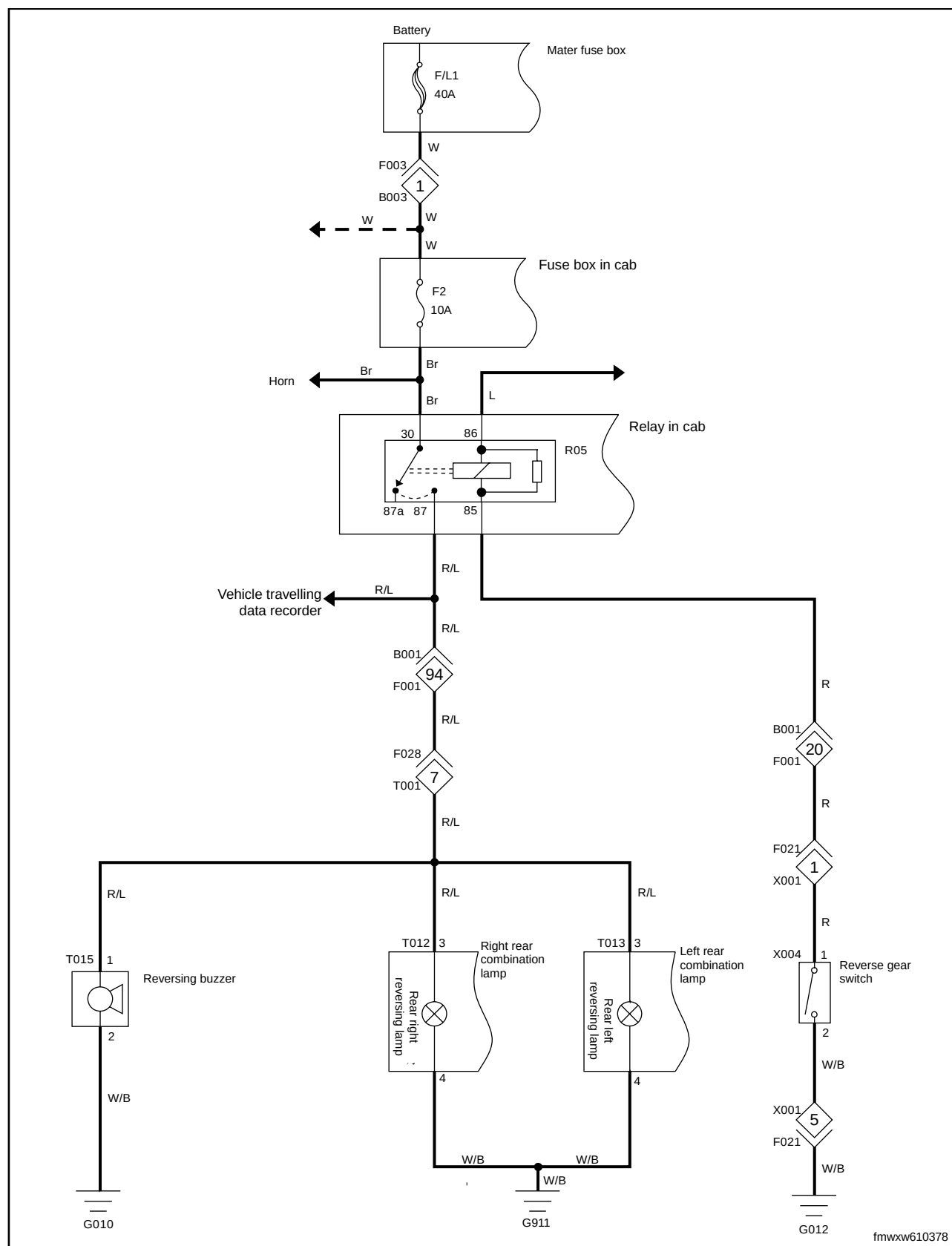


fmwxw610376

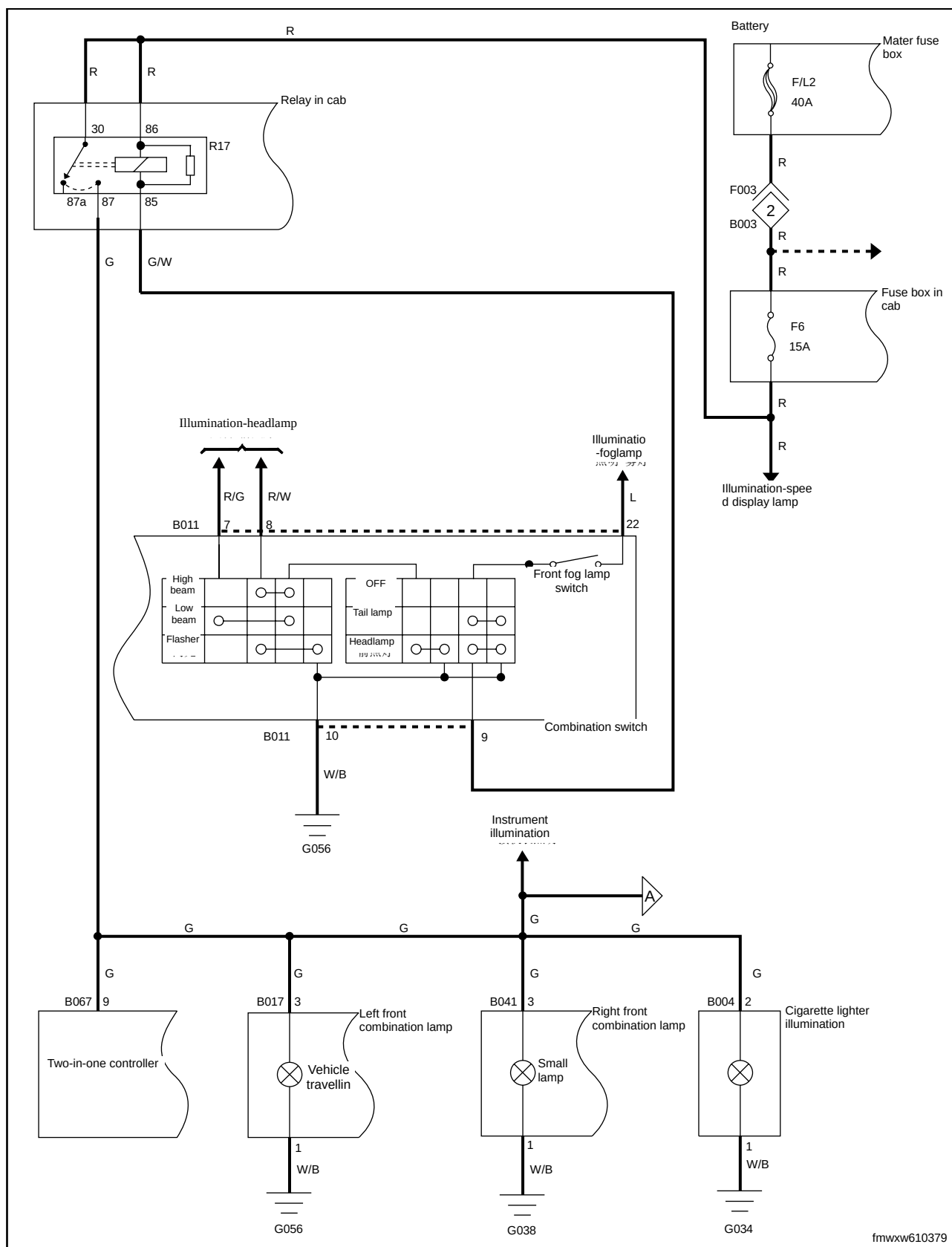
BRAKE LAMP



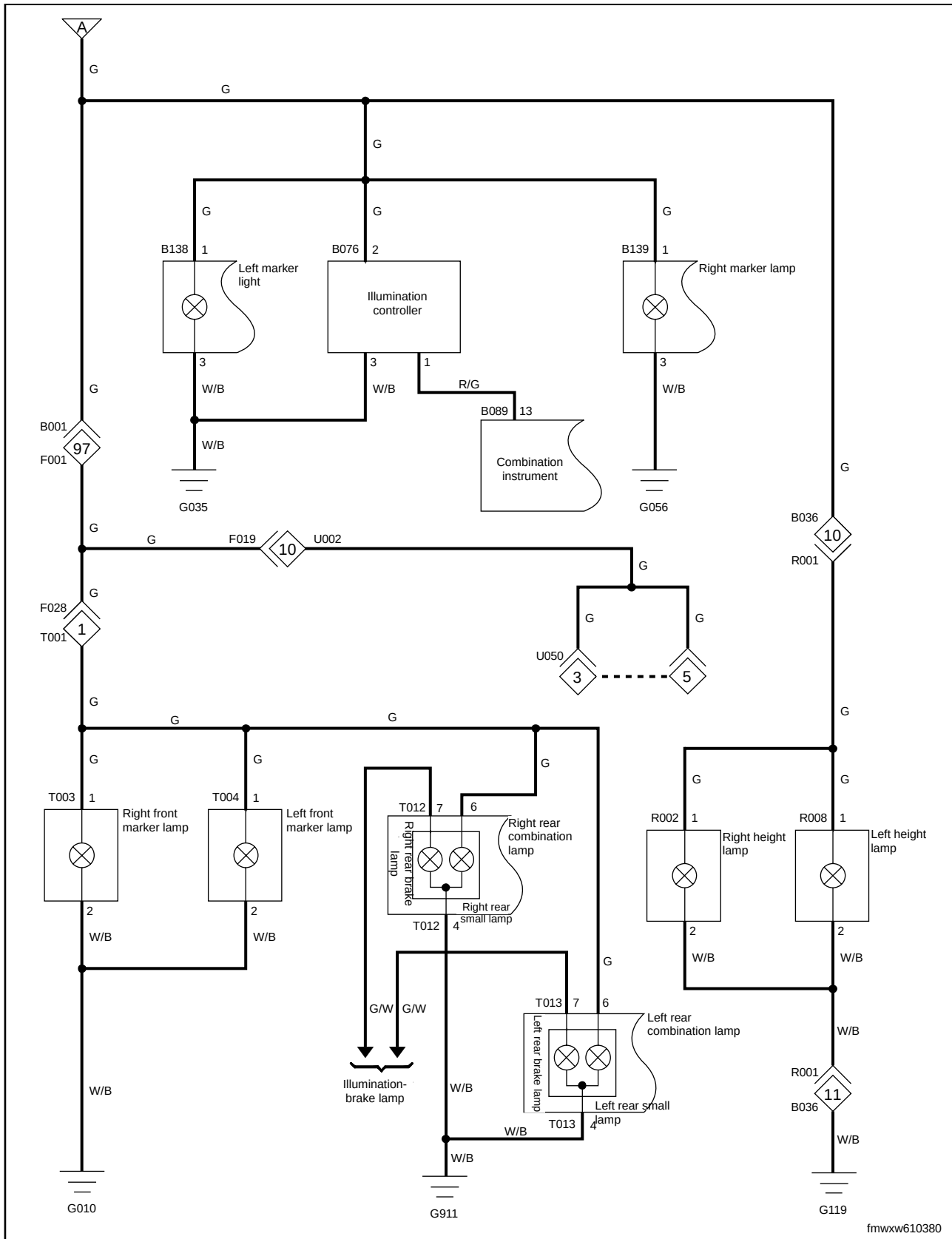
REVERSING LAMP, REVERSING BUZZER



SMALL LAMP, CLEARANCE LAMP, MAKER LAMP

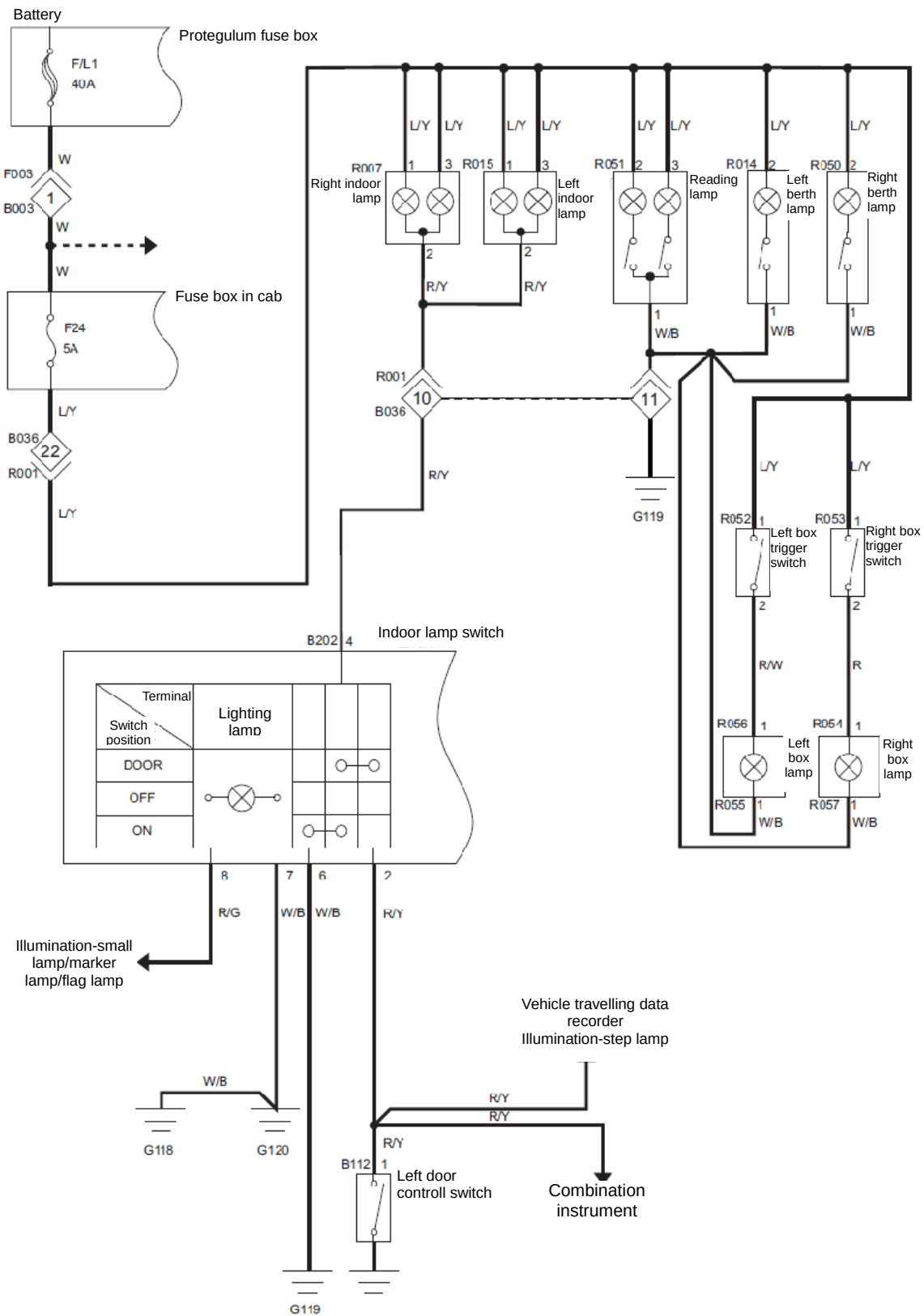


SMALL LAMP, CLEARANCE LAMP, MAKER LAMP (Cont.)



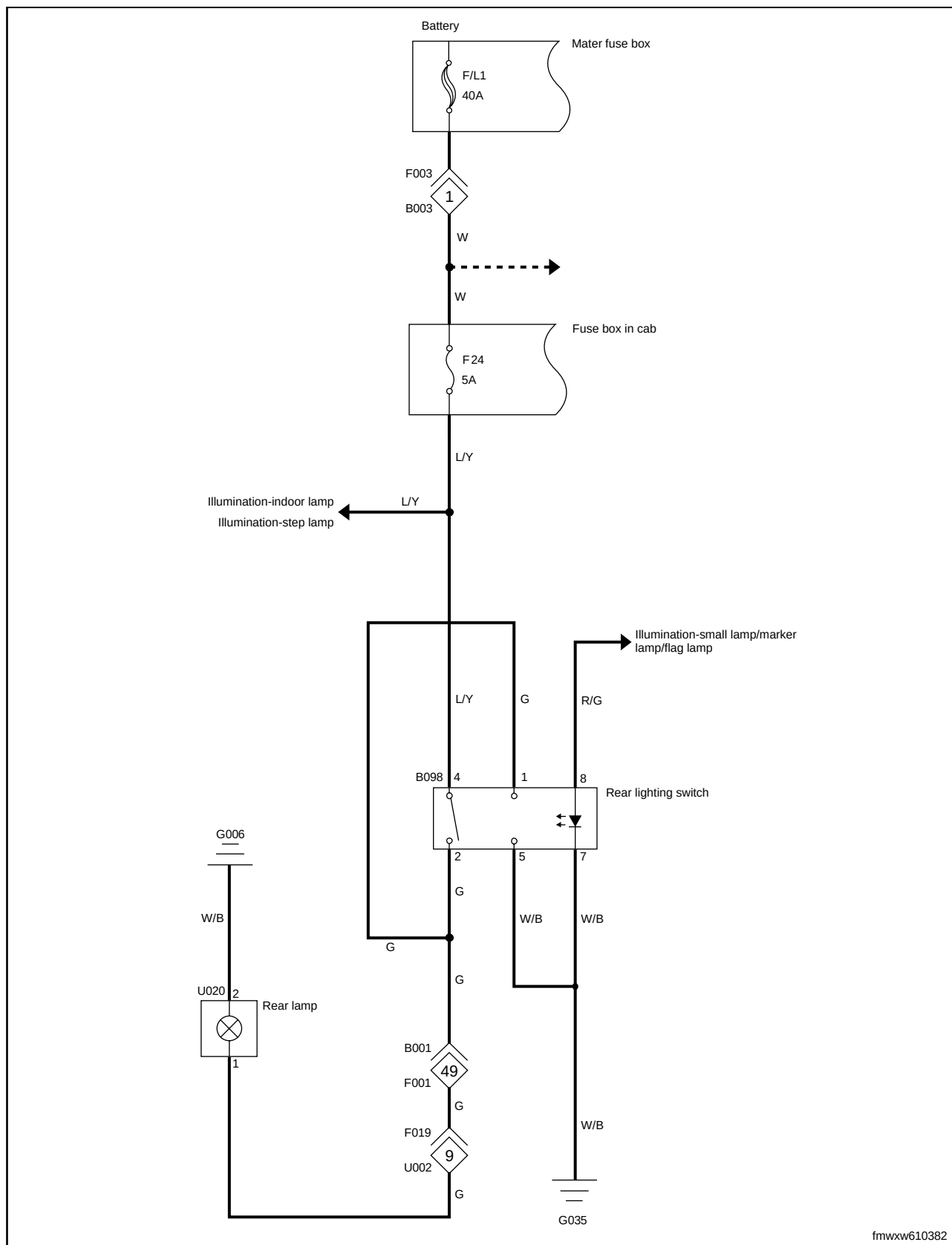
fmwxw610380

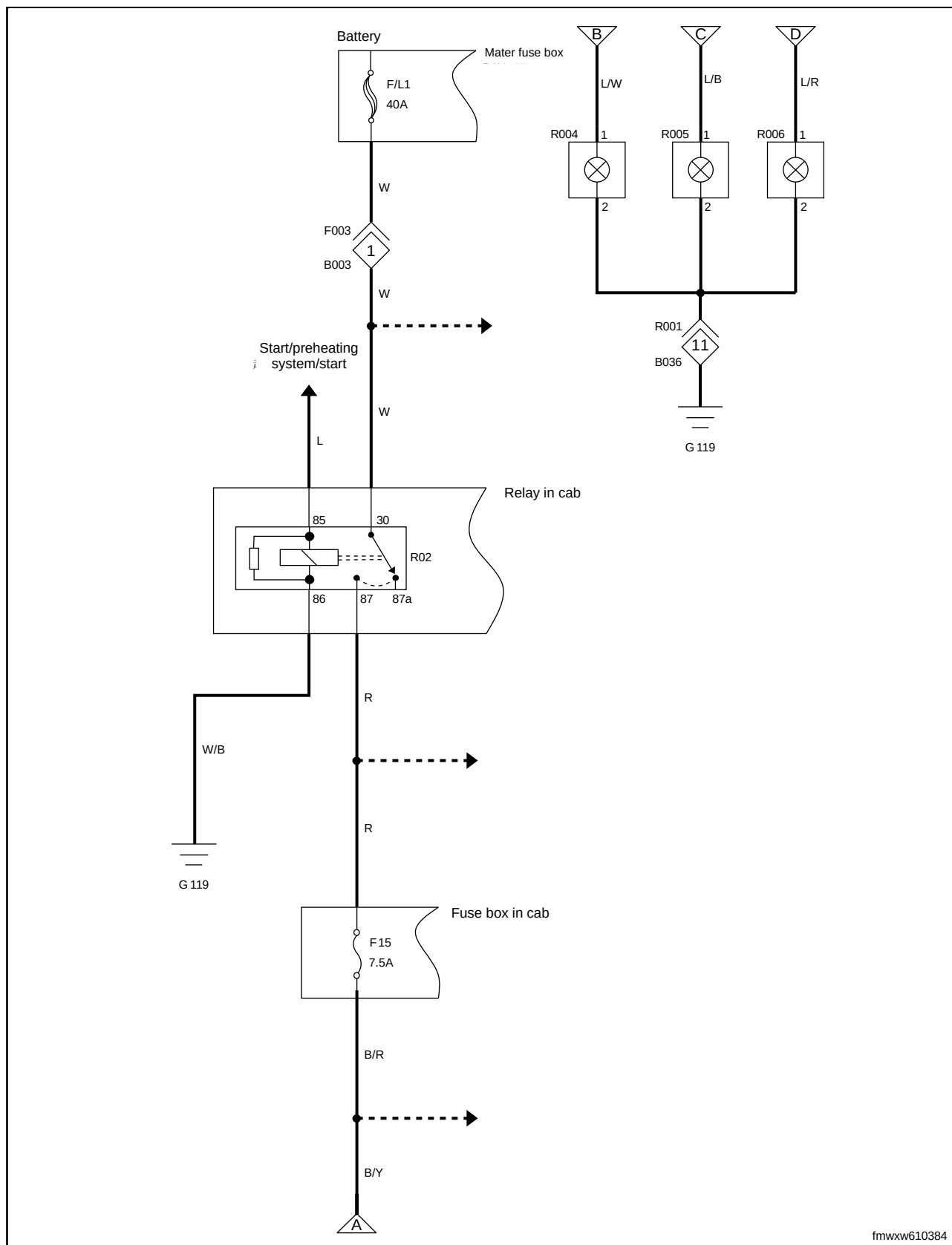
INDOOR LAMP



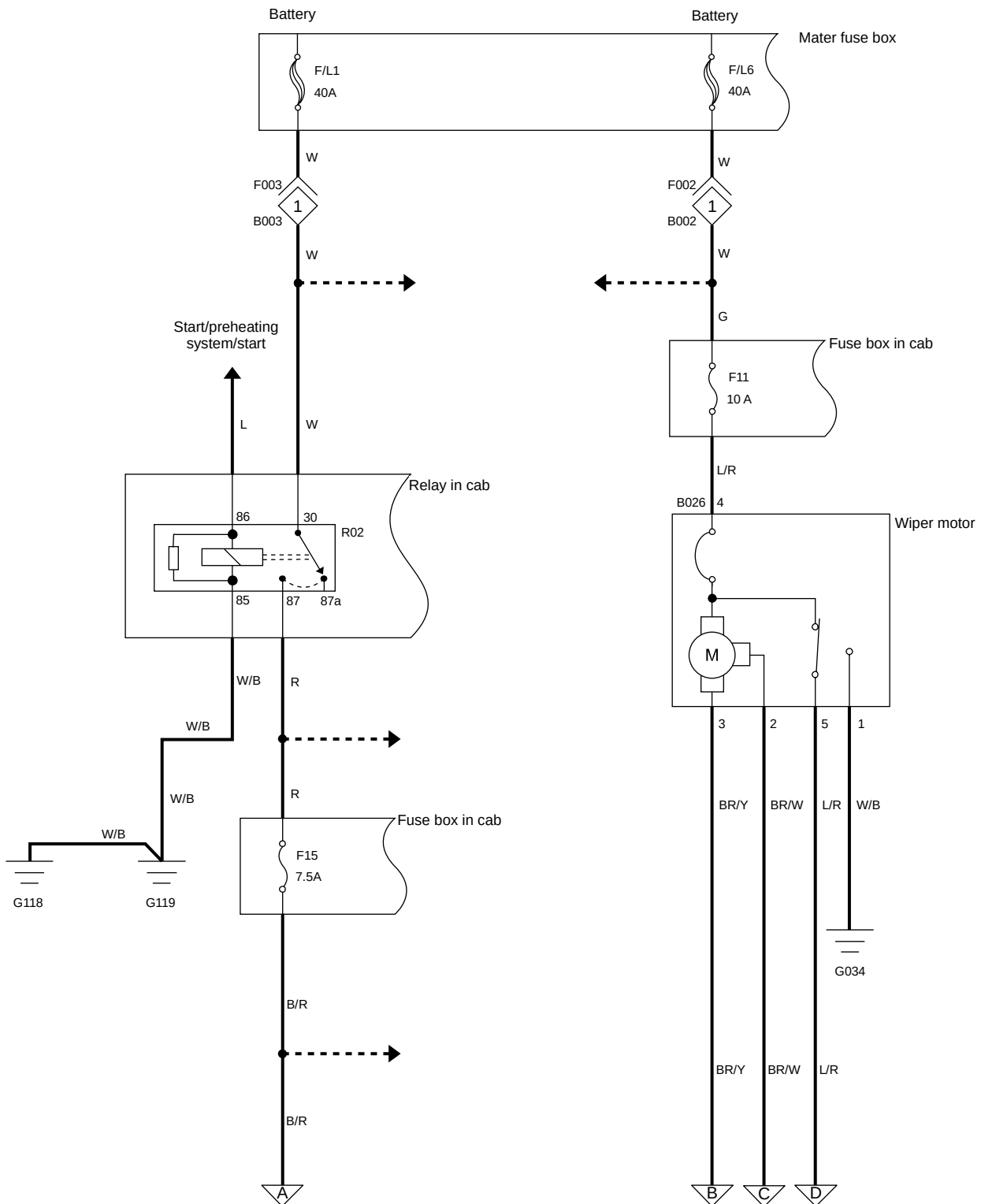
fmwxcw610416

REAR LAMP



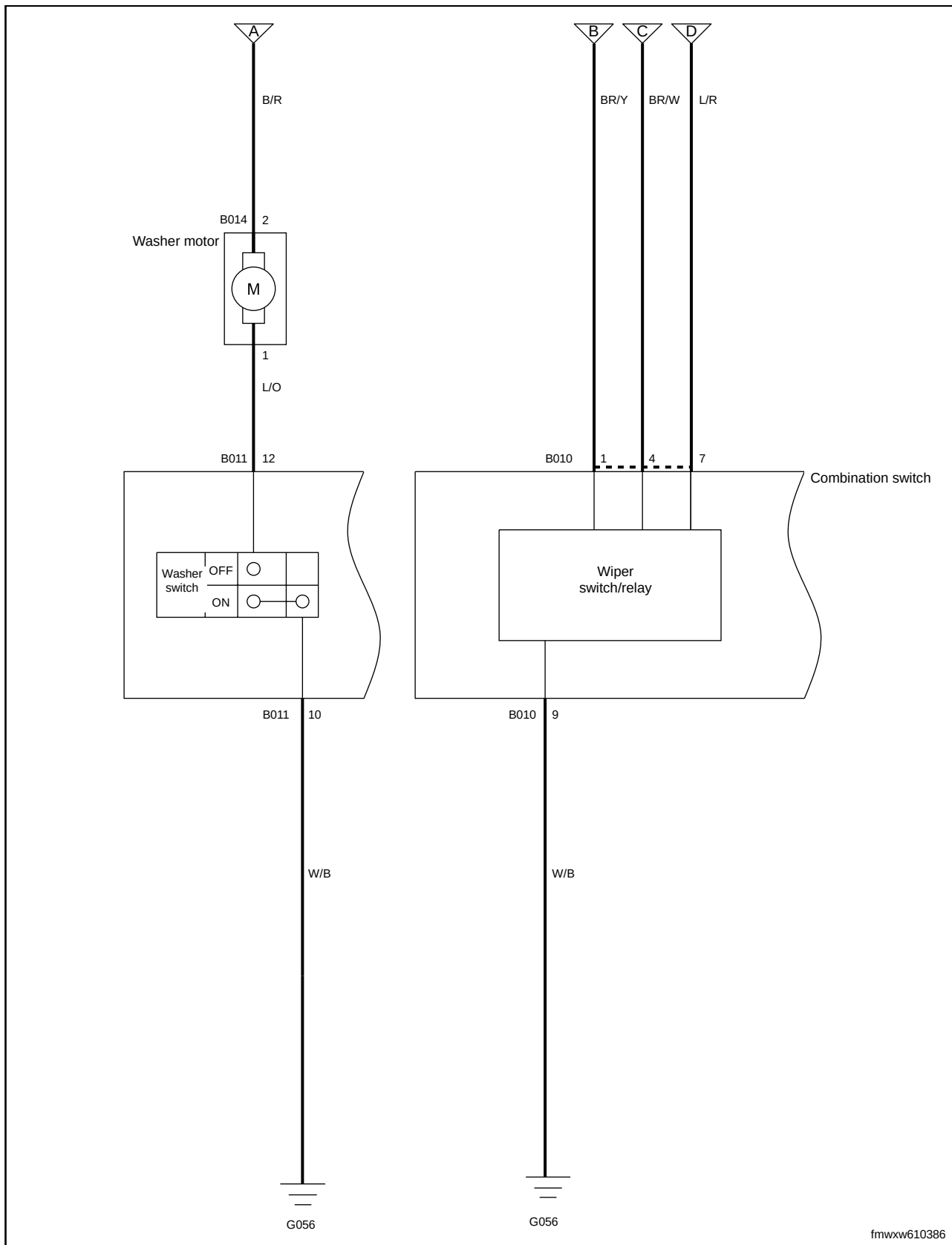
SPEED DISPLAY LAMP (Cont.)

WIPER AND WASHER

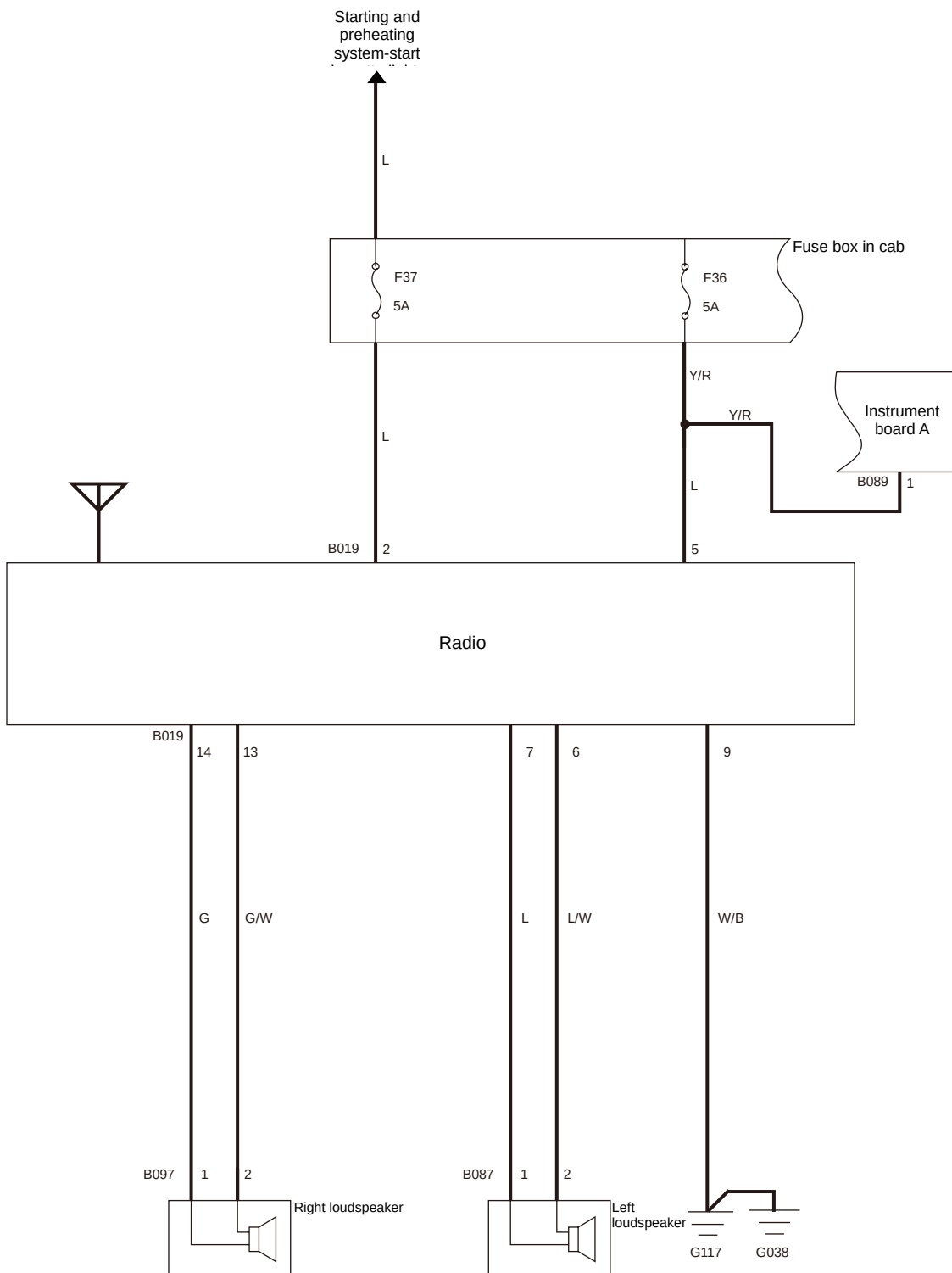


fmwxw610385

WIPER AND WASHER (Cont.)

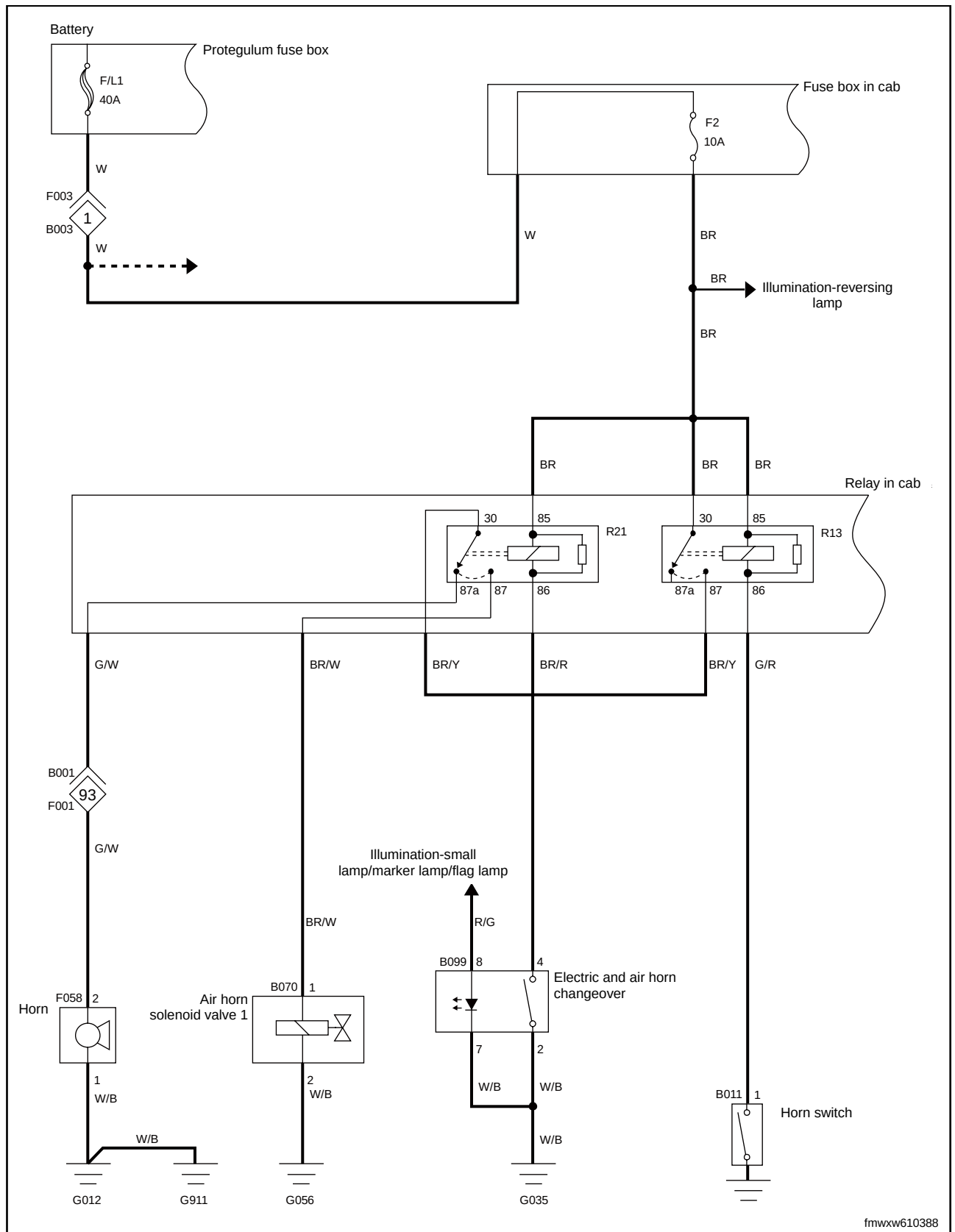


AUDIO SYSTEM

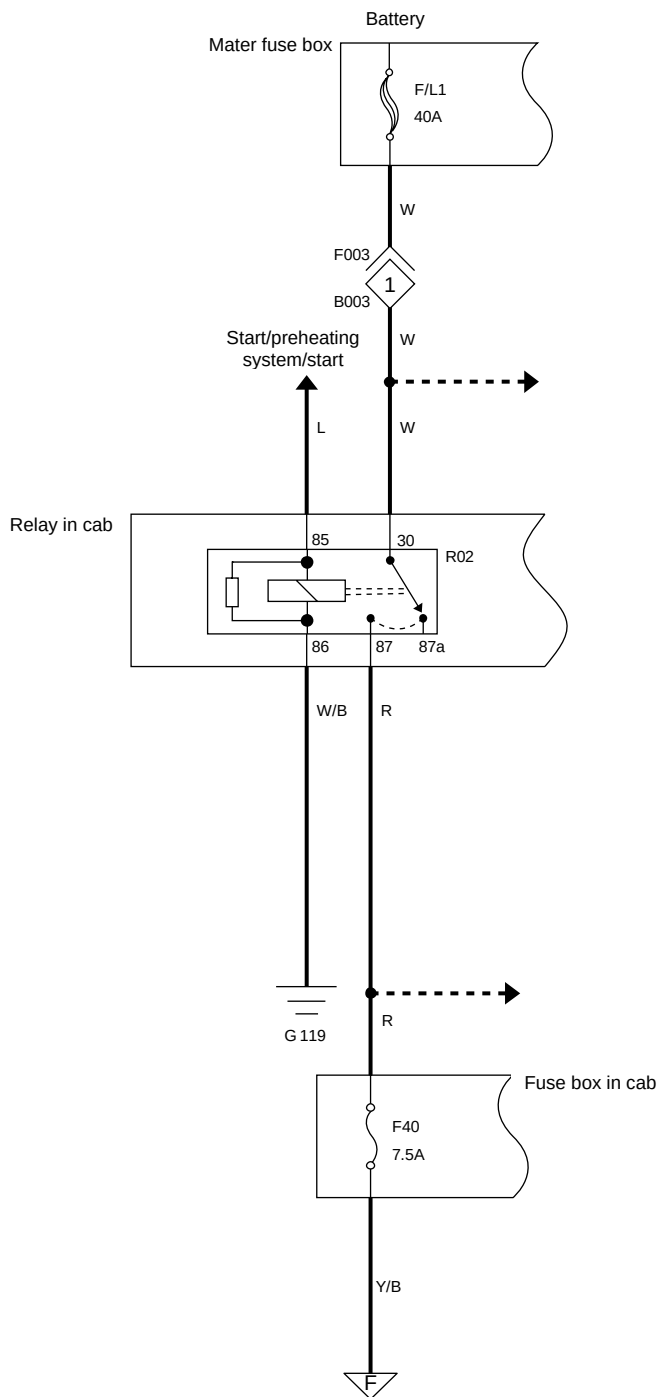


fmwxw610387

HORN

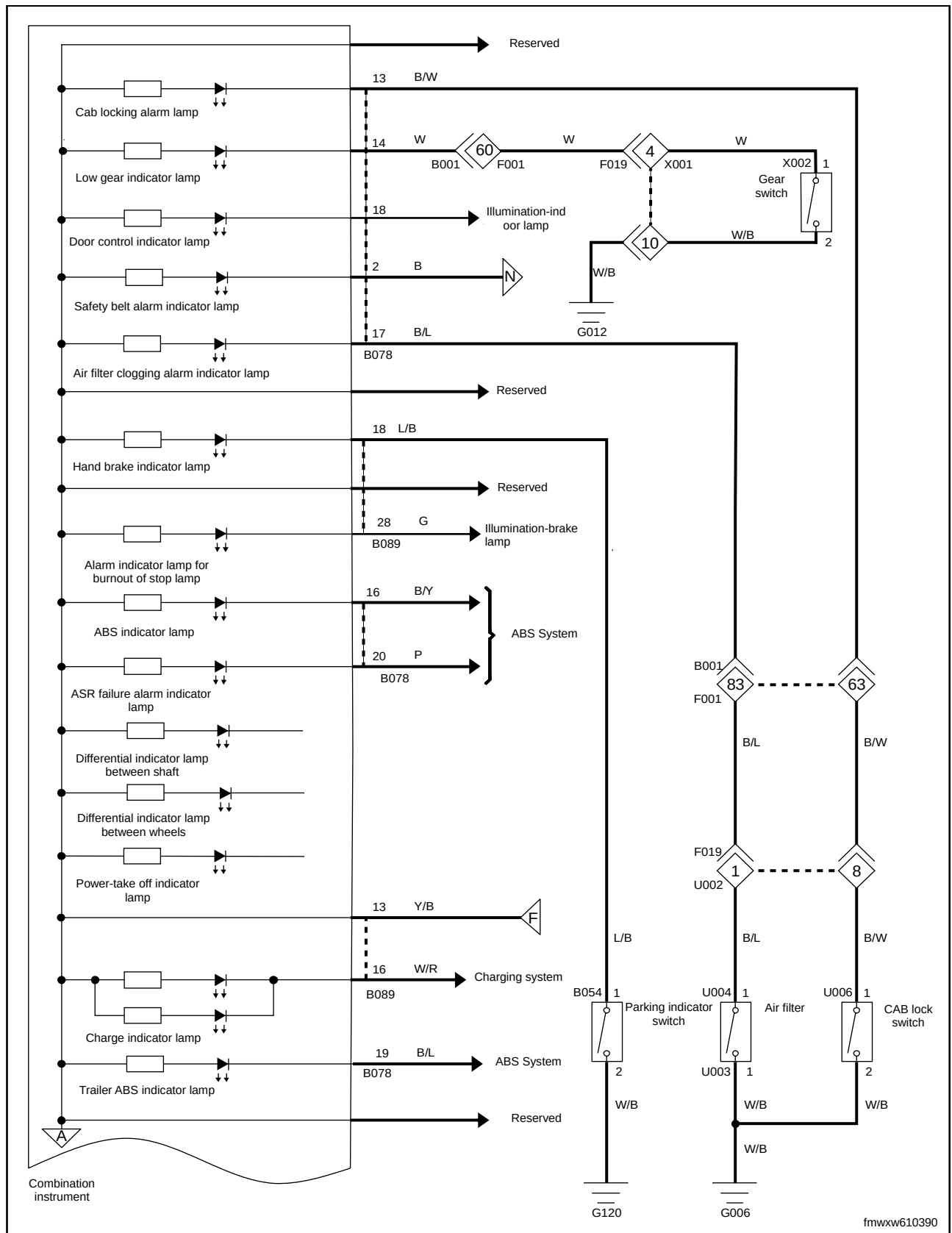


COMBINATION INSTRUMENT

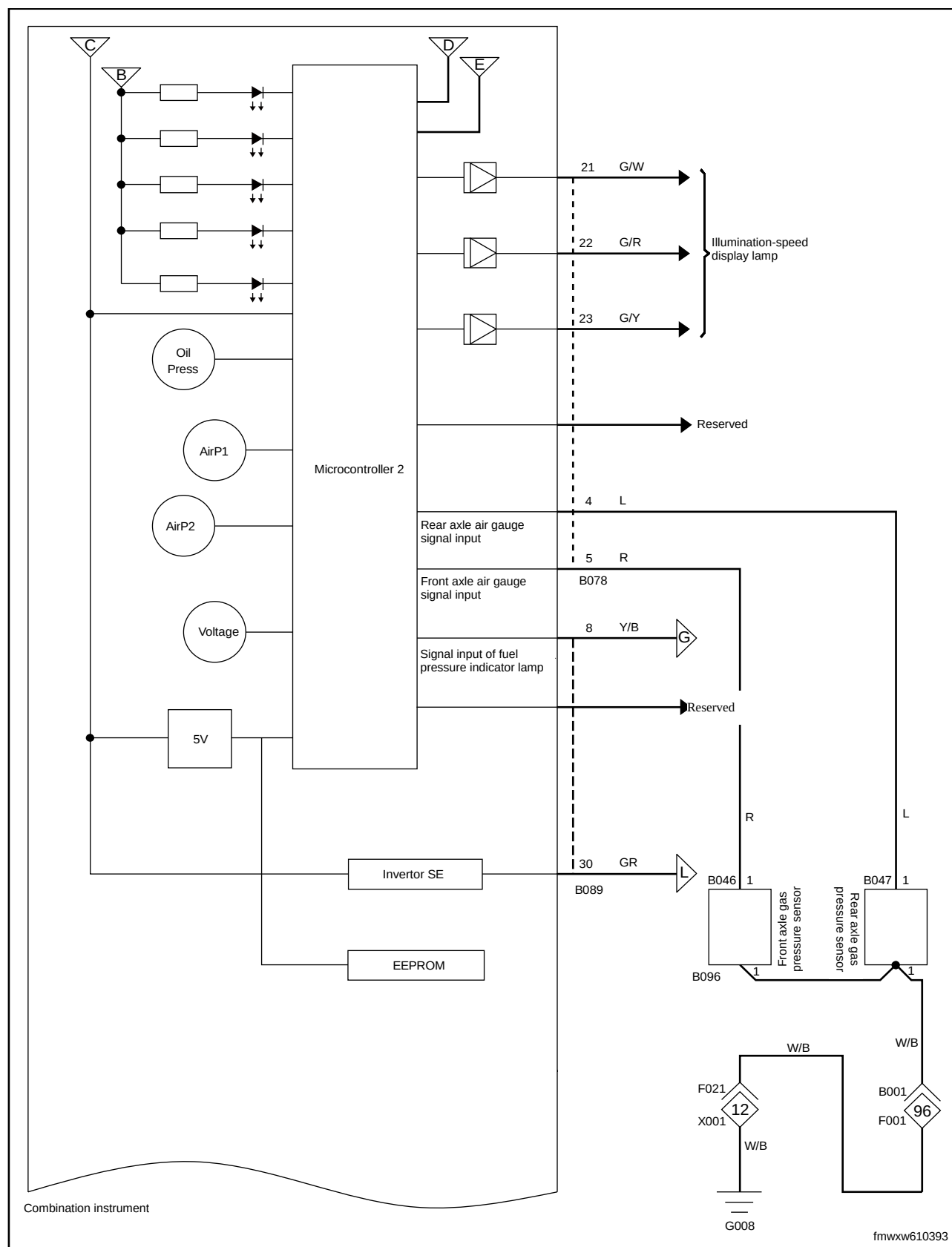


fmwxw610389

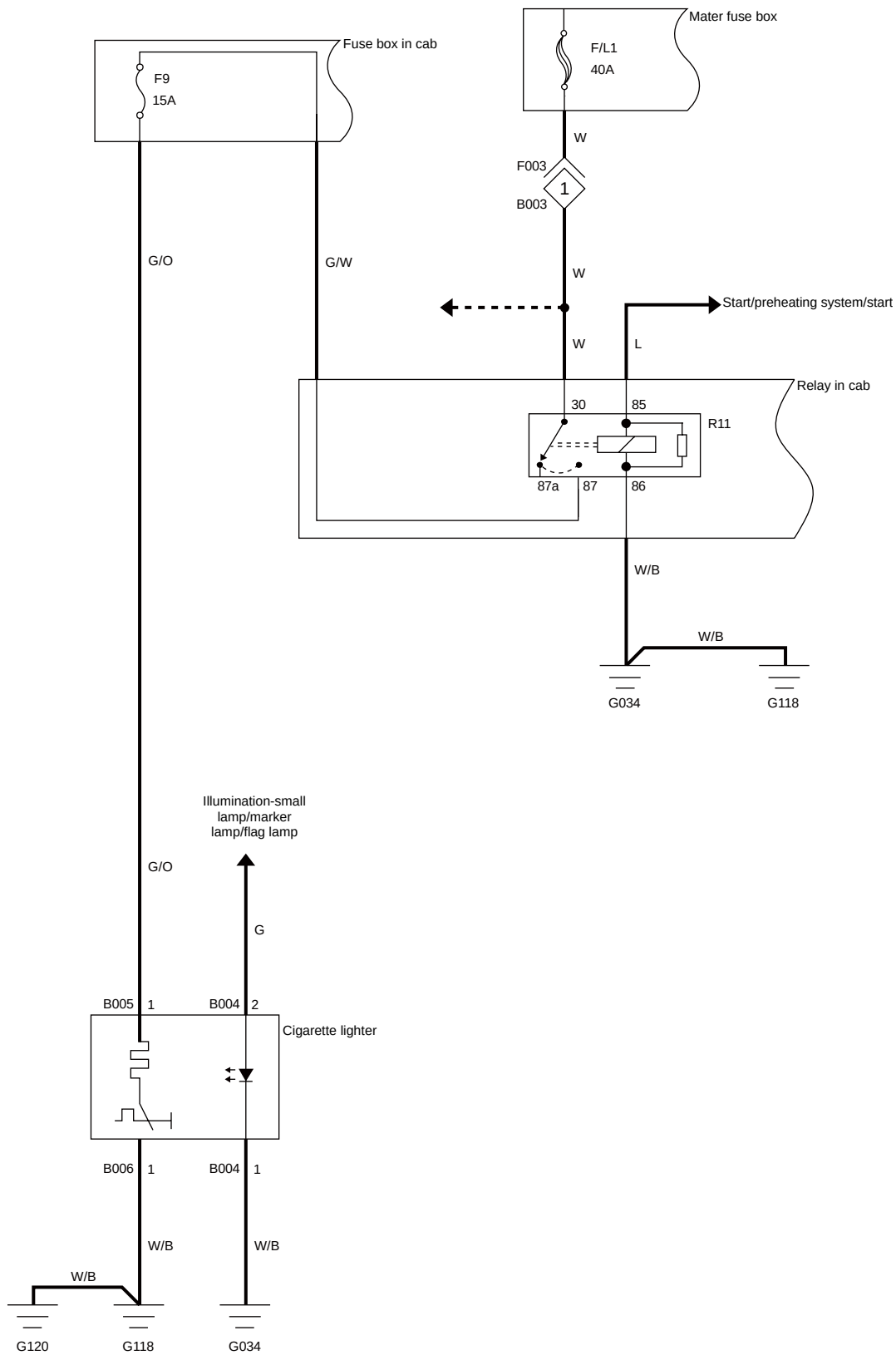
COMBINATION INSTRUMENT (Cont.)



COMBINATION INSTRUMENT (Cont.)

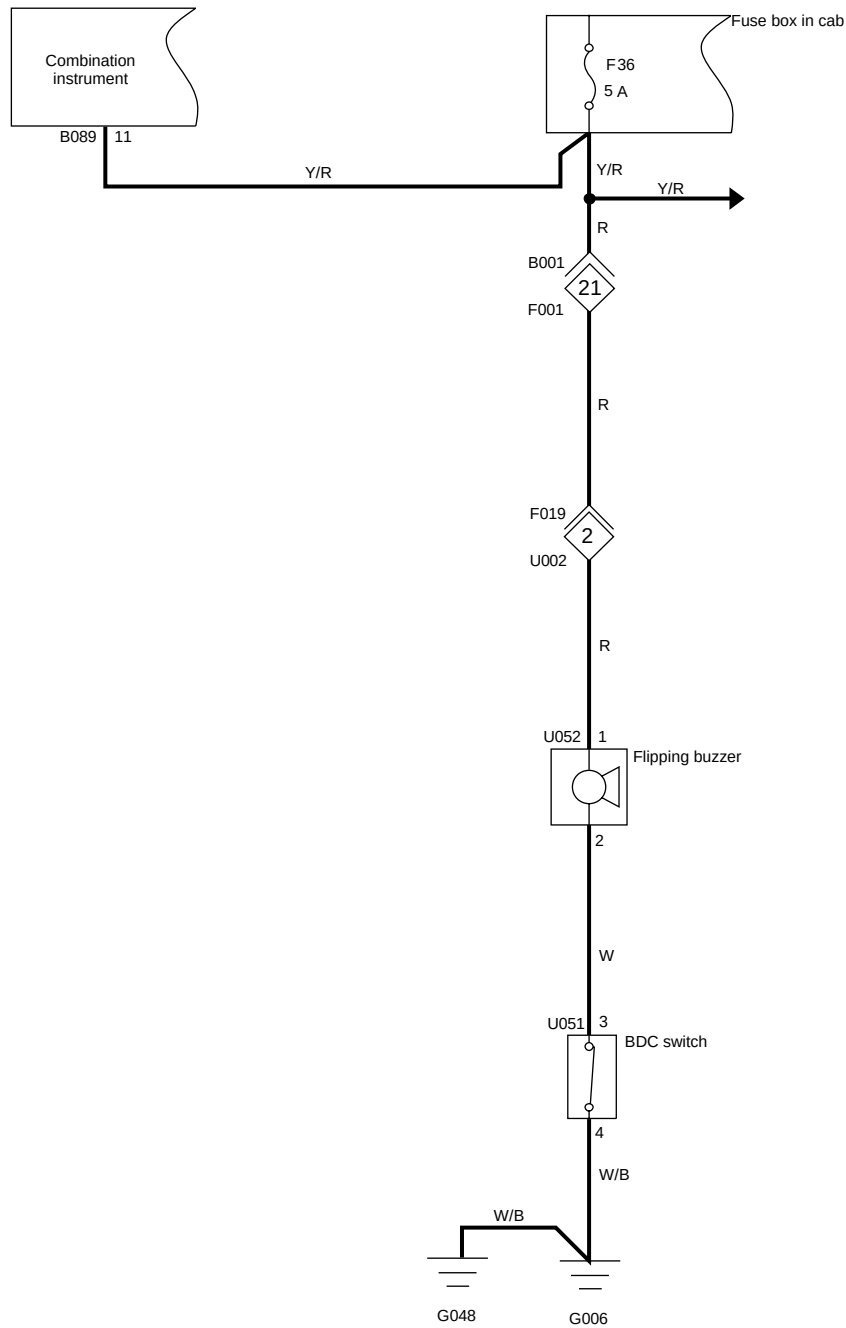


CIGARETTE LIGHTER



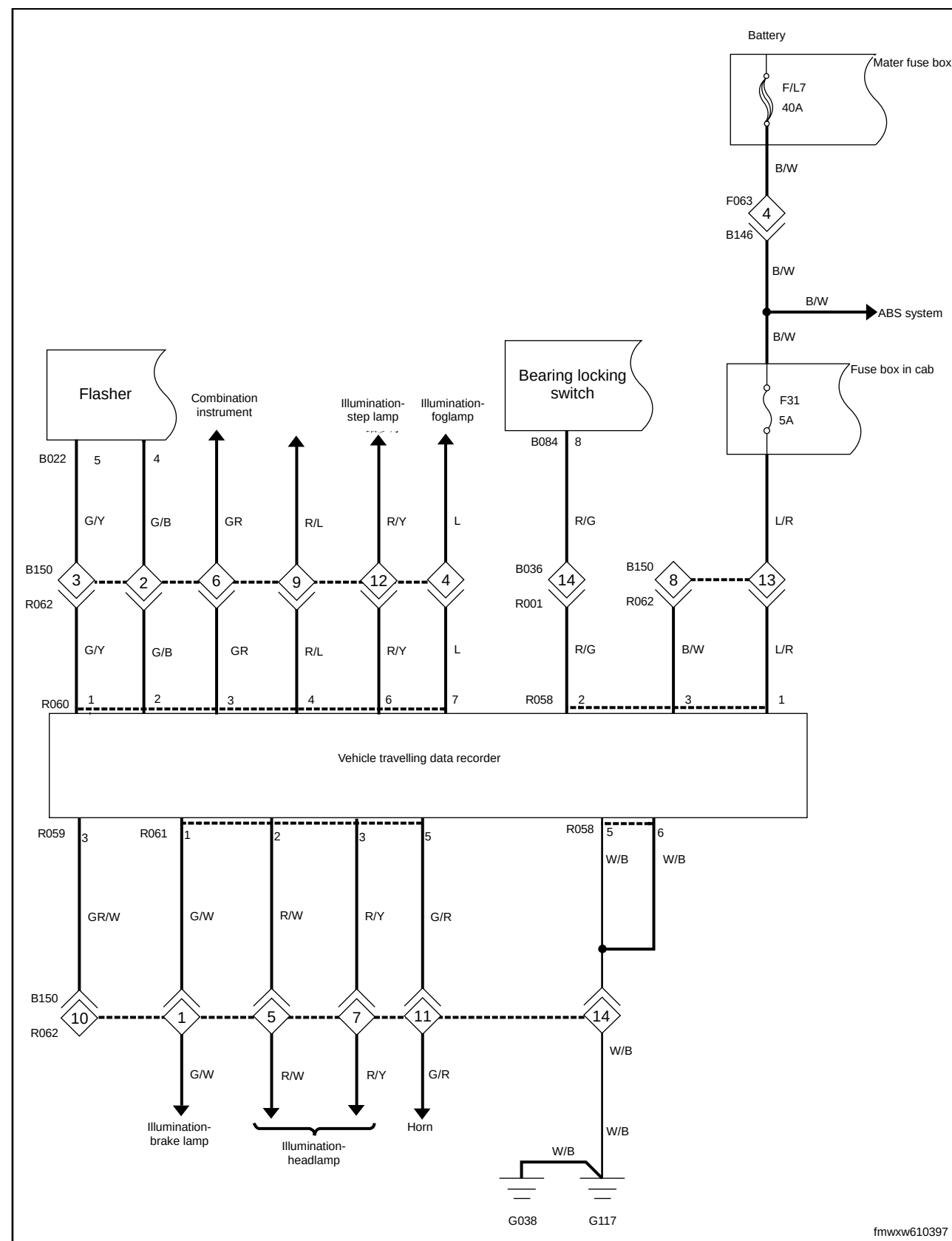
fmwxw610395

CAB DUMPING GEAR (MANNUL)



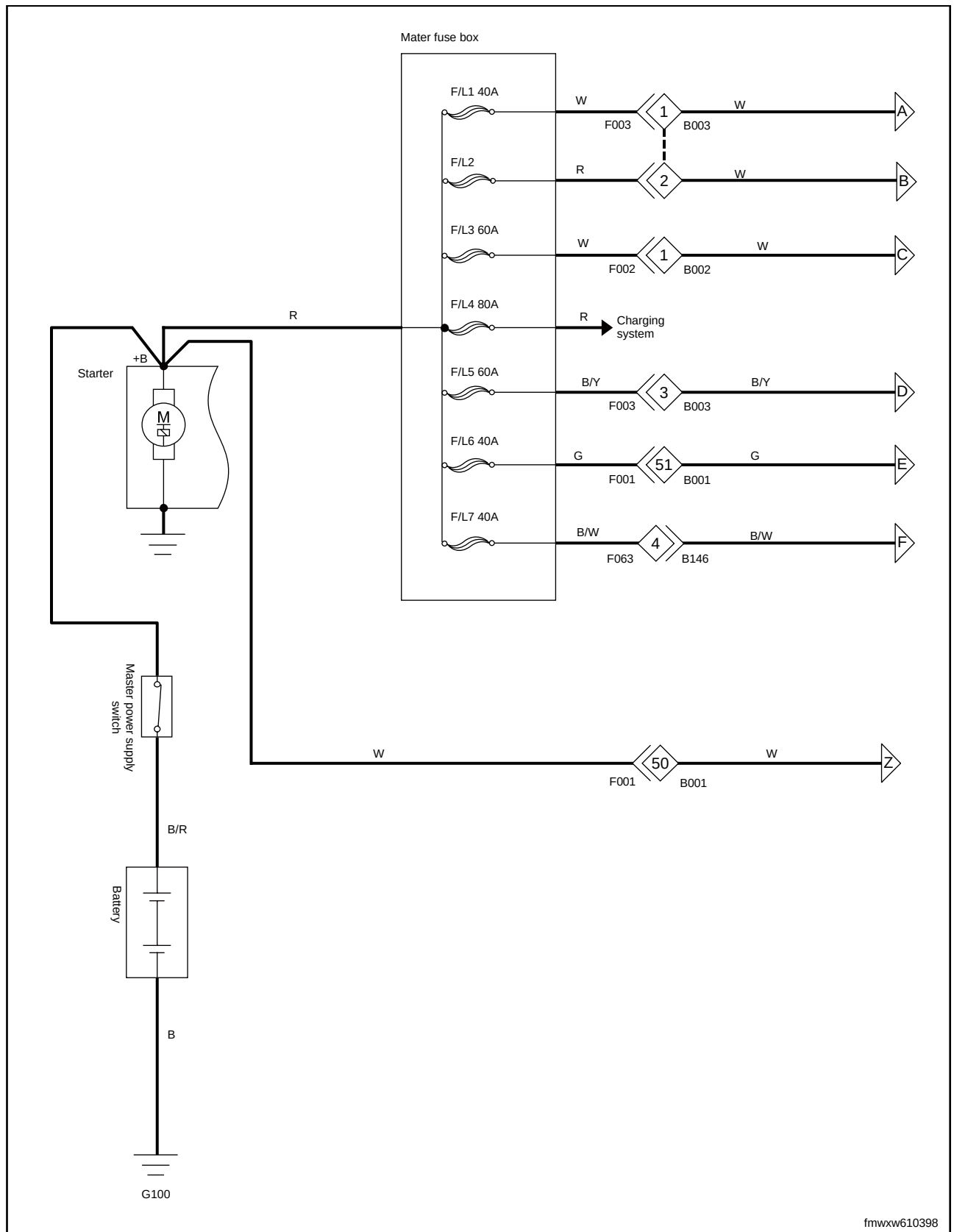
fmwxw610396

DRIVING RECORDER

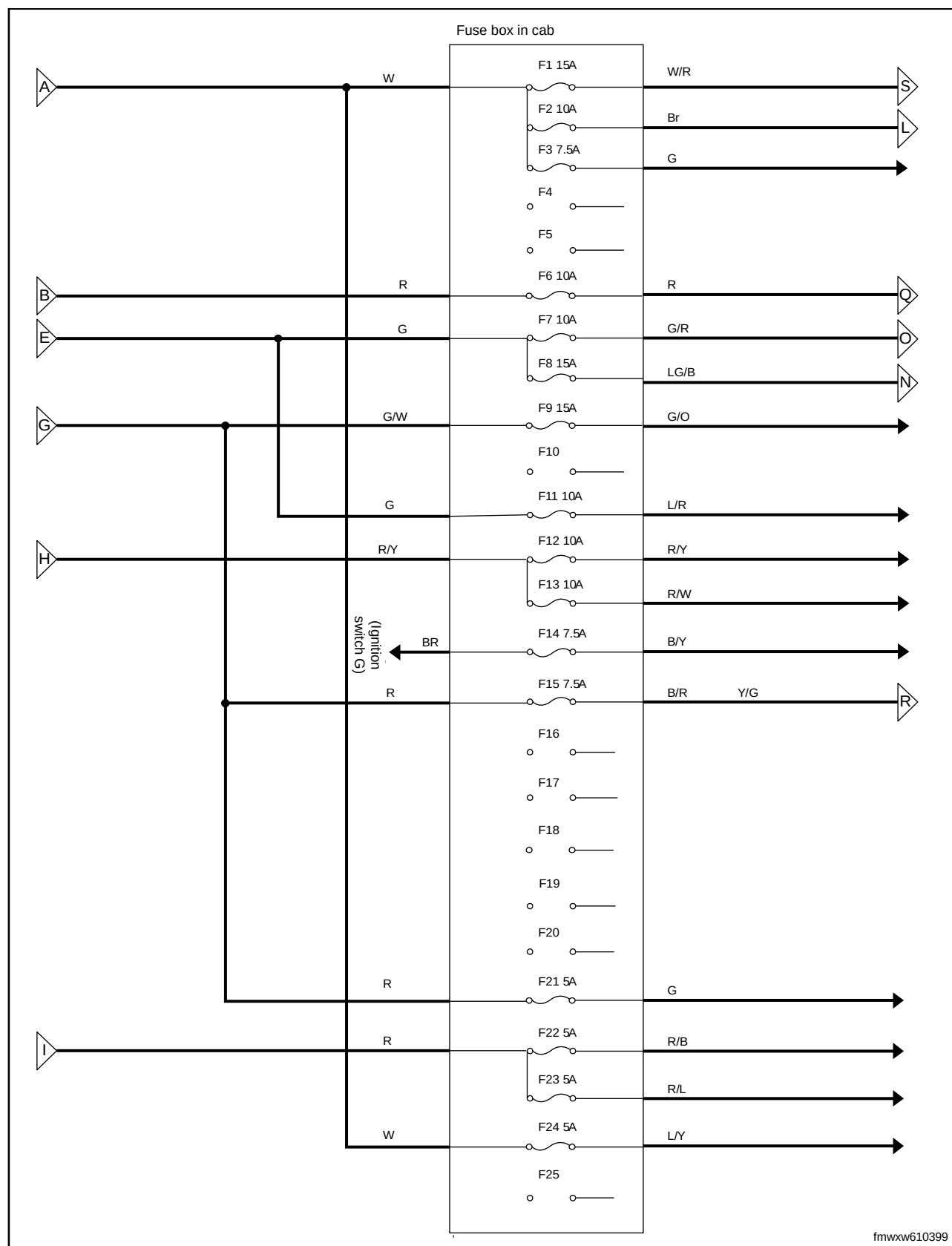


fmwxw610397

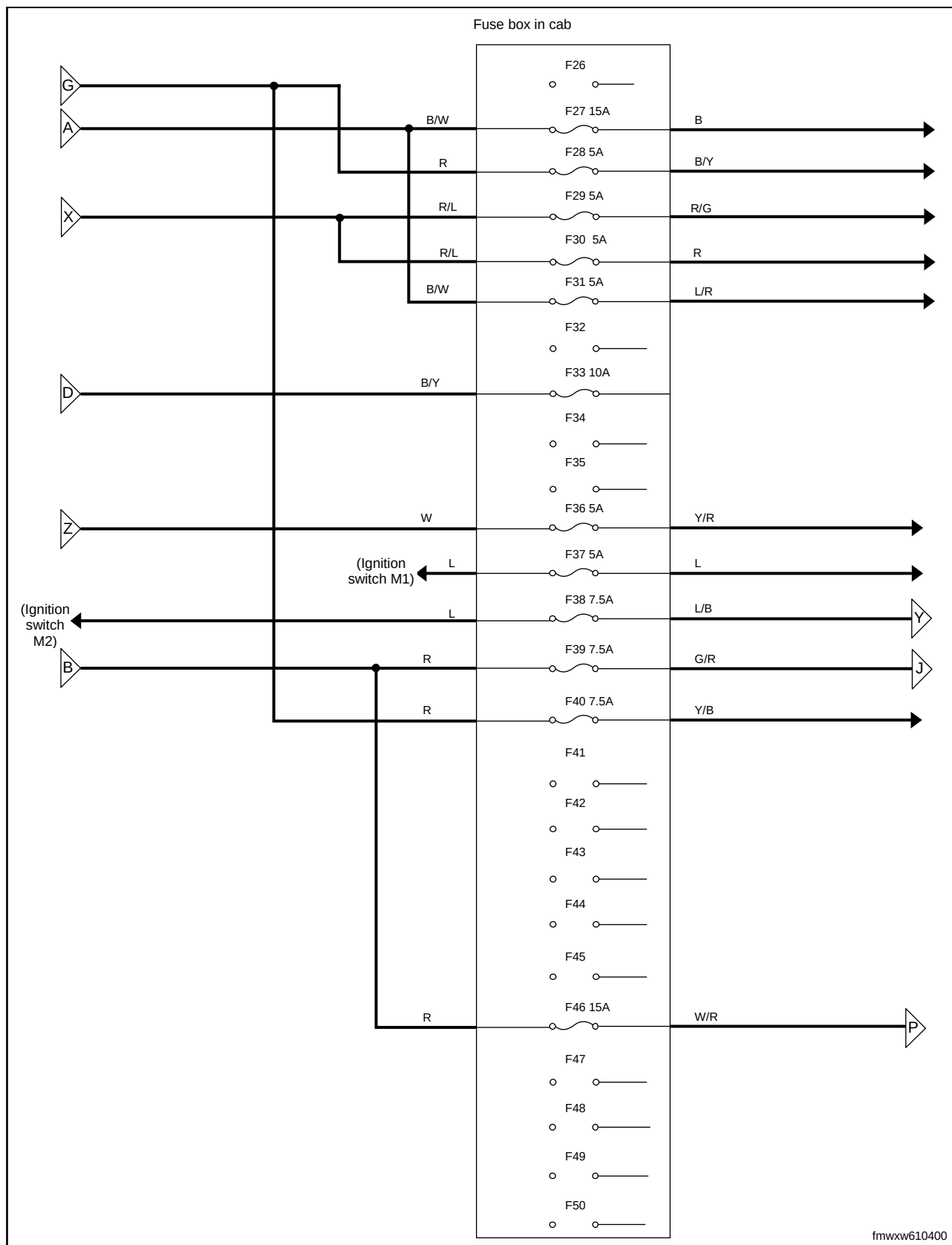
POWER SUPPLY DISTRIBUTION



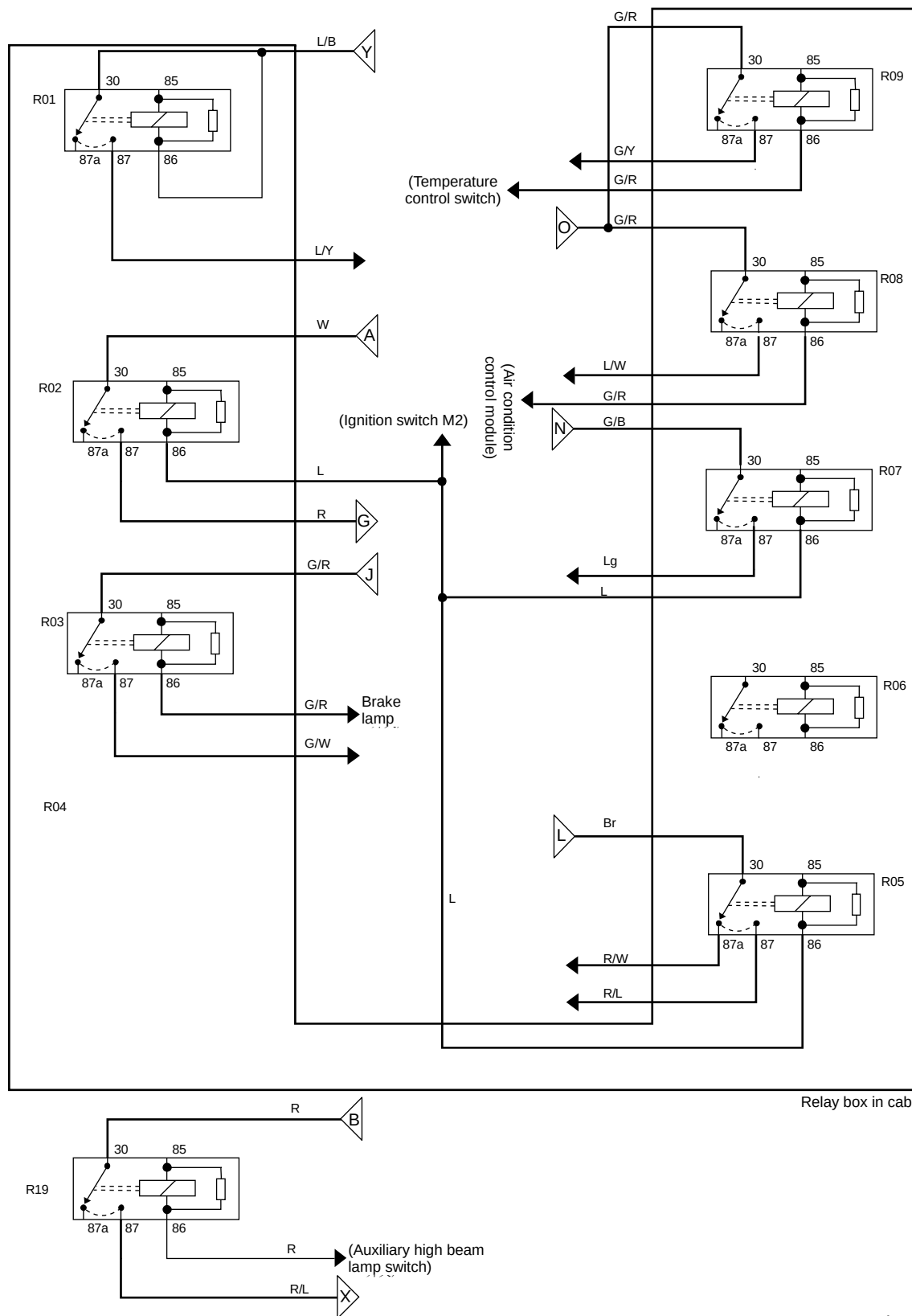
POWER SUPPLY DISTRIBUTION (Cont.)



POWER SUPPLY DISTRIBUTION (Cont.)

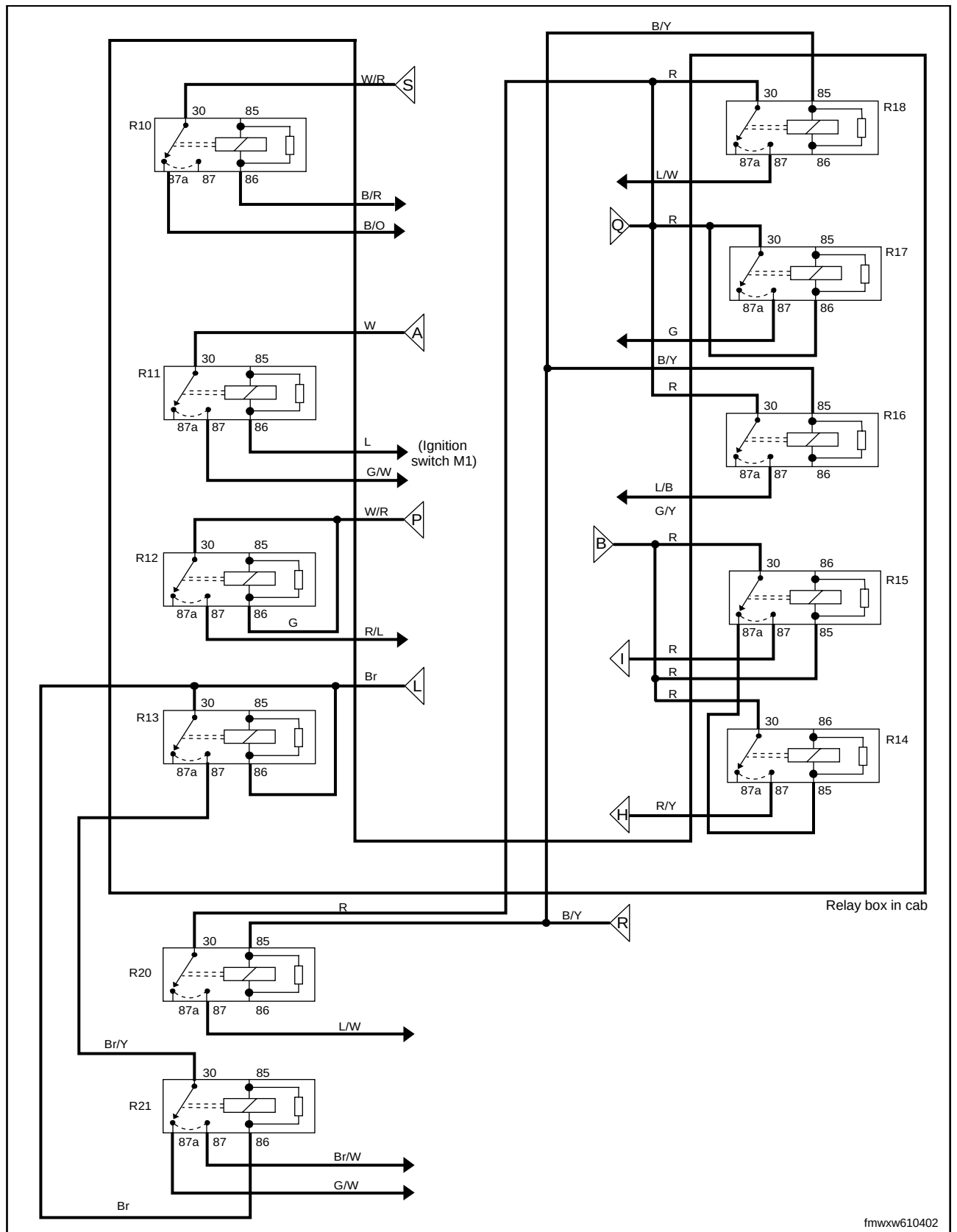


POWER SUPPLY DISTRIBUTION (Cont.)

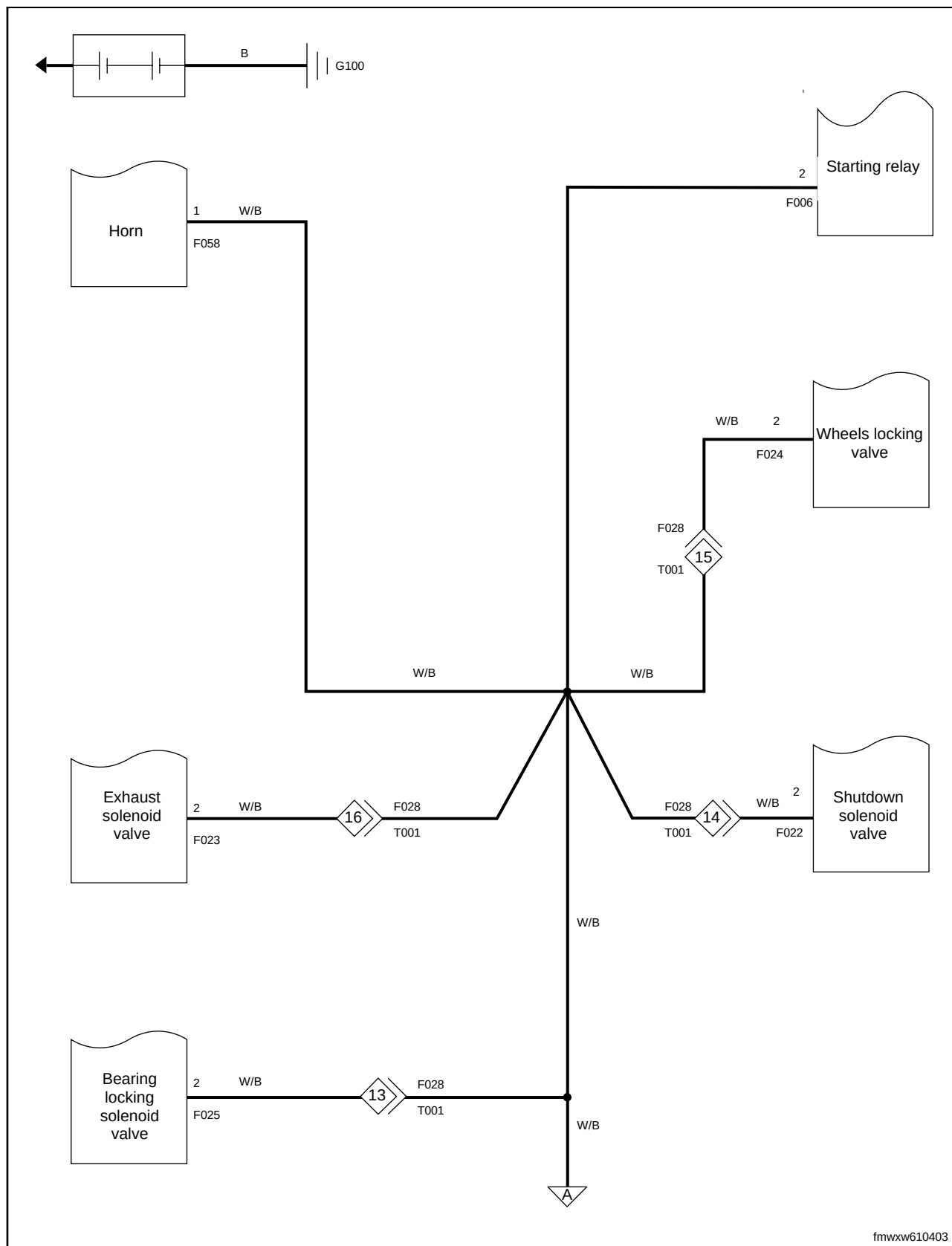


fmwxw610401

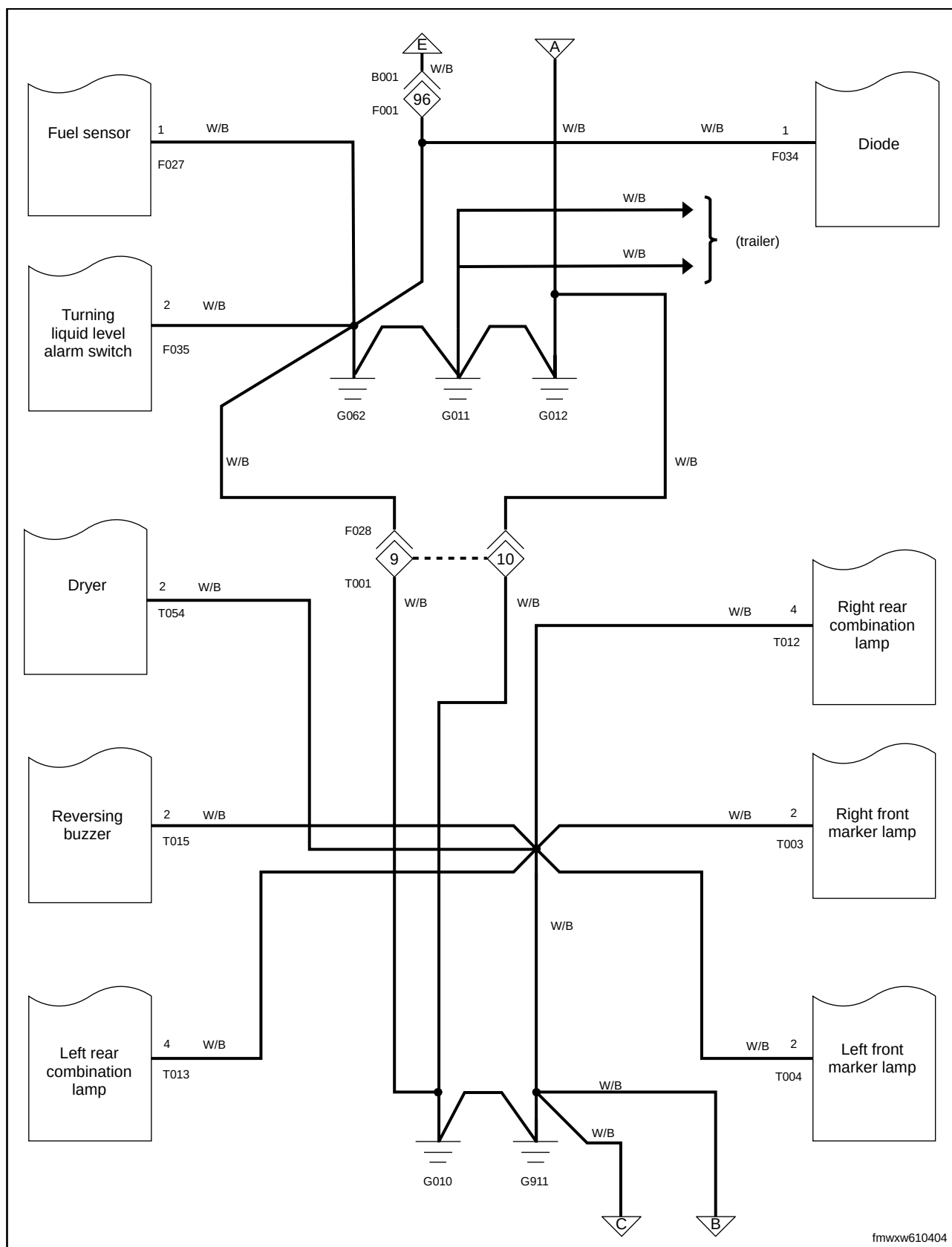
POWER SUPPLY DISTRIBUTION (Cont.)



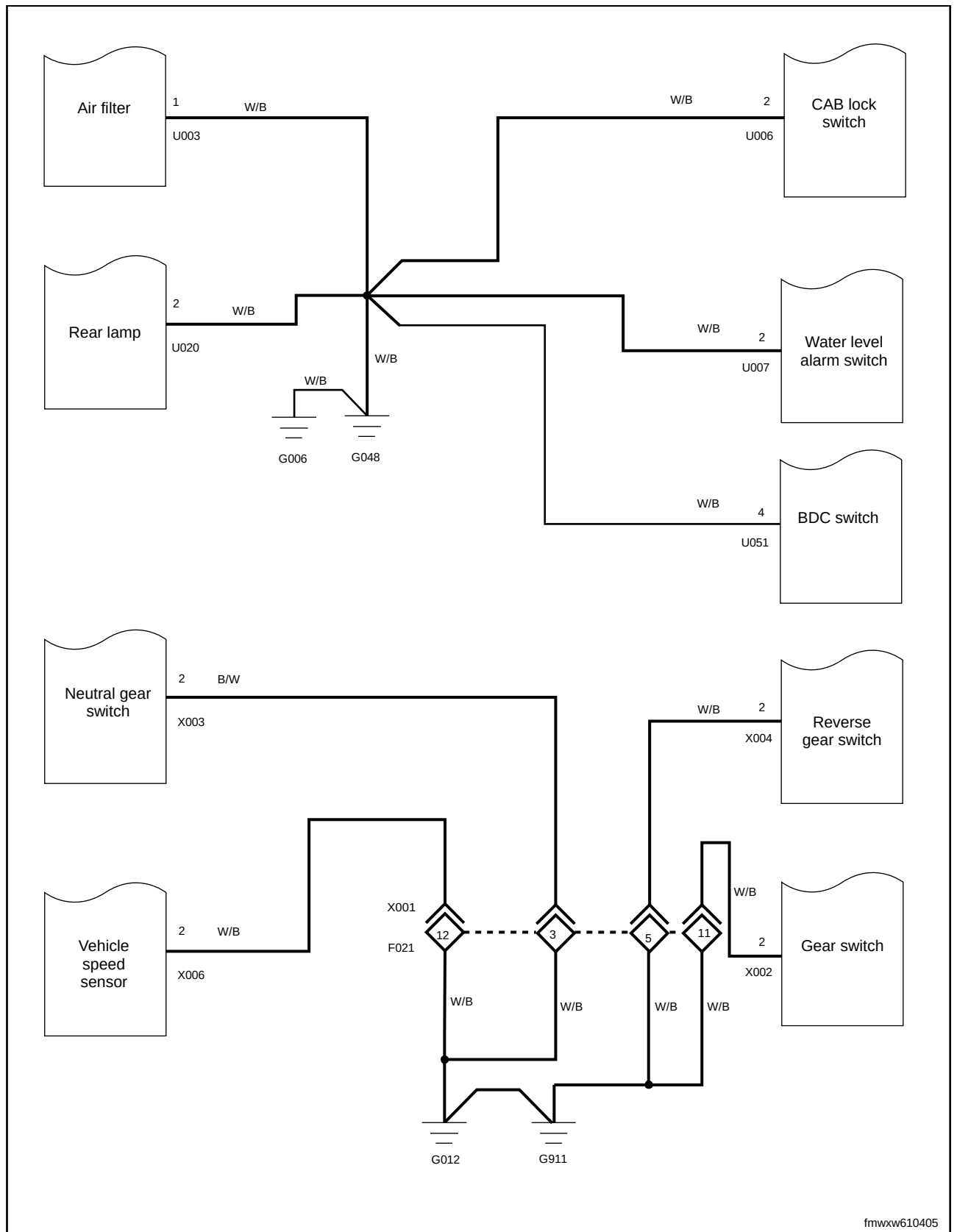
GROUNDING DISTRIBUTION



GROUNDING DISTRIBUTION (Cont.)

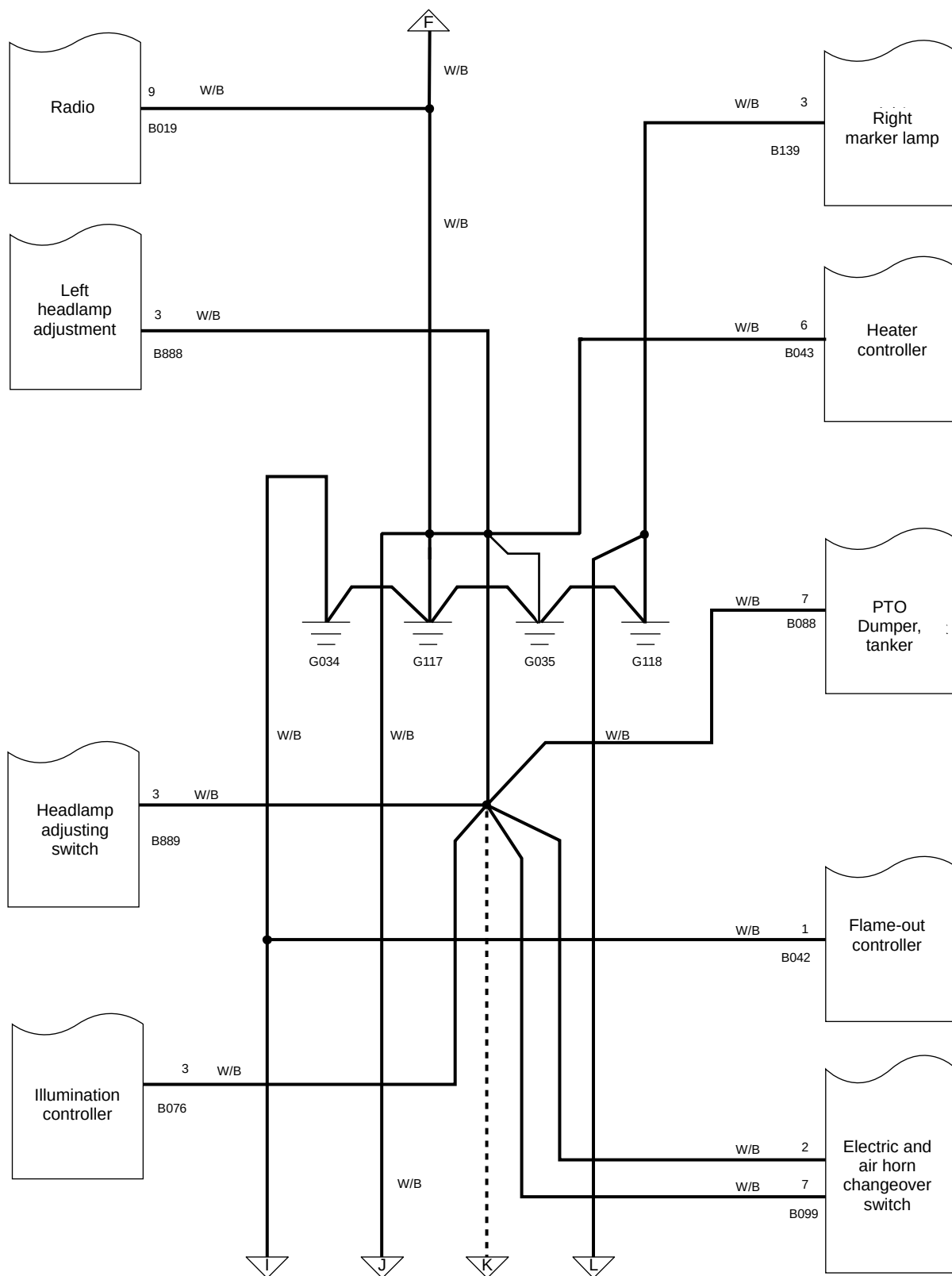


GROUNDING DISTRIBUTION (Cont.)



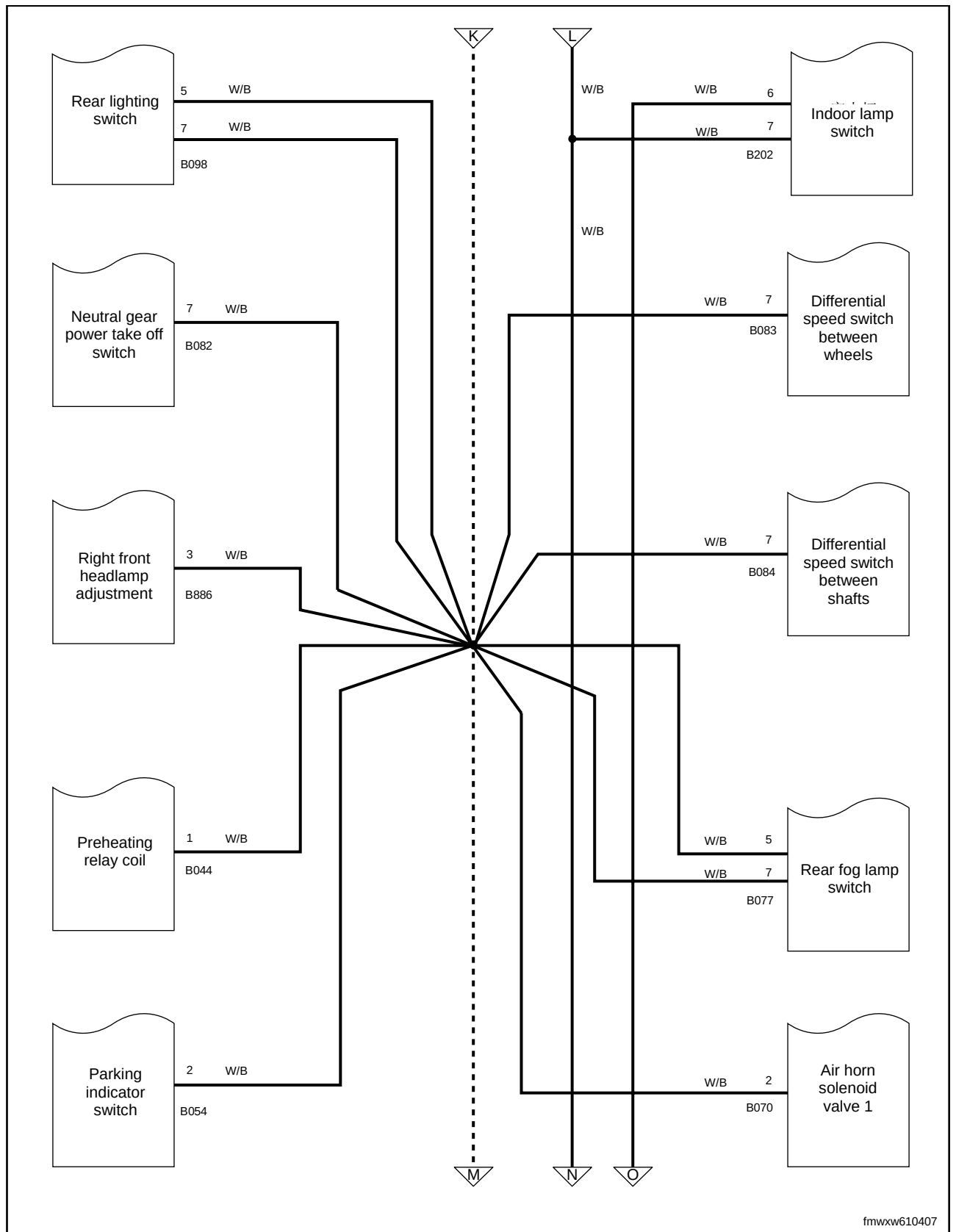
fmwxw610405

GROUNDING DISTRIBUTION (Cont.)

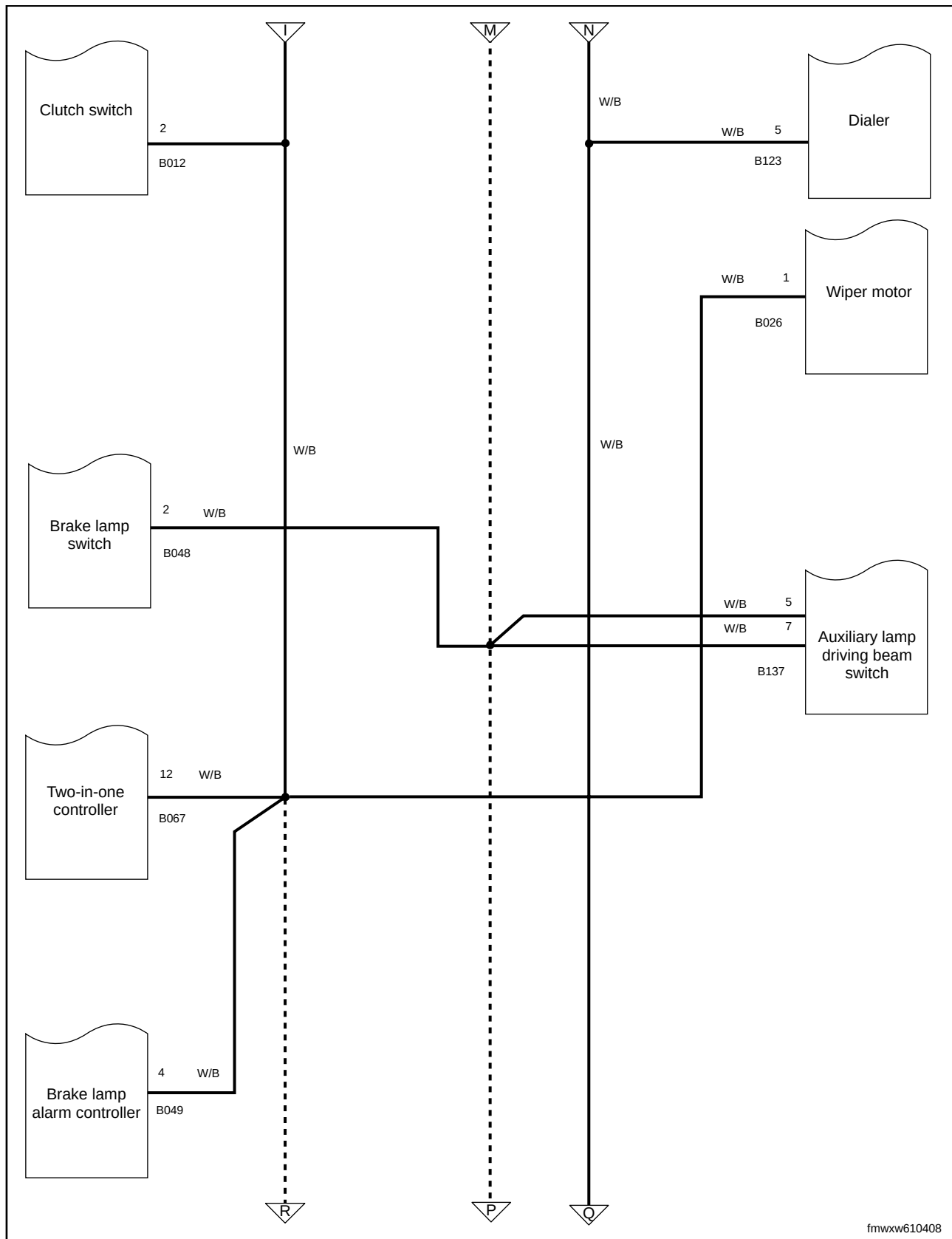


fmwxw610406

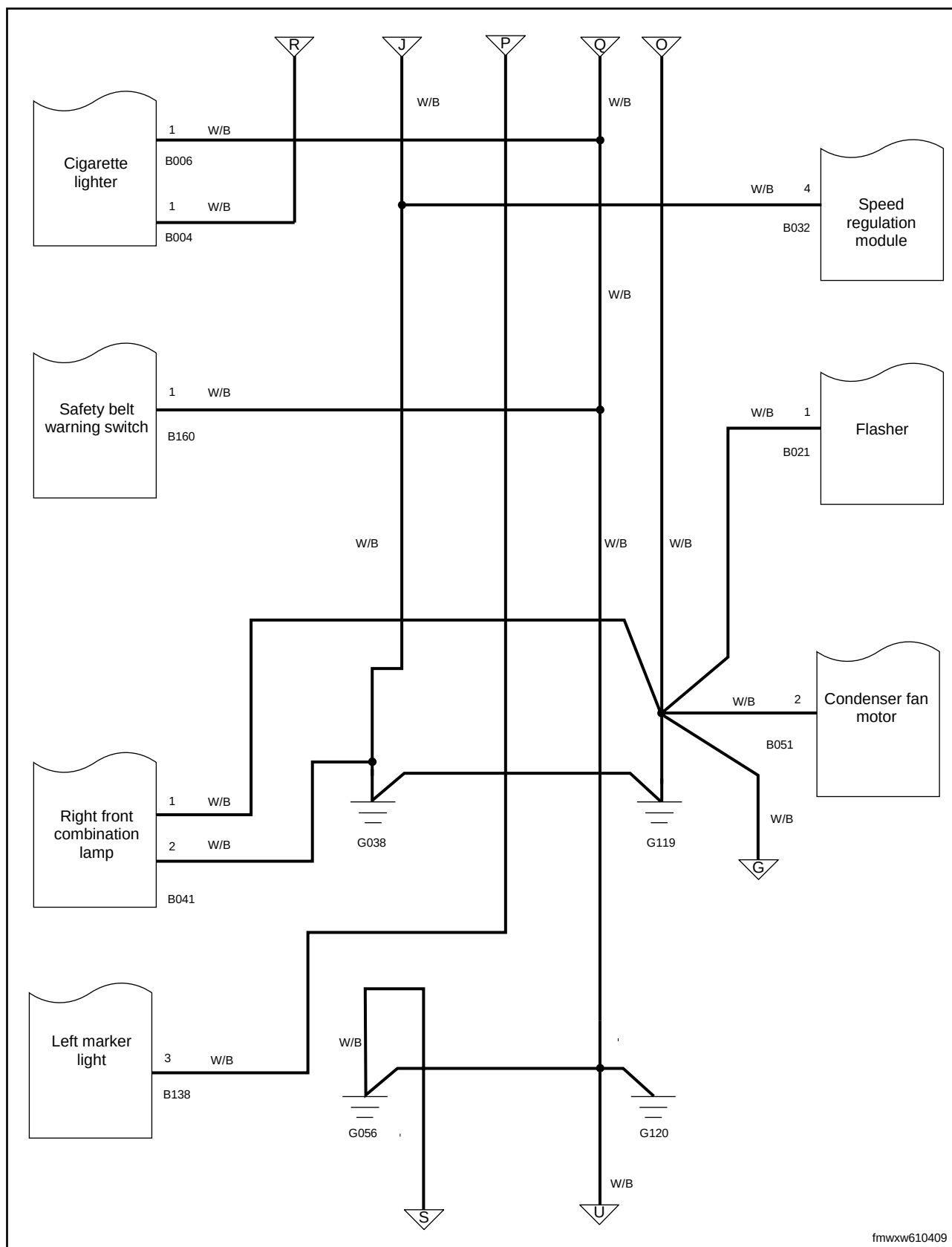
GROUNDING DISTRIBUTION (Cont.)



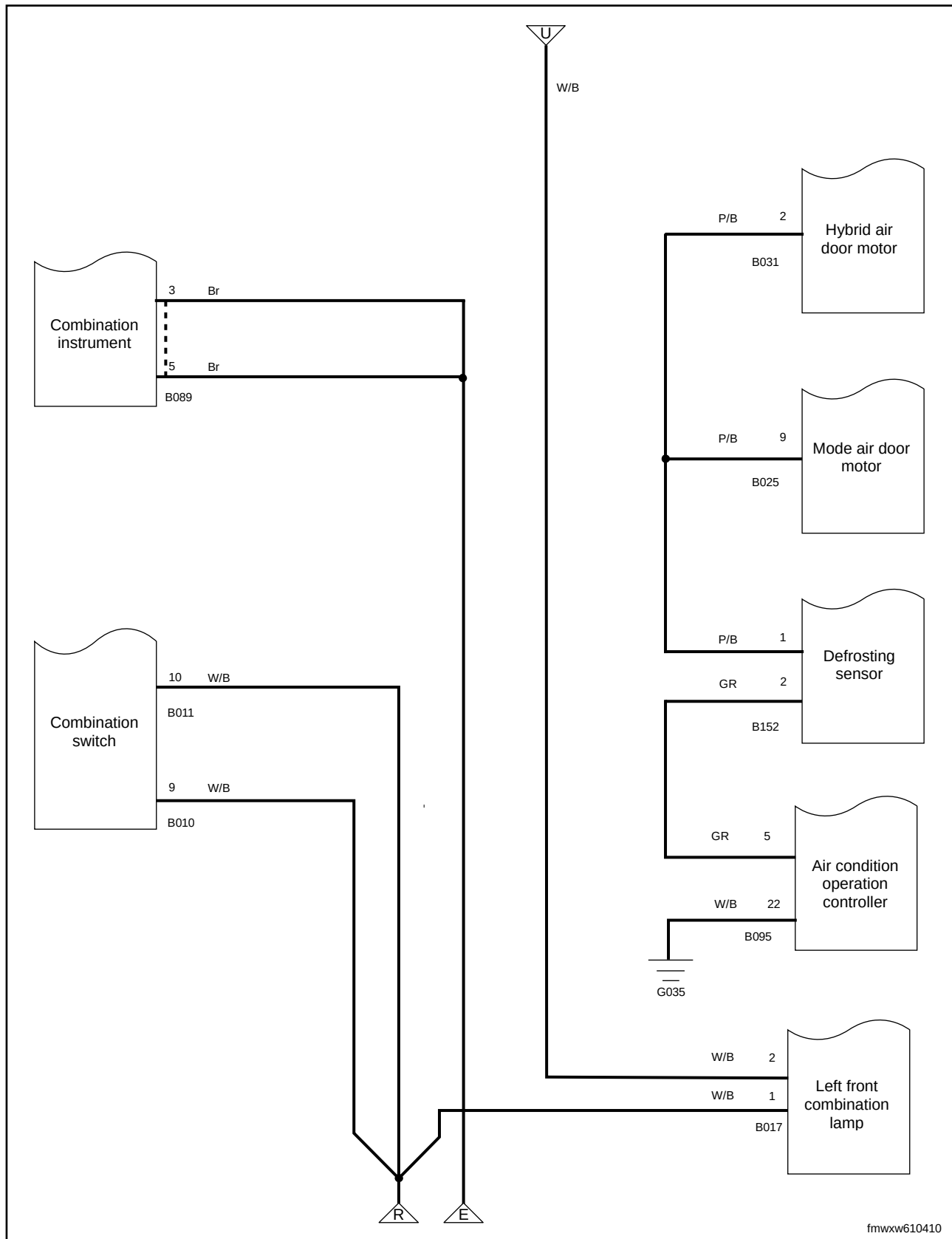
GROUNDING DISTRIBUTION (Cont.)



GROUNDING DISTRIBUTION (Cont.)

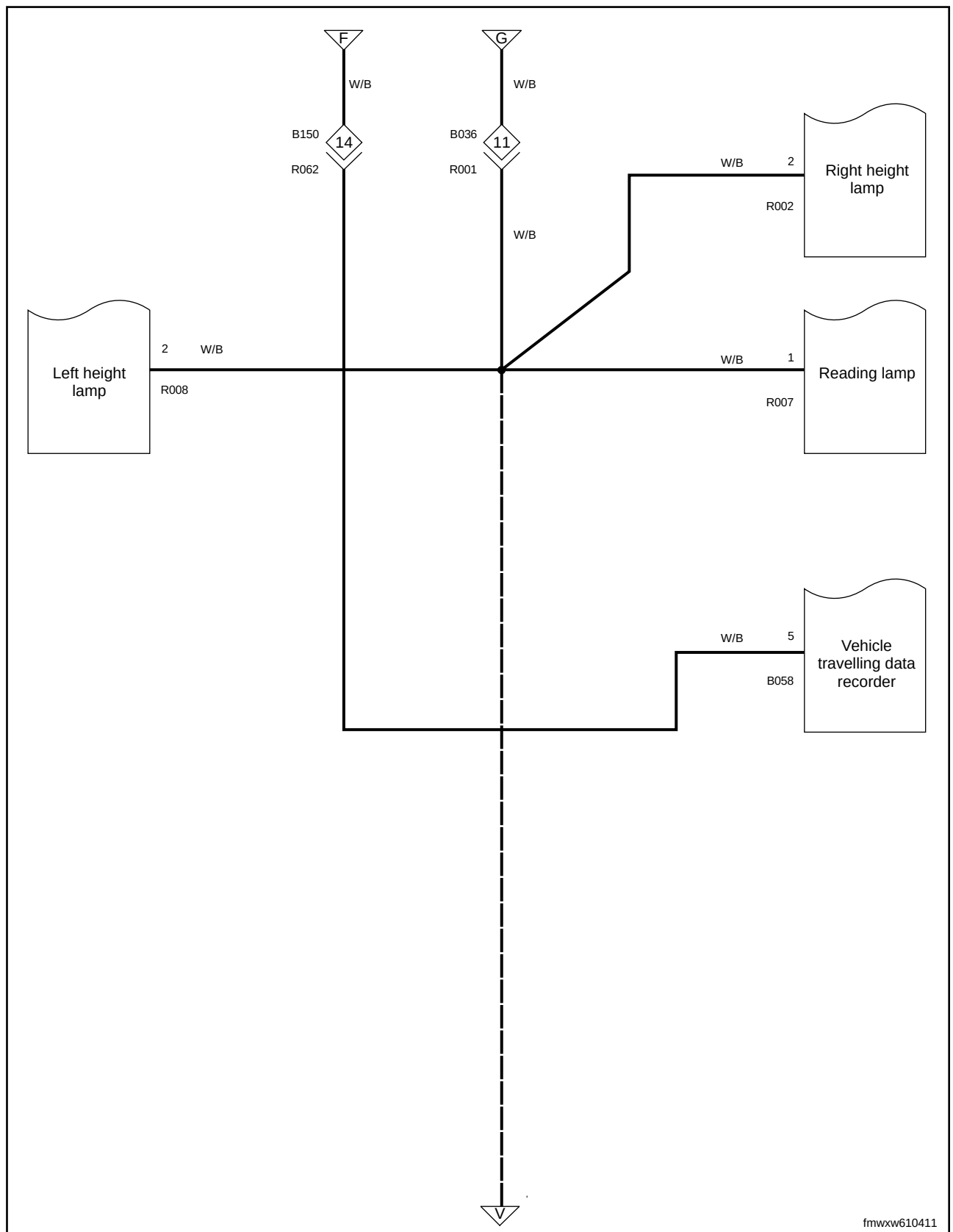


GROUNDING DISTRIBUTION (Cont.)

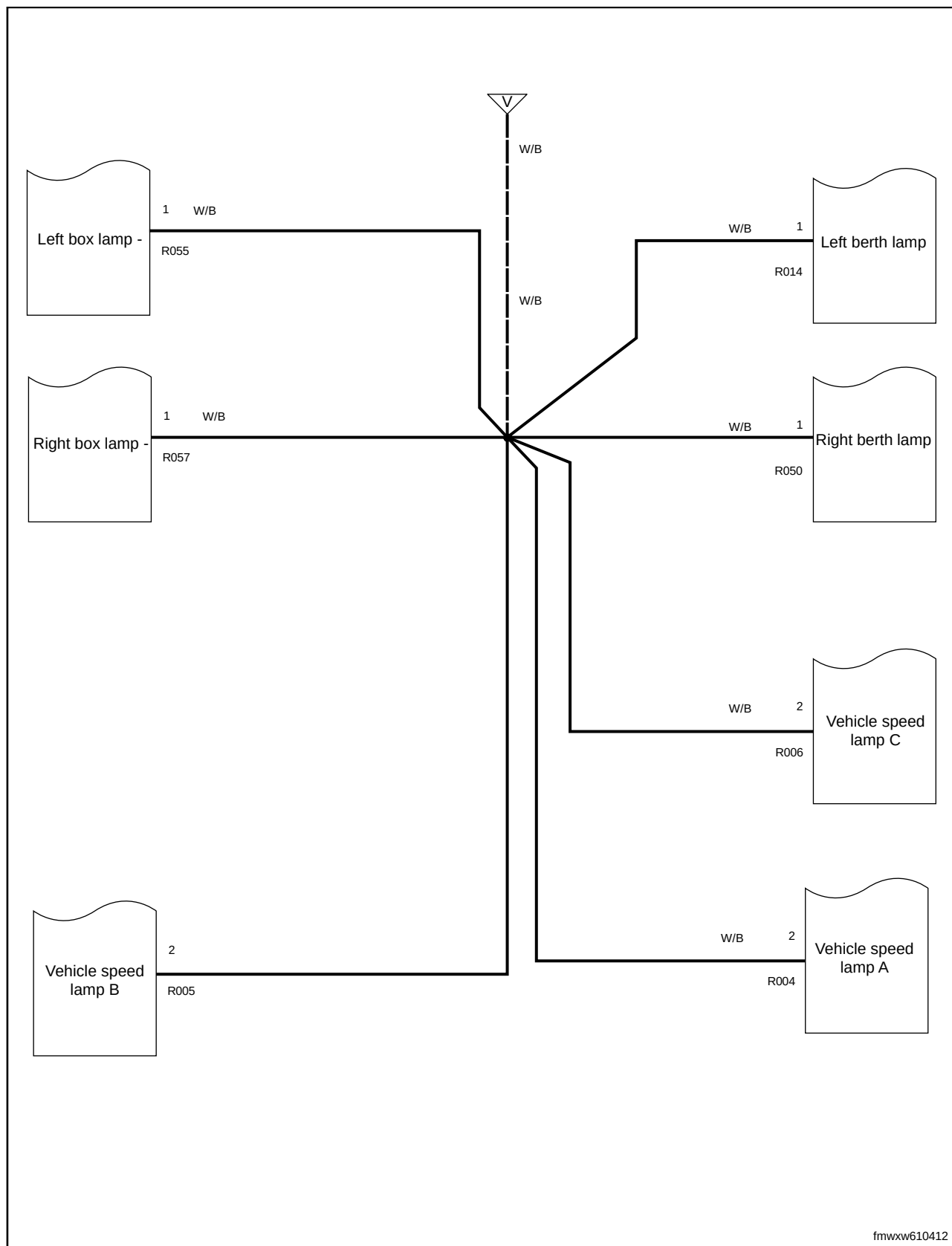


fmwxw610410

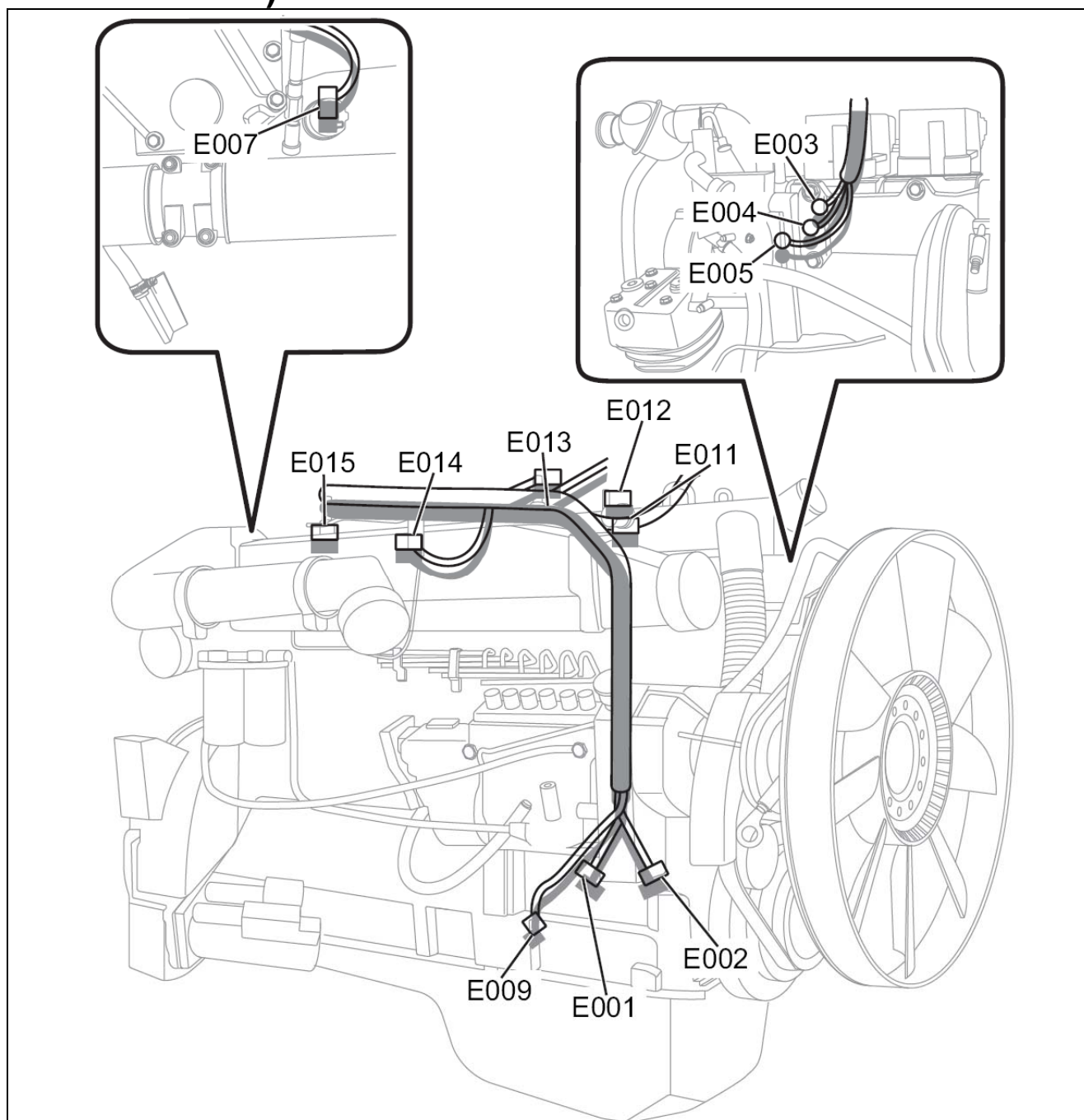
GROUNDING DISTRIBUTION (Cont.)



GROUNDING DISTRIBUTION (Cont.)



CONNECTOR POSITION OF WIRE HARNESS (LEFT HAND DRIVE)

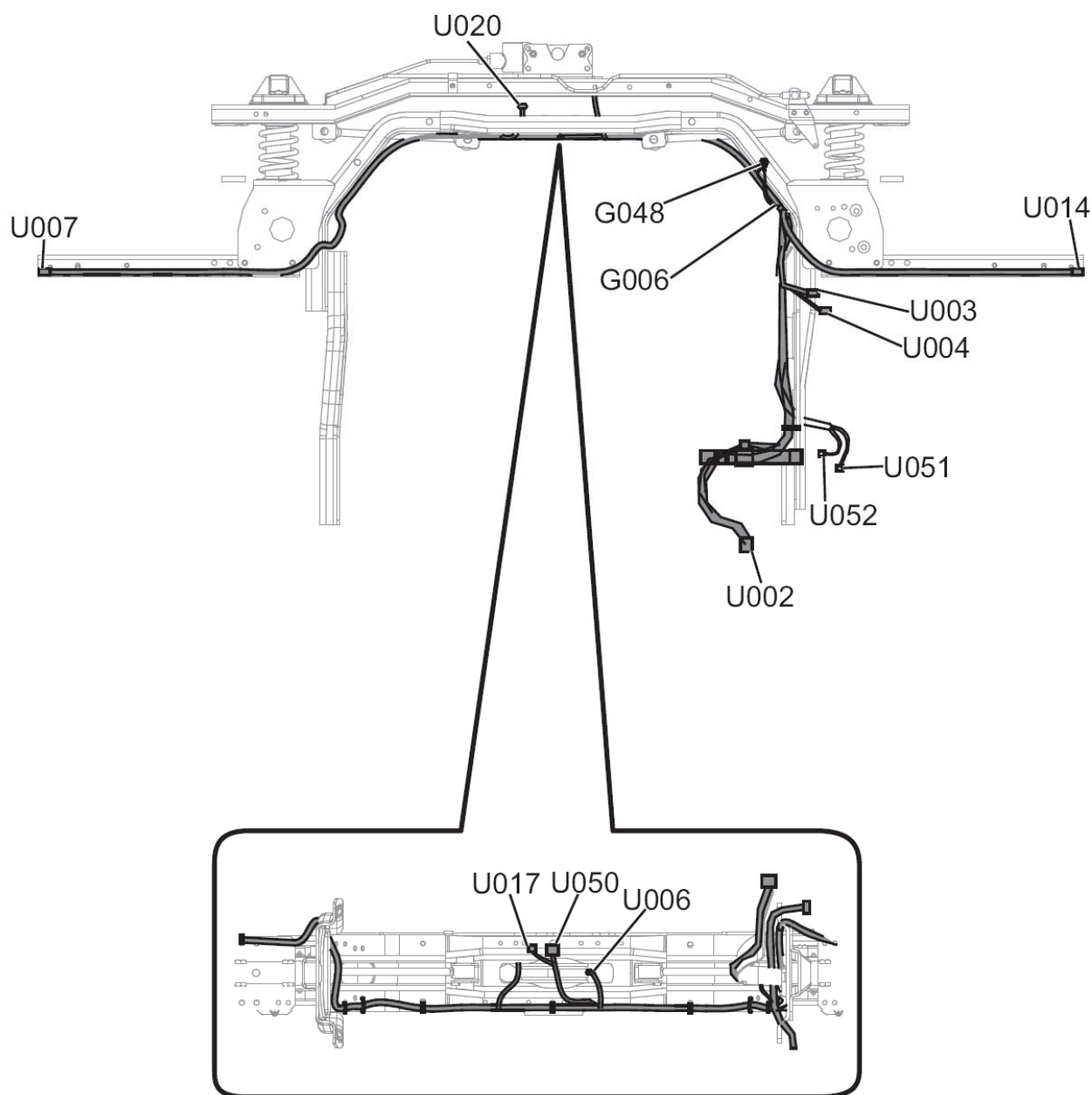


1	E001	To vehicle frame harness A
2	E002	To vehicle frame harness B
3	E003	Generator B
4	E004	Generator N
5	E005	Generator D
6	E007	Engine oil pressure sensor

7	E009	Compressor
8	E011	Water temperature sensor
9	E012	Preheating temperature sensor
10	E013	Preheating plug
11	E014	Preheating solenoid valve
12	E015	Preheating plug II

Fmwxxw610300

61-84 CIRCUIT DIAGRAM-CONNECTOR POSITION OF WIRE HARNESS (LEFT HAND DRIVE)

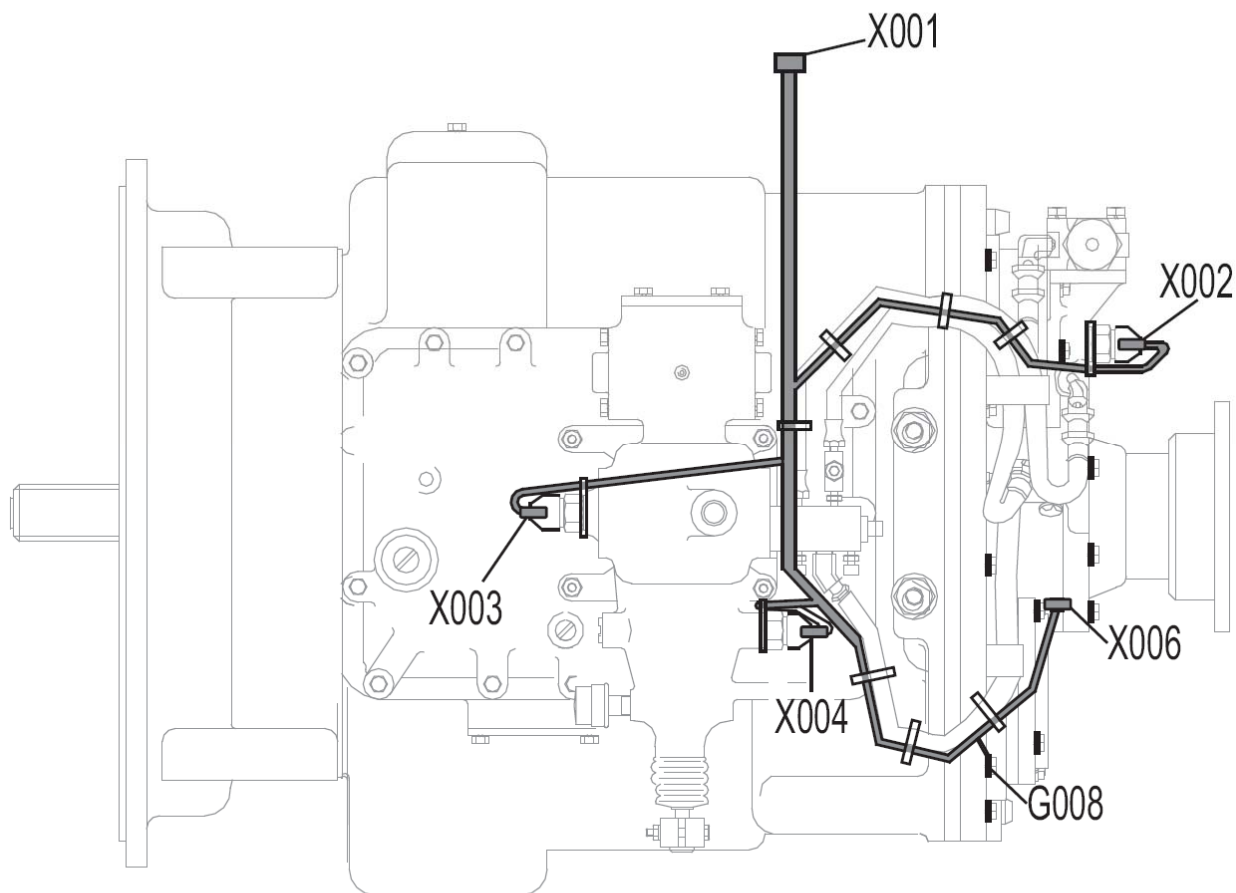


61

1	U002	To tripper mechanism harness
2	U003	Air filter (-)
3	U 004	Air filter (+)
4	U 006	CAB lock switch
5	U 007	Water level alarm switch
6	U 0014	Negative starting switch
7	U 0017	To trailer harness

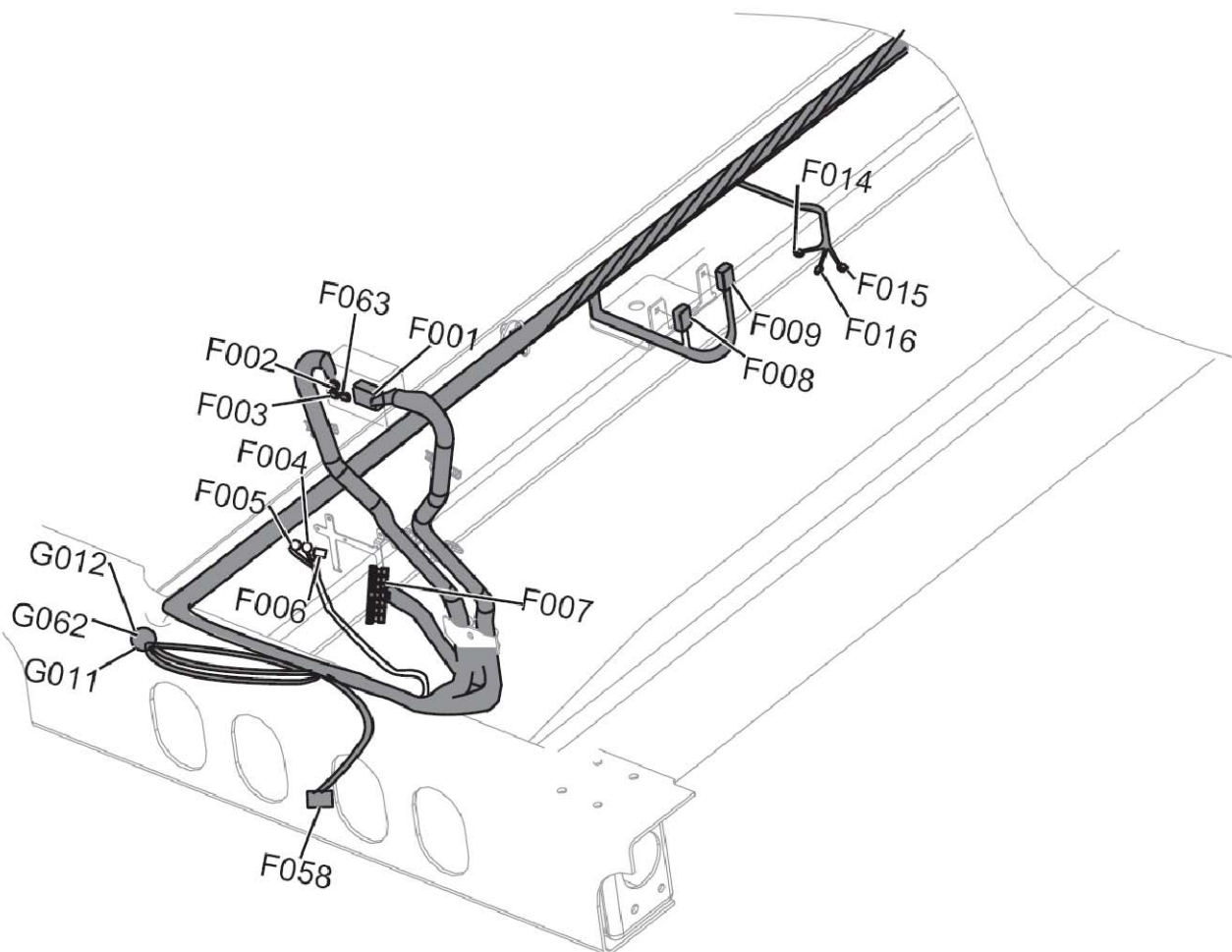
8	U020	Rear lamp
9	U050	To trailer harness
10	U051	BDC switch
11	U052	Flipping buzzer
12	U006	Dumping gear ground
13	U048	Dumping gear ground

Fmwxxw610301



1	X001	To vehicle frame harness I
2	X002	Gear switch
3	X003	Neutral position switch

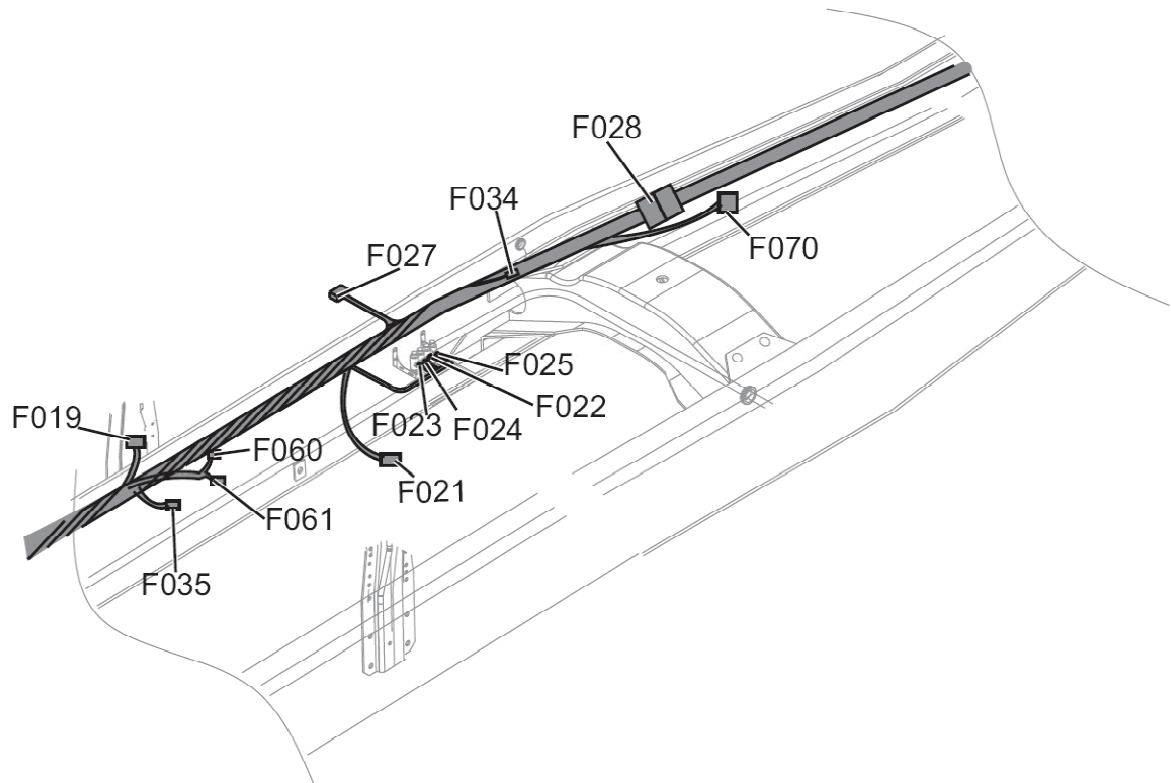
4	X004	Reverse gear switch
5	X006	To vehicle speed sensor
6	X008	Sensor grounding

61-86 CIRCUIT DIAGRAM-CONNECTOR POSITION OF WIRE HARNESS (LEFT HAND DRIVE)

61

1	F002	To vehicle body harness B
2	F003	To vehicle body harness C
3	F004	Starter relay B
4	F005	Starter relay L
5	F006	Starter relay coil
6	F008	To engine harness A
7	F009	To engine harness B
8	F014	Memory power supply

9	F015	Starter B
10	F016	Starter electromagnetic clutch
11	F021	To gearbox wire harness
12	F053	High tone horn
13	G011	1# underpan grounding A
14	G012	1# underpan grounding
15	G062	2# underpan grounding C

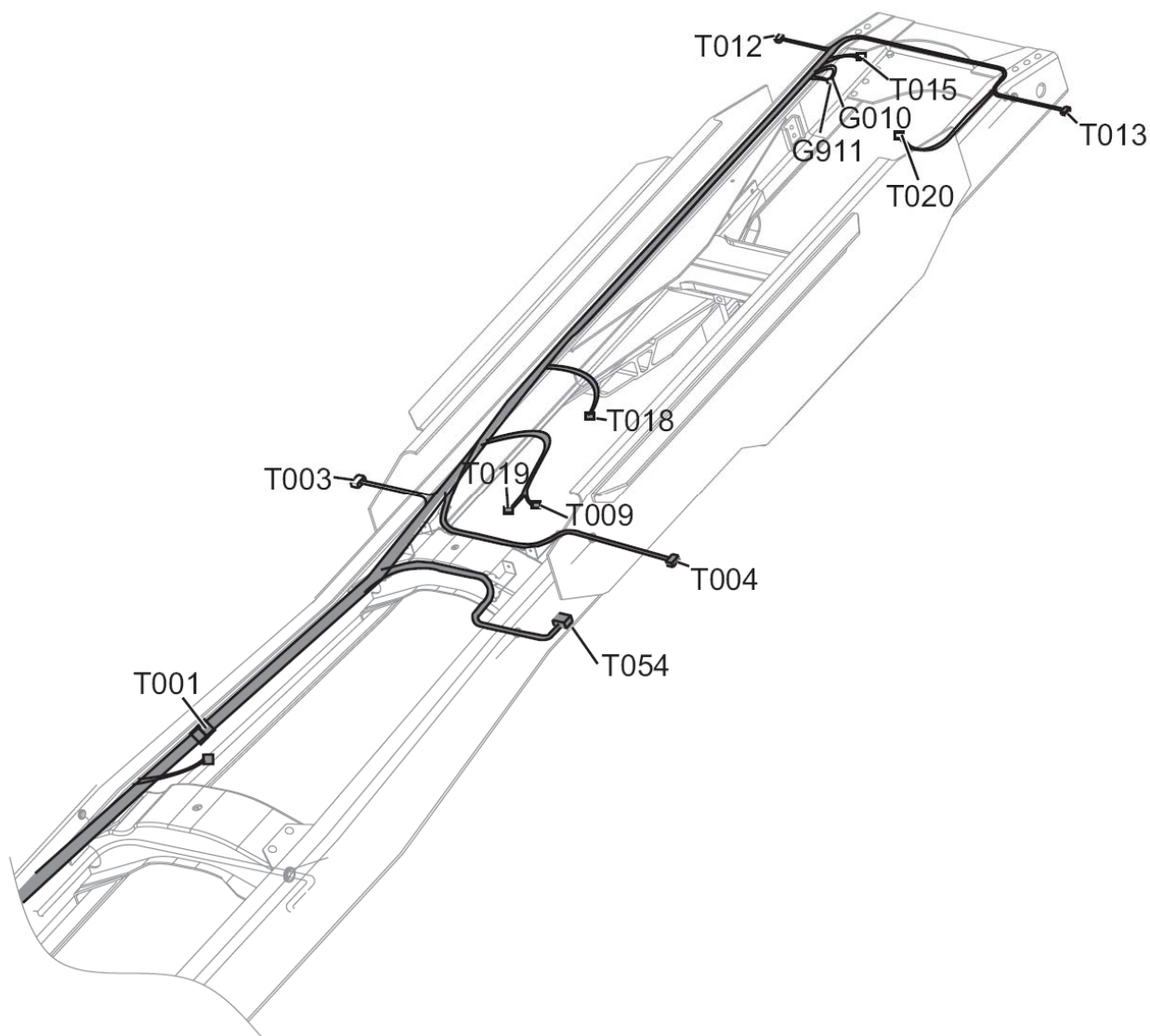
Fmwxw610303



1	F019	To tripper mechanism harness B
2	F021	To gearbox wire harness
3	F022	Shutdown solenoid valve
4	F023	Exhaust solenoid valve
5	F024	Wheels locking valve
6	F025	Bearing locking solenoid valve
7	F027	Fuel sensor

8	F028	To vehicle frame harness II
9	F034	To second pipe
10	F035	Turning liquid level alarm switch
11	F060	Trailer ABS A
12	G061	Trailer ABS B
13	G070	To reversing radar

61-88 CIRCUIT DIAGRAM-CONNECTOR POSITION OF WIRE HARNESS (LEFT HAND DRIVE)

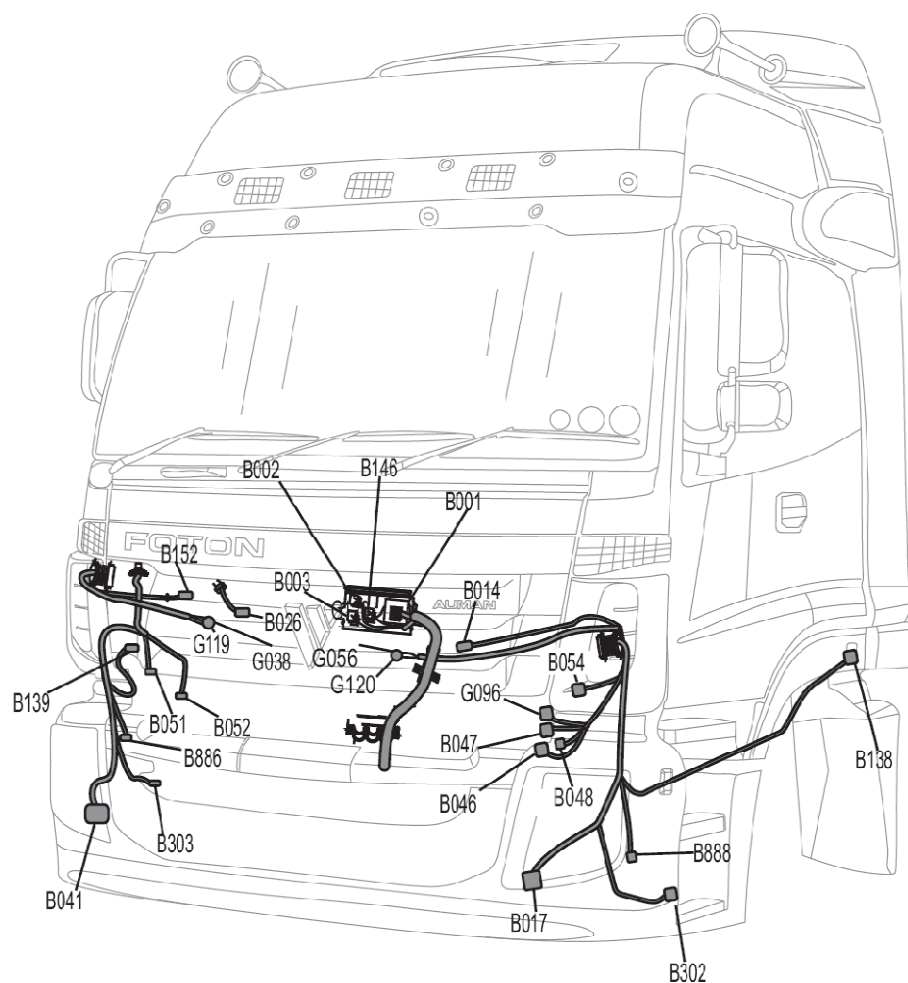


61

1	T001	To vehicle frame harness I
2	T003	Right front marker lamp
3	T004	Left front marker lamp
4	T009	Bearing locking switch (+)
5	T012	Right rear combination lamp
6	T013	Left rear combination lamp
7	T015	Reversing buzzer

8	T018	Wheels lockout switch
9	T019	Lock between shafts
10	T020	Wheels lockout switch (+)
11	T054	Dryer
12	G010	Underpan earth
13	G911	Underpan earth

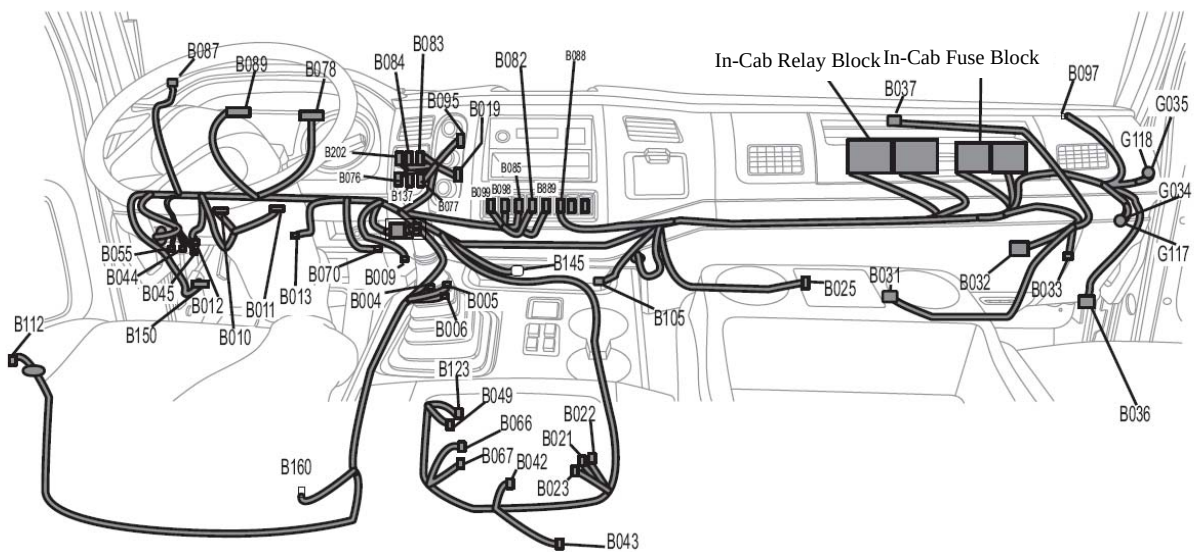
Fmwxxw610305



1	G120	Grounded 7
2	G056	Grounded 8
3	B014	To cold washer engine
4	B054	To parking indicator switch
5	G096	Front & rear axle baroceptor grounding
6	B047	To rear axle baroceptor
7	B046	To front axle baroceptor
8	B048	To stop lamp switch (main)
9	B152	To defrost sensor
10	G038	Grounded 5
11	G119	Grounded 6
12	B051	To cooling fan motor
13	B052	Pressure switch

14	B139	To right marker lamp
15	B001	To vehicle frame harness A
16	B138	To left marker light
17	B888	Left headlamp adjustment
18	B017	To left front combined lamp
19	B302	To left step lamp
20	B886	Right headlamp adjustment
21	B041	To right front combined lamp
22	B303	To right step lamp
23	B026	To wiper motor
24	B146	ABS interface
25	B003	To vehicle frame harness C
26	B002	To vehicle frame harness B

61-90 CIRCUIT DIAGRAM-CONNECTOR POSITION OF WIRE HARNESS (LEFT HAND DRIVE)

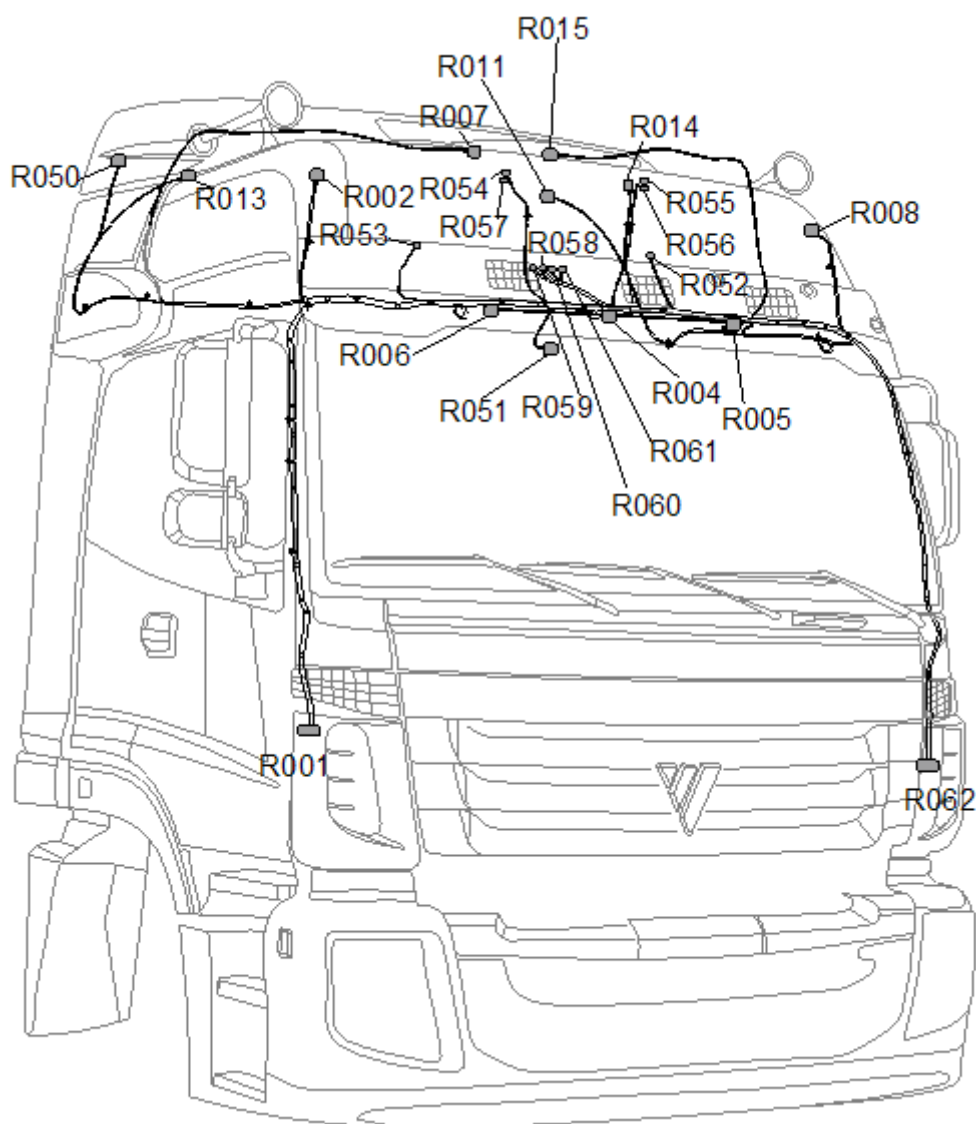


61

1	B087	To left loudspeaker
2	B089	To the instrument A
3	B078	To the instrument B
4	B077	To rear foglamp switch
5	B202	To indoor lamp switch
6	B083	To differential speed switch between wheels
7	B084	To differential speed switch between shafts
8	B095	To air condition operation controller
9	B019	To Radio
10	B088	To PTO dumper, tanker
11	B099	To electric horn changer
12	B098	To rear reversing lamp switch
13	B085	To ABS diagnosis switch
14	B082	To auxiliary box neutral power take-off switch
15	B076	To lighting controller
16	B889	To headlamp adjusting switch
17	B055	To preheating relay
18	B044	To preheating relay coil
19	B045	To preheating relay 30
20	B037	Suction air gate motor
21	B097	To right loudspeaker
22	G035	Grounded 3
23	G118	Grounded 4
24	G034	Grounded 1
25	G117	Grounded 2
26	B010	To combination switch B
27	B012	To clutch switch

28	B150	To ceiling harness
29	B011	To combination switch A
30	B036	To ceiling harness
31	B033	To air-blast motor
32	B032	To speed regulating module
33	B031	Hybrid air door motor
34	B025	Mode air door motor
35	B105	To reversing radar buzzer
36	B145	To ABS harness
37	B043	To preheating controller
38	B123	To dialer
39	B049	To brake lamp alarm controller
40	B066	To two-in-one controller I
41	B067	To two-in-one controller II
42	B042	Flame-out controller
43	B009	To acceleration switch
44	B023	To flasher III
45	B021	To flasher I
46	B022	To flasher II
47	B137	To auxiliary driving beam lamp switch
48	B005	To cigarette lighter (+)
49	B006	To cigarette lighter (-)
50	B004	To cigarette lighter illumination
51	B160	To safety belt pre-tighten switch
52	B112	To left door control switch
53	B070	To air horn solenoid valve 1
54	B013	To ignition switch

Fmwxxw610307



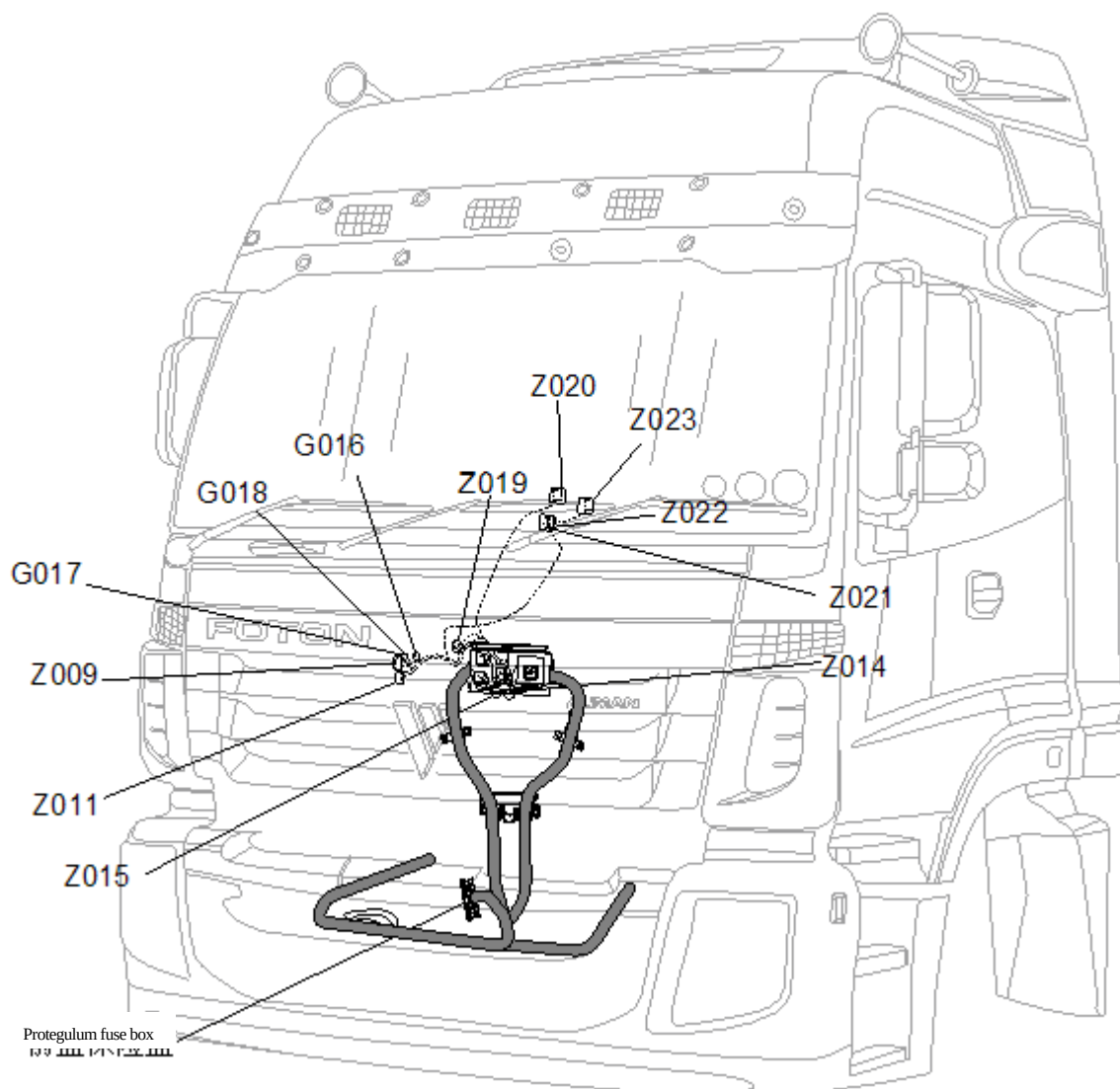
1	R008	Left height lamp
2	R052	Left box trigger switch
3	R061	Vehicle data recorder D
4	R060	Vehicle data recorder C
5	R059	Vehicle data recorder B
6	R058	Vehicle data recorder A
7	R005	Vehicle speed lamp B
8	R004	Vehicle speed lamp A
9	R006	Vehicle speed lamp C
10	R054	Right lamp box +
11	R057	Right lamp box -
12	R051	Reading lamp

13	R050	Right box trigger switch
14	R055	Left lamp box +
15	R056	Left lamp box -
16	R062	To vehicle body harness B
17	R015	Left indoor lamp
18	R014	Left berth lamp
19	R011	Left rear loudspeaker
20	R013	Right rear loudspeaker
21	R002	Right height lamp
22	R007	Right indoor lamp
23	R050	Right berth lamp
24	R001	To vehicle body harness A

Fmwxxw610308

**FOTON**

61-92 CIRCUIT DIAGRAM-CONNECTOR POSITION OF WIRE HARNESS (LEFT HAND DRIVE)

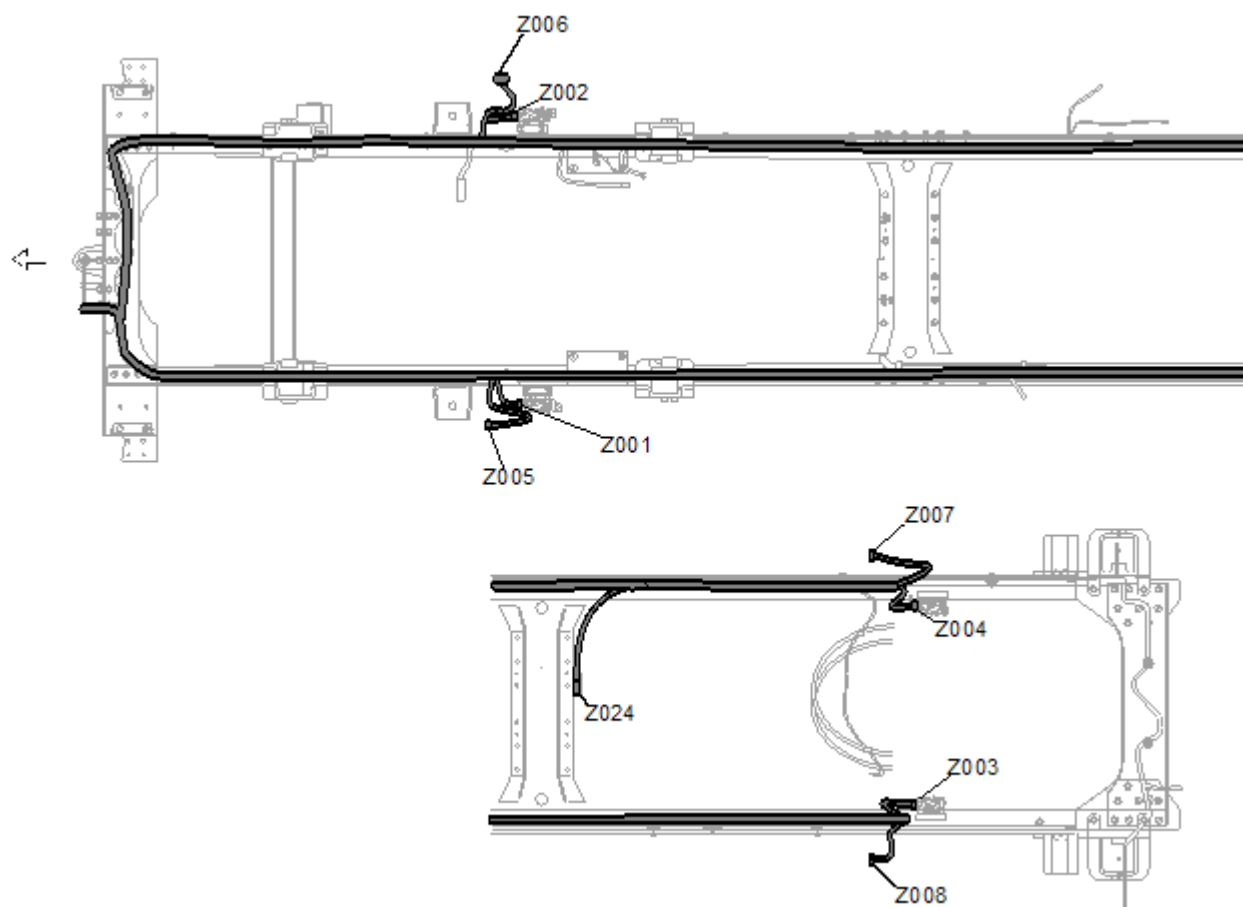


61

1	Z014	To ABS underpan harness
2	Z015	To ABS vehicle body harness
3	G017	Grounded
4	G018	Grounded
5	G019	Grounded
6	Z019	To ABS underpan harness

7	Z011	To ABS module 1
8	Z020	To TPM switch
9	Z021	Diagnosis interface
10	Z022	Diagnosis interface
11	Z023	Diagnosis interface
12	Z009	To ABS module 1

Fmwxxw610309

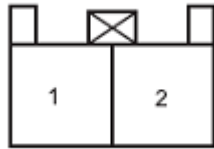


Z001	To left front ABS solenoid valve
Z002	To right front ABS solenoid valve
Z003	To left rear ABS solenoid valve
Z004	To right rear ABS solenoid valve
Z005	To left front ABS wheel speed sensor

Z006	To right front ABS wheel speed sensor
Z007	To left rear ABS wheel speed sensor
Z008	To right rear ABS wheel speed sensor
Z024	To ASR solenoid valve

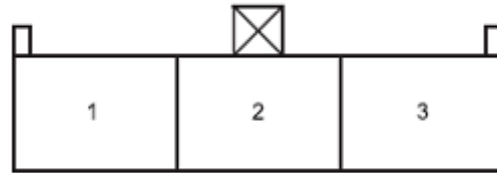
HARNESS CONNECTOR INFORMATION

B009 To acceleration switch



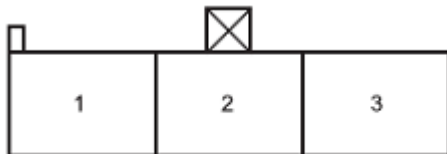
Stitch number	Wire color	Function	Remark
1	L-W	Acceleration switch (+)	
2	L-R	Acceleration switch (-)	

B889 headlamp regulating switch



Stitch number	Wire color	Function	Remark
1	R-Br		
2	Y	Signal gear of headlamp regulating switch	
3	W-B	Headlamp regulating switch grounded	

B076 To lighting controller



Stitch number	Wire color	Function	Remark
1	R-G	Illumination controller (L)	
2	G	Illumination lamp controller (B)	
3	W-B	Illumination controller grounded	

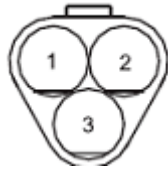
B137 To auxiliary driving beam lamp switch



Stitch number	Wire color	Function	Remark
1	R-G	Indicator lamp for auxiliary lamp work	
2	R	Auxiliary high beam lamp switch (L)	
3			Vacancy
4	R-Y	Auxiliary high beam lamp switch (B)	
5	W-B	Indicator lamp for auxiliary lamp work	
6			Vacancy
7	W-B	Auxiliary high beam lamp switch (E)	
8	R-G	Auxiliary high beam lamp switch (ILL+)	

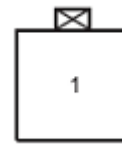
Fmwxw610310

B888 To left front headlamp adjustment



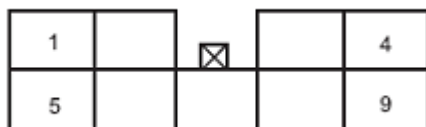
Stitch number	Wire color	Function	Remark
1	R-Br	The motor power supply for left headlamp adjusting	
2	Y	Left headlamp adjusting information	
3	W-B	Left headlamp adjusting motor grounded	

B045 Preheating relay30



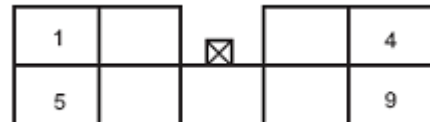
Stitch number	Wire color	Function	Remark
1	B-Y	Preheating relay (B)	

B025 Mode air door motor



Stitch number	Wire color	Function	Remark
1	Lg-B	Mode air door motor (+)	
2	Br-W	Air condition transfer switch	
3	Br-L	Air condition transfer switch	
4	Br-B	Air condition transfer switch	
5	P-L	Mode air door motor	
6	Br	Air condition transfer switch	
7	Br-Y	Air condition transfer switch	
8	Br-G	Air condition transfer switch	
9	P-B	Model air gate motor grounded	

B043 To preheating controller



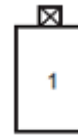
Stitch number	Wire color	Function	Remark
1	Y-R	Heater controller (T)	
2	B-Y	Heater controller (15)	
3	B-R	Heater controller (L)	
4	B-L	Heater controller (MV)	
5	W-L	Heater controller (J)	
6	W-B	Preheating controller grounded	
7	B-Y	heater controller (15)	
8	W-R	heater controller (D+)	
9	B-R	heater controller (50)	

B033 To air-blast motor



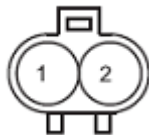
Stitch number	Wire color	Function	Remark
1	Lg-W	Air blower (-)	
2	Lg	Blower motor (+)	

B055 To preheating controller 87



Stitch number	Wire color	Function	Remark
1	B-R	Heater controller L	

B051 To cooling fan motor



Stitch number	Wire color	Function	Remark
1	L-W	Condenser fan motor (+)	
2	W-B	Condenser fan motor grounded	

B052 Pressure switch



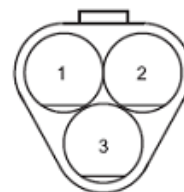
Stitch number	Wire color	Function	Remark
1	G-Y	Pressure switch (+)	
2	G-B	Pressure switch (-)	

B097 To right loudspeaker



Stitch number	Wire color	Function	Remark
1	G	Right front loudspeaker (+)	
2	G-W	Right front loudspeaker (-)	

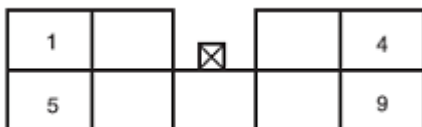
B139 To right marker lamp



Stitch number	Wire color	Function	Remark
1	G	Right marker lamp	
2	G-B	Right turn signal light	
3	W-B	Right turn signal light	

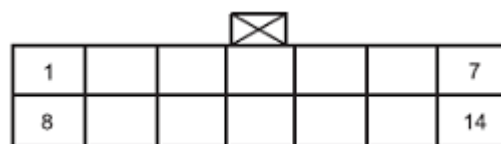
Fmwxxw610312

B042 To flameout controller



Stitch number	Wire color	Function	Remark
1	W-B	Flameout controller grounded	
2			Vacancy
3	L-B	Flame-out controller (OUT1)	
4	B-Y	Flame-out controller (OUT2)	
5	W-R	Flame-out controller (B)	
6			Vacancy
7	W	Flame-out controller (N)	
8	B-W	Flame-out controller (ST)	
9	L	Flame-out controller (IGN)	

B019 To Radio



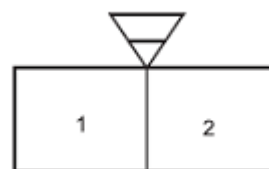
Stitch number	Wire color	Function	Remark
1			Vacancy
2	L	Radio(ACC)	
3			Vacancy
4			Vacancy
5	L	Radio B+	
6	L-W	Radio FL(-)	
7	L	Radio FL(+)	
8			Vacancy
9	W-B	Radio grounded	
10			Vacancy
11			Vacancy
12			Vacancy
13	G-W	Radio FR(-)	
14	G	Radio FR(+)	

B077 To rear foglamp switch



Stitch number	Wire color	Function	Remark
1	W-L	Rear fog lamp indicator lamp (L)	
2	Y-B	Rear fog lamp switch (L)	
3			Vacancy
4	R	Rear fog lamp switch (B)	
5	W-B	Indicating lamp for rear fog lamp work	
6			
7	W-B	Rear fog lamp switch	
8	R-G	Rear fog lamp switch	

B152 Defrosting sensor

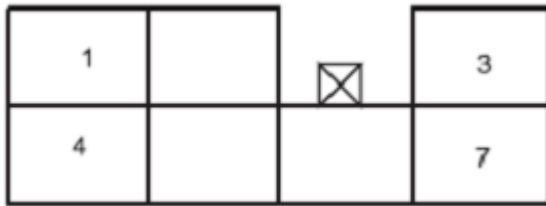


Stitch number	Wire color	Function	Remark
1	P-B	Defrost sensor grounded	
2	GR	Defrosting sensor (+)	

Fmwxw610313

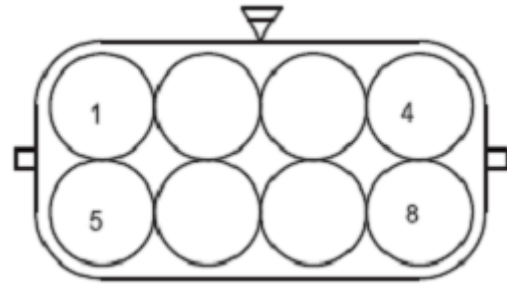


B031 To blending door motor



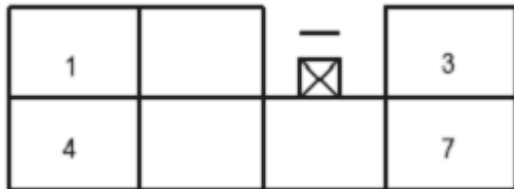
Stitch number	Wire color	Function	Remark
1			Vacancy
2	P-B	Blending micromotor sensor grounded (-)	
3	P	Blending micromotor power (5V+)	
4			Vacancy
5	G	Hybrid air door motor (+)	
6	L	Blending micromotor feedback signal	
7	Lg-W	Hybrid air door motor (-)	

B041 To right front combined lamp



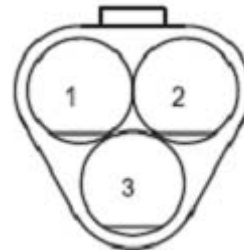
Stitch number	Wire color	Function	Remark
1	W-B	Right headlamp grounded	
2	W-B	Front left fog lamp (-)	
3	G	Right front broad beam lamp (+S)	
4	R-L	Front right fog lamp (+)	
5	R	Right auxiliary (+)	
6	G-Y	Front right turn lamp (+)	
7	R-L	Right low beam lamp (+)	
8	R-W	Right driving beam lamp (+)	

B037 To air inlet gate motor



Stitch number	Wire color	Function	Remark
1			Vacancy
2			Vacancy
3	V-Y	Air inlet internal recycle mode	
4	L	Suction air gate motor	
5			Vacancy
6	V-G	Air inlet external recycle mode	
7			Vacancy

B886 To right front headlamp adjustment



Stitch number	Wire color	Function	Remark
1	R-Br	Motor power supply for right headlamp adjustment	Vacancy
2	Y	Right headlamp adjustment information	
3	W-B	Right headlamp adjustment motor grounded	

Fmwx 610314

CIRCUIT DIAGRAM- HARNESS CONNECTOR INFORMATION

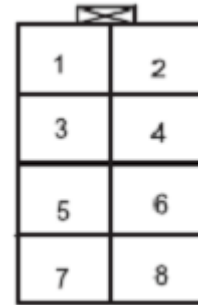
61-99

B088 To PTO dumper, tanker



Stitch number	Wire color	Function	Remark
1	B-R	PTO Working indicator lamp +	
2	W-B	PTO switch illumination grounded	
3			Vacancy
4	Lg	PTO switch (+)	
5	Lg	Power take-off indicator lamp (+)	
6			Vacancy
7	W-B	PTO switch illumination grounded	
8	R-G	PTO switch (ILL+)	

B099 To electric horn conversion



Stitch number	Wire color	Function	Remark
1			Vacancy
2	W-B	Electric-air change-over switch grounded	
3			Vacancy
4	Br-R	Electric-air change-over switch (B)	
5			Vacancy
6			Vacancy
7	W-B	Electric-air change-over switch illumination grounded	
8	R-G	Electric-air change-over switch (ILL+)	

B098 To rear reversing lamp switch



Stitch number	Wire color	Function	Remark
1	G	Indicator lamp for rear lamp	
2	G	Rear lamp switch (-)	
3			Vacancy
4	L-Y	Rear lamp switch (+)	
5	W-B	Indicator lamp for rear lamp -	
6			Vacancy
7	W-B	Rear lamp switch illumination grounded	
8	R-G	Rear lamp switch (ILL+)	

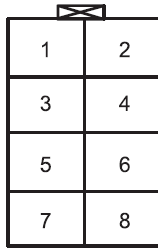
B085 TO ABS diagnosis switch



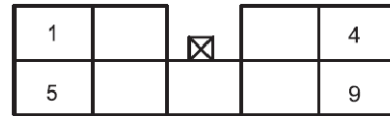
Stitch number	Wire color	Function	Remark
1			Vacancy
2	W-B		
3			Vacancy
4	P	ABS diagnosis switch	
5			Vacancy
6			Vacancy
7	W-B		
8	R-G	ABS diagnosis switch (ILL+)	

Fmwx 610315

B082 To auxiliary box neutral power take-off switch



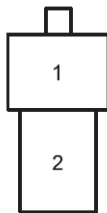
B145 To master vehicle ABS



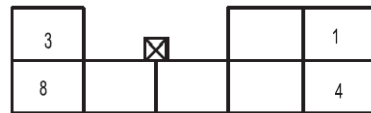
Stitch number	Wire color	Function	Remark
1			Vacancy
2	Lg-R	Auxiliary box neutral switch(-)	
3			Vacancy
4	L-B	Neutral gear power take off switch (+)	
5			Vacancy
6			Vacancy
7	W-B	Auxiliary box neutral switch illumination grounded	
8	R-G	Auxiliary box neutral power take-off (ILL+)	

Stitch number	Wire color	Function	Remark
1	B	ABS ECU (UB1)	
2			Vacancy
3	W-B	ABS central place	
4	B-Y	ABS ECU (B)	
5	B-Y	ABS ECU (WL)	
6			Vacancy
7	B-W	ABS Diagnosis interface (30)	
8	P	Master vehicle ABS interface	
9			Vacancy

B044 To preheating relay coil



B066 To two-in-one controller 1

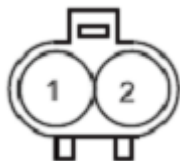


Stitch number	Wire color	Function	Remark
1	W-B	Preheating relay coil grounded	
2	W-L	Preheating relay (+S)	

Stitch number	Wire color	Function	Remark
1	R	Two-in-one controller rear fog lamp insurance (L)	
2			Vacancy
3	Y-B	Two-in-one controller rear fog lamp switch (L)	
4	L-W	Two-in-one controller lamp (L)	
5	Br		
6			Vacancy
7			Vacancy
8	R-L	Two-in-one controller rear fog lamp signal (FS)	

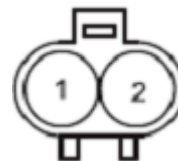
Fmwx 610316

B303 To right step lamp



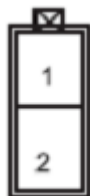
Stitch number	Wire color	Function	Remark
1	L-Y	Right step lamp (+)	
2	R-Y	Right step lamp (-)	

B302 To left step lamp



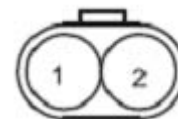
Stitch number	Wire color	Function	Remark
1	L-Y	Left step lamp (+)	
2	R-Y	Left step lamp (-)	

B002 To vehicle frame harness B



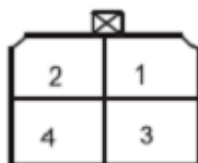
Stitch number	Wire color	Function	Remark
1	W-B	To frame harness grounded	
2	B-R	Preheating plug (+)	

B070 To air horn solenoid valve 1



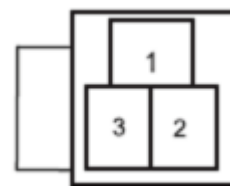
Stitch number	Wire color	Function	Remark
1	Br-W	Air horn solenoid valve (B)	
2	W-B	Air horn solenoid valve (L)	

B146 ABS interface



Stitch number	Wire color	Function	Remark
1	B-Y	ABS trailer 6-2	
2	B-L	Trailer ABS (WL)	
3			Vacancy
4	B-W	F/L1	

B003 To vehicle frame harness C

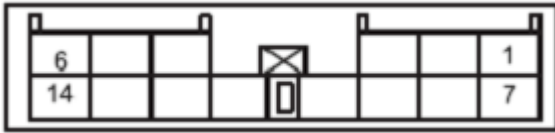


Stitch number	Wire color	Function	Remark
1	W	Main fuse F/L 1	
2	R	Main fuse F/L 2	
3	B-Y	Main fuse F/L 5	

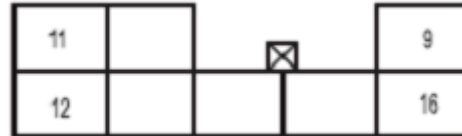
Fmwx 610317



B150 To ceiling harness



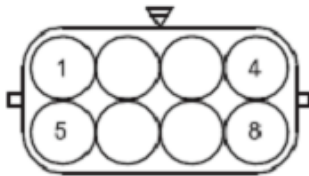
B067 To two-in-one controller 2



Stitch number	Wire color	Function	Remark
1	G-W	Vehicle travelling data recorder(1)	
2	G-B	Vehicle travelling data recorder(2)	
3	G-Y	Vehicle travelling data recorder(3)	
4	L	Vehicle travelling data recorder(4)	
5	R-W	Vehicle travelling data recorder(5)	
6	Gr	Roof wire harness connector	
7	R-G	Vehicle travelling data recorder (HL)	
8	B-W	Vehicle travelling data recorder (IG)	
9	R-L	Vehicle travelling data recorder(8)	
10	Gr-W	Vehicle travelling data recorder(9)	
11	G-R	Vehicle travelling data recorder (HORN)	
12	R-Y	Vehicle travelling data recorder (Door)	
13	L-R	Vehicle travelling data recorder (30)	
14	W-B	Vehicle travelling data recorder (12)	

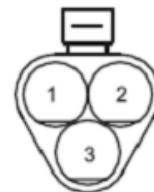
Stitch number	Wire color	Function	Remark
9	G	Two-one controller small lamp signal (C)	
10			Vacancy
11			Vacancy
12	W-B	Two-one controller grounded (-)	
13	R-Y	Two-one controller high beam lamp signal (HR)	
14			Vacancy
15	L-R	Two-one controller window wiper IG (B)	
16	R-B	Two-one controller low beam lamp signal (LH)	

B017 To left front combination lamp



Stitch number	Wire color	Function	Remark
1	W-B	Left front fog lamp grounded	
2	W-B	Left headlamp grounded	
3	G	Left front width lamp (+)	
4	R-L	Front left fog lamp (+)	
5	R-G	Left auxiliary high beam fuse (L)	
6	G-B	Front left turn lamp (+)	
7	R-B	Left low beam lamp (+)	
8	R-Y	Left high beam lamp (+)	

B138 To left marker lamp



Stitch number	Wire color	Function	Remark
1	G	Left marker lamp (+)	
2	G-B	Left marker lamp (+)	
3	W-B	Left marker lamp (E)	

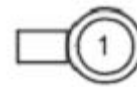
Fmwx 610318

B096 Front & rear axle baroceptor grounding



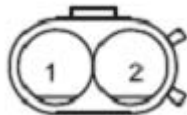
Stitch number	Wire color	Function	Remark
1	W-B	Front/ rear axle gas pressure sensor grounded	

B046 To front axle baroceptor



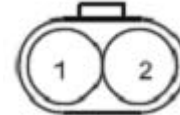
Stitch number	Wire color	Function	Remark
1	R	Front axle gas pressure sensor (+)	

B014 To cold washer engine



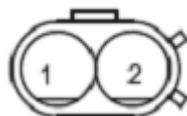
Stitch number	Wire color	Function	Remark
1	B-R	Washer motor (+)	
2	L-O	Washer motor (-)	

B054 To parking indicator switch



Stitch number	Wire color	Function	Remark
1	L-B	Parking switch (+)	
2	W-B	Hand brake switch grounded	

B048 To stop lamp switch



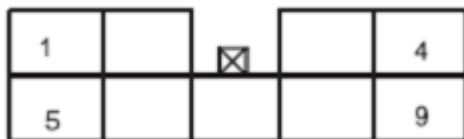
Stitch number	Wire color	Function	Remark
1	G-L	Stop lamp switch (+)	
2	W-B	Brake lamp grounded	

B047 To rear axle baroceptor



Stitch number	Wire color	Function	Remark
1	L	Rear axle gas pressure sensor (+)	

B010 To combination switch B



B013 To ignition switch



Stitch number	Wire color	Function	Remark
1	Br-Y	Combination switch high speed output (HI)	
2			Vacancy
3			Vacancy
4	Br-W	Combination switch low speed output (LO)	
5			Vacancy
6			Vacancy
7	L-R	Combined Switch INT	
8			Vacancy
9	W-B	Wiper switch grounded	

Stitch number	Wire color	Function	Remark
1	Br	Ignition switch (G)	
2	B-W	Ignition switch (S)	
3	W-R	Ignition switch (B1)	
4			Vacancy
5	L	Ignition switch (M1)	
6	L	Ignition switch (M2)	
7			Vacancy
8			Vacancy

B012 To clutch switch



B087 To left loudspeaker



Stitch number	Wire color	Function	Remark
1	L-R	Clutch switch (+)	
2	W-B	Clutch switch grounded	

Stitch number	Wire color	Function	Remark
1	L	Left front loudspeaker (+)	
2	L-W	Left front loudspeaker (-)	

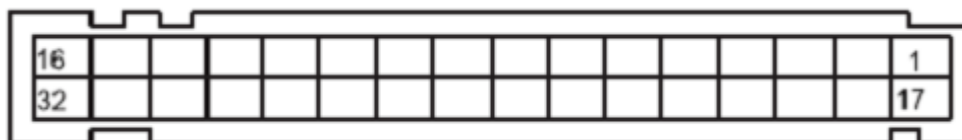
B089 To the instrument A



Stitch number	Wire color	Function	Remark
1			Vacancy
2	Y-L	Coolant level alarm for instrument	
3	Br	Instrument grounding	
4			Vacancy
5	Br	Instrument sensor grounded	
6			Vacancy
7			Vacancy
8	Y-B	Fuel pressure indicator lamp	
9			Vacancy
10	Gr	Engine tachometer input	
11	Y-R	Instrument power (+B)	
12	R-G	Instrument illumination input	
13	Y-B	Instrument power (IG)	
14			Vacancy
15			Vacancy
16	W-R	Charge indicator lamp	

Stitch number	Wire color	Function	Remark
17			Vacancy
18	L-B	Parking indicator lamp	
19			Vacancy
20			Vacancy
21	Y-R	Instrument fuel sensor input	
22	G-Y	Master vehicle turning indicator lamp	
23	Y-G	Instrument water temperature indication (+)	
24	G-B	Trailer turning indicator lamp	
25	R-Y	High beam indicator lamp	
26			Vacancy
27	Gr-W	Instrument vehicle speed signal	
28	G	Alarm indicator lamp for burnout of stop lamp	
29	R-L	Hazard alarm indicator lamp	
30	Gr	Alarm indicator lamp 12volts output	
31			Vacancy
32			Vacancy

B078 To the instrument B



Stitch number	Wire color	Function	Remark
1	B-R	Instrument preheating indication	
2	B	Safety belt prewarning (+)	
3			Vacancy
4	L	Rear axle gas pressure meter	
5	R	Front axle gas pressure meter	
6			
7	R-L	Front fog lamp indicator lamp	
8			Vacancy
9			Vacancy
10	R-B	Passing beam indicator lamp	
11			Vacancy
12	L-Y	Exhaust brake indicator lamp	
13	B-W	CAB lock alarm indicator lamp	
14	W	Low gear indicator lamp	
15			Vacancy
16	B-Y	Instrument (ABS indicator lamp)	

Stitch number	Wire color	Function	Remark
17	B-L	Instrument indicator for air filter blocking alarm	
18	R-Y	Door control instrument indicator lamp	
19	B-L	Trailer ABS diagnosis lamp	
20	P	ASR failure alarm lamp	
21	G-W	Instrument speed 20km/hr	
22	G-R	Instrument speed 60km/hr	
23	G-Y	Instrument speed 40km/hr	
24	Lg	Power take-off indicator lamp (+)	
25			Vacancy
26			Vacancy
27			Vacancy
28			Vacancy
29			Vacancy
30			Vacancy
31			Vacancy
32			Vacancy

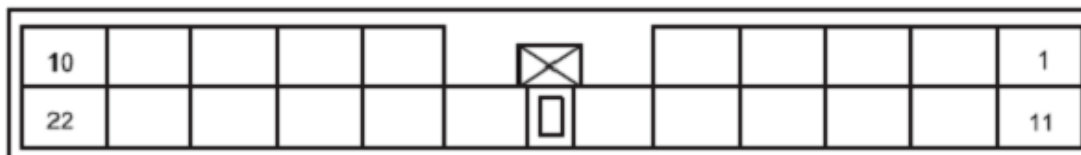
B011 To combination switch A



Stitch number	Wire color	Function	Remark
1	G-R	Horn switch	
2			Vacancy
3			Vacancy
4	L-O	Steering switch (TR)	
5	L-B	Steering switch (TL)	
6			Vacancy
7	R-G	Combination switch (Low beam)	
8	R-W	Combination switch (High beam)	
9	G-W	Tail lamp switch	
10	W-B	Headlamp switch grounded	
11	L	Intermittent controller (11)	

Stitch number	Wire color	Function	Remark
12	L-O	Wiper switch(W)	
13			Vacancy
14			Vacancy
15			Vacancy
16			Vacancy
17	L-P	Exhaust brake switch (+)	
18	L-W	Exhaust brake switch (-)	
19			Vacancy
20	R-L	Hazard alarm switch HZ (ON)	
21	L-O	Steering switch (E1)	
22	L	Front fog light switch (+)	

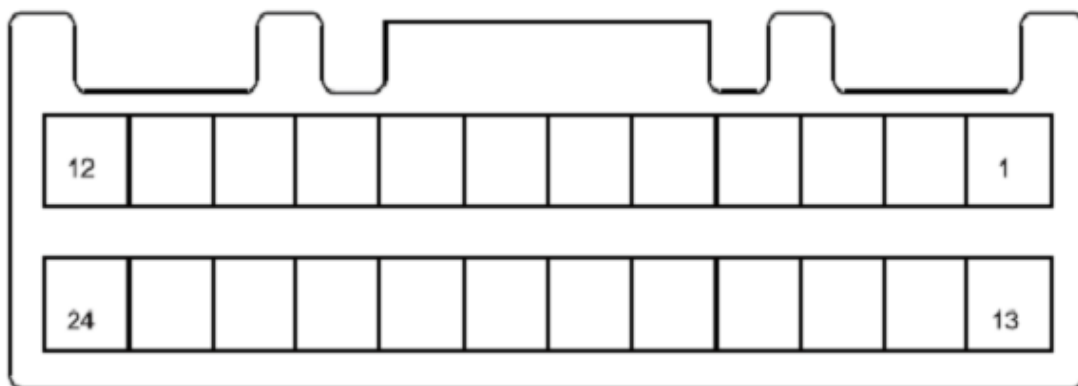
B036 To ceiling harness



Stitch number	Wire color	Function	Remark
1			Vacancy
2			Vacancy
3			Vacancy
4			Vacancy
5			Vacancy
6			Vacancy
7			Vacancy
8			Vacancy
9	G	Left height lamp (+)	
10	R-Y	Indoor lamp (-)	
11	W-B	Ceiling harness grounded	

Stitch number	Wire color	Function	Remark
12			Vacancy
13			Vacancy
14	R-G	Bearing locking switch (ILL+)	
15			Vacancy
16			Vacancy
17			Vacancy
18			Vacancy
19	L-W	Vehicle speed lamp C	
20	L-B	Vehicle speed lamp B	
21	L-W	Vehicle speed lamp A	
22	L-Y	Indoor lamp (+)	

B095 To air condition mode switch



Stitch number	Wire color	Function	Remark	Stitch number	Wire color	Function	Remark
1	B-Y	Air condition mode switch (1)		13	P-L	Air condition mode switch (13)	
2	R-G	Air condition operating controller (2lighting units)		14	Br-B	Air condition mode switch (14)	
3	L	Air condition mode switch (3power supplies)		15	Br-L	Air condition mode switch (15)	
4	V-Y	Air condition mode switch (4)		16	Br-G	Air condition mode switch (16)	
5	Gr	Air condition mode switch (5)		17	Br-Y	Air condition mode switch (17)	
6	V-G	Air condition mode switch (6)		18	Br-W	Air condition mode switch (18)	
7	G	Air condition mode switch (7)		19	Br	Air condition mode switch (19)	
8	Lg-W	Air condition mode switch (8)		20	L-B	Air condition mode switch (20)	
9	P	Air condition mode switch (9)		21	Lg-W	Air condition mode switch (21)	
10	P-B	Air condition mode switch (10)		22	W-B	Air condition operating controller (E)	
11	L	Air condition mode switch (11)		23			Vacancy
12	Lg-B	Air condition mode switch (12)		24			Vacancy

G038 Grounded 5



Stitch number	Wire color	Function	Remark
1	W-B	5# main harness of vehicle body grounding	

G119 Grounded 6



Stitch number	Wire color	Function	Remark
1	W-B	6# main harness of vehicle body grounding	

G120 Grounded 7



Stitch number	Wire color	Function	Remark
1	W-B	7# main harness of vehicle body grounding	

G056 Grounded 8



Stitch number	Wire color	Function	Remark
1	W-B	8# main harness of vehicle body grounding	

G034 Grounded 1



Stitch number	Wire color	Function	Remark
1	W-B	1# main harness of vehicle body grounding	

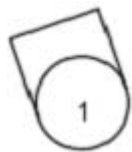
G118 Grounded 4



Stitch number	Wire color	Function	Remark
1	W-B	4# main harness of vehicle body grounding	

Fmwx 610326

G035 Grounded 3



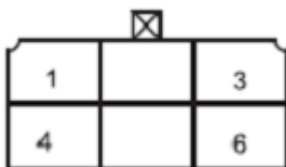
Stitch number	Wire color	Function	Remark
1	W-B	3# main harness of vehicle body grounding	

G117 Grounded 2



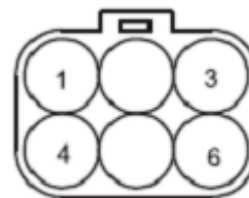
Stitch number	Wire color	Function	Remark
1	W-B	2# main harness of vehicle body grounding	

B032 To speed regulating module



Stitch number	Wire color	Function	Remark
1	Lg-W	Speed regulation module (B)	
2			Vacancy
3	L-Y	Air blower feedback signal	
4	W-B	Speed regulation module grounded	
5			Vacancy
6	L-B	Air blower speed adjusting signal	

B026 To wiper motor



Stitch number	Wire color	Function	Remark
1	W-B	Wiper motor grounded	
2	Br-W	Wiper motor (LO)	
3	Br-Y	Wiper motor (HI)	
4	L-R	Wiper motor (+)	
5	L-R	Wiper motor	
6			blocking

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B105 To reversing radar buzzer



Stitch number	Wire color	Function	Remark
1	R-G	Reversing radar buzzer (B)	
2	R-B	Reversing radar buzzer (L)	

B021 To flasher 1



Stitch number	Wire color	Function	Remark
1	W-B	Flasher grounded	

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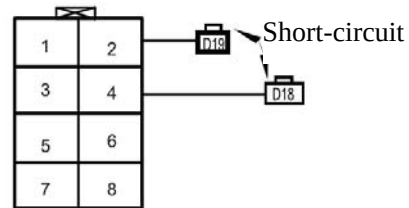
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B005 To cigarette lighter (+)



Stitch number	Wire color	Function	Remark
1	G-O	Cigarette lighter (+)	

B202 To indoor lamp switch



Stitch number	Wire color	Function	Remark
1			Vacancy
2	R-Y	Indoor lamp switch (-)	
3			Vacancy
4	R-Y	Indoor lamp switch	
5			Vacancy
6	W-B	Indoor lamp switch grounded	
7	W-B	Indoor lamp switch illumination (-)	
8	R-G	Indoor lamp switch (ILL+)	

B083 To differential speed switch between wheels



Stitch number	Wire color	Function	Remark
1	B-R	Indicator lamp between wheels (+)	
2	W-R	Wheels lockout switch (+)	
3			Vacancy
4	G	Differential speed switch between wheels (+)	
5	Br-Y	Lock indicator lamp between wheels	
6			Vacancy
7	W-B	Lock switch illumination between wheels grounded	
8	R-G	Wheels lockout switch (ILL+)	

B084 To differential speed switch between shafts



Stitch number	Wire color	Function	Remark
1	B-R	Indicator lamp between shafts (+)	
2	R-W	Bearing locking switch (-)	
3			Vacancy
4	G	Bearing locking switch (B)	
5	Br-W	Lock solenoid valve switch between shafts (+)	
6			Vacancy
7	W-B	Lock switch illumination between shafts grounded	
8	R-G	Bearing locking switch (ILL+)	

Fmwx 610328

B006 To cigarette lighter (-)



Stitch number	Wire color	Function	Remark
1	W-B	Cigarette lighter grounded	

B004 To cigarette lighter illumination



Stitch number	Wire color	Function	Remark
1	W-B	Cigarette lighter illumination grounded	
2	G	Cigarette lighter illumination (+)	

B160 To safety belt pre-tighten switch



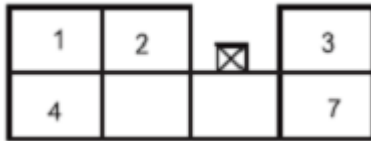
Stitch number	Wire color	Function	Remark
1	W-B	Safety belt pretightening (-)	
2	B	Safety belt pretightening (L)	

B112 To left door control switch



Stitch number	Wire color	Function	Remark
1	R-Y	Door control switch	

B123 To dialer



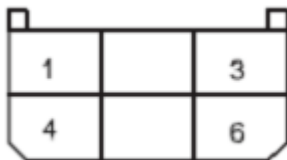
Stitch number	Wire color	Function	Remark
1	Gr	Instrument adjusting card (1)	
2	Gr	Instrument adjusting card (2)	
3			Vacancy
4	L	Instrument adjusting card (4)	
5	W-B	Instrument adjusting card (5)	
6	Gr-W	Instrument adjusting card (6)	
7	Gr-W	Instrument adjusting card (7)	

B023 To flasher 3



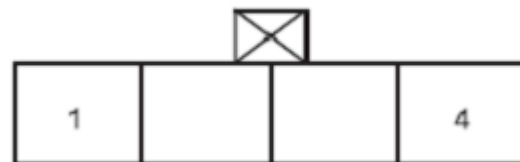
Stitch number	Wire color	Function	Remark
1	L-B	Flasher (L)	
2	G-Y	Flasher (K2)	
3	G-L	Flasher (54R)	
4	G-R	Flasher (54L)	

B022 To flasher 2



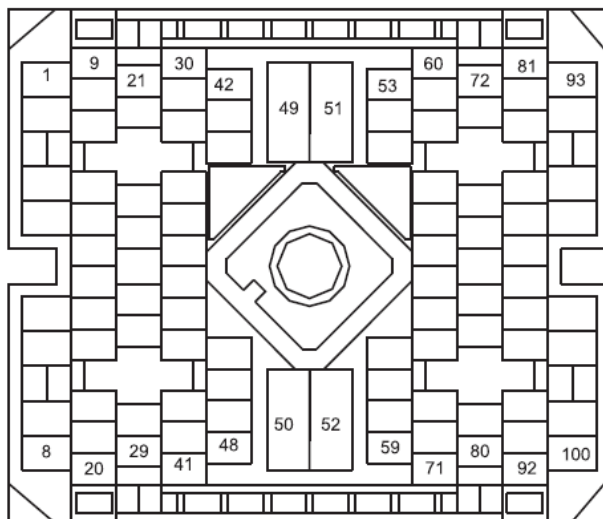
Stitch number	Wire color	Function	Remark
1	G-B	Flasher (K1)	
2	L-O	Flasher turn signal source	
3	G	Flasher (15)	
4	G-B	Flasher (LL)	
5	G-Y	Flasher (RL)	
6	L-O	Flasher (B)	

B049 Brake lamp alarm controller



Stitch number	Wire color	Function	Remark
1	G/W	Brake lamp alarm controller (B)	
2	G/W	Brake alarm controller (L)	
3	G	Brake alarm controller (G)	
4	W-B	Brake lamp alarm controller grounded	

B001 To vehicle frame harness A

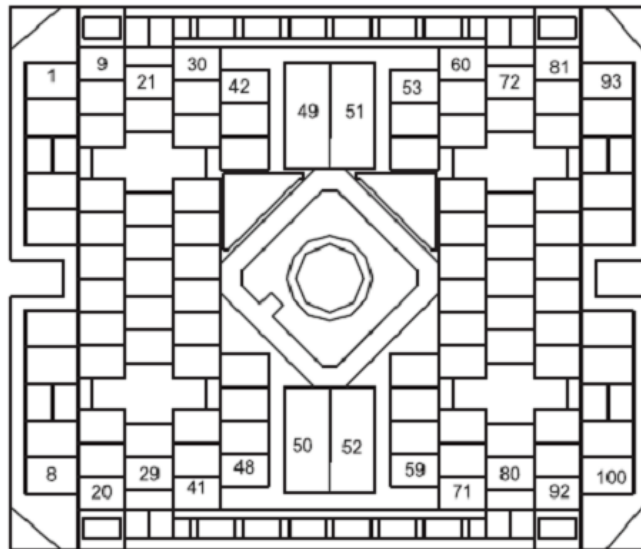


Stitch number	Wire color	Function	Remark
1	B-W	Neutral position switch (+)	
2	L	Auxiliary starter switch (+)	
3	B-R	Neutral position switch (-)	
4	B-O	Starter relay (+S)	
5	L-W	Rear fog lamp (+)	
6	G-R	Left rear trailer turn light (+)	
7	G-L	Right rear trailer turn light (+)	
8	W	Generator (N)	
9	W-R	Wheels locking valve (+)	
10	R-W	Bearing locking solenoid valve (+)	
11			Vacancy
12	Br-W	Switch lock indicator lamp between shafts	
13	Br-Y	Lock solenoid valve switch between shafts (+)	
14			Vacancy
15			Vacancy
16			Vacancy
17	Y-G	Dryer (+)	
18			Vacancy
19			Vacancy
20	R	Reversing lamp switch (+)	
21	R	Cab lock switch (+)	
22			Vacancy
23			Vacancy
24			Vacancy
25			Vacancy

Stitch number	Wire color	Function	Remark
26			Vacancy
27			Vacancy
28			Vacancy
29			Vacancy
30	G	PTo solenoid valve (+)	
31	G-R	Buzzer (+)	
32	L-Y	Exhaust brake solenoid valve (+)	
33	W-L		
34			Vacancy
35			Vacancy
36			Vacancy
37	R-G	Reversing radar control box (L)	
38	R-B	Reversing radar control box (B)	
39			Vacancy
40			Vacancy
41			Vacancy
42	Y		
43	B		
44			Vacancy
45			Vacancy
46			Vacancy
47			Vacancy
48			Vacancy
49	G	Rear lamp (+)	
50	W	Battery switch (+)	

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B001 To vehicle frame harness A



Stitch number	Wire color	Function	Remark	Stitch number	Wire color	Function	Remark
51	G	Main fuse F/L6		76			Vacancy
52	B-L	Preheating solenoid valve (+)		77			Vacancy
53			Vacancy	78			Vacancy
54			Vacancy	79			Vacancy
55			Vacancy	80			Vacancy
56			Vacancy	81	W-R	Generator (D+)	
57			Vacancy	82	Y-B	Engine oil pressure sensor (+)	
58			Vacancy	83	B-L	Air filter blocking alarm switch (+)	
59	W-B	Frame ground		84	Y-G	Water temperature sensor (+)	
60	W	Gear switch (+)		85	Gr	Generator (W)	
61	Y-L	Water temperature alarm switch (+)		86	G-Y	Right rear turn signal lamp (+)	
62	Y-R	Fuel sensor (+)		87	G-B	Left rear turn signal lamp (+)	
63	B-W	CAB lock switch (+)		88			Vacancy
64			Vacancy	89			Vacancy
65			Vacancy	90			Vacancy
66			Vacancy	91			Vacancy
67	Lg	Neutral position switch (+)		92			Vacancy
68	Lg-R	Neutral position solenoid valve (+)		93	G-W	Low tone horn (+)	
69			Vacancy	94	R-L	Reverse lamp (+)	
70			Vacancy	95	G-B	Air condition actuator motor (+)	
71			Vacancy	96	W-B	Frame harness grounded	
72	Gr-W	To vehicle speed sensor (SI)		97	G	Rear marker lamp (+)	
73	Gr	To vehicle speed sensor (SE)		98	L-B	Shutdown solenoid valve (+)	
74	W-B	Power take-off indicator lamp grounded		99	Y-R	Preheating water temperature sensor (+)	
75			Vacancy	100	G-W	Master vehicle turning indicator lamp	

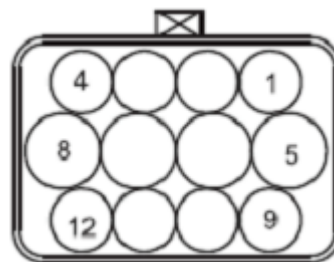
Fmwx 610332

E014 Preheating solenoid valve



Stitch number	Wire color	Function	Remark
1	B-L	Preheating solenoid valve +	

E001 To vehicle frame harness A



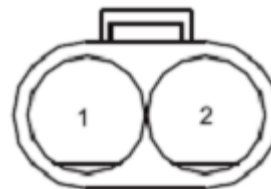
Stitch number	Wire color	Function	Remark
1	W-R	Charge indicator	
2	G-Y	Water temperature instrument alarm	
3	Y-G	Water temperature sensor (+)	
4	Y-B	Engine oil pressure instrument indication	
5	W	Flame-out controller (D+)	
6	G-W	Pressure switch (-)	
7	B-Y	Engine oil pressure instrument alarm	
8	B-L	Heater controller (MV)	
9			blocking
10			blocking
11	Y-R	Heater controller (T)	
12	BR	Engine tachometer input	

E009 To compressor



Stitch number	Wire color	Function	Remark
1	G-W	Compressor (+)	

E007 Engine oil pressure sensor



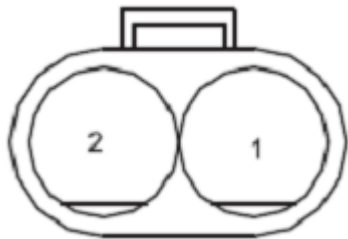
Stitch number	Wire color	Function	Remark
1	B-Y	Engine oil pressure sensor switch	
2	Y-B	Engine oil pressure sensor (+)	

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E011 To water temperature alarm switch



Stitch number	Wire color	Function	Remark
1	G-Y	Water temperature sensor switch	
2	Y-G	Instrument water temperature indication	

E005 To generator (D+)



Stitch number	Wire color	Function	Remark
1	W-R	Generator (D+)	

E004 To generator (N)



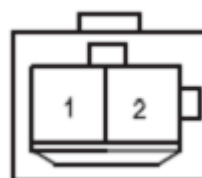
Stitch number	Wire color	Function	Remark
1	BR	Generator (N)	

E003 To generator (+B)



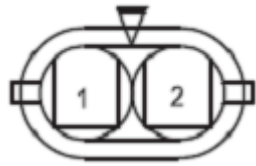
Stitch number	Wire color	Function	Remark
1	W	Generator (B+)	

R008 To left height lamp



Stitch number	Wire color	Function	Remark
1	G	Left height lamp (+)	
2	W-B	Left height lamp (-)	

E002 To vehicle frame harness B



Stitch number	Wire color	Function	Remark
1	B-R	Preheating relay (L)	
2	W	Master fuse (L)	

E012 Preheating temperature sensor



Stitch number	Wire color	Function	Remark
1	Y-R	Preheating temperature sensor (+)	

E013 Preheating plug I



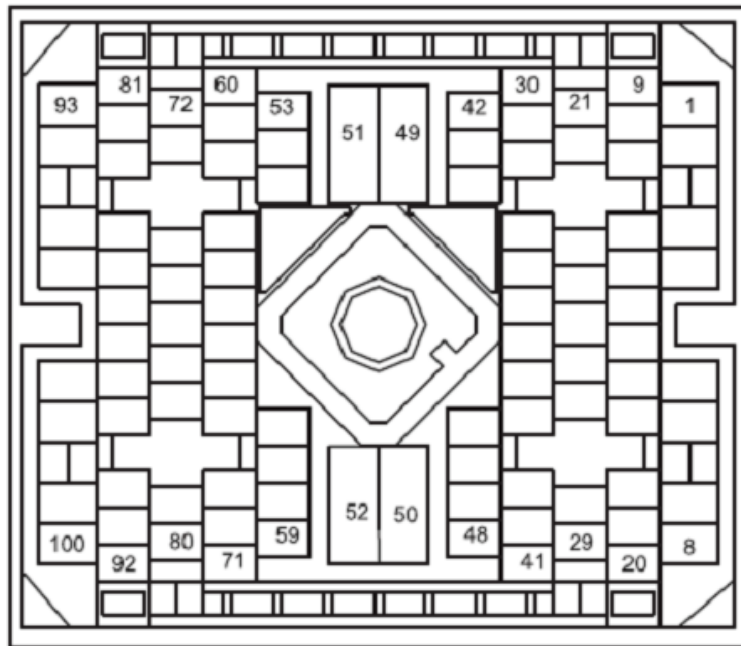
Stitch number	Wire color	Function	Remark
1	B-R	Preheating plug I (+)	

E015 Preheating plug II



Stitch number	Wire color	Function	Remark
1	B-R	Preheating plug II (+)	

F001 To vehicle frame harness A



Stitch number	Wire color	Function	Remark
1	B-W	Ignition switch	
2	L	Ignition switch	
3	B-R	Starter protecting relay (B)	
4	B-O	Starter protecting relay (L)	
5	L-W	Rear fog lamp switch (L)	
6	G-R	Turning flasher (54L)	
7	G-L	Turning flasher (54R)	
8	W	Flame-out controller (N)	
9	W-R	Wheels lockout switch (-)	
10	R-W	Bearing locking switch (-)	
11			Vacancy
12	Br-W	Lock indication between shafts	
13	Br-Y	Lock indication between wheels	
14	Y-G	Turning liquid level alarm indication	
15			Vacancy
16			Vacancy
17	Y-G	Wiper motor fuse (L)	
18			Vacancy
19			Vacancy
20	R	Backup lamp relay (-S)	
21	R	Brake light fuse	
22			Vacancy
23			Vacancy
24			Vacancy
25			Vacancy

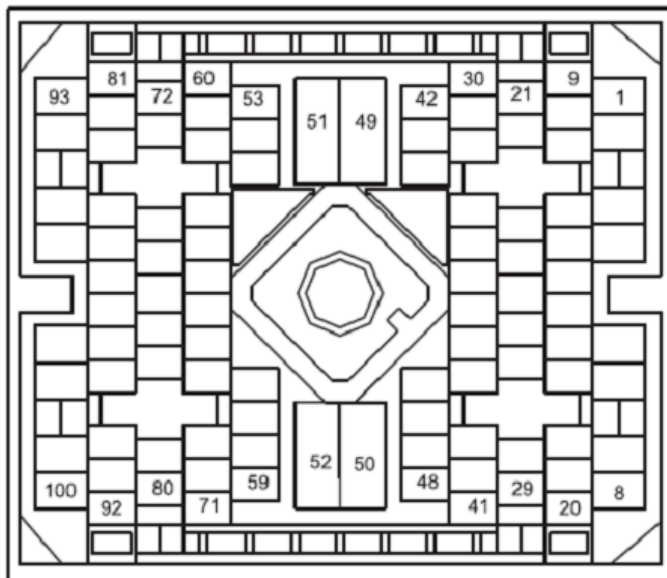
Stitch number	Wire color	Function	Remark
26			Vacancy
27			Vacancy
28			Vacancy
29			Vacancy
30			Vacancy
31			Vacancy
32	L-Y	Exhaust brake relay (L)	
33			Vacancy
34			Vacancy
35			Vacancy
36			Vacancy
37	R-G	Reversing radar buzzer (B)	
38	R-B	Reversing radar buzzer (L)	
39			Vacancy
40			Vacancy
41			Vacancy
42			Vacancy
43			Vacancy
44			Vacancy
45			Vacancy
46			Vacancy
47			Vacancy
48			Vacancy
49	G	Rear lamp switch (L)	
50	W	Memory fuse (B)	

Fmw 610336

CIRCUIT DIAGRAM- HARNESS CONNECTOR INFORMATION

61-121

F001 To vehicle frame harness A



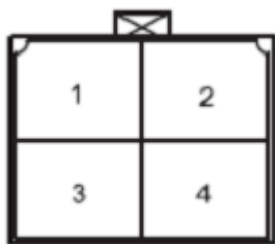
Stitch number	Wire color	Function	Remark	Stitch number	Wire color	Function	Remark
51	G	Air conditioner fuse R/B		76			Vacancy
52	B-L	Heater controller (MV)		77			Vacancy
53				78			Vacancy
54				79			Vacancy
55				80			Vacancy
56				81	W-R	Instrument charging indication	
57				82	Y-B	Engine oil pressure instrument indication	
58				83	B-L	Air filter blocking alarm indication	
59	W-B	Instrument signal (E) grounded		84	Y-G	Instrument water temperature indication	
60	W	Low gear indicator lamp		85	GR	Engine tachometer input	
61	Y-L	Instrument water level alarm		86	G-Y	Turning flasher (RL)	
62	Y-R	Fuel sensor (+)		87	G-B	Turning flasher (LL)	
63	B-W	Instrument CAB lock alarm lamp		88			Vacancy
64			Vacancy	89			Vacancy
65			Vacancy	90			Vacancy
66			Vacancy	91			Vacancy
67			Vacancy	92			Vacancy
68			Vacancy	93	G-W	Horn relay (L)	
69			Vacancy	94	R-L	Reversing relay (-S)	
70			Vacancy	95	G-W	Pressure switch (-)	
71			Vacancy	96	W-B	Instrument sensor grounding (1)	
72	Gr-W	Instrument vehicle speed signal		97	G	Tail lamp relay (L)	
73	Gr	Instrument 12V output		98	L-B	Shutdown relay (OUT1)	
74			Vacancy	99	Y-R	Heater controller (T)	
75			Vacancy	100	G-W	Brake lamp controller	

Fmwx 610337



FOTON

F063 To lifting switch



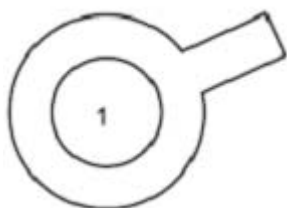
Stitch number	Wire color	Function	Remark
1	B-O	Trailer ABS 15A fuse (B)	
2	B-L	Trailer ABS warning lamp	
3			
4	B-W	Trailer ABS socket	

F058 To high tone horn



Stitch number	Wire color	Function	Remark
1	W-B	Low tone horn (L)	
2	G-W	Low tone horn (B)	

G011 underpan grounding A



Stitch number	Wire color	Function	Remark
1	W-B	Frame 1 electric ground	

G062 underpan grounding C



Stitch number	Wire color	Function	Remark
1	W-B	1# underpan grounding C	

G012 underpan grounding



Stitch number	Wire color	Function	Remark
1	W-B	Frame 1 electric ground	

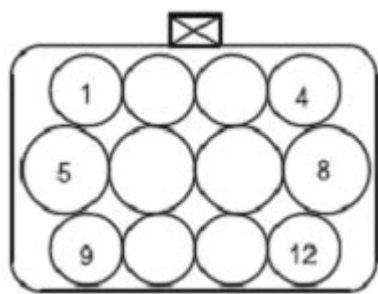
F016 Electromagnetic clutch of starter



Stitch number	Wire color	Function	Remark
1	B-W	Starter (+)	

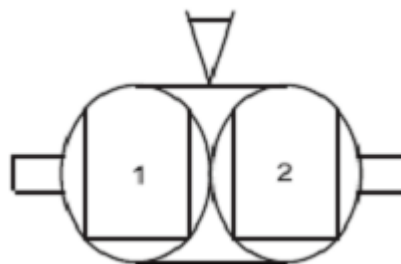
Fmwx 610338

F009 To engine harness B



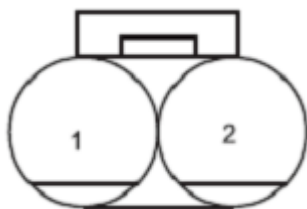
Stitch number	Wire color	Function	Remark
1	W-R	Generator (D+)	
2			blocking
3	Y-G	Water temperature sensor (+)	
4	Y-B	Engine oil pressure sensor (+)	
5	W	Generator (N)	
6	G-W	Compressor	
7	W-B	Engine oil pressure sensor (E)	
8	B-L	Preheating solenoid valve (+)	
9	L-B	Shutdown solenoid valve	
10	W-B	Shutdown solenoid valve (+)	
11	Y-R	Preheating temperature sensor (+)	
12	Gr	Generator (W)	

F008 To engine harness A



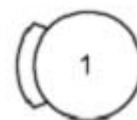
Stitch number	Wire color	Function	Remark
1	W	Generator (B+)	
2	B-R	Preheating plug (+)	

F006 To starting relay coil



Stitch number	Wire color	Function	Remark
1	B-O	Starter relay (+S)	
2	G	Starter relay (-S)	

F017 To memory power supply



Stitch number	Wire color	Function	Remark
1	W	Main power switch (+)	

Fmwx 610339

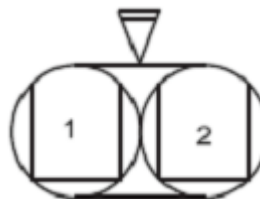


F015 To starter (B)



Stitch number	Wire color	Function	Remark
1	R	Battery (+)	

F035 To turning level alarm switch



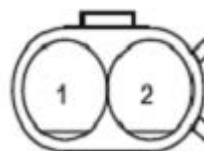
Stitch number	Wire color	Function	Remark
1	Y-G	Turning liquid level alarm switch (+)	
2	W-B	Turning liquid level alarm switch (-)	

F034 To diode



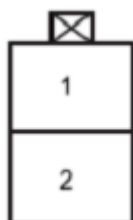
Stitch number	Wire color	Function	Remark
1	W-B	Diode positive	
2	L-Y	Diode grounded	

F070 To reversing radar



Stitch number	Wire color	Function	Remark
1	R-G	Reversing radar control box (L)	
2	R-B	Reversing radar control box (B)	

F002 To vehicle body harness B



Stitch number	Wire color	Function	Remark
1	W-B	Body ground	
2	B-R	Preheating relay	

F003 To vehicle body harness C



Stitch number	Wire color	Function	Remark
1	W	Ignition switch R/B	
2	R	Headlamp relay (B)	
3	B-Y	Preheating relay (B)	

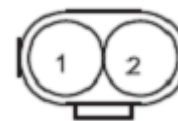
FmwX 610340

F016 To electromagnetic clutch of starter



Stitch number	Wire color	Function	Remark
1	B-W	Starter (+)	

F022 To shutdown solenoid valve



Stitch number	Wire color	Function	Remark
1	L-W	Shutdown solenoid valve (+)	
2	W-B	Shutdown solenoid valve (-)	

F004 To starting relay (B)



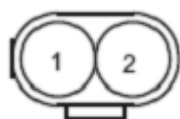
Stitch number	Wire color	Function	Remark
1	W	Starting relay (B)	

F005 To starting relay (L)



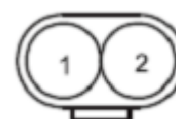
Stitch number	Wire color	Function	Remark
1	B-W	Starting relay (L)	

F024 To lock solenoid valve between wheels



Stitch number	Wire color	Function	Remark
1	W-R	Wheels locking valve (+)	
2	W-B	Wheels locking valve (-)	

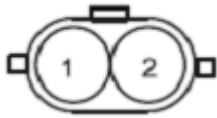
F025 To lock solenoid valve between shafts



Stitch number	Wire color	Function	Remark
1	R-W	Bearing locking solenoid valve (+)	
2	W-B	Bearing locking solenoid valve (-)	

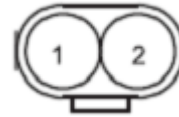
Fmwx 610341

F027 To fuel sensor



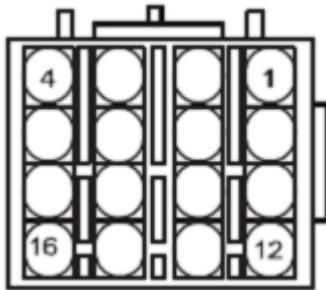
Stitch number	Wire color	Function	Remark
1	W-B	Fuel sensor (E)	
2	Y-B	Instrument fuel indication	

F023 to exhaust solenoid valve



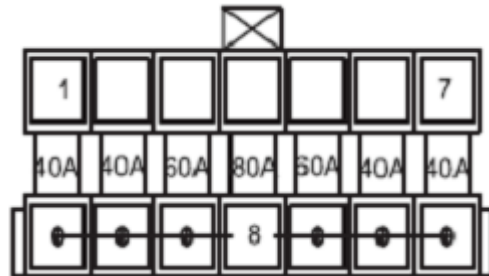
Stitch number	Wire color	Function	Remark
1	L-Y	Exhaust brake solenoid valve (+)	
2	W/B	Exhaust brake solenoid valve (-)	

F028 To vehicle frame harness II



Stitch number	Wire color	Function	Remark
1	G	Right rear marker lamp (B)	
2	G-Y	Right rear turn signal lamp (B)	
3	G-B	Left rear turn signal lamp (B)	
4	Y-G	Dryer (+)	
5	L-W	Rear fog lamp (B)	
6	G-W	Right rear brake lamp	
7	R-L	Reversing lamp switch (+)	
8			blocking
9	W-B	Frame I ground wire	
10	W-B	Frame II ground wire	
11	Br-W	Bearing locking switch	
12	Br-Y	Wheels lockout switch	
13	W-B	Frame III ground wire	
14	W-B	Frame II ground wire	
15	W-B	Frame III ground wire	
16	W-B	Frame III ground wire	

F007 To main fuse box

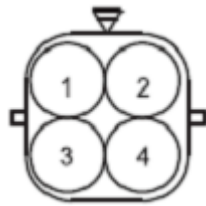


Stitch number	Wire color	Function	Remark
1	W	Main fuse F/L1	
2	R	Main fuse F/L2	
3	W	Master fuse box F/L4	
4	W	Main fuse of generator (L)	
5	B-Y	Main fuse F/L5	
6	G	Main fuse F/L6	
7	B-W	Main fuse F/L7	
8	R	Main fuse R/B	

Fmwx 610342

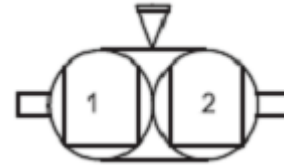
CIRCUIT DIAGRAM- HARNESS CONNECTOR INFORMATION**61-127**

F060 to trailer ABS A



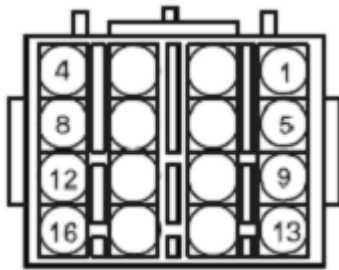
Stitch number	Wire color	Function	Remark
1	B-L	Trailer ABS socket	
2	B-O	Trailer ABS socket	
3	W-B	Trailer ABS ECU (-)	
4			blocking

F061 to trailer ABS B



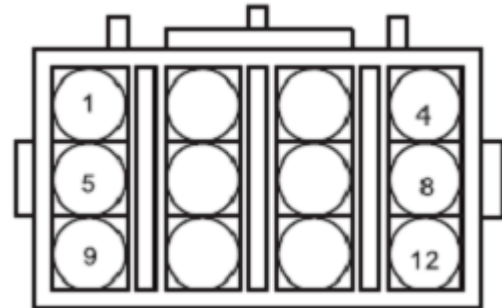
Stitch number	Wire color	Function	Remark
1	B-W	Trailer ABS socket	
2	W-B	Trailer ABS (-)	

F019 To tripper mechanism harness B



Stitch number	Wire color	Function	Remark
1	B-L	Air filter blocking alarm switch	
2	R	Cab lock switch (+)	
3	G-R	Left turning of trailer	
4	B-W	Auxiliary starter switch (+)	
5	Y-L	Water level alarm switch (+)	
6	L	Auxiliary starter switch (-)	
7	G-L	Right turning of trailer	
8	B-W	CAB indicator lamp switch	
9	W-B	Rear lamp (+)	
10	G	Small lamp for left trailer (+)	
11	G	Trailer brake lamp (+)	
12			blocking
13			blocking
14	W-B	Gearbox wire harness ZT7	
15	W-B	Reversing lamp switch (-)	
16	L-W	Trailer foglamp (+)	

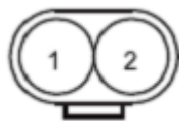
F021 To gearbox wire harness



Stitch number	Wire color	Function	Remark
1	R	Reversing lamp switch (+)	
2	B-R	Neutral position switch (-)	
3	B-W	Neutral position switch (+)	
4	W	Gear switch (+)	
5	W-B	Reversing lamp switch (-)	
6	Gr-W	To vehicle speed sensor (SI)	
7	Gr	To vehicle speed sensor (IG)	
8	Y-G	Dryer (+)	
9	W-B	Dryer (-)	
10	W-B	Gearbox wire harness ZT5	
11	W-B	Gearbox wire harness ZT7	
12	W-B	To vehicle speed sensor (E)	

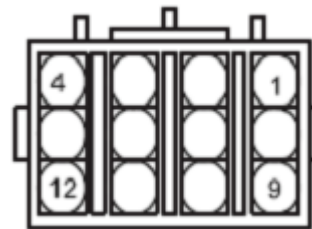
Fmwx 610343

X004 To reverse gear switch



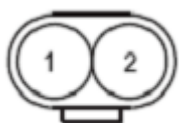
Stitch number	Wire color	Function	Remark
1	R	Reverse gear switch	
2	W-B	Reverse gear switch (-)	

X001 To vehicle frame harness I



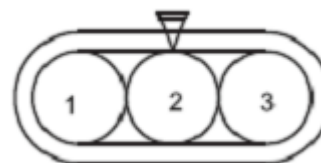
Stitch number	Wire color	Function	Remark
1	R	Reversing relay 85	
2	B-R	Neutral gear relay 85	
3	B-W	Frame ground	
4	W	Low gear indicator lamp	
5	W-B	Frame ground	
6	Gr-W	Instrument (SI)	
7	Gr	Instrument 12 volts output	
8	Gr-W		
9			blocking
10			blocking
11	W-B	Body ground	
12	W-B	Instrument harness grounded	

X003 To neutral position switch



Stitch number	Wire color	Function	Remark
1	B-W	Neutral position switch (-)	
2	B-R	Neutral position switch	

X006 to vehicle speed sensor



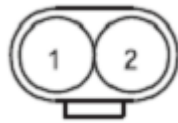
Stitch number	Wire color	Function	Remark
1	Gr-W	To vehicle speed sensor (SI)	
2	W-B	To vehicle speed sensor (E)	
3	Gr	To vehicle speed sensor (IG)	

Fmwx 610344

CIRCUIT DIAGRAM- HARNESS CONNECTOR INFORMATION

61-129

X002 to gear switch



X008 to sensor grounded



Stitch number	Wire color	Function	Remark
1	W	Gear switch (+)	
2	W-B	Gear switch (-)	

Stitch number	Wire color	Function	Remark
1	W-B	Sensor grounded	

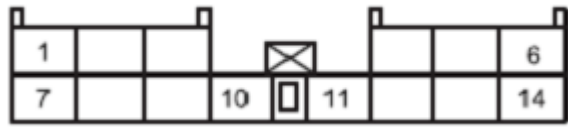
Fmwx 610345

R011 Left rear loudspeaker



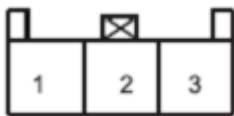
Stitch number	Wire color	Function	Remark
1	GR-R	Left rear loudspeaker (+)	
2	GR-Y	Left rear loudspeaker (-)	

R062 To vehicle body harness B



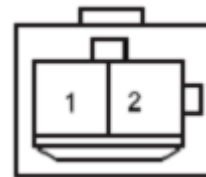
Stitch number	Wire color	Function	Remark
1	G-W	Brake light relay 87	
2	G-B	Flasher	
3	G-Y	Flasher	
4	L	Front foglamp relay	
5	R-W	High beam	
6			
7	R-Y	Low beam	
8	B-W	Ignition switch	
9	R-L	Backup lamp relay (87)	
10	GR-W	To vehicle speed sensor	
11	GR	Horn	
12	R-Y	Left door switch	
13	L-R	Fuse for vehicle data recorder	
14	W-B	Vehicle data recorder	

R007 to indoor lamp



Stitch number	Wire color	Function	Remark
1	L-Y	Right indoor lamp (+)	
2	R-Y	Right indoor lamp (-)	
3	L-Y	Right indoor lamp (+)	

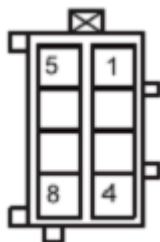
R002 To right height marker lamp



Stitch number	Wire color	Function	Remark
1	G	Right height lamp (+)	
2	W-B	Right height lamp (-)	

FmwX 610346

R058 To vehicle data recorder



R001 To vehicle body harness A



Stitch number	Wire color	Function	Remark
1	L-R	Vehicle data recorder (30)	Vacancy
2	R-G	Vehicle data recorder (LLL+)	Vacancy
3	B-W	Vehicle data recorder (IG)	Vacancy
4			
5	W-B	Vehicle data recorder (-)	Vacancy
6	W-B		
7			
8			

Stitch number	Wire color	Function	Remark
1			Vacancy
2	GR-R	Radio (RL+)	
3	BR-G	Radio (RR+)	
4			Vacancy
5			Vacancy
6			Vacancy
7			Vacancy
8			Vacancy
9	G	Small lamp relay	
10	R-Y	Indoor lamp control switch	
11	W-B	Body ground	
12	GR-Y	Radio (RL-)	
13	BR-R	Radio (RR-)	
14	R-G	Ceiling interface	
15			Vacancy
16			Vacancy
17			Vacancy
18			Vacancy
19	L-R	Vehicle relay	
20	L-B	Vehicle relay	
21	L-W	Vehicle relay	
22	L-Y	Indoor lamp fuse	

R052 Left box trigger switch



Stitch number	Wire color	Function	Remark
1	L-Y	Left box trigger switch (B)	
2	R-W	Left box trigger switch	

R056 Left box lamp+



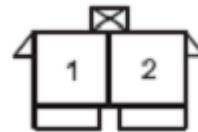
Stitch number	Wire color	Function	Remark
1	R-W	Left box lamp +	

R055 Left box lamp -



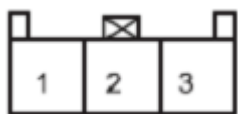
Stitch number	Wire color	Function	Remark
1	W-B	Left box lamp (-)	

R014 Left berth lamp



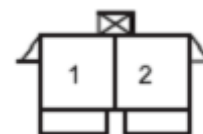
Stitch number	Wire color	Function	Remark
1	W-B	Left berth lamp (-)	
2	L-Y	Left berth lamp (+)	

R015 Left indoor lamp



Stitch number	Wire color	Function	Remark
1	L-Y	Left indoor lamp (+)	
2	R-Y	Left indoor lamp (-)	
3	L-Y	Left indoor lamp (+)	

R050 Right berth lamp



Stitch number	Wire color	Function	Remark
1	W-B	Right berth lamp (-)	
2	L-Y	Right berth lamp (+)	

R057 Right box lamp -



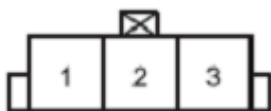
Stitch number	Wire color	Function	Remark
1	W-B	Right box lamp (-)	

R053 Right box trigger switch



Stitch number	Wire color	Function	Remark
1	L-Y	Right box trigger switch B	
2	R	Right box trigger switch	

R051 Reading lamp



Stitch number	Wire color	Function	Remark
1	W-B	Reading lamp (-)	
2	L-Y	Reading lamp (+)	
3	L-Y	Reading lamp (+)	

R013 Right rear loudspeaker



Stitch number	Wire color	Function	Remark
1	BR-G	Right rear loudspeaker (+)	
2	BR-R	Right rear loudspeaker (-)	

R054 Right box lamp +



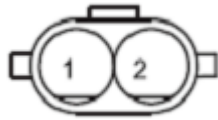
Stitch number	Wire color	Function	Remark
1	W-B	Right box lamp (+)	

R006 Vehicle speed lamp C



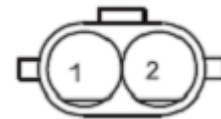
Stitch number	Wire color	Function	Remark
1	L-R	Vehicle speed lamp C (+)	
2	W-B	Vehicle speed lamp C (-)	

R005 Vehicle speed lamp B



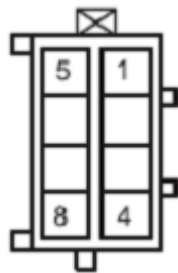
Stitch number	Wire color	Function	Remark
1	L-B	Vehicle speed lamp B (+)	
2	W-B	Vehicle speed lamp B (-)	

R004 Vehicle speed lamp A



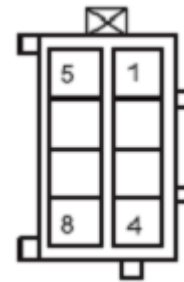
Stitch number	Wire color	Function	Remark
1	L-W	Vehicle speed lamp A (+)	
2	W-B	Vehicle speed lamp A (-)	

R059 Vehicle data recorder B



Stitch number	Wire color	Function	Remark
1			Vacancy
2			Vacancy
3	GR-W	Vehicle data recorder (vehicle speed)	
4			Vacancy
5			Vacancy
6			Vacancy
7			Vacancy
8			Vacancy

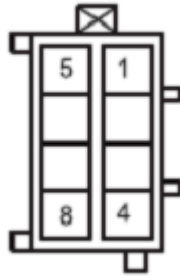
R060 Vehicle data recorder C



Stitch number	Wire color	Function	Remark
1	G-Y	Vehicle data recorder (right turn)	
2	G-B	Vehicle data recorder (left turn)	
3	GR	Vehicle data recorder (vehicle speed)	
4	R-L	Vehicle data recorder (reversing)	
5			Vacancy
6	R-Y	Vehicle data recorder (door)	
7	L	Vehicle data recorder	
8			Vacancy

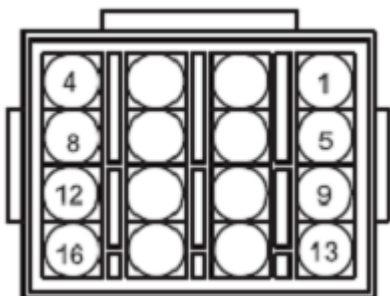
Fmwx 610351

R061 Vehicle data recorder D



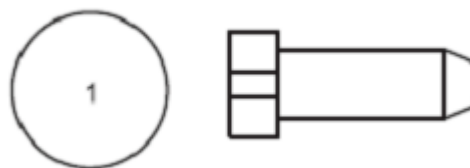
Stitch number	Wire color	Function	Remark
1	G-W	Vehicle data recorder(brake)	
2	R-W	Vehicle data recorder	
3	R-Y	Vehicle data recorder	
4			Vacancy
5	R-Y	Vehicle data recorder(horn)	
6			Vacancy
7			Vacancy
8			Vacancy

T001 to frame front harness



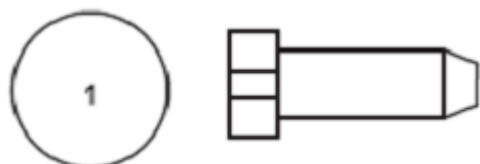
Stitch number	Wire color	Function	Remark
1	Y-G	Wiper motor fuse (L)	
2	G-B	Turning flasher (LL)	
3	G-Y	Turning flasher (RL)	
4	G	Illumination controller (L)	
5			blocking
6	R-L	Reversing relay (L)	
7	G-W	Brake light relay (L)	
8	L-W	Rear fog lamp switch (L)	
9	Br-Y	Lock indicator lamp between wheels	
10	Br-W	Lock indicator lamp between shafts	
11	W-B	Frame 1 electric ground A	
12	W-B	Frame 1 electric ground A	
13	W-B	Wheels locking valve (-)	
14	W-B	Shutdown solenoid valve (-)	
15	W-B	Bearing locking solenoid valve (-)	
16	W-B	Exhaust brake solenoid valve (-)	

T009 to lock switch between shafts (+)



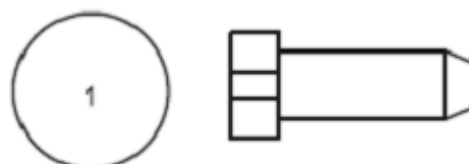
Stitch number	Wire color	Function	Remark
1	Br-W	Lock indicator lamp between shafts	

T018 to lock switch between wheels (+)



Stitch number	Wire color	Function	Remark
1	Br-Y	Middle bridge lockout indicator	

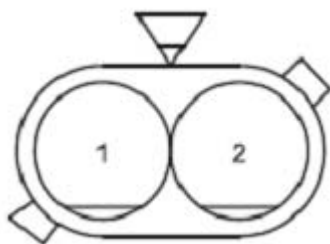
T020 to lock switch between wheels (+)



Stitch number	Wire color	Function	Remark
1	Br-Y	Rear bridge lockout indicator	

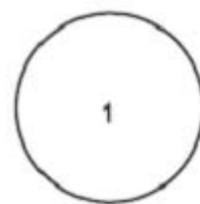
Fmwx 610353

T015 To reversing buzzer



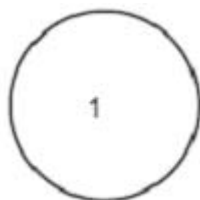
Stitch number	Wire color	Function	Remark
1	R-L	Reversing buzzer (B)	
2	W-B	Reversing buzzer (E)	

G010 Underpan earth



Stitch number	Wire color	Function	Remark
1	W-B	Frame 1 electric ground A	

G911 Underpan earth



Stitch number	Wire color	Function	Remark
1	W-B	Frame 1 electric ground B	

T012 To right rear combination lamp



Stitch number	Wire color	Function	Remark
1	L-W	Right rear fog lamp (B)	
2			blocking
3	R-L	Rear right reversing lamp	
4	W-B	Right front combination lamp (E)	
5	G-Y	Right rear turn signal lamp (B)	
6	G	Right rear tail lamp (B)	
7	G-W	Right rear brake lamp (B)	

T054 To dryer



Stitch number	Wire color	Function	Remark
1	Y-G	To dryer (+)	
2	W-B	Air dryer (-)	

FmwX 610354

T003 To right front marker lamp



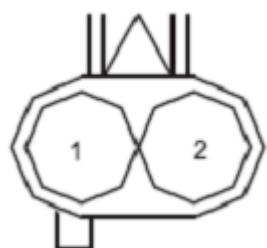
Stitch number	Wire color	Function	Remark
1	G	Right front marker lamp (B)	
2	W-B	Right front marker lamp (E)	

T013 To left rear combination lamp



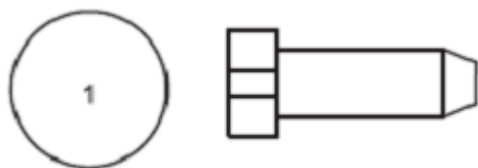
Stitch number	Wire color	Function	Remark
1	L-W	Left rear fog lamp (B)	
2			blocking
3	R-L	Rear left reversing lamp (B)	
4	W-B	Left front combination lamp (E)	
5	G-B	Left rear turn signal lamp (B)	
6	G	Left rear tail lamp (B)	
7	G-W	Left rear brake lamp (B)	

T004 To left front marker lamp

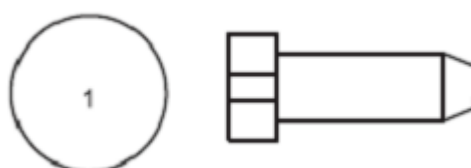


Stitch number	Wire color	Function	Remark
1	G	Left front marker lamp (B)	
2	W-B	Left front marker lamp (E)	

T019 to lock switch between shafts (+)



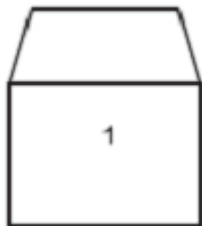
T920 to lock switch between shafts (-)



Stitch number	Wire color	Function	Remark
1	Br-W	Bearing locking switch (+)	

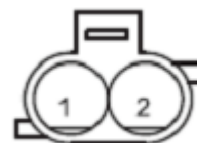
Stitch number	Wire color	Function	Remark
1	W-B	Bearing locking switch (-)	

U003 to air filter (-)



Stitch number	Wire color	Function	Remark
1	W-B	Air filter (-)	

U052 to tumbler buzzer



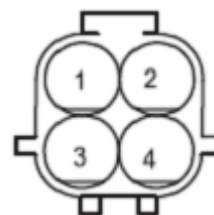
Stitch number	Wire color	Function	Remark
1	B	Flipping buzzer (+)	
2	W	Flipping buzzer (-)	

G048 switching mechanism grounding



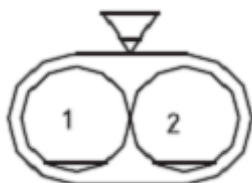
Stitch number	Wire color	Function	Remark
1	W-B	Dumping gear ground	

U051 to lower dead center switch



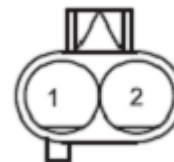
Stitch number	Wire color	Function	Remark
1			blocking
2			blocking
3	W	BDC switch (+)	
4	W-B	BDC switch (-)	

U006 CAB lock switch



Stitch number	Wire color	Function	Remark
1	B-W	Lock switch (+)	
2	W-B	CAB lock switch (-)	

U014 To Auxiliary starter switch



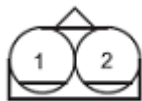
Stitch number	Wire color	Function	Remark
1	L	IG power relay	
2	B-W	Auxiliary starting (+)	

Fmwx 610357



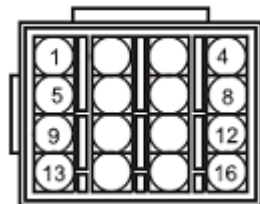
FOTON

U007 To water level alarm switch



Stitch number	Wire color	Function	Remark
1	Y-L	Water level alarm switch +	
2	W-B	Water level alarm switch	

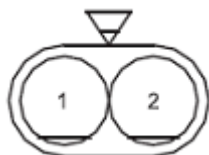
U002 To tripper mechanism harness



Stitch number	Wire color	Function	Remark
1	B-L	Air filter blocking alarm lamp	
2	R	To vehicle frame harness 1	
3	G-R	Turning flasher	
4	B-W	Ignition switch (ST)	
5	Y-L	Water level alarm switch	
6	L	IG power relay	
7	G-L	Turning flasher	
8	B-W	CAD lock indicator lamp	
9	G	Wiper fuse(L)	
10	G	Illumination relay	
11	G-W	Brake light relay	
12	R-L	To vehicle frame harness 1	
13			blocking
14	W-B	Gear box	
15	W-B	Reversing lamp switch (-)	
16	L-W	Fog lamp switch	

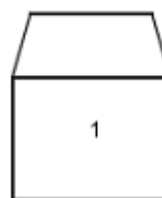
61

U020 Rear lamp



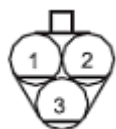
Stitch number	Wire color	Function	Remark
1	G	Rear lamp (+)	
2	W-B	Rear lamp (-)	

U004to air filter (+)



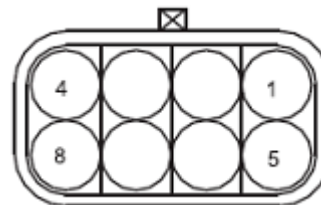
Stitch number	Wire color	Function	Remark
1	B-L	Air filter (+)	

U017 To trailer harness



Stitch number	Wire color	Function	Remark
1	R-L	Trailer reversing lamp	
2	G-W	Trailer brake lamp (B)	
3	L-W	Trailer foglamp (B)	

U050 To trailer harness



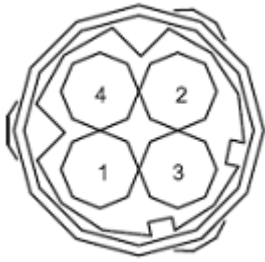
Stitch number	Wire color	Function	Remark
1	W-B	Rear lamp (+)	
2	G	Small lamp of trailer (B)	
3	G-R	Left turning of trailer (B)	
4	G-W	Trailer brake lamp (B)	
5	G-L	Right turning of trailer (B)	
6			blocking
7	L-W	Trailer foglamp (B)	
8	G	Small lamp of trailer (B)	

G006 Dumping gear ground



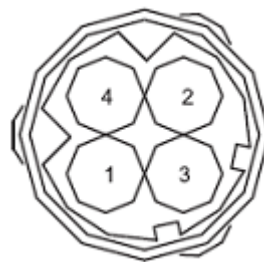
Stitch number	Wire color	Function	Remark
1	W-B	Underpan	

Z001 To left front ABS solenoid valve



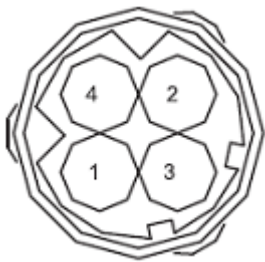
Stitch number	Wire color	Function	Remark
1	Br	Exhaust coil	
2	Y-G	Grounded	
3	L	Air suction coil	
4			blocking

Z002 To right front ABS solenoid valve



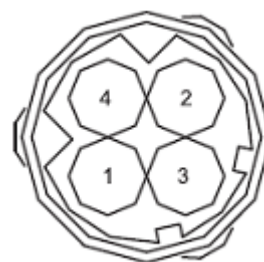
Stitch number	Wire color	Function	Remark
1	Br	Exhaust coil	
2	Y-G	Grounded	
3	L	Air suction coil	
4			blocking

Z003 To left rear ABS solenoid valve



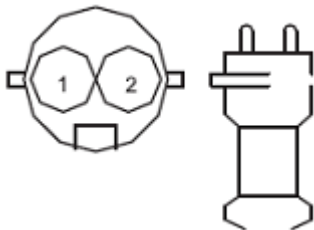
Stitch number	Wire color	Function	Remark
1	Br	Exhaust coil	
2	Y-G	Grounded	
3	L	Air suction coil	
4			blocking

Z004 To right rear ABS solenoid valve



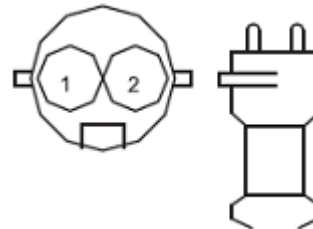
Stitch number	Wire color	Function	Remark
1	Br	Exhaust coil	
2	Y-G	Grounded	
3	L	Air suction coil	
4			blocking

Z005 To left front ABS wheel speed sensor



Stitch number	Wire color	Function	Remark
1	Br	ABS wheel speed sensor (+)	
2	B	ABS wheel speed sensor (-)	

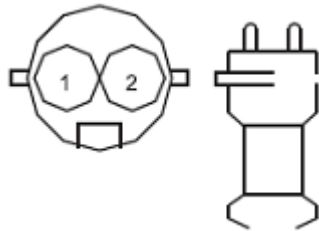
Z006 To right front ABS wheel speed sensor



Stitch number	Wire color	Function	Remark
1	Br	ABS wheel speed sensor (+)	
2	B	ABS wheel speed sensor (-)	

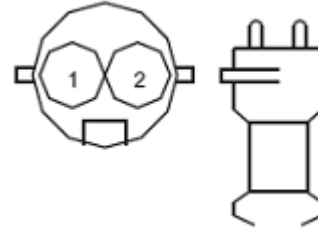
Fmwx 610251

Z007 To left rear ABS solenoid valve



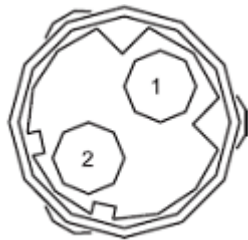
Stitch number	Wire color	Function	Remark
1	Br	ABS wheel speed sensor (+)	
2	B	ABS wheel speed sensor (-)	

Z008 To right rear ABS solenoid valve



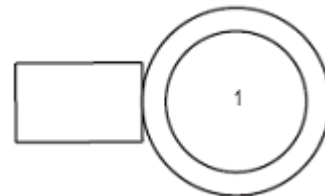
Stitch number	Wire color	Function	Remark
1	Br	ABS wheel speed sensor (+)	
2	B	ABS wheel speed sensor (-)	

Z024 To ASR solenoid valve



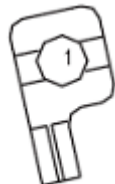
Stitch number	Wire color	Function	Remark
1	L	ASR solenoid valve	
2	Br	ASR solenoid valve	

G016 Grounded



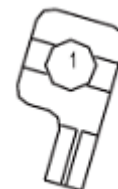
Stitch number	Wire color	Function	Remark
1	W/B	Grounded	

G017 Grounded



Stitch number	Wire color	Function	Remark
1	W/B	Grounded	

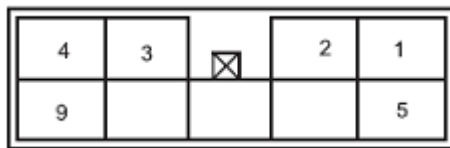
G018 Grounded



Stitch number	Wire color	Function	Remark
1	W/B	Grounded	

Fmwx 610252

Z019 To ABS underpan harness



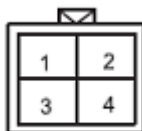
Z020 To TPM switch



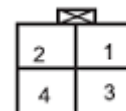
Stitch number	Wire color	Function	Remark
1	B-Y	ABS relay (L)	
2	G	Main vehicle ABS interface SAE J1939 (B)	
3	W-B	ABS relay (31)	
4	R-W	ABS fuse (5A)	
5	B-Y	ABS diagnosis lamp (+)	
6	W	Main vehicle ABS interface SAE J1939 (A)	
7		ABS diagnosis interface	
8	G-Y	ABS indicator lamp	
9	W-R	DBP relay	

Stitch number	Wire color	Function	Remark
1			Vacancy
2	W-B	TPM switch (-)	
3			Vacancy
4	G-L	TPM switch (+)	
5			Vacancy
6			Vacancy
7			Vacancy
8			Vacancy

Z022 Diagnosis interface



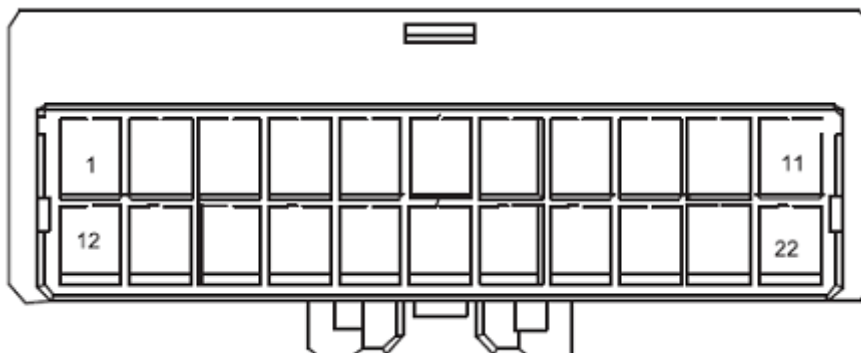
Z023 Diagnosis interface



Stitch number	Wire color	Function	Remark
1	Y	ABS diagnosis interface K	
2	W-B	ABS diagnosis interface (-)	
3	Y-R	ABS diagnosis interface L	
4	B-W	ABS diagnosis interface (+)	

Stitch number	Wire color	Function	Remark
1	Y	ABS diagnosis interface K	
2	W-B	ABS diagnosis interface (-)	
3	Y-R	ABS diagnosis interface L	
4	B-W	ABS diagnosis interface (+)	

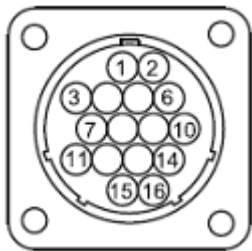
Z014 To ABS underpan harness



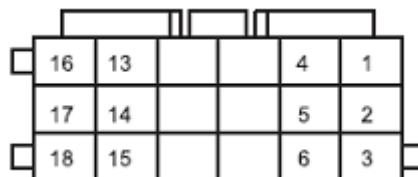
Stitch number	Wire color	Function	Remark
1	Br	Air inlet coil of right front wheel solenoid valve	
2	L	Exhaust coil of right front wheel solenoid valve	
3	G/Y	Exhaust coil of right front wheel solenoid valve	
4	B	Right front wheel sensor (-)	
5	Br	Right front wheel sensor (+)	
6	L	ASR solenoid valve	
7	Br	ABS diagnosis interface K	
8	L	ABS diagnosis interface L	
9	G/Y	Exhaust coil of left rear wheel solenoid valve	
10	B	Right rear wheel sensor (-)	
11	Br	Right rear wheel sensor (+)	

Stitch number	Wire color	Function	Remark
12	Br	Air inlet coil of left front wheel solenoid valve	
13	L	Exhaust coil of left front wheel solenoid valve	
14	G/Y	Exhaust coil of left front wheel solenoid valve	
15	B	Left front wheel sensor (-)	
16	Br	Left front wheel sensor (+)	
17	Br	ASR solenoid valve	
18	Br	Air inlet coil of left rear wheel solenoid valve	
19	L	Exhaust coil of left rear wheel solenoid valve	
20	G/Y	Exhaust coil of left rear wheel solenoid valve	
21	B	Left rear wheel sensor (-)	
22	Br	Left rear wheel sensor (+)	

Z021 Diagnosis interface



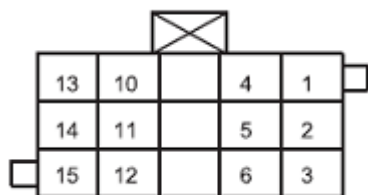
Z009 To ABS module 1



Stitch number	Wire color	Function	Remark
1	B-W	ABS diagnosis interface (+)	
2	W-B	ABS diagnosis interface (-)	
3			Vacancy
4			Vacancy
5			Vacancy
6			Vacancy
7			Vacancy
8	Y	ABS diagnosis interface K	
9			Vacancy
10	Y-R	ABS diagnosis interface L	
11			Vacancy
12			Vacancy
13			Vacancy
14			Vacancy
15			Vacancy
16			Vacancy

Stitch number	Wire color	Function	Remark
1	Br	ECU 18-1	
2	Br	ECU 18-2	
3	Br	ECU 18-3	
4	L	ECU 18-4	
5	L	ECU 18-5	
6	L	ECU 18-6	
7	Br	ASR solenoid valve	
8	Br	ECU 18-8	
9	L	ECU 18-9	
10	Br	ECU 18-10	
11	Br	ECU 18-11	
12	Br	ECU 18-12	
13	B	ECU 18-13	
14	B	ECU 18-14	
15	B	ECU 18-15	
16	L	ASR solenoid valve	
17	Br	ECU 18-17	
18	B	ECU 18-18	

Z011 diagnosis ABS module 2



Stitch number	Wire color	Function	Remark
1	G	SAE J1939 (B)	
2			Vacancy
3	W	SAE J1939 (A)	
4	W-B	ABS fuse (5A)	
5			Vacancy
6	G-L	ECU 14-6	
7	R-W	ABS ECU (+)	
8	B-Y	ABS ECU (UB)	
9	W-B	ABS ECU (OV)	
10	Y	ECU 18-8	
11	Y-R	ECU 18-9	
12			Vacancy
13	G-Y	ASR indicator lamp	
14	W-B	ABS ECU (DBR)	
15	B-Y	ABS ECU (WL)	

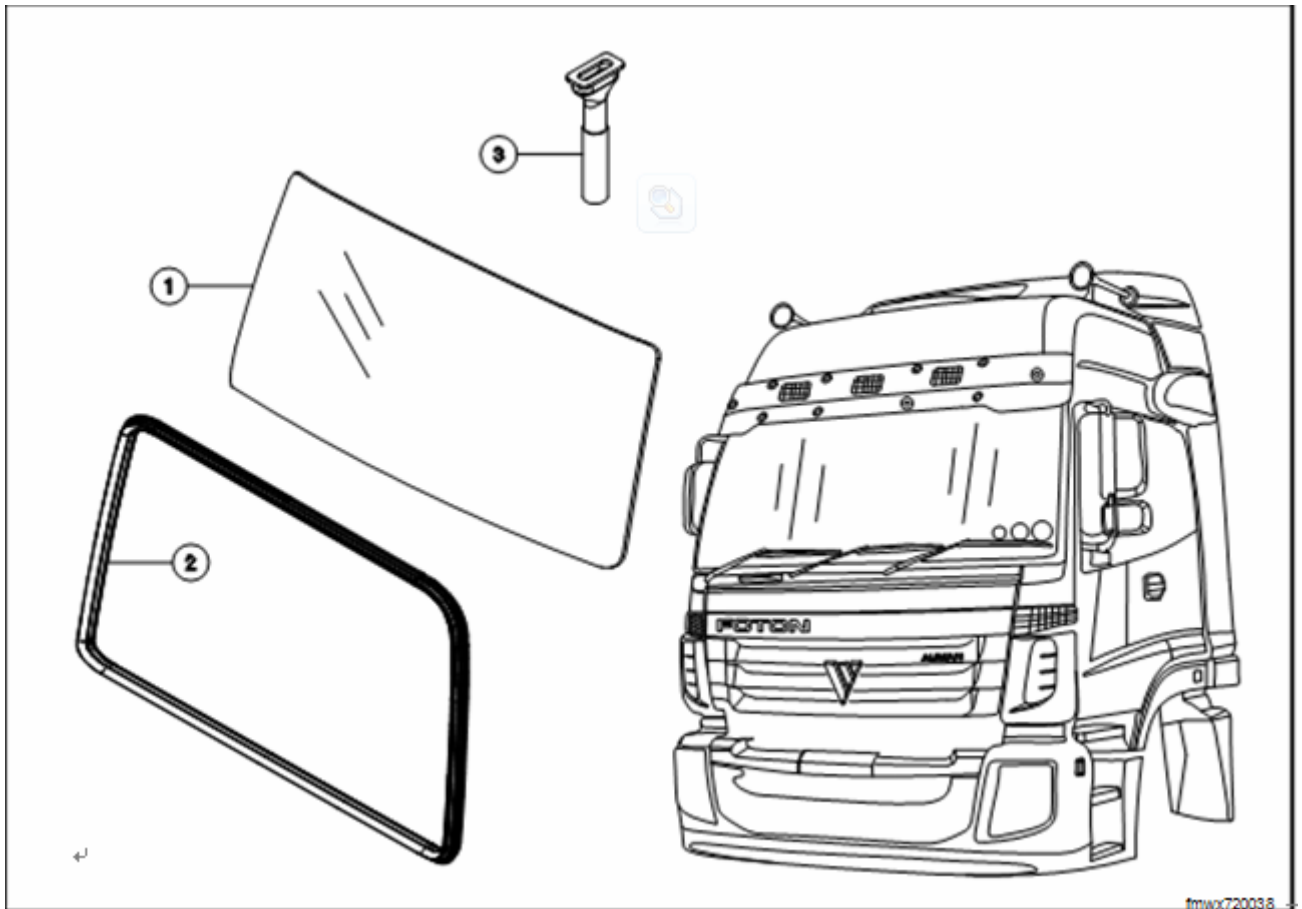
- MEMO -

WINDOW REGULATOR REARVIEW MIRROR

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FRONT WINDSHIELD GLASS

DIAGRAM OF COMPONENTS



1	Front windshield glass
2	Front windshield glass weather strip

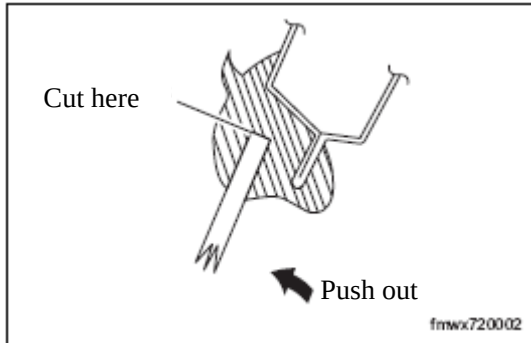
3	Windshield glass drain pipe assembly

REPLACEMENT

Suggestion:

For Diagram of Components, see chapter 72 Window regulator rearview mirror -front windshield glass, component diagram

1 Dismantling of front wiper arm, see chapter 55 Wiper and washer-wiper arm, replacement



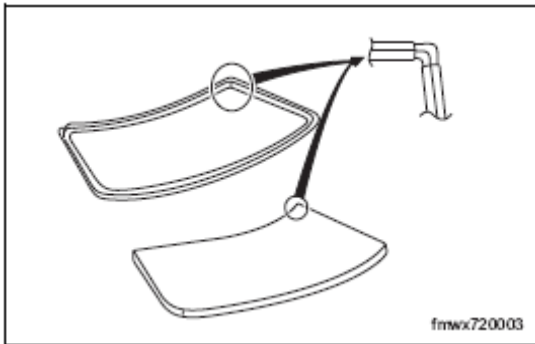
2 Dismantling of front windshield glass

- (a). Cut the weather strip, push glass out of the cab and dismantle it.

Note:

Do not damage the surface of surrounding paint and glass when taking out glass. If flange of the body is damaged, repair and maintain it again for the damaged flange can cause rustiness.

3 Dismantling of front windshield weather strip



4 Installation of front windshield glass weather strip

- (a). Install weather strip by aligning locating marks both on the strip and glass and the displacement between the marks should not exceed 3 mm.
- The strip must be parallel to the glass after it is installed onto the glass.
 - Heat the strip using hot air with temperature of about 75°C before it is installed.

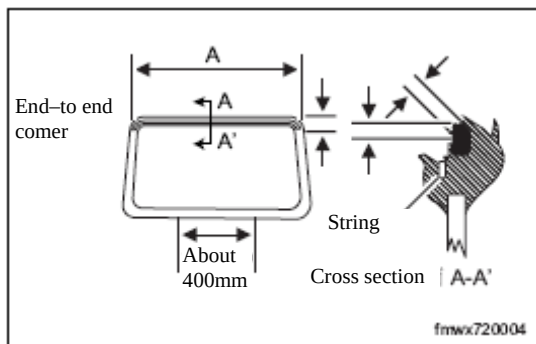
Note:

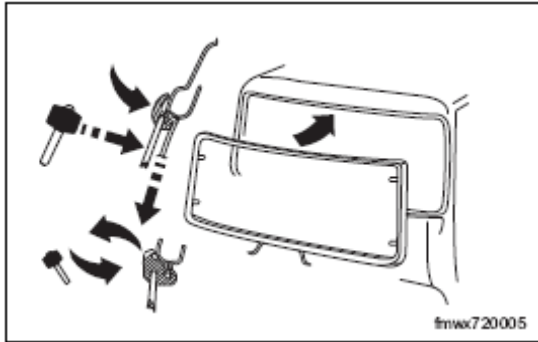
Check and ensure that no dust exist on the top surface of workbench to prevent glass surface from being scratched by foreign matters.

- (b). Put a string, 5.0-6.0mm in diameter between strip openings and a metal tube, about 8.0 mm in diameter can be used. Thread the tube through bottom center of the glass after it is wound by the string for one turn, 400mm away from the bottom center.
- (c). Apply sealant between strip openings.

Note:

Ensure that the applying of sealant is continuous to avoid water leakage and apply sealant again if interruption exceeds 200 mm in position A shown in the figure.





5 Installation of front windshield glass

- (a). Align glass center with the center of the vehicle body and fix glass from outside. Pull the string to glass center from inside and fix the opening onto flange of the body slowly. Support the glass tightly to avoid lateral movement.

Note:

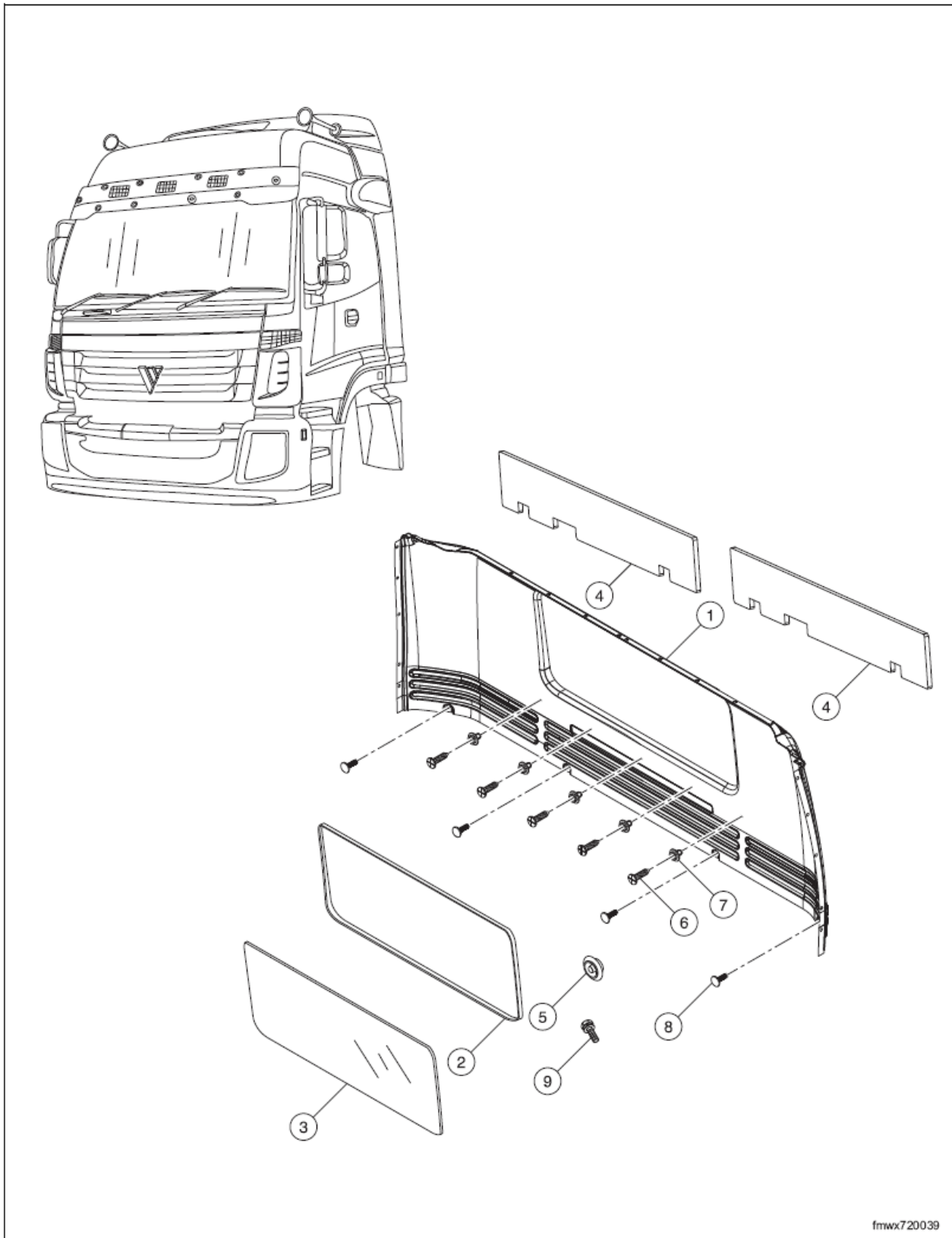
If flange of the vehicle body is damaged when dismantling glass, install glass after the damaged flange is repaired and maintained again, for damage of the flange is apt to cause rustiness. Meanwhile, bending or kink on the opening, if any, should be corrected, otherwise, water leakage will be caused easily. Tap the protrusion on the strip with rubber hammer to level it.

- (b). Wipe locating scratches on glass surface with paraffin. Check if there is any leakage.

6 Installation of front wiper arm, see chapter 55 Wiper and washer-wiper arm, replacement

REAR WINDOW GLASS

DIAGRAM OF COMPONENTS



1	Rear wall trim panel
2	Rear window glass weather strip
3	Rear window glass
4	Rear wall acoustic panel
5	Plugging cover-rear wall

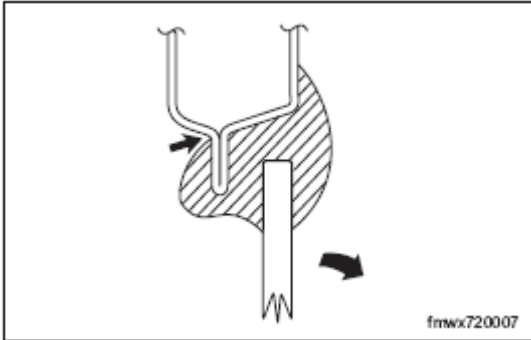
6	Plastic bolt
7	Plastic screw
8	Buckle-side guard panel
9	Hexagon head bolt, spring washer and plain washer assemblies



REPLACEMENT

Suggestion:

Diagram of Components, see chapter 72 Window regulator rearview mirror-rear window glass, component diagram.



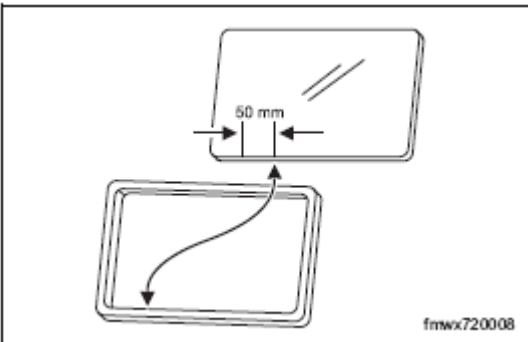
1. Dismantling of rear window glass

- (a). Push weather strip out of flange of the body from two corners on the top of rear window glass, and then push glass outward slowly to take it out completely.

Note:

Do not damage the surface of surrounding paint and glass when dismantling glass. If flange of the body is damaged, repair and maintain it again for the damaged flange can cause rustiness.

2 Dismantling of rear window glass weather strip



3. Installation of rear window glass weather strip

- (a). In the middle of scratches on the glass, put the bonding part of the strip at the position which is about 50 mm away from the glass center and install the strip.
 - The strip must be parallel to the glass after it is installed onto the glass.

Note:

Check and ensure that no dust exists on the top surface of workbench to prevent glass surface from being scratched by foreign matters.

4. Installation of rear window glass

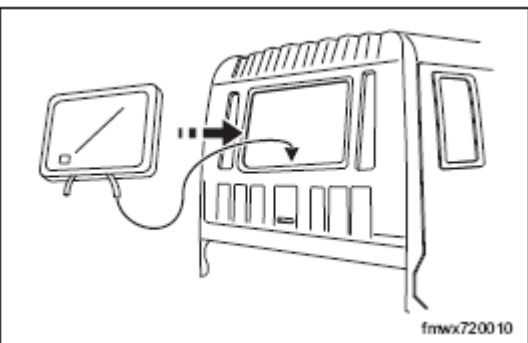
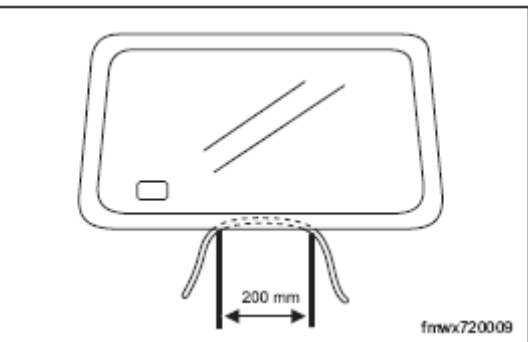
- (a). Put a string, 4.0mm in diameter between strip openings and a metal tube, 6.0 mm in diameter can be used. Thread the tube through bottom center of the glass after it is winded by the string for one turn, 200mm away from the bottom center.

- (b). Align glass center with the center of the vehicle body and fix glass from outside. Pull the string to glass center from inside and fix the opening onto flange of the body slowly. Support the glass tightly to avoid lateral movement.

Note:

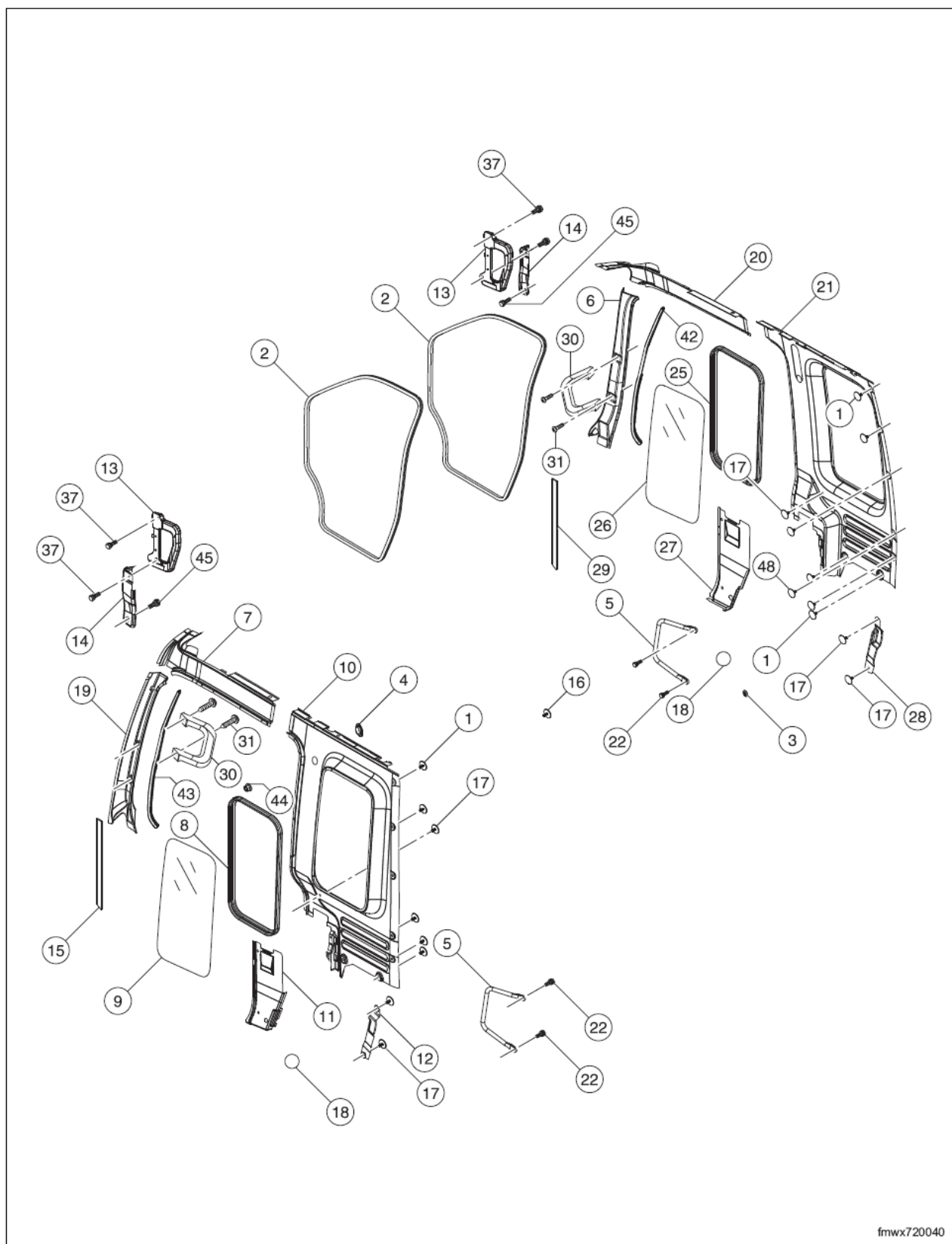
If flange of the body is damaged when dismantling glass, install glass after the damaged flange is repaired and maintained again, for damage of the flange is apt to cause rustiness. Meanwhile, bending or kink on the opening, if any, should be corrected, otherwise, water leakage will be caused easily. Remove dust between the strip and flange of the body to avoid water leakage.

- (c). Wipe locating scratches on glass surface with paraffin. Check if there is any leakage.



SIDE WINDOW GLASS

DIAGRAM OF COMPONENTS



1	Large buckle
2	Door frame guard strip assembly
3	Plugging cover-front wall
4	Plugging cover-lateral wall
5	Rear side getting-on handrail
6	Front post inner guard panel (left)
7	Left side wall front trim panel
8	Left rear side window glass weather strip
9	Left rear side window glass assembly
10	Left side wall upper guard panel
11	Left side wall lower inner guard panel
12	Left rear side wall bracket
13	Front post handrail assembly
14	Post handrail bracket
15	Spill rubber strip (left)
16	Clip-side guard panel (grey)
17	Clip-side guard panel
18	Hole sticker 50
19	Front post inner guard panel (right)
20	Right side wall front trim panel
21	Right side wall upper inner guard pane
22	Hexagon head bolt, spring washer and plain washer assemblies
23	Large washer

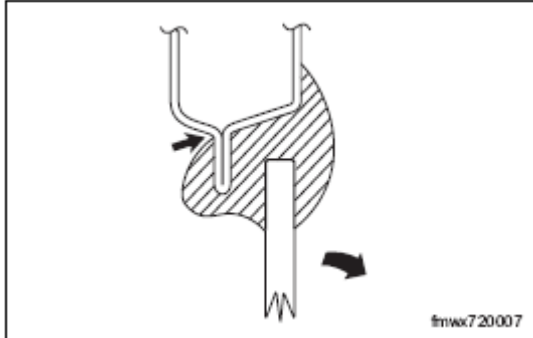
24	Drawing wire clamp
25	Right rear side window glass weather strip
26	Right rear side window glass assembly
27	Right side wall lower inner guard panel
28	Right rear side wall bracket
29	Spill rubber strip (right)
30	Front post handrail assembly
31	Cross recessed pan head screw
32	Drawing wire control wrench assembly
33	Toolbox wrench trim cover
34	Toolbox hinge assembly
35	Toolbox opening drawing wire assembly
36	Screw, spring washer and plain washer assemblies
37	Cross recessed pan head screw, spring washer and plain washer assemblies
38	Toolbox cover assembly
39	Hexagon nut, type 1
40	Toolbox body assembly
41	Hexagon head bolt, spring washer and plain washer assemblies
42	Doorframe weather strip, left
43	Doorframe weather strip, right
44	Hexagon flange nut
45	Hexagon head bolt, spring washer and plain washer assemblies



REPLACEMENT

Suggestion:

Diagram of Components, see chapter 72 Window regulator rearview mirror – side window glass, component diagram.



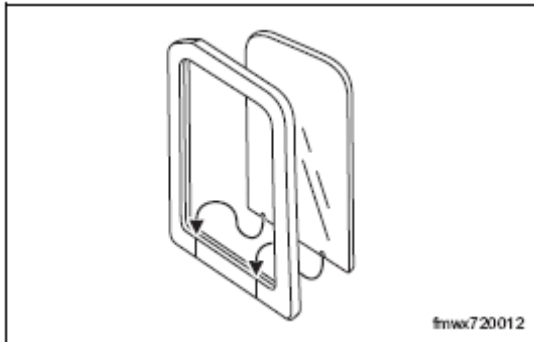
1 Dismantling of side window glass

- (a). Push weather strip out of flange of the body from two corners on the top of side window glass, and then push glass outward slowly to take it out completely.

Note:

Do not damage the surface of surrounding paint and glass when dismantling glass. If flange of the body is damaged, repair and maintain it again for damage of the flange can cause rustiness.

2 Dismantling of side window glass weather strip



3 Installation of side window glass weather strip

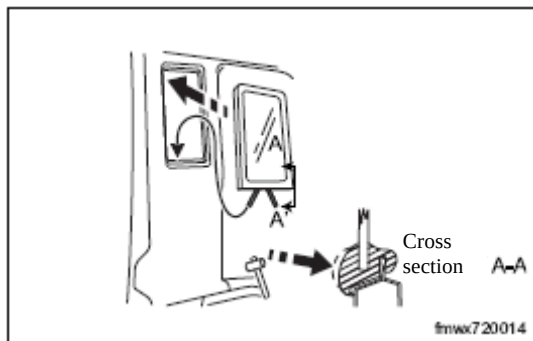
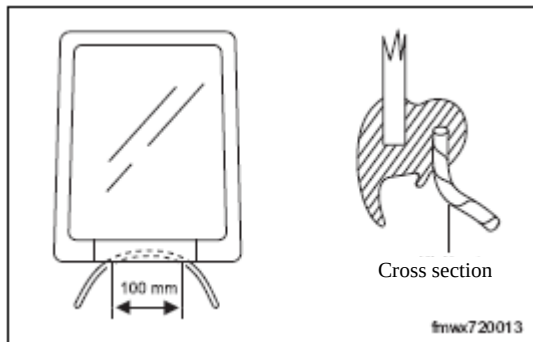
- (a). Loosen clamp nut on the top. Assemble the bonding part with the locating scratches on the glass after they are butt jointed. Displacement between the scratches should not exceed 3 mm.
- The strip should be parallel to the glass when it is installed.

Note:

Check and ensure that no dust exists on the top surface of workbench to prevent glass surface from being scratched by foreign matters.

4 Installation of side window glass

- (a). Put a string, 4.0mm in diameter between strip openings and a metal tube, 6.0 mm in diameter can be used. Thread the tube through bottom center of the glass after it is wound by the string for one turn, 100mm away from the bottom center.



- (b). Align glass center with the center of the vehicle body and fix glass from outside. Pull the string to glass center from inside and fix the opening onto flange of the body slowly. Support the glass tightly to avoid lateral movement.

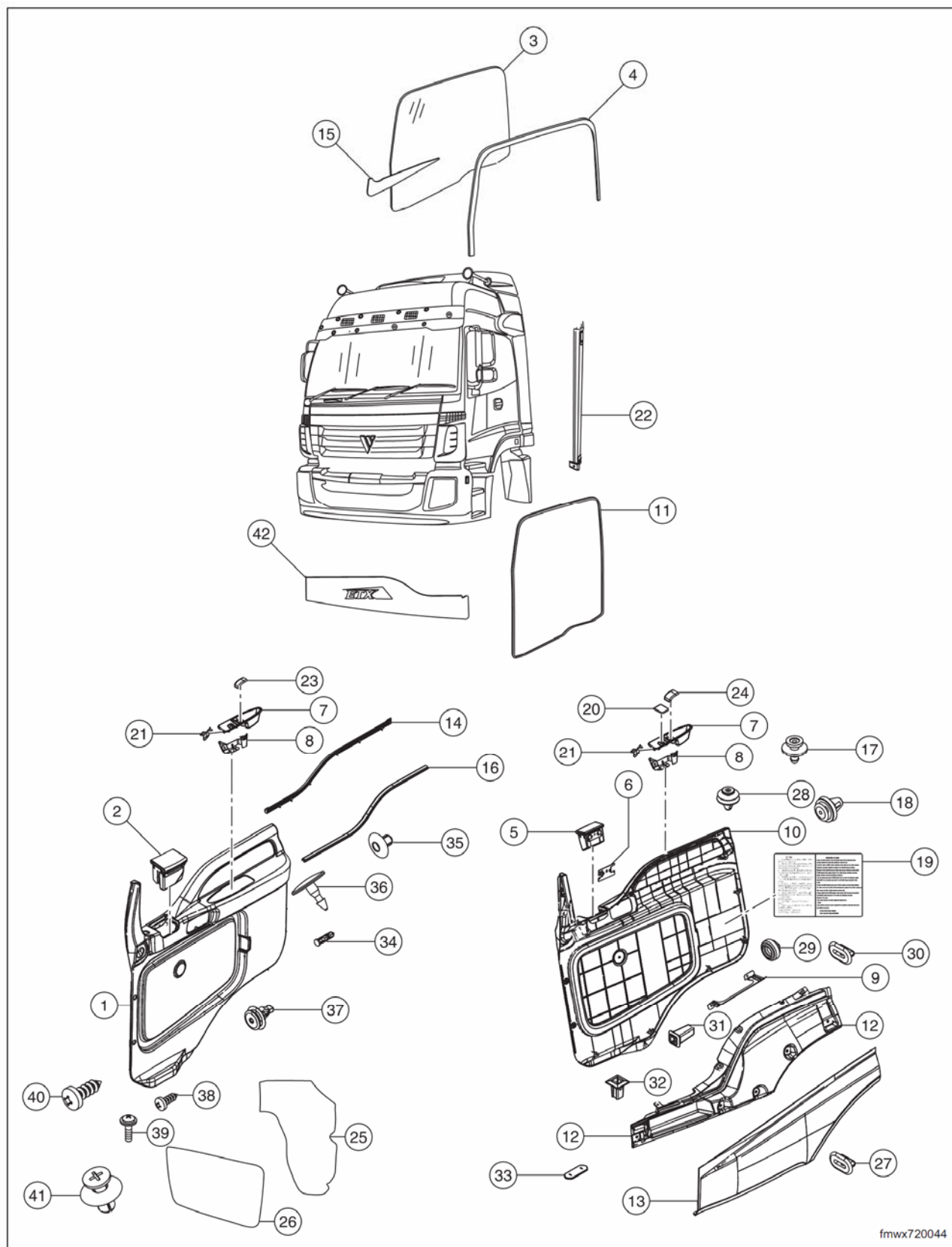
Note:

If flange of the body is damaged when dismantling glass, install glass after the damaged flange is repaired and maintained again, for damage of the flange is apt to cause rustiness. Meanwhile, bending or kink on the opening, if any, should be corrected, otherwise, water leakage will be caused easily. Remove dust between the strip and flange of the body to avoid water leakage.

- (c). Wipe locating scratches on glass surface with paraffin. Check if there is any leakage.

DOOR GLASS

DIAGRAM OF COMPONENTS



1	Right door inner guard panel assembly
2	Ashtray assembly (right)
3	Door glass assembly
4	Door glass weather strip assembly
5	Ashtray assembly (left)
6	Ashtray bracket
7	Inner handrail assembly
8	Inner handrail bracket
9	Limit clip assembly
10	Left door inner guard panel assembly
11	Door weather strip
12	Door lower trim panel lining board
13	Door lower trim panel assembly
14	Door windowsill outer weather strip assembly
15	Door windowsill trimming
16	Door windowsill inner weather strip assembly
17	Buckle
18	Inner guard panel buckle
19	User guide
20	Left inner handrail blank cap A
21	Handrail guard clip

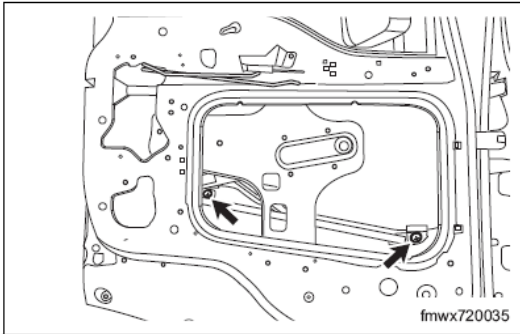
22	Door guide rail assembly
23	Right inner handrail blank cap
24	Left inner handrail blank cap B
25	Door front waterproofing membrane
26	Door rear waterproofing membrane
27	Cup head plug
28	Buckle – door guard panel
29	Round cushion pad
30	Buckle base-top guard panel
31	Plastic nut
32	Buckle base –ventilation hood
33	Lower vent plugging cover
34	Buckle -splash shield
35	Buckle base–splash shield
36	Front door spike
37	Plastic buckle
38	Cross recessed self-tapping screw
39	Cross recessed pan head self-tapping screw and plain washer assemblies
40	Cross recessed self-tapping screw
41	Buckle base — door lower guard panel
42	ETX door side label trimming

REPLACEMENT

Suggestion:

Diagram of Components, see chapter 72 Window regulator rearview mirror – door glass, component diagram.

- 1 Dismantling of door inner guard panel, see chapter 76 interior/exterior trimmings-door inner guard panel, replacement
- 2 Removal of door rear waterproofing membrane.
- 3 Dismantling of door glass weather strip assembly.

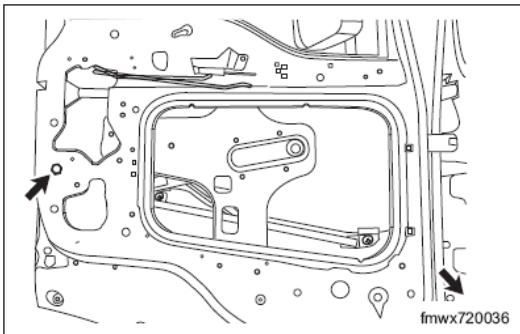


4 Dismantling of door glass assembly

- (a) Move door glass at proper position.
- (b). Remove set bolt of door glass.
- (c) Take out door glass by tilting it about 45°.

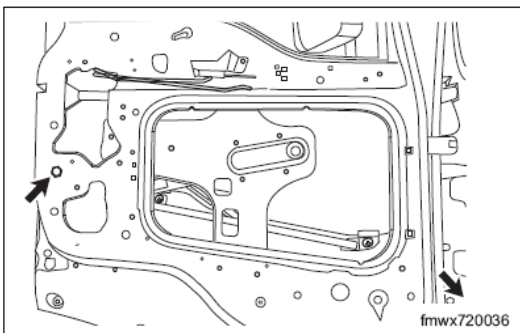
Note:

Take care not to drop the glass.



5 Dismantling of door guide rail assembly

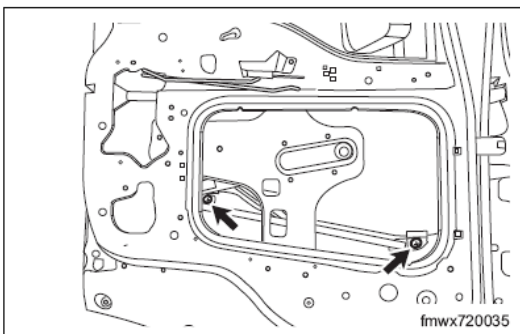
- (a) Remove set bolt of door guide rail.



6 Installation of door guide rail assembly

- (a) Install set bolt of door guide rail.

Torque: 9N.m



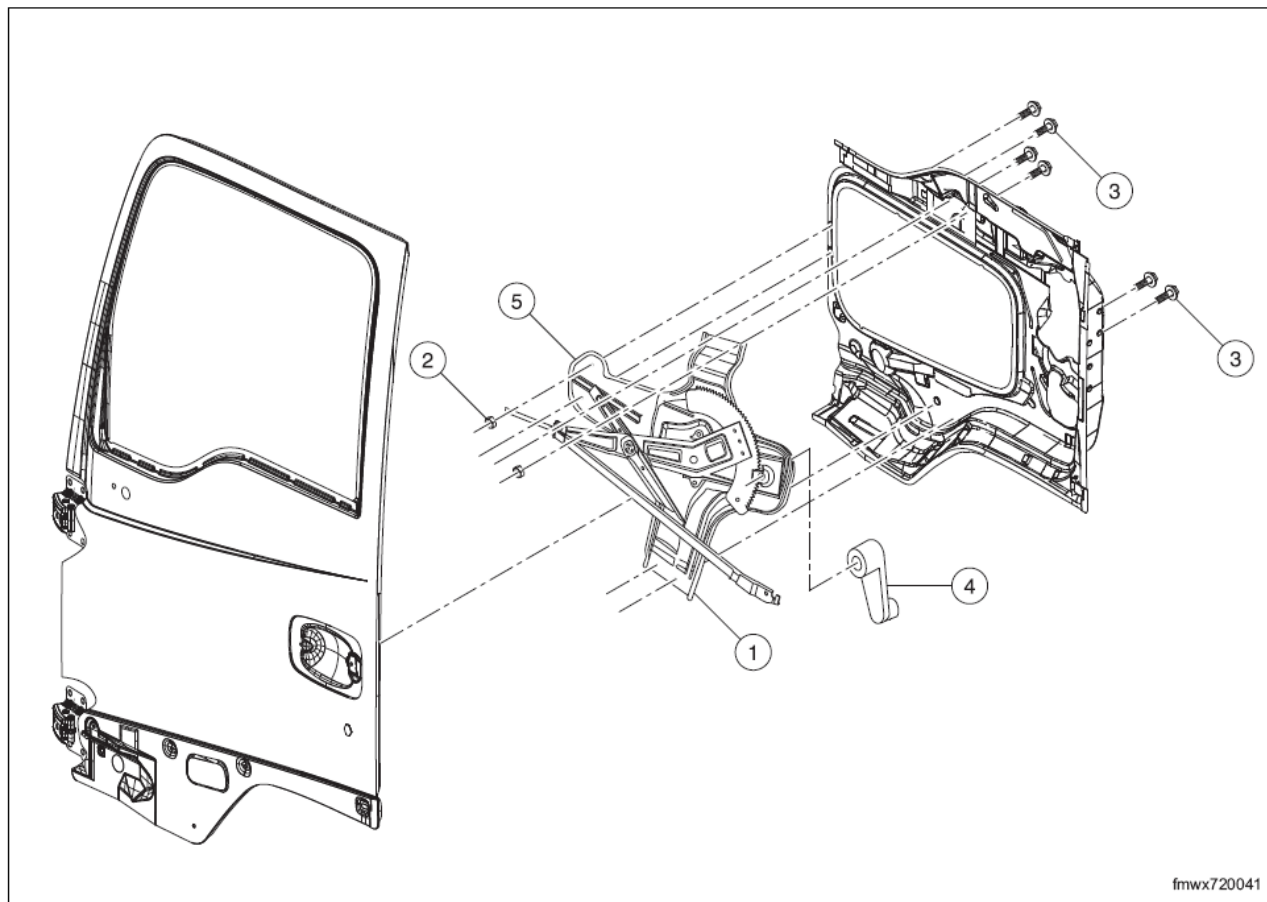
7 Installation of door glass assembly

- (a) Install door glass by tilting it about 45°.
- (b) Install set bolt of door glass.

-
- 8 Installation of door glass weather strip assembly**
 - 9 Installation of door rear waterproofing membrane.**
 - 10 Installation of door inner guard panel, see chapter 76 Interior/exterior inner guard panel, replacement**

WINDOW REGULATOR

DIAGRAM OF COMPONENTS



1	Window regulator assembly
2	Hexagon flange nut
3	Bolt, plain washer and spring washer assemblies

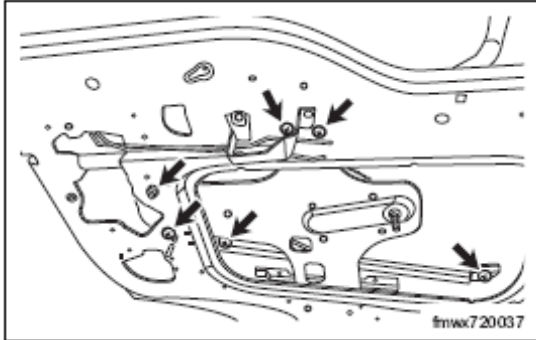
4	Regulator crank assembly
5	Regulator support plate assembly

SERVICE

Suggestion:

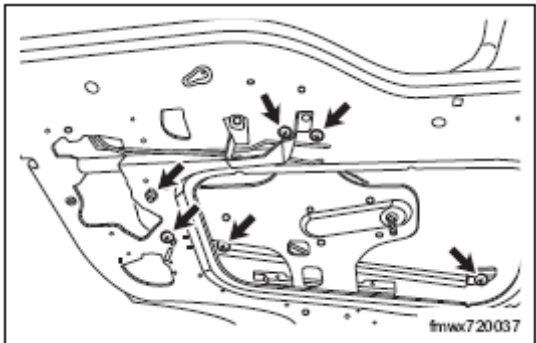
Diagram of Components, see chapter 72 Window regulator rearview mirror –window regulator, component diagram

1. **Dismantling of door inner guard panel, see chapter 76 Interior/exterior trimmings-door inner guard panel, replacement**
2. **Removal of door rear waterproofing membrane**
3. **Dismantling of door glass, see chapter 72 Window regulator rearview mirror-door glass, replacement**



4. **Dismantling of window regulator assembly**
 - (a) Dismantle set bolt and nut of window regulator.

5. **Check of window regulator assembly**
 - (a). Check if door window regulator deform, if any, replace it.
 - (b). Check if each moving roller wear and deform, if any, replace door glass regulator.
 - (c). Check rocker ratchet If fit clearance between rocker ratchet and meshing gear of window rocker arm is too big or any misalignment exists between these two components, replace door glass.
 - (d). Check rocker shaft. The rocker shaft should be rotated smoothly without clicking sound; otherwise, replace door glass regulator.



6. **Installation of window regulator assembly**

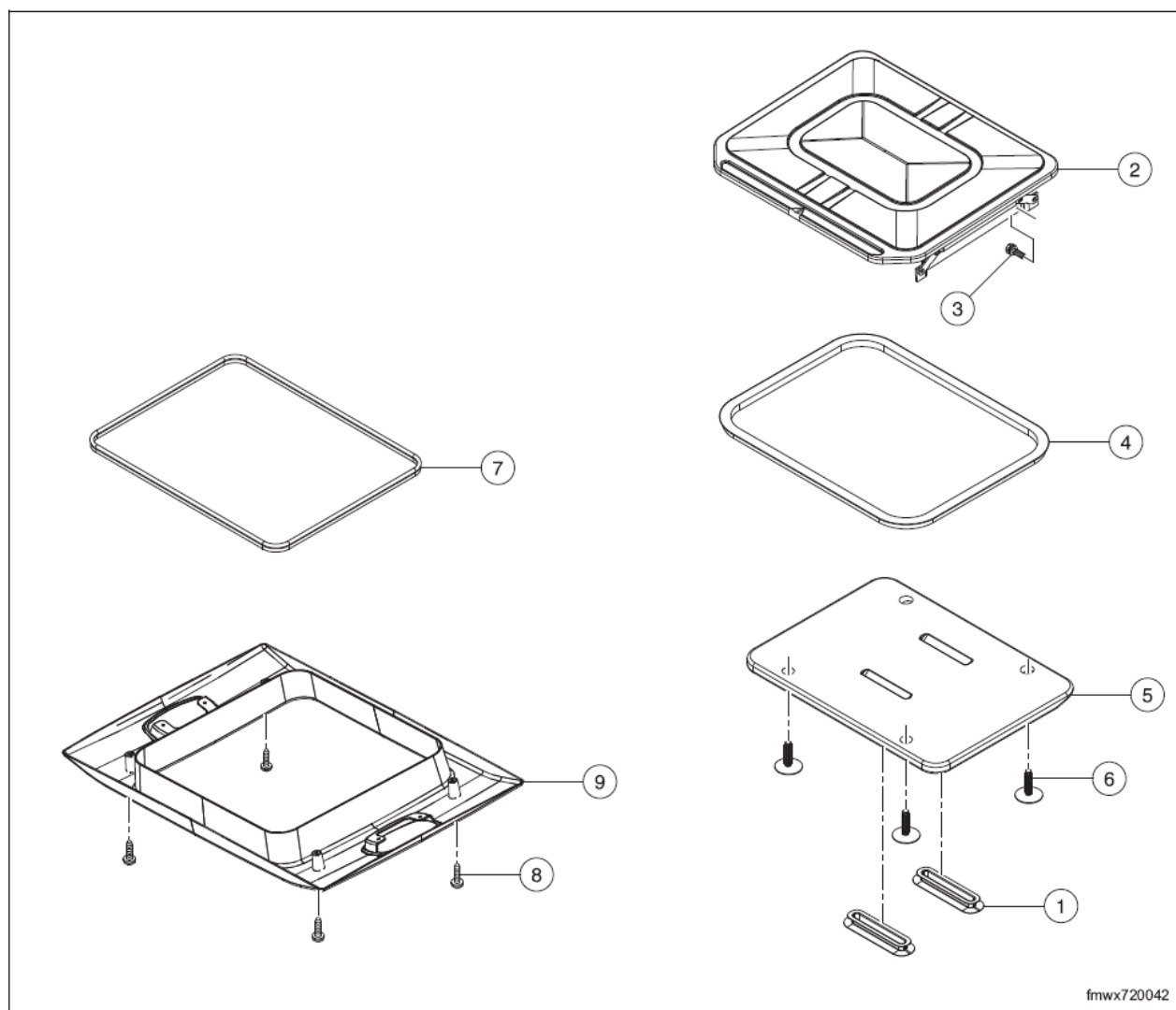
- (a). Install set bolt and nut of window regulator.

Torque: 9N.m

7. **Installation of door glass, see chapter 72 Window regulator rearview mirror-door glass, replacement**
8. **Installation of door rear waterproofing membrane**
9. **Installation of door inner guard panel, see chapter 76 interior/exterior trimmings-door inner guard panel, replacement**

SUNROOF

DIAGRAM OF COMPONENTS



72

1	Handle retainer
2	Sunroof cover assembly
3	Hexagon head bolt, plain washer and spring washer assemblies
4	Sunroof cover sealing strip
5	Top sunroof inner guard panel

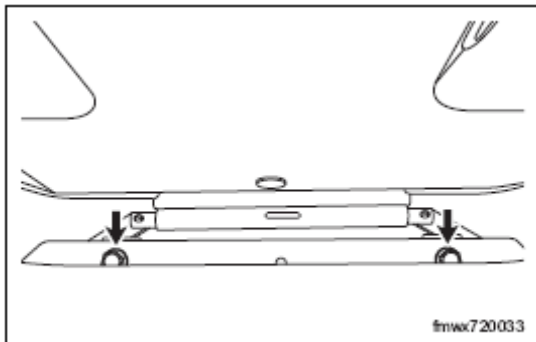
6	Large buckle
7	Sunroof opening sealing strip
8	Screw assemblies
9	Top sunroof protecting frame



REPLACEMENT

Suggestion:

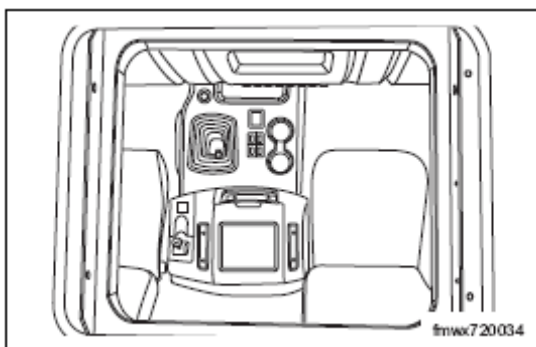
Diagram of Components, see chapter 72 Window regulator rearview mirror-sunroof, component diagram



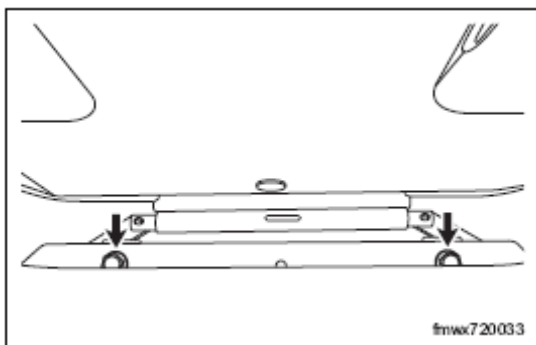
1. Dismantling of sunroof assembly

- (a). Open the sunroof.
- (b). Dismantle set bolt of the sunroof.

Note: there are two bolts respectively on the left and right sides.



- (c). Dismantle the sunroof.



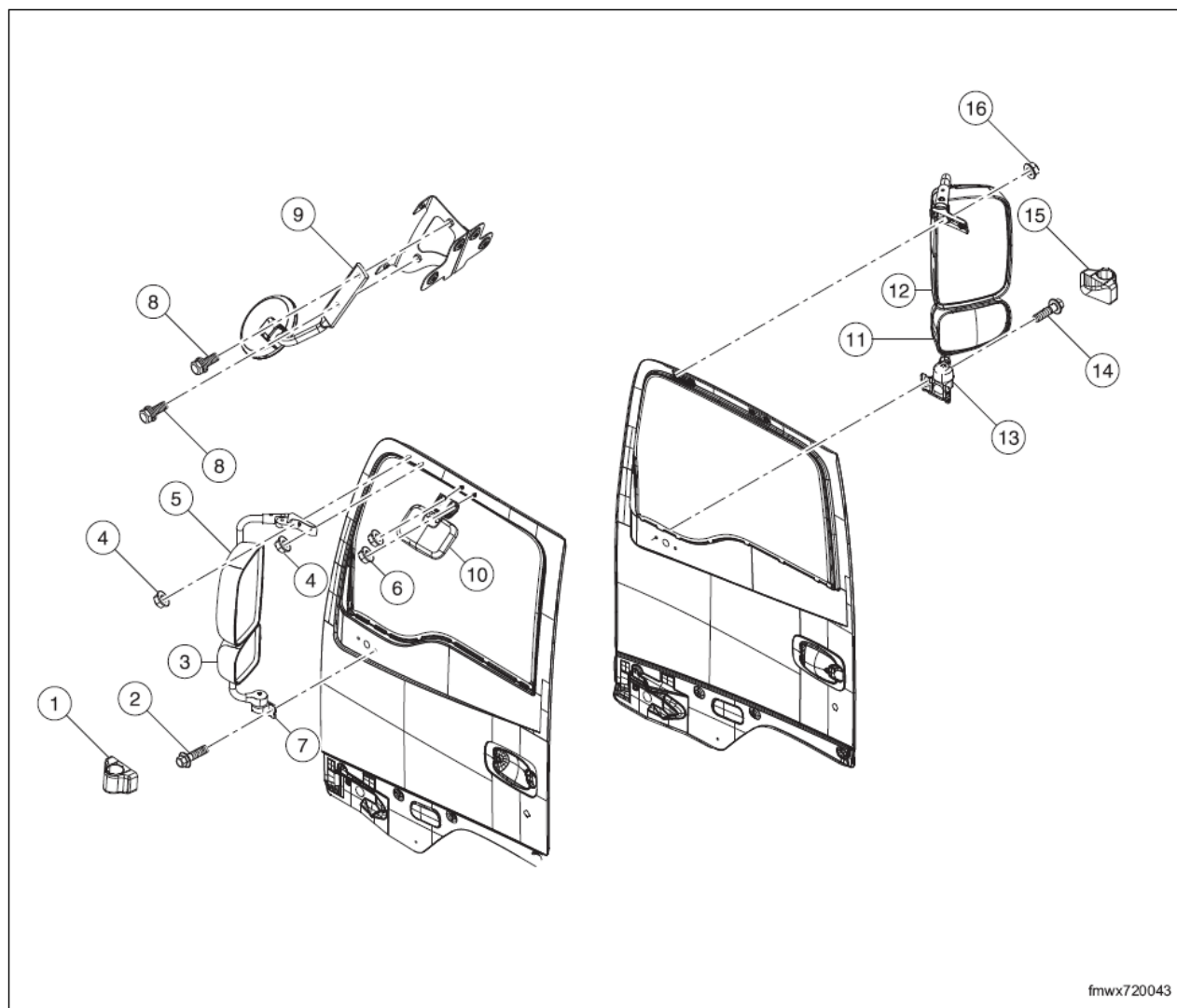
2. Installation of sunroof assembly

- (a). Install set bolt of the sunroof.

Note: there are two bolts respectively on the left and right sides.

REARVIEW MIRROR

DIAGRAM OF COMPONENTS



72

1	Left rearview mirror lower base trim cover plate	9	Front under-view mirror assembly (top)
2	Hexagon socket head screw	10	Side under-view mirror assembly
3	Left wide-angle lens body assembly	11	H3 wide-angle lens body
4	Hexagon flange nut	12	Right manual rearview mirror body assembly
5	Left manual rearview mirror body assembly	13	Right rearview mirror bracket assembly
6	Hexagon flange nut	14	Hexagon socket head screw
7	Left rearview mirror bracket assembly	15	Right rearview mirror lower base trim cover plate
8	Hexagon head bolt, spring washer and plain washer assemblies	16	Hexagon flange nut

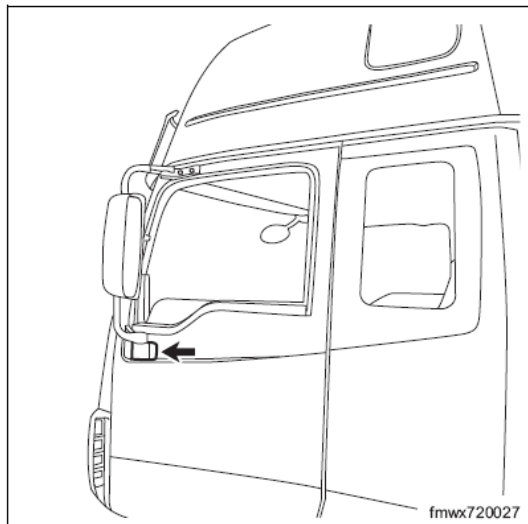


FOTON

REPLACEMENT

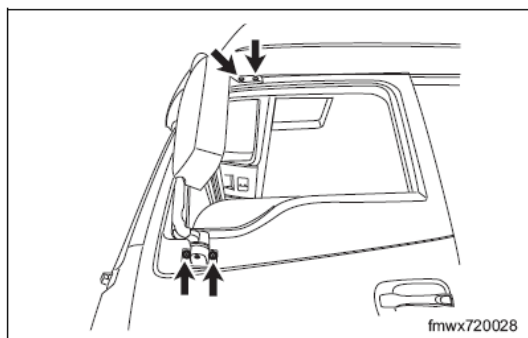
Suggestion:

Diagram of Components, see chapter 72 Window regulator rearview mirror- rearview mirror, component diagram

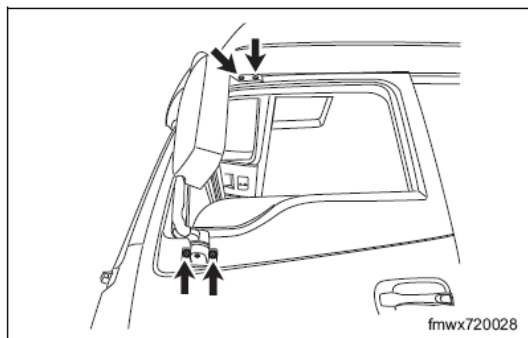


1. Dismantling of left rearview mirror assembly

- (a). Dismantle left rearview mirror lower cover plate.



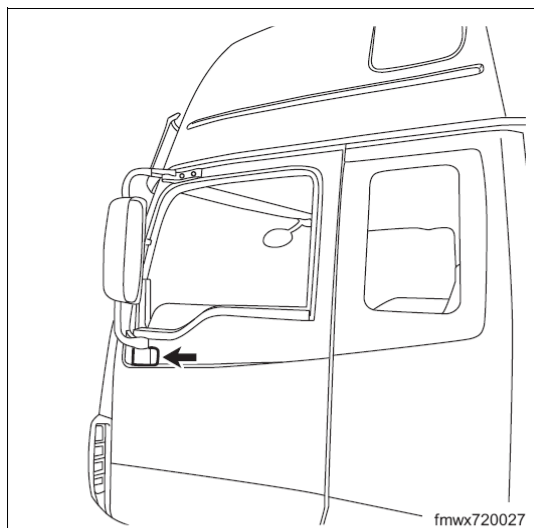
- (b). Dismantle hexagon socket set bolt and set nut of left rearview mirror.



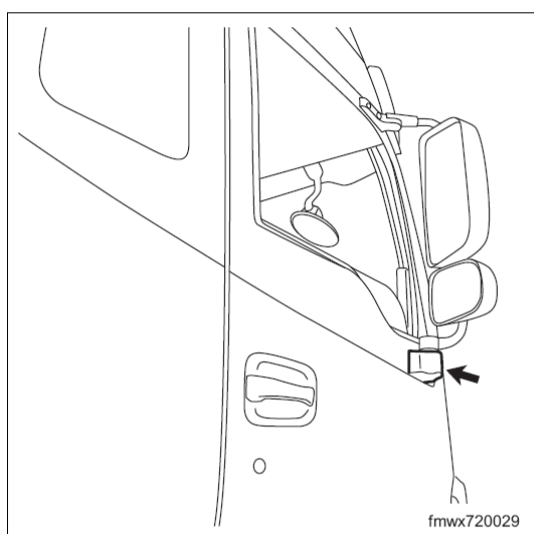
2. Installation of left rearview mirror

- (a). Install hexagon socket set bolt and set nut of left rearview mirror.

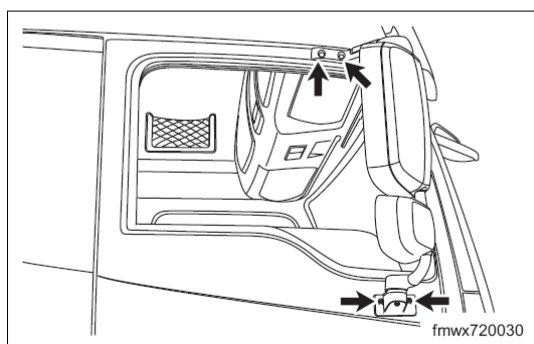
Torque: 20N.m



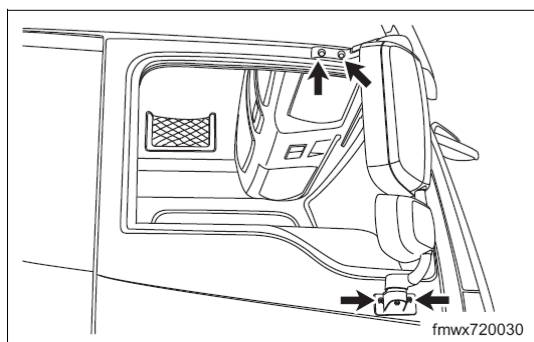
- (b) Install left rearview mirror lower cover plate.



- 3. Dismantling of right rearview mirror assembly**
(a). Dismantle right rearview mirror lower cover plate.

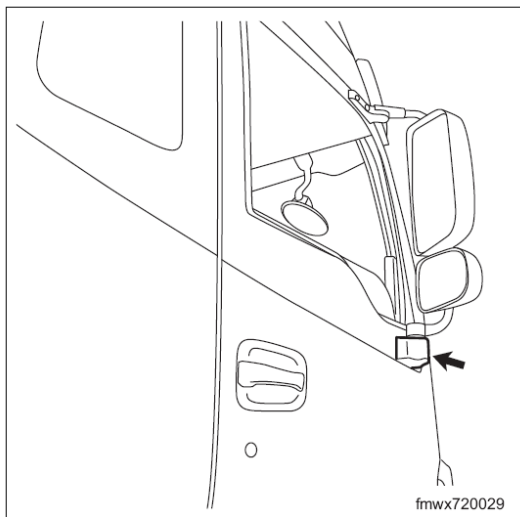


- (b). Dismantle hexagon socket set bolt and set nut of right rearview mirror.



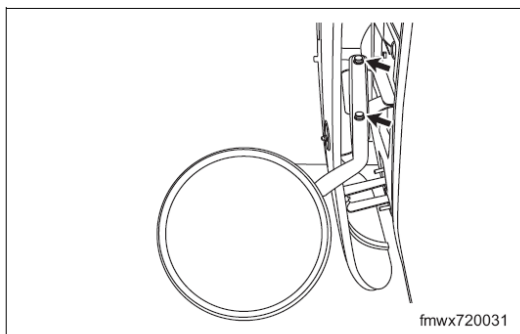
- 4. Installation of right rearview assembly**
(a). Install hexagon socket set bolt and set nut of right rearview mirror.
Torque: 20N.m

- (b). Install right rearview mirror lower cover plate.



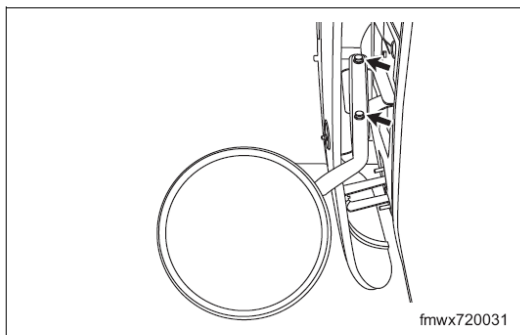
5. Dismantling of front under-view mirror assembly

- (a). Dismantle set bolt and nut of front under-view mirror.



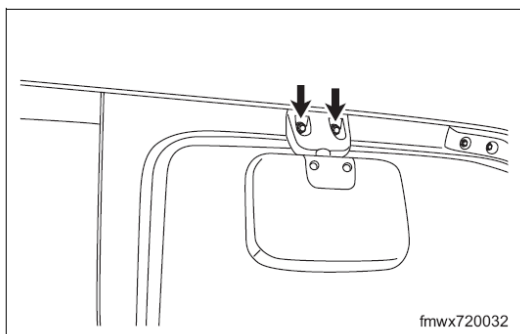
6. Installation of front under-view mirror assembly

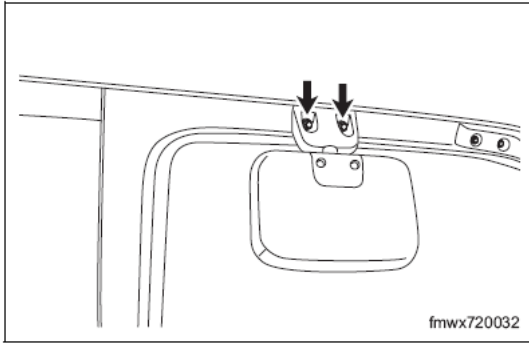
- (a). Install set bolt and nut of front under-view mirror.
Torque: 20N.m



7. Dismantling of side under-view mirror assembly

- (a). Dismantle set nut of side under-view mirror.





8. Installation of side under-view mirror assembly

(a) Install set nut of under-view mirror assembly.

Torque: 24N.m

INSTRUMENT CONSOLE, INSTRUMENTS, AND CIGARETTE LIGHTER

INSTRUMENT CONSOLE.....	73-3
Precautions	73-3
Diagram of Components	73-4
Replacement.....	73-5
COMBINATION INSTRUMENT	73-10
Diagram of Components	73-10
Replacement.....	73-11
CIGARETTE LIGHTER.....	73-13
Diagram of Components	73-13
Replacement.....	73-14



INSTRUMENT CONSOLE

PRECAUTIONS

1. **Disassembling the instrument panel will reset the clock on the combination instrument, however the total mileage will not be reset.**
2. **Disassembling the instrument panel will lead to loss of all saved settings of the audio system.**
 - (a). Reset the audio system after the instrument panel is re-installed.
3. **Cut off the power.**
 - (a). Before disassembling or installing any electric device or when any tool or equipment will easily come into contact with any exposed electric terminal, make sure to disconnect the cathode cable of the battery, in order to prevent injuring the personnel or damaging the vehicle.
 - (b). Make sure to turn off the ignition switch, unless otherwise specified.





1	Left speaker grille assembly
2	Hex head bolt, spring washer, and plain washer subassembly
3	Instrument panel subassembly
4	Right speaker grille assembly
5	Self-tapping screw
6	Right corner panel assembly
7	Left corner panel assembly
8	Phillips pan head self-tapping screw and plain washer subassembly
9	Middle panel assembly

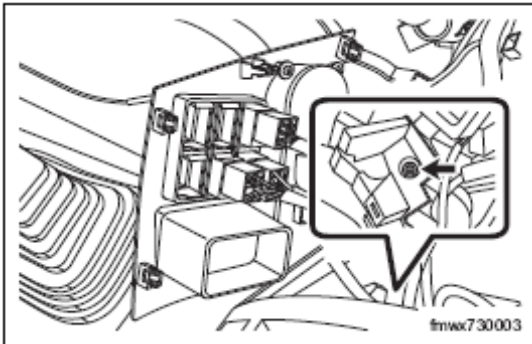
10	Driver trim panel assembly
11	Secondary driver skirt panel assembly
12	Middle lower skirt panel assembly
13	Middle trim panel assembly
14	Instrument panel shield assembly
15	Secondary driver trim panel assembly
16	Middle right panel assembly
17	Relay case cover assembly
18	ST4.2 clip-on nut

REPLACEMENT

Hint:

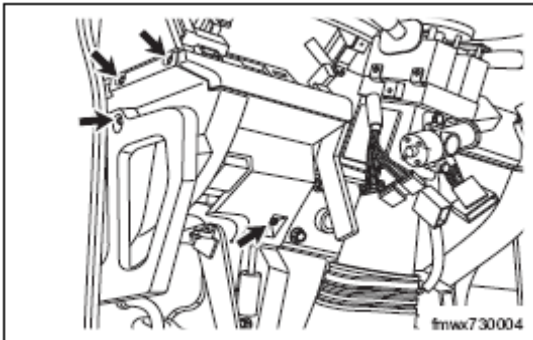
Please refer to Chapter 73 Instrument Console, Instruments, and Cigarette Lighter – Instrument Console, Diagram of Components for diagram of components.

1. Turn off the main power.
2. Position the steering wheel to the lowest position.
3. Disassemble the driver right trim panel assembly.
4. Disassemble the middle trim panel assembly.
5. Disassemble the secondary driver trim panel assembly.
6. Disassemble the combination instrument assembly (Refer to Chapter 73 Instrument Console, Instruments, and Cigarette Lighter – Combination Instrument, Replacement).
7. Disassemble the middle left panel assembly (Refer to Chapter 51 Heater and Air Conditioner – Control Component, Service).

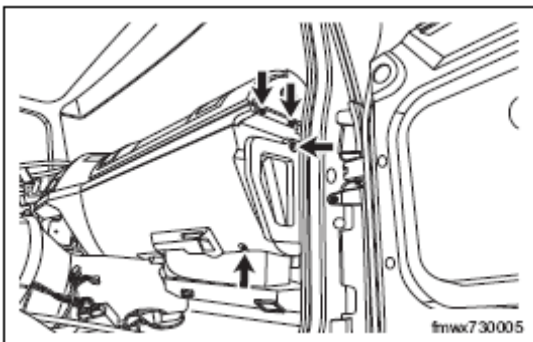


8. Disassemble the fixing screws between instrument console and instrument framework.

9. Disassemble the radio/audio player (Refer to Chapter 56 Audio System – Radio/Audio Player, Replacement).

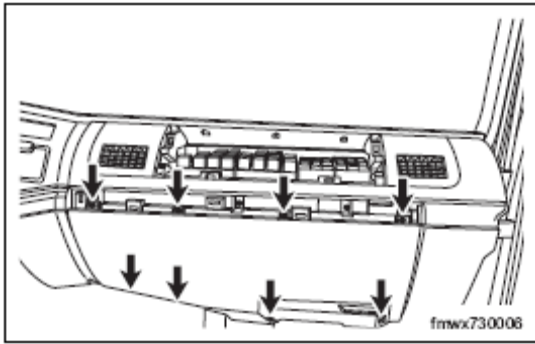


10. Disassemble the left corner panel assembly.
 - (a). Disassemble the fixing bolts from the left front pillar armrest.
 - (b). Disassemble the fixing screws of left corner panel and remove the left corner panel assembly.



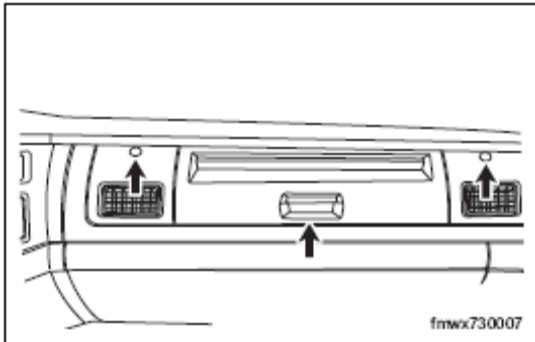
11. Disassemble the right corner panel assembly.
 - (a). Disassemble the fixing bolts from the right front pillar armrest.
 - (b). Disassemble the fixing screws of right corner panel and remove the right corner panel assembly.





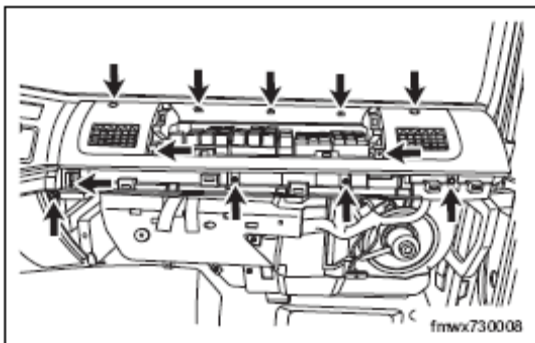
12. Disassemble the secondary driver skirt panel assembly.

- (a). Disassemble the fixing screws of secondary driver skirt panel.



13. Disassemble the secondary driver panel assembly.

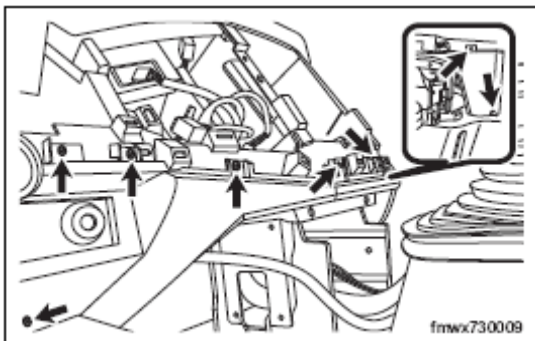
- (a). Disassemble the relay case cover and remove the plugs on both sides.



- (b). Disassemble the fixing screws of secondary driver panel.

14. Disassemble the middle platform rear assembly (Refer to Chapter 73 Instrument Console Instrument Cigarette Lighter – Cigarette Lighter, Replacement).

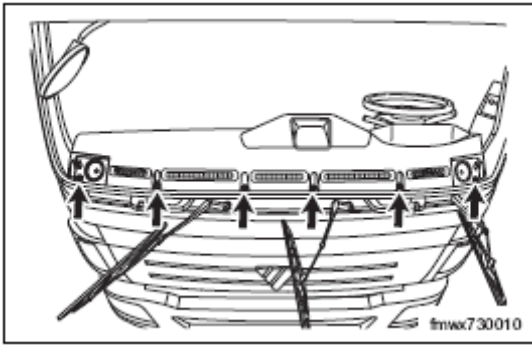
15. Disassemble the middle platform front assembly (Refer to Chapter 73 Instrument Console Instrument Cigarette Lighter – Cigarette Lighter, Replacement).



16. Disassemble the middle lower skirt panel assembly.

- (a). Disassemble the fixing screws of middle lower skirt panel.

17. Disassemble the speaker assembly (Refer to Chapter 56 Audio System – Speaker, Replacement).

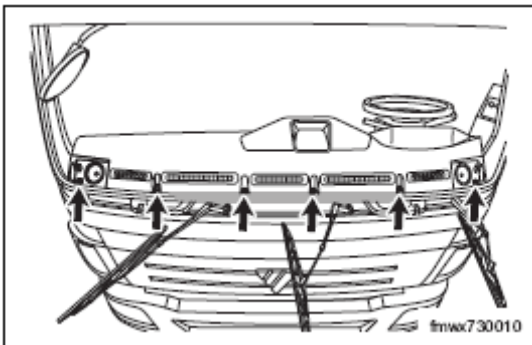


18. Disassemble the instrument panel subassembly.

- (a). Disassemble the fixing bolts of instrument panel subassembly and remove the instrument panel subassembly.

Notice:

Do not damage the surfaces of instrument panel. Place the instrument panel subassembly within a dry and ventilated indoors room far away from the heat source and chemicals. While handling the instrument panel subassembly, handle through the cooperation from multiple operators.



19. Install the instrument panel subassembly.

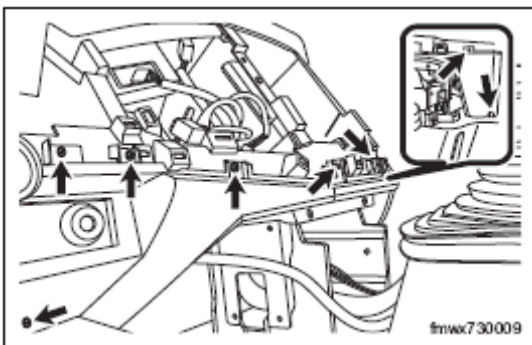
- (a). Install the fixing bolts of instrument panel subassembly.

Torque: 40N·m

Notice:

Do not squeeze or twist the harness.

20. Install the speaker assembly (Refer to Chapter 56 Audio System – Speaker, Replacement).

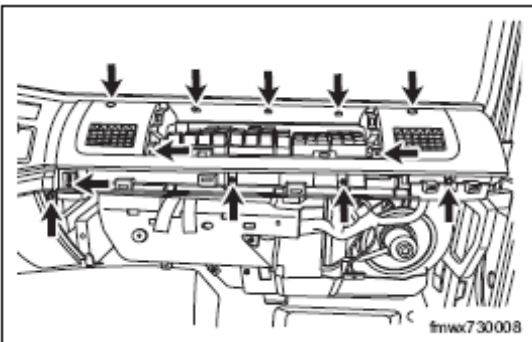


21. Install the middle lower skirt panel assembly.

- (a). Install the fixing screws of middle lower skirt panel.

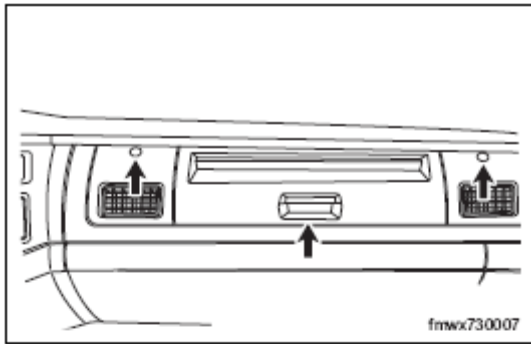
22. Install the middle platform front assembly (Refer to Chapter 73 Instrument Console, Instruments, and Cigarette Lighter – Cigarette Lighter, Replacement).

23. Install the middle platform rear assembly (Refer to Chapter 73 Instrument Console, Instruments, and Cigarette Lighter – Cigarette Lighter, Replacement).

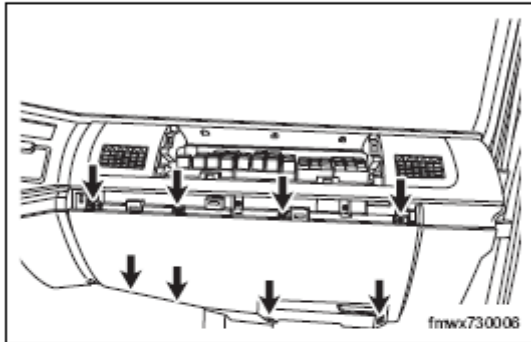


24. Install the secondary driver panel assembly.

- (a). Install the fixing screws of secondary driver panel.

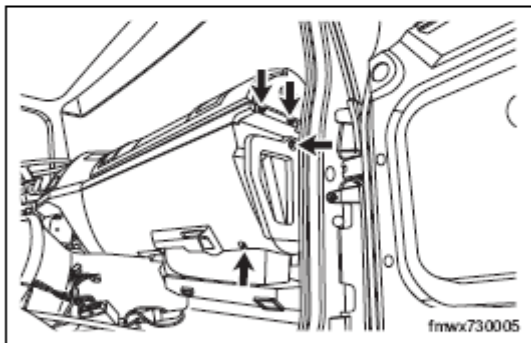


- (b). Install the relay case cover and install the plugs on both sides.



25. Install the secondary driver skirt panel assembly.

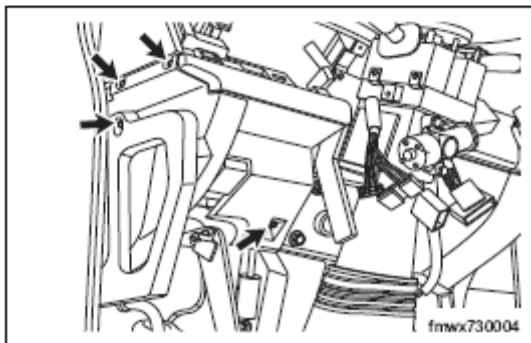
- (a). Install the fixing screws of secondary driver skirt panel.



26. Install the right corner panel assembly.

- (a). Install the fixing screws of right corner panel.
(b). Install the fixing bolts on the right front pillar armrest.

Torque: 8N·m

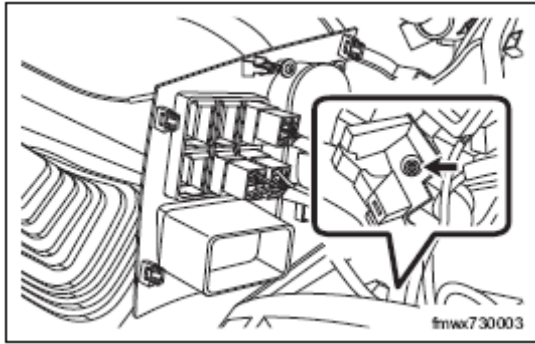


27. Install the left corner panel assembly.

- (a). Install the fixing screws of left corner panel.
(b). Install the fixing bolts on the left front pillar armrest.

Torque: 8N·m

28. Install the radio/audio player (Refer to Chapter 56 Audio System – Radio/Audio Player, Replacement).

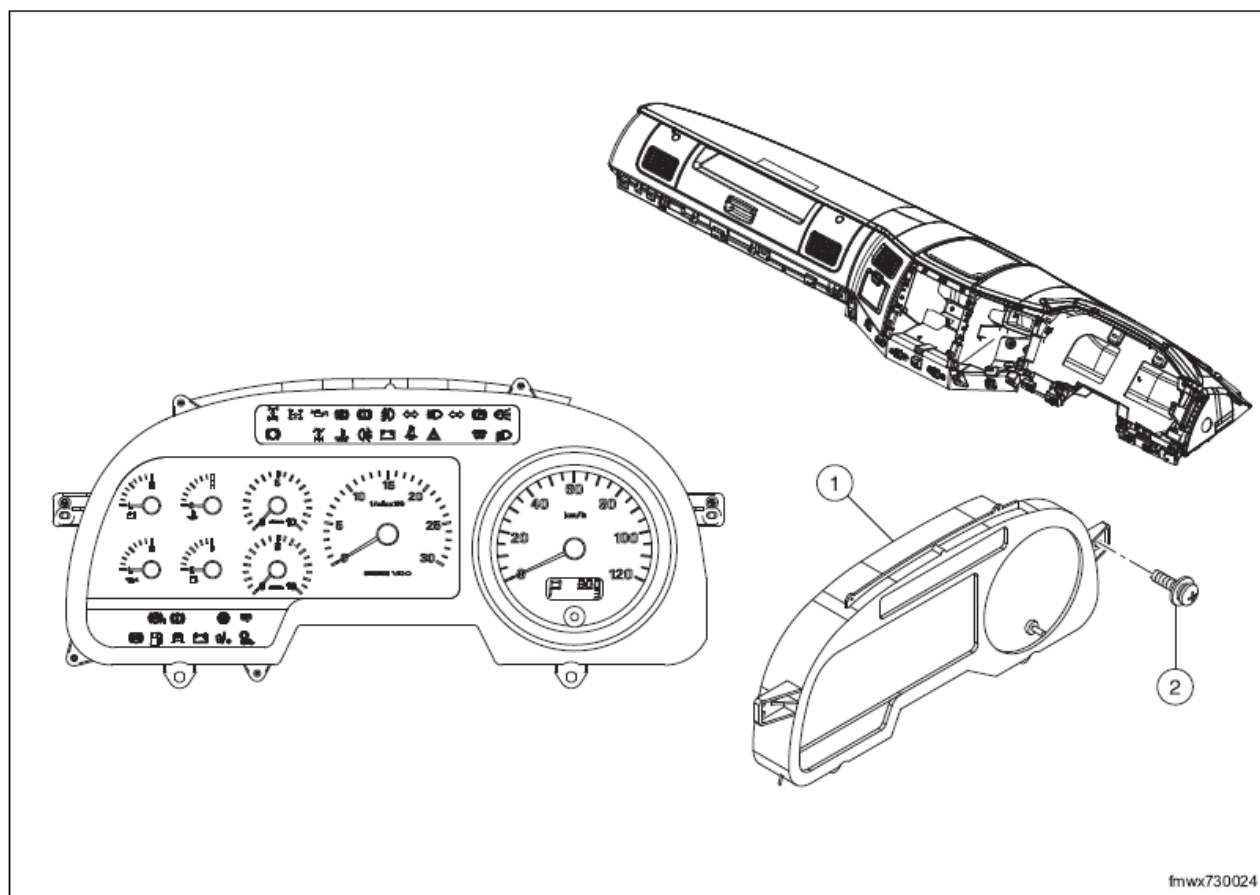


29. Install the fixing screws between instrument console and instrument framework.

30. Install the middle left panel assembly (Refer to Chapter 51 Heater and Air Conditioner – Control Component, Service).
31. Install the combination instrument assembly (Refer to Chapter 73 Instrument Console, Instruments, and Cigarette Lighter – Combination Instrument, Replacement).
32. Install the secondary driver trim panel assembly
33. Install the middle trim panel assembly.
34. Install the driver right trim panel assembly.
35. Adjust the steering wheel to an appropriate position.
36. Turn on the main power.

COMBINATION INSTRUMENT

DIAGRAM OF COMPONENTS



1

Combination instrument assembly

2

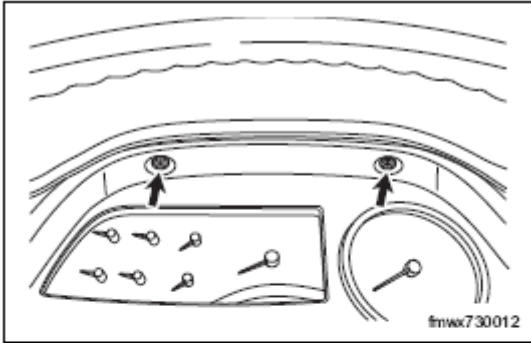
Phillips pan head self-tapping screw
and plain washer subassembly

REPLACEMENT

Hint:

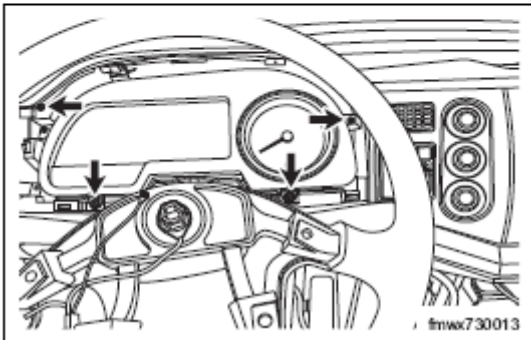
Please refer to Chapter 73 Instrument Console, Instruments, and Cigarette Lighter – Combination Instrument, Diagram of Components for diagram of components.

1. Turn off the main power.
2. Position the steering wheel to the lowest position.



3. Disassemble the instrument face shield assembly.

- (a). Disassemble the fixing screws of the instrument face shield and pull out the instrument face shield assembly backward.



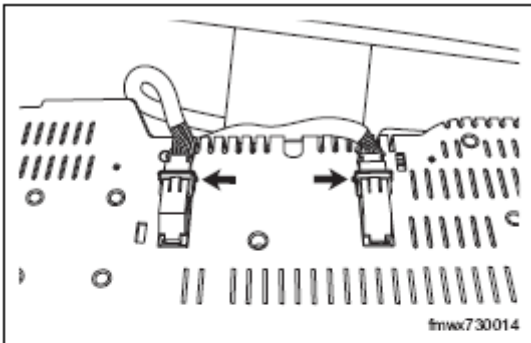
4. Disassemble the combination instrument assembly.

- (a). Disassemble the fixing screws of the combination instrument.

- (b). Disassemble the connector of combination instrument assembly.

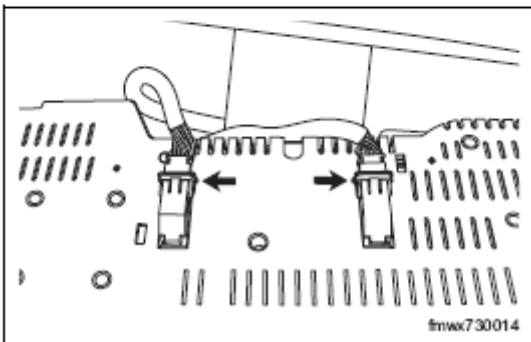
Notice:

While unplugging the connector, grasp the harness connector, instead of the harness.

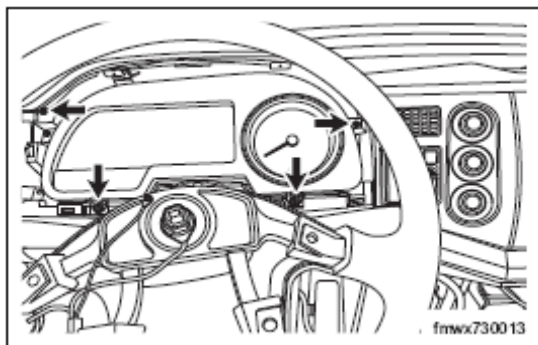


5. Install the combination instrument assembly.

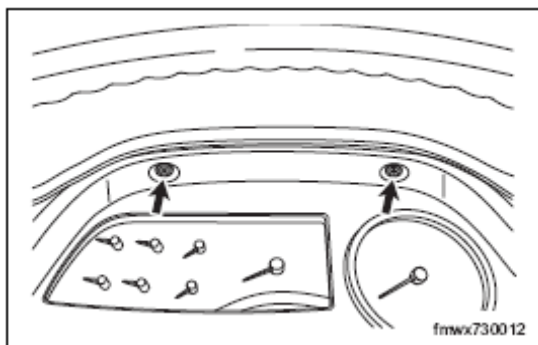
- (a). Install the connector of combination instrument assembly.



73-12 INSTRUMENT CONSOLE, INSTRUMENTS, AND CIGARETTE LIGHTER-COMBINATION INSTRUMENT



- (b). Install the fixing screws of the combination instrument.



6. Install the instrument face shield assembly.

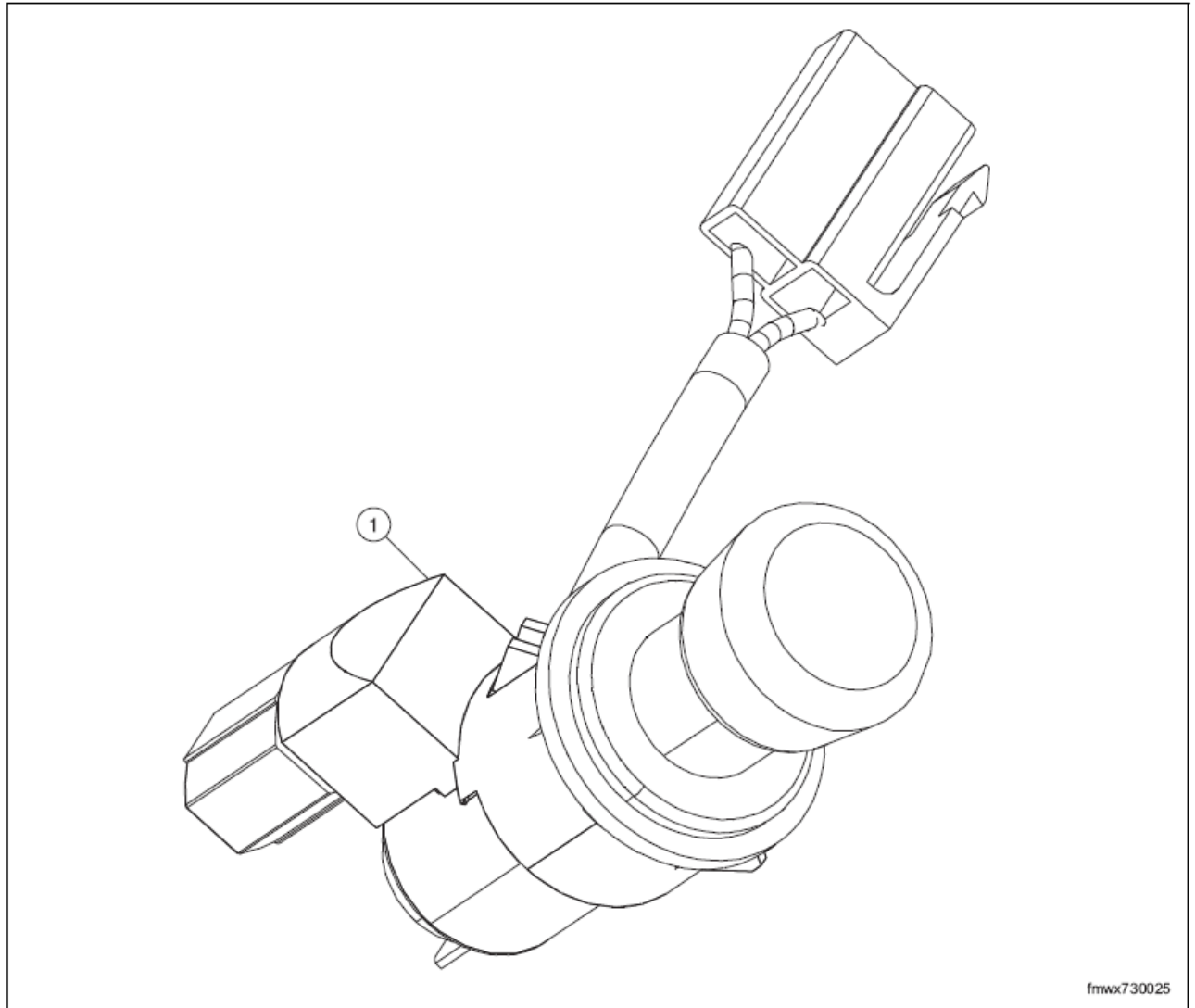
- (a). Install the fixing screws of the instrument face shield.

7. Adjust the steering wheel to an appropriate position.

8. Turn on the main power.

CIGARETTE LIGHTER

DIAGRAM OF COMPONENTS



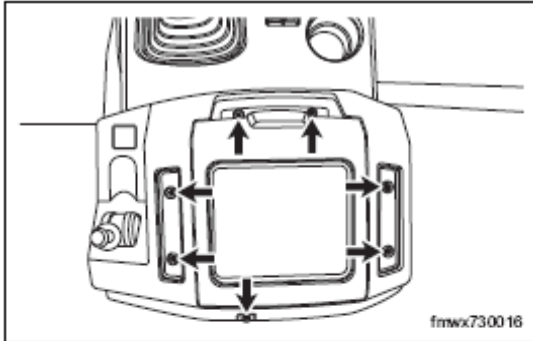
1	Cigarette lighter assembly
---	----------------------------

REPLACEMENT

Hint:

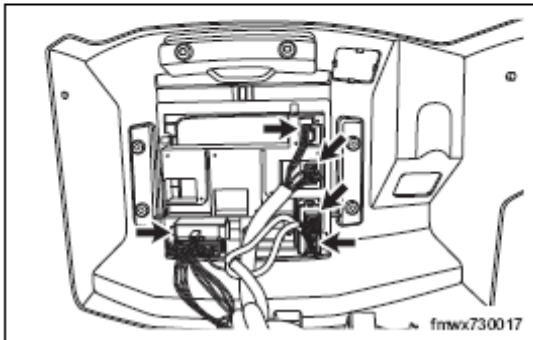
Please refer to Chapter 73 Instrument Console, Instruments, and Cigarette Lighter – Cigarette Lighter, Diagram of Components for diagram of components.

1. Turn off the ignition switch.
2. Unplug the cigarette lighter head.

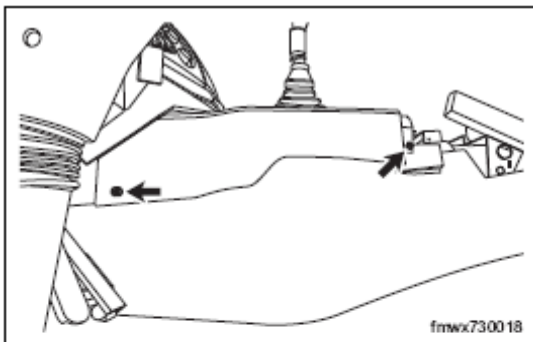


3. Disassemble the middle platform rear assembly.

- (a). Disassemble the fixing screws of the middle platform rear assembly and remove the middle platform rear assembly.

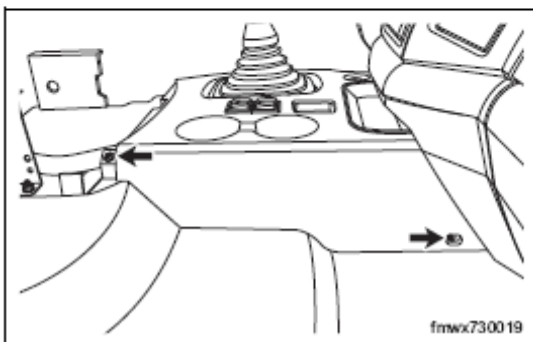


- (b). Disconnect the connectors of all components.

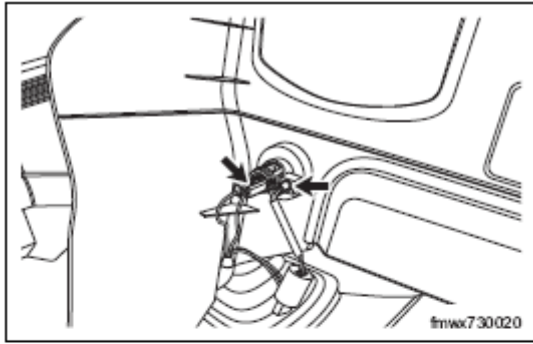


4. Disassemble the middle platform front assembly.

- (a). Disassemble the left fixing screws of the middle platform front assembly.

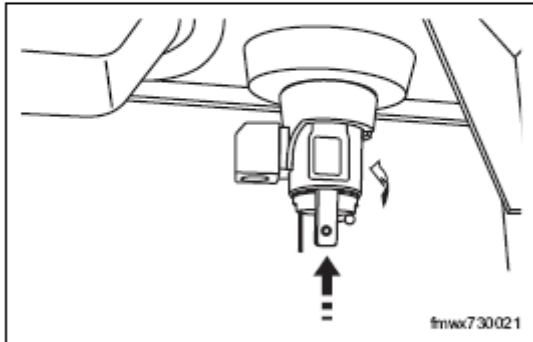


- (b). Disassemble the right fixing screws of the middle platform front assembly.

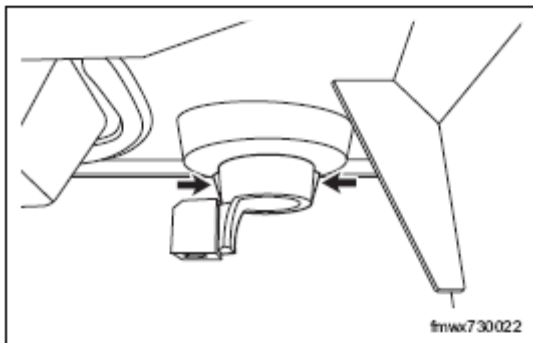


5. Disassemble the cigarette lighter base assembly.

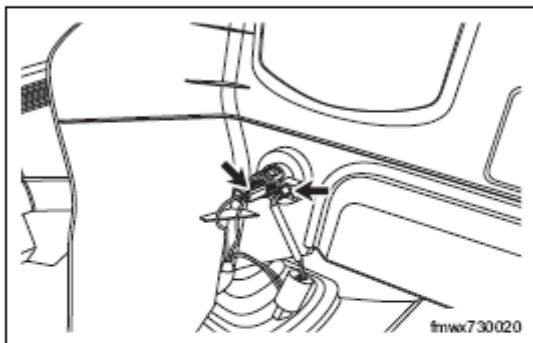
- (a). Upturn the middle platform front assembly and disconnect the power connector of cigarette lighter.
- (b). Remove the lighting lamp of cigarette lighter base.



- (c). From the rear end, rotate the inner ring of cigarette lighter base by approximate 60° and then push out.

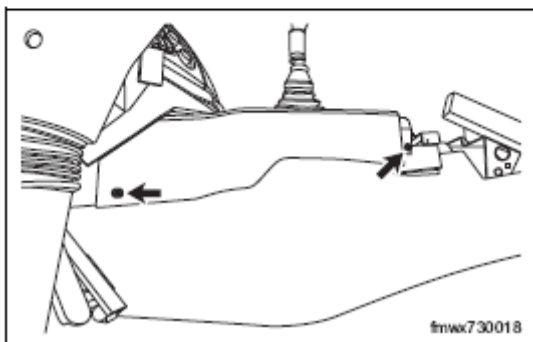


- (d). Loosen the clamp of the cigarette lighter lighting lamp holder with nipper pliers and remove the lighting lamp holder.



6. Install the cigarette lighter base assembly.

- (a). Install the cigarette lighter lighting lamp holder and cigarette lighter base.
- (b). Install the power connector of cigarette lighter and then install the cigarette lighter base lighting lamp.

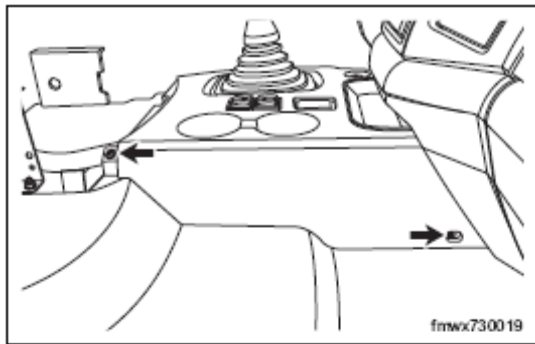


7. Install the middle platform front assembly.

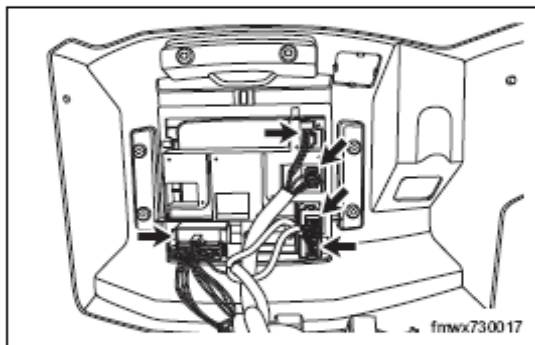
- (a). Install the left fixing screws of the middle platform front assembly.

73-16

INSTRUMENT CONSOLE, INSTRUMENTS, AND CIGARETTE LIGHTER-CIGARETTE LIGHTER

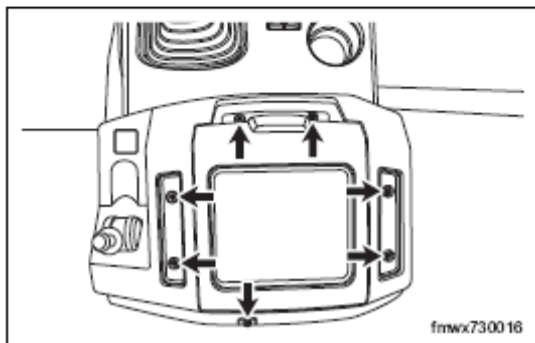


- (b) Install the right fixing screws of the middle platform front assembly.



8. Install the middle platform rear assembly.

- (a). Install the connectors of all components.



- (b). Install the fixing screws of middle platform rear assembly.

9. Insert the cigarette lighter head.

10. Turn on the ignition switch and confirm that the cigarette lighter functions normally.

SEATS

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SEAT ASSEMBLY

OVERVIEW

The driver seat of heavy duty truck is classified into three types, namely airbag damping deluxe type, hydraulic damping standard type, and steel bracket comfort type. The airbag damping deluxe type driver seat:

The seat damping function can automatically adjust depending on the dead weight of the driver, featuring outstanding comfort; The seat damping airbag adopts the German imported original parts, featuring predominant reliability and durability. The airbag damping deluxe type driver seat features headrest adjustment, waist support adjustment, and armrest adjustment functions, with optional electric seat heating function, to guarantee the safe and comfortable driving of the driver.

PRECAUTIONS

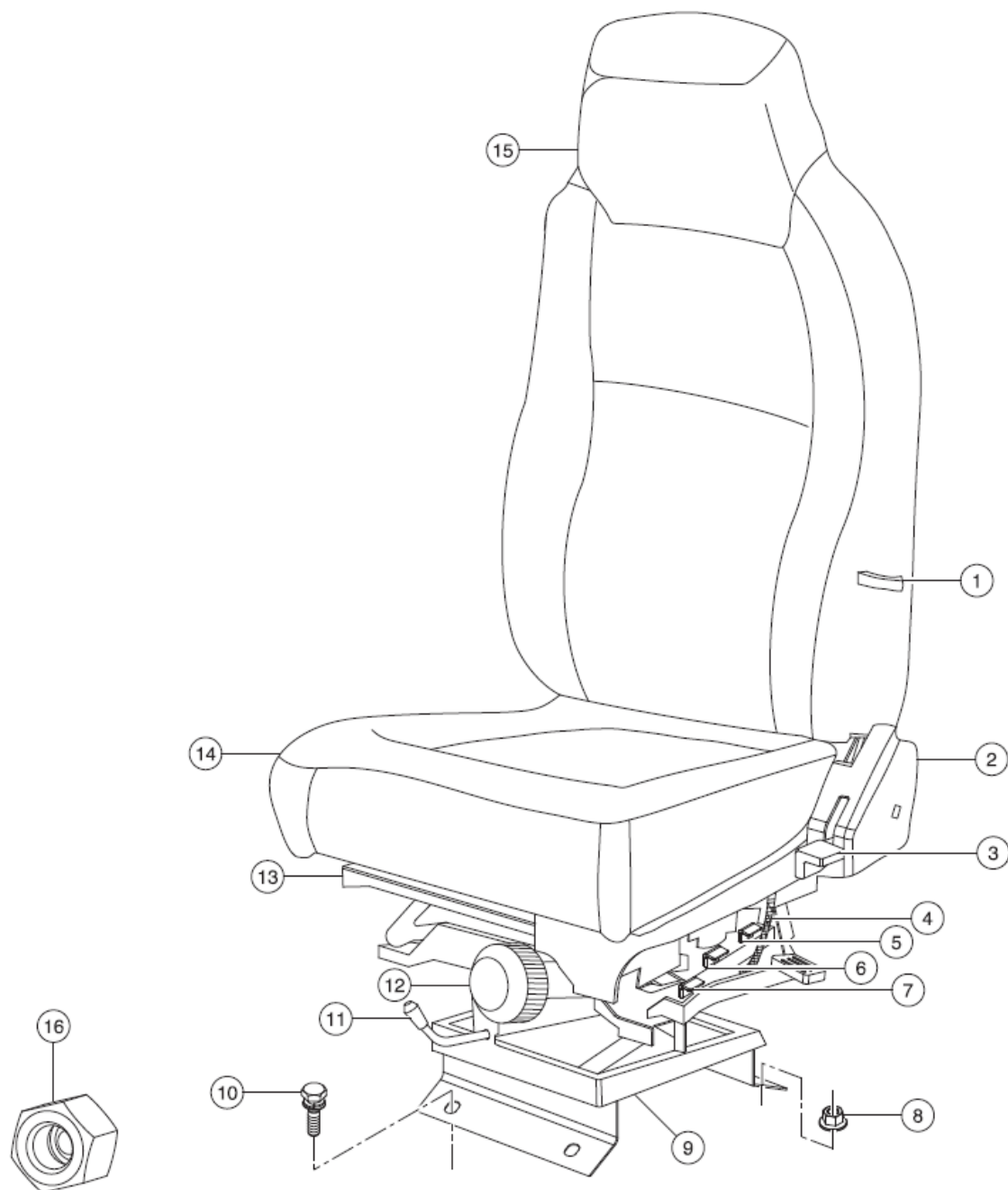
1. Do not place any tool or foreign material beneath the driver seat, in order to prevent impairing the operation function and service life of the seat. Keep clean the damper system and timely remove any foreign material dropped therein.
2. While approaching a very bumpy road, please timely lift the front hooks of the damper to lock the damper and exert the protection function.
3. If there is someone sleeping on the high top sleeper, please timely engage four hooks of the high top sleeper protection net, in order to prevent the roll-off of the one on the high top sleeper in event of the braking or turning of the vehicle.

Please pay attention to the following items at interval of 10,000 km mileage:

1. Check the bolts and nuts at all portions of the seat for looseness. In event of any looseness, please timely tighten the loose bolts or nuts.
2. Periodically clean the dirt from the adjustment mechanism and add lithium-based lubricating oil into the slide groove.
3. For airbag damping deluxe driver seat, check the air valve and air cock for fall-off and air leakage. If any, timely repair or replace the air valve or air cock.
4. The seat is composed of the damper system, lifter mechanism, slideway, and angle adjuster, all of which are bolted together. If any mechanism is damaged, make sure to replace such mechanism subassembly.
5. The wearing parts including the angle adjuster lever and cover, slideway lever, and waist support lever can be replaced separately.

DRIVER SEAT

DIAGRAM OF COMPONENTS



fmwx740021

SEATS-DRIVER SEAT**74-5**

1	Waist adjustment lever
2	Heavy duty truck angle adjuster assembly (left)
3	Angle adjuster lever
4	Slideway adjustment cable assembly
5	Seat cushion rear lifting lever
6	Seat cushion front lifting lever
7	Slideway adjustment lever
8	Hexagon flange nut

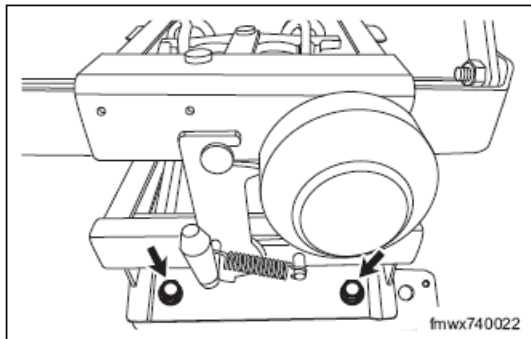
9	Hydraulic damping mechanism assembly
10	Hex head bolt, spring washer, and plain washer subassembly
11	Damper locking lever
12	Weight adjustment rotation lever
13	Seat base and adjustment mechanism assembly
14	Hydraulic damping seat cushion assembly
15	Hydraulic damping seat backrest assembly
16	Plug



DISASSEMBLY AND INSTALLATION

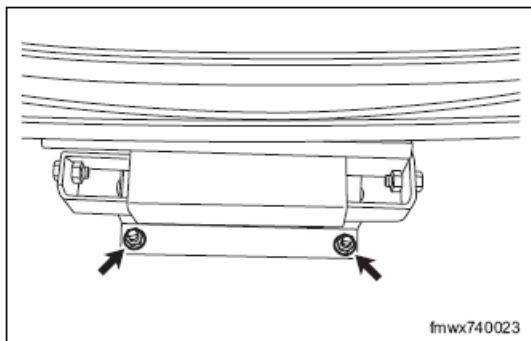
Hint:

Please refer to Chapter 74 Seats – Driver Seat, Diagram of Components for the diagram of the components.

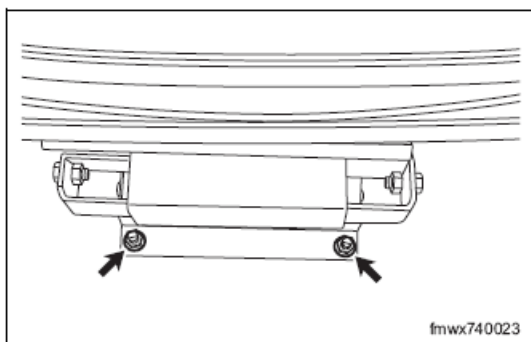


1. Disassemble the fixing bolts and nuts of driver seat.

- (a). Slide the driver seat to the rear end of the slideway.
- (b). Disassemble the front fixing bolts of driver seat.



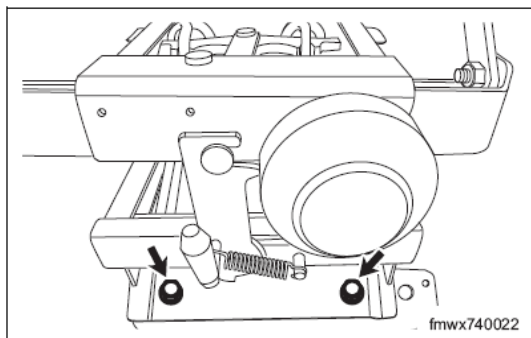
- (c). Slide the driver seat to the front end of the slideway.
- (d). Disassemble the rear fixing nuts of driver seat to remove the driver seat.



2. Install the fixing bolts and nuts of driver seat.

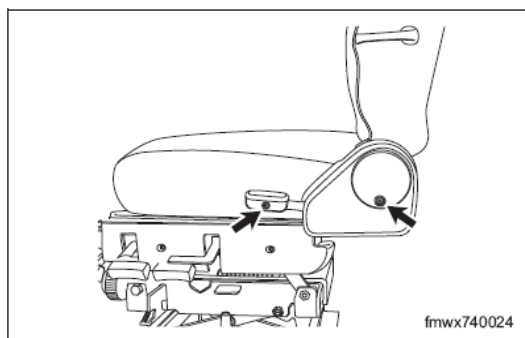
- (a). Place the driver seat to the installation location and install the rear fixing nuts.

Torque: 40N.m



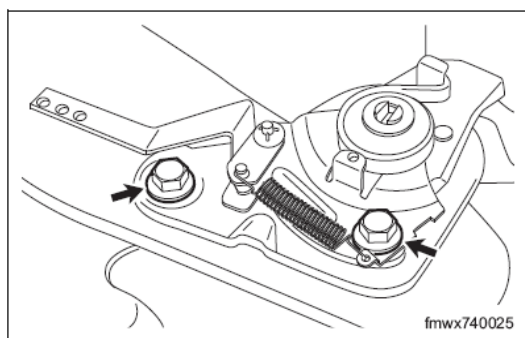
- (b). Slide the driver seat to the rear end of the slideway.
- (c). Install the front fixing bolts of driver seat.
Torque: 40N.m

DISASSEMBLY AND ASSEMBLY

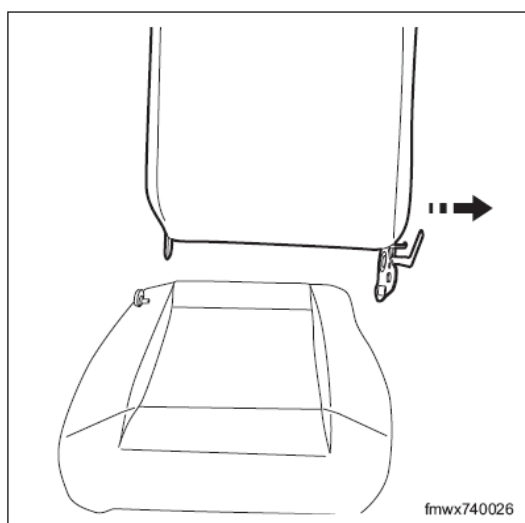


1. Disassemble the driver seat backrest assembly.

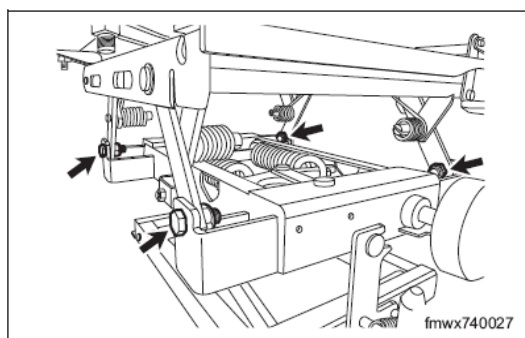
(a). Remove the backrest angle adjuster lever and disassemble the angle adjuster cover screws.



(b). Disassemble the fixing bolts of backrest angle adjuster assembly.



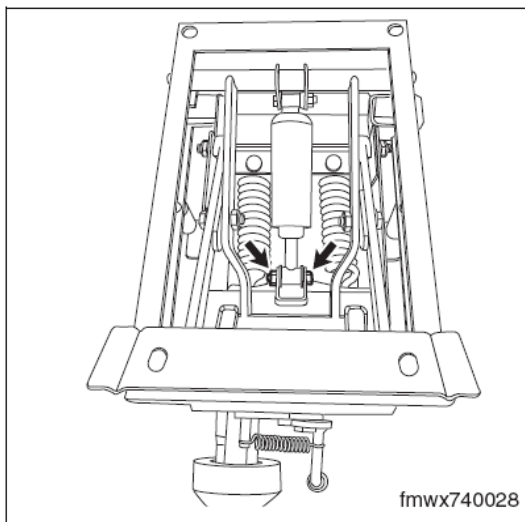
(c). Disassemble the driver seat backrest assembly.



2. Disassemble the driver seat slideway assembly.

(a). Disassemble the fixing nuts of driver seat slideway assembly.

(b). Disassemble the driver seat slideway assembly.

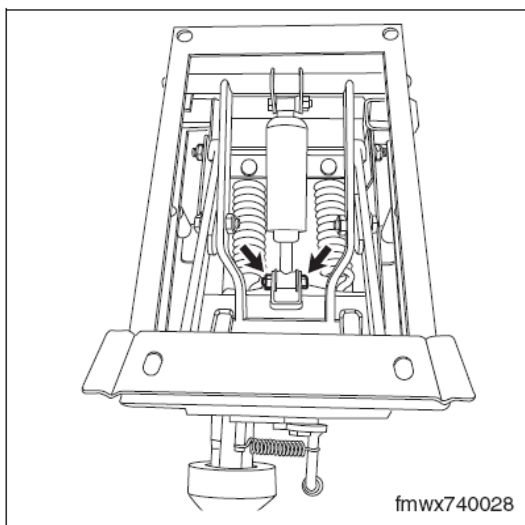


3. Disassemble the driver seat damper assembly.

- (a). Disassemble the fixing nuts of driver seat damper.
- (b). Disassemble the driver seat damper assembly.

Notice:

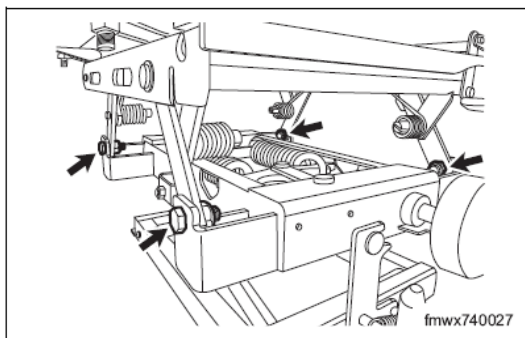
Before disassembling the driver seat damper, adjust the weight adjustment rotation lever to minimum weight position.



4. Install the driver seat damper assembly.

- (a). Install the fixing nuts of driver seat damper.

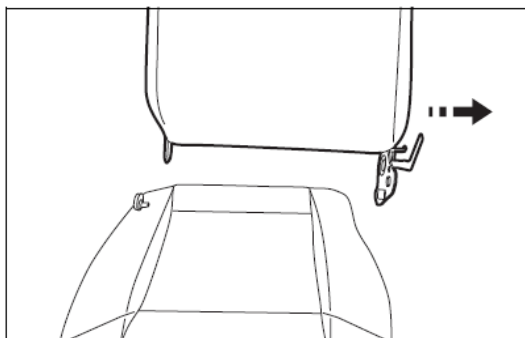
Torque: 63N.m



5. Install the driver seat slideway assembly.

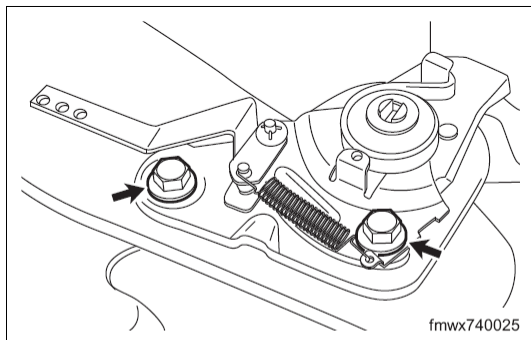
- (a). Install the fixing nuts of driver seat slideway assembly.

Torque: 63N.m



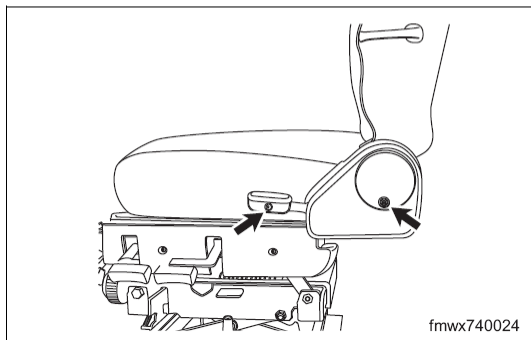
6. Install the driver seat cushion assembly.

- (a). Install the driver seat backrest assembly.



- (b) Install the fixing bolts of backrest angle adjuster assembly.

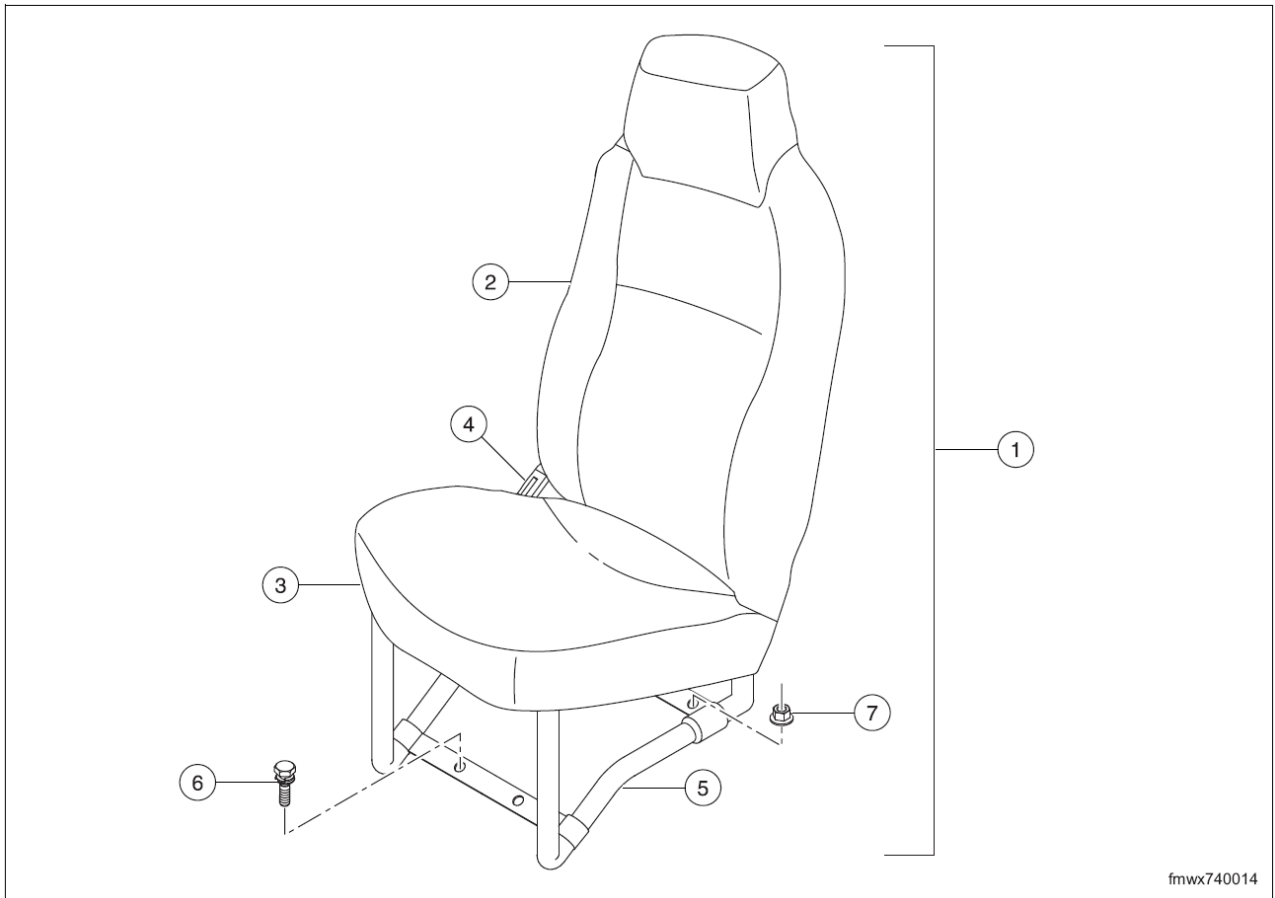
Torque: 63N.m



- (c). Install the angle adjuster lever and install the angle adjuster cover screws.

SECONDARY DRIVER SEAT

DIAGRAM OF COMPONENTS



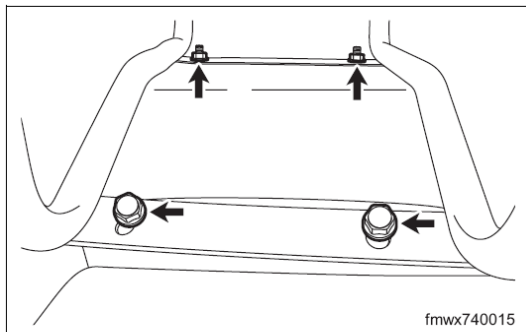
1	Secondary driver seat assembly
2	Backrest assembly
3	Seat cushion assembly
4	Angle adjuster assembly

5	Driver base mechanism assembly
6	Hex head bolt, spring washer, and plain washer subassembly
7	Hexagon flange nut

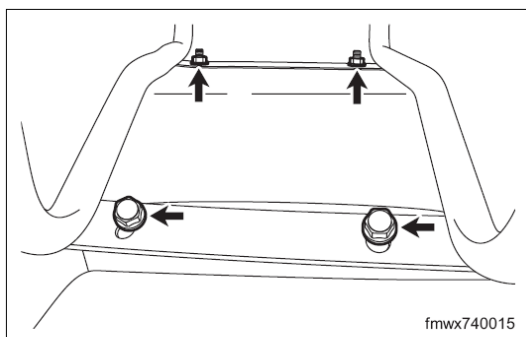
REPLACEMENT

Hint:

Please refer to Chapter 74 Seats – Secondary Driver Seat, Diagram of Components for the diagram of the components.



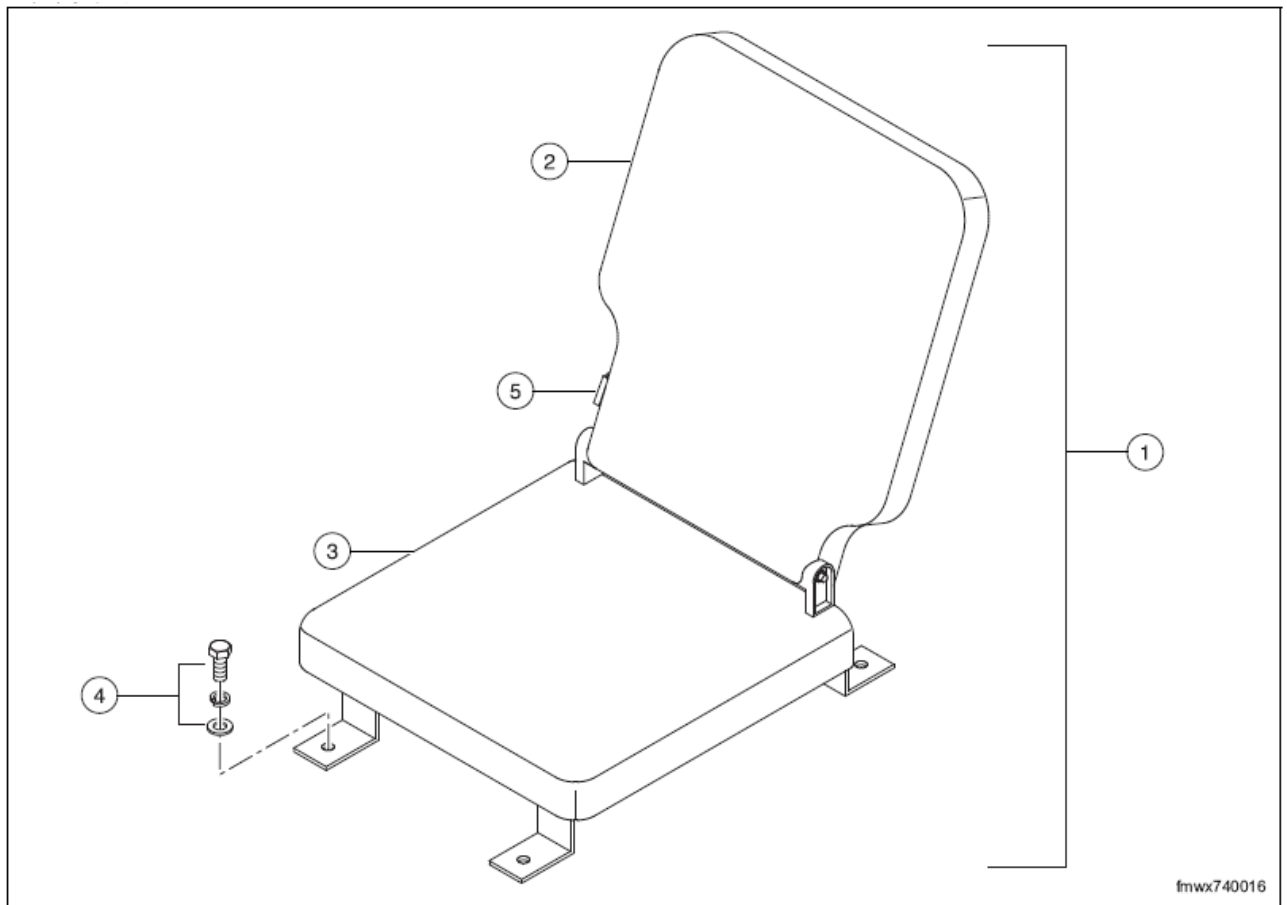
1. **Disassemble the secondary driver seat.**
 - (a). Disassemble the fixing bolts and nuts of secondary driver seat.



2. **Install the secondary driver seat.**
 - (a). Install the fixing bolts and nuts of secondary driver seat.
Torque: 40N.m

MIDDLE SEAT

DIAGRAM OF COMPONENTS



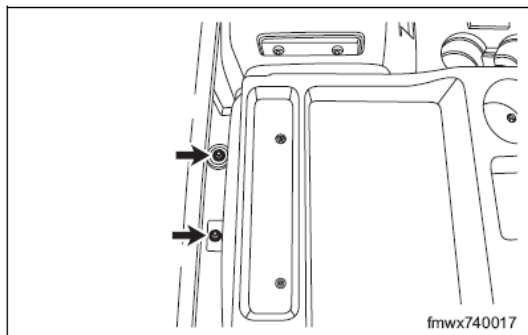
1	Middle seat assembly
2	Middle seat backrest assembly
3	Middle seat cushion assembly

4	Hex head bolt, spring washer, and plain washer subassembly
5	Angle adjuster assembly

REPLACEMENT

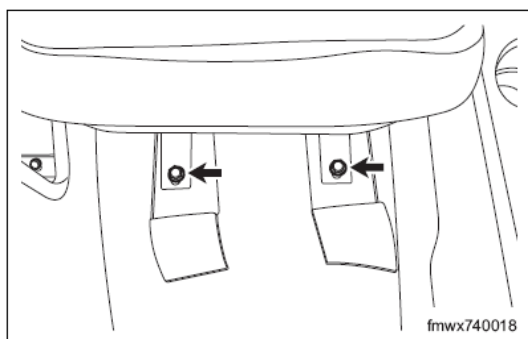
Hint:

Please refer to Chapter 74 Seats – Middle Seat, Diagram of Components for the diagram of the components.

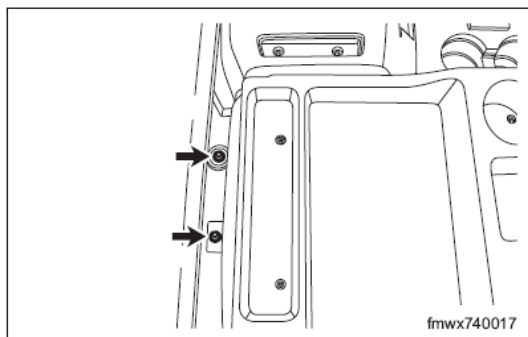


1. Disassemble the middle seat.

(a). Disassemble the fixing nuts of middle seat.



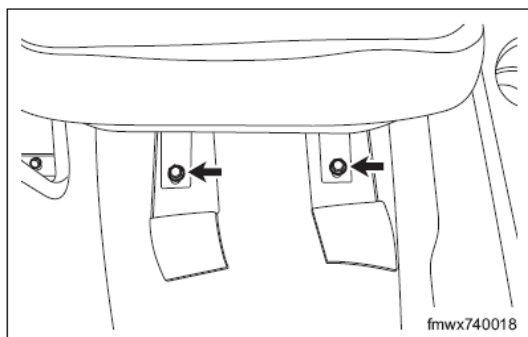
(b). Disassemble the fixing bolts of middle seat.



2. Install the middle seat.

(a) Install the fixing nuts of middle seat.

Torque: 20N.m

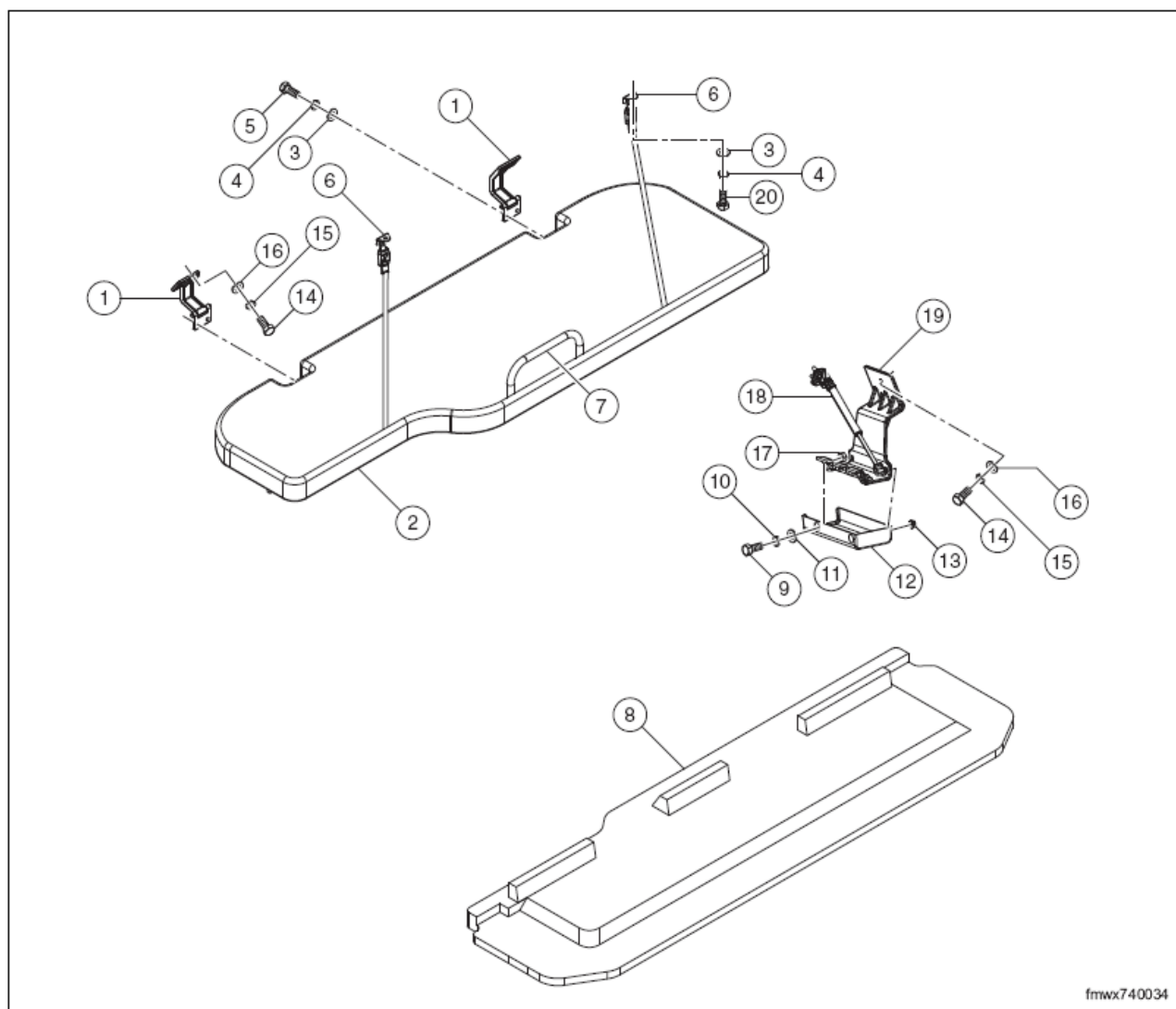


(b). Install the fixing bolts of middle seat.

Torque: 20N.m

SLEEPER DEVICE

DIAGRAM OF COMPONENTS



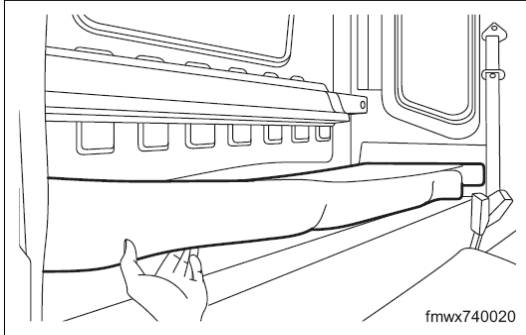
1	Upper sleeper hinge assembly
2	Upper sleeper assembly
3	Plain washer
4	Spring washer
5	Hex head bolt
6	Upper sleeper hook assembly
7	Upper sleeper railing
8	Lower sleeper assembly
9	Phillips hex head bolt with indentation
10	Spring washer

11	Plain washer
12	Sleeper support trim cover
13	Hexagon flange nut
14	Hex head bolt
15	Spring washer
16	Plain washer
17	1# hexagon nut
18	Sleeper air spring assembly
19	Upper sleeper support
20	Hex head bolt

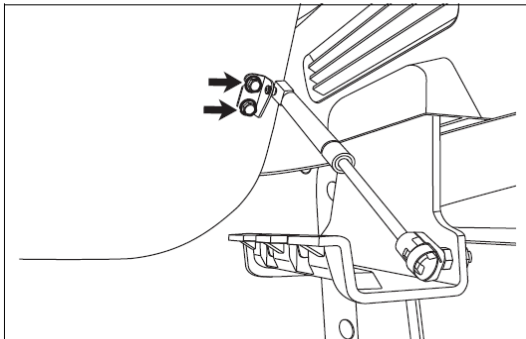
REPLACEMENT

Hint:

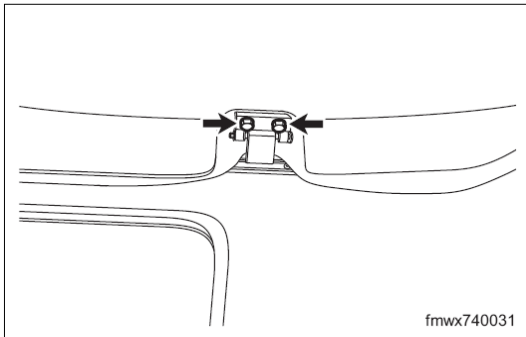
Please refer to Chapter 74 Seats – Sleeper Device, Diagram of Components for the diagram of the components.



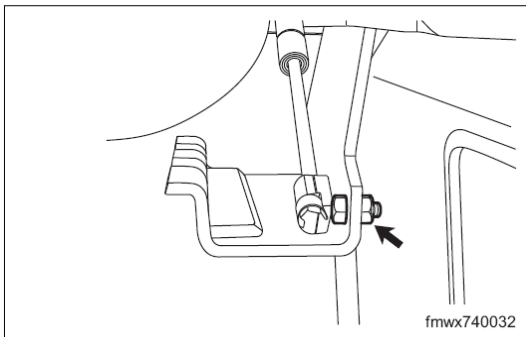
1. **Upturn the lower sleeper cushion assembly for disassembly or replacement.**



2. **Disassemble the high top sleeper assembly.**
 - (a). Disassemble the fixing nuts between high top sleeper and left sleeper air spring.



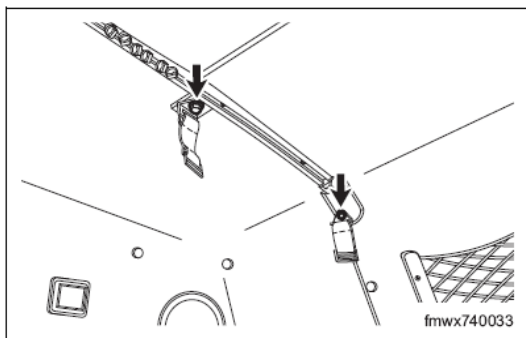
- (b). Disassemble the fixing bolts between upper sleeper hinge and left side of driver cab.



- (c). Disassemble the fixing nuts between left sleeper air spring and driver cab.

Hint:

The disassembly procedure for right components is the same with that for left components.

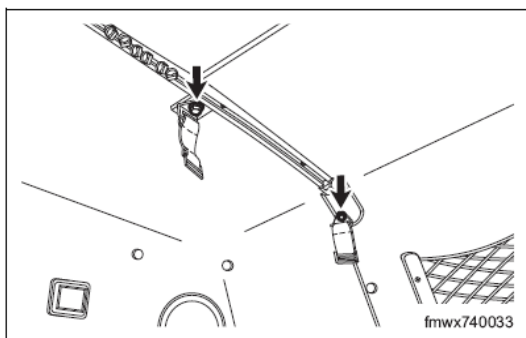


3. Disassemble the protection net hooks of the high top sleeper.

- (a) Disassemble the fixing bolts of the upper sleeper hooks on the left side of driver cab.
- (b) Disassemble the fixing bolts of the upper sleeper hooks on the left wall of driver cab.

Hint:

The disassembly procedure for right components is the same with that for left components.



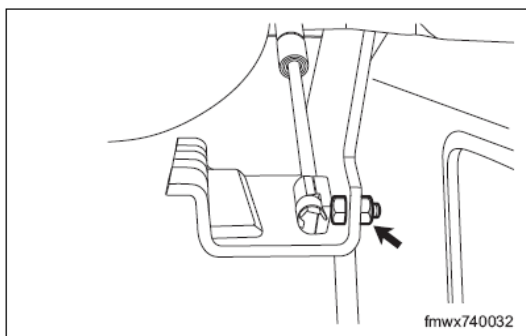
4. Install the protection net hooks of the high top sleeper.

- (a) Install the fixing bolts of the upper sleeper hooks on the left side of driver cab.

Torque: 40N.m

- (b) Install the fixing bolts of the upper sleeper hooks on the left wall of driver cab.

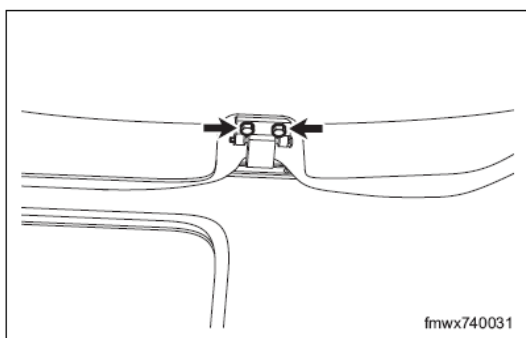
Torque: 20N.m



5. Install the high top sleeper assembly.

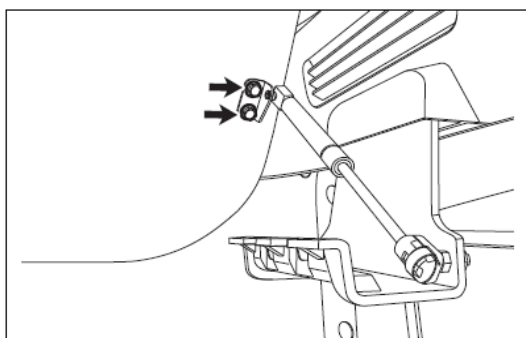
- (a) Install the fixing nuts between left sleeper air spring and driver cab.

Torque: 40N.m



- (b) Install the fixing bolts between upper sleeper hinge and left side of driver cab.

Torque: 20N.m



- (c) Install the fixing nuts between high top sleeper and left sleeper air spring.

Torque: 20N.m

Hint:

The installation procedure for right components is the same with that for left components.

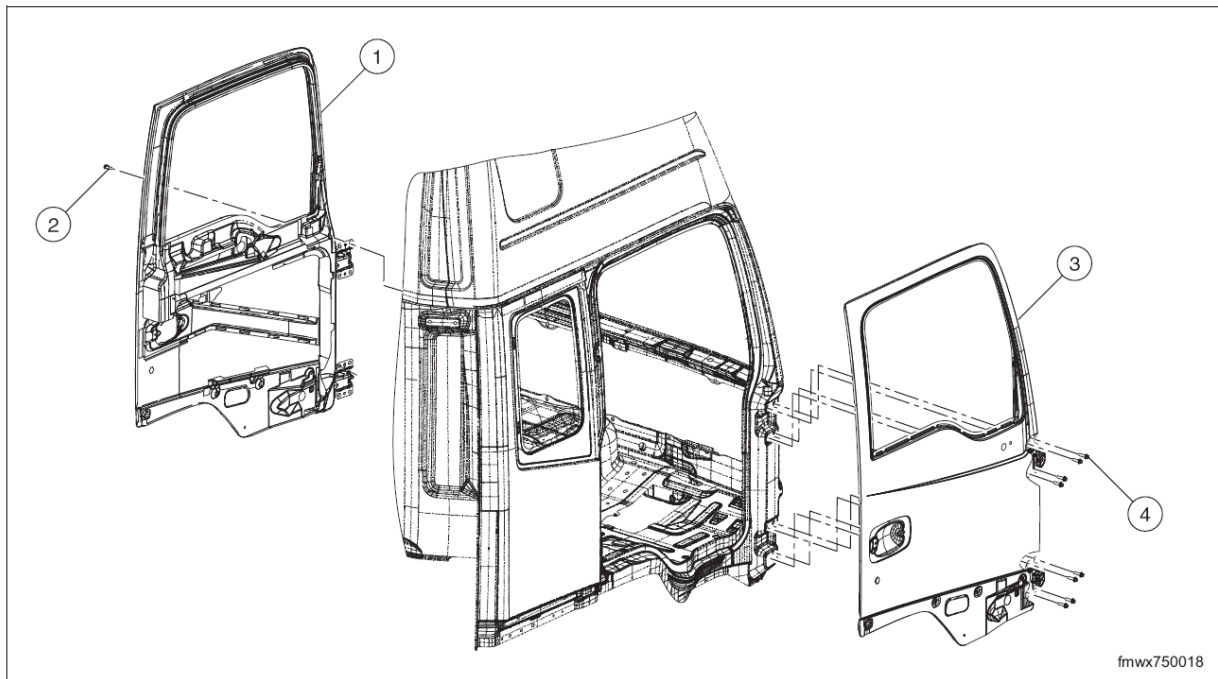
DOOR, DOOR LOCK AND DOOR HANDLE

DOOR ASSEMBLY.....	75-3
DIAGRAM OF COMPONENTS	75-3
ADJUSTMENT	75-4
REPLACEMENT	75-6
DOOR LOCK	75-8
DIAGRAM OF COMPONENTS	75-8
REPLACEMENT	75-9
DOOR HANDLE	75-11
REPLACEMENT	75-11



DOOR ASSEMBLY

DIAGRAM OF COMPONENTS



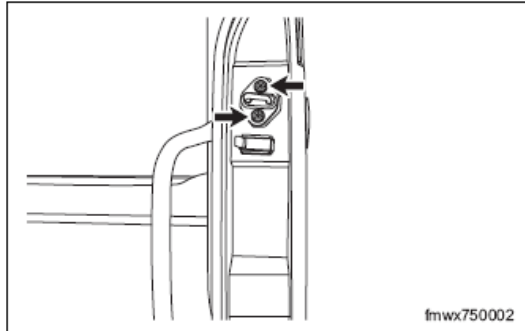
1	Left front door assembly
2	Hexagon flange bolt with serrated bearing surface

3	Right front door assembly
4	Hexagon flange bolt with serrated bearing surface

ADJUSTMENT

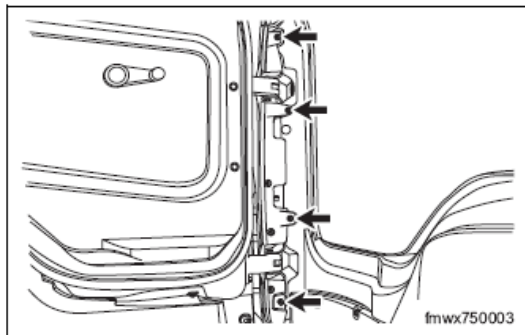
Suggestion:

Diagram of Components, see chapter 75 Door, door lock and door handle-door assembly, component diagram



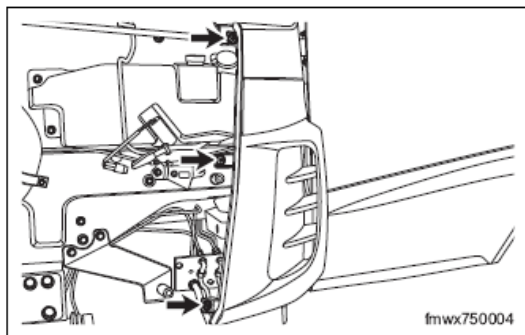
1. Loosening of left door lock catch

- (a). Loosen screw of left door lock catch until the lock catch can move.

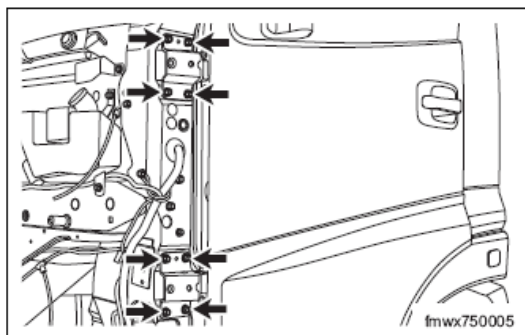


2. Dismantling of left trim angle plate

- (a). Remove binding screw of left trim angle plate.



- (b). Open front flip cover plate, remove binding screw of left trim angle plate and then take down the angle plate



3. Loosening of left front door hinge

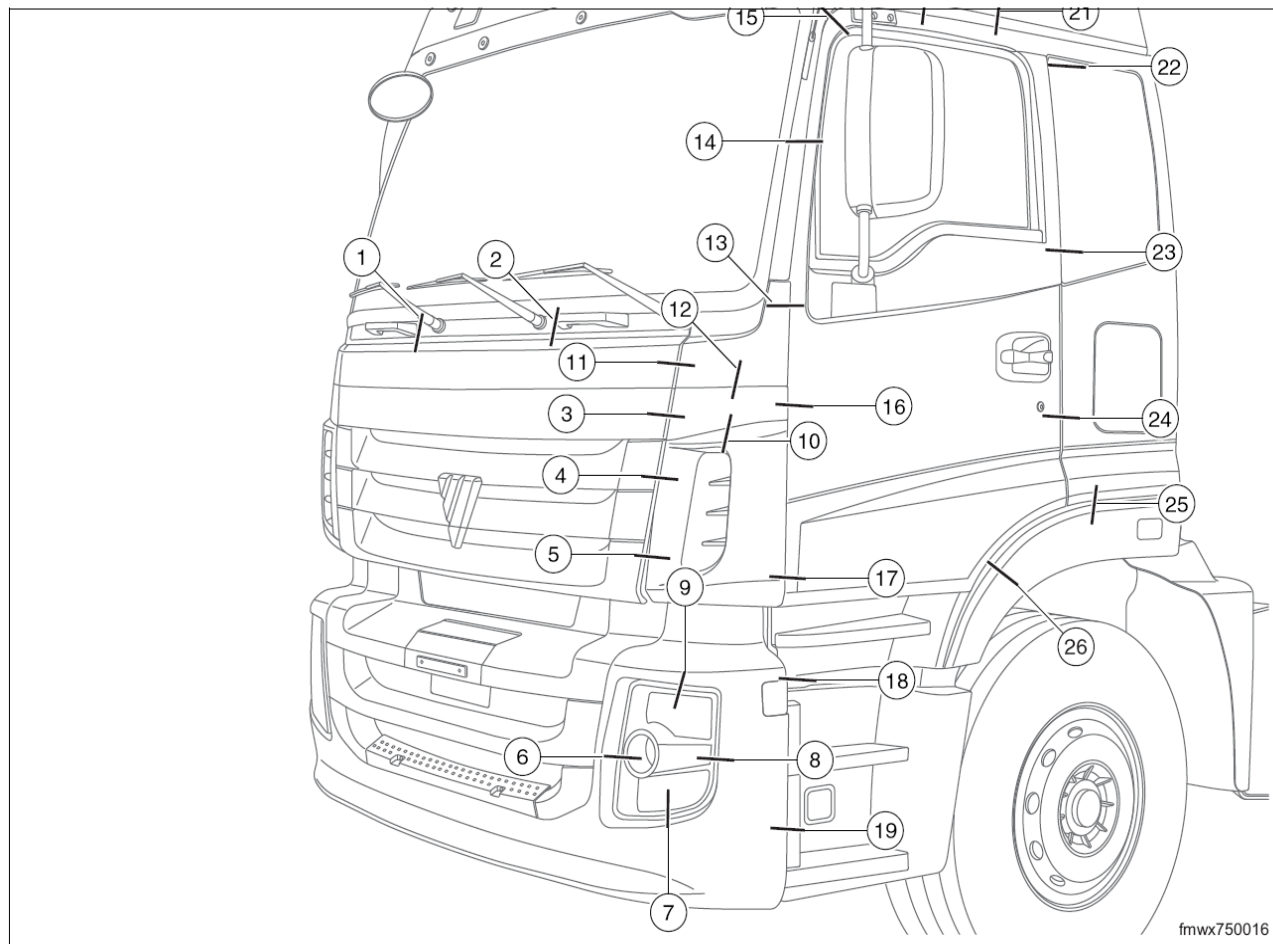
- (a). Loosen set bolt of left front door hinge slowly to enable the door to move slowly.

4. Adjustment of left front door

- (a). Adjust clearance of left front door according to following diagram until the clearance between the door and the cab is appropriate and fasten left door hinge and lock catch bolt.

Suggestion:

Adjustment method for right front door is same as that for left front door.



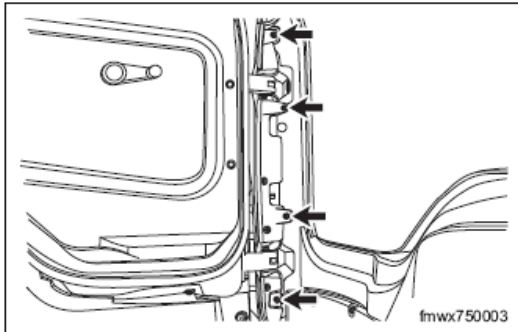
	Clearance	Planeness		Clearance	Planeness
1	5mm	0		5mm	0
2	5mm	0		5mm	0
3	5mm	0		5mm	0
4	5mm	0		5mm	0
5	5mm	0		5mm	0
6	6.2mm	4.13mm	19	14.4mm	0
7	7.4mm	7.21mm	20	5mm	0
8	6.2mm	7.67mm	21	5mm	0
9	6.4mm	7.21mm	22	7mm	0
10	0.5mm	0	23	7mm	0
11	5mm	0	24	7mm	0
12	0.5mm	0	25	10mm	0.5mm
13	5mm	0	26	10mm	



REPLACEMENT

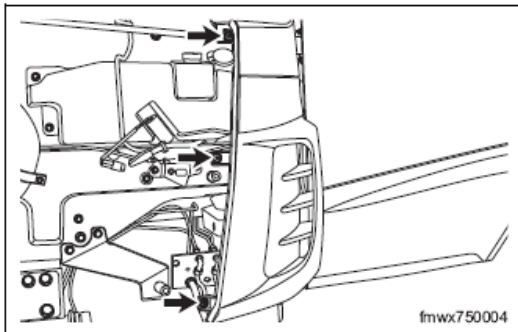
Suggestion:

Diagram of Components, see chapter 75 Door, door lock and door handle-door assembly, component diagram

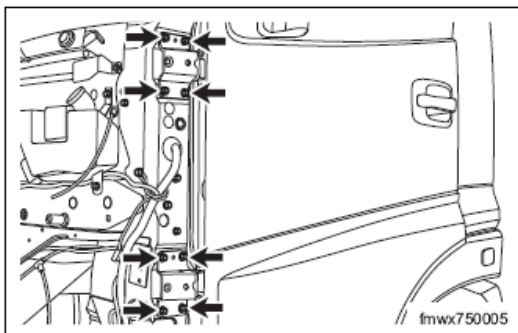


1. Dismantling of left trim angle plate

(a). Dismantle binding screw of left trim angle plate.



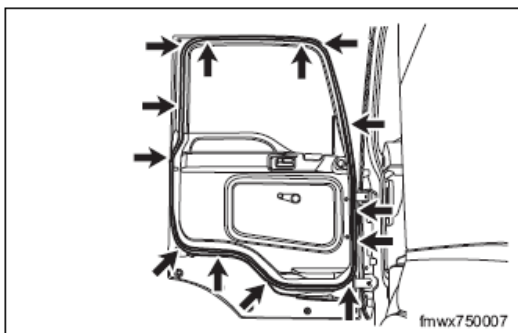
(b). Open front flip cover plate, remove binding screw of left trim angle plate and then take down the angle plate



2. Dismantling of left front door assembly

(a). Dismantle set bolt of left front door hinge.

(b). Dismantle left front door assembly

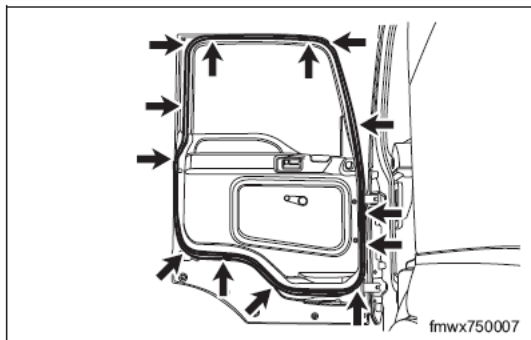


3. Dismantling of left front door weather strip

(a). Remove the weather strip after dismantling left front door weather strip clip.

Note:

The dismantled buckle should not be reused.

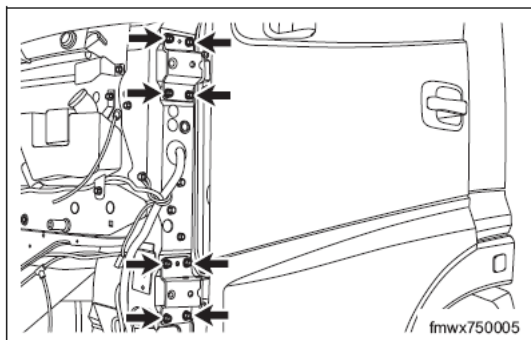


4. Installation of left front door weather strip

- (a). Install left front door weather strip and fix door weather strip buckle.

Note:

The buckle is a disposable component and should be replaced during installation.

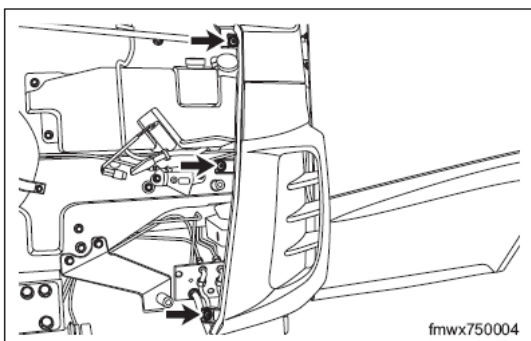


5. Installation of left front door assembly

- (a). Install set bolt of left front door hinge.

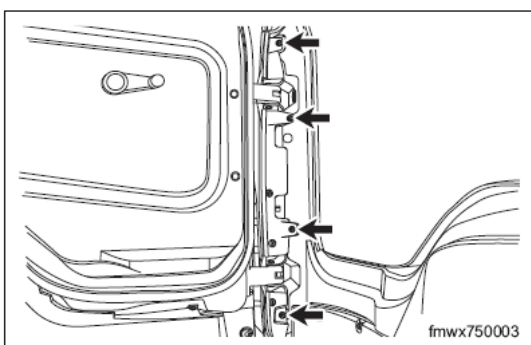
Torque: 30N.m

6. Adjustment left front door, see chapter 75 Door, door lock and door handle-door assembly, adjust



7. Installation of left trim angle plate

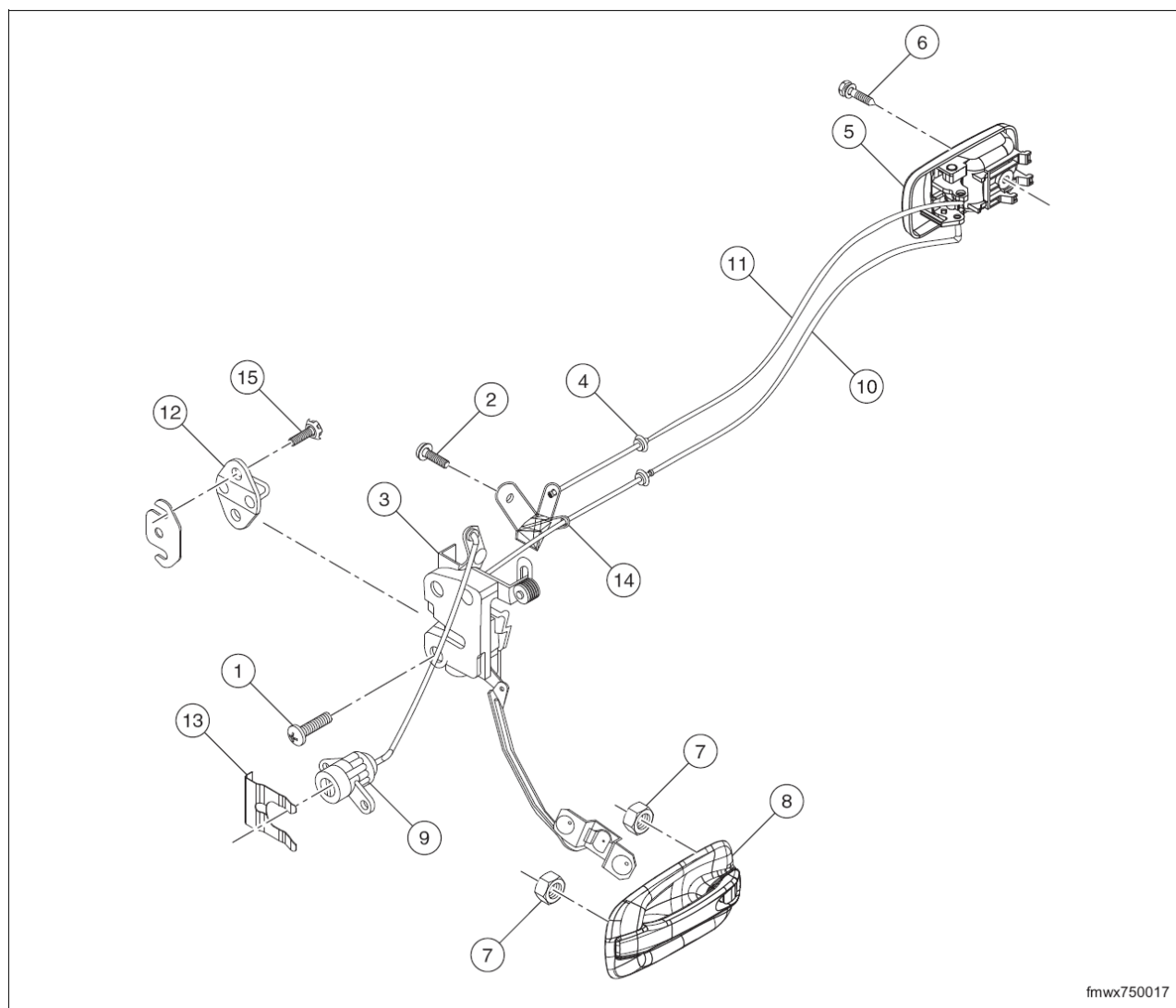
- (a). Install binding screw of left trim angle plate and then close front flip cover plate.



- (b). Install binding screw of left trim angle plate.

DOOR LOCK

DIAGRAM OF COMPONENTS



fmwx750017

1	Cross recessed countersunk head screw
2	Cross recessed countersunk head screw and taper lock washer assemblies
3	Front door lock body assembly
4	Fixing buckle seat
5	Swing-in handle assembly
6	Cross recessed pan head tapping screw and large washer assemblies
7	Hexagon flange nut
8	Swing-out handle assembly

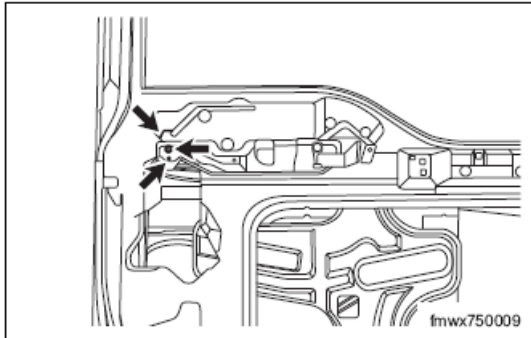
9	Key cylinder assembly
10	Swing-in pull rod
11	Internal locking pull rod
12	Lock catch assembly
13	Fixing clip
14	Drive mechanism assembly
15	Cross recessed countersunk head screw and taper lock washer assemblies

REPLACEMENT

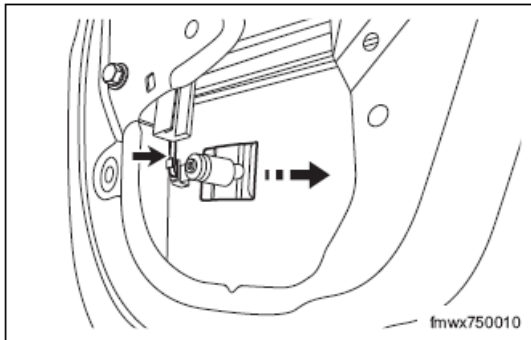
Suggestion:

Diagram of Components, see chapter 75 Door, door lock and door handle, component diagram.

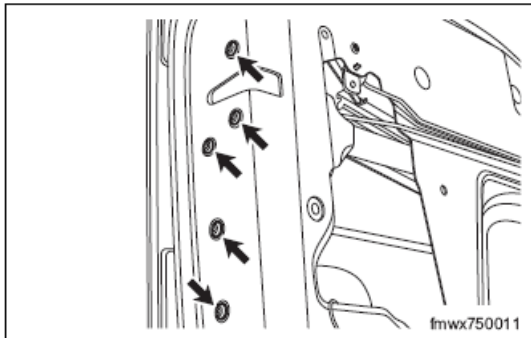
1. **Dismantling of door inner guard panel, see chapter 76 Interior/exterior trimmings-door inner guard panel, replacement**
2. **Removal of door front waterproofing membrane**



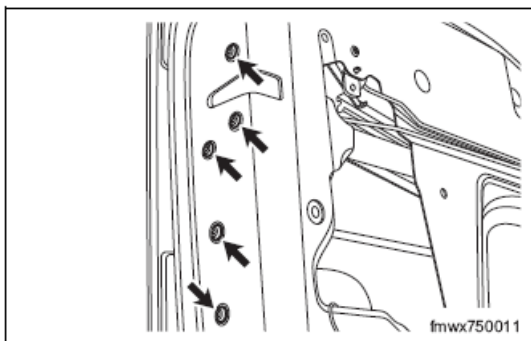
3. **Dismantling of drive mechanism assembly**
 - (a). Disconnect internal locking pull rod and swing-in pull rod.
 - (b). Dismantle screw of drive mechanism.



4. **Dismantling of key cylinder assembly**
 - (a). Disconnect key cylinder link rod.
 - (b). Dismantle key cylinder fixing clip.



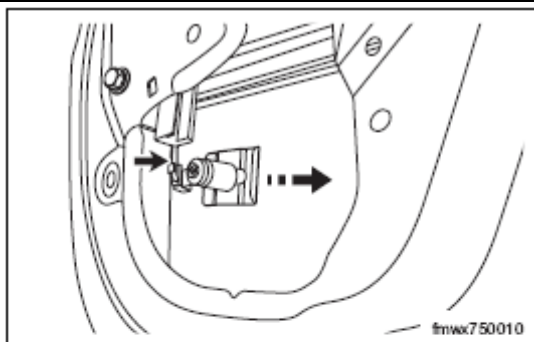
5. **Dismantling of front door lock body assembly**
 - (a). Dismantle set bolt of front door lock body.



6. **Installation of front door lock body assembly**
 - (a). Install set bolt of front door lock body.

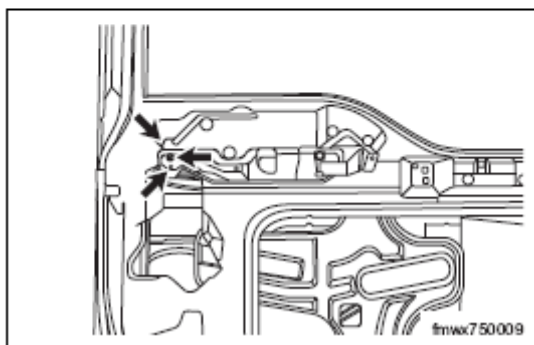
75-10

DOOR, DOOR LOCK AND DOOR HANDLE-DOOR LOCK



7. Installation of key cylinder assembly

- (a). Install key cylinder fixing clip.
- (b). Install key cylinder link rod.



8. Installation of drive mechanism assembly

- (a). Install screw of drive mechanism.
- (b). Install internal locking pull rod and swing-in pull rod.

9. Installation of door front waterproofing membrane

10. Installation of door inner guard panel, see chapter 76 Interior/exterior trimmings-door inner guard panel, replacement

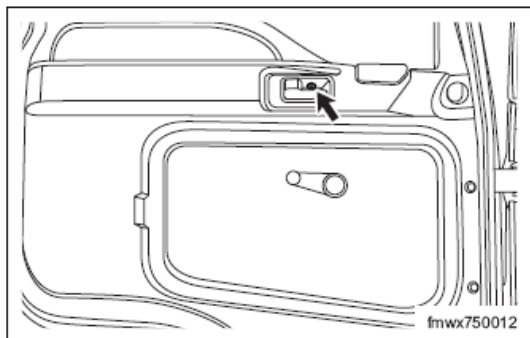


DOOR HANDLE

REPLACEMENT

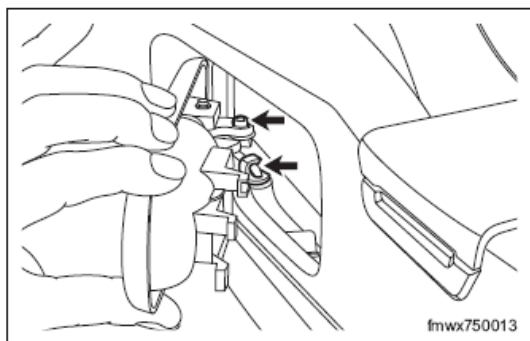
Suggestion:

Diagram of Components, see chapter 75 Door, door lock and door handle-door assembly, component diagram.

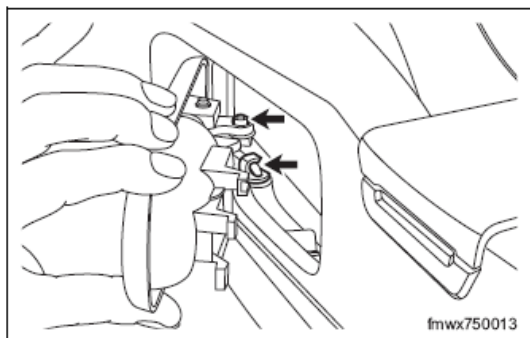


1. Dismantling of swing-in handle assembly

- (a). Dismantle set screw of swing-in handle.

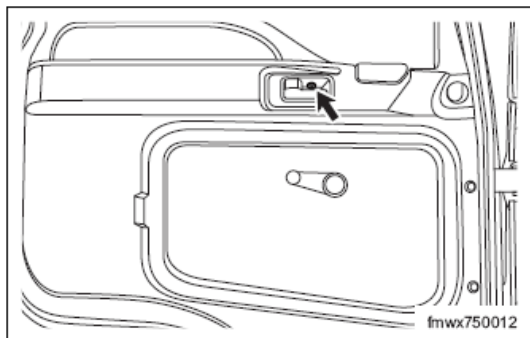


- (b). Disconnect internal locking pull rod and swing-in pull rod.



2. Installation of swing-in handle assembly

- (a). Install internal locking pull rod and swing-in pull rod.



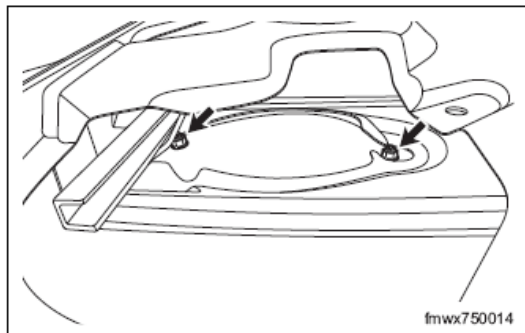
- (b). Install set screw of swing-in handle.



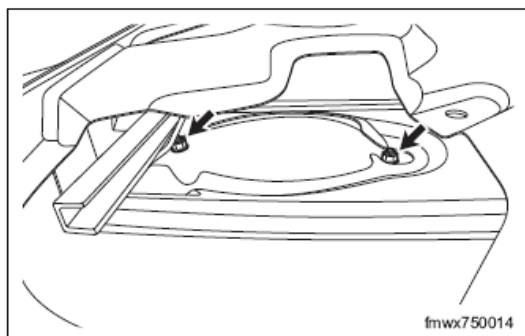
75-12

DOOR, DOOR LOCK AND DOOR HANDLE-DOOR HANDLE

1. Dismantling of door inner guard panel, see chapter 76 Interior/exterior trimmings-door inner guard panel, replacement
2. Removal of door front waterproofing membrane



3. Dismantling of swing-out handle
 - (a). Dismantle set nut of swing-out handle.



4. Installation of swing-out handle
 - (a). Install set nut of swing-out handle.

5. Sticking of door front waterproofing membrane
6. Installation of door inner guard panel, see chapter 76 Interior/exterior trimmings-door inner guard panel, replacement

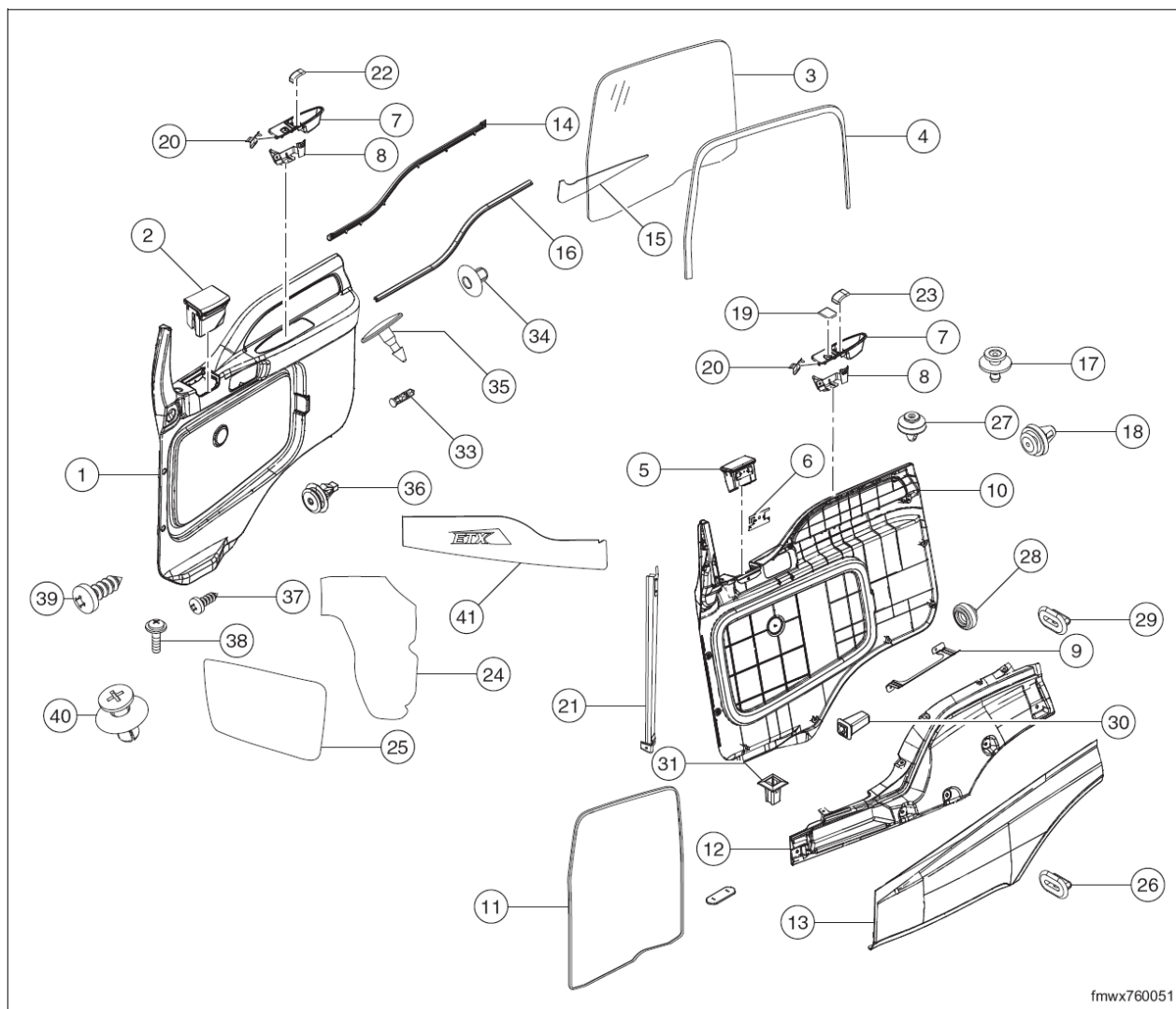


INTERIOR AND EXTERIOR TRIMMINGS

INNER DOOR GUARD PANEL	76-3
Diagram of Components.....	76-3
replacement.....	76-5
SHADING UNITS.....	76-8
Diagram of Components.....	76-8
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CARPET	76-13
Diagram of Components.....	76-13
Replacement	76-15
FRONT BUMPER	76-17
Diagram of Components.....	76-17
Replacement	76-19
SPLASH SHIELD	76-22
Diagram of Components.....	76-22
Replacement	76-24
FRONT COVER.....	76-27
Diagram of Components.....	76-27
Replacement	76-29
GUARDRAIL	76-30
Replacement	76-30

INNER DOOR GUARD PANEL

DIAGRAM OF COMPONENTS



1	RH door inner guard panel assembly
2	Ashtray assembly (RH)
3	Door glass assembly
4	Door window seal assembly
5	Ashtray assembly (LH)
6	Ashtray holder
7	Inner handrail assembly
8	Inner handrail bracket
9	Limit clip assembly
10	LH door inner guard panel assembly
11	Door weather strip
12	Lining panel of bottom door trim panel
13	Bottom door trim panel assembly
14	Door window outer weather strip assembly
15	Door window trimming
16	Door window inner weather strip assembly
17	buckle
18	Buckle of inner handrail panel
19	LH inner handrail blind nut A
20	Clip for handrail cover
21	Front door rail assembly

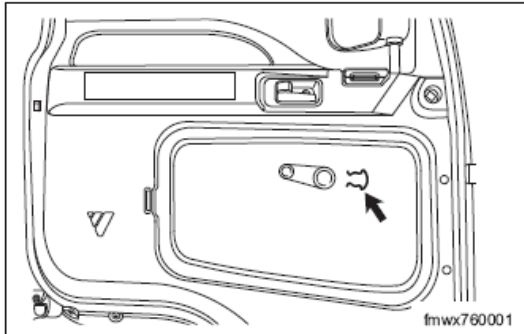
22	RH inner handrail blind nut
23	LH inner handrail blind nut B
24	Front door waterproof membrane
25	Rear door waterproof membrane
26	Semi-circle-head plug
27	Buckle – door guard panel
28	Circular cushion
29	Buckle seat – roof trim panel
30	Plastic nut
31	Buckle seat - ventilation hood
32	Blocking cover of bottom vent
33	Buckle - fender
34	Buckle seat - fender
35	35 Front door spike
36	Plastic buckle
37	Cross recessed self-tapping screw
38	Cross recessed pan head self-tapping screw and plain washer assembly
39	Cross recessed self-tapping screw
40	Buckle seat - bottom door guard panel
41	ETX door side logo trimming



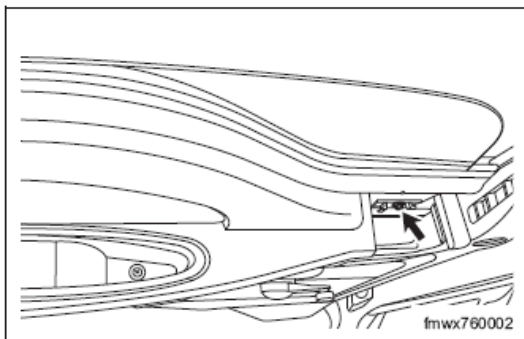
REPLACEMENT

Suggestion:

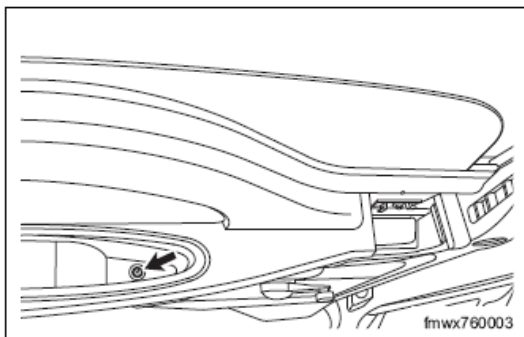
Component diagram, see Chapter 76 Interior and exterior trimmings – inner door guard panel, component diagram.



1. **Dismantle crank of window regulator**
 - (a) Dismantle spring buckle of crank and crank.

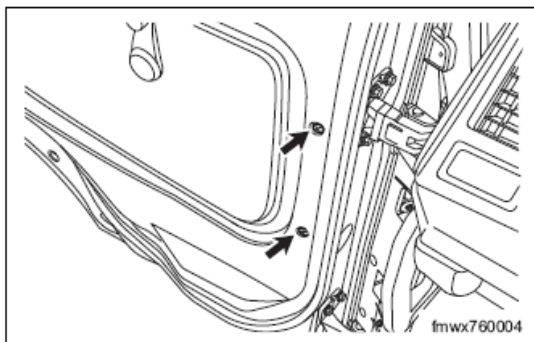


2. **Dismantle ashtray holder**
 - (a) Remove ashtray and dismantle set screws on ashtray holder.

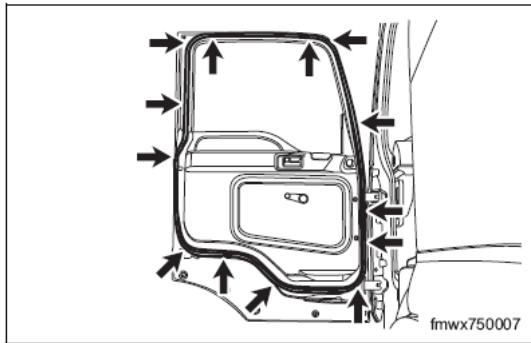


3. **Dismantle inner handle assembly**
 - (a) Remove inner handle blind nuts, dismantle set screws of inner handle assembly, remove inner handle assembly.

4. **Dismantle inner handle, see Chapter 75 Door lock handle – door handle, replacement.**



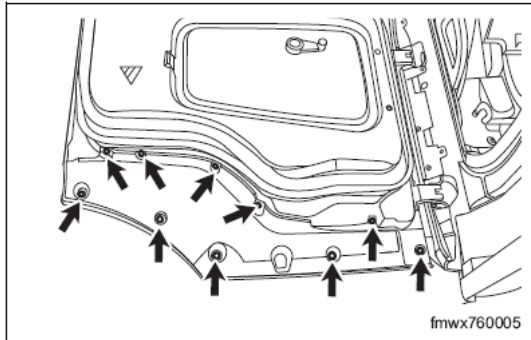
5. **Dismantle inner door guard panel assembly**
 - I(a) Dismantle front door spikes.



(b) Dismantle inner door guard panel.

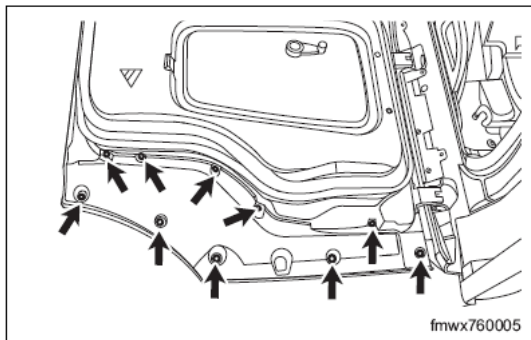
Note:

If any damage occurs on buckles of inner guard panel, they must be replaced by new parts.



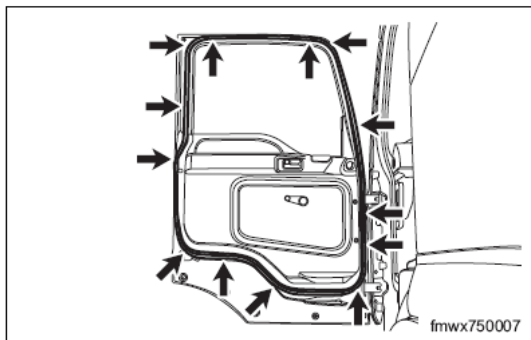
6. Dismantle lining panel of bottom door trim panel

- (a) Dismantle plastic buckles.
- (b) Dismantle fixing bolts and nuts on lining panel of bottom door trim panel.



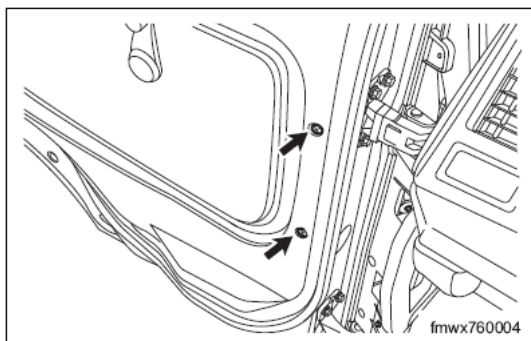
7. Assemble lining panel of bottom door trim panel

- (a) install fixing bolts and nuts on lining panel of bottom door trim panel .



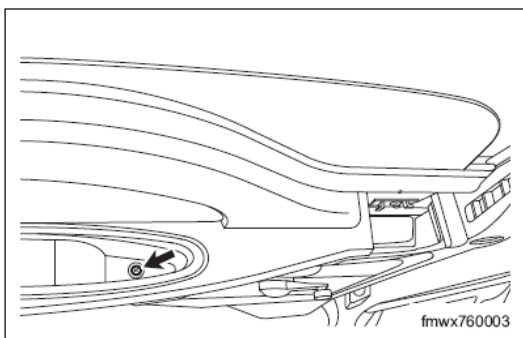
8. Install inner door guard panel assembly

- (a). Assemble inner door guard panel.



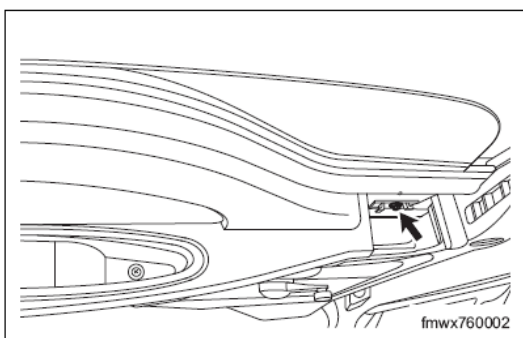
- (b). install front door spikes.

9. Install inner handle, see Chapter 75 Door lock handle – door handle, replacement.



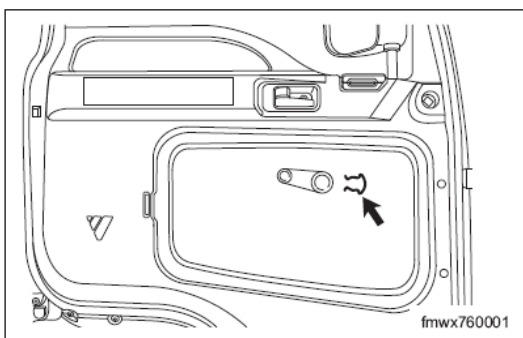
10. Install inner handle assembly

- (a). Install set screws and blind nuts of inner handrail assembly.



11. Install ashtray holder

- (a). Install set screws of ashtray holder and install ashtray.

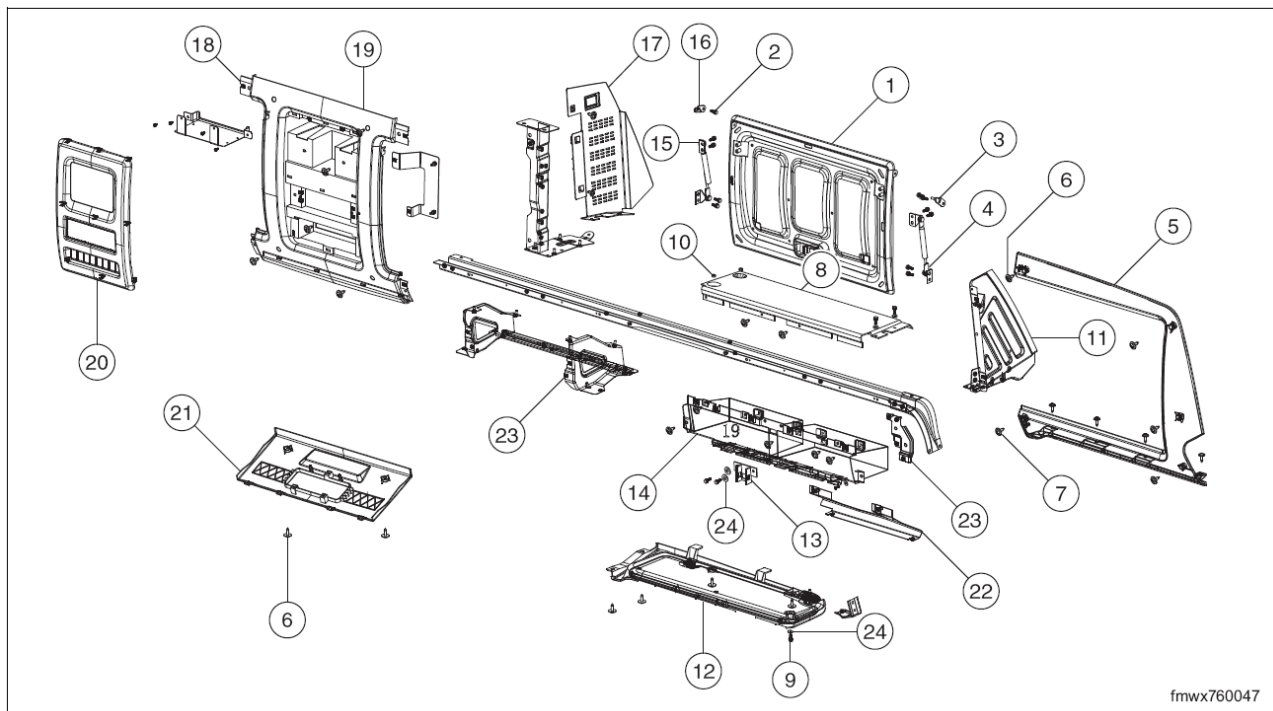


12. Install crank of window regulator

- (a). Install spring buckle of crank.

SHADING UNITS

DIAGRAM OF COMPONENTS



fmwx760047

1	Overhead file cabinet assembly
2	hexagon bolt, spring washer and plain washer
3	Composite parts
4	LH hinge assembly of overhead cabinet door panel
5	Gas spring assembly of overhead cabinet (LH)
6	Cross recessed pan head self-tapping screw and washer assembly
7	Cross recessed pan head self-tapping screw and large washer assembly
8	Partition of overhead file cabinet
9	Metal washer – sun shade
10	hexagon bolt, spring washer and plain washer assembly
11	
12	Bottom trim frame assembly of overhead file cabinet

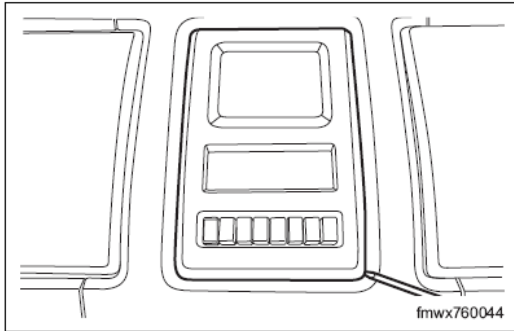
13	Door lock seat
14	Storage box assembly of overhead file cabinet
15	Gas spring assembly of overhead cabinet (RH)
16	RH hinge assembly of overhead cabinet door panel
17	Center board of overhead file cabinet
18	Center trim frame
19	Cross recessed pan head self-tapping screw and large washer assembly
20	Center panel assembly of overhead file cabinet
21	Center bottom trim panel assembly of overhead file cabinet
22	Plastic nut – guide rail
23	ST4.2 spring nut
24	Plain washer

REPLACEMENT

Suggestion:

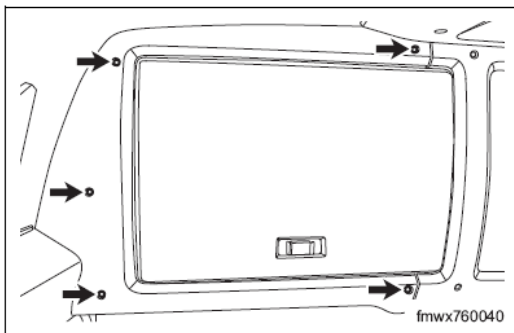
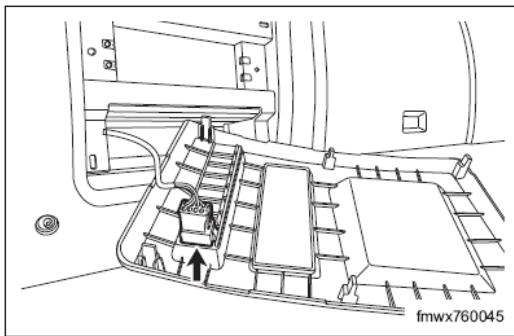
Component diagram, see Chapter 76 Interior and exterior trimmings – shading units, component diagram.

1. Dismantle center bottom trim frame assembly of overhead file cabinet, see Chapter 54 – reading light, dismantling and installation
2. Dismantle high roof sunroof protection frame assembly, see Chapter 54 Lighting – room lights, dismantling and installation



3. Dismantle center trim frame assembly of overhead file cabinet

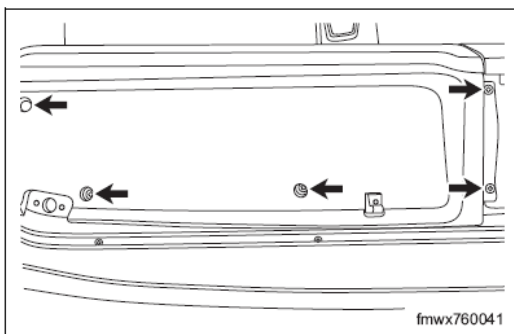
- (a). Unclench center panel assembly of overhead file cabinet and pull out switch connector.



- (b). Dismantle set screws on left trim frame of overhead file cabinet and set screws and bolts on left bottom trim frame of overhead file cabinet

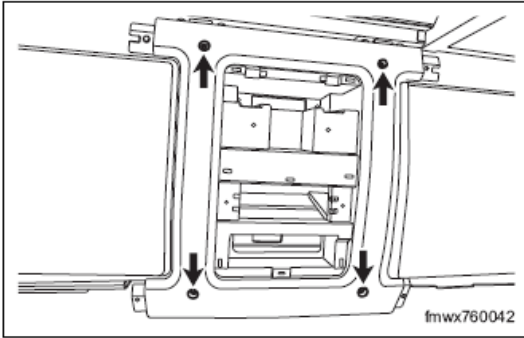
Note:

If any damage occurs on buckles of panel, they must be replaced by new parts.

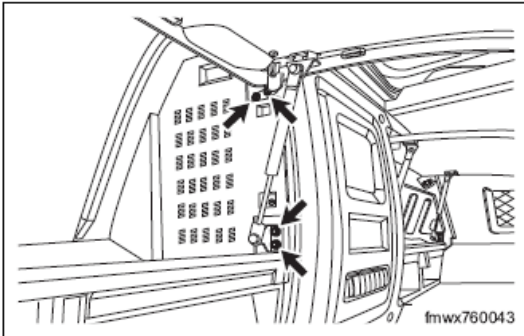


Suggestion:

The procedure of dismantling LH bottom trim frame assembly of overhead file cabinet and LH trim frame is same as that of RH side.



- (c). Dismantle set screws on center trim frame assembly of overhead file cabinet.

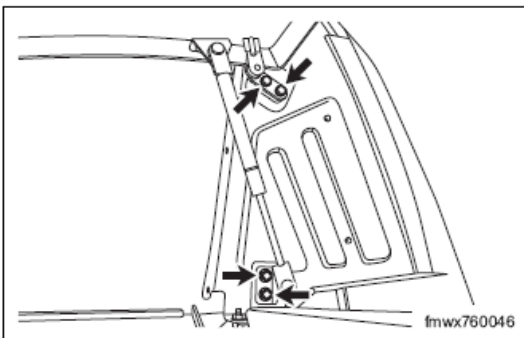


4. Dismantle LH door assembly of LH overhead file cabinet

- (a). Dismantle set bolts on LH door assembly of LH overhead file cabinet, remove LH door assembly of LH overhead file cabinet

Suggestion:

The procedure of dismantling RH door assembly of RH overhead file cabinet is same as that of LH door.

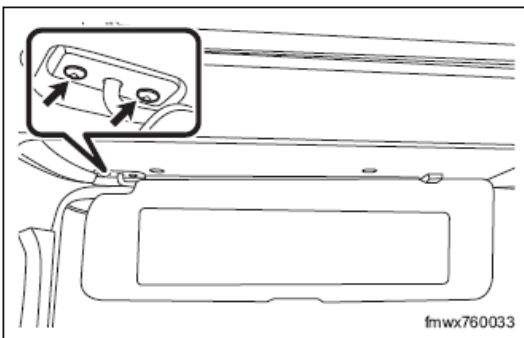
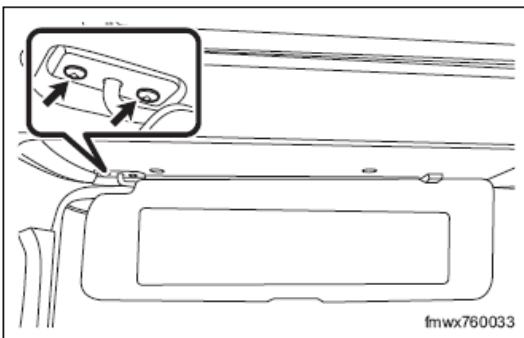


5. Dismantle LH sun shield assembly

- (a). Dismantle set screws of LH sun shield assembly, remove LH sun shield assembly.

Suggestion:

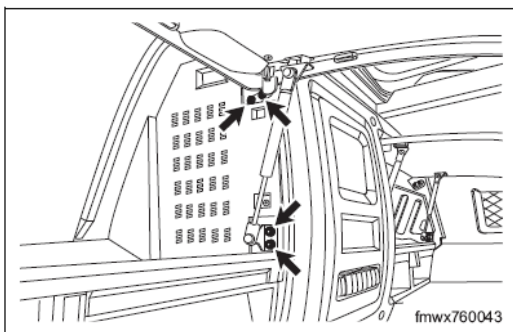
The procedure of dismantling RH sun shield assembly is same as that of LH side.



6. Install LH sun shield assembly

- (a). Install set screws of LH sun shield assembly.

Suggestion: The procedure of assembling RH sun shield assembly is same as that of LH side.

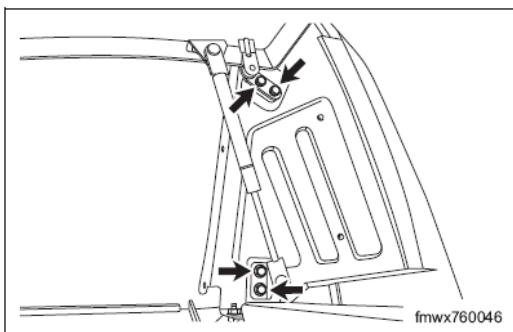


7. Install subassembly of LH overhead file cabinet

- (a). Install set bolts of LH overhead file cabinet subassembly.

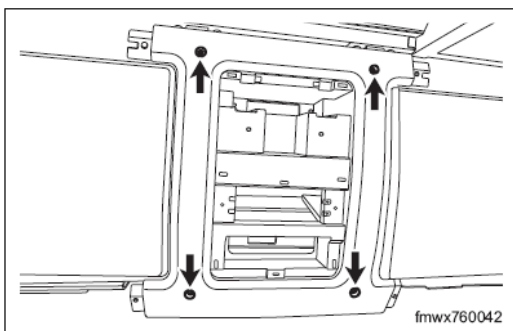
Suggestion:

The procedure of assembling RH overhead file cabinet subassembly is same as that of LH side.



8. Install center panel assembly of flat-top file cabinet

- (a). Install set screws on center trim frame assembly of overhead file cabinet.



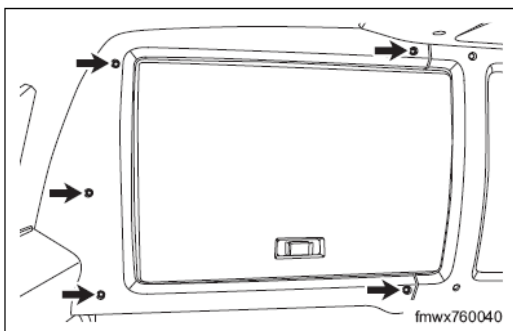
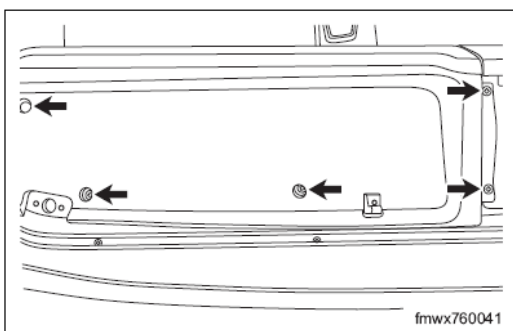
- (b). Install set screws on LH trim frame of overhead file cabinet, set screws and bolts on LH bottom trim frame assembly of overhead file cabinet.

Note:

If any damage occurs on buckles of panel, they must be replaced by new parts.

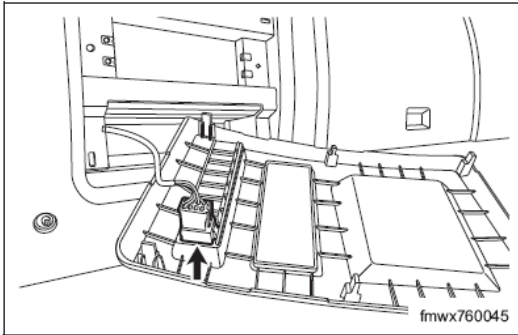
Suggestion:

The procedure of assembling RH bottom trim frame assembly and RH trim frame of overhead file cabinet is same as that of LH side.

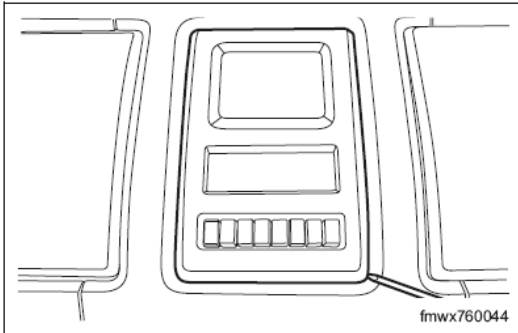


76-12

INTERIOR AND EXTERIOR TRIMMING-SHADING UNITS

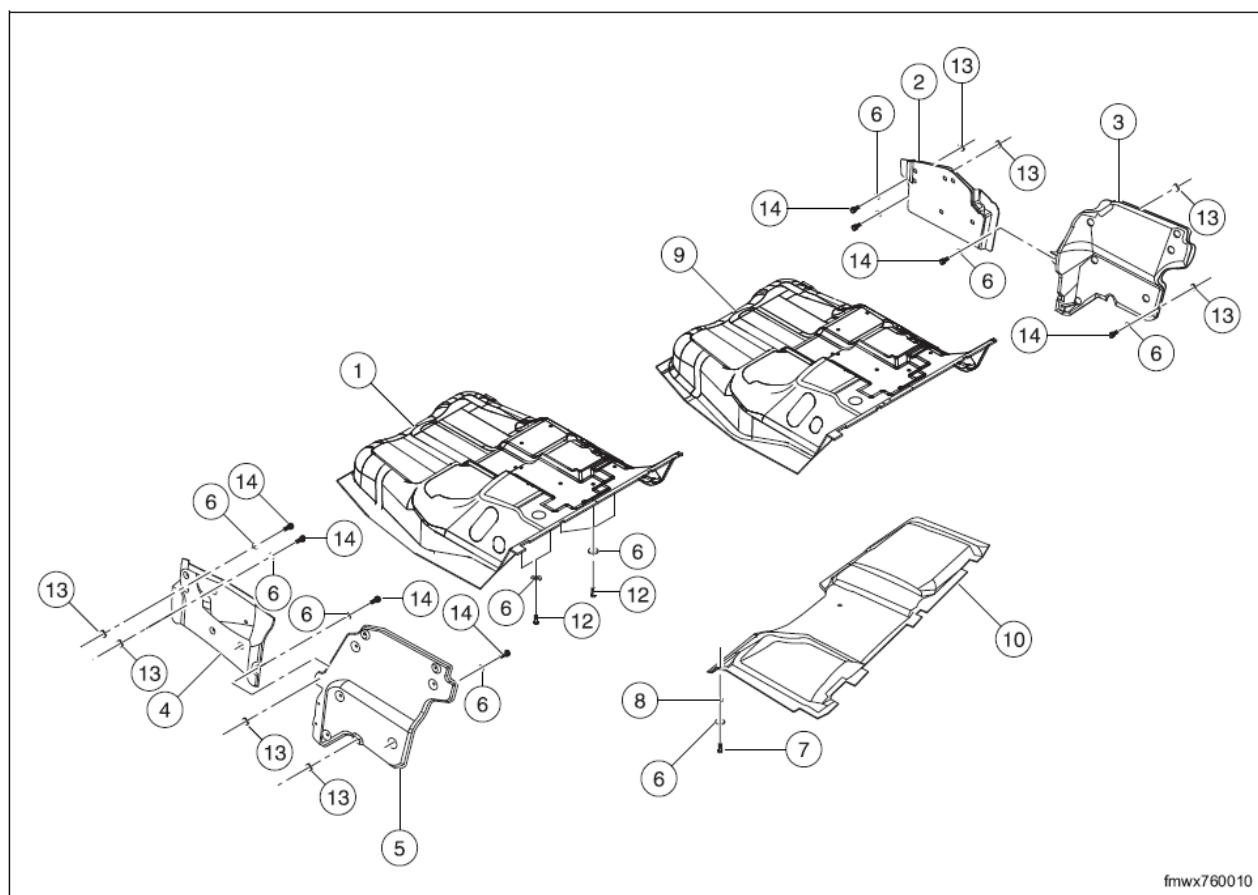


- (c). Connect switch connectors, install overhead center panel assembly.



CARPET

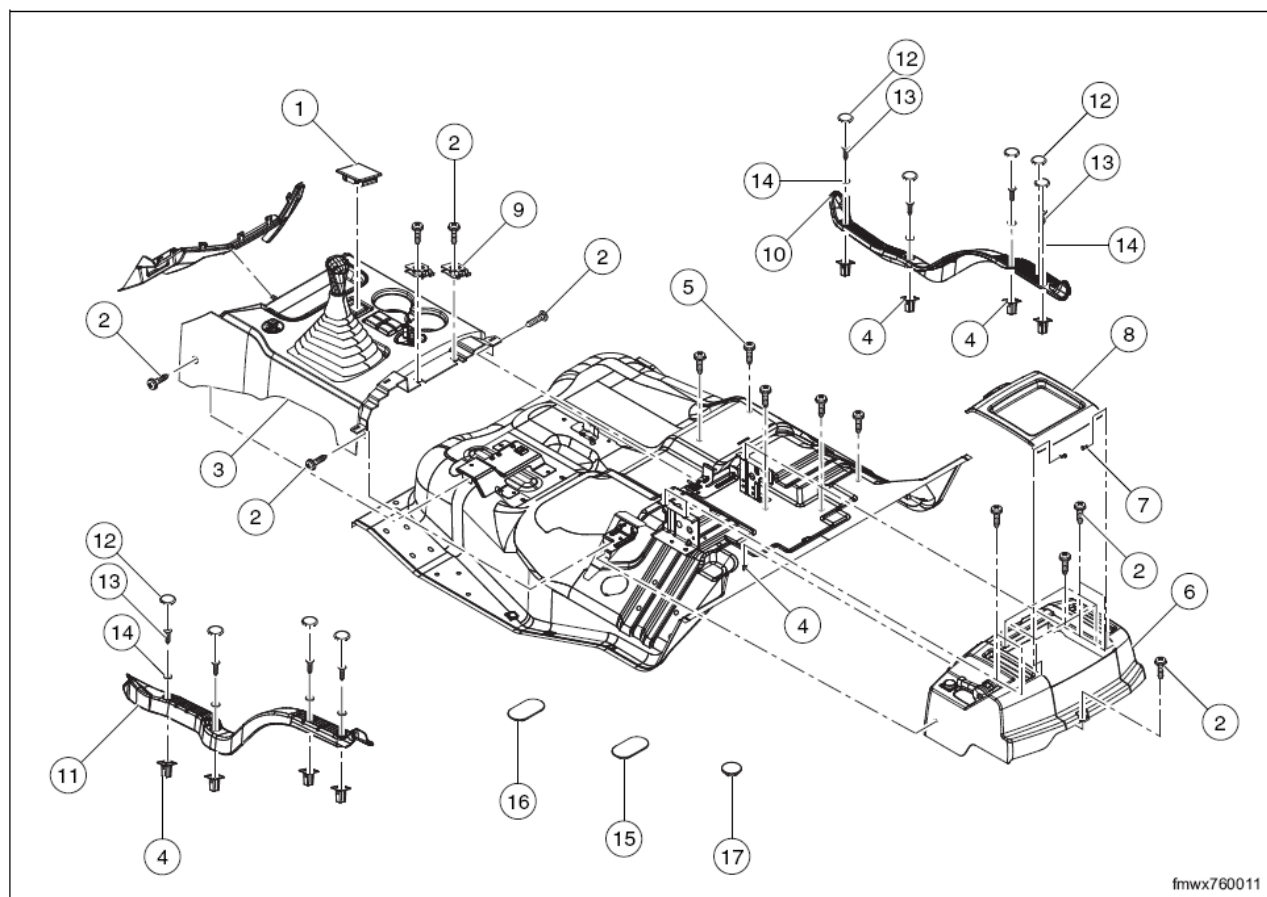
DIAGRAM OF COMPONENTS



fmwx760010

1	Wheel-housing heat pad
2	RH front acoustic board
3	RH rear acoustic board (symmetrical to left side)
4	LH front acoustic board
5	LH rear acoustic board
6	Large washer
7	Self-tapping screw

8	Large washer
9	Carpet assembly
10	Rear floor heat pad
11	Hexagon bolt, spring washer and plain washer assembly
12	Hexagon bolt, spring washer and plain washer assembly
13	Hexagon nut, style 2
14	Hexagon bolt, spring washer and plain washer assembly



1	Switching blind nut of electric rearview mirror
2	Self-tapping screw
3	Front part assembly of center platform
4	Plastic nut
5	Cross recessed pan head self-tapping screw and plain washer assembly
6	Rear part assembly of center platform
7	Shaft pin of cover panel
8	Center cover panel assembly of rear center platform
9	ST4.2 spring nut

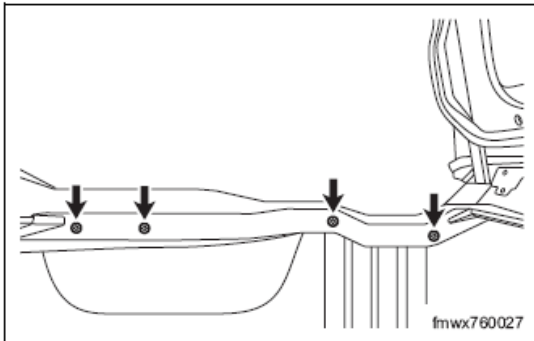
10	RH carpet trim strip
11	LH carpet trim strip
12	Trim strip plugging cover
13	Cross recessed pan head self-tapping screw and plain washer assembly
14	Plain washer
15	Large plugging cover for floor wheel-housing slotted hole
16	Plugging cover for LH floor slotted hole
17	PVC plugging cover 35

REPLACEMENT

Suggestion:

Component diagram, see Chapter 76 Interior and exterior trimmings – carpet , component diagram.

1. Dismantle driver's seat, see Chapter 74 Seats – driver seat, dismantling and installation
2. Dismantle copilot's seat, see Chapter 74 Seats – copilot's seat, replacement
3. Dismantle middle seat, see Chapter 74 Seats – middle seat, replacement
4. Dismantle sleeper units, see Chapter 74 Seats – sleeper units, replacement
5. Dismantle dashboard, see Chapter 73 Dashboard instruments cigar lighter – dashboard, replacement
6. Dismantle gearbox operating mechanism, see Chapter 31 A Gearbox - gearbox operating mechanism, dismantling and installation
7. Dismantle steering gear assembly, see Chapter 42 Power steering mechanism, steering gear assembly, replacement
8. Dismantle braking pedal, see Chapter 26 Service braking – braking pedal, overhaul
9. Dismantle accelerator pedal, see Chapter 17 Engine control - accelerator pedal, replacement



10. Dismantle LH carpet trim strip

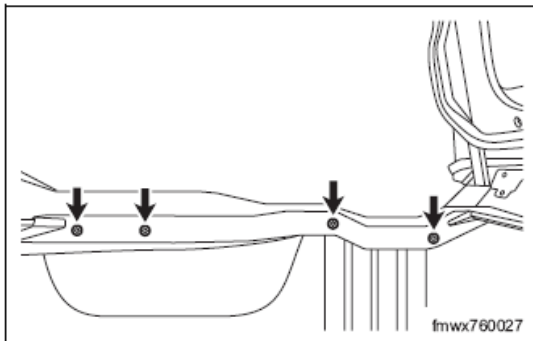
- (a). Dismantle plugging cover of LH trim strip.
- (b). Dismantle set screws of LH trim strip.

Note:

The dismantling procedure of RH side is same as that of LH side.

11. Dismantle carpet assembly

12. Install carpet assembly



13. Assemble LH carpet trim strip

- (a). Install set screws of LH trim strip.
- (b). Install plugging cover of LH trim strip.

Suggestion:

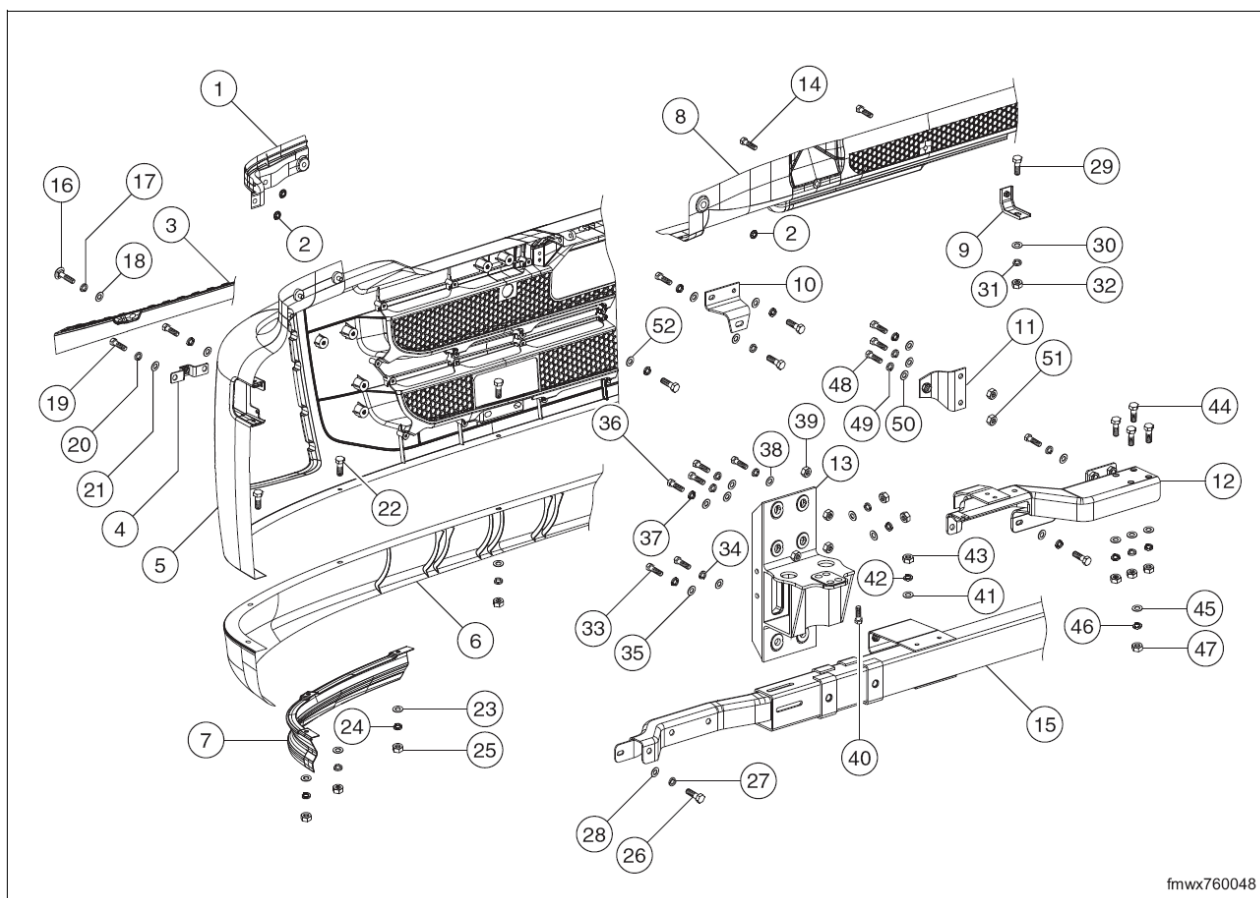
The installation procedure of RH side is same as that of LH side.

14. Install accelerator pedal, see Chapter 17 Engine control - accelerator pedal, replacement
15. Install braking pedal, see Chapter 26 Service braking – braking pedal, overhaul
16. Install steering gear assembly, see Chapter 42 Steering gear and accessories, dismantling and installation
17. Install gearbox operating mechanism, see Chapter 31 A Gearbox - gearbox operating mechanism, dismantling and installation
18. Install dashboard, see Chapter 73 Dashboard instruments cigar lighter – dashboard, replacement

- 19. Install sleeper units, see Chapter 74 Seats – sleeper units, replacement**
- 20. Dismantle middle seat, see Chapter 74 Seats – middle seat, replacement**
- 21. Install copilot's seat, see Chapter 74 Seats – copilot's seat, replacement**
- 22. Install driver's seat, see Chapter 74 Seats – driver seat, dismantling and installation**

FRONT BUMPER

DIAGRAM OF COMPONENTS



1	Bumper trim strip
2	Clip
3	Bumper pedal bracket assembly
4	Bumper pedal bracket assembly
5	Bumper body installation assembly
6	Lower bumper trim panel
7	Stiffener of lower bumper trim panel
8	Upper bumper trim panel
9	Bracket assembly of upper bumper trim panel
10	Middle bumper bracket I
11	Middle bumper bracket II assembly
12	Upper fixing cross member assembly of RH head lamp
13	Connection bracket of frame
14	Hexagon bolt with flange
15	Lower cross member assembly
16	Mushroom head square neck bolt
17	Spring washer
18	Plain washer
19	Hexagon bolt
20	Spring washer
21	Plain washer
22	Hexagon bolt
23	Plain washer
24	Spring washer
25	hexagon nut, style 1
26	Hexagon bolt

27	Spring washer
28	Plain washer
29	Hexagon bolt
30	Plain washer
31	Spring washer
32	Hexagon nut, style 1
33	Hexagon bolt
34	Spring washer
35	Plain washer
36	Hexagon bolt
37	Spring washer
38	Plain washer
39	Hexagon nut, style 1
40	Hexagon bolt
41	Plain washer
42	Spring washer
43	hexagon nut, style 1
44	Hexagon bolt
45	Plain washer
46	Spring washer
47	hexagon nut, style 1
48	Hexagon bolt
49	Spring washer
50	Plain washer
51	hexagon nut, style 1
52	Large washer

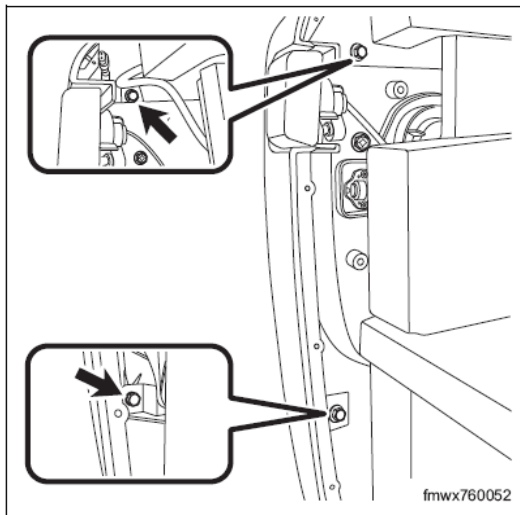


REPLACEMENT

Suggestion:

Component diagram, see Chapter 76 Interior and exterior trimmings – front bumper, component diagram.

1. **Open front flip cover plate**
2. **Turn on driver's cab**

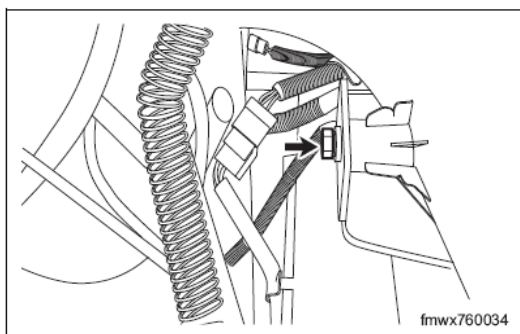


3. **Dismantle front bumper assembly**

- (a). Dismantle set bolts of front bumper and head lamp bracket.

Suggestion:

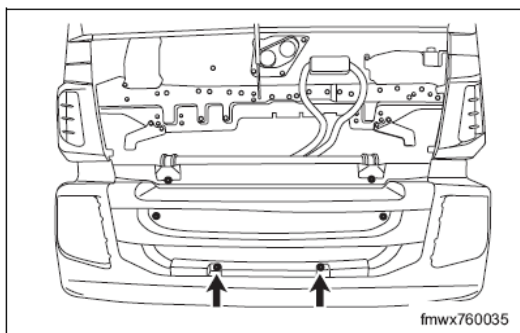
The dismantling procedure of LH side is same as that of RH side.



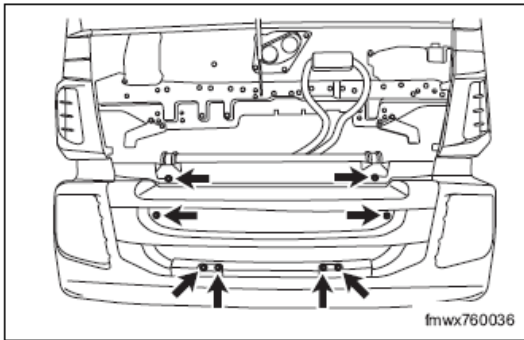
- (b). Dismantle set bolts of front bumper and front crashproof cross member.

Suggestion:

The dismantling procedure of LH side is same as that of RH side.



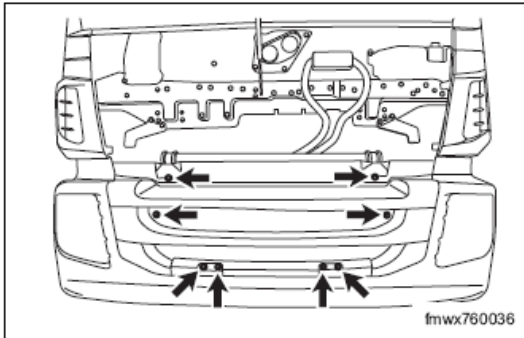
- (c). Dismantle set bolts of front bumper pedal.



- (d). Dismantle set bolts of front bumper, remove front bumper assembly.

Suggestion:

Heavy front bumper requires several people to coordinate in dismantling.



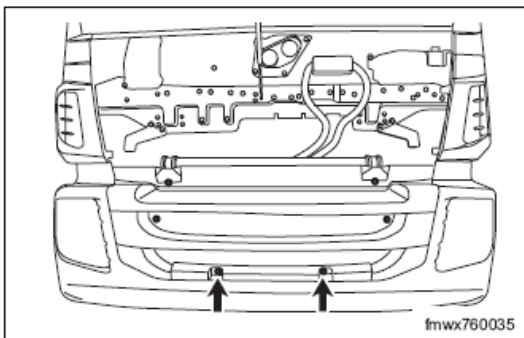
4. Install front bumper assembly

- (a). Install set bolts of front bumper.

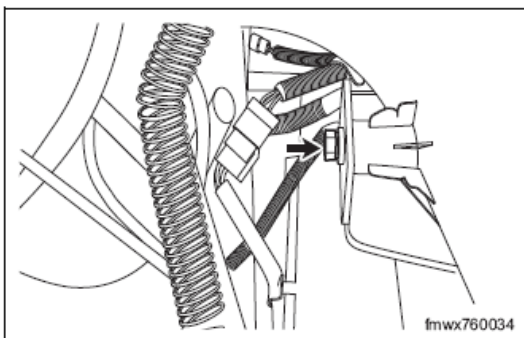
Note:

Heavy front bumper requires several people to coordinate in installation.

Torque: 40 N.m



- (b). Install set bolts of front bumper pedal.

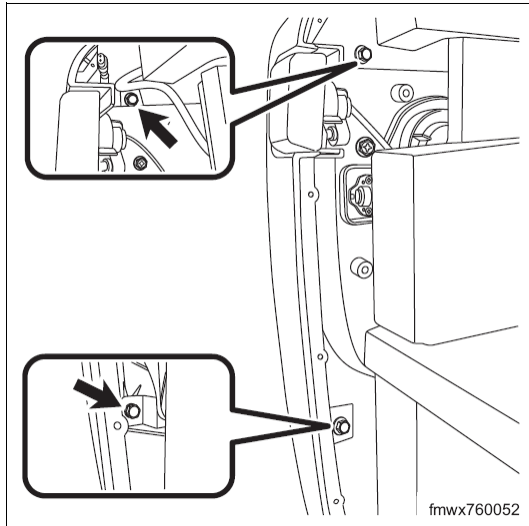


- (c). Install set bolts of front bumper and front crashproof cross member.

Suggestion:

The installation procedure of LH side is same as that of RH side.

Torque: 100 N.m



(d). Install set bolts of front bumper and head lamp bracket.

Suggestion:

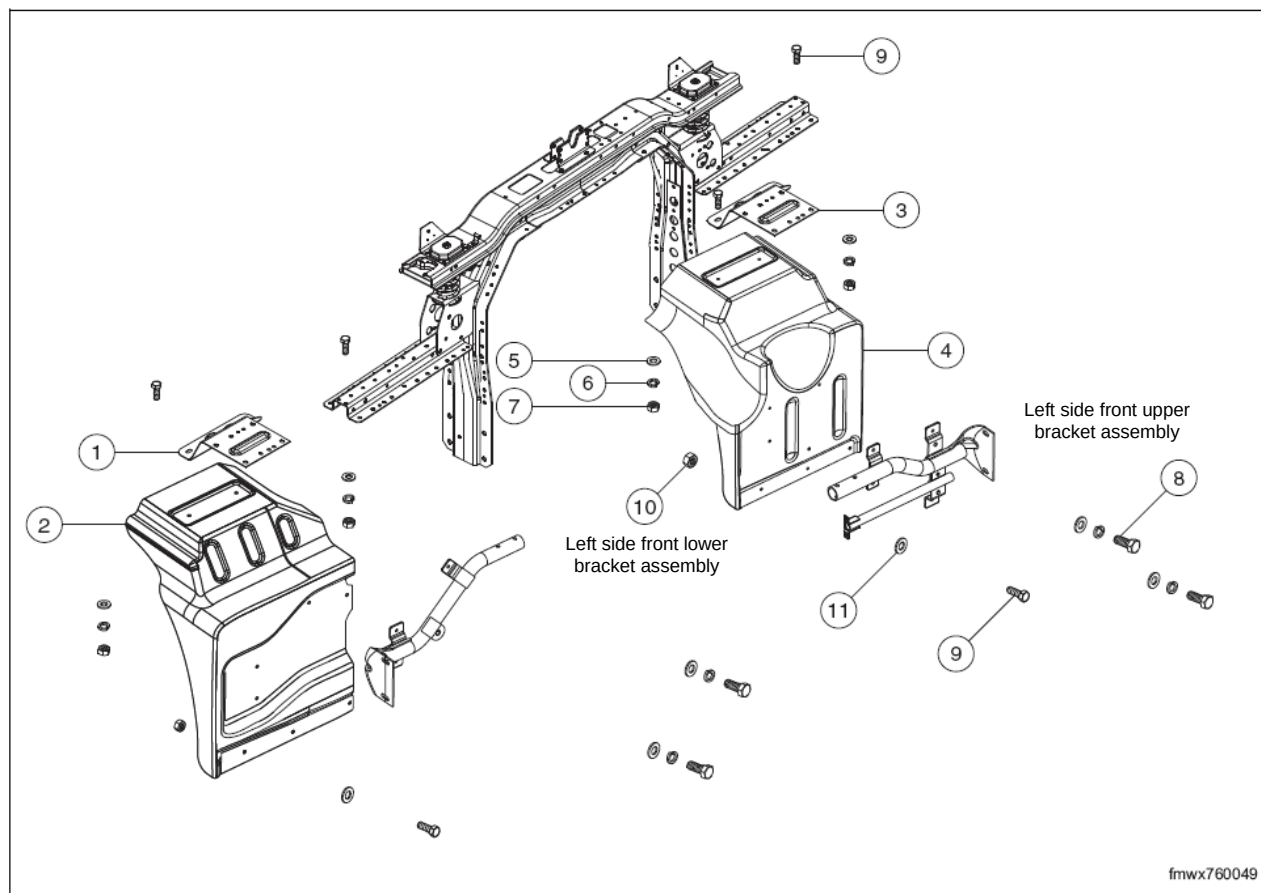
The installation procedure of LH side is same as that of RH side.

Torque:40 N.m

5. Turn off driver's cab
6. Close front flip cover plate

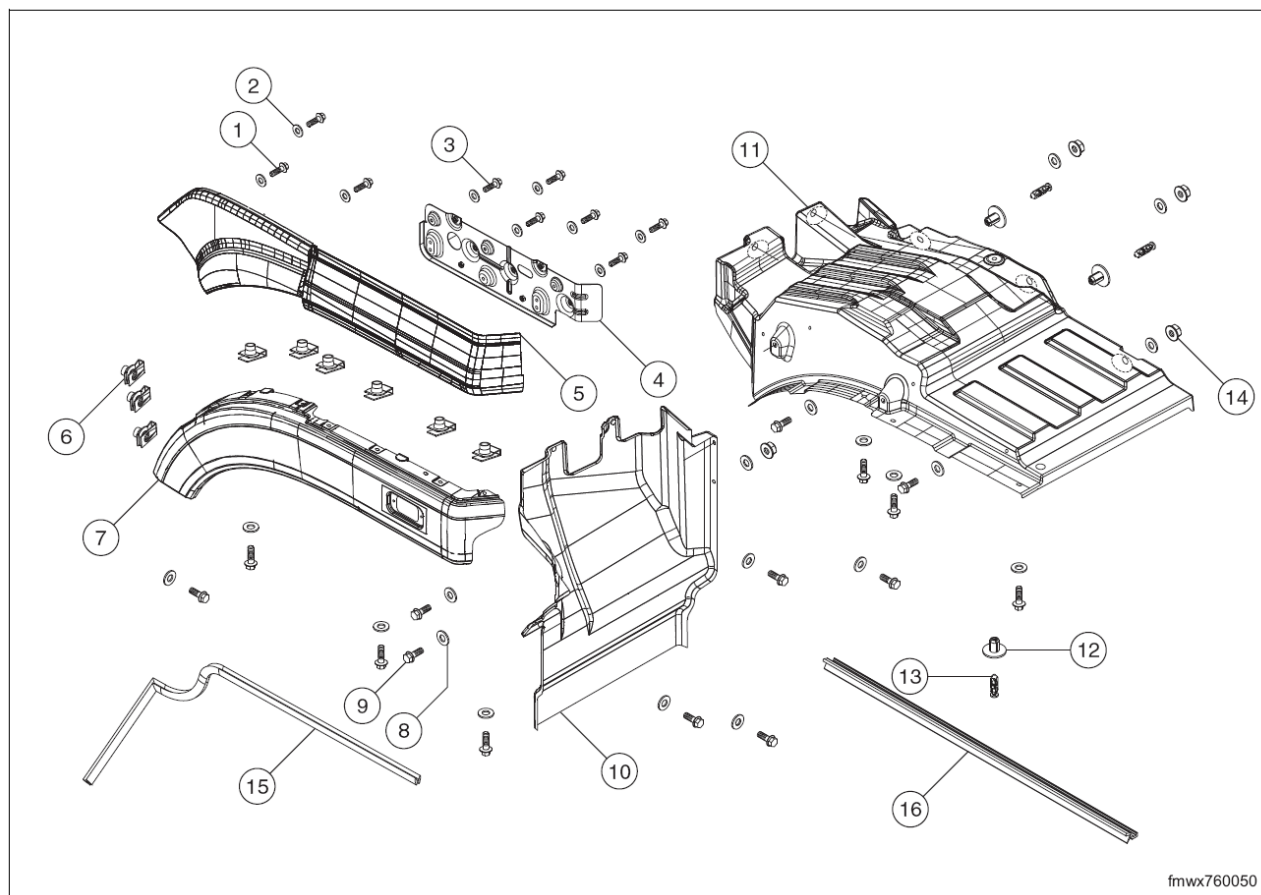
SPLASH SHIELD

DIAGRAM OF COMPONENTS



1	LH rear fender connecting plate
2	LH rear fender
3	RH rear fender connecting plate
4	RH rear fender
5	Plain washer
6	Spring washer

7	Hexagon nuts with flange
8	Hexagon bolt, spring washer and plain washer assembly
9	Hexagon bolt
10	Hexagon nut, style 1
11	Large washer



fmwx760050

1	Hexagon bolt with flange
2	Plain washer
3	Bolt
4	Fender bracket assembly
5	Fender
6	B type spring nut
7	Wheel house
8	Plain washer

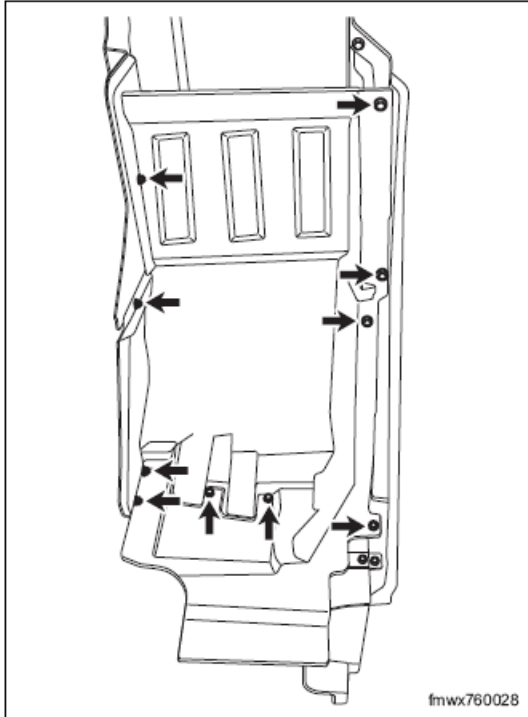
9	Hexagon bolt with flange
10	Front upper splash shield
11	Wheel upper splash shield
12	Buckle seat-splash shield
13	Buckle – splash shield
14	hexagon nut, style 1
15	Fender sealing strip
16	Fender rear sealing strip

REPLACEMENT

Suggestion:

Component diagram, see Chapter 76 Interior and exterior trimmings – splash shield, component diagram.

1. Turn on driver's cab



2. Dismantle upper splash shield assembly

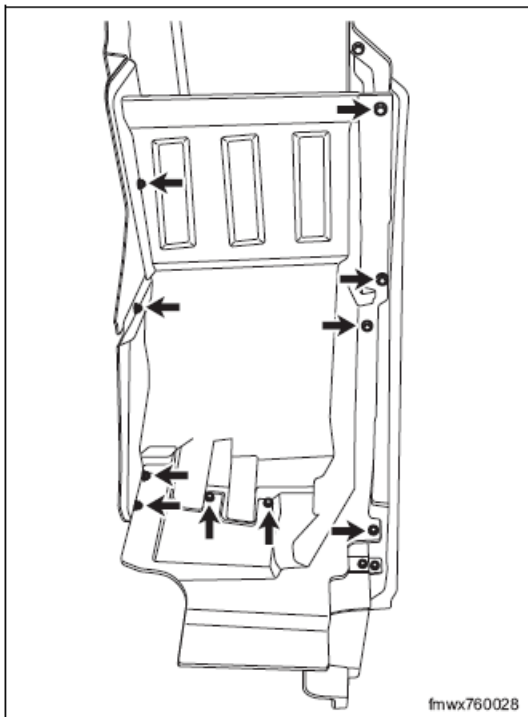
- Disconnect signal lamp connector.
- Dismantle set bolts, nuts and buckles of wheel upper splash shield.

Note:

If any damage occurs on buckles, they must be replaced by new parts.

Suggestion:

The dismantling procedure of LH side is same as that of RH side.

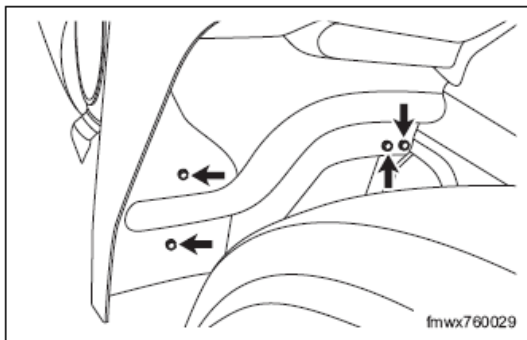


3. Install wheel upper splash shield assembly

- Install set bolts, nuts and buckles of wheel upper splash shield.
- Install signal lamp connector.

Suggestion:

The installation procedure of LH side is same as that of RH side.

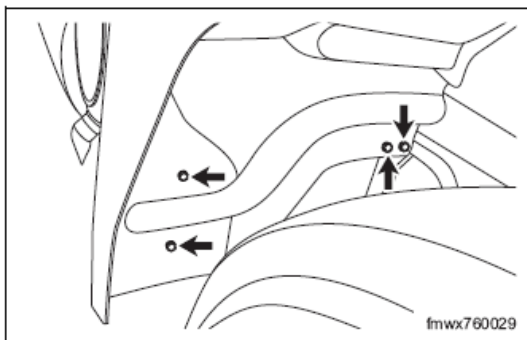
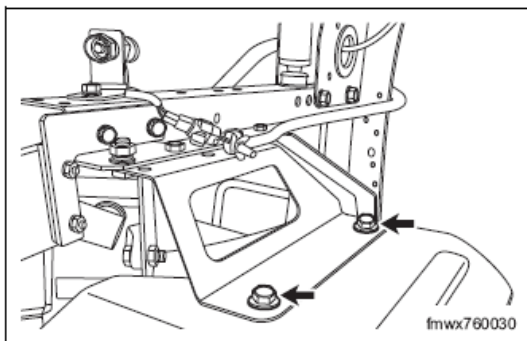


4. Dismantle rear splash shield assembly

(a). Dismantle set bolts of rear splash shield.

Suggestion:

The dismantling procedure of RH side is same as that of LH side.

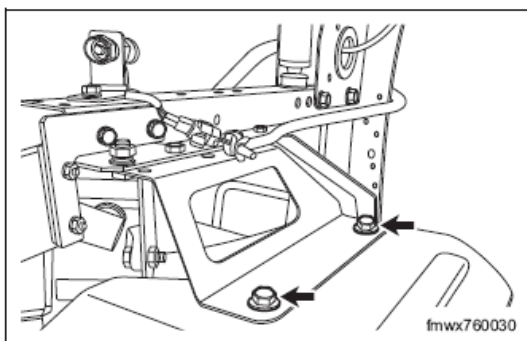


5. Install rear splash shield assembly

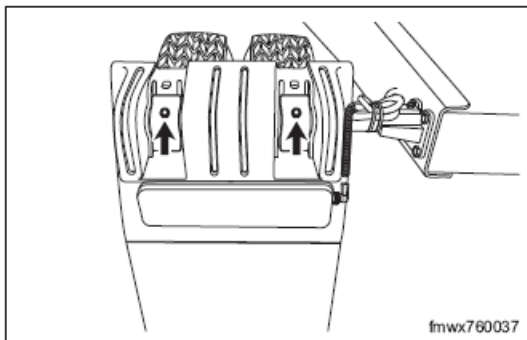
(a). Install set nuts of rear splash shield.

Suggestion:

The mounting procedure of RH side is same as that of LH side.



6. Turn down driver's cab

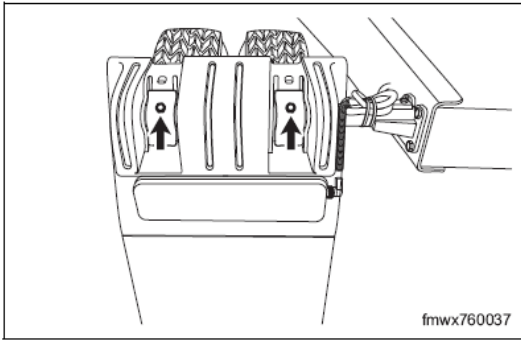


7. Dismantle rear wheel splash shield assembly

(a). Dismantle set bolts of rear wheel splash shield.

Suggestion:

The dismantling procedure of RH side is same as that of LH side.

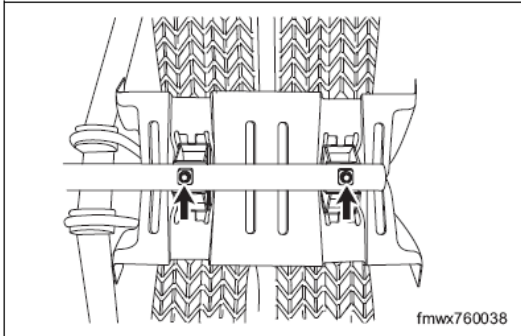


8. Install rear wheel splash shield assembly

- (a). Install set bolts of rear splash shield.

Suggestion:

The mounting procedure of RH side is same as that of LH side.

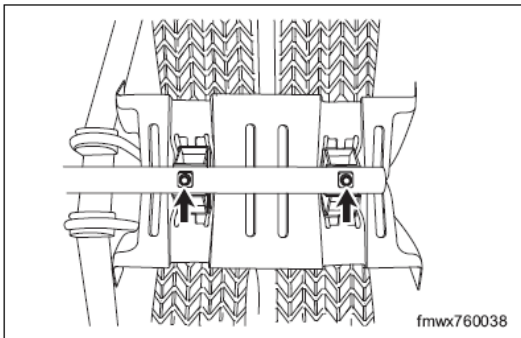


9. Dismantle middle splash shield assembly

- (a). Dismantle set bolts of middle splash shield.

Suggestion:

The dismantling procedure of RH side is same as that of LH side.

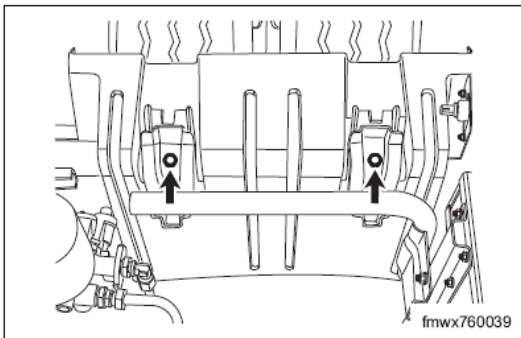


10. Install middle splash shield assembly

- (a). Install set bolts of middle splash shield.

Suggestion:

The mounting procedure of RH side is same as that of LH side.

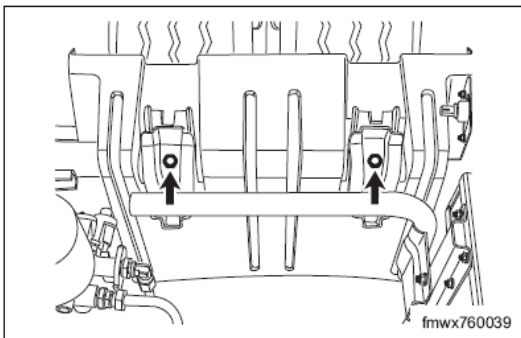


11. Dismantle rear wheel front splash shield assembly

- (a). Dismantle set bolts of rear wheel front splash shield.

Suggestion:

The dismantling procedure of RH side is same as that of LH side.



12. Install rear wheel front splash shield assembly

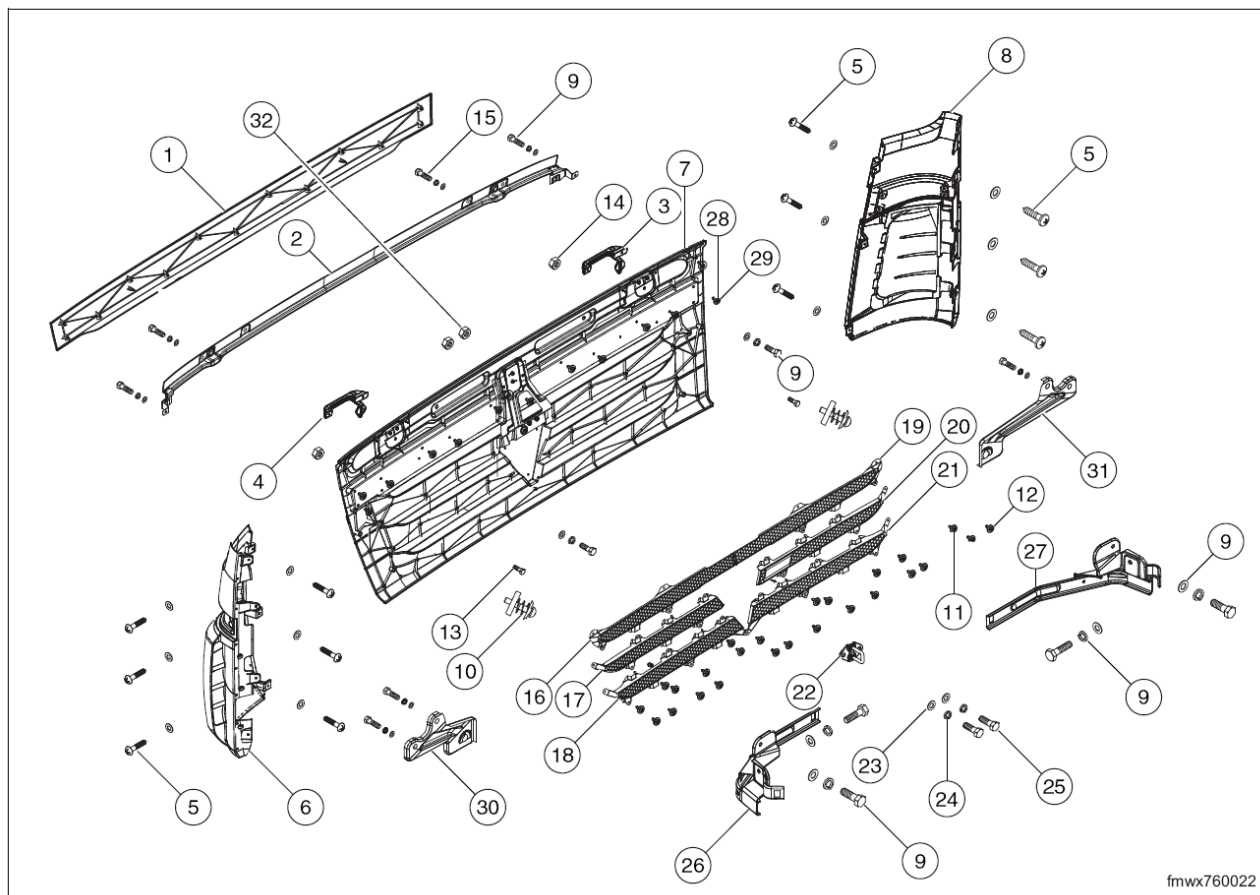
- (a). Dismantle set bolts of rear wheel front splash shield.

Suggestion:

The mounting procedure of RH side is same as that of LH side.

FRONT COVER

DIAGRAM OF COMPONENTS



1	Front cover plate trim panel
2	Wiper fixing plate weld assembly
3	RH front fender handrail and hinge assembly
4	LH front fender handrail and hinge assembly
5	Cross recessed pan head self-tapping screw and plain washer assembly
6	LH trim gusset assembly
7	Front flip cover plate assembly
8	RH trim gusset assembly
9	Hexagon bolt, spring washer and plain washer assembly
10	Flip cover plate latch assembly
11	Cross recessed pan head self-tapping screw – C type(upper/lower housing)
12	Large washer
13	Hexagon bolt with flange
14	Hexagon nuts with flange
15	Hexagon bolt, spring washer and plain washer assembly
16	LH upper cover mesh

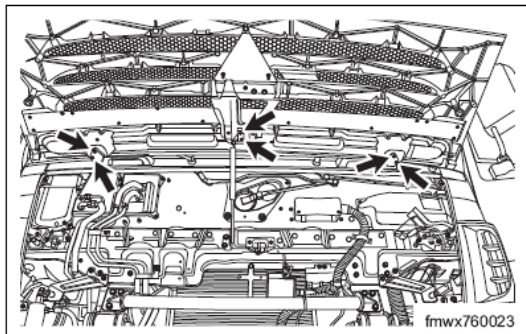
17	LH middle cover mesh
18	LH lower cover mesh
19	Upper cover mesh
20	RH middle cover mesh
21	RH lower cover mesh
22	Limit lock shackle pin assembly
23	Plain washer
24	Spring washer
25	Cross recessed hexagon head bolt
26	LH gusset lower bracket weld assembly
27	RH gusset lower bracket weld assembly
28	Cross recessed pan head self-tapping screw
29	Plain washer
30	Bumper block RH bracket
31	Bumper block LH bracket
32	Hexagon nuts with flange

REPLACEMENT

Suggestion:

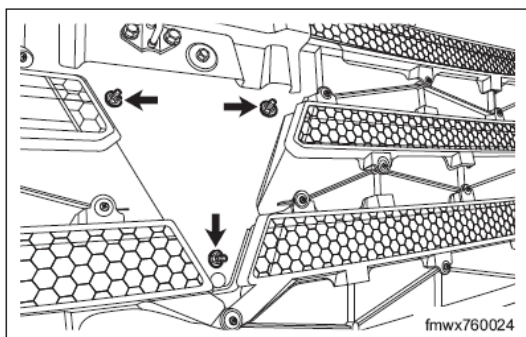
Component diagram, see Chapter 76 Interior and exterior trimmings – front cover, component diagram.

1. Open front flip cover plate



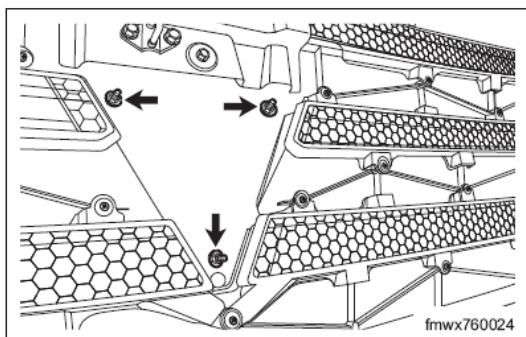
2. Dismantle front flip cover plate assembly

- (a). Dismantle set bolts of front flip cover plate stay bar.
- (b). Dismantle set bolts of front flip cover plate hinge.



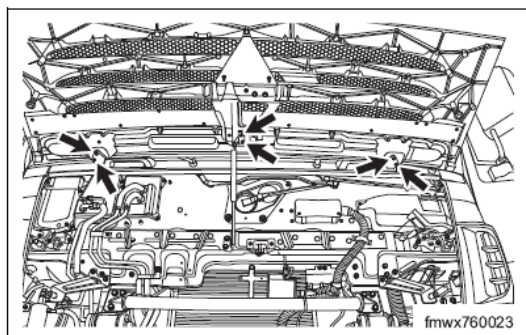
3. Dismantle Foton brand assembly

- (a). Dismantle set nuts of Foton brand.



4. Install Foton brand assembly

- (a). Install set nuts of Foton brand.



5. Install front flip cover plate assembly

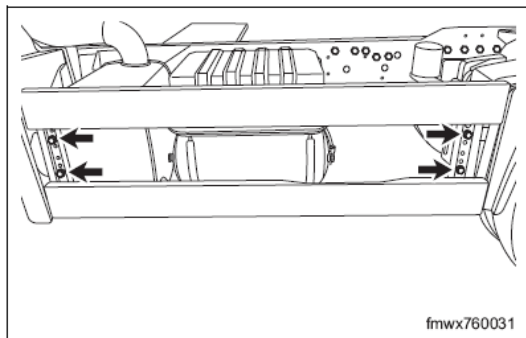
- (a). Install set bolts of front flip cover plate hinge
- (b). Install set bolts of front flip cover plate stay bar.

Torque: 40 N.m

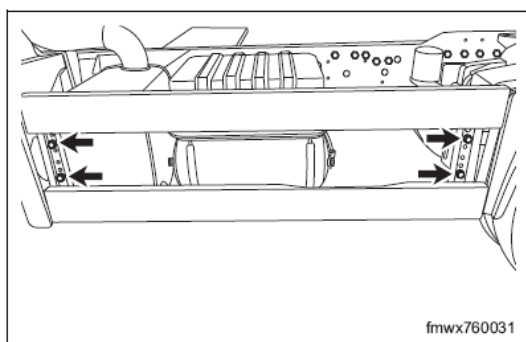
6. Close front flip cover plate

GUARDRAIL

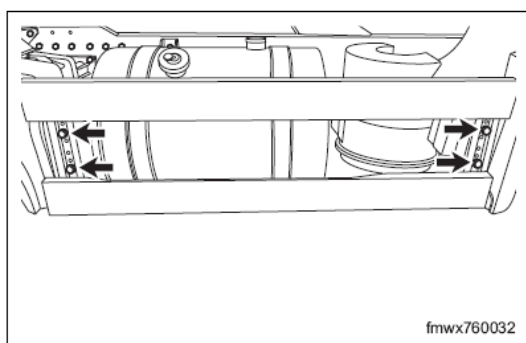
REPLACEMENT



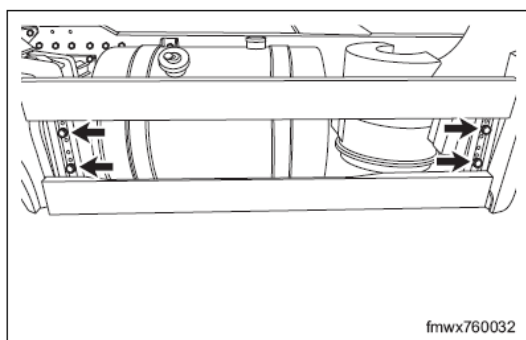
1. **Dismantle LH cargo body guardrail assembly**
(a). Dismantle LH guardrail set bolts.



2. **Install LH cargo body guardrail assembly**
(a). Install LH guardrail set bolts.
Torque: 97N.m



3. **Dismantle RH cargo body guardrail assembly**
(a). Dismantle RH guardrail set bolts.



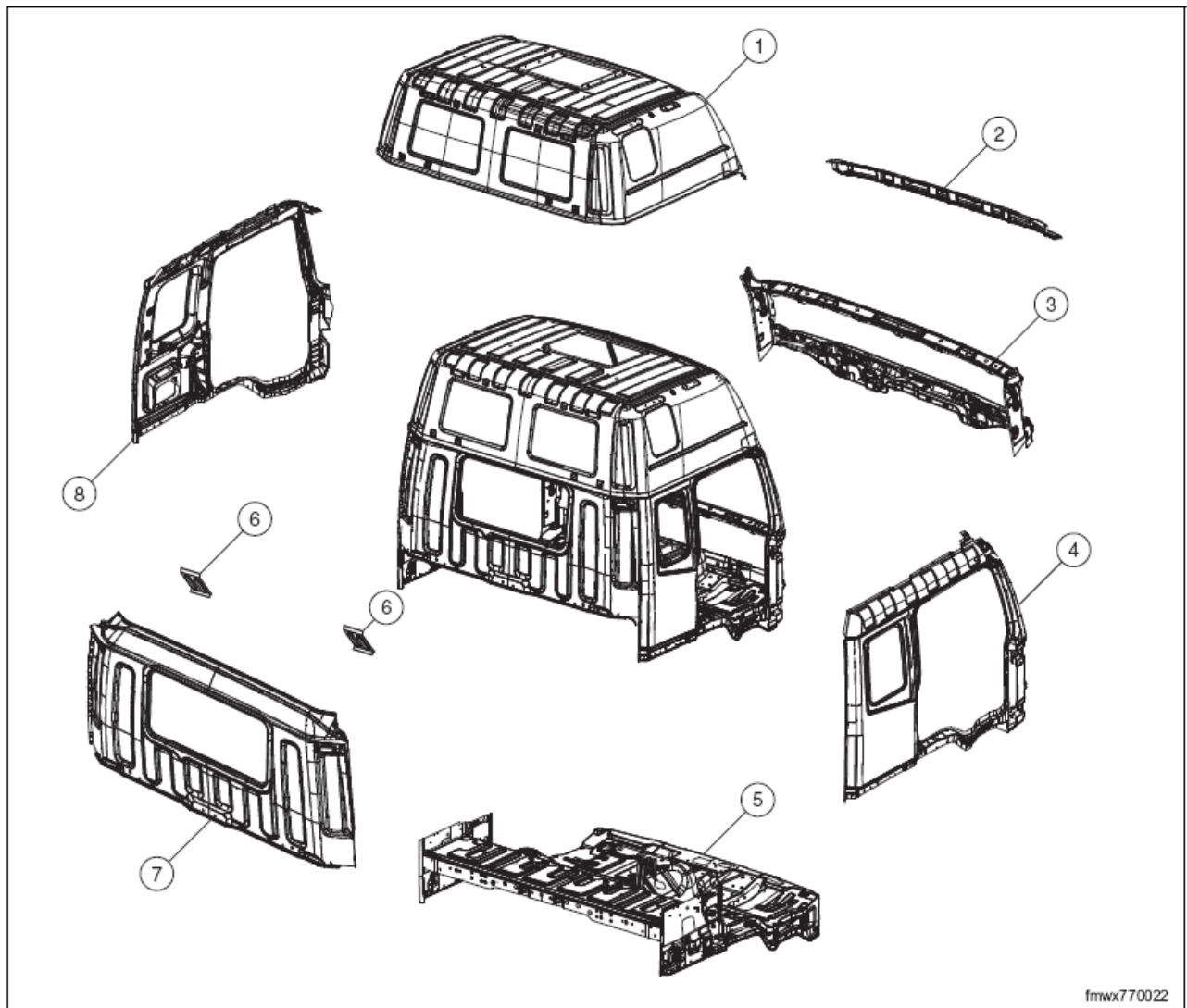
4. **Install RH cargo body guardrail assembly**
(a). Install RH guardrail set bolts.
Torque: 97N.m

CAB

CAB	77-3
DIAGRAM OF COMPONENTS	77-3
REMOVAL AND INSTALLATION OF CAB	
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INSTALLATION OF CAB.....	77-13

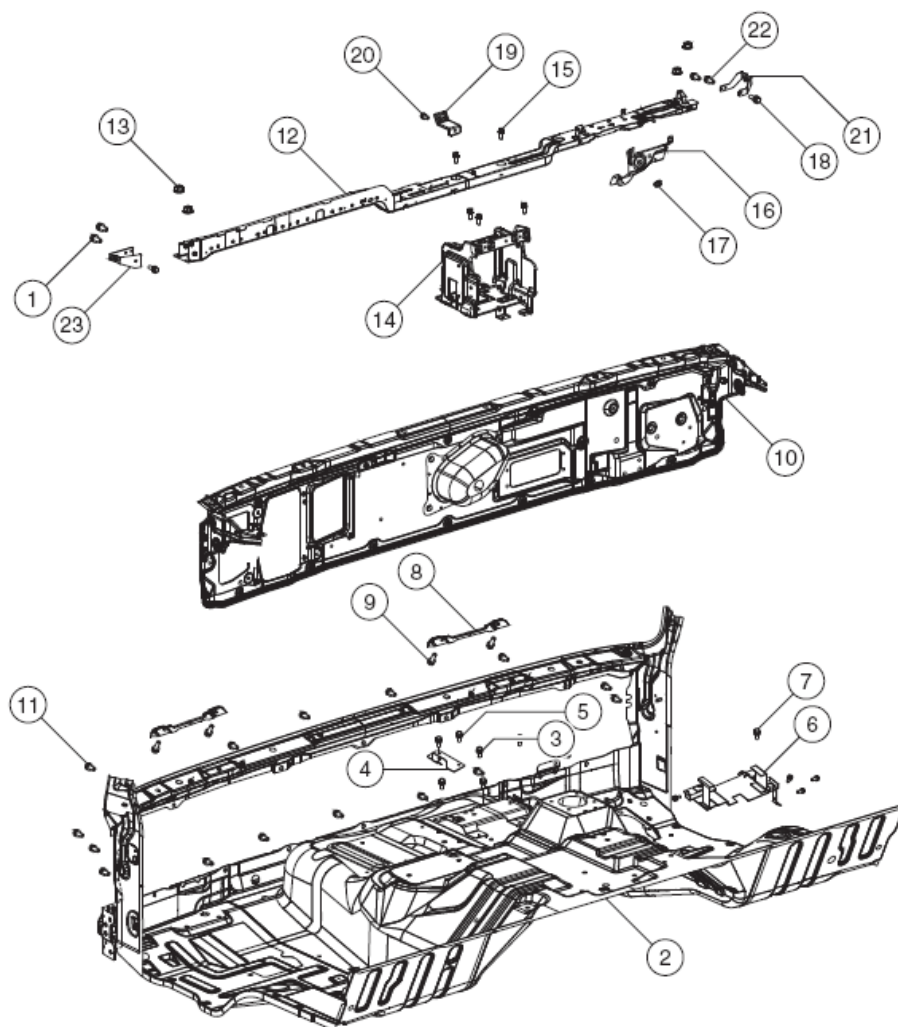
CAB

DIAGRAM OF COMPONENTS



1	Top cover welding assembly
2	Top cover front cross member assembly
3	Front wall welding assembly
4	Right side wall welding assembly

5	Floor welding assembly
6	High-roof rear panel and rear wall panel connecting plate
7	Rear wall welding assembly
8	Left side wall welding assembly



fmwx770023

1	Hexagon bolt, spring washer and plain washer assembly
2	Middle platform front bracket (right) assembly
3	Hexagon bolt, spring washer and plain washer assembly
4	Middle platform front bracket (left) assembly
5	Hexagon bolt, spring washer and plain washer assembly
6	Middle platform bracket assembly
7	Hexagon bolt, spring washer and plain washer assembly
8	Front handle bracket assembly
9	Hexagon bolt, spring washer and plain washer assembly

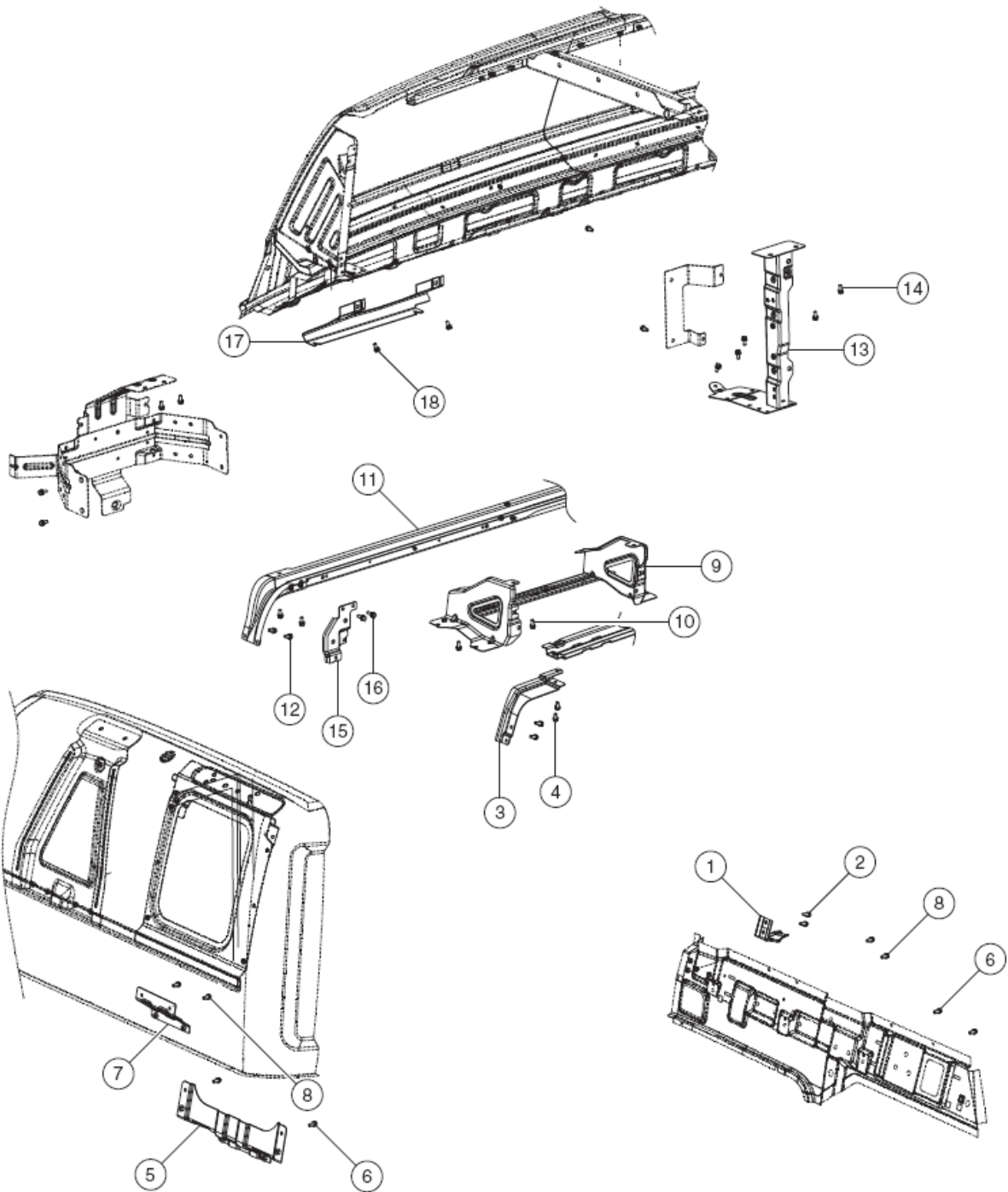
13	Hexagon flanged nut
14	Audio device holder assembly
15	Hexagon bolt, spring washer and plain washer assembly
16	Hand throttle bracket assembly
17	Hexagon flanged nut
18	Hexagon bolt, spring washer and plain washer assembly
19	Instrument panel upper cross member bracket (6)
20	Hexagon bolt, spring washer and plain washer assembly
21	Instrument panel right bracket assembly



CAB-CAB

77-5

10	Front wall front panel assembly	22	Spare parts of hexagon bolt, spring washer and plain washer assembly
11	Hexagon bolt, spring washer and plain washer assembly	23	Instrument panel left bracket assembly
12	Instrument panel upper cross member assembly		



fmwx770024

CAB-CAB**77-7**

1	Roof storage box bracket assembly	10	Hexagon bolt, spring washer and plain washer assembly
2	Hexagon bolt, spring washer and plain washer assembly	11	Roof cover front reinforced beam welding assembly
3	Roof cover and side panel connecting plate	12	Hexagon bolt, spring washer and plain washer assembly
4	Hexagon bolt, spring washer and plain washer assembly	13	Front vertical cabinet left column welding assembly
5	Side roof and upper side beam rear connecting plate assembly	14	Hexagon bolt, spring washer and plain washer assembly
6	Hexagon bolt, spring washer and plain washer assembly	15	Storage cabinet bracket
7	Left side panel and upper side beam connecting plate assembly	16	Hexagon bolt, spring washer and plain washer assembly
8	Hexagon bolt, spring washer and plain washer assembly	17	File cabinet bottom bracket
9	High-roof storage rack assembly	18	Hexagon bolt, spring washer and plain washer assembly

77**FOTON**

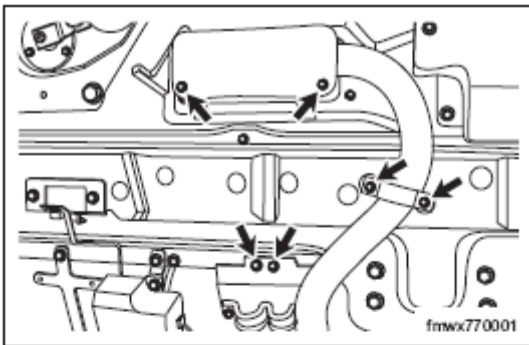
REMOVAL AND INSTALLATION OF CAB ASSEMBLY

REMOVAL AND INSTALLATION OF THE CAB

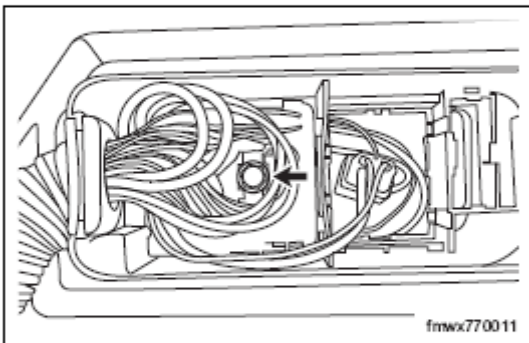
Hint:

As the brake liquid may dissolve the paint, keep external parts away from the brake liquid. The working ground must be level, and the cab and roof shall be cleared up.

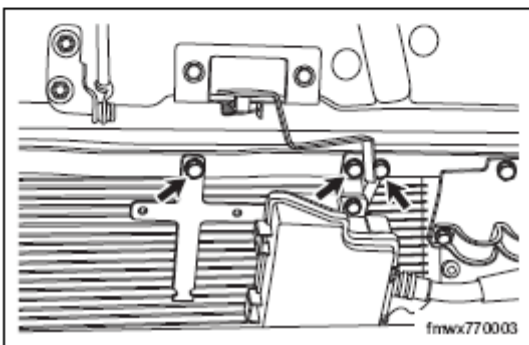
1. Turn up the front tilting cover plate, and turn off the master power switch.
2. Turn up the cab.
3. Disconnect the headlamp wire plug. Refer to Chapter 54: Replacement, Lighting-Front Grouped Lamp.
4. Disconnect the step lamp wire plug. Refer to Chapter 54: Replacement, Lighting-Step Lamp.



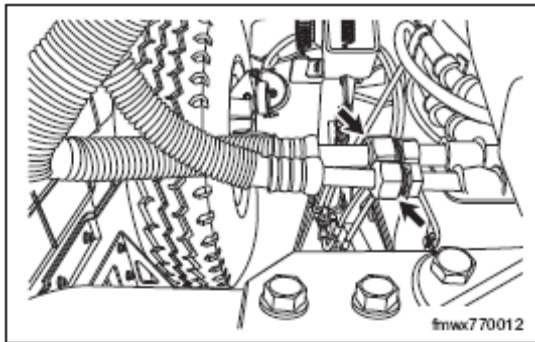
5. Disconnect the front cover plate wire plug, and remove the wire set bolt.
 - (a) Remove the front cover plate wiring box bolt and wire set bolt.



- (b) Remove the wire plug set bolt, and disconnect all plugs of the front cover plate wires.



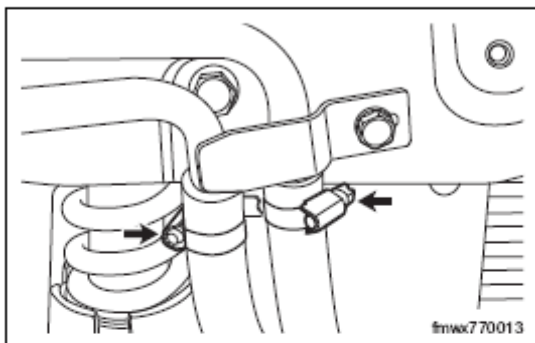
6. Disconnect the general fuse box bolt and front wall panel earthing cable.



7. Disconnect the air conditioner high and low pressure pipes.

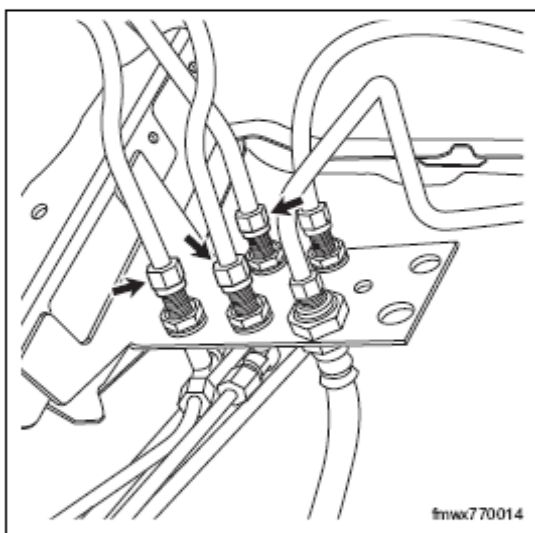
Notice:

Before disconnecting the air conditioner pipe, discharge the cooling medium in the air conditioning system.

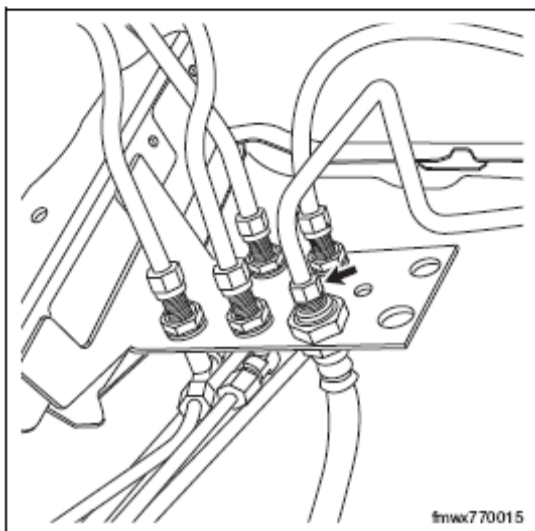


8. Disconnect the air heater water pipe.

(a) Remove the air heater water pipe binding strip.

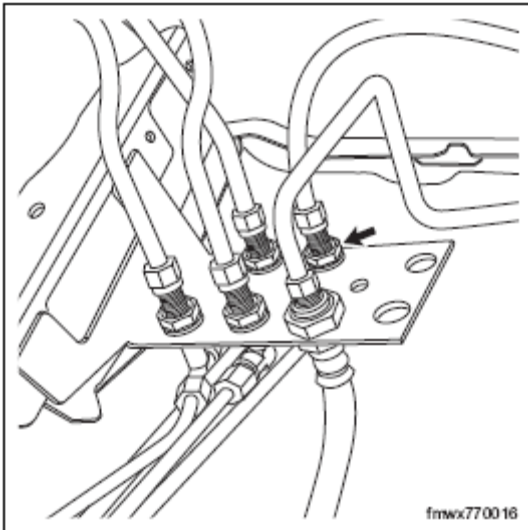


9. Disconnect the parking brake air pipe.



10. Disconnect the clutch master cylinder oil pipe.

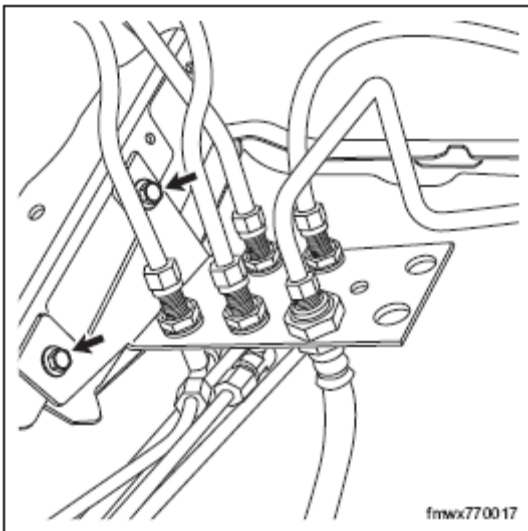




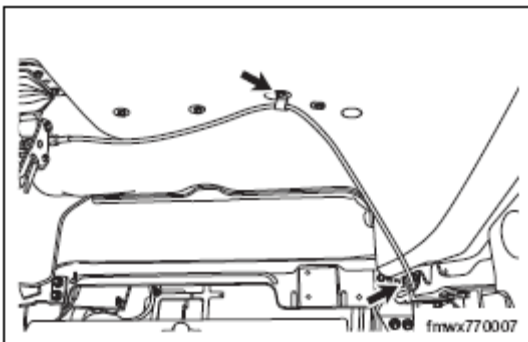
11. Disconnect the air pressure gauge pipe.

Notice:

The color rings on the pipe must be correctly identified to avoid confusion.

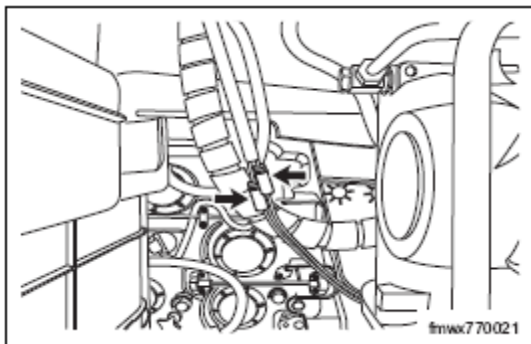


12. Remove the bracket set bolt.



13. Remove the bolt for fixing bracket of the gearshift lever lubricating oil pipe.

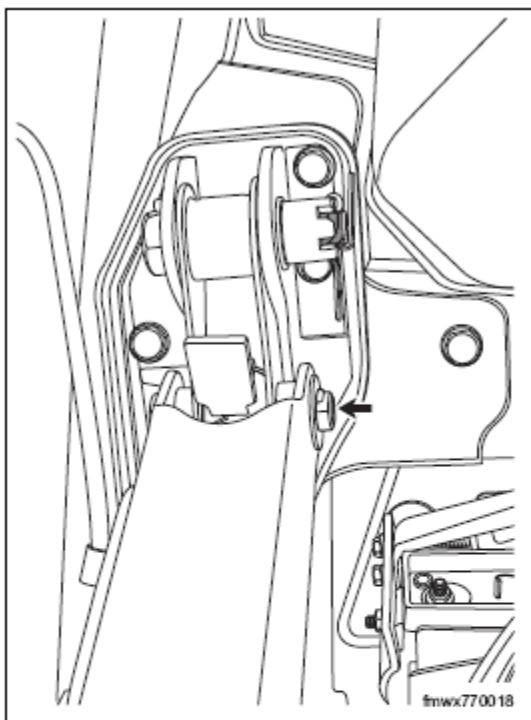
- 14. Disconnect the main brake valve air pipe and wire plug. Refer to Chapter 26: Service, Service Brake-Main Brake Valve.**
- 15. Remove the steering shaft. Refer to Chapter 42: Service, Power Steering Mechanism-Steering Gear Assembly.**
- 16. Remove the transmission control mechanism connecting bolts. Refer to Chapter 31: Removal and installation, Transmission-Transmission Control Mechanism.**



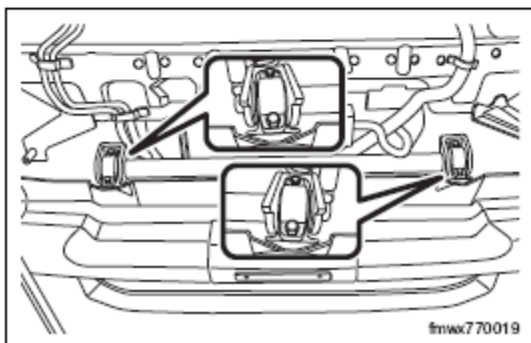
17. Disconnect the air pipe of transmission control mechanism.

18. Recover the cab.

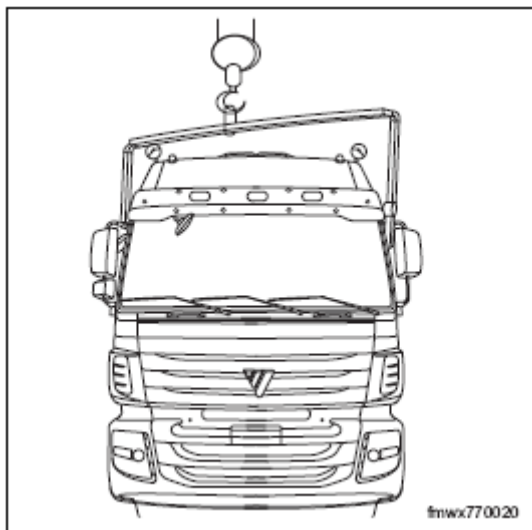
19. Lower the left and right front window glass, and locate the cab sling at the cab middle and slightly closer to the front. Slowly raise the sling till the cab is supported reliably.



20. Remove the tilting cylinder assembly pin shaft.



21. Remove the front fixing seat set bolt.



22. Hoist the cab assembly.

Warning:

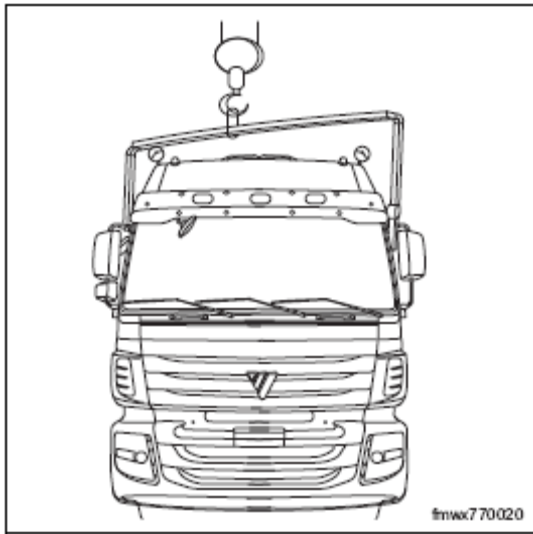
Rapidly place the cab onto the fixture.

Nobody is allowed to stand beneath the cab. In the operation, proper protection measures shall be taken.

Notice:

In the hoisting operation of the cab, ensure that the frame is not entangled by wires, hoses or pipe ends.

INSTALLATION OF CAB



1. Hoist the cab assembly.

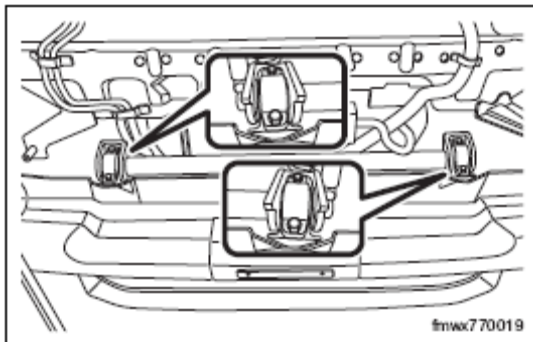
- (a) Slowly raise the sling to hoist the cab, and place it at the front mounting position.

Warning:

Nobody is allowed to stand beneath the cab. In the operation, proper protection measures shall be taken.

Notice:

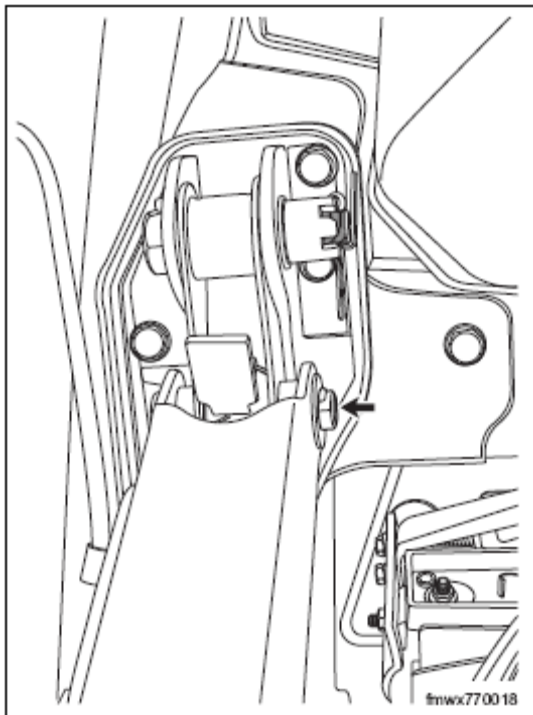
In the hoisting operation of the cab, ensure that the frame is not entangled by wires, hoses or pipe ends.



2. Refit the front fixing seat set bolt.

Torque: 97N.m

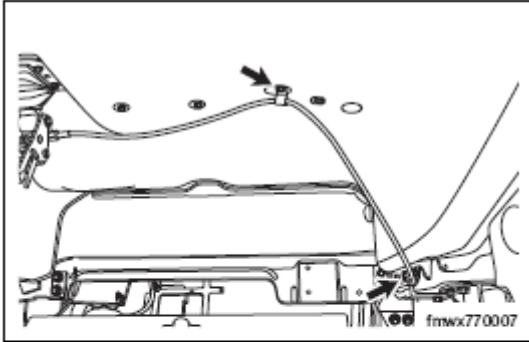
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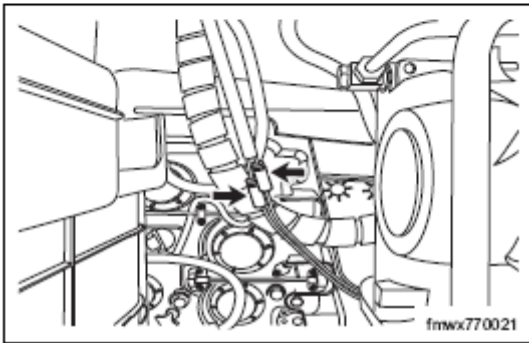
3. Refit the tilting cylinder assembly pin shaft.

4. Remove the cab sling, and slowly turn up the cab.

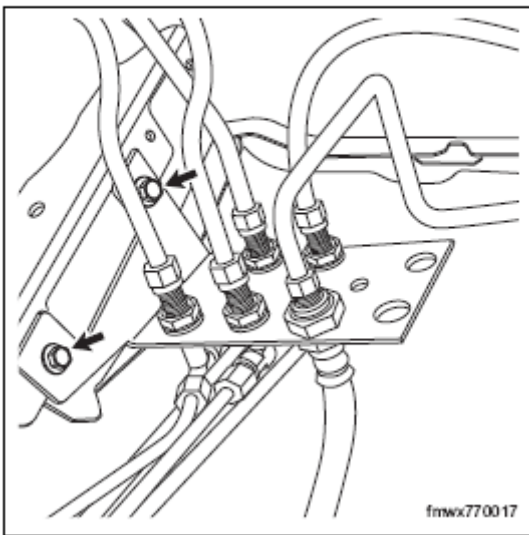
5. Refit the transmission control mechanism connecting bolts. Refer to Chapter 31: Removal and installation, Transmission-Transmission Control Mechanism.
6. Refit the steering shaft. Refer to Chapter 42: Service, Steering Gear and Accessories-Steering Gear Assembly.
7. Refit the main brake valve air pipe and wire plug. Refer to Chapter 26: Service, Service Brake-Main Brake Valve.



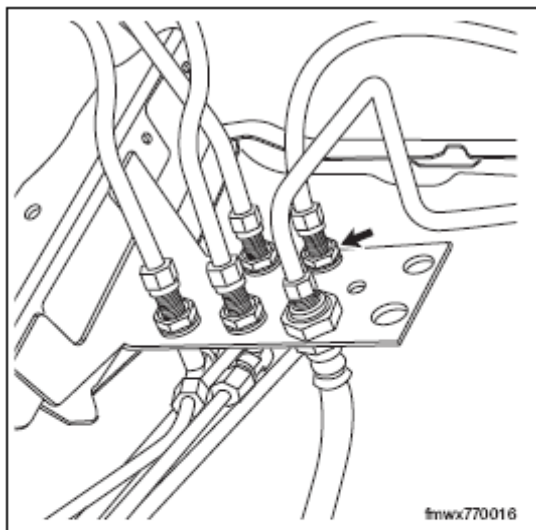
8. Refit the bolt of fixing bracket of the gearshift lever lubricating oil pipe.
Torque: 25N.m



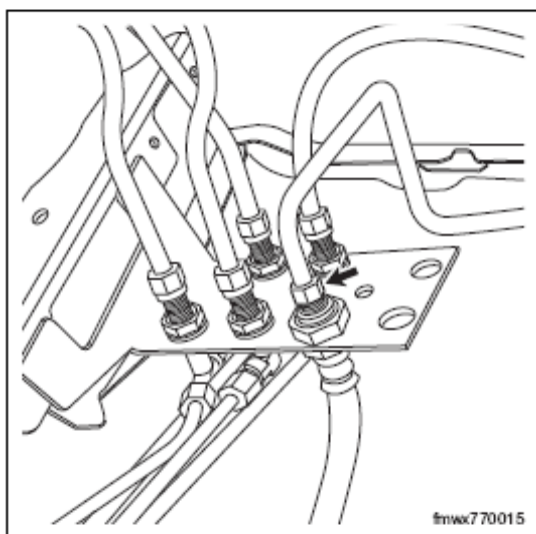
9. Refit the transmission control mechanism air pipe.



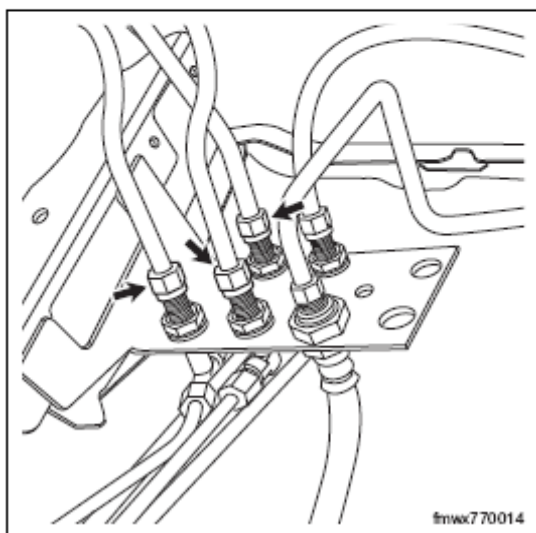
10. Refit the bracket set bolt.



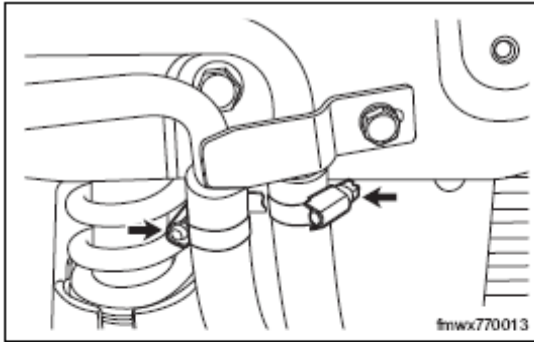
- 11. Refit the air pressure gauge pipe.**



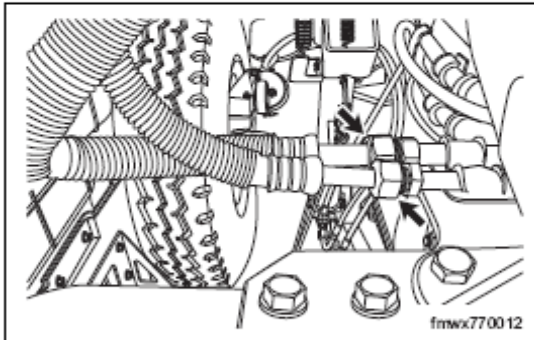
- 12. Refit the clutch master cylinder oil pipe.**



- 13. Refit the parking brake air pipe.**



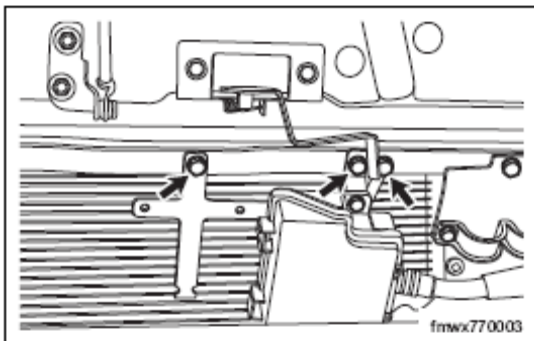
14. Refit the air heater water pipe.



15. Refit the air conditioner high and low pressure pipes.

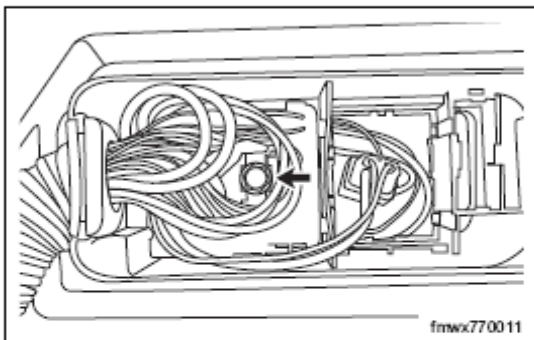
Notice:

Before refilling the cooling medium, the system shall be vacuumized.



16. Refit the general fuse box set bolt and front wall panel earthing cable.

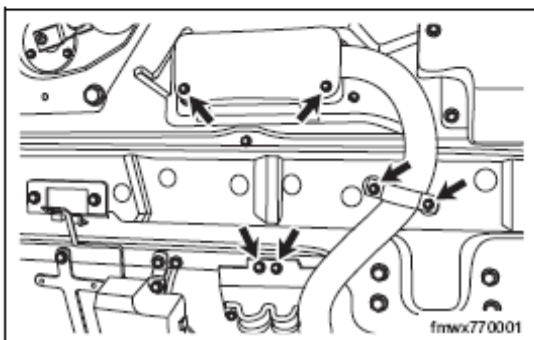
Torque: 25N.m



17. Refit the front cover wire plug and wire set bolt.

- (a) Refit all plugs of the front cover plate wire, and refit the wire plug set bolt.

Torque: 25N.m



- (b) Refit the front cover plate wiring box cover bolt and the wire set bolt.

Torque: 25N.m

-
18. Refit the step lamp wire plug. Refer to Chapter 54: Replacement, Lighting-Step lamp.
 19. Refit the headlamp wire plug. Refer to Chapter 54: Replacement, Lighting-Front Grouped Lamp.
 20. Recover the cab.
 21. Recover the front tilting cover plate, and turn on the master power switch.



TRACTION SADDLE

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SERVICE OF COMMON FAULTS.....	92-8
REPLACEMENT OF WEAR PARTS	92-10

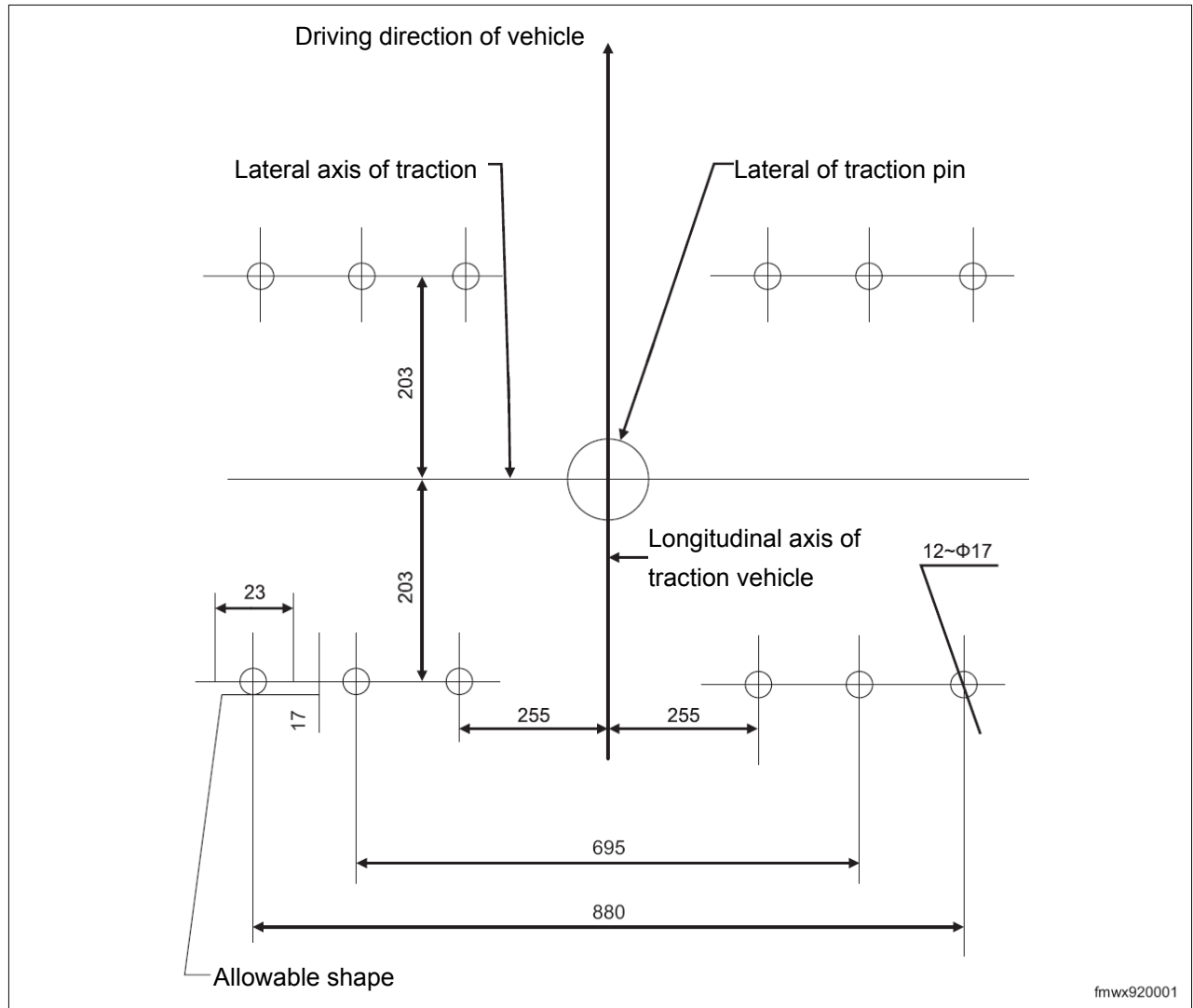


TRACTION SADDLE ASSEMBLY

OVERVIEW

The vehicle traction saddle is a kind of traction component which is used for pulling trailer by cargo truck; it mainly includes hatch cover, saddle seat and locking mechanism. The traction saddle shall be equipped with 12 installing holes with diameter of 17mm; its size at the relative position is shown in the diagram. These holes can be manufactured into slot holes (Dimension: see the diagram) which are vertical with the long axis and longitudinal axis of traction vehicle.

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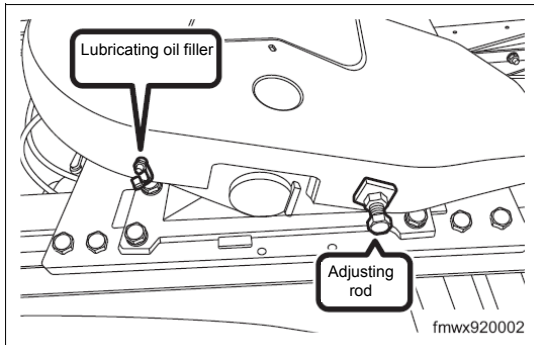
Diameter diagram of installing holes at the relative position

Auman trailer uses the saddle with # 90 traction pin, which is reliably tightened onto the installation base of the saddle with 12 M16 bolts not inferior than Grade 10.9.

PRECAUTIONS

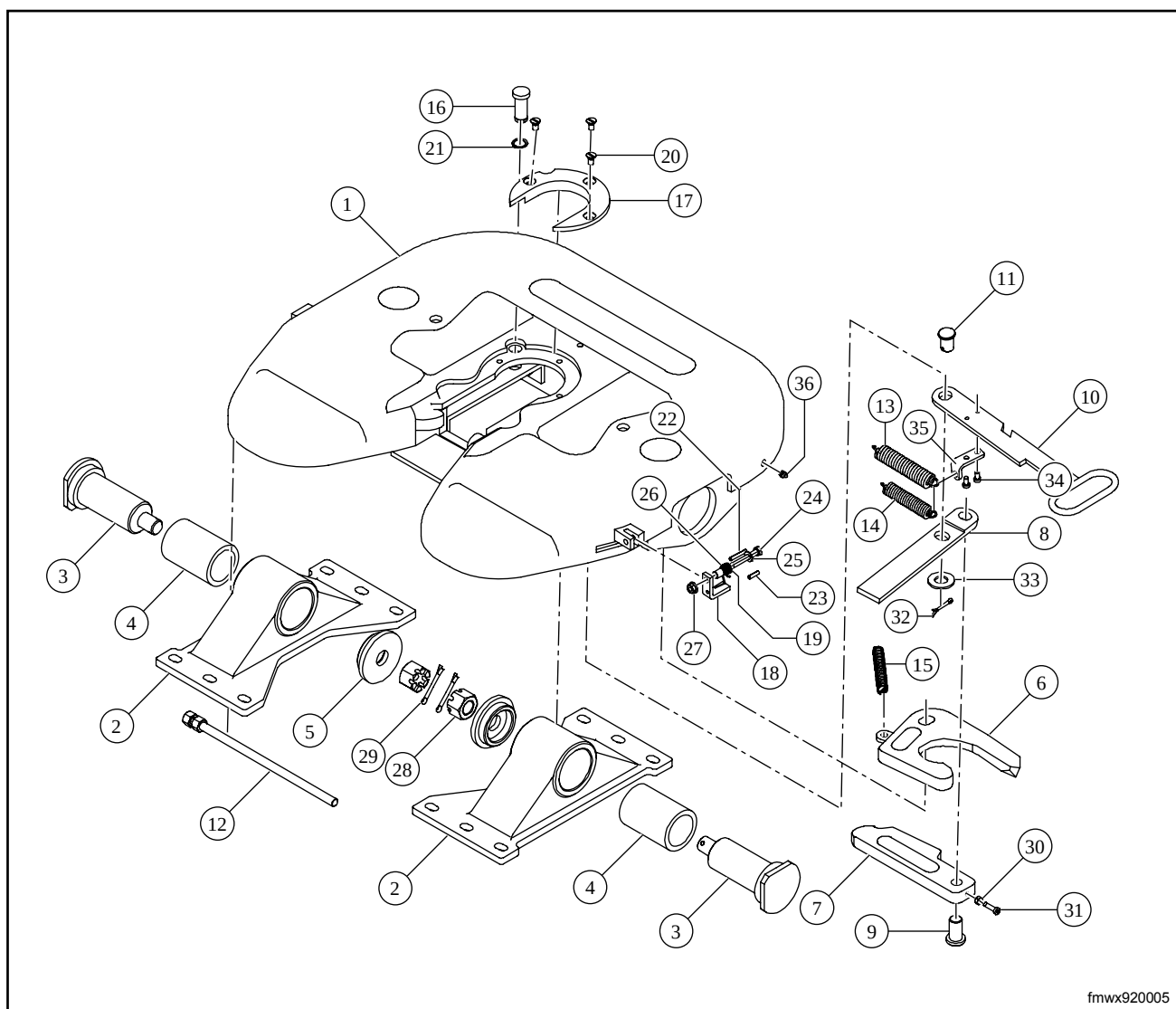
1. Maximum loading capacity of the traction saddle of Auman trailer is 30000KG.
2. Check the fitting clearance between traction pin and traction hook at the first time of jointing traction vehicle and trailer, e.g. oversize clearance (with abnormal noise), meanwhile, adjust the regulating rod on the side of traction base, to rotate and lock the adjusting rod for 1~3 circles along the counter-clockwise direction, make sure that the fitting is tight with no loose feel.

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3. Before using, apply a layer of lubrication grease on the surface of traction saddle shell. For first-time driving, the trailer must be disconnected from vehicles for about 1000 Km distance and the residual grease must be cleared up, meanwhile, the running-in status of shell surface of traction base and the sliding plate of trailer shall be checked carefully, all the obvious grinding defects and marks must be polished and removed completely, the instruments can be used normally after they are cleaned up and applied with sufficient lubrication grease.
4. The eccentric wear phenomenon of traction saddle shell may be caused by the abrasion of rubber bush of supporting feet, thus in order to avoid the degradation of abrasion phenomenon, it is necessary to replace with new rubber bush.
5. When jointing the trailer, it is needed to pull out the tie rod completely, or the traction hook will be damaged.
6. When the jointing work is over, do not start the vehicle until the tie rod is confirmed at the safe position.

DIAGRAM OF COMPONENTS



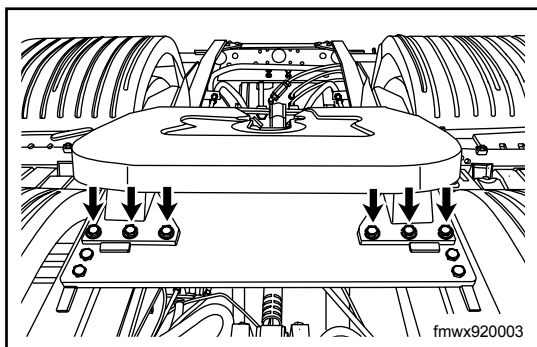
1	Saddle assembly
2	Saddle base
3	Support pin
4	Rubber bush
5	Pin-support bushing
6	Traction hook
7	Wedge
8	Swing rod assembly
9	Wedge bolt
10	Tie rod assembly
11	Tie-rod pin
12	Adjusting rod component
13	Outer spring of tie rod
14	Inner spring of tie rod
15	Traction hook spring
16	Traction hook pin
17	Quick-wear ring
18	Spring retaining plate

19	Torsion spring
20	Slotted countersunk (flat) head screw M12×20-Q
21	φ24 Retainer ring
22	Spring-type straight pin 6×40
23	Spring-type straight pin 6×24
24	Hex bolt M10×65
25	φ10 Plain washer
26	Locating tube
27	Hexangular flange nut M10
28	M30×2 Castellated nut
29	6×60 Split pin
30	M8 Nut
31	M8×30 Socket head screw
32	5×40 Split pin
33	φ24 Plain washer
34	M8×18 Socket head screw
35	Tie-rod spring plate
36	M10×1 Straight-through type forced filling oil cup



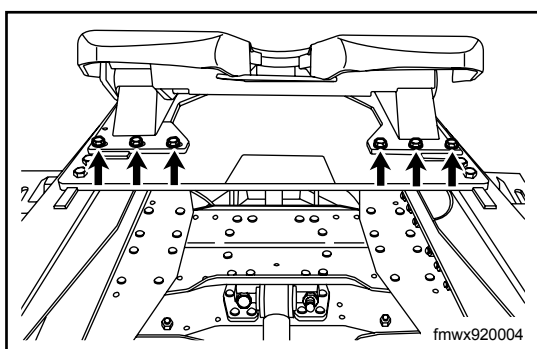
TRACTION SADDLE

REPLACEMENT

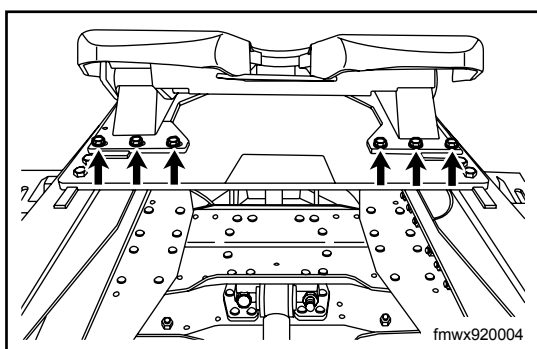


1. Disassemble the traction saddle

- (a). Disassemble the set bolt in front of traction saddle.



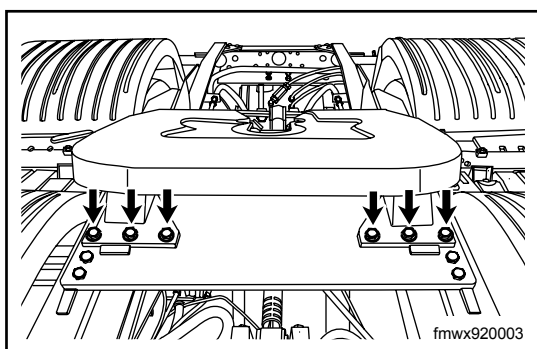
- (b). Disassemble the set bolt at the back of traction saddle.



2. Assemble the traction saddle

- (a). Assemble the set bolt at the back of traction saddle.

Torque: 240 N.m



- (b). Assemble the set bolt in front of traction saddle.

Torque: 240 N.m

SERVICE OF COMMON FAULTS

Faults	Reasons	Measures
The tie rod cannot be pulled out	1. Caused by the manufacturing tolerance of traction pin and the assembled verticality.	Repair the traction pin and adjust its assembly position.
	2. As the regulating rod (for adjusting the clearance between traction saddles) doesn't close up to the wedge head, then during running process, the wedge will become more tightened under the influence of return spring.	Turn and adjust the regulating rod inward till the tie rod are pressed to move outward, then the tie rod can be pulled out. Note: the adjusting range of regulating rod should not be overmuch, or the tie rod cannot move from side to side, meanwhile the tie rod will not be pulled out without relieving the locking state.
Abnormal abrasion	1. No chamfer at the front of mounting plate on the traction pin may cause local damage and abrasion of traction saddle (When jointing two sections, the edge of traction panel will scuff the traction saddle like a knife), which can be worsened during the using process.	Clear up the greasy dirt, polish the two fitting surfaces or replace the sliding plate of trailer.
	2. The mounting plate of traction pin is too short, therefore, at the time of vehicle turning corners (or the traction vehicle running independently), the traction saddle will surpass the mounting plate, and then sandstones will stick on the lubricating grease and result in abrasion.	
	3. Delayed maintenance and deficient lubricating grease will cause abrasion.	
	4. Uncleanliness of the mounting plate between traction saddle and traction pin may also cause abrasion (e.g. the foreign matter like sandstones and metal particles).	
The traction saddle can't swing forward/backward or the heights on two sides are not uniform	1. The inside rubber bush of support pillar has been worn out.	Replace the rubber bush.
Fracture of support base	1. The castings have quality problems.	Replace the support pillar.
	2. Incorrect installation of traction saddle, overloaded for a long time.	Add support device in the stressed part of support pillar.
	3. Lack of bearing bar in the middle parts of support pillar.	Add bearing bar in the corresponding part of connecting plate.



TRACTION SADDLE-TRACTION SADDLE
92-9

Faults	Reasons	Measures
Fracture of traction hook	1. There are old wounds on the fracture parts, some tiny fissures are stretching gradually; these belong to the forging problem.	Replace the traction hook.
	2. No old wounds on the fracture parts, but some inflation and clashing marks exist inside of hook fractures; these belong to the using problem caused by incorrect docking.	
Hollowness of traction saddle when starting and parking (Exaggerated fitting clearance between traction saddle and traction pin)	1. Abrasion of traction hooks and wear ring.	Replace traction hook and wear ring.
	2. Abrasion of traction pin.	Unscrew the regulating rod toward outside, until there is no losing space. If has no effects, then check if every wear part has allowable range or not, replace it if the range is surpassed.
	3. Looseness of traction pin bolt.	Replace the traction pin bolt, and screw it according to relevant specifications.
	4. Looseness of the set bolt of support pillar.	Tighten the mounting bolt and install front/rear limit blocks.

92

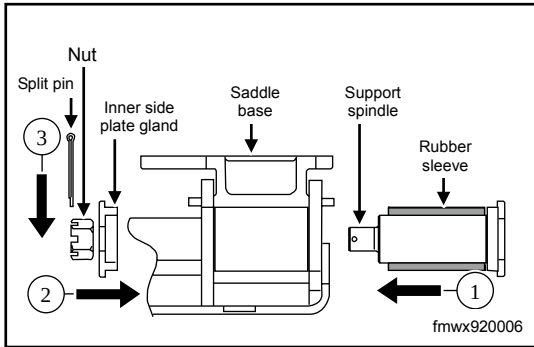
FOTON

REPLACEMENT OF WEAR PARTS

1. Replacement of rubber bush

- (a). If replace the rubber bush, firstly it is needed to disassemble the 12 set bolts from the traction saddle, reverse the traction disk for 180°, remove the split pin and screw off the nut, then use copper rod to knock the thread surface of support shaft, and remove the cover of inner panel, use copper to continue to knock the thread surface of support shaft, to remove the support shaft and rubber bush.

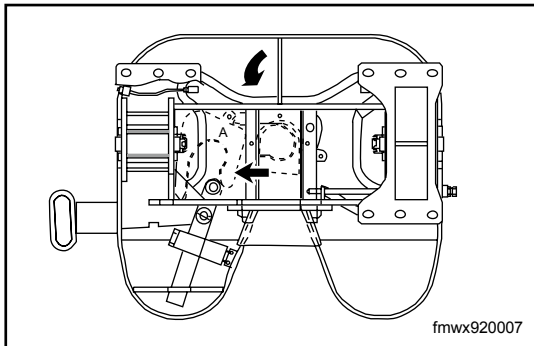
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- (b). Remove the old rubber bush (out of use) from the support shaft, as per the directions and sequences stipulated in the following diagram, to install rubber bush onto the support shaft, and then install support shaft and rubber bush into the interior holes of inner/outer panel and saddle base, then install the inner panel cover and nuts, screw the nuts and install the split pin. Finally reserve the traction saddle for 180° again and install it on the home position of vehicle chassis.

2. Replacement of coupler knuckle

- (a). When replacing the coupler knuckle, it is needed to first dismantle the 12 set bolts from traction saddle, reserve the traction disk for 180°, then pull out the handle and pad a U-type pad block (120mm more or less) at the handle part, make the hole (for inserting tapered iron pin) of tapered iron coincide with the process hole on seat cover.



- (b). Dismantle the split pin and plain washer, and remove the tapered iron pin; pull out the handle and locate it on the card slot edge of seat cover; as per the diagram, to rotate and move the coupler knuckle to position A, and then take it out.
- (c). Insert the new coupler knuckle into position A, as per the direction shown in the following diagram, to reversely rotate and move it to the correct position; install the coupler knuckle pin, plain washer, split pin and drag spring of coupler knuckle in sequence.
- (d). Put U-type iron cushion on the handle position, stir the handle and separate it from the card slot, align these three holes, process hole, tapered-iron inserting hole and lever-inserting hole, and then insert the tapered iron pin and install the plain washer and split pin in sequence.
- (e). Loosen the nut of regulating rod and rotate along the counter-clockwise direction for 2-3 circles, and then knock the handle by hand hammer (the handle shall not be pulled out at this time), rotate the regulating rod along the counter-clockwise direction again to the position where the handle can be pulled out by slightly moving (outward) the tie rod. Screw the nut tightly after the clearance is adjusted properly.

ENGINE (DONGFENG CUMMINS L SERIES)

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Introduction

About this Manual

This L Series Troubleshooting and Repair Manual is intended to aid in determining the cause of engine performance related problems and to provide recommended repair procedures. The manual is divided into sections by system. Each section provides general information, specifications, illustrations, and service tools, where applicable. The specific repair procedures are referenced in the Troubleshooting Logic Charts. The procedures in this manual were developed for the in-chassis environment.

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How to Use this Manual

This manual is organized to provide an easy flow from problem identification to problem correction. A list of troubleshooting symptoms containing the most common engine problems is on page 3-2 in Section 3- Troubleshooting Symptoms. Complete the following steps to locate and correct the problem.

Step 1 Locate the symptom on the list.

Reference is made to the procedure number where the “Troubleshooting Logic Chart” is found.

Step 2 The left column of the “Troubleshooting Logic Chart” indicates a probable cause, starting at the top with the simplest and easiest to repair, and continuing downward to the most difficult.

The right column provides a brief description of the corrective action with the reference number for the repair.

Step 3 Locate the probable cause in the left column then turn to the procedure referenced in the right column.

The repair procedures are listed by system (Cooling System, Lubricating Oil System, Air Intake and Exhaust Systems, Fuel System, Electrical System and Basic Engine Components).

Step 4 The Troubleshooting Logic Charts are based on the following assumptions:

1. The engine has been installed according to the manufacturer’s specifications.
2. The easiest repairs are done first.
3. “Generic” solutions to cover problems with the most common applications and OEM’s.

Symbols

The following groups of symbols have been used in this manual to help communicate the intent of the instructions. When one of the symbols appears, it conveys the meaning defined below.



WARNING – Serious personal injury or extensive property damage can result if the warning instructions are not followed.



CAUTION – Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are not followed.



Indicates a **REMOVAL** or **DISASSEMBLY** step.



Indicates an **INSTALLATION** or **ASSEMBLY** step.



Visual **INSPECTION** is required.



CLEAN the part or assembly.



PERFORM a mechanical or time **MEASUREMENT**.



LUBRICATE the part or assembly.



Indicates that a **WRENCH** or **TOOL SIZE** will be given.



TIGHTEN to a specific torque.



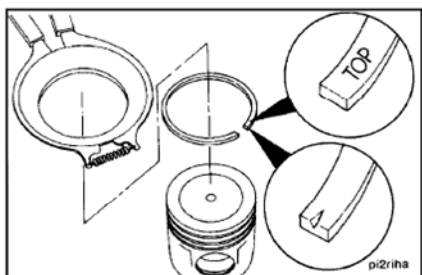
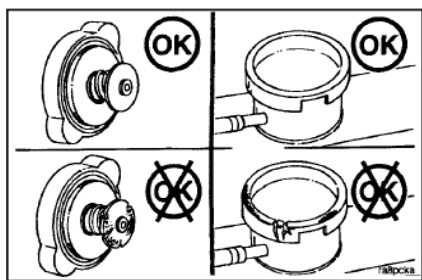
PERFORM an electrical **MEASUREMENT**.



Refer to another location for additional information.



The component weights 23kg (50 lb) or more. To avoid personal injury, use a hoist or get assistance to lift the component.



Illustrations General

The illustrations used in the “Repair Sections” of this manual are intended to give an example of a problem and to show what to look for and where the problem can be found. Some of the illustrations are common and might not look exactly like the engine or parts used in your application. The illustrations contain symbols to indicate an action required and an acceptable (OK) or unacceptable (not OK) condition.

The illustrations are intended to show repair or replacement procedures with the engine “in-chassis”. The illustration can differ from your application, but the procedure given will be the same.

Definition of Terms

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AFC	Air Fuel Control
API	American Petroleum Institute
ASA	Air Signal Attenuator
ASTM	American Society of Testing and Materials
C	Celsius
CARB	California Air Resources Board
C.I.D.	Cubic Inch Displacement
cm	Centimeter
CPL	Control Parts List
cSt	Centistokes
DCA	Diesel Coolant Additive
ECM	Electronic Control Module
E.C.S.	Emission Control System
EPA	Environmental Protection Agency
EPS	Engine Position Sensor
F	Fahrenheit
ft-lb	Foot Pound
GVW	Gross Vehicle Weight
Hg	Mercury
HP	Horsepower
H ₂ O	Water
in-lb	Inch Pound
kg	Kilograms
km	Kilometers
km/l	Kilometers per Liter
kPa	Kilopascal
l	Liter
m	Meter
mm	Millimeter
MPa	Megapascal
MPH	Miles Per Hour
MPQ	Miles Per Quart
N•m	Newton-meter
OEM	Original Equipment Manufacturer
ppm	Parts Per Million

psi	Pounds Per Square Inch
PTO	Power Takeoff
RPM	Revolutions Per Minute
S.A.E.	Society Of Automotive Engineers
STC	Step Timing Control
VS	Variable Speed
VSS	Vehicle Speed Sensor

General Safety Instructions

Important Safety Notice

Warning

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that must be followed to provide personal safety. Specific safety precautions are included in the procedures when they apply.

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- Be aware of hazardous conditions that can exist. Make sure the work area surrounding is dry, bright and draughty without sundries, scattered tools, parts, fire source or other hazard materials.
- Always wear protective glasses and protective shoes when working.
- Rotable parts may cause amputation, result in disabled and threaten life.
- Do not wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery cable (negative first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a "Do Not Operate" tag in the operator's compartment or on the controls.
- Use only the proper engine barring techniques for manually rotating the engine. Do not attempt to rotate the engine by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before you slowly loosen the filler cap and relieve the pressure from the cooling system.
- Do not work on anything that is supported only by lifting jacks or a hoist. Always use blocks or proper stands to support the product before performing any service work.
- Relieve all pressure in the air, oil, and the cooling system before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do not check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- To prevent suffocation and frostbite, wear protective clothing and only disconnect liquid refrigerant (Freon) line in a well ventilated area. To protect the environment, the cooling system must use special emptying or filling equipment to prevent Freon gas (fluorocarbon) diffusion. Federal law requires the recycle use of coolants.
- To avoid personal injury, use a hoist or get assistance when lifting components that weights 23kg (50 lb) or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. Always use a spreader bar when necessary. The lifting hooks must not be side-located.
- Corrosion inhibitor (chemical compound of SCA and lubrication oil) contains alkali. Do not get the substance in your eyes. Avoid prolonged or repeated contact with skin. Do not swallow internally. In case of contact, immediately wash your skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for 15 minutes. Immediately call a physician. Keep out of reach of children.
- Naphtha and Methyl Ethyl Ketone (MEK) are flammable materials and must be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. Keep out of reach of children.

- To avoid burns, be alert for hot parts on products that have just been turned off, and hot fluids in lines, tubes, and compartments.
- Always use tools that in good condition. Make sure you understand how to use them before performing any service work. Use only genuine Dongfeng Cummins or Cummins ReCon® replacement parts.
- Always use the same fastener part number (or equivalent) when replacing fasteners. Do not use a fastener of lesser quality if replacements are necessary.

General Purpose Cleaning Directions

Solvent and Acid Cleaning

Several solvent and acid-type cleaners can be used to clean the engine parts. Dongfeng Cummins Engine Company, Inc. does not recommend any specific cleaners. Always follow the cleaner manufacturer's instructions.

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Experience has shown that the best results can be obtained using a cleaner that can be heated to 90 to 95 degrees Celsius (180 to 200 degrees Fahrenheit). A cleaning tank that provides a constant mixing and filtering of the cleaning solution will give the best results.

Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful not to damage any gasket surfaces. When possible, steam clean the parts before putting them in the cleaning tank.



WARNING: Acid is extremely dangerous and can damage the machinery. Always provide a tank of strong soda water as a neutralizing agent.

Rinse all of the parts in hot water after cleaning. Dry completely with compressed air. Blow off the rinse water from all of the capscrew holes and the oil drillings.

If the parts are not to be used immediately after cleaning, dip them in a suitable rust proofing compound. The rust proofing compound must be removed from the parts before installation on the engine.

Steam Cleaning

Steam cleaning can be used to remove all types of dirt that can contaminate the cleaning tank. It is a good way to clean the oil drillings.



WARNING: Wear protective clothing to prevent personal injury from the high pressure and extreme heat.



Do not steam clean the following parts:

1. Electrical components
2. Circuit
3. Injector
4. Fuel pumps
5. Belts and hoses
6. Bearings

Glass or Plastic Bead Cleaning

Glass or plastic bead cleaning can be used on many engine components to remove carbon deposits. The cleaning process is controlled by the size of the glass or plastic beads, the operating pressure, and the cleaning time.



CAUTION: Do not use glass or plastic bead cleaning on aluminum piston skirts. Do not use glass bead cleaning on aluminum ring grooves. Small particles of glass or plastic will embed in the aluminum and result in premature wear. Valves, turbocharger shafts, etc., can also be damaged. Follow the cleaning directions listed in the procedures.



NOTE: Plastic bead blasting media, Part No. 3822735, can be used to clean aluminum ring grooves. Do not use any bead blasting media on pin bores or aluminum skirts.

Follow the equipment manufacturer's cleaning instructions. The following guidelines can be used to adapt to manufacturer's instructions:

1. Bead size: - Use U.S. size No. 16-20 for piston cleaning with plastic bead media, Part No. 3822735.
 - Use U.S. size No.70 for piston domes with glass media.
 - Use U.S. size No.60 for general purpose cleaning with glass media.
2. Operating Pressure: - Glass: Use 620 kPa [90 psi] for general purpose cleaning.
 - Plastic: Use 270 kPa [40 psi] for piston cleaning.
3. Steam clean or wash the parts with solvent to remove all of the foreign material and glass or plastic beads after cleaning. Rinse with hot water. Dry with compressed air.
4. Do not contaminate the wash tanks with glass or plastic beads.

General Repair Instructions

This engine incorporates the latest technology at the time it was manufactured; yet, it is designed to be repaired using normal repair practices performed to quality standards

- **Cummins Engine Company, Inc. does not recommend or authorize any modifications or repairs of engines or components except for those detailed in Dongfeng Cummins Service Information. In particular, unauthorized modifications of the safety-related components can cause personal injury or death. The following is a partial listing of components classified as safety-related:**

Air compressors	Flywheel Mounting Capscrews
Air controls	Fuel shutoff valve assembly
Air shutoff assemblies	Fuel supply tubes
Balance weights	Lifting brackets
Cooling fan	Throttle controls
Fan hub assembly	Turbocharger compressor housing
Fan mounting brackets	Turbocharger drain line
Fan mounting capscrews	Turbocharger supply line
Fan hub spindle	Turbocharger housing
Flywheel	Damper mounting capscrew
Flywheel Crankshaft Adapter	

- **Follow all safety instructions noted in the procedures**
 - Follow the manufacturer's recommendations for cleaning solvents and other substances used during the repair of the engine. Some solvents and used engine oil have been identified by government agencies as toxic or carcinogenic. Avoid excessive breathing, ingestion and contact with such substances. Always use good safety practices with tools and equipment.
- **Provide a clean environment and follow the cleaning instructions specified in the procedures**
 - The engine and its components must be kept clean. Contamination of the engine or components will cause premature wear.
- **Perform the inspections specified in the procedures**
- **Replace all components or assemblies which are damaged or worn beyond the specifications**
- **Use new genuine Cummins or ReCon® service parts and assemblies**
 - The assembly instructions have been written to use again as many components and assemblies as possible. When it is necessary to replace a component or assembly, the procedure is based on the use of new genuine Dongfeng Cummins components. All of the repair services described in this manual are available from all Dongfeng Cummins Repair Facility.
- **Follow the specified disassembly and assembly procedures to avoid damage to the components**

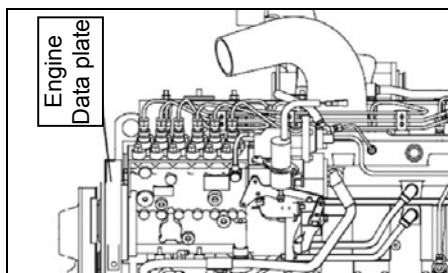
Complete rebuild instructions are available in the shop manual which can be ordered or purchased from a Dongfeng Cummins Authorized Repair Location.

NOTES

Engine Identification

Engine Data plate

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The engine data plate shows specific information about your engine. The engine serial number (1) and Control Parts List (CPL)(2) provide information for ordering parts and service needs.

NOTE: The engine data plate must not be changed unless approved by Dongfeng Cummins Engine Company, Inc.

 Dongfeng Cummins Engine CO., Ltd. 4980063 Xiangfan, Hubei, China WARNING: Injury may result and warranty is voided if fuel rate rpm or altitudes exceed published maximum values for this model and application. Date of Mfg.	C.I.D.	L	Altitude Limit		m
	Model		Fuel rate at adv. HP		mm ³ /stroke
	Engine Serial No.		Net Weight		kg
	Shop Order		Rated kW		at r/min
	Engine ASSY. NO.		Supplier. I.D.		

WORDS ARE WHITE OR THE ALUMINIUM COLOUR WITH RED INK BACKGROUD IN THIS COLUMN

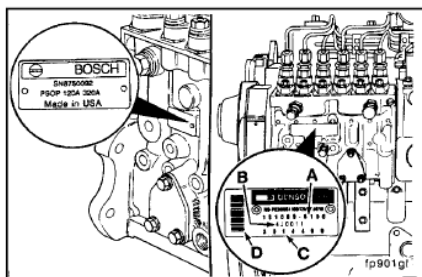
Example

L: Engine Family

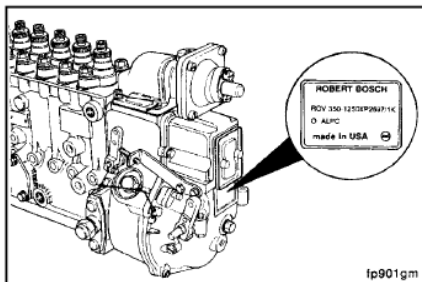
340: Advertised Horsepower

20: Emission standard

Fuel Pump Dataplate



The Bosch and Nippondenso fuel injection pump Dataplate is located on the side of the injection pump. It provides information about fuel pump calibration.



The Cummins part number for the fuel pump-governor combination is located on the governor dataplate.

General Engine Specifications

General Engine Data

Bore	114 mm[4.49 in]
Travel	144.5 mm[5.69 in]
Displacement	8.85 mm[4.49 in]
Compression Ratio	16.6
Firing Order	1-5-3-6-2-4
Valve Clearance	
Valve, Intake	0.30 mm[0.012 in]
Valve, Exhaust	0.61 mm[0.024 in]
Engine Rotation, viewed from the front of engine	clockwise
Intake	Turbocharged Charge Air Cooled(CAC)
Engine Weight with standard accessories	
Net weght	650 kg [1434 lb]
Wet weight with engine fluid	680 kg [1500 lb]

Lubrication System

OIL PRESSURE

At Idle (minimum allowable)	69 kPa [10 psi]
At Rated Speed (minimum allowable)	207 kPa [30 psi]
Regulator valve opening pressure	518 kPa [75 psi]
Differential pressure to open oil filter bypass valve	138 kPa [20 psi]
Oil flow at rated speed (a small amount of oil flows through pressure-regulator)66 L/Min [19 Gallon/Min]	
Oil temperature at rated speed	98.9° to 126.6°C[210°to 260°F]
Oil thermostat	
Full open	116°C[241°F]
Close	104°C[219°F]
Oil pan capacity (whole engine) (high-low)	23 to 19 L
Total system capacity	27.6L

Cooling System

Thermostats

Begins to open	81°C to 83°C [178°F to 182°F]
Fully open.....	95°C[203°F]

Top tank Temperature

Maximum allowable	100°C[212°F]
Minimum recommended	70°C[158°F]
Pressure cap for 99°C [210°F] system	50 kPa[7 psi]
Pressure cap for 104°C [220°F] system	103 kPa[15 psi]
Maximum coolant pressure (without pressure cap, thermostat closed)	290 kPa[40 psi]
Coolant flow (thermostat fully opened, engine speed 2000R/Min)	292 L/ Min
Coolant capacity (engine only)	11.1L
Coolant alarm temperature.....	104°C

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Air Intake and Exhaust System

Maximum allowable intake restriction at rated speed and load with dirty air filter element

Medium: kPa (mm H ₂ O)	2.9[300]
Heavy: kPa (mm H ₂ O)	3.7[380]
Maximum intake restriction with dirty air filter element: kPa (mm H ₂ O)	6.2[536]
Maximum exhaust restriction with exhaust piping and muffler: kPa (mm Hg)	10.0[750]

Fuel System

Maximum fuel inlet restriction to injection pump with clean filter	150 mm Hg
Fuel return restriction.....	520 mm Hg [20.4 in Hg]

Electrical System

24V system**

Maximum resistance of start circuit Ω	0.002
Cold cranking ampere(engine disengaged with clutch): CCA	510

* The number of plates within a given battery size determines reserve capacity. Reserve capacity determines the length of time sustained cranking can occur.

** The CCA calibration for each group of batteries (two 12 volt batteries in series) is based on -18°C[0°F].

Batteries (specific gravity)

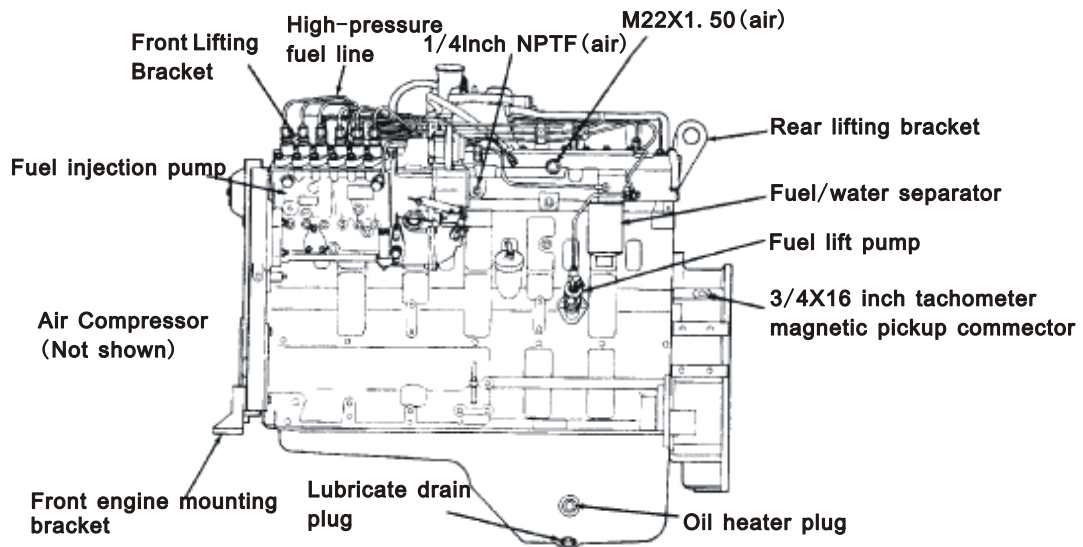
Gravity at 27°C[80°F]	State of charge
1.260- 1.280	100%
1.230- 1.250	75%
1.200- 1.220	50%
1.170- 1.190	25%
1.110- 1.130	Discharge completely

Engine View

The following illustrations contain information about engine components, filters locations, drain points, and access locations for equipment connection testing and engine controls.

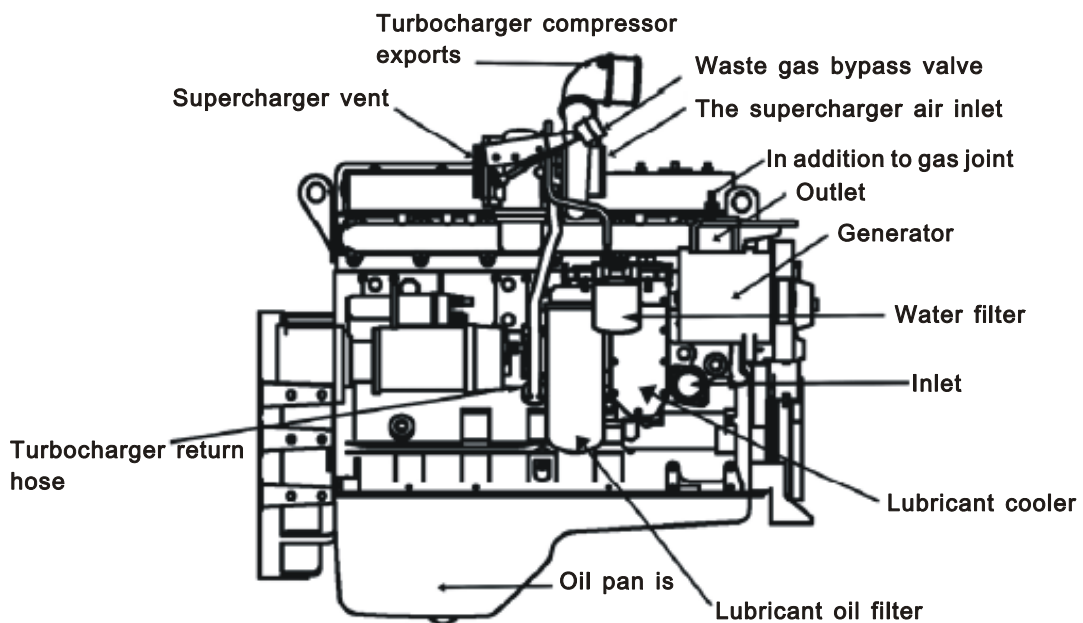
The information and configuration of components shown in these drawings are of a general nature. Some component locations will vary depending on applications and installations.

Fuel Pump – Side View

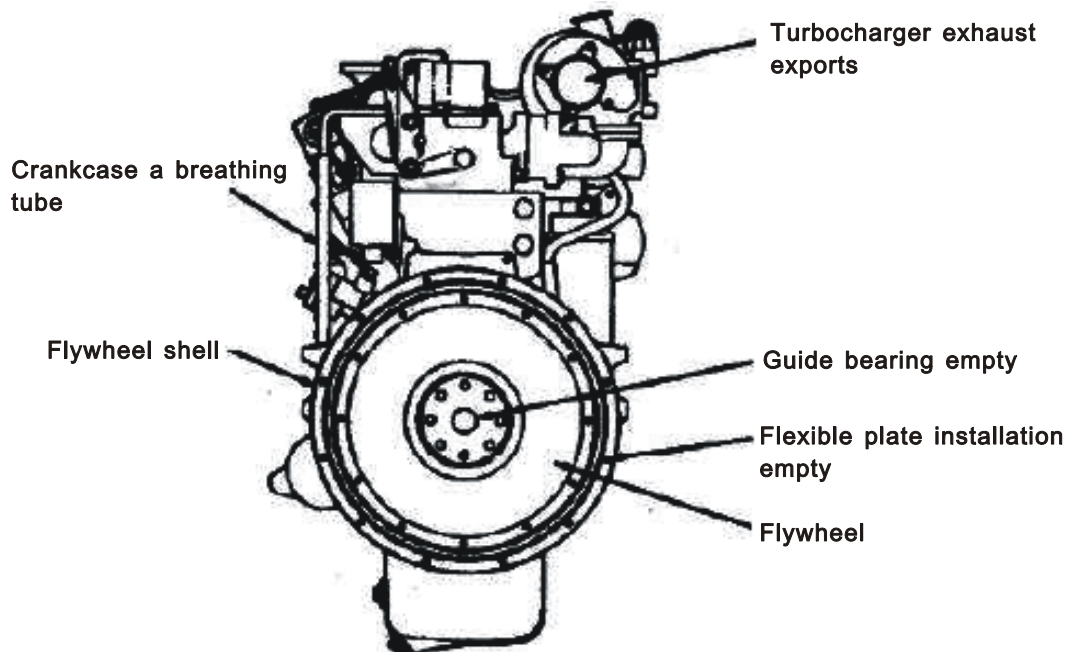


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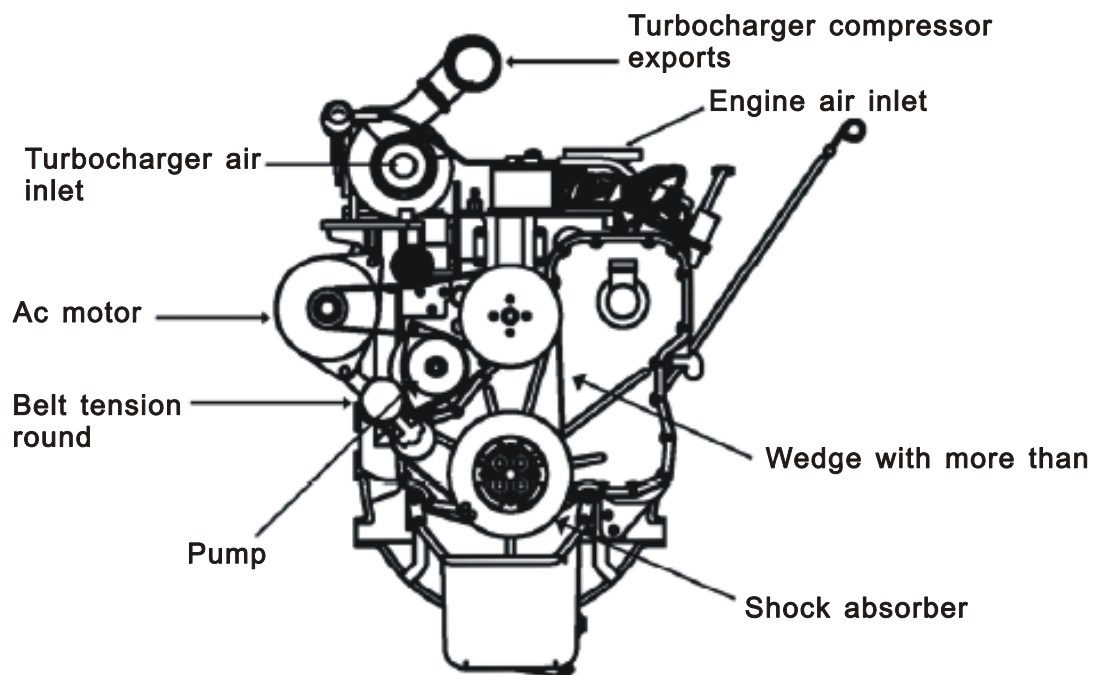
Turbocharger -- Side View



Rear View



Front View



NOTES

Troubleshooting logic charts

Troubleshooting Procedures and Techniques

The key element of successful troubleshooting is thorough analysis of the customer's complaint. The more known about a complaint, the faster and easier the problem can be solved.

The "troubleshooting symptoms tree" on page 3-3 are organized so that a problem can be located and corrected by doing the easiest and most logical things first. Complete all steps in the sequence shown from top to bottom.

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It is impossible to include all solutions to problems that can occur; however, these charts are designed to stimulate a thought process that will lead to the cause and correction of the problem.

Please follow these basic troubleshooting steps:

- Collect all facts concerning the complaint.
- Analyze the problem thoroughly.
- Relate the symptoms to the basic engine systems and components.
- Consider any recent maintenance or repairment that can related to the complaint.
- Recheck before beginning any disassembly.
- Solve the problem by using the symptom charts and doing the easiest things first.
- Determine the cause of the problem and make a thorough repair.
- After repairs have been made, operate the engine to make sure the cause of the complaint has been corrected.

Troubleshooting logic charts

Use the following charts to aid in diagnosing specific engine symptoms. Read each row of blocks from top to bottom. Follow the arrows through the chart to identify corrective action.

Air compressor Noise Excessive

Cause	Correction
Carbon buildup is excessive in the air discharge line	Check for carbon buildup.
Air compressor drive gear or engine train is damaged	Visually inspect the drive gears and gear train and repair as necessary.
Air compressor is internally damaged	Replace the air compressor.

Air Compressor Pumping Excessive Lubricating Oil into the Air System

Cause

Correction

Air compressor cylinder bore or piston rings are worn or damaged

Check air compressor discharge line.

For E type air compressors, ECON valve plumbed wrong or malfunctioning

Correct the plumbing or replace the valve.

Air Compressor Air Pressure Rises Slowly

Cause	Correction
Air system leaks	Check for air compressor gasket leaks. Refer to the manufacturer's instructions for other air system leaks.
Excessive carbon in the air discharge line	Inspect the discharge line.
Air system components is malfunctioning.	Check operation of check valves, alcohol evaporators, air driers, etc. Refer to the manufacturer's instructions.
Air compressor relief valve assembly is malfunctioning	Check unloader valve operation.
Air leaks from the air compressor intake and exhaust valve	Inspect the air compressor intake and exhaust valve assemblies.

Air Compressor Will Not Maintain Adequate Air Pressure

(Not Pumping Continuously)

Cause

Correction

Air system leaks excessive

Check air system plumping. Refer to the manufacturer's instructions.

Air governor is malfunctioning or not set correctly

Check air governor. Refer to procedure 4-04.

Air Compressor Will Not Pump Air

Cause	Correction
Air system leaks excessive	Check air system plumbing. Refer to the manufacturer's instructions.
Air governor malfunctioning or not set correctly	Check air governor operation
Air compressor unloader valve assembly malfunctioning	Check the unloader valve operation

Air Compressor Will Not Stop Pumping

Cause

Correction

Air system leaks

Check air compressor for gasket leaks. Refer to the manufacturer's instructions for other air system leaks.

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Air compressor unloader valve is not receiving correct signal from the air governor

Check the air governor operation.

Air compressor unloader valve assembly leaks

Check the unloader valve operation.

Air compressor unloader valve spring incorrect

Check the unloader valve spring specifications and application.

Engine Not Charging or Insufficient Charging

Cause	Correction
Battery connections loose or corroded	Clean /tighten battery connections
Battery Condition	Battery load test. If the battery power is low, charge the battery before the test. If the battery fails to pass the load test, replace the battery.
Alternator belt pulley loosen	Check /replace belt tensioner.
Alternator pulley loose on shaft	Tighten pulley.
Gauge or lamp malfunction	Check /replace the gauge or lamp
Alternator wires loose or broken	Repair wiring.
Alternator malfunction	Replace alternator. Refer to the vehicle manufacturer's instructions for troubleshooting.

Compress Knock

Cause

Correction

Diethyl ether starting aids malfunction.

Repair /replace Diethyl ether starting aids.

Air in fuel pipe line

Drain the fuel pipe line and check for suction leaks.

Fuel quality is poor

Fill a temporary tank with correct fuel to run the engine as a test. Refer to the operation and maintenance manual.

Engine Overloaded

Use lower gear. Check not exceed the engine's rated load.

Incorrect injection pump timing

Check and correct injection pump timing.

Injector malfunction

Replace the injector. Test and repair.

Coolant Contaminated

Cause	Correction
Rusty coolant, operation without correct mixture of coolant, DCA4 and water	Drain and flush the cooling system. Fill with correct mixture of coolant and water.
	Review the coolant change interval. Refer to the L series engine operation and maintenance manual.
If equipped, leaking transmission oil cooler	Check /replace oil cooler. (Refer to equipment manufacture's instructions)
Oil leaks from oil cooler, head gasket, head and cylinder block	Refer to troubleshooting logic charts for "lubricating oil loss".

Coolant Loss**Cause****Correction**

Radiator or cab heater leaking

Visually inspect the radiator heater, hoses and connections to locate the leak.

If oil is present in the coolant, check for a transmission or oil cooler leak.

External engine leak

Visually inspect the engine and sealing ring of components, gasket or drain plug leaks.

Overheating or leaking compression gases resulting in coolant loss through the radiator overflow

Refer to the troubleshooting logic charts for "Coolant Temperature Above Normal"

If equipped, transmission cooler leak

Check for mixing of coolant and transmission fluid.

Air compressor head or head gasket leaking

Check for coolant in the oil. Check/replace head or gasket. Refer to the manufacture's instructions.

Aftercooler is leaking

Check /replace aftercooler. Check for coolant in the intake manifold.

Lubricating oil cooler is leaking

Check /replace oil cooler. Check for coolant in the oil.

Leaking cylinder head gasket

Check /replace head gasket. Refer to procedure 7-09. Check liner protrusion.

Head cracking with sand hole or expansion plug leak

Check /replace cylinder head.

Cylinder jacket O ring leak.

Remove the oil sump, check for the leaking of cylinder jacket O ring.

Water jacket of cylinder block coolant leak.

Check /replace cylinder block.

Coolant Temperature above Normal - Gradually Overheat

Cause	Correction
Low coolant level	Add coolant. Find out the leak position and eliminate the cause of leak. Refer to the troubleshooting logic diagram "coolant loss"
Radiator charge air finsplugged (automotive only)	Inspect radiator fins-clean if necessary.
Insufficient or obstructed air in radiator.	Check /repair fan wind scooper, fan sensor and clutch. Refer to the manufacture's instructions.
Pump or fan drive belt is loose.	Check the belt tensioner.
Collapsed, obstructed or leaking radiator hose.	Inspect hoses- replace if necessary.
Incorrect oil level.	Add or drain engine oil.
Cooling fan shroud damaged or missing.	Inspect shroud, repair/replace or install.
Incorrect or malfunctioning radiator cap.	Check the radiator cap. Replace if necessary.

Coolant Temperature Above Normal - Gradually Overheat (continued)

Cause

Correction

The density of antifreeze solution is too high.

Check the density, change some antifreeze solution with water.

Temperature sensor or gauge malfunction.

Test the gauge and sensor-repair or replace if necessary.

The thermostat incorrect, lost or malfunction.

Check / replace thermostat.

Radiator shutters are not opening completely or cold weather radiator cover closed.

Inspect the shutters - repair or replace if necessary. Open radiator cover.

Air or gas in cooling system

Check hose clamps for leaks on the suction side of the pump. Make sure the injection speed not exceeding.

Check for leak through cylinder head gasket if aeration continues.

Coolant Temperature Above Normal - Gradually Overheat (continued)

Cause	Correction
Water pump malfunction.	Measure cylinder block coolant pressure. Check / replace water pump.
Plugged cooling passages in radiator, cylinder head, head gasket or cylinder block.	Flush the cooling system, fill with new coolant.
Over fueled injection pump.	Check / replace injection pump.
Design of vehicle cooling system.	Contact the vehicle manufacturer to confirm the fan, radiator and other components of cooling system are standard.

Coolant Temperature above Normal – Suddenly Overheat

Cause	Correction
Very Low coolant level.	Add coolant.
Temperature sensor malfunction.	Check / clean water channel of sensor and coolant. Test / replace sensor.
Temperature gauge malfunction.	Check the gauge – repair or replace if necessary.
Fan drive belt cracking or loose.	Check the belt and tensioner.
Collapsed, obstructed or leaking radiator hose.	Inspect hose.
Incorrect or malfunctioning radiator cap. Low cap calibration pressure.	Check radiator pressure cap.
Incorrect or malfunctioning thermostat.	Check the thermostat.
Radiator shutters are not opening completely or cold weather radiator cover closed. Incorrect setting of shutter thermostat.	Inspect the shutters - repair or replace if necessary. Open radiator cover. Refer to step 1-02. Check the setting of shutter thermostat.
Air or combustion gases in the cooling system.	Check for air or combustion gases in the cooling system.
Vent line from engine and/or radiator plugged or incorrectly routed	Check routing and vent air.
Water pump is malfunctioning	Check water pump operation. Replace the water pump.

Coolant Temperature below Normal

Cause	Correction
Air flow across radiator excessive	Check/ repair fan clutch, and viscous fan, as required. Refer to the manufacturer's instructions.
Radiator shutters stuck in open position	Inspect the shutters, repair or replace if necessary.
Thermostat broken, damaged, incorrect or malfunctioning	Check thermostats and replace if necessary.
Fan malfunctioning	Check fan for continuous operation.

Crankcase Gases (Blowby) – Excessive

Cause	Correction
Crankcase breather vent line restricted	Check vent line restriction.
Turbocharger seals leaking	Check turbocharger seals.
Air compressor is malfunctioning	Check air compressor.
Cylinder head valve guides excessively worn	Replace cylinder head.
Broken or worn piston rings	Check piston rings and cylinder liners.

Engine Difficult to Start or Will Not Start (No Exhaust Smoke)

Cause	Correction
No fuel in tank	Add fuel
Electrical or manual fuel shutdown not open	Check for loose wires and verify that the solenoid is functioning. Check to be sure manual shut off lever is in the run position.
Improper starting procedure	Verify proper starting procedure. Refer to starting instructions in the operation and maintenance manual.
Injection pump not receiving fuel	Loosen the bleed plug at the filter head end. Operate the hand primer on the fuel transfer pump to check for fuel. Check /replace fuel transfer pump if necessary.
Air in the fuel system. If the condition occurs during initial start, following an extended period of non use or after replacing a fuel system component.	Bleed the fuel system.
Fuel drain return	Verify that the fuel return line is plumbed to the bottom of the fuel tank.
Malfunctioning fuel return overflow valve	Check fuel pump return overflow valve.
Fuel filter plugged with water or other contamination	Drain fuel/water separator or replace fuel filter.
Fuel injection pump timing incorrect	Check injection pump timing.
Injection pump malfunctioning or worn	Remove the fuel injection pump, have calibration checked.
Camshaft timing is not correct	Check / correct gear train timing alignment.

Engine Difficult to Start or Will Not Start (Exhaust Smoke)

Cause	Correction
Starting procedure is not correct.	Refer to the operation and maintenance manual.
Engine cranking speed too low	Check engine cranking speed. Refer to troubleshooting logic chart for "engine will not crank or cranks slowly" .
Electrical or manual fuel shut down binds	Check the wires for loose. Make sure that the solenoid is functioning. Check to be sure manual shutoff lever is not binding at the injection pump.
Improper starting procedure	Verify proper starting procedure. Refer to starting instructions in the operation and maintenance manual.
Starting aid needed for cold weather, however not working properly	Check / repair or replace cold starting aid, if necessary.
Air in the fuel system	Bleed the fuel system and check the suction tube for leaks.
Fuel drain back	Verify that the fuel return line is plumbed to the bottom of the fuel tank.
Malfunctioning fuel return overflow valve	Check / replace return overflow valve.

Engine Difficult to Start or Will Not Start (Exhaust Smoke) (Continued)

Cause	Correction
Fuel supply restricted	Clean or replace pre-filters and screens and check fuel lines for restrictions.
Intake air system restricted	Inspect the air intake system for restriction.
Fuel contaminated	Verify by operating engine from a temporary supply tank.
Fuel injection pump timing incorrect	Check top dead center (TDC). Check injection pump timing. Check / adjust the fuel injection pump timing using the spill port timing if equipment is available.
Injectors worn or malfunctioning	Check / replace injectors.
Incorrect valve adjustment	Adjust valve.
Engine compression low	Perform compression check to identify problem.
Injection pump malfunctioning or worn	Remove the fuel injection pump. Have calibration checked.

Rough Idle, Warm Engine

Cause	Correction
Idle speed set too low (below 700 RPM)	Check / adjust low idle screw setting.
Air in fuel system	Bleed fuel system and check the suction tube for leaks.
Fuel return overflow valve malfunctioning	Check / replace fuel return overflow valve.
Fuel transfer pump malfunctioning	Check / replace fuel transfer pump.
Fuel supply restricted	Clean pre-filters and screens and check fuel line for restriction. Replace fuel filter.
Injection nozzles plugged or inoperative	Check / replace injectors
Fuel injection pump timing incorrect	Check injection pump timing.
Engine mounts broken	Replace mounts.
Incorrect valve adjustment	Adjust intake and exhaust valves.
Engine compression low	Perform compression check, repair as required.
Injection pump malfunctioning	Remove the fuel injection pump, check calibration, check the delivery valve for debris.

Engine Misfire

Cause	Correction
Air in the fuel system	Bleed fuel system and check the suction tube for leaks.
Fuel contaminated	Verify by operating engine from a temporary supply tank.
Fuel injection lines leaking	Check for loose connections. Inspect and replace broken lines.
Malfunctioning fuel return overflow valve	Check / replace return overflow valve.
Fuel transfer pump malfunctioning	Check / replace fuel transfer pump.
Fuel supply restricted	Clean pre-filters and screens and check fuel line for restriction. Replace fuel filter.
Incorrect valve adjustment	Inspect push rods, springs. Adjust valves.
Injector nozzles worn or malfunctioning	Replace the injectors.
Fuel injection pump timing incorrect	Check / time injection pump.
Compression low on one or more cylinders	Perform compression check to identify cause (piston rings, head gasket or valves)
Camshaft timing is not correct	Check / correct gear train timing alignment.
Camshaft or push rods damaged	Check / replace parts as required.

Engine Power Output Low

Cause	Correction
Engine overload	Check for added loading from malfunctioning accessories or driven units, brakes dragging and other changes in vehicle loading.
Throttle linkage incorrectly adjusted	Check and adjust throttle linkage for full travel.
Mechanical shutoff lever partially engaged	Check / adjust solenoid linkage.
Fuel quality poor or diesel fuel grade No.1 used above 0°C[32]°F	Verify by operating the engine from a temporary tank of No. 2 diesel fuel. Refer to the L series engine operation and maintenance manual.
If the condition is slow throttle response, air wastegate diaphragm ruptured, wastegate plumbing damaged	Tighten fittings. Replace tube if necessary. Repair plumbing or wastegate diaphragm.
AFC plumbing orifice blocked	Check AFC fittings between intake manifold and fuel pump.
High pressure fuel lines or fittings leaking	Tighten / replace fittings or lines.
Air in the fuel system	Bleed the fuel system and check for suction leaks.
Fuel supply restricted	Clean pre-filters and screens and check fuel line for restriction. Replace fuel filter.
Fuel return overflow valve malfunctioning	Check / replace fuel return overflow valve.
Fuel transfer pump malfunctioning	Check / replace fuel transfer pump.
Lubricating oil lever too high	Drain oil to proper lever.

Engine Power Output Low (Continued)

Cause	Correction
Intake air temperature high – (Above 75°C [168°F])	Use outside air to turbocharger in hot weather.
	Coolant passages plugged in the aftercooler.
	Check charger air cooler for internal restriction. Replace restricted cooler.
	Check / clean debris from front of charge air cooler.
Intake and exhaust system is obstructed	Inspect the air intake and exhaust system for obstruction. Inspect the air cleaner, replace it if necessary.
Fuel temperature high – (Above 71°C [160°F])	Fuel tanks, turn off fuel heater in warm weather.
Air leak between turbocharger and intake manifold	Check and correct leaks in the air crossover tube, charge air cooler connections, hoses, or through holes in the manifold cover.
Exhaust leak between turbocharger and exhaust manifold	Check and correct leaks. Check for a cracked exhaust manifold.
Injector nozzles worn or malfunctioning	Check / replace injectors
Turbocharger worn or malfunctioning	Check for correct boost pressure. Refer to the specification. Replace turbocharger if low.
Incorrect valve adjustment	Adjust valves. Inspect push rods, springs, etc.
Fuel injection pump timing incorrect	Check injection pump timing.
Injection pump malfunctioning or worn	Remove the fuel injection pump. Have calibration checked.
Engine compression low	Perform compression check to identify malfunction. Repair as required.

Engine Noises Excessive

Cause

Correction

Drive belt squeal, insufficient tension or abnormally high loading

Check the tensioner and inspect the drive belt. Make sure water pump, tensioner pulley, fan hub and alternator turn freely.

Check the tension of accessory drive belts. Refer to the equipment manufacturer's instructions. Make sure the accessories turn freely.

Intake air or exhaust leaks

Refer to troubleshooting logic chart for "exhaust black smoke-under loaded".

Valve lash excessive

Adjust valves. Make sure the push rods are not bent or the rocker levers are not severely worn.

Turbocharger noise

Check turbocharger impeller and turbine wheel for housing contact.

Gear train noise

Check / replace vibration damper.

Visually inspect and measure gear backlash. Replace gears as required.

Internal engine noise

Check / replace connecting rod and main bearings.

Engine Starts But Will Not Keep Running

Cause	Correction
Engine starting under load	Disengage driven units and check for loading from malfunctioning accessories.
Engine idle speed too low (below 700 RPM)	Adjust idle speed.
Intake or exhaust system restricted. Engine shut down device malfunctioning	Visually check the intake and exhaust system for restrictions. Make sure shut down is not occurring too soon.
Air in the fuel system or the fuel supply is inadequate	Check the flow through the filter. Bleed the fuel system and check for suction leaks.
Fuel filter plugged or fuel waxing due to cold weather	Drain fuel-water separator or replace filter. Check for fuel waxing in cold weather.
Fuel supply restricted	Clean or replace pre-filters and screens and check for fuel line restrictions.
Fuel contaminated	Verify by operating engine from a temporary supply tank that contains good fuel.
Fuel injection pump timing incorrect	Check and adjust injection pump timing.
Camshaft timing is not correct	Check / correct gear train timing alignment.

Engine Speed Surges at Idle

Cause	Correction
Fuel level low in the tank	Fill the supply tank.
Engine idle speed set too low (below 700 RPM)	Check / adjust low idle speed screw.
Idle incorrectly adjusted (industrial engine-RSV governor)	Check / adjust the bumper spring adjustment.
Air in the fuel system	Check for air in the fuel system. Check the suction tube for leaks.
Fuel supply restricted	Clean or replace pre-filters and screens and check fuel lines for restriction.
Injectors worn or malfunctioning	Clean or replace injectors
Injection pump malfunctioning or worn	Remove fuel injection pump, check calibration.

Engine Vibration Excessive

Cause	Correction
Engine not running smoothly. Idle speed set too low.	Refer to troubleshooting logic chart for "engine runs rough or misfires". Adjust engine low idle speed.
Engine mounts loose or broken.	Check / replace engine mounts (refer to the equipment manufacturer's instructions).
Fan damaged or malfunctioning accessories	Check / replace the vibrating component (refer to the equipment manufacturer's instructions).
Vibration damper malfunctioning	Inspect / replace the vibration damper.
Fan hub malfunctioning	Inspect / replace the fan hub.
Alternator bearing worn or damaged	Check / replace the alternator.
Flywheel misaligned	Check / correct flywheel alignment.
Loose or broken internal components	Inspect crankshaft and rods for damage that causes an unbalance
Drivetrain components worn or unbalanced	Refer to manufacturer's instructions to check and repair.

Engine Will Not Crank or Cranks Slowly

Cause	Correction
Starting circuit connections loose or corroded	Clean and tighten connections.
Battery charge low	Check electrolyte level and specific gravity, charge as required.
No voltage to starter solenoid	Check solenoid voltage.
Solenoid or starting motor malfunction	Replace starting motor.
Crankshaft rotation restricted	Rotate the crankshaft to check for rotational resistance.
Engine driven units engaged	Disengage driven units and check for loading from malfunctioning accessories. Refer to the appropriate section.
Starting motor operating but not cranking the engine	Remove the starting motor and check for broken teeth on the flywheel or broken starting motor spring.

Engine Will Not Reach Rated Speed When Loaded

Cause	Correction
Tachometer malfunction	Check with hand or digital tachometer.
Vehicle overloaded	Verify high idle speed without load. Reduce load or use lower gear.
Throttle linkage worn or incorrectly adjusted	Check throttle linkage adjustment for full travel to the high idle stop screw.
Mechanical shutoff lever partially engaged	Check / adjust shutoff lever.
Fuel quality poor or diesel fuel grade No.1 used above 0°C [32°F]	Verify by operating the engine from a temporary tank of No.2 diesel fuel. Refer to the "fuel recommendations / specifications" in the C series operation and maintenance manual.
Fuel supply inadequate or restricted	Change the fuel filter and check fuel line, pre-filter and screens for restrictions.
Malfunctioning fuel transfer pump	Check / repair or replace fuel transfer pump.
Malfunctioning fuel return overflow valve	Check / replace return overflow valve.
Air fuel control tube leaking and / or restricted orifice, wastegate broken	Check orifice, tighten fittings. Replace tube if necessary. Injection pump operation improperly.
Fuel injection malfunctioning	Remove the fuel injection pump, check calibration.

Engine Will Not Shut Off

Cause

Correction

Engine stalled under overload

Verify the solenoid is not being energized by a short in the wiring. Check the linkage to the shutoff lever for binding. Check for the ability of the spring in the pump to pull the lever to the shutoff position.

Engine running on fumes drawn into air intake

Check the air intake ducts. Locate and isolate the source of fumes.

Fuel leaking to intake manifold

Check for porosity between the fuel filter head to the intake manifold.

Fuel injection malfunctioning

Remove the fuel injection pump for repair, check calibration.

Exhaust Black Smoke – Excessive Under Load

Cause	Correction
Engine being lugged down	Use low gear.
Air filter is restricted	Inspect air cleaner. Check and replace.
Air leak between turbocharger and intake or exhaust manifold.	Correct leaks in the air crossover tube, hoses or through holes in the manifold cover.
Charge air cooler malfunctioning	Check for plugged charge air cooler, internal charge air restriction, or leaking charge air cooler.
Exhaust leak at the manifold or turbocharger	Check / correct leaks in the manifold or turbocharger gaskets. Look for a cracked exhaust manifold.
Turbocharger wastegate malfunctioning	Repair or replace wastegate.
Turbocharger is malfunctioning	Replace turbocharger
More than one seal washer under injector nozzle	Remove extra washers.
Injector nozzle malfunctioning	Remove and have nozzles tested. Replace injectors as necessary.
Engine running too cold (below 60°C [140 °F])	Check thermostat and cooling system.
Fuel injection pump timing incorrect	Check and adjust injection pump timing.
AFC malfunction or injection pump overfueled	Remove and test injection pump.
Piston rings not sealing	Perform a compression check. Repair as required.

Excessive Exhaust White Smoke under Engine Load (warm-up)

Cause	Correction
Starting procedure is not correct	Verify proper starting procedure. Refer to starting instructions in the operation and maintenance manual.
Coolant temperature too low	Refer to Troubleshooting logic chart for "coolant temperature below normal".
Intake air temperature too low	Refer to vehicle operation manual for shutter operation. Check intake air heater operation (if required).
Fuel quality is poor	Verify by operating engine from a temporary tank with good quality fuel. Clean and flush the fuel supply tanks.
Injection pump timing incorrectly adjusted	Check top dead center (TDC). Check / time the fuel injection pump using the spill port timing if equipment is available.
Injector is malfunctioning	Replace the injectors.
Coolant leaking into combustion chamber	Refer to Troubleshooting logic chart for "coolant loss".
Injection pump malfunctioning	Remove fuel injection pump. Have calibration checked. Check for debris in delivery valves.

Fuel Consumption – Excessive

Cause	Correction
Additional loading from malfunctioning accessories	Check / repair accessories and vehicle components. Refer to equipment manufacturer's instructions.
Driver technique	Check the correct gear shifts, deceleration, and idling.
Fuel leaks	Check for external leaks and engine oil diluted with fuel. Check for internal leaks at the fuel transfer pump and injection pump.
Fuel quality poor or No.1 fuel used	Inspect by maintaining and operating engine from a temporary fueling tank that contains high quality fuel.
Intake air or exhaust restriction	Refer to Troubleshooting logic chart for "Exhaust Black Smoke – Excessive Under Load".
Injectors worn or malfunctioning	Check / replace injectors.
Fuel injection pump timing incorrect	Check injection pump timing.
Injection pump calibration incorrect or overfueled	Check for broken adjustment seals on the injection pump. If the seals are broken, remove and calibrate the injection pump.
Valves not seating	Check / adjust valves.

Fuel or Oil Leaking from Exhaust Manifold

Cause	Correction
Operating for extended periods under light or no load conditions	Check the vehicle operation.
Restricted air intake	Check / replace filter element.
	Review operation for excessive idling.
Fuel injection pump timing incorrect	Check / adjust fuel injection pump timing.
Injector needle valve stuck open	Locate and replace malfunctioning injector.
Turbocharger drain line obstructed	Check / clean line.
Turbocharger seals leaking oil	Check / replace turbocharger.
Crankcase gases (blowby) excessive.	Check for excessive blowby.

Oil Contamination

Cause	Correction
Coolant in the oil, internal engine component leaks	Refer to Troubleshooting logic chart for "Coolant Loss".
Oil sludge excessive	Review oil and filter change intervals. Refer to the L Series Operation and Maintenance Manual.
	Make sure the correct oil is being used. Refer to the L Series Operation and Maintenance Manual.
Oil sludge excessive	Review the operation for excessive idling resulting in the engine running below normal temperature.
Fuel transfer pump seal leaking	Replace fuel transfer pump.
Injectoe needle valves not sealing	Locate and replace malfunctioning injector.
Fuel pump internal plunger seal leaking	Remove the fuel injection pump, have repaired and calibrated.
Injection pump malfunction	Remove the fuel injection pump, have repaired and calibrated.

Lubricating Oil Consumption Excessive

Cause	Correction
External leaks	Visually inspect for oil leaks.
Crankcase being overfilled (dipstick calibrated incorrectly)	Verify that the dipstick is correctly marked.
Incorrect oil (specification or viscosity)	Make sure the correct oil is being used. Refer to the L Series Operation and Maintenance Manual.
	Check for reduced viscosity from dilution with fuel.
	Review / reduce the oil change intervals. Refer to the L Series Operation and Maintenance Manual.
High blowby forcing oil out the breather tube.	Check the breather tube area for signs of oil loss. Measure the blowby and perform the required repairs.
Lubricating oil cooler is leaking.	Check for oil in the coolant.
Air compressor pumping oil	Refer to Troubleshooting logic chart for "air compressor pumping excessive lubricating oil into air system".
Turbocharger leaking oil to the air intake or exhaust manifold.	Inspect the turbocharger inlet and outlet for evidence of oil transfer.
Valve seals worn	Inspect / replace the valve seals.
Piston rings not sealing (oil being consumed by the engine)	Perform a compression check. Repair as required.

Low oil pressure

Cause	Correction
Air compressor pumping oil	Add or drain engine oil
Oil diluted with fuel but engine operation normal	Remove and check fuel transfer pump plunger seal. Replace leaking pump. Change engine oil.
Oil diluted with fuel accompanied by rough engine operation or low power	Check for a stuck injector nozzle. If injectors are ok, replace injection pump. Change engine oil.
Oil diluted with water	Look for missing rain caps, oil fill caps, dipsticks, etc. Change oil.
Oil diluted with coolant (anti-freeze)	Check oil cooler, aftercooler, core plugs, cylinder liner, head gasket, and cracked passages in the block and head for leaks. Replace the leaking component and the oil.
Oil specifications incorrect	Check oil specifications. Refer to the L Series Operation and Maintenance Manual.
Oil pressure switch or gauge malfunction	Check oil pressure gauge and switch.
Oil pressure regulating valve stuck open or broken spring	Check and clean. Replace spring if broken.

Lubricating Oil Pressure – Low (continued)

Cause	Correction
Pipe plug loose or missing	Check for external leak at rear of cylinder head, along fuel pump side of block, oil cooler cover and gear housing.
Oil filter plugged	Change lubricating oil and filters.
Lubricating oil cooler is plugged	Check and replace oil cooler.
Cup plug internal leak	Check oil rifle cup plugs, cup plug in front and rear face of block.
Suction tube loose or gasket leaking	Replace gasket and tighten suction tube.
Lubricating oil pump worn	Check / replace oil pump.
Main bearing cap loose	Check / install new bearing(s). Tighten cap.
Connecting rod or main bearings worn	Check / replace bearings. Also, check / replace piston cooling nozzles.

Lubricating Oil Pressure High

Cause	Correction
Pressure switch / gauge malfunctioning	Verify the pressure switch / gauge are malfunctioning correctly.
Engine running too cold.	Refer to Troubleshooting logic chart for "coolant temperature below normal"
Oil viscosity too thick	Make sure the correct oil is being used. Refer to the L Series Operation and Maintenance Manual.
Pressure regulator valve stuck closed	Check / replace valve.

Flame Start System Malfunctions

Cause	Correction
Turn the key to connect Wait to Start (WTS) Light	Wait for the Wait to Start (WTS) Light to go out.
Waiting too long to start vehicle after WTS Light goes out	Turn the start switch to start no longer than 10 seconds after the WTS light goes out.
Battery voltage below 9 volts for a 12 volt and 20 volts for a 24 volt system	Change / replace the battery.
WTS light never turns on	Check the bulb, bulb socket, and wiring.
Electrical glow plug heater of the flame plug not heating up	Repair the electrical circuit to the flame plug.
Electrical heater of the flame plug failed	Check the flame plug electric heater.
Flame start temperature sensor bad	Check sensor.
Engine wiring harness bad	Check the wiring harness for shorts to the ground, insulation chafing, connector corrosion, and connector integrity.

Flame Start System Malfunctions (continued)

Cause	Correction
Fuel not flowing to the flame plug	Check for fuel line waxing. Heat up the fuel lines and remove the wax deposit. Warm up the glow plug and remove the wax deposit.
Flame plug solenoid not opening	Check the flame plug solenoid.
Flame plug filter clogged	Remove the fuel lines and clean the filter.
Flame plug coked / clogged	Check the flame plug for plugging and coking.
Fuel line leaks	Correct leak.
Controller ground bad	Check the wiring harness ground for corrosion or loose connections. Check the controller pin "B" on the two-pin connector for ground.
Power supply to the controller bad	Check the connector at the shutdown solenoid for loose connections, corrosion or connector cracks. Pin A supplies the controller with system voltage on the 6-pin connector.
Oil pressure switch failed	Check the oil pressure switch. Replace sensor.
Controller malfunction	Check the controller logic.

Engine Noises Diagnostic Procedures – General Information

NOTE: When diagnosing engine noise problems, make sure that the noises caused by accessories, such as the air compressor and power takeoff, are not mistaken for engine noises. Remove the accessory drive belts to eliminate noise caused by these units. Noise will also travel to other metal parts not related to the problem. Use of a stethoscope can help locate an engine noise.

Engine noises heard at the crankshaft speed, engine RPM, are noises related to the crankshaft, rods, pistons, and piston pins. Noises heard at the crankshaft speed, one-half of the engine RPM, are related to the valve train. A hand-held digital tachometer can help to determine if the noise is related to components operating at the crankshaft or camshaft speed.

Engine noise can sometimes be isolated by performing a cylinder cutout test. The volume of the noise decreases or the noise disappears, it is related to that particular engine cylinder.

There is not a definite rule or test that will positively determine the source of a noise complaint.

Engine driven components and accessories, such as gear-driven fan clutches, hydraulic pumps, belt-driven alternators, air-conditioning compressors, and turbochargers can contribute to engine noise. Use the following information as a guide to diagnosing engine noise.

Main Bearing Noise (Refer to Engine Noise Excessive – Main Bearing symptom tree)

The noise caused by a loose main bearing is a loud dull knock heard when the engine is pulling a load. If all main bearings are loose, a loud clatter will be heard. The knock is heard regularly every other revolution. The noise is the loudest when the engine is lugging or under heavy load. The knock is duller than a connecting rod noise. Low oil pressure can also accompany this condition.

If the bearing is not loose enough to produce a knock by itself, the bearing can knock if the oil is too thin, or if there is no oil at the bearing.

An irregular noise can indicate worn crankshaft thrust bearings.

An intermittent sharp knock indicates excessive crankshaft end clearance. Repeated clutch disengagements can cause a change in the noise.

Connecting Rod Bearing Noise (Refer to Engine Noise Excessive – Connecting Rod Bearing symptom tree)

Connecting rods with excessive clearance knock at all engine speeds, and under both idle and load conditions. When the bearings begin to become loose, the noise can be confused with piston slap or loose piston pins. The noise increases in volume with engine speed. Low oil pressure can also accompany this condition.

Piston Noise (Refer To Engine Noise Excessive – Piston symptom tree)

It is difficult to tell the difference between piston pin, connecting rod, and piston noise. A loose piston pin causes a loud double knock which is usually heard when the engine is idling. When the injector to this cylinder is cut out, a noticeable change will be heard in the sound of the knocking noise. However, on some engines the knock becomes more noticeable when the vehicle is operated on the road at steady speed condition.

Drivability – General Information

Drivability is a term which in general describes vehicle performance on the road. Drivability problems for an engine can be caused by several different factors. Some of the factors are engine related and some are not.

Before troubleshooting, it is important to determine the exact complaint and whether the engine has a real drivability problem or if it simply does not meet drive expectations. The Drivability – Low Power Customer Complaint Form is a valuable list of questions that must be used to assist the service technician in determining what type of drivability problem the vehicle is experiencing. Complete the checklist before troubleshooting the problem. If an engine is performing to factory specifications but does not meet the customer's expectations, it must be explained to the customer that nothing is wrong with the vehicle and why. The form can be found at the end of this section.

The troubleshooting symptom charts have been set up to divide drivability problems into two different symptoms: Engine Power Output Low and Engine Acceleration or Response Poor.

Low power is a term that is used in the field to describe many different performance problems. However, in this manual low power is defined as the inability of the engine to produce the power necessary to move the vehicle at a speed that can be reasonably expected under the given conditions of load, grade, wind, and so on. Low power is usually caused by the lack of fuel flow which can be caused by any of the following factors:

- incorrect fuel pump or injector calibration
- lack of full travel of the fuel pump throttle
- plugged ASA
- excessive fuel inlet, intake, exhaust, or drainline restriction
- loose fuel pump suction lines

Low power is not the inability of the vehicle to accelerate satisfactorily from a stop or the bottom of a grade. Refer to the troubleshooting tree "Engine Power Output Low" for the proper procedures to locate and correct a Low Power problem. The diagram starts from the basic item "basic content" that can cause low power, and then breaks off into application specific items "Application Specific" that can cause low power. All of the "Application Specific" charts end with a step called "Fuel or Air Delivery Problem". This step leads to an engine performance check which requires engine measurements. The last section of this part is titled "Performance Measurement" which leads the troubleshooter through the causes and corrections based on the outcome of the performance check.

Poor Acceleration / Response is described in this manual as the inability of the vehicle to accelerate satisfactorily from a stop or from the bottom of a grade. Poor Acceleration / Response is difficult to troubleshoot since it can be caused by factors such as:

- engine / pump related factors;
- driver technique;
- improper gearing;
- improper engine application;
- worn clutch or clutch linkage;

Engine related Poor Acceleration / Response can be caused by several different factors such as:

- low no-air setting;
- plugged ASA;
- AFC delay;

---- excessive drainline restriction;

---- low throttle leakage;

---- throttle deadband;

Refer to the troubleshooting symptom chart, Engine Acceleration / Response Poor, for the proper procedures to locate and correct a Poor Acceleration / Response complaint. For additional information, see Troubleshooting Drivability Complaint, Bulletin No. 3387245.

Drivability / Low Power - Customer Compliant Form

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Customer Name / Company _____ Date _____

(1). How did the problem occur? _____ Suddenly _____ Gradually

(2). At what hour / mileage did the problem begin? _____ miles _____ since new

After engine repair? _____ Yes _____ No

After equipment repair? _____ Yes _____ No

After change in equipment use? _____ Yes _____ No

After change in selectable programmable parameters? _____ Yes _____ No

If so, what was repaired and when? _____

(3). Does the vehicle also experience poor fuel economy? _____ Yes _____ No

Answer question 5 through 9 using selections (A through F) listed below. Circle the letter or letters that best describes the complaint.

A-compared to fleet

D- personal expectation

B-compared to competition

E- won't pull on hill

C-compared to previous engine

F- won't pull on flat

A B C D E F

(4). Can the vehicle obtain the expected road speed? _____ Yes _____ No

What is desired speed? _____ rpm/mpH What is achieved speed? _____ rpm/mpH

GVW _____

A B C D

(5). Is the vehicle able to pull the load? _____ Yes _____ No When?

_____ in the hill _____ with a loaded trailer

_____ on the flat

_____ other _____

IF QUESTION 4 OR 5 WAS ANSWERED NO, FILL OUT THE DRIVEABILITY/LOW POWER/EXCESSIVE FUEL CONSUMPTION CHECKLIST AND GO TO THE LOW POWER TROUBLESHOOTING TREE.

A B C D E F

(6). Is the vehicle slow to accelerate or respond? _____ Yes _____ No

_____ from a stop?

_____ after a shift? rpm _____

_____ before a shift? rpm _____

_____ no shift? rpm _____

A B C D

(7). Does the vehicle hesitate after long periods of deceleration or coasting?

_____ Yes _____ No rpm _____

IF QUESTION 6 OR 7 WAS ANSWERED YES, FILL OUT THE DRIVEABILITY/LOW POWER/EXCESSIVE FUEL CONSUMPTION CHECKLIST AND GO TO THE POOR ACCELERATION/ RESPONSE TROUBLESHOOTING TREE.

A B C D E F

(8). Additional Comments: _____

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Drivability/Low Power/Excessive Fuel Consumption – Checklist**Vehicle / Equipment Specifications:**

Year, type, and Model: _____

Transmission _____ Duty Cycle: _____

Rear Axle Ratio, No. of Axles: _____ Application: _____ Industrial _____ Marine _____

Genset _____ Automotive _____

Typical GVW: _____ Engine Rating: _____

Trailer Type and Size: _____ Height: _____ Width: _____

Tire Size _____

Tire type: _____ Radial _____ Standard Tread _____ Extra Tread _____

Fan type: _____ Direct Drive _____ Viscous _____ Clutch _____

Power Steering? _____ Yes _____ No

Air conditioner? _____ Yes _____ No

Air shield? _____ Yes _____ No

Freon compressor? _____ Yes _____ No

GENERAL INSTRUCTIONS:

Fuel pump code _____ DO No.: _____

Mileage: _____ SC No.: _____

Date in service: _____ Fuel pump serial No.: _____

Cruise speed and RPM: _____ ENGINE SERIAL No. _____

Engine model and rating: _____

Rated speed and RPM: _____

PT PACER Equipped? _____ Yes _____ No CU Part No: _____

Road Speed Governor? _____ Yes _____ No TYPE: _____

STC Equipped? _____ Yes _____ No STC Valve Part No: _____

Engine Brake? _____ Yes _____ No Type / Brand: _____

Chassis and other Related Items:

Tank Vents: _____ OK _____ Not OK Obvious Fuel Leaks: _____ Yes _____ No

Brake Drag: _____ OK _____ Not OK Axle Alignment: _____ OK _____ Not OK

Altitude: _____ Ambient Temperature: _____

Fuel Heater _____

Fuel Type: _____ No.1D _____ No.2D Other _____

Typical Terrain: Flat, hilly, % Asphalt, %Concrete _____

Additional Comments:

Fuel Consumption – General Information

The cause of excessive fuel consumption is hard to diagnose and correct because of the potential number of factors involved. Actual fuel consumption problems can be caused by any of the following factors:

- engine factors
- vehicle factors and specifications
- environmental factors
- driver technique and operating practices
- fuel system factors
- low power / drivability problems

Before troubleshooting, it is important to determine the exact complaint and whether the problem is real or perceived, does not meet drivers expectations. "Fuel Consumption- Customer Complaint Form" is a valuable list of questions that can be used to assist the service technician in determining the cause of the problem. The form must be completed before troubleshooting the complaint. The form can be found at the end of the Troubleshooting Symptom section. The followings are some of the factors that must be considered when troubleshooting fuel consumption complaints.

Result of a Low Power / Drivability Problem: An operator will change his driving style to compensate for a low power / drivability problem. Some things the driver is likely to do are, (a) shift to a higher engine RPM or (b) run on the droop curve in a lower gear instead of upshifting to drive at part throttle conditions. These changes in driving style will increase the amount of fuel used.

Driver Technique and Operating Practices: As a general rule, a 1 mph increase in road speed equals a 0.1 mpg increase in fuel consumption. This means that increasing road speed from 50 to 60 mph will result in a loss of fuel mileage of 1 mpg.

Environmental and Seasonal Weather Changes: As a general rule, there can be as much as a 1 to 1.5 mpg difference in fuel consumption depending on the season and the weather conditions.

Excessive Idling Time: Idling the engine can use from 0.5 to 1.5 gallons per hour depending on the engine idle speed.

Truck Route and Terrain: East/West routes experience almost continual crosswinds and headwinds. Less fuel can be used on north/south routes where parts of the trip are not only warmer, but see less wind resistance.

Vehicle Aerodynamics: The largest single power requirement for a truck is the power needed to overcome air resistance. As a general rule, each 10 percent reduction in air resistance results in a 5 percent increase in mpg.

Rolling Resistance: Rolling resistance is the second largest consumer of power on a truck. The type of tire and tread design have a sizeable effect on fuel economy and performance. Changing from a bias ply to a low profile radial tire can reduce rolling resistance by about 36 percent.

Additional vehicle factors, vehicle specs, and axle alignment can also affect fuel consumption. For additional information on troubleshooting fuel consumption complaints, see Troubleshooting Excessive Fuel Consumption.

Fuel Consumption – Automotive Customer Complaint Form

Customer Name / Company _____ Date _____

Answer the following questions. Some questions require making an X next to the appropriate answer.

- (1) What fuel consumption is expected? Expected _____mpg
- (2) What are the expectations based on?
 _____original mileage _____ other units in fleet _____competitive engines
 _____previous engine owned _____expectations only
- (3) When did the problem occur?
 _____since new _____ suddenly _____gradually
- (4) Did the problem start after a repair? _____ Yes _____ No
 If so, what was repaired and when? _____
- (5) Is the vehicle also experiencing a driveability problem (Low power or poor acceleration / response)? _____ Yes _____ No
IF ANSWER YES, FILL OUT THE DRIVEABILITY/LOW POWER/ EXCESSIVE FUEL CONSUMPTION CHECKLIST AND GO TO THE ENGINE POWER OUTPUT LOW TROUBLESHOOTING SYMPTOM CHART.
- (6) Is the problem seasonal? _____ Yes _____ No
- (7) Weather conditions during fuel consumption check?
 _____rain _____snow _____windy _____hot temperatures _____cold temperatures
- (8) How is the fuel consumption measured? Tank _____trip _____month _____year _____
 hubometer _____odometer _____
- (9) Are accurate records kept of fuel added on the road? _____ Yes _____ No
- (10) Do routes vary between compared vehicles? _____ Yes _____ No
- (11) Have routes changed for the engine being checked? _____ Yes _____ No
- (12) What are the loads hauled, compared to the comparison unit? GVW _____
 Heavier _____ Lighter _____
- (13) What is the altitude that the truck is operating at?
 _____ below 10,000 feet _____ above 10,000 feet
- (14) How much of the time is the truck spent idling? _____hours/day
- (15) Is the driver technique or operating practices affecting fuel economy?
 _____ high road speed: mph _____
 _____ operate at rated speed or above: rpm _____
 _____ incorrect shift rpm: shift rpm _____ torque peak _____
 _____ operate at a cruise speed: rpm _____
 _____ believe compensating for low power

IF AFTER FILLING OUT THIS FORM IT APPEARS THAT THE PROBLEM IS NOT CAUSED BY VEHICLE FACTORS, ENVIRONMENTAL FACTORS, OR DRIVER TECHNIQUE, FILL OUT THE DRIVEABILITY/ LOW POWER/ ECESSIVE FUEL CONSUMPTION CHECKLIST AND GO TO THE FUEL CONSUMPTION EXCESSIVE TROUBLESHOOTING SYMPTOM TREE.

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Fuel Consumption – Industrial Customer Complaint Form

Customer name / company _____ Date _____

Answer the following questions. Some questions require making an X next to the appropriate answer.

- (1) What fuel consumption is expected? Expected gph _____
- (2) What are the expectations based on?
 _____ original consumption _____ other units in fleet _____ competitive engines _____
 previous engine owned _____ expectations only _____ engine performance curve
- (3) What did the problem occur?
 _____ since new _____ suddenly _____ gradually
- (4) Did the problem start after a repair? _____ Yes _____ No
 If so, what was repaired and when? _____
- (5) Is the vehicle also experiencing a driveability problem (Low power or poor acceleration / response)? _____ Yes _____ No
- IF ANSWER YES, FILL OUT THE DRIVEABILITY/LOW POWER/ EXCESSIVE FUEL CONSUMPTION CHECKLIST AND GO TO THE ENGINE POWER OUTPUT LOW TROUBLESHOOTING SYMPTOM CHART.**
- (6) Is the problem seasonal? _____ Yes _____ No
- (7) Weather conditions during fuel consumption check?
 _____ rain _____ snow _____ windy _____ hot temperatures _____ cold temperatures
- (8) How is the fuel consumption measured? Tank _____ trip _____ month _____ year _____
 hubometer _____
- (9) Do duty cycles vary between compared units? _____ Yes _____ No
- (10) Have duty cycles changed for the engine being checked? _____ Yes _____ No
- (11) What are the loads compared to a comparison unit? _____ Heavier _____ Lighter
- (12) What is the altitude that the unit is operating at?
 _____ below 10,000 feet _____ above 10,000 feet
- (13) How much of the time is the unit idling? _____ hours/day
- (14) Is the operator technique or operating practices affecting fuel economy?
 _____ operate at rated speed or above: rpm _____
 _____ incorrect shift rpm: shift rpm _____ torque peak _____
 _____ believe compensating for low power

IF AFTER FILLING OUT THIS FORM IT APPEARS THAT THE PROBLEM IS NOT CAUSED BY VEHICLE FACTORS, ENVIRONMENTAL FACTORS, OR DRIVER TECHNIQUE, FILL OUT THE DRIVEABILITY/ LOW POWER/ EXCESSIVE FUEL CONSUMPTION CHECKLIST AND GO TO THE FUEL CONSUMPTION EXCESSIVE TROUBLESHOOTING SYMPTOM TREE.

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Oil Consumption

In addition to the information that follows, a service publication is available entitled Technical Overview of Oil Consumption.

Cummins Engine Company, Inc. defines “Acceptable Oil Usage” as outlined in the following table.

ACCEPTABLE OIL USAGE										
ANY TIME DURING COVERAGE PERIOD										
Engine system	H/quart	H/L	H/imperial quart	Mile/quart	Mile/L	Mile/imperial quart	Kilometer/quart	Kilometer/L	Kilometer/imperial quart	
A	10.0	10.6	12.0	400	425	475	650	675	775	
4B	10.0	10.6	12.0	400	425	475	650	675	775	
6B	10.0	10.6	12.0	400	425	475	650	675	775	
6C	10.0	10.6	12.0	400	425	475	650	675	775	
V/VT-378	4.0	4.3	5.0	--	--	--	--	--	--	
V/VT-504	4.0	4.3	5.0	250	265	310	400	425	485	
V/VT-555	4.0	4.3	5.0	250	265	310	400	425	485	
L Series	4.0	4.3	5.0	250	265	310	400	425	485	
N Series	4.0	4.3	5.0	250	265	310	400	425	485	
V/VT/VTA-903	4.0	4.3	5.0	250	265	310	400	425	485	
KT/KTA19	3.0	3.2	3.75	200	210	250	320	340	390	
V/VT/VTA28	20	2.1	2.5	--	--	--	--	--	--	
KT/KTA38	1.5	1.6	1.8	--	--	--	--	--	--	
KTA50	1.1	1.2	1.3	--	--	--	--	--	--	

Dong Feng Cummins Engine Co. Ltd Marketing Department

Fax: 3320268

Engine Lubricating Oil Consumption Report

Owner's name	Date of delivery Month Day Year		ENGINE SERIAL NO.	
Address	Equipment manufacturer		Engine model & HP	
City state / province	Equipment serial No.		Fuel pump serial No.	
Engine application (describe)	Oil and filter change interval		Complaint originally registered	
	Lubrication oil	Filter	Date	Hours/kilometers
Lubricating oil added				
Added oil Date	Engine operation Miles / hours / kilometers	Added oil quarts Liters	Brand and viscosity of oil used	
Start test				
Last Mileage / Hours / kilometers _____ Minus start Mileage / Hours / kilometers _____				
Equals test Mileage / Hours / kilometers _____ Divided by oil added _____				
Equals _____ Usage Rate _____				
Customer signature	Dong Feng Cummins service location		DECE service manager	

Dong Feng Cummins Engine Co. Ltd**OIL CONSUMPTION REPORT**

Customer Name: _____

Dist/Dir: _____

Engine Model: _____

Km/Hr: _____

Engine Serial No.: _____

CPL No.: _____

Vehicle Make/Model: _____

Date: _____

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1. Review of maintenance history:

List any previous failures that could have had a detrimental effect on cylinder component life. Failures could include fuel, coolant, / or foreign abrasives in the oil, second ring groove beat-out, filter plugging, etc.

Lube oil used:

Brand name _____

Viscosity _____

Change interval _____ km/hr

Bypass oil filter:

Mode _____

Cartridge _____

Change interval _____ km/hr

Full flow oil filters.

Mode _____

Cartridge _____

Change interval _____ km/hr

Air cleaners

Make and model _____

Change interval _____ km/hr

2. List any external engine leaks.

Visually check for any internal leaks and list. Check turbocharger seals, valve guides, air compressor, etc.

3. Had the fuel pump been tampered with?? _____ What is maximum rail pressure readings? _____ if yes, the pump must be reset to factory specifications and the customer sent out to re-evaluate his oil consumption rate and the eligibility requirements must be met again.**4. Drain and refill oil pan to check dipstick markings and notes findings.****5. Only after above checks are completed, leaks corrected and proper documentation is completed, disassemble engine to determine cause for the failure and repair as required.****6. State reason for oil consumption.**

Signed: _____

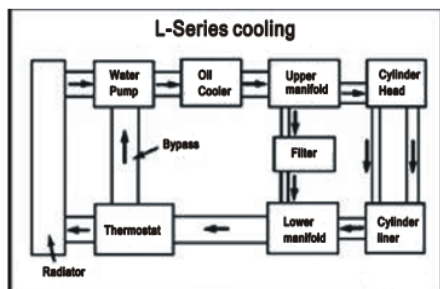
NOTES

Cooling System

Cooling System – General Information

The primary function of the cooling system is to remove the heat created by the engine and its support components. The excess heat energy that is not removed by the cooling system is carried away by exhaust gases and radiation into the atmosphere.

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The accompanying charts on the left illustrate the coolant flow through the engine. For more detail refer to the Cooling System Flow Diagrams at Page 4-3.

Cooling System – Flow Diagram

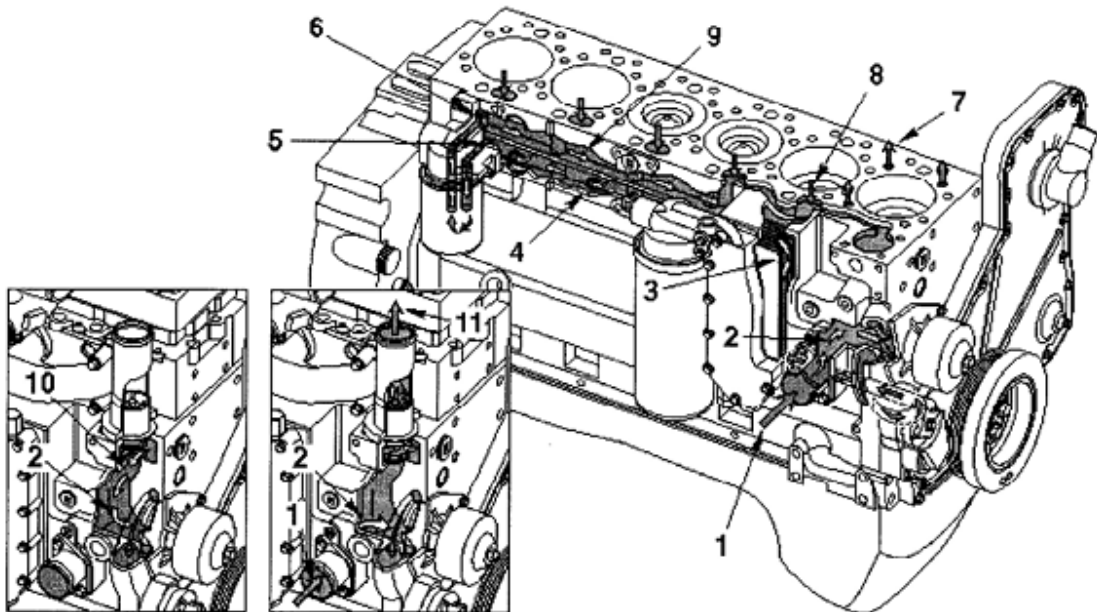
The following illustrations identify the significant features of the cooling system:

Coolant is drawn from the radiator by the integrally mounted water pump. The output from the water pump empties into the bottom of the oil cooler cavity in the cylinder block. The coolant flows into the lower outlet manifold and the intake cylinder liner cavity surrounding from the cooler cavity, and keep the cylinder liner cool, then some coolant flows through the coolant filter and returns to the lower manifold.

The coolant flowing into the cylinder liner cavity is directed to the cylinder head through the casting hole of the block, and returns to the upper water manifold through the orifice, and then to the thermostat controlling the temperature of the engine.

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COOLING SYSTEM



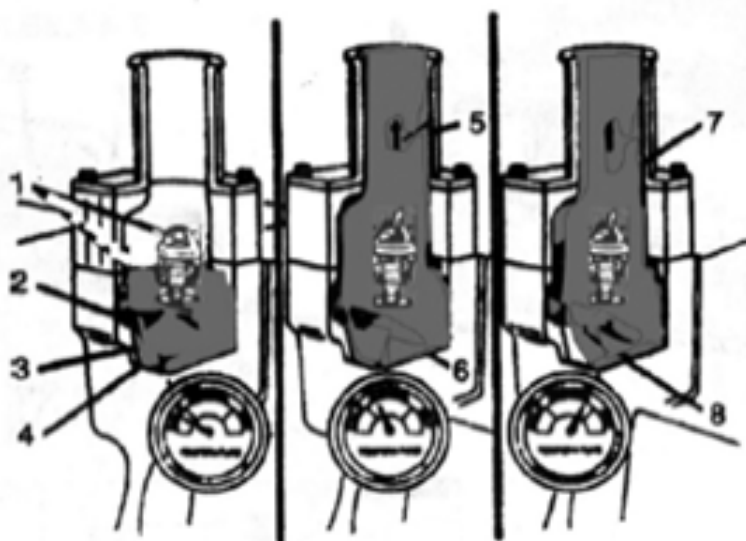
- | | |
|--|---|
| 1. Coolant flowing into the water pump from Radiator | 7. Coolant flows into the Cylinder Head |
| 2. Water Pump | 8. Coolant Return from Cylinder Head |
| 3. Coolant Flow through Lubricating Oil Cooler | 9. Block Upper Water Manifold |
| 4. Block Lower Water Manifold (to cylinder liner) | 10. Bypass passage below the thermostat |
| 5. Coolant Filter Inlet | 11. Coolant flows into the Radiator |
| 6. Coolant Filter Outlet | |

Cooling System – Flow Diagram (Continued)

When engine is below operating temperature, the thermostats are closed. Coolant is bypassed to the water pump inlet. As the coolant temperature increases, both thermostats begin to open allowing some of the coolant to flow to the radiator. At normal operating temperature, both thermostats are fully open and the bypass circuit is closed.

COOLING SYSTEM

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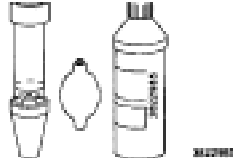
- | | |
|--|--|
| 1. Oven | 5. Part of the coolant flows into the radiator |
| 2. To the water pump inlet | 6. Limit the coolant to the bypass line |
| 3. Bypass Flow | 7. Coolant flows into the radiator |
| 4. Coolant from the lower coolant manifold | 8. Bypass is closed |

Cooling System – Specifications

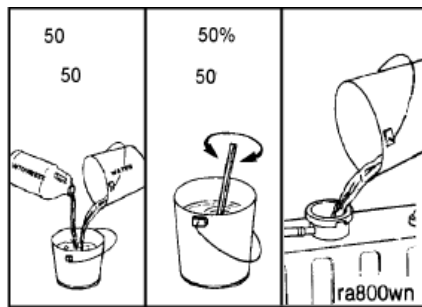
	Metric[U.S.]
Coolant capacity (engine only)	11.1 liters
Thermostats	
Starts to open.....	81 to 83°C [178 to 182°F]
Fully open	95°C [203°F]
Maximum allowable top tank temperature	100°C [212°F]
Minimum recommended top tank temperature	70°C [158°F]
Minimum allowable pressure cap	50 kpa [7.0 psi]
Supplemental coolant additives (SCA) concentration.....	1.5 to 3.0 unit/3.7 liters [1 US gal]

Cooling System – Service Tools

The following special tools are recommended to perform service work in Section 4. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	TOOL DESCRIPTION	Tool Illustration
CC-2626	Cooling System Test Kit The Fleetguard® Coolant Test Kit is used to check the concentration of coolant additives in the cooling system.	
CC-2800	Refractometer The Fleetguard® Refractometer is used to measure the freeze point protection and antifreeze concentration.	
3822985	Combustion Gas Leak Test Kit Includes Part No. 3822986 Test Fluid, Part No. 3822987 Adapter, and Part No. 3877612 Instructions.	

Cooling System – Maintenance



Antifreeze

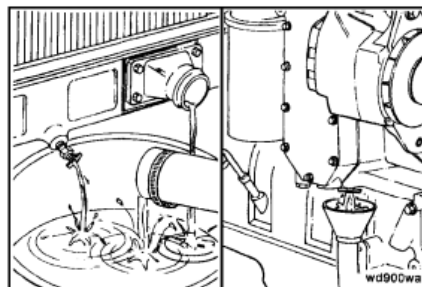
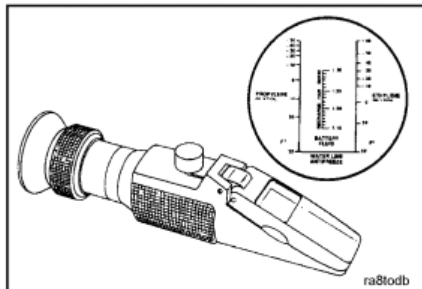
CAUTION: Never use only water for engine coolant. In tropical climates where antifreeze availability can be limited, use a corrosion inhibitor (Cummins Liquid DCA) to protect the engine cooling system.

A premixture of 50 percent ethylene-glycol base antifreeze is required for operation of the engine in temperature environments above -37°C [-34°F]. A mixture of 32 percent water and 68 percent antifreeze is recommended for temperature below -37°C [-34°F].

Antifreeze Concentration – Check

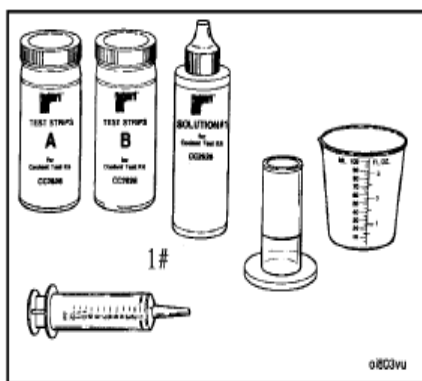
The Fleetguard® refractometer, Part No. CC-2800, provides a reliable and easy-to-read measurement of freeze point protection and glycol (antifreeze) concentration.

The freeze point protection must be checked if coolant is added to the cooling system or annually when operating in temperatures below 0°C [32°F]. Refer to the manufacturer's instruction manual.



Cooling System – Draining

Open the petcocks at the bottom of the radiator and at the bottom of the oil cooler housing. Remove the lower radiator hose. A 20 liter [4 U.S. gallons] drain pan will contain the coolant in most applications.



Additive Concentration – Check



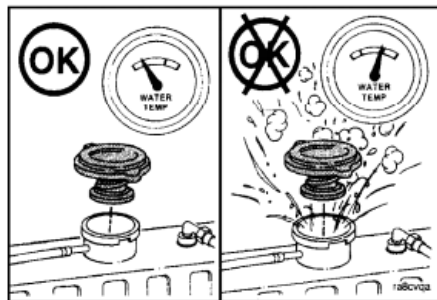
The cooling system must contain the proper coolant additive units to provide the best chemical protection.

Refer to the L Series Operation and Maintenance Manual.

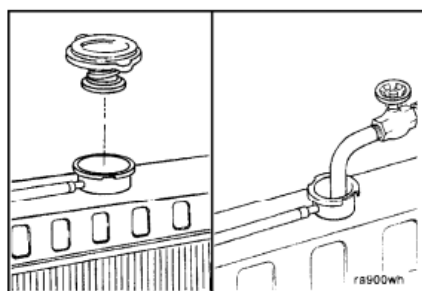
DCA4 Test Kit: Use only DCA4 Test Kit, Fleetguard® Part No. CC-2626, to check the coolant additive concentration in the cooling system.

Cooling System – Cleaning

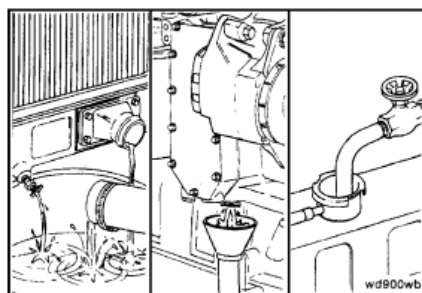
The following is the recommended procedure for flushing and cleaning the engine cooling system of oil or fuel contamination. It is assumed that the source of the contamination has been located and corrected.



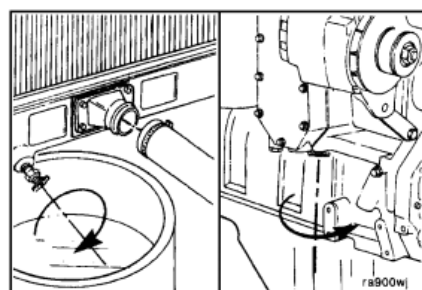
WARNING: Wait until the temperature is below 50°C before removing the coolant system pressure cap. Failure to do so can cause personal injury from heated coolant spray.



Remove the pressure cap. Slowly overfill the top tank to flush as much contaminated coolant as possible out the top of the tank.



Completely drain the cooling system (block, radiator, heaters). Do not remove the coolant filter. Use running water to quickly flush the majority of the contamination, leaving draincocks open. Plugged radiators can require extra treatment beyond these procedures. Consult local regulations concerning disposal of antifreeze and oil.



Connect all hoses, close all draincocks.



NOTE: The performance of RESTORE is dependent On time, temperature, and concentration levels. An extremely flow restricted system, for example, can require higher concentrations of cleaners, higher temperatures, or longer cleaning times. RESTORE can be safely used up to twice the recommended concentration levels. Extremely fouled systems can require more than one cleaning.

Cummins Engine Company, Inc., recommends using Fleetguard® RESTORE or an equivalent. Cooling systems can also be cleaned using non-sudsing washing soda or automatic dish washer soap.

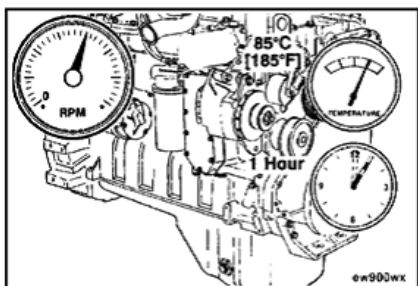
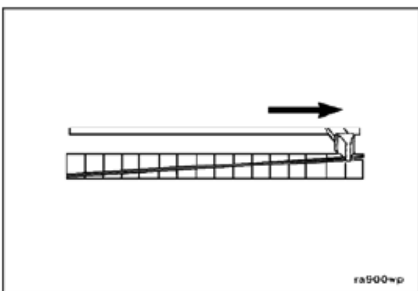
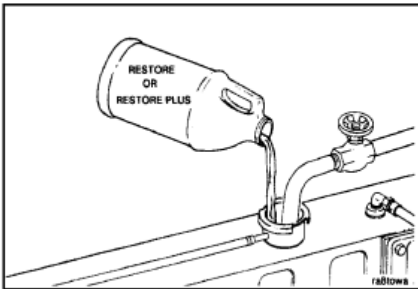
The product used must be alkaline (non-acidic). Use of a liquid cleaner will allow easier mixing and will not have the possibility to plug the cooling system.

If using a cleaner other than RESTORE, consult the lable to determine the amount of cleaner required for the cooling system capacity. When using a powdered cleaner, thoroughly mix the cleaner with water (an amount equal to the cooling system capacity) in a separate container. Fill the cooling system with the mixture.

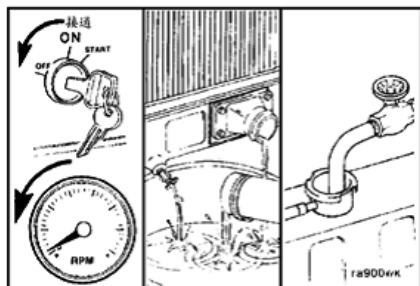
CAUTION: Fleetguard® RESTORE contains no antifreeze. Do not allow the cooling system to freeze during the cleaning operation.

Immediately add 3.8 liters [1 U.S. gallon] of Fleetguard® RESTORE (or equivalent) for each 38 to 57 liters [10 to 15 gallons] of cooling system capacity, and fill the system with plain water. Do not allow the cooling system to dry out. RESTORE will not be as effective if the cooling system is allowed to dry.

Turn the cab heater temperature switch to high to allow maximum coolant flow through the heater core. The blowerfan does not have to be on.

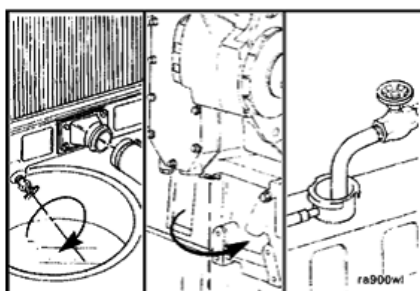


Operate the engine at 2100 RPM at normal operating temperatures (at least 85°C [185°F]) for 1 hour.

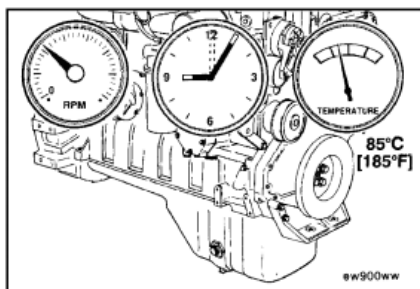


Shut off the engine, and drain the cooling system. Use running water to flush the majority of the contaminated mixture, leaving all draincocks open.

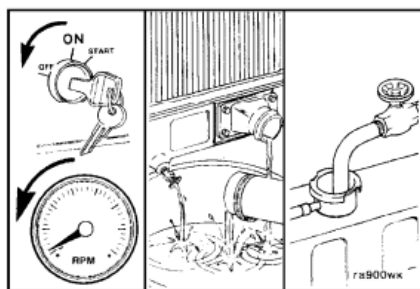
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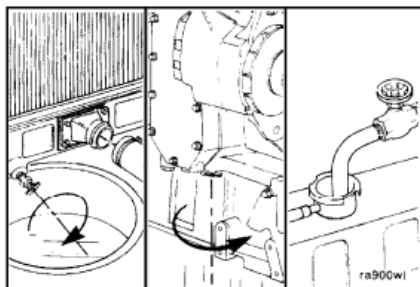
Connect all hoses, close all draincocks and fill the cooling system with clean water (and neutralizer if the cleaner used requires).



Operate the engine at high idle for 5 minutes with the coolant temperature above 85°C [185°F].

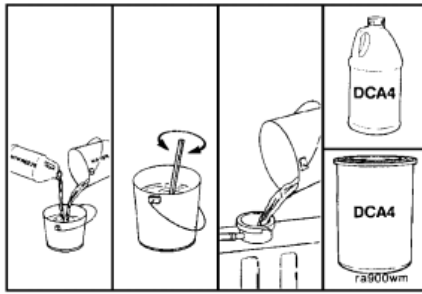


Shut off the engine and completely drain the cooling system again. Use running water to flush the remainder of the rinse water.



Connect all hoses, close all draincocks and leave all heater valves open.

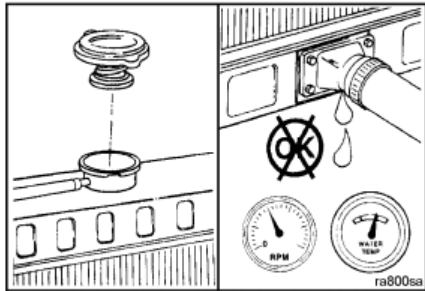
NOTE: If the drain water shows more than just a trace of contamination, the cooling system must be flushed again.



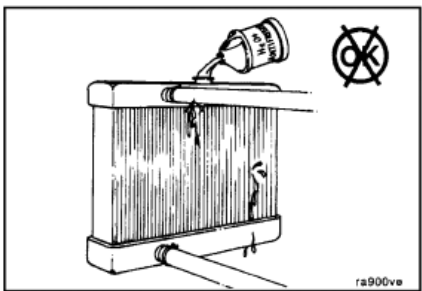
Install a new coolant filter and fill the cooling system with a fresh premixture of 50 percent low silicate antifreeze and 50 percent water.

CAUTION: Use a initial charge filter to bring the coolant to the correct DCA4 concentration level of 1.5 units per 3.8 liters [1 U.S. gallon] of coolant in the system. Refer to the L Series Operation and Maintenance Manual.

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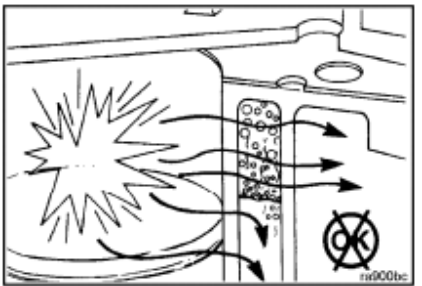
Install the pressure cap. Clean the engine compartment of any contamination residue accumulated during the top tank overfills. Operate the engine to check for leaks and normal operation.



Filling and Draining

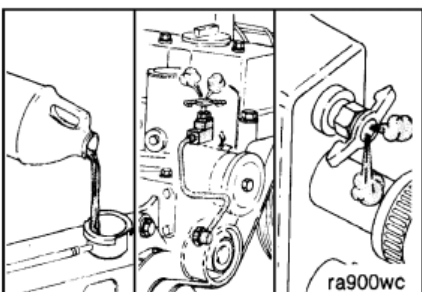
The system is designed to use a specific quantity of coolant. If the coolant level is low, the engine will run hot.

If frequent addition of coolant is necessary, the engine or system has a leak. Find and repair the leak.



The engine coolant passages must be completely filled with coolant.

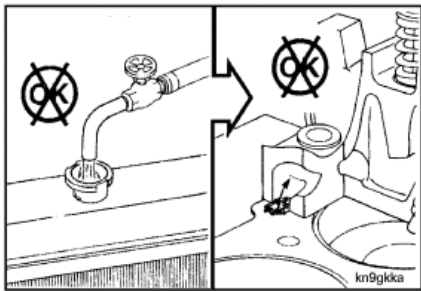
During operation, entrapped air mixes with the coolant which result in cavitation corrosion and poor heat transfer. Highly aerated coolant can cause localized overheating of the cylinder head and block which can result in a cracked head, scored cylinder or blown head gasket.



CAUTION: During filling , air must be vented from the engine coolant passages. Open the engine venting petcock and the petcock on the aftercooler for aftercooled engines. The system must be filled slowly to prevent air locks. Wait 2 to 3 minutes to allow air to be vented, then add mixture to bring the level to the top.



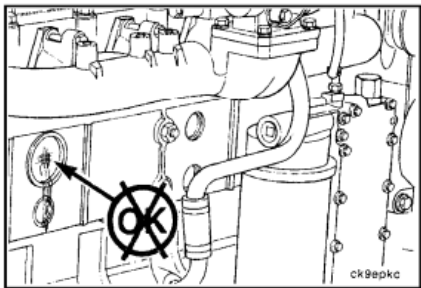
Refer to the Cooling System-Coolant maintenance recommendations.



Water will cause rust formation reducing the flow in the smaller coolant passages.

The small holes in the head gasket are especially susceptible to plugging.

CAUTION: These holes are orifices and their size is critical. Do not enlarge the size or the orifices. To do so will disturb the coolant flow and will not solve an overheating problem.

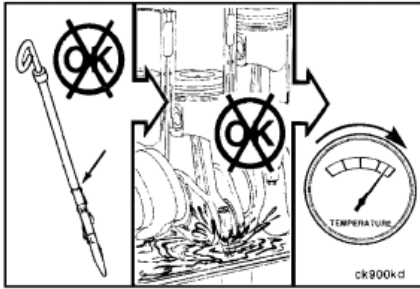


Water used as a coolant for even a relatively short period can result in the cup plugs rusting through allowing the coolant to leak.

CAUTION: A sudden loss of coolant from a heavily loaded engine can result in severe damage to the piston and cylinder liner.



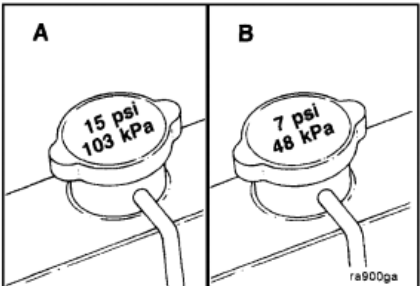
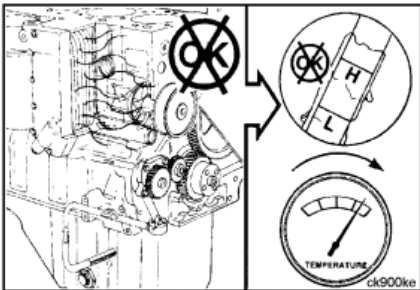
NOTE: Use the correct amount of DCA4 corrosion inhibitor to protect the cooling system. Refer to the Coolant Recommendations in the Operation and Maintenance Manual.



Cooling System – Diagnosing Malfunctions

The function of the cooling system is to maintain a specified operating temperature for the engine. Some of the heat generated by the engine is absorbed by the coolant flowing through the jackets in the cylinder block and head. Heat is removed from the coolant as it flows through the radiator. When troubleshooting overheating problems, remember that too much oil in the oil pan can cause additional heat from friction when the rod journals are submerged in oil.

Overfilling the oil pan raises the oil temperature which is transferred to the cooling system at the oil cooler.



Radiator cap – Pressure test

The system is designed to use a pressure cap to prevent boiling of the coolant.

Different caps are specified for the two recommended systems:

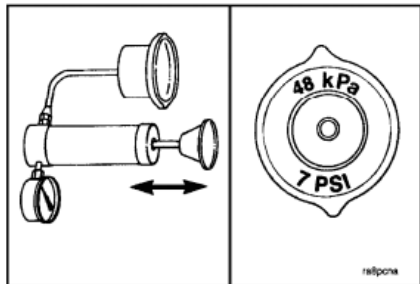
System	Cap
A -104°C [220°F]	103kpa [15 psi]
B -99°C [210°F]	48kpa [7 psi]

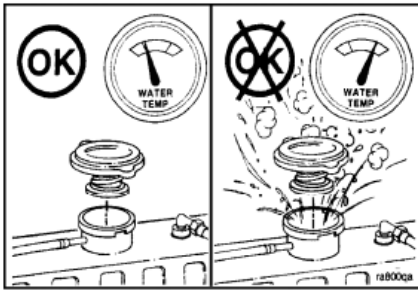
Radiator Cap Pressure Test



The pressure cap must seal within 14 kpas [3 psi] of the value stated on the cap or it must be replaced.

An incorrect or malfunctioning cap can result in the loss of coolant and the engine running hot.





Cooling System – Gas Test

Overflow Method

WARNING: Wait until the temperature is below 50°C [122°F] before removing the cooling system pressure cap. Failure to do so can cause personal injury from heated coolant spray.



Allow the engine to cool, and remove the radiator cap.

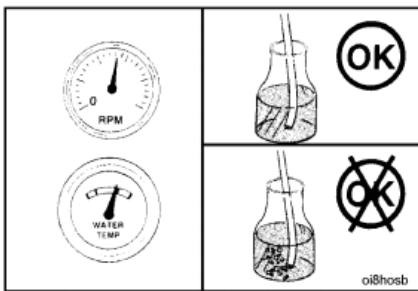
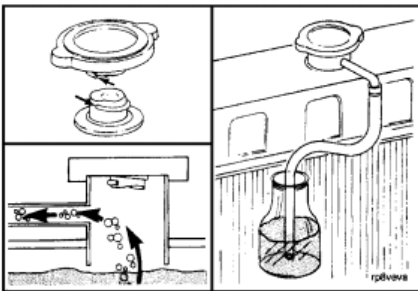


Install a radiator pressure cap with the spring and the pressure relief valve removed.

Attach a rubber hose to the radiator overflow connection.

Put the free end of the hose below the water level in a container of water.

NOTE: The pressure cap must be tightly sealed in the top of the radiator fill neck.



Operate the engine at rated RPM until it reaches a temperature of 82°C [180°F].

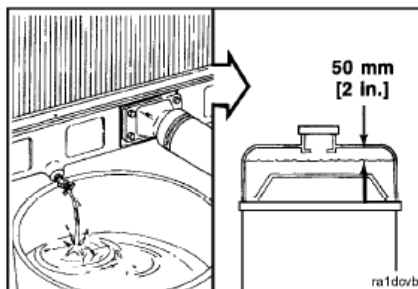
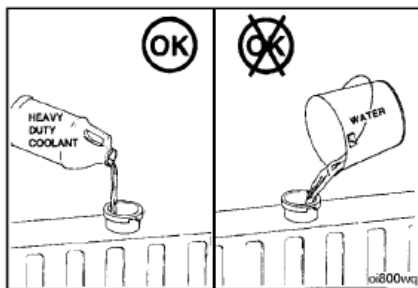
Check for air bubbles in the water container. A combustion gas leak is present if a continuous flow of air bubbles is present.

NOTE: The engine coolant temperature must be stable to perform this test. An increasing coolant temperature will give a false indication of air due to expansion of the coolant in the system.

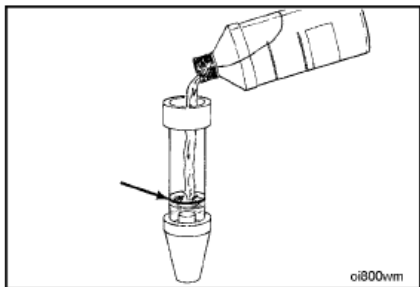
Gas Test

Use Part No. 3822985 Combustion Gas Tester or equivalent to test for combustion gasses in the cooling system.

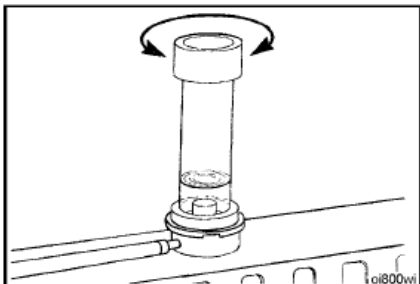
NOTE: It is recommended that the cooling system contain a premixture of 50 percent antifreeze and 50 percent water during the combustion gas leak test. The use of water only can result in a color change in the test fluid from blue to turquoise or light green during the test. This is not an indication if a combustion gas leak.



Drain the coolant level down approximately 50 mm [2 inch] below the radiator cap seal ledge.

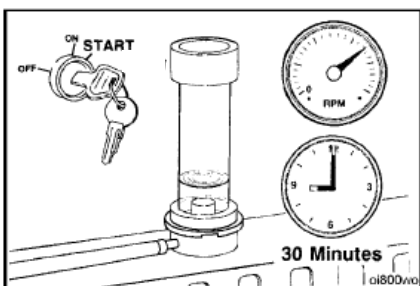


Pour the test fluid into the combustion gas test instrument until it is up to the yellow fill line on the instrument.

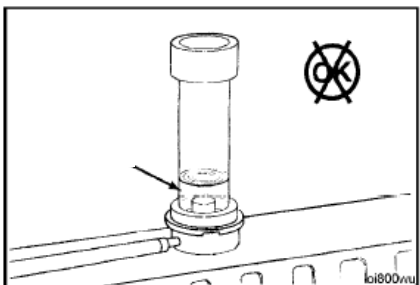


Hold the instrument down firmly and turn back and forth to make sure that an air tight seal is formed between the tester and radiator fill neck.

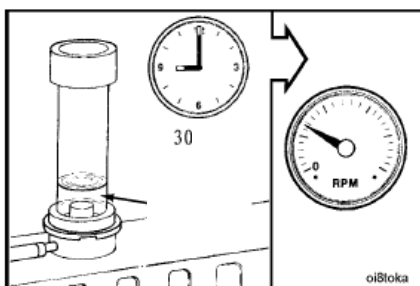
93



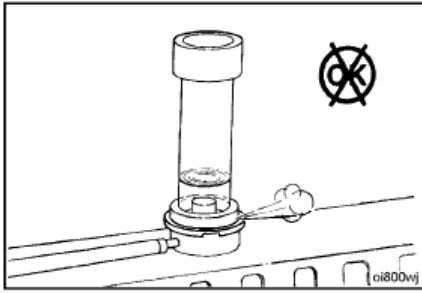
Start the engine and operate at high idle for approximately 30 minutes. Monitor the engine temperature and color of the test fluid during engine operation. Do not allow the engine temperature to exceed 100°C [212°F] during the test.



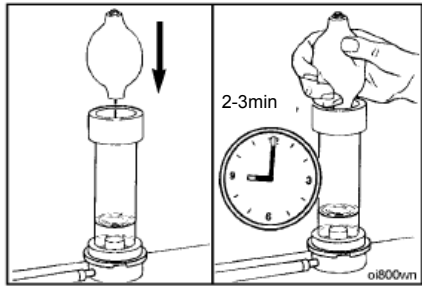
If the color of the test fluid changes from blue to yellow anytime during the test, combustion gasses are leaking into the cooling system. Discontinue the test if the color of test fluid changes from blue to yellow.



If a color of the test fluid does not change from blue to yellow during the 30 minutes test period, return the engine to low idle.



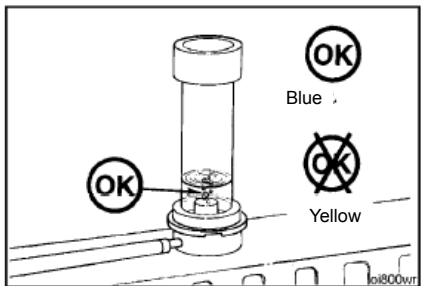
Check the test instrument to make sure that it is firmly sealed in the radiator fill neck.



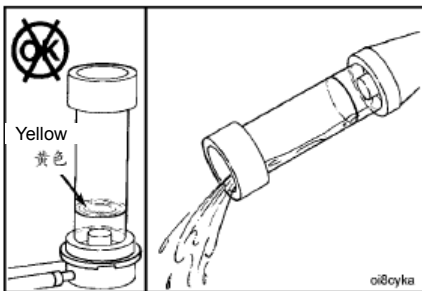
Insert the tip of the rubber ball into the hole in the top of the test instrument. Squeeze the rubber ball 2 to 3 minutes to draw air from the radiator through the test fluid.



If the color of the test fluid remains blue, combustion gasses are not entering the cooling system. If the color of the test fluid changes from blue to yellow, combustion gasses are entering the cooling system and further investigation is required to determine the source of the combustion leak.



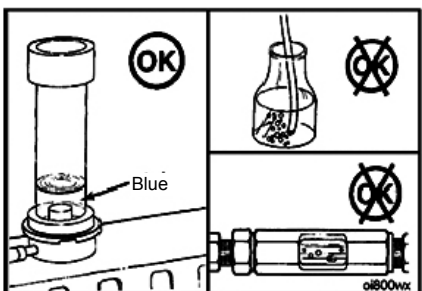
NOTE: As the cooling system warms up to operating temperature, air will be expelled through the combustion gas tester in the form of bubbles in the test fluid. This is due to normal expansion of the coolant. Do not mistake the presence of air bubbles in the tester as combustion gasses or air leaks into the cooling system. A change in the color of the test fluid from blue to yellow is the only indication of combustion gas in the cooling system.



A positive result from the combustion leak tester indicates one or more of the following faults:

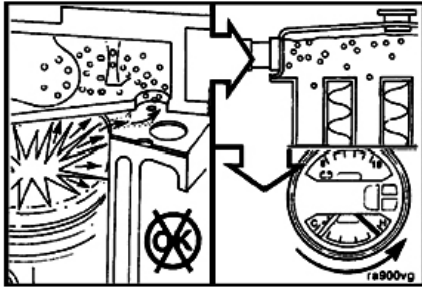
- Cylinder liner protrusion not correct.
- Cracked cylinder liner.
- Air compressor head or gasket leak.

NOTE: Discard the tester fluid if it has indicated yellow.

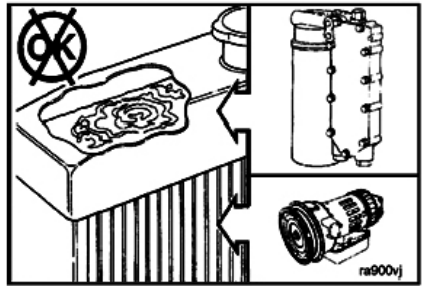


A negative result from the combustion leak tester coupled with a continuous flow of air bubbles from the previous test indicates the following:

- Air entrained due to faulty thermostat ball valve or incorrect fill.

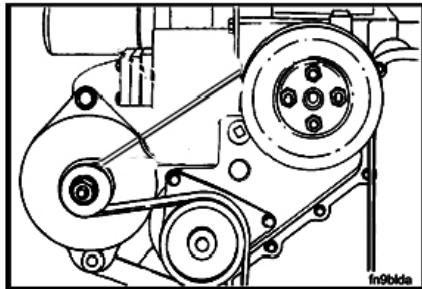


- Air in the coolant can result in loss from the overflow when the aerated coolant is hot. The heated air expands, increasing the pressure in the system causing the cap to open.
- Similarly, coolant can be displaced through the overflow if the head gasket leaks compression gasses to the coolant system.



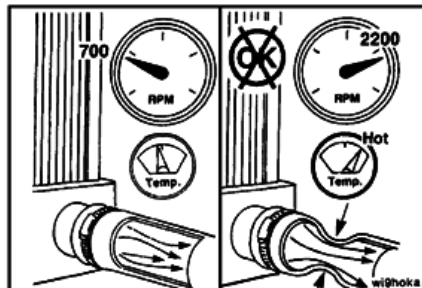
- The operating pressure of the cooling system and the lubricating system can result in the mixing of the fluids if there is a leak between the systems. Refer to the Lubricating Oil System.
- **Transmission fluid can also leak into the coolant through transmission oil coolers.**

NOTE: If the cooling system is contaminated with oil, it must be cleaned and flushed.



Belt Tension

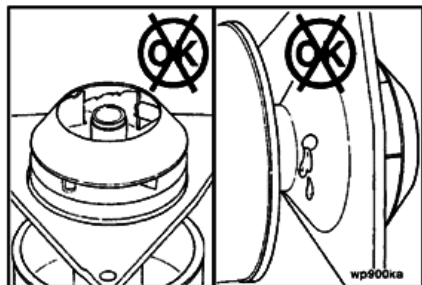
The pump is belt driven from the crankshaft pulley. An automatic belt tensioner is used to prevent the belt from slipping on the pump pulley. A malfunction of the tensioner will cause the water pump impeller to rotate at a slower speed reducing the amount of coolant flow.



Coolant Hose – Check

The coolant flow can also be reduced if the inlet hose to the water pump collapses. A hose will usually not collapse while the engine is running at low speed. Check the hose while the engine is running at rated speed.

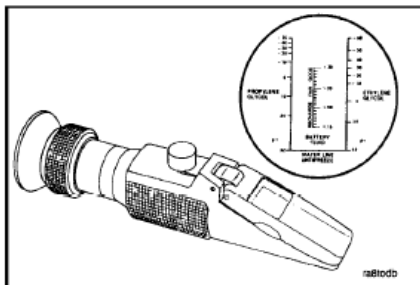
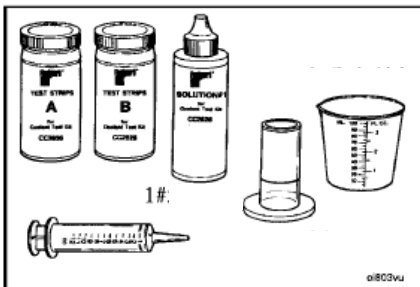
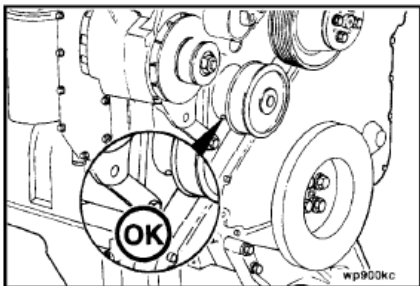
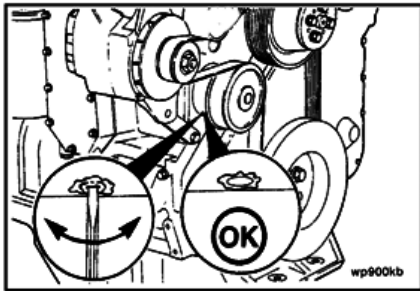
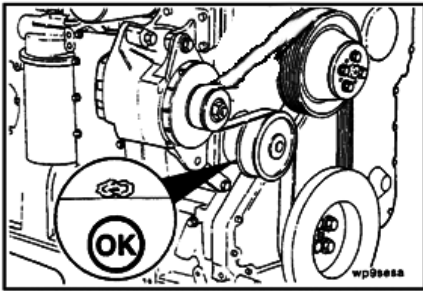
Be sure the engine is warm, a minimum of 88°C [190°F], so the thermostat is open.



Water Pump – Check

The water pump pulls coolant from the bottom of the tank and pumps it through the engine back to the top of the tank for cooling.

A worn or malfunctioning water pump will not produce the flow required to prevent the engine from running hot. Be sure to check the other possibilities indicated in the Troubleshooting Logic Chart before checking the flow or replacing the pump.



Water Pump Seal Weep Hole – Check

The water pump seal design requires a coolant film for lubrication and cooling. Therefore it is normal to observe a minor chemical build up or streaking at the weep hole.

NOTE: A streak or chemical build up at the weep hole is not justification for water pump replacement.

Use the following guidelines to determine if water pump replacement is necessary.



Make sure the weep hole is open.



A small screwdriver or a similar tool can be used to remove any debris.



If no leakage is observed from the weep hole under operating conditions, do not replace the water pump.



If coolant is observed to be dripping from the weep hole:

- Use Fleetguard® coolant test kit, Part No. CC2626, to check the coolant inhibitor level, and adjust the inhibitor level per the test kit chart.



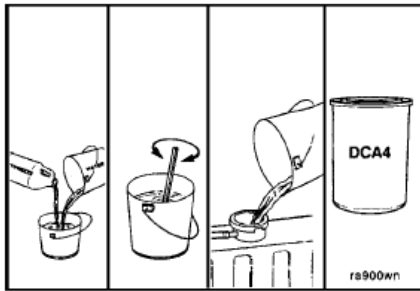
NOTE: Supplemental coolant additive concentrations exceeding 2.0 units per gallon will cause water pump seal leakage.



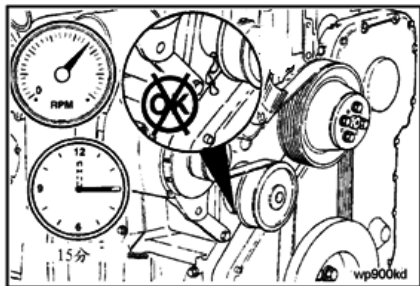
- Use Fleetguard® refractometer, Part No. CC2800, to check the antifreeze level of the coolant.



NOTE: Ethylene glycol type antifreeze concentration exceeding 70 percent will adversely affect freeze point protection and will contribute to water pump seal leakage.



If the antifreeze concentration is above 60 percent, drain all the coolant and add make up water to bring the antifreeze concentration to a minimum of 40 percent to a maximum of 60 percent. Replace the coolant filter, add new coolant inhibitor to the recommended levels as outlined in the Operation and Maintenance Manual.

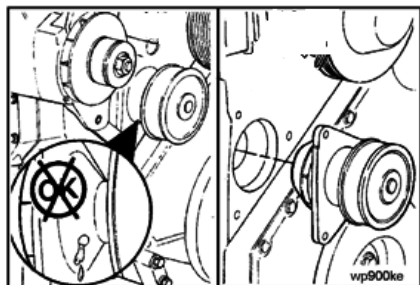


CAUTION: If the coolant leakage is observed as a steady stream upon start-up, stop the engine immediately and replace the water pump.

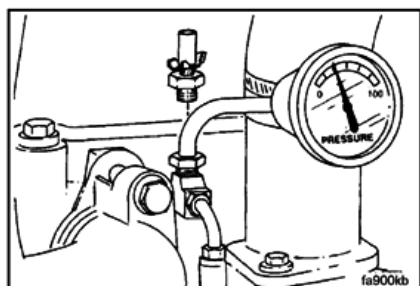
93



Operate the engine at high idle for 15 minutes with the proper inhibitor and antifreeze levels and check the water pump for leakage again.

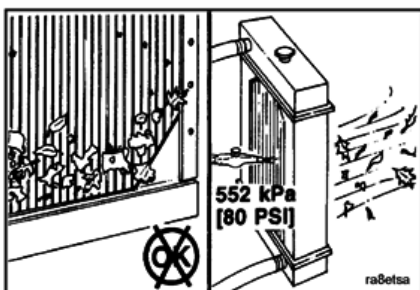


If the coolant is leaking after the above checks, replace the water pump.



The coolant pressure can be measured from the vent petcock to help determine the condition of the pump. At normal operating temperature (thermostat open) and engine operating at 2,000 RPM, the pressure should be:

Pressure cap	Minimum pressure
103kpa [15 psi]	124 kpa [18 psi]
48 kpa [7 psi]	69kpa [10 psi]



Radiator, Fan and Shutters

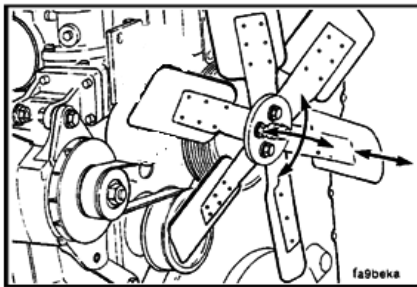
Air forced through the fins of the radiator by a fan cools the coolant pumped through the radiator. Environmental debris (paper, straw, lint, dust, and bugs) can obstruct the fins and stop the flow of air which will reduce the cooling affect of the radiator.



CAUTION: Wear appropriate eye and face protection when using compressed air. Improper use can cause bodily injury from flying debris and dirt.

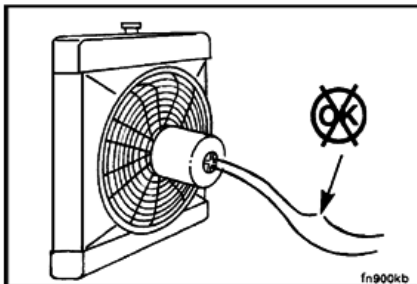
Use compressed air to blow out the dirt and debris.

Air pressure: 550 kpa [80 psi]



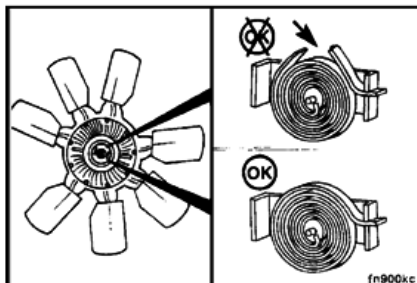
If the fan is belt driven, a slipping belt will result in a slower fan speed and reduced cooling. A malfunctioning automatic belt tensioner can be the problem.

Check the hubs in the fan hub and other pulleys to make sure they are not causing excessive belt vibration and slippage.



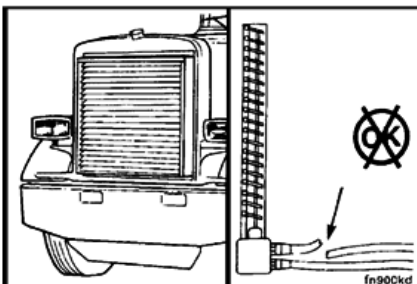
Interruption of the circuit to an electrically driven fan can result in insufficient air flow and cause the engine to run hot.

Make sure that the temperature sensor is functioning correctly.



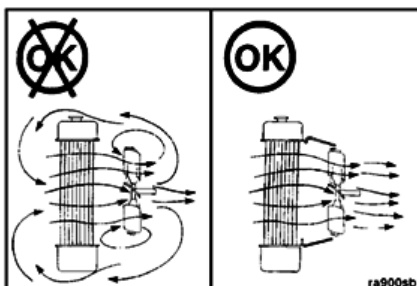
Some applications use thermatic fans. These fans operate only as needed to keep the coolant at the correct temperature. If the fan does not operate when the temperature of the air flow through the radiator increases, the engine will run hot.

Make sure that the temperature sensor is functioning correctly.



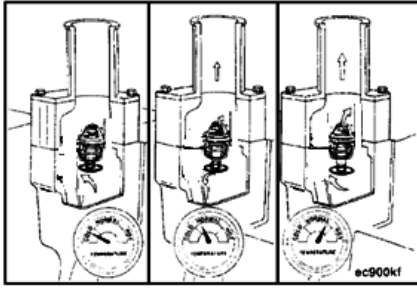
Shutters are designed to control air flow across the radiator. If the shutters fail to open when needed, the engine can run hot. Failure of the shutters to close can result in too much air flow and the engine running cold.

Make sure that the coolant temperature sensor is functioning correctly. Check the air operated shutter controls. Check for air leaks.



Incorrect fan shroud or obstructions can reduce air flow and cause the engine to run hot.

Check to be sure air is not recirculating. Check for damaged baffles.

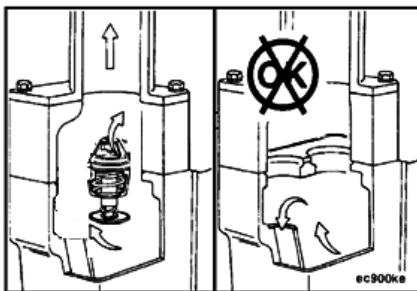


Thermostat Operation and Testing

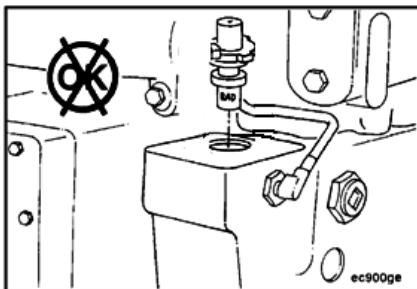
The engine temperature and thermostat seal must operate properly in order for the engine to operate in the most efficient heat range. Overheating or overcooling will shorten engine life.

The thermostat controls the coolant temperature. When the coolant temperature is below operating temperature, coolant is bypassed to the inlet of the water pump. As the coolant temperature increases to a certain degree, both of the thermostat will start to open, and coolant flowing to the bypass will start to be restricted. At engine operating temperature the thermostat will be open and the bypass will be closed.

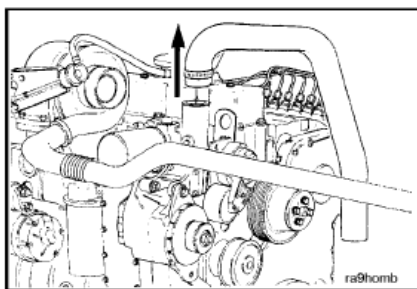
93



CAUTION: Never operate the engine without a thermostat. Without a thermostat, the path of least resistance for the coolant is through the bypass to the pump inlet. This will cause the engine to overheat.



Two identical thermostats are used. An incorrect, damaged, or malfunctioning thermostat can cause the engine to run too hot or too cold.

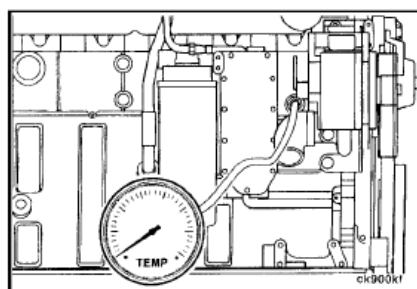


Thermostat Leaks and Operating Temperature –“Testing In -chassis”

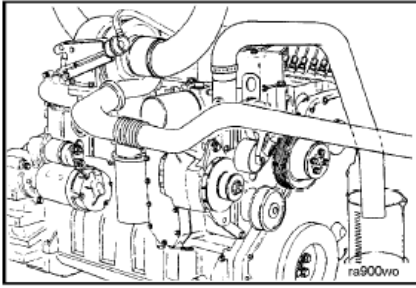
WARNING: Complete this test with the engine coolant temperature below 49°C [120°F], hot steam can cause serious personal injury.



Remove the radiator hose from the thermostat housing.

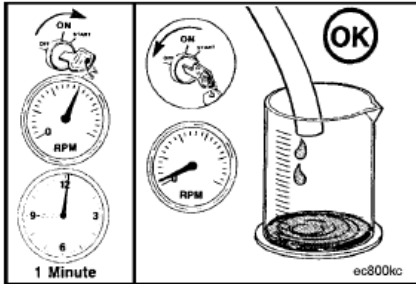


Install a thermocouple or temperature gauge which is known to be accurate in the 3/4 -inch pipe plug located at the front of the cylinder block.



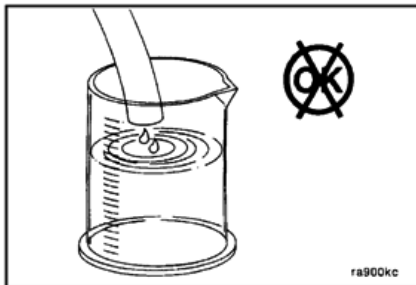
Install a hose with the same size on the thermostat housing outlet long enough to reach a remote dry container used to collect coolant.

Install and tighten a hose clamp on the housing outlet.
Insert the end of the hose into a clean container.

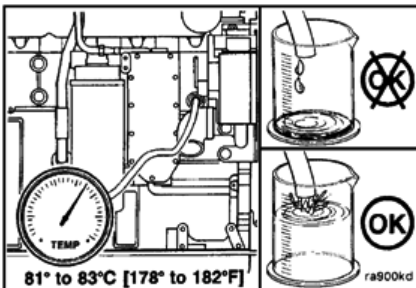


Operate the engine at rated speed for 1 minute.
Shut off the engine and measure the amount of coolant collected in the container.

The amount of coolant collected must not be more than 0.15 liter [5.1 fl. ounces].



If more than 0.15 liter [5.1 fl. ounces] of coolant is collected, the thermostats are leaking and must be replaced. Refer to Procedure 1-08.



Complete the following test in-chassis to test the thermostat opening temperature.

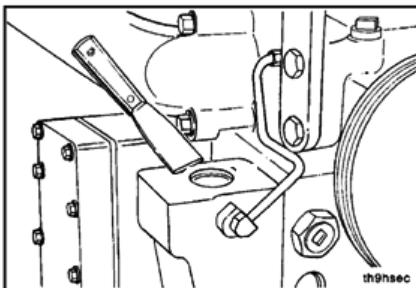
Start the engine and monitor the water temperature gauge and the container. The thermostat initial opening temperature is:

81°C to 83 °C [178°F to 182°F]

Shut off the engine when the coolant starts to flow.



NOTE: If coolant does not start flowing into the container during the initial opening temperature range, the thermostat must be replaced. Refer to Procedure 1-08.

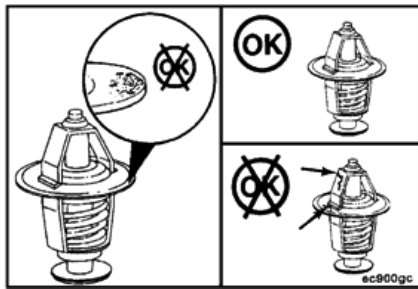


Thermostat Opening Temperature – Test “Thermostat Removed”

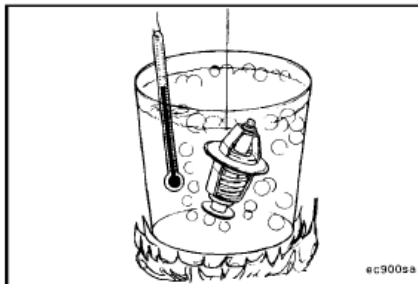
Remove the thermostats and clean the gasket surfaces. Refer to Procedure 1-08.



NOTE: Do not let any debris fall into the thermostat cavity when cleaning gasket surfaces.



Visually inspect the thermostats for damage.

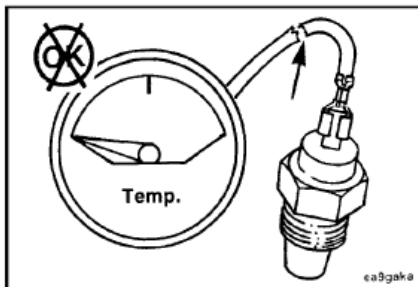


Suspend the thermostats and a 100°C [212°F] thermometer in a container of well stirred water.



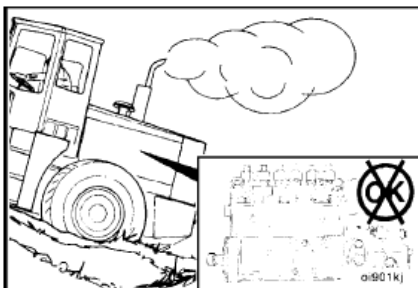
NOTE: Do not allow the thermostats or thermometer to touch the container.

Heat the water and check the thermostats as follows:



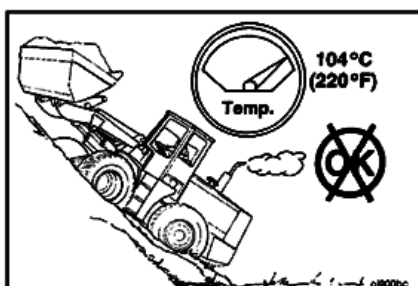
Temperature Gauge Indication

Gauges and sensors are used in the system to measure the coolant temperature. Failure gauges and sensors will provide an incorrect temperature indication.



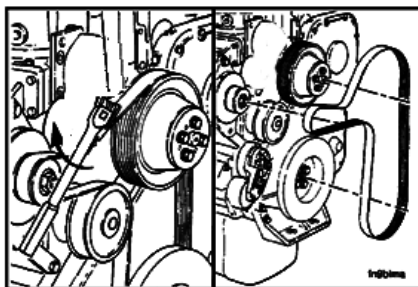
Fuel Pump Overfueled

Overfueling can cause the engine to overheat. Make sure that the fuel pump is calibrated correctly.



Vehicle Overloaded

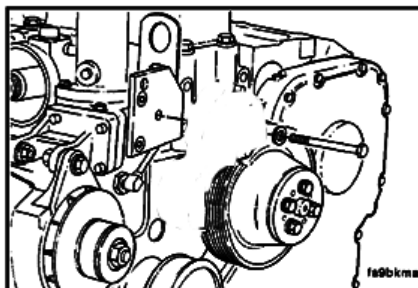
Constant overloading can cause the engine to overheat.



Drive Belt – Replace

3/8 or 1/2 Inch Square Drive Ratchet

Lift the tensioner arm and pulley to remove the belt.



Belt Tensioner – Replace

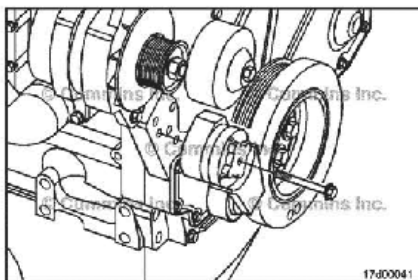
Preparatory Steps:

Remove the drive belt.

Remove

15 mm

Remove the belt tensioner from the bracket.

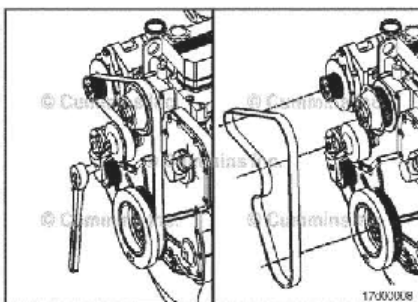


Install

15 mm

Install the belt tensioner.

Torque Value: 43 N • m [32 ft-lb]



Fan Pulley – Replace

Preparatory Steps:

Remove drive belt.

SERVICE TIP: Loosen the capscrews before removing the belt and torque the capscrews after the belt is installed.

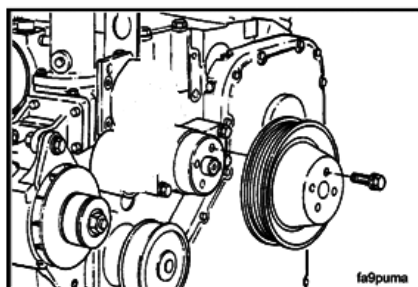
Remove and Install

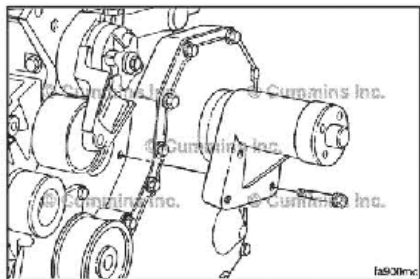
10 mm

Remove the four capscrews, fan and spacer.

Replace the fan pulley.

Torque Value: 24 N • m [18 ft-lb]



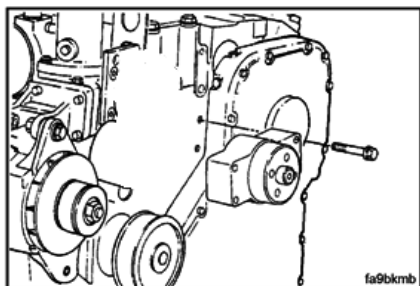


Fan Hub – Replace

Preparatory Steps:



Remove the drive belt.
Remove the fan pulley.



Remove and Install

10 mm



Remove the four screws and replace the fan hub.



Torque Value: 24 N · m [18 ft-lb]



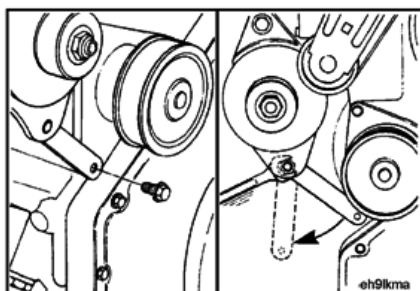
93

Water Pump – Replace

Preparatory Steps:



Drain the coolant.
Remove the drive belt.

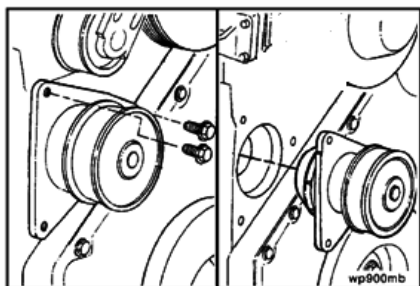


Remove

10 mm, 19mm



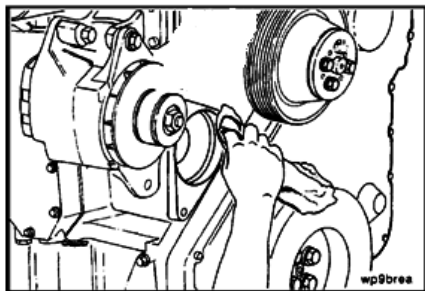
Remove the alternator link.



10 mm

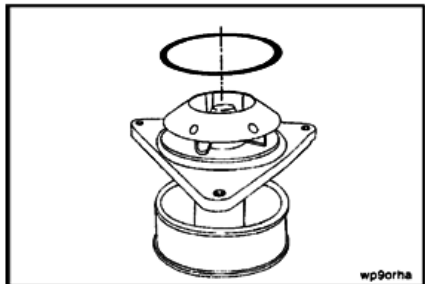


Remove the water pump.



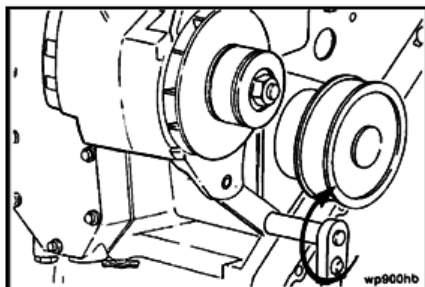
Clean

Clean the sealing surface on the cylinder block.



Installation

Install a new o-ring into the groove in the water pump.



10 mm, 19mm

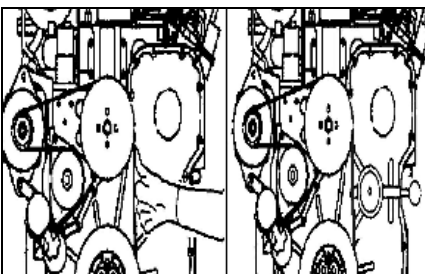
Install the water pump and alternator link.



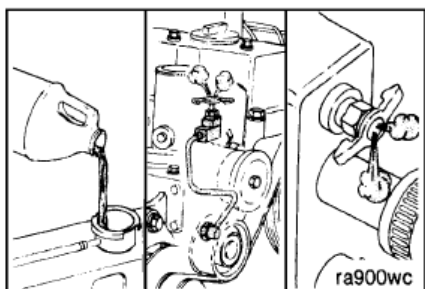
Torque Value:

(Water Pump) 24 N · m [18 ft-lb]

(Alternator link) 43 N · m [32 ft-lb]

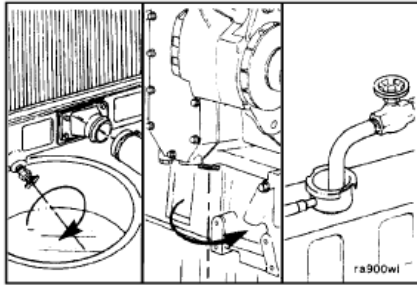


Lift the tensioner arm and pulley to install the drive belt.

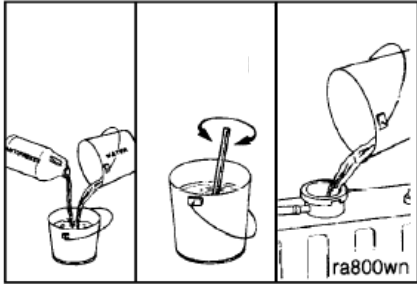


During filling, air must be vented from the engine coolant passages. Open the engine vent petcock if equipped. Also, be sure to open the petcock on the aftercooler for aftercooled engines.

The venting will permit a fill rate of 19 liters/minute [5 U.S.gallons/minute].



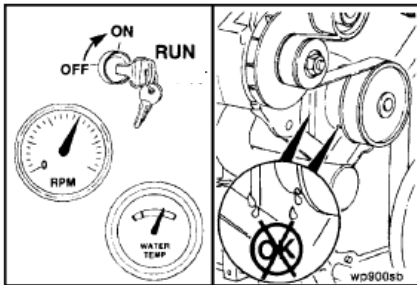
Close the drain valves. Install all hoses previously removed.



Fill the cooling system with a premixture of 50 percent water and 50 percent ethylene-glycol type antifreeze. Since the ability of antifreeze to remove heat from the engine is not as good as water, pouring antifreeze into the engine first could contribute to an over heated condition before the liquids are completely mixed. Refer to Procedure 1-01. for the correct amount of DCA corrosion inhibitor.

Refer to the Cooling System Capacities for Specifications.

Install the pressure cap. Operate the engine until it reaches a temperature of 80°C [180°F], and check for coolant leaks.



Thermostat – Replace

Preparatory Steps:

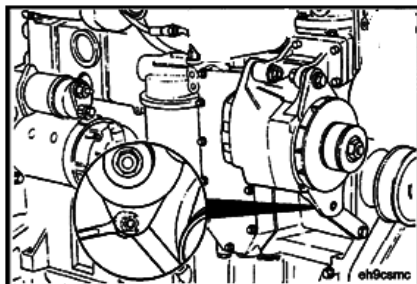


Disassemble the negative (-) battery cable.

Drain 2 liters (2.1U.S. quarts) of coolant.

Remove the radiator hose from the outlet connection.

Remove the drive belt.

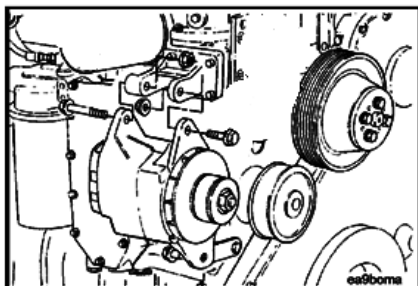


Remove

19 mm

Loosen the alternator link capscrew.

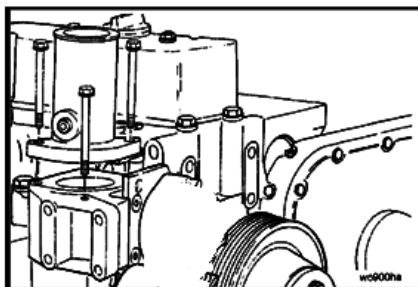
Loosen the tail support capscrew if the alternator is so equipped.



18 mm, 19 mm

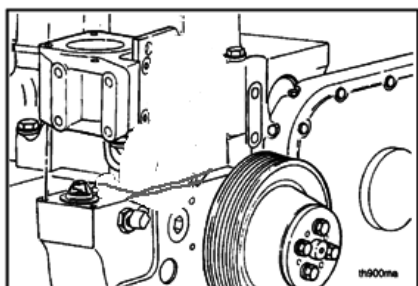
Remove the alternator mounting bolts and nuts. Lower the alternator.

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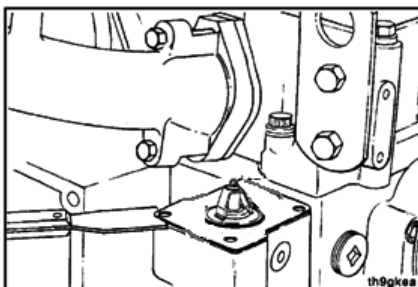


10 mm

Remove the capscrews from the thermostat housing and water outlet connection. Remove the water outlet connection.



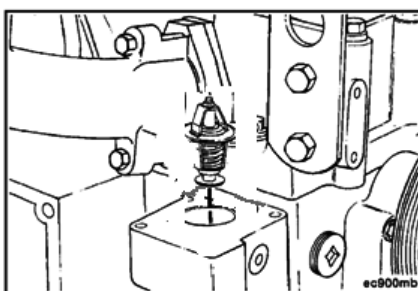
Remove the thermostat hose and belt tensioner assembly.



Clean

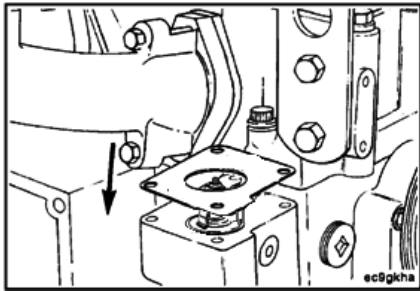
CAUTION: Do not let any debris fall into the thermostat cavity when cleaning gasket surfaces.

Remove the thermostats and clean the gasket surfaces.

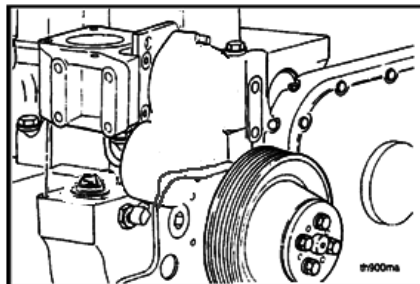


Install

Install the new thermostats.

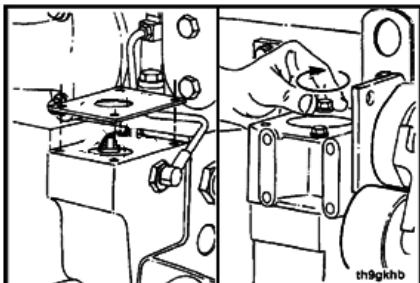


Position a new gasket over the thermostats.

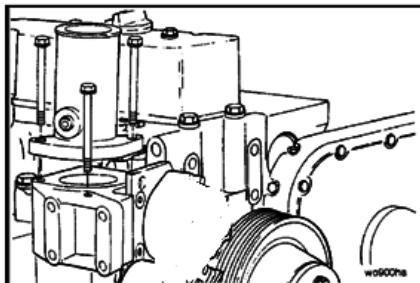


Position the thermostat housing and belt tensioner over the thermostats and gasket.

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Make sure the gasket is aligned with the capscrew holes. Install the capscrews and use your fingers to tighten.



10 mm

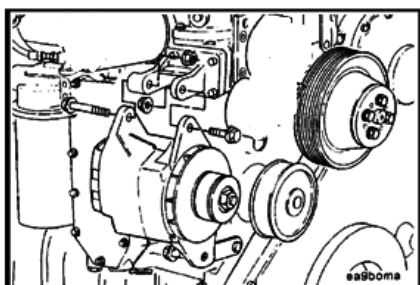


Install the water outlet connection.



Tighten all capscrews.

Torque Value: 24 N · m [18 ft-lb]



18 mm, 19 mm



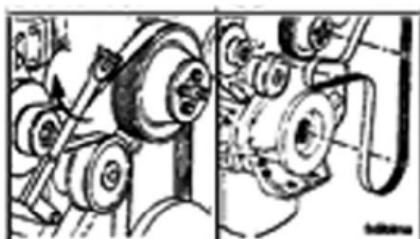
Position the alternator and install the mounting bolts and nuts.



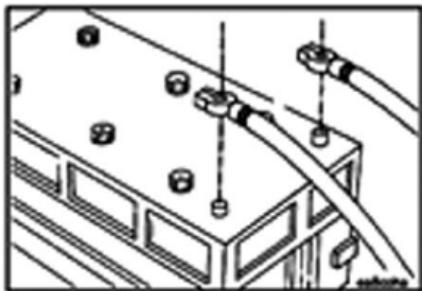
Torque Value:

(alternator is retained) 77 N · m [57 ft-lb]

(alternator is adjustable) 43 N · m [32 ft-lb]

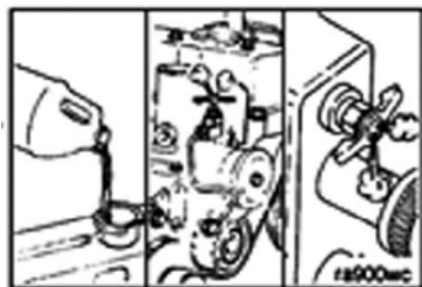


Install the drive belt.



Install and tighten the battery electrical connections.

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CAUTION: During filling, air must be vented from the engine coolant passages. Open the engine vent petcock if equipped. Also, be sure to open the petcock on the aftercooler for aftercooled engines. The system must be filled slowly to prevent air locks. Wait 2 to 3 minutes to allow air to be vented, and then add coolant to bring the level to the bottom of the radiator filler neck. Refer to the cooling system – Coolant Maintenance Recommendations.

Fill the cooling system.



Operate the engine to normal operating temperature and check for leaks.



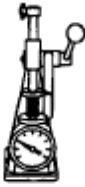
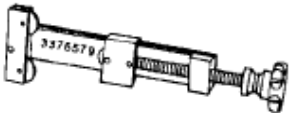
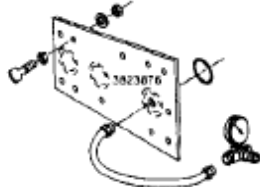
NOTES

Lubricating Oil System

Lubricating Oil System – Service Tools

The following special tools are recommended to perform the procedures in section 2. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

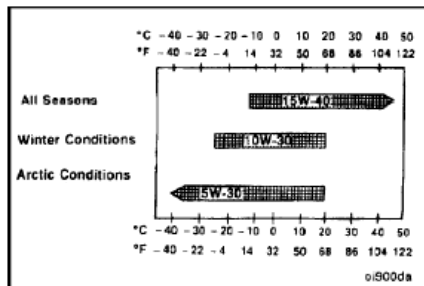
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Tool No.	TOOL DESCRIPTION	Tool illustration
3375049	Lubricating Oil Filter Wrench Used to install and remove oil fuel filters.	 If8logb
3375182	Valve Spring Testing Tool Measure spring force at a given spring height.	 kn8togs
3376579	Tube (Filter) Cutter Used to cut open the filter to permit inspection of the filter element.	 3376579
3823876	Lubricating Oil Cooler Pressure Test Tools Used to pressure test the lubricating oil cooler element.	 3823876



Lubricating Oil System – General Information

Use CF4 multi-viscosity oil or equivalent which meets API Standard for turbocharged engines.



CAUTION: Limited use of low viscosity lubricating oils, such as 10W-30 can aid in starting the engine and providing sufficient lubricating oil flow at ambient temperatures below -5 °C [23 °F]. However, the continuous use of low viscosity lubricating oils can decrease engine life. Refer to the illustration.

Lubricating Oil System – Specifications

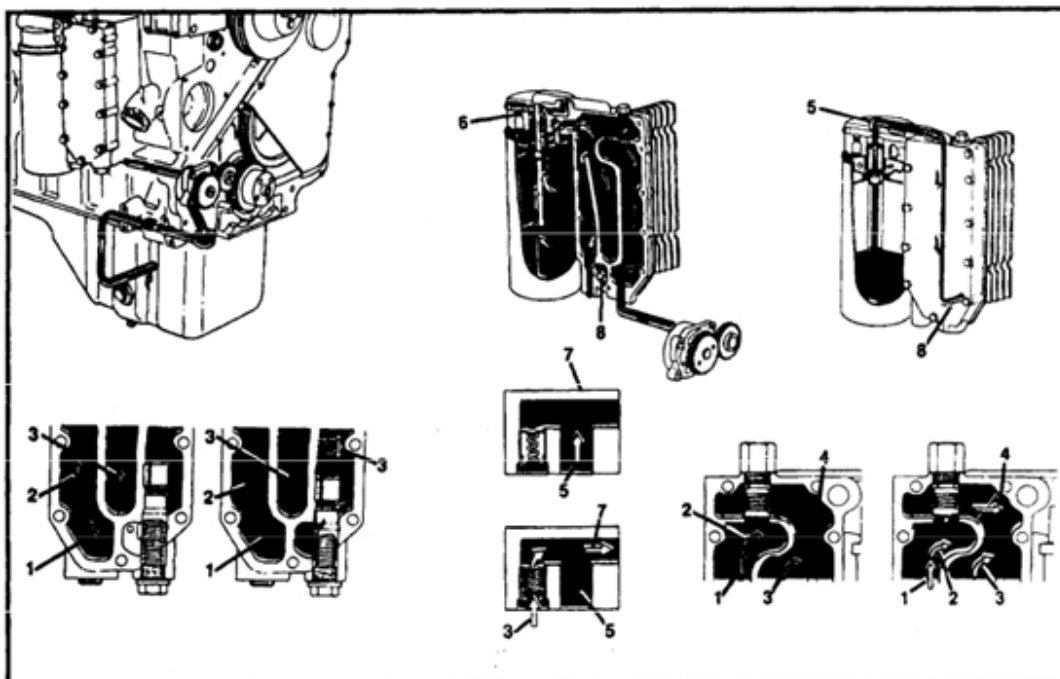
Oil pressure – low idle (minimum allowable)	69 kpa [10 psi]
At rated speed (minimum allowable)	207 kpa [30 psi]
Differential pressure to open oil filter bypass valve	138 kpa [20 psi]
Oil flow at rated speed (less flow through pressure regulator)	66 lpm
Oil temperature at rated speed	99°C to 126.6 °C [210 to 260°F]
Oil capacity of pan (all engines):	
- Low level	19 liters
- High level	23 liters
Total system capacity:	27.6 liters

Lubricating Oil System – Flow Diagram

The lubricating oil flow begins as the gerotor pump draws oil from the pan through the rigid, internal suction tube. The oil flows through the oil passage in the cylinder block to the top of the oil cooler via the inner channels of the cover. When the oil reaches the top of the oil cooler, it flows by the thermostat before entering the oil cooler. If the oil is cold, the thermostat will open allowing some oil to bypass the cooler and flow to the filter. As the temperature of the oil increases, the thermostat will close and force the oil to flow through the cooler element, thereby regulating the oil temperature to the block. Coolant passing around the plates of the element cools the oil. From the cooler, the oil is directed to the combination full flow/bypass oil filter and also to the temperature regulator. The regulator valve remains closed until the oil pressure is approximately 518 kpa [75 psi]. At high pressure, the plunger moves toward the plug and relieves the system by allowing some oil to return to the oil pan. The tapered shoulder on the plunger creates a variable opening to regulate pressure. A combination full flow/bypass oil filter is used. The upper section of the filter contains the full flow filter element while the lower section contains the bypass element. Oil which flows through the full flow portion of the oil filter returns to the block. Oil that flows through the bypass returns to the oil pan. During normal engine operation, oil circulates through the full flow section of the combination filter and into the main oil rifle. If the full flow section of the combination filter becomes plugged to the point that a 137 kpa [20 psi] pressure difference exists across the filter, the bypass valve opens in the oil filter head and routes unfiltered oil to the main oil rifle. This is done to prevent oil starvation to the engine with a plugged filter.

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Lubricating Oil System



1. From the pump
2. To the Lubricating Oil Cooler
3. From the Lubricating Oil Cooler
4. To the Lubricating Oil Filter

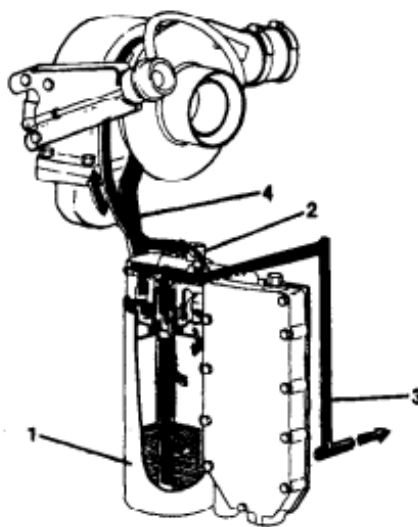
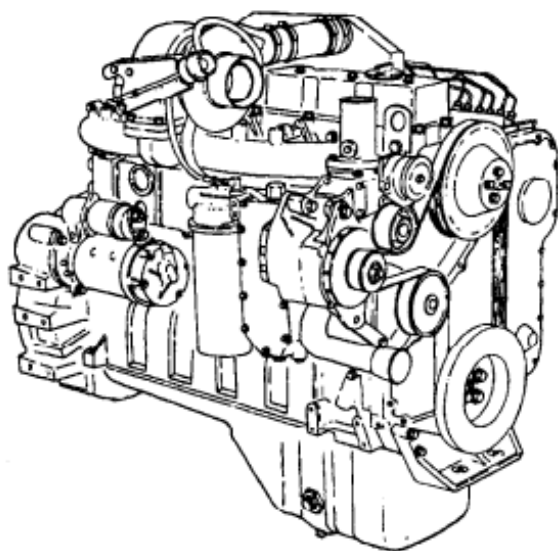
5. From the Lubricating Oil Filter
6. Filter Bypass Valve
7. To main Lubricating Oil Rifle
8. To the Oil pan

Lubricating Oil System – Flow Diagram (continued)

At the filter head, the oil flow is divided: A position flows to the turbocharger; the rest flows down a passage in the cylinder block that connects to a cross drilling over the No. 3 main bearing.

Lubrication for the turbocharger

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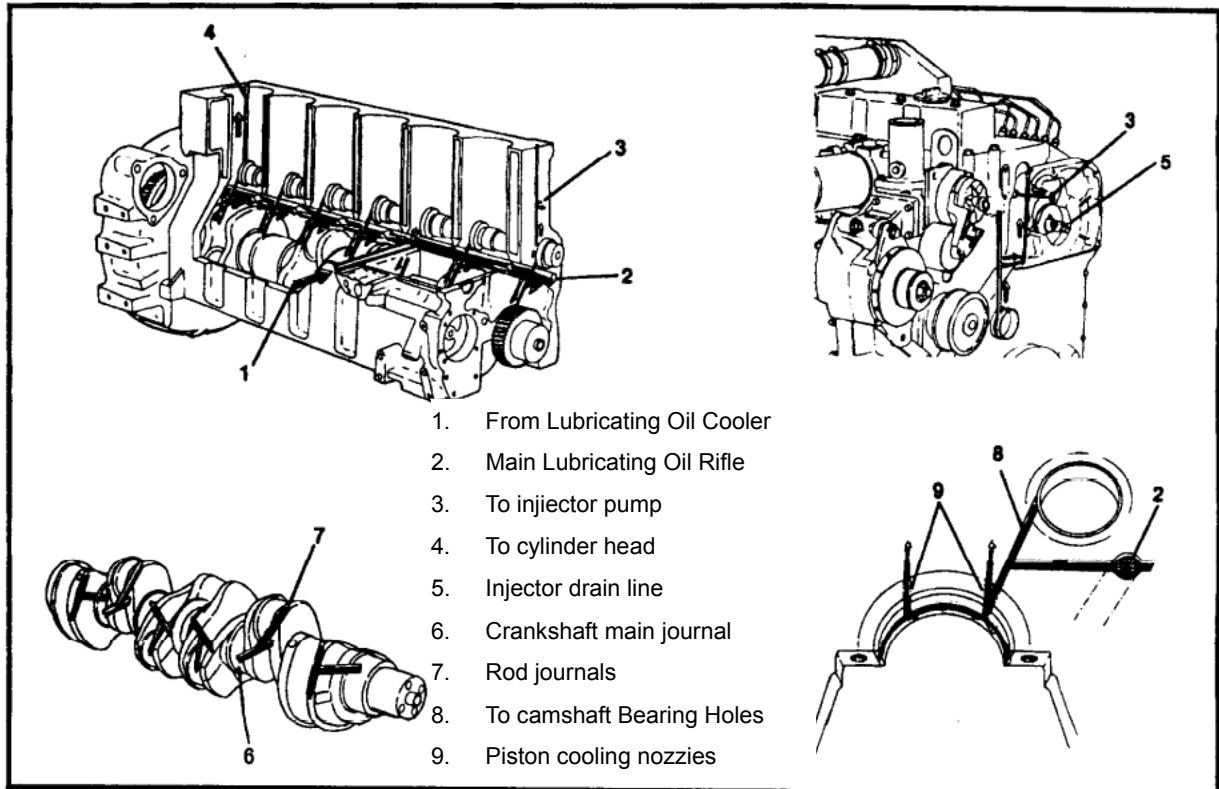
1. Filter
2. Turbocharger Lubricating Oil Supply
3. To Main Lubricating Oil Rifle
4. Turbocharger Lubricating Oil Drain

Lubricating Oil System – Flow Diagram (continued)

The oil has been cooled and filtered, it flows through the cross drilling over the No.3 main bearing to the main oil rifle. The main oil rifle is drilled through the length of the cylinder block and carries oil through individual drillings to the overhead and lower end of the block. A transfer drilling from the main oil rifle intersects with a drilling between the main bearing bore and the camshaft bushing bore. These drillings supply oil to the camshaft bearing and main bearing. The groove in the upper main bearing shell supplies oil to the piston cooling nozzles located in the main bearing saddle. The spray from the nozzle splash lubricates the piston pin. From the main bearings, the oil enters the crankshaft and lubricates the connecting rod bearings through internal cross drillings.

Drillings in the cylinder block and gear housing connect to the external groove on the No.1 camshaft bushing to supply oil to the injection pump. An overflow hole located above the injection pump shaft allows oil to return to the oil pan.

Lubrication for the Power Components

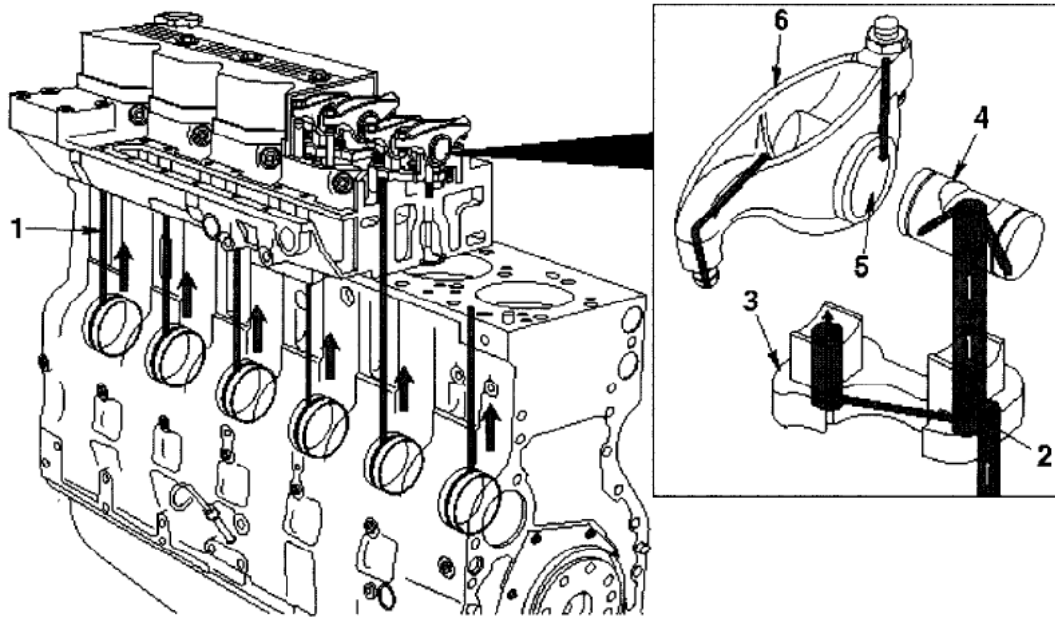


Lubricating Oil System – Flow Diagram (continued)

There are six vertical oil rifles located at the camshaft liner on the cylinder block, which respectively reach the six rocker lever on the cylinder head and direct to the valve stem and base of the push rod through the oil rifles in the cylinder head.

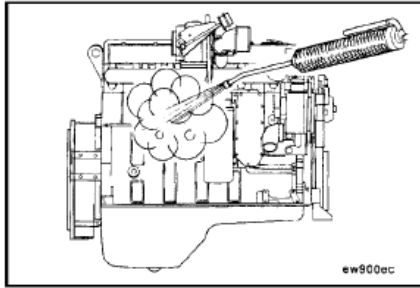
The front gear train assembly is lubricated by oil splash drenched. The oil pump idler gear is force lubricated. From the gear train assembly the oil drains back to the pan for recirculation.

Lubrication for the Top of Engine



10. The oil flows into the cylinder head through the oil passage on the cam bushing
11. The oil passage on the cylinder head
12. The oil flows into the rocker lever bracket
13. The oil flows into and lubricate the rocker lever
14. The oil flows into the rocker
15. Lubricate the pushrod and valve stem on the both end of the rocker lever

1. The oil flows into the cylinder head through the oil passage on the cam bushing
2. The oil passage on the cylinder head
3. The oil flows into the rocker lever bracket
4. The oil flows into and lubricate the rocker lever
5. The oil flows into the rocker
6. Lubricate the pushrod and valve stem on the both end of the rocker lever



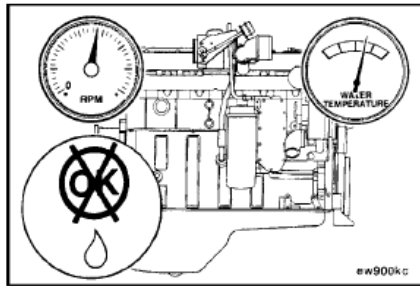
Lubricating Oil Leak (external) – Check

The first step in diagnosing excessive lube oil consumption is to verify that there are no external oil leaks.



WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

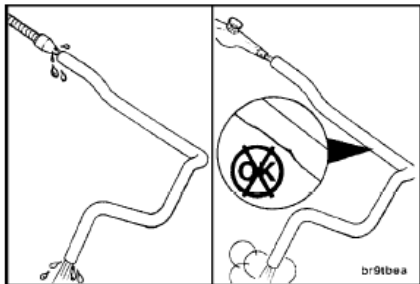
Use a steam cleaner or high pressure washer to clean the engine. Dry with compressed air.



Operate the engine until the coolant temperature reaches 82°C [180°F]. Inspect the exterior of the engine for leaking gaskets, seals, o-rings, pipe plugs, or fittings.



NOTE: Before replacing any gaskets, check the capscrews to make sure they are tightened to the correct torque values. Refer to illustrations later for capscrew torque specifications.



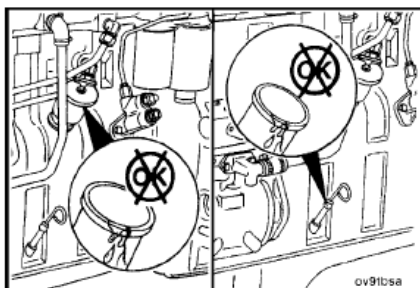
Check the engine crankcase breather tube and hose for restriction.



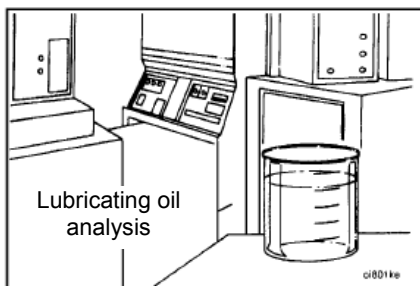
Refer to Procedure for removal.



Use a solvent to clean the hose and tube. Dry with compressed air.



Check for a loose or missing oil dipstick tube, dipstick, or oil fill cap.

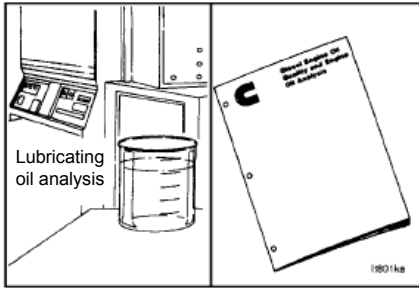


Internal Engine Damage – Check

Lubricating oil analysis

The analysis of used oil can help diagnose internal engine damage and determine if it was caused by one of the followings:

- Intake air filter malfunction
- Coolant leaks
- Oil diluted with fuel
- Metal particles causing wear



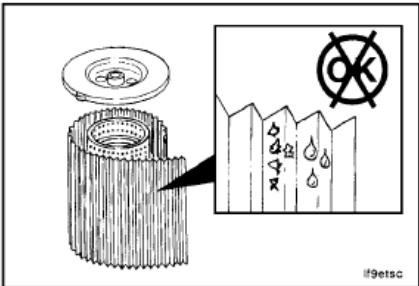
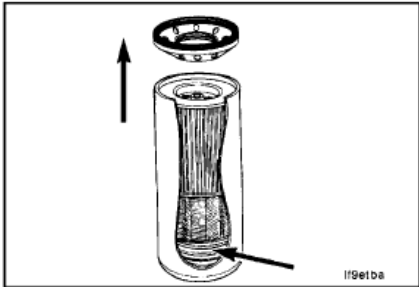
For additional oil analysis information, refer to Cummins Engine Oil Recommendations.

NOTE: Do not disassemble an engine for repair based only on the results of an oil analysis. Inspect the oil filters also. If the oil filter shows evidence of internal damage, find the source of the problem and repair the damage. Refer to the appropriate procedures based on the following oil filter inspection:

Oil Filter Inspection



CAUTION: Carefully cut the full flow oil filter (upper section of combo filter) open. The filter element spring is under compression and can cause personal injury.



Part No. 3376579, Tube Cutter



Use the tube cutter, Part No. 3376579, to open the full flow oil filter (upper section of the bypass filter).



Inspect the filter element for evidence of moisture or metal particles.

Metal

Probable Source

Copper

Bearing and Bushing

Chromium

Ring, Piston

Iron

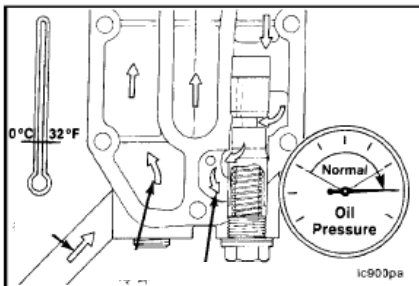
Cylinder Liner

Lead

Bearing Overlay Material

Aluminum

Piston Wear or Scuffing

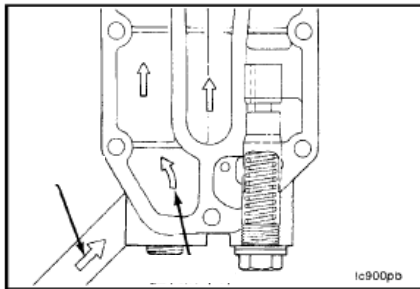


Lubricating Oil System – Diagnosing Malfunctions

Be sure to check items related to oil pressure, such as gauges, oil level, oil contamination and oil viscosity.

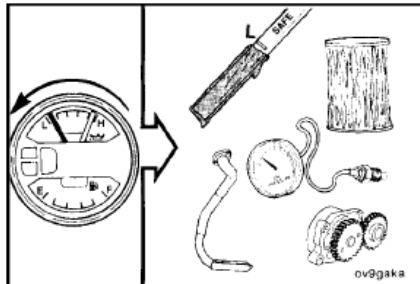
High Oil Pressure

High oil pressure usually occurs after the engine is first started in cold weather. The lubrication system does not have a cold start relief valve. The pressure regulating valve components are machined to a size that will relieve the excessive pressure created by cold engine oil.



Lubricating oil pressure regulator valve

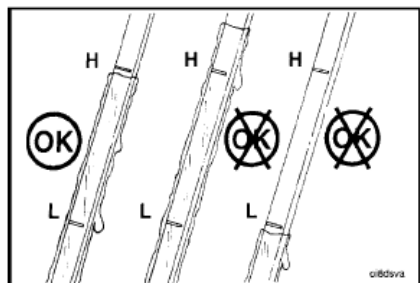
The engine will have high oil pressure if the regulator sticks in the closed position. Check the regulator for freedom of movement.



Low Oil Pressure

Low oil pressure can be caused by several lubrication system related malfunctions. To begin the investigation, determine the engine operating conditions when the low pressure was first observed.

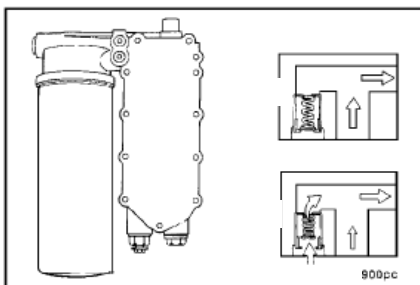
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Engine oil level

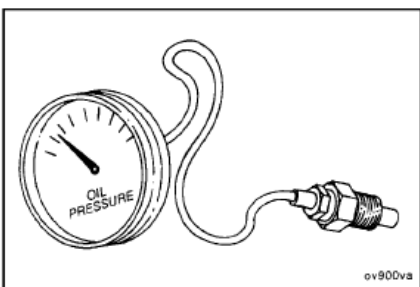
Improper lubricating oil level can cause low lubricating oil pressure.

Never operate the engine with the oil level below the low (L) mark or above the high (H) mark.



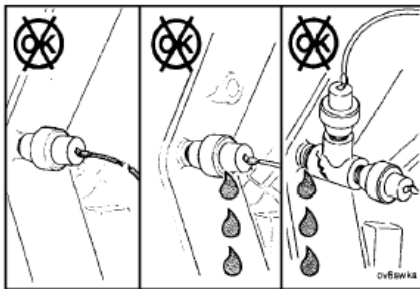
Lubricating oil filter

A plugged filter will cause a gradual loss of oil pressure by approximately 69 kpa [10 PSI]. This will cause the bypass valve to open, allowing unfiltered oil to flow to internal engine components. The oil pressure will remain low until a new filter is installed.



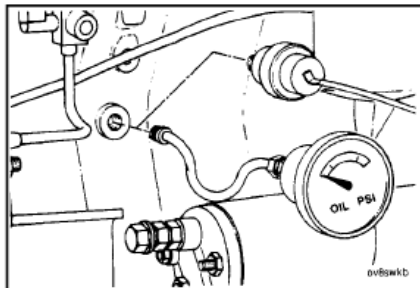
Oil pressure gauge – Check

Check the oil gauge and sending unit to make sure they are operating correctly by verifying the pressure with manual gauge.



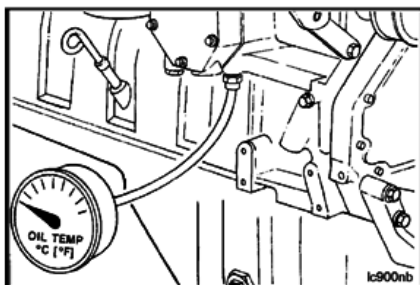
Check the following for defects:

- Electrical wiring broken
- Sending unit malfunction
- Plumbing loose or broken



If a sending unit malfunction is found:

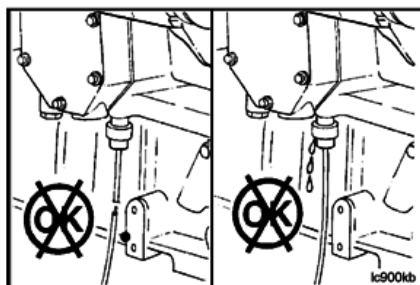
- Use a master gauge of known accuracy to verify the reading of the suspect gauge.
- Connect the line from the master gauge to the main oil rifle on the fuel pump side of the engine.
- Replace the sending unit if it is defective.



Oil Temperature Gauge – Check

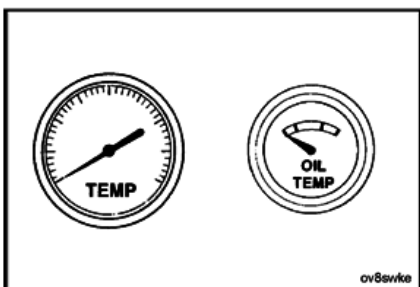
Remove the pipe plug from the bottom of the oil cooler and install the oil temperature gauge sending unit.

The maximum oil temperature at rated engine speed is 126.6°C [260°F].



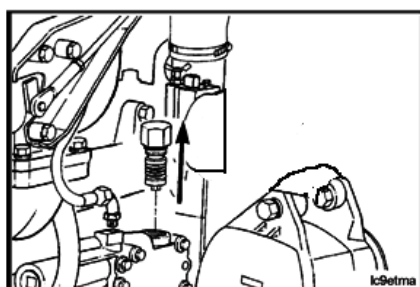
Check the following for defects:

- Electrical wiring broken
- Sending unit malfunction



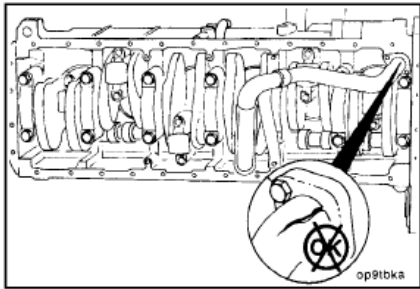
If a sending unit malfunction is found:

- Use a master gauge of known accuracy to verify the reading of the suspect gauge.
- Replace the sending unit if it is defective.



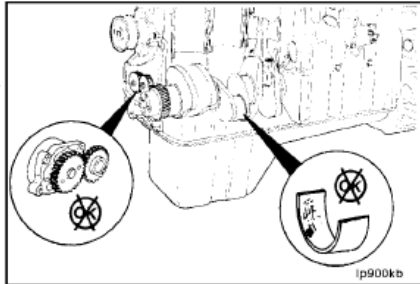
Oil thermostat

NOTE: The oil temperature thermostat can not be checked in-chassis, it must be removed for testing.



Suction Tube

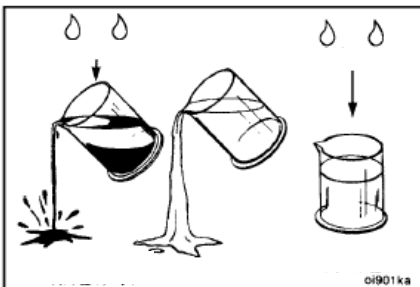
A loose suction tube, damaged gasket or crack in the suction tube can cause a temporary loss of prime for the oil pump. The engine will have low pressure or no oil pressure at starting, followed by normal or low pressure.



Bearing and Lubricating Oil Pump

A steady decrease in oil pressure over a long period of time can be an indication of worn bearings or excessive oil pump wear.

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Oil Dilution

Diluted oil can cause severe engine damage

Check the condition of the lubricating oil.

- Thin, black oil is an indication of fuel in the oil.
- Milky discoloration is an indication of coolant in the oil.

Coolant Diluted Oil

Coolant in the oil results from a crack or leak between the coolant and oil circuits.

The possibility for intermixing can occur in these Components:

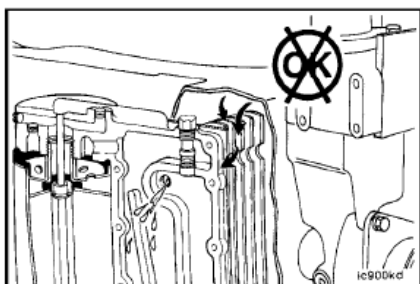
- Oil cooler
- Aftercooler
- Core plugs in cylinder head
- Cylinder liner seals
- Head gasket
- Cylinder liner (crack)
- Cylinder head (cracked passage)
- Cylinder block (cracked passage)
- Air compressor (coolant cooled)

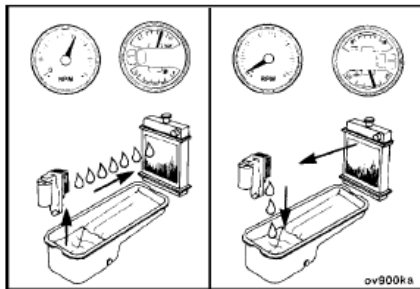
Lubricating Oil Cooler

The oil cooler design does not require gaskets or seals to maintain the separation of oil and coolant.

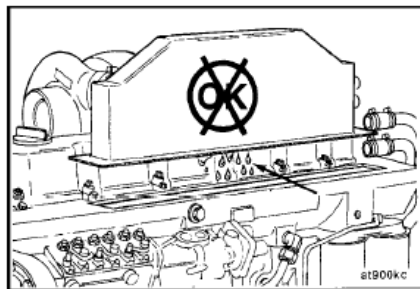


If either the coolant or oil is contaminated, check for a leaking element. Refer to Procedure in this section.





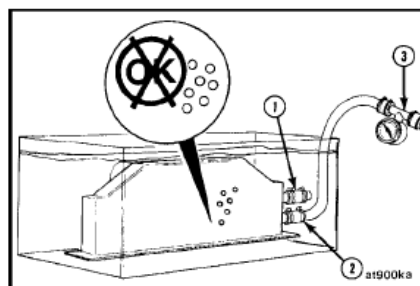
During operation the oil pressure will be higher than coolant pressure. A leak in the oil cooler will show as oil in the coolant. However, following an engine shutdown, the residual pressure in the coolant system can cause coolant to seep through the leak path into the oil.



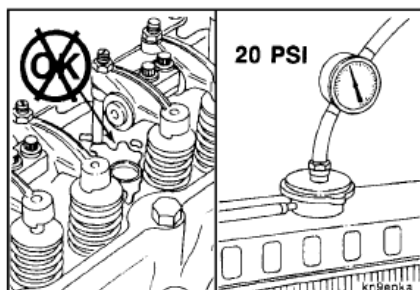
Aftercooler

An aftercooler is also a source for coolant to get in the lubricating oil.

Remove the aftercooler and look for evidence of leaking into the intake manifold.



Plug the bottom inlet tube and pressurize the aftercooler with 348 kPa [50 psi] to check for leaks by submerging in water.

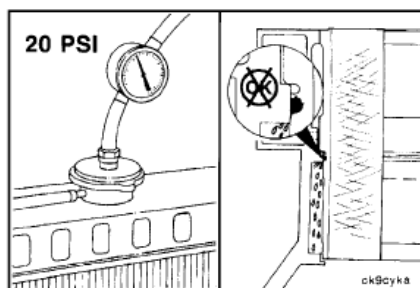


Cylinder Head Expansion Plugs

The expansion plugs in the cylinder head under the valve cover is another potential for oil dilution.

If possible, check for the leaks while the engine is warm, remove the valve cover to look for signs of leaks.

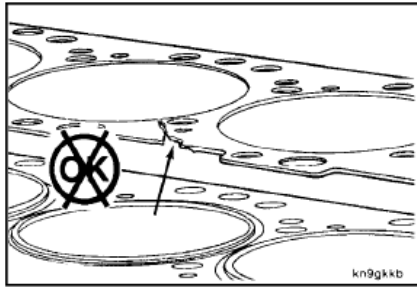
It may be necessary to pressurize the coolant system to 140 kPa [20 psi].



Cylinder Liner Seals

Coolant can enter the lubricating oil through a deteriorated or damaged liner seal.

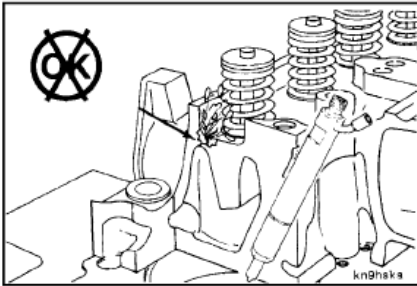
Remove the oil pan and visually inspect the bottom side of liners with the cooling system pressurized.



Cylinder Head Gasket

Coolant in the oil can also be caused by a damaged cylinder head gasket.

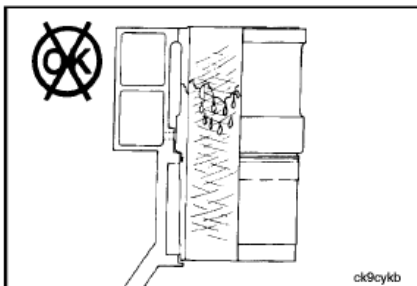
Pressurize the cooling system to check for leaks. It may be necessary to remove the oil pan to locate internal leaks.



Cracked Cylinder Head

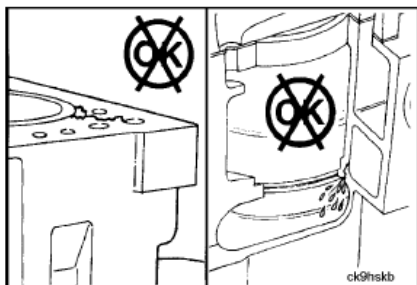
A crack in the head from the water jacket to an oil passage or to the top rocker lever area will cause oil dilution.

Pressurize the cooling system to 140 kpa [20 psi] and check for leaks.



Cracked Cylinder Liner

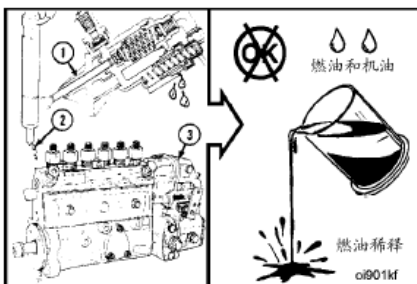
A cracked cylinder liner can leak coolant into the lubricating oil. Remove oil pan and check for the coolant leaking from inside of cylinder head.



Cracked Cylinder Block

A crack in the cylinder block from an oil drilling or passage to the water jacket can cause oil dilution, and can normally be found either as an external leak from head gasket or from the oil pickup tube with the oil pan removed.

The cooling system should be pressurized to 140 kpa [20 psi] to detect leaks.



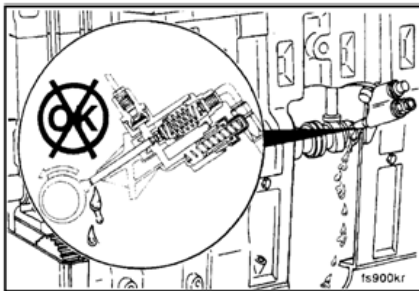
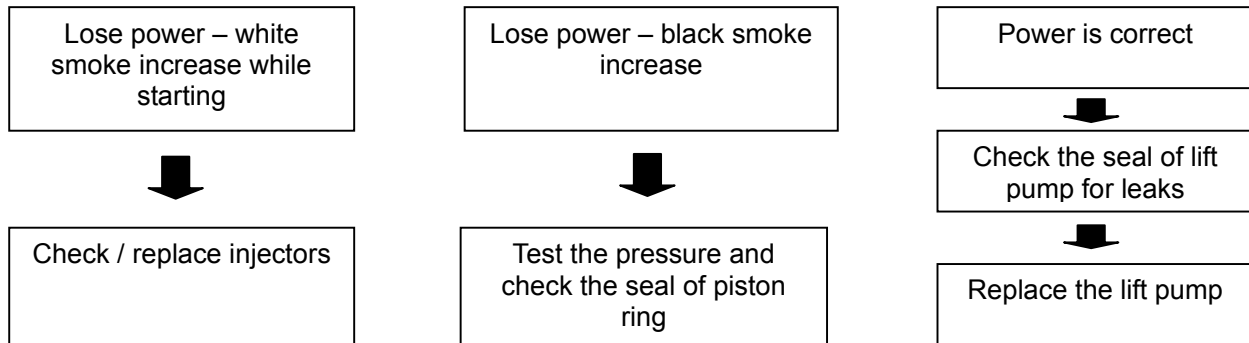
Fuel Diluted Oil

Fuel dilution is limited to three sources:

1. Lift pump
2. Fuel leaking by the rings
3. Injection pump internal wear

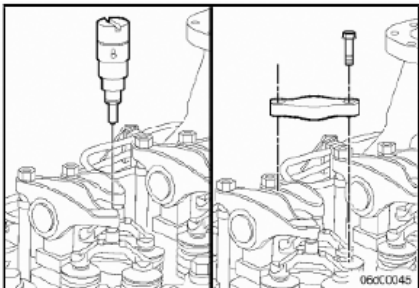
Use the following logic to determine the source of the oil dilution with fuel:

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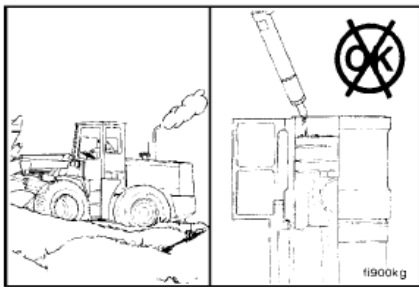
Fuel Transfer Pump

NOTE: On non-automotive engines, a worn or damaged seal around the plunger can allow fuel to leak to the oil pan. Automotive engines have a weep hole to allow the fuel to leak externally.



Fuel Leaking by Piston Rings

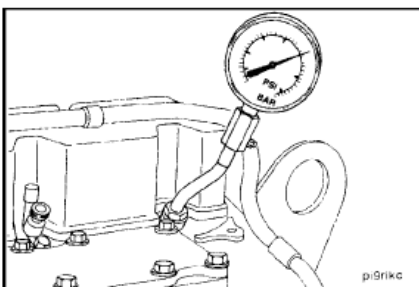
Incomplete combustion in the cylinders can result in unburned fuel draining into the oil pan. This condition can be caused by a leaking injector or reduced compression caused by inadequate piston ring sealing.



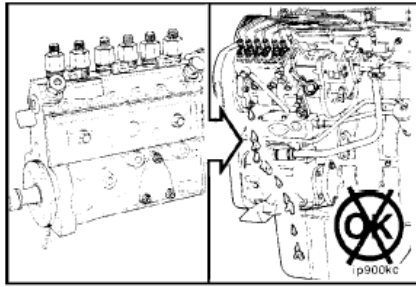
An increase in white exhaust smoke during the first start of the day is a symptom of an injector leaking. An injector leak will also cause the engine to run rough and have low power.



Remove and replace leaking injectors. Refer to the Shop Manual, for test and repair instructions.

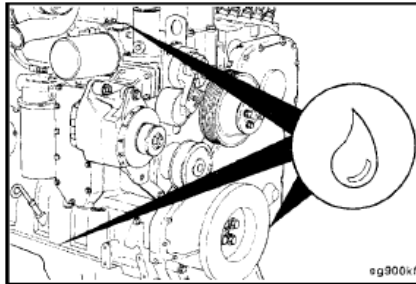


Perform a compression check to verify piston rings are properly sealing.



Injection pump

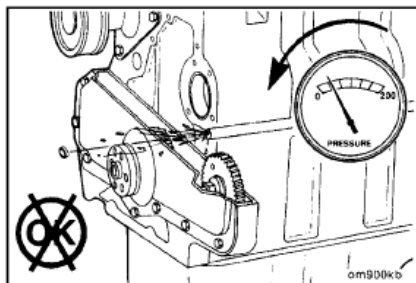
A worn or damaged injection pump can allow fuel to leak into the lubricating oil as it passes through the pump.



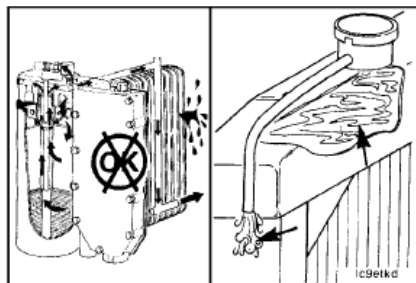
Oil Leaks

Various gaskets, seals and plugs are used to contain the oil. Most leaks can be identified during routine inspection of the engine and vehicle.

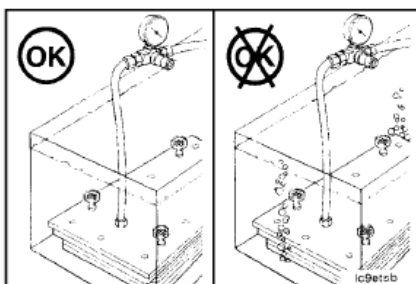
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A damaged rocker assembly oil manifold or blown expansion plug can allow a large quantity of oil to escape resulting in a sudden drop in the oil pressure.

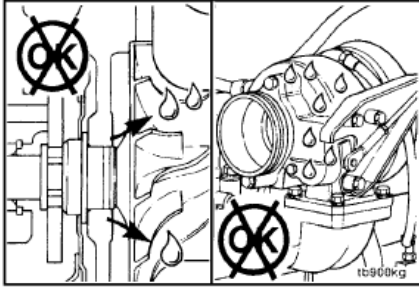


If the oil cooler element ruptures, the oil pressure will force oil into the cooling system. Oil in the coolant should be visible when the radiator cap is removed. As the oil is forced into the cooling system, coolant will be displaced through the radiator overflow.

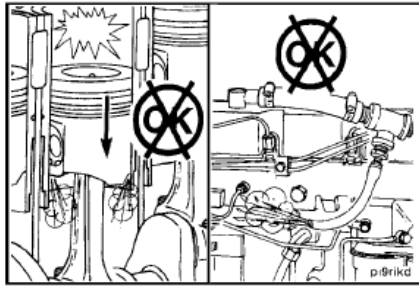


Lubricating Oil Cooler Pressure Test Kit, Part No. 3823876

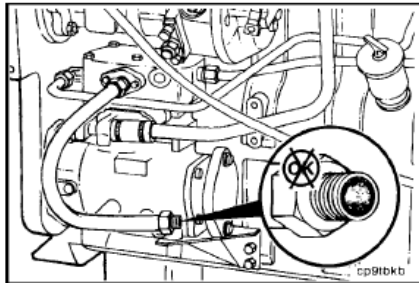
Leaks can be verified by pressure testing the oil cooler element. Apply 483 kpa [70 psi] air pressure to the element to check for leaks.



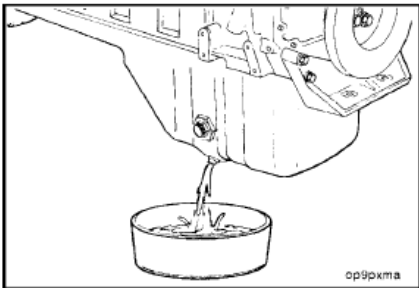
High intake air restriction and worn or damaged seals in the turbocharger can also allow oil to leak into the air crossover pipe and be burned in the engine. This condition can be verified by removing the air crossover tube and looking for oil.



Inadequate sealing of the piston rings will result in combustion gas and oil droplets being blown out the crankcase breather tube and / or consumed by the engine. Refer to related chapters later for measuring crankcase gases (lower blowby).



Oil can also be lost through a worn or malfunctioning air compressor. Look for carbon build up in the air line from the compressor to the air tank and look for oil when draining the tank. Refer to Compressed Air Section for additional diagnostic procedures.



Lubricating Oil Pan – Drain



17 mm

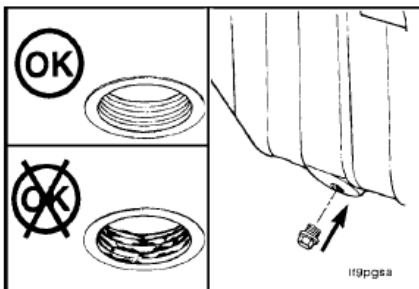


WARNING: Hot oil can cause serious personal injury.
WARNING: Avoid prolonged contact with used engine oil. Such prolonged, repeated contact can cause skin disorders or other bodily injury.



Operate the engine until the coolant temperature reaches 60°C [140°F]. Shut off the engine. Remove the oil drain plug. Drain the oil immediately to make sure all the oil and suspended contaminants are removed from the engine.

NOTE: Use a container that can hold at least 22 liters [23 U.S. qts.] of lubricating oil.



Lubricating Oil Pan –Fill



17 mm



Clean and check the oil drain plug threads and the seal surface.



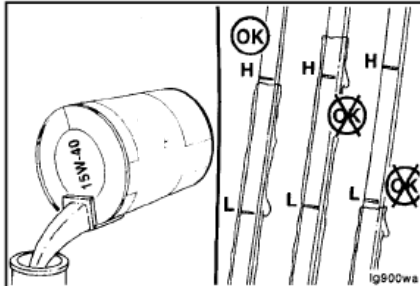
Install the oil drain plug in the lubricating oil pan.



Torque Value: 80N • m [59 ft-lb]



NOTE: Use a high quality 15w-40 CF4 or above oil that meets Cummins specification for natural gas engines.

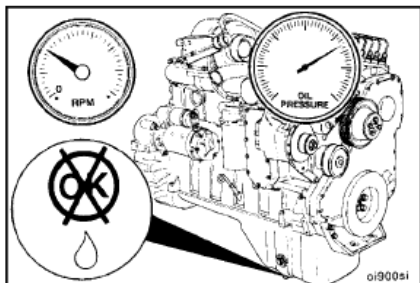


Lubricating Oil Level – Check

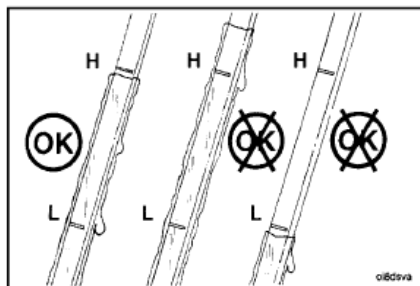
93

Fill the engine with clean oil to the proper level.

NOTE: When filling the oil pan, use the fill tube on the side of the engine rather than on top of the rocker lever cover. Refer to Lubricating Oil System Specifications for engine oil capacity.

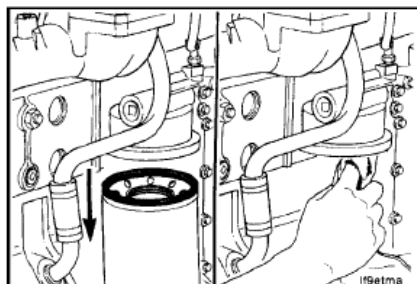


Idle the engine to inspect for leaks at the drain plug.



Turn the engine OFF. Wait approximately 5 minutes to let the oil drain from the upper parts of the engine. Check the level again.

Add oil as necessary to bring the level up to the “H” (high) mark on the dipstick.

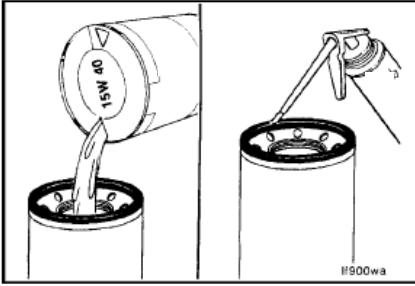


Oil Filter – Replace

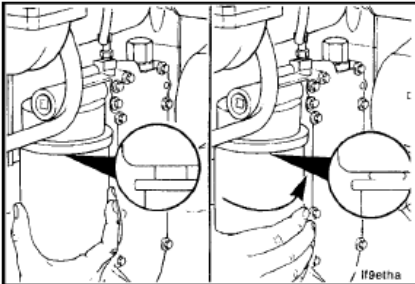
Part No. 3375049, oil filter wrench

Use the oil filter wrench, Part No. 3375049, to remove the filter.

Clean the area around the lubricating oil filter head. Remove the filter. Clean the gasket surface of the filter head.



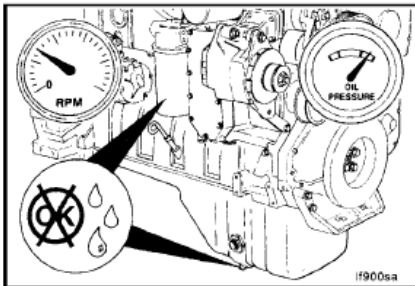
Use clean 15W-40 oil to coat the gasket surface of the filter.
Fill the filter with clean 15W-40 oil.



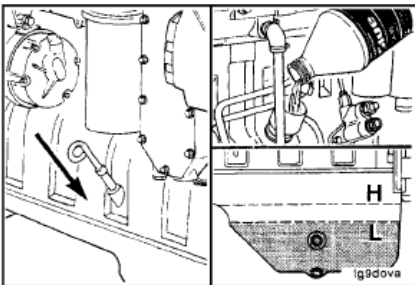
Part No. 3375049, oil filter wrench install the filter on the oil filter head.

Tighten the filter until the gasket contacts the filter head surface.

Use oil filter wrench, Part No. 3375049, to tighten the filter and additional three-fourths to one turn, or follow the instructions supplied with the filter.



Run the engine, check for leaks.

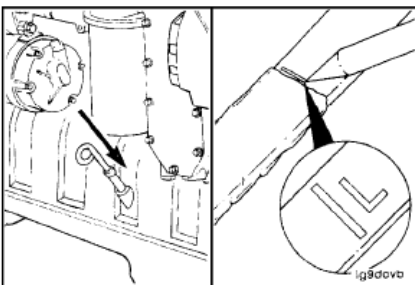


Lubricating Oil dipstick – Calibration



Install the dipstick in the dipstick tube housing.

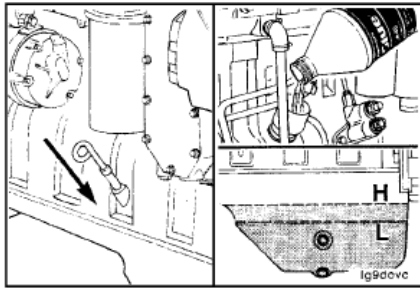
Use clean 15W-40 oil to fill the oil pan to the specified "low" oil level. Refer to Lubricating Oil System Specifications at Page 5-5 for engine oil capacity.



CAUTION: The dipstick will break if the scribe mark is too deep.

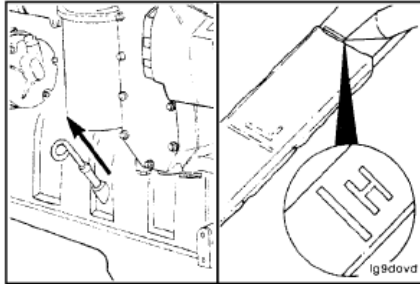
Remove the dipstick and scribe a mark across the dipstick and mark the "low" oil level with an "L".

NOTE: If a new blank dipstick is being used, cut the dipstick off approximately 38 mm [1.5 inch] below the "low" oil level mark.



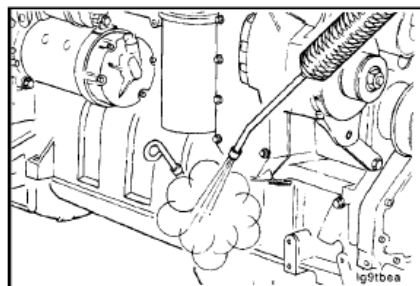
Install the dipstick into the dipstick tube housing.

Fill the oil pan to the specified "high" oil level. Refer to Lubricating Oil System Specifications for engine oil capacity.



Remove the dipstick and scribe a mark across the dipstick and mark the "high" oil level with an "H".

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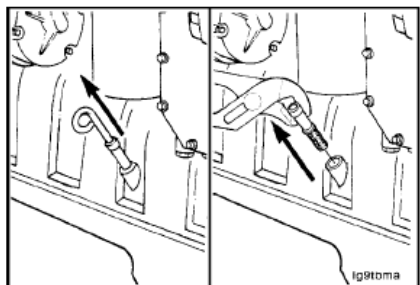


Lubricating Oil Dipstick Tube – Replace

Remove



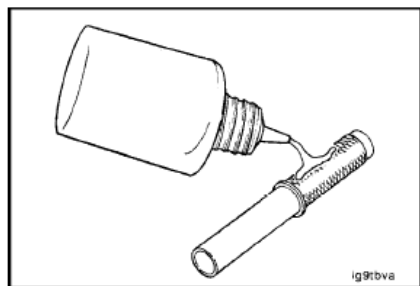
Clean the area around the dipstick tube before removing to prevent debris from entering the oil system.



Remove dipstick from the dipstick tube.

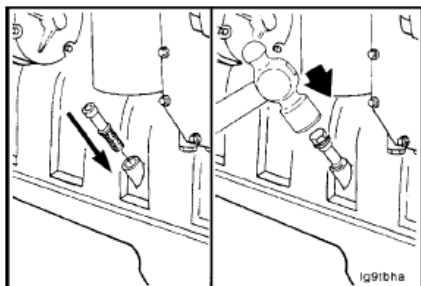
Remove dipstick tube from the cylinder block.

Service Tip: use a dent puller and a M8×1.25×21 mm self-tapping capscrew. Thread the capscrew into the dipstick tube and remove the tube.



Install

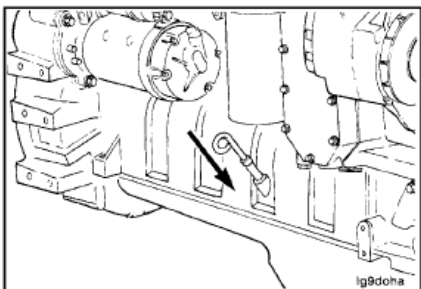
Apply a thin bead of Loctite TM 277, or equivalent, around the bottom of the knurled end of the tube.



Place knurled end of the tube into the dipstick tube bore in the cylinder block.

Use a flat washer and hex head capscrew to drive the tube into the cylinder block.

Lightly drive the dipstick tube until it seats against the block casting.

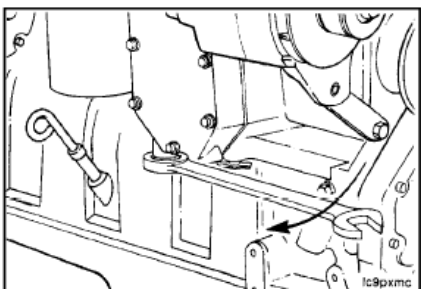


Install dipstick into the dipstick tube.

Lubricating Oil pressure regulator valve, valve and spring – Replace

Preparatory Steps:

Clean debris.

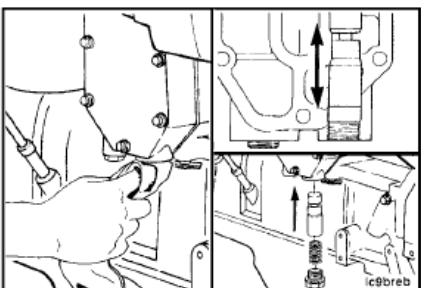


Remove

22 mm



Remove the plug and regulator valve.

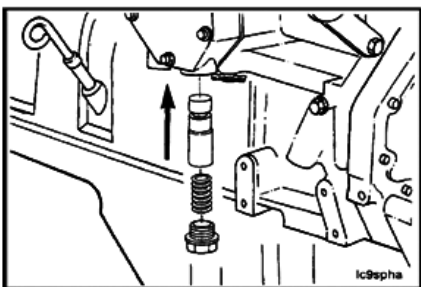


Clean and Check

Clean and inspect the bore and regulator valve before assembly.



The valve must move freely in the bore.



Install

22 mm



Install the regulator and spring.



Torque Value: 80 N • m[59 ft-lb]

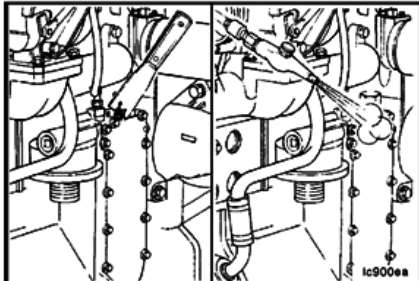


Oil Cooler Element and Gasket – Replace

Preparatory Steps:

Drain the coolant.

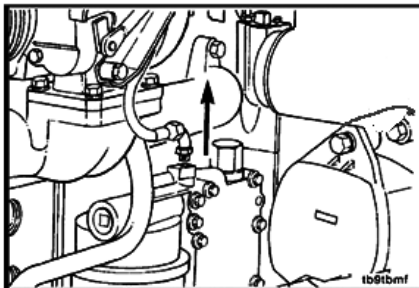
Remove the lubricating oil filter.



Remove

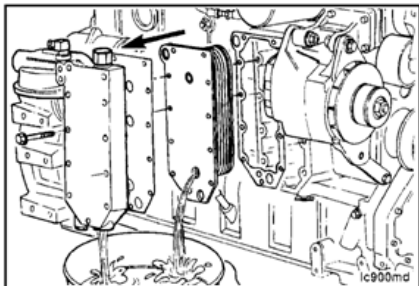
Remove the debris around the lubricating oil cooler.

93



16 mm

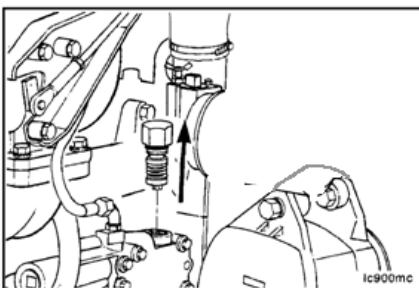
Disconnect the turbocharger supply line from the top of the oil filter.



10 mm

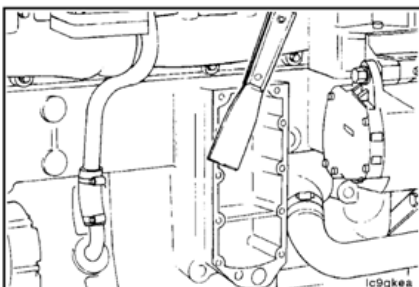
NOTE: Due to the design of the present production lubricating oil cooler cover, there is approximately 0.7 liter [0.75 U.S. Qts.] of oil that does not drain when the system is drained. Place a container under the cooler to catch the oil when the cover is removed.

Remove the lubricating oil cooler cover, elements and gaskets.



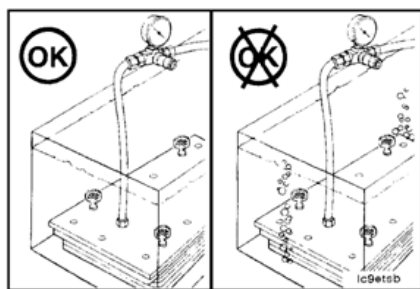
32 mm

Remove the oil temperature thermostat.



Clean and Check

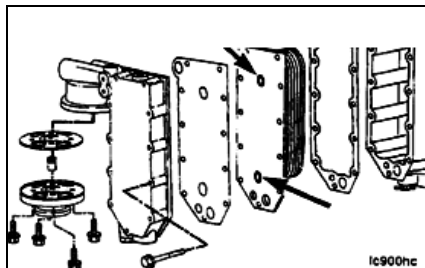
Clean gasket surfaces.



Pressure Test

Part No. 3823876, Lubricating Oil Cooler Pressure Test Kit
Apply 483 kpa [70 PSI] air pressure to the element, check for leaks.

93



Install

10 mm

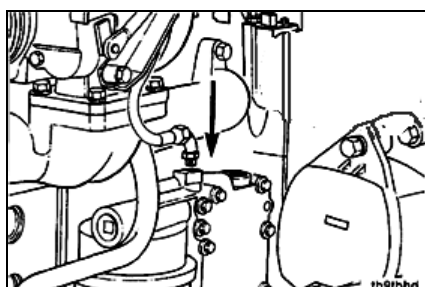
Assemble the lubricating oil cooler gaskets, element and cooler cover gasket and oil temperature thermostat to the cylinder block.

Install the filter head and gasket if removed.

NOTE: Be sure to remove the shipping plugs from the new cooler element.

Torque Value:

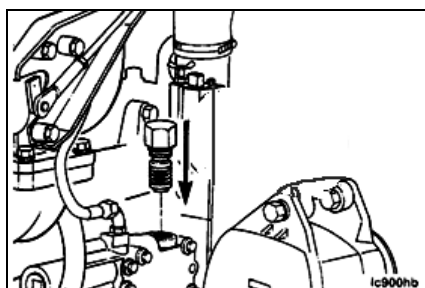
Lubricating Oil Cooler	
Cover Capscrews	24 N • m[18 ft-lb]
Lubricating Oil	
Filter Head Capscrews	24 N • m[18 ft-lb]



16 mm

Connect the turbocharger lubricating oil supply line.

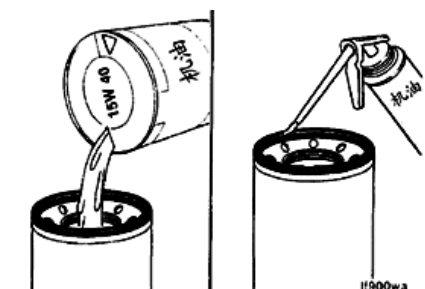
Torque Value: 17 N • m[13 ft-lb]



32 mm

Install lubricating oil thermostat.

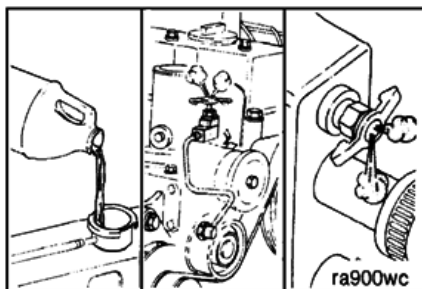
Torque Value: 50 N • m[37 ft-lb]



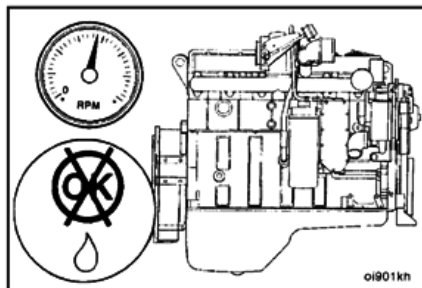
NOTE: Fill the filters with clean lubricating oil before installation.

Install the new oil filter.

Tight the oil filter to the specification.

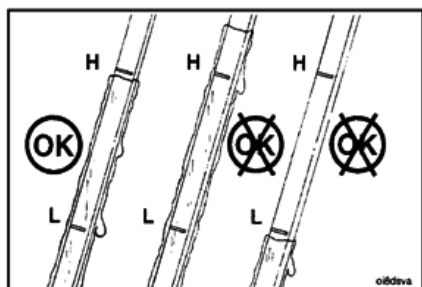


NOTE: Be sure to open the engine and aftercooler vents to allow air to escape as the system is filled. Fill the cooling system.

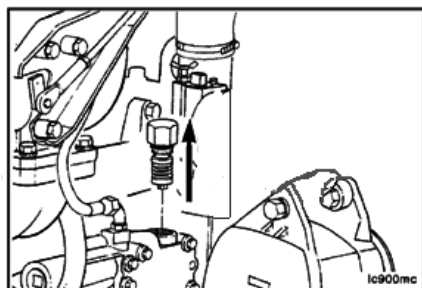


Run the engine, check for leaks.

93



Shut off the engine, and check the oil and coolant levels.



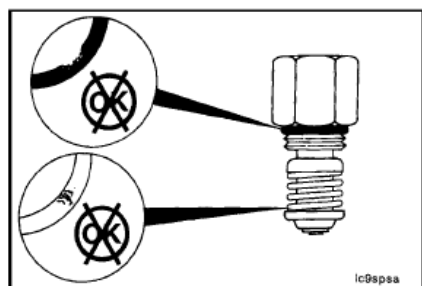
Lubricating Oil Thermostats – Replace



Remove
32 mm

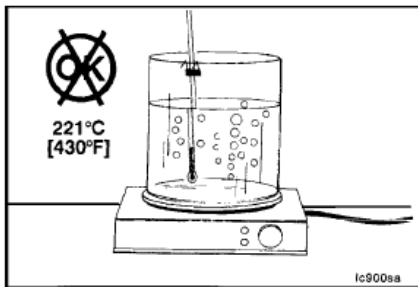


Remove the lubricating oil thermostat.

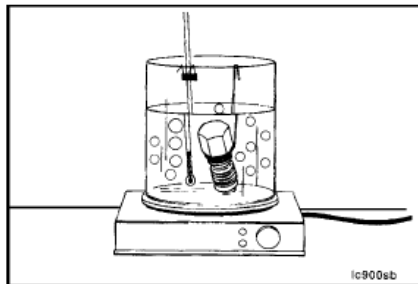


Check

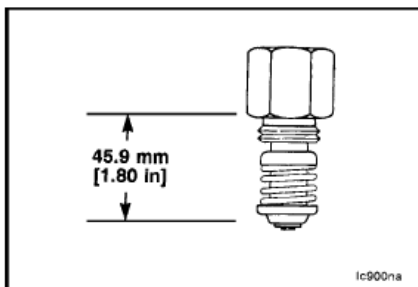
Visually inspect for a damaged o-ring, broken spring or other damage.



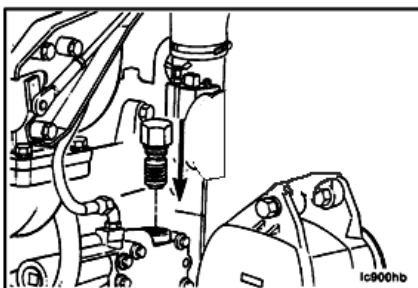
CAUTION: The flash point of new lubricating oil is approximately 221 °C [430 °F]. Do not allow oil temperature in the container to exceed 150°C[300°F]. Do not allow water droplets to enter the container of hot oil. Water droplets will cause a violent reaction which can cause personal injury.



Suspend the thermostat and a 116°C[240°F] thermostat in a container of new lubricating oil. Do not allow the thermostat or the thermometer to touch the sides of the container. Heat the lubricating oil.



NOTE: Write down the temperature at which the thermostat is fully extended. The thermostat must be fully extended to at least 45.9 mm [1.80 inch] when the temperature reaches 104 °C [220 °F] or 116 °C [240 °F] depending on what temperature the thermostat is rated. Replace the thermostat if it does not operate as described.

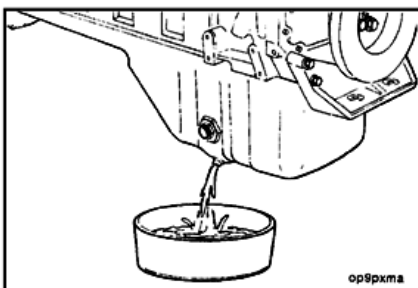


Install



Install the oil temperature thermostat.

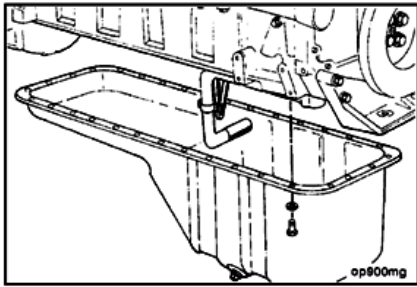
Torque Value: 50 N • m[37 ft-lb]



Lubricating Oil Pan, Suction Tube and Gasket – Replace

17 mm

Remove the oil drain plug for the oil pan to drain the oil.

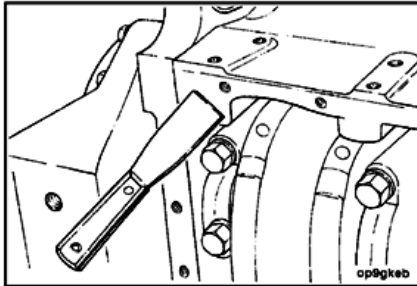


Lubricating Oil Pan – Remove



10 mm

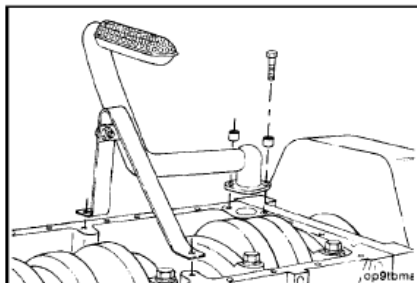
Remove the lubricating oil pan.



Clean



Clean sealing surfaces.

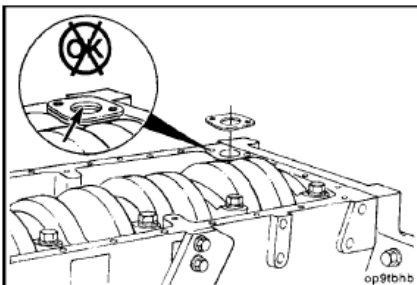


8 mm

Remove the suction tube and gasket.

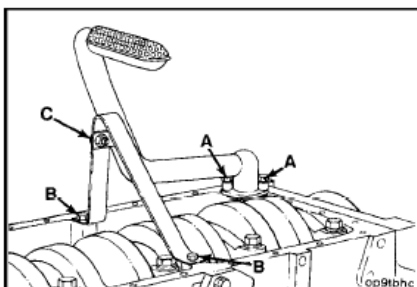


Clean the sealing surface.



Position the new lubricating oil suction tube gasket onto the cylinder block.

Make sure the gasket is correctly installed and does not block the hole for oil passage.



8 mm

Install the lubricating oil suction tube over the gasket and align the mounting holes.

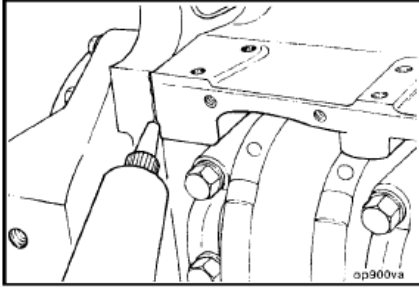


Use the following sequence to tighten the capscrews:



Torque Value:

Step A	Suction tube to Block	9 N • m[80 in-lb]
Step B	Brace to Block	9 N • m[80 in-lb]
Step C	Brace to Suction Tube	9 N • m[80 in-lb]



Lubricating Oil Pan – Install

Be sure to fill the joints between the pan rail, gear housing and rear cover with Three Bond RTV sealant, Cummins Part No. 3823494.

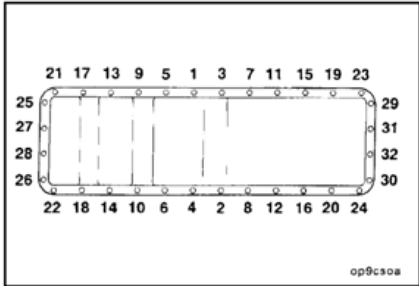
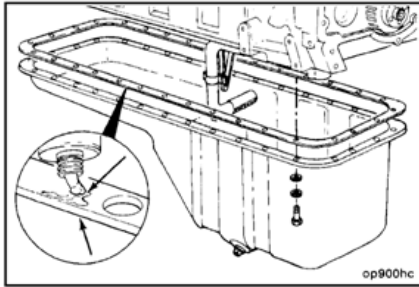
NOTE: The lubricating oil pan should be assembled and the capscrews torqued within 15 minutes after applying the sealant.



Apply a 2 mm [1/16 inch] head of Three Bond Sealant, Part No. 3823494, to both sides of the new lubricating pan gasket.

Install a gasket.

Install the lubricating oil pan.



10 mm

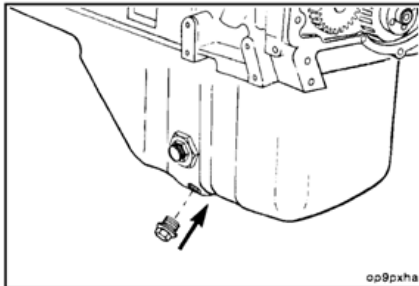
Assemble the washers and capscrews to secure the Lubricating oil pan as illustrated.



Tighten all capscrews in the sequence shown in the accompanying chart.



Torque Value: 24 N • m [18 ft-lb]

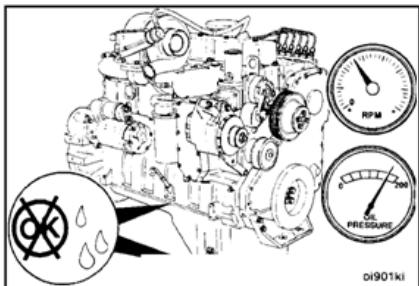


17 mm

Install the oil pan drain plug.

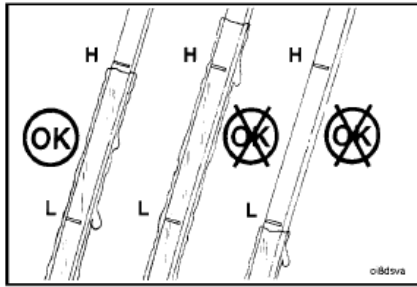


Torque Value: 80 N • m [59 ft-lb]



Fill the oil pan with clean 15w-40 engine oil.

Operate the engine and check for leaks.



Shut off the engine and check the oil level with the dipstick.

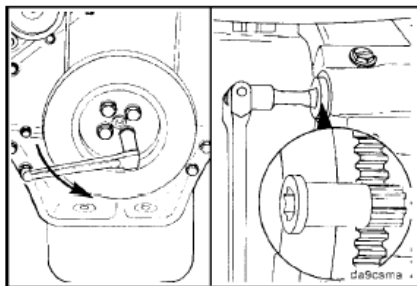
Lubricating Oil Pump – Replace

93

Preparatory Steps:



Remove the drive belt.



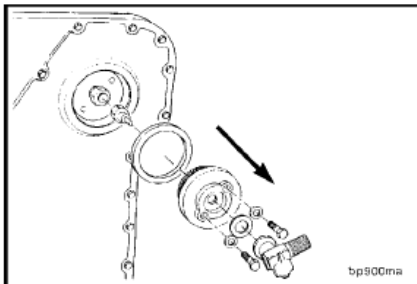
Remove



18 mm, Part No. 3377371, Engine Barring Tool



Remove the vibration damper. Use the barring tool, Part No. 3377371, to keep the crankshaft from rotating.



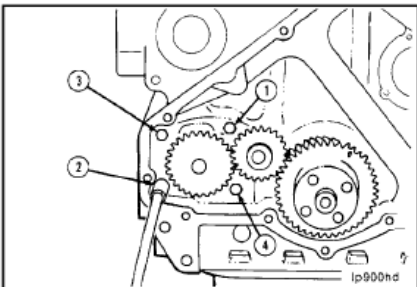
10 mm



Remove gear cover/tachometer drive adapter assembly.



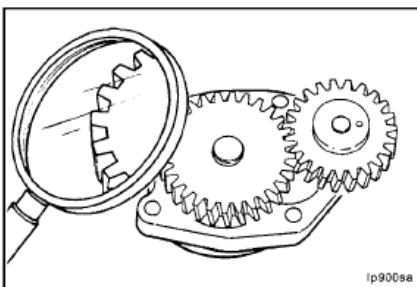
Remove the gear cover.



10 mm



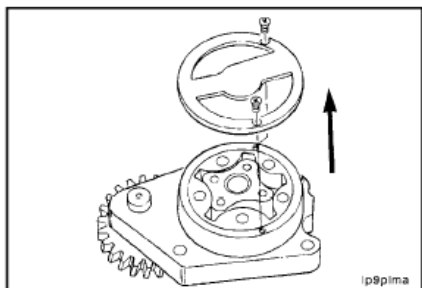
Remove the four lubricating oil pump mounting capscrews.



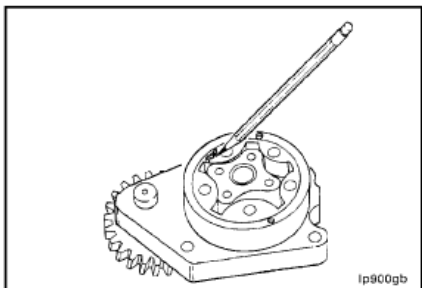
Clean and Check

Visually inspect the lubricating oil pump gears for chips, cracks, or excessive wear.

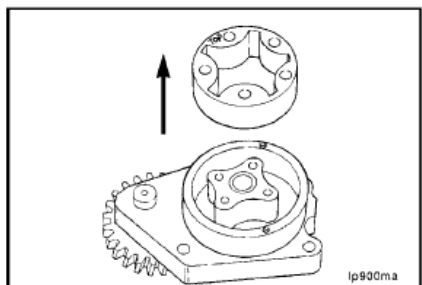
NOTE: Parts replacement is not practical if any of the internal parts are worn beyond the specifications, the pump should be replaced.



Remove the back cover.



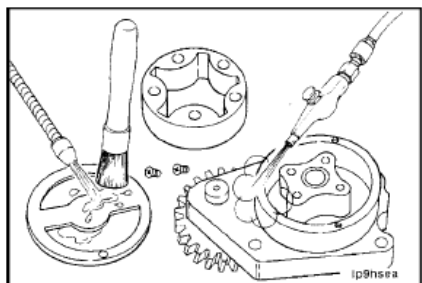
Mark "TOP" on the gerotor planetary.



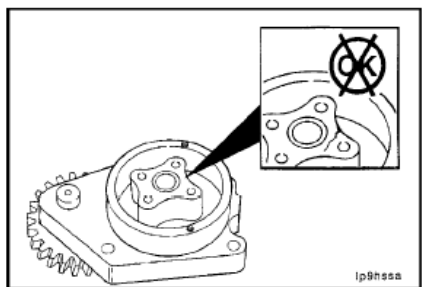
Remove the gerotor planetary.



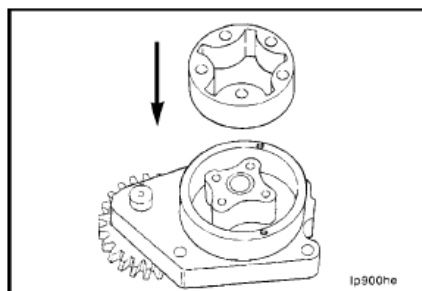
Inspect for excessive wear or damage.



Clean all parts in solvent and dry with compressed air.



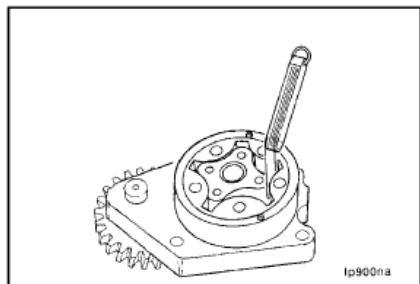
Inspect the pump housing and gerotor drive for damage wear.



Install the gerotor planetary.



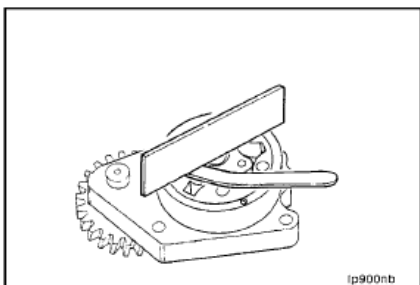
NOTE: Be sure the gerotor planetary is installed in the original position.



Oil Pump Gerotor Tip Clearance

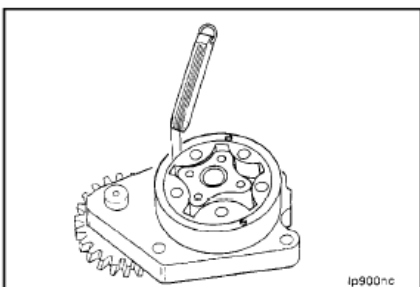
mm		in
0.025	min.	0.001
0.1778	max	0.007

93



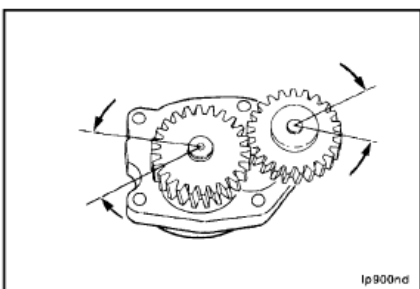
Oil Pump Gerotor Drive / Gerotor Planetary to Port Plate Clearance

mm		in
0.025	min.	0.001
0.127	max	0.005



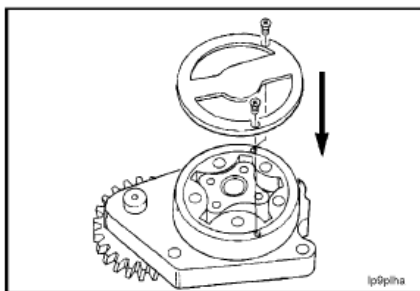
Oil Pump Gerotor Planetary to Body Bore Clearance

mm		in
0.127	min.	0.005
0.381	max	0.015

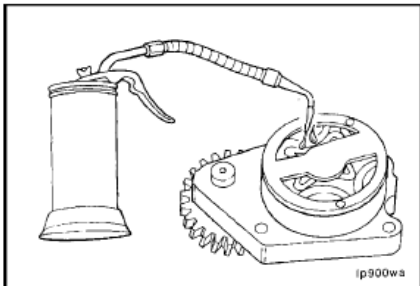


Oil Pump Drive Gear Backlash (Used Pump)

mm		in
0.08	min.	0.003
0.33	max	0.013



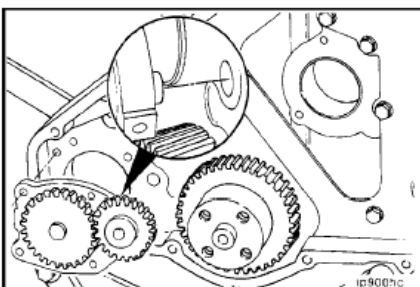
Install the back cover.



Install

Lubricate the pump with clean 15w-40 engine oil.

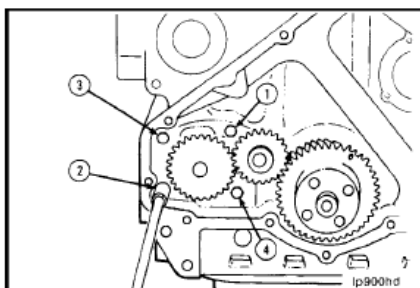
NOTE: Fill the pump with oil during installation to aid in quicker oil suction when the engine is started.



Install the oil pump.



NOTE: Make sure the idler gear pin is installed in the locating bore in the cylinder block.

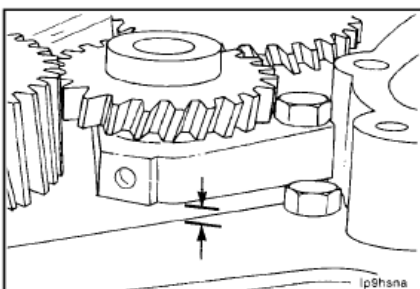


10 mm

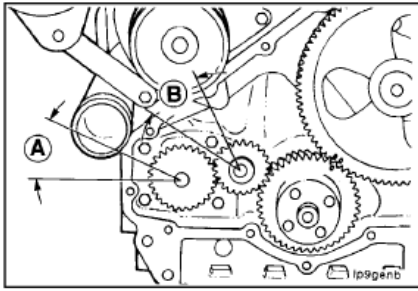
Tighten in the sequence shown.



Torque Value: Step 1 5 N • m[44 in-lb]
Step 2 24 N • m[18 ft-lb]



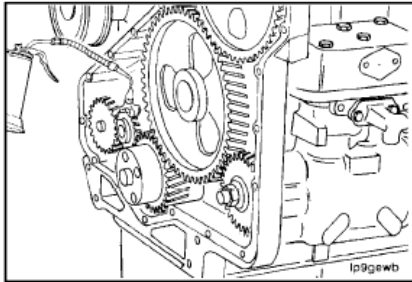
The back plate on the pump seats against the bottom of the bore in the cylinder block. When the pump is correctly installed, the flange on the pump will not touch the cylinder block.



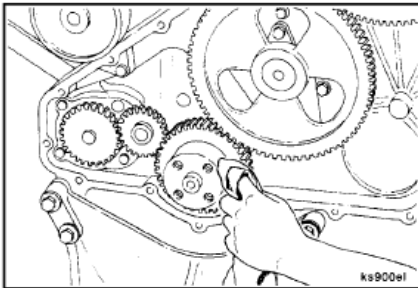
Use a dial indication with a magnetic base to measure the idler gear backlash.

NOTE: Do not allow the mating gears to rotate while measuring the backlash.

Oil Pump Idler Gear Backlash (A & B)		
mm		in
0.08	min.	0.003
0.33	max	0.013



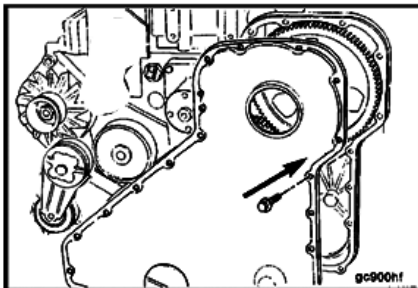
Lubricate the front gear train with clean 15w-40 engine oil.



Thoroughly clean the front seal area of the crankshaft.

If the contact area has a groove worn deep enough to feel with a fingernail or sharp object, it will be necessary to install a wear sleeve over the sealing surface.

NOTE: The seal lip and the sealing surface on the crankshaft must be free from all oil residue to prevent seal leaks.



Use sealant, Part No. 3823494, on both sides of the front cover gasket.

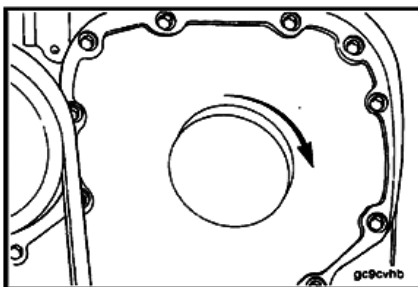


Install the front cover and gasket.

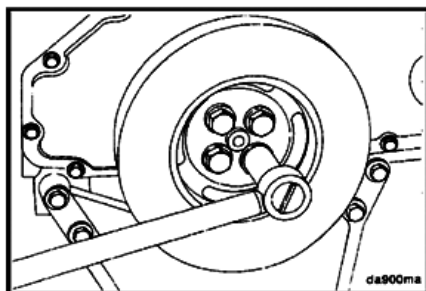
Install the capscrews.

Torque Value: 24N • m[18 ft-lb]

NOTE: Torque the capscrews within 15 minutes after applying the sealant.

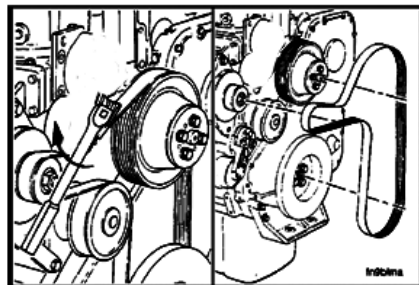


Install the gear cover/tachometer drive adapter assembly.

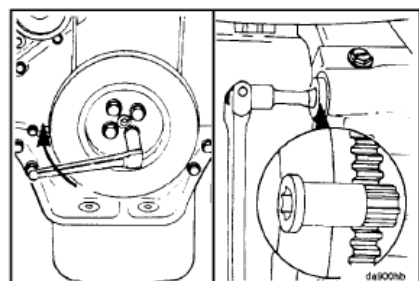


Install the vibration damper. Do not tighten the capscrews to the correct torque value at this time.

93



1/2 inch or 3/8 inch Square Drive
Raise the belt tensioner to install the belt.



18 mm, Part No. 3373371 Engine Barring Tool

Use engine barring tool, Part No. 3373371, to hold the Crankshaft when tightening the capscrews.



Tight the capscrew diagonally.

Torque Value: 200N • m[148 ft-lb]

NOTES

Air Intake and Exhaust Systems

Intake or Exhaust System Diagrams- General Information

The engine was designed as a turbocharged engine.

Air is pulled into the engine from an air filter. Clean air is very important to the life of the engine. Ingested dust and dirt can very quickly damage the cylinders.

93

Make sure that an excellent quality air cleaner is used and that it is periodically replaced according to the manufacturer's recommendations.

L series engines use a chassis-mounted charge air cooler instead of an engine mounted aftercooler to provide cooler charge air to the engine to improve engine performance and reduce emissions. This system also uses large diameter piping to transfer the air from the engine turbocharger to the charge air cooler, then returns the air from the charge air cooler to the engine intake manifold.

NOTE: The long term integrity of the charge air cooling system is the responsibility of the vehicle and component manufacturers.

Some turbocharged engines use a wastegated turbocharger to limit the maximum boost pressure that the turbocharger can develop. Wastegate operation is controlled by an actuator that senses compressor pressure and balances it against a preset spring load. The wastegate valve is located in the turbine inlet passage. When open, it diverts a portion of the exhaust gas away from the turbine wheel, thereby controlling the shaft speed and boost.

CAUTION: The turbocharger is a performance part and must not be tampered with. The wastegate bracket is an integral part of the turbocharger. Tampering with the wastegate components can reduce durability by increasing cylinder pressure and thermal loading due to incorrect inlet and exhaust manifold pressure. Poor fuel economy and failure to meet regulatory emissions laws may result. Increasing the turbocharger boosts will not increase engine power.

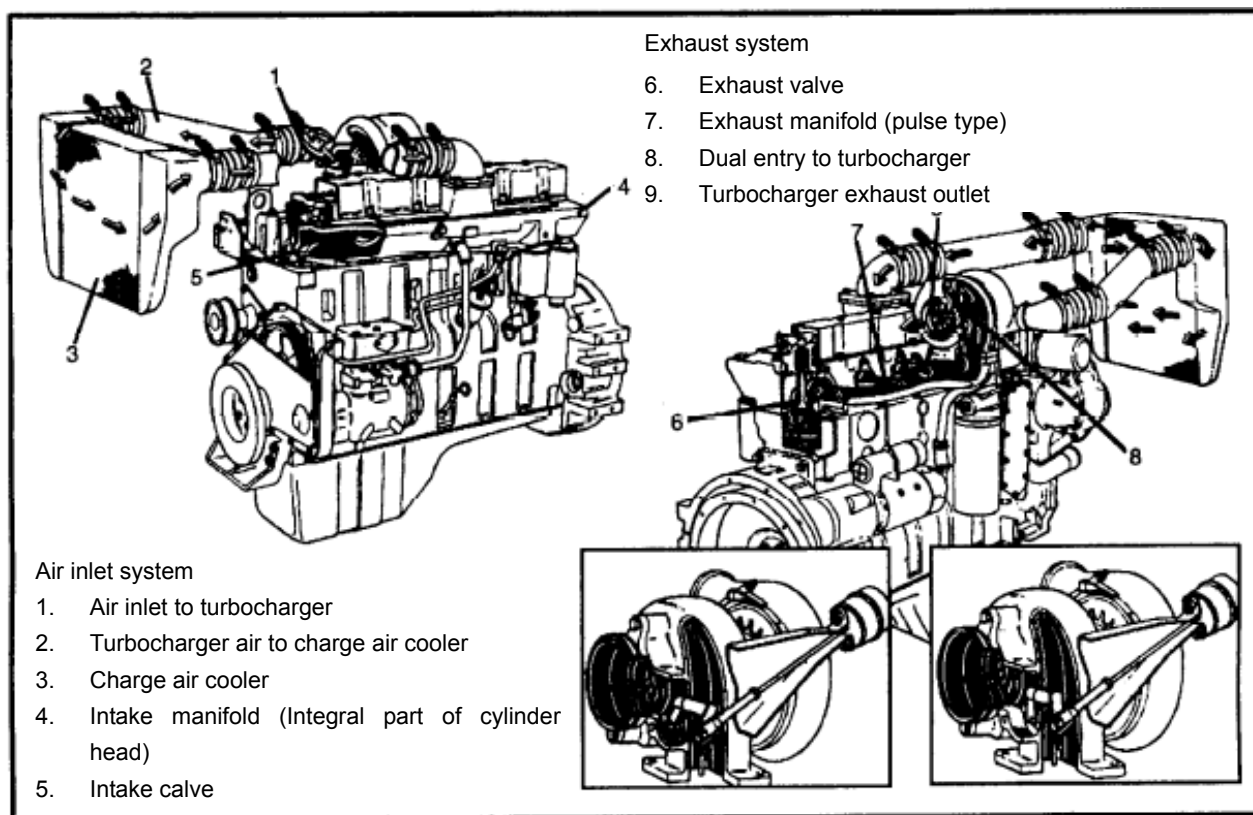
The turbine and compressor wheels and shaft are supported by two rotating bearings in the bearing housing. Oil passages within the bearing housing direct the filtered, pressurized engine oil to the bearings and thrust bearing. The oil is used to lubricate and cool the rotating components to provide for smooth operation. The oil then drains from the bearing housing to the engine oil pan through the oil drain line. A restricted or damaged oil drain line can cause the turbocharger bearing housing to be pressurized causing oil to leak past the seals.

NOTE: An adequate supply of good, filtered oil is very important to the life of the turbocharger. Make sure that excellent quality oil is used and that it and the oil filter are changed according to the maintenance recommendations.

CAUTION: A catalyst is installed on all EPA and CARB approved automotive applications. Lubricating oil blending is not permitted. It will plug up and eventually damage the catalyst. High sulfur fuels must not be used with the catalyst. No welding or modifications of the catalyst are permitted without permission of catalyst manufacturer.

Air System Flow Diagram

Air System

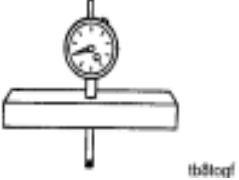
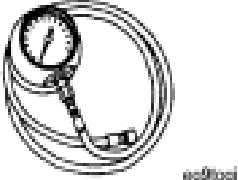
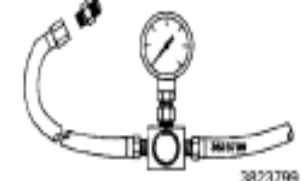


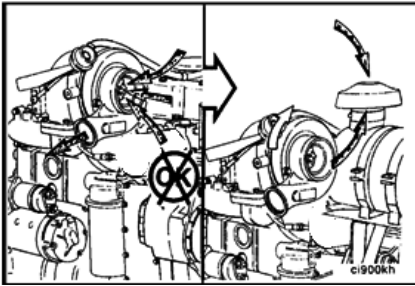
Air Intake and Exhaust System Specifications

Maximum allowable intake restriction (compressor inlet) kpa (with used air filter element)	6.2
Turbocharger Maximum Exhaust Restriction at rated speed and load (Turbine Outlet)	10
Charge air cooler	21 kpa [3 psi]

Air Intake and Exhaust System-Service Tools

The following special tools are recommended to perform procedures in Section 6. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Dong Feng Cummins Market and Service Department.

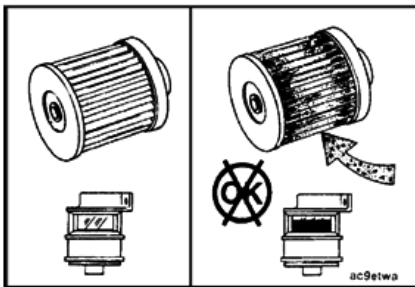
Tool No.	Tool Description	Tool Illustration
ST-537	Digital Depth Gauge Measure turbocharger axial motion.	
ST-1273	Pressure Gauge (0-75 in. Hg.) Used to measure the intake manifold pressure or exhaust back pressure.	
3823799	Turbocharger Wastegate Pressure Setting Kit Used to set wastegate pressure.	



Air Intake and Exhaust System – Troubleshooting

Air Cleaning

The correct amount of clean air to the cylinders is required for good performance. As discussed earlier in Air Flow System, ingested dust and dirt will damage the engine cylinders. Dust and dirt can also damage the valve stems and guides as well as wear down the turbocharger compressor vanes affecting efficiency. Larger debris can damage the blades of the turbocharger.

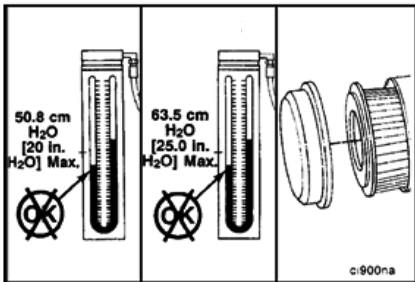


Air flow restriction results in excessive smoke and low power.

Restriction increases as the filter removes contaminations from the intake air. Restricted air flow changes the air-to-fuel ration, reducing power and increasing smoke from the engine. Verify that the air cleaner is being maintained correctly.

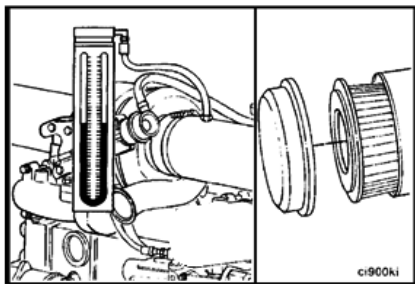


Measurement of air intake restriction is described in this Section.

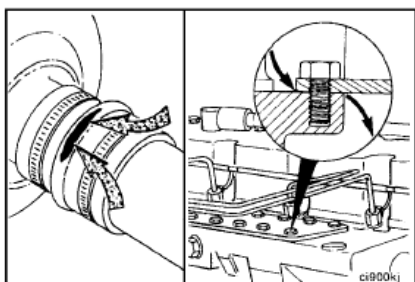


Intake Air Restriction – Check

Replace the air cleaner element when the restriction reaches the maximum limit at rated engine power and speed.



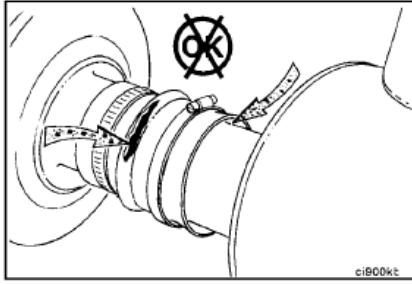
For turbocharged engines, measure the restriction just before the turbocharger. Measure just before the intake manifold for naturally aspirated engines.



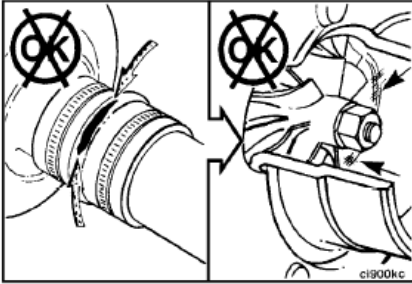
Damage from Non-filtered Air

Loose connections or cracks in the suction side of the intake pipe can allow debris to be ingested by the engine causing rapid wear in the cylinders.

Leaks at the intake manifold, unsealed bolt holes or manifold cover gasket can also allow dust and dirt to be ingested into naturally aspirated engines.



Loose connections or cracks in the suction side of the intake pipe on turbocharged engines can allow debris to be ingested into the turbocharger compressor and forced into the engine.

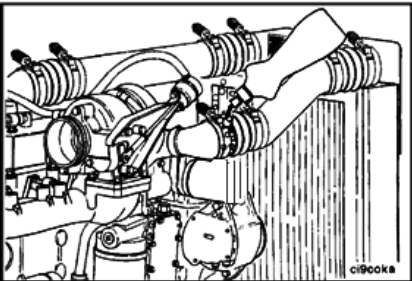


Debris drawn into the air suction side can damage the compressor blades causing an imbalance resulting in bearing failure.

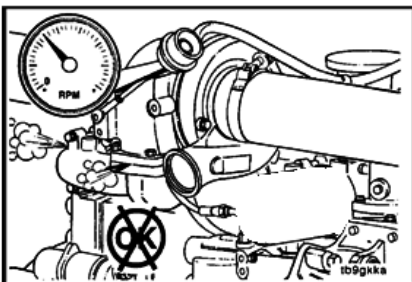
To verify a bearing failure or damaged compressor, remove the intake and exhaust piping and check for contact. The rotor assembly must rotate freely and should not be damaged. Measurement of axial and radial clearance is described in this Section.

Turbocharged Engines – Air Leaks, Pressure Side

Excess smoke and low power from a turbocharged engine can be caused by pressurized air leaking from loose connections or cracks in the crossover tube or intake manifold. This can also cause a noise problem.

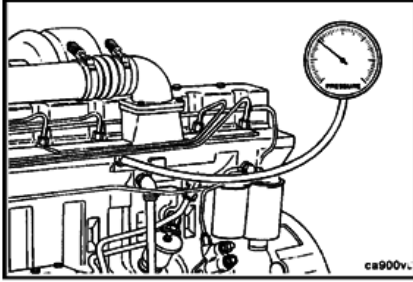


In addition to the visual inspection for cracks and loose fittings, liquid soap can be applied to the charge air cooler, connections and the manifold cover sealing surfaces to find the leaks. The leaks will create bubbles that are easier to detect. Measurement of manifold pressure is described in this Section.



Turbocharged Engines – Exhaust Leaks

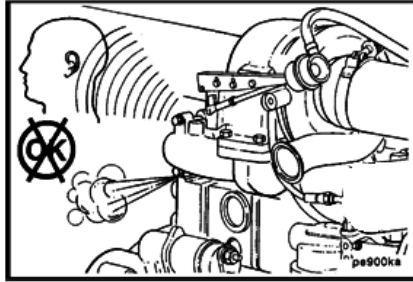
Inspect for exhaust leaks at the exhaust manifold and turbocharger, gasket leaks, exhaust pipe, muffler or catalyst restrictions. Leaks or restrictions will cause the turbine and impeller to operate at a lower speed and reduce the amount of air being forced into the cylinders. The symptom will be excess smoke, low manifold pressure and low power.



Turbocharger Boost Pressure – Measurement

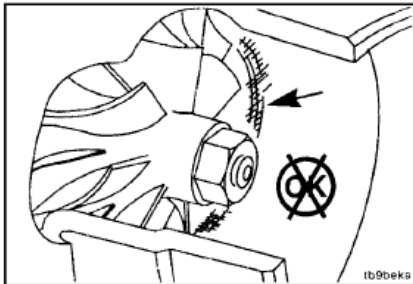
Measure the inlet pressure at the intake manifold by using one of the tapped or plugged intake access holes shown in the illustration. Refer to specifications in this Section.

NOTE: If the engine has charge air cooling, testing must be done to be sure that the charge air cooler system is not leaking or restricting the turbocharger boost pressure. Refer to Procedure 3-06 for detailed charge air cooler testing.



Exhaust leaks can usually be detected audibly or visually by a discoloration caused by the escaping hot gases.

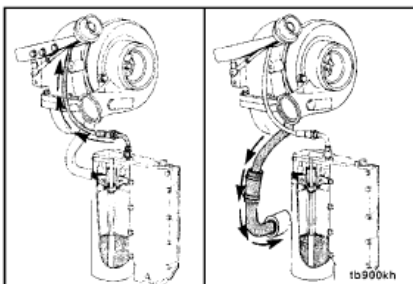
Don't overlook exhaust restriction as a cause of low power. If the exhaust gasses can not flow freely, the turbocharger will not operate efficiently.



Malfunctioning Turbocharger

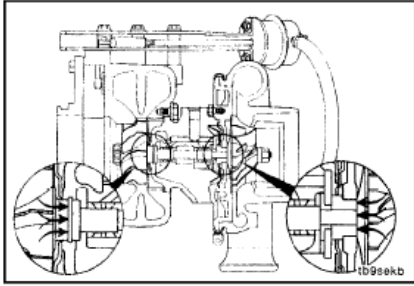
Failure of the internal components of the turbocharger can reduce its effectiveness and also cause excessive smoke and low power. A bearing failure can produce friction which will slow the speed of the rotor assembly. Failed bearings can also allow the blades of the rotor assembly to rub the housing, thus reducing the rotor assembly speed.

Malfunctioning turbocharger waste gate failure or misalignment of the turbocharger waste gate can result in excessively high or low boost pressures. Low boost pressures can cause excessive smoke and low power. High boost pressures can cause major engine damage.



Oil Consumption and Leaks

Engine lubricating oil is used to lubricate the bearings and provide some cooling for the turbocharger. The oil supplied to the turbocharger through the supply line is at engine operating pressure. A return line connected to the bottom of the turbocharger routes the oil back to the engine oil pan.

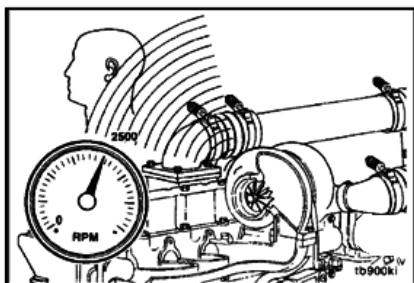
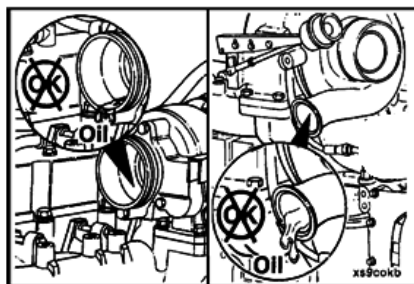
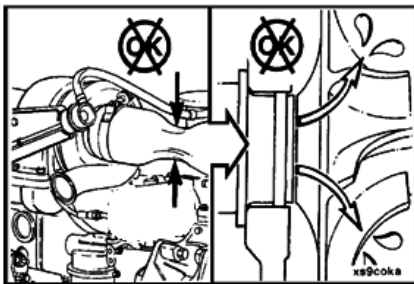
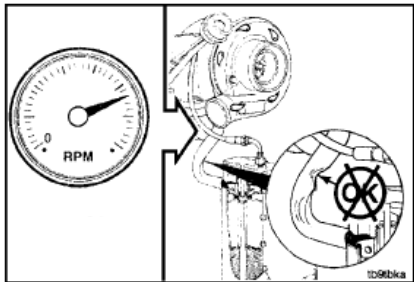


Seal rings are used on each of the rotor assembly. The primary function of the seals is to prevent exhaust gases and compressed air from entering the turbocharger housing. Oil leaks from the seals is rare, but it can occur.

NOTE: Excessive crankcase pressure will not allow the oil to drain from the turbocharger. This will load the bearing housing and allow oil to leak past the compressor seals and into the engine.

NOTE: If turbine seal leakage into the exhaust system occurs on engines with catalysts, check the catalyst back pressure during repair.

A restricted or damaged oil return line will cause the turbocharger housing to be pressurized causing oil to migrate past the seals.



Additionally, high intake or exhaust restrictions can cause vacuum between the compressor and the turbocharger housing resulting in oil leaking past the seals.

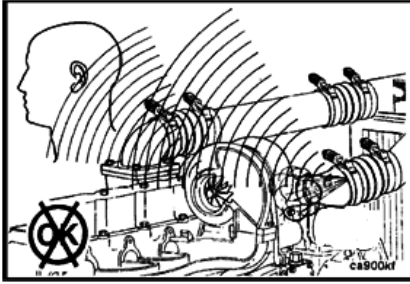


To verify oil leakage past the seals, remove the exhaust pipe and crossover tube and look for oil in the turbine casing and the crossover tube. Locate and correct the restriction as previously discussed.

Turbocharger Noise

It is normal for the turbocharger to emit a "whine" sound that varies in intensity depending on engine speed and load. The sound is caused by the very high rotational speed of the rotor assembly. Consequently, the sound will be more audible at full speed.

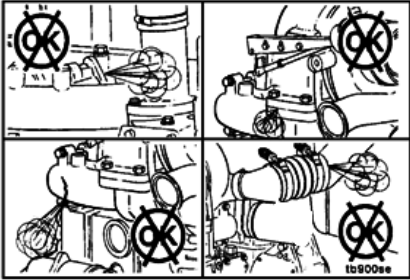
If possible, operate the engine at full speed to verify the noise level.



Leaks in the air system intake and / or exhaust components can produce additional noises.



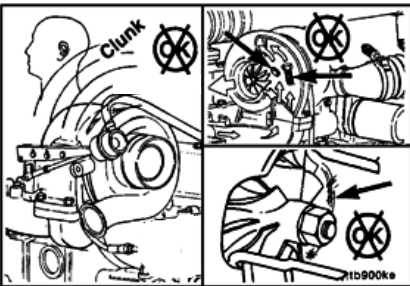
Pressurize the intake system by operating the engine at high idle and check for air intake and crossover tube leaks.



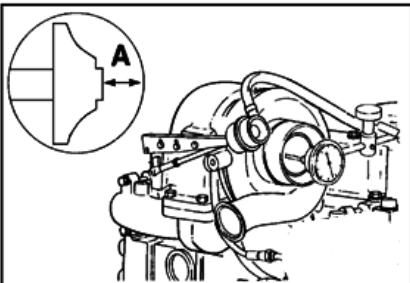
Before removing the turbocharger, make sure that the noise is not caused by leaks from the air system components.



Look for loose turbocharger mounting, exhaust manifold gasket leaks, and cracks in the exhaust manifold.



Lower pitch sounds or rattles at slower engine speeds can indicate debris in the system or the rotor assembly is touching the housings.



Rotor Assembly Clearance – Measurement

Part No. ST-537, Digital Depth Gauge

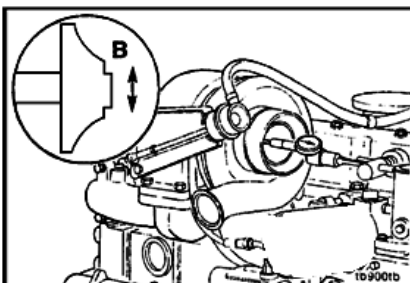


Measure the axial end play.

Axial End Clearance (A)

mm		in
* 0.10	Min	[0.004]
0.16	Max	[0.006]
** 0.03	Min	[0.001]
0.08	Max	[0.003]

Measure the radial shaft clearance.

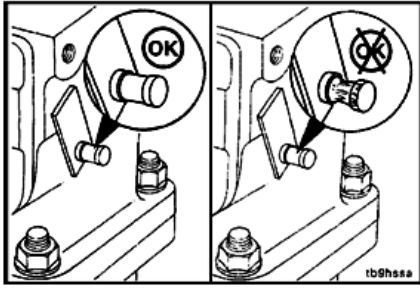


Radial Clearance (B)

mm		in
0.21	Min	[0.008]
0.46	Max	[0.018]



Replace or shop the turbocharger if the clearance does not meet the specifications. About the procedure, refer to Turbocharger Shop Manual.



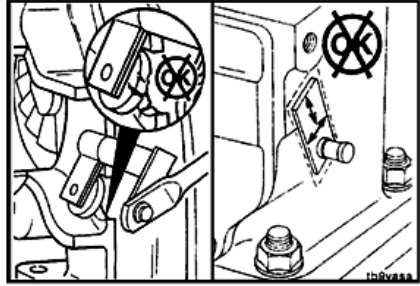
Turbocharger Wastegate Actuator – Visually Inspect



Visually inspect the lever pin.



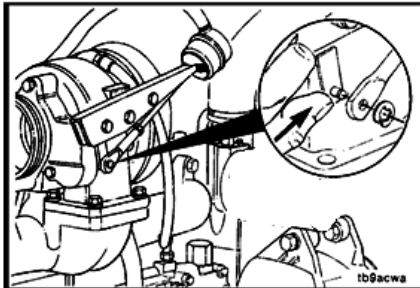
Replace the turbine housing assembly if worn excessively. Refer to the Turbocharger Shop Manual.



Visually inspect the valve and valve seat for cracks or erosion.



Replace the turbine housing assembly if worn excessively. Refer to the Turbocharger Shop Manual.



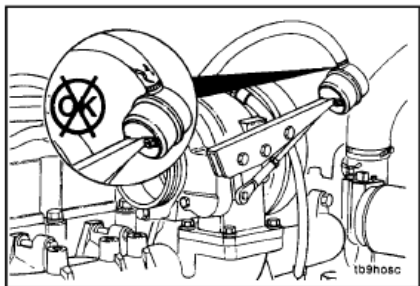
Actuate the lever by hand to be sure that the shaft moves freely and is not seized.



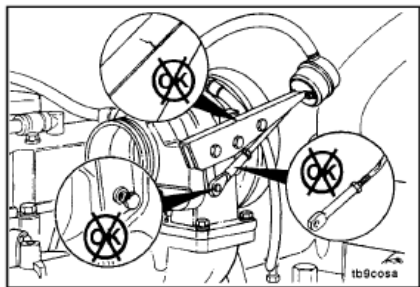
Check for excessive movement between the shaft and bushing.

Replace the turbine housing if the shaft and bushing are damaged or seized.

Refer to the Turbocharger Shop Manual.

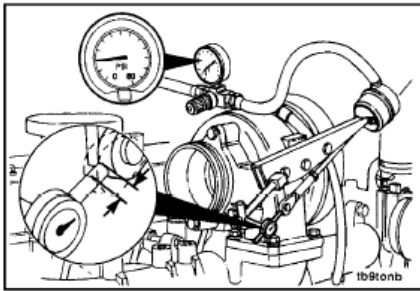


Visually inspect the wastegate actuator hose for cracks or holes. Replace the hose if damaged.



Visually inspect the wastegate mounting bracket, actuator rod, and lever for damage. A bent wastegate mounting bracket, actuator rod, or lever can cause improper operation.

If the wastegate mounting bracket, actuator rod, or lever is bent, it must be replaced.



Turbocharger Wastegate Actuator – Functional Check

Connect regulated air source and an accurate pressure gauge to the capsule. Apply 180 kpa [26 psi] to make sure the wastegate is functioning properly. The actuating rod should move approximately 5 mm [0.200 in] without sticking or air leakage.

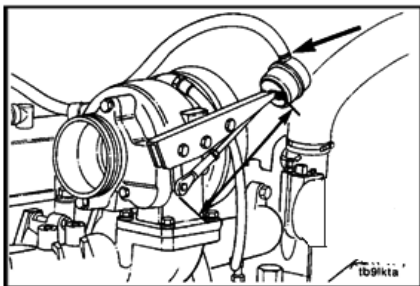
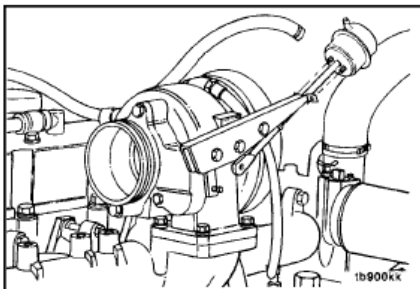
NOTE: A small amount of travel when air pressure is first applied is normal, the tolerance is being removed from the system.



Replace the actuator if no movement of the actuator rod and lever is detected.



If repair is not correct, Turbocharger Wastegate Actuator – Calibration.



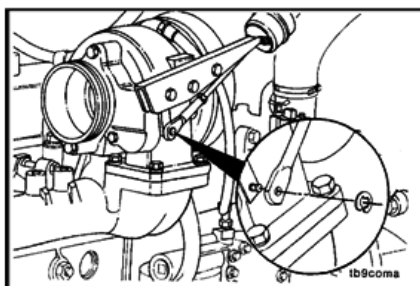
Turbocharger Wastegate Actuator – Replace

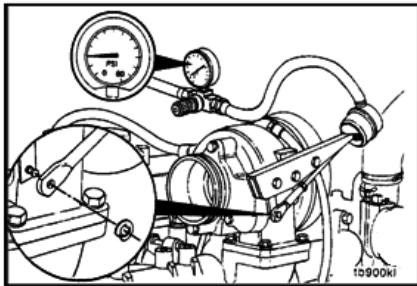
NOTE: Prior to removal, note position length of the control rod from the actuator housing and orientation of the actuator hose connector in relation to the mounting bracket.



Air Regulator with Pressure Gauge

Remove the relating clip from the control lever.





Disconnect the actuator rod end from the turbocharger wastegate lever. This can be accomplished by applying regulated air pressure to the actuator in a sufficient amount to activate control rod movement.

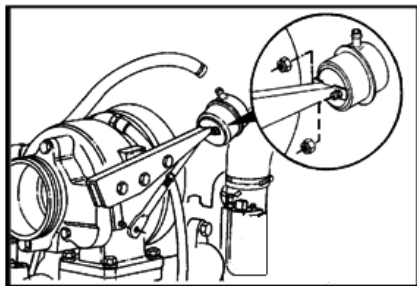
Disconnect the control rod from the turbocharger wastegate lever pin.



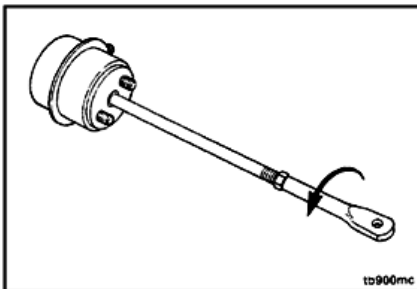
CAUTION: Be careful not to bend the control lever.

NOTE: If the actuator diaphragm material is ruptured and will not hold air pressure other than by hand, manually pull the control rod outward in order to overcome actuator spring tension for removal of the control rod from the turbocharger wastegate lever pin.

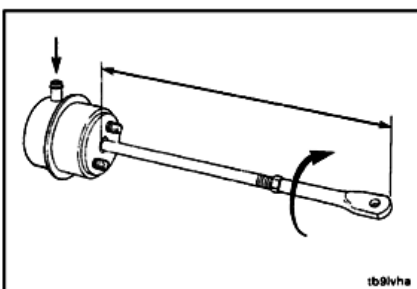
93



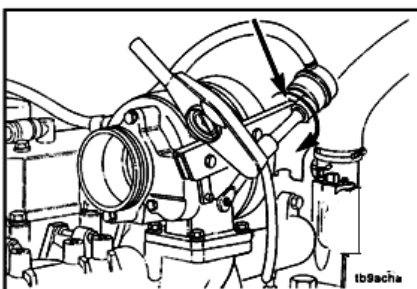
Loosen the actuator mounting capscrews and disconnect the air supply hose and remove assembly from the mounting bracket.



Remove the adjusting link end from the actuator.



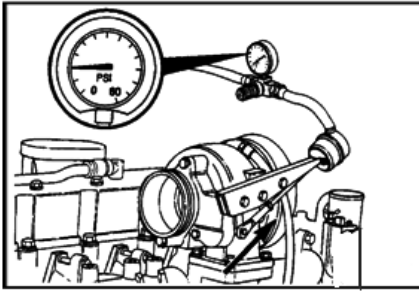
Install the adjusting link end onto the new replacement actuator assembly into approximately the same position as originally removed.



Fit the new actuator assembly to the actuator mounting bracket and install the mounting capscrews.



Torque Value: 4.5 N • m [40 in -lb]



Turbocharger Wastegate Actuator – Calibrate

NOTE: The wastegate is set accurately from the factory. Adjustment is not necessary unless the capsule is removed.

Attach a dial indicator as shown, so that its shaft is in line with the wastegate actuator rod. Set the indicator to zero, with no air pressure gauge to the capsule.



Connect clean, regulated air pressure supply and an accurate pressure gauge to the capsule.

For industrial ratings apply 153 kpa [22.2 psi]. For all other C Series ratings, apply 172 kpa [25.0 psi]. Measure the rod travel and compare to the table below.

Wastegate Actuator Travel Measurement		
	mm	in
	0.33	Min
	1.3	Max
		0.013
		0.050

Replace the actuator if no movement of the actuator rod and lever is detected. Refer to Procedure 3-04.

CAUTION: Do not pull, push or force alignment of the clevis pin.



While pressure is being applied, adjust linkage as follows:

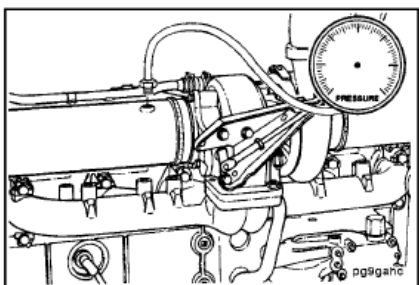
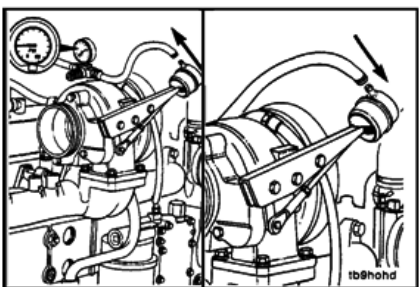
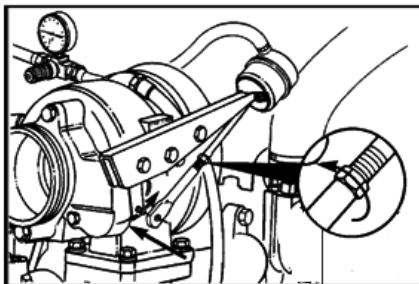
- Pull the wastegate lever to the foremost closed position (lever toward boost capsule).
- Adjust the length of the clevis end of the control rod to where the clevis pin hole aligns to the wastegate lever.
- Install the adjusting link and retaining clip.
- After adjustment is completed, tighten actuator rod locknut.



Disconnect regulated air pressure line from the actuator.



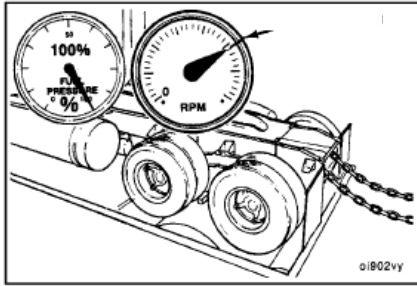
Connect the turbocharger boost line to the actuator and secure hose clamp.



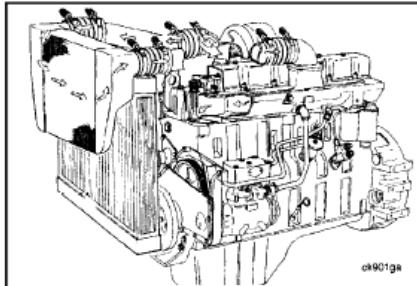
Exhaust Restrictions – Measurement

Install pressure gauge, Part No. ST-1273, to the pressure tap in the exhaust head pipe or at the inlet to the catalyst / muffler assembly.

Operate the engine at rated speed and load. Record the exhaust restriction.



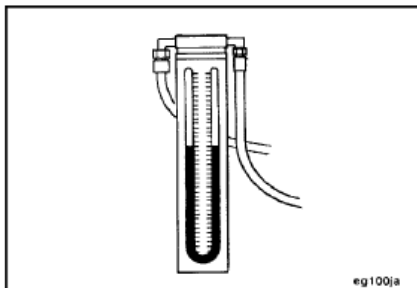
If the restriction is above specifications, inspect the oxidation catalyst and / or muffler, and replace according to the manufacturer's instructions.



Air Cooler (CAC) – Troubleshooting

93

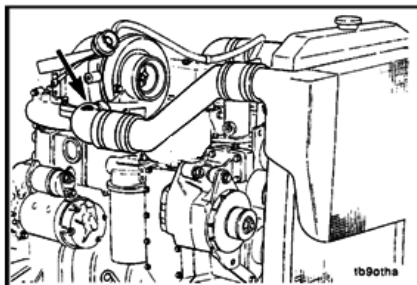
NOTE: The long term integrity of the charge air cooling system is the responsibility of the vehicle and component manufacturers; however, the following symptoms can be checked by any Cummins Authorized Repair Location:



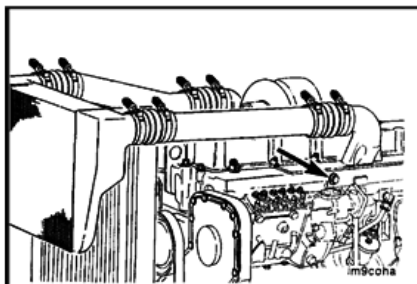
Pressure Drop – Inspect

Preferred Method

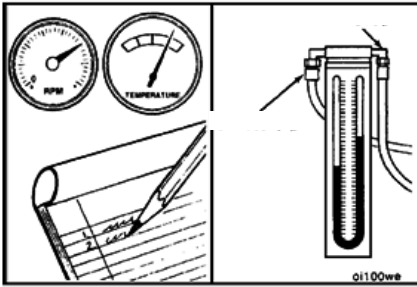
Measure the CAC system pressure drop with a mercury manometer.



Install one end of the manometer into the 1/8 inch pipe tap in the turbocharger compressor outlet elbow.

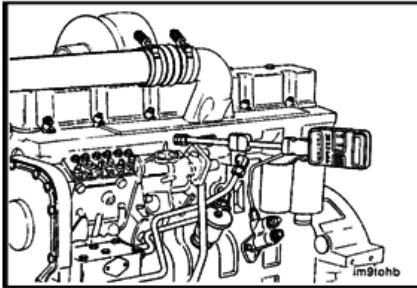


Install the other end of the manometer into the 1/8 inch pipe tap in the intake manifold.



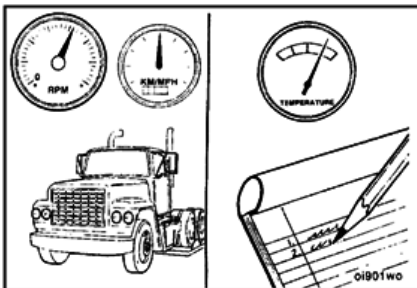
Operate the engine at the maximum advertised horsepower and correcting RPM. Record the readings on the manometer.

If the differential pressure is greater than 156 mm Hg [6.0 in Hg] or 21 kpa [3 psi], check the CAC and associated piping for plugging. Clean or replace if necessary.



Install Fluke digital thermometer, Part No. 3822666, and thermocouple wire kit, Part No. 3822988, into the intake manifold at the 1/8 – inch NPT tap near the air horn connection with the intake manifold.

Install another thermocouple at the air cleaner inlet to measure ambient air temperature.

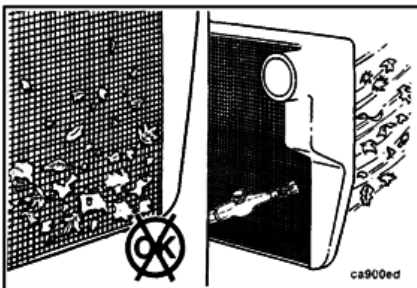


Perform a road test with the engine at peak power and a vehicle speed of 30 mph or greater.

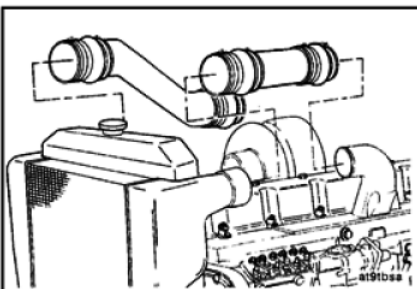
Record the intake manifold temperature and the ambient air temperature.

Calculate the differential temperature:

Intake Manifold Temperature – Ambient Air Temperature –
Differential Temperature

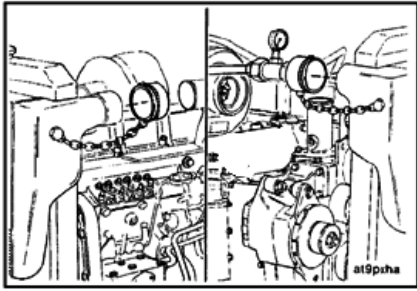


If the temperature differential is greater than 28°C [50°F], check the CAC for dirt and debris on the fins and clean as necessary. If the problem still exists, check the CAC for debris in fins or between the CAC and radiator. Make further checks that the fan installed properly.



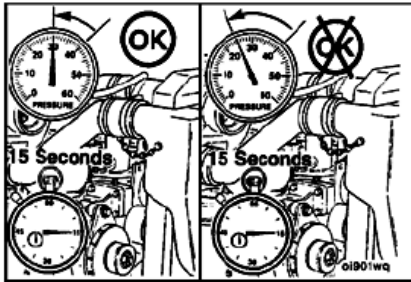
Check – Air Leak

To check the CAC for cracked tubes or header, remove the inlet and outlet hoses from the cooler. The CAC does not have to be removed from the chassis.



Install a plug or cap on the outlet side of the cooler. Install a pressure gauge, air supply line, and air pressure regulator to the inlet side of the cooler.

WARNING: To prevent possible injury if either plug bellows off during the test, secure safety chains on the test plugs to any convenient capscrew on the radiator assembly. This test must be performed with securely fastened safety chains.



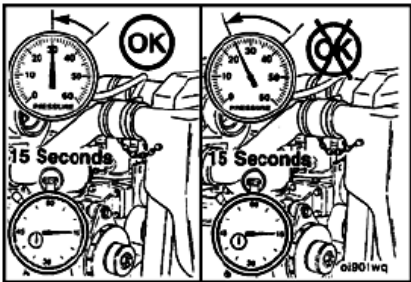
Apply 207 kpa [30 psi] of air pressure to the cooler. Close the air pressure regulator.

Monitor the pressure gauge and determine the rate of pressure decay with a stop watch.

If the pressure decay is 49 kpa [7 psi] or less than 15 seconds, the cooler is okay. If the pressure drop is greater than 49 kpa [7 psi] in 15 seconds, check all connections again.

Determine if pressure decay is caused by a leak in the CAC or from a leaky connection. Use a spray bottle filled with soapy water applied to all hose connections, and watch for bubbles to appear at the location of the leak.

If the pressure decay is caused by a leaky connection, repair the connection and repeat the test. If the leak is within the CAC, repeat the test to verify the accuracy of the pressure delay measurement. Similar pressure decay readings must be obtained at least three consecutive tests before the reading can be considered accurate.



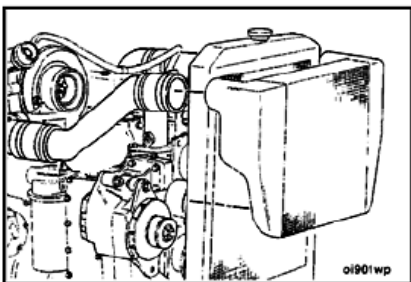
NOTE: If a CAC leaks more than 49 kpa [7 psi] in 15 seconds, it will appear as a major leak in a leak tank.

If the pressure drop is greater than 49 kpa [7 psi] in 15 seconds, the CAC must be replaced.



Refer to the manufacturer's repair manual for replacement instructions.

NOTE: Charge air coolers are not designed to be 100% leak free. If the pressure decay is less than 49 kpa [7 psi] in 15 seconds, then the CAC does not need to be replaced.



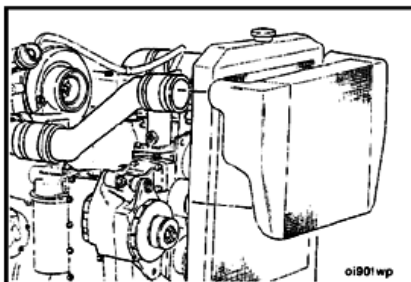
Charge Air Cooler

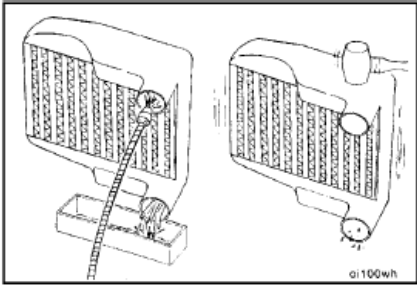
Clean and Check



If the engine experiences a turbocharger failure or any other occasion where oil or debris is put into the CAC, the CAC must be cleaned.

Remove the CAC from the vehicle. Refer to the vehicle manufacturer's instructions.





CAUTION: Do not use caustic cleaner to clean the CAC. Damage to the CAC will result.

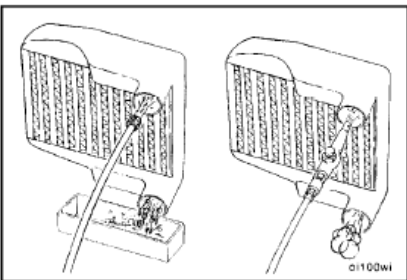


NOTE: Make sure that the tubes are in the vertical direction when flushing.

Flush the CAC internally with solvent in the opposite direction of normal air flow. Shake the CAC and lightly tap on the end tanks with a rubber mallet to dislodge trapped debris. Continue flushing until all debris or oil is removed.

NOTE: If internal debris can not be removed, scrap the CAC.

Use a flashlight and mirror to visually inspect the CAC for internal debris.



After the CAC has been thoroughly cleaned of all oil and debris with solvent, wash the CAC internally with hot soapy water to remove the remaining solvent. Rinse thoroughly with clean water.

Blow compressed air into the CAC in the opposite direction of normal air flow until the CAC is dry internally.



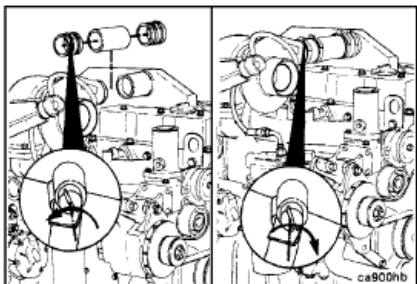
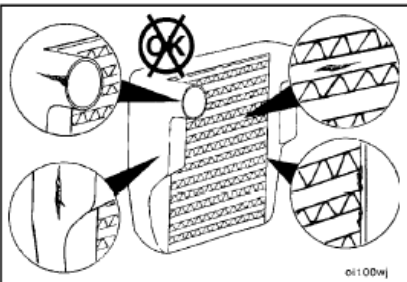
CAUTION: The CAC must be rinsed, dried, and free of solvent, oil, and debris or engine damage will result.



Visually inspect the CAC for cracks, holes or damage.



Inspect the tubes, fins and welds for tears, breaks or other damage. If any damage causes the CAC to fail the air leak check mentioned earlier in this Procedure, the CAC must be replaced. Install the CAC on the vehicle. Refer to the vehicle manufacturer for instructions.



Air Crossover – Replace Removal and Installation



8 mm or screwdriver



Loosen the hose clamps and position the hose so the crossover tube can be removed.



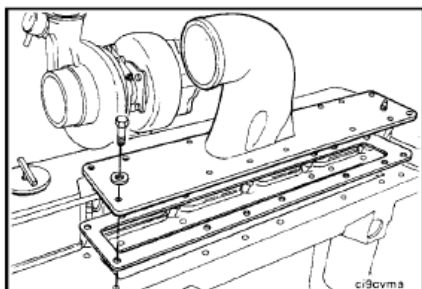
Use new hose and clamps as required to install the crossover tube.

Torque Value: 5 N • m [44 in-lb]

Intake Manifold Cover and Gasket – Replace

Preparatory:

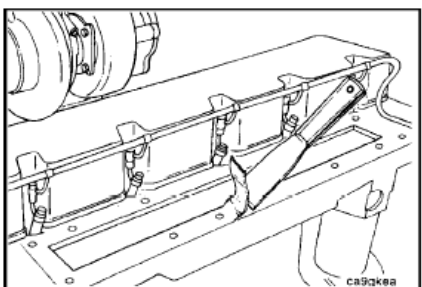
- Disconnect the cold starting aid, if used.
- Remove the air crossover tube, if used.
- Disconnect the charged air cooler hose, if used.



Remove

10 mm

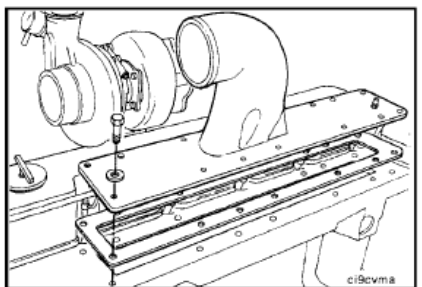
Remove the manifold cover and gasket.



Clean

Clean sealing surfaces.

NOTE: Keep the gasket material and any other material out of the air intake.



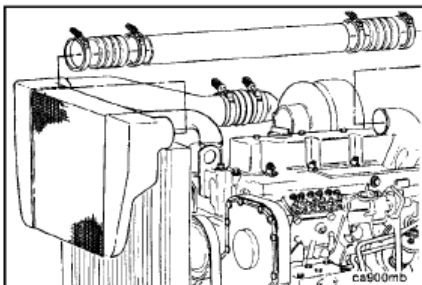
Install

10 mm

Install the cover and a new gasket.



Torque Value: 24N • m [18 ft-lb]

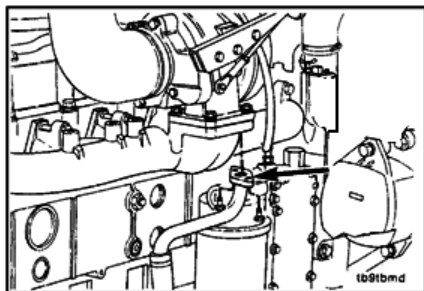


Assemble the intake piping and connect the cold starting aid if used.

Turbocharger – Replace

Preparatory:

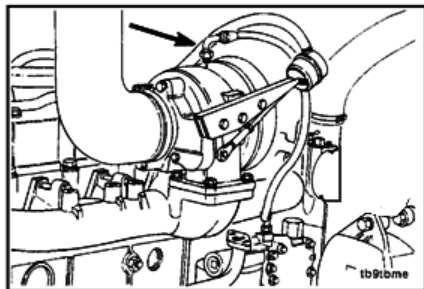
- Remove the air crossover tube, if used.
- Disconnect the charged air cooler hose.
- Disconnect the wastegate actuator hose.
- Disconnect the intake and exhaust pipes.



Remove

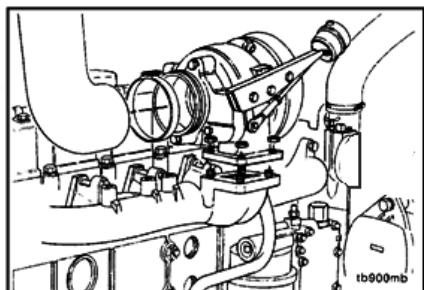
10 mm

Remove the capscrews from the oil drain tube.



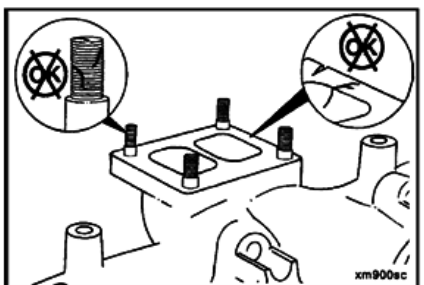
16 mm

Disconnect the oil supply line.



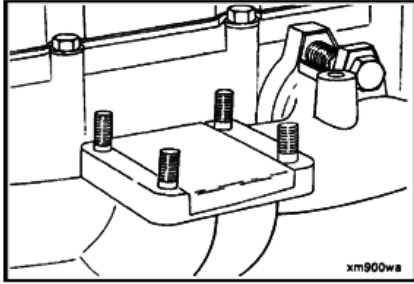
15 mm and 7/16 –inch

Remove the exhaust clamp, turbocharger, and gasket.



Clean and Check

Clean sealing surfaces. Inspect the sealing surface and mounting studs for damage.



NOTE: If the turbocharger is not to be immediately replaced, cover the opening to prevent any material from falling into the manifold.

Inspect the turbocharger wastegate linkage, valve shaft, module, and pressure signal line.

Check or calibrate wastegate.

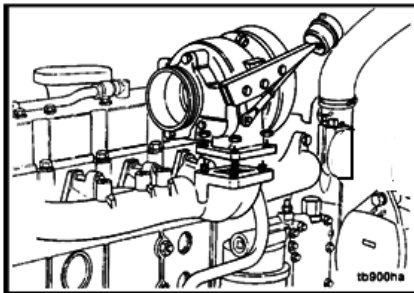
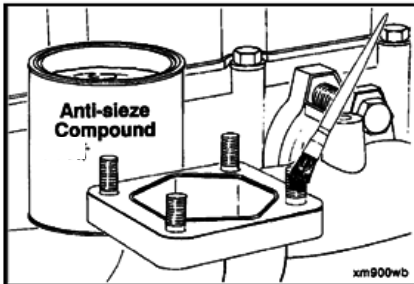


Refer to the Turbocharger Shop Manual, Bulletin No. 3810321, for calibration procedures.



Install

Install a new gasket and apply a high temperature anti-seize compound to the mounting studs.

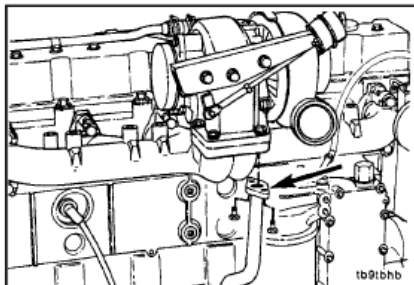


15 mm

Install the turbocharger.



Torque Value: 45N • m [33 ft-lb]



10 mm and 7/16- inch

Use a new gasket and connect the oil drain tube.

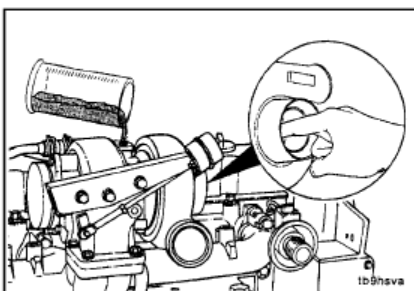


Torque Value:

(Exhaust clamp) 8N • m [71in-lb]

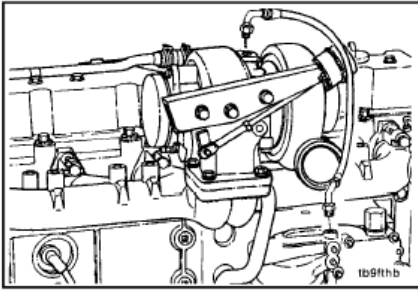


(Drain tube) 24N • m [18 ft-lb]



NOTE: New turbochargers must be pre-lubricated before start-up.

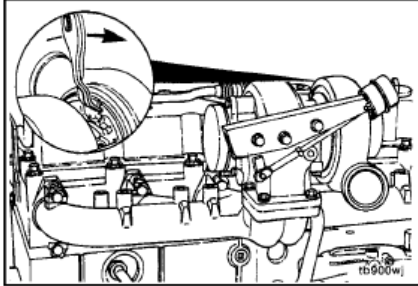
Pour 50 to 60 cc [2 to 3 ounces] of clean engine oil into the oil supply fitting. Rotate the turbine wheel to allow the oil to enter the bearing housing.



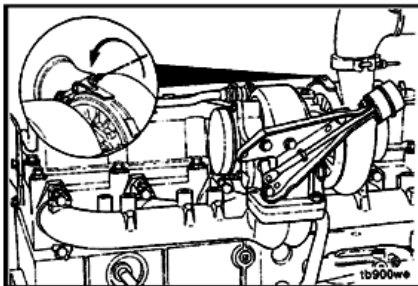
16 mm

Connect the oil supply line.

Torque Value: 15N • m [11 ft-lb]

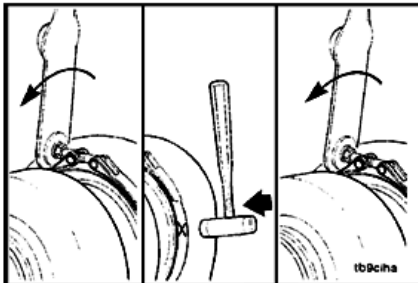


Loosen the snap ring and align the compressor housing with the turbocharger air outlet connection.



7/16 inch

NOTE: If required, loosen the compressor housing V-band clamp and position the housing to align with the turbocharger air outlet pipe.

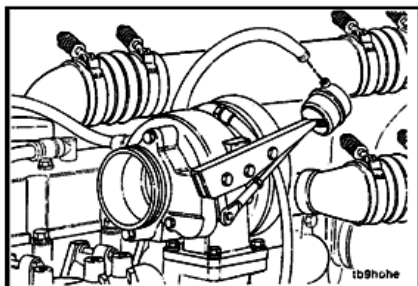


7/16 inch, Plastic Hammer

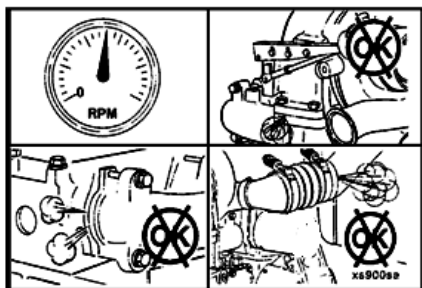
Tighten the band clamp. Tap around the clamp with a plastic hammer and tighten again.

Torque Value: 8N • m [71 in-lb]

NOTE: Effective Oct. 1, 1990 all Holset Turbochargers use silver plated nuts with the v-band clamp. The silver plated nuts require a lower torque than the stainless steel nut to provide the same v-band clamp load.



Connect the wastegate actuator hose.



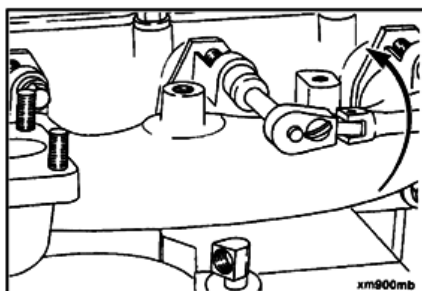
Install the air inlet and exhaust piping.
Operate the engine and check for leaks.

Exhaust Manifold and Gasket – Replace

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Preparatory:

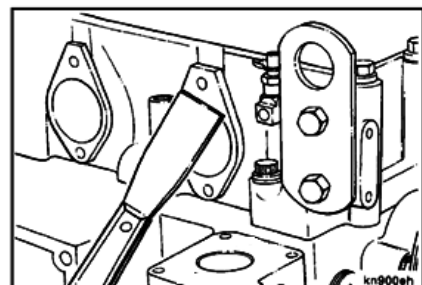
- Remove the air crossover tube, if used.
- Disconnect charge air cooler hose.
- Disconnect the intake and exhaust pipes.
- Remove the turbocharger, if used.



Remove

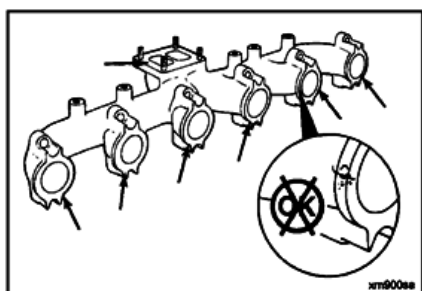
15 mm

Remove the exhaust manifold and the gaskets.

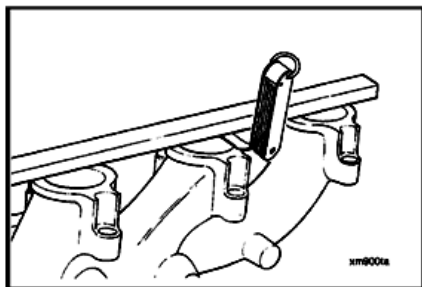


Clean and Inspect

Clean sealing surfaces.



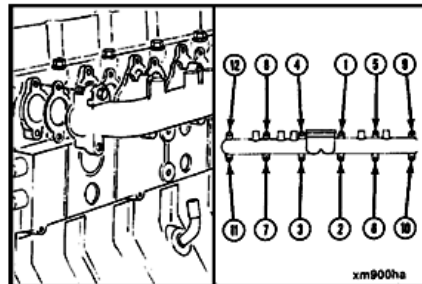
Inspect the gasket surfaces for gouges, scratches, or burnout.



Place a ruler over the exhaust ports to measure the flatness.

Exhaust Manifold Flatness

mm		in
0.20	Max	0.008



Install

15 mm



Install the manifold and new gaskets.



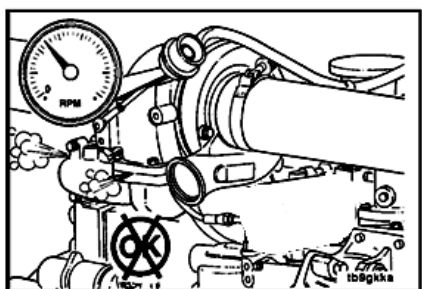
Use new tab to the capscrew.

Torque Value: 43N • m [32 ft-lb]

Follow the tightening sequence shown in the illustration.

Repeat the tightening sequence a second time.

After the capscrews are tightened to the correct torque value, bend over the lockplates to prevent the capscrews from loosening.



Install the parts previously removed. Operate the engine and check for leaks.



Air Intake Manifold Heater Description and Operation



WARNING: Ether must not be used in conjunction with this system.

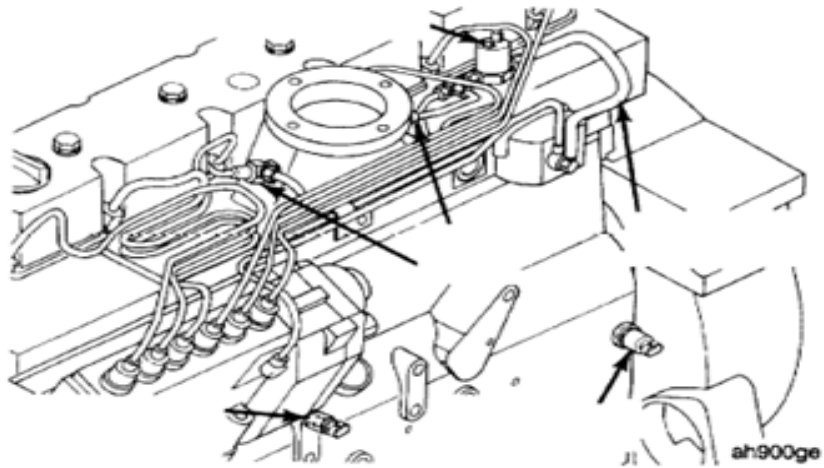
The intake cold start system burns a small amount of diesel fuel in the intake manifold to aid engine starting under cold ambient conditions. The system also operates in a post-start mode to eliminate white smoke while the engine warms up to operating temperatures.

Typical Flame Plug Operation

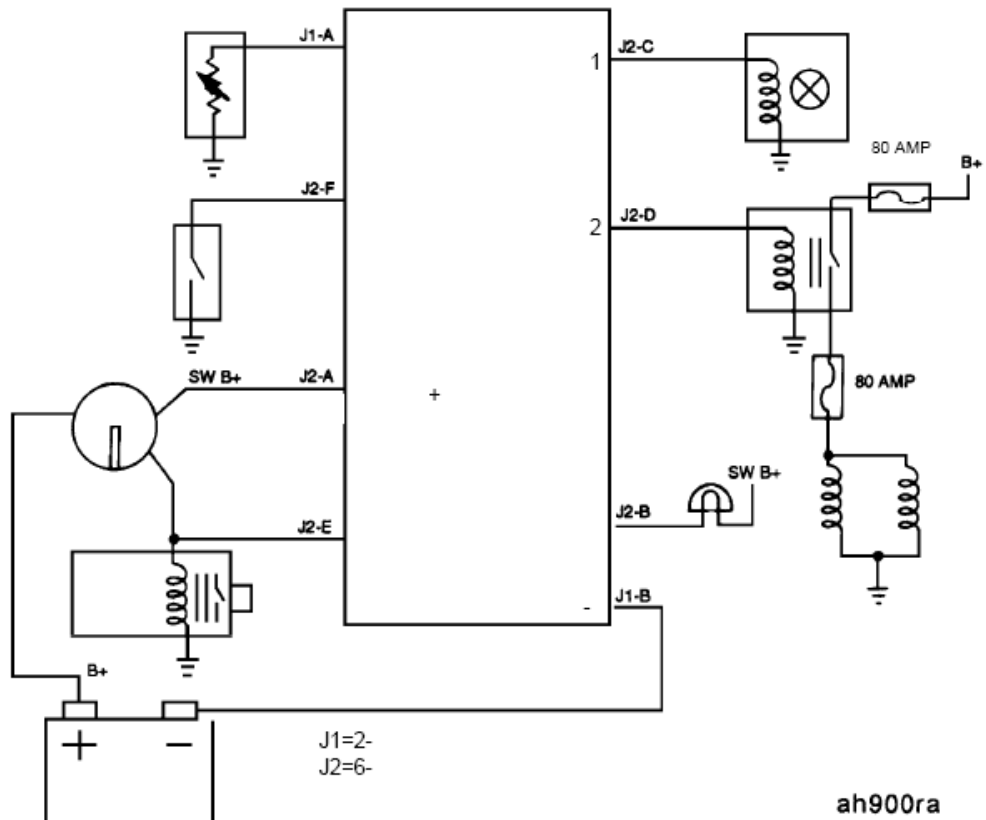
- Key switch "ON".
Controller sensors block temperature and battery voltage.
If below 45°F, wait to start (WTS) light on.
If above 45°F, wait to start (WTS) light on for seconds for bulb check.
- Preheat cycle starts.
Relay closes and starts heating flame plug.
Cycle time depends on battery voltage (see table 1).
Peak current 45A/plug, decreases with time.
- Preheat cycle complete.
WTS light goes out.
- Operator starts engine.
Starts in 5 seconds typically.
Heater current on.
Fuel solenoid powered open.
- Post heat cycle for white smoke begins.
Duration is block temperature dependent (see table 2)

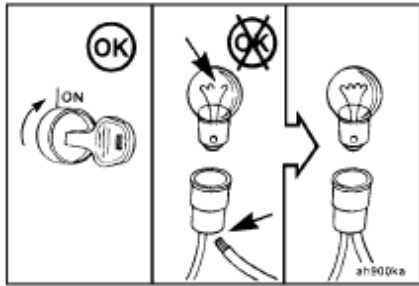
93

Table 1 Preheat Cycle			Table 2 Post Heat Cycle	
Battery Voltage (V)		Preheat Time (Sec)	Engine Temperature (°F)	Post Heat Time (min)
<u>12 volt system</u>	<u>24 volt system</u>			
<9	<20	40	above 45	none
12	24	25	45 to 17	2
13	25	20	below 17	3
>16	>30	abort cycle		



Intake Heater Controller Connection – Diagram





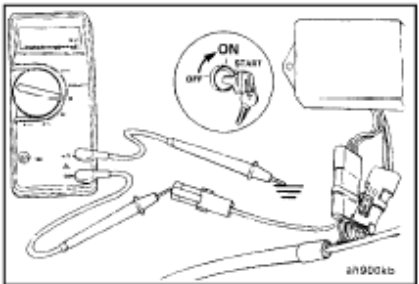
Ignition System – Check

Wait to Start Light (WTS) – Check

Turn the key to the “ON” position. The bulb check logic in the controller will turn the WTS light on for 5 seconds. Visually check the WTS light bulb.

- Check for broken filament on the bulb.
 - Check the socket and wiring.
- Replace the bulb if necessary.

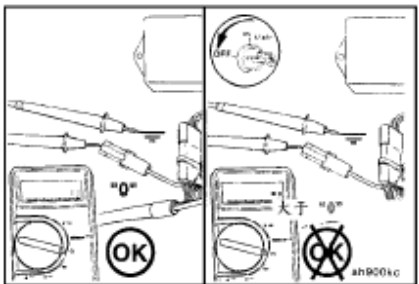
93



Check the WTS Light Wiring

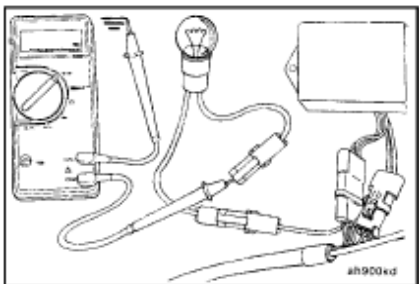
NOTE: The controller provides a ground signal to the bulb.

- Set the digital multimeter, Part No. 3376898, or equivalent to measure resistance in OHMS.
 - Connect the leads of the multimeter to the controller lead of the WTS light and a suitable ground.
 - Turn the key switch to the “ON” position.
 - The multimeter must indicate zero (“0”) or very low resistance.
 - Check the harness for burning or chafing.
 - Check the controller ground if resistance is not close to zero (pin “B”) on the 2-pin connector.
 - Turn the key switch to the “OFF” position.
- Repair the controller wiring if necessary.

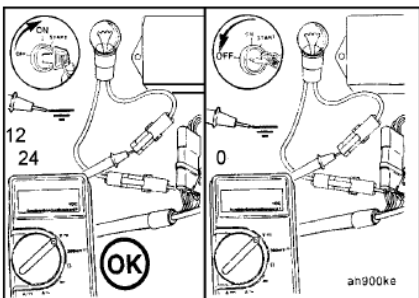


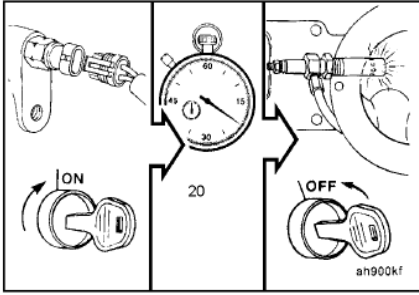
NOTE: The battery positive signal is provided by the chassis.

- Set the digital multimeter, Part No. 3376898, or equivalent to measure the voltage in volts.
- Connect the leads of the multimeter to the chassis lead of the WTS light and a suitable ground.



- Turn the key switch to the “ON” position.
- The multimeter must indicate vehicle system voltage.
- Turn the key switch to the “OFF” position.
- Repair the chassis wiring if necessary.





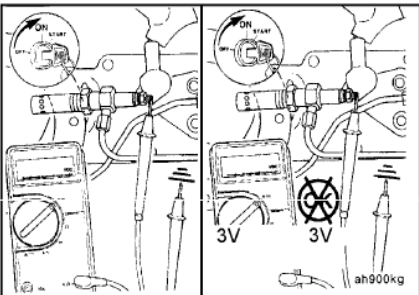
Flame Plug Electrical Circuit – Check

Disconnect the flame plug temperature sensor and install a 10,000 OHMS resistor. Remove the air intake crossover tube.

Turn the key to the “ON” position. Visually inspect the glow plug. The glow plug should be red in color when functioning properly.

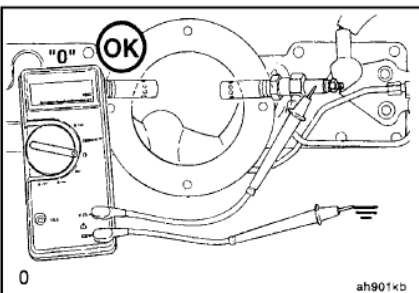
Turn the key switch to the “OFF” position.

If the glow plug is functioning properly, proceed to the Flame Plug Solenoid – Checking.



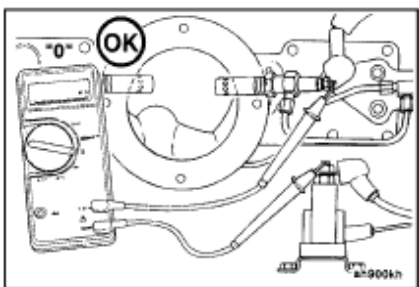
Voltage Check between Flame Plug and Ground

- Set the digital multimeter, Part No. 3376898, or equivalent to measure voltage (VOLTS).
- Connect the leads of the multimeter to the flame plug electrical connection and a suitable ground.
- Turn the key switch to the “ON” position.
- The multimeter must indicate at least 3 volts below the vehicle system voltage.
- Turn the key switch to the “OFF” position.
- If the voltage check is acceptable, proceed to the Flame Plug Electrical Heater – Check.



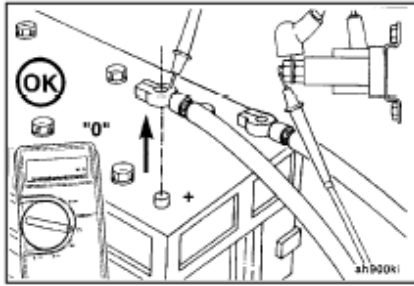
Resistance Check between the Glow Plug and Ground

- Set the digital multimeter to OHMS.
- Connect the leads to the glow plug and a suitable ground.
- The multimeter must indicate zero (0) or very little resistance.
- Ground the manifold cover properly if resistance is high.



Resistance Check between the Flame Plug and Relay

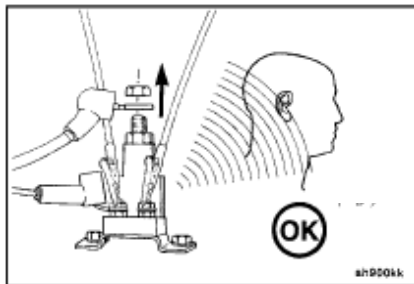
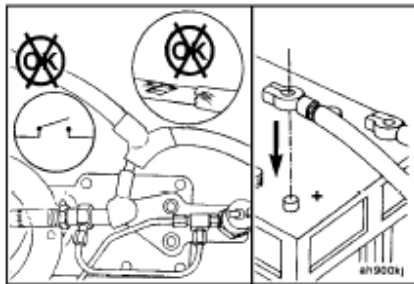
- Set the digital multimeter, Part No. 3376898, or equivalent, to measure resistance (OHMS).
- Connect the leads of the multimeter to the flame plug electrical connection and the relay.
- The multimeter must indicate zero (“0”) or very little resistance.
- Repair / replace the wiring harness if necessary.



Cable Resistance Check between Relay and Battery

- Positive Terminal
Disconnect the battery positive terminal.
- Set the digital multimeter, Part No. 3376898, or equivalent, to measure resistance (OHMS).
- Connect the leads of the multimeter to the battery cable to the relay and the battery positive cable.
- The multimeter must indicate zero ("0") or very little resistance.
- Repair / replace as necessary.
- Inspect the wiring harness and connectors for chafing or shorts to ground.
- If resistance is high or open, check the fusible link in the wiring harness.
- Repair / replace the cable as necessary.
- Install the battery positive terminal.

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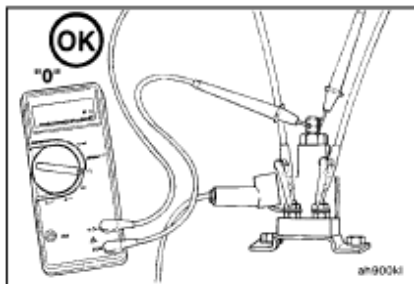


Relay Operation and Resistance – Check

Disconnect the battery lead to the relay.

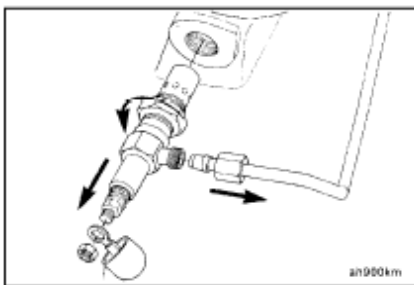
Apply system voltage and ground to the smaller terminals of the relay.

Listen for an audible click to make sure the relay is operating properly.



Apply the system voltage and ground to the smaller terminals of the relay.

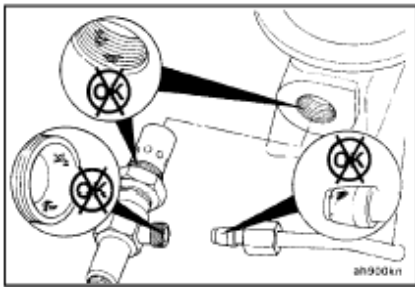
- Set the digital multimeter, Part No. 3376898, or equivalent, to measure resistance (OHMS).
- Connect the leads of the multimeter to the high current relay terminal.
- The multimeter must indicate zero ("0") or very little resistance.
- Replace the relay if necessary.



Removal of the Flame Plug

NOTE: The electrical connector on the flame plug is susceptible to failures due to excessive torque. Removal or installation torque above 4N • m [36 in-lb] will fail the delicate electrical heater.

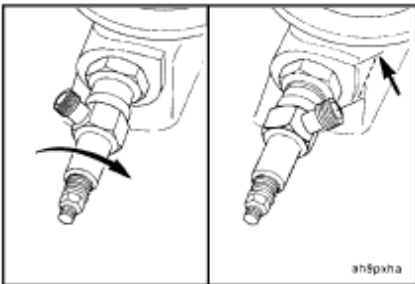
Remove the electrical connector from the plug. Remove the fuel line.



CAUTION: The flame start systems has very small orifices and filter which is susceptible to contamination. When any fuel lines are disconnected, make sure no debris enters the fuel system.

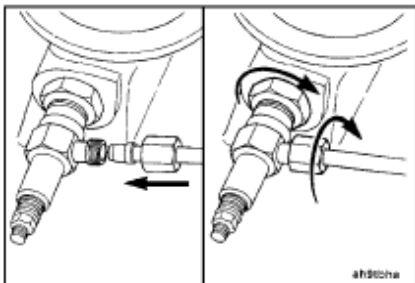
Visually inspect the fuel sealing surfaces on the flame plug and fuel line for scratches or burrs.

Replace the flame plug or fuel line if damaged



Install the flame plug with the jam nut installed.

Bottom out the plug into the manifold and back it out two turns until the plug is aligned with the pointer on the manifold.



Align the fuel plumbing with the flame plug to make sure the fuel tube is centered with the plug.

Install the fuel line.



Torque Value: fuel line 10N • m [89 in-lb]

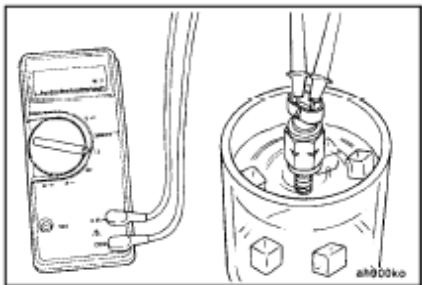
Jam nut 25N • m [18 ft-lb]

Install the electrical connections.



Torque Value: 4N • m [36 in-lb]

CAUTION: Do not exceed this torque. Damage and or failure to the glow plug will result.



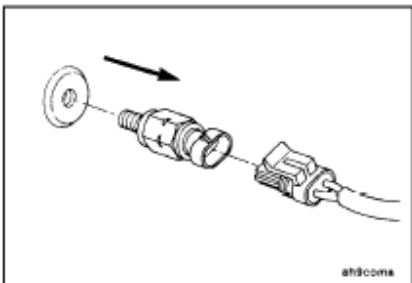
Temperature Sensor – Check

- Set the digital multimeter, Part No. 3376898, or equivalent.
- Connect the leads of the multimeter to the temperature sensor leads.
- Record the resistance at the following conditions.

Temperature °C [°F]	Resistance	Measure Value
Room Temp	1600	
0° [32°]	800	

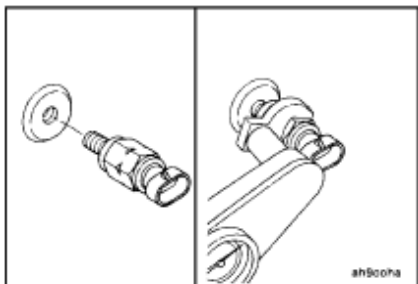
If sensor is 100 OHMS over the specified resistance, replace the sensor. With the key switch “ON”, check the resistance across pins J1A and J1B for resistance.

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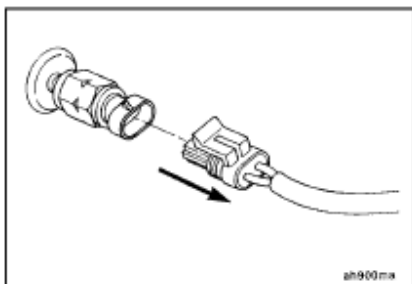
Temperature Sensor – Remove

Remove the electrical connection to the temperature sensor.
Remove sensor.



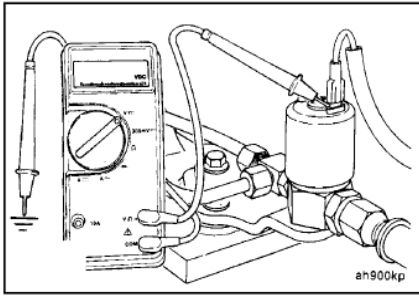
Temperature Sensor – Install

Install the sensor in the reverse order of removal.
Torque Value: 40N • m [30 ft-lb]

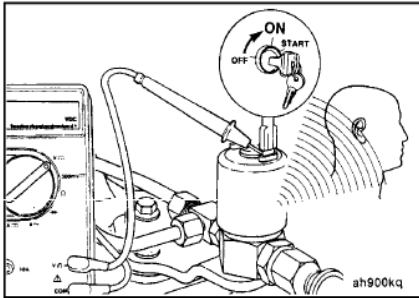


Flame Plug Solenoid – Check

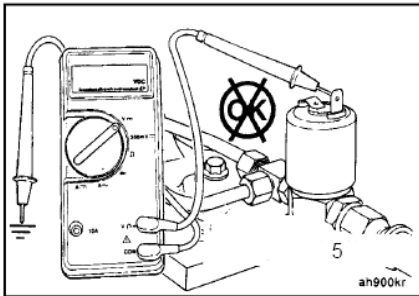
Disconnect the temperature sensor.



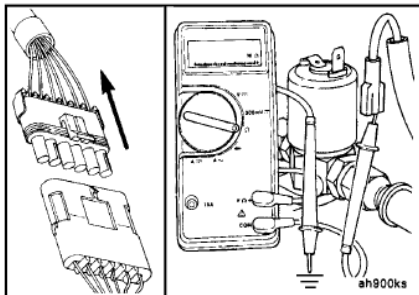
- Set the digital multimeter, Part No. 3376898, or equivalent, to measure the voltage (VOLTS).
- Connect the leads of the multimeter to the flame start fuel solenoid and a suitable ground.



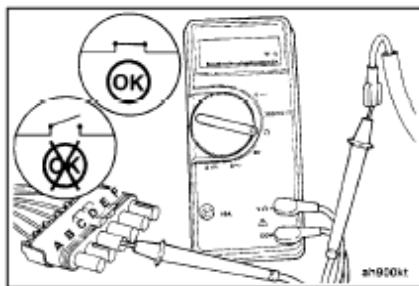
Turn the key switch to the "ON" position.
After the WTS light goes out, attempt to start the engine.
Listen for the solenoid "click".



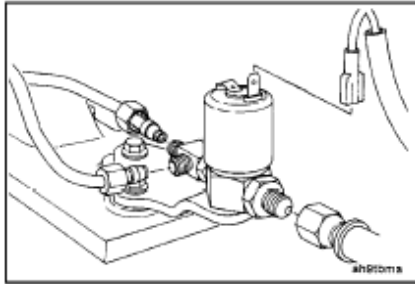
Measure the fuel solenoid connector voltage.
Turn the key switch to the "OFF" position.
If the voltage is 5 volts less than the system voltage,
inspect the engine wiring harness and the controller
harness for shorts or chaffed insulation



Disconnect the control module connector.
Connect the leads of the multimeter to the flame start fuel
solenoid connector and a suitable ground. Resistance
must be infinite or open circuit.
If the wiring harness shorted to the ground, replace or
repair.



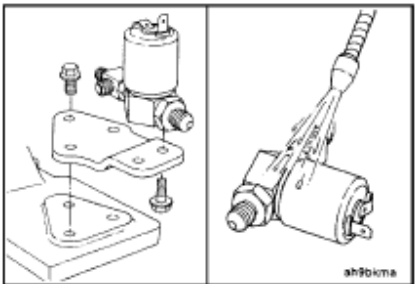
Measure the wiring harness resistance between pin "C"
on the harness connector and the solenoid.
The wiring harness resistance must be zero "0" or close
to zero. If not "0", replace or repair the wiring harness.



Flame Plug Fuel Solenoid Control – Check

Remove the electrical connector.

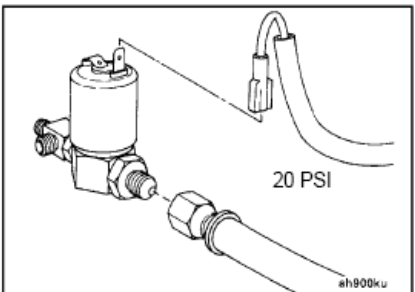
Disconnect the fuel lines from the solenoid valve.



Remove the bracket and solenoid assembly from the intake cover.



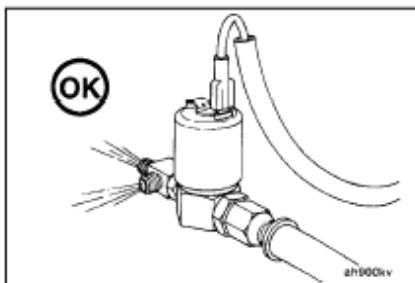
Remove the residual fuel and clean the solenoid.



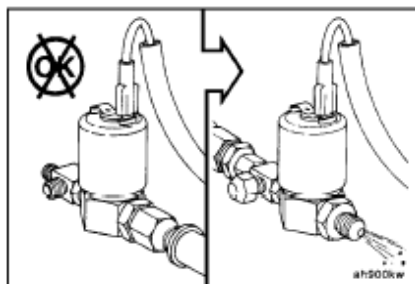
Apply system voltage and a suitable ground to the solenoid.

Apply a clean supply of 20 psi shop air in the inlet side of the solvent valve.

NOTE: The orifice in the solenoid valve is susceptible to plugging. Make sure no debris enters the valve.

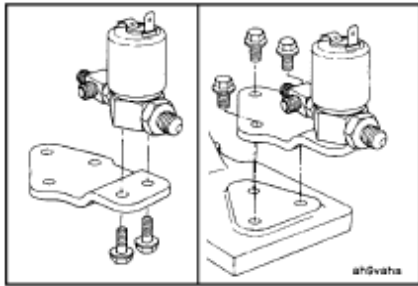


Apply clean shop air to the solenoid and listen / feel for air passage.



If the solenoid is plugged, remove the debris by back flowing the valve with clean shop air.

If the solenoid valve does not open or is still plugged, replace the valve.



Solenoid Valve – Install

8 mm



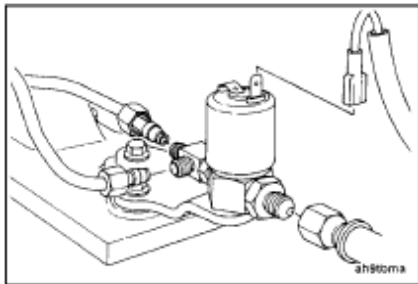
Install the solenoid valve on the bracket.



Torque Value: 9N • m [80 in-lb]

Install the solenoid bracket on the intake cover.

Torque Value: 9N • m [80 in-lb]



Install the solenoid valve fuel supply line.

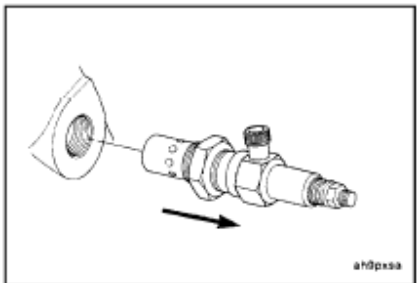


Torque Value: 10 N • m [89 in-lb]

Install the solenoid valve fuel lines.

Torque Value: 10 N • m [89 in-lb]

NOTE: To prevent leaks, inspect the sealing surfaces and align the fuel lines to the solenoid before torquing the fuel lines.

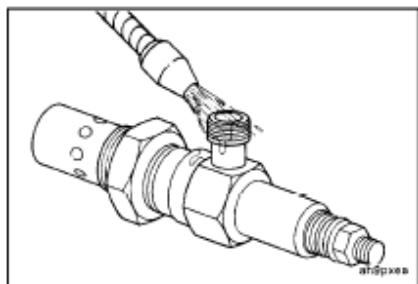


Remove the flame plug.



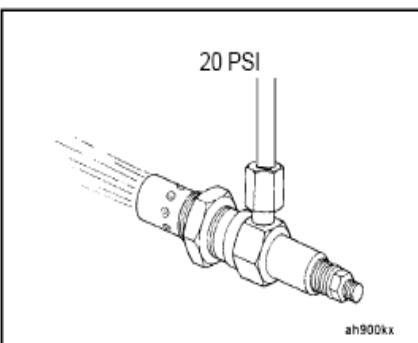
Check the flame plug for plugging and coking.

NOTE: The flame plugs have very small orifices and will fail if plugged with debris. Make sure not to contaminate the plugs.



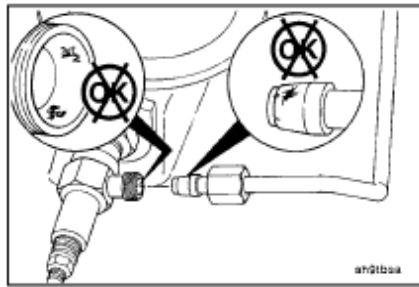
Use a solvent to clean the flame plug filter screen.

NOTE: Do not remove the filter screen from the flame plug. If the screen can not be cleaned with a solvent, replace the plug.



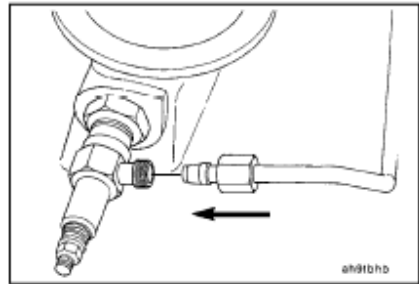
Apply 20 psi of clean shop air to the flame plug and listen/feel for air flow.

If no air flow is detected, replace the plug.



Fuel Line leak - Repair

Remove the fuel line and visually inspect the sealing surfaces for scratches or burrs. Replace the damaged fuel line or the flame plug if necessary.

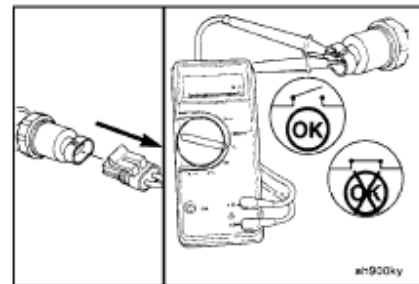


Align the hard-line ends to the end point of the connection.

NOTE: Do not try to force a misaligned fuel line into a connection. This will load one side of the seal and damage the seal.

Install the fuel line.

Torque Value: 10 N • m [89 in-lb]

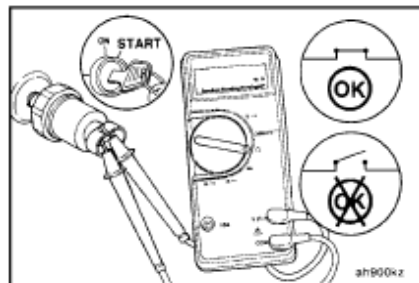


Oil Pressure Switch Function – Check

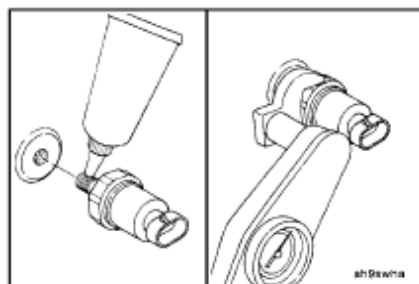
Disconnect the oil pressure sensor.

Connect the leads of the multimeter to the lubricating oil pressure sensor connector.

The resistance must be infinite or open circuit. If the switch is shorted, replace the lubricating oil pressure switch.



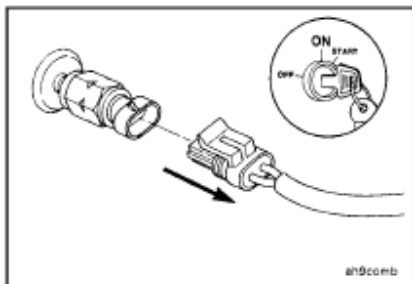
Start the engine (if possible) and measure the lubricating oil pressure switch resistance. If the resistance is not zero “0”, replace the lubricating oil pressure sensor.



Lubricating Oil Pressure Switch – Install

Install the lubricating oil pressure switch.

Torque Value: 20 N • m [15 ft-lb]

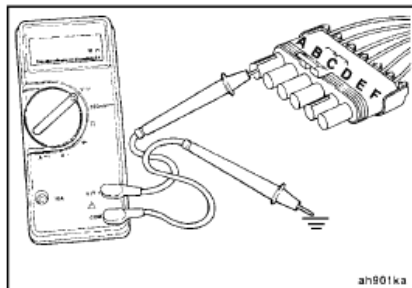


Controller logic circuit – check

Disconnect the temperature sensor connection.

Turn the key switch to the “ON” position.

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Connect the leads of the multimeter to pin “A” on the six pin connector and a suitable ground.

Measure the voltage.

Check for system voltage.

- The controller has an over-voltage protection circuit that will abort all operations if pin “A” has sensed an over-voltage condition. Refer to the chart below:

system voltage	over-voltage limit
12V	18 V
24V	30 V

- The WTS light will flash if the temperature sensor is disconnected or failed.
- If the controller does not have an oil pressure signal within 30 seconds after cranking the engine, the controller will abort the cycle.
- If the controller malfunctions, replace the controller.

NOTES

Fuel System

Fuel System Components and Flow

A cam-actuated fuel transfer pump provides positive fuel pressure to the fuel injection pump. Fuel flow begins as the fuel transfer pump pulls fuel from the supply tank. The system should have a pre-filter or screen to remove larger contaminants from the fuel before reaching the fuel transfer pump. The fuel transfer pump supplies low pressure fuel through the fuel filter head and filter.

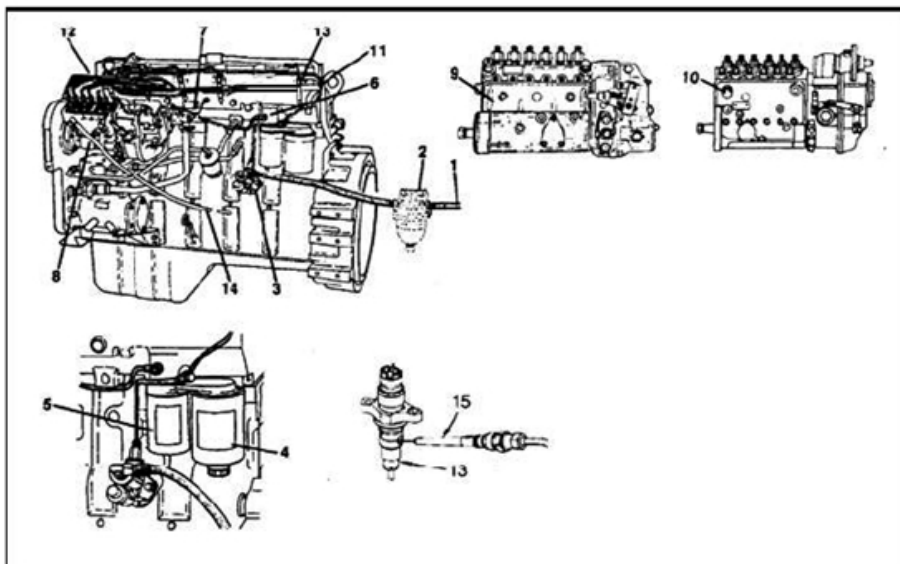
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The fuel injection pump builds the high injection pressures required for combustion and routes the fuel through high pressure fuel lines to each injector.

When the high-pressure fuel reaches the injector, the pressure lifts the needle valve against the spring tension to allow fuel to enter the combustion chamber.

Any leakage past the needle valve enters the fuel drain manifold. The manifold routes leakages from the injectors to the fuel filter head. Fuel from the injection pump vent fitting is returned to the supply tank through the fuel return line.

Fuel System



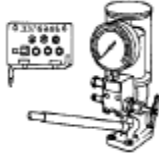
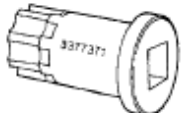
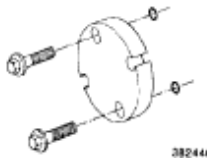
- | | |
|---------------------------------------|--|
| 1. Fuel from supply tank | 9. Robert Bosch PES.A Injection pump |
| 2. Pre-filter or screen | 10. Robert Bosch PES.P Injection pump |
| 3. Lift pump | 11. Fuel drain manifold |
| 4. Fuel/water filter separator | 12. High-pressure fuel line |
| 5. Fuel filters | 13. Robert Bosch, 17mm enclosed injection Pump with nozzle |
| 6. Low-pressure supply line | 14. Fuel return to supply tank |
| 7. Turbo boost pressure control line | 15. Fuel inlet line |
| 8. Robert Bosch PES.MW Injection pump | |

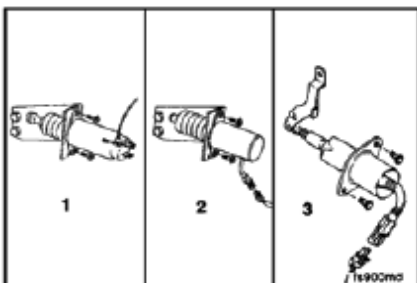
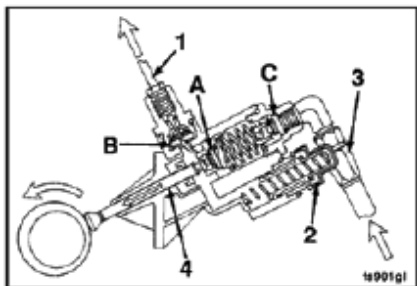
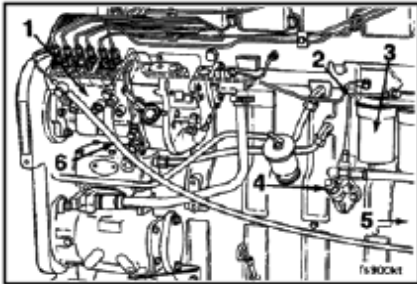
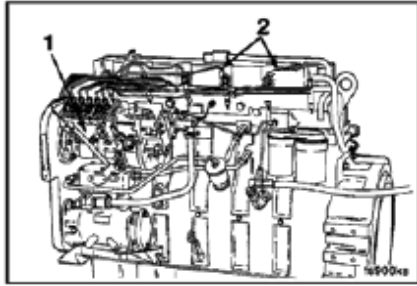
Fuel System Specifications

Fuel transfer pump maximum inlet restriction	150 mm Hg [4 in Hg]
Fuel transfer pump output pressure (minimum) at rated speed	
High Flow	172 kPa [25 psi]
Low Flow	83 kPa [12 psi]
Minimum pressure to fuel pump inlet (all in-line)	
High Flow	138 kPa [20 psi]
Low Flow	48 kPa [7 psi]
Fuel filter restriction (maximum pressure drop across filters)	35 kPa [5 psi]
Fuel return restriction (minimum)	518 mm Hg [20.4 in Hg]

Fuel System – Service Tools

The following special tools are recommended to perform procedures in Section 7. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No	Tool Description	Tool Illustration
3376946	Injection Nozzle Tester Used to test injection nozzles.	
3376947	Injector Nozzle Cleaning Kit Used to clean injection nozzles.	
3377371	Engine Barring Tool Used to rotate the crankshaft.	
3822510	Injector Bore Brush Used to clean carbon from injector bores.	
3823276	Puller, Injector Used to remove injectors.	
3824469	Puller, Fuel Pump Gear Used to remove the fuel pump gear.	
3823425	Wrench, Crowfoot Used to tighten high-pressure fuel lines.	



Fuel System- Diagnosing Malfunctions

The function of the fuel system is to inject a metered quantity of clean, atomized fuel into the engine cylinders at a precise time near the end of the compression stroke of each piston. The components of the system contribute to the delivery of fuel to the cylinders.

1. Injection pump
2. High-pressure fuel lines

Fuel Transfer Pump

The system design requires an inlet pressure of 131 to 172 kPa (19 to 25 psi) to the fuel injection pump.

The fuel transfer pump capacity is designed to deliver pressure in excess of 138 kPa (20 psi). The pressure relief valve controls the inlet to the pump by dumping excess fuel back to the supply tank.

1. Injection pump
2. Fuel supply line
3. Fuel filters
4. Fuel transfer pump
5. Fuel tank
6. Pressure relief valve

The fuel transfer pump is mechanically driven by a plunger running against a special lobe on the camshaft. The fuel transfer pump contains a pumping piston and check valves to control the flow of fuel, and bleed back during engine shutdown.

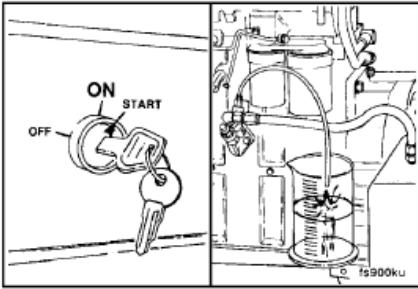
Check valves A, B, C.

1. Low-pressure supply line
2. Priming pump
3. Fuel inlet line
4. Piston

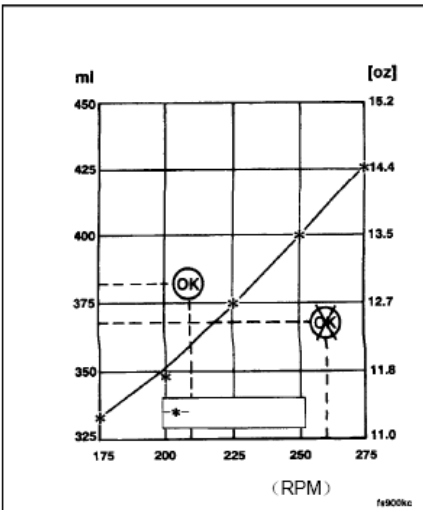
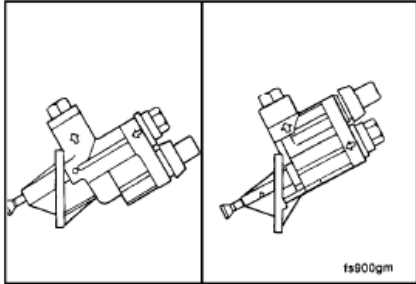


Make sure the wire to the fuel solenoid is disconnected before performing the following check. Residual fuel in the fuel injection pump may allow the engine to start.

1. Synchro-start
2. Trombetta



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To determine if the fuel transfer pump is delivering the correct amount of fuel.

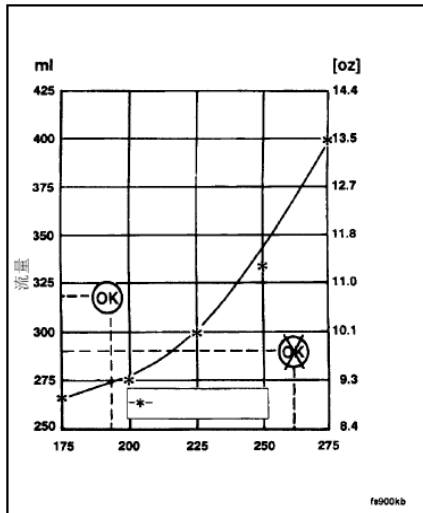
- Measure the engine cranking RPM with a tachometer.
- Measure the fuel transfer pump output for a 30 second cranking cycle.
- Use the data and the following charts to check the fuel transfer pump performance for both the automotive and industrial fuel transfer pumps.

Automotive Fuel Transfer Pump (High Flow)

Use the chart given in the illustration to find the correct flow volume specification for the automotive fuel transfer pump used with the Robert Bosch PES6A (P7100) fuel injection pump.

- Draw a straight vertical line above the measured cranking RPM.
- Draw a straight horizontal line from the measured flow volume to the engine cranking RPM vertical line to find the intersection point.
- Any intersection point above the required flow line indicates an acceptable flow.
- Any intersection point below the required flow line indicates unacceptable flow and a defective pump or too much line restriction.

Example 1	Engine cranking speed	210 RPM
Good Pump	Flow Volume	380ml [12.9 oz]
Example 2	Engine cranking speed	260 RPM
Bad Pump	Flow Volume	370ml [12.5 oz]



Fuel Transfer Pump-Industrial (low flow)

Use the chart given in the illustration to find the correct flow volume specification for the industrial fuel transfer pump used with the Robert Bosch PES6A and MW fuel injection pump

- Draw a straight vertical line above the measured cranking RPM.
- Draw a straight horizontal line from the measured Flow volume to the engine cranking RPM vertical line to find the intersection point.
- Any intersection point below the required flow line indicates an unacceptable flow and a defective pump or too much restriction.

Example 1 Engine cranking speed 190 RPM

Good Pump Flow Volume 320 ml (10.8 oz)

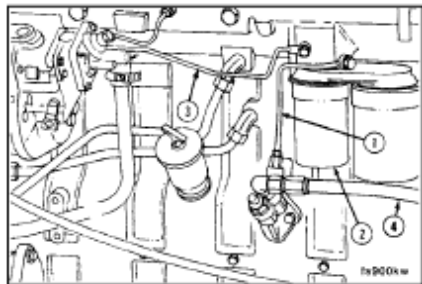
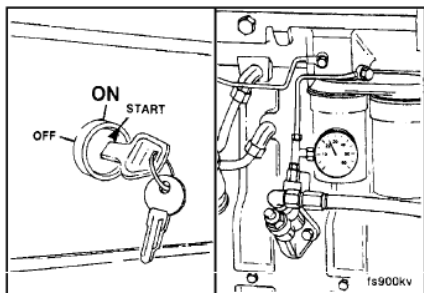
Example 2 Engine cranking speed 260 RPM

Bad Pump Flow Volume 290ml (9.8 oz)

A quick check to determine if the fuel transfer pump is delivering fuel is to measure the output pressure.

Fuel Transfer Pump Output Pressure at Rated Speed

kPa		psi
172	Min (high flow)	25
83	Min (low flow)	12



If the required volume is being delivered, look for a restriction between the fuel transfer pump and the fuel injection pump.

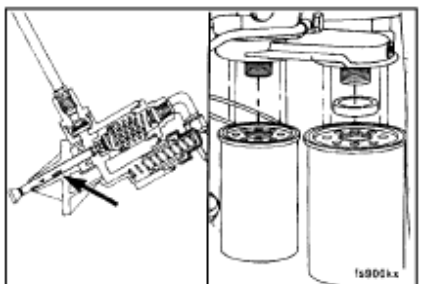
1. Supply line to filter
2. Filter
3. Supply line to fuel injection pump

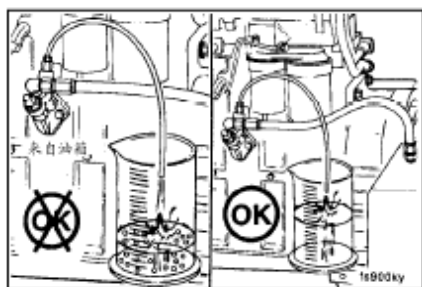
If the required volume is not being delivered, measure the transfer pump inlet restriction with a vacuum gauge between the transfer pump inlet and the supply line from the tank. Refer to the fuel system specification for inlet restriction.

4. Inlet to transfer pump from supply tank.

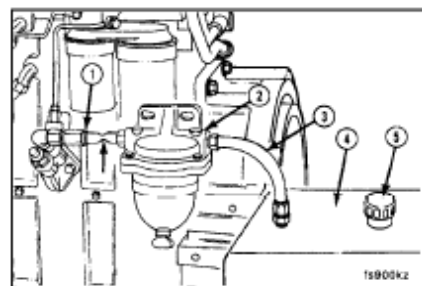
The pressure drop across the filter will increase as the filter removes contamination from the fuel. Therefore, a worn fuel transfer pump will have reduced capacity to force fuel through a dirty filter. This can cause low engine power.

Frequent filter replacement to get full power from the engine can indicate a worn fuel transfer pump.



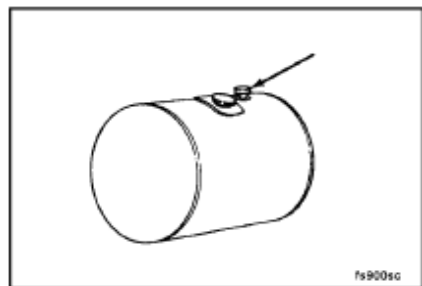


If the fuel is aerated or the volume is low, isolate the fuel transfer pump by connecting the fuel transfer pump inlet to a temporary supply and perform the same check as above.

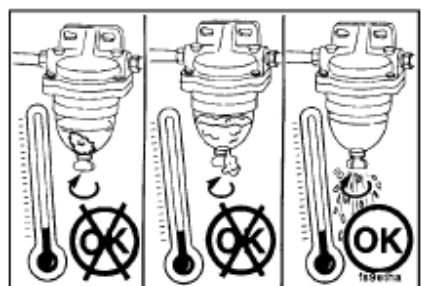


If the fuel transfer pump delivers the required volume of fuel from a temporary supply, check for restrictions or suction leaks in the fuel circuit to the fuel transfer pump.

1. supply line
2. pre-filters
3. supply line
4. supply tank
5. tank vent

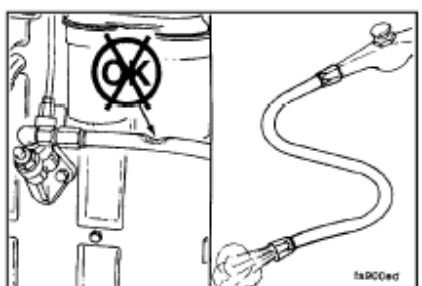


Look for a plugged supply tank vent first.

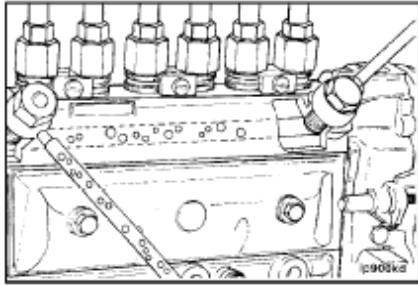


Replace or clean the pre-filter.

In cold weather look for gelled fuel blocking the pre-filter.



Look for kinks that can restrict the supply lines.
Remove and blow out supply lines.



Air in the Fuel System

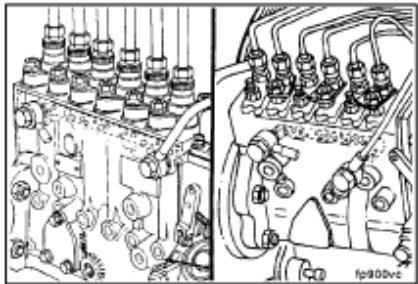
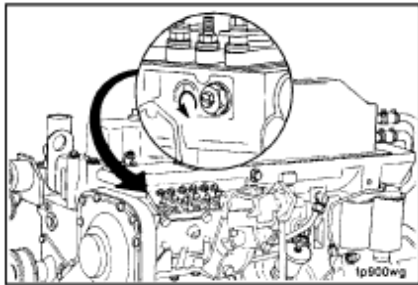
The pressure relief valve arrangement in the supply side of the fuel circuit creates a self-bleeding system on the PES6A fuel injection pump for air introduced during replacement of the supply side components.

Small amounts of air can be bled from the fuel injection pump by operating the hand primer on the fuel transfer pump or by cranking the engine.



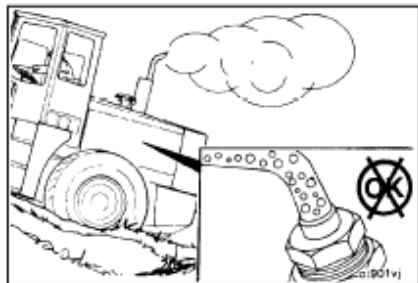
NOTE: PES6MW fuel injection pumps without the fuel drain arrangement on the engine side will require additional venting prior to initial startup, fuel injection pump replacement, or if the engine has been allowed to run out of fuel. Refer to Procedure 5-10 for more details.

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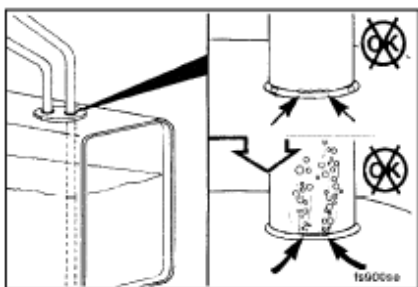


The PES6MW and PES6P fuel injection pumps equipped with engine side fuel drain arrangement creates a self-bleeding system for air introduced during replacement of the supply side components.

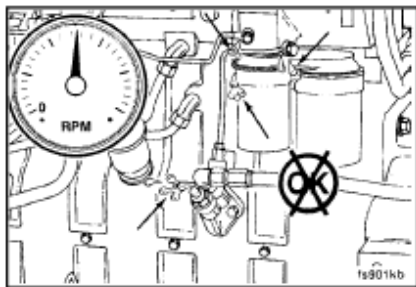
Small amounts of air can be bled from the pump by operating the hand primer on the fuel transfer pump or by cranking the engine.



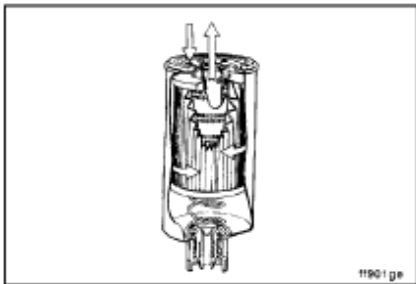
Air from uncorrected leaks in the supply circuit will make the engine: difficult to start, run rough, misfire, produce low power, and can cause excessive smoke and a fuel knock.



A source, which is often overlooked, for air to enter the fuel system is between the inlet of the pre-filter and the suction tube in the tank. Fuel tanks that have the outlet fitting at the top will have a suction tube that extends to the bottom of the tank. Cracks or pin holes in the weld that joins the tube to the fitting can let air enter the fuel system.



Since the fuel transfer pump provides a positive pressure through the fuel filter and supply line to the fuel injection pump, loose connections or defective seals should show as a fuel leak.

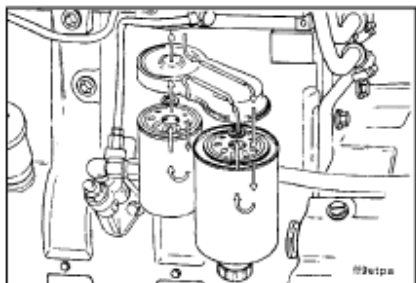
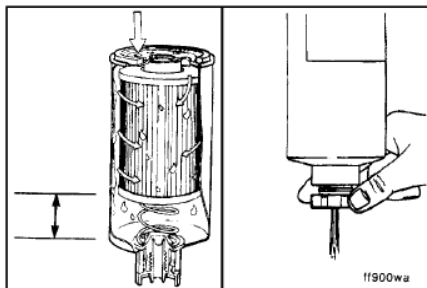


Fuel water separator/ filter unit

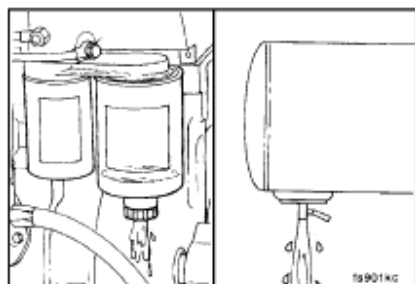
Filtration and separation of water from the fuel is important for trouble-free operation and long life of the fuel system. Some of the clearance between the fuel injection pump parts is very close. For this reason the parts can easily be damaged by rust formation, contamination, or loss of the lubricating film of fuel.

Be sure to use the correct element.

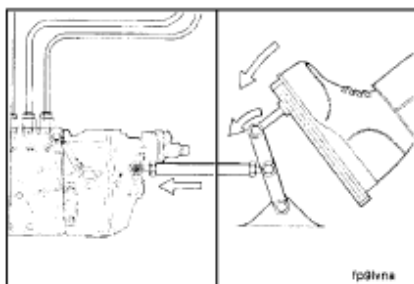
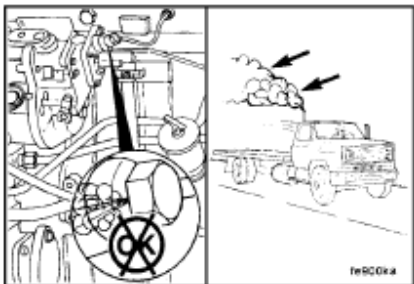
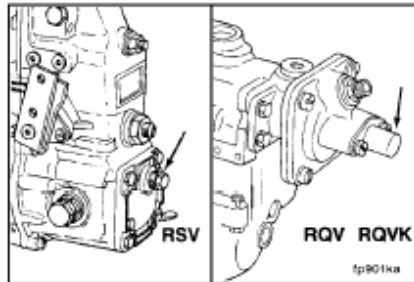
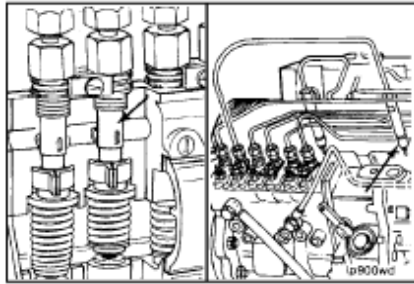
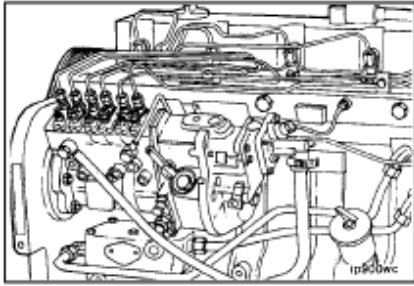
The element has a valve which must be opened daily to drain the collected water.



A dual water separator/filter adapter provides additional filtering capacity. The fuel flows through the adapter to a larger combination fuel water separator filter, and back to the fuel filter for final filtering.



Regular maintenance, including draining moisture from the fuel water separator/filter and supply tanks, is essential to keep water out of the fuel.



Injection Pump

The fuel injection pump performs the three basic functions of:

1. Producing the high fuel pressure required for injection.
2. Metering the exact amount of fuel for each injection cycle.
3. Distributing the high pressure, metered fuel to each cylinder at the precise time.

Individual plungers are used in the fuel injection pumps to develop and distribute the high pressure required for injection.

A worn or damaged plunger in the fuel injection pump will affect only one cylinder.

Governor Malfunctions

Balance between the flyweight governor and the control lever position controls the metering of the amount of fuel to be injected.

The fuel injection pump governor performance and setting can affect engine power. Special equipment and qualified personal are required to verify governor performance. If the seals are broken on the external adjustment screw, the fuel rate may be out of adjustment.

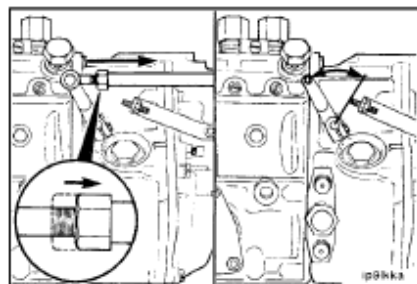
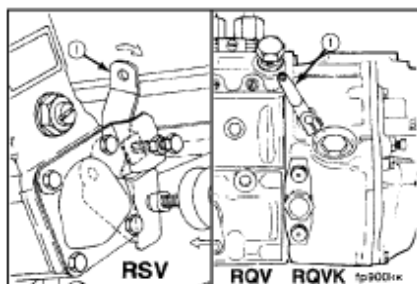
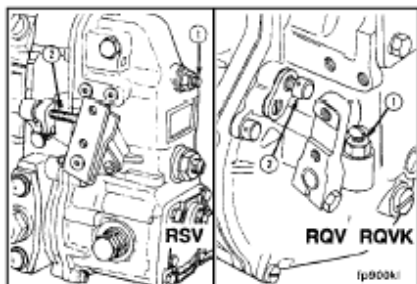
Air Fuel Control (AFC) Malfunctions

The AFC is a performance part and must not be tampered with after adjustment at the factory.

The ROV and RQVK governors are equipped with an air fuel control (AFC) device to help control emissions. The AFC regulates the fuel to air mixture by sensing manifold pressure. A malfunction of the AFC can cause low power and excessive exhaust smoke under load.

Fuel Control Lever Travel and Adjustment

The amount of fuel injected and subsequently the speed and power from the engine is controlled by the fuel control lever. Restricted travel of the fuel control lever can cause low power. Always check for full travel of the fuel control lever when diagnosing a low power complaint.



Fuel Injection Pump Idle Adjustment Screws

The idle speed adjustment screw provides a stop for the fuel control lever at low speed. The idle adjustment screw can be used to increase idle speed for accessory loading or, if required, to lower the idle speed.

The high speed adjustment screw is set at the factory and can only be adjusted at a certified fuel pump shop.

1. idle screw
2. high idle screw

Manual Shut down Levers

The mechanical shut down lever (1) is located on the governor. Levers are spring-loaded in the run position except the electrical direct link shutdown solenoid. Not all applications will use these manual shut down controls.

Partial actuation of the mechanical shut down lever will affect fuel flow and engine power.

Low power or the inability to stop the engine with the manual shut down control can be corrected by adjusting the cable/rod length to permit stop-to-stop lever travel.

Electrical Shut down Devices

Engines using the RSV Governor are equipped with entire the Synchro-Start or Trombetta cylinder block mounted fuel shutoff solenoid to actuate the shutoff lever. Both 12 VDC and 24 VDC external fuel shut off solenoids are available.

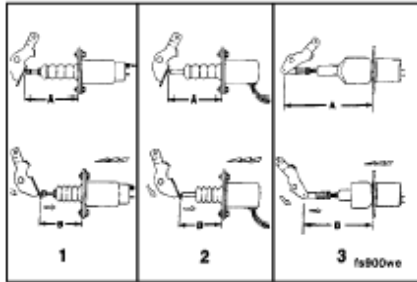


Solenoid surface temperature can exceed 175°C [347°F] which can cause serious burns to the skin in event if contact.

NOTE: Values are taken at 20°C [68°F] and rated voltage. Minimum values are for 25mm [1.00 inch] maximum plunger travel. As the temperature of the solenoid increases the voltage and resistance requirements increase, while the amperage requirements decrease.

The solenoid specifications are as follows:

1. Synchro-Start Cylinder Block Mount



Electric Resistance						
BATTERY	Min Voltage		Min Resistance Ohms		Min Ampres	
VOLTAGE	Hold-in	Pull-in	Hold-in	Pull-in	Pull-in	Holdin
12	7.5	3.0	0.28	19.9	44	0.61
24	15.5	6.0	1.04	79.9	23	0.30

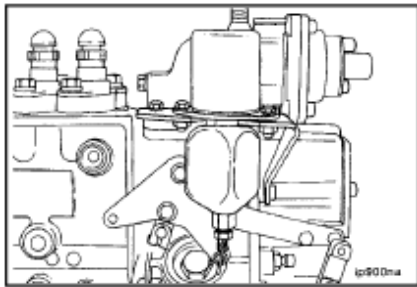
2. Trombetta Cylinder Block Installation



Electric Resistance						
BATTERY	Min Voltage		Min Resistance Ohms		Min Ampres	
VOLTAGE	Hold-in	Pull-in	Hold-in	Pull-in	Pull-in	Holdin
12	10	4.5	0.17	13.6	58.8	0.33
24	20	9.0	0.68	50	29.4	0.18

3. Direct Link, Cylinder Block Mount

Electric Resistance						
BATTERY	Min Voltage		Min Resistance Ohms		Min Ampres	
VOLTAGE	Hold-in	Pull-in	Hold-in	Pull-in	Pull-in	Holdin
12	5.3	2.8	0.22	11.1	55	1.1
24	10.5	5.6	0.82	41.3	29	0.5



Engines using the Robert Bosch PES6P fuel injection pump with the RQVK governor are equipped with the Synchro-Start fuel shutoff solenoid to actuate the shutoff lever. Both 12 VDC and 24 VDC external fuel shutoff solenoids are available.

The solenoid specifications are as follows:

Synchro-Start Governor Mount

Electric Resistance

BATTERY VOLTAGE	Min Voltage		Min Resistance Ohms		Min Ampres	
	Hold-in	Pull-in	Hold-in	Pull-in	Pull-in	Holdin
12	6.5	4.0	0.22	11.1	55	1.10
24	13.0	8.0	0.82	41.3	29	0.60

Wiring Guidelines:

Refer to the chart below to find the correct gauge size and length of continuous wire for the white (pull-in) wire, which connects to the solenoid wiring. The black (ground) wire must be the same gauge as the white (pull-in) wire regardless of its length.

Wire Length

cm	size	Ft. Max	
		12v	24v
0 to 137	14	5	9
0 to 213	12	9	14
0 to 335	10	14	23

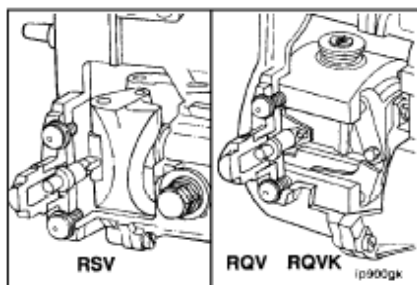
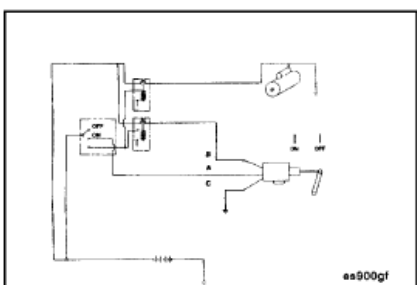
NOTE: 14 gauge wire is required for the red (hold-in) wire, which connects to the "Run" terminal on the ignition switch.

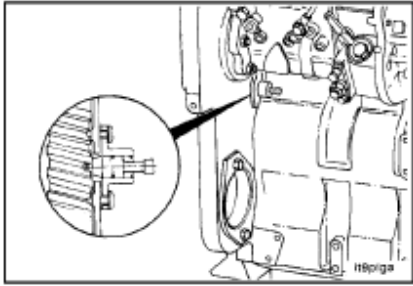
Fuel Injection Pump Timing

Fuel injection pump-to-engine timing is extremely critical. Fuel injection pump timing that is off by only a few crankshaft degrees will cause:

1. Poor performance – starting and power
2. Excessive smoke and emissions
3. Poor fuel economy
4. Excessive cylinder pressure

The governors have a provision for locking the fuel injection pump shaft at a position corresponding to top dead center (TDC) for No.1 cylinder. New and reconditioned fuel injection pumps should be received with the shafts locked in this position.





The engine is equipped with an engine timing pin to locate TDC for No.1 cylinder.

If the timing pin is incorrectly located on the gear housing, the timing procedure will not make sure that the fuel injection pump is timed correctly.



The timing pin assembly is aligned to the gear housing to correspond to a hole in the back side of the camshaft gear when No.1 cylinder is at TDC. If the gear housing or timing pin assembly is removed, it will be necessary to relocate it.

93

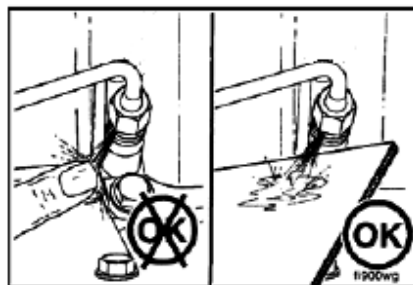
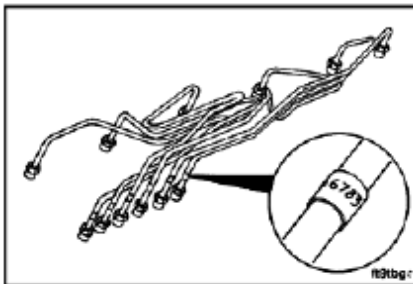
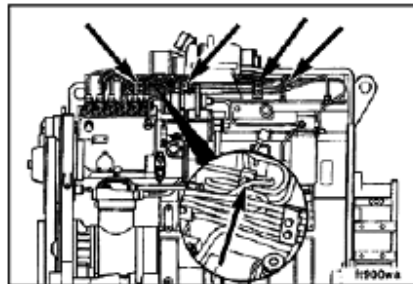
High-pressure fuel line

The high pressure fuel lines are designed and manufactured to deliver fuel at injection pressure to the injectors. The high pressure pulses will cause the lines to expand and contract during the injection cycle.

The high pressure lines must be clamped securely and routed so they do not contact each other or any other component.

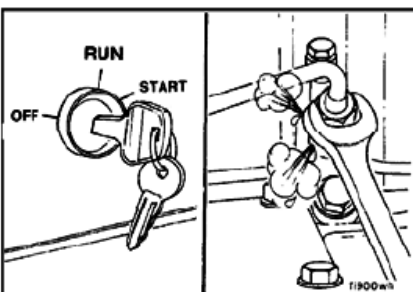
The length, internal size and rigidity of the lines are critical to smooth engine operation. An attached metal tag is used to identify each line with a part number.

Do not weld or substitute lines; use only the specified part number for the engine.



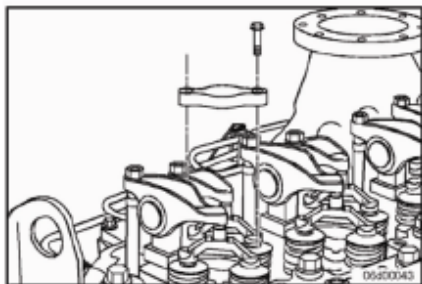
The pressure of the fuel in the line is sufficient to penetrate the skin and cause serious bodily harm.

Use cardboard to check for cracks and leaks. With the engine running, move the cardboard over the fuel lines and look for fuel spray on the cardboard. Fuel leaks can cause poor engine performance.



Bleed the air from the high pressure line at the fitting that connects the injector. Bleed one line at a time until the engine runs smooth.

If the air can not be removed, check the fuel injection pump and supply line for suction leaks.



INJECTOR

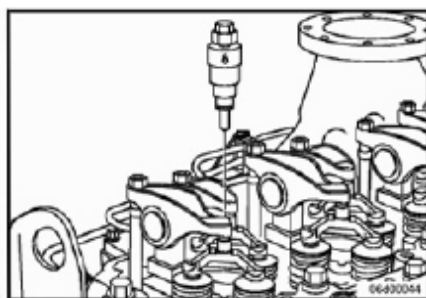
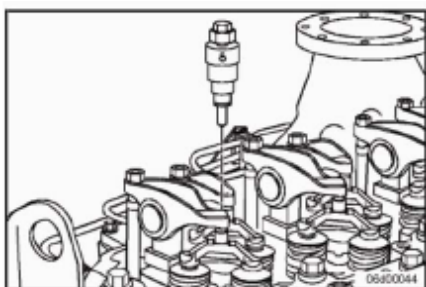
Use Wuxi Ouya 7-hole injectors. However, the part number of injectors varies with engine power.

Remove

Disconnect the high pressure fuel lines connected the fuel rail to high pressure fuel connectors. Remove the adaptor.

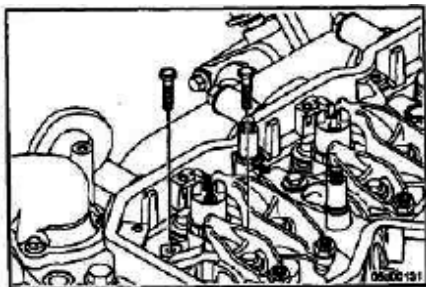
NOTE: The fuel connector must be removed before removing the injector or damage to the connector will result.

Remove the exhaust rocker levers.

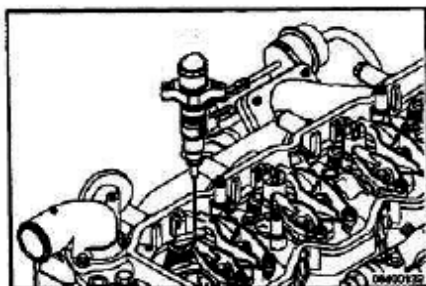


Remove

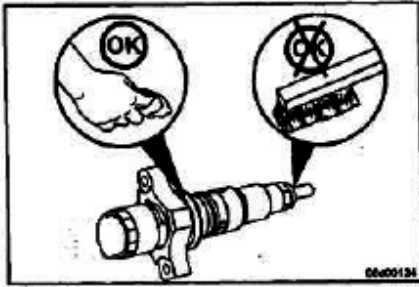
Disconnect the high pressure fuel lines. Remove the adaptor.



Remove the exhaust rocker levers.
Remove the 8mm injector hold-down cap screws



Using the special injector puller, remove the injector from the cylinder head.



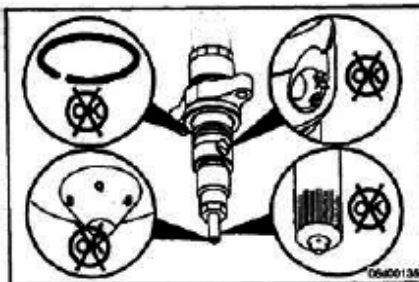
Clean

WARNING: When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

CAUTION: Do not use a steel wire brush or glass beading to clean the injectors. This will damage the nozzle holes.

Clean the injector tip and body with safety solvent and a soft clean cloth.

NOTE: Use a brass brush to remove carbon, if necessary.



Inspect for Reuse

Check injector terminal for carbonation or corrosion.

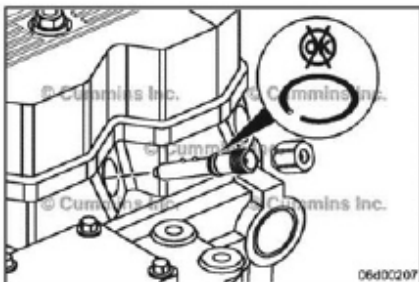
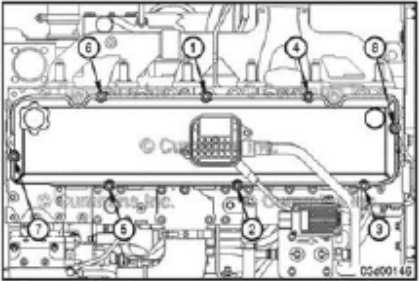
Inspect solenoid terminal for damage.

Inspect injector inlet, high-pressure fuel connectors terminal and inlet for damage.

Note: Overheating will cause the nozzle to turn dark yellow/tan or blue depending on the temperature of overheat.

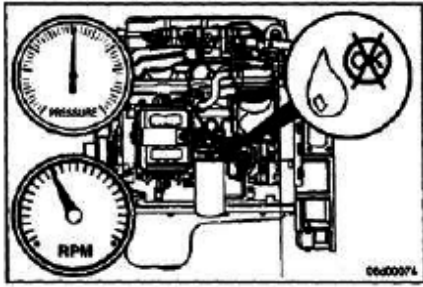
Inspect o-ring for damage.

Install the rocker lever cover.

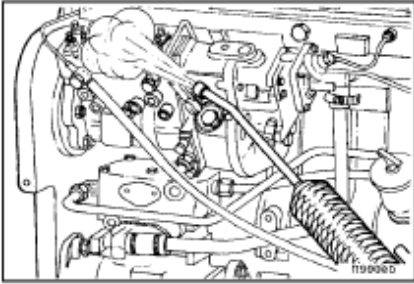


Install the fuel connector.

Install the high pressure injectors fuel lines.



Operate engine, and check for leaks.

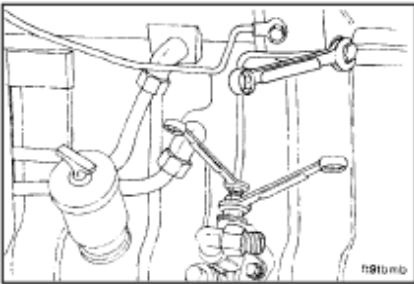


Low Pressure Fuel Lines-Replace

Preparatory:

Clean debris from fittings.

NOTE: Thoroughly clean all fittings and components before removal. Make sure that the debris, water steam or cleaning solution does not reach the inside of the fuel system.



Remove and Install

14mm, 17mm, 20mm



Disconnect the fuel line from the fuel transfer pump and filter head. Use two wrenches to disconnect the line from the fuel transfer pump.

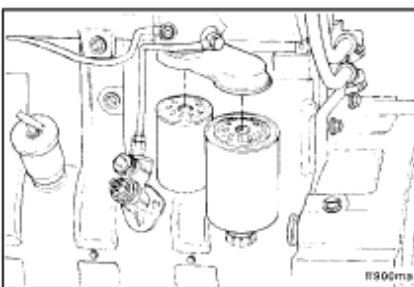
Install the fuel line to the fuel transfer pump and filter head. Use two wrenches to tighten the connection to the fuel transfer pump. Do not over torque, fuel leak may occur.

Torque Value: 24N · m [18 ft-lb]

Fuel Filter Head Adapter – Replace

Preparatory:

Clean debris.



Remove and Install

24mm

Remove the fuel filters.

Remove the retaining nut, fuel filter head adapter and Sealing washers

Install in reverse order of removal.

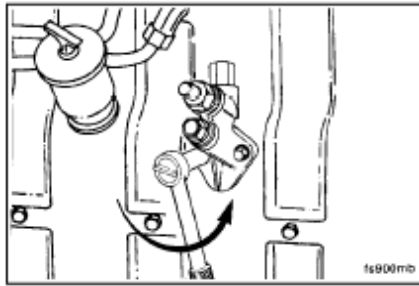
Torque Value: 32N · m [24 ft-lb]

Fuel Lift Pump-Replace / Shop

Preparatory:

Clean debris.

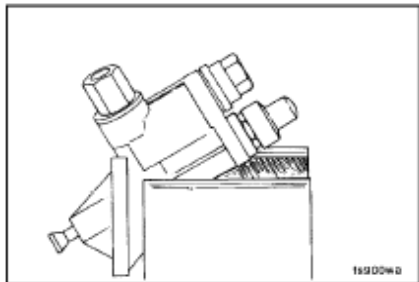
Disconnect fuel lines.



Remove

10mm

Disconnect the lift pump.



Shop

20mm, 26 mm wrench



CAUTION: The hand-prime fitting and inlet fitting are spring loaded. Sudden removal of these two fittings can cause personal injury.



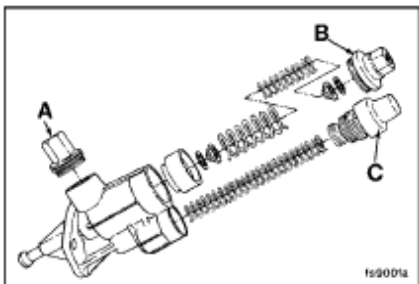
Secure the fuel transfer pump in a vise, taking care not to damage the pump housing.



Remove the rubber boot from the hand-prime fitting.

Remove the three illustrated fittings

Remove all internal components of the fuel transfer pump.



NOTE: Make sure the check valve gaskets are removed from the inlet fitting

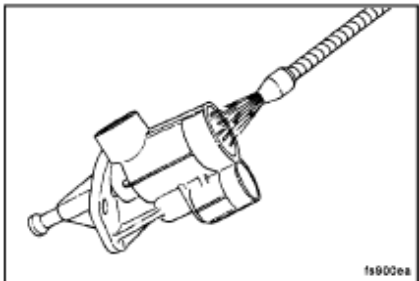
(A) outlet fitting

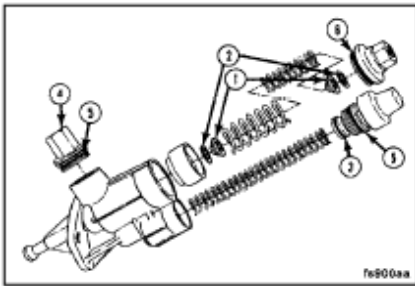
(B) fitting, inlet

(C) Hand primer fitting.

Clean the fuel lift pump

Thoroughly flush the fuel transfer pump with a cleaning solution to remove any debris.





Assembly

20mm, 26mm wrench

Assemble the fuel transfer pump with the new Components supplied in the rebuild kit.

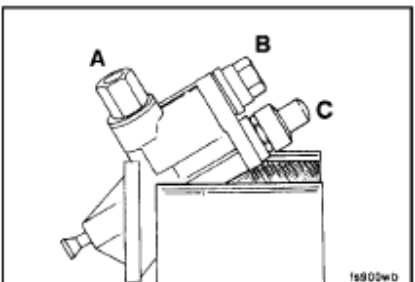
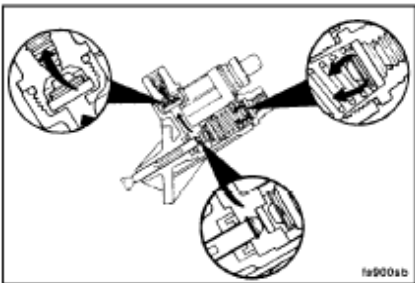
1. check valve
2. check valve gaskets
3. seal o-ring
4. outlet fitting/check valve
5. *o-ring seal (25mm)
6. *o-ring seal (30mm) or (25mm)

*o-ring required is determined by the size of the inlet fitting.

Discard unused o-ring

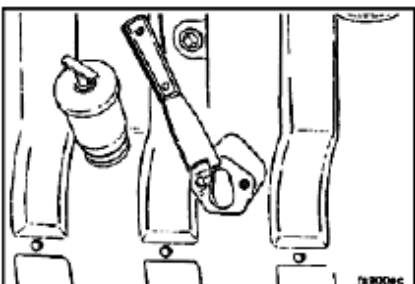
NOTE: Extreme caution must be used to make sure the check valves are installed to open in the direction of the fuel flow.

Improper installation of the check valves will result in low power from the engine.



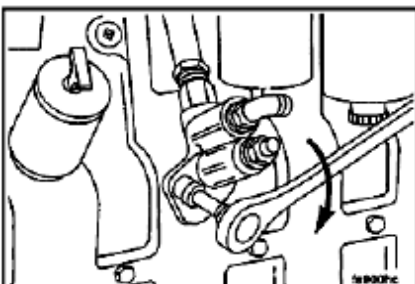
Place the fuel transfer pump in a vise and torque the fittings to the following values:

- | | |
|------------------------|--------------------|
| (A) outlet fitting | 30N · m [22 ft-lb] |
| (B) hand-prime fitting | 30N · m [22 ft-lb] |
| (C) fitting, inlet | 30N · m [22 ft-lb] |



Clean

Clean the mounting surface on the cylinder block.



Install

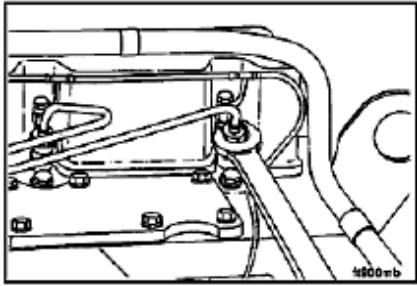
10mm

Install the fuel transfer pump and a new gasket.

Connect the fuel lines.

Torque Value: 24N · m [18 ft-lb]





High Pressure Fuel Lines-Replace



Remove

10 and 17 mm (PES6A and PES6MW Fuel Injection Pump)

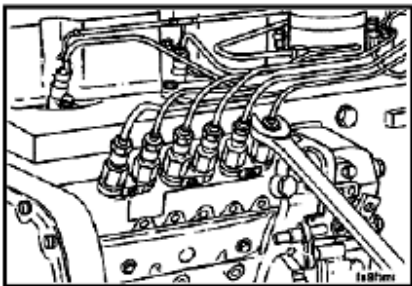


10 and 19 mm (PES6P Fuel Injection Pump)

Clean debris from around the fuel lines.

NOTE: If individual lines are to be replaced, remove the vibration isolators from the set of lines containing the line to be replaced.

Disconnect the lines from the injectors.

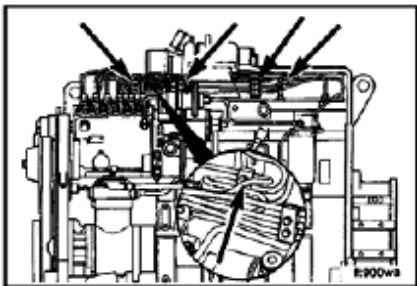


17 mm (PES6A and PES6MW Fuel Injection Pump)



19 mm (PES6P Fuel Injection Pump)

Disconnect the lines from the fuel injection pump.



Install

10 and 17 mm (PES6A and PES6MW Fuel Injection Pump)



10 and 19 mm (PES6P Fuel Injection Pump)

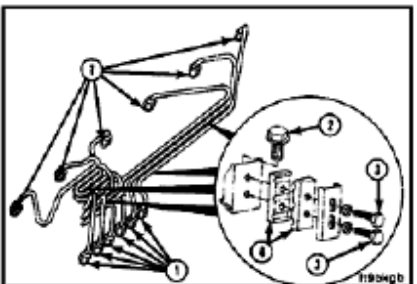
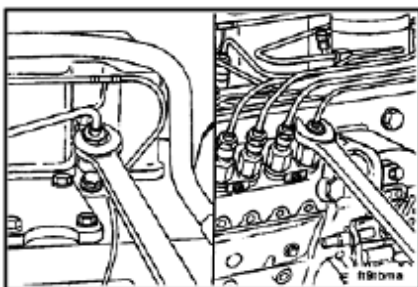
Loosen the vibration isolator cap screws so the fuel lines can be easily moved.

NOTE: To prevent breakage to the fuel lines, they must be connected to the injector and fuel injection pump in a "free state" without forcing the connecting nuts. Since the fuel lines are properly sized for specific application, bending should not be necessary.



CAUTION : If removed, install the support clamp in the original position and make sure the lines do not contact each other or another component.

Install the lines in the reverse order of removal.



Tighten all fittings and mounting hardware.

Torque Value:

- | | |
|----------------------------------|--------------------|
| 1. union | 30N · m [22 ft-lb] |
| 2. support bracket cap screws | 24N · m [18 ft-lb] |
| 3. vibration isolator cap screws | 6N · m [53 in-lb] |

Fuel Manifold (Drain)-Replace

Remove and Install

10mm

Clean debris from around the fuel drain manifold.

Remove the banjo cap screws from the injectors and fuel filter head. Install the fuel drain manifold in the reverse order of removal.

Torque Value:

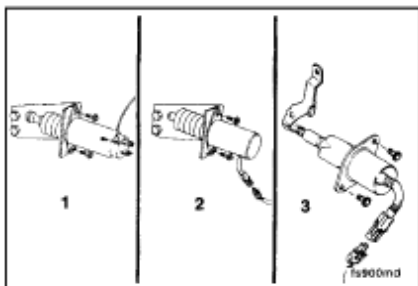
Filter head banjo Retained screw 15N · m [11 ft-lb]

Injector banjo Retained screw 9N · m [80 in-lb]

Fuel Shutoff Valve (FSOV) Solenoid – Replace

Preparatory:

Tag and disconnect wire.



RSV Governor Fuel Shutoff Solenoid – Replace

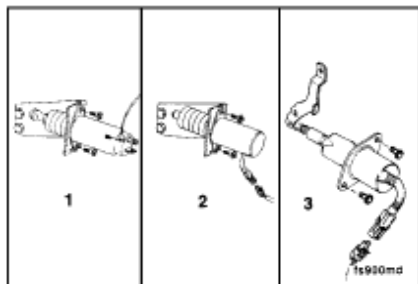


Cylinder block install

10 mm

Remove the two mounting cap screws and remove the solenoid from the bracket.

1. Synchro-start
2. Trombetta
3. Direct link



RSV Governor Fuel Shutoff Solenoid – Install

Cylinder Block Mount

10 mm

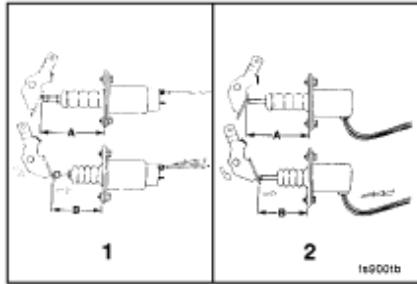
NOTE: Make sure the acorn nut is tightened to be snug on the fuel shutoff solenoid shaft (Synchro-Start only).

Install the new fuel shutoff solenoid and connect the wires.

Make sure the wiring harness on the trombetta solenoid is installed in the 6:00 o'clock position.

Torque Value: 10 N · m [89 in-lb]

1. synchro-start
2. trombetta
3. direct link



Activate the ignition switch and check the plunger travel.

1. Synchro-start

A=86.6 mm [3.4 in]

B=60.2 mm [2.4 in]

2. Trombetta

A=91.4 mm [3.6 in]

B=63.5 mm [2.5 in]

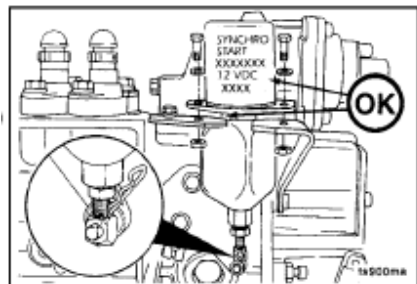
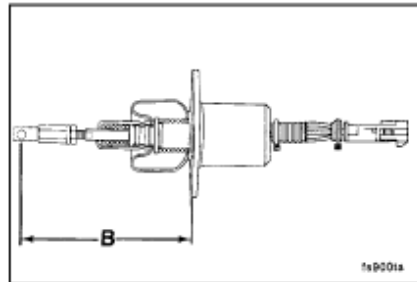
The plunger must be retracted when the fuel shutoff solenoid is activated to the RUN position "B". The fuel shutoff solenoid must operate without binding.

Direct Link Solenoid, Cylinder Block Mount

- Disconnect the solenoid linkage from the lever.
- Activate the ignition switch and check the plunger travel.
- Measure distance "B" from the center of the ball socket to the solenoid mounting flange.

B= 117.1 mm [4.16 in]

The plunger must be retracted when the fuel shutoff solenoid is activated to the RUN position "B". The fuel shutoff solenoid must operate without binding.



RQVK Governor Solenoid – Remove and Install



10 mm

Remove the hitch pin clip, mounting cap screws and the fuel shutoff solenoid.



Install the new solenoid in reverse order of removal and Connect the wires. Make sure the part number and cable Tie block is facing away from the engine.



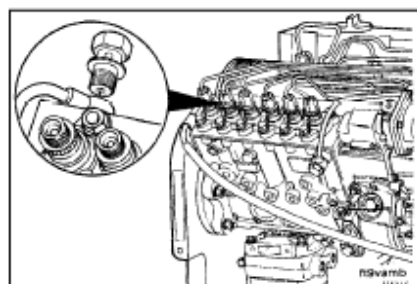
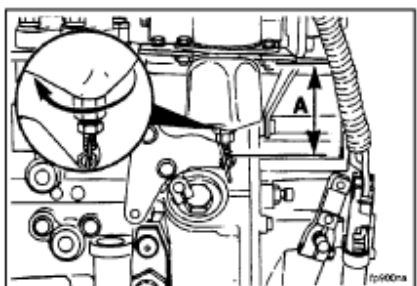
Torque Value: 10 N · m [89 in-lb]



Activate the ignition switch and check the plunger travel.

A=66.9 mm [2.64 in]

NOTE: Measure size A from mounting stand bottom to pivot top.

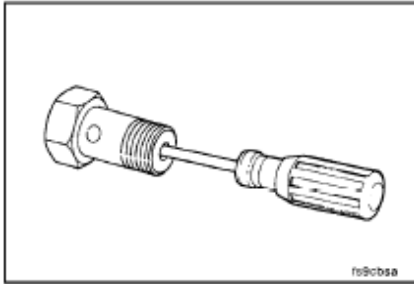


Fuel Return Overflow Valve – Replace



19 mm

Remove the pressure relief valve and copper sealing washers.

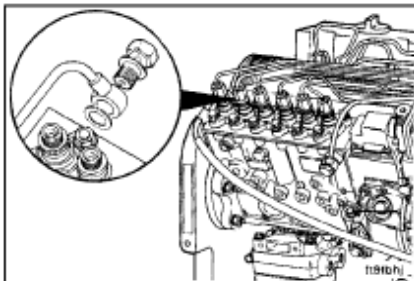


Use a small screwdriver to check that the check ball is not sticking in the high pressure relief valve assembly.

CAUTION: A sticky check ball will result in engine low power.

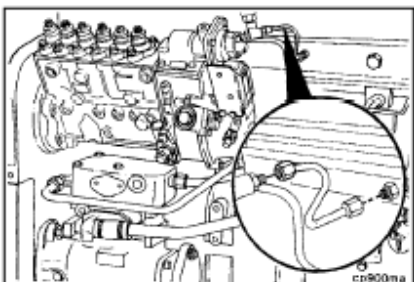


Thoroughly flush the high pressure relief valve with cleaning solution.



10 mm, 19 mm

Install the high pressure relief valve assembly in the reverse order of removal.

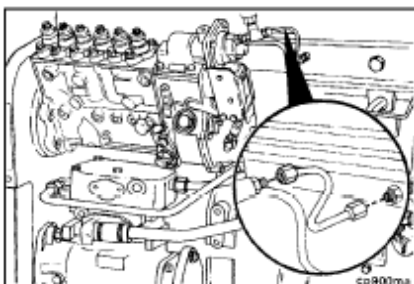


AFC Air Tube – Replace

Remove

17 mm, 13 mm

Remove the AFC air tube.



Install

17 mm, 13 mm

Use new copper washers for the drum fitting.

Install the AFC air tube.

Torque Value:

Connector, Banjo	24 N · m [18 ft-lb]
Threaded Fitting	8 N · m [71 in-lb]



Injection Pump – Replace

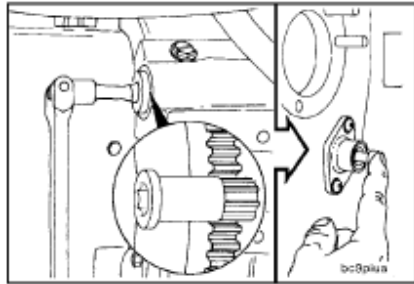
Preparatory:

Clean debris.

Remove all the fuel tubes.

Remove control linkage.

Remove fuel Shutoff Valve Solenoid.



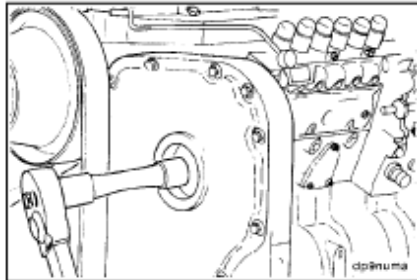
Remove

Part No. 3377371, Barring Tool

Identify the TDC position for the No. 1 cylinder.

Use the TDC pin into the hole in the camshaft gear while slowly rotating the crankshaft.

NOTE: Be sure to disengage the pin after locating TDC.

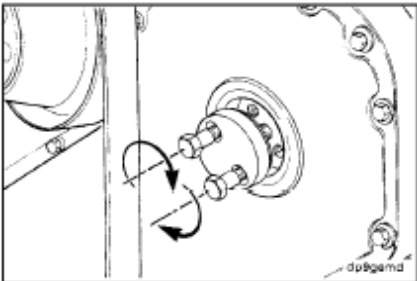


30 mm (PES6P Injection Pump)

Remove the gear cover access cap.

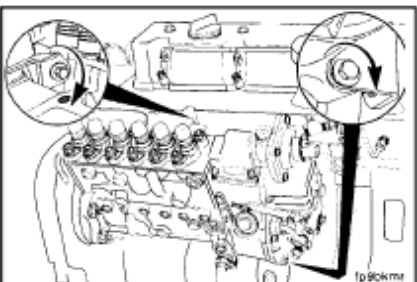


Remove the nut and washer from the fuel injection pump shaft.



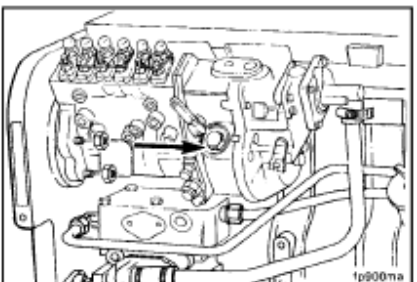
Part No. 3824469, Fuel Pump Gear Puller

Pull the fuel injection pump drive gear loose from the shaft.



13 mm

The support brackets to the engines equipped with the PES6P fuel injection pump must be removed.

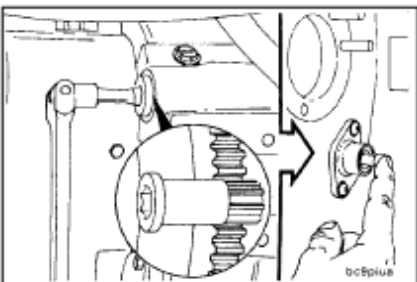


15 mm

Remove the four mounting nuts.

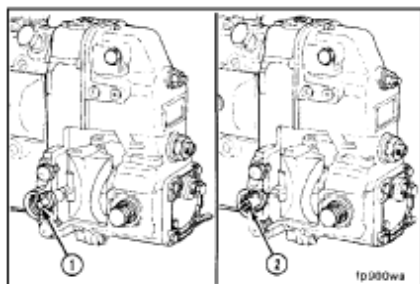


Remove the injection pump.

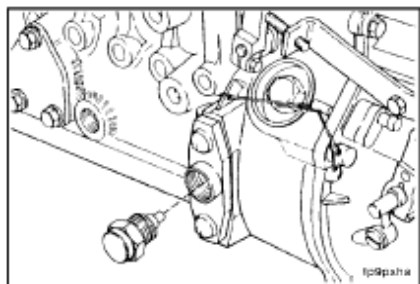


Install

Make sure the engine has No. 1 cylinder at TDC.

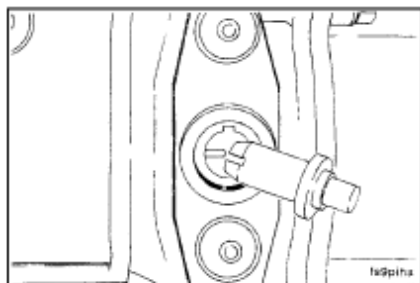


The fuel injection pump also has a timing pin (1). Position the fuel injection pump shaft to correspond with TDC for No. 1 cylinder. After the pump is installed the pin is to be reversed and stored in the housing (2).

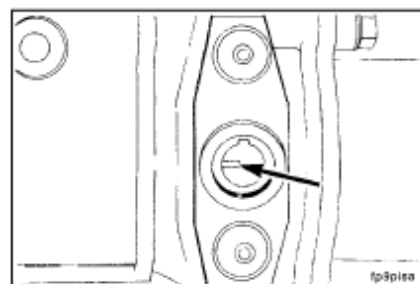


24 mm

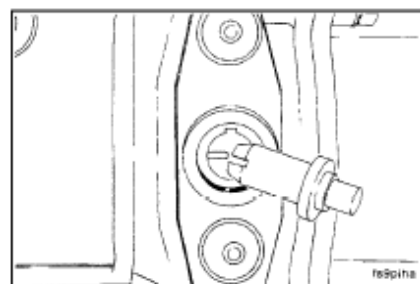
Remove the access plug.



Remove the timing pin.

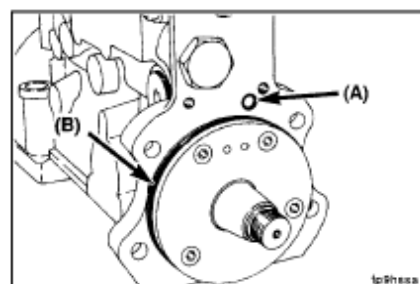


If the timing tooth is not aligned with the timing pin hole, rotate the fuel injection pump shaft until the timing tooth aligns.



Reverse the position of the pin so the slot of the pin will fit over the timing tooth in the pump.

NOTE: PES6P fuel injection pump o-ring is located in the gear housing.

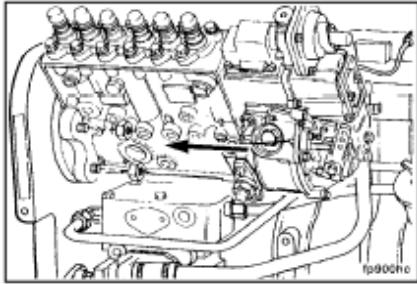


Install and secure the timing pin with the access plug

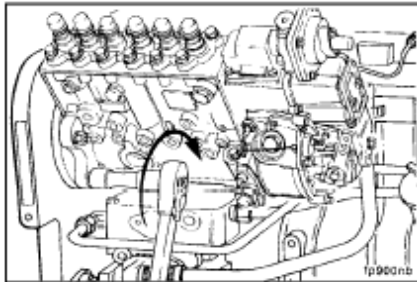
Make sure the o-ring seals for the fill orifice and pilot are correctly installed and are not damaged.

Lubricate the mounting flange with clean lubricating engine oil.

Note: The fuel pump drive gear inside diameter and the shaft outside diameter must be clean and dry before installing the gear.



Slide the fuel injector pump shaft through the drive Gear and position the fuel injection pump flange onto the mounting studs.



15 mm and 13 mm

Mounting nuts.



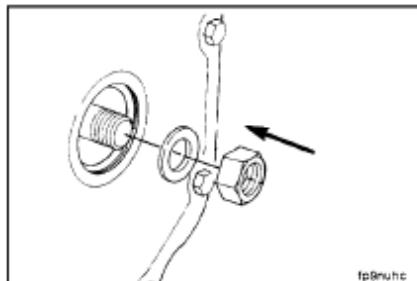
Install the support bracket if so equipped.



Torque Values:

Mounting nuts: 44 N · m [32 ft-lb]

Mounts: 32 N · m [24 ft-lb]



30 mm (PES6P injection pump)

Install the retaining nut and washer.

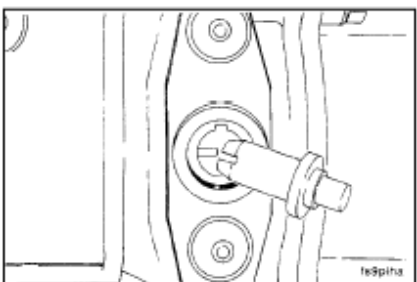
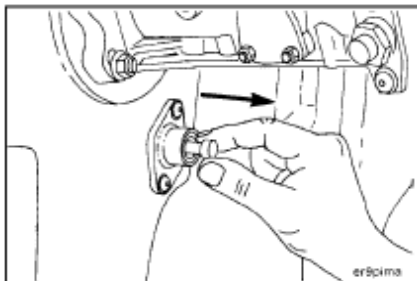


Torque Values: 12 N · m [106 in-lb]



Note: To prevent damage to the timing pins, do not exceed the torque value given. This is not the final torque value for the retaining nut.

Exit engine timing pin.

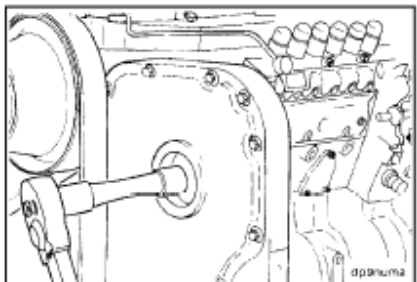


24 mm

Remove the fuel injection pump timing pin plug. Reverse the position of the pin; install the timing pin, plug, and sealing washer.



Torque Values: 15 N · m [11 ft-lb]



30 mm (PES6P injection pump)

Tighten injection pump drive gear nut.



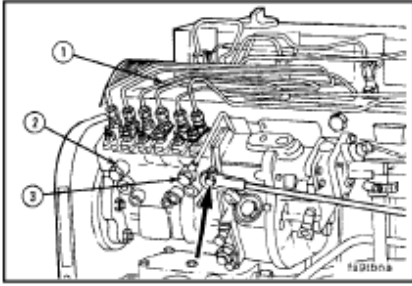
Torque Values:

PES6P injection pump 165 N · m [122 ft-lb]



Install the gear cover access cap hand-tight.



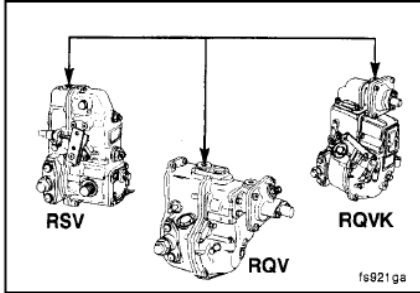


Install the fuel lines and control linkage.



Torque Value

- | | |
|-------------------------------------|---------------------|
| 1. high-pressure fuel line | 30 N · m [22 ft-lb] |
| 2. pressure relief valve fitting | 32 N · m [24 ft-lb] |
| 3. low pressure fuel supply fitting | 32 N · m [24 ft-lb] |



CAUTION: The governor housing must be prelubricated before engine operation. Failure to do so will result in premature governor wear.



10 mm hex drive

Remove the access plug.

Add the following quantity of clean engine oil:

- RSV 450 ml [0.43 qt]
- RQV 750 ml [0.71 qt]
- RQVK 750 ml [0.71 qt]



Install the access plug.

Torque Value: 28 N · m [21 ft-lb]



19 mm (PES6P injection pump)

WARNING: The pressure of the fuel in the high pressure line is sufficient to penetrate the skin and cause serious bodily harm.



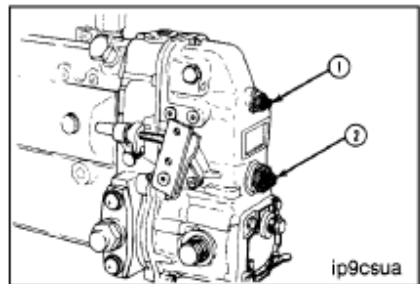
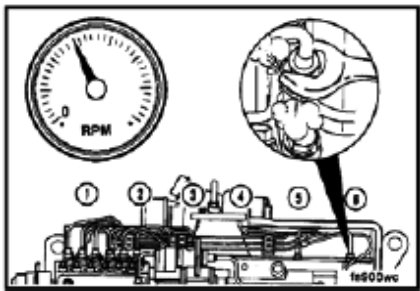
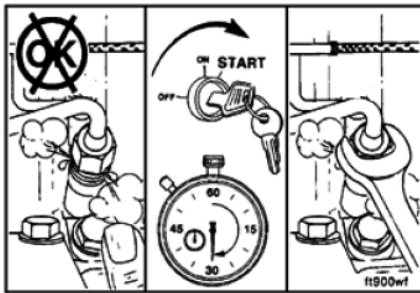
Vent air in high pressure fuel lines. Loosen fitting on injector 1. Place fuel lever to the position RUN. Rotate engine to vent air in fuel lines and tighten the fittings.

Torque Value: 30 N · m [22 ft-lb]



WARNING: The pressure of the fuel in the high pressure line is sufficient to penetrate the skin and cause serious bodily harm.

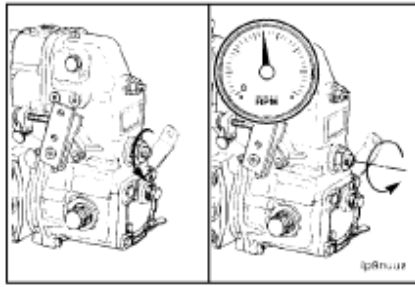
Vent the air in the high pressure line respectively until the engine runs smoothly.



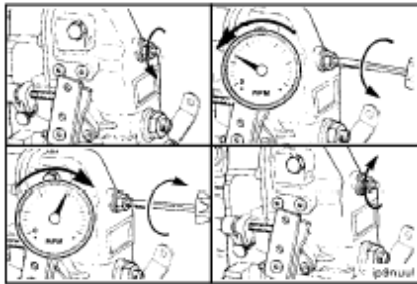
Idle Speed – Adjust

Bosch RSV Governor

Idle speed adjustment for industrial engines requires the setting of both the low idle speed screw (1) and the bumper spring screw (2).

**19 mm, Screwdriver and Tachometer**

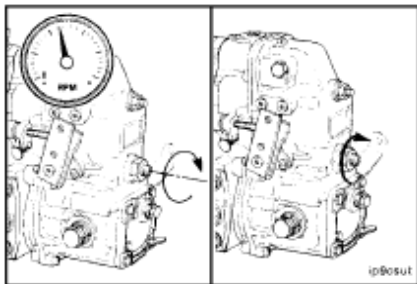
First, loosen the locknut and back out the bumper spring screw until there is no change in engine speed.

**13 mm, Screwdriver and Tachometer**

Loosen the locknut and adjust the idle speed screw to 20 to 30 RPM less than the desired speed. Turn the idle speed screw counterclockwise to decrease RPM; clockwise to increase RPM. Tighten the locknut. Tighten the locknut.



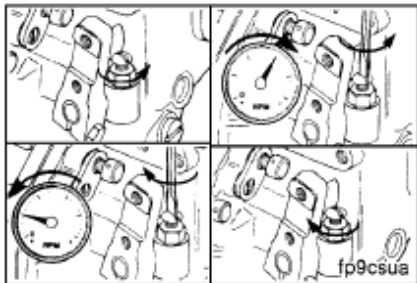
Torque Value: 8 N · m [72 in-lb]

**19 mm, Screwdriver and Tachometer**

Turn the bumper spring screw clockwise until the desired idle speed is obtained. Tighten the locknut.

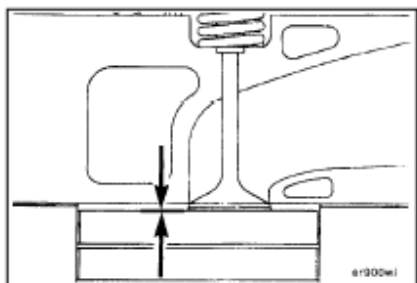


Torque Value: 8 N · m [72 in-lb]

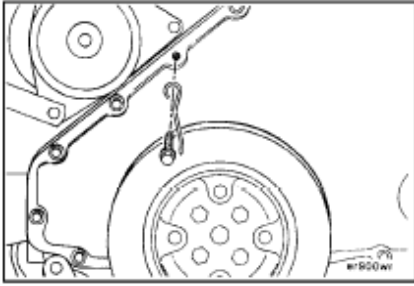
**Bosch RQVK Governor****8 and 10 mm Screwdriver and Tachometer**

Idle speed adjustment on automotive fuel injection pump requires setting of the stop screw.

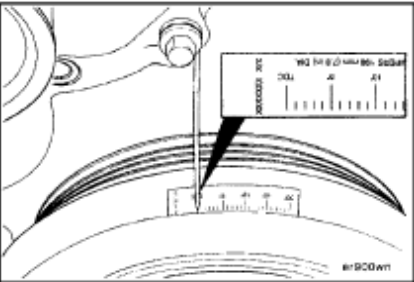
Loosen the locknut and turn the idle speed screw counterclockwise to raise the RPM; clockwise to decrease the idle speed. Tighten the locknut.

**In-line Fuel Injection Pump spill port timing**

Use the No.1 intake valve to make sure the engine is at top dead center(TDC) on the compression stroke for cylinder No.1. Refer to procedure 7-07.



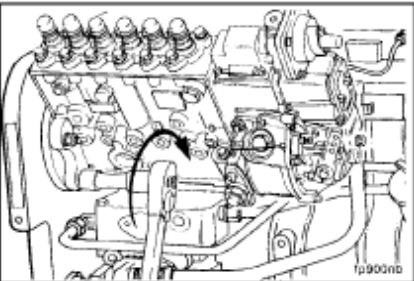
Fabricate a timing mark pointer for the front of the engine. This can be done by forming a piece of wire that can be tightened under one of the gear cover cap screws. Sharpen the wire at the vibration damper end so that it comes to a point for better accuracy.



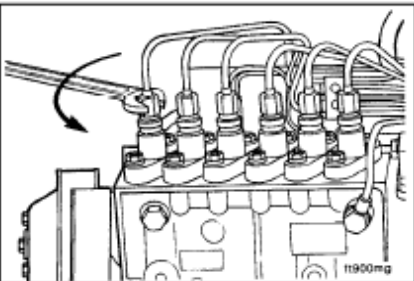
Attach a degree wheel or degree tape to the front of the vibration damper.

Line the "TDC" mark up with the pointer.

The degree wheel/tape should measure to accuracy of at least one degree.

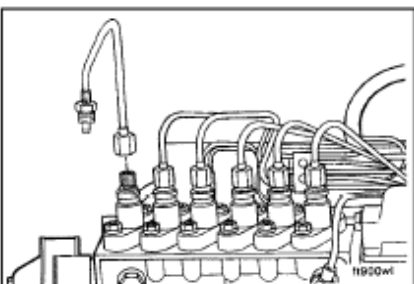


Install the fuel injection pump per the procedure for a new fuel injection pump installation. If the fuel injection pump is already installed, continue the procedure.



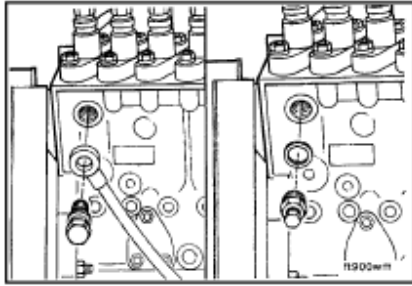
Remove the No. 1 high pressure fuel line from the fuel injection pump.

NOTE: Lines 2 through 6 must not be removed or loosened.



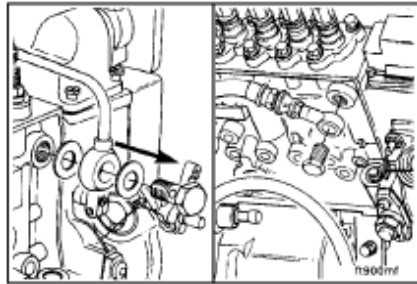
CAUTION: When attaching the fabricated tube, do not bend the No.1 high pressure fuel line. This could cause the inside of the fuel line to flake and cause injector failure.

A short length of high pressure line that is compatible with the fuel lines used on the engine should be bent in a "U" shape and installed onto the delivery valve holder of the fuel injection pump. The line is used to observe when the fuel is or is not flowing through the delivery valve holder assembly. Place a container under the tube to catch the fuel or drain the fuel back into the spill port pump.



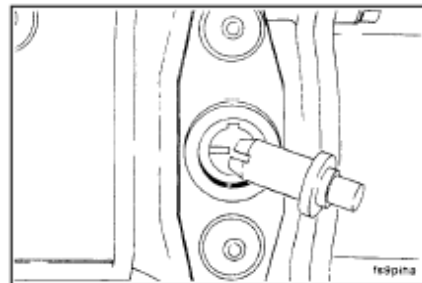
Remove the overflow valve from the fuel injection pump. Install a 14 mm threaded plug and sealing washer into the fuel return port of the fuel injection pump.

NOTE: The fuel return port is located on the inboard front side of the fuel injection pump for automotive inline application and on the out board front side for most of the industrial applications.

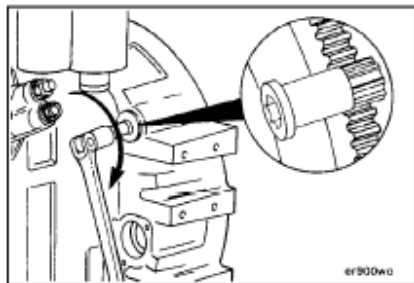


Remove the supply line from the fuel filter head to the fuel injection pump.

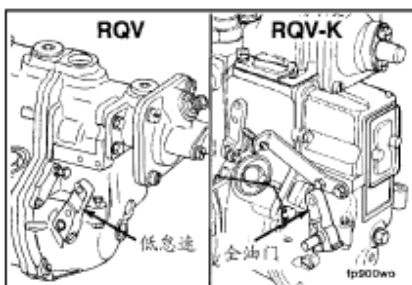
Attach the high pressure outlet hose from the spill port to the fuel injection pump supply port.



Before continuing, make sure the fuel injection pump lock-timing pin is disengaged.



Rotate the crankshaft counterclockwise, as viewed from the front of the engine, to approximately 40 degrees before TDC

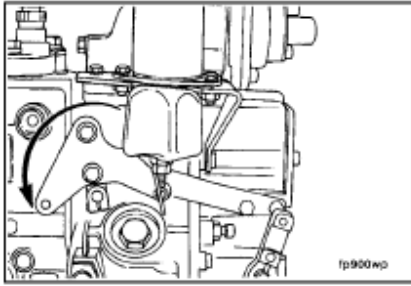


Governor Lever Positioning

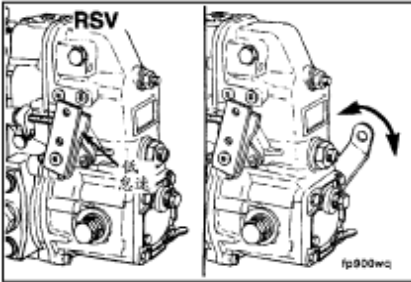
CAUTION: The governor lever must be positioned before pressurizing the fuel injection pump.

The RQV governor throttle lever must be in the low idle lever position.

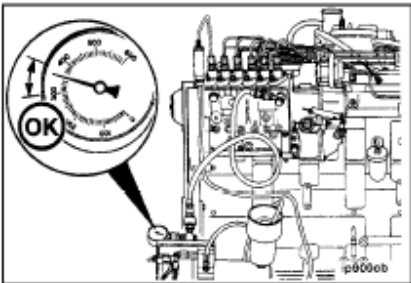
The RQV-K governor throttle lever must be in the high idle throttle position.



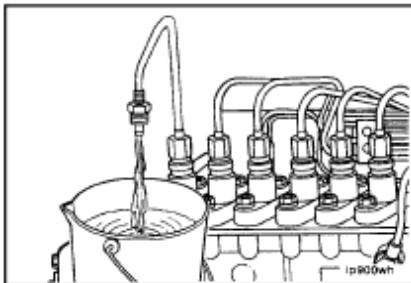
Both the RQV and RQV-K governor require the shut down lever to be in the full run position.



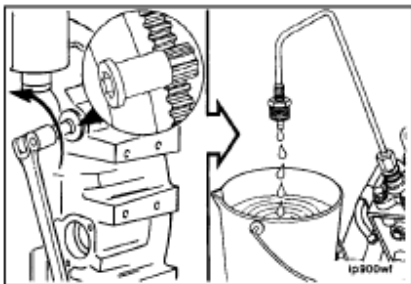
The RSV governor throttle lever must be in the low idle position and the shutdown lever needs to be wired or locked in a suitable fashion to hold the shutdown lever in the 1/2 travel position.



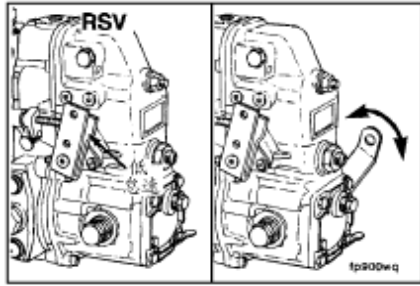
Turn on the spill timing cart pump.
Check the fuel pressure.
The pressure must be between 300 psi and 370 psi.



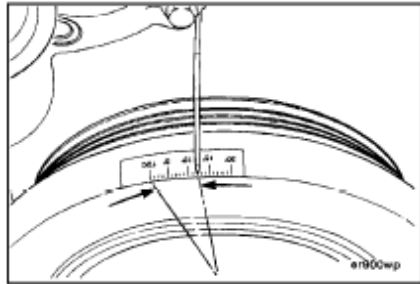
The fuel should be flowing out of the tube attached to the No.1 cylinder of the fuel injection pump. If the fuel is not flowing, recheck the procedures carefully.



Slowly rotate the crankshaft in the clockwise direction, as viewed from the front of the engine, until the fuel flow from the No.1 cylinder begins.
The No.1 plunger element is now approaching "port closure". Continue to rotate the crankshaft slowly until the flow is reduced to a fast drip (more than one drip per second). At the point where the steady stream of flow changes from a solid flow to a fast drip, stop. This is the static timing position of the fuel injection pump.

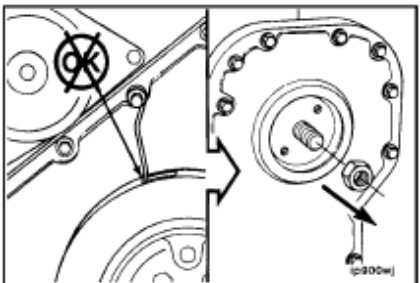


If the flow does not slow down to a drip, check the governor position. Also make sure that the engine is before TDC on the compression stroke. Turn off the spill port pump

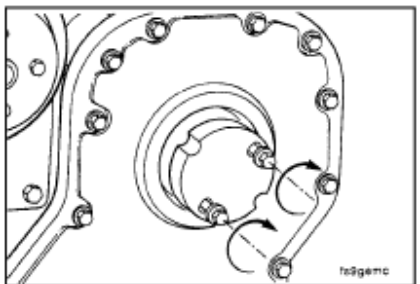


Check the degree wheel on the vibration damper to see what engine degree the timing pointer is indicating. This is spill port static timing. Compare this number to be the timing specification for your particular application.

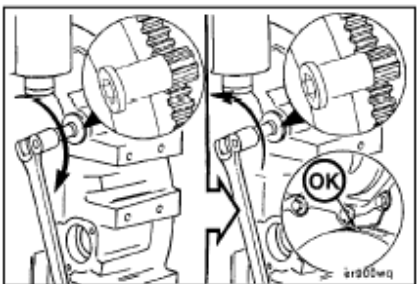
93



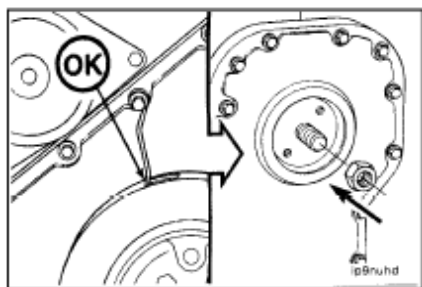
If the fuel injection pump static timing, as measured by the above method, does not agree with the specifications you have been given, remove the large nut that fastens the fuel injection pump camshaft to the fuel pump drive gear. If the crankshaft has rotated, turn on the spill port pump and rotate the crankshaft to find port closure. Turn off the spill port pump.



Use a gear puller tool, pull the fuel injection pump drive gear from the fuel injection pump camshaft taper.



Slowly rotate the crankshaft counterclockwise about 40 degrees past the desired static timing specification. Slowly rotate the crankshaft in the clockwise direction until the timing pointer is indicating the desired static timing.

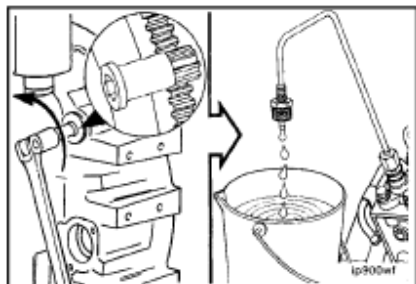


Tighten the fuel injection pump drive nut. Make sure the static timing has not changed after the fuel injection drive nut is torqued to the required specification.

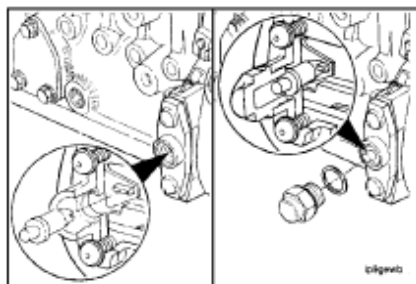
Torque Value:

PES6P Fuel injection pump 165 N · m [122 ft-lb]

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Repeat this procedure as needed until the timing is found to be in agreement with the specification.



The fuel injection pump lock timing pin should fit over the injection pump pointer when the engine is at TDC or on the compression stroke for the No.1 cylinder. If it does not, the fuel injection pump should be adjusted by an authorized fuel injection pump shop or the fuel injection pump was installed incorrectly.

NOTES

Electrical System

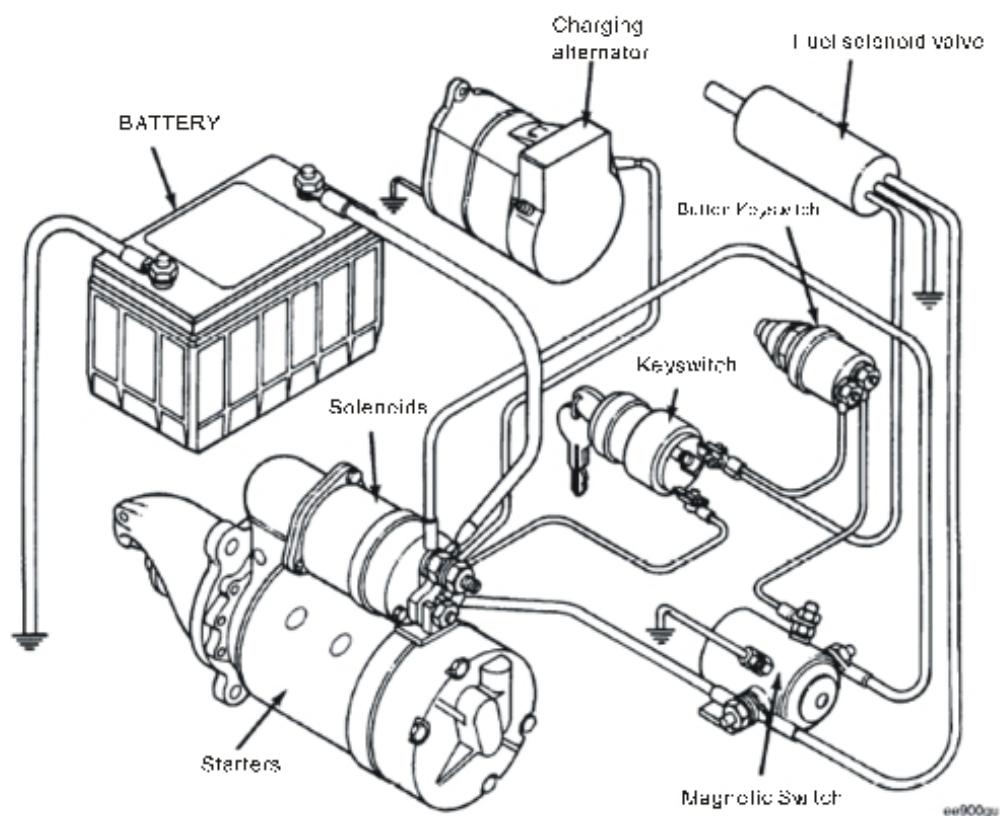
Electrical System Description and Operation

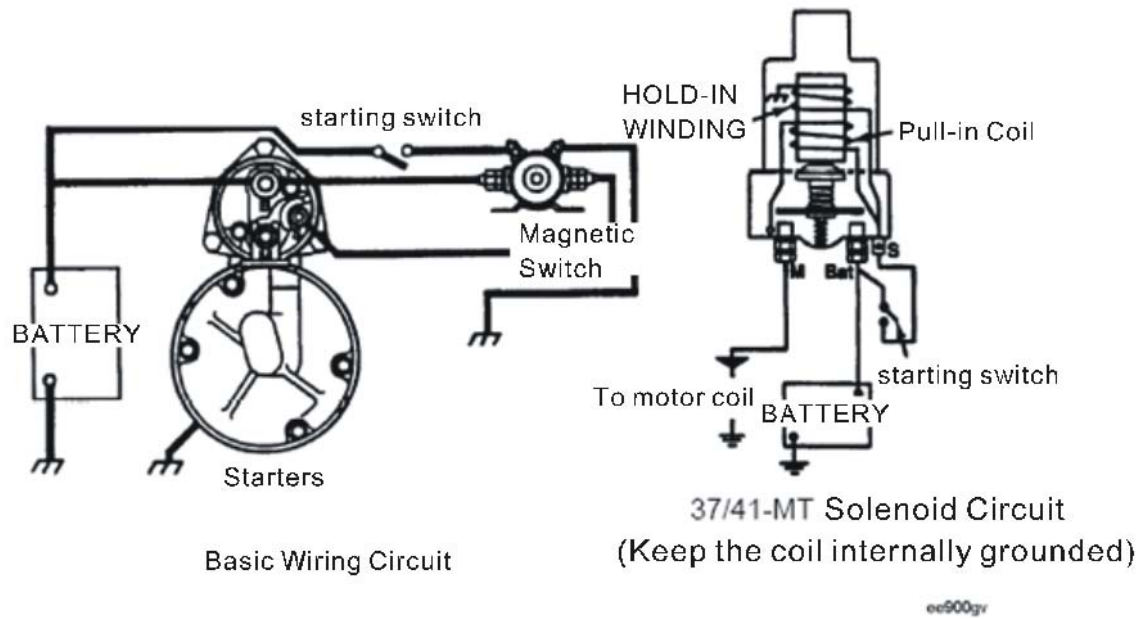
The basic components of the electrical system are the starting motor and the alternator.

If the injection pump uses an electrical fuel shut off valve, refer to the fuel system section of this manual for information concerning the function of the valve.

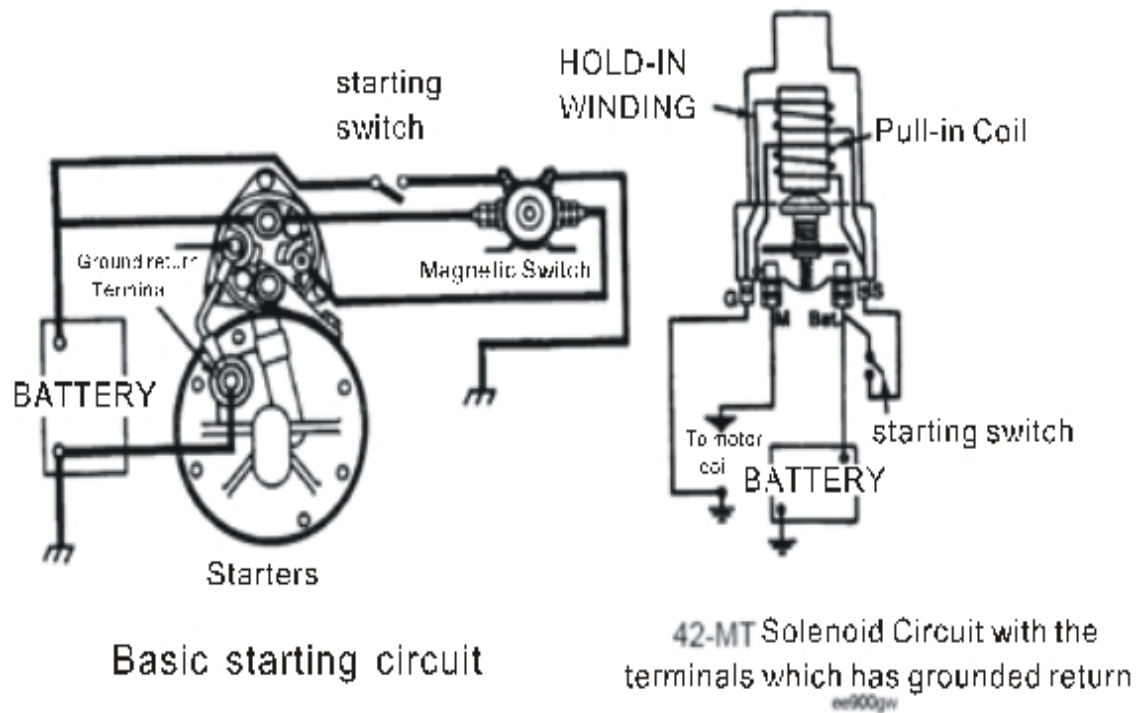
The engine should have temperature and oil pressure sensors connected to indicators and may be wired for automatic shutdown. The engine may also be fitted with a cylinder block heater or oil pan heater.

Starting and Electrical Circuit

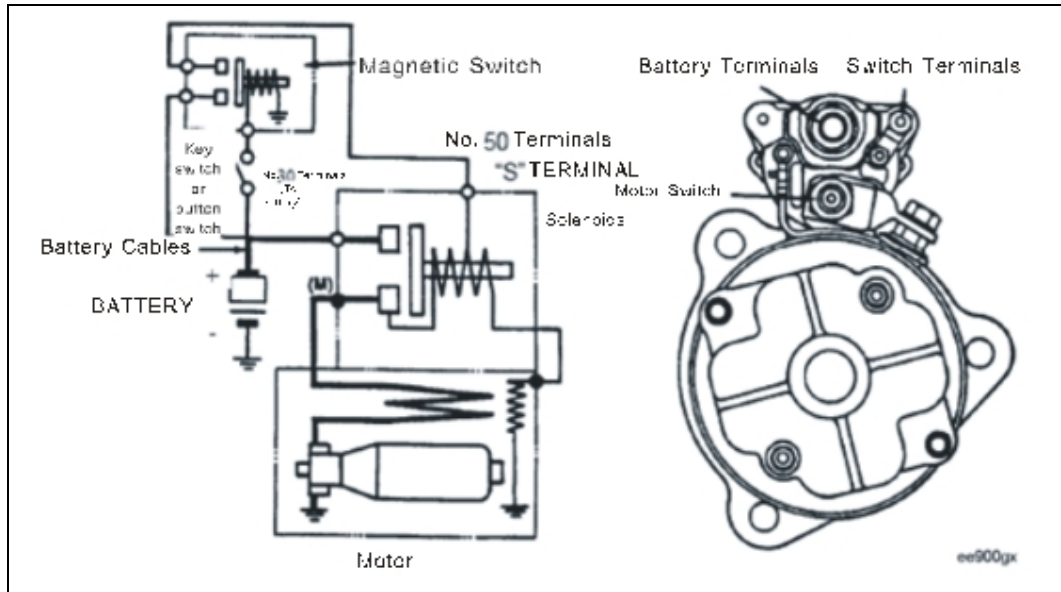




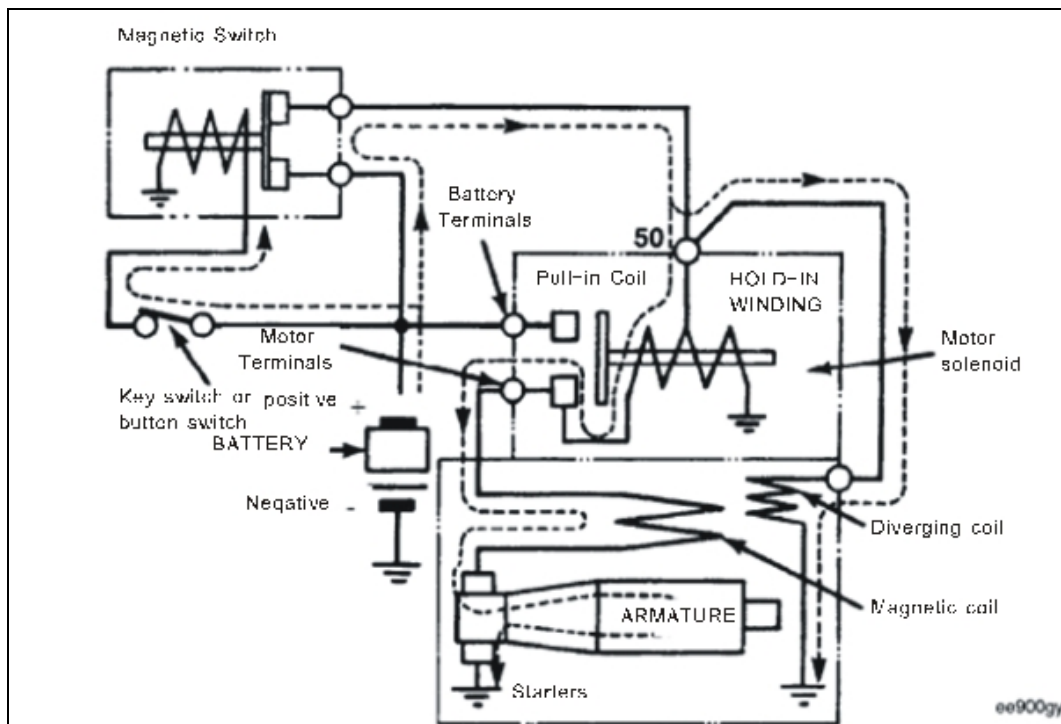
Starters
(Typical Starting Motor Wiring)

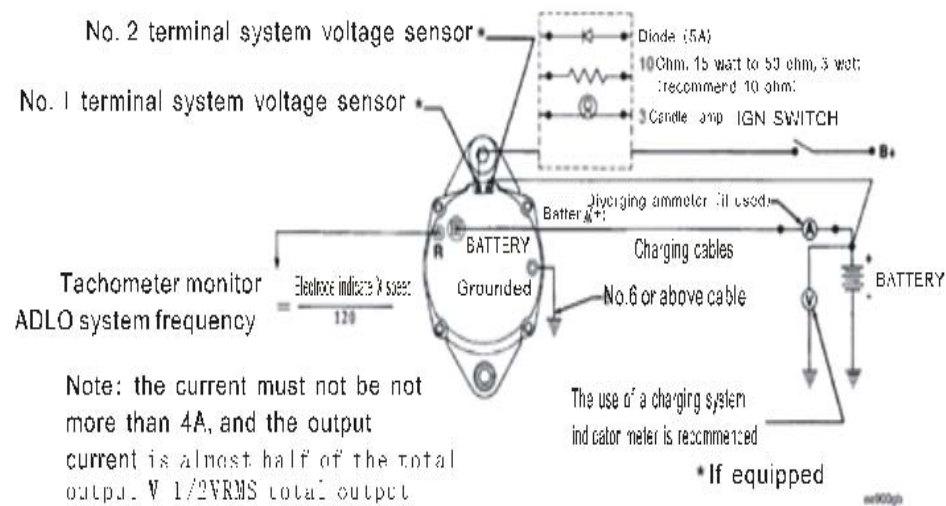


Starters
(Typical Starting Motor Wiring)

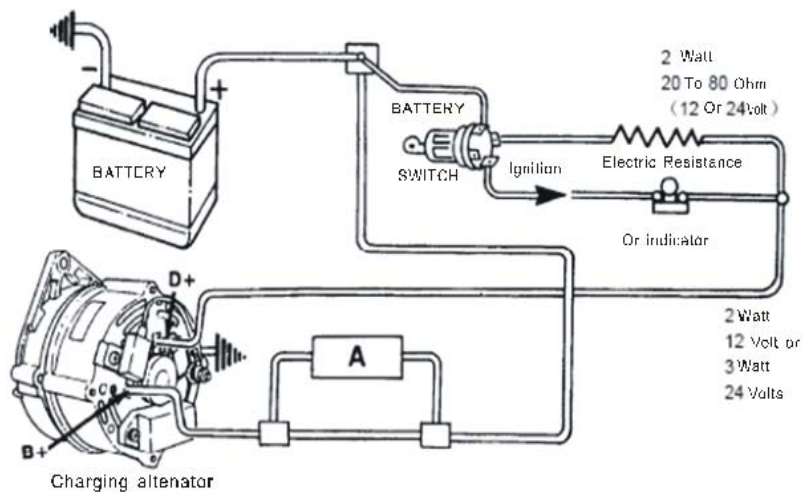


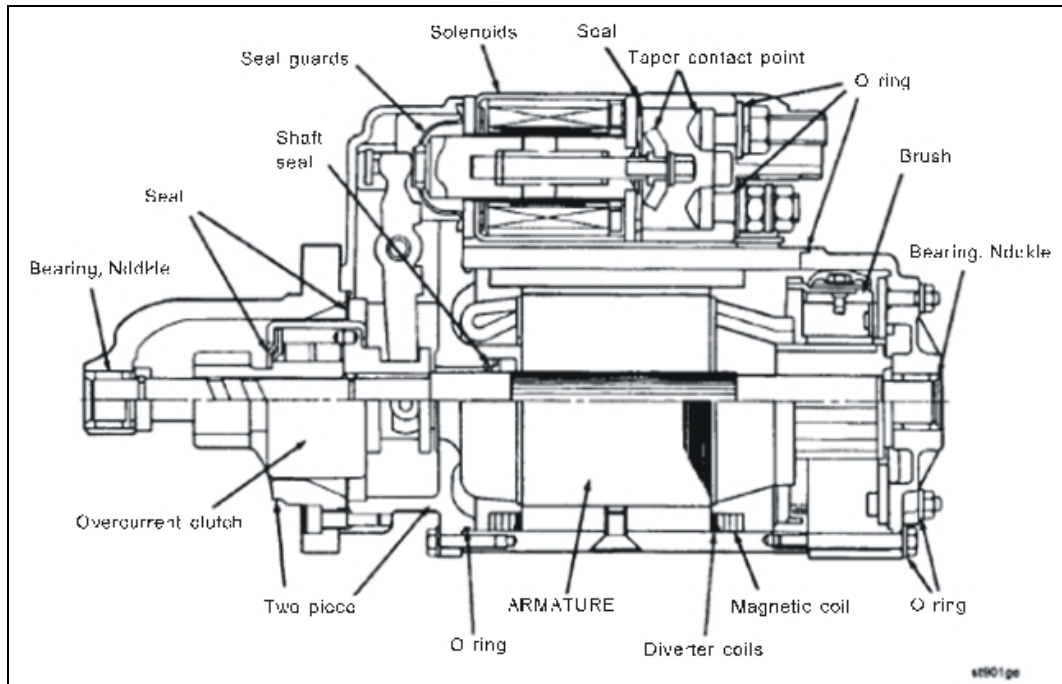
Starting Motor (Typical starting motor wiring)



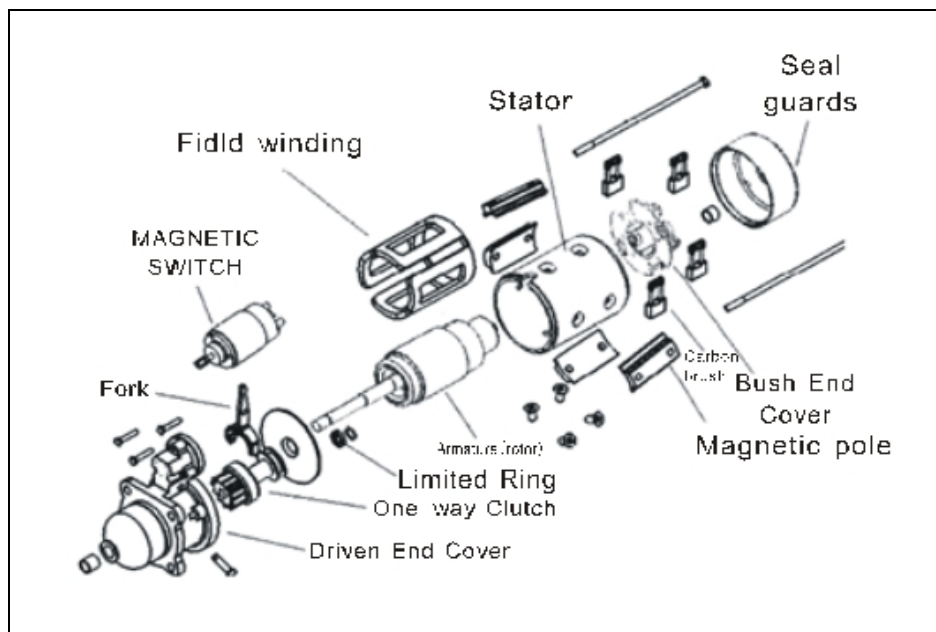


Basic engine wiring (Typical Delco Alternator Wiring Diagram)





QD2816 Starter



Electrical System Specifications

Minimum Recommended Battery Capacity

- 12 volt system
- 24 volt system*
 - 18°C [0°F] Cold cranking amperes900
 - (Reserve capacity amperes)**(270)
 - 0°C [32°F] Cold cranking amperes.....625
 - (Reserve capacity amperes)**(180)

* Per battery (two 12 volt batteries in series)

Ratings are based on -18°C [0°F]

** The number of plates with a given battery size determine reserve capacity. Reserve capacity determines the length of time sustained cranking can occur.

Maximum Allowable Resistance of Starting Circuit

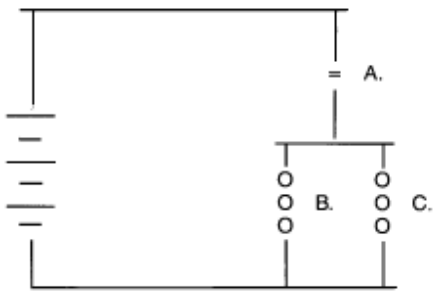
- With 24 v starter – ohms..... (0.0040)

Battery Cables

Total resistance for 24V systems must not exceed 0.002 Ohms

Cable size	Nominal Resistance (Ohms) (Copper Conductor)		Maximum Total Length (sum of both cables)			
			12 Volts		24 Volts	
Gauge	Per meter	Per foot	Meter	Feet	Meter	Feet
4	0.000984	0.00030	Not recommended*	Not recommended*	2.03	6.7
2	0.000615	0.000183	1.63	5.3	3.26	10.6
1	0.000492	0.000150	2.03	6.7	4.06	13.4
0	0.000386	0.000118	2.59	8.5	5.18	17.0
00	0.000292	0.000090	3.43	11.3	6.86	22.6
000	0.000232	0.000071	4.32	14.2	8.64	28.4
*Not recommended						

Wiring Size Recommendations for Starter Solenoid and Fuel Solenoid Circuit

Circuit Diagram

A.= magnetic switch

B.= starter solenoid terminal "S"

C.= fuel solenoid valve pull-in coil

TABLE OF RECOMMENDED WIRE GAUGE: (COPPER CONDUCTOR STRANDED WIRE)

Values in table are AWG. size for 12/24 volt systems.

Wire length in circuit	BAT. Pos to A.	A. to B.	*A. to C.	C. to Bat. Neg
up to 0.9 m [up to 3 ft.]	10/14	12/14	14/16	14/16
1.4 to 2.1m [4.5 to 7 ft.]	10/12	10/14	14/16	14/16
1.4 to 2.1m [4.5 to 7 ft.]	8/10	8/10	12/14	14/16
2.1 to 2.7m [7 to 9 ft.]	6/8	8/10	10/12	12/14
2.7 to 3.4m [9 to 11 ft.]	4/6	6/8	10/12	8/10

Wire length in circuit means total length in each individual circuit, e.g.: BAT. to A. = one circuit.

For example, in a 12 volt circuit:

BAT. Pos to A. =2 m; gauge required = 8g.

A. to B. = 2 m; gauge required = 8g.

A. to C. = 3 m; gauge required = 10g.

B. to Bat. Neg = 3 m; gauge required = 10g.

If the system is double pole wiring, (no frame ground), then the fuel & starter solenoid circuit lengths would include the return cable run to the battery negative.

***Specified requirements for 3 wire fuel solenoids.**

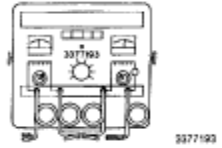
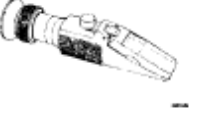
The pull-in wiring (white lead) should conform to the above chart recommendations A to C.

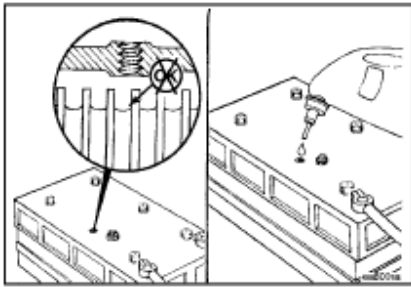
The ground wiring (black lead) must be the same gauge as the pull-in wiring (white lead). The hold-in wiring (red lead) which connects to the "run" terminal should use a minimum of 14 gauge wire.

Note: Starter solenoids are usually internally grounded through the starting motor. No return lead from the starting solenoid to the battery negative is required.

Electrical Equipment – Service Tools

The following special tools are recommended to perform procedures in Section 8. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
3376898	Digital Multimeter Use to measure voltage (volts) and resistance (ohms) in a circuit.	
3377193	Inductive Charging – Cranking Systems Analyzer Use to test generators, alternators, relays, starting motors, regulators and batteries. Contains built-in volt meter and ammeter.	
CC-2800	Refractometer The Fleetgard refractometer is used to check the charge condition of a conventional battery.	



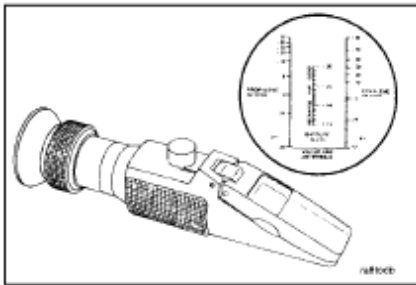
Electrical System – Troubleshooting

Batteries – Check

If conventional batteries are used, remove the cell caps or covers and check the electrolyte level.

NOTE: Maintenance-free batteries are sealed and do not require the addition of water.

Fill each battery cell with distilled water. Refer to the battery manufacturer's specifications.



Refractometer Part No. CC-2800,

Use the Fleetguard Refractometer, Part No. CC-2800, to check the condition of the battery.

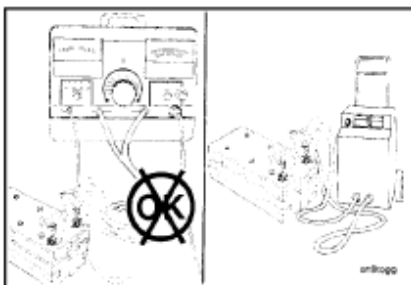
Refer to the battery fluid column in the refractometer to determine the state-of-charge of each battery cell.

NOTE: If the specific gravity of any or all of the cells is below 1.200, the battery must be charged.

	@ 27°C [80°F]
100%	1.260-1.280
75%	1.230-1.250
50%	1.200-1.220
25%	1.170-1.190
	1.110-1.130

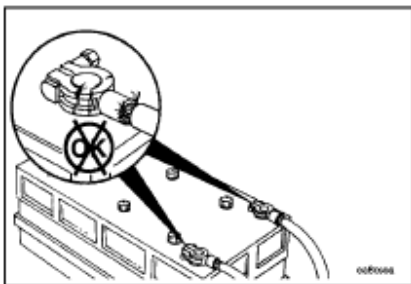


Refer to the accompanying chart to determine the battery state-of-charge based on the specific gravity readings.



Battery tester, Part No. 3377193

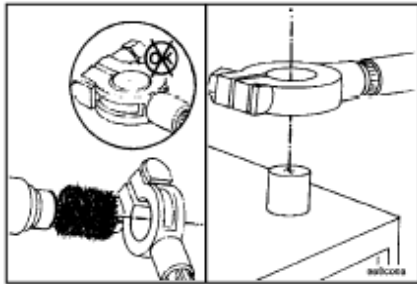
Use battery tester, Part No. 3377193, to test the output amperage of maintenance-free or conventional vent cap batteries. If the output amperage is low, use a battery charger to charge the battery. Refer to the manufacturer's instructions. Replace the battery if it will not charge to the manufacturer's specifications, or will not maintain a charge.



Battery Terminal Connections – Check

Visually inspect the battery terminals for loose, broken, or corroded connections.

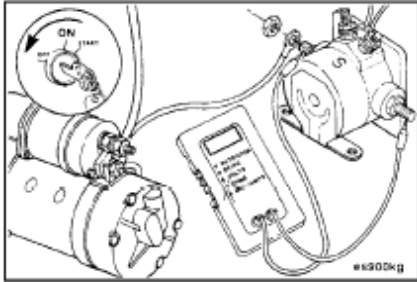
Repair or replace broken cables or terminals.



If the connections are corroded, remove the cables and use a battery cable brush to clean the cable and battery terminals.

Install and tighten the battery cables.

Use grease to coat the battery terminals to prevent corrosion.



Starting Circuit – Check



Magnetic Switch – Check

Be sure the starter motor switch is in the OFF position to prevent electrical shock and personal injury.

Remove the cable connecting the magnetic switch to the starting motor solenoid from the magnetic switch terminal.

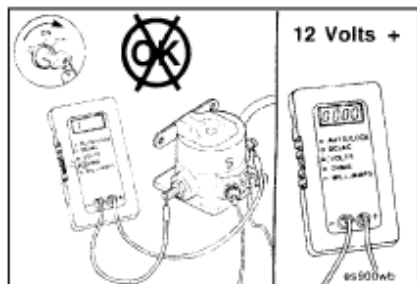
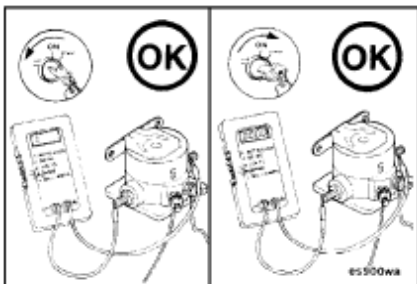
Connect the leads of Part No. 3376898 Digital Multimeter to the two large switch terminals.

Set the multimeter to measure resistance (OHMS).

With the starting motor switch in the “OFF” position, the multimeter must indicate resistance at infinity.

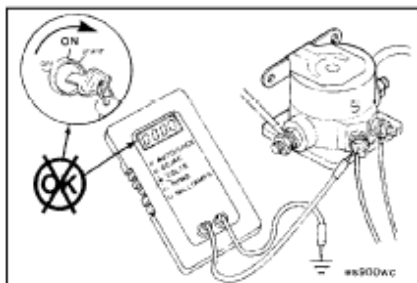
Turn the starting motor switch to the “START” position.

The multimeter must indicate zero or very little resistance.

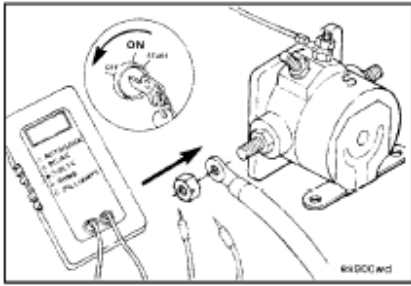


If the multimeter indicates resistance at infinity with the starting motor switch in the “START” position:

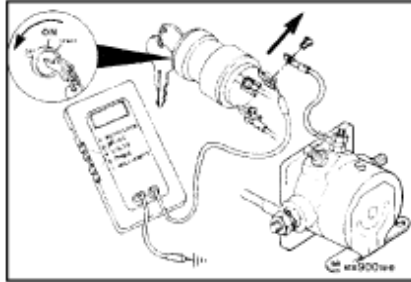
- Turn the starting motor switch to the “OFF” position.
- Set the multimeter scale to read DC voltage.



- Connect one multimeter lead to the magic switch terminal marked “S” and the other lead to the ground.
- Turn the starting motor switch to the “START” position.
- If the multimeter indicates no voltage, the magnetic switch is not the cause of the complaint. Refer to “Starting Motor Switch-Checking” in this procedure.



- Turn the starting motor switch to the "OFF" position.
- Remove the both multimeter leads and connect the magnetic switch to the starting motor solenoid wire.



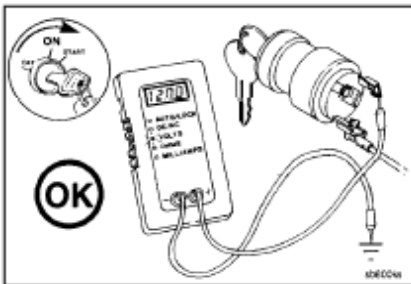
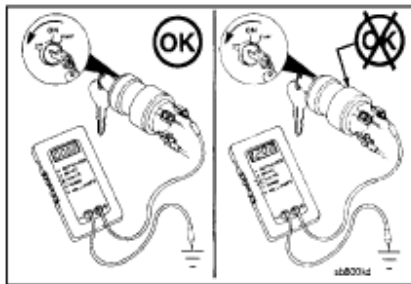
Starting Motor Switch- Check

WARNING: Be sure the starting motor switch is in the "OFF" position to prevent electrical shock and personal injury.

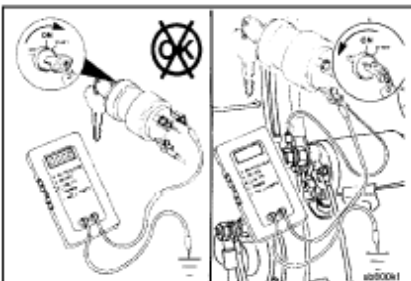
Remove the wire connecting the starting motor switch to the magnetic switch (marked "S" or "Start") from the starting motor switch terminal.

Connect the positive lead of Part No. 3376898 Digital Multimeter to the starting motor switch terminal and the negative lead to a chassis or engine ground location.

NOTE: With the starting motor switch in the "OFF" position, there must not be voltage at the starting motor switch terminal. If the meter indicates voltage, the starting motor switch is malfunctioning and must be replaced.

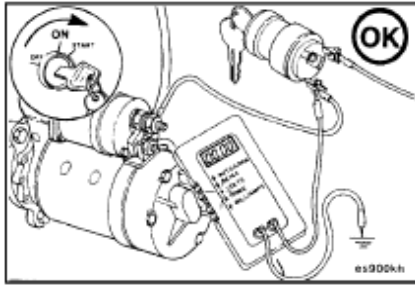


Turn the starting motor switch to the "START" position. The multimeter must indicate system voltage.

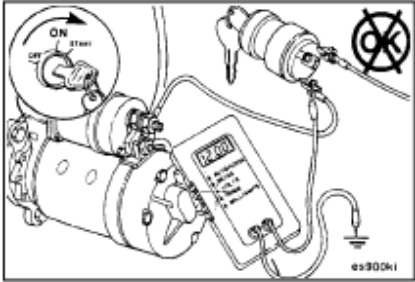


If there is no voltage:

- Turn the start motor switch to the "OFF" position.
- Connect the multimeter positive lead to the starting motor switch terminal having a wire connecting the starting motor switch to the starting motor solenoid "B" terminal.

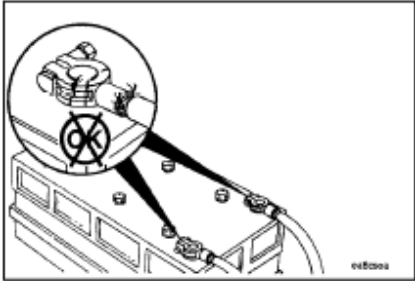


If the meter indicates system voltage at the starting motor switch input terminal, the starting motor switch is defective and must be replaced.



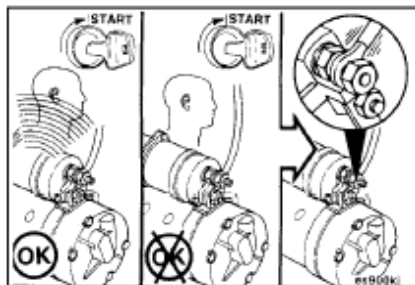
If the meter indicates no voltage, the switch is not the cause of the complaint.

Check the wiring from the starting switch to the starting motor solenoid "B" terminal and from the starting motor solenoid to the battery for broken or damaged wires.



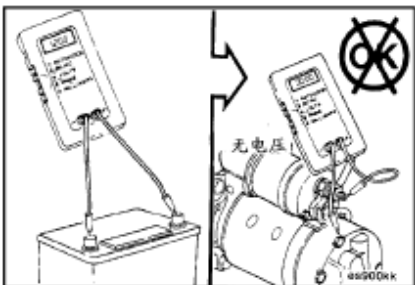
Starting Motor Solenoid and Starting Motor – Check

Before troubleshooting the starting motor, make sure the battery terminals are not loose or corroded. Refer to "Battery Terminal Connections", in this section.



Starter Solenoid

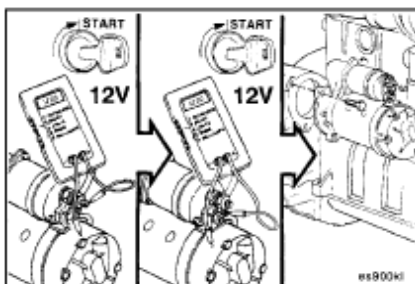
If the starting motor solenoid does not make an audible sound, check for loose wiring connections.



Use a Digital Multimeter such as Part No. 3377161 to set the voltage scale.

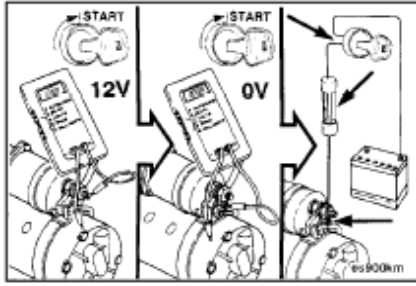


Check for system voltage at the starting motor solenoid battery terminal.



If the multimeter indicates system voltage at the starting motor battery terminal, check the voltage at the starting motor solenoid "S" terminal while the starter switch is energized.

If the multimeter indicates system voltage at "S" terminal, but the starter does not engage, the starting motor solenoid is malfunctioning and the starter must be replaced.



If the multimeter does not indicate system voltage at the “S” terminal, check:

- Fuse
- Voltage to the ignition switch and magnetic switch. Refer to “Starting Motor Switch and Magnetic Switch – Checking” in this section.
- Application safety shutoff systems.

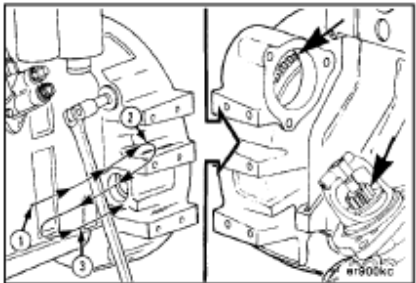
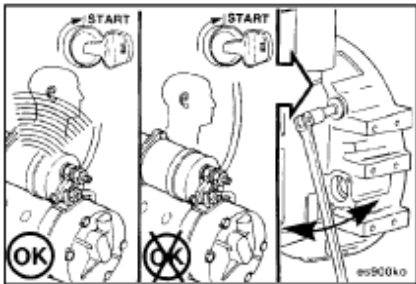
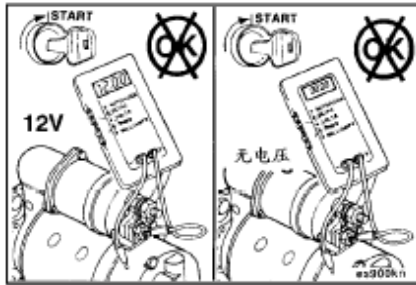


Starter

Check for system voltage at the “M” terminal of the starting motor while the starter switch is energized.

- System Voltage: Starting motor is malfunctioning or not adequately grounded and must be repaired or replaced.
- No Voltage: Starting motor solenoid is malfunctioning and must be replaced.

If the starting motor solenoid makes an audible sound, turn the switch OFF and attempt to rotate the crankshaft in both directions.



Rotate the crankshaft as follows:

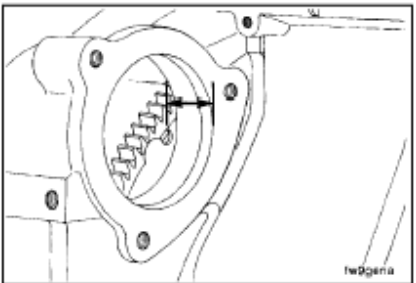
1. Direction of engine rotation.
2. Direction opposite engine rotation.
3. Direction of engine rotation.

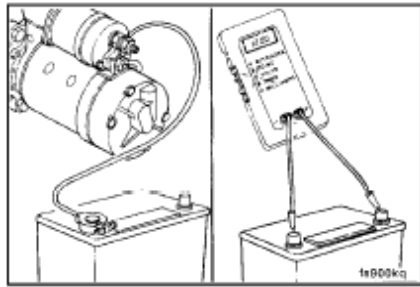
If the starting motor cranks the engine, check the starting motor pinion gear and flywheel ring gear for damage.

If the starting motor pinion gear or the flywheel ring gear is damaged, the damaged components must be replaced.



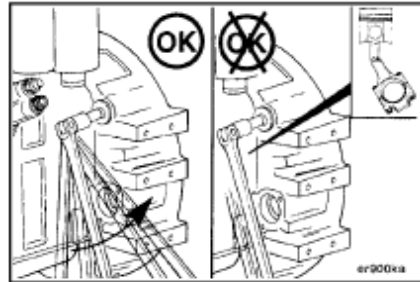
To attain a starter motor mounting surface to ring gear face dimension of 50.8 mm ± 1.5 mm [2.0 in ± 0.060 inch] a starter spacer is used between the starter motor and flywheel housing. If the starter to ring gear spacing dimension is not within specification, check to make sure the correct spacer, flywheel or flexplate, and crankshaft to flexplate mounting adapter (if required) is on the engine, this will help to determine which component is out of spacing specification.



**Engine Cranking Speed Too Slow**

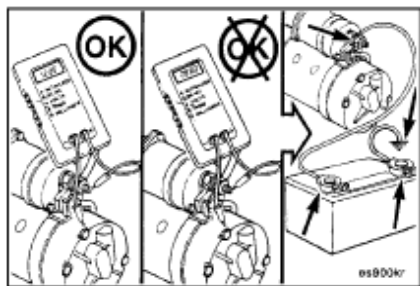
Make sure the wiring connections are clean, tight and not damaged. Refer to "Battery Terminal Connections".

Check battery voltage.



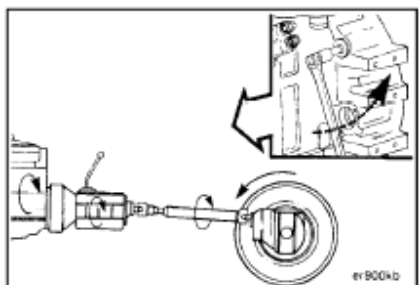
If the crankshaft was not rotated to check the starting motor, rotate the crankshaft in the direction of engine rotation to make sure the engine does not have an internal malfunction.

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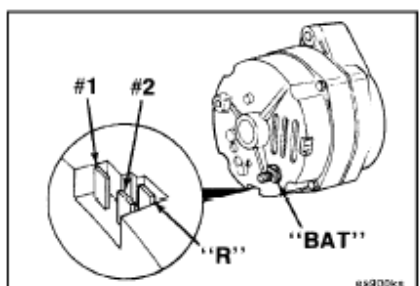


If the engine rotates freely, check the voltage at the starting motor during cranking. If the voltage drops more than 2.4 volts, check that all connections are tight. The limit for 24-volt systems is 4.8 volts.

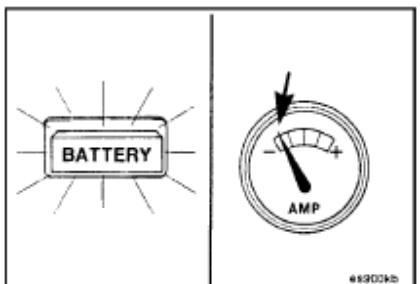
If the cable are adequate size and good condition, but the voltage drop exceeds the limit, replace the starting motor.



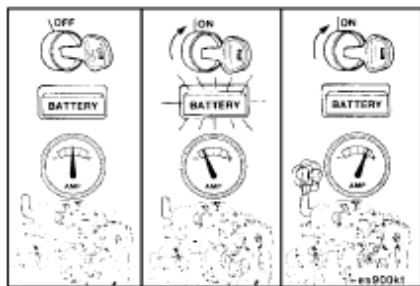
If the resistant required for barring the engine is more than a normal effort, check the various components of the engine and accessories for abnormal.

**Alternator**

The terminals on the alternator are shown in this illustration. The "R" terminal provides one-half system voltage and is used to operate accessories such as the tachometer on generator sets.



Trouble with the charging system may be indicated by the indicator lamp or ammeter.



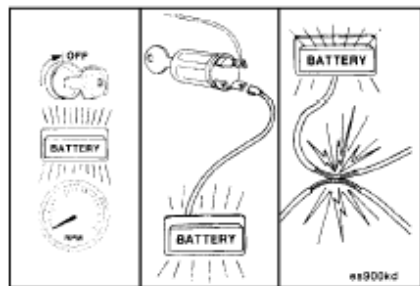
Abnormal Indicator Lamp Operation

Check the indicator lamp for normal operation as shown below:

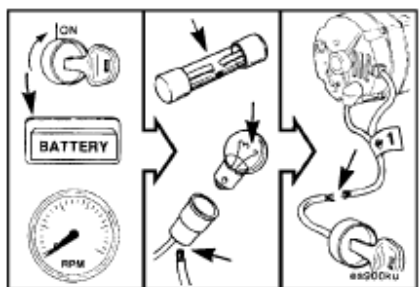
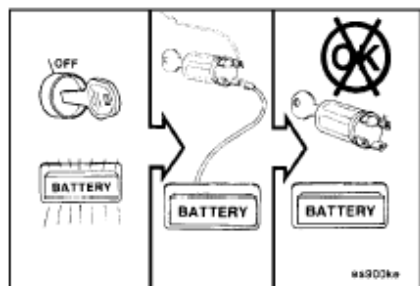
Engine	Switch	Lamp	Ammeter
Stopped	Disconnect	Off	0
Stopped	ON	ON	-
Running	ON	Off	+

Switch Off, Engine Stopped, Lamp On

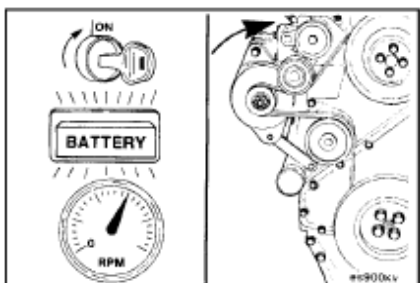
Disconnect the lamp lead to the starter switch. If the lamp stays on, there is a short between the lamp and a wire which connects with starter switch.



If the lamp goes out, there is a short in the switch.

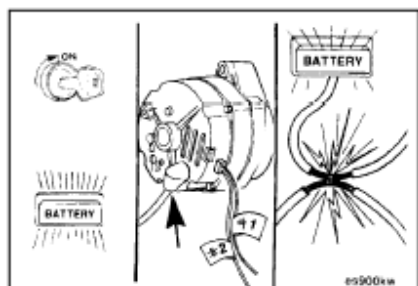


Main Switch On, Engine Stopped, Lamp Off This condition can be caused by an open in the circuit. To determine where an open exists. Check for a blown Fuse, a burned out bulb, defective bulb socket, or an Open in No.1 lead circuit between alternator and starter switch.

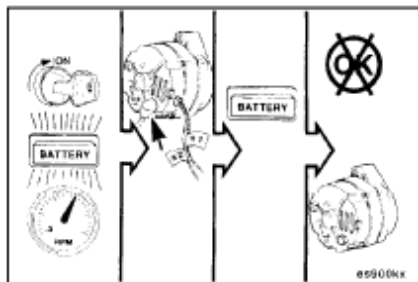


Main Switch On, Engine Running, Lamp On

Check the drive belt and alternator pulley to be sure the alternator is rotating.

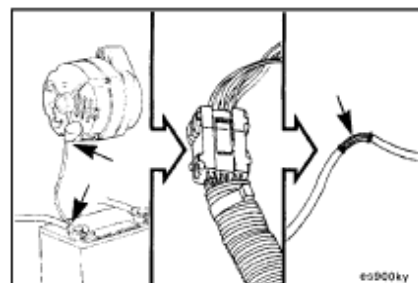


Disconnect the lead to Terminals No.1 and No. 2. If the lamp stays on, there is a short to ground on the alternator side of the lamp.



If the lamp goes out, replace the alternator.

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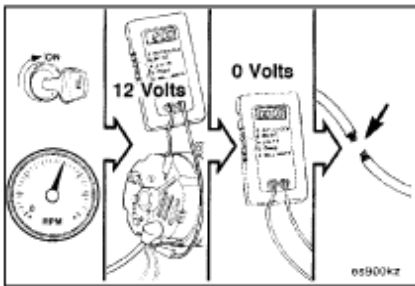


Abnormal Charging System Operation

Check the battery and all wiring connections.



Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the alternator and firewall, and connections at the battery.



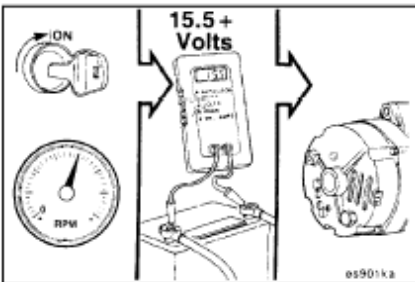
With starter switch on and all wiring harness leads Connected, connect a voltmeter from:

- Alternator "BAT" (Delco 15SI) "B+" (Bosch K1) terminal to ground.
- Alternator No.1 (Delco 15SI) to ground.
- Alternator No.2 (Delco 15SI) to ground.
- Alternator D + (Bosch K1) to ground.



A zero reading indicates an open between the alternator connections and the battery.

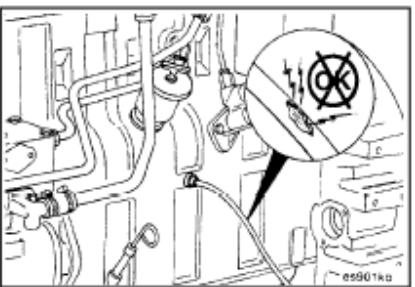
Locate and repair the open circuit.



With all accessories turned OFF, connect a voltmeter across the battery. Operate engine at 1500 RPM or above.



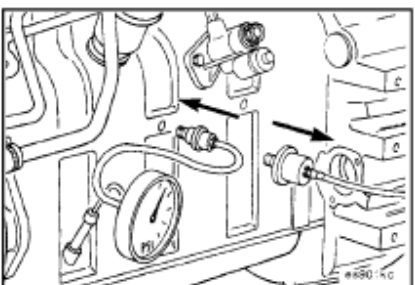
If voltage is 15.5 or more, remove the alternator for repair. The limit for 24 volt systems is 28 volts.



Oil Pressure Switch and Temperature Sensor – Check



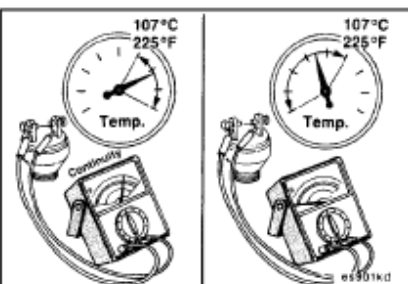
When diagnosing problems with either the pressure switch or the temperature sensor, check for loose or corroded connections and broken wires.



Checking the Oil Pressure Switch

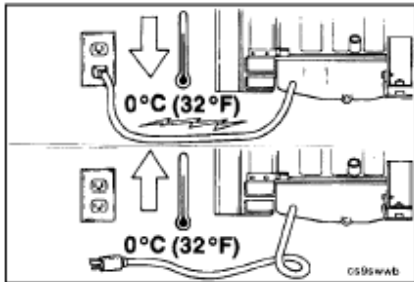
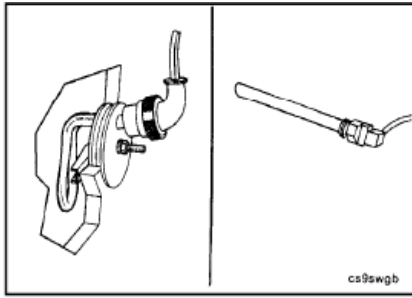


Remove the pressure switch, install a gage, start the engine and measure oil pressure. Minimum oil pressure:
 Low Idle (675 to 725 RPM).....69 kPa [10 PSI]
 High Idle.....207 kPa [30 PSI]
 Pressure switch is set to actuate when oil pressure drops to 55 kPa [8 PSI].



Checking the Temperature Sensor

Check for continuity. The sensor will have continuity only when coolant temperature is above 107°C[225°F].



Coolant or Pan Heaters – Check

The engine block or oil pan heater should make an audible sound when activated. The adjacent parts should be warm to the touch.

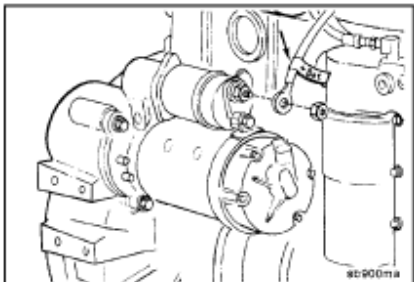
Some heaters will operate continuously when plugged into the correct voltage electrical socket. Operate them only below 0°C [32°F] ambient temperature.

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Starting motor – Replace

Preparatory

- Disconnect the ground cable from the battery.
- Identify each electrical wire with a tag indicating location.

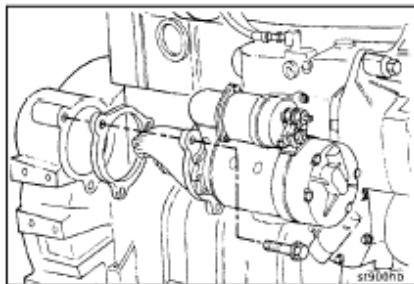


Removal and Installation

19 mm



Remove the batter cable from the solenoid.



16mm and 19 mm

Remove the starting motor and spacer.



Install the starting motor and spacer in the reverse order of removal.



Connect the battery cable to the solenoid.

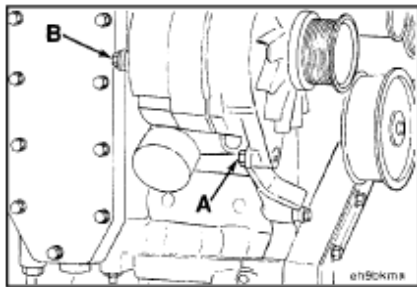
Torque Value: 77N•m [57 ft- lb]



Alternator – Replace

Preparatory:

Disconnect the ground cable from the battery terminal.
Identify each electrical wire a tag indicating location.
Remove the drive belt.



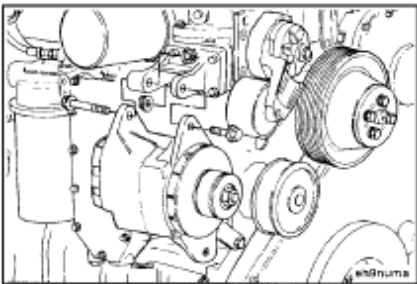
Remove

19 mm



Remove the capscrew (A) from the alternator link.

Remove the capscrew (B) from the tail support bracket.

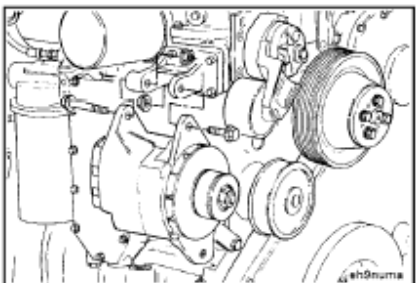


18 mm, 19 mm.



Remove the alternator mounting capscrews and nuts.

Remove the alternator.

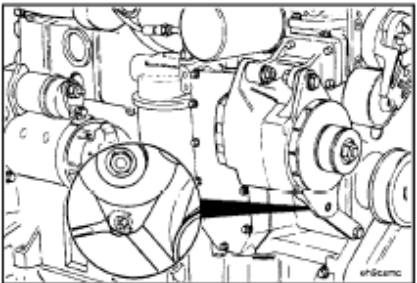


Install

18 mm, 19 mm.

Install the alternator mounting capscrews and nuts.

Torque Value: 77N•m [57 ft- lb]



19 mm

Install the alternator link and the tail support bracket.



Torque Value:

(Alternator End) 43N•m [32 ft- lb]

(Water Pump End) 24N•m [18 ft- lb]



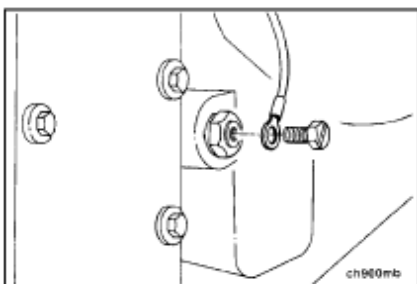
Connect all wires and install the drive belt.



Coolant Temperature Sensor – Replace

Preparatory:

- Drain the coolant.

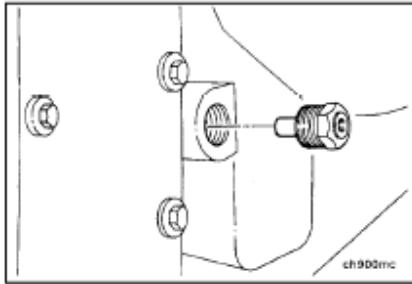


Remove

3/8 – inch wrench or screwdriver

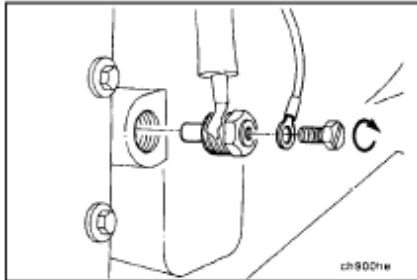


Disconnect the temperature sensor wiring.



7/8 – inch wrench

Remove the temperature sensor.



Install

7/8 – inch and 3/8 - inch wrench or screwdriver

Apply liquid Teflon sealant to the threads when installing the temperature sensor.

Connect the wiring.

Torque Value:

(install into cast iron) 50N•m [37 ft- lb]

(install into Aluminum) 30N•m [22 ft- lb]

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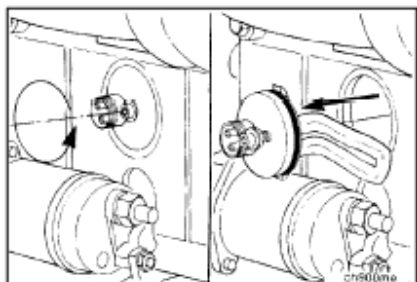
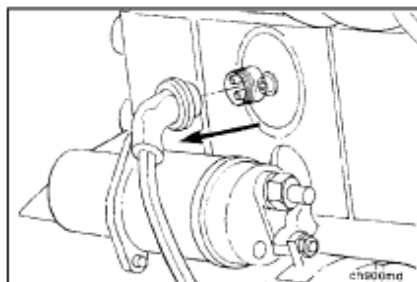
Engine Block and Coolant Heater (750 and 500 volt) – Replace

Preparatory:

- Drain the coolant.

Remove

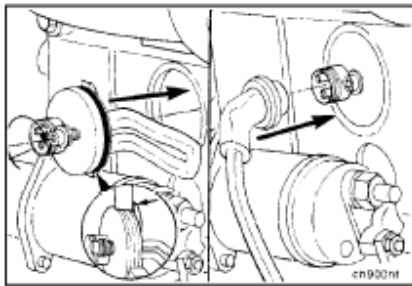
Disconnect engine block heater cables.



4 mm

Loose engine block heater retained screws. Remove the heater from the engine block.





Install

4 mm



CAUTION: If the T- strut is not in the correct location in the bore. This will cause coolant leaks and damage to the engine.



Film of oil on the o-ring, push the heater into the hole. Then hit the heater with a plastic hammer into the hole. Make sure the o-ring will not be damaged while installing, tightening the capscrew.



Torque Value: 12N•m [106 in- lb]

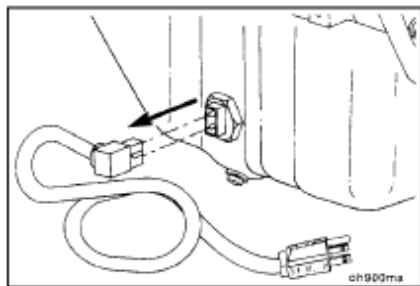
Connect the wires, priming the coolant into the tank until it reaches appropriate level.



Lubricating Oil Pan Heater – Replace

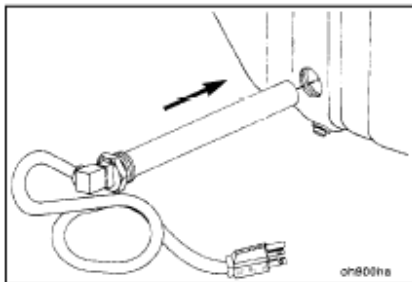
Preparatory:

- Drain the engine lubricating oil.



Remove

Disconnect oil heater cables.



Install

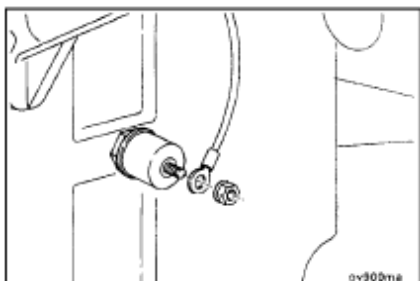
Detent Wrench, 27 Mm Extension Socket, Torque Wrench



Replace the heating elements. Reprime the oil to the correct level.



Torque Value: 120N•m [89 ft- lb]

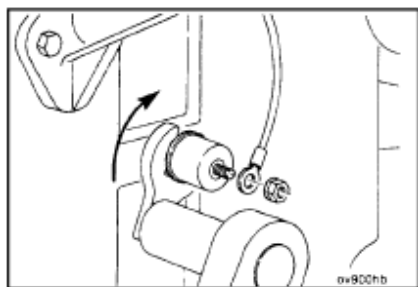


Oil Pressure Switch – Replace

Remove

Remove the wire from the sensor.

The sensor shown in the illustrations may be Different from installation of the equipment manufacturer.



Install

Well connected wire from the switch.

Torque Value:

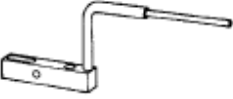
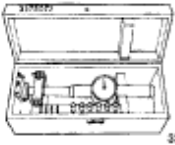
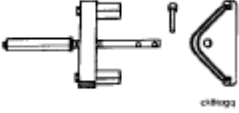
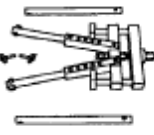
(install into cast iron)	16N•m [12 ft- lb]
(install into Aluminum)	10N•m [89 in- lb]

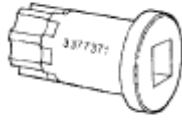
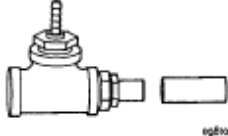
Basic Engine Components

Basic Engine Components –Service Tools

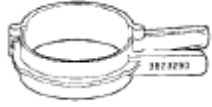
The following special tools are recommended to procedures section 9.the use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

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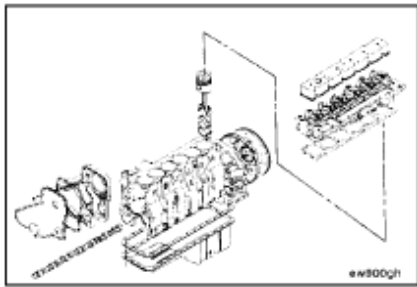
Tool No	Tool Description	Tool Lustration
ST-647	Standard puller Used to remove drive pulleys, impellers, air compressor counterweights, etc.	 adtrcpa
ST-1229	Cylinder liner driver Install cylinder liner into cylinder block	 ST-1229
ST1325	Dial gauge attachment Attaches to crankshaft flange to provide measuring of flywheel and flywheel housing runout with dial bore gauge	 mtrngp
3375068	Cup plug sealant Used when installing pipe plugs, cup plugs, etc. on the engine to prevent leaks	 tprltogk
3375072	Dial bore gauge kit It is used to measure the inside diameter from 78.5 mm(3.09in)to 2.032mm(8.0in)	 3375072
3375629	Universal cylinder liner puller To remove the cylinder liners from cylinder block cylinder liner puller, part No.3822786, is required.	 crltrngp
3376015	Cylinder liner puller (universal) To remove the cylinder liners from the cylinder block, the puller arm extension feet, part No.3376649, is required.	 crltrngp
3376050	Dial indicator and sleeve assembly Use dial indicator, part No.ST-1325, to measure flywheel housing runout	 mtrngp

Tool No	Tool Description	Tool Lustration
3376795	Expansion plug driver handle Used with all expansion plug drivers larger than 0.375 inch diameter.	
3376816	Expansion plug driver Use to install 1.00 inch expansion plug to specified depth. Used with expansion plug driver handle, part No.3376795.	
3377371	Engine barring gear Used to engage the flywheel ring gear to rotate the crankshaft.	
382372	Expansion plug driver Use to install 0.375 inch expansion plug to specified depth.	
3822503	Cylinder liner clamp set Used to clamp the liner into the bore of the cylinder block. Note: requires two cylinder head capscrews (not included in the clamp set).	
3822510	Injector bore brush Used to clean carbon from injector bores.	
3822513	Tappet Removal Tool Kit Used to remove and install valve tappets.	
3822566	Blowby check tool Used with manometer, Part No. ST-1111-3, to Measure the engine crank pressure	
3823137	Piston ring expander Used to install piston rings on to piston without damaging or distorting the rings	

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L Series Engines-Basic Engine Components

Tool No	Tool Description	Tool Lustration
3823290	Piston ring compressor Used to compress the piston rings while installing the pistons into the cylinder bores	 3823290
3823425	Crowfoot wrench Used to torque high pressure fuel line nuts on Bosch fuel pump. Size :17mm 3/8 inch	 3823425
3823494	Sealant(150 gram tube) Used for sealing "T" joints and front gear cover.	 3823494
3823495	Gauge block Measure cylinder liner protrusion on the cylinder block.	 3823495
3823521	Expansion Plug driver Use to install 0.8125 inch expansion plug to specified depth. Used to expansion plug driver handle, Part No.3376795	 3823521
3823522	Expansion plug driver Install 1.1875 inch expansion plug to specified depth .Used with expansion plug driver handle, Part No.3376795	 3823522
3823523	Expansion plug driver Use to install 1.375 inch expansion plug to specified depth. Used with expansion plug driver handle, Part No.3376795	 3823523
3823524	Expansion plug driver Used to install 2.250 inch expansion plug to specified depth.	 3823524
3823559	Cylinder liner counterbore tool Used to process cylinder liner mounting holes edge. Used with cutting plate, part. No. 3823567 and cutter bit, part No. 3823570	 3823559

Tool No	Tool Description	Tool Lustration
3823585	Crankshaft gear installation and removal. Does not work on steel gears.	 3823585
3823589	Camshaft gear installation and removal tool Used to remove and install the camshaft gear from the camshaft with the camshaft installed.	 3823589
3823818	Main bearing rollout tool Used to remove and install main bearing with The crankshaft installed	 3823818
382367	Cutter plate Used with cylinder liner mounting hole tool, Part NO.3823558	 382367
3823570	Cutter bit Used with Part No. 3823567, cutter plate, to machine the cylinder liner counterbore ledge.	 3823570
3824078	Wear sleeve installation tool Used to install the rear crankshaft lubricating oil Seal wear sleeve	 3824078
3824499	Lubricating oil seal installation tool Used to install the front lubricating oil seal in the front cover to a specified depth.	 3824499
3164025	Fuel adapter removal tool Used to remove the fuel adapter.	

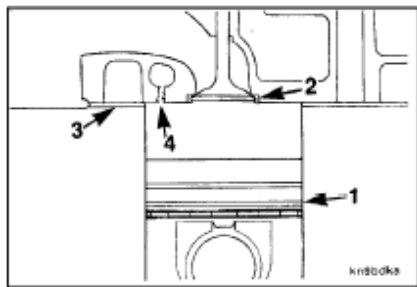


Engine compression –check



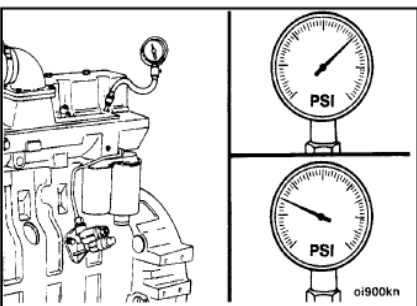
Compression gauge and Adapter

It is very time-consuming to diagnose to check the Function in the following:



1. Piston rings sealing
2. Intake and exhaust valve sealing
3. Cylinder head gasket sealing
4. Cylinder head cracked

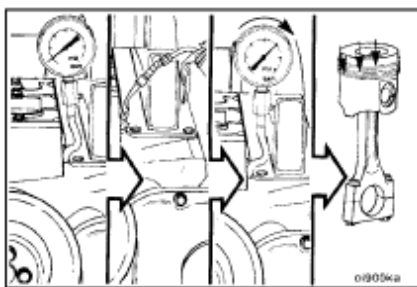
Refer to appropriate in this section for replacement of failed components.



NOTE: Due to variables such as starter and battery conditions that affect engine cranking speed, it is difficult to establish an absolute value can be used as guidelines:

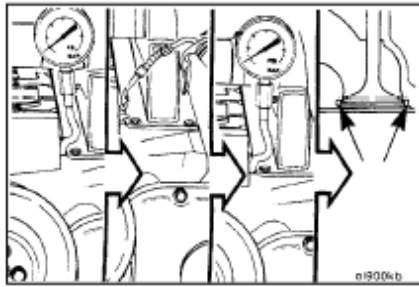
- New engine (cranking speed @250 RPM) 2413kpa [350psi]
- Used engine (cranking speed @250RPM) 2068 kpa [300psi]

It is recommended that the compression pressure be Checked on all cylinders and then compared. All cylinder Should be within 690 kpa [100psi] of each other.



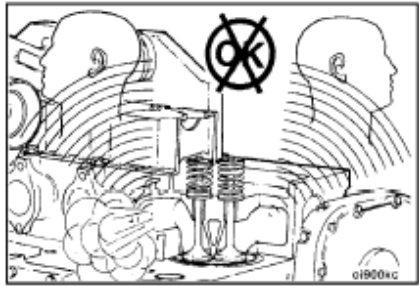
Piston rings sealing

If the compression is low but can be increased Significantly by squirting lubricating oil into the Cylinder, the cause of low compression is inadequate sealing between the piston rings and the cylinder walls.



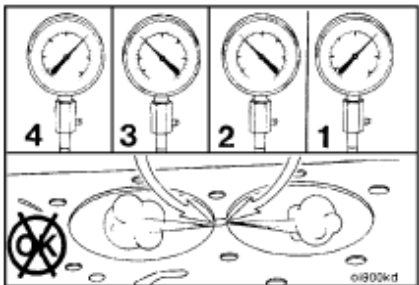
Intake and exhaust valve sealing

If the compression is low on one or more non-adjacent cylinders and the pressure cannot be increased by oiling the rings, improper valve sealing is to be suspected.



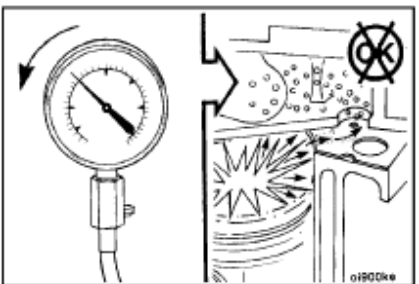
Valve leakage is often audible from the intake and exhaust manifold.

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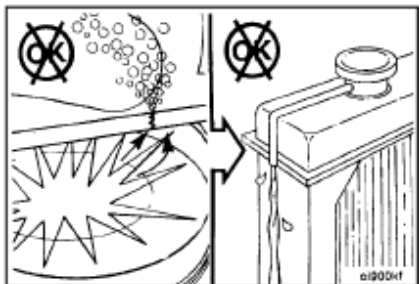


Cylinder head gasket sealing

If the compression is low on adjacent cylinder and the pressure cannot be increased by oiling the rings, the cylinder head gasket is probably leaking between the cylinders.

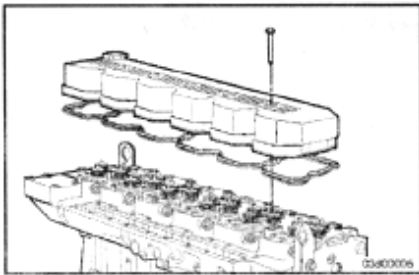


NOTE: low compression on a single cylinder can be caused by an external leak to a coolant passage. A leak to a coolant passage of this magnitude will also result in coolant in the cylinder.



A compression leak to the coolant will normally be detected by loss of coolant as the coolant is blown from the cooling system.

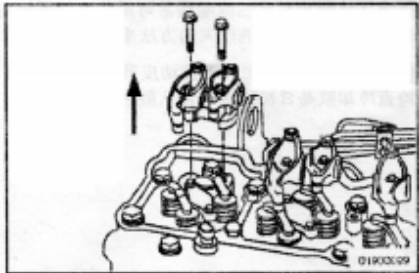
Service tip: remove the drive belt from the water pump. Run the engine for 1 to 2 minutes and check for coolant being blown from the radiator by compression gasses.



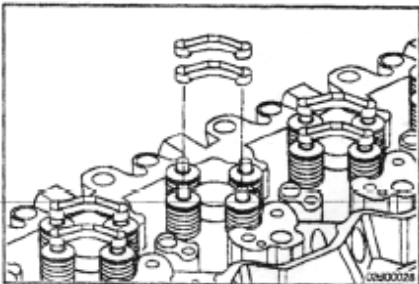
Crosshead

Remove

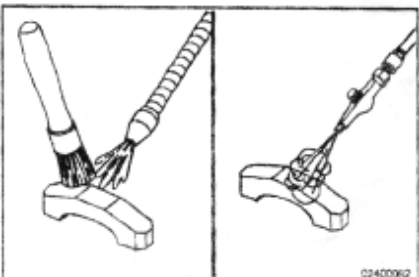
Remove the rocker lever cover.



Remove the rocker lever assembly.



Remove the crossheads.

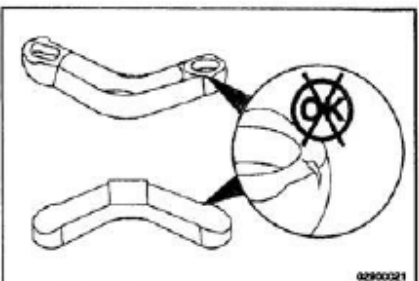


Clean

WARNING: When using solvents, acids, or alkaline materials for cleaning, follow the manufactures recommendations for use. wear goggles and protective clothing to reduce the possibility of personal injury.

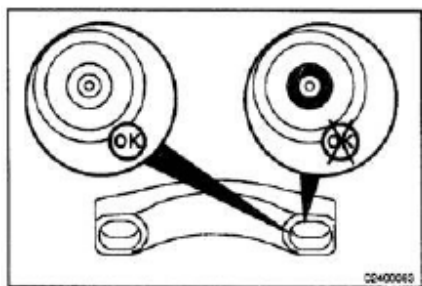
Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal Injury.

Clean the crosshead with solvent. dry with compresses air.

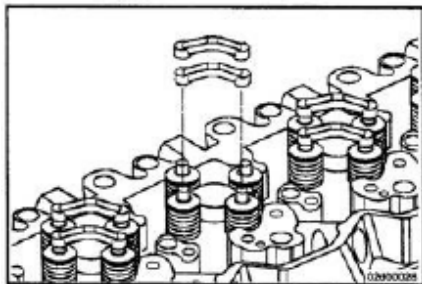


Inspect for reuse

Check crossheads for cracks and /or excessive on rocker lever and valve tip mating surfaces.



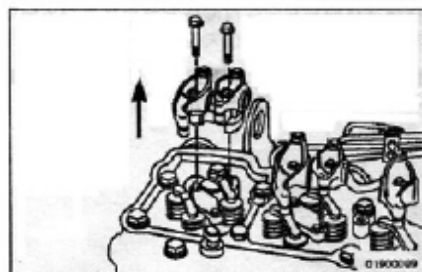
Inspect the contact base for cracks and other damages.



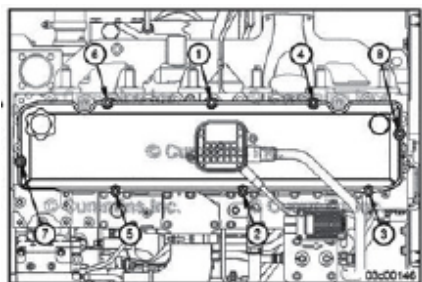
Install

NOTE: the crosshead contains one circular or oval hole. The location of this hole has no special provisions. Install crosshead onto the valve stems.

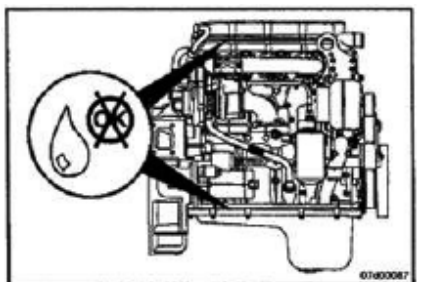
93



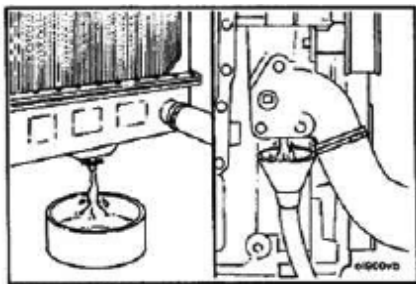
Install the rocker lever assembly.



Install rocker lever cover and gasket.



Operate engine, and check for leaks.



Cylinder heads



Preparatory

WARNING: Coolant can be toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

WARNING: Do not remove the pressure cap from the engine Until the temperature is below 50°C [120°F] to avoid personal injury from hot coolant.

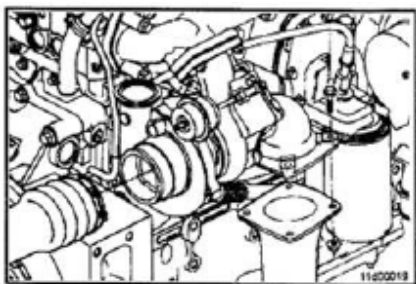
Drain the coolant.

Remove all the tubes and the heater hoses that attaches to the cylinder head.

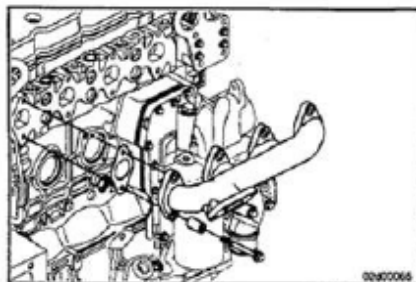


Remove

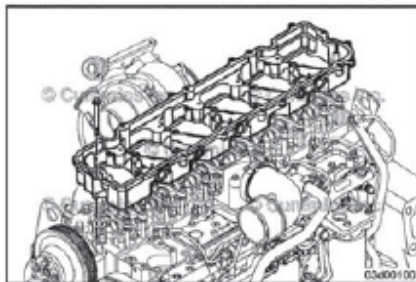
Remove the turbocharger



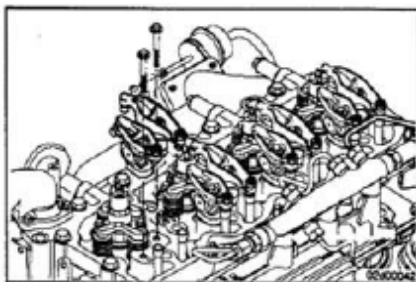
Remove the exhaust manifold.

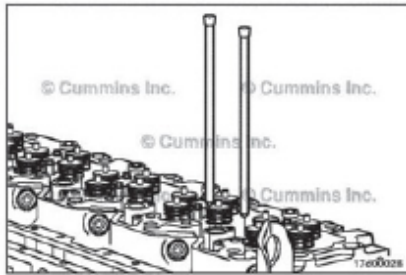


Remove the rocker lever and housing.

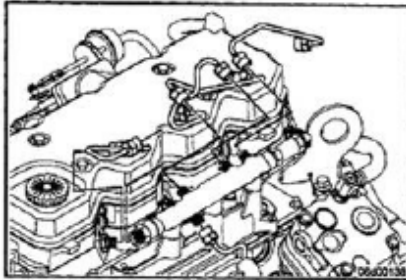


Remove rocker lever and crosshead.

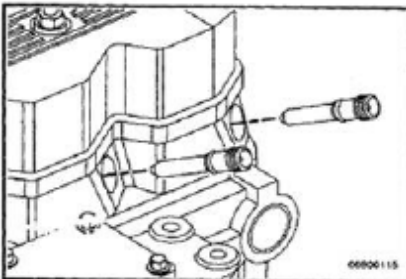




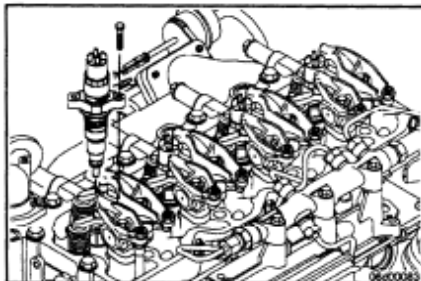
Remove push rods.



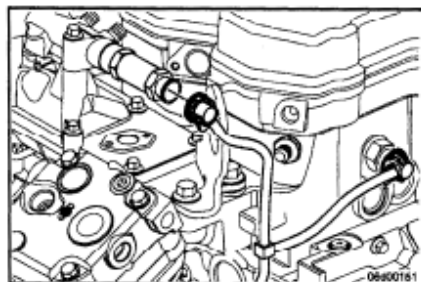
Remove the injector supply line.



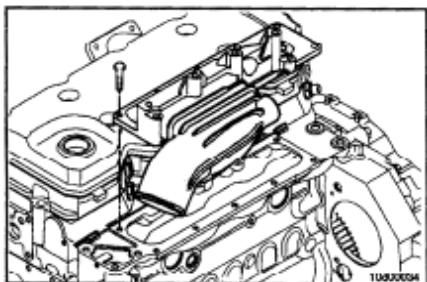
Remove the fuel connection tubes.



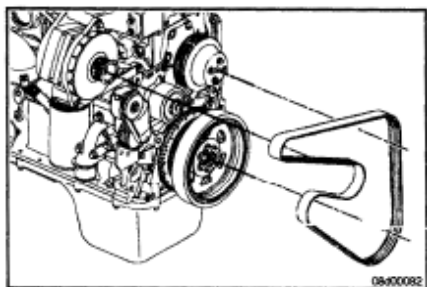
Remove the injectors.



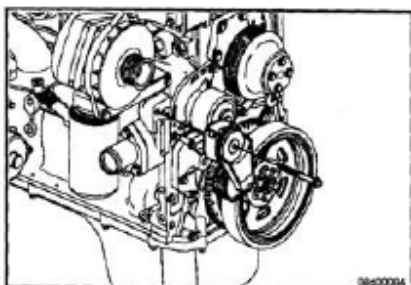
Remove the fuel return lines.



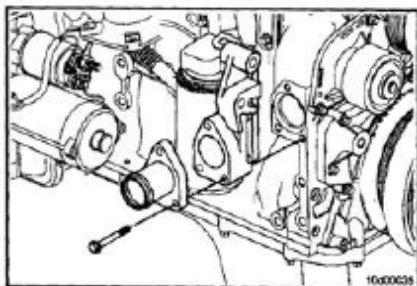
Remove the intake manifold cover.



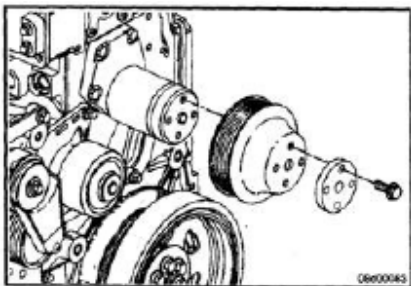
Remove drive belt.



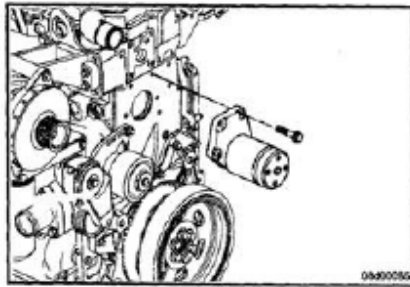
NOTE: Omit this step if the fan hub assembly is not attached to the cylinder head.
Remove the belt tensioner.



NOTE: Omit this step if the fan hub assembly is not attached to the cylinder head.
Remove the tensioner bracket.

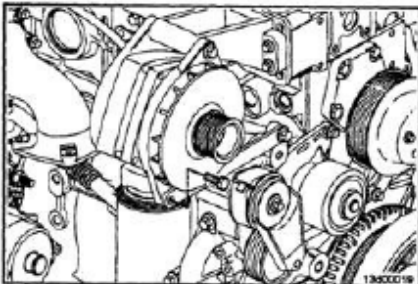


NOTE: Omit this step if the fan hub assembly is not attached to the cylinder head.
Remove the fan hub pulley.



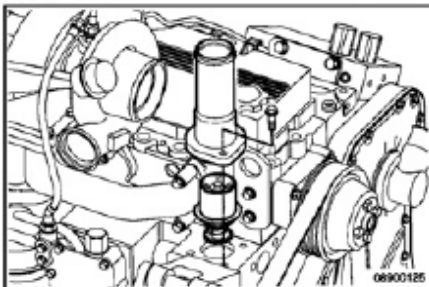
NOTE: Omit this step if the fan hub assembly is not attached to the cylinder head.

Remove the fan hub assembly.

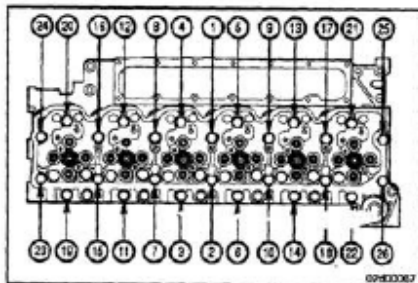


Remove the alternator linkages, mounting capscrews and water inlet fitting capscrews.

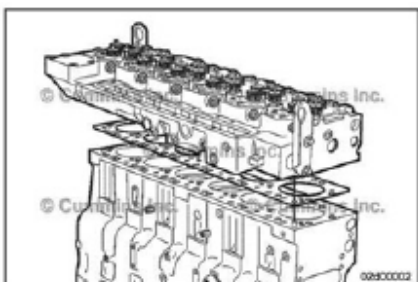
Remove the mounting capscrews from the support bracket, the alternator is pivoted away from the engine.



Remove the thermostat housing and assembly bracket from the engine.

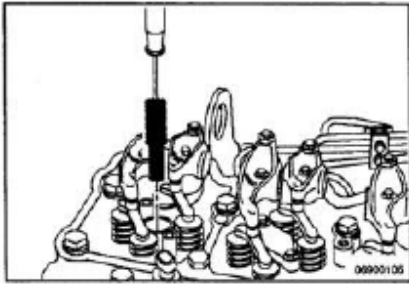


Remove the cylinder head capscrews from the six cylinder engine in the sequence shown in the illustration.



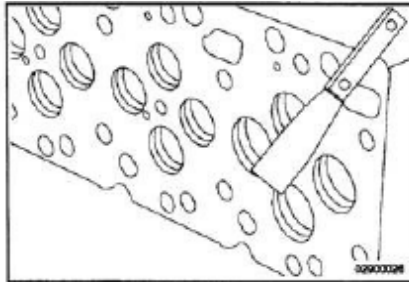
WARNING: The component weighs 23kg [50lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Remove the cylinder head and gasket from the Cylinder block.



Clean

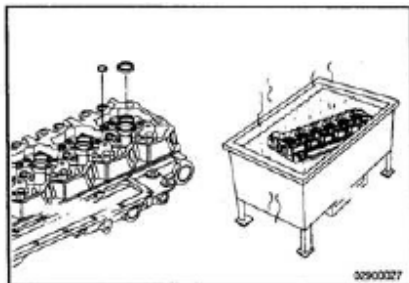
Clean the carbon from the injector nozzle seat with an injector bore brush, Part No.3822510, or equivalent.



Disassemble the cylinder head.



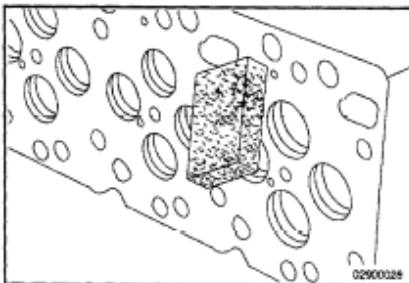
Scrape the gasket material from all gasket surfaces on the block and head.



Clean deposit buildup from coolant passages.

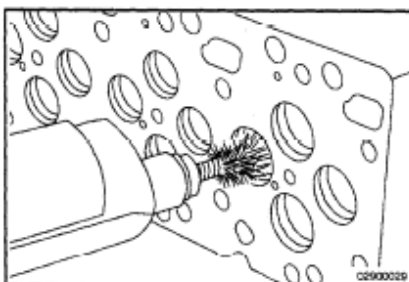


CAUTION: Excessive deposits may be cleaned in an acid tank but the expansion plugs must first be removed.



WARNING: When using solvents, acids, or alkaline materials for cleaning, follow the manufacturers recommendations for use. wear goggle and protective clothing to reduce the possibility of personal injury.

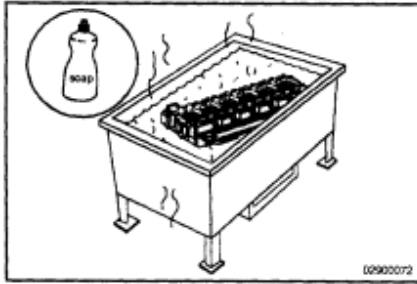
Clean the cylinder head combustion deck with a Scotch – Brite™7448, Part No.38232458, or equivalent, and diesel fuel or solvent.



WARNING: Wear protective eye covering while cleaning carbon deposits to prevent injury.

Clean carbon deposits from the valve pockets with a high quality steel installed in a drill or a die grinder.

NOTE: An inferior quality wire wheel will lose steel bristles during operation, thus causing additional contamination.

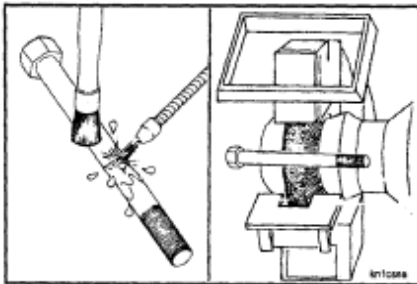


WARNING: Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

Wash the cylinder head in hot soapy water solution.

Wash cylinder head with clean water.

Dry with compressed air.



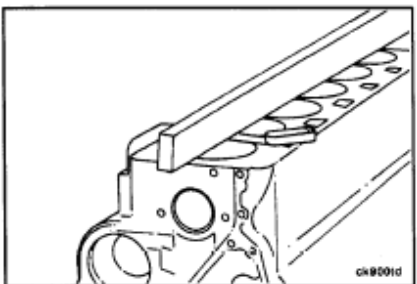
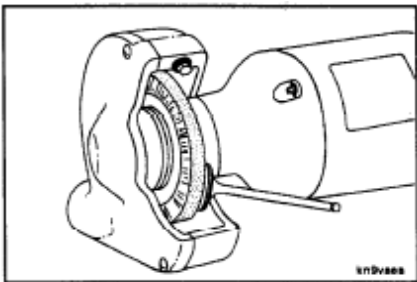
WARNING: When using solvents, acids, or alkaline materials for cleaning, follow the manufactures recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

CAUTION: Do not use caustic or acid solutions to clean the cylinder head capscrews, fail to do this can cause components damage.

Use a petroleum-based solvent to clean the capscrews.

Clean the capscrew thoroughly with a wire brush, a soft wire wheel, or use a non-abrasive bead blast to remove deposits from the shank and the threads.

Clean valves

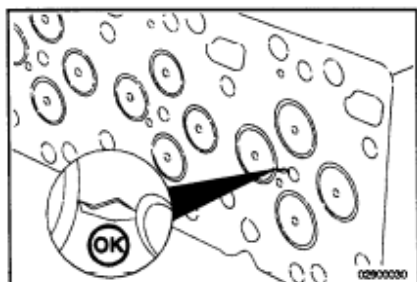


Inspect for reuse

Cylinder block combustion deck inspect

Use a straight edge and feeler gauge to measure the overall flatness, end to end and side to side, must not exceed 0.075 mm [0.003in]

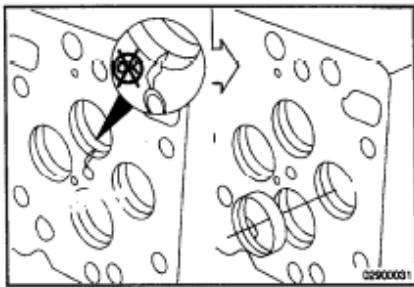
Inspect the combustion deck for any localized dips or imperfections, if present, the cylinder block head deck must be ground.



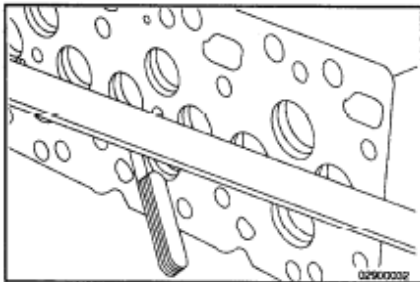
Cylinder head cracks-reuse guidelines

The reuse guidelines for a cylinder head with a crack extending from the injector bore to the intake valve seat are as follows:

If the crack does not extent into the valve seat, the cylinder head is reusable.



If a crack extends into or through the valve seat, the Cylinder head must be replaced.

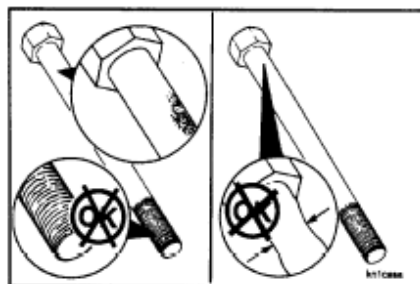


Use a straight edge and a feeler gauge to inspect the cylinder head combustion surface for flatness.

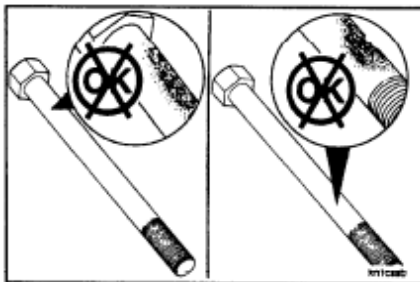
Cylinder head flatness

	mm		in
End to end	0.30 5	MAX	0.012
Side to side	0.076	MAX	0.003

Note: replace cylinder head if flatness is beyond the specification.



Inspect the cylinder head capscrews for damaged threads, corroded surfaces, or a reduced diameter (due to capscrew stretching).



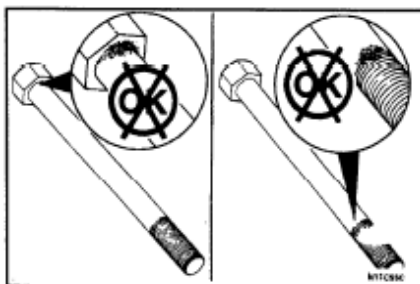
Do not reuse cylinder head capscrews under the following conditions:

- Visible corrosion or pitting exceeds 1 sq cm[0.155sq in]in area.

Examples :

- acceptable is 9.525*9.525mm [3/8*3/8in]
- unacceptable is 12.700*12.700mm{1/2*1/2in}

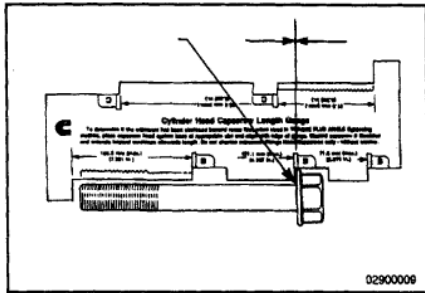
- Visible corrosion or pitting exceeds 0.12mm[0.005in]in depth.



- Visible corrosion or pitting is within 3.2mm[1.8in] of the fillet.



- Stretched beyond “free length” maximum. refer to the measurement procedure below:



Free length measurement

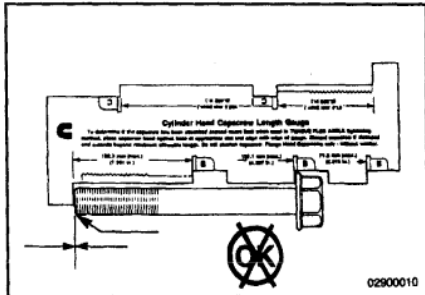
NOTE: If the capscrews are not damaged, they can be reused throughout the life of the engine unless the specified "free length" is exceeded.

Use capscrew length gauge, Part No.3164057 to check the capscrew free length, place the head of The capscrew in the appropriate slot with the flange against the base of the slot.



If the end of the capscrew touches the foot of the gauge, the capscrew is too long and must be discarded.

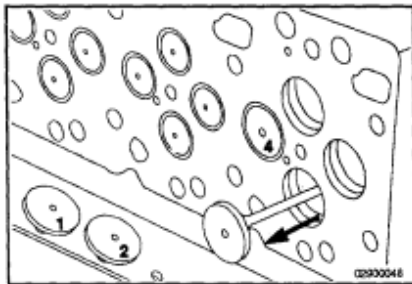
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Capscrew free length

mm

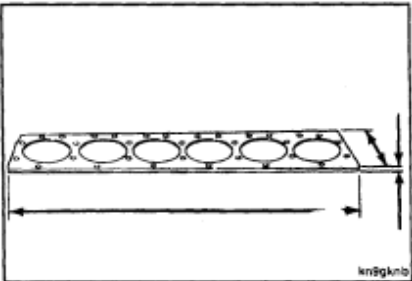
	Capscrew free length	
	mm	
Long capscrews	160	MAX



Pressure test

CAUTION: Do not pressure test a cylinder head with the valves and the valve springs installed. Water entering the cylinder head cannot be dried thoroughly, and will damage the valve guides and valve stems.

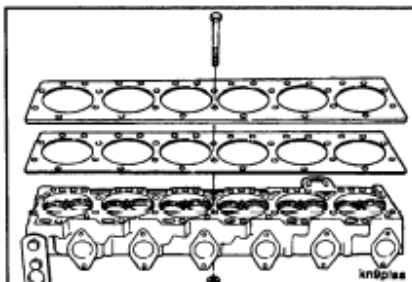
Remove the valve.



NOTE: A cylinder head test fixture can be fabricated from a flat piece of steel or aluminum.

NOTE: Use the cylinder head gasket as a pattern for drilling the capscrew holes.

NOTE: Additional sheet metal is required to cover thermostat housing

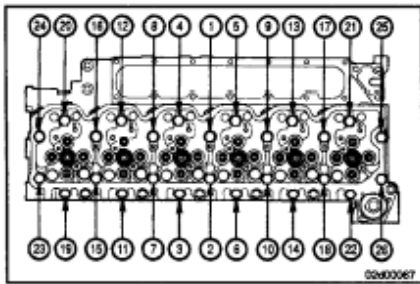


Install cylinder head water test fixture.

1. install a new head gasket.
2. install the test plate.
3. install the following components:

- 26nuts
- 26nuts M12*1.75 hexagonal head flange nut.
- 52nuts 12-mm washer.

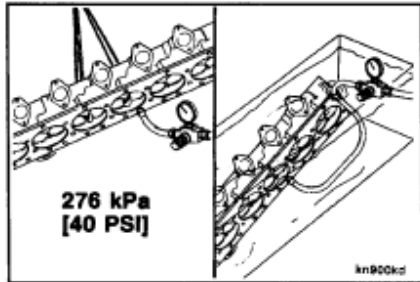
NOTE: Cummins recommends to install the gasket between capscrew and cylinder head, the nuts and the test plates, avoiding to damage the cylinder head deck.



Tight the nuts from the six cylinder in the sequence of the diagram.



Torque valve: 80 N. m [59 ft-lb]



WARNING: The component weighs 23kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.



Connect a regulated air supply hose to the test fixture plate.



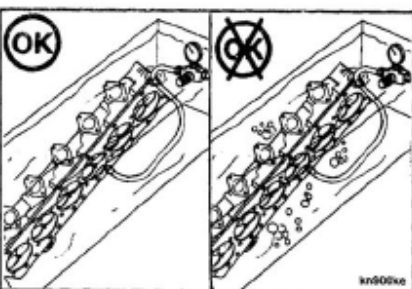
Apply air pressure to cylinder.

Air pressure: 276kpa [40 psi]

Use a nylon lifting strap and a hoist to place the cylinder head in a tank of heated water.

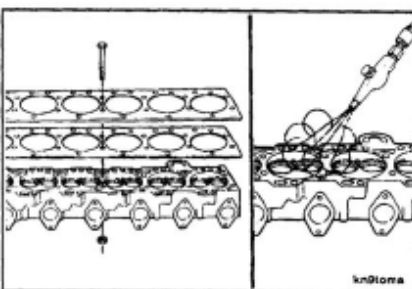
Water temperature: 60°C [140°F]

NOTE: Completely submerge the cylinder head in the water.



Inspect the cylinder head. If bubbles exist, indicate that there is air leak.

If the cylinder head is leaking, it must be repaired or replaced.

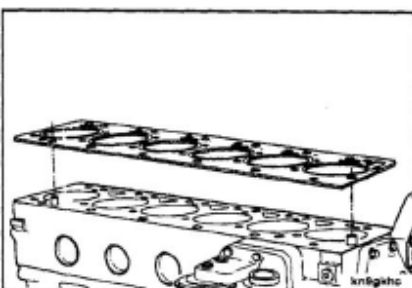


WARNING: Wear appropriate eye and face protection when Using compressed air. Flying debris and dirt can cause personal injury.

Remove the test equipment.

Use compressed air to dry cylinder head.

Install cylinder head.

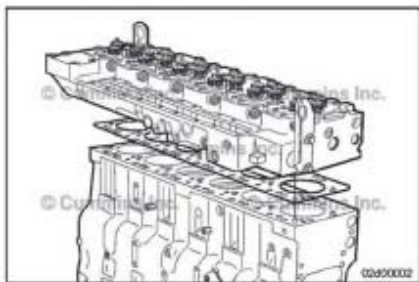


Install



CAUTION: Make sure the new head gasket is correctly aligned with the holes in the cylinder block. If fail to align with cylinder gasket, it can cause damage to the cylinder block.

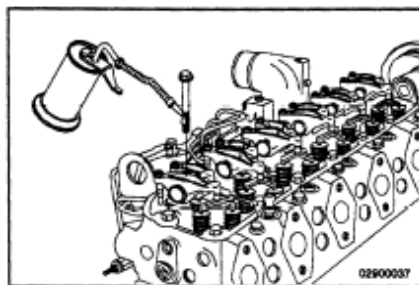
Check the cylinder head gasket for cracks in the silicone covering. If any cracks, replace the cylinder head gasket. Install new head gasket onto dowel pins.



WARNING: The component weighs 23kg[50lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.



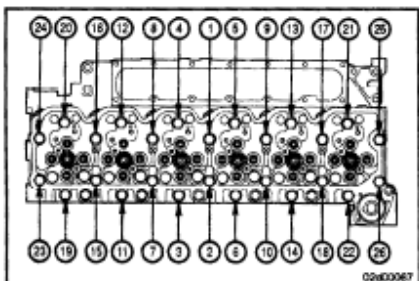
Carefully put the cylinder head on the cylinder block and seat it onto the dowels.



Lubricate the threads and under the heads on the head mounting capscrews with clean engine lubricating oil.

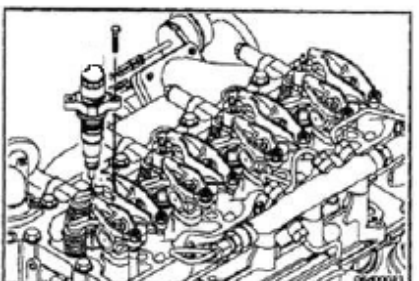


Install capscrews and finger tighten.

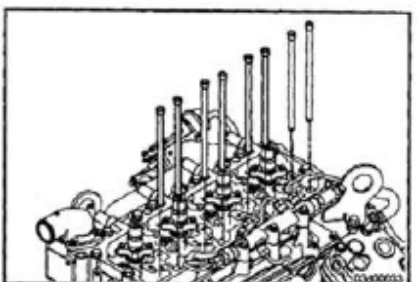


NOTE: Use the illustrated sequence to tighten the cylinder head capscrews. Tighten the bolts.

Step 1	All capscrews	50N.M	
Step 2	All capscrews	150N.M	
Step 3	All capscrews	Final torque value 85-295N.M	

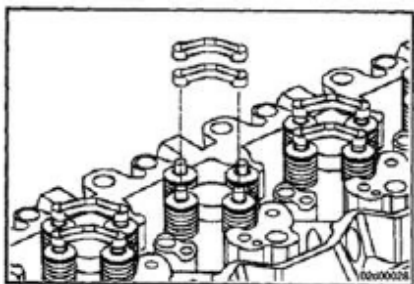


Install the injector.

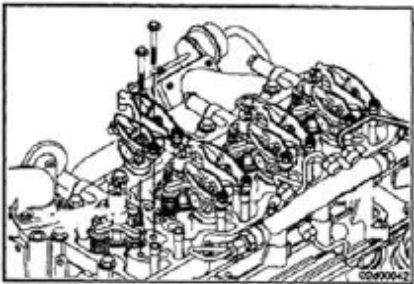


Install the tappet

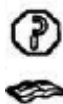
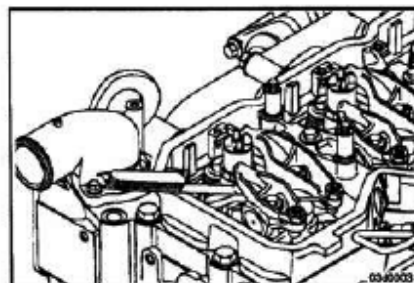




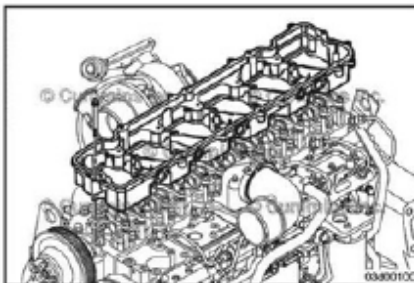
Install the crossheads.



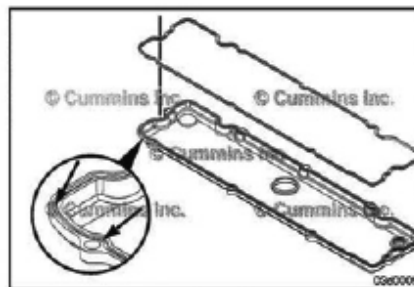
Install the rock arm



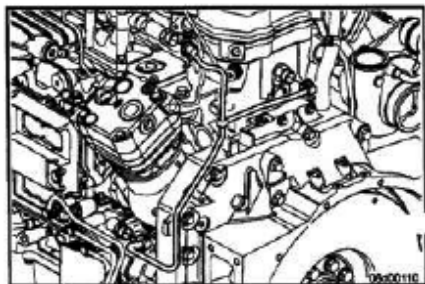
Adjust the valve clearance



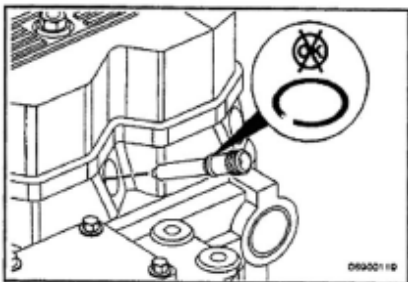
Install the rocker housing.



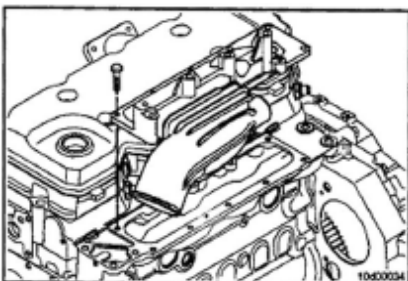
Install rocker lever housing cover gasket and rocker lever housing cover.



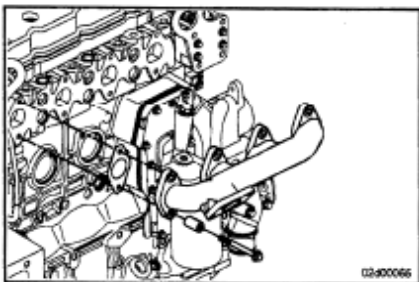
Install the fuel return lines.



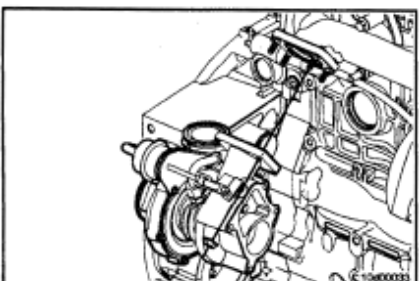
Install the fuel connector.



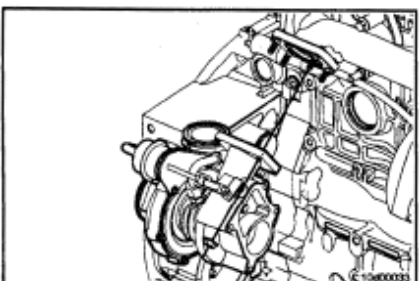
Install intake manifold cover plate.



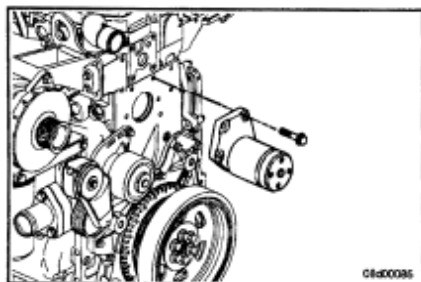
Install the injector supply line.



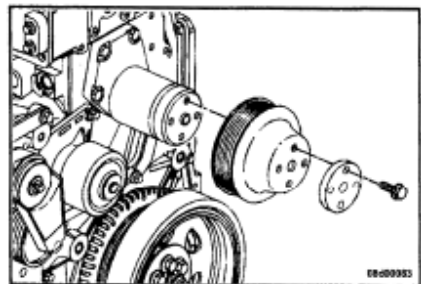
Install the exhaust manifolds.



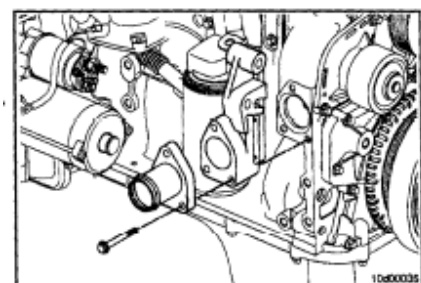
Install the turbocharger.



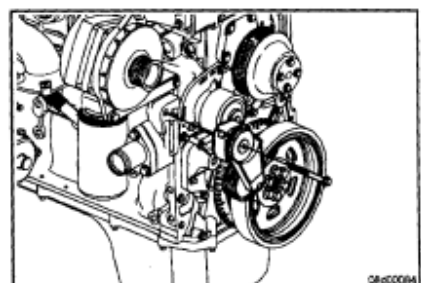
NOTE: Omit this step if the fan hub assembly is not attached to the cylinder head.
Install the fan hub.



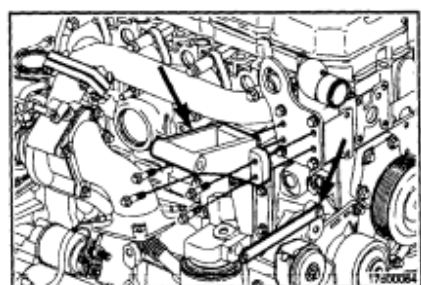
NOTE: Omit this step if the fan hub assembly is not attached to the cylinder head.
Install the fan hub pulley.



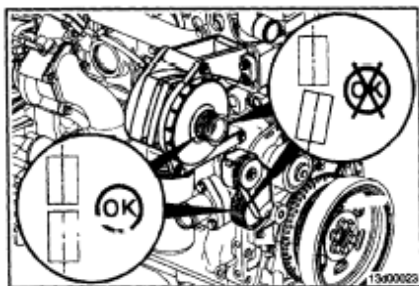
NOTE: Omit this step if the fan hub assembly is not attached to the cylinder head.
Install tensioner bracket onto the cylinder head.



NOTE: Omit this step if the hub assembly is not Attached to the cylinder head.
Install the belt tensioner.

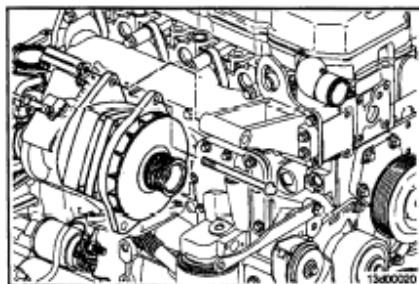


Install the alternator bracket onto the thermostat Housing.



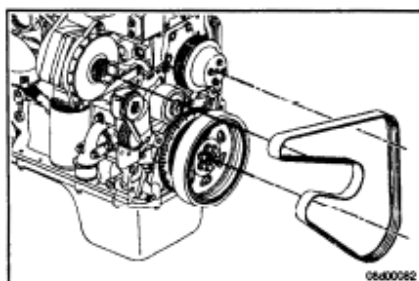
Install the alternator.

NOTE: Use a straight edge to inspect alternator pulley, make sure it is aligned with other pulleys, and parallel to front face of the cylinder block.

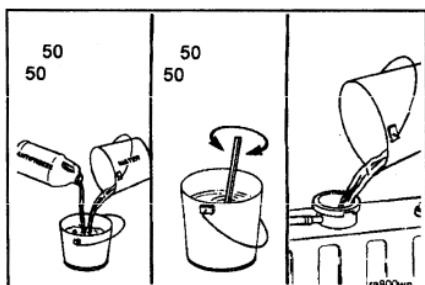


Tighten the alternator capscrews.

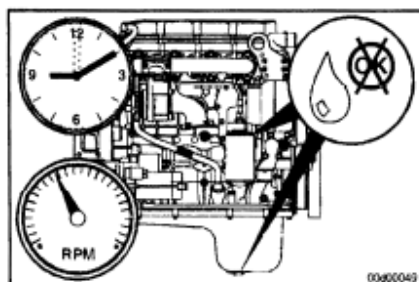
93



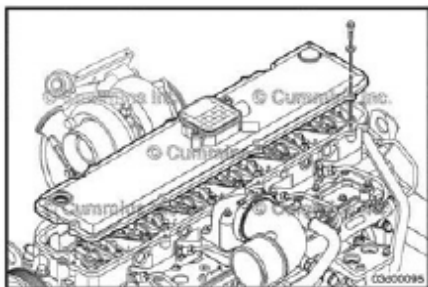
Install the drive belt.



Fill the engine with coolant.



Operate engine, and check for leaks.

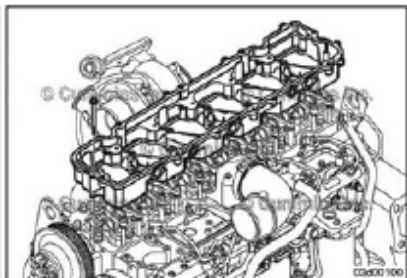


Cylinder head valve guide seals

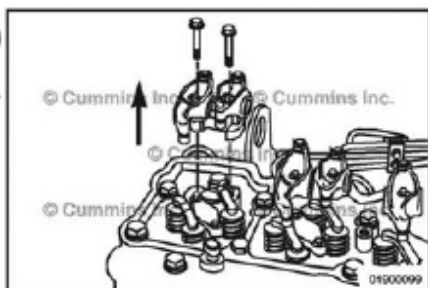
Preparatory



Remove the rocker lever cover.



Remove the rocker lever housing.



Remove

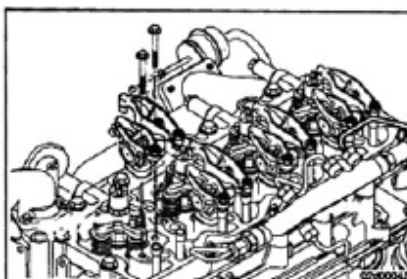
CAUTION: Failure to have the piston at top dead center will result in the valve dropping into the cylinder, engine damage can result.

Rotate the cylinder block piston to be removed to the top dead center (TDC).

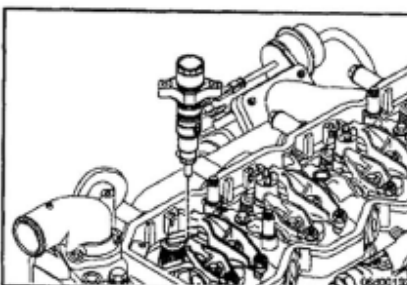
NOTE: when two rocker lever are loose, it indicates that the cylinder is at the top dead center (TDC).

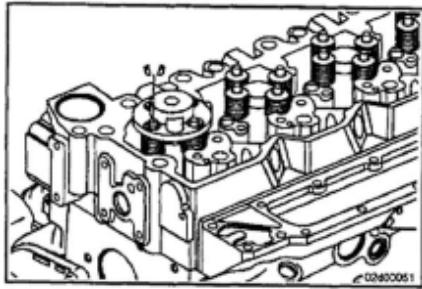


Remove the rocker lever assembly.



Remove the injectors.

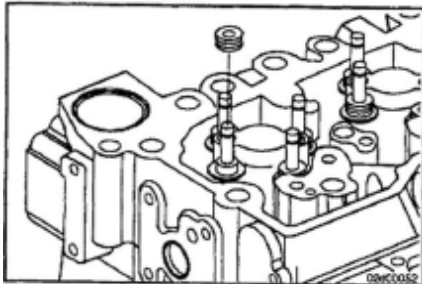




Use valve spring compressor, Part No.3162226, to compress the valve spring.

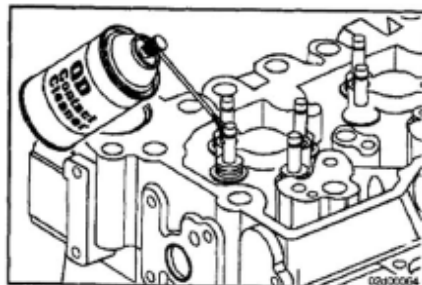


Remove the collets, valve spring compressor, valve spring retainers and valve springs.



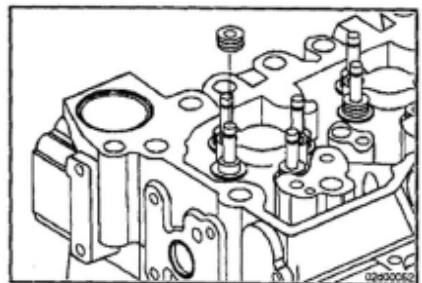
NOTE: use hotclamp pliers, part No.3163293, to remove the valve stem seal.

Remove and discard valve stem seal.



Clean

Use motor cleaner, Part No. 3824510, to clean seal stems.

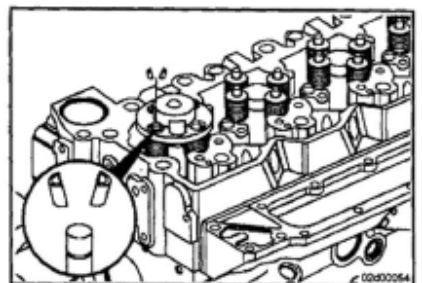


Install

- Install the yellow valve seals on the intake valve guides.
- Install the green valve seals on the exhaust valve guides.
- use valve stem installer, part No. 3164055

NOTE: Use 13mm deep socket and extension bar to install a new valve stem seals in place.

Install new valve stem seals.



Install the valve spring and retainers.

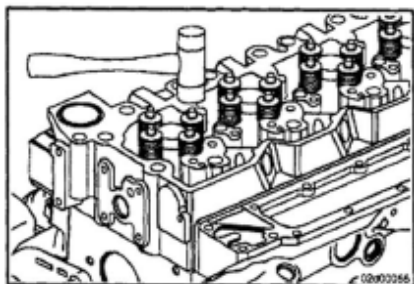


Compress the valve spring with the valve spring compressor, part No.3162226.

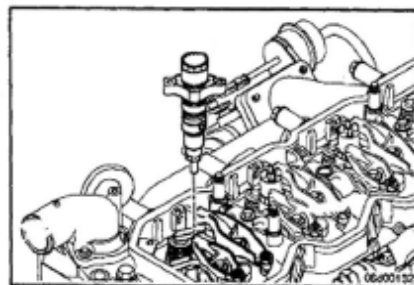


Install the collets.

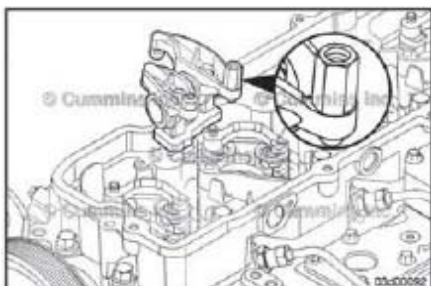
Remove the valve spring compressor.



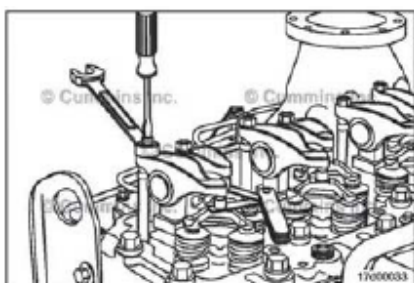
WARNING: Wear goggles when using a hammer to avoid personal injury.
Hit the valve stems with a plastic hammer to make sure that the collets are seated.



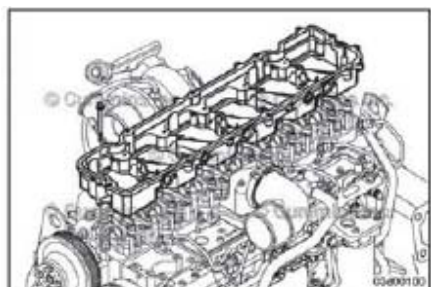
Install the injector.



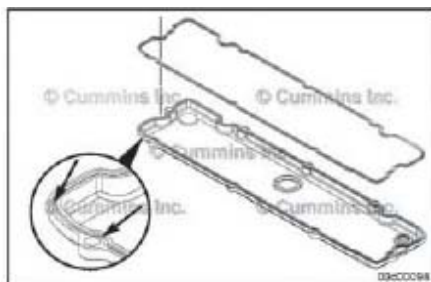
Install the rocker lever assembly.



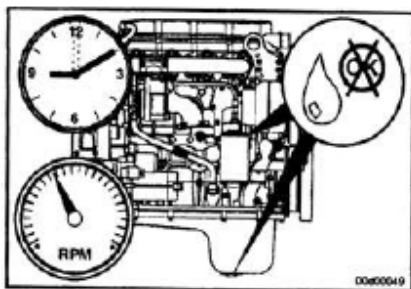
Adjust the overhead.



Install the rocker housing

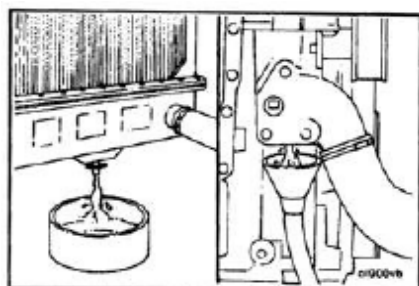


Install rocker lever cover and gasket.

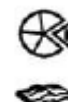
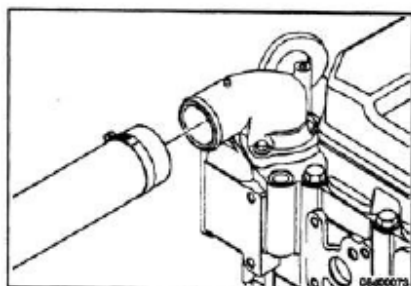


Operate the engine at idle 5 to 10 check for leaks and proper operation.

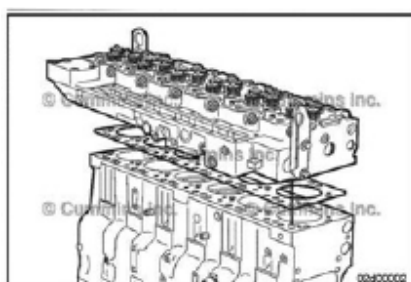
93



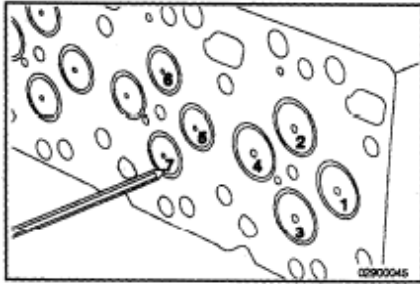
Valve, cylinder head
Preparatory
Drain the coolant.



Remove all water and heater hose from the Cylinder head.



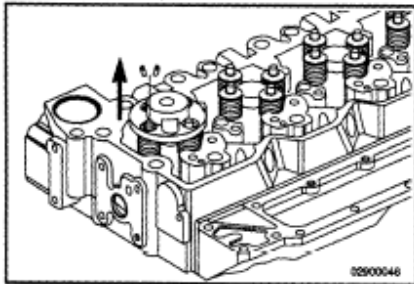
Remove
Pull the cylinder head.



Disassemble

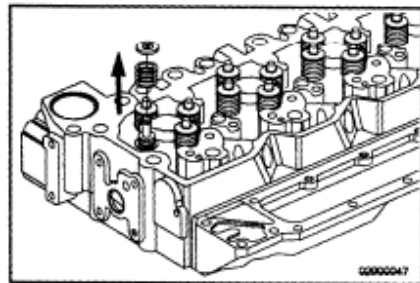
The following disassembly and assembly procedures are provided for inspection purposes only.

Mark the valves to identify their location.

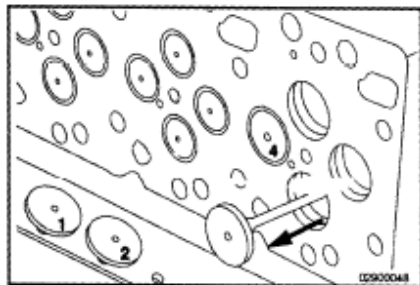


Compress the valve spring and remove the valve stem collets.

Remove the collets.

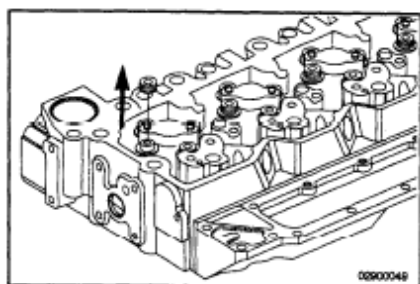


Release valve spring and remove retainer and spring.

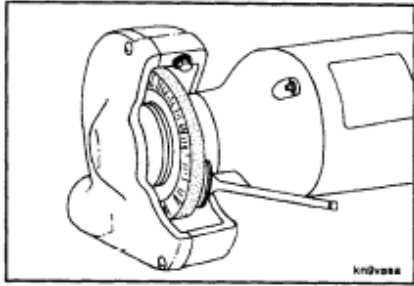


Remove remaining collets, retainers, springs, and valves.

NOTE: Keep the valves in a labeled rack for a correct match with companion seats while making measurements.

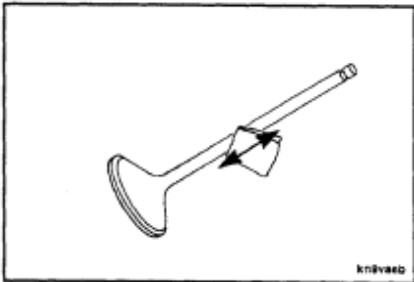


Remove the valve stem seals.

**Clean**

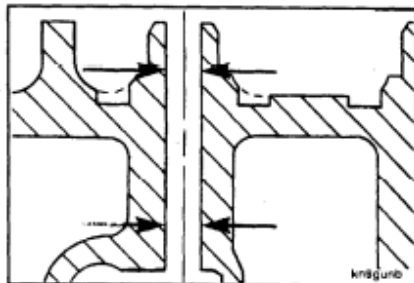
WARNING: Wear protective eye covering when cleaning the valves with wire wheel. Clean the valve heads with a soft wire wheel.

NOTE: Keep the valves in a labeled rack to prevent mixing prior to making measurements.



WARNING: When using solvents, acids, or alkaline materials for cleaning. Follow the manufactures recommendations for use. Wear goggles and protective clothing to avoid personal injury.

Polish the valve stem with a scotch-brite TM7448 and solvent, part Number3823258

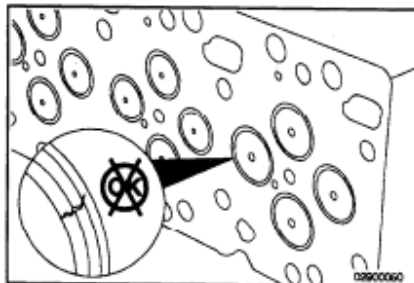


Inspect for reuse.

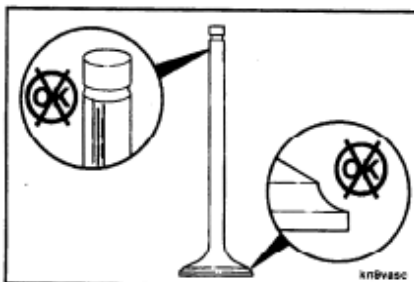
Valve guide inspection.



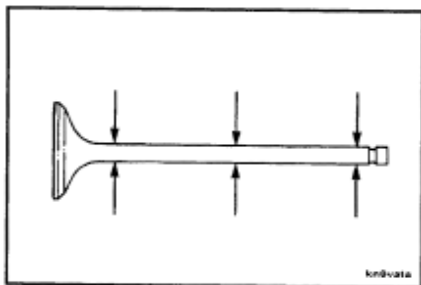
Inspect valve guides.

**Valve seat inspection**

Inspect valve seats.



Inspect for abnormal wear on the heads and stems.



Measure the valve stem diameter.

Valve stem diameter

mm

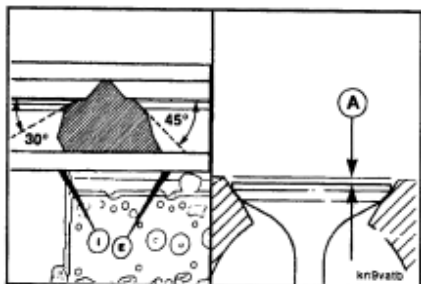
7.96

min

8.00

max

NOTE: If the valve stem diameter is out of specification, the valve stems must be replaced.



Valve seat angle:

- Intake 30 degrees
- Exhaust 45 degrees

Intake valve depth (installed)

mm

0.584

MIN

1.092

MAX

Exhaust valve depth (installed)

mm

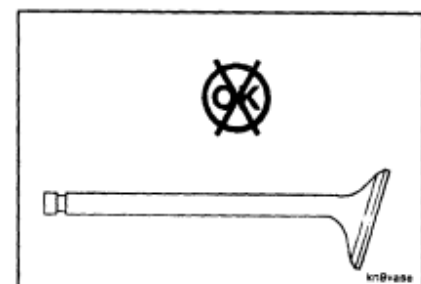
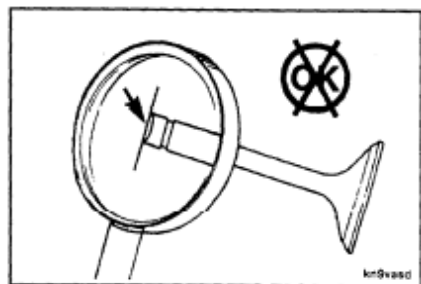
0.965

MIN

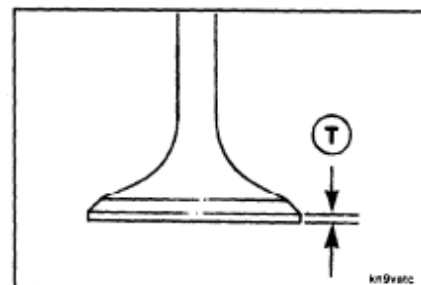
1.473

MAX

NOTE: if valve seat angle is out of specifications, Check the valve stem tip for flatness. If it is worn, then replace the valve stems



Inspect for bent valves. If it is bent, then replace the valve stems.



Measure the rim thickness to determine if there is enough stock to grind the valve.

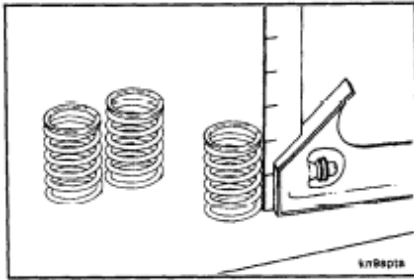
Valve rim thickness limit

mm

2.0

MIN

NITE: If the valve rim thickness is out of specification, then replace it.



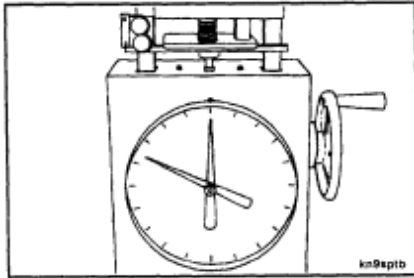
Inspect the valve spring.



Measure the valve spring.

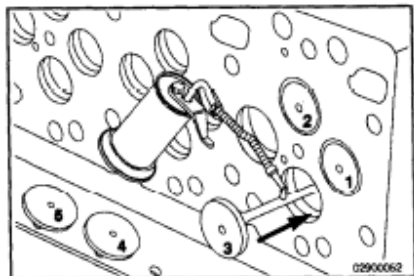
Approx. free length (L): 59.18

Maximum inclination: 1.5mm



A load of 320.8 to 358.8 N[72to 80.7 lb] is required to compress the spring, part No. 3162226, to a height of 35.33mm[1.39in].

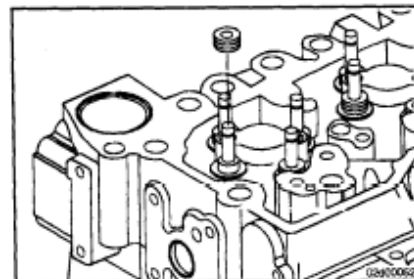
93



Assemble

CAUTION: Lubricate all valve guide bores and valve stems with SAE 90W engine oil. Fail to lubricate valve guide bores and valve stems can cause premature wear of valve guide.

Lubricate the valve stems with SAE 15W-40 engine oil before installing the valves.



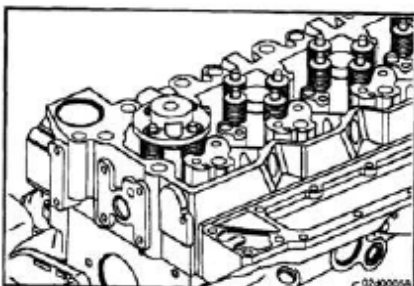
NOTE: clean all cylinder head components before assembling.



Use valve stem installation tool, Part No.3164055, To install new valve stem seals. Position the cylinder head on a flat surface to prevent the valve from falling during installing.

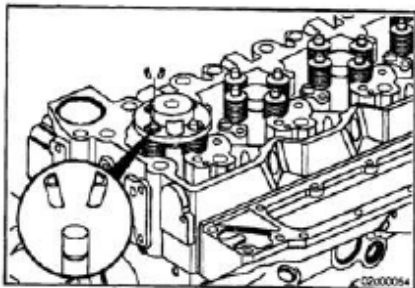


NOTE: Install yellow valve seals onto inlet valve guides, green valve seals onto exhaust valve guides.

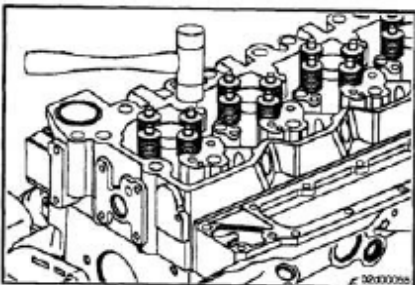


Valve spring compressor

Use valve spring compressor Part No 3162226, To Compress the valve spring after assembling the spring and retainer.

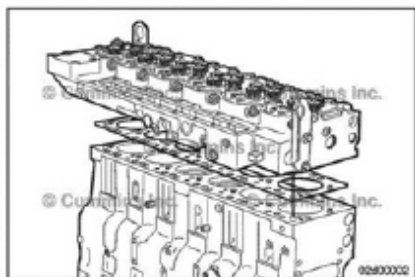


Install new valve collets and release the spring tension.



WARNING: Wear goggle to avoid personal injury. If the collets are not correctly installed, they can fly out when the stems are hit with a hammer.

After assembly, hit the valve stems with a plastic hammer to make sure that the collets are seated.



Install

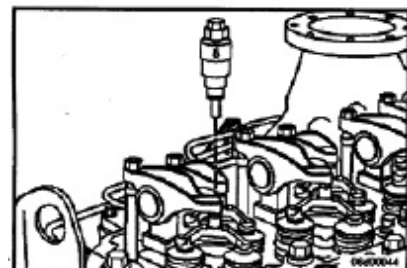


WARNING: The component weighs 23kg [50 lb] or more.

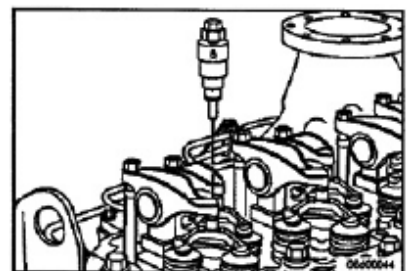


To avoid personal injury, use a hoist or get assistance to lift the component.

Install the cylinder head and gasket.



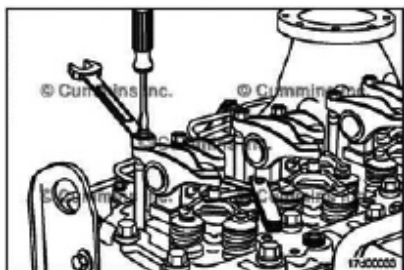
Install the injector.



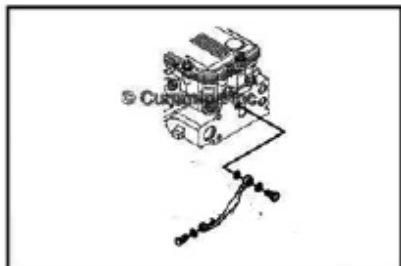
Install the crossheads.



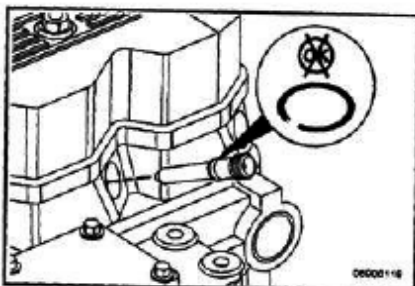
Install the rocker lever.



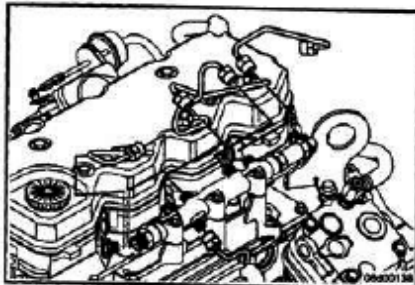
Adjust the valve lash.



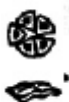
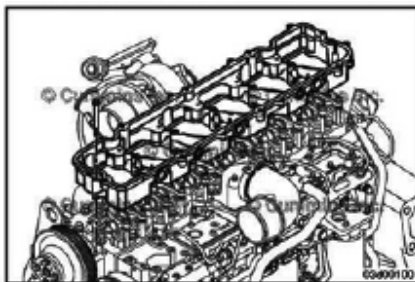
Install the fuel return lines.



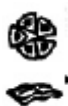
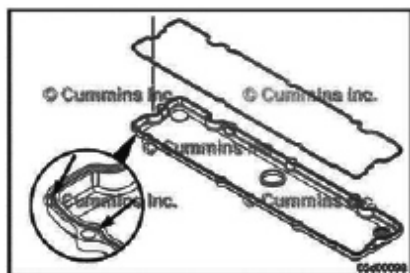
Install the fuel connector.



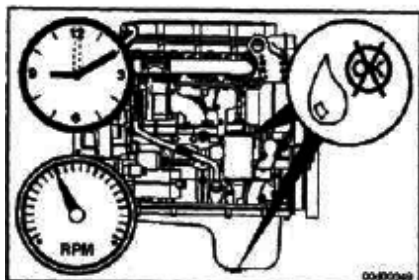
Install the high pressure fuel lines.



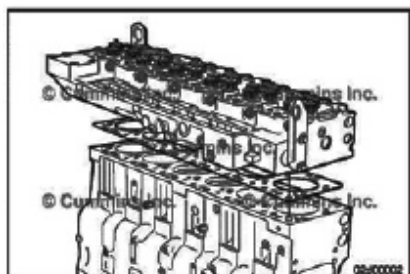
Install the rocker hosing.



Install rocker lever cover and gasket.



Operate engine and check for leaks.



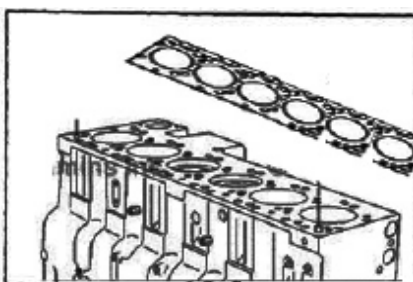
Head gasket

Remove

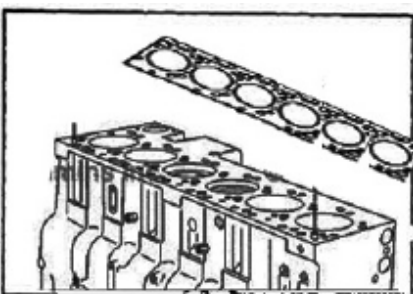


WARNING: The component weighs 23kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Remove cylinder head.



Remove the head gasket.

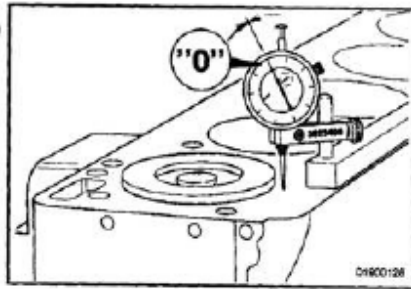


Install

NOTE: Make sure the cylinder head is installed Do not reuse the old gasket.

Install the gasket.

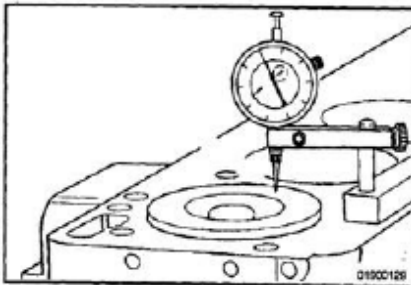
Cylinder gasket are classified. Replace gasket With same part number.



Gasket is rated

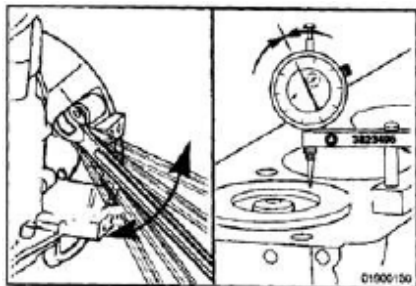
Install the dial indicator on the cylinder head, then return to zero.

NOTE: The procedure is needed only after replacing pistons, crankshaft and connecting rods.



To avoid move from side to side, move the dial Indicator directly over the piston pin.

Do not place the dial indicator tip in the anodized area.

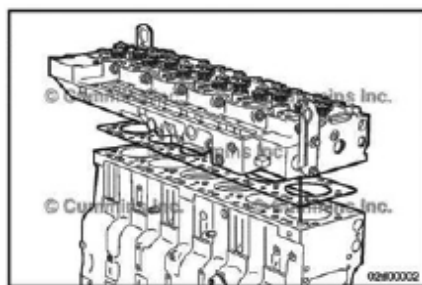


Rotate the crankshaft to the top dead center(TDC). Rotate the camshaft back and forth to find the maximum dial gauge readings.

Record reading.

Repeat the same steps for the remaining cylinders.

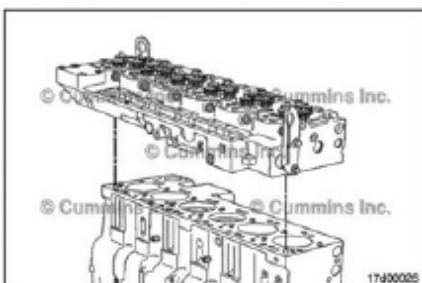
Plus the valve recorded above and then is divide by the numbers of cylinder to obtain the average height.
Average value:<0.301



WARNING: This component weights 23kg[50 ft-lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.



Install cylinder head.



Injector protrusion

Measure

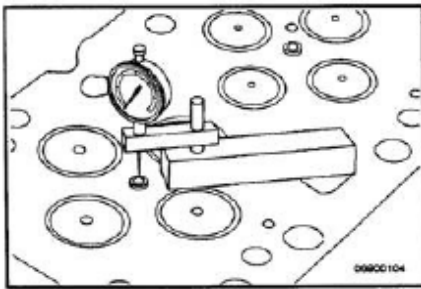


CAUTION: Improper injector protrusion can cause performance problems and high pressure fuel leaks due to misalignment of the fuel connectors.



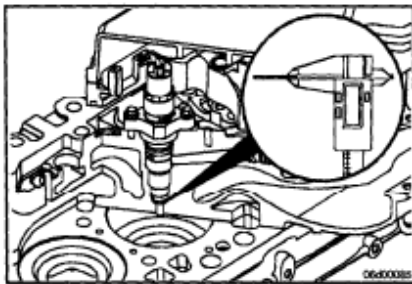
Remove cylinder head.

Measure injector protrusion.



Place the injection protrusion tool on the flat surface of the head. Measure the injector protrusion to highest point on the injector. The protrusion should be within the following specifications:

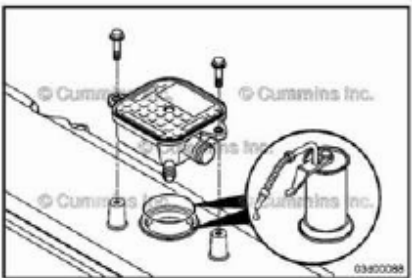
Injector protrusion	
mm	
2.45	MIN
3.15	MIN



If the injector protrusion is out of specification, check the thickness of the injector sealing washer.



If the sealing washer is the correct thickness, check to make sure the injector bore is clean and free of debris.



Overhead adjustment

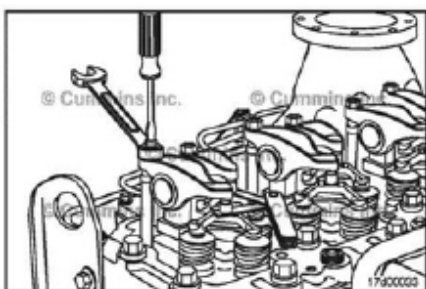
Adjustments

Remove the rocker lever cover and gasket.

CAUTION: Engine coolant temperature should be less than 60°C [140°F].



Use the barring tool, Part No. 3824591, to rotate the crankshaft. If the two No.1 rocker levers are loose, then perform the following procedures. If the two No.1 rockers are unloose, rotate the crankshaft 360 degrees.

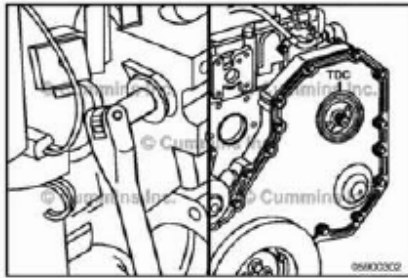


With the engine in this position, lash can be checked on the following rocker arms:

Six-cylinder 1I, 1E, 2I, 3E, 4I AND 5E.

Lash check limits	
	mm
Intake	0.30
Exhaust	0.61

NOTE: lash checks are usually performed as part of a troubleshooting procedure. Resetting is not required during checks as long as the lash measurements are within the above limits.



Measure lash by inserting a feeler gauge between the crosshead and the rocker lever ball insert and socket. If the lash measurement is out of specification, loosen the locknut and adjust the lash to nominal specifications.

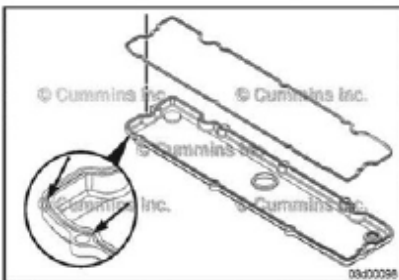
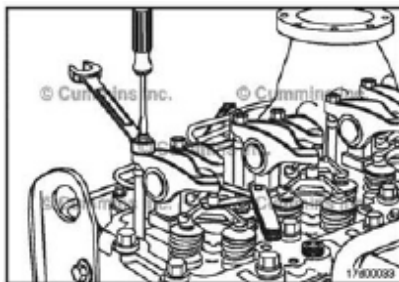
Lash reset specifications

	mm	in
Intake	0.30	
Exhaust	0.61	

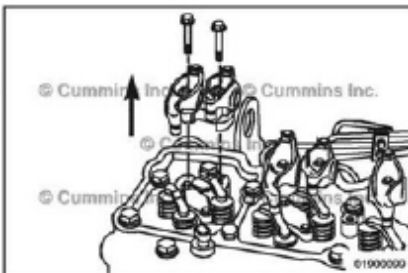
Tighten the locknut and remeasure.

Torque value: 24N.m[212in-lb]

Using the barring tool, Part No.3824591, to rotate the crankshaft 360 degrees and measure lash for the following rocker lever: six –cylinder 2E,3I,4E 5I, 6I, 6E. Reset if out of specification.



Install gasket and rocker lever cover.



Rocker lever

Remove

Remove the rocker lever cover and gasket.

Loosen the adjusting screw locknuts.

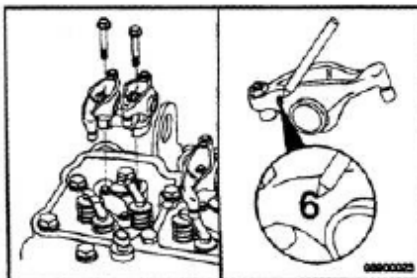
Loosen the adjusting screw until they stop.

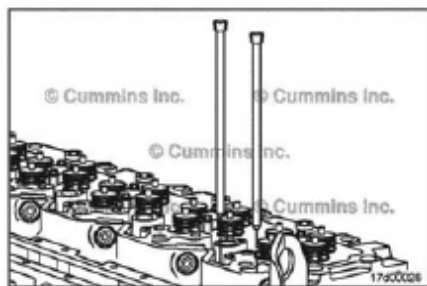
Remove the capscrews from the rocker lever support.

Remove the supports and rocker lever assemblies.

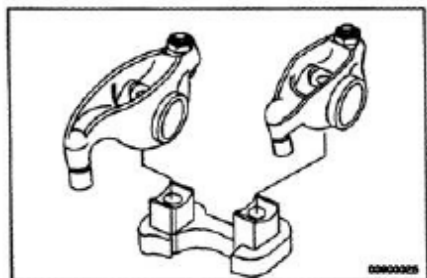
Remove and mark the crossheads one at a time as to their original and position.

The crossheads and rocker assemblies must be installed in their original location and position.





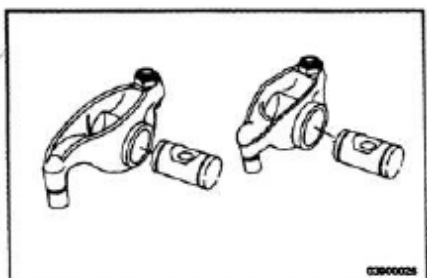
Mark push rods for location.
Remove the pushrods.



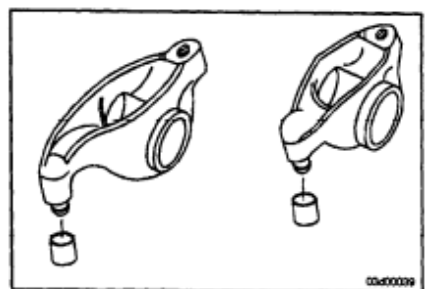
Disassemble
Rocker lever –disassemble

If the rocker levers are to be inspected for reuse, follow these steps.

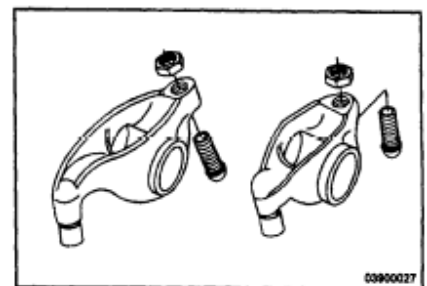
Remove the rocker levers.



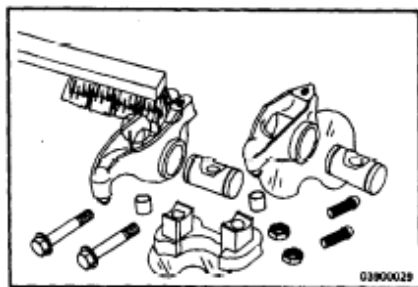
Remove the rocker lever shafts from the rocker levers.



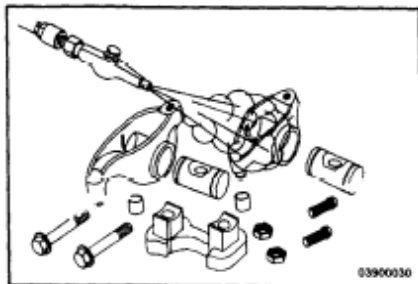
Remove the socket from the rocker lever.



Remove locknut and adjusting screw.

**Clean**

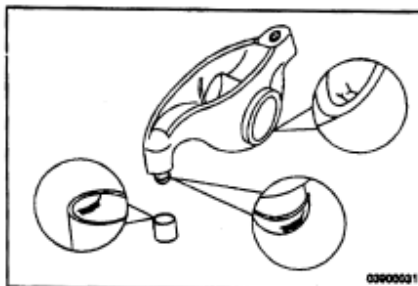
Clean all parts in a strong solution of laundry detergent and hot water.



WARNING: Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause bodily injury.

Use compressed air to dry the parts after rinsing in clean hot water.

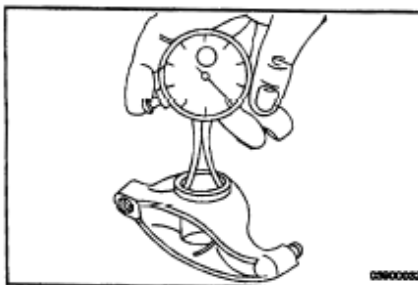
NOTE: The pedestals are made from powdered metal and will continue to show wetness after they have been cleaned and dried.



Inspect for reuse

Inspect for cracks and excessive wear in the bore.

Inspect the water surfaces of the ball insert and socket as well as the retainer.



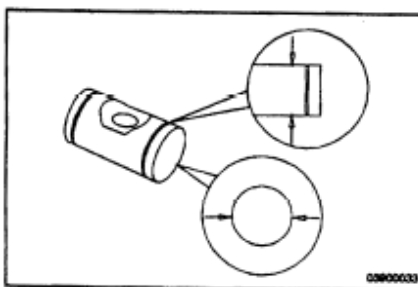
Measure rocker lever bore inside diameter.

Rocker lever bore inside diameter

mm

24.950

MAX



Check rocker arm support and rockshaft.

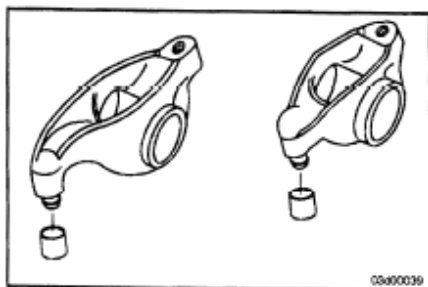
Measure the diameter of rockshaft.

Diameter of rockshaft

mm

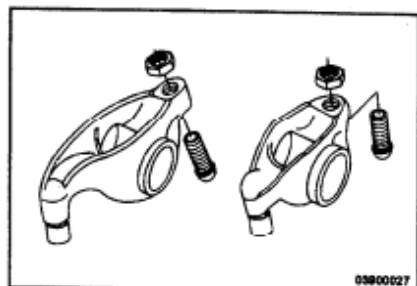
24.950

MIN

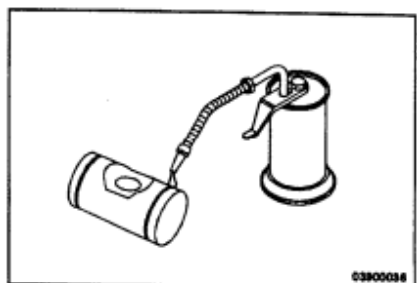


Assemble

Install the sockets.

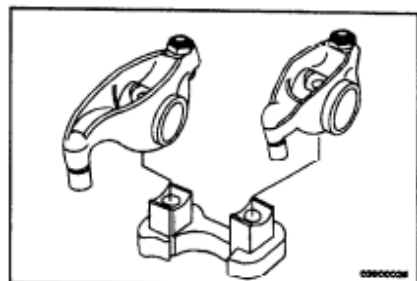


Install adjusting screw and lock nut.

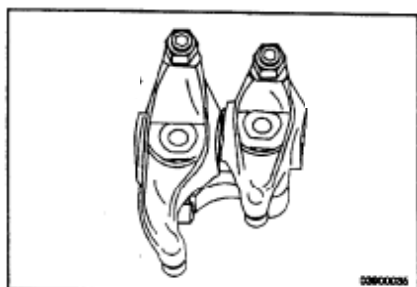


Lubricate the shaft with 15W-40 engine oil.

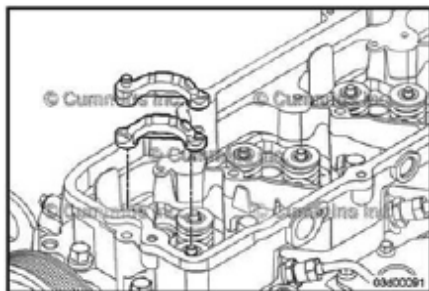
Install the rocker lever shafts into the rocker levers.



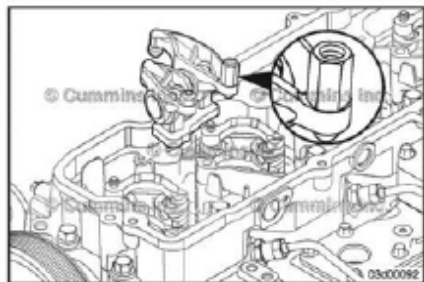
Position the rocker levers on the rocker lever support.



CAUTION: Be sure to assemble the intake and exhaust rocker levers on the correct valves. Failure to do so will result in engine damage.

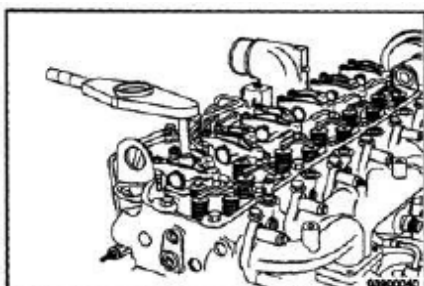


Install the crossheads in their original location and position.
Install push rods to location prior to removal.

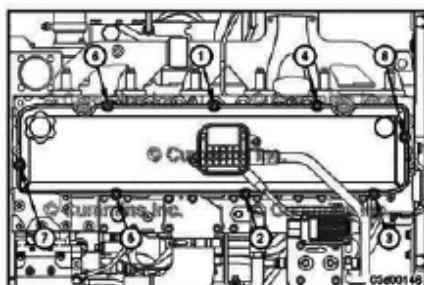


Install the rocker lever assemblies and pedestals in their original locations.
Tighten the pedestal capscrews.
Torque pedestal capscrews.

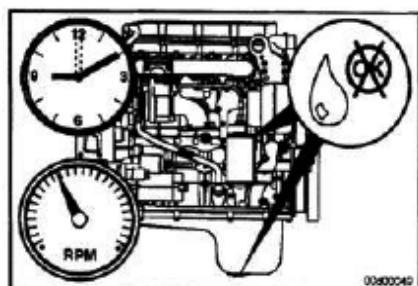
93



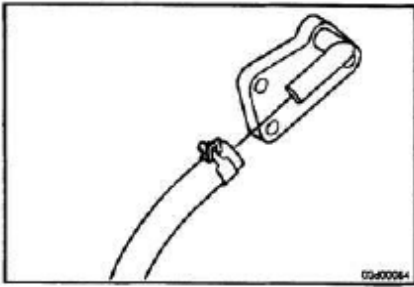
Tighten the pedestal capscrews.
Torque value: 36N.m[27 ft-lb]
Adjust intake and exhaust valves clearance.



Install the rocker lever cover and gasket.



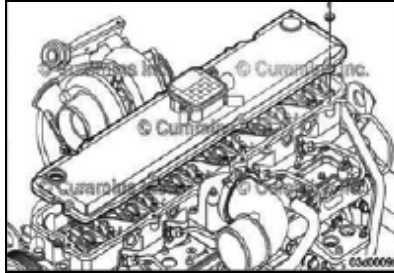
Operate engine and check for leaks.



Rocker covers

Remove

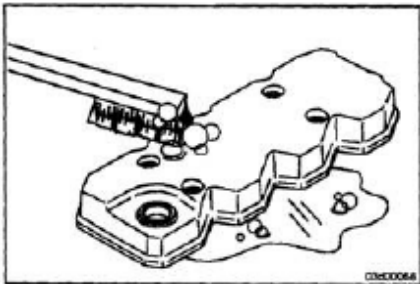
Remove the hose clamp from crankcase breather hose connected the rocker covers to the gear covers.



WARNING: Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

NOTE: It doesn't include nuts and rubber anti- vibration gasket.

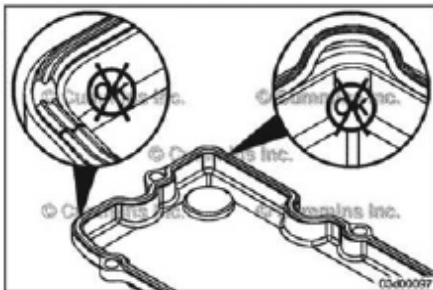
Clean the nuts and the area around sealing connector with the compressed air to remove the loose debris.



Clean

WARNING: Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

Clean the rocker lever cover in hot soapy water. Dry with compresses air.



Inspect for reuse.

Check the gasket for cracks.

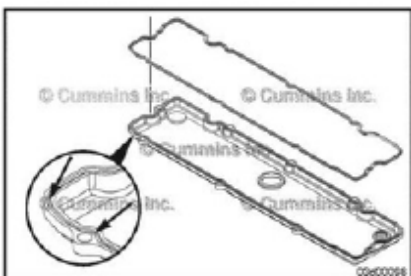
Replace the gasket if cracks are present.

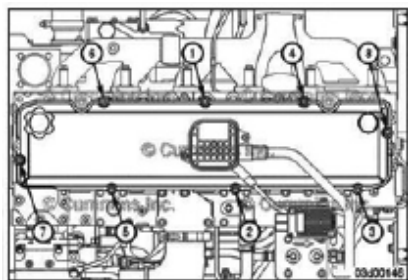


Inspect the cover for cracks or damage.



Install the gasket on the cylinder head.



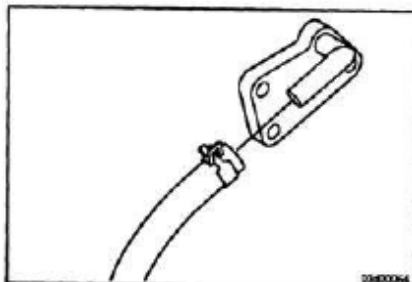


Install rocker lever cover and gasket.

Tighten the bolts.

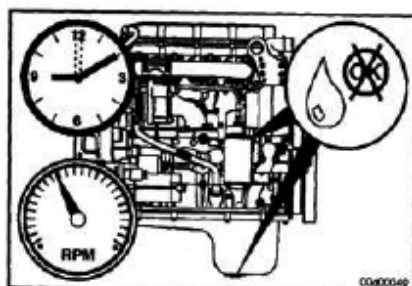


Torque valve: 10N.m[89 in-lb]

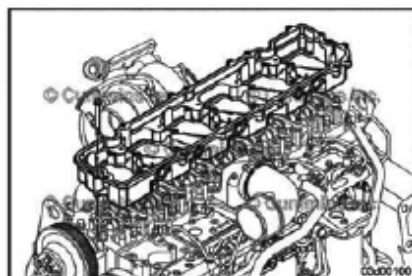


Install the clamps to the breather tube.

93



Operate engine, and check for leaks.

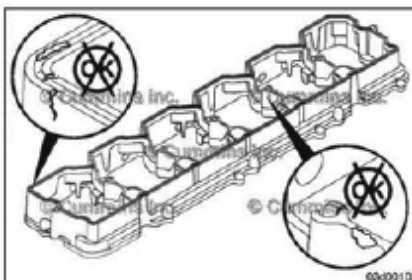


Housing, rocker

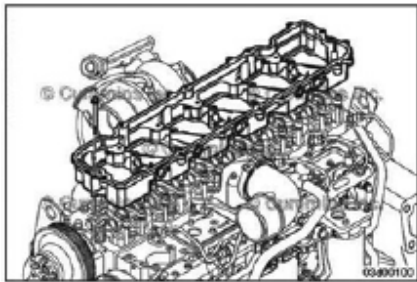
Remove



Remove the rocker lever cover.



Inspect the rocker housing for cracks or other damage, especially the head mounting surfaces.

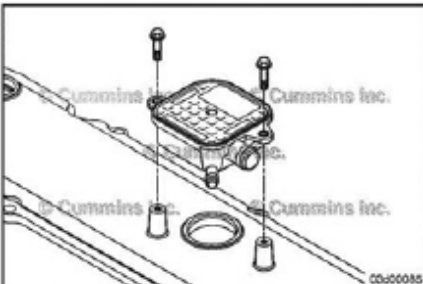


Install

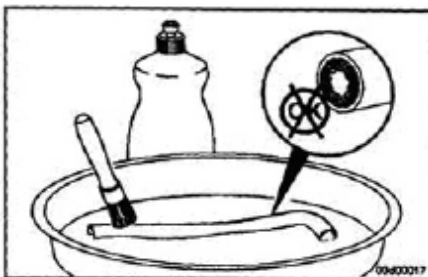
Install the rocker lever housing and gaskets.



Torque value:24N.m[212 in-lb]



Remove the rocker arm chamber over the crankcase vent pipe.



Clean



WARNING: Wear appropriate eye and face protection when using compressed air. flying debris and dirt can cause personal injury.



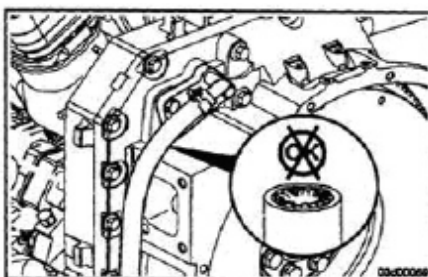
CAUTION: If the crankshaft breather is clogged, clean and replace crankshaft breather tube and vent line to avoid excessive crankshaft pressure.

Be sure to remove the crankshaft vent tube.

Inspect the crankcase breather tube for restrictions and sludge deposit.

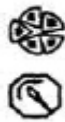
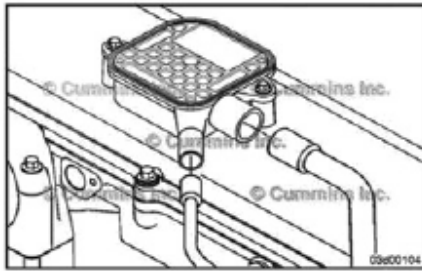
Clean with the soft brush in hot soapy water.

Use compressed air to dry the parts after rinsing in clear hot water.



Inspect for reuse

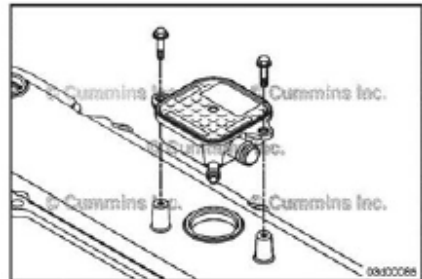
Inspect the crankcase breather tube for restrictions and cracks.



Install

Apply a coat of 2mm LOCTITE5999, to the cover plate.
Install the cover plate and capscrews.

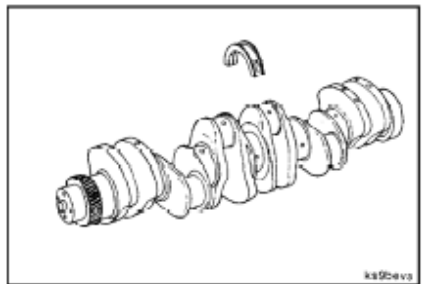
Torque value; 7N.m[62 in-lb]



Install crankcase vent pipe and spring clamp.

Install the connecting piece of crankcase ventilation

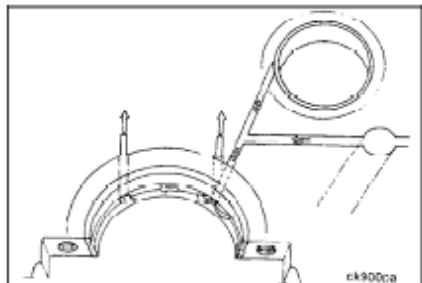
Torque value: 24N.m[212 in-lb]



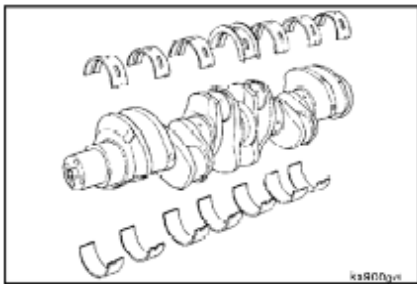
Main and thrust bearings =replace

General information

The engine has seven main bearings. The lower bearing shells are all the same. All of the upper bearing shells are the same except for the No.4 journal. The No.4 journal uses a flanged upper bearing shell. The flanges on the bearing control the end thrust of the crankshaft.

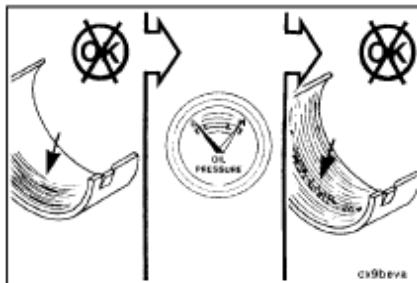


The upper bearings are grooved and have two oval holes in them. One hole aligns with drilling from the main oil rifle, the other hole supplies oil to the piston cooling nozzles.



The following oversize service main and thrust bearing combinations are available for crankshafts that have been machined undersize, either on the main journal or thrust bearing face:

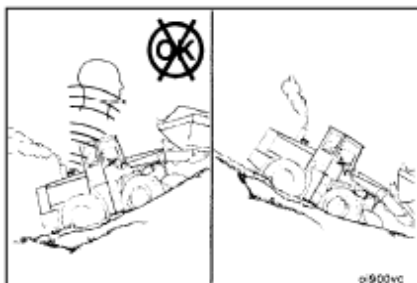
Main bearing journal diameter	Thrust bearing face thickness
STD	STD
-0.25mm[-0.010 inch]	STD
-0.50mm[-0.020 inch]	STD
-0.75mm[-0.030 inch]	STD
-1mm[-0.040 inch]	STD
STD	+0.25mm[+0.010inch]
STD	+0.50mm[+0.020 inch]
-0.5mm[-0.020inch]	+0.50mm[+0.020inch]



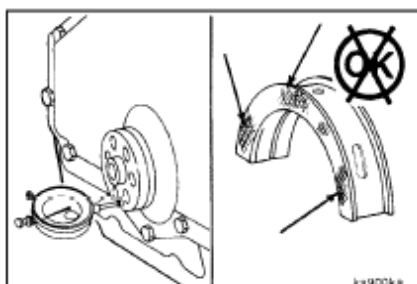
Diagnosing malfunctions

Improper maintenance of the lubrication system is the primary cause of reduced bearing life.

Normally, worn bearings can be detected by reduced oil pressure. If this wear goes undetected, the excessive clearance will increase the impact between the bearing and the crankshaft causing a distinct knocking sound.

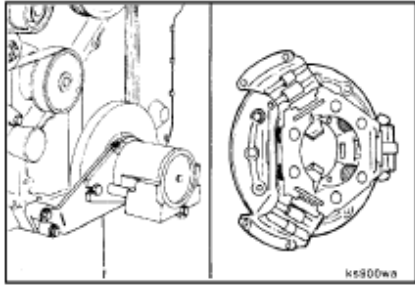


A main bearing noise will be heard when the engine is loaded.

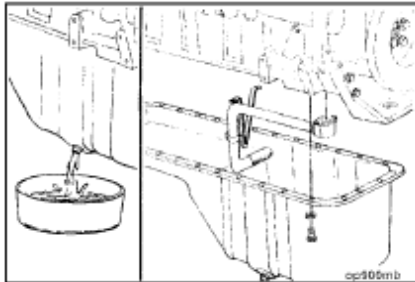


A damaged or worn thrust bearing flange of the upper main bearing shell can be detected by measuring the end thrust of the crankshaft.

Crankshaft end thrust(used)		
mm		in
0.112	Min	0.0044
0.330	Max	0.013



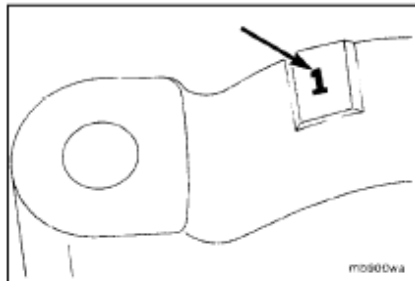
Failures of driven units at the front or rear of the engine which increase the end loading can damage the thrust bearing.



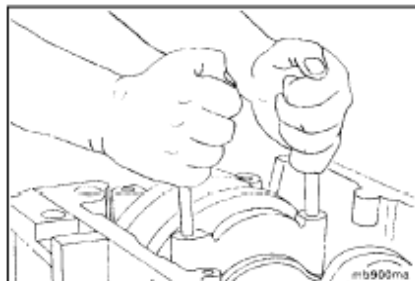
Remove

Drain the lubricating oil.

Remove the lubrication oil pan and suction tube.

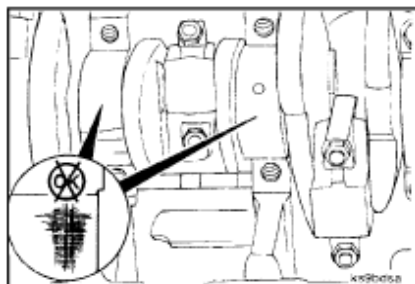


NOTE: The main caps should be numbered. if they are not, be sure to mark them with the correct number.



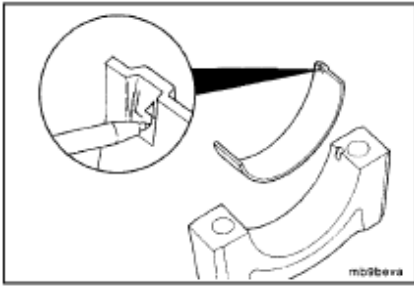
NOTE: Do not pry on the main caps to free them from the cylinder block.

Use two of the main bearing cap bolts to "wobble" the main cap loose, being careful not to damage the bolt threads.

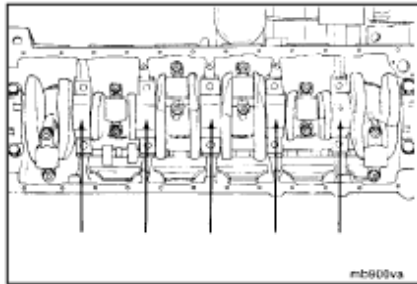


Perform a visual inspection of the main bearing and crankshaft journals. remove the No.2 and 3 caps and the lower main bearing shell from the crankshaft journal.

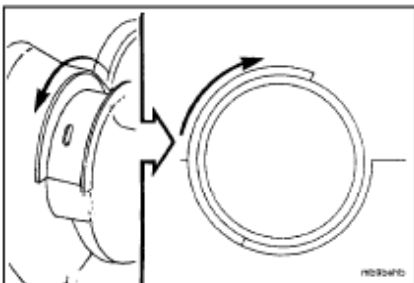
NOTE: The No.4 main bearing cap has a thrust bearing . Check the journals for signs of overheating, deep scratches or other damage. if there is no damage, there is no need to pull the other caps at this time.



Mark the bearing shell with the letter "L"(lower) and the journal number it was removed from.

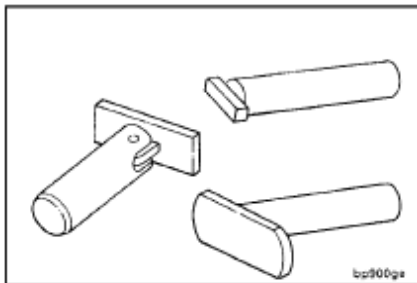


If the main bearing are to be removed, remove all bearing caps except for cylinders No.1 and 7.



CAUTION: Do not damage the crankshaft when removing the thrust bearing.

Use a blunt tool to remove the upper thrust bearing.



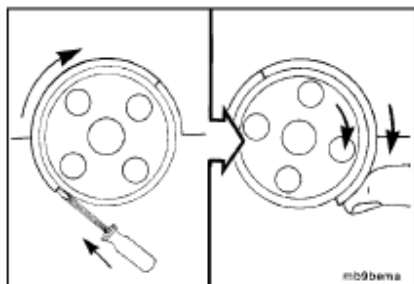
Part No.3823818, main bearing rollout tool



CAUTION: Do not use a capscrow or any hard metal object as This can damage the crankshaft and cause serious engine failure.



To remove the upper main bearing shell, install a tool similar to the one shown, in the oil hole of the main bearing journal. Several varieties of small soft metal plugs are sold specifically for this purpose.

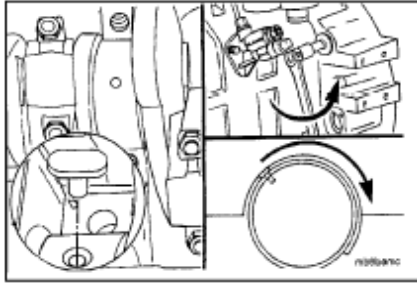


The No.1 main does not have a hole in the journal so the bearing rollout tool be used to replace the bearing.

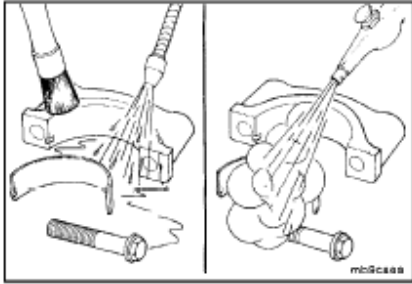
CAUTION: Use care so the screwdriver does not damage the crankshaft or cylinder block.

Use a flat blade screwdriver. gently bump the end of the bearing to loosen it from the block.

Then, use finger pressure against the bearing shell and rotate the crankshaft to roll the bearing out.

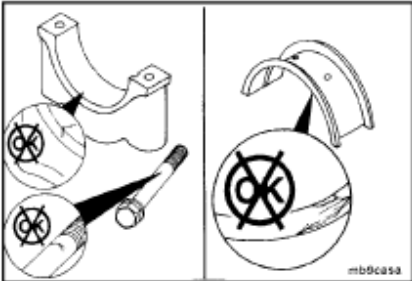
**Part No.3377371,engine barring tool**

Rotate the crankshaft so that the pin pushes against the other end of the bearing tang. Remove the bearing shells. Follow this procedure to remove the other bearings.

**Clean and inspect**

Use solvent and a soft bristle brush to clean the cap, capscrews and bearing and dry with compressed air .

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Visually inspect the main cap and capscrews for damage. Visually inspect the bearing shells and the thrust bearings for cracks, scratches, or damage.



NOTE: If the main bearing are damaged, refer to the L series shop Manual to inspect the crankshaft main bearing journals. If the crankshaft is damaged, the engine must be removed for repair.



Use an outside diameter ball tipped micrometer to measure the main bearing shell thickness.

standard main bearing bearing shell thickness

mm		in
3.446	Min	0.1357
3.454	Max	0.1360



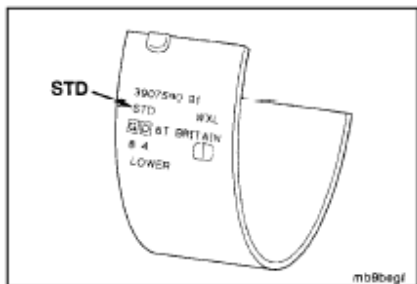
Discard any main bearing shell if it is thinner than the minimum specification.

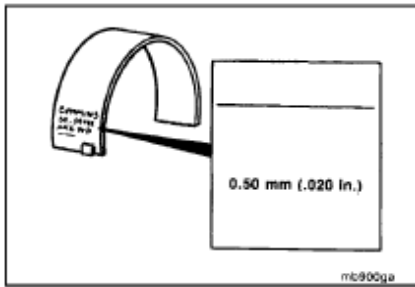
NOTE: For more detailed information of bearing damage, refer to "analysis and prevention of bearing failures,"

Bulletin No.3810387.

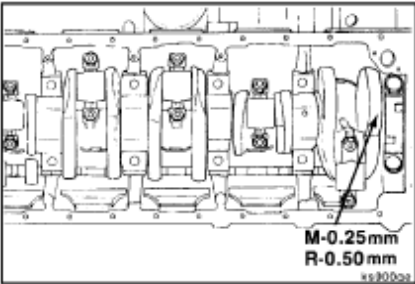


The upper bearing contain two oil holes. the lower bearing do not contain oil hole. both bearings are marked on the back to indicate either standard(STD) or oversize(OS).



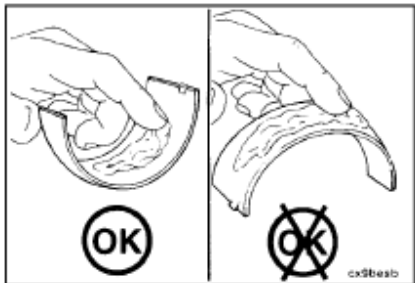


Determine the size of the bearing removed and obtain the same size for installation.



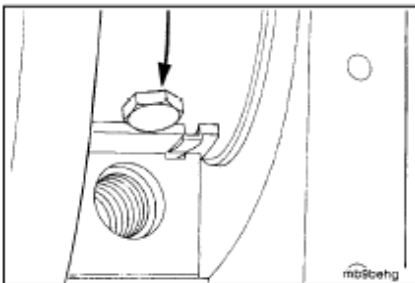
NOTE; Main bearing shells are available for crankshafts which are 0.50 mm [0.020 - inch] undersize. crankshafts which are machined undersize in the connecting rod and main bearing journals are marked on the front counter weight.

If the crankshaft is marked, check the bearing shell part number to make sure the correct bearing size is used.



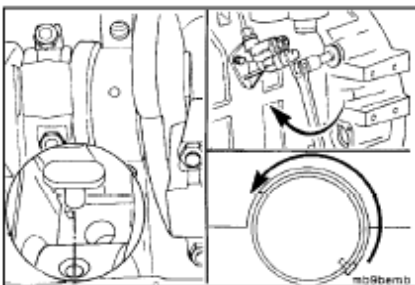
CAUTION: The cylinder block saddle and the cap mating surfaces must be clean and dry when the bearing shells are installed. used bearing must be installed in the same location as they were removed.

Use clean lubriplate TM 105, or equivalent, to lubricate the friction surface between the upper bearing shell and crankshaft journal. do not lubricate the side that is against the cylinder block.



Install

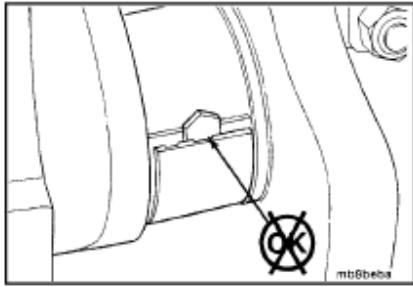
Position the new main bearing on the crankshaft and install as far as possible by hand.



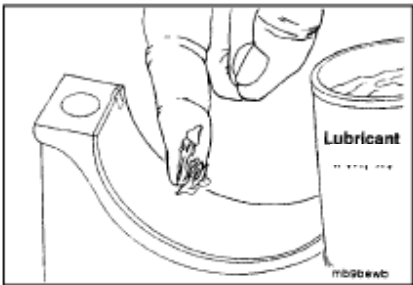
Part No.3377371, engine barring tool

Part No.3823818,Main bearing rollout tool

Use No.3823818, Main bearing rollout tool and Part No.3377371, engine barring tool to finish pushing the bearing in slowly being sure it is aligned with the block. Make sure the rang on the bearing aligns with the notch.

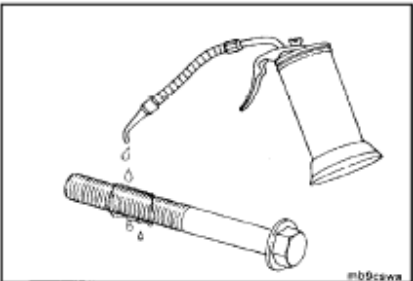


CAUTION: Make sure the pin does not slide under the bearing and damage the crankshaft.

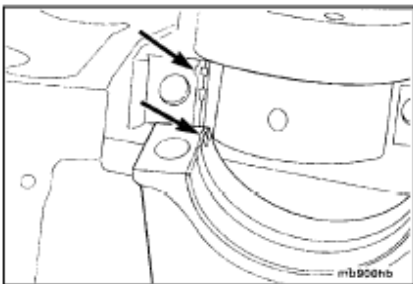


Install the lower main bearing into the bearing caps. Make sure the tang of the bearing shell is in the slot of the cap.

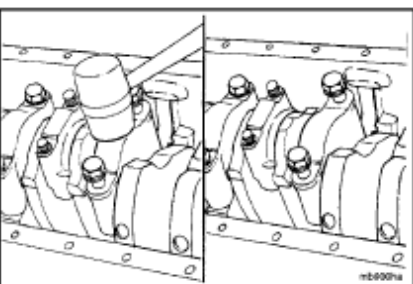
93



Use 15W-40 oil to lubricate the capscrew threads. Drain the excess oil from the capscrews before installing them.



NOTE: The main bearing caps are numbered for location. No.1 starts with the front of the block, and the number face the camshaft side of the engine. When correctly installed, the tangs(slots) should both be on the same side.



Small plastic or rubber mallet

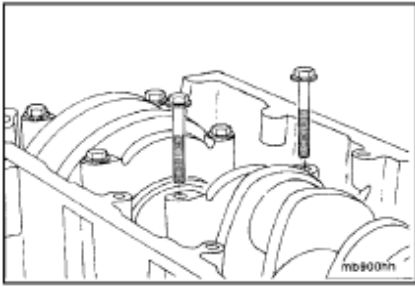
Tap the main cap gently into position.



NOTE: Make sure the bearing does not become dislodged from the cap.



When seated, the main bolts can be threaded in by hand.



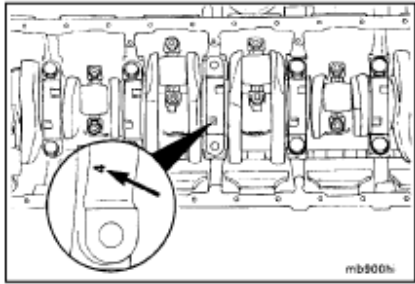
23mm

Install a main bearing cap after each upper bearing is installed to keep the bearing in place while the other upper are installed.

Tighten the capscrews to an initial torque.

Initial Torque value :50 N.m[37ft-lb]

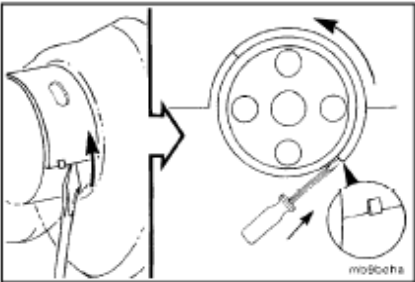
NOTE: Do not tighten to the final torque value at this time.



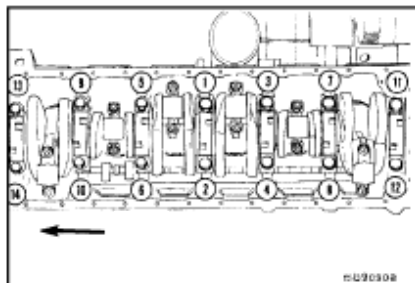
NOTE; The thrust journal does not have tangs or slots.

Care should be taken to be sure the number stamped on the engine.

Push the crankshaft toward the center of its end thrust position to allow clearance for the bearing



Since the bearing rollout tool cannot be used for the No.1 bearing, use a blunt object or screwdriver to push the bearing into position as the crankshaft is rotated.



23mm

Tighten the capscrews evenly following the illustrated sequence.

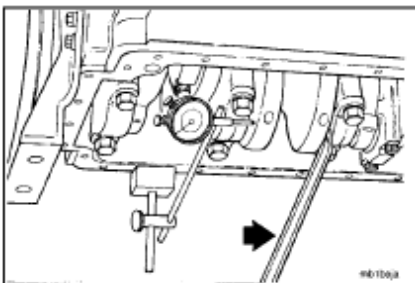
Torque value:

Steps

1-50N.m

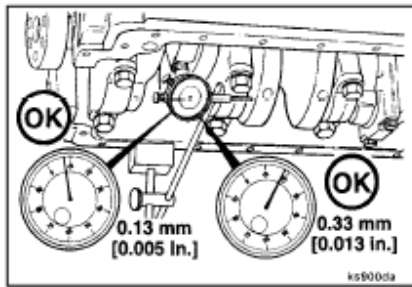
2-195N.m

3-150-250N.m

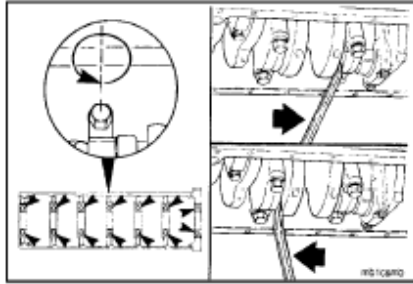


Measure the end clearance of the crankshaft as follows:

- Install a dial indicator of the oil pan flange.
- Put the tip of the gauge against the crankshaft counterweight.
- Push the crankshaft toward the rear of the cylinder block.

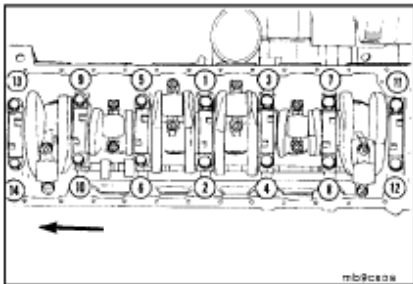


- Set the dial indicator at zero.
- Push the crankshaft toward the front of the cylinder block.
- If the end clearance is less than 0.127 mm[0.005-inch], do the following:

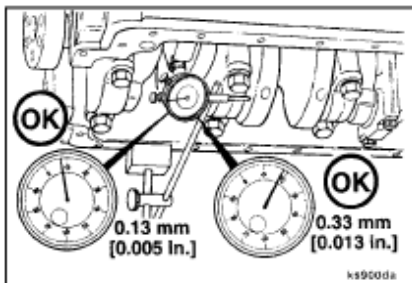


- Loosen the main bearing capscrews one turn.
- Push the crankshaft toward the front and then toward the rear of the cylinder block.

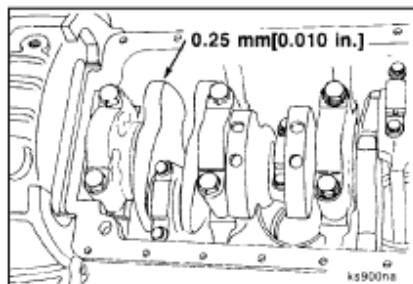
93



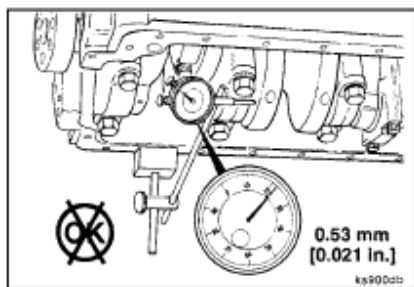
Tighten the main bearing capscrews in the sequence shown to the torque values listed in the installation procedure.



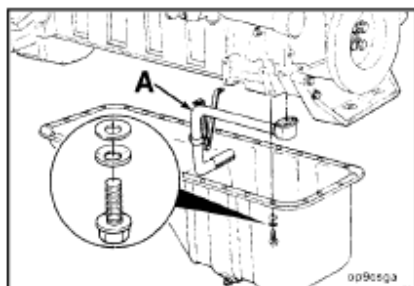
Measure the crankshaft end clearance. The end clearance specification for a new or reground crankshaft with new thrust bearings is 0.085 mm to 0.385mm.



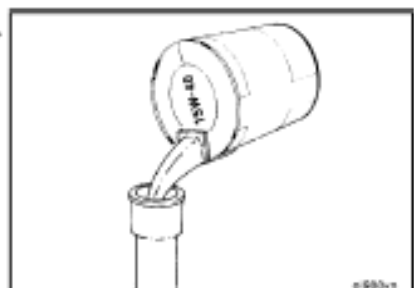
NOTE: Crankshaft that have been reground on the thrust bearing surfaces are marked for oversize thrust bearing on the rear crankshaft counterweight. If the crankshaft counter weight is marked, check the thrust bearing part number to make sure the correct bearing size is used.



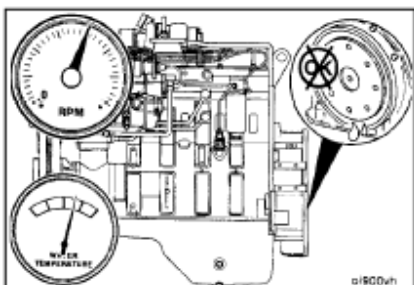
If the crankshaft end play is more than 0.385mm used, the crankshaft must be removed from the engine and repaired. refer to the L Series Shop Manual.



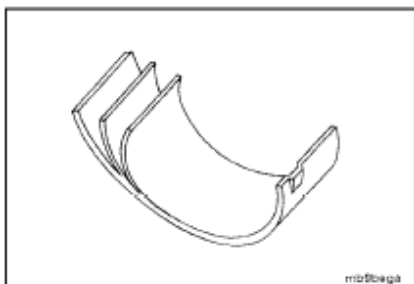
Install the oil pan and suction tube(A)



Fill the engine with lubrication oil.



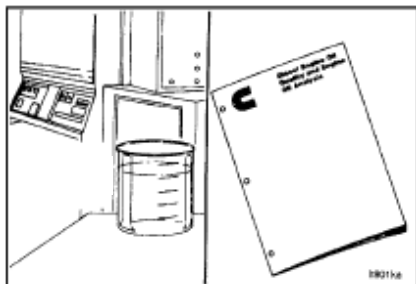
Operate the engine until the coolant temperature reaches 82°C[180°F], and check for lubrication oil leaks.



Connecting rod bearing –replace

Troubleshooting

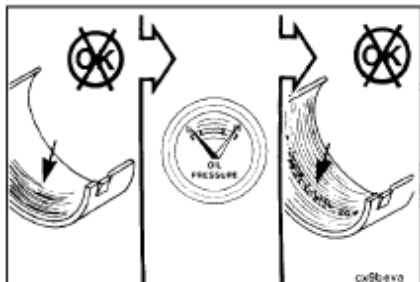
The connecting rod bearing are tri-metal with steel backing.



Improper maintenance of the lubrication system is the primary engine damage.

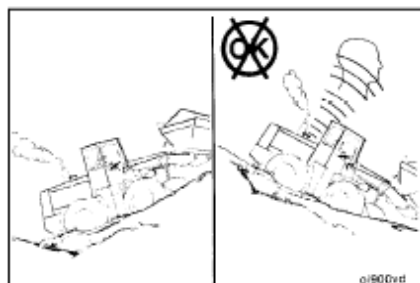
For additional oil analysis, refer to Cummins

Engine Oil Recommendations Bulletin No.3810340.

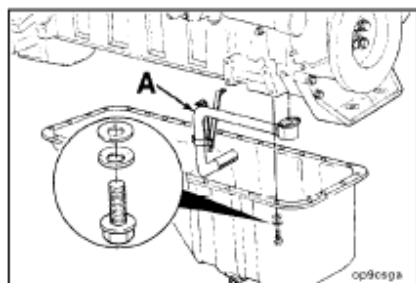


Normally, worn bearing can be detected by reduced oil pressure. but if this wear goes undetected , the excessive clearance will increase the impact between the bearing and the crankshaft causing a distinct knocking sound.

93



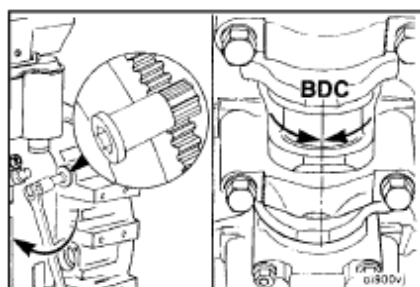
A connecting rod noise occurs when the engine is not loaded. verify by first applying a load and then unloading and listening for the noise.



Remove lubricating oil.

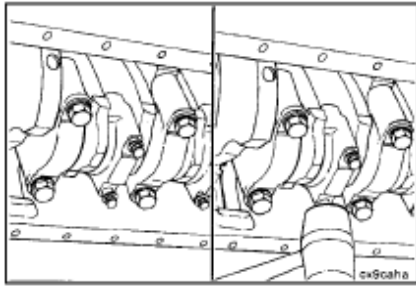


Remove the lubricating oil pan and oil suction tube(A).



Part No.3377371, engine barring gear

Rotate the crankshaft to position two of the connecting rods at bottom dead center(BDC).

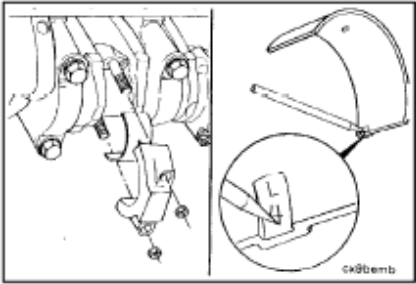


19mm, plastic hammer

Loosen the connecting rod capscrew nuts.

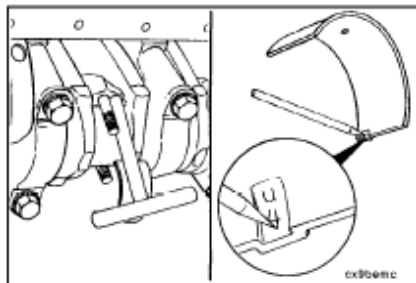
NOTE: DO NOT remove the capscrew nuts.

Hit the connecting rod capscrew nuts with a plastic hammer to loosen the rod caps.

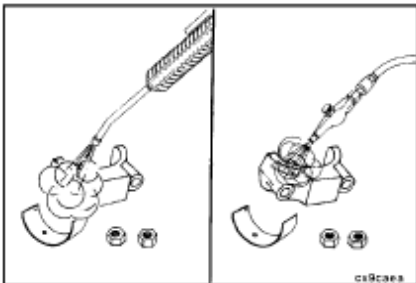


Remove the capscrew nuts and rod cap.

Remove the lower bearing shell from the connecting rod cap and mark it with the letter "L"(lower) and the cylinder number from which it was removed.



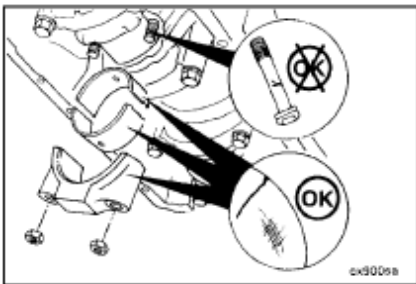
Push the connecting rod away from the crankshaft to allow the upper bearing shell to be removed. Remove the upper bearing shell and mark it with the letter "U" (upper) and the cylinder number from which it was removed.



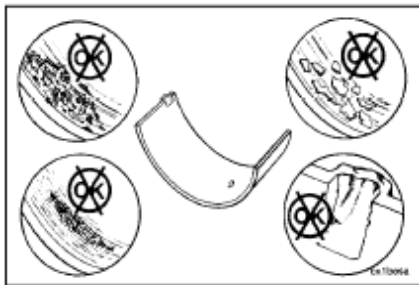
Clean and inspect

WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

NOTE: Refer to "Parts Reuse guidelines", Bulletin No. 3810303, for information on bearing inspection.

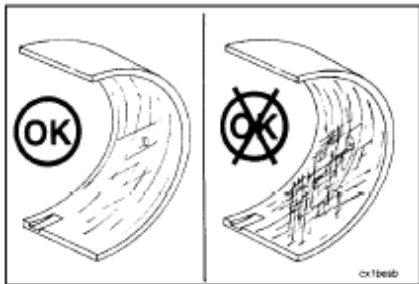


Visually inspect the rod caps, connecting rod bearing saddles. And capscrews for nicks, cracks, burrs, scratches, or fretting.



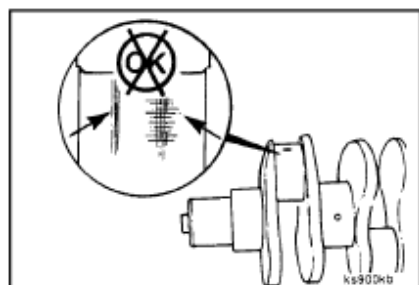
Visually inspect the bearing shells for damage.

NOTE: Replace any bearings with lock tang damage or scratches (deep enough to be felt with a fingernail). Also replace any bearings which show pitting, flaking, or corrosion into the lining.

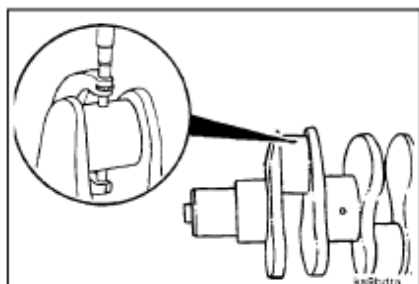


NOTE: Normal bearing wear produces a smooth finish which will wear into the lining. An exposed lining does not always indicate worn bearings. If large areas of the lining are visible in the bearing before the engine has accumulated 240,000 kilometers [150,000 miles] or 3,750 hours, inspect the engine for contamination from fine dirt particles and correct the problem.

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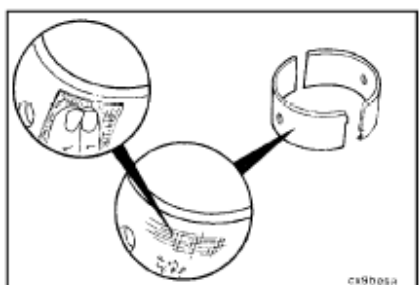


Inspect the crankshaft rod journals for deep scoring or overheating.



Use a micrometer to measure the connecting rod journal.

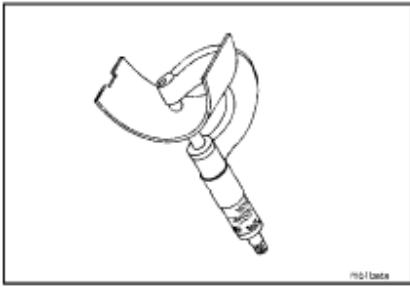
Connecting rod journal dimensions (minimum)		
mm		in
75.987	Criterion	2.9916
75.737	machined 0.25 mm	2.9818
75.487	machined 0.50 mm	2.9719
75.237	machined 0.75 mm	2.9621
74.987	machined 1.00 mm	2.9522



Visually inspect the bearing shell backside for cuts or burrs.

If cuts or burrs can not be removed with Scotch-Brite® 7448 or equivalent, the bearings must be replaced.

NOTE: For more detailed information of bearing damage, refer to "Analysis and Prevention of Bearing Failures,"

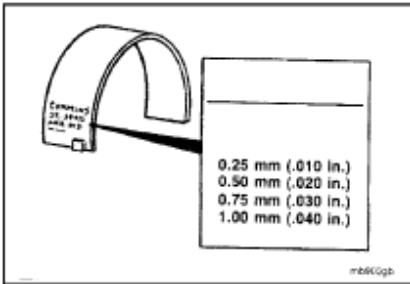


Measure the rod bearing shell thickness with an outside micrometer that has a ball tip.

Standard Connecting Rod Bearing Thickness (Used)

mm		in
2.43	Min	0.0956
2.471	Max	0.0973

Discard a bearing shell if its thickness is below the minimum specification.

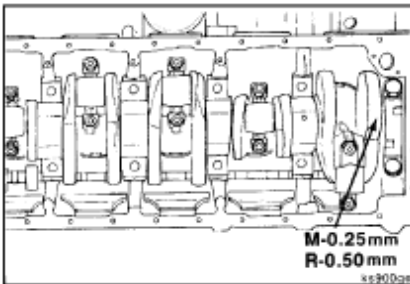


NOTE: Connecting rod bearing shells are identified with A part number and size stamped on the back side.

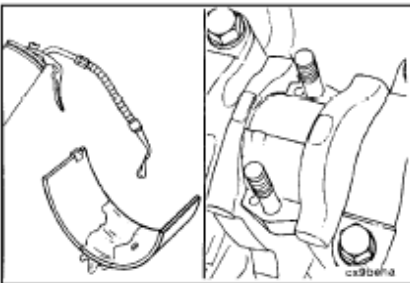


Determine the size of the removed rod bearing shell and Obtain a set of the same size.

Oversize service rod bearings are available for use with crankshafts that have been machined undersize.



Crankshafts which are machined undersize in the connecting rod or main bearing journals are marked on the front counterweight. If the crankshaft is marked, check the bearing shell part number to make sure the correct bearing size is used.



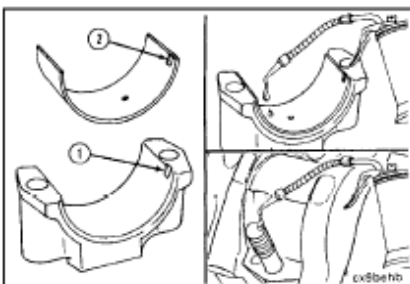
Install



CAUTION: The connecting rod and bearing shell mating surfaces must be clean and dry when the bearing shells are installed.



Used bearings must be installed in their original location. Use clean Lubriplate[®]105, or its equivalent, to lubricate the crankshaft journal mating surface of the upper bearing shell.



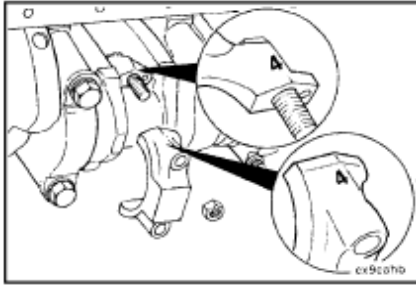
Install the upper bearing shell in the connecting rod with the tang of the bearing in the slot of the rod.



Install the bearing shell in the connecting rod cap with the tang (2) of the bearing shell in the slot (1) of the cap.

Use clean Lubriplate 105, or its equivalent, to lubricate the bearing shell to crankshaft journal mating surface.

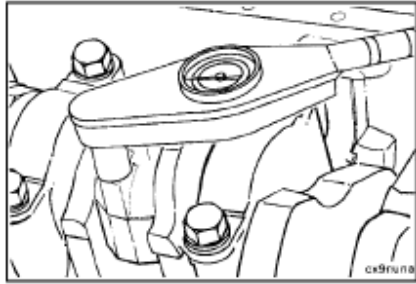
Use clean 15W-40 oil to lubricate the threads of the connecting rod capscrews.



CAUTION: The connecting rod cap number must match the number on the connecting rod and must be installed with the numbers aligned to prevent damage to the connecting rods and the crankshaft. The locking tang of the connecting rod cap must be toward the camshaft side of the cylinder block.

Lubricate under the connecting rod capscrew nuts with clean 15W-40 engine oil.

Install the rod cap and start the connecting rod nuts.



19 mm Socket, Torque Wrench

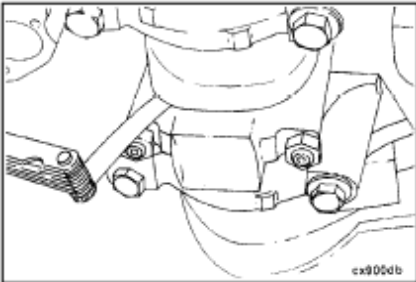
Tighten the connecting rod capscrew nuts in alternating sequence.

Torque Value:

Step 1 - 30 N•m

Step 2 - 70 N•m

Step 3 - 100~147 N•m (average value 120 N•m)



Measure the side clearance between the connecting rod and crankshaft.

Connecting Rod Side Clearance

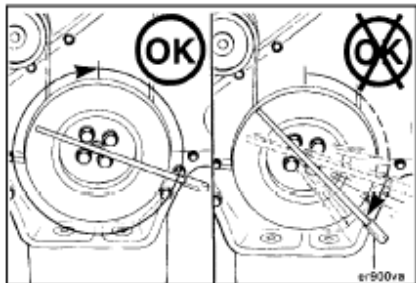
mm

0.10

min

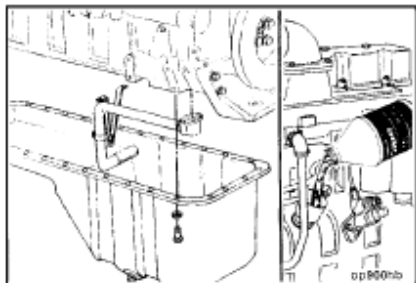
0.33

max



NOTE: The crankshaft must rotate freely.

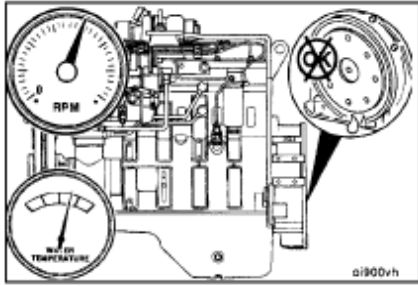
Check for freedom of rotation as the caps are installed. If the crankshaft does not rotate freely, check the installation of the rod bearings and the bearing size.



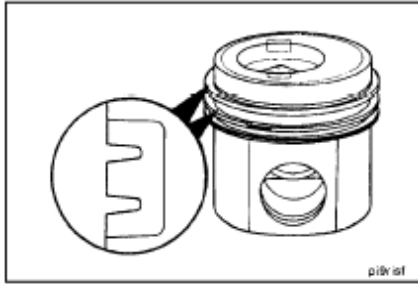
Install the oil suction tube

Install the oil pan.

Fill the lubricating oil pan.



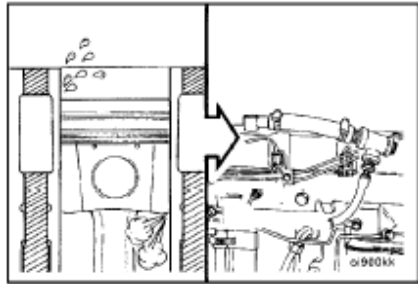
Operate the engine until the coolant temperature reaches 82°C[180°F] and check for leaks and proper operation.



Piston and Piston Rings – Replace

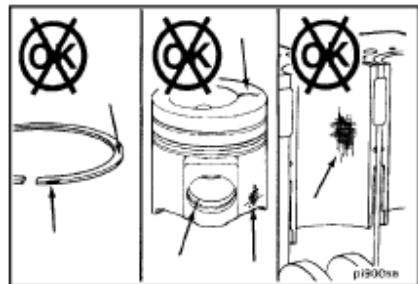
Piston – General Information

Design features include: Aluminum piston with dual Niresist ring insert. The top and intermediate ring grooves are of keystone design. The combustion bowl and piston top are hard anodized on certain higher rated horsepower engines. Always check the part number to be sure the correct configuration is used during piston replacement.

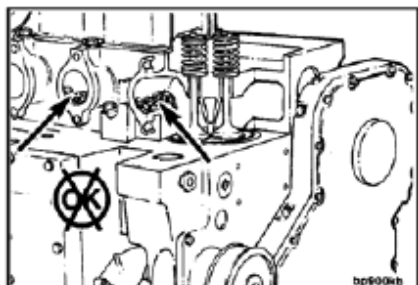


Piston and Rings – Diagnosing Malfunctions

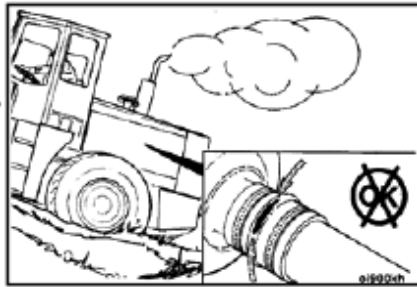
There are a number of power related problems including excessive oil consumption, smoke, blowby and poor performance that can be caused by inadequate sealing between the piston rings and the cylinder liner walls. A blowby measurement can aid in detecting the problem.



A loss of piston ring sealing may be detected during a compression check.

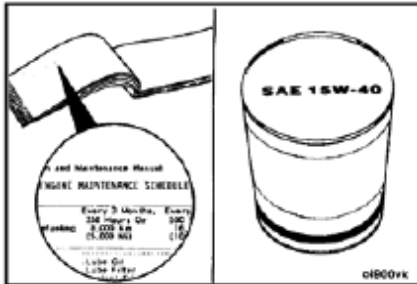


Visual inspection of the exhaust ports after removing the exhaust manifold can also confirm loss of sealing and excessive oil consumption.



The cause of inadequate sealing between the cylinder wall and rings range from extreme abrasive wear “dustout” in a short period of time because of poor maintenance of the air intake system to wear over a long period of service.

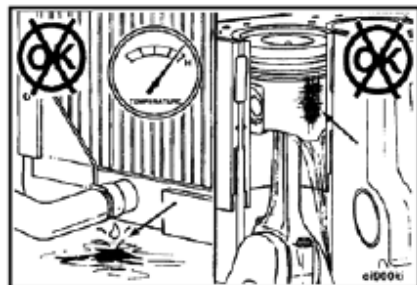
Refer to the troubleshooting for combustion air system.



When troubleshooting for excessive oil consumption, remember oil viscosity can affect cylinder sealing.

Make sure the correct oil change intervals are being followed and the specified grade of oil is being used, refer to the L Series Operation and Maintenance manual.

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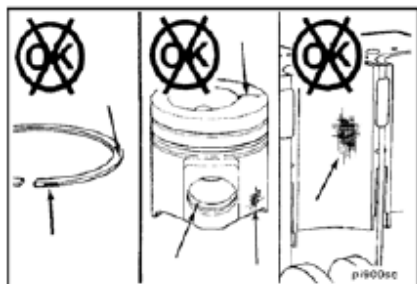


A sudden increase in oil consumption can indicate damage to the cylinder components.

Overheating of the engine from a loss of coolant will also cause the cylinder to overheat resulting in wear or seizure of the piston.



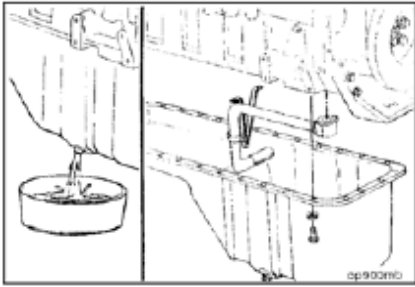
Loss of piston cooling can lead to piston wear or seizure.



Verification of the damaged or worn component requires visual and dimensional inspection of rings, pistons and cylinder liner bores.

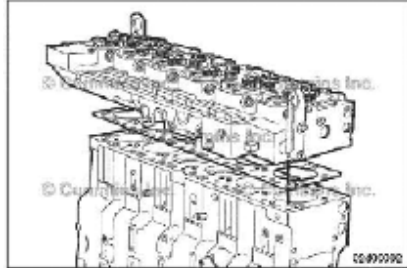
NOTE: If severe piston damage has occurred, check the turbocharger and other exhaust components for damage from debris.



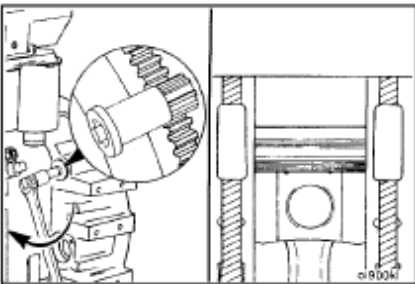


Remove

Drain the lubricating oil.
Remove the lubricating oil pan.

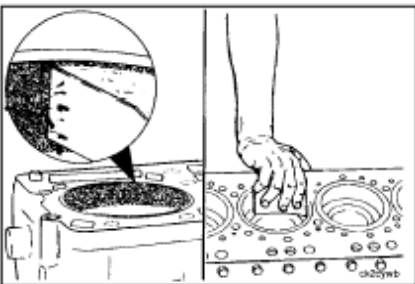


Remove the cylinder head.



Part No. 3377371, Engine Barring Gear

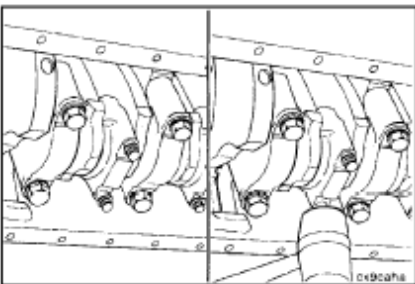
Rotate the crankshaft so the pistons are away from top dead center (TDC).



CAUTION: Do not use emery cloth or sandpaper to remove carbon from the cylinder liners. Aluminum oxide or silicon particles from emery cloth or sandpaper can cause serious engine damage. Do not use any abrasives in the ring travel area. The cylinder liner can be damaged.

Rotate the crankshaft and use a gasket scraper to remove the carbon ridge in each cylinder.

NOTE: Only scrape or sand above the piston travel area. Use a fine fibrous abrasive pad such as Scotch – Brite®7448, or equivalent, and solvent to remove the remaining carbon.



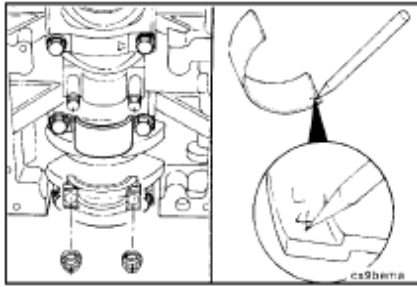
19 mm, Plastic Hammer

Rotate the crankshaft to piston the rod caps at “BDC” for removal.

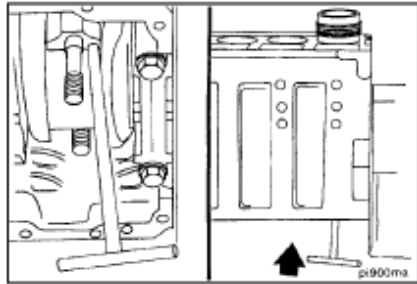
Loosen the connecting rod capscrews nuts.

NOTE: Do not remove the capscrews from the rods.

Use a plastic hammer to hit the connecting rod capscrews to loosen the caps.

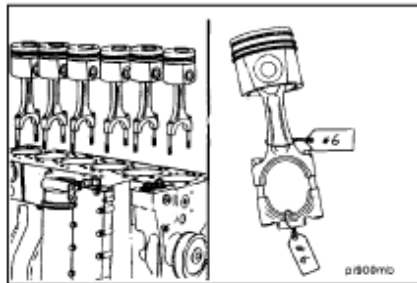


Remove the connecting rod capscrew nuts.
Remove the connecting rod caps.
Remove the lower rod bearing shell.
Mark the cylinder number and the letter "L" (lower) in the flat surface of the bearing tangs.



Use a "T-handle" piston to push the rod away from the crankshaft.

NOTE: Push the rod until the piston rings are outside of the top of the cylinder liner.

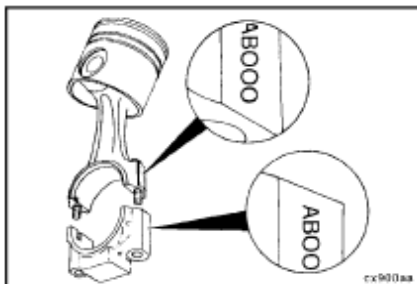


Use both hands to remove the piston and rod assembly.
NOTE: The piston and connecting rod assemblies must be installed in the same cylinder number they were removed from to be sure proper fit of worn mating surfaces if parts are used again.

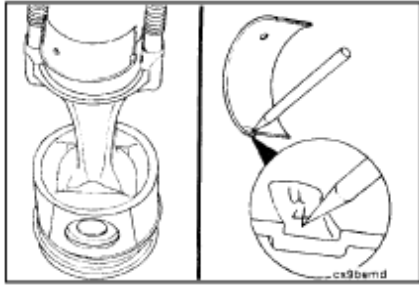
Use a tag to mark the cylinder number each piston and rod assembly was removed from.



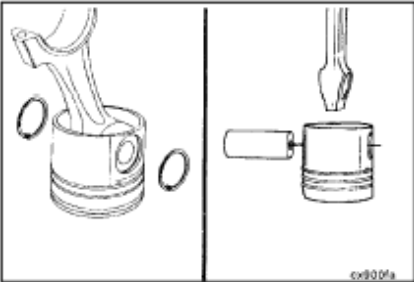
Place the rod and piston assemblies into a container to protect them from damage.



NOTE: Unique serial numbers (not cylinder numbers) are stamped on the connecting rod and matching cap.
When the rods and caps are installed in the engine, the numbers on the rods and caps must match and be installed on the same side of the engine.



Remove the upper bearing shells for connecting rods.
Mark the cylinder number and the letter "U" (upper) in the flat surface of the bearing tang.

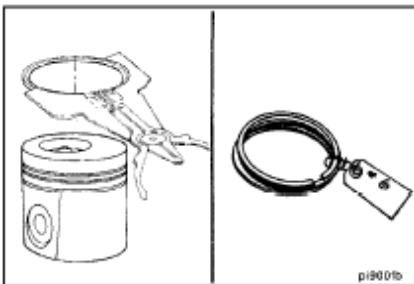


Piston and Connecting Rod Assembly

Use snap ring pliers to remove the snap rings from both sides of the piston.

Remove the piston pin.

CAUTION: Pistons do not require heating.

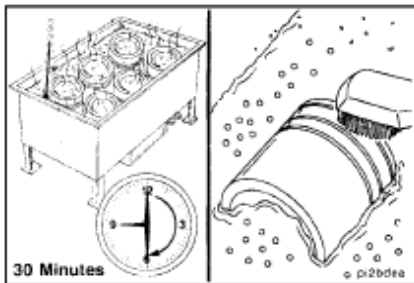


Part No. 3823137, Piston Ring Expander

Remove the piston rings.



Use a tag to mark the cylinder number from which each piston was removed.

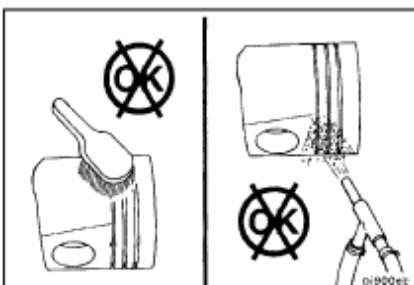


Clean and Inspect

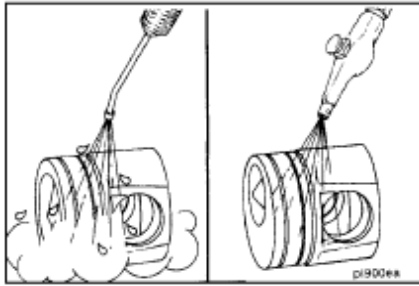
CAUTION: Be sure the cleaning solvent is approved for aluminum. Damage to the pistons can result.

Allow the pistons to soak for a minimum of 30 minutes in a tank containing an approved cleaning solvent for aluminum.

Use a hot, soapy solution and a non-metallic brush to remove carbon deposits.



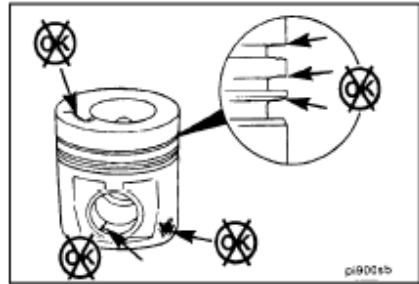
CAUTION: Do not use a metal brush. A metal brush will damage the piston ring grooves. Do not use glass beads, walnut shell or plastic bead blasting to clean the piston ring grooves or pin bores. This can cause the pin bore to crack or the rings to not seat.



WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

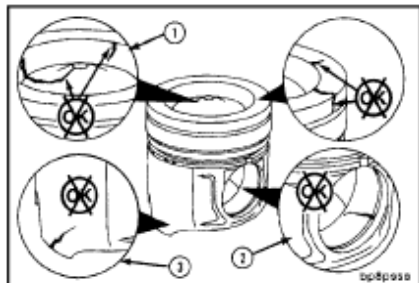
Use steam to clean the pistons.

Dry with compression air.



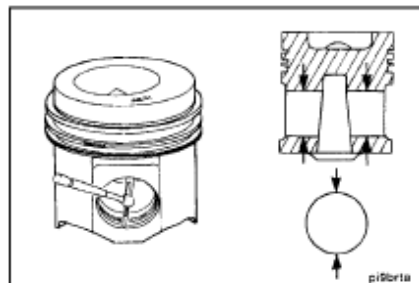
Inspect the piston for damage and excessive wear. Check the top ring grooves, skirt and pin bore.

NOTE: Dimensional inspection of the piston is required only when the cause of the lack of sealing is not apparent.



Visually inspect the piston bowl (1), pin bore (2) and skirt (3) for cracks or damage.

NOTE: Do not use pistons with cracks.



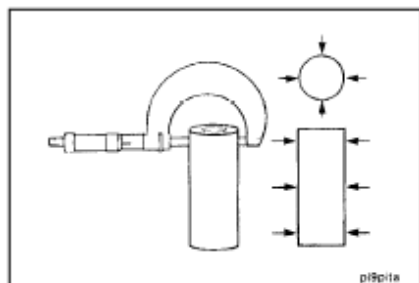
Measure the piston pin bore when the piston temperature is at 20°C [68°F]

Piston Pin Bore I.D

mm		in
45.006	min	1.7719
45.025	max	1.7726

NOTE: Add 0.013 mm [0.0005 - inch] to the bore inside diameter per 5°C [10°F] temperature rise up to 32°C [90°F].

The pin bore should be checked closer to the O. D. of the piston since the pin bore is tapered.



Visually inspect the piston pin for scratches, grooves, or other damage.

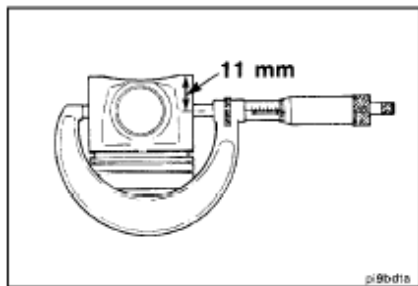


Measure the piston pin outside diameter.

Piston Pin outside Diameter

mm		in
44.993	min	1.7714
45.003	max	1.7718

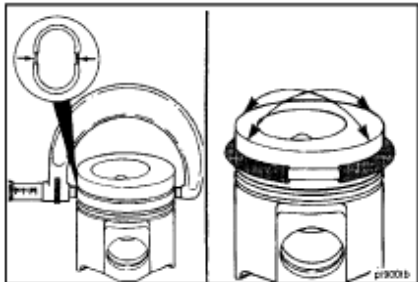
NOTE: Discard the piston pin if it is more than 0.03 mm out of round.



Measure the piston skirt diameter as illustrated.

Piston Skirt O. D.

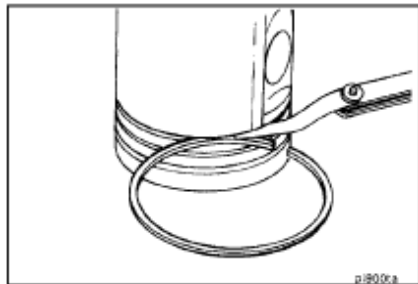
mm		in
113.808	min	4.4806
113.879	max	4.4834



Use a micrometer and Part No. 3823966, piston ring groove gauge, to measure the wear of the top ring groove keystone angle. Use Part No. 3823965, piston ring groove gauge, to measure the wear of the intermediate ring groove keystone angle.

Piston Ring Groove (Keystone Angle)

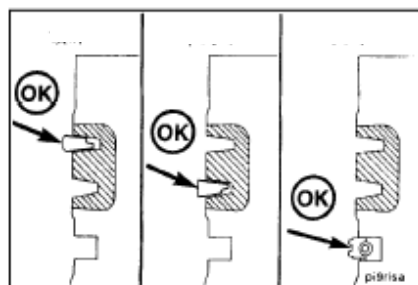
Ring	mm	in
Top ring	113.938 min	4.4857
Intermediate rings	114.323 max	4.5009



Use a new piston ring and feeler gauge to measure the side clearance of the rectangular intermediate and oil control ring grooves.

Piston Ring Clearance (rectangular groove)

Ring	mm	in
Intermediate rings	0.070 min	0.0028
	0.150 max	0.006
Oil control	0.020 min	0.0008
	0.130 max	0.0051



Piston ring – inspect

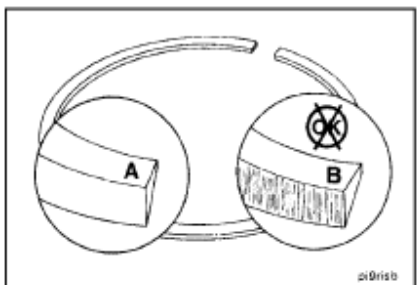
Check the cylinder liner for wear, for those cylinders with no obvious damage; check the following conditions which can cause loss of sealing.

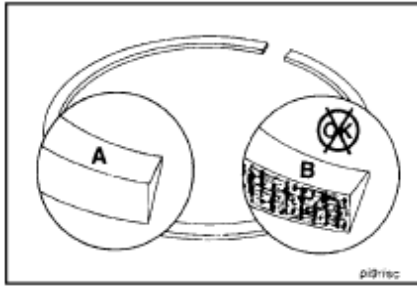
- Rings installed incorrectly.

NOTE: There are two different design intermediate rings used (A) rectangular (B) "reverse twist."

Refer to piston ring installation in this section.

- Condition of ring is worn.
- Abrasive wear is indicated by the concentrated vertical scratches (B). The chromium plate is worn through and the face of the ring has a brighter finish compared to the dull satin finish of a new ring (A).
- This type of wear can be caused by ingested abrasive material. Inadequate cleaning during a previous repair or particles embedded in the liner can cause the condition.



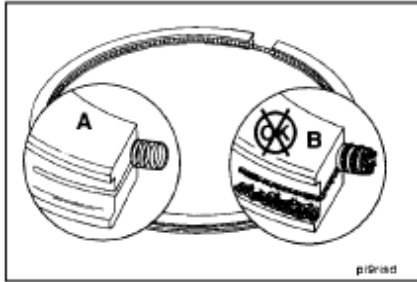


Scuffing and scoring is indicated by the heavy scratches metal discoloration and voids (B).

This damage indicates a break down of the oil film on the liner wall causing transfer of material from the ring face to the liner. The condition can be caused by:

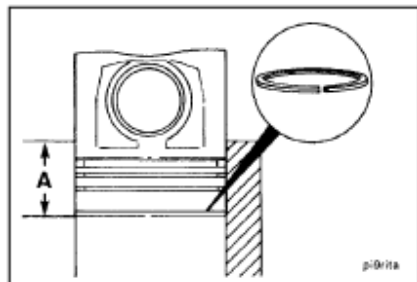
- Engine overheating
- Oil dilution or improper maintenance of the lubrication system.
- Piston cooling nozzle malfunction.

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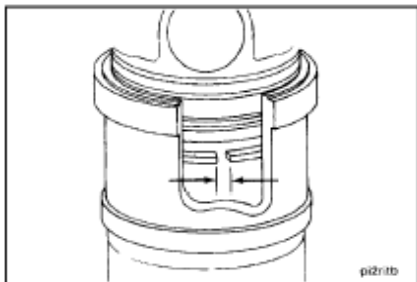
Oil ring plugging in indicated by the deposits in the oil ring grooves (B). Plugging of the ring drains restricts oil drain back which floods the ring belt area resulting in a loss of oil control. The condition can be caused by:

- Low engine operating temperature – long periods of idling or a cooling system malfunction.
- Extended oil change intervals, the wrong grade of oil or poor quality oil.



To check the piston ring gap, use the top end of a piston to align the piston rings in the wear area of the cylinder liner in which they will be used.

A= 89 mm [3.5 inch]

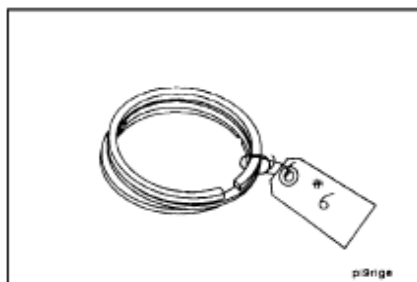


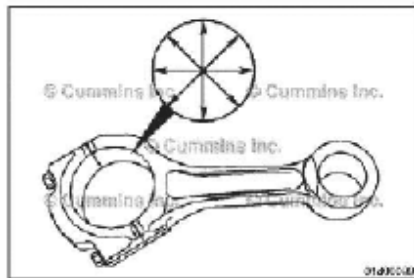
Use a feeler gauge to measure the piston ring end gap. Replace the ring if it does not meet the following specifications:

New Piston ring End Gap			
	mm		in
Top ring	0.40	min	0.016
	0.70	max	0.028
Intermediate rings	0.40	min	0.016
	0.70	max	0.028
Oil ring	0.30	min	0.012
	0.60	max	0.024

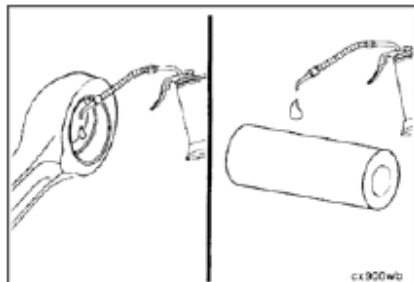
NOTE: Add 0.09 mm [0.004 in] for every 0.03 mm [0.001 in] of cylinder liner bore wear up to the maximum worn limit.

Identify the ring set for installation in the cylinder in which the end gap was measured.





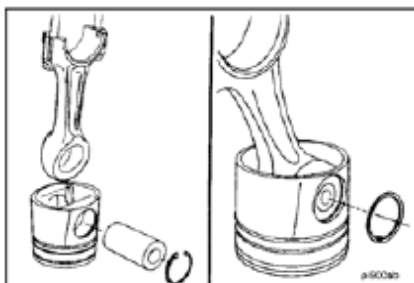
Inspect the connecting rod pin bore and the crankshaft bore.



Install

Piston pin installation.

Use clean 15w-40 oil to coat the connecting rod piston pin bore and the piston pin.

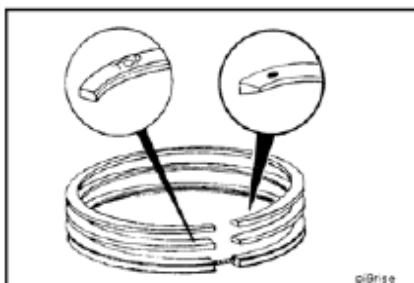


CAUTION: The retainer snap ring must be seated completely in the piston pin groove to prevent engine damage during engine operation.

Install a new snap ring into piston pin bore.

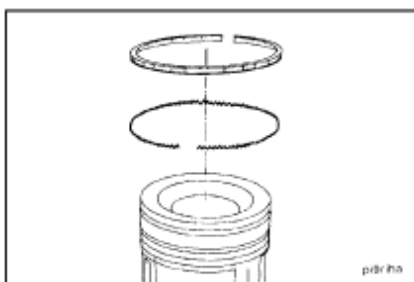
Align the pin bore of the rod with the pin bore of the piston and install the piston pin.

CAUTION: Be sure "Front" marking on the top-piston and the numbers on the rod and cap are oriented correctly.

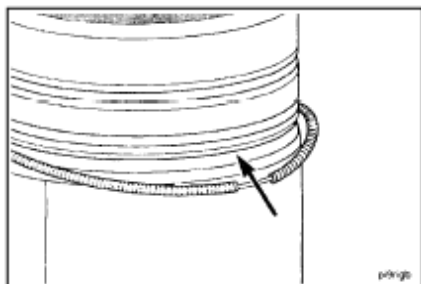


Piston rings installation

The top surface of the two pistons above is correct, with the word "TOP" or the supplier mark facing upward. The bottom or oil control ring can be installed with either side up.



NOTE: The two piece oil control ring must be installed with the expander ring gap 180 degrees from the gap of the oil ring. Do not overlap the end of the expander ring.

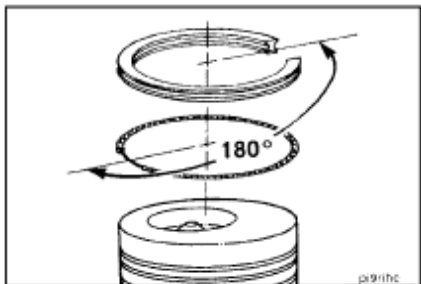


Piston Ring Expander, Part No. 3823137

Install the rings on the piston.



Position the oil ring expander in the oil control ring groove.



Install the oil control ring with the end gap opposite the ends on the expander.

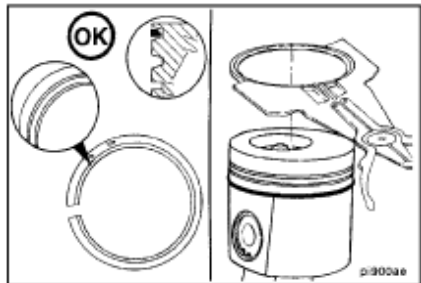
93



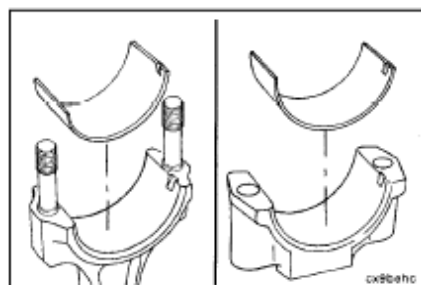
Install the intermediate ring.



NOTE: The intermediate ring must be installed with the cutback notch to the bottom of the piston. The word "TOP" or the "0" stamp will be on the side opposite the cutback notch.



Disconnect the driveline and remove the transmission, if equipped. Refer to the manufacturer's instructions.

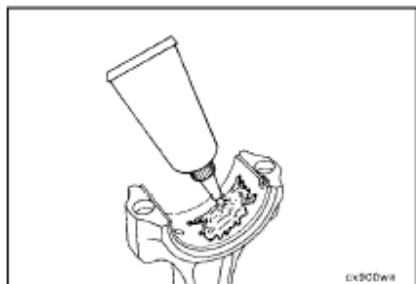


10 mm, 19 mm

Remove the clutch and flywheel, if equipped.

Remove the flywheel housing.

Remove the four lubricating oil pan mounting capscrews which secure the oil pan to the rear cover.

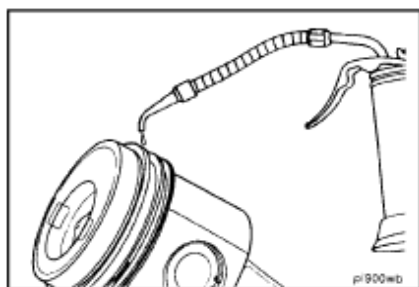


CAUTION: Use extreme care when releasing the oil pan gasket from the rear cover to prevent damage to the gasket.



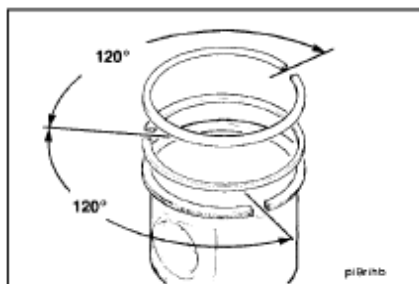
If the gasket is damaged, the oil pan must be removed and the gasket replaced.

Insert a feeler gauge or shim stock between the rear cover and the oil pan gasket. Move the feeler gauge or the shim stock back and forth to release the gasket from the rear cover.

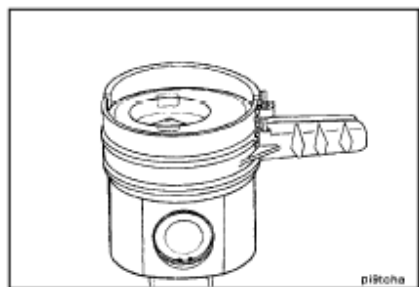


Remove the capscrews from the rear cover, and remove the cover from the crankshaft flange.

Remove the seal from the rear cover.



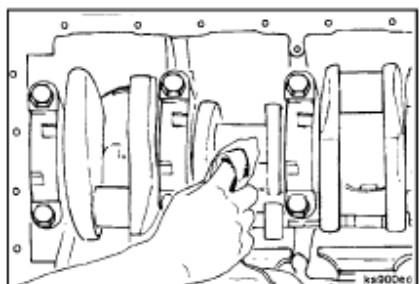
Install the piston rings.



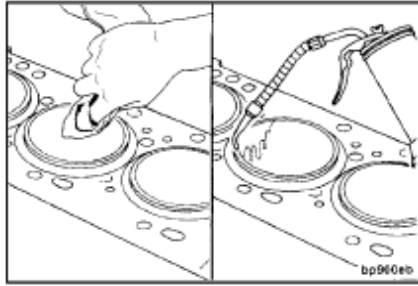
Part No. 3823290, Piston Ring Compressor



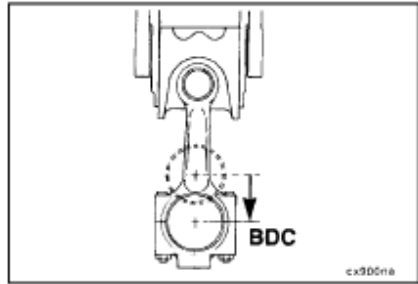
Compress the rings.



Use a clean lint-free cloth to clean the crankshaft bearing journals.



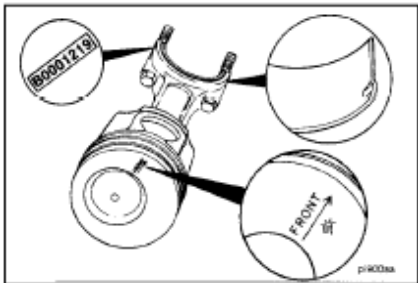
Use a clean lint-free cloth to wipe the cylinder bores.
Lubricate the cylinder bore with clean engine oil.



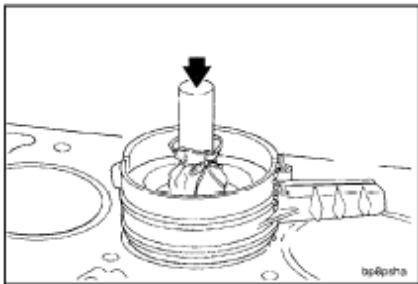
Part No. 3377371, Engine Barring Gear

Rotate the crankshaft to position the journal for the connecting rod at bottom dead center (BDC).

93



CAUTION: Be sure "Front" marking on the piston and the numbers on the rod and cap are oriented as illustrated.



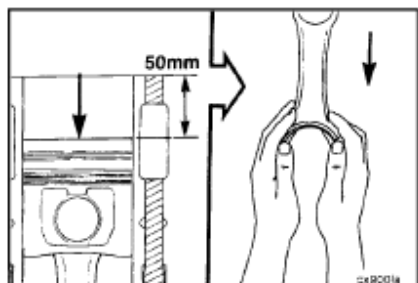
CAUTION: Use care when installing the piston and connecting rod so the cylinder bore is not damaged.

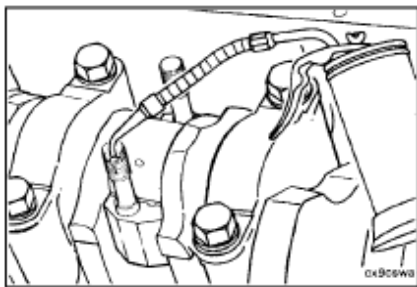
Position the piston and rod assembly into the cylinder bore with the word "front" on the piston toward the front of the cylinder block.

Hold the ring compressor against the cylinder liner. Push the piston through the ring compressor and into the cylinder liner.

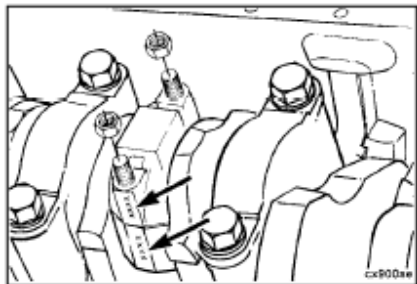
NOTE: If the piston does not move freely, remove the piston and inspect for broken or damaged rings.

Push the piston into the bore until the top of the piston is approximately 50 mm [2 inches] below the top of the bore; pull the connecting rod onto the crankshaft journal.





Use clean engine oil to lubricate the threads of the connecting rod capscrews.



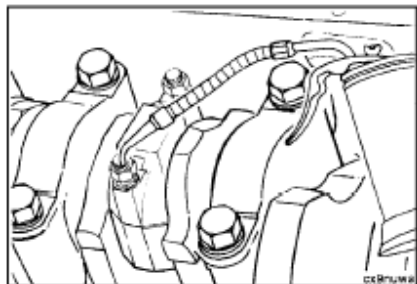
NOTE: The numbers marked on the connecting rod and the cap must be the same. The tang slot side of the cap must be on the same side as the tang slot in the connecting rod when the cap is installed.



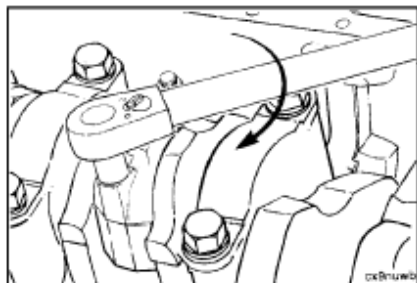
Install the bearing in the connecting rod cap.

Install the rod cap and tight the connecting rod nuts.

Use lubricate®105, or equivalent, to coat the inside diameter of the bearing shell.

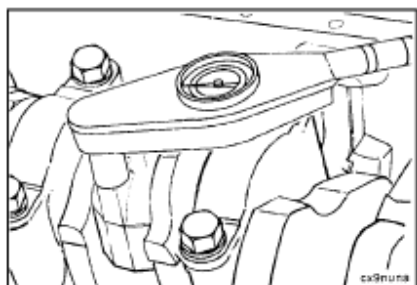


Use clean 15w-40 oil to lubricate the connecting rod nuts.



19 mm

Alternately tighten the rod nuts to pull the rod cap into position.



19 mm Socket, Torque Wrench

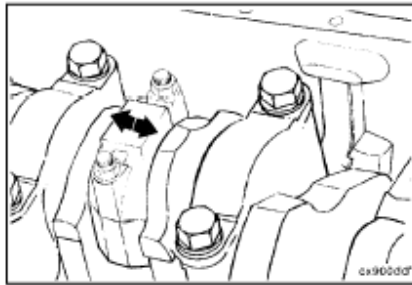
Tighten the connecting rod cap to the connecting rod evenly.

Torque Value:

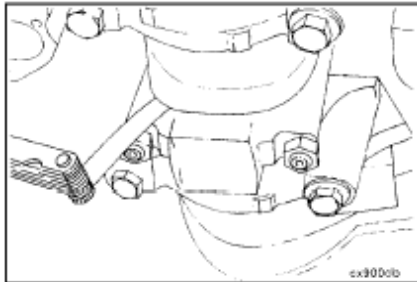
Step 1: 40 N•m [30ft- lb]

Step 2: 80 N•m [60 ft- lb]

Step 3: 120 N•m [88 ft- lb]



Shake the connecting rod after tightening to verify side clearance.

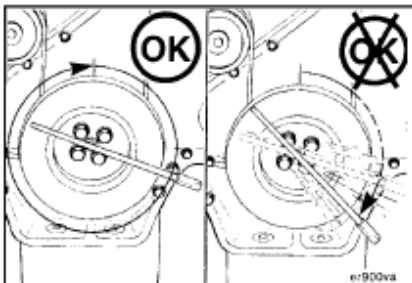


Measure the side clearance between the connecting rod and crankshaft.

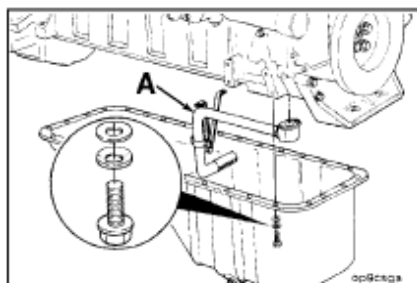
93

Connecting Rod Side Clearance

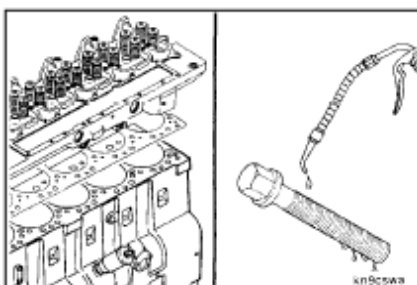
mm		In
0.10	min	0.004
0.33	max	0.013



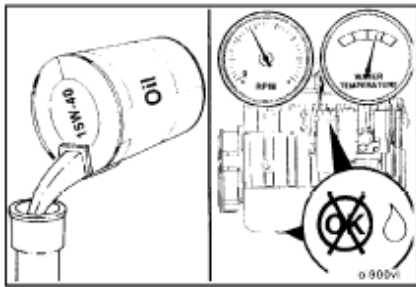
NOTE: The crankshaft must rotate freely. Check for freedom of rotation as the caps are installed. If the crankshaft does not rotate freely, check the installation of the rod bearings and the bearing size.



Install the suction tube (A) and oil pan.

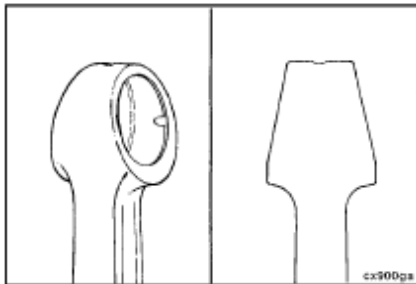


Install the cylinder head.



Fill the lubricating oil pan.

Operate the engine until the coolant temperature reaches 82°C[180°F] and check for leaks and proper operation.

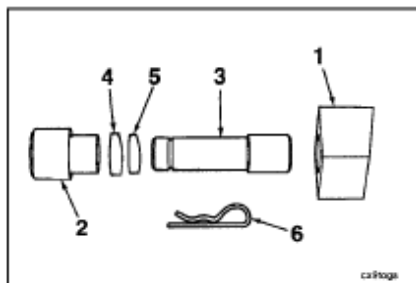


Connecting Rods – Replacement

General Information

The piston pin end of the connecting rod is angle cut to provide additional bearing surface. The piston pin bore in the rod is fitted with a bronze bushing.

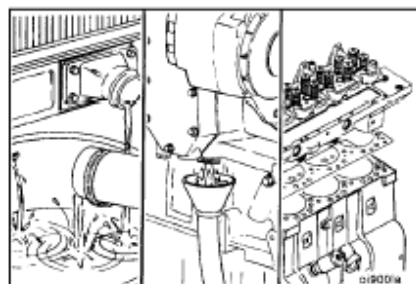
Service replacement rod bushings are available. Refer to the appropriate parts catalog for part numbers.



Rod Pin Bore Bushing Removal / Installation Tool, Part No. 3823690

This tool is used to remove and install the bushing to the correct position.

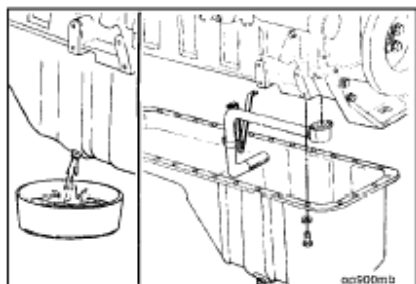
Ref. No.	part numbers	instructions	quantity
1	3823691	Anvil	1
2	3823693	Cup	1
3	3823692	Mandrel	1
4	3823694	Driver Ring	1
5	3823695	Knock-out-ring	1
6		Hitch Pin	1



Remove

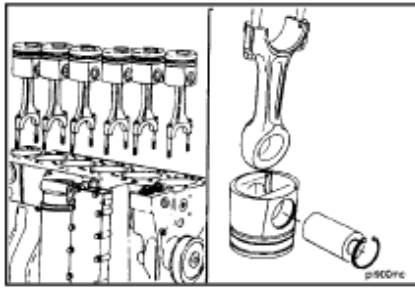
Drain coolant.

Remove the cylinder head.



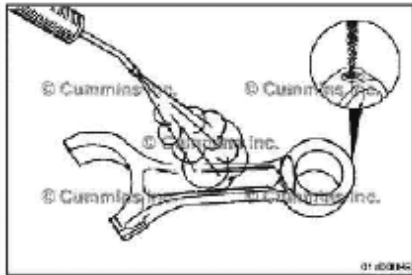
Drain the lubricating oil.

Remove the lubricating oil pan and oil suction tube.



Remove piston and connecting rod assembly from the engine.

Disassemble the piston from the connecting rod.



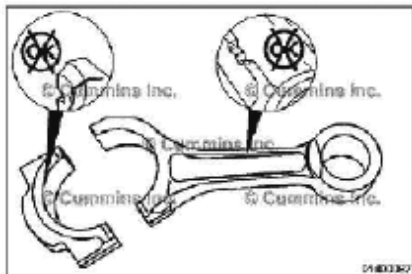
Clean and Inspect

Use a nylon bristle to clean the oil drillings.



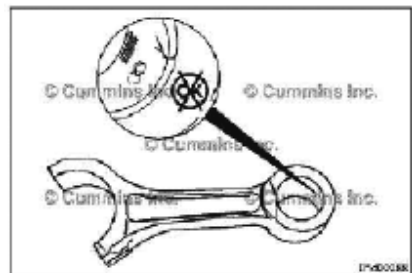
WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Use steam or solvent to clean the rocker lever shaft. Dry with compressed air.

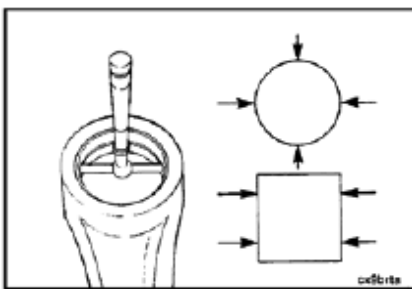


Inspect the rods and the caps for damage.

Replace the connecting rod if the I beam is cracked or damaged.



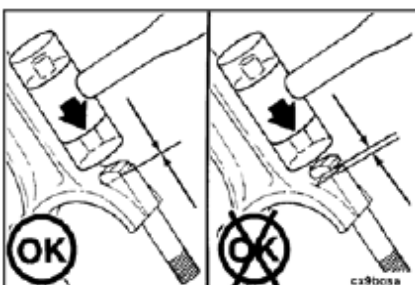
Visually inspect the rod pin bore bushing for damage or Misalignment of the oil hole passage and bushing.



Measure connecting rod piston pin bushing inside diameter.

Connecting Rod Pin Bore Specification

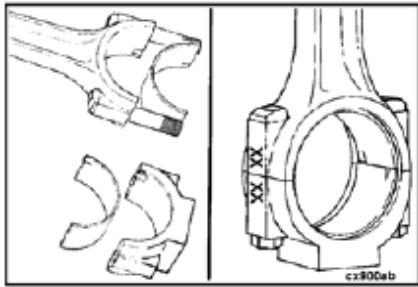
mm		in
45.023	min	1.7726
45.060	max	1.7740



Plastic Hammer

Tap the connecting rod bolts in until the head is aligned and seated on the flat machined surface of the connecting rod.





Install the bearing shells in the connecting rod and cap.
Install the rod cap and start the connecting rod nuts.



NOTE: The connecting rod cap number must match the number on the connecting rod and be installed with the numbers aligned.

Tighten the connecting rod nuts in alternating sequence.

Torque Value:

Step 1: 40N•m [30ft-lb]

Step 2: 80N•m [60ft-lb]

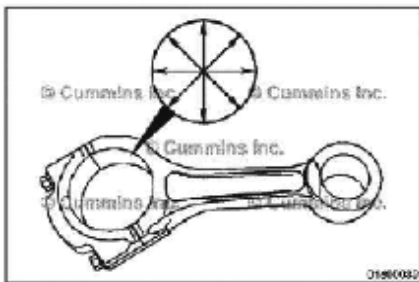
Step 3: 120N•m [88ft-lb]



Measure the connecting rod crankshaft bore inside diameter with the bearing installed.

Connecting Rod Crankshaft Bore I.D

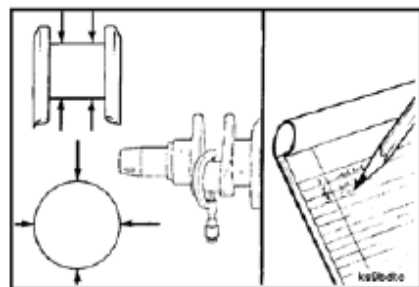
mm		in
76.046	min	2.9939
76.104	max	2.9962



Measure and record the mean diameter of the rod journals on the crankshaft.

Crankshaft Rod Journal Diameter

mm	
75.962	min
76.013	max



Out-of-Roundness: 0.050 mm [0.002 in]

Taper: 0.013 mm [0.0005in]

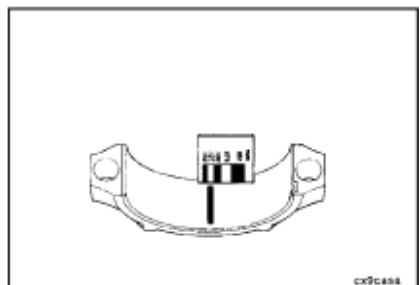
Bearing Clearance: = rod inside diameter minus crankshaft journal diameter.



NOTE: Bearing clearance can also be determined with Plastigauge.

Connecting Rod Bearing Clearance

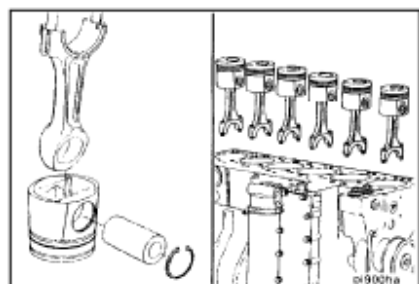
mm		in
0.033	min	0.0013
0.117	max	0.0046

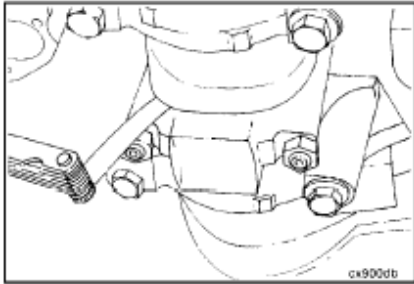


Install

Install the pistons on the connecting rods.

Install the pistons and connecting rod assemblies.

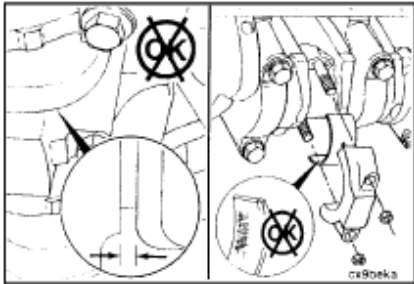




Measure the connecting rod side clearance.

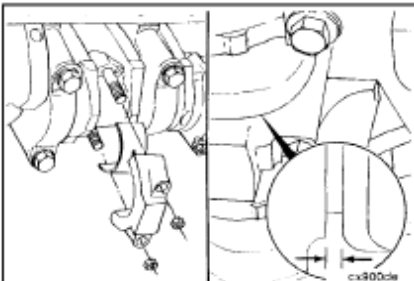
Connecting Rod Side Clearance

mm		in
0.10	min	0.004
0.33	max	0.013



NOTE: If the side clearance not within specifications:

- Remove the rod caps and inspect for dirt, damage, or correct bearings.



Install the connecting rod cap.

Torque Value:

Step 1: 40N•m [30ft-lb]

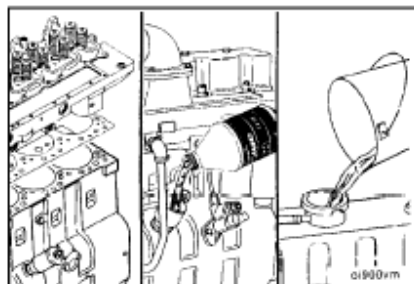
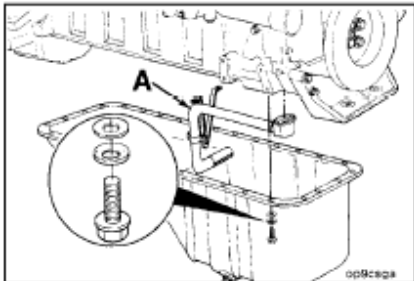
Step 2: 80N•m [60ft-lb]

Step 3: 120N•m [88ft-lb]

- Measure the side clearance again.

NOTE: If the side clearance is not with specifications, the connecting rod must be replaced.

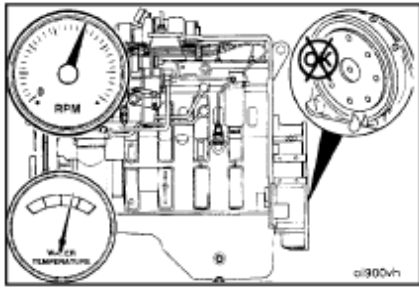
Install the suction tube (A) and oil pan.



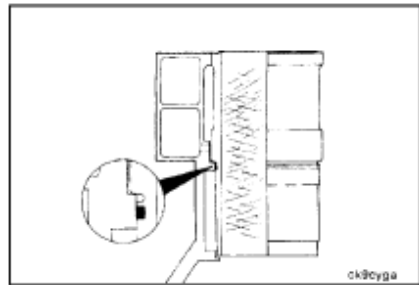
Install the cylinder head.

Fill the lubricating oil pan.

Fill the cooling system.



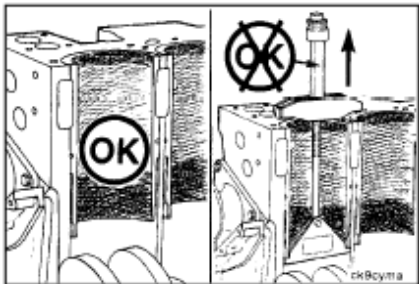
Operate the engine until the coolant temperature reaches 82°C [180°F] and check for leaks and proper operation.



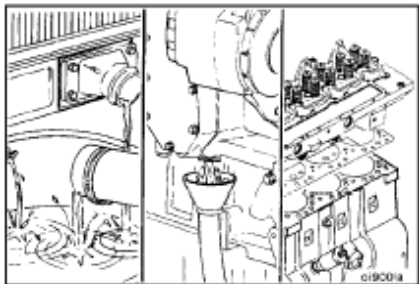
Cylinder Liner – Replacement

General Information

The cylinder block has a replacement cylinder liner. A mid-stop design is used to locate the liner in the block. A press fit between the liner and the block provides coolant sealing at the top of the liner. A rectangular ring seal (liner seal) is used for sealing at the mid-stop portion of the liner.

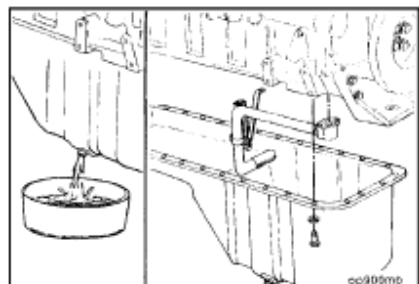


NOTE: Cummins Engine Company, Inc. does not recommend removing the cylinder liners to repair an oil consumption problem if the inside diameters of the liners are within the inspection limits included in this procedure. Careful analysis of the condition of the liner bores, piston rings, and pistons can result in the restoration of cylinder sealing with a minimum replacement of parts.

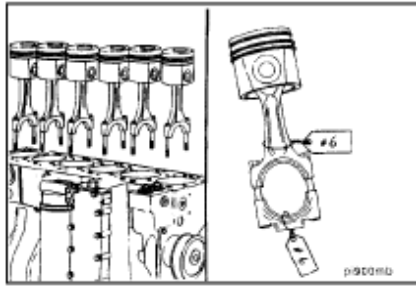


Remove

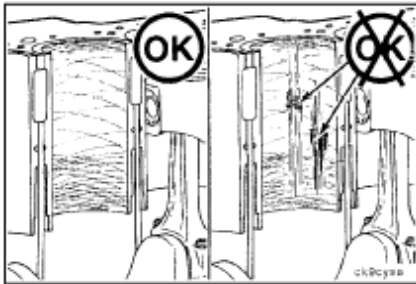
Drain the cooling system.
Remove the cylinder head.



Drain the engine lubricating oil.
Remove the lubricating oil pan and oil suction tube.



Remove the pistons and connecting rods.



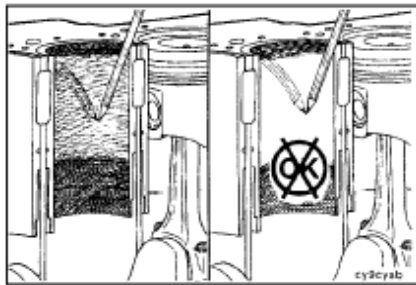
Preliminary Liner Inspection

NOTE: Before removing the cylinder liners, visually inspect the condition to determine reuse.

Visually inspect the inside diameters of the liners for cracks, scuffing, and scoring.

Inspect the inside diameter for vertical scratches deep enough to be felt with a fingernail.

NOTE: If a fingernail catches in the scratch, the liner must be replaced.

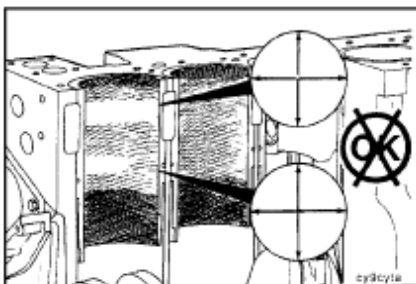


Visually inspect cylinder liner inside diameter for wear.

A moderate wear produces a bright mirror finish in the worn area with traces of the original hone marks or an indication of an etch pattern.

A heavy wear produces a bright mirror finish in the worn area without traces of hone marks or an etch pattern.

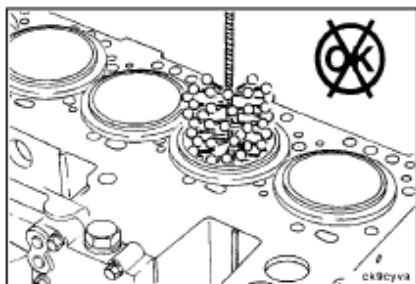
Do not reuse liners with heavy wear or any indications of particle embedment from a failure. Severely worn liners will have a ridge near the top of the liner bore.



Measure the liner inside diameter in four places 90 degrees apart at the top and bottom of the piston travel area.

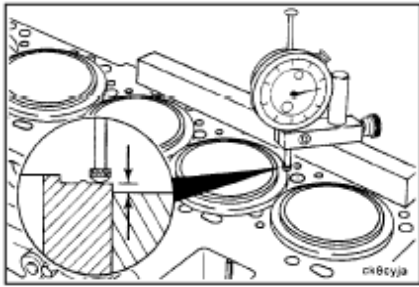
Cylinder Liner Dimensions

mm		in
0.04	maximum out of round	0.0016
0.04	maximum taper	0.0016
114.04	maximum inner diameter	4.4897



NOTE: If a liner bore is not acceptable for reuse, it must be replaced. Damaged liners can not be honed or deglazed. This would destroy the cross-hatch pattern needed for oil control.

NOTE: Do not remove or disturb the liner seals for liners which pass the inspection criteria.



Part No. 3823495 Liner Protrusion Gauge



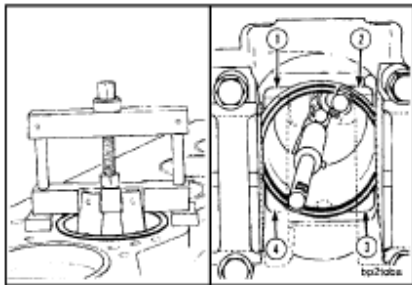
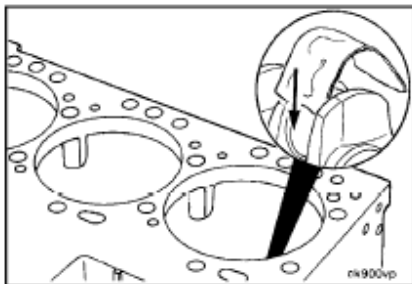
Liner protrusion is the distance the liner protrudes above the block face. Before removing the liners, check the protrusion in the “unclamped” state.

Cylinder Liner Dimensions

mm		in
0.025	min	0.001
0.122	max	0.0048

If the liner was installed correctly and the liner protrusion is out of limits, it will be necessary to machine the counterbore and add shims to restore to the original specifications.

Use clean shop rags to cover the crankshaft to prevent debris from falling into the main journal area or into the connecting rod journal oil drilling.



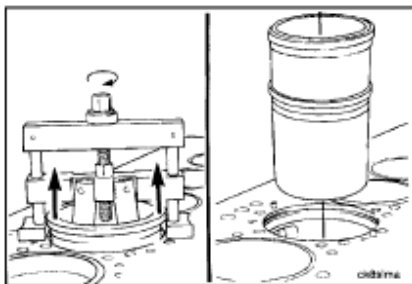
Part No. 3376015 Cylinder Liner Puller



CAUTION: The liner puller must be installed and used as described to avoid damage to the cylinder block. The puller must not contact the block casting at points (1), (2), (3) and (4).



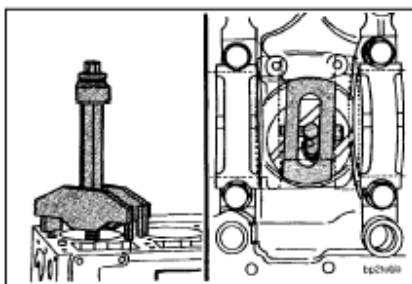
Insert the liner puller into the top of the cylinder block.



NOTE: The liner puller must be centered on the top of the cylinder block.

Turn the puller jackscrew clockwise to loosen the liner from the cylinder block.

Use both hands to remove the liner.



Part No. 3375629 Universal Liner Puller

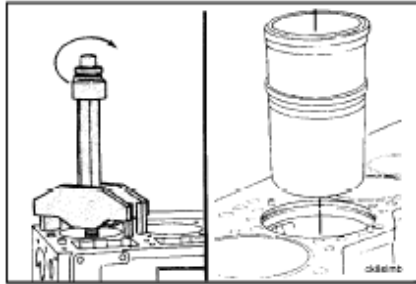


The liner puller must be installed and used as described to avoid damage to the cylinder block.



The puller plate must be parallel to the main bearing saddles and must not overlap the liner outside diameter.

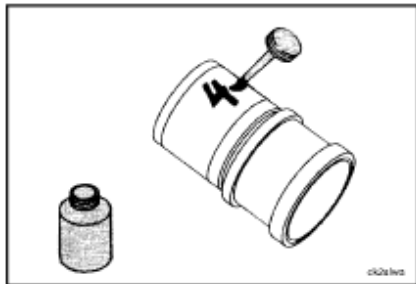
Insert the liner puller into the top of the cylinder block.



NOTE: The liner puller must be centered on the top of the cylinder block.

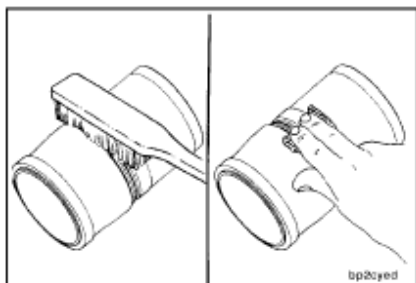
Turn the puller jackscrew clockwise to loosen the liner from the cylinder block.

Use both hands to remove the liner.



Use Dykem® or equivalent to mark the cylinder number on each liner.

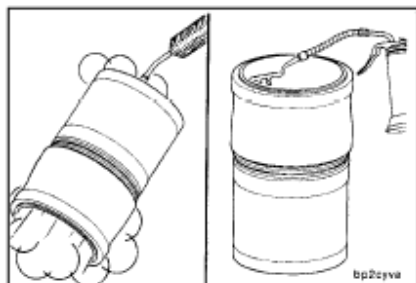
93



Clean and Inspect

CAUTION: Do not use any abrasives in the ring travel area of the liner. The liner can be damaged.

Use a soft wire brush or a fine fibrous abrasive pad such as Scotch-Brite® 7448, or equivalent, to clean the flange seating area.

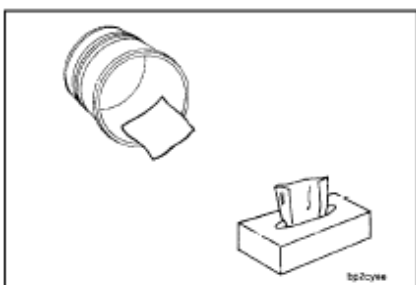


WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Use solvent or steam to clean the liners and dry with compressed air.

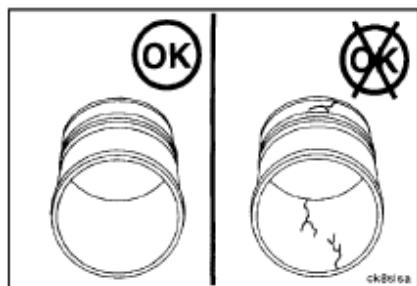
Use clean 15W-40 oil to lubricate the inside diameter of the liners.

Allow the oil to soak in the liner for 5 to 10 minutes.

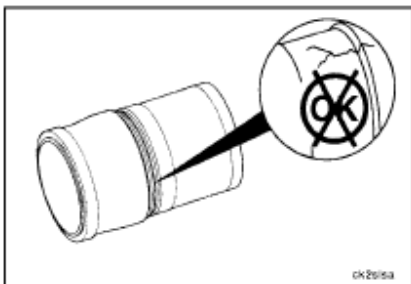


NOTE: Use "lint-free" paper towels to wipe the oil from the inside of the liners.

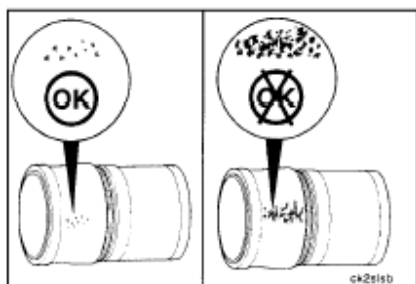
Continue to lubricate the inside of the liners and wipe clean until the paper towel shows no gray or black residue.



Inspect the liners for cracks on the inside and outside diameters.

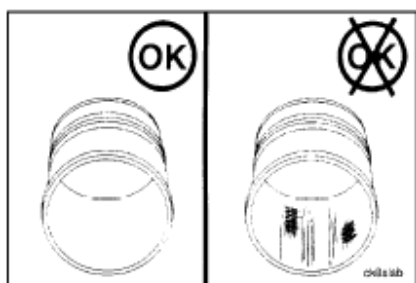


Inspect for cracks under the flange.



Visually inspect the outside diameter and seat area for excessive corrosion or pitting.

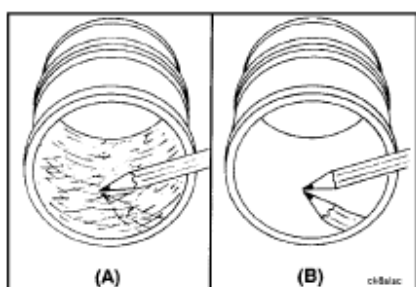
NOTE: Pits must not be more than 1.6 mm [0.06 in] deep. Replace the liner if the pits are too deep or if the corrosion can not be removed with fine emery cloth.



Inspect the inside diameters for vertical scratches deep enough to be felt with a fingernail.

NOTE: If a fingernail catches in the scratch, the liner must be replaced.

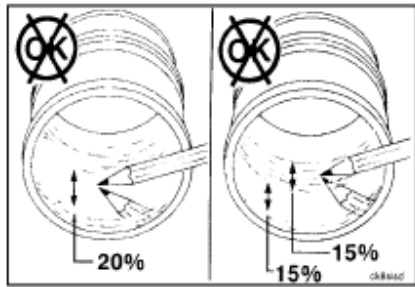
Visually inspect the inside diameter for scuffing or scoring.



Visually inspect the liner inside diameter for worn.

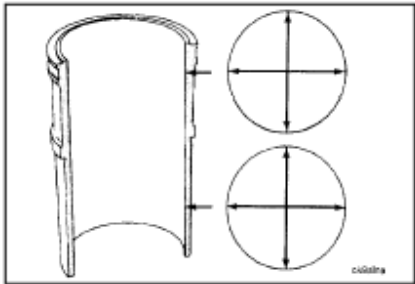
A moderate wear produces a bright mirror finish in the worn area with traces of the original hone marks or an indication of an etch pattern.

A heavy wear produces a bright mirror finish in the worn area with no traces of hone marks or an etch pattern.



Replace the liner if:

- A heavy wear is present over 20 percent of the piston ring travel area.
- Both moderate and heavy wear over 30 percent of the piston ring travel area and one half (15 percent) is heavy wear.

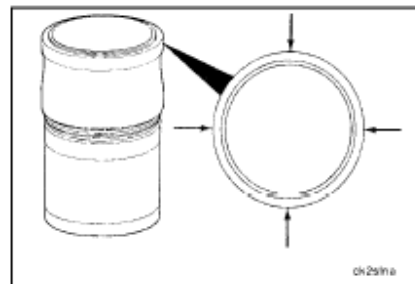


Part No. 3375072, Dial Bore Gauge

Measure the liner inside diameter in four places 90 degrees apart at the top and bottom of the piston travel area.

Cylinder Liner I. D

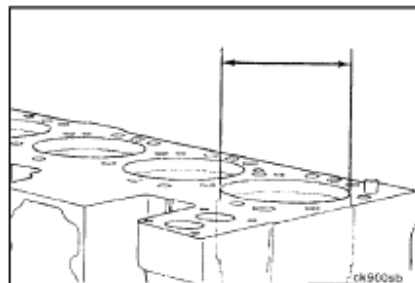
mm		In
114.000	min	4.4882
114.04	max	4.9897



Measure the outside diameter of the liner top press fit area.

Cylinder Liner O. D. (top press fit)

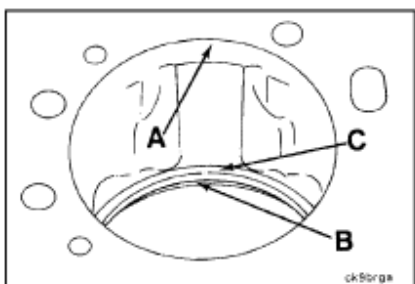
mm		In
130.938	min	5.1550
130.958	max	5.1558



Measure the cylinder liner bore in the block.

Cylinder Liner Bore in Block (press fit bore)

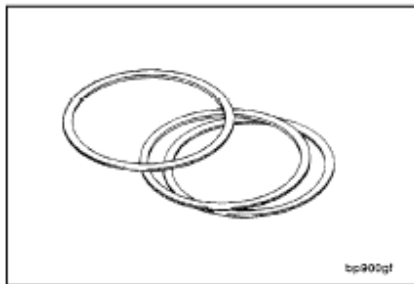
mm		In
130.900	min	5.1535
130.950	max	5.1570



Install

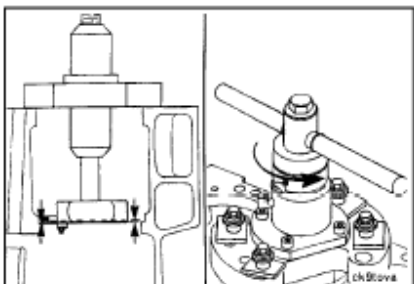
CAUTION: Clean all deposits and debris from sealing surfaces A, B, and C. Use Scotch - Brite® 7448. or equivalent, and cleaning solvent to polish the surfaces. Due to the critical machined tolerances, care should be taken not to remove any additional material.

If surface C has cracks or signs of extreme wear, the counter bore will require machining and the installation of shims for the correct liner protrusion.



Cylinder liner shims are available as follows:

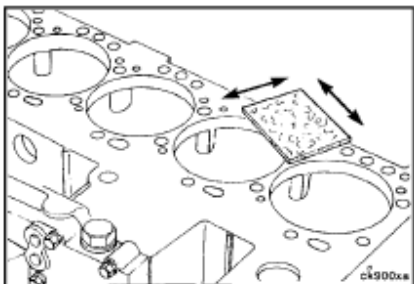
Cylinder Liner Shim Thickness		
mm	part number(s)	In
0.25	3924445	0.010
0.38	3924446	0.015
0.51	3924447	0.020
0.76	3924448	0.030
1.00	3924449	0.040



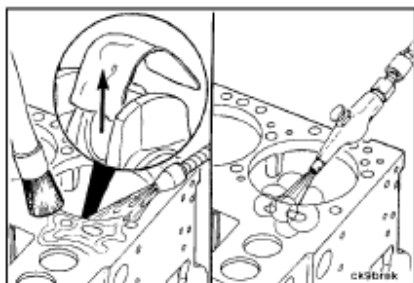
Counter bore Machining Tool, Part No. 3823558

Machine the counter bore to the proper depth.

NOTE: Part No. 3823567, cutter plate, and Part No. 3823570, cutter bit, must be used with the counter bore machining tool.



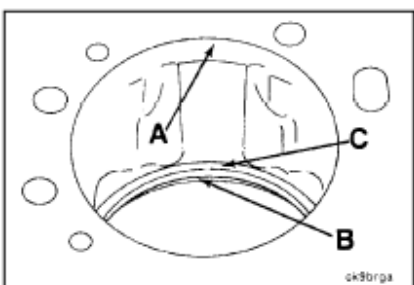
Clean the combustion deck with a gasket scraper or Scotch – Brite.. 7448, or equivalent, and diesel fuel or solvent.



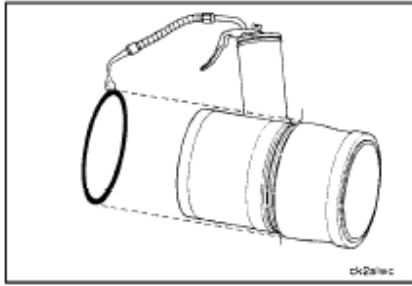
Thoroughly flush the block with mineral spirits or cleaning solvent.

Remove the shop rags and clean the crankshaft with a cleaning solvent.

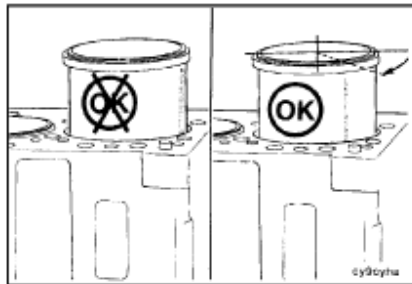
Blow the cylinder bores and crankshaft dry and wipe them clean with a lint-free cloth.



Lubricate surfaces A and B with clean 15W-40 engine oil.

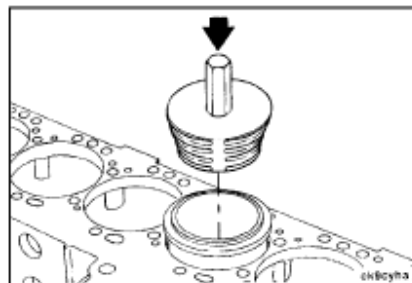


Use clean 15W-40 oil to coat the liner o-ring seals. Install new o-ring seals on the liners.



When reusing liners, install them in the same cylinder from which they were removed and rotate them 45 degrees (1/8 turn) from their original position. When correctly installed, any liner pitting should be positioned as illustrated so the pitted surface is rotated away from the location where pitting occurs.

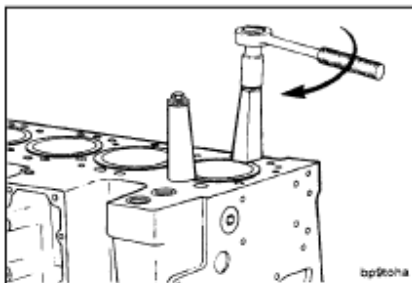
93



Cylinder Liner Driver, Leather Mallet, Part No. ST-1229

Install the liner into the bore of the cylinder block.

NOTE: If the liner does not rest on the cylinder block counter bore seat, remove the liner. Inspect the counter bore seat and liner for nicks, burrs, or dirt. Install the liner again.



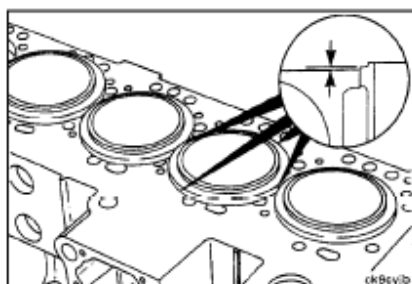
Liner Clamps, Part No. 3822503

Use two cylinder head cap screws and position the two liner clamps as illustrated.

Tighten the cap screws.

Torque Value: 68N•m [50 ft-lb]

Remove the clamps and repeat this procedure until all liners have been clamped and released.



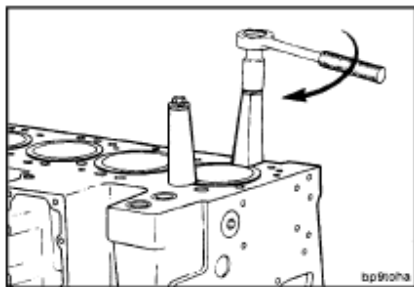
Liner Protrusion Gauge, Part No. 3823495

Liner protrusion is the distance the liner protrudes above the block face.

Measure the liner protrusion at four points 90 degrees apart.

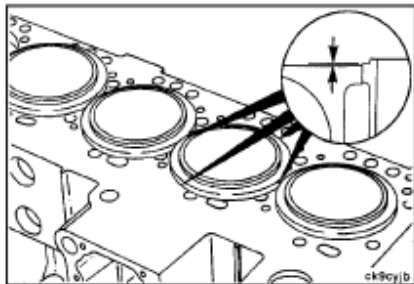
Cylinder Liner Protrusion

mm		In
0.025	min	0.001
0.122	max	0.0048

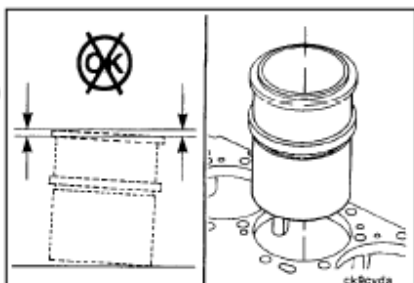


NOTE: If the liner protrusion varies more than 0.025 mm [0.0010 in] for 180 degrees:

- Install and tighten the liner clamps again.

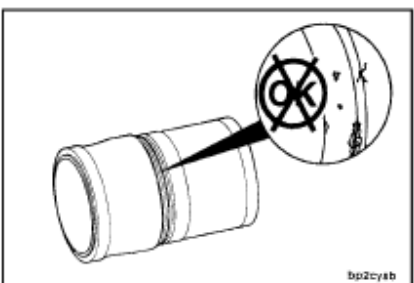


- Inspect the liner protrusion again.

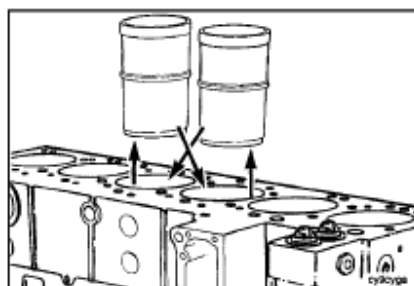


NOTE: If the protrusion still varies more than 0.025 mm [0.0010 in]:

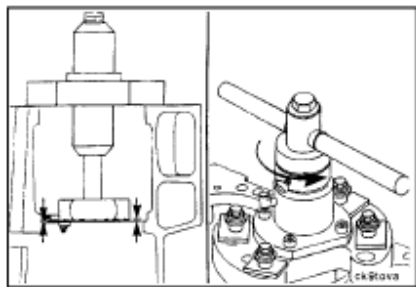
- Remove the liner.



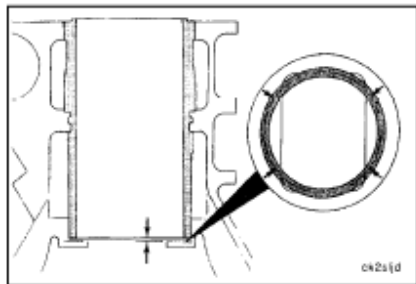
- Inspect the liner sealing edge for burrs, dirt, or damage.
- Replace the liner if it is damaged.
- Install the liner again.
- Inspect the liner protrusion.



Service Tip: If the out-of-limit condition is minimal, tolerance stack-up may allow the protrusion limits to be obtained by installing other new liners in the out-of-limit bore.



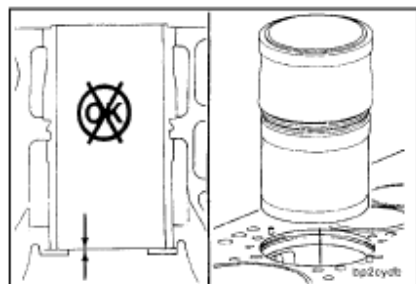
NOTE: If the liner protrusion still does not meet the specifications, machine the cylinder block liner bore for shims.



Use a feeler gauge to inspect the liner to block clearance at the four block casting points.

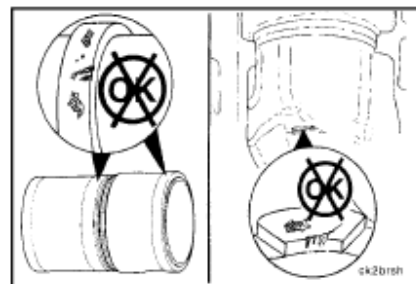
Cylinder Liner to Block Clearance

mm		In
0.229	min	0.009

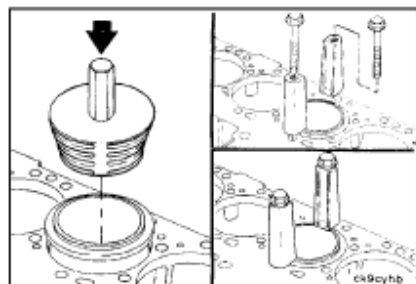


NOTE: If the clearance is less than 0.229 mm [0.009 in]:

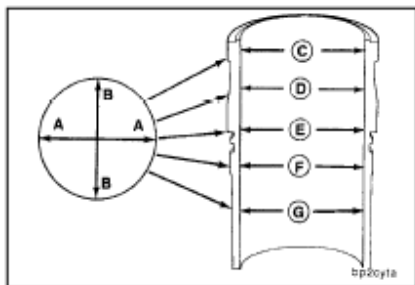
- Remove the liner.



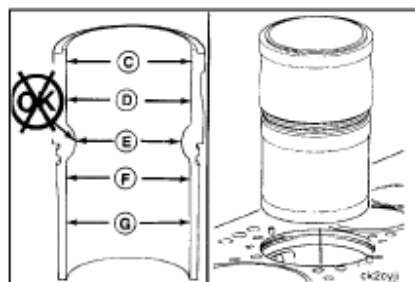
- Inspect the liner and cylinder block for dirt or damage.



- Replace the liner if it is damaged.
- Install the liner again.



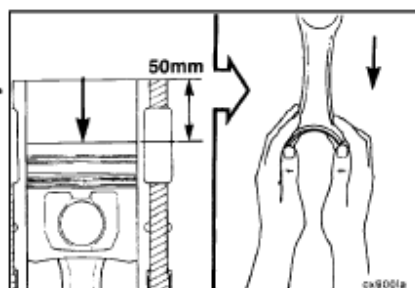
Measure the liner bore for out-of-roundness at points "C", "D", "E", and "G". Measure each point in the direction "AA" and "BB". The bore not be more than 0.08 mm [0.003 in] out - of-round.



NOTE: If the liner bore is more than 0.08 mm [0.003 in] out - of-round:

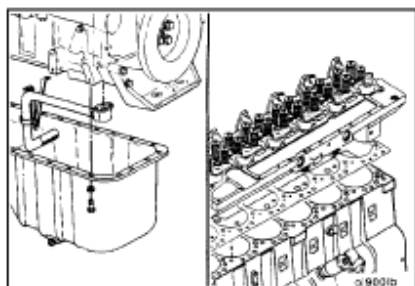


- Remove the liner so the cylinder block liner bore can be measured.

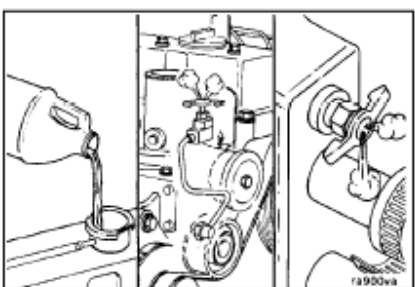


Install the pistons and connecting rods.

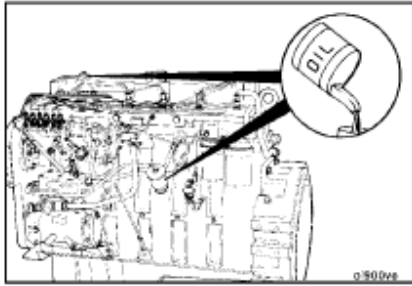
NOTE: Do not interchange pistons from the original cylinder location.



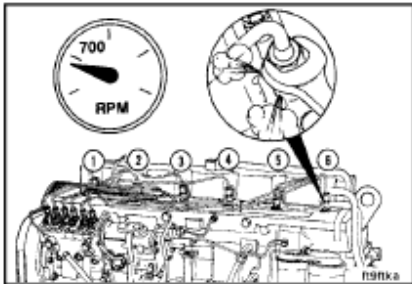
Install the lubricating pan and suction tube.
Install the cylinder head.



Fill and vent the cooling system.



Fill the lubricating system with oil.



19 mm

Start the engine and operate at idle.

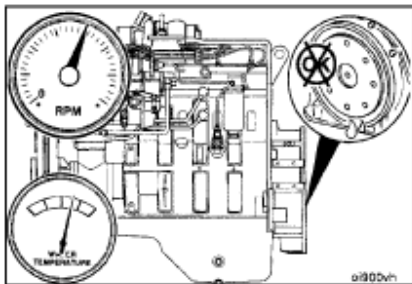
Bleed the high pressure fuel lines.

Loosen the high pressure fuel line to allow entrapped air to escape.

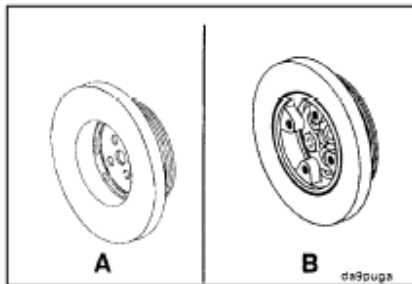


Tighten fuel lines.

Torque Value: 24N•m [18 ft-lb]



Operate the engine until the coolant temperature reaches 82°C [180°F] and check for leaks and proper operation.

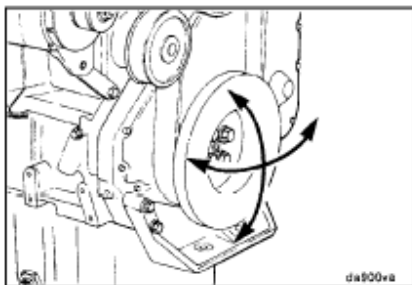


Vibration Damper – Replacement

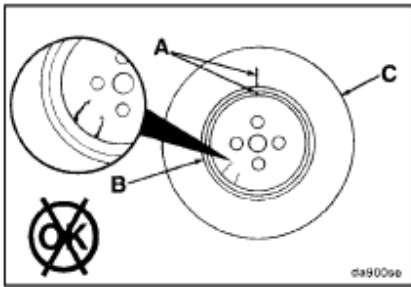
General Information

NOTE: There are two different design vibration dampers used:

- Viscous damper (A) for certain engines rated at speeds above 2500 RPM.
- Rubber element damper (B) for engine rated at speeds below 2500 RPM. The rubber damper is available either with or without the crankshaft adapter.



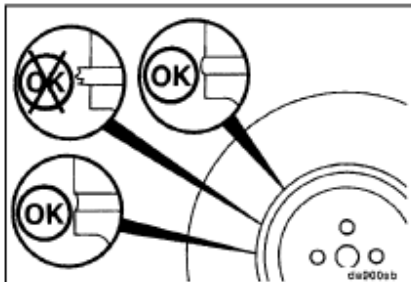
When diagnosing a vibration problem, check the damper for obvious wobble when it is rotating.



Rubber Vibration Damper – Check (on the chassis)

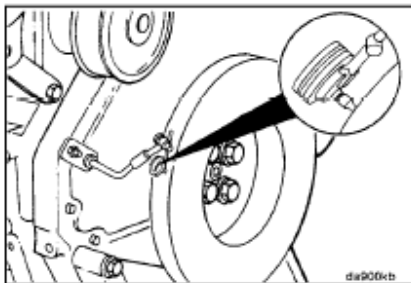
Check the index lines (A) on the damper hub (B) and the inertia member (C). If the lines are more than 1.59 mm [1/16 inch] out of alignment, replace the damper.

Inspect the vibration damper hub (B) for cracks. Replace the damper if the hub is cracked.

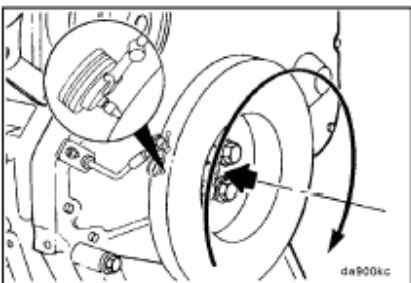


Inspect the rubber member for deterioration. If pieces of rubber are missing or if the elastic member is more than 3.18 mm [1/8 inch] below the metal surface, replace the damper.

NOTE: Also look for forward movement of the damper ring on the hub. Replace the damper if any movement is detected.



Measure the vibration damper eccentricity by installing the dial indicator on the gear cover as indicated.

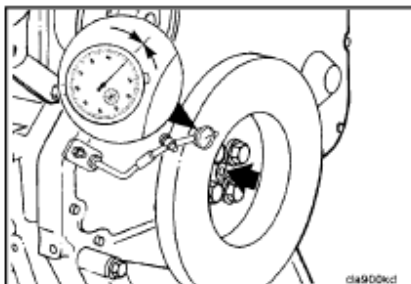


Part No. 3377371, Engine Barring Gear

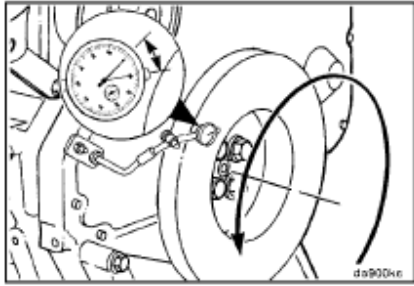
Rotate the crankshaft and record the indicator movement.



Replace the vibration damper if the eccentricity exceeds 0.10 mm [0.004 inch] per 25.4 mm [1.0 inch] of damper diameter. Refer to replacement procedure in this section.



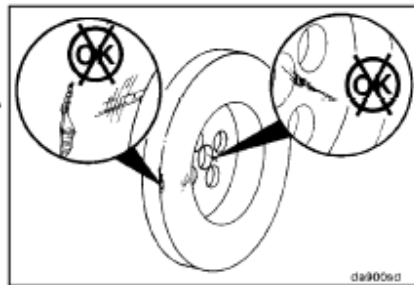
Install the dial indicator, as indicated, to measure wobble. Push the crankshaft to the front or to the rear and zero the indicator.



Rotate the crankshaft 360 degrees, maintaining the position of the crankshaft (either toward the front or the rear) in relation to the cylinder block.

Record the total indicator motion.

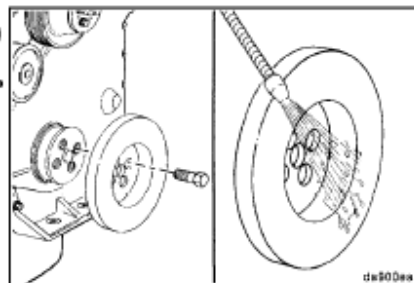
Replace the damper if wobble exceeds 0.18 mm [0.007 inch] per 25.4 mm [1.0 inch] of radius. Refer to replacement procedure in this section.



Viscous Vibration Damper – Check

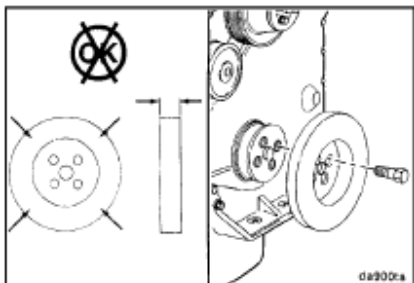
Check the mounting web for cracks. Check the housing for dents or raised surfaces. Replace the damper if any of these defects are identified. Refer to replacement procedure in this section.

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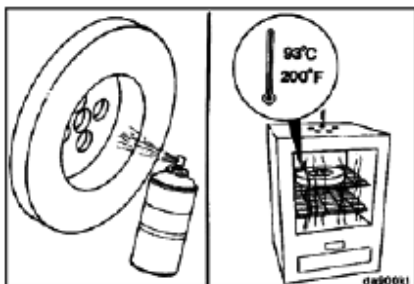
Remove the viscous vibration damper. Refer to replacement procedure in this section.

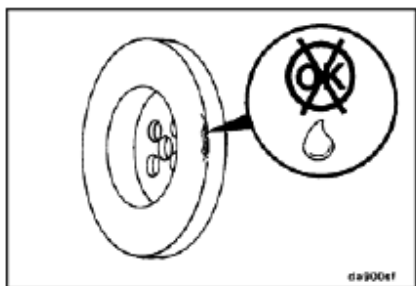
Clean the damper with a solvent cleaner.



The viscous damper is filled with a silicone fluid. After many hours of use, the silicone fluid may become thicker and expand. To determine if the damper thickness is correct, remove the paint from the damper in four locations on either side of the damper. Measure and record the thickness of the damper in four places. Measure the thickness 3.175 mm [0.125 inch] from the outside of the damper. Replace the damper if its thickness varies by more than 0.25 mm [0.010 inch].

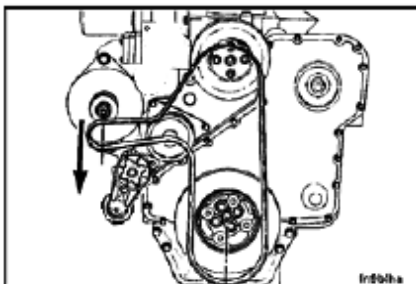
Spray the damper with spot check developer, Type SKD-NF or its equivalent. Heat the damper in an oven (rolled lip side down) at 93°C [200°F] for 2 hours.





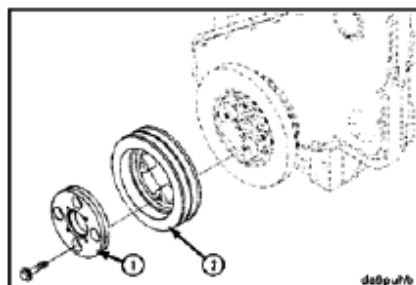
CAUTION: Wear protective gloves to prevent personal injury when handling parts that have been heated.

Remove the damper from the oven and check for fluid leakage. If there is leakage, replace the damper. Refer to replacement procedure in this section.



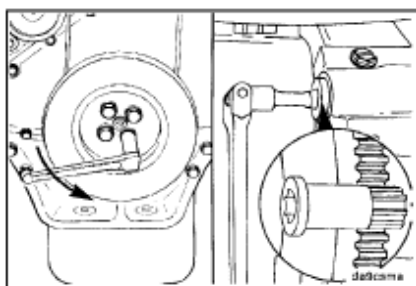
Remove

3/8 or 1/2 Inch Square Drive
Remove the fan drive belt.



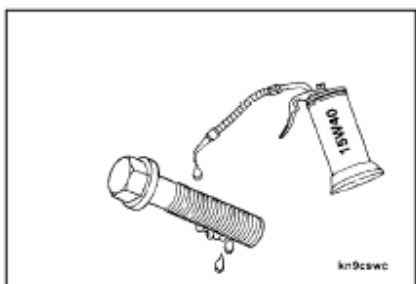
15 mm

Remove the crankshaft adapter (1) and pulley (2), if equipped.



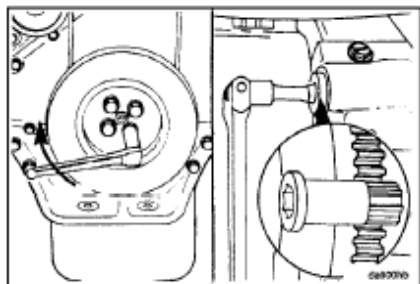
18 mm, Part No. 3377371, Engine Barring Gear

Remove the vibration damper. Use the barring gear to hold the crankshaft while removing the capscrews.



Install

Lubricate the threads of the capscrews with a film of SAE 15w-40 engine oil.



18 mm, Part No. 3377371, Engine Barring Tool

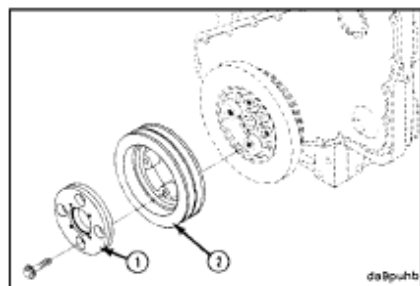
Install the vibration damper.



Use the barring gear to hold the crankshaft when tightening the capscrews.



Torque Value: 200N•m [148 ft-lb]

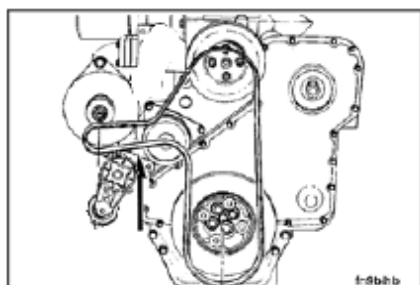


15 mm

Install the crankshaft adapter (1) and pulley (2), if equipped.

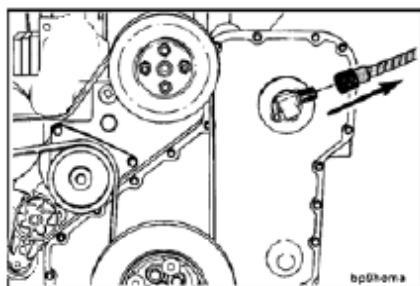


Torque Value: 77N•m [57 ft-lb]



3/8 or 1/2 inch Square Drive

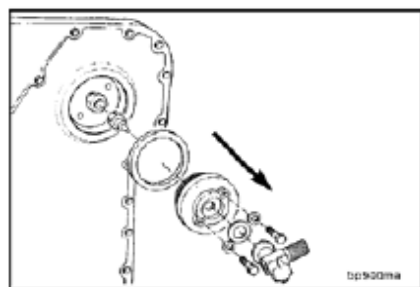
Install the fan drive belt and driven accessories.



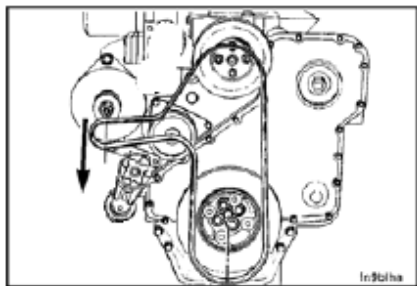
Gear Cover – Replacement

Remove

Install the tachometer drive cable.

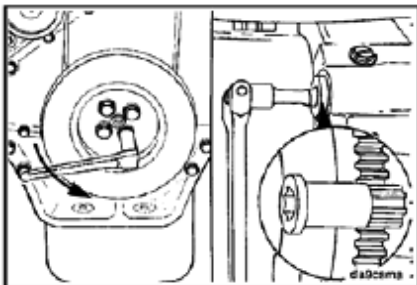


Remove the tachometer drive.



3/8 or 1/2 inch Square Drive

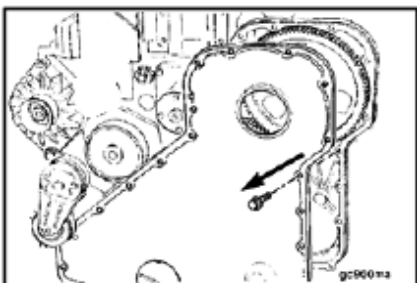
Remove the fan drive belt.



18 mm, Part No. 3377371, Engine Barring Gear

Remove the vibration damper and pulley. Hold the crankshaft while removing the capscrews.

Remove the crankshaft oil seal dust shield, if used.



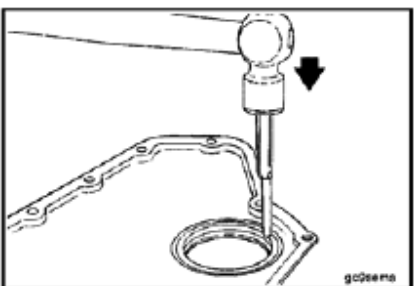
10 mm

Remove the gear cover.



Clean and Inspect

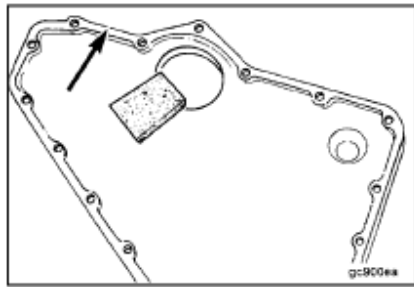
Clean the gasket sealing surface.



Hammer, Punch

Drive or press the seal out of the front cover.

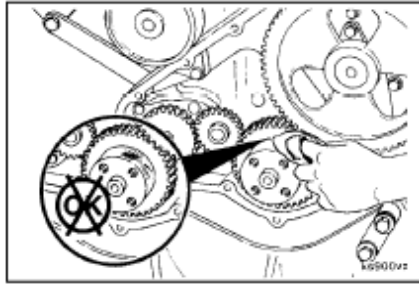




Clean the gasket sealing surfaces and the surface between the oil seal and gear cover.



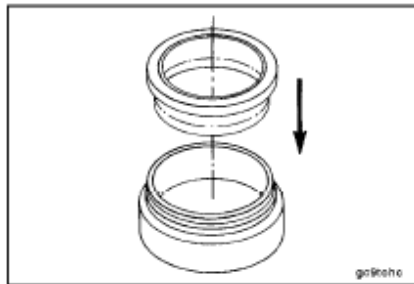
Inspect the gear cover for cracks, dents and other damage.



CAUTION: The seal lip and the sealing surface on the crankshaft must be clean and free from all oil residues to prevent seal leaks.



Thoroughly clean the seal contact area of the crankshaft. Visually inspect the sealing surface of the crankshaft for wear. If the crankshaft has a groove worn due to the oil seal, a wear sleeve must be used to prevent seal leakage.

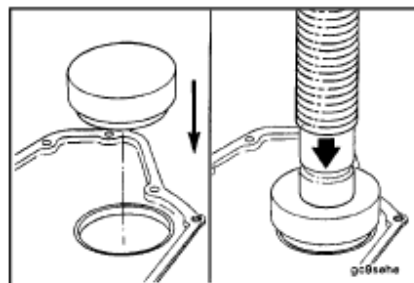


Install

Part No. 3824499 Installation Tool

Leave the plastic pilot installation tool in the lubricating oil seal.

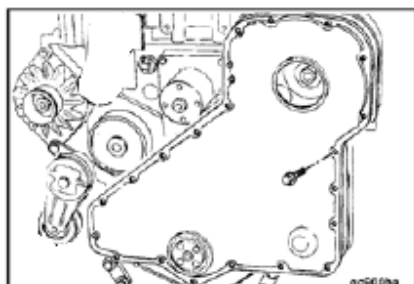
Position the seal on the service tool, Part No. 3824499, with the lubricating oil seal dust lip facing outward.



NOTE: Properly support the gear cover lubricating oil seal flange to prevent damage to the lubricating oil seal and gear cover.

Press the lubricating oil seal into the front cover from the back side of the cover toward the front side of the cover.

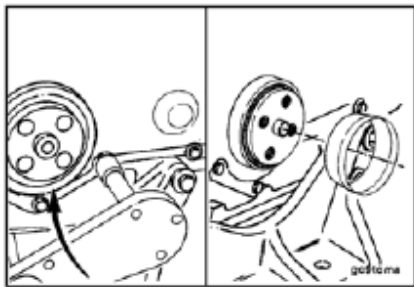
Press the lubricating oil seal until the service tool bottoms against the front cover.



Apply a thin (2 mm) bead of sealant, Part No. 3823494, to both sides of the gear cover gasket.

NOTE: Do not remove the plastic seal pilot tool from the lubricating oil seal at this time. Use the plastic seal pilot tool to guide the seal on the crankshaft.

Install the gasket and gear cover on the engine.



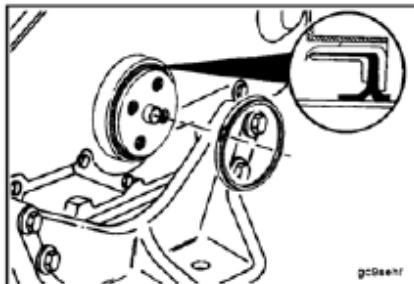
Tighten the gear cover capscrews.



NOTE: The capscrews must be torqued with 15 minutes after applying the sealant to the gasket.

Torque Value: 24N•m [18 ft-lb]

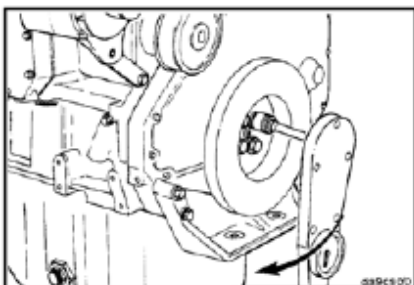
Remove the plastic seal pilot tool from the crankshaft.



Install the crankshaft oil seal dust shield, if used, as follows:

- Push the dust shield onto the crankshaft with the part number facing out away from the engine.
- The dust shield must contact the oil seal.

NOTE: No lubrication is required for installation.



18 mm, Part No. 3377371, Engine Barring Gear



Install the vibration damper and pulley.

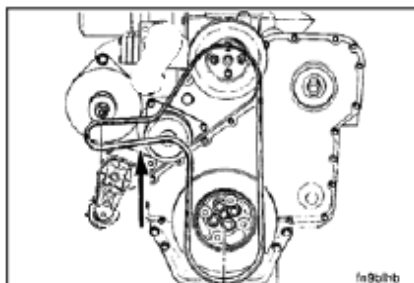


Use the barring gear to hold the crankshaft while tightening the capscrew.

Torque Value:

Vibration Damper: 200N•m [48 ft-lb]

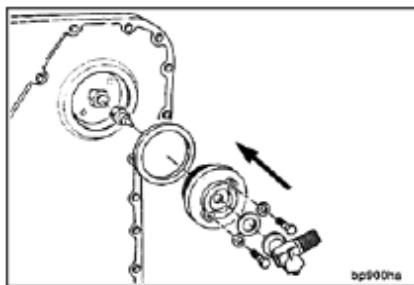
Pulley to Vibration Damper: 77 N•m [7 ft-lb]



3/8 or 1/2 inch Square Drive

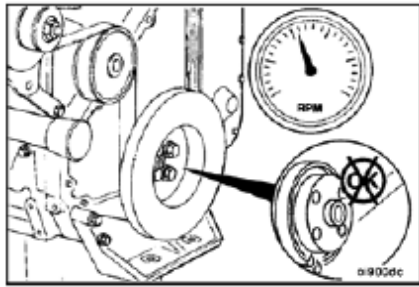


Install the fan drive belt.

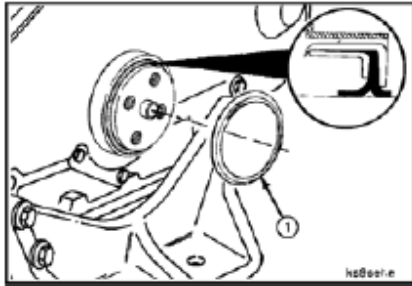


Install the tachometer drive and cable.

Install the drive accessories in the reverse order of removal.



Operate the engine 5 to 10 minutes to check for leaks and proper operation.



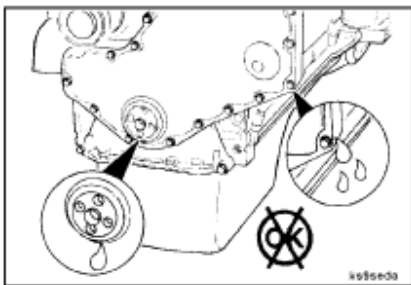
Front Crankshaft Seal – Replace

93

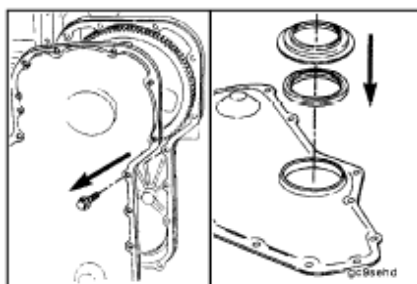
General Information

The front crankshaft seal is mounted in the front gear cover. A double lipped Teflon seal is used. The sealing surface on the crankshaft must be clean and dry during assembly.

NOTE: For engines operating in extremely dusty environments, a dust shield (1) is used to keep debris from entering the seal and causing premature wear to the oil seal and crankshaft.

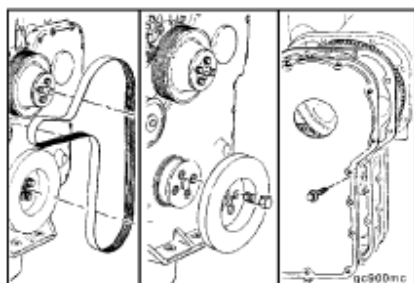


Before removing the gear cover or oil seal, clean the front area of the engine and visually inspect for leaks from the gear cover gasket and seal area. If the seal is leaking, it will be necessary to remove the gear cover for seal replacement.



Remove and Install

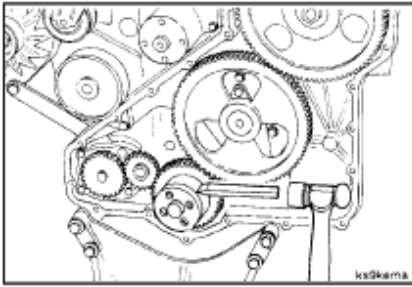
NOTE: Since the gear cover has to be removed to Replace the crankshaft seal, refer to the instructions in “Replacement of the gear cover”.



Crankshaft Wear Sleeve, Front – Replace

Remove

Remove the fan drive belt, vibration damper, gear cover and seal.

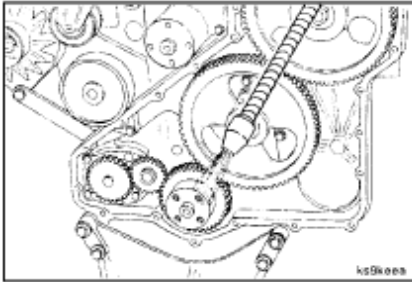


Hammer and Chisel

CAUTION: Do not nick or gouge the crankshaft with the chisel. If the crankshaft is damaged, it must be replaced.

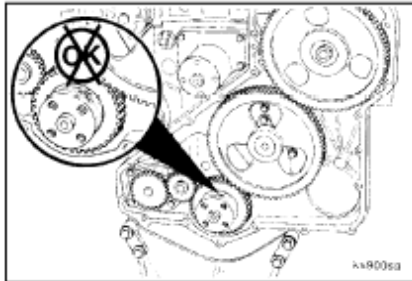


Use a hammer and a chisel that is only as wide as the wear sleeve. Make one or two chisel marks across the wear sleeve. This will expand the wear sleeve allowing the sleeve to be removed.

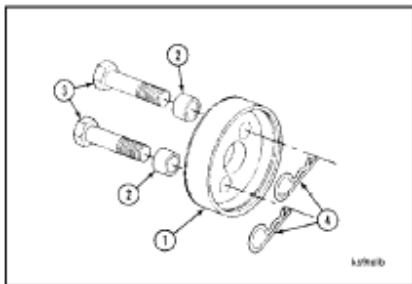


Clean and Inspect

Clean the crankshaft area.



Inspect the crankshaft at the oil seal area for dirt, nicks, chisel marks, scratches, rust or corrosion, or other damage that would prevent a proper wear sleeve installation.



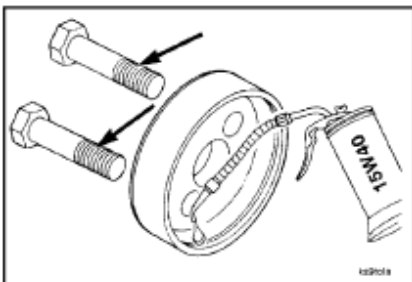
Install

Part No. 3823908, Crankshaft Front Wear Sleeve Installation Tool

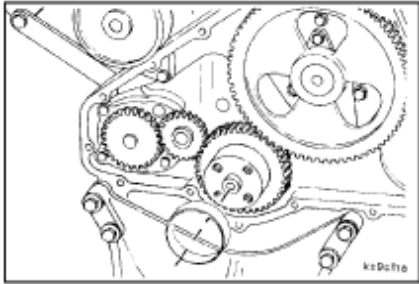
Use the driver to install the wear sleeve to the correct position on the crankshaft. The kit consists of the following:

Refer

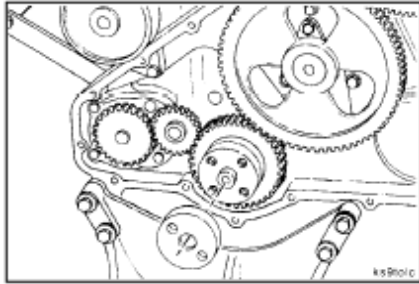
Ref. No.	Instructions	Quantity
1	driver	1
2	washer	2
3	capscrew M14×1.5×60 mm	2
4	hair pin cotter	2



Apply a thin coat of clean 15W-40 lubricating oil to the inside diameter and capscrew threads.

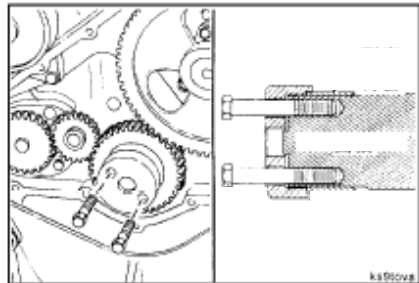


Position the chamfered end of the wear sleeve onto the end of the crankshaft.

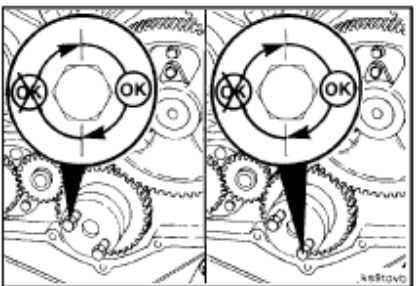


Position the counterbore end of the driver onto the wear sleeve.

93



Install two capscrews (without spacers or hair pin cotters) through the driver and into the crankshaft capscrew holes. Align the wear sleeve and driver perpendicular with the crankshaft. Tighten the capscrews "finger tight".

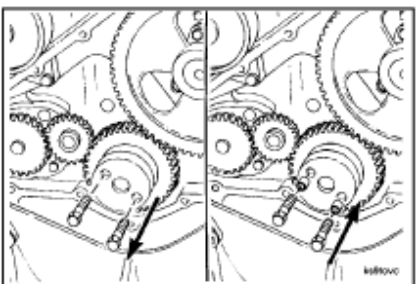


Alternately tighten the capscrews until the sleeve is installed to a depth of approximately 16 mm [0.625 in].



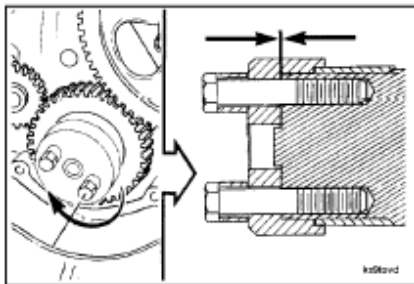
NOTE: To prevent damage to the wear sleeve, do not exceed 1/2 revolution of each capscrew.

Approximate Torque Value: 20 N • m [15 ft-lb]

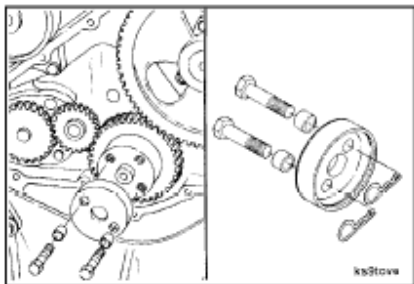


Remove the capscrews and install the spacer on each capscrew. Install the two capscrews again.

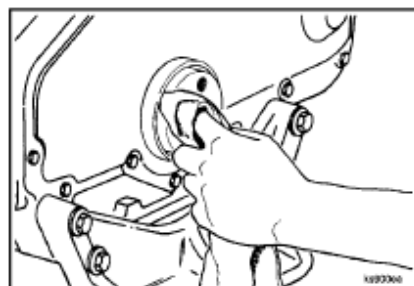




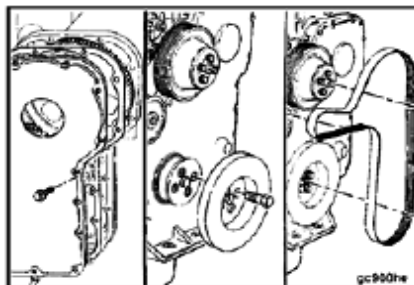
Continue to alternately tighten the capscrews until the bottom of the driver contacts the end of the crankshaft.



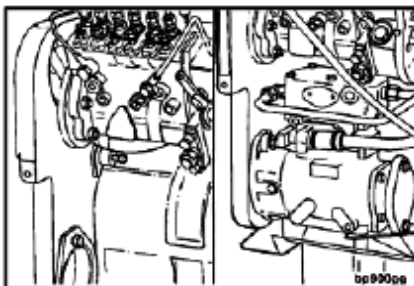
Remove the driver. Use the hair pin cotters to secure the capscrews and spacers to the tool during storage.



Clean the wear sleeve crankshaft of any excess lubricate.
NOTE: The wear sleeve and oil seal mating surface must be clean and dry to be sure of proper oil sealing.



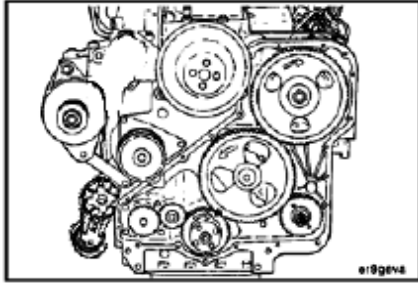
Install the gear cover, vibration damper and fan drive belt.



Gear Housing – Replace

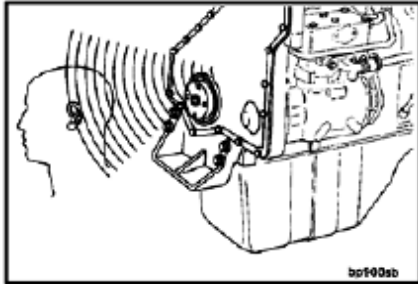
General Information

The gear housing provides a support for the injection pump, timing pin, and the accessory drive gear, if used.



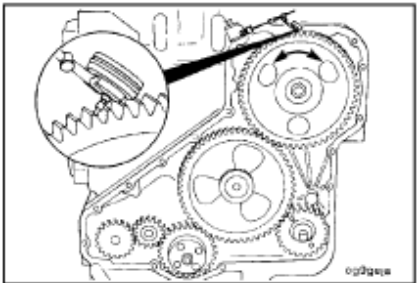
Gear Train

The gear train consists of the crankshaft gear, lubricating oil pump drive and idler gear, camshaft gear, fuel pump drive gear and accessory drive gear, if used.



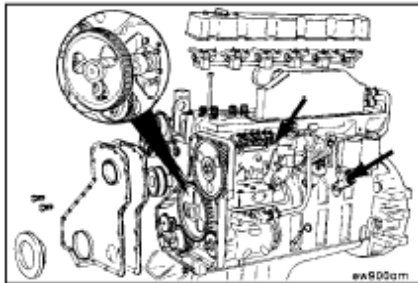
Noise emitted from the gear housing can indicate worn or damage gear teeth or excessive gear back lash.

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Excessive gear backlash can affect engine timing and engine performance.

Refer to the applicable sections in this manual to measure the gear backlash and check gear tooth wear.



Remove

Remove the valve cover.

Remove the rocker assemblies and push rods.

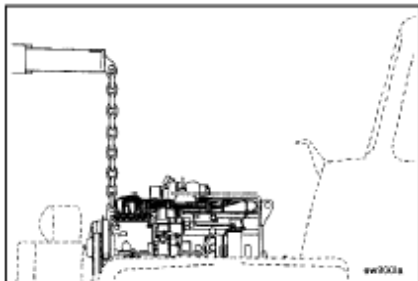
Remove the fan drive belt, vibration damper and gear cover.

Remove the fuel transfer pump.

Remove the fuel injection pump.

Remove the camshaft and follower.

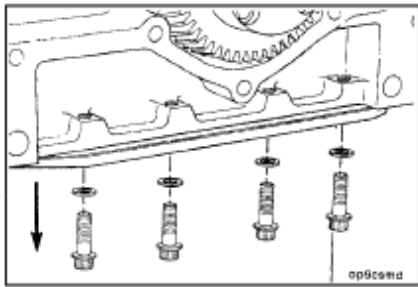
Remove the accessory drive or air compressor, if equipped.



15 mm

Support the front of the engine and remove the front engine mount.





10 mm

Loosen all the oil pan mounting capscrews four to five turns.

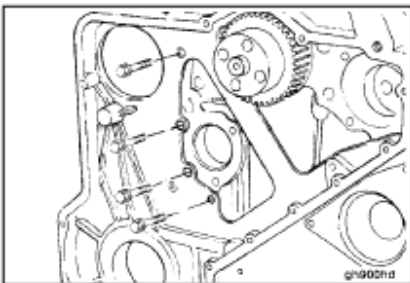


Remove the four front oil pan capscrews which secure the oil pan to the gear housing.



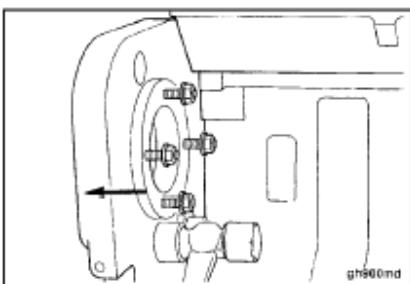
CAUTION: Use extreme care when releasing the oil pan gasket from the gear housing to prevent damage to the gasket. If the gasket is damaged, it may be necessary to remove the oil pan and replace the gasket.

Insert a feeler gauge or a wedge shim stock between the gear housing and the oil pan gasket. Move the feeler gauge or shim stock back and forth to release the gasket from the gear housing.



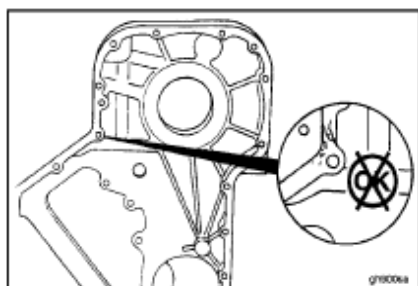
10 mm

Remove the gear housing capscrews.



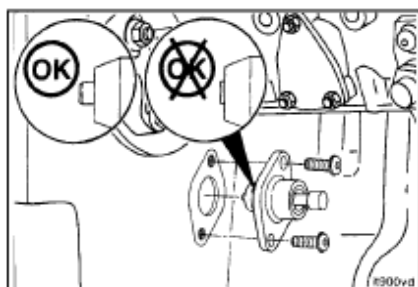
Plastic Hammer

Remove the gear housing.



Clean and Inspect

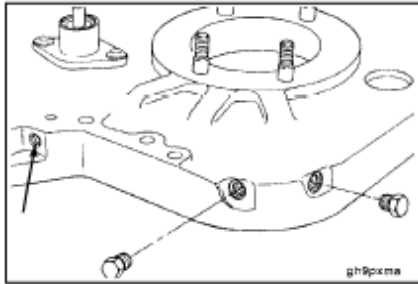
Visually inspect the gear housing for cracks or damaged sealing surfaces.



Inspect the timing pin housing and pin for damage.

NOTE: Do not remove the timing pin assembly unless it is damaged or leaking, or the gear housing is being replaced.

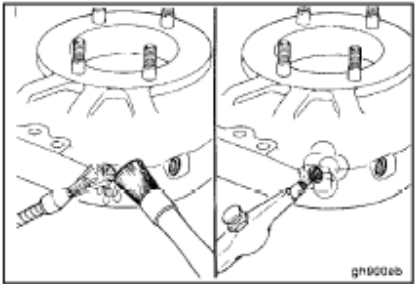




7/16 inch



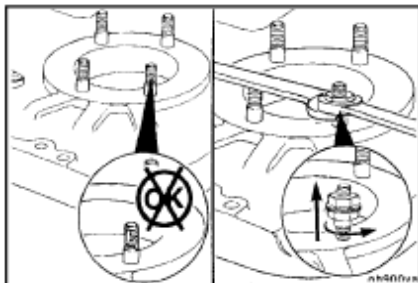
NOTE: if the gear housing is being used again.
Remove the pipe plugs from the oil drillings.



Nylon Brush



Use solvent and nylon bristle brush to clean the oil drillings. Dry with compressed air.



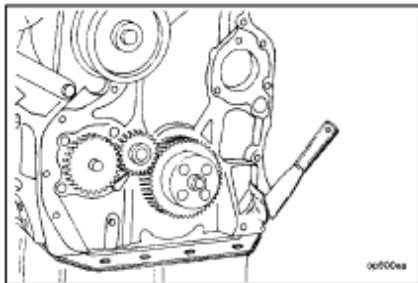
15 mm



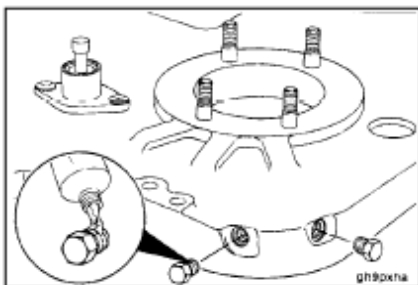
Visually inspect the fuel pump mounting studs for damage.



To install or remove the fuel pump studs, use two nuts locked together on the stud.



Clean the gasket surface of the cylinder block.



Install



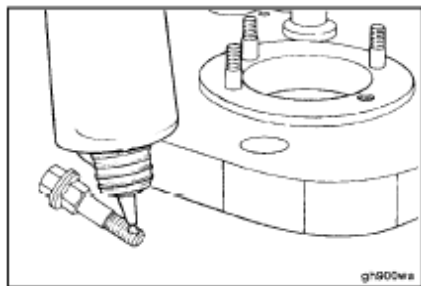
7/16 inch

Coat the pipe plugs with pipe sealant and install.



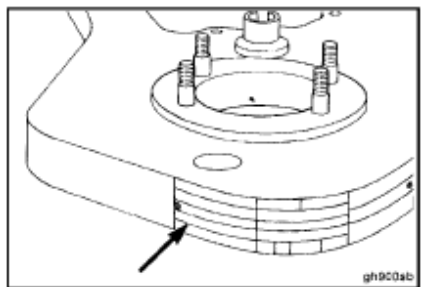
Torque Value: 7N•m[60 in-lb]

Do not over tighten.



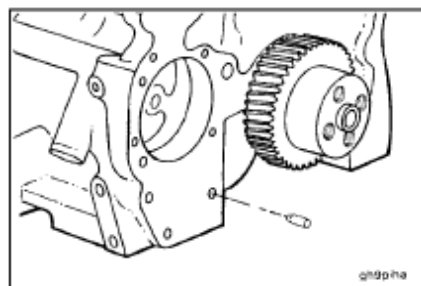
15 mm

If the fuel pump studs are damaged or being installed in a new housing, coat the threads with Loctite™ 242 and use two nuts locked together to remove and install.

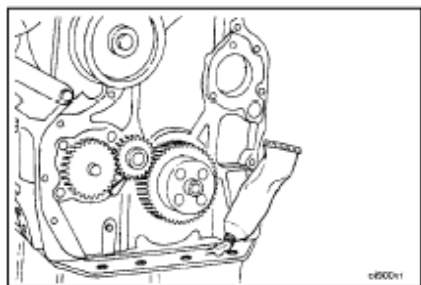


Small Chisel and Hammer

If the gear housing is being replaced, remove the engine data plate and install on the new housing.

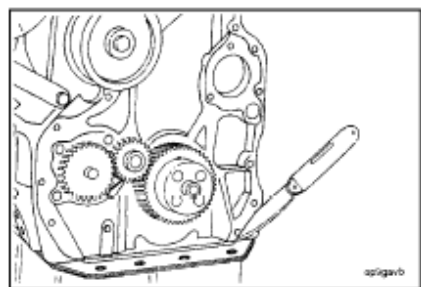


If removed, install the two gear housing dowel pins. The tapered end of the dowel fits into the cylinder block; drive the pin to the bottom of the hole.

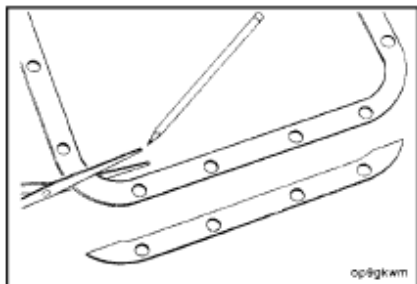


Inspect the oil pan gasket. If it is not torn, apply Part No. 3823494, Three Bond RTV sealant around the capscrew holes and at the joint of the gear housing.

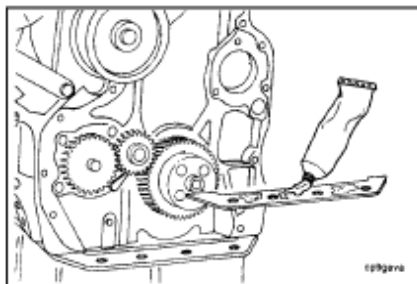
NOTE: The gear housing and lubricating oil pan capscrews must be torqued within 15 minutes after applying the sealant.



If the gasket is torn, it may be repaired. Cut the torn gasket off even with the front of the engine block.



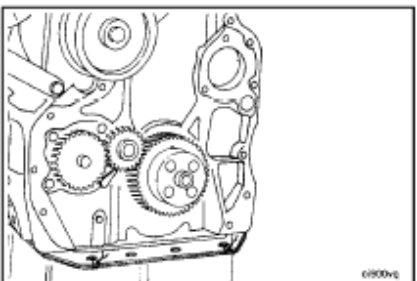
Use the old gasket as a pattern and cut the front section of a new gasket to the same size.



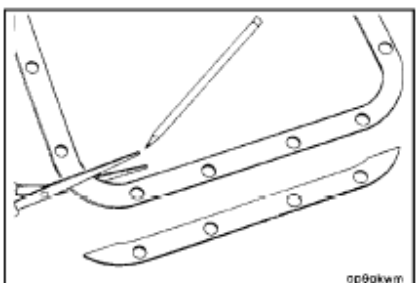
Clean the sealing surfaces and coat the new gasket on both sides with Part No. 3823494. Three Bond RTV sealant.

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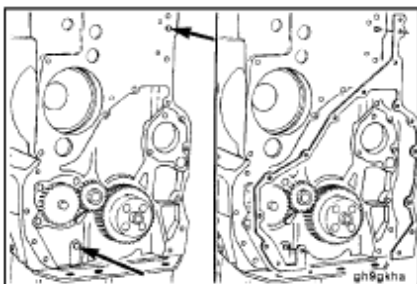
NOTE: The gear housing and lubricating oil pan cap screws must be torqued within 15 minutes after applying the sealant.



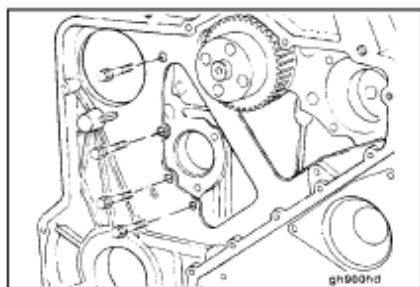
Use common thread or a very fine wire to hold the new gasket splice in position as illustrated.



Mark and trim the new gear housing gasket, as illustrated. 1.59 mm [1/16 inch]



Position the gasket on the alignment dowels.



10 mm

Carefully install the gear housing and capscrews. Make sure both gaskets are in place.



Torque Value:



M8 capscrews 24N•m[18 ft-lb]

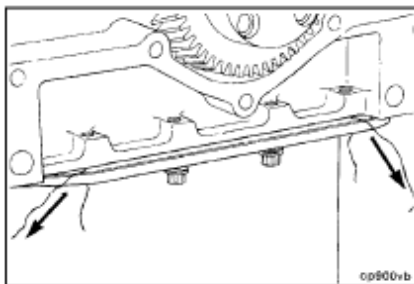
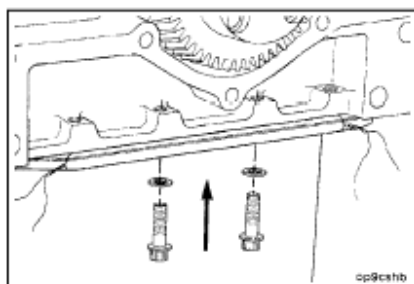


M12 capscrews 60N•m[44 ft-lb]

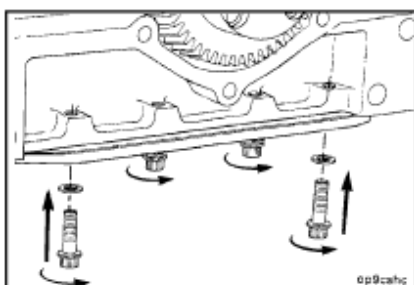
CAUTION: If a new housing or other than the original housing is installed, the timing pin assembly must be accurately located.



Start two oil pan capscrews in the holes not being used to tie the gasket in place.



Remove the thread or wire holding the gasket in place.

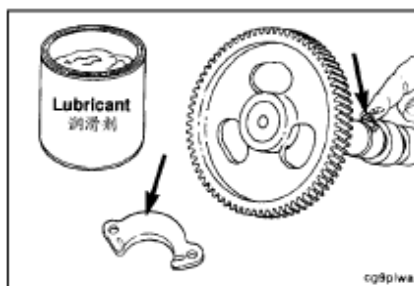


10 mm

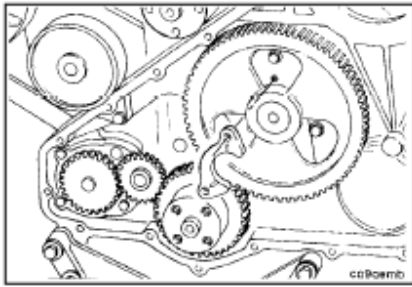
Install the remaining two capscrews and tighten all oil pan mounting capscrews.



Torque Value: 24N•m[18 ft-lb]

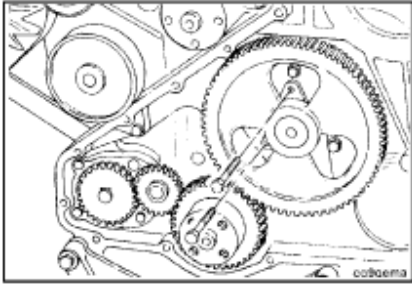


Lubricate the camshaft and thrust plate with Lubricate™ 105.



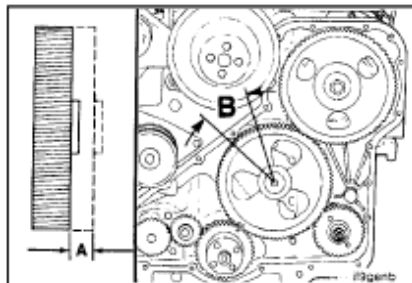
Install the camshaft / thrust plate.

Make sure the timing marks on the camshaft and crankshaft gears are aligned.



Install the thrust plate capscrews.

Torque Value: 24N•m[18 ft-lb]



Verify the camshaft has proper backlash and end play. End play is controlled by the thickness of the thrust plate and the groove in the camshaft.

Camshaft End Clearance (A)

mm

0.1 min

0.36 max

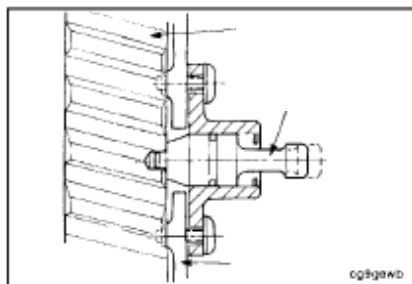
Camshaft Gear Backlash Limits (B)

mm

In

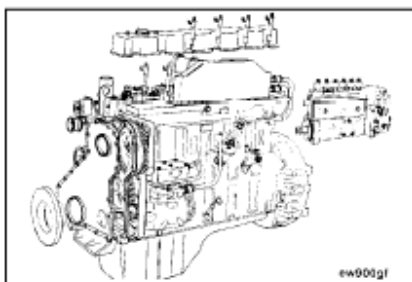
0.08 min 0.003

0.33 max 0.013



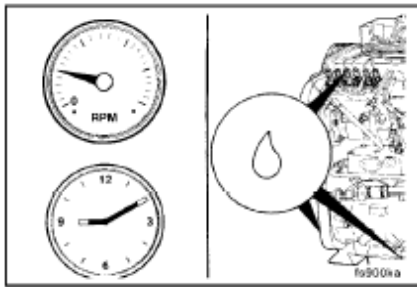
Timing Pin Relocating

NOTE: The location of the timing pin assembly on the gear housing is critical for correct engine adjustments. If the original gear housing is being installed, it is unnecessary to relocate the timing pin. If a new housing is being installed, refer to instructions for timing pin installation and adjustment.

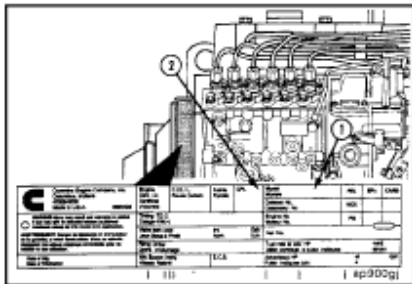


Complete the installation of the removed components:

- Accessory drive or air compressor.
- Fuel injection pump.
- Lift pump.
- Valve tappets.
- Fan drive belt, vibration damper and gear cover.
- Rocker assemblies and push rods.
- Valve cover.



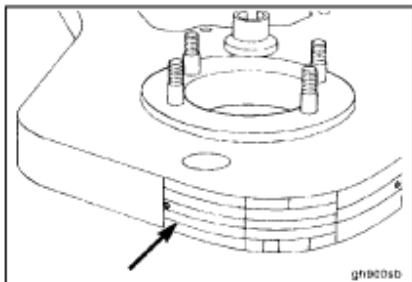
Operate the engine at idle for 5 to 10 minutes to check for leaks and proper operation.



Engine Daplate – Replace

The engine dataplate shows specific information about the engine. The engine serial number (1) and Control Parts List (CPL) (2) provide information for ordering parts and service needs.

The dataplate must remain with the engine. If the gear housing is replaced, remove the dataplate and install it on the new housing.

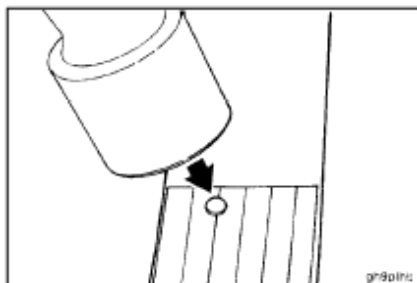


Remove

Small Chisel and Hammer

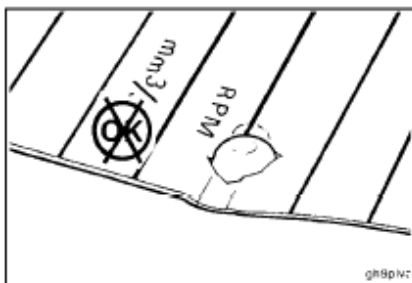


Remove the rivets that secure the dataplate to the gear housing.

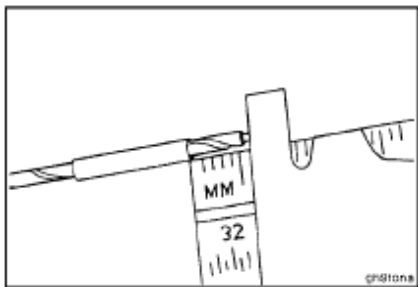


Install

Drive the rivets in until they contact the dataplate.

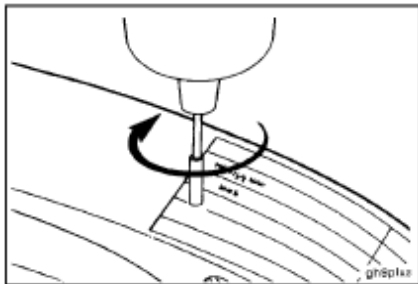


CAUTION: If the rivets are driven in too far, they will cut through the dataplate.



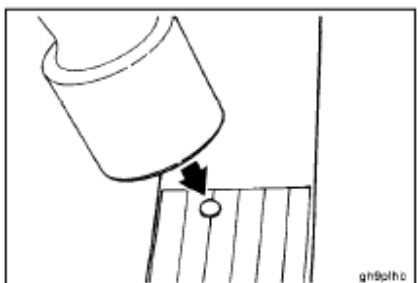
2.0 mm Drill Bit

If the dataplate is loose or has been damaged, drill new holes and attach with new rivets. Mark the drill bit at 6.0 mm [0.236 inch] to avoid drilling too deep into the gear housing.

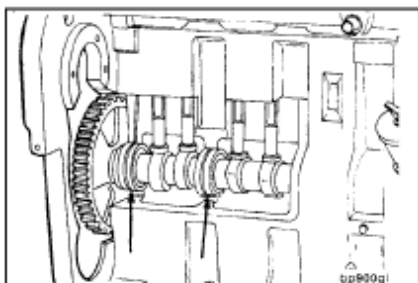


Drill the dataplate, taking care not to destroy any information printed on the dataplate.

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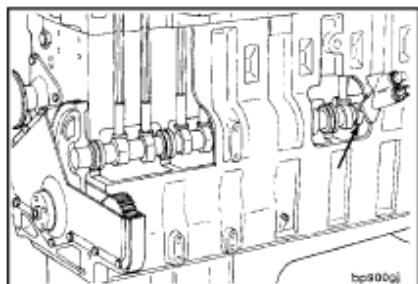
Drive the rivets in until they contact the dataplate.



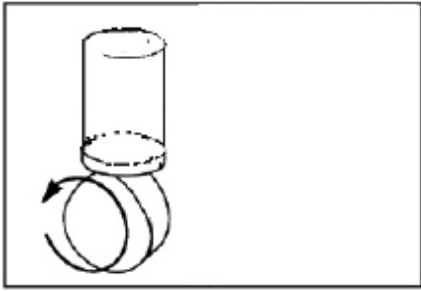
Camshaft – Replace

General Information

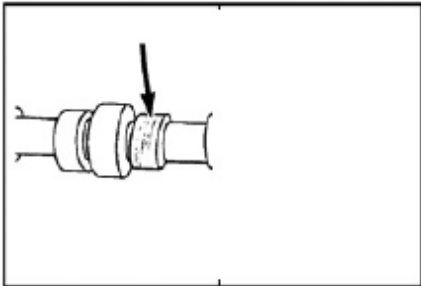
The camshaft is gear driven from the crankshaft. A replaceable bushing is used for each of the camshaft journals.



The camshaft has lobes to operate the intake and exhaust valves and a special lobe to drive the fuel transfer pump. The valve lobes contact the valve tappets which operate the valves. The plunger of the fuel transfer pump rides directly against the special lobe of the camshaft. The profile of the cam lobes is the same for all L Series engines.

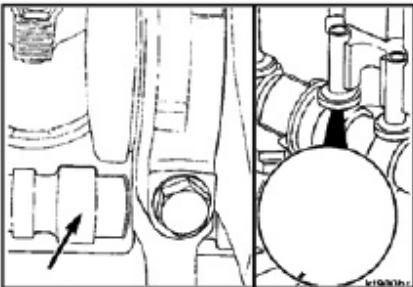


The followers reduces the friction generated from the rolling bearing and lobe.



Diagnosing Malfunctions

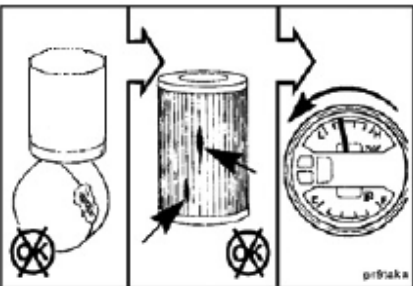
Loose rocker levers and the need to reset the Valve clearance frequently can indicate camshaft lobe or tappet wear. If an inspection of the levers, valve stems and push rods does not show wear, then tappet and/or camshaft lobe wear can be suspected.



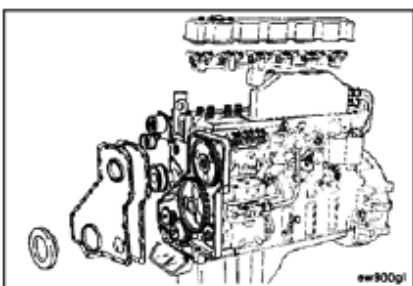
CAUTION: Anytime a new camshaft is installed, new tappets must also be installed.



The camshaft lobes can be visually inspected after removing the oil pan. Similarly, the face of the tappet can be inspected after removing the push rods and lifting the tappet.



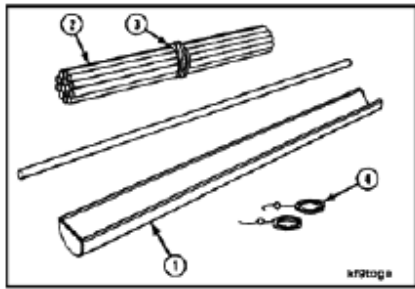
A severely damaged camshaft journal can generate small metal particles which will be found in the oil pan and filter and will be indicated as "iron" in an oil analysis. As the clearance in the journal increases, a small decrease in oil pressure may be detected.



Remove

Remove the following components:

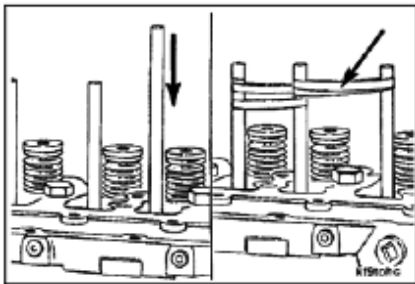
- Valve cover
- Rocker lever assemblies.
- Push rods.
- Vibration damper.
- Gear cover.
- Fuel pump drive gear.
- Lift pump.

**Part No. 3822513, Tappet Removal Tool Kit**

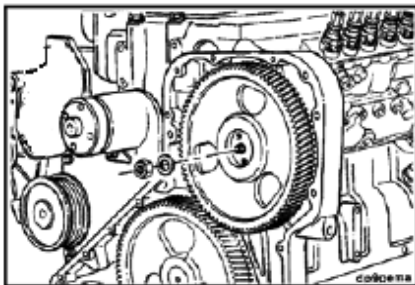
Lift the tappets so the camshaft can be removed.

Refer

Ref. No.	Noun Name	QUALITY
1	Valve Tappet Tray	1
2	Dowel Rods	12
3	Rubber Bands	12
4	Nylon String	1



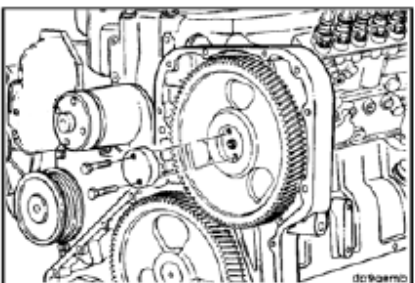
Push a wooden dowel rod into each tappet. It may be necessary to push the dowel into the tappet with a soft face hammer. Pull each valve tappet up until it makes contact with the cylinder block. Put a rubber band around two dowels to hold the tappets off the camshaft.



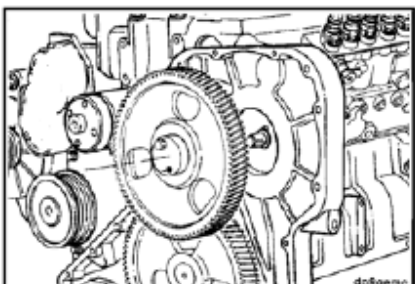
22 mm (PES.A Pump), 27 mm (PES.MW Pump), 30 mm (PES. 6P)



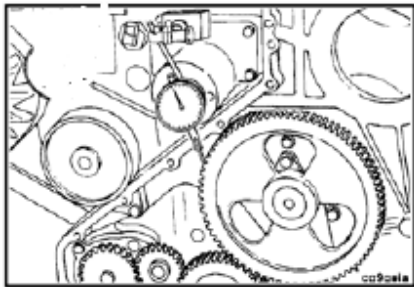
Remove the nut and washer from the fuel pump drive gear..

**Part No. 3824469, Fuel Gear Puller**

Install the puller on the drive gear. Tighten the capscrews until the gear is loose on the fuel pump drive shaft.



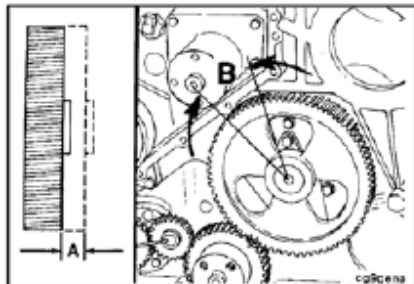
Remove the fuel pump drive gear.



NOTE: If the camshaft or gear are being replaced due to gear train noise, check the gear backlash.

NOTE: Excessive gear backlash can be caused by worn camshaft bushings.

Position an indicator on a tooth of the camshaft gear.



Note the camshaft gear backlash and end clearance.

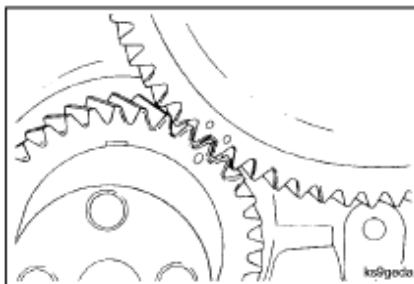
Mark the camshaft gear and crankshaft gear for further analysis if backlash or end clearance exceeds limits.

Camshaft End Clearance (A)

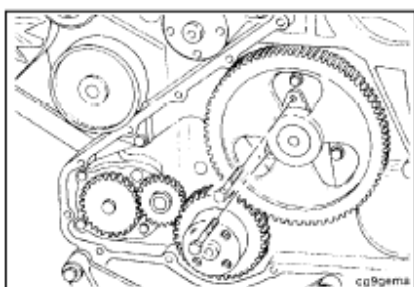
mm		In
0.10	min	0.0047
0.36	max	0.018

Camshaft Gear Backlash Limits (B)

mm		In
0.08	min	0.003
0.33	max	0.013

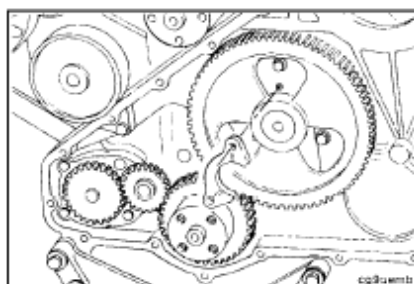


Rotate the crankshaft to align the timing marks before trying to remove the camshaft.

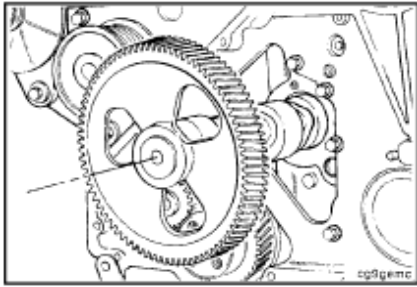


13 mm

Remove the camshaft thrust plate capscrews.

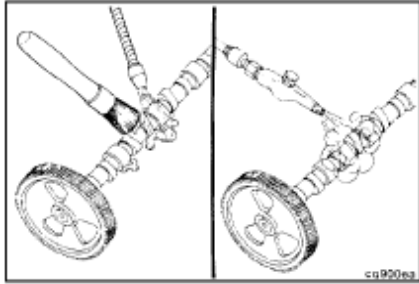


Remove the camshaft thrust plate.



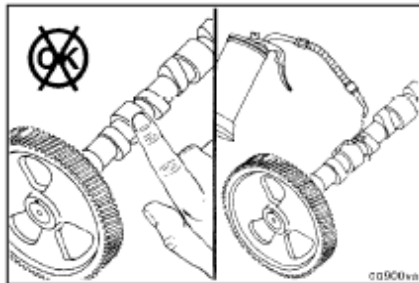
Remove the camshaft from the cylinder block.

NOTE: Rotate the camshaft as it is being removed. Use extreme care to be sure the camshaft bushings are not damaged during the camshaft removal process.

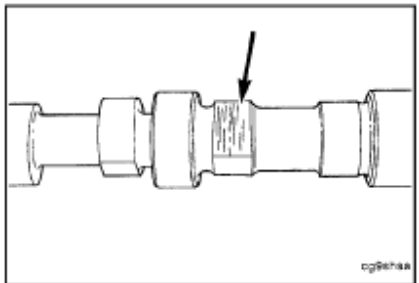


Clean and Inspect

WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury. Clean the camshaft with steam or solvent. Dry with compressed air.

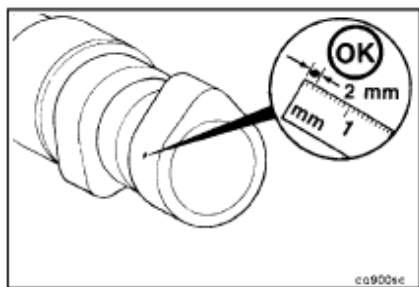


CAUTION: After the camshaft has been steam cleaned, do not touch the machined surfaces with bare hands, this will cause rust to form. Lubricate the camshaft with clean 15W-40 engine oil before handling.



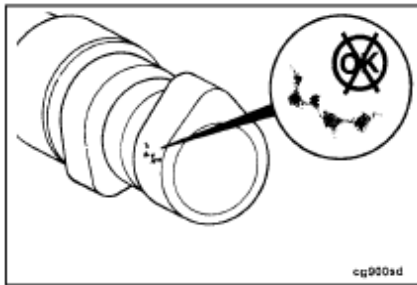
Visually inspect the fuel transfer pump lobe, valve lobes and bearing journals for wear, cranking, pitting, scratches and other damage.

The following criteria defines the size of the pits, allowable wear and edge deterioration of the chilled iron camshaft lobes:

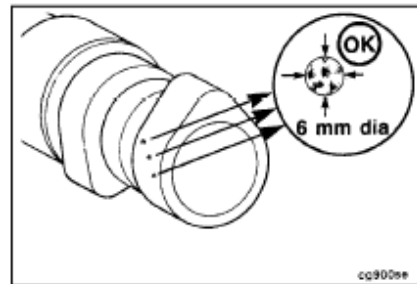


Pitting:

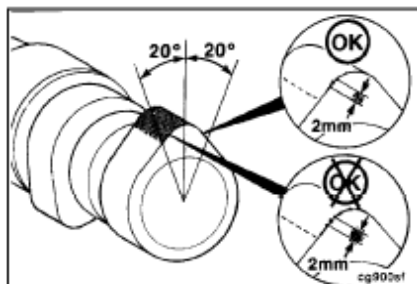
A single pit should not be greater than the area of a 2 mm [0.079 inch] diameter circle.



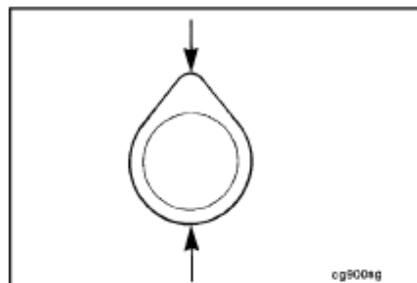
Interconnection of pits is not allowable and is treated as one pit.



The total pits, when added together, should not exceed a circle of 6 mm [0.236 inch].



Only one nick is allowed on both sides (left and right) of the nose of the camshaft lobe apart 20 degrees. (the diameter is not more than 2 mm)

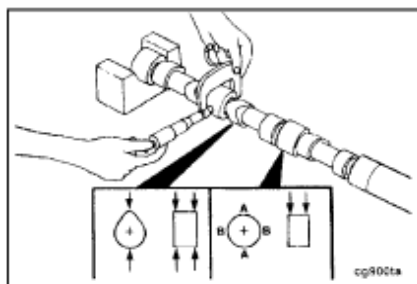


Measure across the peak of the lobes.

Camshaft Lobe Wear Limits (Minimum)

mm

51.03	valve, intake
50.78	valve, exhaust
41.31	lift pump



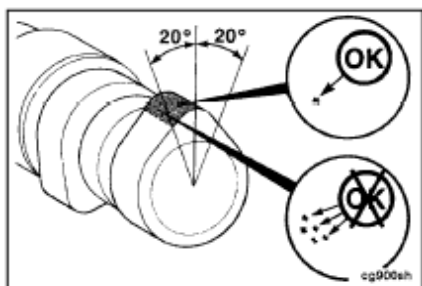
Camshaft Journal Diameter

mm

In

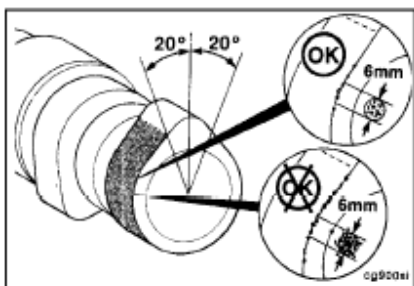
59.962	min	2.3607
60.013	max	2.3627

NOTE: Replace the camshaft if the outside diameter of any bearing surface is less than 59.962 mm [2.3607 inch].



Edge Deterioration (Breakdown)

The area of edge deterioration should not be greater than the equivalent area of a 2 mm [0.079 inch] circle within ± 20 degrees of the nose of the camshaft lobe.



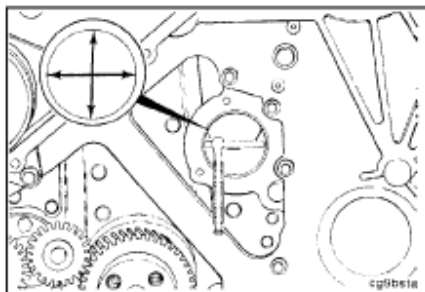
Outside of the ± 20 degrees of the nose of the camshaft lobe, the areas of edge deterioration should not be greater than the equivalent area of a 6 mm [0.236 inch] circle.

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This illustration shows normal grain pattern and a casting flaw within the nose area. Both of these conditions are acceptable for reuse.

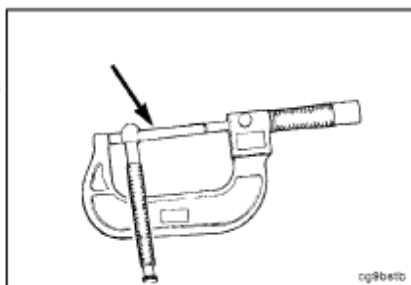
The following three illustrations show wear patterns that are not acceptable for reuse:



Measure the camshaft bores inside diameter with a inside diameter gauge. The bores must be measured apart from 90 degrees.

Camshaft Bore Diameter (maximum)

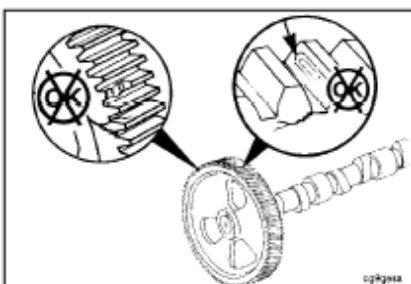
mm		In
64.01	without bushing	2.520
60.12	with bushing	2.367



If the bushing diameter is more than 60.12 mm [2.367 inch], the camshaft bushings must be replaced.

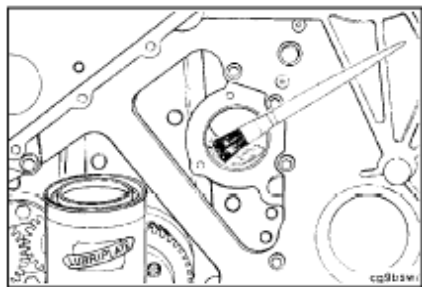


NOTE: The engine must be removed for bushing replacement.



Camshaft Gear Inspection

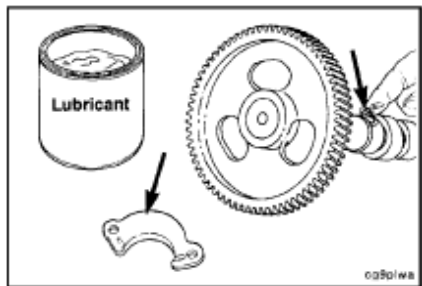
Visually inspect the gear teeth for wear and damage. Look for cracks at the root of the teeth. If the gear is damaged, it must be replaced.



Install

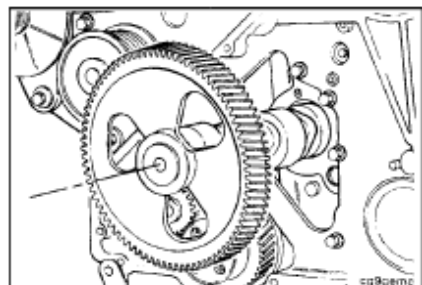
Lubricate the camshaft bores with Lubriplate™ 105.

Service Tip: the crankshaft should be positioned so the No.1 cylinder is at approximately TDC, so the camshaft does not hit the crankshaft counterweight during installation.

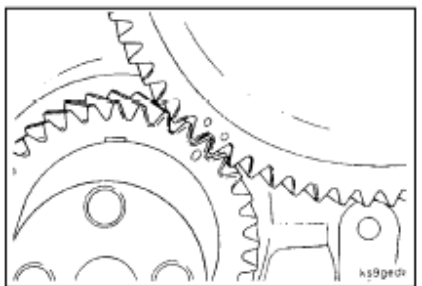


Lubricate the camshaft journals and lobes, and The thrust plate with Lubriplate™ 105.

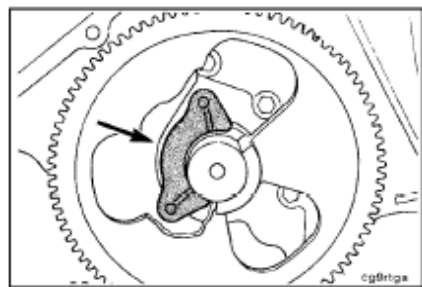
93



Position the camshaft/cam gear assembly into the cylinder block up to the last journal.

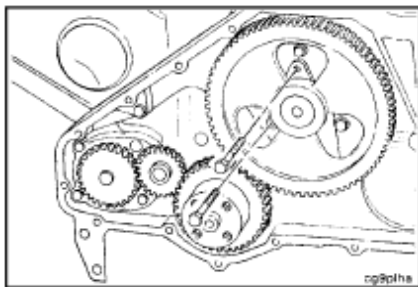


Align the timing marks on the camshaft with the timing mark on the crankshaft.



CAUTION: Make sure the camshaft assembly does not drop on your fingers when installing the thrust plate.

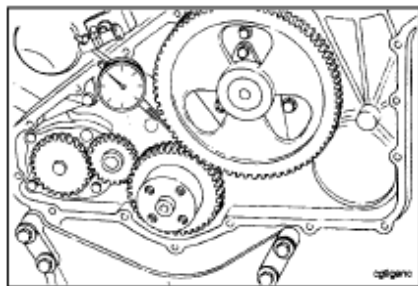
Install the camshaft thrust plate.



13 mm

Install the camshaft thrust plate cap screws.

Torque Value: 24N•m[18 ft-lb]



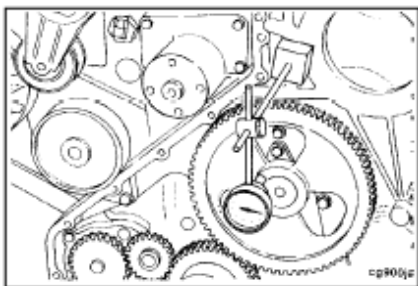
Put a dial indicator on the camshaft gear and check the gear backlash between the camshaft gear and the crankshaft gear.

Camshaft Gear Backlash Limits

mm		In
0.08	min	0.003
0.33	max	0.013

NOTE: The gears must be replaced if the backlash is greater than the above limit.

NOTE: Excessive gear backlash can be caused by worn camshaft bushings.

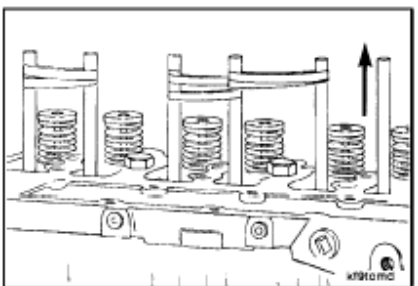


Measure camshaft end clearance with a dial indicator. End clearance is controlled by the thickness of the thrust plate and the groove in the camshaft.

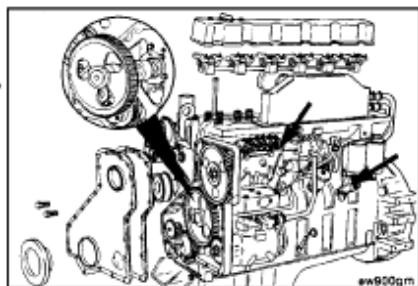
Camshaft End Clearance

mm		In
0.10	min	0.0047
0.36	max	0.0181

NOTE: If the camshaft end clearance is greater than the above limit, the thrust plate must be replaced.

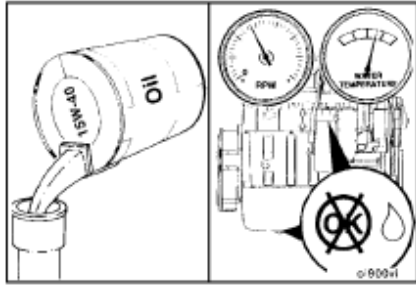


Remove the wooden dowel rods from the valve tappets.

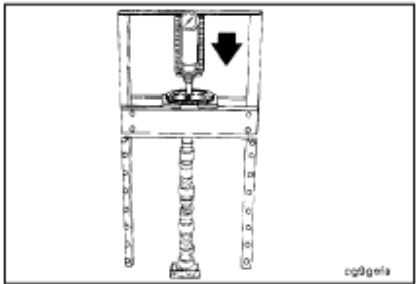


Install all parts that were removed:

- Lift pump.
- Fuel pump drive gear.
- Gear cover.
- Vibration damper.
- Push rods.
- Rocker lever assemblies.
- Valve cover.



Operate the engine until the coolant temperature reaches 82°C [180°F] and check for leaks and proper operation.



Camshaft Gear- Replace

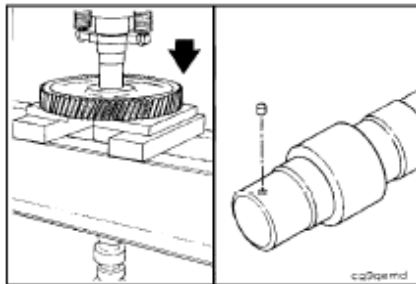
93

Remove

A camshaft gear removal/installation tool, Part No. 3823589, is available for replacing the camshaft gear in restricted areas where the camshaft can not be removed from the engine. Follow the directions included with the tool.

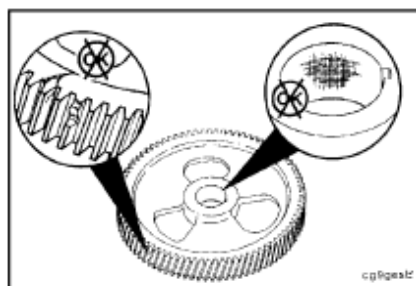
CAUTION: Place a wooden block under the camshaft to avoid damages as the camshaft drops free from the cam gear.

Place the camshaft and gear assembly in a hydraulic press.



Press the gear off the camshaft.

Remove the camshaft dowel pin.

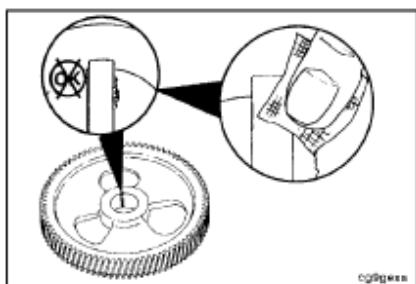


Clean and Inspect

Visually inspect the camshaft gear for cracks, chipped, or broken teeth.

Inspect the camshaft bore for fretting or burns.

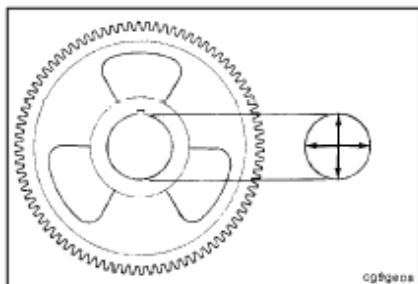
NOTE: If the fretting, burrs, or raised material can not be removed with Scotch-Brite® 7448 or equivalent, replace the camshaft gear.



Inspect the gear keyway for burrs.

Remove burrs with Scotch-Brite TM 7448 or equivalent.

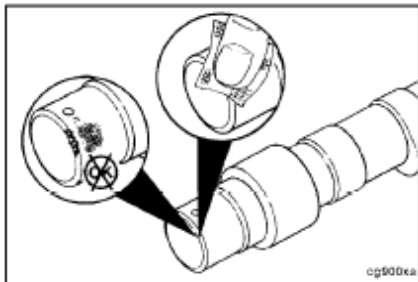
NOTE: If the keyway is damaged or the burrs cannot be removed, the gear must be replaced.



Measure the camshaft gear bore inside diameter.

Camshaft Gear Bore I.D.

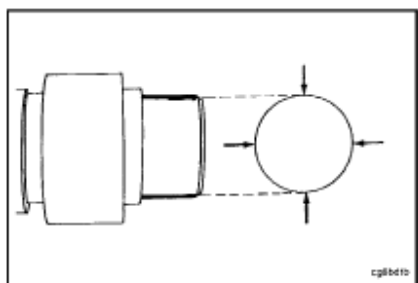
mm		In
41.480	min	1.633
41.505	max	1.634



Visually inspect the camshaft nose for fretting or burrs.



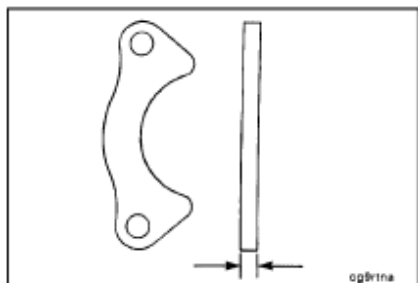
NOTE: If fretting or burrs can not be removed with Scotch-Brite™ 7448 or equivalent, replace the camshaft.



Measure the camshaft gear journal outside diameter.

Camshaft Gear Journal O.D

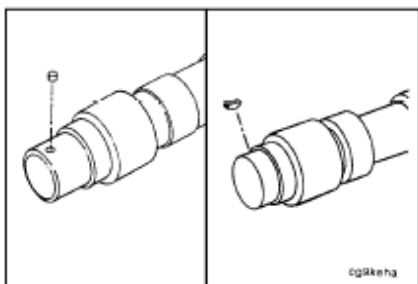
mm		In
41.56	min	1.636
41.58	max	1.637



Measure the camshaft thrust plate thickness.

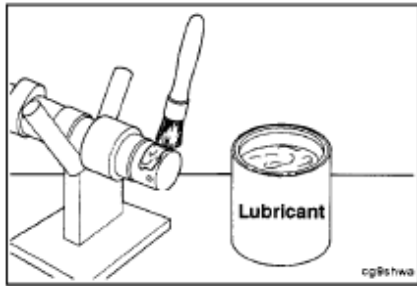
Camshaft Thrust Plate Thickness

mm		In
9.34	min	0.368
9.58	max	0.377

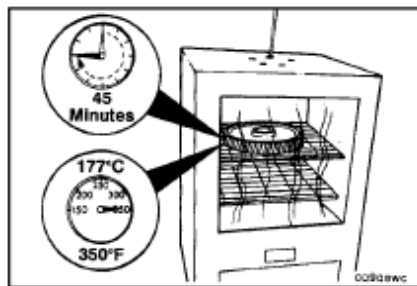


Install

Use a leather hammer to install the camshaft gear dowl pin.



Lubricate the camshaft gear journals with Lubriplate™ 105.

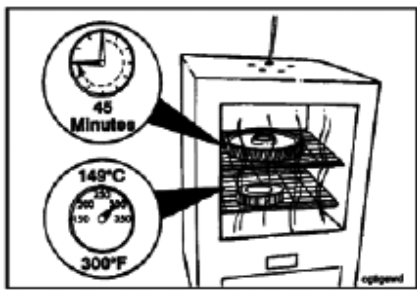


Steel Camshaft Gear

WARNING: Use insulated gloves, Part No. 3823730, when handling heated parts. Hot parts can cause serious personal injury.

Heat the gear in an oven for a minimum of 45 minutes, but not longer than 6 hours.

Temperature: 177°C [350°F]

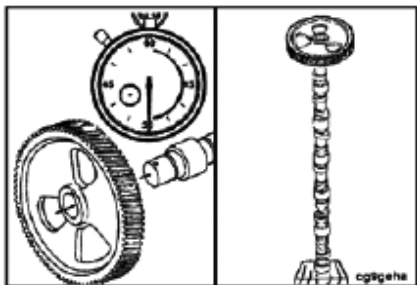


Austempered Camshaft Gear

Heat the gear in an oven for 45 minutes.

CAUTION: The gear will be permanently distorted if overheated. The oven temperature should never exceed the specification.

Temperature: 149°C [300°F]



CAUTION: To prevent engine damage, the timing marks and gear part number must be facing away from the camshaft when the gear is installed.

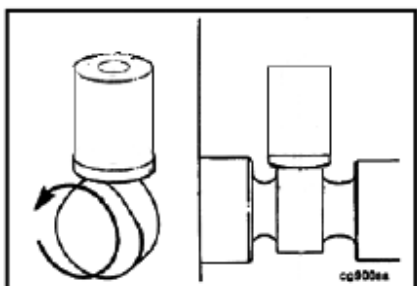


CAUTION: Keep the camshaft in a vertical position with the gear up until the gear has cooled. Do not use water to reduce the cooling time. Using water will crack the gear.



NOTE: The gear must be installed within 30 seconds after it is removed from the oven.

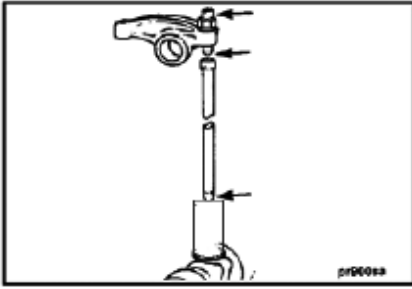
Remove the gear from the oven. Align the keyway in the gear with the dowel pin in the camshaft and install the gear on the camshaft. Be sure the gear is seated against the camshaft shoulder.



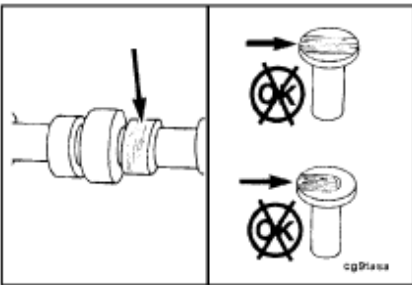
Valve Tappet – Replace

General Information

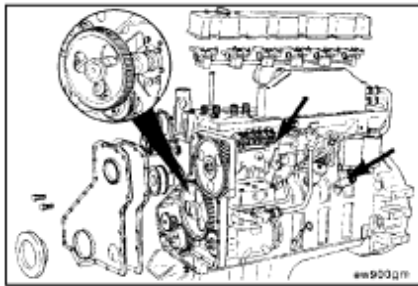
The valve tappets are mushroom shaped. The offset position of the tappet against camshaft lobe causes the tappet to rotate as it lifts the push rod.



The ball end of the push rod fits into the ball socket in the tappet. The other end of the push rod has a ball socket in which the ball end of the rocker lever adjusting screw operates.



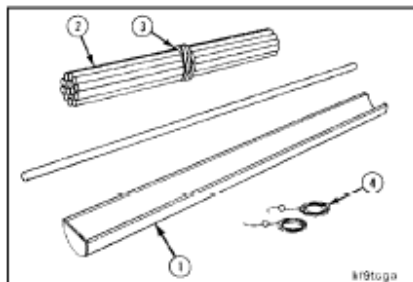
Loose rocker lever and the need to reset the valve clearance frequently can indicate camshaft lobe or tappet wear. If an inspection of the levers, valve stems and push rods does not show wear, then tappet and/or camshaft lobe wear can be suspected.

**Remove****Replacement (with oil pan installed)**

Remove the following components:

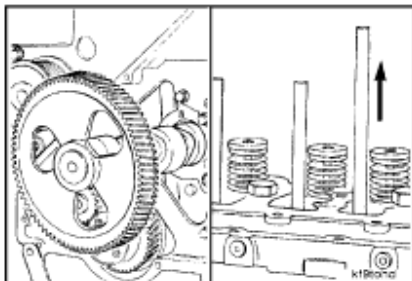
- Valve cover.
- Rocker lever assemblies.
- Push rods.
- Vibration damper.
- Gear cover.
- Fuel pump drive gear.
- Lift pump.
- Camshaft.

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**Part No. 3822513, Tappet Removal Tool Kit**

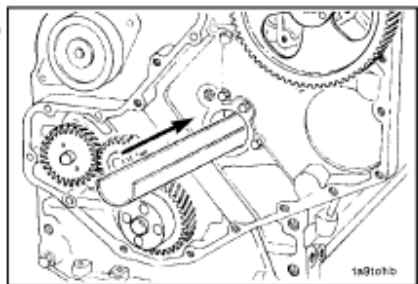
The valve tappets can be removed with the oil pan installed by using Part No. 3822513, tappet removal tool kit. Tool kit consists of:

Refer Ref. No.	Noun name	Quantity
1	Valve Tappet Tray	1
2	Dowel Rods	12
3	Rubber Bands	12
4	Nylon String	1

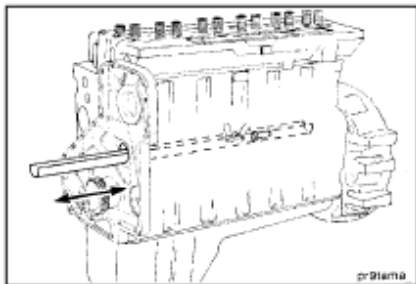


NOTE: It is necessary to remove the camshaft to replace the valve tappets; therefore, the tappets will be raised and secured with the dowel rods. Refer to instructions for camshaft replacement.

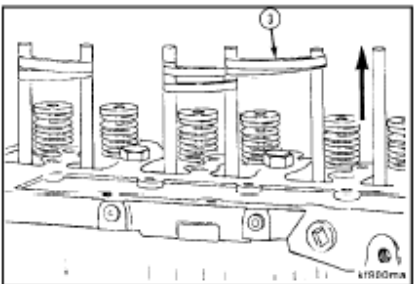
NOTE: Number each tappet with the cylinder number position as it is removed. The tappets must be installed in the same position as removed.



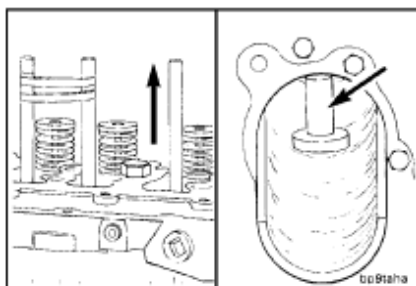
Insert the tray (1) to the full length of the camshaft bore.



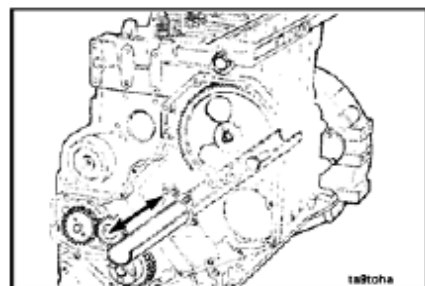
Make sure the tray is positioned so it will catch the tappet when the wooden dowel is removed.



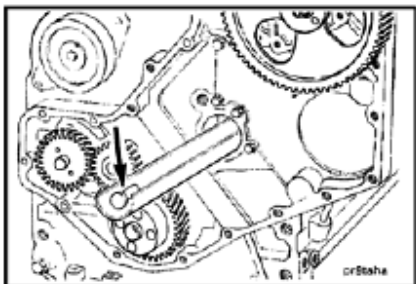
NOTE: Only remove one tappet at a time. Remove the rubber band (3) from the two companion tappets, securing the tappet not to be removed with the rubber band.



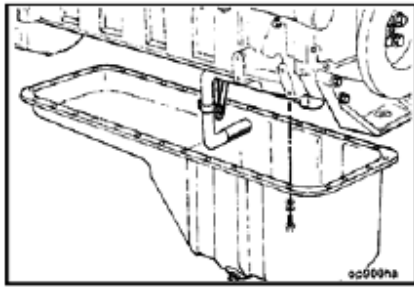
Pull the wooden dowel (2) from the tappet bore allowing the tappet to fall into the plastic tray.



NOTE: The tappet must be in the horizontal position to remove it from the camshaft bore. When the tappet is dropped into the tray, it should fall into the horizontal position. If it does not, gently shake the tray to allow the tappet to fall over.



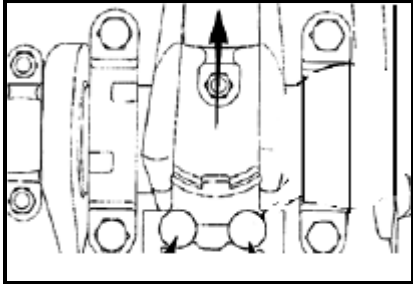
Carefully pull the tray and tappet from the camshaft bore and remove the tappet. Repeat the process until all tappets are removed.



Valve Tappet Removal (With Oil Pan Removed)

10 mm

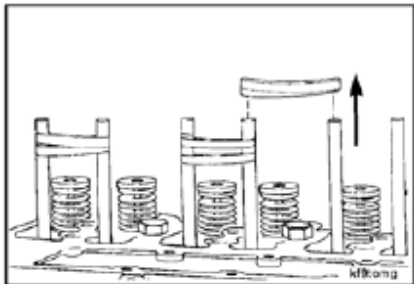
Remove the oil pan.



Part No. 3377371, Engine Barring Gear

Rotate the crankshaft to access the tappets.

NOTE: Only four tappets are accessible at one time. The crankshaft must be rotated three times to access all of the tappets.



Remove the rubber bands from the wooden dowels that are used to hold the tappets up during camshaft removal/installation.

NOTE: Only remove the rubber bands from the accessible tappets.

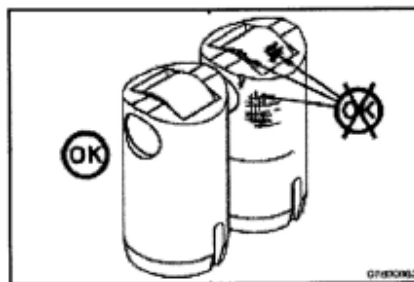
Remove the accessible tappets/dowels.

Remove the tappets from the wooden dowels.

Clean and Inspect

Clean the camshaft with solvent and dry with compressed air.

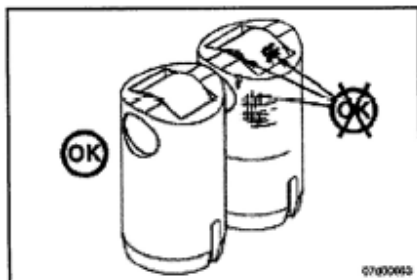
NOTE: If a new camshaft is installed, new tappets also should be installed.



Pit marks on the tappet face are acceptable.

The following criteria defines the size of the pits allowed.

1. A single pit can not be greater than 2 mm [0.078 in] in diameter.
2. Interconnection of pits is not allowed.
3. Total pits when added together should not exceed 6mm [0.236 in] diameter or a total of 4 percent of the tappet face.
4. No pitting is allowed on the edges of the wear face of the tappet.



Inspect the socket, stem and face for excessive wear, cracks, concavity and other damage.

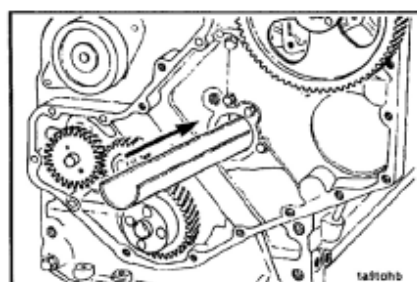
Reuse Guidelines:

- A - normal wear
- B and (C) - abnormal wear – Do not reuse

Measure the valve tappet.

Tappet Diameter

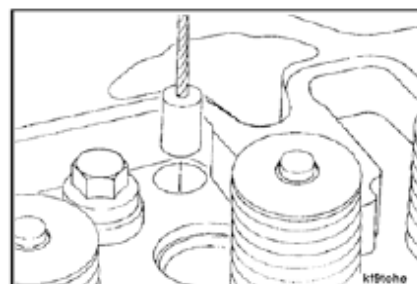
mm	
23.35	min
23.90	max



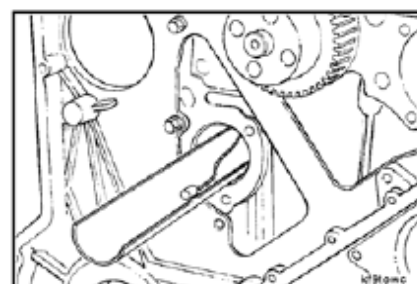
Install

Valve Tappet Installation (With Oil Pan Installed)

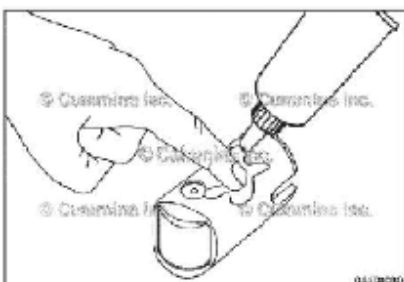
Insert the plastic tray the full length of the camshaft bore.



Insert the installation tool down through the tappet bore and into the plastic tray.

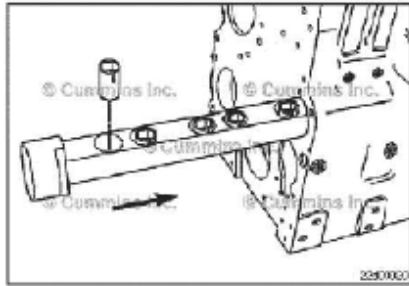


Carefully pull the plastic tray/installation tool out through the front of the camshaft bore.



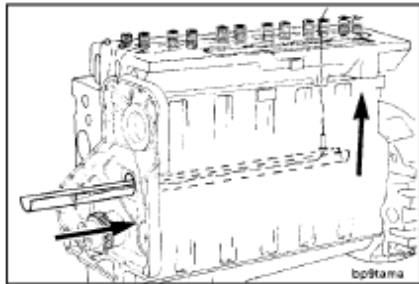
Lubricate the tappets with Lubriplate™ 105.

NOTE: If the tappets to be installed have been previously used, each tappet must be installed in the same position as it was removed from the engine.



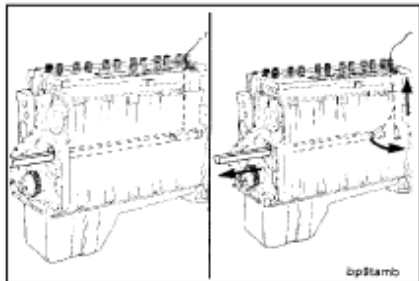
Insert the installation tool into the tappet bore.

NOTE: To aid in removing the installation tool after the tappet is installed, move the tool in and out of the tappet bore several times before installing the tappets.

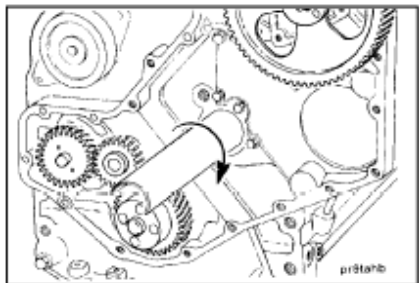


Pull the installation tool and tappet through the camshaft bore and up into the tappet bore.

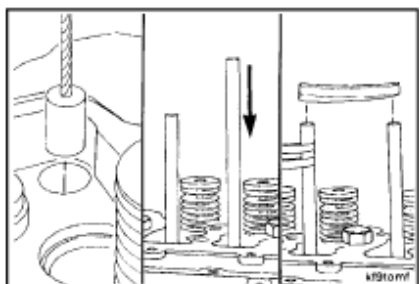
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If difficulty is experienced in getting the tappet to make the bend from the tray up to the tappet bore (due to the webbing of the block), pull the tray out enough to allow the tappet to drop down and align itself, then pull the tappet up into the bore.



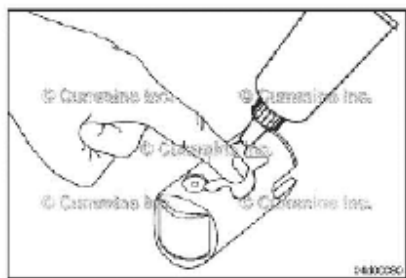
After the tappet has been pulled up into position, turn the tray over in the camshaft bore so that the bottom surface of the tray is against the bottom face of the tappet. This will hold the tappet in place.



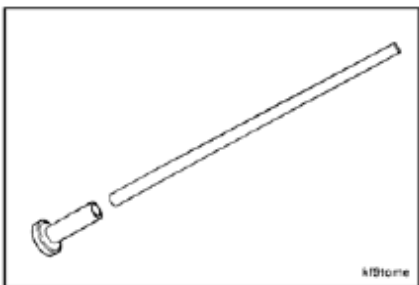
Remove the installation tool from the tappet.

Insert a wooden dowel rod into the top of the tappet. Wrap rubber bands around the wooden dowels to secure the tappets.

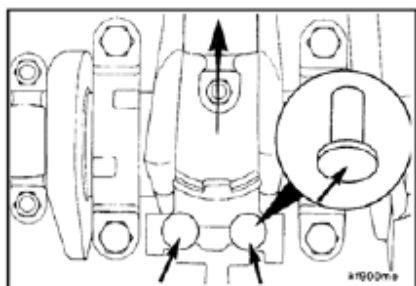
Repeat this process until all tappets have been installed. Remove the dowel rods and release the tappets in the tappet bores.



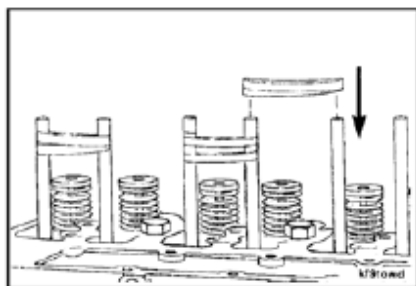
Valve Tappet Installation (with oil pan removed)
Lubricate the tappets with Lubriplate™ 105.



Insert the wooden dowel rods used for holding the tappets up during camshaft removal/installation into the tappets.



NOTE: Only four tappets are accessible at a time which will require rotation of the engine to install the remaining tappets.

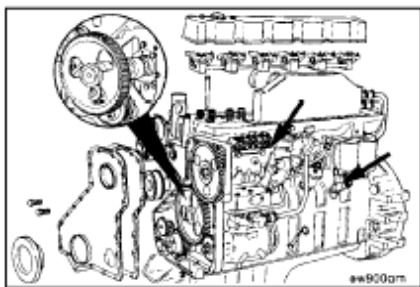


Wrap rubber bands around the wooden dowels to secure the tappets.
Repeat this process until all tappets have been installed.
Remove the dowel rods and release the tappets in the tappet bores.



10 mm
Install the oil pan.

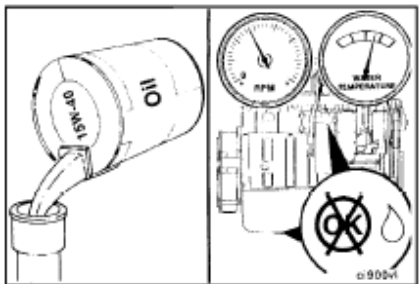




Install all components that were removed:

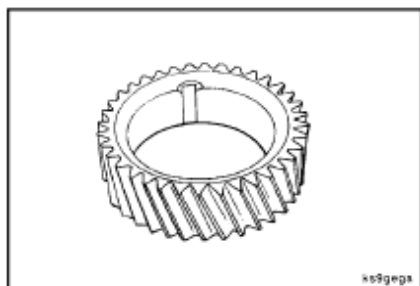
- Camshaft.
- Lift pump.
- Fuel pumps drive gear.
- Gear cove
- Vibration damper.
- Push rods.
- Rocker lever assemblies.
- Valve cover.

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Fill the engine with oil and coolant.

Operate the engine until the coolant temperature reaches 82°C [180°F] and check for leaks and proper operation.

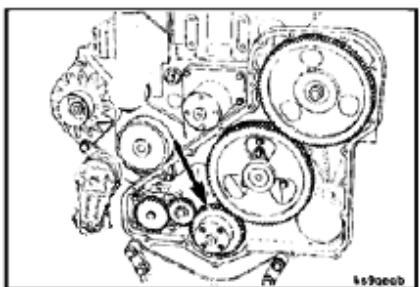


Crankshaft Gear – Replace

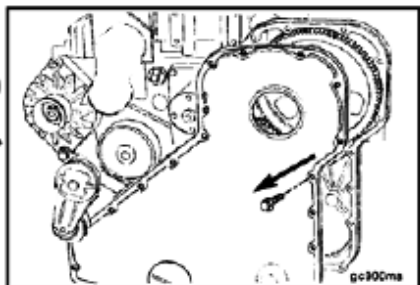
General Information

There are two different crankshaft gears used:

- Steel gear for engines with P7100 Bosch fuel pumps.
- Austempered gear for engines without P7100 Bosch fuel pumps.

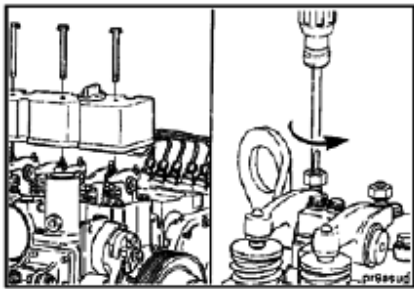


NOTE: The austempered gear can be replaced with the engine in-chassis. The steel gear cannot be replaced in-chassis. It will be necessary to remove the engine.

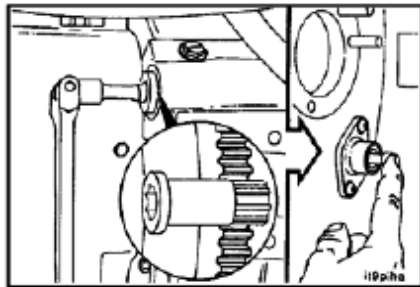


Remove (Austempered Gear)

Remove the gear cover.



Remove the valve cover and loosen all rocker lever adjusting screws to remove the load on the camshaft.

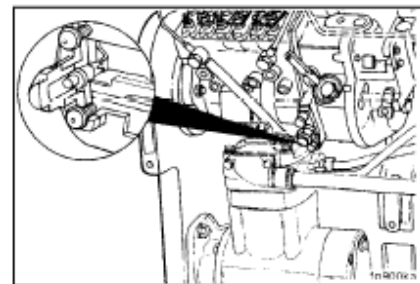


Part No. 3377371, Engine Barring Gear

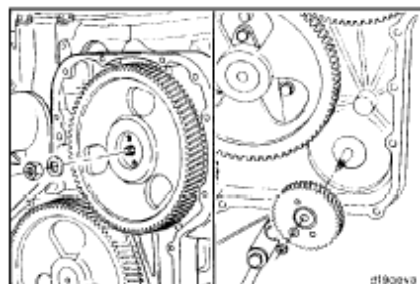
Rotate the crankshaft and align the timing marks of the camshaft and crankshaft gears.



Use a felt marker to black the timing marks on the gear train. Use the marker to make alignment mark on the accessory drive gear and shaft.



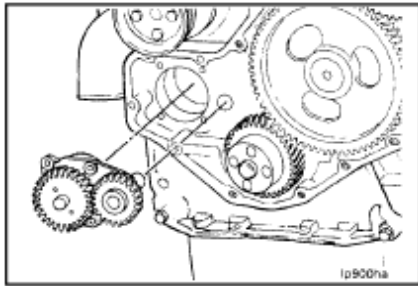
Lock the fuel injection pump.



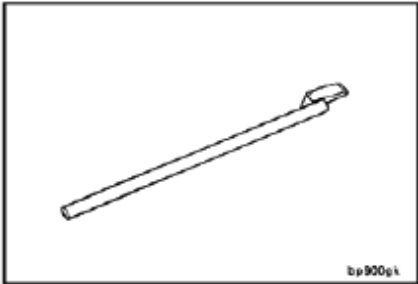
Part No. 3823259, Fuel Pump Gear Puller

Remove the fuel pump drive gear and the accessory drive gear.





Remove the lubricating oil pump assembly.



Part No. 3823585, Crankshaft Gear Splitter

CAUTION: Safety glasses are required when using this tool.



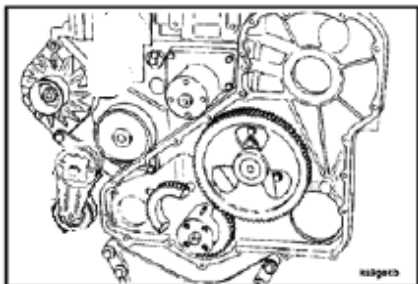
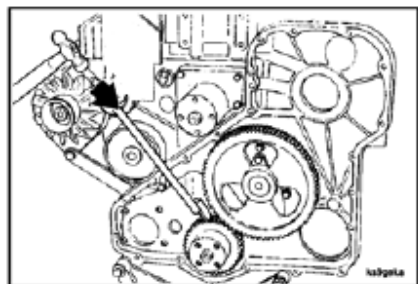
NOTE: Try to accomplish this task with a cold chisel will result in damage to the engine gear housing gasket surface.



CAUTION: Use care to avoid damage to the polished surfaces of the crankshaft by driving the point of the tool into the crankshaft.

NOTE: Do not use gear splitter on steel gears.

Place the point of the chisel between two gear teeth. Strike the splitter with a two or three pound steel hammer. Repeat this step if necessary.



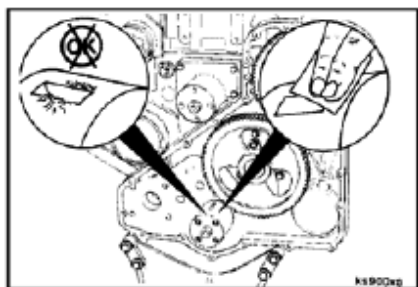
Remove crank gear.



NOTE: The camshaft gear will rotate slightly as the teeth follow the gear helix.

CAUTION: Use great care to not disturb the position of the camshaft gear after the crankshaft gear has been removed.

CAUTION: Do not damage the crankshaft when removing the key. Use a flat chisel and a hammer to remove the crankshaft gear key.

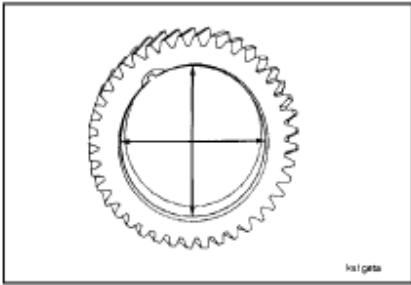


Clean and Inspect

Visually inspect the crankshaft gear journal for burrs or damage.



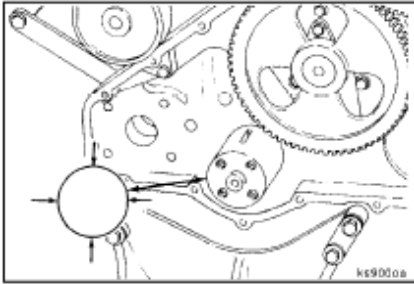
Remove any burrs with Scotch-Brite® 7448, Part No. 3823258, or equivalent.



Measure the crankshaft gear bore inside diameter.

Crankshaft Gear Bore I.D.

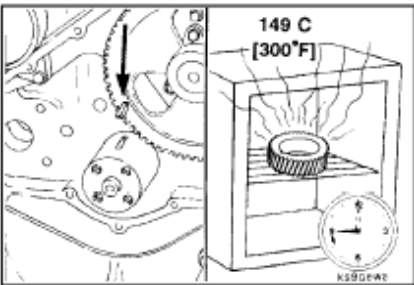
mm		In
75.898	min	2.9881
75.923	max	2.9891



Measure the crankshaft gear fit area outside diameter.

Crankshaft Gear Fit Area O.D.

mm		In
75.987	min	2.991
76.006	max	2.992



Install

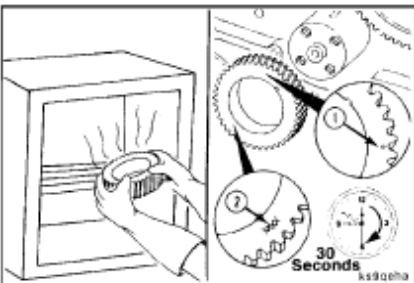
Use a leather hammer to install a new key in the crankshaft keyway.



CAUTION: Do not exceed the specified time or temperature when heating the crankshaft gear. The gear and teeth can be damaged.

Heat the gear in an oven for a minimum of 45 minutes but not more than 6 hours.

Temperature: 149°C[300°F]



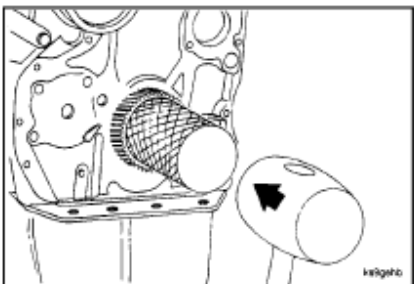
CAUTION: Use installed gloves, Part No. 3823730, when handling heated parts. Hot parts can cause serious personal injury.

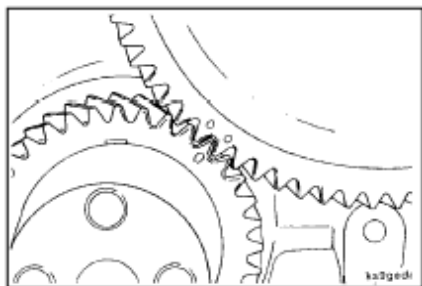
CAUTION: The timing mark (1) and part number (2) on the gear must be facing away from the crankshaft after the gear is installed. Engine damage can result if the gear is installed backwards.

Use lubriplate™ 105, or equivalent, to lubricate the crankshaft gear journal.

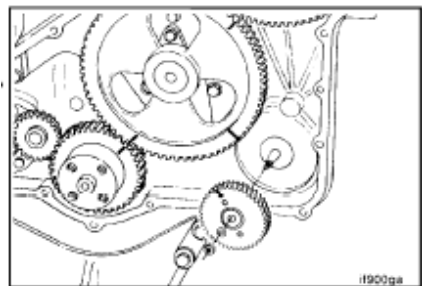
Remove the gear from the oven. Align the keyway of the gear with the key in the crankshaft and install the gear within 30 seconds.

NOTE: If the gear cools and stops on the crankshaft before it is fully installed, use a driver to complete the installation.





NOTE: If any gear were rotated, it will be necessary to align the timing marks of the crankshaft and the camshaft gears.



Install the fuel pump drive gear.

Tighten the capscrews.

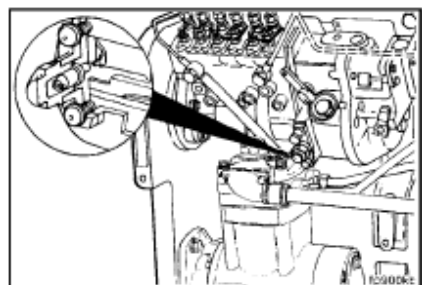


Install the accessory drive gear. Make sure to align the marks that were made during removal.

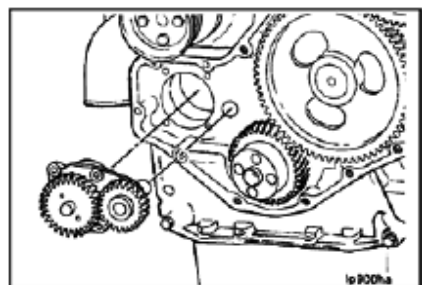


Tighten the capscrews.

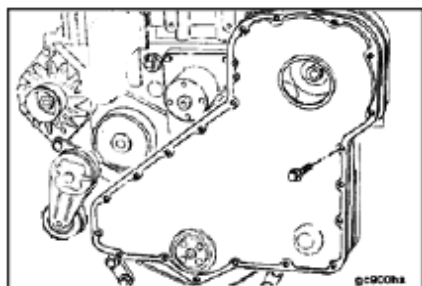
Torque Value: 126N•m[93 ft-lb].



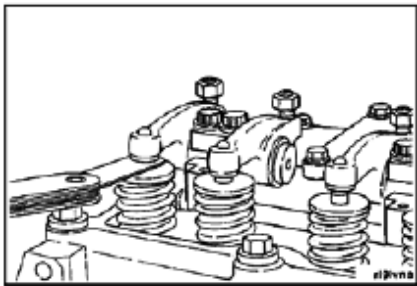
Unlock the fuel injection pump.



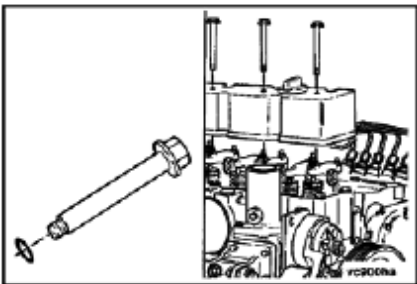
Install the lubricating oil pump.



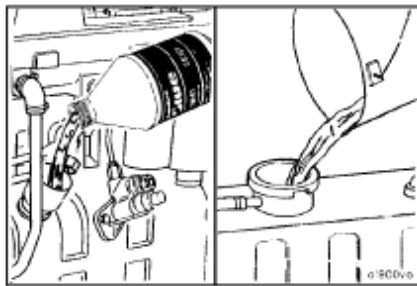
Install gear cover.



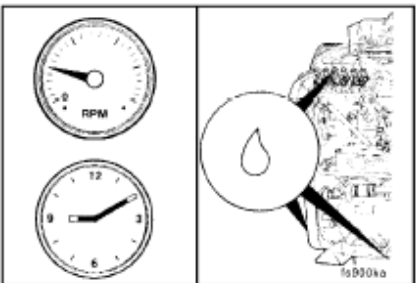
Adjust the valve clearance.



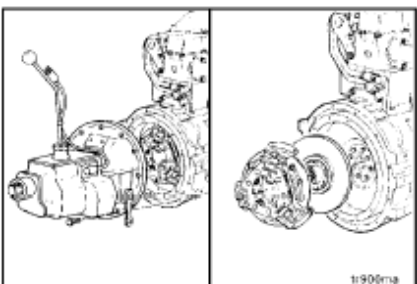
Install the valve cover.



Fill the engine with oil and coolant.



Operate the engine at idle for 5 to 10 minutes to check for leaks and proper operation.



Flywheel – Replace



Remove

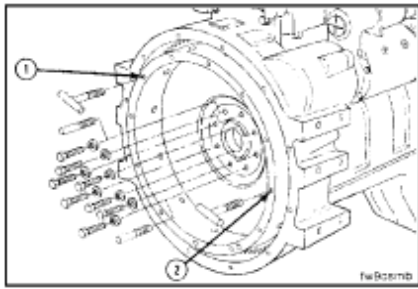


Part No. 3377371, Engine Barring Gear

Remove the vehicle drive line and transmission. Refer to the manufacturer's instructions.

Remove the clutch discs and the pressure plate.

NOTE: Use the barring gear, Part No. 3377371, to hold the flywheel to prevent rotation.



Remove two capscrews 180 degrees apart. Install Two M12×1.25×90 mm guide pins.

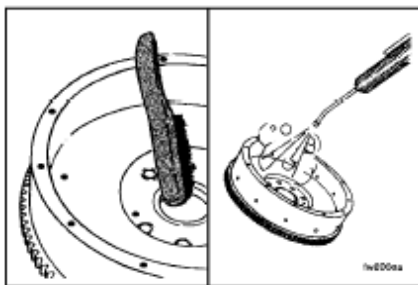
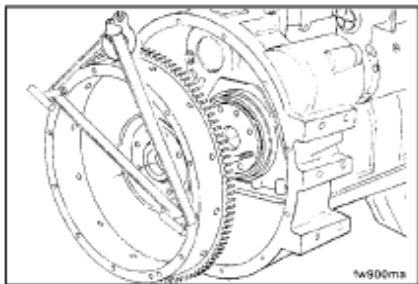
NOTE: If a clutch is used in the equipment, the threads in the clutch pressure plate mounting capscrew holes can be metric or standard. Be sure to use the correct capscrews.

Determine the capscrew thread design and size and install two “T-handles” in the flywheel at positions (1) and (2).

Remove the remaining six flywheel mounting capscrews.

The component weights 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Remove the flywheel from the guide pins.

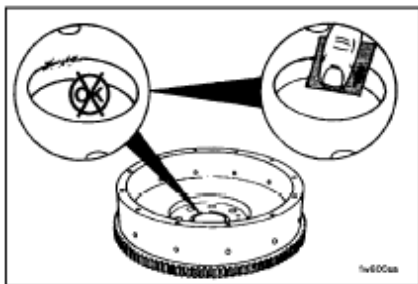


Clean and Inspect

Use a wire brush to clean the crankshaft pilot bore.

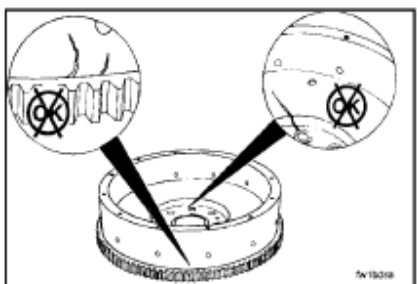
WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Use steam or solvent to clean the flywheel. Dry with compressed air.



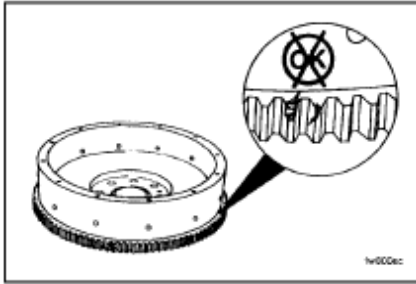
Visually inspect for nicks or burrs.

Use Scotch-Brite® 7448, or equivalent, to remove small nicks and burrs.

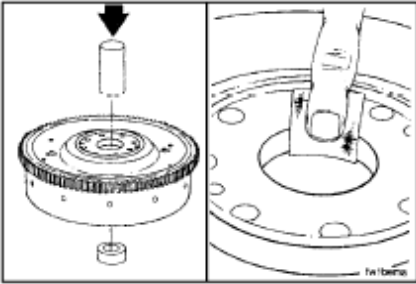


WARNING: Do not use a cracked or resurfaced flywheel. These can break, causing serious personal injury or property damage.

Use the crack detection kit, Part No. 3375432, to check for cracks in the flywheel. Follow the instructions provided with the kit.



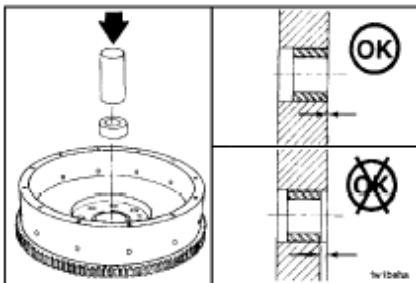
Inspect the flywheel ring gear teeth for cracks and chips.
NOTE: If the ring gear teeth are cracked or broken, the ring gear must be replaced.



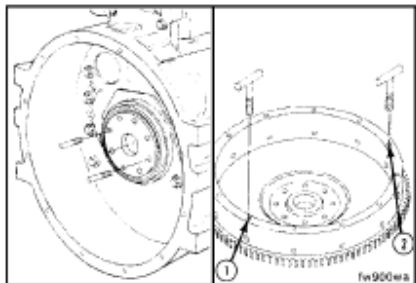
Install

NOTE: Use a new pilot bearing when installing a new or rebuilt clutch.

Use a mandrel and a hammer to remove the pilot bearing. Use a Scotch-Brite® 7448, or equivalent, to clean the pilot bore.



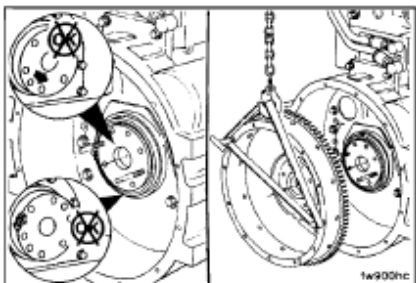
Use a mandrel and hammer to install the pilot bearing.
NOTE: The pilot bearing must be installed even with the pilot bore surface.



Install two M12×1.25×90 mm guide pins into the Crankshaft flange 180 degrees apart.

NOTE: If a clutch is used in the equipment, the threads in the clutch pressure plate mounting capscrew holes can be metric or standard. Be sure to use the correct capscrews.

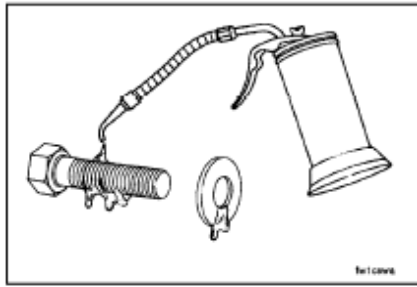
Determine the capscrew thread design and size and install two "T-handles" into the flywheel at points (1) and (2).



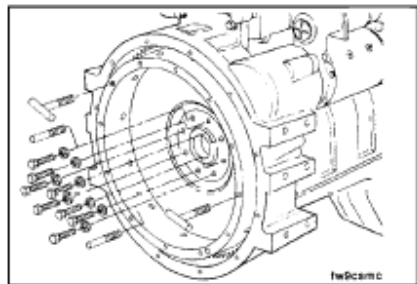
Visually inspect rear face of crankshaft and flywheel mounting flange for cleanliness and scratches or burrs.

The component weights 23 kg [50 lbs] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Install the flywheel on the guide pins.



Lubricate the threads of the capscrews and the surface of the washers with 15W-40 lubricating oil.

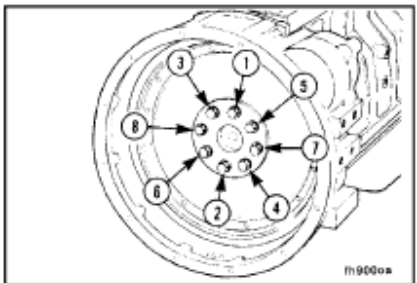


Install the six capscrews.



Remove the "T-handles" and guide pins.

Install the remaining capscrews into the holes from which the guide pins were removed.



19 mm Socket, Torque Wrench, Part No. 3377371, Engine Barring Gear



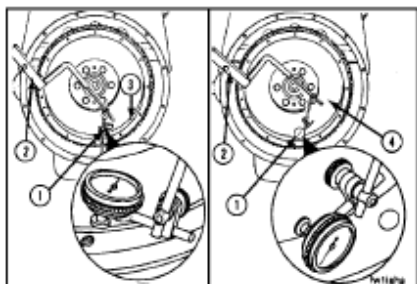
Hold the crankshaft when tightening the flywheel capscrews.



Tighten the capscrews in a star pattern.

Torque Value: 137N•m[101 ft-lb]

Refer to the equipment manufacturer's procedures to install the transmission.



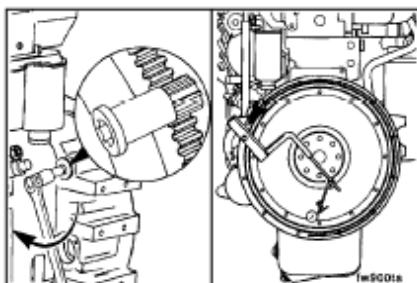
Flywheel Bore Eccentricity Measurement

Use the dial indicator gauge (1), Part No. 3376050, or its equipment and dial gauge attachment (2), Part No. ST-1325, to inspect the flywheel bore (3) and the surface (4) eccentricity.

Install the attachment to the flywheel housing.

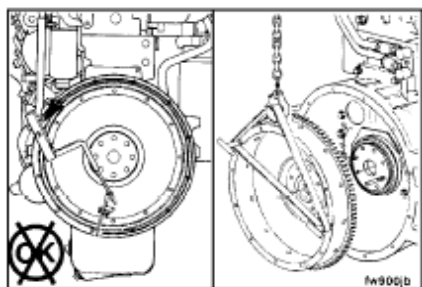
Install the gauge on the attachment.

Install the contact tip of the indicator against the inside diameter of the flywheel bore, and set the dial indicator at "0" (zero).



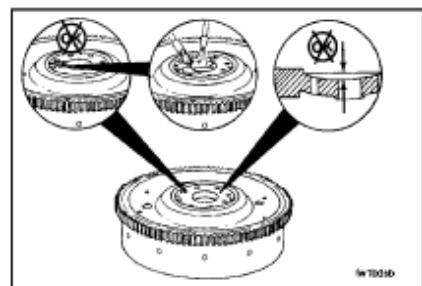
Use the barring gear, Part No. 3377371, to rotate the crankshaft one complete revolution (360 degrees).

NOTE: The total indicator reading (TIR) must not exceed 0.127 mm [0.0050-inch].

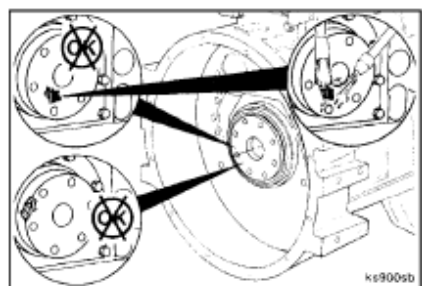


NOTE: If the TIR is greater than the specification, do the following:

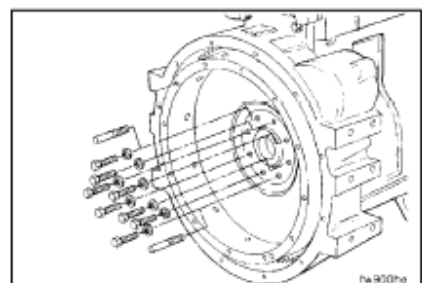
- Remove the flywheel.



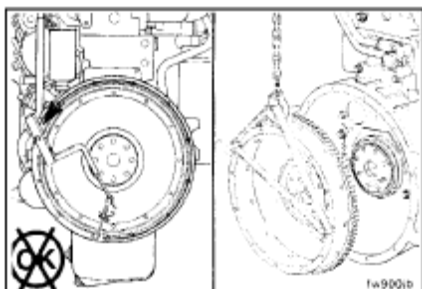
- Inspect the flywheel mounting surface for dirt or damage.



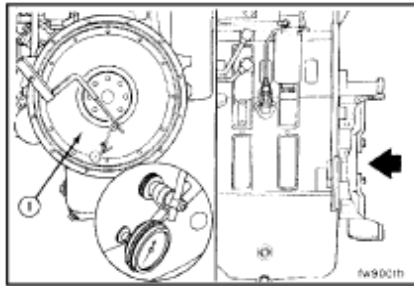
- Inspect the flywheel mounting surface for dirt or damage.



- Install flywheel and inspect bore runout.



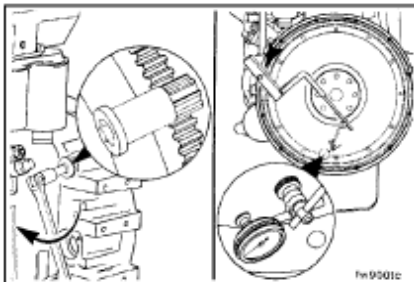
Replace the flywheel if the runout does not meet specification.



Flywheel Face Runout Measurement

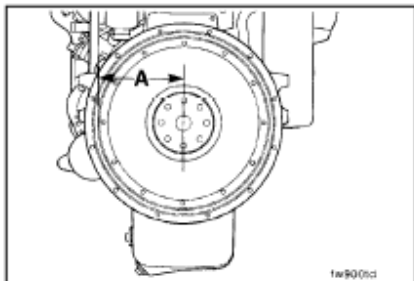
Install the contact tip of the indicator against the flywheel face, as close to the outside diameter as possible, to inspect the face (1) runout.

NOTE: Push the flywheel forward to remove the crankshaft end clearance. Set the indicator at zero.



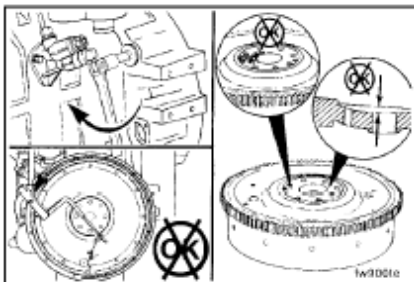
Use the engine barring gear, Part No. 3377371, to rotate the crankshaft one complete revolution. Measure the flywheel runout at four equal points on the flywheel.

NOTE: The flywheel must be pushed toward the front of the engine to remove the crankshaft end clearance each time a point is measured.

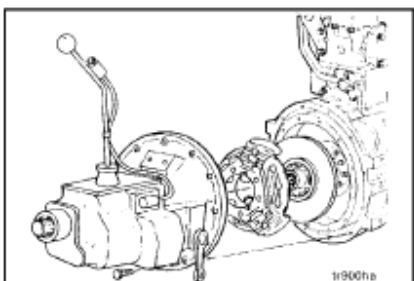


The total indicator reading (TIR) must not exceed the following specifications:

Flywheel. Radius(A)		Flywheel Face Runout Maximum (TIR)	
mm	in	mm	in
203	8	0.203	0.008
254	10	0.254	0.010
305	12	0.305	0.012
356	14	0.356	0.014
406	16	0.406	0.016

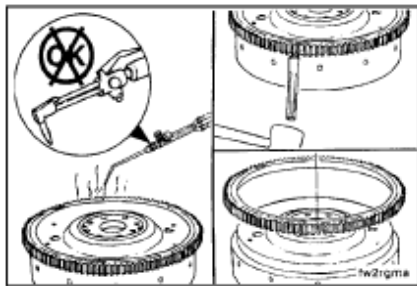


If the flywheel face runout is not within specifications, remove the flywheel. Check for scratches, burrs, or foreign material between the flywheel mounting surface and the crankshaft flange.



Install the clutch discs, pressure plate, transmission and drive line (if equipped) in reverse order of removal. Refer to the manufacturer's instructions.

NOTE: Align the universal joints on each of the drive shaft to prevent vibration.



Flywheel Ring Gear – Replace

Remove

CAUTION: Do not use a cutting torch to heat the ring gear, the flywheel can be damaged.

Heat the outside of the ring gear with a heating torch.

WARNING: Wear eye protection while driving the gear from the flywheel.

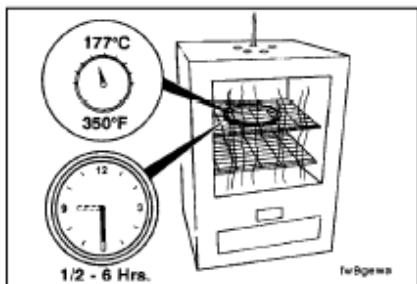
Use a blunt chisel or brass drift and hammer to remove the gear from the flywheel.

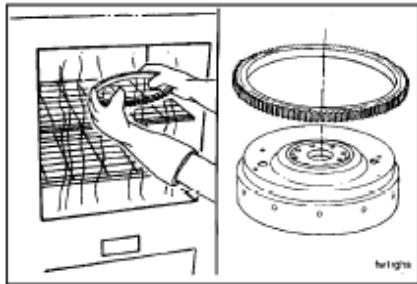
Install

NOTE: Do not attempt to install the ring gear without using heat. Use an oven to heat the new ring gear. Heat the ring gear for a minimum of 30 minutes in a preheated oven. Do not heat the ring gear for more than 6 hours.

Temperature: 177°C[350°F]

NOTE: Do not exceed the specified time or temperature. The metal hardness will be changed.





CAUTION: Wear protective gloves to prevent personal injury when handling parts that have been heated.

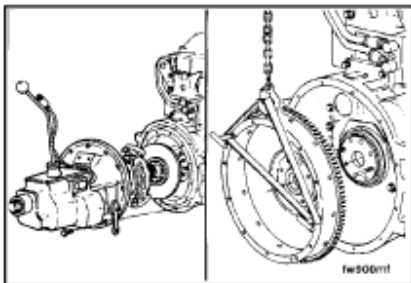


NOTE: The gear must be installed so the bevel on the teeth is toward the crankshaft side of the flywheel.



Remove the gear from the oven, and install it on the crankshaft side of the flywheel before it cools. Allow the air to cool the ring gear. Do not use water or oil to reduce the cooling time.

NOTE: If an oven is not available, use a heating torch to heat the inside diameter of the new ring gear to 177°C [350°F]. Use a crayon or its equivalent to check the ring gear temperature before installing it on the flywheel.



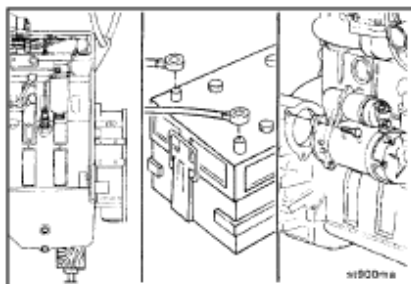
Flywheel Housing – Replace



Remove

Remove the transmission, clutch, and all related components. Refer to the manufacturer's instructions.

Remove the flywheel.



16 mm

CAUTION: Place a wooden block the width of the oil pan between the floor jack and oil pan to prevent damage to the engine.

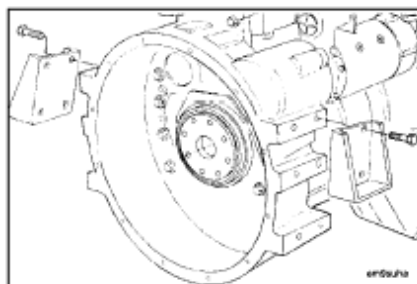


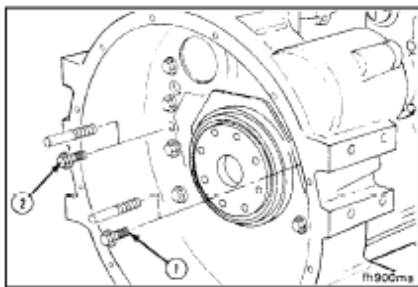
Use a floor jack or a suitable lifting to support the rear of the engine.

Disconnect the battery cables.

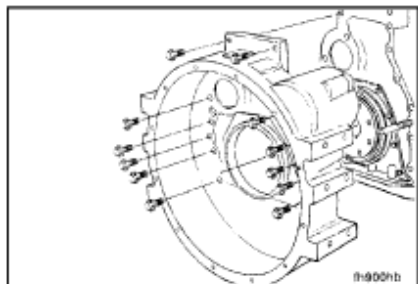
Remove starter motor.

Remove the capscrews and both rear engine mounts.

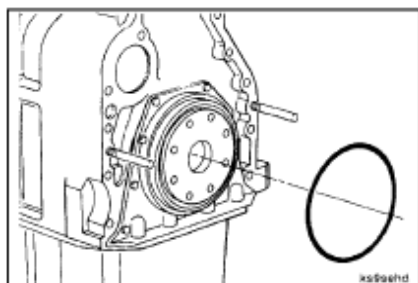




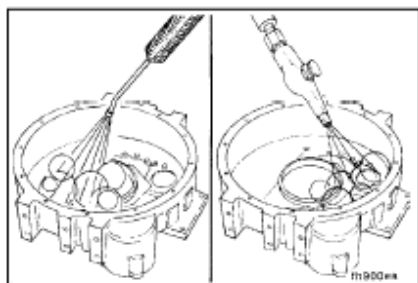
Remove capscrews (1) and (2), and install two M12×1.75×100 mm guide pins.



Remove the remaining capscrews.
The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.
Use a rubber hammer to loosen the flywheel housing.
Remove the flywheel housing.

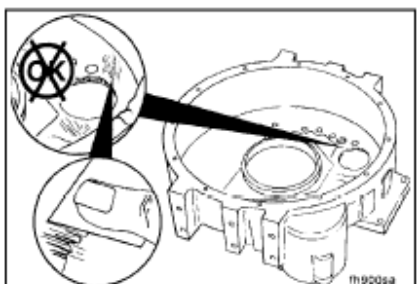


Remove the o-ring from the rear seal cover.

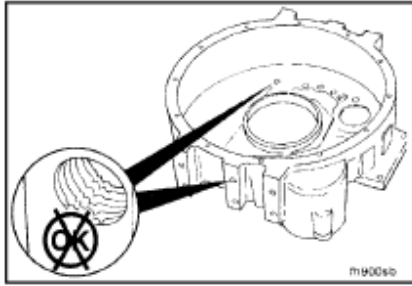


Clean and Inspect

WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.
Use steam or solvent to clean the flywheel housing. Dry with compressed air.

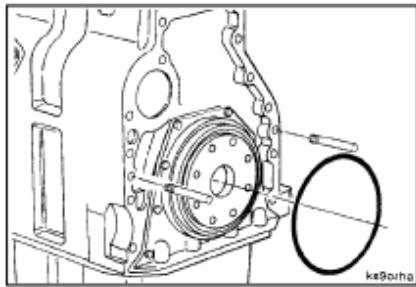


Visually inspect all surfaces for scratches, burrs, or cracks.
Use a fine crocus cloth to remove small scratches and burrs.



Inspect all threaded capscrew holes for damage.

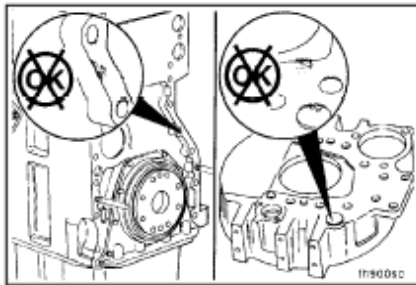
Repair or replace the housing if the capscrew holes are damaged.



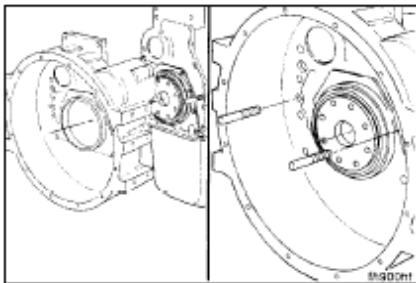
Install (dry clutch application)

Install two M12×1.75×100 mm guide pins into the cylinder block to help support and align the housing during installation.

NOTE: Some dry clutch applications require a sealing ring on the seal housing. Install the sealing ring in the machined surface of the seal housing and lubricate with Lubriplate™ 105.



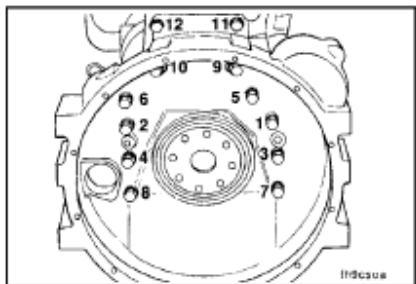
Visually inspect the rear face of the cylinder block and flywheel housing mounting surface for cleanliness and scratches or burrs.



Install the flywheel housing making sure the housing is positioned on the alignment guide pins and guide pins.

NOTE: Be sure the sealing ring is not damaged during installation.

Remove the two M12×1.75×100 mm dowel pins.

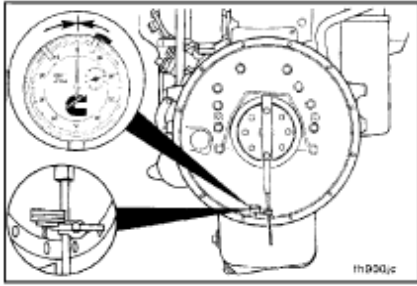


15 mm

Install and tighten the mounting capscrews using the pattern shown in the chart.

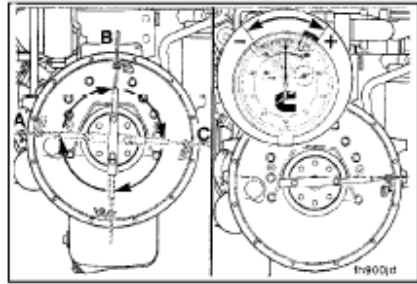
Torque Value: 77 N•m[57 ft-lb].



**Concentricity – Check****Part No. ST-1325, Dial Gauge Attachment**

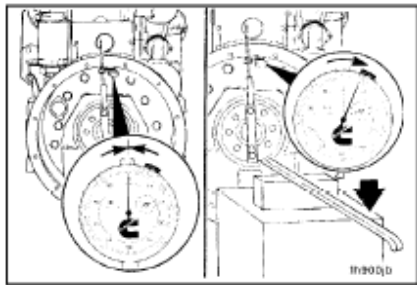
Attach a dial indicator to the crankshaft. The dial indicator can be mounted by any method that holds the extension bar of the indicator rigid so it does not sag. If the bar sags or the indicator slips, the readings obtained will not be accurate.

Position the indicator at the 6:00 o'clock position and zero the gauge.

**Part No. 3377371, Engine Barring Gear**

Slowly rotate the crankshaft. Record the readings obtained at the 9:00 o'clock, 12:00 o'clock, and 3:00 o'clock positions as [a], [b], and [c] in the concentricity work sheet. Recheck zero at the 6:00 o'clock position.

The values for [a], [b], and [c] could be positive or negative. Refer to the accompanying figure to determine the correct sign when recording these values.



Rotate the crankshaft until the dial indicator is at the 12:00 o'clock position and zero the gauge.

NOTE: Do not force the crankshaft beyond the point where the bearing clearance has been removed. Do not pry against the flywheel housing. These actions could cause false bearing clearance readings.

Use a pry bar to raise the rear of the crankshaft to its upper limit. Record the value as [d] in the concentricity work sheet. This is the vertical bearing clearance adjustment and will always be positive.

	a = 0.004
	c = -0.002
	a - c = .006
	b = .003
	d = .002
	b + d = .005



Use the concentricity work sheet to determine the values for the "total vertical" and "total horizontal" values.

The "total horizontal" is equal to the 9:00 o'clock reading, [a], minus the 3:00 o'clock reading, [c].

The "total vertical" is equal to the 12:00 o'clock reading, [b], plus the bearing clearance, [d].

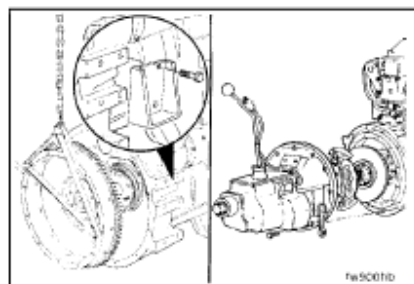
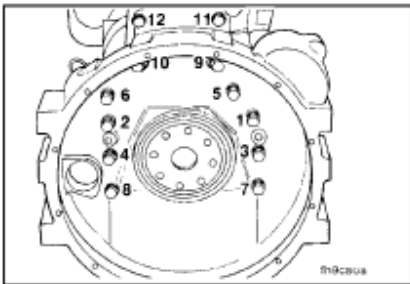
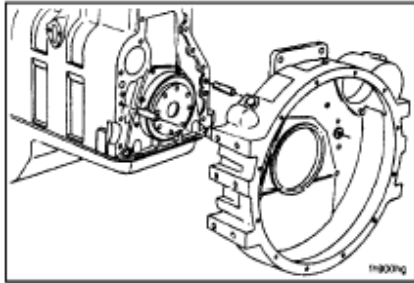
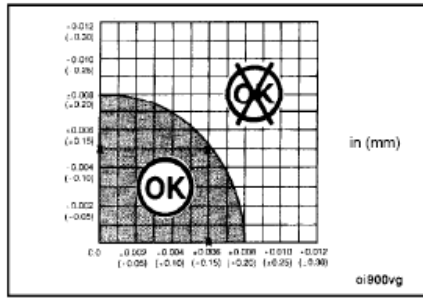
Examples:

6:00 o'clock = ref = 0

9:00 o'clock = (a) = 0.004 inch

12:00 o'clock = (b) = 0.003 inch

3:00 o'clock = (c) = -0.002 inch



Using the work sheet and the numbers from the example, the “total horizontal” value = 0.006 inch and the “total vertical” value = 0.005 inch.

Mark the “total horizontal” value on the horizontal side of the chart and the “total vertical” on the vertical side of the chart.

Use a straight edge to find the intersection point of the “total horizontal” and “total vertical” values. The intersection point must fall within the shaded area for the flywheel housing concentricity to be within specification.

Use the “total horizontal” and “total vertical” values from the previous example, the intersection point falls within the shaded area. Therefore, the flywheel housing concentricity is within specification.

If the intersection point falls outside the shaded area, the ring dowels must be removed and the housing repositioned.

NOTE: The ring dowels are not required to maintain concentricity of the housing/the clamping force of the capscrews holds the housing in position.

After the ring dowels are discarded, install the flywheel housing on the engine.

To position the housing, tighten the capscrews enough to hold the flywheel housing in place, but loose enough to enable small movement when struck lightly with a mallet. Check the concentricity again by following the above procedure.

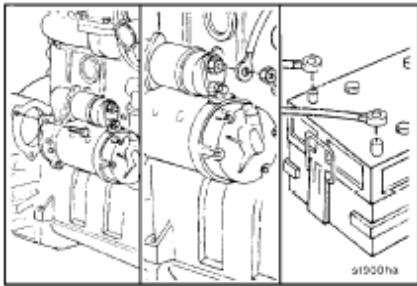
Use the pattern shown in the chart to install and tighten the mounting capscrews.

Torque Value: 77 N•m[57 ft-lb]

Install the rear engine mounts.

Install flywheel.

Install the clutch, transmission, and all related components. Refer to the manufacturer’s instructions.



16 m

Install the starting motor.

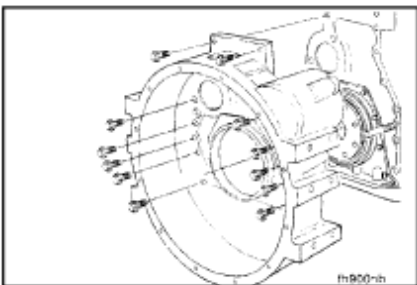


Install and tighten the starting motor capscrews.



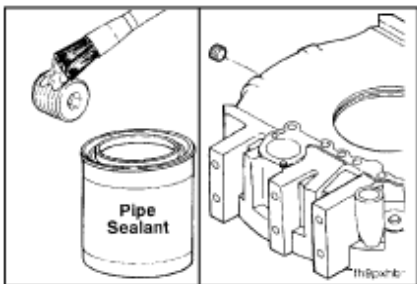
Torque Value: 77 N•m[57 ft-lb]

Connect the battery cables.



Install (Wet Clutch Application)

Perform all the steps in the procedure for dry clutch installation in addition to the following:

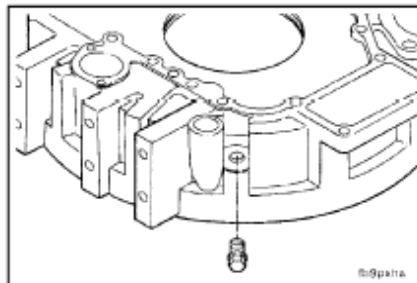


Coat the flywheel housing drain plug with pipe sealant and install into the hole in the bottom of the flywheel housing.

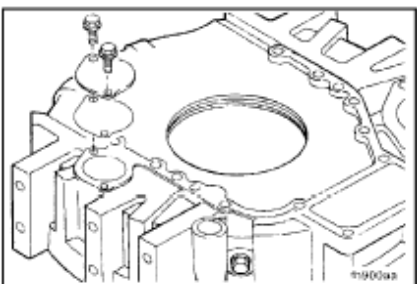


Tighten the plug.

Refer to the pipe plug torque values in Section 12 for different plug sizes.



Install the plastic plug into the tachometer drive access hole.



13 mm

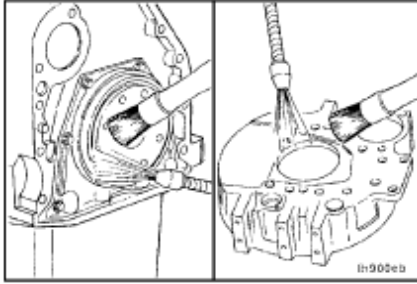
Install the access plate and new gasket.



Install the capscrews and tighten.



Torque Value: 24 N•m[18 ft-lb]



Thoroughly clean the flywheel housing and cylinder block mating surfaces. These surfaces must be clean and free of oil and debris.

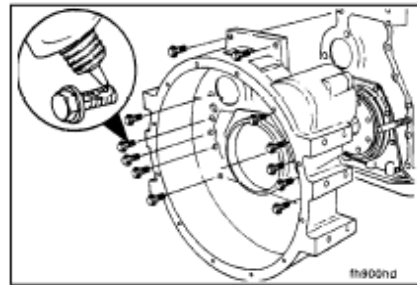
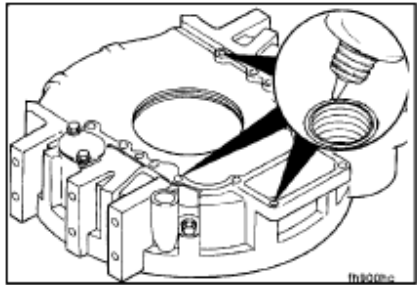
NOTE: The capscrew holes on the mounting pads are drilled through. Coat set screws with Loctite™ 277 and install into holes.

Set Screw Installation Depth

mm		In
0.00	min	0.000
3.00	max	0.118

93

Apply a continuous bead of three bond sealant around all capscrew holes on the mounting surface of the flywheel housing.

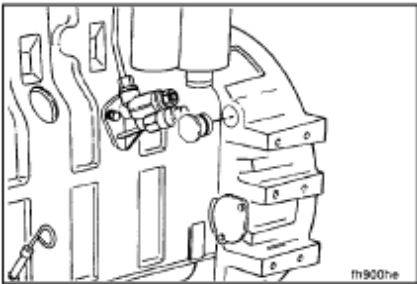


Coat the threads of the mounting capscrews with Loctite™ 277.

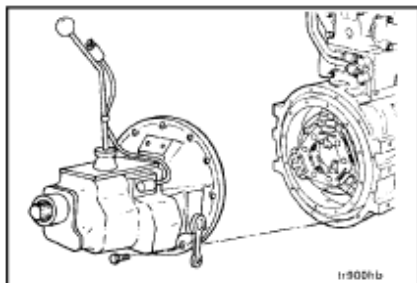


Install and tighten the capscrews.

Torque Value: 77 N•m[57 ft-lb]



Install the plug into the barring gear hole.

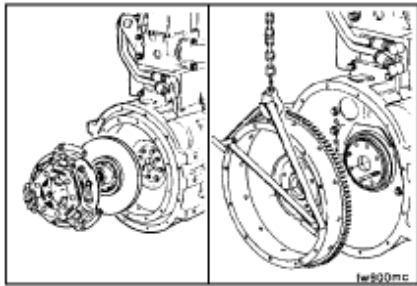


Rear crankshaft seal – Replace

Remove

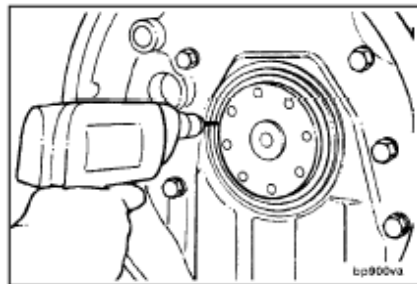
NOTE: It is not necessary to remove the rear cover in order to remove the rear crankshaft seal.

Disconnect the driveline and remove the transmission, if equipped. Refer to the manufacturer's instructions.



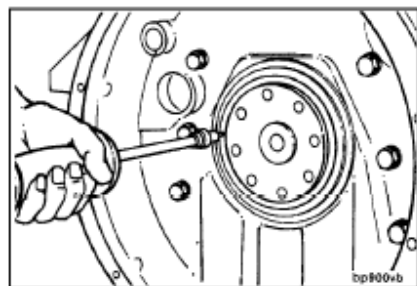
19mm

Remove the clutch and flywheel, if equipped.



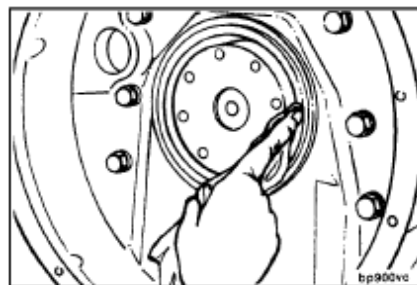
3mm Drill bit, Drill motor

Drill two holes, 180 degrees apart, into the outside metal part of the seal.



No.10 sheet metal screw, slide hammer

Remove the seal.

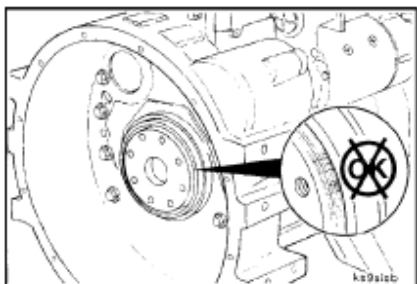


Clean and inspect

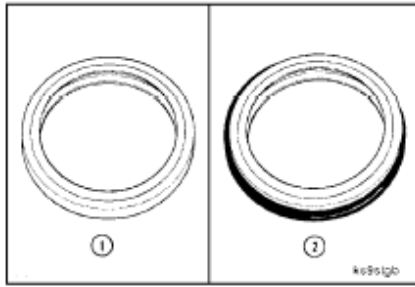
Use a crocus cloth to remove any rust or other deposits from the crankshaft flange.

Use a clean cloth to clean the crankshaft flange.

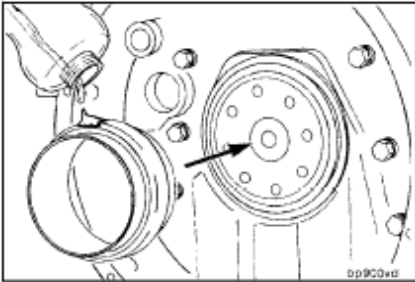
NOTE; Do not use any kind of lubricant to install the seal. The oil seal must be installed with the lip of the seal and the crankshaft clean and dry.



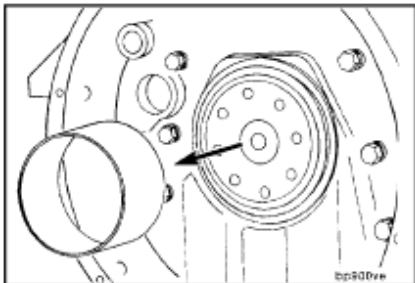
Visually inspect the seal contact area for wear. If the seal contact area has a groove worn deep enough to feel with a fingernail or sharp object, it will be necessary to install a wear sleeve.

**Install**

NOTE: There are two rear seal configurations used; one for dry flywheel housing (1) and one for wet housings (2). The seal for dry housing diameter. The seal for wet housing has a steel case with silicone coated outside diameter. Refer to the appropriate L Series Parts Catalog for the correct part number.

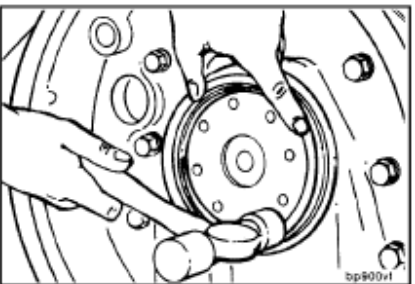


Install the pilot and seal from the seal replacement kit onto the crankshaft. For wet flywheel housings, apply a coat of mild soap to the outside diameter of the seal case. For dry housings, nothing is required on the outside diameter of the seal case.



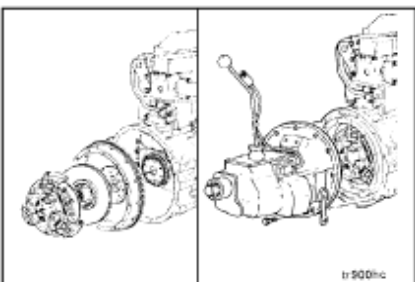
Push the seal onto the pilot and into the bore of the housing. Remove the pilot.

Do not use any sealant on the rear crankshaft seal.

**Hammer**

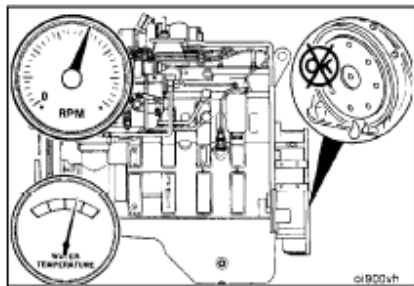
Use the installation tool from the seal replacement kit to install the seal to the correct depth. To prevent damage to the seal, hit the installation tool alternately at the 12:00, 3:00, 6:00, and 9:00 o'clock positions.

NOTE: Make sure the seal is completely installed into the rear housing.

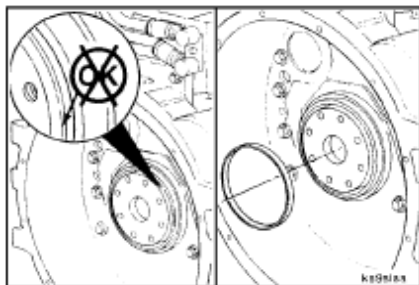


Install the flywheel and clutch, if equipped. Install the transmission and the driveline.

Refer to the manufacture's instructions.



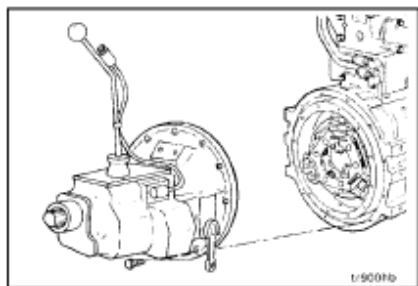
Operate the engine until the coolant temperature reaches 82°C[180°F], and check for leaks and proper operation.



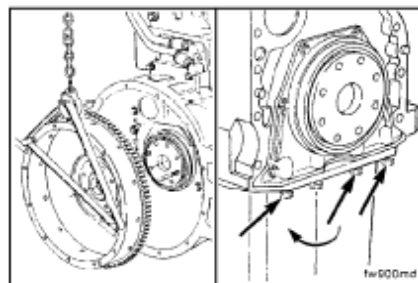
Rear Crankshaft Wear Sleeve-Replace

Remove

If the crankshaft seal has worn a groove in the crankshaft flange, a wear sleeve must be installed to prevent oil leakage.



Disconnect the driveline and remove the transmission, if equipped. Refer to the manufacture's instructions.

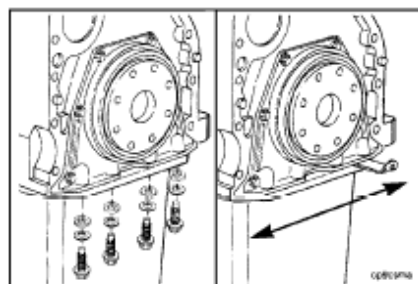


10mm,19mm

Remove the clutch and flywheel, if equipped.

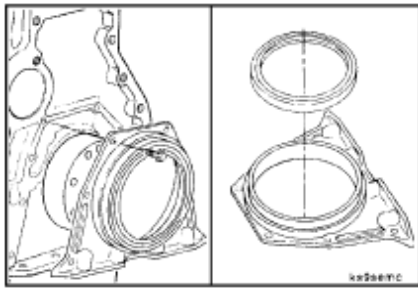
Remove the flywheel housing.

Remove the four lubricating oil pan mounting capscrews which secure the oil pan oil pan to the rear cover.

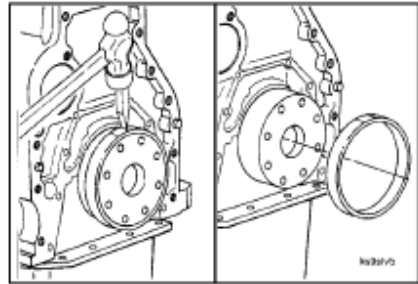


CAUTION: Use extreme care when releasing the oil pan gasket from the rear cover to prevent damage to the gasket. If the gasket is damage, the oil pan must be removed and the gasket replaced.

Insert a feeler gauge or shim stock between the rear cover and the oil pan gasket. Move the feeler gauge or the shim stock back and forth to release the gasket from the rear cover.



Remove the capscrews from the rear cover, and remove the cover from the crankshaft flange.
Remove the rear from the rear cover.



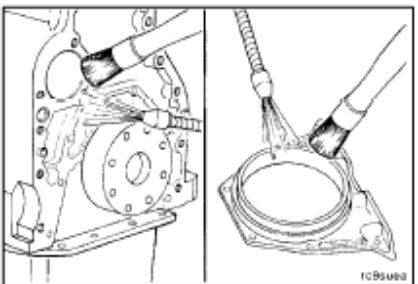
Hammer and chisel

If the crankshaft currently has a wear sleeve, it must be removed before installing a new one.



CAUTION: Do not gouge the crankshaft with the chisel. If the crankshaft is damaged, it must be replaced.

Use a dull chisel that is only as wide as the wear sleeve. Make one or two soft blows with a hammer to make chisel marks across the wear sleeve. This will expand the wear sleeve allowing the sleeve to be removed.

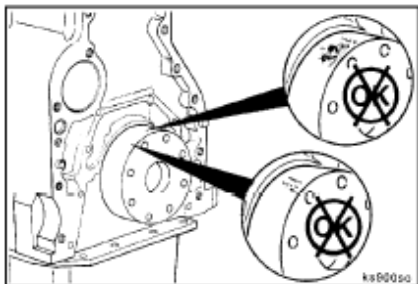


Clean and inspect

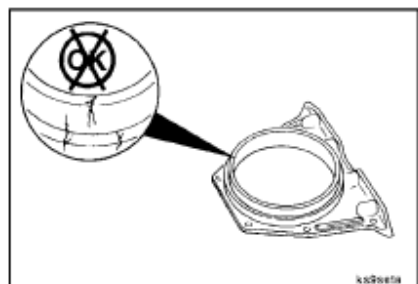
Clean the gasket surface of the cylinder block and rear cover.

Use a crocus cloth to remove any rust or other deposits from the crankshaft flange.

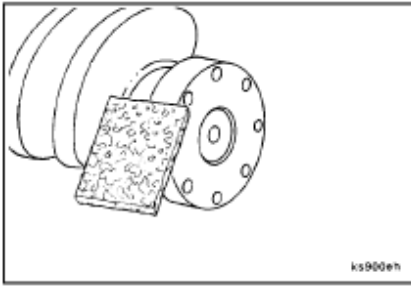
Use a clean cloth to clean the crankshaft flange.



Inspect the crankshaft flange for dirt or scratches.

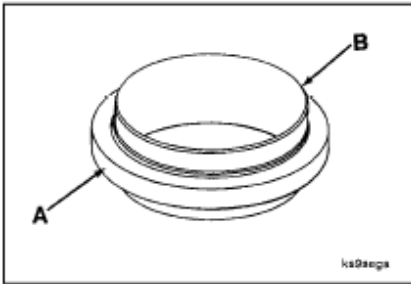


Inspect the rear cover for cracks or other damage.

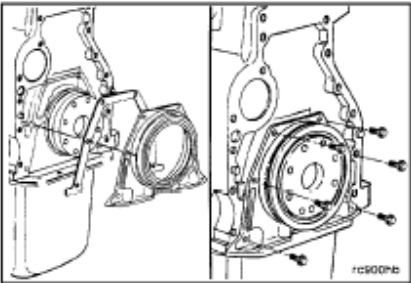


Install

NOTE: Do not use any kind of lubricant to install the seal. The oil seal must be installed with the lip of the oil seal and the crankshaft clean and dry to ensure proper oil sealing.



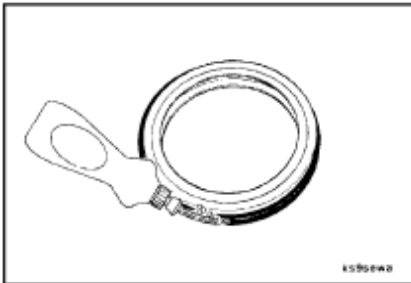
NOTE: The combination crankshaft oil seal (A) wear sleeve (B) replacement kit for service usage is installed on the crankshaft as an assembly. The crankshaft rear oil seal should not be removed from the crankshaft rear seal wear sleeve.



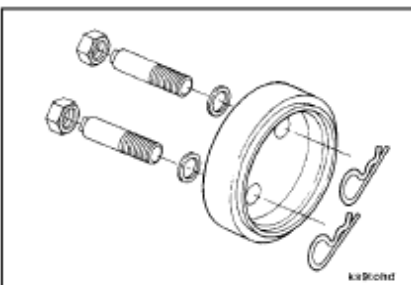
Install rear cover and gasket.

NOTE: Install the rear cover capscrews. Do not tighten. If the oil pan is installed, loosen the oil pan capscrews to allow clearance for rear cover and gasket clearance.

NOTE: The seal installation is being used to properly align the rear cover. Do not push or force the cover in any direction to prevent irregular seal lip position after the seal installation.



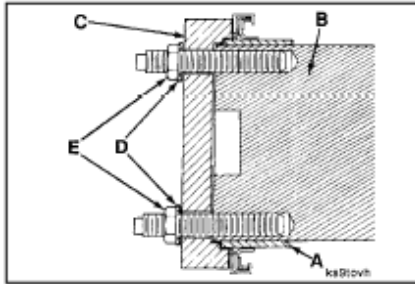
NOTE: The oil seal for a wet flywheel housing requires mid soap on the outside diameter of the seal case. Nothing is required on the outside diameter of the seal case for dry housings.



Use a service tool, part No. 3824078, to install oil seal/wear sleeve assembly. Install two threaded studs into the crankshaft capscrew holes.

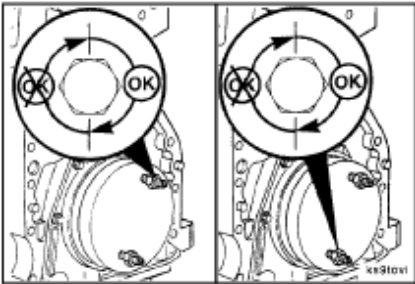


Apply a small amount of clean 15W-40 engine oil to the crankshaft, threaded studs, and inside diameter of the crankshaft rear seal/wear sleeve installation tool.



Position the chamfered end of the wear sleeve(A)onto the end of the crankshaft (B). Position the counterbore with wear sleeve, perpendicular to the end of the crankshaft. Install the washers(D) and nuts(E) onto the threaded studs.

Alternately tighten the nuts until the installation tool contacts the end of the crankshaft.

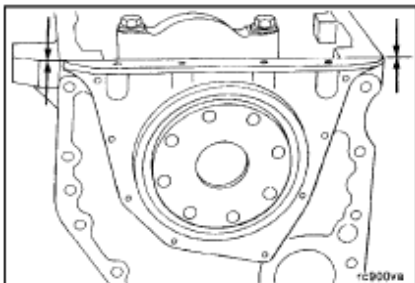


NOTE: Do not exceed 1/2 revolution of each nut to prevent wear sleeve binding and irregular stretch.

Torque value: 20N.M[15 ft-lb]

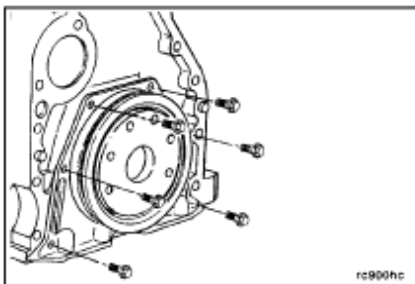
Remove the installation tool and threaded studs.

93



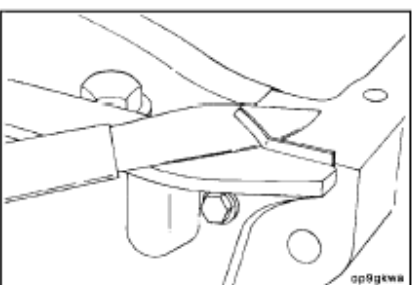
10mm

Align the rear cover even with both sides of the oil pan rail on the cylinder block.



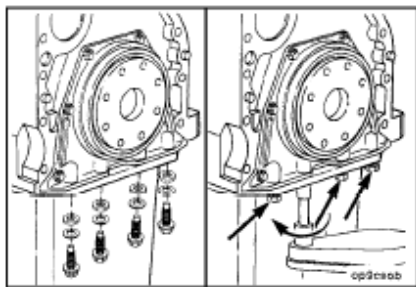
Tighten the rear cover capscrews.

Torque value: 9 N.M[80in-lb]



Trim the gaskets even with the oil pan mounting surface. Make sure the gasket trim does not enter the engine.

NOTE: Be sure to fill the joint between the lubricating oil pan rail and the rear cover with with Three-Bond RTV sealant, Part No. 3823494.

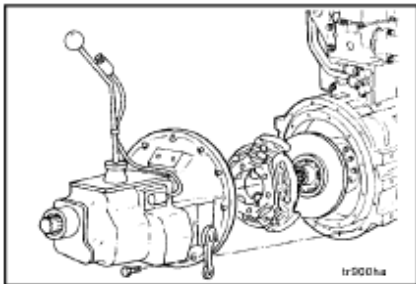


Install the four capscrews which hold the oil pan to the rear cover.



NOTE: The lubricating oil pan capscrews should be torqued within 15 minutes after applying the sealant.

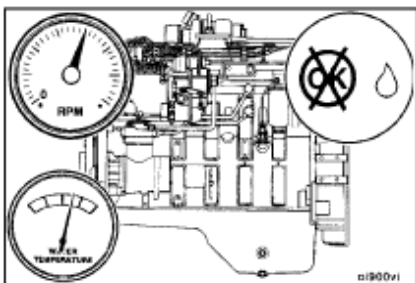
Torque value: 24N.M [18ft-lb]



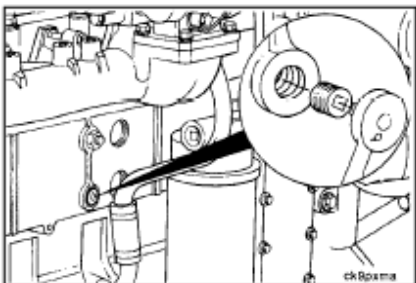
Install the flywheel housing, flywheel and clutch, if equipped.



Install the transmission and the driveline. refer to the manufacturer's instructions.



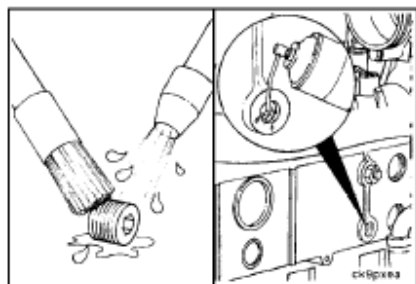
Operate the engine until the coolant temperature reaches 82°C [180°F], and check for leaks and proper operation.



Pipe Plug-Replacement

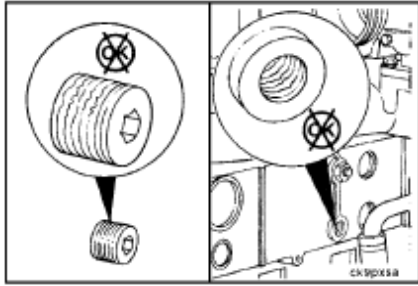
Remove

Select the appropriate size wrench, and remove the pipe plug.



Clean and Inspect

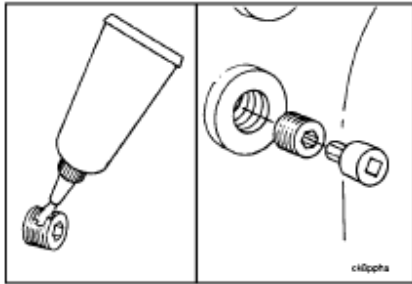
Use spray cleaner, Part No.33755433, or equivalent to clean the threads of the pipe plug and threaded bore.



Visually inspect the threads of the pipe plugs for mutilation or damage.

Visually inspect the threaded bore for damage.

Repair the bore if necessary.



Install

Apply a film of pipe plug sealant, Part No.3375066, or equivalent to the threads.

Install and tighten the pipe plugs.

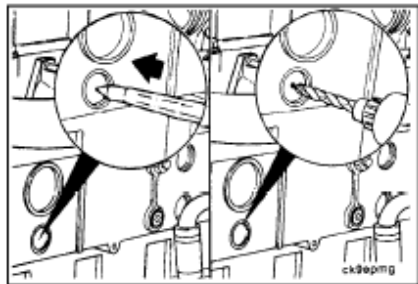
Refer to the following chart for torque values:

in.	mm	lb-ft	N-m	in.-lb	N-m
1/16	1.6	[0.30]	0	15	[10]
1/8	3.2	[0.40]	10	20	[14]
1/4	6.4	[0.50]	20	25	[20]
3/8	9.5	[0.60]	25	30	[20]
1/2	12.7	[0.60]	30	35	[24]
5/8	15.9	[1.00]	40	75	[50]
3/4	19.1	[1.20]	60	95	[70]
1	25.4	[1.50]	75	110	[80]
1 1/4	31.8	[1.80]	90	130	[100]
1 1/2	38.1	[2.00]	100	150	[110]



Tighten pipe plugs to the appropriate torque values.

NOTE: The accompanying chart is also provided in Section V.



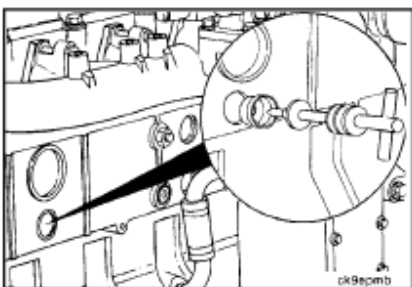
Remove

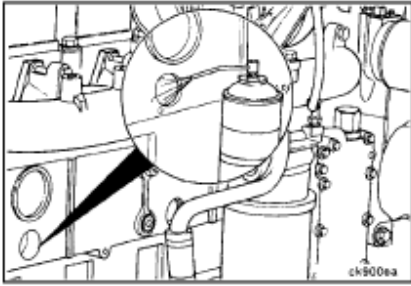
Use a center punch to mark the cup plug for drilling.

CAUTION: Do not allow metal shaving to fall in the engine when drilling a hole in the cup plug. Damage to engine components can occur.

Drill an 1/8-inch hole into the cup plug.

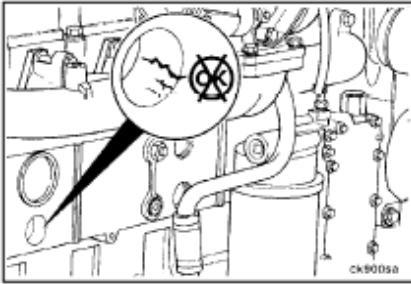
NOTE: Discard all used cup plugs. Do not use them again.





Clean and inspect

Use spray cleaner, Part No. 3375433, or equivalent to clean the cup plug bore.

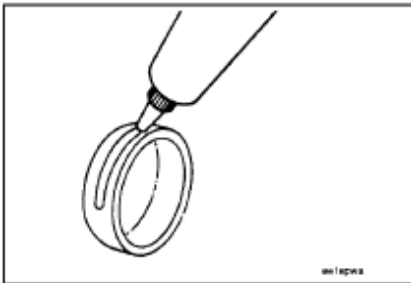


Visually inspect the cup plug bore for damage.

Repair the bore if necessary.



NOTE: Refer to section 12 for cylinder block cup plug bore dimensions and cup plug dimensions.

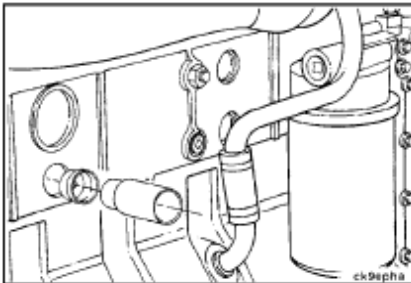


Install

CAUTION: Excessive sealant can run back into the engine and cause damage to other components. Allow the sealant to dry for a minimum of 2 hours before operating the engine.



The plug can come out of the bore if the sealant is not dry. Apply 1 2 mm[1/16 inch]bead of plug lock 'N Seal' Part No. 557568, or equivalent to the outside diameter of the cup plug and the inside diameter of cup plug bore.

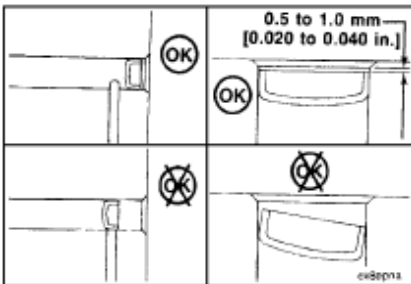


NOTE: Use a cup plug driver to install the cup plug to the correct depth in the cup plug bore.



Use the following cup plug drivers:

Tool P/N	Cup Plug P/N	Cup Plug Dimension
3822372	3900955	0.375inch
3823521	3902606	0.8125inch
3376816	3900957	1.00inch
3823522	156975	1.1875inch
3823523	3905401	1.375inch
3823524	3900965	2.250inch



CAUTION: Do not install the cup plug too deep. The cross drillings in the cylinder block may be blocked. If the plug is not installed straight and flat, it must be replaced with a new cup plug.

The cup plug must be installed with the edge of the plug 0.5 to 1.0mm [0.020 to 0.040 in]deeper than the leading entrance chamber of the bore.

Engine Testing

Engine Testing-General information

The engine test is a combination of an engine run-in and a performance check. The engine run-in procedure provides an operating period that allow the engine parts to achieve a final finish and fit. The performance check provides an opportunity to perform final adjustments needed to optimize the engine performance.

An engine test can be performed using either an engine dynamometer or a chassis dynamometer. If a dynamometer is not available, an engine test must be performed in a manner that simulates a dynamometer test.

Check the dynamometer before beginning the test. The dynamometer must have the capability to test the performance of the engine when the engine is operating at the maximum rpm and horsepower range (full power).

The engine crankcase pressure, often referred to as engine blowby, is an important factor that indicates when the piston rings have achieved the correct finish and fit. Rapid changes of blowby or values that exceed specification more than 50 percent indicate that something is wrong. The engine test must be discontinued until the cause has been determined and corrected.

Engine Testing Specifications

Note: Due to variations in ratings of different engine models, refer to the specific engine data sheet for the particular engine model being tested.

Maintain the following limits during a chassis dynamometer test:

Intake restriction(maximum)

- Clean Filter 380mm H₂O [15in.H₂O]
- Dirty Filter 635MMH₂O [25IN.H₂O]

Air inlet temperature(maximum) 50°C [100°F]

Exhaust temperature 700°C [1290°F]

Exhaust back pressure(maximum) 10KPa

Coolant temperature(maximum) 100°C [212°F]

Lubricating oil temperature(maximum) 126.6°C [260°F]

Engine oil pressure:

- At low idle(minimum allowable) 69kPa [10psi]
- Rated speed(min imum allowable) 207kPa [30psi]

Fuel filter restriction(maximum)

- Dirty filter 89mm Hg [3.5IN.Hg]
- Fuel return restriction(maximum) 35kPa [5psi]

Blowby:

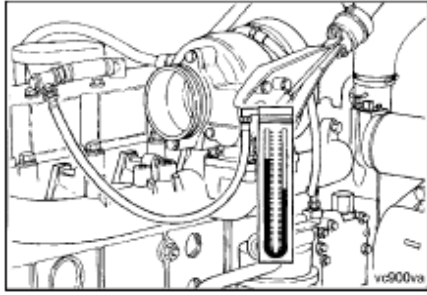
New(L/Min)

Used(L/Min)

226

*Blowby checking tool, part no.3822566,has a special 7.67mm[0.302in.]orifice that must be used to obtain an accurate reading.

Refer to the Blowby Conversion chart to convert liters/minute into inches/water.



Blowby Measurement

Blowby is generally recorded in liters/minute.

Install the part no.3822566 engine blowby tool, to the crankcase breather tube in the valve cover.

Install a water manometer to the engine blowby tool.

Use the blowby conversion chart to convert the manometer reading to liters/minute.

NOTE: A pressure gauge can be used to record the engine blowby.

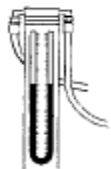
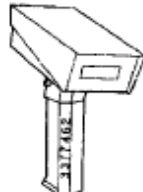
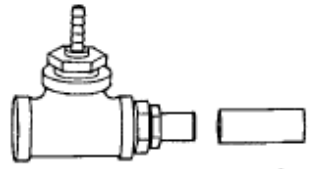
Minimum gauge capacity:1270mm Hg[50in Hg]

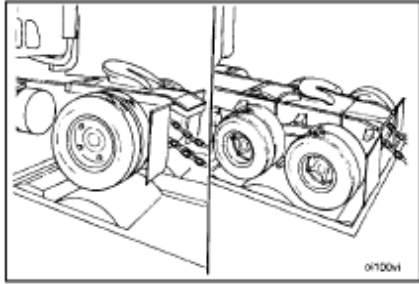
Blowby conversion chart (7.67mm[0.302in]) orifice

In Hg	liter/minute
1	50
2	84
3	103
4	119
5	133
6	145
7	155
8	164
9	172
10	180
11	187
12	193
13	200
14	206
15	211
16	217
17	222
18	226
19	229
20	232

Engine Testing –Service Tools

The following special tools are recommended to perform procedures in section 10. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins authorized repair location.

Tool No	Tool Description	Tool Illustration
93 St-434	Vacuum Gauge Check fuel filter restriction during the engine performance test. Part No.ST-434-2and vacuum gauge ,Part No.ST-434-12,are used to perform the test	 eg8t0gc
ST-1111-3	Manometer Used with the blowby check tool to measure engine crankcase pressure	 eg100ja
ST-1273	Pressure Gauge Used to measure engine intake manifold pressure	 eg8t0gi
3375275	Pressure Gauge (0-160 psi) Used to measure lubricating oil pressure	 3375275
3377462	Digital optical tachometer Used to measure engine speed (RPM).	 3377462
3822566	Blowby checking tool Use with manometer,part No.ST-1111-3,to measure the engine crankcase pressure	 eg8t0ge



⚠ Chassis Dynamometer –operate

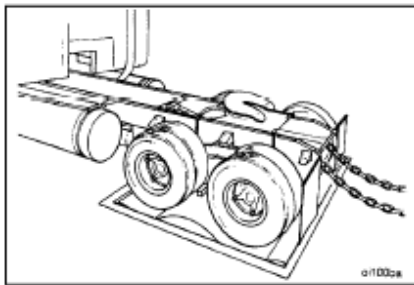
The performance of an engine installed in on-highway vehicles can be tested on a chassis dynamometer.

NOTE: Due to driveline efficiency and engine –driven accessories, the engine horsepower when measured at the rear wheels will be reduced by approximately:

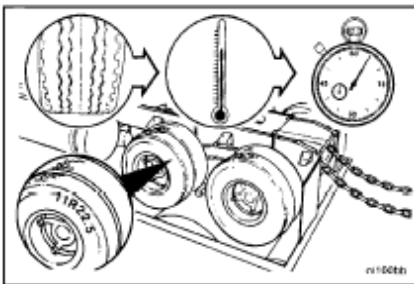
- 20%,single axle vehicles
- 25%,tandem axle vehicles

NOTE: These percentages are used for engine run-in only and are not to be used as absolute figures.

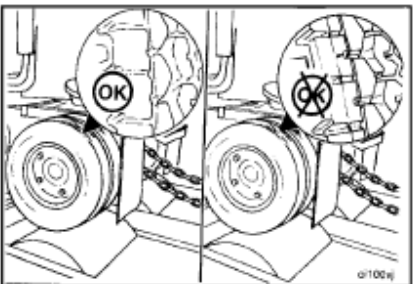
93



CAUTION: Following all the vehicle manufacture's safety precautions before installing or operating a vehicle on a chassis dynamometer.

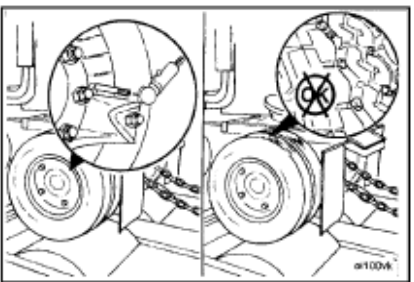


CAUTION: Low profile radial tires are more sensitive to heat than bias ply tires. Excessive operating time at full load can damage tires due to overheating. Check the tire manufacturer's recommendations for the maximum allowable chassis dynamometer operating time.



Following the general safety precautions listed below while operating the chassis dynamometer:

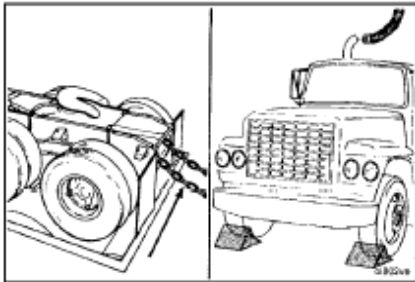
- use tires that have more than 160kilometers [100miles]on them. do not use new tires.
- Do not use recapped tires or tires or tires of different sizes or designs.



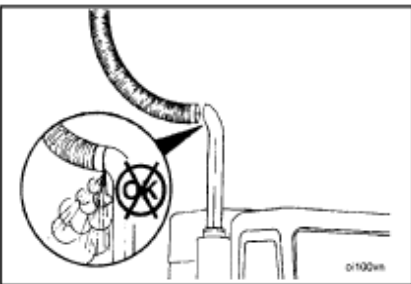
- Make sure the tires are inflated to the manufacturer's specifications.
- Remove all rocks or other material from the tread dynamometer rollers.



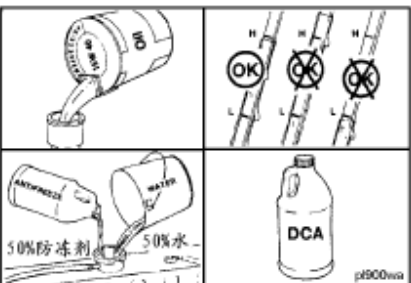
- Make sure there is correct overhead clearance for exhaust stacks, air deflectors, or other attachments above the cab.



- Carefully position the vehicle on the rollers.
- CAUTION:** To prevent damage to the chassis dynamometer, there must be some slack in the tension of the tie-down chains.
- Attach the tie-down chains to the rear of the vehicle, and put wheel chocks in front of the front wheels.

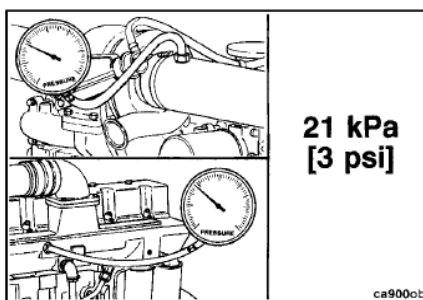
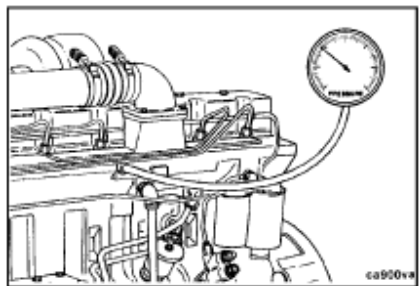
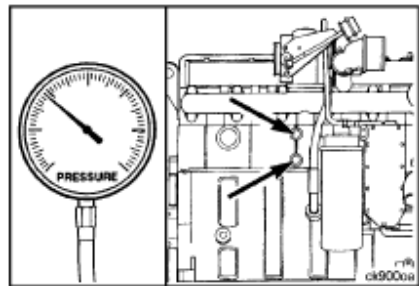
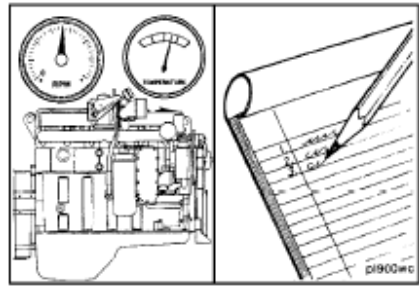
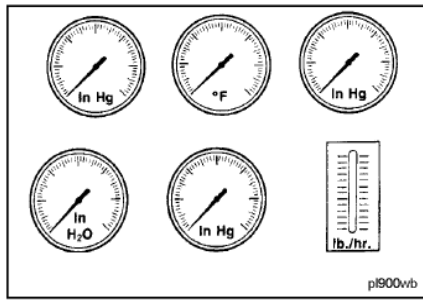


- Adjust the vehicle and dynamometer room exhaust system so make sure all exhaust gases are removed from the room.
- Refer to the chassis dynamometer and vehicle Manufacturer's recommendations and specifications for testing procedures.
- Make sure all instrumentation is removed before removing the vehicle from the dynamometer.



Chassis dynamometer – general Engine test

The following procedure assumes that the lubricating oil and fuel system were correctly primed, the dipstick calibrated, and the engine filled to the correct levels with oil and coolant during installation of the engine into the chassis. If these system were not serviced during installation of the engine, refer to appropriate sections in this manual or to the latest L series operation and maintenance manual, bulletin No. 3810248, for instructions on filling the lubrication oil and the cooling systems.



The number of instruments and gauges required to perform a chassis dynamometer test will vary according to the type and the capability of the test equipment used.

It is good practice to observe these measurements even if engine performance does not meet specifications, these measurements can indicate possible reasons for poor performance.

To correctly monitor an engine's performance, record the following parameters:

- lubrication oil pressure(vehicle instrument panel)
- Coolant temperature(vehicle instrument panel)
- Coolant pressure
- Intake manifold pressure
- Air inlet restriction:
- Blowby
- Engine speed (rpm)(vehicle instrument panel)
- wheel horsepower(WHP)(dynamometer controls)
- Exhaust back pressure

Measure the coolant pressure at the exhaust side of the cylinder block.

Minimum gauge capacity:415kpa[60psi]

Measure the intake manifold pressure (turbocharger Boost).install a pressure gauge,part No.ST-1273,in The loction shown.

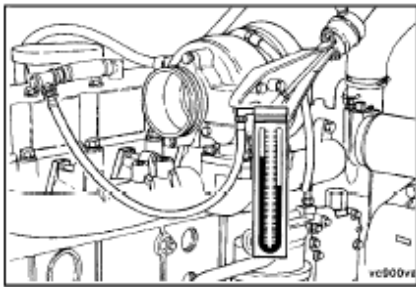
Minimum gauge capacity:1905 mm Hg[75 in Hg]

Connect a water manometer to the turbocharger Air inlet pipe to test air restriction.

NOTE: the manometer connection must be installed at a 90 degree angle to the air flow in a straight section of pipe, one pipe diameter before the turbocharger.

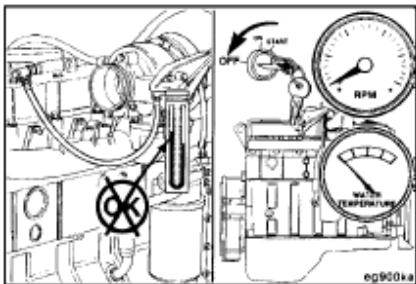
NOTE: A vacuum gauge can be used in place of the Water manometer.

Minimum gauge capacity:760 mm Hg[30 in Hg]

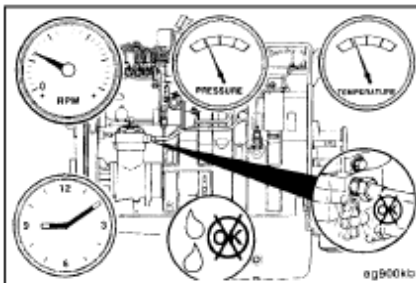


Measure the blowby by installing blowby checking Tool, part No.3822566 in the crankcase breather vent. Connect the blowby tool to a water manometer .refer To procedure for blowby specifications.

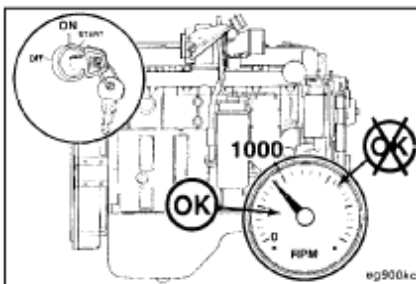
NOTE: Excessive blowby indicates an engine internal components malfunction gases to enter the crankcase.



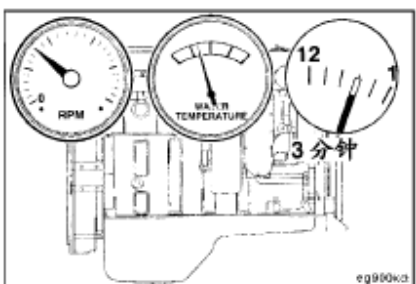
NOTE: If a sudden increase in blowby occurs, or if blowby exceeds the maximum allowable limit during any run –in step, return to the previous step and continue the run – in. if blowby does not reach an acceptable level, discontinue the run-in and determine the cause.



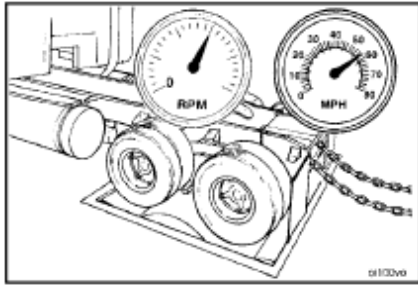
NOTE: Avoid long idle periods. Operate the engine at Low idle only long enough (3 to 5 minutes) to check for correct oil pressure and any fuel, oil water,or air leaks.



CAUTION: Do not allow the engine speed to exceed 1000 RPM Before run-in. the internal components can be damaged.



CAUTION: Do not shut off the engine immediately after the last step of the run-in is completed. allow the engine to cool by operating at low idle for a minimum of 3 minutes to avoid internal component damage.



Engine Run-in – (Chassis Dynamometer)

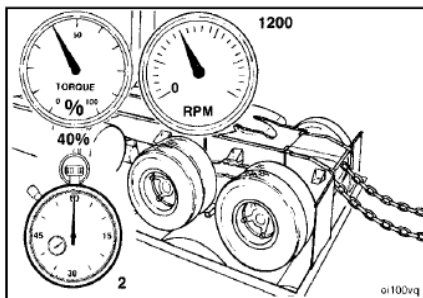
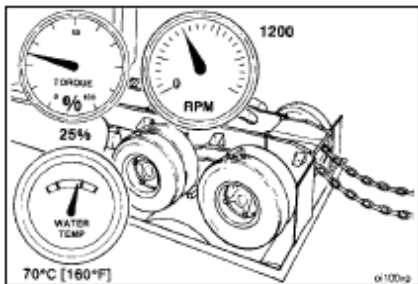


CAUTION: To avoid internal component damage, refer to Chassis dynamometer general engine test before Operating the engine.

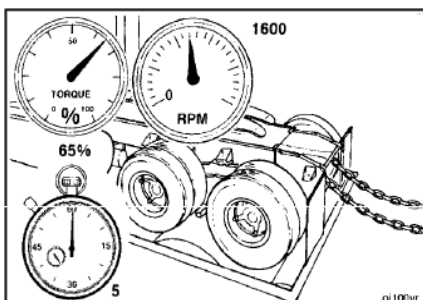
NOTE: Refer to chassis dynamometer operation at page 10-6 for general operating procedures and safety precautions.

NOTE: Operate the vehicle in a gear that produces a road speed of 90 to 95 kmh [55 to 60 mph].

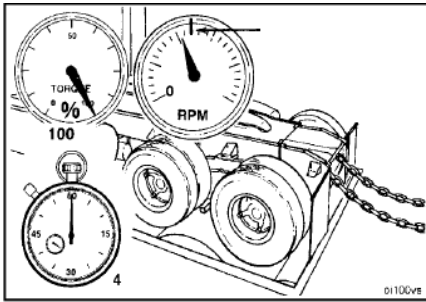
Operate the engine at 1200 RPM and 25 percent of rated load until the coolant temperature reaches 70°C [158°F]



Operate the engine at 1200 RPM AND 40 percent of rated load for 2 minutes. Check the gauges and record the readings.

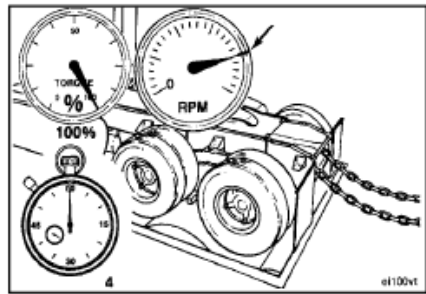


Operate the engine at 1600 RPM and 65 percent of Rated load for 5 minutes. Check the gauges and record the reading.



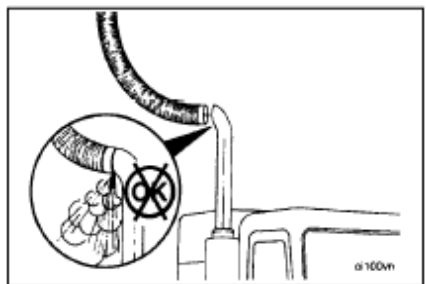
Operate the engine at torque peak RPM and full load for 4 minutes. Check the gauges and record the readings.

NOTE: Refer to the engine data sheet for the torque Peak RPM of the engine model being tested.

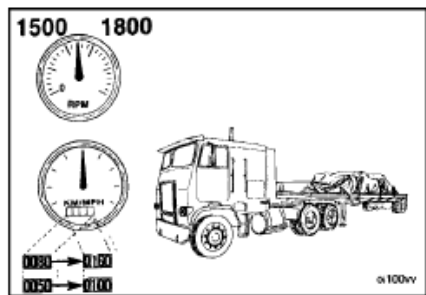


Operate the engine at rated speed(RPM)and full load for 4 minutes. Check the gauge and record the readings. Compare the reading to those published on the appropriate engine data sheet.

CAUTION: Do not shut off the engine immediately after the run-in is completed. allow the engine to cool by Operating it at low idle for a minimum of 3 minutes to avoid internal component damage.



Make sure all instrumentation is removed before Removing the vehicle from the dynamometer.



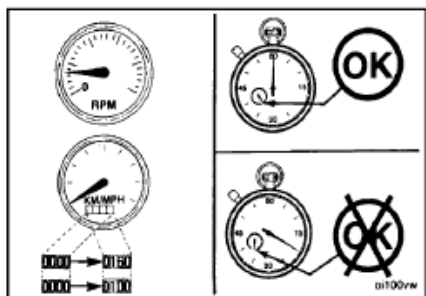
Engine run-in (without dynamometer)

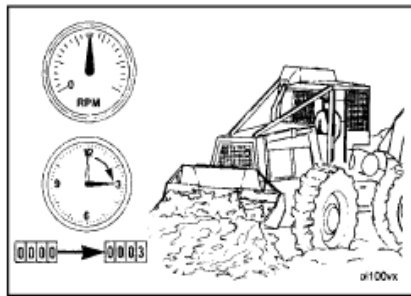
On –highway applications

CAUTION: Refer to chassis dynamometer-general engine to Avoid internal component damage.

Operate the engine at 1500 to 1800 RPM in high gear for the first 80 to 160 kilometers [50 to 100 miles] after rebuild.

NOTE: do not idle the engine for more than 5 minutes at any one time during the first 160 kilometers[100 miles] of operation.

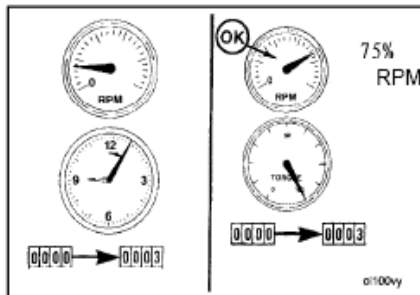




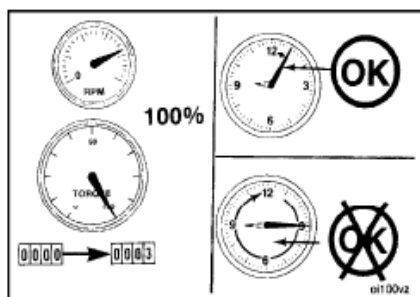
Refer to chassis dynamometer –general engine

test(procedure 8-03)before operating the engine to avoid internal component damage.

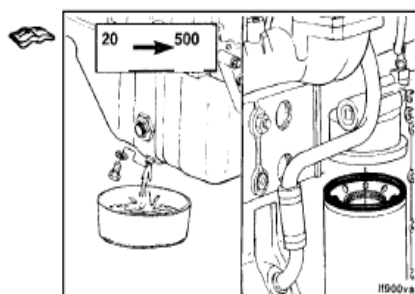
Operate the engine as follows during the first 3 Hour after rebuild:



1. Do not idle the engine for more than 5 minutes at any one time.
2. operate the engine at 75 percent throttle while loaded.



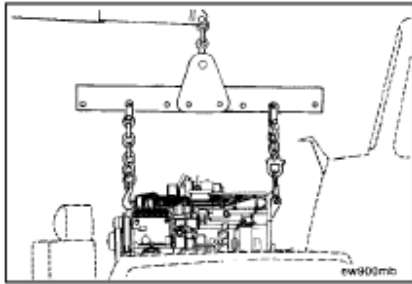
3. do not operate the engine at rated speed(RPM) and full load for more than 5 minutes at any one time.



Change the lubricating oil and filter 800 km[500 miles]
Or 20 hours of operation. Refer to procedures 2-04 for Instructions.

NOTES

Engine Remove and Install

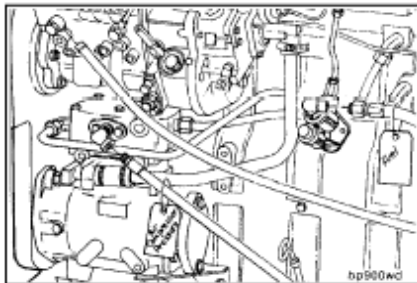


Engine Remove and Install-General Information

The procedures to replace an engine will vary with different engine models, the type of equipment, optional equipment, and the shop facilities. use the following procedures as a guide.

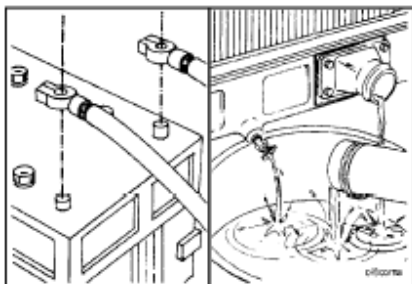
NOTE: All replacement steps will not apply to all types of equipment. complete only the steps which apply to the equipment involved. use the equipment manufacturer's recommendations and precautions for removal of chassis parts to gain access to the engine.

93

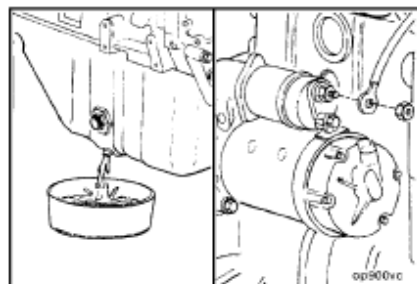


Engine -Removal

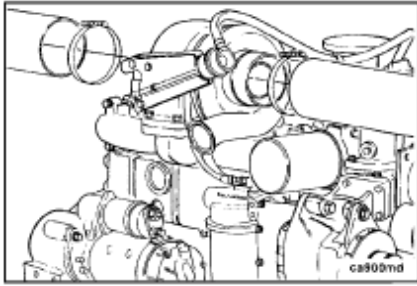
Place a tag on all hoses, lines, linkage, and electrical connections as they are removed to identify their locations.



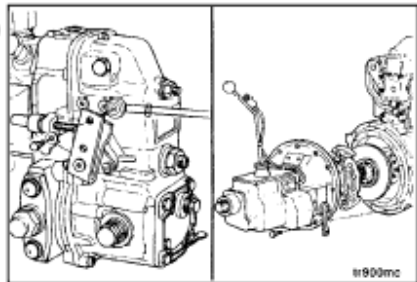
Disconnect the battery cables.
Drain the engine coolant.



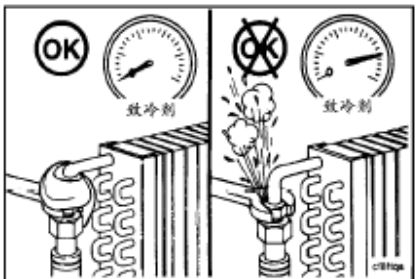
Drain the lubrication oil.
Disconnect the starter cable, engine ground straps, cab or chassis to engine hoses, tubing, electrical wires and hydraulic lines.



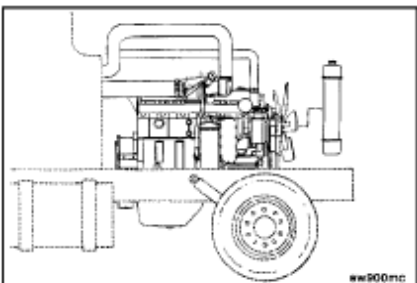
Disconnect the intake and exhaust pipes.
Disconnect all chassis mounted engine driven accessories.



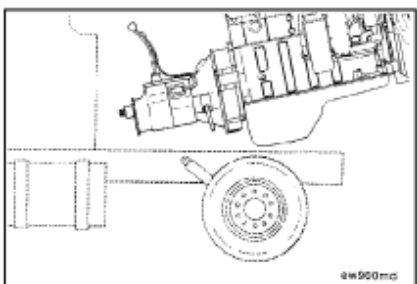
Disconnect the throttle from the injector pump.
Disconnect the drive units from the flywheel.



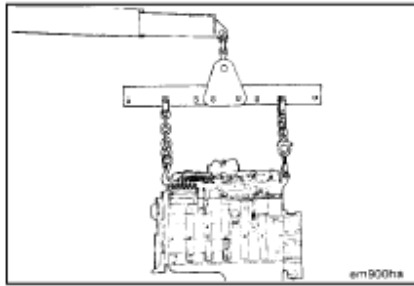
WARNING: If a liquid refrigerant system (air conditioning) is used, wear eye and face protection and wrap a cloth around the fittings before removal. Liquid refrigerant can cause serious eye and skin injury.



Remove all chassis components necessary remove the engine from the equipment.

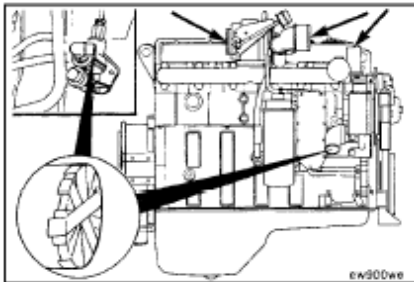


NOTE: On applications where the rear engine mounts are attached to transmission, it may be necessary to remove the engine and transmission as an assembly.
WARNING: The engine lifting equipment must be designed to safely lift the engine and transmission as an assembly. The dry weight of the standard engine and transmission as an without accessories is 606kg[1335lb]. Refer to the equipment manufactures specifications for the transmission weight.



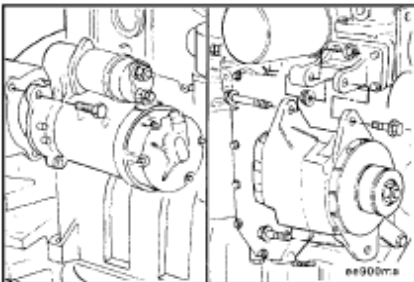
Use a properly rated hoist and engine lifting fixture, attached to the engine mounted lifting brackets to remove the engine.

NOTE: If the transmission to prevent it from falling.

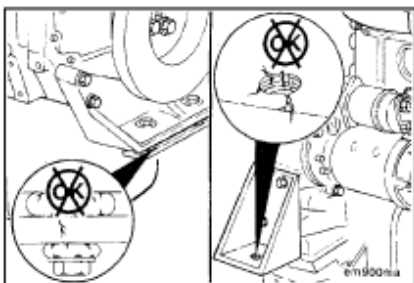


Cover all engine openings to prevent dirt and debris from entering the engine.

Place the engine on suitable engine support stands.



Remove all remaining accessories and brackets to use with the replacement engine.

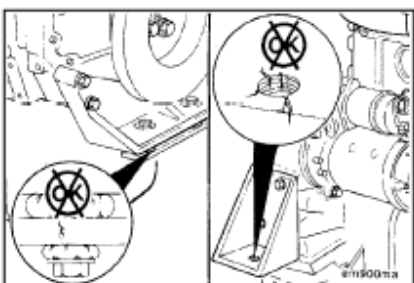


Engine Assembly Inspection

Inspect all rubber-cushioned mounts for cracks or damage.

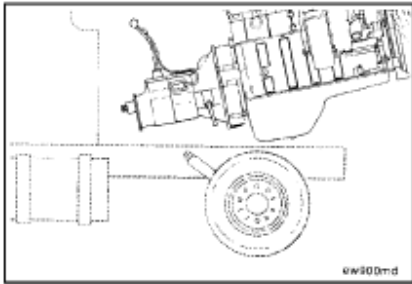
Inspect all mounting brackets for cracks or damaged bolt holes.

NOTE: Damaged engine mounts and brackets can cause engine misalignment. Drive line components damage may result in vibration complaints.



Engine – Install

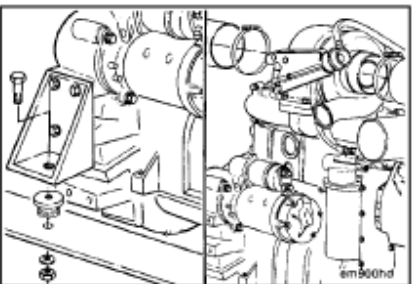
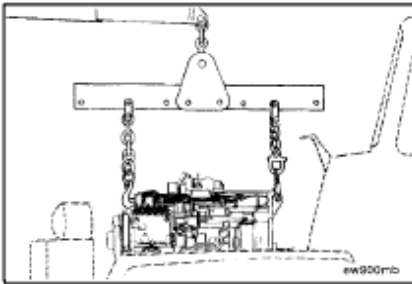
Install all accessories and brackets that were removed from the previous engine.



NOTE: On application where the rear engine mounts are attached to the transmission, it may be necessary to install the engine and transmission as an assembly.

WARNING: The engine lifting equipment must be designed to safely lift the engine and transmission as an assembly. The net weight of the engine without accessories is 650 kg. Refer to the equipment manufacturer's for the transmission weight.

Use a properly rated hoist and engine lifting fixture, attached to the engine mounted lifting brackets to install the engine.

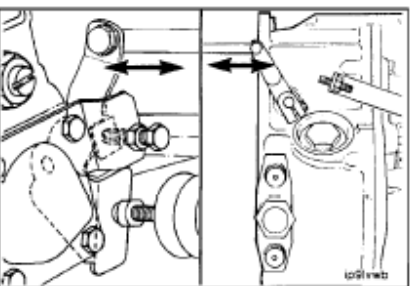
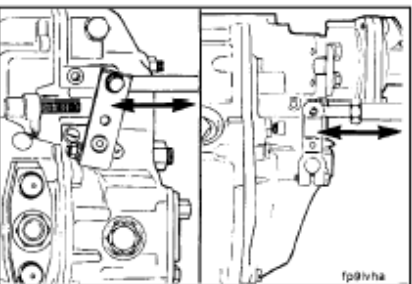


Align the engine in the chassis and tighten the engine mounting capscrews. Refer to the equipment manufacture's torque specifications. Connect all engine and chassis mounted accessories that were removed.

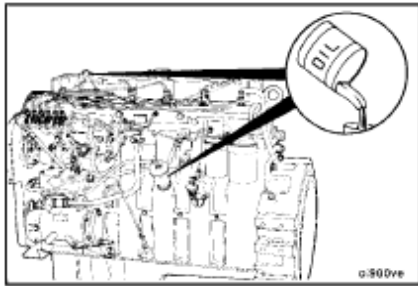
NOTE: Be sure all lines, hoses, and tubes are properly routed and fastened to prevent damage. Be sure the air intake and exhaust pipe connections are tight and free of leaks.

Throttle Control Lever Connection

When connecting the cable/rod to the control lever, adjust the length so the lever has stop-to-stop movement.

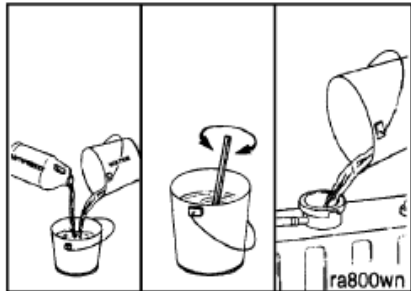


Adjust the length of the cable/rod to the mechanical shut down lever so there is stop-to-stop movement.



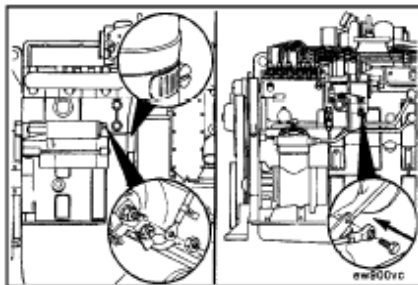
Fill the engine with clean 15W-40 lubricating oil.

NOTE: The total oil system capacity, including full flow and bypass filters is, 27.6liters.



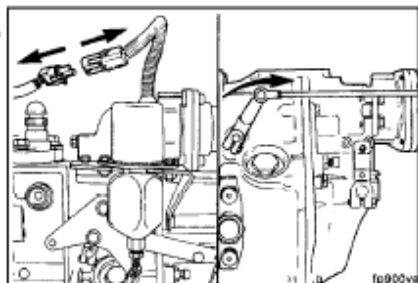
Fill the cooling system with a premixture of 50 percent water, 50 percent ethylene glycol base antifreeze and DCA4 corrosion protection.

NOTE: The total coolant capacity(engine only) is:
Air after cooled: 11.1 liters.

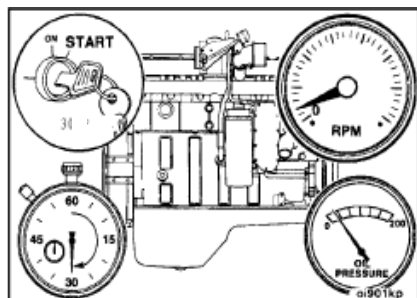


CAUTION: Installation of the radiator cap at this point is critical to proper purging of air trapped in the cooling system. Improper purging of air from the cooling system will result in engine damage from overheating.

Perform a final inspection to make sure that all hoses, wires, linkages, and components have been properly installed and tightened.

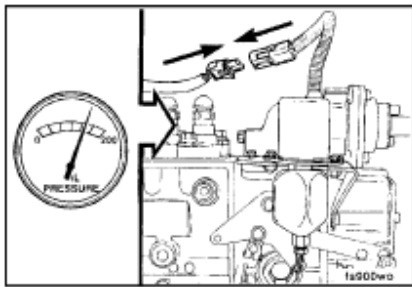


Make sure the fuel is shut off by removing the wire from the fuel solenoid or the mechanical fuel shut off is in the "OFF" position. This is necessary to prevent the engine from starting during the oil rifle pressure charging operation.

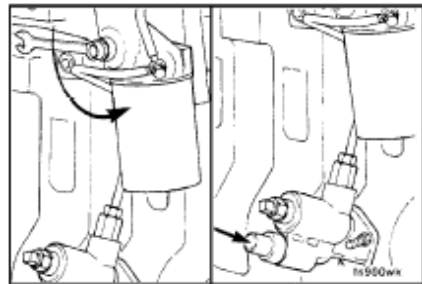


CAUTION: Do not engage the starting motor for more than 30 seconds. Restart in 2 minutes after the motor shut down.

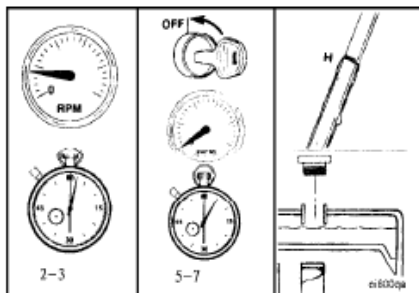
Crank the engine until the oil pressure gauge indicates a positive pressure.



After pressure is observed, connect the wire to the fuel solenoid.

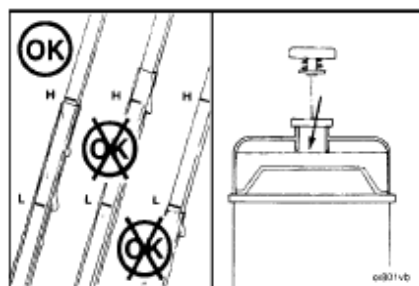


Prime the low pressure fuel system fuel system by opening the bleed screw.
Operate the plunger on the fuel transfer pump until the fuel flowing from the fitting is free of air.
Tighten the bleed screw.

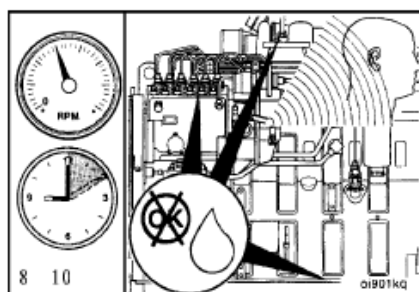


Operate the engine at low idle for 2 to 3 minutes.
WARNING: Do not remove the radiator cap from a hot engine. Hot steam can cause serious personal injury. The engine coolant temperature must be below 50°C [122°F].

Shut off the engine and wait 5 to 7 minutes for the oil to drain to the oil pan and check the oil and coolant levels again.



Fill the engine to the correct oil and coolant levels if necessary. Refer to the lubricating oil specifications and cooling system.



Operate the engine at 1000 to 1200 RPM for 8 to 10 minutes. Check for proper operation, unusual noises, and coolant, fuel or lubricating oil leaks.
Repair all leaks and component problems. Refer to the appropriate procedures.
Refer to the engine run-in and test procedures.

NOTES

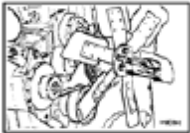
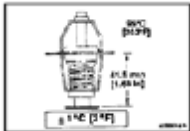
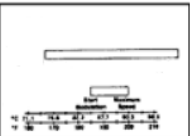
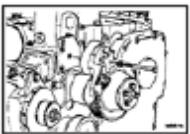
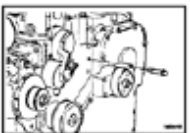
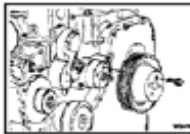
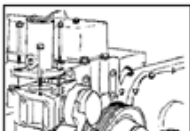
Engine Components Specifications

Specification – General Information

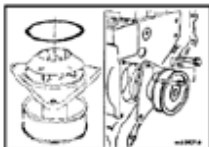
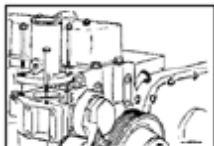
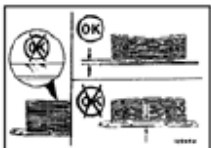
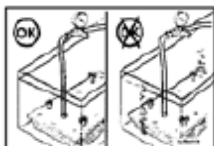
This section contains the engine and component specifications used in this manual, separated by systems in the same sequence they appear in the manual. A procedure number will each component description to aid in locating illustrations that describe inspection procedures. Component capscrew installation torque values will follow the specifications in each systems procedure.

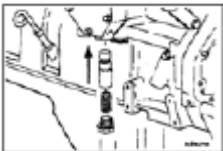
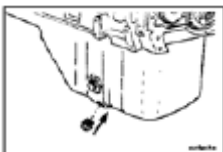
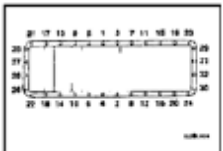
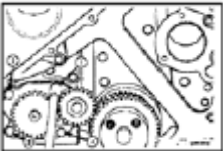
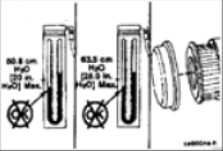
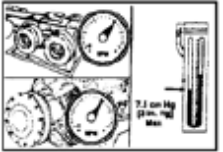
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Note: There are some component rebuild specifications listed in this section. The procedures for rebuilding these components are not included in this manual. If the procedure number is not listed, refer to the L Series shop manual for rebuild information.

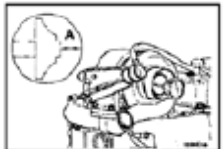
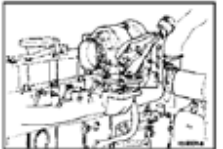
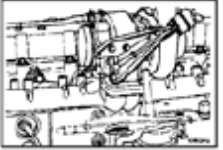
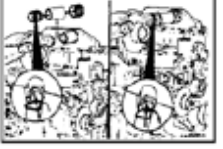
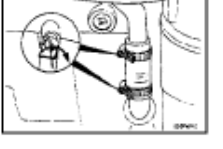
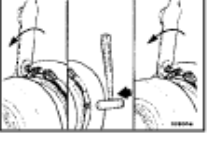
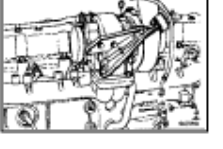
Component or assembly(procedure)		Ref. No./Steps	Metric	Imperial	
Component specifications and torque values					
Cooling system specifications					
Fan hub shaft end clearance		0.15mm	MAX	0.006 in	
Thermostat operating temperature		81℃	MIN	178°F	
Initial opening temperature		83℃	MAX	182°F	
		95℃	MAX	203°F	
Fully open temperature		41.5mm	MAX	1.63in	
Viscous fan drive operating temperature		85℃		185°F	
Start modulation		93℃		200°F	
Global maximum					
Radiator cap pressure test					
A-104℃[220°F]		103kpa	MIN	15psi	
B-99℃ [210°F]		48kpa	MIN	7psi	
Cooling system torque values					
Belt tensioner mounting capscrew		43N.M		32ft-lb	
Fan hub mounting capscrew					
		24N.M		18ft-lb	
Fan hub pulley mounting capscrews					
		43N.M		32ft-lb	
Hose clamps					
		5N.M		44in-mb	
Thermostat housing mounting capscrews					
		24N.M		18ft-lb	

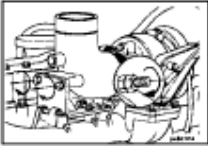
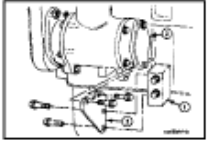
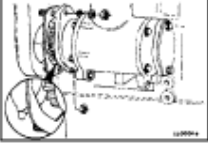
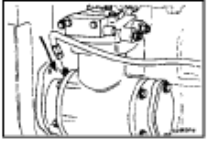
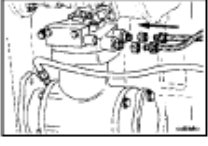
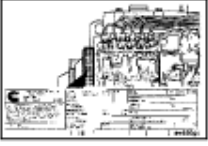
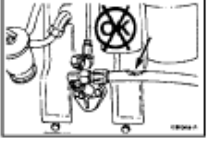
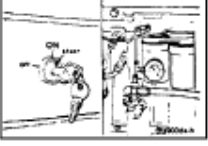
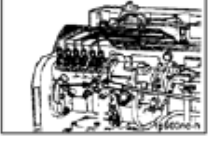
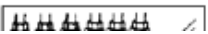
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L Series Engines-Engine Components Specifications

Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Water pump mounting capscrews		24N.M	18ft-lb	
Water outlet connection		24N.M	18ft-lb	
Lubricating oil system specifications				
Oil cooler distortion		0.8mm	MAX 0.031in	
Oil cooler element pressure test				
pressurize the cooler to 483kpa[70psi],and check for leaks by submerging in water.				
Oil pressure regulator spring				
Oil pressure regulator spring 13-coils		86.63mm	Okay 3.411in	
Spring load at 53.98mm[2.125in] Valve open		190N	MIN 42.8lbf	
Spring load at 60.33mm[2.375in]		153N	MIN 34.4lbf	
Oil pump gerotor tip clearance		0.025mm	MIN 0.001in	
		0.178mm	MAX 0.007in	
Oil pump port plate clearance		0.025mm	MIN 0.005in	
		0.127mm	MAX 0.015in	
Oil pump body bore clearance		0.127mm	MIN 0.005in	
		0.381mm	MAX 0.015in	
Oil pump drive gear backlash		0.08mm	MIN 0.003in	
		0.03mm	MAX 0.013in	
Oil pump idler gear backlash		0.08mm	MIN 0.003in	
		0.03mm	MAX 0.013in	
Lubricating oil system torque values				
				

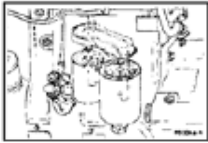
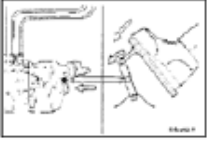
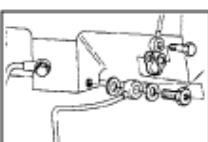
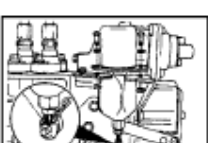
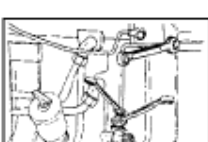
Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial		
Crankcase breather tube bracket					
M8(rocker cover)		24N.M	18ft-lb		
M12(cylinder head)		77N.M	57ft-lb		
Oil cooler mounting capscrews		24N.M	18ft-lb		
Oil filter head mounting capscrews		24N.M	18ft-lb		
Lubricating oil pressure regulator plug					
		80N.M	59ft-lb		
Oil drain pulg					
		80N.M	59ft-lb		
Oil pan mounting capscrews					
NOTE: Tighten the capscrews in the sequence shown. Start at the center of the oil pan and alternate toward both ends.		24N.M	18ft-lb		
Oil pump suction tube bracket					
Suction tube to block	A	9N.M	80in-lb		
Brace to block	B	9N.M	80in-lb		
Brace to suction tube	C	9N.M	80in-lb		
Oil pump mounting capscrews					
		24N.M	18ft-lb		
Oil thermostat					
		50N.M	37ft-lb		
Air combustion system specifications					
Intake air restriction					
Naturally aspirated		50.8cmH ₂ O	MAX	20.0 inH ₂ O	
Turbocharged		63.5cmH ₂ O	MAX	25.0in H ₂ O	
Exhaust air restriction		76.2mm	MAX	3.0inHg	
		152.4mm	MAX	6.0inHg	
Turbocharger radial clearance(side to side)					

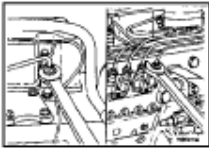
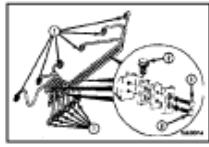
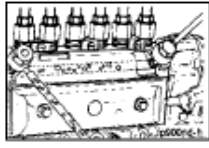
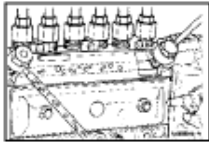
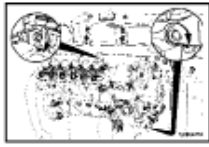
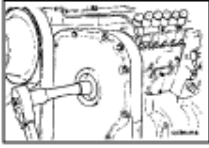
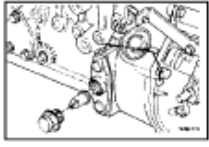
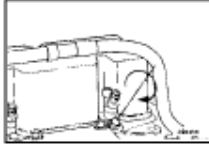
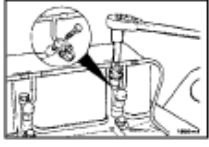
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L Series Engines-Engine Components Specifications

Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Turbocharger axial clearance(end clearance)		0.21mm	MIN 0.008in	
		0.46mm	MAX 0.018in	
Charge air cooler		0.03mm	MIN 0.001in	
		0.08mm	MAX 0.003in	
Differential pressure across cooler		21Kpa	MAX 3psi	
Air combustion system torque				
Turbocharger mounting nut		45N.M	33ft-lb	
Turbocharger oil drain mounting capscrew		4N.M	8ft-lb	
Turbocharger air crossover hose clamps		5N.M	44in-lb	
Turbocharger oil drain line hose clamps		5N.M	44in-lb	
Turbocharger turbine housing capscrews		11N.M	97in-lb	
Turbocharger compressor housing clamp		8N.M	71in-lb	
Turbocharger oil supply line connection		35N.M	26ft-lb	
NOTE: Hold turbo supply fitting when tightening turbo oil supply line.				

Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Turbocharger discharger elbow		8N.M	71in-lb	
Compressed air system torque values				
Air compressor brace to air compressor				
Mounting capscrews				
Holset		43N.M	32ft-lb	
Bendix		43N.M	32ft-lb	
Midland		32N.M	24ft-lb	
Air compressor brace to cylinder block		43N.M	32ft-lb	
mounting capscrew				
Air compressor flange mounting nuts				
Nuts		77N.M	57ft-lb	
Stud to gear housing		hand-tighten		
Air compressor oil supply line		15N.M	12ft-lb	
Air compressor coolant lines		35N.M	26ft-lb	
Fuel system specifications				
Engine low idle speed				
Refer to the engine dataplate.				
Fuel transfer pump inlet restriction		150mm Hg	MAX	
Fuel transfer pump outlet pressure at rated speed				
	High flow	172kpa	MIN	25psi
Fuel pump				
Fuel inlet pressure	high flow	138kpa	MIN	20psi
	low flow	48kpa	MIN	7psi
Fuel injection pump				
				

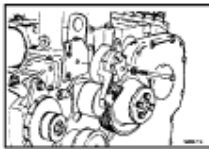
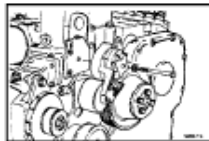
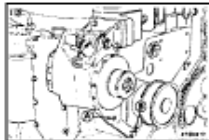
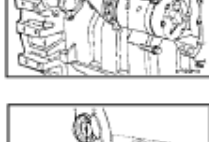
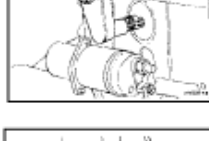
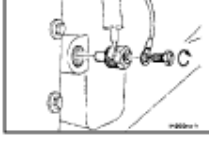
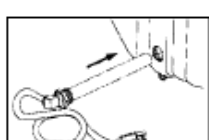
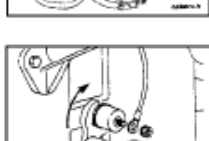
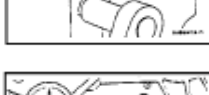
93-412
L Series Engines-Engine Components Specifications

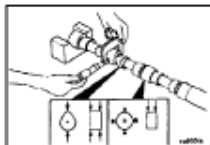
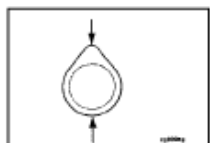
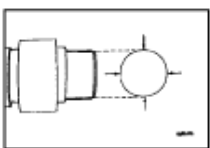
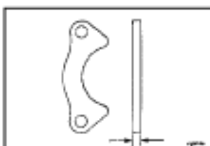
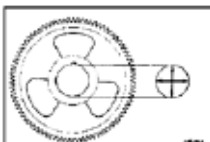
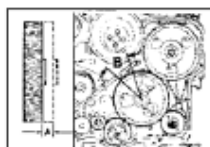
Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Fuel drain line restriction		518mmHg	MAX 20.4 in Hg	
Fuel filter restriction				
Pressure drop across filter		35kpa	MAX 5psi	
Fuel drain line restriction		70kpa	MAX 10psi	
Injection pump throttle lever				
Over travel separation amount		3.18mm	MIN 0.125in	
		6.35mm	MAX 0.250in	
Fuel system torque values				
AFC air fuel control fitting		24N.M	+18ft-lb	
Fuel filters.				
CAUTION: Hand tighten only. Mechanical tightening will damage the fuel filter.				
Fuel filter head adapter		4N.M	35in-lb	
Fuel filter adapter nut		32N.M	24ft-lb	
Fuel filter head banjo fittings		24N.M	18ft-lb	
Fuel pump solenoid mounting capscrews		10N.M	89in-lb	
Fuel transfer pump				
Fuel fittings		24N.M	18ft-lb	
Fuel transfer pump mounting capscrews		24N.M	18ft-lb	

Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
High-pressure fuel fitting		30N.M	22ft-lb	
High pressure fuel line support bracket		24N.M	18ft-lb	
Vibration isolator capscrew		6N.M	53in-lb	
Injection pump supply banjo fitting		32N.M	24ft-lb	
Injection pump Mounting nuts		44N.M Hand-tighten	32ft-lb	
Injection pump lower support bracket				
M10 pump to support bracket capscrew		24N.M	18ft-lb	
M10 support bracket to block capscrew		77N.M	57ft-lb	
Injection pump drive gear nut				
P Pump		165N.M	122ft-lb	
Injection pump timing pin access plug		15N.M	11ft-lb	
Injector clamp capscrew		24N.M	18ft-lb	
Injection nozzle drain banjo fitting		10N.M	89 in-lb	
Electrical system specifications				
Alternator belt				
Belt tensioner, no adjustment necessary.				

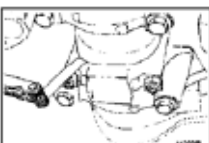
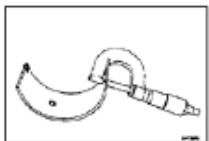
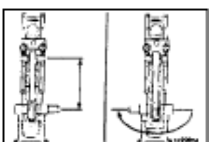
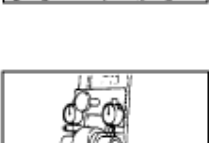
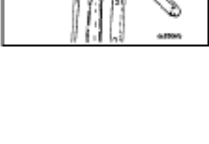
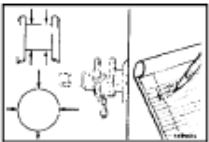
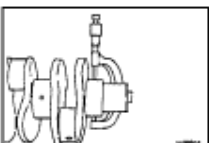
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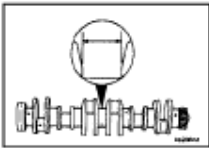
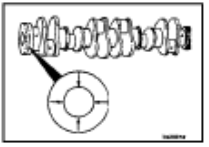
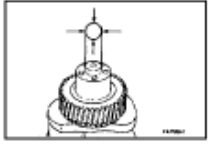
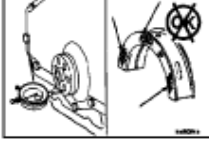
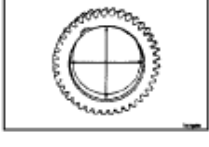
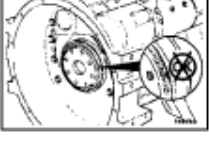
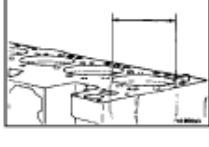
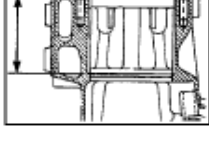
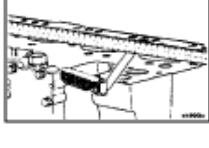
L Series Engines-Engine Components Specifications

Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial													
Battery specific gravity		at 27 °C [80 °F] state of charge		<table><tr><td></td><td>@ 27 °C [80 °F]</td></tr><tr><td>100%</td><td>1.260-1.280</td></tr><tr><td>75%</td><td>1.230-1.250</td></tr><tr><td>50%</td><td>1.200-1.220</td></tr><tr><td>25%</td><td>1.170-1.190</td></tr><tr><td></td><td>1.110-1.130</td></tr></table>		@ 27 °C [80 °F]	100%	1.260-1.280	75%	1.230-1.250	50%	1.200-1.220	25%	1.170-1.190		1.110-1.130
	@ 27 °C [80 °F]															
100%	1.260-1.280															
75%	1.230-1.250															
50%	1.200-1.220															
25%	1.170-1.190															
	1.110-1.130															
		1.260 to 1.280	100%													
		1.230 to 1.250	75%													
		1.200 to 1.220	50%													
		1.170 to 1.190	25%													
		1.110 to 1.130	discharged completely													
Electrical system torque values																
Alternator belt tensioner capscrew		44N.M	32ft-lb													
Alternator mounting pivot	A															
M10 capscrew		44N.M	32ft-lb													
Alternator lower support bracket	B															
M8 capscrew		24N.M	18 ft-lb													
M10 capscrew		44N.M	32ft-lb													
Alternator mounting capscrew	C	77N.M	57ft-lb													
Alternator mounting capscrew		77N.M	57ft-lb													
Coolant heater		12N.M	106in-lb													
Temperature sensor																
Install – cast Iron		50N.M	37ft-lb													
Install – aluminum		30N.M	22ft-lb													
Oil heater element		120N.M	89ft-lb													
Oil pressure switch																
Install – cast iron		16 N.M	12ft-lb													
Install –aluminum		10N.M	89in-lb													
Basic engine component																

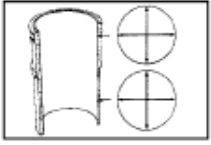
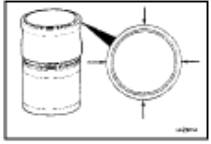
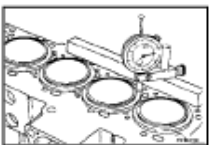
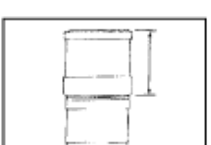
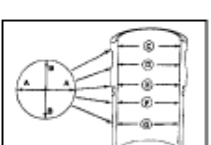
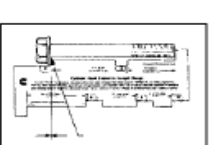
Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
specifications				
Camshaft bore I.D.				
With bushing		60.12mm	2.367in	
Without bushing		64.1mm	2.520in	
NOTE: If one of the bushings exceeds the specifications, all of the bushings must be replaced.				
Camshaft journal O.D.		59.962mm	MIN 2.3607 in	
		60.013mm	MAX 2.3627in	
Camshaft lobe diameter				
Intake lobe		51.03mm	MIN 2.0383 in	
		51.72mm	MAX 2.0571 in	
Exhaust lobe		50.78mm	MIN 2.0313 in	
		51.46mm	MAX 2.0501 in	
Fuel transfer pump lobe		41.310mm	MIN 1.6264 in	
		41.829mm	MAX 1.6468 in	
Camshaft nose (gear mounting surface)O.D.		41.562mm	MIN 1.6363 in	
		41.580mm	MAX 1.6370 in	
Camshaft thrust plate thickness		9.340mm	MIN 0.3677 in	
		9.600mm	MAX 0.3772 in	
Camshaft gear bore I.D.		41.480mm	MIN 1.6331 in	
		41.505mm	MAX 1.6341 in	
Camshaft end clearance	(A)	0.10mm	MIN	
		0.36mm	MAX	
Camshaft gear backlash limits	(B)	0.08mm	MIN 0.003 in	
		0.33mm	MAX 0.013 in	
Connecting rod piston pin bushing inner				

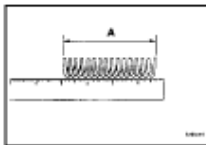
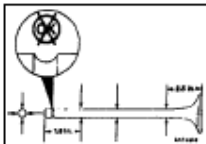
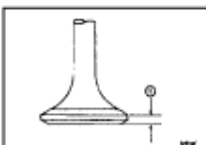
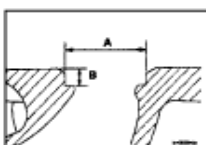
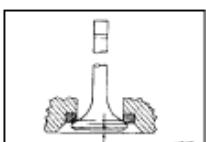
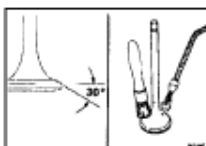
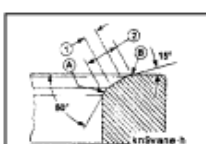
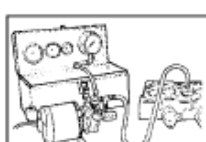
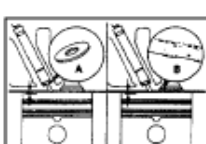
93-416**L Series Engines-Engine Components Specifications**

Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
diameter		45.023mm	MIN 1.7726 in	
(with bearing)		45.060mm	MAX 1.7740 in	
Connecting rod crankshaft bore I.D (with bearing shell)		76.046mm	MIN 2.9939 in	
.		76.104mm	MAX 0.0046 in	
Connecting rod side clearance in (with plastigauge)		0.033mm	MIN 0.0013	
		0.017mm	MAX 0.0046 in	
Connecting rod side clearance		0.100mm	MIN 0.0039 in	
		0.330mm	MAX 0.0130 in	
Connecting rod bearing journal thickness				
Criterion		2.455mm	MIN 0.0966 in	
		2.471mm	MAX 0.0973 in	
Connecting rod length		215.975mm	MIN 8.5029 in	
		216.025mm	MAX 8.5049 in	
Connecting rod bend(alignment)				
• without bushing		0.20mm	MAX 0.008 in	
• with bushing		0.15mm	MAX 0.006 in	
Connecting rod twist				
• without bushing		0.50mm	MAX 0.020 in	
• with bushing		0.30mm	MAX 0.012 in	
Crankshaft connecting rod journal				
• O.D		75.962mm	MIN 2.9906 in	
		76.013mm	MAX 2.9926 in	
• Out -of -round		0.050mm	MAX 0.0020 in	
• Taper		0.013mm	MAX 0.0005 in	
Crankshaft main journa				
• O.D.		97.962mm	MIN 3.8568 in	
		98.031mm	MAX 3.8595 in	
• Out -of -round		0.050mm	MAX 0.0020 in	
• Taper		0.013mm	MAX 0.0005 in	

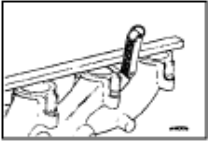
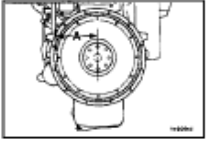
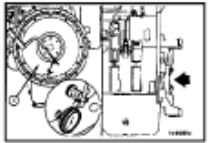
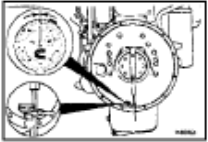
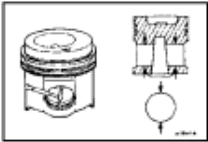
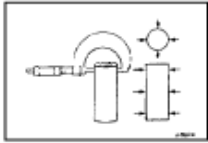
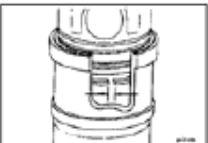
Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Crankshaft thrust face width(standard)		42.975mm 3.076mm	MIN 1.6919 in max 0.0005 in	
Crankshaft rear oil seal flange outside diameter		129.975mm 130.025mm	MIN 5.1171 in MAX 5.1191 in	
Crankshaft damper pilot O.D.		23.924mm 24.000mm	MIN 0.9419 in MAX 0.9449 in	
Crankshaft gear journal O.D.		75.987mm 76.006mm	MIN 2.991 in MAX 2.992in	
Crankshaft end clearance				
New		0.127mm 0.385mm	MIN 0.005 in MAX 2.992 in	
Used		0.533mm	MAX 0.021 in	
Crankshaft gear bore I.D.		75.898mm 75.923mm	MIN 2.9881 in MAX 2.9891 in	
Crankshaft rear oil seal wear groove		0.25mm	MAX 0.010 in	
Cylinder block upper liner bore I.D.		130.900mm 130.990mm	MIN 5.1535 in MAX 5.1570 in	
Cylinder block upper deck to mid stop liner seat area		122.930mm 123.000mm	MIN 4.8397 in MAX 4.8425 in	
Cylinder block				
Surface flatness overall		0.075mm	MAX 0.0030 in	
Surface flatness within 50mm[2.0 in]		0.012mm	MAX 0.0005 in	
Cylinder block main bearing bore I.D.				
• without bearing		104.982mm	MIN 4.1333 in	

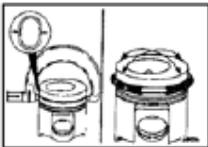
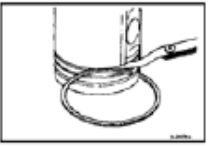
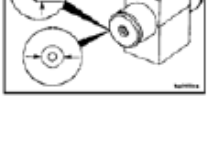
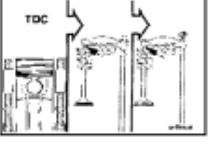
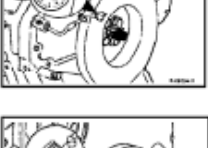
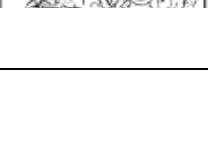
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L Series Engines-Engine Components Specifications

Component or assembly(procedure)	Ref. No./Steps	Metric		Imperial	
• with bearing		105.018mm	MAX	4.1344 in	
		98.079mm	MIN	3.8614 in	
		98.123mm	MAX	3.8632 in	
Cylinder head cup plug requirements					
Apply a bead of Loctite™277 or					
Cummins sealant,	1	30.43mm		1.198 in	
Part No.3375068,	2	58.06mm		2.286 in	
around the outside diameter of					
all cup plugs before installation					
Cylinder liner I.D.		114.000mm	MIN	4.4882 in	
		114.000mm	MAX	4.4897 in	
Cylinder liner O.D.(top press fit)		130.938mm	MIN	5.1550 in	
		130.958mm	MIX	5.1558 in	
Cylinder liner protrusion		0.025mm	MIN	0.0010 in	
		0.122mm	MAX	0.0048 in	
Cylinder liner-to-block clearance		0.229mm	MIN	0.0090 in	
Cylinder liner seat area depth		123.026mm	MIN	4.8435 in	
		123.052mm	MAX	4.8445 in	
Cylinder liner out-of-round		0.08mm	MAX	0.003 in	
Cylinder liner taper		0.08mm	MAX	0.003 in	
Cylinder head capscrew free length					
• Short jackscrew		81.5mm	MAX	3.21 in	
• Long jackscrew		160mm	MAX	6.40 in	
Cylinder head flatness					
End to end(longitudinal)		0.200mm	MAX	0.0079 in	
Side to side (transverse)		0.076mm	MAX	0.0030 in	

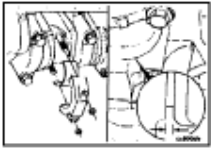
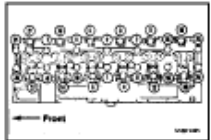
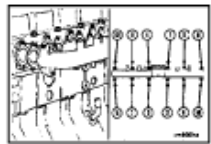
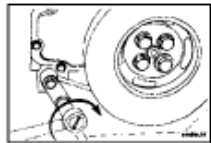
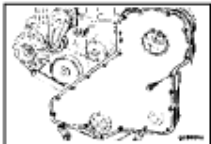
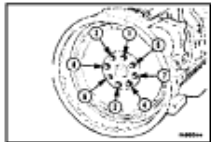
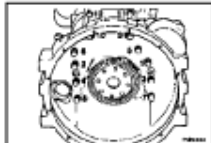
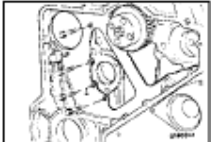
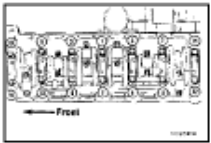
Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Valve spring free height(7 1/2 coils)		59.18mm	nominal 2.585 in	
Valve stem outside diameter		7.96mm 8.00mm		
Valve head thickness at O.D.				
Intake		2.21mm	criterion	
Exhaust in		2.21mm	criterion	
Valve guide I.D.(installed)				
Intake valve		49.25mm 49.75mm	MIN MAX	
Exhaust valve		49.25mm 49.75mm	MIN MAX	
Valve guide bore inside diameter		15.931mm 15.971mm	MIN MAX 0.6271 in 0.6288 in	
Valve recess in cylinder head				
Exhaust valve		1.09mm 1.62mm	MIN MAX 0.043 in 0.064 in	
Intake valve		0.59mm 1.12mm	MIN MAX 0.023 in 0.044 in	
Valve face angle				
Intake valve		30°		
Exhaust valve		45°		
Valve seat width limit				
Grind area (A)with a 60 degree stone, and(B)with a 15 degree stone to center the seat on the valve face and obtain the valve seat width limits.		1.5mm 2.0mm	MIN MAX 0.060 in 0.080 in	
Valve seat leakage (Hg)				
New		635mm Hg	MIN 25 in Hg	
Used		457mmHg	MAX 18 in Hg	
Injector nozzle tip protrusion		3.0mm 4.0mm	MIN MAX 0.118 in 0.157 in	

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L Series Engines-Engine Components Specifications

Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Exhaust manifold flatness		0.20mm	MAX 0.008 in	
Flywheel face runout T.I.R.	I.R.(A)			
	mm in			
	203 8	0.203mm	MAX 0.008in	
	254 10	0.254mm	MAX 0.010in	
	305 12	0.305mm	MAX 0.012in	
	356 14	0.356mm	MAX 0.014in	
	406 16	0.406mm	MAX 0.016in	
Flywheel bore runout T.I.R.		0.127mm	MAX 0.0050 in	
Flywheel bore alignment T.I.R.	SAE NO			
	1	0.20mm	MAX 0.008 in	
	2	0.20mm	MAX 0.008 in	
	3	0.20mm	MAX 0.008 in	
Main bearing thickness(standrd)		3.446mm	MIN 0.01357 in	
		3.454mm	MAX 0.1360 in	
Main bearing clearance with plastigauge		0.066mm	MIN 0.0026 in	
		0.134mm	MAX 0.0053 in	
Piston pin bore I.D.		45.006 mm	MIN 1.7719 in	
		45.025mm	MIN 1.7726 in	
Piston pin outside diameter		44.993mm	MIN 1.7710 in	
		45.003mm	MAX 1.7718 in	
Piston ring gap(new)				
Top ring gap		0.35mm	MIN 0.014 in	
		0.60mm	MAX 0.024 in	
Intermediate ring gap			MIN 0.014 in	
0.35mm		0.65mm	MAX 0.026 in	
Oil ring gap		0.30mm	MIN 0.0118in	
		0.60mm	MAX 0.0236 in	
Piston skirt O.D. (worn limit)		113.808mm	MIN 4.4806 in	

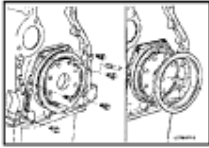
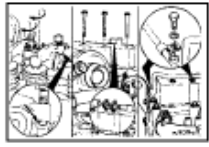
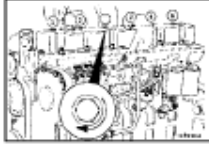
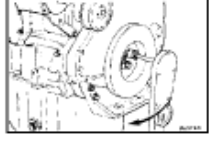
Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Top ring groove keystone angle wear		113.879mm	MIN 4.4834 in	
Use micrometer and part No.3823966		113.938mm	MIN 4.4857 in	
Intermediate ring groove keystone angle wear		114.323mm	MIN 4.5009 in	
Use micrometer and part No.3823965		0.070mm	MIN 0.0028in	
Intermediate rectangular ring side clearance		0.150mm	MAX 0.0059 in	
Oil ring gap		0.020mm	MIN 0.0008in	
		0.130mm	MAX 0.0051 in	
Rocker lever bore I.D.		24.987mm	MIN	
		25.013mm	MAX	
Rocker lever shaft O.D.		24.950mm	MIN	
		24.962mm	MAX	
Tappet O.D.		23.35mm	MIN	
		23.39mm	MAX	
Valve adjustment clearance				
Intake valve		0.30mm	Nominal 0.012 in	
Exhaust valve		0.61mm	Nominal 0.024 in	
Vibration damper face runout		0.28mm	MAX 0.011 in	
Vibration damper eccentricity TIR		0.28mm	MAX 0.011 in	
Vibration damper thickness				
Measure the thickness at four locations 90 degrees apart approximately 3.18 mm[0.125 in]from the outside diameter. The difference between any two of the four measurements must not exceed 0.25mm[0.010in].				
Basic engine torque				
Camshaft thrust plate capscrew		24N.M	18ft-lb	

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L Series Engines-Engine Components Specifications

Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Connecting Rod Nut	Step1	40N.M	30ft-lb	
	2	80N.M	60ft-lb	
	3	120N.M	88ft-lb	
Cylinder head mounting capscrews	Step 1	50N.M (all capscrews)		
	2	150N.M(long only)	105ft-lb	
	3	120N.M	88ft-lb	
Exhaust manifold capscrews with lock tabs				
lockplae		43N.M	32ft-lb	
Front engine support bracket mounting capscrews		112N.M	83ft-lb	
No support		60 N.M	44ft-lb	
Front gear cover capscrew		24 N.M	18ft-lb	
Flywheel mounting capscrews		140 N.M	101ft-lb	
Flywheel housing mounting capscrews		77N.M	57ft-lb	
Gear housing mounting capscrews				
8M		24N.M	18ft-lb	
M12		60N.M	44ft-lb	
Main bearing cap capscrews	Step 1	50N.M	37ft-lb	
	2	119N.M	88ft-lb	
	3	176N.M	129ft-lb	

L Series Engines-Engine Components Specifications

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Component or assembly(procedure)	Ref. No./Steps	Metric	Imperial	
Rear seal cover capscrews		9N.M	80in-lb	
Rocker support set screw		55N.M	41ft-lb	
Valve cover set screw		24N.M	18ft-lb	
Vibration damper				
The pulley to vibration damper		200N.M	148ft-lb	
		77N.M	57in-lb	

Drive belt tension

SAE belt size	Belt tension gauge		Belt tension		Belt tension range	
	Part number(s)		New		Used	
	Click-type	Burroughs	N	lbf	N	lbf
0.380in	3822524		620	140	270 to 490	60-110
0.440in	3822524		620	140	270 to 490	60-110
1/2in	3822524	ST-1138	620	140	270 to 490	60-110
11/16in	3822524	ST-1138	620	140	270 to 490	60-110
3/4in	3822524	ST-1138	620	140	270 to 490	60-110
7/8in	3822524	ST-1138	620	140	270 to 490	60-110
4rib	3822524	ST-1138	620	140	270Q to 530	60-110
5rib	3822524	ST-1138	670	150	290 to 580	60-110
6rib	3822525	ST-1293	710	160	360 to 710	65-130
8rib	3822525	ST-1293	890	200	440 to 890	80-160
10rib	3822525	3823138	1110	250	530 to 1070	100-200
12rib	3822525	3823138	1330	300		120-240

- A belt is considered used if it has been in service for ten minutes or longer.
- If used belt tension is less than the MIN value, tighten the belt to the maximum used belt value.

Fraction, Decimal, Millimeter Conversions

8 THS.	16 THS	32 NDS	64 THS	INCHES	MM	8 THS	16 THS	32 NDS	64 THS	INCHES	MM
			1	0.0156	0.397				33	0.5156	13.097
		1		0.0313	0.794			17		0.5313	13.494
			3	0.0469	1.191				35	0.5469	13.891
	1			0.0625	1.588		9			0.5625	14.288
			5	0.0781	1.984				37	0.5781	14.684
		3		0.0938	2.381			19		0.5938	15.081
			7	0.1094	2.778				39	0.6094	15.478
1				0.1250	3.175	5				0.6250	15.875
			9	0.1406	3.572				41	0.6406	16.272
		5		0.1563	3.969			21		0.6563	16.669
			11	0.1719	4.366				43	0.6719	17.066
	3			0.1875	4.763		11			0.6875	17.463
			13	0.2031	5.159				45	0.7031	17.859
		7		0.2188	5.556			23		0.7188	18.256
			15	0.2344	5.953				47	0.7344	18.653
1/4				0.2500	6.350	3/4				0.7500	19.050
			17	0.2656	6.747				49	0.7656	19.447
		9		0.2813	7.144			25		0.7813	19.844
			19	0.2969	7.541				51	0.7969	20.241
	5			0.3125	7.938		13			0.8125	20.638
			21	0.3281	8.334				53	0.8281	21.034
		11		0.3438	8.731			27		0.8438	21.431
			23	0.3594	9.128				55	0.8594	21.828
3				0.3750	9.525	7				0.8750	22.225
			25	0.3906	9.922				57	0.8906	22.622
		13		0.4063	10.319			29		0.9063	23.091
			27	0.4219	10.716				59	0.9219	23.416
	7			0.4375	11.113		15			0.9375	23.813
			29	0.4531	11.509				61	0.9531	24.209
		15		0.4688	11.906			31		0.9688	24.606
			31	0.4844	12.303				63	0.9844	25.003
1/2				0.5000	12.700	1IN				1.0000	25.400

Conversion Factor: 1 IN=25.4MM

Weight and Measures-Conversion Factors

Quantity	U.S.Customary		Metric		From U.S. Customary To metric Multiply by	From metric To U.S. Customary Multiply by
	Unit name	Abbr.	Unit name	Abbr.		
Area	Sq.inch	In ²	Sq.millimeters	Mm ²	645.16	0.001550
			Sq.centimeters	Cm ²	6.452	0.155
	Sq.foot	Ft ²	Sq.meter	M ²	0.0929	10.764
Fuel consumption	Pounds per Horsepower hour	Lb/hp-hr	Grams per kilowatt hour	g/kw-hr	608.277	0.001645
Fuel Performance	Miles pergallon	mpg	Kilometers per liter	Km/l	0.4251	2.352
	Gallons per mile	gpm	Liters per kilometer	l/km	2.3527	0.4251
Force	Pounds force	lbf	Newton	N	4.4482	0.224809
Length	Inch	in	Millimeters	mm	25.40	0.039370
	Foot	ft	Millimeters	mm	304.801	0.00328
Power	horsepower	hp	kilowalt	kw	0.746	1.341
pressure	Pounds force per sq.inch	psi	kilopascals	kpa	6.8948	0.145037
	Inches of mercury	In hg	kilopascals	kpa	3.3769	0.29613
	Inches of water	In h ₂ O	kilopascals	kpa	0.2488	4.019299
	Inches of mercury	In hg	Kilopascals of mercury	Mm hg	25.40	0.039370
	Inches of water	In h ₂ O	Millimeters of water	Mm h ₂ O	25.40	0.039370
	Bars	bars	kilopascals	kpa	100.001	0.00999
	Bars	bars	Kilopascals of mercury	Mm hg	750.06	0.001333
	Deg F	°F	Centigrade	°C	(°F-32)/1.8	(1.8*°C)+32
Torque	Pound force per foot	Ft/lb	Newton-meter	N.M	1.35582	0.737562
	Pound force per inch	In lb	Newton-meter	N.M	0.113	8.850756
velocity	Miles/hour	mph	Kilometers/hour	kph	1.6093	0.6214
volume	Gallon(U.S.)	Gal.	litre	l	3.7853	0.264179
liquid	Gallon(imp)	Gal.	litre	l	4.546	0.219976
displacement	Cubic inch	In ³	litre	l	0.01639	61.02545
	Cubic inches	In ³	Cubic centimeter	Cm ³	16.387	0.06102
Weight (mass)	Pounds(avoir.)	lb	kilograms	kg	0.4536	2.204623
Work	British thermal unit	BTU	joules	j	1054.5	0.000948
	British thermal unit	BTU	Kilowatt-hour	kw-hr	0.000293	3414
	Horsepower hours	Hp-hr	Kilowatt-hour	kw-hr	0.746	1.341

Newton-meter to foot-pound conversion chart

N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1	8.850756 in-lb	55	41	155	114
5	44 in-lb	60	44	160	118
6	53 in-lb	65	48	165	122
7	62 in-lb	70	52	170	125
8	71 in-lb	75	55	175	129
9	80 in-lb	80	59	180	133
10	89 in-lb	85	63	185	136
1	0.737562 ft-lb	90	66	190	140
12	9	95	70	195	144
14	10	100	74	200	148
15	11	105	77	205	151
16	12	110	81	210	155
18	13	115	85	215	159
20	15	120	89	220	162
25	18	125	92	225	165
30	22	130	96	230	170
35	26	135	100	235	173
40	30	140	103	240	177
45	33	145	107	245	180
50	37	150	111	250	184
NOTE: To convert from Newton-Meters to Kiloaram-Meters divide Newton-Meters by 9.803					

Set screw marking and torque values

⚠ CAUTION: When replacing capscrews, always use a capscREW of the same measurement and

Strength as the capscREW being replaced. Using the wrong capscREws can result in engine damage.

Most of the capscREws used on the L series engine are metric. Some components, such as the air compressor and fuel pump, are installed using U.S. customary capscREws.

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Metric capscREws and nuts are identified by the grade number stamped on the head of the head of the capscREW or on the surface of the nuts. U.S. Customary capscREws are identified by radial lines stamped on the head of the capscREW.

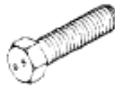
The following examples indicate how capscREws are identified:

Metric-M8-1.25*25			U.S. Customary[5/16*18*1-1/2]		
M8	1.25	25	5/16	18	1-1/2
Major thread	Distance	Length	Major thread	Number threads	Length
Diameter	Between threads	In	Diameter	Per Inch	Unit
In Millimeters	In Millimeters	Millimeters	In Inches		Inch

NOTE:

1. Always use the torque values listed in the following tables when specific torque values are not available.
2. Do not use the torque values which are specified in other sections of this manual.
3. The torque values in the table are based on the use of lubricated threads.
4. When the ft-lb value is less than 10, give consideration to converting the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.

Set screw marking and torque values-metric

commercial steel class													
8.8				10.9				12.9					
Set screw marking													
													
8.8				10.9				12.9					
Body Size													
Torque					Torque				Torque				
Diameter		Iron casting		Aluminum		Iron casting		Aluminum		Iron casting		Aluminum	
mm	N•m		ft-lb		N•m		ft-lb		N•m		ft-lb		
6	9	5	7	4	14	9	11	7	14	9	11		
7	14	9	11	7	18	14	14	11	23	18	18	1	
8	25	18	18	14	32	23	25	18	36	27	28	2	
10	40	30	30	25	60	45	45	35	70	50	55	4	
12	70	55	55	40	105	75	80	60	125	95	100	7	
14	115	85	90	65	160	120	125	95	195	145	150	11	
16	180	130	140	100	240	175	190	135	290	210	220	16	
18	230	170	180	135	320	240	250	185	400	290	310	23	

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Set screw marking and torque values-U.S.customary

SAE level		5	8
Set screw marking These are all SAE 5 (3lines) capscrew			
			

Set screw torque values-5 level set screw Set screw torque values-8 level set

Capscrew body size	Iron casting		Aluminum		Iron casting		Aluminum	
	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1/4 - 20	9	7	8	6	15	11	12	9
- 28	12	9	9	7	18	13	14	10
5/16 - 18	20	15	16	12	30	22	24	18
- 24	23	17	19	14	33	24	25	19
3/8 - 16	40	30	25	20	55	40	40	30
- 24	40	30	35	25	60	45	45	35
7/16 - 14	60	45	45	35	90	65	65	50
- 20	65	50	55	40	95	70	75	55
1/2 - 13	95	70	75	55	130	95	100	75
- 20	100	75	80	60	150	110	120	90
9/16 - 12	135	100	110	80	190	140	150	110
- 18	150	110	115	85	210	155	170	125
5/8 - 11	180	135	150	110	255	190	205	150
- 18	210	155	160	120	290	215	230	170
3/4 - 10	325	240	255	190	460	340	365	270
- 16	365	270	285	210	515	380	410	300
7/8 - 9	490	360	380	280	745	550	600	440
- 14	530	390	420	310	825	610	660	490
1 - 8	720	530	570	420	1100	820	890	660
- 14	800	590	650	480	1200	890	960	710

Pipe plug torque values

Size		Torque		Torque	
Thread	Actual full diameter of thread	Inside aluminum parts	Inside the iron castings or steel parts		
in	in	N•m	ft-lb	N•m	ft-lb
1/16	0.32	5	45 in-lb	15	10
1/8	0.41	15	10	20	15
1/4	0.54	20	15	25	20
3/8	0.68	25	20	35	25
1/2	0.85	35	25	55	40
3/4	1.05	45	35	75	55
1	1.32	60	45	95	70
1-1/4	1.66	75	55	115	85
1-1/2	1.90	85	65	135	100

Tap-drill chart -U.S. customary and metric

Section 12 Engine Components Specification

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L series engines

Tap-drill chart -U.S. customary and metric

NOTE ON SELECTING TAP-DRILL SIZES: The tap drill sizes shown on this card give the theoretical tap drill size for approximately 60% and 70% of full thread depth. Generally, it is recommended that drill sizes in the 75% range are recommended for shallow hole tapping (less than 1 1/2 time the hole diameter) in soft metals and mild steel.

Size of screw hole		Drillbit size	Size of screw hole		Drillbit size	Size of screw hole		Drillbit size	Size of screw hole		Drillbit size
60%	75%		60%	75%		60%	75%		60%	75%	
		48			4.40 mm			7.50 mm			13.25 mm
		1.95 mm			16			19/64			17/32
		5/64			4.50 mm			7.60 mm			13.50 mm
	3-48	47			15			N	M15×1.5	5/8-11	13.75 mm
	M2.5×.45	2.00 mm		M5.5×.9	4.60 mm		M9×1.25	7.70 mm	5/8-11	M16×2	35/64
		2.05 mm	12-24	12-28	14			7.75 mm			14.00 mm
		46			13			7.80 mm			14.25 mm
3-48	3056	45			4.70 mm			7.90 mm		5/8-18	9/16
M2.5×.45	M2.6×.45	2.10 mm	M5.5×.9		4.75 mm	M9×1.25	3/8-16	5/16	M16×2	M16×1.5	14.50 mm
3-56	4-36	2.15 mm	12-28		3/16		M9×1	8.00 mm	5/8-18		37/64
		44			12			O			14.75 mm
M2.6×.45		2.20 mm			4.80 mm			8.10 mm	M16×1.5		15.00 mm
4-36	4-40	2.25 mm			11	M9×1		8.20 mm			19.32
		43			4.90 mm			P			15.25 mm
		2.30 mm			10			8.25 mm			39/64
		2.35 mm			9			8.30 mm			15.50 mm
4-40	4-48	42		M6×1	5.00 mm	3/8-16	1/8-27NPT	21/64	M17×1.5	M18×2.5	15.75 mm
		3/32			8			8.40 mm			5/8
4-48	M3×.6	2.40 mm			5.10 mm		3/8-24	Q	M18×2.5	M18×2	16.00 mm
		41		1/4-20	7		M10×1.5	8.50 mm	M18×2		16.25 mm
		2.45 mm			13/64			8.60 mm		3/4-10	41/64
		40			6			R		M18×1.5	16.50 mm
M3×.6	M3×.5	2.50 mm	M6×1		5.20 mm	3/8-24		8.70 mm	3/4-10	M19×2.5	21/32
		39			5	1/8-27NPT		11/32	M18×1.5		16.75 mm
	5-40	38		M6×.75	5.25 mm		M10×1.25	8.75 mm	M19×2.5		17.00 mm
M3×.5		2.60 mm			5.30 mm	M10×1.5		8.80 mm			43/64
5-40	5-44	37	1/4-20		4			S			17.25 mm
5-44	6-32	2.70 mm	M6×.75		5.40 mm	M10×1.25	M10×1	8.90 mm	3/4-16	3/4-16	11/16
		36		1/4-28	3			9.00 mm		M20×2.5	17.50 mm
		2.75 mm			5.50 mm			T			17.75 mm
		7/64			7/32			9.10 mm			45/64
		35		1/4-28	5.60 mm	M10×1		23/64	M20×2.5	M20×2	18.00 mm
		2.80 mm			2			9.20 mm	M20×2		18.25 mm
		34			5.70 mm			9.30 mm			23/32
6-32	6-40	33			5.75 mm		7/16-14	U		M20×1.5	18.50 mm
	M3.5×6	2.90 mm			1			9.40 mm			47/64
		32			5.80 mm		M11×1.5	9.50 mm	M20×1.5		18.75 mm
M3.5×6		3.00 mm			5.90 mm			3/8			19.00 mm
6-40		31			A			V			3/4
		3.10 mm			15/64			9.60 mm			19.25 mm
		1/8		M7×1	6.00 mm			9.70 mm		7/8-9	49/64
		3.20 mm			B			9.75 mm		M22×2.5	19.50 mm
	M4×.75	3.25 mm			6.10 mm	M11×1.5		9.80 mm	7/8-9		25/32
		30			C	7/16-14		9.90 mm			19.75 mm
M4×.75	M4×.7	3.30 mm	M7×1		6.20 mm			9.90 mm	M22×2.5	M22×2	20.00 mm
M4×.7		3.40 mm			D		7/16-20	25/64		7/8-14	51/64
	8-32	29		M7×.75	6.25 mm			10.00 mm	M22×2		20.25 mm
		3.50 mm			6.30 mm			X	M22×1.5		20.50 mm
8-32	8-36	28			E	7/16-20		10.20 mm	7/8-14		13/16
		9/64			1/4			Y			20.75 mm
		3.60 mm	M7×.75		6.40 mm			13/32	M22×1.5	M24×3	21.00 mm
8-36		27			6.50 mm			Z			53/64
		3.70 mm			F			10.50 mm			21/25 mm
		26		5/16-18	6.60 mm	M12×1.75	M12×1.5	27/64			27/32
	M4.5×.75	3.75 mm			G		1/2-13	10.75 mm			21.50 mm
	10-24	25			6.70 mm	M12×1.5	M12×1.25	11.00 mm	M24×3		21.75 mm
		3.80 mm			17/64			7/16			55/64
		24			6.75 mm	1/4-18NPT				M24×2	22.00 mm
M4.5×.75		3.90 mm	5/16-18		H			11.25 mm		1"-8	7/8
		23			6.80 mm			11.50 mm	M24×2		22.25 mm
		5/32		5.16-24	6.90 mm			29/64		M24×1.5	22.50 mm
10-24		22		M8×1	I			11.75 mm	1"-8		57/64
	M5×1	4.00 mm	M8×1.25	M8×1	7.00 mm			11.50 mm	M24×1.5		22.75 mm
	10-32	21			J			29/64		M25×2	23.00 mm
		20			7.10 mm		1/2-20	15/32		1"-12	29/32
	M5×.9	4.10 mm	5/16-24		K		M14×2	12.00 mm	M25×2		23.25 mm
	M5×.8	4.20 mm			9/32			12.25 mm	1"-12	1"-14	59/64
M5×1		19	M8×1		7.20 mm	9/16-12		31/64		M25×1.5	23.50 mm
10-32		4.25 mm			7.25 mm	M14×2	M14×1.5	12.50 mm			23.75 mm
M5×.9		4.30 mm			7.30 mm		9/16-18	1/2	M20×1.5		15/16
M5×.8		18			L	M14×1.5	M14×1.25	12.75 mm	1"-14		
		11/64			7.40 mm	M14×1.25		13.00 mm			
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