

SHOP MANUAL

KOMATSU

**140-3 SERIES
DIESEL ENGINE**

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SAFETY

SAFETY NOTICE

IMPORTANT SAFETY NOTICE

Proper service and repair is extremely important for safe machine operation. The service and repair techniques recommended by Komatsu and described in this manual are both effective and safe. Some of these techniques require the use of tools specially designed by Komatsu for the specific purpose.

To prevent injury to workers, the symbol  is used to mark safety precautions in this manual. The cautions accompanying these symbols should always be followed carefully. If any dangerous situation arises or may possibly arise, first consider safety, and take the necessary actions to deal with the situation.

GENERAL PRECAUTIONS

Mistakes in operation are extremely dangerous. Read the Operation and Maintenance Manual carefully BEFORE operating the machine.

1. Before carrying out any greasing or repairs, read all the precautions given on the decals which are fixed to the machine.
2. When carrying out any operation, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
 - Always wear safety glasses when hitting parts with a hammer.
 - Always wear safety glasses when grinding parts with a grinder, etc.
3. If welding repairs are needed, always have a trained, experienced welder carry out the work. When carrying out welding work, always wear welding gloves, apron, hand shield, cap and other clothes suited for welding work.
4. When carrying out any operation with two or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the operation. Before starting work, hang UNDER REPAIR signs on the controls in the operator's compartment.
5. Keep all tools in good condition and learn the correct way to use them.

6. Decide a place in the repair workshop to keep tools and removed parts. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dirt or oil on the floor. Smoke only in the areas provided for smoking. Never smoke while working.

PREPARATIONS FOR WORK

7. Before adding oil or making any repairs, park the machine on hard, level ground, and block the wheels or tracks to prevent the machine from moving.
8. Before starting work, lower blade, ripper, bucket or any other work equipment to the ground. If this is not possible, insert the safety pin or use blocks to prevent the work equipment from falling. In addition, be sure to lock all the control levers and hang warning signs on them.
9. When disassembling or assembling, support the machine with blocks, jacks or stands before starting work.
10. Remove all mud and oil from the steps or other places used to get on and off the machine. Always use the handrails, ladders or steps when getting on or off the machine. Never jump on or off the machine. If it is impossible to use the handrails, ladders or steps, use a stand to provide safe footing.

PRECAUTIONS DURING WORK

11. When removing the oil filler cap, drain plug or hydraulic pressure measuring plugs, loosen them slowly to prevent the oil from spurting out. Before disconnecting or removing components of the oil, water or air circuits, first remove the pressure completely from the circuit.
12. The water and oil in the circuits are hot when the engine is stopped, so be careful not to get burned.
Wait for the oil and water to cool before carrying out any work on the oil or water circuits.
13. Before starting work, remove the leads from the battery. Always remove the lead from the negative (–) terminal first.
14. When raising heavy components, use a hoist or crane.
Check that the wire rope, chains and hooks are free from damage.
Always use lifting equipment which has ample capacity.
Install the lifting equipment at the correct places.
Use a hoist or crane and operate slowly to prevent the component from hitting any other part.
Do not work with any part still raised by the hoist or crane.
15. When removing covers which are under internal pressure or under pressure from a spring, always leave two bolts in position on opposite sides. Slowly release the pressure, then slowly loosen the bolts to remove.
16. When removing components, be careful not to break or damage the wiring. Damaged wiring may cause electrical fires.
17. When removing piping, stop the fuel or oil from spilling out. If any fuel or oil drips onto the floor, wipe it up immediately. Fuel or oil on the floor can cause you to slip, or can even start fires.
18. As a general rule, do not use gasoline to wash parts. In particular, use only the minimum of gasoline when washing electrical parts.
19. Be sure to assemble all parts again in their original places.
Replace any damaged parts with new parts.
 - When installing hoses and wires, be sure that they will not be damaged by contact with other parts when the machine is being operated.
20. When installing high pressure hoses, make sure that they are not twisted. Damaged tubes are dangerous, so be extremely careful when installing tubes for high pressure circuits. Also, check that connecting parts are correctly installed.
21. When assembling or installing parts, always use the specified tightening torques. When installing protective parts such as guards, or parts which vibrate violently or rotate at high speed, be particularly careful to check that they are installed correctly.
22. When aligning two holes, never insert your fingers or hand. Be careful not to get your fingers caught in a hole.
23. When measuring hydraulic pressure, check that the measuring tool is correctly assembled before taking any measurements.
24. Take care when removing or installing the tracks of track-type machines.
When removing the track, the track separates suddenly, so never let anyone stand at either end of the track.

FOREWORD

GENERAL

This shop manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgments. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This shop manual mainly contains the necessary technical information for operations performed in a service workshop. For ease of understanding, the manual is divided into the following chapters; these chapters are further divided into the each main group of components.

STRUCTURE AND FUNCTION

This section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

In addition, this section may contain hydraulic circuit diagrams, electric circuit diagrams, and maintenance standards.

TESTING AND ADJUSTING

This section explains checks to be made before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs.

Troubleshooting charts correlating "Problems" with "Causes" are also included in this section.

DISASSEMBLY AND ASSEMBLY

This section explains the procedures for removing, installing, disassembling and assembling each component, as well as precautions for them.

MAINTENANCE STANDARD

This section gives the judgment standards for inspection of disassembled parts.

The contents of this section may be described in STRUCTURE AND FUNCTION.

OTHERS

This section mainly gives hydraulic circuit diagrams and electric circuit diagrams.

In addition, this section may give the specifications of attachments and options together.

NOTICE

The specifications contained in this shop manual are subject to change at any time and without any advance notice. Use the specifications given in the book with the latest date.

HOISTING INSTRUCTIONS

HOISTING

! Heavy parts (25 kg or more) must be lifted with a hoist, etc. In the **DISASSEMBLY AND ASSEMBLY** section, every part weighing 25 kg or more is indicated clearly with the symbol .

- If a part cannot be smoothly removed from the machine by hoisting, the following checks should be made:
 - 1) Check for removal of all bolts fastening the part to the relative parts.
 - 2) Check for existence of another part causing interference with the part to be removed.

WIRE ROPES

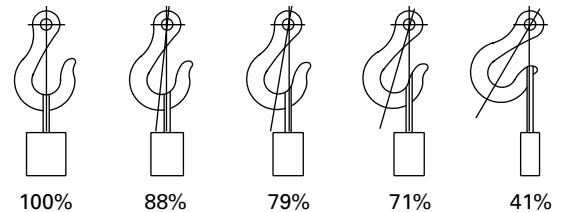
- 1) Use adequate ropes depending on the weight of parts to be hoisted, referring to the table below:

Wire ropes
(Standard "Z" or "S" twist ropes
without galvanizing)

Rope diameter	Allowable load	
	kN	tons
mm		
10	9.8	1.0
11.5	13.7	1.4
12.5	15.7	1.6
14	21.6	2.2
16	27.5	2.8
18	35.3	3.6
20	43.1	4.4
22.4	54.9	5.6
30	98.1	10.0
40	176.5	18.0
50	274.6	28.0
60	392.2	40.0

- ★ The allowable load value is estimated to be one-sixth or one-seventh of the breaking strength of the rope used.
- 2) Sling wire ropes from the middle portion of the hook.

Slinging near the edge of the hook may cause the rope to slip off the hook during hoisting, and a serious accident can result. Hooks have maximum strength at the middle portion.



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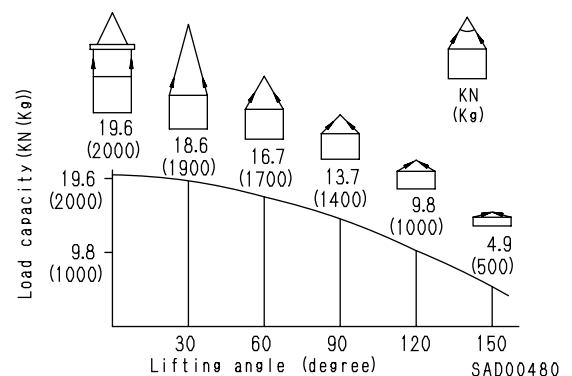
- 3) Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound onto the load.

! Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original winding position on the load, which can result in a dangerous accident.

- 4) Do not sling a heavy load with ropes forming a wide hanging angle from the hook.

When hoisting a load with two or more ropes, the force subjected to each rope will increase with the hanging angles. The table below shows the variation of allowable load kN {kg} when hoisting is made with two ropes, each of which is allowed to sling up to 9.8 kN {1000 kg} vertically, at various hanging angles.

When two ropes sling a load vertically, up to 19.6 kN {2000 kg} of total weight can be suspended. This weight becomes 9.8 kN {1000 kg} when two ropes make a 120° hanging angle. On the other hand, two ropes are subjected to an excessive force as large as 39.2 kN {4000 kg} if they sling a 19.6 kN {2000 kg} load at a lifting angle of 150°.



METHOD OF DISASSEMBLING, CONNECTING PUSH-PULL TYPE COUPLER

! Before carrying out the following work, release the residual pressure from the hydraulic tank. For details, see TESTING AND ADJUSTING, Releasing residual pressure from hydraulic tank.

! Even if the residual pressure is released from the hydraulic tank, some hydraulic oil flows out when the hose is disconnected. Accordingly, prepare an oil receiving container.

Disconnection

- 1) Release the residual pressure from the hydraulic tank. For details, see TESTING AND ADJUSTING, Releasing residual pressure from hydraulic tank.
- 2) Hold adapter (1) and push hose joint (2) into mating adapter (3). (See Fig. 1)
 - ★ The adapter can be pushed in about 3.5 mm.
 - ★ Do not hold rubber cap portion (4).
- 3) After hose joint (2) is pushed into adapter (3), press rubber cap portion (4) against (3) until it clicks. (See Fig. 2)
- 4) Hold hose adapter (1) or hose (5) and pull it out. (See Fig. 3)
 - ★ Since some hydraulic oil flows out, prepare an oil receiving container.

Connection

- 1) Hold hose adapter (1) or hose (5) and insert it in mating adapter (3), aligning them with each other. (See Fig. 4)
 - ★ Do not hold rubber cap portion (4).
- 2) After inserting the hose in the mating adapter perfectly, pull it back to check its connecting condition. (See Fig. 5)
 - ★ When the hose is pulled back, the rubber cap portion moves toward the hose about 3.5 mm. This does not indicate abnormality, however.

Type 1

Fig. 1

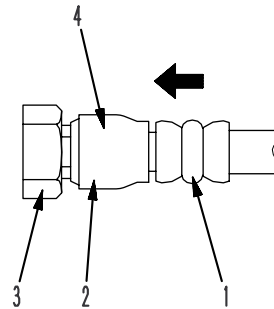


Fig. 2

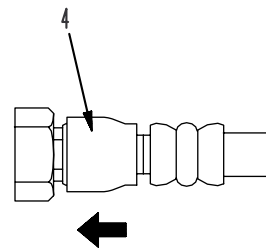


Fig. 3

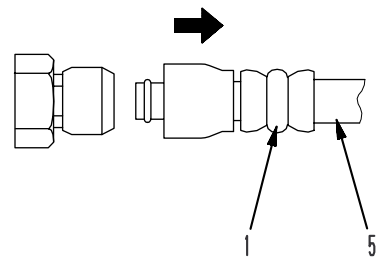


Fig. 4

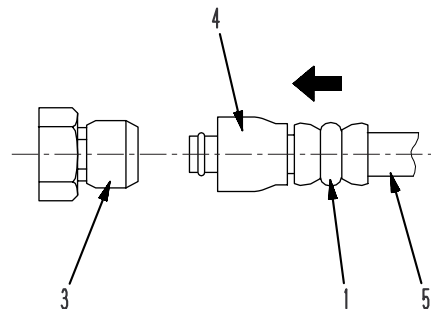
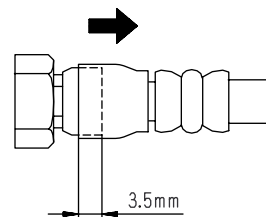


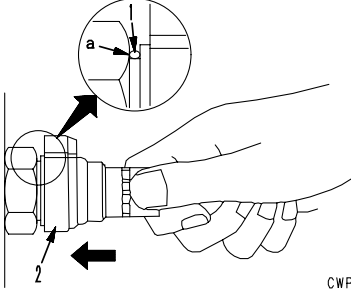
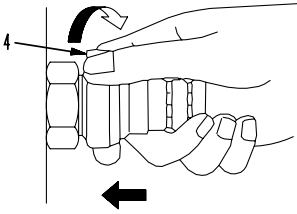
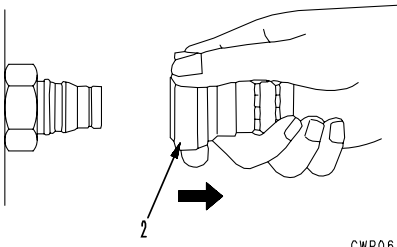
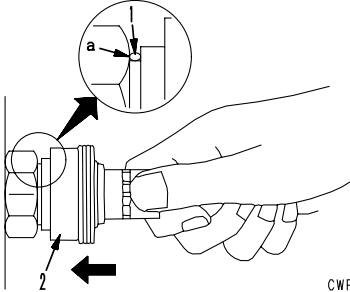
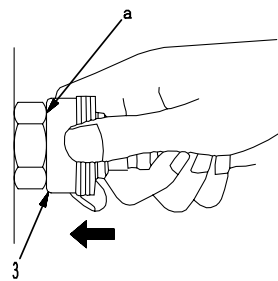
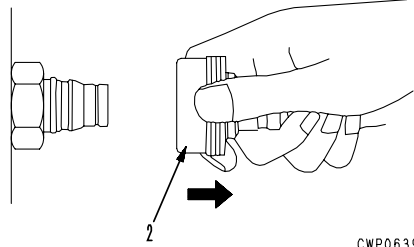
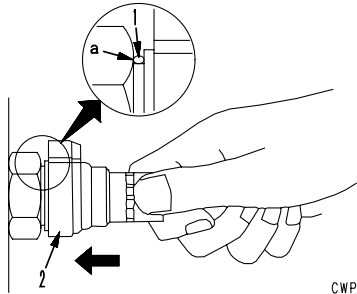
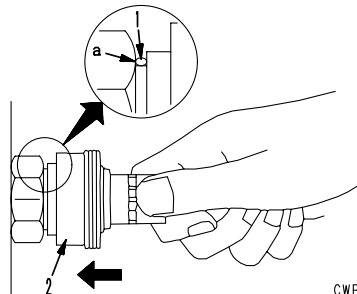
Fig. 5



CWP10701

FOREWORD

METHOD OF DISASSEMBLING, CONNECTING PUSH-PULL TYPE COUPLER

	Type 2	Type 3
Disassembly	1) Hold the mouthpiece of the tightening portion and push body (2) in straight until sliding prevention ring (1) contacts contact surface a of the hexagonal portion at the male end.  CWP06392 2) Hold in the condition in Step 1), and turn lever (4) to the right (clockwise).  CWP06394 3) Hold in the condition in Steps 1) and 2), and pull out whole body (2) to disconnect it.  CWP06396	1) Hold the mouthpiece of the tightening portion and push body (2) in straight until sliding prevention ring (1) contacts contact surface a of the hexagonal portion at the male end.  CWP06391 2) Hold in the condition in Step 1), and push until cover (3) contacts contact surface a of the hexagonal portion at the male end.  CWP06393 3) Hold in the condition in Steps 1) and 2), and pull out whole body (2) to disconnect it.  CWP06395
Connection	Hold the mouthpiece of the tightening portion and push body (2) in straight until sliding prevention ring (1) contacts contact surface a of the hexagonal portion at the male end to connect it.  CWP06392	Hold the mouthpiece of the tightening portion and push body (2) in straight until sliding prevention ring (1) contacts contact surface a of the hexagonal portion at the male end to connect it.  CWP06391

COATING MATERIALS

- ★ The recommended coating materials such as adhesives, gasket sealants and greases used for disassembly and assembly are listed below.
- ★ For coating materials not listed below, use the equivalent of products shown in this list.

Category	Komatsu code	Part No.	Q'ty	Container	Main applications, features
Adhesives	LT-1A	790-129-9030	150 g	Tube	Used to prevent rubber gaskets, rubber cushions, and cock plug from coming out.
	LT-1B	790-129-9050	20 g (2 pcs.)	Polyethylene container	Used in places requiring an immediately effective, strong adhesive. Used for plastics (except polyethylene, polypropylene, tetrafluoroethylene and vinyl chloride), rubber, metal and non-metal.
	LT-2	09940-00030	50 g	Polyethylene container	- Features: Resistance to heat and chemicals - Used for anti-loosening and sealant purpose for bolts and plugs.
	LT-3	790-129-9060 (Set of adhesive and hardening agent)	Adhesive: 1 kg Hardening agent: 500 g	Can	Used as adhesive or sealant for metal, glass and plastic.
	LT-4	790-129-9040	250 g	Polyethylene container	Used as sealant for machined holes.
	Holtz MH 705	790-126-9120	75 g	Tube	Used as heat-resisting sealant for repairing engine.
	Three bond 1735	790-129-9140	50 g	Polyethylene container	- Quick hardening type adhesive - Cure time: within 5 sec. to 3 min. - Used mainly for adhesion of metals, rubbers, plastics and woods.
	Aron-alpha 201	790-129-9130	2 g	Polyethylene container	- Quick hardening type adhesive - Quick cure type (max. strength after 30 minutes) - Used mainly for adhesion of rubbers, plastics and metals.
	Loctite 648-50	79A-129-9110	50 cc	Polyethylene container	- Resistance to heat, chemicals - Used at joint portions subject to high temperatures.
Gasket sealant	LG-1	790-129-9010	200 g	Tube	Used as adhesive or sealant for gaskets and packing of power train case, etc.
	LG-5	790-129-9070	1 kg	Can	- Used as sealant for various threads, pipe joints, flanges. - Used as sealant for tapered plugs, elbows, nipples of hydraulic piping.
	LG-6	790-129-9020	200 g	Tube	- Features: Silicon based, resistance to heat, cold - Used as sealant for flange surface, tread. - Used as sealant for oil pan, final drive case, etc.

FOREWORD
COATING MATERIALS

Category	Komatsu code	Part No.	Q'ty	Container	Main applications, features
Adhesives	LG-7	790-129-9070	1 g	Tube	• Features: Silicon based, quick hardening type • Used as sealant for flywheel housing, intake manifold, oil pan, thermostat housing, etc.
	Three bond 1211	790-129-9090	100 g	Tube	• Used as heat-resisting sealant for repairing engine.
Molybdenum disulphide lubricant	LM-G	09940-00051	60 g	Can	• Used as lubricant for sliding portion (to prevent from squeaking).
	LM-P	09940-00040	200 g	Tube	• Used to prevent seizure or scuffing of the thread when press fitting or shrink fitting. • Used as lubricant for linkage, bearings, etc.
Grease	G2-LI	SYG2-400LI SYG2-350LI SYG2-400LI-A SYG2-160LI SYGA-160CNLI	Various	Various	• General purpose type
	G2-CA	SYG2-400CA SYG2-350CA SYG2-400CA-A SYG2-160CA SYGA-160CNCA	Various	Various	• Used for normal temperature, light load bearing at places in contact with water or steam.
	Molybdenum disulphide lubricant	SYG2-400M	400 g (10 per case)	Belows type	• Used for places with heavy load

FOREWORD

STANDARD TIGHTENING TORQUE

STANDARD TIGHTENING TORQUE

STANDARD TIGHTENING TORQUE TABLE (WHEN USING TORQUE WRENCH)

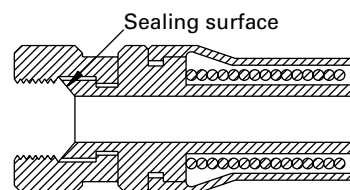
★ In the case of metric nuts and bolts for which there is no special instruction, tighten to the torque given in the table below.

Thread diameter of bolt	Width across flats		
mm	mm	Nm	kgm
6	10	13.2 ± 1.4	1.35 ± 0.15
8	13	31 ± 3	3.2 ± 0.3
10	17	66 ± 7	6.7 ± 0.7
12	19	113 ± 10	11.5 ± 1
14	22	177 ± 19	18 ± 2
16	24	279 ± 30	28.5 ± 3
18	27	382 ± 39	39 ± 4
20	30	549 ± 59	56 ± 6
22	32	745 ± 83	76 ± 8.5
24	36	927 ± 103	94.5 ± 10.5
27	41	1320 ± 140	135 ± 15
30	46	1720 ± 190	175 ± 20
33	50	2210 ± 240	225 ± 25
36	55	2750 ± 290	280 ± 30
39	60	3290 ± 340	335 ± 35

Thread diameter of bolt	Width across flats		
mm	mm	Nm	kgm
6	10	7.85 ± 1.95	0.8 ± 0.2
8	13	18.6 ± 4.9	1.9 ± 0.5
10	14	40.2 ± 5.9	4.1 ± 0.6
12	27	82.35 ± 7.85	8.4 ± 0.8

TABLE OF TIGHTENING TORQUES FOR FLARED NUTS

★ In the case of flared nuts for which there is no special instruction, tighten to the torque given in the table below.



SAD00483

Thread diameter	Width across flat	Tightening torque	
mm	mm	Nm	kgm
14	19	24.5 ± 4.9	2.5 ± 0.5
18	24	49 ± 19.6	5 ± 2
22	27	78.5 ± 19.6	8 ± 2
24	32	137.3 ± 29.4	14 ± 3
30	36	176.5 ± 29.4	18 ± 3
33	41	196.1 ± 49	20 ± 5
36	46	245.2 ± 49	25 ± 5
42	55	294.2 ± 49	30 ± 5

FOREWORD
STANDARD TIGHTENING TORQUE
TABLE OF TIGHTENING TORQUES FOR SPLIT FLANGE BOLTS

★ In the case of split flange bolts for which there is no special instruction, tighten to the torque given in the table below.

Thread diameter	Width across flat	Tightening torque	
mm	mm	Nm	kgm
10	14	65.7 ± 6.8	6.7 ± 0.7
12	17	112 ± 9.8	11.5 ± 1
16	22	279 ± 29	28.5 ± 3

TABLE OF TIGHTENING TORQUES FOR O-RING BOSS PIPING JOINTS

★ Unless there are special instructions, tighten the O-ring boss piping joints to the torque below.

Nominal No.	Thread diameter	Width across flat	Tightening torque	
	mm	mm	Nm	kgm
02	14	Varies depending on type of connector.	34.3 ± 4.9	3.5 ± 0.5
03, 04	20		93.1 ± 9.8	9.5 ± 1
05, 06	24		142.1 ± 19.6	14.5 ± 2
10, 12	33		421.4 ± 58.8	43 ± 6
14	42		877.1 ± 132.3	89.5 ± 13.5

TABLE OF TIGHTENING TORQUES FOR O-RING BOSS PLUGS

★ Unless there are special instructions, tighten the O-ring boss plugs to the torque below.

Nominal No.	Thread diameter	Width across flat	Tightening torque	
	mm	mm	Nm	kgm
08	08	14	7.35 ± 1.47	0.75 ± 0.15
10	10	17	11.27 ± 1.47	1.15 ± 0.15
12	12	19	17.64 ± 1.96	1.8 ± 0.2
14	14	22	22.54 ± 1.96	2.3 ± 0.2
16	16	24	29.4 ± 4.9	3 ± 0.5
18	18	27	39.2 ± 4.9	4 ± 0.5
20	20	30	49 ± 4.9	5 ± 0.5
24	24	32	68.6 ± 9.8	7 ± 1
30	30	32	107.8 ± 14.7	11 ± 1.5
33	33	n	127.4 ± 19.6	13 ± 2
36	36	36	151.9 ± 24.5	15.5 ± 2.5
42	42	n	210.7 ± 29.4	21.5 ± 3
52	52	n	323.4 ± 44.1	33 ± 4.5

FOREWORD
STANDARD TIGHTENING TORQUE
TIGHTENING TORQUE FOR 102 ENGINE SERIES
1) BOLT AND NUTS

Use these torques for bolts and nuts (unit: mm) of Cummins Engine.

Thread diameter	Tightening torque	
mm	Nm	kgm
6	10 ± 2	1.02 ± 0.20
8	24 ± 4	2.45 ± 0.41
10	43 ± 6	4.38 ± 0.61
12	77 ± 12	7.85 ± 1.22

2) EYE JOINTS

Use these torques for eye joints (unit: mm) of Cummins Engine.

Thread diameter	Tightening torque	
mm	Nm	kgm
6	8 ± 2	0.81 ± 0.20
8	10 ± 2	1.02 ± 0.20
10	12 ± 2	1.22 ± 0.20
12	24 ± 4	2.45 ± 0.41
14	36 ± 5	3.67 ± 0.51

3) TAPERED SCREWS

Use these torques for tapered screws (unit: inch) of Cummins Engine.

Thread diameter	Tightening torque	
inch	Nm	kgm
1 / 16	3 ± 1	0.31 ± 0.10
1 / 8	8 ± 2	0.81 ± 0.20
1 / 4	12 ± 2	1.22 ± 0.20
3 / 8	15 ± 2	1.53 ± 0.41
1 / 2	24 ± 4	2.45 ± 0.41
3 / 4	36 ± 5	3.67 ± 0.51
1	60 ± 9	6.12 ± 0.92

TIGHTENING TORQUE TABLE FOR HOSES (TAPER SEAL TYPE AND FACE SEAL TYPE)

- ★ Tighten the hoses (taper seal type and face seal type) to the following torque, unless otherwise specified.
- ★ Apply the following torque when the threads are coated (wet) with engine oil.

Nominal size of hose	Width across flats	Tightening torque (Nm {kgm})		Taper seal type	Face seal type	
		Range	Target	Thread size (mm)	Nominal thread size - Threads per inch, Thread series	Root diameter (mm) (Reference)
02	19	35 - 63 {3.5 - 6.5}	44 {4.5}	14	$\frac{9}{16}$ - 18UNF	14.3
03	22	54 - 93 {5.5 - 9.5}	74 {4.5}	—	$\frac{11}{16}$ - 16UN	17.5
	24	59 - 98 {6.0 - 10.0}	78 {8.0}	18	—	—
04	27	84 - 132 {8.5 - 13.5}	103 {10.5}	22	$\frac{13}{16}$ - 16UN	20.7
05	32	128 - 186 {13.0 - 19.0}	157 {16.0}	24	1 - 14UNS	25.4
06	36	177 - 245 {18.0 - 25.0}	216 {22.0}	30	$1\frac{3}{16}$ - 12UNF	30.3
(10)	41	177 - 245 {18.0 - 25.0}	216 {22.0}	33	—	—
(12)	46	197 - 294 {20.0 - 30.0}	245 {25.0}	36	—	—
(14)	55	246 - 343 {25.0 - 35.0}	294 {30.0}	42	—	—

ELECTRIC WIRE CODE

In the wiring diagrams, various colors and symbols are employed to indicate the thickness of wires.

This wire code table will help you understand WIRING DIAGRAMS.

Example: 5WB indicates a cable having a nominal number 5 and white coating with black stripe.

CLASSIFICATION BY THICKNESS

Nominal number	Copper wire			Cable O.D. (mm)	Current rating (A)	Applicable circuit
	Number of strands	Dia. of strands (mm ²)	Cross section (mm ²)			
0.85	11	0.32	0.88	2.4	12	Starting, lighting, signal etc.
2	26	0.32	2.09	3.1	20	Lighting, signal etc.
5	65	0.32	5.23	4.6	37	Charging and signal
15	84	0.45	13.36	7.0	59	Starting (Glow plug)
40	85	0.80	42.73	11.4	135	Starting
60	127	0.80	63.84	13.6	178	Starting
100	217	0.80	109.1	17.6	230	Starting

CLASSIFICATION BY COLOR AND CODE

Priority	Circuits Classification		Charging	Ground	Starting	Lighting	Instrument	Signal	Other
1	Primary	Code	W	B	B	R	Y	G	L
		Color	White	Black	Black	Red	Yellow	Green	Blue
2	Auxiliary	Code	WR	—	BW	RW	YR	GW	LW
		Color	White & Red	—	White & Black	Red & White	Yellow & Red	Green & White	Blue & White
3		Code	WB	—	BY	RB	YB	GR	LR
		Color	White & Black	—	Black & Yellow	Red & Black	Yellow & Black	Green & Red	Blue & Yellow
4		Code	WL	—	BR	RY	YG	GY	LY
		Color	White & Blue	—	Black & Red	Red & Yellow	Yellow & Green	Green & Yellow	Blue & Yellow
5		Code	WG	—	—	RG	YL	GB	LB
		Color	White & Green	—	—	Red & Green	Yellow & Blue	Green & Black	Blue & Black
6		Code	—	—	—	RL	YW	GL	—
		Color	—	—	—	Red & Blue	Yellow & White	Green & Blue	—

CONVERSION TABLE

METHOD OF USING THE CONVERSION TABLE

The Conversion Table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion Table, see the example given below.

EXAMPLE

- Method of using the Conversion Table to convert from millimeters to inches

1. Convert 55 mm into inches.

- Locate the number 50 in the vertical column at the left side, take this as (A), then draw a horizontal line from (A).
- Locate the number 5 in the row across the top, take this as (B), then draw a perpendicular line down from (B).
- Take the point where the two lines cross as (C). This point (C) gives the value when converting from millimeters to inches. Therefore, 55 mm = 2.165 inches.

2. Convert 550 mm into inches.

- The number 550 does not appear in the table, so divide by 10 (move the decimal point one place to the left) to convert it to 55 mm.
- Carry out the same procedure as above to convert 55 mm to 2.165 inches.
- The original value (550 mm) was divided by 10, so multiply 2.165 inches by 10 (move the decimal point one place to the right) to return to the original value. This gives 550 mm = 21.65 inches.

Millimeters to inches

1 mm = 0.03937 in

	0	1	2	3	4	5	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

FOREWORD

CONVERSION TABLE

Millimeters to Inches

1 mm = 0.03937 in

	0	1	2	3	4	5	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound

1 kg = 2.2046 lb

	0	1	2	3	4	5	6	7	8	9
0	0	2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.53	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26

FOREWORD**CONVERSION TABLE****Liter to U.S. Gallon**

1ℓ = 0.2642 U.S. Gal

	0	1	2	3	4	5	6	7	8	9
0	0	0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.361	25.625	25.889	26.153

Liter to U.K. Gallon

1ℓ = 0.21997 U.K. Gal

	0	1	2	3	4	5	6	7	8	9
0	0	0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.950	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.699	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

FOREWORD**CONVERSION TABLE****kgm to ft. lb**

1 kgm = 7.233 ft. lb

	0	1	2	3	4	5	6	7	8	9
0	0	7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	296.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.7	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	976.5	983.7	990.9	998.2	1005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1345.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

FOREWORD**CONVERSION TABLE****kg/cm² to lb/in²**1 kg/cm² = 14.2233 lb/in²

	0	1	2	3	4	5	6	7	8	9
0	0	14.2	28.4	42.7	56.9	71.1	85.3	99.6	113.8	128.0
10	142.2	156.5	170.7	184.9	199.1	213.4	227.6	241.8	256.0	270.2
20	284.5	298.7	312.9	327.1	341.4	355.6	369.8	384.0	398.3	412.5
30	426.7	440.9	455.1	469.4	483.6	497.8	512.0	526.3	540.5	554.7
40	568.9	583.2	597.4	611.6	625.8	640.1	654.3	668.5	682.7	696.9
50	711.2	725.4	739.6	753.8	768.1	782.3	796.5	810.7	825.0	839.2
60	853.4	867.6	881.8	896.1	910.3	924.5	938.7	953.0	967.2	981.4
70	995.6	1010	1024	1038	1053	1067	1081	1095	1109	1124
80	1138	1152	1166	1181	1195	1209	1223	1237	1252	1266
90	1280	1294	1309	1323	1337	1351	1365	1380	1394	1408
100	1422	1437	1451	1465	1479	1493	1508	1522	1536	1550
110	1565	1579	1593	1607	1621	1636	1650	1664	1678	1693
120	1707	1721	1735	1749	1764	1778	1792	1806	1821	1835
130	1849	1863	1877	1892	1906	1920	1934	1949	1963	1977
140	1991	2005	2020	2034	2048	2062	2077	2091	2105	2119
150	2134	2148	2162	2176	2190	2205	2219	2233	2247	2262
160	2276	2290	2304	2318	2333	2347	2361	2375	2389	2404
170	2418	2432	2446	2460	2475	2489	2503	2518	2532	2546
180	2560	2574	2589	2603	2617	2631	2646	2660	2674	2688
190	2702	2717	2731	2745	2759	2773	2788	2802	2816	2830
200	2845	2859	2873	2887	2901	2916	2930	2944	2958	2973
210	2987	3001	3015	3030	3044	3058	3072	3086	3101	3115
220	3129	3143	3158	3172	3186	3200	3214	3229	3243	3257
230	3271	3286	3300	3314	3328	3343	3357	3371	3385	3399
240	3414	3428	3442	3456	3470	3485	3499	3513	3527	3542

FOREWORD

CONVERSION TABLE

Temperature

Fahrenheit-Centigrade Conversion ; a simple way to convert a Fahrenheit temperature reading into a Centigrade temperature reading or vice versa is to enter the accompanying table in the center or boldface column of figures.

These figures refer to the temperature in either Fahrenheit or Centigrade degrees.

If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.

If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

$$1^{\circ}\text{C} = 33.8^{\circ}\text{F}$$

°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4	85	185.0
-28.3	-19	-2.2	-8.9	16	60.8	10.6	51	123.8	30.0	86	186.8
-27.8	-18	-0.4	-8.3	17	62.6	11.1	52	125.6	30.6	87	188.6
-27.2	-17	1.4	-7.8	18	64.4	11.7	53	127.4	31.1	88	190.4
-26.7	-16	3.2	-7.2	19	66.2	12.2	54	129.2	31.7	89	192.2
-26.1	-15	5.0	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-25.6	-14	6.8	-6.1	21	69.8	13.3	56	132.8	32.8	91	195.8
-25.0	-13	8.6	-5.6	22	71.6	13.9	57	134.6	33.3	92	197.6
-24.4	-12	10.4	-5.0	23	73.4	14.4	58	136.4	33.9	93	199.4
-23.9	-11	12.2	-4.4	24	75.2	15.0	59	138.2	34.4	94	201.2
-23.3	-10	14.0	-3.9	25	77.0	15.6	0	140.0	35.0	95	203.0
-22.8	-9	15.8	-3.3	26	78.8	16.1	61	141.8	35.6	96	204.8
-22.2	-8	17.6	-2.8	27	80.6	16.7	62	143.6	36.1	97	206.6
-21.7	-7	19.4	-2.2	28	82.4	17.2	63	145.4	36.7	98	208.4
-21.1	-6	21.2	-1.7	29	84.2	17.8	64	147.2	37.2	99	210.2
-20.6	-5	23.0	-1.1	30	86.0	18.3	65	149.0	37.8	100	212.0
-20.0	-4	24.8	-0.6	31	87.8	18.9	66	150.8	40.6	105	221.0
-19.4	-3	26.6	0	32	89.6	19.4	67	152.6	43.3	110	230.0
-18.9	-2	28.4	0.6	33	91.4	20.0	68	154.4	46.1	115	239.0
-18.3	-1	30.2	1.1	34	93.2	20.6	69	156.2	48.9	120	248.0
-17.8	0	32.0	1.7	35	95.0	21.1	70	158.0	51.7	125	257.0
-17.2	1	33.8	2.2	36	96.8	21.7	71	159.8	54.4	130	266.0
-16.7	2	35.6	2.8	37	98.6	22.2	72	161.6	57.2	135	275.0
-16.1	3	37.4	3.3	38	100.4	22.8	73	163.4	60.0	140	284.0
-15.6	4	39.2	3.9	39	102.2	23.3	74	165.2	62.7	145	293.0
-15.0	5	41.0	4.4	40	104.0	23.9	75	167.0	65.6	150	302.0
-14.4	6	42.8	5.0	41	105.8	24.4	76	168.8	68.3	155	311.0
-13.9	7	44.6	5.6	42	107.6	25.0	77	170.6	71.1	160	320.0
-13.3	8	46.4	6.1	43	109.4	25.6	78	172.4	73.9	165	329.0
-12.8	9	48.2	6.7	44	111.2	26.1	79	174.2	76.7	170	338.0
-12.2	10	50.0	7.2	45	113.0	26.7	80	176.0	79.4	175	347.0

UNITS

In this manual, the measuring units are indicated with International System of units (SI).
As for reference, conventionally used Gravitational System of units are indicated in parentheses { }.

Example:

N {kg}
Nm {kgm}
MPa {kg/cm²}
kPa {mmH₂O}
kPa {mmHg}
kW/rpm {HP/rpm}
g/kWh {g/HPh}

01 GENERAL

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OUTLINE

1. Applicable machine

Engine	Engine Serial No.	Applicable machine	
SA6D140E-3	110001 – 112349 112350 and up	D155AX-5	Bulldozer
		D155AX-5	Bulldozer
		PC600-6	Hydraulic excavator
		WA500-3	Wheel loader
		DCA400SSK	Generator
SAA6D140E-3		HD325-6	Dump truck
		HM350-1	Articulated dump truck
		HM350-1 (–40°C spec.)	Articulated dump truck
		HM400-1	Articulated dump truck
		PC750-6, PC750LC-6, PC750-7	Hydraulic excavator
		PC800-6, PC800-7	Hydraulic excavator
SDA6D140E-3		PC1800-6 (USA)	Hydraulic excavator
		D275A-5	Bulldozer
		D275AX-5	Bulldozer

2. Outline of engine

- The 140E-3 engine clears strict exhaust gas regulations (USA: EPA regulations for the year 2001, EU: regulations for the year 2002, Japan: construction equipment regulations for the year 2004). At the same time, it is a high performance, high efficiency engine which achieves low fuel consumption, low noise, improved exhaust gas color, and improved acceleration.
This engine has been newly developed to meet various purposes of use as the power unit for construction equipment and industrial machinery.
- This engine is the successor to the 140E-2 engine. It is an in-line, 6-cylinder, water-cooled, direct injection type following in the steps of the 4-cycle diesel engine configuration, while introducing various types of new technology.
 - 1) Electronic control high-pressure fuel injection system
Previously, the engine was a mechanical governor control type engine using a jerk type in-line injection pump. But with this engine, the whole series uses an electronic control high-pressure fuel injection type common rail injection system. With this system, high-pressure fuel at a level of 118 MPa {1200 kg/cm²} can be injected from the low speed range to the high speed range. Furthermore, electronic control provides the feature of being able to carry out control of the optimum injection configuration to match the speed and load. As a result, the engine achieves clean exhaust gas performance, clean exhaust gas color and low fuel consumption and low noise.
 - 2) The piston is a high-quality steel casting piston with a shaker cooling galley, a re-entrant combustion chamber used from the 140E-2 engine, and with the Komatsu traditional minimum heat expansion. As a result, it not only provides clean exhaust gas performance, clean exhaust gas color, and low fuel consumption, but also achieves high durability and high reliability.
 - 3) The compression ratio has been raised from the conventional level to improve the combustion efficiency, thereby providing low fuel consumption and reducing the emission of white smoke when starting the engine in cold areas. In addition, the use of the electronic control high-pressure fuel injection system explained above and the optimization of the spray characteristics when starting in low temperatures is designed to improve the starting performance and reduce the emission of white smoke.
 - 4) The turbocharger is an improved version of the Komatsu KTR110 turbocharger job proven on the 140E-2 engine, which boasts high reliability and high performance. The improved points are the supply air recirculation port to control the surge at the compressor end and the high efficiency design added to the turbine. As a result, success has been achieved in providing excellent performance over a wide range from low speed to high speed to achieve high engine performance and low fuel consumption.
 - 5) Conventionally, there was one piston cooling nozzle for the piston cooling, but this has been increased to two to give a twin piston cooling system. As a result, the durability of the piston has been increased, and at the same time, the temperature at the rear face of the piston has been reduced, thereby preventing the lubricating oil from being exposed to high temperature and deterioration. In this way, it has been possible to use the electronic control high-pressure fuel combustion system to achieve combustion with little generation of soot and a long drain interval for the oil. (This has been extended from the conventional 250 h to 500 h.) Furthermore, a large capacity oil pan is available for the high output specification to provide an increase in the oil drain interval.
 - 6) With the cylinder block, the overall length, overall width, and overall height are the same as usual to maintain the compactness. In addition, the top surface thickness has been increased to suppress the deformation after long periods of operation to make it easier to machine the engine when rebuilding. Furthermore, by increasing the rigidity of the main ribs to improve the basic rigidity, deformation and vibration of the block under load has been suppressed and low noise has been achieved. This contributes to clearing various noise restrictions, in particular the European noise restrictions, which have become strict recent years.

- 7) Three underframes are set in the form of beams at the bottom surface of the cylinder block to suppress the vibration of the block skirt and to reduce noise. Moreover, these are built into the oil pan, so there is no exposure of any new joining surface on the outside; therefore there is no problem of leakage of oil.
- 8) The high-pressure pump, which creates the high pressure in the common rail injection system, is 1/3 of the size of the conventional in-line fuel injection pump. In addition, it has a flange mount instead of a saddle mount, and is connected compactly to the timing gear case. As a result, the radiation noise is reduced, thereby achieving low noise.
- 9) The lubrication pump capacity has been increased by 15% over the pump for the conventional engine, thereby contributing to improved reliability and durability.
- 10) The air cleaner has been changed from the conventional end face seal type to a radial seal type to prevent the entry of dust on the clean side caused by deformation of these parts. In addition, a 5-stage display type air cleaner clogging sensor is provided to give accurate information about the timing for cleaning.
- 11) The oil filter is a high-performance, high-efficiency combination filter which can capture not only the large particles of dirt but also small particles. This filter system is used for all specifications
- 12) The fuel filter is a high-performance, high-efficiency special fuel filter which can also catch small particles of dirt. This filter system is used for all specifications and protects the electronic control high-pressure fuel injection system.
- 13) The features of the electronically control engine have been used to the maximum limit, and the following functions have been provided.
 - Sensing is carried out for the important features of the engine (water temperature, oil pressure, fuel injection amount, fuel injection pressure, etc.). If it is judged that the operating condition is abnormal, the computer issues an alarm and the system is set to the emergency escape mode.
 - After starting the engine in extremely low temperature, if the engine speed is raised suddenly, excessive load will be applied to the bearings before the lubricating oil has circulated sufficiently. This will reduce the service life of the engine; in particular, excessive load will be applied to the turbocharger. To prevent this, a turbo protect system has been installed to limit the engine speed.

SPECIFICATIONS

Engine			SA6D140E-3		
Machine model			D155AX-5 (110001 – 112349)	D155AX-5 (112350 and up)	WA500-3
No. of cylinders - bore x stroke	mm		6 – 140 x 165		
Piston displacement	ℓ {cc}		15.2 {15,230}		
Firing order	—		1 – 5 – 3 – 6 – 2 – 4		
Dimensions	Overall length	mm	1,499	1,630	1,787
	Overall width	mm	1,054	1,326	970
	Overall height (excl. exhaust pipe)	mm	1,738	1,262	1,670
	Overall height (incl. exhaust pipe)	mm	—	—	—
Performance	Rated horsepower	kW{HP}/rpm	252{338}/1,900 (Gross)	248{332}/1,900 (Gross)	235{316}/2,100 (Net)
	Max. torque	Nm{kgm}/rpm	1,635{166.7}/1,250 (Gross)	1,635{166.7}/1,250 (Gross)	1,370{140}/1,400 (Net)
	High idling speed	rpm	2,100 ± 50	2,100 ± 50	2,350 ± 50
	Low idling speed	rpm	740 ⁺²⁵ ₀	740 ⁺²⁵ ₀	725 ± 25
	Min. fuel consumption ratio	g/kW·h {g/HP·h}	205 {153}	205 {153}	207 {154}
Dry weight		kg	1,645	1,618	1,610
Fuel supply pump		—	Denso ECD-U2		
Governor		—	Electronic control type		
Lubricating oil amount (replacement amount)		ℓ	42 (37)	42 (37)	42 (37)
Cooling water		ℓ	26 (Engine only)	26 (Engine only)	26 (Engine only)
Alternator		—	24V, 35A	24V, 60A, 75A	24V, 50A
Starting motor		—	24V, 11kW	24V, 11kW	24V, 11kW
Battery		—	12V 170Ah x 2	12V 170Ah x 2	12V 170Ah x 2
Turbocharger		—	Komatsu KTR110L	Komatsu KTR110L	Komatsu KTR110L
Air compressor		—	—	—	—
Others		—	With aftercooler	With aftercooler	With aftercooler

GENERAL

SPECIFICATIONS

SA6D140E-3				
DCA400SSK (DENYO generator)	PC600-6			
6 – 140 x 165 15.2 {15,230} 1 – 5 – 3 – 6 – 2 – 4				
1,632 978 1,634 —	1,630 1,326 1,262 —			
357{478}/1,800 (60Hz) (Net) Max.1,890 (60Hz) 800 ⁺⁵⁰ ₀ (At rated flywheel horsepower) 214{160} (60Hz)	287{385}/1,800 (Net) 1,755{179}/1,400 (Net) 1,950 ± 50 800 ± 25 215 {158}			
1,750	1,700			
Denso ECD-U2 Electronic control type				
74 (71)	42 (37)			
27 (Engine only)	26 (Engine only)			
24V, 35A 24V, 7.5kW 12V 200Ah x 2	24V, 75A 24V, 11kW 12V 170Ah x 2			
Komatsu KTR110L —	Komatsu KTR110L —			
With aftercooler	With aftercooler			

GENERAL

SPECIFICATIONS

Engine			SAA6D140E-3		
Machine model			PC750,750LC-6,PC750-7 PC800-6,PC800-7	PC1800-6(USA) (2 engines)	
No. of cylinders - bore x stroke		mm	6 – 140 x 165		
Piston displacement		ℓ {cc}	15.2 {15,230}		
Firing order		—	1 – 5 – 3 – 6 – 2 – 4		
Dimensions	Overall length	mm	1,832	1,624	
	Overall width	mm	1,185	1,264	
	Overall height (excl. exhaust pipe)	mm	1,902	1,626	
	Overall height (incl. exhaust pipe)	mm	—	—	
Performance	Rated horsepower	kW{HP}/rpm	338{454}/1,800 (Net)	338{454}/1,800 (Net)	
	Max. torque	Nm{kgm}/rpm	2,138{218}/1,350 (Net)	2,138{218}/1,350 (Net)	
	High idling speed	rpm	1,980 ± 50	1,980 ± 50	
	Low idling speed	rpm	825 ± 25	825 ± 25	
	Min. fuel consumption ratio	g/kW·h {g/HP·h}	207 {154}	207 {154}	
Dry weight		kg	1,720	1,720	
Fuel supply pump		—	Denso ECD-U2		
Governor		—	Electronic control type		
Lubricating oil amount (replacement amount)		ℓ	58 (53)	58 (53)	
Cooling water		ℓ	26 (Engine only)	26 (Engine only)	
Alternator		—	24V, 90A	24V, 90A	
Starting motor		—	24V, 11kW	24V, 11kW	
Battery		—	12V 170Ah x 2	12V 170Ah x 2	
Turbocharger		—	Komatsu KTR110L	Komatsu KTR110L	
Air compressor		—	—	Zexel Recipro type single cylinder (only for front engine)	
Others		—	With air-cooled aftercooler	With air-cooled aftercooler	

GENERAL
SPECIFICATIONS

SAA6D140E-3				
HD325-6	HM350-1	HM350-1 (-40°C spec.)	HM400-1	
6 – 140 x 165				
15.2 {15,230}				
1 – 5 – 3 – 6 – 2 – 4				
1,762	1,792	1,792	1,792	
1,192	1,238	1,238	1,238	
1,615	1,470	1,470	1,470	
—	—	—	—	
379{508}/2,000 (Gross)	298{399}/2,000 (Gross)	298{399}/2,000 (Gross)	335.8{444}/2,000 (Gross)	
2,170{221}/1,400 (Gross)	1,950{199}/1,400 (Gross)	1,950{199}/1,400 (Gross)	2,048{209}/1,400 (Gross)	
2,400 ± 50	2,200 ⁺⁵⁰ ₀	2,200 ⁺⁵⁰ ₀	2,200 ⁺⁵⁰ ₀	
725 ± 25	725 ± 25	725 ± 25	725 ± 25	
196	196	196	196	
{144}	{144}	{144}	{144}	
1,600	1,620	1,620	1,620	
Denso ECD-U2				
Electronic control type				
59 (55)	56 (52)	56 (52)	56 (52)	
26 (Engine only)	26 (Engine only)	26 (Engine only)	26 (Engine only)	
24V, 50A	24V, 50A	24V, 75A	24V, 50A	
24V, 11kW	24V, 11kW	24V, 11kW x 2	24V, 11kW	
12V 170Ah x 2	12V 170Ah x 2	12V 170Ah x 2	12V 170Ah x 2	
Komatsu KTR110L Zexel Recipro type single cylinder	Komatsu KTR110L —	Komatsu KTR110L —	Komatsu KTR110L —	
With air-cooled aftercooler and exhaust brake	With air-cooled aftercooler and exhaust brake	With air-cooled aftercooler and exhaust brake	With air-cooled aftercooler and exhaust brake	

GENERAL

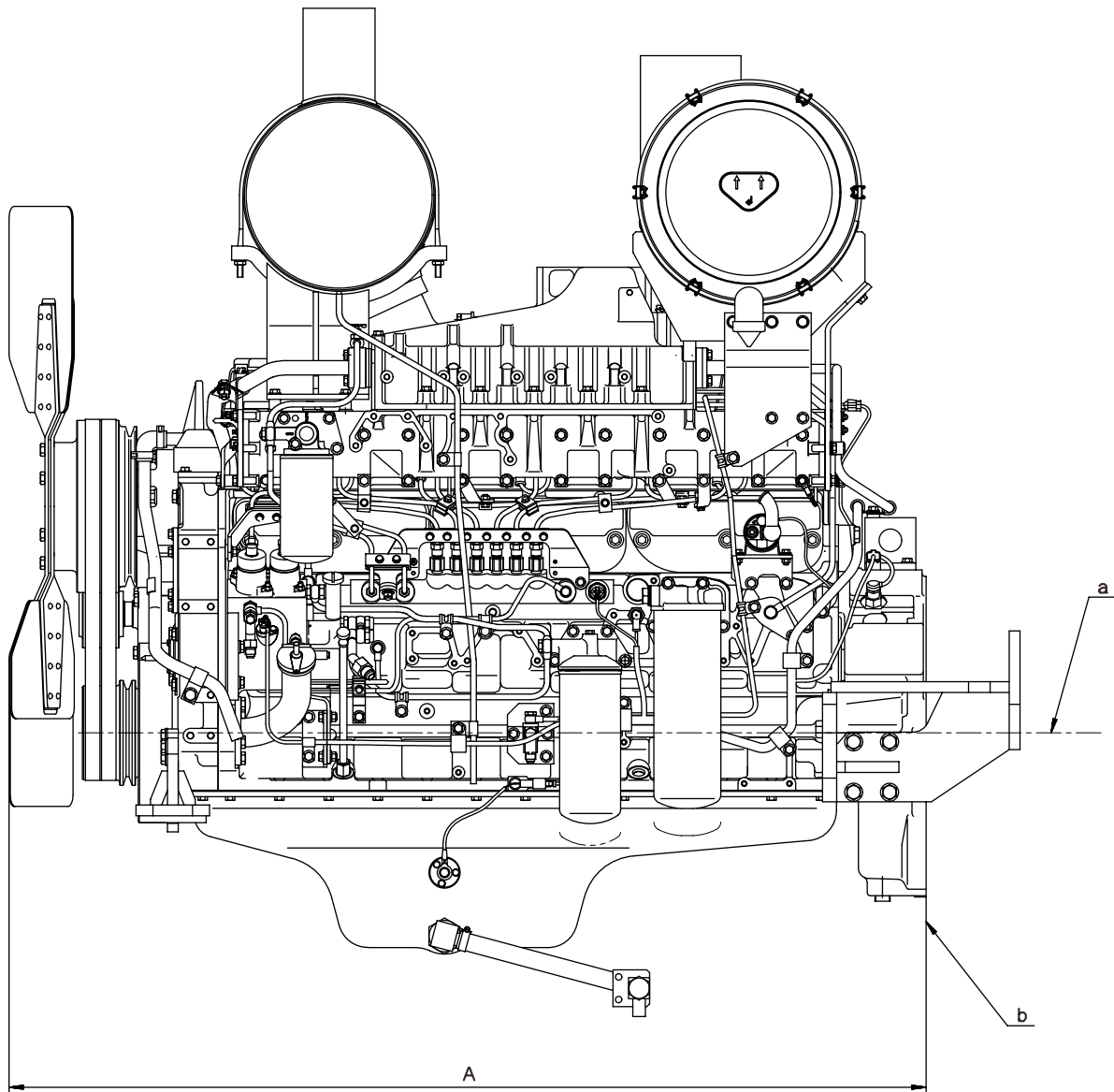
SPECIFICATIONS

Engine			SDA6D140E-3		
Machine model			D275A-5 D275AX-5		
No. of cylinders - bore x stroke	mm		6 – 140 x 165		
Piston displacement	ℓ {cc}		15.2 {15,230}		
Firing order	—		1 – 5 – 3 – 6 – 2 – 4		
Dimensions	Overall length	mm	1,461		
	Overall width	mm	966		
	Overall height (excl. exhaust pipe)	mm	2,020		
	Overall height (incl. exhaust pipe)	mm	—		
Performance	Rated horsepower	kW{HP}/rpm	332{446}/2,000 (Gross)		
	Max. torque	Nm{kgm}/rpm	1,990{203}/1,400 (Gross)		
	High idling speed	rpm	2,200 ± 50		
	Low idling speed	rpm	700 ± 30		
	Min. fuel consumption ratio	g/kW·h {g/HP·h}	— {—}		
Dry weight		kg	1,765		
Fuel supply pump		—	Denso ECD-U2		
Governor		—	Electronic control type		
Lubricating oil amount (replacement amount)		ℓ	62 (55)		
Cooling water		ℓ	26 (Engine only)		
Alternator		—	24V, 75A		
Starting motor		—	24V, 11kW		
Battery		—	12V 170Ah x 2		
Turbocharger		—	Komatsu KTR110L		
Air compressor		—	—		
Others		—	With aftercooler		

OVERALL DRAWING

SA6D140E-3 LEFT SIDE DRAWING

- ★ The diagram shows the equipment for the WA500-3.
- ★ The shape may differ according to the machine model.

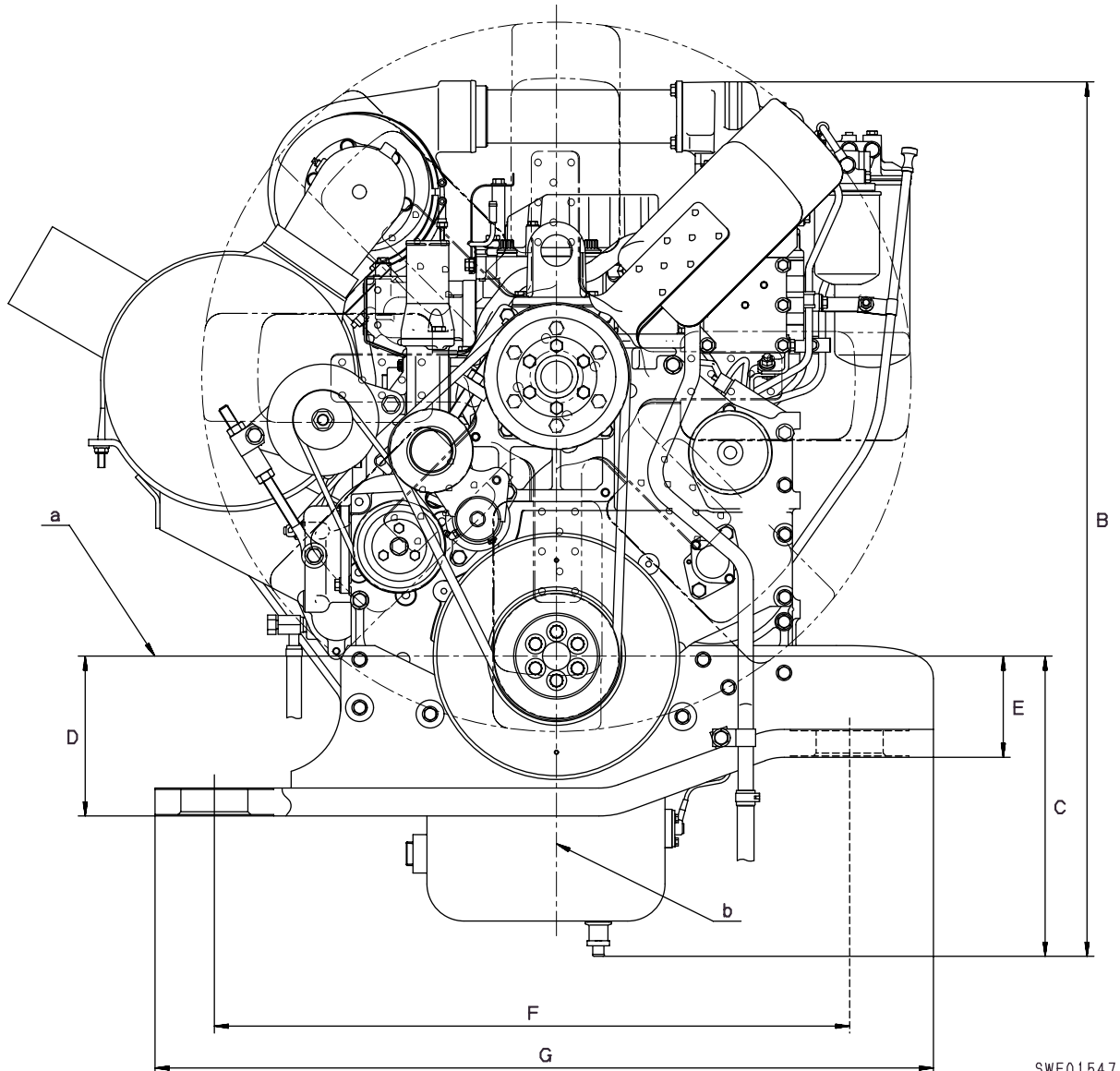


SWE01546

- a. Crankshaft center
- b. Flywheel housing rear surface

SA6D140E-3 FRONT DRAWING

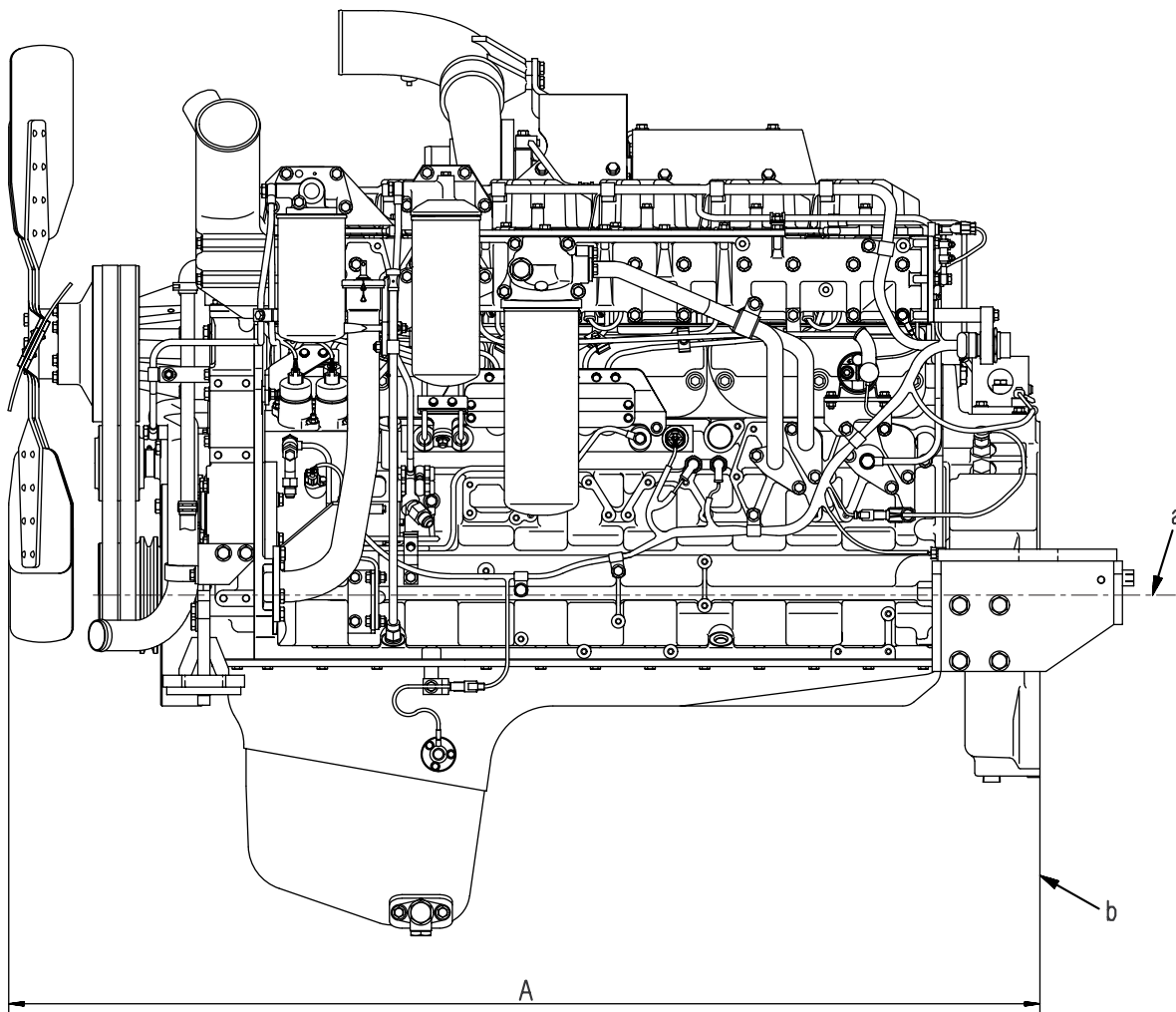
- ★ The diagram shows the equipment for the WA500-3.
- ★ The shape may differ according to the machine model.



- a. Crankshaft center
- b. Cylinder liner center

SAA6D140E-3 LEFT SIDE DRAWING

- ★ The diagram shows the equipment for the HM350-1 and HM400-1.
- ★ The shape may differ according to the machine model.

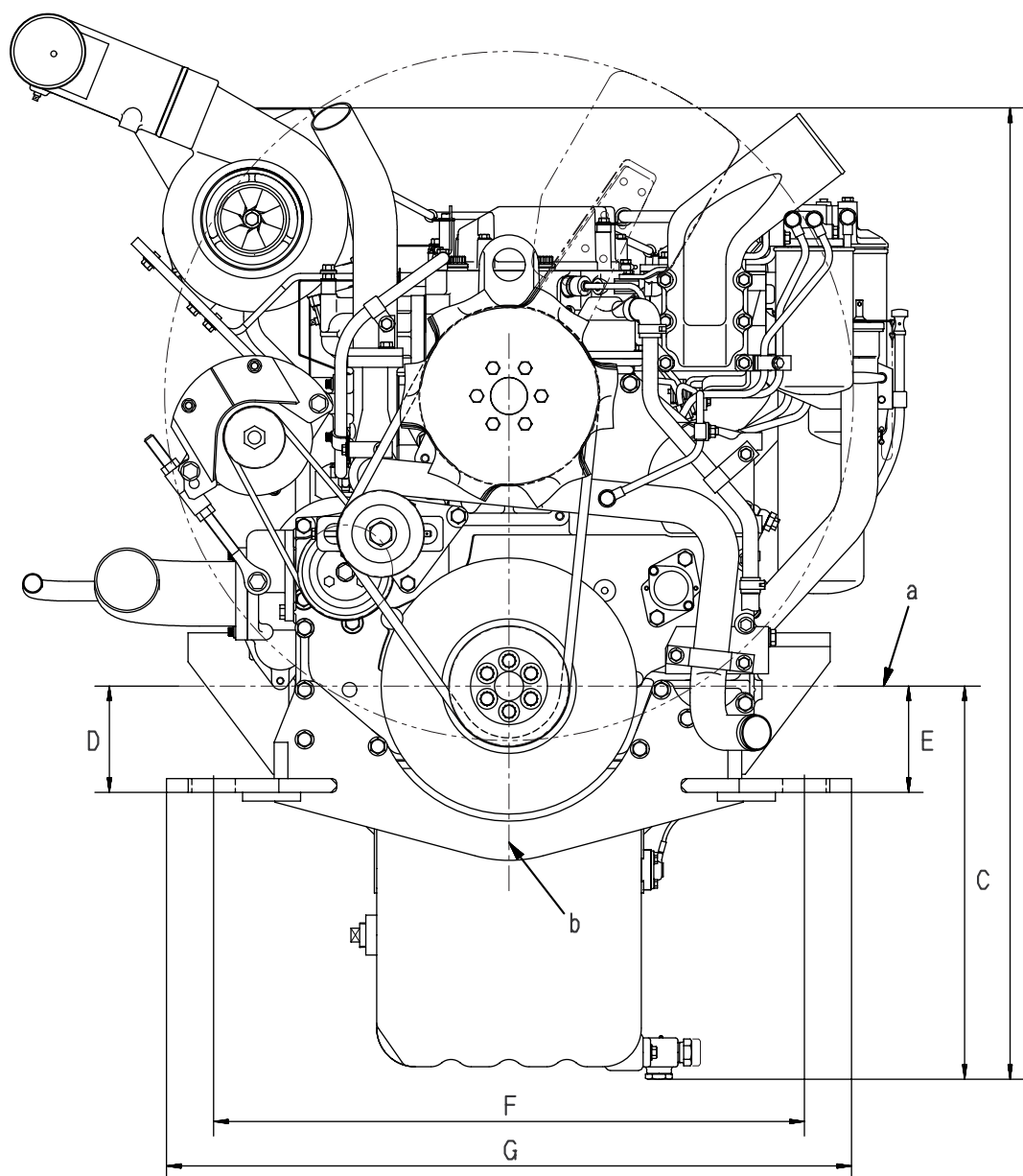


SJE01871

- a. Crankshaft center
- b. Flywheel housing rear surface

SAA6D140E-3 FRONT DRAWING

- ★ The diagram shows the equipment for the HM350-1 and HM400-1.
- ★ The shape may differ according to the machine model.

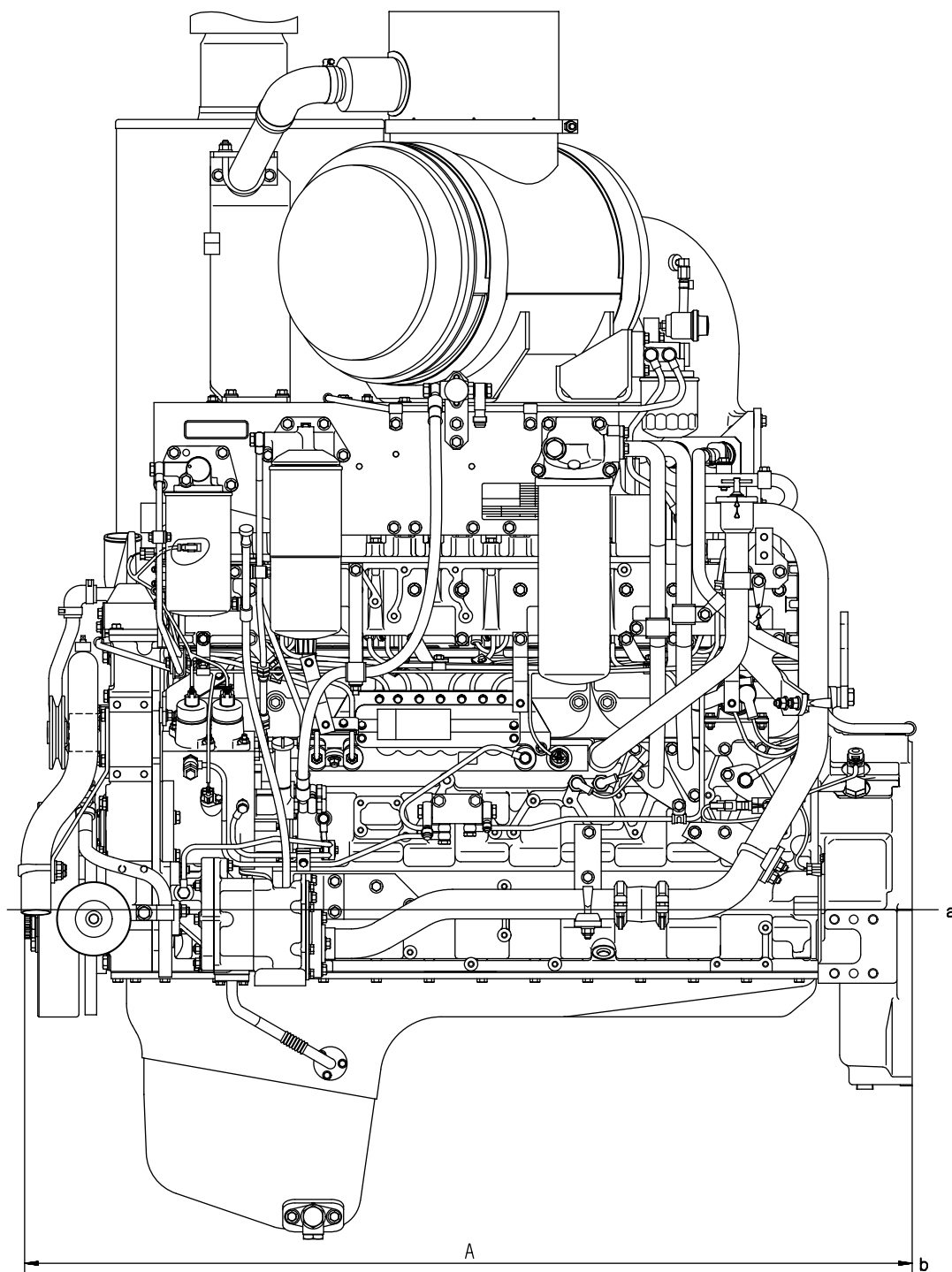


SJE01872

- a. Crankshaft center
- b. Cylinder liner center

SDA6D140E-3 LEFT SIDE DRAWING

- ★ The diagram shows the equipment for the D275AX-5.
- ★ The shape may differ according to the machine model.

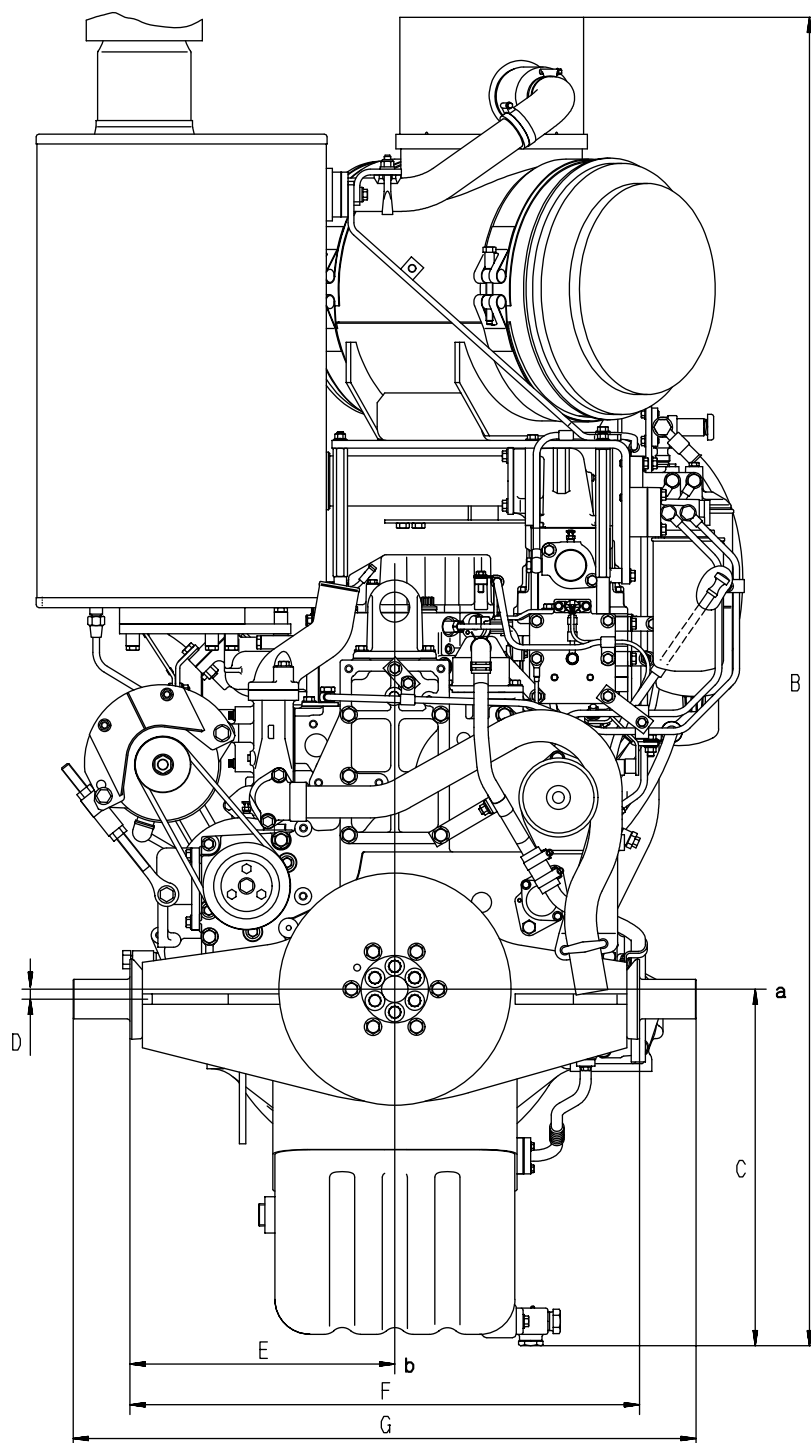


SJE02052

- a. Crankshaft center
- b. Flywheel housing rear surface

SDA6D140E-3 FRONT DRAWING

- ★ The diagram shows the equipment for the D275AX-5.
- ★ The shape may differ according to the machine model.



SJE02053

- a. Crankshaft center
- b. Cylinder liner center

DIMENSION TABLE

★ These dimensions are reference values for use when installing to a test bench.

Engine	Machine model	Dimensions for each part (mm)						
		A	B	C	D	E	F	G
SA6D140E-3	PC600-6	1,630	1,262	430	227	143	910	1,115
	WA500-3	1,621	1,670	370	—	—	812	943
	D155AX-5 (110001 – 112349)	1,499	1,738	419	14	459	868	1,040
	D155AX-5 (112350 and up)	1,446	1,799	419	14	459	868	1,040
	DCA400SSK	1,632	1,634	406	—	—	—	—
SAA6D140E-3	PC750-6, PC750LC-6 PC750-7 PC800-6, PC800-7	1,575	1,902	594	196	196	1,000	1,185
	PC1800-6 (USA)	1,624	1,625	594	196	196	1,000	1,185
	HD325-6	1,686	1,585	542	—	—	—	1,156
	HM350-1, HM400-1	1,642	1,469	542	146.5	146.5	815	945

Engine	Machine model	Dimensions for each part (mm)						
		A	B	C	D	E	F	G
SDA6D140E-3	D275A-5, D275AX-5	1,461	2,020	542	15	422	794	966

WEIGHT TABLE

Unit : kg

No.	Item	Main item	SA6D140E-3		SAA6D140E-3	
1	Turbocharger	Komatsu KTR110L	23		23	
2	Cylinder head assembly	Cylinder head, valve, valve spring	22.5 x 6		22.5 x 6	
3	Cylinder block assembly	Cylinder block, bearing cap, cylinder liner	480		480	
4	Front cover		43		43	
5	Oil pan		D155AX-5 WA500-3	30	PC750-6,PC750-7 PC800-6,PC800-7 PC1800-6	36
			DCA400SSK (DENYO generator)	62	HD325-6 HM350-1 HM400-1	28
6	Flywheel assembly	Flywheel ring gear	D155AX-5 WA500-3	60	PC750-6,PC750-7 PC800-6,PC800-7 PC1800-6	60
			DCA400SSK (DENYO generator)	114	HD325-6 HM350-1 HM400-1	47
7	Flywheel housing assembly		D155AX-5	60	PC750-6,PC750-7 PC800-6,PC800-7 PC1800-6	59
			WA500-3	55		
			DCA400SSK (DENYO generator)	64	HD325-6 HM350-1 HM400-1	59
8	Crankshaft assembly	Crankshaft, crankshaft gear	136		136	
9	Camshaft assembly	Camshaft, cam gear thrust plate	19		19	
10	Piston, connecting rod assembly	Piston, piston ring, piston pin, connecting rod	10.7 x 6		10.7 x 6	
11	Oil pump		6.5		6.5	
12	Fuel supply pump		13		13	
13	Water pump		17		17	
14	Alternator	24V 35A	9.5		9.5	
		24V 50A	11		11	
		24V 75A	12.5		19	
		24V 90A	—		PC800-6 (USA) PC800-7 (USA) PC1800-6 (USA)	19
15	Starting motor	24V 7.5kW	15.5		15.5	
		24V 11kW	18		18	
16	Air compressor		11		11	
17	Aftercooler assembly		45		PC750-6,PC750-7 PC800-6,PC800-7 PC1800-6	37
					HD325-6 HM350-1 HM400-1	35

GENERAL
WEIGHT TABLE

Unit : kg

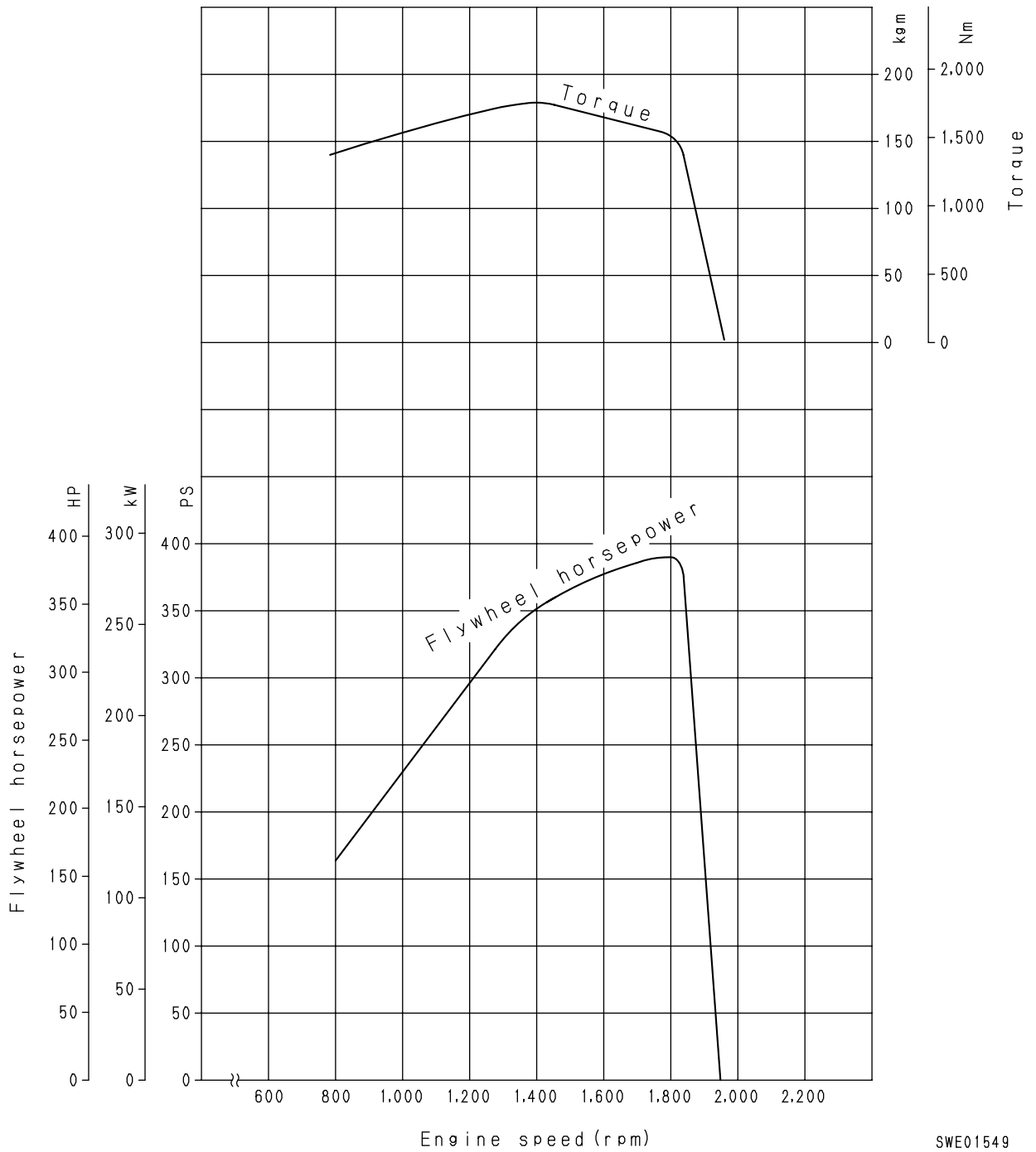
SDA6D140E-3									
23									
22.5 x 6									
480									
43									
D275A-5 D275AX-5	28								
D275A-5 D275AX-5	60								
D275A-5 D275AX-5	59								
136									
19									
10.7 x 6									
6.5									
13									
17									
—									
—									
12.5									
—									
—									
18									
—									
45									

ENGINE PERFORMANCE CURVE

Engine	Engine Serial No.	Machine model	Page
SA6D140E-3		PC600-6	01-51
	110001 – 112349	D155AX-5	01-52
	112350 and up	D155AX-5	01-52-1
		WA500-3	01-53
SAA6D140E-3		HD325-6	01-70
		PC750, PC750LC-6, PC750-7 PC800-6, PC800-7 PC1800-6	01-71
		HM350-1	01-72
		HM400-1	01-73
SAD6D140E-3		D275A-5, D275AX-5	01-90

SA6D140E-3 [For PC600-6]

Rated output: 287kW {385HP} / 1,800 rpm (Net)
Max. torque: 1,755 Nm {179 kgm} / 1,400 rpm (Net)

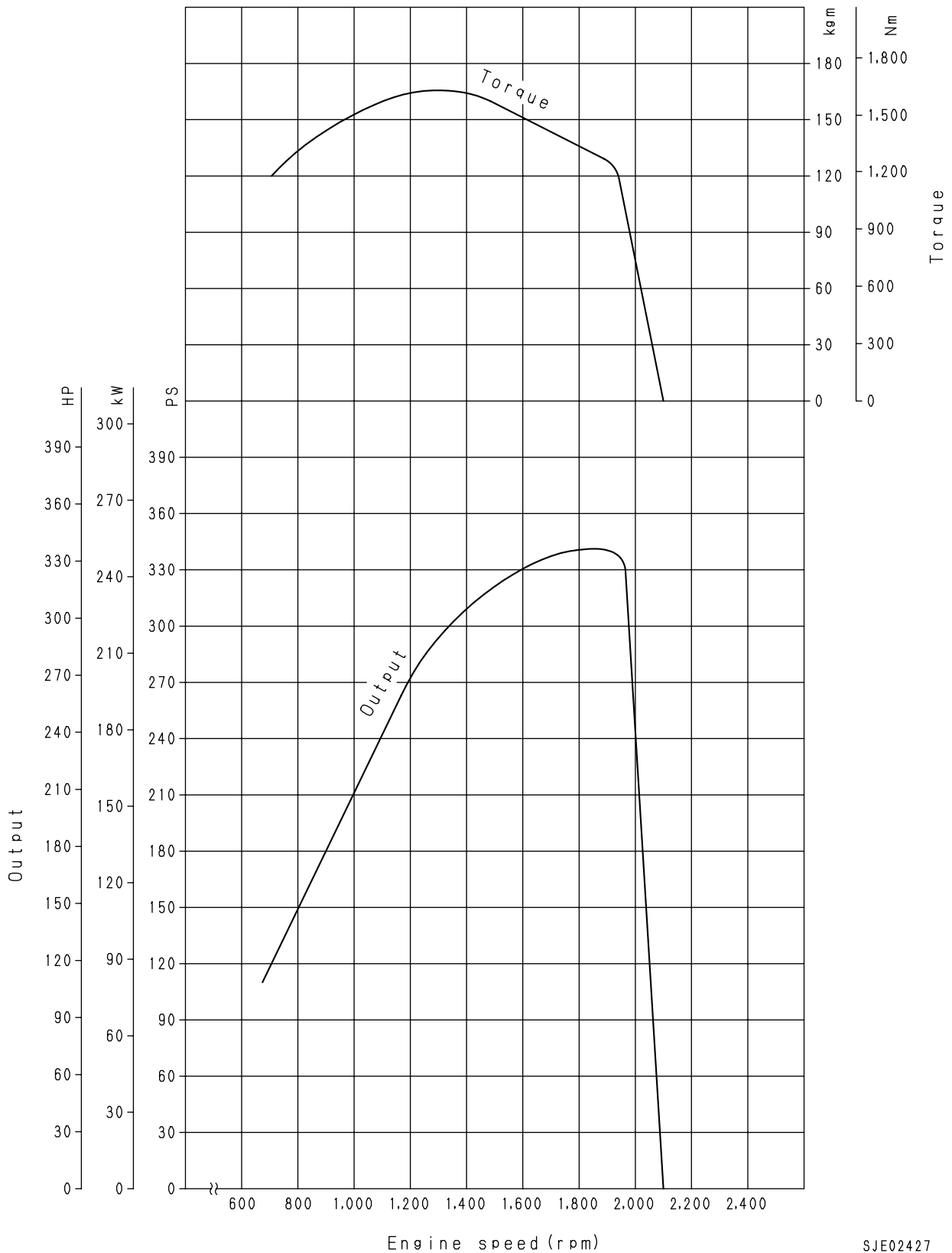


SWE01549

SA6D140E-3 [For D155AX-5 (110001 – 112349)]

Rated output: 252kW {338HP} / 1,900 rpm (Gross)

Max. torque: 1,635 Nm {166.7 kgm} / 1,250 rpm (Gross)

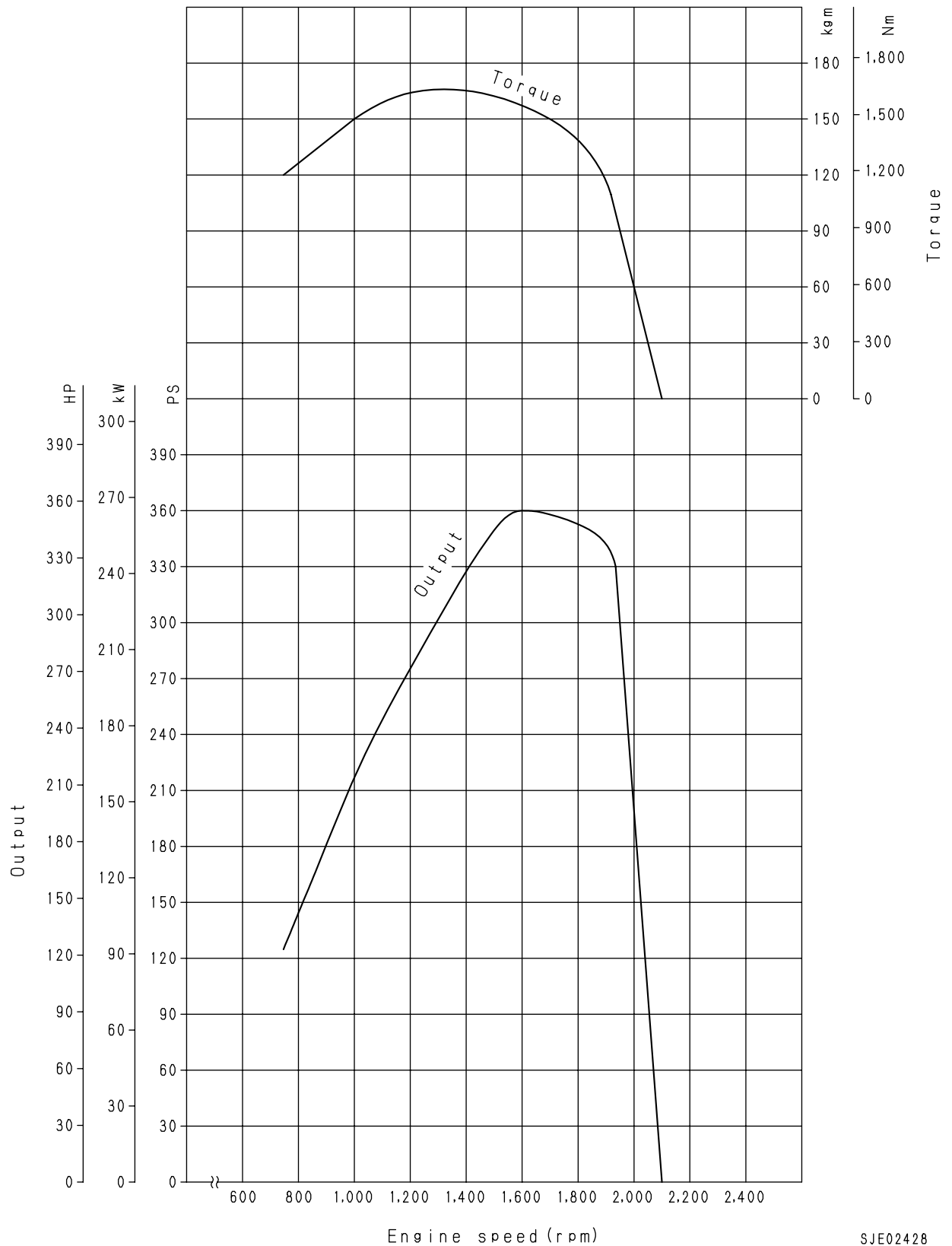


SJE02427

SA6D140E-3 [For D155AX-5 (112350 and up)]

Rated output: 248kW {332HP} / 1,900 rpm (Gross)

Max. torque: 1,635 Nm {166.7 kgm} / 1,250 rpm (Gross)

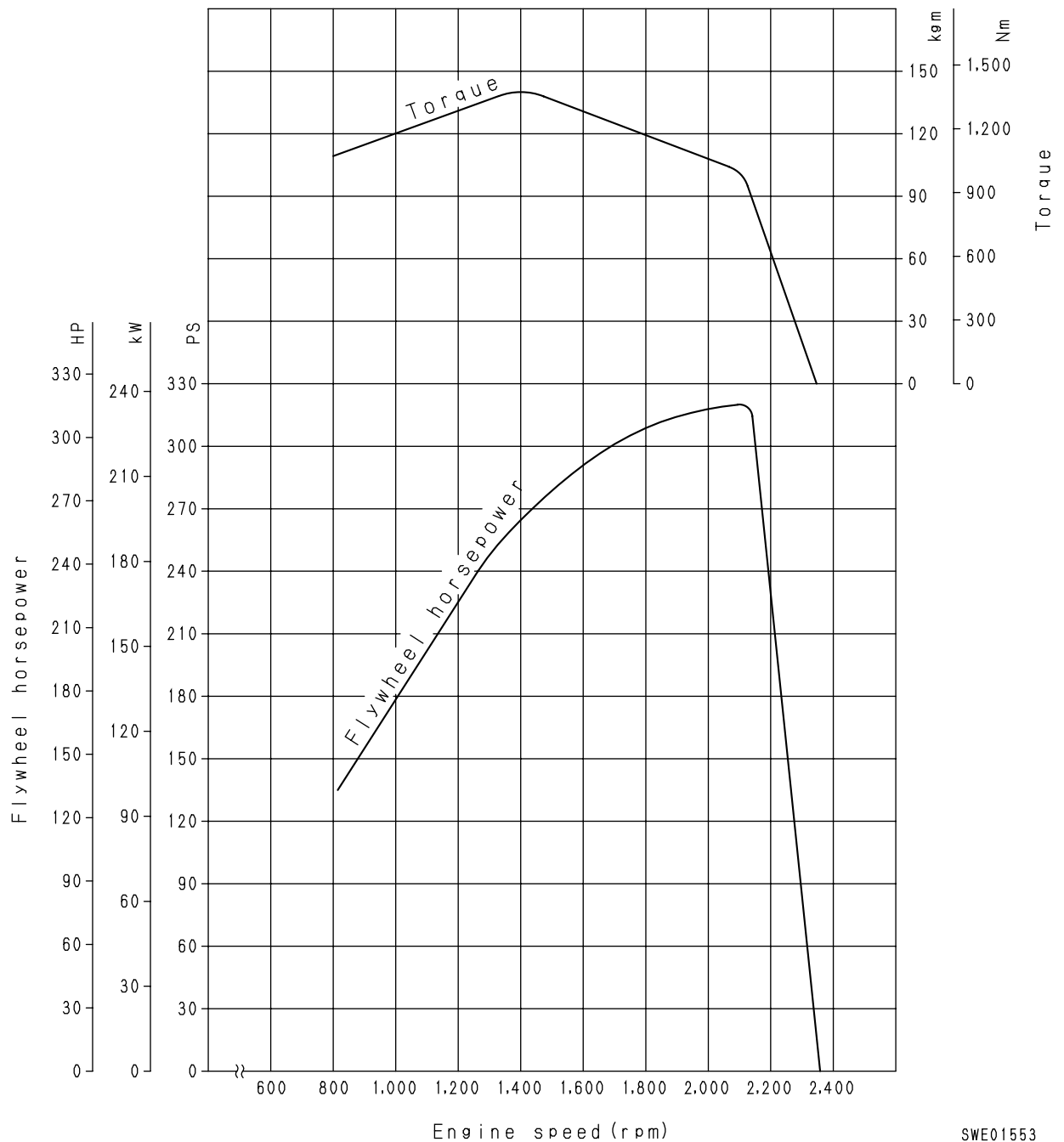


SJE02428

SA6D140E-3 [For WA500-3]

Rated output: 235kW {316HP} / 2,100 rpm (Net)

Max. torque: 1,370 Nm {140 kgm} / 1,400 rpm (Net)

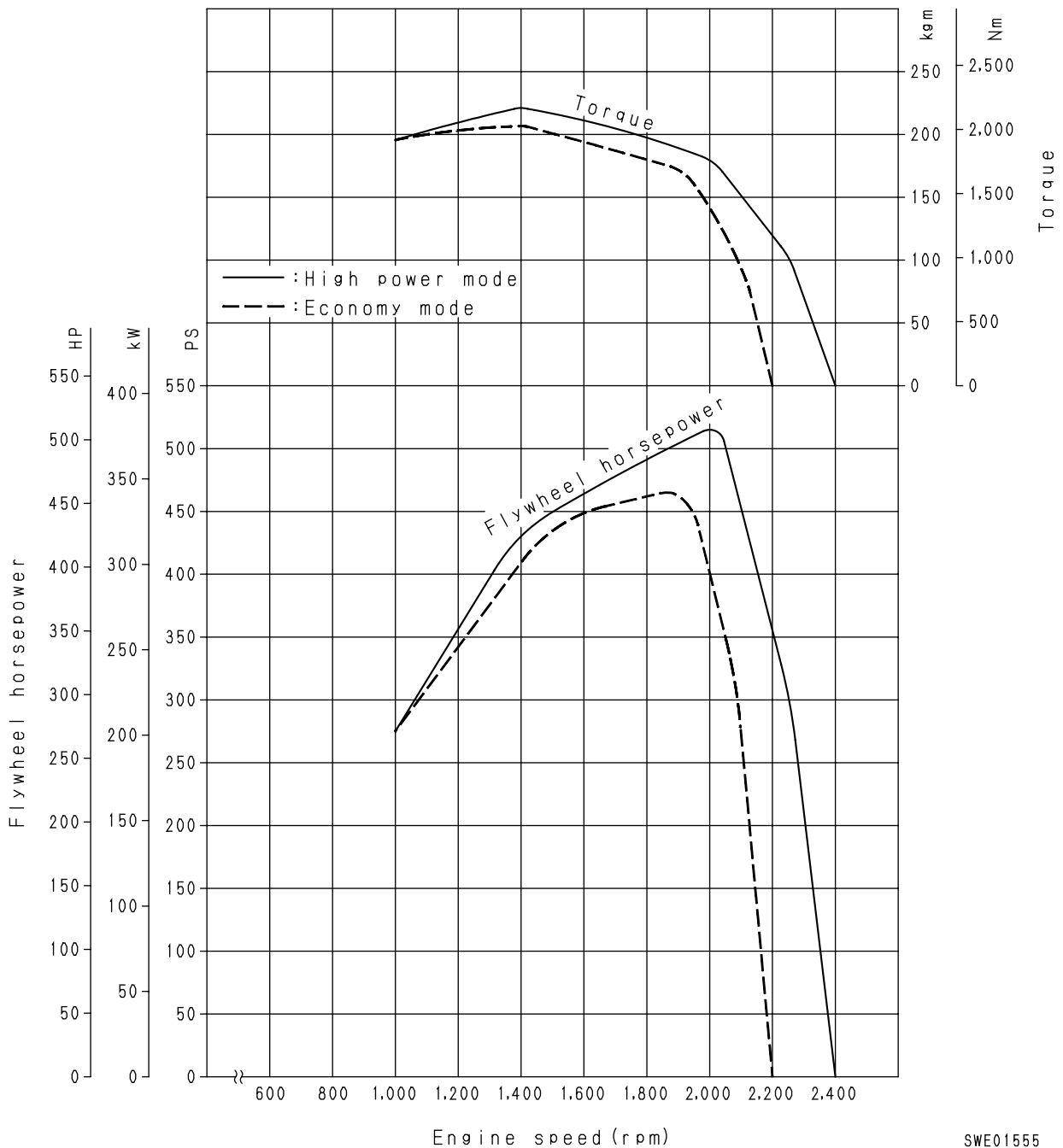


SWE01553

SAA6D140E-3 [For HD325-6]

Rated output: 379kW {508HP} / 2,000 rpm (Gross)

Max. torque: 2,170 Nm {221 kgm} / 1,400 rpm (Gross)

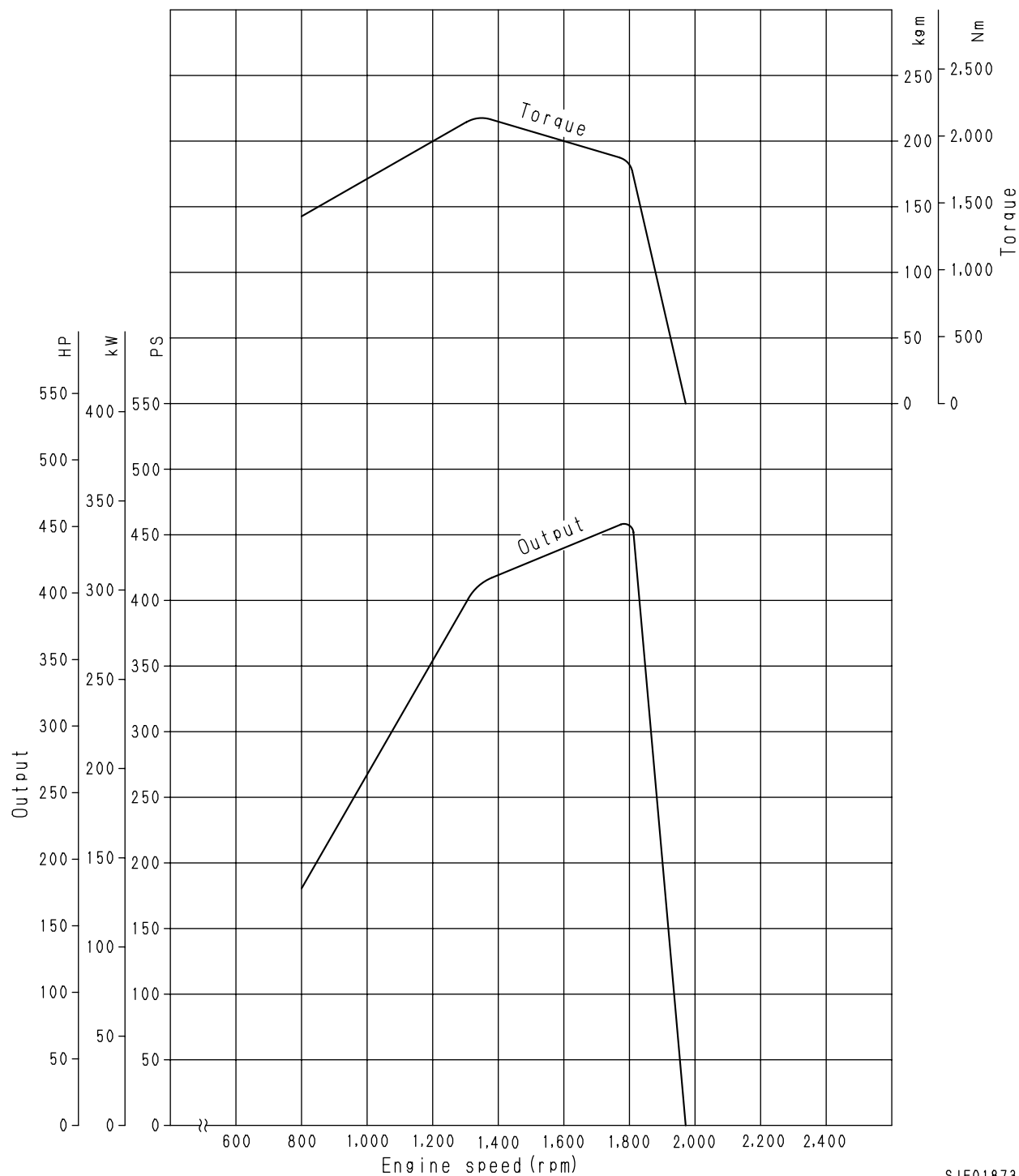


SWE01555

SAA6D140E-3 [For PC750-6, PC750LC-6, PC750-7, PC800-6, PC800-7, PC1800-6]

Rated output: 338kW {454HP} / 1,800 rpm (Net)

Max. torque: 2,138 Nm {218 kgm} / 1,350 rpm (Net)

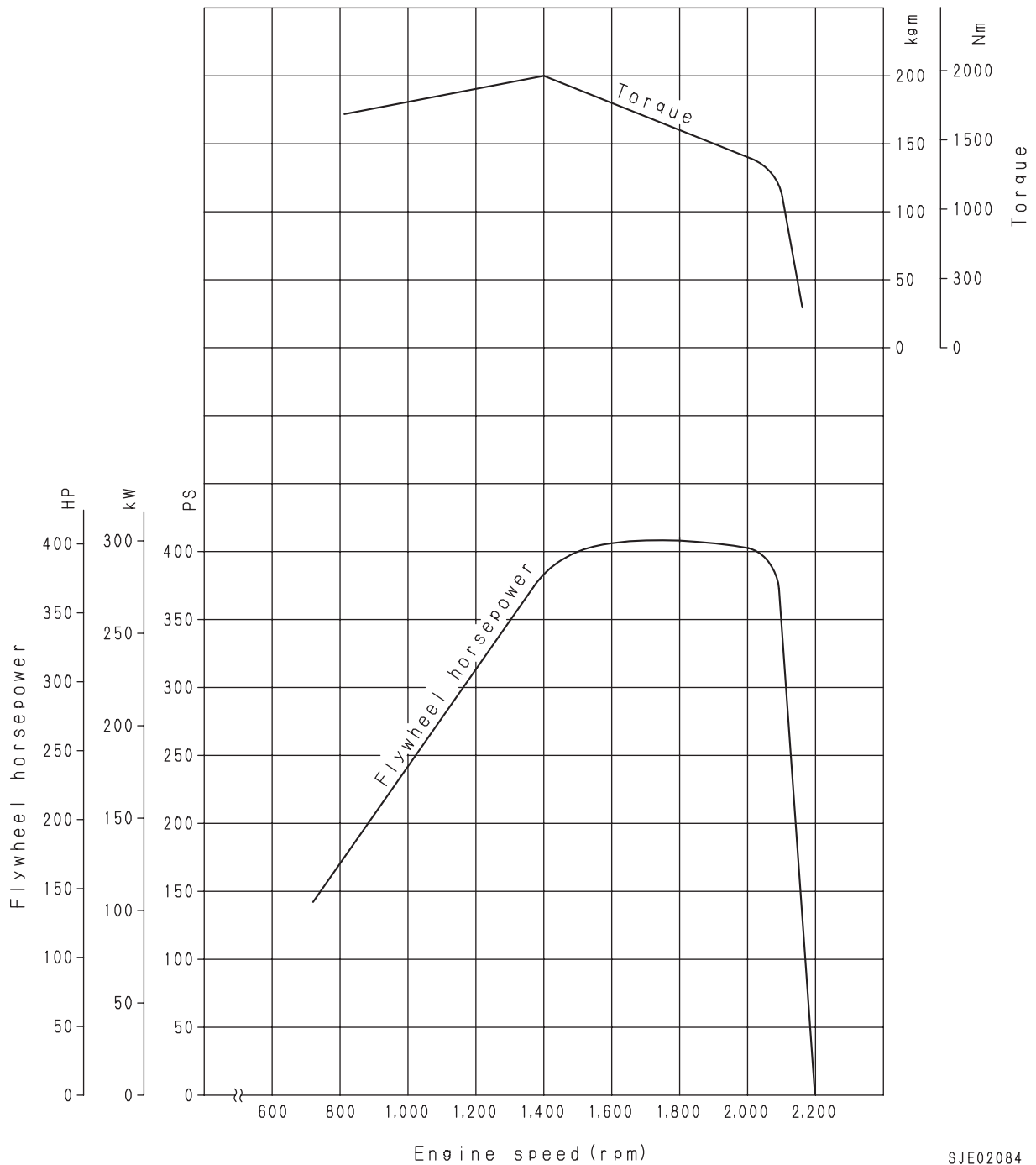


SJE01873

SAA6D140E-3 [For HM350-1]

Rated output: 298kW {399HP} / 2,000 rpm (Gross)

Max. torque: 1,950 Nm {199 kgm} / 1,400 rpm (Gross)

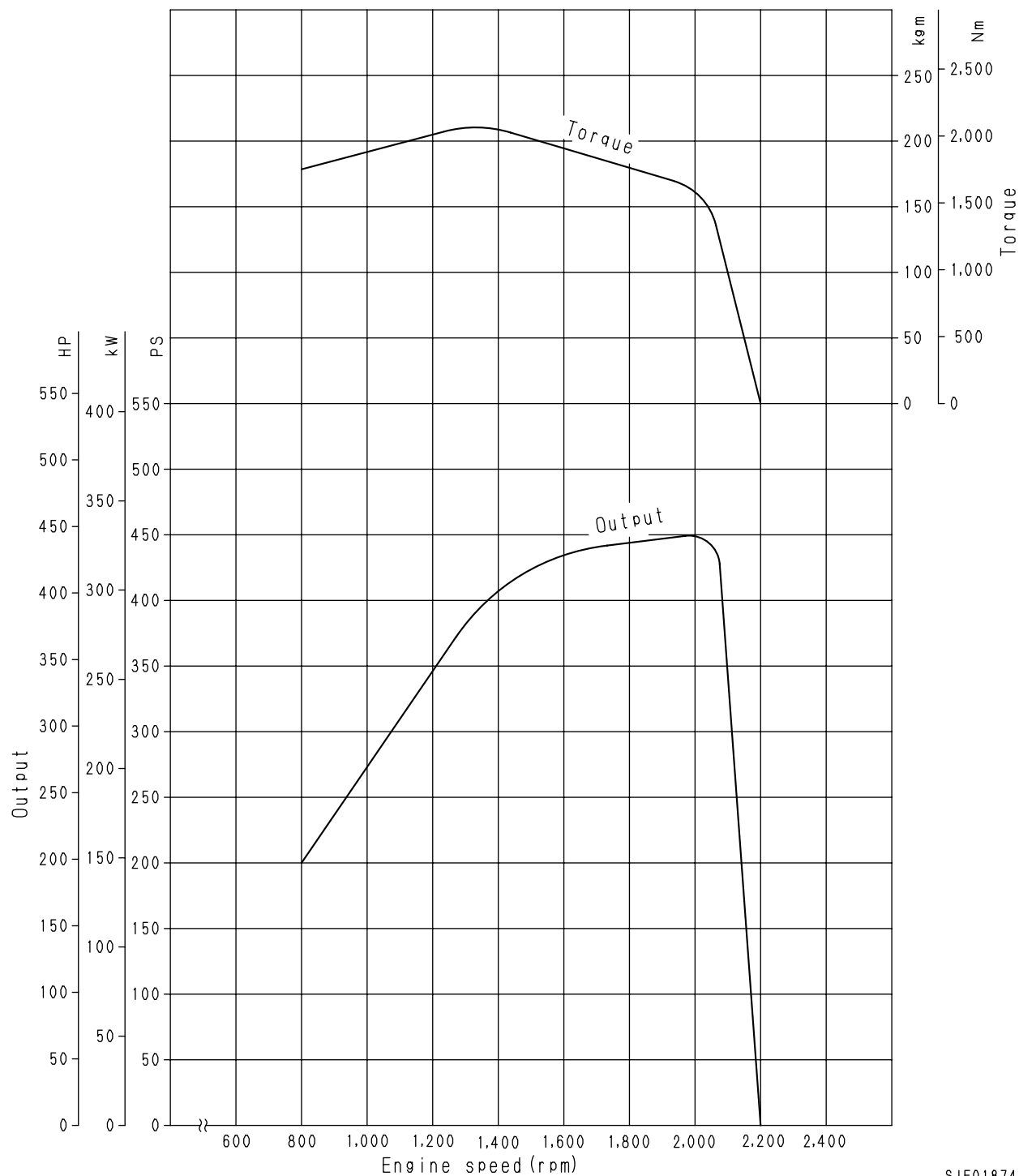


SJE02084

SAA6D140E-3 [For HM400-1]

Rated output: 335kW {444HP} / 2,000 rpm (Gross)

Max. torque: 2,048 Nm {209 kgm} / 1,400 rpm (Gross)

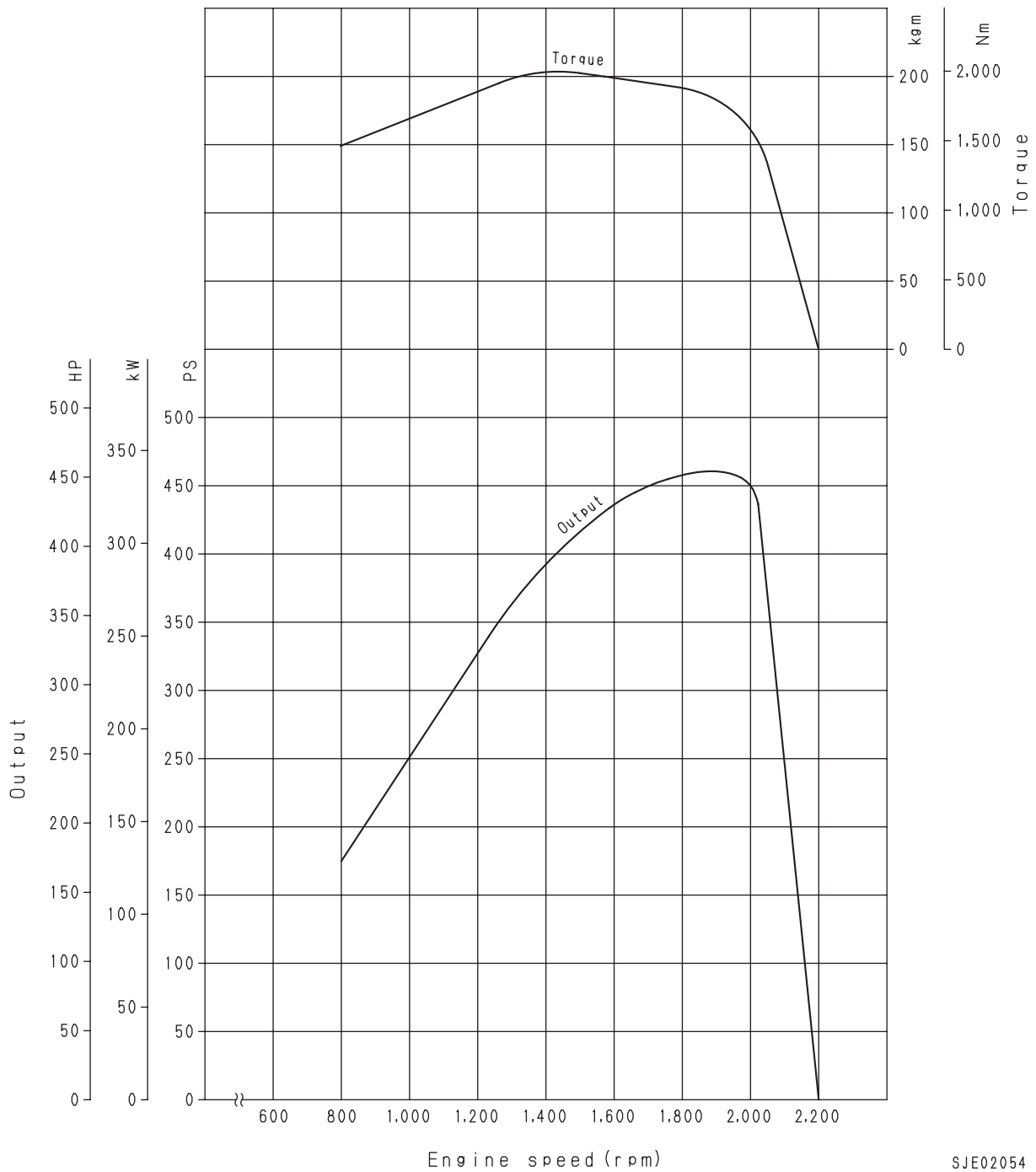


SJE01874

SDA6D140E-3 [For D275A-5, D275AX-5]

Rated output: 335kW {446HP} / 2,000 rpm (Gross)

Max. torque: 1,990 Nm {203 kgm} / 1,400 rpm (Gross)



SJE02054

11 STRUCTURE AND FUNCTION, MAINTENANCE STANDARD

INTAKE, EXHAUST SYSTEM

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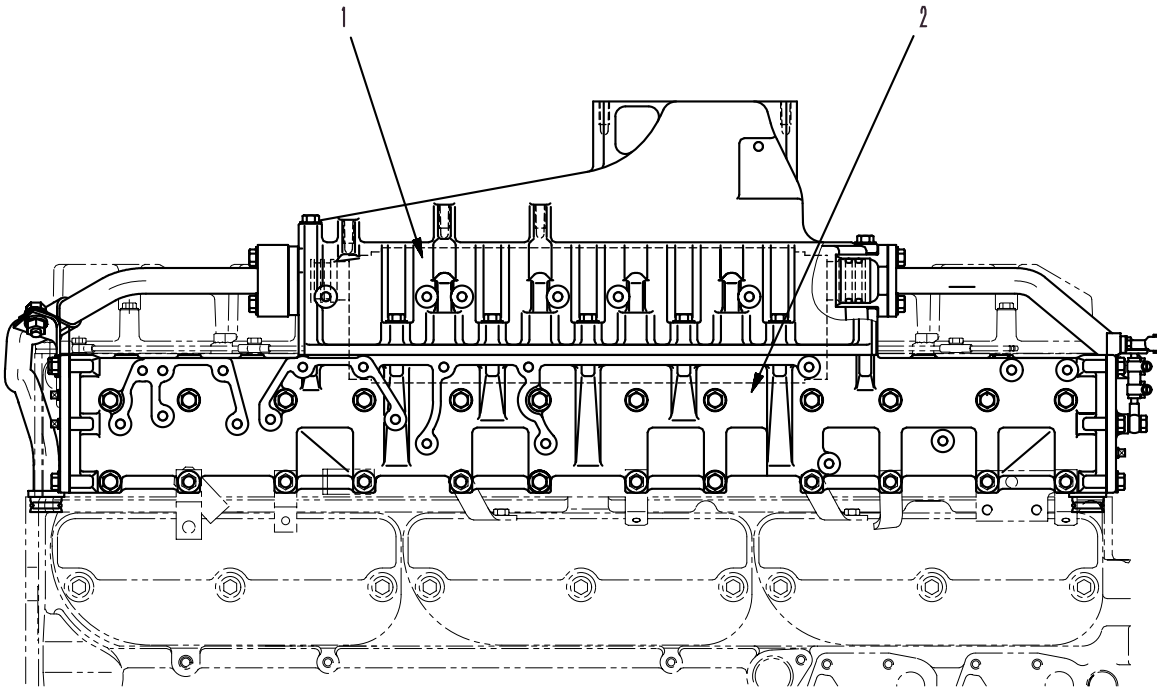
ELECTRICAL COMPONENTS

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STARTING MOTOR	11-106
STARTING AID	11-108

INTAKE, EXHAUST EQUIPMENT

SA6D140E-3 (Left side face of engine)

- ★ The diagram shows the equipment for the PC600-6.
- ★ Details may change for reasons such as modification.

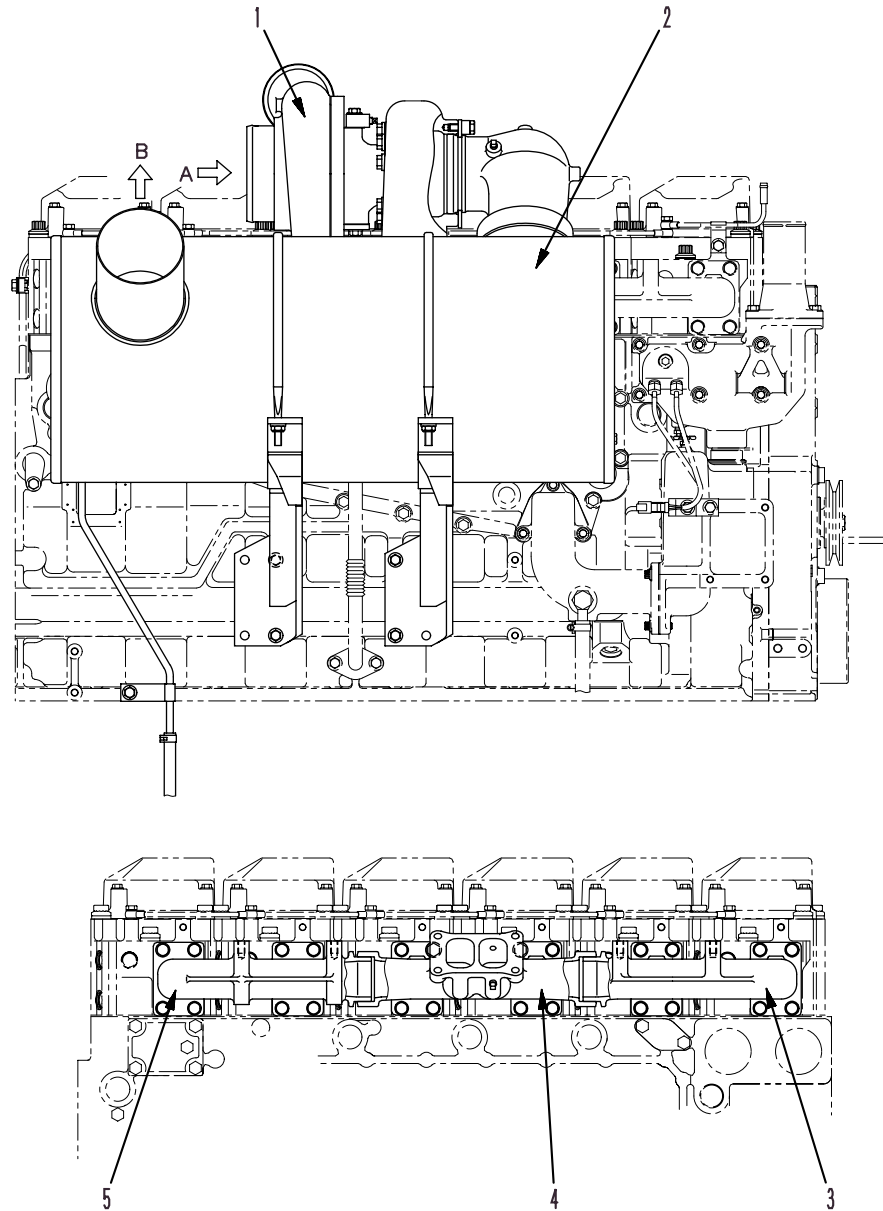


SXE01556

1. Aftercooler
2. Intake manifold

SA6D140E-3 (Right side face of engine)

- ★ The diagram shows the equipment for the PC600-6.
- ★ Details may change for reasons such as modification.



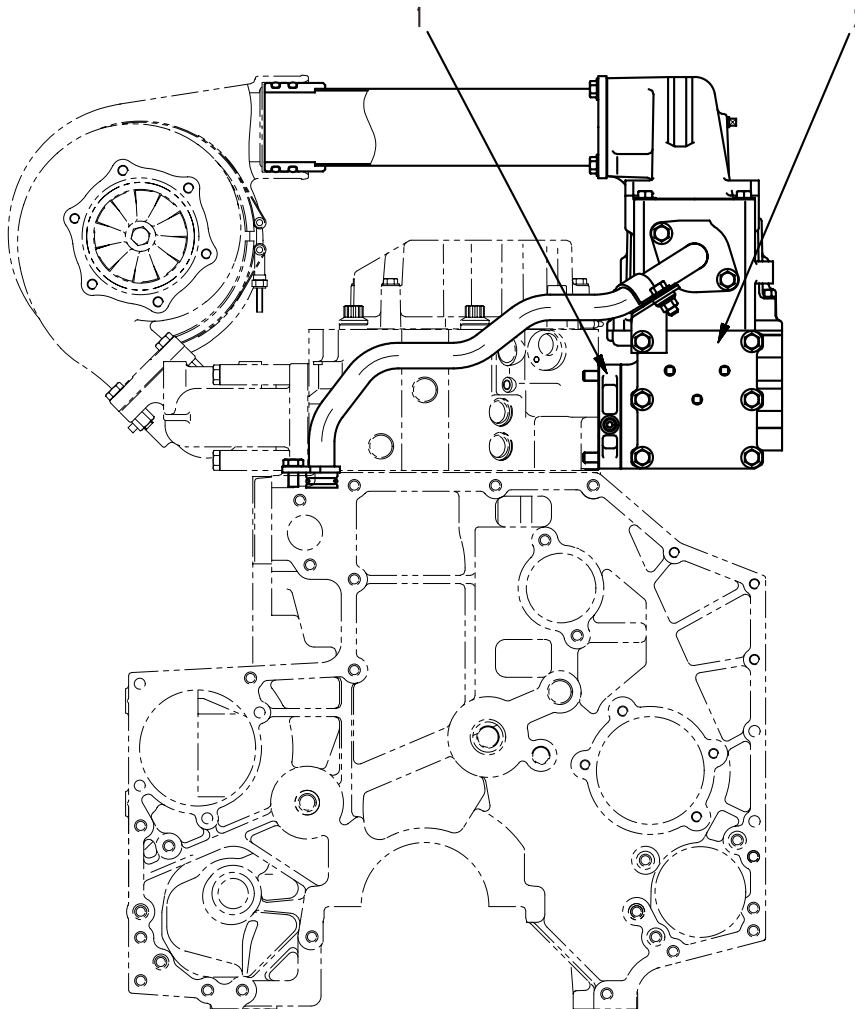
SWE01557

1. Turbocharger
2. Muffler
3. Exhaust manifold (front)
4. Exhaust manifold (center)
5. Exhaust manifold (rear)

- A. Intake inlet
B. Exhaust outlet

SA6D140E-3 (Front face of engine)

- ★ The diagram shows the equipment for the PC600-6.
- ★ Details may change for reasons such as modification.

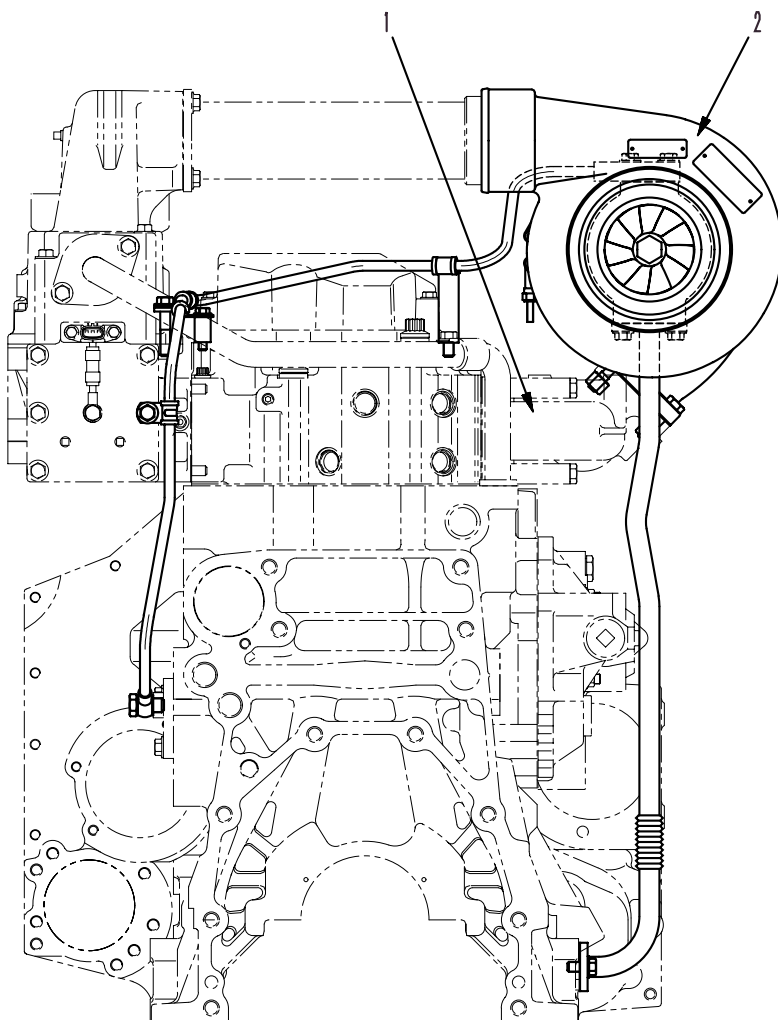


SXE01558

1. Electric heater (electrical intake air heater)
2. Intake manifold

SA6D140E-3 (Rear face of engine)

- ★ The diagram shows the equipment for the PC600-6.
- ★ Details may change for reasons such as modification.

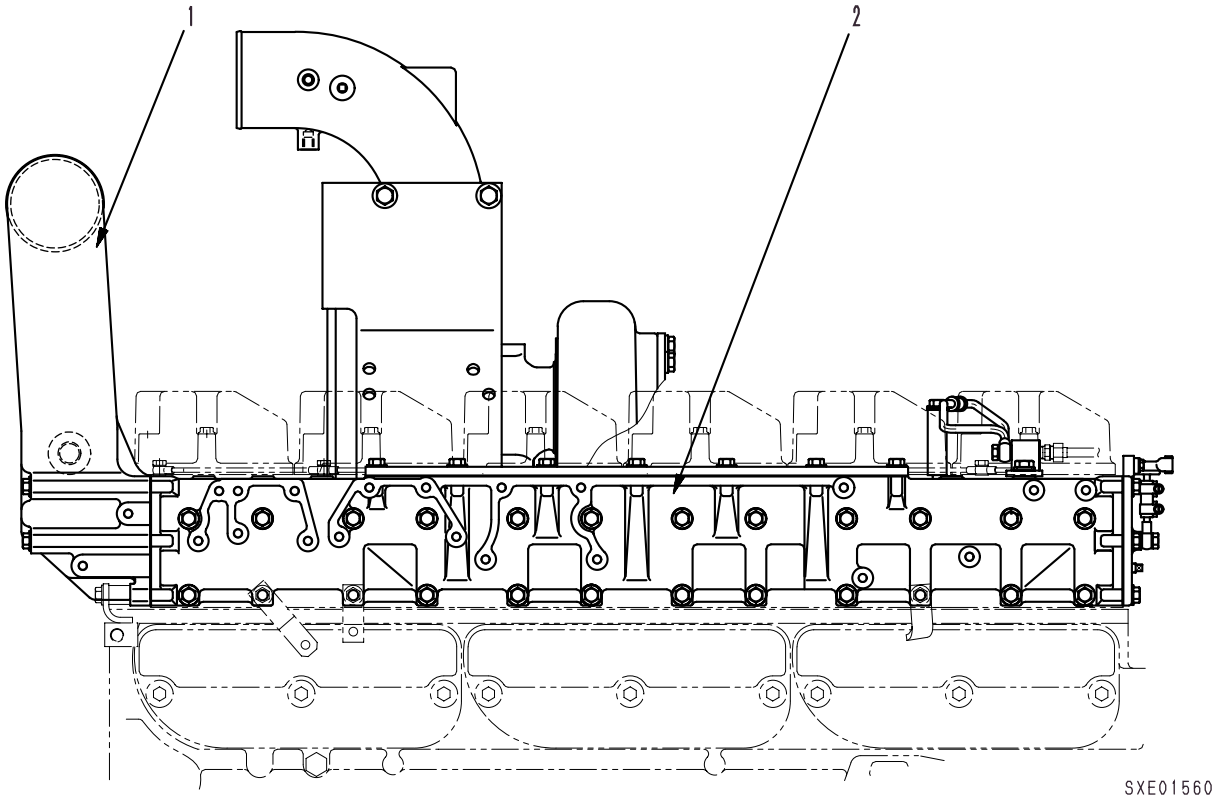


SXE01559

1. Exhaust manifold
2. Turbocharger

SAA6D140E-3 (Left side face)

- ★ The diagram shows the equipment for the HD325-6.
- ★ Details may change for reasons such as modification.

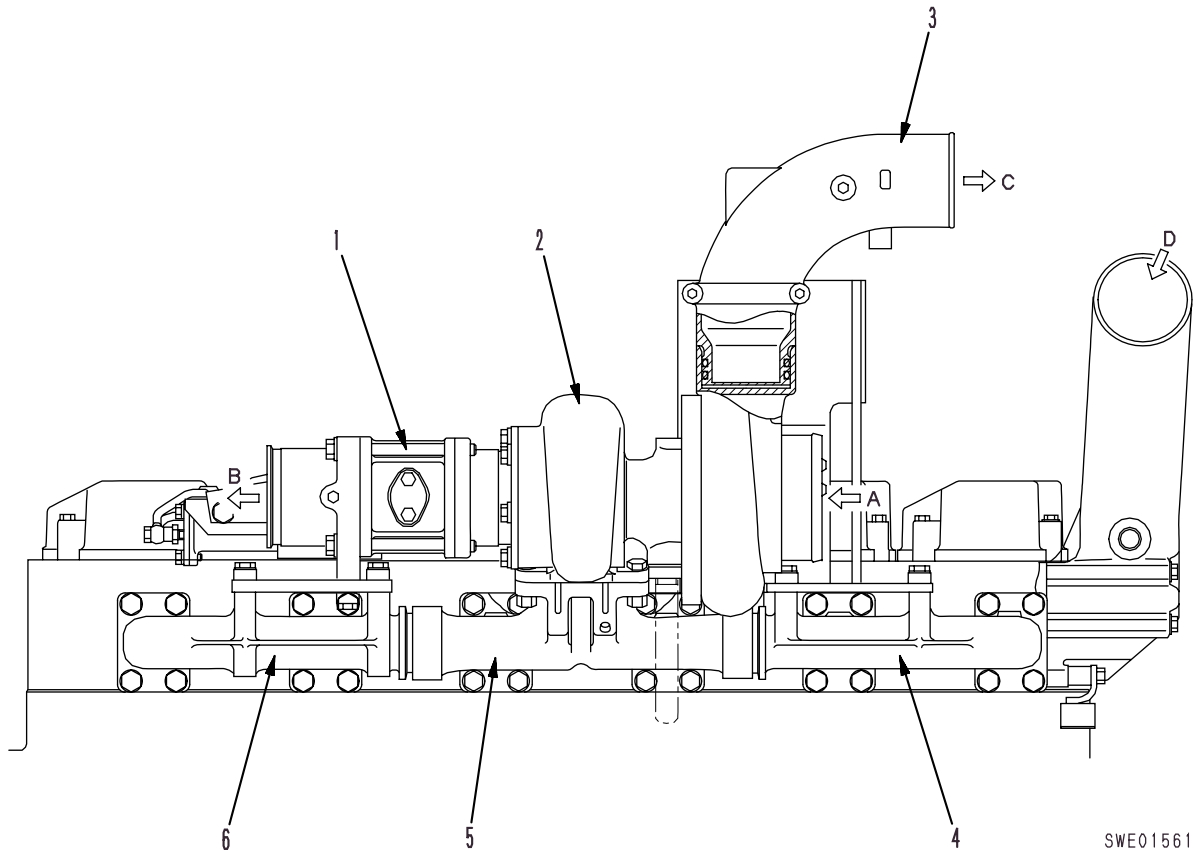


1. Connector (between air-cooled aftercooler and intake manifold)
2. Intake manifold

SXE01560

SAA6D140E-3 (Right side face)

- ★ The diagram shows the equipment for the HD325-6.
- ★ Details may change for reasons such as modification.

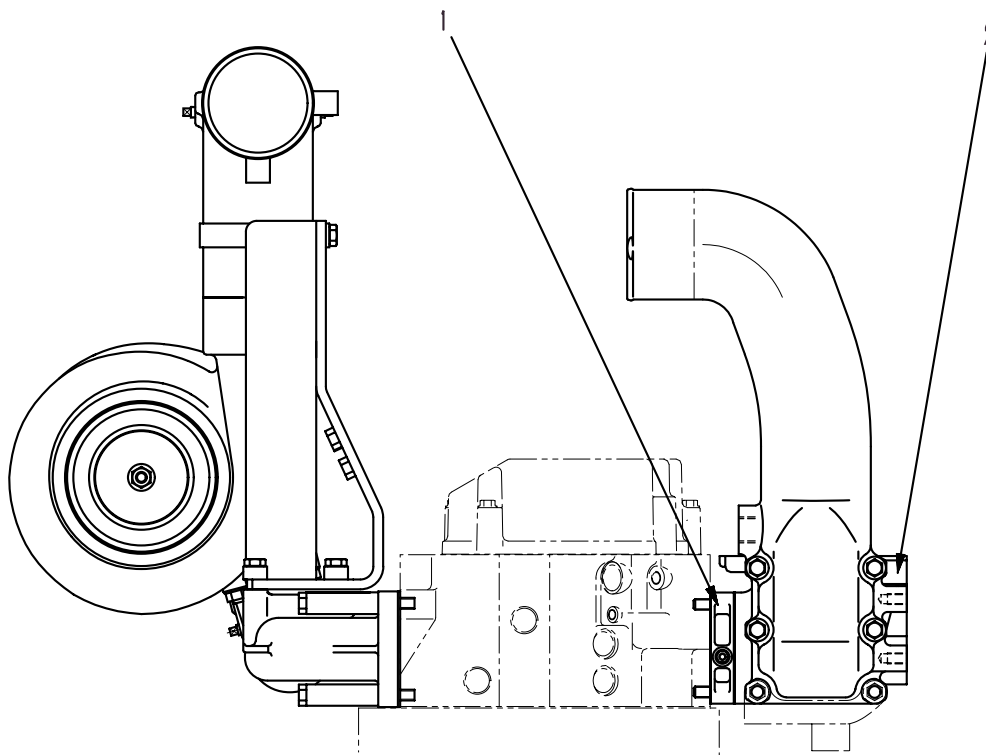


SWE01561

- | | |
|-----------------------------------|--|
| 1. Exhaust brake (butterfly type) | A. Intake inlet |
| 2. Turbocharger | B. Exhaust outlet |
| 3. Intake connector | C. Air supply (between turbocharger and air-cooled aftercooler) |
| 4. Exhaust manifold (front) | D. Air supply (between air-cooled aftercooler and air supply manifold) |
| 5. Exhaust manifold (center) | |
| 6. Exhaust manifold (rear) | |

SAA6D140E-3 (Front face)

- ★ The diagram shows the equipment for the HD325-6.
- ★ Details may change for reasons such as modification.

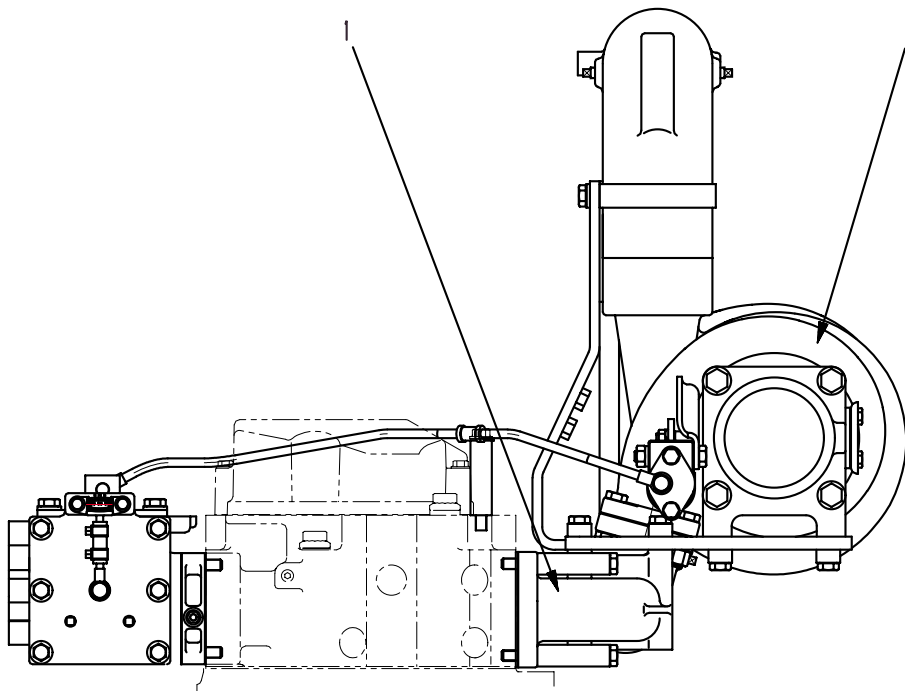


SXE01562

1. Electric heater (electrical intake air heater)
2. Intake manifold

SAA6D140E-3(Rear face)

- ★ The diagram shows the equipment for the HD325-6.
- ★ Details may change for reasons such as modification.



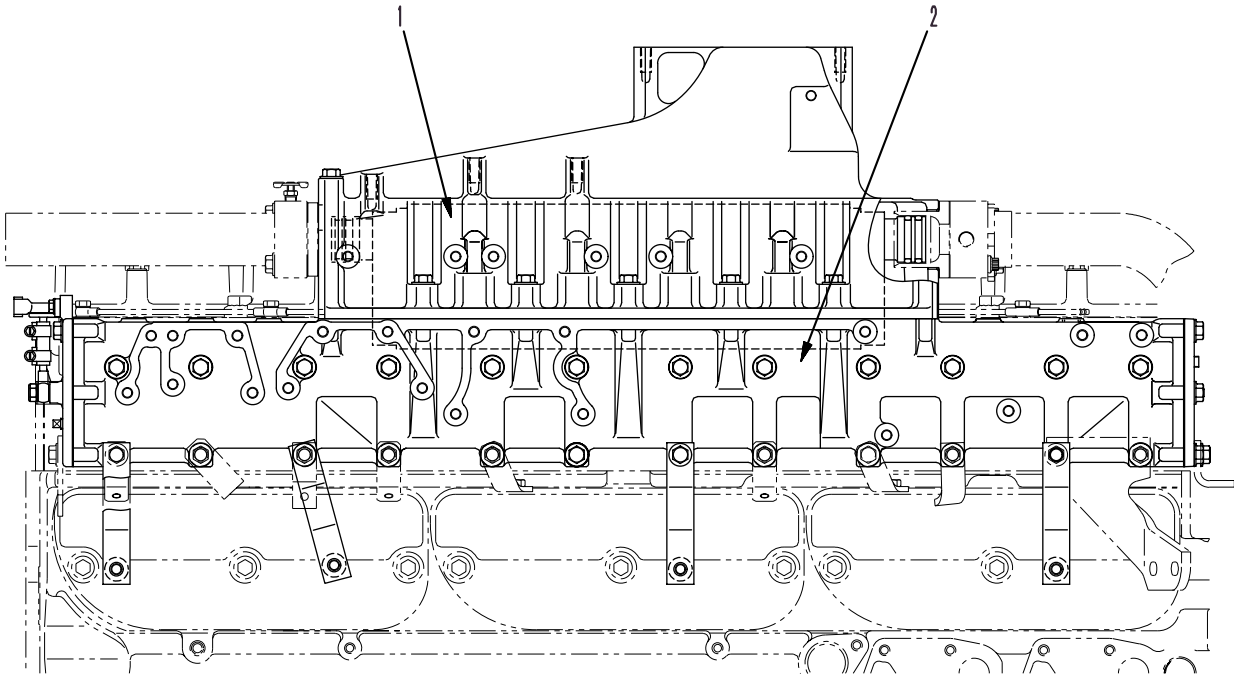
SXE01563

1. Exhaust manifold
2. Turbocharger

STRUCTURE AND FUNCTION, MAINTENANCE STANDARD

SDA6D140E-3 (Left side face of engine)

- ★ The diagram shows the equipment for the D275AX-5.
- ★ Details may change for reasons such as modification.



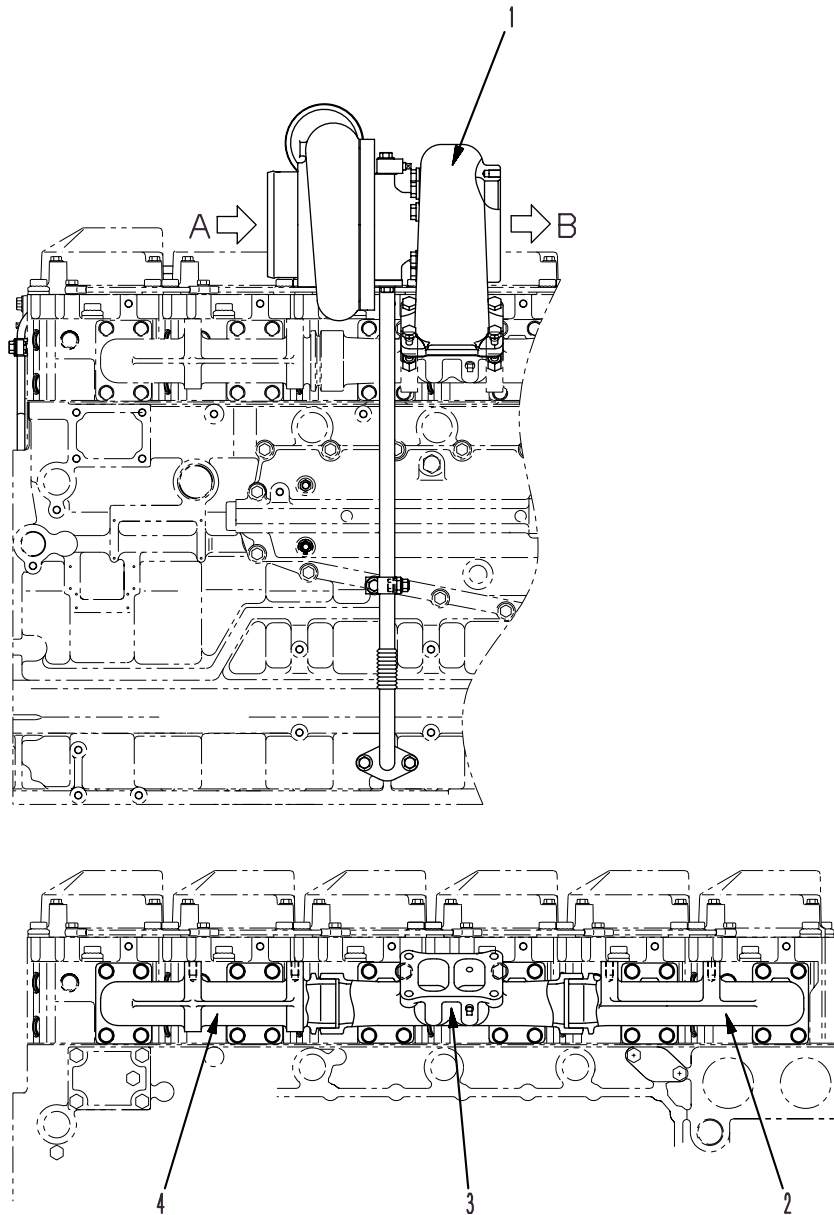
SJE02055

1. Aftercooler
2. Intake manifold

STRUCTURE AND FUNCTION, MAINTENANCE STANDARD

SDA6D140E-3 (Right side face of engine)

- ★ The diagram shows the equipment for the D275AX-5.
- ★ Details may change for reasons such as modification.



1. Turbocharger
2. Exhaust manifold (front)
3. Exhaust manifold (center)
4. Exhaust manifold (rear)

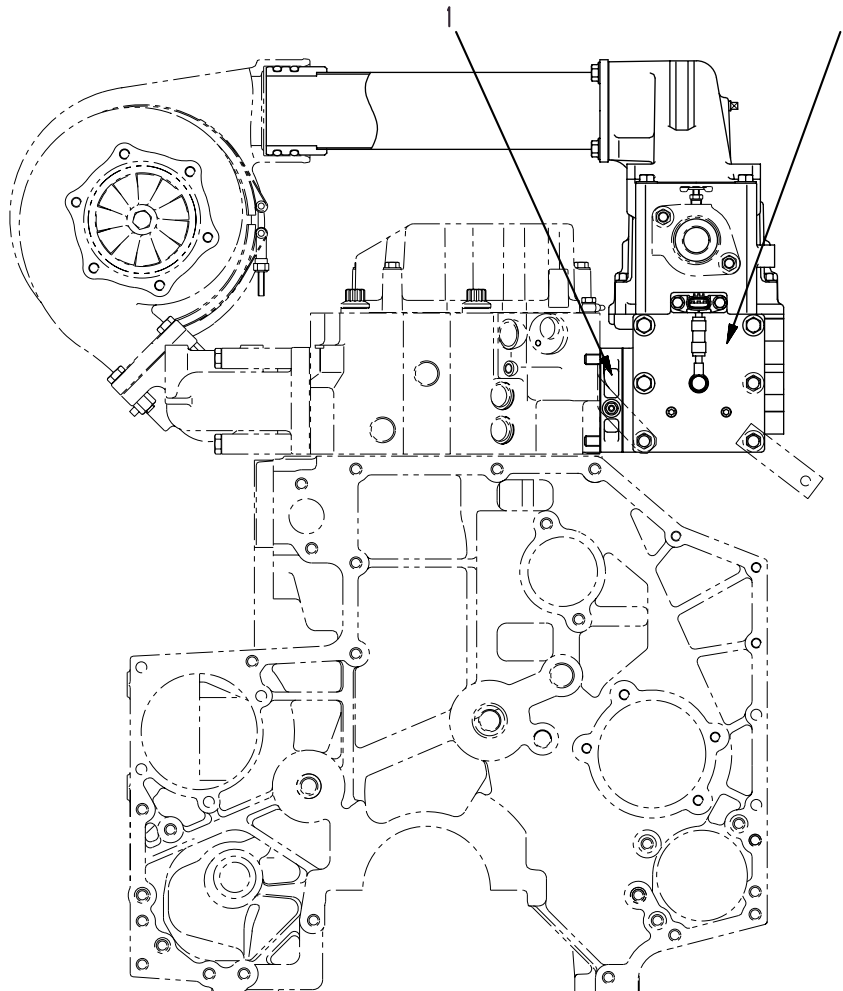
- A. Intake inlet
- B. Exhaust outlet

SJE02056

STRUCTURE AND FUNCTION, MAINTENANCE STANDARD

SDA6D140E-3 (Front face of engine)

- ★ The diagram shows the equipment for the D275AX-5.
- ★ Details may change for reasons such as modification.



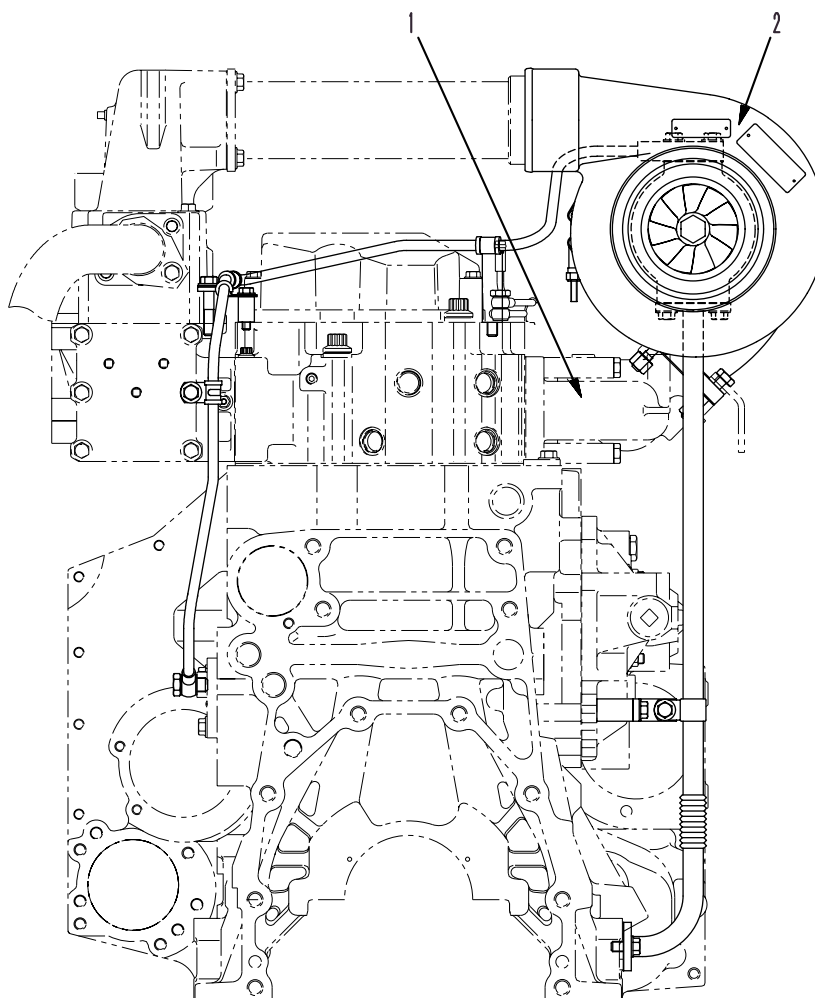
SJE02057

1. Electric heater (electrical intake air heater)
2. Intake manifold

STRUCTURE AND FUNCTION, MAINTENANCE STANDARD

SDA6D140E-3 (Rear face of engine)

- ★ The diagram shows the equipment for the D275AX-5.
- ★ Details may change for reasons such as modification.



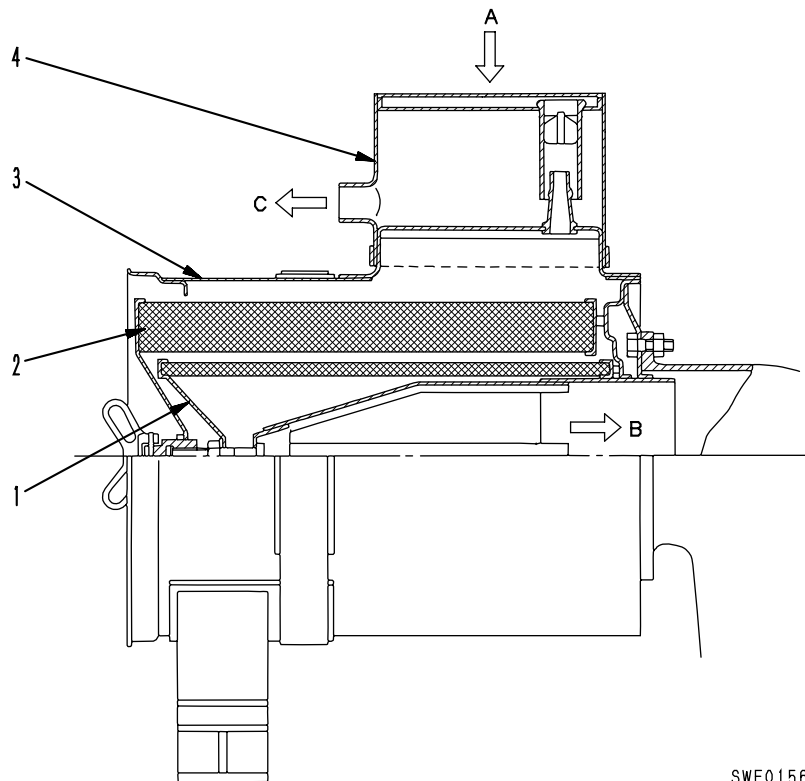
SJE02058

1. Exhaust manifold
2. Turbocharger

AIR CLEANER

KOMACLONE TYPE (MULTICYCLONE TYPE) EGB TYPE

★ Details may differ according to the machine model.



SWE01564

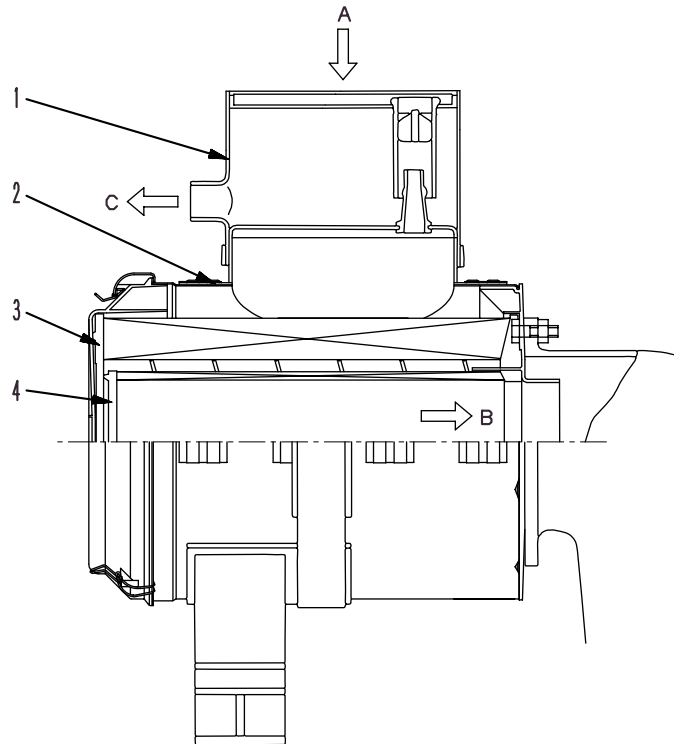
- 1. Inner element
- 2. Outer element
- 3. Air cleaner casing
- 4. Precleaner

- A. Intake air port
- B. To turbocharger (intake air port)
- C. To muffler (dust)

Engine	Machine model	Type	Dust discharge method for precleaner	No. of elements
SA6D140E-3	D155AX-5 (110001 – 112349)	Komacclone, multicyclone type (EGB type)	Automatic discharge (exhaust ejector)	Inner cylinder 1, Outer cylinder 1
SAA6D140E-3	HD325-6			

ERB TYPE

★ Details may differ according to the machine model.



SJE02059

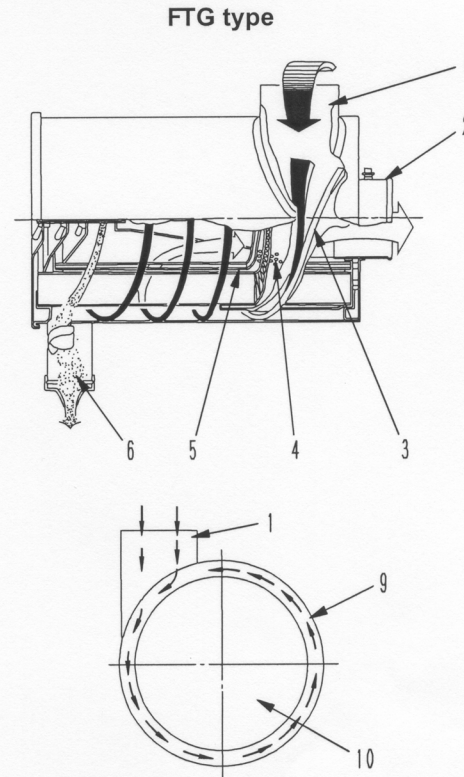
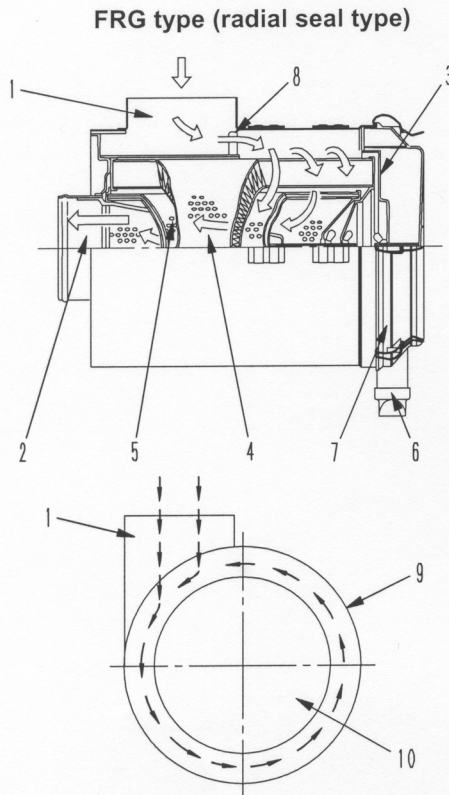
1. Precleaner
2. Air cleaner casing
3. Outer element
4. Inner element

- A. Intake air port
- B. To turbocharger (intake air port)
- C. To muffler (dust)

Engine	Machine model	Type	Dust discharge method for precleaner	No. of elements
SDA6D140E-3	D275A-5	Komaclone, multicyclone type (ERB type)	Automatic discharge (exhaust ejector)	Inner cylinder 1, Outer cylinder 1
	D275AX-5			
SA6D140E-3	D155AX-5 (112350 and up)			

FRG, FTG TYPE (CYCLOPACK TYPE)

★ Details may differ according to the machine model.



SWE01565

- | | | | |
|---------------|--------------------|------------------------|-------------|
| 1. Inlet | 4. Primary element | 7. Dust pan | 10. Element |
| 2. Outlet | 5. Safety element | 8. Guide vane (sleeve) | |
| 3. Guide vane | 6. Vacuator valve | 9. Body | |

Engine	Machine model	Type	Vacuator valve	No. of elements
SA6D140E-3	PC600-6	FRG (radial seal type)	Automatic discharge	Inner cylinder 1, Outer cylinder 1
	DCA400SSK	FTG	Automatic discharge	Inner cylinder 1, Outer cylinder 1
SAA6D140E-3	PC750,750LC-6 PC750-7 PC800-6,PC800-7	FRG (radial seal type)	Automatic discharge	Inner cylinder 1, Outer cylinder 1
	PC1800-6	FRG (radial seal type)	Automatic discharge	Inner cylinder 1, Outer cylinder 1

Features (FRG, FTG type)

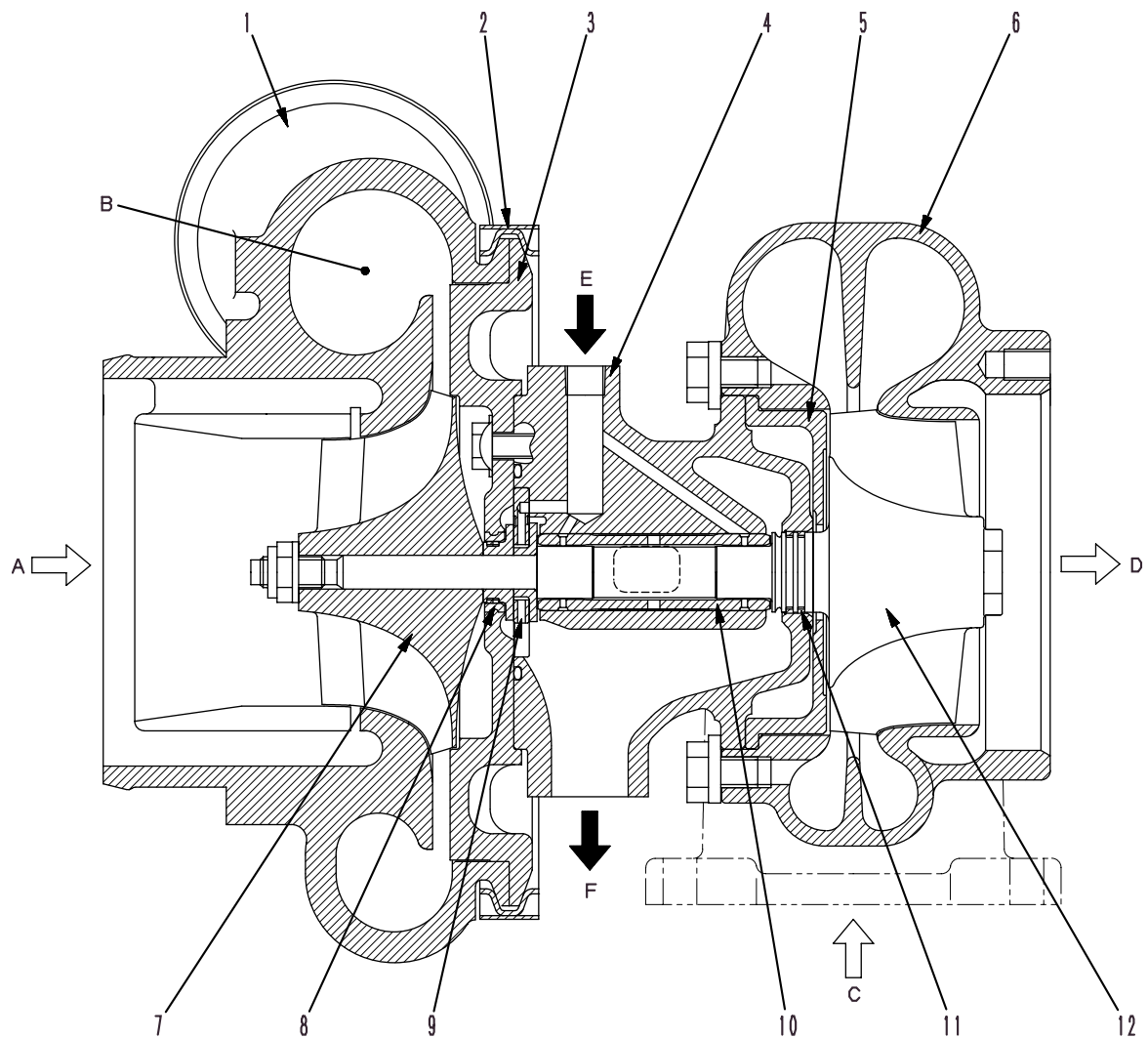
- The element diameter is the same and the outside diameter of the body is small. The inlet is placed in the direction of connection, so no guide vane is used; a simple spiral guide vane can give ample centrifugal force.
- The dust pan has no guide vane and its structure is simple.

Structure

- Air containing dust is sucked into the tangential from inlet (1). The dust is separated by the centrifugal separation effect of guide vane (3). More than 99.9% of the dust is then removed by primary element (4), and the clean air then passes through safety element (5) and outlet (2), and is sent to the engine.
- The dust and water separated by guide vane (3) circulates around the inside wall of body (9), flies into vacuator valve (6), and is automatically discharged.

TURBOCHARGER

KTR110L (AIR-COOLED TYPE).



SWE01566

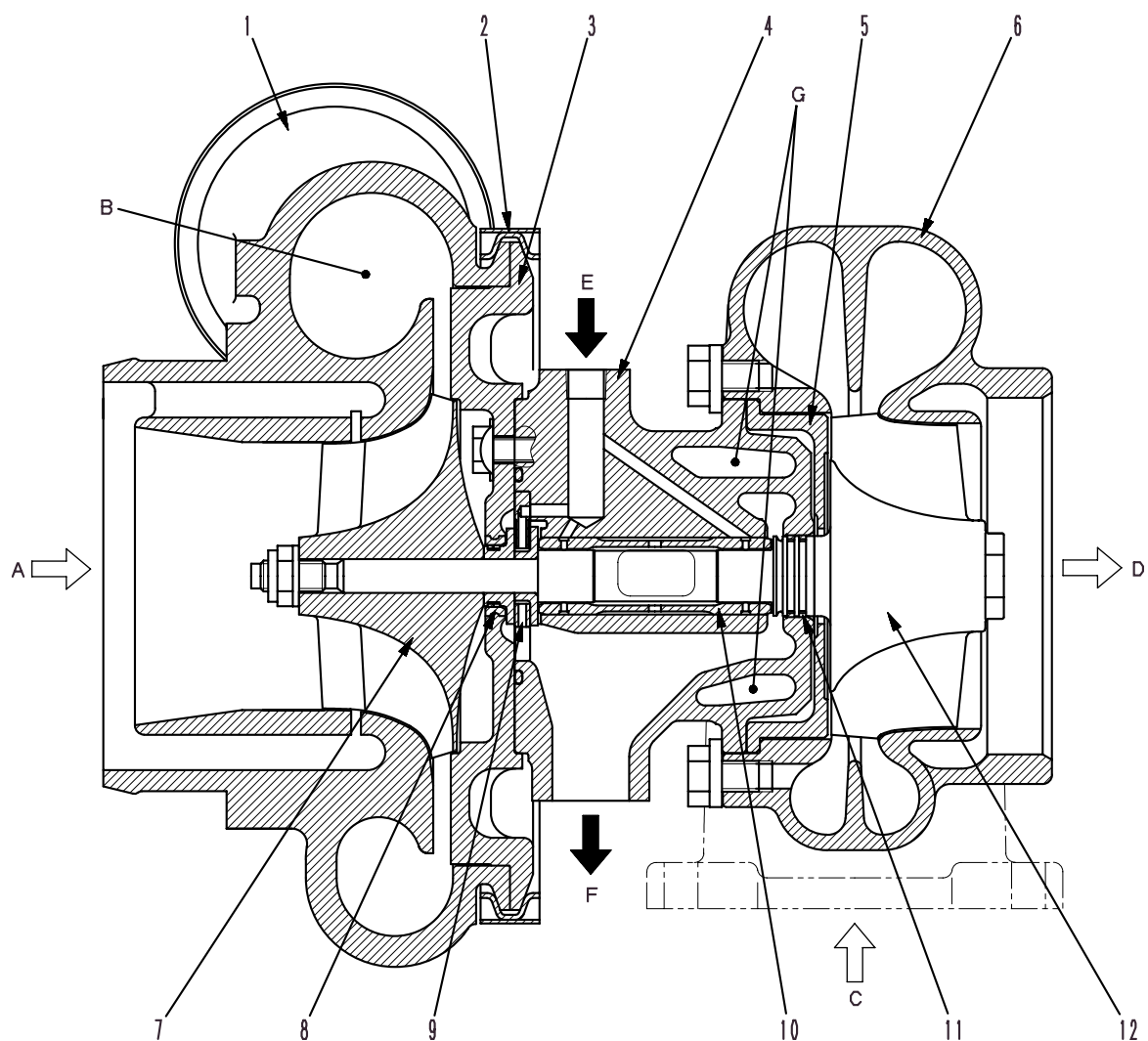
1. Blower housing
2. V-band
3. Diffuser plate
4. Center housing
5. Shroud
6. Turbine housing
7. Turbine impeller
8. Seal ring
9. Bearing
10. Thrust bearing
11. Seal ring
12. Blower impeller

- A. Intake inlet
- B. Intake outlet
- C. Exhaust inlet
- D. Exhaust outlet
- E. Oil inlet
- F. Oil outlet

Specifications

Type: Komatsu KTR110L (air-cooled)
 Overall length: 308mm
 Overall width: 305mm
 Overall height: 287mm
 Weight: 24kg

KTR110L (WATER-COOLED TYPE).



SWE01648

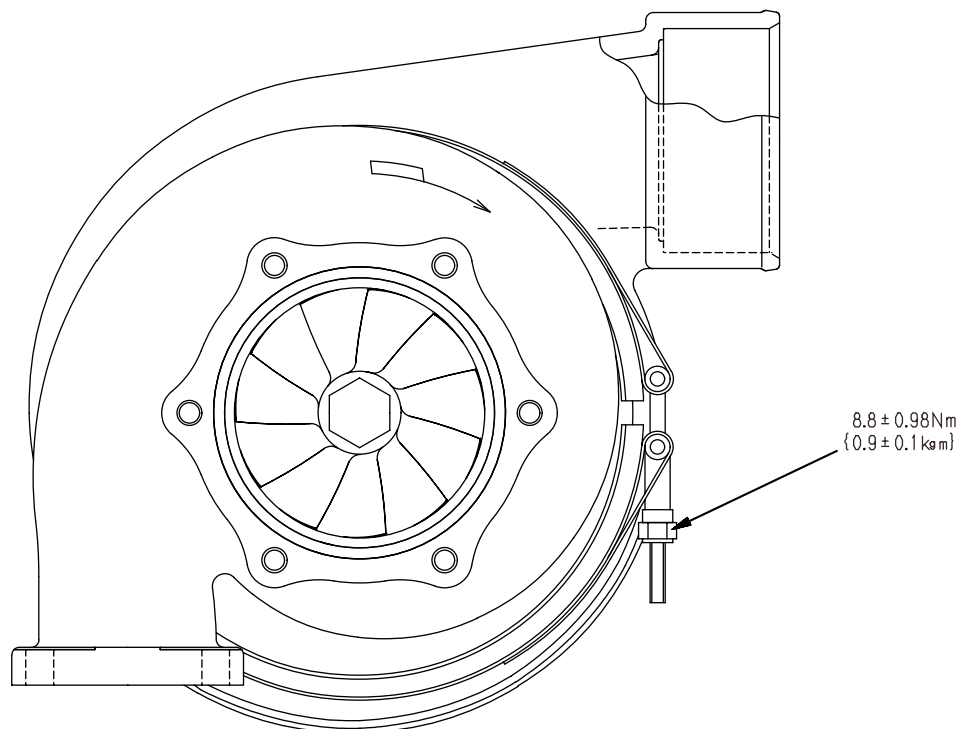
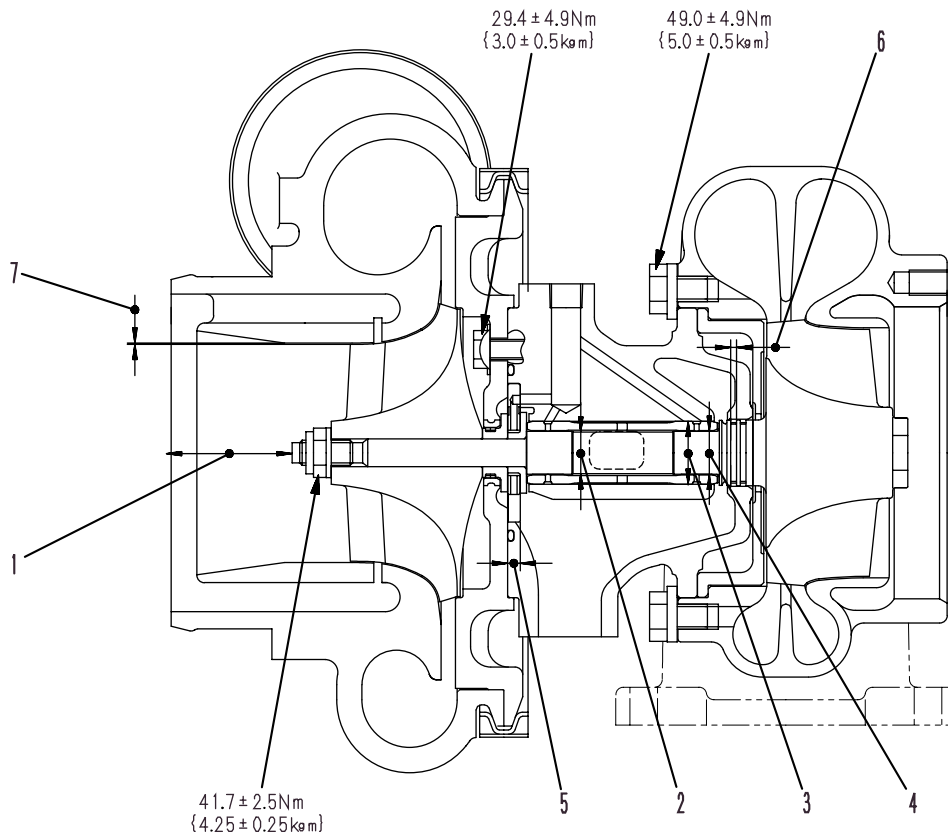
1. Blower housing
2. V-band
3. Diffuser plate
4. Center housing
(Water-cooled center housing is option)
5. Shroud
6. Turbine housing
7. Turbine impeller
8. Seal ring
9. Bearing
10. Thrust bearing
11. Seal ring
12. Blower impeller

- A. Intake inlet
- B. Intake outlet
- C. Exhaust inlet
- D. Exhaust outlet
- E. Oil inlet
- F. Oil outlet
- G. Cooling water

Specifications

Type: Komatsu KTR110L (water-cooled)
 Overall length: 308mm
 Overall width: 305mm
 Overall height: 287mm
 Weight: 24kg

KTR110L



SWE01644

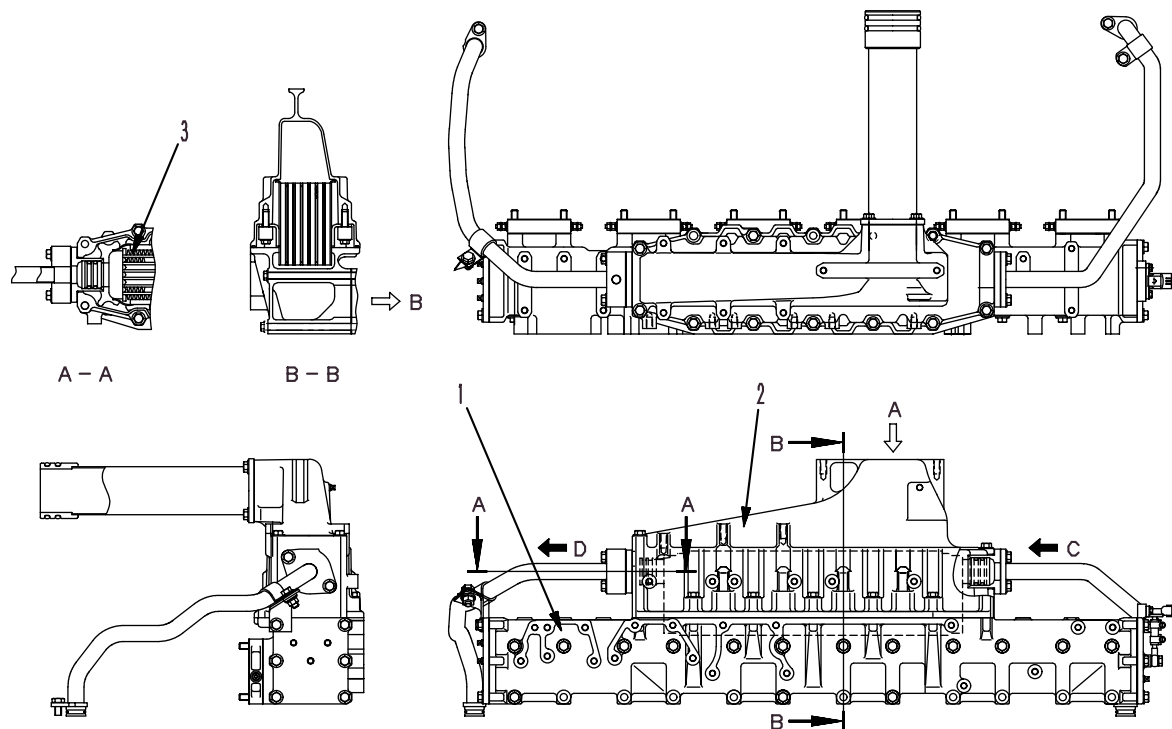
Unit: mm

No.	Check item		Criteria				Remedy	
1	End play (Play in axial direction)		Standard		Repair limit		Replace parts related to thrust	
			0.08 – 0.13		0.18			
2	Radial play (Play in radial direction)		0.25 – 0.44		0.60		Replace parts related to bearing	
3	Outside diameter or journal bearing Inner diameter of center housing		Standard size	Tolerance		Repair limit		Replace
				Shaft	Hole	Shaft	Hole	
			25	−0.050 −0.067	+0.021 0	24.92	25.03	
4	Inner diameter of journal bearing Outside diameter of wheel shaft		17	−0.032 −0.043	+0.009 −0.003	16.95	17.04	
	Bend of wheel shaft			Repair limit: 0.010 (Total indicated runout)				
5	Thickness of thrust bearing		Standard size	Tolerance		Repair limit		
				Shaft	Hole	Shaft	Hole	
			5	−0.08 −0.11	+0.02 0	4.86	5.04	
6	Thickness of seal ring	Turbine side	2.3	−0.08 −0.10	−0.03 −0.04	2.15	2.35	
		Blower side	2	−0.08 −0.10	−0.03 −0.04	1.85	2.05	
7	Clearance between blower housing and impeller		Tolerance(min.): 0.20				Replace parts	

AFTERCOOLER

WATER-COOLED TYPE SA6D140E-3

★ Details may differ according to the machine model.



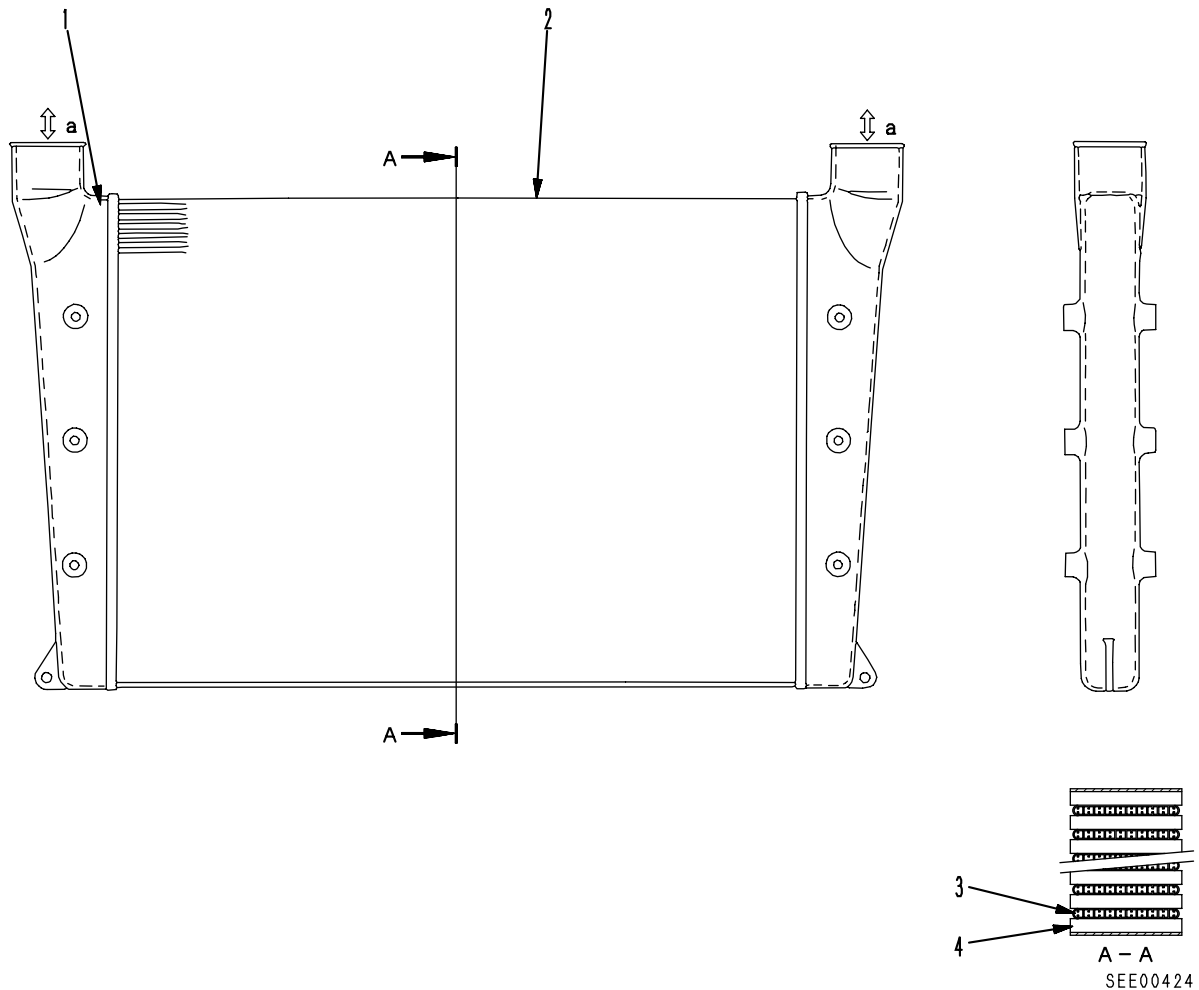
SWE01567

1. Intake manifold
2. Aftercooler cover
3. Aftercooler core

- A. Intake inlet
- B. Intake outlet
- C. Cooling water inlet (from cylinder head)
- D. Cooling water outlet (to thermostat)

**AIR-COOLED TYPE
SAA6D140E-3**

- ★ The diagram shows the equipment for the HD325-6.
- ★ Details may change for reasons such as modification.

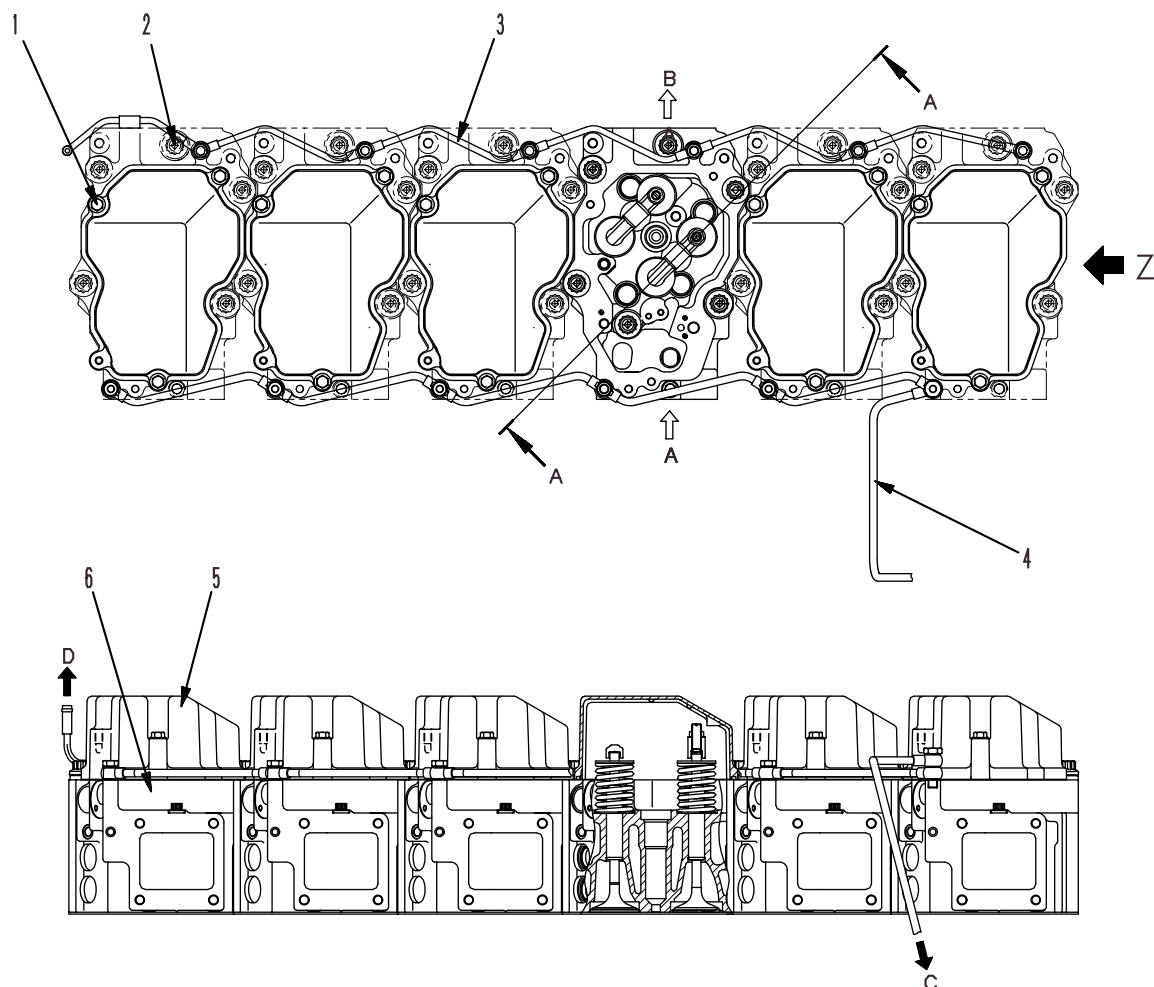


1. Tank
2. Side support
3. Tube
4. Fin

- a. Air supply inlet/outlet port
(turbocharger $\longleftrightarrow$ intake manifold)

CYLINDER HEAD

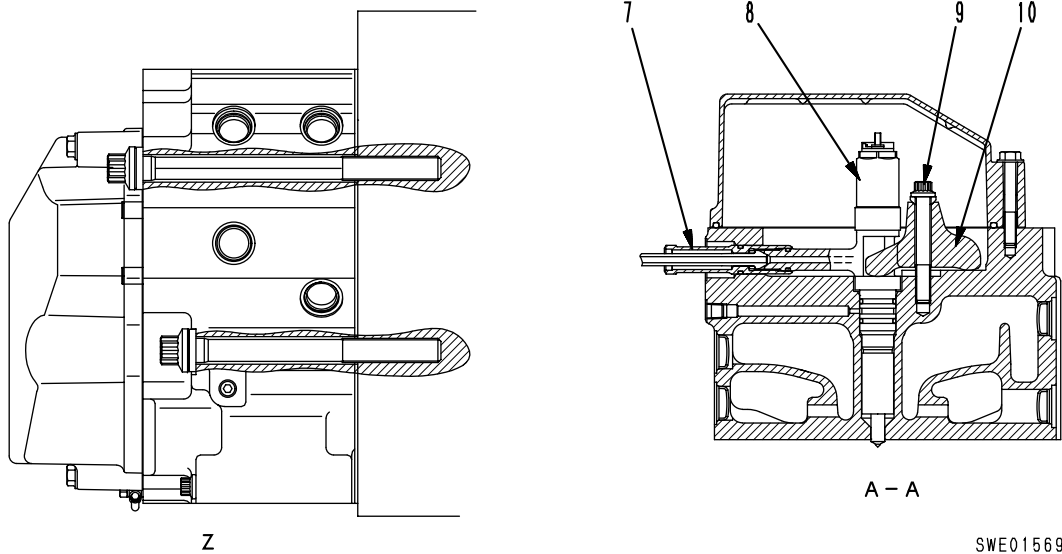
★ Details may differ according to the machine model.



SWE01568

1. Rocker housing bolt
2. Cylinder head bolt
3. Cooling water air bleed pipe
4. Fuel spill pipe
5. Rocker cover
6. Cylinder head
7. Injector connector
8. Injector assembly
9. Injector holder mounting bolts
10. Injector holder retainer

- A. Intake
- B. Exhaust
- C. To fuel tank
- D. To radiator



Specifications

Cylinder head

- Direct injection type
- 4 valves
- Split type, 1 cylinder, 1 head
- Valve bridge, concentrated cooling around injector
- Cylinder head bolt: Plastic range tightening method

Valve seat

- Valve seat insert press fitted for both intake and exhaust

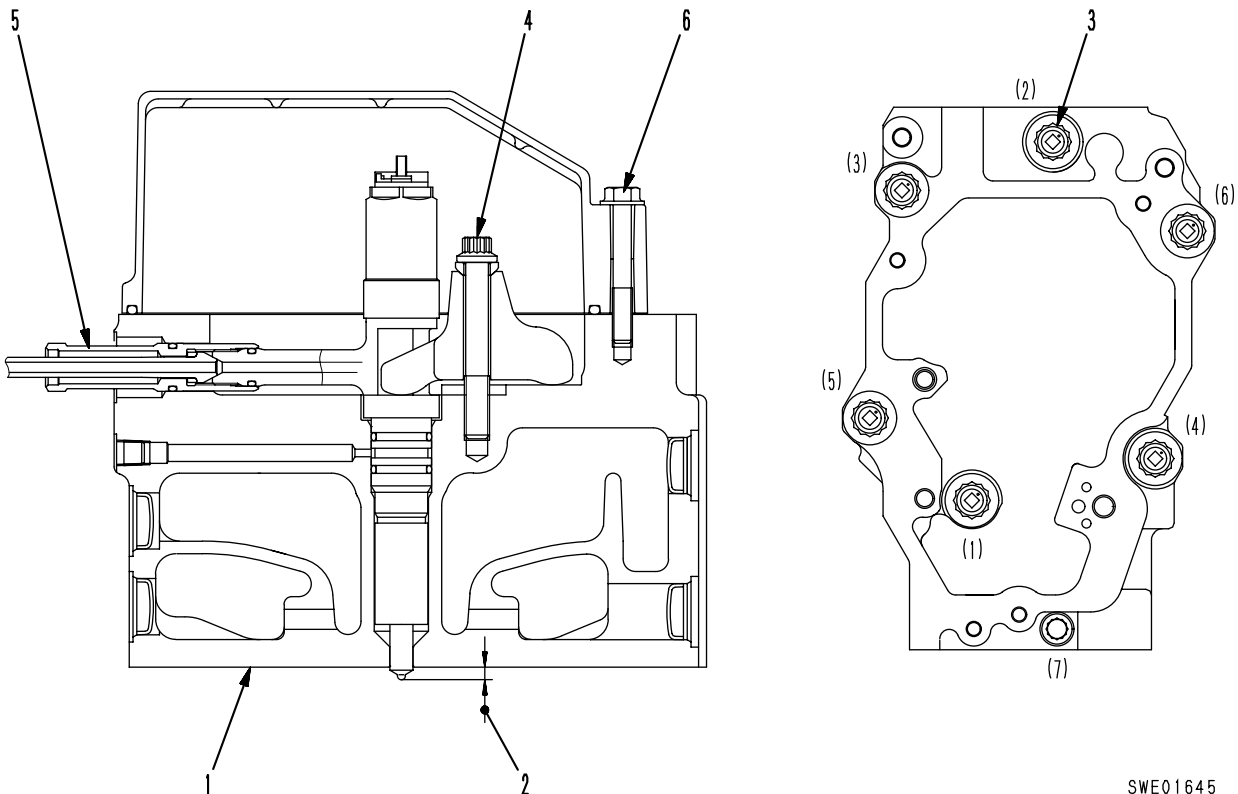
Rocker cover

- Float type seal

Injector

- Mount: Dry type (no sleeve)

★ Nos. (1) – (7) in the diagram indicate the order of tightening for the cylinder head mounting bolts.



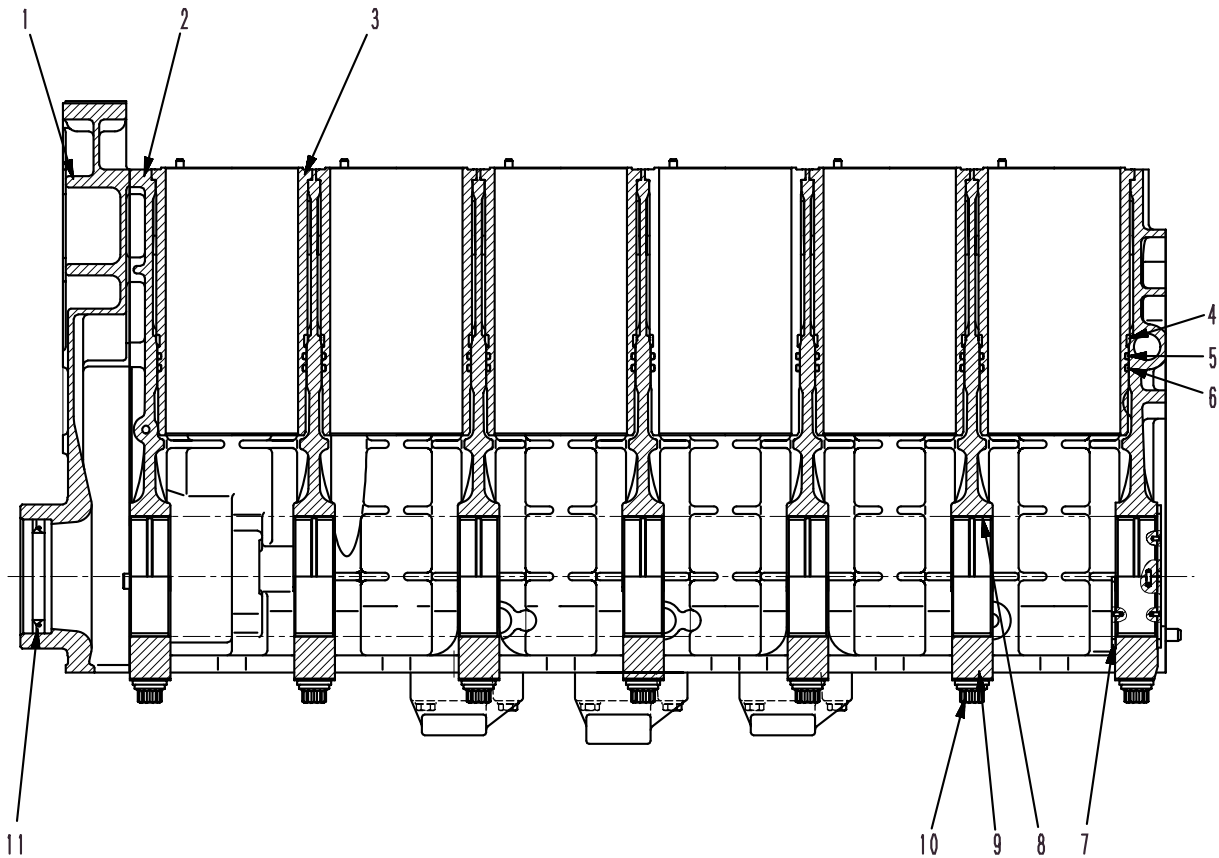
SWE01645

Unit: mm

No.	Check item	Criteria				Remedy
1	Distortion of cylinder head mounting surface	Standard		Repair limit		Repair by grinding or replace
		0 – 0.06		0.09		
2	Protrusion of nozzle	Engine		Standard		Replace nozzle or cylinder head
		SA6D140E-3 SAA6D140E-3		4.7 – 5.3		
3	Tightening torque of cylinder head mounting bolt (Coat the thread areas with molybdenum disulfide or engine oil)	Bolt No.	Order	Target (Nm {kgm})	Range (Nm {kgm})	Tighten in sequence as indicated above.
		(1) – (6)	1st step	147 {15}	137 – 157 {14 – 16}	
			2nd step	216 {22}	284 – 294 {29.0 – 30.0}	
			3rd step	Retighten with 90°	90 ^{+30°} ₀	
		(7)	—	68.6 {7}	58.8 – 73.6 {6 – 7.5}	
4	Tightening torque of injector holder mounting bolt	Target (Nm {kgm})		Range (Nm {kgm})		Retighten
		66.7 {6.8}		58.8 – 73.6 {6 – 7.5}		
5	Tightening torque of fuel injection pipe	37.3 {3.8}		34.3 – 40.2 {3.5 – 4.1}		
6	Tightening torque of cylinder head cover mounting bolt	14.7 {3.3}		29.4 – 34.3 {3.0 – 3.5}		

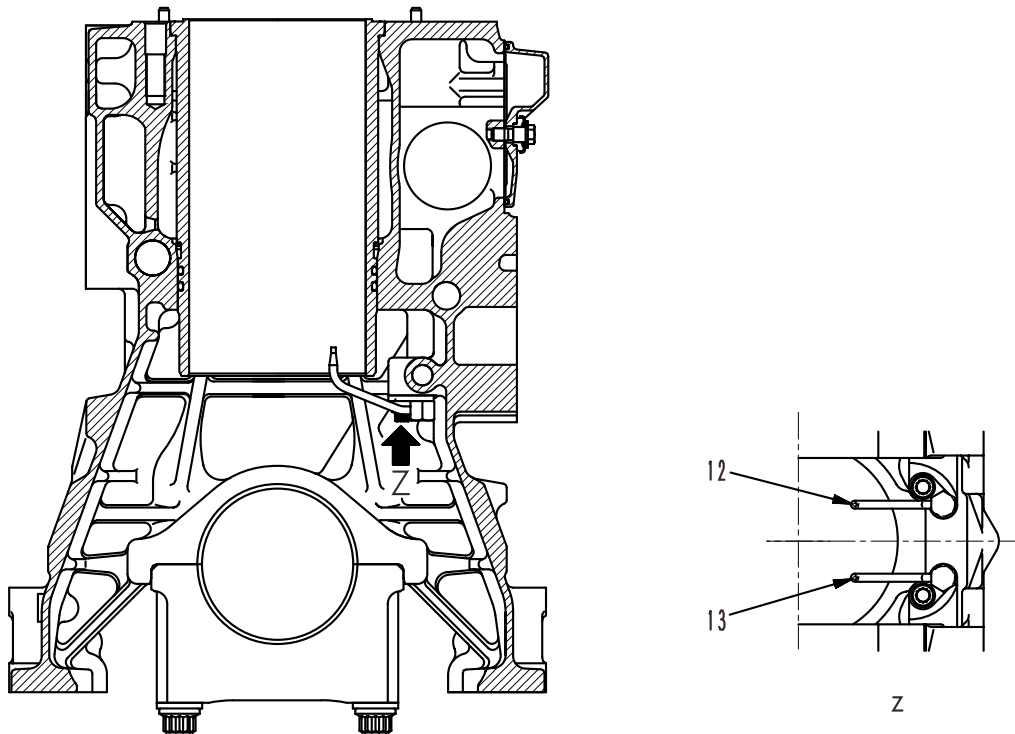
★ The cylinder head bolt can be re-used up to a maximum of 5 times. Each time the bolt is re-used, make a punch mark on the bolt head.

CYLINDER BLOCK



SXE01570

- | | |
|-------------------|---------------------------------------|
| 1. Front cover | 8. Main bearing |
| 2. Cylinder block | 9. Main bearing cap |
| 3. Cylinder liner | 10. Main bearing cap bolt |
| 4. Clevis seal | 11. Front oil seal |
| 5. Liner O-ring | 12. Piston cooling nozzle (front end) |
| 6. Liner O-ring | 13. Piston cooling nozzle (rear end) |
| 7. Thrust bearing | |



SXE01571

Specifications

Cylinder block

- Crankshaft: 7 bearings
- Camshaft: High cam type, 7 bearings
- Main cap bolt: Plastic range tightening method

Front seal

- Single lip with dust seal (lay-down seal)

Piston cooling

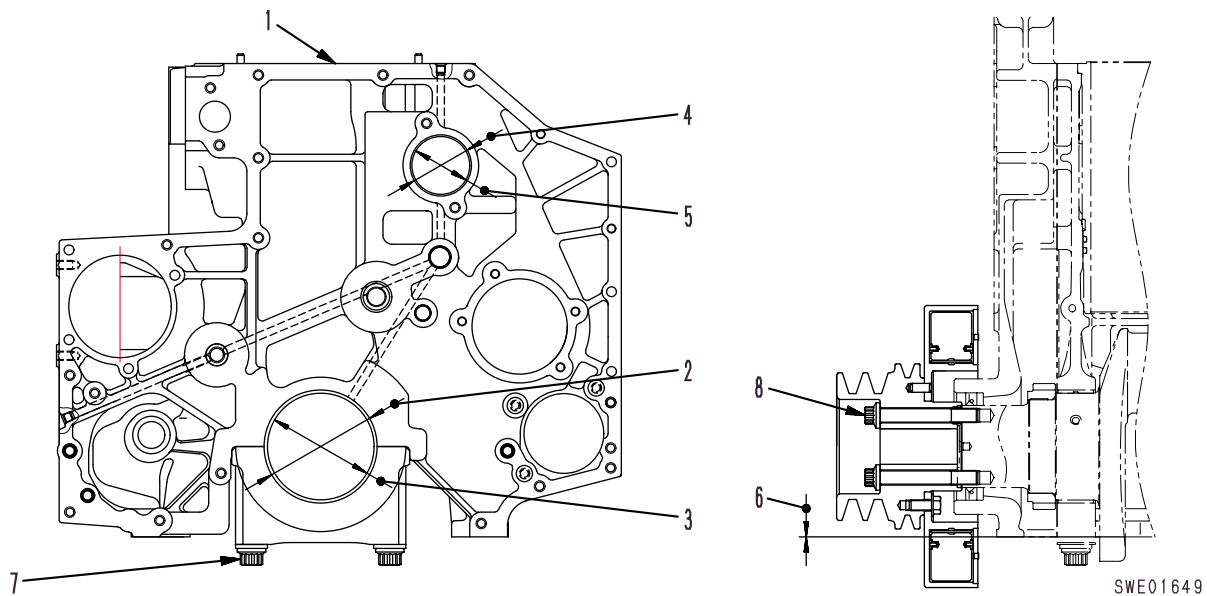
- With piston cooling nozzle (2 for each cylinder)

Cylinder liner

- Wet type
- Inside surface machining: Platt honing, Tuftride treatment

Liner ring

- Top: Clevis seal
- Middle: O-ring (ethylene propylene rubber)
- Bottom: O-ring (silicon rubber)

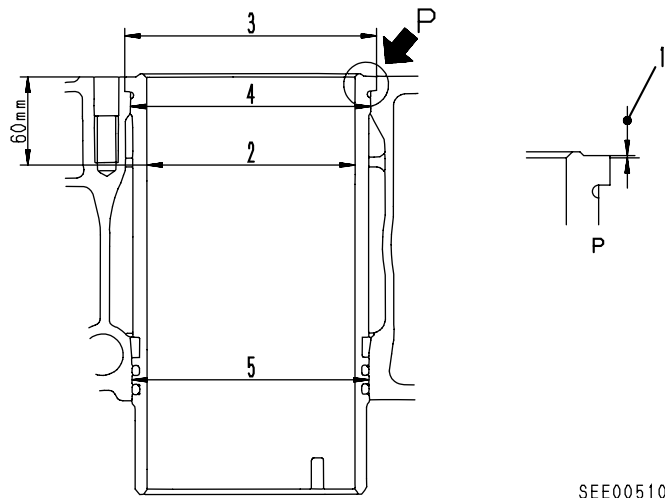


Unit: mm

No.	Check item	Criteria			Remedy
1	Distortion of cylinder head mounting surface	Standard size	Repair limit		Repair by grinding or replace
		0 – 0.09	0.135		
2	Inside diameter of main bearing hole	Standard size	Tolerance		Replace main bearing cap
		127	+0.018 –0.006		
	Thickness of main bearing	3.5	0 –0.010		Replace main bearing
	Roundness of main bearing hole	Repair limit: 0.005			
3	Inside diameter of main bearing	Standard size	Tolerance	Repair limit	Replace main bearing
		120	+0.038 –0.006	120.15	
4	Inside diameter of camshaft bushing hole	69	+0.030 0	—	Repair or replace cylinder block
5	Inside diameter of camshaft bushing	65	+0.040 0	65.15	Replace camshaft bushing
6	Difference of face between cylinder block and front cover	Repair limit: 0.14			Repair by reassembling
7	Tightening torque of main bearing cap bolt (Coat thread area with engine oil)	Order	Target (Nm{kgm})	Range (Nm{kgm})	Retighten
		1st step	117.7 {12}	107.9 – 127.5 {11 – 13}	
		2nd step	235 {24}	230.1 – 239.9 {23.5 – 24.5}	
		3rd step	Retighten with 90°	90 ^{+30°} ₀	
8	Tightening torque of crank pulley mounting bolt	Target (Nm{kgm})		Range (Nm{kgm})	
		275 {28}		245 – 309 {25 – 31.5}	

★ The main cap bolt can be re-used up to a maximum of 5 times. Each time the bolt is re-used, make a punch mark on the bolt head.

CYLINDER LINER



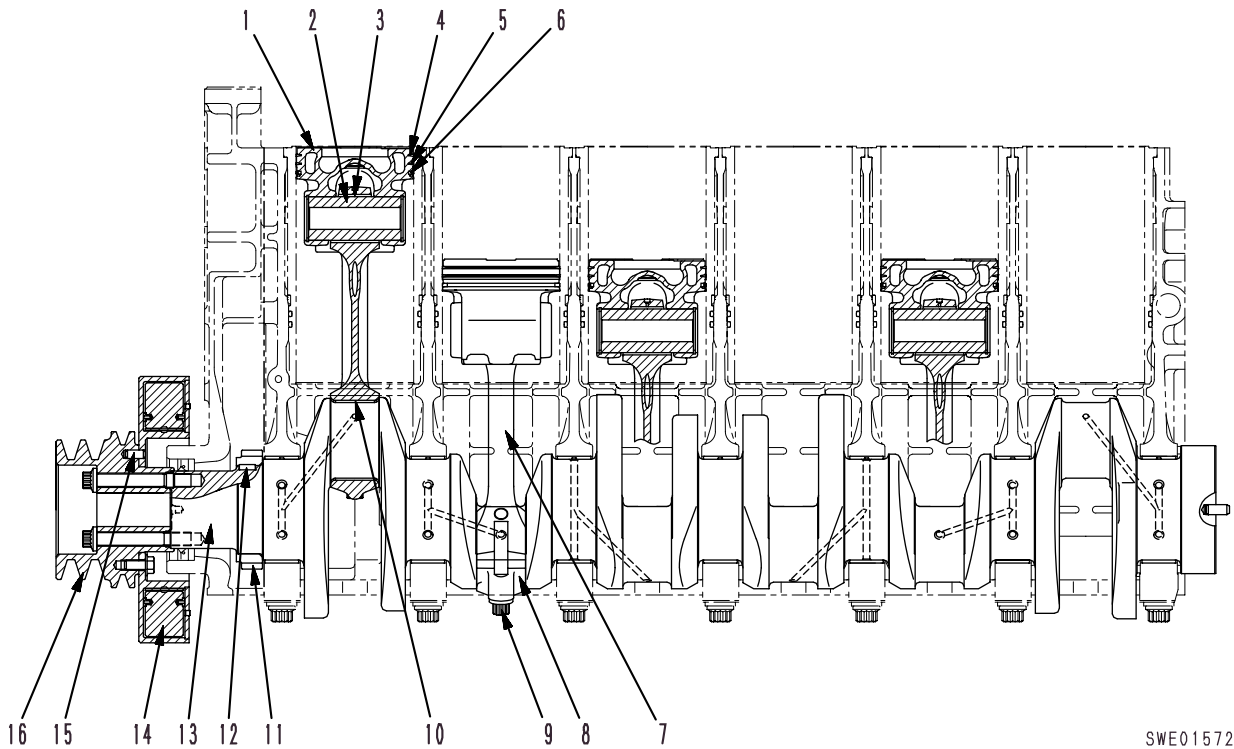
SEE00510

Unit: mm

No.	Check item	Criteria			Remedy
1	Protrusion of cylinder liner	Permissible range: 0.07 – 0.15			Replace cylinder liner or cylinder block
2	Inside diameter of cylinder liner	Standard size	Tolerance	Repair limit	Replace cylinder liner
		140	+0.040 0	140.14	
	Roundness of cylinder liner	Repair limit: 0.02			
	Cylindricity of cylinder liner	Repair limit: 0.02			
3	Outside diameter of cylinder liner (Counter bore)	Standard size	Tolerance		
		170.2	0 –0.10		
	Clearance between cylinder liner and block (Counter bore)	Standard: 0 – 0.163			Replace cylinder liner or cylinder block
4	Outside diameter of cylinder liner (Counter bore bottom)	Standard size	Tolerance		Replace cylinder liner
		161.2	+0.090 +0.050		
	Interference between cylinder liner and block (Counter bore bottom)	Standard interference	Interference limit		Replace cylinder liner or cylinder block, or repair
		0.02 – 0.12	Min. 0.02		
5	Outside diameter of cylinder liner (O-ring)	Standard size	Tolerance		Replace cylinder liner
		158	–0.073 –0.103		
	Clearance between cylinder liner and block (O-ring)	Standard: 0.024 – 0.089			Replace cylinder liner or cylinder block

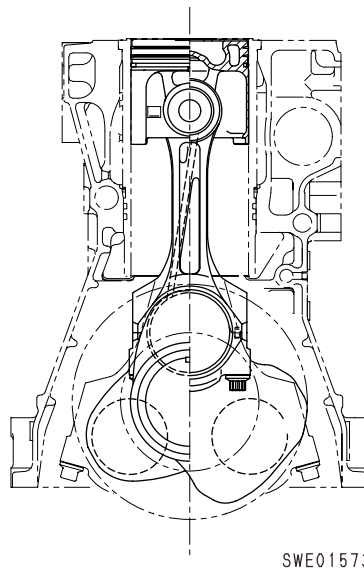
MAIN MOVING PARTS

★ Details may differ according to the machine model.



SWE01572

- | | |
|---------------------------|--|
| 1. Piston (FCD piston) | 9. Connecting rod cap bolt |
| 2. Piston pin | 10. Connecting rod bearing |
| 3. Connecting rod bushing | 11. Crankshaft gear (No. of teeth: 36) |
| 4. Top ring | 12. Key (crankshaft gear) |
| 5. Second ring | 13. Crankshaft |
| 6. Oil ring | 14. Vibration damper |
| 7. Connecting rod | 15. Pin (crankshaft pulley) |
| 8. Connecting rod cap | 16. Crankshaft pulley |



Specifications

Crankshaft:

Closed die forging
Journal, fillet portion
Induction hardening

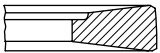
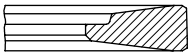
Piston:

Ductile Special cast iron thin metal structure
(FCD piston)
Re-entrant piston

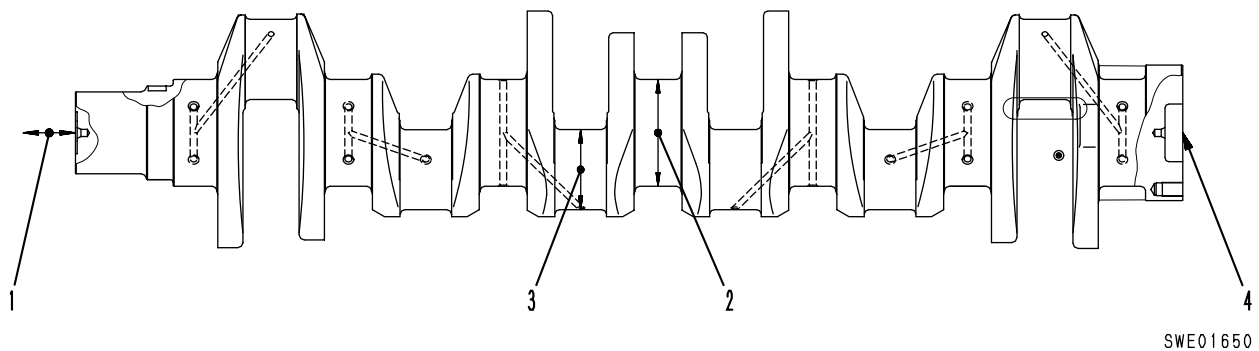
Connecting rod:

Closed die forging
Cap bolt: Screw type, plastic range
tightening method, with lubricating oil hole

Piston ring

Top ring	Second ring	Oil ring
Both surface keystone, Inner cut, Barrel face, Hard chrome plating	Both surface keystone, inner cut, taper face, hard chrome plating	M-shape steel, with coil expander, surface nitriding
 SWE01574	 SWE01575	 SWE01576

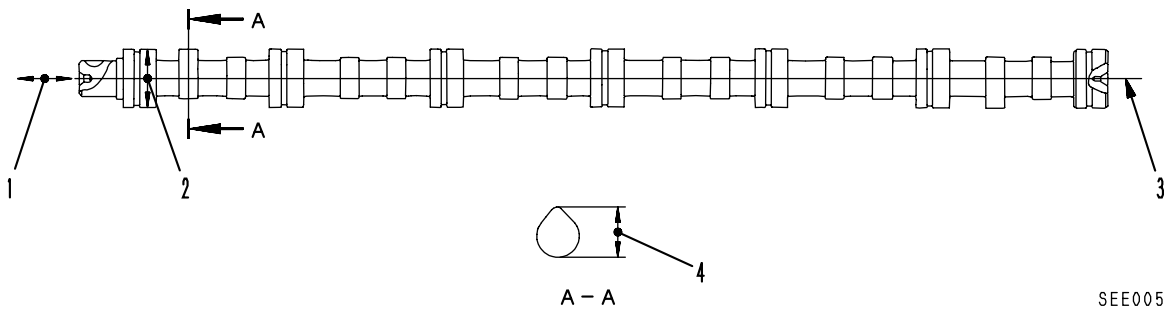
CRANKSHAFT



Unit: mm

No.	Check item	Criteria				Remedy
1	End play	Standard size		Repair limit		Repair by using over size thrust bearing or replace
		0.140 – 0.315		0.50		
2	Outside diameter of main journal		Stan- dard size	Toler- ance	Repair limit	Repair by using over size bearing or replace
		STD	120.00	−0.050 −0.068	119.88	
		0.25 U.S.	119.75		119.63	
		0.50 U.S.	119.50		119.38	
		0.75 U.S.	119.25		119.13	
		1.00 U.S.	119.00		118.88	
	Roundness of main journal	Standard size		Repair limit		
		0 – 0.009		0.020		
	Clearance of main journal	Standard clearance		Clearance limit		Replace main bearing
		0.044 – 0.106		0.27		
3	Outside diameter of crank pin journal		Stan- dard size	Toler- ance	Repair limit	Repair by using under size bearing or replace
		STD	90.00	−0.050 −0.068	89.88	
		0.25 U.S.	89.75		89.63	
		0.50 U.S.	89.50		89.38	
		0.75 U.S.	89.25		89.13	
		1.00 U.S.	89.00		88.88	
	Roundness of crank pin journal	Standard size		Repair limit		
		0 – 0.009		0.020		
	Clearance of crank pin journal	Standard clearance		Clearance limit		Replace connecting rod bearing
		0.042 – 0.110		0.24		
4	Bend of crankshaft	Standard size		Repair limit		Repair by using under size bearing or replace
		Coaxiality of all main journals: Max. 0.150		0.20		
		Coaxiality of neighboring journals: Max. 0.050		0.10		

CAMSHAFT

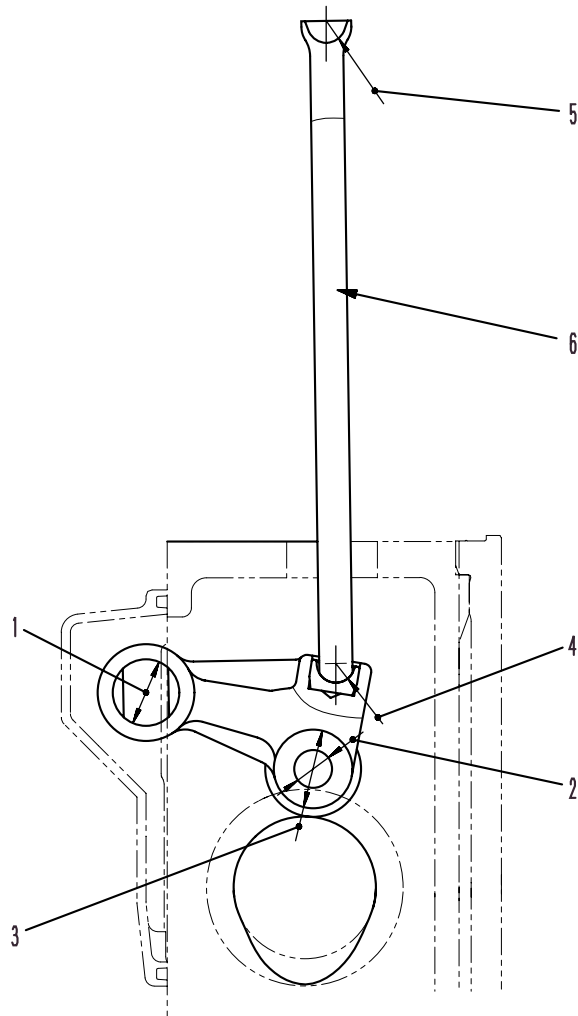


SEE00512

Unit: mm

No.	Check item	Criteria				Remedy
1	End play	Standard size		Repair limit		Replace thrust plate
		0.1 – 0.25		0.36		
2	Outside diameter of camshaft journal	Standard size		Tolerance		Replace camshaft
		65		–0.016 –0.036		
	Clearance of camshaft journal	Standard clearance		Clearance limit		Replace camshaft bushing
		0.016 – 0.096		0.15		
3	Bend of camshaft	Repair limit: 0.03 (Total indicated runout)				Replace camshaft
4	Cam height	Cam	Standard size	Tolerance	Repair limit	
		Intake	55.48	±0.1	55.08	
		Exhaust	55.75	±0.1	55.35	

CAM FOLLOWER AND PUSH ROD

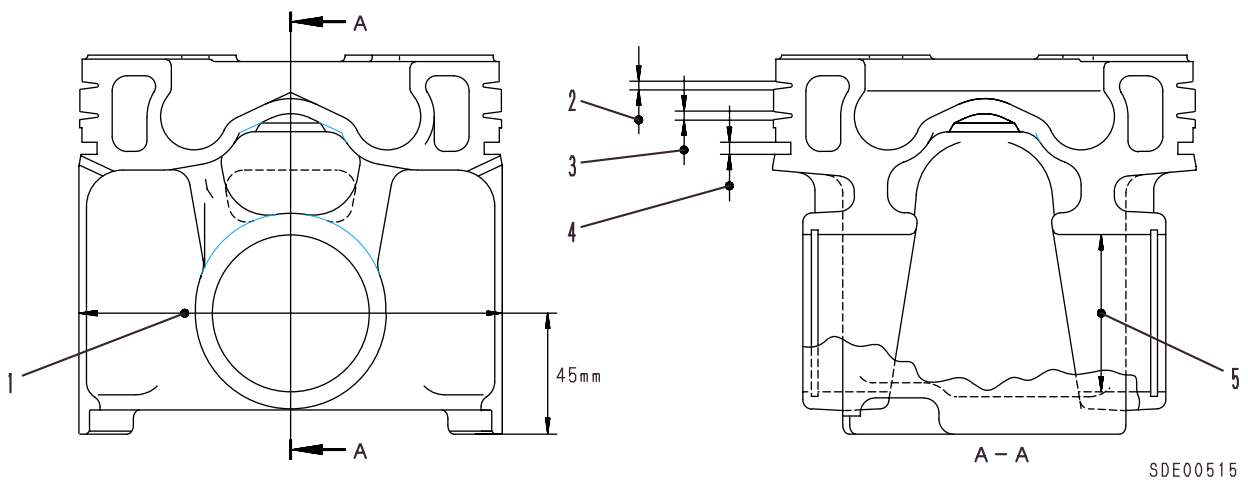


SXE01651

Unit: mm

No.	Check item	Criteria			Remedy
1	Outside diameter of cam follower shaft	Standard size	Tolerance	Repair limit	Replace
		22	−0.021 −0.034	21.92	
	Inside diameter of cam follower shaft hole	22	+0.021 0	22.07	
2	Outside diameter of cam roller	31.7	+0.05 +0.02	31.50	
3	Inside diameter of cam roller	12.7	+0.038 +0.013	12.78	
	Outside diameter of cam roller pin	12.63	±0.006	12.56	
4	Radius of push rod ball end	Standard size		Tolerance	
		12.7		0 −0.20	
5	Radius of push rod socket end	13.4		0 −0.20	
6	Bend of push rod	Repair limit: 0.3 (Total indicated runout)			

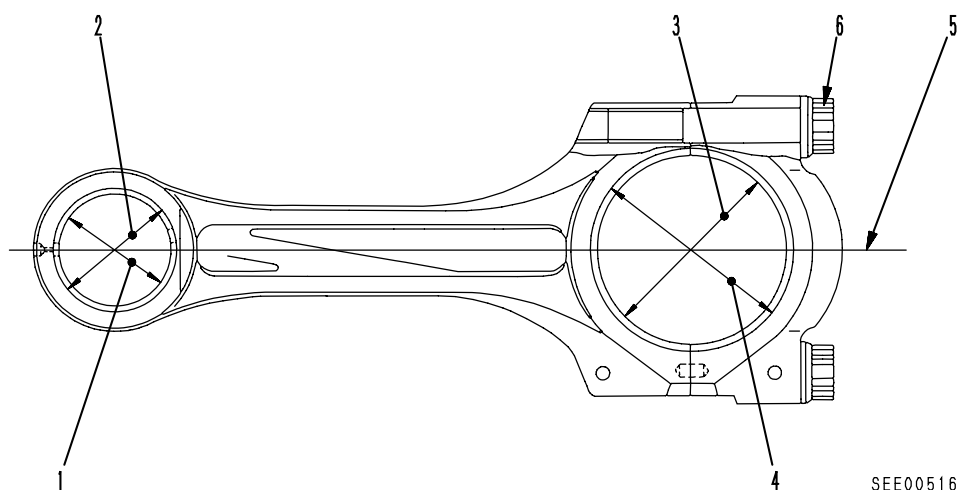
PISTON • PISTON RING • PISTON PIN



Unit: mm

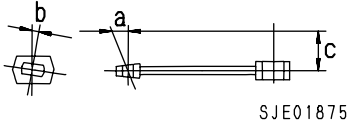
No.	Check item	Criteria				Remedy
1	Outside diameter of piston	Standard size		Tolerance	Repair limit	Replace piston
		140		−0.125 −0.155	139.81	
2	Thickness of piston ring	No.	Measuring point	Standard size	Tolerance	Replace piston ring
		2	Top ring	2.9	−0.015 −0.035	
		3	Second ring	2.41	−0.010 −0.035	
		4	Oil ring	4	−0.010 −0.030	
	Width of piston ring groove	2	Top ring	Judge using groove wear gauge		Replace piston
		3	Second ring			
		4	Oil ring	4	+0.040 +0.025	
	Clearance between piston ring and ring groove	No.	Measuring point	Standard clearance	Clearance limit	Replace piston or piston ring
		2	Top ring	Judge using groove wear gauge		
		3	Second ring			
		4	Oil ring	0.035 – 0.060	0.14	
	Piston ring gap	2	Top ring	0.42 – 0.57 (Tension 16.5 – 23.5N {1.68 – 2.40kg})	2.0	Replace piston ring or cylinder liner
		3	Second ring (Distinguishing 2RN white mark)	0.65 – 0.80 (Tension 16.2 – 24.2N {1.65 – 2.47kg})	1.5	
		4	Oil ring	0.30 – 0.50 (Tension 70.1 – 94.6N {7.15 – 9.65kg})	1.0	
5	Outside diameter of piston pin	Standard size		Tolerance		Replace piston pin
		52		0 −0.006		
	Inside diameter of piston pin hole	52		+0.045 +0.035		Replace piston
	Clearance between piston pin and piston	Standard clearance		Clearance limit		Replace piston or piston pin
0.035 – 0.051		0.10				

CONNECTING ROD



SEE00516

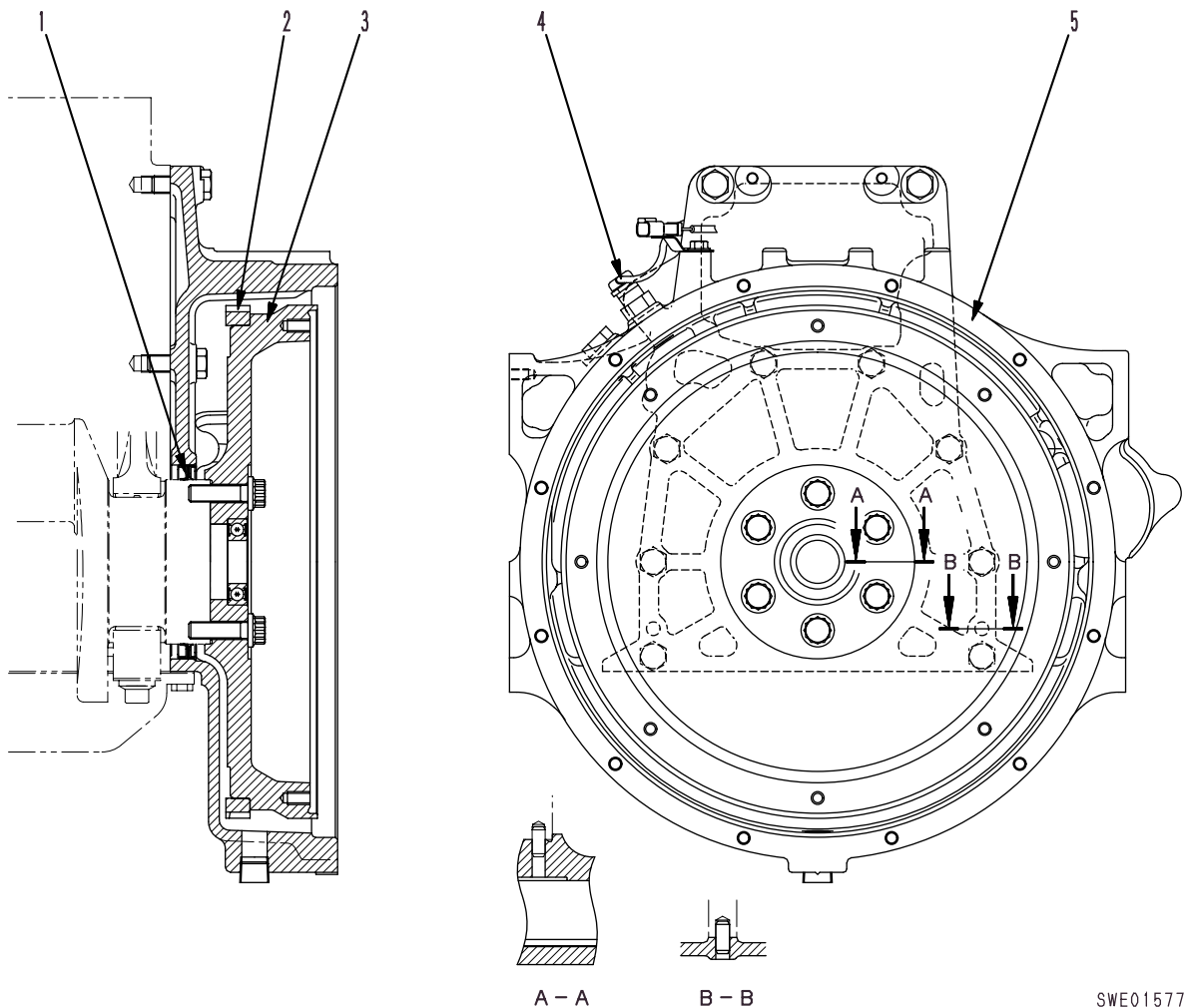
Unit: mm

No.	Check item	Criteria					Remedy	
1	Inside diameter of bushing at connecting rod small end (Treat with reamer after press fitting bushing)	Standard size	Tolerance		Repair limit		Replace bushing (New part is supplied as a semi-finished part)	
		52	+0.049 +0.030		52.09			
	Clearance between bushing at connecting rod small end and piston pin	Standard clearance		Clearance limit			Replace bushing or piston pin	
		0.030 – 0.055		0.11				
2	Inside diameter of bushing hole at connecting rod small end	Standard size		Tolerance			Replace connecting rod	
		57.4		+0.030 0				
3	Inside diameter of bearing at connecting rod big end	Standard size	Tolerance		Repair limit		Replace bearing	
		90	+0.042 –0.008		90.15			
4	Inside diameter of bearing hole at connecting rod big end (Measure after tightening connecting rod cap bolt with specified torque)	95	+0.026 –0.004		—		Replace connecting rod	
	Thickness of connecting rod bearing	2.5	+0.002 –0.008		—		Replace bearing	
5	Parallelism and twist of connecting rod				Item	Standard size	Repair limit	Replace connecting rod
					Parallelism a	0.20	0.25	
					Twist b	0.30	0.35	
					Dimension c	264	—	
6	Tightening torque of connecting rod cap mounting bolt (Coat bolt threads and nut seats with engine oil)	Standard size	Target (Nm{kgm})		Range (Nm{kgm})		Retighten	
		1st step	127.5 {13}		117.7 – 132.4 {12.5 – 13.5}			
		2nd step	Retighten with 90°		90 ^{+30°} ₀			
—	Weight of connecting rod	Permissible range: Variation between weights on the machine max. 154g					Replace	

★ The connecting rod cap bolt can be re-used up to a maximum of 5 times. Each time the bolt is re-used, make a punch mark on the bolt head.

FLYWHEEL, FLYWHEEL HOUSING

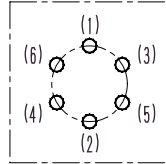
★ Details may differ according to the machine model.



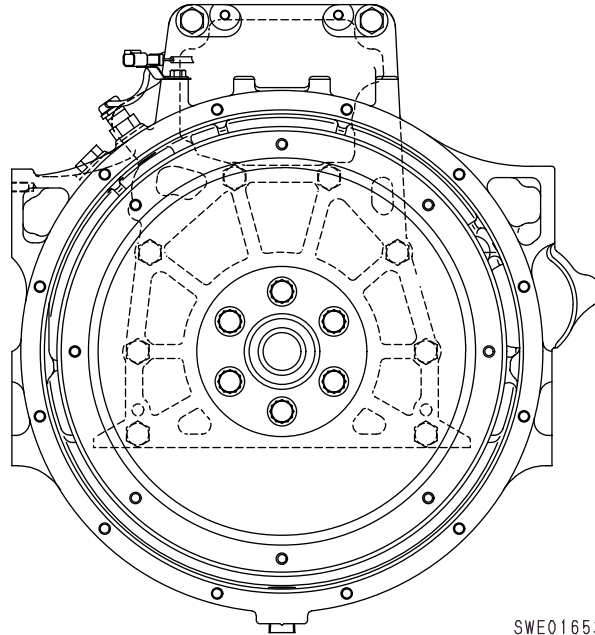
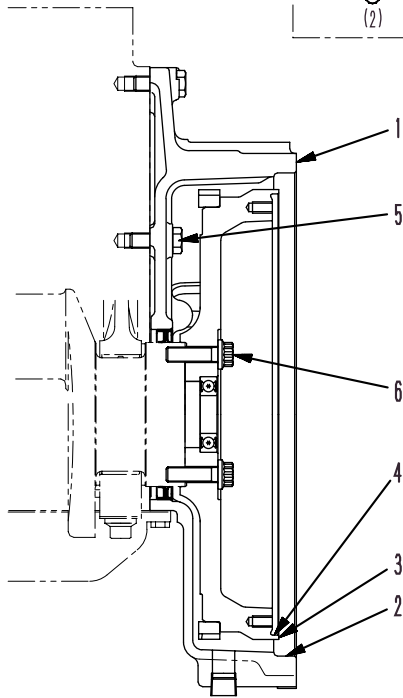
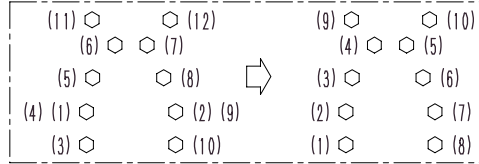
1. Rear seal
2. Ring gear
3. Flywheel
4. Engine speed sensor (NE revolution sensor)
5. Flywheel housing

- ★ When tightening the flywheel mounting bolts, tighten the first time with an impact wrench, then use a torque wrench for the second time.

Order for tightening flywheel mounting bolts



Order for tightening flywheel housing mounting bolts



SWE01653

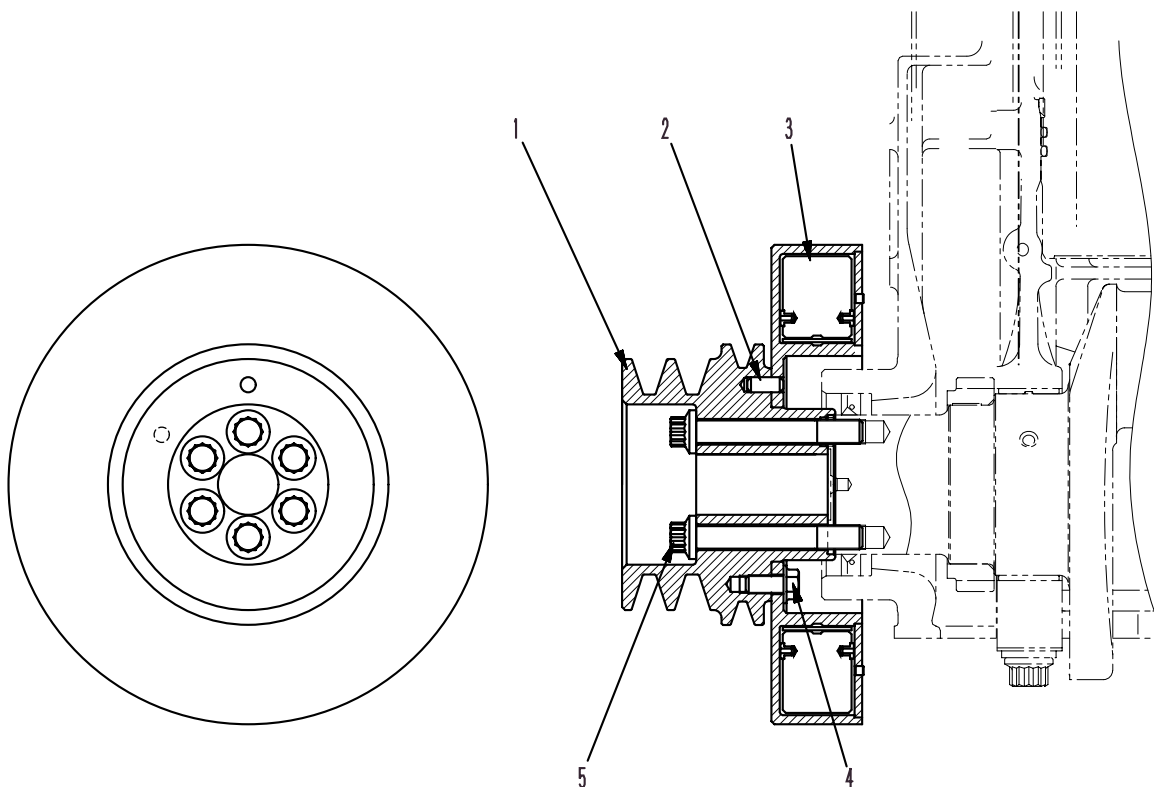
Unit: mm

No.	Check item	Criteria			Remedy
1	Face runout of flywheel housing	Repair limit: 0.20			Repair
2	Radial runout of flywheel housing	Repair limit: 0.20			
3	Face runout of flywheel	Repair limit: 0.20			
4	Radial runout of flywheel	Repair limit: 0.13			
5	Tightening torque of flywheel housing mounting bolts (Coat thread and seat with engine oil)	Order	Target (Nm{kgm})	Range (Nm{kgm})	Tighten the bolt as shown in the diagram order
		1st step	191 {19.5}	147 – 235 {15 – 24}	
		2nd step	275 {28.0}	245 – 309 {25 – 31.5}	
6	Tightening torque of flywheel mounting bolts (Coat thread and seat with engine oil)	Order	Target (Nm{kgm})	Range (Nm{kgm})	Tighten or retighten the bolt as shown in the diagram order
		1st step	118 {12}	113 – 123 {11.5 – 12.5}	
		2nd step	Retighten with 90°	90 ^{+30°} ₀	

- ★ The flywheel mounting bolt can be re-used up to a maximum of 5 times. Each time the bolt is re-used, make a punch mark on the bolt head.

VIBRATION DAMPER

★ Details may differ according to the machine model.

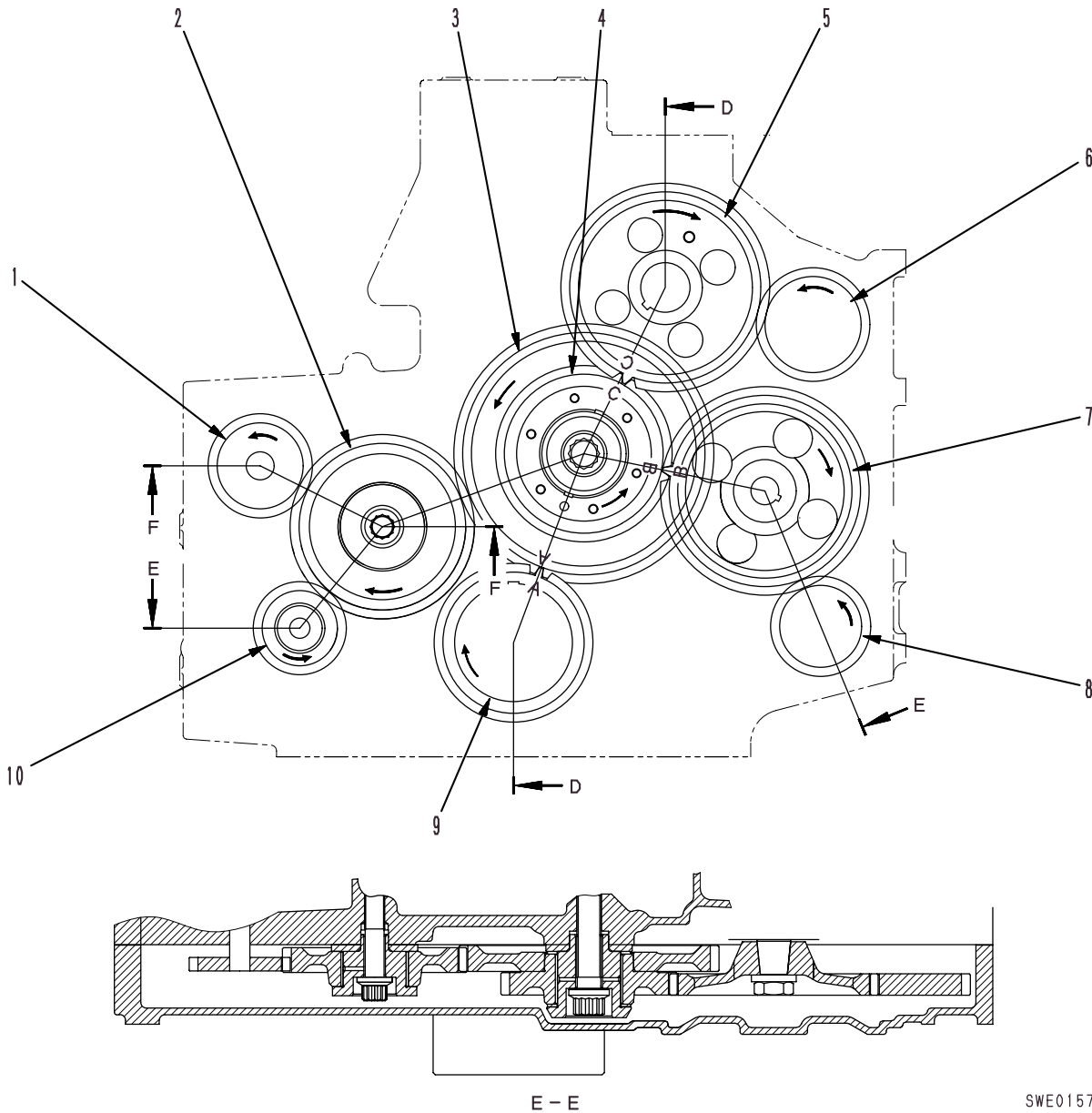


SXE01578

1. Crankshaft pulley
2. Pin (between crankshaft and crankshaft pulley)
3. Vibration damper
4. Bolt (between crankshaft pulley and vibration damper)
5. Bolt (between crankshaft and crankshaft pulley)

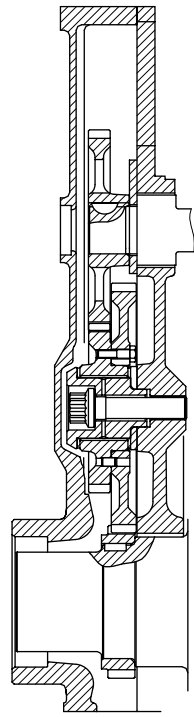
TIMING GEAR

★ Details may differ according to the machine model.

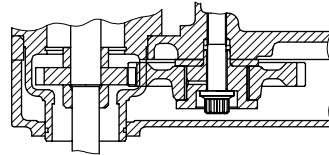


- | | |
|--------------------------------|--------------------|
| 1. Water pump drive gear | (No. of teeth: 23) |
| 2. Sub idler gear | (No. of teeth: 42) |
| 3. Idler gear, large | (No. of teeth: 60) |
| 4. Idler gear, small | (No. of teeth: 40) |
| 5. Cam gear | (No. of teeth: 48) |
| 6. Air compressor drive gear | (No. of teeth: 24) |
| 7. Fuel supply pump drive gear | (No. of teeth: 48) |
| 8. PTO gear (opt) | (No. of teeth: 22) |
| 9. Crankshaft gear | (No. of teeth: 36) |
| 10. Oil pump drive gear | (No. of teeth: 20) |

- A. Timing mark
(between crankshaft gear and idler gear)
- B. Timing mark
(between crankshaft gear and fuel supply pump drive gear)
- C. Timing mark
(between crankshaft gear and cam gear)

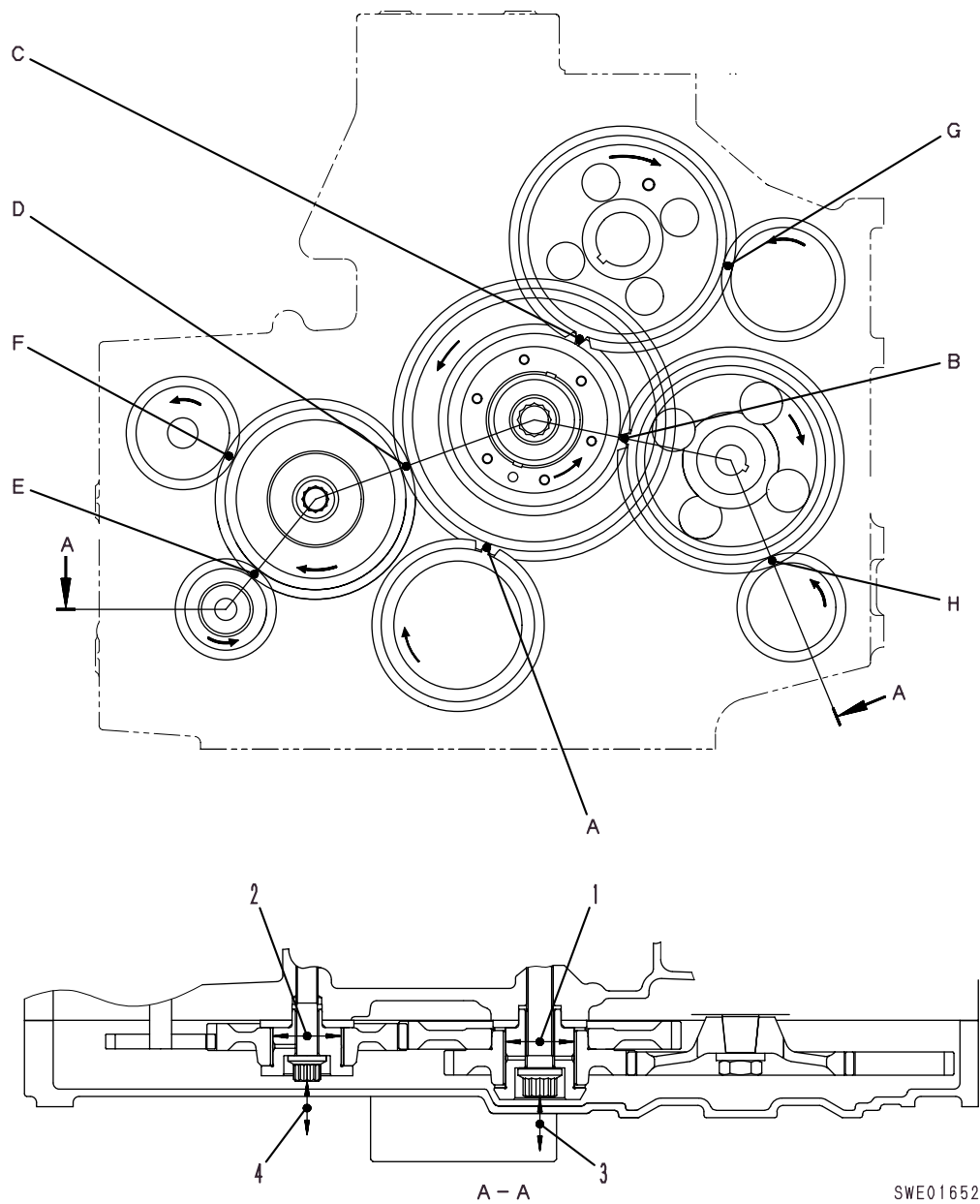


D - D



F - F

SWE01580

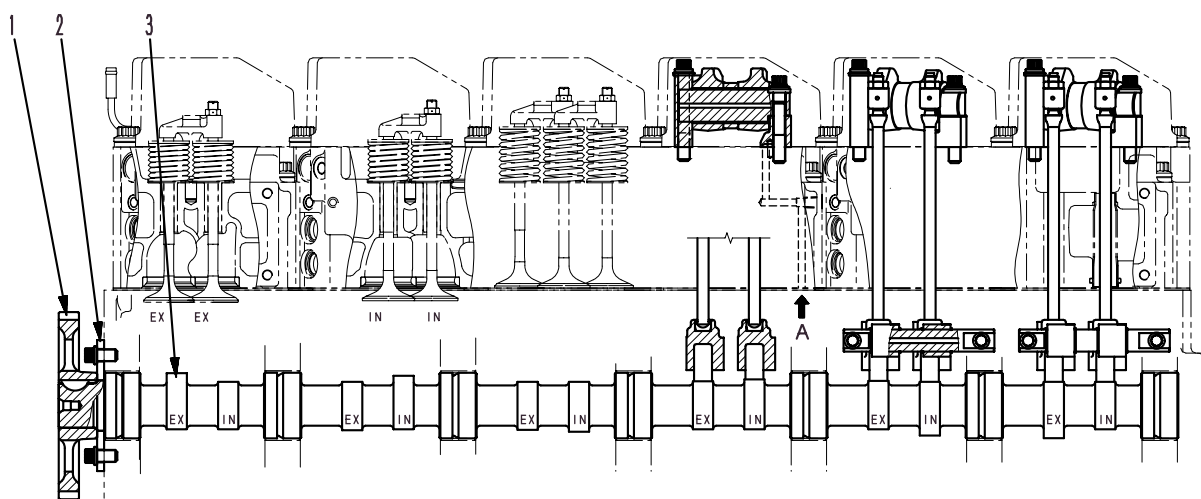
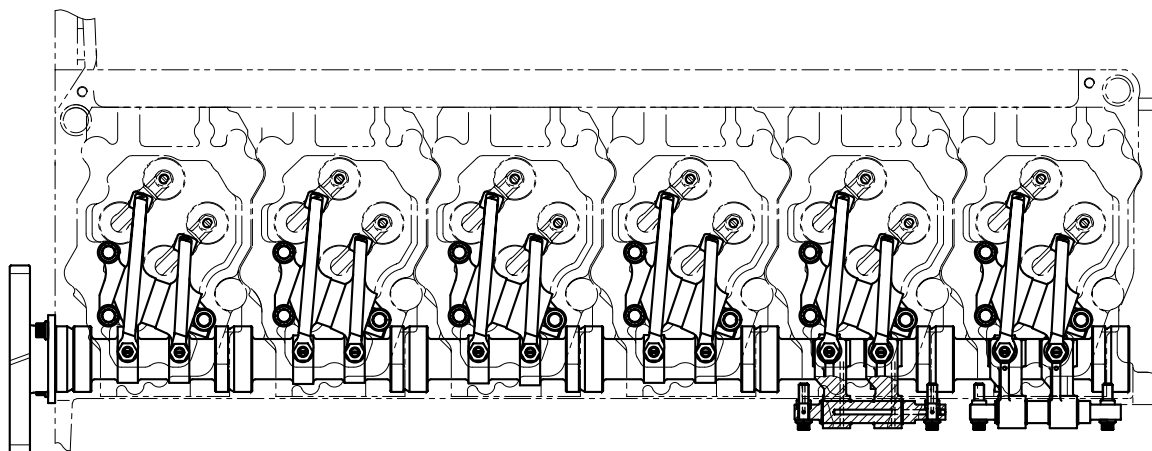


Unit: mm

No.	Check item	Criteria					Remedy
1	Clearance between main idler gear bushing and shaft	Standard size	Tolerance		Standard clearance	Clearance limit	Replace bushing
			Shaft	Hole			
		56	−0.016 −0.029	+0.034 +0.009	0.025 – 0.063	0.20	
2	Clearance between sub idler gear bushing and shaft	56	−0.016 −0.029	+0.055 0	0.016 – 0.084	0.20	
3	End play of main idler gear	Standard size			Repair limit		Replace thrust bearing
		0.06 – 0.24			0.4		
4	End play of sub idler gear	0.11 – 0.23			0.4		
—	Backlash of each gears	Measuring point	Gears		Standard size	Repair limit	Replace
		A	Crankshaft gear and main idler gear (Large)		0.028 – 0.312	0.6	
		B	Main idler gear (Small) and fuel supply pump drive gear		0.016 – 0.278		
		C	Main idler gear (Small) and camshaft gear		0.016 – 0.278		
		D	Main idler gear (Large) and sub idler gear		0.028 – 0.313		
		E	Sub idler gear and oil pump drive gear		0.080 – 0.417		
		F	Sub idler gear and water pump drive gear		0.095 – 0.346		
		G	Camshaft gear and air compressor drive gear		0.118 – 0.369		
		H	Fuel supply pump drive gear and PTO gear (Lower)		0.118 – 0.369		

VALVE SYSTEM

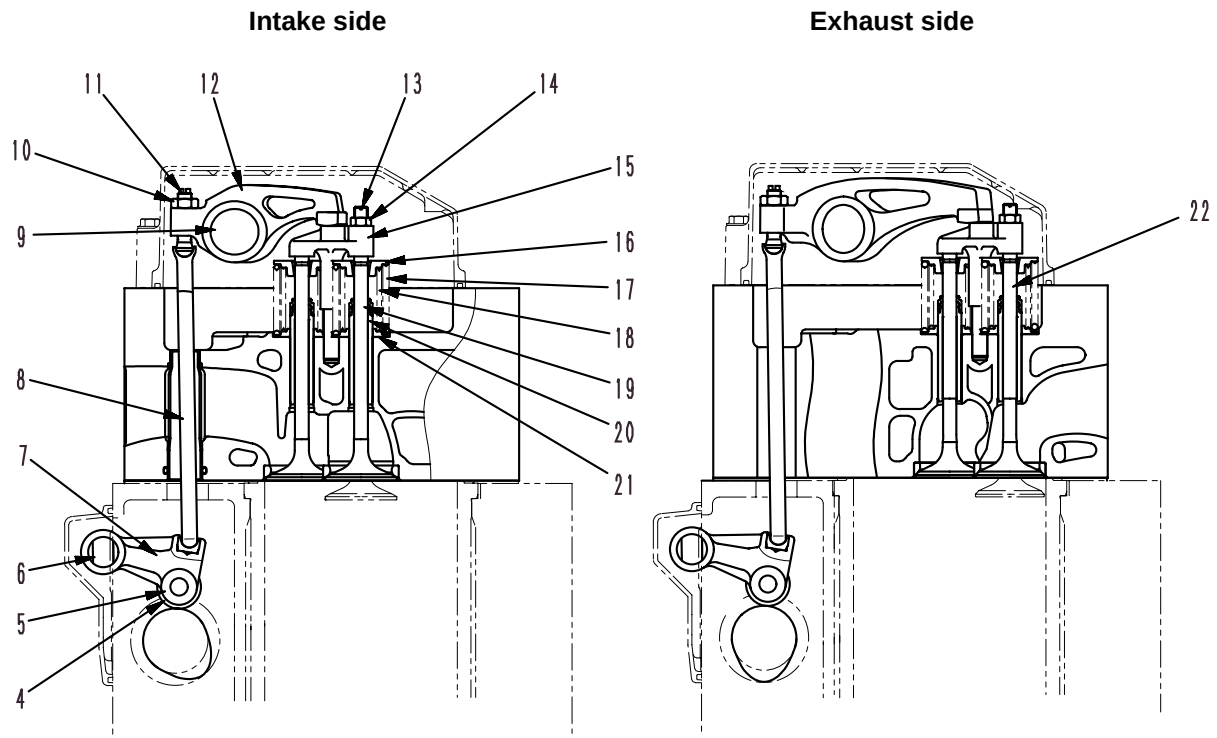
★ The shape may differ according to the machine model.



SXE01581

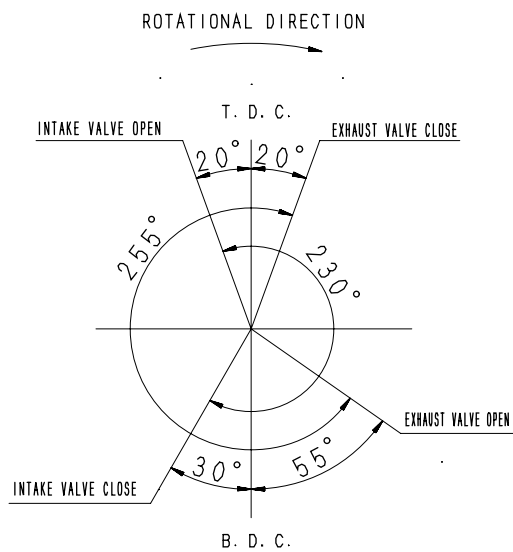
1. Cam gear (No. of teeth: 48)
2. Thrust plate
3. Camshaft
4. Cam roller
5. Cam roller pin
6. Cam follower shaft
7. Cam follower
8. Push rod
9. Rocker arm shaft
10. Locknut
11. Rocker arm adjustment screw
12. Rocker arm

13. Crosshead adjustment screw
14. Locknut
15. Crosshead
16. Valve retainer
17. Valve spring (outer)
18. Valve spring (inner)
19. Intake valve
20. Valve guide
21. Spring seat
22. Exhaust valve
- A. Lubrication oil inlet



Valve timing

SXE01582



SXE01584

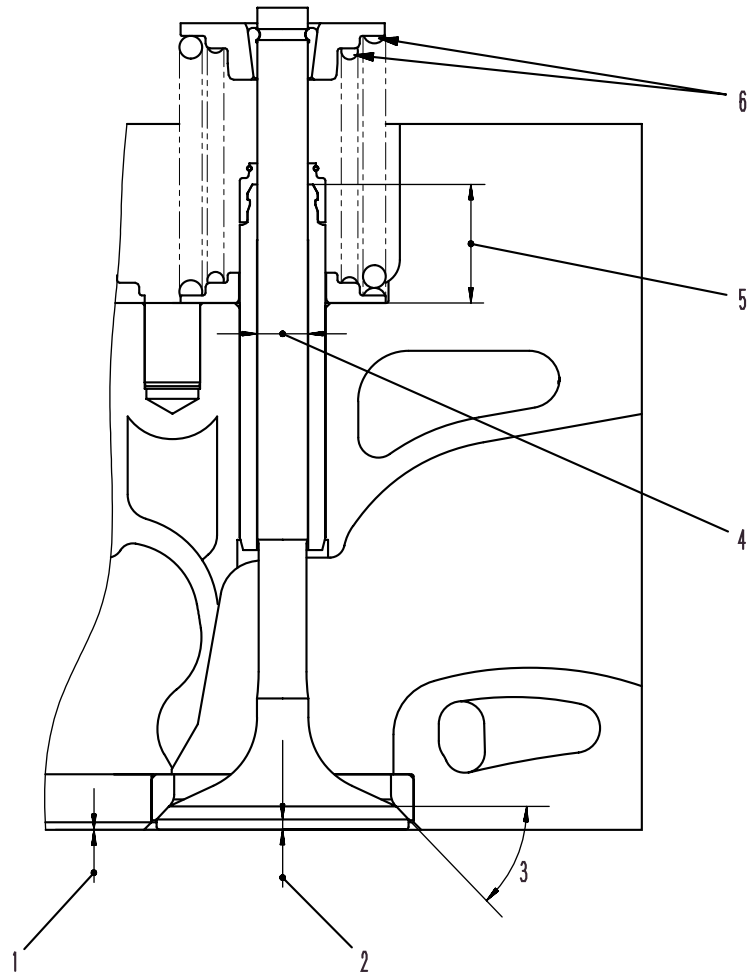
Specifications

Camshaft:

Solid-drawn steel bar (precut)

Journal portion, cam portion : Induction hardening

VALVE, VALVE GUIDE

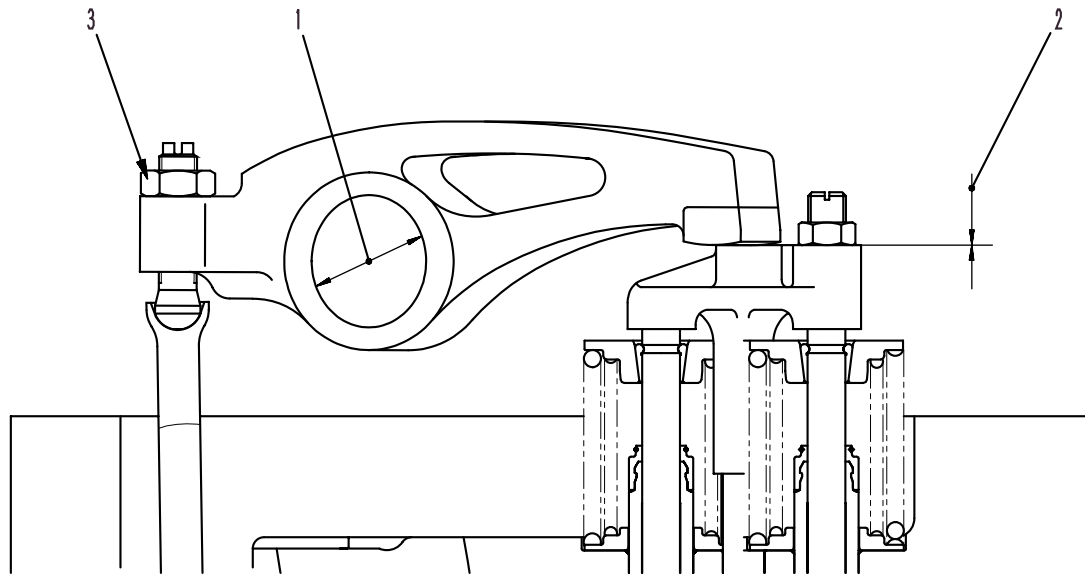


SXE01646

Unit: mm

No.	Check item	Criteria				Remedy	
1	Amount of valve sinking	Valve		Standard size	Tolerance	Repair limit	Replace valve or valve seat
		Intake valve		0	±0.10	0.70	
		Exhaust valve		0	±0.10	0.70	
2	Thickness of valve lip	Valve		Standard size		Repair limit	Replace valve
		Intake valve		2.4		1.9	
		Exhaust valve		2.15		1.75	
3	Valve seat angle	Valve		Standard size		Tolerance	Repair or replace valve and valve seat
		Intake valve		30°		±15'	
		Exhaust valve		45°		±15'	
4	Outside diameter of valve stem	Intake valve		10		-0.045 -0.060	Replace valve
		Exhaust valve		10		-0.074 -0.089	
	Inside diameter of valve guide	Before inserting		9.5		+0.019 +0.001	Replace valve guide
		After inserting		10		±0.011	
	Clearance between valve guide and valve stem	Valve		Standard size		Repair limit	Replace valve or valve guide
		Intake valve		0.034 – 0.071		0.22	
		Exhaust valve		0.063 – 0.100		0.24	
Bend of valve stem		Repair limit: 0.02 (Total indicated runout, for 100)				Replace valve	
5	Protrusion of valve guide	Standard size			Tolerance		Repair
		22.0			±0.2		
6	Free lenth of valve spring	Spring		Standard size		Repair limit	Replace valve spring
		Large		81.7		—	
		Small		72.0		—	
	Installed load of valve spring	Spring	Installed length	Standard installed load (N {kg})		Installed load limit (N {kg})	
		Large	51.0	424.3±21.6 {43.3±2.2}		377.3 {38.5}	
		Small	46.0	215.6±10.8 {22.0±1.1}		192.1 {19.6}	
Squarence of valve spring		Repair limit: 2° (for both end)					

ROCKER ARM AND SHAFT

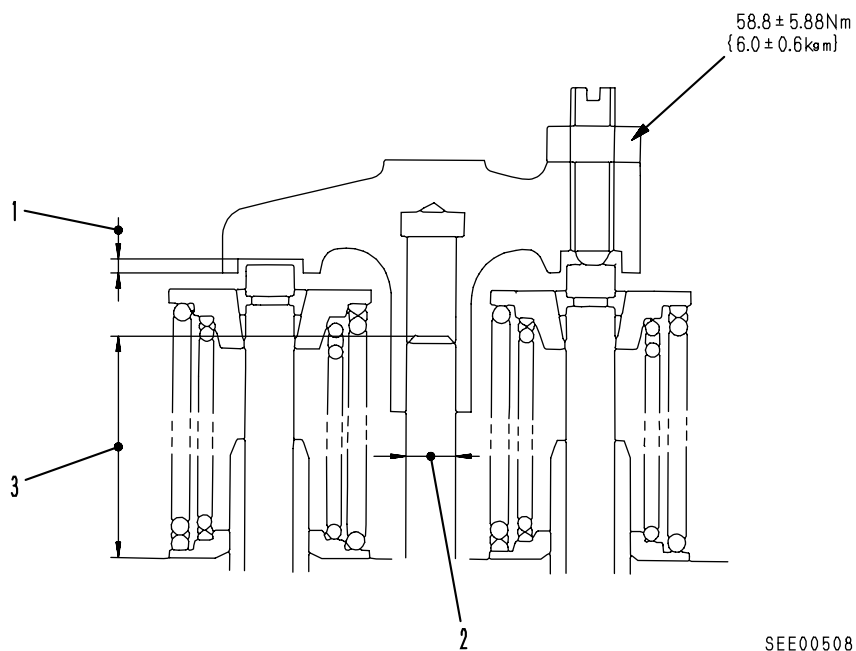


SXE01647

Unit: mm

No.	Check item	Criteria			Remedy
1	Outside diameter of rocker arm shaft	Standard size		Tolerance	Replace rocker arm shaft
		32.0		± 0.0065	
	Inside diameter of rocker arm bushing	32.0		+0.087 +0.035	Replace rocker arm
		Standard clearance		Clearance limit	
	Clearance between rocker arm shaft and rocker arm bushing	0.0285 – 0.0935		0.13	Replace rocker arm or rocker arm shaft
2	Valve clearance (When engine is cold)	Valve	Standard size	Tolerance	Adjust
		Intake	0.35	± 0.02	
		Exhaust	0.57	± 0.02	
3	Tightening torque of rocker arm adjustment screw locknut	Target (Nm {kgm})		Range (Nm {kgm})	Retighten
		58.8 {6}		52.9 – 64.7 {5.4 – 6.6}	

CROSSHEAD AND GUIDE

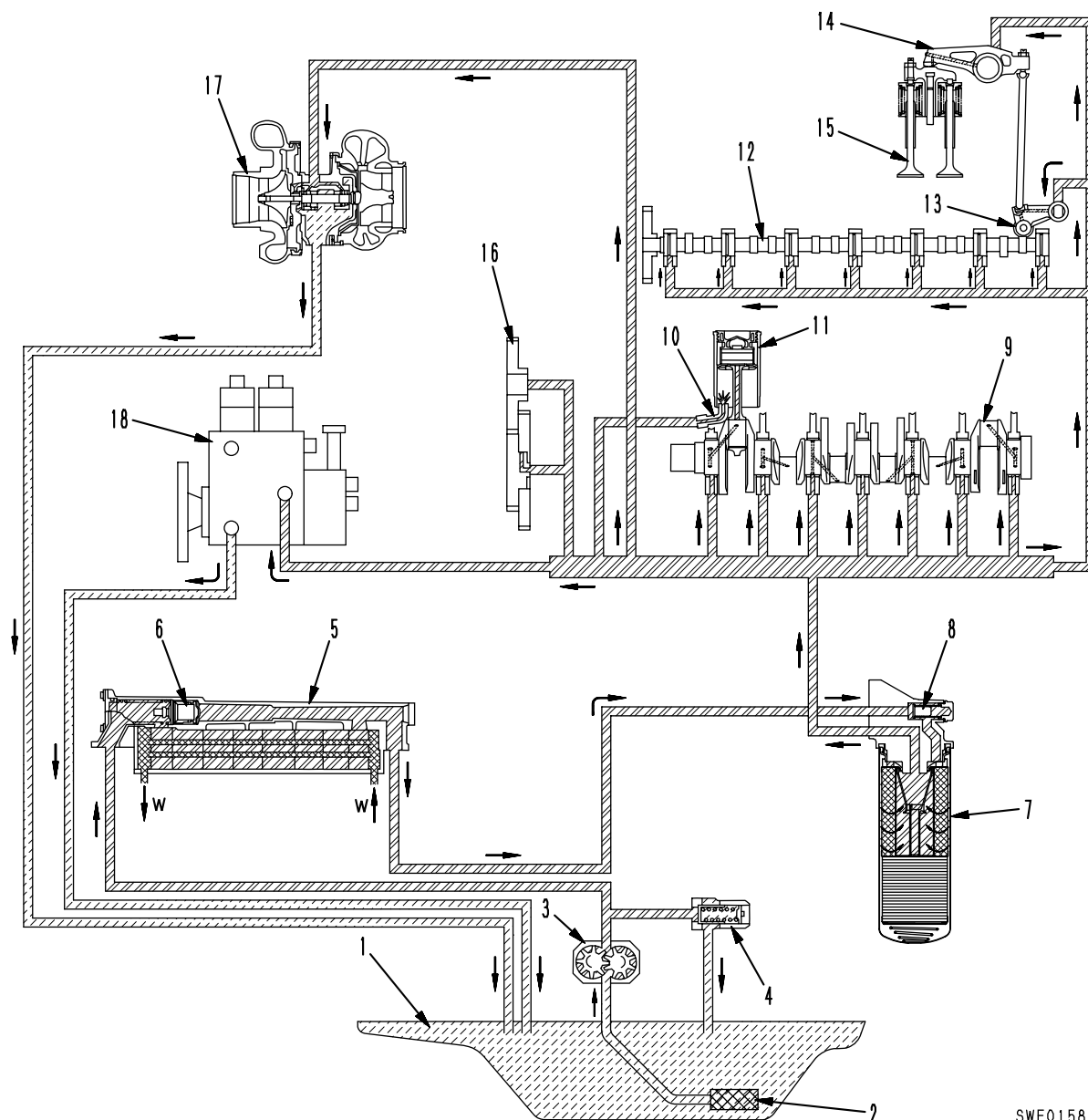


Unit: mm

No.	Check item	Criteria			Remedy
		Standard size	Tolerance	Repair limit	
1	Depth of crosshead stem	6.2	+0.3 0	6.61	Replace
2	Inside diameter of crosshead	11.04	±0.02	11.17	
	Outside diameter of crosshead guide	11	+0.011 0	10.95	
3	Protrusion of crosshead guide	49.0	±0.25	—	Repair

LUBRICATION SYSTEM DIAGRAM

★ The shape may differ according to the machine model.

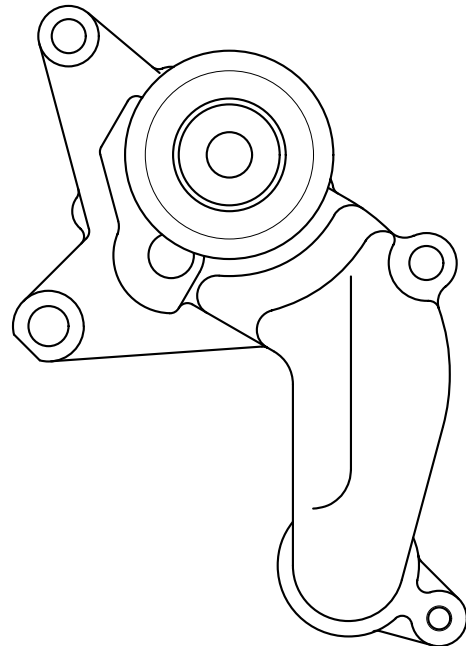
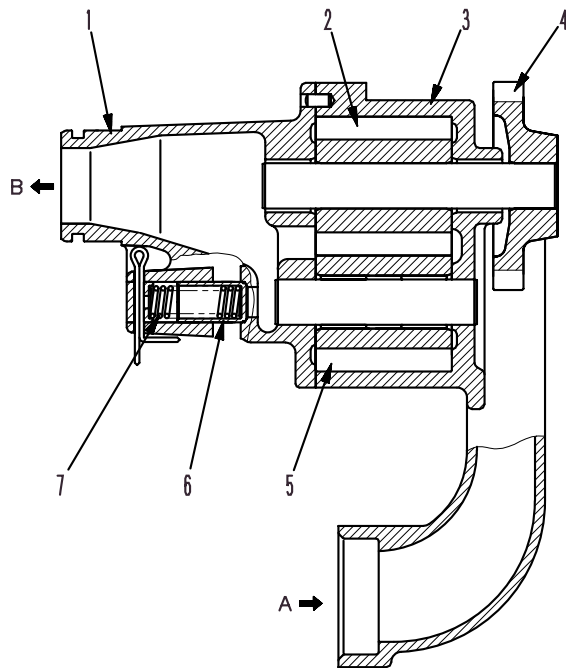


SWE01585

- | | | |
|-----------------|---------------------------|-------------------------------|
| 1. Oil pan | 8. Safety valve | 15. Intake, exhaust valve |
| 2. Oil strainer | 9. Crankshaft | 16. Timing gear |
| 3. Oil pump | 10. Piston cooling nozzle | 17. Turbocharger |
| 4. Relief valve | 11. Piston | 18. Fuel supply pump assembly |
| 5. Oil cooler | 12. Camshaft | |
| 6. Thermo valve | 13. Cam follower | |
| 7. Oil filter | 14. Rocker arm | |
| | | W. Cooling water |

OIL PUMP

★ Details may change for reasons such as modification.



SXE01586

1. Pump cover
2. Drive gear
3. Pump body
4. Pump drive gear (No. of teeth: 20)
5. Driven gear
6. Relief valve
7. Valve spring

- A. From oil pan
B. To oil cooler

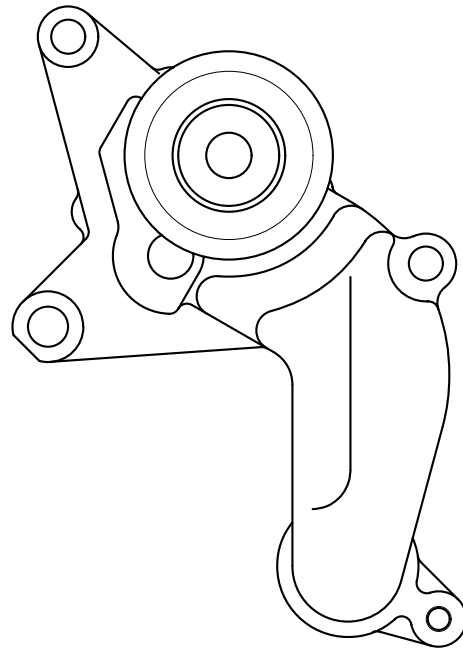
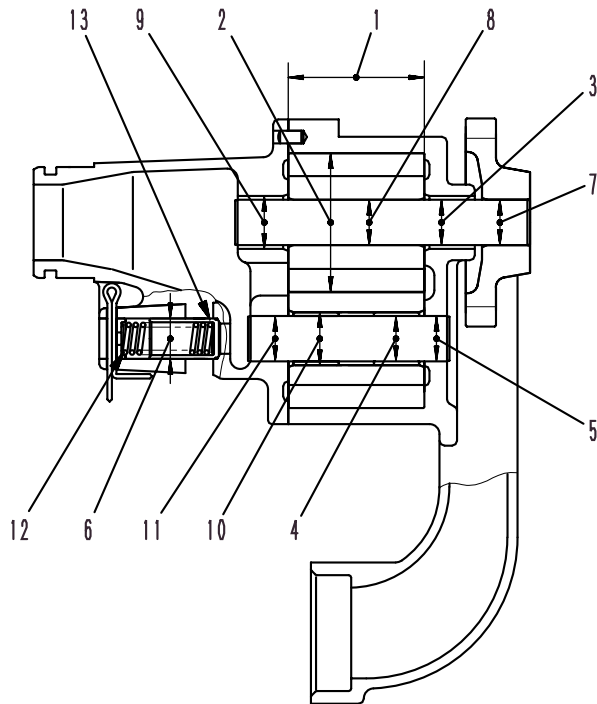
Specifications

Oil pump

Type: Gear pump
Speed: Engine speed x 1.8

Main relief valve

Cracking pressure: 588 ± 49 kPa
{ 6.0 ± 0.5 kg/cm²}



SXE01654

STRUCTURE AND FUNCTION, MAINTENANCE STANDARD

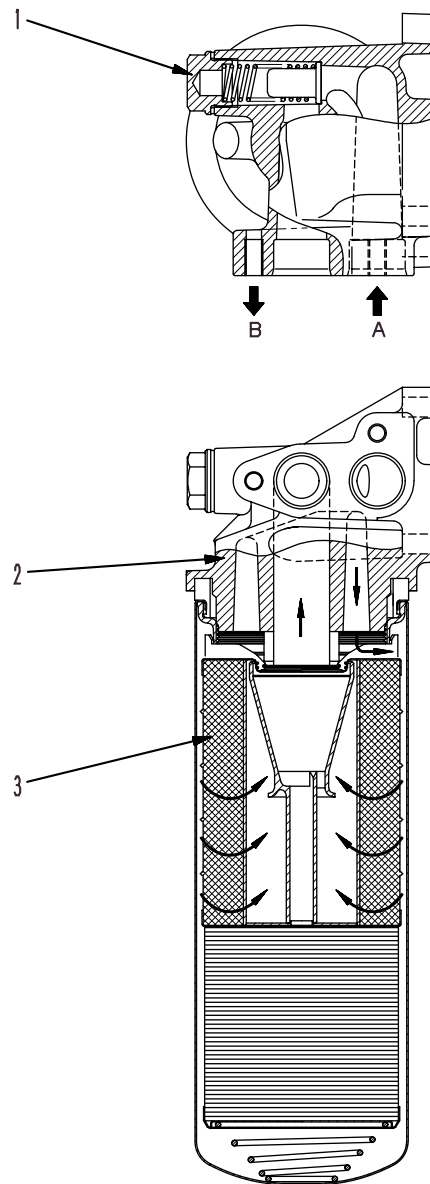
OIL PUMP

Unit: mm

No.	Check item	Criteria					Remedy	
1	Axial clearance of pump gear	Standard size	Tolerance		Standard clearance	Clearance limit	Replace gear or body	
			Gear thickness	Housing depth				
		54	0 −0.030	+0.067 +0.040	0.04 – 0.097	0.10		
2	Radial clearance of pump gear	Standard size	Tolerance		Standard clearance	Clearance limit		
			Gear O.D.	Housing I.D.				
		54.99	−0.15 −0.21	+0.06 0	0.15 – 0.27	0.30		
3	Clearance between drive shaft and pump body bushing	Standard size	Tolerance		Standard clearance	Clearance limit	Replace bushing	
			Shaft	Hole				
		18	+0.106 +0.088	+0.173 +0.146	0.040 – 0.085	—		
4	Clearance between driven shaft and driven gear bushing	18	+0.090 +0.070	+0.147 +0.122	0.032 – 0.077	—		
5	Clearance between driven shaft and body	18	+0.090 +0.070	+0.129 +0.102	0.012 – 0.059	—		
6	Clearance between relief valve and pump cover	16	−0.040 −0.060	+0.043 0	0.040 – 0.103	—		
7	Interference between drive shaft and oil pump drive gear	Standard size	Tolerance		Standard interference	interference limit	Replace	
			Shaft	Hole				
		18	+0.106 +0.088	+0.065 +0.047	0.023 – 0.059	—		
8	Interference between drive gear and drive shaft	18	+0.106 +0.088	+0.049 +0.028	0.039 – 0.078	—		
9	Interference between drive shaft bushing and pump cover	21	+0.090 +0.065	+0.021 0	0.044 – 0.090	—		
10	Interference between driven shaft bushing and driven gear	21	+0.090 +0.065	+0.021 0	0.044 – 0.090	—		
11	Interference between driven shaft and pump cover	18	+0.090 +0.070	+0.040 +0.022	0.030 – 0.068	—		
12	Main relief valve spring	Standard size			Repair limit			
		Free length	Installed length	Installed load (N{kg})	Free length	Installed load (N{kg})		
		49.1	32.0	126.4 {12.9}	—	113.7 {11.6}		
13	Main relief valve set pressure	Standard: 588 ± 49kPa {6.0 ± 0.5 kg/cm ² }						

OIL FILTER

★ The shape may differ according to the machine model.



SWE01587

1. Safety valve
2. Filter head
3. Cartridge

- A. Oil inlet
B. Oil outlet

Specifications

Oil filter

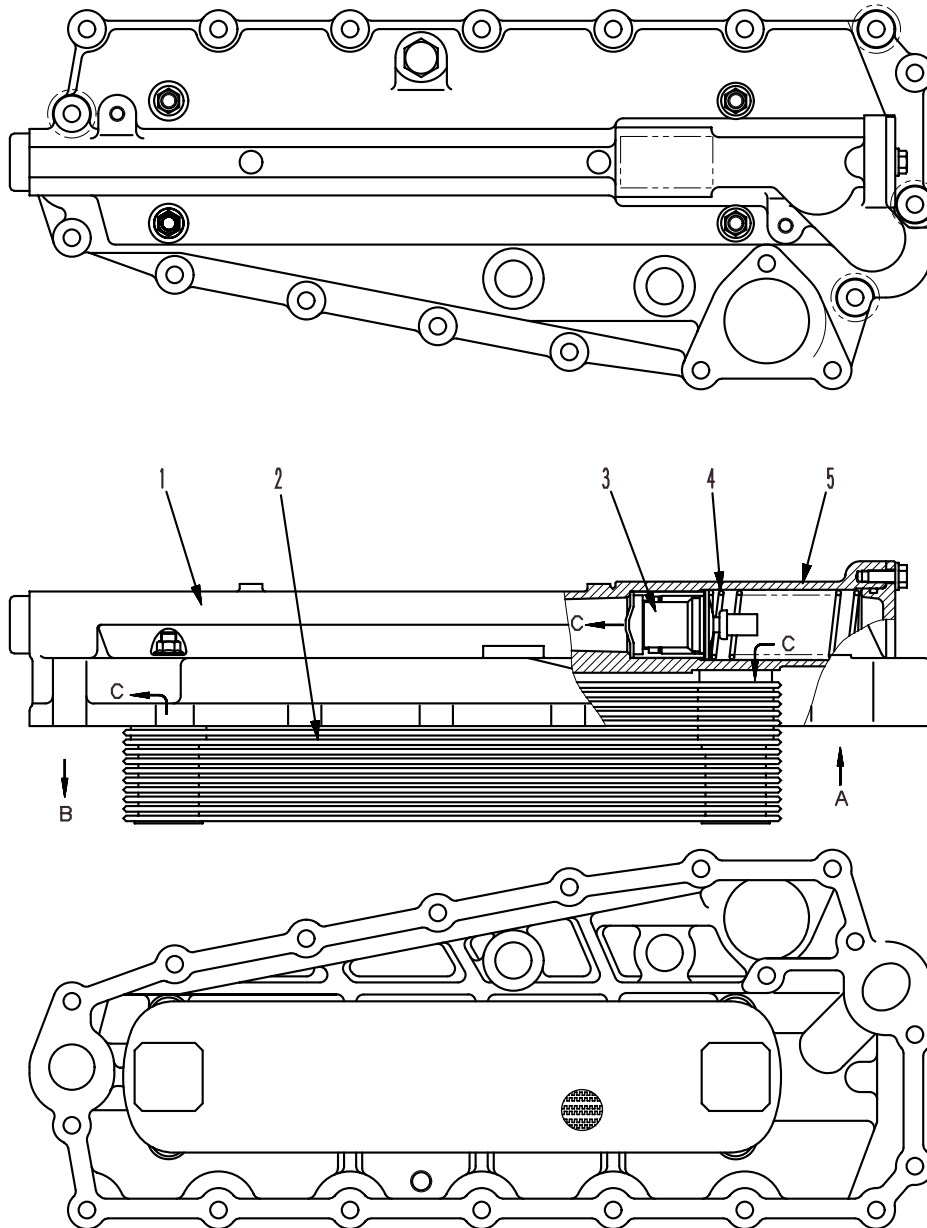
- Filtering area: 0.42 m² (Full-flow)

Safety valve

- Cracking pressure: 245 ± 19 kPa
{2.5 ± 0.2 kg/cm²}

OIL COOLER

★ The shape may differ according to the machine model.



SXE01588

1. Oil cooler cover
 2. Cooler element
SA6D140E-3 (D155AX-5A): 12 stages
SA6D140E-3, SAA6D140E-3: 15 stages
 3. Thermo valve
 4. Thermo valve spring
 5. Thermo valve cover
- A. Oil inlet
B. Oil outlet
C. Cooling water

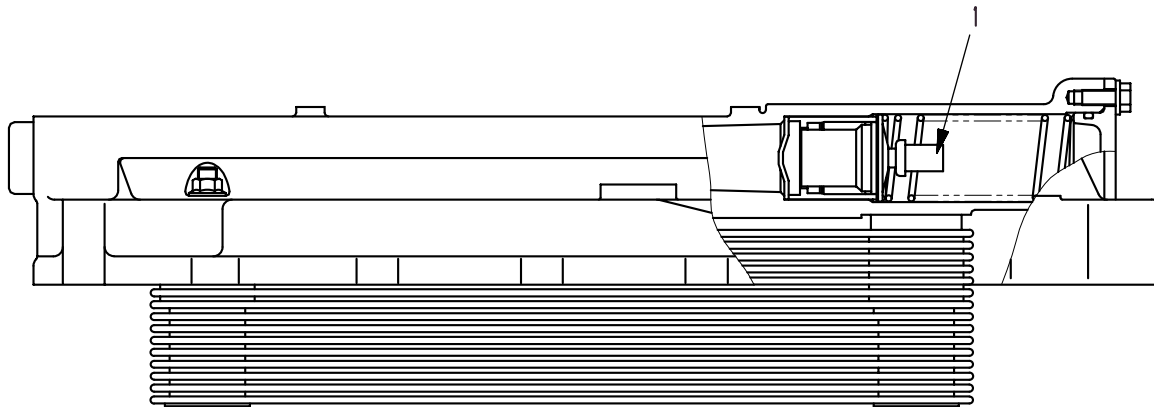
Specifications

Oil cooler thermo valve

- Cracking temperature: $85 \pm 1.5^{\circ}\text{C}$
- Fully open temperature: 100°C
- Fully open lift: 8 mm

Oil cooler

- Heat transmission surface
SA6D140E-3 (D155AX-5A): 0.986m^2
SA6D140E-3, SAA6D140E-3: 1.230m^2
- Heat exchange
SA6D140E-3 (D155AX-5A):
Min. 29,000 kcal/h
SA6D140E-3, SAA6D140E-3:
Min. 39,800 kcal/h



SXE01655

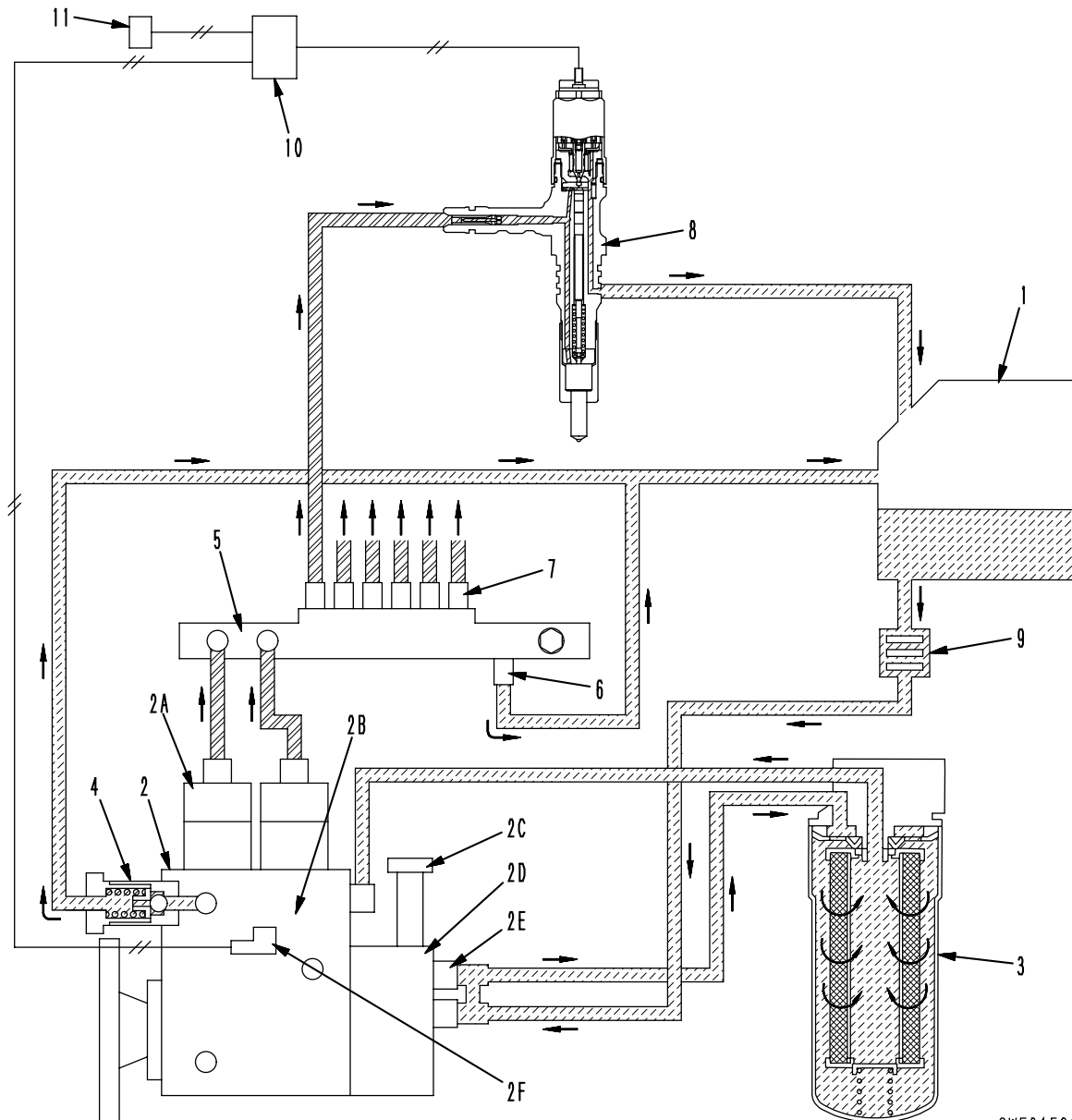
Unit: mm

No.	Check item	Criteria	Remedy
1	Lift of thermostat to fully open position	Min 8mm (soak the valve in oil bath at 100°C for 4 to 5 minutes to check)	Replace
	Opening/closing of thermostat	Check that the valve closes fully when the oil temperature has gone down to 85°C from 100°C when the valve was fully open. (Soak the valve in an oil bath for 4 to 5 minutes to check)	

FUEL SYSTEM DIAGRAM

CRI SYSTEM

★ CRI is short for Common Rail Injection. Hereinafter called CRI.



SWE01589

- | | |
|------------------------------|-------------------------------|
| 1. Fuel tank | 3. Fuel filter |
| 2. Fuel supply pump assembly | 4. Overflow valve |
| 2A. PCV | 5. Common rail |
| 2B. High-pressure pump | 6. Pressure limiter |
| 2C. Priming pump | 7. Flow damper |
| 2D. Feed pump | 8. Injector assembly |
| 2E. Bypass valve | 9. Fuel cooler |
| 2F. G revolution sensor | 10. ECU (Engine Control Unit) |
| | 11. NE revolution sensor |

OUTLINE OF CRI SYSTEM

OUTLINE

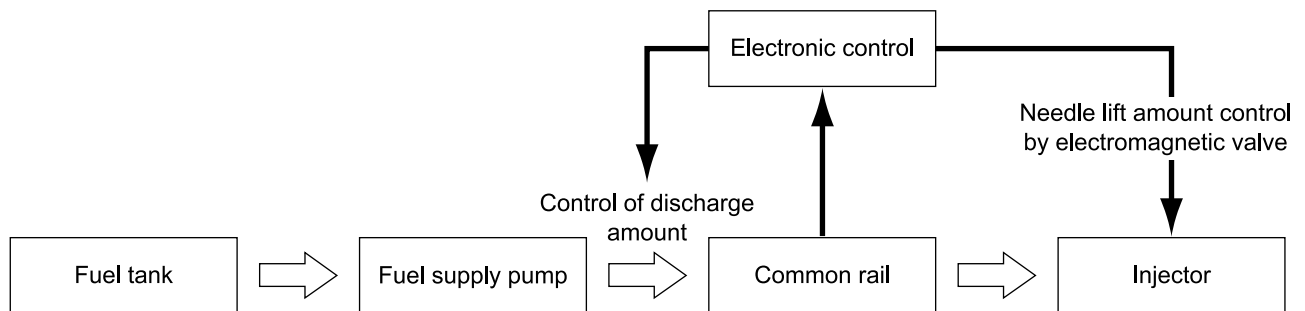
The CRI system detects the condition of the engine (engine speed, accelerator angle, cooling water temperature, etc.) from various sensors, and uses a microcomputer to carry out overall control of the fuel injection amount, fuel injection timing, and fuel injection pressure to operate the engine under the optimum conditions. The computer also carries out self-diagnosis of the main components, and if any abnormality is found, it carries out diagnosis and sends an alarm to inform the operator. It also has a fail-safe function to stop the engine according to the location of the abnormality and a backup function to switch the control method to make it possible to continue operation.

STRUCTURE

The CRI system can be divided in terms of function into the fuel system and control system.

1. Fuel system

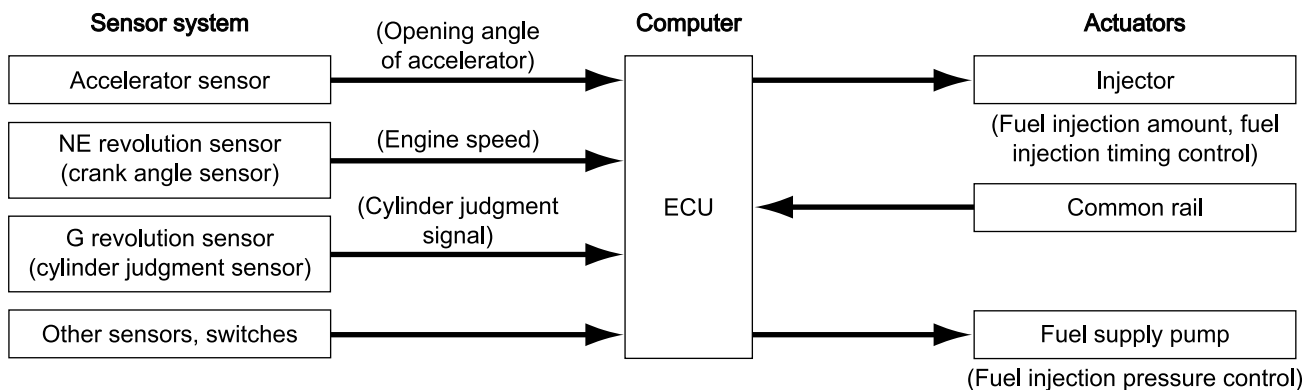
The high-pressure fuel generated by the fuel supply pump goes from the common rail and is distributed to each cylinder. The start and finish of injection is controlled by opening or closing the nozzle needle valve by using an electromagnetic valve inside the injector.



2. Control system

The ECU (Engine Control Unit) carries out control by calculating the length of time and the timing of sending current to the injector by using the signals from the sensors installed to the engine and various parts of the machine so that it injects a suitable amount at the suitable injection timing.

The control system and electrical components can be broadly divided into the sensors, computer, and actuators.



STRUCTURE AND FUNCTION OF CRI SYSTEM

The CRI system consists of the fuel supply pump, common rail, and injectors, and the ECU and sensors that control them.

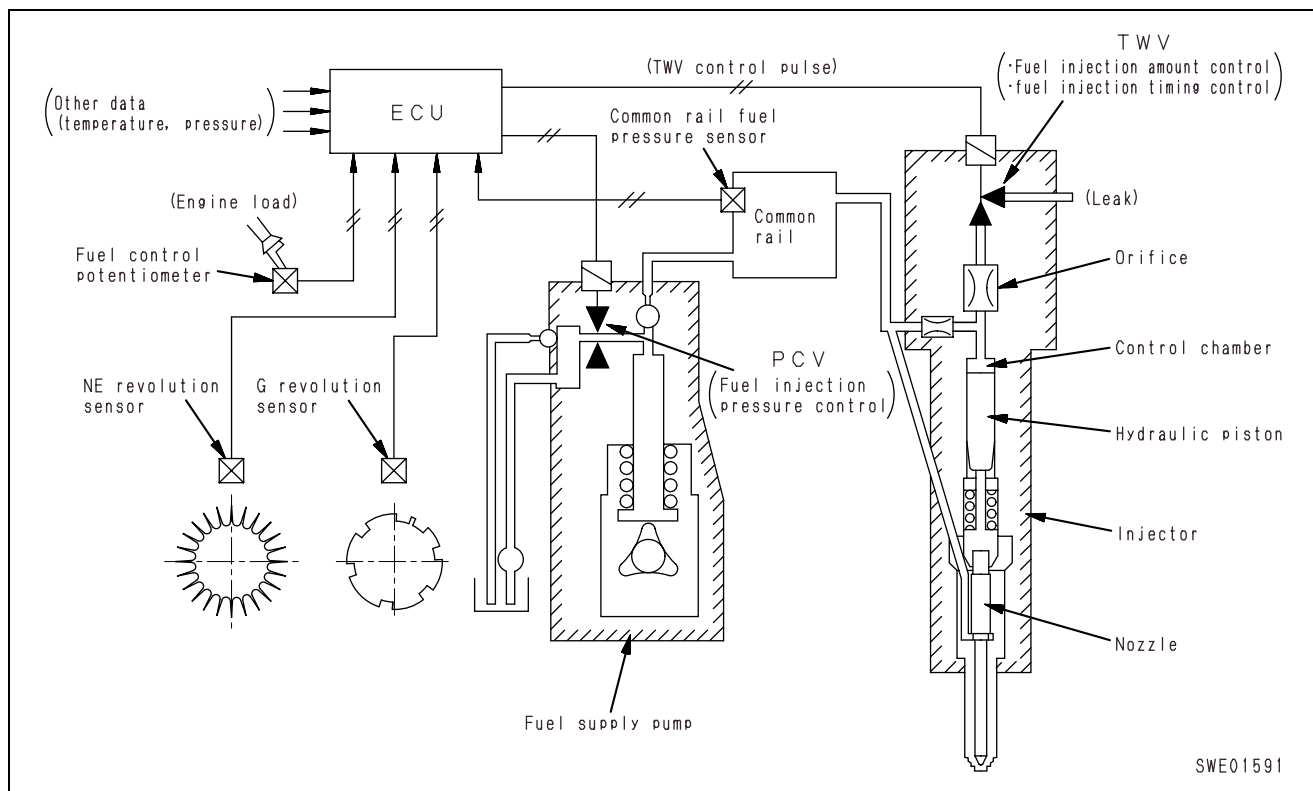
The fuel supply pump generates fuel pressure inside the common rail. The fuel pressure is controlled by the amount of fuel discharged from the supply pump. The amount of fuel discharged is controlled by sending an electrical signal from the ECU to switch the PCV (discharge control valve) of the fuel supply pump ON-OFF.

The common rail accepts the fuel pressure generated by the fuel supply pump and distributes it to the cylinders. The fuel pressure is detected by the common rail fuel pressure sensor installed in the common rail. It carries out feed back control to ensure that the actual pressure value matches the command pressure value set in accordance with the engine speed and engine load.

The fuel pressure of the common rail passes through the fuel injection pipes of each cylinder and is applied to the control chamber and the nozzle of the injector.

The injector controls the amount of fuel injection and the fuel injection timing. It controls by switching the TWV (Two-Way electromagnetic Valve) ON-OFF. When the TWV is turned ON (conducts electricity), the fuel circuit is switched so that the high-pressure fuel in the control chamber passes through the orifice and flows out. The needle valve goes up because of the nozzle cracking pressure actuated by the high-pressure fuel at the nozzle end, and fuel injection is started. When the TWV is switched OFF (no current flows), the control chamber becomes a fuel circuit with the high-pressure fuel applied through the orifice, so the needle valve goes down and fuel injection is completed.

Therefore, the fuel injection timing is controlled electronically by the timing of the electricity passing through the TWV, and the amount of fuel injected is controlled by the amount of time that electricity passes through the TWV.



STRUCTURE AND FUNCTION OF COMPONENTS

1. Fuel supply pump

1) Outline

The fuel supply pump consists of the priming pump, feed pump, and high-pressure pump. Its function generates the fuel pressure inside the common rail by the control of the fuel discharge amount.

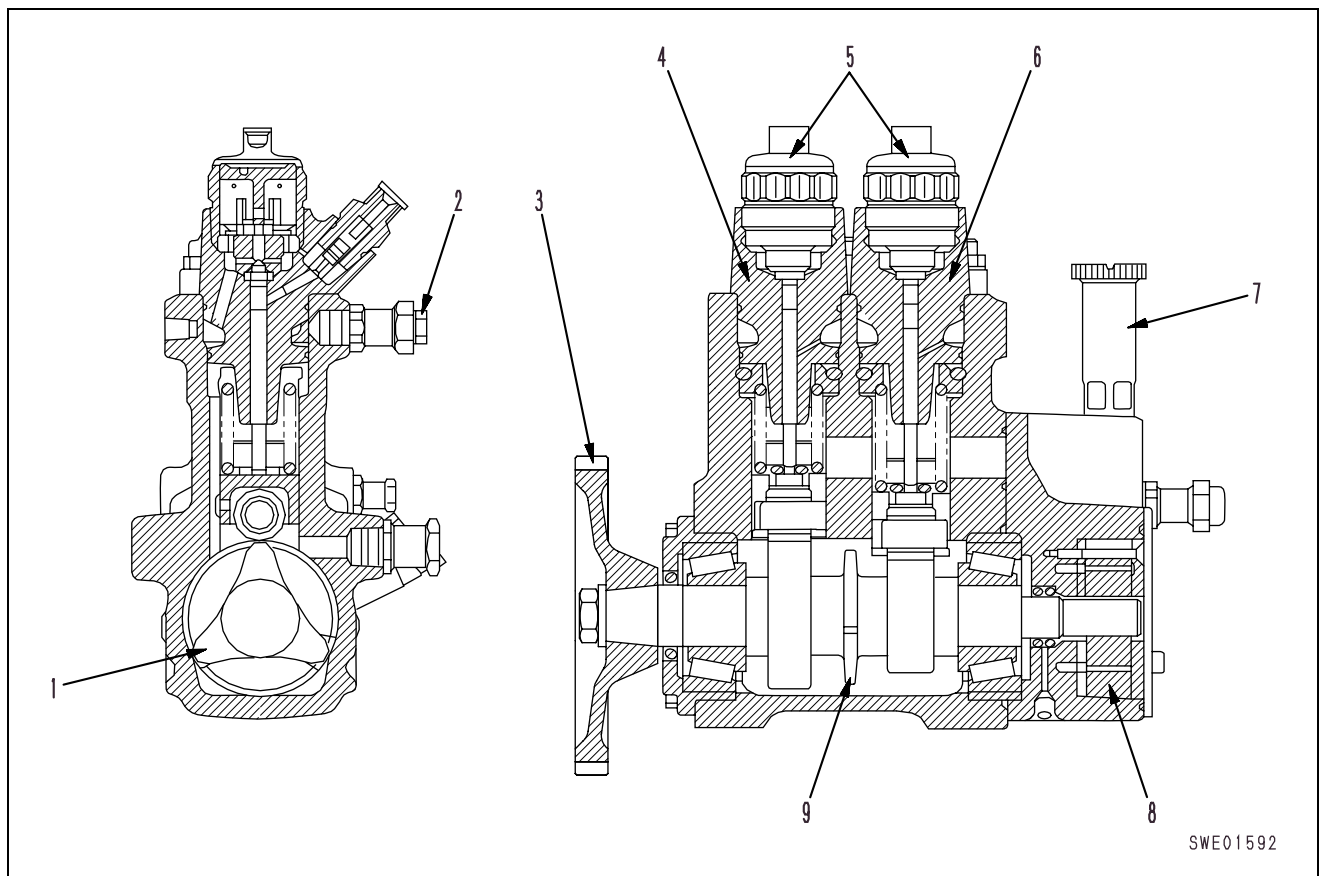
2) Structure

With the high-pressure pump, pump control valves (discharge amount control valves) are installed to each cylinder to control the force feed system and fuel discharge amount in the same way as the conventional in-line fuel injection pump.

By employing cams with 3 protrusions, the necessary number of high-pressure pumps (cylinders) is reduced to 1/3 of the number of engine cylinders. In addition, the force feed to the common rail is the same number of times as the number of times of fuel injection, so it is possible to obtain a smooth and stable common rail pressure.

The fuel force fed from the high-pressure pump to the common rail is divided as follows for each pump.

The No. 1 high-pressure pump (drive gear side) (4) covers the drop in the pressure inside the common rail because of the fuel injection of the No. 1, No. 3, and No.5 cylinders, while the No. 2 high-pressure pump (feed pump side) (6) covers the drop in the pressure inside the No.2, No.4 and No.6 cylinders of common rail in the same way.

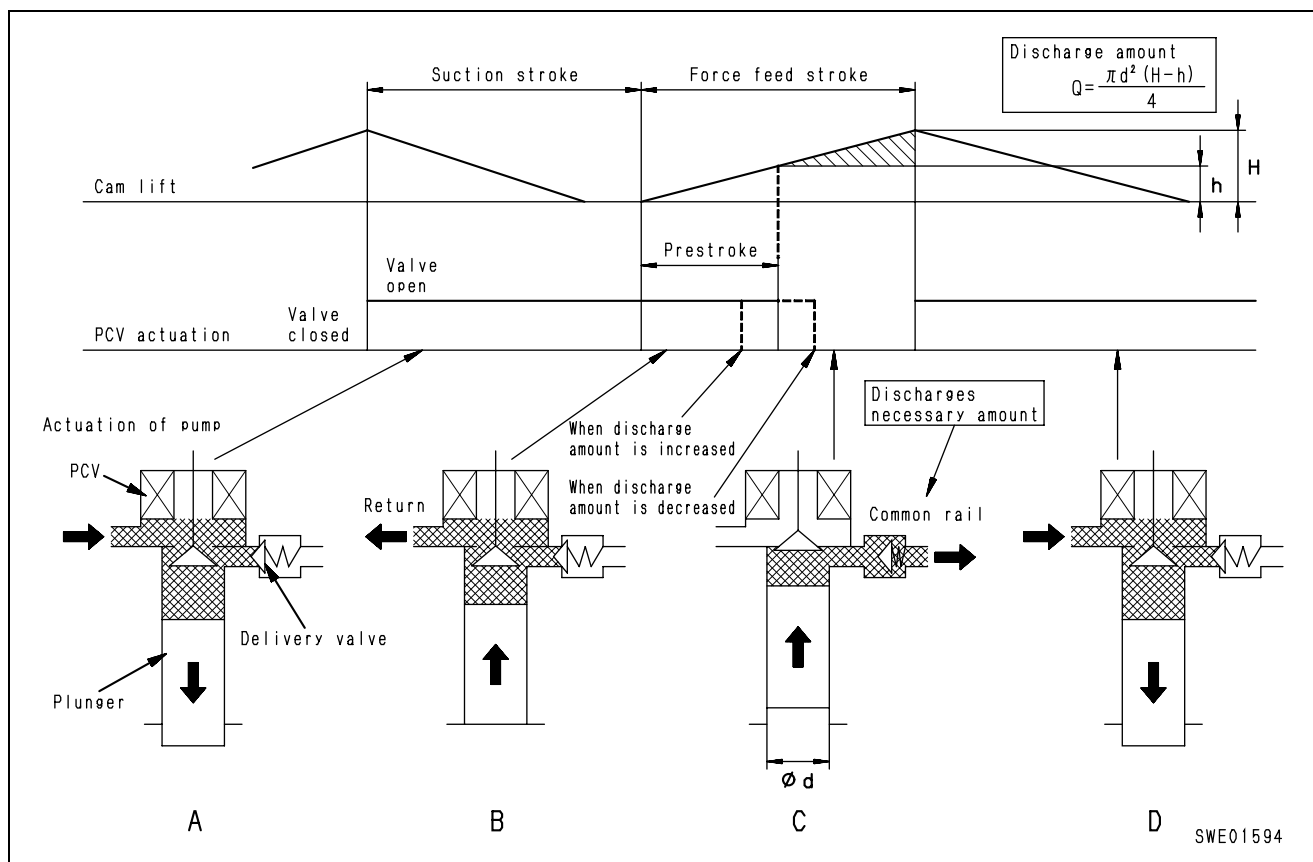


1. 3-protrusion type cam
2. Overflow valve
3. Drive gear
4. No.1 high-pressure pump
5. PCV (discharge control valve)

6. No.2 high-pressure pump
7. Priming pump
8. Feed pump
9. G revolution sensor gear

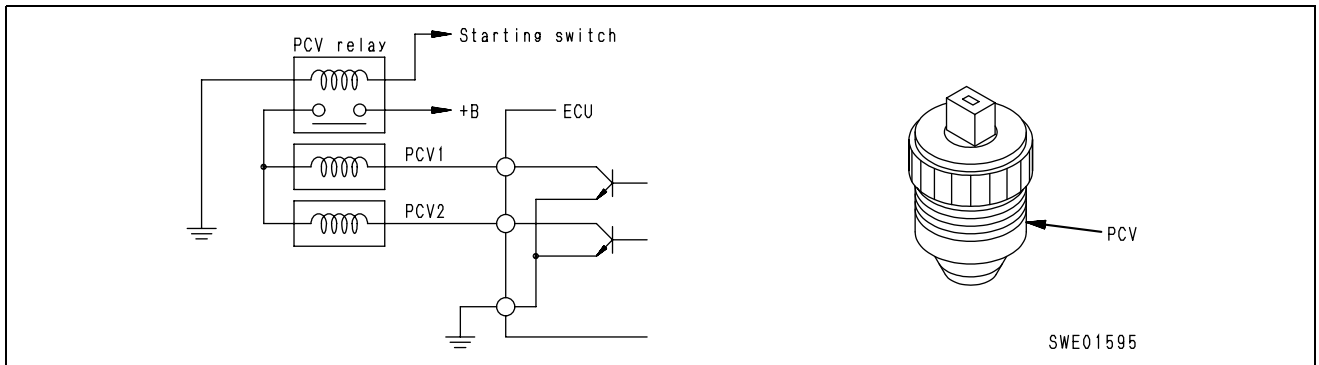
3) Operation

- A. During the down stroke of the plunger, the PCV is open, so the low-pressure fuel passes through the PCV and is sucked into the plunger chamber.
- B. Even when the plunger enters the up stroke while there is no electricity flowing to the PCV and it remains open, the fuel taken in passes through the PCV, so the pressure does not rise and it is returned.
- C. When electricity is sent to the PCV to close the valve with timing matching the necessary discharge amount, the return passage is cut off, and the pressure in the plunger chamber rises. Therefore, the fuel passage through the delivery valve (check valve) and is force fed to the common rail.
In other words, when the PCV is closed, the plunger lift becomes the amount of discharge, and by changing the timing of closing the PCV (plunger prestroke), the discharge amount changes and the common rail fuel pressure is controlled.
- D. When the cam passes the maximum lift, the plunger enters the down stroke and the pressure inside the plunger chamber goes down. When this happens, the delivery valve closes and stops the force feed of fuel. In addition, the flow of current to the PCV is stopped, so the PCV opens and low-pressure fuel is sucked into the plunger chamber. In other words, it returns to the condition in A.



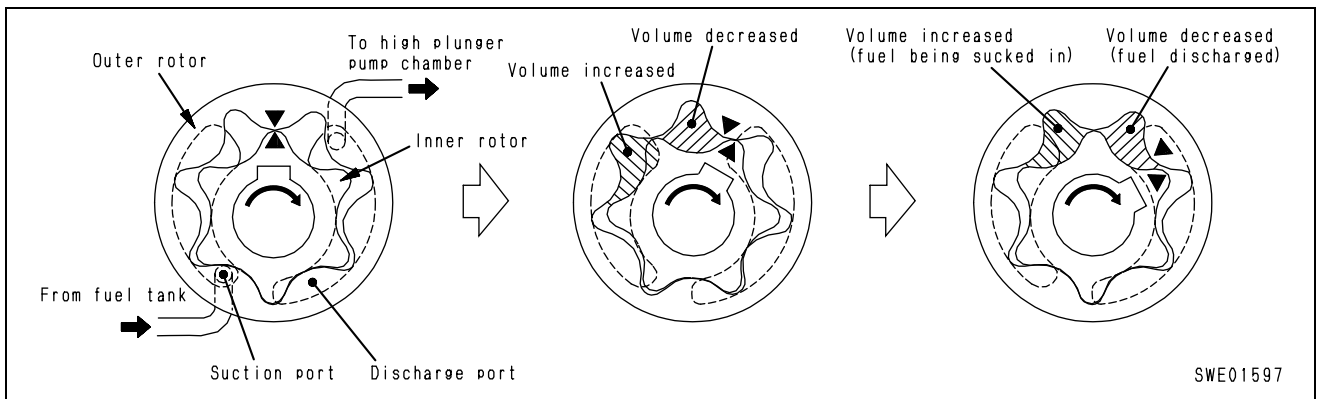
4) PCV (discharge control valve)

The PCV acts to adjust the fuel discharge amount from the fuel supply pump to adjust the common rail fuel pressure. The discharge amount sent to the common rail from the fuel supply pump is determined by the timing of the electric current sent to the PCV.



5) Feed pump

The feed pump is built into the fuel supply pump assembly. It sucks up the fuel from the fuel tank, sends it through the fuel filter, and into the high-pressure pump chamber. The feed pump rotor is driven by the camshaft, and when the outer/inner rotors start to turn respectively, fuel is sucked in at the suction side and sent out at the discharge side according to the change in the size of space created by the outer/inner rotors.

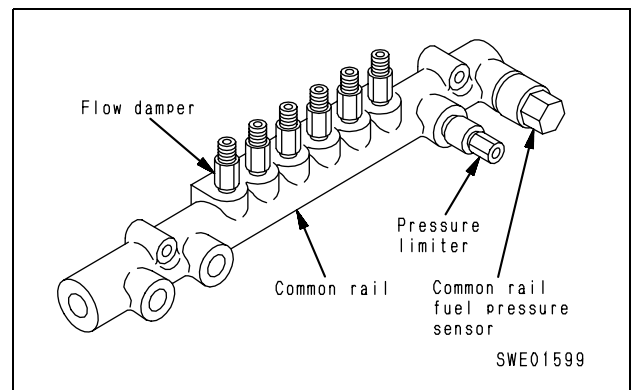


2. Common rail

1) Structure

The common rail acts to distribute the high-pressure fuel generated by the high-pressure pump and send it to the injector of each cylinder. The common rail is equipped with a common rail fuel pressure sensor, flow damper, and pressure limiter.

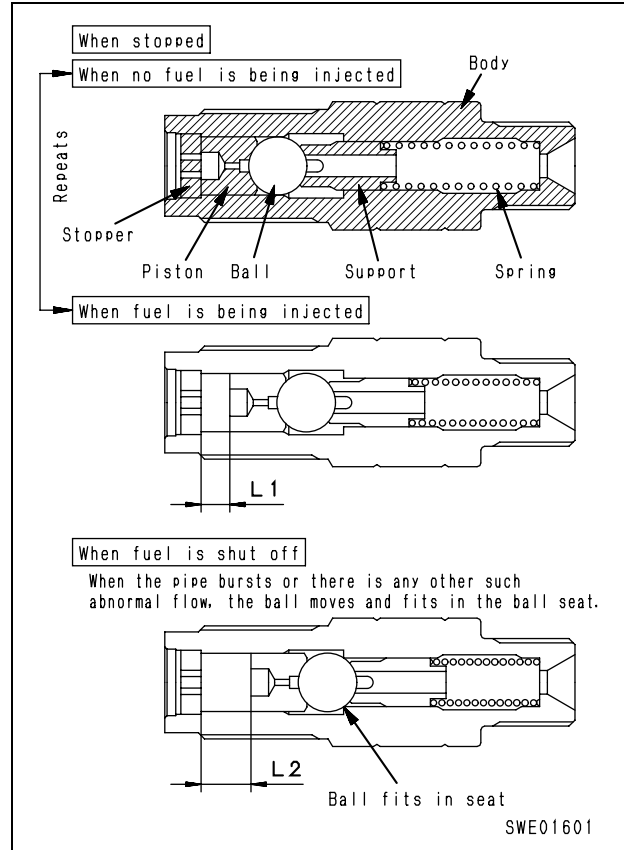
The flow damper is equipped with a fuel injection pipe and sends high-pressure fuel to the injector. The piping of the pressure limiter is arranged to return to the fuel tank.



2) Flow damper

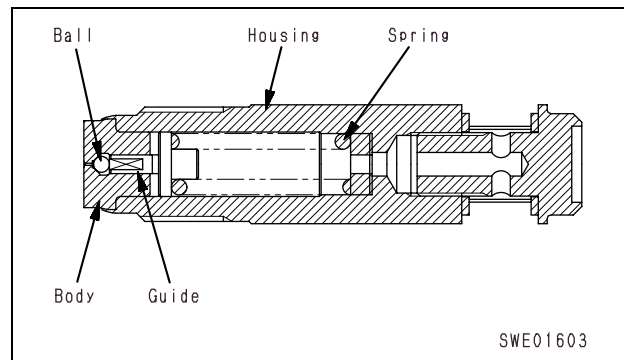
The flow damper reduces the pressure pulses inside the high-pressure piping and acts to supply fuel at a stable pressure to the injector. If any excess fuel flow out, it acts to shut off the fuel passage and prevent any abnormal outflow of fuel.

If any abnormal outflow is generated, high pressure bears on the piston, so the piston and ball move to the right as shown in the diagram and come into contact with the seat. As a result, the fuel passage is shut off.



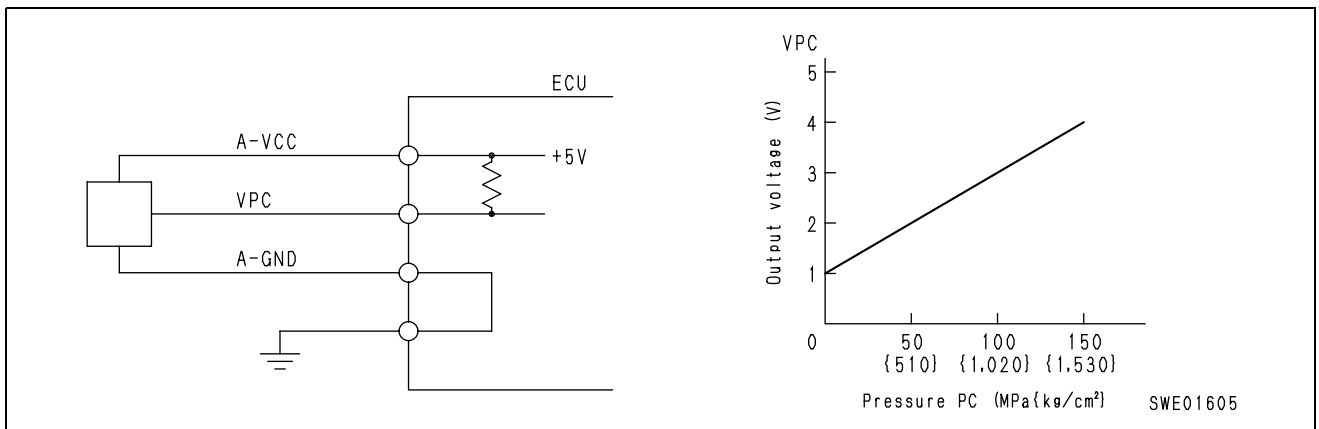
3) Pressure limiter

The pressure limiter opens if any abnormal high pressure is generated, and acts to allow the pressure to escape. It is actuated (opens) if the fuel pressure in the common rail reaches approx. 140 MPa {1,430 kg/cm²}, and when the pressure goes down to approx. 30 MPa {310 kg/cm²}, it is restored (closes) and acts to maintain the pressure.



4) Common rail fuel pressure sensor

The common rail fuel pressure sensor is installed to the common rail and detects the fuel pressure. The sensor is a semi-conductor pressure sensor. This uses the characteristic of silicon, which changes the electrical resistance if pressure is applied to it.



3. Injector

1) Outline

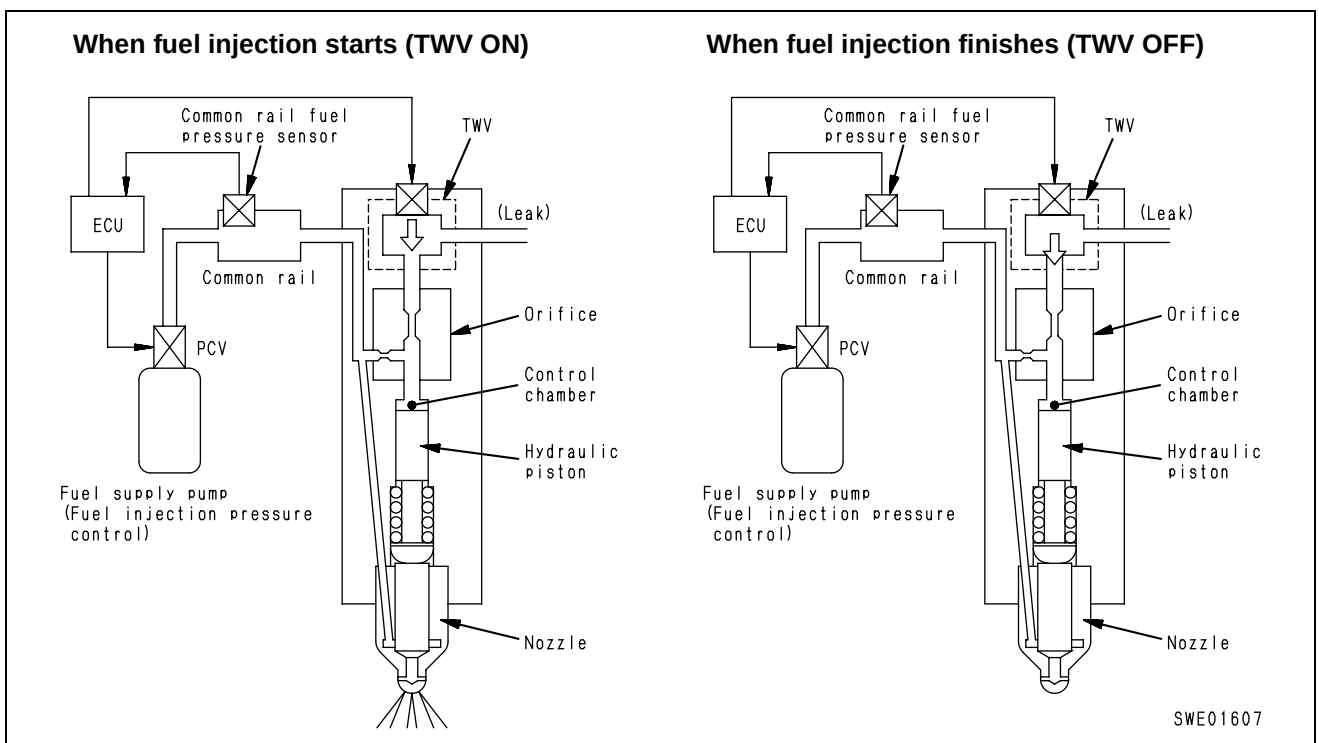
The function of the injectors is to inject high-pressure fuel from the common rail according to the signal from the ECU into the injection chamber of the engine at the optimum fuel injection timing, fuel injection amount, fuel injection ratio and spray condition.

The TWV (Two-Way electromagnetic Valve) controls the pressure in the control chamber in order to control the start and finish of the fuel injection.

The orifice controls the angle of opening of the nozzle to control the fuel injection ratio.

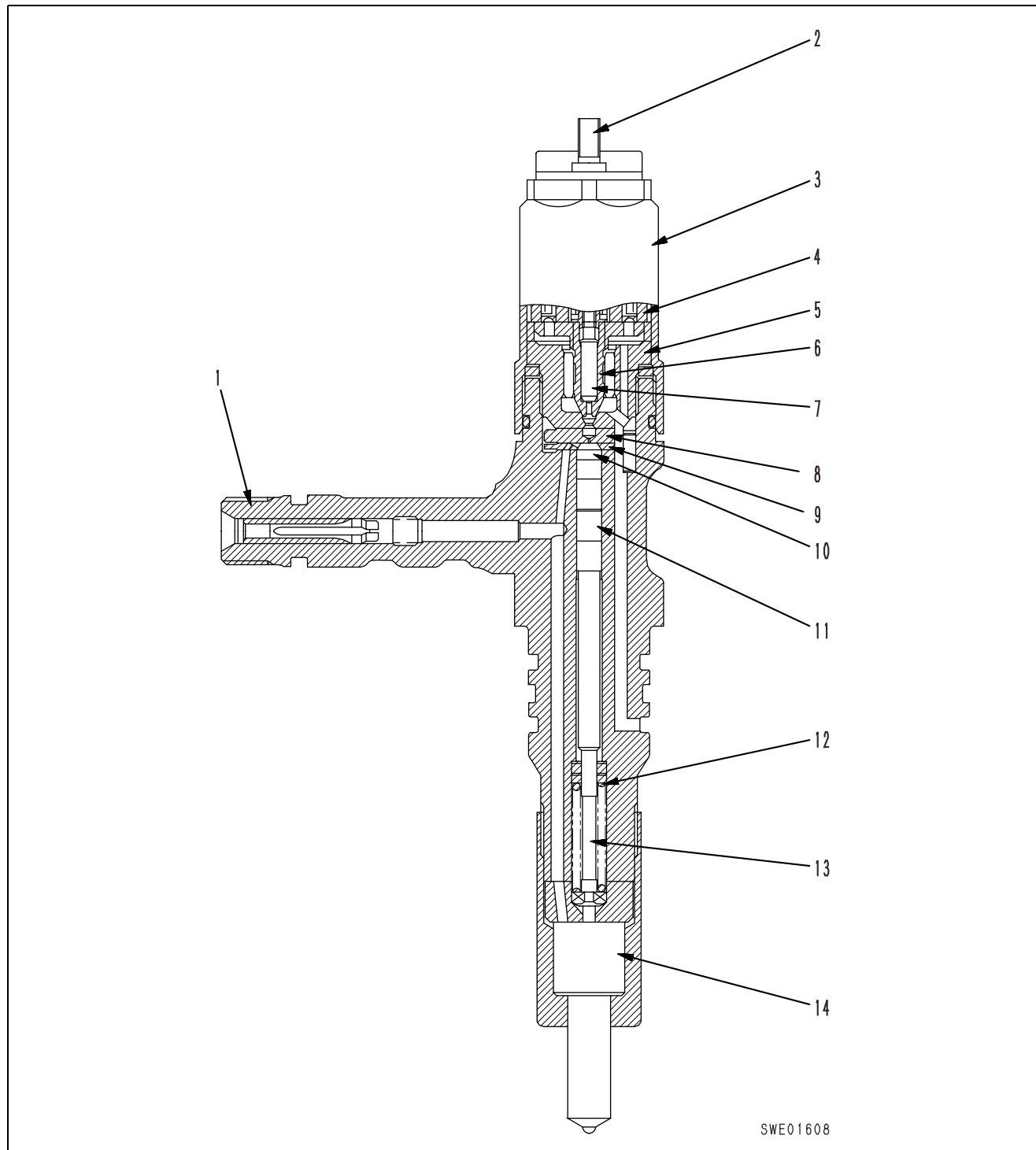
The hydraulic piston transmits force to the needle valve of the nozzle according to the pressure in the control chamber.

The nozzle acts to spray out the fuel.



2) Structure

The injector consists of a conventional nozzle, 2-way electromagnetic valve, hydraulic piston, and orifice which controls the fuel injection ratio.



- 1. Inlet connector
- 2. Terminal
- 3. Upper body
- 4. Solenoid

- 5. Outer body
 - 6. Inner valve
 - 7. Valve body
 - 8. OUT orifice
 - 9. IN orifice
- } Valve assembly

- 10. Control chamber
- 11. Command piston
- 12. Spring
- 13. Pressure pin
- 14. Nozzle assembly

3) Operation

The TWV of the injector is a 2-way valve and consists of inner valve (fixed) (4) and outer valve (variable) (3). It is precisely joined to the same shaft. It forms both the inner and outer seats, and when the TWV is switched ON/OFF, one of the two seats is selected to open.

i) No injection of fuel

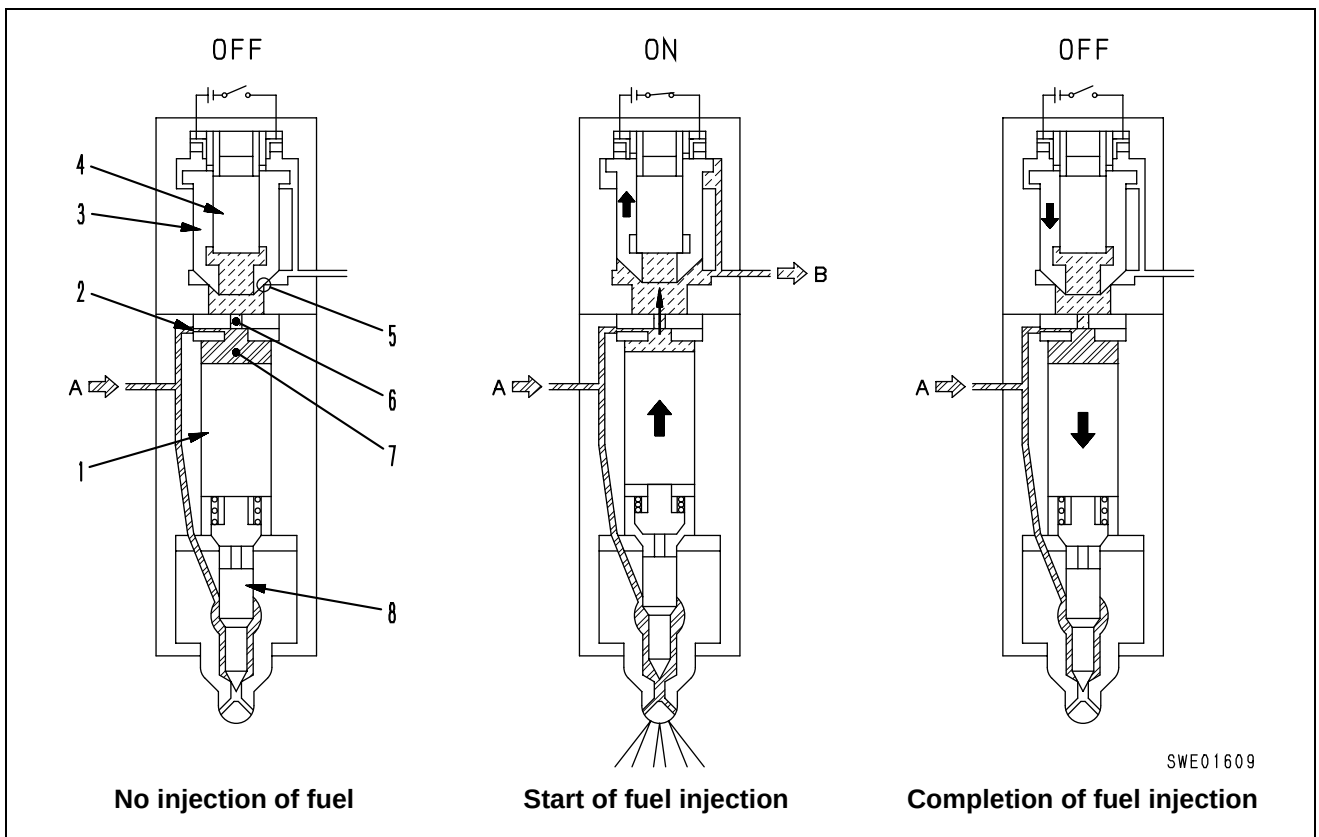
When no electric current is being sent to the solenoid, outer valve (3) is pushed down by the valve spring and the fuel pressure, and outer seat (5) is closed. High pressure from the common rail is applied to control chamber (7), so nozzle (8) is closed and there is no fuel injection.

ii) Start of fuel injection

When electric current starts to flow to the TWV, outer valve (3) is pulled up by the electromagnetic force and outer seat (5) opens. As a result, fuel flows out from the control chamber through orifices (2) and (6), the nozzle needle goes up, and fuel injection starts. Because of the action of orifices (2) and (6), the fuel injection ratio is gradually raised. If electric current continues to be sent, the maximum fuel injection ratio is reached.

iii) Completion of fuel injection

When the flow of electric current to the TWV is stopped, outer valve (3) goes down under the force of the valve spring and the fuel pressure, and outer seat (5) closes. When this happens, the high-pressure fuel in the common rail is suddenly applied to the control chamber, so the nozzle is suddenly closed and a sharp completion of the fuel injection is obtained.

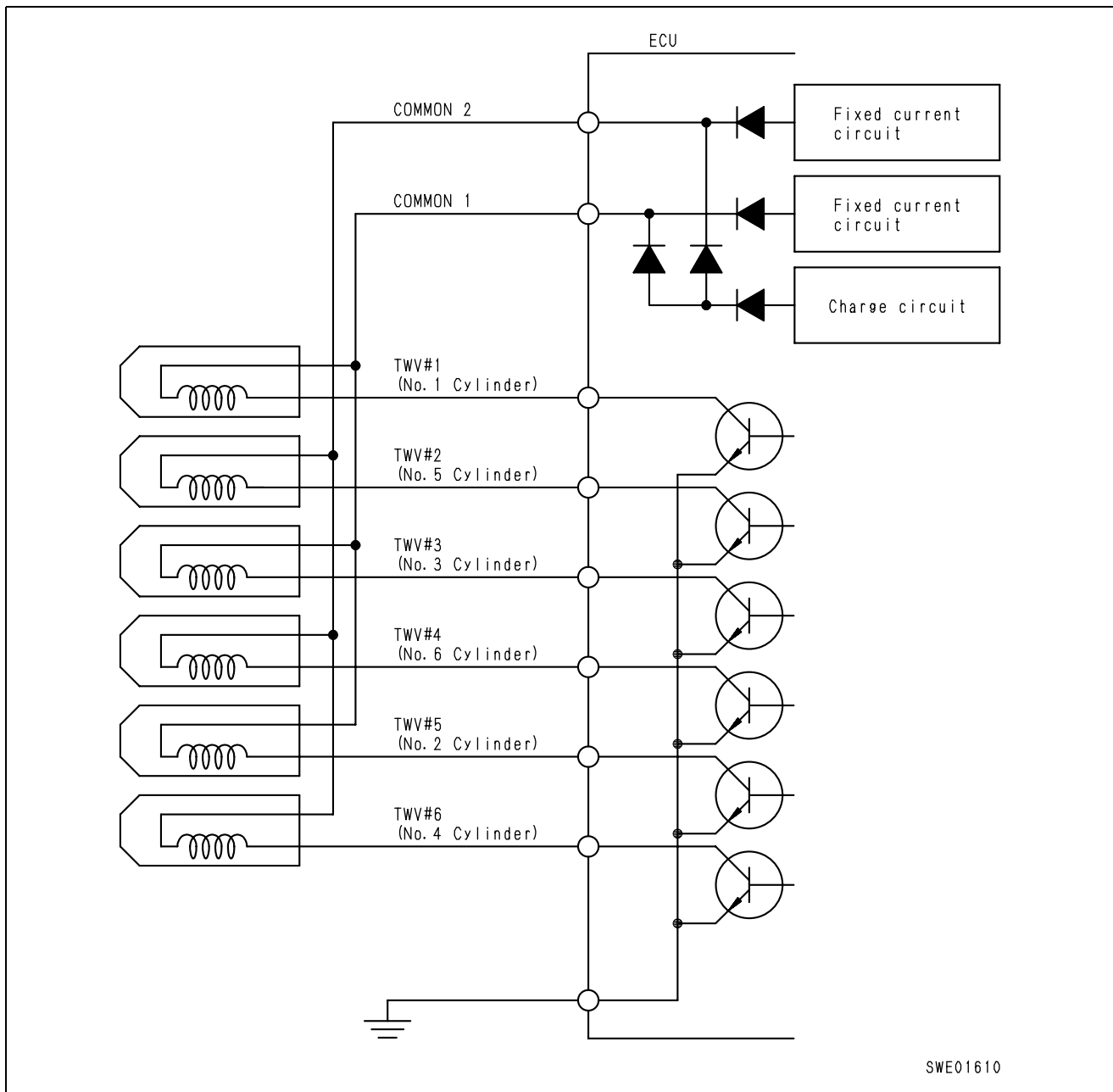


1. Hydraulic piston
2. Orifice 1
3. Outer valve
4. Inner valve
5. Outer seat
6. Orifice 2

7. Control chamber
8. Nozzle

- A.** Common rail (always at high pressure)
(18 to 130MPa{180 to 1,330kg/cm²})
- B.** Leak

4) Electric circuit diagram



⚠ High voltage (118V) is applied to the wiring harnesses connected to the ECU and EDU COMMON1, COMMON2, and TWV #1 to #6, so be careful to avoid electrocution.

4. Sensors and relays

1) NE revolution sensor (crank angle sensor)

When the signal hole in the flywheel passes the sensor, the line of magnetic force passing through the coil changes and an AC voltage is generated in the coil.

Signal holes are provided in the flywheel every 7.5° , but there are 3 places where there is no hole, so there is a total of 45 signal holes. Therefore, for every 2 turns of the engine, 90 pulses are output. From this signal, the engine speed and the crank angle for every 7.5° is detected.

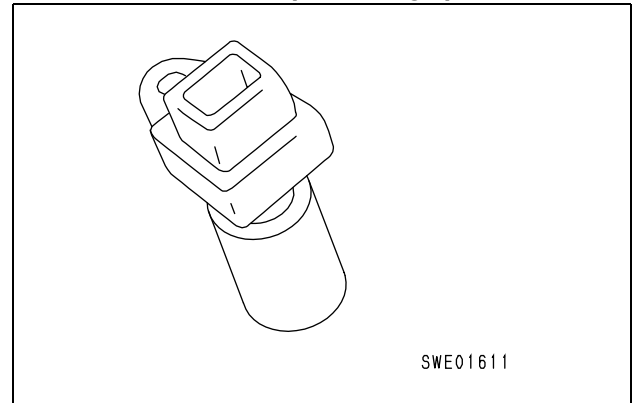
2) G revolution sensor (cylinder judgement sensor)

In the same way as the NE revolution sensor, the change in the line of magnetic force passing through the coil is used to generate an AC voltage.

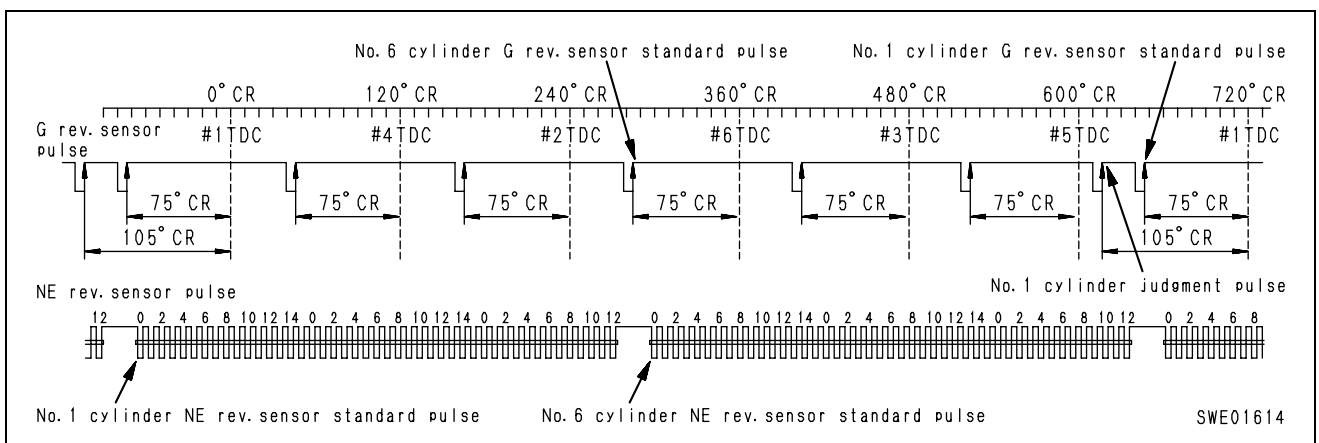
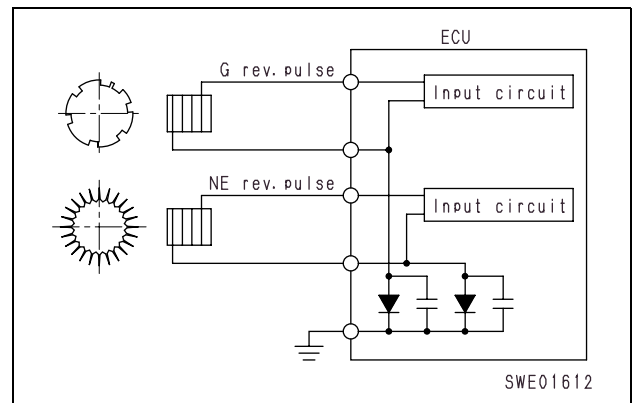
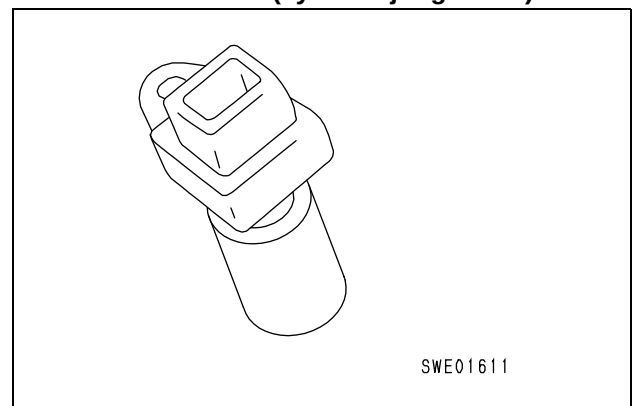
The disc-shaped gear provided in the center of the camshaft of the high-pressure pump has teeth cut (a notch is made) every 120° , and in addition, there is an extra tooth at one point. Therefore, for every 2 turns of the engine, 7 pulses are output.

The combination of the NE revolution sensor pulse and G revolution sensor pulse is recognized as the No. 1 cylinder standard pulse.

NE revolution sensor (crank angle)

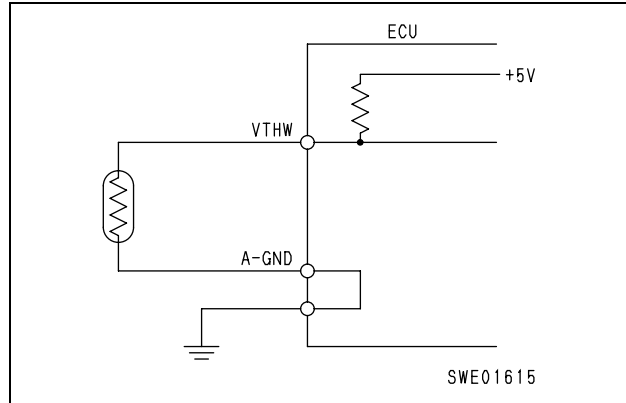


G revolution sensor (cylinder judgement)



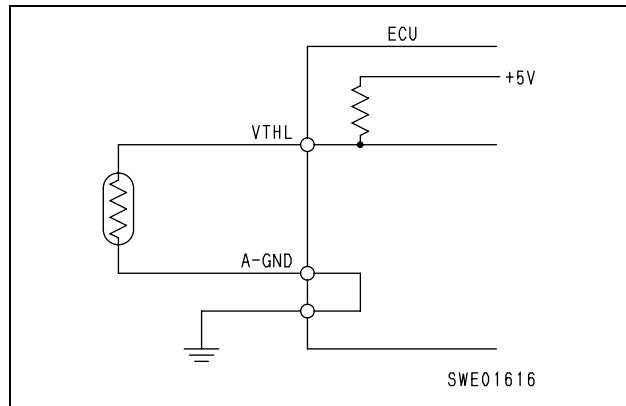
3) Water temperature sensor

The water temperature sensor detects the temperature of the engine cooling water and sends it to the ECU. The sensor uses a thermistor which changes the resistance value according to the temperature. It applies voltage to the thermistor and detects with the voltage divided into the resistance value inside the computer and the resistance value of the thermistor.



4) Fuel temperature sensor

The fuel temperature sensor detects the temperature of the fuel and sends it to the ECU. The sensor uses a thermistor which changes the resistance value according to the temperature. It applies voltage to the thermistor and detects with the voltage divided into the resistance value inside the computer and the resistance value of the thermistor.



Controls

The CRI system control of the fuel injection amount and fuel injection timing is carried out more suitably than on the mechanical governor and timer used in conventional fuel injection pumps.

The system control carries out the necessary calculation in the ECU from the signal from the sensors installed to the engine and machine, and controls the timing and length of time that electricity is sent to the injector so that it can carry out the optimum fuel injection at the optimum fuel injection timing.

1. Control function for fuel injection amount

The function to control the fuel injection amount replaces the conventional function of the governor. It functions to control the fuel injection so that the optimum fuel injection amount is injected, based on the signal from the engine speed and accelerator angle.

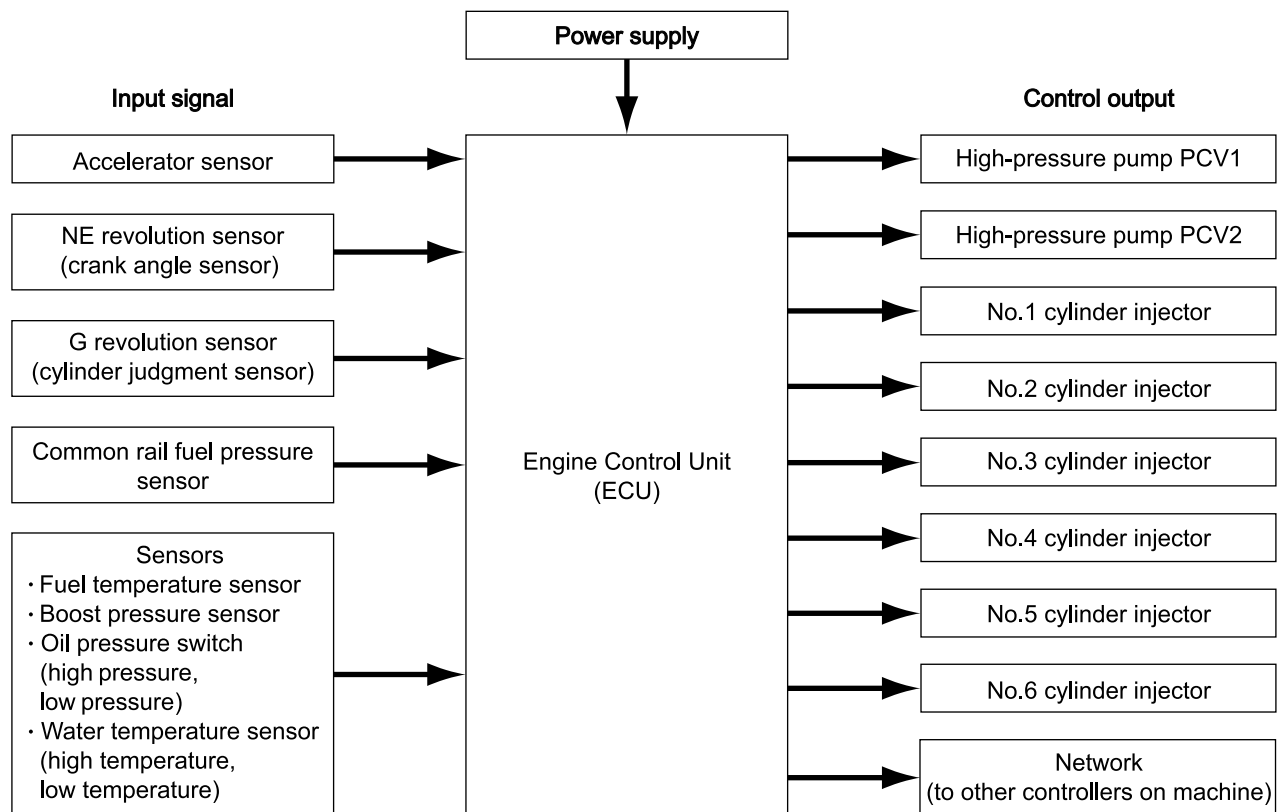
2. Control function for fuel injection timing

The function to control the fuel injection timing replaces the conventional function of the timer. It functions to control the fuel injection so that the optimum fuel injection timing is carried out, based on the signal from the engine speed and fuel injection amount.

3. Control function for fuel injection pressure (common rail fuel pressure control function)

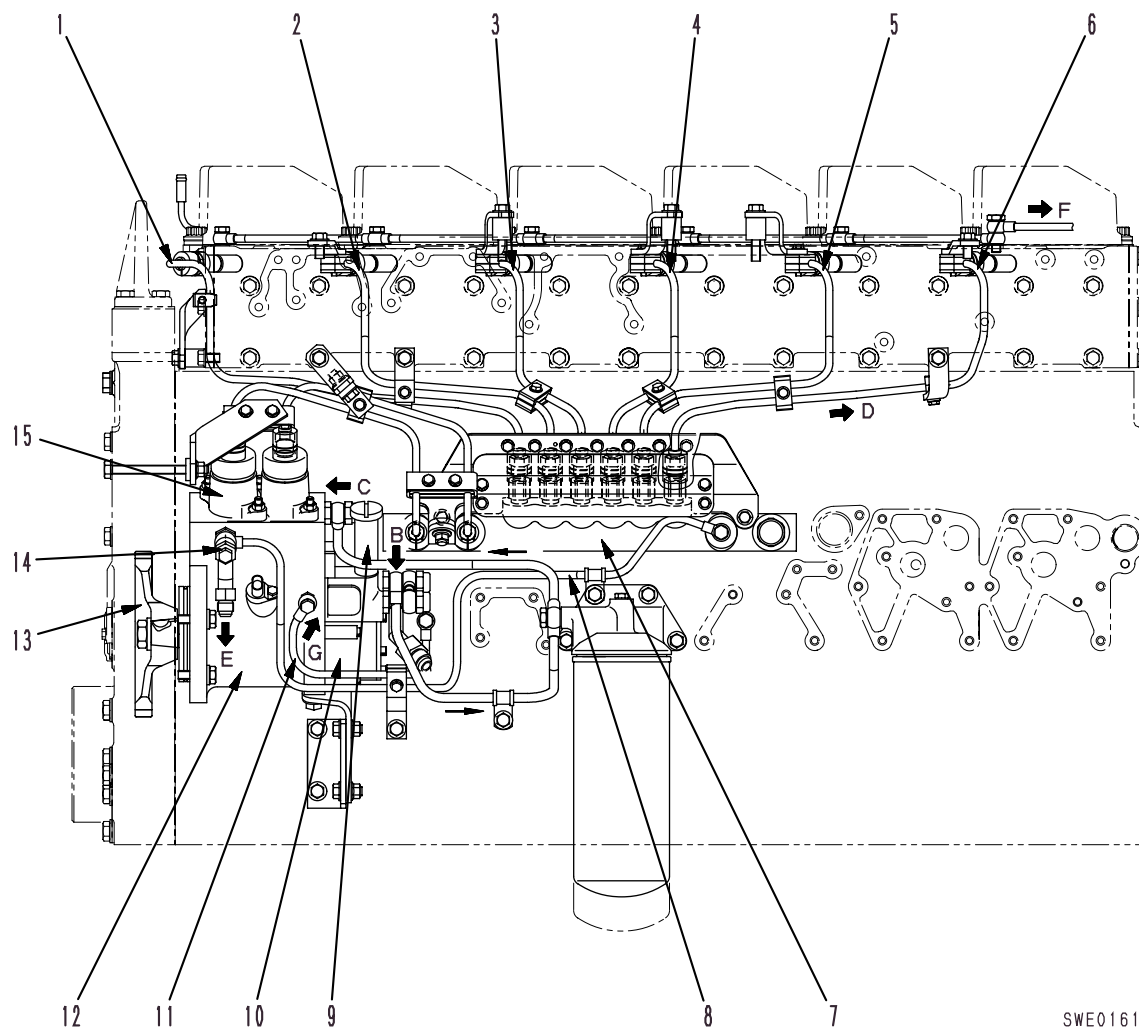
The function to control the fuel injection pressure (common rail fuel pressure control function) measures the fuel pressure with the common rail fuel pressure sensor. This function feeds back to the ECU and controls the amount of fuel discharged from the fuel supply pump.

It controls the pressure feedback so that it matches the optimum value (command value) set according to the engine speed and fuel injection amount.



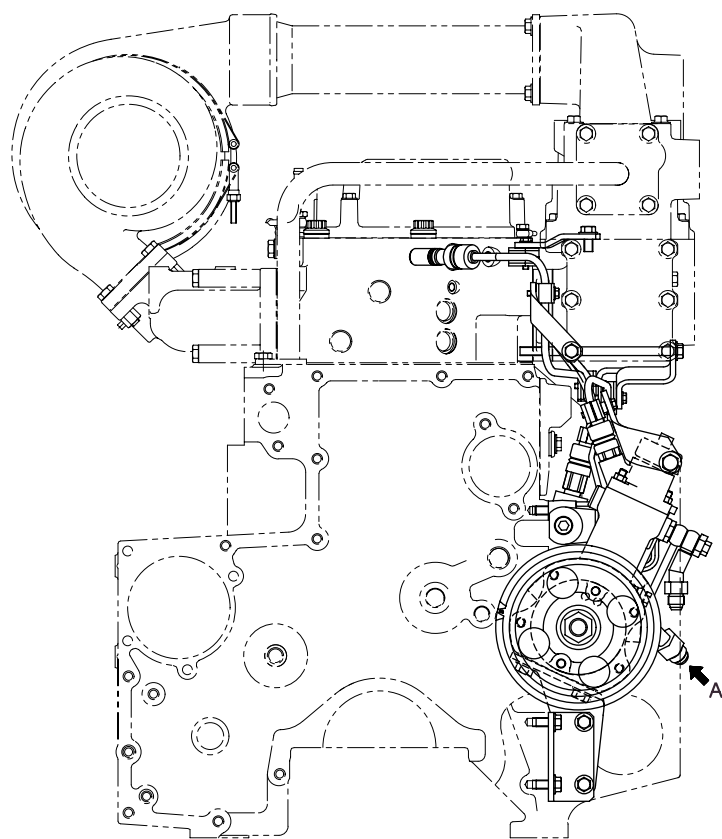
FUEL PIPING

★ The shape may differ according to the machine model.



SWE01617

- | | |
|---|--|
| 1. Fuel injection pipe (No. 1 cylinder) | 9. Priming pump |
| 2. Fuel injection pipe (No. 2 cylinder) | 10. Feed pump |
| 3. Fuel injection pipe (No. 3 cylinder) | 11. Oil inlet pipe (for pump lubrication oil) |
| 4. Fuel injection pipe (No. 4 cylinder) | 12. High-pressure pump |
| 5. Fuel injection pipe (No. 5 cylinder) | 13. Fuel supply pump drive gear (No. of teeth: 48) |
| 6. Fuel injection pipe (No. 6 cylinder) | 14. Overflow valve |
| 7. Common rail | 15. PCV |
| 8. Fuel return pipe | |



SWE01618

- A. Fuel inlet
- B. To fuel filter
- C. From fuel filter
- D. To injector
- E. Fuel return (between overflow valve and fuel tank)
- F. Fuel return (between injector and fuel tank)
- G. Engine oil (to fuel supply pump)

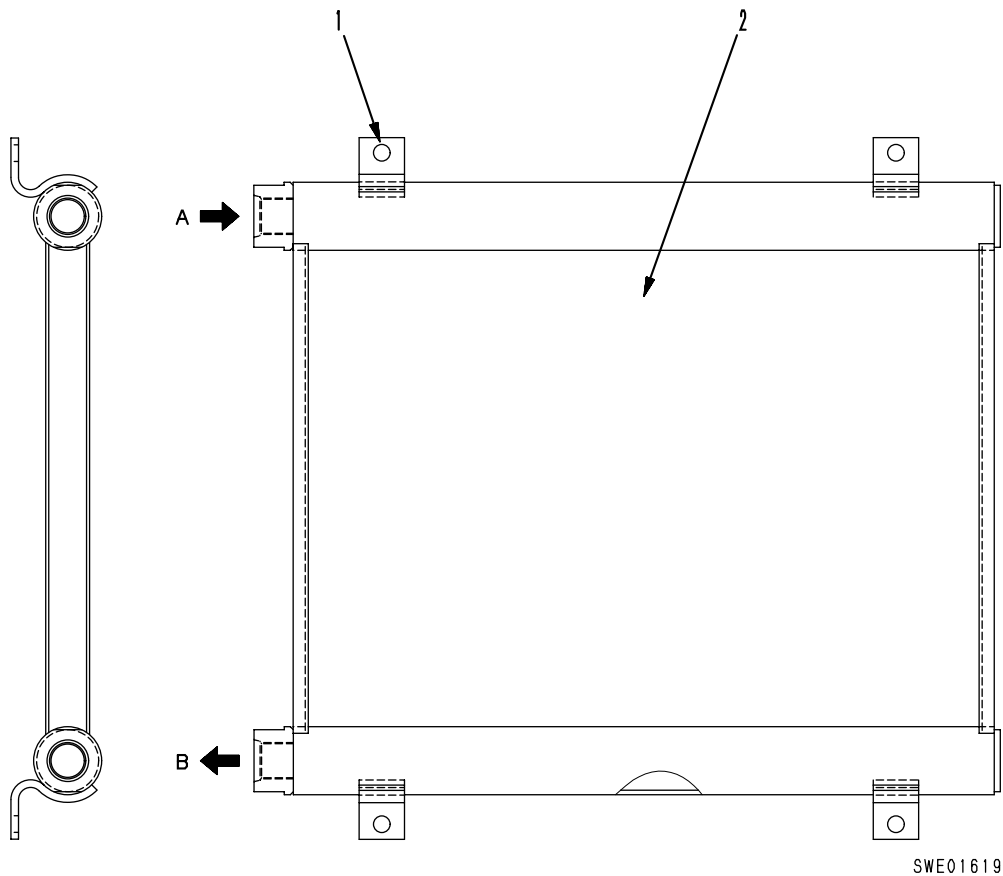
Specifications

Fuel supply pump

- Maker: Nihon Denso
- Type: Denso ECD-U2
- Lubrication method: Forced lubrication using engine oil

FUEL COOLER

★ The shape may differ according to the machine model.



- 1. Mount bracket
- 2. Core

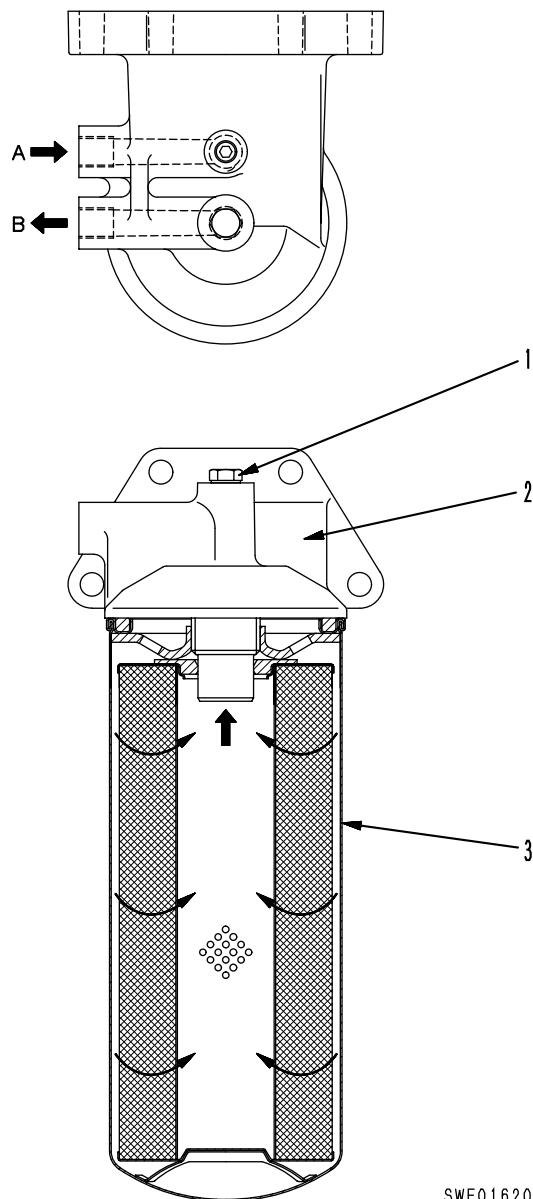
- A. From fuel tank
- B. To fuel supply pump

Specifications

- Cooling method: Air cooled
- Core type: AL-CFT-1
- Heat dissipation surface: 3.31m²

FUEL FILTER

★ The shape may differ according to the machine model.

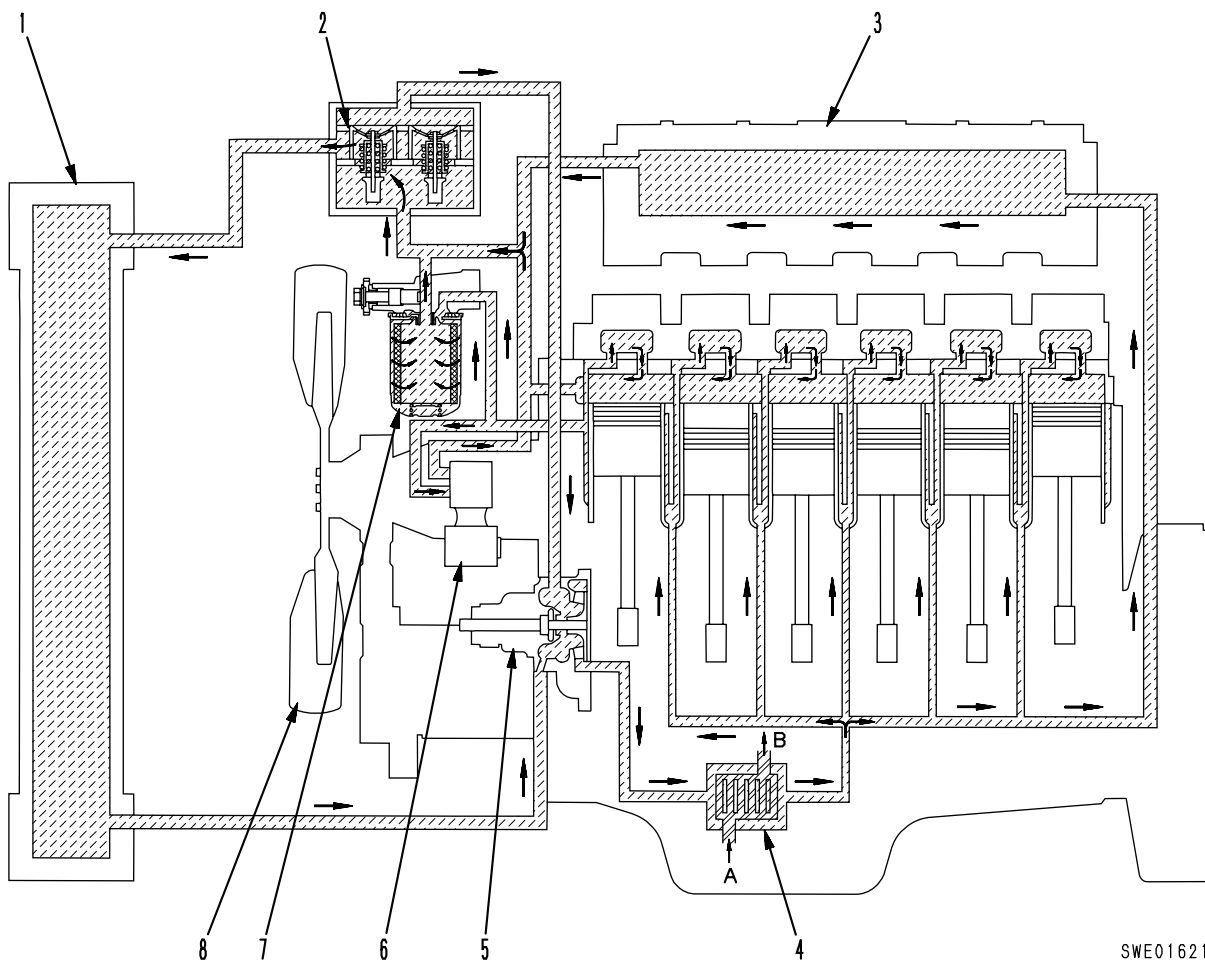


Specifications

- Filtering area: 1.0 m²

COOLING SYSTEM DIAGRAM

SA6D140E-3 (for construction equipment, generators)

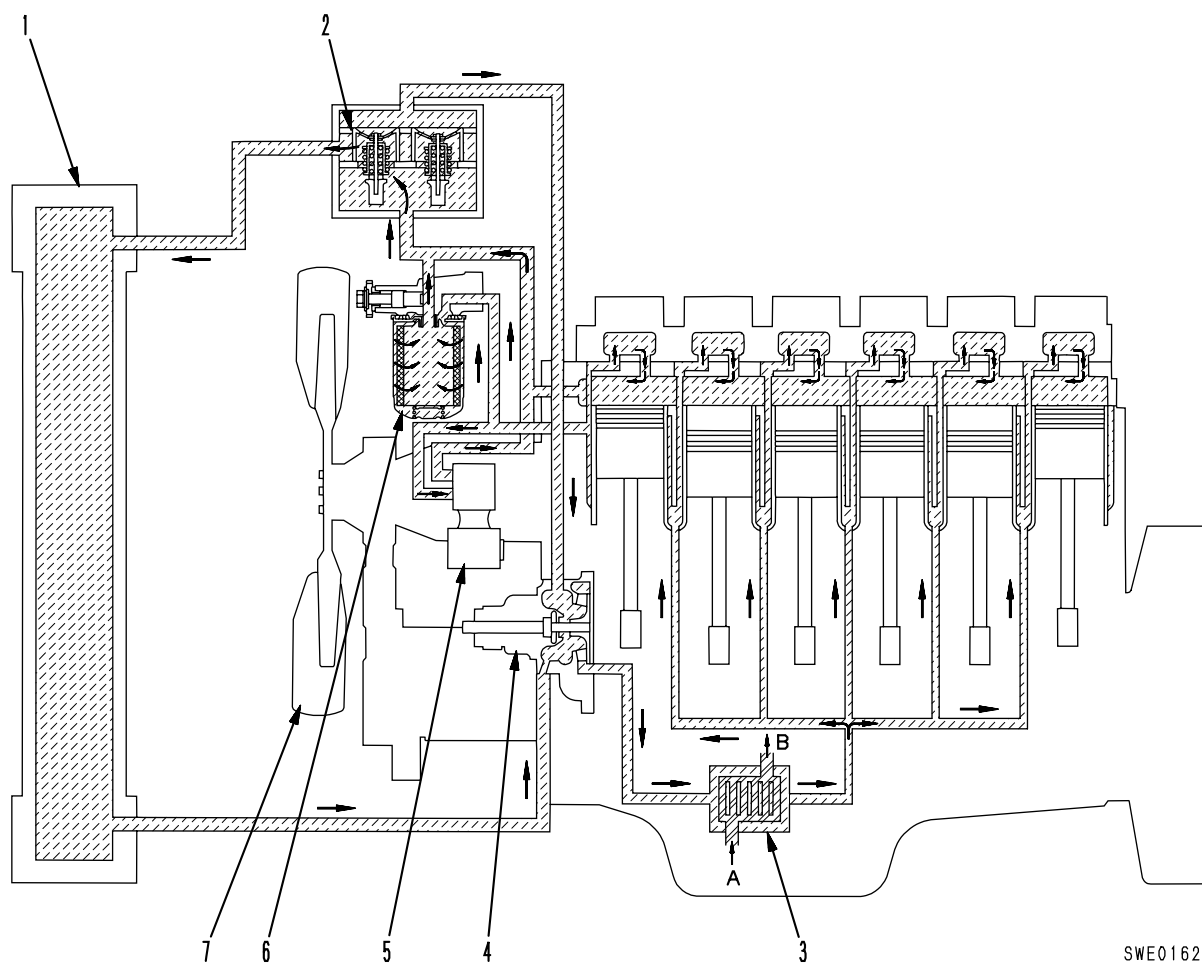


SWE01621

1. Radiator
2. Thermostat
3. Water-cooled aftercooler
4. Oil cooler
5. Water pump
6. Air compressor
7. Corrosion resistor
8. Cooling fan

- A. Oil inlet
B. Oil outlet

SAA6D140E-3 (for construction equipment, generators)

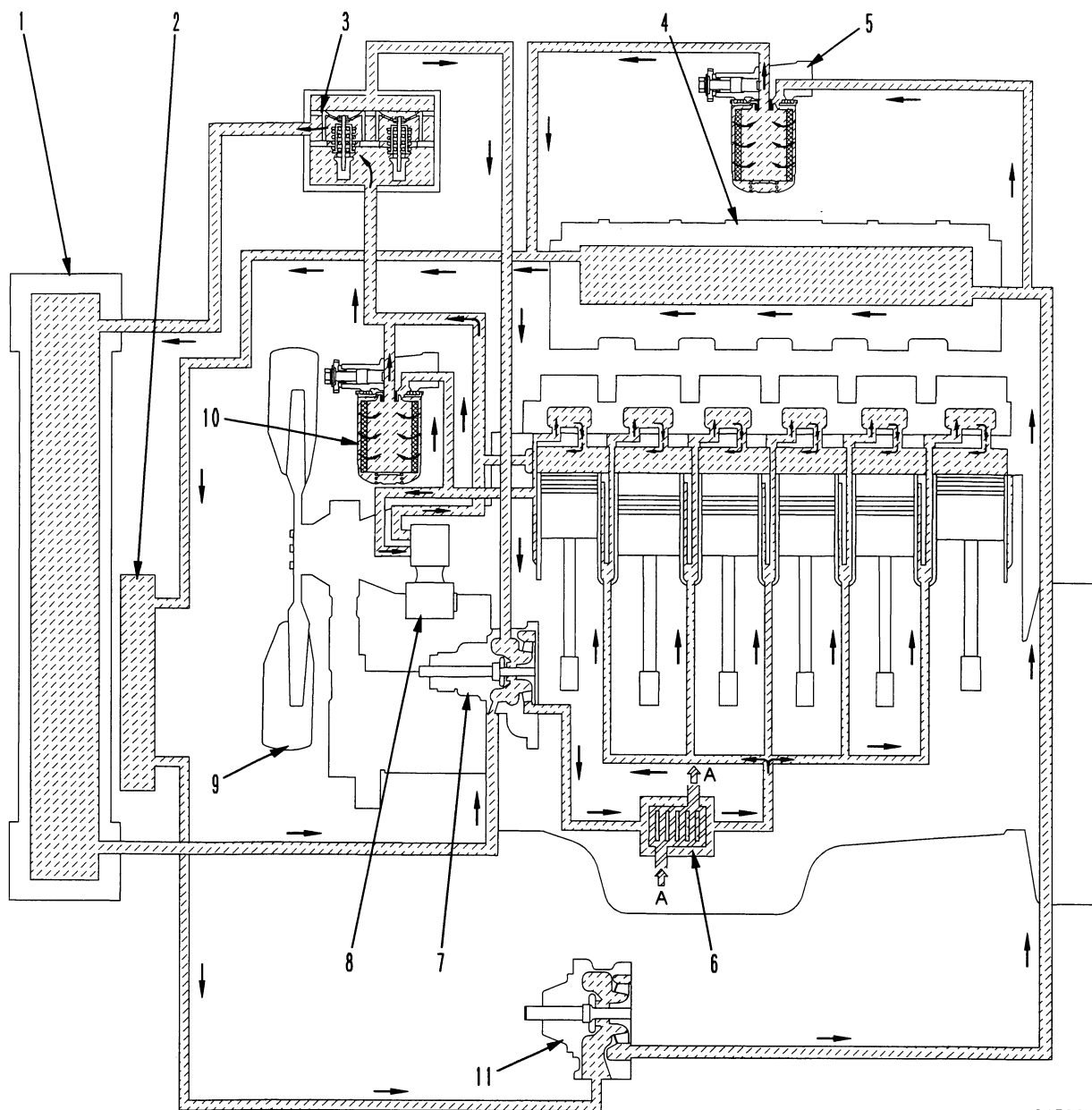


SWE01622

1. Radiator
2. Thermostat
3. Oil cooler
4. Water pump
5. Air compressor
6. Corrosion resistor
7. Cooling fan

- A. Oil inlet
B. Oil outlet

SDA6D140E-3



SJE02143

1. Radiator
2. Radiator (for aftercooler cooling circuit)
3. Thermostat
4. Water-cooled aftercooler
5. Corrosion resistor
6. Oil cooler
7. Water pump
8. Air compressor
9. Cooling fan
10. Corrosion resistor (for aftercooler cooling circuit)
11. Water pump (for aftercooler cooling circuit)

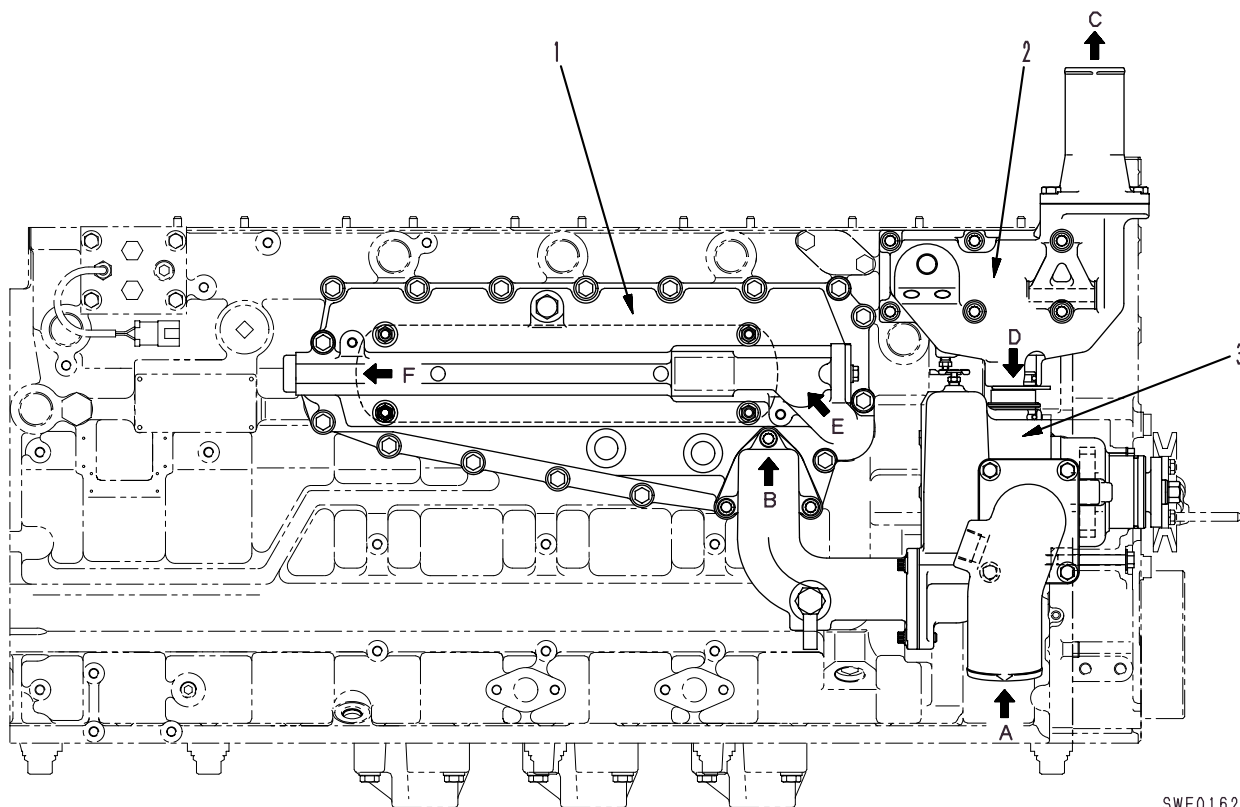
A. Oil inlet and outlet

WATER PUMP

MOUNT

SA6D140E-3
SAA6D140E-3

- ★ The diagram shows the equipment for the PC600-6.
- ★ The shape may differ according to the machine model.



SWE01623

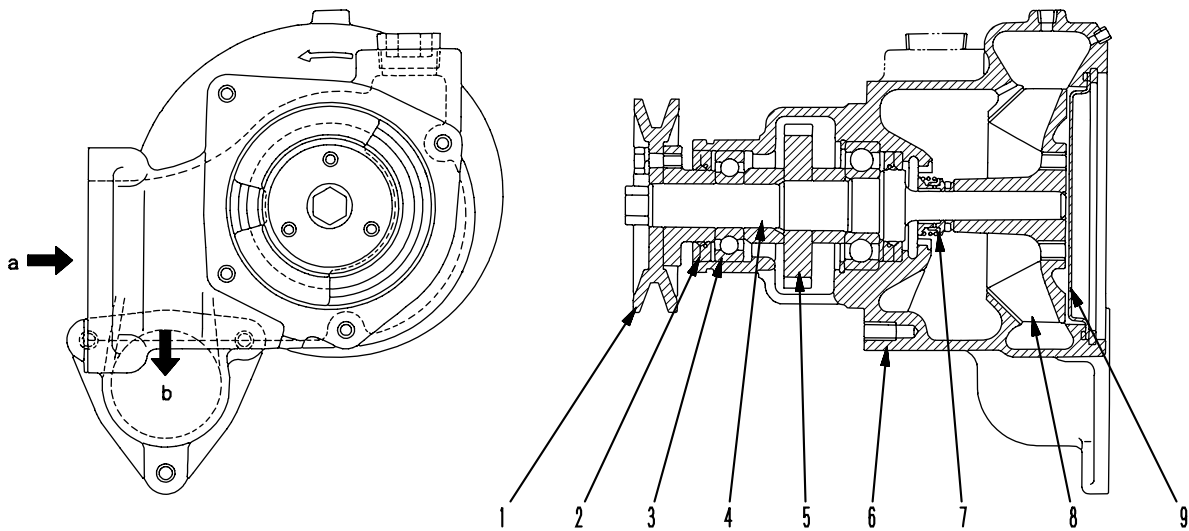
1. Oil cooler
2. Thermostat housing
3. Water pump

- A. From radiator outlet (cooling water)
From heat exchanger outlet (for marine use)
- B. To engine through oil cooler (cooling water)
- C. To radiator inlet (cooling water)
To heat exchanger (for marine use)
- D. From thermostat (cooling water)
- E. From oil pump (oil)
- F. To all parts of engine (oil)

WATER PUMP

SA6D140E-3
SAA6D140E-3

★ The shape may differ according to the machine model.



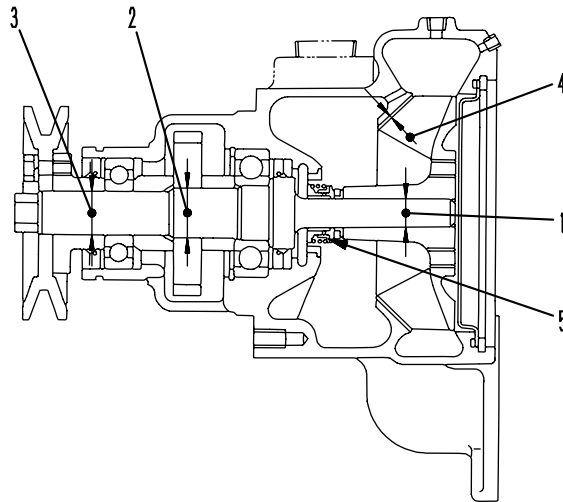
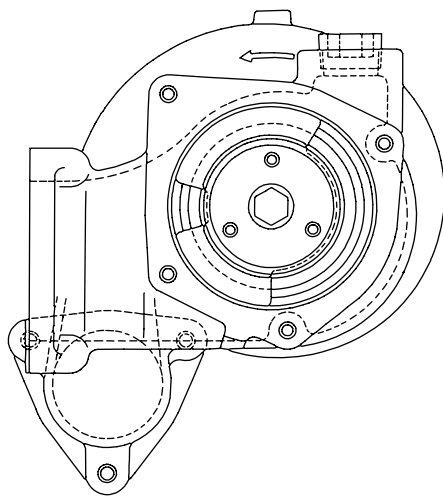
SEE00474

1. Pulley for alternator drive
2. Oil seal
3. Ball bearing
4. Pump shaft
5. Water pump drive gear (No. of teeth: 23)
6. Pump body
7. Water seal
8. Impeller
9. Pump cover

- a. From radiator
- b. To oil cooler

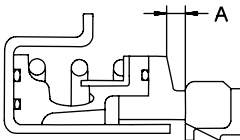
Specifications

Type: Centrifugal type, gear driven
Speed: Engine speed x 1.56
Water flow: 800 ℓ/min
Overall lifting height: 14 m



SEE00525

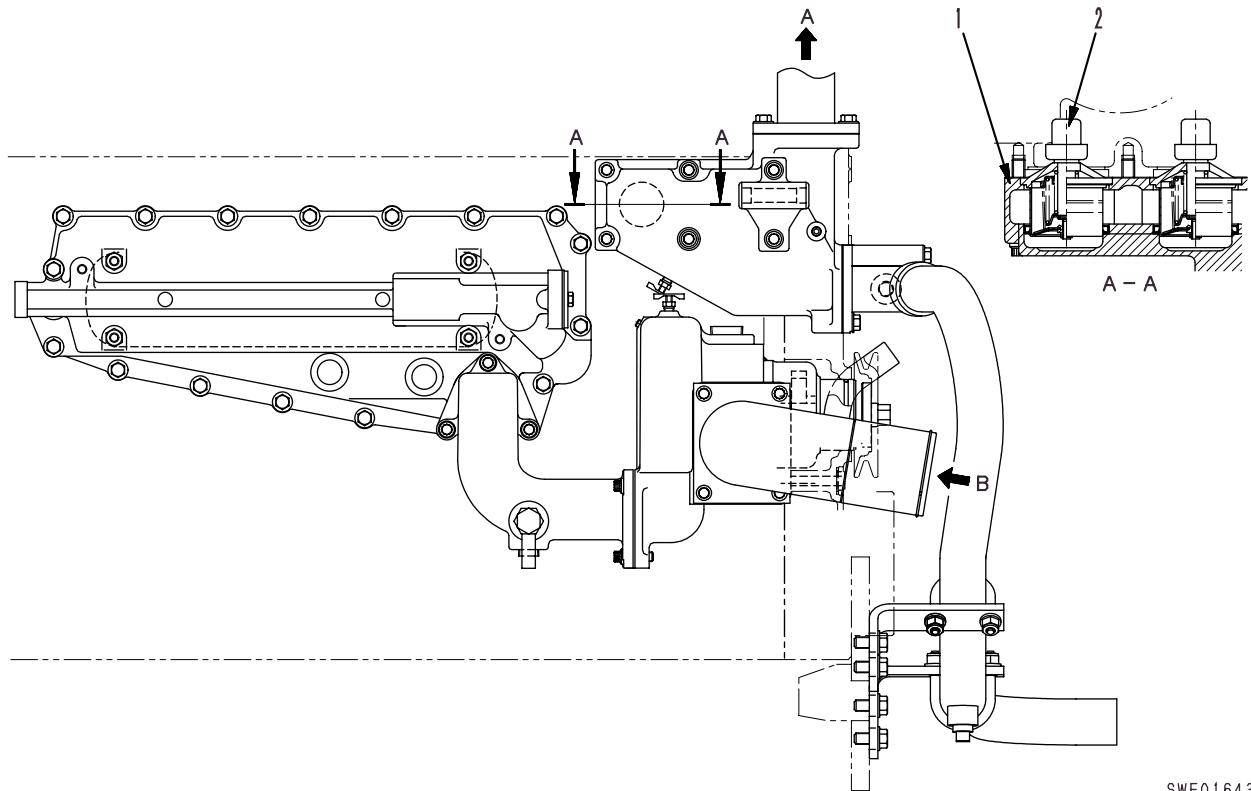
Unit: mm

No.	Check item	Criteria				Remedy
1	Interference between impeller and shaft	Standard size	Tolerance		Standard interference	Replace
			Shaft	Hole		
		16	-0.082 -0.095	-0.020 -0.150	0.025 – 0.068	
2	Interference between drive gear and shaft	28	+0.015 +0.002	-0.023 -0.053	0.025 – 0.068	
3	Interference between pulley flange and shaft	25	+0.015 +0.002	-0.021 -0.041	0.025 – 0.056	
4	Clearance between impeller and body	Standard clearance: 0.6 – 0.9 (Including end play)				
5	Abrasion of seal ring in water seal	 Repair limit A: 1.5 SEE00524				

SEE00524

THERMOSTAT

★ The shape may differ according to the machine model.



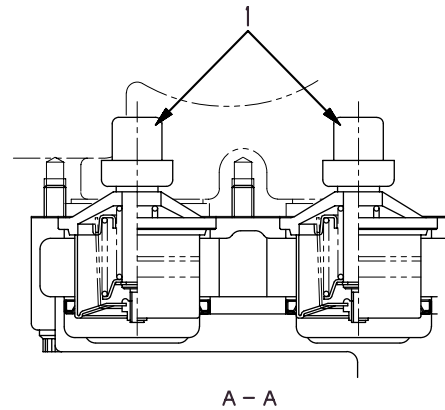
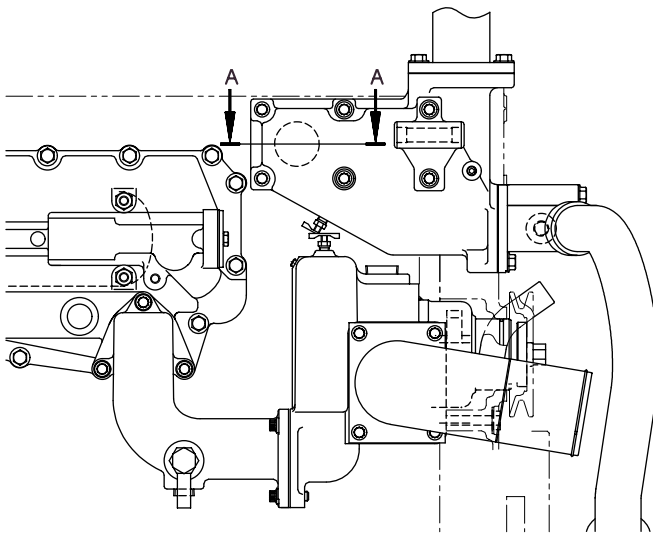
SWE01643

1. Thermostat housing
2. Thermostat

- A. To radiator
- B. To water pump
From brake cooler (HD325-6)
From machine oil cooler (D155AX-5)

Specifications

Cracking temperature: $76.5 \pm 2^{\circ}\text{C}$
Fully open temperature: 90°C
Full open lift: Min. 10 mm



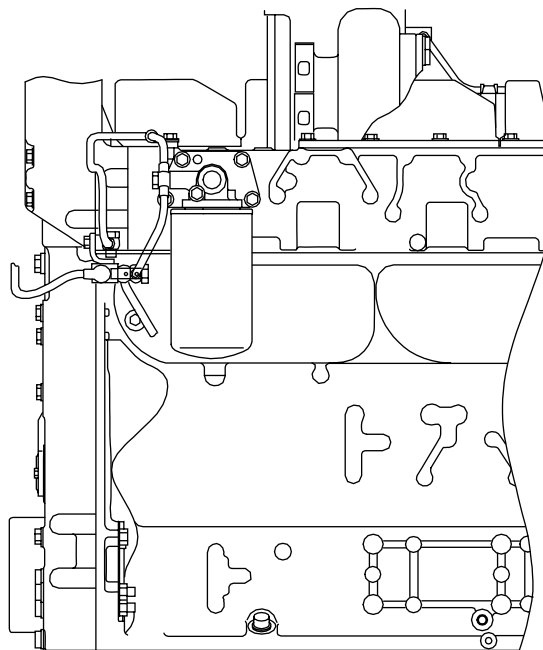
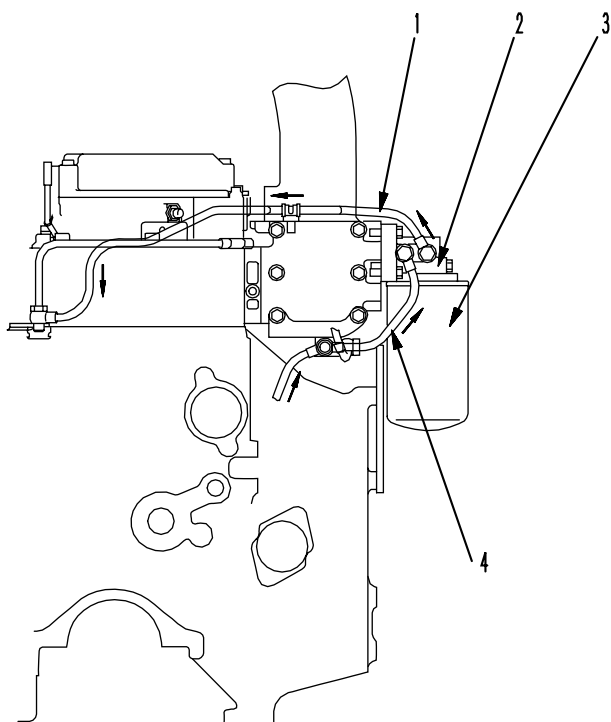
SWE01656

			Unit: mm
No.	Check item	Criteria	Remedy
1	Lift of thermostat to fully open position	Min 9mm (soak the valve in oil bath at 90°C for 4 to 5 minutes to check)	Replace
	Opening/closing of thermostat	Check that the valve closes fully when the water temperature has gone down to 76.5°C from 90°C when the valve was fully open. (Soak the valve in a water bath for 4 to 5 minutes to check)	

CORROSION RESISTOR

MOUNT

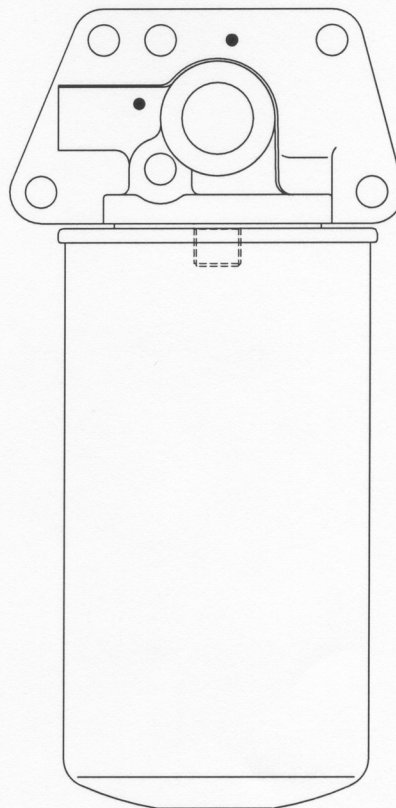
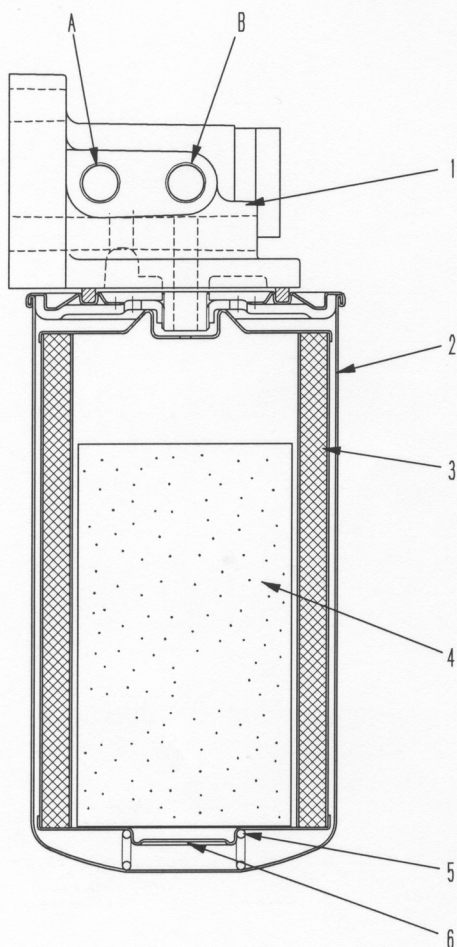
★ The shape may differ according to the machine model.



SWE01624

1. Tube (return from corrosion resistor)
2. Corrosion resistor head
3. Corrosion resistor cartridge
4. Tube (to corrosion resistor)

★ The shape may differ according to the machine model.



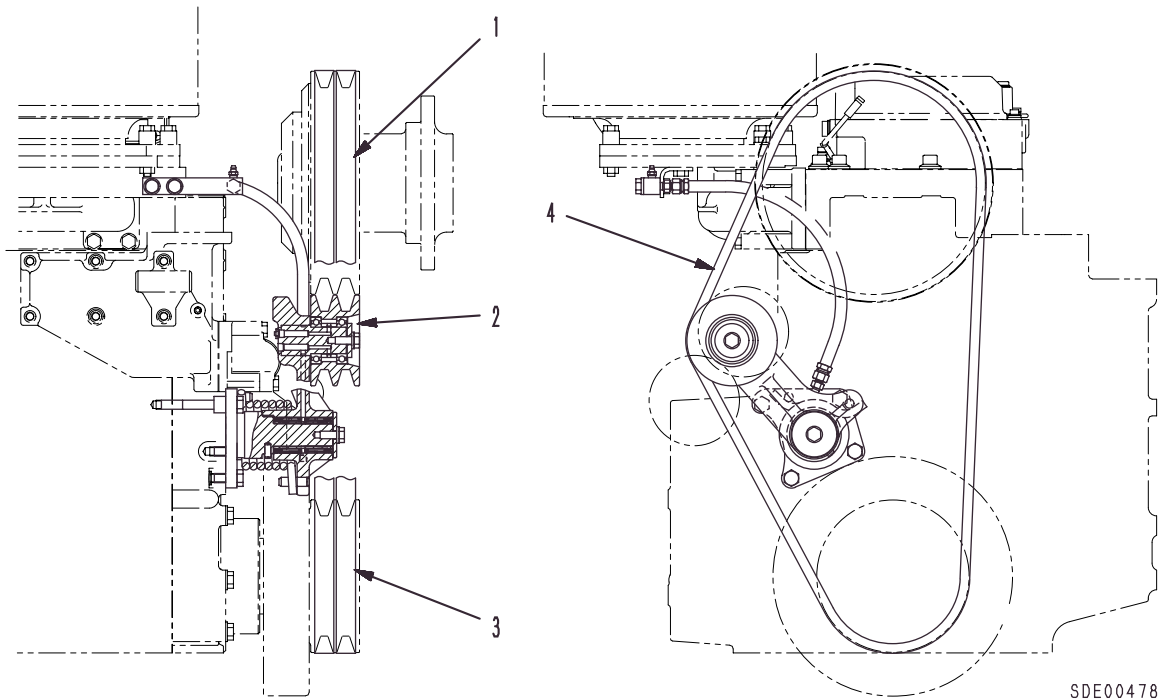
- SA6D140E-3 :
 - 400g (PC600-6)
 - 600g (D155AX-5, WA500-3, CS360-2)
- SAA6D140E-3:
 - 600g (HM350-1, HM400-1, D275A-5, D275AX-5)
 - 1,000g (HD325-6, DCA400SSK, PC750-6, PC750-7, PC800-6, PC800-7, PC1800-6)

COOLING FAN DRIVE

MOUNT (AUTO-TENSION TYPE)

★ The shape may differ according to the machine model.

SA6D140E-3



SDE00478

1. Fan pulley
2. Tension pulley
3. Crankshaft pulley
4. Fan belt

Outside diameter of pulley

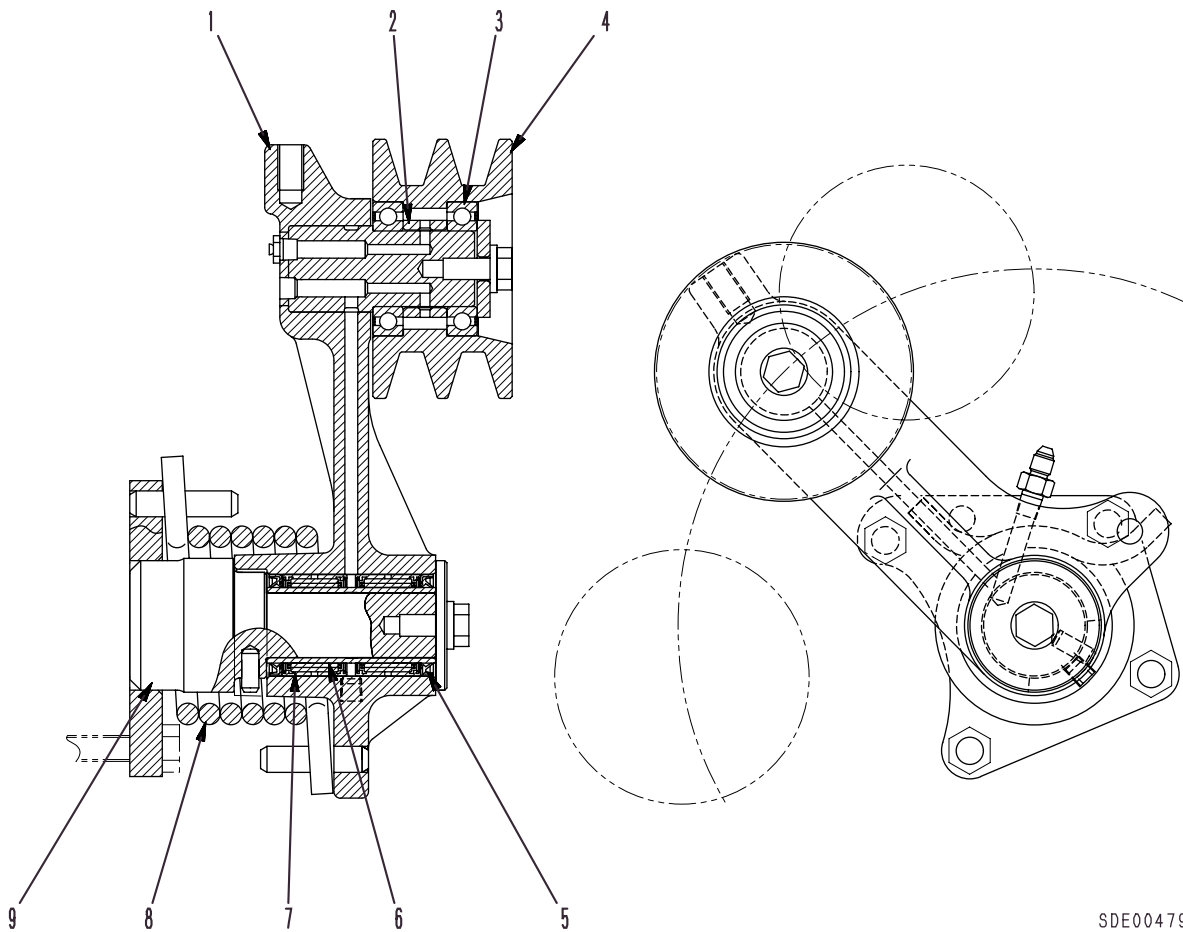
Unit: mm

Engine	Machine model	Crankshaft pulley	Fan pulley	Tension pulley
SA6D140E-3	D155AX-5 (Standard) (110001 – 112349)	200	293	120
	D155AX-5 (Scraper specification) (110001 – 112349)	200	314	120

TENSION PULLEY

★ The shape may differ according to the machine model.

SA6D140E-3 (D155AX-5) (110001 – 112349)



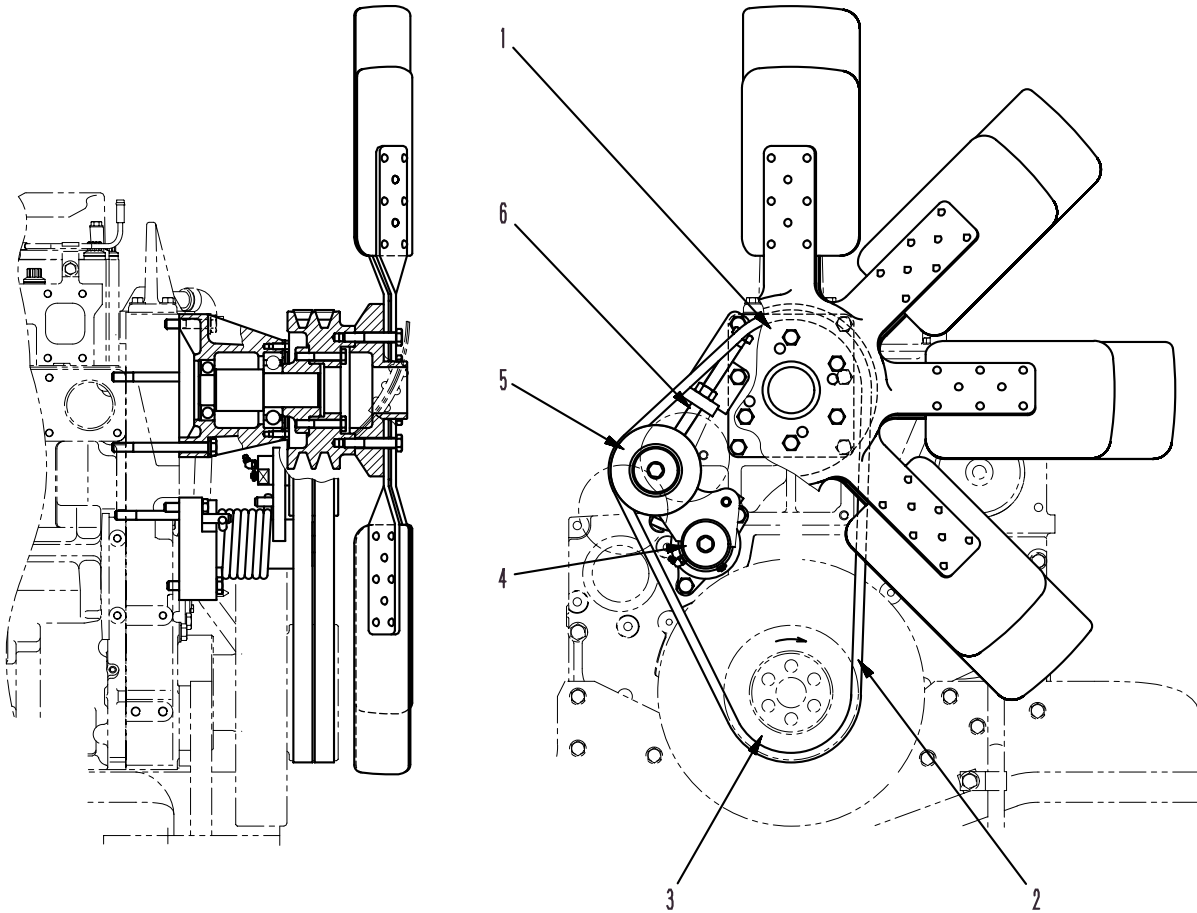
SDE00479

1. Bracket
2. Spacer
3. Ball bearing
4. Tension pulley
5. Oil seal
6. Inner race
7. Needle bearing
8. Coil spring
9. Tension shaft

MOUNT (AUTO-TENSION TYPE)

★ The shape may differ according to the machine model.

SA6D140E-3



SXE01627

1. Fan pulley
2. Fan belt
3. Crankshaft pulley
4. Tension shaft
5. Tension pulley
6. Adjustment bolt

Outside diameter of pulley

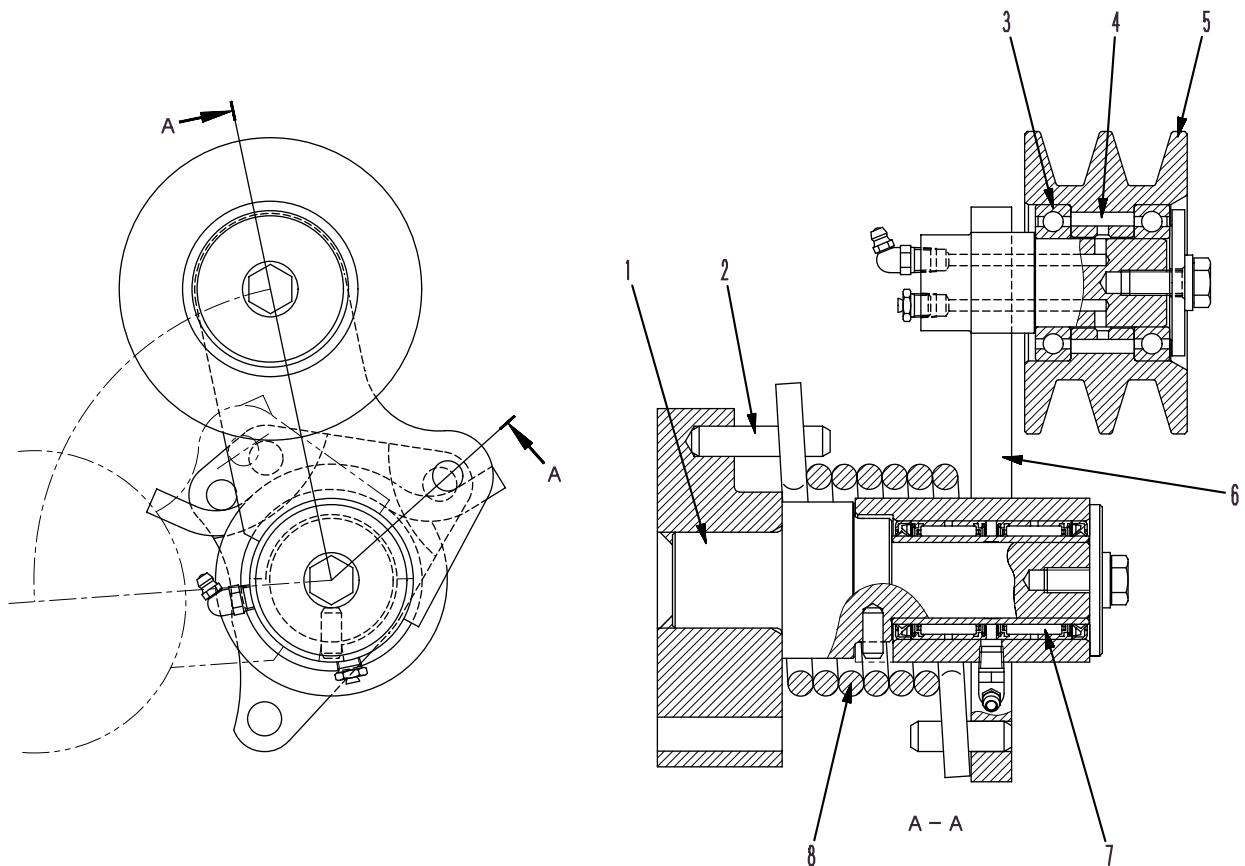
Unit: mm

Engine	Machine model	Crankshaft pulley	Fan pulley	Tension pulley
SA6D140E-3	PC600-6	180	208	120

TENSION PULLEY

SA6D140E-3 (PC600-6)

★ The shape may differ according to the machine model.



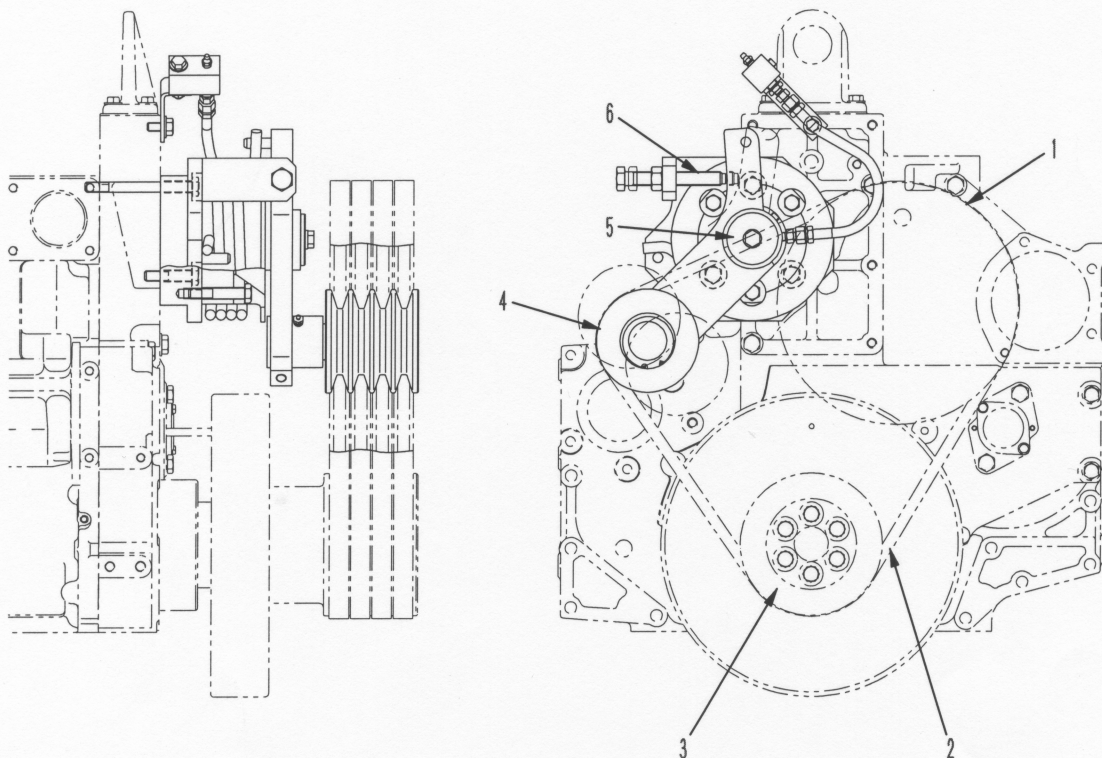
SWE01628

1. Tension shaft
2. Stopper pin
3. Ball bearing
4. Spacer
5. Tension pulley
6. Tension bracket
7. Roller bearing
8. Spring

MOUNT (AUTO-TENSION TYPE)

★ The shape may differ according to the machine model.

SAA6D140E-3



SJE01876

1. Fan pulley
2. Fan belt
3. Crankshaft pulley
4. Tension pulley
5. Tension shaft
6. Adjustment bolt

Outside diameter of pulley

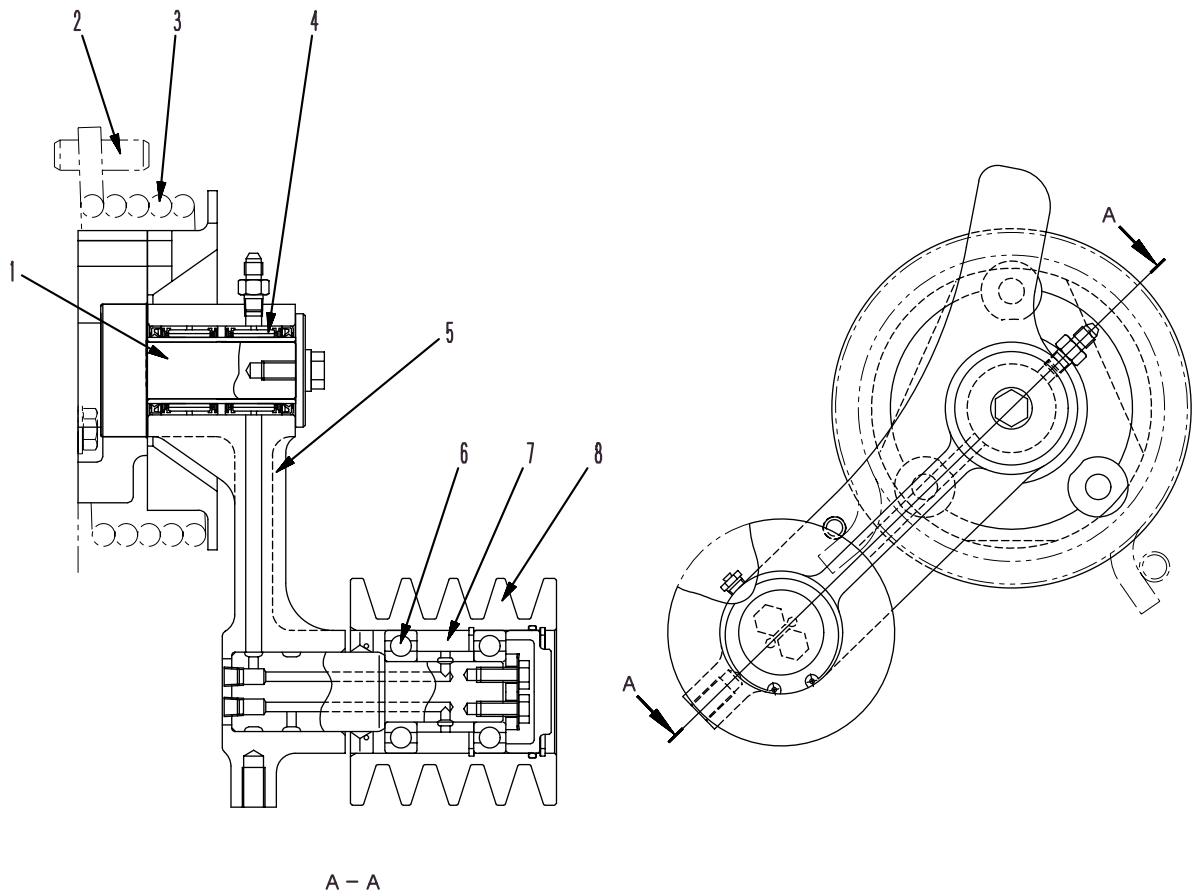
Unit: mm

Engine	Machine model	Crankshaft pulley	Fan pulley	Tension pulley
SAA6D140E-3	PC750, 750LC-6, PC750-7 PC800-6, PC800-7	174	282	120
	PC1800-6	166	282	120

TENSION PULLEY

★ The shape may differ according to the machine model.

SAA6D140E-3 (PC750, 750LC-6, PC800-6)



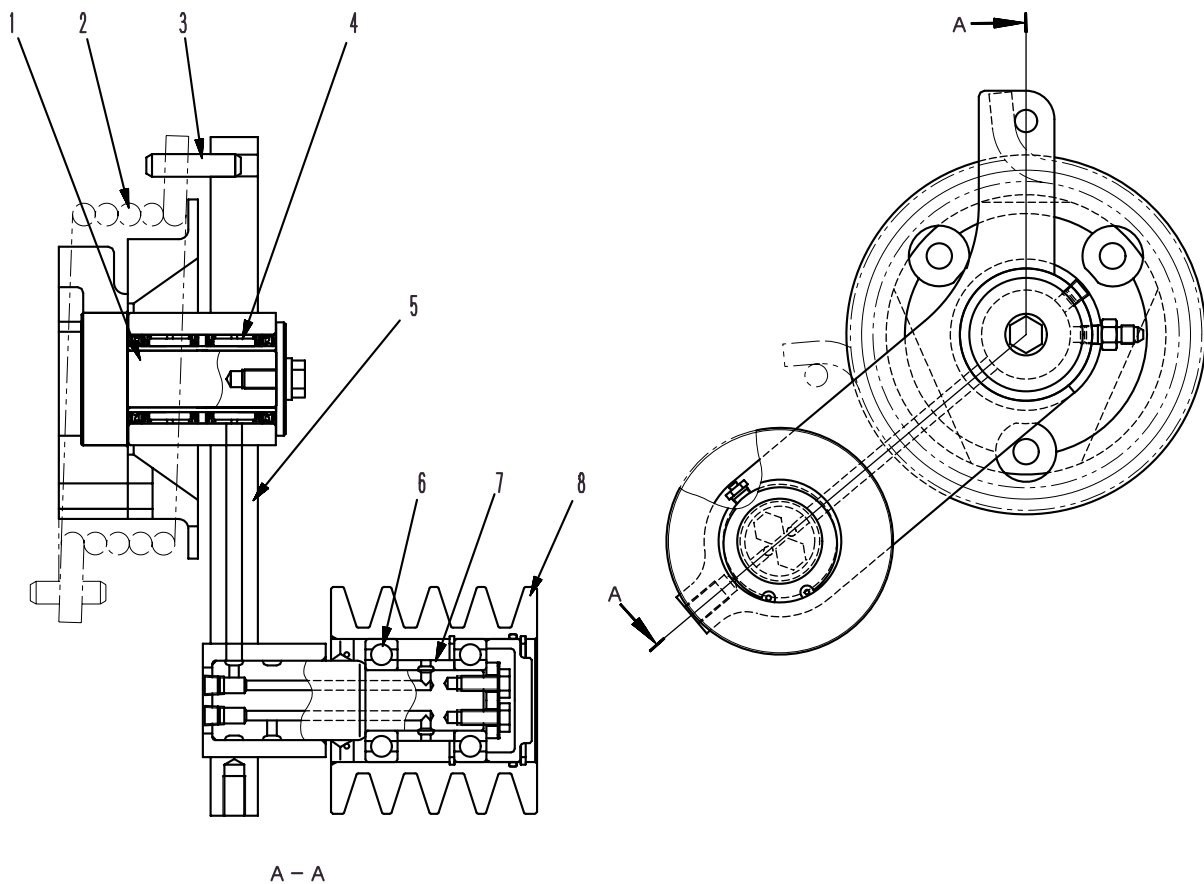
SJE01877

1. Tension shaft
2. Stopper pin
3. Spring
4. Roller bearing
5. Tension bracket
6. Ball bearing
7. Spacer
8. Tension pulley

TENSION PULLEY

★ The shape may differ according to the machine model.

SAA6D140E-3 (PC1800-6)



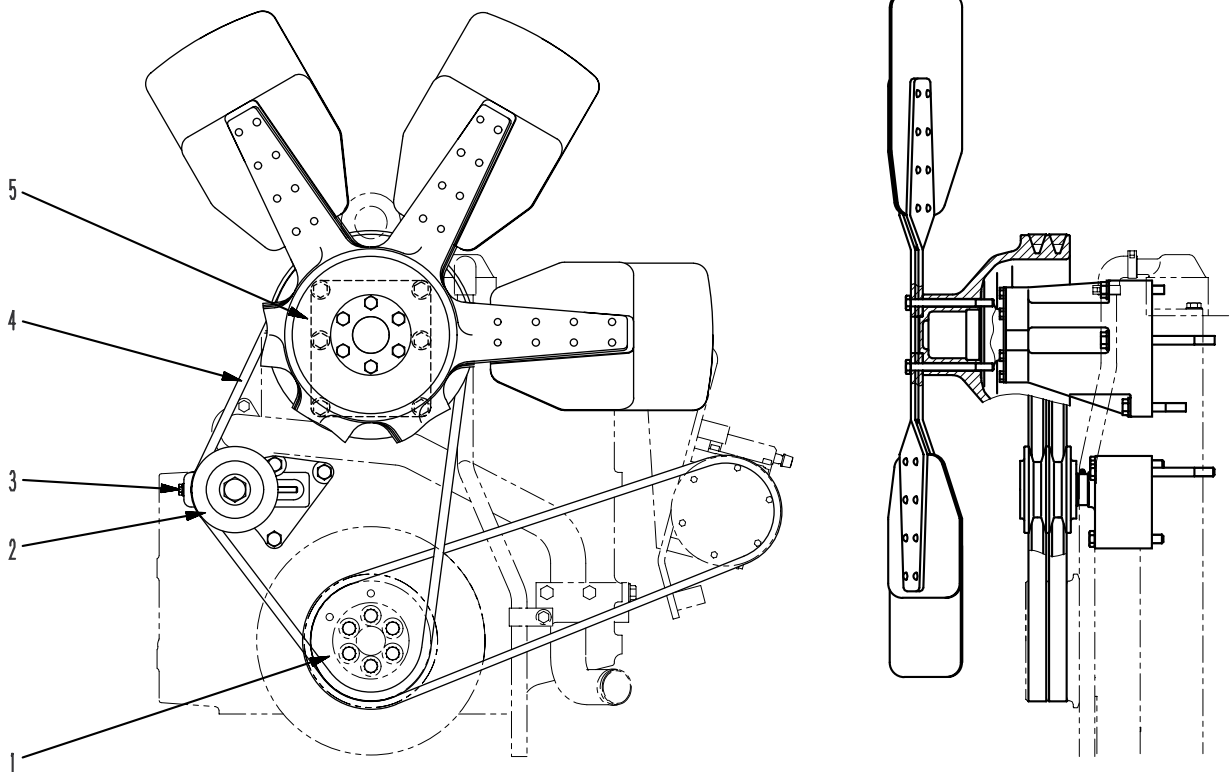
SXE01989

1. Tension shaft
2. Spring
3. Stopper pin
4. Roller bearing
5. Tension bracket
6. Ball bearing
7. Spacer
8. Tension pulley

MOUNT (ADJUSTING BOLT TYPE)

★ The shape may differ according to the machine model.

SA6D140E-3
SAA6D140E-3



SWE01629

1. Crankshaft pulley
2. Tension pulley
3. Adjustment bolt
4. Fan belt
5. Fan pulley

Outside diameter of pulley

Unit: mm

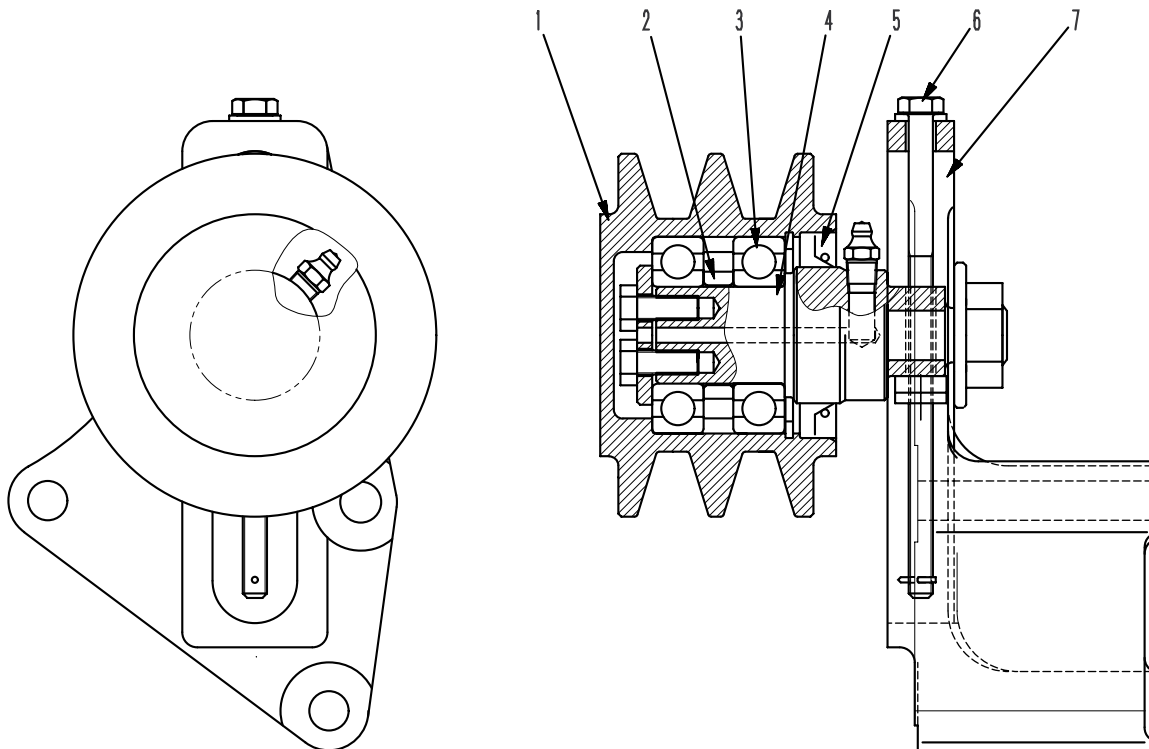
Engine	Machine model	Crankshaft pulley	Fan pulley	Tension pulley
SA6D140E-3	WA500-3	166	304	120
	DCA400SSK	160	210	120
SAA6D140E-3	HD325-6	166	277	120
	HM350-1, HM400-1	166	248	120

TENSION PULLEY

SA6D140E-3 (WA500-3)

SAA6D140E-3 (HD325-6, HM350-1, HM400-1)

★ The shape may differ according to the machine model.



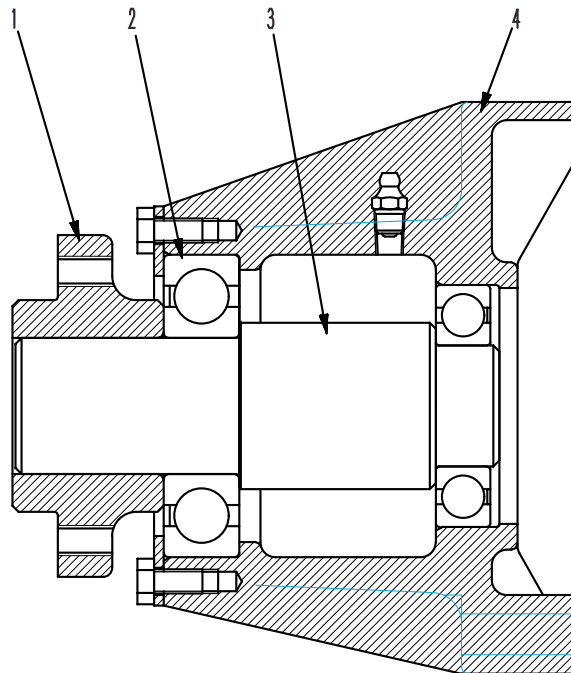
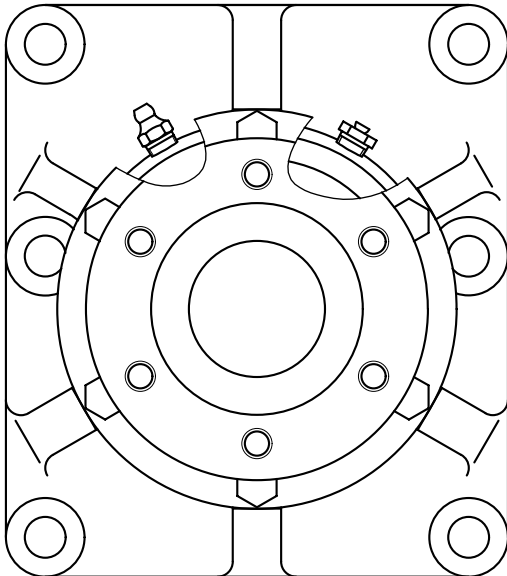
SXE01626

1. Tension pulley
2. Spacer
3. Ball bearing
4. Tension shaft
5. Oil seal
6. Adjustment bolt
7. Bracket

FAN MOUNT CASE

SA6D140E-3 (PC600-6)

★ The shape may differ according to the machine model.



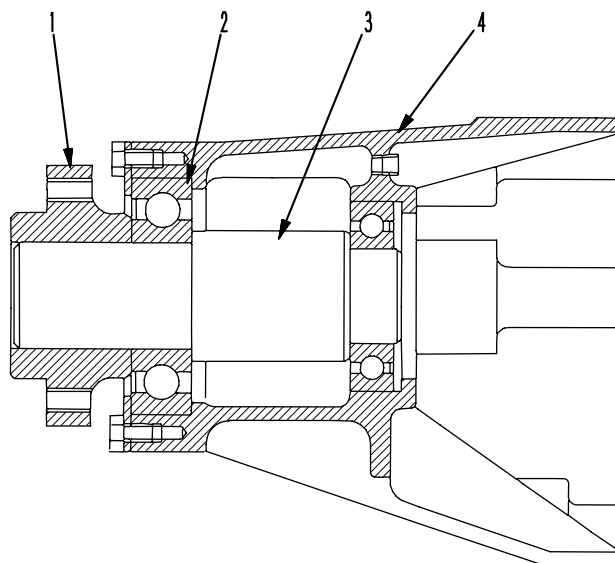
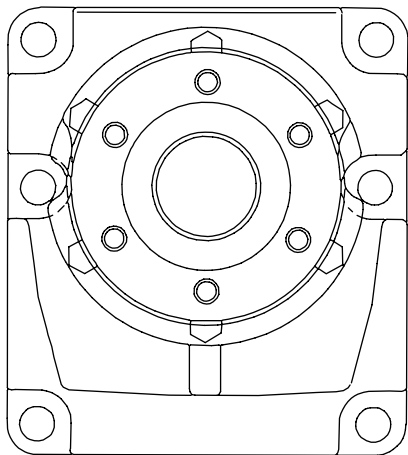
SXE01630

1. Fan pulley hub
2. Ball bearing
3. Shaft
4. Case

FAN MOUNT CASE

SAA6D140E-3 (HD325-6)

★ The shape may differ according to the machine model.



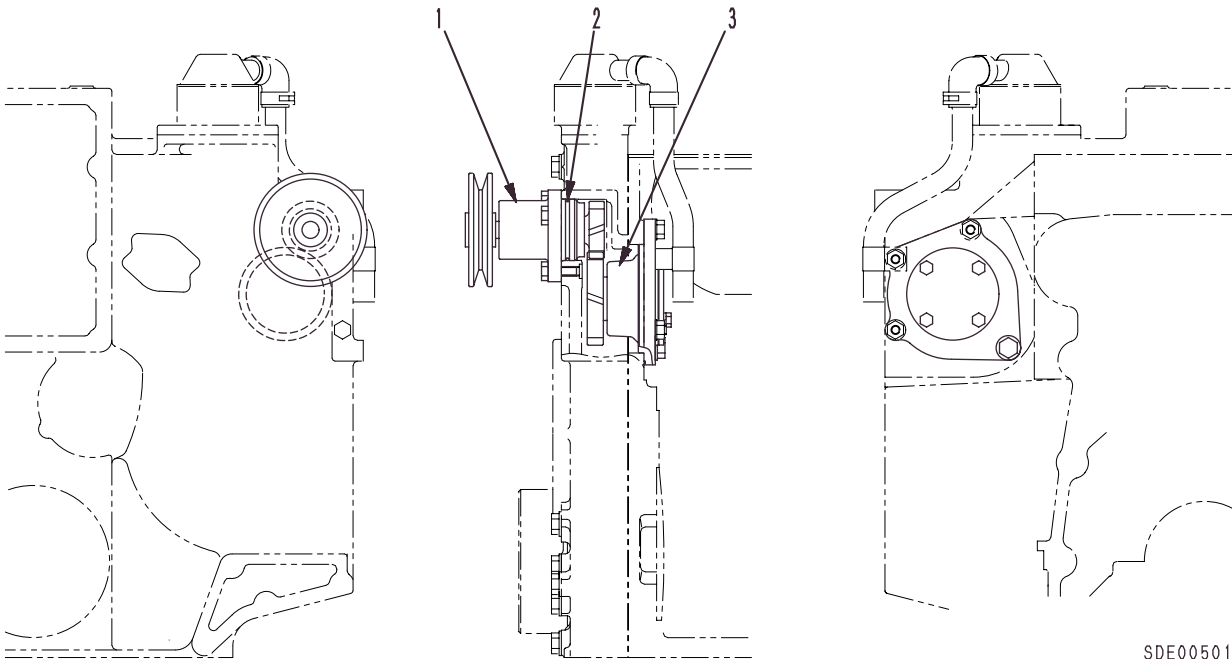
SEE00484

1. Fan pulley hub
2. Ball bearing
3. Shaft
4. Case

FRONT PTO

MOUNT

★ The shape may differ according to the machine model.

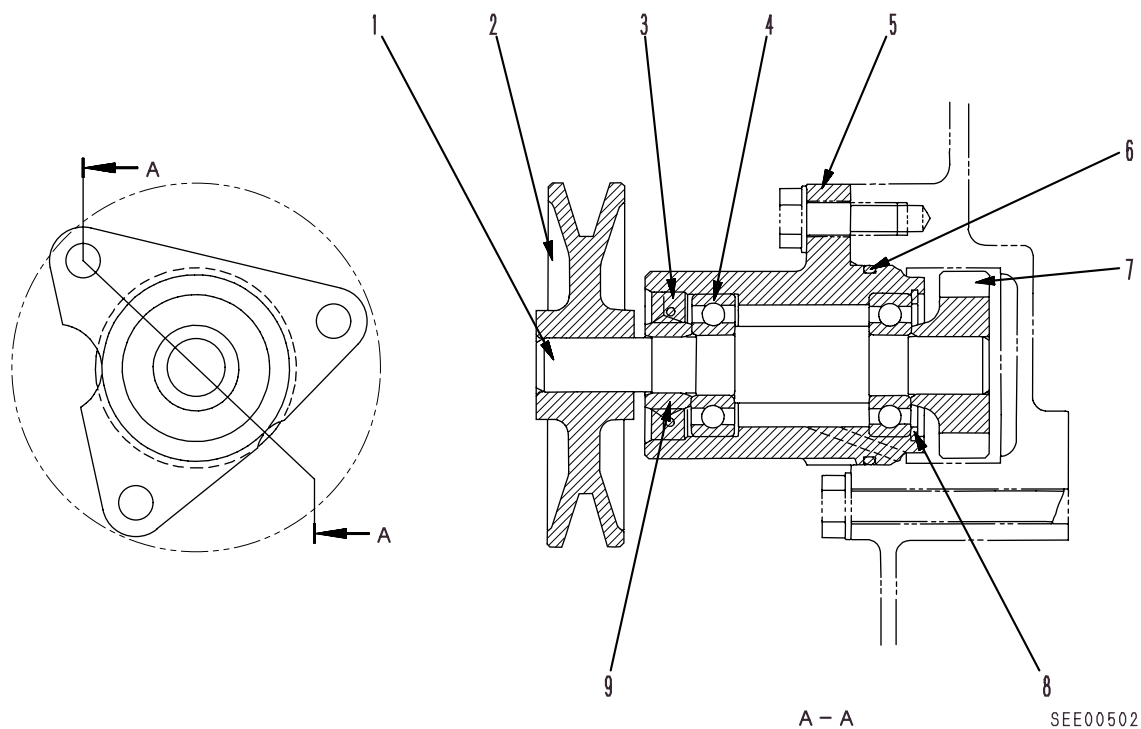


SDE00501

1. Front PTO
2. O-ring
3. Front PTO drive gear assembly

FRONT PTO

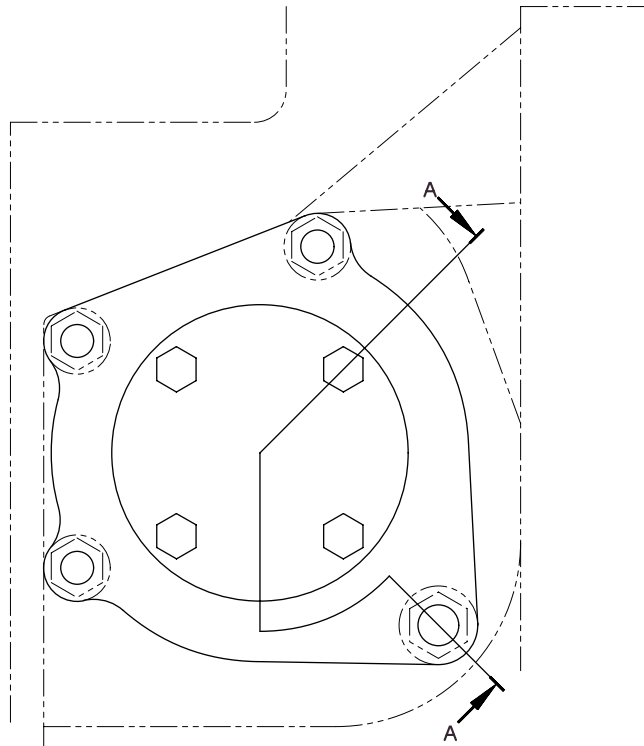
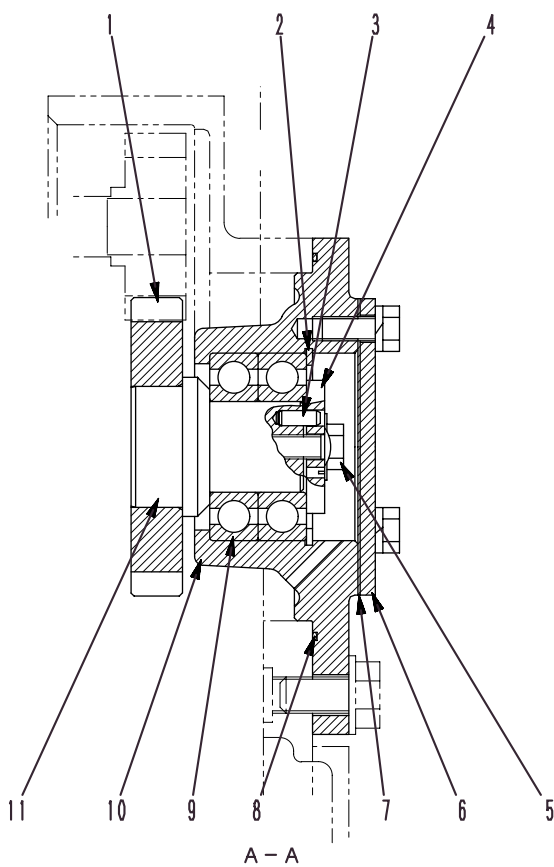
★ The shape may differ according to the machine model.



1. Shaft
2. Pulley
3. Oil seal
4. Bearing (x 2)
5. Housing
6. O-ring
7. Gear (No. of teeth: 14)
8. Snap ring
9. Sleeve

FRONT PTO DRIVE GEAR

★ The shape may differ according to the machine model.



SDE00503

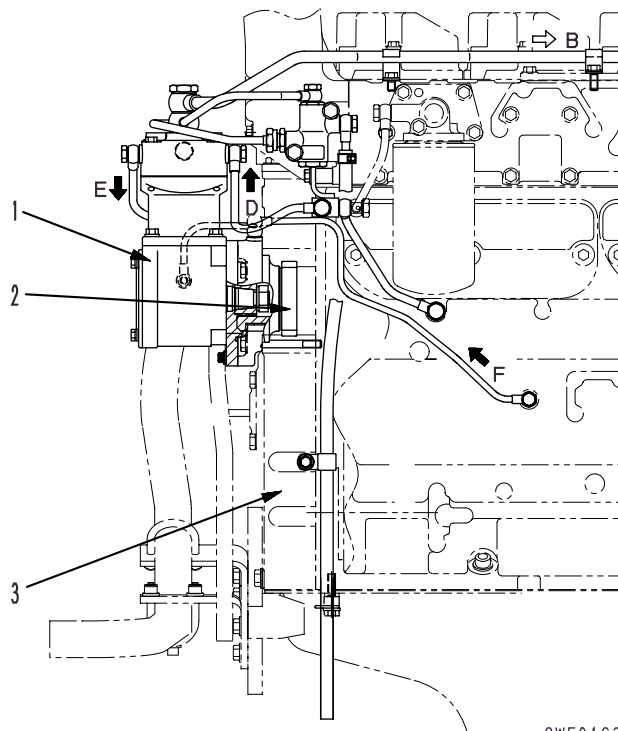
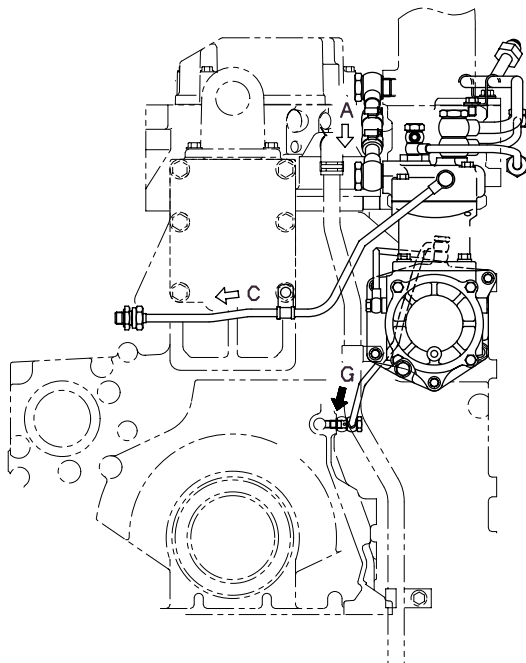
1. Gear (No. of teeth: 24)
2. Snap ring
3. Pin
4. Plate
5. Bolt
6. Flange
7. Gasket
8. O-ring
9. Bearing (x 2)
10. Housing
11. Shaft

AIR COMPRESSOR

MOUNT

SAA6D140E-3 (HD325-6, PC1800-6 Front engine)

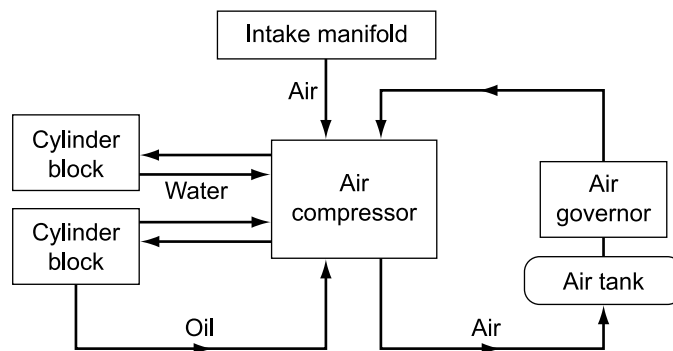
★ The shape may differ according to the machine model.



SWE01631

1. Air compressor
2. Air compressor drive gear (No. of teeth: 24)
3. PTO case

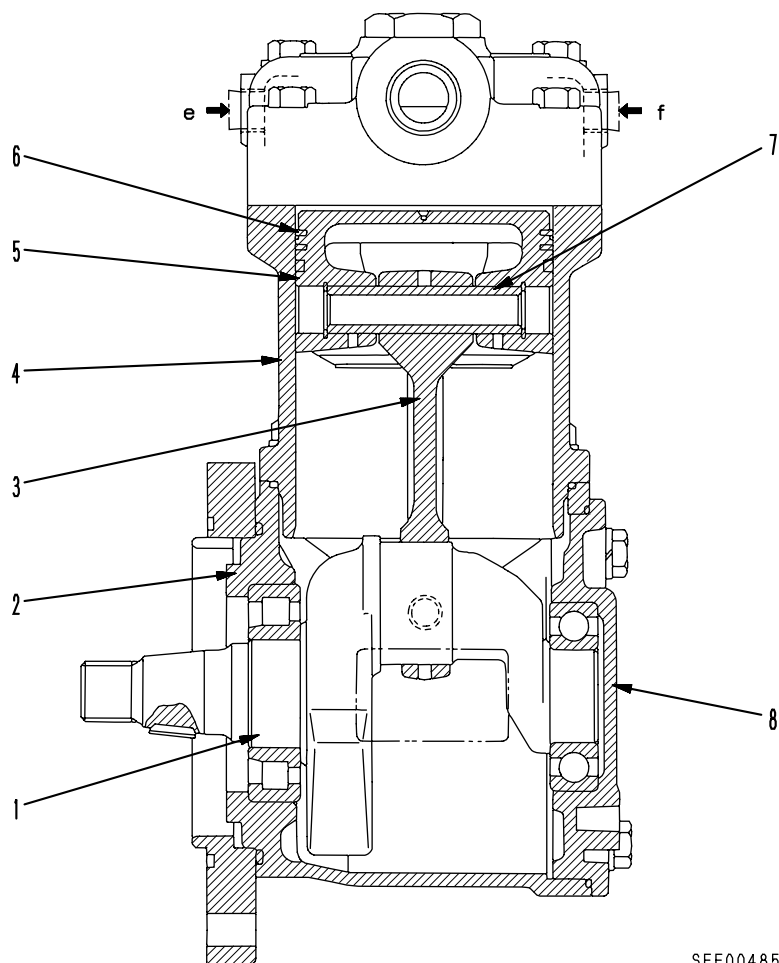
- A. From intake manifold (air)
- B. Discharge port (air)
- C. Unloaded from air governor (air)
- D. From cylinder block (cooling water)
- E. To cylinder block (cooling water)
- F. From cylinder block (oil inlet)
- G. To cylinder block (oil outlet)



AIR COMPRESSOR

★ The shape may differ according to the machine model.

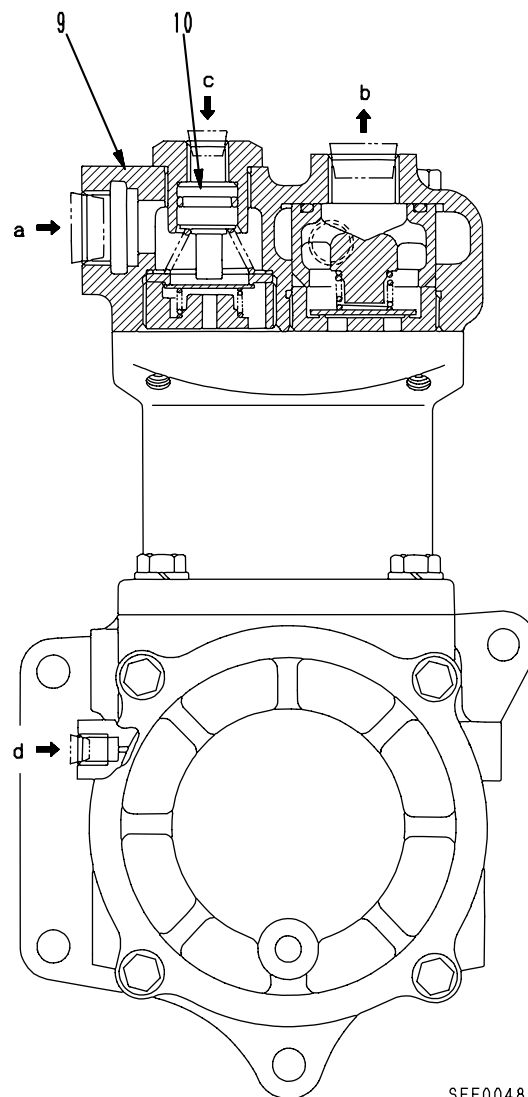
SAA6D140E-3 (HD325-6, PC1800-6 Front engine)



SEE00485

1. Crankshaft
2. Crankshaft case
3. Connecting rod
4. Cylinder
5. Piston
6. Piston ring
7. Piston pin
8. Bearing cover
9. Cylinder head
10. Unloader valve

- a. Air suction port
- b. Air discharge port
- c. Unload
- d. Oil inlet
- e. Cooling water inlet/outlet
- f. Cooling water inlet/outlet



Specifications

Air compressor

- Type: Zexel, single cylinder, double acting
- Discharge amount: 340 cc/rev (theoretical value)
- Normal pressure: 834kPa {8.5 kg/cm²} (at max. load)
- Weight: 11 kg

Unloader valve

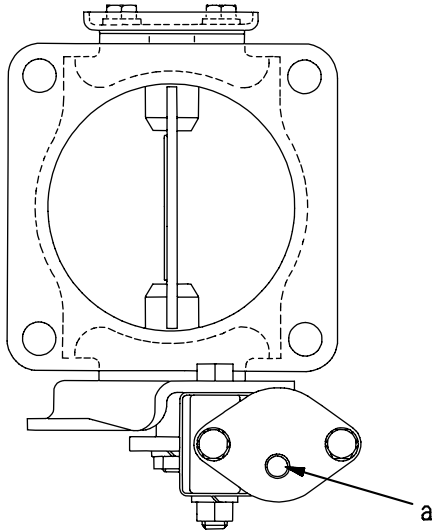
- Cracking pressure: 618kPa {6.3kg/cm²}
- Cracking pressure: 529kPa {5.4kg/cm²}

EXHAUST BRAKE

SAA6D140E-3 (HD325-6)

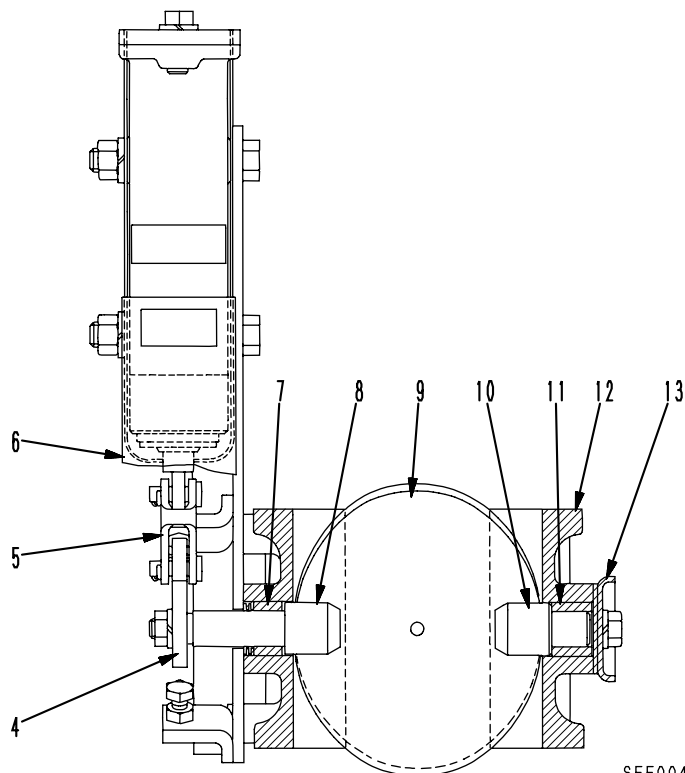
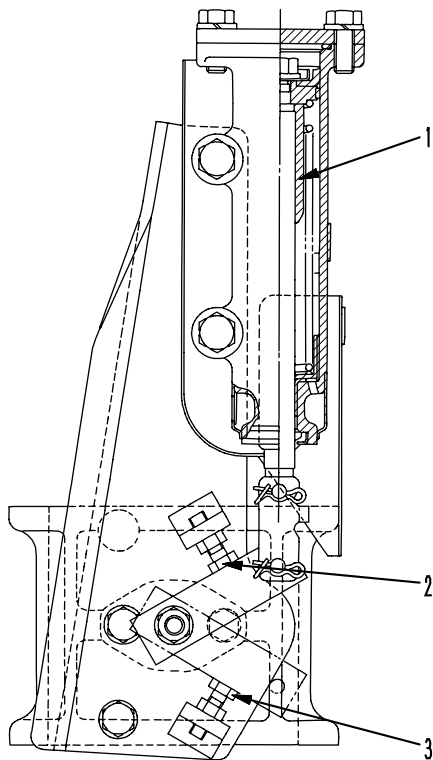
BUTTERFLY VALVE TYPE

- ★ The shape may differ according to the machine model.



Outline

The exhaust brake is installed between the engine turbocharger and muffler. It is actuated by air pressure from the solenoid valve, and throttles the exhaust passage from the turbocharger to the muffler to reduce the speed of the engine. The exhaust brake consists of the valve mechanism and a hydraulic cylinder that operates the valve.



SEE00489

1. Hydraulic cylinder
2. Stopper bolt (fully open position)
3. Stopper bolt (fully closed position)
4. Lever
5. Yoke
6. Insulator
7. Bushing

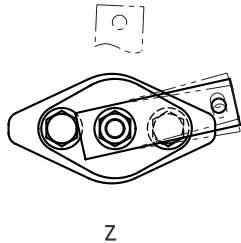
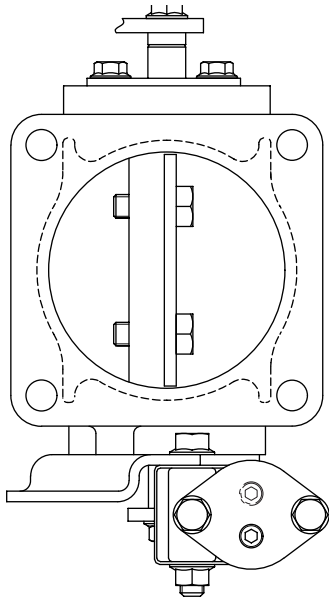
8. Spindle
9. Valve
10. Spindle
11. Bushing
12. Valve body
13. Cover

a. From exhaust brake valve

SAA6D140E-3 (HM350-1, HM400-1)

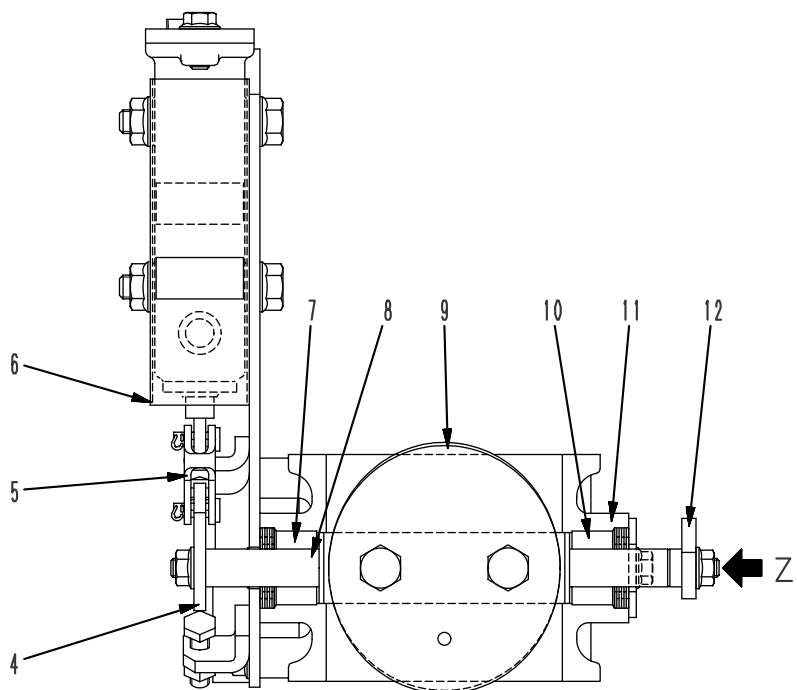
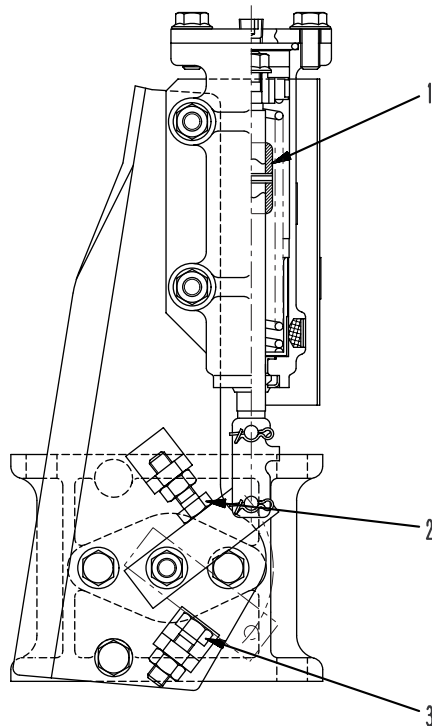
★ The shape may differ according to the machine model.

BUTTERFLY VALVE TYPE



Outline

The exhaust brake is installed between the engine turbocharger and muffler. It is actuated by air pressure from the solenoid valve, and throttles the exhaust passage from the turbocharger to the muffler to reduce the speed of the engine. The exhaust brake consists of the valve mechanism and a hydraulic cylinder that operates the valve. If the exhaust brake button switch is operated, the cable and hydraulic cylinder connected to the exhaust brake operate the exhaust brake. The exhaust brake is released by changing the button switch.



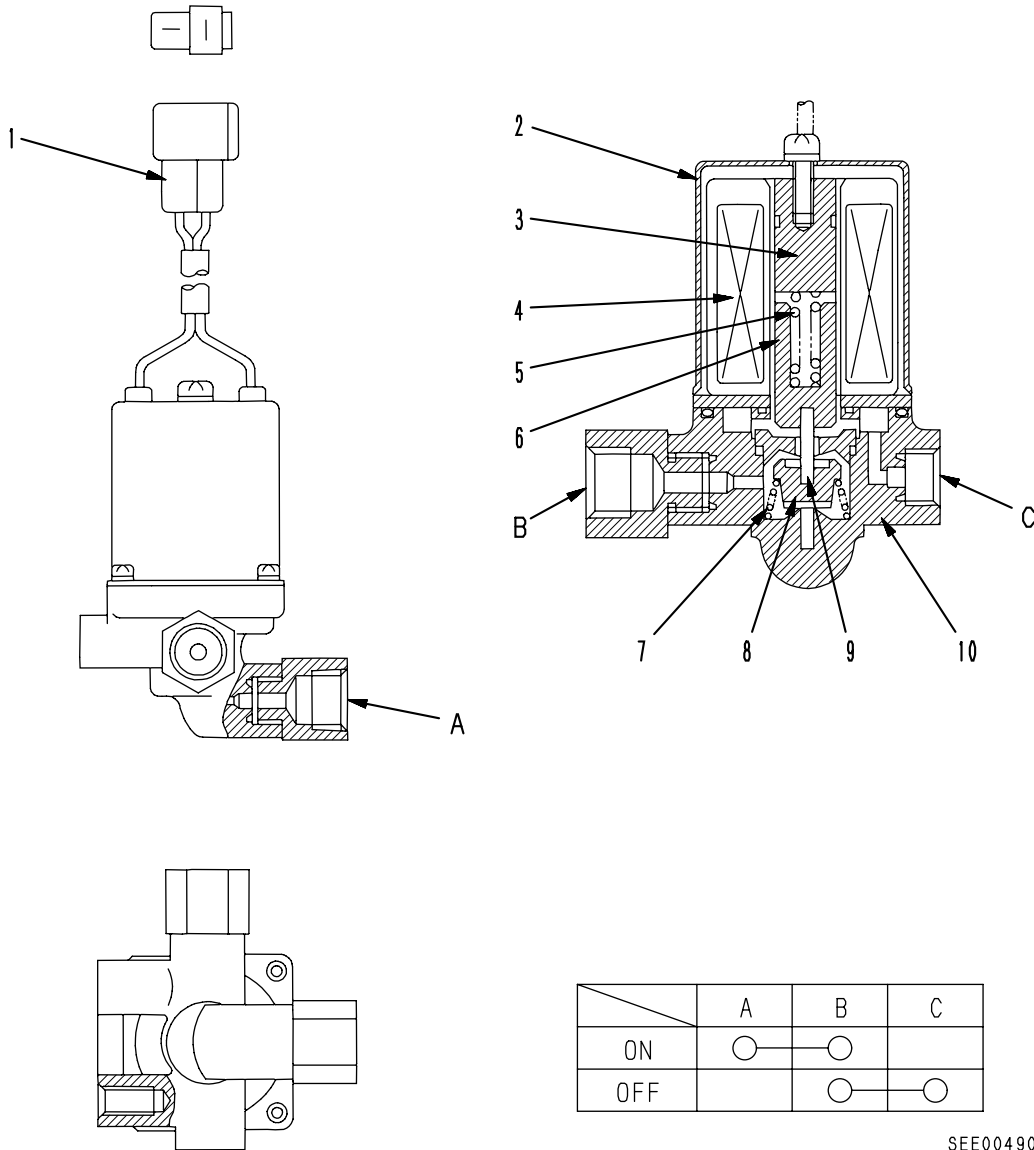
1. Hydraulic cylinder
2. Stopper bolt (fully open position)
3. Stopper bolt (fully closed position)
4. Lever
5. Yoke
6. Insulator
7. Bushing

8. Shaft
9. Valve
10. Bushing
11. Valve body
12. Lever

SJE01878

SOLENOID VALVE FOR EXHAUST BRAKE (BUTTERFLY VALVE TYPE)

★ The shape may differ according to the machine model.



1. Connector
2. Case
3. Core
4. Coil assembly
5. Spring
6. Plunger
7. Spring
8. Valve
9. Rod
10. Body

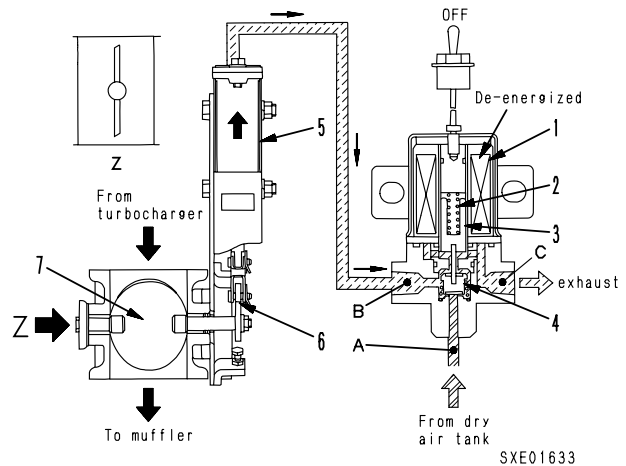
- A. From air tank
- B. To exhaust brake
- C. Exhaust outlet

Operation

Exhaust brake (butterfly valve type)

1. When exhaust brake switch is OFF

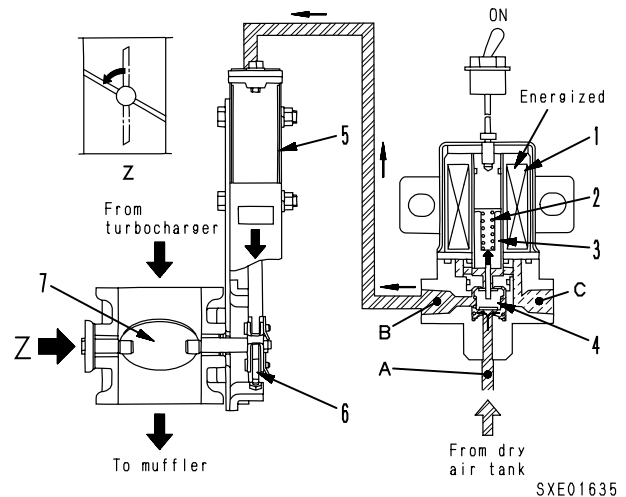
When the switch is at the OFF position, solenoid (1) of the exhaust brake valve is de-energized. In this condition, ports **A** and **B** of the exhaust brake valve are closed, and ports **B** and **C** are open. Therefore, the air entering cylinder (5) of the butterfly valve returns from port **B** to port **C** and is released to the atmosphere, and butterfly valve (7) fully opens the passage from the turbocharger to the muffler.



2. When exhaust brake switch is ON

When the switch is turned ON, solenoid (1) of the exhaust brake valve is energized, plunger (3) and valve (4) move up, ports **B** and **C** close, and ports **A** and **B** open. The air from the dry tank enters port B and flows to cylinder (5) of the butterfly valve. When this happens, the cylinder extends, lever (6) moves down and butterfly valve (7) fully closes the passage from the turbocharger to the muffler. As a result, the engine speed goes down and the travel speed of the machine when going down hills is limited.

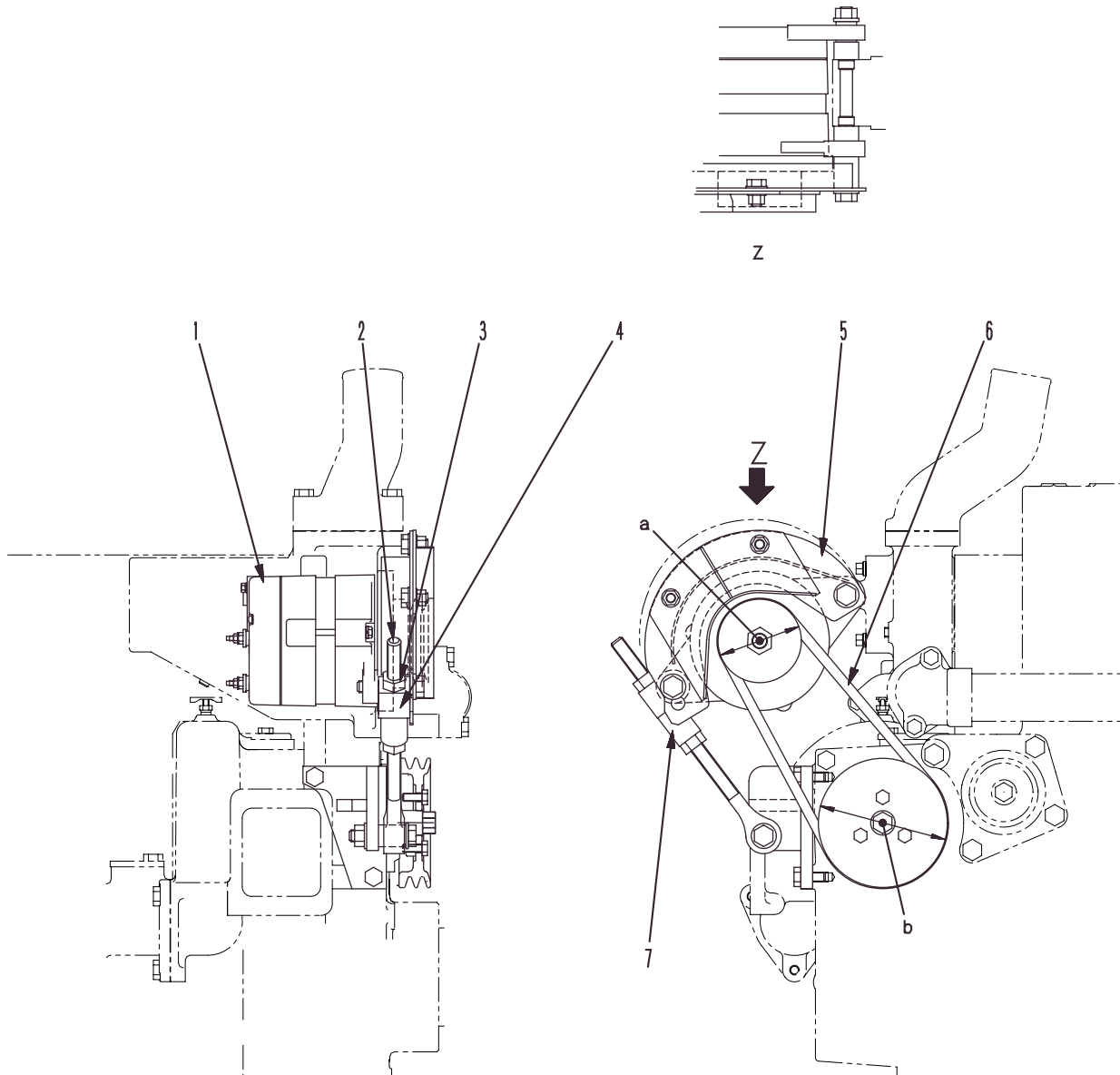
Even if the switch is ON, if the accelerator pedal is being depressed, the exhaust brake limit switch is actuated to stop the engine brake from having any effect.



ALTERNATOR

MOUNT

★ The shape may differ according to the machine model.

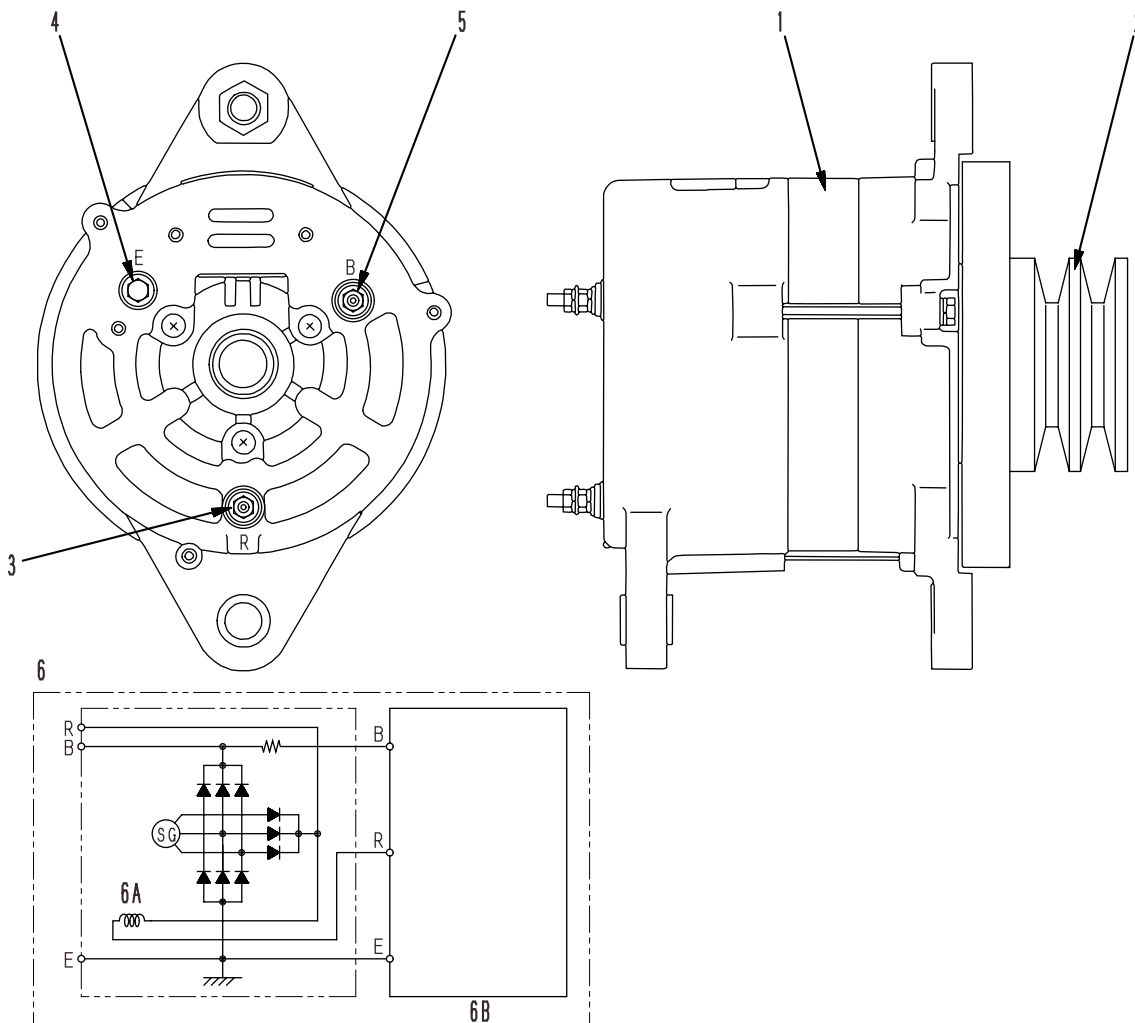


1. Alternator
2. Adjustment rod
3. Nut (x 2)
4. Plate
5. Cover
6. V-belt (x 2)
7. Spacer

- a. Outside diameter of alternator pulley: 85mm
- b. Outside diameter of alternator drive pulley: 132 mm

ALTERNATOR WITH BUILT-IN REGULATOR (OPEN TYPE, 35A)

★ The shape may differ according to the machine model.



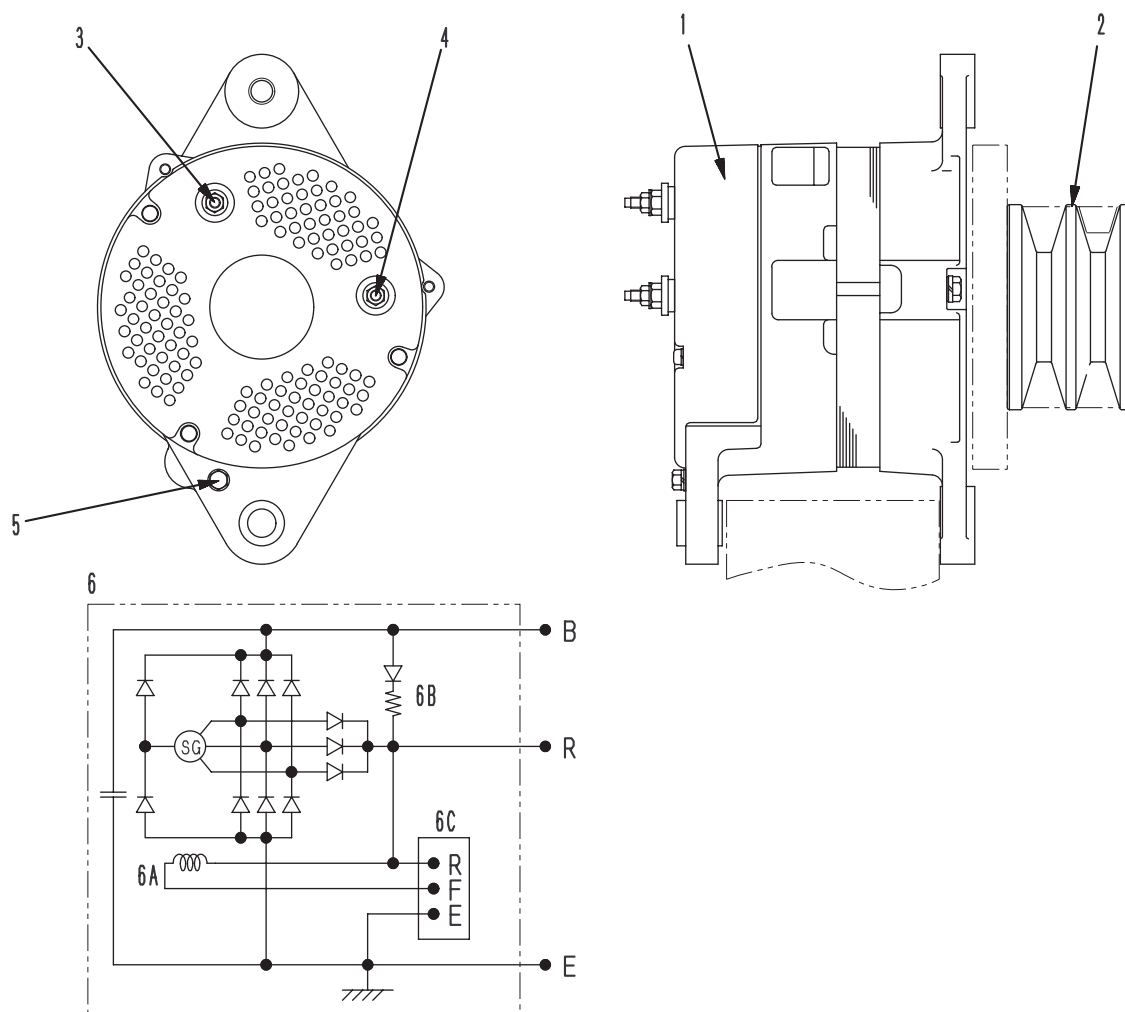
SXE01639

- 1. Alternator
- 2. Alternator pulley
- 3. Terminal R
- 4. Terminal E
- 5. Terminal B
- 6. Internal electric circuit diagram
- 6A. Field coil
- 6B. Regulator

Engine	Machine model	Type	Specification	Outside diameter of pulley (mm)	Weight (kg)
SA6D140E-3	D155AX-5 (110001 – 112349)	Nikko Denki Open type (brushless)	24V, 35A	85	9.5
	DCA400SSK	Nikko Denki Open type (brushless)	24V, 35A	85	9.5
SAA6D140E-3		Nikko Denki Open type (brushless)	24V, 35A	85	9.5
		Nikko Denki Open type (brushless)	24V, 35A	85	9.5

ALTERNATOR WITH BUILT-IN REGULATOR (OPEN TYPE, 50A)

★ The shape may differ according to the machine model.



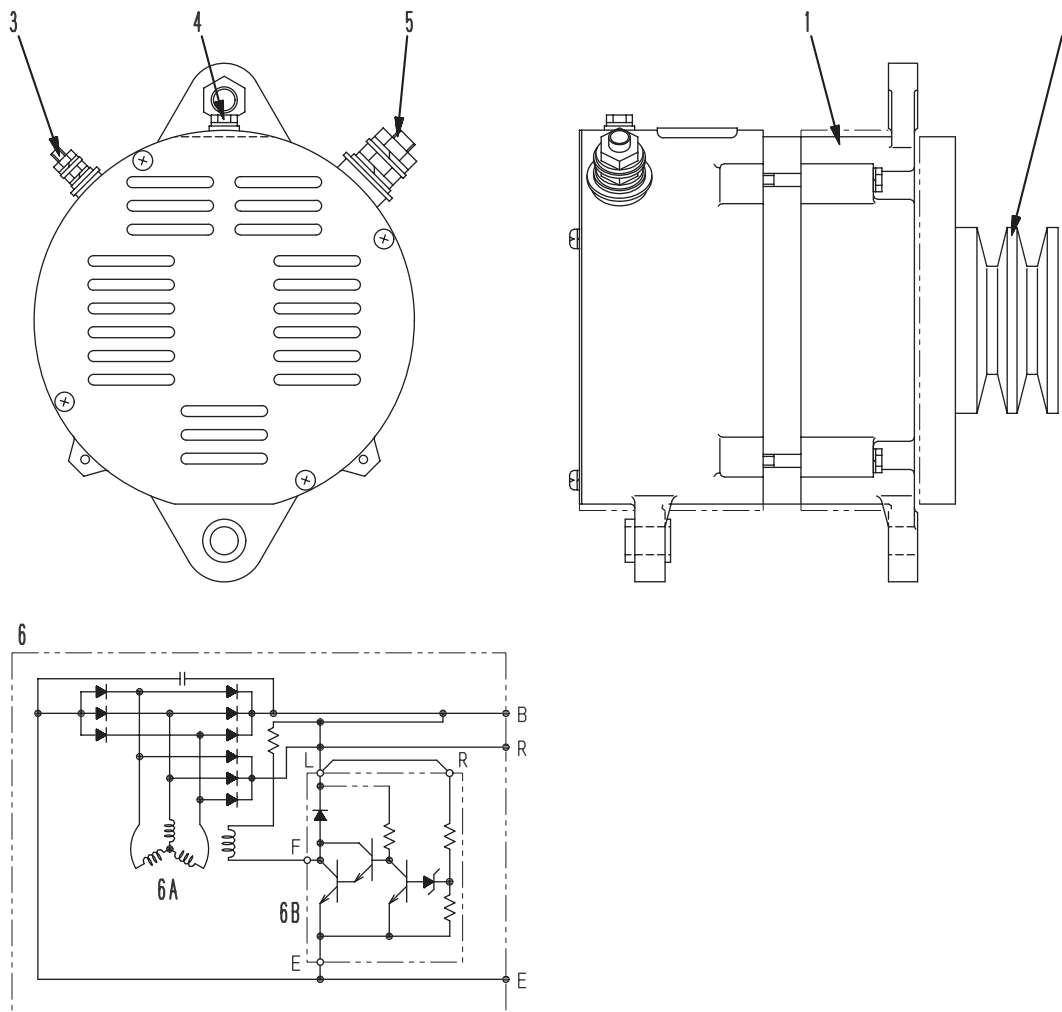
SJE02085

1. Alternator
2. Alternator pulley
3. Terminal B
4. Terminal R
5. Terminal E
6. Internal electric circuit diagram
 - 6A. Field coil
 - 6B. Primary energized resistance
 - 6C. Regulator

Engine	Machine model	Type	Specification	Outside diameter of pulley (mm)	Weight (kg)
SA6D140E-3	WA500-3	Nikko Denki Open type (brushless)	24V, 50A	85	11
		Nikko Denki Open type (brushless)	24V, 50A		
SAA6D140E-3	HD325-6	Nikko Denki Open type (brushless)	24V, 50A	85	11
	HM350-1	Nikko Denki Open type (brushless)	24V, 50A	85	11
	HM350-1 (-40°C spec.) HM400-1				

ALTERNATOR WITH BUILT-IN REGULATOR (OPEN TYPE, 50A)

★ The shape may differ according to the machine model.



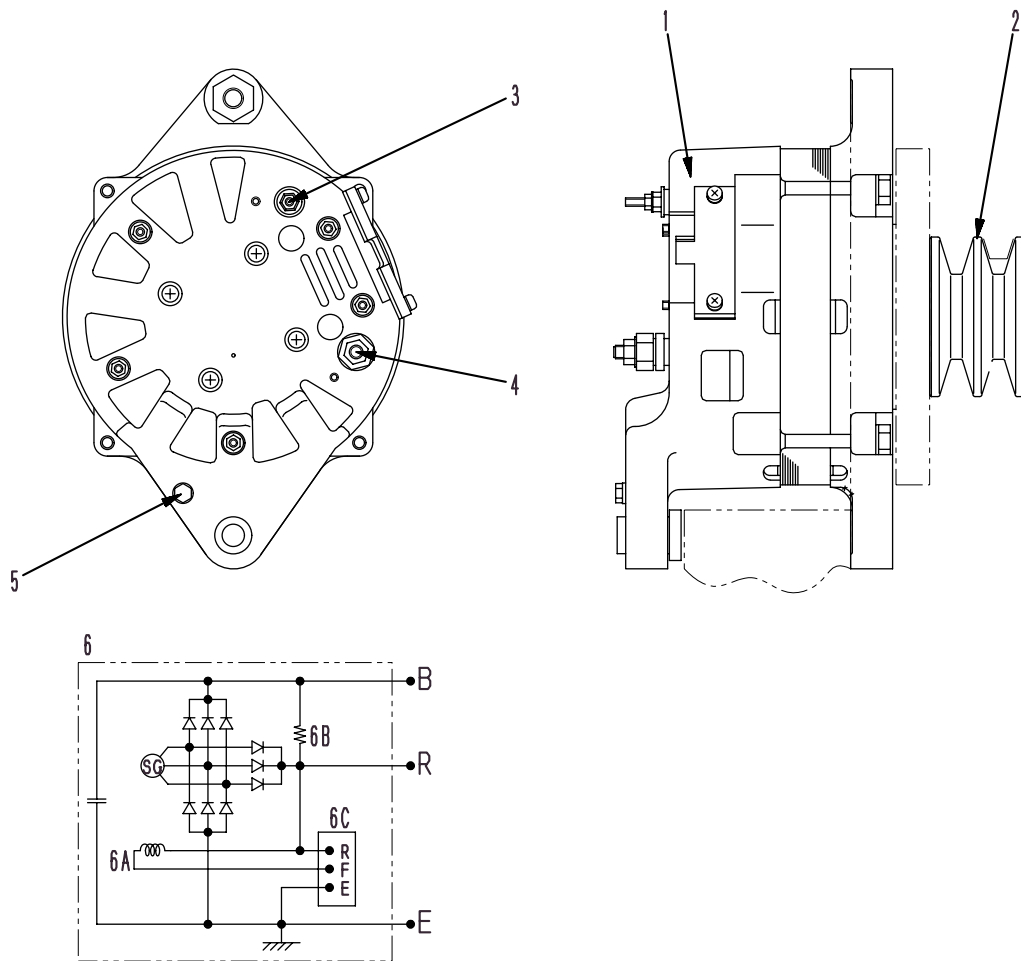
SJE02086

- 1. Alternator
- 2. Alternator pulley
- 3. Terminal B
- 4. Terminal E
- 5. Terminal R
- 6. Internal electric circuit diagram
 - 6A. Alternator
 - 6B. Regulator

Engine	Machine model	Type	Specification	Outside diameter of pulley (mm)	Weight (kg)
SA6D140E-3		Sawafuji Denki Open type (brushless)	24V, 50A	85	12
		Sawafuji Denki Open type (brushless)	24V, 50A	85	12
		Sawafuji Denki Open type (brushless)	24V, 50A	85	12
		Sawafuji Denki Open type (brushless)	24V, 50A	85	12
		Sawafuji Denki Open type (brushless)	24V, 50A	85	12

ALTERNATOR WITH BUILT-IN REGULATOR (OPEN TYPE, 60A)

★ The shape may differ according to the machine model.



SJE01879

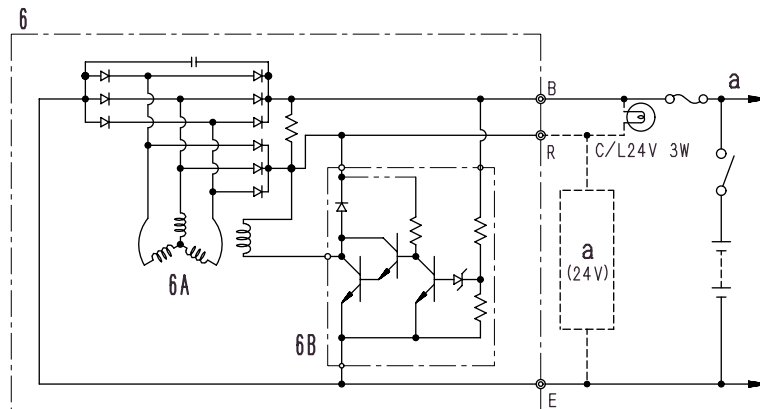
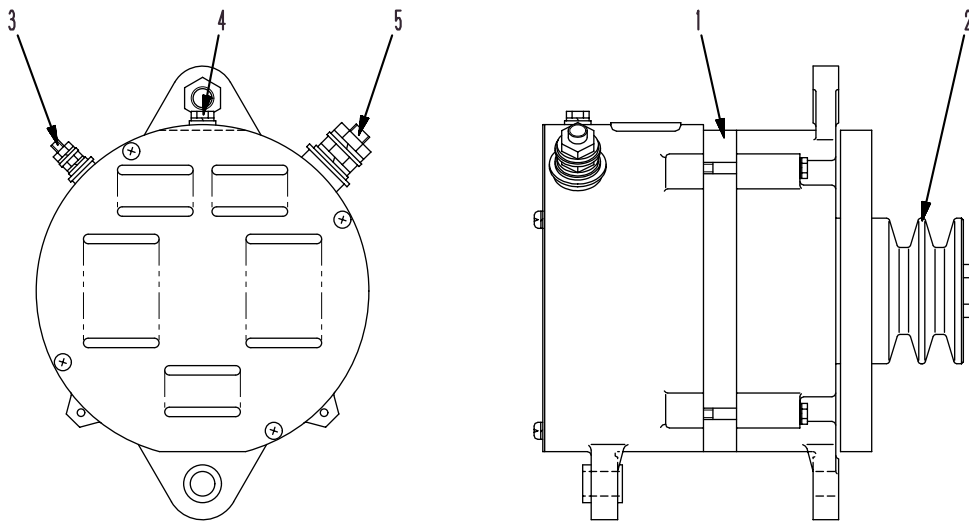
- 1. Alternator
- 2. Alternator pulley
- 3. Terminal B
- 4. Terminal R
- 5. Terminal E
- 6. Internal electric circuit diagram
 - 6A. Field coil
 - 6B. Primary energized resistance
 - 6C. Regulator

Engine	Machine model	Type	Specification	Outside diameter of pulley (mm)	Weight (kg)
SA6D140E-3	D155AX-5 (112350 and up)	Nikko Denki Open type (brushless)	24V, 60A	85	11
		Nikko Denki Open type (brushless)	24V, 60A		
SAA6D140E-3	PC750, PC750LC-6, PC750-7 PC800-6, PC800-7	Nikko Denki Open type (brushless)	24V, 60A	85	11
		Nikko Denki Open type (brushless)	24V, 60A		

STRUCTURE AND FUNCTION, MAINTENANCE STANDARD

ALTERNATOR WITH BUILT-IN REGULATOR (OPEN TYPE, 75A)

★ The shape may differ according to the machine model.



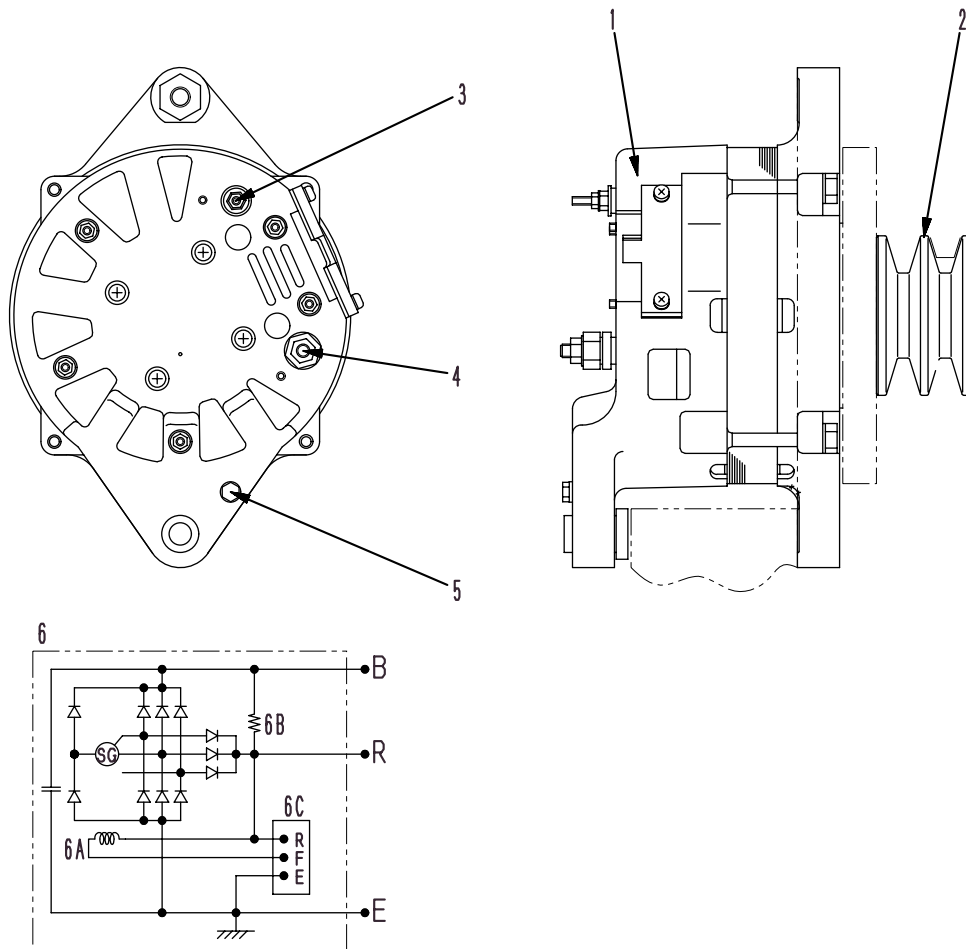
SJE02083

- 1. Alternator
- 2. Alternator pulley
- 3. Terminal B
- 4. Terminal E
- 5. Terminal R
- 6. Internal electric circuit diagram
- 6A. Alternator
- 6B. Regulator
- a. Load

Engine	Machine model	Type	Specification	Outside diameter of pulley (mm)	Weight (kg)
SDA6D140E-3	D275A-5	Sawafuji Denki Open type (brushless)	24V, 75A	85	12.5
	D275AX-5	Sawafuji Denki Open type (brushless)	24V, 75A	85	12.5
SA6D140E-3	D155AX-5 (112350 and up)	Sawafuji Denki Open type (brushless)	24V, 75A	85	12.5
		Sawafuji Denki Open type (brushless)	24V, 75A	85	12.5

ALTERNATOR WITH BUILT-IN REGULATOR (OPEN TYPE, 90A)

The shape may differ according to the machine model.



SJE01880

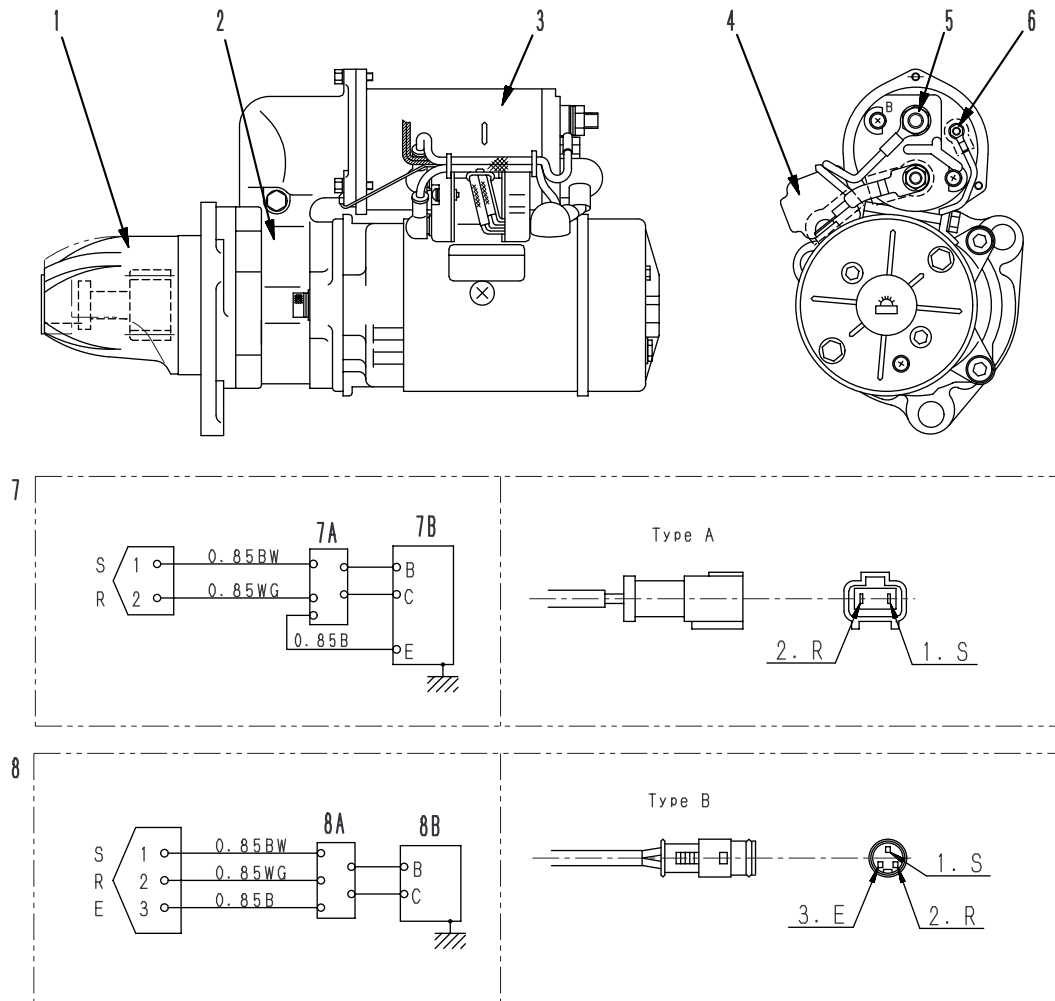
1. Alternator
2. Alternator pulley
3. Terminal B
4. Terminal R
5. Terminal E
6. Internal electric circuit diagram
 - 6A. Field coil
 - 6B. Primary energized resistance
 - 6C. Regulator

Engine	Machine model	Type	Specification	Outside diameter of pulley (mm)	Weight (kg)
SAA6D140E-3	PC800-6 (OPT) PC800-7 (OPT)	Nikko Denki Open type (brushless)	24V, 90A	85	19
	PC1800-6 (USA)	Nikko Denki Open type (brushless)	24V, 90A	85	19

STARTING MOTOR

For 7.5 kW

★ The shape may differ according to the machine model.



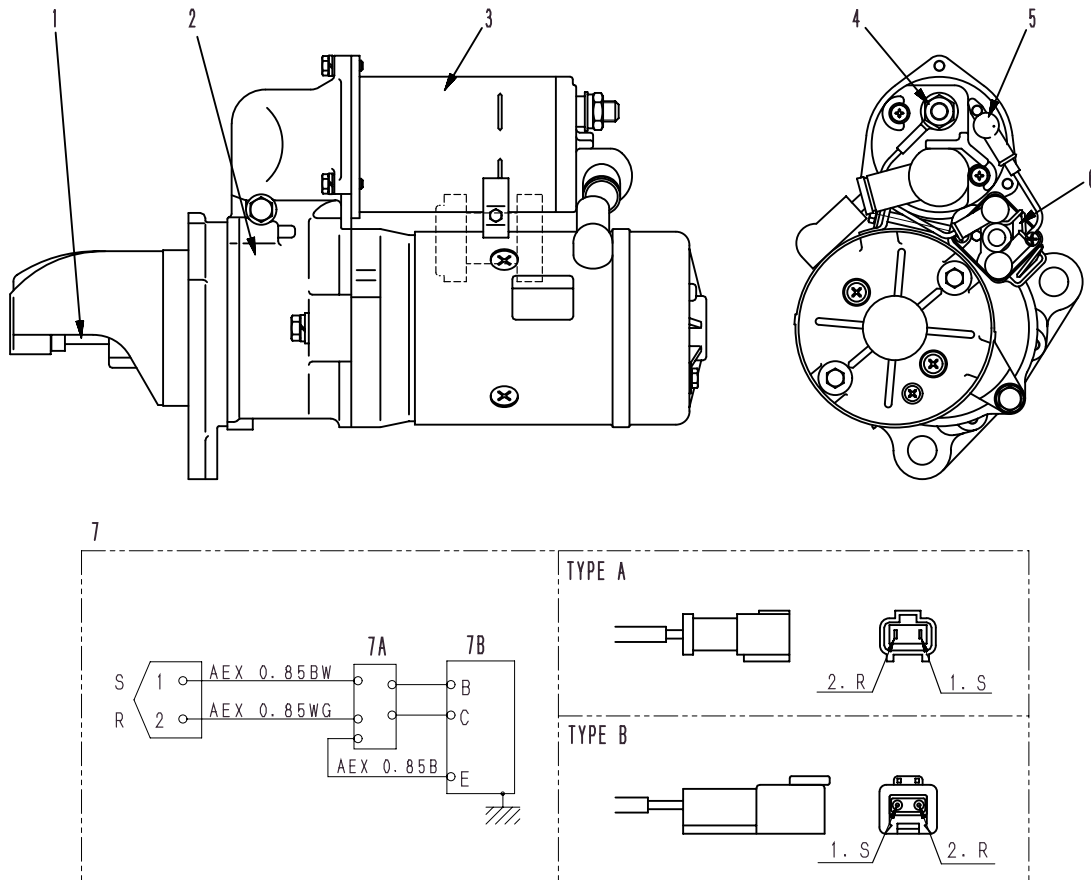
SJE02095

- 1. Pinion gear
- 2. Starting motor assembly
- 3. Magnetic switch
- 4. Safety relay
- 5. Terminal B
- 6. Terminal C
- 7. External wiring diagram (2-pin connector type)
 - 7A. Safety relay portion
 - 7B. Starting motor portion
- 8. External wiring diagram (3-pin connector type)
 - 8A. Safety relay portion
 - 8B. Starting motor portion
- S. To starting switch terminal C
- R. To alternator terminal R
- E. To ground

Engine	Machine model	Type	Specification	No. of pinion teeth	Weight (kg)	Connector type
SA6D140E-3	DCA400SSK (Denyo generator)	Nikko Denki Waterproof, oilproof type	24V, 7.5kW	12	18	A
SAA6D140E-3		Nikko Denki Waterproof, oilproof type	24V, 7.5kW	12	18	

For 11kW

★ The shape may differ according to the machine model.



SXE01640

1. Pinion gear
2. Starting motor assembly
3. Magnetic switch
4. Terminal B
5. Terminal C
6. Safety relay

7. External wiring diagram (2-pin connector type)
- 7A. Safety relay portion
- 7B. Starting motor portion

- S. To starting switch terminal C
 R. To alternator terminal R
 E. To ground

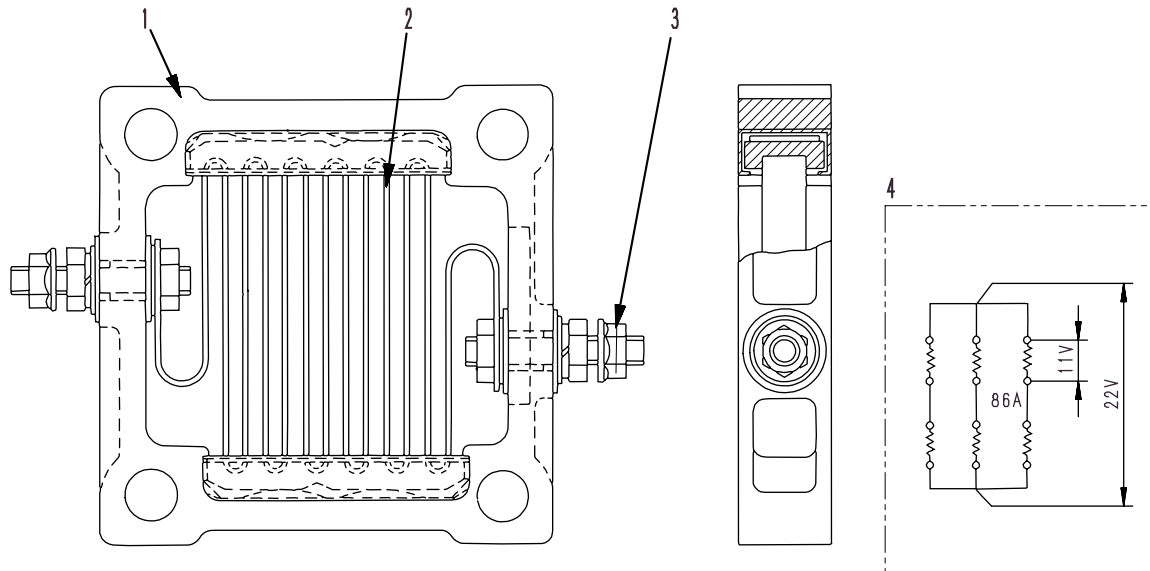
Engine	Machine model	Type	Specification	No. of pinion teeth	Weight (kg)	Connector type
SA6D140E-3	D155AX-5 WA500-3	Nikko Denki Waterproof, oilproof type	24V, 11kW	12	18	B
SAA6D140E-3	HD325-6	Nikko Denki Waterproof, oilproof type	24V, 11kW	12	18	B
	PC750, 750LC-6, PC750-7 PC800-6, PC800-7	Nikko Denki Waterproof, oilproof type	24V, 11kW	12	18	B
	PC1800-6	Nikko Denki Waterproof, oilproof type	24V, 11kW	12	18	B
	HM350-1 HM400-1	Nikko Denki Waterproof, oilproof type	24V, 11kW	12	18	B
SDA6D140E-3	D275A-5, D275AX-5	Nikko Denki Waterproof, oilproof type	24V, 11kW	12	18	B

STARTING AID

ELECTRICAL INTAKE AIR HEATER

★ The shape may differ according to the machine model.

For SA6D140E-3



SXE01641

1. Body
2. Heater coil
3. Terminal
4. Wiring diagram

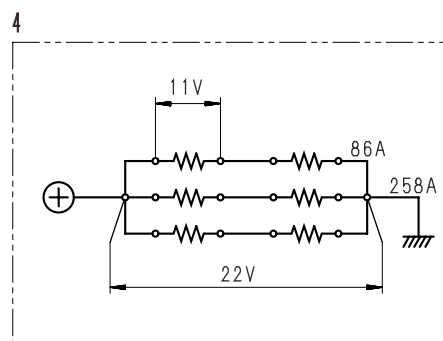
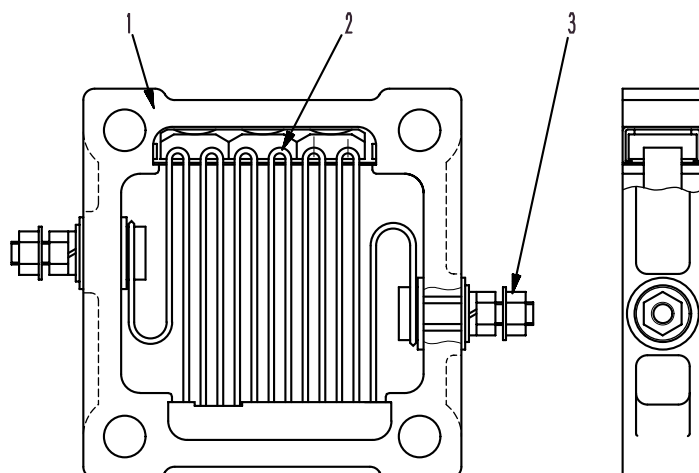
Specifications

Heater type: Electrical intake air heater

- Rated voltage: 22V (DC)
- Load current: 86A

For SAA6D140E-3

★ The shape may differ according to the machine model.



SXE01642

1. Body
2. Heater coil
3. Terminal
4. Wiring diagram

Specifications

Heater type: Electrical intake air heater

- Rated voltage: 22V (DC)
- Load current: 86A

12 TESTING AND ADJUSTING

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STANDARD VALUE TABLE FOR TESTING, ADJUSTING,
AND TROUBLESHOOTING

Engine				SA6D140E-3	
Machine model				D155AX-5	
Category	Item	Measurement conditions, etc.	Unit	Standard value for new machine	Service limit value
Performance	Engine speed	High idling Low idling	rpm rpm	2,100 ± 50 740 ⁺²⁵ ₀	2,100 ± 50 740 ⁺²⁵ ₀
	Speed needed to start	0° (without starting aid) −20° (with starting aid)	rpm rpm	Min. 110 Min. 85	— —
Intake, exhaust system	Intake resistance	Whole speed range	kPa{mmH ₂ O}	Max. 3.73 {Max. 380}	7.47 {762}
	Intake air pressure	At rated horsepower	kPa{mmHg}	Min. 113 {Min. 850}	93 {700}
	Exhaust pressure	At rated horsepower	kPa{mmHg}	Min. 100 {Min. 750}	84 {630}
	Exhaust temperature	Whole speed range (−20°C)	°C	Max. 650	700
	Exhaust gas color	At sudden acceleration (low idling → high idling)	Bosch index	Max. 5.0	7.0
		At rated horsepower	Bosch index	Max. 1.0	2.5
		At high idling	Bosch index	Max. 1.0	2.0
Engine proper	Valve clearance	Intake valve Exhaust valve	mm mm	0.35 0.57	— —
	Compression pressure	Oil temperature: 40 – 60°C (engine speed: 200 – 250 rpm)	MPa{kg/cm ² }	Min. 4.1 {42}	2.8{29}
Lubrication system	Blow-by pressure	At rated horsepower (water temperature : Min. 70°C)	kPa{kg/cm ² }	Max. 1.47 {150}	2.94{300}
	Oil pressure (oil temperature : Min. 80°C)	At rated horsepower SAE30 or SAE15W-40	MPa{kg/cm ² }	0.34 – 0.54 {3.5 – 5.5}	0.21 {2.1}
		SAE10W	MPa{kg/cm ² }	0.29 – 0.49 {3.0 – 5.0}	0.18 {1.8}
		At low idling SAE30 or SAE15W-40	MPa{kg/cm ² }	Min. 0.12 {Min. 1.2}	0.08 {0.8}
		SAE10W	MPa{kg/cm ² }	Min. 0.10 {Min. 1.0}	0.07 {0.7}
	Oil temperature	Whole speed range (inside oil pan)	°C	90 – 110	120
Cooling system	Oil consumption	Fuel consumption ratio at continuous rated horsepower	%	Max. 0.3	0.6
	Radiator pressure valve function	Cracking pressure (differential pressure)	kPa{kg/cm ² }	—	—
	Fan speed	At rated speed	rpm	1,295 ± 40	—
	Fan belt tension	Deflection when pressed with fin- ger force of approx. 98 kN {10 kg}	mm	Auto tension	—
Cooling system	Alternator belt tension	Deflection when pressed with fin- ger force of approx. 98 kN {10 kg}	mm	13 – 16	13 – 16

SA6D140E-3					
PC600-6		WA500-3		DCA400SSK (DENYO generator)	
Standard value for new machine	Service limit value	Standard value for new machine	Service limit value	Standard value for new machine	Service limit value
1,950 ± 50 800 ± 25	1,950 ± 50 800 ± 25	2,350 ± 50 725 ± 25	2,350 ± 50 725 ± 25	Max.1,890 (60Hz) 800 ⁺⁵⁰ ₀	Max.1,890 (60Hz) 800 ⁺⁵⁰ ₀
Min. 110 Min. 85	— —	Min. 110 Min. 85	— —	Min. 110 Min. 85	— —
Max. 3.73 {Max. 380} Min. 127 {Min. 950} Min. 107 {Min. 800} Max. 650	7.47 {762} 107 {800} 89 {670} 700	Max. 3.73 {Max. 380} Min. 107 {Min. 800} Min. 107 {Min. 800} Max. 650	7.47 {762} 89 {670} 91 {680} 700	Max. 3.73 {Max. 380} Min. 160 {Min. 1,200} Min. 120 {Min. 900} Max. 650	7.47 {762} 128 {960} 96 {720} 700
Max. 4.0	6.0	Max. 4.0	6.0	—	—
Max. 1.0 Max. 1.0	2.5 2.0	Max. 1.0 Max. 1.0	2.5 2.0	Max.1.0 Max.1.0	2.5 2.0
0.35 0.57	— —	0.35 0.57	— —	0.35 0.57	— —
Min. 4.1 {42}	2.8{29}	Min. 4.1 {42}	2.8{29}	Min. 4.1 {42}	2.8{29}
Max. 1.47 {150}	2.94{300}	Max. 1.47 {150}	2.94{300}	Max. 1.96 {200}	3.92{400}
0.34 – 0.54 {3.5 – 5.5} 0.29 – 0.49 {3.0 – 5.0}	0.21 {2.1} 0.18 {1.8}	0.34 – 0.54 {3.5 – 5.5} 0.29 – 0.49 {3.0 – 5.0}	0.21 {2.1} 0.18 {1.8}	0.29 – 0.49 {3.0 – 5.0} 0.25 – 0.44 {2.5 – 4.5}	0.21 {2.1} 0.18 {1.8}
Min. 0.12 {Min. 1.2} Min. 0.10 {Min. 1.0}	0.08 {0.8} 0.07 {0.7}	Min. 0.12 {Min. 1.2} Min. 0.10 {Min. 1.0}	0.08 {0.8} 0.07 {0.7}	Min. 0.12 {Min. 1.2} Min. 0.10 {Min. 1.0}	0.08 {0.8} 0.07 {0.7}
90 – 110	120	90 – 110	120	90 – 110	120
Max. 0.3	0.6	Max. 0.3	0.6	Max. 0.3	0.6
—	—	—	—	69 ± 10 {0.70 ± 0.10}	69 ± 10 {0.70 ± 0.10}
1,555 ± 50	1,555 ± 50	1,140 ± 35	1,140 ± 35	1,370 ± 40(60Hz)	1,370 ± 40(60Hz)
Semiauto tension	—	13 – 15 (New part) 17 – 19 (Tension adjusted)	13 – 15 (New part) 17 – 19 (Tension adjusted)	8 – 12	8 – 12
13 – 16	13 – 16	13 – 16	13 – 16	13 – 16	13 – 16

**STANDARD VALUE TABLE FOR TESTING,
ADJUSTING, AND TROUBLESHOOTING**
TESTING AND ADJUSTING

Engine				SAA6D140E-3	
Machine model				HD325-6	
Category	Item	Measurement conditions, etc.	Unit	Standard value for new machine	Service limit value
Performance	Engine speed	High idling Low idling	rpm rpm	2,400 ⁺⁵⁰ ₀ 725 ± 25	2,400 ⁺⁵⁰ ₀ 725 ± 25
	Speed needed to start	0° (without starting aid) -20° (with starting aid)	rpm rpm	Min. 110 Min. 85	— —
Intake, exhaust system	Intake resistance	Whole speed range	kPa(mmH ₂ O)	Max. 3.73 {Max. 380}	7.47 {762}
	Intake air pressure	At rated horsepower	kPa(mmHg)	Min. 133 {Min. 1,000}	112 {840}
	Exhaust pressure	At rated horsepower	kPa(mmHg)	Min. 113 {Min. 850}	96 {720}
	Exhaust temperature	Whole speed range (-20°C)	°C	Max. 650	700
	Exhaust gas color	At sudden acceleration (low idling → high idling)	Bosch index	Max. 4.0	6.0
		At rated horsepower	Bosch index	Max. 1.0	2.5
		At high idling	Bosch index	Max. 1.0	2.0
Engine proper	Valve clearance	Intake valve Exhaust valve	mm mm	0.35 0.57	— —
	Compression pressure	Oil temperature: 40 – 60°C (engine speed: 200 – 250 rpm)	MPa(kg/cm ²)	Min. 4.1 {42}	2.8{29}
	Blow-by pressure	At rated horsepower (water temperature : Min. 70°C)	kPa(kg/cm ²)	Max. 1.96{200}	3.92{400}
Lubrication system	Oil pressure (oil temperature : Min. 80°C)	At rated horsepower SAE30 or SAE15W-40	MPa(kg/cm ²)	0.34 – 0.54 {3.5 – 5.5}	0.21 {2.1}
		SAE10W	MPa(kg/cm ²)	0.29 – 0.49 {3.0 – 5.0}	0.18 {1.8}
		At low idling SAE30 or SAE15W-40	MPa(kg/cm ²)	Min. 0.12 {Min. 1.2}	0.08 {0.8}
		SAE10W	MPa(kg/cm ²)	Min. 0.10 {Min. 1.0}	0.07 {0.7}
	Oil temperature	Whole speed range (inside oil pan)	°C	90 – 110	120
Cooling system	Oil consumption	Ratio to fuel consumption at continuous rated output	%	Max. 0.3	0.6
	Radiator pressure valve function	Cracking pressure (differential pressure)	kPa(kg/cm ²)		
	Fan speed	At rated speed	rpm	1,200 ± 35	1,200 ± 35
	Fan belt tension	Deflection when pressed with fin- ger force of approx. 98 kN {10 kg}	mm	13 – 15 (New part) 17 – 19 (Tension adjusted)	13 – 15 (New part) 17 – 19 (Tension adjusted)
	Alternator belt tension	Deflection when pressed with fin- ger force of approx. 98 kN {10 kg}	mm	13 – 16	13 – 16

TESTING AND ADJUSTING
**STANDARD VALUE TABLE FOR TESTING,
ADJUSTING, AND TROUBLESHOOTING**

SAA6D140E-3					
HM350-1, HM400-1		PC750,750LC-6,PC750-7,PC800-6,7		PC1800-6 (2 engines)	
Standard value for new machine	Service limit value	Standard value for new machine	Service limit value	Standard value for new machine	Service limit value
2,200 ⁺⁵⁰ ₀ 725 ± 25	2,200 ⁺⁵⁰ ₀ 725 ± 25	1,980±50 825 ± 25	1,980±50 825 ± 25	1,980±50 825 ± 25	1,980±50 825 ± 25
Min. 110 Min. 85	— —	Min. 110 Min. 85	— —	Min. 110 Min. 85	— —
Max. 3.73 {Max. 380} Min. 116 {Min. 870} Min. 100 {Min. 750} Max. 650	7.47 {762} 97 {730} 83 {620} 700	Max. 2.94 {Max. 300} Min. 117 {Min. 880} Min. 103 {Min. 770} Max. 650	7.47 {762} 93.3 {700} 82.6 {620} 700	Max. 2.94 {Max. 300} Min. 117 {Min. 880} Min. 103 {Min. 770} Max. 650	7.47 {762} 93.3 {700} 82.6 {620} 700
Max. 4.0	6.0	Max. 4.0	6.0	Max. 4.0	6.0
Max. 1.0 Max. 1.0	2.5 2.0	Max. 1.0 Max. 1.0	2.5 2.0	Max. 1.0 Max. 1.0	2.5 2.0
0.35 0.57	— —	0.35 0.57	— —	0.35 0.57	— —
Min. 4.1 {42}	2.8{29}	Min. 3.8 {39}	2.7 {27}	Min. 3.8 {39}	2.7 {27}
Max. 1.96{200}	3.92{400}	Max. 1.96{200}	3.92{400}	Max. 1.96{200}	3.92{400}
0.34 – 0.54 {3.5 – 5.5} 0.29 – 0.49 {3.0 – 5.0}	210 {2.1} 180 {1.8}	0.34 – 0.54 {3.5 – 5.5} 0.29 – 0.49 {3.0 – 5.0}	0.21 {2.1} 0.18 {1.8}	0.34 – 0.54 {3.5 – 5.5} 0.29 – 0.49 {3.0 – 5.0}	0.21 {2.1} 0.18 {1.8}
Min. 0.12 {Min. 1.2} Min. 0.10 {Min. 1.0}	700 {0.8} 700 {0.7}	Min. 0.12 {Min. 1.2} Min. 0.10 {Min. 1.0}	0.08 {0.8} 0.07 {0.7}	Min. 0.12 {Min. 1.2} Min. 0.10 {Min. 1.0}	0.08 {0.8} 0.07 {0.7}
90 – 110	120	90 – 110	120	90 – 110	120
Max. 0.3	0.6	Max. 0.3	0.6	Max. 0.3	0.6
—	—	—	—	—	—
1,335 ± 40	1,335 ± 40	1,110 ± 35	1,110 ± 35	1,050 ± 30	1,050 ± 30
13 – 15 (New part) 17 – 19 (Tension adjusted)	13 – 15 (New part) 17 – 19 (Tension adjusted)	(Auto-Tension)	(Auto-Tension)	(Auto-Tension)	(Auto-Tension)
13 – 16	13 – 16	13 – 16	13 – 16	13 – 16	13 – 16

TESTING AND ADJUSTING

Engine				SDA6D140E-3	
Machine model				D275A-5, D275AX-5	
Category	Item	Measurement conditions, etc.	Unit	Standard value for new machine	Service limit value
Performance	Engine speed	High idling Low idling	rpm rpm	2,200 ± 50 700 ± 30	2,200 ± 50 700 ± 30
	Speed needed to start	0° (without starting aid) –20° (with starting aid)	rpm rpm	Min. 110 Min. 85	— —
Intake, exhaust system	Intake resistance	Whole speed range	kPa{mmH ₂ O}	Max. 2.94 {Max. 300}	7.47 {762}
	Intake air pressure	At rated horsepower	kPa{mmHg}	Min. 117 {Min. 880}	93.3 {700}
	Exhaust pressure	At rated horsepower	kPa{mmHg}	Min. 103 {Min. 770}	82.6 {620}
	Exhaust temperature	Whole speed range (–20°C)	°C	Max. 650	700
	Exhaust gas color	At sudden acceleration (low idling → high idling)	Bosch index	Max. 4.0	6.0
		At rated horsepower	Bosch index	Max. 1.0	2.5
		At high idling	Bosch index	Max. 1.0	2.0
Engine proper	Valve clearance	Intake valve Exhaust valve	mm mm	0.35 0.57	— —
	Compression pressure	Oil temperature: 40 – 60°C (engine speed: 200 – 250 rpm)	MPa{kg/cm ² }	Min. 3.8{39}	2.7{27}
Lubrication system	Blow-by pressure	At rated horsepower (water temperature : Min. 70°C)	kPa{kg/cm ² }	Max. 1.96{200}	3.92{400}
	Oil pressure (oil temperature : Min. 80°C)	At rated horsepower SAE30 or SAE15W-40	MPa{kg/cm ² }	0.34 – 0.54 {3.5 – 5.5}	0.21 {2.1}
		SAE10W	MPa{kg/cm ² }	0.29 – 0.49 {3.0 – 5.0}	0.18 {1.8}
		At low idling SAE30 or SAE15W-40	MPa{kg/cm ² }	Min. 0.12 {Min. 1.2}	0.08 {0.8}
		SAE10W	MPa{kg/cm ² }	Min. 0.10 {Min. 1.0}	0.07 {0.7}
	Oil temperature	Whole speed range (inside oil pan)	°C	90 – 110	120
Cooling system	Oil consumption	Ratio to fuel consumption at continuous rated output	%	Max. 0.3	0.6
	Radiator pressure valve function	Cracking pressure (differential pressure)	kPa{kg/cm ² }	—	—
	Fan speed	At rated speed	rpm	1,200 ± 35	1,200 ± 35
	Fan belt tension	Deflection when pressed with finger force of approx. 98 kN {10 kg}	mm	—	—
	Alternator belt tension	Deflection when pressed with finger force of approx. 98 kN {10 kg}	mm	13 – 16	13 – 16

STANDARD VALUE TABLE FOR ELECTRICAL RELATED PARTS

Name of component	Connector No.	Inspection method	Judgment table	Measurement conditions					
NE revolution sensor	SNE (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>85 – 210 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	85 – 210 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect SNE.	
Between (1) and (2)	85 – 210 Ω								
Between (1), (2) and ground	Min. 1 MΩ								
G revolution sensor	SG (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>1.4 k – 3.5 kΩ</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	1.4 k – 3.5 kΩ	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect SG.	
Between (1) and (2)	1.4 k – 3.5 kΩ								
Between (1), (2) and ground	Min. 1 MΩ								
Water temperature low-temperature sensor	TWL (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (A) and (B)</td><td>9 k – 0.3 kΩ</td></tr><tr><td>Between (A), (B) and ground</td><td>Min. 1MΩ</td></tr></table>	Between (A) and (B)	9 k – 0.3 kΩ	Between (A), (B) and ground	Min. 1MΩ	1) Turn starting switch OFF. 2) Disconnect TWL. 3) Water temperature: 10 – 100°C	
Between (A) and (B)	9 k – 0.3 kΩ								
Between (A), (B) and ground	Min. 1MΩ								
Water temperature high-temperature sensor	TWH (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>90 k – 3.5 kΩ</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	90 k – 3.5 kΩ	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect TWH. 3) Water temperature: 10 – 100°C	
Between (1) and (2)	90 k – 3.5 kΩ								
Between (1), (2) and ground	Min. 1 MΩ								
Oil pressure low-pressure switch	POL (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td rowspan="2">Between terminal and sensor (ground)</td><td>Engine stopped</td><td>Max. 1 Ω</td></tr><tr><td>600 rpm and above</td><td>Min. 1 MΩ</td></tr></table>	Between terminal and sensor (ground)	Engine stopped	Max. 1 Ω	600 rpm and above	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect POL.
Between terminal and sensor (ground)	Engine stopped	Max. 1 Ω							
	600 rpm and above	Min. 1 MΩ							
Oil pressure high-pressure switch	POH (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td rowspan="2">Between terminal and sensor (ground)</td><td>Engine stopped</td><td>Max. 1 Ω</td></tr><tr><td>1,300 rpm and above</td><td>Min. 1 MΩ</td></tr></table>	Between terminal and sensor (ground)	Engine stopped	Max. 1 Ω	1,300 rpm and above	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect POH.
Between terminal and sensor (ground)	Engine stopped	Max. 1 Ω							
	1,300 rpm and above	Min. 1 MΩ							
Boost pressure sensor	CN1 CN2	Measure voltage	If the condition is as shown in the table below, it is normal <table><tr><td>Between CN2 (2) and (10)</td><td>4.6 – 5.4 V</td></tr><tr><td>Between CN1 (3) and CN2 (10)</td><td>0.3 – 4.7 V</td></tr></table>	Between CN2 (2) and (10)	4.6 – 5.4 V	Between CN1 (3) and CN2 (10)	0.3 – 4.7 V	1) Connect T-adaptor to CN1 and CN2. 2) Start engine.	
Between CN2 (2) and (10)	4.6 – 5.4 V								
Between CN1 (3) and CN2 (10)	0.3 – 4.7 V								
Fuel temperature sensor	TFL (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>9 k – 0.3 MΩ</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	9 k – 0.3 MΩ	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect TFL 3) Fuel temperature: 10 – 100°C	
Between (1) and (2)	9 k – 0.3 MΩ								
Between (1), (2) and ground	Min. 1 MΩ								
Common rail fuel pressure sensor	CN1 CN2	Measure voltage	If the condition is as shown in the table below, it is normal <table><tr><td>Between CN2 (2) and (10)</td><td>4.6 – 5.4 V</td></tr><tr><td>Between CN1 (3) and CN2 (10)</td><td>0.3 – 4.7 V</td></tr></table>	Between CN2 (2) and (10)	4.6 – 5.4 V	Between CN1 (3) and CN2 (10)	0.3 – 4.7 V	1) Connect T-adaptor to CN1 and CN2. 2) Start engine.	
Between CN2 (2) and (10)	4.6 – 5.4 V								
Between CN1 (3) and CN2 (10)	0.3 – 4.7 V								

TESTING AND ADJUSTING

STANDARD VALUE TABLE FOR ELECTRICAL RELATED PARTS

Name of component	Connector No.	Inspection method	Judgment table	Measurement conditions				
Fuel supply pump PCV1	PV1 (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>2.3 – 5.3 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	2.3 – 5.3 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect PV1.
Between (1) and (2)	2.3 – 5.3 Ω							
Between (1), (2) and ground	Min. 1 MΩ							
Fuel supply pump PCV2	PV2 (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>2.3 – 5.3 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	2.3 – 5.3 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect PV2.
Between (1) and (2)	2.3 – 5.3 Ω							
Between (1), (2) and ground	Min. 1 MΩ							
No. 1 fuel injector	IJ1 (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>0.4 – 1.1 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	0.4 – 1.1 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect IJ1.
Between (1) and (2)	0.4 – 1.1 Ω							
Between (1), (2) and ground	Min. 1 MΩ							
No. 2 fuel injector	IJ2 (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>0.4 – 1.1 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	0.4 – 1.1 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect IJ2.
Between (1) and (2)	0.4 – 1.1 Ω							
Between (1), (2) and ground	Min. 1 MΩ							
No. 3 fuel injector	IJ3 (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>0.4 – 1.1 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	0.4 – 1.1 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect IJ3.
Between (1) and (2)	0.4 – 1.1 Ω							
Between (1), (2) and ground	Min. 1 MΩ							
No. 4 fuel injector	IJ4 (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>0.4 – 1.1 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	0.4 – 1.1 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect IJ4.
Between (1) and (2)	0.4 – 1.1 Ω							
Between (1), (2) and ground	Min. 1 MΩ							
No. 5 fuel injector	IJ5 (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>0.4 – 1.1 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	0.4 – 1.1 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect IJ5.
Between (1) and (2)	0.4 – 1.1 Ω							
Between (1), (2) and ground	Min. 1 MΩ							
No. 6 fuel injector	IJ6 (male)	Measure resistance	If the condition is as shown in the table below, it is normal <table><tr><td>Between (1) and (2)</td><td>0.4 – 1.1 Ω</td></tr><tr><td>Between (1), (2) and ground</td><td>Min. 1 MΩ</td></tr></table>	Between (1) and (2)	0.4 – 1.1 Ω	Between (1), (2) and ground	Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect IJ6.
Between (1) and (2)	0.4 – 1.1 Ω							
Between (1), (2) and ground	Min. 1 MΩ							

★ The connector No. for the component differs according to the machine model on which the engine is mounted.

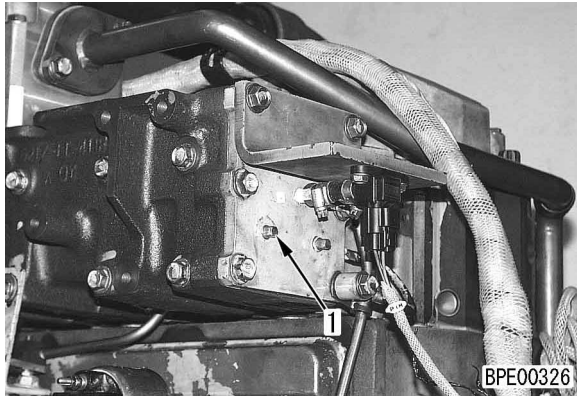
TOOLS FOR TESTING, ADJUSTING, AND TROUBLESHOOTING

Check or adjustment item	Sym bol	Part Number	Part Name	Remarks
Intake resistance	A	Pressure test kit	799-203-2002	-9.8 – 0 kPa{-1,000 – 0 mmH ₂ O}
Intake air pressure				0 – 200 kPa{0 – 1,500 mmHg}
Exhaust pressure				0 – 200 kPa{0 – 1,500 mmHg}
Blow-by pressure				0 – 9.8 kPa{0 – 1,000 mmH ₂ O}
Lubricant pressure				0 – 1.0 MPa{0 – 10 kg/cm ² }
Fuel pressure				0 – 1.0 MPa{0 – 10 kg/cm ² }
Intake and exhaust temperatures	B	Digital temperature gauge	799-101-1502	-99.9 – 1,299°C
Oil and water temperatures				
Exhaust color	C	Handy smoke checker	799-201-9000	
		Smoke meter	Commercially available	
Compression pressure	D	Compression gauge	795-502-1590	6.9 MPa{70 kg/cm ² }
		Adapter	795-471-1310	For 140E-3 engine
		Gasket	6217-71-6110	
Valve clearance	E	Feeler gauge	Commercially available	Intake: 0.35 mm, Exhaust: 0.57 mm
Quality of lubricant	F	Engine oil checker	799-201-6000	
Specific gravity of battery electrolyte	G	Battery, coolant tester	795-501-1001	Temperature: -5 to -50°C
Coolant freezing temperature				Specific gravity: 1.100 – 1.300
Pressure valve function	H	Radiator cap tester	799-202-9001	0 – 0.2 MPa{0 – 2 kg/cm ² }
Leakage from cooling system				
Quality of coolant	J	Water quality tester	799-202-7001	PH, nitrous acid ion density
Clogging of radiator	K	Anemometer (wind speed)	799-202-2001	1 – 40 m/s
Electric components, wiring harnesses	L	Harness checker	799-601-9000	T-adapter, box for HD30, DT
		Socket	799-601-9410	For speed sensor
		Adapter	799-601-9420	For pressure sensor
		Socket	799-601-9430	For PCV

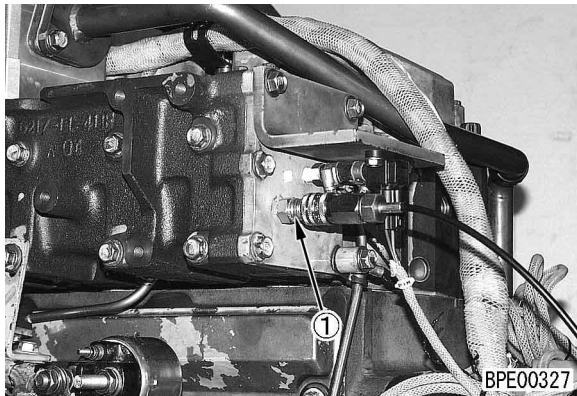
MEASURING INTAKE AIR PRESSURE (BOOST PRESSURE)

⚠ When installing or removing the measuring equipment, be careful not to touch high-temperature parts.

1. Remove air intake pressure measurement plug (1).



2. Fit nipple ① of pressure test kit A, then connect to the pressure test kit.

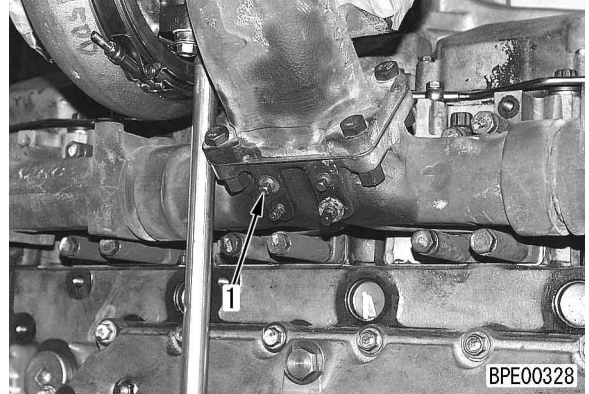


3. Start the engine and measure the intake air pressure when the engine is running at rated horsepower.
 - ★ When measuring with the engine mounted on the machine, measure according to the conditions given in the shop manual for the machine.
4. After completing the measurement, remove the measurement equipment and set to the original condition.

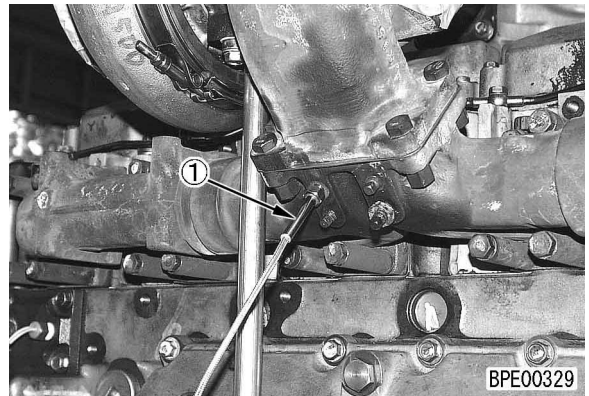
MEASURING EXHAUST TEMPERATURE

⚠ Wait for the exhaust manifold temperature to go down before removing or installing the measuring equipment.

1. Remove exhaust temperature measurement plug (1).



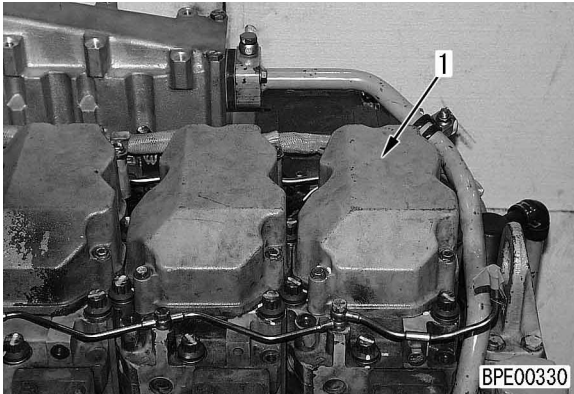
2. Fit sensor ① of digital temperature gauge B, then connect to the digital temperature gauge.



3. Start the engine and measure the exhaust temperature when the engine is running at rated horsepower.
 - ★ When measuring with the engine mounted on the machine, measure according to the conditions given in the shop manual for the machine.
4. After completing the measurement, remove the measurement equipment and set to the original condition.

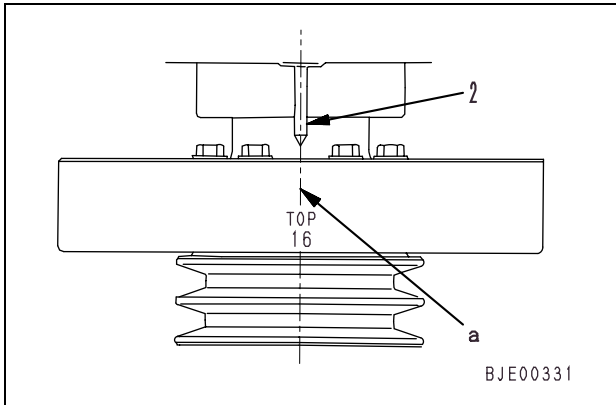
ADJUSTING VALVE CLEARANCE

1. Remove cylinder head cover (1).



2. Rotate the crankshaft in the normal direction to set No. 1 cylinder at compression top dead center, and align pointer (2) with the [1.6] mark **a** on the damper.

- ★ Crank the crankshaft with the hexagonal portion at the tip of the water pump drive shaft.
- ★ At compression top dead center, the valve rocker arm can be moved by hand by the amount of the valve clearance. If the rocker arm does not move, the crankshaft is not at compression dead center, so rotate it one more turn.



3. To adjust the valve clearance, insert the feeler gauge into clearance **b** between rocker arm (3) and crosshead (4), and adjust the valve clearance with adjustment screw (5).

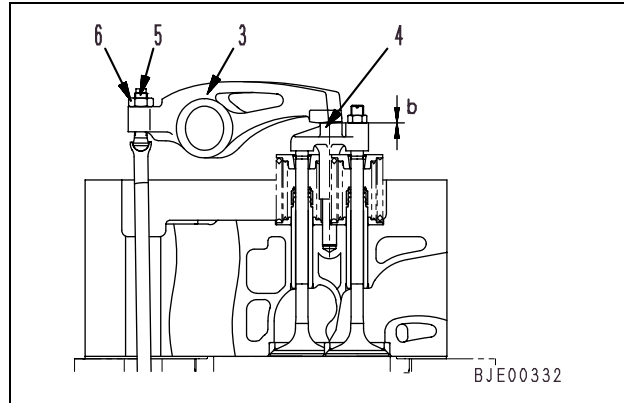
- ★ Insert the feeler gauge and turn adjustment screw (5) until the clearance is a sliding fit.
- ★ Valve clearance Intake valve: 0.35 mm
Exhaust valve: 0.57 mm

4. Tighten locknut (6) to hold adjustment screw (5) in position.

 **kgm** Locknut :

53.0 – 64.7 Nm {5.4 – 6.6 kgm}

- ★ After tightening the locknut, check the clearance again.



5. Turn the crankshaft 120° each time in the normal direction and repeat the procedure in Steps 2 to 4 to adjust the valves of each cylinder according to the firing order.

- ★ Firing order : 1–5–3–6–2–4

6. After completing the measurement, set to the original condition.

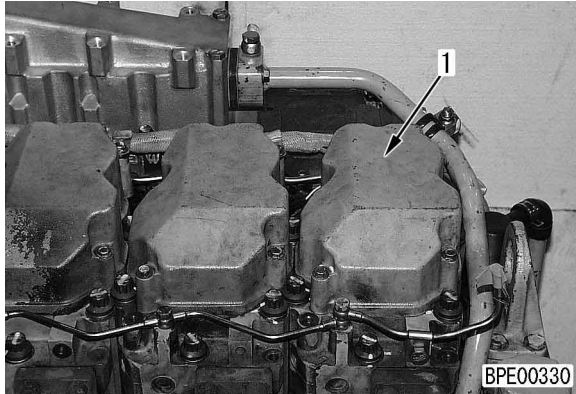
 **kgm** Cylinder head cover mounting bolt:

29.4 – 34.3 Nm {3.0 – 3.5 kgm}

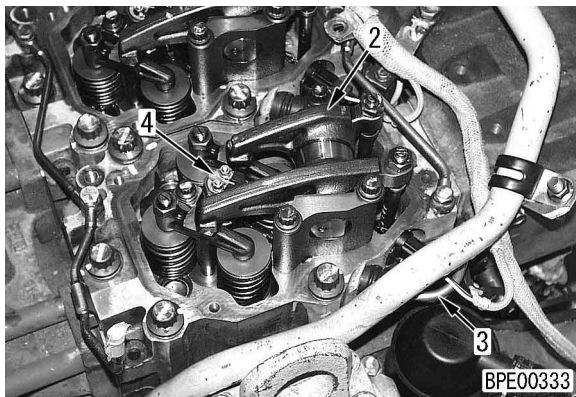
MEASURING COMPRESSION PRESSURE

- ⚠ When measuring the compression pressure, be careful not to touch the exhaust manifold or muffler, or to get caught in rotating parts.
- ★ Measure the compression pressure with the engine warmed up. (Oil temperature: 40 – 60°C)

1. Remove cylinder head cover (1).



2. Remove rocker arm assembly (2).
3. Disconnect fuel high-pressure tube (3), then remove the injector wiring harness and fuel injector (4).
 - ★ Disconnect the injector wiring harness from the terminal at the injector end and the bracket at the rocker housing end, then remove from the injector. (Loosen the terminal nuts in turn.)
 - ★ Pass a wire under the fuel passage protruding to the side, then pull up the injector (do not twist or lever the top of the injector).



4. Fit adapter ① of compression gauge D, then connect to the compression gauge.
 - ★ Coat the connection of the adapter and gauge with a small amount of engine oil to prevent leakage.
 - ★ Hold the adapter in position with an injector holder.

kgm Mounting bolt:

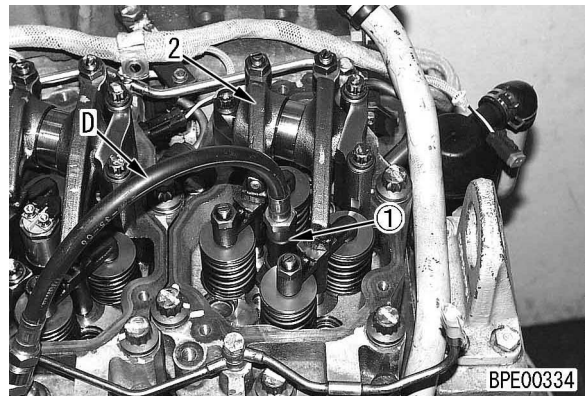
58.8 – 73.5 Nm {6.0 – 7.5 kgm}

5. Install rocker arm assembly (2), then adjust the valve clearance.

kgm Mounting bolt:

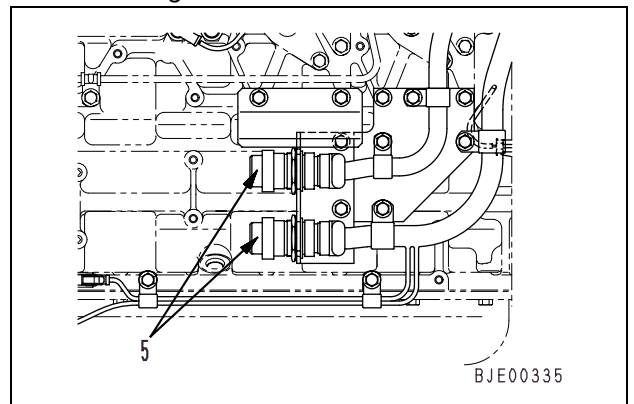
93 – 103 Nm {9.5 – 10.5 kgm}

- ★ For details, see ADJUSTING VALVE CLEARANCE.



6. Disconnect 2 engine central connectors (5).

- ⚠ If the connectors are not disconnected, there is danger that the engine may start during the measurement operation, so always be sure to disconnect them.
- ⚠ Cover the connector at the controller end with vinyl to prevent electrical leakage or short circuit with the ground.



7. Measure the compression pressure when the engine is cranked with the starting motor.
 - ★ Measure the compression pressure when the gauge indicator is stable.

TESTING AND ADJUSTING MEASURING COMPRESSION PRESSURE, MEASURING BLOW-BY PRESSURE

8. After completing the measurement, remove the measurement equipment and set to the original condition.

★ Install the fuel injector and fuel high-pressure tube as follows.

- 1) Assemble holder (12) to injector (11), then set in the mounting position on the cylinder head.

- 2) Temporarily tighten mounting bolt (13).

★ Tighten so that the injector can still move.

- 3) Temporarily tighten tube sleeve (14) to injector (11).

★ Tighten until it contacts the injector and stops.

- 4) Tighten mounting bolt (13) fully.

 Mounting bolt:

58.8 – 73.5 Nm {6.0 – 7.5 kgm}

- 5) Tighten tube sleeve (14) fully.

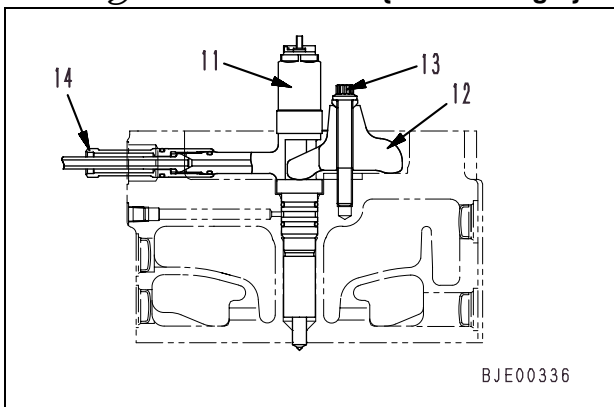
 Sleeve:

39.2 – 49.0 Nm {4 – 5 kgm}

- 6) Install the injector wiring harness.

★ Tighten the terminal nuts at the top of the injector in turn.

 Nut: **2 ± 0.2 Nm {0.2 ± 0.02 kgm}**



 Rocker arm assembly mounting bolt:

93 – 103 Nm {9.5 – 10.5 kgm}

★ Adjust the valve clearance. For details, see ADJUSTING VALVE CLEARANCE.

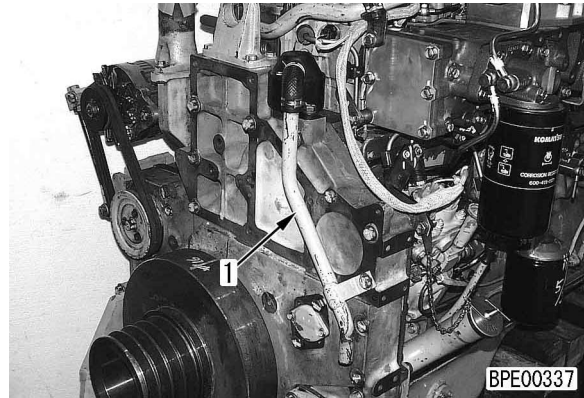
 Cylinder head cover mounting bolt:

29.4 – 34.3 Nm {3.0 – 3.5 kgm}

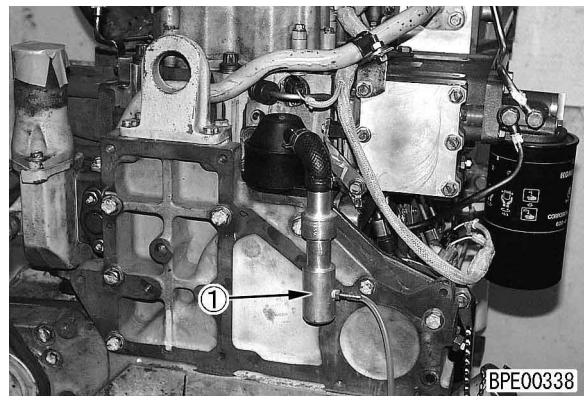
MEASURING BLOW-BY PRESSURE

1. Remove blow-by tube (1).

★ For the type where a hose is installed to the tip of the blow-by tube, the measurement can be made at the tip of the hose, so there is no need to remove the blow-by tube.



2. Install nozzle ① of pressure test kit A, then connect to the pressure test kit.



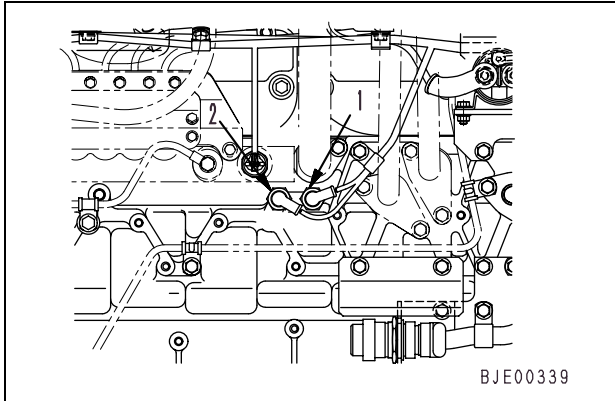
3. Measure the blow-by pressure when the engine is running at rated horsepower.

★ When measuring with the engine mounted on the machine, measure according to the conditions given in the shop manual for the machine.

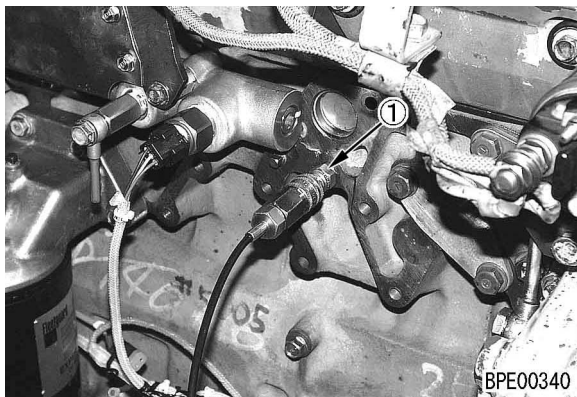
4. After completing the measurement, remove the measurement equipment and set to the original condition.

MEASURING OIL PRESSURE

1. Remove oil pressure low-pressure switch (1) or oil pressure high-pressure switch (2).
 - ★ Wrap the wiring harness of the disconnected switch with tape to prevent it from touching the cylinder block.



2. Fit nipple ① to pressure test kit A, then connect to the pressure test kit.



3. Start the engine and measure the oil pressure when the engine is running at low idling and high idling.
4. After completing the measurement, remove the measurement equipment and set to the original condition.



Oil pressure switch:

2.9 – 5.9 Nm {0.3 – 0.6 kgm}

HANDLING EQUIPMENT IN FUEL CIRCUIT

- ★ Precaution for inspection and maintenance of fuel system

With the common rail type fuel injection system, more precise equipment is used than with the conventional fuel injection pump and nozzle, so problems may occur if dirt or dust get in.

When carrying out installation and maintenance of the fuel system, pay more attention than usual to prevent dirt or dust from getting in. If there is any dirt stuck to any part, use clean fuel to wash it off completely.

- ★ Precautions when replacing fuel filter cartridge
Always use a genuine Komatsu part for the fuel filter cartridge.

With the common rail type fuel injection system, more precise equipment is used than with the conventional fuel injection pump and nozzle, so a special filter with high efficiency filtering ability is used to prevent dirt or dust from getting in.

For this reason, if any filter is used as a substitute for the genuine filter, there is danger that problems will occur with the fuel system. To prevent this, never use such filters.

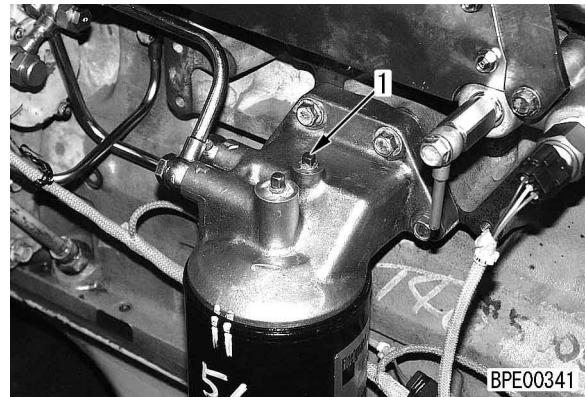
RELEASING REMAINING PRESSURE IN FUEL SYSTEM

- ★ When the engine is running, pressure is generated in both the low-pressure circuit and high-pressure circuit of the fuel line.
Low-pressure circuit: Feed pump – fuel filter – fuel supply pump
High-pressure circuit: Fuel supply pump – common rail – fuel injector
- ★ For both the low-pressure circuit and high-pressure circuit, the pressure automatically goes down to a safe level 30 seconds after the engine is stopped.
- ★ The remaining pressure in the fuel system must be completely released before carrying out inspection of the fuel system or removal or installation of the equipment. Always follow the following precautions when carrying out the operation.
- ⚠ When inspecting the fuel line or removing or installing equipment, wait for at least 30 seconds after the engine is stopped to release the remaining pressure in the fuel system before starting the operation. (There is still pressure remaining in the circuit, so do not start operations immediately after the engine is stopped).

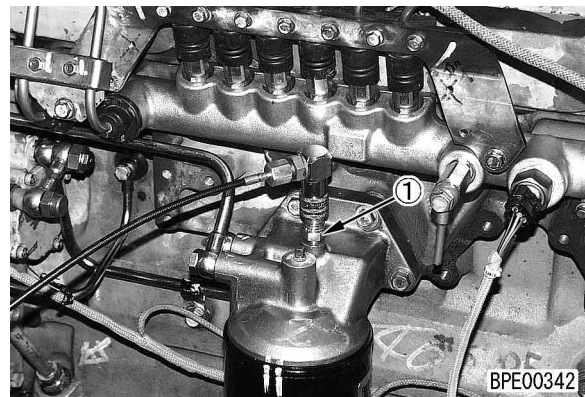
MEASURING FUEL PRESSURE

- ★ Measure the fuel pressure only for the low-pressure circuit between the feed pump – fuel filter – fuel supply pump.
- ⚠ The high-pressure circuit between the fuel supply pump – common rail – fuel injector is under extremely high pressure, so it cannot be measured.

1. Remove fuel pressure measurement plug (1).



2. Fit nipple ① of pressure test kit A, then connect to the pressure test kit.



3. Start the engine and measure the fuel pressure at high idling.
4. After completing the measurement, remove the measurement equipment and set to the original condition.
- ★ For the standard values, see "TROUBLESHOOTING OF ELECTRICAL SYSTEM (E MODE)"

REDUCED CYLINDER MODE OPERATION

- ★ Reduced cylinder mode operation means setting the fuel injectors of a single cylinder or multiple cylinders electrically to the NO INJECTION condition to run the engine on a reduced number of cylinders. It has the following purposes and effects.

- ★ The reduced cylinder mode operation must be carried out when the engine is mounted on the machine.

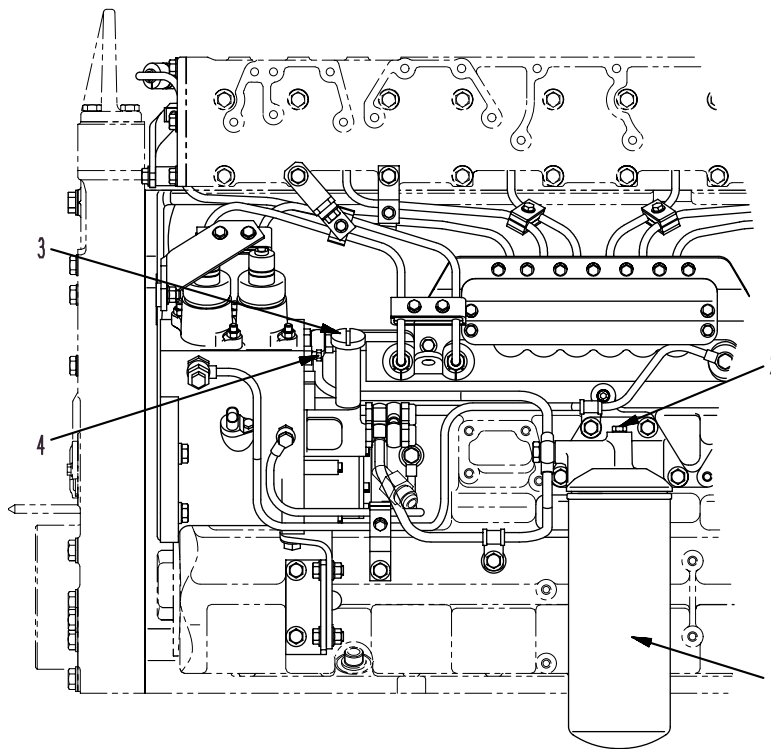
In addition, when carrying out reduced cylinder mode operation, it is necessary to operate switches or the panel on the machine mounting the engine, so see the shop manual for the machine for details of the method of operation.

1. The reduced cylinder mode operation is used when it is thought that one of the engine cylinders is not giving normal output (combustion). It is a method to determine which cylinder is not operating normally.
2. With the reduced cylinder mode operation, if there is no change in the engine speed and output from the present condition (engine run on all cylinders), even when a cylinder is set to NO INJECTION, it means that this cylinder is the cause of the problem.

Such problems may occur for the following reasons.

- Leakage from cylinder head gasket
 - Defective injection by the fuel injector
 - Defective piston, piston ring, cylinder liner
 - Defective valve mechanism (dynamic valve)
 - Defective electrical system
3. With the common rail type fuel injection system, the fuel injector for each cylinder is operated individually by electronic control. So compared with the mechanical type fuel injection system, it is possible to carry out the reduced cylinder mode operation with simple operation of the switches. This makes it easier to narrow down the location of the problem.]

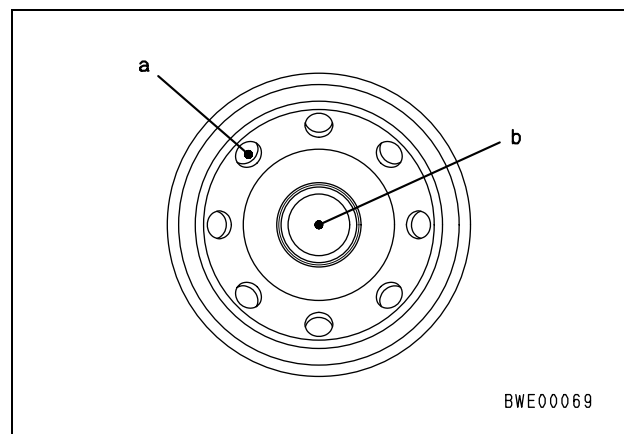
BLEEDING AIR FROM FUEL SYSTEM



BJE00343

- ★ Bleed the air as follows if the engine has run out of fuel or the fuel circuit equipment has been removed and installed.
- ★ With the type where the priming pump and fuel filter have a remote mount, operate the remote control for the priming pump to bleed the air.

1. Remove fuel filter (1), fill with fuel, then install again.
 - ★ When filling, use clean fuel and be careful not to let dirt get in.
 - ★ Add fuel through inlet ports **a** (8 places) of the filter. Since hole **b** is the outlet port (clean side), do not add fuel through it.
 - ★ If clean fuel is not available, do not remove the filter. Operate the priming pump to fill the inside of the filter with fuel.



BWE00069

2. Remove air bleed plug (2) of the fuel filter and operate priming pump (3).

- ★ Continue operating the priming pump until fuel flows out from the plug hole. When fuel comes out, install the plug.

 kgm Air bleed plug:

7.8 – 9.8 Nm {0.8 – 1.0 kgm}

3. Loosen air bleeder (4) of the fuel supply pump and operate priming pump (3) 90 – 100 times.

- ★ Operate the priming pump until fuel flows out from the bleeder. When the fuel flows out, tighten the bleeder, then operate the priming pump several times until the pump becomes stiff.

 kgm Air bleeder:

4.9 – 6.9 Nm {0.5 – 0.7 kgm}

4. Crank the engine with the starting motor and start the engine.

- ★ When the high-pressure circuit is cranked with the engine, the air is automatically bled.
- ★ If the engine does not start, the air has probably not properly bled from the low-pressure circuit, so repeat the procedure from Step 2.

CHECK FOR LEAKAGE IN FUEL SYSTEM

- ⚠** With the fuel system, the high-pressure circuit is under extremely high pressure, so if fuel leaks when the engine is running, there is danger of fire.
Check for fuel leakage as follows when checking the fuel circuit or when equipment has been removed and installed.
- ★ To make it easier to check for fuel leakage, wipe the engine itself and the surrounding area clean and remove all oil and grease before starting the inspection.
1. Spray the fuel supply pump, common rail, fuel injector, and high-pressure piping connections with a color checker (developing solution).
 2. Start the engine, run it at under 1000 rpm, and when the speed stabilizes, stop the engine.
 3. Check the fuel piping and equipment for fuel leakage.
 - ★ Check the high-pressure circuit for fuel leakage, particularly at the places sprayed with color checker.
 - ★ If there is fuel leakage, carry out repairs, then repeat the check from Step 2.
 4. Start the engine and run it at low idling.
 5. Check the fuel piping and equipment for fuel leakage.
 - ★ Check the high-pressure circuit for fuel leakage, particularly at the places sprayed with color checker.
 - ★ If there is fuel leakage, carry out repairs, then repeat the check from Step 2.
 6. Start the engine and run it at high idling.
 7. Check the fuel piping and equipment for fuel leakage.
 - ★ Check the high-pressure circuit for fuel leakage, particularly at the places sprayed with color checker.
 - ★ If there is fuel leakage, carry out repairs, then repeat the check from Step 2.
 8. Start the engine, run it at high idling, then apply load to the engine.
 - ★ If this inspection is carried out with the engine mounted on the machine, stall the torque converter or relieve the hydraulic pump.
 9. Check the fuel piping and equipment for fuel leakage.
 - ★ Check the high-pressure circuit for fuel leakage, particularly at the places sprayed with color checker.
 - ★ If there is fuel leakage, carry out repairs, then repeat the check from Step 2.
 - ★ If no fuel leakage is found, the check is complete.

ADJUSTING SPEED SENSOR

- ★ The G revolution sensor and NE revolution sensor for the common rail type fuel injection system cannot be adjusted.
- ★ Adjust the speed sensor as follows for the type which uses an electronic system on the machine and detects the signal from the flywheel ring gear.

1. Screw in sensor (1) until the tip contacts the tip of the tooth of flywheel ring gear (2).

- ★ Check that there is no damage or metal powder on the tip of the sensor when installing.

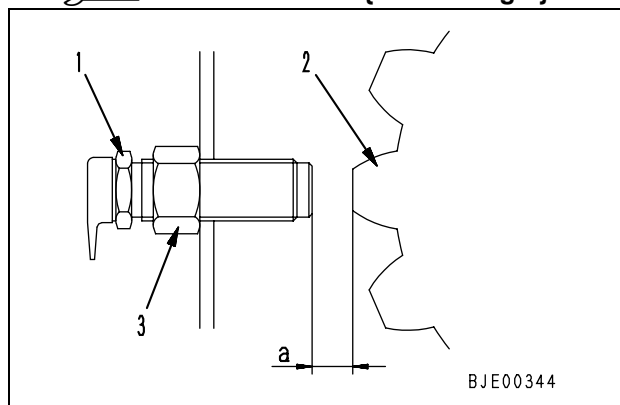
 Thread: **Hydraulic sealant**

2. Turn sensor (1) back 1/2 – 2/3 turns.

- ★ This makes a clearance of 0.75 – 1.00 mm between the tip of the sensor and the tip of the gear tooth.

3. Hold sensor (1) in position with nut (3).

 Nut: **69 – 74 Nm {7.0 – 7.5 kgm}**



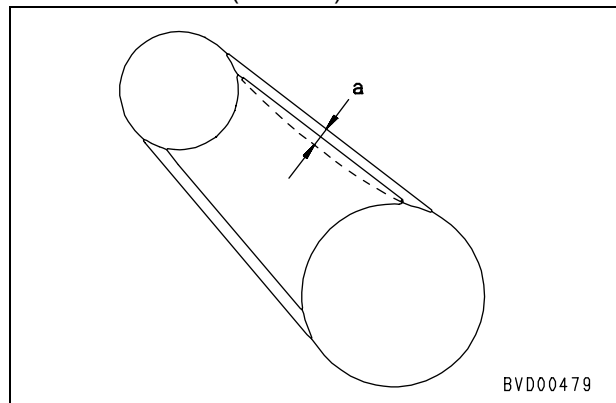
TESTING AND ADJUSTING ALTERNATOR BELT TENSION

1. Inspecting

Measure deflection **a** when the belt is pressed with a finger at a point midway between the alternator pulley and drive pulley.

- ★ Pushing force: Approx. 98 Nm {approx. 10 kg}

- ★ Deflection (one belt): 13 – 16 mm



2. Adjusting

- ★ This makes a clearance of 0.75 – 1.00 mm between the tip of the sensor and the tip of the gear tooth.

- ★ If the deflection is not within the specified range, adjust as follows.

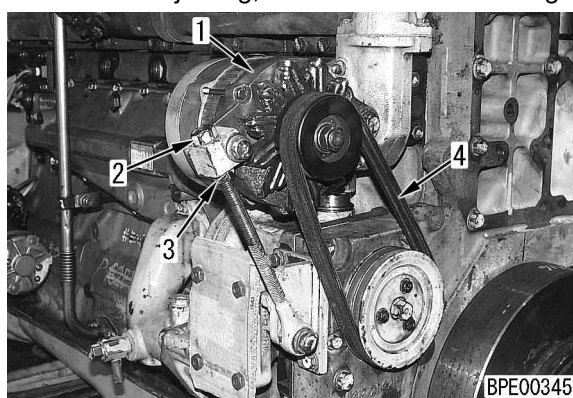
- 1) Loosen 2 mounting bolts of alternator (1) and 1 lock bolt of the bar.
- 2) Loosen locknut (2), move alternator (1) with adjustment nut (3), and adjust the tension of belt (4).

- ★ Deflection (one belt): 13 – 16 mm

- 3) Tighten locknut (2).

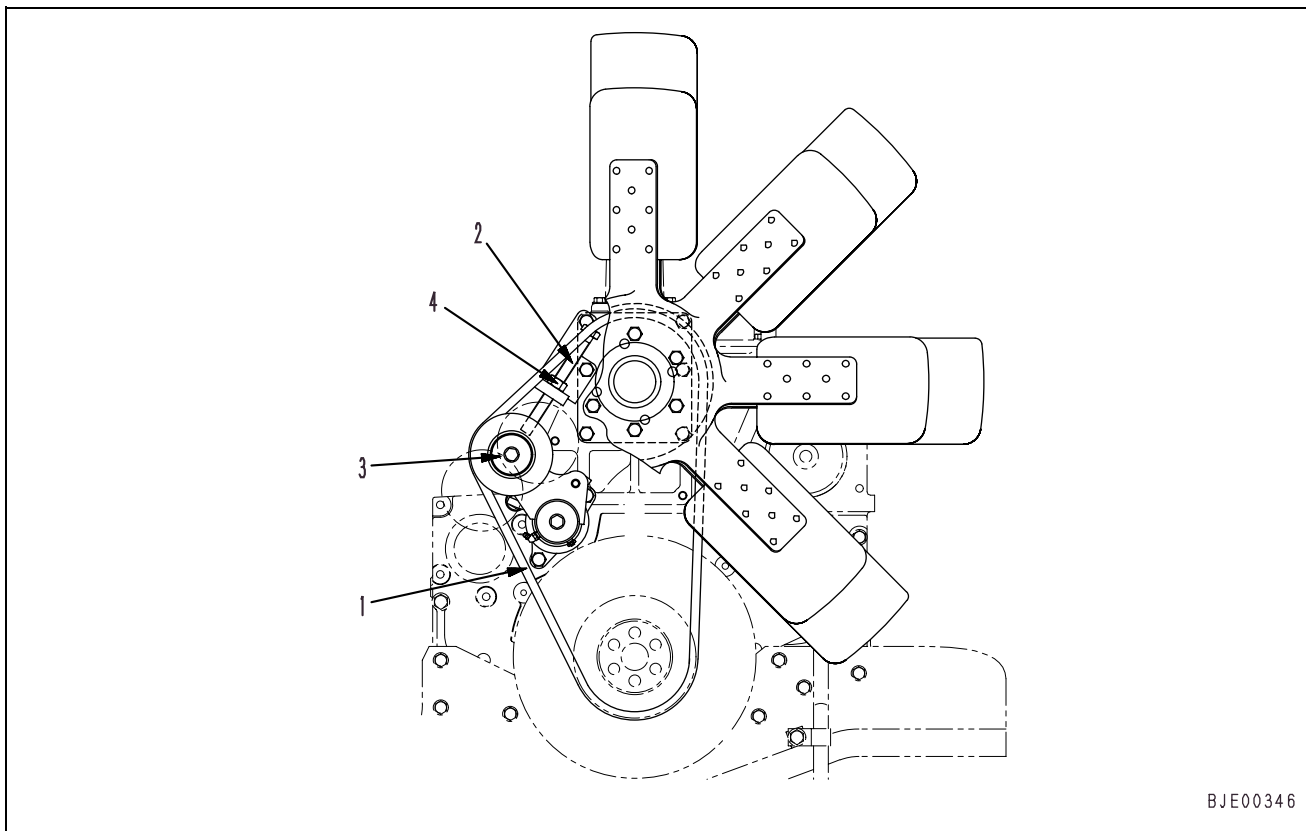
- 4) Tighten 2 mounting bolts of alternator (1) and 1 lock bolt of the bar.

- ★ After adjusting, check the belt tension again.



TESTING AND ADJUSTING FAN BELT TENSION

SEMI AUTO TENSION TYPE



BJE00346

1. Inspection

With the semi auto tension type, there is no need to inspect until the belt is replaced.

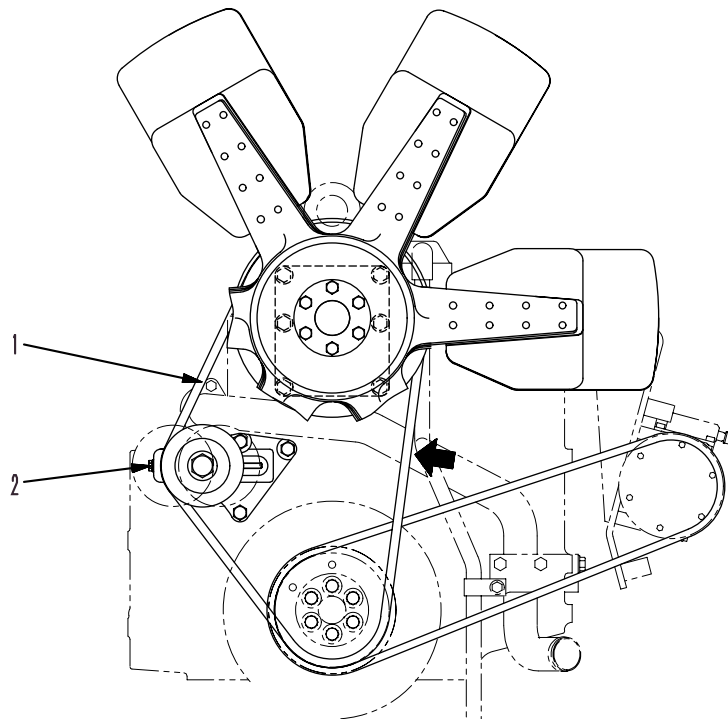
2. Adjustment

- 1) Install 2 belts (1).
 - ★ Loosen the stopper bolt when installing the belts.
- 2) Tighten stopper bolt (2) until it contacts bracket (3).
- 3) Tighten stopper bolt (2) a further 2 turns and hold in position with locknut (4).

 kgm Locknut:

245.0 – 308.7Nm {25.0 – 31.5 kgm}

ADJUSTING BOLT TYPE



BJE00347

1. Inspection

Check that the deflection is normal when the belt is pressed with a finger at a point midway between the fan pulley and crankshaft pulley.

- ★ Check each belt individually.
- ★ Pushing force: Approx.98 Nm {approx.10 kg}
- ★ Deflection : 13 – 15 mm (new part)
17 – 19 mm (tension adjusted)

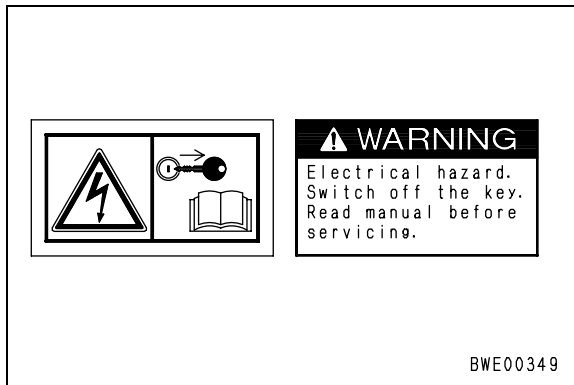
2. Adjustment

- ★ If the deflection is not within the standard value, adjust as follows.

- 1) Install 2 belts (1).
- 2) Adjust the deflection of the belt with adjustment bolt (2).

- ★ Deflection : 13 – 15 mm (new part)
17 – 19 mm
(tension adjusted)

HANDLING CONTROLLER HIGH VOLTAGE CIRCUIT



- ⚠ With the controller, a high voltage circuit (110 – 130V) is used for the fuel injector drive. As a result, a high voltage circuit is connected to the wiring harness and connector from the controller to the fuel injector.
 - ★ Normally, high voltage is output from the controller to the fuel injector only when the engine is running. When the engine is stopped, the output stops.
 - ⚠ If the high voltage circuit is touched directly, there is danger of electrocution, so observe the following precautions when carrying out inspection.
1. The connectors, including those for the high voltage circuit, are as follows.
 - Controller connector: **CN6, CN7**
 - Intermediate connector: **EC1**
 - Injector connector: **IJ1, IJ2, IJ3, IJ4, IJ5, IJ6**
 - Terminal at head of injector (inside head cover)
 2. When disconnecting or connecting the applicable connector, always turn the starting switch OFF before starting.
 3. When a T-adaptor has been inserted or connected to the applicable connector to carry out troubleshooting, never start the engine.
 - ★ If the starting switch is operated, operate it only to OFF or ON. Never turn it to the START position.

RUN-IN STANDARD

- ★ This list shows the standard on condition that the fan is removed.
- ★ Load are given for the case of the dynamometer arm length is 716mm.

Engine	Machine model	item		item					
				1	2	3	4	5	6
SA6D140E-3	D155AX-5 (110001 – 112349)	Running time	min	2	8	2	3	5	
		Engine speed	rpm	740	1,100	1,450	1,700	1,900	
		Dynamometer load	N{kg}	0{0}	430{44}	860{88}	1,280{130}	1,770{181}	
		Output	kW{HP}	0{0}	36{48}	94{126}	165{221}	252{338}	
	D155AX-5 (112350 and up)	Running time	min	2	8	2	3	5	
		Engine speed	rpm	740	1,000	1,200	1,500	1,900	
		Dynamometer load	N{kg}	0{0}	350{36}	870{89}	1,390{142}	1,750{178}	
		Output	kW{HP}	0{0}	26{35}	79{106}	157{210}	249{334}	
	PC600-6	Running time	min	2	8	2	3	5	
		Engine speed	rpm	800	1,000	1,200	1,500	1,800	
		Dynamometer load	N{kg}	0{0}	520{53}	1,130{115}	1,810{185}	2,260{231}	
		Output	kW{HP}	0{0}	39{52}	101{135}	204{274}	306{410}	
	WA500-3	Running time	min	2	8	2	3	5	
		Engine speed	rpm	725	1,000	1,200	1,500	2,100	
		Dynamometer load	N{kg}	0{0}	390{40}	780{80}	1,180{120}	1,570{160}	
		Output	kW{HP}	0{0}	29{39}	71{95}	132{177}	247{331}	
	DCA400SSK (DENYO generator)	Running time	min	2	8	2	3	5	
		Engine speed	rpm	800	1,000	1,200	1,500	1,800	
		Dynamometer load	N{kg}	0{0}	540{55}	1,840{188}	2,160{220}	2,700{276}	
		Output	kW{HP}	0{0}	40{54}	166{223}	243{325}	366{490}	
SAA6D140E-3	HD325-6	Running time	min	2	8	2	3	5	
		Engine speed	rpm	725	1,300	1,650	1,900	2,000	
		Dynamometer load	N{kg}	0{0}	590{60}	1,180{120}	1,760{180}	2,530{258}	
		Output	kW{HP}	0{0}	57{76}	146{196}	250{335}	379{508}	
	HM350-1	Running time	min	2	8	2	3	5	
		Engine speed	rpm	725	1,000	1,200	1,500	2,000	
		Dynamometer load	N{kg}	0{0}	402{41}	1,000{102}	1,600{163}	1,990{203}	
		Output	kW{HP}	0{0}	30{40}	90{120}	180{242}	299{400}	
	HM400-1	Running time	min	2	8	2	3	5	
		Engine speed	rpm	800	1,300	1,650	1,900	2,000	
		Dynamometer load	N{kg}	0{0}	510{52}	1,030{105}	1,540{157}	2,207{225}	
		Output	kW{HP}	0{0}	50{67}	127{170}	219{294}	331{444}	
	PC750-6 PC750LC-6 PC750-7 PC800-6 PC800-7	Running time	min	2	8	2	3	5	
		Engine speed	rpm	825	1,000	1,200	1,500	1,800	
		Dynamometer load	N{kg}	0{0}	520{53}	1,310{134}	2,100{214}	2,620{267}	
		Output	kW{HP}	0{0}	39{52}	118{159}	236{316}	354{474}	
	PC1800-6 (2 engines)	Running time	min	2	8	2	3	5	
		Engine speed	rpm	825	1,000	1,200	1,500	1,800	
		Dynamometer load	N{kg}	0{0}	520{53}	1,310{134}	2,100{214}	2,620{267}	
		Output	kW{HP}	0{0}	39{52}	118{159}	236{316}	354{474}	

TESTING AND ADJUSTING
RUN-IN STANDARD

Engine	Machine model	item		item					
				1	2	3	4	5	6
SDA6D140E-3	D275A-5 D275AX-5	Running time	min	2	8	2	3	5	
		Engine speed	rpm	700	1,000	1,200	1,500	2,000	
		Dynamometer load	N{kg}	0{0}	441{45}	1,110{113}	1,770{180}	2,220{226}	
		Output	kW{HP}	0{0}	33{45}	100{136}	199{270}	332{452}	

PERFORMANCE TEST STANDARDS

Engine	Machine model	Test item	Specification value	Speed (rpm)	Dynamometer load (N {kg})
SA6D140E-3	D155AX-5 (110001 – 112349)	Rated horsepower	252 kW/1,900 rpm (Gross) {338 HP/1,900 rpm} (Gross)	1,900 ± 5	1,755 – 1,820 {179 – 186}
		Max. torque	1,635 Nm/1,250 rpm (Gross) {166.7 kgm/1,250 rpm} (Gross)	1,250 ± 50	2,235 – 2,325 {228 – 237}
		High idling speed	2,100 ± 50 rpm	2,100 ± 50	—
		Low idling speed	740 ⁺²⁵ ₀ rpm	740 ⁺²⁵ ₀	—
	D155AX-5 (112350 and up)	Rated horsepower	248 kW/1,900 rpm (Gross) {332 HP/1,900 rpm} (Gross)	1,900 ± 5	1,705 – 1,775 {174 – 181}
		Max. torque	1,635 Nm/1,250 rpm (Gross) {166.7 kgm/1,250 rpm} (Gross)	1,250 ± 50	2,235 – 2,325 {228 – 237}
		High idling speed	2,100 ± 50 rpm	2,100 ± 50	—
		Low idling speed	740 ⁺²⁵ ₀ rpm	740 ⁺²⁵ ₀	—
	PC600-6	Rated horsepower	287 kW/1,800 rpm (net) {385 HP/1,800 rpm} (net)	1,800 ± 5	2,195 – 2,330 {224 – 238}
		Max. torque	1,755 Nm/1,400 rpm (net) {179 kgm/1,400 rpm} (net)	1,400 ± 100	2,460 – 2,620 {251 – 267}
		High idling speed	1,950 ± 50 rpm	1,950 ± 50	—
		Low idling speed	800 ± 25 rpm	800 ± 25	—
	WA500-3	Rated horsepower	235 kW/2,100 rpm (net) {316 HP/2,100 rpm} (net)	2,100 ± 5	1,520 – 1,610 {155 – 164}
		Max. torque	1,370 Nm/1,400 rpm (net) {140 kgm/1,400 rpm} (net)	1,400 ± 50	1,890 – 2,010 {193 – 205}
		High idling speed	2,350 ± 50 rpm	2,350 ± 50	—
		Low idling speed	725 ± 25 rpm	725 ± 25	—
	DCA400SSK (DENYO generator)	Rated horsepower	357 kW/1,800 rpm (Net, 60Hz) {478 HP/1,800 rpm} (Net, 60Hz)	1,800 ± 5 (60Hz)	2,620 – 2,780 (60Hz) {267 – 284} (60Hz)
		Max. torque			
		High idling speed	Max. 1880 rpm (60Hz)	Max. 1,880 rpm (60Hz)	—
		Low idling speed	800 ⁺⁵⁰ ₀ rpm	800 ⁺⁵⁰ ₀ rpm	—

★ This table shows the standard values using the JIS correction factor.

★ The output and torque values in the table are the standard values with the fan removed, so they are different from the specification values.

★ The table shows the standard values with an air cleaner installed, muffler installed, alternator under no load, and air compressor open (when installed).

★ The dynamometer load shows the value for an arm length of 716 mm.

TESTING AND ADJUSTING
PERFORMANCE TEST STANDARDS

Output (kW{HP})	Torque (Nm{kgm})	Fuel consumption (sec/300cc)	Cooling water temperature (°C)	Lubricating oil temperature (°C)	Lubricating oil pressure (kPa{kg/cm ² })	Exhaust temperature (°C)
244 – 253 (gross) {326 – 339} (gross)	—	Min. 16.3	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	1,600 – 1,670 (gross) {163 – 170} (gross)	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	—	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—
—	—	Min. 16.3	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	1,600 – 1,670 (gross) {163 – 170} (gross)	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	—	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—
297 – 315 (gross) {398 – 422} (gross)	—	Min. 14.1	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	1,760 – 1,870 (gross) {180 – 191} (gross)	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	—	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—
239 – 254 (gross) {320 – 340} (gross)	—	Min. 15.7	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	1,350 – 1,440 (gross) {138 – 147} (gross)	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	—	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—
345 – 376 (gross, 60Hz) {474 – 504} (gross, 60Hz)	—	Min. 10.6 (60Hz)	70 – 90	90 – 110	290 – 490 {3.0 – 5.0}	Max. 650
—	—	—	70 – 90	90 – 110	Min. 120	—
—	—	—	70 – 90	80 – 110	Min. 1.2	—

★ Use ASTM D975 diesel oil as the fuel.

★ Use SAE 15W-40 or SAE 30 as the lubricating oil.

TESTING AND ADJUSTING
PERFORMANCE TEST STANDARDS

Engine	Machine model	Test item	Specification value	Speed (rpm)	Dynamometer load (N {kg})
SAA6D140E-3	HD325-6	Rated horsepower	379 kW/2,000 rpm (net) {508 HP/2,000 rpm} (net)	2,000 ± 5	2,450 – 2,600 {250 – 265}
		Max. torque	2,170 Nm/1,400 rpm (net) {221 kgm/1,400 rpm} (net)	1,400 ± 100	2,930 – 3,120 {299 – 318}
		High idling speed	2,400 ⁺⁵⁰ ₀ rpm	2,400 ⁺⁵⁰ ₀	—
		Low idling speed	725 ± 25 rpm	725 ± 25	—
	HM350-1	Rated horsepower	298 kW/2,000 rpm (Gross) {399 HP/2,000 rpm} (Gross)	2,000 ± 5	—
		Max. torque	1,950 Nm/1,400 rpm (Gross) {199 kgm/1,400 rpm} (Gross)	1,400 ± 100	—
		High idling speed	2,200 ⁺⁵⁰ ₀ rpm	2,200 ⁺⁵⁰ ₀	—
		Low idling speed	725 ± 25 rpm	725 ± 25	—
	HM400-1	Rated horsepower	331 kW/2,000 rpm (net) {444 HP/2,000 rpm} (net)	2,000 ± 5	—
		Max. torque	2,050 Nm/1,400 rpm (net) {209 kgm/1,400 rpm} (net)	1,400 ± 100	—
		High idling speed	2,200 ⁺⁵⁰ ₀ rpm	2,200 ⁺⁵⁰ ₀	—
		Low idling speed	725 ± 25 rpm	725 ± 25	—
	PC750-6 PC750LC-6 PC750-7 PC800-6 PC800-7	Rated horsepower	338 kW/1,800 rpm (net) {454 HP/1,800 rpm} (net)	1,800 ± 5	2,550 – 2,690 {260 – 274}
		Max. torque	2,138 Nm/1,350 rpm (net) {218 kgm/1,350 rpm} (net)	1,350 ± 100	2,930 – 3,100 {299 – 316}
		High idling speed	1,980 ± 50 rpm	1,980 ± 50	—
		Low idling speed	825 ± 25 rpm	825 ± 25	—
	PC1800-6 (2 engines)	Rated horsepower	338 kW/1,800 rpm (net) {454 HP/1,800 rpm} (net)	1,800 ± 5	2,550 – 2,690 {260 – 274}
		Max. torque	2,138 Nm/1,350 rpm (net) {218 kgm/1,350 rpm} (net)	1,350 ± 100	2,930 – 3,100 {299 – 316}
		High idling speed	1,980 ± 50 rpm	1,980 ± 50	—
		Low idling speed	825 ± 25 rpm	825 ± 25	—

- ★ This table shows the standard values using the JIS correction factor
- ★ The output and torque values in the table are the standard values with the fan removed, so they are different from the specification values.
- ★ The table shows the standard values with an air cleaner installed, muffler installed, alternator under no load, and air compressor open (when installed).
- ★ The dynamometer load shows the value for an arm length of 716 mm..

TESTING AND ADJUSTING
PERFORMANCE TEST STANDARDS

Output (kW{HP})	Torque (Nm{kgm})	Fuel consumption (sec/300cc)	Cooling water temperature (°C)	Lubricating oil temperature (°C)	Lubricating oil pressure (kPa{kg/cm ² })	Exhaust temperature (°C)
368 – 390 (gross) {493 – 523} (gross)	—	Min. 11.8	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	2,100 – 2,230 (gross) {214 – 228} (gross)	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—
289 – 307 (gross) {387 – 411} (gross)	—	Min.	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	Max. 650
—	1,890 – 2,010 (gross) {193 – 205} (gross)	—	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	Max. 680
—	—	—	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—
—	—	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 650
—	—	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	Max. 680
—	—	—	70 – 90	90 – 110	340 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—
343 – 364 (gross) {460 – 488} (gross)	—	Min.	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	Max. 650
—	2,100 – 2,230 (gross) {214 – 227} (gross)	—	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	Max. 650
—	—	—	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—
343 – 364 (gross) {460 – 488} (gross)	—	Min.	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	Max. 650
—	2,100 – 2,230 (gross) {214 – 227} (gross)	—	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	Max. 650
—	—	—	70 – 90	90 – 110	290 – 490 {3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120 {Min. 1.2}	—

★ Use ASTM D975 diesel oil as the fuel.

★ Use SAE 15W-40 or SAE 30 as the lubricating oil.

TESTING AND ADJUSTING

PERFORMANCE TEST STANDARDS

Engine	Machine model	Test item	Specification value	Speed (rpm)	Dynamometer load (N {kg})
SDA6D140E-3	D275A-5 D275AX-5	Rated horsepower	332 kW/2,000 rpm (Gross) {446 HP/2,000 rpm} (Gross)	2,000 ± 5	2,150 – 2,290 {219 – 233}
		Max. torque	1,990 Nm/1,400 rpm (Gross) {203 kgm/1,400 rpm} (Gross)	1,400 ± 100	2,700 – 2,860 {275 – 292}
		High idling speed	2,200 ± 50 rpm	2,200 ± 50 rpm	—
		Low idling speed	700 ± 30 rpm	700 ± 30 rpm	—
		Rated horsepower			
		Max. torque			
		High idling speed			
		Low idling speed			
		Rated horsepower			
		Max. torque			
		High idling speed			
		Low idling speed			
		Rated horsepower			
		Max. torque			
		High idling speed			
		Low idling speed			

- ★ This table shows the standard values using the JIS correction factor
- ★ The output and torque values in the table are the standard values with the fan removed, so they are different from the specification values.
- ★ The table shows the standard values with an air cleaner installed, muffler installed, alternator under no load, and air compressor open (when installed).
- ★ The dynamometer load shows the value for an arm length of 716 mm..

TESTING AND ADJUSTING

PERFORMANCE TEST STANDARDS

Output (kW{HP})	Torque (Nm{kgm})	Fuel consumption (sec/300cc)	Cooling water temperature (°C)	Lubricating oil temperature (°C)	Lubricating oil pressure (kPa{kg/cm ² })	Exhaust temperature (°C)
322 – 343 (gross)	—	Min. 11.8	70 – 90	90 – 110	340 – 490	Max. 650
{431 – 460} (gross)	—	—	70 – 90	90 – 110	{3.5 – 5.0}	—
—	1,930 – 2,050 (gross)	—	70 – 90	90 – 110	340 – 490	Max. 680
—	{197 – 209} (gross)	—	70 – 90	90 – 110	{3.5 – 5.0}	—
—	—	—	70 – 90	80 – 110	Min. 120	—
					{Min. 1.2}	

- ★ Use ASTM D975 diesel oil as the fuel.
- ★ Use SAE 15W-40 or SAE 30 as the lubricating oil.

TROUBLESHOOTING OF ENGINE SYSTEM (S MODE)

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POINTS TO REMEMBER WHEN TROUBLESHOOTING

- ⚠ Stop the machine in a level place, and check that the safety pins and blocks are securely fitted, and the parking brake is securely applied.
- ⚠ When carrying out the operation with two or more workers, keep strictly to the agreed signals, and do not allow any unauthorized person to come near.
- ⚠ If the radiator cap is removed when the engine is still hot, boiling water may spurt out and cause serious burns. Always wait for the water temperature to go down before removing the radiator cap.
- ⚠ Be extremely careful not to touch any hot parts or to get caught in any rotating parts.
- ⚠ When disconnecting wiring, always disconnect the negative (–) terminal of the battery first.
- ⚠ When removing a plug or cap from a location which is under pressure from oil, water, or air, always release the internal pressure first. When installing measuring equipment, be sure to connect it properly.

The aim of troubleshooting is to pinpoint the basic cause of the failure, to carry out repairs swiftly, and to prevent reoccurrence of the failure. When carrying out troubleshooting, an important point is of course to understand the structure and function. However, a short cut to effective troubleshooting is to ask the operator various questions to form some idea of possible causes of the failure that would produce the reported symptoms.

1. When carrying out troubleshooting, do not hurry to disassemble the components

If components are disassembled immediately any failure occurs:

- Parts that have no connection with the failure or other unnecessary parts will be disassembled
- It will become impossible to find the cause of the failure.

It will also cause a waste of man-hours, parts, or oil or grease, and at the same time, will also lose the confidence of the user or operator.

For this reason, when carrying out troubleshooting, it is necessary to carry out thorough prior investigation and to carry out troubleshooting in accordance with the fixed procedure.

2. Points to ask user or operator

- 1) Have any other problems occurred apart from the problem that has been reported?
- 2) Was there anything strange about the machine before the failure occurred?
- 3) Did the failure occur suddenly, or were there problems with the machine condition before this?
- 4) Under what conditions did the failure occur?
- 5) Had any repairs been carried out before the failure? When were these repairs carried out?
- 6) Has the same kind of failure occurred before?

3. Checks before troubleshooting

- 1) Is there any sign of abnormality in the machine or engine?
- 2) Always carry out the Checks before starting.
- 3) Carry out other checks if necessary.
- 4) Other maintenance items can be checked externally, so check any item that is considered to be necessary.
- 5) Check for any error display on the controller.

4. Confirming failure

Confirm the extent of the failure yourself, and judge whether to handle it as a real failure or as a problem with the method of operation, etc.

- ★ When operating the machine to re-enact the troubleshooting symptoms, do not carry out any investigation or measurement that may make the problem worse.

5. Troubleshooting

Use the results of the investigation and inspection in Items 2 – 4 to narrow down the causes of failure, then use the troubleshooting matrix or flowchart to locate the position of the failure exactly.

- ★ The basic procedure for troubleshooting is as follows.

- 1) Start from the simple points.
- 2) Start from the most likely points.
- 3) Investigate other related parts or information.

6. Measures to remove root cause of failure

Even if the failure is repaired, if the root cause of the failure is not repaired, the same failure will occur again.

To prevent this, always investigate why the problem occurred. Then, remove the root cause.

METHOD OF USING TROUBLESHOOTING CHARTS

This troubleshooting chart is divided into three sections: **questions, check items, and troubleshooting**. The questions and check items are used to pinpoint high probability causes that can be located from the failure symptoms or simple inspection without using troubleshooting tools.

Next, troubleshooting tools or direct inspection are used to check the high probability causes to make final confirmation.

[Questions]

Sections **Ⓐ** + **Ⓑ** in the chart on the right corresponds to the items where answers can be obtained from the user. The items in **Ⓑ** are items that can be obtained from the user, depending on the user's level.

[Check items]

The serviceman carries out simple inspection to narrow down the causes. The items under **Ⓒ** in the chart on the right correspond to this.

The serviceman narrows down the causes from information **Ⓐ** that he has obtained from the user and the results of **Ⓒ** that he has obtained from his own inspection.

[Troubleshooting]

Troubleshooting is carried out in the order of probability, starting with the causes that have been marked as having the highest probability from information gained from **[Questions]** and **[Check items]**.

The basic method of using the troubleshooting chart is as follows.

Items listed for **[Questions]** and **[Check items]** that have a relationship with the Cause items are marked with **○**, and of these, causes that have a high probability are marked with **◎**.

Check each of the **[Questions]** and **[Check items]** in turn, and marked the **○** or **◎** in the chart for items where the problem appeared. The vertical column (Causes) that has the highest number of points is the most probable cause, so start troubleshooting for that item to make final confirmation of the cause.

As a rule, do not use it when calculating the points for locating the cause, but it can be included if necessary to determine the order for troubleshooting.

Use the **△** in the Cause column as reference for **[Degree of use (Operated for long period)]** in the **[Questions]** section as reference.

		Causes		
		(1)	(2)	(3)
Questions	(a)	◎		
	(b)			◎
	(c)		◎	
	(d)	○		
	(e)			○
Check items				
Trouble-shooting	i	●		
	ii		●	
	iii			●

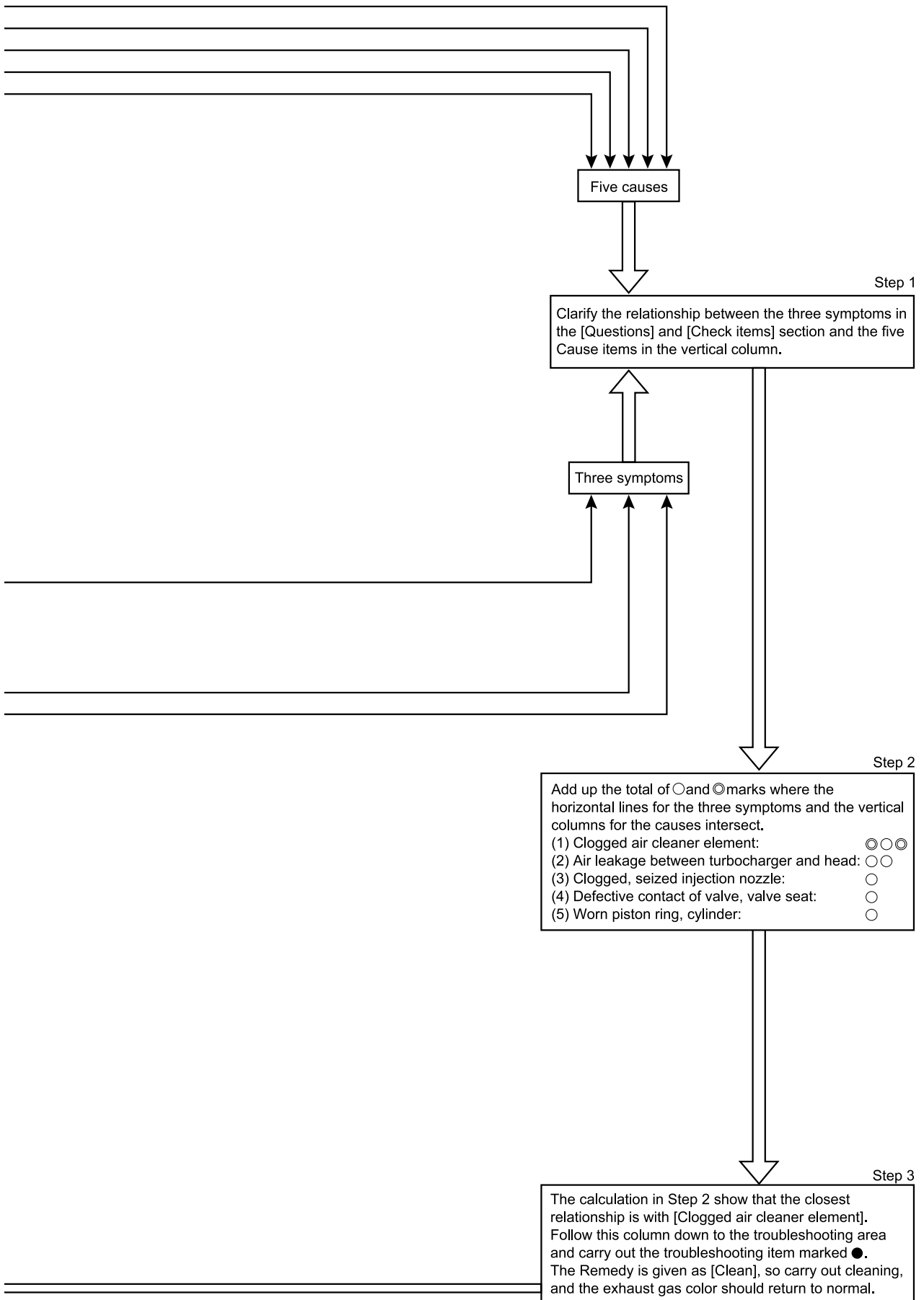
<Example of troubleshooting> Exhaust smoke is black

S-7 Exhaust smoke is black (incomplete combustion)

General causes why exhaust smoke is black

- Insufficient intake of air
- There is excessive fuel.
- Abnormal fuel injection condition
- Improper selection of fuel
- Engine overheating
 - ★ See troubleshooting for [Overheat].
- Controller controlled by delayed mode
(The injection amount (output) is limited because an error has occurred in the electrical system.)

		Causes														
		Clogged air cleaner element	Seized turbocharger, interference	Defective contact of valve and valve seat	Improper valve clearance	Leakage of air between turbocharger and cylinder head	Crushed, clogged muffler	Worn piston ring, cylinder liner	Stuck, seized fuel supply pump plunger	Clogged, seized fuel injector	Worn fuel injector	Clogged fuel spill piping	Defective fuel injection timing	Defective fuel injection pressure	Defective water temperature sensor	
Questions	Confirm recent repair history															
	Degree of use of machine	Operated for long period	△		△				△		△					
	Color of exhaust gas	Suddenly became black		◎						○	○					
		Gradually became black	◎				○				○	○				
		Blue under light load							◎							
	Non-specified fuel is being used								○	○						
	Engine oil must be added more frequently							◎								
	Power was lost	Suddenly		◎			○		○	○						
		Gradually	○		○		○		○							
	Dust indicator lamp is red	◎														
	Muffler is crushed						◎									
	Leakage of air between turbocharger and cylinder head, loose clamp					◎										
	Operates in low-temperature mode even at normal temperatures												○	○	○	
	Check items	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low								○	◎					
Noise of interference is heard from around turbocharger when engine is run			◎													
Abnormal noise is heard from around cylinder head when engine is run				◎												
Stall speed is too high (excessive injection of fuel)											○	○				
Exhaust noise is abnormal			○				◎			○						
Engine pickup is poor and combustion is irregular			○		○	○	○		○	◎						
Blow-by gas is excessive								◎								
When hose from the injector to spill collection portion is disconnected, spill flow is found to be abnormally high (go to Troubleshooting E-26).											◎					
Troubleshooting	Check air cleaner directly	●														
	When turbocharger is rotated by hand, it is found to be heavy		●													
	When compression pressure is measured, it is found to be low			●				●								
	Check valve clearance directly				●											
	When muffler is removed, exhaust color returns to normal						●									
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"								●							
	Engine speed does not change when operation of certain cylinders is stopped in reduced cylinder mode									●						
	Check fuel spill piping directly											●				
	Carry out troubleshooting for E Mode "Abnormality in water temperature sensor"														●	
Remedy		Clean	Replace	Replace	Adjust	Correct	Replace	Replace	Replace	Replace	Replace	Correct	Adjust	Adjust	Replace	



S-1 Starting performance is poor (starting always takes time)

General causes why starting performance is poor

- Defective electrical system
- Insufficient supply of fuel
- Insufficient intake of air
- Improper selection of fuel

- ★ With the common rail fuel injection system, the fuel injection timing is recognized electrically, so even when the starting operation is carried out, the engine may not start until the crankshaft has completed two rotations. However, this does not indicate any abnormality.

		Causes											
		Clogged air cleaner element	Defective contact of valve, valve seat	Worn piston ring, cylinder	Clogged air breather hole in fuel tank cap	Leakage, clogging, air in fuel piping	Clogged fuel filter, element	Clogged fuel feed pump strainer	Stuck, seized fuel supply pump plunger	Defective fuel injector	Defective intake air heater system	Defective regulator	Defective alternator
Questions	Confirm recent repair history												
	Degree of use of machine	Operated for long period	△				△	△					△
	Ease of starting	Gradually became worse	○	◎	◎		○	○					
		Starts when warm									◎		◎
	Non-specified fuel is being used						○	○	○	○			
	Replacement of filters has not been carried out according to Operation Manual		◎				◎	◎	○	○			
	Engine oil must be added more frequently				◎								
	Preheating indicator lamp does not light up during preheating or in low temperatures										◎		
	Charging caution lamp lights up while engine is running											◎	◎
	Dust indicator lamp is red		◎										
Check items	Air breather hole in fuel tank cap is clogged				◎								
	Leakage of fuel from fuel piping					◎			○				
	When fuel priming pump is operated, there is no response, or operation is too heavy					◎	○	○					
	Starting motor cranks engine slowly												◎
	When engine is cranked with starting motor,	No fuel comes out even when fuel filter air bleed plug is removed					◎	◎					
		When hose at collection portion for spill flow from fuel injector is disconnected, spill flow is small (See Troubleshooting E-26)							◎				
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low									◎			
	Engine does not pick up smoothly, and combustion is irregular			○	○					◎			
	There is hunting from engine (rotation is irregular)					○	◎	○					
	Blow-by gas is excessive				◎								
Troubleshooting	Check air cleaner directly		●										
	When compression pressure is measured, it is found to be low			●	●								
	When air is bled from fuel line, air comes out					●							
	Check fuel filter, strainer directly						●						
	Check fuel feed pump strainer directly							●					
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"								●				
	Engine speed does not change when operation of certain cylinders is stopped in reduced cylinder mode									●			
	Intake air heater mount does not become warm during operation of preheating										●		
	Is voltage 26 – 30V between alternator terminal B and terminal E with engine at low idling?	Yes										●	
		No											●
	When specific gravity of electrolyte or voltage of battery is measured, it is found to be low												●
Remedy		Clean	Correct	Replace	Clean	Correct	Clean	Clean	Replace	Replace	Replace	Replace	Replace

S-2 Engine does not start

a) Engine does not turn

General causes why engine does not turn

- Internal parts of engine seized
 - ★ See "Engine stops during operations".
- Defective electrical system
- Failure in power train
 - ★ Carry out troubleshooting of the machine.

a) Engine does not turn			Causes								
General causes why engine does not turn			Broken flywheel ring gear	Defective or deteriorated battery	Defective battery terminal connection	Defective battery relay	Defective starting switch	Defective starting motor	Defective safety relay or safety switch	Defective wiring of starting circuit	
• Internal parts of engine seized											
★ See "Engine stops during operations".											
• Defective electrical system											
• Failure in power train											
★ Carry out troubleshooting of the machine.											
Questions	Confirm recent repair history										
	Degree of use of machine	Operated for long period	△	△							
	Condition of horn when starting switch is turned ON	Horn does not sound			⊙		○			⊙	
		Horn volume is low		⊙							
Check items	When battery is checked, battery electrolyte is found to be low			⊙							
	Battery terminal is loose				⊙						
	When starting switch is turned to ON, there is no actuation sound from battery relay			○		⊙					
	When starting switch is turned to START, pinion does not move out			○			○			⊙	
	When starting switch is turned to START, pinion moves out, but	Speed of rotation is low		⊙							
		Makes grating noise	⊙					⊙			
		Soon disengages again							⊙		
		Makes rattling noise and does not turn		○				○	○		
Troubleshooting	Check flywheel ring gear directly		●								
	When specific gravity of electrolyte or voltage of battery is measured, it is found to be low			●							
	Turn the starting switch OFF, connect the cord, and carry out troubleshooting at ON	There is no voltage (20 – 30 V) between battery relay terminal B and terminal E				●					
		When terminal B and terminal C of starting switch are connected, engine starts					●				
		When terminal B and terminal C of starting motor are connected, engine starts						●			
		When terminal B and terminal C of safety relay are connected, engine starts							●		
		When terminal of safety switch and terminal B of starting motor are connected, engine starts							●		
Remedy		Replace	Replace	Correct	Replace	Replace	Replace	Replace	—		

Carry out troubleshooting for machine mounting the system.

b) Engine turns but no exhaust smoke comes out
General causes why engine turns but no exhaust smoke comes out

- Fuel is not being supplied
- Supply of fuel is extremely small
- Improper selection of fuel (particularly in winter)

b) Engine turns but no exhaust smoke comes out General causes why engine turns but no exhaust smoke comes out • Fuel is not being supplied • Supply of fuel is extremely small • Improper selection of fuel (particularly in winter)			Causes														
			Improper fuel used	Insufficient fuel in tank	Clogged air breather hole in fuel tank	Leakage, clogging, air in fuel piping	Clogged fuel filter, element	Clogged fuel feed pump gauze filter	Seized, abnormally worn fuel feed pump	Broken fuel supply pump shaft, key	Stuck, seized fuel supply pump plunger	Defective fuel supply pump PCV	Mistaken connection of fuel supply pump PCV	Defective actuation of fuel overflow valve (does not close)	Defective actuation of fuel flow damper	Defective fuel injector (excessive spill amount)	
Questions	Confirm recent repair history																
	Degree of use of machine	Operated for long period				△	△	△									
	Exhaust smoke suddenly stops coming out (when starting again)								⊙	○	⊙	⊙	⊙		△	△	
	Replacement of filters has not been carried out according to Operation Manual						⊙	⊙			△					○	
	Fuel tank is found to be empty			⊙													
	Air breather hole in fuel tank cap is clogged			○	⊙												
	Rust and water are found when fuel tank is drained						○	○	○		○	○					
	When fuel filter is removed, there is no fuel in filter		⊙			⊙											
	There is leakage from fuel piping					⊙											
	When fuel priming pump is operated, there is no response, or operation is too heavy					⊙	○	○									
Check items	When engine is cranked with starting motor,	No fuel comes out even when fuel filter air bleed plug is removed		○		○			⊙	○							
		When hose at collection portion for spill flow from fuel injector is disconnected, spill flow is small (See Troubleshooting E-26)				○				⊙	⊙	⊙	⊙			○	
Troubleshooting	When air is bled from fuel line, air comes out					●											
	Check fuel filter directly						●										
	Check fuel feed pump gauze filter directly							●									
	Check fuel feed pump directly								●								
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"									●	●		●				
	Carry out troubleshooting for E Mode "Abnormality in fuel supply pump PCV"											●					
	Check fuel overflow valve directly													●			
	Possible to start in reduced cylinder mode														●	●	
		Remedy	Replace	Add	Correct	Correct	Replace	Clean	Replace	Replace	Replace	Replace	Correct	Replace	Replace	Replace	

c) Exhaust smoke comes out but engine does not start (Fuel is being injected)

General causes why exhaust smoke comes out but engine does not start

- Lack of rotating force due to defective electrical system
- Insufficient supply of fuel
- Insufficient intake of air
- Improper selection of fuel

		Causes											
		Clogged air cleaner element	Defective, broken dynamic valve system (valve, rocker lever, etc.)	Worn piston ring, cylinder liner	Improper fuel used	Clogged air breather hole in fuel tank cap	Leakage, clogging, air in fuel system	Clogged fuel filter, strainer	Clogged fuel feed pump strainer	Stuck, seized fuel supply pump plunger	Clogged injector, defective spray	Defective or deteriorated battery	Defective low-temperature water temperature sensor, disconnection
Questions	Confirm recent repair history												
	Degree of use of machine	Operated for long period		△				△	△		△		
	Suddenly failed to start		⊙							⊙			○
	Non-specified fuel is being used									○	○		
	Replacement of filters has not been carried out according to Operation Manual	⊙						⊙	⊙				
	Engine oil must be added more frequently			⊙									
	Preheating indicator lamp does not light up during preheating or in low temperatures												⊙
	Dust indicator lamp is red	⊙											
	Air breather hole in fuel tank cap is clogged					○							
	Rust and water are found when fuel tank is drained							⊙	⊙				
	When fuel filter is removed, there is no fuel in filter				⊙								
	There is leakage from fuel piping						⊙						
	When fuel priming pump is operated, there is no response, or operation is too heavy						⊙	○	○				
	Starting motor cranks engine slowly										⊙		
Check items	When engine is cranked, abnormal noise is heard from around cylinder head	⊙											
	When engine is cranked with starting motor,	No fuel comes out even when fuel filter air bleed plug is removed											
		When hose at collection portion for spill flow from fuel injector is disconnected, spill flow is small (See Troubleshooting E-26)											
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low										⊙		
Troubleshooting	Check air cleaner element directly	●											
	Remove head cover and check directly		●										
	When compression pressure is measured, it is found to be low			●									
	When air is bled from fuel line, air comes out						●						
	Check fuel filter, strainer directly							●					
	Check fuel feed pump strainer directly								●				
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"									●			
	Spray condition is poor when fuel injector is tested as individual part										●		
	When specific gravity of electrolyte or voltage of battery is measured, it is found to be low											●	
	Defective water temperature gauge display on machine												●
	Intake air heater mount does not become warm during preheating												●
	Remedy	Clean	Replace	Replace	Replace	Clean	Correct	Clean	Clean	Replace	Clean	Replace	Replace

S-3 Engine does not pick up smoothly (follow-up is poor)

General causes why engine does not pick up smoothly

- Insufficient intake of air
- Insufficient supply of fuel
- Abnormal fuel injection condition
- Improper selection of fuel
- Controller controlled by delayed mode
(The injection amount (output) is limited because an error has occurred in the electrical system.)

		Causes											
		Clogged air cleaner element	Defective contact of valve and valve seat	Improper valve clearance	Seized turbocharger, interference	Worn piston ring, cylinder liner	Clogged air breather hole in fuel tank cap	Leakage, clogging, air in fuel piping	Clogged fuel filter, strainer	Clogged fuel feed pump strainer	Stuck, seized fuel supply pump plunger	Defective actuation of fuel flow damper (excessive leak from injector)	Clogged fuel injector, defective spray (dirt caught)
Questions	Confirm recent repair history												
	Degree of use of machine Operated for long period	△	△			△			△	△			
	Engine pick-up suddenly became poor				⊙		○	○					○
	Non-specified fuel is being used							⊙	⊙	⊙			⊙
	Replacement of filters has not been carried out according to Operation Manual	⊙						⊙	⊙	⊙			
	Engine oil must be added more frequently				⊙								
	Dust indicator lamp is red	⊙											
	Air breather hole in fuel tank cap is clogged						⊙						
	Rust and water are found when fuel is drained							⊙	⊙				
	There is leakage from fuel piping							⊙					
	When fuel priming pump is operated, there is no response, or operation is too heavy							⊙	○	○			
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low										○		⊙
	Color of exhaust gas Blue under light load					⊙							
	Black	⊙	○		⊙								⊙
Check items	Abnormal noise is heard from around cylinder head when engine is run			⊙									
	Noise of interference is heard from around turbocharger				⊙								
	High idling speed under no load is normal, but speed suddenly drops when load is applied						○		⊙	⊙			
	There is hunting from engine (rotation is irregular)						○		○	⊙			○
	Blow-by gas is excessive					⊙							
Troubleshooting	Check air cleaner element directly	●											
	When compression pressure is measured, it is found to be low		●			●							
	Check valve clearance directly			●									
	When turbocharger is rotated by hand, it is found to be heavy				●								
	When air is bled from fuel line, air comes out							●					
	Check fuel filter, strainer directly								●				
	Check fuel feed pump strainer directly									●			
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"										●		
	Engine speed does not change when operation of certain cylinders is stopped in reduced cylinder mode											●	●
Remedy		Clean	Replace	Adjust	Replace	Replace	Clean	Correct	Clean	Clean	Replace	Replace	Correct

S-4 Engine stops during operations

General causes why engine stops

- Internal part of engine seized
- Insufficient supply of fuel
- Engine overheating
 - ★ See troubleshooting for [Overheat].
- Failure in power train
 - ★ Carry out troubleshooting of the machine.

		Causes													
		Broken dynamic valve system (valve, rocker lever, etc.)	Broken, seized piston, connecting rod	Broken, seized crankshaft bearing	Broken, seized gear train	Insufficient fuel in tank	Clogged air breather hole in fuel tank	Clogged, leaking fuel piping	Clogged fuel filter, strainer	Clogged fuel feed pump strainer	Broken, seized fuel feed pump	Broken fuel supply pump drive shaft, key	Stuck, seized fuel supply pump plunger	Broken auxiliary equipment (pump, compressor, etc.)	Failure in power train mounted on machine
Questions	Confirm recent repair history														
	Degree of use of machine	Operated for long period							△	△					
	Condition when engine stopped	Abnormal noise was heard and engine stopped suddenly	◎	◎	◎	◎					○	◎	○	◎	◎
		Engine overheated and stopped		◎	○									○	
		Engine stopped slowly				◎			○	○					
		There was hunting and engine stopped				◎	○		○	○	○				
	Non-specified fuel is being used								○	○	○		○		
	Replacement of filters has not been carried out according to Operation Manual								◎	◎					
	Fuel level caution lamp lights up					◎									
	Fuel tank is found to be empty					◎									
	Air breather hole in fuel tank cap is clogged						◎								
	There is leakage from fuel piping							◎							
	When priming pump is operated, there is no response, or operation is too heavy							◎	○	○					
	Rust and water are found when fuel tank is drained								◎	◎					
	Metal particles are found when oil is drained			◎	◎					○	○				
Check items	When it is attempted to turn engine by hand	Does not turn at all		◎	◎										
		Turns in opposite direction	◎												
		Moves amount of backlash			◎									◎	
		Fuel supply pump shaft does not turn									◎				
	Engine rotates, but stops when load is applied to machine														◎
Troubleshooting	Check dynamic valve system directly		●												
	Check piston and connecting rod directly			●											
	Check crankshaft directly				●										
	Check gear train directly					●									
	Check fuel filter, strainer directly								●						
	Check fuel feed pump strainer directly									●					
	Check fuel feed pump directly										●				
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"											●	●		
	When auxiliary equipment (Hyd. pump, air compressor) is removed, engine turns													●	
Remedy		Replace	Replace	Replace	Replace	Add	Clean	Correct	Clean	Clean	Replace	Replace	Replace	Replace	—

S-5 Engine does not rotate smoothly (hunting)

General causes why engine does not rotate smoothly

- Air in fuel system
- Speed sensor is not normal
(abnormality not big enough to generate error display)

		Causes									
		Low idling speed is too low	Insufficient fuel in tank	Clogged air breather hole in fuel tank	Leakage, clogging, air in fuel piping	Clogged fuel feed pump strainer	Clogged fuel filter, strainer	Defective actuation of fuel flow damper (excessive leak from injector)	Clogged fuel injector, defective spray (dirt caught)	Defective Ne revolution sensor, defective wiring harness	Defective G revolution sensor, defective wiring harness
Questions	Confirm recent repair history										
	Degree of use of machine	Operated for long period				△	△				
	Condition of hunting	Occurs at a certain speed range	○							○	○
		Occurs at low idling	◎		○	○	○	○	○	○	○
		Occurs even when speed is raised		○						○	○
		Occurs on slopes		◎						○	○
Check items	Replacement of filters has not been carried out according to Operation Manual										
	Fuel tank is found to be empty										
	Air breather hole in fuel tank cap is clogged										
	Rust and water are found when fuel tank is drained										
	There is leakage from fuel piping										
	When fuel priming pump is operated, there is no response, or operation is too heavy										
Troubleshooting	When air is bled from fuel line, air comes out										
	Check fuel feed pump strainer directly										
	Check fuel filter, strainer directly										
	Engine speed does not change when operation of certain cylinders is stopped in reduced cylinder mode										
	Carry out troubleshooting for E Mode "Abnormality in Ne revolution sensor"										
	Carry out troubleshooting for E Mode "Abnormality in G revolution sensor"										
Remedy		Correct	Add	Clean	Replace	Replace	Replace	Replace	Correct	Correct	Correct

S-6 Engine lacks output (or lacks power)

General causes why engine lacks output

- Insufficient intake of air
- Insufficient supply of fuel
- Abnormal fuel injection condition
- Improper selection of fuel
- Engine overheating
 - ★ See troubleshooting for [Overheat].
- Controller controlled by delayed mode
(The injection amount (output) is limited because an error has occurred in the electrical system.)

		Causes																
		Clogged air cleaner element	Leakage in air intake piping	Seized turbocharger, interference	Defective contact of valve and valve seat	Improper valve clearance	Worn piston ring, cylinder liner	Clogged air breather hole in fuel tank cap	Clogged, leaking fuel piping	Clogged fuel filter, strainer	Clogged fuel feed pump gauze filter	Stuck, seized fuel supply pump plunger	Clogged fuel injector, defective spray (dirt caught)	Defective drive of fuel injector (signal, solenoid)	Defective mount of boost pressure sensor (air leakage)	Defective boost pressure sensor	Defective fuel temperature sensor	
Questions	Confirm recent repair history																	
	Degree of use of machine	Operated for long period	△			△		△		△	△							
	Power was lost	Suddenly		○										○		○		
		Gradually	○			○		○		○	○		○		○			
	Replacement of filters has not been carried out according to Operation Manual									○	○							
	Non-specified fuel is being used		◎															
	Engine oil must be added more frequently					○	○	○										
	Dust indicator lamp is red		◎															
	Air breather hole in fuel tank cap is clogged							◎										
	There is leakage from fuel piping								◎									
	Power is lacking after short stop in operations																◎	
	Check items	Color of exhaust gas	Black	◎	◎													
Blue under light load					◎													
When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low												◎						
Noise of interference is heard from around turbocharger when engine is run			◎															
Abnormal noise is heard from around cylinder head when engine is run						◎												
High idling speed of engine is low														○				
High idling speed under no load is normal, but speed suddenly drops when load is applied									◎	◎	○							
Engine pickup is poor and combustion is irregular			◎					○	○			◎						
There is hunting from engine (rotation is irregular)								○	○	○	○							
Blow-by gas is excessive				◎														
Troubleshooting		When air cleaner element is inspected directly, it is found to be clogged		●														
		Check air intake piping directly			●													
	When boost pressure is measured, it is found to be low		●	●	●													
	When compression pressure is measured, it is found to be low					●		●										
	Check valve clearance directly						●											
	Check fuel filter, strainer directly									●								
	Check fuel feed pump gauze filter directly										●							
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"											●						
	Engine speed does not change when operation of certain cylinders is stopped in reduced cylinder mode												●	●				
	Check mounting of boost pressure sensor directly														●			
	Carry out troubleshooting for E Mode "Abnormality in boost pressure sensor"															●		
	Carry out troubleshooting for E Mode "Abnormality in fuel temperature sensor"																●	
Remedy		Clean	Correct	Replace	Replace	Adjust	Replace	Clean	Correct	Replace	Clean	Replace	Replace	Replace	Correct	Replace	Replace	

S-7 Exhaust smoke is black (incomplete combustion)

General causes why exhaust smoke is black

- Insufficient intake of air
- There is excessive fuel.
- Abnormal fuel injection condition
- Improper selection of fuel
- Engine overheating
 - ★ See troubleshooting for [Overheat].
- Controller controlled by delayed mode
(The injection amount (output) is limited because an error has occurred in the electrical system.)

General causes why exhaust smoke is black			Causes																	
• Insufficient intake of air • There is excessive fuel. • Abnormal fuel injection condition • Improper selection of fuel • Engine overheating ★ See troubleshooting for [Overheat]. • Controller controlled by delayed mode (The injection amount (output) is limited because an error has occurred in the electrical system.)			Clogged air cleaner element	Seized turbocharger, interference	Defective contact of valve and valve seat	Improper valve clearance	Leakage of air between turbocharger and cylinder head	Crushed, clogged muffler	Worn piston ring, cylinder liner	Stuck, seized fuel supply pump plunger	Clogged, seized fuel injector	Worn fuel injector	Clogged fuel spill piping	Defective fuel injection timing	Defective fuel injection pressure	Defective water temperature sensor				
			Confirm recent repair history																	
			Degree of use of machine	Operated for long period	△		△				△		△							
			Color of exhaust gas	Suddenly became black		◎						○	○							
				Gradually became black	◎				○				○	○						
				Blue under light load							◎									
			Non-specified fuel is being used									○	○							
			Engine oil must be added more frequently								◎									
			Power was lost	Suddenly		◎			○		○	○								
				Gradually	○		○		○	○										
			Dust indicator lamp is red		◎															
			Muffler is crushed							◎										
			Leakage of air between turbocharger and cylinder head, loose clamp						◎											
			Operates in low-temperature mode even at normal temperatures														○	○	○	
			When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low									○	◎							
Noise of interference is heard from around turbocharger when engine is run			◎																	
Abnormal noise is heard from around cylinder head when engine is run					◎															
Stall speed is too high (excessive injection of fuel)												○	○							
Exhaust noise is abnormal			○				◎			○										
Engine pickup is poor and combustion is irregular			○		○	○	○		○	◎										
Blow-by gas is excessive								◎												
When hose from the injector to spill collection portion is disconnected, spill flow is found to be abnormally high (go to Troubleshooting E-26).											◎									

Troubleshooting	Check air cleaner directly	●															
	When turbocharger is rotated by hand, it is found to be heavy		●														
	When compression pressure is measured, it is found to be low			●				●									
	Check valve clearance directly				●												
	When muffler is removed, exhaust color returns to normal					●											
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"								●								
	Engine speed does not change when operation of certain cylinders is stopped in reduced cylinder mode									●							
	Check fuel spill piping directly											●					
	Carry out troubleshooting for E Mode "Abnormality in water temperature sensor"																●
	Remedy		Clean	Replace	Replace	Adjust	Correct	Replace	Replace	Replace	Replace	Replace	Correct	Adjust	Adjust		Replace

S-8 Oil consumption is excessive (or exhaust smoke is blue)

General causes why oil consumption is excessive

- Abnormal combustion of oil
- The engine has been run at low or high idling for a long time continuously (more than 20 minutes continuous operation is not allowed).
- External leakage of oil
- Wear of lubrication system

			General causes why oil consumption is excessive														
			Causes														
			Dust sucked in from intake system	Worn, broken valve (stem, guide, seal)	Turbocharger		Clogged breather or breather hose	Broken piston ring	Worn piston ring, cylinder liner	Worn, broken rear seal	Broken oil cooler	Leakage from oil cooler	Leakage from oil filter	Leakage from oil piping	Leakage from oil drain plug	Leakage from oil pan or cylinder head	
Questions	Confirm recent repair history																
	Degree of use of machine	Operated for long period		△	△	△			△								
	Oil consumption suddenly increased						⊙			○							
	Engine oil must be added more frequently							⊙		○							
	Engine oil becomes contaminated quickly						○	○	⊙								
	Outside of engine is dirty with oil										⊙	⊙	⊙	⊙	⊙		
	Loose piping clamp in air intake system		⊙														
	Inside of turbocharger air supply pipe is dirty with oil					⊙											
	Inside of exhaust pipe is dirty with oil			○	⊙												
	There is oil in engine cooling water										⊙						
	Oil level in clutch or damper chamber rises									⊙							
	Exhaust smoke is blue under light load							⊙	⊙								
Check items	Amount of blow-by gas			○		○		⊙	⊙								
	Excessive																
		None					⊙										
Troubleshooting	When intake manifold is removed, dust is found inside		●														
	When intake manifold is removed, inside is found to be extremely dirty			●													
	Excessive play of turbocharger shaft				●	●											
	Check breather element directly						●										
	When compression pressure is measured, it is found to be low							●	●								
	Check rear oil seal directly									●							
	Pressure-tightness test of oil cooler shows there is leakage										●	●					
	There is external leakage of oil from engine												●	●	●	●	
Remedy			Correct	Correct	Replace	Replace	Clean	Replace	Replace	Correct	Replace	Replace	Correct	Correct	Correct	Correct	

S-9 Oil becomes contaminated quickly

General causes why oil becomes contaminated quickly

- Entry of exhaust gas into oil due to internal wear
- Clogging of lubrication passage
- Improper fuel used
- Improper oil used
- Operation under excessive load

General causes why oil becomes contaminated quickly			Causes									
			Defective seal at turbocharger turbine end	Worn valve, valve guide	Worn piston ring, cylinder liner	Clogged breather, breather tube	Clogged oil cooler	Clogged oil filter	Defective oil filter safety valve	Clogged turbocharger lubrication drain tube	Exhaust smoke color is poor	
Questions	Confirm recent repair history											
	Degree of use of machine	Operated for long period	△	△	△							
	Non-specified fuel is being used						○					
	Engine oil must be added more frequently				◎							
	Even when oil temperature rises, oil filter caution lamp lights up					◎		○				
	When oil filter is inspected, metal particles are found			○	○			◎				
	Inside of exhaust pipe is dirty with oil			◎								
	Engine oil temperature rises quickly						◎					
	Check items	Color of exhaust gas	Blue under light load			◎						
			Black									◎
Amount of blow-by gas		Excessive	○	○	◎					○		
		None				◎						

Troubleshooting	Excessive play of turbocharger shaft	●								See S-7
	When compression pressure is measured, it is found to be low		●	●						
	Check breather, breather tube directly				●					
	Check oil cooler is inspected directly					●				
	Check oil filter directly						●			
	Spring of oil filter safety valve catching or broken							●		
	Check turbocharger drain tube directly								●	
Remedy		Replace	Replace	Replace	Clean	Clean	Replace	Replace	Clean	—

See S-7

S-10 Fuel consumption is excessive

General causes why fuel consumption is excessive

- Leakage of fuel
- Improper condition of fuel injection (injection pressure, injection timing)
- Excessive injection of fuel

		Causes								
		Leakage of fuel inside head cover	External leakage from fuel piping, fuel filter	Defective fuel feed pump oil seal	Defective supply pump plunger	Defective common rail fuel pressure	Defective fuel injector spray	Defective actuation of fuel injector	Defective fuel injection timing	Defective water temperature low-temperature sensor
Questions	Confirm recent repair history									
	Degree of use of machine	Operated for long period		△	△		△			
	Condition of fuel consumption	More than for other machines of same model				○		○	○	○
		Gradually increased			○		○			
		Suddenly increased	○	○						
Check items	There is external leakage of fuel from engine		◎							
	There is irregular combustion						◎			
	Engine oil level rises and smells of diesel fuel		◎	◎						
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low						◎			
	Engine low idling speed is high									
	Engine stall speed is high							○		
	Exhaust gas color	Black				○	○		○	○
		White	○							
Troubleshooting	Remove head cover and check directly		●							
	Check fuel feed pump oil seal directly			●						
	Carry out troubleshooting for E Mode "Fuel supply pump non-force feed"				●					
	Engine speed does not change when operation of certain cylinders is stopped in reduced cylinder mode						●			
	When flow of oil from fuel injector at spill return collection portion is measured, it is found to be excessive							●		
	Carry out troubleshooting for E Mode "Abnormality in water low-temperature sensor"									●
	Check with monitoring function on machine				●			●		
Remedy		Correct	Correct	Replace	Replace	—	Replace	Replace	—	—

S-11 Oil is in cooling water (or water spurts back, or water level goes down)

General causes why oil is in cooling water

- Internal leakage in lubrication system
- Internal leakage in cooling system

General causes why oil is in cooling water			Causes						
				Broken cylinder head, head gasket					
				Internal cracks in cylinder block					
				Damaged cylinder liner O-ring, holes caused by pitting			△		
				Insufficient protrusion of cylinder liner					
				Broken oil cooler core, O-ring				△	
				Broken hydraulic cooler or transmission oil cooler					
Questions	Confirm recent repair history								
	Degree of use of machine	Operated for long period				△			
	Oil level	Suddenly increased	○				○	○	
		Gradually increased		○	○				
	Hard water is being used as cooling water					○		○	
Check items	Engine oil level has risen, oil is cloudy white			○	○		⊙		
	Excessive air bubbles inside radiator, spurts back		⊙				⊙		
	Hydraulic oil, transmission oil is cloudy white							⊙	
	When hydraulic oil, transmission oil is drained, water is found							⊙	
	Troubleshooting	Pressure-tightness test of cylinder head shows there is leakage		●					Carry out trouble-shooting of machine
Check cylinder block, liner directly			●	●					
Check cylinder liner directly					●				
Pressure-tightness test of oil cooler shows there is leakage						●			
			Remedy	Replace	Replace	Replace	Replace	Replace	—

S-12 Oil pressure caution lamp lights up (drop in oil pressure)

General causes why oil pressure drops

- Leakage, clogging, wear of lubricating system
- Defective oil pressure control
- Improper oil used (improper viscosity)
- Deterioration of oil due to overheating

General causes why oil pressure drops			Causes											
			Worn bearing, journal	Lack of oil in oil pan	Water, fuel in oil	Clogged strainer inside oil pan	Clogged, broken pipe inside oil pan	Defective oil pump	Defective oil pump relief valve	Clogged oil filter	Leaking, crushed, clogged hydraulic piping	Defective oil pressure sensor	Defective oil level sensor	
Questions	Confirm recent repair history													
	Degree of use of machine	Operated for long period	△					△		△				
	Oil pressure caution lamp lights up								○	◎				
	Non-specified oil is being used		○							○				
	Replacement of filters has not been carried out according to Operation Manual									◎				
	Condition when oil pressure lamp lights up	Lights up at low idling	◎						○					
		Lights up at low idling and high idling		○		◎	◎	◎	○					
		Lights up on slopes		◎										
		Sometimes lights up							◎			○	○	
	Oil temperature caution lamp lights up (machines equipped with lamp)			◎									◎	
Oil level in oil pan is low			◎											
There is crushing, external leakage from hydraulic piping										◎				
Check items	Oil is cloudy white or smells of diesel oil				◎									
	Metal particles are found when oil is drained		◎											
	Metal particles are found when oil inside oil filter is drained		◎					○						

Troubleshooting	Metal particles are found in oil filter	●		See S-13.									
	Check oil pan strainer pipe directly					●	●						
	Oil pump rotation is heavy, there is play							●					
	Deterioration, damage of valve, spring in oil pump relief valve								●				
	Check oil filter directly									●			
	Carry out troubleshooting for E Mode "Abnormality in oil pressure sensor"											●	
	When oil level sensor is replaced, oil pressure caution lamp goes out												●
Remedy		Clean	Add	—	Clean	Clean	Replace	Adjust	Clean	Correct	Replace	Replace	

S-13 Oil level rises (water, fuel in oil)

General causes why oil level rises

- Water in oil (cloudy white)
- Fuel in oil (diluted, smells of diesel fuel)

- ★ If there is oil in the cooling water, carry out troubleshooting for "Oil is in cooling water".

			Causes									
			Broken cylinder head, head gasket	Leakage of fuel inside head cover	Cracks inside cylinder block	Damaged cylinder liner O-ring, holes made by pitting	Worn, damaged rear oil seal	Broken oil cooler core, O-ring	Clogged water pump drain (breather hole), defective seal	Defective thermostat seat	Defective part inside fuel supply pump	Defective auxiliary equipment seal (pump, air compressor)
Questions	Confirm recent repair history											
	Degree of use of machine	Operated for long period				△	△		△			△
	Fuel consumption has increased			⊙							⊙	
	Water must be added more frequently		○							⊙		
	There is oil in engine cooling water		○		○			⊙				
	Oil smells of diesel fuel			⊙							⊙	
	Oil is cloudy white		○							⊙		
	When engine is started, drops of water come from muffler		○									
	When radiator cap is left open and engine is run at idling, an abnormal number of bubbles appear, or water spurts back		⊙			○						
	Exhaust smoke is white			○						○		
Check items	Water pump drain hole (breather hole) is clogged								⊙			
	When water pump drain hole (breather hole) is cleaned, water comes out								⊙			
	Oil level goes down in clutch chamber or damper chamber						⊙					
	Oil level goes down in hydraulic tank											⊙
Troubleshooting	When compression pressure is measured, it is found to be low		●									
	Remove head cover and check directly			●								
	Check cylinder block, liner directly				●	●						
	Check rear oil seal directly						●					
	Pressure-tightness test of oil cooler shows there is leakage							●				
	Remove water pump and check directly								●			
	Remove thermostat cover and check directly									●		
	Remove fuel supply pump and check directly										●	
	Check auxiliary equipment seal directly											●
Remedy			Replace	Correct	Replace	Replace	Correct	Replace	Replace	Correct	Replace	Replace

S-14 Water temperature becomes too high (overheating)

General causes why water temperature becomes too high

- Lack of cooling air (deformation, damage of fan)
 - Drop in heat dissipation efficiency
 - Defective cooling circulation system
 - Rise in oil temperature in power train
- ★ Carry out troubleshooting for machine.

		Causes											
		Broken cylinder head, head gasket	Damaged cylinder liner O-ring, holes made by pitting	Clogged, broken oil cooler	Lack of cooling water	Broken water pump	Defective actuation of thermostat (does not open)	Clogged, crushed radiator fins	Clogged radiator core	Defective radiator cap (pressure valve)	Fan belt slipping, worn fan pulley	Defective water temperature gauge	Rise in power train oil temperature
Questions	Confirm recent repair history												
	Degree of use of machine	Operated for long period	△	△				△	△				
	Condition of overheating	Suddenly overheated			○	◎					○		
		Always tends to overheat					○	◎	◎		○		
	Water temperature gauge	Rises quickly			○		◎						
		Does not go down from red range										◎	
Check items	Radiator water level caution lamp lights up				◎								
	Engine oil level has risen, oil is cloudy white		◎	○									
	Fan belt tension is loose										◎		
	There is play when fan pulley is rotated					◎							
	Cloudy white oil is floating on cooling water			◎									
	Excessive air bubbles inside radiator, water spurts back	◎											
	When light bulb is held behind radiator, no light passes through							◎					
	Radiator shroud, inside of underguard are clogged with dirt or mud							◎			◎		
	Water is leaking because of cracks in hose or loose clamps				◎								
	Cooling water flows out from radiator overflow hose								◎				
	Fan belt whines under sudden acceleration										◎		
	Power train oil temperature enters red range faster than engine water temperature												◎
Troubleshooting	When compression pressure is measured, it is found to be low	●											
	Check cylinder liner directly		●										
	Check oil cooler directly			●									
	Temperature difference between top and bottom radiator tanks is excessive				●								
	When function test is carried out on thermostat, it does not open even at cracking temperature					●							
	Temperature difference between top and bottom radiator tanks is small						●						
	Check radiator core directly							●					
	When function test is carried out on radiator cap, cracking pressure is found to be low								●				
	Check fan belt, pulley directly												
	When water temperature is measured, it is found to be normal											●	
Remedy		Replace	Replace	Replace	Add	Replace	Replace	Correct	Correct	Replace	Correct	Replace	—
Carry out troubleshooting for machine.													

S-15 Abnormal noise is made

General causes why abnormal noise is made

- Abnormality due to defective parts
- Abnormal combustion
- Air sucked in from intake system

- ★ Judge if the noise is an internal noise or an external noise.
- ★ If the engine is not thoroughly warmed up, the engine sound becomes slightly louder because it is operated in the low temperature mode, but this is not an abnormality.
- ★ When the engine is accelerated, it enters the acceleration mode and the engine noise is higher for 3 seconds, but this is not an abnormality.

		Causes											
		Leakage of air between turbocharger and cylinder head	Seized turbocharger, interference	Broken dynamic valve system (valve, rocker lever, etc.)	Defect inside muffler (dividing board out of position)	Improper valve clearance	Excessive wear of piston ring, cylinder liner	Improper gear train backlash	Missing, seized bushing	Deformed fan, loose fan belt, interference	Clogged, seized fuel injector	Dirt caught in fuel injector	Defective fuel injection timing (abnormal water temperature low temperature sensor)
Questions	Confirm recent repair history												
	Degree of use of machine	Operated for long period					△						
	Condition of abnormal noise	Gradually occurred					○			○			
		Suddenly occurred		○	○				○				
	Non-specified fuel is being used										○		
	Engine oil must be added more frequently						◎						
	Metal particles are found in oil drained from oil filter						◎		◎				
	Leakage of air between turbocharger and cylinder head	◎											
	Noise of interference is heard from around turbocharger when engine is run		◎										
	Abnormal noise is heard from around cylinder head when engine is run			◎		◎							
	Vibrating noise is heard from around muffler when engine is run				◎								
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low										◎	○	
	Color of exhaust gas	Blue under light load					◎						
		Black	○	◎		○							
Check items	Engine pickup is poor and combustion is abnormal										◎		
	Abnormal noise is loud when accelerating					○		○		○	○		
	Blow-by gas is excessive						◎						
Troubleshooting	When turbocharger is rotated by hand, it is found to be heavy		●										
	Check dynamic valve system directly			●									
	When muffler is removed, abnormal noise disappears				●								
	Check valve clearance directly					●							
	When compression pressure is measured, it is found to be low						●						
	Remove timing gear cover and check directly							●	●				
	Check fan, fan belt directly									●			
	Engine speed does not change when operation of certain cylinders is stopped in reduced cylinder mode										●	●	
	Abnormal noise is made only when starting											●	
	Check with monitoring function on machine												●
		Replace	Replace	Correct	Replace	Replace	Replace	Replace	Correct	Replace	Correct	Replace	Correct
Remedy		Replace	Replace	Correct	Replace	Replace	Replace	Replace	Correct	Replace	Correct	Replace	Correct

S-16 Vibration is excessive

General causes why vibration is excessive

- Defective parts (abnormal wear, breakage)
- Improper alignment with machine
- Abnormal combustion

★ If there is abnormal noise together with the vibration, carry out troubleshooting also for "Abnormal noise is made".

General causes why vibration is excessive			Causes									
- Defective parts (abnormal wear, breakage) - Improper alignment with machine - Abnormal combustion												
★ If there is abnormal noise together with the vibration, carry out troubleshooting also for "Abnormal noise is made".												
			Defective dynamic valve system (valve, rocker lever, etc. stuck)	Worn main bearing, connecting rod	Improper gear train backlash	Worn cam bushing	Defective fuel injection timing	Loose engine mounting bolts, broken cushion	Misalignment between engine and equipment on machine	Worn front support spigot joint portion	Broken part inside output shaft (damper)	
Questions	Confirm recent repair history											
	Degree of use of machine	Operated for long period		△		△		△		△		
	Condition of vibration	Suddenly increased	○								○	
		Gradually increased		○		○		○		○		
	Non-specified fuel is being used			○		○						
Check items	Metal particles are found in oil drained from oil filter			◎		◎						
	Metal particles are found when oil pan is drained			◎		◎						
	Oil pressure is low at low idling			○		○						
	Vibration occurs at mid-range speed							○			○	
	Vibration follows engine speed				○			○	○	○	○	
	Exhaust smoke is black			◎								
Troubleshooting	Check dynamic valve system directly		●									
	Check main bearing, connecting rod bearing directly			●								
	Check gear train directly				●							
	Check cam bushing directly					●						
	Check with monitoring function directly						●					
	Check engine mounting bolts directly							●				
	When face runout and radial runout are inspected, they are found to be incorrect								●			
	Check support spigot joint portion directly									●		
	Check inside of output shaft (damper) directly										●	
		Remedy	Replace	Replace	Replace	Replace	Adjust	Replace	Adjust	Replace	Replace	

TROUBLESHOOTING OF ELECTRICAL SYSTEM (E MODE)

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- ★ This section gives the outline of the troubleshooting procedures for troubleshooting of the electrical system related to the engine proper and the engine controller.
When carrying out troubleshooting of the electrical system with the engine mounted on the machine, see this section and the shop manual for the machine.

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POINTS TO REMEMBER WHEN TROUBLESHOOTING

- ⚠ Stop the machine in a level place, and check that the safety pins and blocks are securely fitted, and the parking brake is securely applied.
- ⚠ When carrying out the operation with two or more workers, keep strictly to the agreed signals, and do not allow any unauthorized person to come near.
- ⚠ If the radiator cap is removed when the engine is still hot, boiling water may spurt out and cause serious burns. Always wait for the water temperature to go down before removing the radiator cap.
- ⚠ Be extremely careful not to touch any hot parts or to get caught in any rotating parts.
- ⚠ When disconnecting wiring, always disconnect the negative (–) terminal of the battery first.
- ⚠ When removing a plug or cap from a location which is under pressure from oil, water, or air, always release the internal pressure first. When installing measuring equipment, be sure to connect it properly.

The aim of troubleshooting is to pinpoint the basic cause of the failure, to carry out repairs swiftly, and to prevent reoccurrence of the failure. When carrying out troubleshooting, an important point is of course to understand the structure and function. However, a short cut to effective troubleshooting is to ask the operator various questions to form some idea of possible causes of the failure that would produce the reported symptoms.

1. When carrying out troubleshooting, do not hurry to disassemble the components

If components are disassembled immediately any failure occurs:

- Parts that have no connection with the failure or other unnecessary parts will be disassembled
- It will become impossible to find the cause of the failure.

It will also cause a waste of man-hours, parts, or oil or grease, and at the same time, will also lose the confidence of the user or operator.

For this reason, when carrying out troubleshooting, it is necessary to carry out thorough prior investigation and to carry out troubleshooting in accordance with the fixed procedure.

2. Points to ask user or operator

- 1) Have any other problems occurred apart from the problem that has been reported?
- 2) Was there anything strange about the machine before the failure occurred?
- 3) Did the failure occur suddenly, or were there problems with the machine condition before this?
- 4) Under what conditions did the failure occur?
- 5) Had any repairs been carried out before the failure? When were these repairs carried out?
- 6) Has the same kind of failure occurred before?

3. Checks before troubleshooting

- 1) Is there any sign of abnormality in the machine or engine?
- 2) Always carry out the Checks before starting.
- 3) Carry out other checks if necessary.
- 4) Other maintenance items can be checked externally, so check any item that is considered to be necessary.
- 5) Check for any error display on the controller.

4. Confirming failure

Confirm the extent of the failure yourself, and judge whether to handle it as a real failure or as a problem with the method of operation, etc.

- ★ When operating the machine to re-enact the troubleshooting symptoms, do not carry out any investigation or measurement that may make the problem worse.

5. Troubleshooting

Use the results of the investigation and inspection in Items 2 – 4 to narrow down the causes of failure, then use the troubleshooting matrix or flowchart to locate the position of the failure exactly.

- ★ The basic procedure for troubleshooting is as follows.

- 1) Start from the simple points.
- 2) Start from the most likely points.
- 3) Investigate other related parts or information.

6. Measures to remove root cause of failure

Even if the failure is repaired, if the root cause of the failure is not repaired, the same failure will occur again.

To prevent this, always investigate why the problem occurred. Then, remove the root cause.

METHOD OF USING TROUBLESHOOTING FLOWCHART

① Troubleshooting code number and problem

The title at the top of the troubleshooting chart gives the troubleshooting code number and the problem with the machine.

② General precautions

When carrying out troubleshooting for the problem, precautions that apply to all items are given at the top of the page under the title and marked with ★.

The common precautions marked ★ at the top of the page are not given in the (box formed by a broken line) on the left, but must always be followed when carrying out the check given in the on the right.

③ Distinguishing conditions

Even with the same problem, the method of troubleshooting may differ according to the model, component, or problem. In such cases, the failure mode is further divided into sections marked with small letters (for example, a), b)), so go to the appropriate section to carry out troubleshooting.

If the troubleshooting table is not divided into sections, start troubleshooting from the first check item in the flowchart.

④ Method of following troubleshooting chart

NOTE: The number written at the top right corner of the is an index number; it does not indicate the order to follow.)

- To the left of the there is (box formed by a broken line). This contains the procedure and conditions needed for inspection and measurement of the item in the . Before starting inspection or measurement, always read the instructions for the procedure carefully, and make sure that you understand them.
- Check or measure the item inside , and judge if the result is YES or NO. If the judgement values in the are correct or the answer to the question inside the is YES, follow the YES line; if the judgement value is not correct, or the answer to the question is NO, follow the NO line. Continue the troubleshooting for the next item in the same way.

Following the YES or NO lines according to the results of the inspection or measurement will lead finally to the Cause and Remedy block. Check the cause and take the action given as the remedy.

⑤ Troubleshooting tools

Details of the tools needed for troubleshooting are given separately in the table of TOOLS FOR TESTING, ADJUSTING, AND TROUBLESHOOTING.

<Example of troubleshooting>

① E-20 Error code [E-70] [Excess current in fuel supply pump PCV1 system]

② ★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.

④

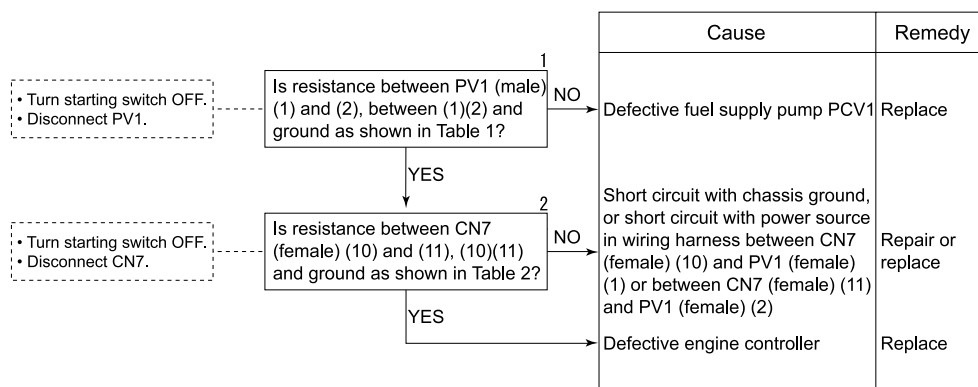


Table 1

PV1 (male)	Resistance value
Between (1) and (2)	2.3 – 5.3 Ω
Between (1)(2) and ground	Min. 1 MΩ

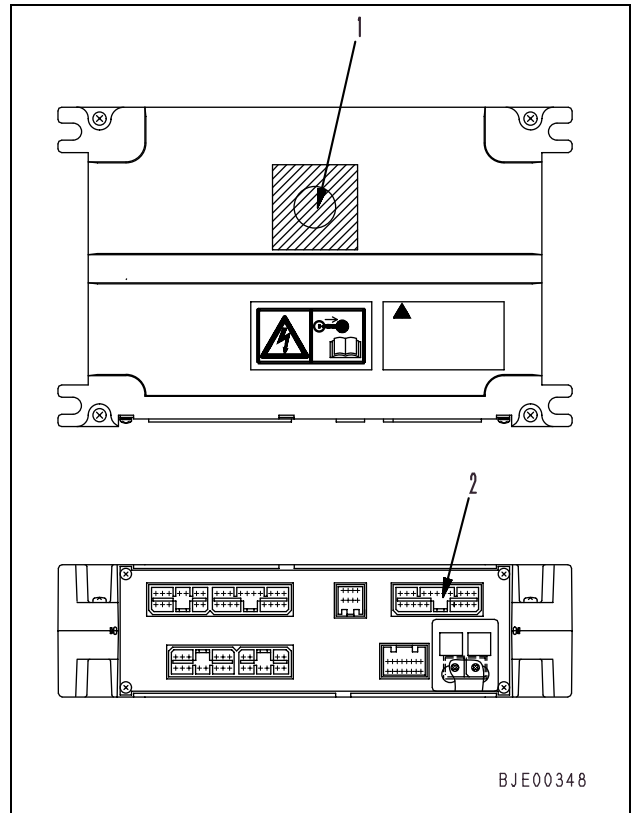
Table 2

CN7 (male)	Resistance value
Between (10) and (11)	2.3 – 5.3 Ω
Between (10)(11) and ground	Min. 1 MΩ

ERROR CODE DISPLAYS AND POINTS TO REMEMBER WHEN TROUBLESHOOTING

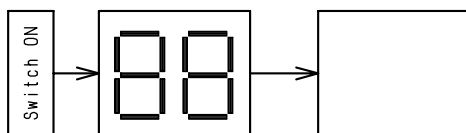
1. Error code displays

- The engine controller displays the appropriate error code for the abnormality in display window (1) of the controller using seven segments with two alphanumeric digits.
- When the starting switch is turned ON, the display check displays [88], then displays [E] to show the occurrence of an error and a 2-digit code repeatedly.
If there are multiple service codes in memory, the display returns to the first display after completing all the displays.
- To prevent mistakes when reading, the numerals and letters are displayed as follows.
Numerals: **0 1 2 3 4 5 6 7 8 9**
Alphabet: **A b C d E**
- When re-enacting an abnormality or after completion of repair of an abnormality, keep the starting switch at the ON position and connect the No. 4 pin circuit of connector (2) CN4 to the ground.

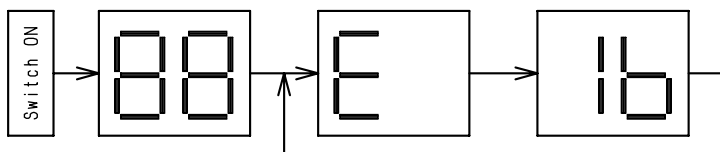


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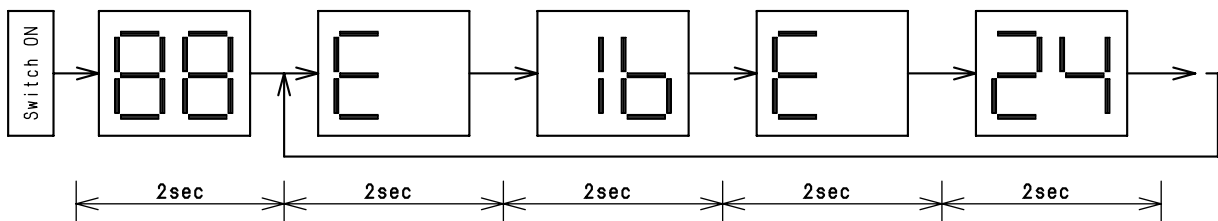
① Display when normal



② Display when error occurs (only error code [E-1b] displayed)



③ Display when error occurs (error code [E-1b], [E-24], etc. displayed together)



TJE00929

2. Table of error codes

Error code	Nature of abnormality	Operation for re-enaction
E-1b	Abnormality in NE revolution sensor system	Start engine.
E-1C	Abnormality in G revolution sensor system	Start engine.
E-20	Abnormality in model selection system	Turn starting switch ON.
E-22	Overrun	Start engine.
E-23	Overheat	Start engine.
E-24	Drop in oil pressure	Start engine.
E-30	Abnormality in idling validation signal system	Turn starting switch ON.
E-31	Abnormality in throttle sensor system	Turn starting switch ON.
E-34	Abnormality in water temperature high-temperature sensor system	Turn starting switch ON.
E-36	Abnormality in oil pressure switch system	Start engine.
E-3C	Abnormality in boost pressure sensor system	Turn starting switch ON.
E-3d	Abnormality in fuel temperature sensor system	Turn starting switch ON.
E-50	Abnormality in preheat relay contact system	Turn starting switch ON.
E-51	Abnormality preheat relay coil system	Turn starting switch ON.
E-54	Short circuit in starting switch signal C	Turn starting switch OFF.
E-56	Abnormality 1 in power source system	Turn starting switch ON.
E-57	Abnormality 2 in power source system	Turn starting switch OFF.
E-5A	Abnormality fuel injection quantity control switch signal	Turn starting switch ON.
E-6A	Abnormality in water temperature low-temperature sensor system	Turn starting switch ON.
E-70	Excess current in fuel supply pump PCV1 system	Turn starting switch ON.
E-71	Excess current in fuel supply pump PCV2 system	Turn starting switch ON.
E-74	Disconnection in fuel supply pump PCV1 system	Turn starting switch ON.
E-75	Disconnection in fuel supply pump PCV2 system	Turn starting switch ON.
E-77	Abnormality in common rail fuel pressure sensor system	Turn starting switch ON.
E-79	Abnormality 1 in common rail fuel high pressure	Start engine.
E-7A	Abnormality 2 in common rail fuel high pressure	Start engine.
E-7b	Fuel supply pump non-force feed 1	Start engine.
E-7C	Fuel supply pump non-force feed 2	Start engine.
E-7d	Abnormality in common rail fuel pressure	Start engine.
E-80	Defective controller	Turn starting switch ON.
E-81	Disconnection in No. 1 fuel injector system	Turn starting switch ON.
E-82	Disconnection in No. 2 fuel injector system	Turn starting switch ON.
E-83	Disconnection in No. 3 fuel injector system	Turn starting switch ON.
E-84	Disconnection in No. 4 fuel injector system	Turn starting switch ON.
E-85	Disconnection in No. 5 fuel injector system	Turn starting switch ON.
E-86	Disconnection in No. 6 fuel injector system	Turn starting switch ON.
E-8A	Short circuit in No. 1, No. 2, No. 3 fuel injector system	Turn starting switch ON.
E-8b	Short circuit in No. 4, No. 5, No. 6 fuel injector system	Turn starting switch ON.

3. Points to remember when troubleshooting

- 1) Points to remember if abnormality returns to normal by itself:

If the connector is disconnected and the T-adapter is inserted, or if the T-adapter is removed and the connector is returned to its original position when carrying out troubleshooting of the failure, and the error code is no longer displayed, or the [E] for the error code is no longer displayed, the abnormality has probably returned to normal.

However, there is a high probability that the same problem will occur again, so it is desirable to follow up this problem carefully.

- 2) Handling error code:

When carry out troubleshooting after displaying the error codes, save all the errors that have been displayed, then delete them. Following this, try to re-enact the problem and carry out troubleshooting for the error codes that are displayed.

- ★ Among the error codes that are saved, there are some that were caused by mistaken operation or when the connectors were disconnected, so re-enacting the failure prevents time from being wasted on unnecessary checks.

After completing troubleshooting, erase all the error codes.

- 3) Handling connectors

- ★ Before starting troubleshooting, check that the connectors related to the error code are properly inserted.
- ★ Always connect any disconnected connectors before going on the next step or after completing troubleshooting.

ACTION TAKEN BY CONTROLLER AND CONDITION OF MACHINE WHEN ERROR CODE IS DISPLAYED

Error code	System with abnormality	Nature of abnormality
E-1b	Abnormality in NE revolution sensor system	1. Defective contact, disconnection, short circuit, or short circuit with ground in wiring harness inside NE revolution sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (5) (+) and NE revolution sensor SNE (1) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (12) (–) and NE revolution sensor SNE (2) 4. Defective engine controller
E-1C	Abnormality in G revolution sensor system	1. Defective contact, disconnection, short circuit, or short circuit with ground in wiring harness inside G revolution sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (1) (+) and G revolution sensor SG (1) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (9) (–) and G revolution sensor SG (2) 4. Defective engine controller
E-20	Abnormality in model selection system	1. Defective model selection connector 2. Defective contact, or disconnection in wiring harness between controller CN4 (13) and model selection connector MSC (1) 3. Short circuit with ground in wiring harness between controller CN4 (14) and model selection connector MSC (2) 4. Defective contact, or disconnection in wiring harness between controller CN4 (15) and model selection connector MSC (3) 5. Defective engine controller
E-22	Overrun	1. Engine speed goes above operating range. 2. Defective engine controller
E-23	Overheat	1. Engine water temperature goes above operating range. 2. Defective engine controller
E-24	Drop in oil pressure	1. Engine oil pressure goes below operating range. 2. Defective oil pressure low-pressure sensor 3. Defective oil pressure high-pressure sensor 4. Short circuit with chassis ground in wiring harness between controller CN4 (5) and oil pressure low-pressure sensor POL 5. Short circuit with chassis ground in wiring harness between controller CN4 (6) and oil pressure low-pressure sensor POH 6. Defective engine controller
E-30	Abnormality in idling validation signal system	1. Defective throttle sensor 2. Defective contact or disconnection in wiring harness between controller CN4 (female) (8) (GND) and throttle sensor TS (female) (4) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN4 (female) (11) (signal 2) and throttle sensor TS (female) (5) 4. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN4 (female) (12) (signal 3) and throttle sensor TS (female) (6) 5. Defective engine controller
E-31	Abnormality in throttle sensor system (accelerator pedal type)	1. Defective throttle sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (4) (power source) and throttle sensor TS (3) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (6) (signal) and throttle sensor TS (2) 4. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (11) (GND) and throttle sensor TS (1) 5. Defective engine controller
	Abnormality in throttle sensor system (fuel control dial type)	1. Defective throttle sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (4) (power source) and throttle sensor TS (1) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (6) (signal) and throttle sensor TS (2) 4. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (11) (GND) and throttle sensor TS (3) 5. Defective engine controller
E-34	Abnormality in water temperature high-temperature sensor system	1. Defective water temperature high-temperature sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (4) (signal) and water temperature high-temperature sensor TWH (1) 3. Defective contact or disconnection in wiring harness between controller CN2 (10) (GND) and water temperature high-temperature sensor TWH (2) 4. Defective engine controller

TROUBLESHOOTING
ACTION TAKEN BY CONTROLLER AND CONDITION OF MACHINE WHEN ERROR CODE IS DISPLAYED

Condition when normal	Action by controller	Problem that appears on machine
Sensor resistance value Between SNE (1) and (2): 85 – 210 Ω	- Limits output for operation (when problem occurs independently) - Control of the system becomes impossible (when E-1C occurs at same time)	- Reduces output (when problem occurs independently) - Engine stops during operation (when E-1C occurs at same time) - Engine cannot be started (when E-1C occurs at same time)
Sensor resistance value Between SG (1) and (2): 1.4 k – 3.5 kΩ	- Limits output for operation (when problem occurs independently) - Control of the system becomes impossible (when E-1C occurs at same time)	- Output is reduced (when problem occurs independently) - Engine stops during operation (when E-1b occurs at same time) - Engine cannot be started (when E-1b occurs at same time)
- Resistance in ground connection circuit Between CN4 (female) and ground: Max. 1 Ω - Resistance in ground cut-off circuit Between CN4 (female) and ground: Min. 1 MΩ	Carries out operation under normal control.	Output is reduced
	Stops fuel injection until engine speed goes down to operating range.	Engine speed varies abnormally.
	Limits fuel injection amount until temperature goes down to operating range.	Output is reduced
- Low-pressure switch resistance value Between POL and ground Engine stopped: Max. 1 Ω Engine above 600 rpm: Min. 1 MΩ - High-pressure switch resistance value Between POH and ground Engine stopped: Max. 1 Ω Engine above 1,300 rpm: Min. 1 MΩ	Limits output for operation	Runs at low idling.
- Signal 2 voltage (between CN4 (11) and (8)) Throttle below 0.446 V: Max. 1 V Throttle above 0.446 V: 15 – 30 V - Signal 3 voltage (between CN4 (12) and (8)) Throttle below 0.446 V: 15 – 30 V Throttle above 0.446 V: Max. 1 V	Carries out operation under normal control.	Operates normally.
- Sensor power source voltage Between CN1 (4) and (11): 4.6 – 5.4 V - Sensor signal voltage Between CN1 (6) and (11): 0.3 – 4.5 V	- Actuated with throttle signal 100% (when problem occurs independently and simultaneously) - Actuated with throttle signal 0% (when E-24 and E-36 occur at same time)	- Fixed at high idling (when problem occurs independently) - Fixed at low idling (when E-24 and E-36 occur at same time)
- Sensor power source voltage Between CN1 (4) and (11): 4.6 – 5.4 V - Sensor signal voltage Between CN1 (6) and (11): 0.3 – 4.7 V	- Actuated with throttle signal 100% (when problem occurs independently and simultaneously) - Actuated with throttle signal 0% (when E-24 and E-36 occur at same time)	- Fixed at high idling (when problem occurs independently) - Fixed at low idling (when E-24 and E-36 occur at same time)
Sensor resistance value (water temperature: 10 – 100°C) Between TWH (1) and (2): 90 k – 3.5 kΩ	Carries out operation under normal control.	Fixes water temperature signal output to machine at 90°C

TROUBLESHOOTING

ACTION TAKEN BY CONTROLLER AND CONDITION
OF MACHINE WHEN ERROR CODE IS DISPLAYED

Error code	System with abnormality	Nature of abnormality
E-36	Abnormality in engine oil pressure switch system	1. Defective oil pressure low-pressure sensor 2. Defective oil pressure high-pressure sensor 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN4 (5) and oil pressure low-pressure sensor POL 4. Defective contact or disconnection in wiring harness between controller CN4 (6) and oil pressure low-pressure sensor POH 5. Defective engine controller
E-3C	Abnormality in boost pressure sensor system	1. Defective boost pressure sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (2) (power source) and boost pressure sensor PBA (3) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (3) (signal) and boost pressure sensor PBA (2) 4. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (10) (GND) and boost pressure sensor PBA (1) 5. Defective engine controller
E-3d	Abnormality in fuel temperature sensor system	1. Defective fuel temperature sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (11) (signal) and fuel temperature sensor TFL (A) 3. Defective contact or disconnection in wiring harness between controller CN2 (10) (GND) and fuel temperature sensor TFL (B) 4. Defective engine controller
E-50	Abnormality in preheat relay contact system	1. Defective heater relay 2. Defective contact, disconnection, short circuit with ground, or short circuit with power source in wiring harness between controller CN4 (3) and heater relay HR3 3. Defective engine controller
E-51	Abnormality in preheat relay coil system	1. Defective preheater relay 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (5) and preheater relay RPH (2) 3. Defective engine controller
E-54	Short circuit in starting switch C signal system	1. Defective starting switch 2. Short circuit with power source in wiring harness between controller CN4 (2) and starting switch terminal C 3. Defective engine controller
E-56	Power source system abnormality 1	1. Defective power source relay 2. Defective contact, disconnection, or short circuit with ground in wiring harness between starting switch terminal ACC and power source relay RPW (1) 3. Defective contact or disconnection in wiring harness between power source relay RPW (2) and ground 4. Defective contact, disconnection, or short circuit with ground in wiring harness between power source fuse and power source relay RPW (3) 5. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN7 (6)(14) and power source relay RPW (5) 6. Defective engine controller
E-57	Power source system abnormality 2	1. Defective power source relay 2. Short circuit with power source in wiring harness between controller CN7 (6)(14) and power source relay (5) 3. Defective engine controller
E-5A	Abnormality in fuel injection quantity control switch signal	1. Defective setting of fuel injection quantity control switch 2. Defective engine controller
E-6A	Abnormality in water temperature low-temperature sensor system	1. Defective water temperature low-temperature sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (3) (signal) and water temperature low-temperature sensor TWL (A) 3. Defective contact or disconnection in wiring harness between controller CN2 (10) (GND) and water temperature low-temperature sensor TWL (B) 4. Defective engine controller
E-70	Excess current in fuel supply pump PCV1 system	1. Defective fuel supply pump PCV1 2. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN7 (10) and PCV1 solenoid PV1 (1) 3. Short circuit with power source in wiring harness between controller CN7 (11) and PCV1 solenoid PV1 (2) 4. Defective engine controller
E-71	Excess current in fuel supply pump PCV2 system	1. Defective fuel supply pump PCV2 2. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN7 (4) and PCV2 solenoid PV2 (1) 3. Short circuit with power source in wiring harness between controller CN7 (12) and PCV2 solenoid PV2 (2) 4. Defective engine controller

TROUBLESHOOTING

ACTION TAKEN BY CONTROLLER AND CONDITION
OF MACHINE WHEN ERROR CODE IS DISPLAYED

Condition when normal	Action by controller	Problem that appears on machine
- Low-pressure switch resistance value Between POL and ground Engine stopped: Max. 1 Ω Engine above 600 rpm: Min. 1 MΩ - High-pressure switch resistance value Between POH and ground Engine stopped: Max. 1 Ω Engine above 1,300 rpm: Min. 1 MΩ	1. Carries out operation under normal control.	1. Operates normally.
- Sensor power source voltage Between PBA (3) and (1): 4.6 – 5.4 V - Sensor signal voltage Between PBA (2) and (1): 0.3 – 4.7 V	—	1. Operates normally.
Sensor resistance value (fuel temperature: 10 – 100°C) Between TFL (A) and (B): 9 k – 0.3 kΩ	1. Carries out operation under normal control.	1. Operates normally.
Preheating signal voltage Between CN4 (3) and ground Preheating not actuated: Max. 1 V Preheating actuated: 20 – 30 V	1. Carries out operation under normal control.	1. Starting ability in cold weather becomes worse.
Preheating signal voltage Between CN1 (5) and (6) Preheating not actuated: 20 – 30 V Preheating actuated: Max. 1 V	1. Carries out operation under normal control.	1. Starting ability in cold weather becomes worse.
Starting switch C signal voltage Between CN4 (2) and ground Starting switch at ON: Max. 1 V Starting switch at START: 20 – 30 V	1. Carries out operation under normal control.	1. Operates normally 10 seconds after engine starts.
Power source voltage Between CN7 (6)(14) and (5)(13) Starting switch at ON: 20 – 30 V	—	1. Engine stops during operation. 2. Engine cannot be started.
Power source voltage Between CN7 (6)(14) and (5)(13) Starting switch at OFF: Max. 8 V	1. Carries out operation under normal control.	1. Operates normally.
Either fuel injection quantity control switch 1 or 2 of controller is set to [F]	1. Carries out operation under normal control.	1. Fuel injection quantity control setting cannot be changed.
Sensor resistance value (water temperature: 10 – 100°C) Between TWL (A) and (B): 9 k – 0.3 kΩ	1. Carries out operation under normal control.	1. Exhaust gas color at low temperatures is poor. 2. Starting ability at low temperatures is poor.
Solenoid resistance value Between PV1 (1) and (2): 2.3 – 5.3 Ω	1. Stops output to PCV1 (when problem occurs independently) 2. Stops output to PCV1 and PCV2 (when E-71 occurs at same time)	1. Operates normally (when problem occurs independently) 2. Stops engine (when E-71 occurs at same time)
Solenoid resistance value Between PV2 (1) and (2): 2.3 – 5.3 Ω	1. Stops output to PCV2 (when problem occurs independently) 2. Stops output to PCV1 and PCV2 (when E-70 occurs at same time)	1. Operates normally (when problem occurs independently) 2. Stops engine (when E-70 occurs at same time)

TROUBLESHOOTING

ACTION TAKEN BY CONTROLLER AND CONDITION
OF MACHINE WHEN ERROR CODE IS DISPLAYED

Error code	System with abnormality	Nature of abnormality
E-74	Disconnection in fuel supply pump PCV1 system	1. Defective fuel supply pump PCV1 2. Defective contact or disconnection in wiring harness between controller CN7 (10) and PCV1 solenoid PV1 (1) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN7 (11) and PCV1 solenoid PV1 (2) 4. Defective engine controller
E-75	Disconnection in fuel supply pump PCV2 system	1. Defective fuel supply pump PCV2 2. Defective contact or disconnection in wiring harness between controller CN7 (4) and PCV2 solenoid PV2 (1) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN7 (12) and PCV2 solenoid PV2 (2) 4. Defective engine controller
E-77	Abnormality in common rail fuel pressure sensor system	1. Defective common rail fuel pressure sensor 2. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (2) (power source) and fuel pressure sensor PFL (1) 3. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN1 (1) (signal) and fuel pressure sensor PFL (2) 4. Defective contact, disconnection, or short circuit with ground in wiring harness between controller CN2 (10) (GND) and fuel pressure sensor PFL (3) 5. Defective engine controller
E-79	Common rail fuel high-pressure abnormality 1	1. Viscosity of fuel is too high (unsuitable fuel) 2. Defective overflow valve 3. Defective pressure limiter 4. Defective common rail fuel pressure sensor 5. Clogged overflow piping
E-7A	Common rail fuel high-pressure abnormality 2	★ See E-79.
E-7b	Supply pump non-force feed abnormality 1	1. Defective fuel low-pressure circuit (etc) 2. Defective fuel supply pump PCV 3. Defective pressure limiter 4. Defective common rail fuel pressure sensor 5. Defective fuel injector 6. Leakage from fuel high-pressure piping
E-7C	Supply pump non-force feed abnormality 2	★ See E-7b.
E-7d	Abnormality in common rail fuel pressure	★ See E-79.
E-80	Abnormality in controller	1. Defective contact or disconnection in wiring harness between controller CN7 (5)(13) and ground 2. Defective engine controller
E-81	Disconnection in No. 1 fuel injector system	1. Defective No. 1 fuel injector 2. Defective contact or disconnection in wiring harness between controller CN6 (7) (–) and No. 1 injector IJ1 (1) 3. Defective contact or disconnection in wiring harness between controller CN6 (8) (+) and No. 1 injector IJ1 (2) 4. Defective engine controller
E-82	Disconnection in No. 2 fuel injector system	1. Defective No. 2 fuel injector 2. Defective contact or disconnection in wiring harness between controller CN6 (4) (–) and No. 2 injector IJ2 (1) 3. Defective contact or disconnection in wiring harness between controller CN6 (10) (+) and No. 2 injector IJ2 (2) 4. Defective engine controller
E-83	Disconnection in No. 3 fuel injector system	1. Defective No. 3 fuel injector 2. Defective contact or disconnection in wiring harness between controller CN6 (3) (–) and No. 3 injector IJ3 (1) 3. Defective contact or disconnection in wiring harness between controller CN6 (9) (+) and No. 3 injector IJ3 (2) 4. Defective engine controller

TROUBLESHOOTING

ACTION TAKEN BY CONTROLLER AND CONDITION
OF MACHINE WHEN ERROR CODE IS DISPLAYED

Condition when normal	Action by controller	Problem that appears on machine
Solenoid resistance value Between PV1 (1) and (2): 2.3 – 5.3 Ω	- Stops output to PCV1 (when problem occurs independently) - Stops output to PCV1 and PCV2 (when E-71 occurs at same time)	- Operates normally (when problem occurs independently) - Stops engine (when E-71 occurs at same time)
Solenoid resistance value Between PV2 (1) and (2): 2.3 – 5.3 Ω	- Stops output to PCV2 (when problem occurs independently) - Stops output to PCV1 and PCV2 (when E-70 occurs at same time)	- Operates normally (when problem occurs independently) - Stops engine (when E-70 occurs at same time)
- Sensor power source voltage Between PFL (1) and (3): 4.6 – 5.4 V - Sensor signal voltage Between PFL (2) and (3): 0.3 – 4.7 V	Limits output with open control.	Output is reduced
—	Operation carried out with limited output	Output is reduced
—	- Stops output to fuel supply pump - Limits output to fuel injector	Output is reduced
—	Operation carried out with limited output	Output is reduced
—	Operation is carried out with limited output and engine speed.	Output and engine speed are reduced.
—	Carries out operation under normal control.	- The engine does not run at high idling speed when there is no load - The engine stops when a large load is applied
—	Operation carried out with limited output	- The engine does not run at high idling speed when there is no load - The engine stops when a large load is applied - Engine stops during operation. - Engine cannot be started.
No. 1 injector resistance value Between IJ1 (1) and (2): 0.4 – 1.1 Ω	- Stops output to No. 1 injector (when problem occurs independently) - Stops output to fuel supply pump, all fuel injectors (when at same time in E-82 to E-86)	- Output is reduced (when problem occurs independently) - Engine stops (when E-82 to E-86 occur at same time)
No. 2 injector resistance value Between IJ2 (1) and (2): 0.4 – 1.1 Ω	- Stops output to No. 2 injector (when problem occurs independently) - Stops output to fuel supply pump, all fuel injectors (when E-81 to E-86 occur at same time)	- Output is reduced (when problem occurs independently) - Engine stops (when E-81 to E-86 occur at same time)
No. 3 injector resistance value Between IJ3 (1) and (2): 0.4 – 1.1 Ω	- Stops output to No. 3 injector (when problem occurs independently) - Stops output to fuel supply pump, all fuel injectors (when E-81 to E-86 occur at same time)	- Output is reduced (when problem occurs independently) - Engine stops (when E-81 to E-86 occur at same time)

TROUBLESHOOTING

ACTION TAKEN BY CONTROLLER AND CONDITION
OF MACHINE WHEN ERROR CODE IS DISPLAYED

Error code	System with abnormality	Nature of abnormality
E-84	Disconnection in No. 4 fuel injector system	1. Defective No. 4 fuel injector 1. Defective contact or disconnection in wiring harness between controller CN7 (3) (–) and No. 4 injector IJ4 (1) 1. Defective contact or disconnection in wiring harness between controller CN7 (9) (+) and No. 4 injector IJ4 (2) 1. Defective engine controller
E-85	Disconnection in No. 5 fuel injector system	1. Defective No. 5 fuel injector 2. Defective contact or disconnection in wiring harness between controller CN7 (1) (–) and No. 5 injector IJ5 (1) 3. Defective contact or disconnection in wiring harness between controller CN7 (7) (+) and No. 5 injector IJ5 (2) 4. Defective engine controller
E-86	Disconnection in No. 6 fuel injector system	1. Defective No. 6 fuel injector 1. Defective contact or disconnection in wiring harness between controller CN7 (2) (–) and No. 6 injector IJ6 (1) 1. Defective contact or disconnection in wiring harness between controller CN7 (8) (+) and No. 6 injector IJ6 (2) 1. Defective engine controller
E-8A	Short circuit in No. 1, No. 2, No. 3 fuel injector system	1. Defective No. 1 fuel injector 2. Defective No. 2 fuel injector 3. Defective No. 3 fuel injector 4. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN6 (7) (+) and No. 1 injector IJ1 (1) 5. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN6 (8) (–) and No. 1 injector IJ1 (2) 6. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN6 (4) (+) and No. 2 injector IJ2 (1) 7. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN6 (10) (–) and No. 2 injector IJ2 (2) 8. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN6 (3) (+) and No. 3 injector IJ3 (1) 9. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN6 (9) (–) and No. 3 injector IJ3 (2) 10. Defective contact or disconnection in wiring harness between controller CN7 (5)(13) and ground 11. Defective engine controller
E-8b	Short circuit in No. 4, No. 5, No. 6 fuel injector system	1. Defective No. 4 fuel injector 2. Defective No. 5 fuel injector 3. Defective No. 6 fuel injector 4. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN7 (3) (+) and No. 4 injector IJ4 (1) 5. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN7 (9) (–) and No. 4 injector IJ4 (2) 6. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN7 (1) (+) and No. 5 injector IJ5 (1) 7. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN7 (7) (–) and No. 5 injector IJ5 (2) 8. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN7 (2) (+) and No. 6 injector IJ6 (1) 9. Short circuit with chassis ground or short circuit with power source in wiring harness between controller CN7 (8) (–) and No. 6 injector IJ6 (2) 10. Defective contact or disconnection in wiring harness between controller CN7 (5)(13) and ground 11. Defective engine controller

TROUBLESHOOTING
ACTION TAKEN BY CONTROLLER AND CONDITION OF MACHINE WHEN ERROR CODE IS DISPLAYED

Condition when normal	Action by controller	Problem that appears on machine
No. 4 injector resistance value Between IJ4 (1) and (2): 0.4 – 1.1 Ω	- Stops output to No. 4 injector (when problem occurs independently) - Stops output to fuel supply pump, all fuel injectors (when E-81 to E-86 occur at same time)	- Output is reduced (when problem occurs independently) - Engine stops (when E-81 to E-86 occur at same time)
No. 5 injector resistance value Between IJ5 (1) and (2): 0.4 – 1.1 Ω	- Stops output to No. 5 injector (when problem occurs independently) - Stops output to fuel supply pump, all fuel injectors (when E-81 to E-86 occur at same time)	- Output is reduced (when problem occurs independently) - Engine stops (when E-81 to E-86 occur at same time)
No. 6 injector resistance value Between IJ6 (1) and (2): 0.4 – 1.1 Ω	- Stops output to No. 6 injector (when problem occurs independently) - Stops output to fuel supply pump, all fuel injectors (when E-81 to E-85 occur at same time)	- Output is reduced (when problem occurs independently) - Engine stops (when E-81 to E-85 occur at same time)
- No. 1 injector resistance value Between IJ1 (1) and (2): 0.4 – 1.1 Ω - No. 2 injector resistance value Between IJ2 (1) and (2): 0.4 – 1.1 Ω - No. 3 injector resistance value Between IJ3 (1) and (2): 0.4 – 1.1 Ω	- Stops output to No. 1, No. 2, No. 3 fuel injectors (when problem occurs independently) - Stops output to fuel supply pump, all fuel injectors (when E-8b occurs at same time)	- Output is greatly reduced (when problem occurs independently) - Engine stops (when E-8b occurs at same time)
- No. 4 injector resistance value Between IJ4 (1) and (2): 0.4 – 1.1 Ω - No. 5 injector resistance value Between IJ5 (1) and (2): 0.4 – 1.1 Ω - No. 6 injector resistance value Between IJ6 (1) and (2): 0.4 – 1.1 Ω	- Stops output to No. 4, No. 5, No. 6 fuel injectors (when problem occurs independently) - Stops output to fuel supply pump, all fuel injectors (when E-8A occurs at same time)	- Output is greatly reduced (when problem occurs independently) - Engine stops (when E-8A occurs at same time)

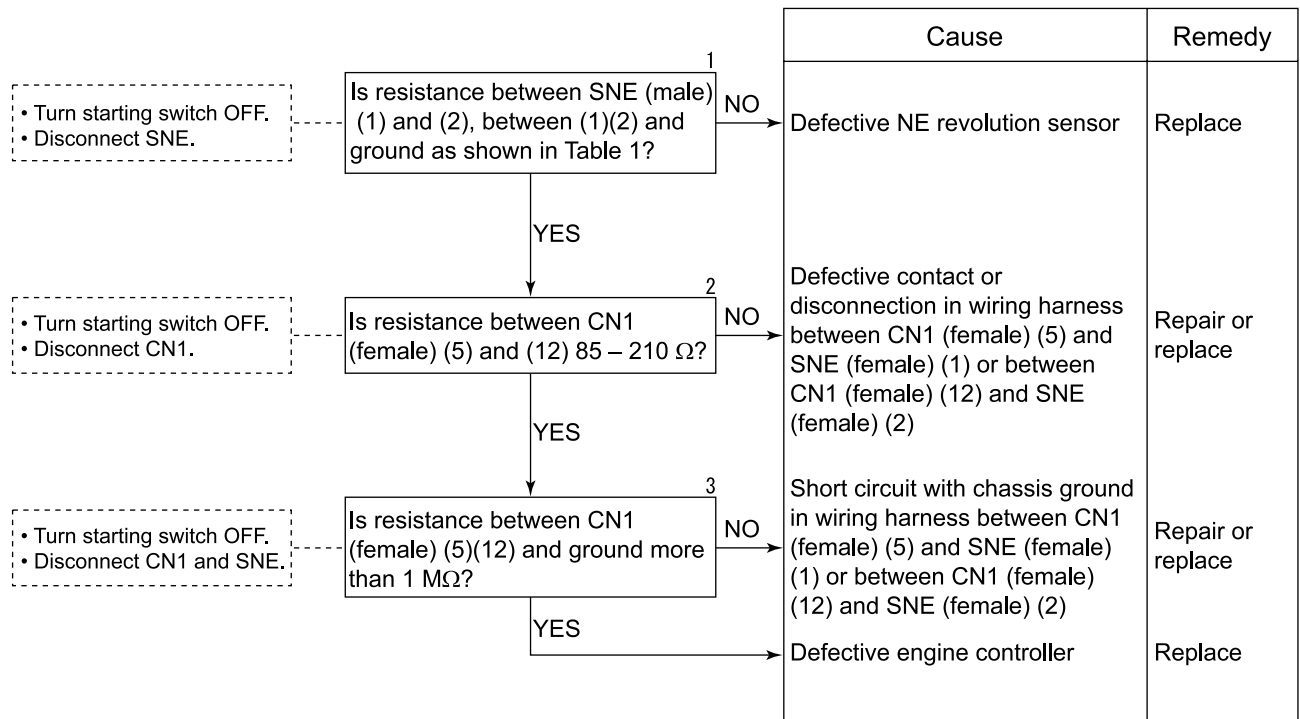
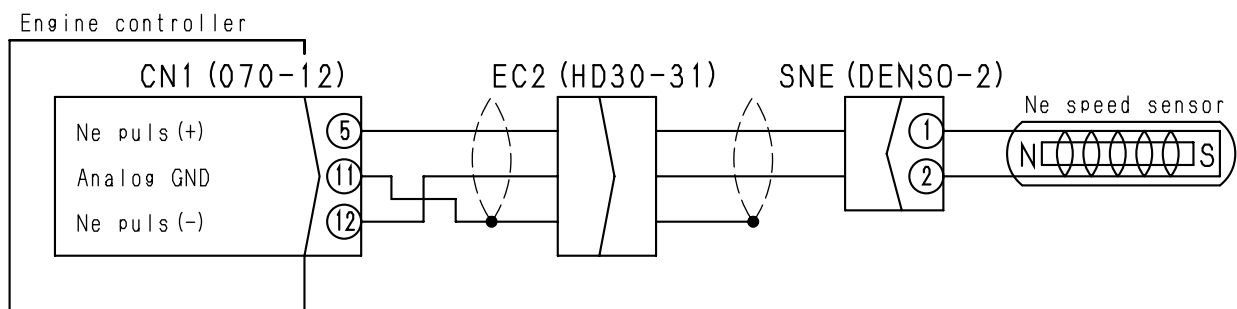
E-1 Error code [E-1b] [Abnormality in NE revolution sensor system]

Table 1

SNE (male)	Resistance value
Between (1) and (2)	85 – 210 Ω
Between (1)(2) and ground	Min. 1 MΩ

E-1 Related electrical circuit diagram

BJE00301

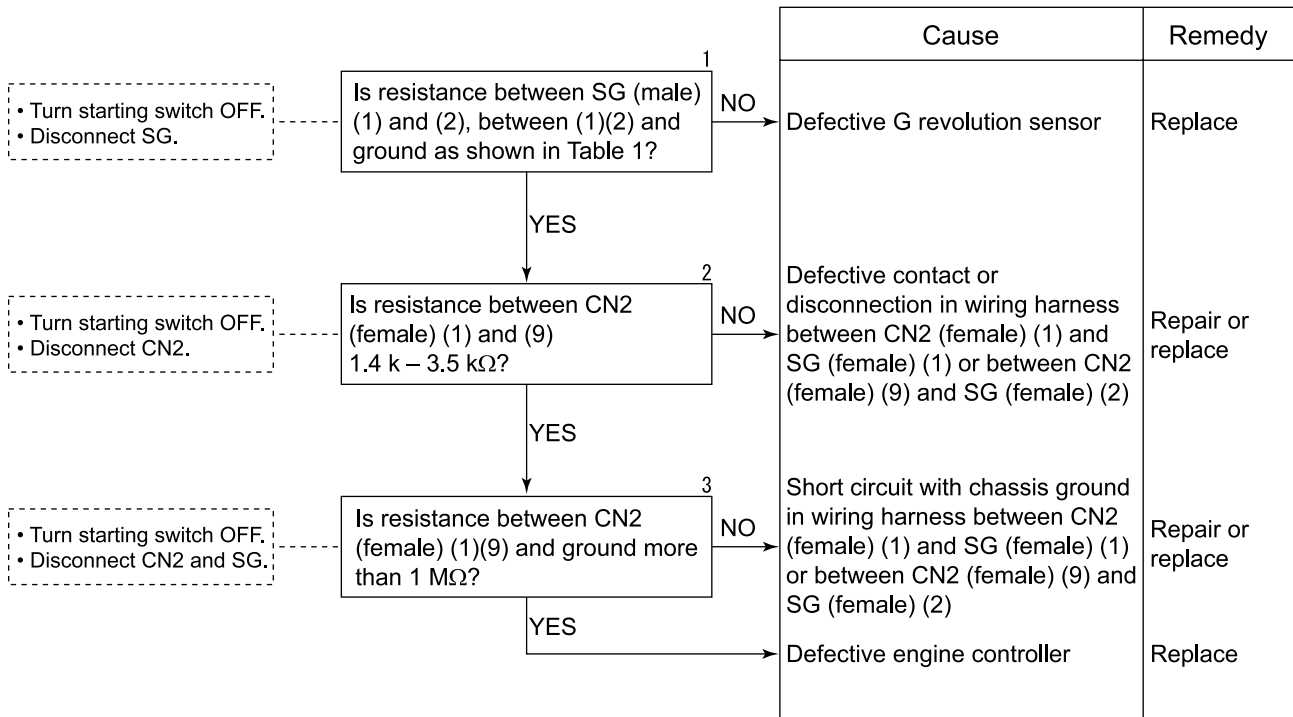
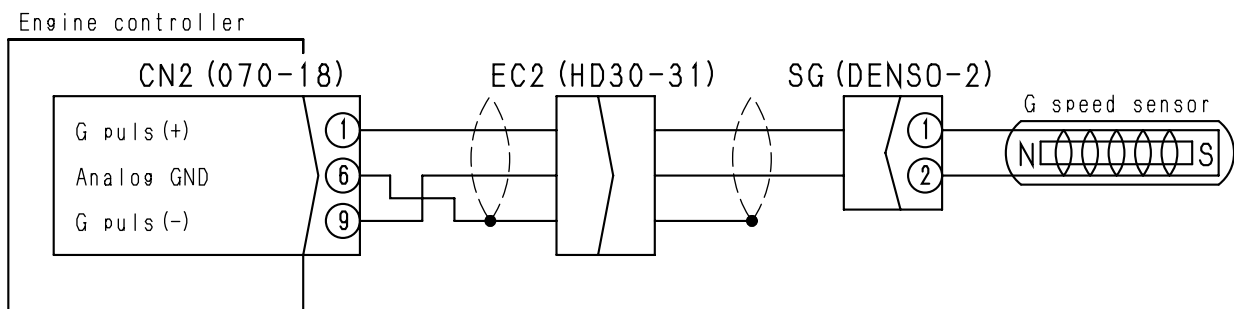
E-2 Error code [E-1C] [Abnormality in G revolution sensor system]

Table 1

SG (male)	Resistance value
Between (1) and (2)	1.4 k – 3.5 kΩ
Between (1)(2) and ground	Min. 1 MΩ

E-2 Related electrical circuit diagram

BJE00302

E-3 Error code [E-20] [Abnormality in model selection system]

- ★ The troubleshooting given below takes a particular machine as an example, so the content of the troubleshooting and the electric wiring diagrams will differ according to the actual model of machine.

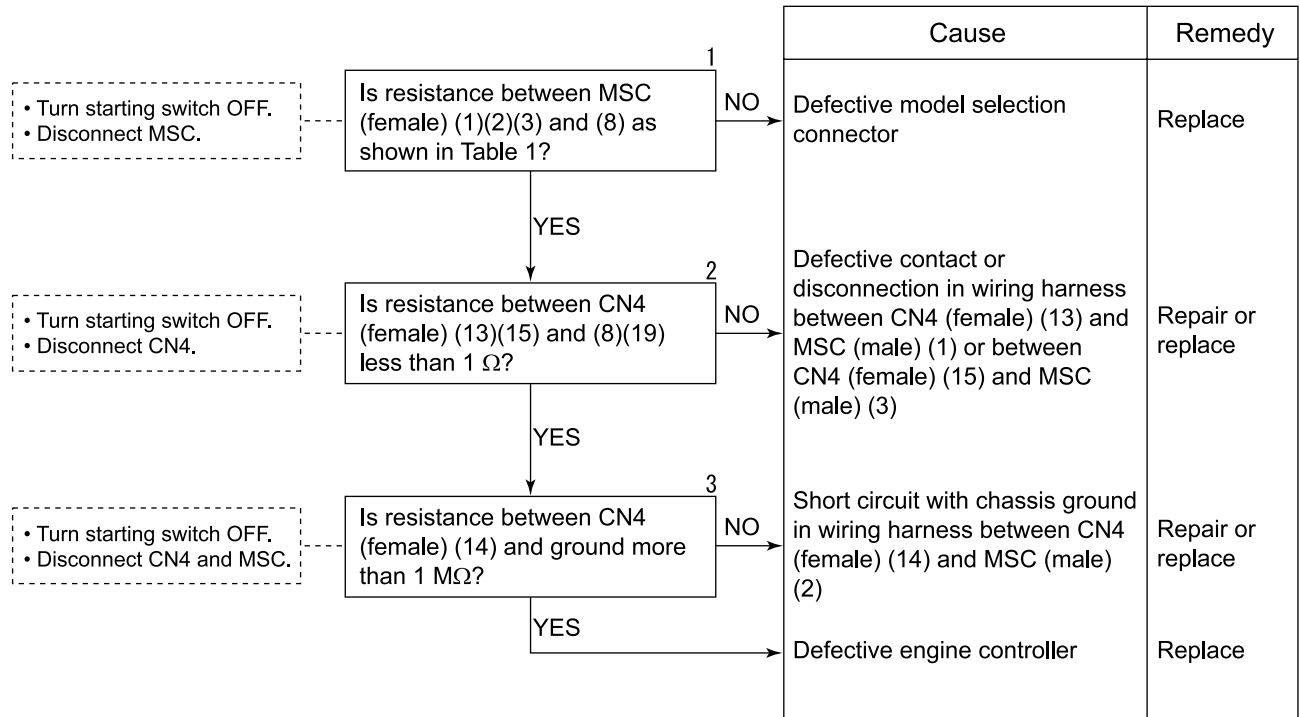
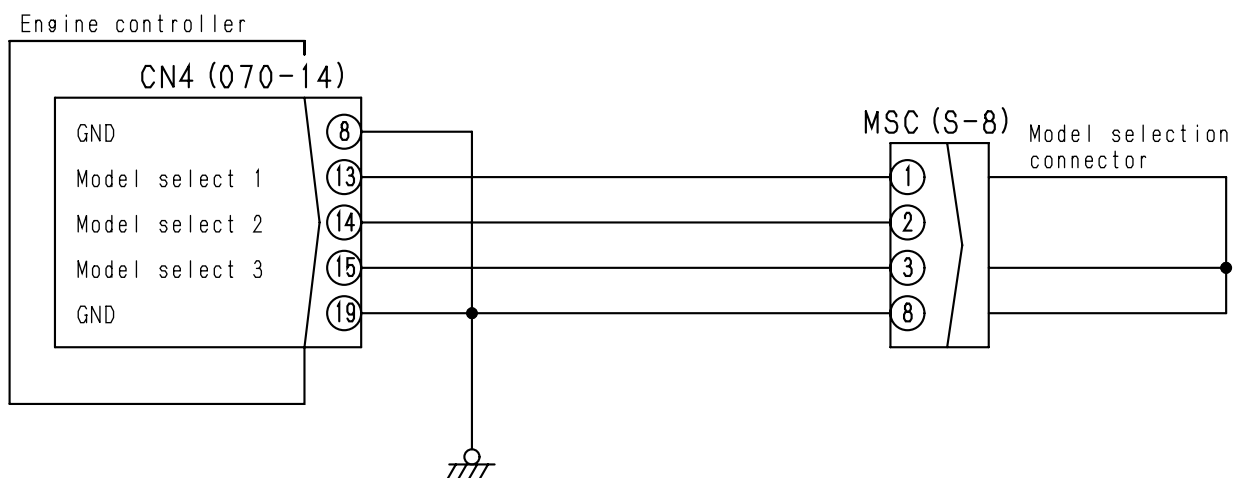


Table 1

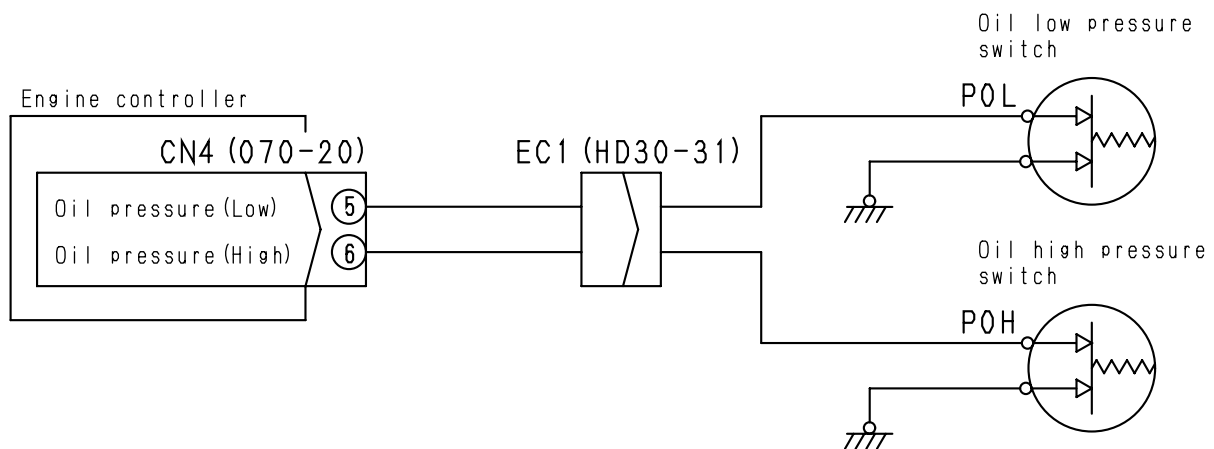
MSC (female)	Resistance value
Between (1) and (8)	Max. 1 Ω
Between (2) and (8)	Min. 1 M Ω
Between (3) and (8)	Max. 1 Ω

E-3 Related electrical circuit diagram

BJE00303

E-6 Error code [E-24] [Drop in oil pressure]

		Cause	Remedy
See TESTING AND ADJUSTING.	Is engine oil pressure normal? YES NO	Drop in engine oil pressure	Check cause of problem and repair damage to engine
- Insert T-adapter to CN4. - Engine at low idling.	Is voltage between CN4 (5) and ground 20 – 30 V? YES NO		
- Turn starting switch OFF. - Disconnect CN4 and POL.	Is resistance between CN4 (female) (5) and ground more than 1 MΩ? YES NO	Short circuit with chassis ground in wiring harness between CN4 (female) (5) and POL Defective oil pressure low-pressure switch	Repair or replace Replace
- Insert T-adapter to CN4. - Engine at midrange speed (Min. 1,300 rpm)	Is voltage between CN4 (6) and ground 20 – 30 V? YES NO	Defective engine controller	Replace
- Turn starting switch OFF. - Disconnect CN4 and POH.	Is resistance between CN4 (female) (6) and ground more than 1 MΩ? YES NO	Short circuit with chassis ground in wiring harness between CN4 (female) (6) and POH. Defective oil pressure high-pressure switch	Repair or replace Replace

E-6 Related electrical circuit diagram

BJE00304

E-7 Error code [E-30] [Abnormality in idling validation signal system]

★ This troubleshooting applies only to machines with an accelerator pedal type throttle sensor.

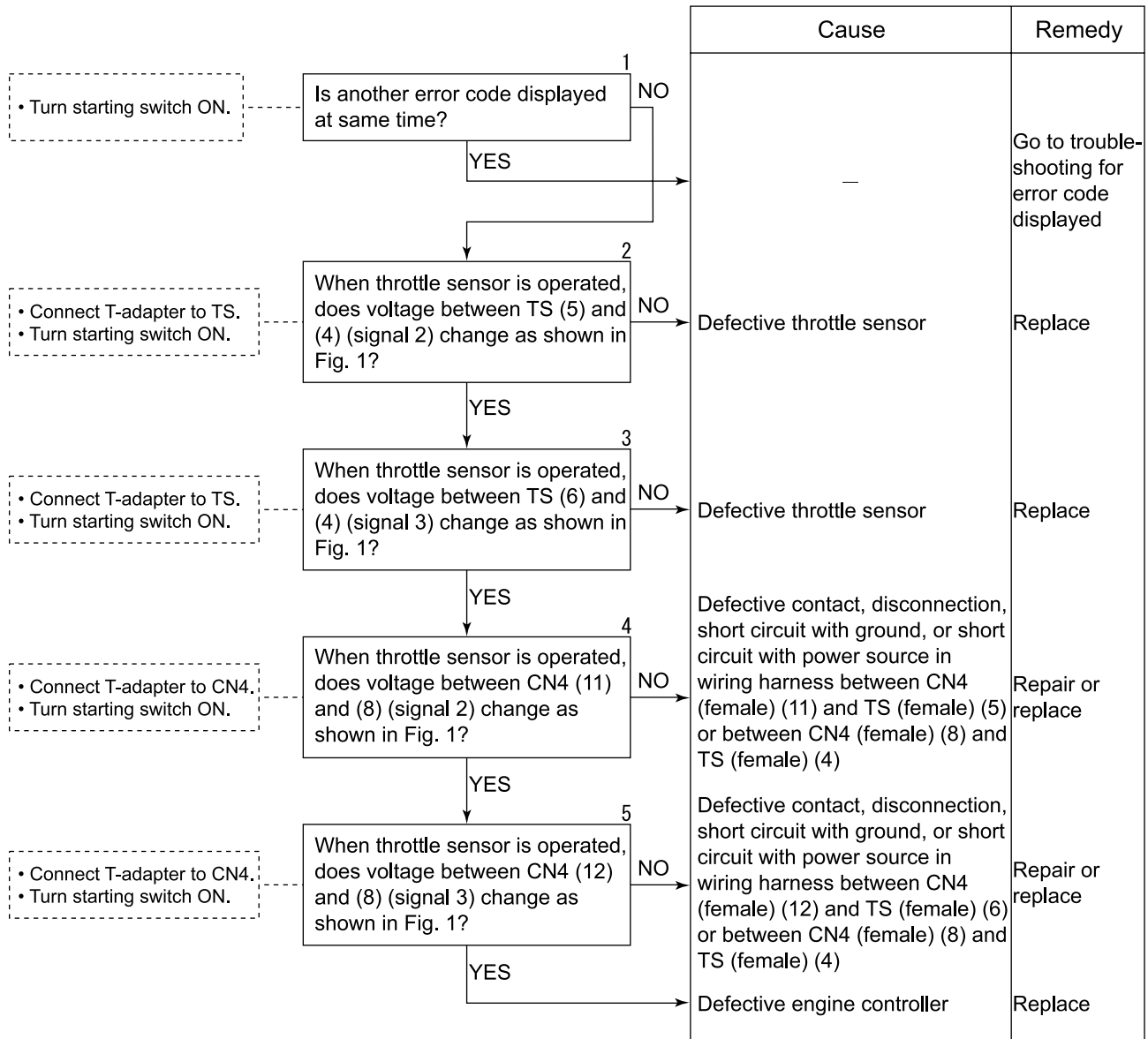
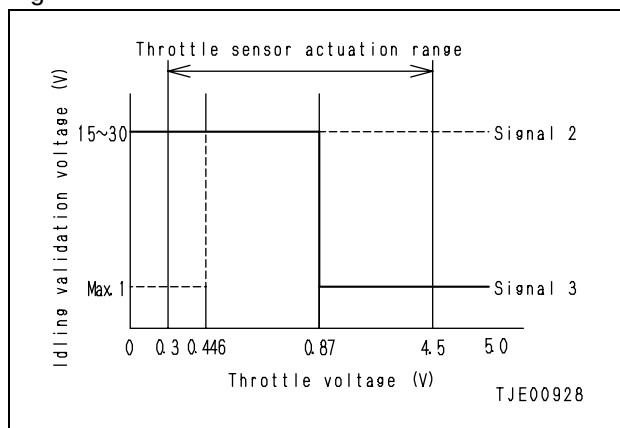
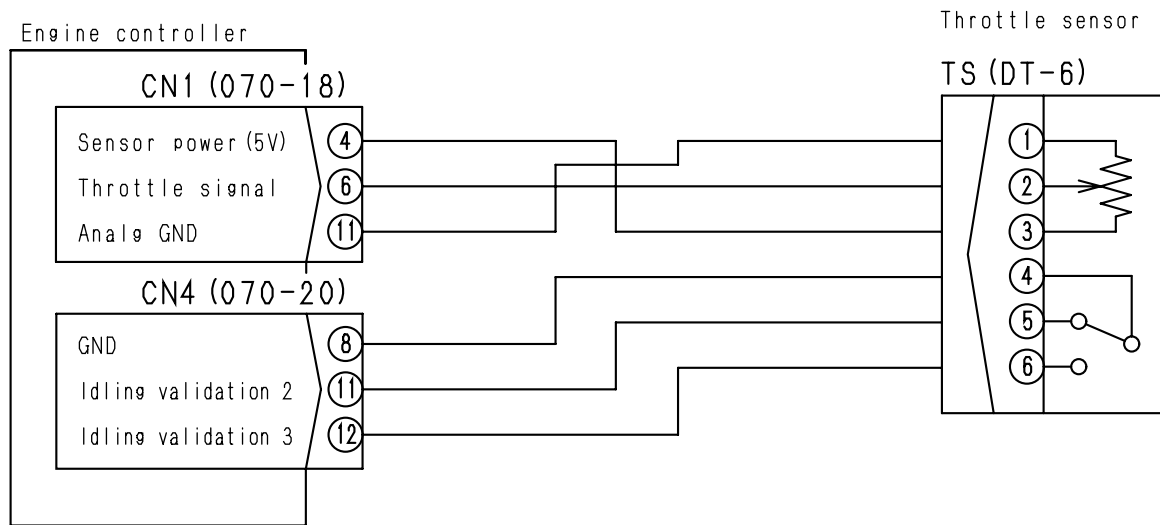


Fig. 1



E-7 Related electrical circuit diagram



BJE00322

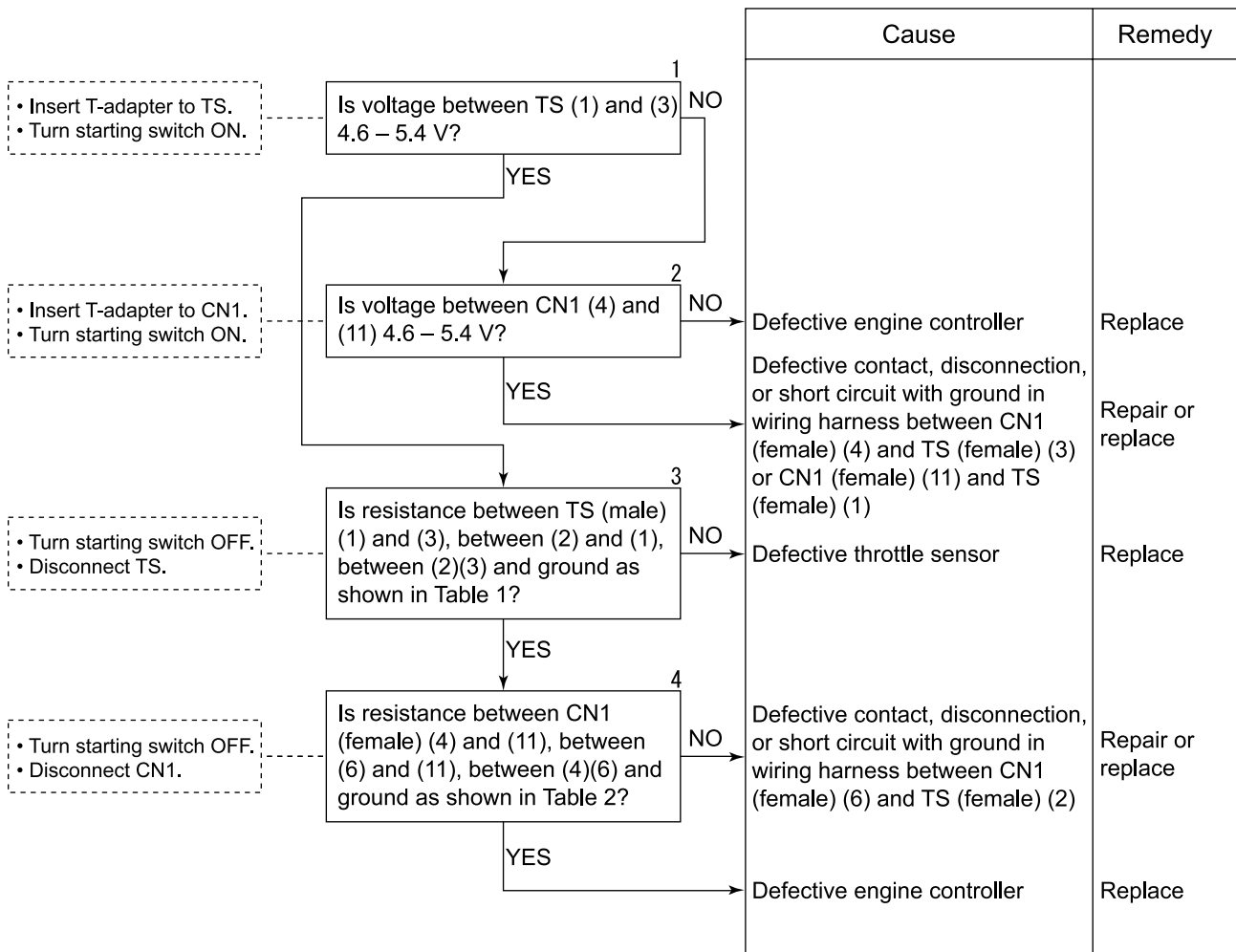
E-8 Error code [E-31] [Abnormality in throttle sensor system]**a) Accelerator pedal type throttle sensor**

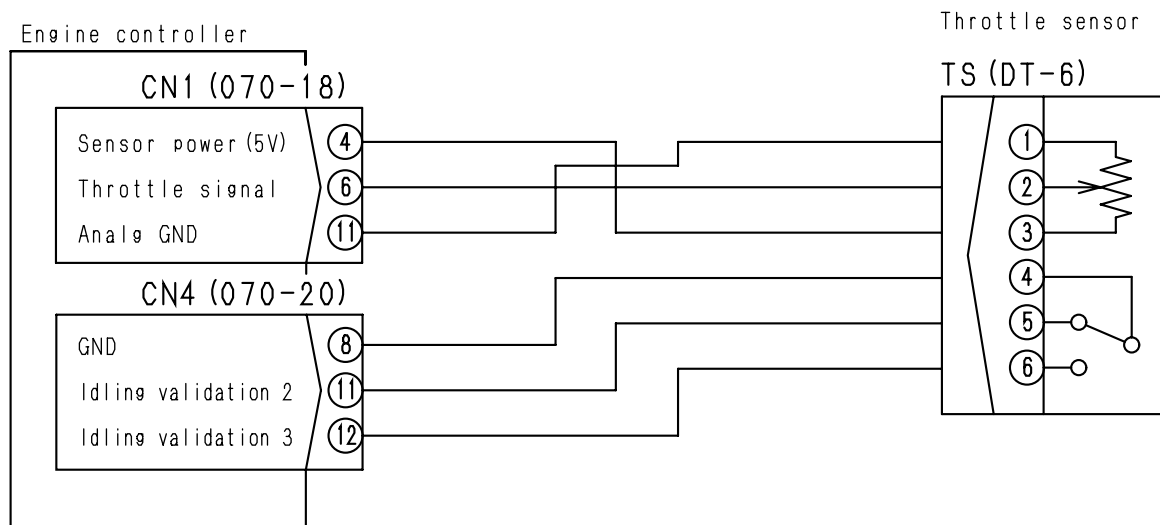
Table 1

TS (male)	Resistance value
Between (1) and (3)	4.0 k – 6.0 kΩ
Between (2) and (1)	0.5 – 2.7 kΩ
Between (2)(3) and ground	Min. 1 MΩ

Table 2

CN1 (male)	Resistance value
Between (4) and (11)	4.0 k – 6.0 kΩ
Between (6) and (11)	0.5 – 2.7 kΩ
Between (4)(6) and ground	Min. 1 MΩ

E-8 a) Related electrical circuit diagram



BJE00322

b) Fuel control dial type throttle sensor

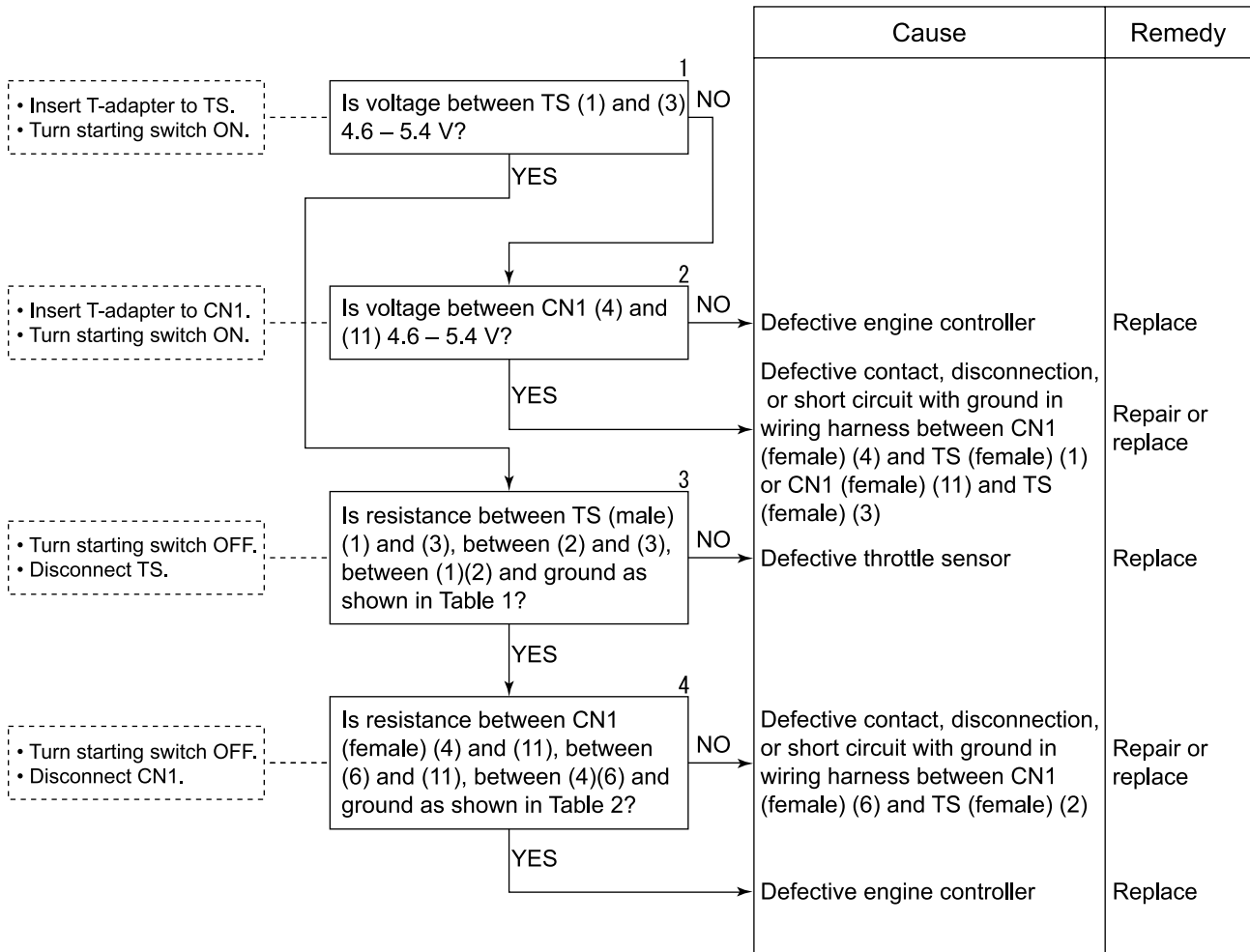


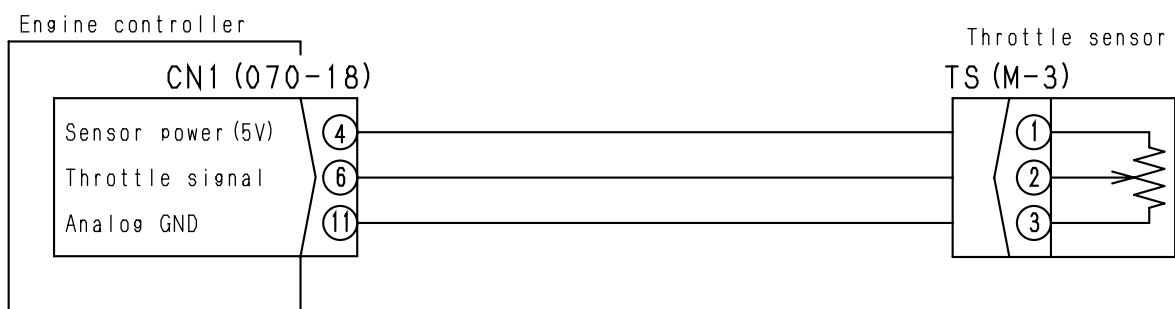
Table 1

TS (male)	Resistance value
Between (1) and (3)	4.0 k – 6.0 kΩ
Between (2) and (3)	0.5 – 2.7 kΩ
Between (1)(2) and ground	Min. 1 MΩ

Table 2

CN1 (male)	Resistance value
Between (4) and (11)	4.0 k – 6.0 kΩ
Between (6) and (11)	0.5 – 2.7 kΩ
Between (4)(6) and ground	Min. 1 MΩ

E-8 b) Related electrical circuit diagram



BJE00305

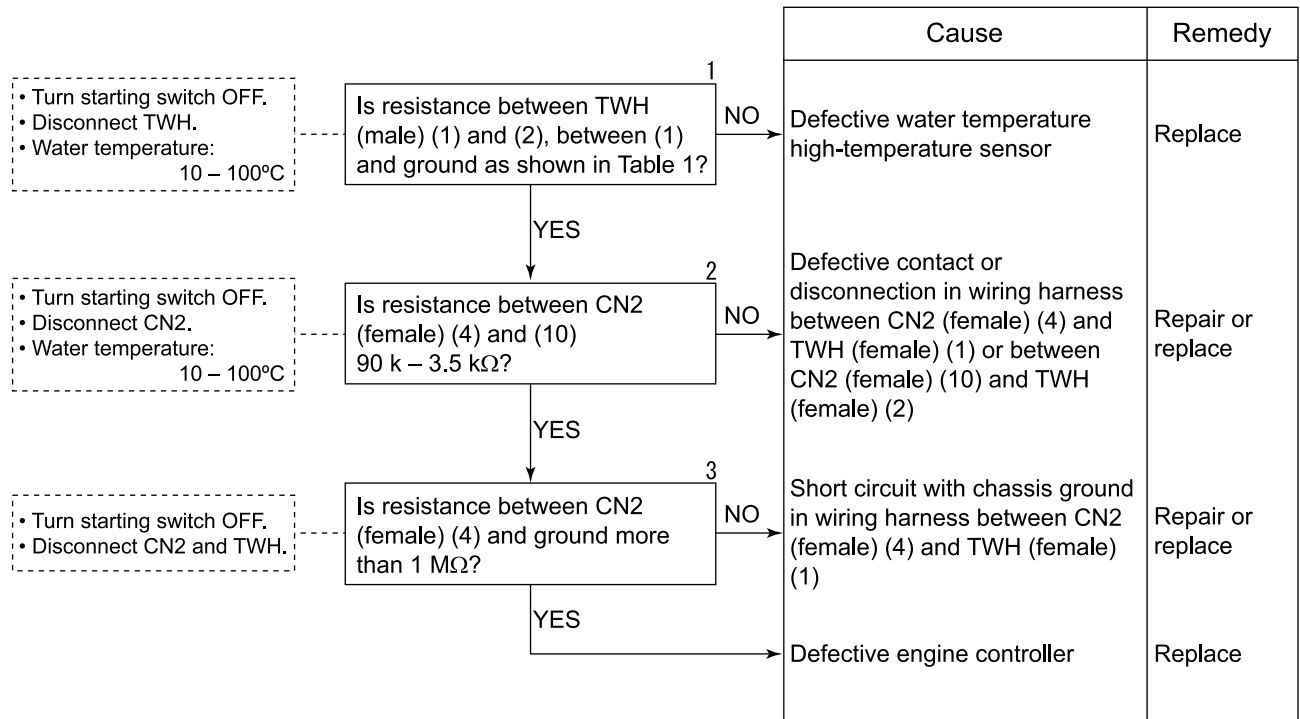
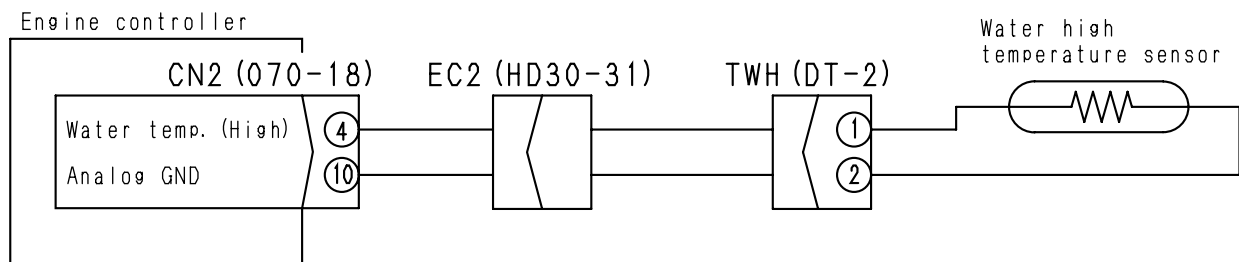
E-9 Error code [E-34] [Abnormality in water temperature high-temperature sensor system]

Table 1

TWH (male)	Resistance value
Between (1) and (2)	90 k – 3.5 kΩ
Between (1) and ground	Min. 1 MΩ

E-9 Related electrical circuit diagram

BJE00306

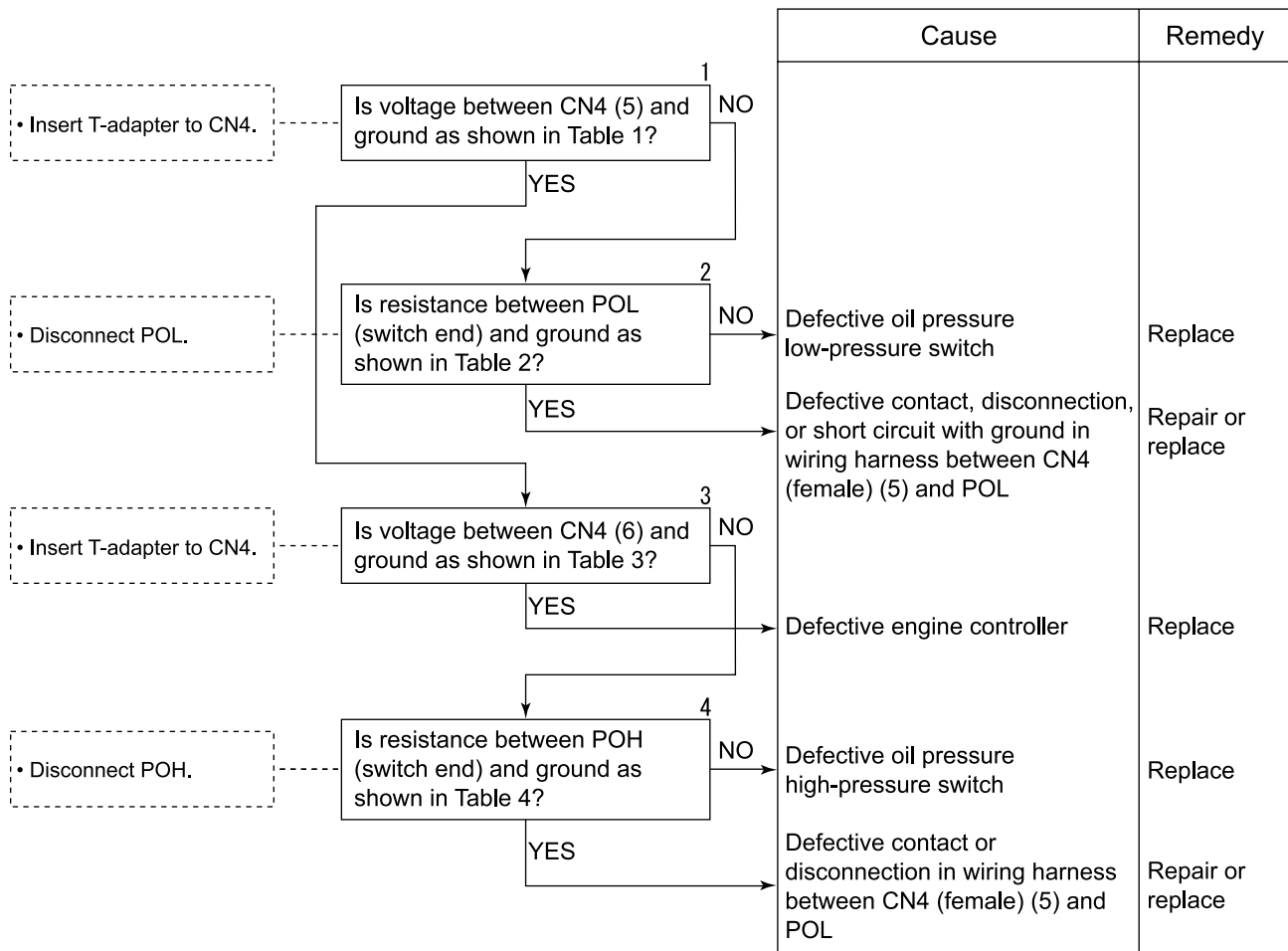
E-10 Error code [E-36] [Abnormality in oil pressure switch system]

Table 1

CN4	Engine	Voltage
Between (5) and ground	When stopped	Max. 1 V
	At 600 rpm or more	20 – 30 V

Table 2

POL	Engine	Resistance value
Between POL (switch) and ground	When stopped	Max. 1 Ω
	At 600 rpm or more	Min. 1 MΩ

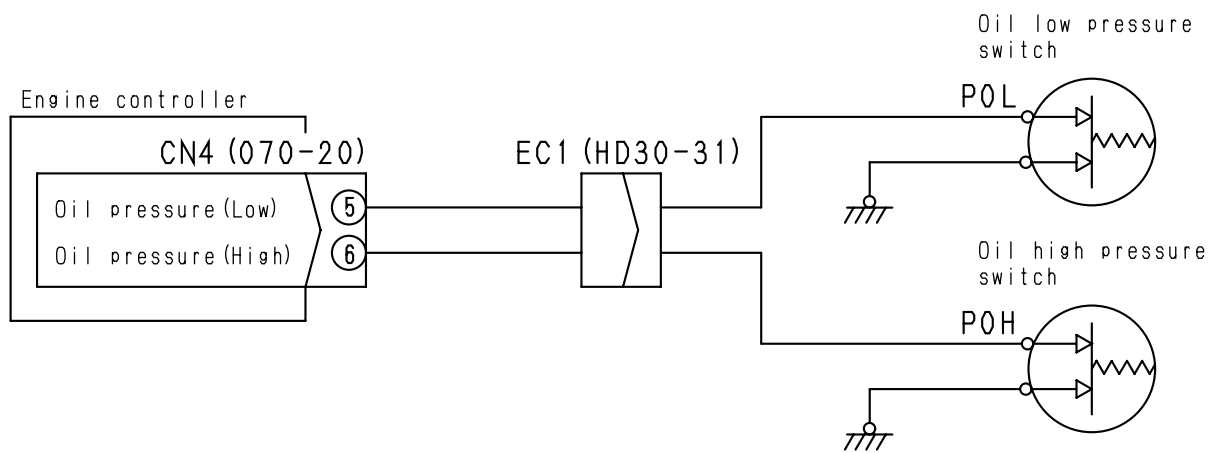
Table 3

CN4	Engine	Resistance
Between (6) and ground	When stopped	Max. 1 V
	At 1,300 rpm or more	20 – 30 V

Table 4

POH	Engine	Resistance
Between POH (switch) and ground	When stopped	Max. 1 Ω
	At 1,300 rpm or more	Min. 1 MΩ

E-10 Related electrical circuit diagram



BJE00304

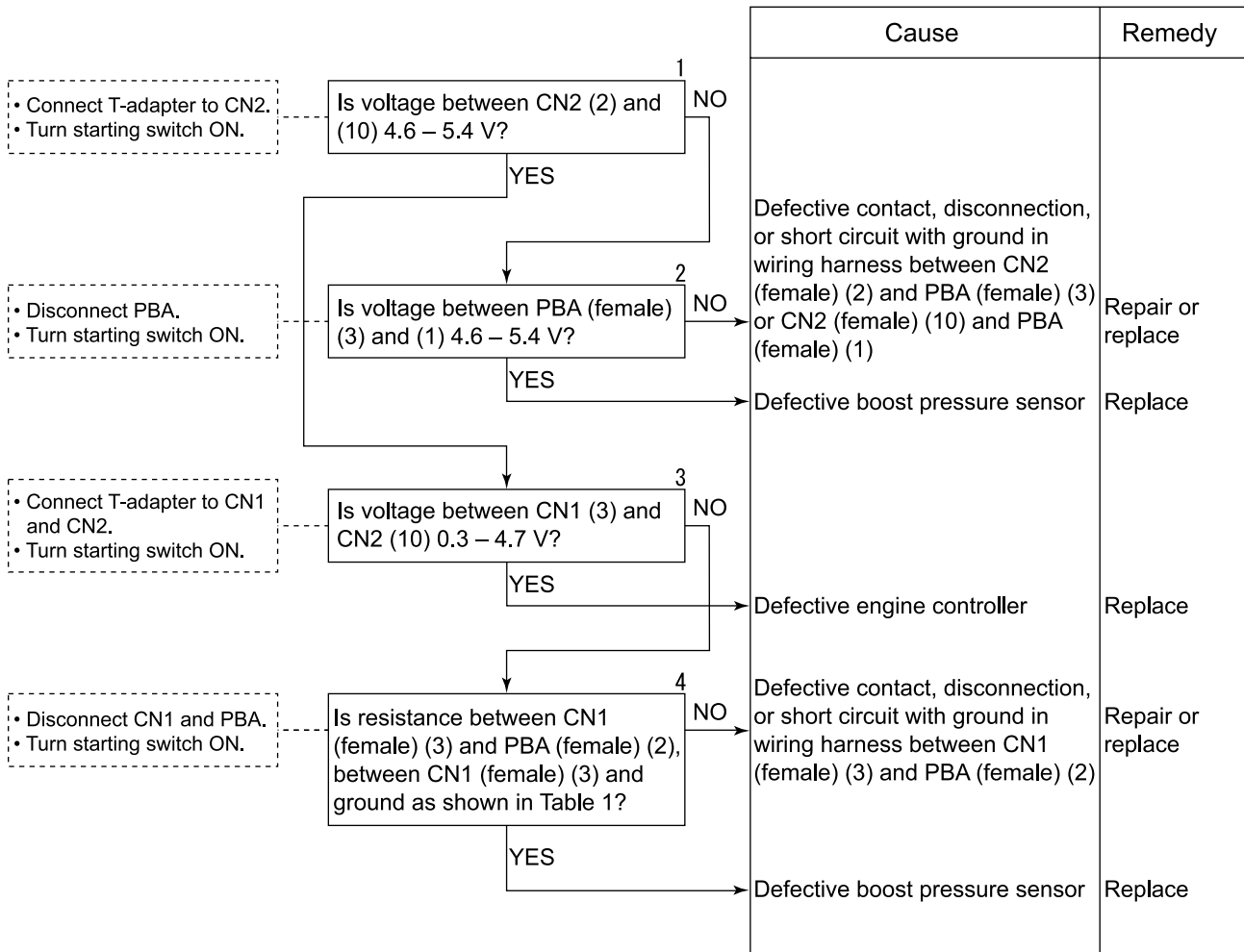
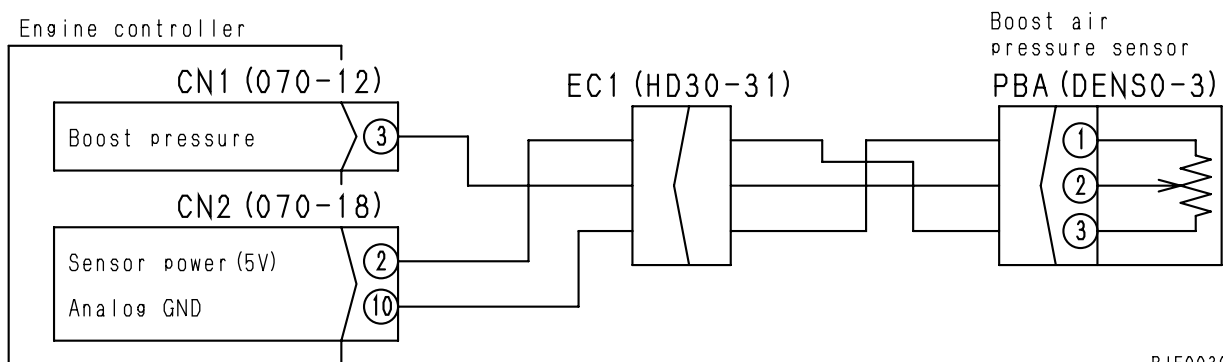
E-11 Error code [E-3C] [Abnormality in boost pressure sensor system]

Table 1

CN1, PBA (female)	Resistance value
Between CN1 (3) and PBA (2)	Max. 1 Ω
Between CN1 (3) and ground	Min. 1 M Ω

E-11 Related electrical circuit diagram

BJE00307

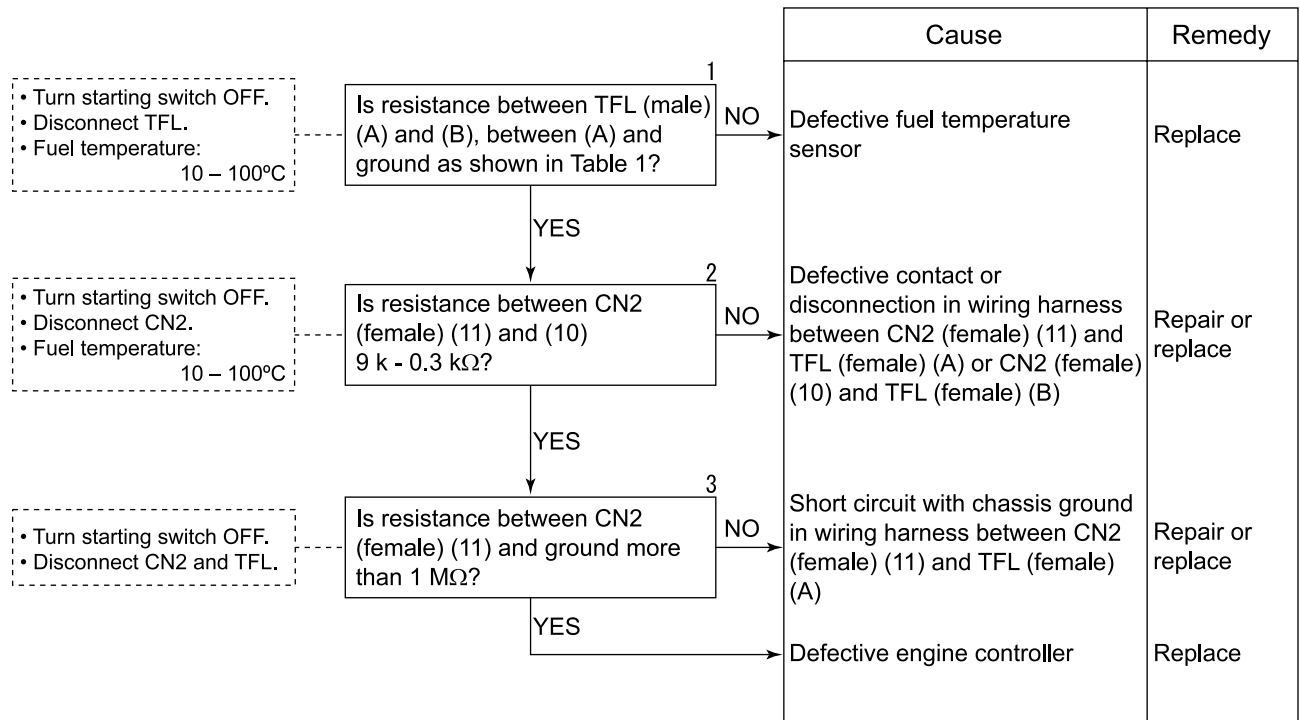
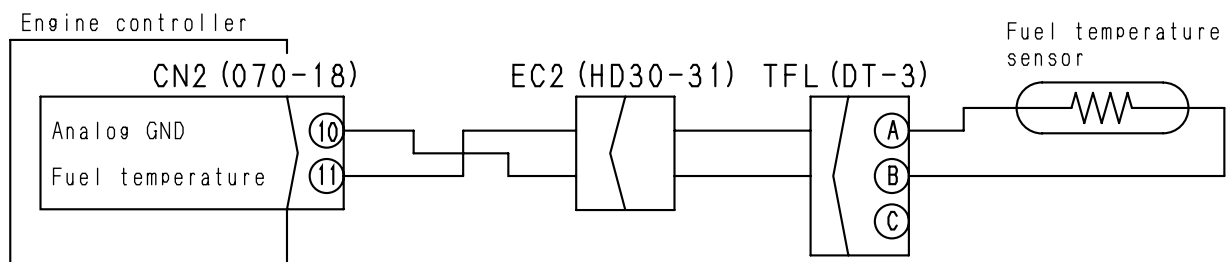
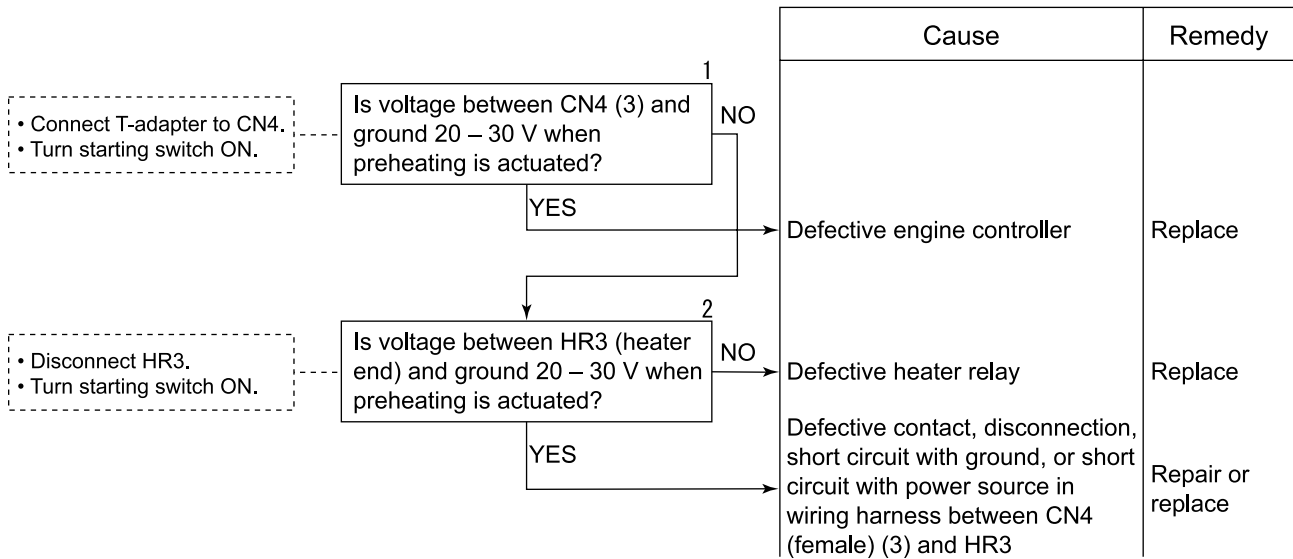
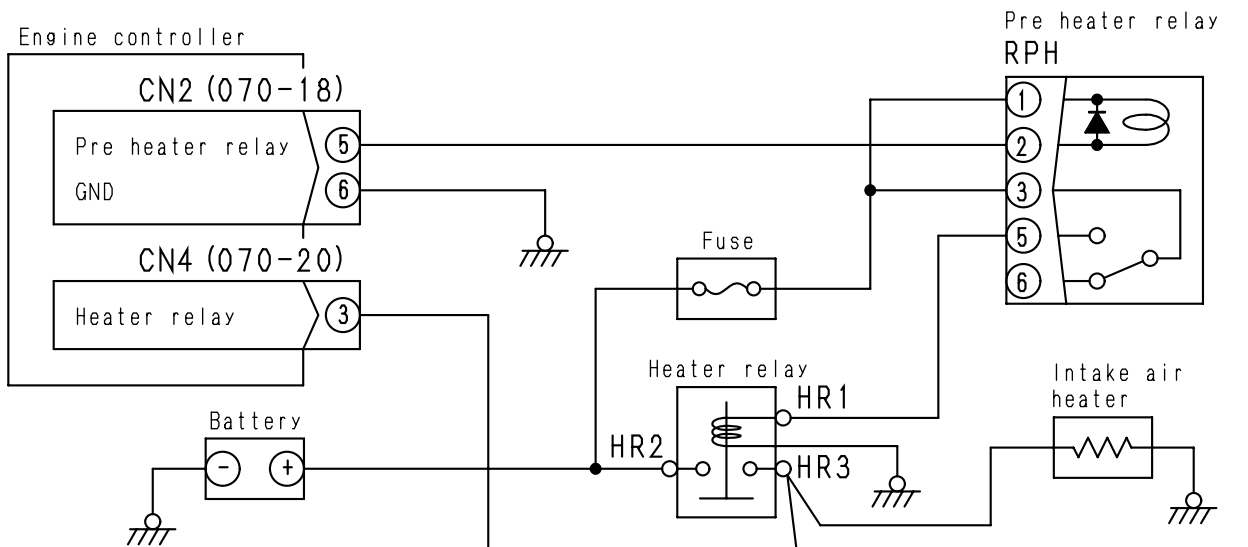
E-12 Error code [E-3d] [Abnormality in fuel temperature sensor system]

Table 1

TFL (Male)	Resistance value
Between (A) and (B)	9 k – 0.3 kΩ
Between (A) and ground	Min. 1 MΩ

E-12 Related electrical circuit diagram

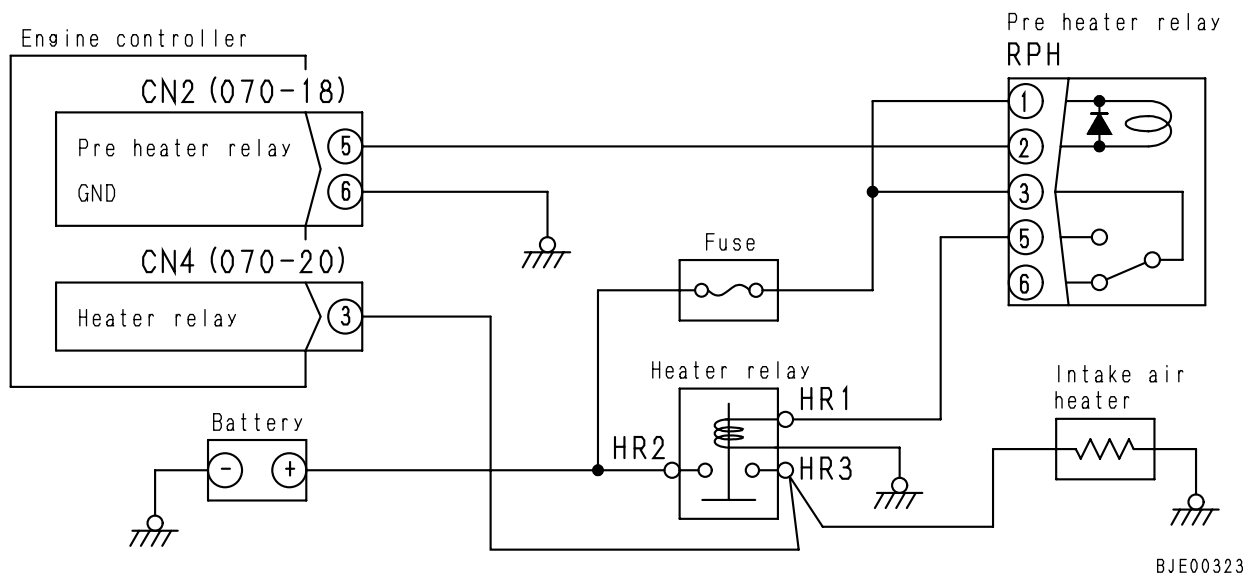
BJE00308

E-13 Error code [E-50] [Abnormality in preheating relay connecting point system]**E-13 Related electrical circuit diagram**

BJE00323

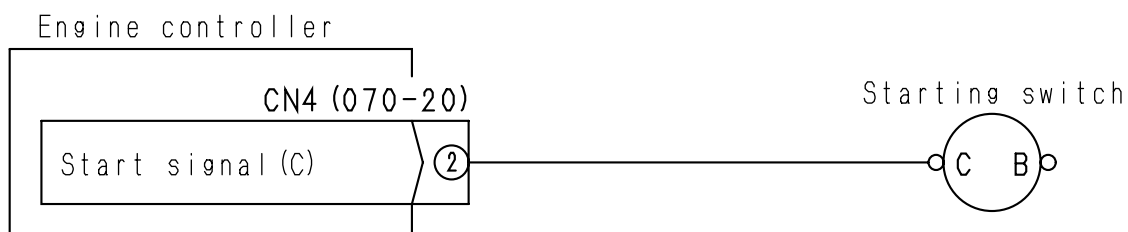
E-14 Error code [E-51] [Abnormality in preheat relay coil system]

		Cause	Remedy
• Turn starting switch OFF. • Disconnect RPH.	Is resistance between RPH (male) (1) and (2) 200 – 400 Ω ?	NO Defective preheater relay	Replace
	YES		
• Connect T-adaptor to CN2. • Turn starting switch ON.	Is voltage between CN2 (5) and ground 20 – 30 V when preheating is actuated?	NO Defective contact, disconnection, or short circuit with ground in wiring harness between CN2 (female) (5) and RPH (female) (2)	Repair or replace
	YES	Defective engine controller	Replace

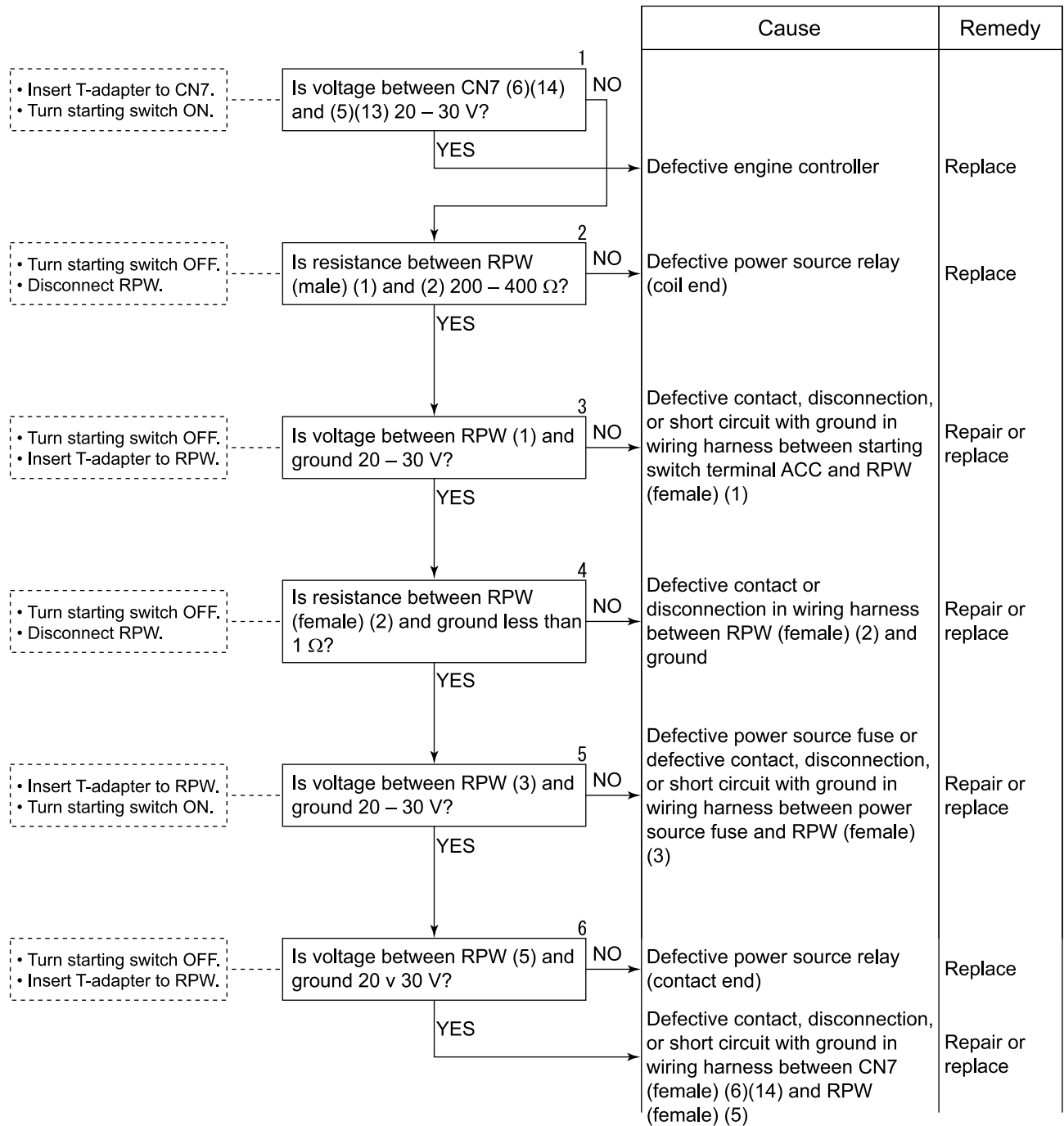
E-14 Related electrical circuit diagram

E-15 Error code [E-54] [Short circuit in starting switch C system]

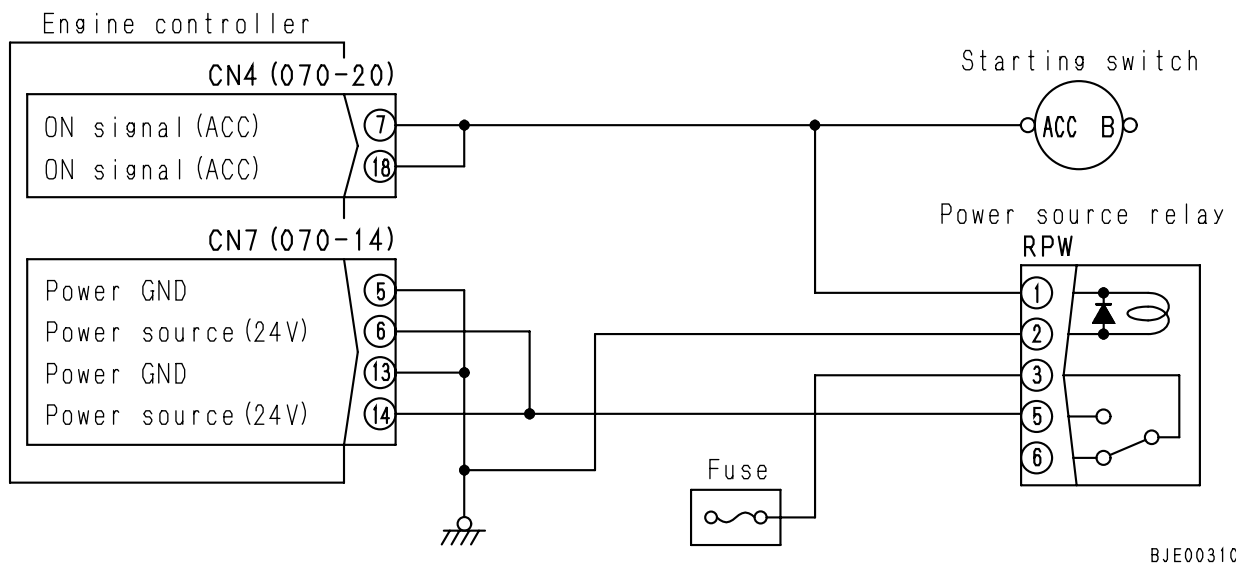
		Cause	Remedy
• Connect T-adapter to CN4. • Turn starting switch ON.	1 Is voltage between CN4 (2) and ground less than 1 V? YES	Defective engine controller	Replace
	NO		
• Disconnect starting switch terminal C. • Turn starting switch ON.	2 Is voltage between starting switch terminal C and ground less than 1 V? YES	Short circuit with power source in wiring harness between CN4 (female) (2) and starting switch terminal C	Repair or replace
	NO	Defective starting switch	Replace

E-15 Related electrical circuit diagram

BJE00309

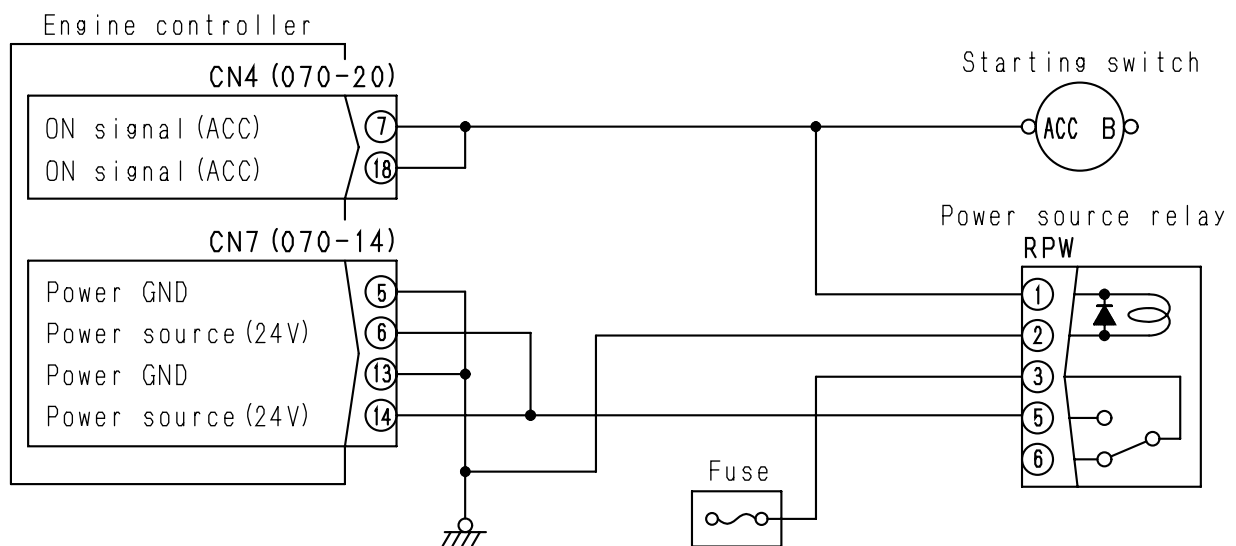
E-16 Error code [E-56] [Power source system abnormality 1]

E-16 Related electrical circuit diagram



E-17 Error code [E-57] [Power source system abnormality 2]

		Cause	Remedy
• Turn starting switch OFF. • Insert T-adapter to CN7.	1 Is voltage between CN7 (6)(14) and (5)(13) less than 8 V? YES NO	Defective engine controller	Replace
	2 Is voltage between CN7 (6)(14) and (5)(13) less than 8 V? YES NO	Short circuit with power source in wiring harness between CN7 (female) (6)(14) and RPW (female) (5) Defective power source relay (contact end)	Repair or replace Replace

E-17 Related electrical circuit diagram

BJE00310

E-18 Error code [E-5A] [Abnormality in fuel injection quantity control switch signal]

		Cause	Remedy
Are both fuel injection quantity control switches 1 and 2 set to [F]? 1	NO	Defective engine controller	Replace
	YES	Defective fuel injection quantity control switch setting	Adjust again

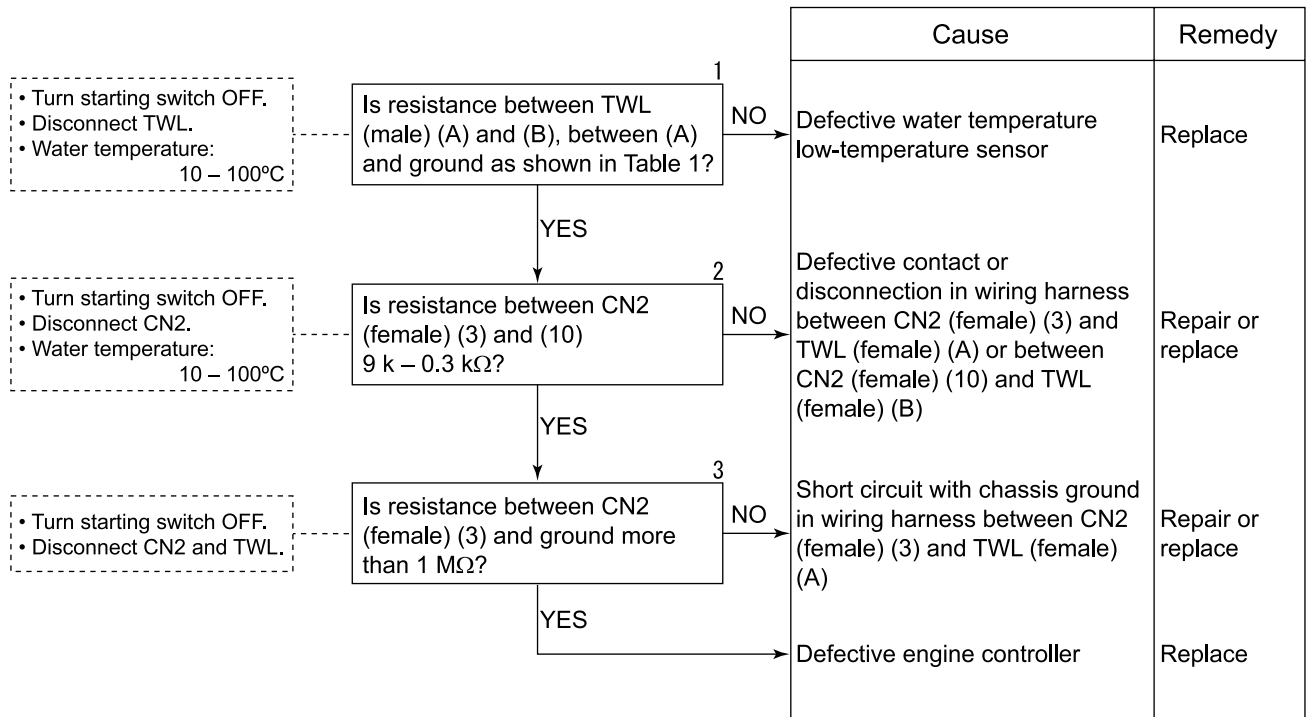
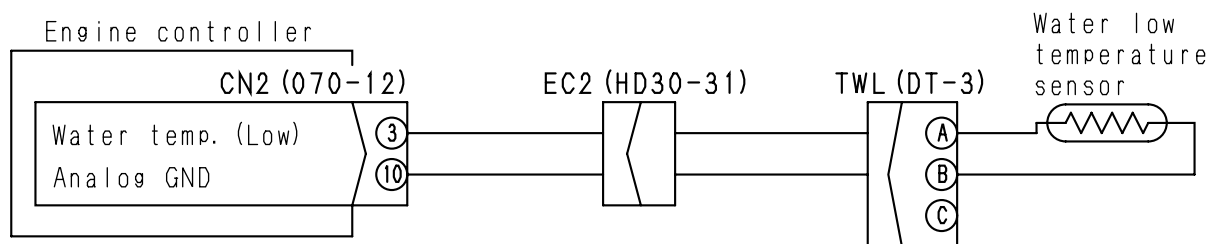
E-19 Error code [E-6A] [Abnormality in water temperature low-temperature sensor system]

Table 1

TWL (male)	Resistance value
Between (A) and (B)	9 k – 0.3 kΩ
Between (A) and ground	Min. 1 MΩ

E-19 Related electrical circuit diagram

BJE00311

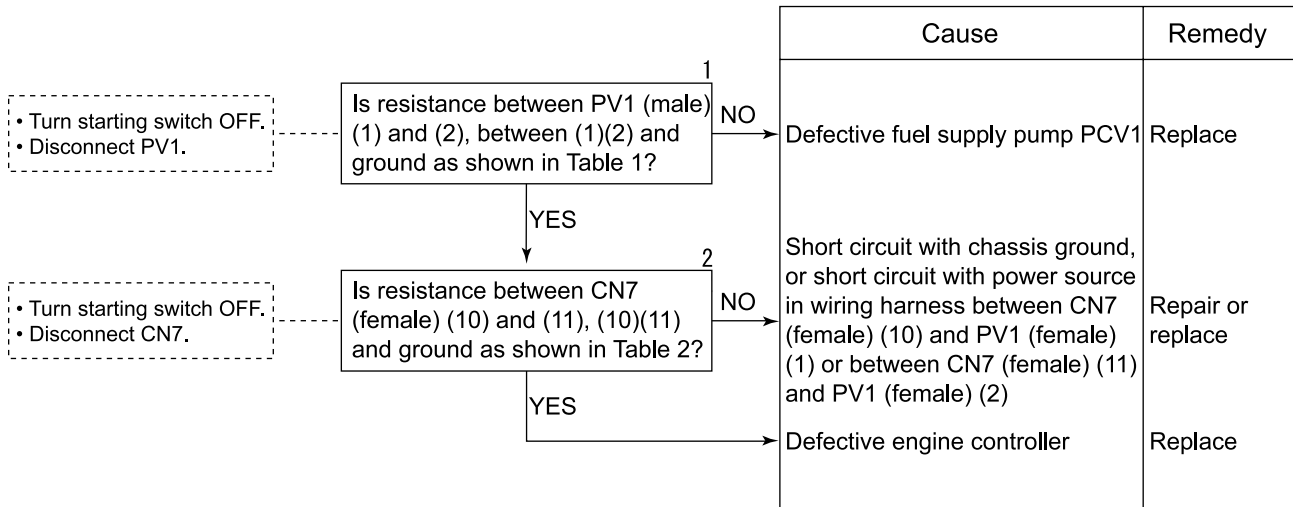
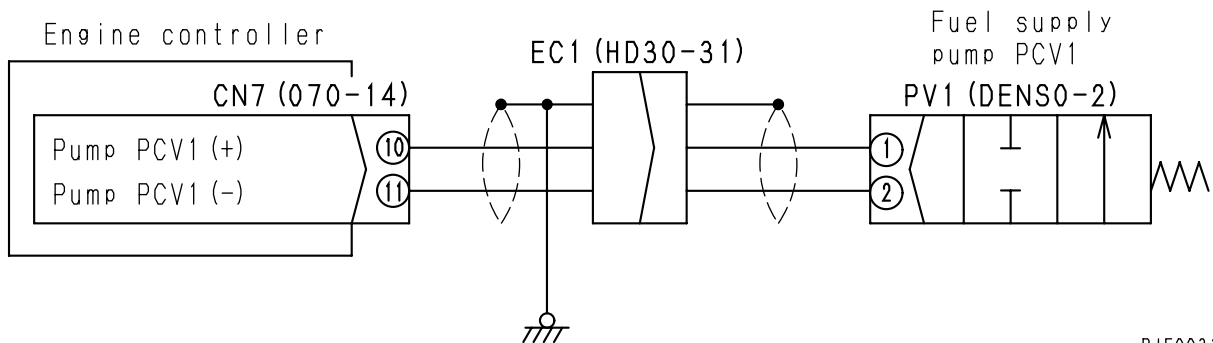
E-20 Error code [E-70] [Excess current in fuel supply pump PCV1 system]

Table 1

PV1 (male)	Resistance value
Between (1) and (2)	2.3 – 5.3 Ω
Between (1)(2) and ground	Min. 1 MΩ

Table 2

CN7 (male)	Resistance value
Between (10) and (11)	2.3 – 5.3 Ω
Between (10)(11) and ground	Min. 1 MΩ

E-20 Related electrical circuit diagram

BJE00312

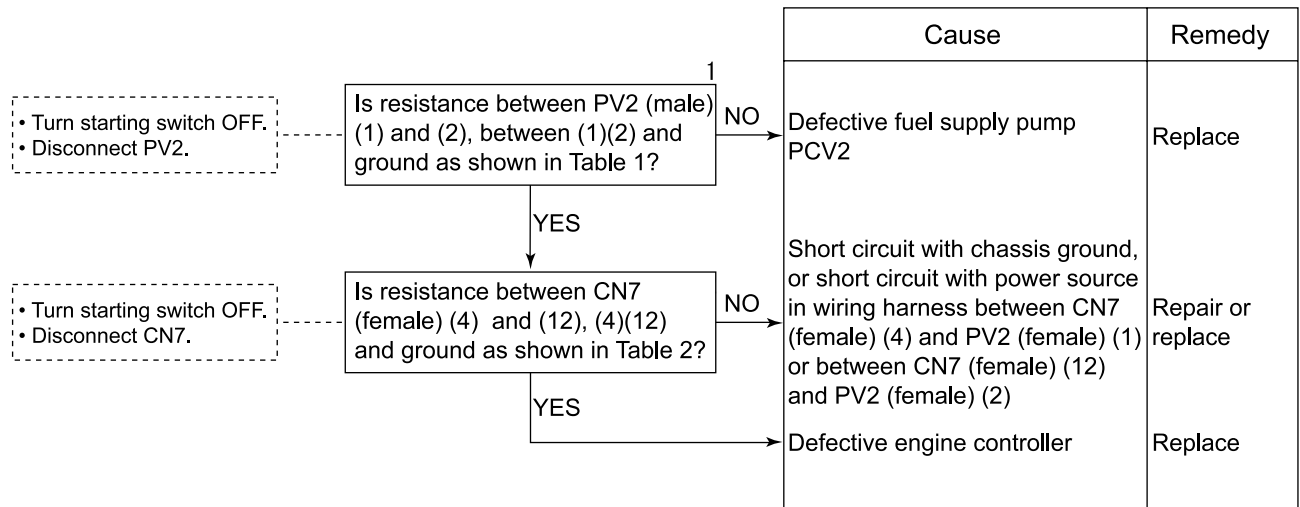
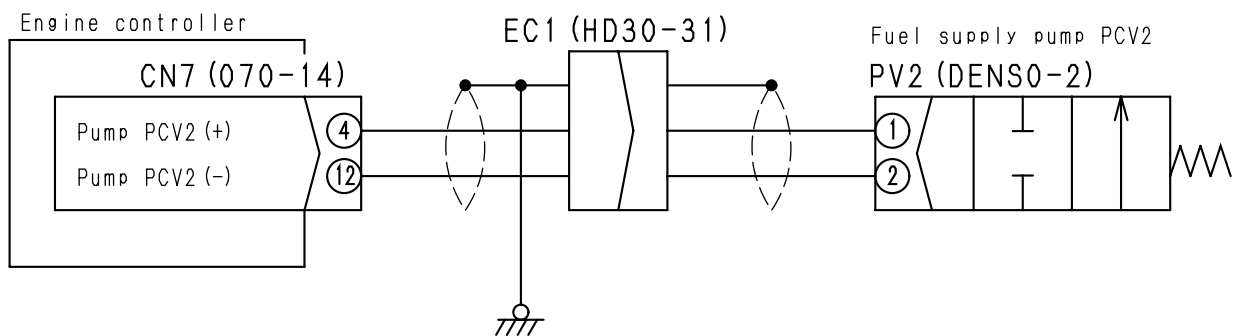
E-21 Error code [E-71] [Excess current in fuel supply pump PCV2 system]

Table 1

PV2 (male)	Resistance value
Between (1) and (2)	2.3 – 5.3 Ω
Between (1)(2) and ground	Min. 1 M Ω

Table 2

CN7 (male)	Resistance value
Between (4) and (12)	2.3 – 5.3 Ω
Between (4)(12) and ground	Min. 1 M Ω

E-21 Related electrical circuit diagram

BJE00313

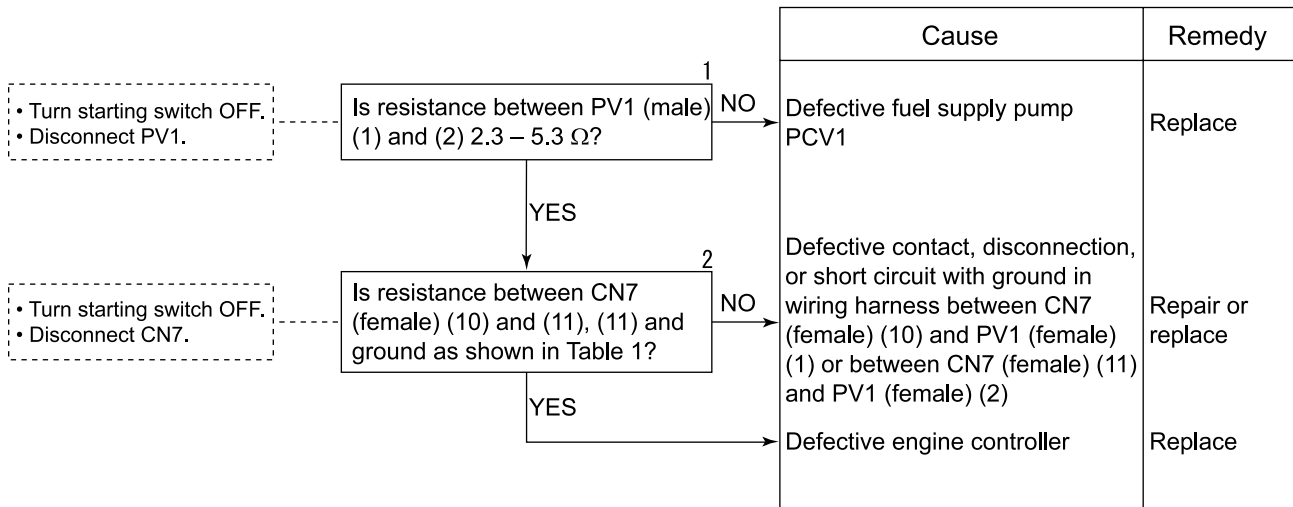
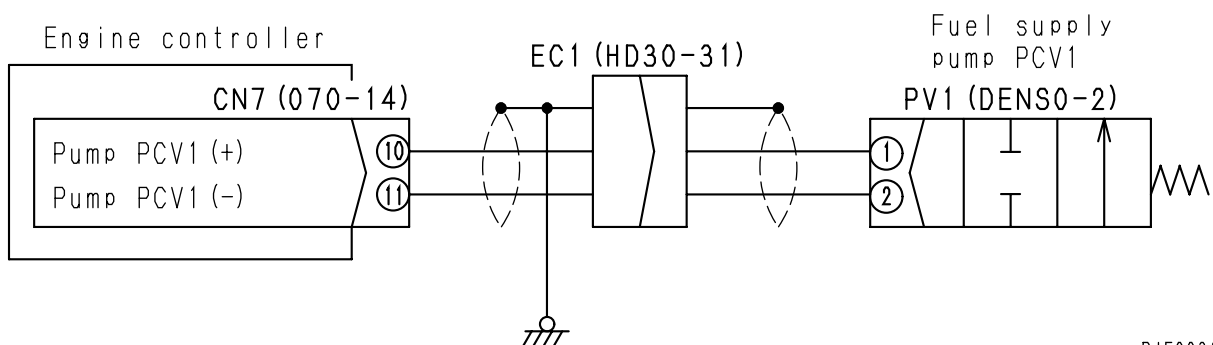
E-22 Error code [E-74] [Disconnection in fuel supply pump PCV1 system]

Table 1

CN7 (male)	Resistance value
Between (10) and (11)	2.3 – 5.3 Ω
Between (1)(2) and ground	Min. 1 MΩ

E-22 Related electrical circuit diagram

BJE00312

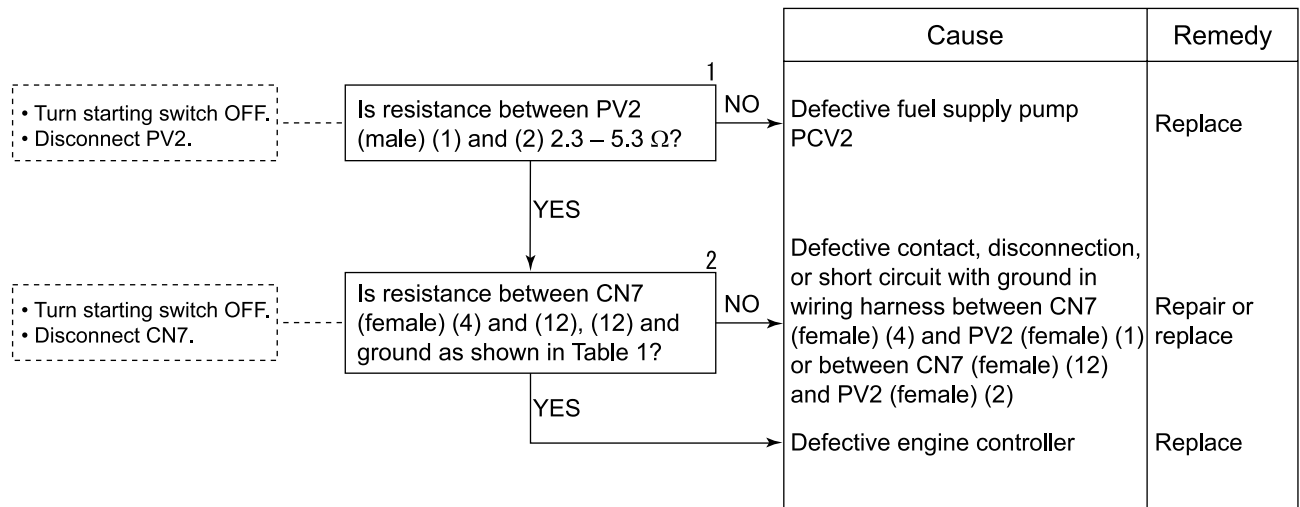
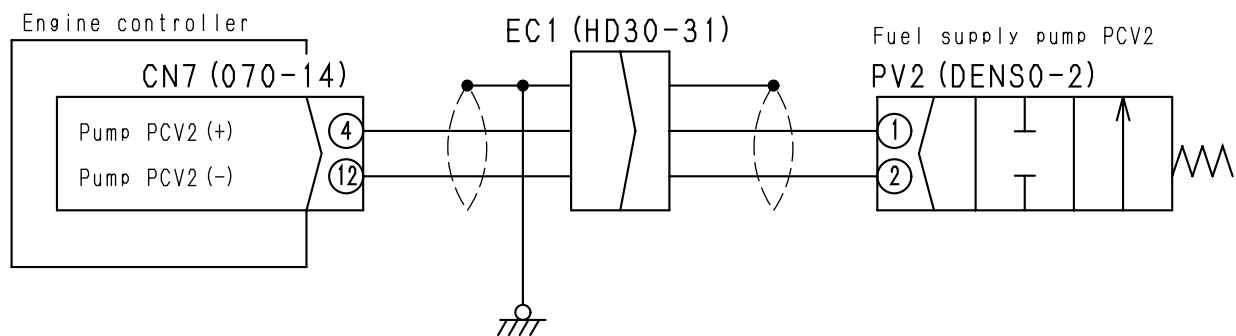
E-23 Error code [E-75] [Disconnection in fuel supply pump PCV2 system]

Table 1

CN7 (male)	Resistance value
Between (4) and (12)	2.3 – 5.3 Ω
Between (12) and ground	Min. 1 M Ω

E-23 Related electrical circuit diagram

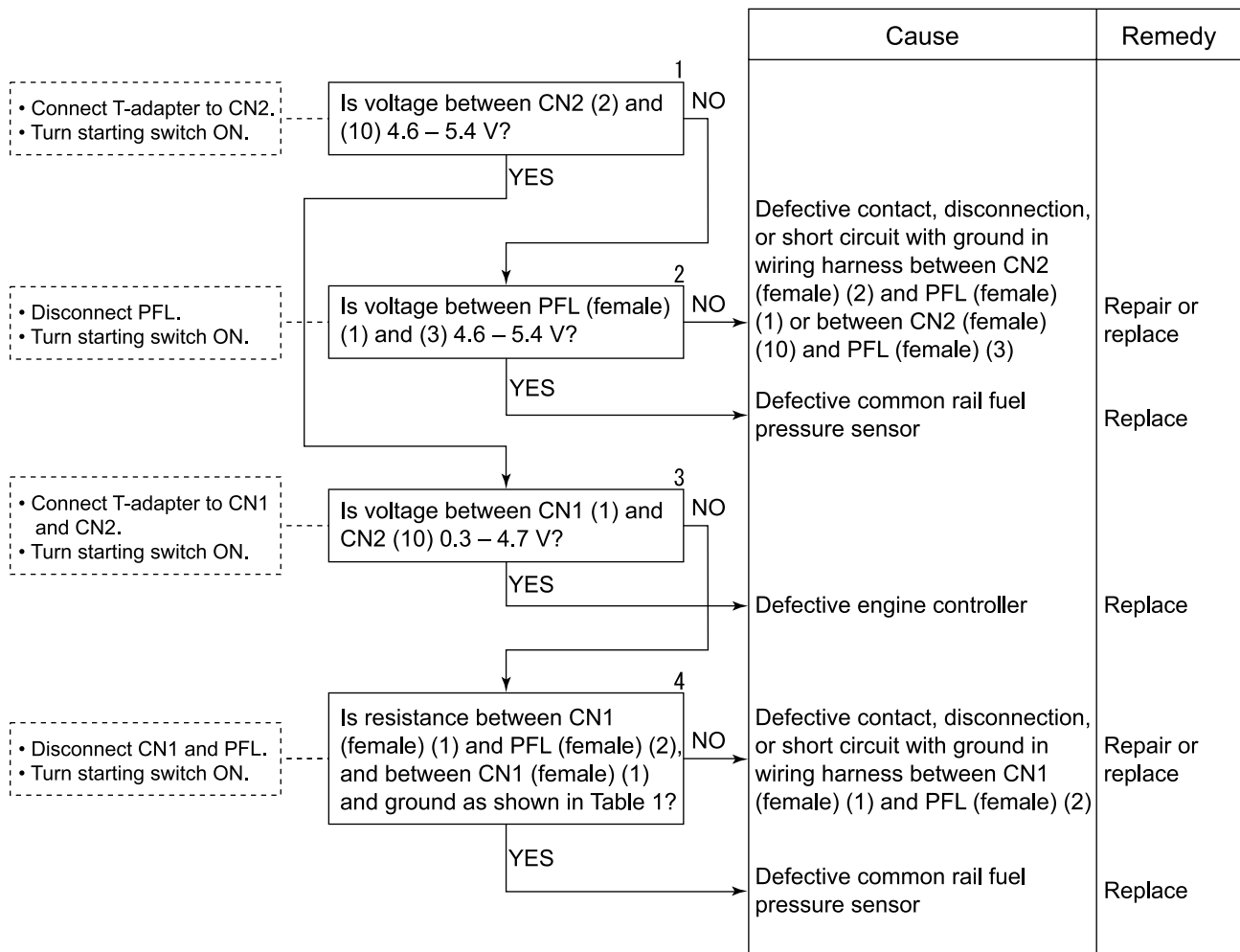
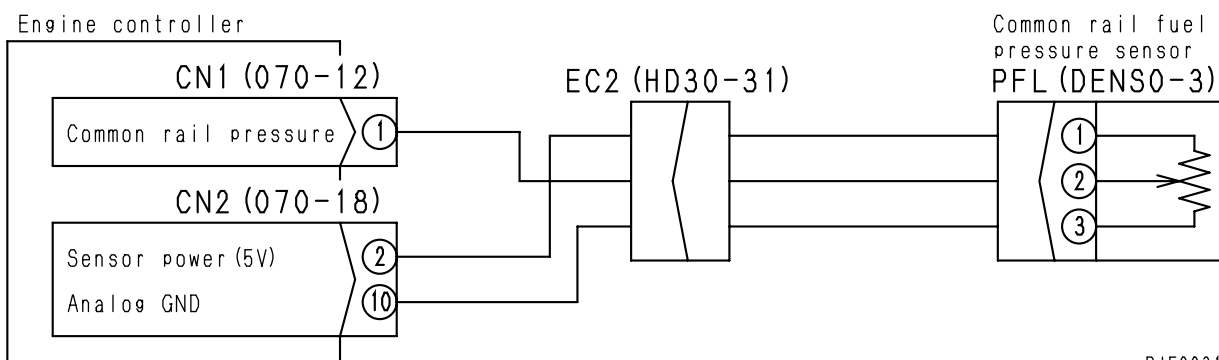
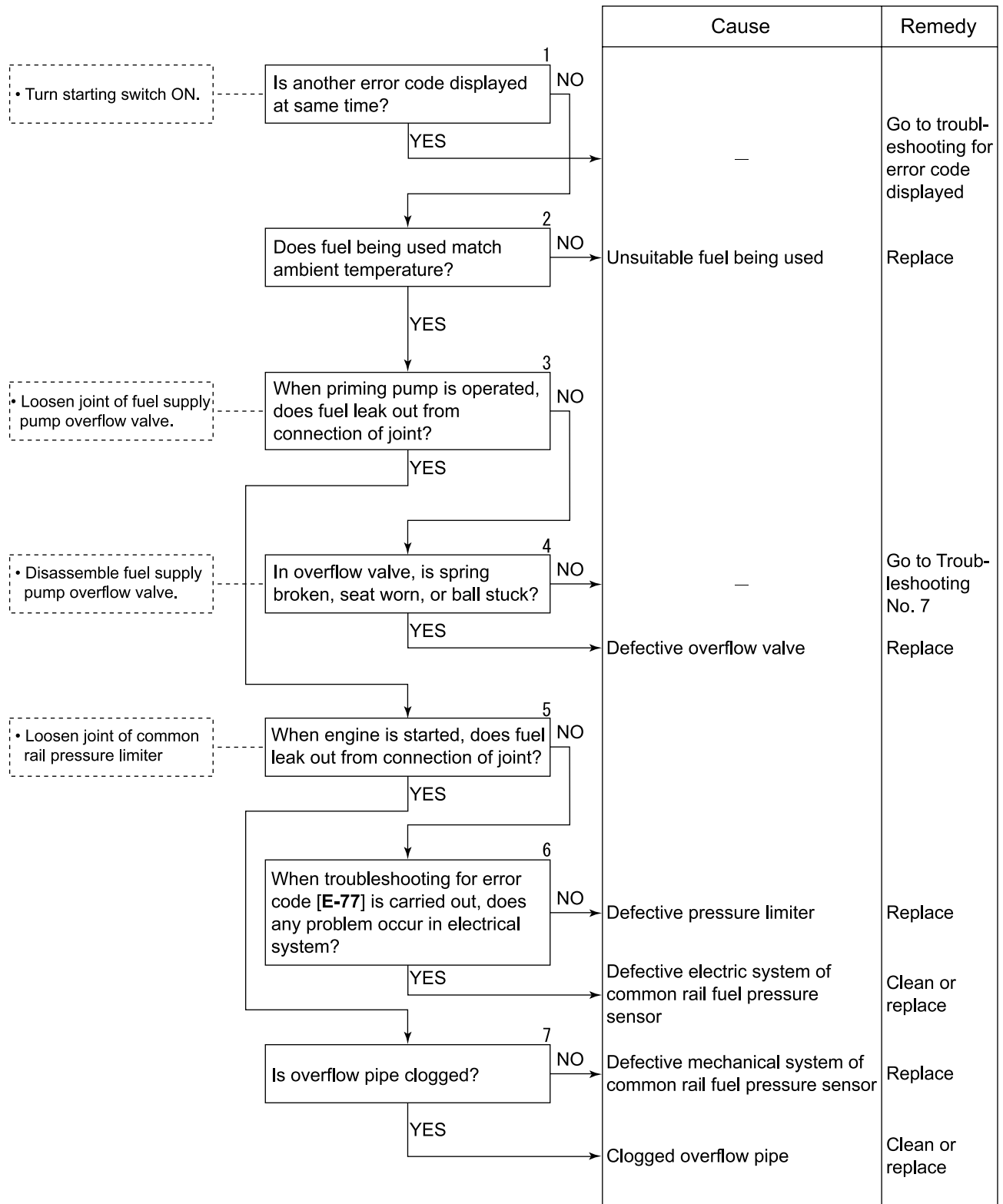
E-24 Error code [E-77] [Abnormality in common rail fuel pressure sensor system]

Table 1

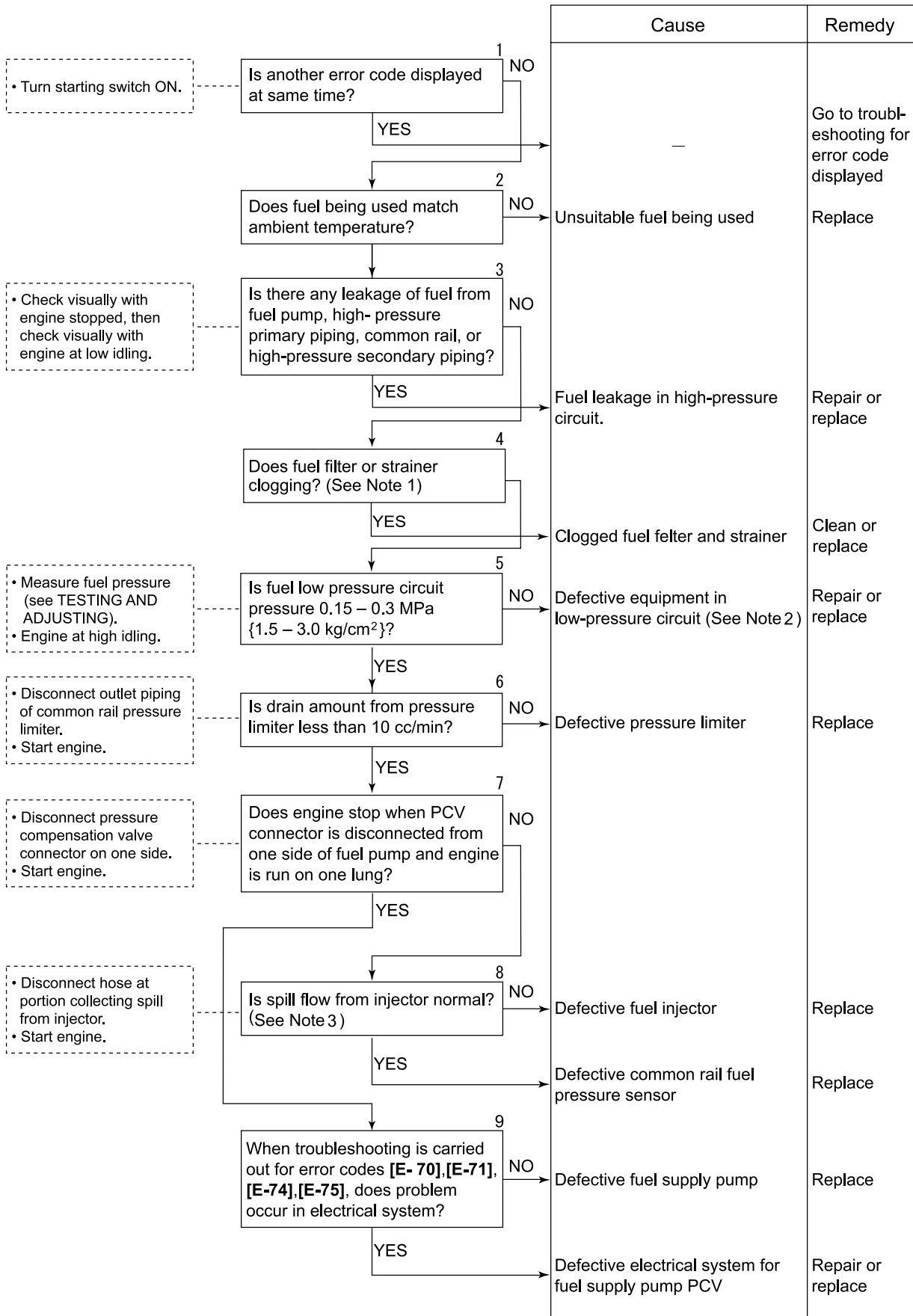
CN1, PFL (female)	Resistance value
Between CN1 (1) and PFL (2)	Max. 1 Ω
Between CN1 (1) and ground	Min. 1 MΩ

E-24 Related electrical circuit diagram

BJE00314

E-25 Error code [E-79] [Common rail fuel high pressure abnormality 1]**Error code [E-7A] [Common rail fuel high pressure abnormality 2]**

**E-26 Error code [E-7b] [Fuel supply pump non-force feed 1]
Error code [E-7C] [Fuel supply pump non-force feed 2]**



Note 1: Carry out inspection, maintenance, and replacement of the filter and strainer as follows.

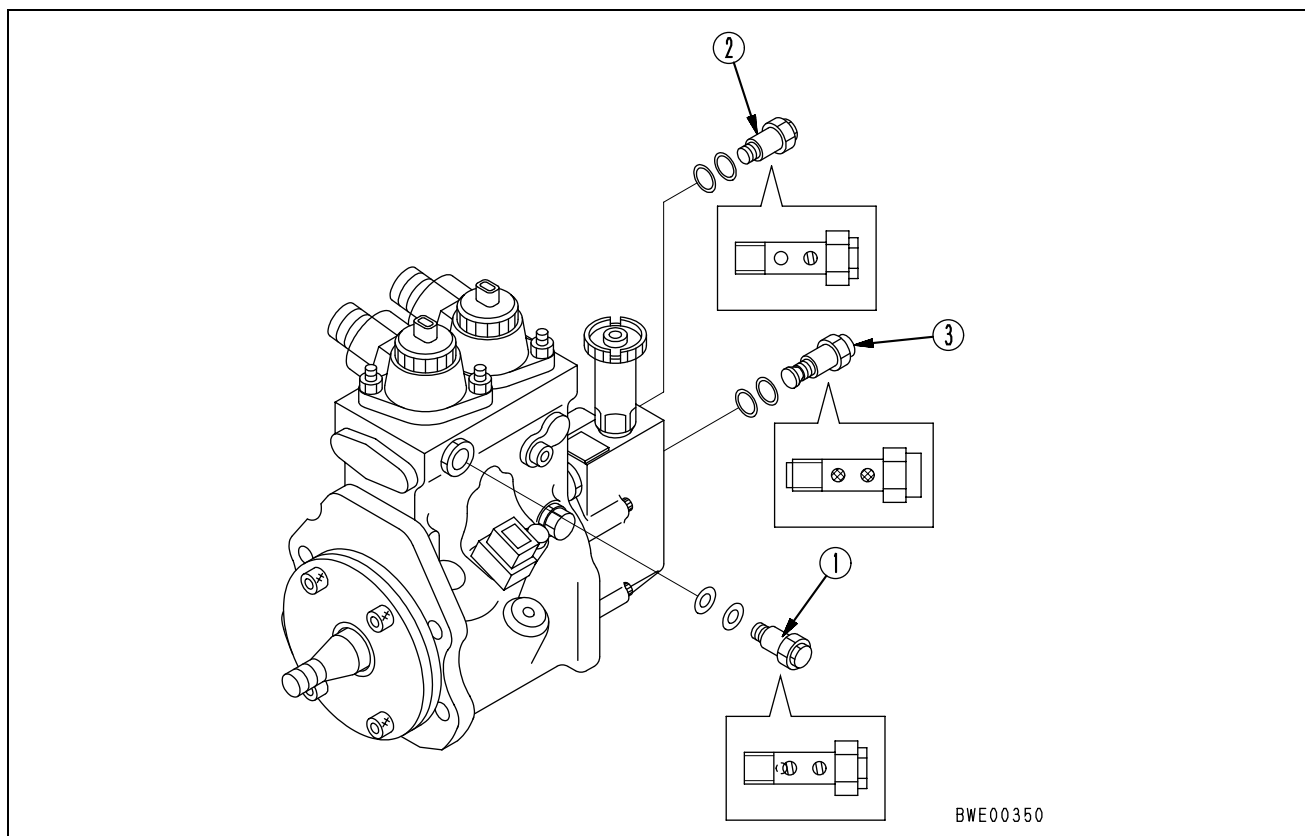
- 1) Gauze filter
Disassemble and inspect. If it is clogged, clean it.
- 2) Strainer on upstream side of gauze filter
If the gauze filter is clogged, clean the upstream strainer also.
- 3) Fuel filter
If the problem is not solved even when Steps 1) and 2) above have been carried out, replace the fuel filter.

Note 2: If the equipment in the low-pressure circuit is defective, inspect the following points.

- 1) Remaining amount of fuel
- 2) Stuck, worn feed pump
- 3) Leakage, clogged low-pressure fuel piping
- 4) Defective operation of bypass valve, mistaken assembly of other parts (see Fig. 1)
- 5) Fuel entering oil pan (fuel leakage inside head cover)

Fig. 1 Installation position of overflow valve ①, bypass valve ②, fuel inlet port joint (with gauze filter) ③

- Overflow valve ①: Spring can be seen from hole at nut end
- Bypass valve ②: Gauze filter can be seen from both holes
- Fuel inlet port joint ③: Spring can be seen from both holes



Note 3: Method of measuring amount of fuel spill flow

⚠ The fuel in the spill line is at high temperature (up to 90°C), so be careful not to burn yourself during the operation.

- 1) Disconnect the hose connected to the spill tube return collection portion (rear of engine).
- 2) Connect another hose to the tip of the spill tube, and collect the spill fuel in a container.
- 3) Start the engine, stall the engine at each speed, and measure the spill fuel amount for 1 minute.

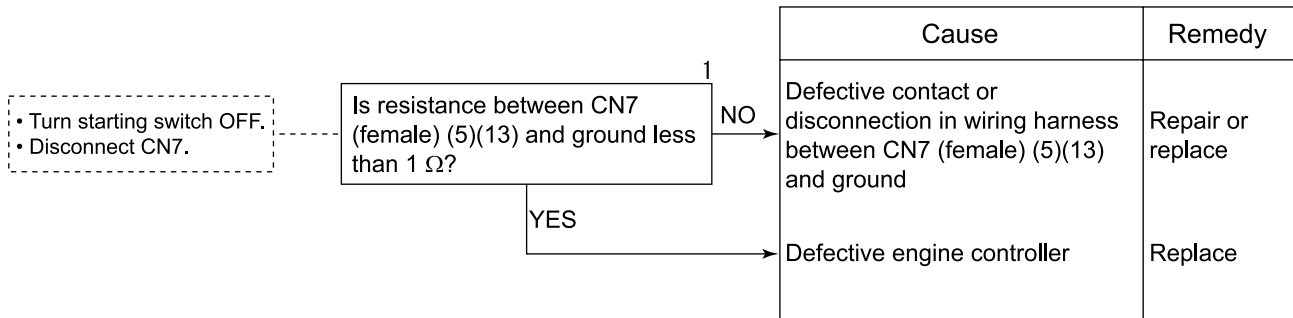
Limits for fuel spill amount (total for 6 cylinders)

Stall speed (rpm)	Spill limit (cc/min)
1,600	960
1,700	1,020
1,800	1,080
1,900	1,140
2,000	1,200

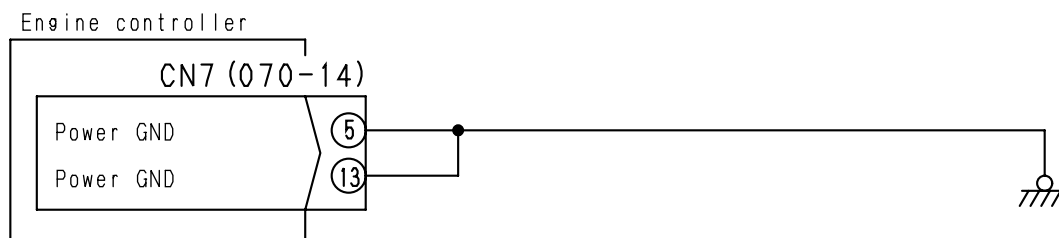
E-27 Error code [E-7d] [Abnormality in common rail fuel pressure]

★ Go to Troubleshooting of error codes [E-79] and [E-7A].

E-28 Error code [E-80] [Defective controller]



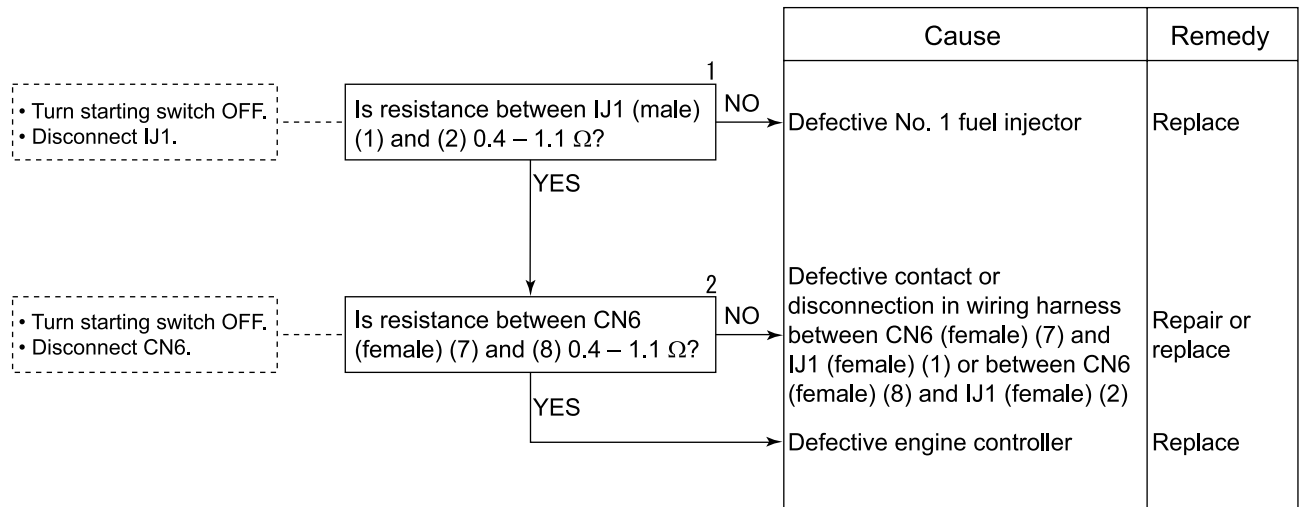
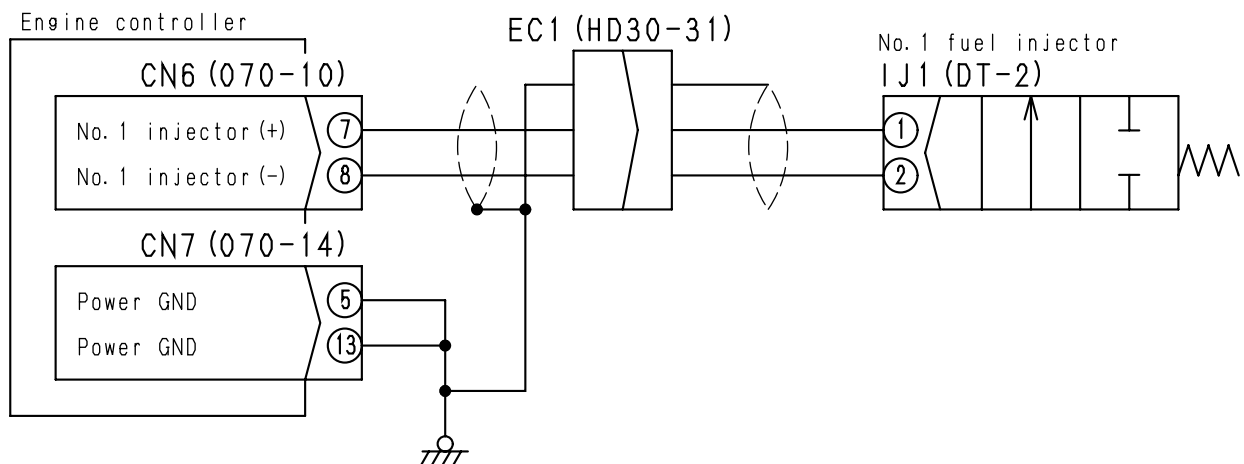
E-28 Related electrical circuit diagram



BJE00325

E-29 Error code [E-81] [Disconnection in No. 1 fuel injector system]

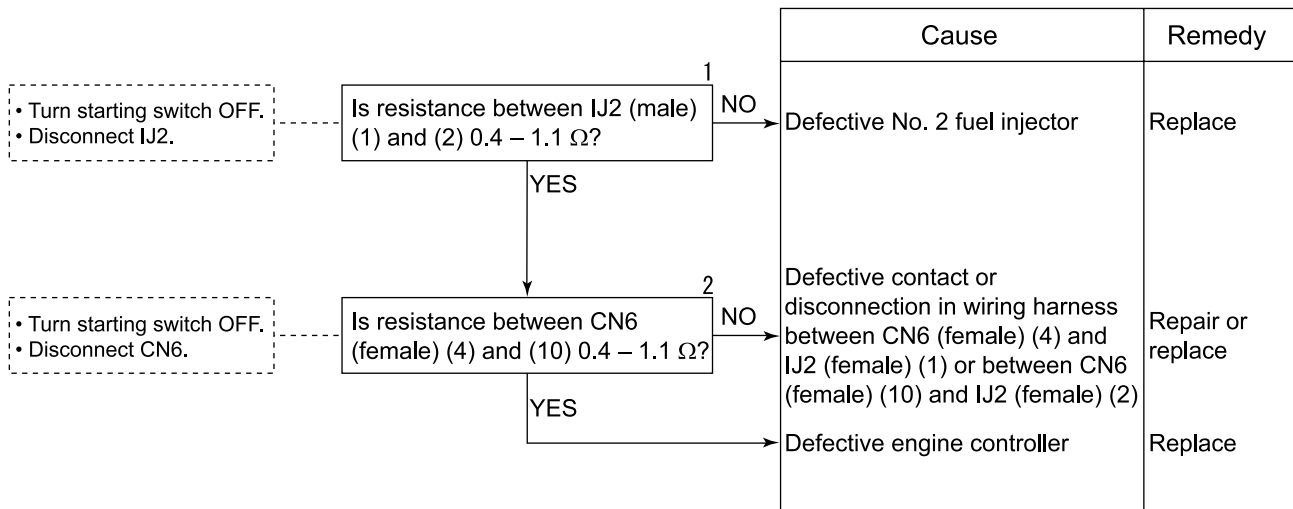
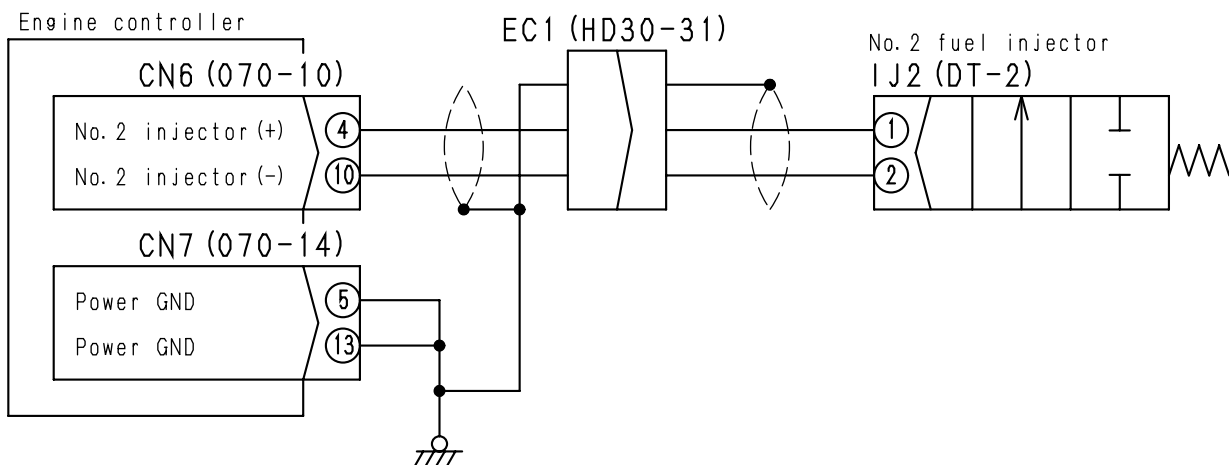
⚠ A high voltage (110 – 130 V) is used in the electrical circuit for the fuel injector, so be careful of electrocution or electric leakage. For details, see TESTING AND ADJUSTING, Handling controller high voltage circuit.

**E-29 Related electrical circuit diagram**

BJE00315

E-30 Error code [E-82] [Disconnection in No. 2 fuel injector system]

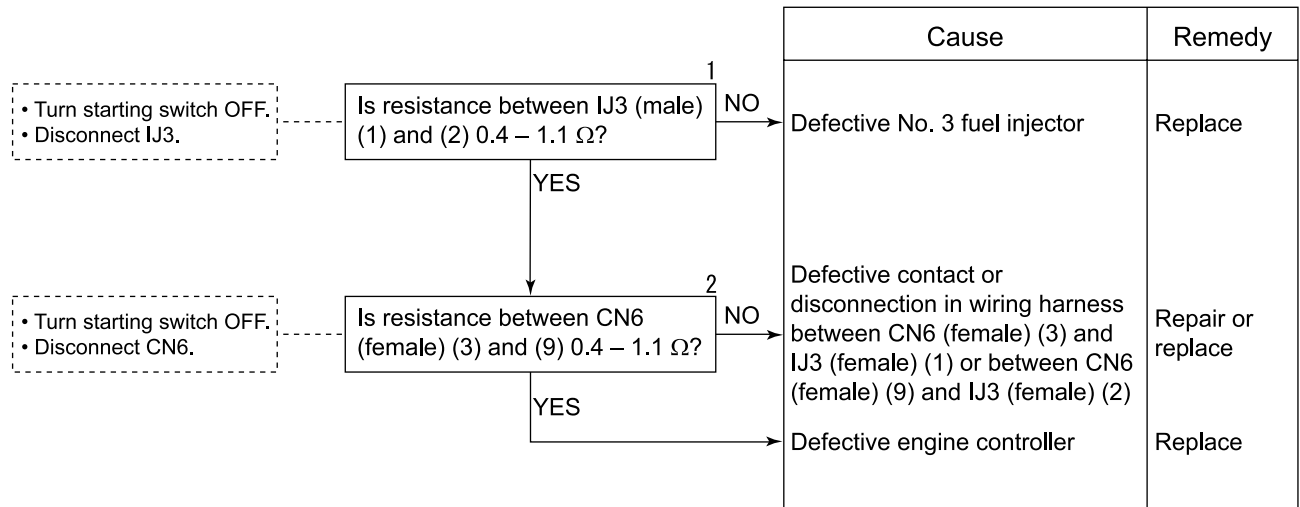
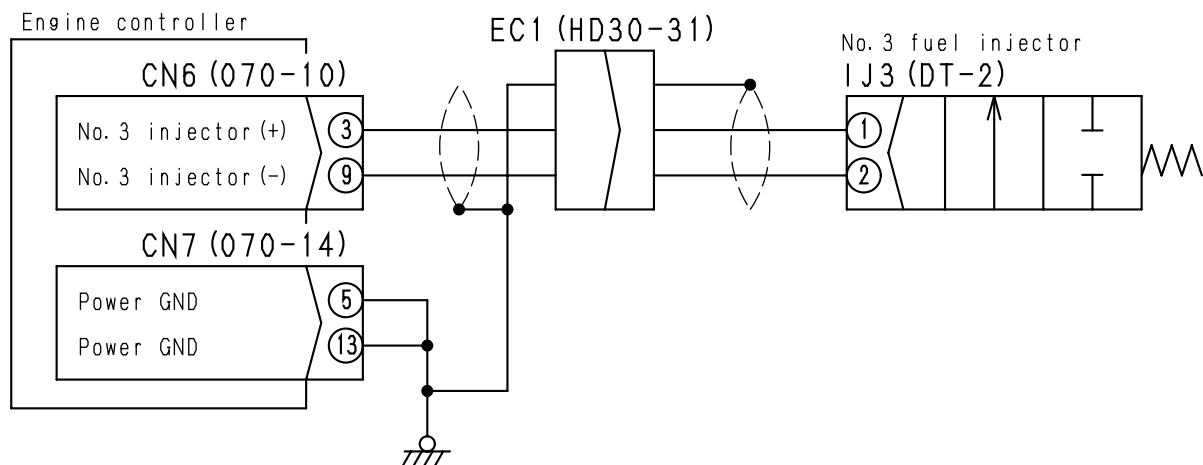
⚠ A high voltage (110 – 130 V) is used in the electrical circuit for the fuel injector, so be careful of electrocution or electric leakage. For details, see TESTING AND ADJUSTING, Handling controller high voltage circuit.

**E-30 Related electrical circuit diagram**

BJE00316

E-31 Error code [E-83] [Disconnection in No. 3 fuel injector system]

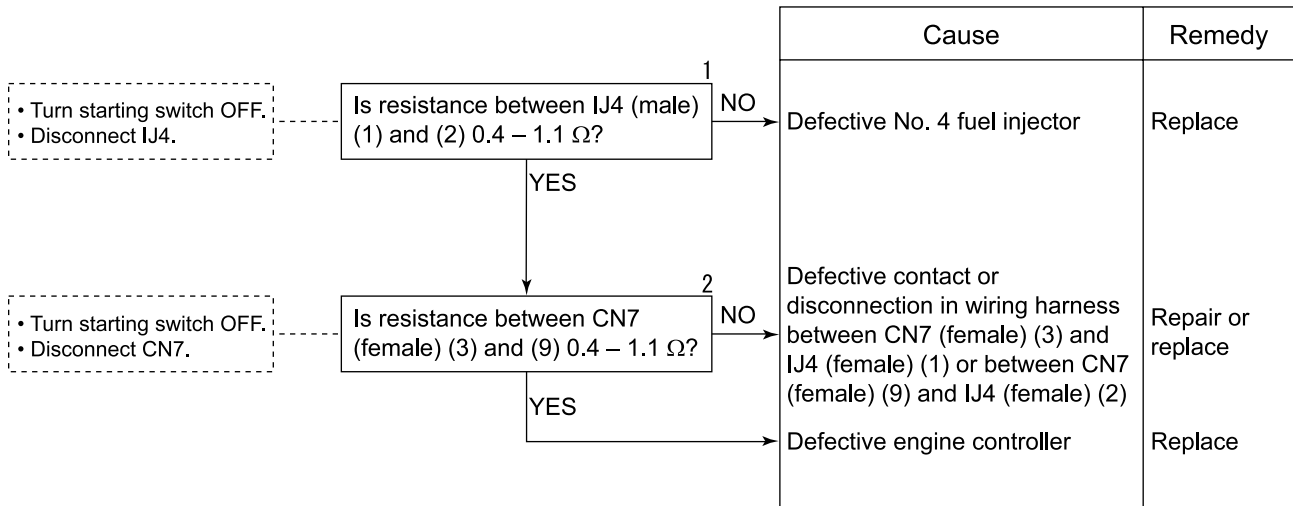
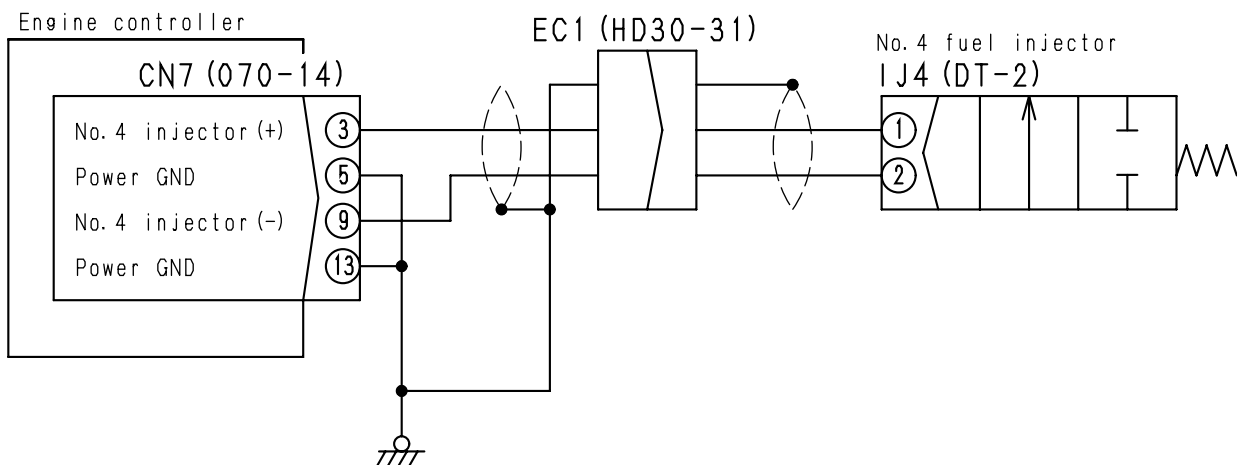
⚠ A high voltage (110 – 130 V) is used in the electrical circuit for the fuel injector, so be careful of electrocution or electric leakage. For details, see TESTING AND ADJUSTING, Handling controller high voltage circuit.

**E-31 Related electrical circuit diagram**

BJE00317

E-32 Error code [E-84] [Disconnection in No. 4 fuel injector system]

⚠ A high voltage (110 – 130 V) is used in the electrical circuit for the fuel injector, so be careful of electrocution or electric leakage. For details, see TESTING AND ADJUSTING, Handling controller high voltage circuit.

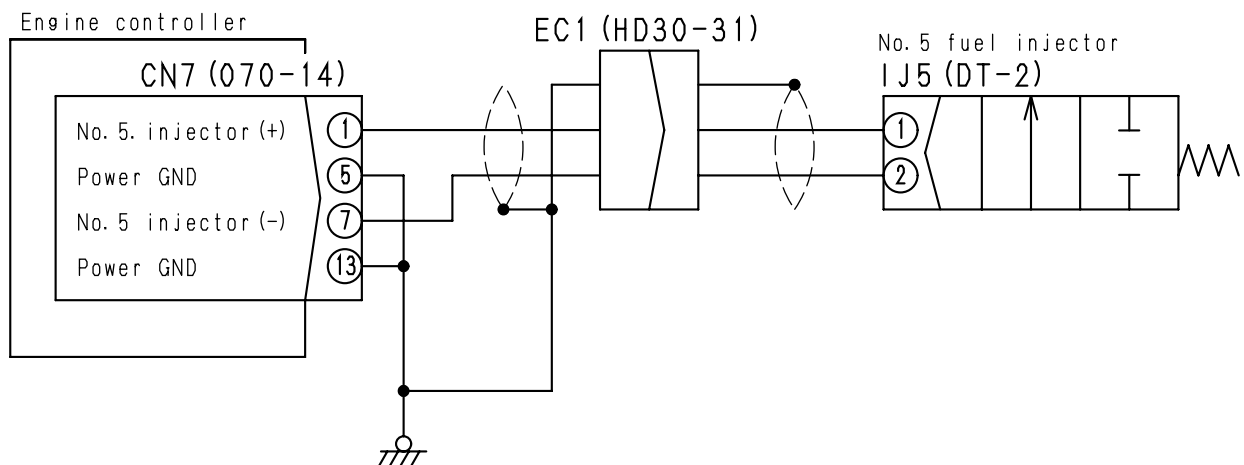
**E-32 Related electrical circuit diagram**

BJE00318

E-33 Error code [E-85] [Disconnection in No. 5 fuel injector system]

⚠ A high voltage (110 – 130 V) is used in the electrical circuit for the fuel injector, so be careful of electrocution or electric leakage. For details, see TESTING AND ADJUSTING, Handling controller high voltage circuit.

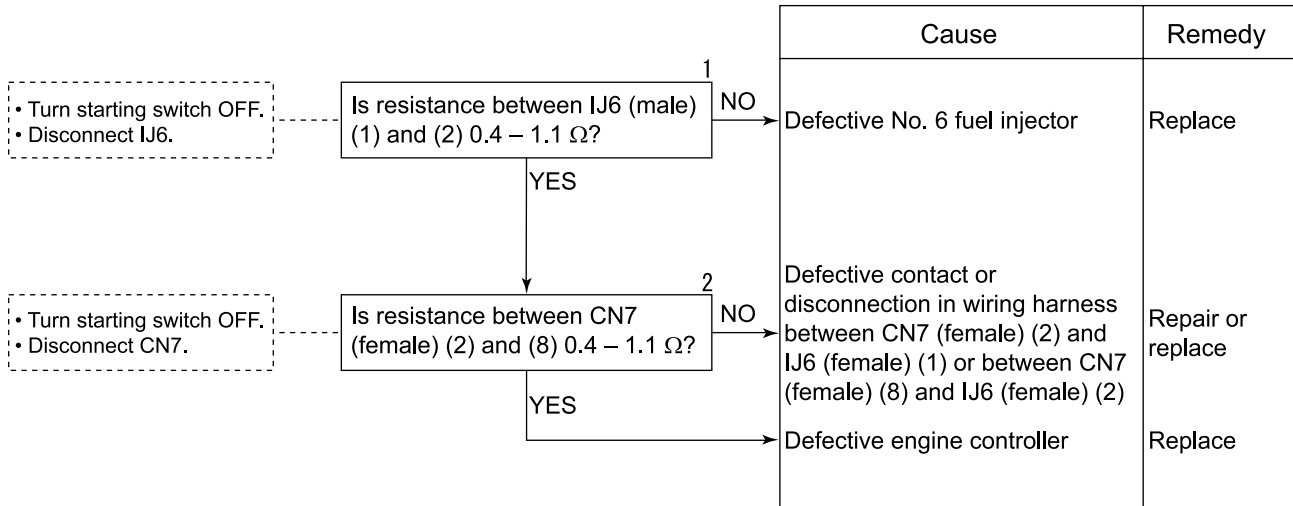
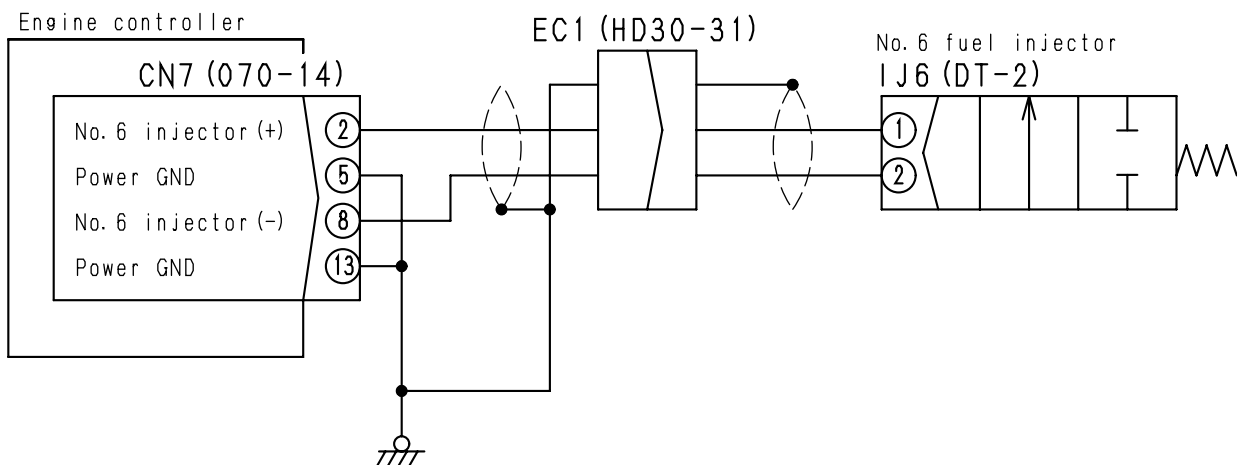
		Cause	Remedy
• Turn starting switch OFF. • Disconnect IJ5.	1 Is resistance between IJ5 (male) (1) and (2) 0.4 – 1.1 Ω ? YES NO	Defective No. 5 fuel injector	Replace
	2 Is resistance between CN7 (female) (1) and (7) 0.4 – 1.1 Ω ? YES NO	Defective contact or disconnection in wiring harness between CN7 (female) (1) and IJ5 (female) (1) or between CN7 (female) (7) and IJ5 (female) (2) Defective engine controller	Repair or replace Replace

E-33 Related electrical circuit diagram

BJE00319

E-34 Error code [E-86] [Disconnection in No. 6 fuel injector system]

⚠ A high voltage (110 – 130 V) is used in the electrical circuit for the fuel injector, so be careful of electrocution or electric leakage. For details, see TESTING AND ADJUSTING, Handling controller high voltage circuit.

**E-34 Related electrical circuit diagram**

BJE00320

E-35 Error code [E-8A] [Short circuit in No. 1, No. 2, No. 3 fuel injector system]

⚠ A high voltage (110 – 130 V) is used in the electrical circuit for the fuel injector, so be careful of electrocution or electric leakage. For details, see TESTING AND ADJUSTING, Handling controller high voltage circuit.

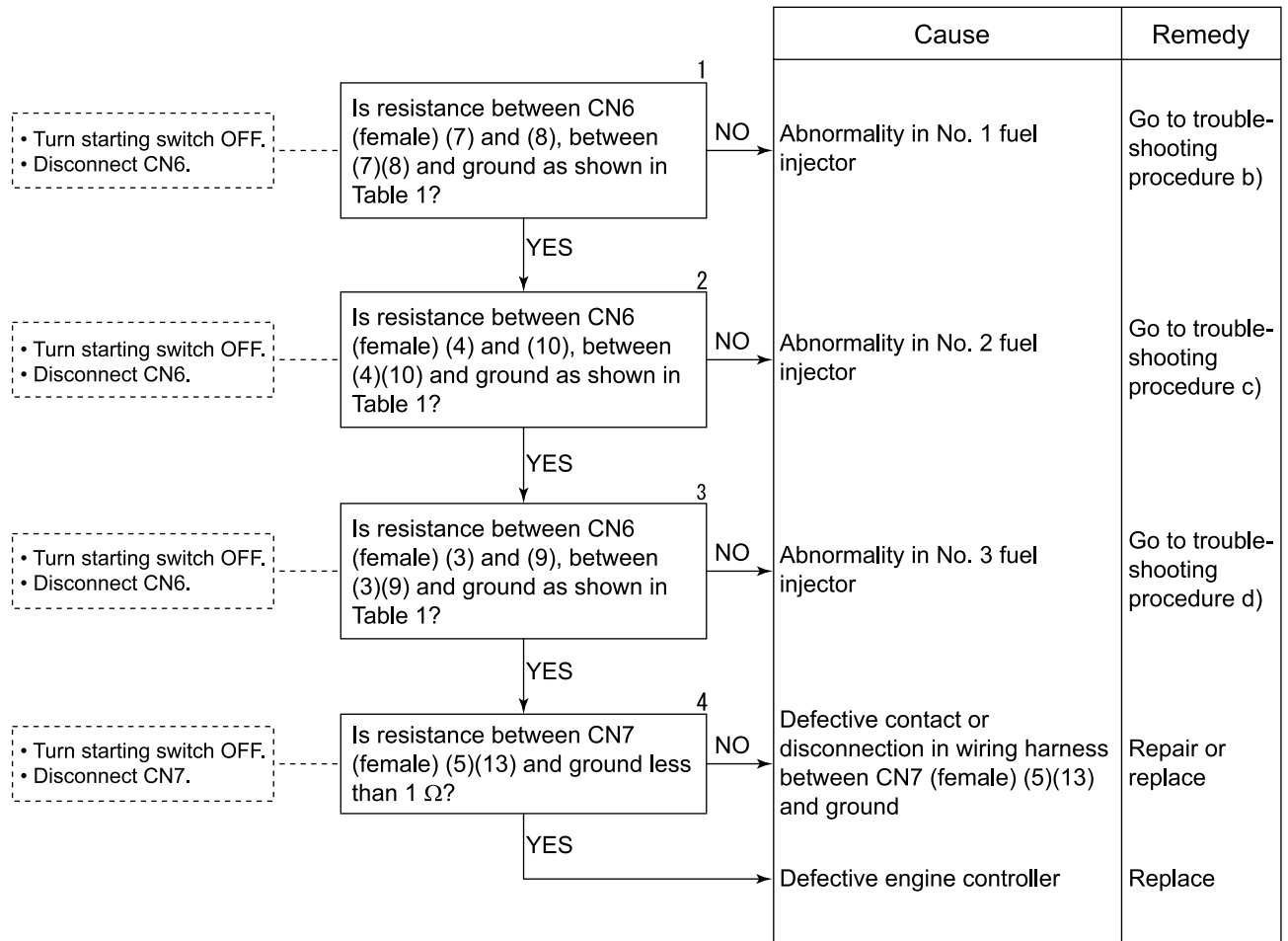
a) Determining location of problem

Table 1

CN6 (female)	CN6 (female)	CN6 (female)	Resistance value
Between (7) and (8)	Between (4) and (10)	Between (3) and (9)	0.4 – 1.1 Ω
Between (7)(8) and ground	Between (4)(10) and ground	Between (3)(9) and ground	Min. 1 MΩ

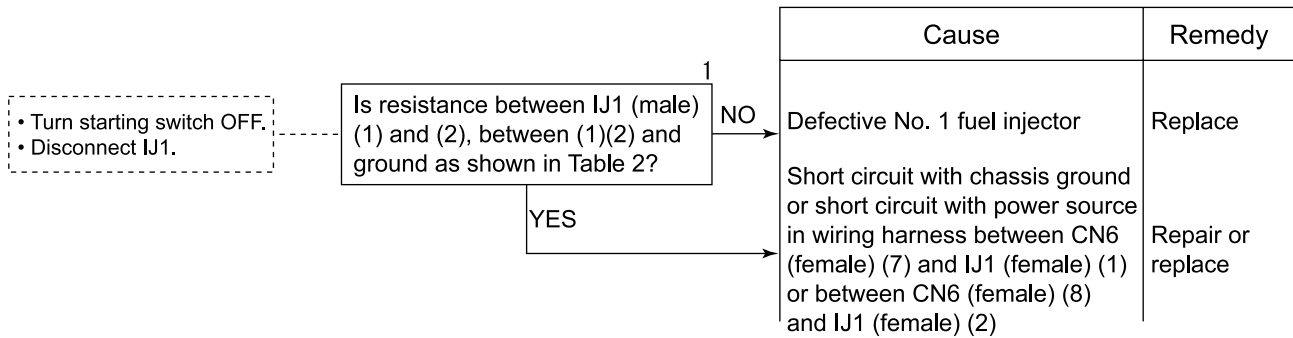
b) Troubleshooting No. 1 fuel injector system

Table 2

IJ1 (female)	Resistance value
Between (1) and (2)	0.4 – 1.1 Ω
Between (1)(2) and ground	Min. 1 MΩ

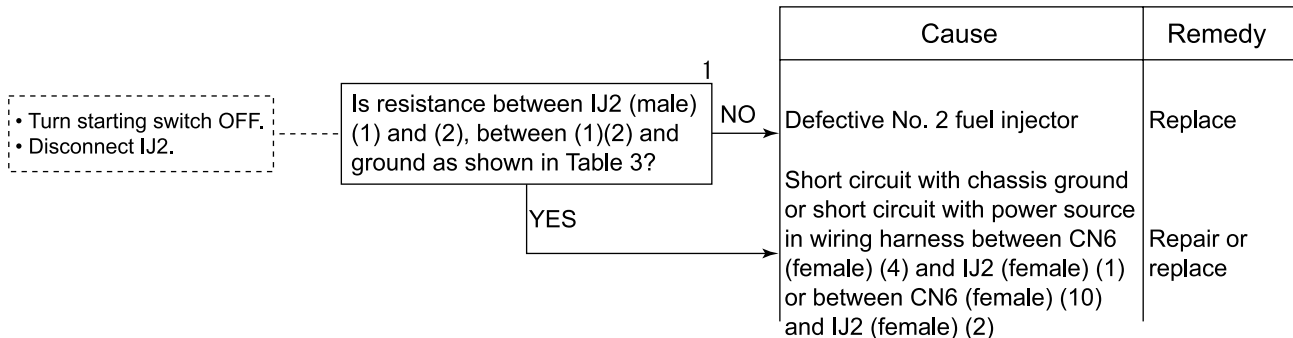
c) Troubleshooting No. 2 fuel injector system

Table 3

IJ2 (female)	Resistance value
Between (1) and (2)	0.4 – 1.1 Ω
Between (1)(2) and ground	Min. 1 MΩ

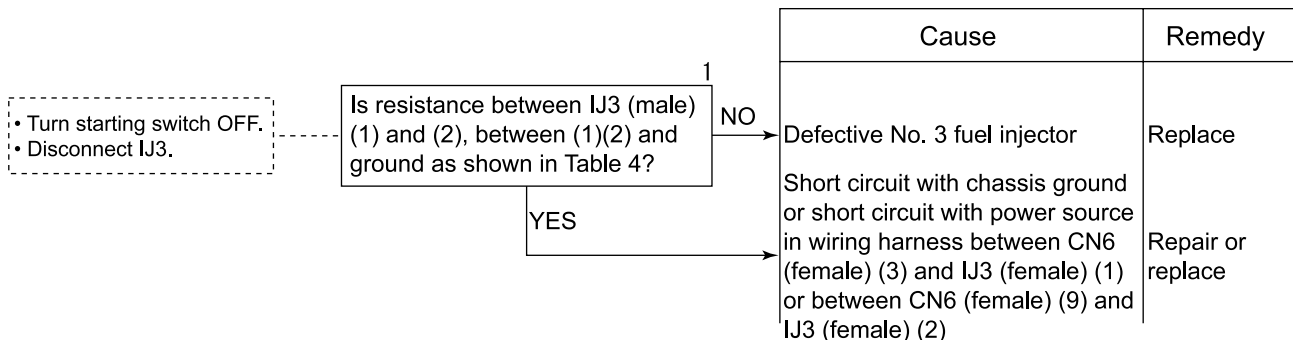
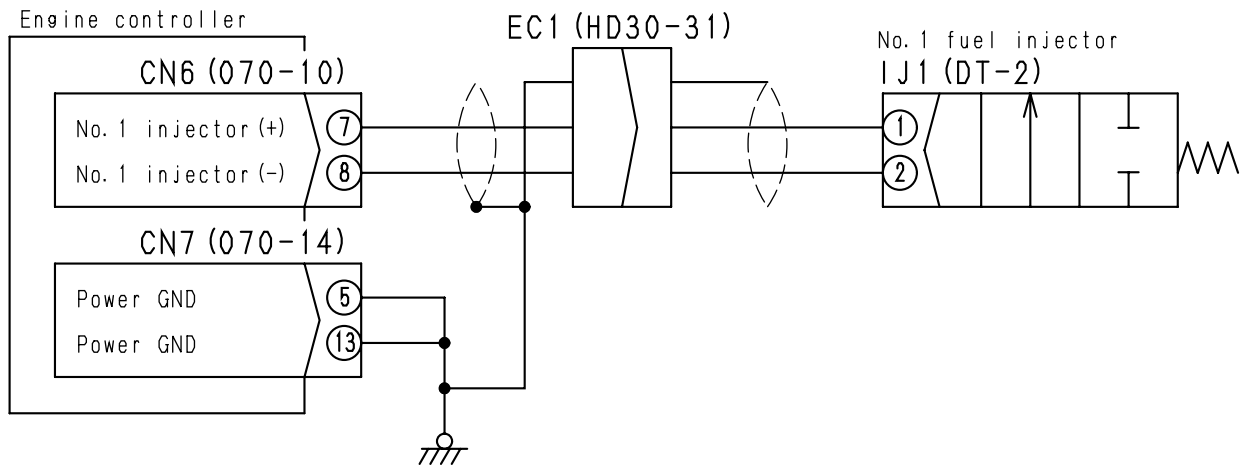
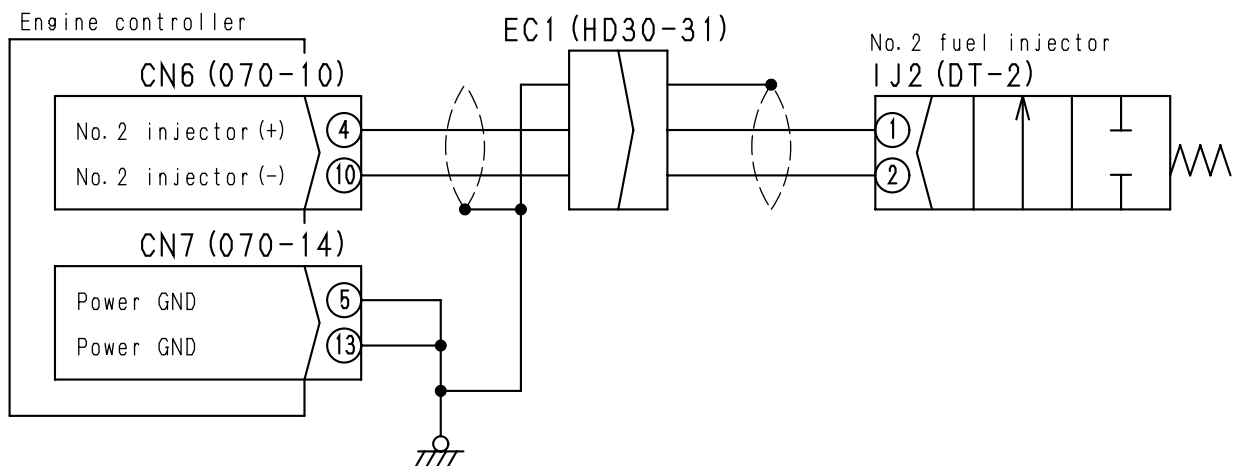
d) Troubleshooting No. 3 fuel injector system

Table 4

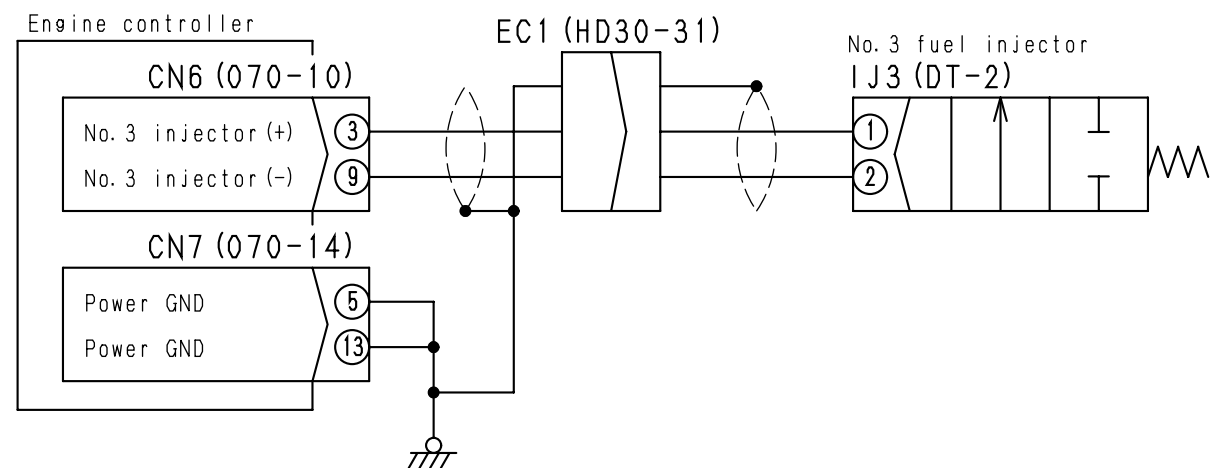
IJ3 (female)	Resistance value
Between (1) and (2)	0.4 – 1.1 Ω
Between (1)(2) and ground	Min. 1 MΩ

E-35 a), b) Related electrical circuit diagram

BJE00315

E-35 a), c) Related electrical circuit diagram

BJE00316

E-35 a), d) Related electrical circuit diagram

BJE00317

E-36 Error code [E-8b] [Short circuit in No. 4, No. 5, No. 6 fuel injector system]

⚠ A high voltage (110 – 130 V) is used in the electrical circuit for the fuel injector, so be careful of electrocution or electric leakage. For details, see TESTING AND ADJUSTING, Handling controller high voltage circuit.

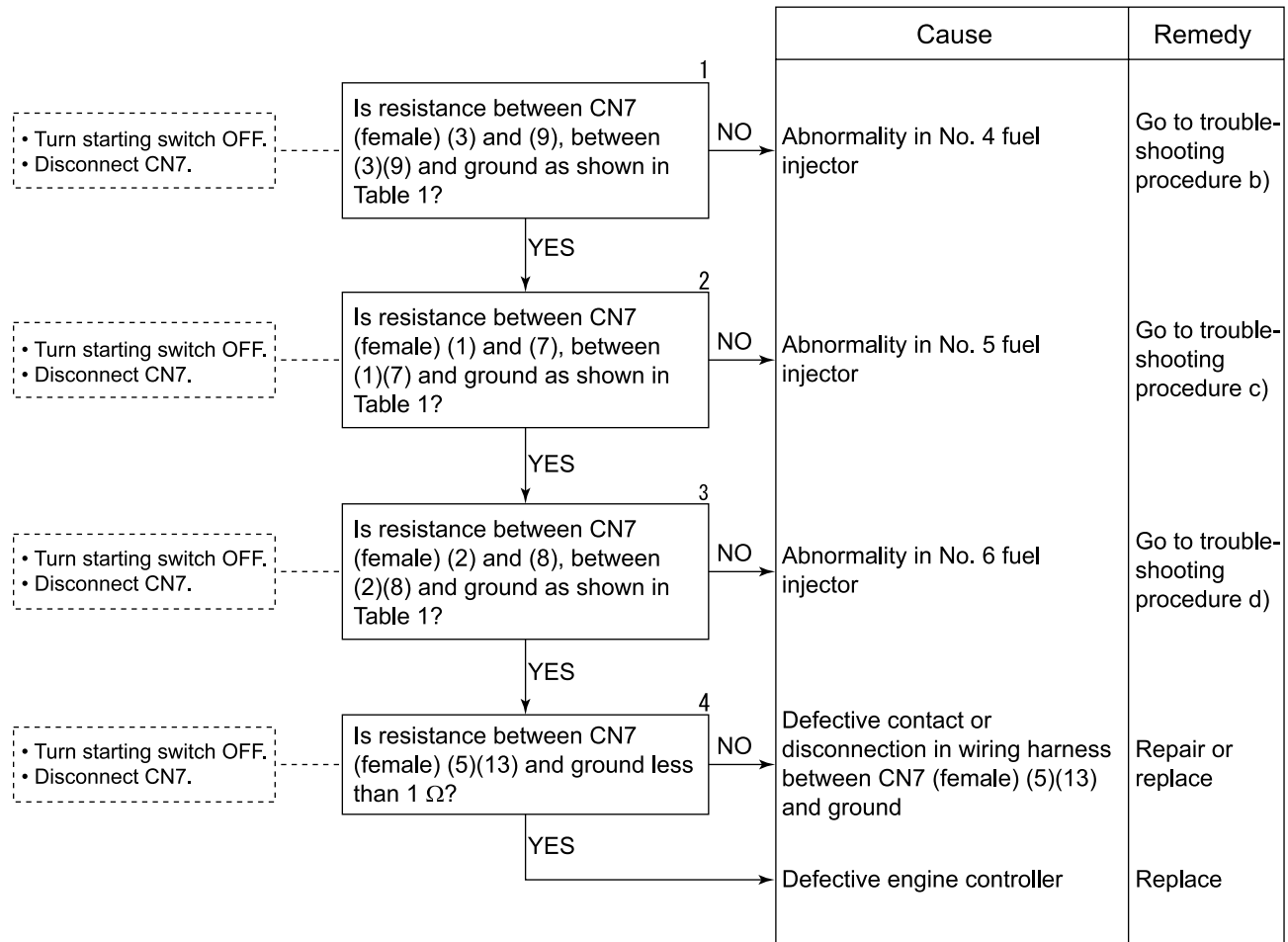
a) Determining location of problem

Table 1

CN6 (female)	CN6 (female)	CN6 (female)	Resistance value
Between (3) and (9)	Between (1) and (7)	Between (2) and (8)	0.4 – 1.1 Ω
Between (3)(9) and ground	Between (1)(7) and ground	Between (2)(8) and ground	Min. 1 MΩ

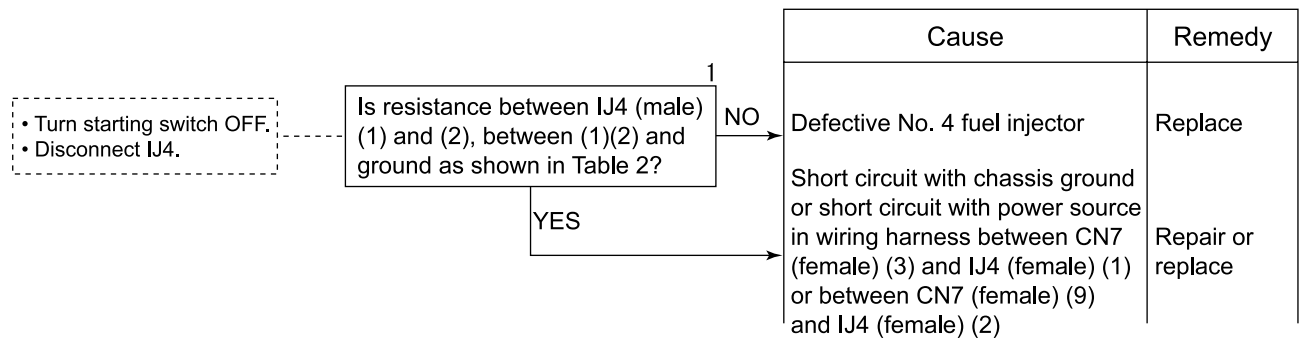
b) Troubleshooting No. 4 fuel injector system

Table 2

IJ4 (female)	Resistance value
Between (1) and (2)	0.4 – 1.1 Ω
Between (1)(2) and ground	Min. 1 M Ω

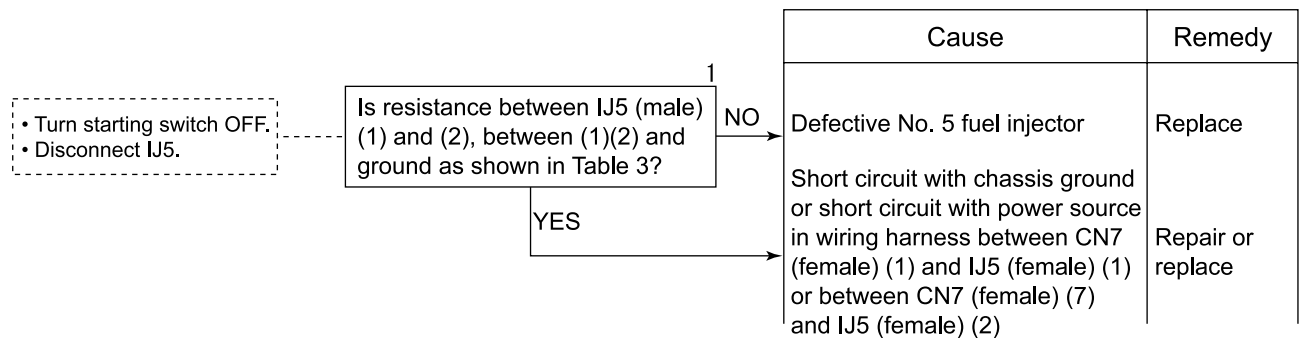
c) Troubleshooting No. 5 fuel injector system

Table 3

IJ5 (female)	Resistance value
Between (1) and (2)	0.4 – 1.1 Ω
Between (1)(2) and ground	Min. 1 M Ω

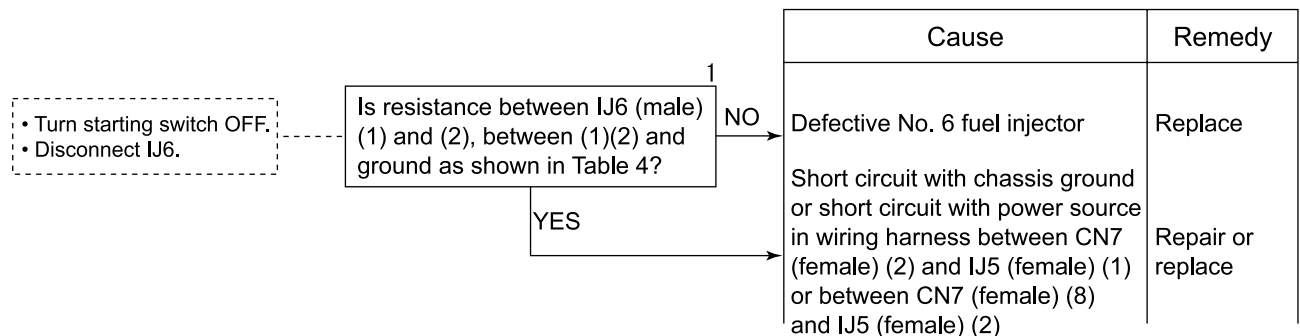
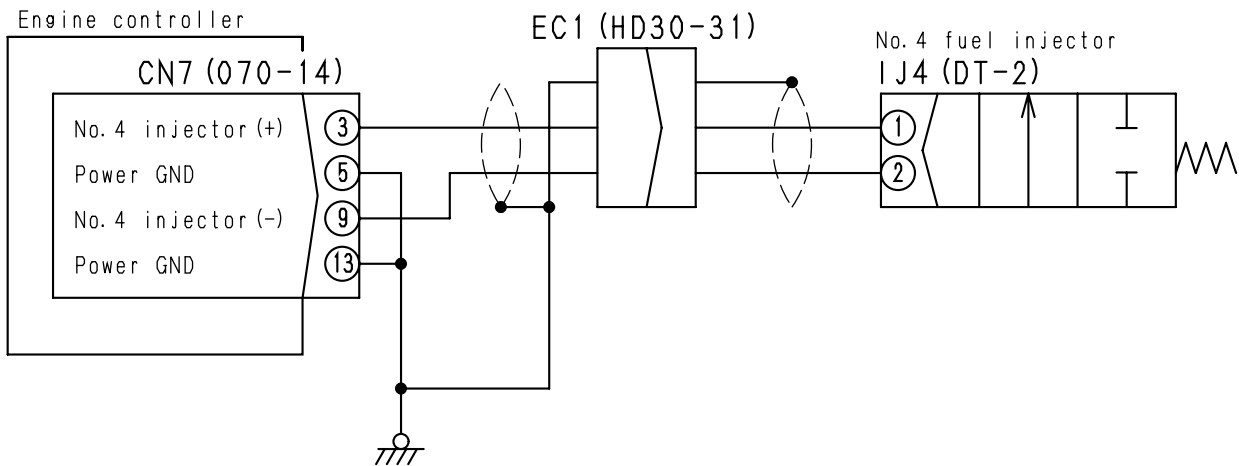
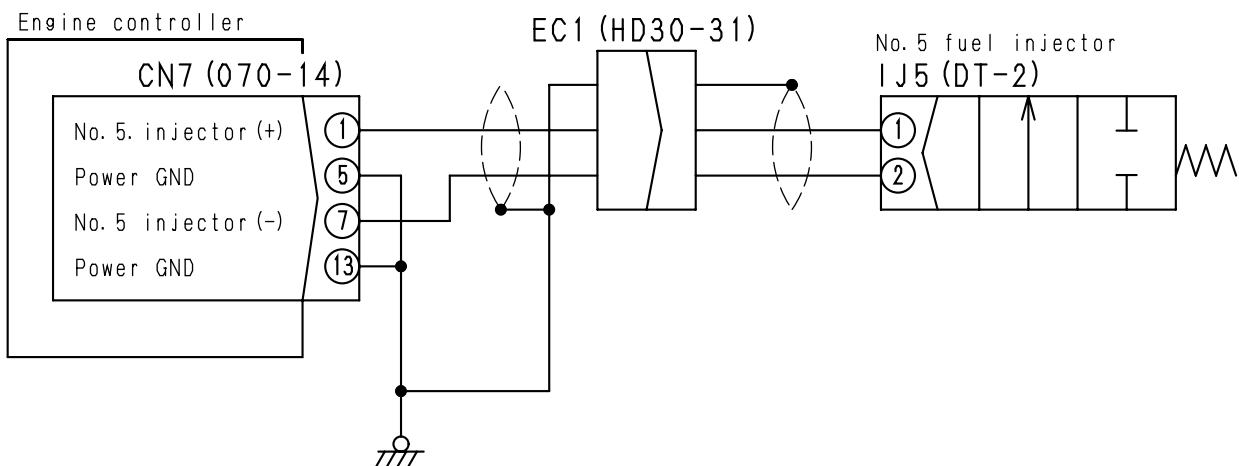
d) Troubleshooting No. 6 fuel injector system

Table 4

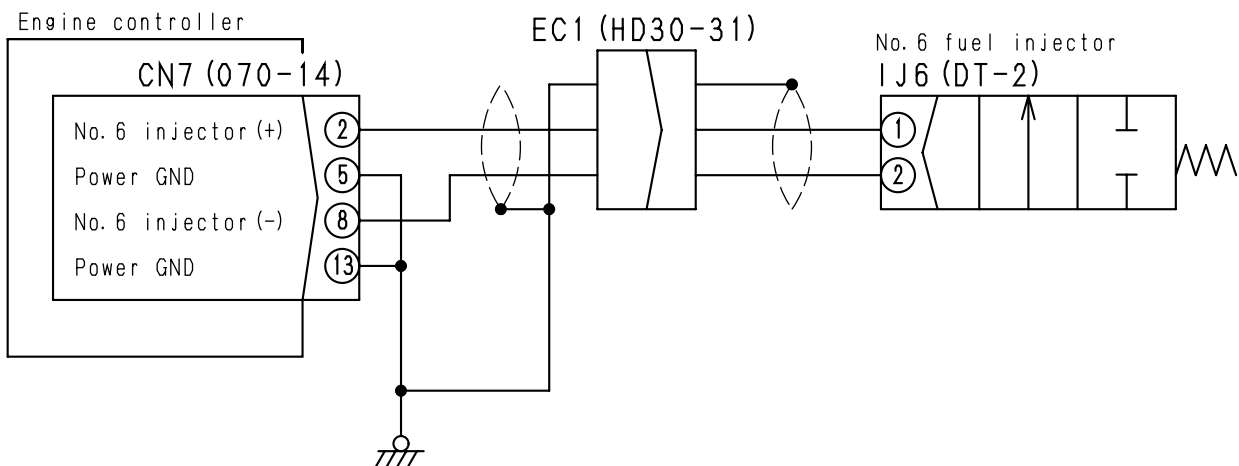
IJ6 (female)	Resistance value
Between (1) and (2)	0.4 – 1.1 Ω
Between (1)(2) and ground	Min. 1 M Ω

E-36 a), b) Related electrical circuit diagram

BJE00318

E-36 a), c) Related electrical circuit diagram

BJE00319

E-36 a), d) Related electrical circuit diagram

BJE00320

13 DISASSEMBLY AND ASSEMBLY

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METHOD OF USING MANUAL

1. When removing or installing unit assemblies

- 1) When removing or installing a unit assembly, the order of work and techniques used are given for the removal operation; the order of work for the installation operation is not given.
- 2) Any special techniques applying only to the installation procedure are marked , and the same mark is placed after the relevant step in the removal procedure to indicate which step in the installation procedure it applies to.

(Example)

REMOVAL OF ○ ○ ○ ○ ASSEMBLY Title of operation

 Precautions related to safety when carrying out the operation

1. X X X X (1) Step in operation

★ Technique or important point to remember when removing XXXX (1).

2. △ △ △ △ (2):  Indicates that a technique is listed for use during installation

3. □ □ □ □ assembly (3)



..... Quantity of oil or water drained

INSTALLATION OF ○ ○ ○ ○ ASSEMBLY Title of operation

- Carry out installation in the reverse order to removal.

 Technique used during installation

★ Technique or important point to remember when installing △ △ △ △ (2)

- Adding water, oil Step in operation

★ Point to remember when adding water or oil



..... Quantity when filling with oil and water

2. General precautions when carrying out installation or removal (disassembly or assembly) of units are given together as PRECAUTIONS WHEN CARRYING OUT OPERATION, so be sure to follow these precautions when carrying out the operation.

3. Listing of special tools

- 1) For details of the description, part number, and quantity of any tools (A1, etc.) that appear in the operation procedure, see the SPECIAL TOOLS LIST given in this manual.

PRECAUTIONS WHEN CARRYING OUT OPERATION

[When carrying out removal or installation (disassembly or assembly) of units, be sure to follow the general precautions given below when carrying out the operation.]

1. Precautions when carrying out removal work

- If the coolant contains antifreeze, dispose of it correctly.
- After disconnecting hoses or tubes, cover them or fit blind plugs to prevent dirt or dust from entering.
- When draining oil, prepare a container of adequate size to catch the oil.
- Confirm the match marks showing the installation position, and make match marks in the necessary places before removal to prevent any mistake when assembling.
- To prevent any excessive force from being applied to the wiring, always hold the connectors when disconnecting the connectors. Do not pull the wires.
- Fit wires and hoses with tags to show their installation position to prevent any mistake when installing.
- Check the number and thickness of the shims, and keep in a safe place.
- When raising components, be sure to use lifting equipment of ample strength.
- When using forcing screws to remove any components, tighten the forcing screws uniformly in turn.
- Before removing any unit, clean the surrounding area and fit a cover to prevent any dust or dirt from entering after removal.

★ Precautions when handling piping during disassembly

Fit the following blind plugs into the piping after disconnecting it during disassembly operations.

1) Hoses and tubes using sleeve nuts

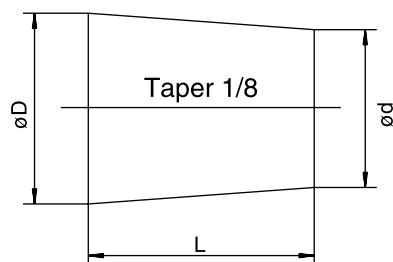
Nominal number	Plug (nut end)	Sleeve nut (elbow end) Use the two items below as a set
02	07376-50210	07221-20210 (Nut), 07222-00210 (Plug)
03	07376-50315	07221-20315 (Nut), 07222-00312 (Plug)
04	07376-50422	07221-20422 (Nut), 07222-00414 (Plug)
05	07376-50522	07221-20522 (Nut), 07222-00515 (Plug)
06	07376-50628	07221-20628 (Nut), 07222-00616 (Plug)
10	07376-51034	07221-21034 (Nut), 07222-01018 (Plug)
12	07376-51234	07221-21234 (Nut), 07222-01219 (Plug)

2) Split flange type hoses and tubes

Nominal number	Flange (hose end)	Sleeve head (tube end)	Split flange
04	07379-00400	07378-10400	07371-30400
05	07379-00500	07378-10500	07371-30500

3) If the part is not under hydraulic pressure, the following corks can be used.

Nominal number	Part Number	Dimensions		
		D	d	L
06	07049-00608	6	5	8
08	07049-00811	8	6.5	11
10	07049-01012	10	8.5	12
12	07049-01215	12	10	15
14	07049-01418	14	11.5	18
16	07049-01620	16	13.5	20
18	07049-01822	18	15	22
20	07049-02025	20	17	25
22	07049-02228	22	18.5	28
24	07049-02430	24	20	30
27	07049-02734	27	22.5	34



DEW00401

2. Precautions when carrying out installation work

- Tighten all bolts and nuts (sleeve nuts) to the specified (KES) torque.
 - Install the hoses without twisting or interference.
 - Replace all gaskets, O-rings, cotter pins, and lock plates with new parts.
 - Bend the cotter pins and lock plates securely.
 - When coating with adhesive, clean the part and remove all oil and grease, then coat the threaded portion with 2 – 3 drops of adhesive.
 - When coating with gasket sealant, clean the surface and remove all oil and grease, check that there is no dirt or damage, then coat uniformly with gasket sealant.
 - Clean all parts, and correct any damage, dents, burrs, or rust.
 - Coat rotating parts and sliding parts with engine oil.
 - When press fitting parts, coat the surface with anti-friction compound (LM-P).
 - After fitting snap rings, check that the snap ring is fitted securely in the ring groove.
 - When connecting wiring connectors, clean the connector to remove all oil, dirt, or water, then connect securely.
 - When using eyebolts, check that there is no deformation or deterioration, screw them in fully, and align the direction of the hook.
 - When tightening split flanges, tighten uniformly in turn to prevent excessive tightening on one side.
- ★ When operating the hydraulic cylinders for the first time after reassembling cylinders, pumps and other hydraulic equipment removed for repair, always bleed the air as follows:
- 1) Start the engine and run at low idling.
 - 2) Operate the work equipment control lever to operate the hydraulic cylinder 4 – 5 times, stopping the cylinder 100 mm from the end of its stroke.
 - 3) Next, operate the hydraulic cylinder 3 – 4 times to the end of its stroke.
 - 4) After doing this, run the engine at normal speed.
- ★ When using the machine for the first time after repair or long storage, follow the same procedure.

3. Precautions when completing the operation

- If the coolant has been drained, tighten the drain valve, and add water to the specified level. Run the engine to circulate the water through the system. Then check the water level again.
- If the hydraulic equipment has been removed and installed again, add engine oil to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.
- If the piping or hydraulic equipment have been removed, always bleed the air from the system after reassembling the parts.
 - ★ For details, see TESTING AND ADJUSTING, Bleeding air.
- Add the specified amount of grease (molybdenum disulphide grease) to the work equipment parts.

SPECIAL TOOL LIST

- ★ Tools with part number 79 x T- xxx - xxxx cannot be supplied (they must be locally manufactured).
- ★ Necessity: ■ Cannot be substituted, should always be installed (used)
 ● Extremely useful if available, can be substituted with commercially available part
- ★ New/Remodel: N Tools with new part numbers, newly developed for this model
 R Tools with upgraded part numbers, remodeled from items already available for other models
 Blank Tools already available for other models, used without any modification
- ★ Tools marked ○ in the Sketch column are tools introduced in the sketches of the special tools (See SKETCHES OF SPECIAL TOOLS).

Component	Symbol	Part No.	Part Name	Necessity	Q'ty	New/Remodel	Sketch	Nature of work, remarks
Disassembly, assembly of engine assembly	A	790-901-1260	Adapter (To be installed to B)	■	1			
	B	790-501-2001	Engine overhaul stand	■	1			
Removal, installation of cylinder head valve spring	C	795-102-2102	Spring pusher	■	1			
Removal, installation of piston ring	D	795-100-1191	Piston ring tool	■	1			
Removal of cylinder liner	E	795-236-1000	Liner puller	■	1			
Press fitting of cylinder liner	F	795-230-5472	Liner driver	■	1			
Insertion of piston assembly	G	795-236-1500	Piston holder	■	1			
Measurement of projection of cylinder liner	H	795-502-1121	Gauge holder	■	1			
Adjustment of valve clearance	I	795-125-1210	Filler gauge	●	1			
Angular tightening of bolt	J	790-331-1110	Wrench	●	1			
Pulling rear seal out of engine	L	795-931-1100	Seal puller	●	1			
Press fitting of front seal	M	795-521-1110	Push tool	■	1			
		01050-31640	Bolt	■	3			
Press fitting of engine rear seal	N	1	795-931-1210	Sleeve jig	■	1		
		2	795-931-1220	Sleeve jig	■	1		
		3	01050-31645	Bolt	■	3		
		4	01050-31625	Bolt	■	3		
Removal of fuel supply pump	O	1	795-471-1320	Plate	■	1	N	
		2	01017-32020	Bolt	■	1	N	
		3	01010-81095	Bolt	■	2	N	
		4	01643-31032	Washer	■	2	N	

GENERAL DISASSEMBLY OF ENGINE

- ★ The following disassembly and assembly procedures are for SA6D140E-3 of HD325-6 specification. The shapes, quantity, locations, etc. of some parts of a machine disassembled actually may be different from the following explanation. Take care.

1. Preparation work

Before disassembling the engine, check its parts for cracking, damage, etc. and clean it generally and carefully for accurate inspection of its parts and quick disassembly and assembly.

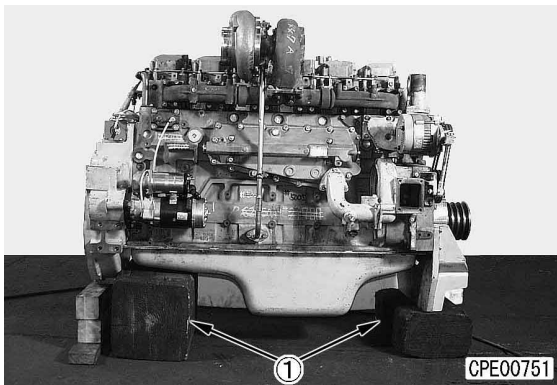
- ★ Before cleaning the engine, carefully seal or remove the openings, electric parts, and wiring connectors so that water will not enter them.
- Prepare a stable engine stand (Block ①) and secure the engine assembly on it so that it will not tip over.



Engine assembly:

Approx. 1,550 kg

(Weight depends on the model on which the engine is mounted)



- Drain the engine cooling water and engine oil.

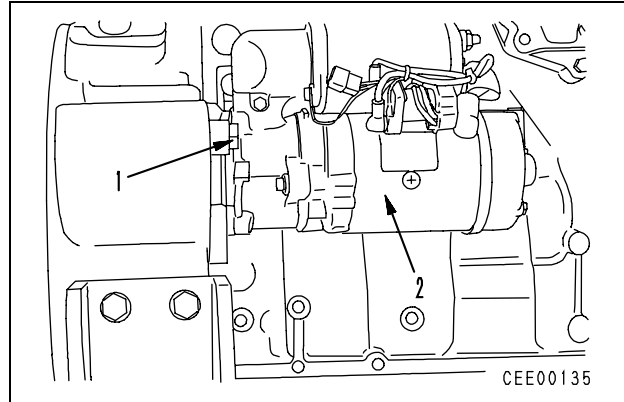


Engine oil: **Approx. 37 ℓ**

- ★ Amount of oil depends on the model on which the engine is mounted.

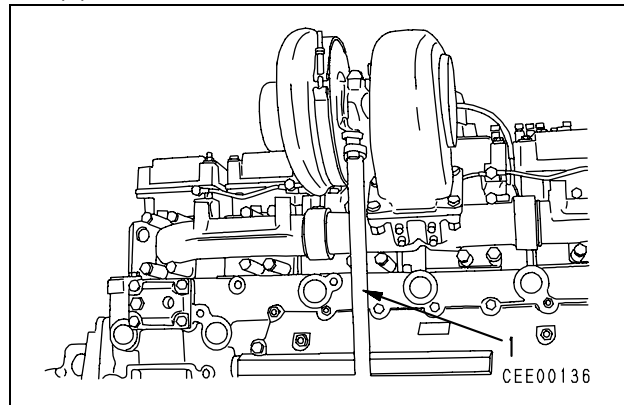
2. Starting motor assembly

Remove 3 mounting bolts (1), then remove starting motor assembly (2).



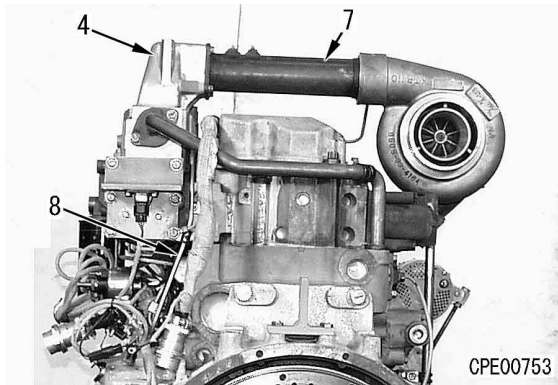
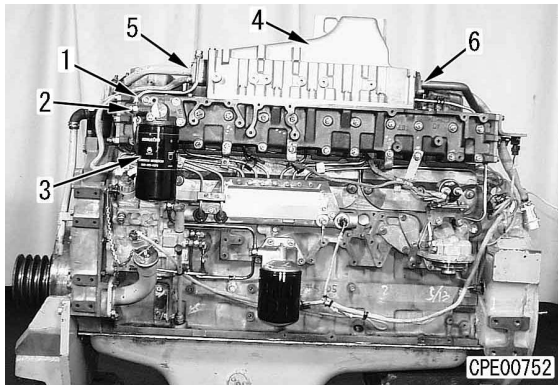
3. Turbocharger lubricating oil return tube

Remove turbocharger lubricating oil return tube (1).



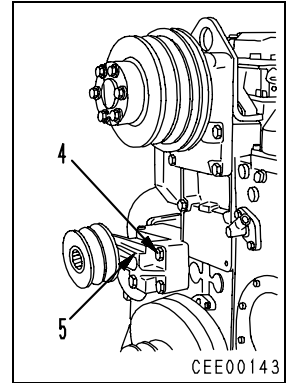
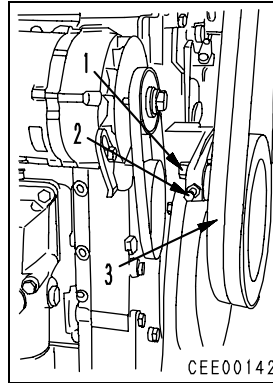
4. Corrosion resistor, aftercooler, and air intake pipe

- 1) Remove tubes (1) and (2) and 5 mounting bolts of corrosion resistor (3), then remove corrosion resistor (3) (only when it is installed).
- 2) Remove tubes (5) and (6) of aftercooler (4).
- 3) Remove the 14 mounting bolts of the aftercooler.
- ★ The 3 bolts on the head cover side are used to the fuel high-pressure tube clamp, too.
- 4) Remove the mounting bolts of air intake pipe (7) and turbocharger lubricating oil tube (8), then lift off aftercooler (4).
- 5) Pull out air intake pipe (7).



5. Tension pulley assembly

- 1) Loosen tension pulley mounting nut (1).
- 2) Loosen adjustment bolt (2) and move the tension pulley inward, then remove fan belt (3).
- 3) Remove mounting bolt (4) and tension pulley assembly (5).

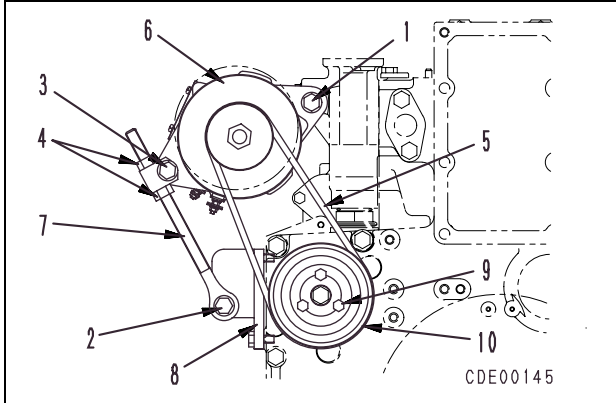


6. Fan pulley assembly

Remove the mounting bolt and the fan pulley assembly.

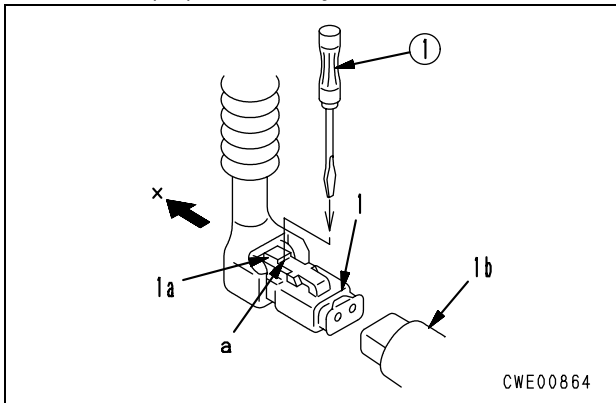
7. Alternator assembly and pulley

- 1) Loosen mounting bolts (1), (2), and (3).
- 2) Loosen 2 adjustment nuts (4) and remove 2 alternator belts (5).
- 3) Remove mounting bolts (1), (2), and (3), then remove alternator assembly (6) and adjustment rod (7).
- 4) Remove bracket (8).
- 5) Remove mounting bolt (9) and pulley (10).

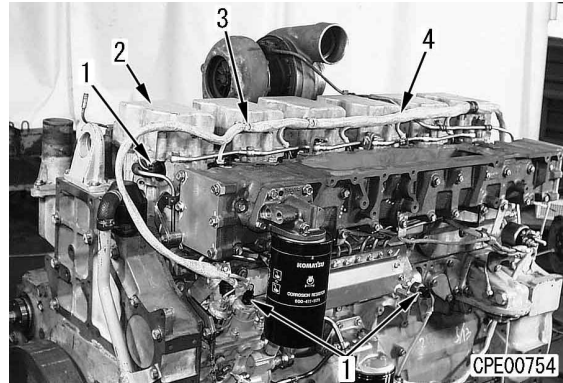


8. Fuel system wiring harness assembly

- 1) Remove the connector of each fuel injector, fuel supply pump, and connector (1) of the common rail, etc.
- ★ Insert flat-head screwdriver ① in the shouldered part (part "a"). Pressing the stopper (1a), move the screwdriver in the direction of X to disconnect connect (1).
- (1b): On fuel injector harness side



- 2) Remove 3 clamps (3) secured with the mounting bolts of head cover (2), then remove harness (4).



9. Turbocharger assembly and exhaust manifold

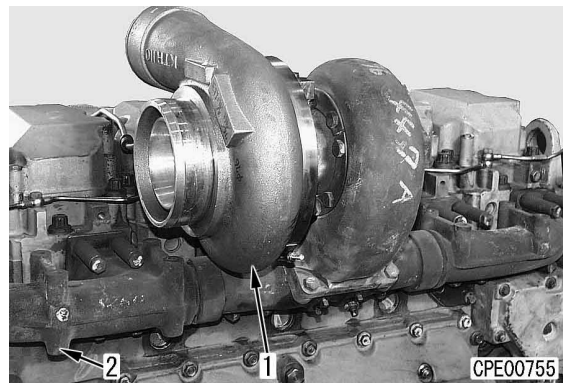
- 1) Remove the 4 mounting bolts and lift off turbocharger (1).



Turbocharger assembly:

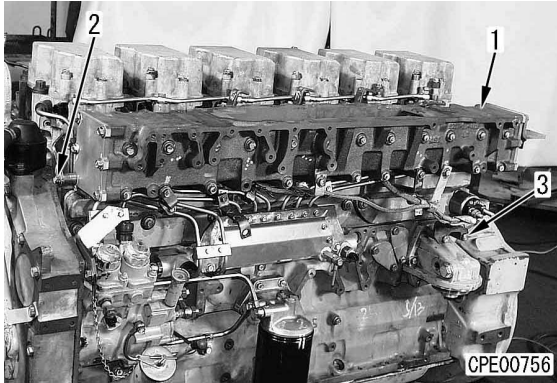
Approx. 30 kg

- 2) Remove the mounting bolts and exhaust manifold (2).



10. Intake manifold assembly

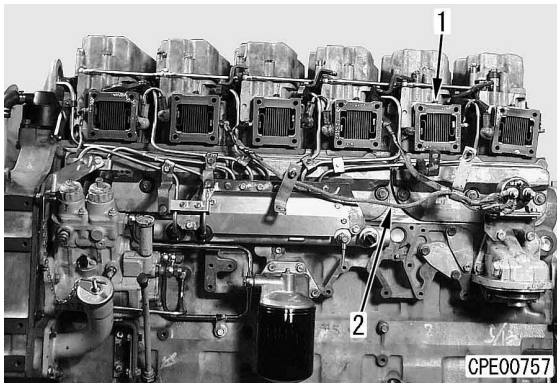
- 1) Sling intake manifold (1) temporarily.
- 2) Remove bolt (2) [Remove the bolt on the rear side of the clamped heater ground (on the opposite side) similarly, too].
- 3) Remove the mounting bolts of the intake manifold.
 - ★ Remove mounting bolt (3) of the heater relay, too.
- 4) Lift off intake manifold (1).



- ★ Bolt (3) is used to secure the electrical intake air heater, heater wiring harness, clamp, and fuel tube clamp together.

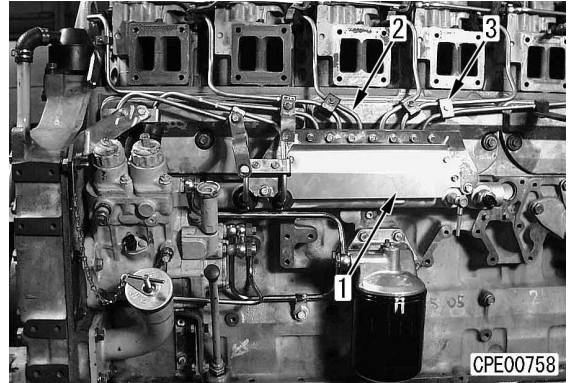
11. Electrical intake air heater and wiring harness assembly

- 1) Remove each electrical intake air heater (1) and wiring harness assembly (2).

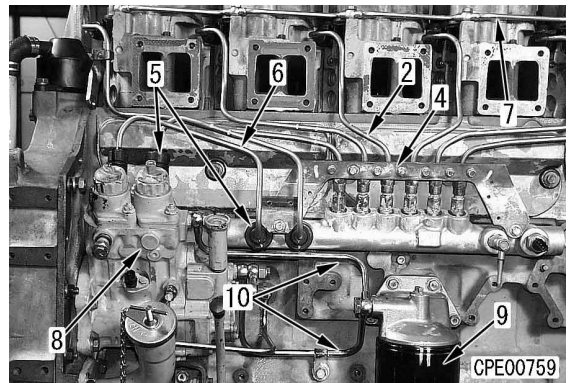


12. Common rail and fuel filter assembly

- 1) Remove the 4 mounting bolts and cover (1), then remove the rubber boot from the mounting part of each high-pressure pipe (2).
- 2) Remove each clamp (3) of each high-pressure pipe (2).

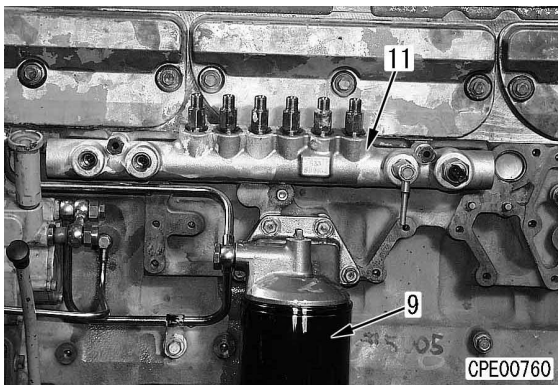


- 3) Remove the bolt of holding bracket (4) of high-pressure pipe (2), then remove bracket (4).
- 4) Remove rubber boot (5) and each high-pressure pipe (6).
- 5) Remove fuel spill pipe (7) and water temperature spill pipe on its rear side together.
- 6) Remove 2 fuel pipes (10) between fuel supply pump (8) and fuel filter (9).



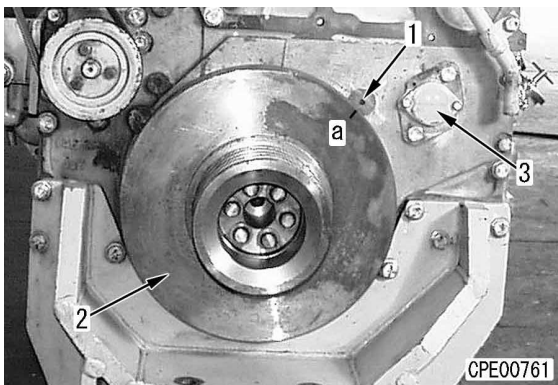
- ★ Remove the high-pressure pipes in the order of common rail No. 1 fuel injector No. 1 ... No. 2.
- 7) Remove the 2 mounting bolts and common rail (11).

- 8) Remove the 4 mounting bolts and filter assembly (9).

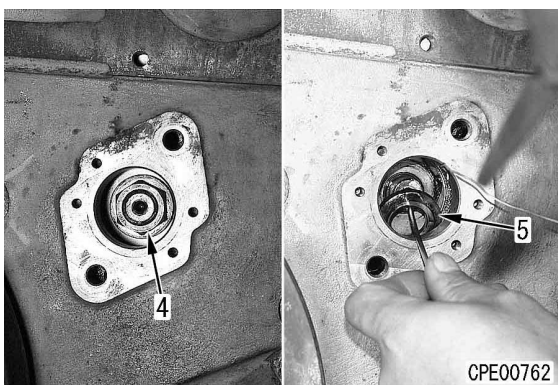


13. Fuel supply pump assembly

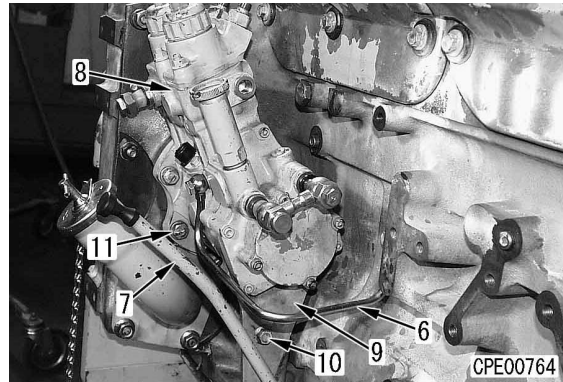
- 1) Match 1.6 TOP line "a" on damper (2) to pointer (1).
- 2) Remove the mounting bolt and front cover (3).



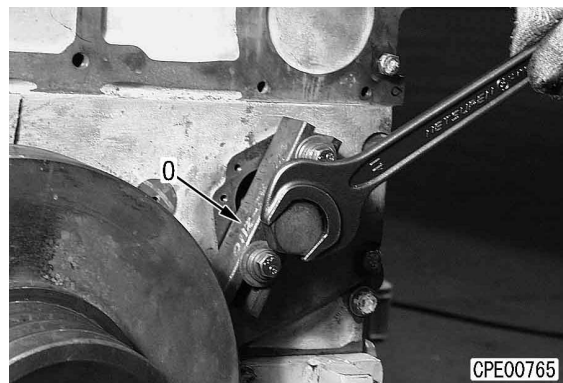
- 3) Remove nut (4) and washer (5), taking care not to drop them inside.



- 4) Remove fuel supply pump lubrication tube (6).
- 5) Remove engine oil level gauge guide (7).
- 6) Remove 2 mounting bolts (10) of mounting bracket (9) of fuel supply pump (8).
- 7) Remove 4 mounting bolts (11) of the fuel supply pump.

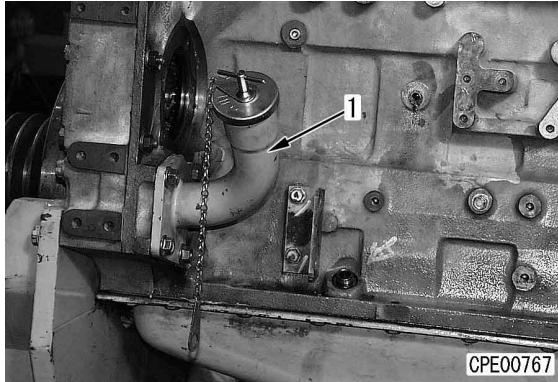


- 8) Using jig O, push out the fuel supply pump shaft to take out the fuel supply pump assembly.



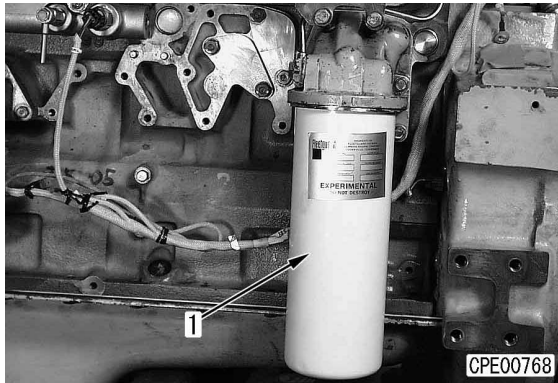
14. Engine oil filler

- 1) Remove the 1 mounting bolt, 3 nuts, and engine oil filler (1).
- ★ The 3 nuts are tightened together with the front cover.



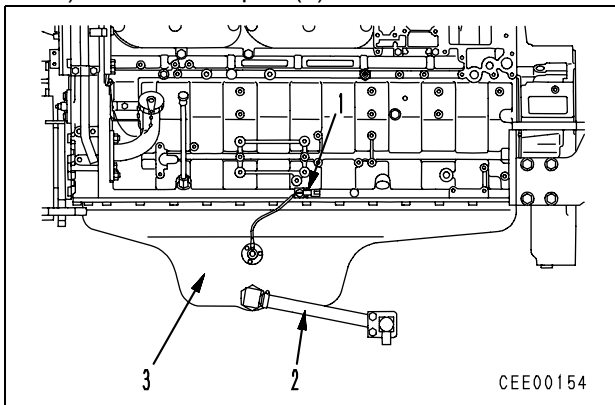
15. Engine oil filter assembly

- 1) Remove the bolts and filter assembly (1).



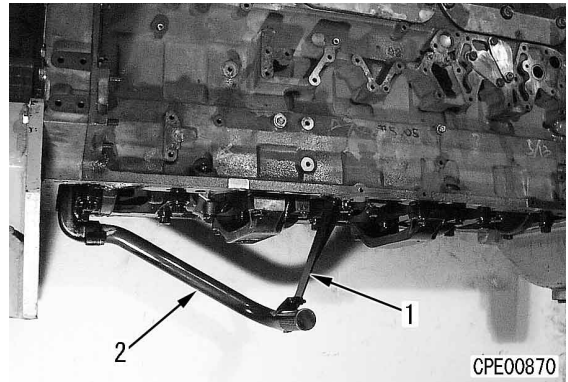
16. Oil pan

- 1) Remove wiring connector (1) from the bracket.
- 2) Disconnect drain hose (2).
- 3) Remove oil pan (3).



17. Suction pipe and underframe

Remove bracket (1) and suction pipe (2).



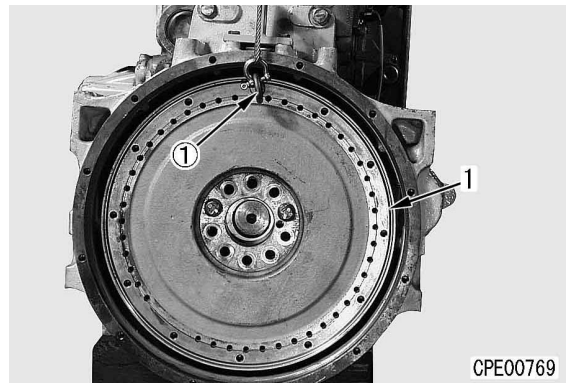
- ★ After removing the suction pipe, sling the engine and place it on stable blocks placed under the front, rear, right, and left parts of the cylinder block. The crankshaft must be able to turn (The engine must not be installed on an engine overhaul stand).

18. Flywheel

- 1) Using sling ①, sling flywheel (1) temporarily. Remove the 10 mounting bolts and lift off the flywheel.
- ★ Be careful not to touch the flywheel to the engine revolution sensor.

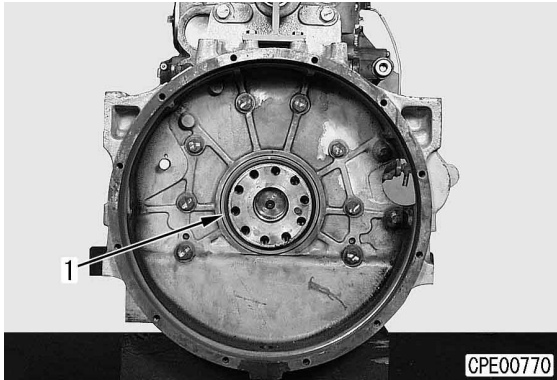


Flywheel: 62 kg

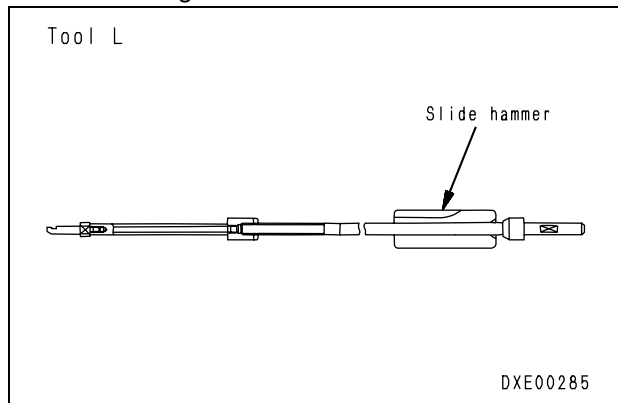


19. Engine rear oil seal

- 1) When removing rear seal (1) without removing the flywheel housing, follow the procedure below.

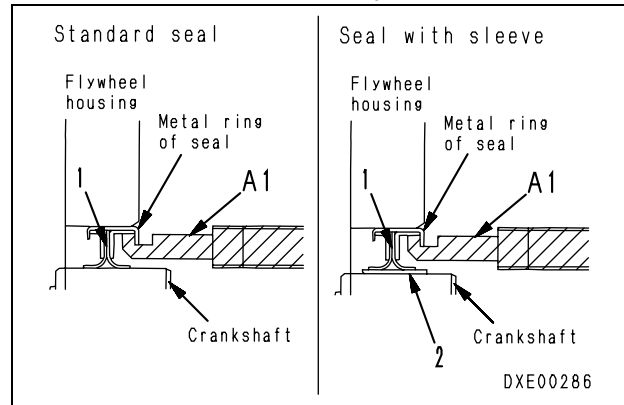


- Removal of standard seal
Hitch the end of tool L to the metal ring of seal (1) and pull out the seal with impacts of a slide hammer.
- ★ Before pulling out the seal, drive in it a little to separate it from the housing for the ease of removal.
- ★ Do not use a drill, etc. since chips may enter the engine.

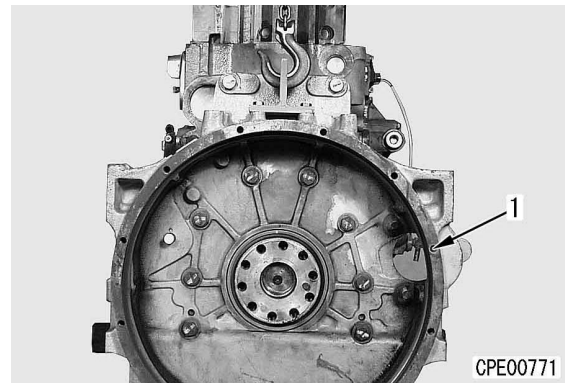


- Removal of seal having sleeve
 - 1) Hitch the end of tool L to the metal ring of seal (1) and pull out the seal with impacts of a slide hammer.
 - ★ Before pulling out the seal, drive in it a little to separate it from the housing for the ease of removal.
 - 2) Cut and remove sleeve (2) with a chisel and a hammer.

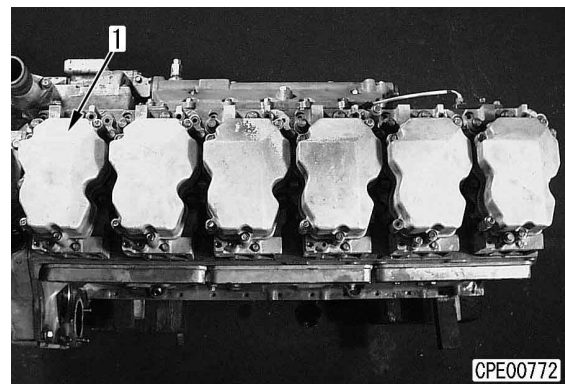
- ★ When cutting the sleeve, take care extremely not to damage the crankshaft.
- ★ Remove the all chips.

**20. Flywheel housing**

- 1) Set a sling to the hanging hook and sling flywheel housing (1) temporarily. Remove the mounting bolts and sling flywheel housing (1).

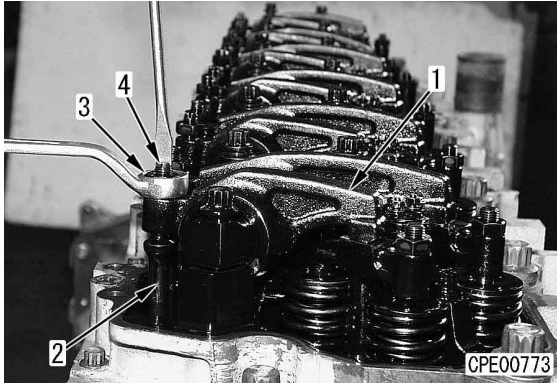
Housing: **75 kg****21. Head cover**

- Remove the mounting bolts of each head cover (1), then remove the head covers.



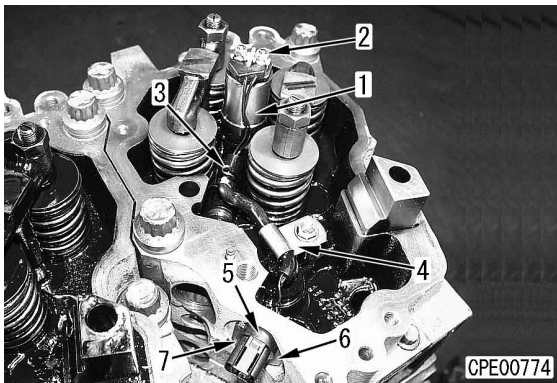
22. Rocker arm

- 1) Remove 3 mounting bolts and rocker arm (1).
- ★ Loosen lock nut (3) and loosen adjustment screw (4) by 2 - 3 turns so that an excessive force will not be applied to push rod (2) when the rocker arm is installed again.



23. Fuel injector assembly

- 1) Remove 2 nuts (2) of the upper solenoid valve of fuel injector (1) and pull out spring clamp (3). Remove the bolt of clamp (4), 1 mounting bolt (7) of holder (6) of connector (with O-ring) (5) and holder (6), then push in connector (5) to remove it.



- 2) Loosen the bolt of holder (8) of fuel injector (1), then remove fuel injector (1).



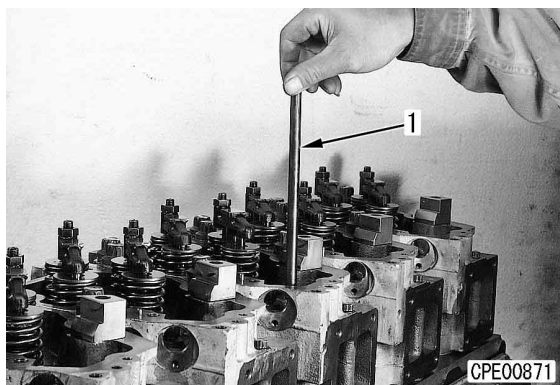
- 3) Insert a small L-bar under connection (9) of fuel injector (1) and pry up fuel injector (1) carefully.
- ★ Never hold the solenoid valve on the top of the injector with pliers, etc.



- ★ Precautions for removing only injector to replace only injector or only nozzle tip
Before starting the above work to remove the injector, loosen the bolts mounting the injector onto the clamp intake manifold near the injectors of high-pressure pipe clamps No. 1 - No. 6. Remove the sleeve of the high-pressure pipe on the injector side and pull out the injector, taking care that its tip will not touch the concave part of the injector.

24. Push rod

Remove push rod (1).

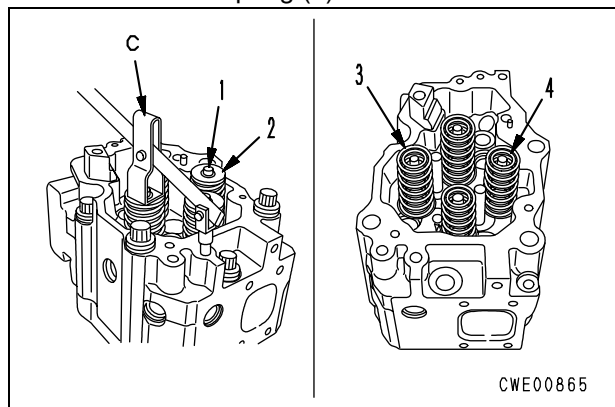


25. Cylinder head assembly, Cross head

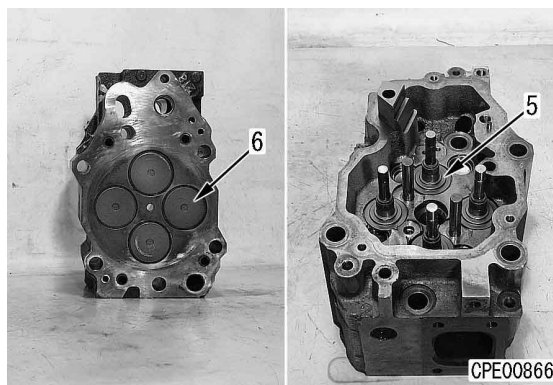
- 1) Remove cross head (1).
- 2) Remove mounting bolts (2) and cylinder head assembly (3).
- 3) Remove each cylinder head gasket.



- Disassemble the cylinder head assembly according to the following procedure.
 - i) Using tool C, compress the valve spring and remove cotter (1).
 - ii) Remove upper seat (2), outer spring (3), and inner spring (4).



- iii) Remove lower seat (5).
- iv) Raise the cylinder head and remove valve (6).

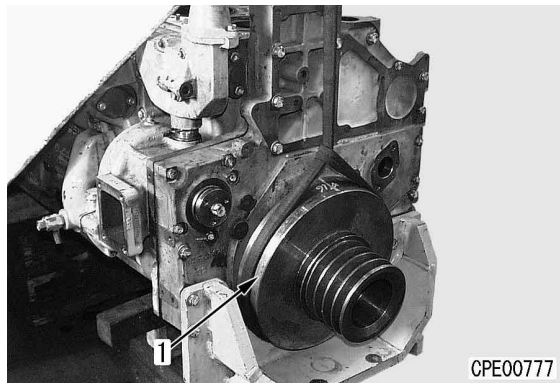


26. Damper pulley assembly

- 1) Sling damper pulley (1) temporarily and remove 6 mounting bolts, then lift off the damper.



Damper pulley assembly: **55 kg**

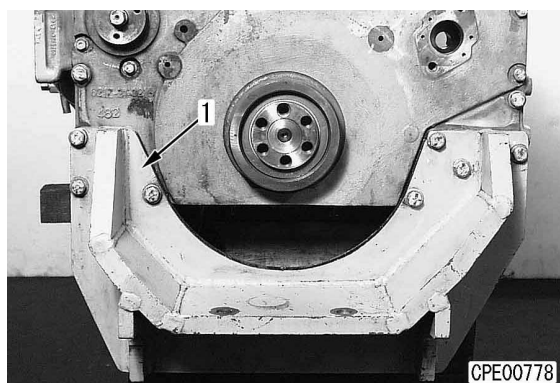


27. Support assembly

- 1) Sling support (1) temporarily and remove the mounting bolts, then lift off the support.

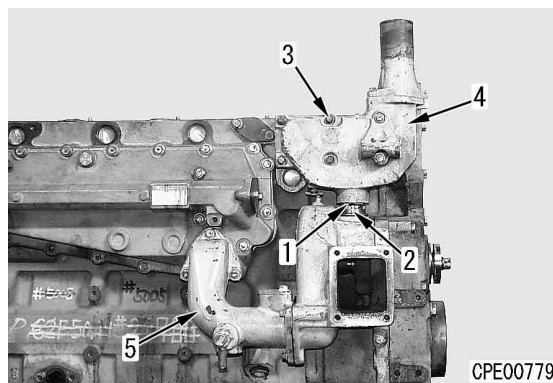


Support: **65 kg**



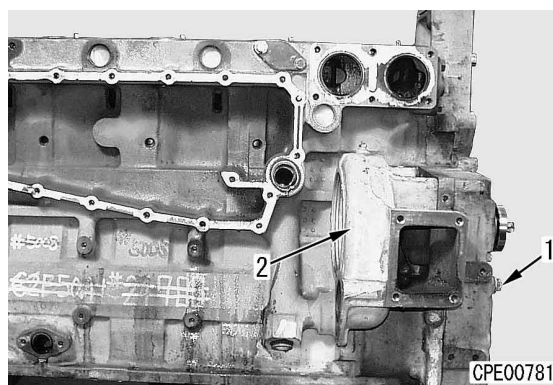
28. Thermostat assembly

- 1) Remove ring (1) and shift tube (2) up, then remove mounting bolts (3) and thermostat case assembly (4).
- 2) Remove the mounting bolts and tube (5).



29. Water pump assembly

- 1) Remove 4 bolts (1) (used to secure the gear case, too) and water pump (2).

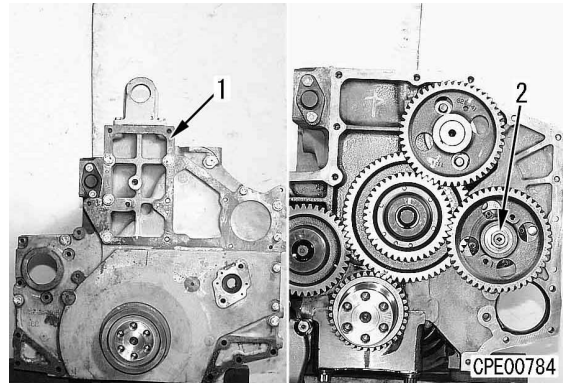
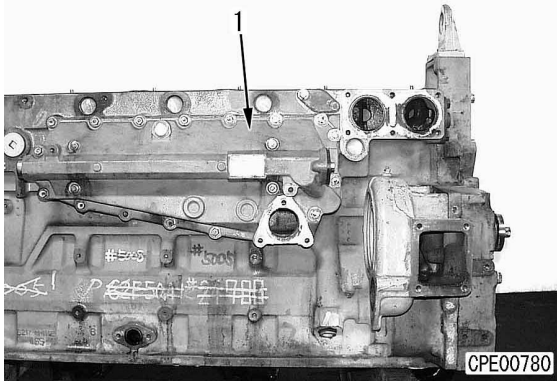


30. Oil cooler assembly

- ★ Using a sling and a bolt hole, sling the oil cooler assembly temporarily.
- 1) Remove the 19 bolts and 4 nuts (The 4 nuts at the center are used to install the cooler), then lift off oil cooler assembly (1).

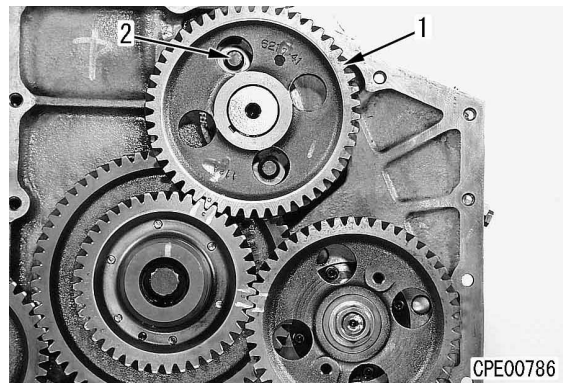


Oil cooler assembly: **35 kg**



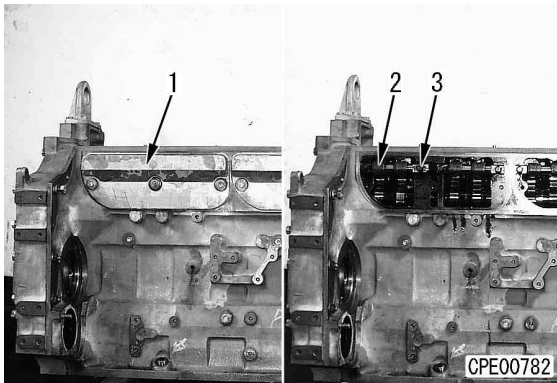
33. Cam shaft

- 1) Match mounting bolt (2) to the hole of cam gear (1), loosen bolt (2) and remove cam shaft gear (1).



31. Cam follower assembly

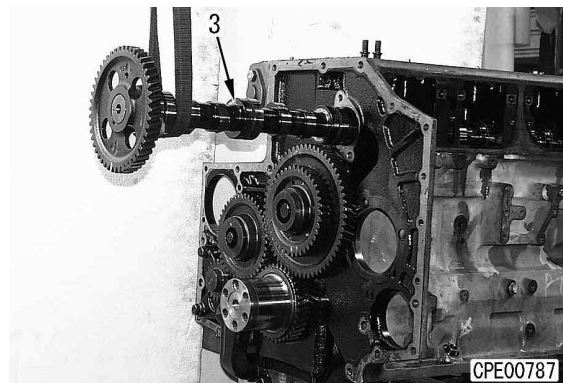
- 1) Remove the 3 cover mounting bolts and cover (1).
- 2) Remove mounting bolts (3) and cam follower (2).



- 2) Sling cam shaft (3) temporarily and pull it out, turning it so that the cam bushing will not be damaged.



Cam shaft: **Approx. 25 kg**



32. Gear case cover

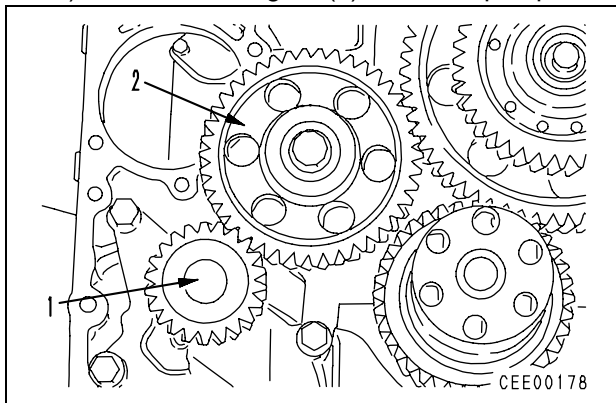
- 1) Install a sling to the hook and sling the gear case cover temporarily.
- 2) Remove the mounting bolts of cover (1), then sling and move the cover forward to remove it.
- ★ When moving the cover, take care that the fuel supply pump drive gear will not fall.
- ★ If the fuel supply pump was not removed in the above section, remove the cover, then remove nut (2) and pump.



Cover: **70 kg**

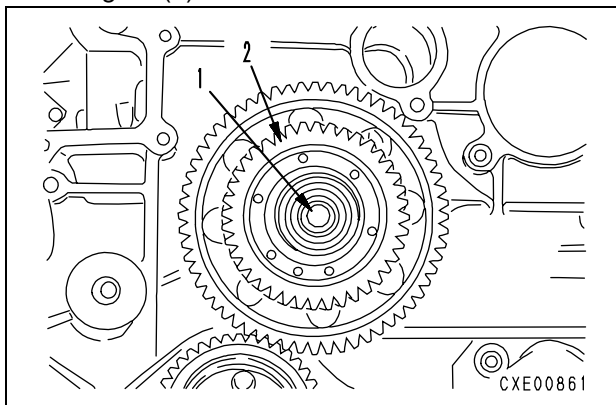
34. Oil pump assembly and idler gear for oil pump

- 1) Remove oil pump assembly (1).
- 2) Remove idler gear (2) for the oil pump.



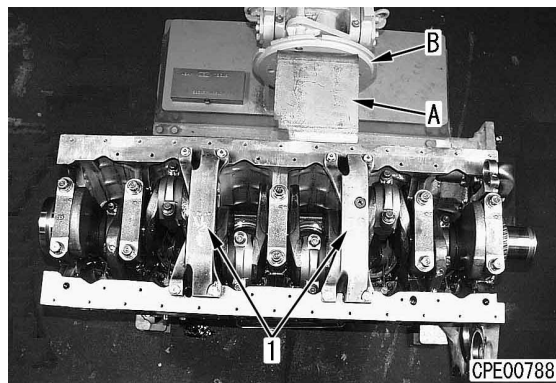
35. Main idler gear

- 1) Remove mounting bolt (1) and main idler gear (2).



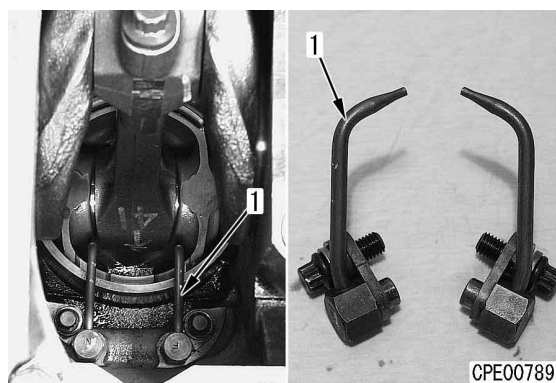
36. Setting to engine overhaul stand and underframes

- 1) Install tool A to the cylinder block, then sling and set the engine to tool B.
- 2) Remove the 4 mounting bolts each and 2 underframes (1).



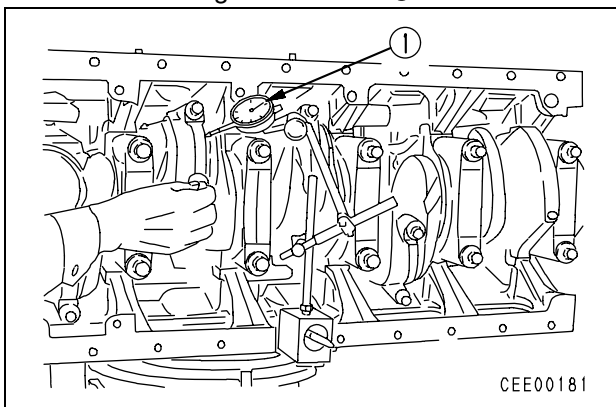
37. Cooling nozzle

- 1) Remove the mounting bolt and cooling nozzle (1).
- ★ Each cylinder has 2 cooling nozzles each. Before pulling out the piston, be sure to remove the cooling nozzles.

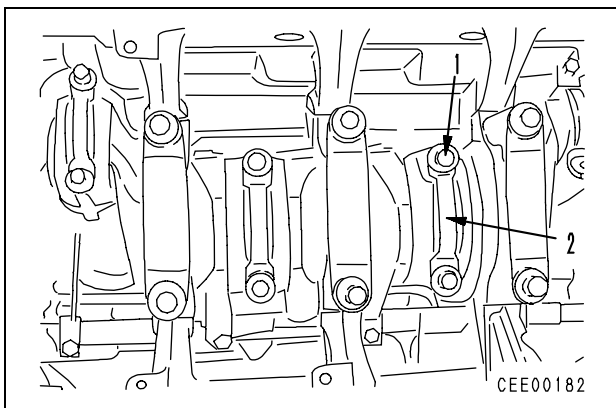


38. Piston and connecting rod assembly

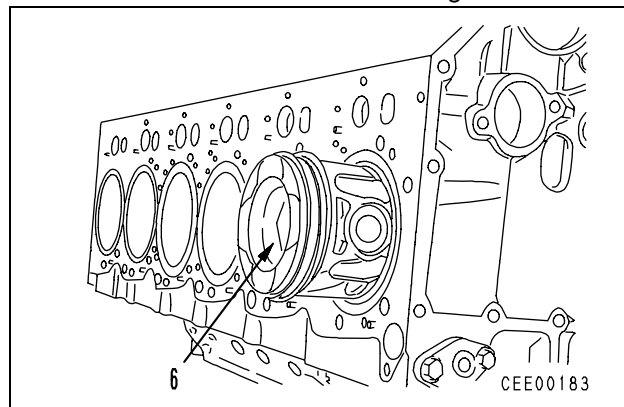
- 1) Check the No. stamped on the connecting rod cap.
 - The cap No. and the cylinder No. must be the same.
 - The position of the stamped No. must be stamped on the cam side.
 - ★ If the position is not stamped, stamp it before removing the connecting rod.
- 2) Turn the crankshaft so that the piston to be removed will be at the bottom dead center.
- 3) Remove the carbon from the top of the liner with a fine sandpaper.
- ★ Before removing the piston and connecting rod assembly, measure the end play of the connecting rod with tool ①.



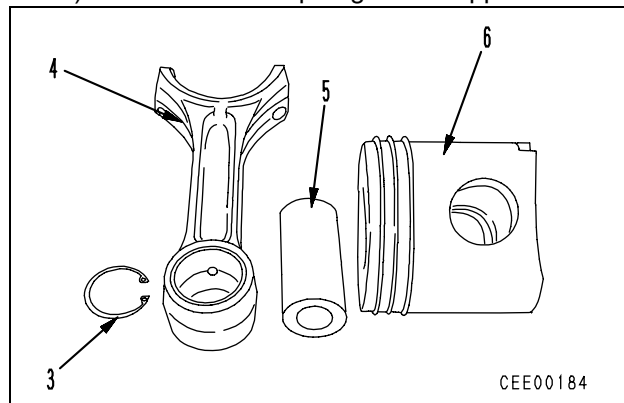
- 4) Remove connecting rod cap mounting bolts (1).
- 5) Remove connecting rod cap (2) and connecting rod bearing together by hitting them lightly with a plastic hammer, taking care not to damage the threads of the connecting rod.



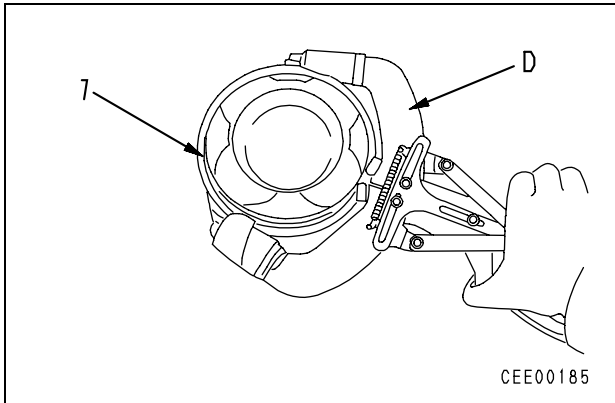
- 6) Push in the piston and connecting rod assembly with a wooden bar from the oil pan side to remove them, supporting piston (6) on the cylinder head side.
 - ★ Take care not to damage the inside surface of the liner with a corner of the connecting rod.
- 7) Similarly to the above, remove the other pistons and connecting rod assemblies.
 - ★ Store the pistons and connecting rod assemblies, taking care not to damage the sliding surfaces of the pistons, bearing metal surfaces, etc.
 - ★ Assemble the connecting rods and caps temporarily and store them together with the bearings so that they will not be mistaken when assembled again.



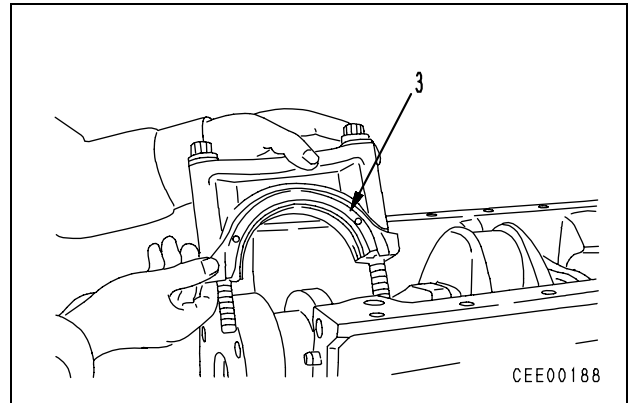
- Disassemble the piston and connecting rod assembly according to the following procedure.
 - i) Remove snap ring (3).
 - ii) Support connecting rod (4) with one hand and pull out piston pin (5) to disconnect piston (6) and the connecting rod from each other.
 - iii) Remove the snap ring on the opposite side.



- iv) Using tool **D**, remove piston ring (7).
 ★ Store the piston, connecting rod, connecting rod bearing metal, piston ring, and piston pin for each cylinder.

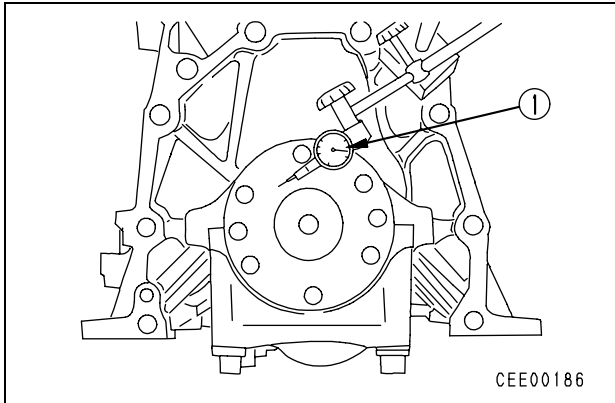


- 3) Main cap No. 7 is equipped with lower thrust bearing metal (3). After removing it, make a mark of the fitting position of the bearing metal.

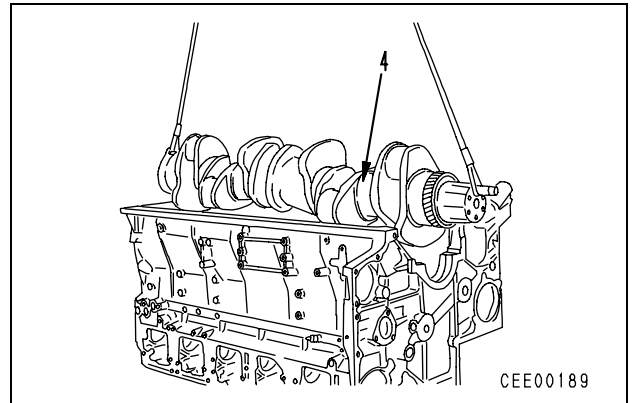


39. Crankshaft

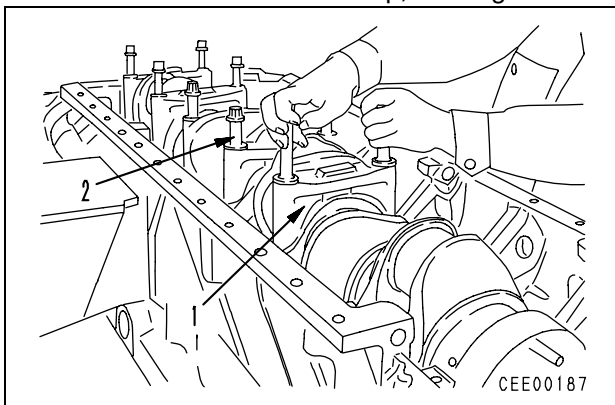
- ★ Before removing the crankshaft, measure its end play with tool ①.



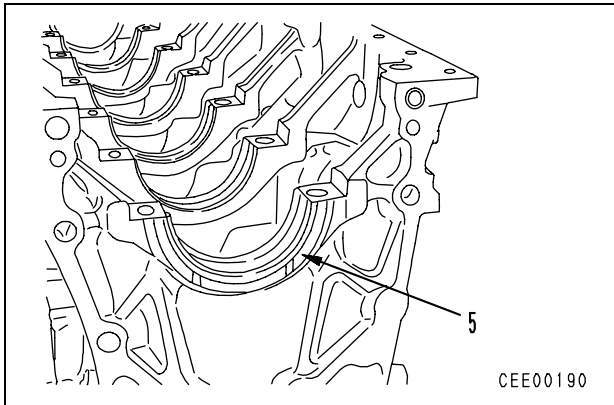
- 4) Using wires, lift off crankshaft (4).
 ★ When slinging the crankshaft, take care not to hit it against the cylinder block.
 ★ Store the crankshaft so that its sliding surfaces will not be damaged.



- 1) Remove mounting bolts (2) of main cap (1).
 2) Insert the bolts in the holes of the main cap and remove the main cap, shaking the bolts.



5) Remove upper thrust bearing metal (5).

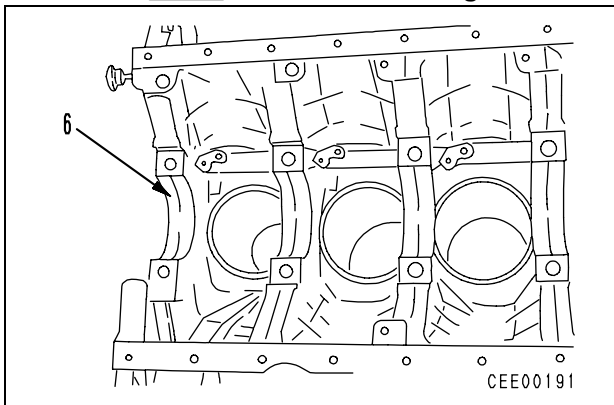


6) Remove upper bearing metal (6).

- ★ Make marks of the fitting positions of the main caps, main bearing metals, and thrust bearing metals with tags or paint, then store them for each cap, taking not to damage them.

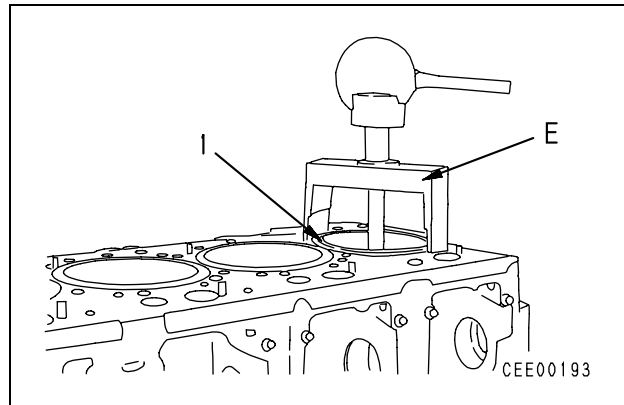
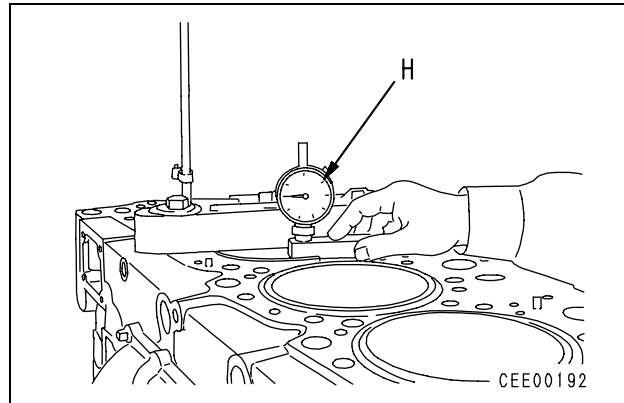


Crankshaft: 140 kg



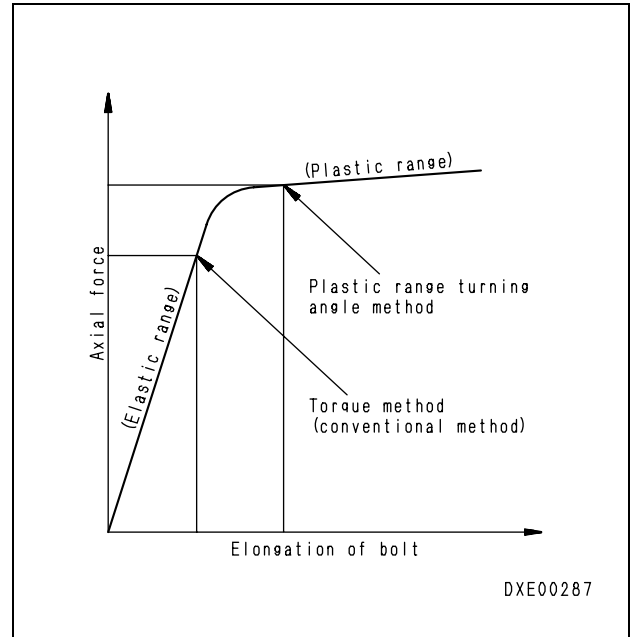
40. Cylinder liners

- ★ Before removing the cylinder liners, measure the projection of each of them with tool H. Using tool E, remove cylinder liners (1).



Tightening bolts by plastic-region turning angle method

- The important bolts of 140E-3 Series engines are tightened by the plastic-region turning angle method. In this method, special bolts are used and tightened to the load at which they start permanent deformation (plastic region). Accordingly, accurate and high tilting force is obtained.
- ★ Generally, tightening torque of bolts is controlled. It is difficult, however to control the tilting force accurately because of the effects of the coefficient of friction.
- In the plastic-region turning angle method, tightening of a bolt is controlled by its initial tightening torque and turning angle.
- Bolts of 140E-3 Series engine tightened by plastic-region turning angle method
 - 1) Cylinder head mounting bolt
 - 2) Main cap mounting bolt
 - 3) Connecting rod cap mounting bolt
 - 4) Flywheel mounting bolt
 - 5) Idler bolt
- ★ If the plastic-region turning angle method is applied, the tightened bolts have permanent strain. Accordingly, the allowable number of using times of each bolt is limited. Observe the following precautions.
 - 1) Before tightening each bolt, measure its stem length and make sure that the result is less than the using limit. If the stem is longer than the using limit, do not use it but replace it.
 - 2) If a bolt is tightened more than the specified angle, remove it and measure its stem length again.
 - 3) Try to tighten each bolt to the standard angle as accurately as possible.
- ★ Clean each part carefully, and check it for bruise, flaw, cavity, etc. Make sure each oil or water path is through.

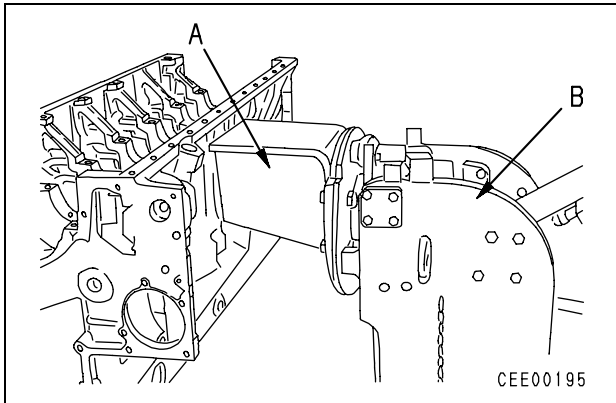


GENERAL ASSEMBLY OF ENGINE

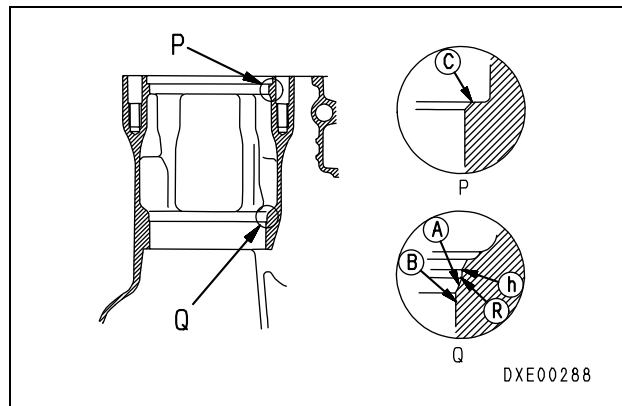
- ★ The following assembly procedures are for SA6D140E-3 of HD325-6 specification. The shapes, quantity, locations, etc. of some parts of a machine assembled actually may be different from the following explanation. Take care.

Preparation work

- Install adapter "A" to the cylinder block, then sling the cylinder block and set it to engine over-haul stand "B".

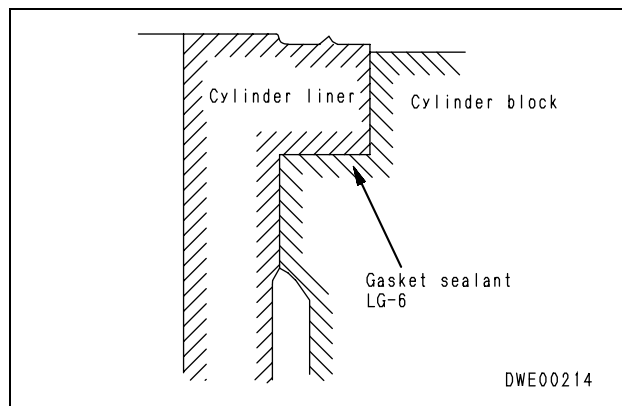


- Before inserting the cylinder liners, prepare the cylinder block according to the following procedure.
 - 1) Remove the rust and scales from faces ① and ② with sandpaper, etc. until the machined surface is exposed.
 - 2) Polish part ③ with sandpaper of about No. 60 until it becomes a smooth rounded surface.
 - 3) Polish parts ④ and ⑤ with sandpaper of about No. 60 until they become smooth. If part ④ is sharp or has burrs, finish it with a scraper or sandpaper. Finish this surface particularly smoothly so that it will not damage the O-ring.
 - 4) If face ② is so pitted that it cannot be repaired, replace the cylinder block.
 - 5) If faces ① and ④ are pitted, finish them smoothly.
 - 6) Check the counterbored part and remove burrs and fins. If chips or dust is on face ③, the liner does not fit and water may leak and the liner does not project sufficiently.
 - ★ If the counterbored part is drooping, corroded, or pitted, repair it.



1. Cylinder liner

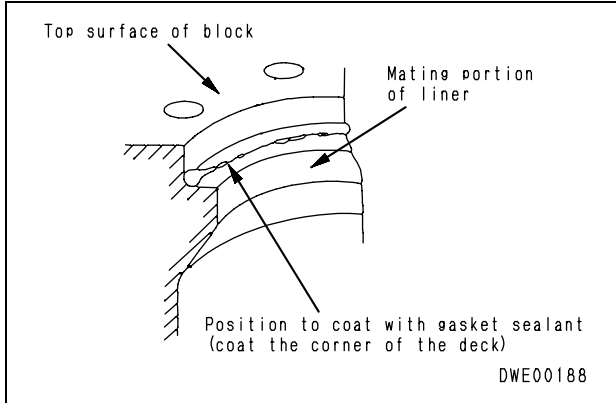
- ★ Replace the liner O-ring and clevis seal with new ones just before installing the liner.
- Method of fitting liner O-ring and clevis seal
 - 1) Make sure that the cylinder liner O-ring groove and periphery of the liner are not roughened because of rusting or pitting.
 - If the above items are roughened because of rusting or pitting, water may leak. Accordingly, replace the liner with new one.



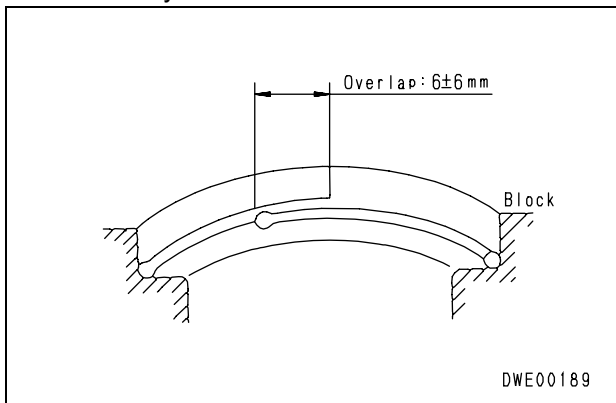
DISASSEMBLY AND ASSEMBLY

GENERAL ASSEMBLY OF ENGINE

- 2) Apply silicon gasket sealant LG-6 to the parts of the cylinder block and cylinder liner which will fit to the counterbored part.
 - Wipe off dirt and oil with cloth from the contact faces of the counterbored part of the cylinder block and liner flange.

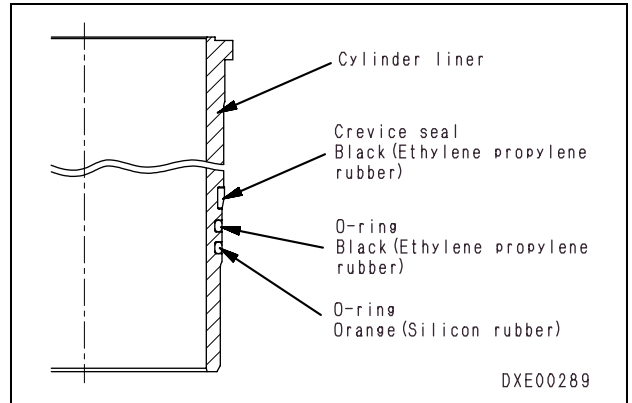


- Apply LG-6 in line 2 - 3 mm in diameter.
- Lap the ending point of LG-6 over the starting point by 6 ± 6 mm.
- ★ If the applied gasket sealant is left for a long time, its surface becomes hard. Accordingly, install the cylinder block to the cylinder head in 50 minutes.

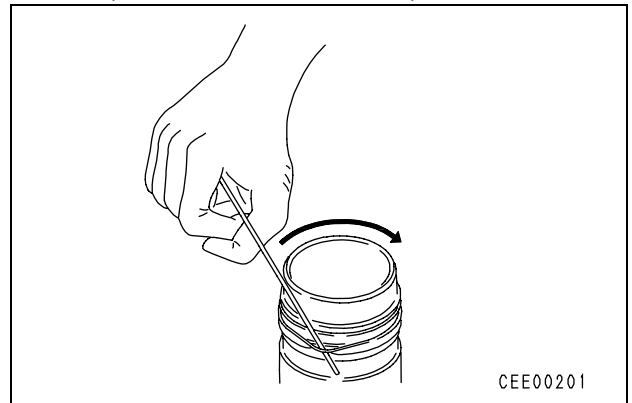


- 3) Apply rubber lubricant RF-1 to the liner O-ring and cylinder block O-ring groove.
 - ★ RF-1: DAIDO KAGAKU KOGYO CO., LTD. If RF-1 is not available, apply clean engine oil SAE No. 30 to the liner O-ring and clevis seal.

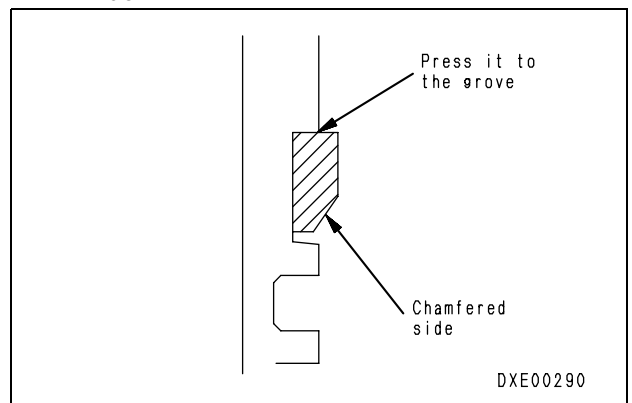
- ★ Since the clevis seal and O-ring are swollen and deteriorated by oil, do not leave them in oil. Apply a small amount of oil to them thinly with a brush just before fitting them.



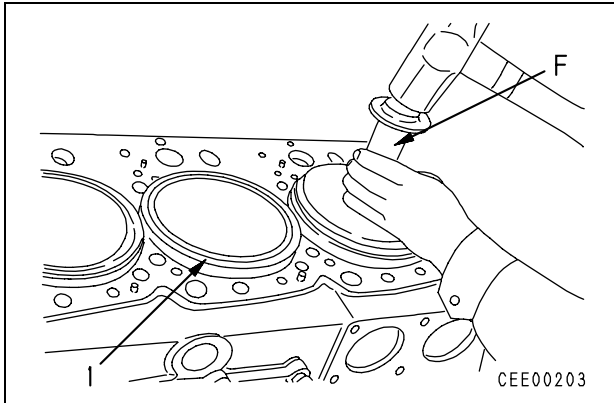
- 4) After fitting the liner O-ring, check it for twist. If it is twisted, correct it with a smooth rod (about 10 mm in diameter).



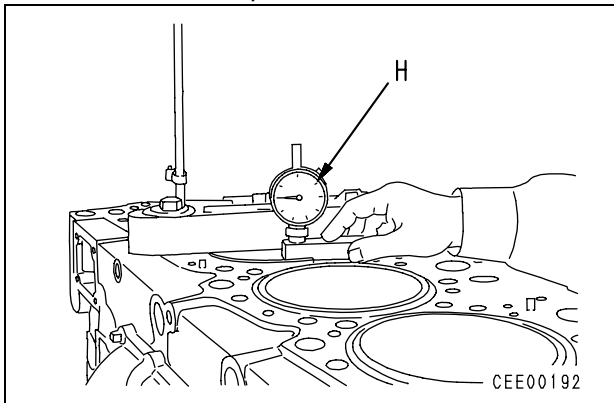
- 5) When fitting the clevis seal, press it against the seal groove all round so that it will not be twisted.
 - ★ Fit the clevis seal with the chamfered side down.



- Method of inserting cylinder liner
 - 1) Insert the cylinder liner in the cylinder block with stamp "A or B" on its top, taking care not to damage the O-ring.
 - 2) Push in the liner with both hands, applying your weight.
 - ★ If the liner does not enter the cylinder smoothly under your weight, the O-ring may be broken. In this case, check the cylinder block for burrs, fins, etc.
 - 3) Using tool F, press fit cylinder liner (1) to the cylinder block.

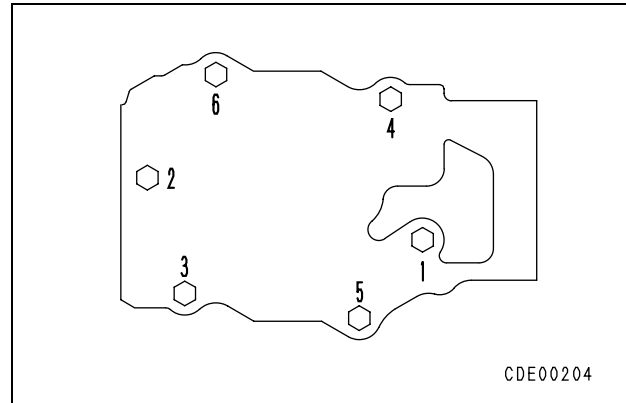


- 4) After press fitting the cylinder liner, measure its projection with tool H.
 - ★ When measuring the projection of the liner, tighten the liner with a plate so that it will not be lifted by the O-ring.
 - ★ Projection of liner: 0.08 – 0.18 mm
 - ★ If the gasket sealant is projected from the fitting parts of the cylinder block and cylinder liner up to the top of the cylinder block, wipe it off.



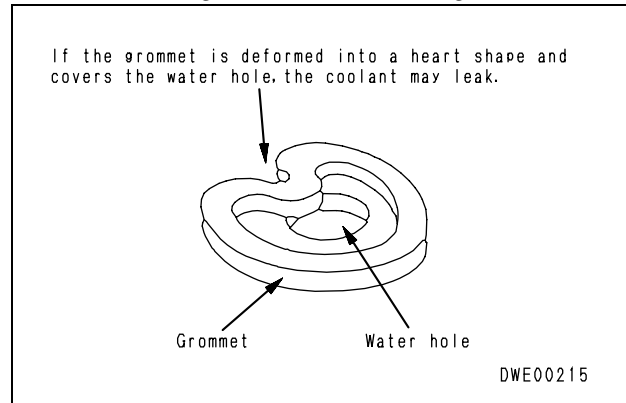
- 5) After inserting the liner, tighten the cylinder head temporarily by using the used head gasket to prevent the gasket sealant from projecting through the space between the block and liner. At this time, observe the following tightening torque and tightening order.

 Temporary tightening torque:
137 – 157 Nm {14 – 16 kgm}



- 6) Loosen the cylinder head mounting bolts and cylinder head and wipe off the gasket sealant projected from the counterbored part.

- ★ Be sure to perform 5) and 6) above since the projected gasket sealant can deform the grommet of the head gasket.



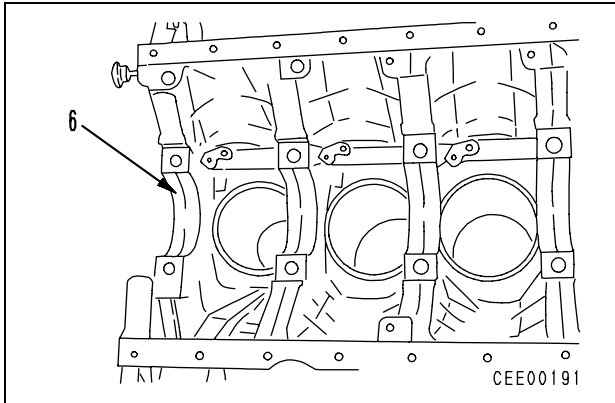
2. Crankshaft

- 1) Fit upper main bearing metal (6) to the cylinder block, matching the projection of the former to the cut of the latter.

★ Before fitting the bearing metal, make sure that its back side is free from foreign matter. Apply engine oil SAE No. 30 to the inside of the bearing metal.

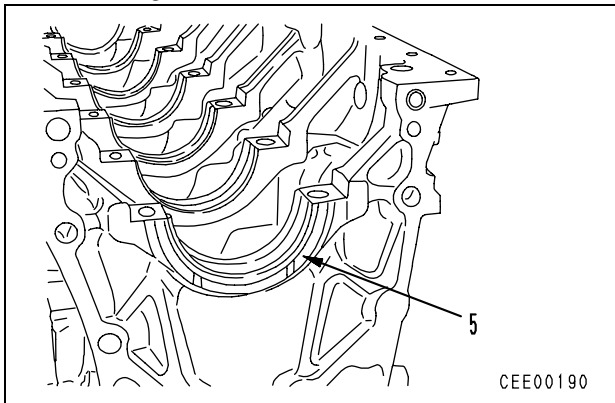
⚠ Do not apply engine oil to the back side of the bearing metal.

★ Upper bearing metal: With oil hole



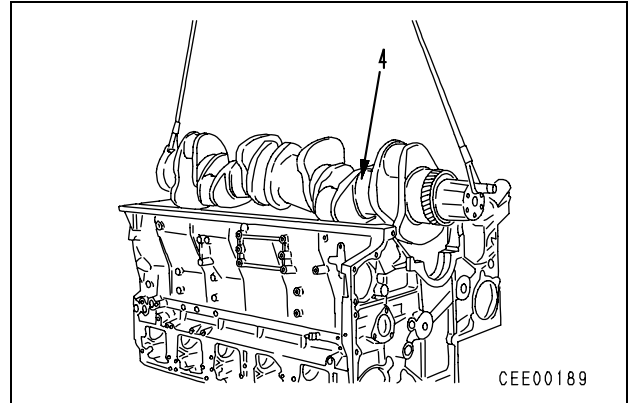
- 2) Drive the roll pin so that it will be projected by 2.7 – 3.4 mm from the block end, then install upper thrust bearing metal (5).

★ Install the thrust bearing metal with the grooved surface on the crankshaft side.



- 3) Using wires, sling and install crankshaft (4) in position, taking care not to hit it against the cylinder block.

★ If the crank gear was replaced, put it in an electric oven, etc. to heat it at 200°C for at least 30 minutes, then install it by shrink fit.

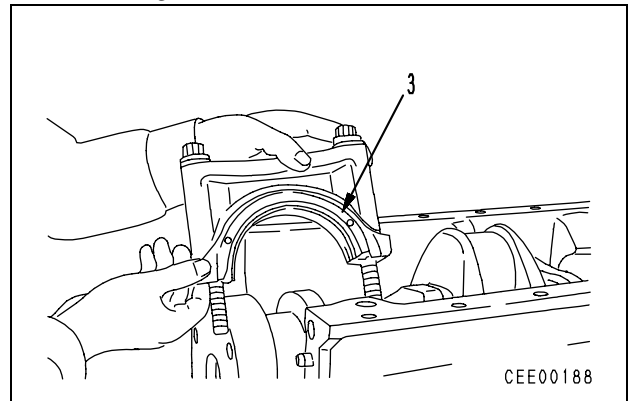


- 4) Fit the lower main bearing metal to the main cap, matching the projection of the former to the cut of the latter.

★ Before fitting the bearing metal, make sure that its back side is free from foreign matter.

- 5) Drive the roll pin of cap No. 7 so that it will be projected by 2.7 – 3.4 mm from the cap end, then install upper thrust bearing metals (3) to both sides.

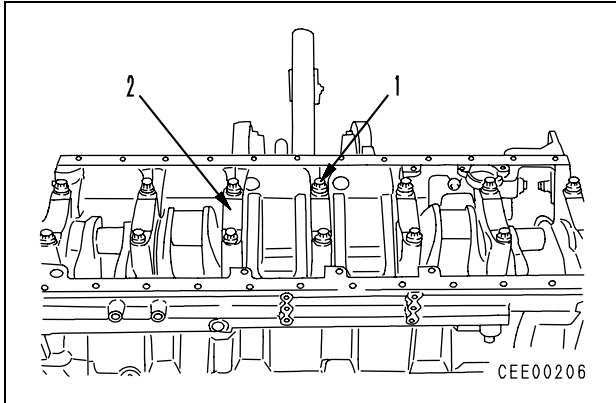
★ Install each thrust bearing metal with the grooved surface on the crankshaft side.



DISASSEMBLY AND ASSEMBLY**GENERAL ASSEMBLY OF ENGINE**

- 6) Apply engine oil SAE No. 30 to the journal face of the crankshaft. Make sure that the No. stamped on main cap (2) and the No. of the cylinder block are the same, then install the main cap.

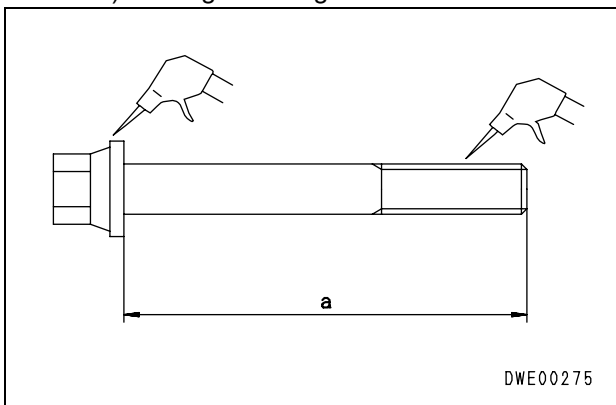
★ Install the main cap with the cast part No. side toward the front of the engine.



- 7) Before tightening main cap mounting bolts (1), check the following items.

★ If a bolt is longer than the following using limit or has been tightened 5 times (having 5 punch marks denoting the number of tightening times) or more, replace it.

- Measure stem length "a" of every bolt and make sure that it is less than the using limit.
- Using limit length of bolt: 176.3 mm



- 8) Apply engine oil SAE No. 30 to the threaded parts and washers of main cap mounting bolts (1), then tighten bolts (1) to secure the main cap.

- 9) Tighten main cap mounting bolts (1) according to the following procedure.

★ Tighten the bolts from the center bolt to the outer ones in order by the following steps.

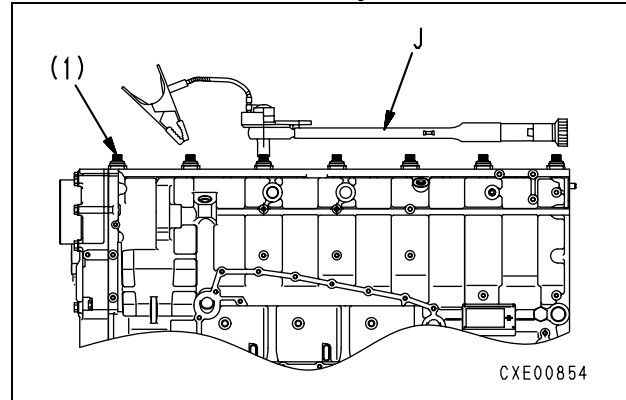
 **Mounting bolt:**

1st time: **108 – 128 Nm {11 – 13 kgm}**

2nd time: **230 – 240 Nm {23.5 – 24.5 kgm}**

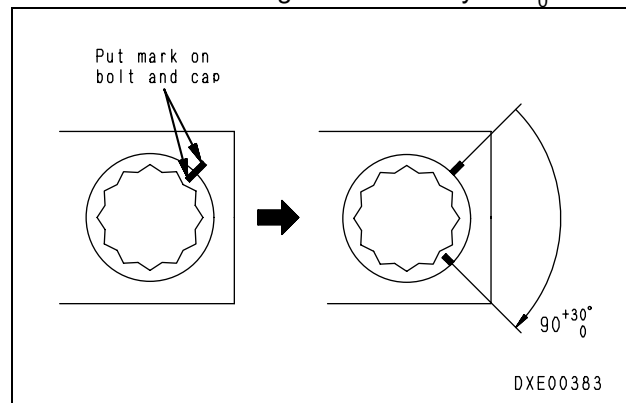
3rd time: 1) When using tool J

Using the angle tightening wrench (tool J), tighten the bolt by $90^{+30^{\circ}}_0$.



- 2) When not using tool J

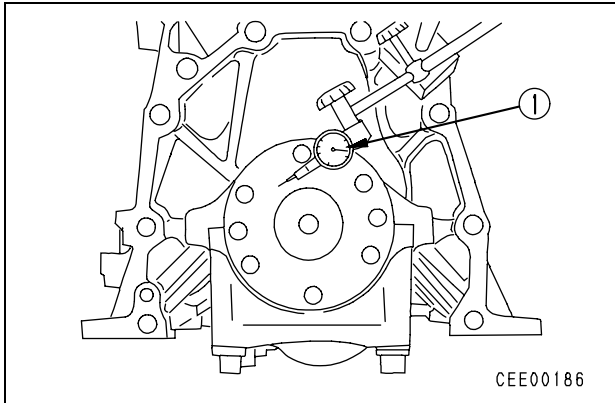
Make marks on the main cap and bolt with paint, then tighten the bolt by $90^{+30^{\circ}}_0$.



- 10) After tightening the bolts, make sure that the crankshaft turns smoothly.

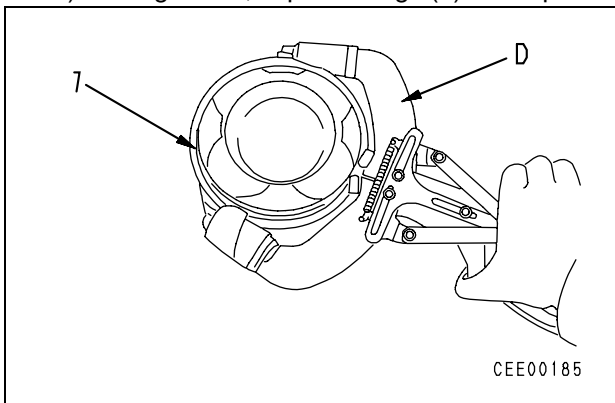
- 11) Measure the end play of the crankshaft with tool ①.

★ End play: 0.140 – 0.315 mm

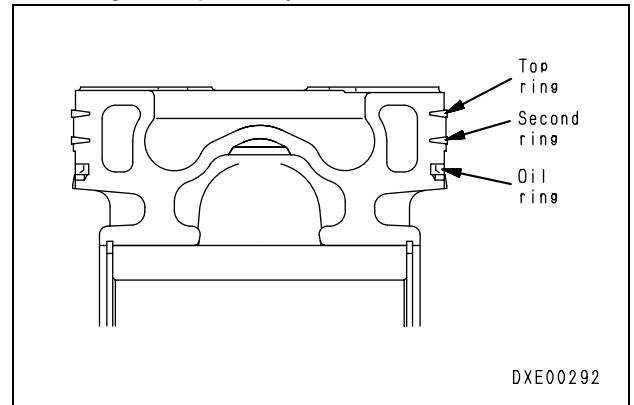


3. Piston and connecting rod assembly

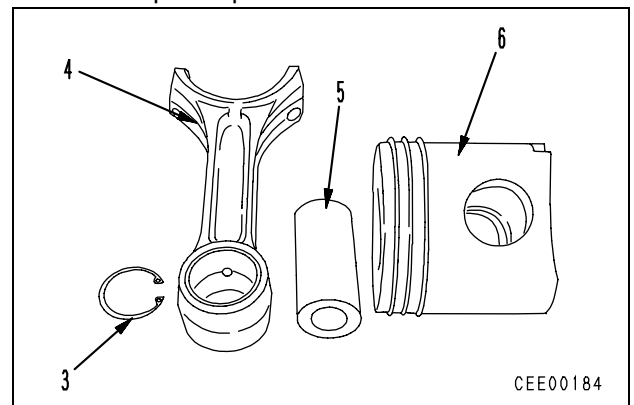
- ★ Referring to STRUCTURE AND FUNCTION, MAINTENANCE STANDARD, fit the cylinder liner and piston selectively.
 - Install the piston and connecting rod assembly according to the following procedure.
- 1) Using tool D, fit piston rings (7) to the piston.



- ★ Fit each piston ring as shown in the following figure.
- ★ Fit each piston ring with a stamped mark side up.
- ★ When fitting the oil ring, fit the expander to the piston, then fit the oil ring. At this time, check that the expander is fitted to the ring groove perfectly.



- 2) Set the piston and connecting rod.
- ★ Select a piston (6) and a connecting rod (4) having the same stamped cylinder No. on them and set those Nos. in the same direction, then insert piston pin (5) to assemble connecting rod (4) and piston (6).
- 3) Fit snap rings (3) on both sides to secure the piston pin.

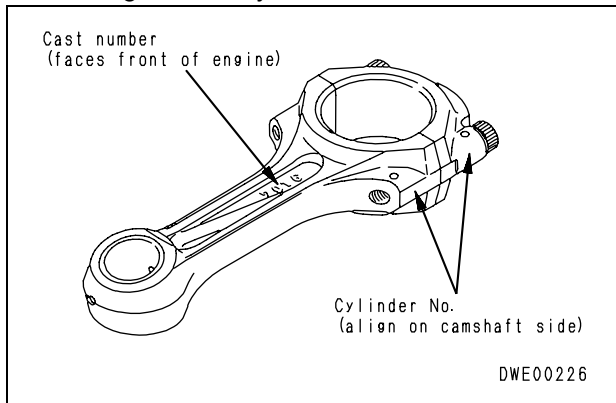


- 4) Fit the upper bearing metal to the connecting rod, matching the projection of the former to the cut of the latter.
- ★ Before fitting the bearing metal, make sure that its back side is free from foreign matter.

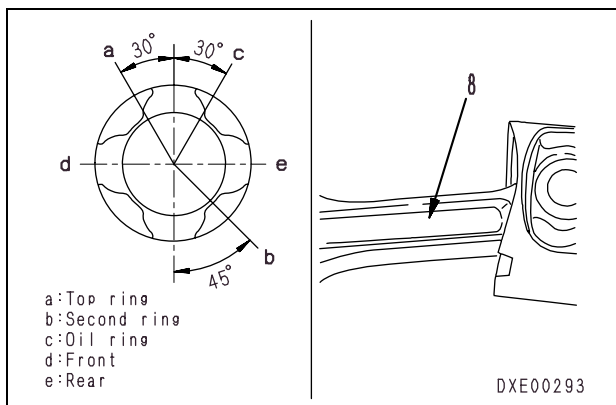
DISASSEMBLY AND ASSEMBLY

GENERAL ASSEMBLY OF ENGINE

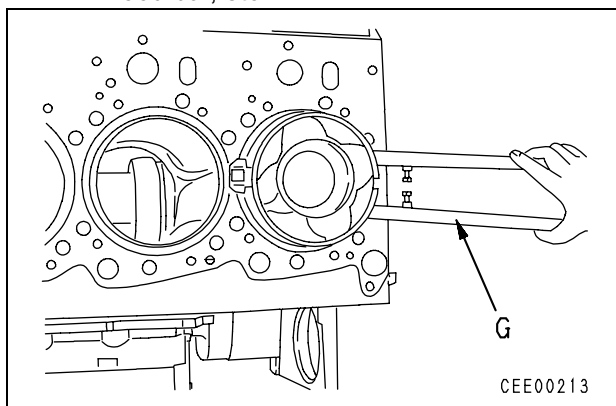
- 5) Bring the crankshaft of the objective cylinder to the bottom dead center and apply engine oil SAE No. 30 to the inside of the connecting rod and cylinder.



- 6) Set the connecting rod with the cast letters directed to the front of the engine (with the stamped No. on the cam shaft) and insert the piston and connecting rod assembly (8), setting the cuts of the piston rings as shown below.

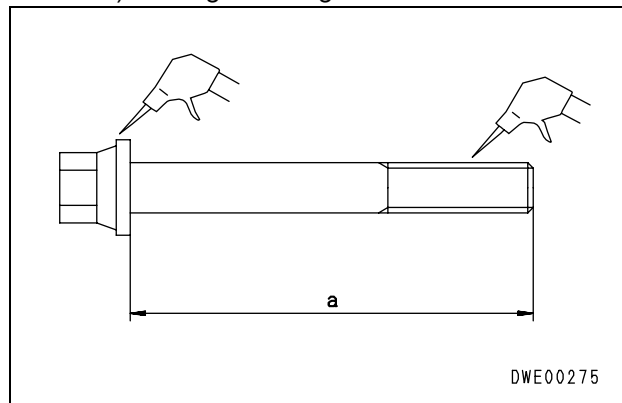


- 7) Using piston holder **G**, reduce the piston ring and push in the piston head with a wood bar, etc.



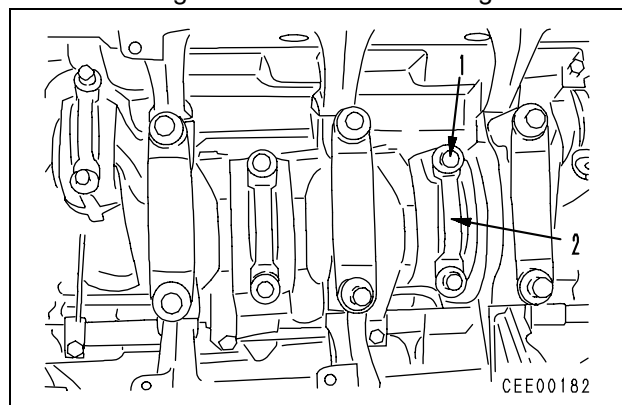
- 8) Before tightening the connecting rod cap mounting bolts, check the following item.

- ★ If a bolt is longer than the following using limit or has been tightened 5 times (having 5 punch marks denoting the number of tightening times) or more, replace it.
- i) Measure stem length "a" of every bolt and make sure that it is less than the using limit.
- ii) Using limit length of bolt: 95.0 mm



- 9) Fit the lower bearing metal to the connecting rod cap (2), matching the projection of the former to the cut of the latter.

- ★ Before fitting the bearing metal, make sure that its back side is free from foreign matter.
- ★ Apply engine oil SAE No. 30 to the sliding surface of the connecting cable.



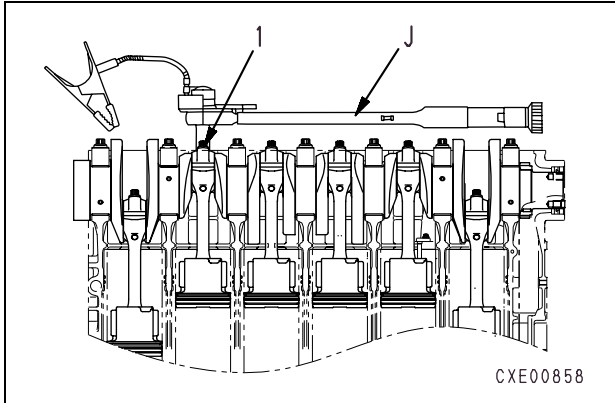
- 10) Apply engine oil SAE No. 30 to the threaded parts of the connecting rod cap bolts (1) and bolt seats, then tighten the bolts in the following order.

 Mounting bolt:

1st time: **123 – 132 Nm {12.5 – 13.5 kgm}**

2nd time: 1) When using tool J

Using the angle tightening wrench (tool J), tighten the bolt by $90^{+30^{\circ}}_0$.

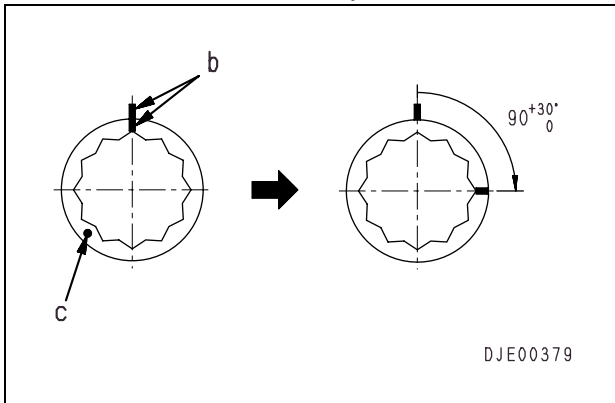


- 2) When not using tool J

Make marks on the main cap and bolt "b" with paint, then tighten the bolt by $90^{+30^{\circ}}_0$.

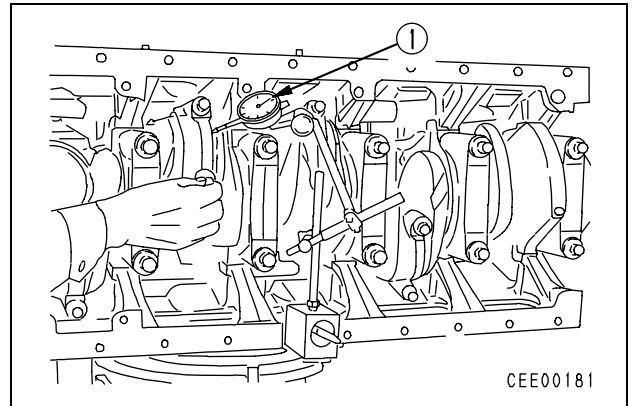
- ★ After tightening the bolt, make a punch mark "c" on its head. If the bolt has 5 punch marks, replace it.

- 11) After installing the piston and connecting rod assembly, turn the crankshaft to make sure that it rotates normally.



- 12) Measure the side clearance of the connecting rod with tool ①.

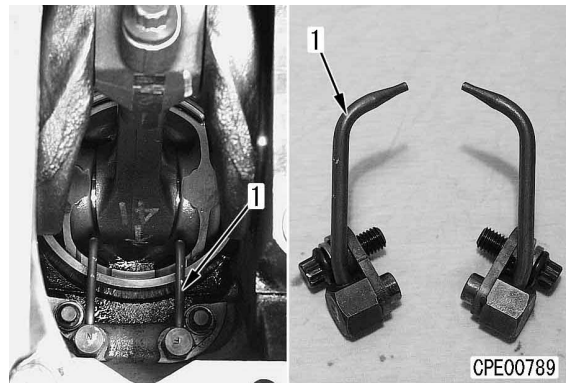
- ★ Side clearance: 0.100 – 0.274 mm
- ★ Make a punch mark on the bolt similarly to the main cap bolt.



4. Cooling nozzle

Install cooling nozzles (1) with the mounting bolts.

- ★ Install 2 cooling nozzles each to each cylinder.



5. Main idler gear

- 1) Fit shaft (2) to main idler gear (1), then fit 2 bearings (3) and washer (4) to the inside.
- 2) Matching mark "A" of the crankshaft gear to that of main idler gear (1), tighten mounting bolt (5).

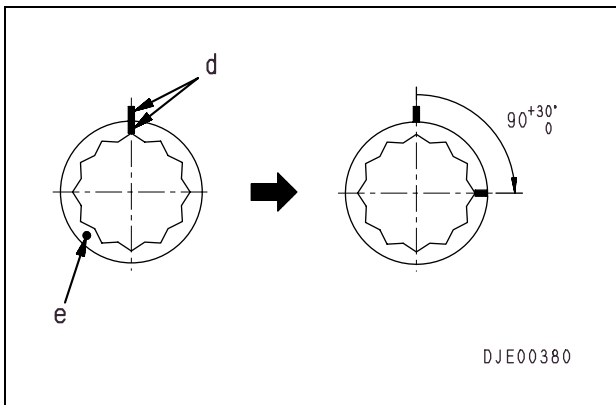
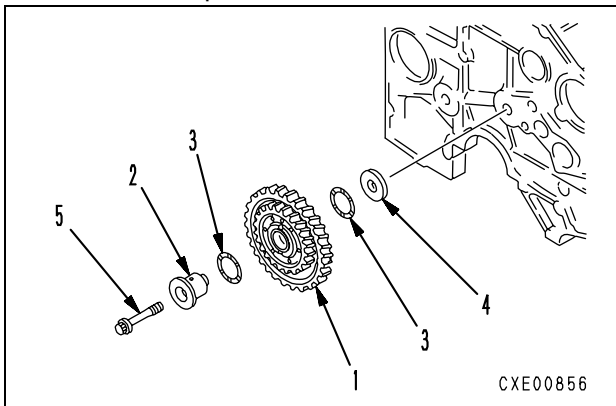
 **kgm** Mounting bolt:

1st time: **$304 \pm 39.2 \text{ Nm}$ { $31 \pm 4 \text{ kgm}$ }**

2nd time: Make marks on the bolt and seat "d" on the idler gear shaft with paint, then tighten the bolt by 90^{+30}_0 .

★ After tightening the bolt, make a punch mark "e" on its head.

- If the bolt has 5 punch marks, replace it.

**6. Idler gear for oil pump and oil pump assembly**

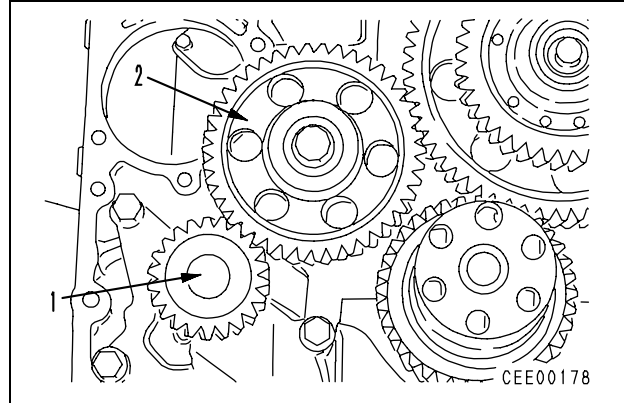
- 1) Install idler gear (2) for the oil pump.
- 2) Fit the O-ring and install oil pump assembly (1).

 **kgm** Idler gear mounting bolt:

$377.6 - 426.6 \text{ Nm}$ { $38.5 - 43 \text{ kgm}$ }

 **kgm** Oil pump assembly mounting bolt:

$98 - 123 \text{ Nm}$ { $10 - 12 \text{ kgm}$ }



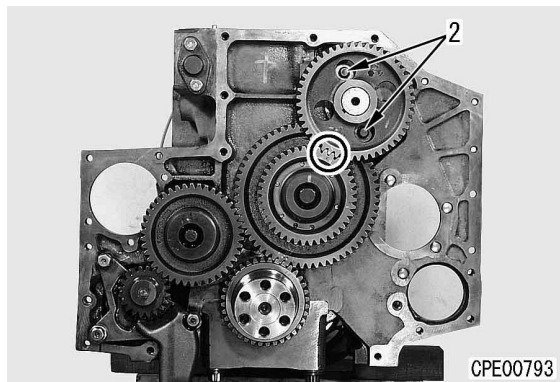
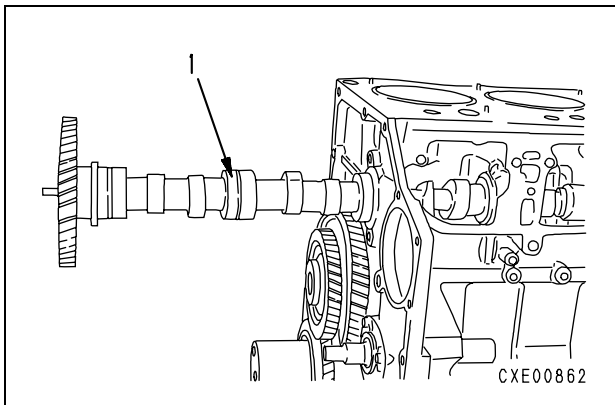
7. Cam shaft

Apply engine oil SAE No. 30 to the journal face of cam shaft (1). Matching mark "B" of the cam shaft gear to that of the main idler gear, tighten mounting bolts (2).

 **kgm** Mounting bolt:

98 – 123 Nm {10 – 12.5 kgm}

- ★ When installing the cam shaft, turn it so that the cam bushing will not be damaged.
- ★ If the cam gear was replaced, put it in an electric oven, etc. to heat it at 220 – 240°C for at least 30 minutes, then install it by shrink fit.

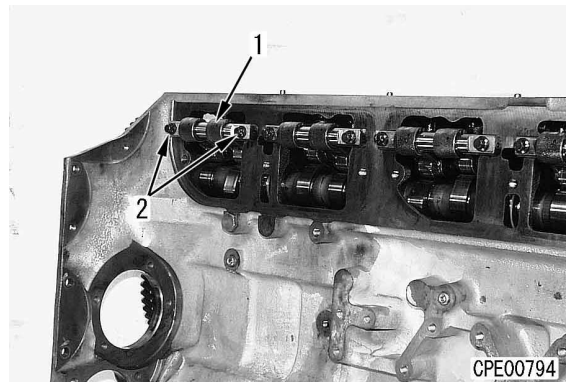


8. Cam follower

- 1) Install cam follower (1), matching it to the dowel pin, and tighten mounting bolts (2).

 **kgm** Mounting bolt:

44.1 – 58.8 Nm {4.5 – 6.0 kgm}

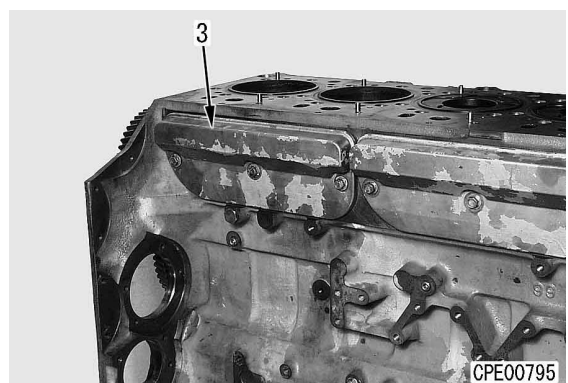


- 2) Fit the O-ring and install cover (3).

 **kgm** Mounting bolt:

9.8 – 12.7 Nm {1.0 – 1.3 kgm}

- ★ The cam follower mounting bolt is hollow. Make sure that the hole is not clogged.

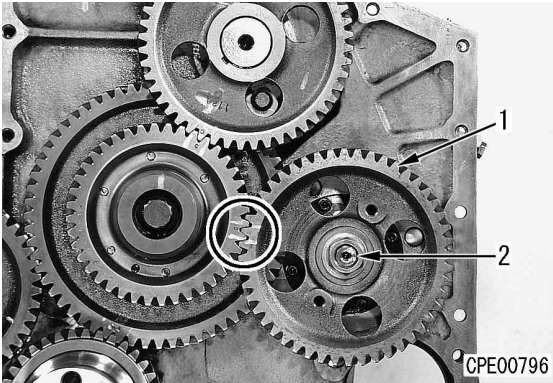


9. Fuel supply pump drive gear

Fit the key to the fuel supply pump and install them from the rear of the case. Matching mark "B" of the pump drive gear to that of the main idler gear (1) (Part ○, install the drive gear and tighten mounting nut (2).

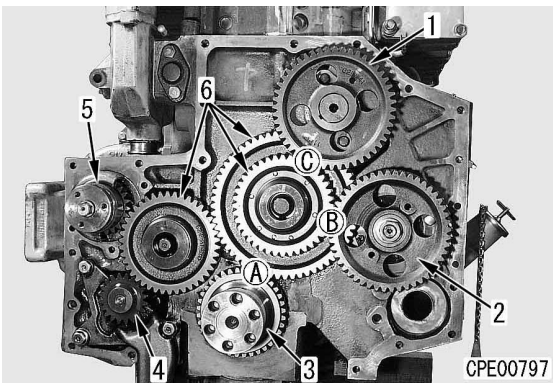
 **kgm** Mounting nut:

176 – 196 Nm {18 – 20 kgm}

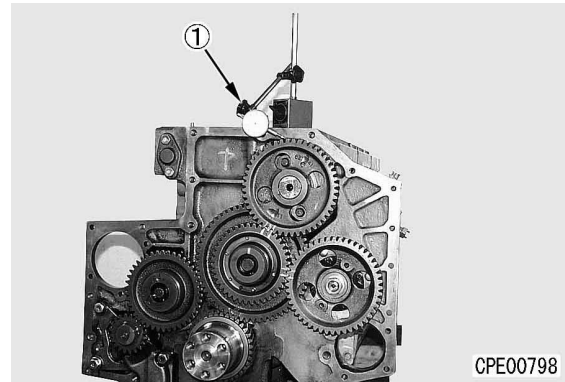


★ Make sure that the match marks (A, B, C) of each drive gear are matched to those of the idler gear.

1. Camshaft gear
2. Fuel supply pump drive gear
3. Crankshaft gear
4. Oil pump drive gear
5. Water pump drive gear
6. Idle gear



★ Measure the backlash and end play of each gear with dial gauge ①.

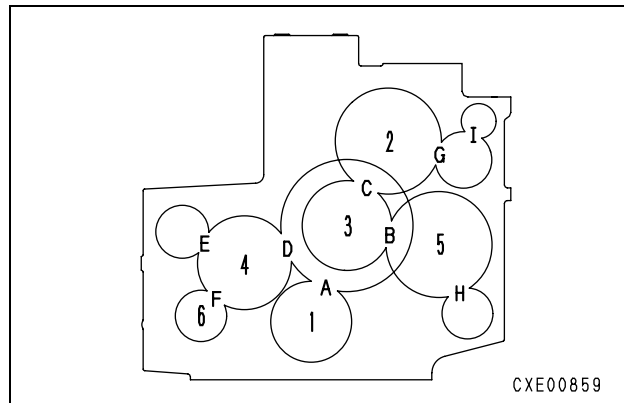


1) Standard backlash of each gear

Position	Range (mm)
A	0.028 – 0.312
B	0.016 – 0.278
C	0.016 – 0.278
D	0.028 – 0.313
E	0.095 – 0.346
F	0.080 – 0.417
G	0.118 – 0.369
H (OP)	0.118 – 0.369
I (OP)	0.118 – 0.369 (compressor)

2) Standard end play of each gear

Position	Range (mm)
1	0.140 – 0.315
2	0.100 – 0.250
3	0.050 – 0.170
4	0.050 – 0.170
5	0.070 – 0.200
6	0.030 – 0.088

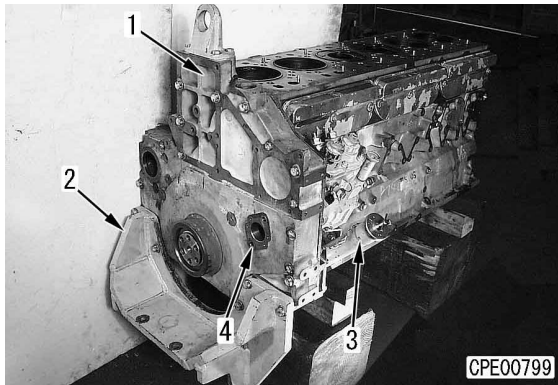


10. Removal from engine overhaul stand

Remove the engine from the engine overhaul stand and set it on the engine stand.

11. Gear case, front support, and oil filler

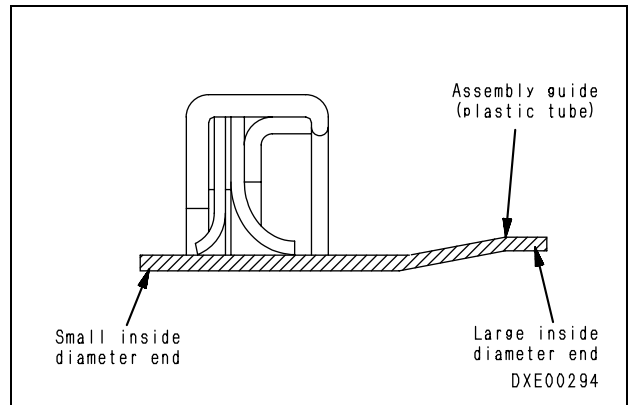
- ★ Secure the gear case, front support, and oil filler together at 3 points.
- 1) Fit the gasket to gear case cover (1) and secure them with the mounting bolts temporarily.
- 2) Secure front support (2) with the mounting bolts temporarily.
- 3) Secure oil filler (3) with the mounting bolts temporarily. Install cap (4) to remove and install the fuel supply pump singly, too.



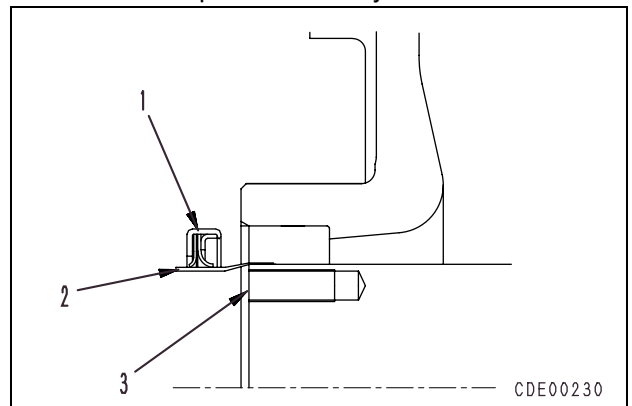
12. Engine front oil seal

Install front seal (1) according to the following procedure.

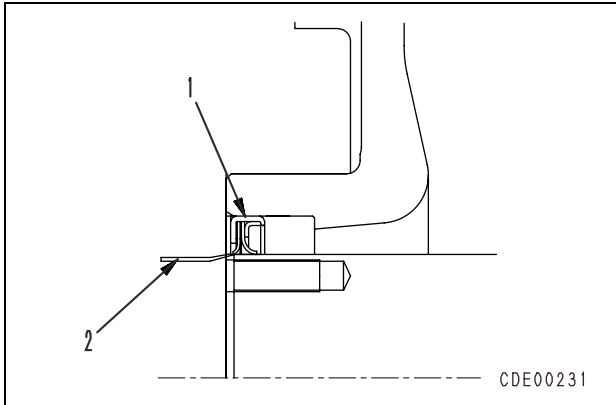
- ★ Before installing the seal, make sure that the end corners and lip sliding surfaces of the crankshaft and housing are free from flaw, burr, fin, and rust.
- ★ When installing the seal, do not apply oil or grease to the shaft and seal lip. Wipe off the oil from the shaft.
- ★ Never remove the inside plastic cylinder of the replacement seal before installing the seal.



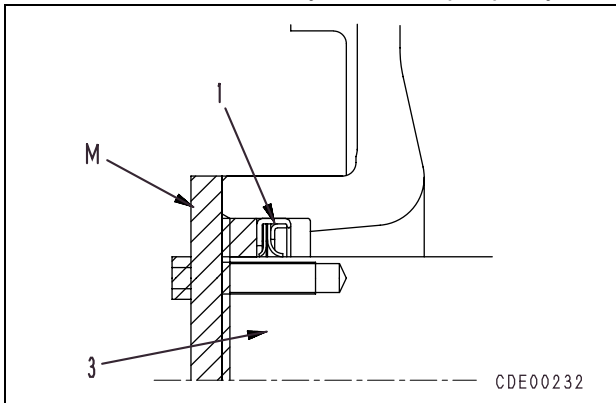
- 1) Bring the large inside diameter side of plastic inside cylinder (2) to the end of crankshaft (3).
- ★ Take care not to mistake the direction of the plastic inside cylinder.



- 2) Hold the metal ring of seal (1) with both hands and push it in firmly as if you are passing over the large inside diameter side of the plastic inside cylinder.
- 3) After pushing in the seal, remove plastic inside cylinder (2).
 - ★ When removing the inside cylinder, take care not to damage the seal lip.



- 4) Tighten the bolts of tool **M** evenly to press fit seal (1) until the end of tool **M** reaches the end of crankshaft (3).
 - ★ When press fitting the seal, take care not to damage the lip on the PTO side with the tool set, etc.
 - ★ After press fitting the seal, remove the red sealant layer from its periphery.



13. Damper pulley assembly

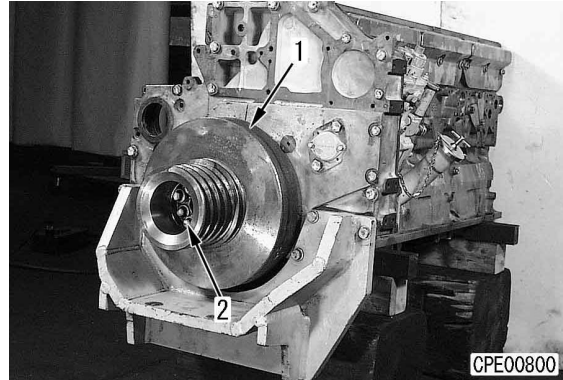
- 1) Matching the dowel pin of damper pulley assembly (1), tighten 6 mounting bolts (2).



Mounting bolt:

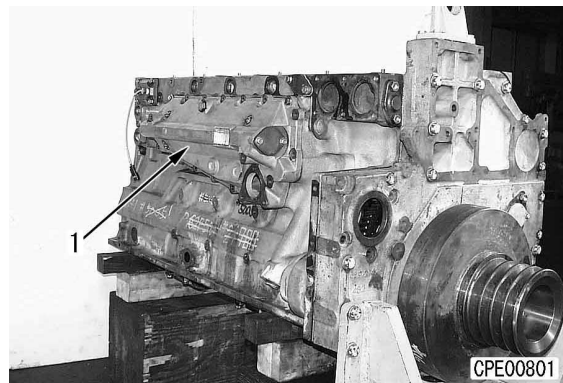
245 – 308.7 Nm {25 – 31.5 kgm}

- ★ The dowel pin of the damper is a thin tube. Take care not to break it.



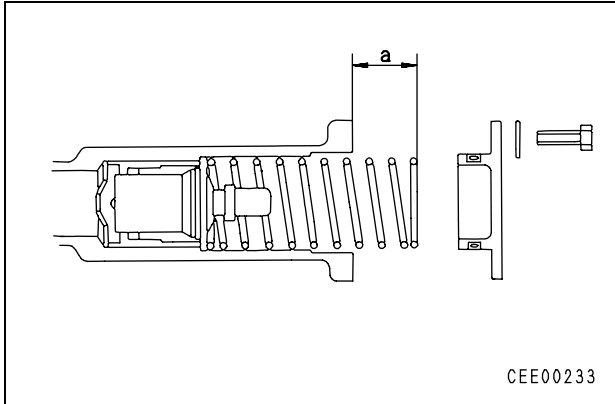
14. Oil cooler assembly

- Fit the gasket and install oil cooler assembly (1).



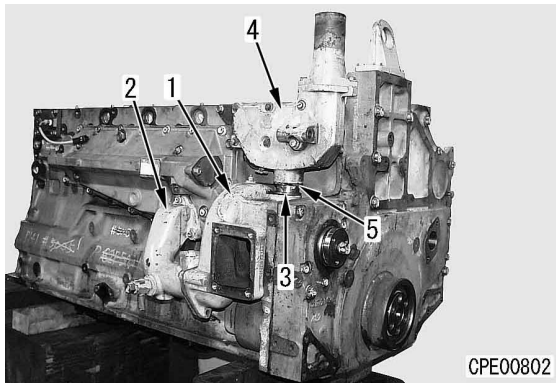
- ★ After installing the thermo-valve, measure the projection of the spring. If the projection is too much, remove and install the valve correctly.

Projection "a" of spring: **24 mm**



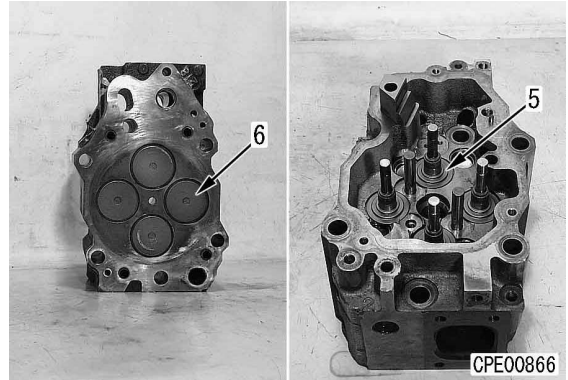
15. Water pump assembly and thermostat assembly

- ★ The water pump is secured together with the gear case.
- 1) Fit the 2 O-rings and install water pump assembly (1).
 - 2) Fit the gasket to tube (2), then install them.
 - 3) Fit the O-ring to tube (3), then insert them in thermostat case assembly (4).
 - 4) Fit the gasket to thermostat assembly (4), then install thermostat assembly (4).
 - 5) Move tube (3) down and insert it in the water pump and install stopper ring (5).

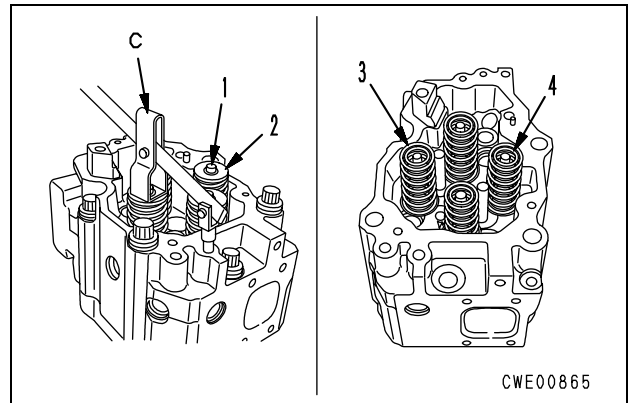


16. Cylinder head assembly

- 1) Assemble the cylinder head assembly according to the following procedure.
 - i) Apply engine oil SAE No. 30 to the valve stem and inside of the valve guide. Press fit the valve stem seal and install valve (6).
- ★ A special tool to insert the valve stem seal is necessary.
- ii) Raise the cylinder head and install lower seat (5).

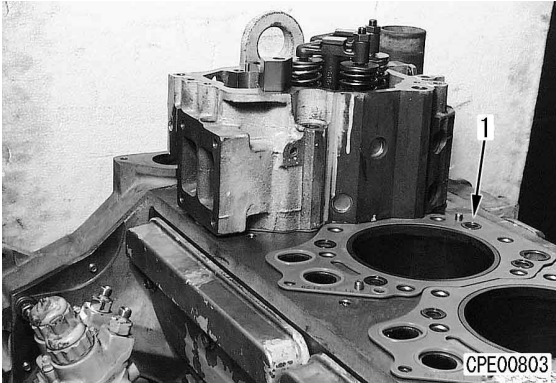


- iii) Fit inner spring (4) and outer spring (3), then install upper seat (2).
- iv) Using tool **C**, compress the valve spring and install valve cotter (1).
- ★ Hit the valve stem lightly with a plastic hammer to check that the cotter is fitted to the groove of the valve stem.



- 2) Check that the cylinder head mounting face and inside of the cylinder are free from foreign matter, then set cylinder head gasket (1).

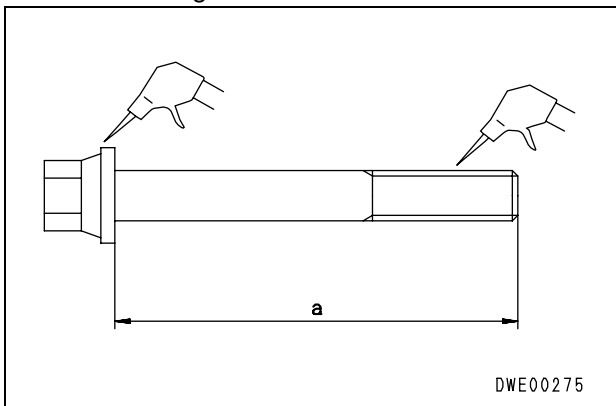
★ When fitting the gasket, check that the grommets are fitted correctly.



- 3) Before tightening the cylinder head mounting bolts, check the following item.

★ If a bolt is longer than the following using limit or has been tightened 5 times (having 5 punch marks denoting the number of tightening times) or more, replace it.

- Measure stem length "a" of every bolt and make sure that it is less than the using limit.
- Using limit length of bolt
Short bolt: 170.8 mm
Long bolt: 205.8 mm



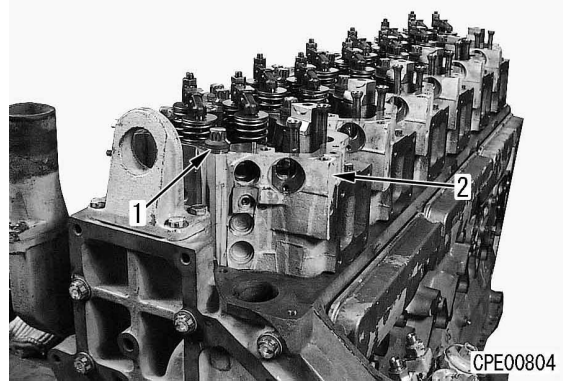
- 4) Install cylinder head assembly (2) and tighten mounting bolts (1).



Mounting bolt:

Lubricant containing molybdenum disulfide (LM-P)

★ A special socket to tighten the head bolts is necessary.



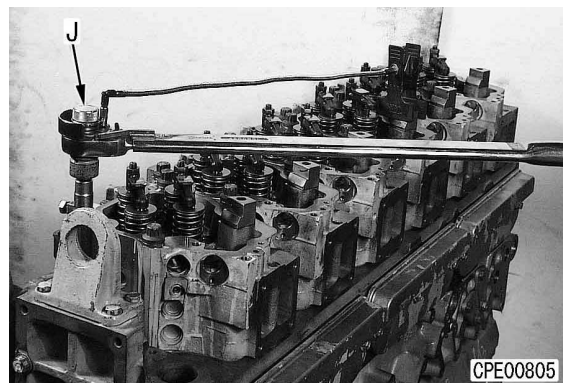
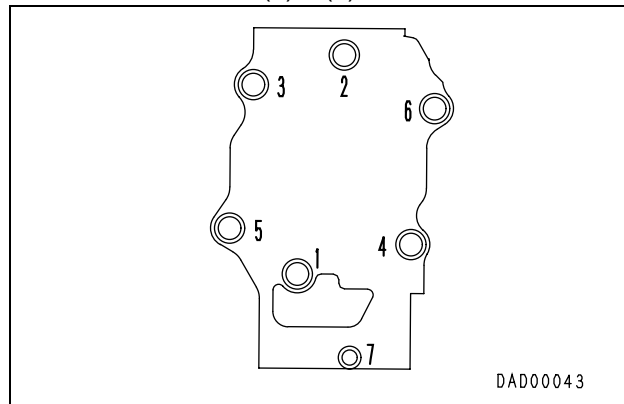
Mounting bolt:

1st time: **137 – 157 Nm {14 – 16 kgm}**

2nd time: **284 – 294 Nm {29.0 – 30.0 kgm}**

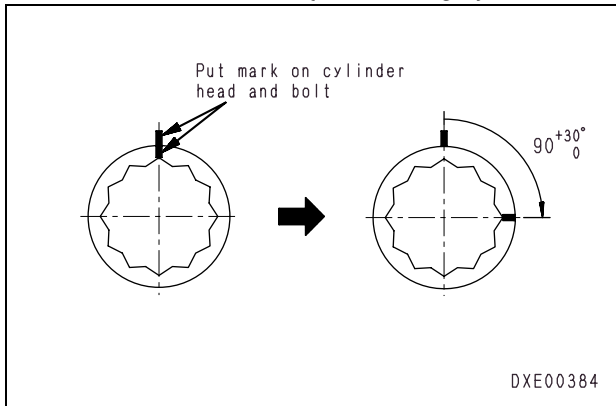
3rd time: 1) When using tool J

Using the angle tightening wrench (tool J), tighten the bolts by 90^{+30}_0 in the order of (1) – (6).



- 2) When not using tool J
Make marks on the bolts and head with paint, then tighten the bolts by $90^{+30^{\circ}}_0$ in the order of (1) – (6).

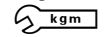
★ After tightening bolts (1) – (6), tighten bolt (7) to 66.6 ± 7.4 Nm $\{6.8 \pm 0.8$ kgm $\}$



17. Cross head

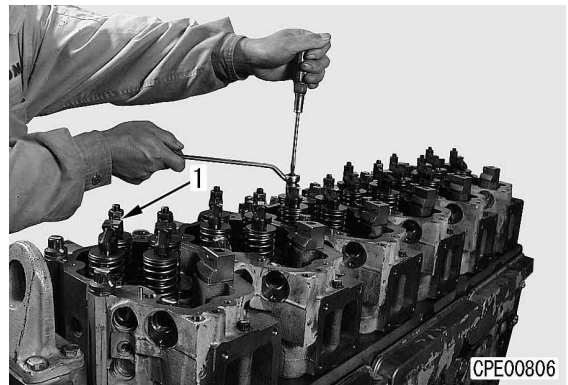
Install cross head (1).

- ★ Adjust the cross head according to the following procedure.
- Loosen the locknut and return the adjustment screw.
 - Holding the top of the cross head lightly, tighten the adjustment screw.
 - After the adjustment screw touches the valve stem, tighten it further by 20° .
 - Tighten the locknut.



kgm Locknut:

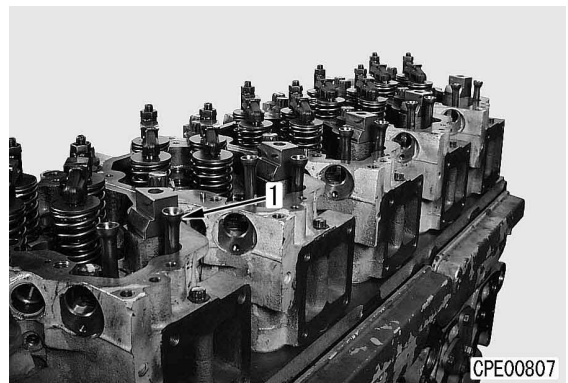
53 – 64.7 Nm $\{5.4 – 6.6$ kgm $\}$



18. Push rod

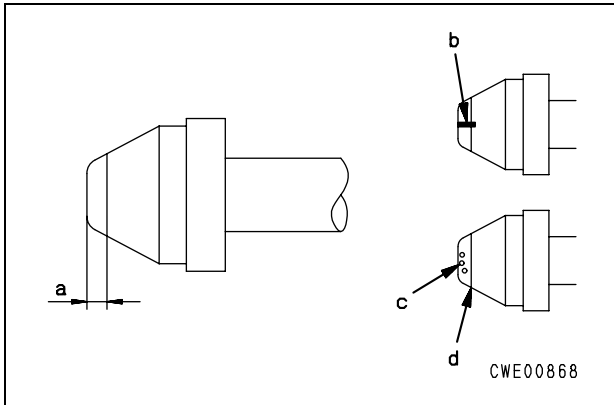
Install push rod (1).

- ★ Make sure that the push rod is in the cam follower.



19. Fuel injector, holder, and connection

- ★ When installing the high-pressure pipe, check it for visible longitudinal slit "b", pit "c", or level difference (wear) in part "d" (End of the taper seal: Part of 2 mm from the end) which is felt with a nail in the taper seal part of the connecting section (Part "a": 2 mm from the end). If any of those defects can cause fuel leakage, replace the high-pressure pipe.



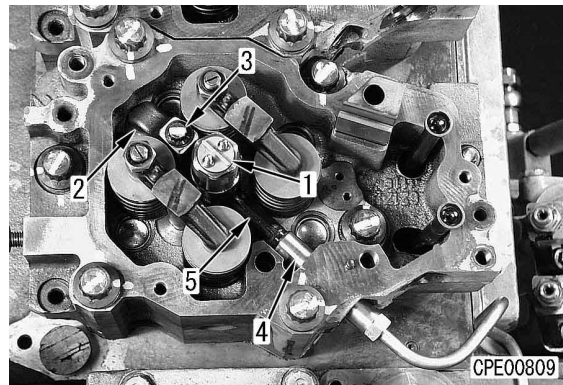
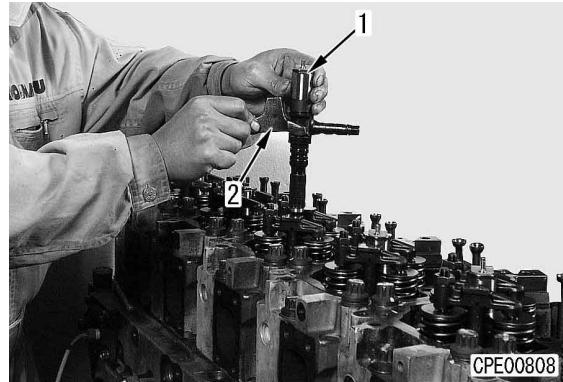
- ★ Make sure that the inside of the injector sleeve is free from dirt.
- 1) Fit the gasket and O-ring to the fuel injector and apply engine oil SAE No. 30 to them.
 - 2) Insert holder (2) in fuel injector (1), then insert them simultaneously with the injector connection directed to the hole for the fuel high-pressure pipe.
 - 3) Fit the ball washer and holder (2) to bolt (3), then tighten them temporarily. Insert high-pressure pipe sleeve (4) in the hole for the fuel high-pressure pipe and secure it temporarily, matching it to injection (5). Secure holder (2) with bolt (3) permanently.
- ★ Apply engine oil to the spherical surface of the ball washer (to fit the ball washer).



Holder mounting bolt:

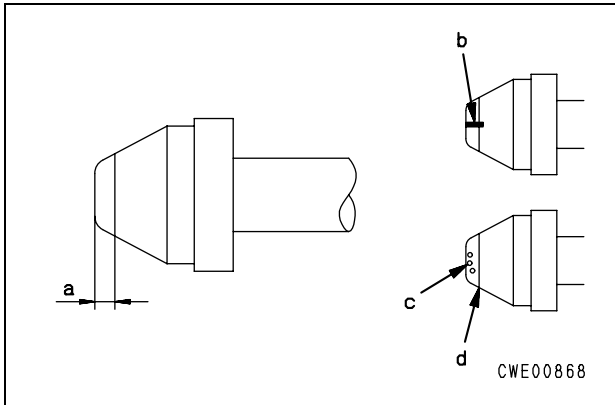
58.8 – 73.5 Nm {6.0 – 7.5 kgm}

- ★ After securing the holder, remove the high-pressure pipe sleeve and install the other injectors in order according to the above procedure.



20. Common rail high-pressure pipe

- ★ When installing the high-pressure pipe, check it for visible longitudinal slit "b", pit "c", or level difference (wear) in part "d" (End of the taper seal: Part of 2 mm from the end) which is felt with a nail in the taper seal part of the connecting section (Part "a": 2 mm from the end). If any of those defects can cause fuel leakage, replace the high-pressure pipe.

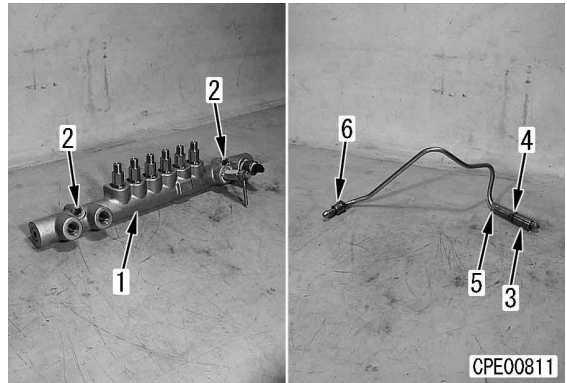
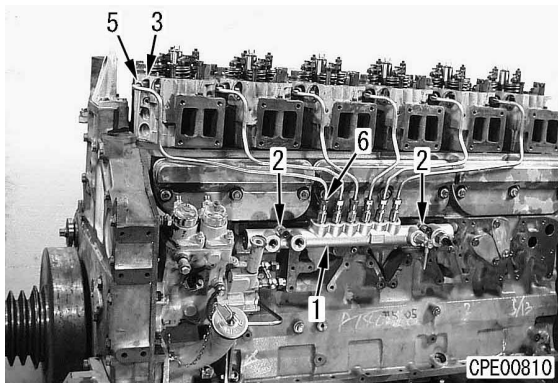


- Assembly of common rail and injector
- 1) Secure common rail (1) temporarily with special bolts (2).
- 2) Fit O-ring (4) to high-pressure pipe sleeve (3) and apply engine oil SAE No. 30 to them. Matching them to the connection of the injector, tighten sleeve nut (5) and sleeve nut (6) on the common rail side temporarily. (Tighten No. 1 – No. 6 temporarily in order.)
- 3) Tighten 2 special bolts (2) permanently.



Special bolt:

59 – 74 Nm {6 – 7.5 kgm}



- 4) Tighten high-pressure pipe sleeve nuts (5) and (6) permanently with spanner-type torque wrench ①.



Sleeve nut:

39.2 – 49 Nm {4 – 5 kgm}

- ★ After finishing the work, make sure that O-ring (4) is not projected from the sleeve.
- ★ When installing the high-pressure pipe without removing the fuel injector (for example, when replacing only the high-pressure pipe with new one), follow the procedure below.

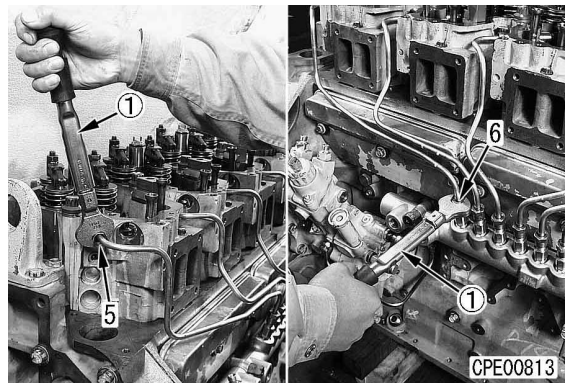
- 1) Screw sleeve nut (5) by 2 turns with the hand into the threads of the fuel injector, then tighten it with a spanner.

Note 1) If sleeve nut (5) does not catch the threads, press its end with another small spanner, etc. and turn its hexagonal part with the proper spanner.



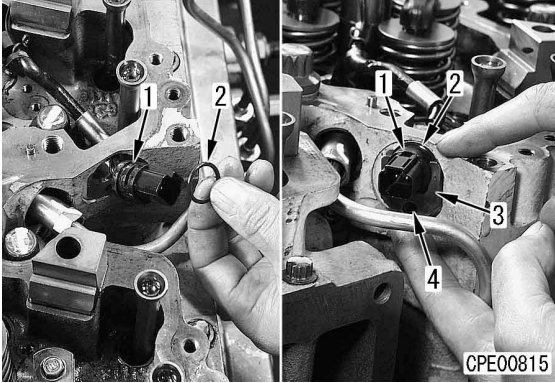
Sleeve nut: 39.2 – 49 Nm {4 – 5 kgm}

Note 2) After finishing the work, make sure that O-ring (4) is not projected from the sleeve.



21. Fuel injector wiring harness assembly

- ★ It is difficult to insert the connector from inside with the O-ring fitted to it.
- 1) Remove O-ring (2) from wiring harness connector (1). Take wiring harness connector (1) out of the connector hole and install O-ring (2) and apply engine oil SAE No. 30 to them. Install connector holder (3) and push it in and secure it with mounting bolt (4).

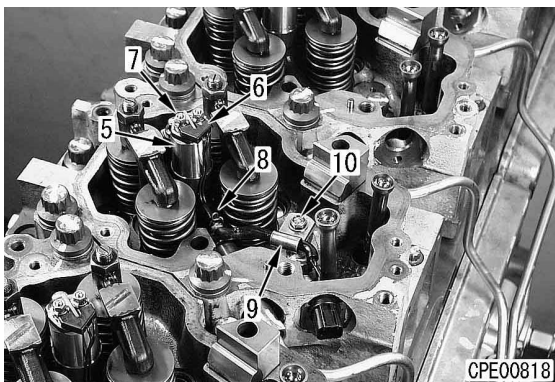
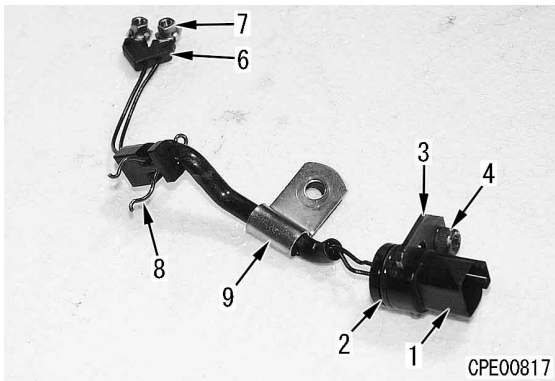


- 2) Install wiring harness terminal (6) to injector terminal (5) and tighten 2 nuts (7). Insert wiring harness holder clamp (8) in the injector connection and secure wiring harness clamp (9) with bolt (10).

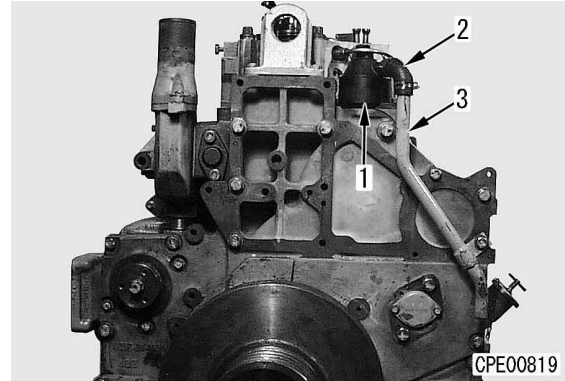
Terminal nut:

1.8 – 2.2 Nm {0.18 – 0.22 kgm}

- ★ Eliminate the slack of the wiring harness and press it against the body of the injector.

**22. Breather**

- 1) Fit the O-ring and breather (1).
 Mounting bolt:
24.5 – 29.4 Nm {2.5 – 3.0 kgm}
- 2) Install hose (2) and tube (3), then secure them with the clamp.

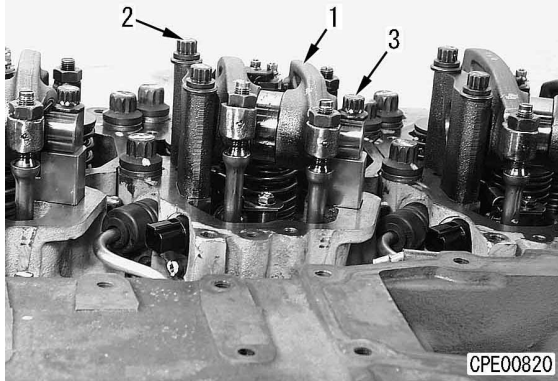


23. Rocker arm

Install rocker arm (1) and secure it with mounting bolts (2) and (3).

- ★ Before tightening the mounting bolts, make sure that the ball of the adjustment screw is fitted to the socket of the push rod.

 **kgm** Mounting bolt:
93 – 103 Nm {9.5 – 10.5 kgm}

**24. Adjustment of valve clearance**

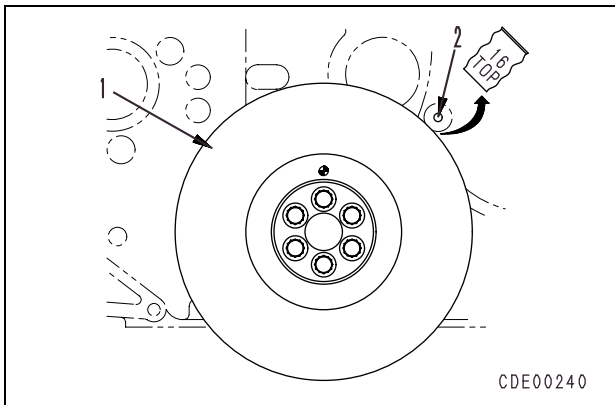
Adjust the valve clearance according to the following procedure.

- ★ Adjust the clearance between the cross head and rocker arm to the following value.
- ★ Valve clearance (in cold state)

Unit: mm

Air intake valve	Exhaust valve
0.35 ± 0.02	0.57 ± 0.02

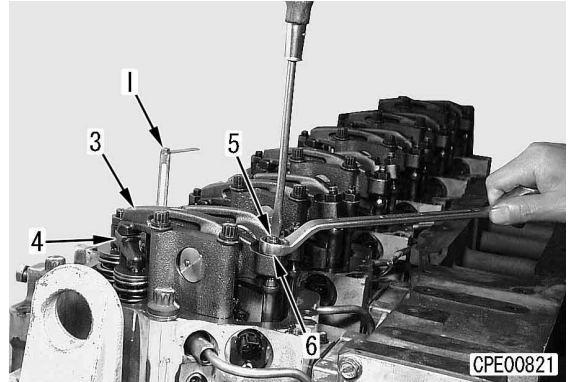
- ★ Crank the engine and adjust the valve clearance of each cylinder in the ignition order of 1, 5, 3, 6, 2, and 4.
- 1) Turn the crankshaft forward and match the "1.6TOP" line of vibration damper (1) to pointer (2), watching the movement of the valve.
 - ★ The position of the pointer depends on the model on which the engine is mounted.



- 2) Insert filler gauge "I" between rocker arm (3) and cross head (4) and tighten adjustment screw (5) to the degree that the filler gauge can be moved lightly.
- 3) Tighten locknut (6) to secure the adjustment screw.

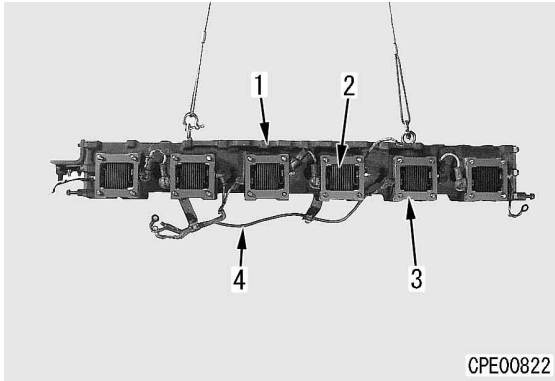
 **kgm** Locknut:
53 – 64.7 Nm {5.4 – 6.6 kgm}

- ★ After tightening the locknut, check the valve clearance again. (See TESTING AND ADJUSTING, too.)



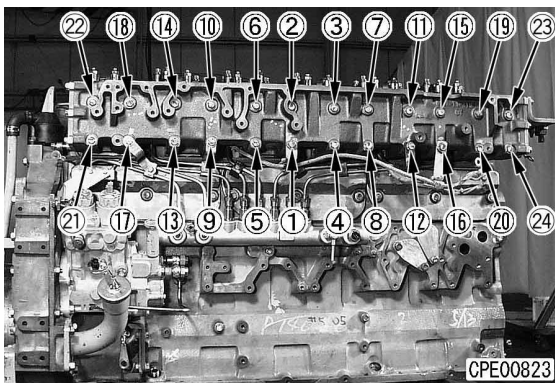
25. Air intake manifold and electrical intake air heater

- 1) Fit gaskets (3) to both sides of electrical intake air heater (2), then install them to intake manifold (1).
- 2) Install wiring harness assembly (4) to heater (2), then assemble them and intake manifold (1) together.



- 3) Install intake manifold (1) to the cylinder head.
- 4) Tighten the intake manifold mounting bolts in the following order (① – ②④).

 Intake manifold mounting bolt:
59 – 74 Nm {6 – 7.5 kgm}

**26. Fuel supply pump, high-pressure pipe, and bracket**

- ★ When installing the high-pressure pipe, check it for visible longitudinal slit "b", pit "c", or level difference (wear) in part "d" (End of the taper seal: Part of 2 mm from the end) which is felt with a nail in the taper seal part of the connecting section (Part "a": 2 mm from the end). If any of those defects can cause fuel leakage, replace the high-pressure pipe.

- 1) Tighten 2 bolts (2) of fuel supply pump bracket (1) by hand.
- 2) Tighten the nuts of 2 high-pressure pipes (3) between the fuel supply pump and common rail by hand.

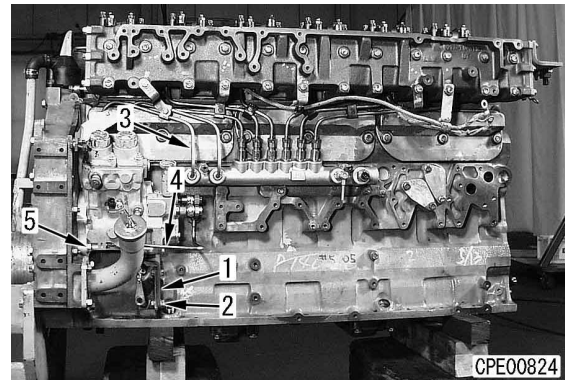
 Nut on pump side:
39.2 – 49 Nm {4 – 5 kgm}

 Nut on common rail side:
49 – 58.8 Nm {5 – 6 kgm}

- 3) Tighten the nuts of fuel supply pump lubrication tube (4) by hand.

 Nut on pump side:
7.9 – 12.7 Nm {0.8 – 1.3 kgm}

 Nut on block side:
9.8 – 12.7 Nm {1.0 – 1.3 kgm}

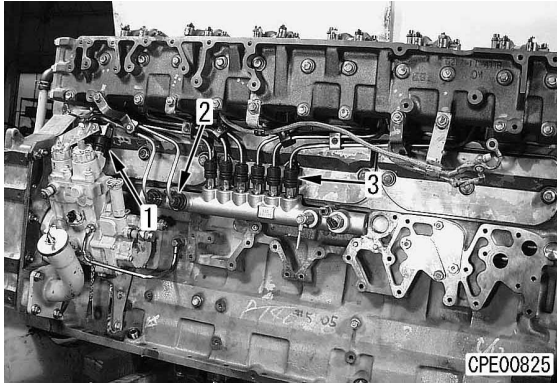


- 4) Tighten the bolts and nuts of the high-pressure pipe, lubrication tube, fuel supply pump, and bracket permanently in order.

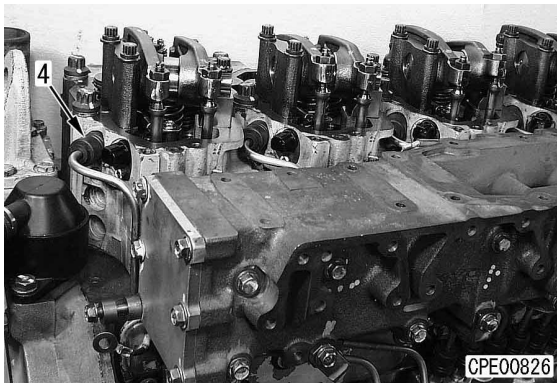
★ Apply LOCTITE to fuel supply pump mounting bolts (5).

27. Fuel guard rubber caps

- ★ There are 16 rubber caps. All of them have respective slits, the directions of which are important.
- 1) Fit the 2 rubber caps at fuel supply pump output (1) with their slits toward the cylinder block. Fit the 2 rubber caps at common rail inlet (2) with their slits down. Fit the rubber caps at common rail outlet (3) with their slits toward the cylinder block.



- 2) Fit the 6 rubber caps at fuel injector inlet sleeve (4) with their slits down.
- ★ Secure the rubber caps with metal clips.

**28. High-pressure pipe clamps and gate frame**

- 1) Tighten the all bolts of the 5 high-pressure pipe clamps (1) by hand, then tighten them permanently. Then, secure the clamp stays permanently.
- 2) Tighten the all bolts of the stays and upper and lower clamps of high-pressure pipe clamps (4) – (6) by hand.
- 3) Tighten the bolts of the upper and lower clamps permanently (to bend the rubber before securing the stay permanently).

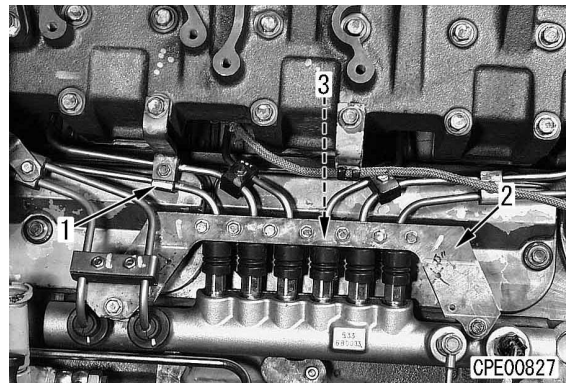
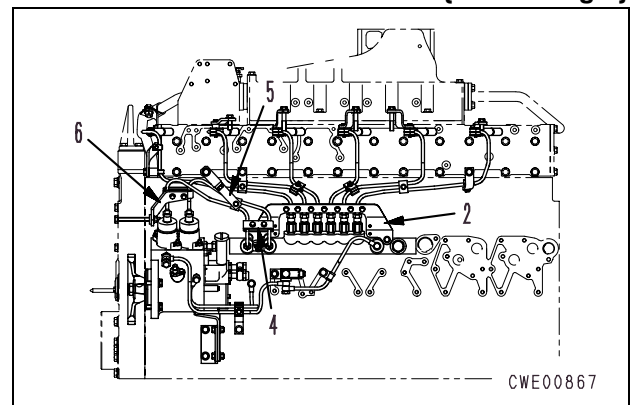
 Clamp bolt:

$9.8 \pm 1.0 \text{ Nm}$ { $1.0 \pm 0.1 \text{ kgm}$ }

- ★ At this time, secure the clamps in the order of (4), (5), and (6). [If the clamps are secured in this order, excessive forces are not applied to the mounting parts of the supply pump (Stress concentration on the mounting parts of the supply pump is prevented).]
- 4) Secure the stays in the order of (4), (5), and (6).
- 5) Install gate frame (2) temporarily. Secure clamp (3) (on the back side of the gate frame) permanently first, then secure gate frame (2) permanently with special bolts (4).

 Clamp bolt:

$9.8 \pm 1 \text{ Nm}$ { $1.0 \pm 0.1 \text{ kgm}$ }

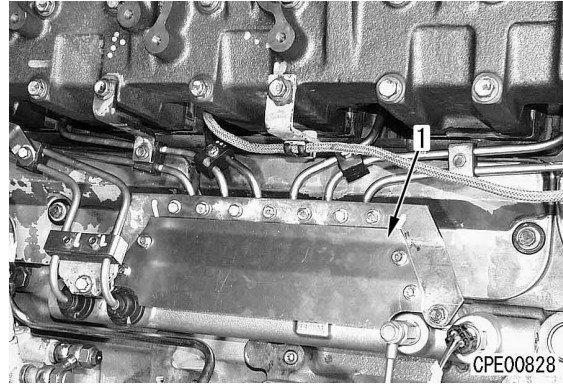


- ★ The fuel guard rubber caps are installed so that fuel will not spout over the hot parts of the engine and catch fire when it leaks for some reason.
- ★ The fuel guard rubber caps and covers are installed so that fuel will not spout over the hot parts of the engine and catch fire even if it leaks from the high-pressure pipe. Accordingly, if they are removed, hardened, or damaged, they must be replaced with new ones.
- ★ All of the 15 high-pressure pipe clamps, fuel supply pump, common rail, and injector inlet sleeve are very important parts. If the engine is operated while those parts are loosened, hardened, or removed, the contact parts of the high-pressure pipe may be broken by wear and vibration. Accordingly, be sure to tighten the bolts of those parts to the specified torque to secure the high-pressure pipe normally.
- ★ If the high-pressure pipe is bent or modified and reused or used as a substitute for another part, it may be broken, and that is very dangerous. Never use the bent high-pressure pipe.

29. Gate frame cover

- ★ Even if fuel spouts out, the gate frame and cover prevent it from staying in the form of mist.

- 1) Secure cover (1) with the mounting bolts.

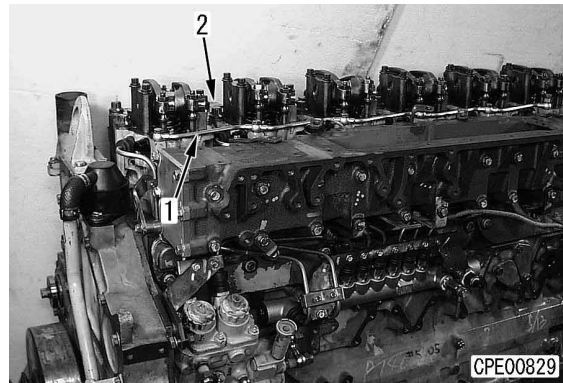


30. Fuel, cooling water, and spill pipes

- 1) Fit the gaskets to both ends of fuel spill pipe (1), then install them.
- 2) Fit the gaskets to both ends of cooling water spill pipe (2), then install them. (Exhaust manifold side)

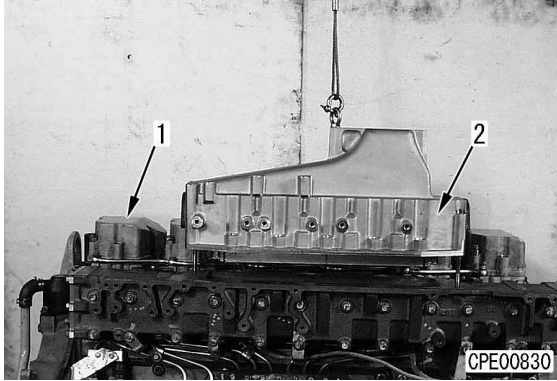
 Joint bolt:

9.8 – 12.7 Nm {1.0 – 1.3 kgm}

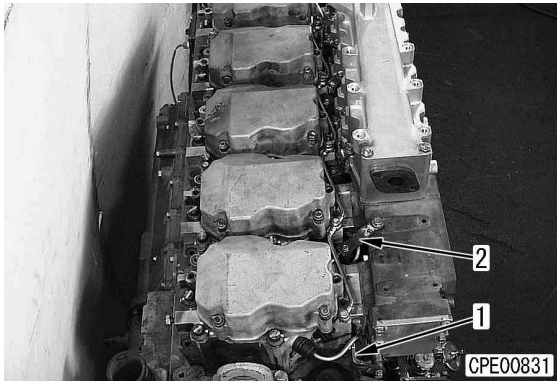


31. Head cover and aftercooler

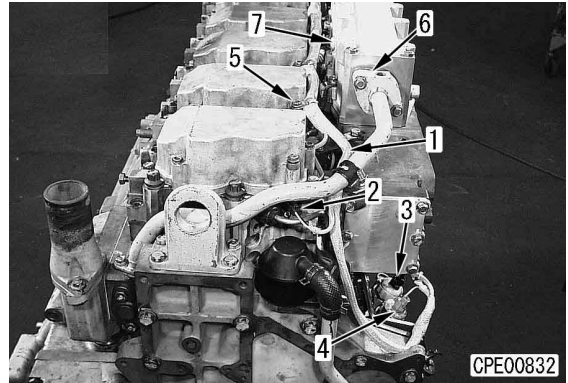
- 1) Fit the O-ring to head cover (1).
 Mounting bolt: **29.4 – 34.3 Nm {3.0 – 3.5 kgm}**
- 2) Fit the O-ring to aftercooler (2). Tighten the 14 bolts permanently from the central one to the outer ones in the diagonal order.
 Mounting bolt: **58.8 – 73.5 Nm {6.0 – 7.5 kgm}**

**32. High-pressure pipe, clamps, and stays**

- ★ Install the 3 high-pressure pipe clamps on the fuel injector side to the air intake manifold and the 3 at the center to the aftercooler with the stays.
- 1) Tighten all of high-pressure clamps (1) and stays (2) by hand.
 - 2) Tighten the clamps permanently.
 Clamp: **9.8 ± 1 Nm {1.0 ± 0.1 kgm}**
 - 3) Tighten the stays permanently.

**33. Fuel injector wiring harness assembly and aftercooler circulation tube**

- 1) Install fuel injector wiring harness (1) and connect connectors (2) to the female side of each fuel injector. Connect fuel supply pump connects (3) and (4).
- 2) Install the clamps of the wiring harness assembly to head cover bolts (5).
- 3) Fit the O-ring to the block side of aftercooler circulation tube (6) and fit the gasket to the cooler side, then install them to both sides of aftercooler (7).



34. Flywheel housing

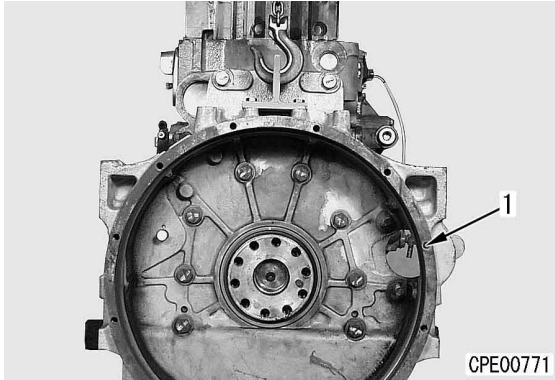
- 1) Sling flywheel housing (1) and apply gasket sealant to its fitting face, then install it to the cylinder block and tighten the mounting bolts.

★ When installing the housing, take care not to damage the oil seal.

 Fitting face:

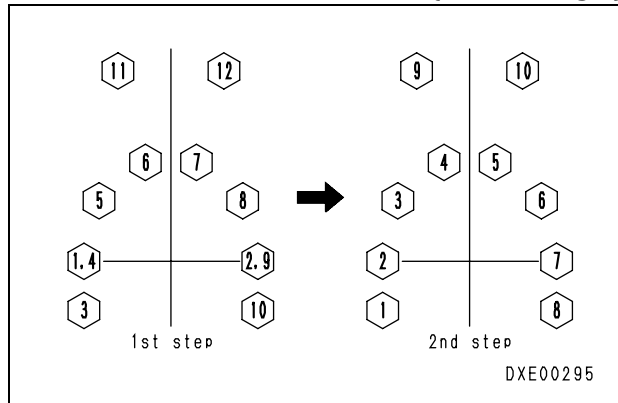
Gasket sealant (LG-7)

 Apply engine oil SAE No. 30 to threads and seat of bolt.



- ★ Tighten the flywheel housing mounting bolts in the following order and procedure.
- ★ When tightening the bolts for the first time, tighten bolts 1, 4 and 2, 9 twice.

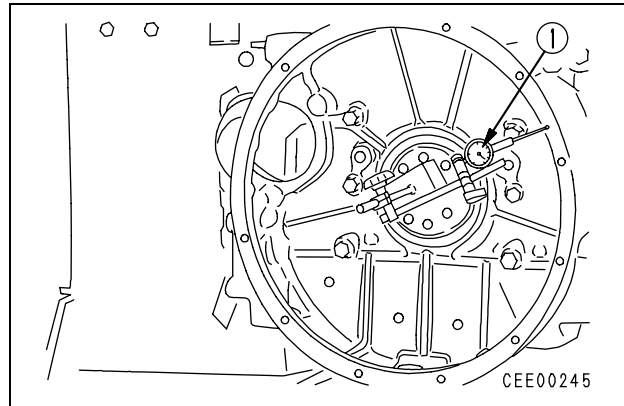
 **Flywheel housing mounting bolt:**
 1st time: **147 – 235 Nm {15 – 24 kgm}**
 2nd time:
245 – 309 Nm {25 – 31.5 kgm}



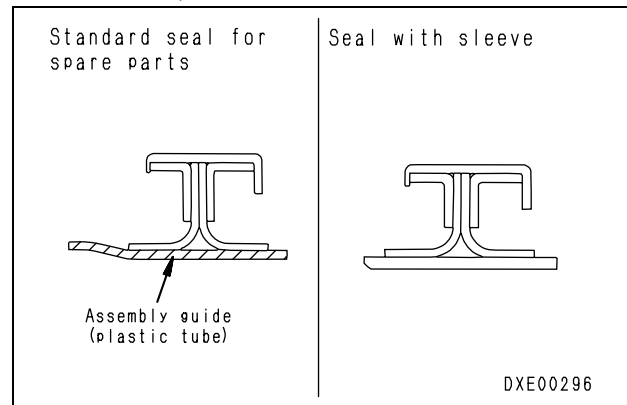
- 2) After installing the flywheel housing, measure its facial runout and radial runout with tool ①.

★ Radial runout: Max. 0.30 mm

★ Facial runout: Max. 0.30 mm

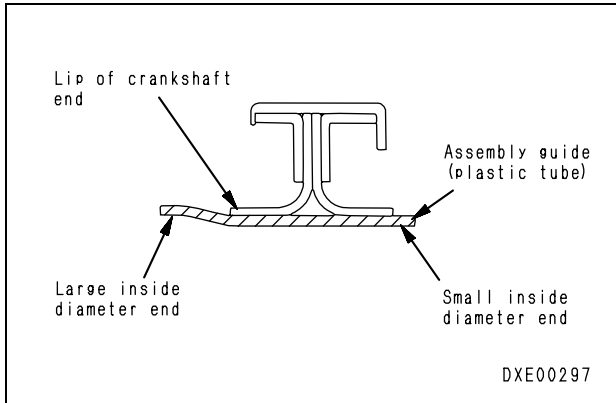
**35. Engine rear oil seal**

- ★ Check the Teflon seal (Laydown lip seal) by checking the wear of the shaft and replace it with the "standard seal" or "sleeved seal", if necessary. If the shaft is worn to the degree of luster (Feel with a finger. Wear depth must be less than 10 μm.) and does not have any flaw, install the standard seal. In other cases, install the sleeved seal.

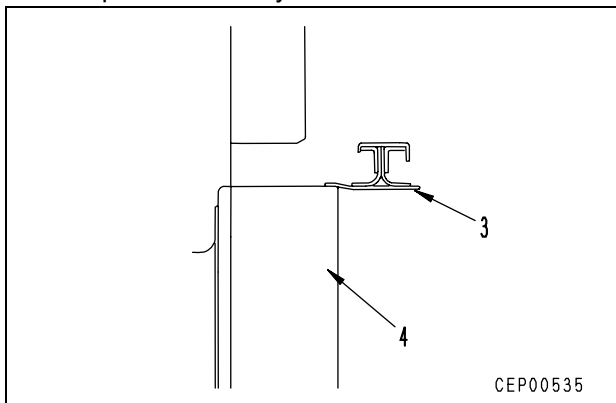


Procedure for installing standard seal

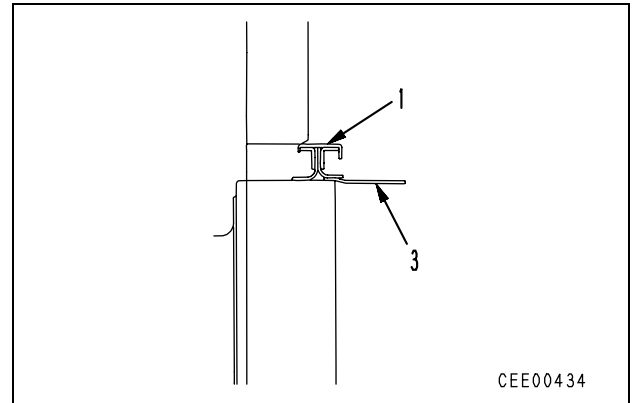
- ★ Before installing the seal, make sure that the end corners and lip sliding surfaces of the crankshaft and housing are free from flaw, burr, fin, and rust.
- ★ When installing the seal, do not apply oil or grease to the shaft and seal lip. Wipe off the oil from the shaft.
- ★ Never remove the inside plastic cylinder of the standard spare seal before installing the seal.



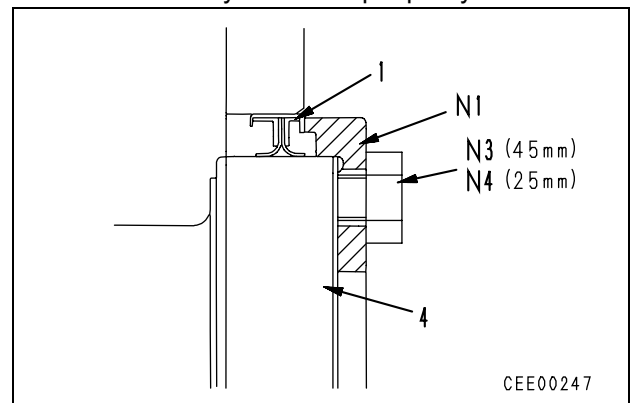
- 1) Bring the large inside diameter side of plastic inside cylinder (3) to the end of crankshaft (4).
 - ★ Take care not to mistake the direction of the plastic inside cylinder.



- 2) Hold the metal ring of seal (1) with both hands and push it in firmly.
- 3) After pushing in the seal, remove plastic inside cylinder (3).
 - ★ When removing the inside cylinder, extremely take care not to damage the seal lip.

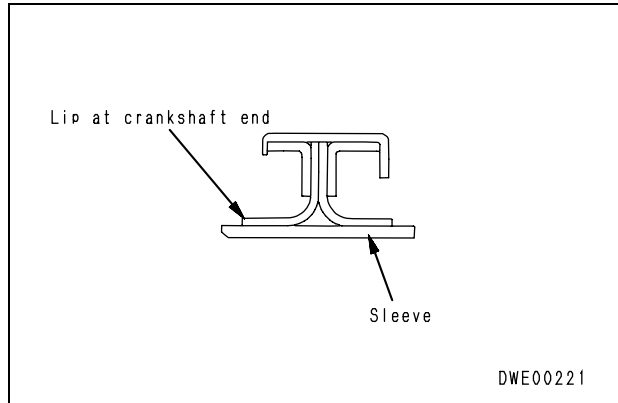


- 4) Tighten the 3 bolts evenly to press fit seal (1) until the end of tool **N1** reaches the end of crankshaft (4).
 - ★ First, tighten tool **N1** until bolt **N3** (45 mm) stops, then tighten **N4** (25 mm).
 - ★ When press fitting the seal, take care not to damage the lip on the PTO side with the tool set, etc.
 - ★ After press fitting the seal, remove the red sealant layer from its periphery.



Procedure for installing sleeved seal

- ★ Before installing the seal, make sure that the end corners and lip sliding surfaces of the crankshaft and housing are free from flaw, burr, fin, and rust.
- ★ When installing the seal, do not apply oil or grease to the shaft, sleeve, and seal lip. Wipe off the oil from the shaft.
- ★ Handle the seal and sleeve as an assembly and never separate them from each other.

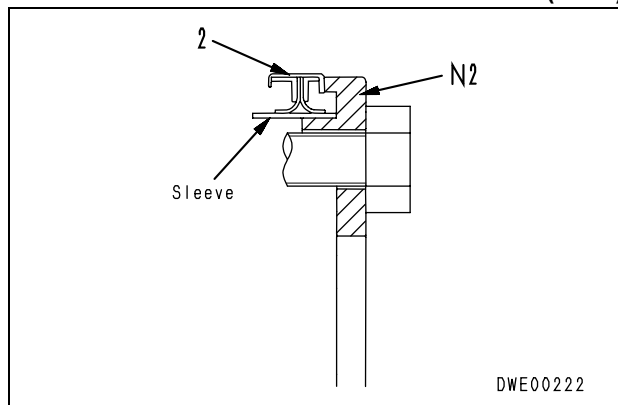


- 1) Set sleeve/seal (2) to tool **N2**.



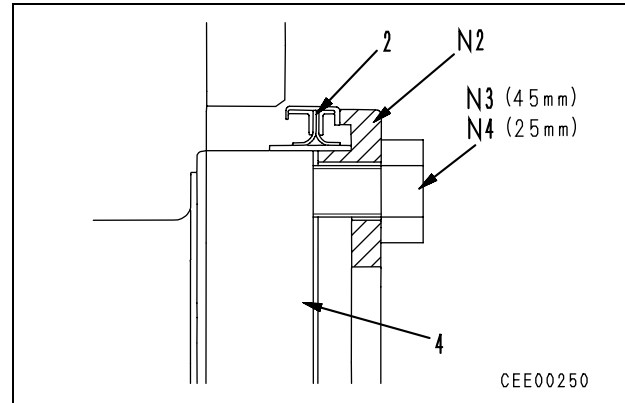
Inside of sleeve:

Gasket sealant (LG-7)



- 2) Bring the sleeve of the seal in contact with the end of the crankshaft, then tighten the 3 bolts evenly to press fit sleeve/seal (2) until the end of tool **N2** reaches the end of crankshaft (4).

- ★ First, tighten tool **N2** until bolt **N3** (45 mm) stops, then tighten **N4** (25 mm).

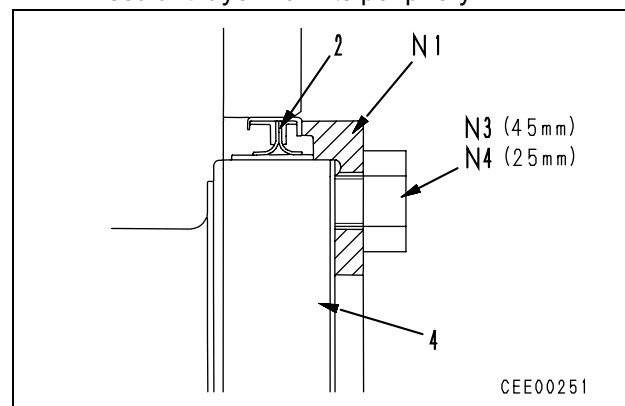


- 3) Remove tool **N2** and install tool **N1**.

- 4) Tighten the 3 bolts evenly to press fit sleeve/seal (2) until the end of tool **N1** reaches the end of crankshaft (4).

- ★ First, tighten too **N1** until bolt **N3** (45 mm) stops, then tighten **N4** (25 mm).

- ★ After press fitting the seal, remove the red sealant layer from its periphery.



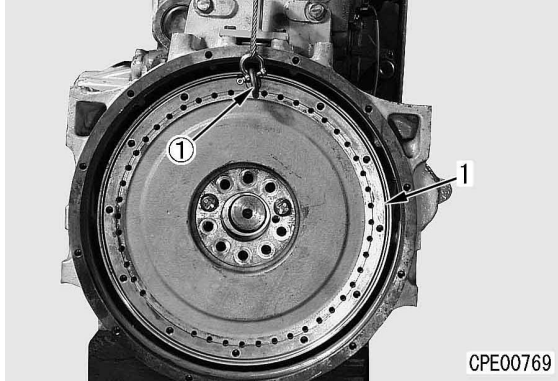
36. Flywheel

Using hanging bolt ① (12 mm, P = 1.75), sling flywheel (1) and install it to the crankshaft and tighten the mounting bolts.

 Apply engine oil SAE No. 30 to threads and seat of bolt.

 Flywheel: **60kg**

- ★ When installing the flywheel, match the dowel pin of the crankshaft to the hole of the flywheel.
- ★ Be careful not to touch the flywheel to the engine revolution sensor.



- ★ Tighten the mounting bolts in the following order.

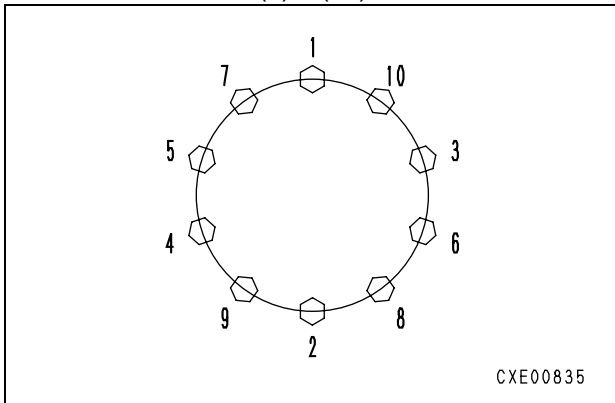
 Flywheel mounting bolt:

1st time:

112.7 – 122.5 Nm {11.5 – 12.5 kgm}

2nd time: 1) When using tool J

Using the angle tightening wrench (tool J), tighten the bolts by $90^{+30^{\circ}}_0$ in the order of (1) – (10).

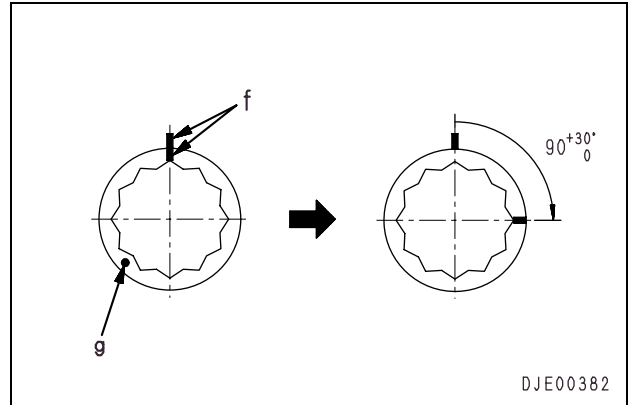


2) When not using tool J

Make marks on the bolt and flywheel **f** with paint, then tighten the bolts by $90^{+30^{\circ}}_0$ in the order of (1) – (10).

- ★ After tightening the bolt, make a punch mark **"g"** on its head.

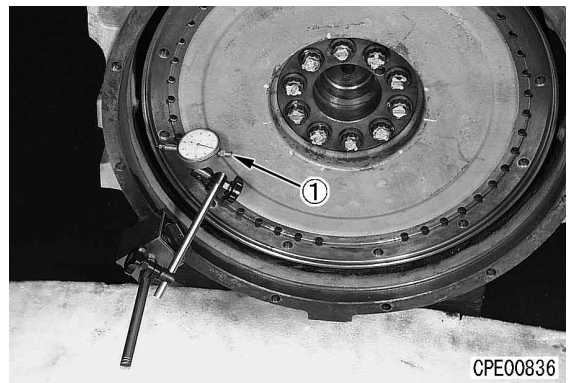
- If the bolt has 5 punch marks, replace it.



- ★ After installing the flywheel, measure its facial runout and radial runout with tool ①.

★ Radial runout: Max. 0.30 mm

★ Facial runout: Max. 0.30 mm

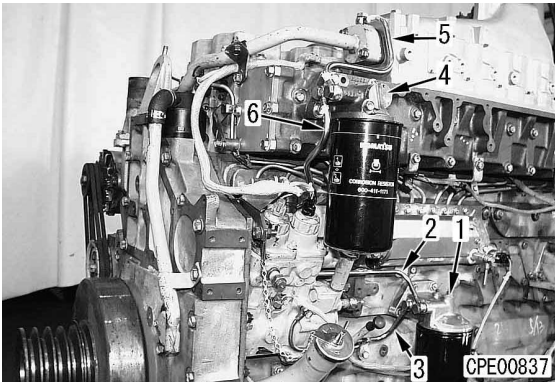


37. Fuel filter assembly and corrosion resistor assembly

- 1) Install fuel filter assembly (1) and pipes (2) and (3).
- 2) Install corrosion resistor assembly (4) (only when it has been installed) and pipes (5) and (6).

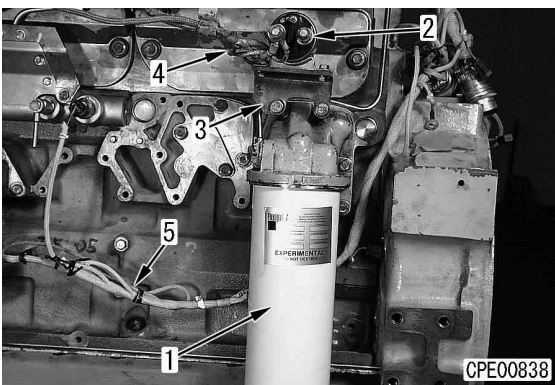
 Pipe mounting bolt:
24.5 – 34.3 Nm {2.5 – 3.5 kgm}

- ★ When supplying fuel into the fuel filter, supply it through the 8 small holes on the periphery (dirty side). Since the center hole is on the clean side, never supply fuel through it. (For details, see the operation manual.)



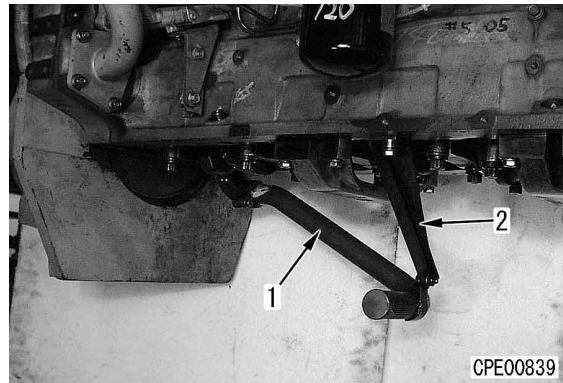
38. Oil filter assembly and heater relay assembly

- ★ Install the oil filter bracket and heater relay bracket together.
- 1) Install oil filter assembly (1) temporarily, then install bracket (3) of heater relay assembly (2) permanently.
 - 2) Install heater wiring harness (3) to heater relay (2).
 - 3) Install pressure-system wiring harness assembly (5) and its connectors.



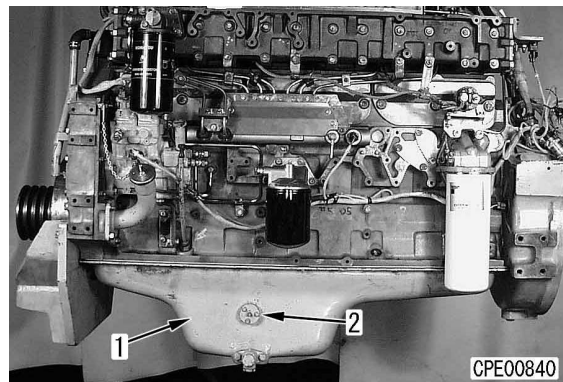
39. Suction pipe

- 1) Install the O-ring and suction pipe (1), then install bracket (2) to the cylinder block.



40. Oil pan

- 1) Install the gasket and oil pan (1).
- 2) Connect level sensor connector (2).

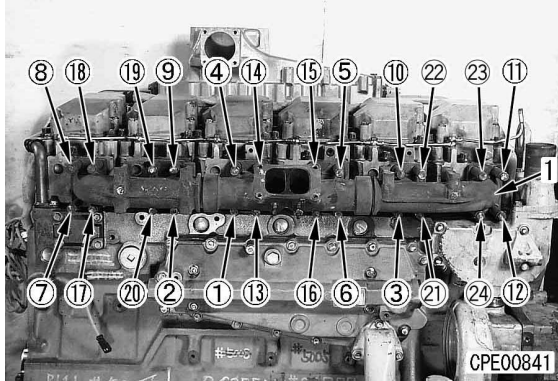


41. Exhaust manifold

- 1) Install the gasket and exhaust manifold (1), then secure them with mounting bolts (2).
- ★ Tighten the bolts ① – ③ first in order, then tighten the other bolts ④ – ⑭ in order.

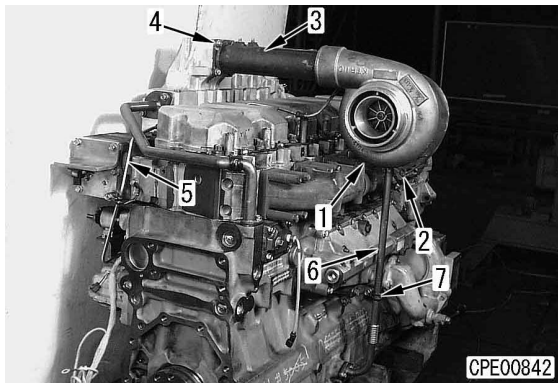
Mounting bolt:

59 – 74 Nm {6 – 7.5 kgm}



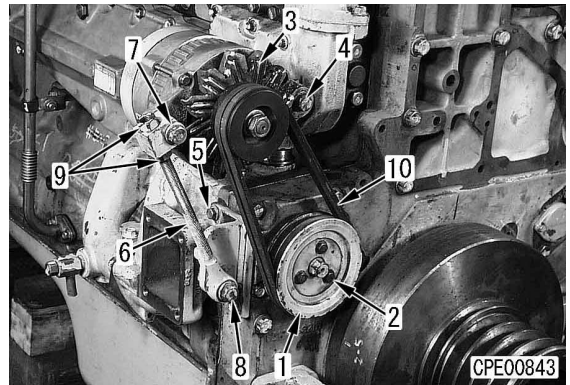
42. Turbocharger assembly

- 1) Install the gasket and turbocharger assembly (1), then secure them with 4 bolts (2).
- kgm Mounting bolt and nut:
44.1 – 49 Nm {4.5 – 5 kgm}
- 2) Fit 2 O-rings to air intake pipe (3), then insert them in the turbocharger. Fit the gasket to the opposite side and install to the aftercooler with bolts (4).
- 3) Install turbocharger lubrication tube (5). Fit the gasket to drain tube (6) and install clamp (7).



43. Alternator assembly and pulley

- 1) Install pulley (1) and secure it with mounting bolt (2).
- 2) Install alternator assembly (3) and secure it with bolt (4) temporarily.
- 3) Install bracket (5).
- 4) Install adjustment rod (6) with bolts (7) and (8) temporarily and loosen 1 adjustment nuts (9).
- 5) Install alternator belt (10).
- 6) Adjust the belt tension with nut (9) so that each belt will be deflected by 13 – 15 mm when its center is pressed with force of 98 N {10 kg}.
- 7) Tighten bolts (4), (7), and (8).

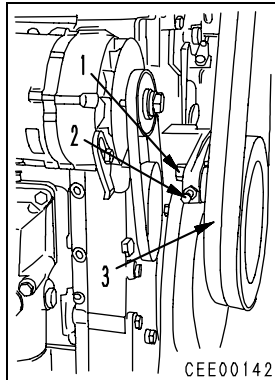
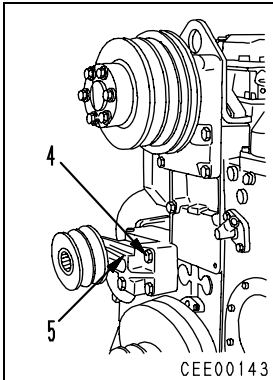


44. Fan pulley assembly

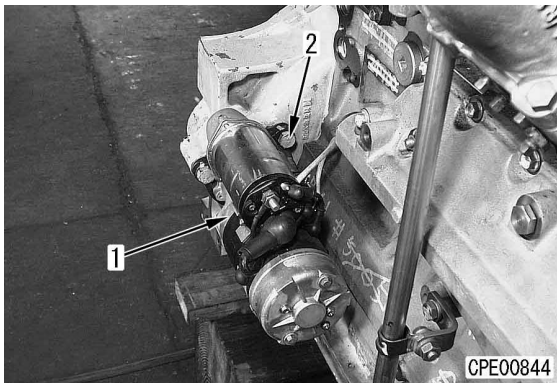
Install the fan pulley assembly and secure it with the bolts.

45. Tension pulley assembly

- 1) Install tension pulley assembly (5) with mounting bolts (4).
- 2) Install fan belt (3) to the pulley.
- 3) Tighten adjustment bolt (2) to move the tension pulley outward and adjust the belt tension so that the fan belt will be deflected by 13 – 15 mm (when new) or 17 – 19mm (when reused) when its center is pressed with force of 98 N {10 kg}, then tighten tension fixing nut (1) (when the auto-tensioner is not installed).

**46. Starting motor assembly**

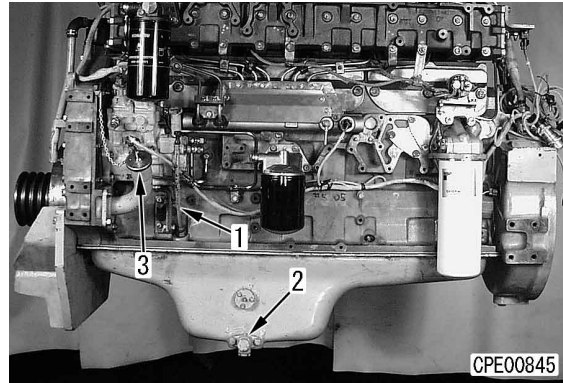
- 1) Install the gasket and starting motor assembly (1) with 3 mounting bolts (2).
- ★ Bind the starting circuit wires (starting motor connector) to the wires of the C-terminal circuit so that they will not interfere with the cylinder block and starting motor.

**47. Level gauge and supplying engine oil**

- 1) Install level gauge guide (1).
- 2) Make sure that engine oil drain plug (2) is tightened.
- 3) Supply engine oil through oil filler (3) to the specified level.



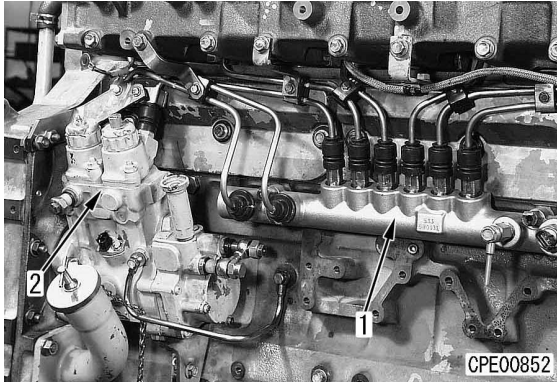
Engine oil pan: **Approx. 37 ℓ**

**48. Precautions for handling of electric wiring harnesses**

- ★ It is dangerous to install the high-pressure pipe near the electric wiring harnesses for electronic control. The wiring harnesses may be deformed through the actual operation (by operator's feet, etc.) Accordingly, after finishing the work around the high-pressure piping described here, confirm that the pipe is separated from the harnesses more than 10 mm. If the pipe is near the harnesses, adjust the harnesses to make a space wider than 10 mm.
- If a wiring harness touches the pipe, its cover may be removed, and that can cause a short circuit or breakage of the pipe.

49. Method for checking fuel high-pressure piping for fuel leakage after assembly of engine

- ★ If high-pressure fuel supply pump (2), common rail (1), or high-pressure pipe is re-installed, check the engine for fuel leakage.

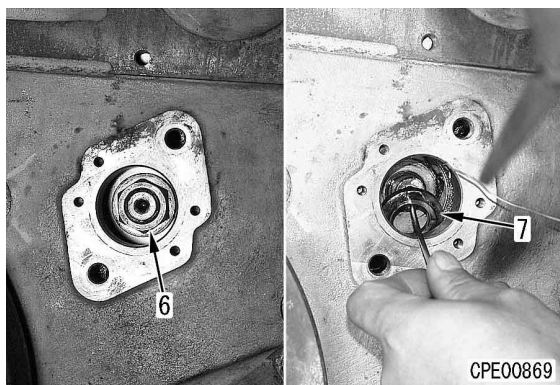
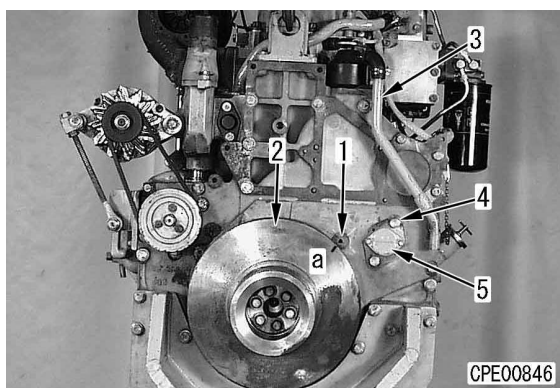


- ★ Clean and degrease the engine so that fuel leakage can be detected easily.
- 1) Spray color checker (developer) to the joints of the fuel supply pump, common rail, fuel injector, and high-pressure pipe.
 - 2) Start and run the engine at speed below 1,000 rpm. Stop the engine after its rotation is stabilized.
 - 3) Check the fuel piping and devices for fuel leakage.
 - ★ Mainly check the parts sprayed with the color checker for fuel leakage from the high-pressure circuit.
 - ★ If any fuel leaks, repair and repeat the inspection from step 2).
 - 4) Start and run the engine at low idling.
 - 5) Check the fuel piping and devices for fuel leakage.
 - ★ Mainly check the parts sprayed with the color checker for fuel leakage from the high-pressure circuit.
 - ★ If any fuel leaks, repair and repeat the inspection from step 2).

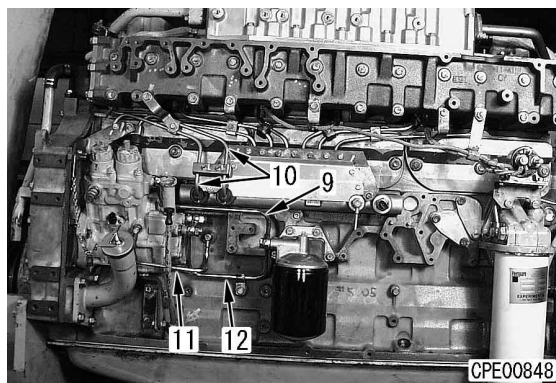
- 6) Start and run the engine at high idling.
- 7) Check the fuel piping and devices for fuel leakage.
 - ★ Mainly check the parts sprayed with the color checker for fuel leakage from the high-pressure circuit.
 - ★ If any fuel leaks, repair and repeat the inspection from step 2).
- 8) Start and run the engine at high idling and apply a load to it.
 - ★ If the engine is mounted on the machine, stall the torque converter or relieve the hydraulic pump.
- 9) Check the fuel piping and devices for fuel leakage.
 - ★ Mainly check the parts sprayed with the color checker for fuel leakage from the high-pressure circuit.
 - ★ If any fuel leaks, repair and repeat the inspection from step 2).
 - ★ If any fuel does not leak, finish the inspection.

PROCEDURE FOR REMOVING AND INSTALLING FUEL SUPPLY PUMP UNIT

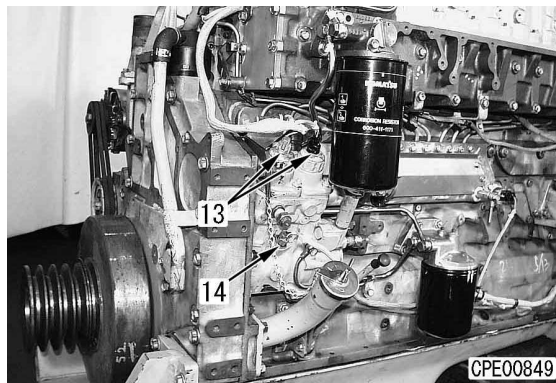
1. Watch the movement of the valve, then match the 1.6TOP line "a" of damper (2) to pointer (1).
★ Set the valve at the TOP position of 1st cylinder.
2. Remove breather tube (3).
3. Remove plugs 4 (2 each at top and bottom) and check that the fuel supply pump drive gear is matched to the forcing tap hole.
4. Remove cover (5), then remove gear mounting nut and washers (6) and (7), taking care not to drop them inside the engine.



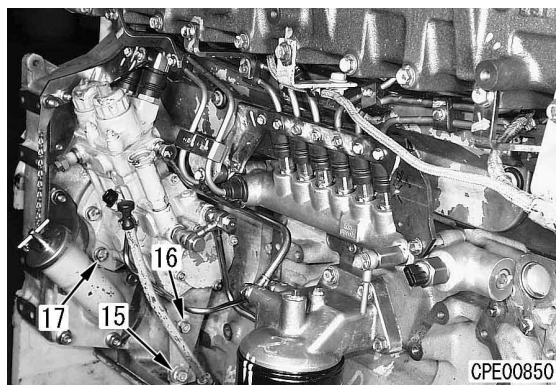
5. Set the gear puller jig "O".
6. Bolts O3 (see step 10) must be fitted to the gear puller tap (2 places).
7. Remove the fuel hose, then remove fuel tube (9), fuel supply tube (10), oil tube (11), and overflow tube (12).
★ Mask the joints and pipe ends to prevent dust from entering them.



8. Remove wiring harness connectors (13) and (14).
★ Mask the connectors to prevent dust from entering them.

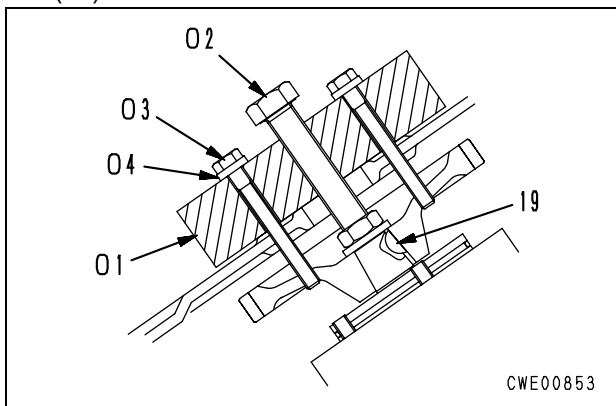


9. Loosen bracket bolt and nut (15) and (16) and fuel supply pump mounting bolts 17 (4 each on front and back sides).



DISASSEMBLY AND ASSEMBLY PROCEDURE FOR REMOVING AND INSTALLING FUEL SUPPLY PUMP

10. Turn bolt **O2** clockwise to pull out the fuel supply pump drive gear. Take care not to drop the key (19).



11. Remove the bolts and nuts loosened in 9 above, then remove the fuel supply pump.

12. Procedure for installing fuel supply pump

Install the fuel supply pump by performing the removal procedure in the reverse order.

★ Tightening torque kgm :

- 1) Fuel supply pump drive gear mounting nut: 176.5 – 196.1 Nm {18 – 20 kgm}

- 2) Fuel supply pump tube

Supply pump side:

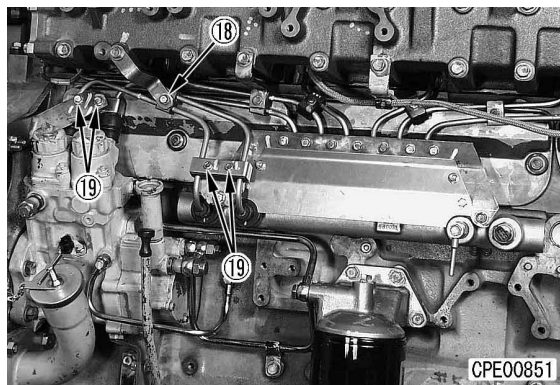
39.2 – 49.0 Nm {4 – 5 kgm}

Common rail side:

49.0 – 58.8 Nm {5 – 6 kgm}

- 3) Clamp

Ⓔ, Ⓕ: **9.8 ± 1.0 Nm {1.0 ± 0.1 kgm} (M6)**



15 REPAIR AND REPLACEMENT OF PARTS

CYLINDER HEAD

GRINDING OF FITTING FACE OF CYLINDER HEAD	15- 2
REPLACING VALVE SEAT INSERT	15- 3
PRESSURE TEST.....	15- 8
REPLACING VALVE GUIDE	15- 9
REPLACING CROSSHEAD GUIDE.....	15-10
GRINDING VALVE	15- 11

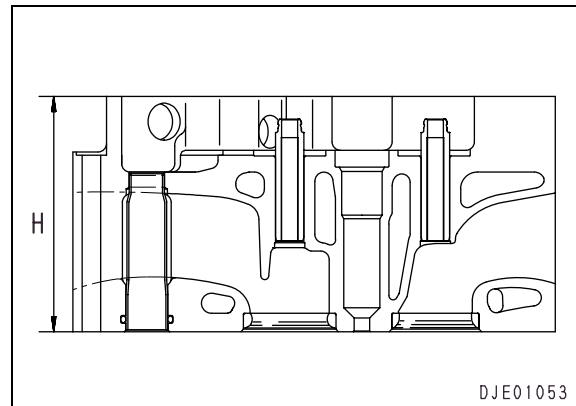
CYLINDER BLOCK

REPLACING CAM BUSHING	15-12
REPLACING CRANKSHAFT GEAR	15-15
REPLACING CAM GEAR.....	15-16
REPLACING FLYWHEEL RING GEAR	15-17
REPLACING CONNECTING ROD SMALL END BUSHING.....	15-18

GRINDING OF FITTING FACE OF CYLINDER HEAD

1. Grinding

- 1) Remove the valve seat insert. See the section of replacement of the valve seat insert.
- 2) Remove the strain and corrosion of the cylinder head by grinding them within the allowable limit of the cylinder head height **H**, then stamp the letter "R" on the left side of the cylinder head.
 - ★ Cylinder head height **H**
Basic height: 140 ± 0.05 mm
 - ★ Limit after grinding: 139.65 mm
 - ★ Grinding height/time: 0.10 – 0.15 mm
 - ★ Roughness of ground surface: 6 S max.
 - ★ Change of cross level: 0.05 mm max.
 - ★ Grinding limit: 0.3 mm
 - ★ Height difference among cylinder heads of each engine: 0.15 max.
- 3) Fit an oversize insert one rank larger. See the section of replacing valve seat insert.



2. Check after grinding

Confirm that the sinking distance of the valve is within the standard range. Grind for adjustment, if necessary.

- ★ Standard sinking distance of valve:
 0 ± 0.1 mm

REPLACING VALVE SEAT INSERT

Special tools

No.	Part No.	Part Name	Q'ty
A	795-100-4800	Puller (valve seat)	1
1	790-101-5001	Push tool (KIT)	1
B	2 790-101-5081	• Plate (for intake valve)	1
3	790-101-5071	• Plate (for exhaust valve)	1
1	795-100-3003	• Seat cutter (KIT)	1
	795-100-3100	• Body ass'y	1
	795-100-3200	• Micrometer	1
	795-100-3300	• Gauge	1
	795-100-3400	• Tool head	1
	795-100-3601	• Head support	1
C	2 795-100-3710	• Cutter (for oversize machining)	1
3	795-100-3720	• Cutter (for 30°)	1
4	795-100-3730	• Cutter (for 45°)	1
5	795-100-4210	• Pilot (10.000 mm)	1
	795-100-4220	• Pilot (10.010 mm)	1
	795-100-4230	• Pilot (10.020 mm)	1
	795-100-4240	• Pilot (10.030 mm)	1

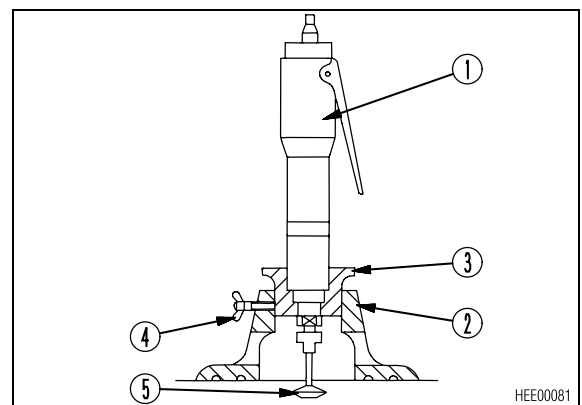
1. Removal of valve seat insert

- ⚠** When using a grinder to carry out this work, carry out a test run for one minute before starting the operation to check that there is no abnormality.
- If the grindstone has been replaced, carry out the test run 3 minutes.

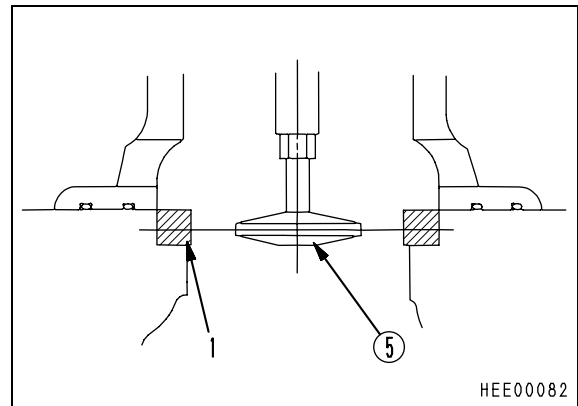
- ⚠** Check that there is no damage to the grindstone, fit it to the grinder spindle so that there is no play, and wear safety glasses when using the grinder.

• When removing with a valve seat puller

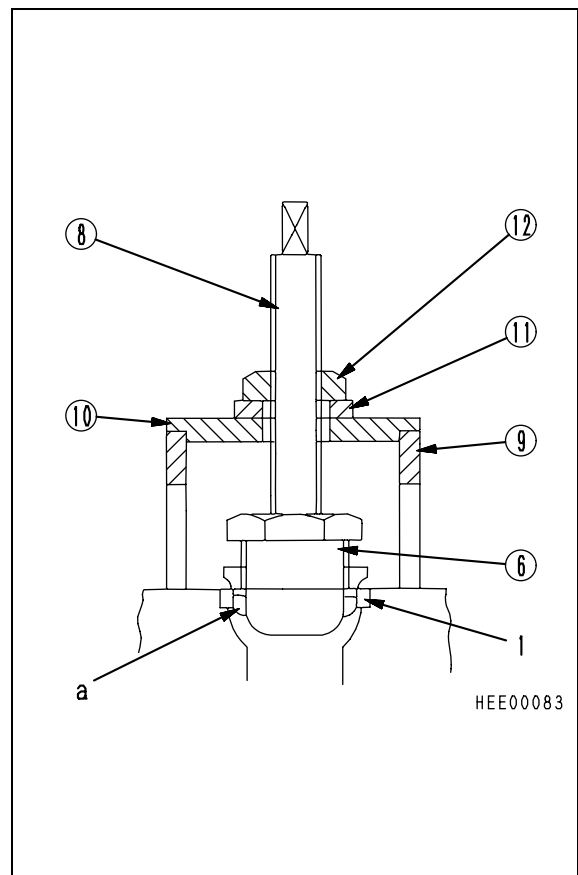
- 1) Install grindstone ⑤ to grinder ①.
 - 2) Align the groove of sleeve ③ with holder ②, and insert.
- ★ Adjust the position of the grinder with set screw ④.



- 3) Adjust the position of the grinder so that the center of grindstone ⑤ is at the center of seat insert (1), then tighten the set screw to fix the grinder in place.
 - 4) Rotate the grindstone and move it slowly until it contacts insert (1).
 - 5) Press the grindstone lightly against the inside face of the insert and make a groove around the whole circumference of the inside face of the insert.
- ★ Depth of groove: Approx. 1 mm

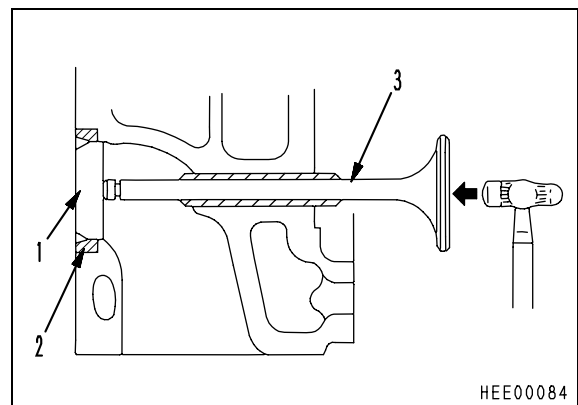


- 6) Push the three claws a of puller head ⑥ of tool A inwards by hand, and fit into insert (1).
 - 7) Tighten screw ⑧ to push the three claws into the groove on the inside face of the insert.
- ★ When the claws are completely in contact with the groove, stop tightening.
- 8) Insert bridge ⑨ on the outside of the puller head, set plates ⑩ and ⑪ on top of the bridge, and tighten nut ⑫ to pull out the insert.



• **When welding a bar to the insert to remove**

- 1) Weld bar (1) (diameter: approx. $\phi 10$) of a diameter 0.1 – 0.5 mm smaller than the inside diameter of the insert to insert (2).
- ★ Be careful not to deposit any of the welding metal on the head itself.
- 2) When the temperature of the weld has dropped to around room temperature, insert a used valve (3) in the opposite direction, and hit the face of the valve with a small hammer to remove the insert.
- ★ Be careful not to hit too hard, as any excessive shock may cause the weld to break off.

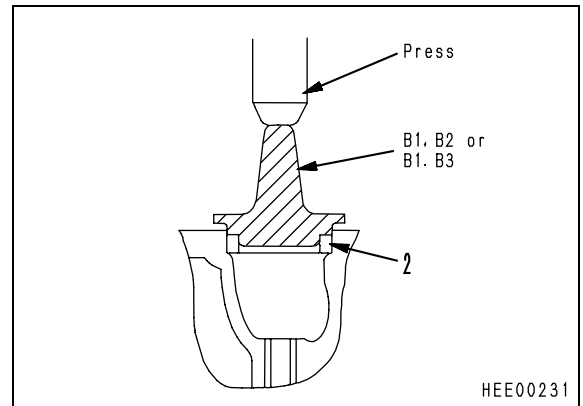


2. Press fitting valve seat insert

- **When not grinding and correcting press-fitting surface of valve seat insert**

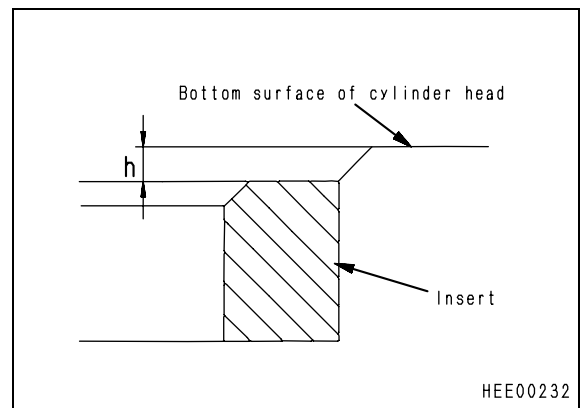
1) Using tools **B1** and **B2**, or tools **B1** and **B3**, press fit standard valve seat insert (2) with a press.

- ★ Do not use a hammer to press fit.
- ★ Press-fitting force for valve seat insert
Intake side: Approx. 14.7 kN {1.5 ton}
Exhaust side: Approx. 14.7 kN {1.5 ton}



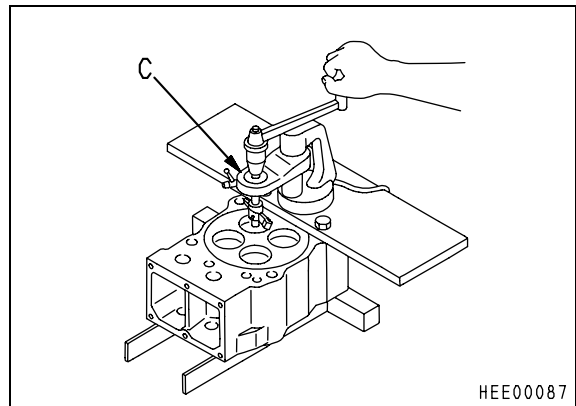
2) Check the insertion depth **h** of the insert from the bottom surface of the cylinder head.

- ★ Insertion depth **h** of insert
Intake side: 2.2 mm
Exhaust side: 2.4 mm



3. Oversize machining of mounting hole for valve seat insert

- 1) Using tools **C1** and **C2**, grind the hole to the one level larger oversize.
 - ★ Machine within an oversize range of 1.0 mm. If it is more than 1.0 mm, replace the cylinder head.

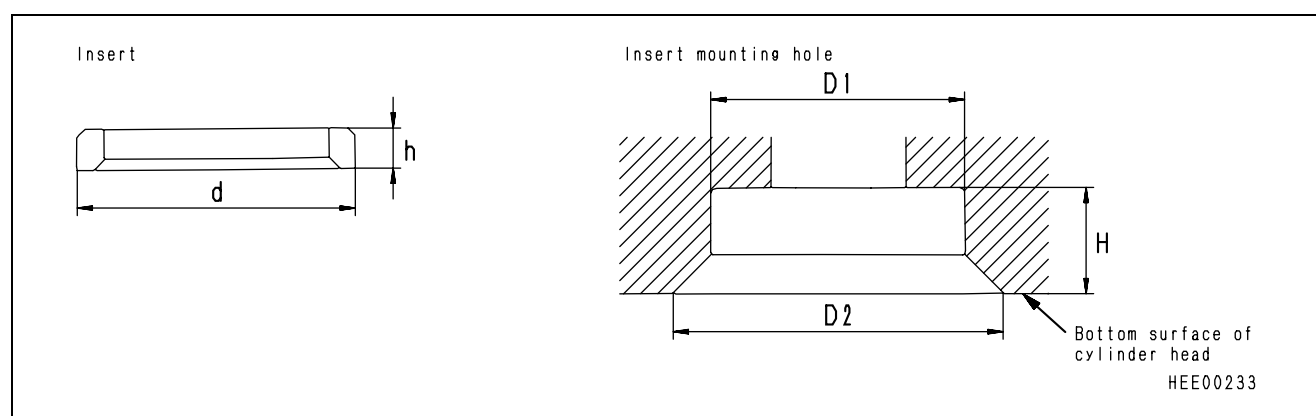


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• Method of machining insert and mounting hole

Unit: mm

Insert	Valve	Insert		Insert mounting hole		
		d	h	D1	D2	H
STD	Intake	55.0 $^{+0.100}_{+0.090}$	8.8 $^0_{-0.1}$	55.0 $^{+0.019}_0$	58.00 ± 0.2	11 $^0_{-0.1}$
	Exhaust	52.0 $^{+0.080}_{+0.070}$	8.6 $^0_{-0.1}$	52.0 $^{+0.019}_0$	55.00 ± 0.2	11 $^0_{-0.1}$
0.25 O.S.	Intake	55.25 $^{+0.100}_{+0.090}$	8.8 $^0_{-0.1}$	55.25 $^{+0.019}_0$	58.25 ± 0.2	11 $^0_{-0.1}$
	Exhaust	52.25 $^{+0.080}_{+0.070}$	8.6 $^0_{-0.1}$	52.25 $^{+0.019}_0$	55.25 ± 0.2	11 $^0_{-0.1}$
0.50 O.S.	Intake	55.5 $^{+0.100}_{+0.090}$	8.92 $^0_{-0.1}$	55.5 $^{+0.019}_0$	58.50 ± 0.2	11.12 $^0_{-0.1}$
	Exhaust	52.5 $^{+0.080}_{+0.070}$	8.72 $^0_{-0.1}$	52.5 $^{+0.019}_0$	55.50 ± 0.2	11.12 $^0_{-0.1}$
0.75 O.S.	Intake	55.75 $^{+0.100}_{+0.090}$	9.05 $^0_{-0.1}$	55.75 $^{+0.019}_0$	58.75 ± 0.2	11.25 $^0_{-0.1}$
	Exhaust	52.75 $^{+0.080}_{+0.070}$	8.85 $^0_{-0.1}$	52.75 $^{+0.019}_0$	55.75 ± 0.2	11.25 $^0_{-0.1}$
1.00 O.S.	Intake	56.0 $^{+0.100}_{+0.090}$	9.18 $^0_{-0.1}$	56.0 $^{+0.019}_0$	59.00 ± 0.2	11.38 $^0_{-0.1}$
	Exhaust	53.0 $^{+0.080}_{+0.070}$	8.98 $^0_{-0.1}$	53.0 $^{+0.019}_0$	56.00 ± 0.2	11.38 $^0_{-0.1}$

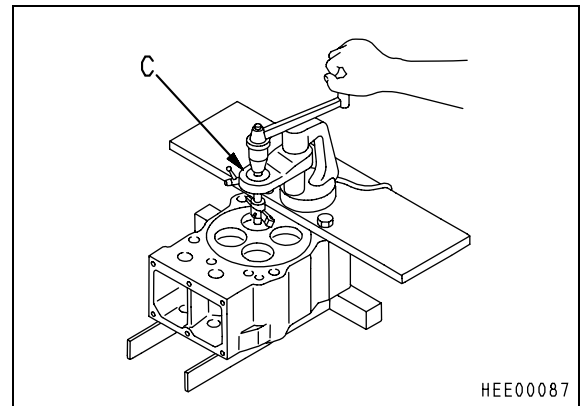


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- ★ Roughness of inside surface: Within 6.3 S
- ★ Roughness at bottom of mounting hole:
Within 12.5 S
- ★ Concentricity with valve guide inside surface:
Within 0.03 mm (TIR)

4. Finishing insert seat surface

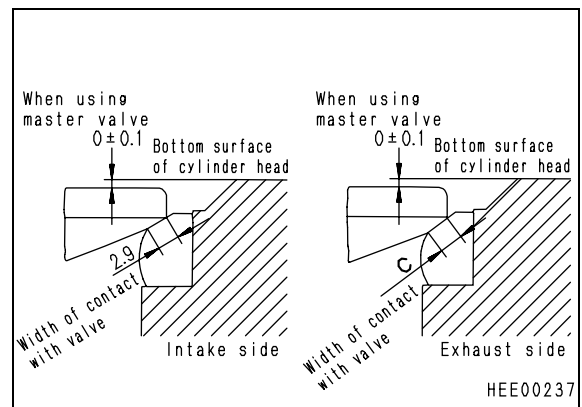
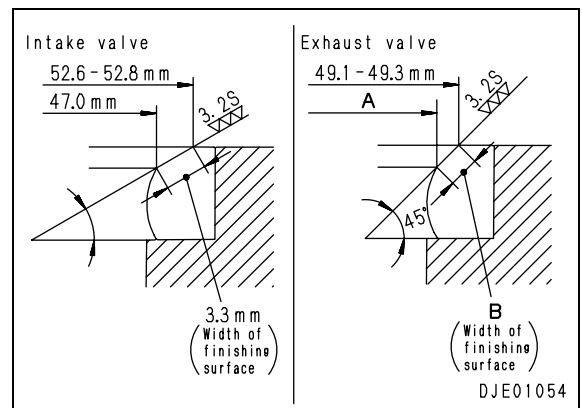
- 1) Using tools **C1**, **C3**, and **C4**, finish the surface of the insert seat to the dimensions shown in the diagram right.
- ★ When selecting a pilot **C5** to insert into the valve guide, choose one that gives no clearance.



- 2) Rub the seat surface with compound.

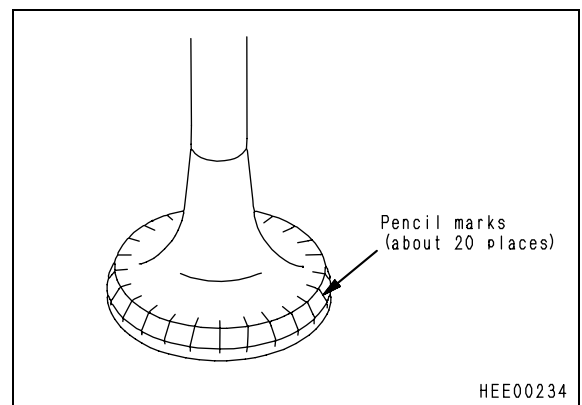
Width of finished face of exhaust valve insert and width of contact with valve Unit: mm

Part No.	Width of finished surface	Width of contact with valve (when using master valve)
6210-11-1320 (STD.) 6210-19-1320 (0.25 O.S.) 6210-18-1320 (0.50 O.S.) 6210-17-1320 (0.75 O.S.) 6210-16-1320 (1.00 O.S.)	A: 47.1 B: 1.5	C: 1.5 ± 0.2
6210-11-1321 (STD.) 6210-19-1321 (0.25 O.S.) 6210-18-1321 (0.50 O.S.) 6210-17-1321 (0.75 O.S.) 6210-16-1321 (1.00 O.S.)	A: 45.7 B: 2.5	C: 2.5 ± 0.2



5. Finish inspection

- Coat the seat surface of the new valve thinly with red lead (minimum), insert it in the valve guide, push lightly against the valve insert surface, and rotate 10°. Check the valve insert contact surface, and confirm that the contact is uniform without any breaks.
- Or
Make marks with a pencil on the seat surface of the new valve as shown in the diagram below, insert it in the valve guide, push lightly against the valve insert surface, and rotate 10°. Check that the pencil marks have been erased uniformly around the whole circumference.



PRESSURE TEST

- When corrections have been made around the cylinder head, test the pressure as follows.

Special tools

No.	Part No.	Part Name	Q'ty
A	790-553-1600	Coolant tester kit	1
B	79A-471-1050	Pump assembly	1

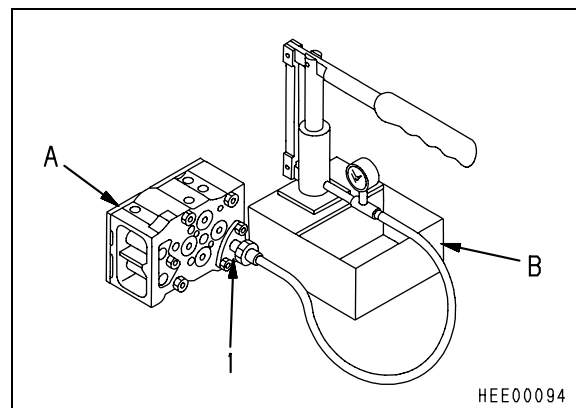
1. Water pressure test

- Assemble tool **A** and tool **B**, and connect the hose to flange (1).
 - Apply water pressure (0.34 – 0.39 MPa {3.5 – 4.0 kg/cm²}) for approx. 10 minutes, and check that there is no leakage from around the cylinder head.
- ★ When carrying out this test, heat the whole cylinder head and carry out the test with hot water (80 – 95°C).

2. Air pressure test

- Connect the compressor hose to flange (1).
- Put the head in the container of water, apply air pressure (0.29 – 0.34 MPa {3.0 – 3.5 kg/cm²}) for approx. 30 seconds, and check that there is no leakage in the water.

- ★ If the above test shows any cracks around the plate plugs, replace the cylinder head.



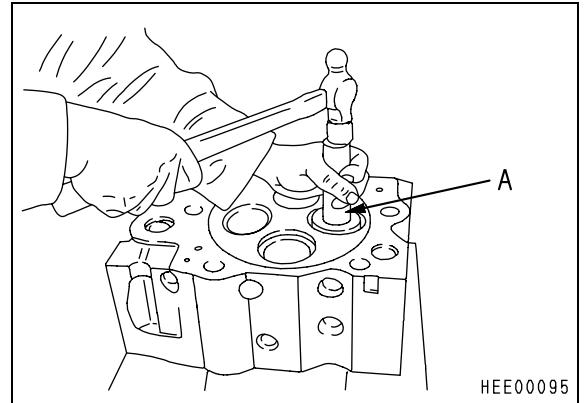
REPLACING VALVE GUIDE

Special tools

No.	Part No.	Part Name	Q'ty
A	795-100-1520	Valve guide remover	1
B	795-411-1310	Valve guide driver	1

1. Removal of valve guide

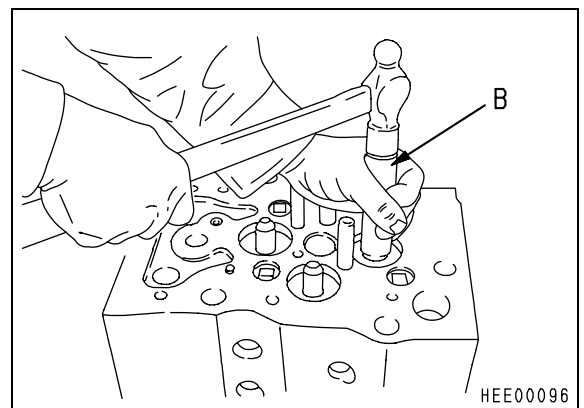
Using valve guide remover **A**, remove the valve guide.



2. Press fitting valve guide

- 1) Press fit the valve guide until the tip of valve guide driver **B** contacts the cylinder head.
- 2) Measure the protrusion of the valve guide and check that it is within the standard range.

★ Valve guide protrusion (Tolerance):
 $22 \pm 0.2 \text{ mm}$



REPLACING CROSSHEAD GUIDE

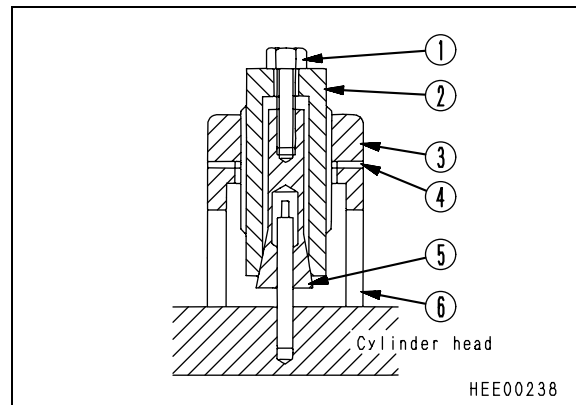
Special tools

No.	Part No.	Part Name	Q'ty
A	795-140-6410	Crosshead guide puller	1
B	795-130-1310	Crosshead guide driver	1

1. Removal of crosshead guide

Using crosshead guide puller **A**, remove the crosshead guide.

- 1) As shown in the diagram, grip crosshead guide with collet ⑤ of puller.
- 2) Tighten collet with bolt ①, and lock sleeve ②.
- 3) Turn nut ③, and pull out crosshead guide.
- 4) Remove any burrs or flashes from the crosshead guide mount.



2. Press fitting crosshead guide

Using tool **B**, insert the crosshead guide in the cylinder head, and use a copper bar or plastic hammer to press fit until the protrusion is within the permitted tolerance.

- ★ Protrusion of crosshead guide (Tolerance):
 $49 \pm 0.5 \text{ mm}$

GRINDING VALVE

Special tool

No.	Part No.	Part Name	Q'ty
A	Commercially available	Valve refacer	1

1. Grinding seat face

Grind the seat surface with valve refacer **A**.

- ★ Valve seat angle

Intake valve: 30°
Exhaust valve: 45°

2. Checking after grinding

Measure the thickness of the valve head, protrusion of the valve and the contact of the valve seat face to check that they are within the standard range.

- ★ Thickness of valve head

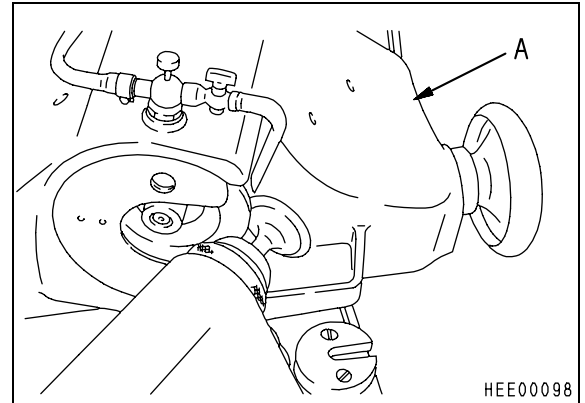
Intake valve: 2.4 mm
Exhaust valve: 2 mm

- ★ Insertion depth of valve (Standard):

0 ± 0.1 mm

- ★ Contact width of valve (Standard):

Intake valve: 4.33 mm
Exhaust valve: 3.47 mm



HEE00098

REPLACING CAM BUSHING

Special tools

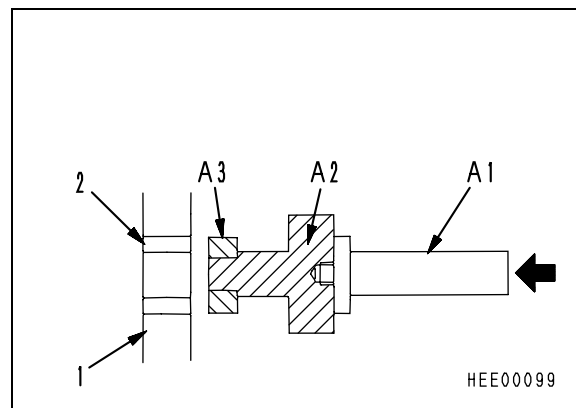
No.	Part No.	Part Name	Q'ty
A	795-213-1200	Push tool	1
A	1 795-213-1250	Push bar	1
	2 795-213-1210	Push tool	1
	3 795-213-1240	Collar	1
	4 795-213-1230	Guide	1
	5 792-103-0400	Grip	1

1. Removal of cam bushing

- ★ When replacing the cam bushing, first remove the blind plug at the rear of the cylinder block.

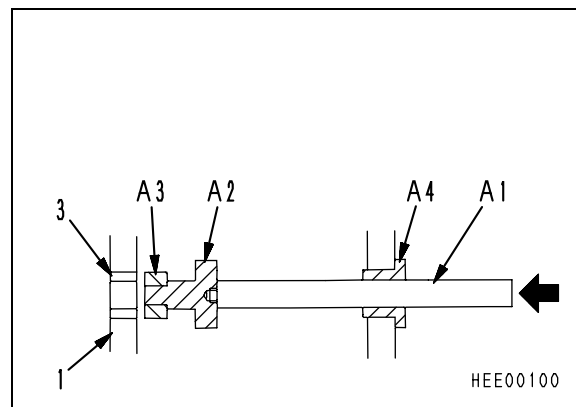
1) Removal of No. 1, 7 bushings

As shown in the diagram, assemble push tool **A2**, collar **A3**, and push bar **A1** of push tools **A**, then hit the push bar to knock bushing (2) out from cylinder block (1).



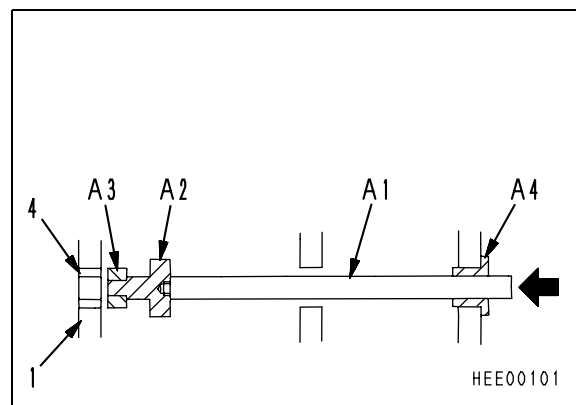
2) Removal of No. 2, 6 bushings

Assemble push bar **A1**, push tool **A2**, collar **A3**, and guide **A4** of push tool **A**, then hit the push bar to knock bushing (3) out from cylinder block (1).



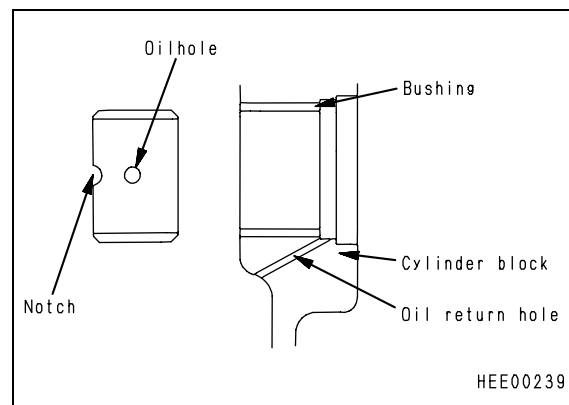
3) Removal of No. 3, 4, 5 bushings

Assemble push bar **A1**, push tool **A2**, collar **A3**, and guide **A4** of push tool **A**, then hit the push bar to knock bushing (4) out from cylinder block (1).

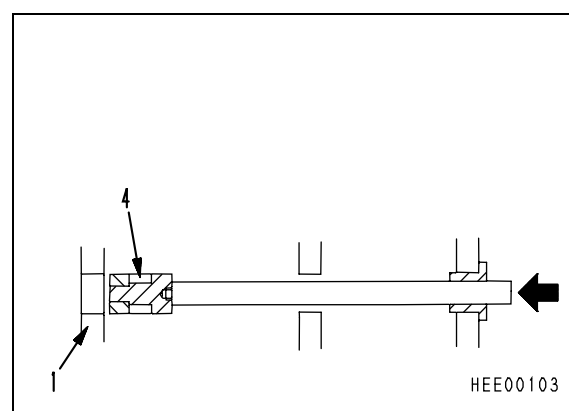


2. Assembly of cam bushing

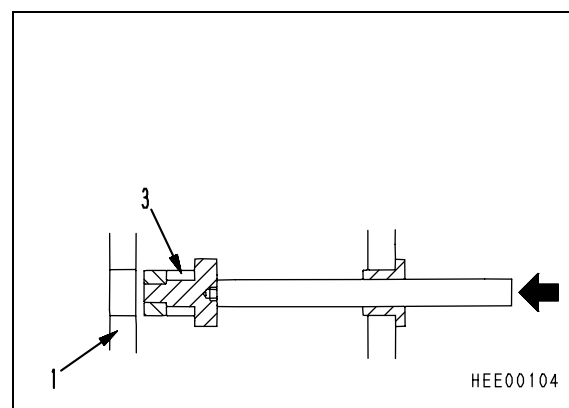
- After removing the bushing, remove any burrs or dirt, and clean the mounting hole of the bushing.



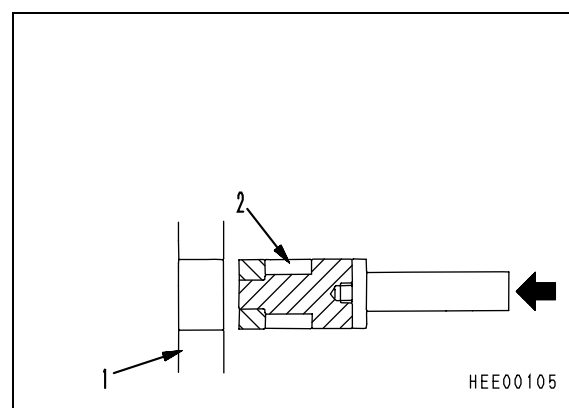
- Press fitting No. 3, 4, 5 bushings
Assemble bushing (4) to tool **A**, and press fit the bushing until the oil hole of cylinder clock (1) matches the oil hole of the bushing.



- Press fitting No. 2, 6 bushings
Assemble bushing (3) to tool **A**, and press fit the bushing until the oil hole of cylinder clock (1) matches the oil hole of the bushing.



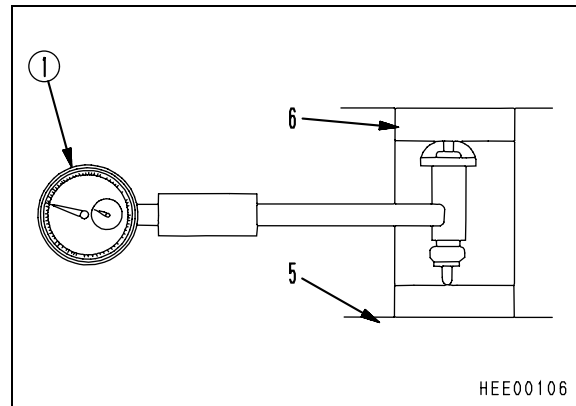
- Press fitting No. 1, 7 bushings
Assemble bushing (2) to tool **A**, and press fit the bushing until the oil hole of cylinder clock (1) matches the oil hole of the bushing.



3. Inspection

- 1) Using inside gauge ①, measure the inside diameter of the bushing.
- 2) Check the clearance between the bushing and shaft, and if the clearance is not within the specified range, or the shaft does not move smoothly, correct the inside diameter of the bushing with a reamer.
- 3) When the inside diameter of the bushing has been corrected with a reamer, clean all the metal particles from the oil hole and oil groove.

- ★ Inside diameter of cam bushing: $\phi 65^{+0.06}_{-0}$ mm
- ★ Clearance of camshaft journal:
0.016 – 0.096 mm



REPLACING CRANKSHAFT GEAR

Special tools

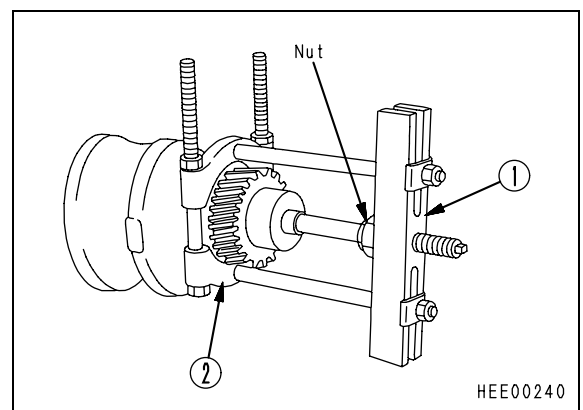
No.	Part No.	Part Name	Q'ty
①	790-101-2800	Bearing puller	1
②	790-101-2300	Push puller	1

1. Removal of gear

Make a scratch in the surface at the root of the teeth with a grinder, then assemble pullers ① and ②, and turn the nut to remove the gear.

- ★ If the gear cannot be removed in this way, make a scratch in the surface at the root of the teeth with a grinder, then heat the gear with a burner and knock the gear out with a copper rod.

- ★ Be careful not to damage the shaft.



2. Press fitting gear

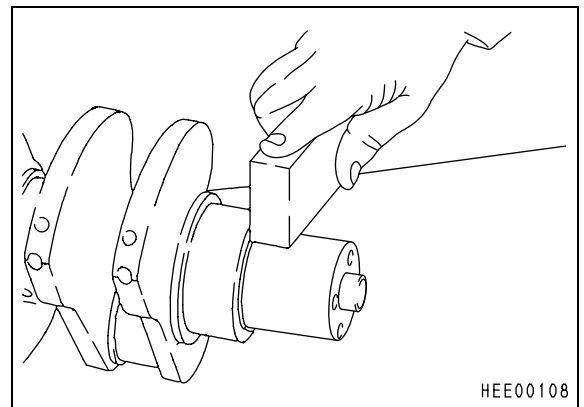
- 1) Check the gear mounting surface, key groove, and flange surface, and if there are any scratches, correct them with an oil-stone.
- 2) Knock a new key into the key groove of the shaft.
- 3) Heat the gear for the specified time at the specified shrink-fitting temperature.

- ★ Crankshaft gear shrink-fitting temperature: 200°C

Heating time: Min. 30 minutes

- 4) Put the timing mark on the outside, then use a hitting tool to press fit until the side face of the gear is in close contact with the shaft flange.

- ★ Knock in quickly before the gear becomes cool.



REPLACING CAM GEAR

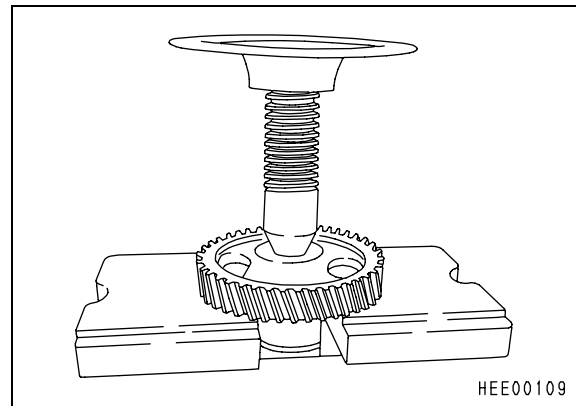
1. Removal of gear

Set the camshaft assembly on the press stand, then push the camshaft to remove the gear.

- ⚠ When setting the camshaft assembly on the press stand, be careful not to get caught your fingers between the press stand and the gear.

2. Press fitting gear

- 1) Check the gear mounting surface, key groove, and flange surface, and if there are any scratches, correct them with an oil-stone.
- 2) Knock a new key into the key groove of the shaft.
- 3) Assemble the thrust plate.
- 4) Heat the gear for the specified time at the specified shrink-fitting temperature.
 - ★ Crankshaft gear shrink-fitting
temperature: 220 – 240°C
Heating time: Min. 30 minutes
- 5) Put the timing mark on the outside, then use a hitting tool to press fit until the side face of the gear is in close contact with the shaft flange.
 - ★ Knock in quickly before the gear becomes cool.



REPLACING FLYWHEEL RING GEAR

 Be careful not to let the flywheel fall and injure you.

1. Removal of ring gear

Make a scratch in the surface at the root of the teeth with a grinder, then split with a chisel to remove.

 Be careful when handling the grinder and chisel.

2. Press fitting ring gear

- 1) Check the ring gear mounting surface, and if there are any scratches, correct them with an oilstone.
- 2) Heat the ring gear for the specified time at the specified shrink-fitting temperature.
 - ★ Ring gear shrink-fitting temperature:
Max. 200°C
Heating time: Min. 50 minutes
- 3) Set the chamfered face of the ring gear facing the flywheel, and press fit until the side face of the gear is in close contact with the flywheel.

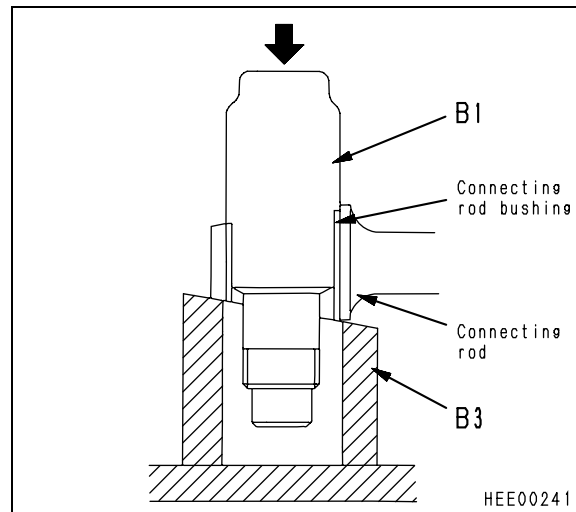
REPLACING CONNECTING ROD SMALL END BUSHING

Special tools

No.	Part No.	Part Name	Q'ty
A	795-240-6400	Push tool (KIT)	1
B	1	795-240-6410 Push tool	1
	2	795-240-6420 Push tool	1
	3	795-240-6430 Block	1
	4	01530-03912 Nut	1

1. Removal of connecting rod bushing

- 1) Set the connecting rod to tool **B3**.
- 2) Using tool **B1**, remove the connecting rod bushing with press.
- ★ After removing the bushing, remove any burrs or flashes, and clean the mounting hole of the bushing.



2. Press fitting connecting rod bushing

- 1) Set connecting rod to tool **B3**.
- 2) Assemble connecting rod bushing in tool **B1**, set tool **B2** in position, then secure with tool **B4** so that it does not move.
- ★ Align the oil hole of the connecting rod bushing with the oil hole of the connecting rod.
- 3) Push tool **B1** with press, and press fit the connecting rod bushing.

- The bushing is supplied as a semi-finished product, so the inside diameter is too small and the piston pin will not go in.

After press fitting the bushing, machine the inside diameter of the bushing with a reamer or honing machine in accordance with the maintenance standard.

- ★ After machining, clean all the metal particles from the oil hole and oil groove.

