

Shop Manual

DL200A Wheel Loader

Serial Number 10001 and Up

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950106-01057E

January 2013

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Safety

Wheel Loader Safety

Edition 1

MEMO

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up
DL250A	10001 and Up
DL300A	10001 and Up
DL420A	10001 and Up
DL550A	10001 and Up

SAFETY MESSAGES

Safety messages and safety decals included in this manual and on the machine provide instructions how to operate, service and maintain the machine. Safety messages and safety decals indicate potential hazards and describe safety precautions required to avoid hazards. Operator and maintenance personnel should read and understand these safety messages and decals before beginning operation or maintenance.

SAFETY ALERT SYMBOL

Be Prepared - Get to Know All Operating and Safety Instructions.

This is a Safety Alert Symbol. Wherever it appears in this manual or on safety decals on the machine, you must be alert to the potential for personal injury or accidents. Always observe safety precautions and follow recommended procedures.

Signal Words

The signal words "DANGER", "WARNING", "CAUTION" are used throughout safety messages and safety decals in this manual or on the machine. They indicate an existence of, and the relative seriousness of a hazard. All three indicate that a safety risk is involved. Observe the precautions indicated whenever a Safety Alert Symbol is present, no matter which signal word appears next to it.

DANGER

DANGER - This signal word is used on safety messages and safety labels and indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

WARNING - This signal word is used on safety messages and safety labels and indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

CAUTION - This signal word is used on safety messages and safety labels and indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.

SAFETY DECALS

Location of safety labels (decals) can vary from unit to unit.

Refer to appropriate Operation and Maintenance Manual, and parts manual for your unit.

Always replace damaged or faded decals.

GENERAL

Safe Operation is Operator's Responsibility

Only trained and authorized personnel should operate and maintain the machine.

Follow all safety rules, regulations and instructions when operating or performing maintenance on machine.

- Do not operate machine if you are under the influence of drugs or alcohol. An operator who is taking prescription drugs must get medical advice to determine if he or she can safely operate the machine.
- When working with other personnel on a work site, be sure that all personnel know the nature of work and understand all hand signals that are to be used.
- Be sure that all guards and shields are installed in their proper location. Have guards and shields repaired or replaced immediately if damaged.
- Be sure that you understand the use and maintenance of all safety features such as pilot cutoff switch and seat belt. Use them at all times.
- Never remove, modify or disable any safety features. Always keep them in good operating condition.
- Always check for and know the location of underground and overhead utility lines before working.
- Failure to use and maintain safety features according to instructions in this manual, Safety Manual and Shop Manual can result in death or serious injury.

Know Your Machine

Know how to operate your machine. Know the purpose of all controls, gauges, signals, indicators and monitor displays. Know the rated load capacity, speed range, braking and steering characteristics, turning radius and operating clearances. Keep in mind that rain, snow, ice, loose gravel, soft ground, slopes etc., can change operating capabilities of your machine.

Proper Work Tools and Attachments

Only use work tools and attachments that are recommended by DOOSAN for use on DOOSAN machines. When installing and using optional attachments, read instruction manual for attachment, and general information related to attachments in this manual. Because DOOSAN cannot anticipate, identify or test all attachments that owners may want to install on their machines, contact DOOSAN for written authorization and approval of attachments, and their compatibility with optional kits.

Attachments and attachment control systems that are compatible with the machine are required for safe and reliable machine operation. Do not exceed maximum operating weight (machine weight plus attachment) that is listed on ROPS certification plate.

Make sure that all guards and shields are in place on machine and on work tool. Depending on type or combination of work equipment, there is a potential that work equipment could interfere with the cabin or other parts of machine. Before using unfamiliar work equipment, check if there is any potential of interference, and operate with caution.

While you are performing any maintenance, testing, or adjustments to attachments, stay clear of the following areas: cutting edges, pinch points, and crushing surfaces.

Never use attachment as a work platform or manlift.

Contact your DOOSAN distributor about auxiliary hydraulic kits for attachments installation. If you are in doubt about the compatibility of a particular attachment with the machine, consult your DOOSAN distributor.

Pressurized Fluids

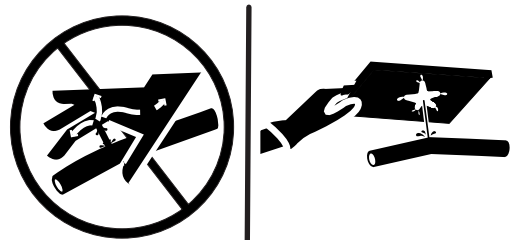
Pressurized air or fluids can cause debris and/or fluids to be blown out. This could result in death or serious injury.

Immediately after operations are stopped, coolant, engine oil, and hydraulic oil are at their highest temperatures and the radiator and hydraulic tank are still under pressure. Always wait for temperature to cool down. Follow specified procedures when attempting to remove caps, drain oil or coolant, or replacing filters. Always wait for temperature to cool down, and follow specified procedures when performing these operations. Failure to do so can result in death or serious injury.

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

Pressure can be trapped in a hydraulic system and must be relieved before maintenance is started.

Releasing trapped pressure can cause sudden machine movement or attachment movement. Use caution if you disconnect hydraulic lines or fittings.



FG018457

Figure 1

High-pressure oil that is released can cause a hose to whip or oil to spray. Fluid penetration can result in death or serious injury. If fluid enters skin or eyes, get immediate medical attention from a physician familiar with this injury.

Obey all local laws and regulations for disposal of liquids.

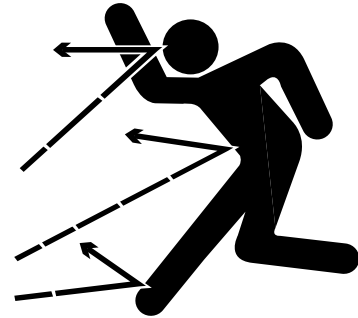
To prevent hot coolant from spraying out, stop engine and wait for coolant to cool. Using gloves, slowly loosen cap to relieve pressure.

Flying or Falling Objects

On work sites where there is a potential hazard that flying or falling objects can come in contact with operator's cabin, select and use a guard to match operating conditions for additional operator protection.

Working in mines, tunnels, deep pits, and loose or wet surfaces, can produce hazard of falling rocks or flying objects. Additional protection for operator's cabin may be required such as a Falling Object Protective Structure (FOPS) or window guards. Contact your DOOSAN distributor for information on available protective guards.

To prevent personnel from being struck by flying objects, keep personnel out of work area.



HAOA110L

Figure 2



HAOA100L

Figure 3

Personal Protective Equipment (PPE)

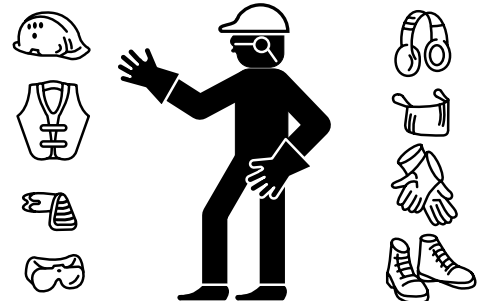
Do not wear loose clothing and accessories. Secure long hair. These items can snag on controls or on other parts of equipment.

Do not wear oily clothes. They are highly flammable.

Do not forget that some risks to your health may not be immediately apparent. Exhaust gases and noise pollution may not be visible, but these hazards can cause disabling or permanent injuries. Breathing masks and/or ear protection may be required.

Wear a hard hat, safety shoes, safety goggles, mask, leather gloves, earplugs and other protective equipment, as required.

While working on machine, never use inadequate tools. They could break or slip, or they may not adequately perform intended functions.



HAOA020L

Figure 4

Correction of Machine Problems

If any machine problems are found during operation and maintenance (noise, vibration, smell, incorrect gauges, smoke, oil leakage, etc.), or if any abnormal warning alerts are displayed on display monitor, stop the machine immediately and take the necessary corrective actions. Do not operate the machine until problem has been corrected.

Crushing and Cutting

Keep objects away from moving fan blades. Fan blades can throw and cut objects.

Do not use a wire rope that is kinked or frayed, or a wire rope with any loss of diameter. Wear leather gloves when handling a wire rope.

When striking a loose retainer pin, it can fly out and can cause a serious injury. Make sure that area is clear of personnel when striking a retainer pin. To avoid injury to your eyes, wear safety goggles when striking a retainer pin.

Do not put your hand, arm or any other part of your body between movable parts. If going between movable parts is necessary, always position and secure work equipment so it cannot move. Properly support equipment before performing any work or maintenance under raised equipment.

If control levers are operated, clearance between machine and work equipment will change and this may lead to serious damage or can result in death or serious injury. Stay clear of areas that may have a sudden change in clearance with machine movement or equipment movement. Stay clear of all rotating and moving parts. Unless instructed, never attempt adjustments while machine is moving or while engine is running.

Do not depend on hydraulic cylinders to support raised equipment. Equipment can fall if a control is moved, or if a hydraulic line breaks, is loosened or disconnected.

If it is necessary to remove guards to perform maintenance, always install guards after maintenance is completed.

Always have at least two people working together if the engine must be running during service. One person needs to remain in the operator's seat, ready to work the controls to stop the machine or stop engine, if necessary.



HDO1010L

Figure 5

Hot Coolant and Oils - Burn Prevention

Do not touch any part of an operating engine. Immediately after operations are stopped, coolant, engine oil, and hydraulic oil are at their highest temperatures. The radiator and hydraulic tank are still under pressure. Always wait for temperature to cool down. Attempting to remove caps, drain oil or coolant, or replacing filters may lead to serious burns, if done when hot. Relieve all pressure in air system, hydraulic oil system, lubrication system, fuel system, and cooling system, before any lines, fittings or related items are disconnected.



FG019095

Figure 6

To prevent hot oil or coolant from spraying out, stop engine and wait for oil and coolant to cool. Using gloves, slowly loosen cap to relieve pressure.



FG019096

Figure 7

Fire and Explosion Prevention

All fuels, most lubricants and some coolant mixtures are flammable and can cause a fire resulting in death or serious injury, and property damage. Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause fire.

Inspect for and remove all flammable materials such as spilled fuel and oil, and debris from machine. Do not allow any flammable materials to accumulate on machine.

Always observe the following:

- Add fuel, oil, antifreeze and hydraulic fluid to machine only in a well ventilated area. Machine must be parked with controls, lights and switches turned "OFF." Engine must be "OFF" and any flames, glowing embers, auxiliary heating units or spark causing equipment must be extinguished, or turned "OFF" and kept well clear of machine.
- Dust that is generated from repairing or grinding nonmetallic hoods or nonmetallic fenders can be toxic, flammable and explosive. Repair these components in a well ventilated area away from flames or sparks and wear a dust mask when grinding painted parts.



HDO10151

Figure 8



FG018458

Figure 9

Maintenance

The machine and some attachments have components that reach high temperatures under normal operating conditions. The primary source of high temperatures are the engine and exhaust system. If damaged or incorrectly maintained, the electrical system can be a source of arcs or sparks.

Flammable debris (leaves, straw, etc.) must be removed regularly. If flammable debris is allowed to accumulate, it can cause a fire hazard. Clean machine often to avoid this accumulation. Flammable debris in an engine compartment is a potential fire hazard.

The operator's area, engine compartment and engine cooling system must be inspected every day and cleaned. This is necessary to prevent fire hazards and overheating.

Operation

Do not use machine where exhaust, arcs, sparks or hot components can contact flammable material, explosive dust or gases.

Do not operate machine near any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil spray or fuel spray in case of a break in a line, hose, or seal. Exhaust shields must be correctly installed and maintained properly.

Electrical

Check all electrical wiring and connections for damage daily.

Keep battery terminals clean and tight. Repair or replace any damaged parts or wires that are loose or frayed. Clean all electrical connections and tighten all electrical connections.

Never check battery charge by placing a metal object across terminal posts. Use a voltmeter or a hydrometer.

Battery gas can explode and can result in death or serious injury. Follow procedures in this manual for connecting battery and for jump-starting. Do not jump-start or charge a frozen or damaged battery. Keep all flames and sparks away from batteries. Do not smoke in battery charging area.

Improper jumper cable connections can cause an explosion that can result in death or serious injury. Refer to Operation and Maintenance Manual for proper procedure in this manual.

Do not charge a frozen battery. This can cause an explosion.

After market radios or other electric operated equipment in cabin must have a fuse in the electrical circuit.

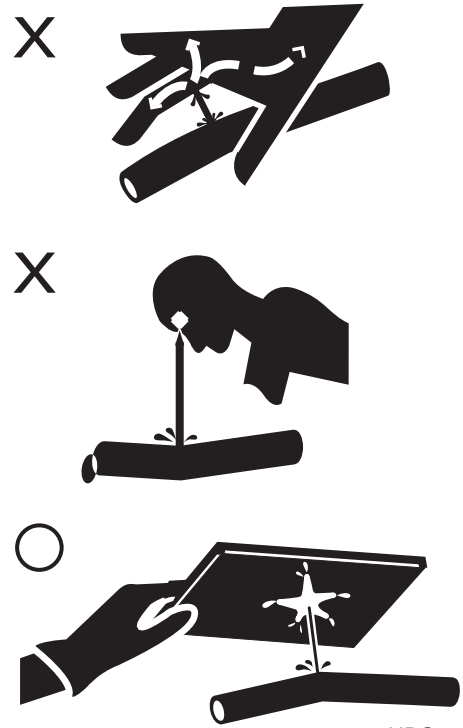
Hydraulic System

Check hydraulic tubes, hoses and fittings for damage, wear or for leaks. Hydraulic lines and hoses must be properly routed and have adequate support and secure clamps. Leaks can cause fires. Never use a flame or bare skin to check for leaks.

Tighten or replace any parts that show leakage.

Check that all hose and tube clamps, guards, and cushions are securely attached. If they are loose, they can vibrate during operation and rub against other parts. This can cause damage to hoses and cause high-pressure oil to spray on hot surfaces, causing a fire and death or serious injury.

Always clean fluid spills. Do not use gasoline or diesel fuel for cleaning parts. Use commercial nonflammable solvents.



HDO1045I

Figure 10

Fueling

Use caution when you are refueling a machine.

Fuel is flammable and can catch fire if it is brought close to a flame.

Stop engine and let it cool before adding fuel. Do not smoke while you are refueling a machine. Do not refuel a machine near flames or sparks. Fill fuel tank outdoors.

Keep fuel and other fluid reservoir caps tight and do not start engine until caps have been secured.

Store fuels and lubricants in properly marked containers away from unauthorized personnel. Store oily rags and any flammable materials in protective containers.

Static electricity can produce dangerous sparks at fuel filling nozzle. In very cold, dry weather or other conditions that could produce a static discharge, keep tip of fuel nozzle in constant contact with neck of fuel filling nozzle, to provide a ground and prevent sparks.

Always place plastic fuel containers on the ground before filling.



ARO1050S

Figure 11

Never Use Ether Starting Aids

Do not use ether or starting fluids on any engine that has glow plugs, or an electric grid type manifold heater. These starting aids can cause an explosion and result in death or serious injury.

Use procedures in this manual for connecting battery and for jump-starting.



FG018458

Figure 12

Welding and Grinding

Always clean machine and attachment, disconnect battery switch, and disconnect wiring from electronic controllers before welding. Cover rubber hoses, battery and all other flammable parts. Keep a fire extinguisher near machine when welding.

Toxic dust or gas can be produced when grinding or welding painted parts. Grinding or welding painted parts must be done in a well ventilated area. Wear a dust mask when grinding painted parts.

Dust generated from repairing nonmetallic parts such as hoods, fenders or covers can be flammable or explosive.

Repair such components in a well ventilated area away from flames or sparks.

Do not weld on lines or on tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent before welding or flame cutting.

If a Fire Occurs

If a fire occurs:

- Do not attempt to move machine or continue operations.
- Turn starter switch to "O" (OFF) position to stop engine.
- Use handrails and steps to get off machine.
- Immediately call for help or fire station.
- When using a fire extinguisher, always aim extinguisher at base of fire.
- If an optional fire extinguishing system is in place, be familiar with its operating procedures.

NOTE: Depending on job conditions, other procedures could be necessary if a fire occurs.



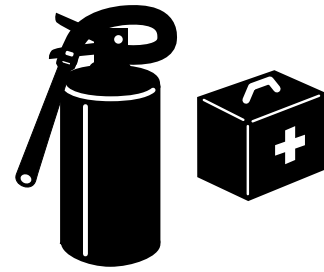
FG018459

Figure 13

Fire Extinguisher and First-Aid Kit (Emergency Medical Kit)

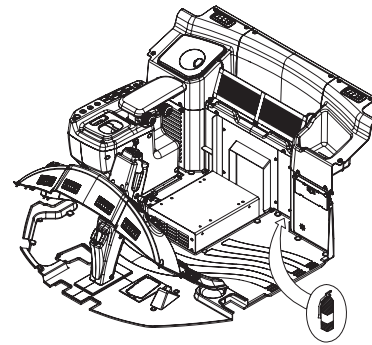
To be prepared in the event of a fire:

- Be sure that fire extinguishers have been provided and read labels to ensure that you know how to use them. It is recommended that an appropriately sized (2.27 kg [5 lb] or larger) multipurpose A/B/C fire extinguisher be mounted in cabin. Check and service fire extinguisher at regular intervals and make sure that all work site crew members are adequately trained in its use.
- Inspect fire extinguisher and service fire extinguisher regularly.
- Follow instructions on extinguisher instruction plate.
- Keep a first aid kit in storage compartment (Figure 15) and keep another kit at work site. Check kit periodically and keep it properly supplied.
- Keep emergency numbers for doctor, ambulance service, hospital and fire department readily available.



HDO1009L

Figure 14



FG018919

Figure 15

Electrical System and Electrical Shock

Never short across starter terminals or across batteries. Shorting could damage electrical system and engine neutral start system.

When engine is running or immediately after it has stopped, high voltage is generated at injector terminal and inside engine controller, so there is a potential for an electrical shock. Never touch injector terminal or inside of engine controller.

NOTE: *If it is necessary to touch injector terminal or inside engine controller, contact your DOOSAN distributor.*

Rollover Protective Structure (ROPS)

The operator's cabin is a ROPS certified structure for protecting the seat belted operator. It absorbs the impact energy of a rollover impact. Do not allow machine weight (mass) to exceed certified value on certification plate. If weight is exceeded, the ROPS structure will not be able to fulfill its safety function.

Do not increase machine weight beyond certified value by modifying machine or by installing attachments on machine. If weight limit of protective equipment is exceeded, protective equipment will not be able to protect operator, and this can result in death or serious injury. Always observe the following:

- This machine is equipped with a protective structure. Do not remove protective structure and perform operations without it.
- Never modify the operator's cabin by welding, grinding, drilling holes or adding attachments unless instructed by DOOSAN in writing. Changes to the cabin can cause loss of operator protection from rollover and falling objects, and result in death or serious injury.
- When protective structure is damaged or deformed by falling objects or by rolling over, its strength will be reduced and it will not be able to adequately protect the operator. Contact your DOOSAN distributor if you have any questions about the ROPS. Never repair a damaged ROPS cabin.
- Always wear your seat belt when operating machine.

TRANSPORTATION

Obey State and Local Over-the-Road Laws & Regulations

Check federal, state and local laws and regulations regarding weight, width and length of a load before making preparations for transporting on public roads or highways.

The hauling vehicle, trailer and load must be in compliance with applicable regulations for the shipping route.

Partial disassembly of the machine may be necessary to meet travel restrictions or particular conditions at work site. See Shop Manual for information on partial disassembly.

Refer to Operation and Maintenance Manual for information on loading, unloading and towing.

The machine can be disassembled into parts for transporting. Contact your DOOSAN distributor for assistance with disassembly.

Loading and Unloading

To prevent machine tipping or rollover when loading or unloading machine, always do the following:

- Perform loading and unloading only on firm, level ground. Maintain a safe distance from edge of road or drop-off.
- Never use work equipment to load or unload machine. The machine may fall or tip over.
- Always use loading ramps of adequate strength and capacity. Be sure that ramps are wide, and long enough to provide a safe loading slope. Take steps to prevent ramps from moving out of position or coming off.
- Clean ramp surfaces so they are free of grease, oil, ice and loose materials. Remove dirt from machine tires. On a rainy day, be careful since ramp surfaces can be slippery.
- Turn auto idle switch "OFF."
- Run engine at low speed and travel slowly.
- When on ramps, do not operate any control lever except for shift lever.
- Never correct your steering on ramps. If necessary, drive off ramps, correct machine direction, then drive back onto ramps.
- For machines equipped with a cabin, always lock door after loading machine to prevent door from suddenly opening during transportation.

Transporting Machine

When transporting machine on a trailer or truck, do the following:

- The weight, transportation height, and overall length of machine may change depending on work equipment attached to it. Always check the machine dimensions and work equipment's dimensions before transporting.
- When passing over bridges or structures on private land, check that structure is strong enough to support weight of machine. Before traveling on public roads, check with appropriate authorities and follow their instructions.

OPERATION

Always make sure that the machine is properly maintained.

Before Engine Starting

Machine Condition

Every day before starting engine for first time, perform the following checks and repair machine before operating, as necessary. If these checks are not properly done death or serious injury could result.

- Check coolant, fuel, and hydraulic tank oil levels, and check for clogged air cleaner and damage to electrical wiring.
- Check operation of gauges, cameras (if equipped) and angle of mirrors, and check that pilot cutoff switch is set to "O" (OFF) position.
- Check that pedals move freely, and pilot control lever (s) returns to "NEUTRAL" when released.
- Check that attachment is properly attached and locked.

IMPORTANT

Only use Ultra Low Sulfur Diesel (ULSD) fuel and API-CJ-4/ACEA-E9 grade engine oil.

Make sure that the machine is equipped with a lighting system that is adequate for job conditions and check that the lights are working properly.

Before performing checks, move machine to an area where there are no obstructions, and operate slowly. Do not allow personnel near machine.

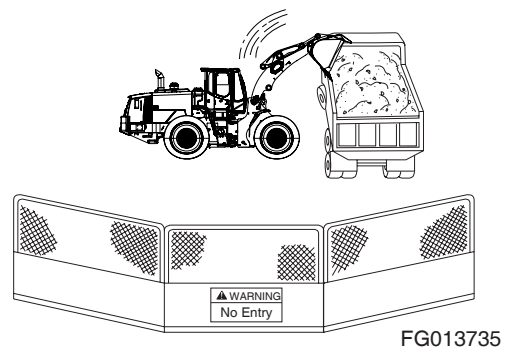
Know maximum operating dimensions of your machine.

Work Site

Before starting operations, thoroughly check work area for any hazards, such as underground utility lines, overhead electrical lines, unstable ground, excessive slopes, etc.

Before starting engine and moving machine, make sure that no one is underneath machine, around machine, or on machine.

Know width and length of your machine and work equipment to maintain proper clearance when you operate machine or work equipment near fences or near boundary obstacles.



FG013735

Figure 16

Know appropriate work site hand signals and personnel that are authorized to give hand signals. Follow hand signals from only one person.

If you need to operate on a street, protect pedestrians and cars by designating a person for work site traffic duty or by erecting fences and posting "No Entry" signs around work site.

Erect barricades or fences, post "No Entry" signs, and take other steps to prevent people from coming close to or entering work site. If people come too close to a moving machine, they may be struck or caught by machine, and this can result in death or serious injury.

Check Tire Pressure and Condition

Maintain tire pressure but do not overinflate. Inspect tires and wheels daily. When inflating tires, follow procedures in Maintenance Section, which include using an extension to avoid standing in front of or over a tire. Do not change a tire unless you understand proper tire maintenance procedures and are using proper equipment.

Refer to Operation and Maintenance Manual.

Mounting/Dismounting

Before getting on or off machine, if there is any oil, grease, or mud on handrails or steps, wipe it off immediately. Always keep these parts clean. Repair any damage and tighten any loose bolts.

Never jump on or off machine. In particular, never get on or off a moving machine. These actions can result in death or serious injury.

When getting on or off machine, always face machine. Maintain three-point contact (both feet and one hand or one foot and both hands) with handrails and steps to ensure that you support yourself securely.

Never hold onto any control levers when getting on or off machine.

Securely latch door. If you grip handrail inside door when moving on platform outside of door, and door latch is not securely engaged, door may move and cause you to fall resulting in death or serious injury.

Use points marked by arrows in diagram when getting on or off machine.

Do not carry tools or supplies when you mount or dismount the machine.

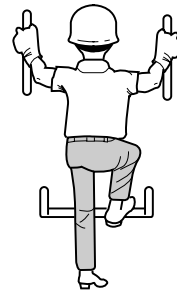


Figure 17

HA3O1003

Cleaning

Remove all straw, wood chips, leaves, grass, paper and other flammable debris accumulated in engine compartment, mufflers and around battery. Remove any dirt from window glass, mirrors, handrails, and steps.

Do not leave tools or spare parts in operator's cabin. Vibration of machine during operation can cause tools or spare parts to fall and damage or break control levers or switches. Tools and spare parts can also get caught in spaces between control levers and cause accidental movement of work equipment causing death or serious injury.

When entering operator's cabin, always remove all mud and oil from your shoes. If you operate travel pedal with mud or oil stuck to your shoes, your foot could slip off the control, or dirt and debris may interfere with proper operation of control levers.

After using ashtray, make sure that any matches or cigarettes are properly extinguished, and be sure to close ashtray.

Clean window glass and working lights for good visibility.

Do not stick suction pads to window glass. Suction pads act as a lens and can cause fire.

Never bring flammable or explosive items into operator's cabin. Do not leave cigarette lighters laying around operator's cabin. If temperature inside operator's cabin becomes too high, there is a potential hazard that lighter could explode.

Secure all loose items such as lunch boxes, and other items that are not a part of the machine itself.

Operator Station

Inspect condition of seat belt and mounting hardware. Replace any parts that are worn or damaged. Do not use a seat belt extension on a retractable seat belt.

Adjust seat so full pedal travel can be achieved with operator's back against back of seat.

Keep all windows and doors closed on machine.

Adjust operator's seat to a position where it is easy to perform operations, and check that there is no damage or excessive wear to seat belt or mounting clamps.

Never reach in through a window to work a control. Do not try to operate the machine unless in operator's seat with the seat belt fastened.

Adjust and clean mirrors so area to rear of machine can be seen clearly from operator's seat.

When standing up from operator's seat, always place pilot cutoff switch in "O" (OFF) position. If you accidentally move work equipment levers when they are not locked, the machine could suddenly move and cause damage, death or serious injury.

Seat Belt

Check seat belt daily for correct function.

Inspect seat belt system more often if machine is exposed to severe environmental conditions or applications. Conduct the following inspections and replace seat belt system as necessary:

1. Check webbing. If system is equipped with a retractor, pull webbing completely out and inspect full length of webbing. Look for cuts, wear, fraying, dirt and stiffness.
2. Check buckle and latch for correct operation.
3. Make sure latch plate is not excessively worn, deformed or buckle is not damaged or casing is broken.
4. Check retractor web storage device (if equipped) by extending webbing and checking that it spools out and retracts correctly.
5. Check webbing in areas exposed to ultraviolet (UV) rays from sun or extreme dust or dirt. If original color of webbing in these areas is extremely faded and/or webbing is packed with dirt, webbing strength may be reduced.

NOTE: *Contact your DOOSAN distributor for seat belt system replacement parts.*



WARNING

AVOID DEATH OR SERIOUS INJURY

Failure to properly inspect and maintain seat belt and seat belt system can cause lack of operator restraint and can result in death or serious injury.

Before fastening seat belt, check that there is no problem in belt mounting bracket. If it is worn or damaged, replace seat belt immediately. Fasten seat belt so it is not twisted.

Always wear seat belt when operating machine.

Visibility Information

A rear view camera (if equipped) and mirrors provide the operator with additional means to see the work area.

NOTE: *These devices may vary from one region to another, depending upon local and regional laws and regulations. If a machine is moved or sold into another region or marketplace, it is the owner's responsibility to make sure it complies with all applicable laws and regulations.*



WARNING

AVOID DEATH OR SERIOUS INJURY

Failure to check for and clear people from the surrounding area of a machine can result in death or serious injury. The operator should make sure that visual aids (mirrors and camera(s)) are in proper working condition.

Your machine may be equipped with visual aids such as mirrors or a rear view camera. Even with these aids, there still may be areas around the machine which cannot be seen from the operator's seat. Always keep bystanders out of the work area. Be careful when operating and always look in direction of travel.

Adjust visual aids for best visibility around machine.

When backing up, press camera button (if equipped) to change display mode on display monitor so you can check rear and side of machine.

Before moving machine, look around work site and use mirrors and display monitor to confirm that no one is in the work area.

While operating or traveling in places with poor visibility it may be impossible to confirm condition of the work site. Inspect and remove any obstacles around the machine that could be damaged and keep other personnel and bystanders out of the work area.

Inspect equipment and repair immediately if there are problems with visual aids. If machine cannot be fixed immediately, DO NOT use the machine. Contact your DOOSAN distributor and arrange for repairs.

Work Site Rules

- If visibility cannot be sufficiently assured, use a flagman. The operator should pay careful attention to signals and follow instructions from flagman.
- Signals should only be given by one flagman.
- When working in dark places, turn "ON" work lights and front lights on the machine. Set up additional lighting in area.
- Stop operations if there is poor visibility, such as fog, snow, rain, or sandstorms.
- Check mirrors and rear view camera (if equipped) on machine before starting operations. Clean off any dirt and adjust view for good visibility.

When operating or traveling during poor visibility conditions, follow the preceding work site rules.

It may not be possible to adjust the visual aids to see all the way around the machine. Therefore, additional precautions such as flagman, barricades, etc., must be taken to keep other personnel and bystanders out of the work area.

Boost Starting or Charging Engine Batteries

Follow these instructions to prevent an explosion or fire when connecting booster cables to batteries:

- Turn "OFF" all electric equipment before connecting leads to battery. This includes electric switches on battery charger or battery booster equipment.
- When boost starting from another machine or vehicle do not allow two machines to touch. Wear safety goggles and gloves while battery connections are made.
- 24 volt battery units consisting of two series connected 12 volt batteries have a cable connecting one positive (+) terminal on one of the 12 volt batteries to a negative (-) terminal on the other battery. Booster or charger cable connections must be made between the nonseries connected positive (+) terminals and between the negative (-) terminal of the booster battery and metal frame of the machine being boosted or charged. The final booster cable connection, at metal frame of the machine being charged or boost started, must be as far away from the batteries as possible. Refer to Operation and Maintenance Manual for proper procedure.
- Connect positive (+) cable first when installing cables and disconnect negative (-) cable first when removing them.

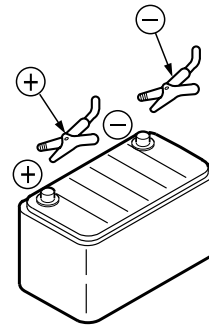


Figure 18

HAOA310L

Starting Engine

Only operate the machine from the operator's seat with your seat belt fastened.

Only operate controls while engine is running.

Check for proper operation of all controls and all protective devices while you operate the machine slowly in an open area.

- Check operation of work equipment and travel system.
- Check for any problems with machine. Check for: unusual sounds, vibration, heat, odor, or improper readings from gauges. Check for any oil or fuel leaks.
- If any problem is found, stop operation and perform repairs immediately.

Do not use cellular telephones inside operator's cabin when driving or operating the machine.

When operating the machine, do not extend your hands or head out of window.

- Do not attempt to start engine by short-circuiting engine starting circuit. This can result in death or serious injury, or fire.
- When starting engine, sound horn as a warning to alert personnel in the work area.

If there is a warning tag or "DO NOT OPERATE" tag hanging from pilot control lever (joystick), do not start engine or move lever.

- Prevent personnel and all bystanders from walking or standing under raised boom, unless it is properly supported.

Traveling

When traveling with the machine, always keep lights on; make sure that you are in compliance with all federal, state and local laws and regulations concerning warning flags and signs.

If engine stops while machine is traveling and the machine is not equipped with an emergency steering system, it will be impossible to operate the steering system and control machine movement.

Pilot control valve lever (joystick) should not be operated while traveling.

Lower work equipment so it is 430 mm (16.9 in) above ground.

Never travel over obstacles or steep slopes that will cause machine to tilt severely. Travel around any slope or obstacle that causes 10°C tilt, or more.

Do not operate steering suddenly. Work equipment can hit ground and this can damage machine or structures in area.

When traveling on rough ground, travel at low speed, and avoid sudden changes in direction.

Keep to permissible water depth. See Operation and Maintenance manual.

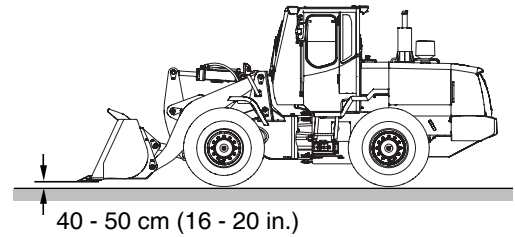
When traveling over bridges or structures check first that bridge or structure can withstand weight of machine. Never exceed the maximum permitted load for bridges or structures.

It is important to keep in mind that the machine, in comparison with the rest of traffic, is a slow moving and wide vehicle which can cause traffic delays. Pay attention to traffic behind you and allow traffic to pass you.

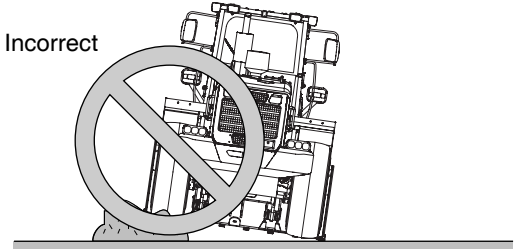
Before operating the machine or work equipment, always observe the following precautions to prevent death or serious injury.

- When changing travel direction from forward to reverse or from reverse to forward, reduce speed and stop machine before changing travel direction.
- Sound horn to alert people in area.
- Check that there is no one in area around machine. There are restricted visibility areas behind machine
- When operating in areas with poor visibility, designate a flagman to direct work site traffic.
- Keep unauthorized personnel away from turning radius or travel path of the machine.

Travel Position

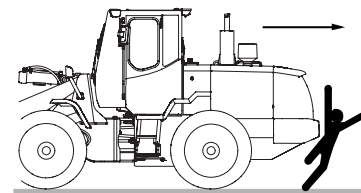
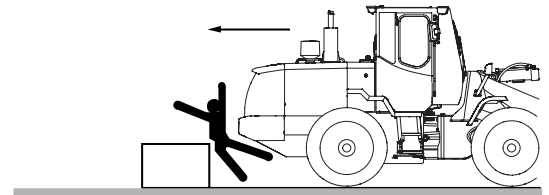


Incorrect



FG026304

Figure 19



FG026305

Figure 20

Be sure to observe these precautions even if a back up alarm or mirrors are installed.

- Check that back up alarm works properly and that mirrors are clean, not damaged and properly adjusted.
- Always latch door and windows of operator's cabin in position (open or closed).
- On work sites where there is a hazard of flying or falling objects, or of objects entering operator's cabin, check that door and windows are securely closed. Install additional guards, if work site application requires them.

Never turn starter switch to "O" (OFF) position when traveling. This can cause a loss of steering control.

Do not operate attachments while traveling.

Never travel over obstacles or excessive slopes that will cause machine to tilt severely. Avoid any slope or obstacle that can cause machine to tilt 10° or more to right or left, or 30° or more from front to rear.

When traveling on rough ground, travel at low speed, and avoid sudden changes in direction.

Know permitted ground pressure. Ground pressure of the machine may change depending on attachment and load.

Keep height and length of attachment in mind.

Lifting and Digging

The operator is responsible for any load carried when traveling on public roads and while working with the machine.

- Keep loads secure so they do not fall off while operating.
- Do not exceed maximum load for the machine. Machine operation will be affected when center of gravity changes, caused by extended loads and different attachments.

To lift loads safely, the following must be evaluated by the operator and work site crew.

- Condition of ground support.
- Machine configuration and attachments.
- Weight, lifting height and lifting radius.
- Safe rigging of load.
- Proper handling of suspended load.

Always watch load.

Do not suddenly lower or stop work equipment.

- Do not move bucket over head of personnel or bystanders, over the operator's seat of dump trucks or other hauling equipment. The load may spill or bucket can come in contact with the dump truck or the equipment causing property damage or cause death or serious injury.

Digging Beneath Overhangs

Do not dig beneath an overhang. The overhang could collapse on top of operator and cause death or serious injury.

Reposition the machine to another digging area before steep overhangs are formed. Know height and reach limits of the machine and plan while working. Park the machine away from overhangs before stopping work.

Digging Beneath Wheel Loader

Never dig beneath the machine. The earth beneath the machine could collapse. This could cause wheel loader to tip or rollover, which could cause death or serious injury to operator. Working around deep pits, trenching or along high walls may require support blocks, especially after heavy rains or during spring thaws.

Operation on Slopes

Dig evenly around work site whenever possible, trying to gradually level any existing slope. If it is not possible to level area or avoid working on a slope, it is recommended that you reduce size and cycling rate of workload.

On sloping surfaces, use caution when positioning the machine before starting a work cycle. Always fasten your seat belt. Stay alert for unstable situations and avoid getting into them. For example, you should always avoid positioning the bucket over downhill side of machine when parked perpendicular to slope. Avoid full extensions of bucket in a downhill direction. Lifting bucket too high, or too close to the machine, while the machine is turned uphill can also be hazardous.

When possible, operate machine up slopes and down slopes. Keep the heavy end of the machine uphill. Avoid operating machine across slope.

On hills, banks or slopes, position bucket approximately 400 mm (16 in) above ground. In case of an emergency, quickly lower bucket to ground to help stop machine.

Do not travel on grass, fallen leaves, or wet steel plates. Even slight slopes can cause machine to slide down a slope. Travel at low speed and make sure that the machine is always traveling directly up or directly down the slope.

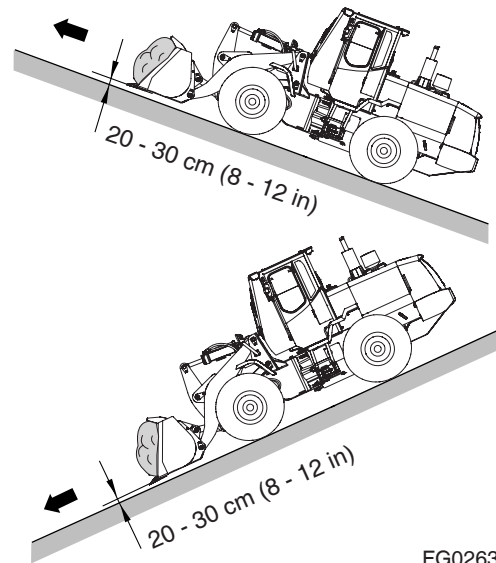
Do not change travel direction on a slope. This could result in tipping or sliding sideways of machine.

If the machine begins to slide down on a grade, immediately dump load and turn the machine downhill.

Be careful to avoid any ground condition which could cause the machine to tip. Tipping can occur when you work on hills, on banks, or on slopes. Tipping can also occur when you cross ditches, ridges, or travel over unexpected obstructions.

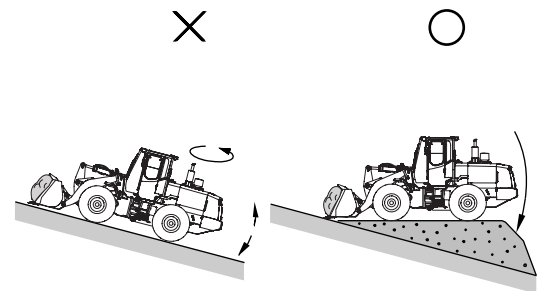
Keep the machine under control. Do not overload the machine beyond capacity.

- Do not turn on slopes or travel across slopes. Always go down to a flat place to change position of the machine, then travel backup the slope again.



FG026386

Figure 21



FG026392

Figure 22

Towing

When necessary to tow another vehicle, towrope must be tied to towing pin on counterweight at rear of vehicle.

NOTE: *The machine must be used for towing only in an emergency.*



WARNING

AVOID DEATH OR SERIOUS INJURY

Do not tow machine at a speed over 10 km/h (6 MPH) and do not tow machine farther than 10 km (6 mi). This will prevent damage to machine transmission caused by the from lack of lubrication.



WARNING

AVOID DEATH OR SERIOUS INJURY

When towing another vehicle on a public road, take necessary precautionary measures to let other vehicles and people know that you are towing another vehicle. Use a flag, rotating beacon light, or hazard light.

NOTE: *Follow all laws and regulations when towing another vehicle with the machine.*

If loader is being towed by another vehicle and engine will not start, remove front and rear driveshafts; otherwise transmission will rotate without being properly lubricated, causing transmission damage. Before removing the driveshafts, apply parking brake and securely block wheels.

If engine can be started and steering wheel and brakes function normally, have someone get in the machine that is going to be towed in order to steer it.

Before towing a vehicle make sure that the following items have been checked:

- Check weights of the machine and the vehicle being towed. Make sure the machine has sufficient braking capacity to stop towed vehicle.
- Check if vehicle being towed can brake and steer. If not, do not allow anyone to ride on towed vehicle.
- Check towrope or tow bar for damage and make sure it has sufficient strength for work.
- When necessary to descend a grade, another towing vehicle must be used in rear to provide additional braking.

To prevent death or serious injury when towing, always do the following:

- Follow the instruction given in this manual.
- When performing preparation work for towing with two or more people, determine signals to use and correctly follow these signals.
- Always attach wire rope onto left and right hooks and secure in position.
- If engine on problem machine will not start or there is a failure in brake system, always contact your DOOSAN distributor before towing.
- Never go between towing machine and towed machine during towing operation.
- Do not perform towing on steep slopes, so select a place where slope is gradual. If there is no place where slope is gradual, perform operations to reduce angle of slope before starting towing operation.
- When towing a machine, always use a wire rope with a sufficient towing capacity.
- Do not use a wire rope that is kinked or frayed, or a wire rope with any loss of diameter. Wear leather gloves when handling a wire rope.
- Do not use lightweight towing hook for towing another machine.
- Make sure that towing eyes and towing devices are adequate for towing loads.
- Only connect wire rope to a drawbar or to a hitch.
- Operate the machine slowly and be careful not to apply any sudden load to wire rope.

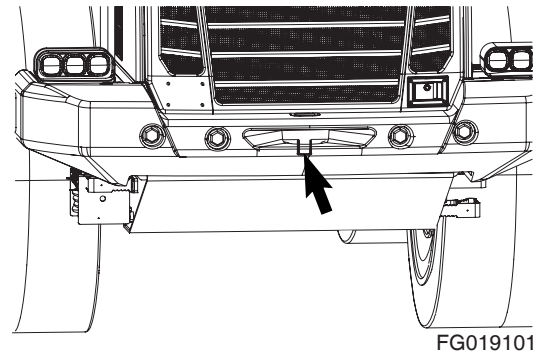


Figure 23

Attachment

Never let anyone ride on any work attachment, such as bucket, forks or grapple. This creates a falling and/or crushing hazard, and can result in death or serious injury.

- When using a fork or grapple, do not attempt to pick up an object with its tips. This could damage the machine or cause personal injury, if picked-up object falls off attachment.
- Do not use impact force of work equipment for demolition work. This could damage work equipment, cause broken materials to fly off or a rollover. This could result in death or serious injury.



Figure 24

HAAD4050

Equipment Lowering with Engine Stopped

Before lowering any equipment with the engine stopped, clear the area around the equipment of all personnel and bystanders. The procedure to use will vary with the type of equipment to be lowered. Keep in mind most systems use a high-pressure fluid or air to raise or lower equipment. The procedure will cause high-pressure air, or hydraulic pressure, or some other media to be released in order to lower the equipment.

Wear appropriate personal protective equipment and follow the procedures in the Operation and Maintenance Manual.

Preventing Risk of Injuries or Death From Boom and Bucket



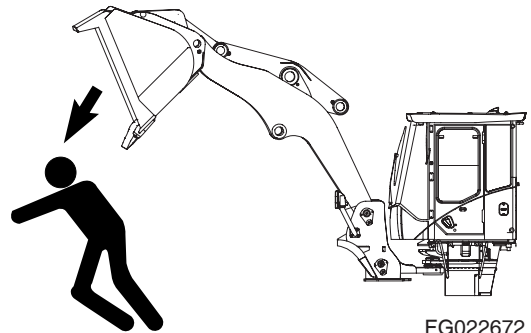
DANGER

AVOID DEATH

When operating machine or making repairs, never allow bystanders in work area or repair area. Operation and service personnel must be careful when working around machine, especially around boom and bucket and articulation joint.

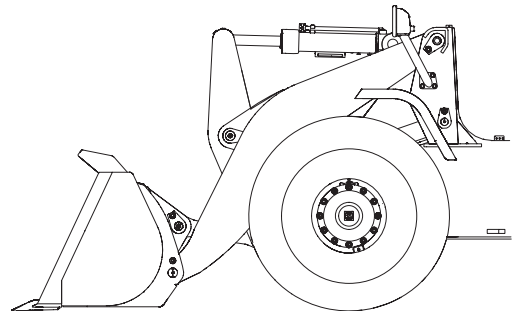
An unexpected lowering of front structure can cause death or serious injury.

1. While operating a machine, do not let people enter the work area. A sudden collapse of front structure caused from a hydraulic hose failure can result in death or serious injury.
2. When stopping or parking machine, lower front structure to ground. If this is not done, sudden collapse of front structure caused from a hydraulic hose failure can result in death or serious injury.



FG022672

Figure 25



FG023188

Figure 26

3. When repairing or inspecting machine, with front structure raised in air, firmly support front structure. When installing supporting structure, check that it is rated and approved to support the weight of the structure.

High-pressure loads between lift arm structure and support can cause support to slip, causing boom to collapse, leading to death or serious injury. Always install the supporting structure on level and firm ground.

A supporting structure must be used, when disconnecting front hoses or removing any other mechanical component related to front structure. High-pressure oil can be ejected from front hydraulic cylinder that can cause the lift arm to suddenly lower or attachment movement resulting in death or serious injury.

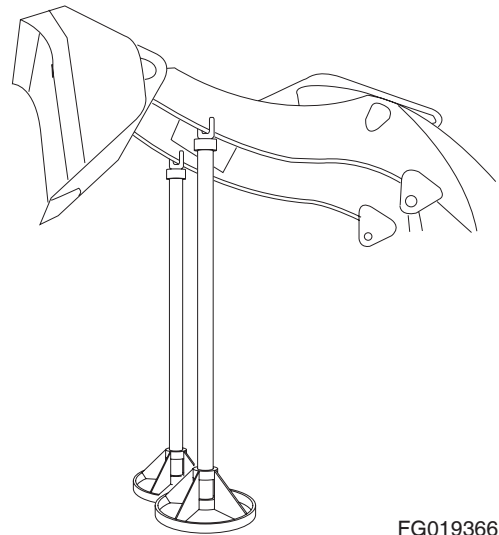


WARNING

AVOID DEATH OR SERIOUS INJURY

Pressurized oil has enough force to pierce skin and cause death or serious injury.

If fluid enters skin or eyes, get immediate medical attention from a physician familiar with this injury.



FG019366

Figure 27

Engine Stop

Turn engine starter switch to "O" (OFF) position and remove engine starter switch key.

Before lowering any equipment with engine stopped, clear area around equipment of all personnel and bystanders. This procedure will cause high-pressure air or hydraulic pressure to be released to lower equipment.

Do not stop engine immediately after the machine has been operated under load. This can cause overheating and accelerated wear of engine components.

After the machine is parked, allow engine to run for at least five (5) minutes before stopping the engine. This allows hot areas of engine to begin to cool gradually.

- Do not leave operator's seat when there is a raised load.

Parking Machine

Park machine on firm, level ground away from traffic and away from high walls, drop-offs and any area of potential water accumulation or runoff. If parking on an incline is unavoidable, block wheels to prevent movement. Lower bucket or other working attachment completely to ground, or to an support saddle, to prevent unintended or accidental movement.

When parking on public roads, provide fences barricades, signs, flags, or lights, and put up any other necessary signs to ensure that passing traffic can see machine clearly. Park machine so machine, flags, barricades, signs and fences do not obstruct traffic.

After front attachment has been lowered to an overnight storage position and all switches and operating controls are in "OFF" position and place the pilot cutoff switch to "O" (OFF) position. This will disable all pilot control functions.

Always close door of operator's cabin and lock all equipment to prevent any unauthorized person from operating the machine.

The hydraulic system remains pressurized, provided that the accumulator, is charged even when engine is not running. Accumulator pressure should decrease in a short time (approximately one minute). While hydraulic system maintains a charge, hydraulic work tools and machine controls remain functional.

Machine movement will occur if any controls are moved. This can result in death or serious injury.

Always move hydraulic lockout control to "LOCK" position before stopping the engine or immediately after engine stops running.

Preservation/Storing Machine

Perform the following if storing the machine for more than one month.

Conditions	Maintenance Required
Cleaning	Pressure wash under wheel loader. Inspect for damage or loose or missing parts.
Lubrication	Perform all daily lubrication procedures.
	Apply a coating of light oil to exposed plated metal surfaces, such as hydraulic cylinder rods, etc.
	Apply a coating of light oil to all control linkages and control cylinders (control valve spools, etc.)
Battery	Turn "OFF" the battery disconnect switch.
Cooling System	Inspect coolant recovery tank to make sure that antifreeze level in system is at correct level.
	Every 90 days, use a hydrometer to measure protection level of coolant. Refer to Operation and Maintenance Manual to determine amount of protection cooling system requires. Add coolant as required.
Hydraulic System	Once a month, start engine and follow procedures in Operation and Maintenance Manual listed in this manual.

1. Complete the steps listed above.
2. Wash machine and touch up paint finish to avoid rusting.
3. Treat exposed parts with antirust agent, lubricate machine thoroughly and apply grease to unpainted surfaces like lifting and tilting cylinders etc.
4. Fill fuel tank and hydraulic oil tank to "FULL" marks.
5. Cover exhaust pipe (parking outside).
6. Make sure that coolant is at proper concentration for expected lowest temperatures.
7. Park machine on level, firm ground where there is no risk of freezing, landslide or flooding. Avoid parking machine on a slope.

Keep in mind that theft and burglary risk can be minimized by:

- Removing starter key when the machine is left unattended.
- Locking doors and covers after working hours.
- Turning off electrical current with battery disconnect switch.
- Parking machine where risk of theft, burglary and damage is minimized.
- Removing valuables from cabin such as cellular phone, computer, radio and bags.

See Operation and Maintenance Manual for more information.

Checks After Long-term Parking

- All oil and fluid levels.
- Tension of all belts.
- Air pressure.
- Air cleaner.
- Batteries and electrical connections.
- Lubricate all greasing points.
- Wipe off grease from piston rods.
- Inspect for signs of nests (i.e. birds, rodents, etc.)

MAINTENANCE

Improper operation and maintenance can result in death or serious injury. Read manual and safety decals before operating or maintaining the machine. Follow all instructions and safety messages.



WARNING

AVOID DEATH OR SERIOUS INJURY

Follow instructions before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments, repairs or service. Untrained operators and failure to follow instructions can result in death or serious injury.

- Never service DOOSAN equipment without instructions.
- Always lower lift arm and attachment to ground before doing any maintenance.
- Use correct procedure to lift and support machine.
- Cleaning and maintenance are required daily.
- Welding or grinding painted parts must be done in well ventilated areas.
- Wear a dust mask when grinding painted parts. Toxic dust and gas can be produced.
- Vent exhaust to outside when engine must be running for service.
- Exhaust system must be tightly sealed. Exhaust fumes are hazardous and can cause death or serious injury.
- Stop and allow engine to cool and clean engine of flammable materials before checking fluids.
- Never service or adjust machine with engine running unless instructed to do so in this manual.
- Avoid contact with leaking hydraulic fluid or diesel fuel under pressure. It can penetrate skin or eyes.
- Never fill fuel tank while engine running, while smoking, or when near an open flame or sparks.
- Keep body, jewelry and clothing away from moving parts, electrical components, hot parts and exhaust.
- Wear eye protection to guard from battery acid, compressed springs, fluids under pressure and flying debris when engines is running or tools are used. Use eye protection approved for welding.

- Lead-acid batteries produce flammable and explosive gases.
- Keep arcs, sparks, flames and lighted tobacco away from batteries.
- Batteries contain acid which burns eyes or skin on contact.
- Wear protective clothing. If acid contacts body, flush well with water. For eye contact flush well and get immediate medical attention from a physician familiar with this injury.
- The maintenance procedures which are given in this manual can be performed by the owner or operator without any specific technical training. Maintenance procedures which are not in this manual must be performed **ONLY BY QUALIFIED SERVICE PERSONNEL**. Always use genuine DOOSAN replacement parts.
- Only authorized personnel should service and repair the machine. Do not allow unauthorized personnel access to the machine or into work area.
- Lower work equipment and stop engine before performing maintenance.
- Park machine on firm, level ground.
- Turn starter switch to "ON" position and set pilot cutoff switch to "I" (ON) position. Cycle work levers (joysticks) back and forth, left and right at full stroke 2 to 3 times to eliminate remaining internal pressure in hydraulic circuit.
- Check that battery relay is "OFF" and main power is shut off. (Wait for approximately one minute after turning "OFF" engine starter switch key and press horn button. If horn does not sound, the main power is shut off.)
- Put blocks against tire to prevent the machine from moving.
- To prevent injury, do not perform maintenance with engine running. If maintenance must be done with engine running, perform maintenance with at least two workers and do the following:
 - One worker must always sit in the operator's seat and be ready to stop engine at any time. All workers must maintain contact with other workers.
 - When maintenance operations are near fan, fan belt, or other rotating parts, there is a potential hazard of being caught in rotating parts. Keep hands and tools away.
- Never drop or insert tools or other objects into rotating fan or fan belt. Parts can break off and hit someone.
- Do not touch any control levers or control pedals. If any control levers or control pedals must be operated, always give a signal to other workers and instruct them to move away.

- When performing maintenance of engine that causes exposure to engine noise for long periods of time, wear hearing protection while working.
- If noise from the machine is too loud, it can cause temporary or permanent hearing loss and/or other problems.
- Do not smoke when you service an air conditioner or if refrigerant gas is present.
- Inhaling fumes either from a flame or gas from a cigarette that has contacted air conditioner refrigerant can cause death or serious injury.
- Never put maintenance fluids into glass containers. Drain all liquids into a suitable containers.
- Unless instructed otherwise, perform maintenance with equipment in servicing position. Refer to this manual for the proper procedure for placing equipment in servicing position.

Warning Tag

Alert others that service or maintenance is being performed by attaching a "DO NOT OPERATE" warning tag to the operator's cabin controls – and other machine areas, if required. Use of the pilot cutoff switch in the "O" (OFF) position, complies with the Occupational Safety and Health Administration's (OSHA) lockout requirements.



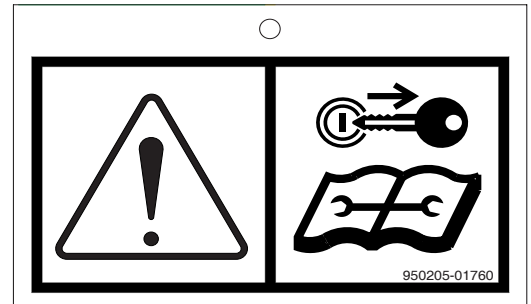
FG018690

Figure 28

"DO NOT OPERATE" warning tags, are available from your DOOSAN distributor.

- Always attach "DO NOT OPERATE" warning tag to work equipment control lever in the operator's cabin to alert others that service or maintenance is being performed on the machine. Attach additional warning tags on the machine, if necessary.
- Keep warning tags in tool box while they are being used. If there is not tool box, store them in the owner manual storage pocket.
- If another person starts engine, and operates control levers or control pedals while you are performing service or maintenance, it can result in death or serious injury.

Attach a "DO NOT OPERATE" warning tag to starter switch or to controls before servicing or repairing equipment. Warning tags (Special Instruction, SEHS7332) are available from your DOOSAN distributor.



FG018596

Figure 29

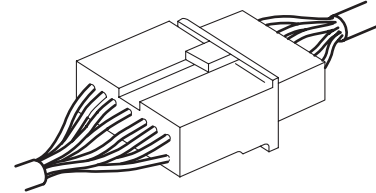
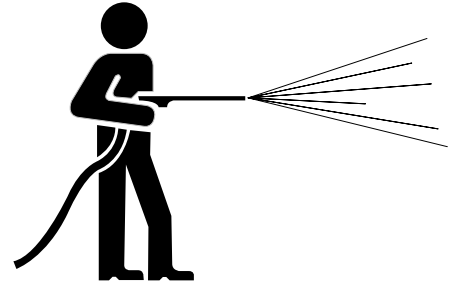
Cleaning

Clean machine before performing inspection and maintenance.

If inspection and/or maintenance are done when machine is dirty, it will become more difficult to locate problems, and this increases the risk of serious injury from slipping on steps and/or the work platform areas.

When washing machine, do the following:

- Wear shoes with nonslip soles to prevent slipping and falling.
- Wear safety goggles and protective clothing when washing machine with high-pressure steam or water.
- Do not spray water directly on electrical components (sensors and connectors). If water gets into electrical system, it can cause operation problems.
- Pick up any tools or hammers that are laying in workplace. Wipe up any grease or oil to prevent slippery surfaces, that can cause tripping or slipping.
- When cleaning cabin top window which is made of polycarbonate material, use tap water. Avoid use of organic solvents for cleaning, such as benzene, toluene or methanol. These solvents can cause a chemical reaction that will dissolve and damage the window.



ARO1330L

Figure 30

Proper Tools and Clothing

Only use tools that are intended for the type of service to be done. Metal pieces from low quality or damaged tools, such as chisels or hammers, can break off and cause death or serious injury..



HDO1037L

Figure 31

Disassembling Precautions

When using a hammer to remove pins, pins can fly out or metal particles may break off. Always do the following:

- Hitting hard metal pins, bucket teeth, cutting edges or bearings with a hammer, can cause metal pieces to break or fly off resulting in serious injury. Always wear safety goggles and leather gloves. Keep personnel and bystanders away.

Use of Lighting

When checking fuel, oil, battery electrolyte, window washer fluid, or coolant, always use proper lighting equipment to prevent arcs or sparks that could cause a fire or explosion resulting in death or serious injury.



HDO1040L

Figure 32

Fire and Explosion Prevention

Fuels, most lubricants and some coolant mixtures are flammable. Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire resulting in property damage or death or serious injury.

Store all fuels and all lubricants in properly marked and approved containers and keep away from all unauthorized personnel.

Store oily rags and other flammable material in a protective container.

Tighten all fuel and oil caps.

Do not smoke while you refuel machine or while you are in a refueling area.

Do not smoke in battery charging areas or in areas that contain flammable material.

Clean all electrical connections and tighten all electrical connections. Check electrical wires daily for wires that are loose or frayed. Tighten all loose, and repair or replace all frayed, electrical wires before operating machine.

Remove all flammable materials and debris from the engine compartment, exhaust system components and hydraulic lines.



HDO1015I

Figure 33

Burn Prevention

When checking radiator coolant level, stop engine, let engine and radiator cool down, then check coolant recovery tank. If coolant level in coolant recovery tank is near upper limit, there is enough coolant in radiator.

Using gloves, loosen radiator cap slowly to release internal pressure before removing radiator cap.

If coolant level in coolant recovery tank is below lower limit, add coolant.

Cooling system conditioner contains alkali which can cause personal injury. Do not allow alkali to contact skin, eyes, or other body parts.

Allow cooling system components to cool before draining cooling system.

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact skin, eyes or other body parts.

Vent hydraulic tank only after engine has been stopped and hydraulic tank is cool. Using gloves, slowly tilt hydraulic tank air breather to relieve pressure.

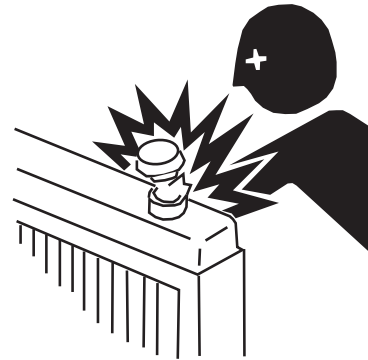
Relieve all pressure in hydraulic oil system, in fuel system, or in cooling system before disconnecting any lines, hoses, fittings, or related components.

Batteries give off flammable fumes that can explode and start a fire.

Do not smoke while you are checking battery electrolyte level.

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact skin or eyes or other body parts.

Always wear safety goggles and face protection when working with batteries.



HAAE1980

Figure 34

Rubber That Contains Fluorides

Observe extra great care when it is suspected that you may have to handle rubber that contains fluorides.

Certain seals which have to withstand high operating temperatures (e.g. in engines, transmissions, axles, hydraulic motors and pumps) may be made from rubber that contains fluorides, which, when exposed to high heat (fire), forms hydrogen fluoride and hydrofluoric acid. This acid is very corrosive and cannot be rinsed or washed off from the skin. It causes very severe burns which take a long time to heal.

It usually means that damaged tissue must be surgically removed. Several hours may pass after contact with the acid, before any symptoms appear and therefore one is not given any immediate warning. The acid may remain on the machine parts for several years after a fire.

If swelling, redness or a stinging feeling appears and one suspects that cause may be contact with heated rubber that contains fluorides, contact a medical doctor immediately. If a machine, or part of a machine, has been exposed to fire or severe heat, it must be handled by specially trained personnel. In all handling of machines after a fire, thick rubber gloves and protective goggles must be used.

The area around a part which has been very hot and which may be made of rubber that contains fluorides must be decontaminated by thorough and ample washing with limewater (a solution or suspension of calcium hydroxide, i.e. slaked lime in water). After the work has been completed, the gloves must be washed in limewater and then discarded.

Rubber and Plastics

Polymer materials when heated, can form compounds that create a health hazard and can harm the environment. Scrapped rubber and plastic must never be burned. Extra precautions must be taken when servicing machines that have been in a fire or exposed to extreme heat.

If gas cutting or welding is to be done near such materials, the following safety instructions must be followed:

- Protect the material from heat.
- Use protective gloves, protective goggles and an approved respirator.

Waste Hazardous to the Environment

Painted parts or parts made of plastic or rubber which are to be scrapped must never be burned, but must be taken care of by an approved refuse handling plant.

Batteries, plastic objects and anything else which is suspected of being dangerous to the environment must be taken care of in an environmentally safe way.

Check List After Fire

When handling a machine which has been damaged by fire or been exposed to intense heat, the following protective measures must under all circumstances be followed:

Use thick, gloves made of rubber and wear goggles which are certain to protect your eyes.

Never touch burned components with your bare hands, as there is a risk that you may come into contact with melted polymer materials. First wash thoroughly with plenty of limewater (a solution or suspension of calcium hydroxide, i.e. slaked lime in water).

As a precaution, seals (O-rings and other oil seals) should always be handled as if they were made of rubber that contains fluorides.

Treat skin, which is suspected of having touched burned rubber that contains fluorides, with Hydrofluoric Acid Burn Jelly or something similar. Seek medical advice. Symptom may not appear until several hours afterwards.

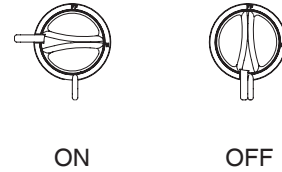
Discard gloves, rags etc. which are suspected of having touched burned rubber that contains fluorides.

Welding Repairs

When performing welding repairs, perform welding in a properly equipped and well ventilated area. Repairs must be performed by a qualified welder. Welding operations, can create potential hazards, including generation of gas, fire, or electric shock. Never let an unqualified welder do welding.

A qualified welder must do the following:

- To Prevent explosion of the battery, turn battery disconnect switch to "OFF" position.
- To prevent generation of gas, remove paint from location of the weld.
- If hydraulic equipment, piping or component ports close to them are heated, a flammable gas or mist could cause an explosion or fire. To prevent this, protect and insulate components from excessive heat.
- Do not weld on pipes or on tubes that contain flammable fluids. Do not flame cut pipes or tubes that contain flammable fluids. Before welding on pipes or tubes, or before flaming cut pipes or tubes, clean them thoroughly with a nonflammable solvent. Make sure pressure inside pipes or tubes does not cause a rupture of the component parts.
- If heat is applied directly to rubber hoses or piping under pressure, they may suddenly break, so cover and insulate them with a fireproof covering.
- Wear protective clothing.
- Make sure there is good ventilation.
- Remove all flammable objects and make sure a fire extinguisher is available for immediate use.



FG020630

Figure 35

Preparation for Electrical Welding On Body Structure

To prevent damage to ECU by electrical welding, observe the following procedures:

1. Turn battery disconnect switch to "OFF" position.
2. Proceed with welding.
3. Clean battery compartment.
4. Turn battery disconnect switch to "ON" position.
5. Close battery compartment door.

Precautions for Removal, Installation, and Storage of Attachments

Before starting removal and installation of attachments, decide on the team leader.

Do not allow anyone except the authorized workers close to the machine or attachment.

Place attachments that have been removed from the machine in a safe place so they do not fall. Put up a fence around the attachments and take other measures to prevent unauthorized persons from entering.



HDO1041L

Figure 36

Working on Machine

When performing maintenance operations on machine, prevent tripping and falling by keeping area around your feet clean and free of objects and debris. Always do the following:

- Do not spill oil or grease.
- Do not leave tools laying around.
- Watch your step when walking.
- Never jump down from machine. When getting on or off machine, use steps and handrails, and maintain a three-point contact (both feet and one hand or both hands and one foot) to support yourself.
- If job requires it, wear protective clothing.
- To prevent injury from slipping or falling, when working on hood or covers, never stand or walk on areas except areas equipped with nonslip pads.
- If it is necessary to work under raised equipment or the machine, support work equipment and machine securely with blocks and stands strong enough to support weight of work equipment and machine.
- Do not work under the machine if machine is lifted off ground and the machine is supported only with work equipment. If any control levers are moved, or there is damage to hydraulic system, work equipment or the machine will suddenly drop causing death or serious injury.



ARO1380L

Figure 37

Lock Inspection Covers

When performing maintenance with inspection cover open, use lock bar to secure cover to prevent cover from suddenly closing causing death or serious injury.

If maintenance work is done with the inspection cover open but not locked, it could suddenly close because of the wind or movement of the machine.

Accumulator

The pilot control system is equipped with an accumulator. For a short period of time after engine has been stopped, accumulator will store a pressure charge that allow hydraulic controls to be activated. Activation of any controls will allow selected functions to operate under force of gravity.

When performing maintenance on pilot control system, release hydraulic pressure in system as described in Operation and Maintenance Manual.

The accumulator is charged with high-pressure nitrogen gas. If it is improperly handled it can explode causing death or serious injury. Always observe the following precautions:

- Do not drill or punch holes in accumulator or expose it to any flames, fire or external heat source.
- Do not weld on accumulator.
- When performing disassembly or maintenance of accumulator, or when disposing of accumulator, charged nitrogen gas must be properly released prior to beginning such work. Contact your DOOSAN distributor for assistance.
- Wear safety goggles and leather gloves when working on an accumulator. Hydraulic oil under pressure can penetrate skin and result in death or serious injury. If fluid enters skin or eyes, get immediate medical attention from a physician familiar with this injury.



FG018458

Figure 38

Compressed Air

- When cleaning filters, radiator or other components with compressed air, there is a hazard of flying particles that can result in serious injury.
- Always wear safety goggles, dust mask, leather gloves, and other protective devices.

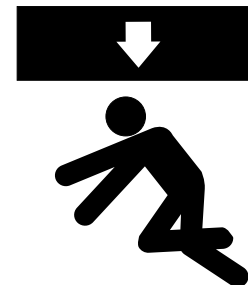
Supports and Blocking for Work Equipment

Do not allow weight or equipment loads to remain suspended and unsupported.

Lower lift arm and attachment to ground before leaving operator's seat.

Do not use hollow, cracked or unstable. Always use an approved support to prevent sudden lowering of the lift arm.

Do not work under any equipment supported only by a lifting jack.



HDO1042L

Figure 39

High-pressure Lines, Tubes and Hoses

When inspecting or replacing high-pressure piping or hoses, check to verify that pressure has been released from circuit. Failure to release pressure can result in death or serious injury. Release pressure as described in Operation and Maintenance Manual. Always do the following:

- Wear eye protection and leather gloves.
- Fluid leaks from hydraulic hoses or pressurized components can be difficult to see but has enough force to pierce skin and can result in death or serious injury. Always use a piece of wood or cardboard to check for suspected hydraulic leaks. Never use your hands or expose your fingers. Always wear safety goggles.
- Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install lines, tubes or hoses that are bent or damaged.
- Make sure that all clamps, guards and heat shields are correctly installed to prevent vibration, rubbing against other parts, and excessive heat during operation.
- Replace hose or components if any of the following problems are found:
 - Damage or leakage from hose end fitting.
 - Wear, damage, cutting of hose covering, or wire braiding is exposed on any hose.
 - Cover portion is swollen in any section.
 - The hose is twisted or crushed.
 - Foreign material is embedded in hose covering.
 - Hose end is deformed.
 - Connection fittings are damaged or leaking.

NOTE: Refer to Operation and Maintenance Manual for additional European regulations.

High-pressure is generated inside engine fuel lines when engine is running. Before performing inspection or maintenance of fuel line system, wait for at least thirty seconds after stopping engine to let internal pressure drop and tip breather cap up to release residual pressure.

Oil or fuel leaks from high-pressure hoses can cause fire or improper operation, which can result in death or serious injury. If any loose bolts are found, stop work and tighten to specified torque. If any damaged hoses are found, stop operations immediately and contact your DOOSAN distributor for replacement parts.

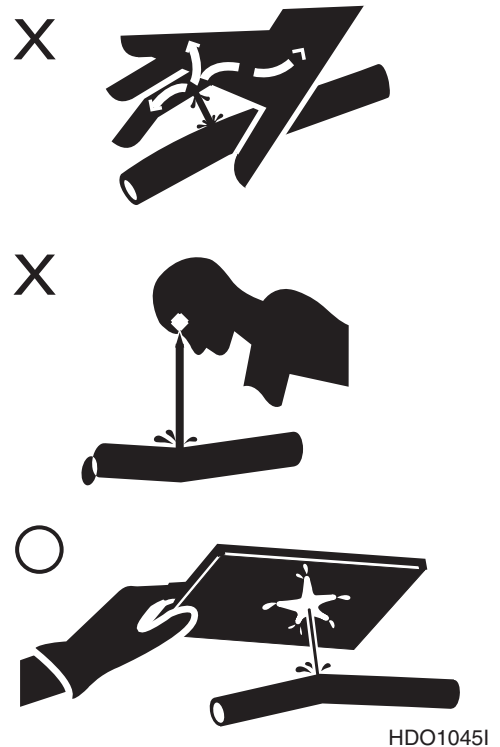


Figure 40

Battery

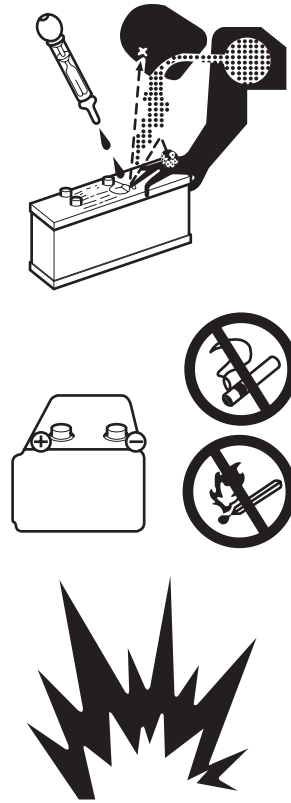
Battery Hazard Prevention

Battery electrolyte contains diluted sulfuric acid and generates hydrogen gas. Hydrogen gas is highly explosive, and improper handling can cause death or serious injury, or fire. Do not allow electrolyte to contact skin or eyes. Always wear safety goggles and protective clothing when servicing batteries. Wash hands after touching batteries and connectors. Use of acid-resistant gloves is recommended. Always observe the following precautions.

- Do not smoke or bring any flame near battery.
- When working with batteries, always wear safety goggles, protective clothing, and acid-resistant gloves.
- If you spill battery electrolyte on yourself or your clothes, immediately flush area with water.
- If battery electrolyte gets into your eyes, flush them immediately with large quantities of water and get immediate medical attention from a physician familiar with this injury.
- If you accidentally drink battery electrolyte, call a poison prevention center immediately and get immediate medical attention from a physician familiar with this injury.
- When cleaning top surface of battery, wipe it with a clean, damp cloth. Never use gasoline, thinner, or any other organic solvent or detergent.
- Tighten battery caps.
- If battery electrolyte is frozen, do not charge battery or start engine with power from another source. This could cause the battery to explode and start a fire.
- When charging battery or starting with power from another source in cold temperatures let battery electrolyte thaw and check that there is no leakage of battery electrolyte before starting operation.
- Always remove battery from machine before charging.
- Do not use or charge battery if battery electrolyte level is below LOW LEVEL line. This can cause an explosion. Periodically check battery electrolyte level and add distilled water to bring electrolyte level to FULL LEVEL line.
- Before maintaining or working with batteries, turn starter switch to "O" (OFF) position.

Since there is a potential hazard that sparks could be generated, always do the following:

- Do not let tools, rings or other metal objects make any contact between battery terminals. Do not leave tools or other metal objects lying near battery.



FG018464

Figure 41

- When disconnecting battery terminals, wait for approximately one minute after turning engine starter switch key to "O" (OFF) position, and be sure to disconnect grounding terminal; negative (-) terminal first. Conversely, when connecting them, begin with positive (+) terminal and then grounding (-) terminal, Make sure that all terminals are connected securely.
- Flammable hydrogen gas is generated when battery is charged. Remove battery from machine, take it to a well ventilated place, and remove battery caps, before charging it.
- After charging, tighten battery caps securely.
- After charging, secure battery back in machine.

When repairing or welding electrical system, wait for approximately one minute after turning engine starter switch key "OFF." Then disconnect negative (-) terminal of battery to stop flow of electricity.

ENVIRONMENT AND CIRCUMSTANCES

Work Site Areas Requiring Extra Caution

- Do not operate too close to edge of a quay, ramp, etc.
- Do not operate too close to edge of a steep slope or drop-off. Use caution when working in a place where machine may tip over.
- Do not operate on soft ground or near river bank that could collapse or where ground may not support weight of machine.
- Observe changes in ground and traction conditions after a rain or other changes in weather.

Digging Under an Overhang

Do not dig work face under an overhang. This can cause overhang to collapse and fall on top of the machine, resulting in death or serious injury.

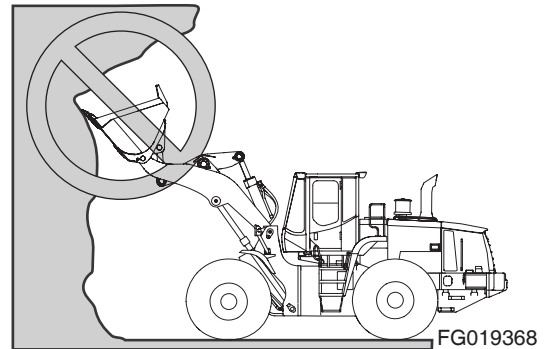


Figure 42

Deep Digging

Do not perform deep digging under front of machine. The ground under machine may collapse and cause machine to fall resulting in death or serious injury.

Working heavy loads on loose, soft or uneven ground, can cause side load conditions resulting in a tip over and injury. Traveling without a load or a balanced load may also be hazardous.

Use machine only for its intended purpose. Using it for other purposes will cause failures.

- Do not perform demolition work under machine. There is a hazard that the machine may become unstable and tip over.
- When working on or from top of buildings or other structures, check if structure can support weight of machine and attachment. If a building structure collapses, this can cause death or serious injury.

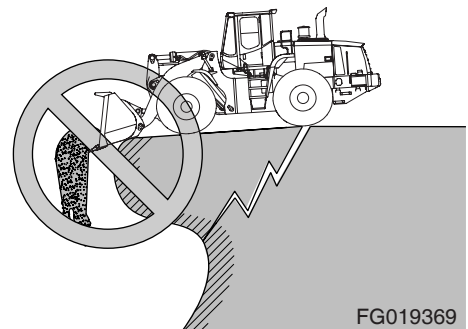


Figure 43

Drop-off or Edge

When working near or at an edge of a drop-off, the machine could tip over, which can result in death or serious injury. Always fasten your seat belt. Check ground conditions of work site before operating to prevent the machine from falling or rollover, and to prevent ground, stockpiles, or banks from collapsing.

Do not travel too close to edge of a drop-off. When working on or from top of buildings or other structures, check if structure can support weight of machine and attachment. If a building structure collapses, this can cause death or serious injury.

Poor Visibility

For good visibility, always do the following:

- When working in dark areas, attach working lights and front lights to the machine. If necessary, set up additional lighting at work site.
- Stop operations when visibility is poor, such as in fog, mist, snow, and rain. Wait for visibility to improve before starting operation.

To avoid hitting work equipment and damaging other property, always do the following:

- When working in tunnels, on bridges, under electrical wires, or when parking the machine or performing other operations in places with limited height, be careful not to hit and damage other equipment or property.
- To prevent hitting objects, operate machine at a slow speed when working in confined spaces, indoors, or in crowded areas.
- Do not move bucket over the top of personnel or bystander or over operator's cabin of dump truck or other machines.

Loose or Soft Ground

Do not operate on soft ground or near edge of drop-offs, overhangs, or deep ditches. The ground can collapse because of the weight of the machine causing the machine to fall or rollover.

Check ground conditions before beginning work with the machine. If ground is soft, reposition the machine before operating.

The excavated material must not be dumped too close to edge. The distance from an edge of an excavation where the excavated material should be dumped depends on soil type and moisture content. If loose clay is being excavated, place it at least 5 m (16 ft) away from edge.

If excavated material is dumped too close to edge, its weight can cause a landslide.

Thawing of frozen ground, rain, traffic, piling and blasting are other factors which increase risk of landslide. The risk also increases on sloping ground. If it is not possible to dig a trench and adequately slope its sides, always install shoring equipment.

Loose ground may easily give way under weight of the machine.

When working on loose or unstable ground, it is important not to dig too deep and to carefully reposition the machine.

Do not panic and do not raise bucket, if ground should begin to collapse. Lower work equipment to improve stability of machine.

Never dig under machine, if there is a potential of causing a landslide.

High-voltage Cables

Do not travel or operate machine near electrical cables or overhead power lines. There is a hazard of electric shock, which can cause property damage and result in death or serious injury. The bucket or other attachment does not have to make physical contact with power lines for current to cause an electrocution.

Use a spotter and hand signals to stay away from power lines not clearly visible to operator. On work sites where machine may operate close to electrical cables, always do the following:

- Remember that electrical voltage determines what the minimum distance is to stay away from the power line. See the following table for minimum distances when working near electrical power lines. Electrical flashover can occur and cause damage to the machine or cause machine and cause death or serious injury.

Voltage	Minimum Distance
6.6 kV	3 m (9' 10")
33.0 kV	4 m (13' 1")
66.0 kV	5 m (16' 5")
154.0 kV	8 m (26' 3")
275.0 kV	10 m (32' 10")

- Always contact the power company responsible before beginning work near high voltage power lines.

Underground Operation

If excavation is in an underground location or in a building, make sure there is adequate overhead clearance, and adequate ventilation.

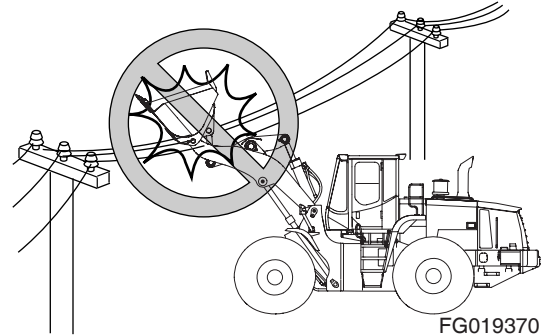


Figure 44

Special equipment and engines may be required in some countries. Contact your DOOSAN distributor for more information.

Check that there is sufficient room for machine and load.

Move slowly.

Make sure that authorities or companies responsible for underground cables, utilities, and electrical lines have been contacted and that their instructions are followed. Also check which rules apply to ground personnel regarding exposing cables, utilities and electrical lines.

Consider all electrical cables as live.

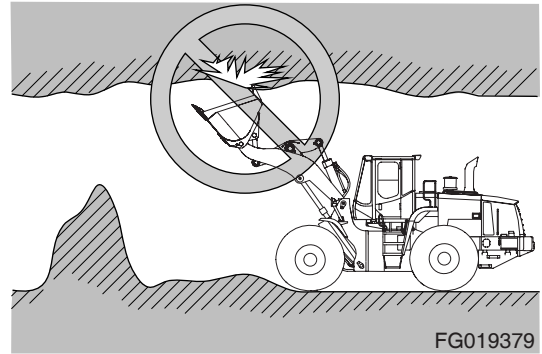


Figure 45

Working in Water

After working in water, lubricate all lubrication points on front and rear frames which have been under water so water is removed.

The water depth is an important factor to take into consideration when the machine is working in swampy areas. Do not enter water whose depth exceeds the machine's minimum ground clearance height or is high enough to wet the bottom of the axle housing.

As a rule of thumb, the allowable water depth is about 430 mm (16.9 inches). This means that the machine should not be used in a river.

Observe the following conditions:

1. Check the water depth in advance when crossing across a river.
2. Use the same precautions before crossing across a swampy area.
3. Do not enter rivers whose riverbed is steep or has a rapid flow.

IMPORTANT

Avoid use of the loader in salt water. Salt water will cause the development of rust which will shorten the life of the loader.

Working in Contaminated Environment

When working within area which is contaminated or where there is a health risk, check local laws and regulations and contact your DOOSAN distributor for assistance with identifying what additional safety precautions need to be taken.

Operation in Extreme Conditions

Operation In Extreme Cold

In extremely cold weather, avoid sudden travel movements and stay away from even slight slopes. The machine could slide down the slope.

Snow accumulation could hide potential hazards and slippery surfaces.

Warming up the engine for a short period may be necessary to avoid operating with sluggish or reduced working capacity. The jolting shocks and impact loads caused by bumping or bottoming boom or attachment could cause severe stress in very cold temperatures. Reducing work cycle rate and workload may be necessary.

If machine is to be operated in extremely cold weather temperatures, certain precautions must be taken. The following checks should be made before operating the machine:

1. Check cooling system for correct mixture of antifreeze solution for lowest expected temperature. Carefully inspect cooling system and repair as necessary.
2. Keep batteries fully charged to prevent freezing. If distilled water is added to batteries, run engine at least one hour to mix electrolyte solution.
3. Keep engine in good mechanical condition for easy starting and good performance during adverse weather.
4. Use engine oil with proper specifications for expected temperatures. Refer to Operation and Maintenance Manual.
5. Always keep fuel tank full. Drain condensation from tank before and after operation. Drain and service fuel filter. To eliminate clogging of fuel filters because of wax crystal formation in fuel, be sure that fuel used has a cloud point specification below lowest expected temperature.
6. Lubricate entire machine according to Operation and Maintenance Manual and/or the lubrication chart on machine.
7. Start engine and allow it to reach normal operating temperature before operating.
 - If mud and ice collects and freezes on any of moving parts while machine is idle, apply heat to thaw frozen material before attempting to operate machine.
 - Operate hydraulic units with care until they have reached a temperature which enable them to operate normally.
 - Check all machine controls, pedals and functions to be sure they are operating correctly before operating.
8. An extra outer air filter must be kept in operator's cabin to replace existing element that could become iced and cause restricted airflow to engine.
9. Clean off all mud, snow and ice to prevent freezing. Cover machine with a tarp if possible and keep ends of tarp from freezing to ground.

Operation in Extreme Heat

Continuous operation of machine in high temperatures can cause machine to overheat. Monitor engine and hydraulic system temperatures and stop machine to let it cool, when necessary.

1. Frequently inspect and maintain fan and radiator. Check coolant level in radiator. Check grilles and radiator fins for accumulation of dirt, debris and insects which could block cooling passages.
 - Formation of scale and rust in cooling system occurs more rapidly in extremely high temperatures. Change antifreeze each year to keep corrosion inhibitor at full strength.
 - If necessary, flush cooling system periodically to keep passages clear. Avoid use of water with a high alkali content which increases scale and rust formation.
2. Check level of battery electrolyte daily. Keep electrolyte above plates to prevent damage to batteries. Use a slightly weaker electrolyte solution in hot climates. Batteries self-discharge at a higher rate if left standing for long periods at high temperatures. If machine is to stand for several days, remove batteries and store in a cool place.

IMPORTANT

Do not store acid type storage batteries near stacks of tires. Acid fumes can damage rubber.

3. Service fuel system as directed in Operation and Maintenance Manual. Check for water content before filling fuel tank. High temperatures and cooling off cause condensation in storage drums.
4. Lubricate as specified in Operation and Maintenance Manual Lubrication Decal on machine.
5. Do not park machine in sun for long periods of time. If possible, park machine under cover to protect it from sun, dirt and dust.
 - A. Cover machine if no suitable shelter is available. Protect engine compartment and hydraulics from dirt and debris.
 - B. In hot, damp climates, corrosion will occur on all parts of machine and will be accelerated during rainy season. Rust and paint blisters will appear on metal surfaces and fungus growth will appear on other surfaces.
 - C. Protect all unfinished, exposed surfaces with a film of preservative lubricating oil. Protect cables and terminals with ignition insulation compound. Apply paint or suitable rust preventive to damaged surfaces to protect them from rust and corrosion.

Operation In Dusty and Sandy Areas

Operation of machine can cause dust in almost any area. However, when in predominantly dusty or sandy areas, additional precautions must be taken.

1. Keep cooling system fins and cooling areas clean. Blow out with compressed air, if possible, as often as necessary.



WARNING

AVOID DEATH OR SERIOUS INJURY

Wear goggles when using compressed air to prevent face or eye injury.

2. Use care when servicing fuel system to prevent dust and sand from entering tank.
3. Service air cleaner at frequent intervals, check air restriction indicator daily and keep dust cup and dust valve clean. Prevent dust and sand from entering engine parts and compartments as much as possible.
4. Lubricate and perform services outlined on current lubrication chart on machine and Operation and Maintenance Manual. Clean all lubrication fittings before applying lubricant. Sand mixed with lubricant becomes very abrasive and accelerates wear on parts.
5. Protect machine from dust and sand as much as possible. Park machine under cover to keep dust and sand from damaging unit.

Operation in Rainy or Humid Conditions

Operation under rainy or humid conditions is similar to that as in extreme heat procedures previously listed in addition:

1. Keep all exposed surfaces coated with preservative lubricating oil. Pay particular attention to damaged or unpainted surfaces. Cover all paint cracks and chip marks as soon as possible to prevent corrosive effects.

Operation in Saltwater Areas

Saltwater and saltwater spray is very corrosive. When operating in saltwater areas, or in or around snow, observe the following precautions:

1. When exposed to saltwater, dry machine thoroughly and rinse with freshwater, as soon as possible.
2. Keep all exposed surfaces coated with preservative lubricating oil. Pay attention to damaged paint surfaces.
3. Keep all painted surfaces in good repair.
4. Lubricate machine as prescribed on lubrication chart on machine or Operation and Maintenance Manual. Shorten lubricating intervals for parts exposed to salt water.
5. Check operating controls to ensure proper functionality and that they return to "NEUTRAL" when released.

Operation at High Altitudes

Operation instructions at high altitudes are the same as those provided for extreme cold. Before operating at high altitudes, engine fuel and air mixture may have to be adjusted according to appropriate engine manual.

1. Check engine operating temperature for evidence of overheating. The radiator cap must make a perfect seal to maintain coolant pressure in cooling system.
 - Perform warming-up operation thoroughly. If machine is not thoroughly warmed up before control levers or control pedals are operated, reaction of machine will be slow.
 - If battery electrolyte is frozen, do not charge battery or start engine with a different power source. There is a potential hazard that could cause a battery explosion or fire.
 - Before charging or starting engine with a different power source, thaw battery electrolyte and check for any leakage of electrolyte before starting.

Operation During Electrical Storms

During electrical storms, do not enter or exit machine.

- If you are off machine, keep away from machine until storm passes.
- If you are in cabin, remain seated with machine stationary until storm passes. Do not touch controls or anything metal.

Exhaust Ventilation

Engine exhaust gases can cause unconsciousness, loss of alertness, judgment and motor control. This can result in death or serious injury.

Make sure there is adequate ventilation before starting engine in any enclosed area.

Check for and be aware of any open windows, doors or ductwork where exhaust may be carried, or blown by wind, exposing others to hazardous exhaust gases.

Ventilation for Enclosed Area

If it is necessary to start engine within an enclosed area, or when handling fuel, flushing oil, or paint; open doors and windows to ensure that adequate ventilation is provided to prevent gas poisoning.

Diesel engine exhaust contains combustible materials which can be harmful to your health.

Always run engine in a well ventilated area. If you are in an enclosed area, vent exhaust to outside.



ARO1770L

Figure 46

Asbestos Information



WARNING

AVOID DEATH OR SERIOUS INJURY

Avoid exposure to dust containing asbestos as it can cause death or serious injury to the lungs and other organs (mesothelioma, lung and other cancers, and asbestosis).

Asbestos dust can be HAZARDOUS to your health if it is inhaled. Materials containing asbestos fiber can be present on work sites. Breathing air that contains asbestos fiber can ultimately cause serious or fatal lung damage or diseases such as mesothelioma, lung and other cancers, and asbestosis. To prevent lung damage from asbestos fiber, observe the following precautions:

- Use an approved respirator that is approved for use in an asbestos-laden atmosphere.
- Use water for cleaning to keep down dust.
- Always observe any laws and regulations related to work site and working environment.
- Avoid brushing or grinding materials that contain asbestos.
- Use a vacuum cleaner that is equipped with a high efficiency particulate air filter can also be used.
- Comply with applicable laws and regulations for workplace.
- Stay away from areas that might have asbestos particles in air.

Silica Dust Information



WARNING

AVOID DEATH OR SERIOUS INJURY

Avoid exposure to dust containing crystalline silica particles as it can cause serious injury to the lungs (silicosis).

Cutting or drilling concrete containing sand or rock containing quartz can result in exposure to silica dust. Do not exceed Permissible Exposure Limits (PEL) to silica dust as determined by OSHA or other work site rules, laws and regulations. Use a respirator, water spray or other means to control dust. Silica dust can cause lung disease and is known to the state of California to cause cancer.



ARO1770L

Figure 47



ARO1770L

Figure 48

Disposal of Hazardous Materials

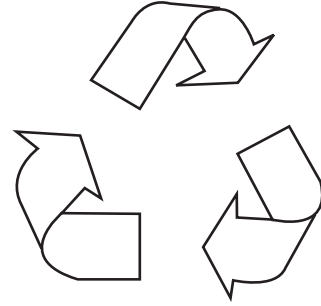
Physical contact with used motor oil or gear oil could create a health risk. Wipe oil from your hands promptly and wash off any remaining residue.

Used motor oil or gear oil is an environmental contaminant and should only be disposed of at approved collection facilities. To prevent pollution of environment, always do the following:

- Never dump waste oil in a sewer systems, rivers, etc.
- Always put drained oil from your machine in approved, leak proof containers. Never drain oil directly onto ground.
- Obey appropriate laws and regulations when disposing of harmful materials such as oil, fuel, solvent, filters, and batteries.

Improperly disposing of waste can threaten environment. Potentially harmful fluids must be disposed of according to local laws and regulations.

Use all cleaning solutions with care. Report all necessary repairs.



FG009156

Figure 49

Sound

Sound Level Information: Hearing protection may be needed when machine is operated with an open operator station for extended periods or in a noisy environment.

See Operation and Maintenance Manual for sound levels for your machine.

Vibration

Hands and Arms: The weighted root mean square acceleration to which hands and arms are subjected to less than 2.5 m/s^2 .

Whole Body: The weighted root mean square acceleration to which whole body is subjected to less than 0.5 m/s^2 .

Measurements are obtained on a representative machine, using measuring procedures as described in the following standard: ISO 2631/1, ISO 5349, and SAE J1166.

Recommendations for Reducing Vibrations:

1. Select proper machine, equipment and attachments for a particular application.
2. Replace any damaged seat with a genuine DOOSAN seat. Keep seat properly maintained and adjusted.
 - Adjust seat and suspension for weight and size of operator.
 - Inspect and maintain suspension and adjustment mechanisms for seat regularly.
3. Check that the machine is properly maintained.
4. Operate controls smoothly when; steering, accelerating, slowing down, loading, or moving attachments.
5. Adjust machine speed and travel path to reduce vibration level.
 - Slow down when traveling over rough terrain or long distances.
 - Avoid obstacles and rough terrain.

Specifications

Specification for DL200A

Edition 1

MEMO

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Specification for DL200A

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

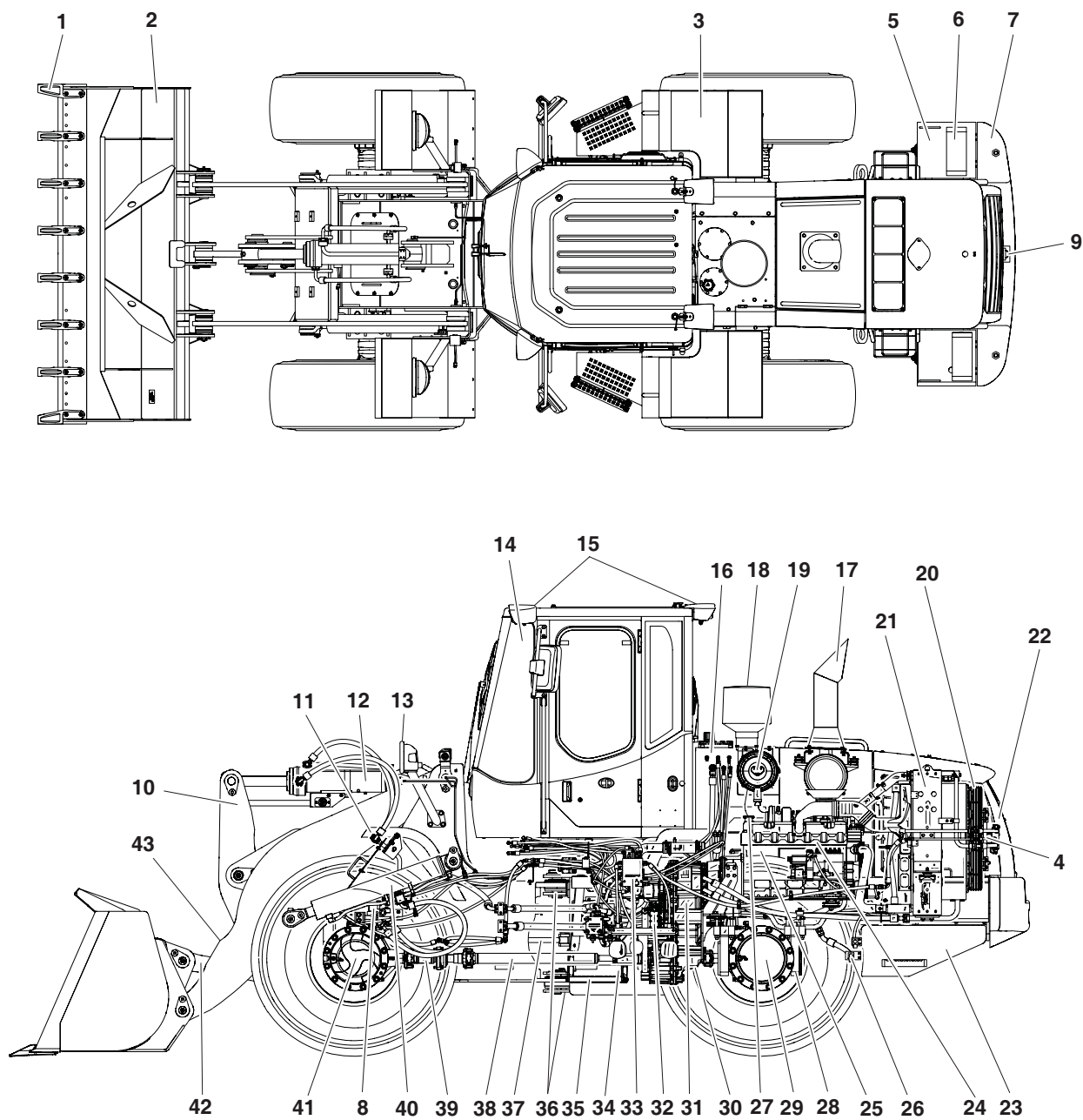
Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

COMPONENT LOCATIONS



FG027770

Figure 1

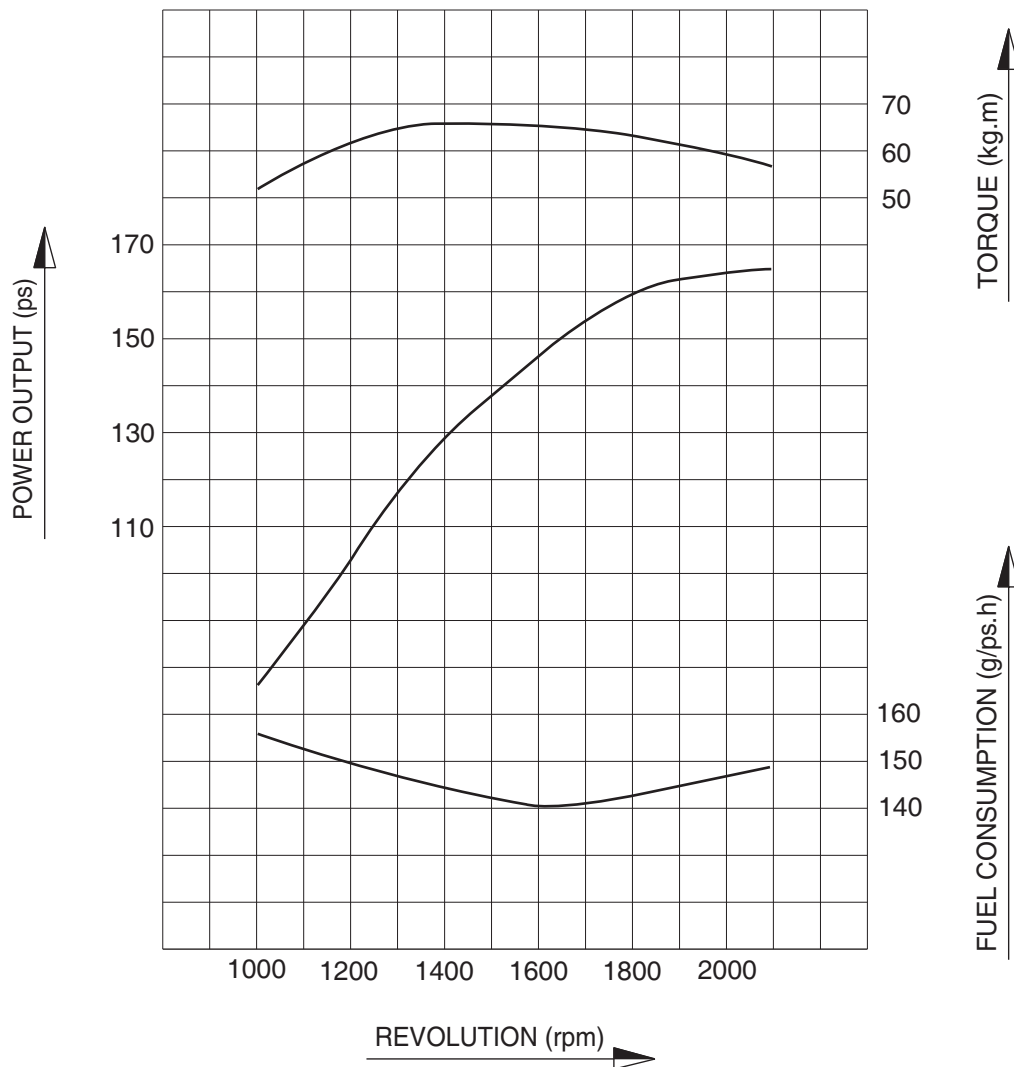
Reference Number	Description
1	Bucket Teeth
2	Bucket
3	Rear Wheel Cover
4	Air Conditioner Condenser
5	Battery Box
6	Rear Light
7	Counterweight
8	MCV
9	Towing Pin
10	Tilt Lever
11	Front Wheel Cover
12	Bucket Cylinder
13	Headlight Support
14	Operator's Cabin
15	Work Light
16	Oil Tank
17	Muffler
18	Engine Air Intake Precleaner
19	Air Cleaner
20	Fan
21	Radiator
22	Grille
23	Fuel Tank

Reference Number	Description
24	Engine
25	Engine Oil Filter
26	Engine Oil Drain Port
27	Engine Oil Fill Cap
28	Rear Axle Pivot
29	Rear Axle
30	Drive Shaft (Rear)
31	Transmission
32	Transmission Oil Filter
33	Pump
34	Parking Brake
35	Ladder
36	Center Pin
37	Steering Wheel Cylinder
38	Drive Shaft (Center)
39	Drive Shaft (Front)
40	Boom Cylinder
41	Front Axle
42	Loader ArmLink
43	Loader Arm

GENERAL SPECIFICATIONS

Item		Specification
Standard Bucket Capacity (BOT / BOC)		2.0 m ³ (2.4 yd ³) / 2.1 m ³ (2.5 yd ³)
Vehicle Weight (BOT / BOC)		11,120 kg (24,515 lb) / 11,175 kg (24,640 lb)
Engine (SAE J1995 Gross)		
Maker and Model		DOOSAN DB58TI
Max. Gross Power		121kw (162 hp) / 2,100 rpm
Rated Gross Power		121kw (162 hp) / 2,100 rpm
Rated NET Power		121kw (162 hp) / 2,100 rpm
Max. Torque		637 Nm (470 ft lb) / 1,400 rpm
Transmission		
Full Automatic Power -Shift		Full Automatic Power Shift
Speeds		4 Forward, 3 Reverse
Brake Systems		
Travel Brakes		Full Hydraulic, Separate Dual Line Wet Disks
Parking Brake		Spring-Applied Hydraulic-Released
Performance		
Travel Speed (km/h)	Forward	7.5(4.7)/12.5(7.8)/21(13)/36(22.4)
	Reverse	7.5(4.7)/13(8.1)/23.5(14.6)
Steering Angle		± 40°
Min. Tire Turning Radius (Center Tire Edge)		5,210 mm (17' 1")
Min. Tire Turning Radius (BOT / BOC Edge)		5,810 mm (19' 1") / 5,785 mm (19' 3")
Safe Operating Load (BOT /BOC Edge)		3,630 kg (8,000 lb)
Max. Breakout Force		103 kN (23,155 lb)
Arm Raise Time		6.0 ±0.5 sec.
Bucket Dump Time		1.3 ±0.3 sec.
Arm Lowering Time		4.0 ±0.4 sec.
Maximum Gradeability		30° (58%)

ENGINE PERFORMANCE CURVES



FG028589

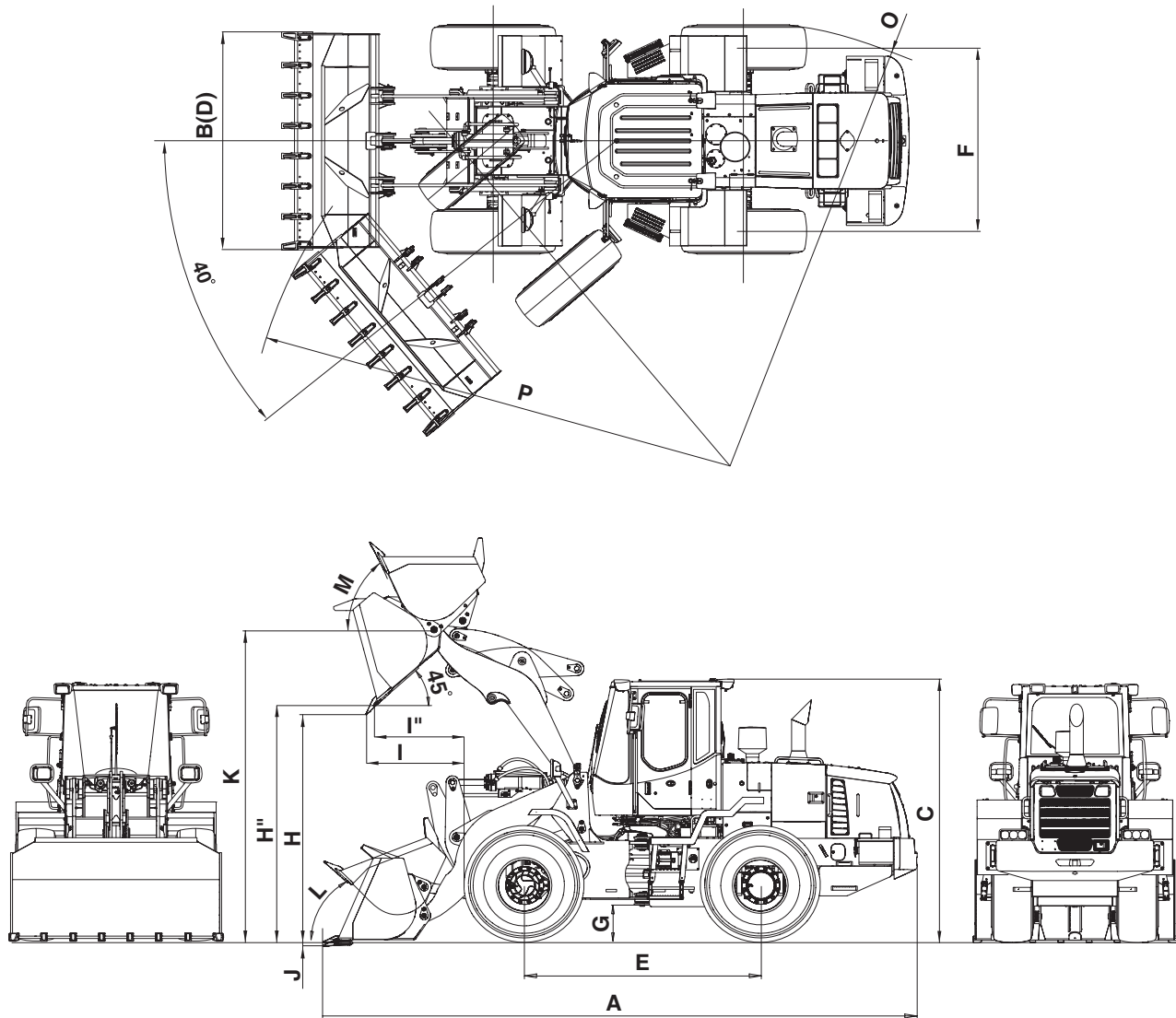
Figure 2

Performance standard	SAE J 1995 gross
Rated Gross Power	164 ps (162 hp) / 2,100 rpm
Maximum Torque	SAE J1995: 63 kg•m (470 ft lb) / 1,400 rpm - Gross
Fuel Consumption (Min ~ Rated)	141 g / ps.h @ Rated Speed

NOTE: *Barometric Pressure: 760 mm (30") Mercury*
 Temperature: 20°C (68°F)
 W/O Cooling Fan: Driven by hydraulic fan motor
 Alternator: 24 V, 60 amp
 Exhaust System: Complete, attached
 Air Cleaner; Installed

WORKING RANGE AND DIMENSIONS

Figure 1, illustrates exterior machine dimensions and working range of machine when it is equipped with a standard bucket.



FG028494

Figure 1

Category		DL200A	
Tire Size		20.5-25-16 PR (L3)	
Overall Length (BOT / BOC)	(A)	7,320 mm (24' 0") / 7,230 mm (23' 9")	
Overall Width	(B)	2,550 mm (8' 4")	
Overall Height	(C)	3,240 mm (10' 8")	
Bucket Width	(D)	2,550 mm (8' 4")	
Wheel Base	(E)	2,900 mm (9' 6")	
Tread	(F)	1,930 mm (6' 4")	
Ground Clearance	(G)	450 mm (1' 6")	
Dump Height (BOT / BOC)	(H)	2,730 mm (8' 11")	2,795 mm (9' 2")
Dump Height (Bucket Edge)	(H")	2,855 mm (9' 8")	
Dump Reach (BOT / BOC)	(I)	1,000 mm (3' 3")	940 mm (3' 1")
Dump Reach (Bucket Edge)	(I")	875 mm (2' 10")	
Digging Depth	(J)	75 mm (3")	
Bucket Hinge Height	(K)	3,840 mm (12' 7")	
Max.Tilt Angle at Carry Position	(L)	47°	
Max.Tilt Angle at Fully Raised	(M)	64°	
Max.Dump Angle at Fully Raised	(N)	45°	
Turning Radius			
(Out Tire Edge)	(O)	5,210 mm (17' 1")	
(BOT / BOC Edge)	(P)	5,810 mm (19' 1")	5,785 mm (19' 3")

WORKING CAPACITIES

Bucket Capacity

Standard toothed bucket has a capacity of 2.0 m³ (2.4 yd³).

Stability Data (EN - and ISO - Norms)

[Unit: kg (lb)]

Bucket Mount	Pin On	Remark
Configuration	Bolt-on Tooth (2.0 m ³)	* Base On 20.5-25-16PR (L3)
Lifting Capacity @ Max. Height	5,590 kg (12,320 lb)	** This data is applicable on firm level ground.
Static Tipping Load @ Max. Reach - Straight	8,690 kg (19,160 lb)	*** Do not lift the load which exceeds legal "Rated Operating Load" when you work with the specific tools.
Static Tipping Load @ Max. Reach - Full Turn	7,260 kg (16,005 lb)	
Rated Operating Load	3,650 kg (8,050 lb)	

Material Weight

The data below describes weight of a cubic meter (cubic yard) of many types of workload materials.

APPROXIMATE WEIGHT OF WORKLOAD MATERIALS

MATERIAL	LOW WEIGHT OR DENSITY 1,100 KG/M ³ (1,850 LB/YD ³), OR LESS	MEDIUM WEIGHT OR DENSITY 1,600 KG/M ³ (2,700 LB/YD ³), OR LESS	HIGH WEIGHT OR DENSITY 2,000 KG/M ³ (3,370 LB/YD ³), OR LESS
Charcoal	401 kg/m ³ (695 lb/yd ³)	-----	-----
Coke, blast furnace size	433 kg/m ³ (729 lb/yd ³)	-----	-----
Coke, foundry size	449 kg/m ³ (756 lb/yd ³)	-----	-----
Coal, bituminous slack, piled	801 kg/m ³ (1,350 lb/yd ³)	-----	-----

MATERIAL	LOW WEIGHT OR DENSITY 1,100 KG/M³ (1,850 LB/YD³), OR LESS	MEDIUM WEIGHT OR DENSITY 1,600 KG/M³ (2,700 LB/YD³), OR LESS	HIGH WEIGHT OR DENSITY 2,000 KG/M³ (3,370 LB/YD³), OR LESS
Coal, bituminous r. of m., piled	881 kg/m ³ (1,485 lb/yd ³)	-----	-----
Coal, anthracite	897 kg/m ³ (1,512 lb/yd ³)	-----	-----
Clay, DRY, in broken lumps	1,009 kg/m ³ (1,701 lb/yd ³)	-----	-----
Clay, DAMP, natural bed	-----	1,746 kg/m ³ (2,943 lb/yd ³)	-----
Cement, Portland, DRY granular	-----	1,506 kg/m ³ (2,583 lb/yd ³)	-----
Cement, Portland, DRY clinkers	-----	1,362 kg/m ³ (2,295 lb/yd ³)	-----
Dolomite, crushed	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Earth, loamy, DRY, loose	-----	1,202 kg/m ³ (2,025 lb/yd ³)	-----
Earth, DRY, packed	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Earth, WET, muddy	-----	-----	1,762 kg/m ³ (2,970 lb/yd ³)
Gypsum, calcined, (heated, powder)	961 kg/m ³ (1,620 lb/yd ³)	-----	-----
Gypsum, crushed to 3 inch size	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Gravel, DRY, packed fragments	-----	-----	1,810 kg/m ³ (3,051 lb/yd ³)
Gravel, WET, packed fragments	-----	-----	1,922 kg/m ³ (3,240 lb/yd ³)
Limestone, graded above 2	-----	1,282 kg/m ³ (2,160 lb/yd ³)	-----
Limestone, graded 1-1/2 or 2	-----	1,362 kg/m ³ (2,295 lb/yd ³)	-----

MATERIAL	LOW WEIGHT OR DENSITY 1,100 KG/M³ (1,850 LB/YD³), OR LESS	MEDIUM WEIGHT OR DENSITY 1,600 KG/M³ (2,700 LB/YD³), OR LESS	HIGH WEIGHT OR DENSITY 2,000 KG/M³ (3,370 LB/YD³), OR LESS
Limestone, crushed	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Limestone, fine	-----	-----	1,602 kg/m ³ (2,705 lb/yd ³)
Phosphate, rock	-----	1,282 kg/m ³ (2,160 lb/yd ³)	-----
Salt	929 kg/m ³ (1,566 lb/yd ³)	-----	-----
Snow, light density	529 kg/m ³ (891 lb/yd ³)	-----	-----
Sand, DRY, loose	-----	1,522 kg/m ³ (2,565 lb/yd ³)	-----
Sand, WET, packed	-----	-----	1,922 kg/m ³ (3,240 lb/yd ³)
Shale, broken	-----	1,362 kg/m ³ (2,295 lb/yd ³)	-----
Sulphur, broken	529 kg/m ³ (1,620 lb/yd ³)	-----	-----

IMPORTANT

Weights are approximations of estimated average volume and mass. Exposure to rain, snow or ground water; settling or compaction due to overhead weight and chemical or industrial processing or changes due to thermal or chemical transformations could all increase value of weights listed in table.

General Maintenance

General Maintenance Instructions

Edition 4

MEMO

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General Maintenance Instructions

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

WELDING PRECAUTIONS AND INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

To avoid accidents, personal injury and the possibility of causing damage to the machine or to components, welding must only be performed by properly trained and qualified personnel, who possess the correct certification (when required) for the specific welding fabrication or specialized repair being performed.



WARNING

AVOID DEATH OR SERIOUS INJURY

Structural elements of the machine may be built from a variety of steels. These could contain unique alloys or may have been heat-treated to obtain particular strength characteristics. It is extremely important that welding repairs on these types of steel are performed with the proper procedures and equipment. If repairs are performed incorrectly, structural weakening or other damage to the machine (that is not always readily visible) could result. Always consult *DOOSAN* After Sales Service before welding on integral components (loader arm, frames, car body, track frames, upper structure, attachment, etc.) of the machine. It is possible that some types of structurally critical repairs may require Magnetic Particle or Liquid Penetrant testing, to make sure there are no hidden cracks or damage, before the machine can be returned to service.



WARNING

AVOID DEATH OR SERIOUS INJURY

Always perform welding procedures with proper safety equipment and adequate ventilation in a dry work area. Keep a fire extinguisher near and wear personal protective equipment.



WARNING

AVOID DEATH OR SERIOUS INJURY

Observe the following safety instructions:

1. Use adequate safety shielding and keep away from fuel and oil tanks, batteries, hydraulic piping lines or other fire hazards when welding.
 2. Never weld when the engine is running. Battery cables must be disconnected before the welding procedure is started.
 3. Never weld on a wet or damp surface. The presence of moisture causes hydrogen embrittlement and structural weakening of the weld.
 4. If welding procedures are being performed near cylinder rods, operator's cabin window areas or any other assemblies could be damaged by weld spatters. Use adequate shielding protection in front of the assembly.
 5. During welding equipment setup, always attach ground cables directly to the area or component being welded to prevent arcing through bearings, bushings, or spacers.
 6. Always use correct welding rods for the type of weld being performed and observe recommended precautions and time constraints. AWS Class E7018 welding rods for low alloy to medium carbon steel must be used within two hours after removal from a freshly opened container. Class E11018G welding rods for T-1 and other higher strength steel must be used within 1/2 hour of removal from a freshly opened container.
-

HYDRAULIC SYSTEM - GENERAL PRECAUTIONS

Always maintain oil level in the system at recommended levels. Assemblies that operate under heavy loads, at high-speed, with extremely precise tolerances between moving parts (e.g. pistons and cylinders, or shoes and swash plates), can be severely damaged if oil supply runs dry.

Assemblies can be run dry and damaged severely in a very short time when piping or hoses are disconnected to repair leaks and/or replace damaged components. Hoses that are inadvertently switched during disassembly (inlet for outlet and vice versa), air introduced into the system or assemblies that are low on oil because of neglect or careless maintenance, could all produce sufficient fluid loss to cause damage or improper operation.

When starting the engine (particularly after long layoff or storage intervals), make sure that all hydraulic controls and operating circuits are in neutral, or "OFF". That will prevent pumps or other components that may be temporarily oil starved from being run under a load.

Replacement of any hydraulic system component could require thorough cleaning, flushing, and some amount of prefilling with fresh, clean oil if the protective seal on replacement parts has obviously been broken or if seal integrity may have been compromised. When protective seals are removed before installation and reassembly, inspect all replacement parts carefully, before they are installed. If the replacement part shows no trace of factory prelube or has been contaminated by dirt or by questionable oils, flushing and prefilling with clean hydraulic fluid is recommended.

Vibration, irregular or difficult movement or unusual noise from any part of the hydraulic system could be an indication of air in the system (and many other types of problems). As a general precaution (and to help lessen the risk of potential long-term damage), allow the engine to run at no-load idle speed immediately after initial start-up. Hydraulic fluid will circulate, releasing any air that may have been trapped in the system before load demands are imposed.

Before starting the machine, a daily walk-around safety inspection, including a quick visual inspection for any exterior evidence of leaking hydraulic fluid, can help extend the service life of system components.

IMPORTANT

Hydraulic system operating conditions (repetitive cycling, heavy workloads, fluid circulating under high-pressure) make it extremely critical that dust, grit or any other contamination be kept out of the system. Observe fluid and filter change maintenance interval recommendations and always preclean any exterior surface of the system before it is exposed to air. For example, the reservoir fill cap and neck area, hoses that have to be disassembled, and the covers and external surfaces of filter canisters should all be cleaned before disassembly.

MAINTENANCE SERVICE AND REPAIR PROCEDURE

General Precautions

Fluid level and condition should always be checked whenever any other maintenance service or repair is being performed.

NOTE: *If the unit is being used in an extreme temperature environment (in subfreezing climates or in high temperature, high humidity tropical conditions), frequent purging of moisture condensation from the hydraulic reservoir drain tap must be a regular and frequent part of the operating routine. In more moderate, temperate climates, draining reservoir sediment and moisture may not be required more than once or twice every few months.*

Inspect drained oil and used filters for signs of abnormal coloring or visible fluid contamination at every oil change. Abrasive grit or dust particles will cause discoloration and darkening of the fluid. Visible accumulations of dirt or grit could be an indication that filter elements are overloaded (and will require more frequent replacement) or that disintegrating bearings or other component failures in the hydraulic circuit may be imminent or have already occurred. Open the drain plugs on the main pump casings and check and compare drain oil in the pumps. Look for evidence of grit or metallic particles.

Vibration or unusual noise during operation could be an indication of air leaking into the circuit (Refer to the appropriate Troubleshooting section for component or unit for procedures.), or it may be evidence of a defective pump. The gear type pilot pump could be defective, causing low pilot pressure, or a main pump broken shoe or piston could be responsible.

NOTE: *If equipped, indicated operating pressure, as shown on the multidisplay digital gauge on the Instrument Panel ("F-Pump" and "R-Pump") will be reduced because of a mechanical problem inside the pump. However, pressure loss could also be because of cavitation or air leakage, or other faults in the hydraulic system.*

Check the exterior case drain oil in the main pumps. If no metallic particles are found, make sure there is no air in the system. Unbolt and remove tank return drain line from the top part of the swing motor, both travel motors and each main pump. If there is air in any one of the drain lines, carefully prefill the assembly before bolting together the drain line piping connections. Run the system at low rpm.

HYDRAULIC SYSTEM CLEANLINESS AND OIL LEAKS

Maintenance Precautions for Hydraulic System Service

Whenever maintenance, repairs or any other troubleshooting or service is being performed, it's important to remember that the hydraulic system - including both the interior and exterior surfaces of assemblies, and every drop of operating fluid - must be protected from contamination.

Dust and other foreign contaminants are major contributors to premature wear in hydraulic circuits. The narrow tolerances, rapidly moving parts and high operating pressures of the system require that fluid be kept as clean as possible. The performance and dependability of the machine (and the service life of individual components) can be noticeably reduced if proper precautions are not observed:

- Use a noncombustible, evaporative type, low residue solvent and thoroughly clean exterior surfaces of assemblies before any part of the circuit is opened or disassembled.

NOTE: *It's just as important to clean the cap and reservoir top before routine fluid changes or quick checks as it is before major repairs. (Accumulated dirt attracts moisture, oil and other fluids - and more dirt.)*

- Keep dismantled parts covered during disassembly. Use clean caps, plugs or tape to protect the disconnected openings of flanges, manifolds and piping.
- Do not allow cleaning solvents or other fluids to mix with the oil in the system. Use clean oil to flush any traces of solvent or other residue before reassembly.
- If metal or rubber fragments are found in the system, flush and replace all fluid in the system and troubleshoot the circuit to identify the source of contamination.

IMPORTANT

Make sure that cleaning solvents will be compatible with rubber materials used in the hydraulic system. Many petroleum based compounds can cause swelling, softening, or other deterioration of system sealing elements, such as O-rings, caps and other seals.

Oil Leakage Precautions

Oil that is visibly seeping from joints or seals should always serve as a "red flag" alarm.

Leaks must alert the machine operator and maintenance crew that air, water and dirt have an open, free passageway through which to enter the circuit. Corrosive salt air, freezing and thawing condensation cycles and working environments that are full of fine dust are especially hazardous. Clogging of valve spools or external piping (especially pilot circuit piping) can gradually diminish or suddenly put a stop to normal hydraulic function. You can prevent having to make these types of repairs by the following recommended assembly procedures:

1. Use new O-rings and oil seals whenever hydraulic assemblies are rebuilt.
2. Prepare joint surfaces before assembly by checking alignment and flatness. Clean and repair corrosion or any other damage.
3. Follow bolt torque recommendations and all other assembly requirements.

NOTE: *Grease lip seals before assembly.*

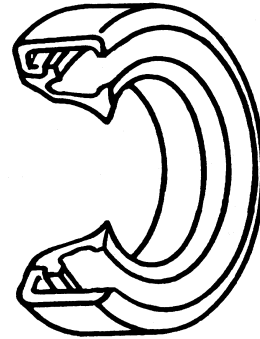


Figure 1

0565A

CLEANING AND INSPECTION

General Instructions

All parts must be clean to permit an effective inspection. During assembly, it is very important that no dirt or foreign material enters unit being assembled. Even minute particles can cause malfunction of close fitting parts such as thrust bearing, matched parts, etc.



WARNING

AVOID DEATH OR SERIOUS INJURY

Do not inhale vapors or allow solvent type cleaners to contact skin. Keep solvent away from open flame, arcs or sparks or other sources of ignition that could start a fire.

1. Clean all metal parts thoroughly using a suitable cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all oils, lubricants, and/or foreign materials are dissolved and parts are thoroughly clean.
2. For bearings that can be removed, soak them in a suitable cleaning fluid for a minute or two, then remove bearings from cleaning fluid and strike flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. To dry bearings, use moisture-free compressed air. Be careful to direct airstream across bearing to avoid spinning bearings that are not lubricated. **DO NOT SPIN BEARINGS WHEN DRYING**; bearings may be rotated slowly by hand to facilitate drying process.
3. Carefully inspect all bearing rollers, cages and cups for wear, chipping or nicks to determine condition. Do not replace a bearing cone or cup individually without replacing mating cup or cone at the same time. After inspection, dip bearings in lightweight oil and wrap in clean lintless cloth or paper to protect them until installation.

For those bearings that are to be inspected in place; inspect bearings for roughness of rotation, scoring, pitting, cracked or chipped races. If any of these defects are found, replace bearings. Also, inspect defective bearing housing and/or shaft for grooved, galled or burred conditions that indicate bearing has been turning in its housing or on its shaft.

4. It is more economical to replace oil seals, O-rings, sealing rings, gaskets and retaining rings when unit is disassembled than waiting for premature failures; refer to latest Micro Fiche and/or Parts Book for replacement items.

Be careful when installing sealing members, to avoid cutting or scratching. Curling under of any seal lip will seriously impair its efficiency. Apply a thin coat of Loctite #120 to outer diameter of metal casing and on oil seals to assure an oil tight install into retainer. Use extreme care not to get Loctite on lips of oil seals. If this happens, that portion of the seal will become brittle and allow leakage.

When replacing lip type seals, make sure spring loaded side is towards oil to be sealed.

5. If available, use magna-flux or similar process for checking for cracks that are not visible. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks or scores. Replace all gears showing cracks or spots where case-hardening has worn through. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they have not been sprung, bent, or no twisted splines, and that shafts are true.

NOTE: *Spline wear is not considered detrimental except where it affects tightness of splined parts.*

Inspect thrust washers for distortion, scores, burs, and wear. Replace thrust washer if defective or worn.

6. Inspect bores and bearing surfaces of cast parts and machined surfaces for scratches, wear, grooves and dirt. Remove any scratches and burrs with crocus cloth. Remove foreign material. Replace any parts that are deeply grooved or scratched which would affect their operation.

Bearing Inspection

The conditions of the bearing are vital to the smooth and efficient operation of the machinery. When any component containing bearings is disassembled, always carefully examine the condition of the bearings and all of its components for wear and damage.

Once the bearing is removed, clean all parts thoroughly using a suitable cleaning solution. If the bearing is excessively dirty, soak the bearing assembly in a light solution and move the bearing around until all lubricants and/or foreign materials are dissolved and the parts are thoroughly clean.

When drying bearings, moisture free compressed air can be used. Be careful not to direct the air in a direction which will force the bearing to dry spin while not being properly lubricated.

After the bearings have been cleaned and dried, carefully inspect all bearing rollers, cages and cups for wear, chipping or nicks. If the bearing cannot be removed and is to be inspected in place, check for roughness of rotation, scoring, pitting, cracked or chipped races. If any of these defects are found replace the whole bearing assembly. NEVER replace the bearing alone without replacing the mating cup or the cone at the same time.

After inspection lightly coat the bearing and related parts with oil and wrap in a clean lintless cloth or paper and protect them from moisture and other foreign materials until installation.

It is also important to inspect the bearing housing and/or shaft for grooved, galled or burred conditions that indicate the bearing has been turning in its housing or on its shaft.

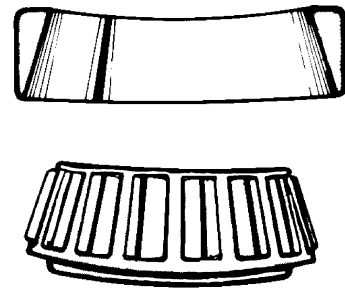
If available, use magna-flux or similar process for checking for cracks that are not visible.

The following illustrations will aid in identifying and diagnosing some of the bearing related problems.

NOTE: *The illustrations will only show tapered roller bearings, but the principles of identifying, diagnosing and remedying the defects are common to all styles and types of bearings.*

Normal Bearing

Smooth even surfaces with no discoloration or marks.

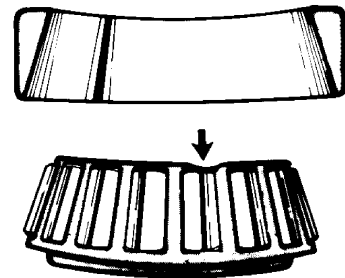


HASA620S

Figure 2

Bent Cage

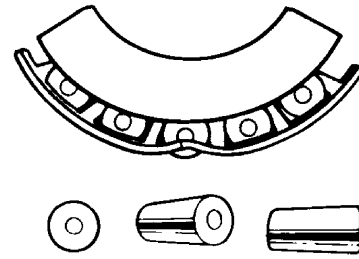
Cage damage because of improper handling or tool usage.



HASA460S

Figure 3

Replace bearing.



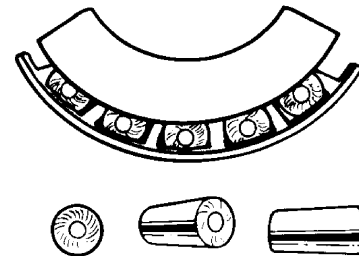
HASA470S

Figure 4

Galling

Metal smears on roller ends because of overheat, lubricant failure or overload.

Replace bearing - check seals and check for proper lubrication.



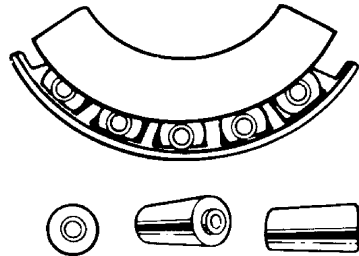
HASA480S

Figure 5

Abrasive Step Wear

Pattern on roller ends caused by fine abrasives.

Clean all parts and housings, check all parts and housings, check seals and bearings and replace if leaking, rough or noisy.



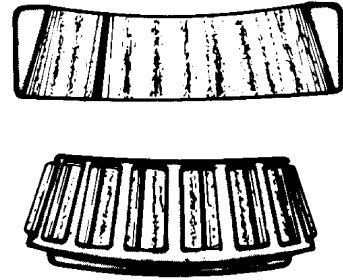
HASA490S

Figure 6

Etching

Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.

Replace bearings - check seals and check for proper lubrication.



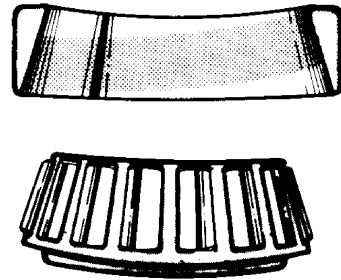
HASA500S

Figure 7

Misalignment

Outer race misalignment because of foreign object.

Clean related parts and replace bearing. Make sure races are properly seated.



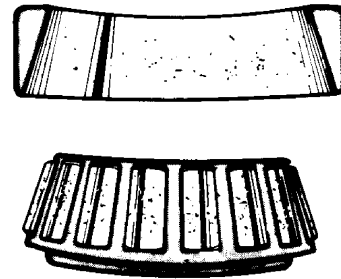
HASA510S

Figure 8

Indentations

Surface depressions on race and rollers caused by hard particles of foreign materials.

Clean all parts and housings, check seals and replace bearings if rough or noisy.



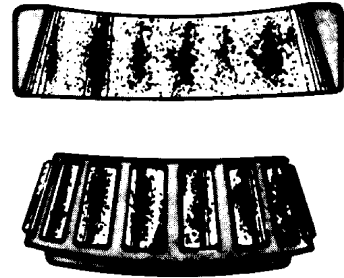
HASA520S

Figure 9

Fatigue Spalling

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.



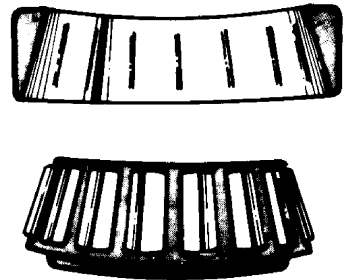
HASA530S

Figure 10

Brinelling

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.

Replace bearing if rough or noisy.



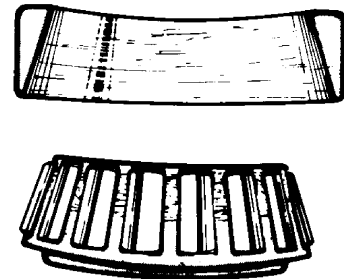
HASA540S

Figure 11

Cage Wear

Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication.

Replace bearings - check seals.



HASA550S

Figure 12

Abrasive Roller Wear

Pattern on races and rollers caused by fine abrasives.

Clean all parts and housings, check seals and bearings and replace if leaking, rough or noisy.

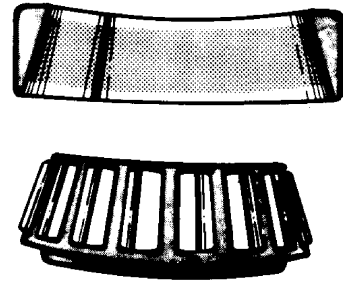


Figure 13

HASA560S

Cracked Inner Race

Race cracked because of improper installation, cocking or poor bearing seat.

Replace all parts and housings, check seals and bearings and replace if leaking.

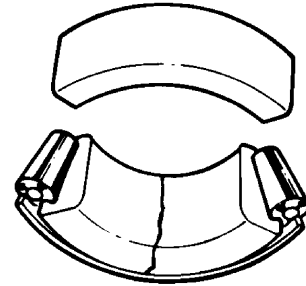


Figure 14

HASA570S

Smears

Smearing of metal because of slippage caused by poor installation, lubrication, overheating, overloads or handling damage.

Replace bearings, clean related parts and check for proper installation and lubrication.

Replace shaft if damaged.

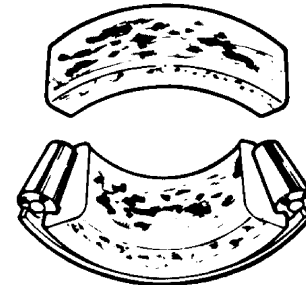


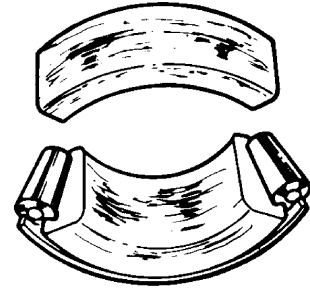
Figure 15

HASA580S

Fretting

Corrosion set up by small relative movement of parts with no lubrication.

Replace bearing. Clean all related parts. Check seals and check for proper lubrication.



HASA590S

Figure 16

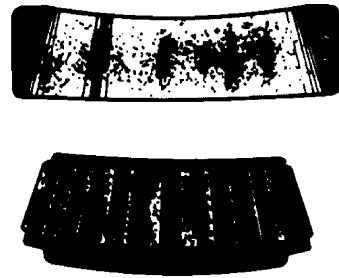
Heat Discoloration

Heat discoloration can range from faint yellow to dark blue resulting from overload or incorrect lubrication.

Excessive heat can cause softening of races or rollers.

To check for loss of temper on races or rollers, a simple file test may be made. A file drawn over a tempered part will grab and cut metal, whereas a file drawn over a hard part will glide readily with no metal cutting.

Replace bearing if overheating damage is indicated. Check seals and other related parts for damage.



HASA600S

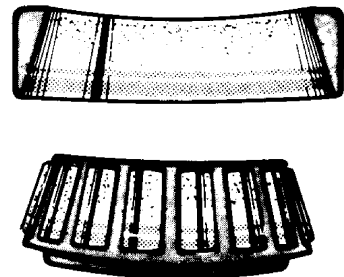
Figure 17

Stain Discoloration

Discoloration can range from light brown to black caused by incorrect lubrication or moisture.

If the stain can be removed by light polishing or if no evidence of overheating is visible, the bearing can be reused.

Check seals and other related parts for damage.



HASA610S

Figure 18

Standard Torques

Edition 4

MEMO

Table of Contents

Standard Torques

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
ALL MODELS	ALL RANGES

TORQUE VALUES FOR STANDARD METRIC FASTENERS

NOTE: The units for the torque values are kg•m (ft lb).

Dia. x Pitch (mm)	Grade										
	3.6 (4A)	4.6 (4D)	4.8 (4S)	5.6 (5D)	5.8 (5S)	6.6 (6D)	6.8 (6S)	6.9 (6G)	8.8 (8G)	10.9 (10K)	12.9 (12K)
M5 x Std.	0.15 (1.08)	0.16 (1.15)	0.25 (1.80)	0.22 (1.59)	0.31 (2.24)	0.28 (2.02)	0.43 (3.11)	0.48 (3.47)	0.50 (3.61)	0.75 (5.42)	0.90 (6.50)
M6 x Std.	0.28 (2.02)	0.30 (2.16)	0.45 (3.25)	0.40 (2.89)	0.55 (3.97)	0.47 (3.39)	0.77 (5.56)	0.85 (6.14)	0.90 (6.50)	1.25 (9.04)	1.50 (10.84)
M7 x Std.	0.43 (3.11)	0.46 (3.32)	0.70 (5.06)	0.63 (4.55)	0.83 (6.00)	0.78 (5.64)	1.20 (8.67)	1.30 (9.40)	1.40 (10.12)	1.95 (14.10)	2.35 (16.99)
M8 x Std.	0.70 (5.06)	0.75 (5.42)	1.10 (7.95)	1.00 (7.23)	1.40 (10.12)	1.25 (9.04)	1.90 (13.74)	2.10 (15.18)	2.20 (15.91)	3.10 (22.42)	3.80 (27.48)
M8 x 1	0.73 (5.28)	0.80 (5.78)	1.20 (8.67)	1.00 (7.23)	1.50 (10.84)	1.35 (9.76)	2.10 (15.18)	2.30 (16.63)	2.40 (17.35)	3.35 (24.23)	4.10 (29.65)
M10 x Std.	1.35 (9.76)	1.40 (10.12)	2.20 (15.91)	1.90 (13.74)	2.70 (19.52)	2.35 (19.99)	3.70 (26.76)	4.20 (30.37)	4.40 (31.18)	6.20 (44.84)	7.20 (52.07)
M10 x 1.25	1.50 (10.84)	1.60 (11.57)	2.50 (18.08)	2.10 (15.18)	3.10 (22.42)	2.80 (20.25)	4.30 (31.10)	4.90 (35.44)	5.00 (36.16)	7.00 (50.63)	8.40 (60.75)
M12 x Std.	2.40 (17.35)	2.50 (18.08)	3.70 (26.76)	3.30 (23.86)	4.70 (33.99)	4.20 (30.37)	6.30 (45.56)	7.20 (52.07)	7.50 (54.24)	10.50 (75.94)	12.50 (90.41)
M12 x 1.25	2.55 (18.44)	2.70 (19.52)	4.00 (28.93)	3.50 (25.31)	5.00 (36.16)	4.50 (32.54)	6.80 (49.18)	7.70 (55.69)	8.00 (57.86)	11.20 (81.00)	13.40 (96.92)
M14 x Std.	3.70 (26.76)	3.90 (28.20)	6.00 (43.23)	5.20 (37.61)	7.50 (54.24)	7.00 (50.63)	10.00 (72.33)	11.50 (83.17)	12.00 (86.79)	17.00 (122.96)	20.00 (144.66)
M14 x 1.5	4.10 (29.65)	4.30 (31.10)	6.60 (47.73)	5.70 (41.22)	8.30 (60.03)	7.50 (54.24)	11.10 (80.28)	12.50 (90.41)	13.00 (94.02)	18.50 (11.26)	22.00 (158.12)
M16 x Std.	5.60 (40.50)	6.00 (43.39)	9.00 (65.09)	8.00 (57.86)	11.50 (83.17)	10.50 (75.94)	15.50 (112.11)	17.90 (129.47)	18.50 (133.81)	26.00 (188.05)	31.00 (224.22)
M16 x 1.5	6.20 (44.84)	6.50 (47.01)	9.70 (70.16)	8.60 (62.20)	12.50 (90.41)	11.30 (81.73)	17.00 (122.96)	19.50 (141.04)	20.00 (144.66)	28.00 (202.52)	35.50 (256.77)
M18 x Std.	7.80 (56.41)	8.30 (60.03)	12.50 (90.41)	11.00 (79.56)	16.00 (115.72)	14.50 (104.87)	21.00 (151.89)	27.50 (198.90)	28.50 (206.14)	41.00 (296.55)	43.00 (311.01)
M18 x 1.5	9.10 (65.82)	9.50 (68.71)	14.40 (104.15)	12.50 (90.41)	18.50 (133.81)	16.70 (120.79)	24.50 (177.20)	27.50 (198.90)	28.50 (206.14)	41.00 (296.55)	49.00 (354.41)
M20 x Std.	11.50 (83.17)	12.00 (86.79)	18.00 (130.19)	16.00 (115.72)	22.00 (159.12)	19.00 (137.42)	31.50 (227.83)	35.00 (253.15)	36.00 (260.38)	51.00 (368.88)	60.00 (433.98)
M20 x 1.5	12.80 (92.58)	13.50 (97.64)	20.50 (148.27)	18.00 (130.19)	25.00 (180.82)	22.50 (162.74)	35.00 (253.15)	39.50 (285.70)	41.00 (296.55)	58.00 (419.51)	68.00 (491.84)
M22 x Std.	15.50 (112.11)	16.00 (115.72)	24.50 (177.20)	21.00 (151.89)	30.00 (216.99)	26.00 (188.05)	42.00 (303.78)	46.00 (332.71)	49.00 (354.41)	67.00 (484.61)	75.00 (542.47)
M22 x 1.5	17.00 (122.96)	18.50 (133.81)	28.00 (202.52)	24.00 (173.59)	34.00 (245.92)	29.00 (209.75)	47.00 (339.95)	52.00 (44.76)	56.00 (405.04)	75.00 (542.47)	85.00 (614.80)
M24 x Std.	20.50 (148.27)	21.50 (155.50)	33.00 (238.68)	27.00 (195.29)	40.00 (289.32)	34.00 (245.92)	55.00 (397.81)	58.00 (419.51)	63.00 (455.67)	82.00 (593.10)	92.00 (655.43)
M24 x 2.0	23.00 (166.35)	35.00 (253.15)	37.00 (267.62)	31.00 (224.22)	45.00 (325.48)	38.00 (202.52)	61.00 (441.21)	67.00 (484.61)	74.00 (535.24)	93.00 (672.66)	103.00 (744.99)

TORQUE VALUES FOR STANDARD U.S. FASTENERS

Type	SAE Grade	Description	Bolt Head Marking
1	1 or 2	WILL HAVE NO MARKINGS IN THE CENTER OF THE HEAD. Low or Medium Carbon Steel Not Heat-treated.	
5	5	WILL HAVE THREE RADIAL LINES. Quenched and Tempered Medium Carbon Steel.	
8	8	WILL HAVE 6 RADIAL LINES. Quenched and Tempered Special Carbon or Alloy Steel.	

Recommended torque, in foot-pounds, for all Standard Application Nuts and Bolts, provided:

1. All thread surfaces are clean and lubricated with SAE-30 engine oil. (See Note.)
2. Joints are rigid, that is, no gaskets or compressible materials are used.
3. When reusing nuts or bolts, use minimum torque values.

NOTE: *Multiply the standard torque by:*

0.65 When finished jam nuts are used.

0.70 When Molykote, white lead or similar mixtures are used as lubricants.

0.75 When Parkerized bolts or nuts are used.

0.85 When cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.

0.9 When hardened surfaces are used under the nut or bolt head.

NOTE: *When reusing bolts and nuts in service, use minimum torque values.*

The following General Torque Values must be used where **SPECIAL TORQUE VALUES** are not given.

NOTE: Torque values listed throughout this manual are lubricated (wet) threads; values must be increased 1/3 for nonlubricated (dry) threads.

Thread Size	Heat-treated Material Grade 5 and Grade 8			
	Grade 5 (3 Radial Dashes on Head)		Grade 8 (6 Radial Dashes on Head)	
	Foot-pounds (ft lb)	Newton Meter (Nm)	Foot-pounds (ft lb)	Newton Meter (Nm)
1/4" - 20	6	8	9	12
1/4" - 28	7	9	11	15
5/16" - 18	13	18	18	24
5/16" - 24	15	20	21	28
3/8" - 16	24	33	34	46
3/8" - 24	27	37	38	52
7/16" - 14	38	52	54	73
7/16" - 20	42	57	60	81
1/2" - 13	58	79	82	111
1/2" - 20	65	88	90	122
9/16" - 12	84	114	120	163
9/16" - 18	93	126	132	179
5/8" - 11	115	156	165	224
5/8" - 18	130	176	185	251
3/4" - 10	205	278	290	393
3/4" - 16	240	312	320	434
7/8" - 9	305	414	455	617
7/8" - 14	334	454	515	698
1" - 8	455	617	695	942
1" - 14	510	691	785	1064
1 1/8" - 7	610	827	990	1342
1 1/8" - 12	685	929	1110	1505
1 1/4" - 7	860	1166	1400	1898
1 1/4" - 12	955	1295	1550	2102
1 3/8" - 6	1130	1532	1830	2481
1 3/8" - 12	1290	1749	2085	2827
1 1/2" - 6	1400	2034	2430	3295
1 1/2" - 12	1690	2291	2730	3701
1 3/4" - 5	2370	3213	3810	5166
2" - 4 1/2	3550	4813	5760	7810

NOTE: If any bolts and nuts are found loose or at values less than what the chart states, it is recommended that loose bolt and/or nut be replaced with a new one.

TYPE 8 PHOSPHATE COATED HARDWARE

This chart provides tightening torque for general purpose applications using original equipment standard hardware as listed in the Parts Manual for the machine involved. **DO NOT SUBSTITUTE.** In most cases, original equipment standard hardware is defined as Type 8, coarse thread bolts, nuts and thru hardened flat washers (Rockwell "C" 38 - 45), all phosphate coated and assembled without supplemental lubrication (as received) condition.

The torques shown below also apply to the following:

1. Phosphate coated bolts used in tapped holes in steel or gray iron.
2. Phosphate coated bolts used with phosphate coated prevailing torque nuts (nuts with distorted threads or plastic inserts).
3. Phosphate coated bolts used with copper plated weld nuts.

Markings on bolt heads or nuts indicate material grade **ONLY** and are **NOT** to be used to determine required torque.

Nominal Thread Diameter	Standard Torque $\pm 10\%$	
	Kilogram-meter (kg·m)	Foot-pounds (ft lb)
1/4"	1.1	8
5/16"	2.2	16
3/8"	3.9	28
7/16"	6.2	45
1/2"	9.7	70
9/16"	13.8	100
5/8"	19.4	140
3/4"	33.2	240
7/8"	53.9	390
1"	80.2	580
1 - 1/8"	113.4	820
1 - 1/4"	160.4	1160
1 - 3/8"	210.2	1520
1 - 1/2"	279.4	2020
1 - 3/4"	347.1	2510
2"	522.8	3780

TORQUE VALUES FOR HOSE CLAMPS

The following chart provides the tightening torques for hose clamps used in all rubber applications (radiator, air cleaner, operating lever boots, hydraulic system, etc.).

Clamp Type and Size	Torque			
	Radiator, Air Cleaner, Boots, Etc.		Hydraulic System	
	Kilogram-meter (kg•m)	Inch Pounds (in lb)	Kilogram-meter (kg•m)	Inch Pounds (in lb)
"T" Bolt (Any Diameter)	0.68 - 0.72	59 - 63	-----	-----
Worm Drive - Under 44 mm (1-3/4 in) Open Diameter	0.2 - 0.3	20 - 30	0.5 - 0.6	40 - 50
Worm Drive - Over 44 mm (1-3/4 in) Open Diameter	0.5 - 0.6	40 - 50	-----	-----
Worm Drive - All "Ultra-Tite"	0.6 - 0.7	50 - 60	0.5 - 0.6	40 - 50

ORFS SWIVEL NUT RECOMMENDED TORQUE

Dash Size	Hose I.D.	Thread Size	Torque (kg•m) Recommended
4	1/4"	9/16"	2.4 - 2.6
6	3/8"	11/16"	3.3 - 3.9
8	1/2"	13/16"	5.1 - 5.7
12	3/4"	1 3/16"	11.7 - 12.7
16	1"	1 7/16"	15.3 - 17.3
20	1 1/4"	1 11/16"	18.0 - 20.0

TORQUE VALUES FOR SPLIT FLANGES

The following chart provides the tightening torques for split flange connections used in hydraulic systems. Split flanges and fitting shoulders should fit squarely. Install all bolts, finger tight and then torque evenly.

NOTE: *Over torquing bolts will damage the flanges and/or bolts, which can cause leakage.*

Flange Size (*)	Bolt Size	Bolt Torque	
		Kilogram-meter (kg•m)	Foot-pounds (ft lb)
1/2"	5/16"	2.1 - 2.5	15 - 18
3/4"	3/8"	3.0 - 3.7	22 - 27
1"	3/8"	3.7 - 4.8	27 - 35
1 - 1/4"	7/16"	4.8 - 6.2	35 - 45
1 - 1/2"	1/2"	6.4 - 8.0	46 - 58
2"	1/2"	7.6 - 9.0	55 - 65
2 - 1/2"	1/2"	10.9 - 12.6	79 - 91
3"	5/8"	19.1 - 20.7	138 - 150
3 - 1/2"	5/8"	16.2 - 18.4	117 - 133

(*) - Inside diameter of flange on end of hydraulic tube or hose fitting.

NOTE: *Values stated in chart are for Standard Pressure Series (Code 61) Split Flanges.*

TORQUE WRENCH EXTENSION TOOLS

Very large diameter, high-grade fasteners (nuts, bolts, cap screws, etc.) require a great deal of turning force to achieve recommended tightening torque values.

Common problems that could occur as a result are:

- Recommended torque exceeds the measuring capacity of the torque wrench.
- Specialized sockets do not fit the adapter on the front end (nose) of the torque wrench.
- Generating adequate force on the back end (handle) of the wrench is difficult or impossible.
- Restricted access or an obstruction may make use of the torque wrench impossible.
- A unique application requires fabrication of an adapter or other special extension.

Most standard torque wrenches can be adapted to suit any one of the proceeding needs or situations, if the right extension tool is used or fabricated.

Torque Multiplication

A wrench extension tool can be used to increase the tightening force on a high capacity nut or bolt.

For example, doubling the distance between the bolt and the back (handle) end of the torque wrench doubles the tightening force on the bolt. It also halves the indicated reading on the scale or dial of the torque wrench. To accurately adjust or convert indicated scale or dial readings, use the following formula:

$I = A \times T / A + B$ where:

I = Indicated force shown on the torque wrench scale or dial.

T = Tightening force applied to the nut or bolt (actual Torque).

A = Length of the torque wrench (between the center of the nut or bolt and the center of the handle).

B = Length of the extension.

As an example, if a 12" extension is added to a 12" torque wrench, and the indicated torque on the dial reads "150 ft lb", the real force applied to the bolt is 300 ft lb:

$$I = \frac{A \times T}{A + B} = \frac{12 \times 300}{12 + 12} = \frac{3600}{24} = 150$$

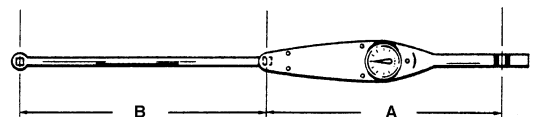


Figure 1

0552A

NOTE: *The formula assumes there is no added deflection or "give" in the joint between the extension and torque wrench. Readings may also be inaccurate:*

- If the extension itself absorbs some of the tightening force and starts to bend or bow out.
- If an extension has to be fabricated that is not perfectly straight (for example, an extension made to go around an obstruction, to allow access to a difficult to tighten fastener), the materials and methods used must be solid enough to transmit full tightening torque.

Other Uses for Torque Wrench Extension Tools

Torque wrench extensions are sometimes made up for reasons other than increasing leverage on a fastener.

For example, a torque wrench and extension can be used to measure adjustment "tightness" of a linkage or assembly. Specially fabricated extensions can be used to make very precise checks of the force required to engage or disengage a clutch mechanism, release a spring-applied brake assembly, or "take up" free play in most any movable linkage.

Once the value of the adjustment force is established, repeated checks at regular intervals can help to monitor and maintain peak operating efficiency. These types of adjustment checks are especially useful if physical measurements of linkage travel are difficult to make or will not provide the needed degree of precision and accuracy.

To allow the assembly or mechanism to accept a torque wrench, welding a nut or other adapter on the end of a linkage shaft or other leverage point will allow turning the shaft or assembly manually.

Tightening Torque Specifications (Metric)

(For coated threads, prelubricated assemblies.)

IMPORTANT

Disassembly, overhaul and replacement of components on the machine, installation of new or replacement parts and/or other service-related maintenance may require the use of thread or flange sealing assembly compound.

Use the information on this page as a general guide in selecting specific formulas that will meet the particular requirements of individual assembly installations. *DOOSAN* does not specifically approve a specific manufacturer or brand name, but the following table of "Loctite" applications is included for which cross-references to other manufacturer's products should also be widely available.

IMPORTANT

Use primer "T" or "N" for all cold weather assembly of fastener adhesives, with Threadlocker sealers 222, 242/243, 262, 271, 272, or 277.

I. "Loctite" Fastener Adhesives

Product	Application	Color	Removal	Breakaway Cure Strength (in lb) of Sealer Alone
222	Low strength for 6 mm (1/4") or smaller fasteners.	Purple	Hand tools	45
242 or 243	Medium strength for 6 mm (1/4") and larger fasteners.	Blue	Hand tools	80
262	High strength for high-grade fasteners subject to shock, stress and vibration.	Red	Heat/260°C (500°F) Remove HOT (NO solvent)	160
271	Extra high strength for fine thread fasteners up to 25 mm (1") diameter.	Red	Heat/260°C (500°F) Remove HOT	160
272	High temperature/high strength for hostile environments to 232°C (450°F).	Red	Heat/316°C (600°F) Remove HOT	180
277	Extra high strength for coarse thread fasteners 25 mm (1") diameter and larger.	Red	Heat/260°C (500°F) Remove HOT	210

II. "Loctite" Pipe Thread Sealant

Product	Application	Color	Removal	Required Setup
545	"No-filler/nonclog" formula for high-pressure hydraulic systems. Over application will not restrict or foul system components.	Purple	Hand tools	4 Hours (or 1/2 hour with Locquic "T" Primer)
656	Solvent resistant, higher viscosity tapered thread sealer.	White	Hand tools	4 Hours (or 1/2 hour with Locquic "T" Primer)

III. "Loctite" gasket/flange sealer

Product	Application	Color	Notes
518	Gasket eliminator specifically made for aluminum flanges/surfaces. For hydraulic systems to 34,475 kPa (5,000 psi).	Red	Use Locquic "N" primer for fast (1/2 - 4 hours) setup. Unprimed setup 4 - 24 hours.
504	Low-pressure/wide-gap gasket eliminator compound. Fills gaps to 0.0012 mm (0.030"), cures to rigid seal.	Orange	Use Locquic "N" primer for faster (1/2 - 4 hours) setup. Unprimed setup 4 - 24 hours.
515	General purpose, fast setup, flexible-cure gasket eliminator. For nonrigid assemblies subject to shock, vibration or deflection.	Purple	Use Locquic "N" primer for faster (1/4 - 2 hours) setup. Unprimed setup 1 - 12 hours.

IV. "Loctite" retaining compounds

Product	Application	Color	Notes
609	For bushings, sleeves, press fit bearings, splines and collars. For gaps to 0.0002 mm (0.005"), temperatures to 121°C (250°F).	Green	Use Locquic "N" primer for increased bond strength and all cold temperature applications.
620	For high temperatures to 232°C (450°F).	Green	Same as 609, above.
680	For high strength bonds and tight clearance gaps, to 0.00008 mm (0.002").	Green	Same as 609, above.

V. "Loctite" Adhesives

Product	Application	Color	Notes
380	Black Max instant adhesive for shock and vibration-resistant bonds.	Black	May take 120 hours to reach full cure strength.
454	Adhesive for porous surfaces.	Clear	Full strength in 24 hours.
480	Increased strength (+50%), shock and vibration-resistant.	Black	Full strength in 24 hours.

Drivetrain

Transmission and Torque Converter

Edition 1

MEMO

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Transmission and Torque Converter

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SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

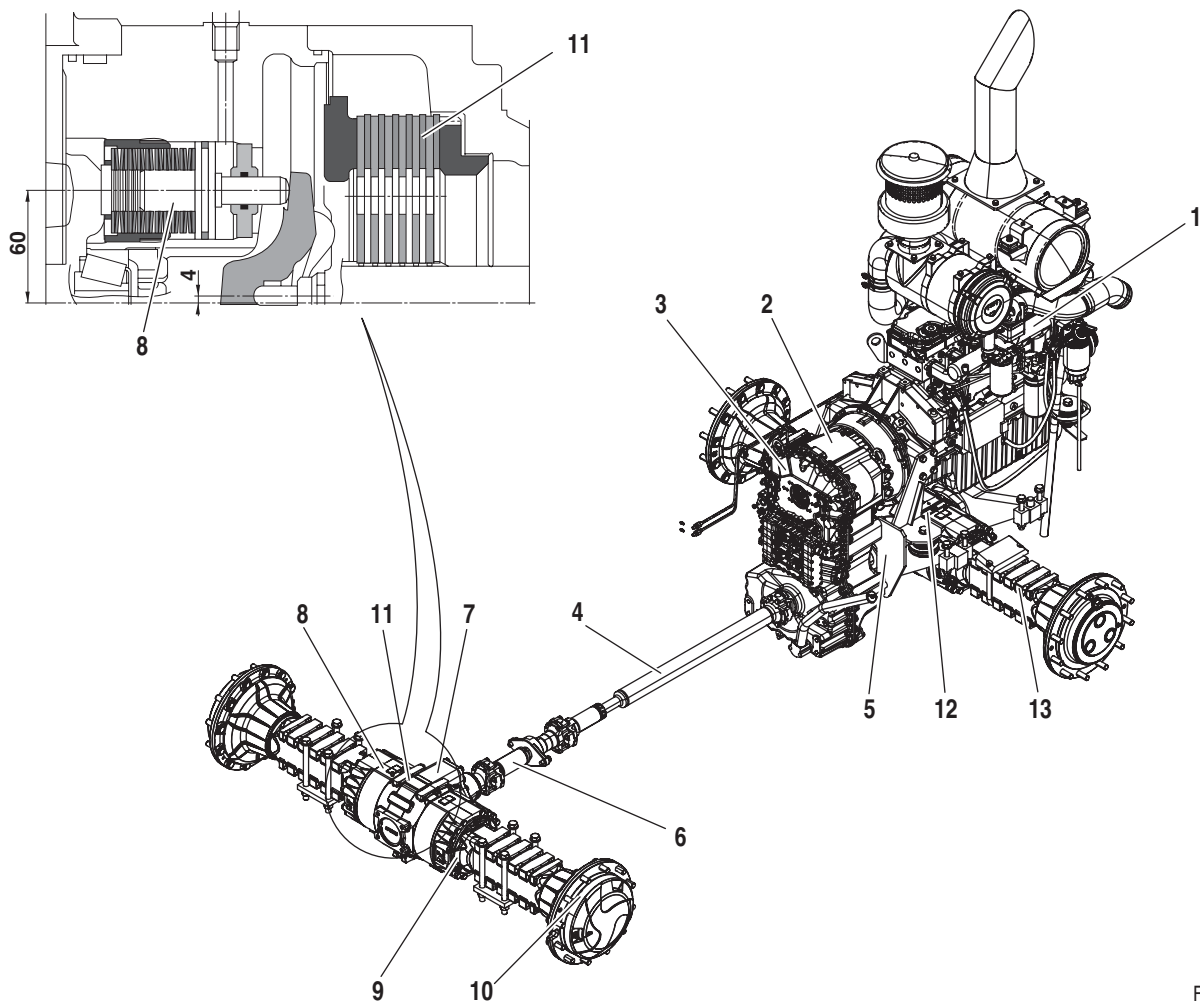
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL

Figure 1, shows layout of power train assemblies. The engine (1, Figure 1) drives a torque converter (2), which drives a power shift transmission (3). Two output shafts extend out of the transmission. Each output shaft has a drive shaft attached to it. Center drive shaft (4) drives a front drive shaft (6) that drives the front differential (7).

A parking brake (8, Figure 1) is mounted on the differential input shaft. The front differential is enclosed in the front axle housing (9). Each end of the front axle housing contains reduction gearing (10). Each end of the front axle housing also contains a service brake (11). Rear drive shaft (5) drives the rear differential (12). The rear differential is enclosed in the rear axle housing (13). Each end of the rear axle housing contains reduction gearing (10). Each end of the front / rear axle housing also contains a service brake (11).



FG008678

Figure 1

Reference Number	Description
1	Engine
2	Torque Converter
3	Transmission
4	Center Drive Shaft
5	Rear Drive Shaft
6	Front Drive Shaft
7	Front Differential

Reference Number	Description
8	Parking Brake
9	Front Axle Housing
10	Reduction Gearing
11	Service Brake
12	Rear Differential
13	Rear Axle Housing

TRANSMISSION AND TORQUE CONVERTER

The machine contains a powershift transmission that has four forward speeds and three speeds in reverse. Gear changes are made by an electrohydraulic control valve that is mounted on transmission. Moving gear select lever in cab, generates an electrical signal that is transmitted to the control valve. The control valve contains proportional valves that direct pressurized fluid to various clutches that control the forward and reverse gears.

Item		DL200A
Torque Converter	Model	4WG-160 (Full Auto)
	Type	3-Element, 1-Stage, Single-phase, E/G mounted with flexible plate
	Oil Cooler	Air-cooled
	Charging Pump	83.2 lpm at 2,300 rpm
	Hydraulic Pump P.T.O	1 : 1
	T/C Size	Ø 300 mm
	Stall Ratio	2.91
	Safety Relief	11 Bar (160 psi)
Transmission	Type	Full Power Shift, Counter shaft
	Speeds	4 Forward / 3 Reverse
	Ratio	F: 3.611 / 2.024 / 1.088 / 0.619 R: 3.424 / 1.981 / 1.031
	Power Shift Control Pressure	16 - 18 bar (232 - 261 psi)
	Shift Control	Electric Shift with Proportional Valve
Oil Capacity		35 l (9.3 U.S. gal)
Dry Weight		360 kg (794 lb)
Output Flange	Front	6 C Mechanics
	Rear	6 C Mechanics

Powershift Transmission

The multispeed reversing transmission in layshaft design is engaged under load by hydraulically controlled multidisk clutches.

All gears wheels are constantly meshing and running in antifriction bearings.

The gear wheels, bearings and clutches are cooled and lubricated with oil.

The 4-speed reversing transmission is equipped with 6 multidisk clutches.

At the shifting, the corresponding plate pack is compressed by a piston, movable in axial direction, which is pressurized by pressure oil.

A compression spring is pushing back the piston, thus the releasing the plate pack. As to layout of transmission and the indication of closed clutches in single speeds, See "The Chart of Measuring Points and Connection 4 WG-160" on page -11. and "Oil Circuit Diagram 4WG-160" on page -13.

Transmission Control

Transmission control, See "The Chart of Measuring Points and Connection 4 WG-160" on page -11., Electrohydraulic unit on page -12 and "Oil Circuit Diagram 4WG-160" on page -13.

The transmission pump, necessary for the oil supply of converter, and the transmission control, is input-side mounted from outside, together with stator shaft and oil supply flange, on transmission. The drive is realized by the pump-wheel flange of converter.

The feed rate of pump is $Q = 105 \text{ lpm}$ at $n_{\text{Engine}} = 2000 \text{ min}^{-1}$.

This pump is sucking the oil through the coarse filter out of oil sump and delivers it through the ZF-Fine filter can be fitted also externally from transmission - to system pressure valve.

ZF-Fine filter

Grade of filtration according to ISO 4572: $\beta_{30} \geq 75$ $\beta_{15} = 25$ $\beta_{10} = 5.0$

Filter area at least: $3,700 \text{ cm}^2$

Dust capacity according to ISO 4572 at least: 17 g

The six clutches of transmission are selected via the 6 proportional valves P1 to P6.

The proportional valve (pressure regulator unit) consist of pressure regulator (e.g. Y1). follow-on slide and oscillation damper.

The pilot pressure of 9 bar (130.54 psi) for the control of follow-on slides is created by the reducing valve. The pressure oil ($16 +2 \text{ bar}$ ($230 +29 \text{ psi}$)) is directed through the follow-on slide to corresponding clutch.

By the direct proportional selection with separated pressure modulation for each clutch, the pressure to clutches, taking part in gear change, are controlled. In this way, a hydraulic intersection of clutches to be engaged and disengaged becomes possible. This is loading due to fast shifting without traction force interruption.

At the shifting, the following criteria will be considered:

- Speed of engine, turbine, central gear train and output.
- -Transmission temperature.
- -Shifting mode (up-, down-, reverse shifting and speed engagement out of Neutral).
- -Load level (full and part load, traction, overrun inclusive consideration of load cycles during the shifting).

Transmission and Torque Converter(ZF 4WG-160)

The system pressure valve is limiting the max. control pressure to 16 +2 bar (230 +29 psi) and releases the main stream to converter and lubricating circuit.

A converter relief valve is installed in converter inlet, which protects the converter against high internal pressure (opening pressure 11 bar (160 psi)).

Within the converter, the oil is the medium of power transmission according to well-known hydrodynamic principle.

To avoid cavitation, the converter must be always completely filled with oil.

This is achieved by a converter pressure holding valve, following the converter, with an opening pressure of at least 3.5 bar (51 psi).

The oil, escaping from converter, is directed to a heat exchanger.

The oil is directed from heat exchanger to transmission and from there to lubricating oil circuit so that all lubricating points are supplied with cooled oil.

In the electrohydraulic control unit there are 6 pressure regulators installed See "Hydraulic Control Unit (HSG-94)" on page -53.

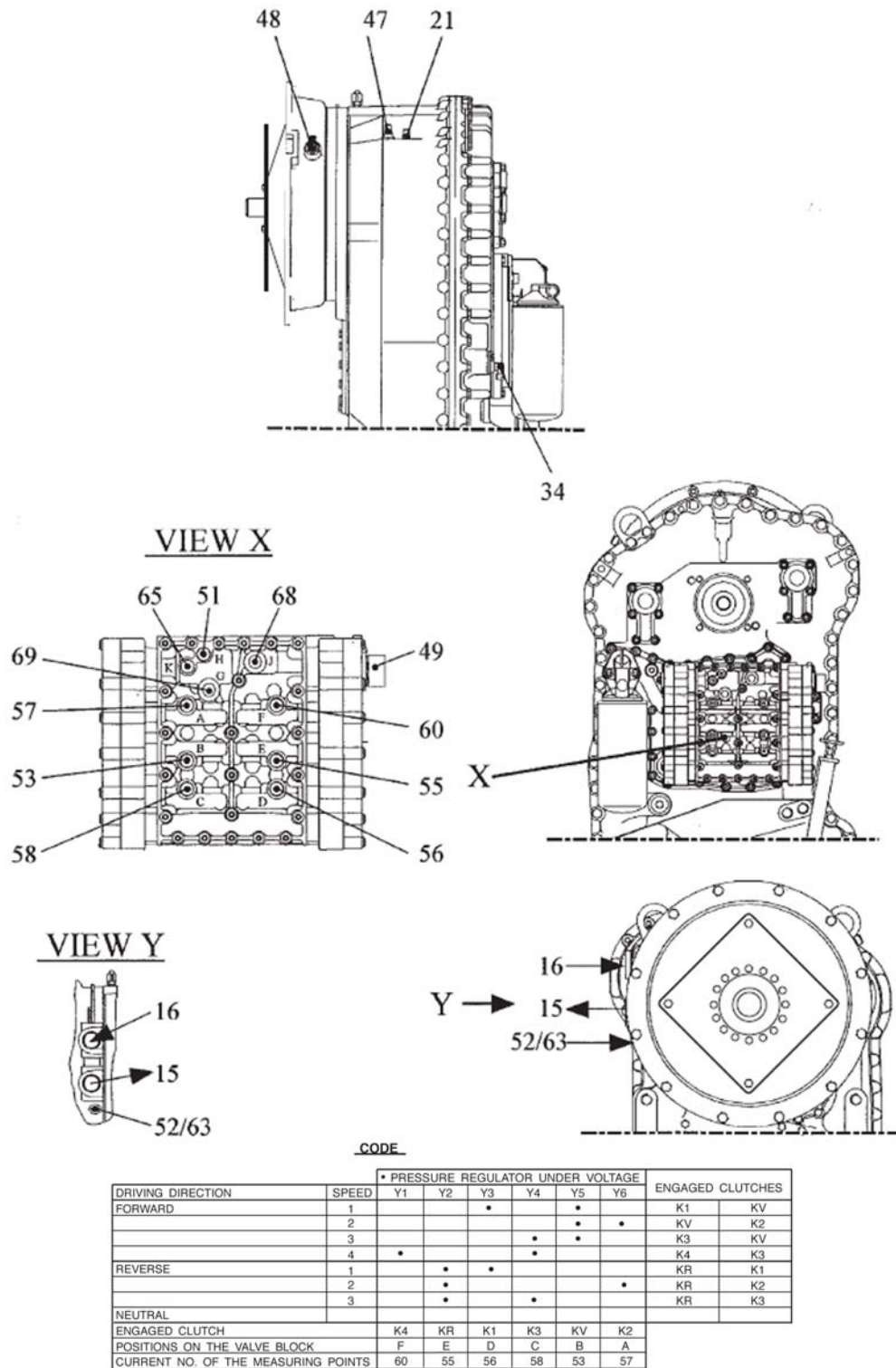
The allocation of pressure regulators to single speeds can be seen on "The Chart of Measuring Points and Connection 4 WG-160" on page -11 and "Oil Circuit Diagram 4WG-160" on page -13.

The Chart of Measuring Points and Connection 4 WG-160

The marked positions correspond with the positions on the "Oil Circuit Diagram 4WG-160" on page -13.

The measurements have to be carried out at hot transmission (about 80° - 90°C).

No.	Denomination of Position	Connection	Marking on Valve Block
Measuring Points for Pressure Oil and Temperature			
51	Converter Inlet - Opening pressure 9 bar (130 psi)	M10 x 1	H
52	Converter Exit - Opening pressure 3.5 bar (51 psi)	M14 x 1.5	
53	Clutch Forward 16+2 bar (230 - 260 psi) KV	M10 x 1	B
55	Clutch Reverse 16 +2 bar (230 +29 psi) KR	M10 x 1	E
56	Clutch 16 +2 bar (230 +29 psi) K1	M10 x 1	D
57	Clutch 16 +2 bar (230 +29 psi) K2	M10 x 1	A
58	Clutch 16 +2 bar (230 +29 psi) K3	M10 x 1	C
60	Clutch 16 +2 bar (230 +29 psi) K4	M10 x 1	F
63	Converter Exit Temperature 100°C, Short-time 120°C	M14 x 1.5	
65	System Pressure 16 +2 bar (230 +29 psi) K4	M10 x 1	K
Measuring points for Delivery Rates			
15	Connection to Heat Exchanger	1 5/16" - 12UNF-2B	
16	Connection from Heat Exchanger	1 5/16" - 12UNF-2B	
Inductive Transmitters and Speed Sensor			
21	Inductive Transmitter n Turbine	M18 x 1.5	
34	Speed Sensor n Output and Speedometer	-----	
47	Inductive Transmitter n Central Gear Train	M18 x 1.5	
48	Inductive Transmitter n Engine	M18 x 1.5	
Connections			
49	Plug Connection on Hydraulic Control Unit		
68	Pilot Pressure (Optional)	M16 x 1.5	J
69	System Pressure (Optional)	M16 x 1.5	G



APS0450S

Figure 2

Oil Circuit Diagram 4WG-160

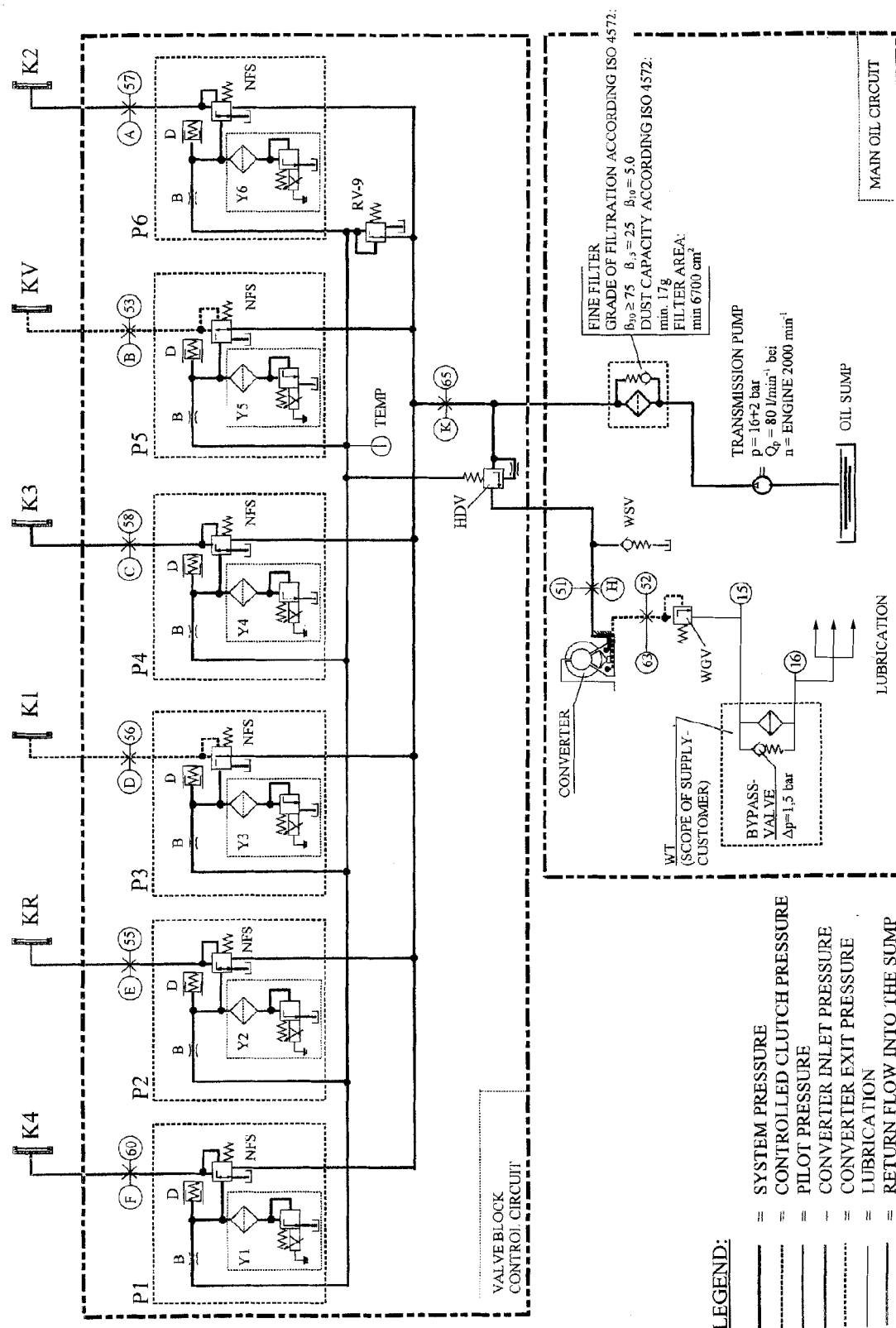
Reference Number	Positions
WT	Heat Changer
WGV	Converter Back Pressure Valve 3.50 bar (51 psi)
WSV	Converter Relief Valve 9 bar (131 psi)
HDV	System Pressure Valve 16 +2 bar (232 +29 psi)
RV-9	Pressure Reducing Valve 9 bar (131 psi)
NFS	Follow-on Slide
D	Oscillation Damper
B	Orifice
P1	Proportional Valve - Clutch K4
P2	Proportional Valve - Clutch KR
P3	Proportional Valve - Clutch K1
P4	Proportional Valve - Clutch K3
P5	Proportional Valve - Clutch KV
P6	Proportional Valve - Clutch K2
Y1 - Y6	Pressure Regulator
TEMP	Temperature Sensor

CODE

DRIVING DIRECTION	SPEED	• PRESSURE REGULATOR UNDER VOLTAGE						ENGAGED CLUTCHES	
		Y1	Y2	Y3	Y4	Y5	Y6		
FORWARD	1			•		•		K1	KV
	2					•	•	KV	K2
	3				•	•		K3	KV
	4	•			•			K4	K3
REVERSE	1		•	•				KR	K1
	2		•				•	KR	K2
	3		•		•			KR	K3
NEUTRAL									
ENGAGED CLUTCH		K4	KR	K1	K3	KV	K2		
POSITIONS ON THE VALVE BLOCK		F	E	D	C	B	A		
CURRENT NO. OF THE MEASURING POINTS		60	55	56	58	53	57		

FG008638

Figure 3



TRANSMISSION ELECTRICAL COMPONENTS

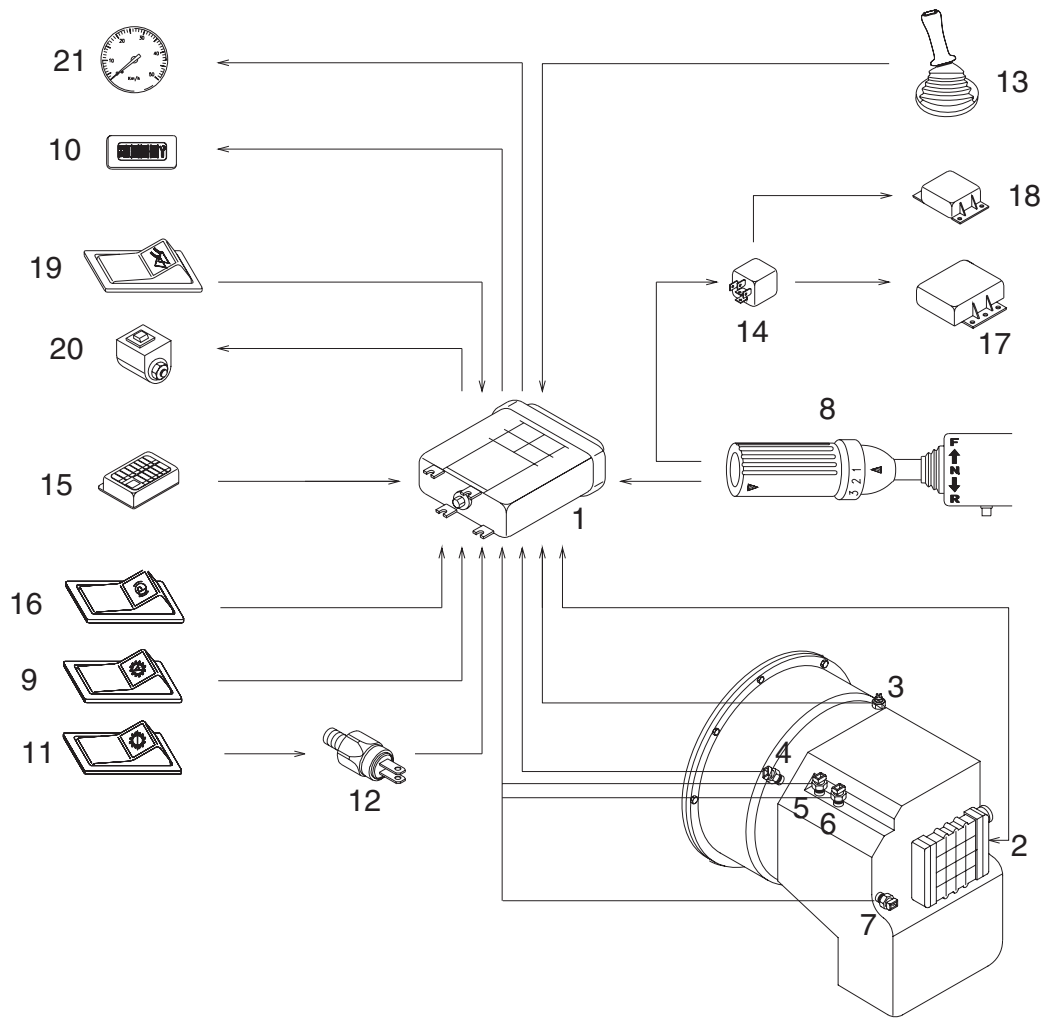


Figure 5

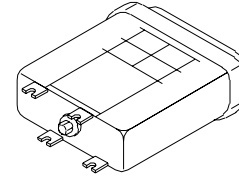
AJS0191L

Reference Number	Description
1	T/M Controller
2	T/M Control Valve
3	T/M Oil Temperature Sensor
4	Engine Pickup Sensor
5	Central Gear Pickup Sensor
6	Turbine Pickup Sensor
7	Output Speed Sensor
8	Shift Lever Switch
9	Auto Selector Switch
10	Display
11	T/M Cutoff Switch

Reference Number	Description
12	T/M Cutoff Pressure Switch
13	Downshift Switch
14	Safety Starter Switch
15	Fuse Box
16	Parking Brake Switch
17	Control Unit
18	Starter Controller
19	LIS (Load Isolation System) Switch (Optional)
20	LIS Solenoid Valve
21	Speedometer

TCU (Transmission Control Unit)

1. Sending a control signal transmitted from shift lever to control valve, generates a speed.
2. In auto mode, transmits the appropriate signals to control valves according to load and engine rpm.
3. Detecting a fault, controls various clutches.

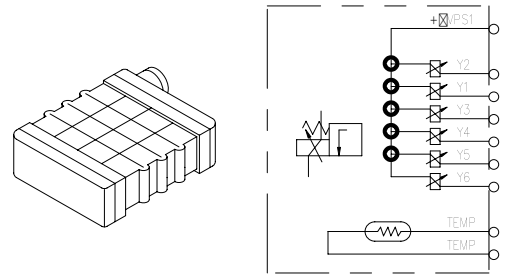


AJS0200L

Figure 6

Transmission Control Valve

1. The transmission control valve contains a temperature sensor and proportional solenoid valves (Y1-Y6) that direct pressurized fluid to various clutches that generates a speed with control the shift gears.
2. Specification of proportional solenoid valve.
 - Resistance: $19\ \Omega \pm 1.9\ \Omega$ at 20°C .
 - Pressure: $0.8\ \text{kg/cm}^2 \rightarrow 8.3\ \text{kg/cm}^2$ (11 - 118 psi)
3. The contained temperature sensor detects the temperature of control valve and transmits the electrical signal to TCU, and serves TCU determines gears to change.
 - Neutral: At temperature less than -30°C
 - 1st or 2nd gear: At temperature less than -10°C
 - Normal Operation: At temperature greater than -10°C

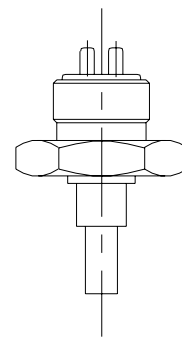


FG005184

Figure 7

Transmission Oil Temperature Sensor

1. Detecting a oil temperature of transmission and send a control signal to transmission oil temperature gauge.
2. Specification
 - Resistance
 - $216\ \Omega \pm 30\ \Omega$ (at 60°C)
 - $81.2\ \Omega \pm 10\ \Omega$ (at 90°C)
 - $36.5\ \Omega \pm 3.5\ \Omega$ (at 120°C)
 - $18.7\ \Omega \pm 2.1\ \Omega$ (at 150°C)

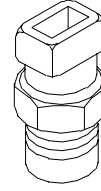


AJS0220L

Figure 8

Engine Pickup Sensor

1. Detect a revolution of gear array in engine side.
2. Specification
 - Resistance: $1050\Omega \pm 10\%$ (at 20°C)
 - Fasten torque: $3 \text{ kg}\cdot\text{m}$ (22 ft lb)
 - Gap: $0.5 + 0.8 \text{ mm}$
($0.0197 + 0.0315 \text{ in}$)
 - Output: 4 Pulse/Rev.

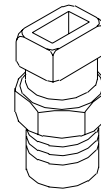


AJS0230L

Figure 9

Central Gear Pickup Sensor

1. Detect a revolution of central gear array
2. Specification
 - Resistance: $1050\Omega \pm 10\%$ (at 20°C)
 - Fasten torque: $3 \text{ kg}\cdot\text{m}$ (22 ft lb)
 - Gap: $0.5 + 0.8 \text{ mm}$
($0.0197 + 0.0315 \text{ in}$)
 - Output: 91 Pulse/Rev.

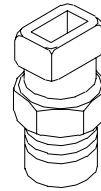


AJS0240L

Figure 10

Turbine Pickup Sensor

1. Detect a revolution of gear array in turbine side.
2. Specification
 - Resistance: $1050\Omega \pm 10\%$ (at 20°C)
 - Fasten torque: $3 \text{ kg}\cdot\text{m}$ (22 ft lb)
 - Gap: $0.5 + 0.8 \text{ mm}$
($0.0197 + 0.0315 \text{ in}$)
 - Output: 59 Pulse/Rev.



AJS0250L

Figure 11

Output Speed Sensor

1. Detect a revolution of gear array in transmission output side.
2. Specification
 - Voltage Supply: 20 V - 32 V
 - Operation Frequency: 2 Hz - 5 KHz
 - Fasten torque (M8): 2.35 kg•m (17 ft lb)
 - Gap: 1.0 - 1.5 mm
(0.0394 - 0.0591 in)
 - Output: 60 Pulse/Rev.

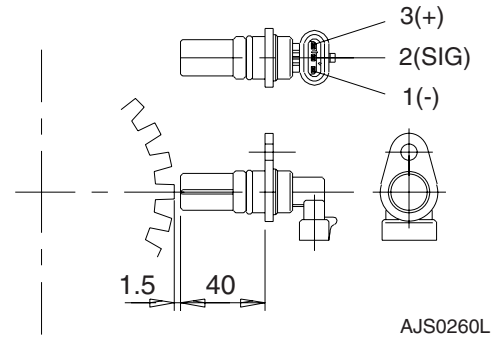


Figure 12

Shift Lever Switch (DW-3)

1. Forward, Reverse and Shift
 - F: Forward
 - N: Neutral
 - R: Reverse
 - 1,2,3,4: Shift Step
 - * Forward shift range: 1 - 4
 - * Reverse shift range: 1 - 3
2. Kick-down (Down Shift) Switch
 - KD: Kick-down Switch
3. Lever Lock Key
 - N: Neutral (The lever is not moved.)
 - D: Driving (The lever is released.)
4. Switch Circuit

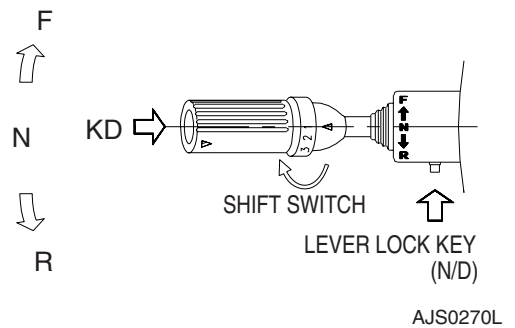


Figure 13

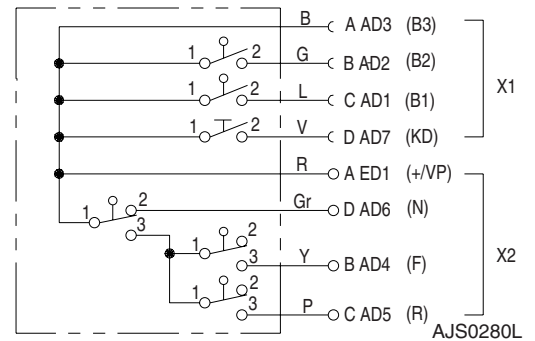


Figure 14

5. Terminal Position and Color

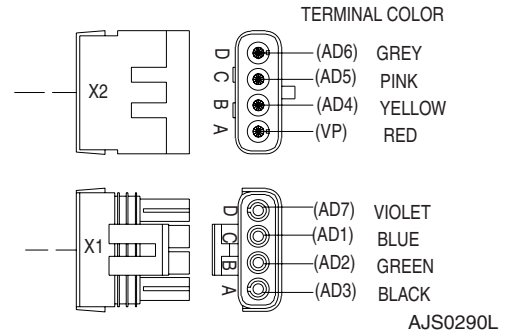


Figure 15

6. Switch Connection

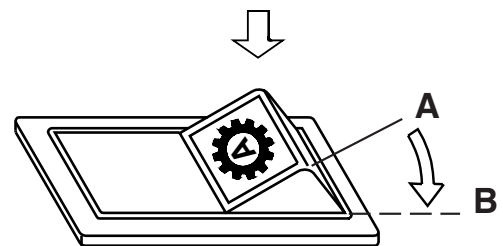
GEAR		FORWARD				REVERSE				NEUTRAL				KICK DOWN
TERMINAL		1	2	3	4	1	2	3	4	1	2	3	4	
ED1	VP	*	*	*	*	*	*	*	*	*	*	*	*	*
AD1	B1	*			*	*			*	*			*	
AD2	B2			*	*			*	*			*	*	
AD3	B3	*	*	*	*	*	*	*	*	*	*	*	*	
AD4	V	*	*	*	*									
AD5	R					*	*	*	*					
AD6	AS									*	*	*	*	
AD7	KD													*

AJS0300L

Figure 16

Auto Selector Switch

1. This is an auto/manual selector switch.
2. When the switch is in "I" (Auto) position, the gear shifting will take place automatically to be selected by the operator, according to load and to vehicle speed.
3. Automatic shifting takes place between gears.
 - Forward: 2nd - 3rd - 4th
 - Reverse: 2nd - 3rd
4. When the switch is in "O" (Manual) position, the shifting is returned to manual mode and the control signal shifts the transmission to gear selected by the operator.



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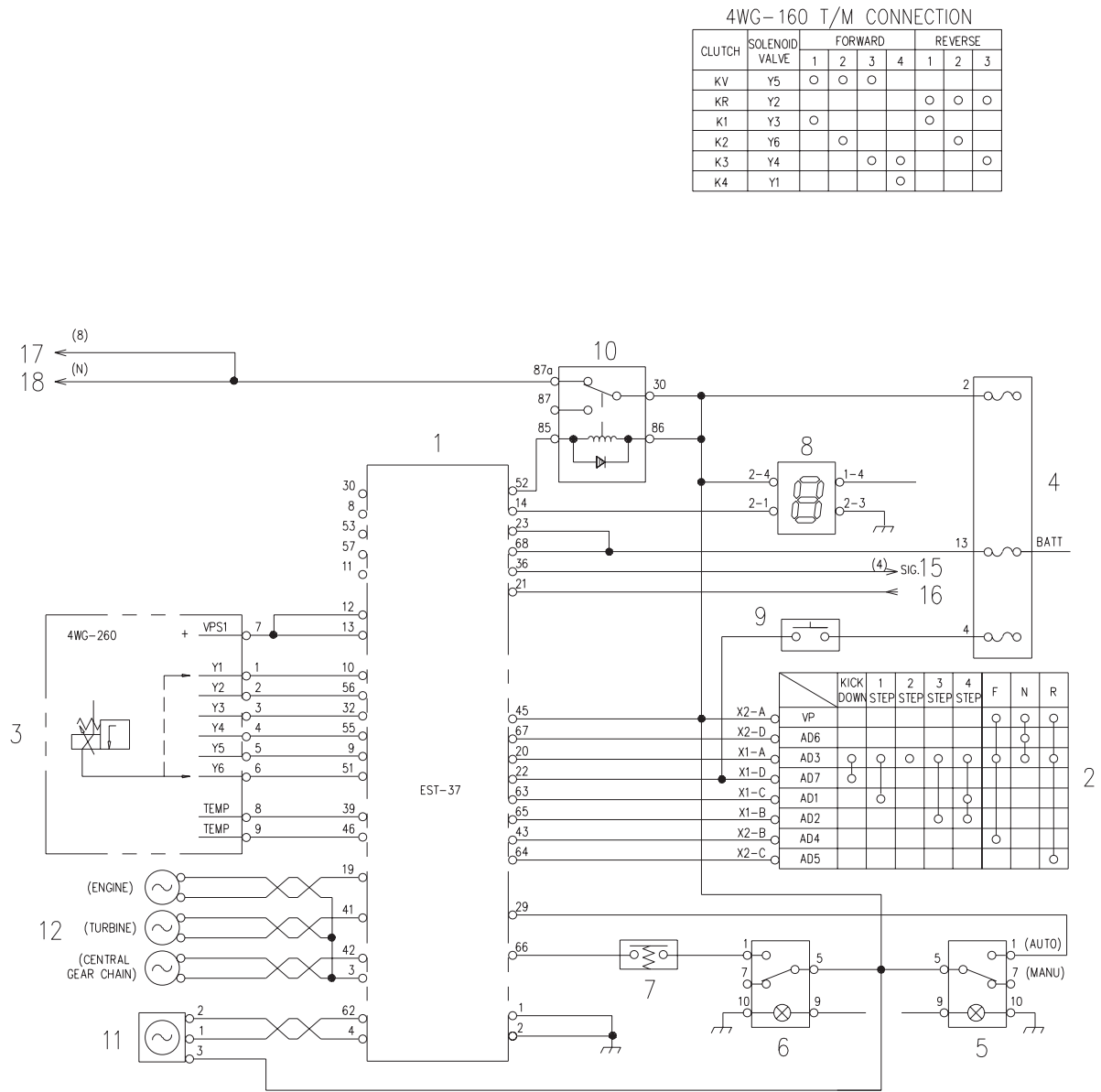
Figure 17

Display

NOTE: See "Transmission Error Codes (ZF)" shop manual section.

TRANSMISSION ELECTRICAL CIRCUITS

T/M Controller Circuit



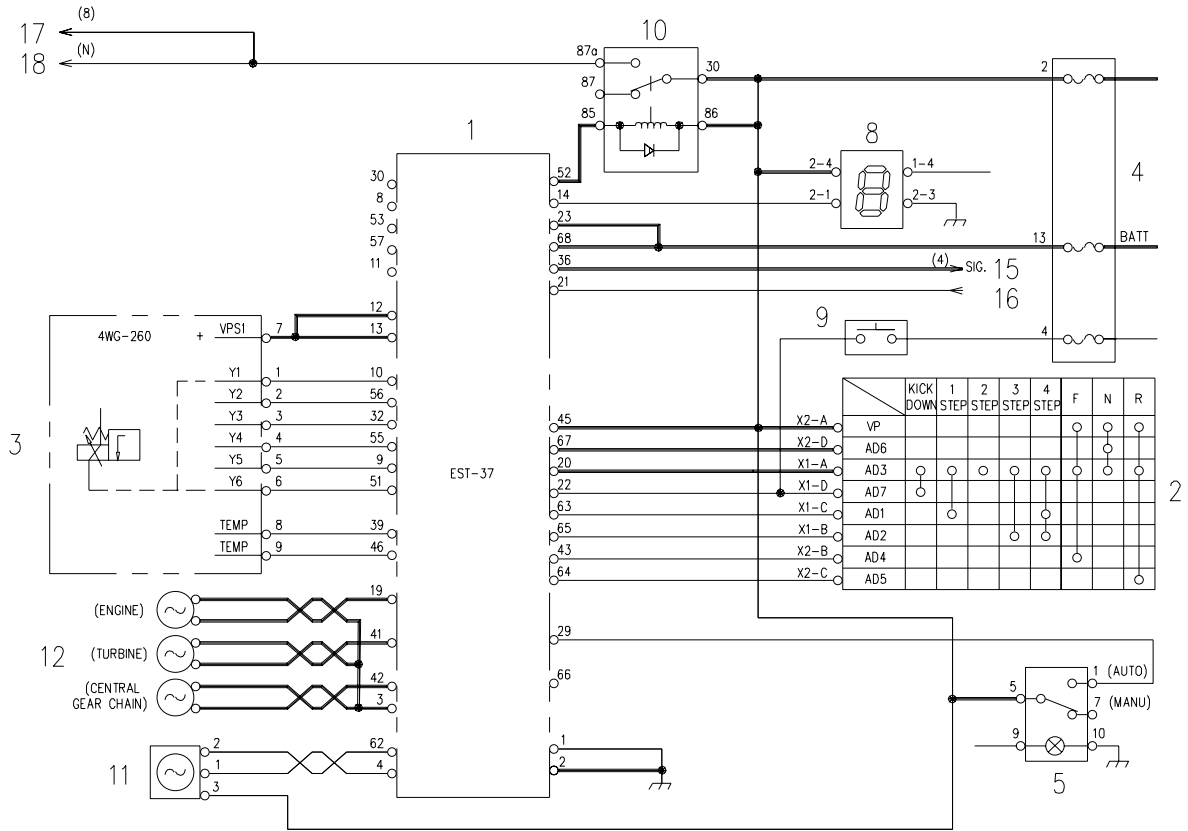
AJS0311L

Figure 18

The transmission proportioning solenoid valves are shown here as (Y1 thru Y6, Figure 18).

Traveling Circuits

Neutral



AJS0320L

Figure 19

When all transmission solenoid valves are de-energized (OFF) the transmission is in "NEUTRAL."



Figure 20

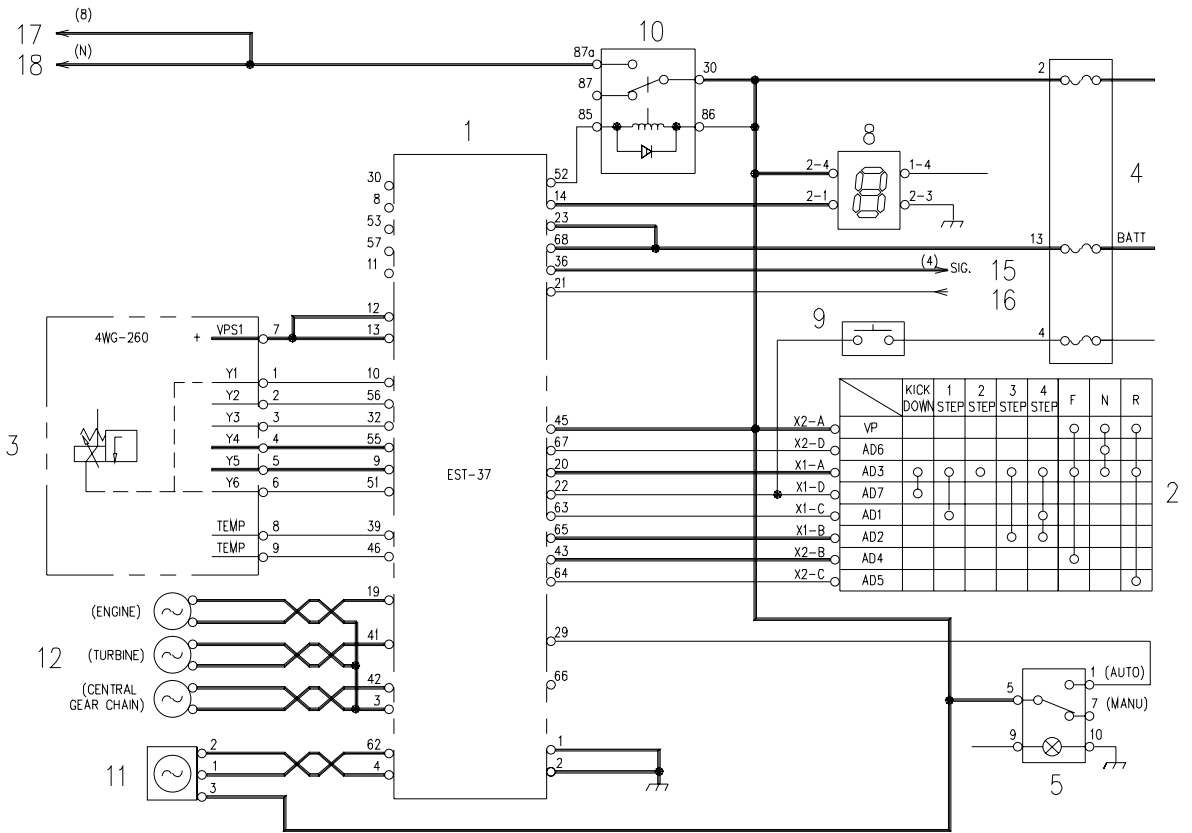
Transmission solenoid valves (Y3 and Y5, Figure 20) are energized when in forward first gear.



Figure 21

Transmission solenoid valves (Y5 and Y6, Figure 21) are energized when in forward second gear.

Forward Third Gear



AJS0350L

Figure 22

Transmission solenoid valves (Y4 and Y5, Figure 22) are energized when in forward third gear.

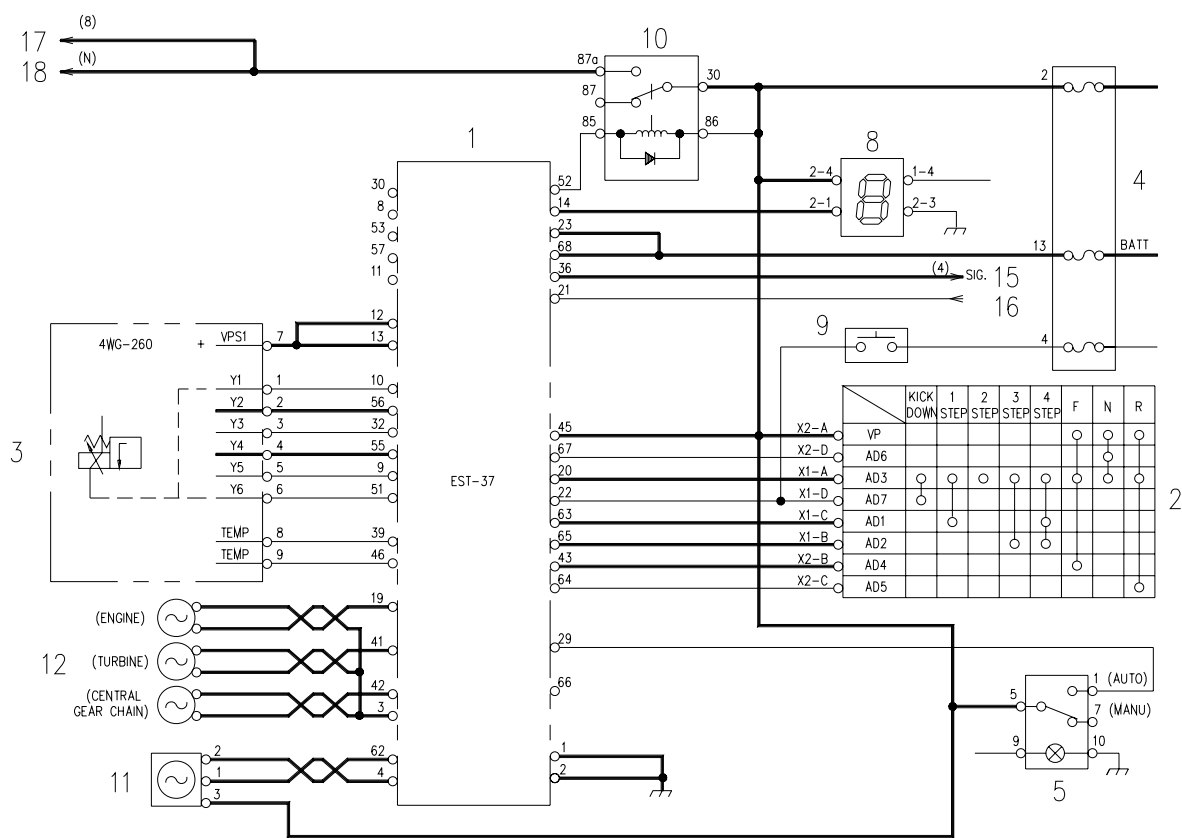
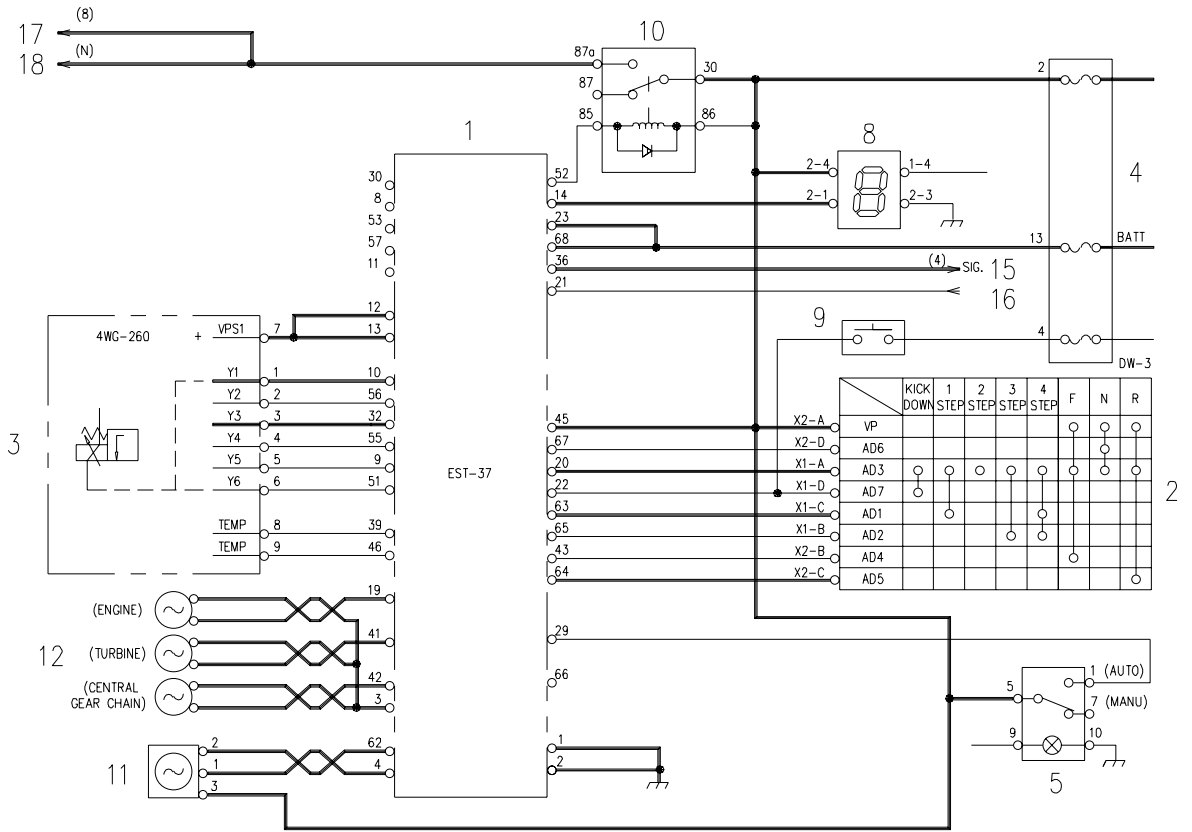


Figure 23

Transmission solenoid valves (Y2 and Y4, Figure 23) are energized when in forward fourth gear.

Reverse First Gear

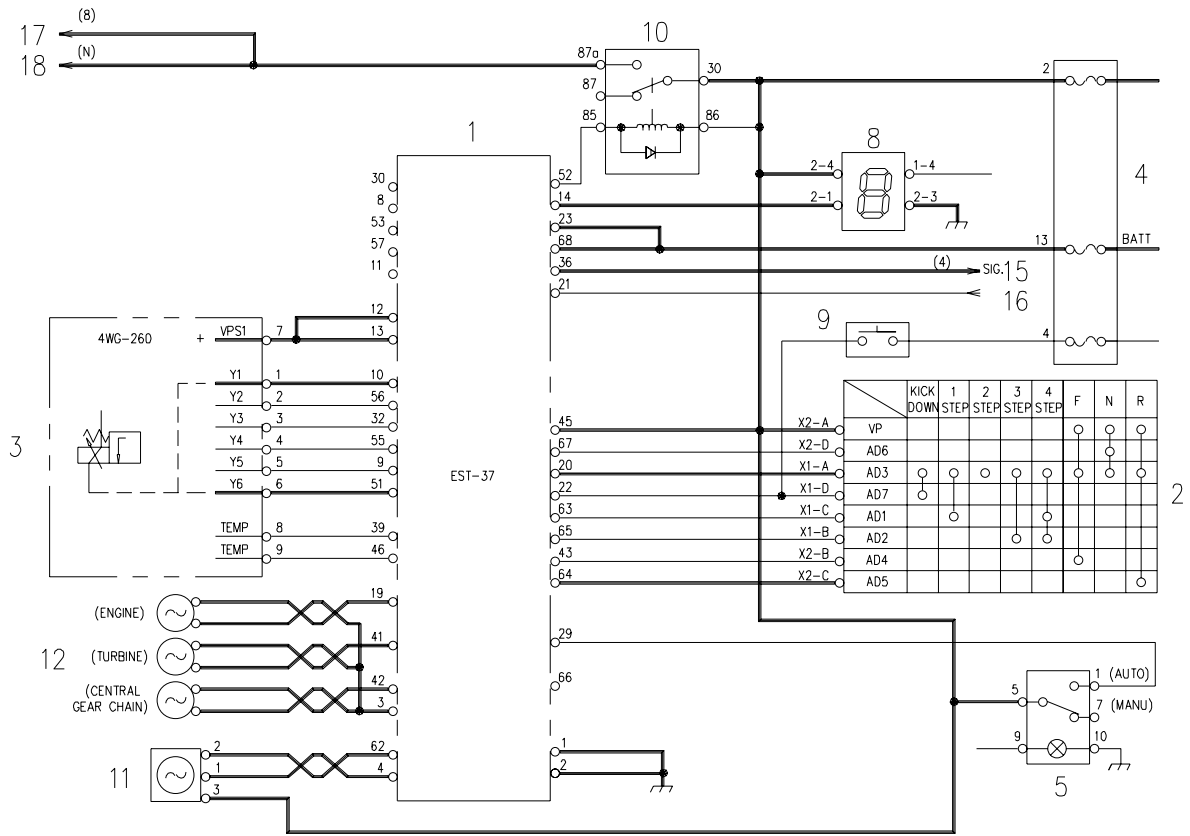


AJS0370L

Figure 24

Transmission solenoid valves (Y1 and Y3, Figure 24) are energized when in reverse first gear.

Reverse Second Gear

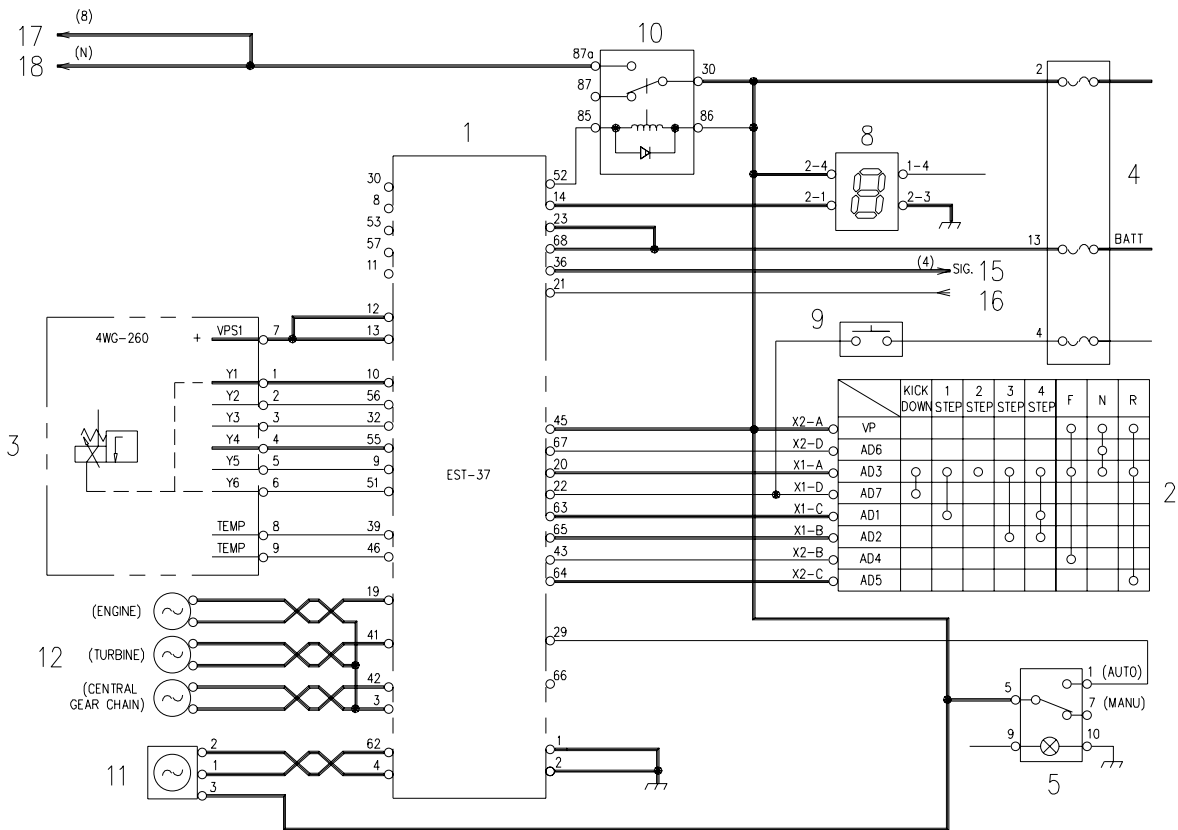


AJS0380L

Figure 25

Transmission solenoid valves (Y1 and Y6, Figure 25) are energized when in reverse second gear.

Reverse Third Gear



AJS0390L

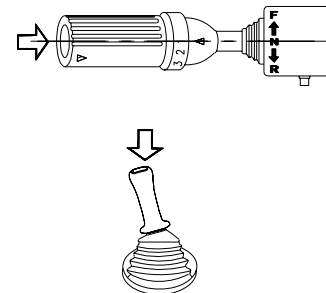
Figure 26

Transmission solenoid valves (Y1 and Y4, Figure 26) are energized when in reverse third gear.

Downshift

Overview

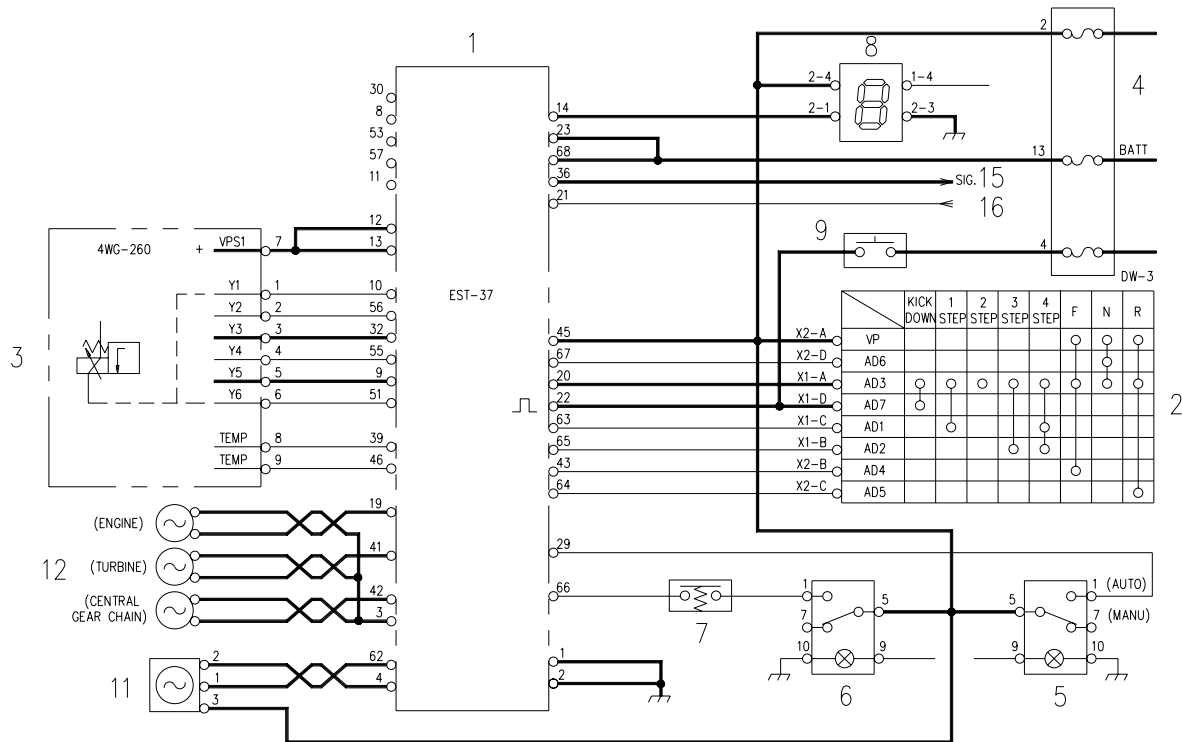
1. There are two downshift switches down Figure 27, and it is possible for operators to select one of them according to the condition.
2. If the downshift switch is depressed during the machine moving, downshifting takes place automatically. As a result, fast digging and moving is possible. But at the manual mode the kick-down can only be activated.
3. If a change or traveling direction takes place or the downshift switch is depressed a second time, downshifting is released automatically.



AJS0400L

Figure 27

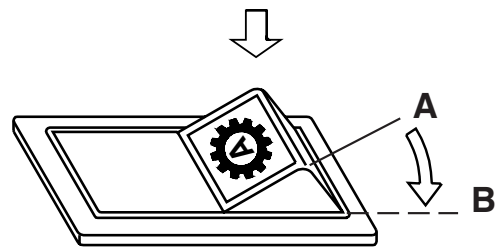
Kick-down: Forward Second Gear to Forward First Gear (Auto Selector Switch "O"- Manual Mode)



AJS0410L

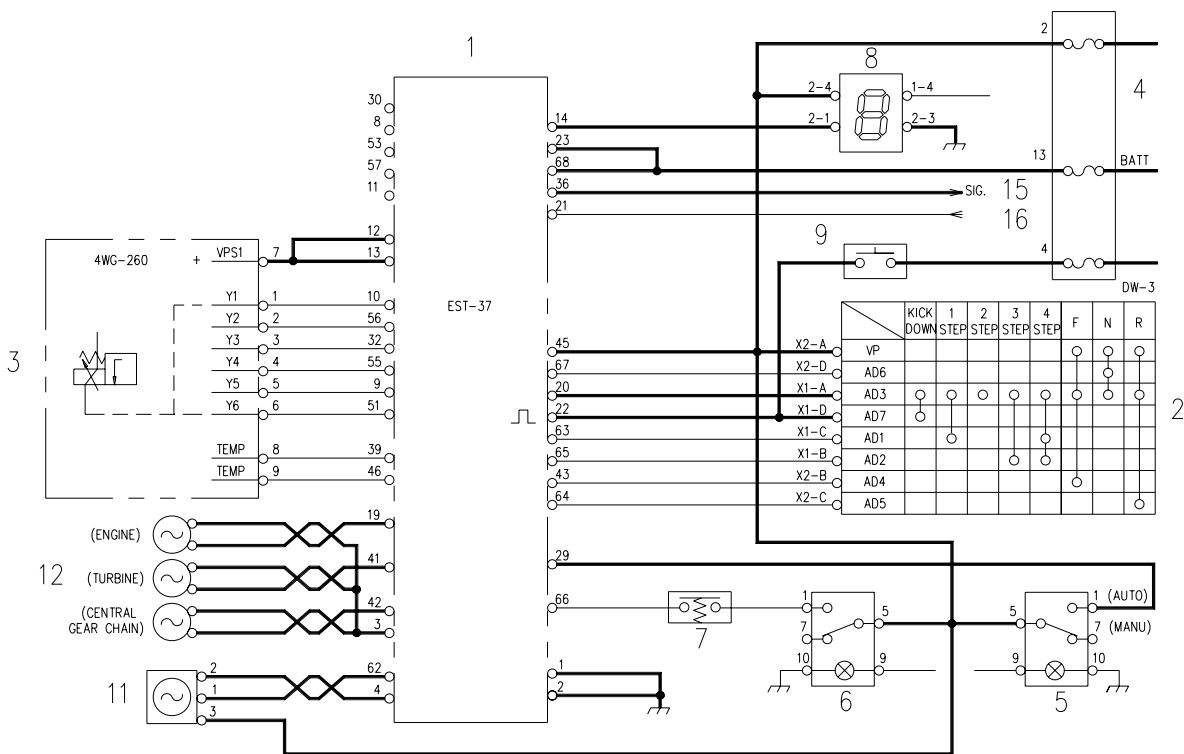
Figure 28

With the auto selector switch (Figure 29) is in the "O" and the forward second gear is selected, if either downshift switch (Figure 27) is activated, a pulse is sent to the "22" transmission controller. This signal energizes solenoid valves, (Y3 and Y5), which shifts the transmission to the forward first gear. When either switch (Figure 27) is selected a second time, the transmission pulse signal of the "22" terminal is interrupted and solenoid valve, Y5 and Y6, are energized and the transmission returns to the forward second gear.



HLB2007L

Figure 29

Downshift (Auto Selector Switch "I" - Auto Mode)

AJS0420L

Figure 30

When the auto selector switch (Figure 30) is in the "I" position, the "29" terminal of transmission controller is energized. This allows the transmission to automatically upshift and downshift gears depending on the load and on the engine speed.

If either downshift switch (Figure 27) is activated, a pulse signal is sent to the "22" terminal of transmission controller. This signal shifts the transmission to the next lowest gear.

Automatic Gear Selection	Downshift Switch "Activated"
Fourth Gear	Downshift to Third Gear
Third Gear	Downshift to Second Gear
Second Gear	Downshift to First Gear
First Gear	Remains in First Gear

When either downshift (Figure 27) is depressed a second time, the transmission pulse signal of the "22" is interrupted and the transmission returns to normal operation.

NOTE: The fourth to the third gear changes without any rpm change when the downshift switch is pressed.

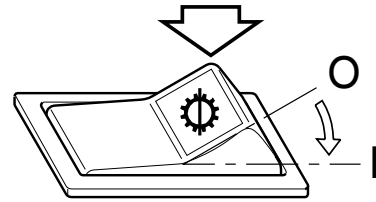
NOTE: The third to the second gear, and the third to the first gear, changes occur when the rpm is reduced 200 - 300 rpm from current setting.

Transmission Cut Off

When the brake pedal is depressed while transmission cutoff switch (Figure 31) is in "I" position, the transmission cutoff switch turns "ON" and current is supplied to '66' terminal of transmission controller.

All current being supplied to transmission solenoid valves (Y1 thru Y6) is cut off and the transmission is in "NEUTRAL."

NOTE: To protect transmission, transmission cutoff switch does not function in third and fourth gears.



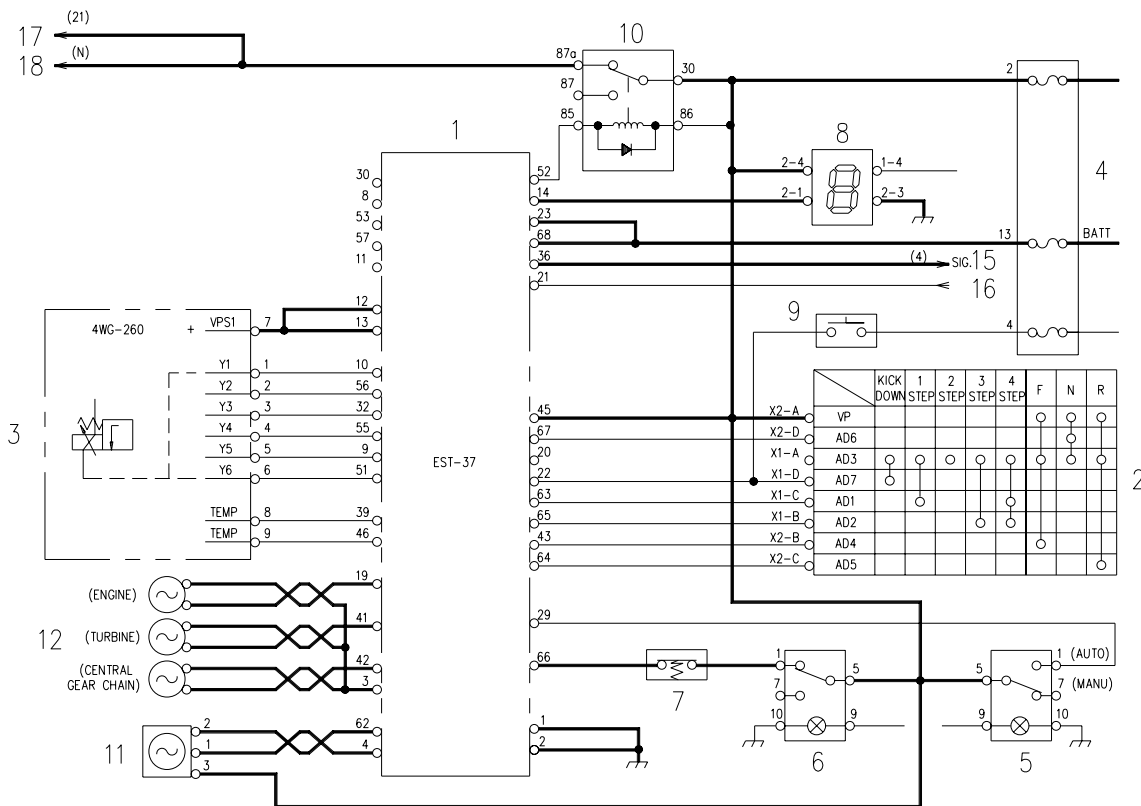
HA3O2018

CAUTION

Figure 31

AVOID INJURY

When the machine is traveling or working in place of inclination, the transmission cutoff switch (Figure 31) must be placed in position 'O' for the purpose of using engine braking and the normal braking function at the same time.

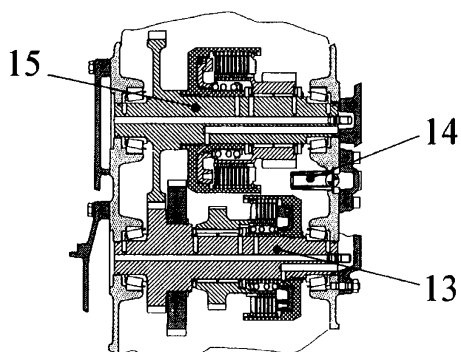
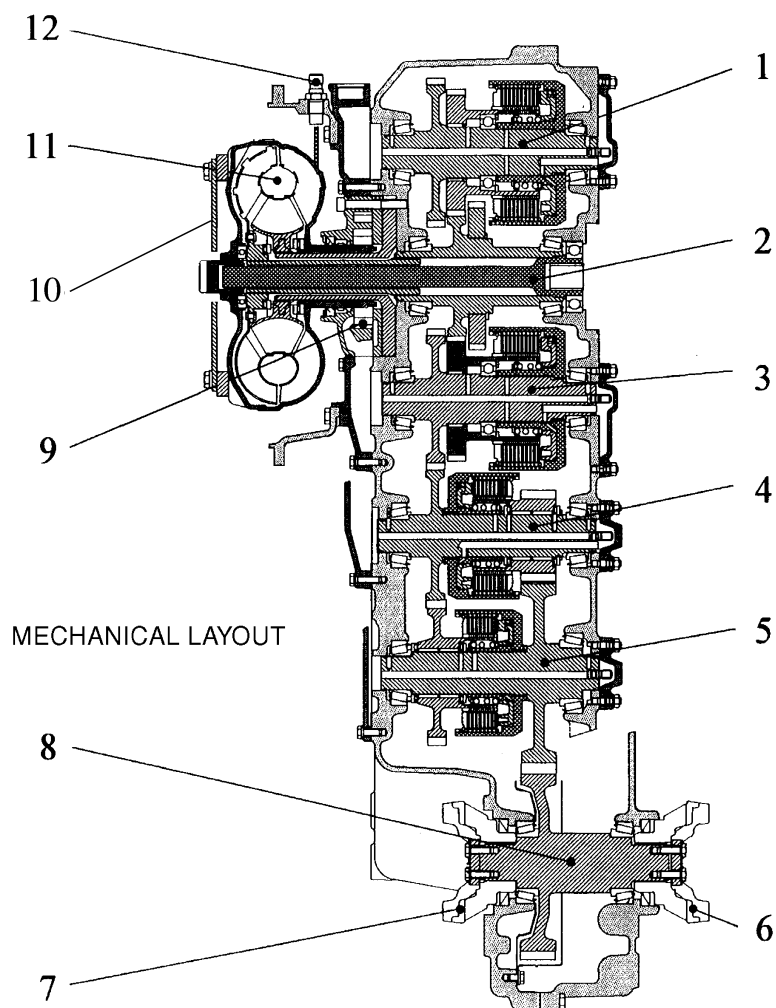


AJS0430L

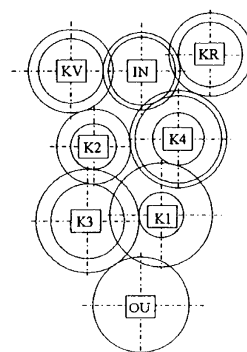
Figure 32

INSTALLATION VIEW

Inner Section



GEAR PATTERN



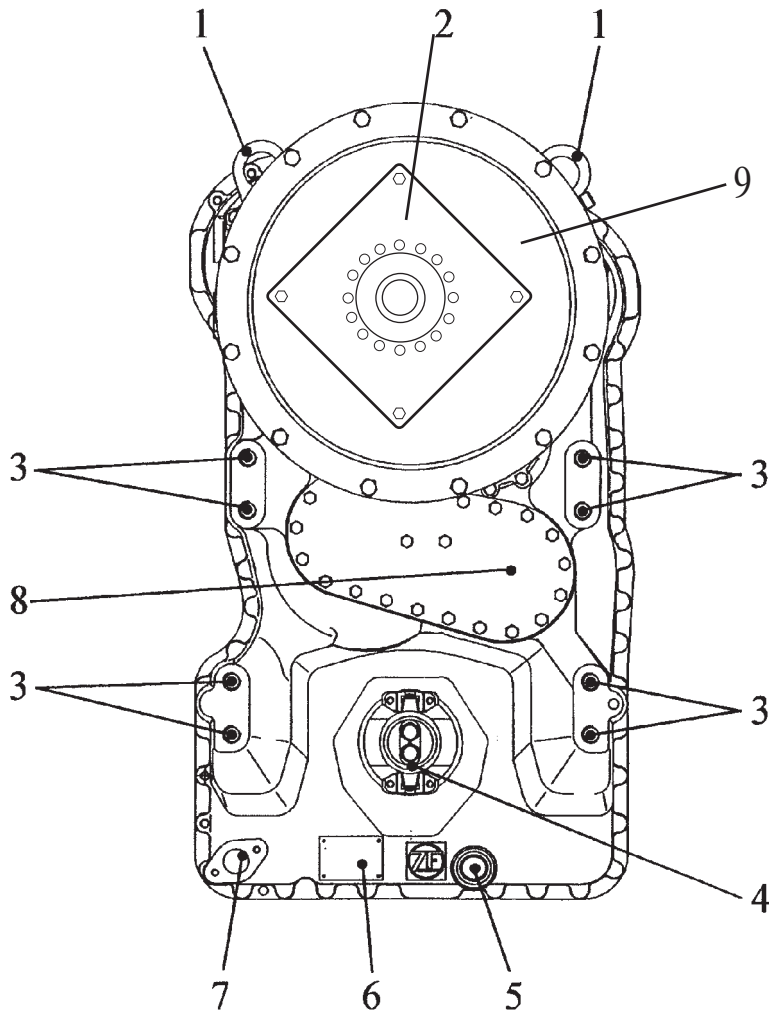
APS0520S

Figure 33

Reference Number	Description
1	Clutch Shaft KR
2	Power Take-off: Coaxial: Engine - Dependent
3	Clutch Shaft KV
4	Clutch Shaft K2
5	Clutch Shaft K5
6	Output Flange - Rear
7	Output Flange - Converter Side
8	Output Shaft
9	Transmission Pump

Reference Number	Description
10	Diaphragms - Direct Mounting
11	Converter
12	Inductive Transmitter for Engine Speed
13	Clutch Shaft K4
14	Converter Relief Valve
15	Clutch Shaft K1

Front View



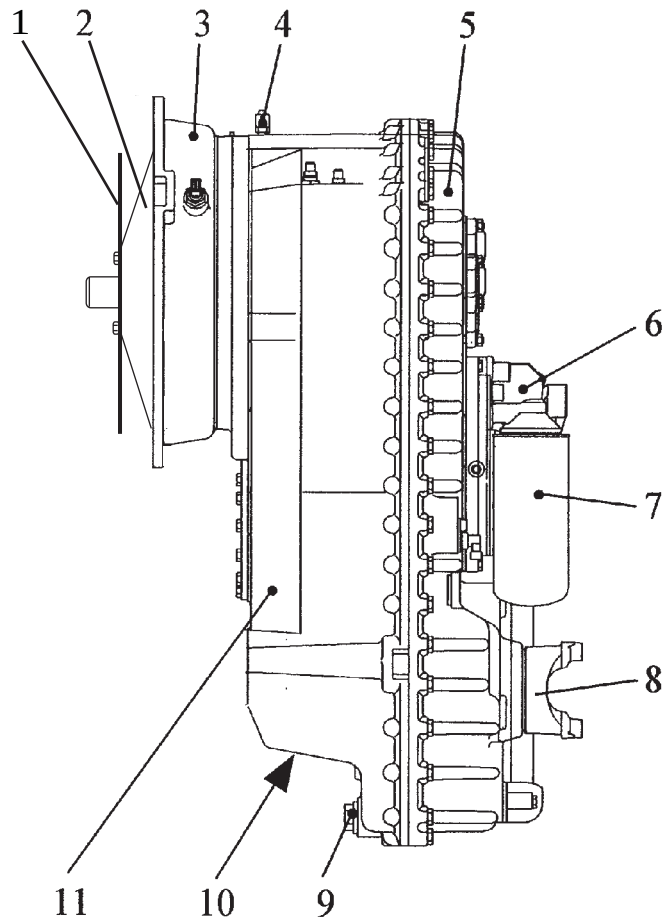
APS0470S

Figure 34

Reference Number	Description
1	Lifting Lugs
2	Diaphragms - Direct Mounting
3	Transmission Suspension Threads M20
4	Output Flange - Converter Side
5	Oil Drain Plug with Magnetic Insert M38x1.5

Reference Number	Description
6	Model Identification Plate
7	Attachment Possibility for Oil Level Tube with Oil Dipstick (Converter Side)
8	Attachment Possibility for Emergency Steering Pump
9	Converter

Side View



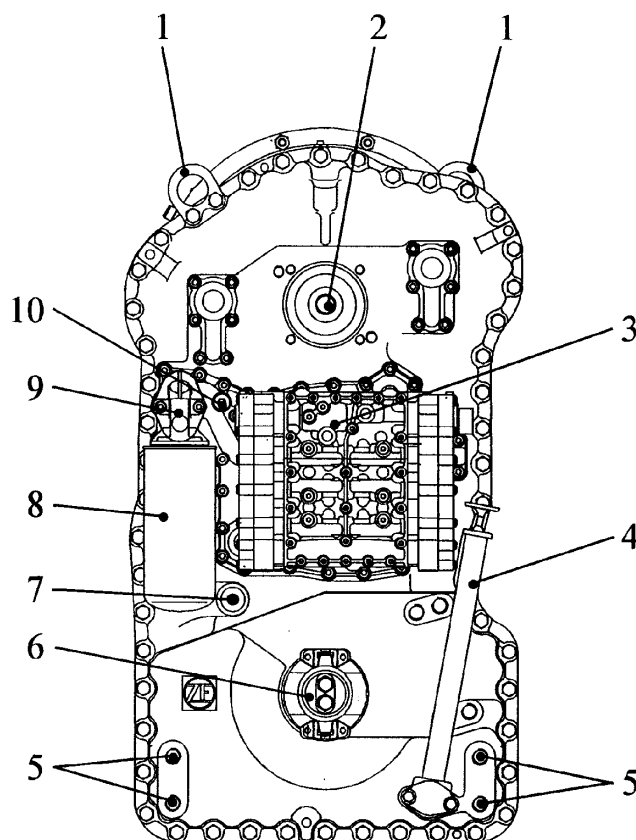
APS0480S

Figure 35

Reference Number	Description
1	Diaphragms - Direct Mounting
2	Converter
3	Converter Bell Housing
4	Breather
5	Transmission - Case Cover
6	Filter Head

Reference Number	Description
7	Exchange Filter (Fine Filter)
8	Output Flange - Rear
9	Oil Drain Plug with Magnetic Insert M38x1.5
10	Output Flange - Converter Side
11	Transmission Case

Rear View



APS0490S

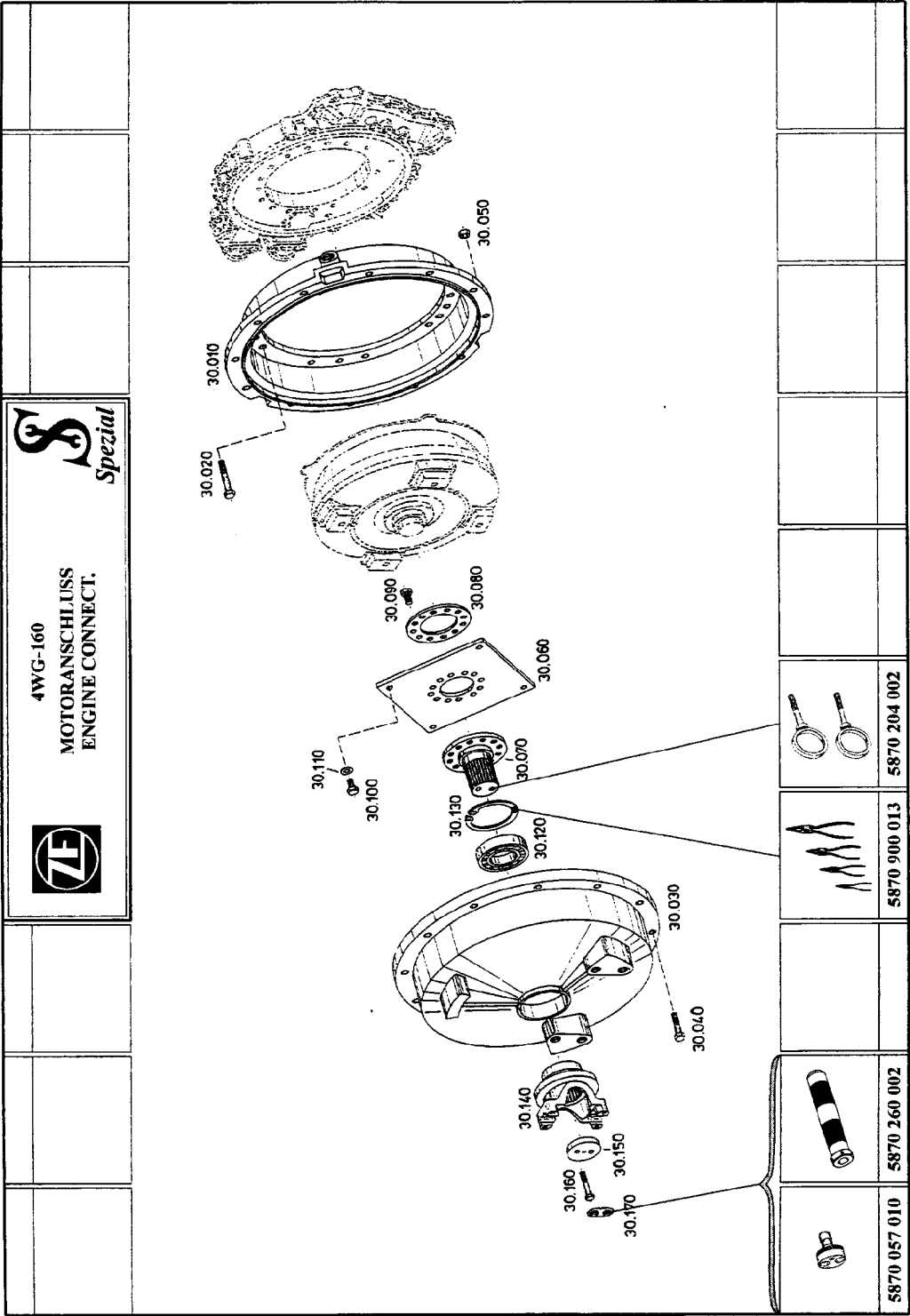
Figure 36

Reference Number	Description
1	Lifting Lugs
2	Power Take-off; Coaxial; Engine - Dependent
3	Electro - hydraulic Control
4	Oil Level Tube With Oil Dipstick
5	Transmission Suspension Threads M20

Reference Number	Description
6	Output Flange - Rear
7	Port - Return Line From Parking Brake(Optional)
8	Exchange Filter(Fine Filter)
9	Filter Head With Connection For Filter Restriction Switch
10	Port-System Pressure to Parking Brake Valve (Option)

SPECIAL TOOLS

Engine Connection



Ausgabe/Edition: 04/97

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APS0010S

Figure 37

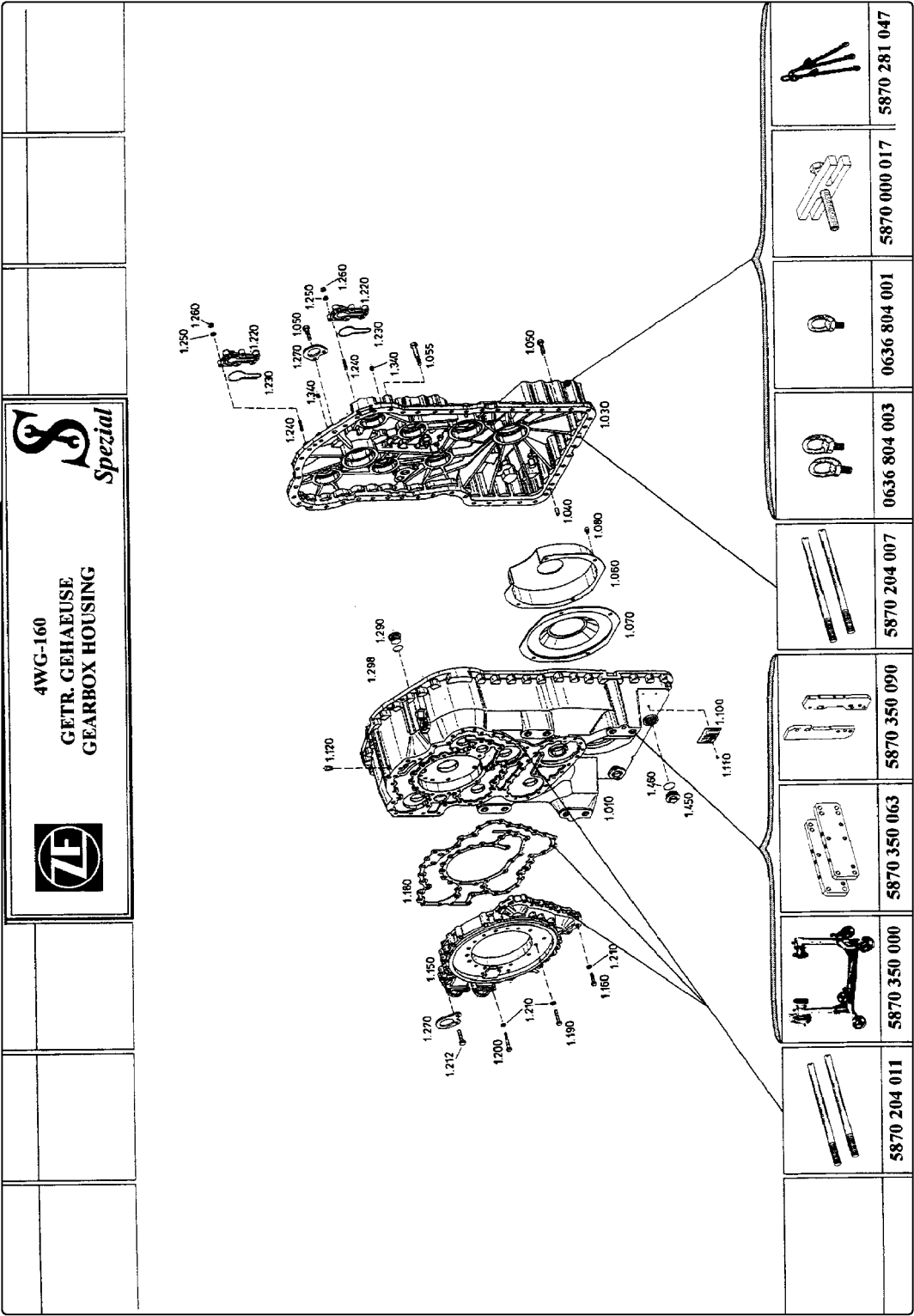


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APS0020S

Figure 38

Gearbox Housing



Coupling

Coupling K1

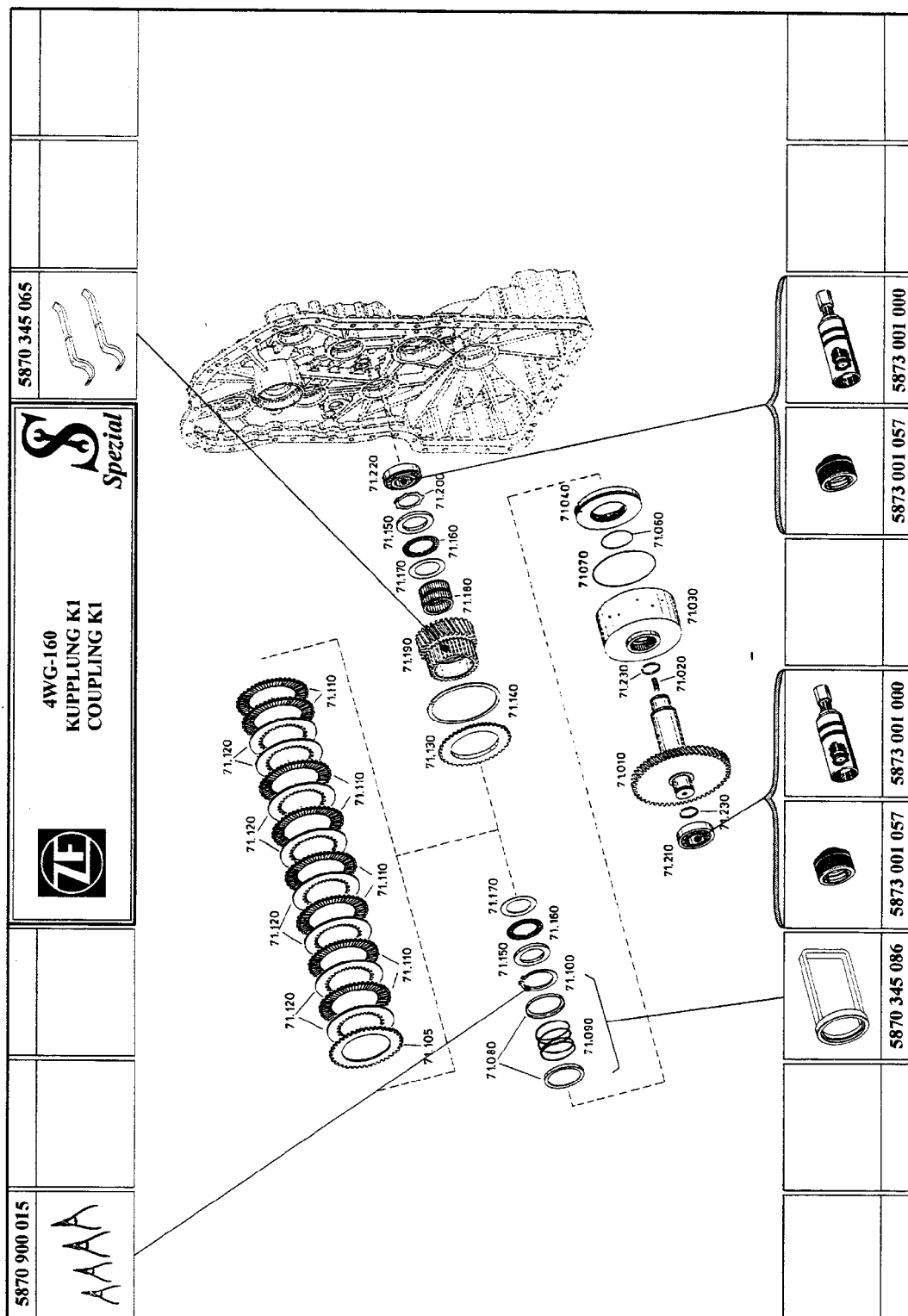


Figure 40

APS0040S



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APS0050S



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APS0070S

Figure 42



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APS0080S

Figure 43

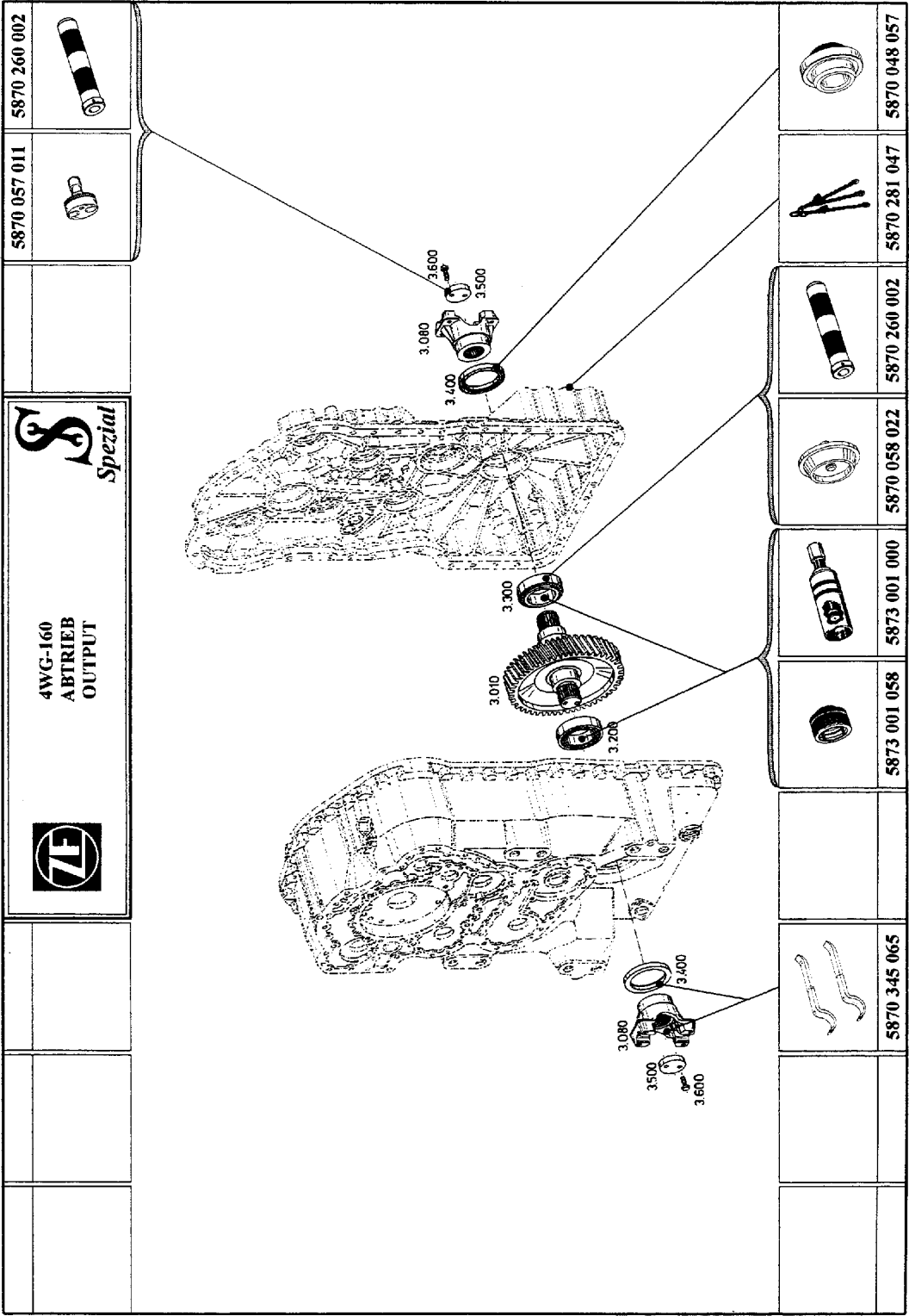


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APS0090S

Figure 44

Output



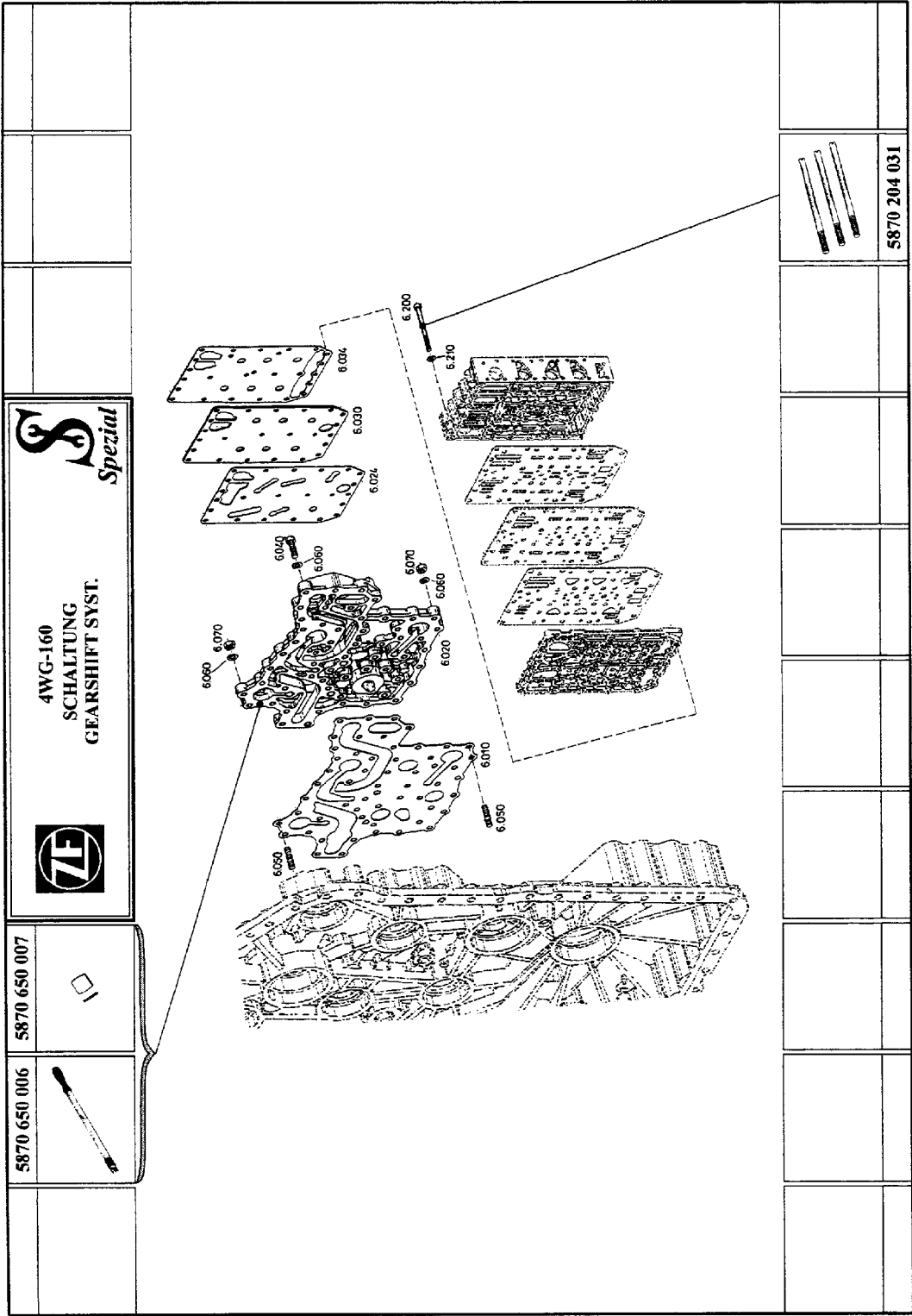
Ausgabe/Edition: 04/97

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APS0100S

Figure 45

Gearshift System



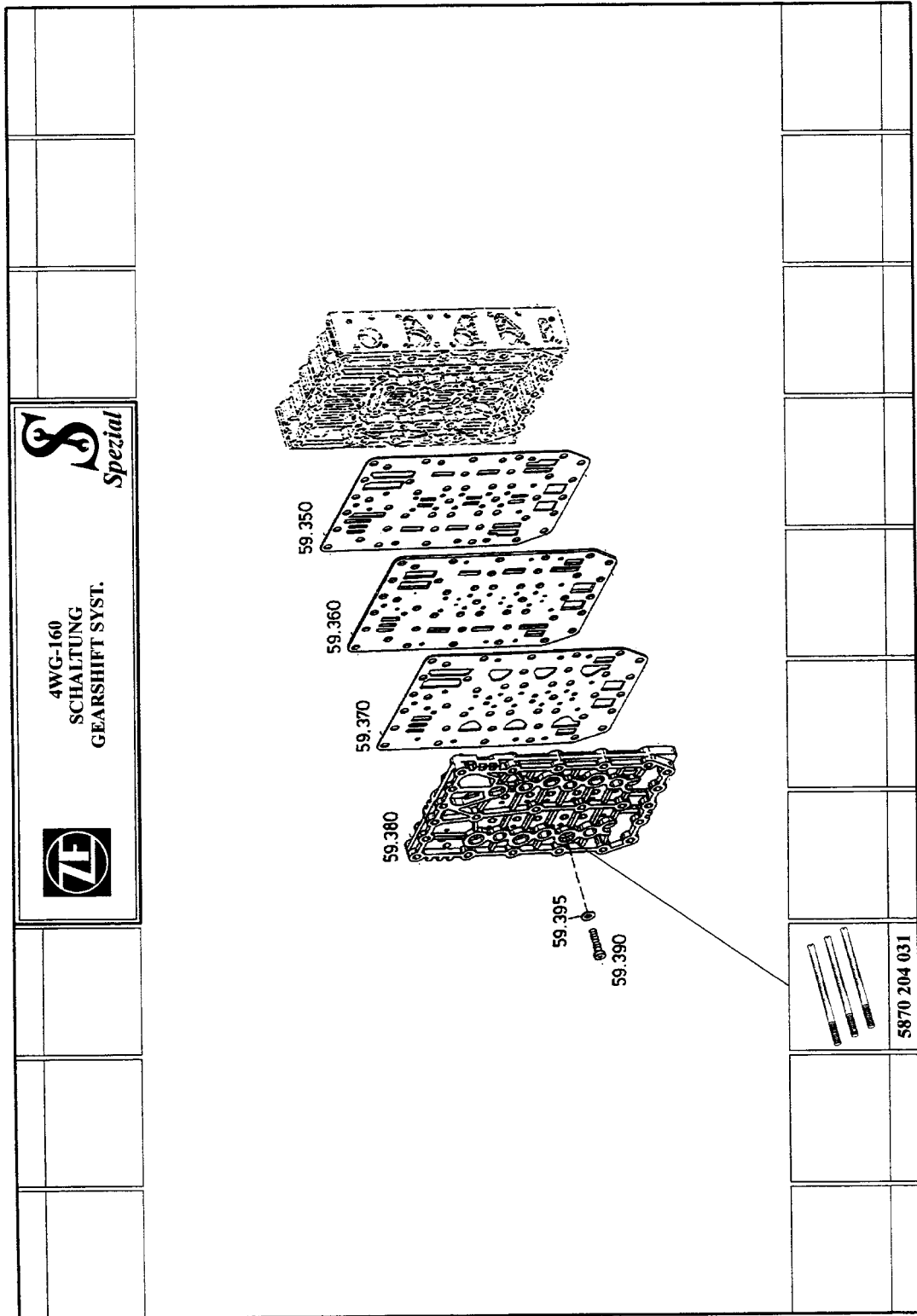
Ausgabe/Edition: 04/97

Figure 46

APS0110S

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SP002933
Page 47



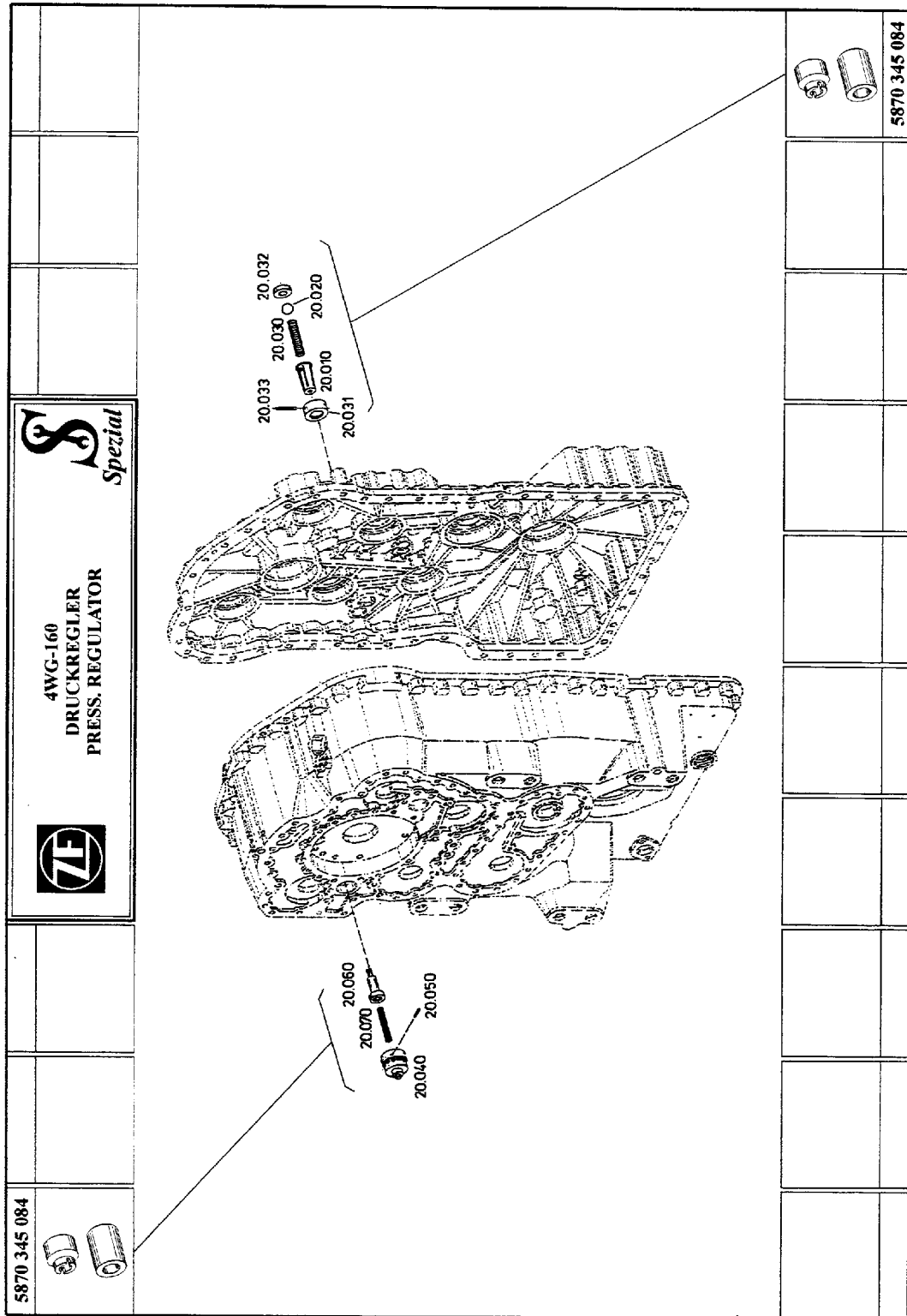
Ausgabe-/Edition: 04/97

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APS0130S

Figure 48

Pressure Regulator



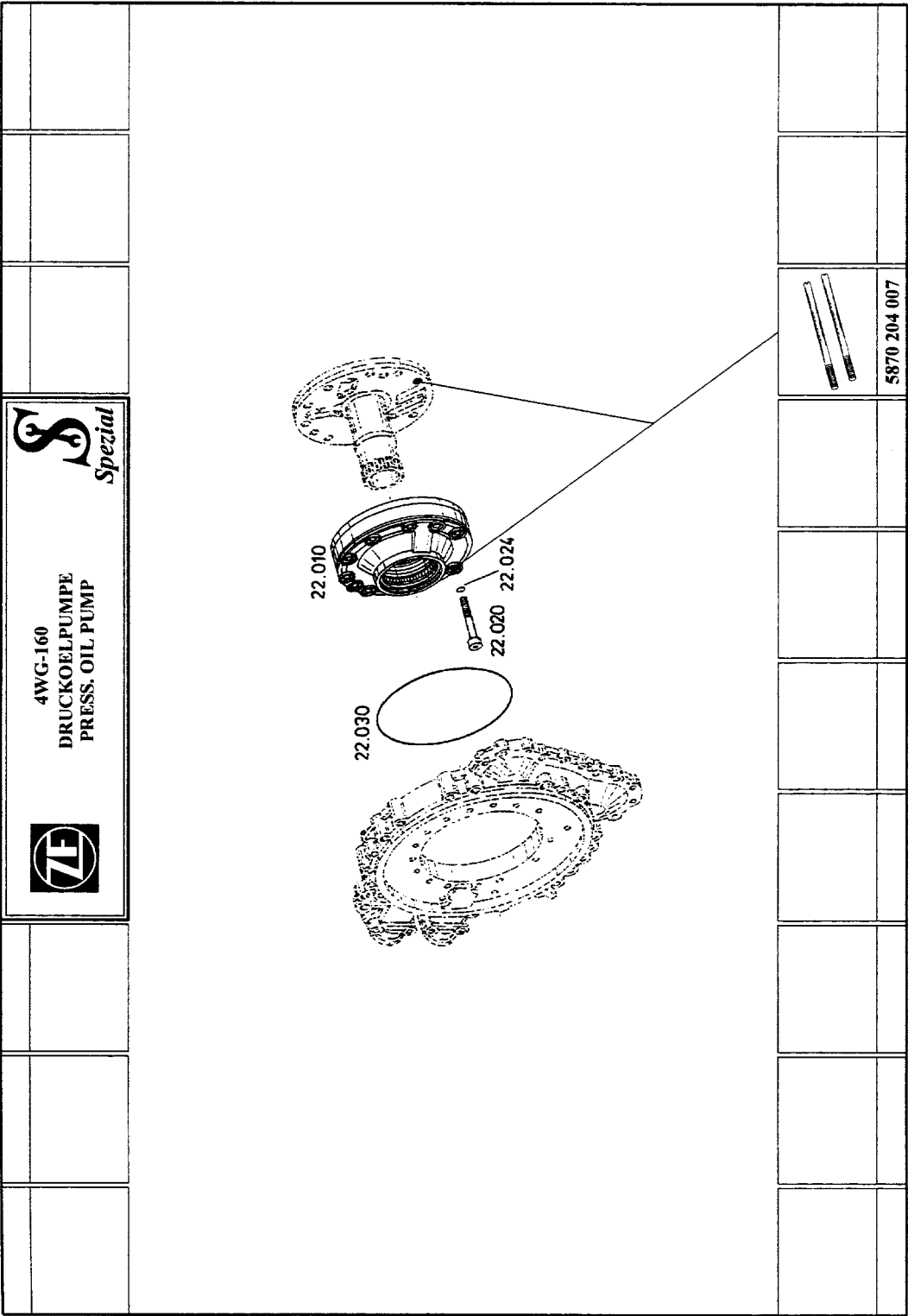
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APS0140S

Figure 49

Pressure Oil Pump



Ausgabe:/Edition: 04/97

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APS0150S

Figure 50

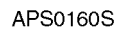


Figure 51

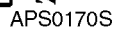


Figure 52

HYDRAULIC CONTROL UNIT (HSG-94)

Figure 53, shows a sectional view of HSG-94.

IMPORTANT

Different versions in relation to position of cable harness are possible.

In this connection, pay attention to Specifications of Vehicle Manufacturer.

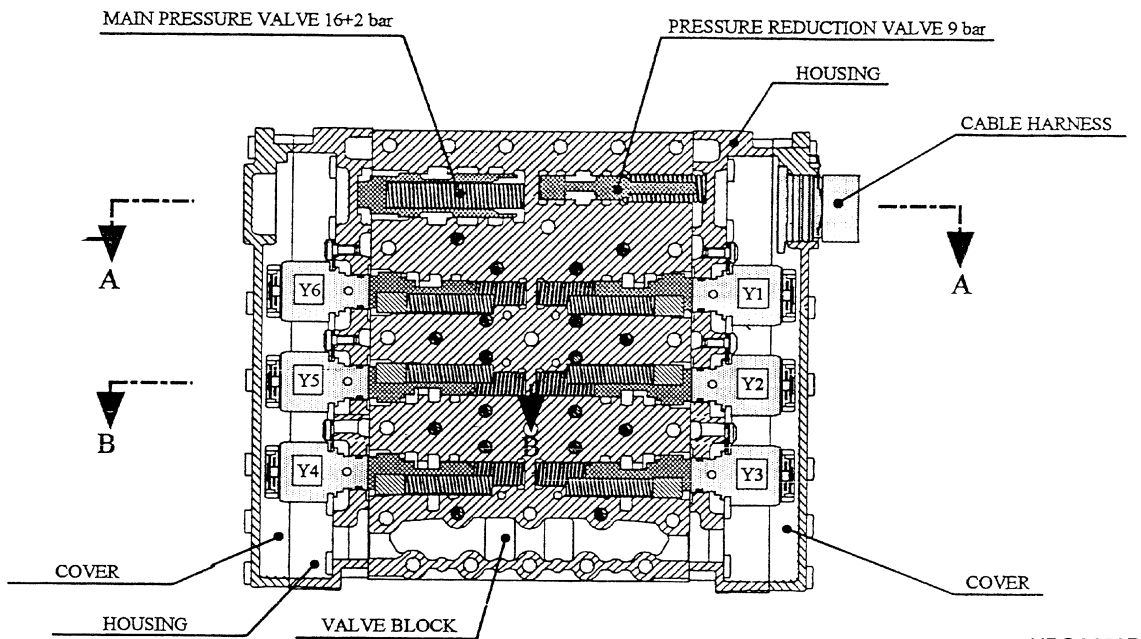
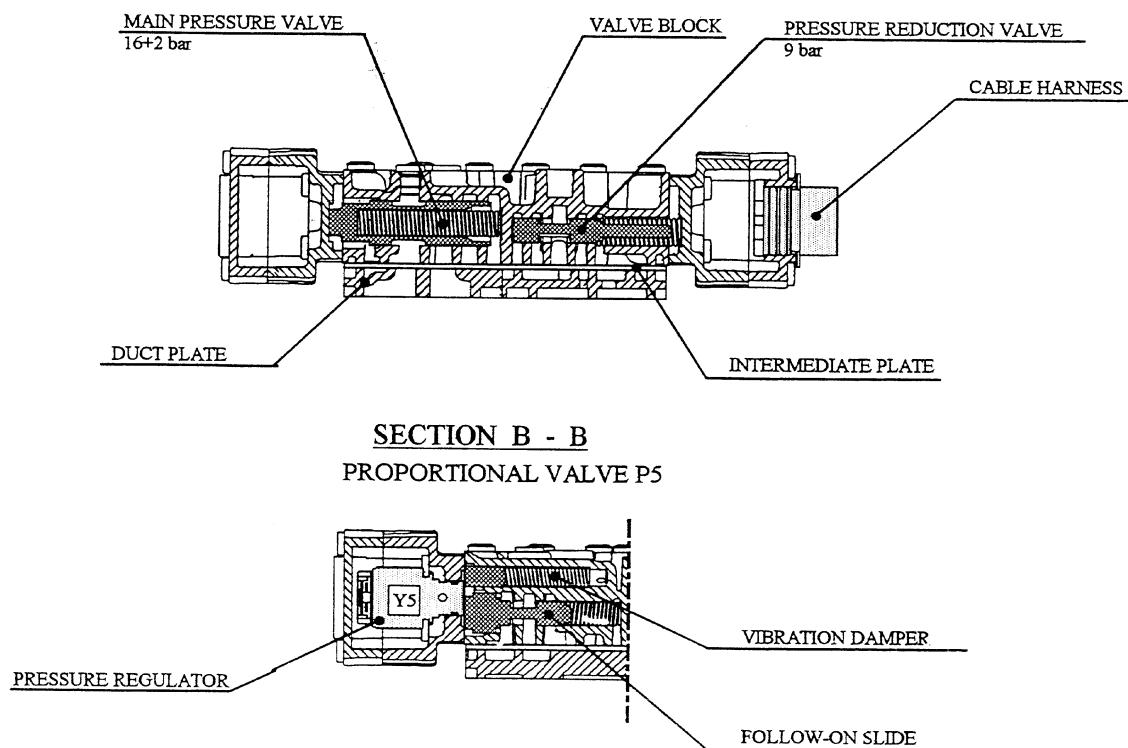


Figure 53

HBOA650P

Section A -A

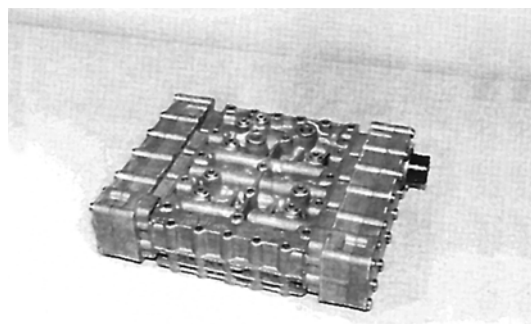


HBOA660P

Figure 54

Disassembly

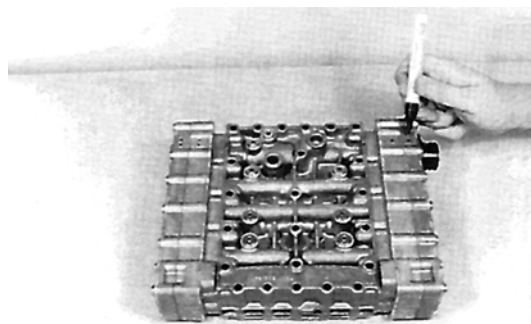
1. Figure 55, shows complete control unit.



HLA2005P

Figure 55

2. Mark installation position of different covers, housing and cable harness with valve housing.

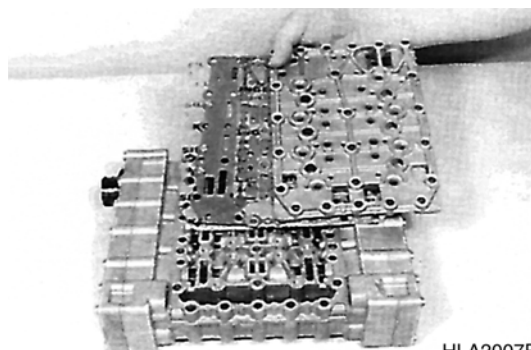


HLA2006P

Figure 56

3. Remove socket head screws.
4. Separate duct plate, 1st gasket, intermediate plate and 2nd gasket from valve housing.

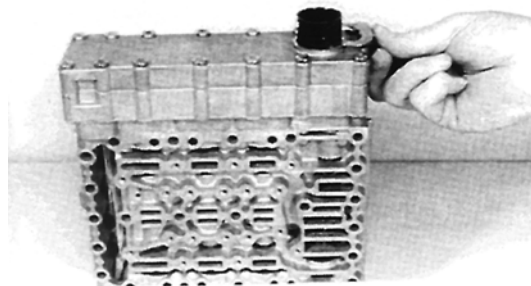
(S) Box spanner (Torx TX-27) - 5873 042 002



HLA2007P

Figure 57

5. Remove retaining clip.



HLA2008P

Figure 58

6. Remove socket head screws.
7. Separate cover from housing and cable harness.
(S) Box spanner (Torx TX-27) - 5873 042 002

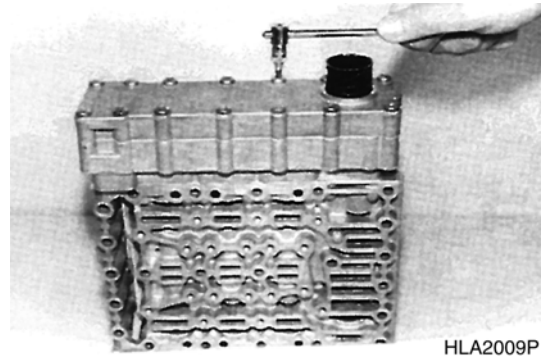


Figure 59

8. Disassemble opposite cover.
9. Disconnect pressure regulator and remove cable harness.

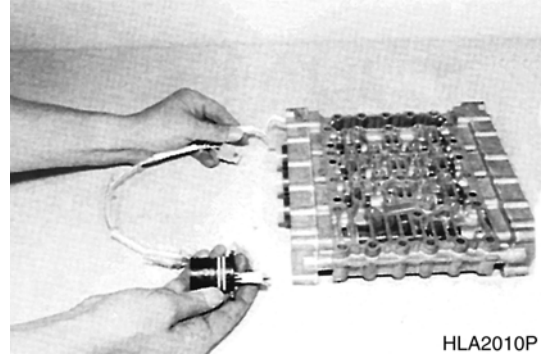


Figure 60

10. Remove socket head screws, remove fixing plate and pressure regulators (3x).
(S) Box spanner (Torx TX-27) - 5873 042 002

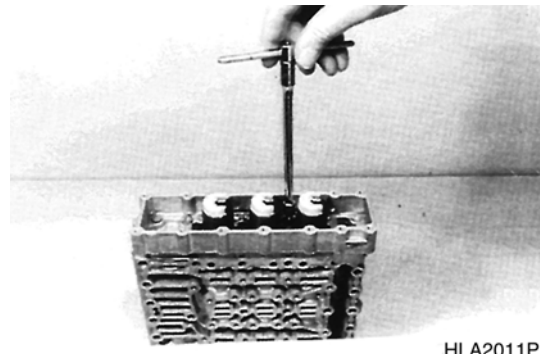


Figure 61

11. Remove two socket head screws and locate housing provisionally, using adjusting screws. (Housing is under spring preload). Remove remaining socket and screws.
(S) Box spanner (Torx TX-27) - 5873 042 002
(S) Adjusting screws - 5870 204 036

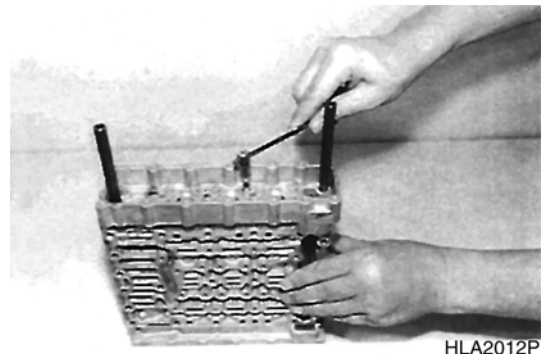
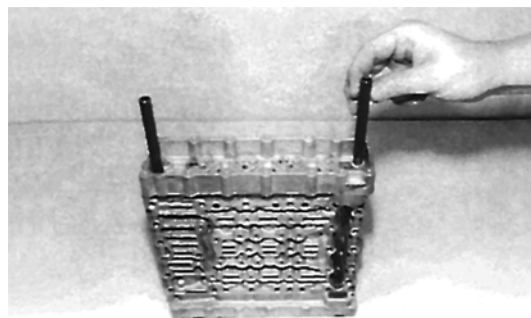


Figure 62

12. Separate housing from valve housing by loosening adjusting screws uniformly.

(S) Adjusting screws - 5870 204 036



HLA2013P

Figure 63

13. Remove components (Figure 64).
14. Remove opposite pressure regulators, housing and components accordingly (Figure 65).



HLA2014P

Figure 64



HLA2015P

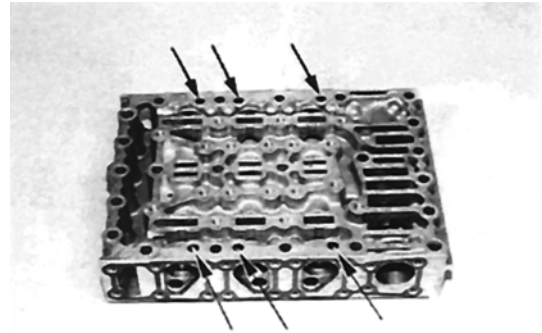
Figure 65

Reassembly

NOTE: Check all components for damage and replace if necessary. Before installation, check free travel of all moving parts in housing. Spools can be exchanged individually. Oil components before reassembly according to ZF-List of lubricants TE-ML 03.

Insert diaphragms with concave side facing up until seated.

NOTE: Installation position, see arrows.

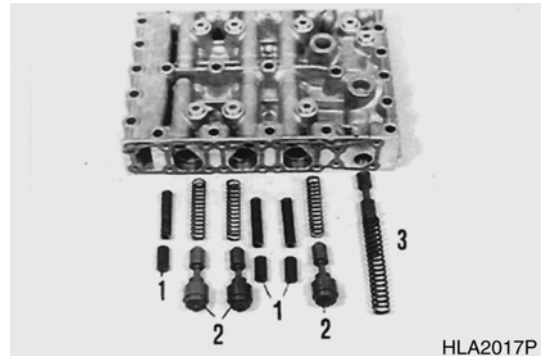


HLA2016P

Figure 66

1. Figure 67, shows the following components:

Reference Number	Description
1	Vibration Damper (3x Spool and Compression Spring)
2	Follow On Site (3x Spool and Compression Spring)
3	Pressure Reducing Valve (1x Spool and Compression Spring)

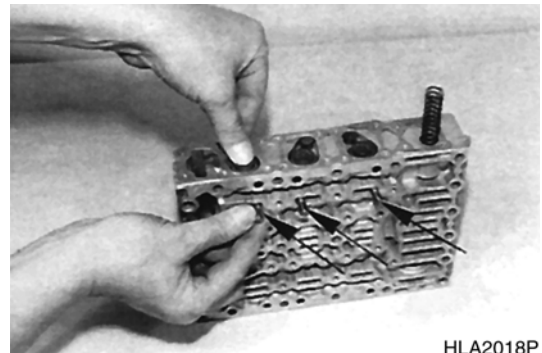


HLA2017P

Figure 67

2. Install components according to Figure 67.

NOTE: Preload compression spring of follow on site slides and locate spool provisionally using cylindrical pins $\varnothing$ 5.0 mm (0.1969 in) (assembly aid), See Figure 68.



HLA2018P

Figure 68

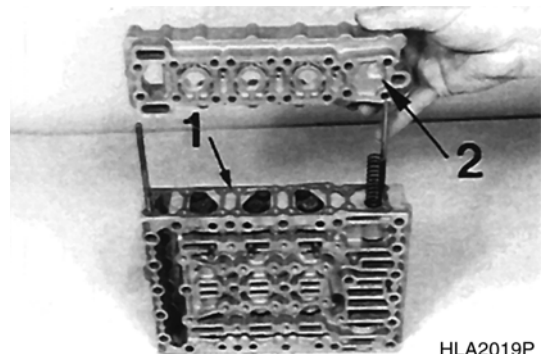
3. Install two adjusting screws.

4. Assemble gasket (1, Figure 69) and housing cover (Figure 69). Position housing cover uniformly, using adjusting screws, until seated and remove cylindrical pins (assembly aid) again (Figure 69).

NOTE: Pay attention to different housing covers.

5. Install recess $\varnothing$ 15.0 mm (0.5906 in) (2, Figure 69), facing spring of pressure reducing valve.

(S) Adjusting screws - 5870 204 036



HLA2019P

Figure 69

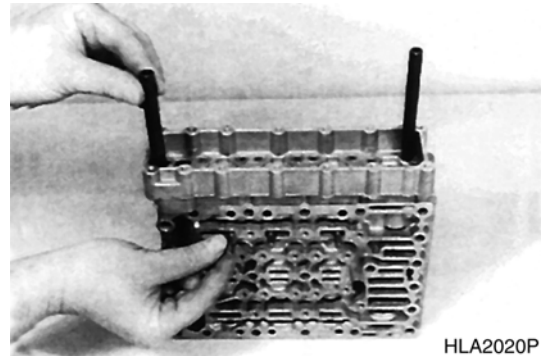


Figure 70

6. Fasten housing cover using socket head screws.

NOTE: Torque limit 0.56 kg•m (4 ft lb).

(S) Box spanner (Torx TX-27) - 5873 042 002

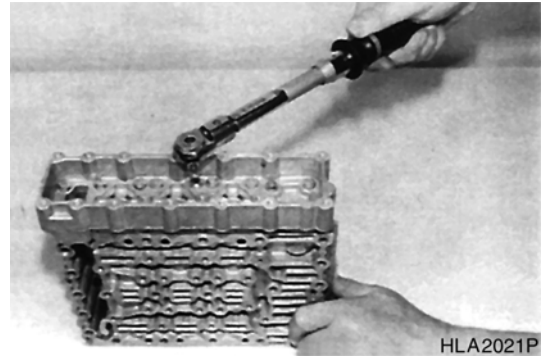


Figure 71

7. Install pressure regulators and attach using fixing plates and socket head screws.

NOTE: Install fixing plate, with claw facing down. Pay attention to radial installation position of pressure regulators, see Figure 72.

NOTE: Torque limit 0.56 kg•m (4 ft lb).

(S) Box spanner (Torx TX-27) - 5873 042 002

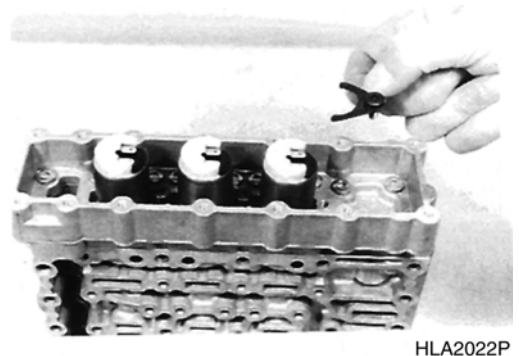


Figure 72

8. Preassemble opposite side.

A. Figure 73, shows the following components:

Reference Number	Description
1	Main Pressure Valve (1x Spool and Compression Spring.)
2	Follow On Slide (3x Spool and Compression Spring)
3	Vibration Damper (3x Spool and Compression Spring)



Figure 73

B. Install components according to Figure 73.

- C. Preload compression springs of follow on slides and locate spool provisionally using cylindrical pins $\varnothing$ 5.0 mm (0.1969 in) (assembly aid). See arrows.
- D. Install two adjusting screws.
- E. Assemble gasket (1, Figure 74) and housing cover, and position them uniformly against shoulder, using adjusting screws.

NOTE: Pay attention to different housing covers, install recess $\varnothing$ 19.0 mm (0.7480 in) (2, Figure 74), facing main pressure valve.

- F. Down, fasten housing cover using socket head screws.

NOTE: Torque limit 0.56 kg•m (4 ft lb).

- G. Remove cylindrical pins (assembly aid) again.

(S) Adjusting screws - 5870 204 036

(S) Box spanner (Torx TX-27) - 5873 042 002

- H. Install pressure regulators and attach using fixing plates and socket head screws.

NOTE: Install fixing plates, with claw facing down.

- I. Pay attention to radial installation position of pressure regulators, see Figure 75.

NOTE: Torque limit 5.5 N.

(S) Box spanner (Torx TX-27) - 5873 042 002

- J. Install cable harness and connect pressure regulators (6x).

NOTE: Pay attention to installation position of cable harness, see also markings (Figure 56).

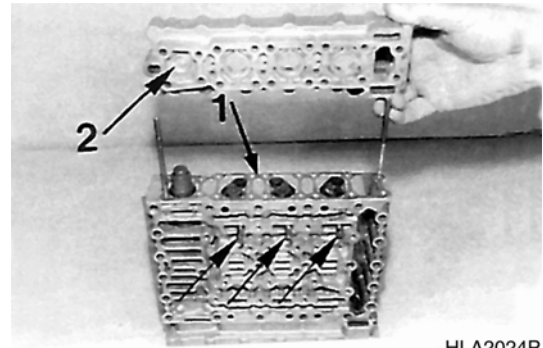


Figure 74

HLA2024P

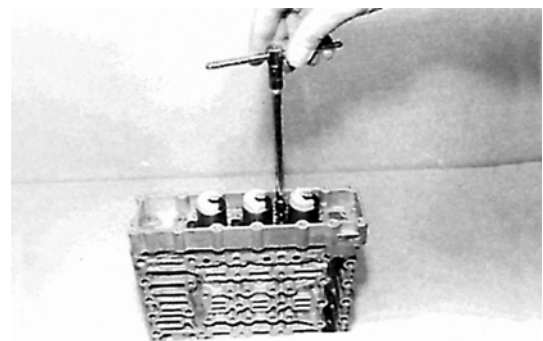


Figure 75

HLA2025P

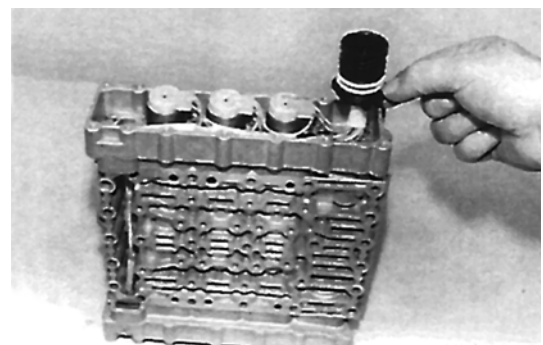


Figure 76

HLA2026P

- K. Install female connector against shoulder, with groove facing guide nose of cover.
- L. Install gaskets (Figure 77) and fasten cover using socket head screws.

NOTE: Torque limit 0.56 kg•m (4 ft lb).

(S) Box spanner (Torx TX-27) - 5873 042 002

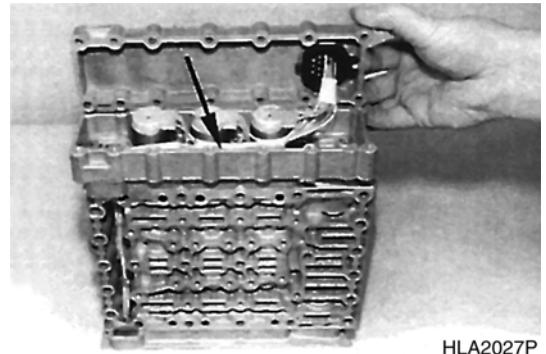


Figure 77

- M. Install female connector using retaining clamp, see Figure 78.

- N. Install opposite cover.

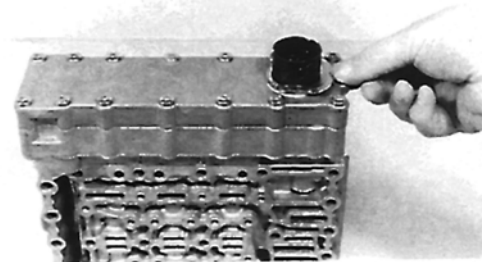


Figure 78

- O. Install two adjusting screws and mount gasket I.

NOTE: Pay attention to different gaskets, see Figure 79 and Figure 82.

(S) Adjusting screws - 5870 204 063

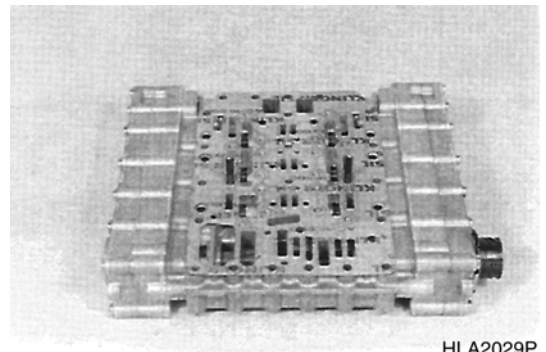


Figure 79

- 9. Intermediate plate-version with screens:

- A. Insert screens (6x) flash -mounted into bore of intermediate plate, see Figure 80.

NOTE: Pay attention to installation position screens are facing up (facing duct plate).

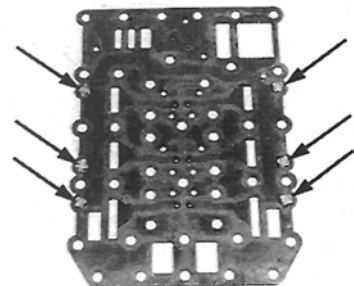
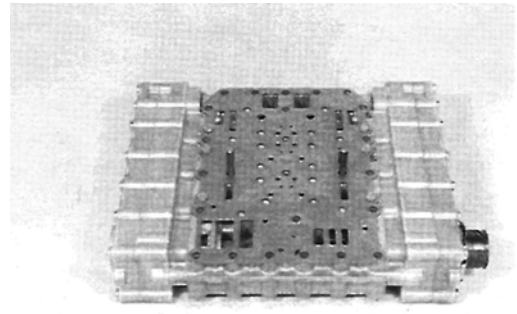


Figure 80

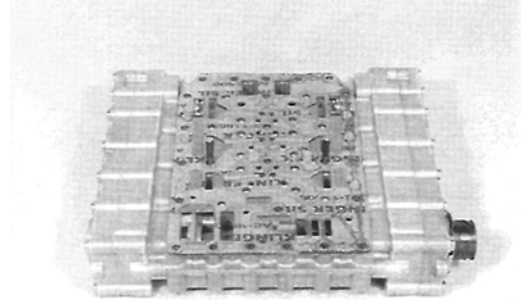
- B. Mount intermediate plate, with screens with screens facing up.



HLA2031P

Figure 81

- C. Mount gasket II.



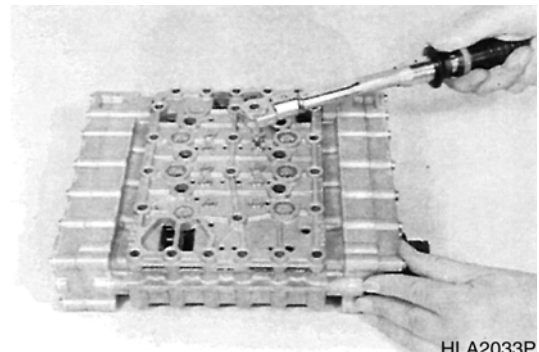
HLA2032P

Figure 82

- D. Mount duct plate and fasten it uniformly using socket head screws.

NOTE: Torque limit 1 kg•m (7 ft lb).

(S) Box spanner (Torx TX-27) - 5873 042 002



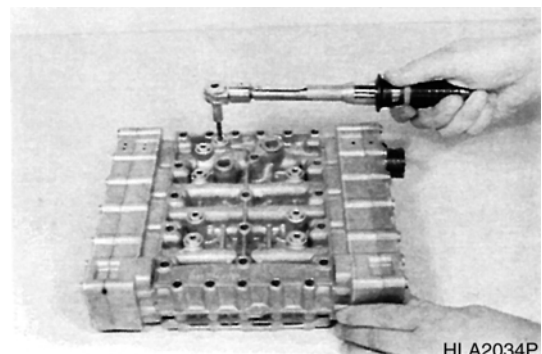
HLA2033P

Figure 83

- E. install new O-rings on plugs (8x) and install them.

NOTE: Torque limit 0.61 kg•m
(4.4 ft lb).

NOTE: The installation of hydraulic control unit is described in following section.



HLA2034P

Figure 84

POWERSHIFT TRANSMISSION

DISASSEMBLY

Remove Filter Unit

1. Remove warning switch (Figure 85) from filter head.

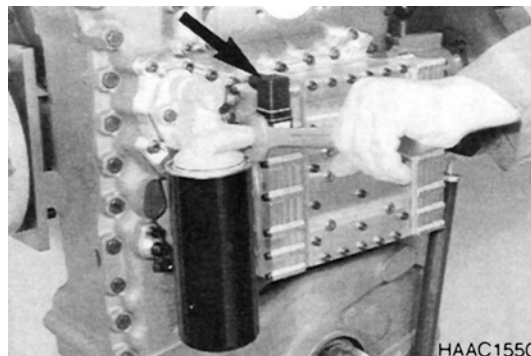


Figure 85

2. Remove oil filter from filter head.
(S) Belt spanner - 5870 105 005

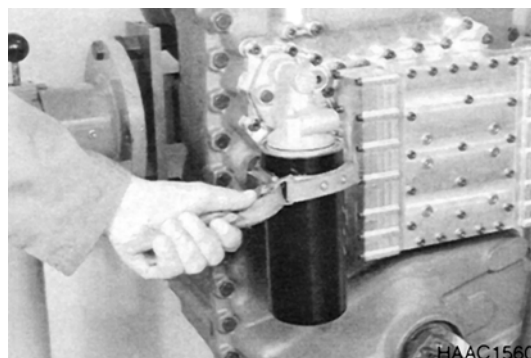


Figure 86

3. Loosen hex. head screws and remove filter head from duct plate.

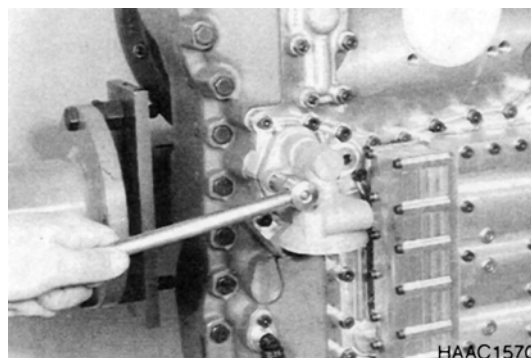


Figure 87

Remove Hydraulic Control Unit (HGS-94) and Duct Plate from Gearbox Housing

1. Loosen socket head screws, install two adjusting screws and remove control unit from duct plate.
(S) Adjusting screws - 5870 204 031

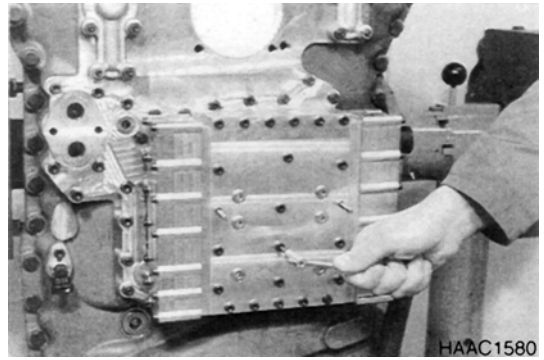


Figure 88

2. Remove both gaskets and intermediate plate.
(S) Adjusting screws - 5870 204 031

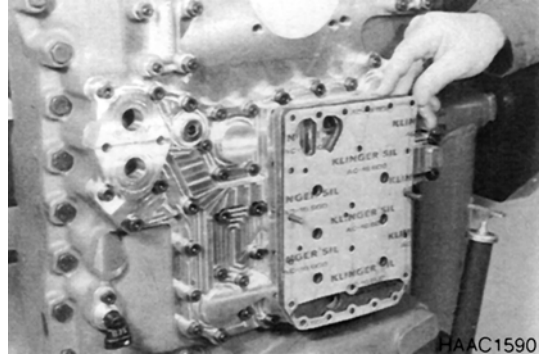


Figure 89

3. Loosen socket head screws and hex. nuts and remove duct plate from gearbox housing.
4. Remove flat gasket.
(S) Adjusting screws - 5870 204 031

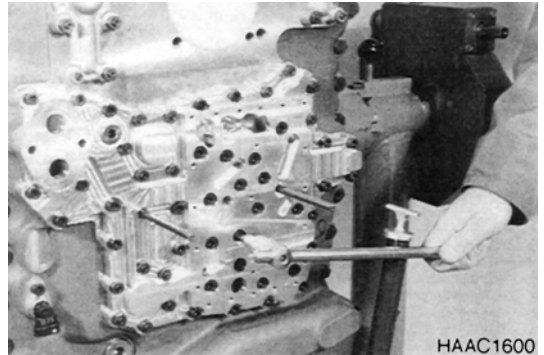


Figure 90

Remove and Dismantle Converter Safety Valve

1. Pull converter safety valve out of housing bore.

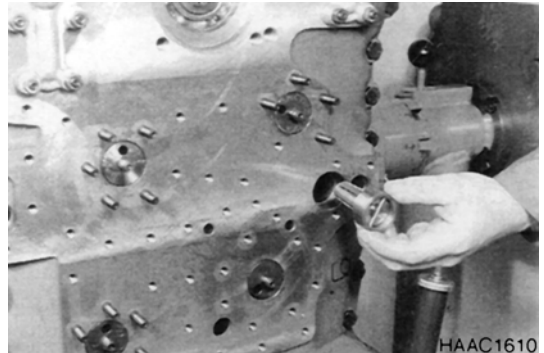


Figure 91

2. Figure 92, shows required special tool for the dismantling of the converter safety valve.

Reference Number	Description
1	Converter safety valve (compl.)
(S)	Assembly aid - 5870 345 084

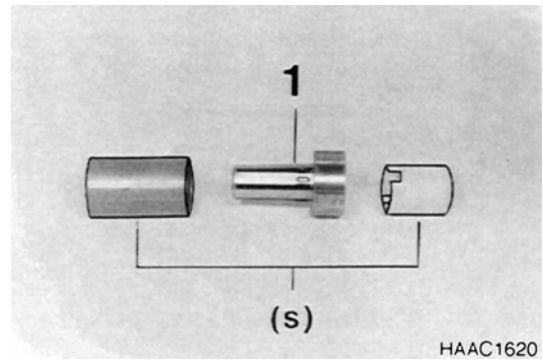


Figure 92

3. Preload compression spring carefully, remove cylindrical pin (Figure 93) and components (Figure 94).

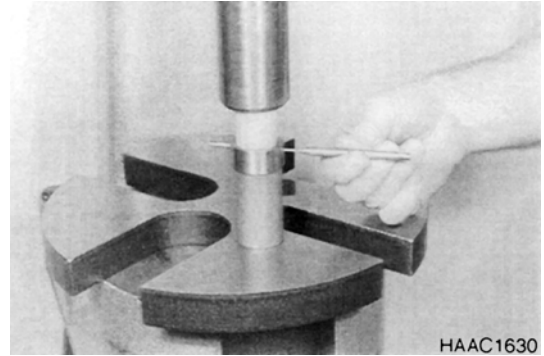


Figure 93

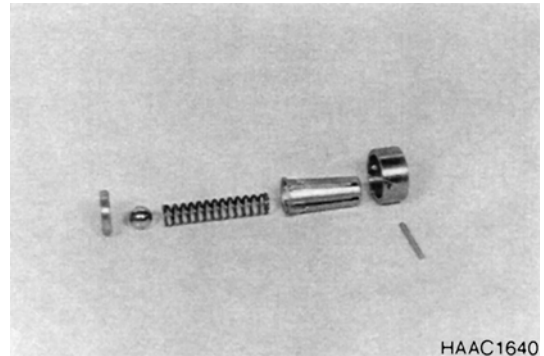


Figure 94

Engine Connection - Converter

1. Remove lock plate and loosen hex. head screws.
2. Remove disk and pry input flange from shaft.

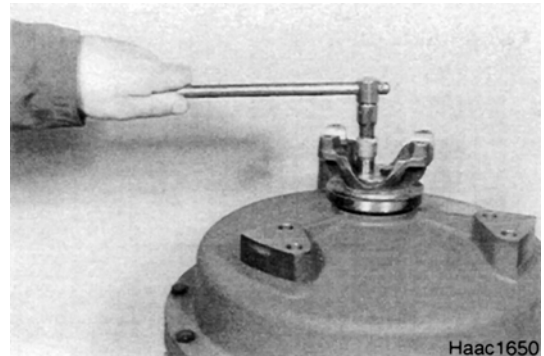


Figure 95

3. Loosen screw connection.

NOTE: *Mark radial installation position of the housing cover.*

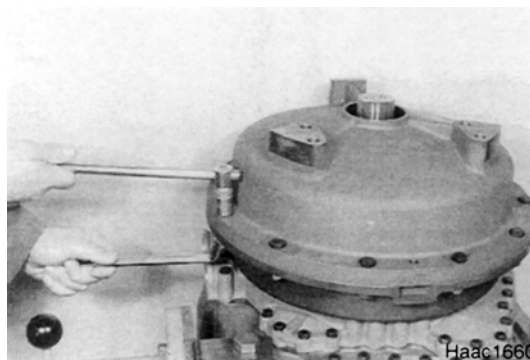


Figure 96

4. Using lifting device remove cover with converter from transmission.

(S) Set of eye bolts - 5870 204 002

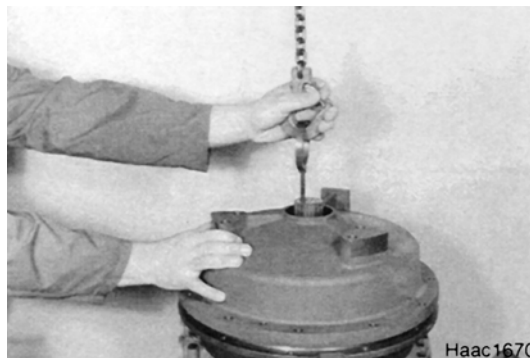


Figure 97

5. Press input shaft, reap. converter out of the cover (ball bearing).

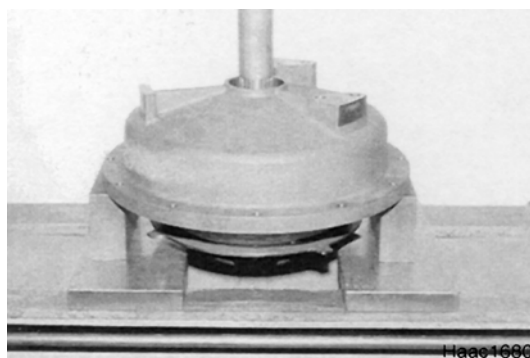


Figure 98

6. Squeeze retaining ring out and remove ball bearing.

(S) Set of internal pliers - 5870 900 013

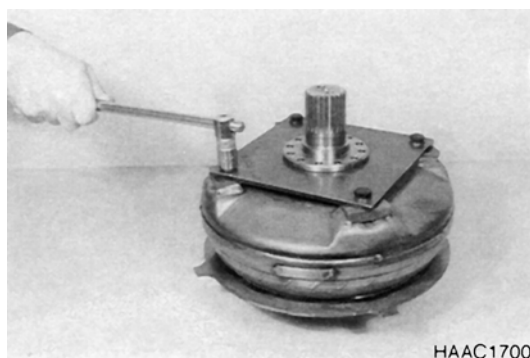


Figure 99

7. Loosen hex. head screws and remove membrane from converter.



Figure 100

8. Loosen hex. head screws and remove input shaft from the membrane.



Figure 101

9. Remove inductive transmitter (n Engine).

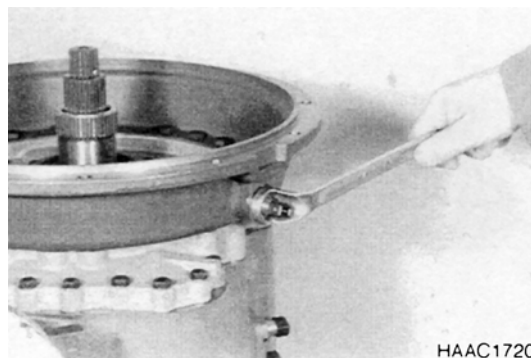


Figure 102

10. Loosen hex. head screws and remove converter housing.

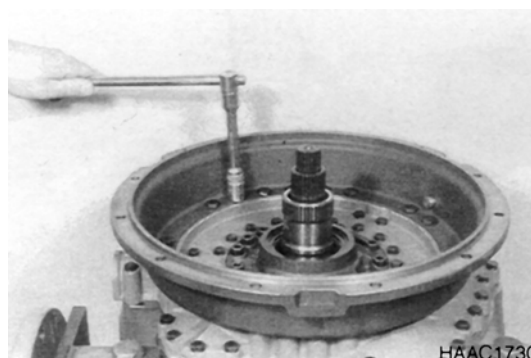


Figure 103

Remove Transmission Pump

1. Loosen socket head screws.

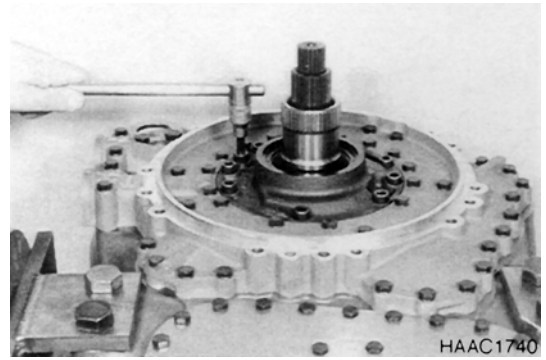


Figure 104

2. Apply separating device (S) on the splines run out of the stator shaft and pull pump (compl.) out of the housing bores, using two-leg puller.

(S) Separating device - 5870 300 024

(S) Two-leg puller - 5870 970 004

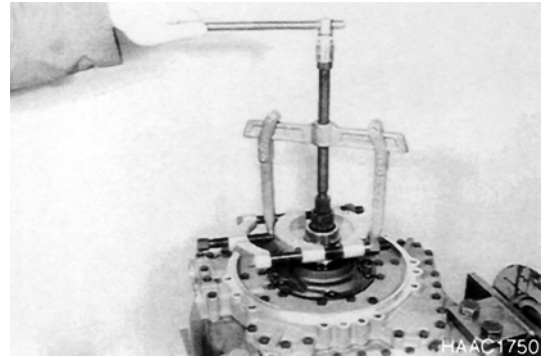


Figure 105

3. Remove transmission pump from stator.
4. Remove cam plate from pump.

NOTE: *If traces of wear are seen in the pump housing or the cam disk, the complete pump has to be replaced.*

5. Fit cam disk again and attach it using grooved pins (2x).

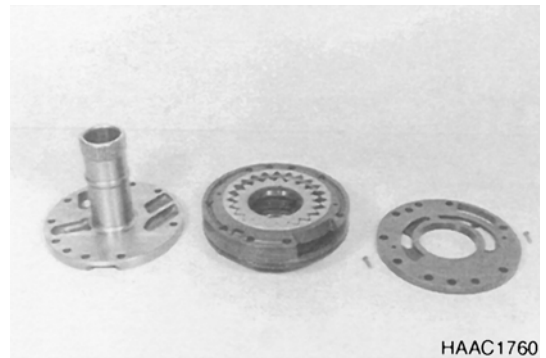


Figure 106

6. Loosen hex. head screws and remove oil feed housing.
7. Remove flat gasket.

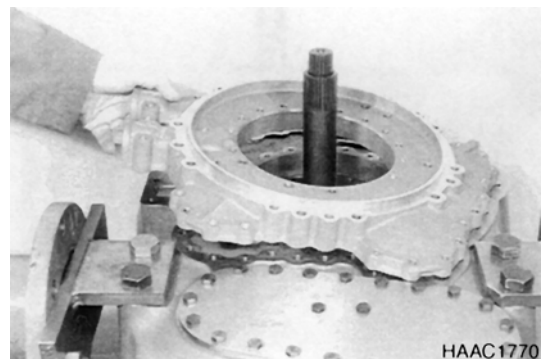


Figure 107

Converter Pressure Valve

1. Pull converter pressure valve out of housing bore.

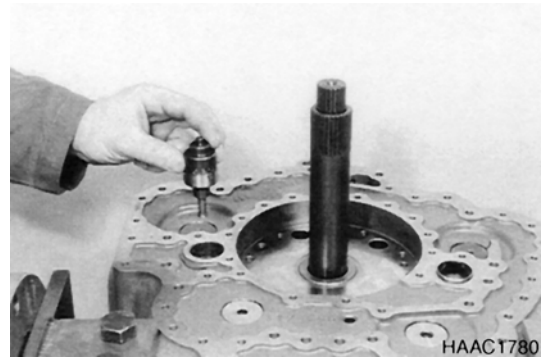


Figure 108

2. Figure 109, shows the special tool required for dismantling converter pressure valve.

Reference Number	Description
1	Converter Pressure Valve (Compl.)
(S)	Assembly Aid - 5870 345 084

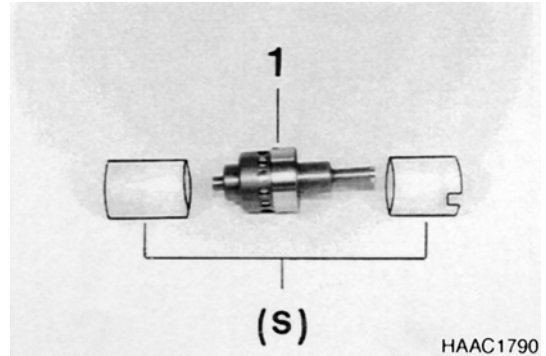


Figure 109

3. Preload compression spring carefully, drive roll pin out and remove components.

(S) Assembly aid - 5870 345 084

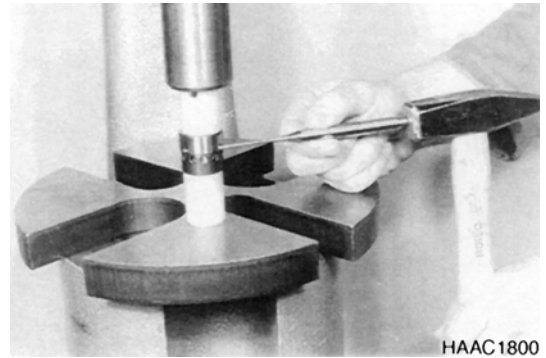


Figure 110

4. Loosen hex. head screws, remove cover and flat gasket.

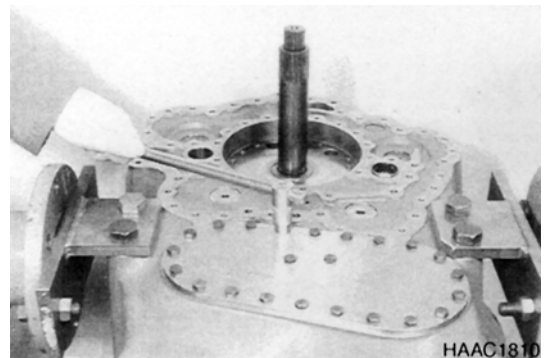


Figure 111

Remove Outputs Input and Clutches

1. Remove lock plate, hex. head screws, and pry converter side output flange from shaft.
2. Pry shaft seal out of housing bore.
3. Tilt gearbox 180° and remove rear output flange.
(S) Pry bar - 5870 345 065

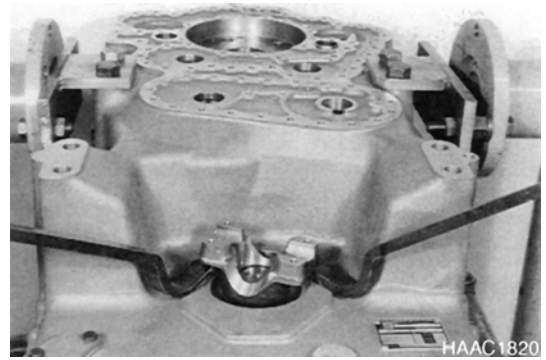


Figure 112

4. Remove speed sensor and both inductive transmitters (Figure 113).

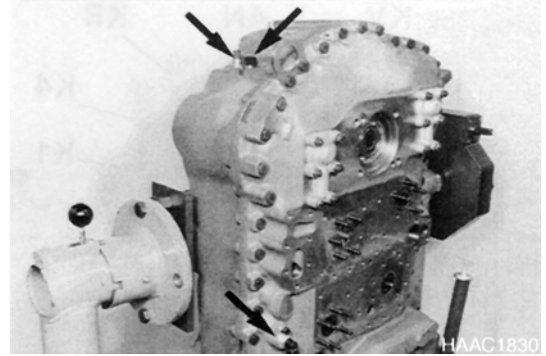


Figure 113

5. Loosen hex. nuts and remove the two covers (Figure 114).
6. Loosen screw connection.

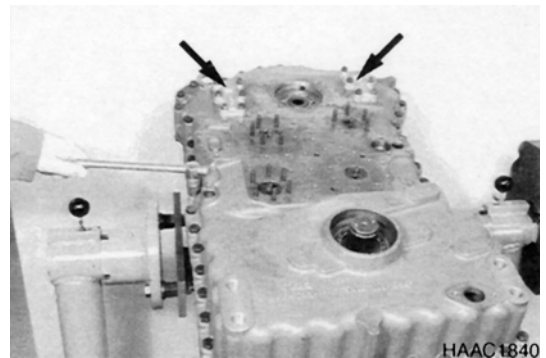


Figure 114

7. Drive both cylindrical pins (Figure 115) out.

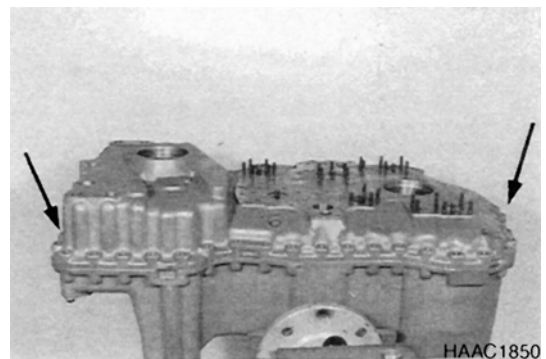


Figure 115

8. Remove housing cover carefully from gearbox housing, using lifting device.

(S) Lifting chain - 5870 281 047

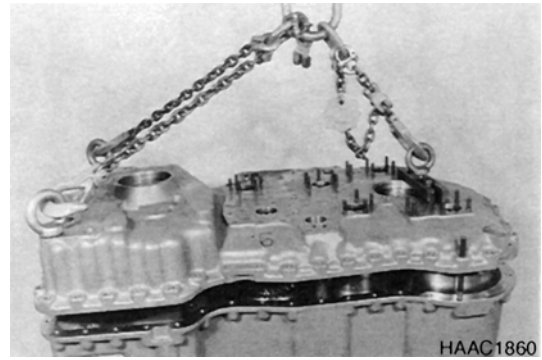


Figure 116

9. Figure 117, shows the installation position of the single clutches and of the input and output.

Reference Number	Description
KV	Clutch - Forward
KR	Clutch - Reverse
K1	Clutch - 1st Speed
K2	Clutch - 2nd Speed
K3	Clutch - 3rd Speed
K4	Clutch - 4th Speed
AN	Input
AB	Output

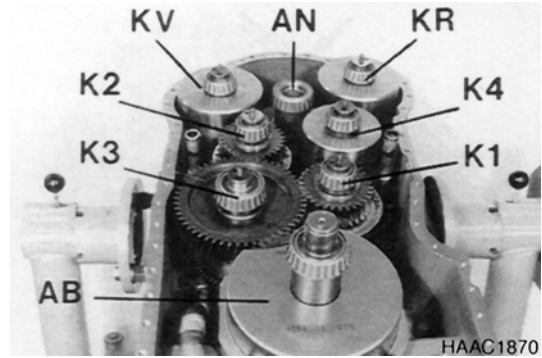


Figure 117

NOTE: The following Figures describe the common removal of all clutches. For this purpose, the housing cover, combined with special tool (Handles 5870 260 010) is necessary. The removal of single clutches without help of the housing cover and the handles is extremely difficult because of the installation conditions. Besides, there is the danger of injuries.

NOTE: Before the common removal of the clutches, the output shaft must be removed, see Figure 118.

10. Loosen socket head screws and remove output shaft and both oil baffle plates.



Figure 118

11. Assemble housing cover carefully until contact is obtained.
12. Attach all clutches in the housing cover, using handles (S).
(S) Handle (6 pieces needed) - 5870 260 010

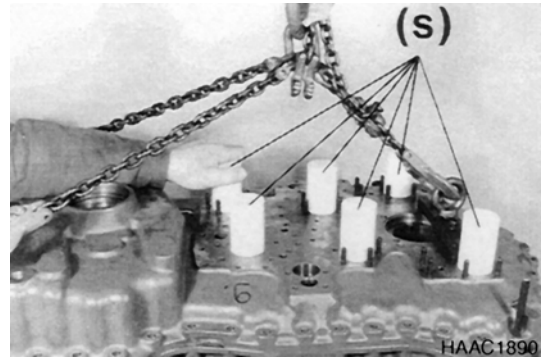


Figure 119

13. Remove housing cover along with clutches from gearbox housing, using lifting device.
(S) Handle (6 pieces needed) - 5870 260 010

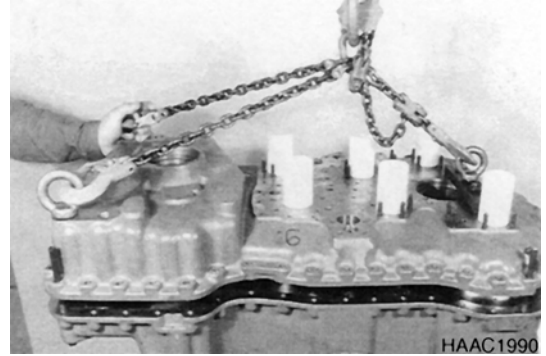


Figure 120

14. Fasten housing cover on assembly car.

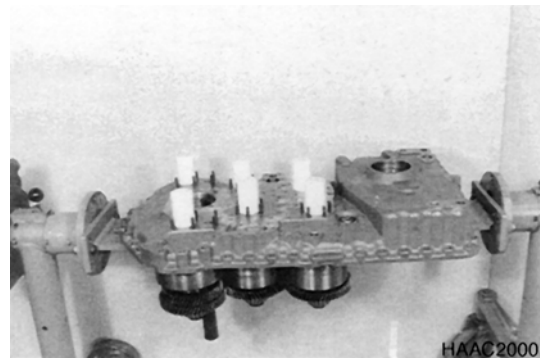


Figure 121

15. Tilt housing cover 180°.
16. Remove handles.
(S) Handle (6 pieces needed) - 5870 260 010

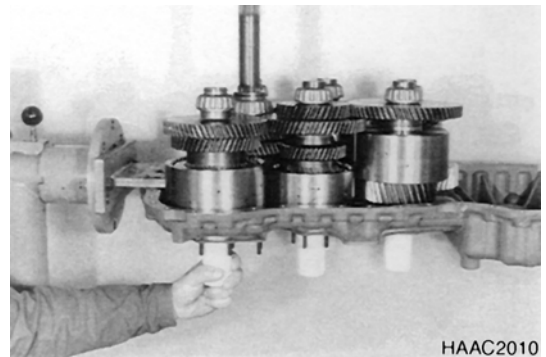


Figure 122

17. Remove clutch K2.

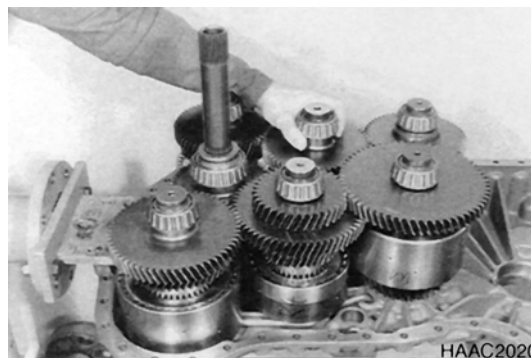


Figure 123

18. Remove clutch K1, at the same time, lift clutch K4.

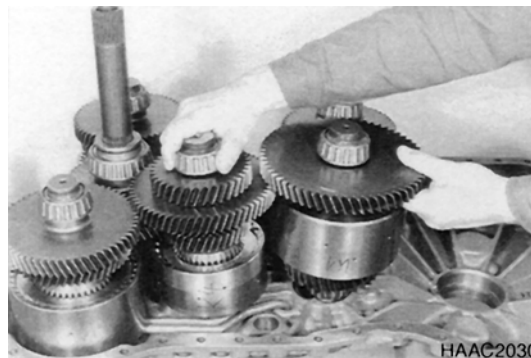


Figure 124

19. Lift clutch K3 out of the housing cover.



Figure 125

20. Remove clutch K4, at the same time lift input slightly.



Figure 126

21. Remove clutches KV and KR together with input from the housing cover.

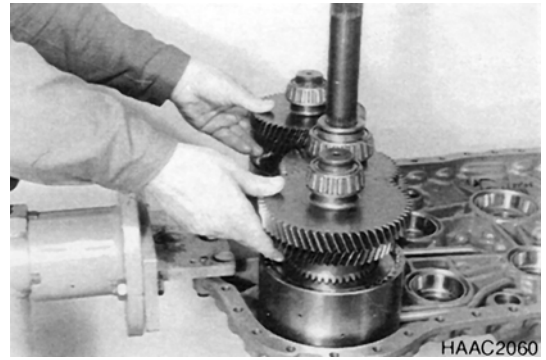


Figure 127

22. Remove outer bearing race and pull output shaft (power take off) out of the housing bore.

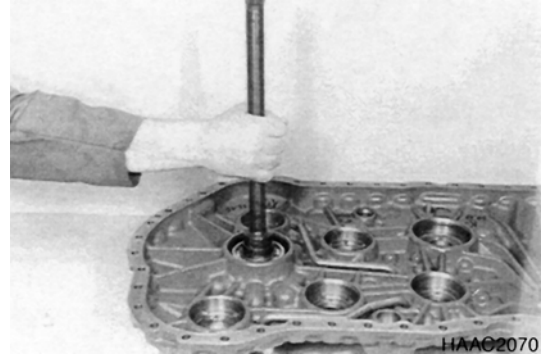


Figure 128

23. Squeeze rectangular ring (Figure 129) out and remove ball bearing from shaft.

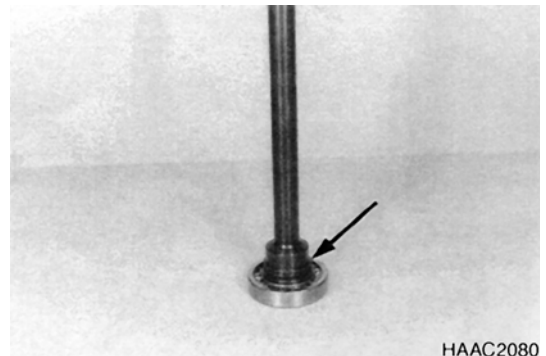


Figure 129

NOTE: *If contrary to the ZF-Recommendation, the tapered roller bearings of the clutches and of the input and output are not replaced, the allocation of the inner and outer races to the single assemblies must at least be maintained.*

24. Mark inner and outer bearing races.

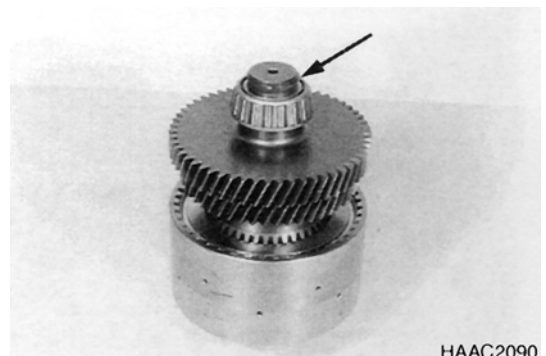


Figure 130

Dismantle Clutch KV and KR

NOTE: *The following Figures show the disassembly of the clutch KV. The disassembly of the clutch KR is analogous.*

1. Squeeze rectangular ring out.
2. Pull tapered roller bearing from shaft.
3. Remove opposite tapered roller bearing.

(S) Grab sleeve - 5873 001 057

(S) Basic set - 5873 001 000

4. Remove plate carrier from shaft.

(S) Hammer - 5870 280 004

5. Squeeze snap ring out and remove plate pack.

6. Preload compression spring, squeeze retaining ring out and remove components.

(S) Assembly aid - 5870 345 086

(S) Set of external pliers - 5870 900 015

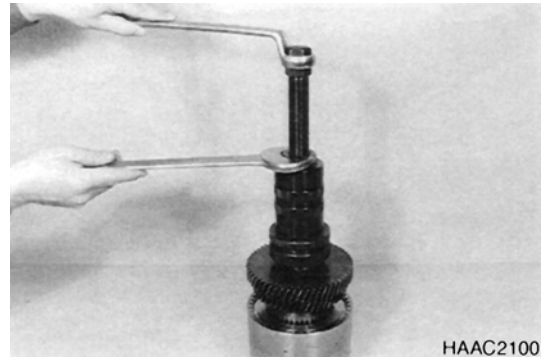


Figure 131

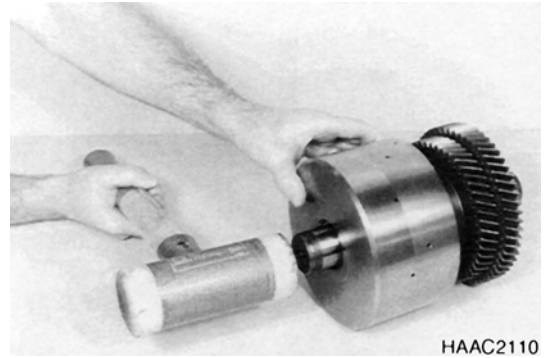


Figure 132

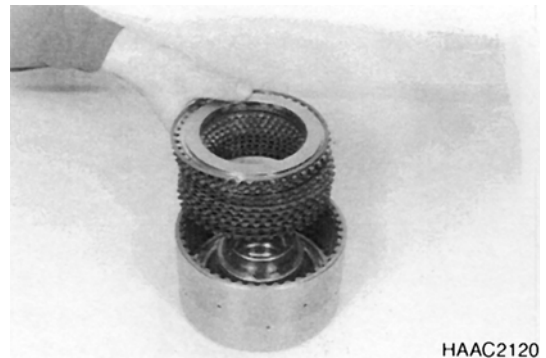


Figure 133



Figure 134

7. Lift piston using compressed air out of the cylinder bore and remove it.

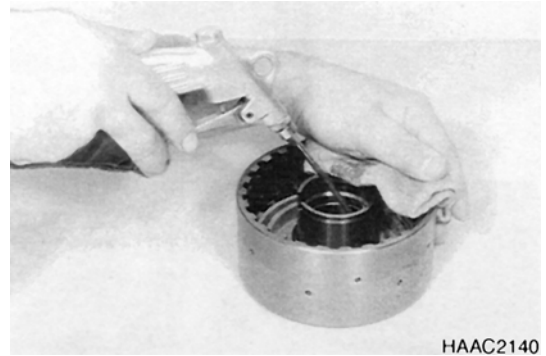


Figure 135

8. Remove both O-rings.

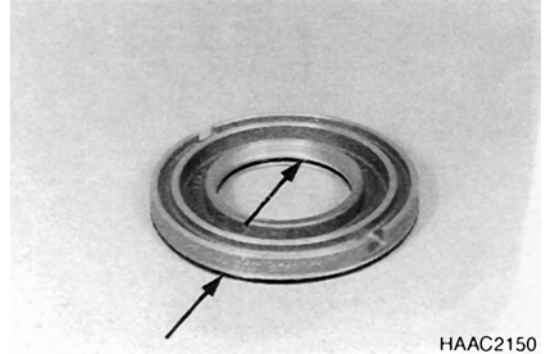


Figure 136

9. Squeeze inner retaining ring (shaft) out.
(S) Set of external pliers - 5870 900 015

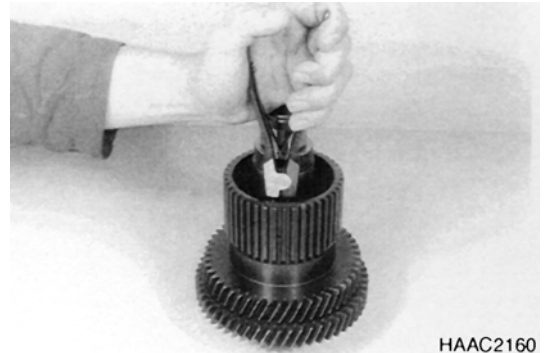


Figure 137

10. Locate idler gear using separating device (Figure 138) and press it from the shaft (Figure 139).
11. Remove released needle bearing.
(S) Separating device - 5870 300 028

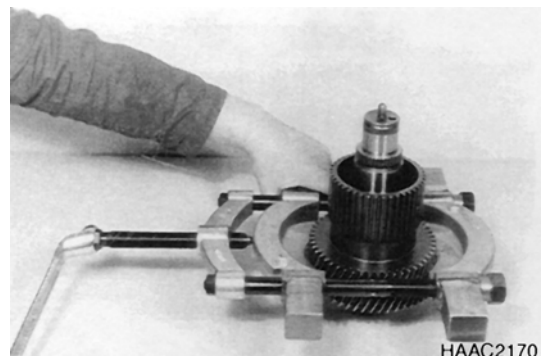


Figure 138

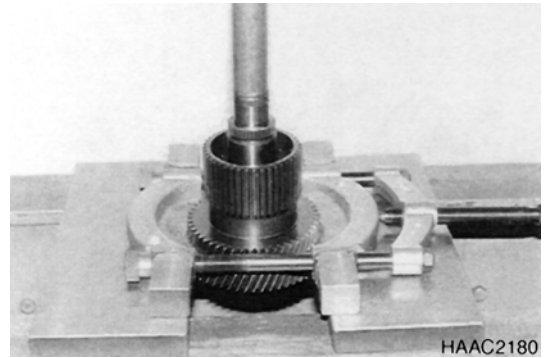


Figure 139

12. Squeeze retaining ring out and remove ball bearing.

NOTE: *The disassembly of the clutch KR has to be carried out.*

(S) Set of internal pliers - 5870 900 013

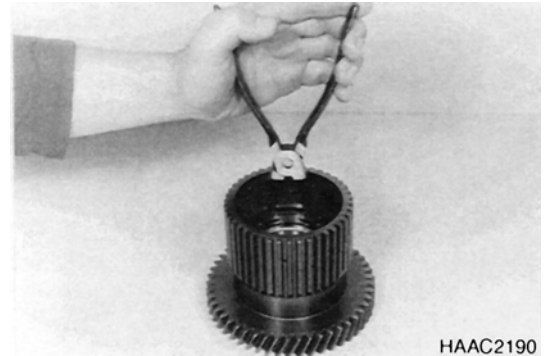


Figure 140

Dismantle Clutch K1. K2 and K3

NOTE: *The following Figures show the disassembly of the clutch K3*

1. The disassembly of the clutches K1 and K2 is analogous. Squeeze rectangular ring (Figure 141) out.

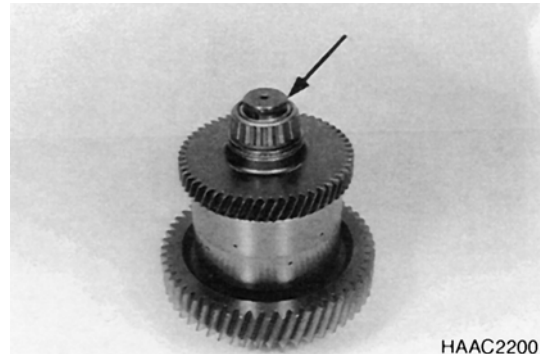


Figure 141

2. Pull tapered roller bearing from the shaft.
3. Remove opposite tapered roller bearing accordingly, see Figure 141 and Figure 142.

(S) Grab sleeve - 5873 001 057

(S) Grab sleeve (K3 - on output side) - 5873 001 058

(S) Basic set - 5873 001 000

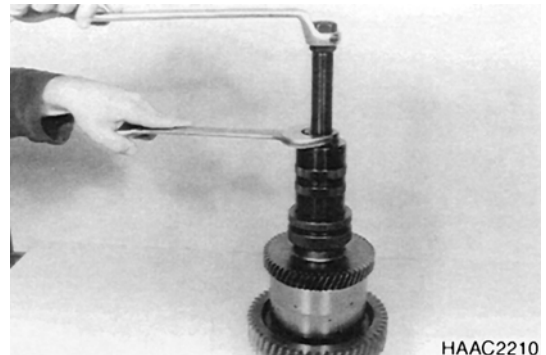


Figure 142

4. Remove running disk, axial needle cage and axial washer.

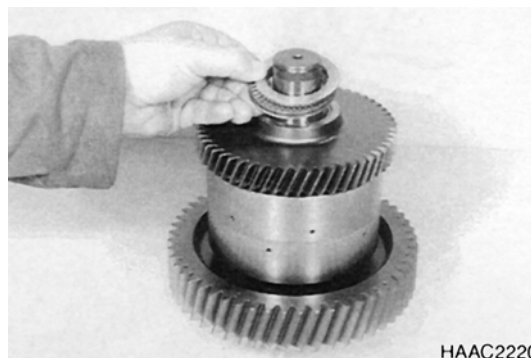


Figure 143

5. Remove idler gear.

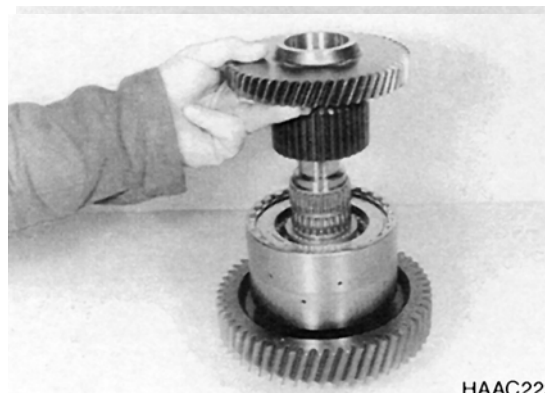


Figure 144

6. Remove both needle bearings and axial bearing (compl.).

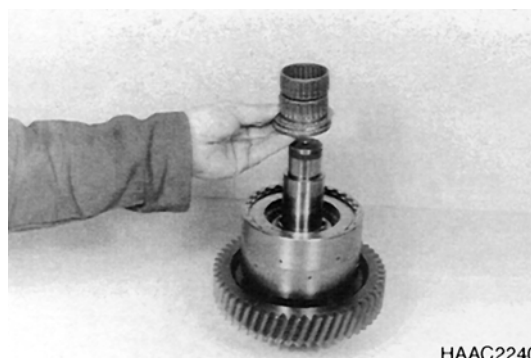


Figure 145

7. Squeeze snap ring out and remove plate pack.

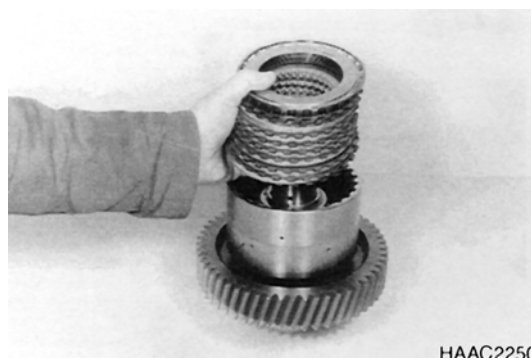


Figure 146

8. Preload compression spring, squeeze retaining ring out and remove components.

(S) Assembly aid (K2 and K3) - 5870 345 085

(S) Assembly aid (K1) - 5870 345 086

(S) Set of external pliers - 5870 900 015



Figure 147

9. Press piston out of the plate carrier, using compressed air.

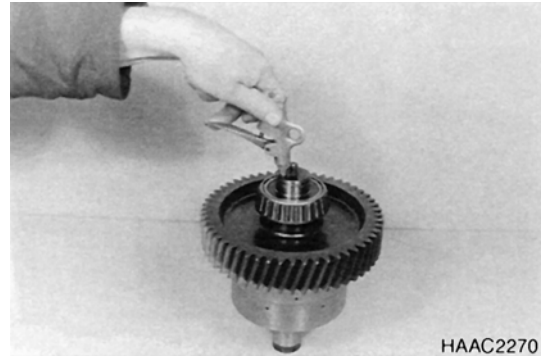


Figure 148

10. Pry plate carrier from the shaft.

(S) Pry bar - 5870 345 065

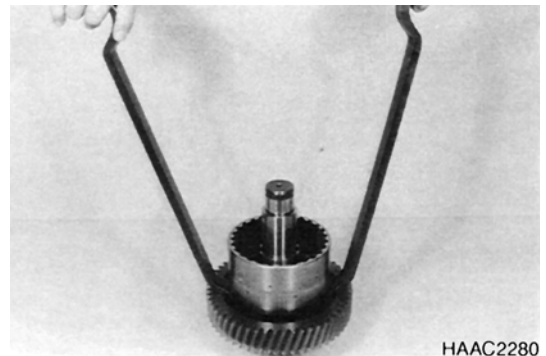


Figure 149

Dismantle Clutch K4

1. Squeeze rectangular ring out and pull tapered roller bearing from the shaft.
2. Remove opposite tapered roller bearing.

(S) Grab sleeve - 5873 001 057

(S) Basic set - 5873 001 000

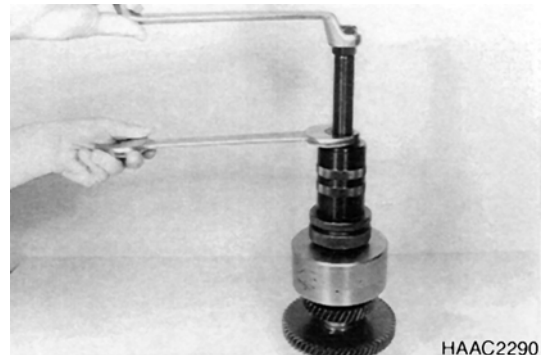
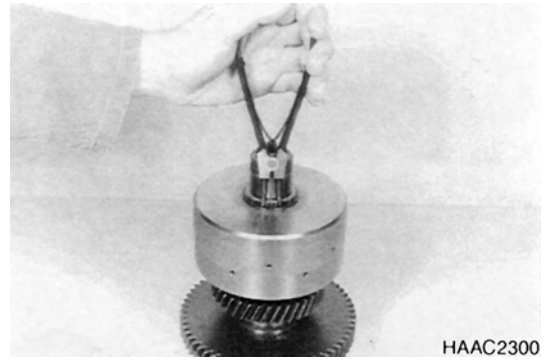


Figure 150

3. Squeeze retaining ring out and remove plate carrier from the shaft.

(S) Assembly aid - 5870 345 085

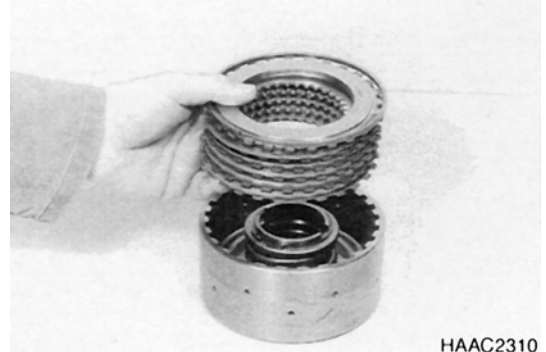
(S) Set of external pliers - 5870 900 015



HAAC2300

Figure 151

4. Squeeze snap ring out and remove plate pack.



HAAC2310

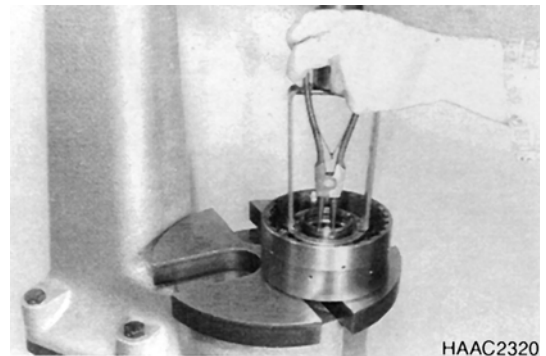
Figure 152

5. Preload compression spring, squeeze retaining ring out and remove components.

6. Remove piston.

NOTE: *The separation of shaft and gear is not possible (shrink fit).*

(S) Assembly aid - 5870 345 085



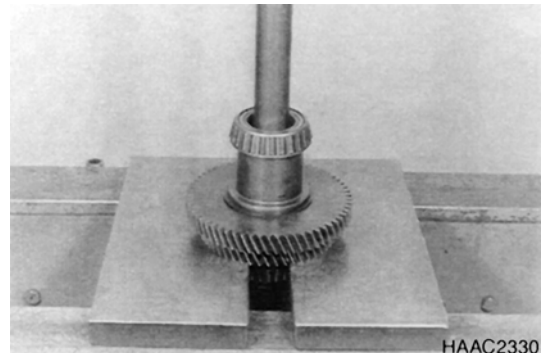
HAAC2320

Figure 153

Dismantle Input Shaft

1. If necessary, press turbine shaft out of the input shaft.

NOTE: *The turbine shaft is axially fixed using a snap ring which will be destroyed at the pressing out.*



HAAC2330

Figure 154

2. Squeeze rectangular ring out and pull off the tapered roller bearing.
3. Pull off the opposite tapered roller bearing.

NOTE: *The separation of input shaft (1, Figure 155) and gear (2) is not possible (shrink fit).*

(S) Grab sleeve - 5873 001 058

(S) Basic set - 5873 001 000

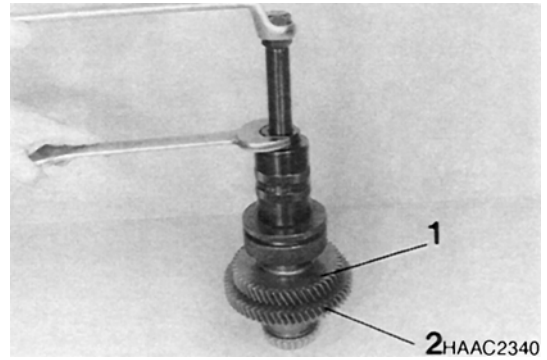


Figure 155

REASSEMBLY

NOTE: *If contrary to the ZF-Recommendation, the tapered roller bearings of the clutches and of the input and output would are not replaced, the allocation of the inner and outer races to the single assemblies must at least be maintained.*

Mount Oil Pipes

NOTE: *To ensure the correct reassembly of the oil pipes, the use of the specified special tool (S) is imperative.*

1. Install studs (Figure 156).

NOTE: *Torque limit (M8) 1 kg•m (7 ft lb).*

NOTE: *Insert studs with Loctite Crype No. 262).*



Figure 156

2. Place distance tubes over the studs.

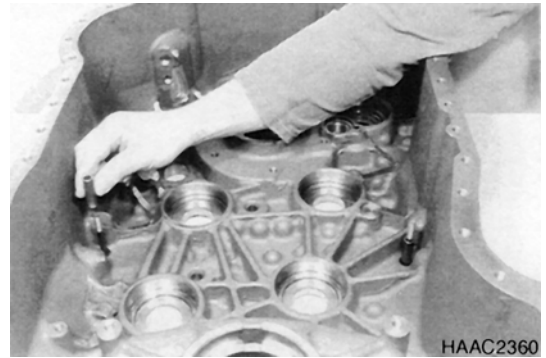


Figure 157

3. Insert suction tube (1, Figure 158), pressure pipe (2) and pressure pipe lubrication (3) into the housing bores.
4. Fasten suction tube (1) and pressure pipes (2) provisionally using socket head screw and hex. nuts.

NOTE: Torque limit (M8/8.8) 2.35 kg•m (17 ft lb).

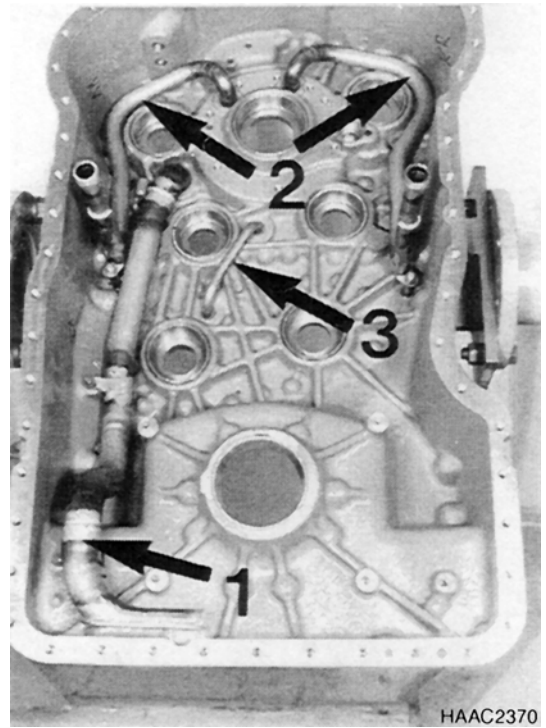


Figure 158

5. Locate both pressure pipes using special device.
(S) Tension bar - 5870 654 030

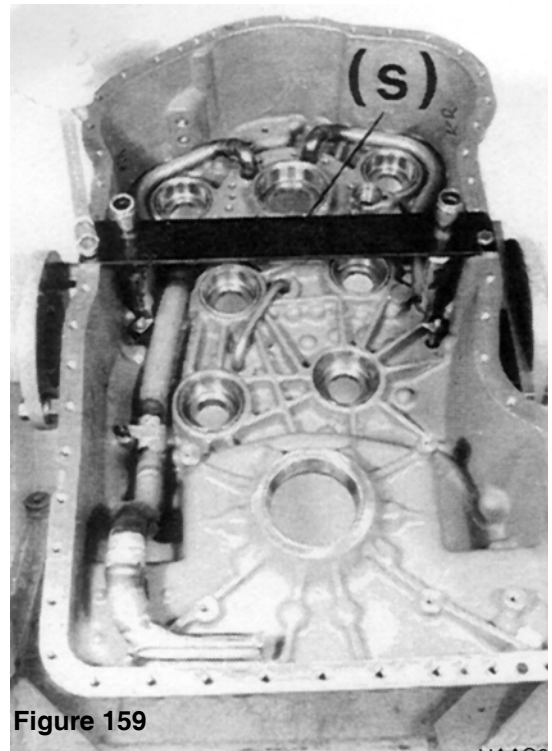


Figure 159

6. Tilt housing 180°.
7. Roll in suction tubes and pressure pipes (Figure 160) into the housing bores, using special tool.

NOTE: *Pipe end of pressure pipes (Figure 160) must be slightly below the housing plane face, if necessary equalize.*

(S) Rolling tool - 5870 600 003

(S) Rolling tool - 5870 600 004

(S) Rolling tool - 5870 600 005

(S) Rolling tool - 5870 600 006

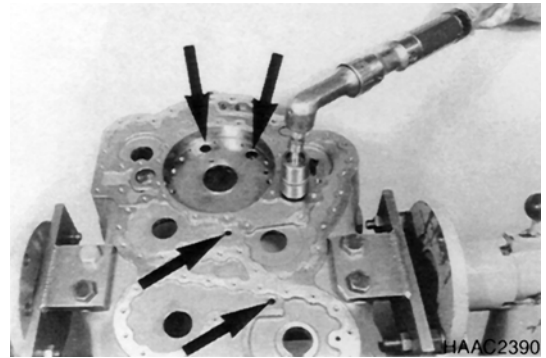


Figure 160

8. Tilt housing 180°.
9. Check installation position of the two pressure pipes and correct if necessary.

NOTE: *Pipes must be located in the Special device (S) without play and pressure.*

10. Remove special device.

(S) Tension bar - 5870 654 030

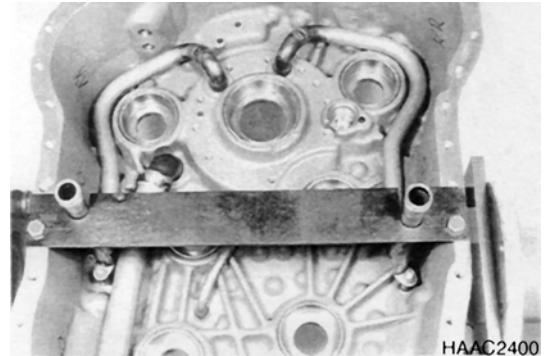


Figure 161

11. Install new O-ring on screw plug and install it.

NOTE: *Torque limit (M30x1,5) 5.20 kg•m (38 ft lb).*

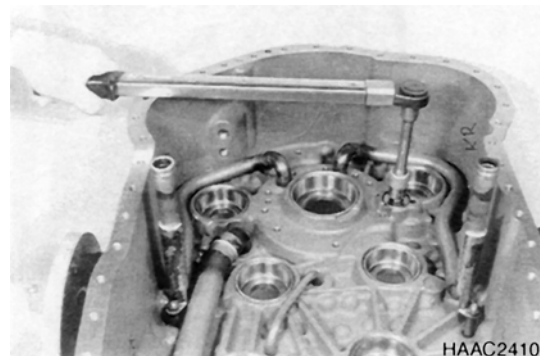


Figure 162

12. Insert all outer bearing races into the housing bore.

NOTE: *In the case that already run bearings are reused, pay attention to the allocation of the outer bearing races, see also Note, Page 82. Pay attention to the corresponding markings.*

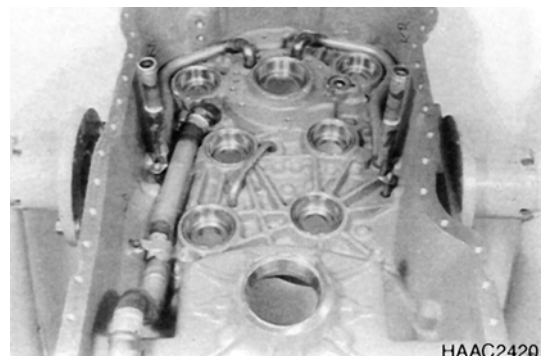


Figure 163

13. Insert both oil pipes (Figure 164) into the housing cover, tilt housing cover 180° and roll in oil pipes into the housing bores.

NOTE: *The pipe end must be situated slightly below the housing plane face.*

(S) Rolling tool - 5870 600 005

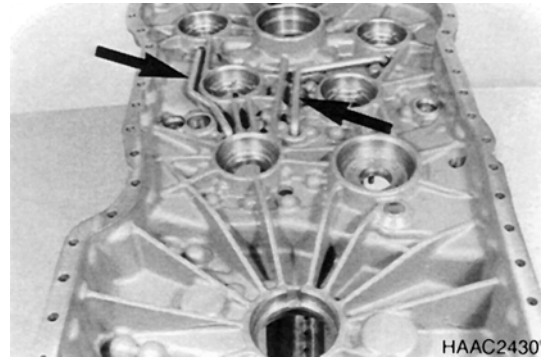


Figure 164

14. Install studs 27x (M8x25) according to the Figure 165.

NOTE: *Torque limit (M8) 1 kg•m (7 ft lb).*

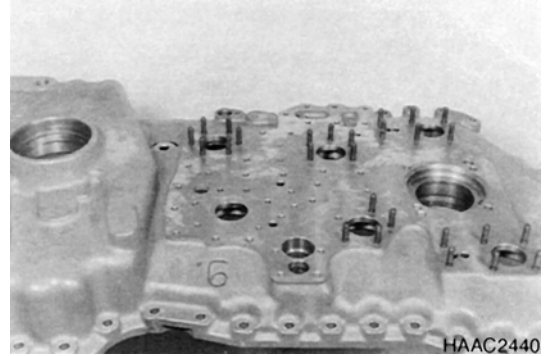


Figure 165

15. Insert set screws (2x) into the housing bores (Figure 166).

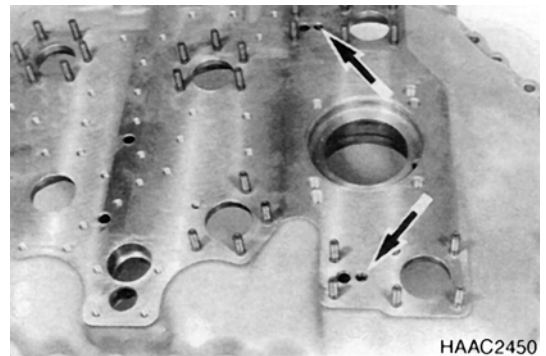


Figure 166

Reassemble Clutch KV and KR

NOTE: *The following Figures describe the reassembly of the clutch KV. The reassembly of the clutch KR has to be carried out.*

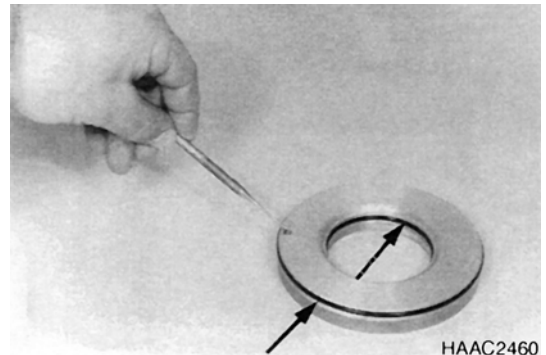


Figure 167

Preassembly Plate Carrier

NOTE: *Figure 167 thru Figure 170.*

1. Check function of the drain valve.

NOTE: *Ball may not seize, if necessary clean using compressed air.*

2. Insert both O-rings (Figure 168) into the recesses of the piston and oil them.

NOTE: *Make sure that O-rings are not twisted.*

3. Assemble piston until contact is obtained.

NOTE: *Pay attention to the installation position, see Figure.*

4. Install compression spring along with spring cup (2x).

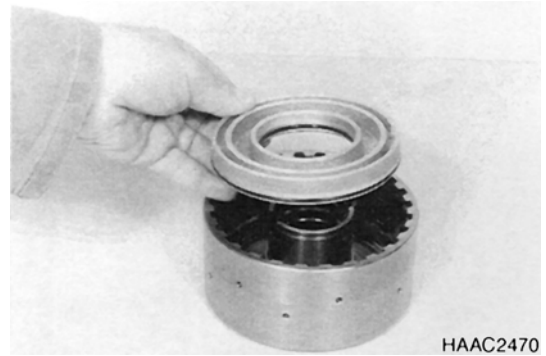


Figure 168



Figure 169

5. Preload compression spring and attach it using retaining ring.

(S) Assembly aid - 5870 345 086

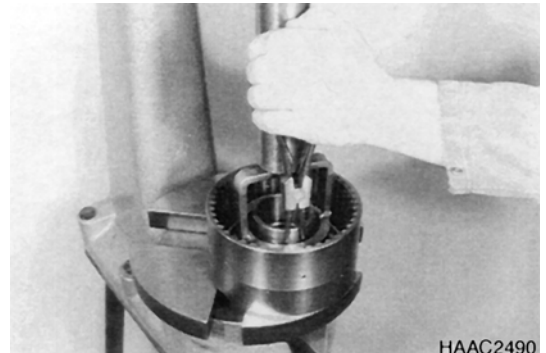


Figure 170

Plate Pack KV and KR

NOTE: The plate equipment, reas. stacking of clutch KV and KR is identical.

Reference Number	Description
1	Plate Carrier
2	Piston
3	Outer Plate - One-sided Coated
4	Inner Plates
5	Outer Plates - Coated On Both Sides
6	Snap Ring (Optional, S = 2.10 - 4.20 mm (0.0827 - 0.1654 in))
7	End Shim

NOTE: Install outer plate 3 with the uncoated side facing the piston, reas. the end shim.

1. Install on the end shim side two outer and inner plates each.

NOTE: Effective number of friction surfaces = 18.

2. Adjust plate clearance = $2.50^{+0.20}$ mm ($0.0984^{+0.0079}$ in).

NOTE: For the adjustment of the plate clearance there are snap rings of different thickness available. To ensure a faultless measuring result, in tall plates for the movement without oil.

3. Install plate pack according to Figure 171.

4. Mount end shim and squeeze snap ring (e.g. s = 3.0 mm (0.1181 in)).

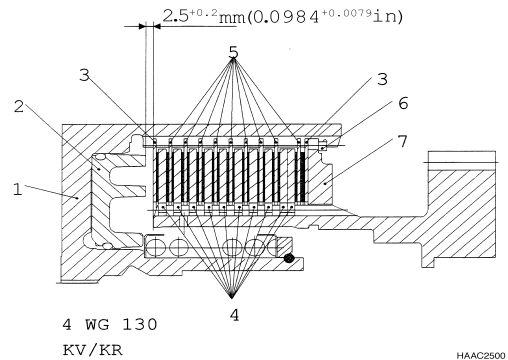


Figure 171

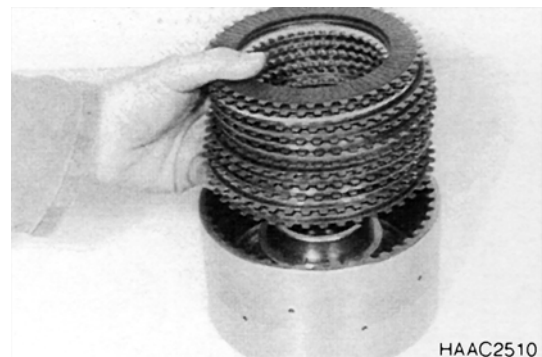


Figure 172

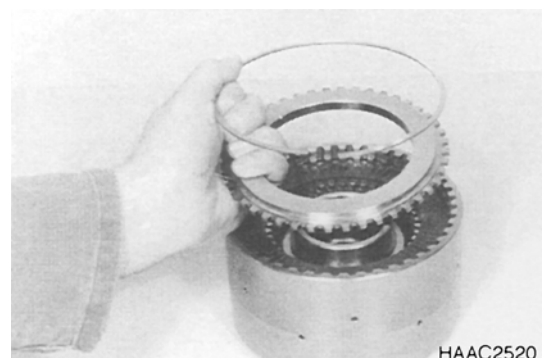


Figure 173

5. Press end shim on with about 10 kg (22 lb) and measure Dimension I from the end face/plate carrier to the end shim.

Dimension I e.g. 7.250 mm (0.2854 in)

(S) Digital depth gauge - 5870 200 072

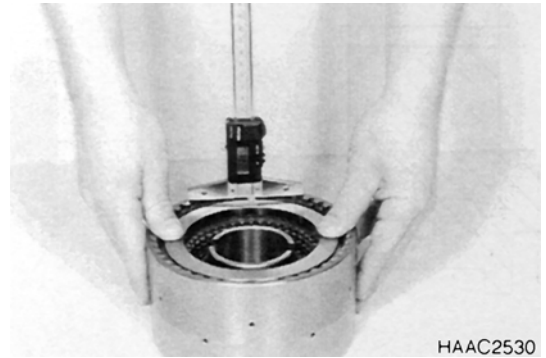


Figure 174

6. Press end shim against snap ring (upward) until contact is obtained and determine Dimension II.

Dimension II e.g. 4.750 mm (0.1870 in)

(S) Digital Depth gauge - 5870 200 072

EXAMPLE:

Dimension I	7.250 mm (0.2854 in)
Dimension II	- 4.750 mm (0.1870 in)
Difference = Plate clearance	<u>2.50 mm (0.0984 in)</u>

NOTE: *In case of deviations from the required plate clearance, correct using corresponding snap ring ($s = 2.10 - 4.20 \text{ mm}$ (0.0827 - 0.1654 in))*

7. Remove plate pack, oil and install it again.
8. Install idler gear until all inner plates are accommodated.

NOTE: *This step makes the later assembling of the idler gear easier.*

9. Remove idler gear again.

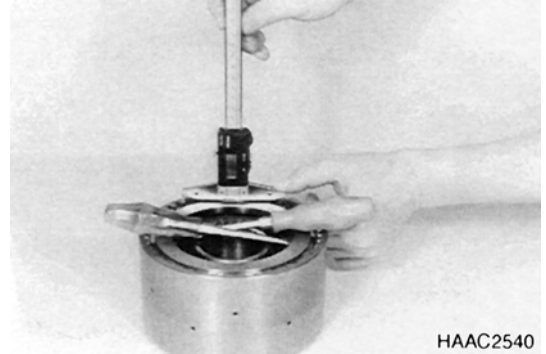


Figure 175

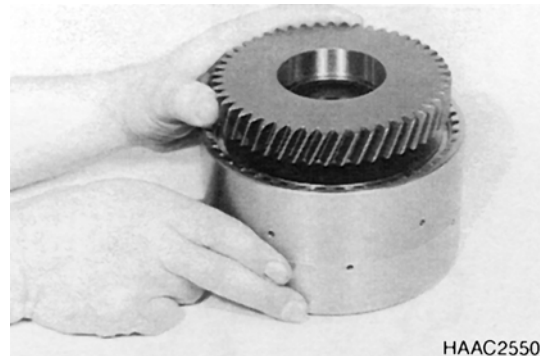


Figure 176

10. Install stud (Figure 177).

NOTE: Use Loctite #243.

NOTE: Torque limit (M10) 1.73 kg•m (13 ft lb).

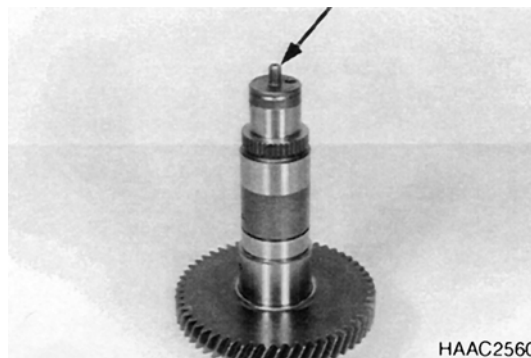


Figure 177

11. Insert ball bearing until contact is obtained and attach it using retaining ring.

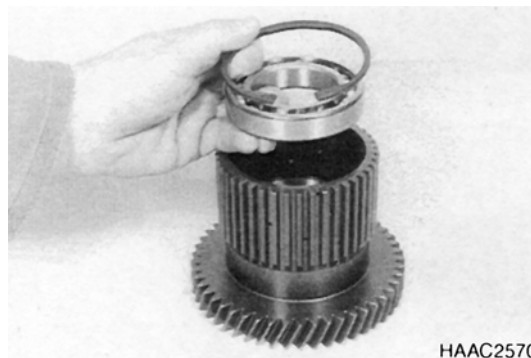


Figure 178

12. Assemble needle bearing.

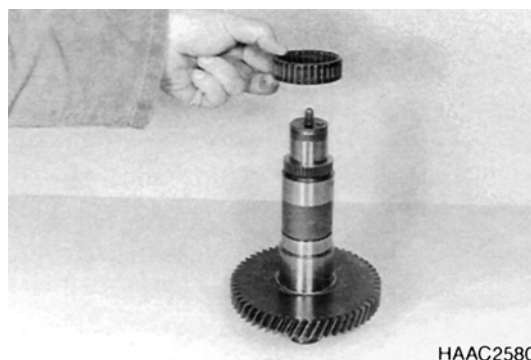


Figure 179

13. Press idler gear against shoulder.

NOTE: Support it on the inner bearing race.

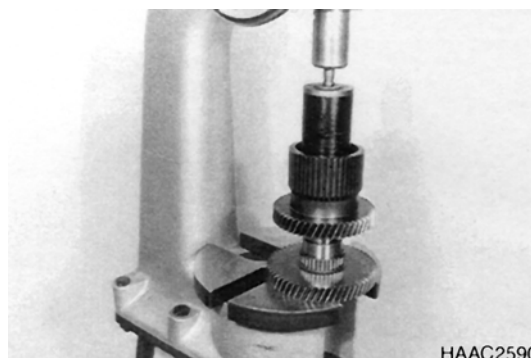


Figure 180

14. Attach idler gear axially using retaining ring.

NOTE: *At clutch KR there is no recess in the shaft - assemble retaining ring until contact on the inner bearing race is obtained.*

(S) Set of internal pliers - 5870 900 013

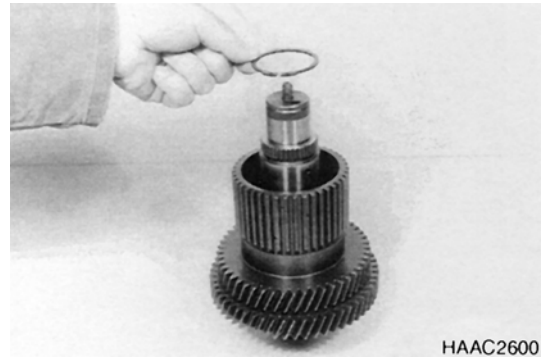


Figure 181

15. Assemble pre-assembled plate carrier until contact is obtained.

NOTE: *Only if the plate carrier plane face is overlapping with the shaft collar, the accommodation of all inner plates is ensured, see Figure 183.*

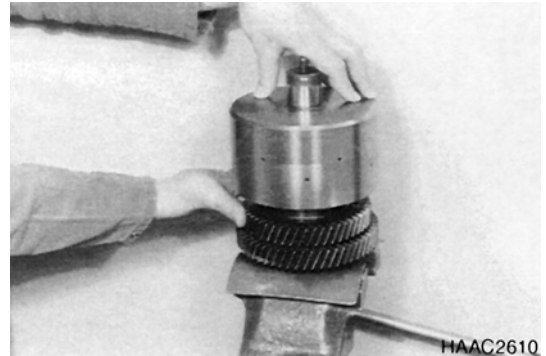


Figure 182

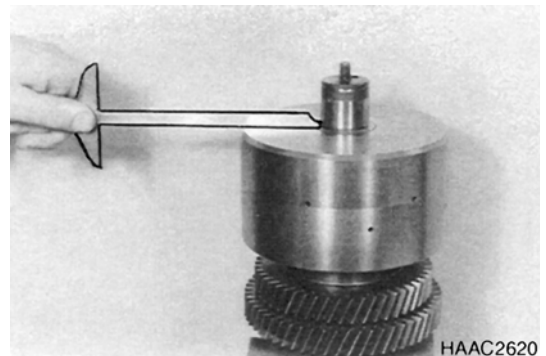


Figure 183

16. Press tapered roller bearing against shoulder.
17. Install opposite tapered roller bearing.

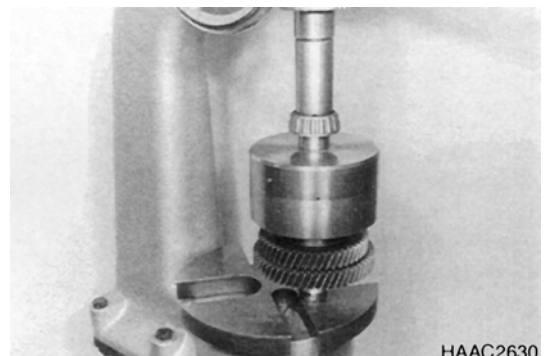


Figure 184

18. Check function of clutch using compressed air.

NOTE: *At correctly installed components, the closing, reap. opening of the clutch is clearly audible.*

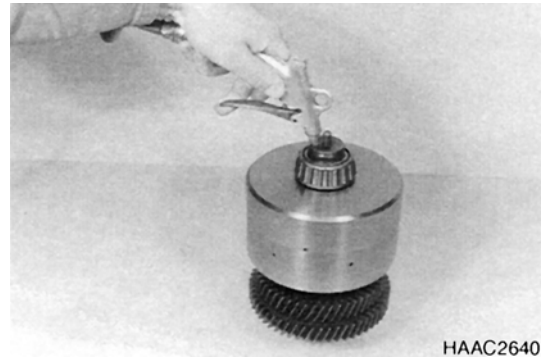


Figure 185

Reassemble Clutches K1, K2 and K3

NOTE: *The following Figures describe the reassembly of the clutch K3. The reassembly of the clutches K1 and K2 has to be carried out.*

1. Install stud (Figure 186).

NOTE: *Use Loctite #243.*

NOTE: *Torque limit (M10) 1.73 kg•m (13 ft lb).*

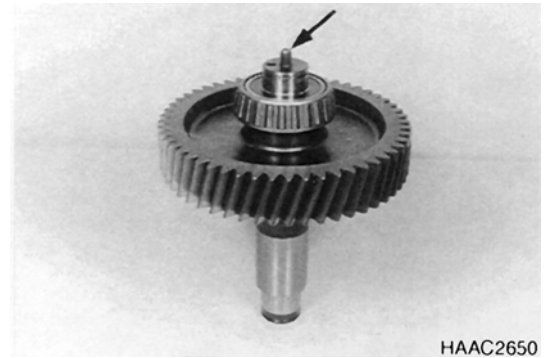


Figure 186

2. Assemble plate carrier until contact is obtained.

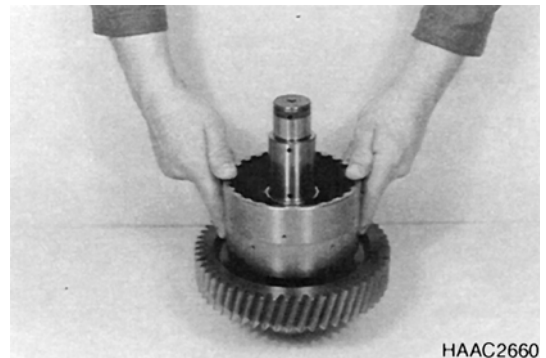


Figure 187

3. Check function of the drain valve.

NOTE: *Bail may not seize, if necessary clean using compressed air.*

4. Insert both O-rings (Figure 188) into the piston recesses and oil them.

NOTE: *Make sure that O-rings are not twisted.*

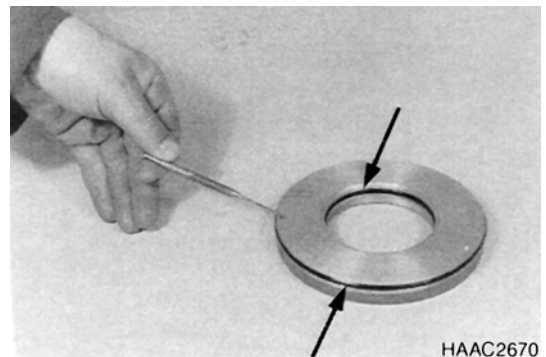


Figure 188

5. Install piston until contact is obtained.

NOTE: Pay attention to the installation position, see Figure.

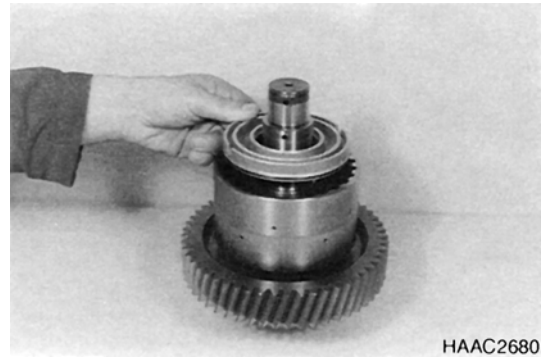


Figure 189

6. Install compression spring along with spring cup (2x).

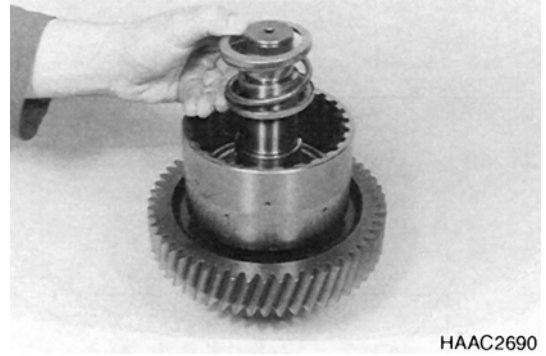


Figure 190

7. Preload compression spring and attach it using retaining ring.

(S) Assembly aid (K2 and K3) - 5870 345 085

(S) Assembly aid (K1) - 5870 345 086

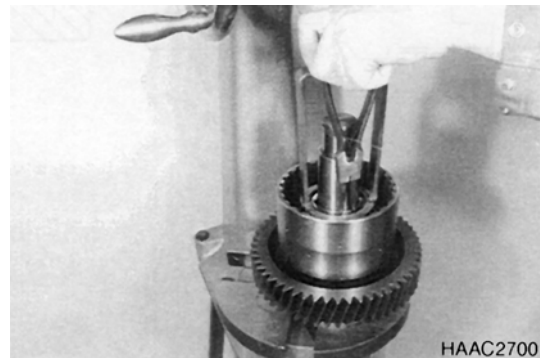


Figure 191

Plate Pack K1, K2, and K3

NOTE: Stacking of clutch plates K1, K2 and K3 is identical. Figure 192, shows the installation position of the components.

Reference Number	Description
1	Plate Carrier
2	Piston
3	Outer Plate - One-sided Coated
4	Inner Plates
5	Outer Plates Coated on Both Sides
6	Snap Ring (Optional, s = 2.10 - 4.20 mm (0.0827 - 0.1654 in))
7	End Shim

NOTE: Install outer plate 3 with the uncoated side facing the piston. Install two outer and inner plates each on the end shim side. Effective number of the friction surfaces = 14.

8. Adjust plate clearance = $2.10^{+0.20}$ mm ($0.0827^{+0.0079}$ in).

NOTE: For the plate clearance adjustment there are snap rings of different thickness available. To ensure a faultless measuring result, in tall the plates for the moment without oil.

9. Install plate pack according to Figure 192.

10. Fit end shim and squeeze snap ring (e.g. 3.0 mm (0.1181 in)) in.

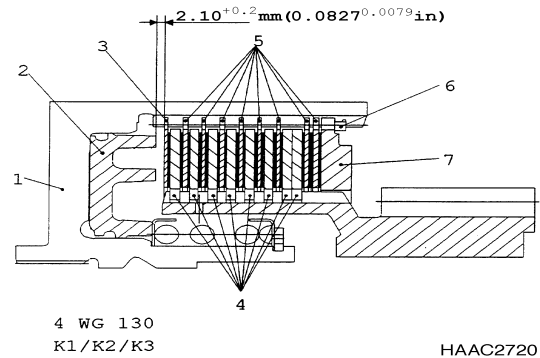


Figure 192

HAAC2720

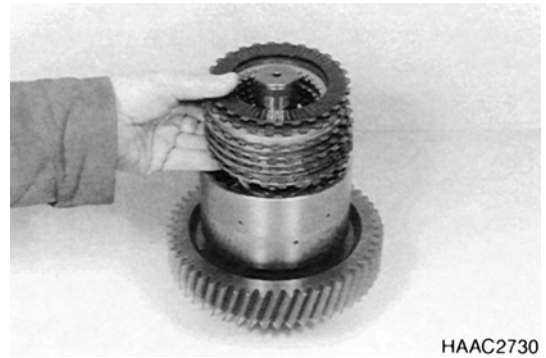


Figure 193

HAAC2730

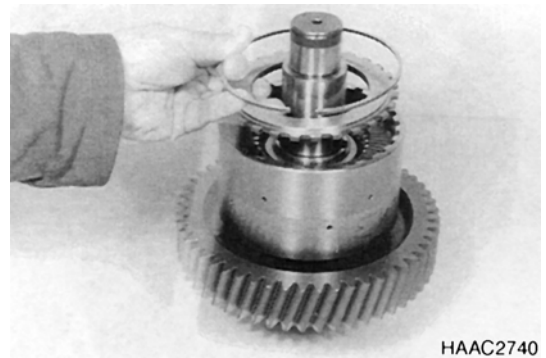


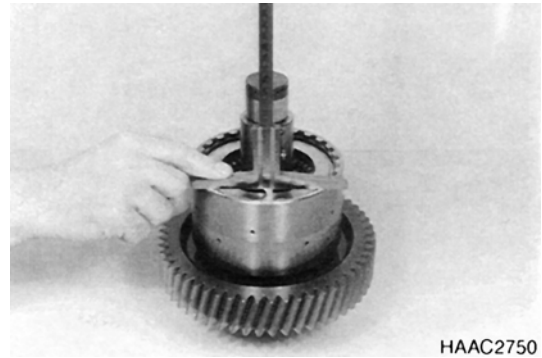
Figure 194

HAAC2740

11. Press end shim on with about 10 kg (22 lb), and measure Dimension I from the end face/plate carrier to the end shim.

Dimension I e.g. 8.20 mm (0.3228 in)

(S) Digital depth gauge - 5870 200 072



HAAC2750

Figure 195

12. Press end shim against snap ring (upward) until contact is obtained, and determine Dimension II.

Dimension II e.g. 6.0 mm (0.2362 in)

(S) Digital depth gauge - 5870 200 072

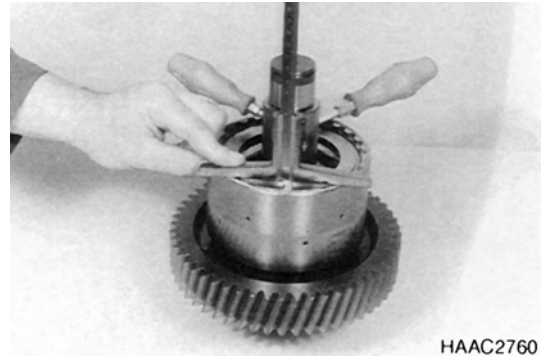
EXAMPLE:

Dimension I	8.20 mm (0.3228 in)
Dimension II	- 6.0 mm (0.2362 in)
Difference = Plate clearance	<u>2.20 mm (0.0866 in)</u>

NOTE: In case of deviations from the required plate clearance, correct using corresponding snap ring ($s = 2.10 - 4.20 \text{ mm (0.0827 - 0.1654 in)}$).

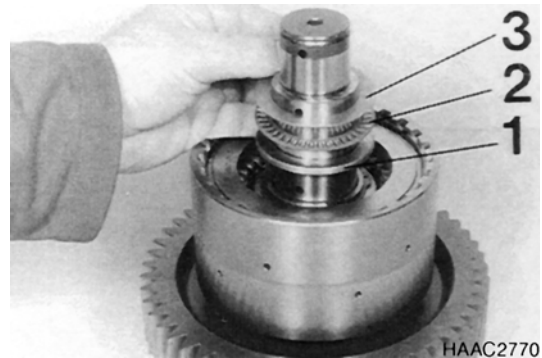
13. Remove plate pack, oil and install it again.
14. Assemble running disk (1, Figure 197) (50 x 70 x 4), axial needle cage (2) and axial washer (3) (50 x 70 x 1).

NOTE: Install running disk 1 with the chamfer facing the axial needle cage.



HAAC2760

Figure 196



HAAC2770

Figure 197

15. Assemble both needle bearings.

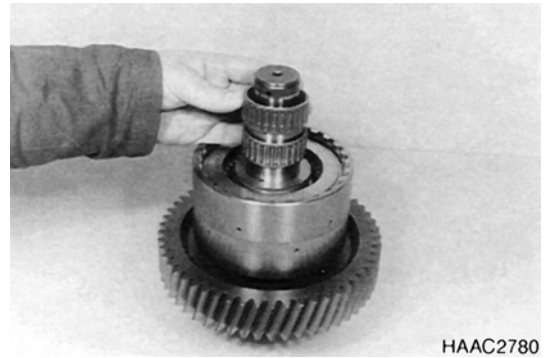


Figure 198

16. Install idler gear until all inner plates are accommodated.

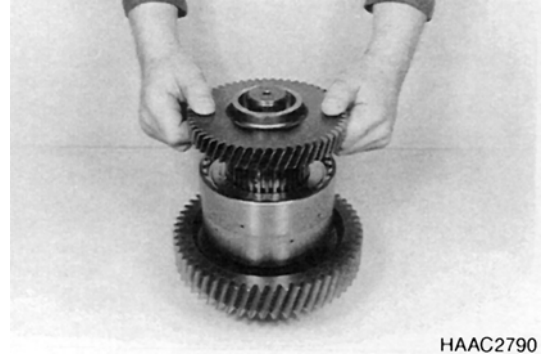


Figure 199

17. Assemble axial washer 3 (50 x 70 x 1), axial needle cage 2 and running disk 1 (50 x 70 x 4).

NOTE: Install running disk 1 with the chamfer facing the axial needle cage.

NOTE: Only if the running disk is overlapping with the shaft collar, the accommodation of all the inner plates is ensured.

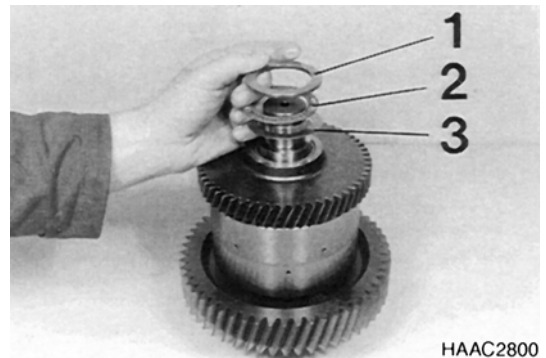


Figure 200

18. Press tapered roller bearing against shoulder.

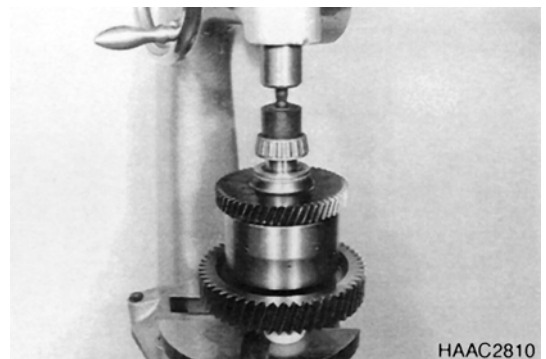


Figure 201

19. Press tapered roller bearing against shoulder.

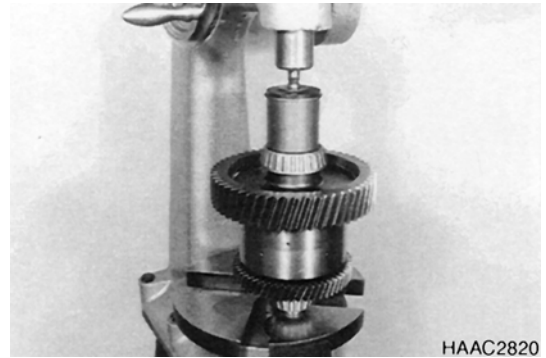


Figure 202

20. Check function of the clutch using compressed air.

NOTE: *At correctly installed components, the closing, reap. opening of the clutch is clearly audible.*

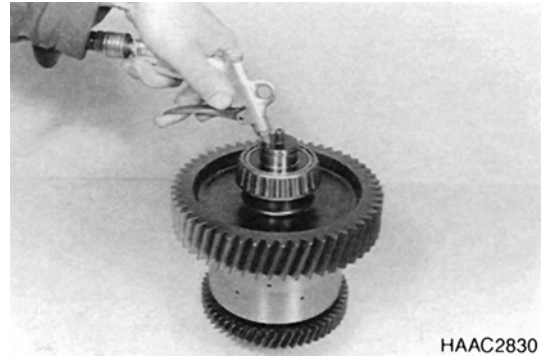


Figure 203

Reassemble Clutch K4

1. Cool shaft (about -80°C (-112°F)), heat gear (about $+120^{\circ}\text{C}$ ($+248^{\circ}\text{F}$)) and assemble it until contact is obtained.

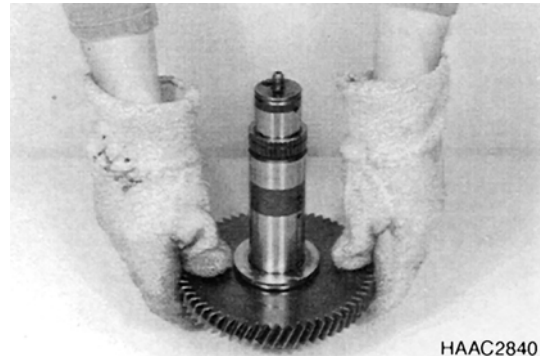


Figure 204

2. Locate gear axially using retaining ring.
(S) Set of external pliers - 5870 900 015



Figure 205

3. Install stud (Figure 206).

NOTE: Use Loctite (Type No. 243).

NOTE: Torque limit (M10) 1.73 kg•m (13 ft lb).

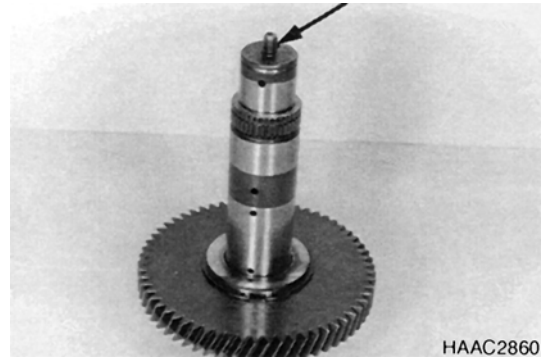


Figure 206

4. Check function of the drain valve.

NOTE: Ball may not seize, if necessary clean using compressed air.

5. Insert both O-rings (Figure 207) into the piston recesses and oil them.

NOTE: Make sure that O-rings are not twisted.

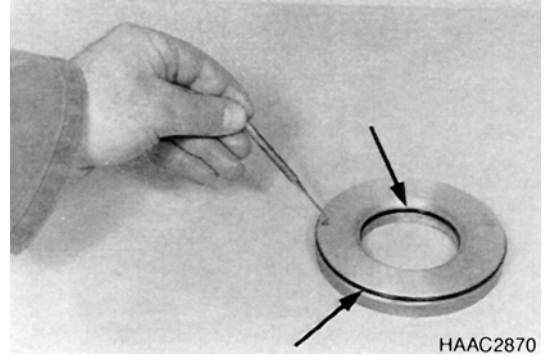


Figure 207

6. Install piston until contact is obtained.

NOTE: Pay attention to the installation position, see Figure.

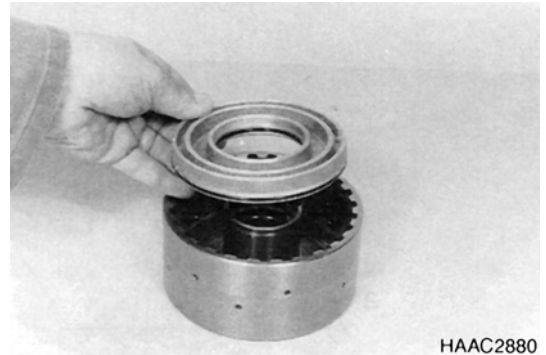


Figure 208

7. Install compression spring and spring cup (2x), preload and attach using retaining ring.

(S) Assembly aid - 5870 345 085



Figure 209

Plate Pack K4

Figure 210, shows the installation position of the components.

Reference Number	Description
1	Plate Carrier
2	Piston
3	Outer Plate - One-sided Coated
4	Inner Plates
5	Outer Plates - On Both Sides Coated
6	Snap Ring (Optional, s = 2.10 - 4.2 mm (0.0827 - 0.1654 in))
7	End Shim

NOTE: Install outer plate 3 with the uncoated side facing the piston.

NOTE: Effective number of friction surfaces = 10.

1. Adjust plate clearance = $1.20^{+0.20}_{-0.20}$ mm ($0.0472^{+0.0079}_{-0.0079}$ in).

NOTE: For the plate clearance adjustment there are snap rings of different thickness available. To ensure a faultless measuring result, install the plates for the moment without oil.

2. Install plate pack according to Figure 210.

3. Fit end shim and squeeze retaining ring (e.g. s = 3.0 mm (0.1181 in)).

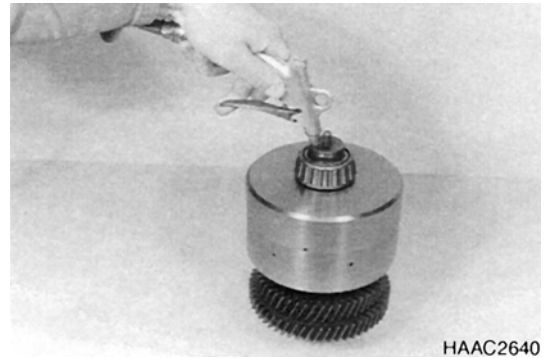


Figure 210

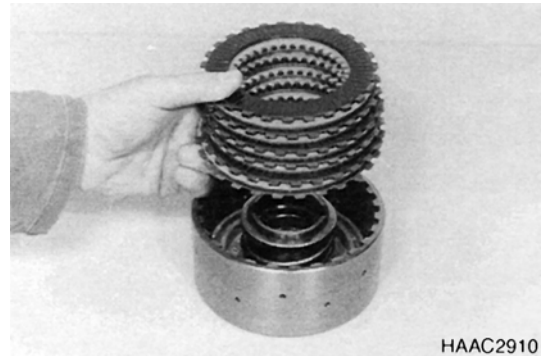


Figure 211

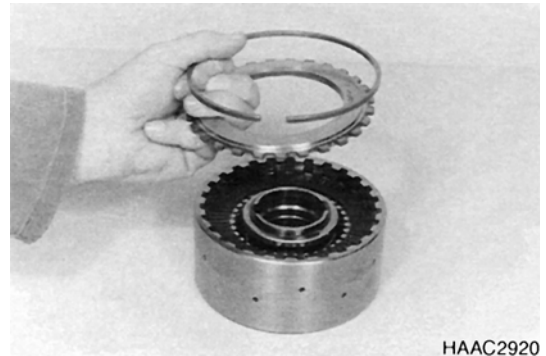


Figure 212

4. Press end shim on with about 10 kg (22 lb)) and measure Dimension I from the end face/plate carrier to the end shim.

Dimension I e.g. 7.20 mm (0.2835 in)
(S) Digital depth gauge - 5870 200 072

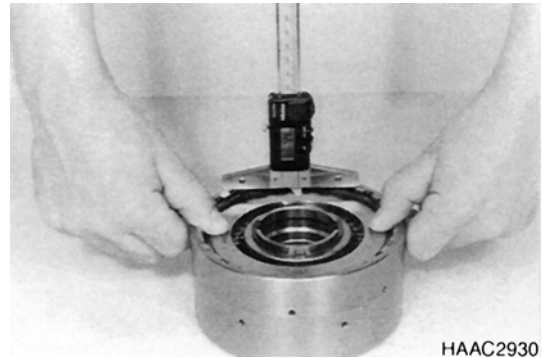


Figure 213

5. Press end shim against snap ring (upward) until contact is obtained and determine Dimension II.

Dimension II e.g. 6.0 mm (0.2362 in)
(S) Digital depth gauge - 5870 200 072

EXAMPLE:

Dimension I	7.20 mm (0.2835 in)
Dimension II	6.00 mm (0.2362 in)
Difference = Plate clearance	120.00 mm (4.7244 in)

NOTE: *In case of deviations from the required plate clearance, correct using corresponding snap ring ($s = 2.10 - 4.20$ mm (0.0827 - 0.1654 in)).*

6. Install idler gear until all inner plates are accommodated.

NOTE: *This step makes the later assembling of the idler gear easier.*

7. Remove idler gear again.

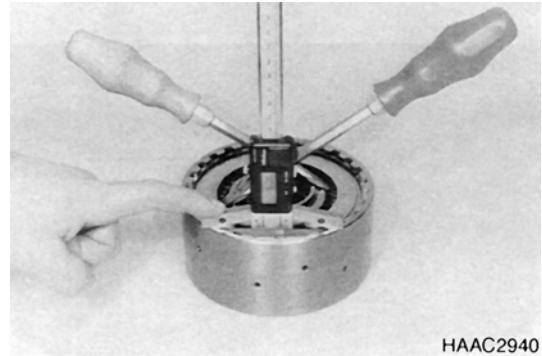


Figure 214

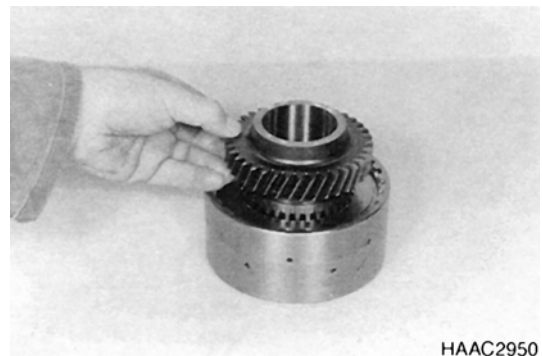


Figure 215

8. Assemble both axial washers and needle cage.

NOTE: *Upper and lower axial washer have the same thickness (50x 70x 1).*

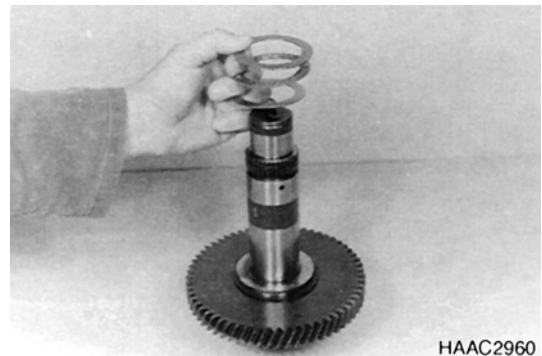


Figure 216

9. Assemble both needle bearings.

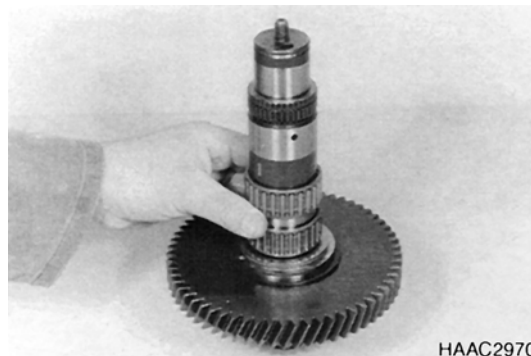


Figure 217

10. Assemble idler gear.

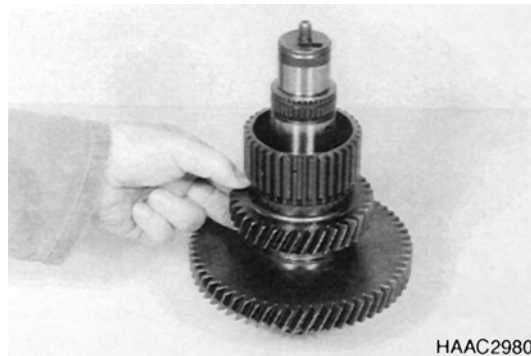


Figure 218

11. Assemble axial washer (3, Figure 219) (50 x 70 x 1) needle cage (2) and running disk (1) (50 x 70 x 4).

NOTE: Install running disk 1 with the chamfer facing the needle cage.

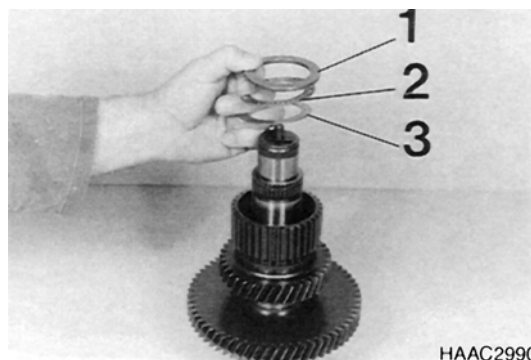


Figure 219

12. Assemble pre-assembled plate carrier until all inner plates are accommodated.

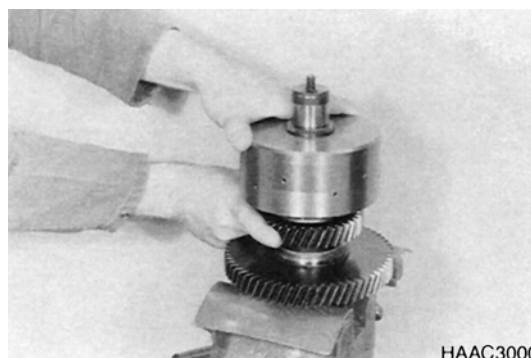


Figure 220

13. Attach plate carrier axially using retaining ring.

(S) Set of external pliers - 5870 900 015

(S) Handle - 5870 260 010

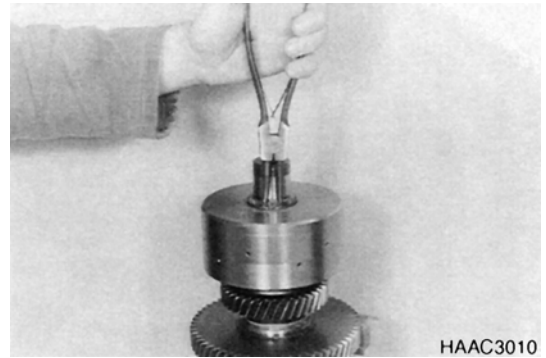


Figure 221

14. Press tapered roller bearing against shoulder.

15. Install opposite tapered roller bearing.

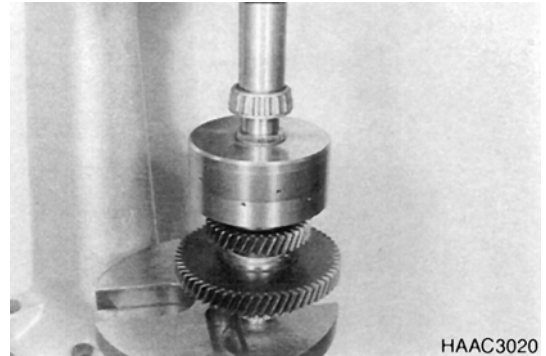


Figure 222

16. Check function of the clutch using compressed air.

NOTE: *With correctly installed components, the closing, reap. opening of the clutch is clearly audible.*

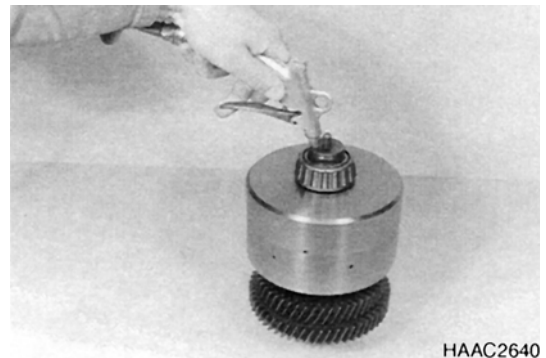


Figure 223

Pre-assemble Input Shaft

1. Cool the input shaft (about -80°C (-112°F)), heat gear (about +120°C (+248°F)) and assemble it until contact is obtained.

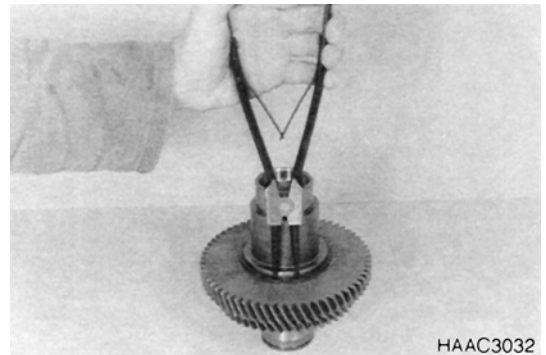


Figure 224

2. Attach gear axially using retaining ring.
(S) Set of external pliers - 5870 900 015

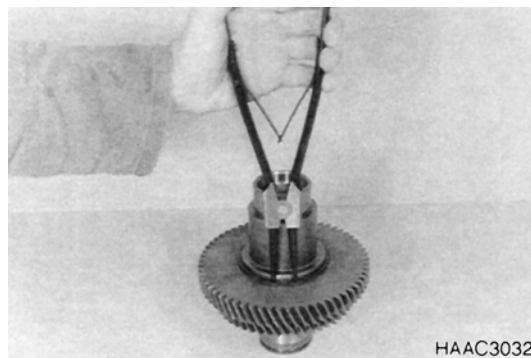


Figure 225

3. Squeeze snap ring into the recess of the turbine shaft.

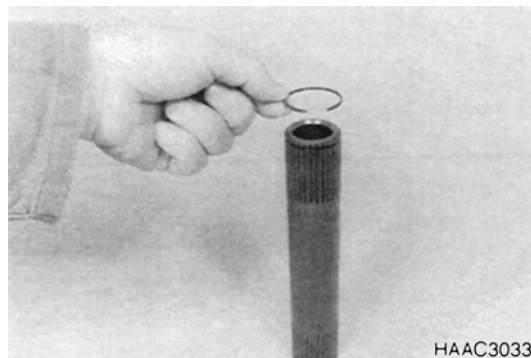


Figure 226

4. Install turbine shaft until the snap ring snaps into the recess of the input shaft - turbine shaft is axially fixed.

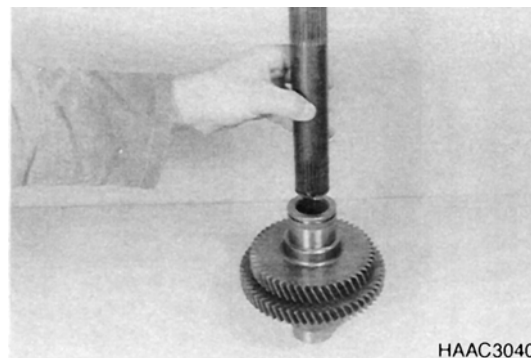


Figure 227

5. Press both inner bearing races against shoulder.

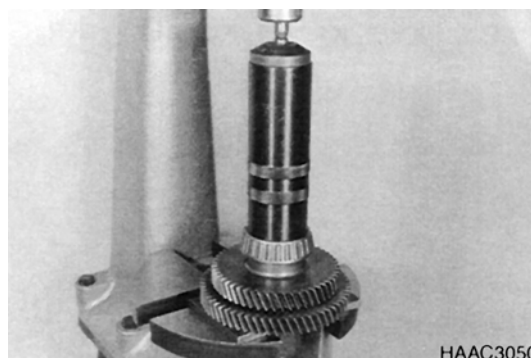


Figure 228

6. Install ball bearing.
7. Squeeze rectangular ring (Figure 229) in and hook it in.

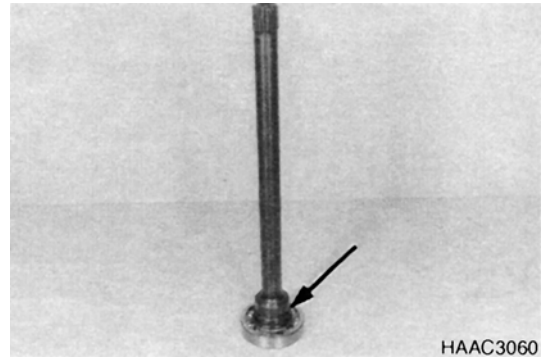


Figure 229

8. Insert output shaft into the housing bore until contact is obtained.

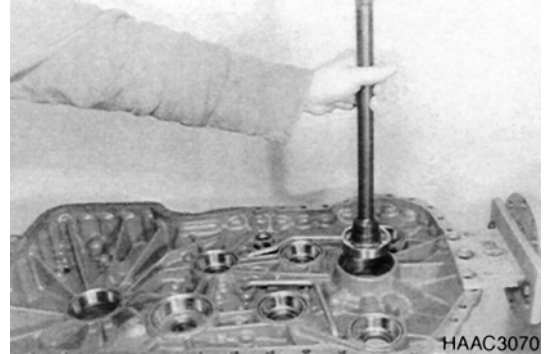


Figure 230

Install Pre-assembled Output Shaft and Clutches

NOTE: *The following Figures describe the common installation of all clutches. For it, the housing cover, combined with special tool (Handle 5870 260 010) is needed. The reassembly of single clutches without housing cover and handles is extremely difficult because of the installation conditions. Besides, there is the danger of injury.*

1. Insert all outer bearing races into the housing cover until contact is obtained.

NOTE: *In the case that already run bearings are reused, pay attention to the allocation of the outer bearing races, see also Note, Page 82*

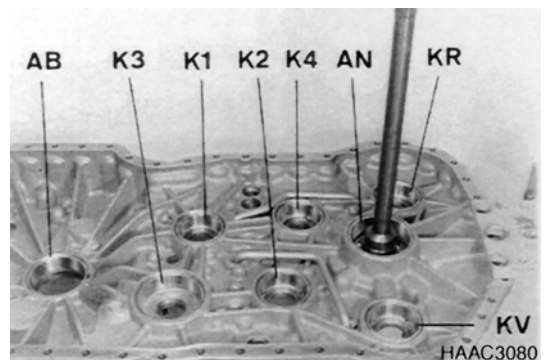


Figure 231

2. Insert clutch KR, input shaft and clutch KV together into housing cover.

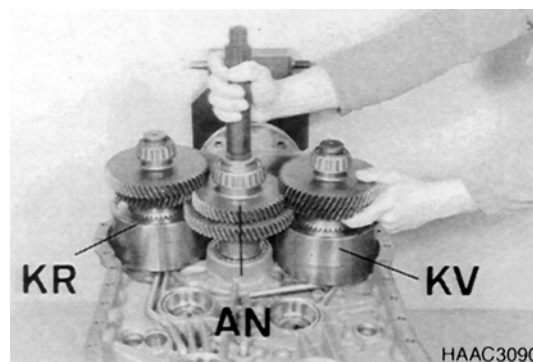


Figure 232

3. Install clutch K4.

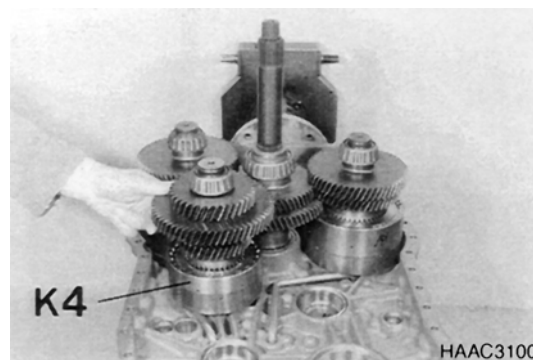


Figure 233

4. Install clutch K3.

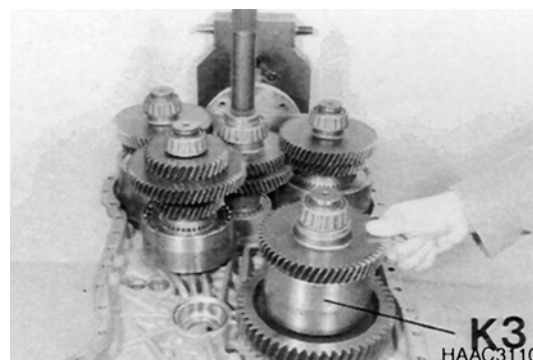


Figure 234

5. Position clutch K1.

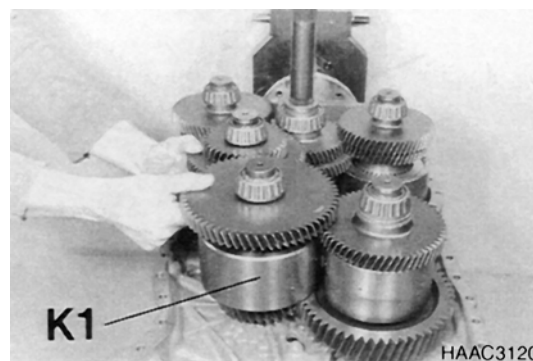


Figure 235

6. Insert clutch K2.

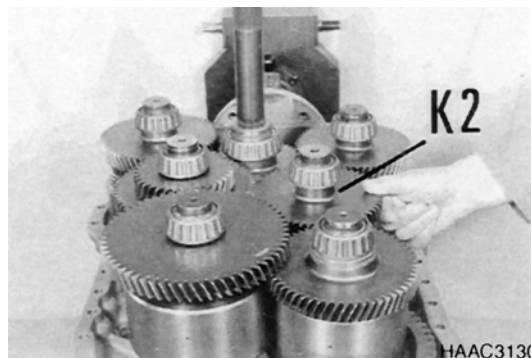


Figure 236

7. Figure 237, shows the installation position of the single clutches in the housing cover.

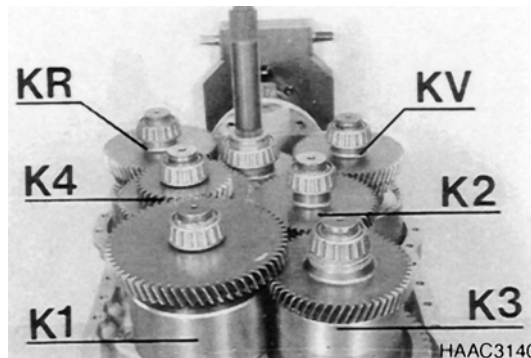


Figure 237

8. Locate all clutches using Handles (S).
(S) Handle (6 pieces needed) - 5870 260 010

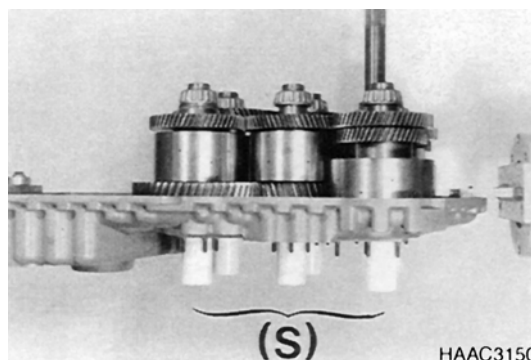


Figure 238

9. Squeeze rectangular rings (7 pieces, see Figure 239) in and hook them in.
10. Grease rectangular rings and align them centrically.

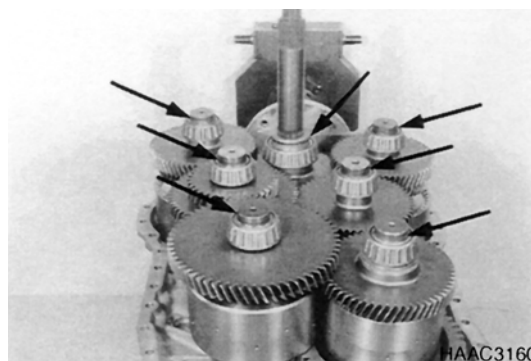


Figure 239

11. Tilt housing cover 180°.
12. Mount eye bolts, see Figure 240.
(S) 2x Eye bolt M20 - 0636 804 003
(S) 1x Eye bolt M16 - 0636 804 001
(S) Puller device - 5870 000 017

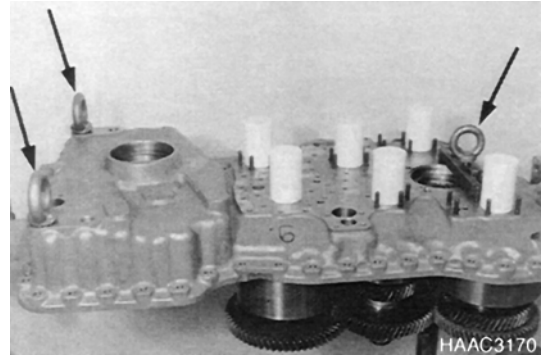


Figure 240

13. Install adjusting screws (S).
14. Position housing cover using lifting device carefully on the gearbox housing until contact is obtained, reposition the clutches in the gearbox housing.

NOTE: Pay attention to the overlapping of the oil pipes with the bores in the housing cover.

- (S) Lifting chain - 5870 281 047
(S) Adjusting screws - 5870 204 007

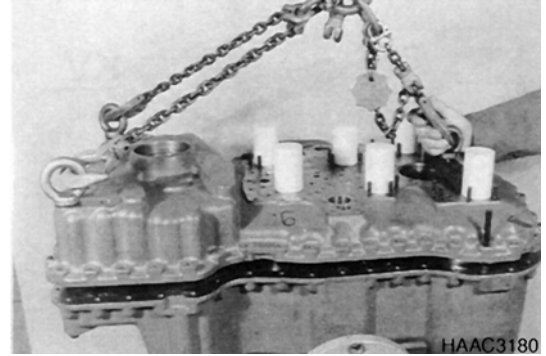


Figure 241

15. Remove handles.
(S) Lifting chain - 5870 281 047



Figure 242

16. Remove housing cover from gearbox housing, using lifting device.
(S) Lifting chain - 5870 281 047

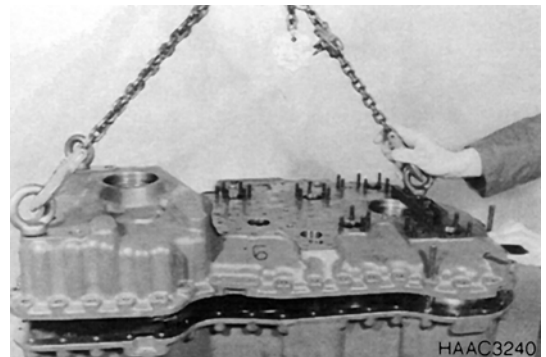


Figure 243

Output

1. Assemble sheet and press both inner bearing races against shoulder until contact is obtained.

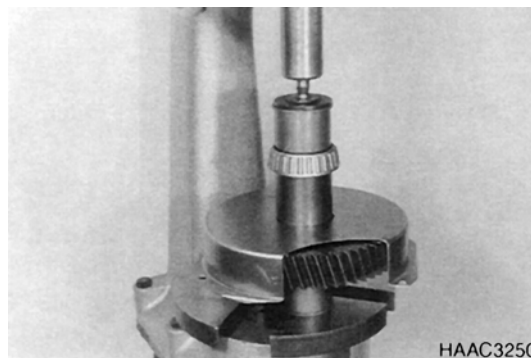


Figure 244

2. Insert outer bearing race (Figure 245) into the housing bore until contact is obtained.

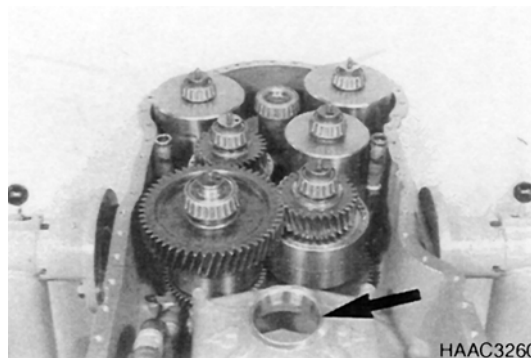


Figure 245

3. Position screening plate.

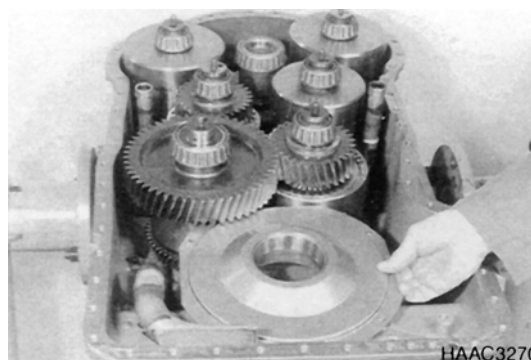


Figure 246

4. Insert output shaft.

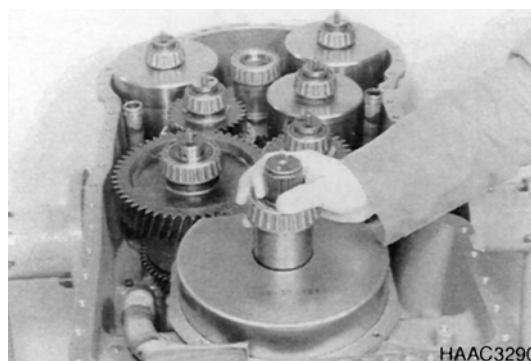


Figure 247

5. Fasten both sheets using socket head screws (4x).

NOTE: Insert socket head screws with Loctite (Type No. 243).

NOTE: Torque limit (M8/8.8) 2.35 kg•m (17 ft lb).

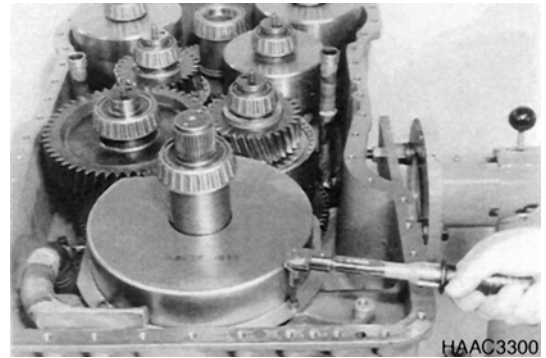


Figure 248

6. Squeeze rectangular rings (6x) into the recesses of the clutch shafts and hook them in.
7. Grease rectangular rings and align them centrally.

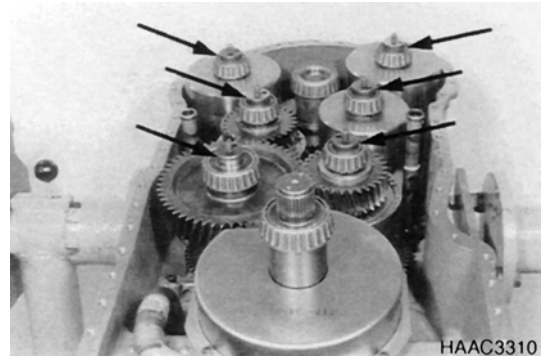


Figure 249

8. Insert both O-rings (Figure 250) into the annular groove of the oil pipes and grease them.

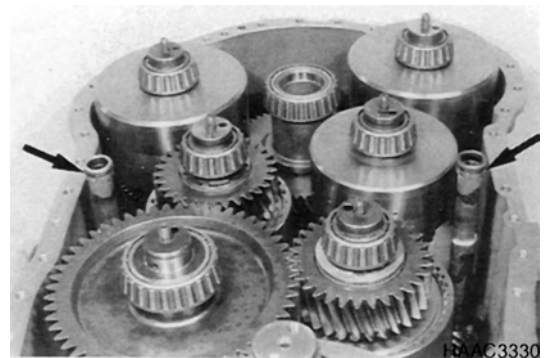


Figure 250

9. Cover mounting face with sealing compound Loctite #574.
10. Install adjusting screws (S) and position housing cover carefully against gearbox housing until contact is obtained, using lifting device.

NOTE: Pay attention to the overlapping of the oil pipe with the bores in the housing cover.

(S) Adjusting screws - 5870 204 007

(S) Lifting chain - 5870 281 047

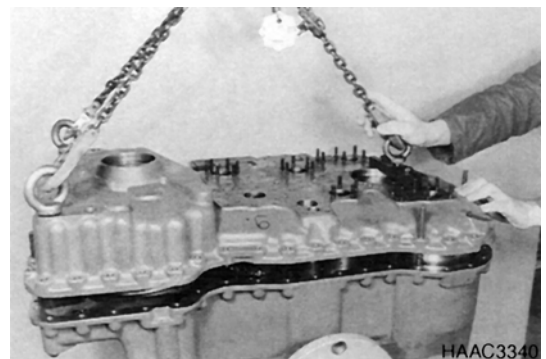


Figure 251

11. Install both cylindrical pins.

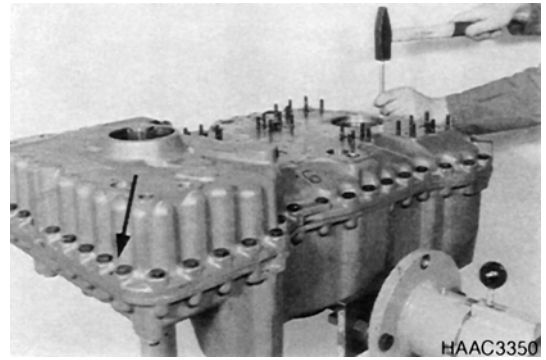


Figure 252

12. Fasten housing cover using hex. head screws.

NOTE: Torque limit (M10/8.8) 4.69 kg•m (34 ft lb).

NOTE: Pay attention to the position of the fixing plate, see Figure 253.

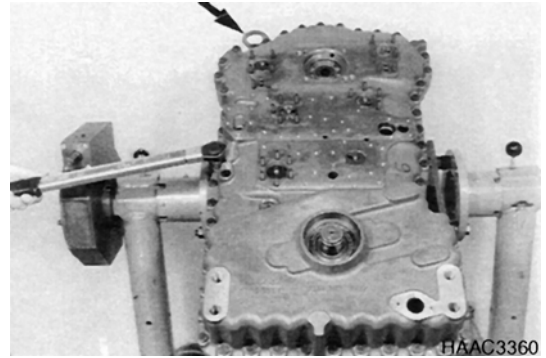


Figure 253

13. Install shaft seal, with the sealing lip facing the oil chamber.

NOTE: By application of the prescribed driver, the exact installation position is obtained. Wet rubber coated outer diameter with spirit. Grease sealing lip.

(S) Driver - 5870 048 057

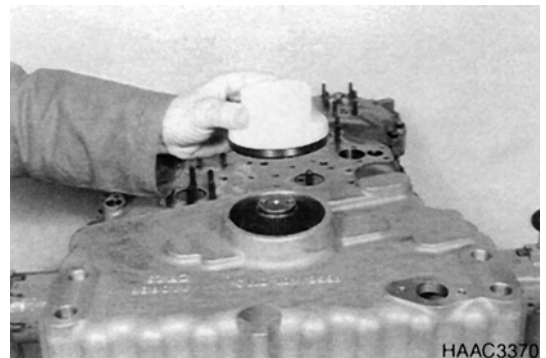


Figure 254

14. Heat the output flange (Max. 90°C (194°F)), assemble it and attach it using washer and hex. head screws.

NOTE: Wet contact area of washer with sealing compound Loctite (Type No. 574).

NOTE: Torque limit (M8/10.9) 3.47 kg•m (25 ft lb).

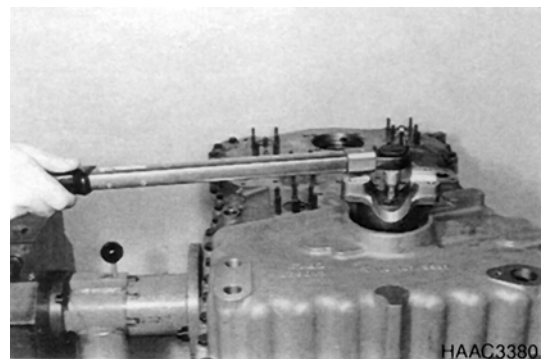


Figure 255

15. Attach hex. head screws using lock plate.
16. Install output flange on the converter side accordingly (Figure 254 thru Figure 256).
(S) Driver - 5870 057 011
(S) Handle - 5870 260 002

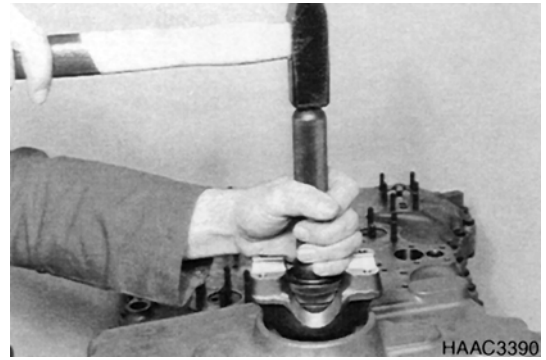


Figure 256

Converter Pressure Valve

NOTE: Figure 257, shows the components of the converter pressure valve.

Reference Number	Description
1	Piston
2	Compression Spring
3	Valve Insert
4	Roll Pin

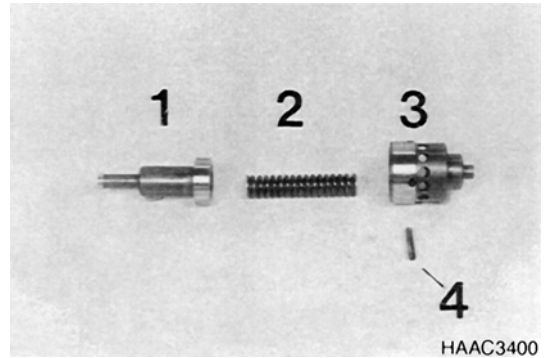


Figure 257

1. Install compression spring and piston, preload and attach them using roll pin.
(S) Assembly aid - 5870 345 084

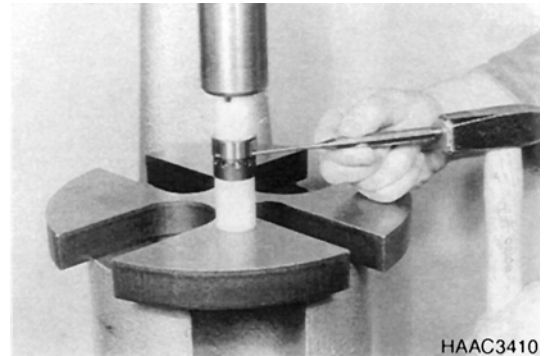


Figure 258

2. Insert pre-assembled converter pressure valve into the housing bore.

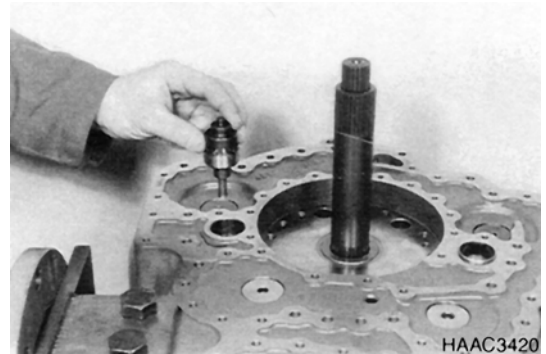


Figure 259

Oil Feed Housing - Transmission Pump

1. Install two adjusting screws (Figure 260) and mount flat gasket.

(S) Adjusting screws - 5870 204 011

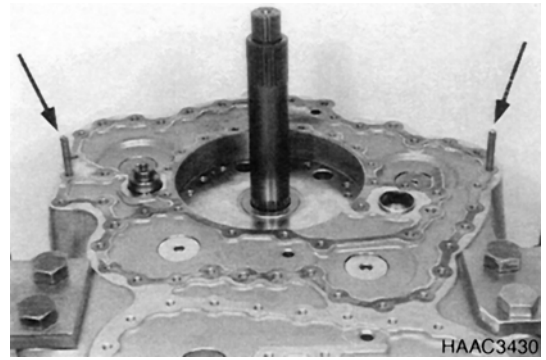


Figure 260

2. Mount oil feed housing and attach it provisionally using washers and hex. head screws.

NOTE: *Screw the hex. head screws in only until contact is obtained do not tighten.*

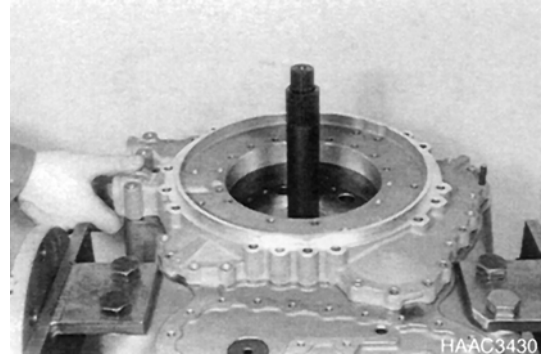


Figure 261

3. Install two adjusting screws and install stator shaft until contact is obtained.

NOTE: *Pay attention to the overlapping of the bores.*

(S) Adjusting screws - 5870 204 007

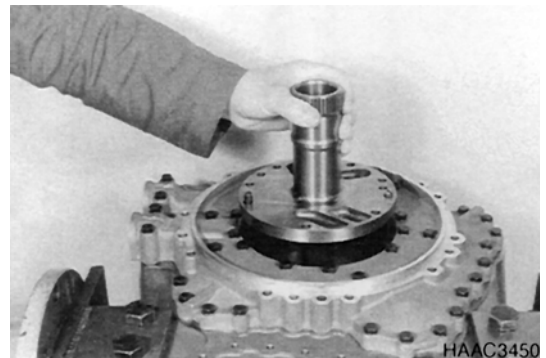


Figure 262

4. Install O-ring (Figure 263) and oil it.

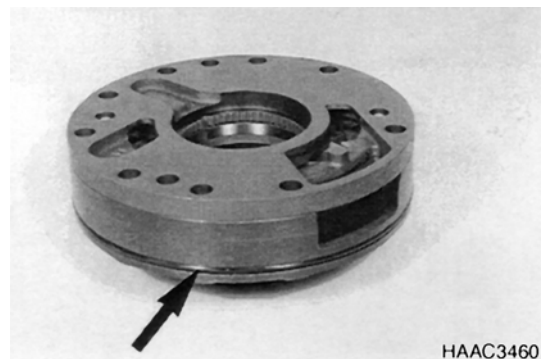


Figure 263

5. Install transmission pump (compl.) until contact is obtained.

NOTE: Pay attention to the overlapping of the bores.

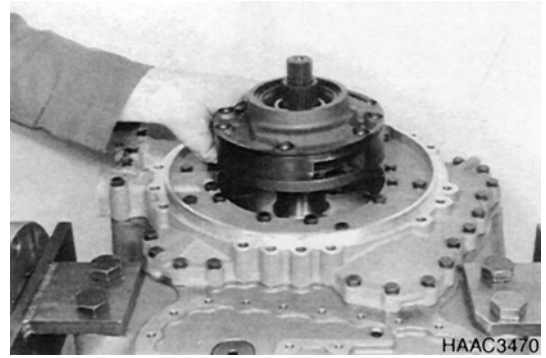


Figure 264

6. Install new O-rings on socket head screws (Figure 265).

NOTE: Grease O-Rings.

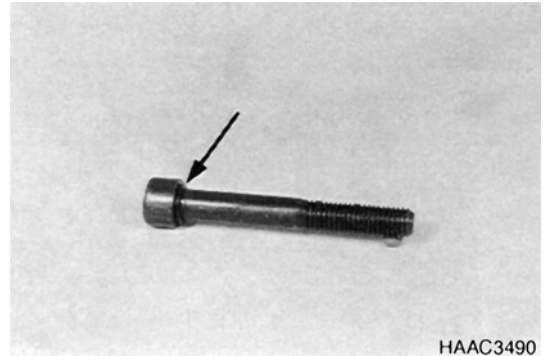


Figure 265

7. Fasten transmission pump using socket head screws.

NOTE: Torque limit (M10/8.8) 4.69 kg•m (34 ft lb).

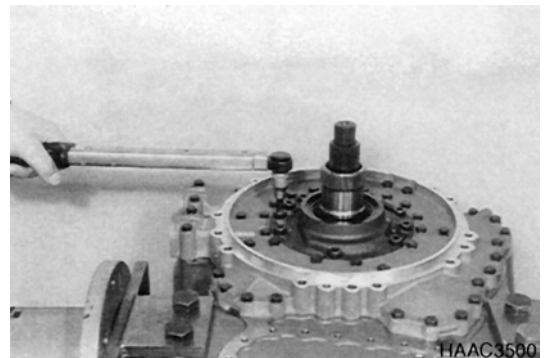


Figure 266

8. Attach oil feed housing finally using hex. head screws (mount flat washers).

NOTE: Torque limit 2.55 kg•m (18 ft lb).

NOTE: Pay attention to the installation position of the fixing plate, see Figure 268.

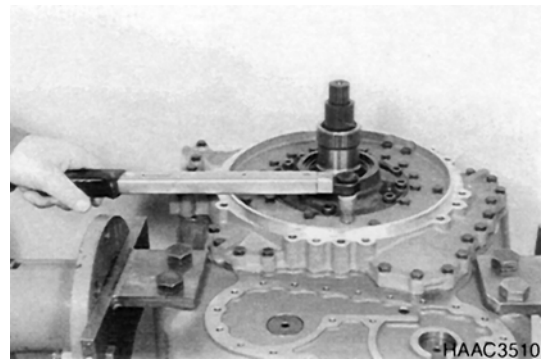


Figure 267

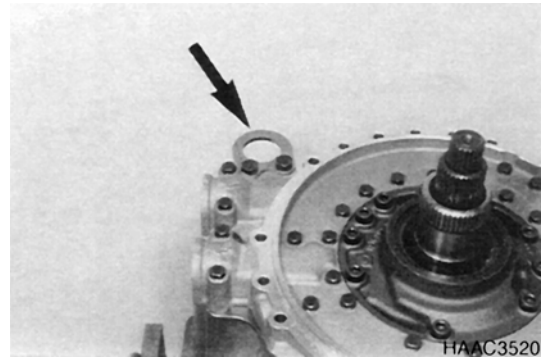


Figure 268

9. Install flat gasket and cover. Secure into place using hex. head screws.

NOTE: Torque limit (M8/8.8) 2.35 kg•m (17 ft lb).

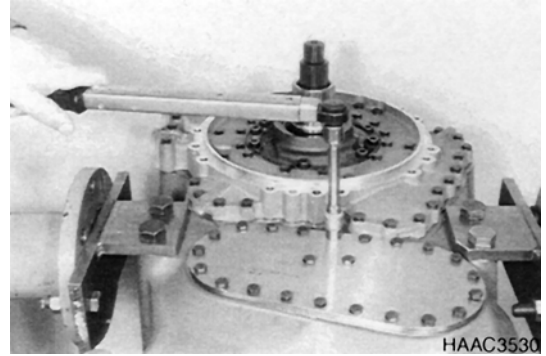


Figure 269

Converter Safety Valve

1. Figure 270, shows the components of the converter safety valve.

Reference Number	Description
1	Plate
2	Ball
3	Compression Spring
4	Valve Insert
5	Valve Sleeve
6	Cylindrical Pin

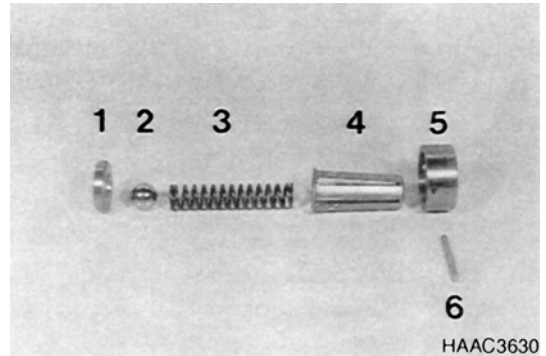


Figure 270

2. Reassemble components according to Figure 270, preload and attach using cylindrical pin.

(S) Assembly aid - 5870 345 084

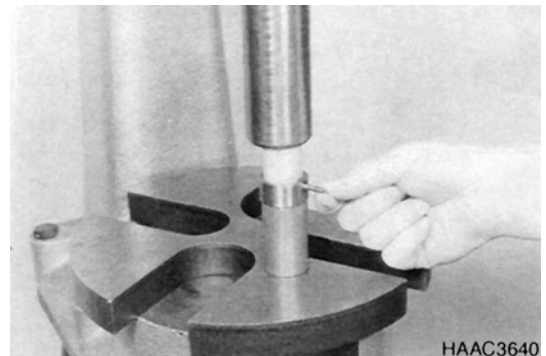


Figure 271

3. Insert converter safety valve (compl.) into the housing bore until contact is obtained.

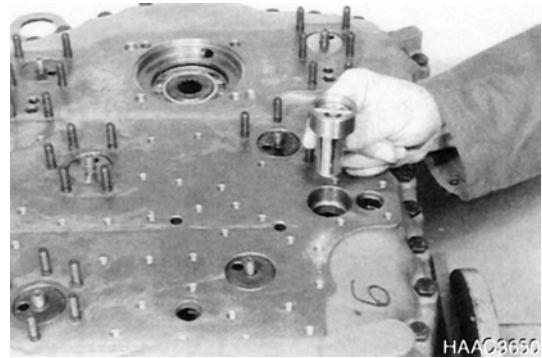


Figure 272

Attaching Duct Plate

1. Install both screw plugs (Figure 273).

NOTE: *Install new sealing rings.*

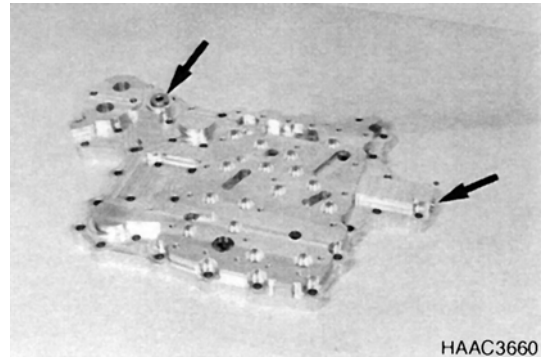


Figure 273

2. Install gasket, place duct plate against shoulder and fasten it using socket head screws and hex. nuts (mount flat washers).

NOTE: *Torque limit 2.55 kg•m (18 ft lb).*

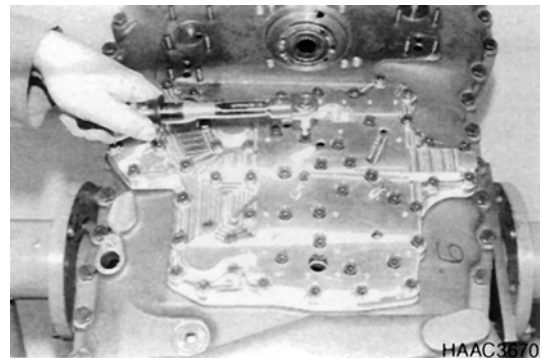


Figure 274

Attaching Hydraulic Control Unit

1. Install two adjusting screws.
2. Mount gasket (1, Figure 276), intermediate plate (2) and gasket (3).

NOTE: *Pay attention to the installation position of the different gaskets, see Figure 276.*

(S) Adjusting screws - 5870 204 031

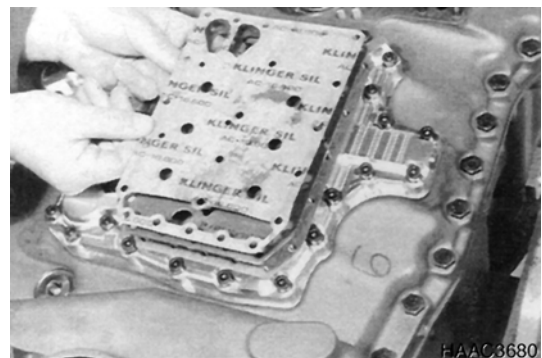
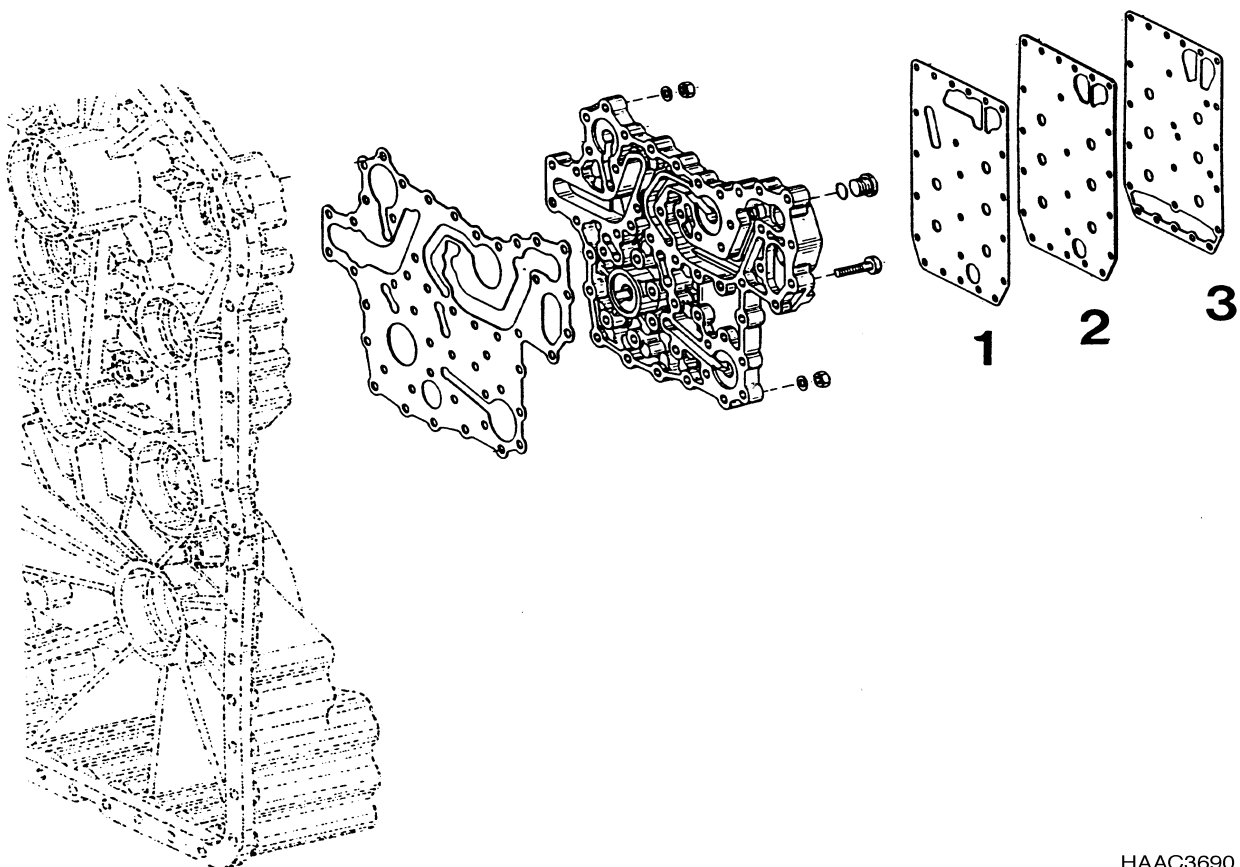


Figure 275

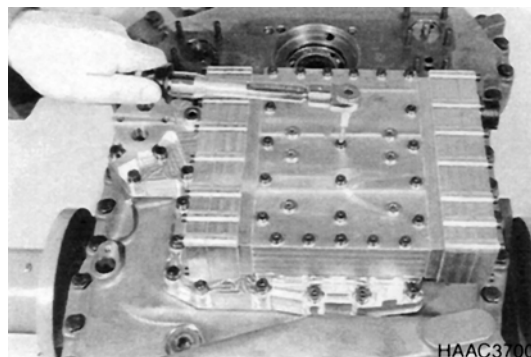


HAAC3690

Figure 276

3. Fasten complete control unit on the duct plate, using socket head screws.

NOTE: Torque limit 1 kg•m (7 ft lb).



HAAC3700

Figure 277

Filter

1. Figure 278, shows the components of the filter unit.

NOTE: *Install new O-rings (Figure 278).*

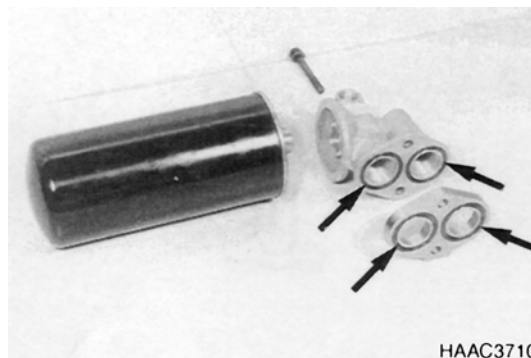


Figure 278

2. Fasten intermediate plate and filter head using hex. head screws (mount flat washers).

NOTE: *Torque limit 2.55 kg•m (18 ft lb).*

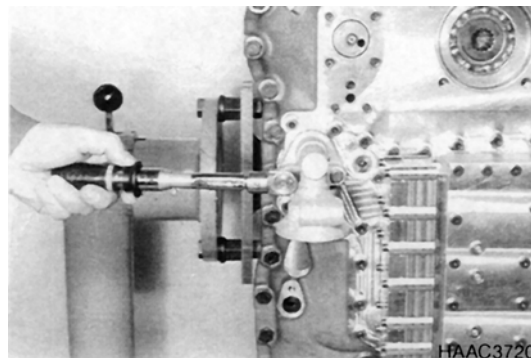


Figure 279

3. Oil gasket and tighten exchange filter handtight.

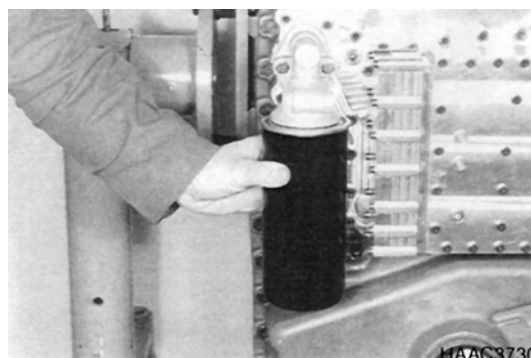


Figure 280

4. If necessary, install warning switch (according to the version).



Figure 281

5. Insert O-ring (Figure 282) into the annular groove of the oil feed covers.

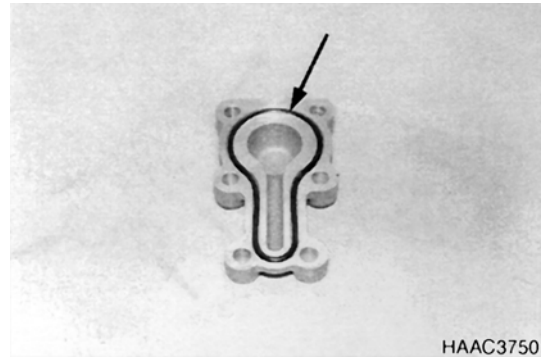


Figure 282

6. Fasten the two covers (Figure 283) using hex. nuts (mount flat washers) on the housing.

NOTE: Torque limit 2.55 kg•m (18 ft lb).

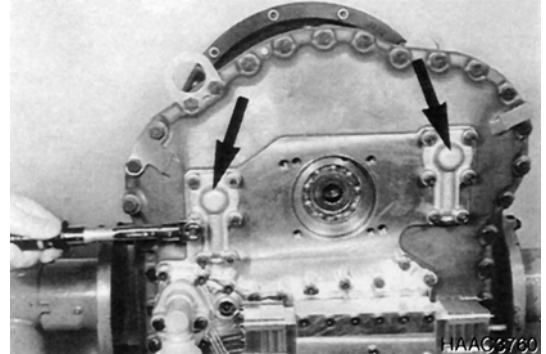


Figure 283

7. Mount oil level tube.
8. Install screw plug (Figure 284).

NOTE: Install new gaskets.

NOTE: Torque limit (M8/8.8) 2.35 kg•m (17 ft lb).

NOTE: Torque limit (screw plug M26x1,5) 8.16 kg•m (59 ft lb).

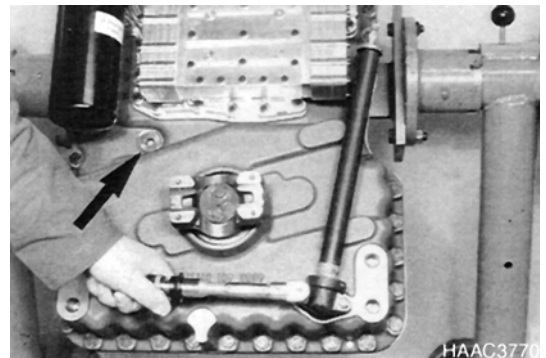


Figure 284

Speed Sensor and Inductive Transmitter

1. Grease O-ring, install speed sensor (Figure 285) and fasten it using socket head screw.

NOTE: Torque limit (M8/8.8) 2.35 kg•m (17 ft lb).

Reference Number	Description
34	Speed - Output and Speedometer

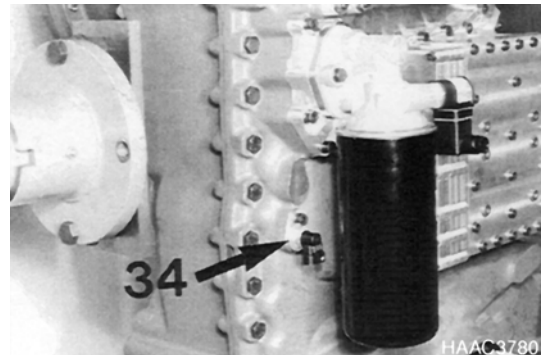


Figure 285

2. Install new O-rings on inductive transmitters and install.

NOTE: Torque limit 3 kg•m (22 ft lb).

Reference Number	Description
48	Speed - Engine
47	Speed - Central Gear Train
21	Speed - Turbine

3. Install breather (Figure 286).

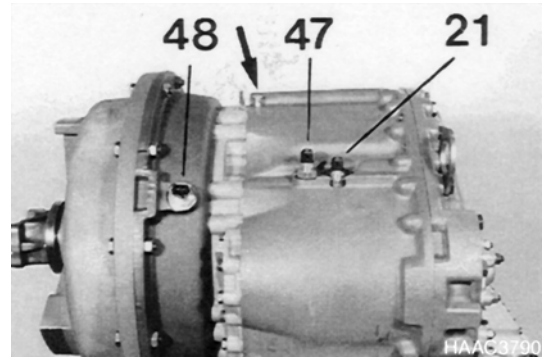


Figure 286

4. Install gasket and cover plate (1, Figure 287).

NOTE: Torque limit (M8/8.8) 2.35 kg•m (17 ft lb).

5. Install new O-ring on screw plug (2) and install.

NOTE: Torque limit 14.28 kg•m (105 ft lb).

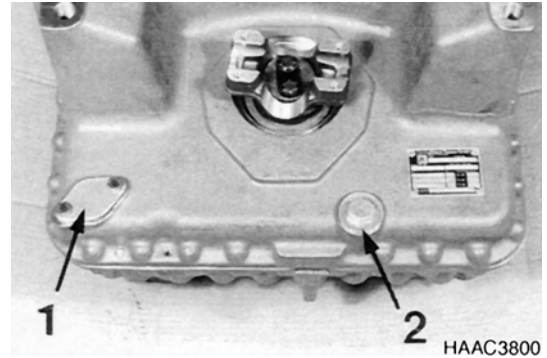


Figure 287

Transmission Error Codes (ZF)

Edition 1

MEMO

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Transmission Error Codes (ZF)

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

INTRODUCTION

The "WG" series of ZF Transmissions use an electronic control system called "ZF-Ergopower."

The Ergo System (for short) allows the transmission to function either in a manual powershift mode, or in a fully automatic mode.

An LCD display (Figure 1) is in the cab. This display gives the machine operator a continuous status of the operating condition of the system. It displays normal operational codes, and fault codes.

ABBREVIATIONS

Throughout this section the following abbreviations are used to indicate various conditions.

Abbreviations	
ABS	Anti Blocking System
ADM (1 - 6)	Ausgeschaltet Digital Minus (Switched Off Digital Minus)
AFP	Automatic Filling Parameter Adjustment
CAN	Controller Area Network
LIS (1 and 2)	Load Isolation System (Solenoids 1 and 2)
O.C.	Open Circuit
OP-Mode	OPeration Mode
S.C.	Short Circuit
TCU	Transmission Control Unit
VPS (1 and 2)	Variable Power Supply

DISPLAY

If a fault is detected, the display shows a spanner symbol (g) for a fault. The display shows the fault code, if the gear selector is in neutral position.

If more than one fault is detected, each fault code is shown for about 1 second.

Reference Letter	Description
a, f	Automatic Range (Upshifting and Downshifting)
b, c, d, e	Preselected Gear
g	EST-37 has detected an error and is flashing.
h	This character will not be used at the EST-37.

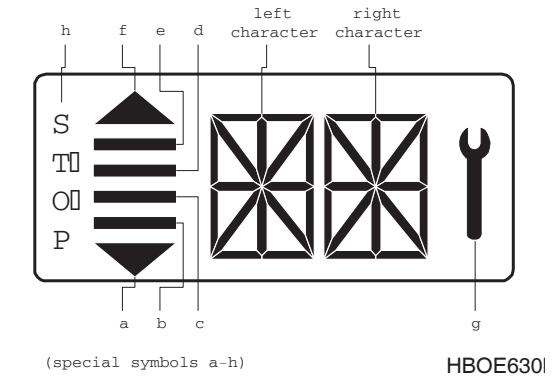


Figure 1

Description of Fault Codes

The first number of the error code is the category that it is grouped into. They are as follows for the first number.

First Number	Meaning of Number
1 Hex	Digital Input Signal
2 Hex	Analog Input Signal
3 Hex	Speed Signal
4 Hex	CAN Signal Error
5 Hex	CAN Signal Error
6 Hex	CAN Signal Error
7 Hex	Analog Current Output Signal
8 Hex	Analog Current Output Signal
9 Hex	Digital Output Signal
A Hex	Digital Output Signal
B Hex	Transmission Fault, Clutch Error
C Hex	Logical Fault
D Hex	Power Supply
E Hex	High Speed Signal
F Hex	General Fault

DISPLAY DURING OPERATION

Symbol	Meaning	Remarks
1F, 1R 2F, 2R 3F, 3R 4F 5F 6F LF, LR	Actual gear and direction. Left digit shows actual gear. Right digit shows actual direction. Limp home gear.	-
F or R, no gear	Clutch Cut Off.	-
F or R flashing	Direction F or R selected while turbine speed is too high. CAUTION: Gear will engage if turbine speed drops.	-
NN	Not neutral, waiting for neutral after power up or a severe fault.	Go engage a gear, first move shift selector to neutral position and again to F or R position.
**	Oil temperature too low, no gear available.	Warm up engine / transmission.
*N	Oil temperature low, only one gear available.	Warm up engine / transmission.
1 bar (special symbol)	Manual mode 1. gear.	-
2 bars	Manual mode 2. gear.	-
3 bars	Manual mode 3. gear.	-
4 bars	Manual mode 4. gear.	-
4 bars and 2 arrows	Automatic mode.	-
Bars flashing	6 WG: converter lockup clutch open. 4 WG: Downshift mode active.	Difference of engine and turbine speed above a certain limit and lockup clutch not activated.
Spanner	At least one fault active.	Select neutral to get fault code displayed.
Fault code	See fault code list (See page -13).	-
WS	Warning sump temperature.	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner).
WR	Warning retarder temperature.	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner).
WE	Warning high engine speed.	Changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner).
PN	Direction F or R selected while parking brake engaged.	Transmission in neutral until parking brake is released. CAUTION: Vehicle starts to move after release of parking brake.

Symbol	Meaning	Remarks
F or R flashing	Direction F or R selected while turbine speed is to high. CAUTION: Gear will engage if turbine speed drops.	-
EE flashing	No communication with display.	Checked wiring from TCU to display.

DEFINITION OF OPERATING MODES

Normal

There is no failure detected in transmission system or failure has no or slight effects on transmission control. TCU will work without or in special cases with little limitations. (See "Table of Fault Codes" on page -13.)

Substitute Clutch Control

TCU cannot change gears or direction under control of normal clutch modulation. TCU uses substitute strategy for clutch control. All modulations are only time controlled. (Comparable with EST 25.)

Limp-home

The detected failure in the system has strong limitations to transmission control. TCU can engage only one gear in each direction. In some cases only one direction will be possible.

TCU will shift the transmission into neutral at the first occurrence of the failure. First, the operator must shift the gear selector into neutral position.

If output speed is less than a threshold for neutral to gear and the operator shifts the gear selector into forward or reverse, the TCU will select the limp-home gear.

If output speed is less than a threshold for reversal speed and TCU has changed into the limp-home gear and the operator selects a shuttle shift, TCU will shift immediately into the limp-home gear of the selected direction.

If output speed is greater than the threshold, TCU will shift the transmission into neutral. The operator has to slow down the vehicle and must shift the gear selector into neutral position.

Transmission shut Down

TCU has detected a severe failure that disables control of the transmission.

TCU will shut off the solenoid valves for the clutches and also the common power supply (VPS1).

Transmission shifts to Neutral. The park brake will operate normally, also the other functions which use ADM 1 to ADM 8.

The operator has to slow down the vehicle. The transmission will stay in neutral.

TCU Shut Down

TCU has detected a severe failure that disables control of system.

TCU will shut off all solenoid valves and also both common power supplies (VPS1, VPS2). The park brake will engage, also all functions are disabled which use ADM 1 to ADM 8.

The transmission will stay in neutral.

NOTE: *VPS2: is the LIS (option power supply).*

CLUTCH PACK AND SOLENOID VALVE

CROSS-REFERENCE TABLE

Throughout the fault codes, references are made to various clutch packs within the transmission. These clutch pack references are indicated as K1, K2, etc.

Clutch pack charge pressure is controlled by proportional valves that contain a solenoid valve.

The following chart identifies which solenoid valve corresponds to each clutch pack.

Clutch Pack	Solenoid Valve (Proportioning Valve) Number						
	Mega 130 4WG-100	Mega 160 4WG-130	Mega 250-V 4WG-190	Mega 300-V 4WG-210	Mega 400-III PLUS 4WG-260	Mega 400-V 4WG-260	Mega 500-V 4WG-310
K1	Y3	Y3	Y3	Y3	Y3	Y3	Y3
K2	Y6	Y6	Y6	Y6	Y6	Y6	Y6
K3	Y4	Y4	Y4	Y4	Y4	Y4	Y4
K4	Y1	Y1	Y1	Y1	Y2	Y2	Y2
KR	Y2	Y2	Y2	Y2	Y1	Y1	Y1
KV	Y5	Y5	Y5	Y5	Y5	Y5	Y5

TABLE OF FAULT CODES

The fault codes shown in this table are a complete list of codes that are common to more than one version of the transmission. Some of the versions are 4WG (four speed) and 6WG (six speed).

NOTE: *This fault code list is valid for the ZF Software Versions V 53.x to V58.0*

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
11	Logical error at gear range signal. TCU detected a wrong signal combination for gear range. • Cable from shift lever to TCU is broken. • Cable is defective and is contacted to battery voltage or vehicle ground. • Shift lever is defective.	TCU shifts transmission to neutral. OP-Mode: transmission shut down.	Check cables from TCU to shift lever. Check signal combinations of shift lever positions for gear range.	Failure cannot be detected in systems with DW2/DW3 shift lever. Fault is taken back if TCU detects a valid signal for position.
12	Logical error at direction select signal. TCU detected a wrong signal combination for direction. • Cable from shift lever to TCU is broken. • Cable is defective and is contacted to battery voltage or vehicle ground. • Shift lever is defective.	TCU shifts transmission to neutral. OP-Mode: transmission shut down.	Check cables from TCU to shift lever. Check signal combinations of shift lever positions F-N-R.	Fault is taken back if TCU detects a valid signal for direction at shift lever.
17 **	S.C. to ground at Solenoid LIS1 (Function No. 1). TCU detected a wrong voltage at output pin, that looks like a S.C. to vehicle ground. • Cable is defective and is contacted to vehicle ground. • Solenoid LIS1 (Function No. 1) device has an internal defect. • Connector pin is contacted to vehicle ground.	Customer specific.	Check cable from TCU to Solenoid LIS1 (Function No. 1) device. Check connectors from Solenoid LIS1 (Function No. 1) to TCU. Check resistance of Solenoid LIS1 (Function No. 1) device.	1) See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
18 **	S.C. to battery voltage at Solenoid LIS1 (Function No. 1). TCU detected a wrong voltage at output pin, that looks like a S.C. to battery voltage. • Cable is defective and is contacted to battery voltage. • Solenoid LIS1 (Function No. 1) device has an internal defect. • Connector pin is contacted to battery voltage.	Customer specific.	Check cable from TCU to Solenoid LIS1 (Function No. 1) device. Check connectors from Solenoid LIS1 (Function No. 1) to TCU. Check resistance of Solenoid LIS1 (Function No. 1) device.	1) See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
19 **	O.C. at Solenoid LIS1 (Function No. 1). TCU detected a wrong voltage at output pin, that looks like a O.C. for this output pin. • Cable is defective and has no connection to TCU. • Solenoid LIS1 (Function No. 1) device has an internal defect. • Connector has no connection to TCU.	Customer specific.	Check cable from TCU to Solenoid LIS1 (Function No. 1) device. Check connectors from Solenoid LIS1 (Function No. 1) device to TCU. Check resistance of Solenoid LIS1 (Function No. 1) device.	1) See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
1A **	S.C. to ground at Solenoid LIS2 (Function No. 2). TCU detected a wrong voltage at output pin, that looks like a S.C. to vehicle ground. • Cable is defective and is contacted to vehicle ground. • Solenoid LIS2 (Function No. 2) device has an internal defect. • Connector pin is contacted to vehicle ground.	Customer specific.	Check cable from TCU to Solenoid LIS2 (Function No. 2) device. Check connectors from Solenoid LIS2 (Function No. 2) device to TCU. Check resistance of Solenoid LIS2 (Function No. 2) device.	1) See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
1B **	S.C. to battery voltage at Solenoid LIS2 (Function No. 2). TCU detected a wrong voltage at output pin, that looks like a S.C. to battery voltage. • Cable is defective and is contacted to battery voltage. • Solenoid LIS2 (Function No. 2) device has an internal defect. • Connector pin is contacted to battery voltage.	Customer specific.	Check cable from TCU to Solenoid LIS2 (Function No. 2) device. Check connectors from Solenoid LIS2 (Function No. 2) device to TCU. Check resistance of Solenoid LIS2 (Function No. 2) device.	1) See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
1C **	O.C. at Solenoid LIS2 (Function No. 2). TCU detected a wrong voltage at output pin, that looks like a O.C. for this output pin. • Cable is defective and has no connection to TCU. • Solenoid LIS2 (Function No. 2) device has an internal defect. • Connector has no connection to TCU.	Customer specific.	Check cable from TCU to Solenoid LIS2 (Function No. 2) device. Check connectors from Solenoid LIS2 (Function No. 2) device to TCU. Check resistance of Solenoid LIS2 (Function No. 2) device.	1) See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
25	S.C. to battery voltage or O.C. at transmission sump temperature sensor input. The measured voltage is too high: • Cable is defective and is contacted to battery voltage. • Cable has no connection to TCU. • Temperature sensor has an internal defect. • Connector pin is contacted to battery voltage or is broken.	No reaction, TCU uses default temperature. OP-Mode: normal.	Check cable from TCU to sensor. Check connectors. Check temperature sensor.	-----
26	S.C. to ground at transmission sump temperature sensor input. The measured voltage is too low: • Cable is defective and is contacted to vehicle ground. • Temperature sensor has an internal defect. • Connector pin is contacted to vehicle ground.	No reaction, TCU uses default temperature. OP-Mode: normal.	Check cable from TCU to sensor. Check connectors. Check temperature sensor.	-----

* Only Mega 400-III PLUS

** Only Series "V"

Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
31	S.C. to battery voltage or O.C. at engine speed input. TCU measures a voltage higher than 7.00 V at speed input pin. • Cable is defective and is contacted to battery voltage. • Cable has no connection to TCU. • Speed sensor has an internal defect. • Connector pin is contacted to battery voltage or has no contact.	OP-Mode: substitute clutch control.	Check cable from TCU to sensor. Check connectors. Check speed sensor.	-----
32	S.C. to ground at engine speed input. TCU measures a voltage less than 0.45V at speed input pin. • Cable / connector is defective and is contacted to vehicle ground. • Speed sensor has an internal defect.	OP-Mode: substitute clutch control.	Check cable from TCU to sensor. Check connectors. Check speed sensor.	-----
33	Logical error at engine speed input. TCU measures a engine speed over a threshold and the next moment the measured speed is zero. • Cable / connector is defective and has bad contact. • Speed sensor has an internal defect. • Sensor gap is incorrect.	OP-Mode: substitute clutch control.	Check cable from TCU to sensor. Check connectors. Check speed sensor. Check sensor gap.	This fault is reset after power up of TCU.
34	S.C. to battery voltage or O.C. at turbine speed input. TCU measures a voltage higher than 7.00 V at speed input pin. • Cable is defective and is contacted to battery voltage. • Cable has no connection to TCU. • Speed sensor has an internal defect. • Connector pin is contacted to battery voltage or has no contact.	OP-Mode: substitute clutch control. If a failure is existing at output speed, TCU shifts to neutral. OP-Mode: limp home.	Check cable from TCU to sensor. Check connectors. Check speed sensor.	-----
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
35	S.C. to ground at turbine speed input. TCU measures a voltage less than 0.45V at speed input pin. • Cable / connector is defective and is contacted to vehicle ground. • Speed sensor has an internal defect.	OP-Mode: substitute clutch control. If a failure is existing at output speed, TCU shifts to neutral. OP-Mode: limp home.	Check cable from TCU to sensor. Check connectors. Check speed sensor.	-----
36	Logical error at turbine speed input. TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero. • Cable / connector is defective and has bad contact. • Speed sensor has an internal defect. • Sensor gap is incorrect.	OP-Mode: substitute clutch control. If a failure is existing at output speed, TCU shifts to neutral. OP-Mode: limp home.	Check cable from TCU to sensor. Check connectors. Check speed sensor. Check sensor gap.	This fault is reset after power up of TCU.
37	S.C. to battery voltage or O.C. at internal speed input. TCU measures a voltage higher than 7.00 V at speed input pin. • Cable is defective and is contacted to battery voltage. • Cable has no connection to TCU. • Speed sensor has an internal defect. • Connector pin is contacted to battery voltage or has no contact.	OP-Mode: substitute clutch control.	Check cable from TCU to sensor. Check connectors. Check speed sensor.	-----
38	S.C. to ground at internal speed input. TCU measures a voltage less than 0.45V at speed input pin. • Cable / connector is defective and is contacted to vehicle ground. • Speed sensor has an internal defect.	OP-Mode: substitute clutch control.	Check cable from TCU to sensor. Check connectors. Check speed sensor.	-----
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
39	Logical error at internal speed input. TCU measures a internal speed over a threshold and at the next moment the measured speed is zero. • Cable / connector is defective and has bad contact. • Speed sensor has an internal defect. • Sensor gap is incorrect.	OP-Mode: substitute clutch control.	Check cable from TCU to sensor. Check connectors. Check speed sensor. Check sensor gap.	This fault is reset after power up of TCU.
3A	S.C. to battery voltage or O.C. at output speed input. TCU measures a voltage higher than 12.5 V at speed input pin. • Cable is defective and is contacted to battery voltage. • Cable has no connection to TCU. • Speed sensor has an internal defect. • Connector pin is contacted to battery voltage or has no contact.	Special mode for gear selection; OP-Mode: substitute clutch control. If a failure is existing at turbine speed, TCU shifts to neutral. OP-Mode: limp home.	Check cable from TCU to sensor. Check connectors. Check speed sensor.	-----
3B	S.C. to ground at output speed input. TCU measures a voltage less than 1.00V at speed input pin. • Cable / connector is defective and is contacted to vehicle ground. • Speed sensor has an internal defect.	Special mode for gear selection. OP-Mode: substitute clutch control. If a failure is existing at turbine speed, TCU shifts to neutral. OP-Mode: limp home.	Check cable from TCU to sensor. Check connectors. Check speed sensor.	-----
3C	Logical error at output speed input. TCU measures a output speed over a threshold and at the next moment the measured speed is zero. • Cable / connector is defective and has bad contact. • Speed sensor has an internal defect. • Sensor gap is incorrect.	Special mode for gear selection. OP-Mode: substitute clutch control. If a failure is existing at turbine speed, TCU shifts to neutral. OP-Mode: limp home.	Check cable from TCU to sensor. Check connectors. Check speed sensor. Check sensor gap.	This fault is reset after power up of TCU.
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
3E	Output speed zero doesn't fit to other speed signals. If transmission is not neutral and the shifting has finished, TCU measures output speed zero and turbine speed or internal speed not equal to zero. • Speed sensor has an internal defect. • Sensor gap is incorrect.	Special mode for gear selection. OP-Mode: substitute clutch control. If a failure is existing at turbine speed, TCU shifts to neutral. OP-Mode: limp home.	Check sensor signal of output speed sensor. Check sensor gap of output speed sensor. Check cable from TCU to sensor.	This fault is reset after power up of TCU.
71	S.C. to battery voltage at clutch K1. The measured resistance value of valve is out of limit, voltage at K1 valve is too high. • Cable / connector is defective and has contact to battery voltage. • Cable / connector is defective and has contact to another regulator output of TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending, TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from TCU to gearbox. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
72	S.C. to ground at clutch K1. The measured resistance value of valve is out of limit, voltage at K1 valve is too low. • Cable / connector is defective and has contact to vehicle ground. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending, TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
73	O.C. at clutch K1. The measured resistance value of valve is out of limit. • Cable / connector is defective and has no contact to TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending, TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
74	S.C. to battery voltage at clutch K2. The measured resistance value of valve is out of limit, voltage at K2 valve is too high. • Cable / connector is defective and has contact to battery voltage. • Cable / connector is defective and has contact to another regulator output of TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
75	S.C. to ground at clutch K2. The measured resistance value of valve is out of limit, voltage at K2 valve is too low. • Cable / connector is defective and has contact to vehicle ground. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
76	O.C. at clutch K2. The measured resistance value of valve is out of limit. • Cable / connector is defective and has no contact to TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
77	S.C. to battery voltage at clutch K3. The measured resistance value of valve is out of limit, voltage at K3 valve is too high. • Cable / connector is defective and has contact to battery voltage. • Cable / connector is defective and has contact to another regulator output of TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
78	S.C. to ground at clutch K3. The measured resistance value of valve is out of limit, voltage at K3 valve is too low. • Cable / connector is defective and has contact to vehicle ground. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
79	O.C. at clutch K3. The measured resistance value of valve is out of limit. • Cable / connector is defective and has no contact to TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
7D	S.C. to ground at engine derating device. • Cable is defective and is contacted to vehicle ground. • Engine derating device has an internal defect. • Connector pin is contacted to vehicle ground.	Engine derating will be on until TCU power down even if fault vanishes (loose connection). OP-Mode: normal.	Check cable from TCU to engine derating device. Check connectors from engine derating device to TCU. Check resistance ¹⁾ of engine derating device.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34. (Only Mega 500-V)
7E	S.C. to battery voltage at engine derating device. • Cable / connector is defective and is contacted to battery voltage. • Engine derating device has an internal defect.	No reaction. OP-Mode: normal.	Check cable from TCU to engine derating device. Check connectors from backup alarm device to TCU. Check resistance ¹⁾ of backup alarm device.	Only Mega 500-V
7F	O.C. at engine derating device. TCU detected a wrong voltage at output pin, that looks like a O.C. for this output pin. • Cable is defective and has no connection to TCU. • Engine derating device has an internal defect. • Connector has no connection to TCU.	No reaction. OP-Mode: normal.	Check cable from TCU to engine derating device. Check connectors from engine derating device to TCU. Check resistance ¹⁾ of engine derating device.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34. (Only Mega 500-V)
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
81	S.C. to battery voltage at clutch K4. The measured resistance value of valve is out of limit, voltage at K4 valve is too high. • Cable / connector is defective and has contact to battery voltage. • Cable / connector is defective and has contact to another regulator output of TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
82	S.C. to ground at clutch K4. The measured resistance value of valve is out of limit, voltage at K4 valve is too low. • Cable / connector is defective and has contact to vehicle ground. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
83	O.C. at clutch K4. The measured resistance value of valve is out of limit. • Cable / connector is defective and has no contact to TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
84	S.C. to battery voltage at clutch KV. The measured resistance value of valve is out of limit, voltage at KV valve is too high. • Cable / connector is defective and has contact to battery voltage. • Cable / connector is defective and has contact to another regulator output of TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
85	S.C. to ground at clutch KV. The measured resistance value of valve is out of limit, voltage at KV valve is too low. • Cable / connector is defective and has contact to vehicle ground. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
86	O.C. at clutch KV. The measured resistance value of valve is out of limit. • Cable / connector is defective and has no contact to TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
87	S.C. to battery voltage at clutch KR. The measured resistance value of valve is out of limit, voltage at KR valve is too high. • Cable / connector is defective and has contact to battery voltage. • Cable / connector is defective and has contact to another regulator output of TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
88	S.C. to ground at clutch KR. The measured resistance value of valve is out of limit, voltage at KR valve is too low. • Cable / connector is defective and has contact to vehicle ground. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
89	O.C. at clutch KR. The measured resistance value of valve is out of limit. • Cable / connector is defective and has no contact to TCU. • Regulator has an internal defect.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check cable from TCU to gearbox. Check connectors from gearbox to TCU. Check regulator resistance. ¹⁾ Check internal wire harness of gearbox.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
91 **	S.C. to ground at relay reverse warning alarm. TCU detected a wrong voltage at output pin, that looks like a S.C. to vehicle ground. • Cable is defective and is contacted to vehicle ground. • Backup alarm device has an internal defect. • Connector pin is contacted to vehicle ground.	Backup alarm will be on until TCU power down even if fault vanishes (loose connection). OP-Mode: normal.	Check cable from TCU to backup alarm device. Check connectors from backup alarm device to TCU. Check resistance ¹⁾ of backup alarm device.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
92 **	S.C. to battery voltage at relay reverse warning alarm. TCU detected a wrong voltage at output pin, that looks like a S.C. to battery voltage. • Cable is defective and is contacted to battery voltage. • Backup alarm device has an internal defect. • Connector pin is contacted to battery voltage.	No reaction. OP-Mode: normal.	Check cable from TCU to backup alarm device. Check connectors from backup alarm device to TCU. Check resistance ¹⁾ of backup alarm device.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
93 **	O.C. at relay reverse warning alarm. TCU detected a wrong voltage at output pin, that looks like a O.C. for this output pin. • Cable is defective and has no connection to TCU. • Backup alarm device has an internal defect. • Connector has no connection to TCU.	No reaction. OP-Mode: normal.	Check cable from TCU to backup alarm device. Check connectors from backup alarm device to TCU. Check resistance ¹⁾ of backup alarm device.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
94 **	S.C. to ground at relay starter interlock. TCU detected a wrong voltage at output pin, that looks like a S.C. to vehicle ground. • Cable is defective and is contacted to vehicle ground. • Starter interlock relay has an internal defect. • Connector pin is contacted to vehicle ground.	No reaction. OP-Mode: normal.	Check cable from TCU to starter interlock relay. Check connectors from starter interlock relay to TCU. Check resistance ¹⁾ of starter interlock relay.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
95 *	O.C. at LIS1 solenoid valve. The measured resistance value of the valve is out of limit. • Cable/connector is defective and has no contact to TCU. • Valve has an internal defect.	No reaction. OP-Mode: normal.	Check the cable from TCU to the valve. Check the connectors from valve to TCU. Check the valve resistance.	If fault code 95 and 98 are both being displayed for about one second each, see combined fault code.
95 **	S.C. to battery voltage at relay starter interlock. TCU detected a wrong voltage at output pin, that looks like a S.C. to battery voltage. • Cable is defective and is contacted to battery voltage. • Starter interlock relay has an internal defect. • Connector pin is contacted to battery voltage.	No reaction. OP-Mode: normal.	Check cable from TCU to starter interlock relay. Check connectors from starter interlock relay to TCU. Check resistance ¹⁾ of starter interlock relay.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
95 * 98 * Each fault code shown for about one second.	S.C. battery voltage or ground at LIS1 solenoid valve or LIS2 solenoid valve. • Cable is defective and is contacted to vehicle ground or vehicle ground. • Cable has no connection to TCU. • Valve has an internal defect. • Connector pin is contacted to battery voltage or is broken. • Connector pin is contacted to vehicle ground.	No reaction. OP-Mode: normal.	Check the cable from TCU to the valve. Check the connector. Check the valve.	-----
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
96 **	O.C. at relay starter interlock. TCU detected a wrong voltage at output pin, that looks like a O.C. for this output pin. • Cable is defective and has no connection to TCU. • Starter interlock relay has an internal defect. • Connector has no connection to TCU.	No reaction. OP-Mode: normal.	Check cable from TCU to starter interlock relay. Check connectors from starter interlock relay to TCU. Check resistance ¹⁾ of starter interlock relay.	¹⁾ See "measurement of Resistance at Actuator/sensors and Cable" on page 1-34.
98 *	O.C. at LIS2 solenoid valve. The measured resistance value of the valve is out of limit. • Cable/connector resistance and has no contact to TCU. • Valve has an internal defect.	No reaction. OP-Mode: normal.	Check the cable from TCU to the valve. Check the connectors from valve to TCU. Check the valve resistance.	If fault code 95 and 98 are both being displayed for about one second each, see combined fault code.
B1	Slippage at clutch K1. TCU calculates a differential speed at closed clutch K1. If this calculated value is out of range, TCU interprets this as slipping clutch. • Low pressure at clutch K1. • Low main pressure. • Wrong signal at internal speed sensor. • Wrong signal at output speed sensor. • Sensor gap is incorrect. • Clutch is defective.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check pressure at clutch K1. Check main pressure in system. Check sensor gap at internal speed sensor. Check sensor gap at output speed sensor. Check signal at internal speed sensor. Check signal at output speed sensor. Replace clutch.	-----
B2	Slippage at clutch K2. TCU calculates a differential speed at closed clutch K2. If this calculated value is out of range, TCU interprets this as slipping clutch. • Low pressure at clutch K2. • Low main pressure. • Wrong signal at internal speed sensor. • Wrong signal at output speed sensor. • Sensor gap is incorrect. • Clutch is defective.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check pressure at clutch K2. Check main pressure in system. Check sensor gap at internal speed sensor. Check sensor gap at output speed sensor. Check signal at internal speed sensor. Check signal at output speed sensor. Replace clutch.	-----
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
B3	Slippage at clutch K3. TCU calculates a differential speed at closed clutch K3. If this calculated value is out of range, TCU interprets this as slipping clutch. • Low pressure at clutch K3. • Low main pressure. • Wrong signal at internal speed sensor. • Wrong signal at output speed sensor. • Sensor gap is incorrect. • Clutch is defective.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check pressure at clutch K3. Check main pressure in system. Check sensor gap at internal speed sensor. Check sensor gap at output speed sensor. Check signal at internal speed sensor. Check signal at output speed sensor. Replace clutch.	-----
B4	Slippage at clutch K4. TCU calculates a differential speed at closed clutch K4. If this calculated value is out of range, TCU interprets this as slipping clutch. • Low pressure at clutch K4. • Low main pressure. • Wrong signal at internal speed sensor. • Wrong signal at turbine speed sensor. • Sensor gap is incorrect. • Clutch is defective.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check pressure at clutch K4. Check main pressure in system. Check sensor gap at internal speed sensor. Check sensor gap at turbine speed sensor. Check signal at internal speed sensor. Check signal at turbine speed sensor. Replace clutch.	-----
B5	Slippage at clutch KV. TCU calculates a differential speed at closed clutch KV. If this calculated value is out of range, TCU interprets this as slipping clutch. • Low pressure at clutch KV. • Low main pressure. • Wrong signal at internal speed sensor. • Wrong signal at turbine speed sensor. • Sensor gap is incorrect. • Clutch is defective.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check pressure at clutch KV. Check main pressure in system. Check sensor gap at internal speed sensor. Check sensor gap at turbine speed sensor. Check signal at internal speed sensor. Check signal at turbine speed sensor. Replace clutch.	-----
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
B6	Slippage at clutch KR. TCU calculates a differential speed at closed clutch KR. If this calculated value is out of range, TCU interprets this as slipping clutch. • Low pressure at clutch KR. • Low main pressure. • Wrong signal at internal speed sensor. • Wrong signal at turbine speed sensor. • Sensor gap is incorrect. • Clutch is defective.	TCU shifts to neutral. OP-Mode: limp home. If failure at another clutch is pending. TCU shifts to neutral. OP-Mode: TCU shut down.	Check pressure at clutch KR. Check main pressure in system. Check sensor gap at internal speed sensor. Check sensor gap at turbine speed sensor. Check signal at internal speed sensor. Check signal at turbine speed sensor. Replace clutch.	-----
B7	Overtemp sump. TCU measured a temperature in oil sump that is over allowed threshold.	No reaction. OP-Mode: normal.	Cool down machine. Check oil level. Check temperature sensor.	-----
D1	S.C. to battery voltage at power supply for sensors. TCU measures more than 6V at the pin AU1 (5V sensor supply).	See fault codes No. 21 - 2C.	Check cables and connectors to sensors, which are supplied from AU1. Check the power supply at the pin AU1 (should be approximately 5V).	Fault codes No. 21 to No. 2C may be a reaction of this fault.
D2	S.C. to ground at power supply for sensors. TCU measures less than 4V at the pin AU1 (5V sensor supply).	See fault codes No. 21 - 2C.	Check cables and connectors to sensors, which are supplied from AU1. Check the power supply at the pin AU1 (should be approximately 5V).	Fault codes No. 21 to No. 2C may be a reaction of this fault.
D3	Low power at battery. Measured voltage at power supply is lower than 18 V.	Shift to neutral. OP-Mode: TCU shut down.	Check power supply battery. Check cables from batteries to TCU. Check connectors from batteries to TCU.	-----
D4	High power at battery. Measured voltage at power supply is higher than 32 V.	Shift to neutral. OP-Mode: TCU shut down.	Check power supply battery. Check cables from batteries to TCU. Check connectors from batteries to TCU.	-----
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
D5	Error at switch 1 for valve power supply VPS1. TCU switched on VPS1 and measured VPS1 is off or TCU switched off VPS1 and measured VPS1 is still on. • Cable or connectors are defect and are contacted to battery voltage. • Cable or connectors are defect and are contacted to vehicle ground. • Permanent power supply KL30 missing. • TCU has an internal defect.	Shift to neutral. OP-Mode: TCU shut down.	Check fuse. Check cables from gearbox to TCU. Check connectors from gearbox to TCU. Replace TCU.	-----
D6	Error at switch 2 for valve power supply VPS2. TCU switched on VPS2 and measured VPS2 is off or TCU switched off VPS2 and measured VPS2 is still on. • Cable or connectors are defect and are contacted to battery voltage. • Cable or connectors are defect and are contacted to vehicle ground. • Permanent power supply KL30 missing. • TCU has an internal defect.	Shift to neutral. OP-Mode: TCU shut down.	Check fuse. Check cables from gearbox to TCU. Check connectors from gearbox to TCU. Replace TCU.	-----
E3	S.C. to battery voltage at display output. TCU sends data to the display and measures always a high voltage level on the connector. • Cable or connectors are defective and are contacted to battery voltage. • Display has an internal defect.	No reaction. OP-Mode: normal.	Check the cable from TCU to the display. Check the connectors at the display. Change display.	-----
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

Fault Code (hex)	Meaning of the Fault Code (Possible reason for fault detection.)	Reaction of the TCU	Possible Steps to Repair	Remarks
E4	S.C. to ground at display output. TCU sends data to the display and measures always a high voltage level on the connector. • Cable or connectors are defective and are contacted to vehicle ground. • Display has an internal defect.	No reaction. OP-Mode: normal.	Check the cable from TCU to the display. Check the connectors at the display. Change display.	-----
F1	General EEPROM fault. TCU cannot read nonvolatile memory. • TCU is defective.	Transmission stay neutral. OP-Mode: TCU shut down.	Replace TCU.	Often shown together with fault code F2.
F2	Configuration lost. TCU has lost the correct configuration and can't control the transmission. • Interference during saving data on nonvolatile memory. • TCU is brand new or from another vehicle.	Transmission stay neutral. OP-Mode: TCU shut down.	Reprogram the correct configuration for the vehicle (e.g. with cluster controller,...).	-----
F3	Application error. Something of this application is wrong.	Transmission stay neutral. OP-Mode: TCU shut down.	Replace TCU!	This fault occurs only if an test engineer did something wrong in the application of the vehicle.
F5 **	Clutch failure. AFP was not able to adjust clutch filling parameters. • One of the AFP-Values is out of limit.	Transmission stay neutral. OP-Mode: TCU shut down.	Check clutch.	TCU shows also the affected clutch on the Display.
F6 **	Clutch Adjustment Data lost. TCU was not able to read correct clutch adjustment parameters. • Interference during saving data on nonvolatile memory. • TCU is brand new.	No reaction, Default values = 0 for AFP offsets used. OP-Mode: normal.	Execute AFP.	-----
* Only Mega 400-III PLUS ** Only Series "V" Gray shaded boxes are error codes for other applications. They are only given for general reference purposes.				

TABLE OF FAULT CODES - ERGO-CONTROL

Error Code Number	Meaning of Error Code	Remarks
11	Logical error at gear range signal.	
12	Logical error at direction select signal.	
21	Short circuit to battery voltage at clutch cutoff input.	
22	Short circuit to ground or open circuit at clutch cutoff input.	
23	Short circuit to battery voltage at load sensor input.	Not used.
24	Short circuit to ground or open circuit at load sensor input.	Not used.
25	Short circuit to battery voltage or open circuit at temperature sensor input.	
26	Short circuit to ground at temperature sensor input.	
31	Short circuit to battery voltage at engine speed input.	
32	Short circuit to ground or open circuit at engine speed input.	
33	Logical error at engine speed input.	
34	Short circuit to battery voltage at turbine speed input.	
35	Short circuit to ground or open circuit at turbine speed input.	
36	Logical error at turbine speed input.	
37	Short circuit to battery voltage at internal speed input.	
38	Short circuit to ground or open circuit at internal speed input.	
39	Logical error at internal speed input.	
3A	Short circuit to battery voltage at output speed input.	
3B	Short circuit to ground or open circuit at output speed input.	
3C	Logical error at output speed input.	
71	Short circuit to battery voltage at clutch K1.	
72	Short circuit to ground at clutch K1.	
73	Open circuit at clutch K1.	
74	Short circuit to battery voltage at clutch K2.	
75	Short circuit to ground at clutch K2.	
76	Open circuit at clutch K2.	

Error Code Number	Meaning of Error Code	Remarks
77	Short circuit to battery voltage at clutch K3.	
78	Short circuit to ground at clutch K3.	
79	Open circuit at clutch K3.	
7A	Short circuit to battery voltage at converter clutch.	Not used.
7B	Short circuit to ground at converter clutch.	Not used.
7C	Open circuit at converter clutch.	Not used
81	Short circuit battery voltage at clutch K4.	
82	Short circuit to ground at clutch K4.	
83	Open circuit at clutch K4.	
84	Short circuit to battery voltage at clutch KV.	
85	Short circuit to ground at clutch KV.	
86	Open circuit at clutch KV.	
87	Short circuit to battery voltage at clutch KR.	
88	Short circuit to ground at clutch KR.	
89	Open circuit at clutch KR.	
91	Short circuit battery voltage at relay reverse warning alarm.	
92	Short circuit to ground at relay reverse warning alarm.	
93	Open circuit at relay reverse warning alarm.	
94	Short circuit to battery voltage at relay starter interlock.	
95	Short circuit to ground at relay starter interlock.	
96	Open circuit at relay starter interlock.	
97	Short circuit to battery voltage at park brake solenoid.	
98	Short circuit ground at park brake solenoid.	
99	Open circuit at park brake solenoid.	
B1	Slippage at clutch K1.	
B2	Slippage at clutch K2.	
B3	Slippage at clutch K3.	
B4	Slippage at clutch K4.	
B5	Slippage at clutch KV.	

Error Code Number	Meaning of Error Code	Remarks
B6	Slippage at clutch KR.	
D1	Short circuit to battery voltage at power supply for sensors.	
D2	Short circuit to ground at power supply for sensors.	
D3	Low power at battery.	
D4	High power at battery.	
D5	Error at switch 1 for valve power supply.	
D6	Error at switch 2 for valve power supply.	
E1	Short circuit to battery at speedometer output.	Not used.
E2	Short circuit to ground or open circuit at speedometer output.	Not used.
E3	Short circuit to battery voltage at display output.	Not used.
E4	Short circuit to ground or open circuit at display output.	Not used.
E5	Error at communication on CAN.	
F1	General EEPROM fault.	
F2	Configuration lost.	
F3	Application error.	

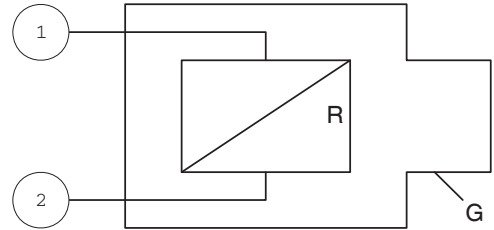
MEASUREMENT OF RESISTANCE AT ACTUATOR/ SENSORS AND CABLE

Actuator

Open circuit: $R_{12} \approx R_{1G} \approx R_{2G} \approx \infty$

Short cut to ground: $R_{12} \approx R$; $R_{1G} \approx 0$, $R_{2G} \approx R$ or $R_{1G} \approx R$, $R_{2G} \approx 0$ (for S.C. to ground, G is connected to vehicle ground)

Short cut to battery: $R_{12} \approx R$; $R_{1G} \approx 0$, $R_{2G} \approx R$ or $R_{1G} \approx R$, $R_{2G} \approx 0$ (for S.C. to battery, G is connected to battery voltage).



HBOE640I

Figure 2

Cable

open circuit:

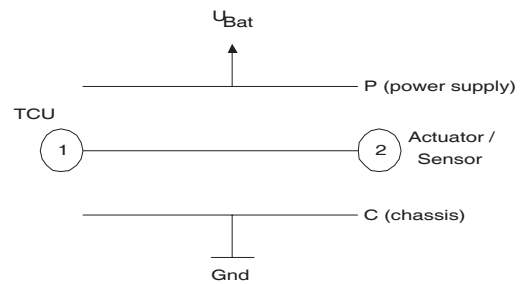
$R_{12} \approx R_{1P} \approx R_{1C} \approx R_{2P} \approx R_{2C} \approx \infty$

short cut to ground:

$R_{12} \approx 0$; $R_{1C} \approx R_{2C} \approx 0$, $R_{1P} \approx R_{2P} \approx \infty$

short cut to battery:

$R_{12} \approx 0$, $R_{1C} \approx R_{2C} \approx \infty$, $R_{1P} \approx R_{2P} \approx 0$



HBOE650I

Figure 3

Axle

Edition 1

MEMO

Table of Contents

Axle

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

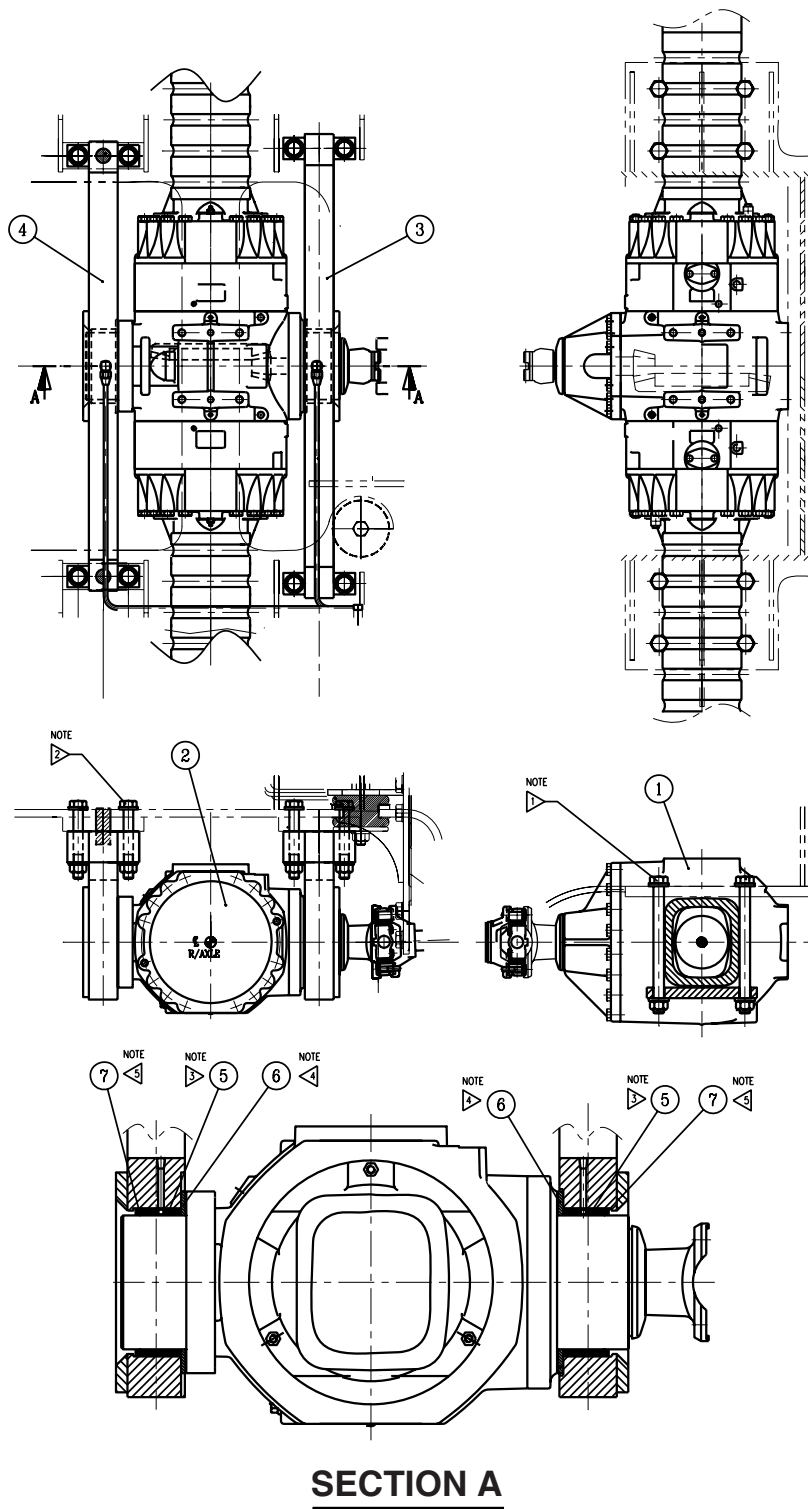
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

Outline

			Front Axle
Type			Frame-Fixed Semi-Floating
Overall Reduction Ratio			22.8:1 (DANA Axle)
Differential Type	DANA Axle	Standard	L.S.D.Type (with Heavy duty)
		Option	S.T.D Type
Max. Static Load		Front	23,000 kg (50,700 lb)
		Rear	19,000 kg (41,890 lb)
Max. Out Put Torque			6,000 kg•m (43,400 ft lb)
Brake	Type		Multi Wet Disc
	Torque	DANA Axle	1,020 kg•m @ 40 bar each side (7,380 ft lb @ 580 psi)
Parking Brake	Type	DANA Axle	280 kg•m (2,025 ft lb)
	Release Pressure	DANA Axle	52 - 65 Bar (755 - 940 psi)
Drive Flange (Front / Rear)		DANA Axle	6C / 5C



APS0230L

Figure 1 DRIVE AXLE ASSEMBLY

Reference Number	Description
1	Front Axle
2	Rear Axle
3	Axle Support (Front)
4	Axle Support (Rear)

Reference Number	Description
5	Bushing
6	Thrust Washer
7	O-ring

NOTE: 1) 60 kg•m (430 ft lb) Threaded area: Loctite #262.

NOTE: 2) 51 kg•m (370 ft lb)

NOTE: 3) Inner surface: Grease (Assemble with chamfered surface toward axle.)

NOTE: 4) Surface: Grease

NOTE: 5) Surface: Grease

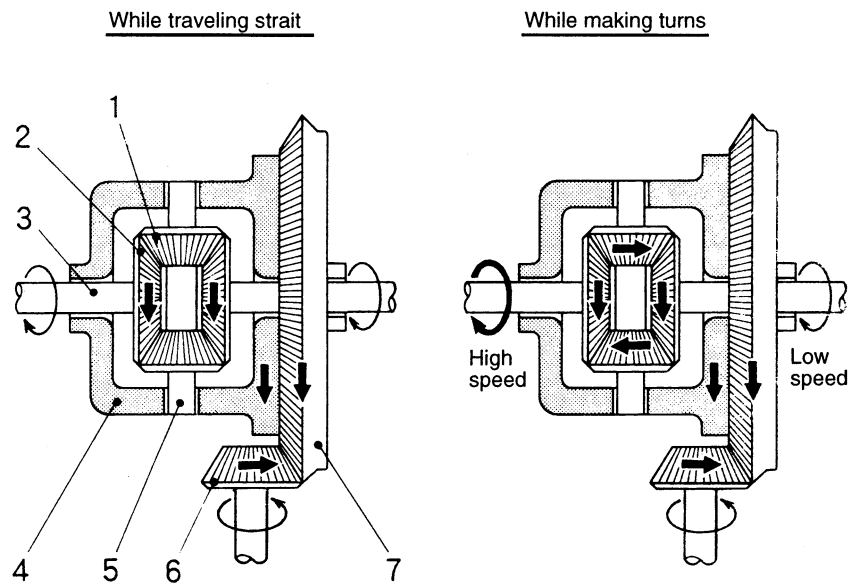
Differential (Standard)

The differential is integral with the reduction gear.

The power from the drive shafts is transmitted through the drive pinion and the ring gear to the differential gear case. It is then sent through the right and left side gears to the final reduction gear assembly. The speed reduction of the power is accomplished by the drive pinion and the ring gear.

Differential Operation

While the loader travels straight, the ring gear, differential gear case, and side gears rotate together, with the pinion gears inside the differential gear case not rotating. The power of the same speed is thus transmitted from the right and left side gears through the axle shafts to the wheels. When the loader makes a turn, the right and left wheels rotate at different speeds; the pinion gears in the differential gear case rotate around their own axes according to the difference in speed between the right and left side gears.



HAAD0840

Figure 2 DIFFERENTIAL GEAR OPERATION

Reference Number	Description
1	Pinion Gear
2	Side Gear
3	Axle Shaft
4	Differential Gear Case

Reference Number	Description
5	Spider
6	Drive Pinion
7	Ring Gear

Self Locking Differential

Structure of self-locking differential is same as conventional differential, it additionally has a multidisc brake among right and left side gears, and differential gear box. It produces a relative motion which creates a brake force with torque condition of both wheels. Finally, brake moment gives a locking effect to wheel with a larger road friction coefficient to increase a torque. Locking ratio of axles is 35%.

TROUBLESHOOTING

Problem	Cause	Remedy
Insufficient braking.	Incorrect adjustment.	Inspect disc thickness, If usable readjust brakes.
	Brake disc worn out.	Inspect disc thickness, and replace if necessary.
	Incorrect brake fluid.	Replace all seals in axle and master cylinder that have made contact with incorrect fluid, and all brake hoses. If incorrect fluid leaked into axle oil, seals and O-rings in axle must be replaced.
	Loss of brake fluid.	Inspect for and repair any leaks in outside brake circuit or master cylinder.
	Overheated axle causing brake fluid to vaporize (brake return when axle cools).	See "Overheating" problem.
Soft brake pedal	Air in brake circuit.	Bleed brake system.
Ineffective safety brake.	Incorrect adjustment.	Inspect disc thickness, If usable readjust brakes.
	Brake disc worn out.	Inspect disc thickness, and replace if necessary.

Problem	Cause	Remedy
Overheating.	Oil level wrong.	Drain, flush, and refill oil to proper level
	Too small of a brake gap.	Readjust brakes.
	Parking brake drags.	Unlock brake and adjust to correct gap.
	Incorrect brake fluid in system.	Replace all seals in axle and master cylinder that have made contact with incorrect fluid, and all brake hoses. If incorrect fluid leaked into axle oil, seals and O-rings in axle must be replaced.
	No free pedal at master cylinder.	Readjust brake pedal.
	Restriction in brake line	Inspect for and replace any damaged lines.
	Restriction in return line of brake Servo system.	Inspect for and replace any damaged lines. Inspect for and remove any filter, tee'd in line, or any other source of back pressure from return line.
	Incorrect lubricant.	Change retaining rings of brake circuit and brake pump.
Diff-lock inoperative.	If manual, loose or not properly adjusted linkage	Inspect and correct linkage and readjust.
	If hydraulic, problems in hydraulic or electrical circuits of the vehicle.	Inspect and correct.
	If hydraulic, problems in actuating cylinder (notable through loss of oil or increase of oil level in axle).	Rebuild cylinder.
	If limited slip differential, worn discs.	Replace discs.
Oil coming out of breather	Leak in internal brake system.	Inspect disc thickness, and replace if necessary. Replace all seals in axle and master cylinder that have made contact with incorrect fluid, and all brake hoses. If incorrect fluid leaked into axle oil, seals and O-rings in axle must be replaced.
	Leak in diff-lock actuating cylinder.	Rebuild cylinder.

Problem	Cause	Remedy
No-spin indexing noise when driving straight.	Unequal tire pressure (left and right).	Inflate tires to recommended pressure.
	Different style, size, or brand of tires between left and right side.	Change tires to same style, size, or brand.
Noise during coast or under power the same.	Damaged wheel bearings.	Replace and adjust.
Noise under power greater than during coast.	Low oil level	Refill oil to proper level.
	Incorrect lubricant.	Change retaining rings of brake circuit and brake pump.
	Ring and pinion worn.	Inspect through rear cover. Replace and adjust.
	Worn ring and pinion bearings.	Inspect through rear cover. Replace and adjust.
	Worn planetary gears or bearings.	Replace.
Noise under coast greater than under power.	Loose pinion nut	Inspect ring, pinion, and pinion bearings. If undamaged, retighten nut.
	Only one pinion bearing damaged.	Replace and adjust.
Noise during turn (Without No-spin).	Worn spider and/or side gears.	Replace.
A "Stick slip" noise when going from forward to reverse.	Worn or damaged cardanshaft.	Inspect and replace.
	Loose wheel.	Inspect for wheel and wheel stud damage. Replace if needed and torque lug nuts.
	Spider pins loose in diff-carrier.	Inspect through rear cover. Replace.
	Damaged or missing spider and/or side gear washers.	Replace.

SPECIAL TOOLS

Special Tool T15

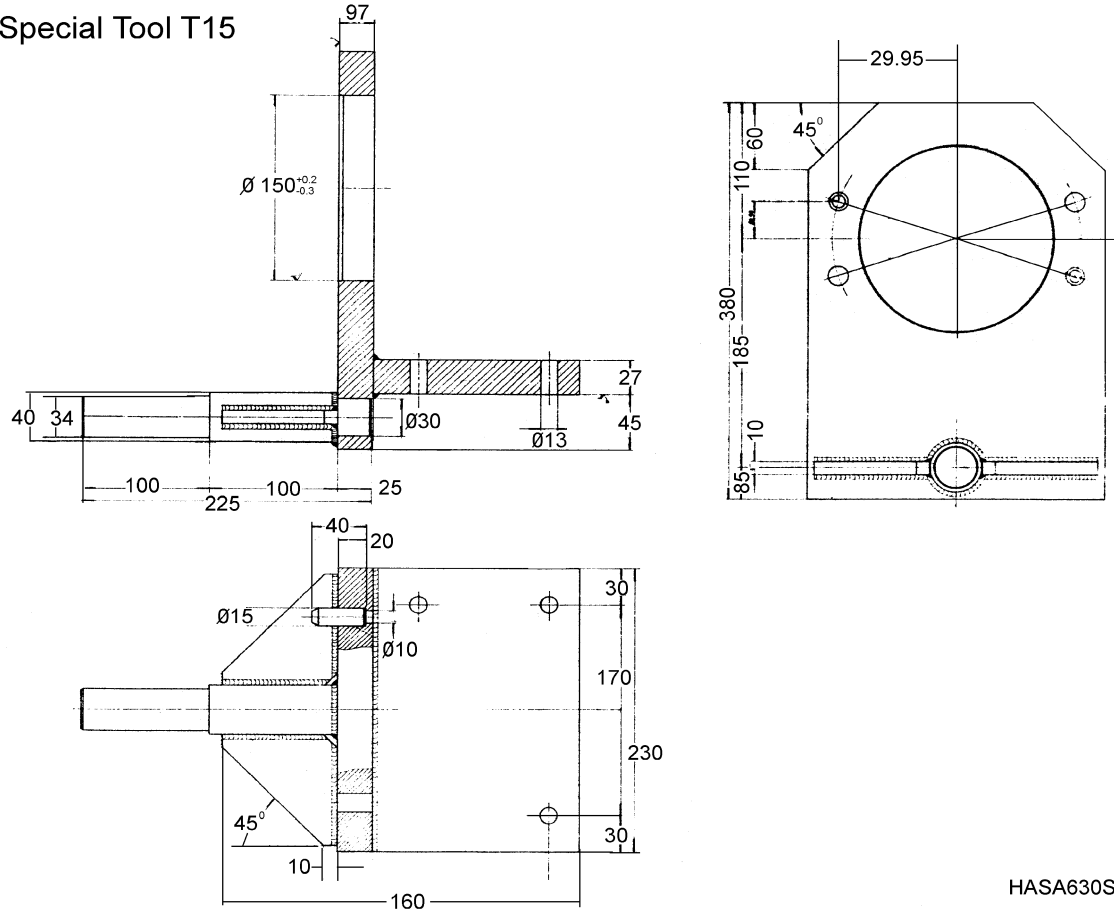
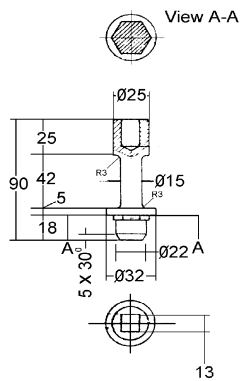
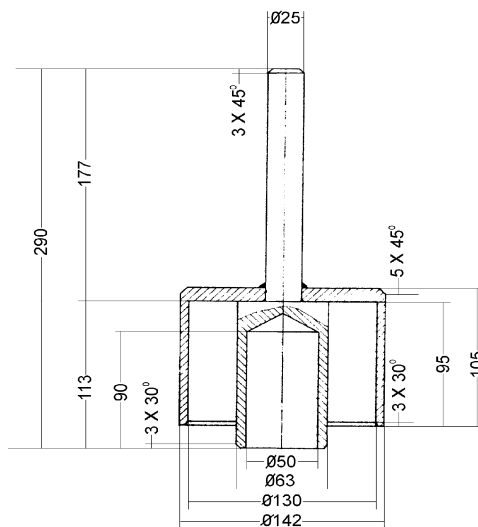


Figure 3 DIFFERENTIAL GEAR OPERATION

Special Tool T18



Special Tool T19



Special Tool T20

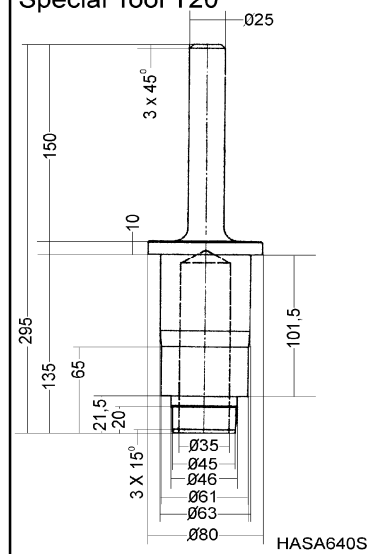
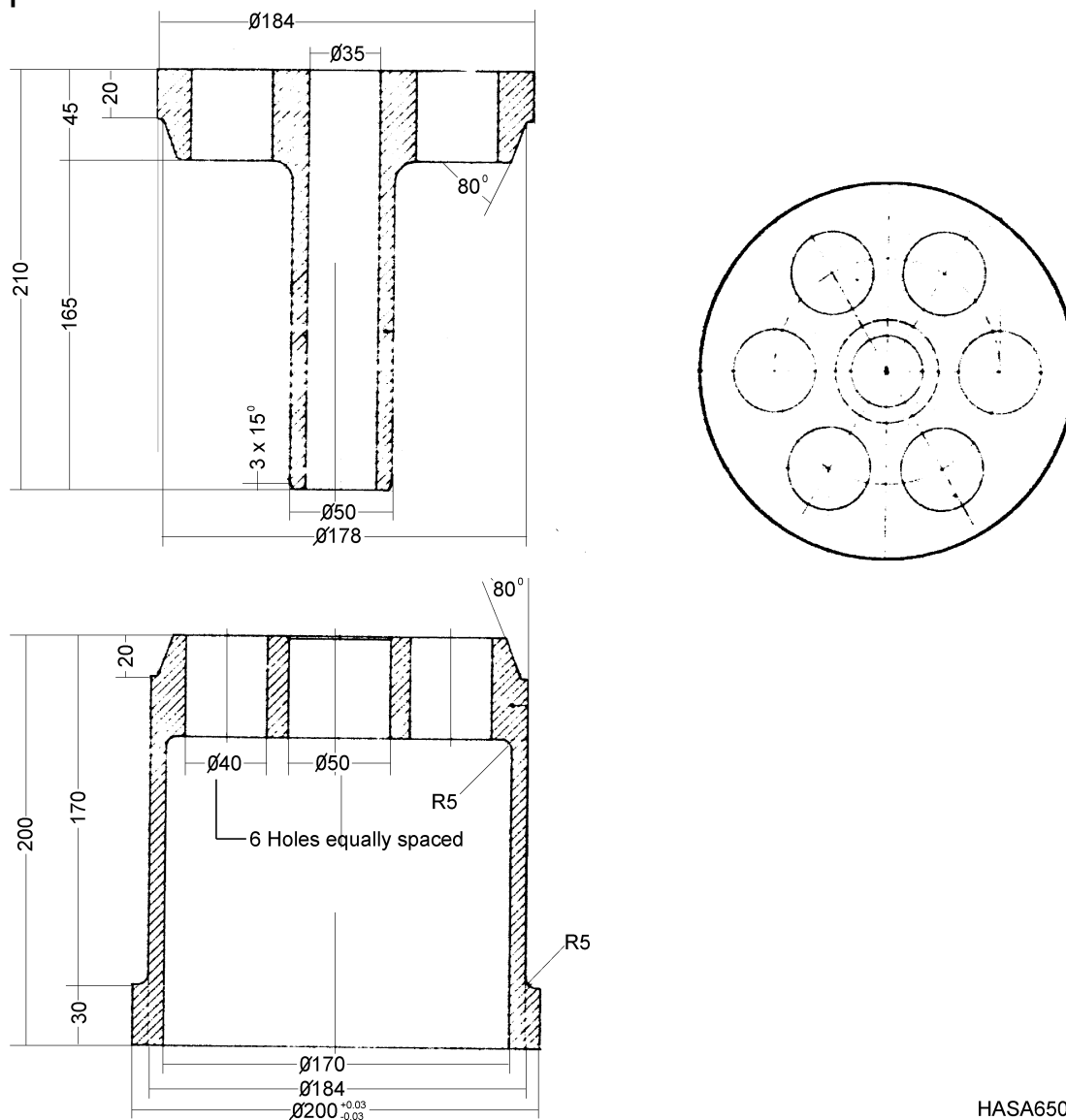


Figure 4

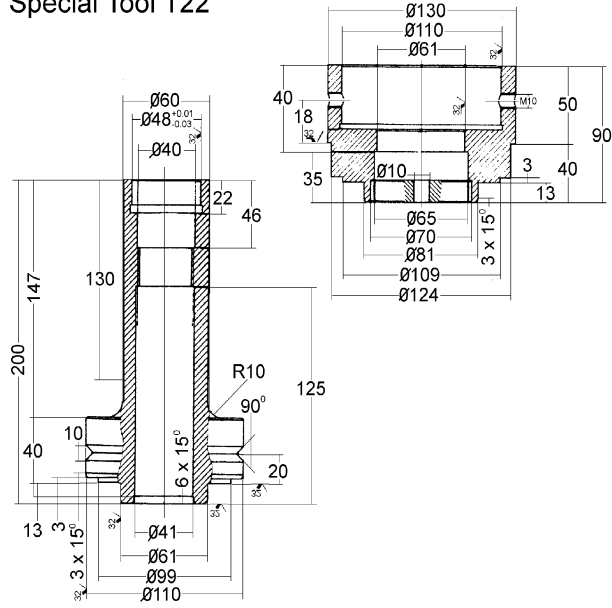
Special Tool T21



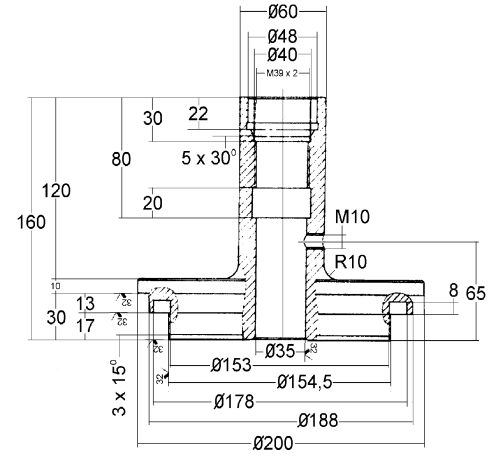
HASA650S

Figure 5 DIFFERENTIAL GEAR OPERATION

Special Tool T22



Special Tool T23



HASA660S

Figure 6

CLARK-HURTH / DANA AXLE IDENTIFICATION

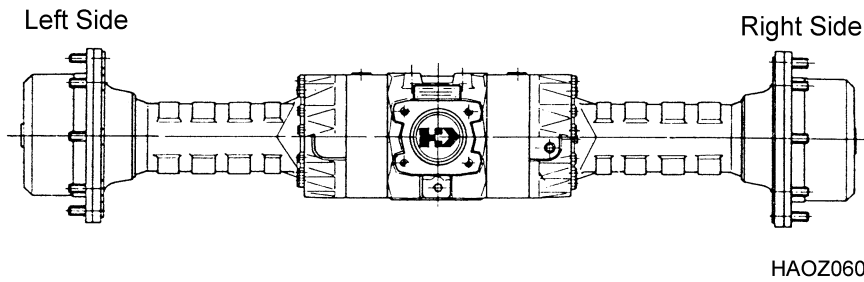


Figure 7

- 1 = Type and Model
- 2 = Serial Number
- 3 = Lubricant

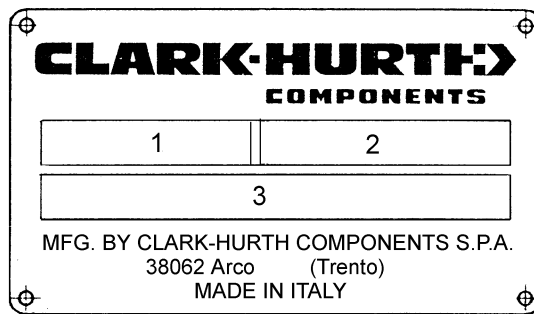


Figure 8

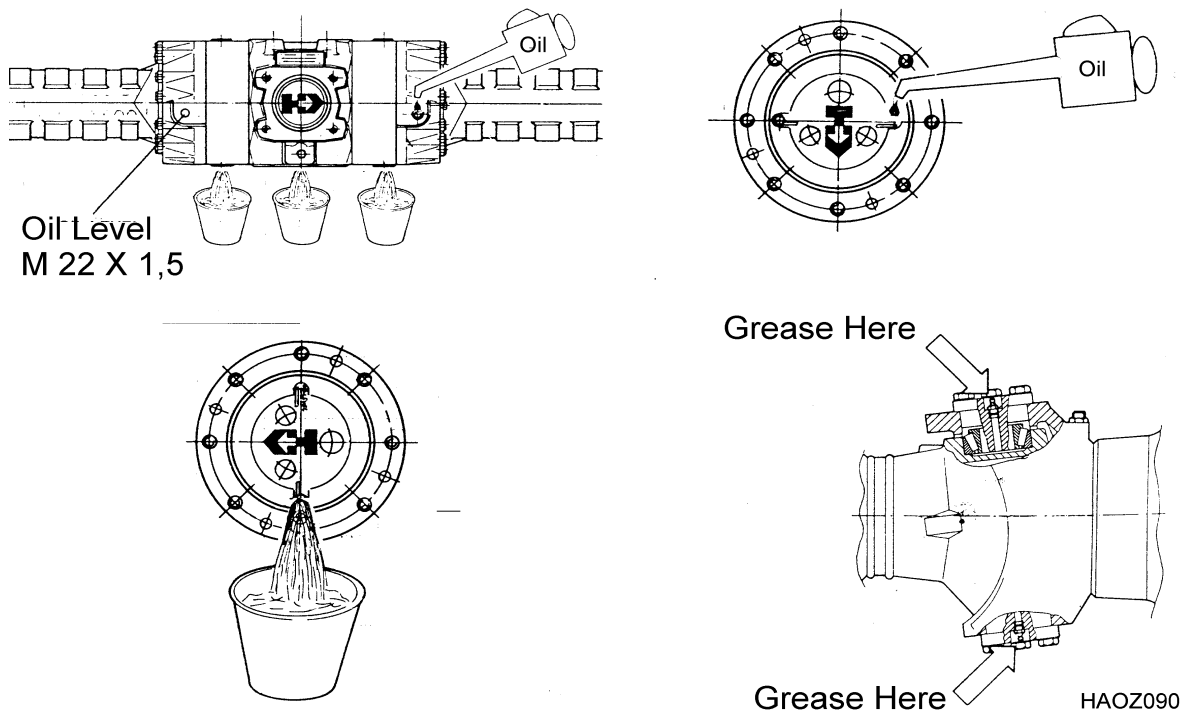


Figure 9

Maintenance and Lubrication

Operation	Period	Lubricant
Check Levels:		SAE 85 W 90 API GL4 - L-2105
Differentials	Monthly	With additives for oil immersed disc brakes.
Planetary Reduction	Every 400 hours	
Oil Change	Brake-In: 250 Hours	SAE 85 W 90 API GL4 - L-2105-B
Differentials	Every 1500 hours	With additives for oil immersed disc brakes
Planetary Reduction	Every 1500 hours	
Greasing:		Grease: Multipurpose lithium base
Under normal use	Monthly	
Under heavy duty use	Weekly	
Screw and bolt retorquing	Every 200 hours	-
Service brake circuit	Only for mineral oil use e.g. ATF Dexron II. Make sure that master cylinder seals are suitable for mineral oil.	

Brake Disc

Wear Check and Replacement

1. Insert feeler gauge into oil level check hole to check thickness of brake discs.

Minimum thickness: S = 4.5 mm (0.18 in).

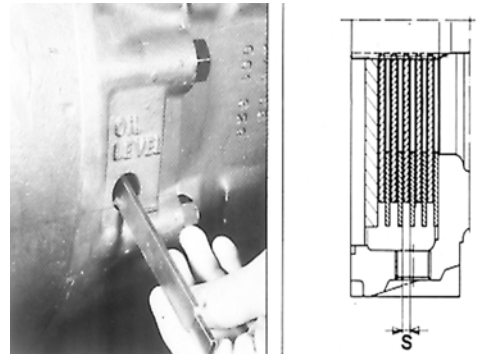


Figure 10

2. Remove mounting nuts and axle housing.

NOTE: Axle housing must be removed horizontally.

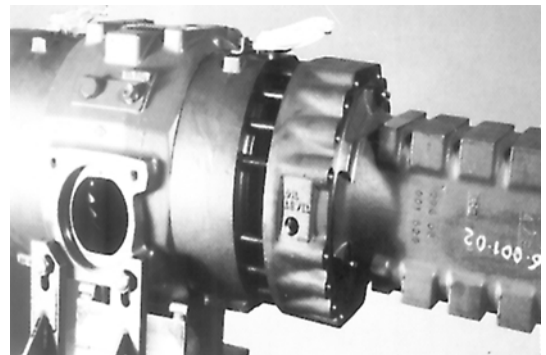


Figure 11

3. Remove brake discs.

NOTE: *If brake discs do not need to be replaced, remove complete pack without changing position of discs.*

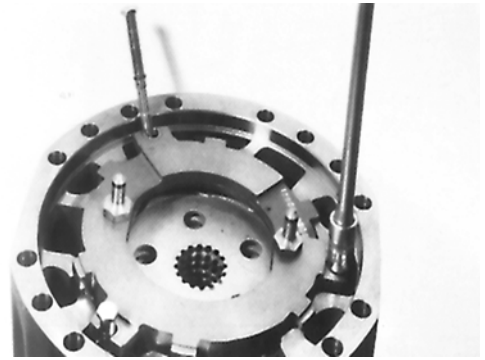


Figure 12

4. Assembly in reverse order of disassembly.

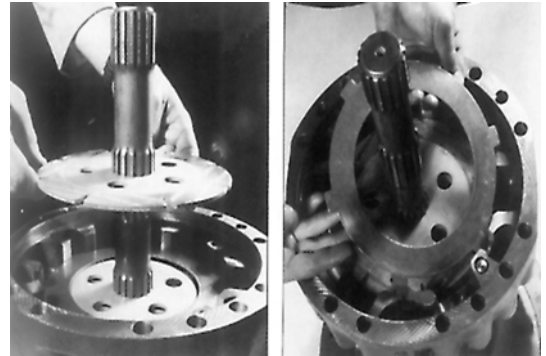


Figure 13

Adjustment of Brake Disc Gap

1. Turn adjusting bolts (1) counterclockwise till it stops, then back off 3/4 revolutions clockwise; this corresponds to a gap of 0.75 mm (0.03 in) between brake discs.

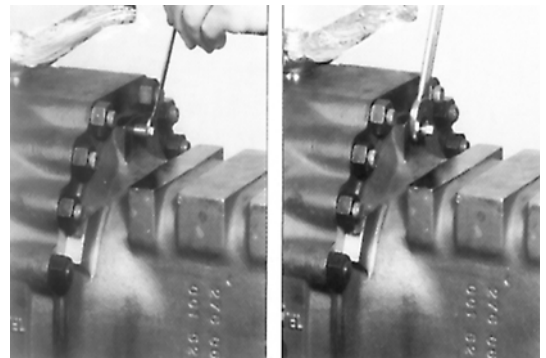


Figure 14

2. Remove brake piston (2).

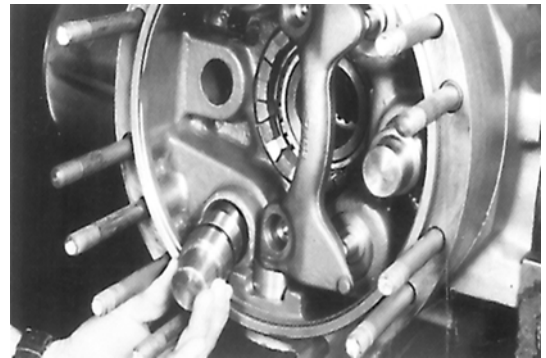


Figure 15

3. Replace O-rings (3) and check piston (2) for wear, scratches, and gouges.

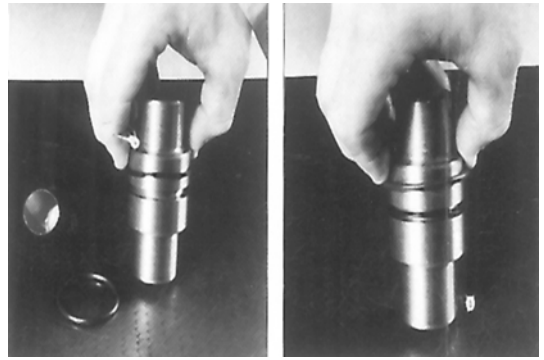


Figure 16

4. Apply pressure with compressed air for 10 minutes each side.

NOTE: Air Pressure at 0.5 ± 1 bar (7 psi).

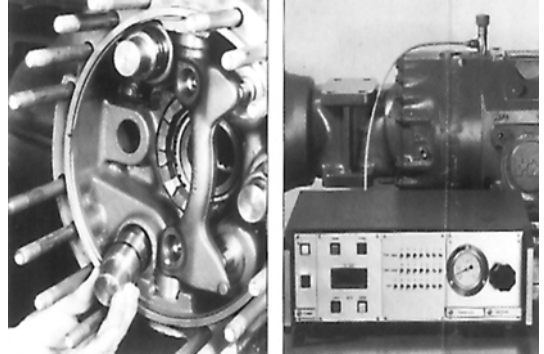


Figure 17

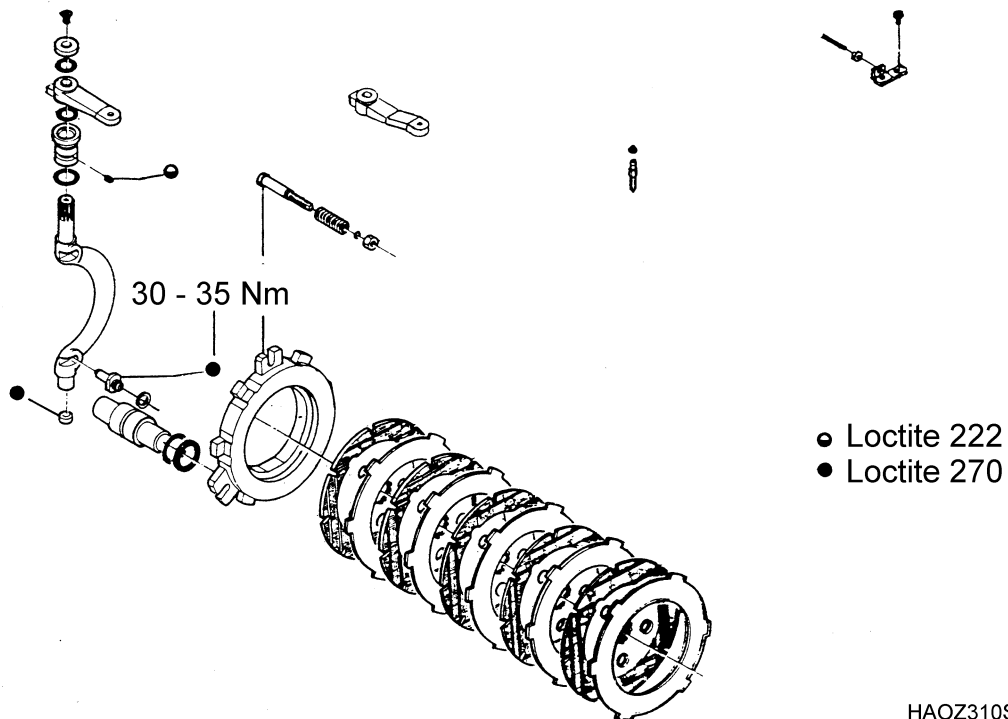


Figure 18

Safety Brake

1. Apply 25 - 35 bar (360 - 510 psi) of pressure to hydraulic circuit, then remove axle housing.

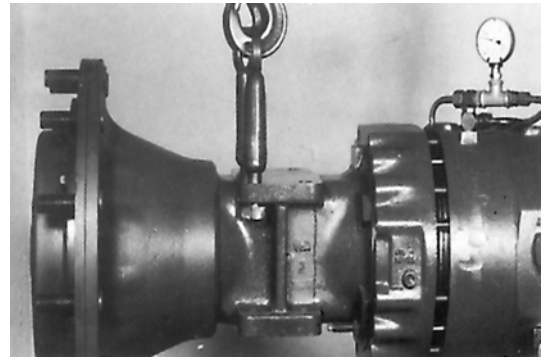


Figure 19

2. Remove four mounting studs and disassemble intermediate covers.

NOTE: Use care not to damage parts when disassembling.

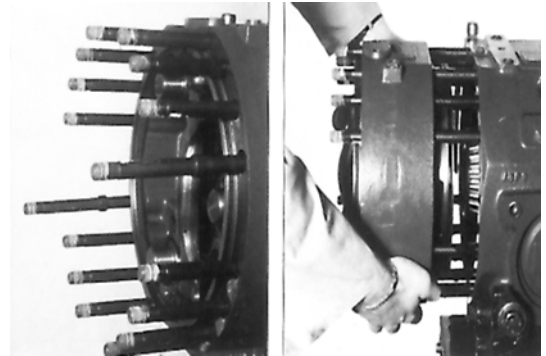


Figure 20

3. Unlock and remove spring applied safety brake pistons. Check pistons and replace if necessary.

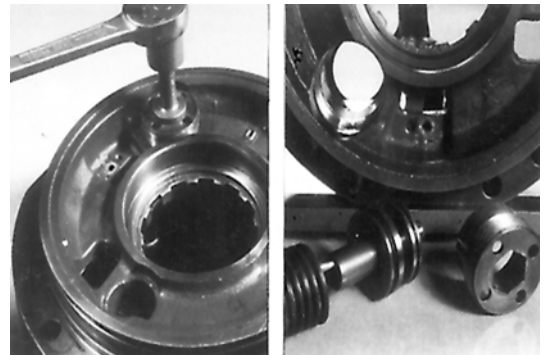


Figure 21

4. Assembly cover in reverse order of disassembly. Special tool T18 is required (refer to "Special Tools" in back of this section). Check torque of cover (refer to standard torque charts in "General Maintenance Procedures" section).

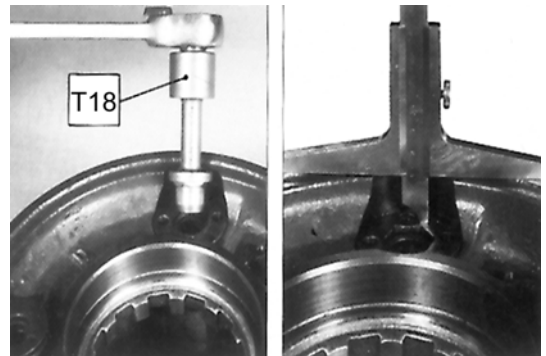


Figure 22

5. Lock safety brake piston into position.

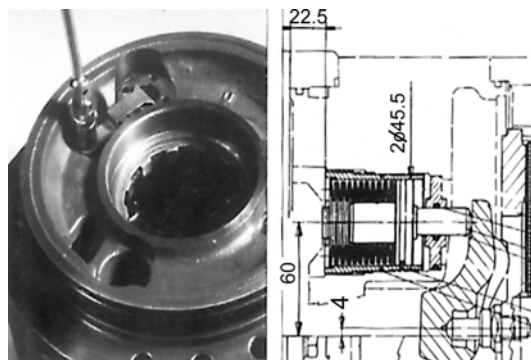


Figure 23

6. Remove brake discs, and check for wear or damage, replace if required.

NOTE: Pay attention to direction for reassembly.

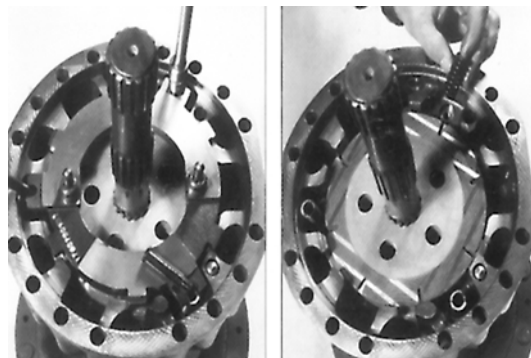


Figure 24

7. Align lubrication holes of brake discs at reassembly.

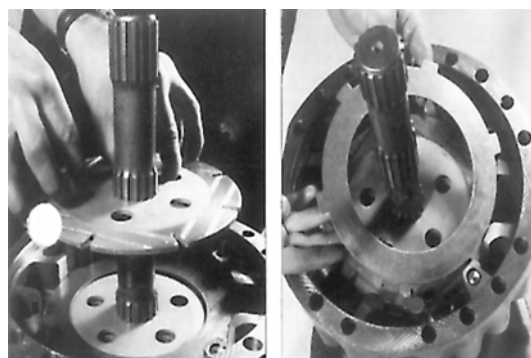


Figure 25

8. Remove pinion and ring gear.

NOTE: Pay attention of direction for reassembly.

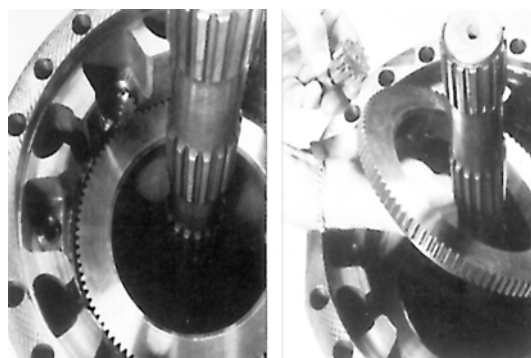


Figure 26

9. Remove internal lever.

NOTE: Pay attention of direction for reassembly.

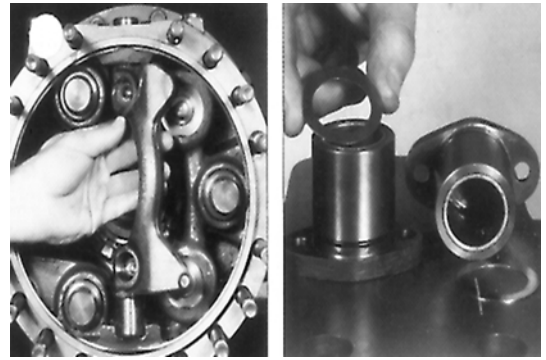


Figure 27

10. Assemble axle and apply 25 - 35 bar (360 - 510 psi) of pressure into hydraulic circuit.

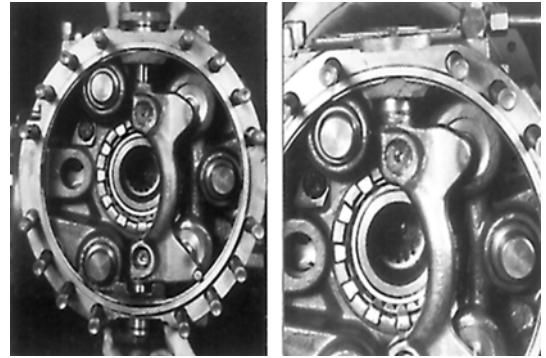


Figure 28

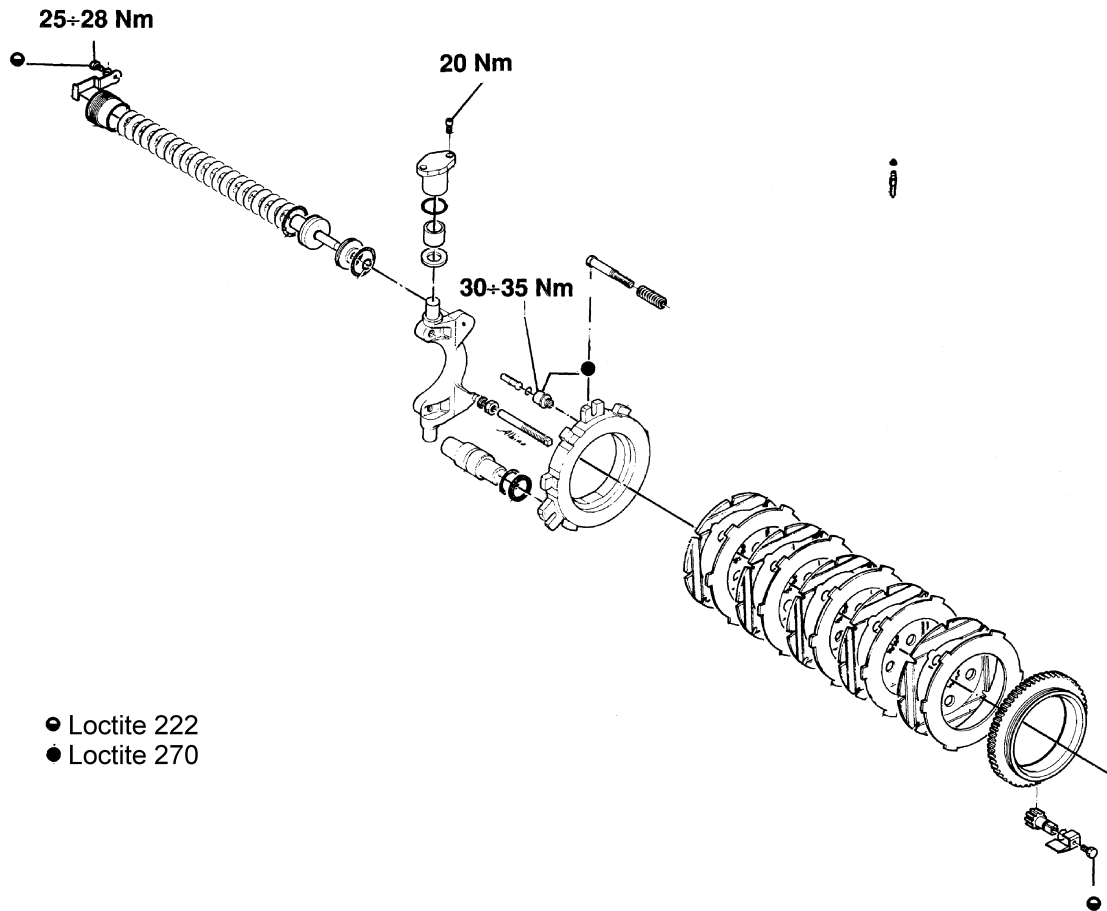


Figure 29

Adjustment of Safety Brake

1. Apply 25 - 35 bar (360 - 510 psi) of pressure in hydraulic circuit, then remove bolt and locking plate.

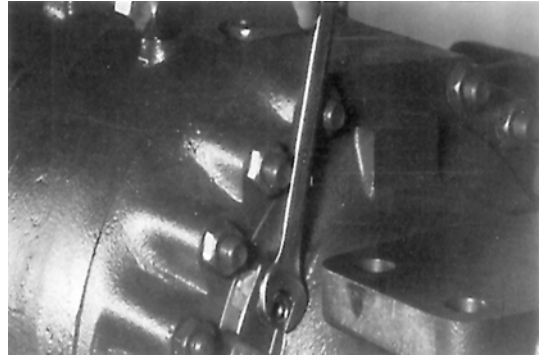


Figure 30

2. Turn the pinion with 8 N•m (6 ft lb) torque counterclockwise till it stops. Adjust gap between brake discs by turning three complete revolutions clockwise.

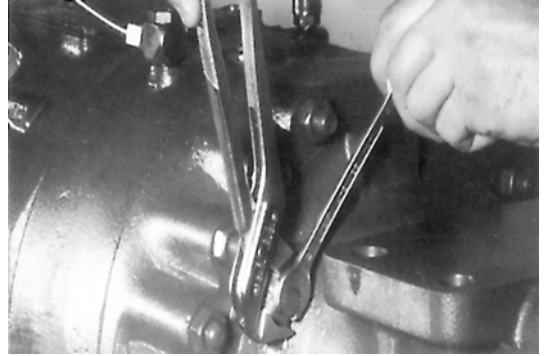


Figure 31

3. Set adjusting studs to unlock safety brake at 47 mm (1.85 in), and lock counter nut

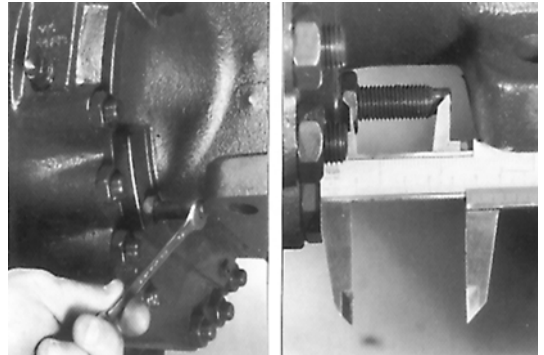


Figure 32

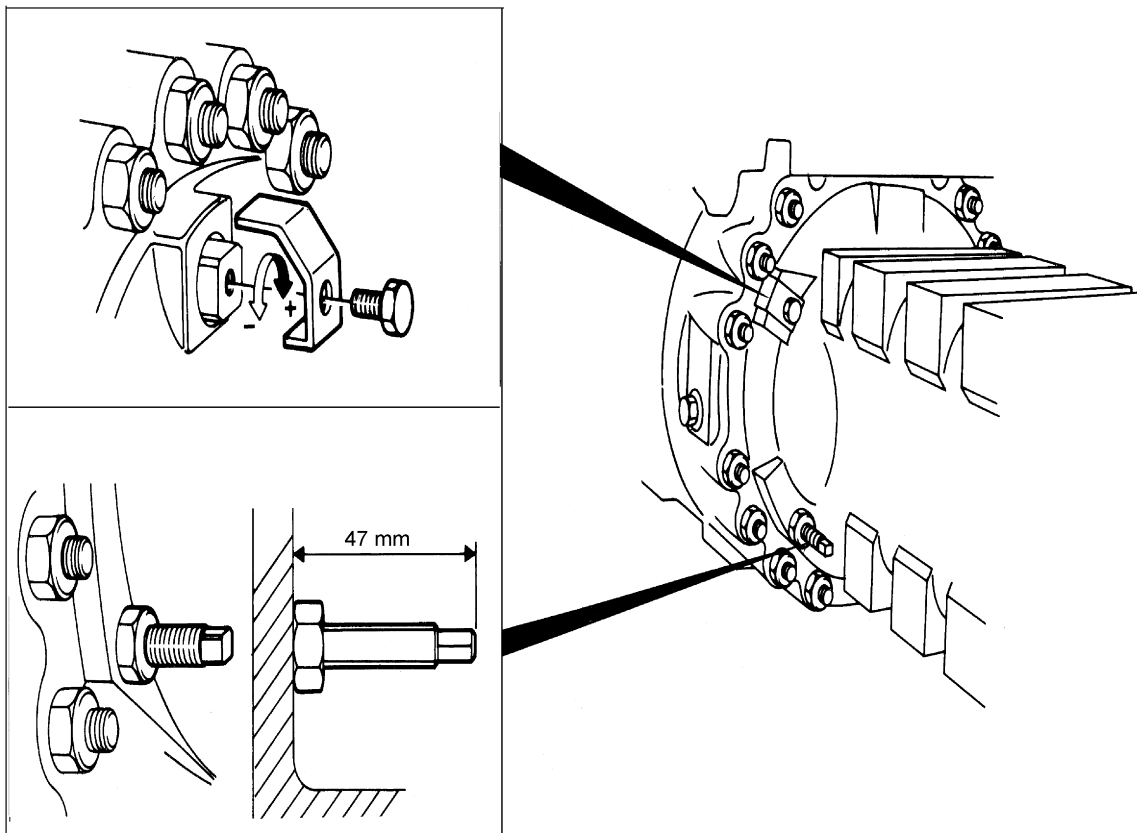


Figure 33

Wheel Hub

1. Remove planetary gear cover

NOTE: *Mark direction for reassembly.*



Figure 34

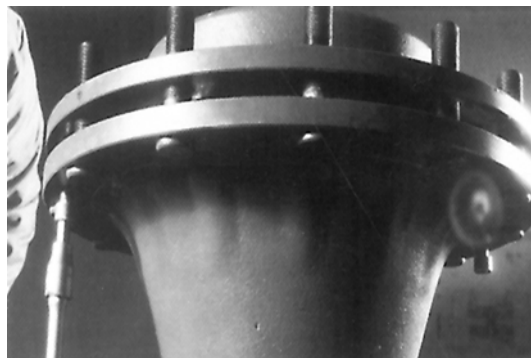


Figure 35

2. Remove locking plate.

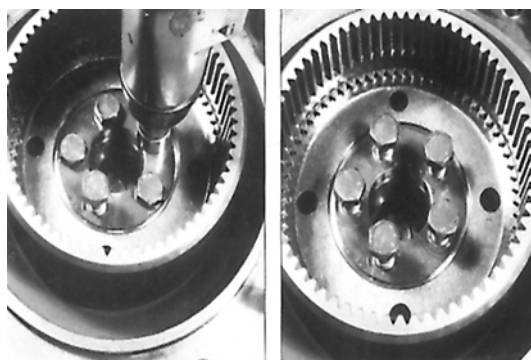


Figure 36

3. Use partially threaded M18 X 1,5 screws to support puller.

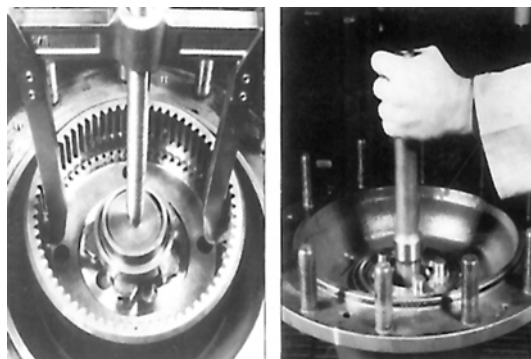


Figure 37

4. Inspect for wear or damage and replace any parts as required.

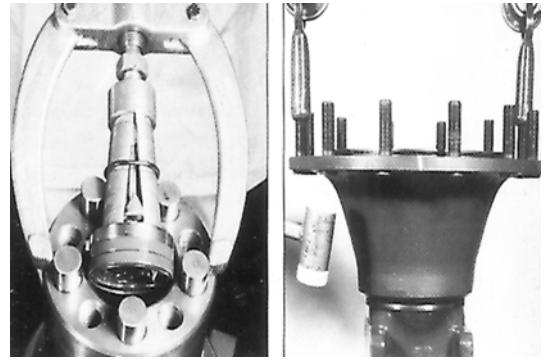


Figure 38

5. Install outer races and taper roller bearings. Special tool T21 is required (refer to "Special Tools" in back of this section).

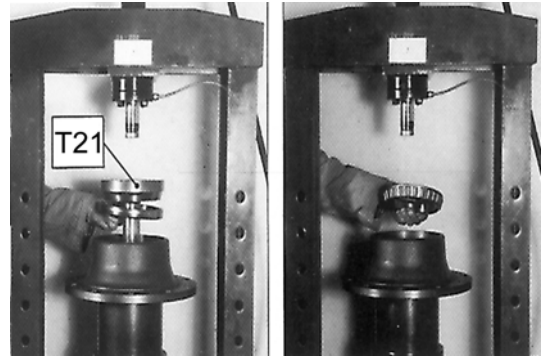


Figure 39

6. Install seal. Special tool T23 is required (refer to "Special Tools" in back of this section).

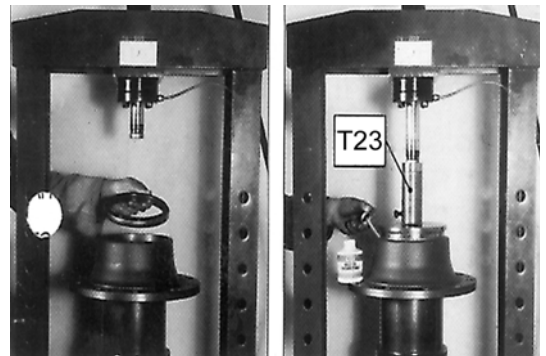


Figure 40

7. Install wheel studs.

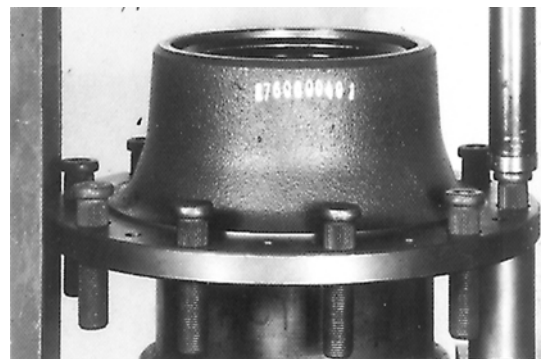


Figure 41

8. Install wheel hub and center ring. Special tool T20 is required (refer to "Special Tools" in back of this section).

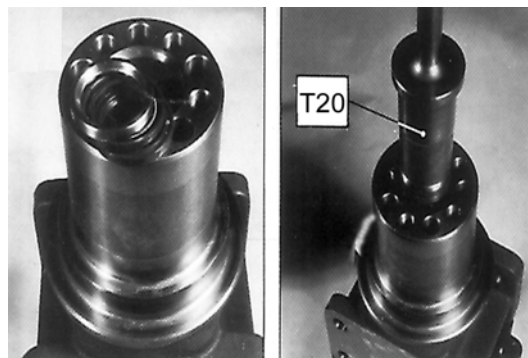


Figure 42

9. Install wheel hub onto axle housing.



Figure 43

10. Install gear rim on center wheel.

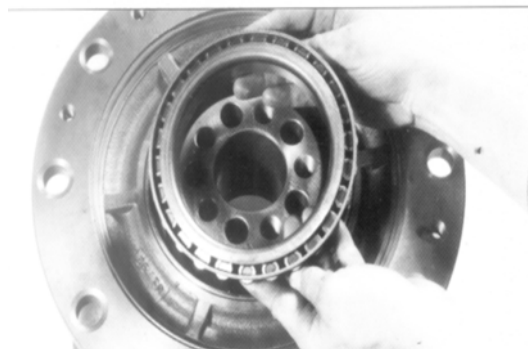


Figure 44

11. Special tool T19 is required (refer to "Special Tools" in back of this section).

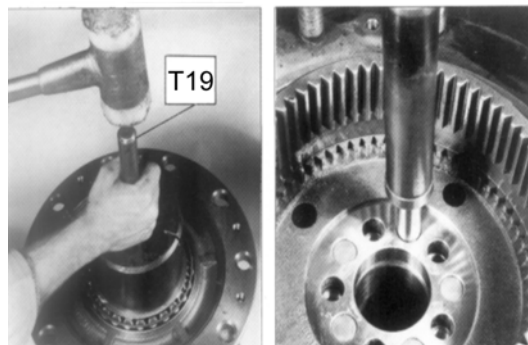


Figure 45

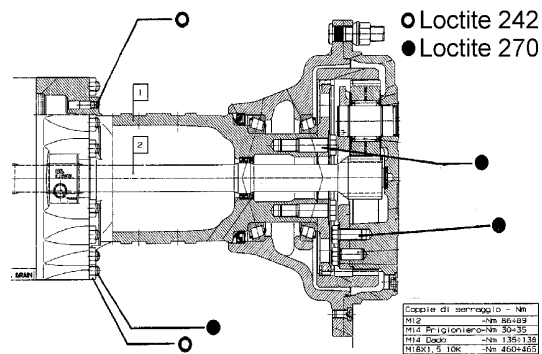


Figure 46

12. Install locking plate.

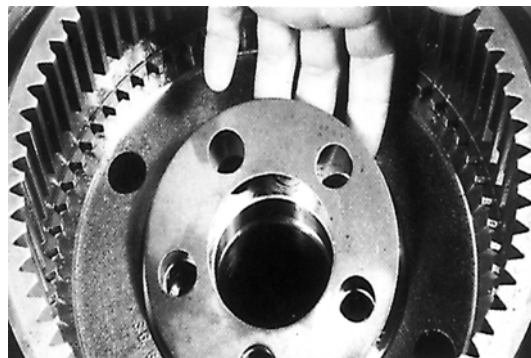


Figure 47

13. Apply Loctite #270 on locking plate bolts (M18 X 1.5 10K), and tighten to 460 - 465 N•m (338 - 342 ft lb) torque.



Figure 48

14. Torque new bearings with seals to 30 to 40 N•m (22 - 29 ft lb).

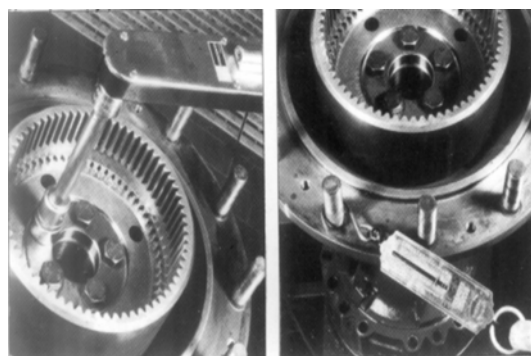


Figure 49

Planetary Reduction Gears

1. Remove cover.

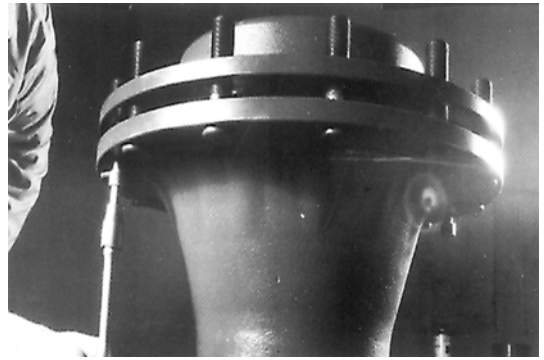


Figure 50

2. Mark location of reduction gears for reassembly. Remove locking plates.

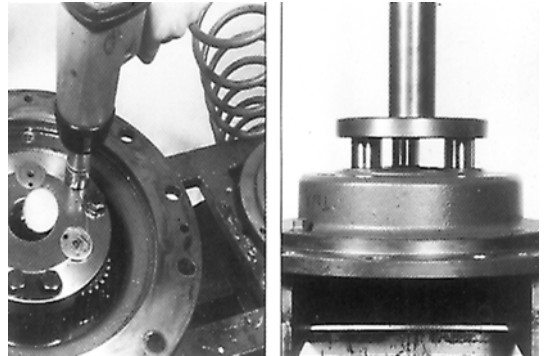


Figure 51

3. Remove planet gears and inspect for wear or damage, and replace as required.

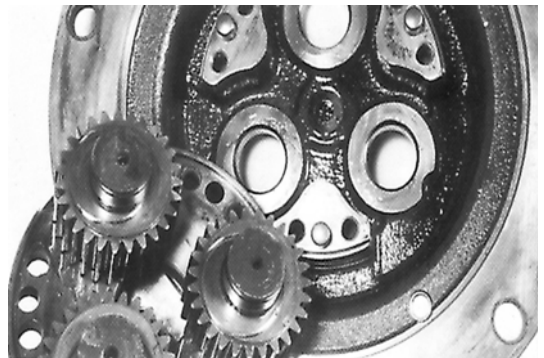


Figure 52

4. Remove O-rings, retaining rings, thrust washers, planet gears, needle bearings, and planet gear shafts.

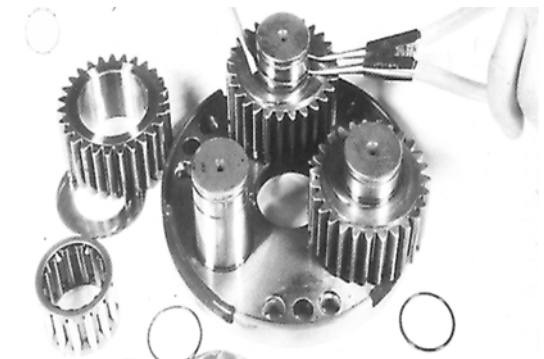


Figure 53

5. Reassemble planet gear shafts, thrust washers, needle bearings, and planet gears.

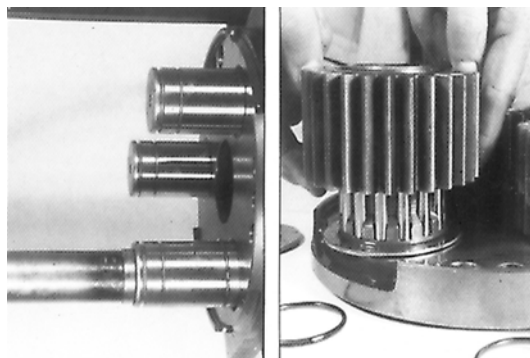


Figure 54

6. Install retaining rings and O-rings.

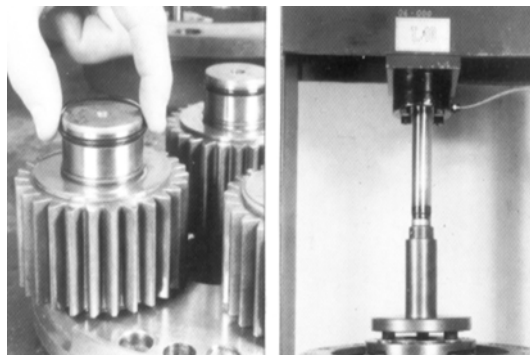


Figure 55

7. Line up assembly marks and install locking plates. Apply Loctite #270 to lock plate bolts.

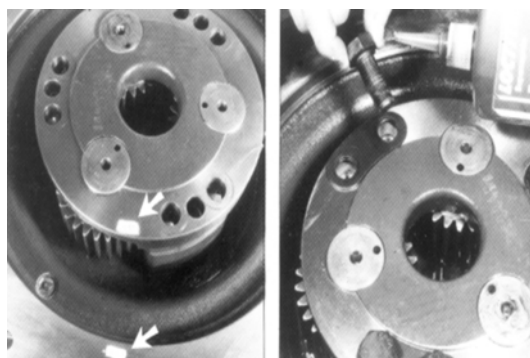


Figure 56

8. Torque bolts to 315 - 320 N•m (232 - 235 ft lb).

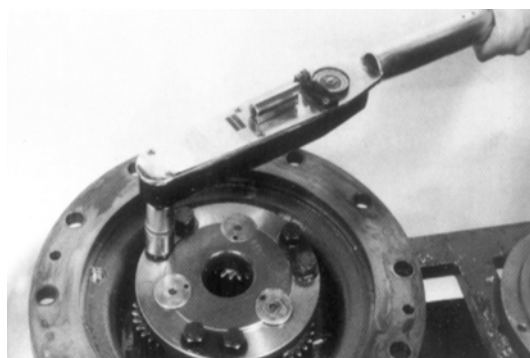


Figure 57

9. Install planetary cover making sure of direction of installation.

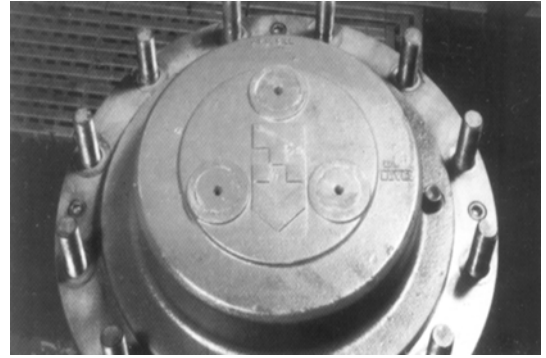


Figure 58



Figure 59

Bevel Pinion Support (Rear Axle)

1. Remove bevel pinion support. Be careful, and guard against damage to parts.



Figure 60

2. Special tool T15 is required (refer to "Special Tools" in back of this section).

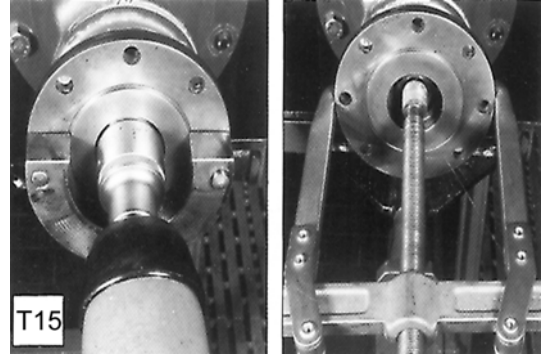


Figure 61

3. Using a press, remove pinion gear and bearing cups from cage, then remove bearings and spacer from pinion gear.

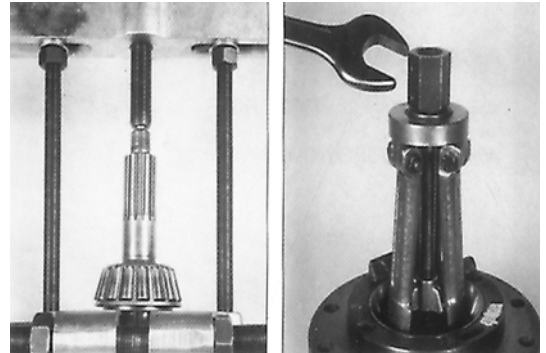


Figure 62

4. Assemble external races and taper roller bearings, check cover measurement "A."

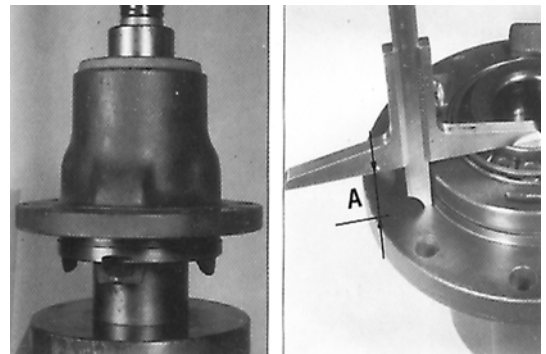


Figure 63

5. Determination of shim pack S1 for preload of taper roller bearings.

NOTE: $S1 = B - C + X$

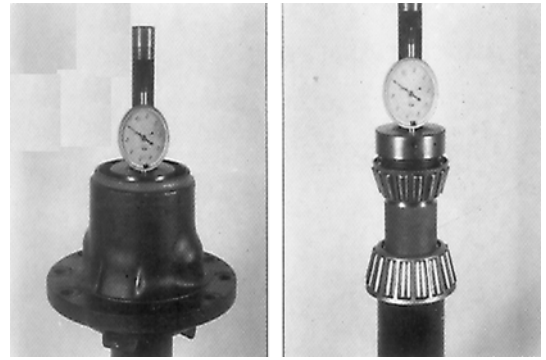


Figure 64

6. Value $X = 0,09 - 0,11$ mm (0.003 - 0.004 in) (Rear Axle)

NOTE: Value $X = 0,11 - 0,14$ mm (0.004 - 0.006 in) (Front Axle)

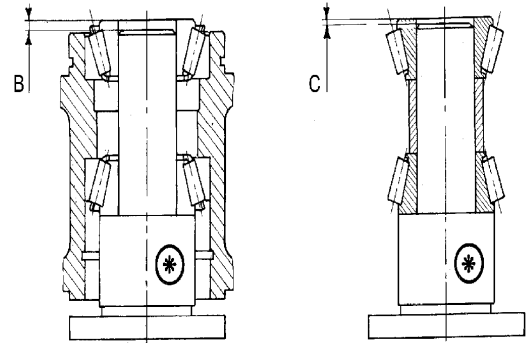


Figure 65

7. Press fit bearing cone onto pinion gear, then assemble spacer and shim.

NOTE: There must be no clearance at contact faces of any parts.

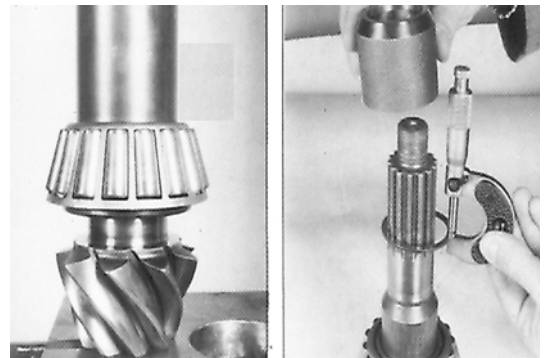


Figure 66

8. Press fit bearing cups in cage. Assemble pinion gear in cage, then press fit bearing cone. Apply pressure to bearing at specified load, and rotate the case to settle bearing. A special tool T22 is required (refer to "Special Tools" in back of this section).

NOTE: Specified load = 49 Kn (5 ton)

NOTE: When rotating the case at the specified load, rotate lightly by hand. If the rotation is not smooth, replace the bearing and spacer, and again rotate lightly by hand.

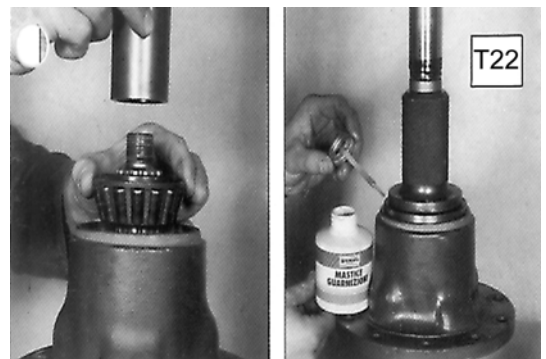


Figure 67

9. Press fit oil seal evenly in cage.

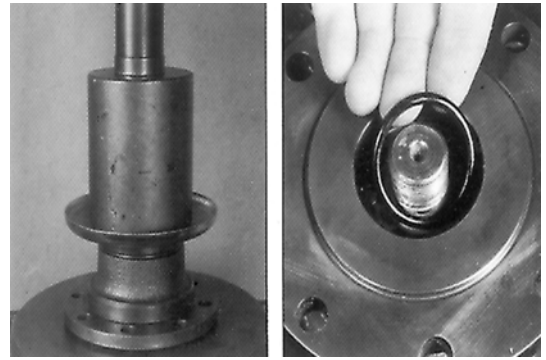


Figure 68

10. Assemble with Loctite #242.

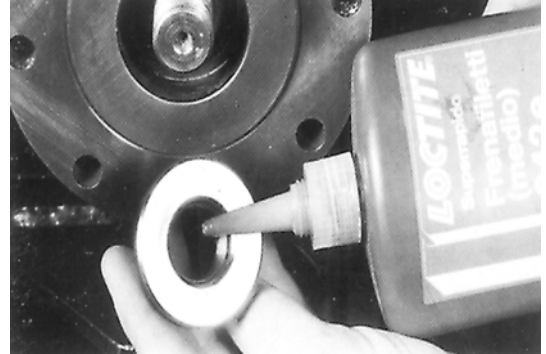


Figure 69

11. Tighten nut with a torque wrench, then check rotation torque.

NOTE: Nut Torque: 600 - 800 N•m (441 - 588 ft lb)
(Rear Axle)

NOTE: Nut Torque: 500 - 700 N•m (368 - 515 ft lb)
(Front Axle)

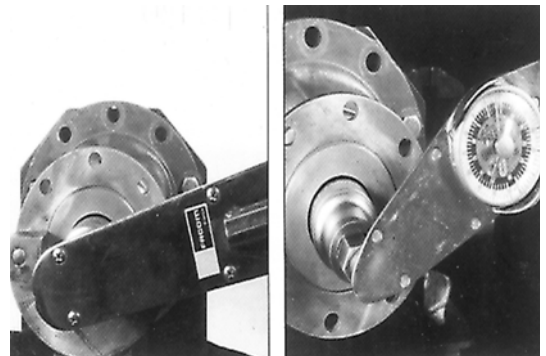


Figure 70

12. Rotation Torque: 120 - 130 N•m (88 - 96 ft lb) (Rear Axle)

NOTE: Rotation Torque: 120 - 150 N•m (88 - 110 ft lb)
(Front Axle)

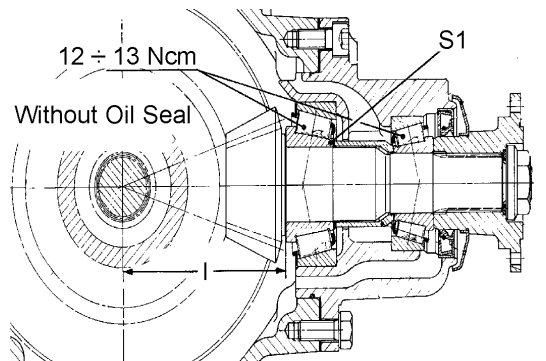


Figure 71

● Loctite 270

Rear Axle

$l = 135 \text{ mm} / X = 0,09 \div 0,11 \text{ mm}$

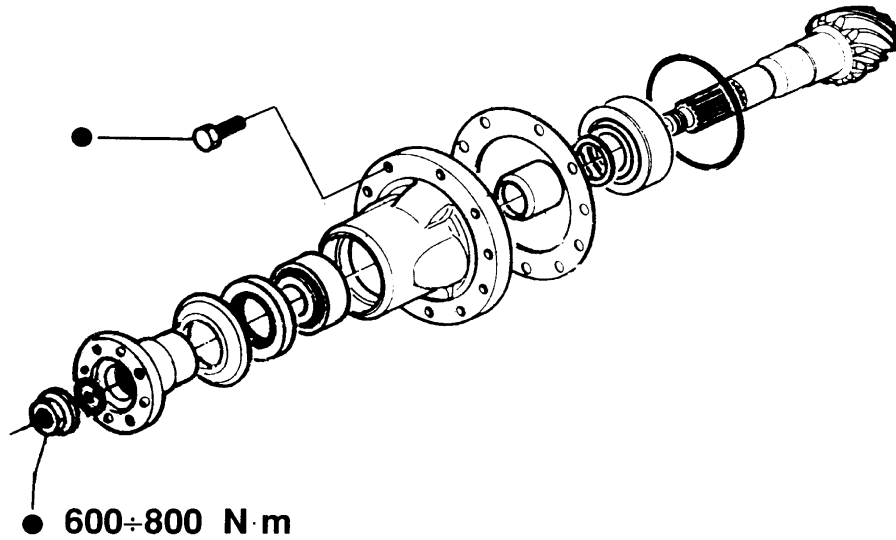
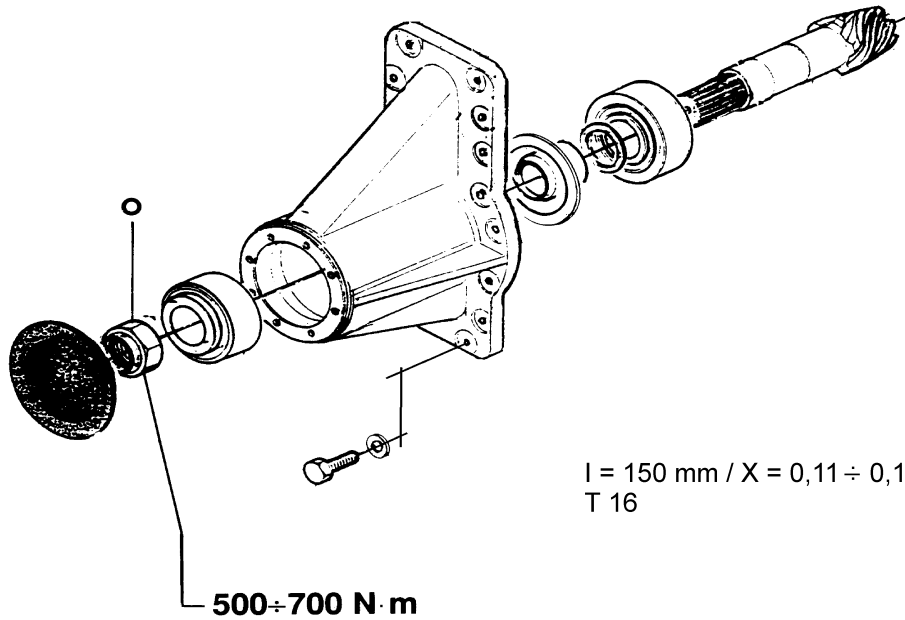


Figure 72

○ Loctite 242

Front Axle



$l = 150 \text{ mm} / X = 0,11 \div 0,14 \text{ mm}$
T 16

Figure 73

13. Remove axle housing.

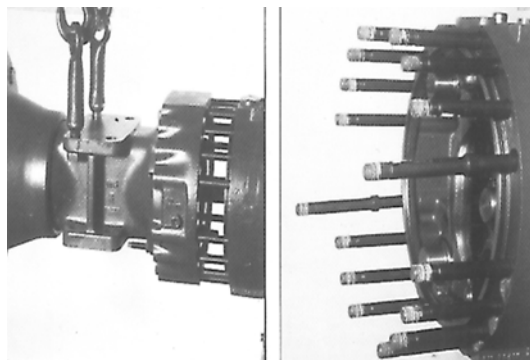


Figure 74

14. Remove differential carrier, then remove bevel gear.

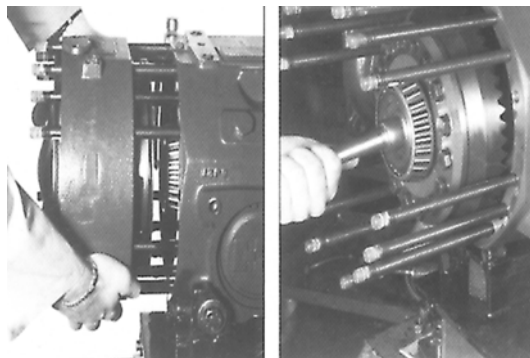


Figure 75

15. Remove bearing, then remove spring pin from cross shaft,

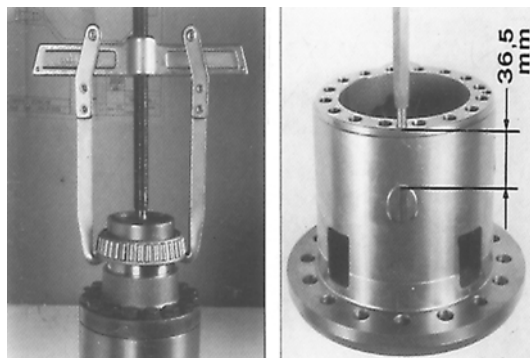


Figure 76

NOTE: *Replace fitting bolts of crown wheel every time they are removed.*

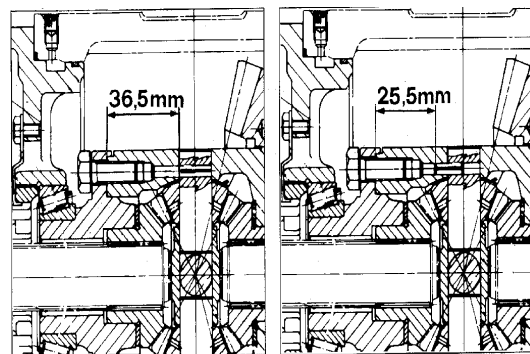


Figure 77

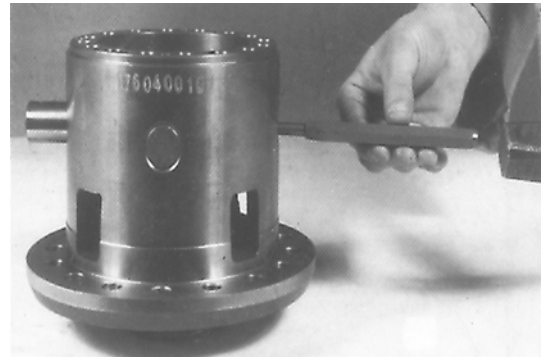


Figure 78

16. Assemble in reverse order of disassembly. Mount sun wheels and planet gears.

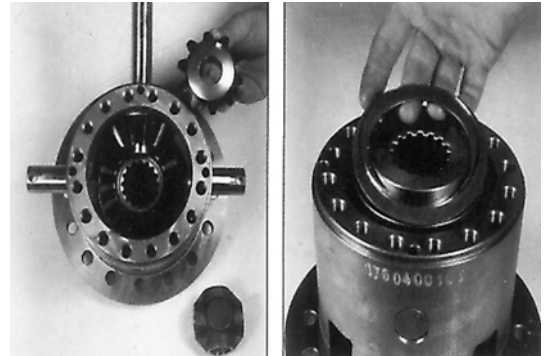


Figure 79

17. Insert spring pins half way up the shaft.

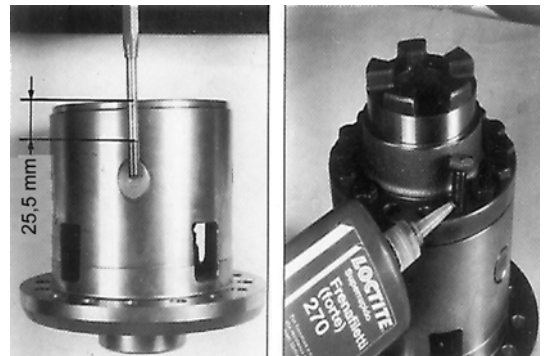


Figure 80

18. Use Loctite #270.

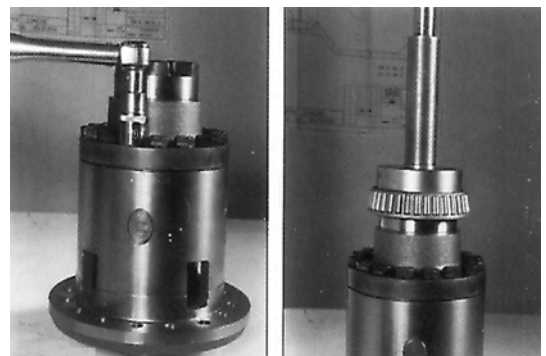


Figure 81

19. Torque M12 X 35 X 1,25-10K bolts to 135 - 138 N•m (99 - 102 ft lb).

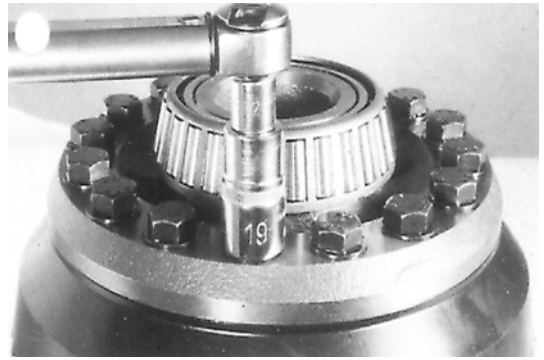


Figure 82

Self Locking Differential

1. Disassemble and check for worn or damaged parts, and replace as necessary.

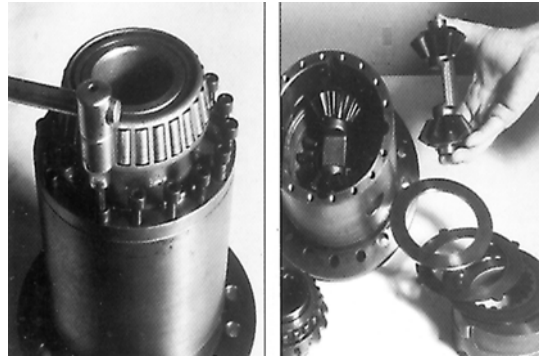


Figure 83

2. When assembling check to be sure discs are not deformed.

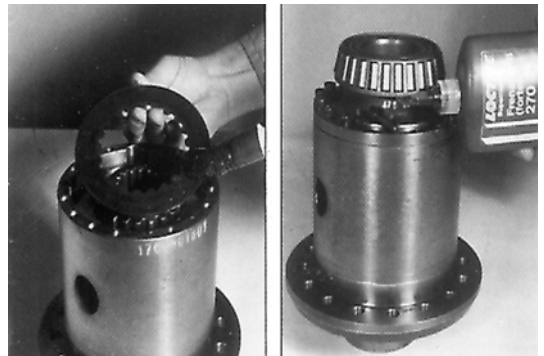


Figure 84

3. Use Loctite #270.

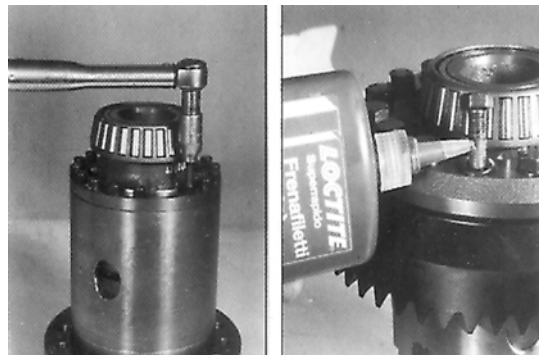


Figure 85

4. Torque M12 X 35 X 1,25-10K bolts to 135 - 138 N•m (99 - 102 ft lb).

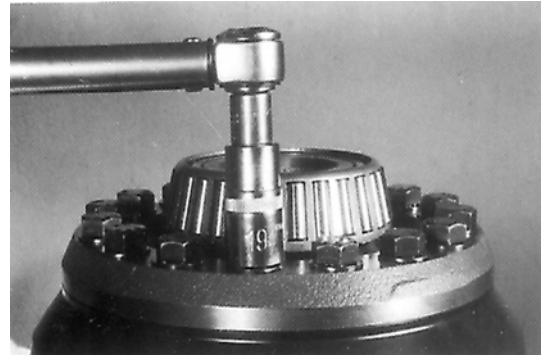


Figure 86

- Loctite 222
- Loctite 270

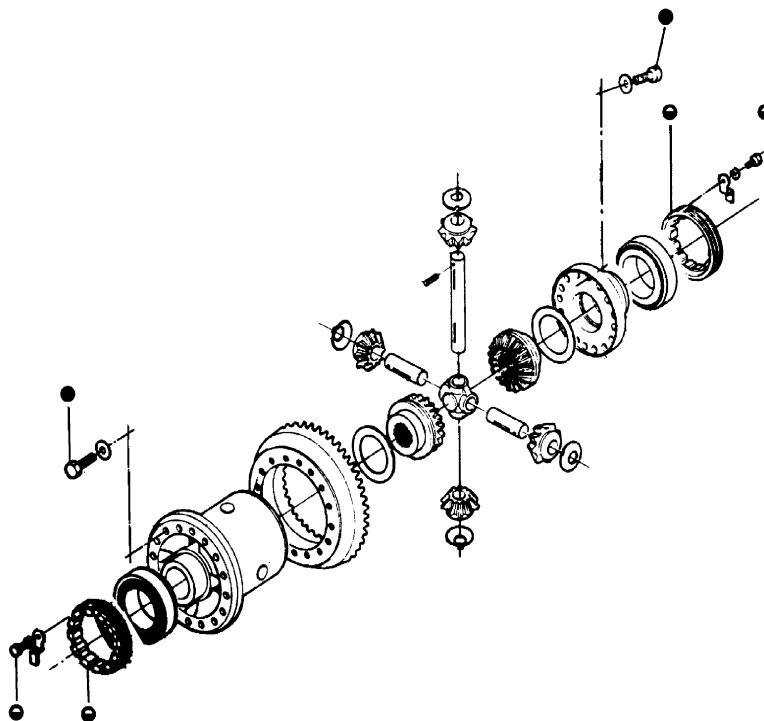


Figure 87

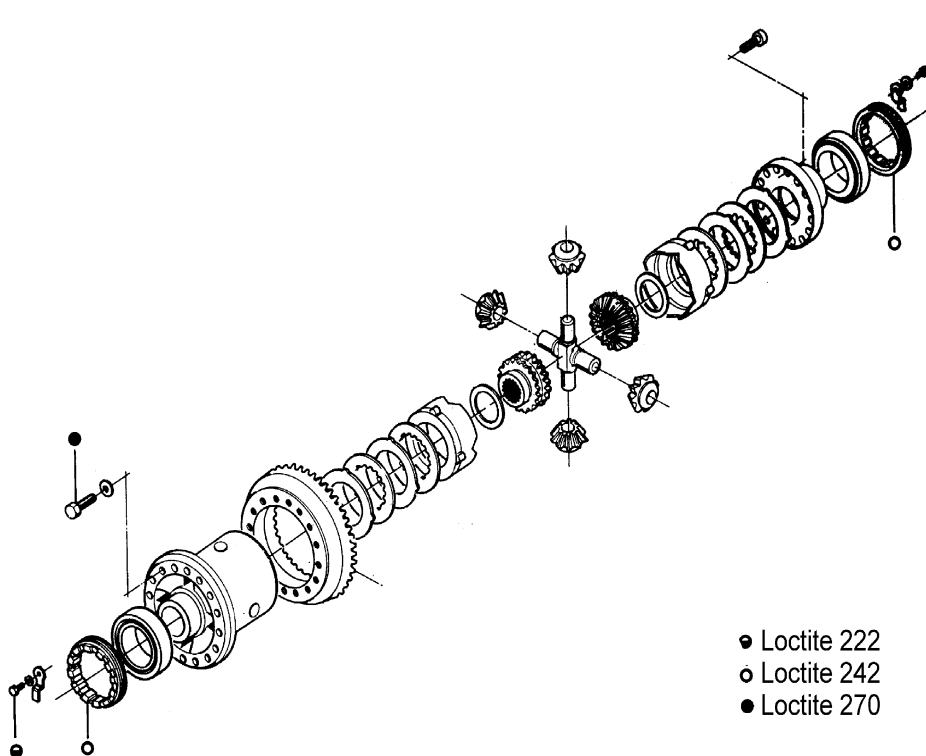


Figure 88

Parking Brake

Edition 2

MEMO

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Parking Brake

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Functional Characteristics and Maintenance Instructions for Spring Loaded Sliding Caliper Brakes	7
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2. Mounting and Basic Setting Regulations	9
3. Adjusting Regulations	10
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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

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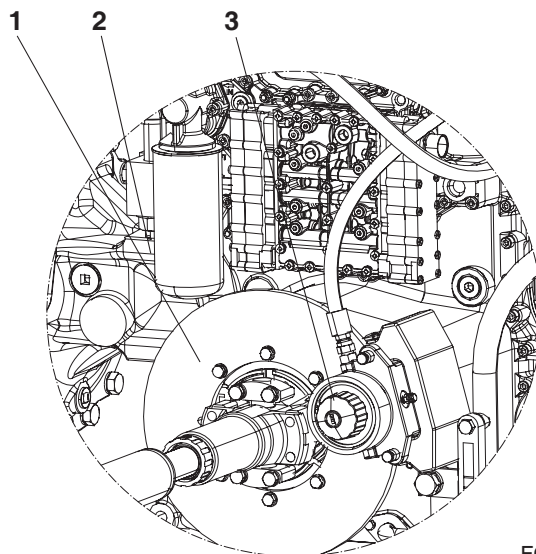
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up
DL250A	10001 and Up

GENERAL DESCRIPTION

• Type	• Electrically-controlled hydraulic caliper brake
• Control Pressure	• 120 kg/cm ² (1740 psi)



FG006707

Figure 1

Reference Number	Description
1	Parking Brake Disk
2	Transmission

Reference Number	Description
3	Parking Brake

FUNCTIONAL CHARACTERISTICS AND MAINTENANCE INSTRUCTIONS FOR SPRING LOADED SLIDING CALIPER BRAKES

1. Functional Characteristics of Spring Loaded Sliding Caliper Brakes

The two identical brake pads (3) and (4) slide freely on guide bolt (2), which is fastened in housing (1). The guide bolts (2) are guided in an additional brake anchor plate which in turn is screwed onto vehicle; i.e. its transmission.

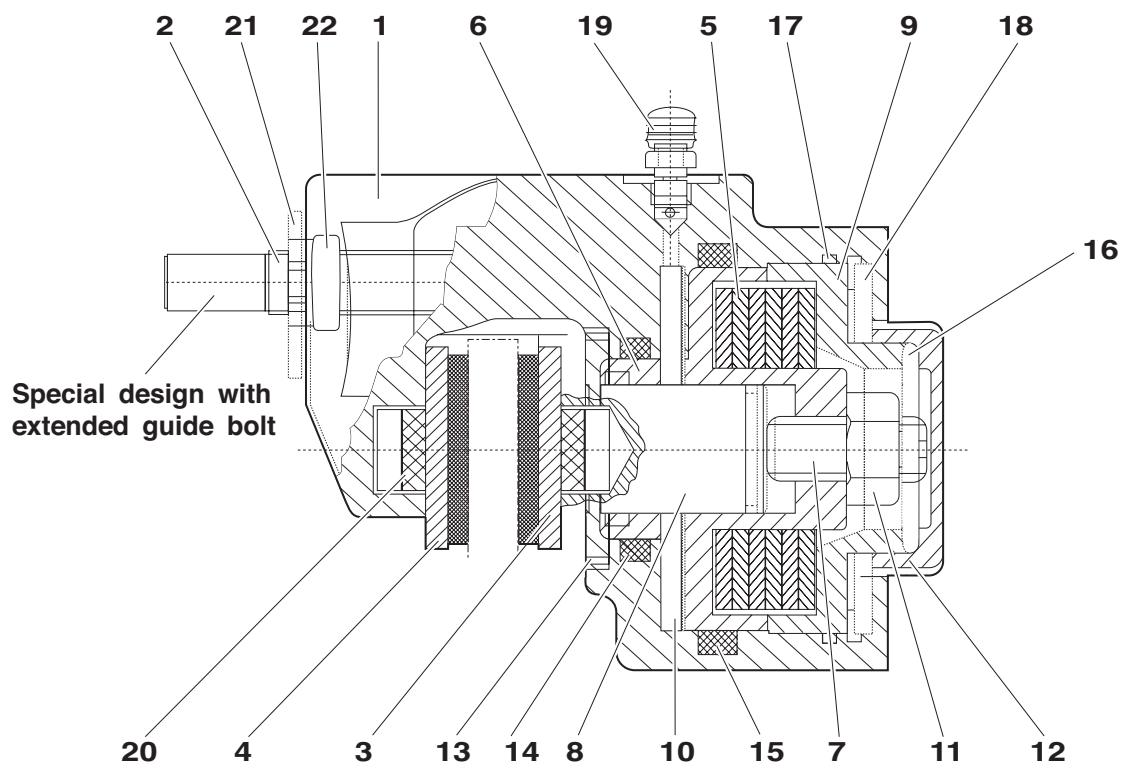
On actuation, the brake generates a clamping force at the brake lining plates (3) and (4), which causes a tangential force/braking moment to be generated at the brake disk, the extent of which depends on coefficients of friction generated by the linings.

The clamping force is generated by the bank of cup springs (5), during which the piston (6) is moved together with the adjusting screw (7), the thrust bolt (8) and the brake pad (3) towards the brake disk.

When the brake pad (3) comes into contact with the brake disk, the reaction force shifts the housing (1) onto guide bolts (2) until the brake pad (4) is also pressed against the brake disk.

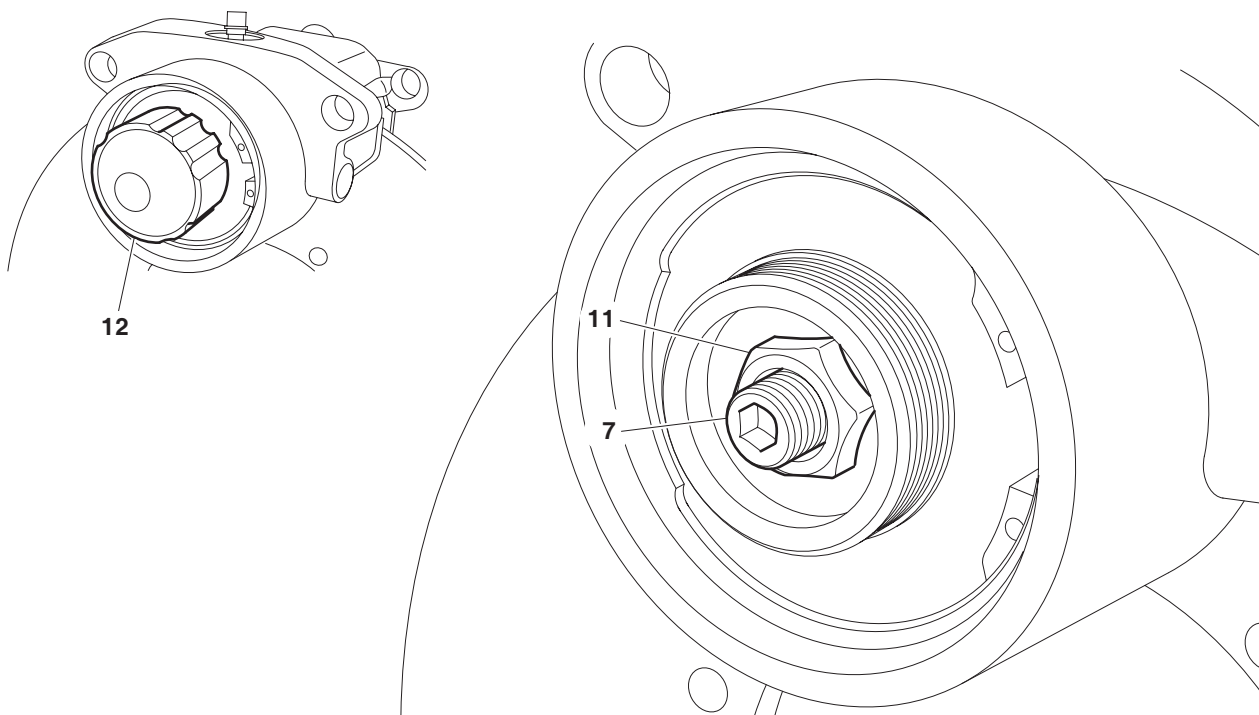
The brake is released by complete pretensioning of bank of cup springs (5). During this process, through application of necessary release pressure after overcoming the cup spring force, the piston (6) must move back until it comes to rest against the pressure ring (9).

The clamping force diminishes with wear of brake lining and brake disk. The brake must be adjusted at the latest at the times indicated by the adjusting specification below (point 3).



FG008072

Figure 2



FG027225

Figure 3

2. Mounting and Basic Setting Regulations

Basic brake setting is required after mounting new brake lining plates or brake disks, and during all repair stages and in case of insufficient braking performance.

All mounting and basic setting work must be carried out on brake when cold. Proceed as follows:

1. Release the screw cap (12).
2. Release the lock nut (11) (size 24 or 30) and turn the adjusting screw (7) counterclockwise using a size 8 or 10 socket wrench until the pressure bolt (8) comes to rest against the face surface of piston (6).
3. In this status, the brake can be mounted onto brake disk and fastened.
4. Mount the pressure connection and apply necessary release pressure to the brake until the bank of cup springs (5) is completely pretensioned.
5. Turn the adjusting screw (7) manually clockwise until both brake pads (3) and (4) make contact with the brake disk (it is then no longer possible to turn the adjusting screw (7) without exerting a major amount of force).
6. Turn the adjusting screw (7) counterclockwise in order to set the following rated clearances:

Type	Adjusting screw	Clearance (mm)		Revolutions
Small	M16 (size 8)	min.	0.5	1/4
		Rated clearance	1.0	12
		max.	1.5	3/4
Large	M20 (size 10)	min.	1.0	2/5
		Rated clearance	2.0	4/5
		max.	3.0	1 1/5

7. Hold the adjusting screw in position (7) with a hexagonal socket wrench and lock with lock nut (11).
8. Mount the screw cap (12) and tighten as far as possible manually.
9. Mount the pressure connection in accordance with the instructions of axle/gear manufacturer and bleed the piston chamber using bleeding valve (19).

3. Adjusting Regulations

During this adjusting process, the parking brake must be released; i.e. the bank of cup springs (5) must be completely pretensioned.

1. Stand the vehicle on an even surface and secure against rolling away. Only then, release the parking brake.
2. Release the screw cap (12) and unscrew.
3. Release the lock nut (11) (size 24 or 30) and turn the adjusting screw (7) with socket wrench size 8 or 10 manually clockwise until the two brake pads (3) and (4) make contact with the brake disk.
4. Turn the adjusting screw (7) counterclockwise and set the clearance specified in the above table.
5. Hold the adjusting screw (7) in position with the hexagonal socket wrench and lock with the lock nut (11).
6. Mount the screw cap (12) and tighten as far as possible manually.
7. Actuate the brake valve several times and check the braking efficiency of parking brake on a slope.

4. Emergency Release of Parking Brake

After the failure of pressure, release the parking brake by using following manual procedure.

1. The vehicle has to be against moving away.
2. Release the screw cap (12) and unscrew.
3. Release the lock nut (11) (size 24 or 30) and turn the adjusting screw (7) with socket wrench size 8 or 10 manually counterclockwise until the brake disk is free.

NOTE: *You need for the emergency release an actuation torque of 4.08 kg•m (30 ft lb) respectively 7.14 kg•m (52 ft lb).*

4. Mount the lock nut (11) and the screw cap (12) and tighten both as far as possible manually. (Protection against dirt)

NOTE: *Now, the vehicle do not have any brake function. The vehicle must be secured against moving away with proper means. Before putting the vehicle into operation again, the brake has to be adjusted according to point 2. respectively point 3.*

5. Maintenance and Repair Work

Maintenance and Exchange of Brake Pads

The brake pads themselves are maintenance free. All that is required here is a check for damaged parts, and inspection to ensure that the brake disk remains easy running.

The thickness of brake lining must be subjected to a visual inspection at regular intervals, which depend on vehicle usage, but every six months at the latest. In case of a minimal residual lining thickness, these intervals must be reduced accordingly in order to avoid major damage to the brake or disk.

Small brake: min. residual thickness 1.0 mm per brake lining plate (6 mm carrier plate thickness)

Large brake: min. residual thickness 2.0 mm per brake lining plate (8 mm carrier plate thickness)

Once these thickness are reached, the brake lining must be replaced in accordance with the following regulation:

1. Stand the vehicle on an even surface and secure against rolling away. Only then, release the parking brake by applying the necessary release pressure.
2. Release the screw cap (12) and unscrew.
3. Release the lock nut (11) (size 24 or 30) and turn the adjusting screw (7) with socket wrench size 8 or 10 manually clockwise until it lies flush with the inside of piston (6).
4. Press back the pressure bolt (8) using a suitable screw driver until it comes to rest against the piston (6) (i.e. by levering).
5. Depending on free space available, release one of two guide bolts (2), removing the safety splint (21), unscrewing the castellated nut (22) and pulling the guide bolt (2) from brake anchor plate (1). The brake lining plates (3) and (4) can now be removed tangentially to the brake disk.

NOTE: *In case of minimal clearance; i.e. it is not possible for space reasons to exchange the brake lining plate in accordance with these instructions, the brake must be moved completely. To do this, pull the two guide bolts from brake anchor plate.*

NOTE: *Check the pressure hose. If the pressure hose is too short, it must be unscrewed in order to allow the brake to be removed.*

Reassembly Differentials must always have been performed beforehand, than release pressure by actuating the hand brake valve!

6. Exchange the brake pads (3) and (4) and insert the guide bolts (2) into brake anchor plate (1), checking whether the permanent magnets (20) still have sufficient magnetic force to hold the brake lining plates (3) and (4).

NOTE: *Should this not be the case, the permanent magnets (20) must also be changed ("lever out" using a suitable screw driver).*

NOTE: *When the brake has been completely removed, the pressure hose must be screwed back on and the brake bled.*

7. Secure the guide bolts (2) with castellated nut (22) and locking splint (21).

NOTE: *Only Knott original spare lining plates may be used. If any other spare parts are used, no warranty claims will be accepted for either the brakes or their functional characteristics.*

After mounting new brake lining plates or their repair, the brake must be correctly set in accordance with the instructions under point 3.

Changing the Seal

Faulty seals must be exchanged in accordance with the instructions below:

1. Stand the vehicle on an even surface and secure against rolling away. Only then, release the parking brake by applying the necessary release pressure.
2. Release the screw cap (12) and unscrew.
3. Release the lock nut (11) (size 24 or 30) and turn the adjusting screw (7) with socket wrench size 8 or 10 manually counter clockwise until the adjuster screw (7) measured 27 mm - 30 mm outside of piston (6).
4. Release pressure by actuating the hand brake valve, than unscrew the pressure hose and completely remove brake. The bank of cup springs (5) is now completely depressurized.
5. Remove retaining ring (18) and remove pressure ring (9) from housing (1).
6. Remove bank of cup springs (5) and piston (6).
7. Exchange the seals (14) (15) and (17) and replace the individual parts in reverse sequence.

NOTE: *Pay attention to the mounting direction of seal rings (14) and (15), otherwise leaks can occur.*

NOTE: *When mounting the new seal rings, pay attention not to damage the sealing lip by using a suitable mounting needle with rounded edges.*

When mounting the piston, the sliding and sealing surfaces must be greased lightly using lubricating grease to DIN 51825.

The dust protection cap (13) is fitted with a vulcanized steel ring that is used to press it through the locating hole. For exchanging, "lever out" the ring using a suitable tool. The new dust protection cap must be pressed in with the aid of a suitable mounting ring and screw clamps or a lever press.

8. Mount the brake in accordance with the above procedure into vehicle / at the axle.

NOTE: *For exchange purpose, only use Knott original spare and spare parts sets. These must be ordered through the vehicle manufacturer.*

6. General

Any discovered defects or damage to parts not listed here must naturally be repaired or replaced using original parts.

For any other information not contained in these instructions or for more detailed instructions, please contact the vehicle or brake manufacturer.

Driveshaft

Edition 1

MEMO

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WARNING

AVOID DEATH OR SERIOUS INJURY

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APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

Drive Shaft Weight

Front drive shaft (1): approx. 14.2kg (31.3 lbs).

Center drive shaft (2): approx. 20.2 kg (44.5lbs).

Rear drive shaft (3): approx. 7.2 kg (15.9 lbs).

Drive Shaft Coupling Dimension

Front drive shaft : 6C (Front Axle input flange) - 6C.

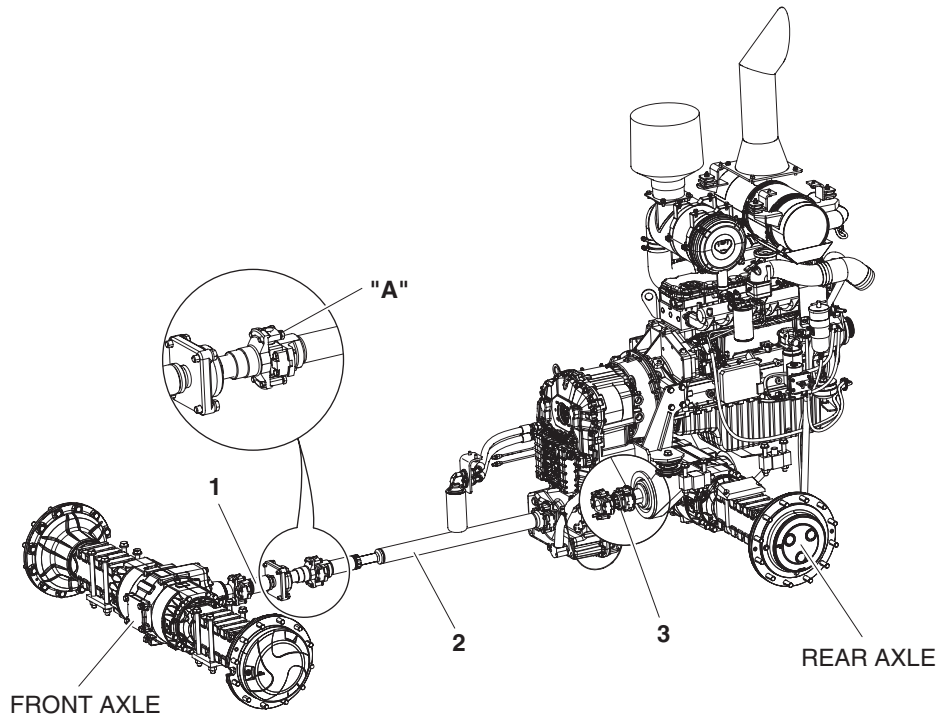
Center drive shaft : 6C - 6C (Transmission output flange).

Rear drive shaft : 6C - 5C (Rear Axle input flange).

Drive Shaft, Tightening Torque

Front/ Center/ Rear drive shaft bolt ("A") : $6\pm0.5\text{kg}\cdot\text{m}$ (43 ± 4 lb ft)

Threaded area: Loctite #242



FG013106

Figure 1

Reference Number	Description
1	Brake Pedal Valve
2	Brake, Pilot & Fan Motor Supply Valve
3	Steering Accumulator
4	Steering Accumulator

Reference Number	Description
5	Brake Pump
6	Brake Filter
7	Parking Brake
8	Rear Axle
9	Front Axle

Brake

Service Brake

Edition 1

MEMO

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MEMO

SAFETY INSTRUCTIONS



WARNING

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APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

This machine is equipped with a fully hydraulic operated brake system and have independent circuit for the front axle & rear axle.

The brake system is composed of brake pedal valve, brake supply valve & accumulators and provided with oil through brake supply valve from pump.

A system pressure drop below 65 Bar(943 psi) will be indicated on the display panel in the cab, warning lamp will flash and also alarm will sound.

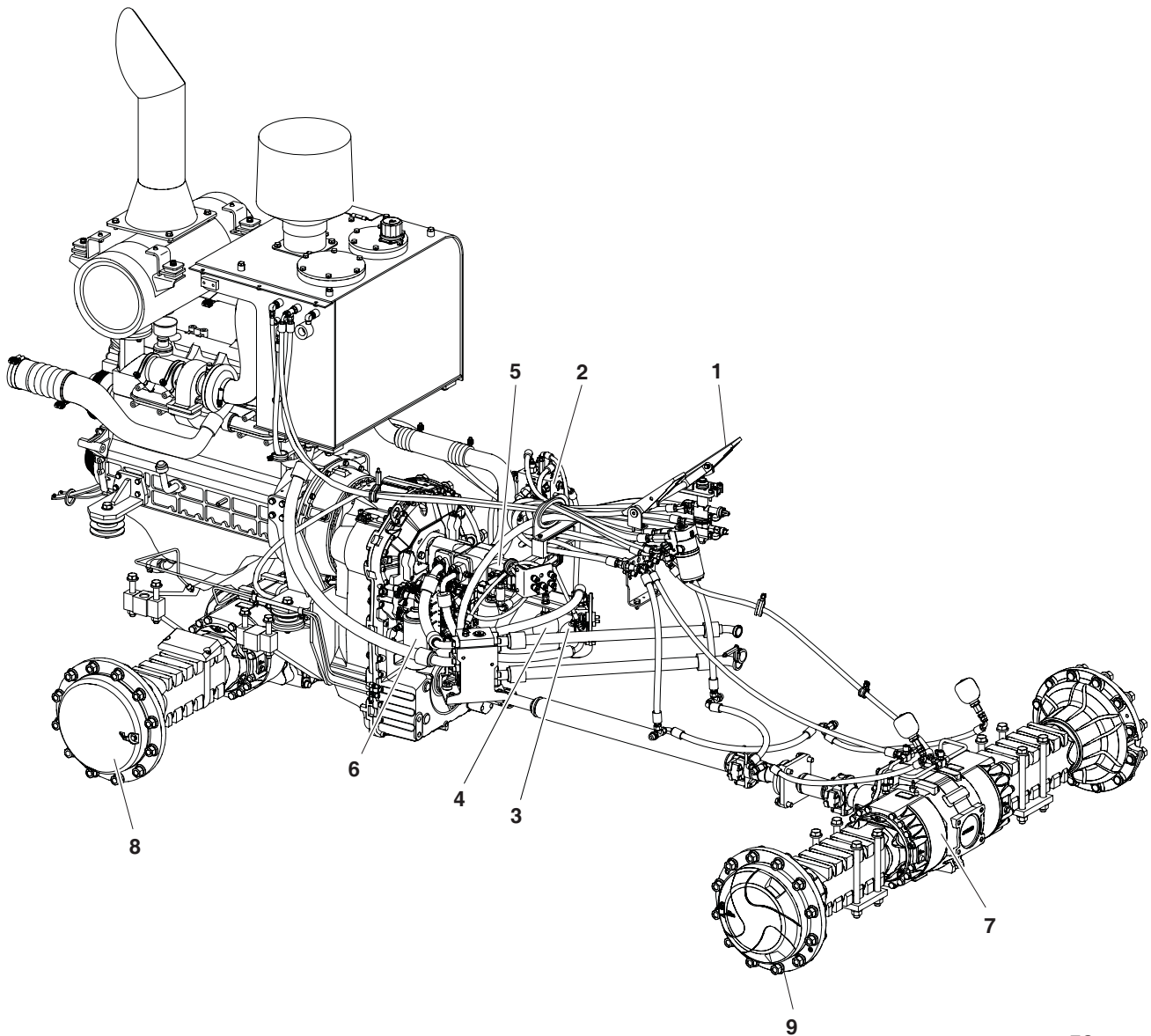


Figure 1

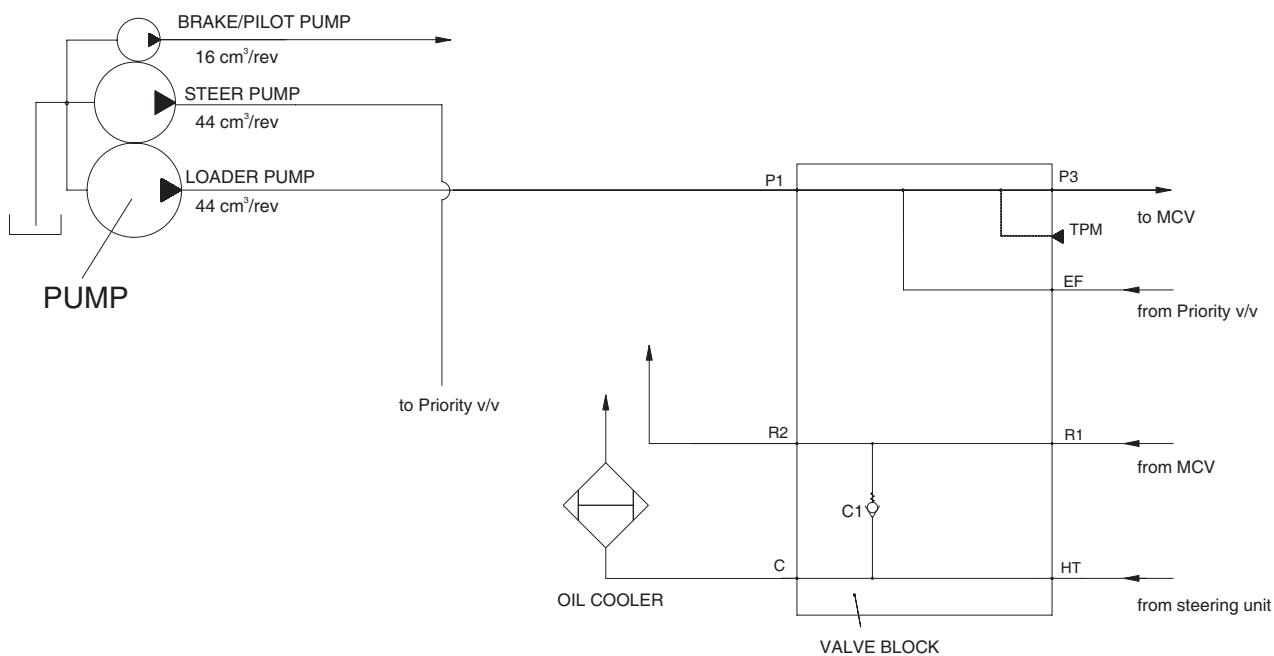
FG028725

Reference Number	Description
1	Brake Pedal Valve
2	Brake, Pilot & Fan Motor Supply Valve
3	Brake Accumulator
4	Pilot Accumulator

Reference Number	Description
5	Brake Pump
6	Brake Filter
7	Parking Brake
8	Rear Axle
9	Front Axle

SERVICE BRAKE SYSTEM

A brake pump (Figure 2) supplies pressurized fluid to the brake hydraulic system. Force on the brake pedal moves two spools in the brake valve. The spools are proportional. The farther the brake pedal is pushed, the greater the amount of fluid that passes through each spool. One spool ports fluid to brake pistons in the front axle. The other spool ports fluid to brake pistons in the rear axle. Pressure on the brake pistons applies pressure to the brake discs, and this stops axle shaft and wheel rotation. The brake hydraulic system also contains two accumulators. The accumulators hold a volume of pressurized fluid large enough to allow the brakes to be applied nine times with full pressure, after the engine has been turned off. The brake hydraulic system includes a pressure operated transmission cutoff switch (Figure 2). Pressing the brake pedal will open cutoff switch. When the transmission cutoff switch in the operator's cab is selected, this will cut off current to a solenoid operated hydraulic valve in the transmission. This prevents operation of the forward clutch in the transmission. This prevents the transmission from driving the wheels forward when the brake pedal is pressed.



FG028609

Figure 2

Brake Supply Valve

Edition 1

MEMO

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Brake Supply Valve

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SAFETY INSTRUCTIONS



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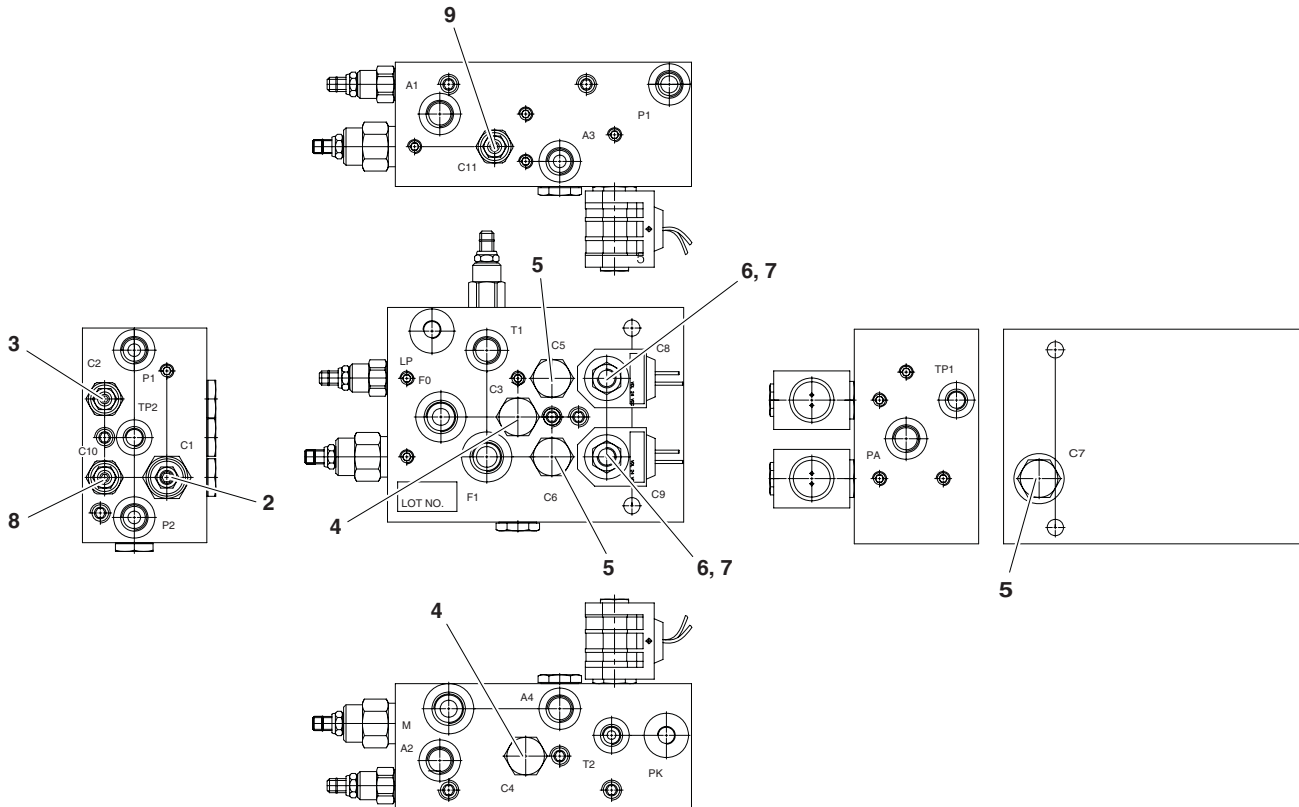
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

BRAKE, PILOT & FAN MOTOR SUPPLY VALVE

This valve controls oil flow to the brake pedal valve for braking, to the pilot controller for operation of bucket and boom and to the fan motor.

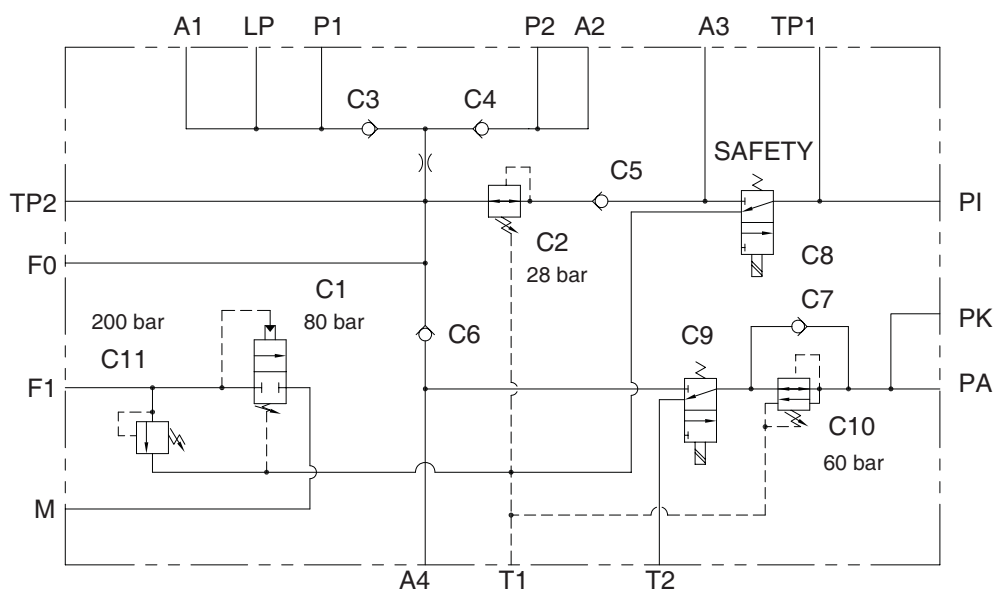


FG028595

Figure 1 Brake & Fan Motor Supply Valve

Reference Number	Description
1	Body (84*145*200)
2	Sequence (C1)
3	Reducing (C2)
4	Check (C3, C4)
5	Check (C5, C6, C7)
6	Solenoid (C8, C9)

Reference Number	Description
7	Coil (C8, C9)
8	Reducing (C10)
9	Relief (C11)
10	Wrench Plug
11	Wrench Plug
12	Orifice (Ø1.2-M8*1.25)



FG028704

Figure 2 Hydraulic Circuit

Specifications

Item		Specifications
Max. Operating Pressure		210 kg/cm ² (3,000 psi)
Rated Flow		57 l/min (15.05 gpm)
Setting Pressure	C1 Sequence Valve	81.5 kg/cm ² (80 ±2 bar @ 30 liter/min)
	C2 Reducing Valve	28.5 kg/cm ² (28 ±2 bar @ 20 liter/min)
	C10 Reducing Valve	61.1 kg/cm ² (60 ±2 bar @ 20 liter/min)
	C11 Relief Valve	203.9 kg/cm ² (200 ±2 bar @ 30 liter/min)
Port Size	F0, F1, M	PF 1/2 O-ring
	TP1, TP2, T2	PF 1/4 O-ring
	LP, PK	Ø30 PF 1/4 BSP
	All other ports	PF 3/8 O-ring

Brake Pedal Valve

Edition 1

MEMO

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MEMO

SAFETY INSTRUCTIONS



WARNING

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APPLICABLE MODELS

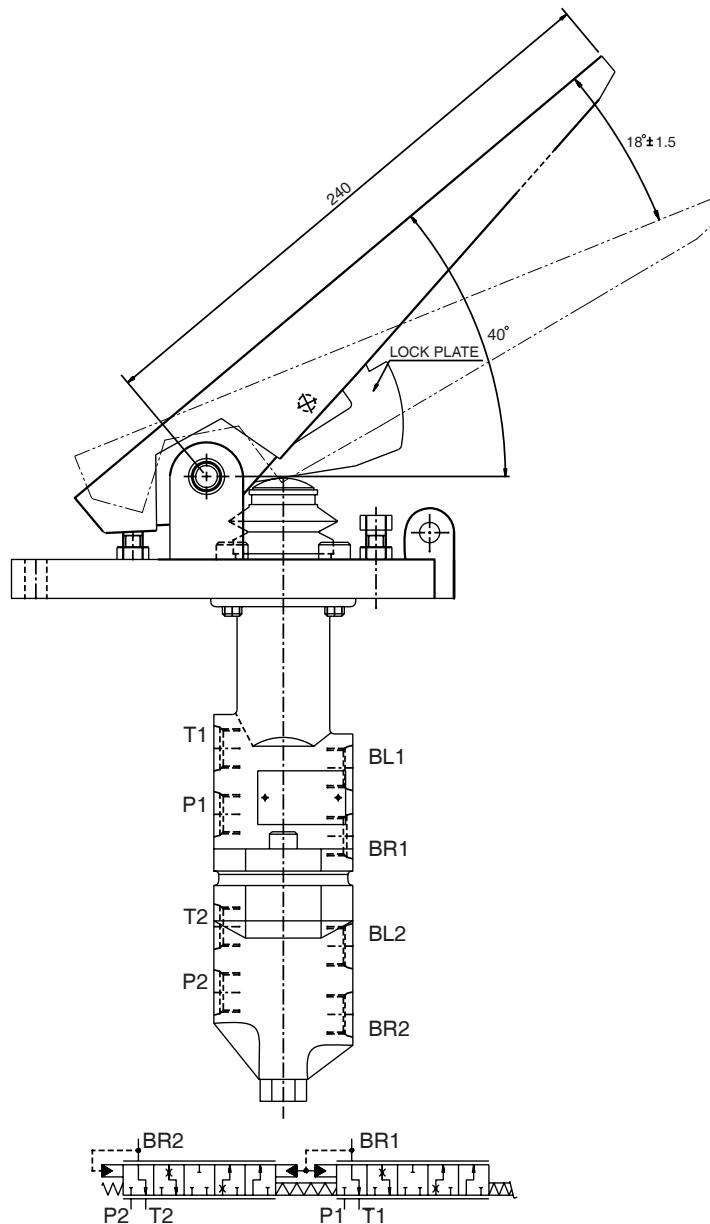
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

Theory of Operation

The brake pedal valve is attached to, and operated by, the brake pedal. See Figure 1. The valve contains two spools. See Figure 2. One spool ports fluid to the brake pistons in the front axle, and the other spool ports fluid to the brake pistons in the rear axle. Maximum system operating pressure is 45 ± 3 bars (653 ± 44 psi). If something in one of the circuits should fail, the other circuit will continue to operate.



FG008844

Figure 1

When the brake pedal is depressed, force is applied to the working element (6, Figure 2). This force is transferred to the primary control spool (1) and the secondary control spool (2) by the main control spring (5). This causes the control spools to close the path from the supply ports (P1 and P2) to the tank ports (T1 and T2). Simultaneously, the spool then open a path from the brake circuit ports (Br1 and Br2) to the supply ports (P1 and P2). Drilled passages in the control spools (1 and 2) allow fluid pressure in the ports P1 and P2 to act against the main control spring (5). This allows the brake pressure in both circuits to rise proportionally to the force applied to the brake pedal.

As the force applied to the brake pedal becomes constant, the control spools (1 and 2) move into a balanced position and hold the braking pressure constant.

When force is removed from the brake pedal, this removes force from the control spring. The return springs (3 and 4) now move the control spools (1 and 2) to the upward. The spools open a path from the brake circuit ports (Br1 and Br2) to the tank ports (T1 and T2) and this releases the pressure from the brake circuits.

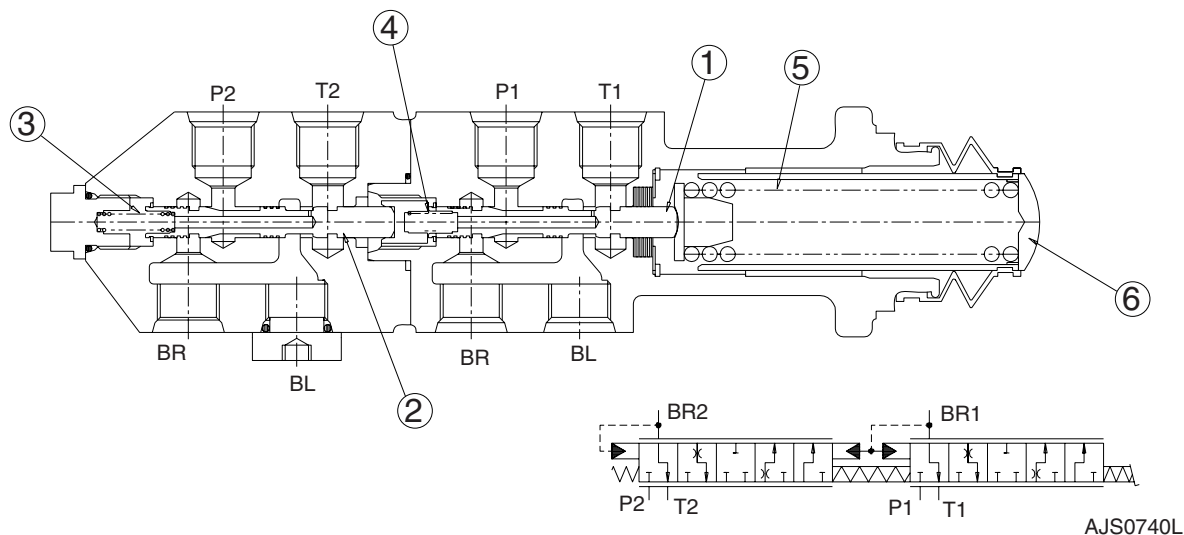


Figure 2

Reference Number	Description
1	Primary Control Spool
2	Secondary Control Spool
3	Lower Spring

Reference Number	Description
4	Upper Spring
5	Main Control Spring
6	Working Element

Specification

Item	Specification
Braking Pressure	46 ±3.1 kg/cm ² (45 ±3 bars)
Pedal Force	18 ±2.0 kg
Operating Angle	18 ±2°

Accumulator

Edition 1

MEMO

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Accumulator

Safety Instructions	5
Applicable Models	5
General Description	6
Specifications	8
Accumulator for LIS	9

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

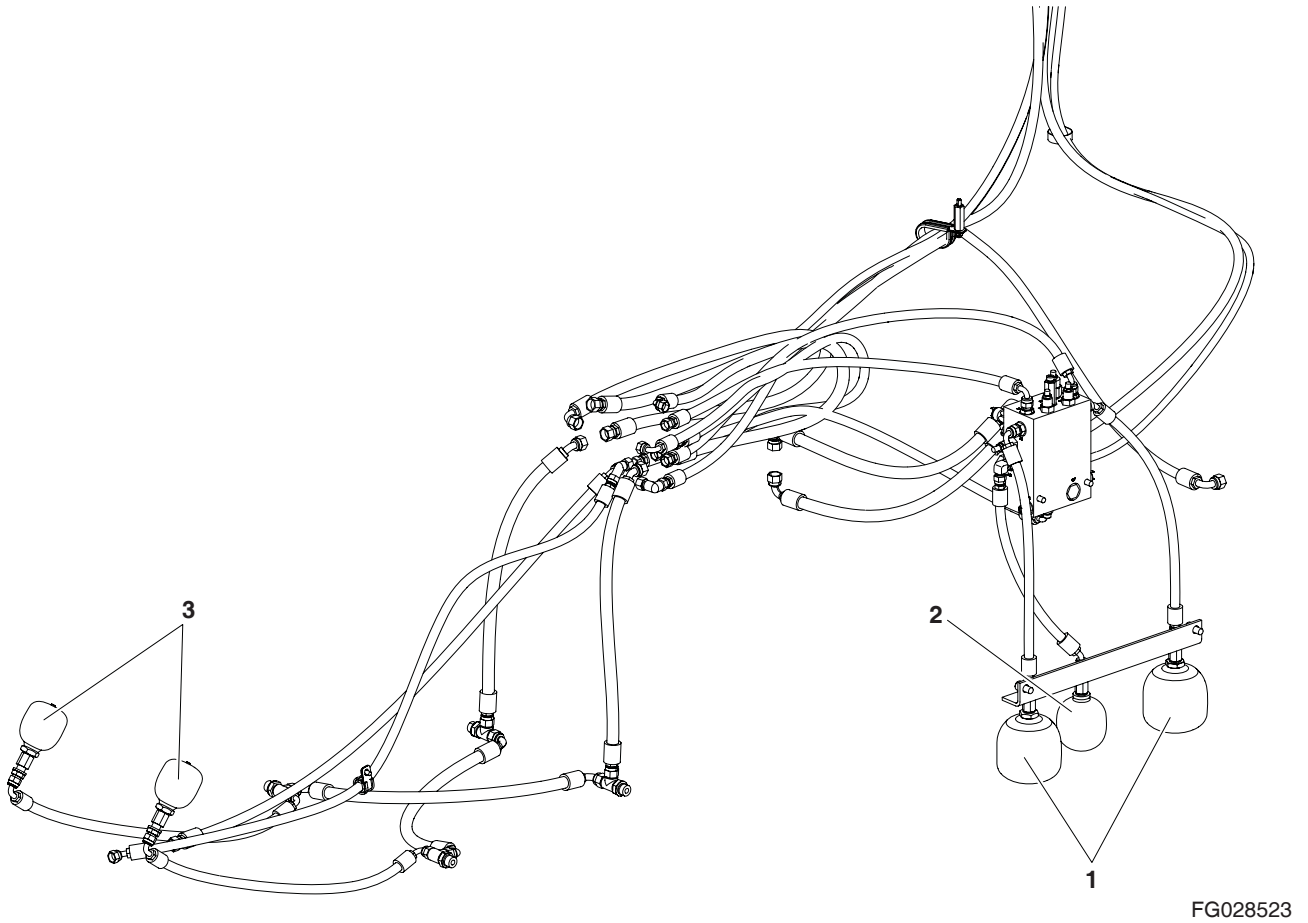


Figure 1

Reference Number	Description
1	Brake Accumulator
2	Pilot Accumulator

Reference Number	Description
3	Steering Accumulator

The accumulator is a gas charged storage device designed to hold a reserve quantity of hydraulic fluid under pressure. Accumulators are used in hydraulic circuits in much the same way that condensers (or capacitors) are used to collect, store and maintain electrical charge in a circuit.

In a hydraulic circuit, minor variations or lags in pump output that might otherwise cause unsteady or irregular operation are made up from the supply of pressurized oil in the accumulator.

Reference Number	Description
1	Shell
2	Diaphragm
3	Poppet
4	Fluid Port

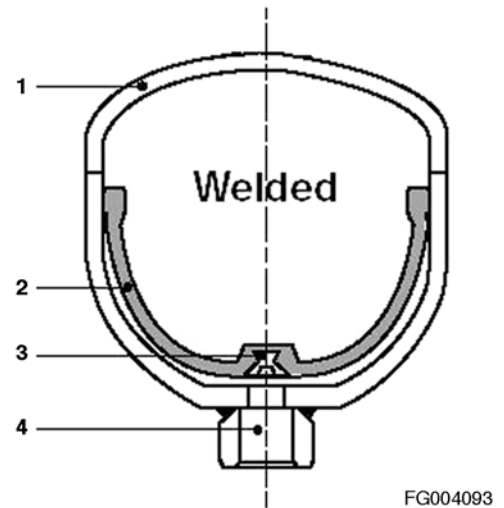


Figure 2

Accumulators are solidly constructed to resist the high operating pressures of the fluids they contain. There are only three main moving parts: a valve assembly at the top allows adding or expelling gas from the compressible, precharged upper chamber; a valve assembly at the bottom of the accumulator for passing hydraulic fluid in and out, and an elastic diaphragm to separate the two chambers. The flexible diaphragm changes shape to conform to the changing pressures and volumes of the two fluids in the upper and lower chambers.

There are six possible positions the diaphragm can be in and they are as follows:

1. With no gas charge in the upper chamber 0 bar (0 psi, empty) and no oil in the bottom 0 bar (0 psi, dry) the elastic diaphragm hangs loosely.
2. When the prepressure charge of gas (usually nitrogen) is introduced through the valve at the top of the accumulator, the diaphragm expands to maximum size. The valve button in the center of the diaphragm pushes into the fluid opening in the bottom chamber, sealing off the lower valve. If the pressure of the gas charge exceeds system oil pressure, no fluid enters the accumulator. The button also keeps the diaphragm from protruding into the lower valve opening.

NOTE: Precharge pressure is referred to as the "P1" pressure. The accumulator manufacturer's "P1" rated pressure should be stamped or marked on the accumulator's rating plate. Annual checks of actual precharge pressure should be made by tapping a hydraulic pressure gauge (and 3-way adapter coupling) into the valve on the bottom of the accumulator. When hydraulic fluid is pushed out the lower valve opening by the pressure of the gas charge on the other side of the diaphragm - and there is no counter pressure from system oil - the valve button on the bottom of the diaphragm eventually seals off

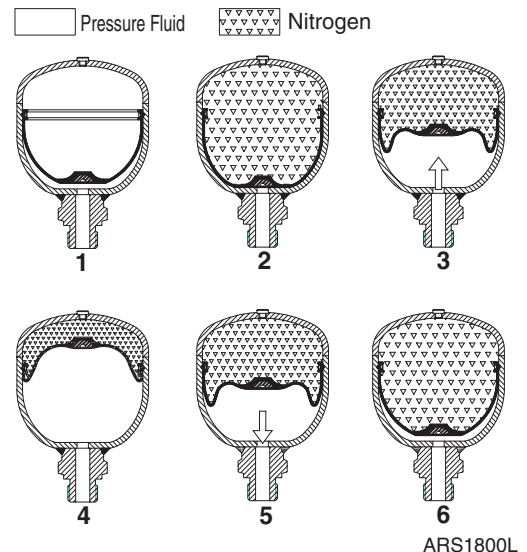


Figure 3

the lower oil passage. Just after the needle on the gauge reaches its highest point (when there is 0 bar (0 psi) resistance from hydraulic system pressure) pressure on the gauge will drop sharply to zero, as the accumulator is completely emptied of oil and the diaphragm button closes.

Record the highest gauge reading and compare to the "P1" rated precharge pressure on the accumulator manufacturer's data label. Repeat this test at least once a year to verify proper functioning of the accumulator.

3. As hydraulic system pressure overcomes accumulator precharge pressure, the flexible diaphragm begins to retract upward.
4. When system oil is at highest working pressure and the accumulator fills to maximum reserve capacity, the flexible diaphragm is pushed up into the top of the upper chamber.

The highest working pressure is sometimes referred to as the "P3" pressure and can also be referenced on the manufacturer's data label on the exterior of the accumulator.

5. If system oil pressure begins to fall off or is momentarily checked or interrupted, the energy stored on the other side of the diaphragm, in the form of compressed gas, pushes oil back out of the lower chamber, maintaining oil pressure of the circuit.
6. With minimal system pressure, an equilibrium point may be reached in which accumulator precharge pressure and hydraulic system oil pressure achieve a rough balance. In this condition a minimal amount of oil is stored in the accumulator.

Specifications

System	Charge Pressure	Volume
Brake	30 kg/cm ² (29.4 bar (430 psi))	750 cc (45.77 in ³)
Pilot	15 kg/cm ² (14.7 bar (210 psi))	320 cc (19.53 in ³)
Steering	35 kg/cm ² (34.3 bar (498 psi))	160 cc (9.76 in ³)

Accumulator for LIS

Specification

General	
Ambient Temperature Range	- 20 ~ + 80 °C
Weight	20 kg (44 b)
Hydraulic	
Operating Pressure	286 kg/cm ² (280 bar (4,061 psi))
Max. Nominal Flow	200 lpm
Capacity (Oil)	3 liters

Parts List

The gas pressure p0 is variable
with our charging and gauging set.
Torque screw 20Nm

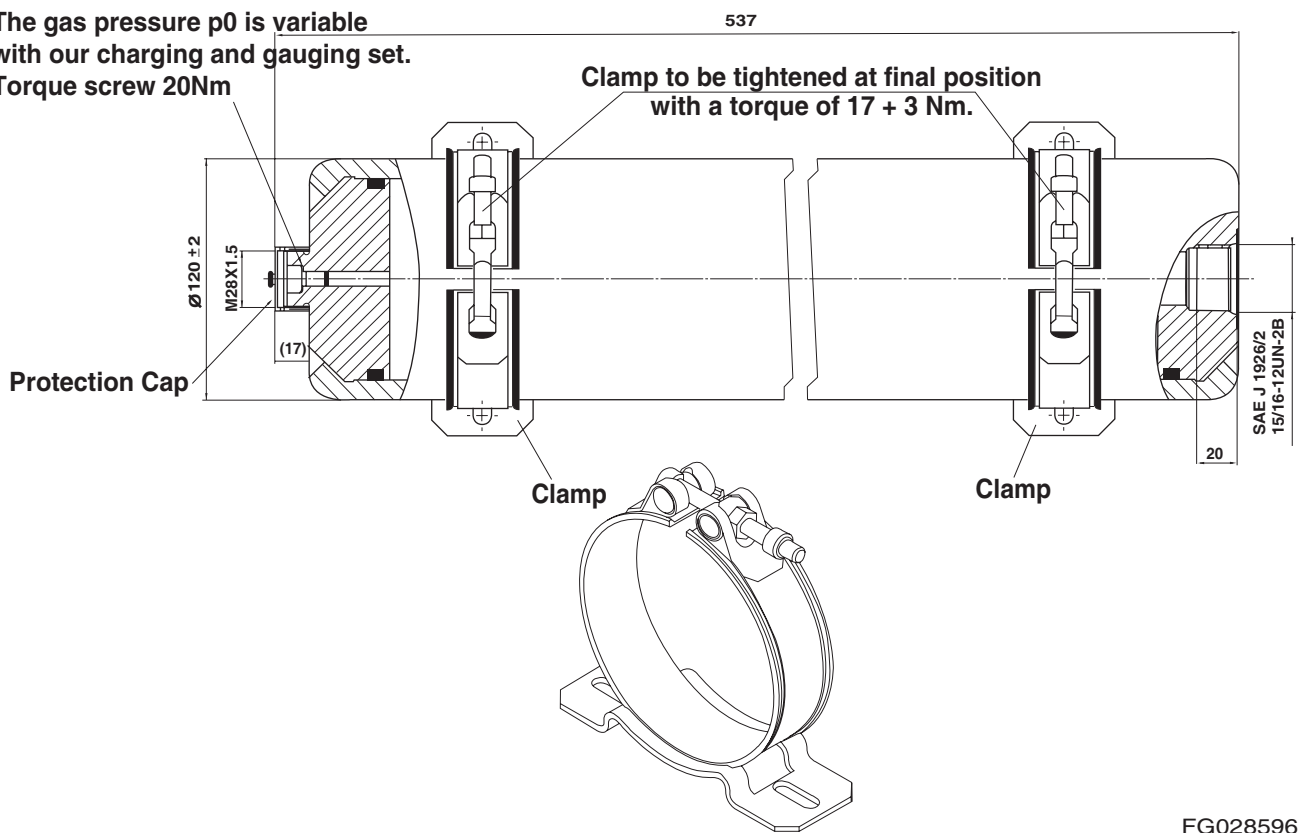


Figure 4

Steering

Power Steering System

Edition 1

MEMO

Table of Contents

Power Steering System

Safety Instructions	5
Applicable Models	5
General Description	6
Disassembly	7
Assembly	14

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

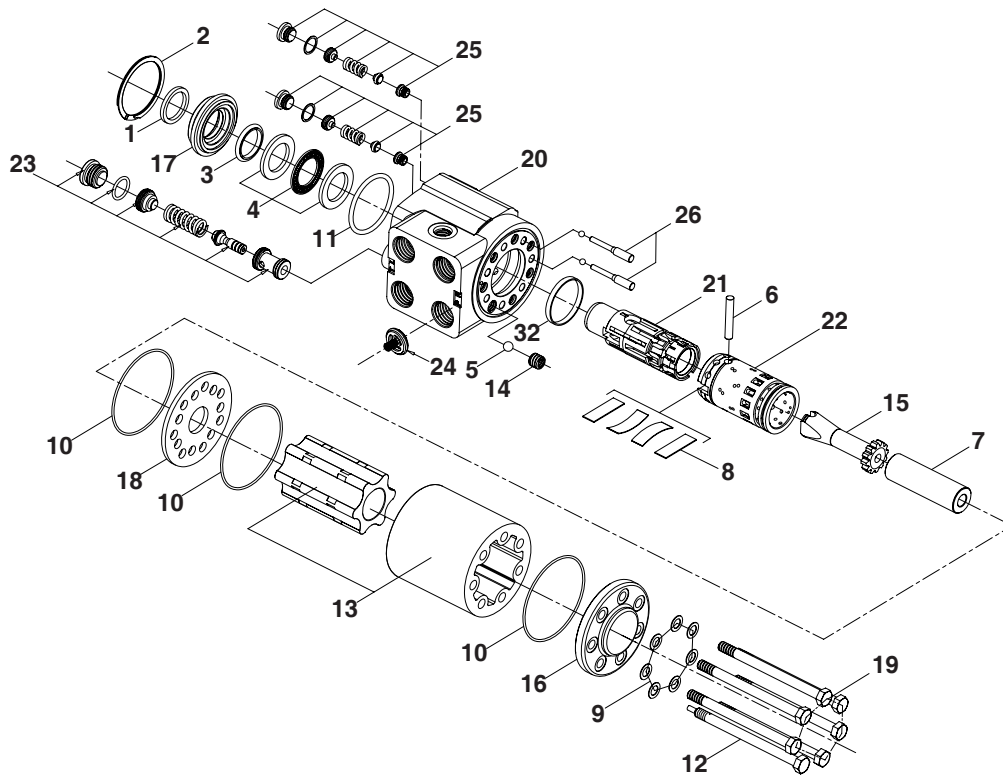
Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200-3	10001 and Up
DL200A	10001 and Up
DL250A	10001 and Up

GENERAL DESCRIPTION



FG026048

Figure 1

Reference Number	Description
1	Dust Seal
2	Retaining Ring
3	Cap Seal
4	Bearing Assembly
5	Ball
6	Pin
7	Spacer
8	Spring
9	Washer
10	O.ring
11	O.ring
12	Rolled Screw
13	Gerotor Set

Reference Number	Description
14	Bore Screw
15	Drive
16	End Cap
17	Gland Bushing
18	Plate
19	Cap Screw
20	Housing
21	Spool
22	Sleeve
23	Relief Valve Assembly
24	Check Valve Assembly
25	Shock Valve Assembly
26	Suction Valve Assembly

DISASSEMBLY

1. Dismantle steering column from steering unit and place the steering unit in the holding tool.
Screw out the screws in the end cover (6 plus one special screw)

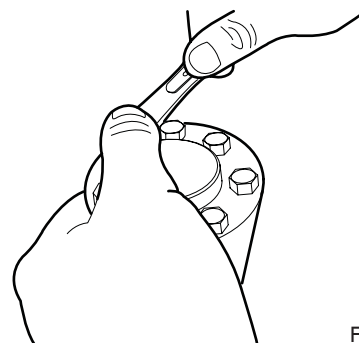


Figure 2

FG026049

2. Remove the end cover, take out the O-ring.

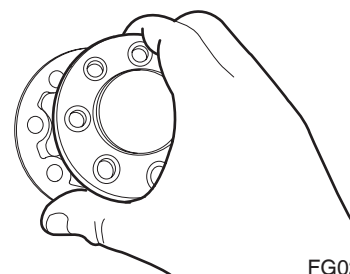


Figure 3

FG026050

3. Lift the gerotor set, take out the O-ring.

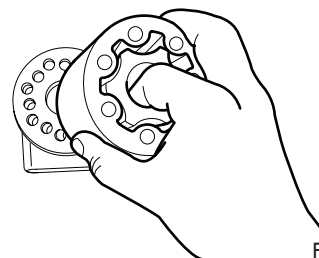


Figure 4

FG026051

4. Remove the drive.

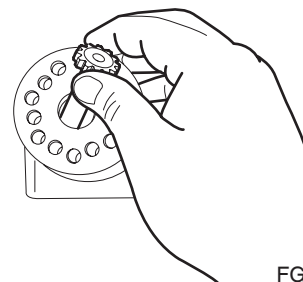


Figure 5

FG026052

5. Remove the plate.

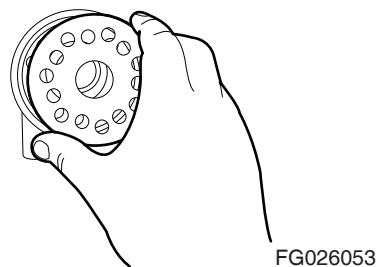


Figure 6

6. Screw out the bore screw with flat end driver.

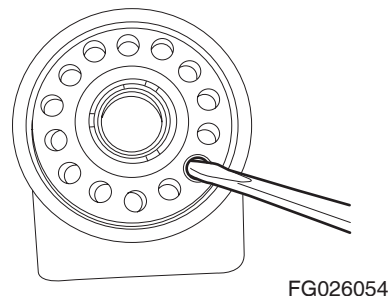


Figure 7

7. Take out the o-ring.

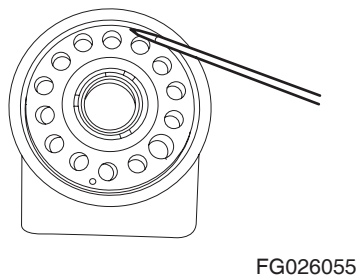


Figure 8

8. Shake out the check valve ball and suction valve ball and rolled pins.

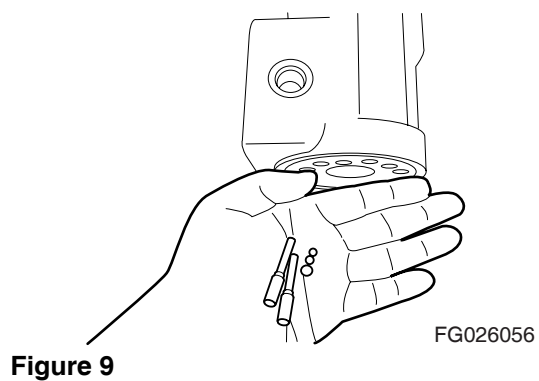
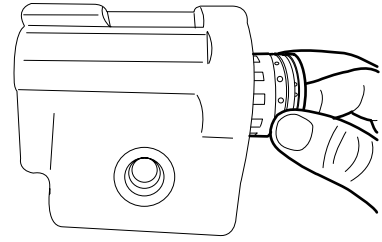


Figure 9

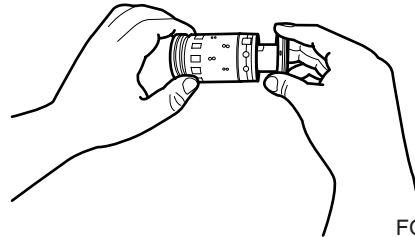
9. Make sure to keep the cross pin in the sleeve and spool horizontal. Press the spool inwards and the sleeve, ring, bearing races and bearing will be pushed out of the housing together.



FG026057

Figure 10

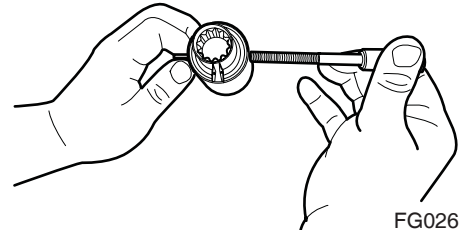
10. Take bearing races and bearing from the sleeve and spool.



FG026058

Figure 11

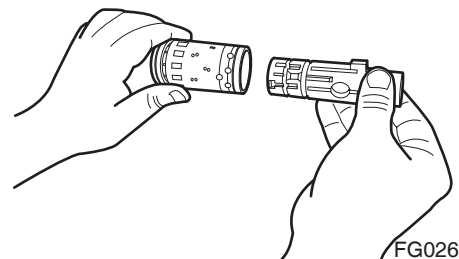
11. Press out the pin. Use the special screw from the end cover.



FG026059

Figure 12

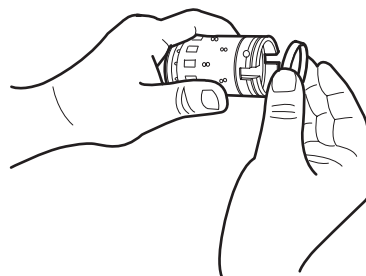
12. Carefully press the spool out of the sleeve.



FG026060

Figure 13

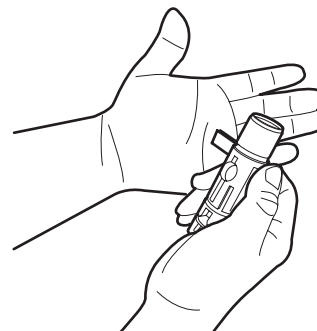
13. Take out the ring from the sleeve.



FG026061

Figure 14

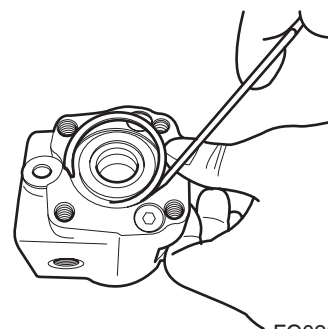
14. Press out the centering and plate springs.



FG026062

Figure 15

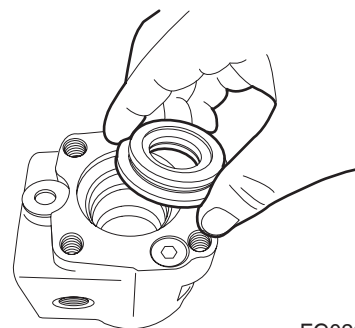
15. Remove the retaining ring by plying its leaf using flat end driver roundly.



FG026063

Figure 16

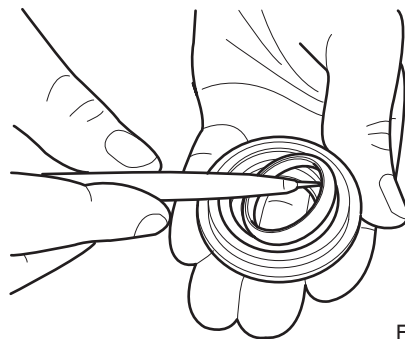
16. Remove the gland bushing.



FG026064

Figure 17

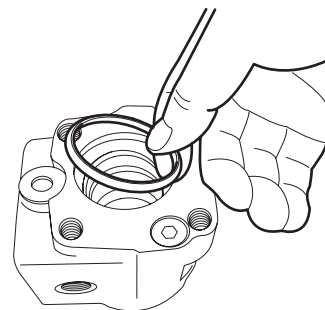
17. Remove cap seal and dust seal.



FG026065

Figure 18

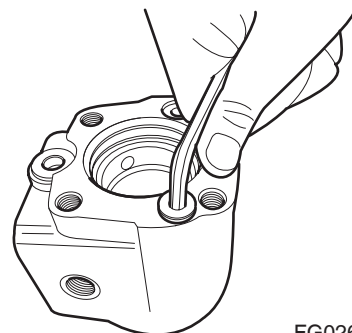
18. Take out the o-ring.



FG026066

Figure 19

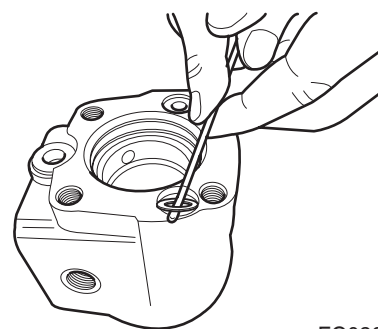
19. Remove plugs from shock valves using a 6 mm hexagon wrench.



FG026067

Figure 20

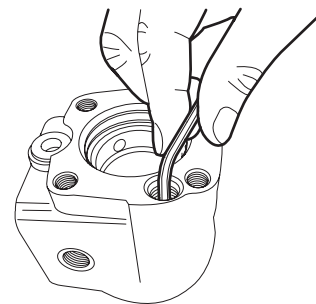
20. Remove copper washer from the housing.



FG026068

Figure 21

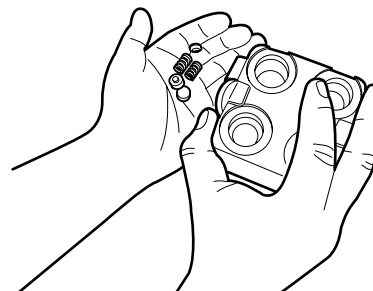
21. Remove fixed plug using 4 mm hexagon wrench.



FG026069

Figure 22

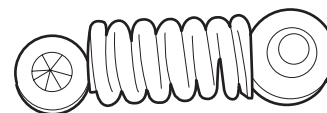
22. Shake out the spring and poppets. The seat is firmly fixed in the housing.



FG026070

Figure 23

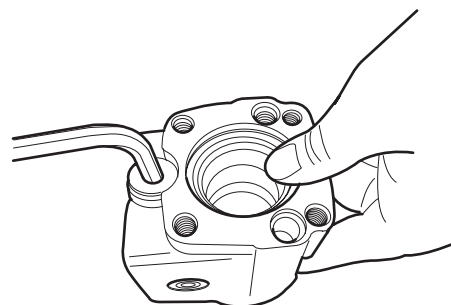
23. Dismantled shock valve.



FG026071

Figure 24

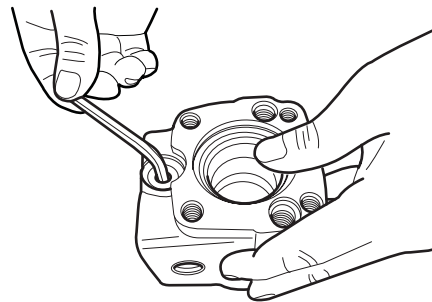
24. Remove the relief valve plug using 8 mm hexagon wrench. Take out the o-ring.



FG026072

Figure 25

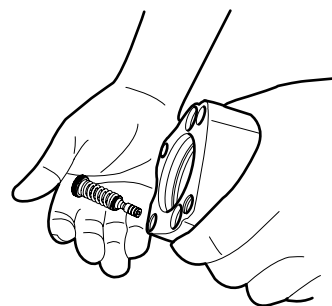
25. Remove spring seat using 6mm hexagon wrench.



FG026073

Figure 26

26. Shake out the spring and spool from the housing.
The bushing is firmly fixed in the housing.



FG026074

Figure 27

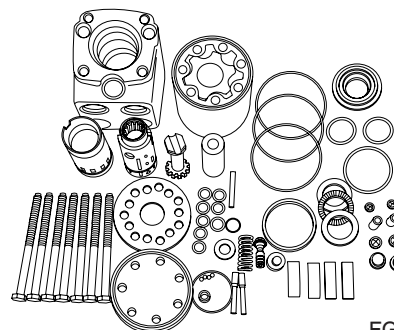
27. Dismantled relief valve.



FG026075

Figure 28

28. The steering unit is now completely dismantled.

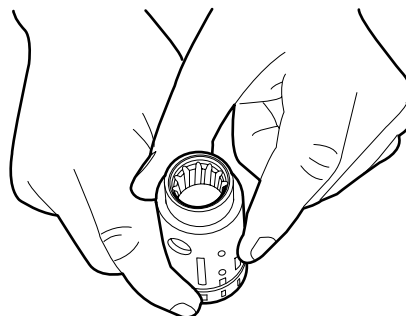


FG026076

Figure 29

ASSEMBLY

1. Press the centering and plate spring into the spool.



FG026077

Figure 30

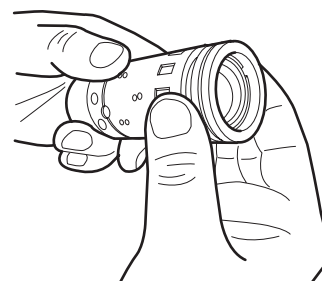
2. Make sure the centering and plate spring aligned as shown.



FG026078

Figure 31

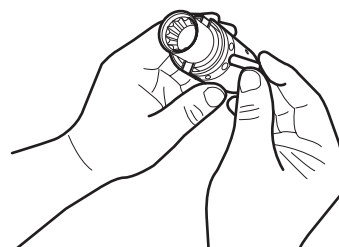
3. Make sure the spool and sleeve aligned correctly in relation to each other.
(There are three slots in the spool and three holes in the sleeve in the end. Rotate them so that the slots and holes aligned with each other.)



FG026079

Figure 32

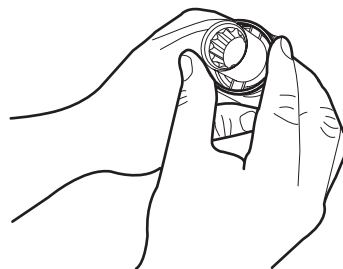
4. Push the pin into the sleeve.



FG026080

Figure 33

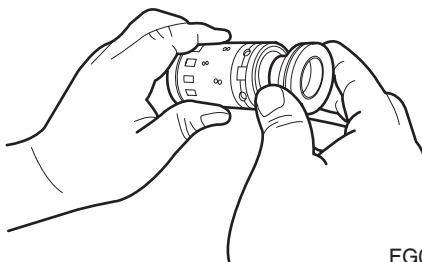
5. Fit the ring into the sleeve.



FG026081

Figure 34

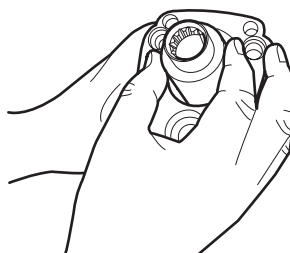
6. Line up the bearing and bearing race as shown.



FG026082

Figure 35

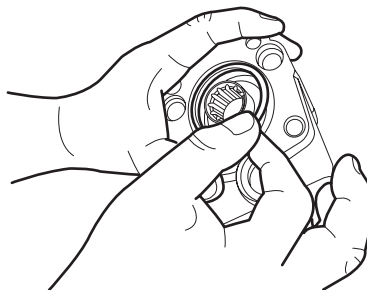
7. Guide the spool and sleeve into the housing bore.



FG026083

Figure 36

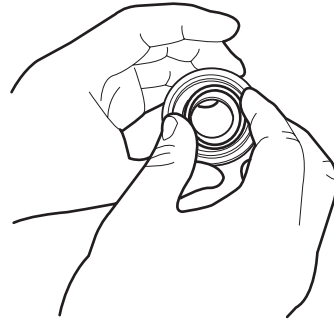
8. Place the o-ring.



FG026084

Figure 37

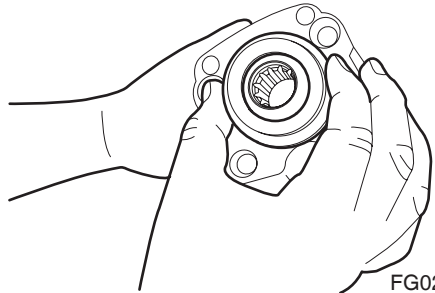
9. Squeeze the cap seal into the gland bushing and push hard the dust seal into it.



FG026085

Figure 38

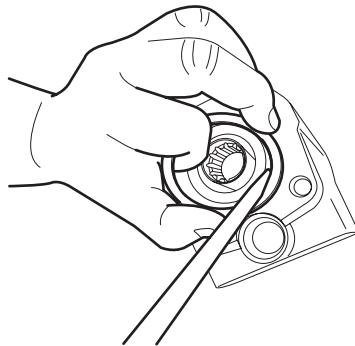
10. Place gland bushing between the spool and the housing.



FG026086

Figure 39

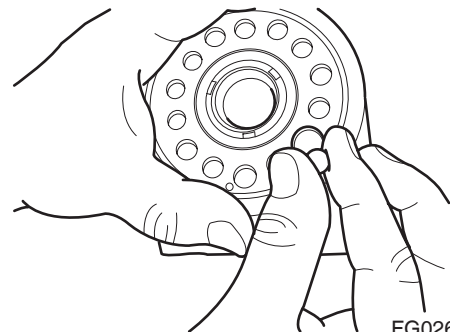
11. Push the retaining ring into the housing by plying each lip roundly by flat end driver.



FG026087

Figure 40

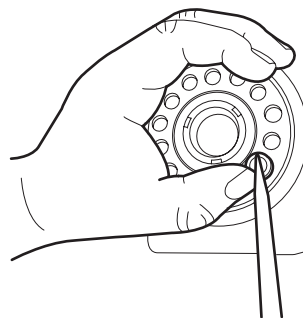
12. Put the ball into the housing hole.



FG026088

Figure 41

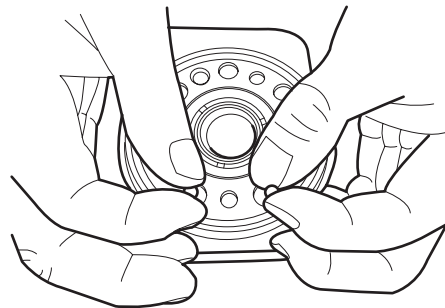
13. Screw in the bore screw by flat end driver.
(The top of the screw must lie just below the surface)



FG026089

Figure 42

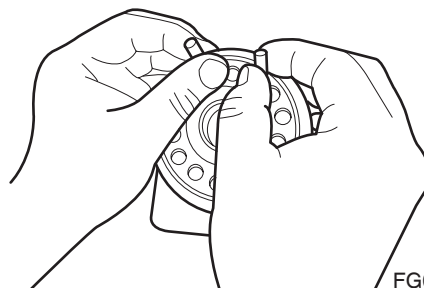
14. Place the small balls into the holes as shown.



FG026090

Figure 43

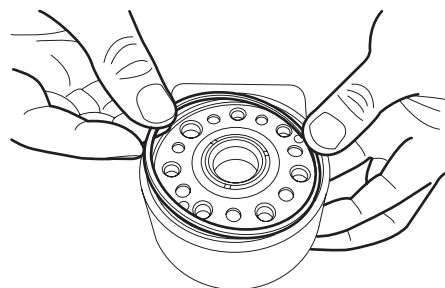
15. Place rolled pins into the holes.



FG026091

Figure 44

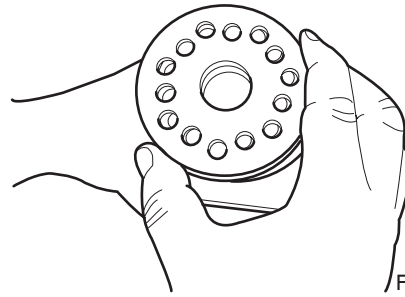
16. Place the o-ring.



FG026092

Figure 45

17. Place the plate so that the holes match with the housing's.



FG026093

Figure 46

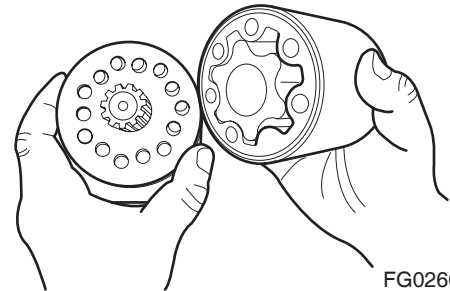
18. Guide the drive. Turn the pin by it so that the pin position take the known position.



FG026094

Figure 47

19. Place the o-ring into the groove of stator. Place the gerotor set on the plate. (The splined area contacts drive).



FG026095

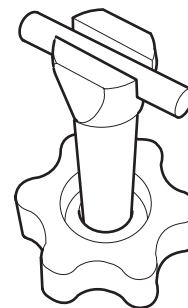
Figure 48



CAUTION

AVOID INJURY

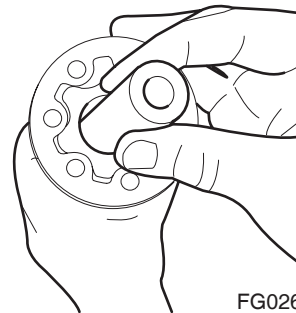
Fit the inner rotor with drive and make sure the pin and the dedendum of the rotor be aligned as shown.



FG026096

Figure 49

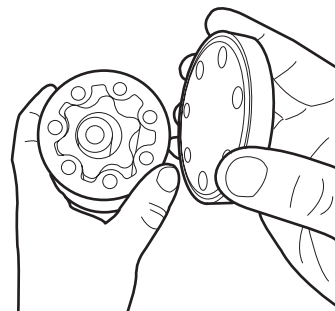
20. Fit the spacer.



FG026097

Figure 50

21. Put the o-ring into the end cap groove and place the end cap on the housing.

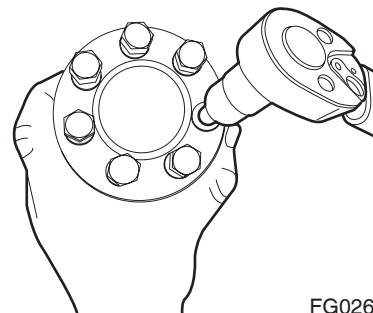


FG026098

Figure 51

22. Tighten cap and rolled screw after put the copper washer on them.

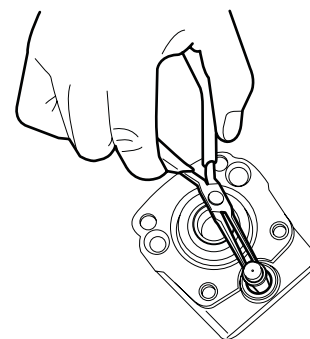
- Tightening Torque: 30 ± 6 Nm



FG026099

Figure 52

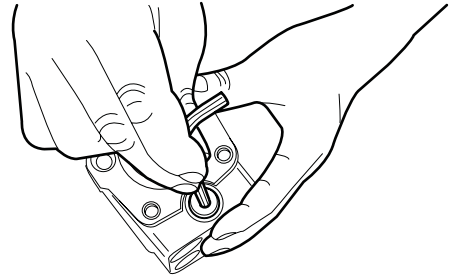
23. Fit the relief spool into the busing.



FG026100

Figure 53

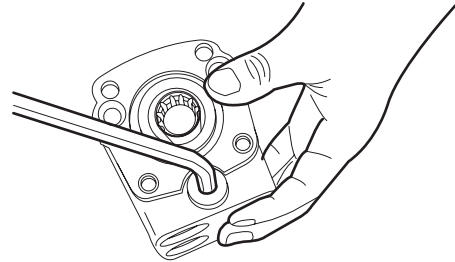
24. Fit the spring and spring seat. (Do the pressure setting on a test bench or the vehicle. Calk the seat by punching it.)



FG026101

Figure 54

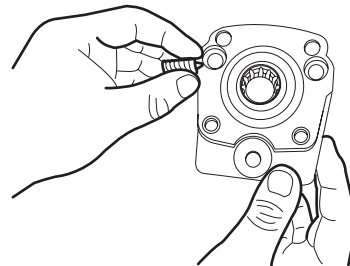
25. Screw in the plug with o-ring.
- Tightening torque: 60 ± 5 Nm



FG026102

Figure 55

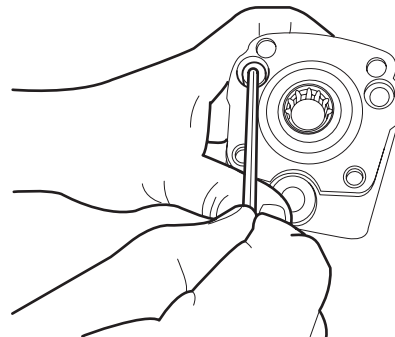
26. Fit the poppet and spring into the shock valve bore.



FG026103

Figure 56

27. Screw into the fixed plug. (Do the pressure setting on a test bench or the vehicle. Calk the plug by punching it.)

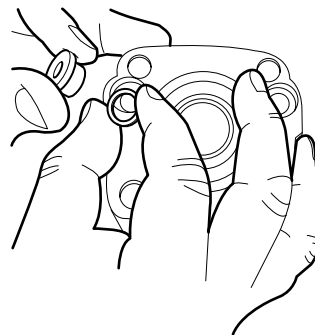


FG026104

Figure 57

28. Put the copper washer and screw in the plug.

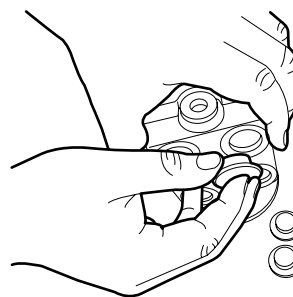
- Tightening torque: 30 ± 5 Nm



FG026105

Figure 58

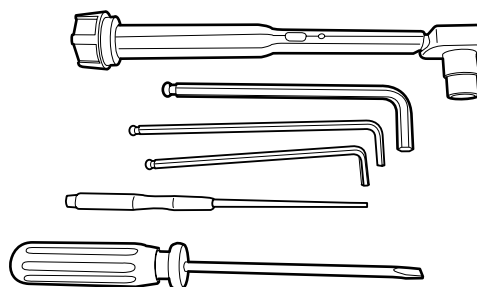
29. Plug the ports (T, L, R, LS) by rubber plugs. Screw in the plastic cap into the P-port.



FG026106

Figure 59

- Tools



FG026107

Figure 60

Steering

Edition 1

MEMO

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Steering

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Steering Unit	8
Function	8
Function	10
Picture of Components	10

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

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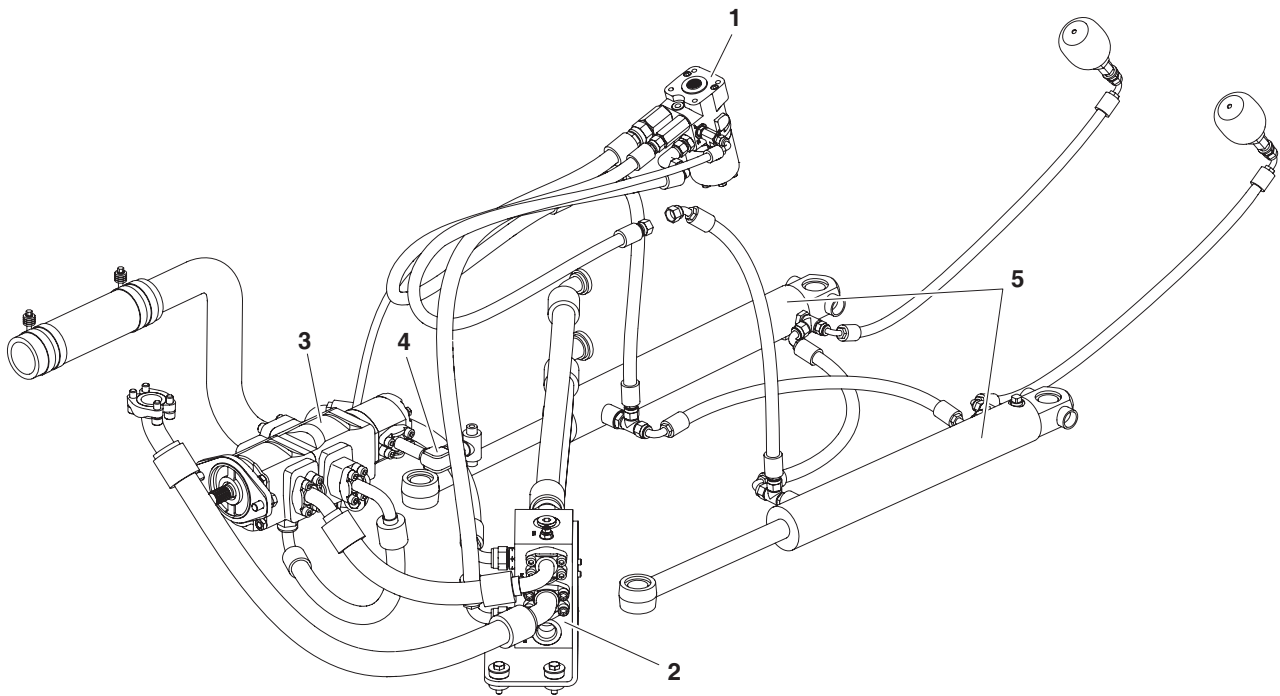
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

Power Steering System



FG028503

Figure 1

Reference Number	Description
1	Steering Unit
2	Main Block Valve
3	Main & Steering Pump

Reference Number	Description
4	Priority Valve
5	Steering Cylinder

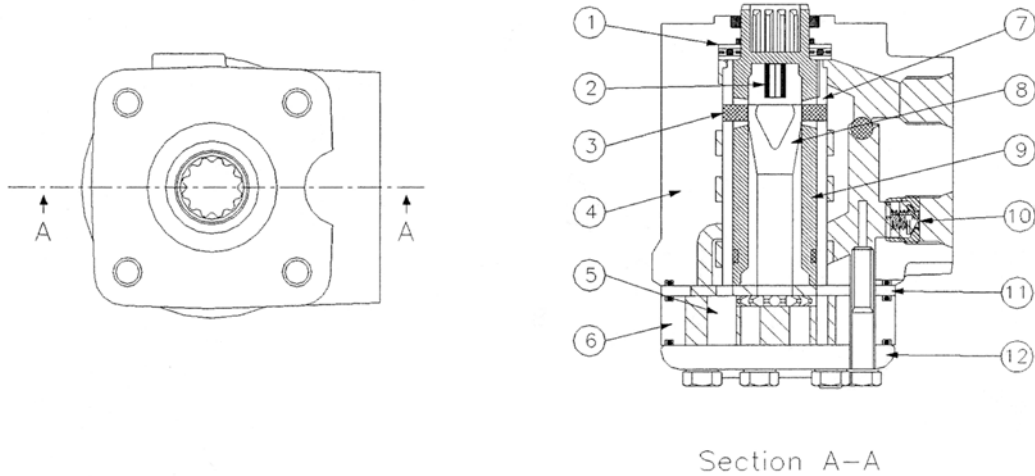


Figure 2 HYDRAULIC CIRCUIT

Reference Number	Description
1	Cushion Valve
2	Steering Unit
3	Main Block Valve

Reference Number	Description
4	Main & Steering Pump
5	Priority Valve
6	Steering Cylinder

Steering Unit



BYS0080S

Figure3

Reference Number	Description
1	Bearing
2	Neutral Position Spring
3	Cross Pin
4	Housing
5	Gear Wheel
6	Gear Rim

Reference Number	Description
7	Sleeve
8	Cardan Shaft
9	Spool
10	Check Valve
11	Distributor Plate
12	End Cover

Function

The steering unit consists of a rotary valve and a rotary metering unit.

Via a steering column the steering unit is connected to the steering wheel of the vehicle.

When the steering wheel is turned, oil is directed from the steering system pump via the rotary valve (spool and sleeve) and rotary metering (gear wheel set) to the cylinder ports L or R, depending on the direction of turn. The rotary meter, meters the oil flow to the steering cylinder in proportion to the rotation of the steering wheel.



Spool (9) is connected directly to the drive shaft of steering wheel. It is connected to sleeve (7) by center pin (3) (not in contact with the spool when the steering wheel is at Neutral) and neutral position spring.

At the same time, the cardan shaft is meshed with the gear rim (5) of the Gerotor set, by the splices.

There are four ports in valve body. They are connected to the pump circuit, tank circuit, and the head, and left and right steering cylinder. In addition, the pump port and tank port are connected inside the body by the check valve. If there is on flow available, oil will be sucked in directly from the tank through the check valve (Emergency steering).

FUNCTION

The main relief valve is inside the EHPS valve, and set the maximum circuit pressure of the steering circuit. When the EHPS valve is being actuated, and the steering circuit goes up above the set pressure of this valve, oil will be relieved, and the priority valve spool will be actuated, and the oil will be drained to EF port.

Picture of Components

Main steering spool.

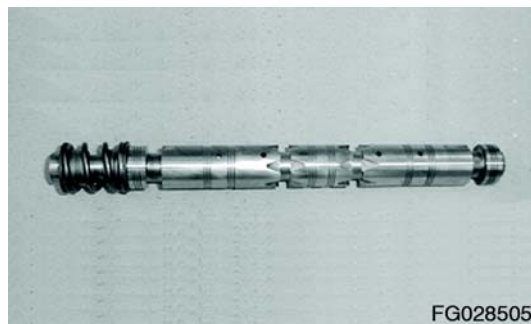


Figure 5

Priority spool.



Figure 6

Metering spool.



Figure 7

Relief valve.

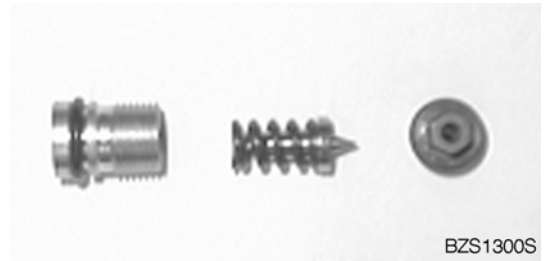


Figure 8

Shock valve



Figure 9

Pressure reducing valve



Figure 10

Shuttle valve

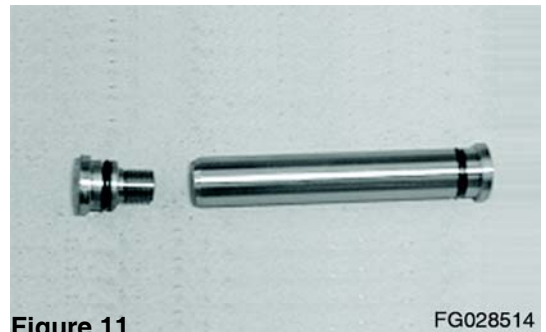


Figure 11

End cover mounted on the house with 4 screws

Torque $0.82 \pm 0.05 \text{ kg}\cdot\text{m}$ (5.90 ft lb).

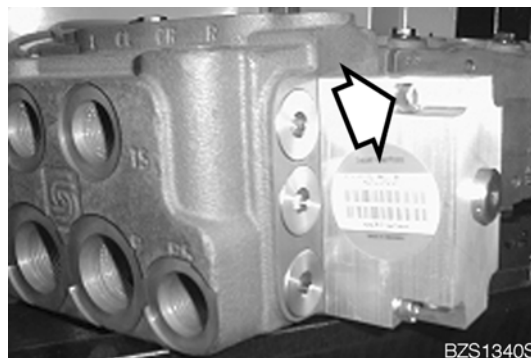


Figure 12

EHPS house.

Reference Number	Description
1	Metering Spool
2	Main Spool (Behind End Cover)
3	Pressure Reduction Valve (Behind End Cover)
4	Priority Spool

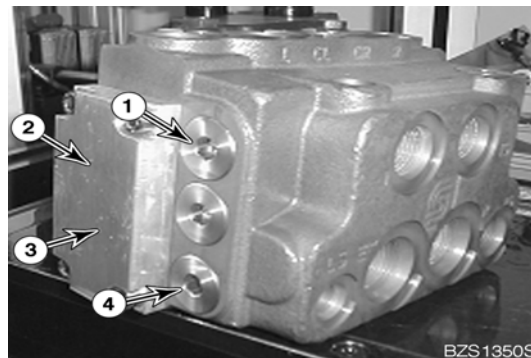


Figure 13

Emergency Steering

Edition 1

MEMO

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Emergency Steering

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Emergency Steering Automatic Test	8
Pump & DC Motor	10

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

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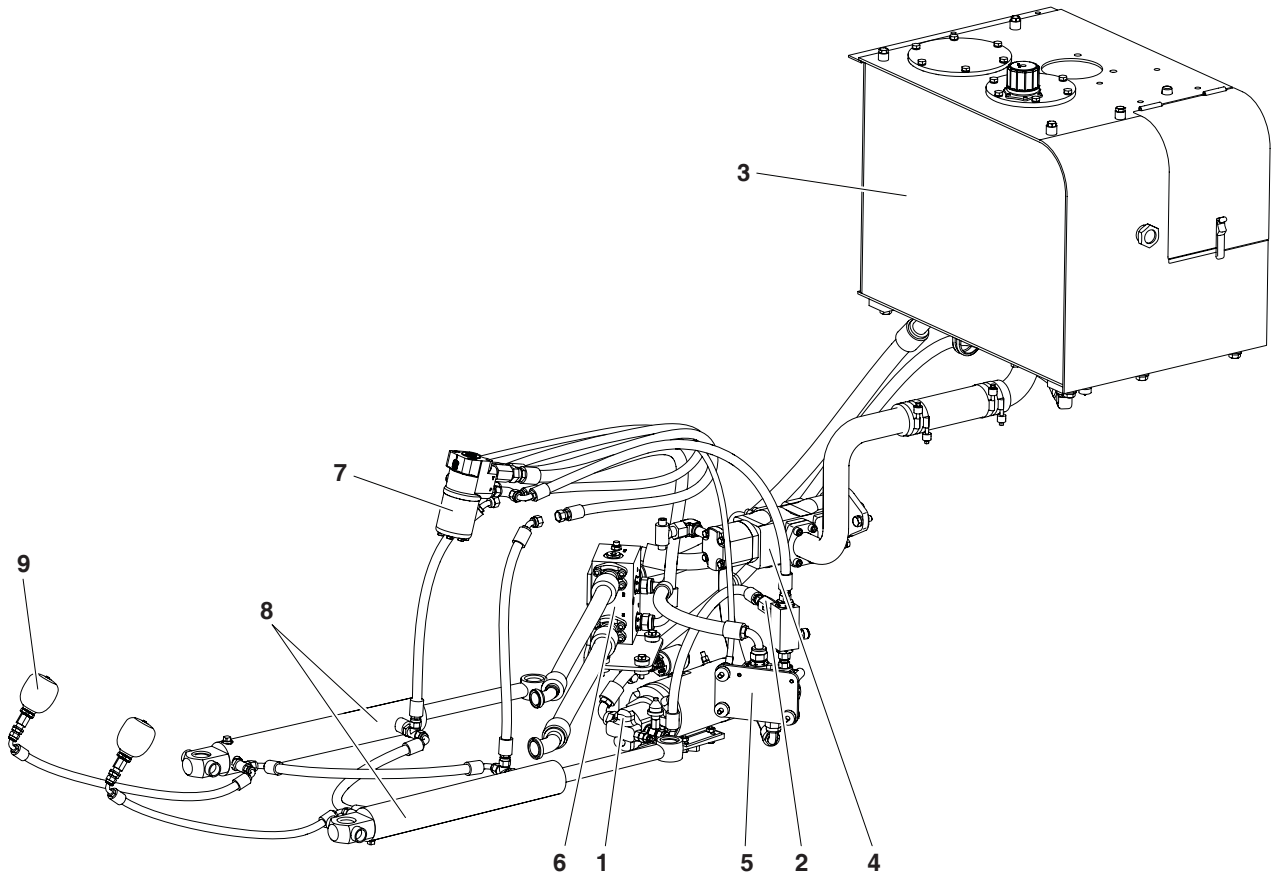
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

This system is designed for applications requiring a secondary steering when the primary source becomes nonfunctional & includes electrically-driven hydraulic pump controlled by the emergency steering relay.



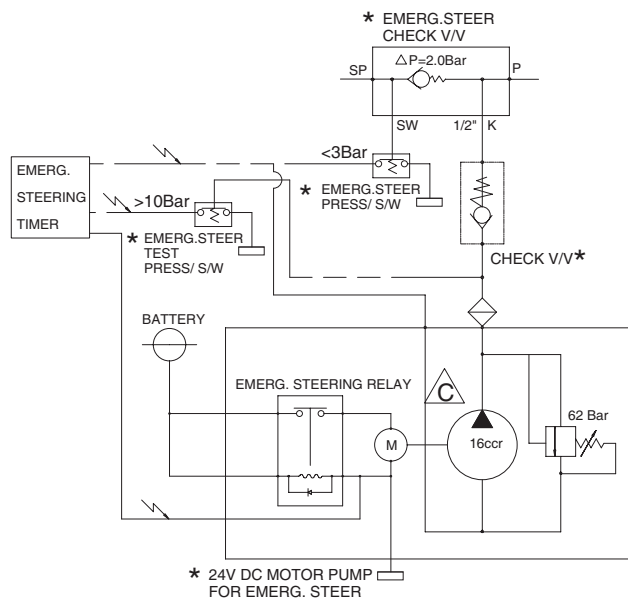
FG028524

Figure 1

Reference Number	Description
1	Pump & DC Motor
2	Shuttle Valve
3	Oil Tank
4	Steering Pump
5	Priority Valve

Reference Number	Description
6	Unloader Valve
7	Steering Unit
8	Steer Cylinder
9	Accumulator

If travel speed exceeds 5 km/h and the pressure at the check valve (4) is under 3.0 bar (44 psi), emergency steering starts. This is run for 60 seconds by the timer.



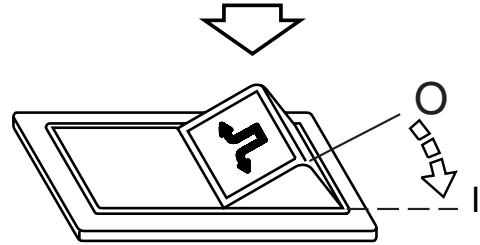
*ELECTRIC EMERGENCY STEERING (OPT.)

FG028607

Figure 2 Electric Circuit

Emergency Steering Function Test

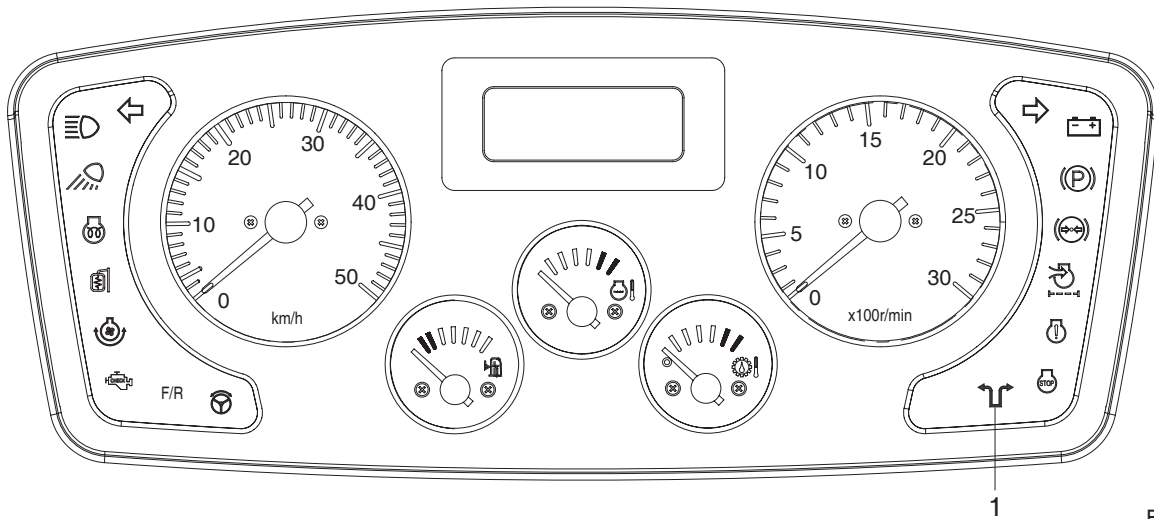
Emergency steering system function test is performed on a stationary machine with engine off. The ignition switch must be in position I (ON). When test switch in the cabin is pressed, turn steering wheel at the same time. If system is functioning properly the machine should steer.



AJO0011L

Figure 3 TEST SWITCH

The secondary steering indicator light should turn "ON". Emergency steering indicator light (option) indicates that emergency steering pump starts(1).



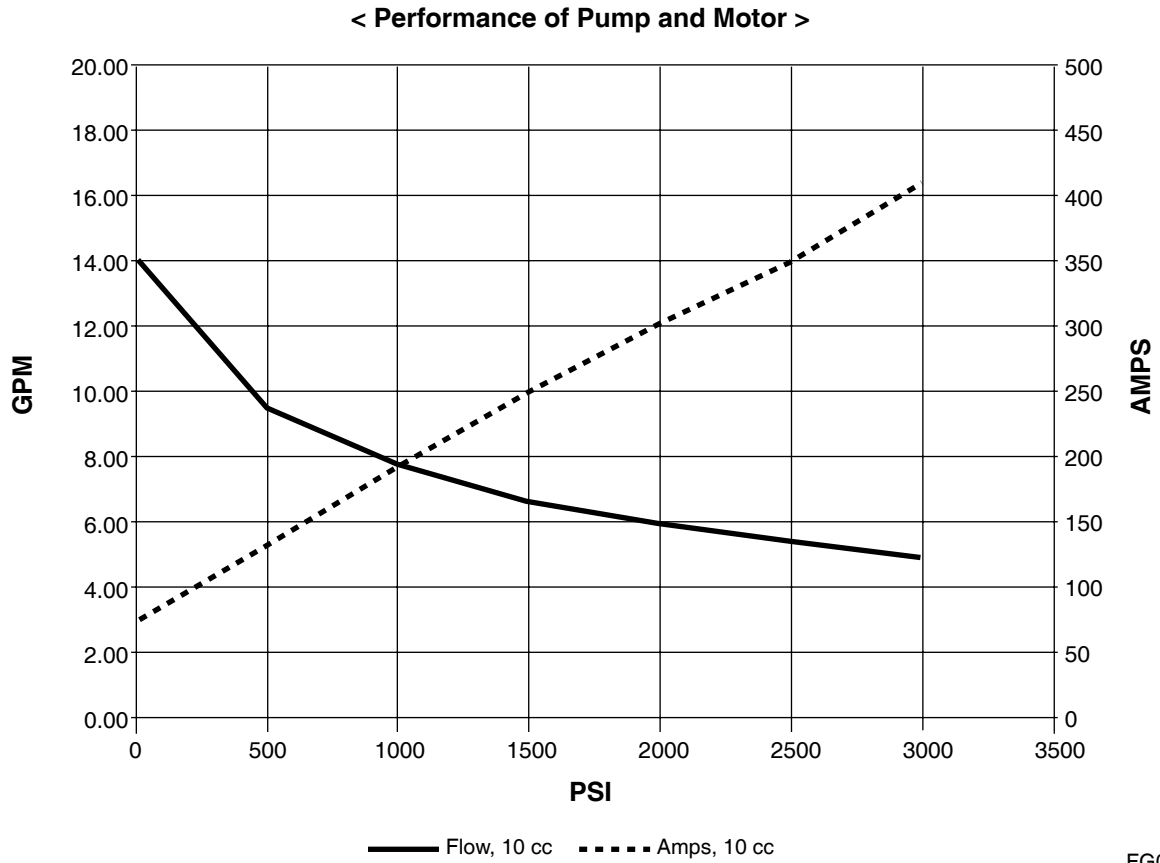
FG006741

Figure 4

Emergency Steering Automatic Test

This is a system that check a pressure on the emergency steering line. It starter switch turn to I (ON) position, a emergency lamp on the front gauge panel light up about 3 seconds.

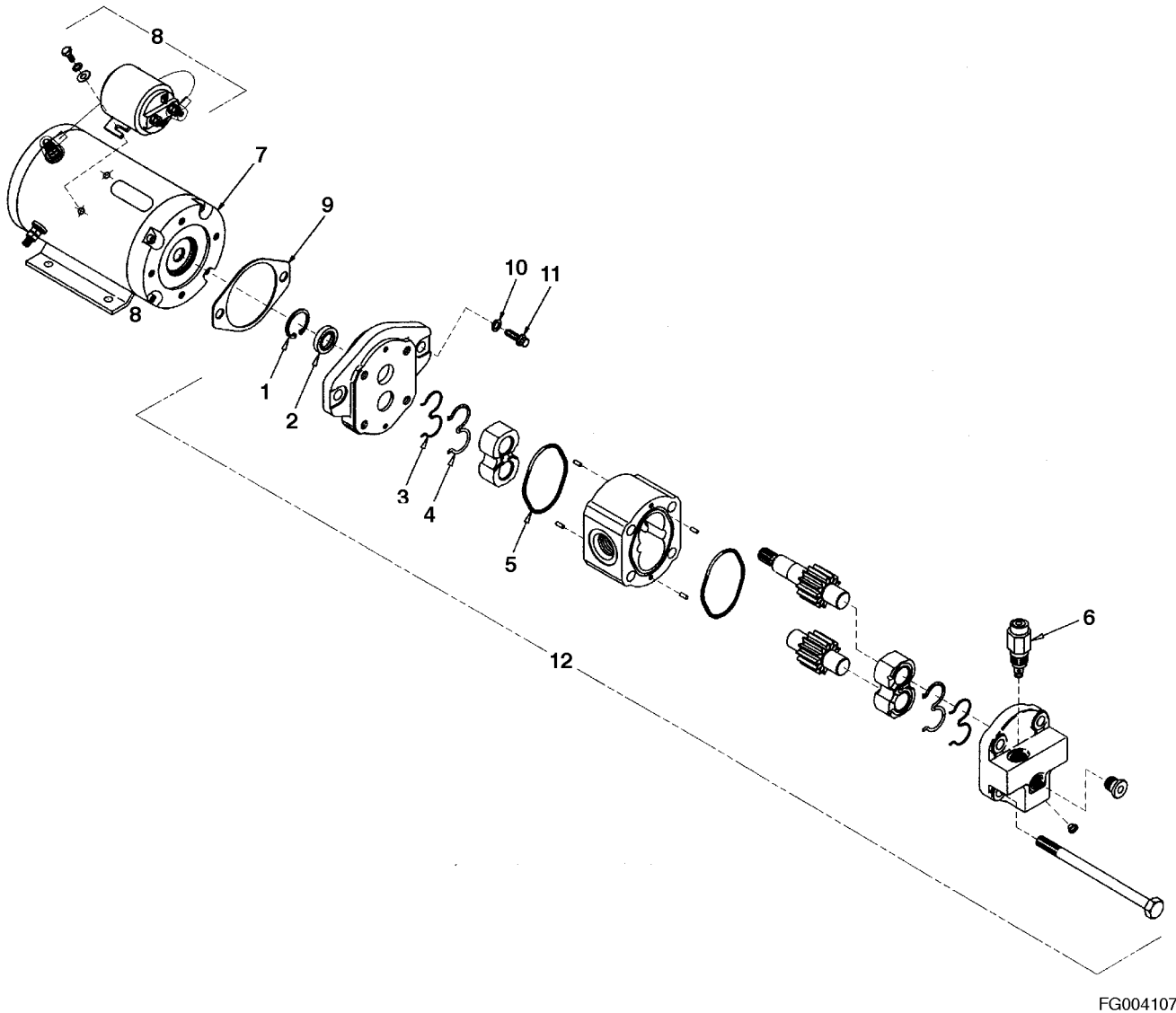
Do not press test switch continuously. Continuously pressing switch will cause heavy battery discharge. The emergency steering DC-motor uses high consumption of power as Figure 5.



FG005128

Figure 5

PUMP & DC MOTOR



FG004107

Figure 6

Reference Number	Description
1	Retaining Ring
2	Shaft Seal
3	Backup Ring
4	Seal
5	O-ring
6	Valve Assembly

Reference Number	Description
7	DC Motor
8	Start Sw Kit
9	Gasket
10	Lock Washer
11	Mounting Screw
12	Pump Assembly

Frame

Articulation Center

Edition 1

MEMO

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Articulation Center

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

The loader frame is an articulated type: the front frame is joined to the rear frame with two hinge pins around which the loader pivots for steering.

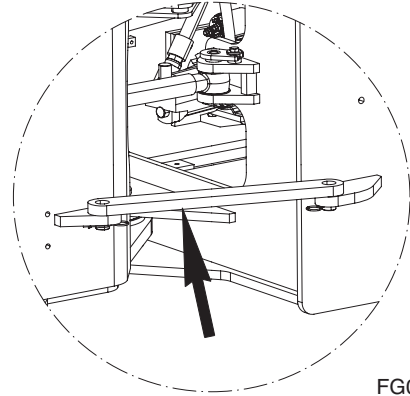


CAUTION

AVOID INJURY

When the loader is steered, the area near the center hinge pins becomes so narrow that you might get caught between the front and rear frames. Before trying to service the loader, make sure to set the frame lock plate.

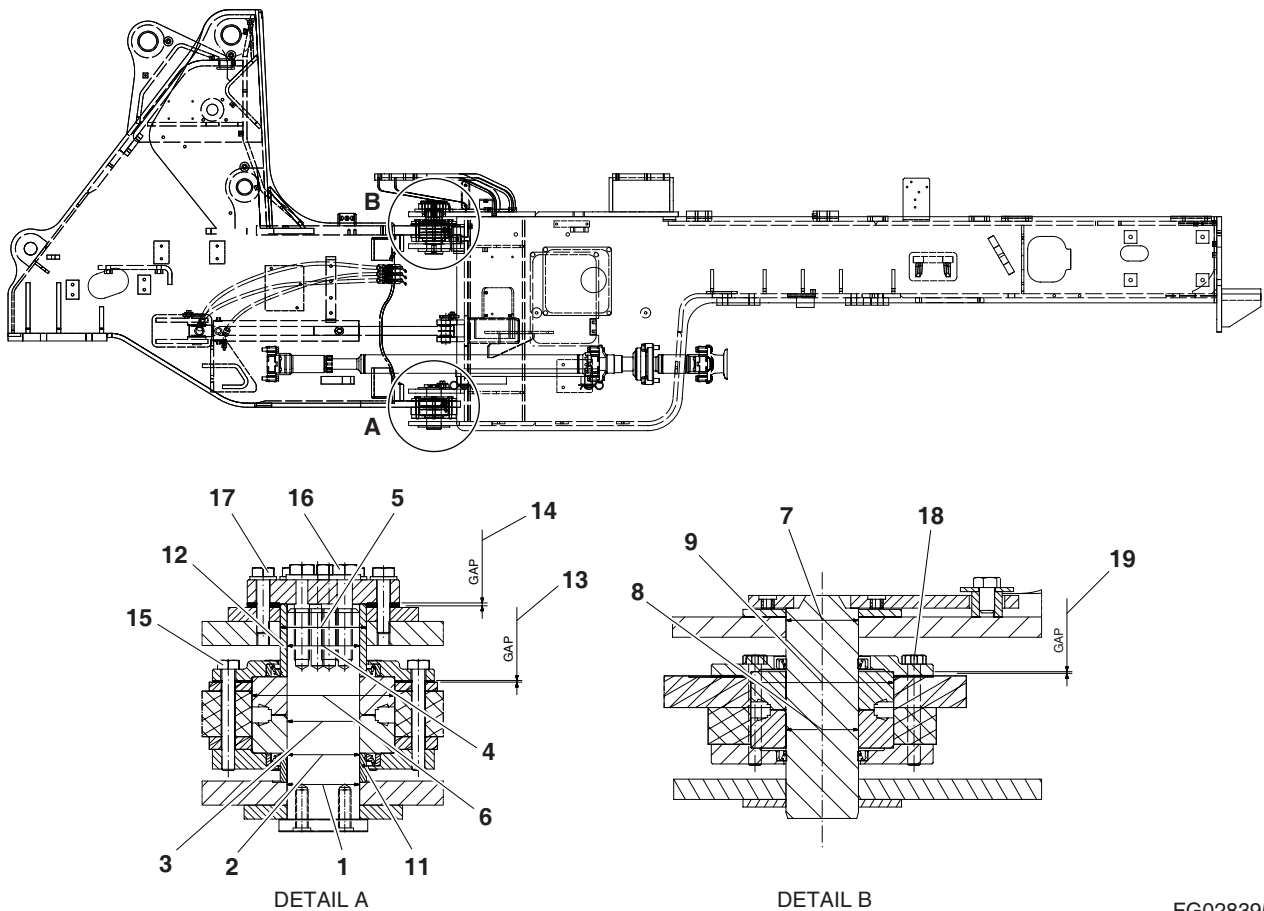
Before moving (traveling) the loader, make sure the frame lock plate is set to the original position.



FG006713

Figure 1

Maintenance Standard



FG028395

Figure 2

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	Replace
1	Clearance between upper hinge pin and rear frame	57.2	-0.065 -0.101	+0.029 -0.031	0.034 - 0.13	-	
2	Clearance between upper hinge pin and spacer (small)	57.2	-0.065 -0.101	-0.035 +0.005	0.070 - 0.136	-	
3	Clearance between upper hinge pin and bearing	57.2	-0.065 -0.101	+0.136 -0.090	0.215 - 0.264	-	
4	Clearance between upper hinge pin and spacer (large)	57.2	-0.065 -0.101	+0.035 +0.005	0.070 - 0.136	-	
5	Clearance between rear frame and spacer (large)	68	+0.076 +0.030	-0.036 -0.090	0.112 - 0.066	-	
6	Clearance between front frame and upper hinge bearing	112.7	-0.013 -0.039	+0.013 -0	0.013 - 0.103	-	
7	Clearance between lower hinge pin and rear frame	57.2	-0.065 -0.101	+0.029 -0.031	0.034 - 0.130	-	
8	Clearance between lower hinge pin and bearing	57.2	-0.065 -0.101	-0.037 -0.05	0.015 - 0.064	-	
9	Clearance between front frame and lower hinge bearing	112.7	-0.013 -0.039	+0.013 -0	0.013 - 0.103	-	
11	Height of upper hinge spacer (small)	25.6 ⁺⁰ _{-0.13}	-	-	0	0	
12	Height of upper hinge spacer (large)	47.8 ⁺⁰ _{-0.13}	-	-	0	0	
13	Shim thickness for upper hinge and retainer (front frame)	1.124 - 1.644	-	-	-	-	
14	Shim thickness for upper hinge and retainer (rear frame)	1.5-2.5	-	-	-	-	
15	Tightening torque of upper hinge retainer mounting bolt	When adjusting with shim: 4 ±0.2 kg•m Final value: 8 ±1.0 kg•m					Retighten
16	Tightening torque of upper hinge retainer mounting bolt	When adjusting with shim: 4 ±0.2 kg•m Final value: 13 ±1.0 kg•m					
17	Tightening torque of upper hinge pin mounting bolt	8 ±1.0 kg•m					
18	Tightening torque of lower hinge pin mounting bolt	When adjusting with shim: 4 ±0.2 kg•m Final value: 8 ±1.0 kg•m					
19	Shim thickness for lower hinge and retainer (front frame)	1.124 - 1.644 mm					

Counterweight

Edition 2

MEMO

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Counterweight

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Counterweight	6

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

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APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

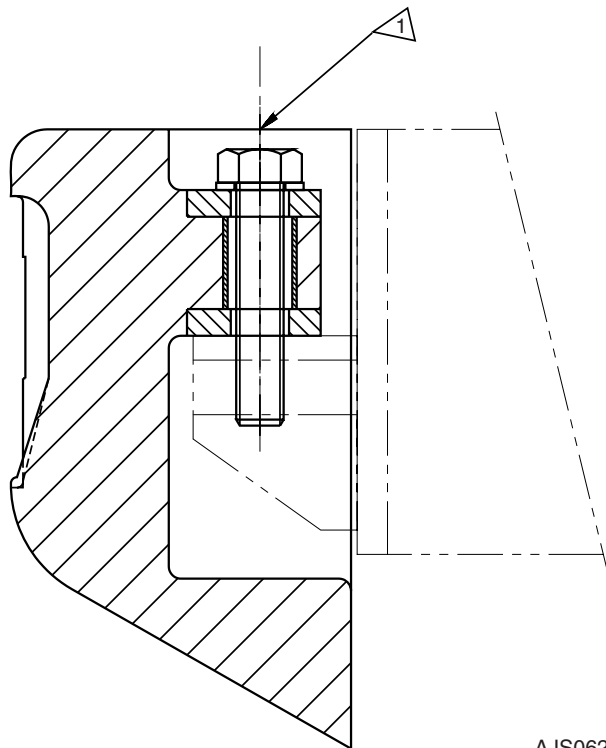
MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up
DL250A	10001 and Up
DL300A	10001 and Up
DL420A	10001 and Up
DL550A	10001 and Up

SPECIFICATIONS

NOTE: *Weight.*

Model	Weight	Serial Number Range
DL200A	550 kg (1,212 lb)	S/N 5001 and Up
DL250A	1,140 kg (2,508.8 lb)	S/N 5001 and Up
DL300A	1,005 kg (2,213 lb)	S/N 5001 and Up
DL420A	1,275 kg (2,813 lb)	S/N 5001 and Up
DL550A	2,020 kg (4,453 lb)	S/N 5001 and Up

COUNTERWEIGHT



AJS0620L

Figure 1

NOTE: *Tighten bolts to the torque value list in the following table.*

DL200A	115 kg•m (830 ft lb)
DL250A	115 kg•m (830 ft lb)
DL300A	250 kg•m (1,800 ft lb)
DL420A	250 kg•m (1,800 ft lb)
DL550A	250 kg•m (1,800 ft lb)

Tank

Oil Tank

Edition 1

MEMO

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Oil Tank

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MEMO

SAFETY INSTRUCTIONS



WARNING

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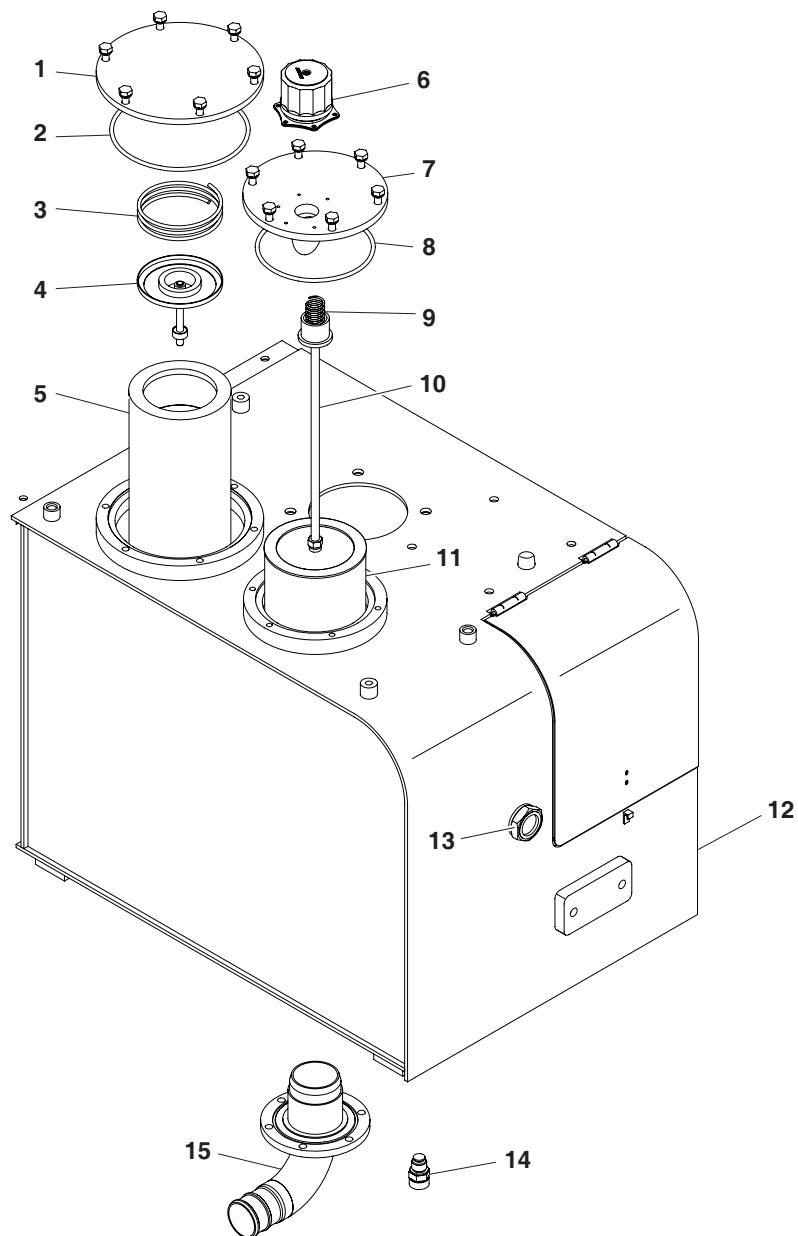
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

Parts List



FG028660

Figure 1

Reference Number	Description
1	Cover
2	O-ring
3	Spring
4	Bypass Valve
5	Return Filter
6	Air Breather
7	Cover
8	O-ring

Reference Number	Description
9	Spring
10	Rod
11	Suction Filter
12	Oil Tank
13	Level Gauge
14	Drain Cock
15	Suction Pipe

Specifications

Oil Tank	
Type	Pressurized Sealing
Capacity	115 liters (30 U.S. gal.)
Air Breather (System)	
Open Pressure	0.40 kg/cm ² (5.69 psi, 0.39 bar)
Vacuum pressure	0.035 kg/cm ² (0.5 psi, 0.03 bar) at 900 L/min. (238 U.S. gal./min.)
Return Filter	
Filtration Rating	10 μ
Pressure Drop	0.25 kg/cm ² (3.55 psi, 0.24 bar) at 600 L/min. (159 U.S. gal./min.), 20 cSt
Filtration Efficiency	Over 99.5%
Suction Filter	
Filtration Rating	177 μ
Bypass Valve	
Cracking Pressure	1.5 kg/cm ² (21.33 psi, 1.47 bar) at 40 liters (10.5 U.S. gal.), 20 cSt
Pressure Drop	2.0 kg/cm ² (28.44 psi, 1.96 bar) at 40 liters (10.5 U.S. gal.), 20 cSt

Fuel Tank

Edition 1

MEMO

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Fuel Tank

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MEMO

SAFETY INSTRUCTIONS



WARNING

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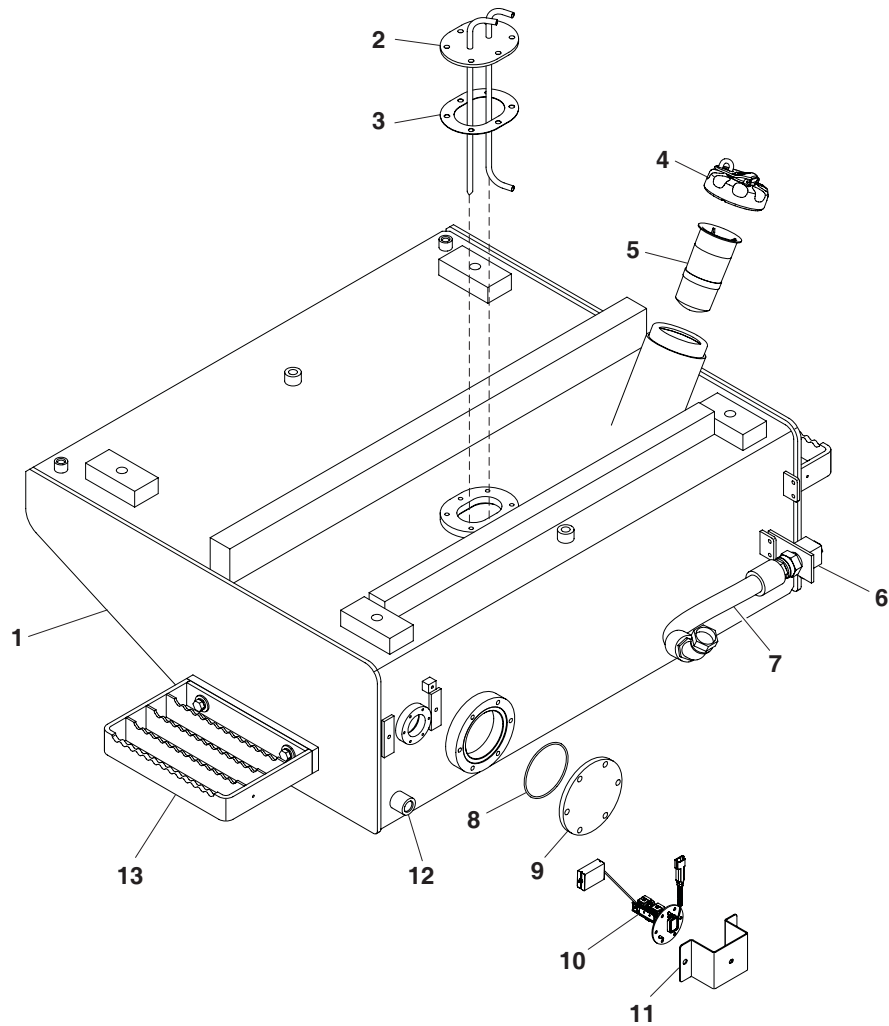
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

Parts List



FG028417

Figure 1

Reference Number	Description
1	Fuel Tank
2	Fuel Pipe
3	Packing
4	Fuel Cap
5	Fuel Strainer
6	Drain Cock
7	Hose: Engine Oil Drain

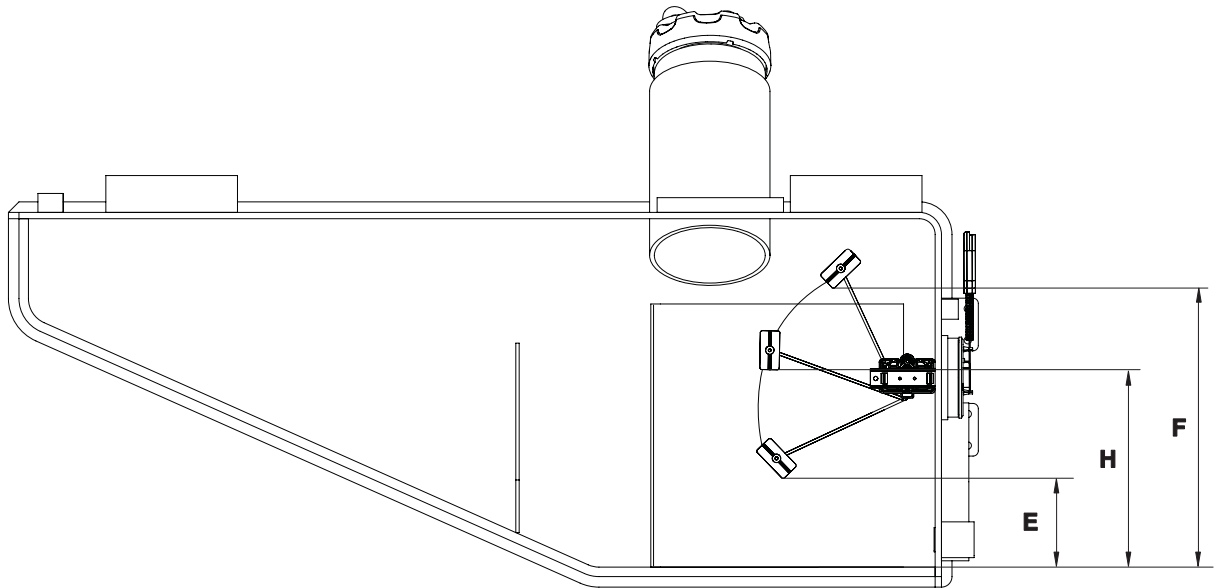
Reference Number	Description
8	O-ring
9	Cover
10	Fuel Sender
11	Sender Cover
12	Drain Plug
13	Step

Specifications

Fuel Tank	
Capacity (System)	243 liters (64 U.S. gal.)
Suction Filter	
Filtration Rating	60 μ
Ambient Temperature Range	-40 - +80°C
Fuel Strainer	
Filtration Rating	24 μ
Ambient Temperature Range	-40 - +80°C

Fuel Sender Setting

POINTER Position	Unit	E	1/4	H	3/4	F
Float Height	mm	77	130	193	250	291
Available Fuel Volume	liter	18.5	47.8	91.8	139.3	231.2
Ratio (/Total Volume)	%	8.0	20.7	39.7	60.3	100



FG028526

Figure 2

Hydraulics

Cylinders

Edition 2

MEMO

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Cylinders

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MEMO

SAFETY INSTRUCTIONS



WARNING

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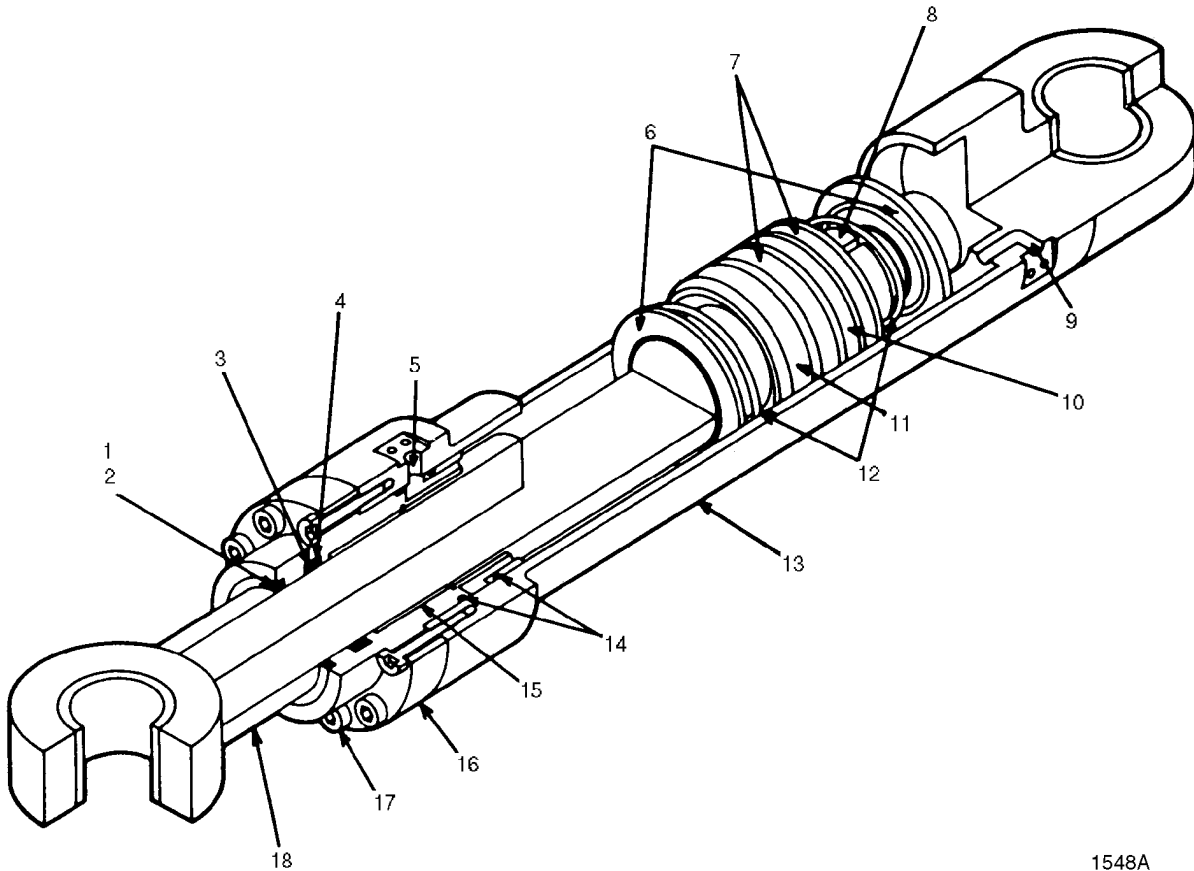
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up
DL250A	10001 and Up
DL300A	10001 and Up
DL420A	10001 and Up

GENERAL DESCRIPTION

The machine contains boom cylinders, buckets cylinders and steering cylinders. Each cylinder contains a cylinder tube, piston rod, piston, and cylinder head. See Figure 1. The piston is held to piston rod by a nut. A dust seal protects the U-ring and oil seal from dirt and also prevents oil from leaking out of the cylinder.



1548A

Figure 1

Reference Number	Description
1	Retaining Ring
2	Dust Seal
3	U-ring
4	Seat O-ring
5	Port (A)
6	Cushion Plate
7	Wear Ring
8	Piston Nut
9	Port (B)

Reference Number	Description
10	Seal O-ring
11	Piston
12	Spring
13	Cylinder Tube
14	O-ring, Backup Ring
15	Bushing
16	Cylinder Head
17	Bolt
18	Piston Rod

Theory of Operation

Reference Number	Description
1	Piston
2	Oil Path A
3	Oil Path B

Cylinder piston rods are extended or retracted by oil flow to back side of cylinder (shown as "oil path A") or to front of the cylinder ("oil path B").

The cylinder rod is extended as oil flow is pumped through the circuit to the back side of the piston. The force (F1) of the piston stroke can be expressed by the formula below, where P = circuit oil pressure and the inside diameter of the cylinder is expressed by B (Figure 2).

$$F_1 = P \times \frac{\pi B^2}{4}$$

(P: Pressure, $\pi = 3.14$, B: Cylinder Inside Diameter)

Reference Number	Description
1	Cylinder Inside Diameter - B
2	Oil Path A
3	Oil Path B
4	Rod Diameter

When the cylinder rod is retracted, oil flow through the circuit from the pump to the front side of the cylinder generates a force (F2) that can be expressed by the formula in which the diameter of the piston rod is expressed by R, and the other two terms are the same as in the preceding expression.

$$F_2 = P \times \frac{\pi(B^2 - R^2)}{4}$$

Because the volume of oil needed to lengthen the cylinder rod (Q1) is greater than the volume of oil required to retract the cylinder rod, it takes more time to decrease cylinder stroke length than it does to lengthen it.

$$Q_1 = S \times \frac{\pi(B^2)}{4}$$

$$Q_2 = S \times \frac{\pi(B^2 - R^2)}{4}$$

$$Q_1 > Q_2$$

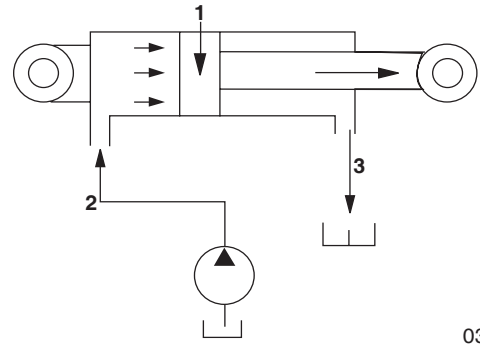


Figure 2

0330

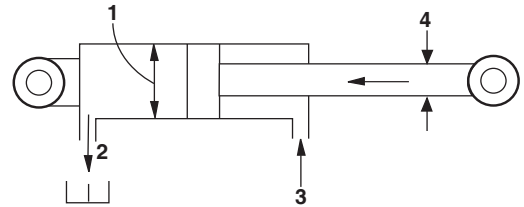


Figure 3

0331

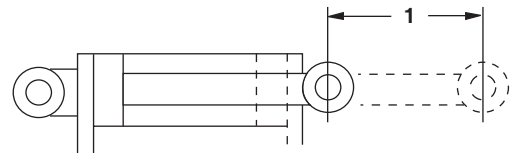
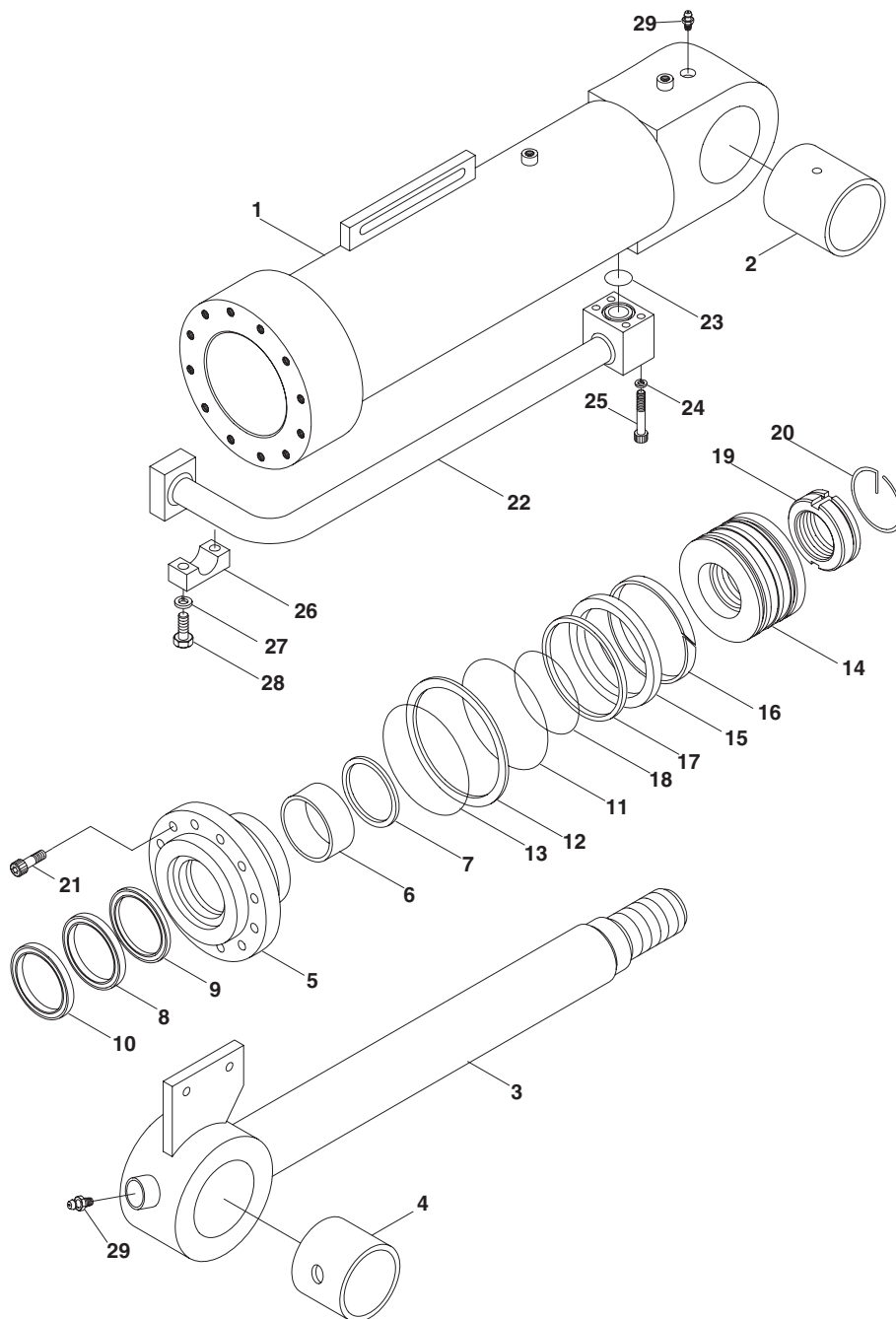


Figure 4

0332

Parts List

Bucket Hydraulic Cylinder



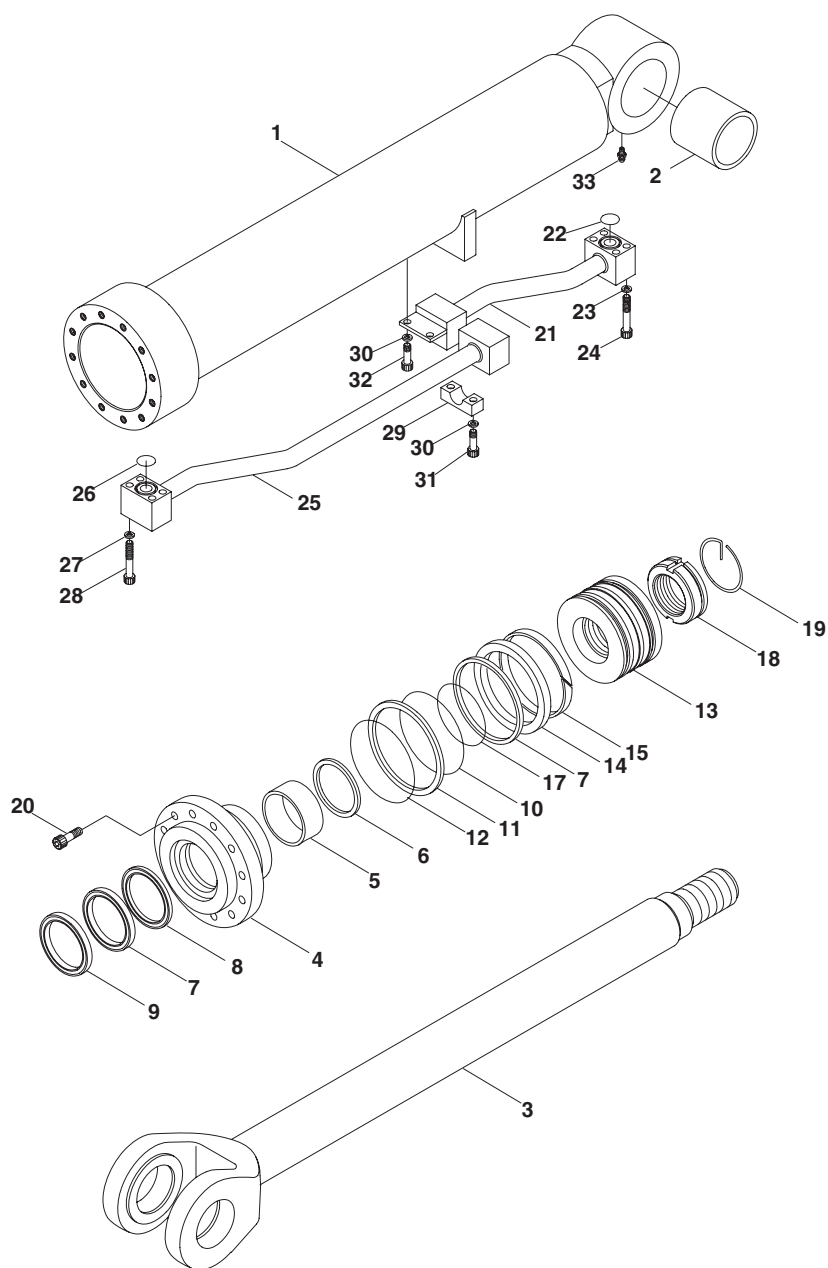
BAS0170L

Figure 5

Reference Number	Description
1	Tube Assembly
2	Steel Bushing
3	Rod Assembly
4	Steel Bushing
5	Rod Cover
6	DU-bushing
7	Retaining Ring
8	U-packing
9	Backup Ring
10	Dust wiper
11	O-ring
12	Backup Ring
13	O-ring
14	Piston
15	Glyd Ring

Reference Number	Description
16	Wear Ring
17	Dust Ring
18	O-ring
19	Piston Nut
20	Lock Ring
21	Socket Hex Bolt
22	Pipe Assembly
23	O-ring
24	Spring Washer
25	Hex Bolt
26	Pipe Clamp
27	Spring Washer
28	Hex Bolt
29	Grease Fitting Seal Kit

Lift Hydraulic Cylinder



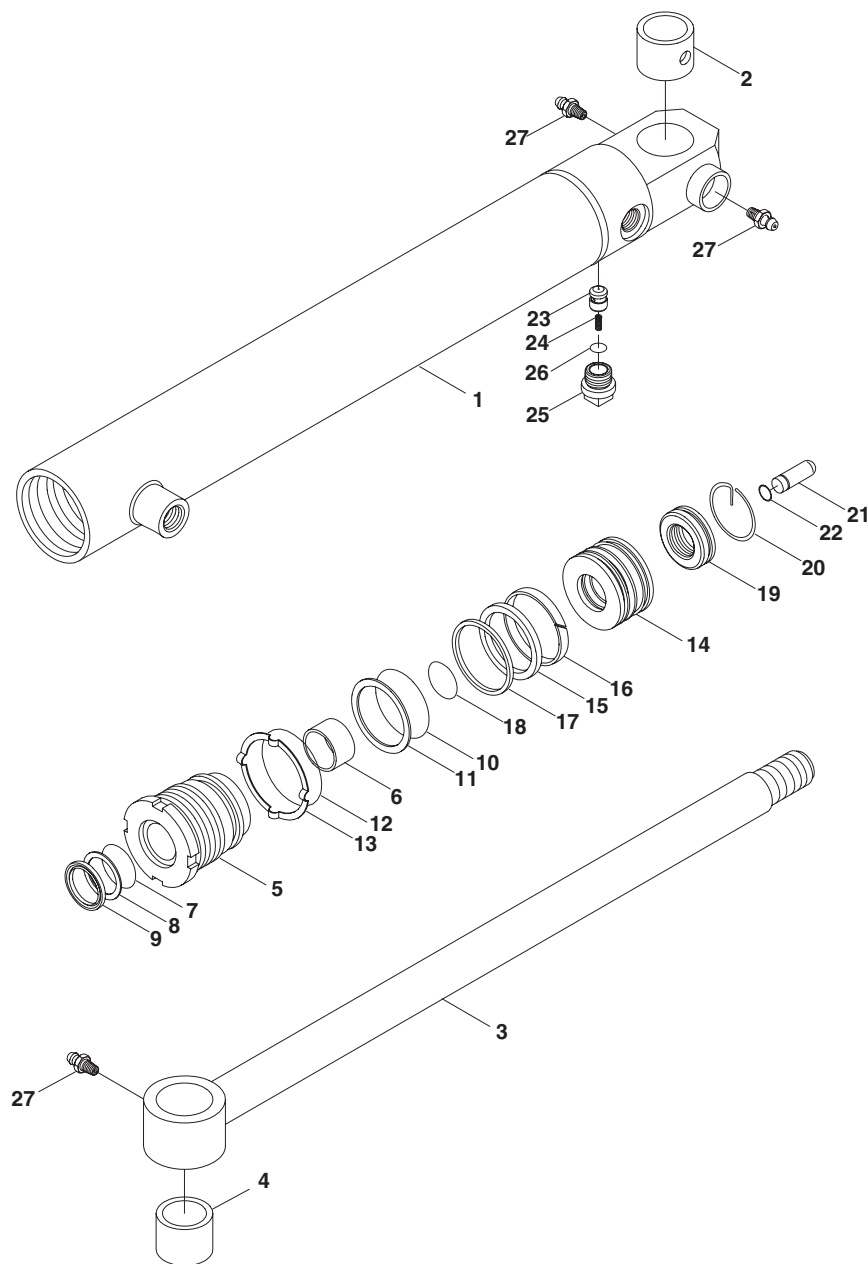
BAS0180L

Figure 6

Reference Number	Description
1	Tube Assembly
2	Steel Bushing
3	Rod Assembly
4	Rod Cover
5	DU-bushing
6	Retaining Ring
7	U-packing
8	Backup Ring
9	Dust wiper
10	O-ring
11	Backup Ring
12	O-ring
13	Piston
14	Glyd Ring
15	Wear Ring
16	Dust Ring
17	O-ring

Reference Number	Description
18	Piston Nut
19	Lock Ring
20	Socket Hex Bolt
21	Pipe Assembly
22	O-ring
23	Spring Washer
24	Hex Bolt
25	Pipe Assembly
26	O-ring
27	Spring Washer
28	Socket Hex Bolt
29	Pipe Clamp
30	Spring Washer
31	Hex Bolt
32	Hex Bolt
33	Grease Fitting Seal Kit

Steering Hydraulic Cylinder



BAS0190L

Figure 7

Reference Number	Description
1	Tube Assembly
2	Steel Bushing
3	Rod Assembly
4	Steel Bushing
5	Rod Cover
6	DU-bushing
7	U-packing
8	Backup Ring
9	Dust wiper
10	O-ring
11	Backup Ring
12	O-ring
13	Washer
14	Piston

Reference Number	Description
15	Glyd Ring
16	Wear Ring
17	Dust Ring
18	O-ring
19	Piston Nut
20	Lock Ring
21	Cushion Plunger
22	Stop Ring
23	Check Valve
24	Spring
25	Plug
26	O-ring
27	Grease Fitting Seal Kit

TROUBLESHOOTING, TESTING AND ADJUSTMENT

Problem	Possible Cause	Remedy
Oil leaking between cylinder head (16) and piston rod (18). (Index nos. refer to Figure 1)	Foreign material in U-ring (3).	Remove foreign material.
	Scratches in U-ring (3).	Replace U-ring (3).
	Damage to U-ring (3).	Replace U-ring (3).
	Foreign material in dust seal (2).	Remove foreign material.
	Scratches to dust seal (2).	Replace dust seal.
	Damage to dust seal (2).	Replace dust seal.
	Foreign material in seal O-ring (4).	Remove foreign material.
	Scratches in seal O-ring (4).	Replace O-ring (4).
	Damage to seal O-ring (4).	Replace O-ring (4).
	Scratches on sealing surface of piston rod (18).	If scratches are not deep, hone with an oil stone and lubricate. If scratches are deep, replace piston rod (18).
	Deep scratches on inner surface of bushing (15).	Replace bushing.
Oil leaking between cylinder head (16) and cylinder tube (13).	Damage to O-rings (14).	Replace O-rings (14).
Oil leaking from welded area of cylinder tube (13).	Damage to welded area.	Replace cylinder tube (13).
Oil leaking between cylinder head (16) and piston rod (18). (Index nos. refer to Figure 1).	Foreign material in U-ring (3, Figure 1)	Remove foreign material.
	Scratches in U-ring (3, Figure 1).	Replace U-ring (3).
	Damage to U-ring (3, Figure 1).	Replace U-ring (3).
	Foreign material in dust seal (2, Figure 1).	Remove foreign material.
	Scratches in dust seal (2, Figure 1).	Replace dust seal (2).
	Damage to dust seal (2, Figure 1).	Replace dust seal (2).
	Foreign material in seal O-ring (4, Figure 1).	Remove foreign material.
	Scratches in seal O-ring (4, Figure 1).	Replace O-ring (4).
	Damage to seal O-ring (4, Figure 1).	Replace O-ring (4).
	Scratch on sealing surface of piston rod (18, Figure 1).	If scratches are not deep, hone with an oil stone and lubricate. If scratches are deep, replace piston rod (18).
	Deep scratches on inner surface of bushing (15, Figure 1).	Replace bushing.
Oil leaking between cylinder head (16) and cylinder tube (13).	Damage to O-rings (14, Figure 1).	Replace O-rings (14).
Oil leaking from welded area of cylinder tube (13).	Damage to welded area.	Replace cylinder tube (13).

Problem	Possible Cause	Remedy
Cylinder drops from pull of gravity.	Light scratches on sealing surface of cylinder tube (13, Figure 1).	Hone out scratches with oil stone.
	Deep scratches on sealing surface of cylinder tube (13, Figure 1).	Replace cylinder tube (13).
	Deep scratches on sealing surface of piston O-rings (10, Figure 1).	Replace O-rings (10).
	Foreign material in U-ring (3, Figure 1).	Remove foreign material.
	Scratches in U-ring (3, Figure 1).	Replace U-ring (3).
	Damage to U-ring (3, Figure 1).	Replace U-ring (3).
	Nylon wear rings (7, Figure 1) twisted.	Replace nylon wear rings (7).
	Nylon wear rings (7, Figure 1) scratched.	Replace nylon wear rings (7).
	Nylon wear rings (7, Figure 1) have other damage.	Replace nylon wear rings (7).
Slow bucket and boom movements.	Reduced oil flow due to dirty filter or dirty intake line.	Disassemble and clean parts.
	Air drawn into circuit through loose connections.	Tighten intake connections.
	Reservoir oil level too low.	Fill reservoir to correct level.
	Relief valve pressure setting incorrect.	Adjust relief valve pressure.
	Damaged pump shaft or pump drive sleeve.	Replace damaged parts.
	Pump worn or damaged internally.	Replace worn or damaged parts.
	Relief valve sticking.	Disassemble and inspect cartridge. Clean or replace cartridge.
	Air in pressure line.	Perform cylinder bleeding procedure to remove air. Tighten or replace pressure line.
	Damaged pipe or hose.	Replace pipe or hose.
	Worn cylinder seals.	Replace worn parts.
Low-pressure, shown by weak upward movement of boom and bucket.	Reduced oil flow due to dirty filter or dirty intake line.	Disassemble and clean parts.
	Reservoir oil level too low.	Fill reservoir to correct level.
	Relief valve pressure setting incorrect.	Adjust relief valve pressure.
	Pump worn or damaged internally.	Replace worn or damaged parts.
	Relief valve sticking.	Disassemble and inspect cartridge. Clean or replace cartridge.
	Worn cylinder seals.	Replace worn parts.
	Low pump output due to dirty discharge pipes.	Remove and clean pump discharge pipes.
	Relief valve spring is weak. Relief valve poppet worn.	Replace worn parts.

Problem	Possible Cause	Remedy
Cylinder drops when control valve is in neutral.	Worn plunger in control valve.	Replace plunger.
	Stuck overload relief valve due to worn seat surface.	Replace worn parts.
	Loose pipes or joints.	Tighten parts.
	Worn piston seal on hydraulic cylinder.	Replace seal.
Vibration or excessive noise.	Excessive resistance in pump intake line.	Inspect intake line and clean or replace as necessary.
	Air being drawn into intake line.	Inspect pipe joints and tighten.
	Chattering relief valve.	Change oil, replace valve.
Air bubbles in oil.	Wrong type of operating oil.	Drain and fill with proper type of oil.
	Oil level too low.	Raise to proper level.
	Air trapped in system.	Perform cylinder bleeding procedure to remove air.
Frequent rubber hose damage.	System pressure too high.	Adjust relief valve pressure.
	Hoses breaking due to contact with another machine parts.	Restrain hoses to prevent contact.

DISASSEMBLY

NOTE: Keep on hand a container large enough to hold all of the oil in cylinder being repaired. When cylinder rod and head are removed, oil will run out of cylinder.

NOTE: Dispose of drained fluids according to local regulations.

1. Use an allen wrench to remove bolts that hold cylinder head to cylinder tube. See Figure 8.

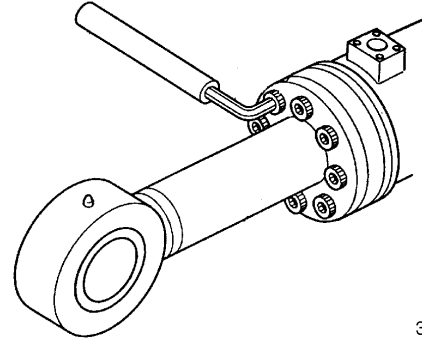


Figure 8

3826A

2. Support cylinder rod with a lifting sling. See Figure 9. Slide cylinder rod out of cylinder tube. Rotate cylinder rod slightly as it is being pulled from cylinder tube. This will make it easier to pull rod out of tube.

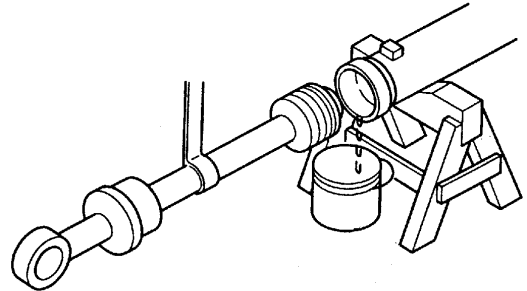


Figure 9

3827A

3. Set cylinder rod assembly in a repair fixture and secure rod in place. See Figure 10. Use a power wrench and socket to remove nut that holds piston on rod.

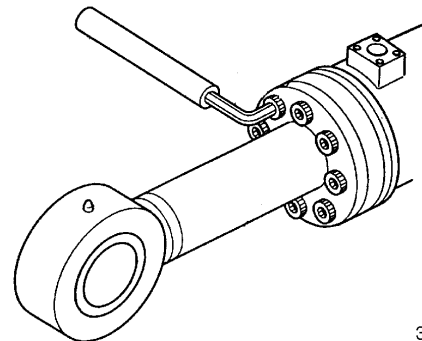
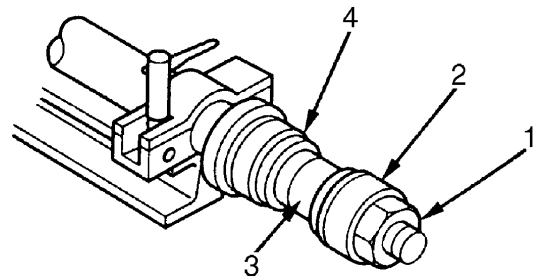


Figure 10

3826A

4. Remove piston nut (1, Figure 11), piston assembly (2), cushion flange (3), and cylinder head assembly (4).

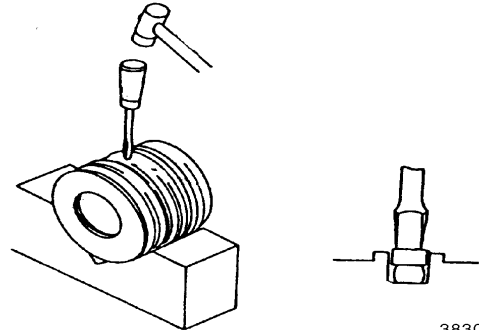
Reference Number	Description
1	Piston Nut
2	Piston Assembly
3	Cushion Flange
4	Cylinder Head Assembly



3829A

Figure 11

5. Do not remove slipper seal, backup ring, and back ring from piston. If these three items are not scratched or damaged. See Figure 12. Once these 3 items are removed from piston, they must be replaced. They cannot be reused. Exercise caution when removing slipper seal to prevent damage to piston O-ring groove. Remove wear rings from piston.

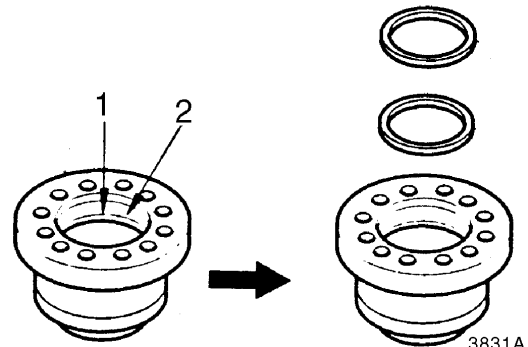


3830A

Figure 12

6. When disassembling cylinder head do not remove slipper seal, backup ring, back ring, or dust seal unless items are scratched or damaged. If seals are removed from head, they must be replaced. They cannot be reused. Remove retaining ring, (1, Figure 13). Use a screwdriver to remove dust seal (2) from head.

Reference Number	Description
1	Retaining Ring
2	Dust Seal

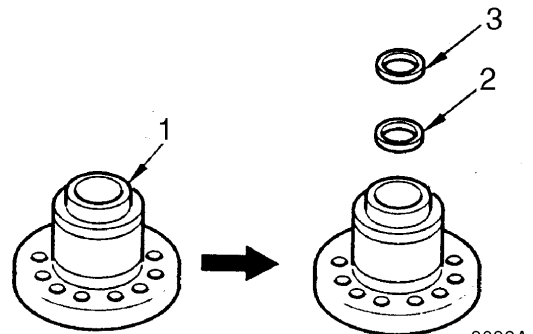


3831A

Figure 13

7. Use caution to prevent damage to any parts of U-packing (1, Figure 14). Remove U-packing (1). Remove O-ring (2), and ring (3).

Reference Number	Description
1	U-Packing
2	O-ring
3	Ring



3832A

Figure 14

CLEANING AND INSPECTION (WEAR LIMITS AND TOLERANCES)

For general cleaning and inspection procedures, refer to "General Maintenance Procedures" section.

REASSEMBLY

NOTE: Check cylinder head grooves for U-packing and dust seal. If edges of grooves are sharp or have burns, use an oil stone to smooth surface. See Figure 15.

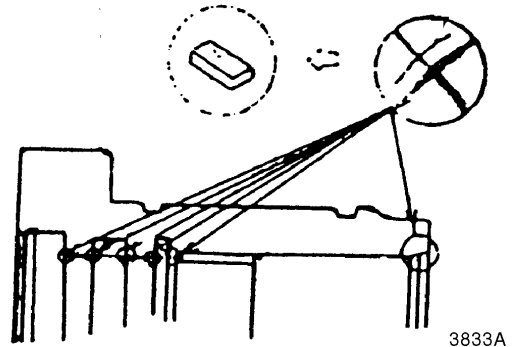


Figure 15

1. Apply grease to inner part of cylinder head and to U-packing groove. See Figure 16.

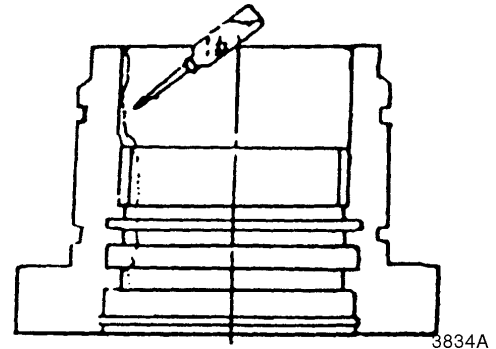


Figure 16

2. Install split backup ring into its groove by compressing ring. See Figure 17. Make sure that ends of ring do not overlap.

NOTE: The U-packing can be installed by hand or by using a seal installing jig. The jig should be made of copper, aluminum, or plastic. If a jig is used, be sure that jig does not have sharp edges that could damage U-packing.

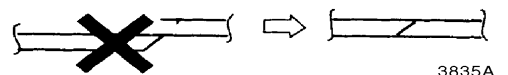
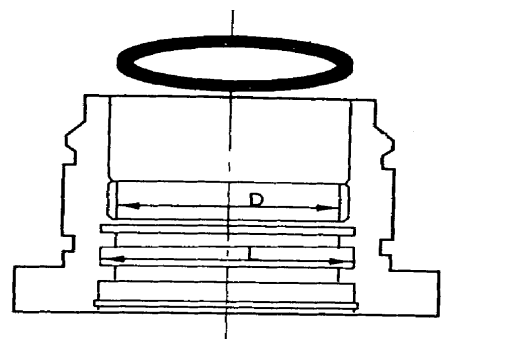
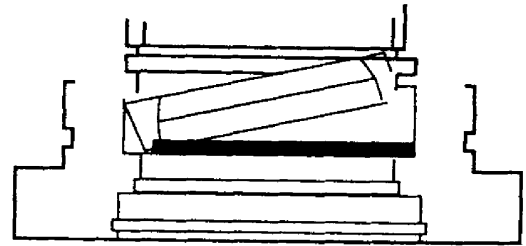


Figure 17

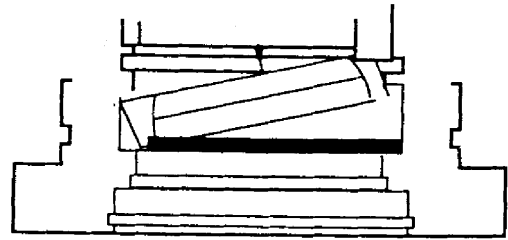
3. Insert one side of U-packing in its groove. See Figure 18.



3836A

Figure 18

4. Carefully push down on other side of U-packing until entire U-packing is seated in its groove. See Figure 19.

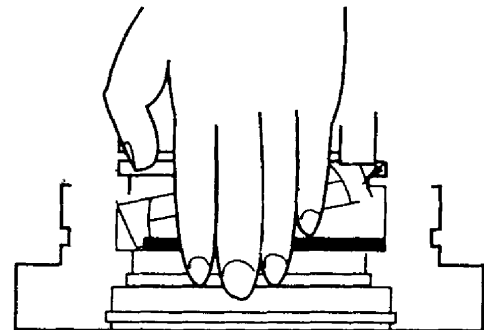


3837A

Figure 19

5. Check to be sure that U-packing and backup ring are correctly installed by pushing with your hand on inner diameter of U-packing. See Figure 20.

NOTE: *There are 2 backup rings used on outside of cylinder head. One backup ring is continuous. The other backup ring is open, split by an angled cut.*

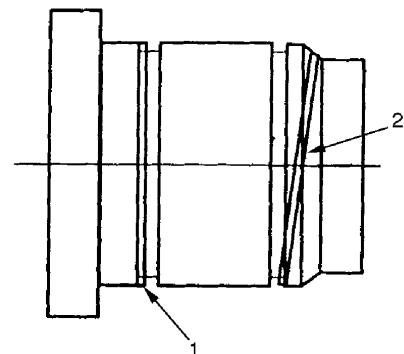


3838A

Figure 20

6. Use grease or an adhesive to hold split backup ring (1, Figure 21) in place. Install split backup ring (1) in groove closest to flange on cylinder head.

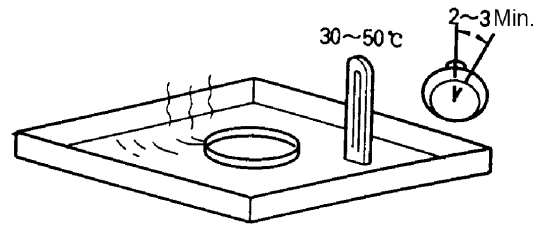
Reference Number	Description
1	Split Backup Ring
2	Continuous Backup Ring



3840A

Figure 21

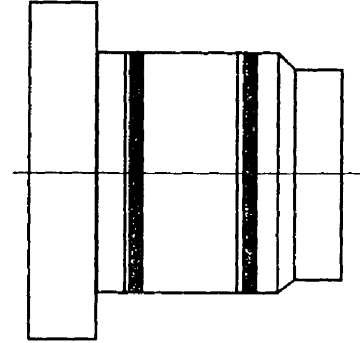
7. Place continuous backup ring in warm water. See Figure 22. Water temperature should be 30 - 50°C (86 - 122°F). Leave ring in water for 2 - 3 minutes. Slide continuous backup ring (2, Figure 21) over cylinder head and into its groove.



3839A

Figure 22

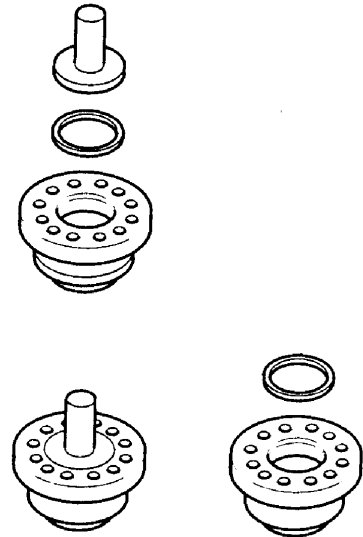
8. Install an O-ring over each of backup rings. See Figure 23.



3841A

Figure 23

9. Use a seal installing jig to install dust seal into cylinder head. See Figure 24. Install retaining ring.



3842A

Figure 24

10. On piston, check corners of grooves that piston rings will be mounted in. See Figure 25. If any burrs, roughness, or sharp edges (1) are present, use an oil stone to smooth roughened areas and dull sharp edges.

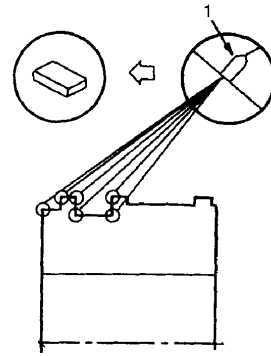


Figure 25

3843A

11. Apply grease or hydraulic oil to corner of piston at position A. See Figure 26.

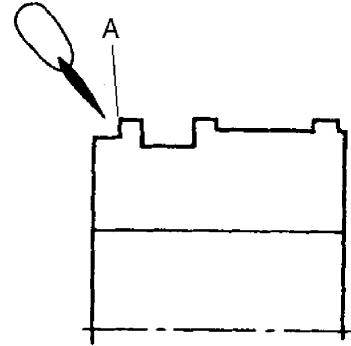


Figure 26

3844A

12. Insert one end of backup ring into its groove. See Figure 27. Use your hand to slide other end of ring into groove.

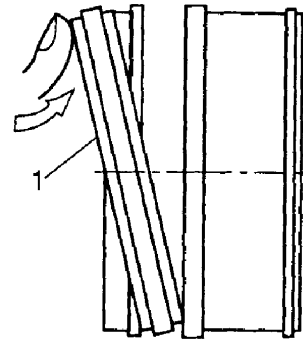


Figure 27

3845A

13. Use warm water to expand slipper seal. See Figure 28. This will make seal easier to install. Set slipper seal in 60 -100° C (140 - 212° F) water for 5 minutes or longer.

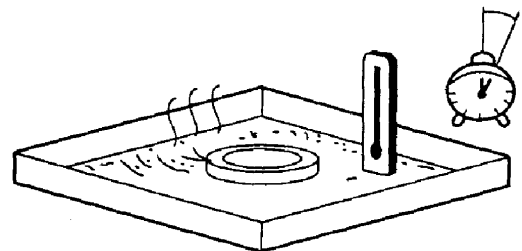


Figure 28

3846A

14. Insert one end of slipper seal, (1, Figure 29) into its groove. Use your hand to slide other end of slipper seal into groove.



WARNING

AVOID DEATH OR SERIOUS INJURY

Before piston is inserted into cylinder tube, make sure that slipper seal is no longer expanded. If seal is still expanded, it could catch on threaded portion of cylinder tube. An expanded seal could also jam inside cylinder tube.

15. Install two backup rings, (1, Figure 30). One ring fits on either side of slipper seal (2).

Reference Number	Description
1	Backup Ring
2	Slipper Seal

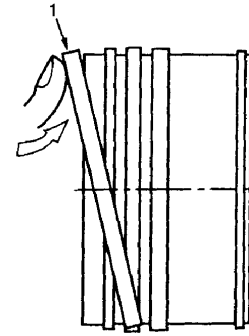


Figure 29

3847A

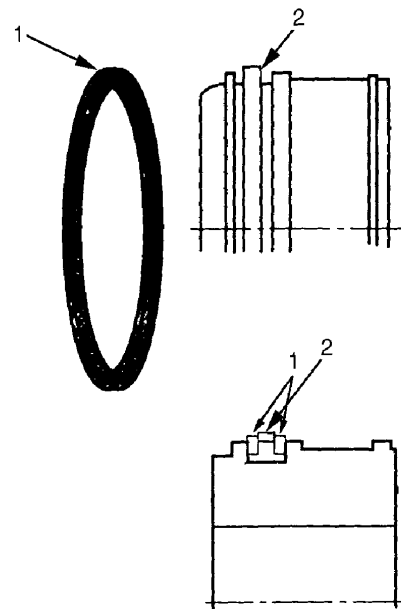


Figure 30

4031A

16. Install wear ring (1, Figure 31) on piston.

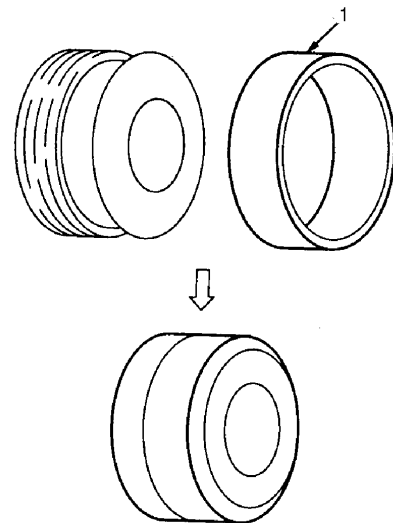


Figure 31

3849A

17. Set cylinder rod (1, Figure 32) into a repair fixture (2). Securely clamp rod to fixture. Exercise caution to prevent nicks or scratches to chrome plated areas of rod. chrome plated area is oil sealing surface of rod.

Reference Number	Description
1	Cylinder Rod
2	Repair Fixture

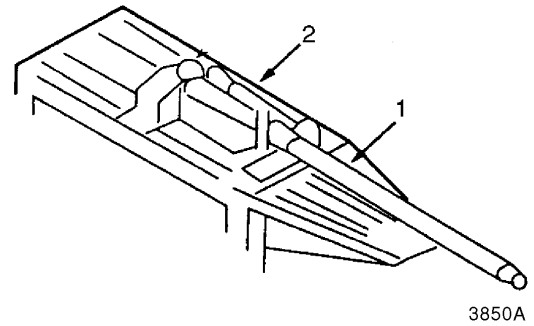


Figure 32

18. Slide cylinder head assembly (1, Figure 33) onto cylinder rod (2). Use caution to prevent threads on rod from damaging seal inside cylinder head.

Reference Number	Description
1	Cylinder Head
2	Cylinder Rod

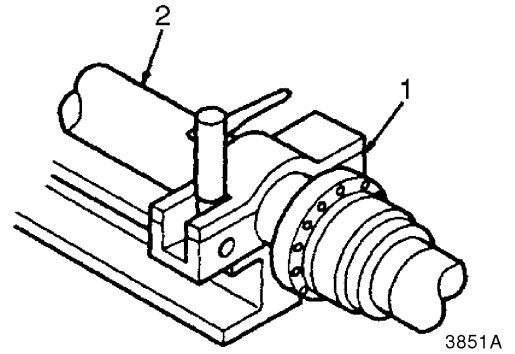


Figure 33

19. Install cushion flange (1, Figure 34) on cylinder rod (2). Slide piston assembly (3) onto cylinder rod (2).

Reference Number	Description
1	Cushion Flange
2	Cylinder Rod
3	Piston Assembly

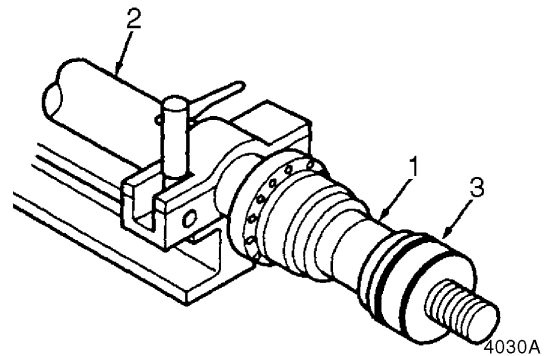


Figure 34

20. Install piston nut (1, Figure 35) and tighten it with an impact wrench. Then use a torque wrench to tighten nut (1) to specified torque.

After nut has been tightened, check to see that cushion flange moves.

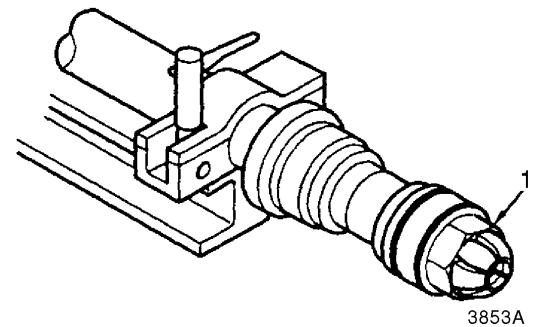


Figure 35

21. Slide rod assembly into cylinder tube. Align punch mark (1, Figure 36) with port (2) in cylinder tube. This will align hole (3) in cylinder head with port (2).

Reference Number	Description
1	Punch Mark
2	Port
3	Hole

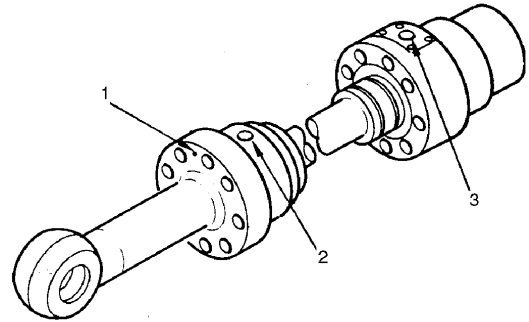


Figure 36

3855A

22. Install bolts in cylinder head and tighten them to torque specified in bolt torque chart. See Figure 37. Double check to make sure that hole in cylinder head is align with port in cylinder tube.

NOTE: After rebuilding a cylinder, or after loosening a cylinder hydraulic line, air must be bled from hydraulic system. To bleed air from system, first extend and retract a cylinder (or pair of cylinders) about 5 times at low engine rpm. Stop cylinder about 100 mm (4 in) short of full extension and full retraction. Then fully extend and retract cylinder about 5 times, also at low engine rpm.

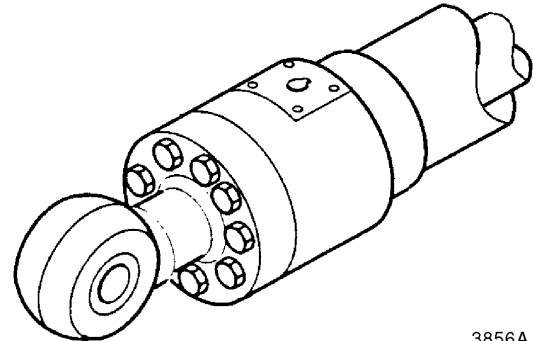


Figure 37

3856A

Main Pump

Edition 1

MEMO

Table of Contents

Main Pump

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

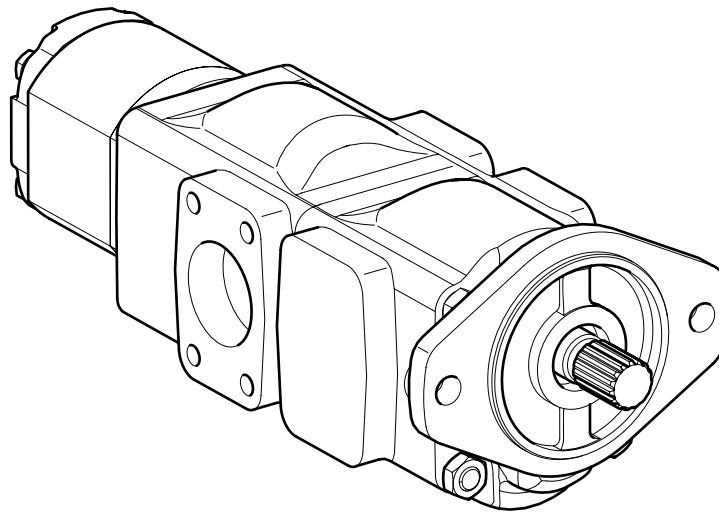
The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

Theory Of Operation

The hydraulic pump is a triple vane pump which contains three pumping sections. The first pumping section supplies oil for the front attachment. The second pumping section supplies oil for the steering cylinders. Surplus oil which is not necessary for the steering function is directed into control valve to join the first pump's oil by the priority valve. The third pump section, is the pilot pump, used for brakes and pilot line operation.



FG028525

Figure 1

1. First pumping section.
Pumping displacement: 44 cc/rev. (2.69 in³/rev)
Front attachment.
2. Second pumping section.
Pumping volume: 44 cc/rev. (2.69 in³/rev)
Steering and front attachment.
3. Pilot pumping section.
Pumping volume: 16 cc/rev. (0.98 in³/rev)
Fan, Brakes and pilot line operation.

Parts List

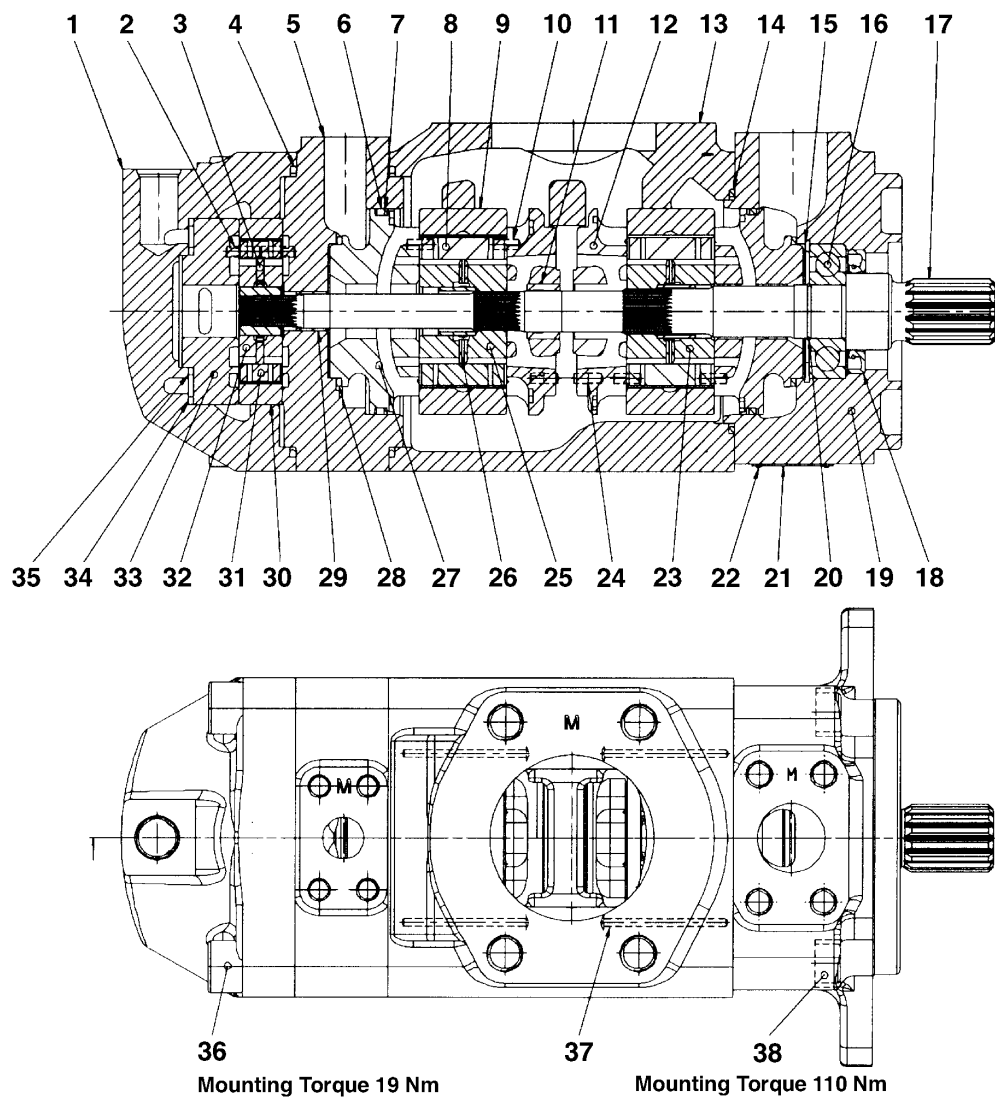
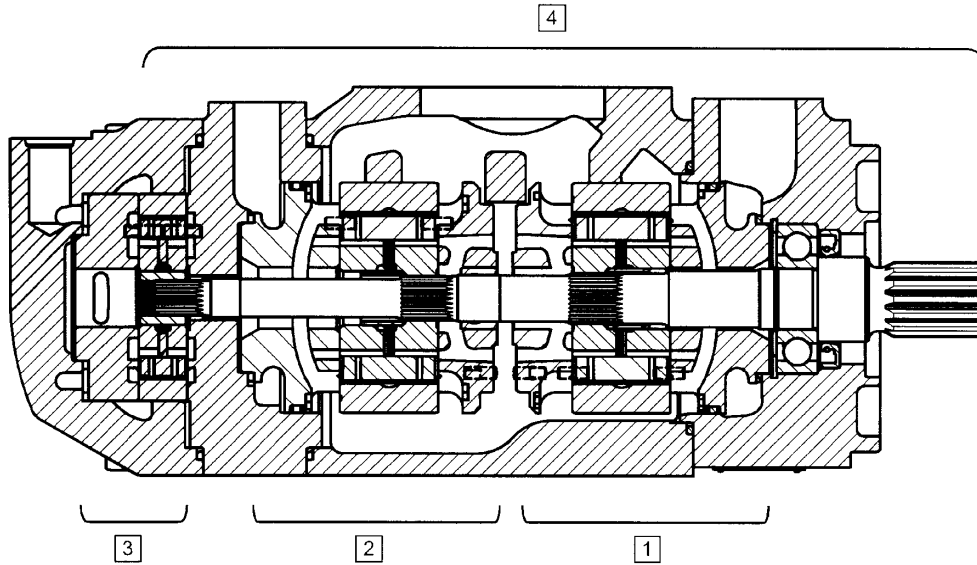


Figure 2

Reference Number	Description
1	End Cap T67CBA
2	Dowel Pin
3	Pin-vane Holdout T67BB
4	O-ring
5	Port Block T67CBA
6	Square Section Seal
7	Backup Ring
8	Vane T6CM
9	Cam Ring T6C 020
	Cam Ring T6C 017
10	Dowel Pin
11	Bushing
12	Port Plate Rear T6CC
13	Housing T67CBA
14	O-ring
15	Retaining Ring
16	Ball Bearing
17	Splined Shaft SAE-C T67CCA-Code3
18	Shaft Seal (S1-0.7 bar)

Reference Number	Description
19	Mounting Cap T67CCA
20	Round Section Ring
21	Plate Name
22	Rivet Pop
23	Rotor T6CM Assembly
24	Dowel pin
25	Rotor T6CM Assembly
26	Pin-vane Holdout T6CM
27	Port Plate Pressure T6CC
28	Square Section Seal
29	Bushing
30	Cam Ring T7A 006
31	Vane T7A
32	Rotor T7A Assembly
33	Port Plate Pressure T67CB "A"
34	Square Section Seal
35	Square Section Seal
36	Screw
37	Screw
38	Screw

Service Kits



AOS0250S

Figure 3

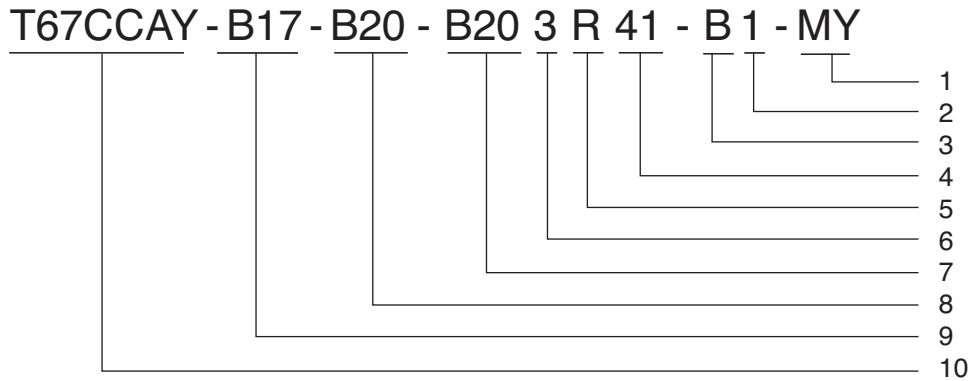
Reference Number	Kit	Code Number	Remark
1	P1 Cartridge (B17)	S24-40164-0	Rotor, vane, holdout pins, port-plates
2	P2 Cartridge (B20)	S24-77212	
3	P3 Cartridge (B20)	S24-94162	
-	Seal Kit (S1-0.7bar)	S24-76934	All seals included: shaft seal, square-rings, O-rings
4	Shaft and Bearing Assembly (Code 3)	S24-76933	Shaft, bearing, retaining ring



Figure 4

Specification

Model Number Code Series T6DC



FG005314

Figure 5

Reference Number	Description
1	Modification
2	Seal Class
3	Design Letter
4	Porting Combination
5	Direction of Rotation

Reference Number	Description
6	Type of Shaft
7	Cam Ring for "P3"
8	Cam Ring for "P2"
9	Cam Ring for "P1"
10	Series

Specifications

Item	Specification		
	Main Pump	Steering Pump	Pilot Pump
Model Number	T67CCAY-B17-B20-B20-3R41-B1MY		
Type	Vane		
Displacement	58.3 cc/rev (3.56 in ³ /rev)	63.8 cc/rev (3.89 in ³ /rev)	19.8 cc/rev (1.208 in ³ /rev)
Intermittent Pressure	285 kg/cm ² (4,060 psi)		326 kg/cm ² (4,641 psi)
Continuous Pressure	245 kg/cm ² (3,480 psi)		295 kg/cm ² (4,206 psi)
Max. Speed	2,800 min ⁻¹		
Min. Speed	600 min ⁻¹		

SPECIAL TOOLS

Special tools will help to properly install the shaft seal. A shaft seal driver of proper size must be used to install the shaft seal. A protective cone must be used over the shaft end to prevent damage to the shaft seal when installing the shaft.

The remainder of the pump disassembly and assembly can be accomplished with normal repair shop tools and good repair practices. Refer to Figure 6 and Figure 7 for proper configuration and dimensions for the seal driver and protective cone.

Seal Driver

A seal driver is required to install shaft seal in the pump mounting cap.

- NOTE:**
1. Material: 4140 or equivalent.
 2. Remove all burrs and break sharp edges: 0.25/0.13R.
 3. Length 19 mm ("A" dia) to be heat treated Rc 50/55.

- NOTE:**
- A dia: 34.90 - 34.75
 - B dia: 57.10 - 56.92
 - C: 145
 - Tool ref.: SS2

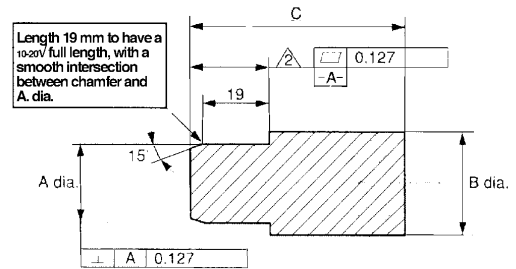


Figure 6

AOS0230S

Protective Cone

A protective cone is to be used when installing shaft assembly in the mounting cap. The protective cone prevents damaging the lips of the shaft seal during insertion.

- NOTE:**
1. Material: TEFLON preferred.
 2. Remove all burrs and break sharp edges: 0.25/0.13 R.

- NOTE:**
- A: 60
 - B dia: 35.00 - 34.95
 - C dia: 31.33 - 31.25
 - Tool ref.: CP14

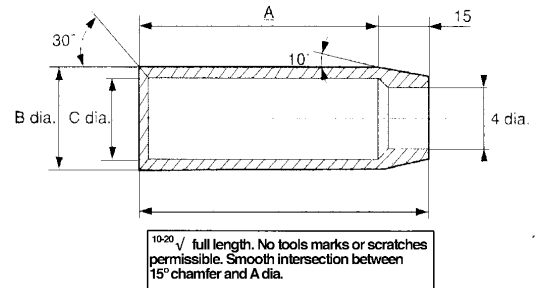


Figure 7

AOS0240S

DISASSEMBLY

1. Securely hold pump in a vise or similar equipment, on mounting cap (19) making sure pump is level.

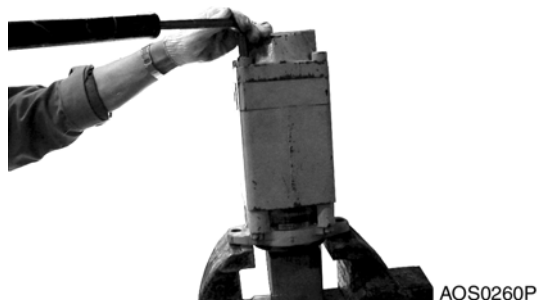


Figure 8

2. Remove end cap (1) screws (36).



Figure 9

3. Match mark pump so that proper port orientation can be done during reassembly.
4. Remove end cap (1).



Figure 10

5. Remove O-ring (4, Figure 2)



Figure 11

6. P3 cartridge is not held together.
7. Remove port-plate (33, Figure 12) and cam ring (30, Figure 30).



Figure 12

8. Carefully remove rotor (32) and vanes (31).



Figure 13

9. Carefully remove port block (5) and P2 cartridge together.

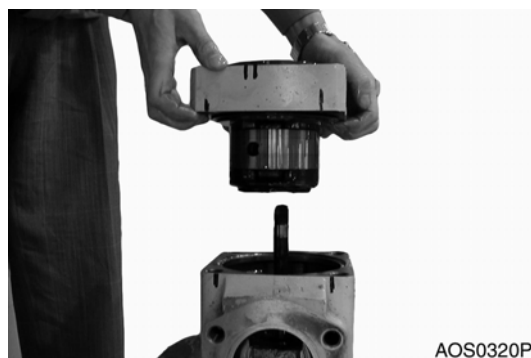


Figure 14

10. Remove O-ring (4).



Figure 15

11. Extract P2 cartridge from port block (5) by using a gear puller or by prying upward. Use care not to damage parts.

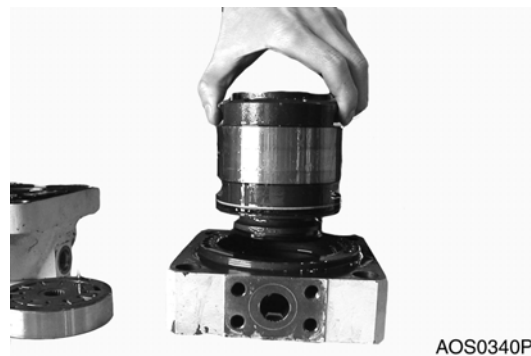


Figure 16

12. Turn pump vertically 180°.
13. Remove screws (38).

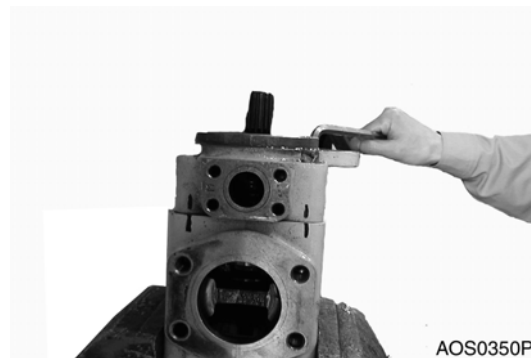


Figure 17

14. Remove mounting cap (19) and P1 cartridge from housing (13).



Figure 18

15. Remove O-ring (14).



Figure 19

16. Extract P1 cartridge from mounting cap (19) by using a gear puller or by prying upward. Use care not to damage parts.



Figure 20

REASSEMBLY

1. Securely hold pump in a vise or similar equipment, on housing (13). Be sure it is level (light grip).
2. Carefully insert P1 cartridge.



WARNING

AVOID DEATH OR SERIOUS INJURY

Replace all seals and backup rings with new ones.

Make sure the dowel pin(s) (10) are properly inserted in corresponding hole in housing (13).

3. Install new O-ring (14) in housing (13).



Figure 21



Figure 22

4. Aligning match marks made during disassembly, insert mounting cap (19) and shaft assembly. Shaft (17) should go smoothly through P1 cartridge.



WARNING

AVOID DEATH OR SERIOUS INJURY

When inserting P1 cartridge in mounting cap, make sure the white teflon backup ring is not damaged and securely in place.

5. Use screws (38) to ensure mounting cap (19) goes down straight and does not tilt.

NOTE: *Tighten screws (38) to 110 Nm (80 ft lb).*

6. Turn pump vertically 180°. Then securely hold it in vise on mounting cap, making sure it is level.



Figure 23

7. Insert P2 cartridge.



WARNING

AVOID DEATH OR SERIOUS INJURY

Make sure the dowel pin is properly inserted in the corresponding hole in housing (13).



Figure 24

8. Install new O-ring (14) in housing (13).

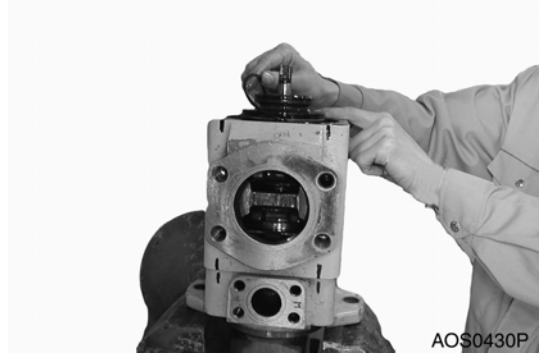


Figure 25

9. Aligning match marks made during disassembly, install port block (5) on housing (13).



Figure 26

10. Position rotor (32), with vanes (31), on splines of shaft (17).

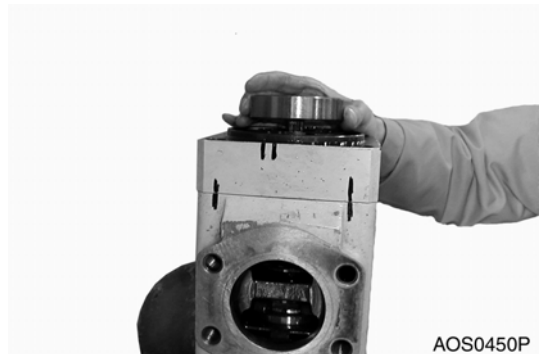


Figure 27

11. Install dowel pin (2) in port block (5).
12. Install cam ring (9).



WARNING

AVOID DEATH OR SERIOUS INJURY

Make sure rotation is as per required.

13. Install dowel pin (2) in cam ring (9).
14. Install pressure plate (33).



Figure 28



Figure 29

15. Install new square section seal (35)
16. Install new O-ring (4) in port block (5).
17. Install new square section seal (34) in end cap (1).



Figure 30

18. Install end cap (1) on P3 cartridge.



Figure 31

19. Use screws (38) to ensure end cap (1) goes down straight and does not tilt.

NOTE: *Tighten screws (38) to 190 Nm (140 ft lb).*

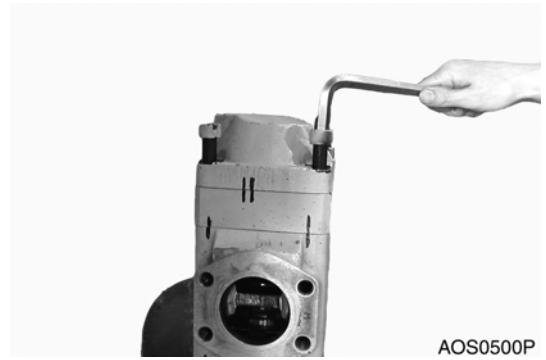


Figure 32

Main Control Valve

Edition 1

MEMO

Table of Contents

Main Control Valve

Safety Instructions	5
Applicable Models	5
General Description	6
Specifications	9
Operation	10
Neutral	10
Bucket/option Spool Operation	10
Boom Spool Operation	11
Relief Valve	11
Operation (Main Relief Valve)	12
Operation (Port Relief Valve)	13

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200	5001 and Up
DL200A	10001 and Up
DL200-TC	10001 and Up
DL200-TONY	5001 and Up

GENERAL DESCRIPTION

The main control valve controls the operation of the bucket, boom, and option cylinders. The bucket spool has priority over the boom spool.

Pump output flows to port P on the main control valve. See Figure 1. Maximum pressure is prevented from exceeding the desired level by the main relief valve (1). See hydraulic schematic (Figure 2). When all spools on the main control valve are in the neutral position (when the pilot valve is not being operated), oil passes through port P, the bucket spool, the boom spool, the option spool, and passes out T, the tank port. Oil that passes out the tank port passes through a filter and returns to tank.

Overload relief valve (2) are installed in the bucket circuit to protect circuit components in the event of abnormally high-pressure. One valve works as a relief valve while the other valve works as an anticavitation valve to provide additional oil flow to the opposite side of the bucket cylinders.

Boom spool has two important roles in loader work at the floating position. One is that it is possible to lower the boom by its weight without oil supply from the pump, and that, at the same time, the oil from the pump makes it possible to combine with the bucket crowd at the max. height of bucket through the bucket line. Another is that boom and bucket are positioned at the level as the cylinder ports A and B are open as a leveling function of ground. There is a suction check valve (3) in the boom power port. When the boom is dropped suddenly by its weight, the cylinder bottom has a cavitation with a lack of oil supply. The check valve supplements oil to prevent the cavitation.

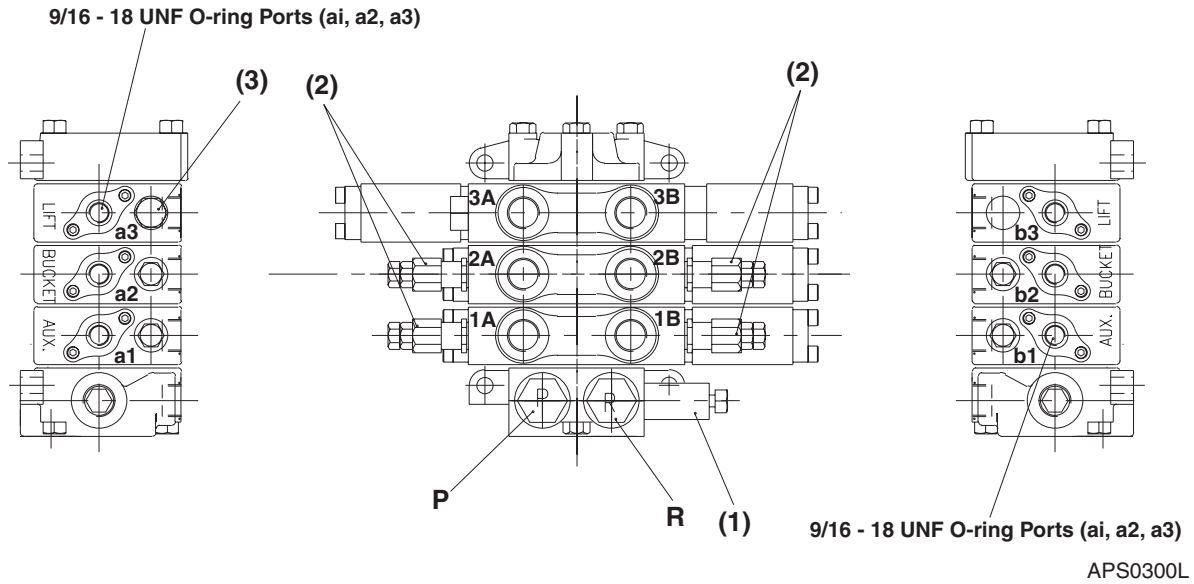
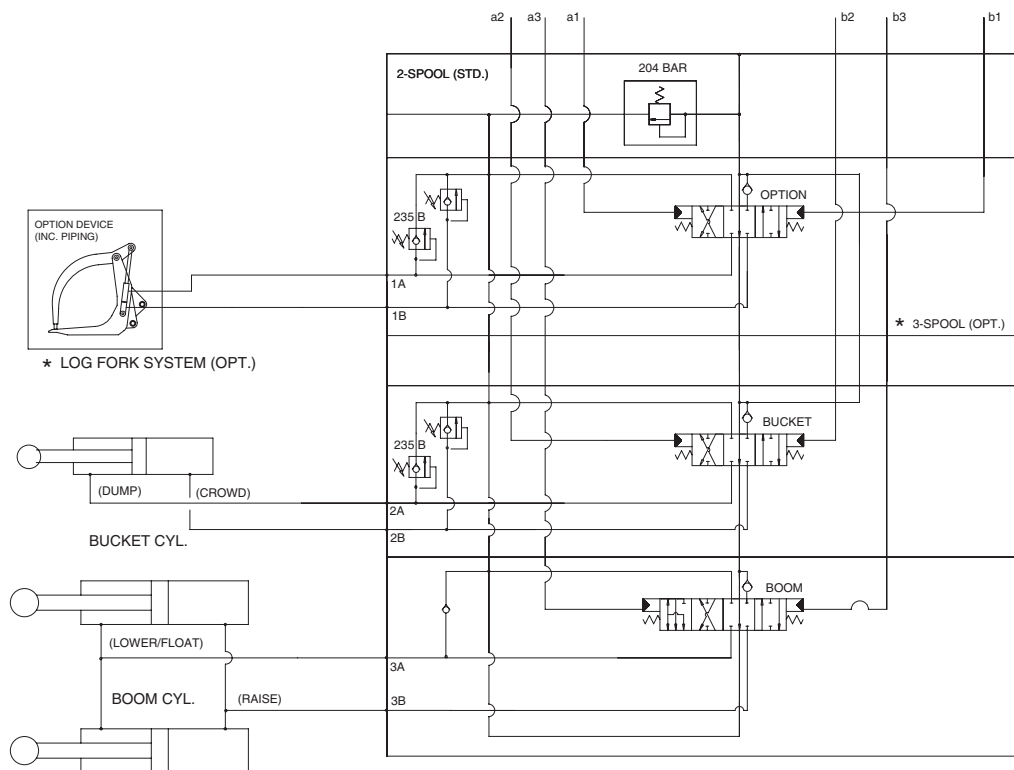


Figure 1



FG028608

Figure 2 CONTROL VALVE HYDRAULIC CIRCUIT

Reference Number	Description
a1	Option Valve Port
a2	Bucket Dump Valve Port
a3	Boom Down Valve Port
b1	Option Valve Port
b2	Bucket Crowd Valve Port
b3	Boom Up Valve Port
1A	Option Cylinder Port (To Option Cylinder Rod)
2A	Bucket Dump Port (To Bucket Cylinder Rod)

Reference Number	Description
3A	Boom Lower Port / float Valve Port (To Boom Cylinder Rod)
1B	Option Cylinder Port (To Option Cylinder Tube)
2B	Bucket Crowd Port (To Bucket Cylinder Tube)
3B	Boom Up Port (To Boom Cylinder Tube)
(1)	Main Relief Valve
(2)	Overload Relief Valve
(3)	Anticavitation Check Valve

SPECIFICATIONS

	2-Spool (STD.)	3-Spool (OPT.)
Type	Pilot Control with Float spool	
Spool Diameter	Ø 28 mm (1.10 in)	
Spool Arrangement	Bucket - Boom	Bucket - Boom - Auxiliary
Main relief pressure	208 kg/cm ² (204 bars @ 144 liters/min)	
Overload relief pressure	240 kg/cm ² (235 bars @ 30 liters/min)	

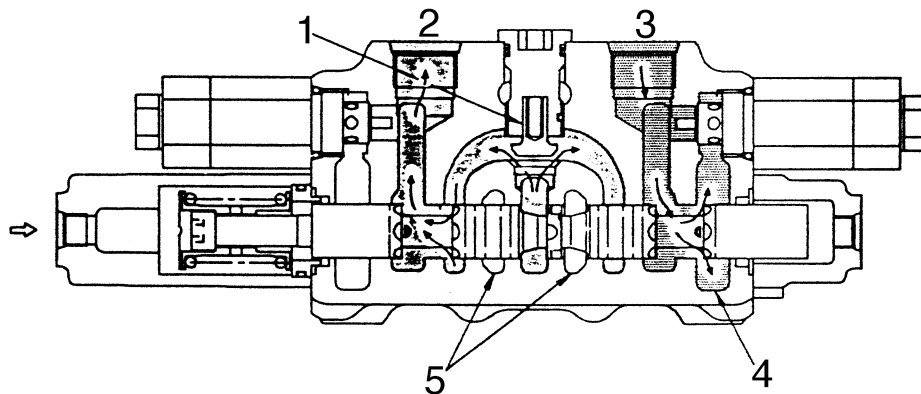
OPERATION

Neutral

When the spools of the bucket section and the boom section are in neutral, both the cylinder ports A (rod side) and B (tail side) are closed by the spools.

The pressure oil which has reached the control valve flows through the inlet section, past the neutral oil passages in the bucket section and the boom section to the outlet section from which it is directed to the low-pressure oil passage and leaves the control valve through the exhaust port of the inlet section.

Bucket/option Spool Operation



HAAA2220

Figure 3 OPERATION IN BUCKET/OPTION

Reference Number	Description
1	Load Check
2	Port A1
3	Port B1
4	Tank Passage
5	Center By-pass Passage

When the bucket spool moves in the direction indicated by the arrow

The neutral oil passage is closed by the spool and the pressure oil pushes open the load check valve to flow to the cylinder port (A1) from which it is directed into the bucket cylinder rod side.

The oil discharged from the bucket cylinder tail side flows through the cylinder port (B1) to the low pressure oil passage.

Boom Spool Operation

Boom Float

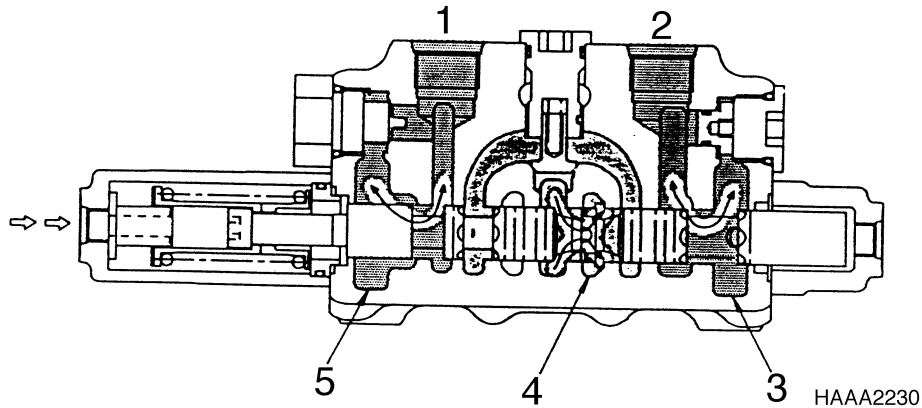


Figure 4 OPERATION IN BOOM FLOAT

Reference Number	Description
1	Port A2
2	Port B2
3	Tank Passage
4	Center By-pass Passage
5	Tank Passage

When the control lever is further pushed down from the “Down” position to the “Float” position, the boom spool moves as indicated in the illustration.

Due to this motion the neutral passage is opened. The pressure oil flows as if in neutral position. The cylinder ports (A2) and (B2) are connected to the low-pressure oil passage. As a result, the booms float over the ground surface according to its irregularities. The oil discharged from the boom cylinder rod side is sent to the tail side and the oil forced out from its tail side is sent to the rod side respectively through the low-pressure oil passage in the control valve.

Relief Valve

Main Relief Valve

The main relief valve is located between the neutral oil passage and the low pressure oil passage (return oil passage) in the inlet section.

Port Relief Valve

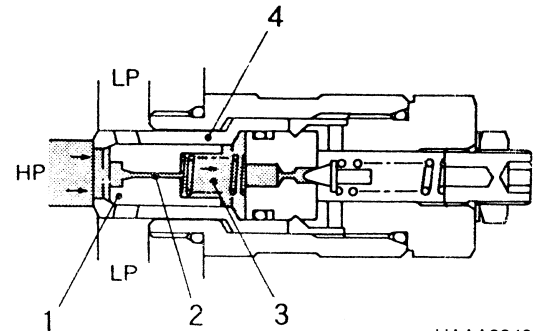
The port relief valve is located between the rod side cylinder port and the low-pressure oil passage (return oil passage) in the bucket spool section.

The combination valve, used as the port relief valve, serves both as the relief valve and an anticavitation valve.

Operation (Main Relief Valve)

Operation in Inoperative State

The pressure oil in the neutral oil passage (HP) flows through the throttle hole (2) in the main poppet (1) to fill the internal cavity (3). Owing to the difference in area on which the hydraulic pressure acts, the main poppet (1) closely seats to the sleeve (4).

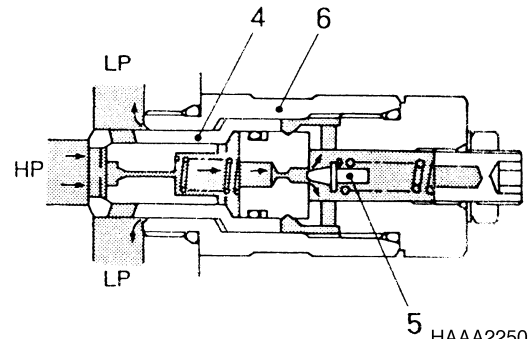


HAAA2240

Figure 5 IN INOPERATIVE STATE

Operation (A)

When the pressure in the neutral oil passage (HP) rises and exceeds the relief pressure setting, the pilot poppet (5) opens. The pressure oil flows from the pilot poppet into the low pressure oil passage (LP), passing between the sleeve (4) and the housing (6).

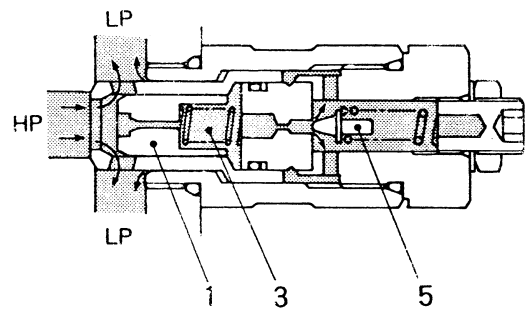


HAAA2250

Figure 6 OPERATION (A)

Operation (B)

As the pilot poppet (5) opens, the pressure in the internal cavity (3) lowers to move the main poppet (1) so that the pressure oil in the neutral oil passage (HP) flows directly into the low pressure oil passage (LP).



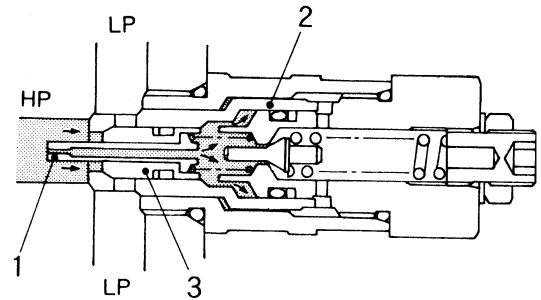
HAAA2260

Figure 7 OPERATION (B)

Operation (Port Relief Valve)

In the Inoperative State

The pressure oil at the cylinder port (HP) flows through the hole in the piston poppet (1) to act from the opposite sides of the check valve poppet (2) and relief valve poppet (3). Owing to the difference in area on which the hydraulic pressure acts, both poppets close to seat the same time.

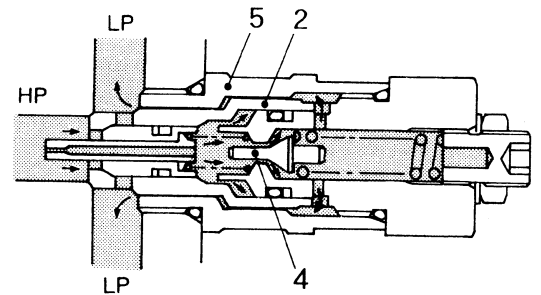


HAAA2270

Figure 8 IN INOPERATIVE STATE

Operation (A)

When the pressure at the cylinder port (HP) rises and exceeds the relief pressure setting, the pilot poppet (4) opens. The pressure oil flows from the pilot poppet into the low-pressure oil passage (LP), passing between the check valve poppet (2) and the housing (5).

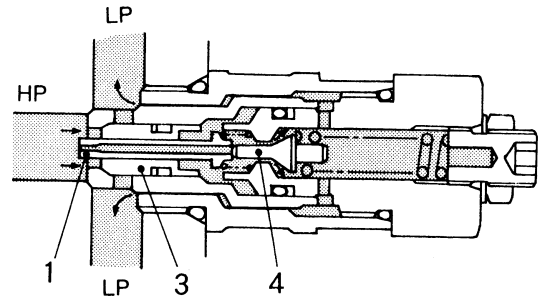


HAAA2280

Figure 9 OPERATION (A)

Operation (B)

As the pilot poppet (4) opens, the pressure at the back of the piston poppet (1) lowers to move the piston poppet (1). As a result, the hole in the piston poppet (1) is closed so that the pressure at the back of the relief valve poppet (3) drops further.

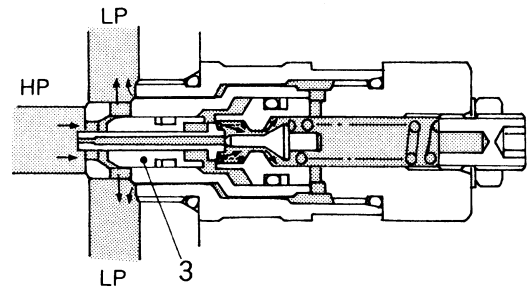


HAAA2290

Figure 10 OPERATION (B)

Operation (C)

The pressures across the relief valve poppet (3) loses balance. Due to pressure differential, the relief valve poppet moves so that the pressure oil at the cylinder port (HP) flows directly to the low-pressure oil passage (LP).

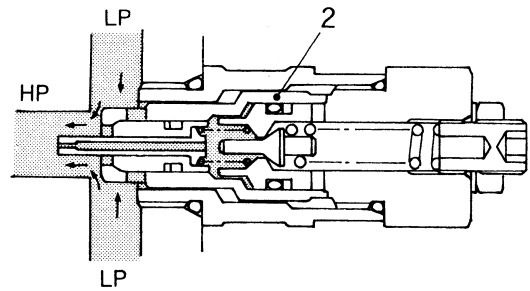


HAAA2300

Figure 11 OPERATION (C)

Sucking Operation

If the pressure at the cylinder port (HP) becomes lower than that at the low-pressure oil passage (LP) due to the development of cavitation, the check valve poppet (2) moves depending upon the difference in area on which negative pressure acts across the check valve poppet. Consequently, oil is supplied from the low-pressure oil passage (LP) to the cylinder port side (HP) to eliminate the cavitation.



HAAA2310

Figure 12 SUCKING OPERATION

Load Isolation System

Edition 1

MEMO

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Load Isolation System

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Accumulator Charging Method	8
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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up
DL250A	10001 and Up

GENERAL DESCRIPTION

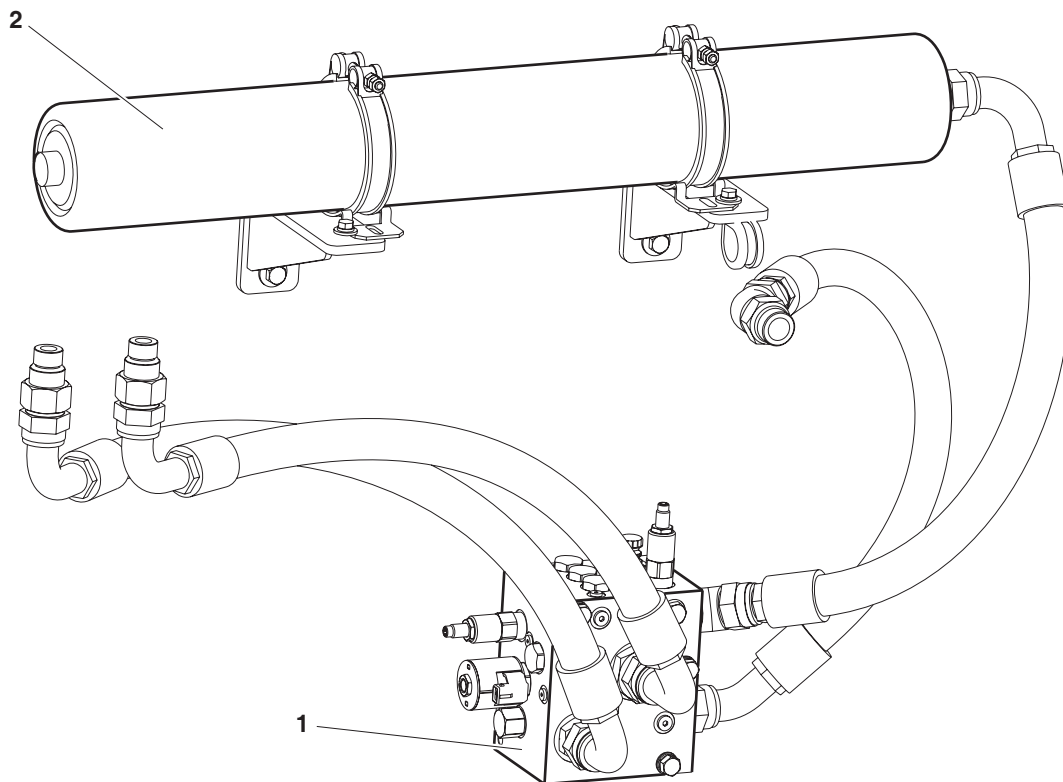
Load Isolation System (LIS) reduces loader pitching movements that effect the machine and operator.

For this the lifting line is connected to the hydraulic accumulator by a switching valve that absorbs the loads caused by the pitching movement.

The following advantages apply when Load Isolation System is fitted:

- Higher transport speeds
- Higher handling rates
- Stable steering characteristics
- Shorter braking distances
- More comfort for the operator
- Lower mechanical loading of the entire machine
- Fewer repairs or down times with identical handling rates

Overview



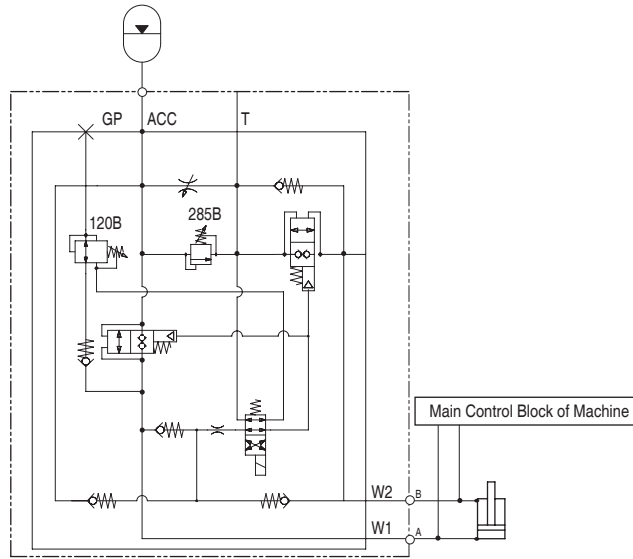
FG022234

Figure 1

Reference Number	Description
1	LIS Valve

Reference Number	Description
2	Accumulator

Hydraulic Circuit



FG026381

Figure 2

Accumulator Charging Method

Before charging accumulator, the bucket has to be on the ground.

Rotate screw of drain valve (shown in the circuit) of LIS valve.

After residual pressure is removed, tighten drain screw again.

Remove gas valve guard and gas valve cap of accumulator.

Back gas chuck "T" handle of charging kit all the way out (counterclockwise) before attaching charging assembly to accumulator gas valve.

Close bleed valve.

Attach swivel nut to gas valve and tighten.

Crack open nitrogen bottle valve and slowly fill accumulator.

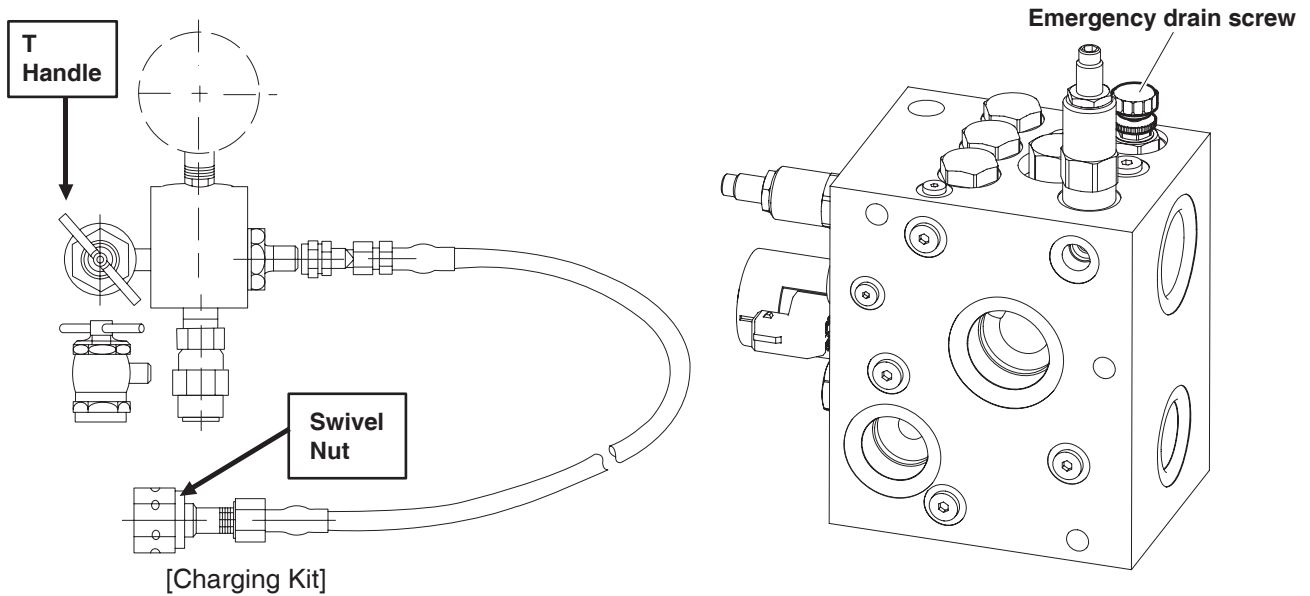
Shut off when gauge indicates desired precharge 20 kg/cm² (20 bar (290 psi)).

Let the precharge set for 10 to 15 minutes. This will allow the gas temperature to stabilize. If the desired precharge 20 kg/cm² (20 bar (290 psi)) is exceeded, close nitrogen bottle valve, then slowly open bleed valve. Do not reduce precharge by depressing valve core with a foreign object. High-pressure may rupture rubber valve seat.

When finished precharging accumulator, turn "T" handle all the way out on gas chuck, then open bleed valve.

Hold gas valve to keep from turning, loosen swivel nut, remove assembly. Check for precharge leak using a common leak reactant.

Replace gas valve cap and valve guard.



FG022235

Figure 3



WARNING

AVOID DEATH OR SERIOUS INJURY

Before maintenance or servicing accumulators, remove all pressure inside the accumulator.

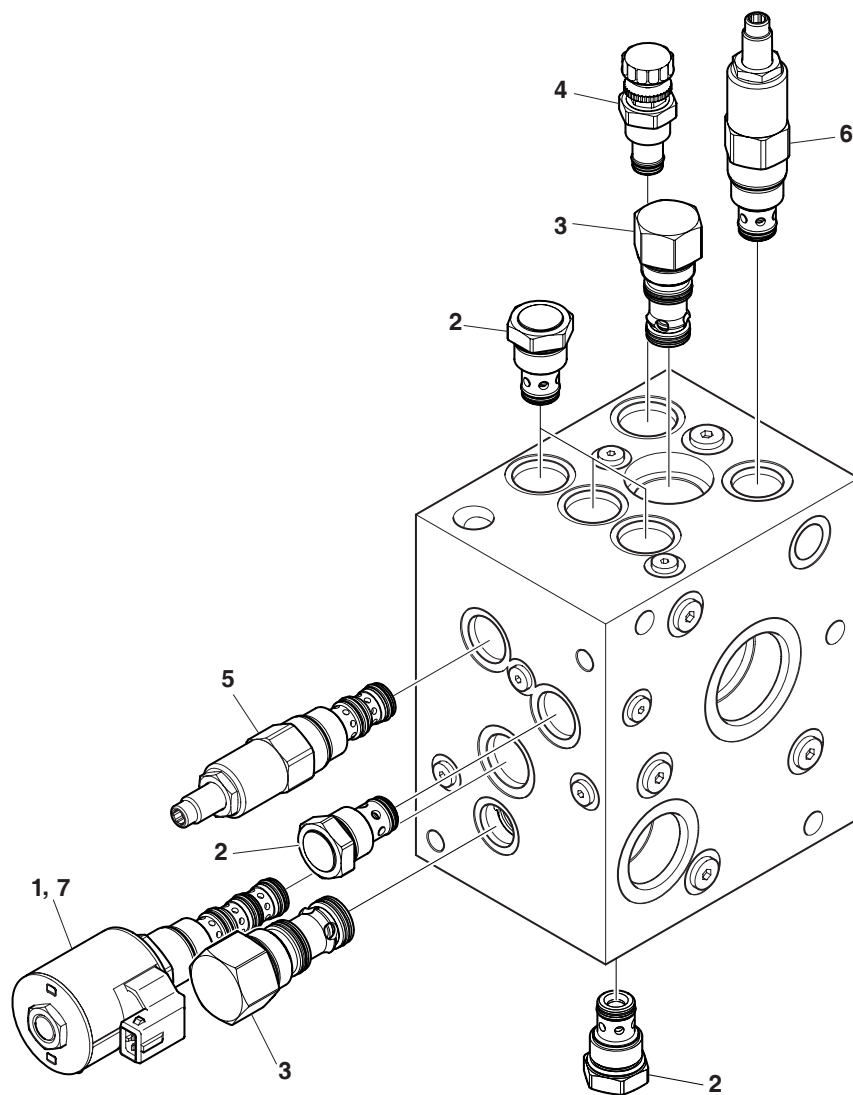
Always lower bucket or attachment to the ground.

LIS Valve

Specification

General		
Installation		Optional
Ambient Temperature Range		- 20 - + 80°C
Weight		23.5 kg (51.8 lb)
Hydraulic		
Max. Operating Pressure	Ports A, B	291 kg/cm ² (285 bar (4,134 psi))
	Port T	31 kg/cm ² (30 bar (435 psi))
Max. Nominal Flow	Ports A, X2	152 l/min
Pressure Fluid Mineral Oil		(HL, HLP) to DIN 51 524
Viscosity range		50 - 2000 ^{mm} 2/s
Degree of Contamination (Max. Permissible)		ISO 4406 (C) class 20/18/14
Electrical		
Control Voltage		24 V
Power Consumption (Solenoid)		20.31 W

Parts List



FG023821

Figure 4

Reference Number	Description
1	Coil
2	Check Valve
3	Logic Valve
4	Needle Valve

Reference Number	Description
5	Priority Valve
6	Relief Valve
7	Solenoid Valve

Unloader Valve

Edition 1

MEMO

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Unloader Valve

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

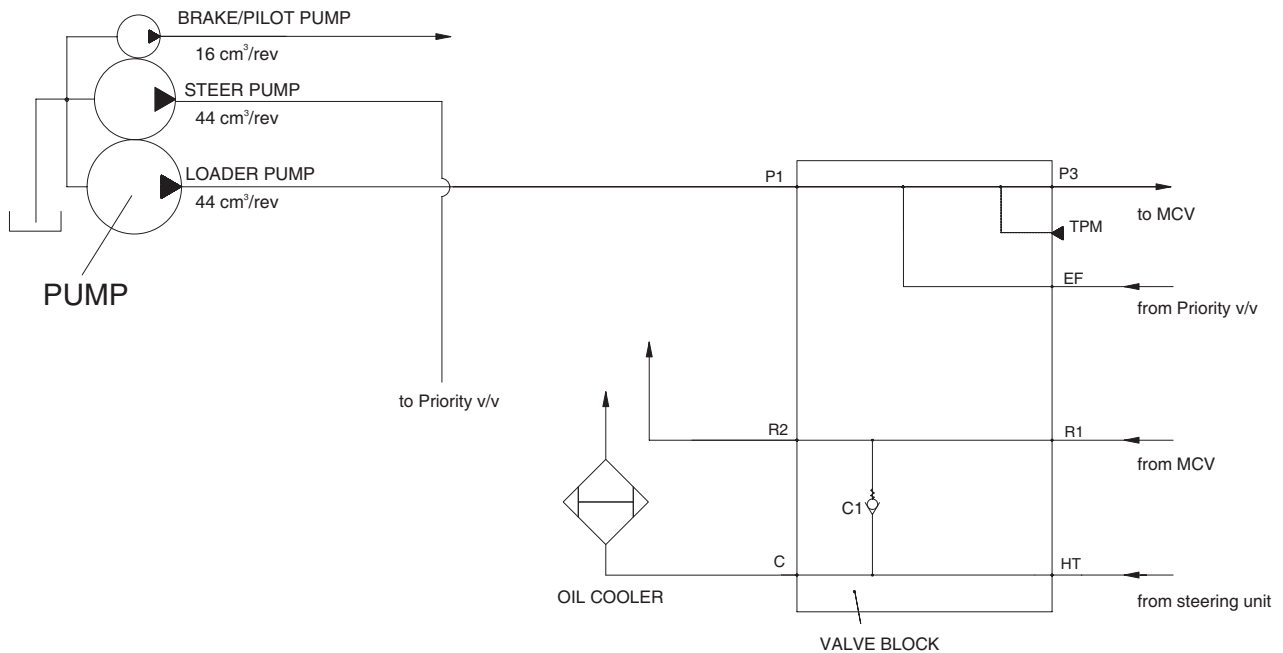
Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200	5001 and Up
DL200A	10001 and Up
DL200-TC	10001 and Up
DL200-TONY	5001 and Up

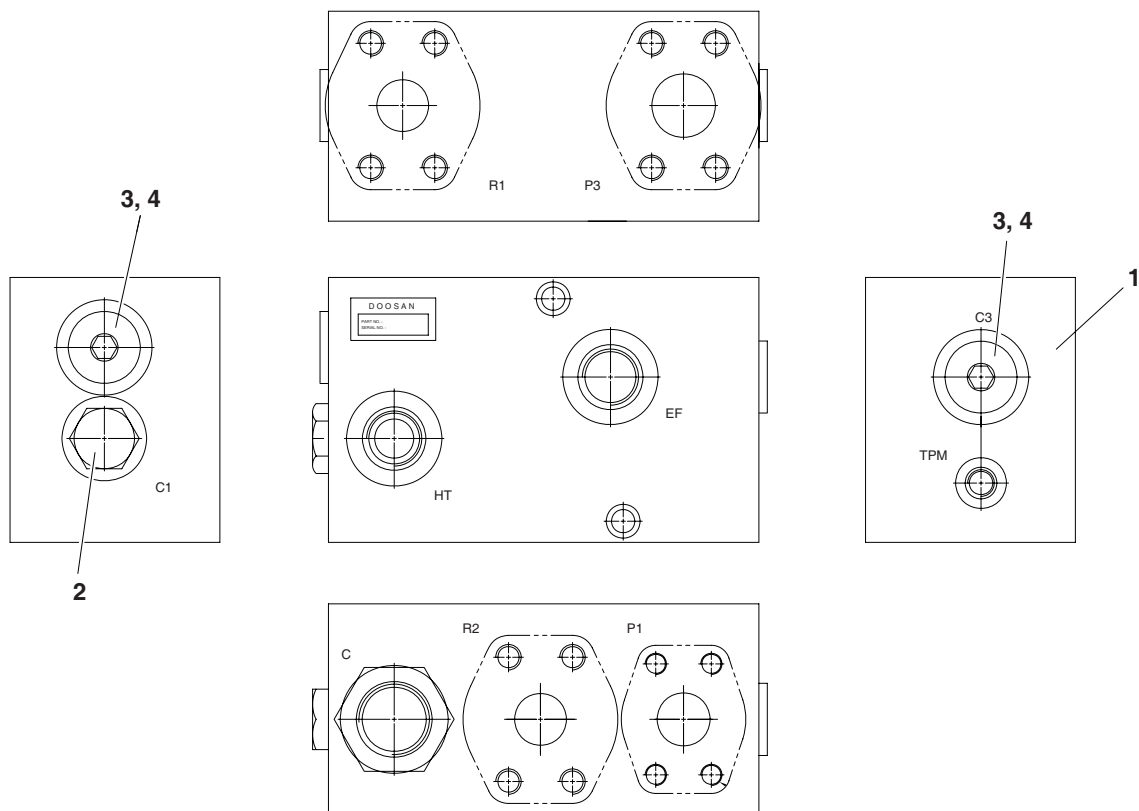
The unloading valve is made up of one cartridges C1. When pressure in the main pump output line is low, the unloading valve diverts output from the steering pump and directs it to the main pump output line. This line supplies the boom, bucket, and option control valves. This additional fluid creates faster cycle times. When pressure in the main pump output line is high, the unloading valve directs steering pump flow to tank.



FG028609

Figure 1 UNLOADING CIRCUIT

Unloader Cartridge Identification



FG028601

Figure 2 VALVE CARTRIDGE IDENTIFICATION

Reference Number	Description	Remark
1	Body	99×125×203
2	Check Valve	C1
3	Wrench Plug	
4	O-ring	

Pilot System

Edition 1

MEMO

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Pilot System

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

GENERAL DESCRIPTION

When no force is applied to the lever (1, Figure 1), the return spring (4) positions the lever at the "NEUTRAL" position. When the lever is moved, plunger (5) is moved, which pushes down the return spring (4). At the same time, spool (2) is moved by spring (3). When spool (2) moves down, a groove (6) in the spool opens the pilot pressure line to the line that the lever controls. This allows the pilot pressure to flow to the boom or bucket control valve, where the pilot pressure operates the control valve. When the lever is completely moved in one direction, the solenoid (7) energizes the electromagnet (8) and holds the lever in the fully moved position.

Pilot Valve Operation

The lever handle is positioned on the right side of the operator's seat. This single lever controls the following machine functions: raise boom, lower boom, bucket crowd, and bucket dump. The lever positions are identified as follows:

F - Float

L - Lower

N - Neutral

R - Raise

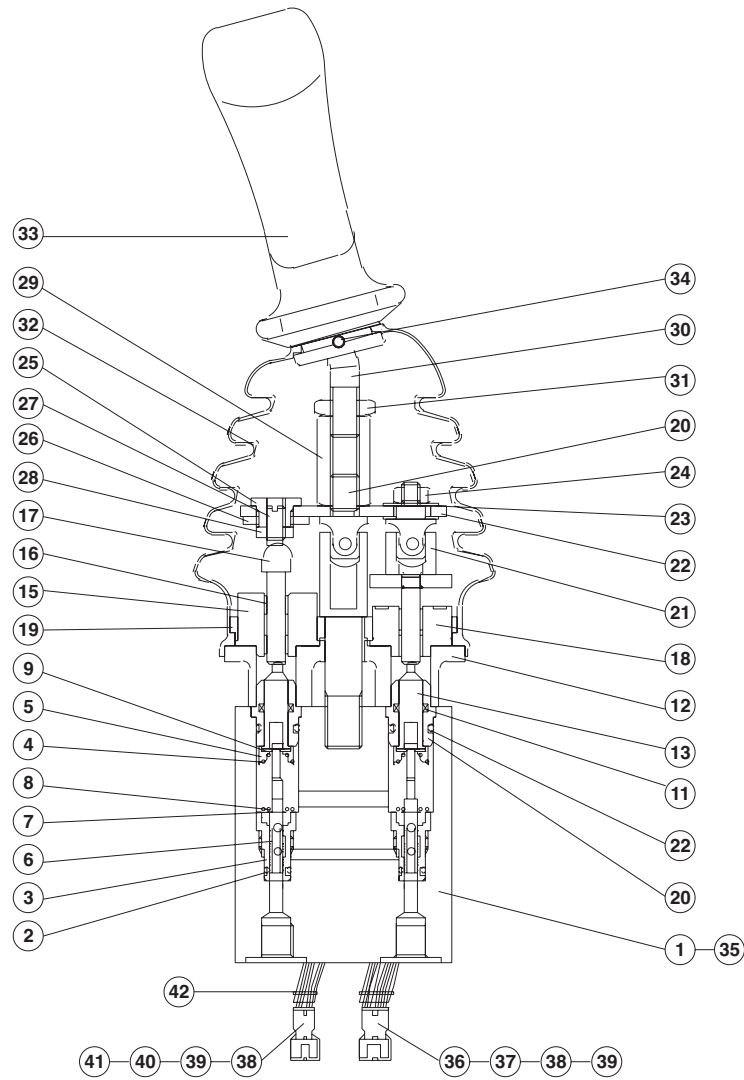
H - Hold Position

C - Bucket Crowd

D - Bucket Dump

HR - Holds lever in Raise Mode.

Parts List



BAS0130L

Figure 1

Reference Number	Description
1	Body
2	O-ring
3	Plug
4	Spring
5	Spring Seat
6	Spool
7	Spring Seat
8	Spring
9	Stopper
10	Plug
11	Rod Seal
12	O-ring
13	Push Rod
14	Plate
15	Rod Stopper
16	Du-bushing
17	Rod
18	Magnet
19	Plate
20	Joint Assembly
21	Joint Assembly

Reference Number	Description
22	Plate
23	Washer
24	Nut
25	Plug
26	Nut
27	Set Screw
28	Nut
29	Nut
30	Connector
31	Nut
32	Boot
33	Handle Assembly
34	Spring Pin
35	Plug
36	Housing
37	Holder Rear
38	Terminal
39	Seal Wire
40	Housing
41	Holder Rear
42	Clip Band

FUNCTION

The pilot system uses low-pressure oil to operate the main control valves. The main components of the pilot system are pump, pressure reducing valve, accumulator, pilot cutoff valve and pilot valves.

With the engine running, oil flows from hydraulic tank to pilot pump. The oil flows from the pump through pressure reducing valve to pilot cutoff valve. The pressure reducing valve maintains pilot system pressure at 30 kg/cm² (30 bar (435 psi)).

From the pilot cutoff valve, the oil flows into the pilot control valves. Pilot valve is a closed center valve.

The oil cannot flow through the valve when it is in the HOLD position because it is a closed center valve.

When the control lever is moved to the DUMP position, oil flows through oil lines to the ends of the bucket spool of main control valve. This causes the main control valve spool to move. Movement of the spool opens passages for attachment pressure oil to flow to the rod end of the bucket cylinder.

Spool movement also opens a passage for return oil from the head end of the bucket cylinder to flow back to hydraulic tank. Attachment pressure oil acts on the rod end of the bucket cylinder and, because the head end of the cylinder is now vented to tank, the bucket will dump.

When the control lever is moved to the CROWD position, oil flows through oil lines to the ends of the bucket spool of main control valve. This causes the main control valve spool to move in the opposite direction.

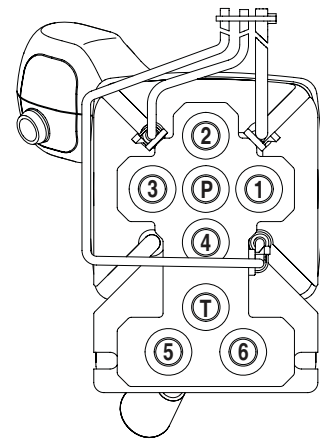
Movement of the spool in this direction opens passages for pressure oil to flow to the head end of the tilt cylinder. Spool movement also opens a passage for return oil from the rod end of the tilt cylinder to flow back to the hydraulic tank. Attachment pressure oil acts on head end of the tilt cylinder and because the rod end of the cylinder is now vented to tank, the bucket will crowd.

WALVOIL FNR JOYSTICK

Specification

Hydraulic Fluid	ISO VG #46 or SIMILAR
Ambient Temperature	-29 - +93°C
Hydraulic Oil Temperature	-20 - +100°C
Vibration	3 -5G/ 30Hz
Shock	10G
Supply Pressure	28 kg/cm ² (27 bar (1,450 psi))
Supply Flow	15 l/min
Contamination	NAS 9 Grade after Flushing

Reference Number	Description
P	Brake and Pilot Supply Valve (PL port)
T	Tank Return
1	Boom Up
2	Bucket Crowd
3	Boom Down
4	Bucket Dump
5	Option
6	Option

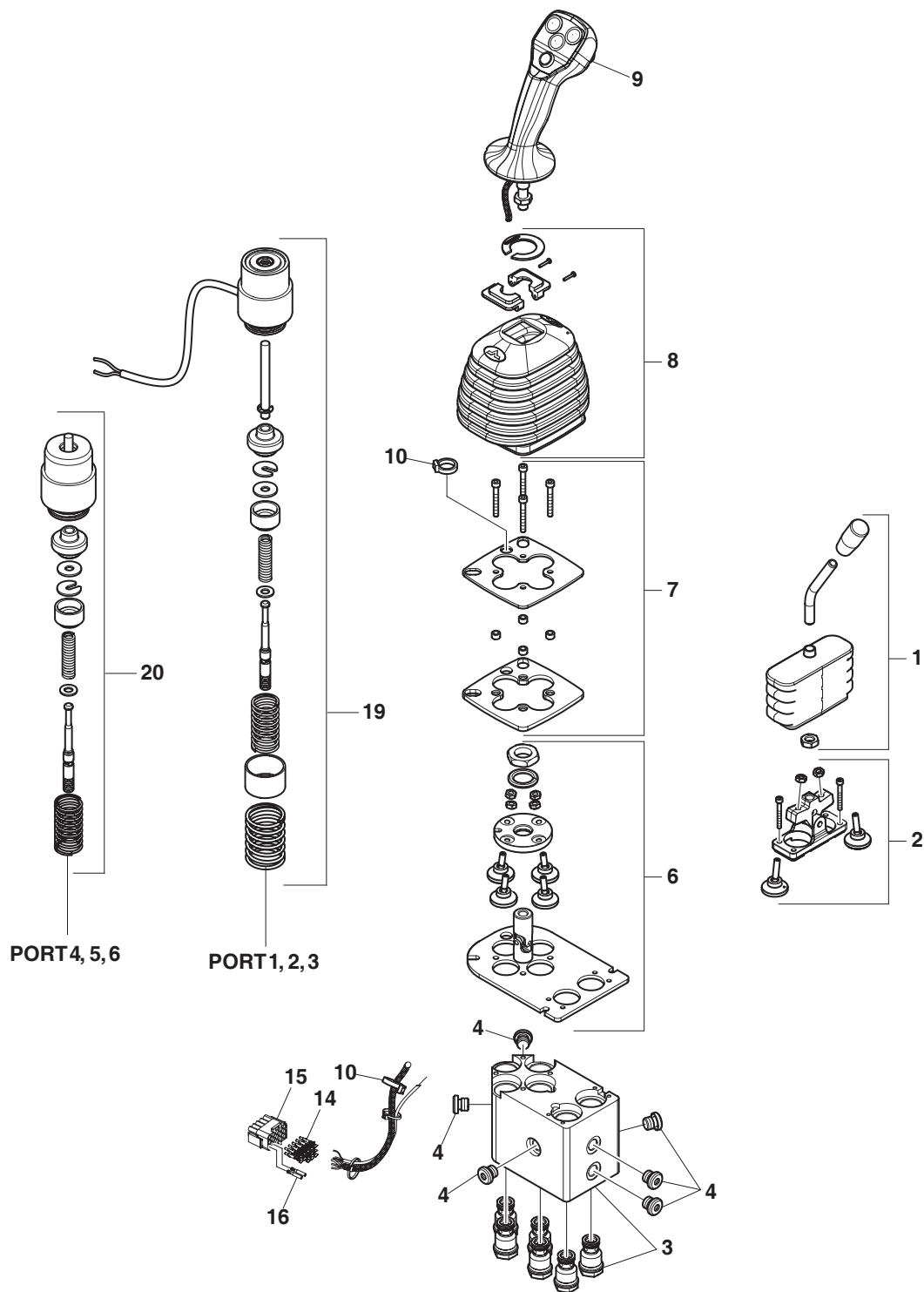


PORT NAME
(BOTTOM VIEW)

FG028499

Figure 2

Parts List



FG021663

Figure 3

Reference Number	Description	Qty.
1	2nd Lever Kit	1
2	Spool Kit	1
3	Body Kit	1
4	Plug	6
5	Ring	6
6	Plate Kit	1
7	Flange Kit	1
8	Bellows Kit	1

Reference Number	Description	Qty.
9	Handle	1
10	Clip Band	4
11	Terminal	1
12	Connector	1
13	Keying Pin	1
14	Spool Kit (UT1,2,3)	1
15	Spool Kit (UT4,5,6)	1

Hydraulic Schematic DL200A

Edition 1

MEMO

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

DL200A

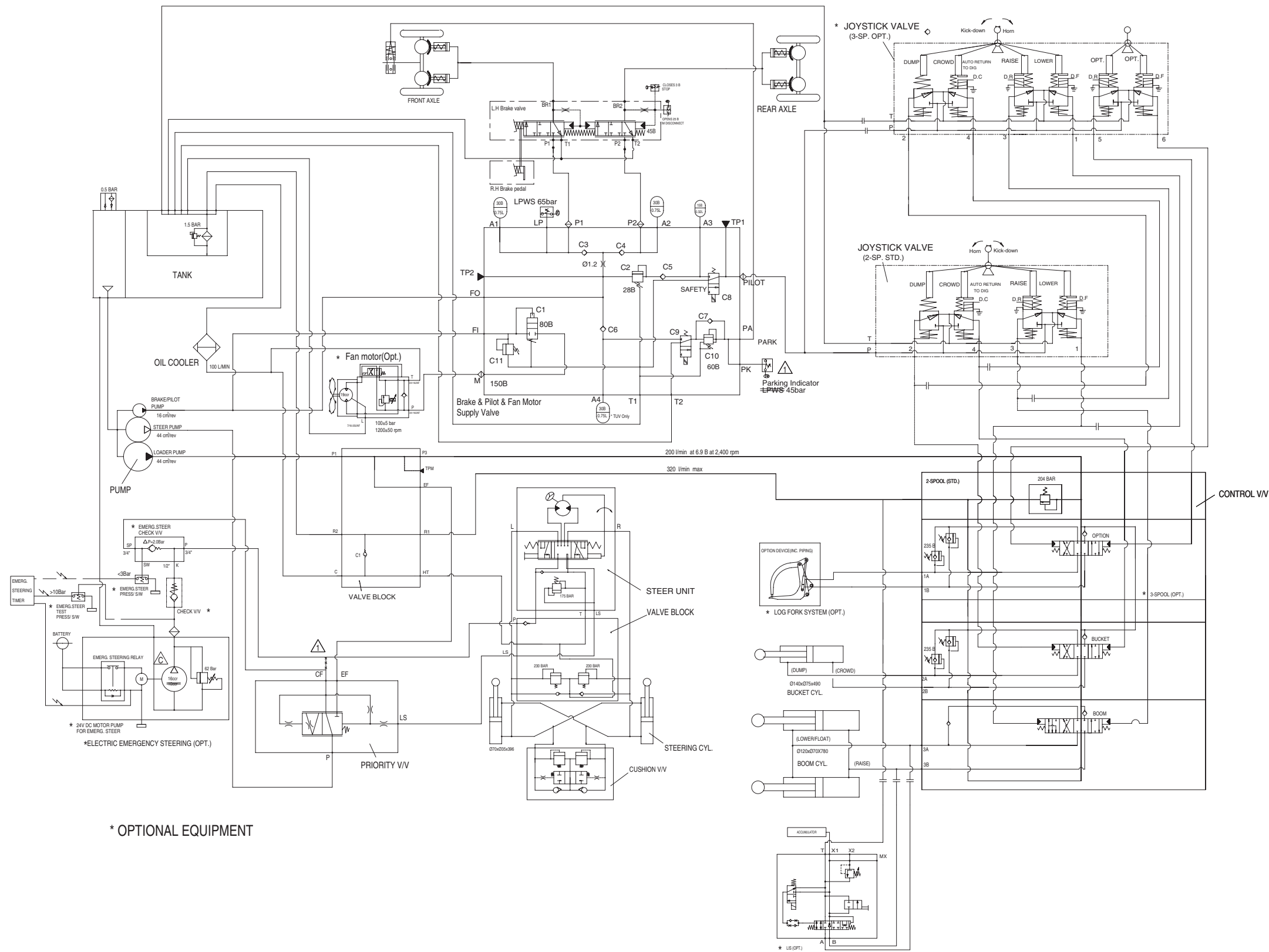


Figure 1

Electrical System

Air Conditioner

Edition 2

MEMO

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Air Conditioner

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

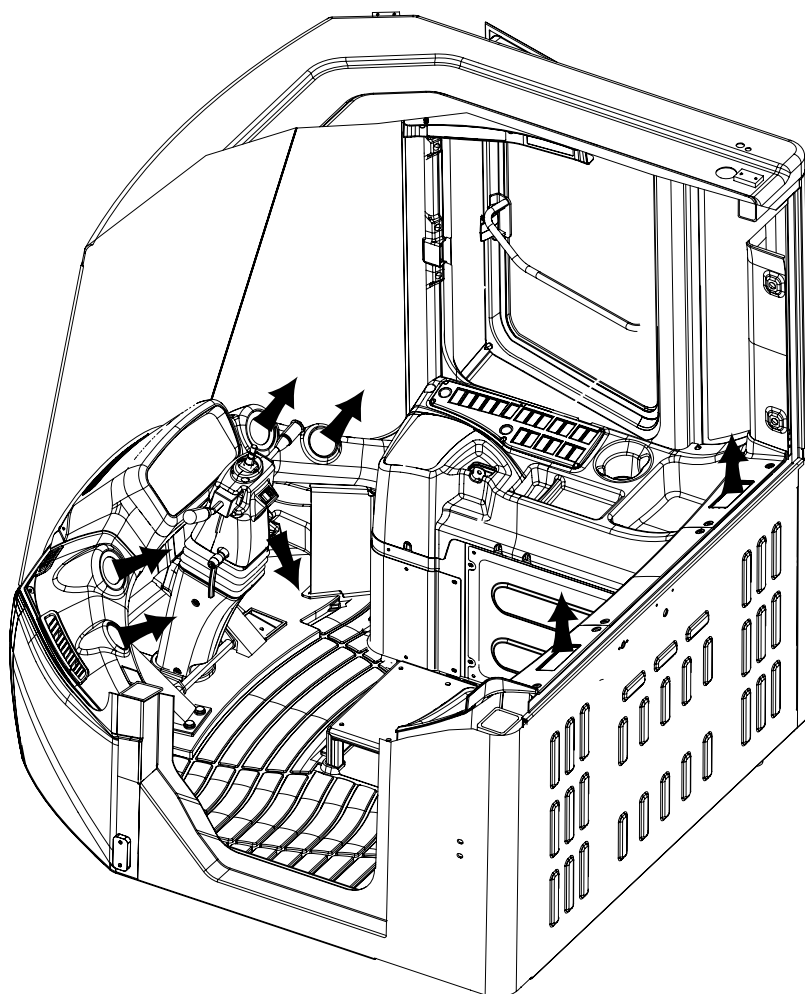
Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up
DL250A	10001 and Up
DL300A	10001 and Up
DL420A	10001 and Up

GENERAL DESCRIPTION



FG004488

Figure 1

The heater and air conditioner are combined into one blower unit in the right control stand of operator's seat. If necessary, the operator can control inner temperature using the operation panel installed in the top of the right side door.

The unit is equipped with an air filtration system which filters out dirt and dust particles from air being circulated into the operator's cab. This filter (1, Figure 2) should be cleaned out at approximately every 500 hours and replaced with a new one every 1,000 hours.

NOTE: *In the event that the unit is being operated in a dusty environment, cleaning and replacement should be performed more frequently.*



WARNING

AVOID DEATH OR SERIOUS INJURY

All service and inspection of the air-conditioning system should be performed with the starter switch in the "O" (OFF) position.

NOTE: *Refer to appropriate operation and maintenance manual for latest service intervals.*

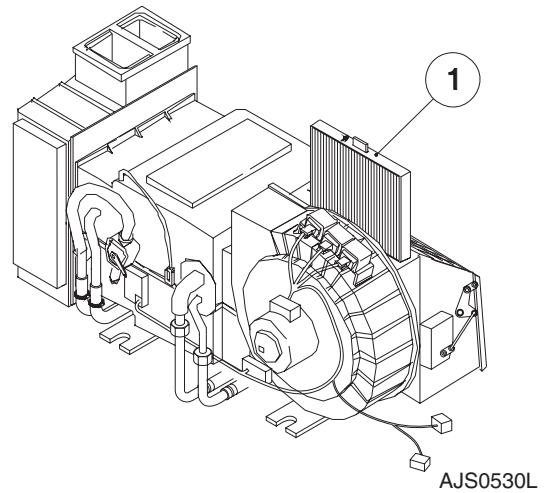


Figure 2

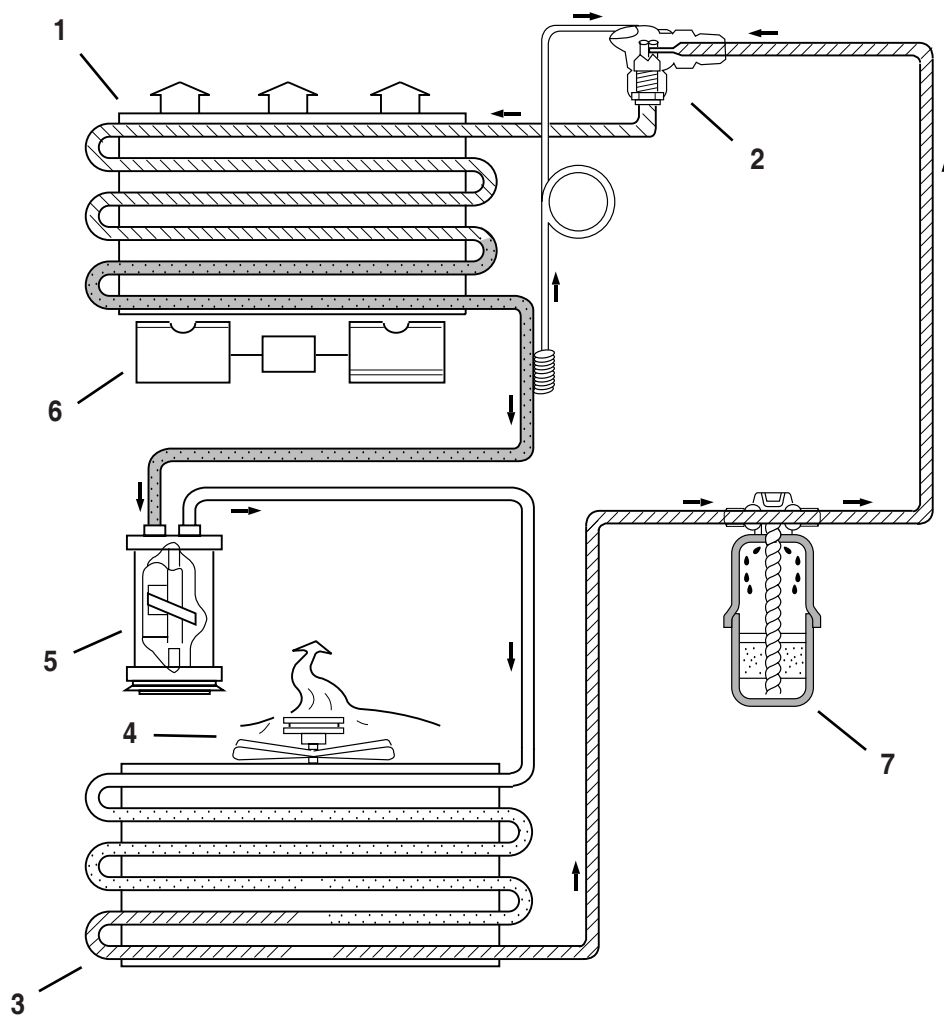
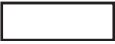


Figure 3

Reference Number	Description
1	Evaporator
2	Expansion Valve
3	Condenser
4	Condenser Fan

Reference Number	Description
5	Compressor
6	Blower Fan
7	Receiver Dryer

Shading	Temperature	Refrigerant State
	High	High-pressure Gas
	High	High-pressure Liquid
	Low	Low-pressure Liquid
	High	High-pressure Gas/Liquid
	Low	Low-pressure Gas

- Refrigerant (R134a) is compressed to approximately 15 kg/cm² (213 psi) within the compressor.
- The compressed refrigerant flows into the condenser at high temperature (approximately 80°C (176°F)).
- The refrigerant in the condenser is cooled to approximately 60° by the condenser fan. At this time the refrigerant changes from the gas to the liquid state, even though the temperature has only been reduced 20°C (68°F). (From 80° - 60°C (176° - 140°F)).
- The refrigerant in its liquid form is injected into the evaporator through the expansion valve. At this time the pressure is reduced by approximately 2 kg/cm² (28 psi) and the temperature is also reduced. As a result, the refrigerant absorbs the heat from the air surrounding the evaporator creating a cooling effect and changes from the gas to the liquid state.
- The refrigerant again flows into the compressor in the gaseous state and the process is repeated.

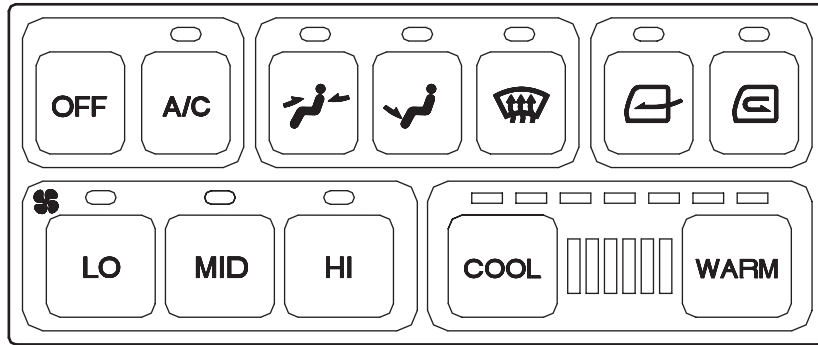


WARNING

AVOID DEATH OR SERIOUS INJURY

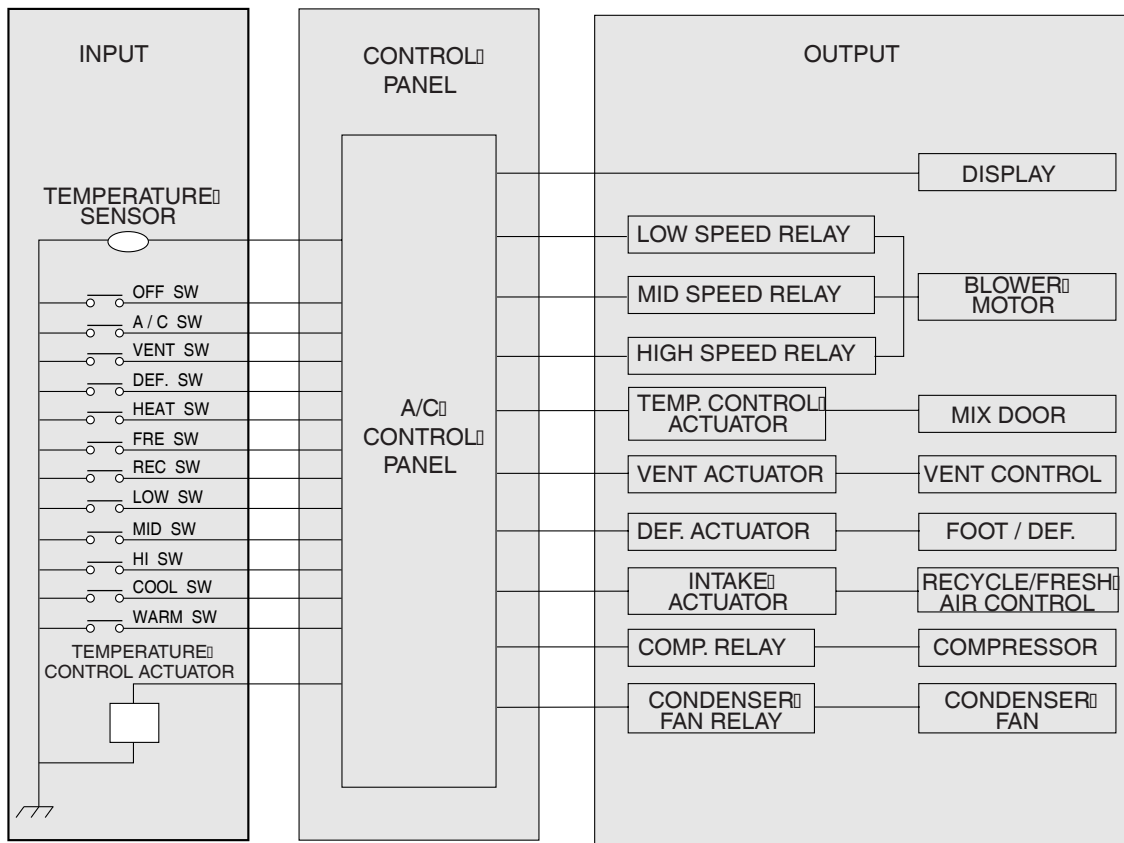
Refrigerant gas is pressurized and sealed in the air-conditioning system. Special precautions are required for the proper recharging or release of refrigerant. Release of refrigerant into the atmosphere is strictly regulated by law. Make sure that you are in compliance with all mandated federal, state and municipality requirements, before starting any service or repair of the air conditioner. Refrigerant gas used in the system must meet or exceed specifications for R134a refrigerant, or any subsequently issued environmentally mandated standard.

CONTROL PANEL



FG004455

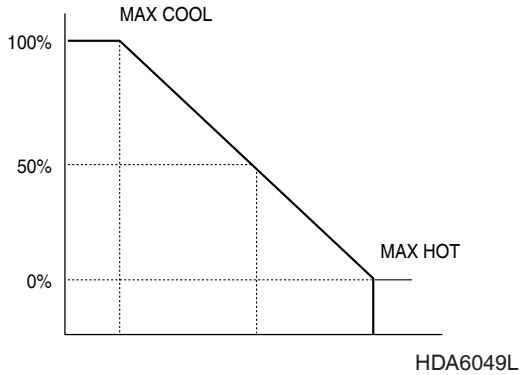
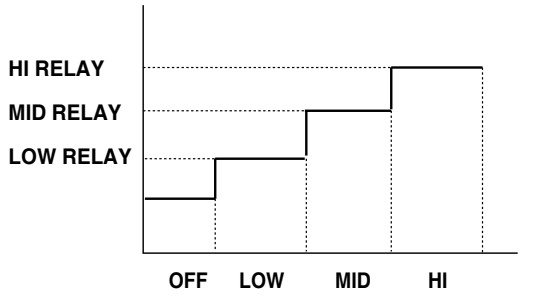
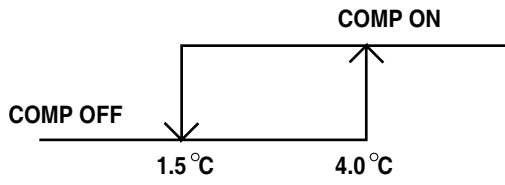
Figure 4



HDA6048L

Figure 5

CONTROL SPECIFICATIONS

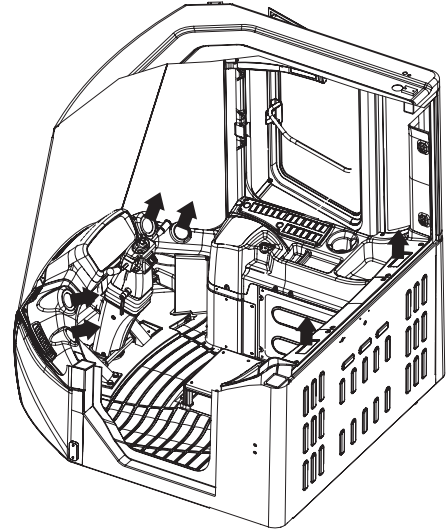
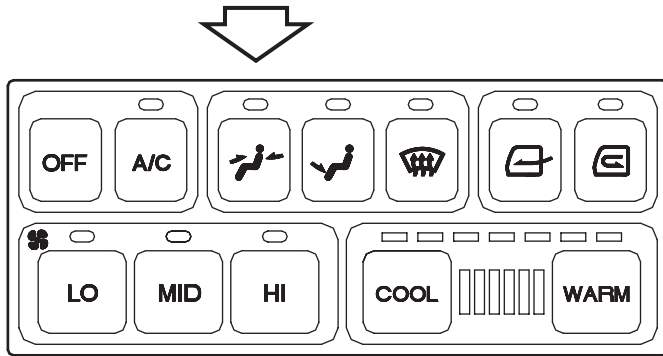
Control Item	Control Switch	Control Specifications
Temperature Control	"COOL" Switch "WARM" Switch	 Figure 6 Temperature control switch consists of a 24 step variable selector. The display uses 7, Green / Red two color LED's to display the selected temperature.
Blower Fan Speed Control	"OFF" Switch "LOW" Switch "MID" Switch "HI" Switch	 Figure 7
Compressor Control	Temperature Sensor	 Figure 8

TEMPERATURE LEVEL CONTROL AND DISPLAY

Step	LED 1	LED 2	LED 3	LED 4	LED 5	LED 6	LED 7	Position Sensor Voltage	Remark
0	Green	Green	Green	Green	Green	Green	Green	4.50 V $\pm$ 0.2	MAX. COOL
1	Green	Green	Green	Green	Green	Green	Green	4.33 V $\pm$ 0.2	
2	Green	Green	Green	Green	Green	Green	Green	4.15 V $\pm$ 0.2	
3	Red	Green	Green	Green	Green	Green	Green	3.98 V $\pm$ 0.2	
4	Red	Green	Green	Green	Green	Green	Green	3.80 V $\pm$ 0.2	
5	Red	Green	Green	Green	Green	Green	Green	3.63 V $\pm$ 0.2	
6	Red	Red	Green	Green	Green	Green	Green	3.46 V $\pm$ 0.2	
7	Red	Red	Green	Green	Green	Green	Green	3.28 V $\pm$ 0.2	
8	Red	Red	Green	Green	Green	Green	Green	3.11 V $\pm$ 0.2	
9	Red	Red	Red	Green	Green	Green	Green	2.93 V $\pm$ 0.2	
10	Red	Red	Red	Green	Green	Green	Green	2.76 V $\pm$ 0.2	
11	Red	Red	Red	Green	Green	Green	Green	2.59 V $\pm$ 0.2	
12	Red	Red	Red	Red	Green	Green	Green	2.41 V $\pm$ 0.2	
13	Red	Red	Red	Red	Green	Green	Green	2.24 V $\pm$ 0.2	
14	Red	Red	Red	Red	Green	Green	Green	2.07 V $\pm$ 0.2	
15	Red	Red	Red	Red	Red	Green	Green	1.89 V $\pm$ 0.2	
16	Red	Red	Red	Red	Red	Green	Green	1.72 V $\pm$ 0.2	
17	Red	Red	Red	Red	Red	Green	Green	1.54 V $\pm$ 0.2	
18	Red	Red	Red	Red	Red	Red	Green	1.37 V $\pm$ 0.2	
19	Red	Red	Red	Red	Red	Red	Green	1.20 V $\pm$ 0.2	
20	Red	Red	Red	Red	Red	Red	Green	1.02 V $\pm$ 0.2	
21	Red	Red	Red	Red	Red	Red	Red	0.85 V $\pm$ 0.2	
22	Red	Red	Red	Red	Red	Red	Red	0.67 V $\pm$ 0.2	
23	Red	Red	Red	Red	Red	Red	Red	0.50 V $\pm$ 0.2	MAX. HOT

AIR DISCHARGE ACCORDING TO PATH SELECTION

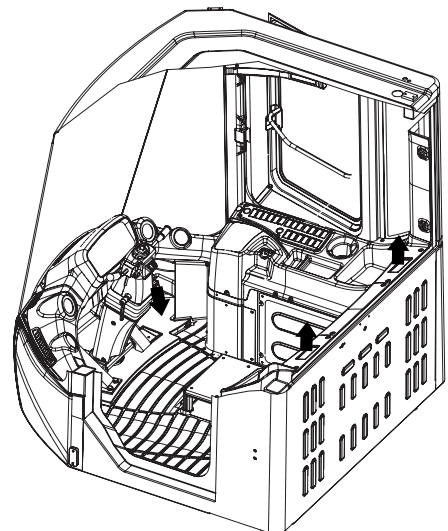
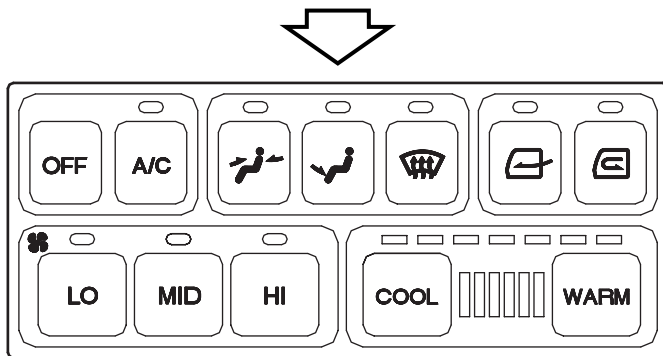
Face + Rear



FG004481

Figure 9

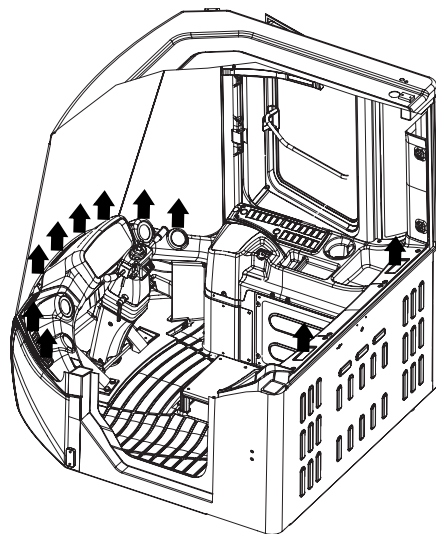
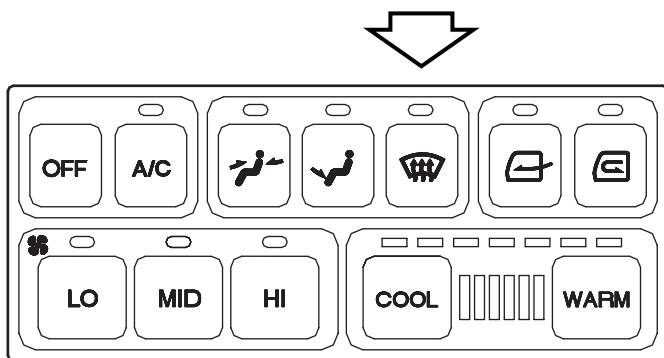
Foot + Rear



FG004482

Figure 10

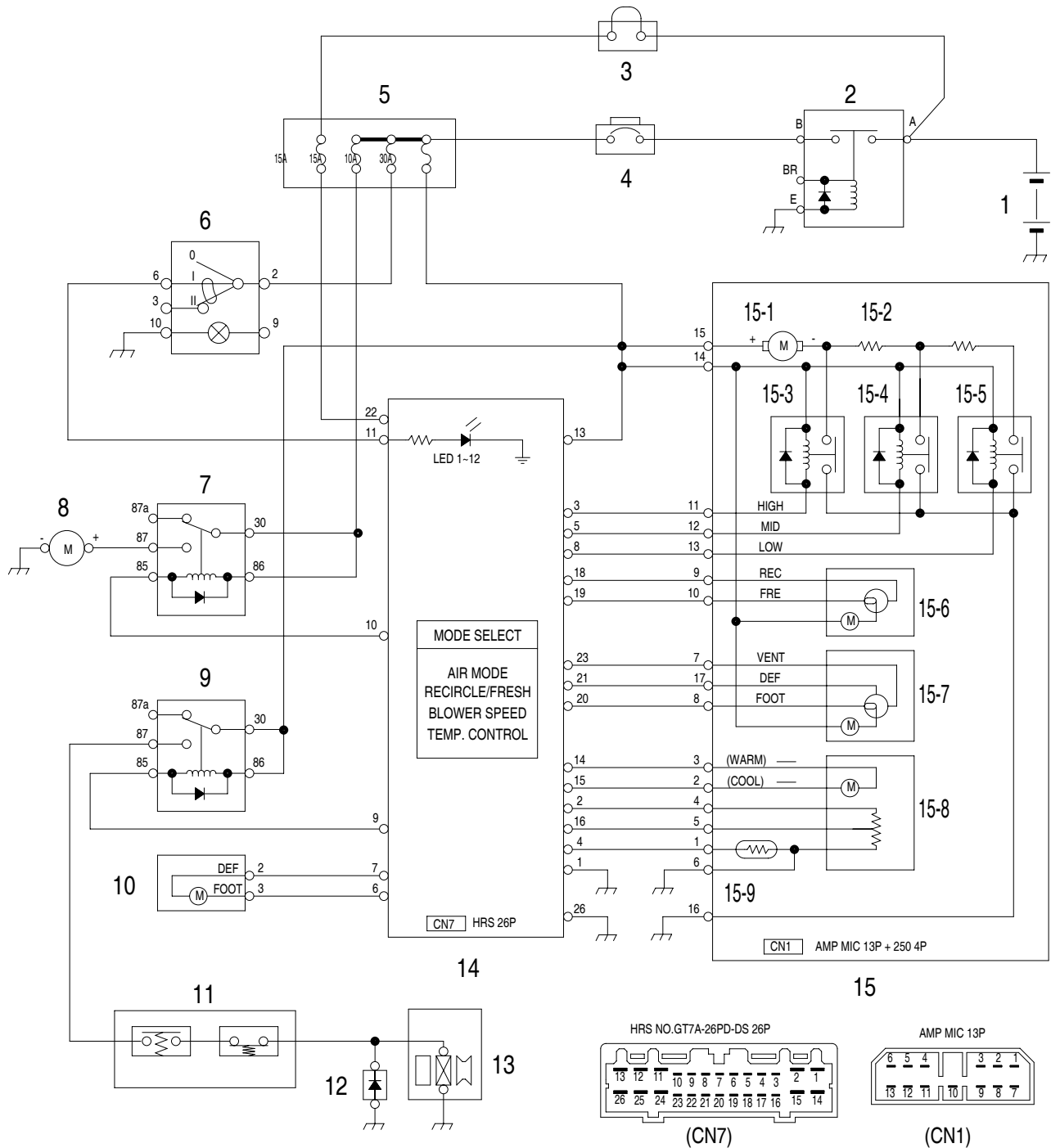
Defroster + Rear



FG004483

Figure 11

AIR-CONDITIONING SYSTEM CIRCUIT DIAGRAM



FG004394

Figure 12

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Fuse Box
6	Headlight Switch
7	Condenser Fan Relay
8	Condenser Fan Motor
9	Compressor Relay
10	Foot / Defrost Control Actuator
11	Receiver Drier
12	Diode
13	Compressor

Reference Number	Description
14	A/C Control Panel
15	A/C Unit
15-1	Blower Motor
15-2	Resister
15-3	High Speed Relay
15-4	Mid Speed Relay
15-5	Low Speed Relay
15-6	Recirculate / Fresh Air Control Actuator
15-7	Vent Actuator
15-8	Temperature Control Actuator
15-9	Temperature Sensor (Evaporator)

TROUBLESHOOTING

Refrigerant Pressure Check

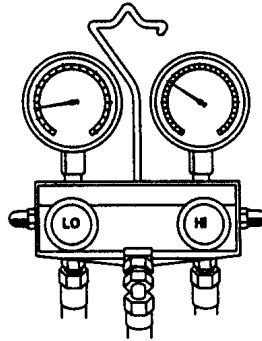


Figure 13

HDA6074L

1. Open all doors and windows.
2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 rpm.
4. Check high / low-pressure of refrigerant.

1	High-pressure: 8 - 10 kg/cm ² (114 - 142 psi) Low-pressure: Approximately 1 kg/cm ² (14 psi)		
Possible Cause: Low Refrigerant Level			
Step	Inspection Item		Remedy
1	Check for traces of refrigerant oil.	Yes	Reassemble using correct tightening torque.
		No	Go to next step.
2	Using a leak detection device or soapy water check for refrigerant leakage at all major components and joints.	Yes	Repair leaking component.
		No	Recharge system to correct pressure.

2	High-pressure: Over 23 kg/cm ² (327 psi) Low-pressure: Approximately 2.5 - 3 kg/cm ² (36 - 43 psi)		
Possible Cause: Overcharge, Frost on condenser			
Step	Inspection Item		Remedy
1	Check for condenser pin damage or contamination.	Yes	Clean, repair or replace condenser.
		No	Refrigerant overcharge.

3	High-pressure: Approximately 20 - 25 kg/cm² (284 - 356 psi) Low-pressure: Approximately 2.5 - 3.5 kg/cm² (36 - 50 psi)
Possible Cause: Air in system.	
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system. NOTE: <i>If the system has been exposed to the air for a long period of time, replace the receiver dryer.</i>	

4	High-pressure: Over 6 kg/cm ² (85 psi) Low-pressure: Approximately 760 mmHg (Negative Pressure)		
Possible Cause: Refrigerant does not circulate			
Step	Inspection Item		Remedy
1	1. Connect manifold gauge and start engine. 2. Turn on air conditioner. 3. Set blower switch to HIGH position. 4. Turn air conditioner OFF and wait 10 minutes.	Yes	Moisture in system, replace receiver dryer.
	5. Recheck high / low-pressure readings. High-pressure: 13 - 19 kg/cm ² (185 - 270 psi) Low-pressure: 1.5 - 3.3 kg/cm ² (21 - 47 psi)	No	Contaminated system, replace expansion valve. (Replace evaporator core assembly.)

5	High-pressure: Over 6 - 18 kg/cm² (85 - 256 psi) Low-pressure: 500 mmHg (Negative Pressure) - Dial indicator needle unstable.
Possible Cause: Moisture in system has iced up the expansion valve.	
NOTE: <i>When the absorbed moisture freezes the pressure readings may look normal. Careful readings should be made to determine whether pressure is in normal range.</i>	
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system. NOTE: <i>If the system has been exposed to the air for a long period of time, replace the receiver dryer.</i>	

6	High-pressure: Over 22 - 23 kg/cm ² (313 - 327 psi) Low-pressure: 2.5 kg/cm ² (36 psi)		
Possible Cause: Refrigerant pressure problem due to defective expansion valve or temperature sensor.			
Step	Inspection Item		Remedy
1	Inspect whether the temperature sensor is installed properly.	Yes	Replace expansion valve.
		No	Exchange duct sensor.

7	High-pressure: Over 7 - 11 kg/cm² (100 - 156 psi) Low-pressure: 4 - 6 kg/cm² (57 - 85 psi)
Possible Cause: Low refrigerant pressure due to poor compressor compression	
Inspect and replace compressor if necessary.	

WEIGHT OF R134a GAS USED IN MACHINES

Model	Weight of Gas
DL200A	850 $\pm$ 20 grams (30 $\pm$ 0.7 oz)
DL250A	850 $\pm$ 20 grams (30 $\pm$ 0.7 oz)
DL300A	850 $\pm$ 20 grams (30 $\pm$ 0.7 oz)
DL420A	850 $\pm$ 20 grams (30 $\pm$ 0.7 oz)
DL550A	850 $\pm$ 20 grams (30 $\pm$ 0.7 oz)

REFRIGERANT SYSTEM REPAIRS



WARNING

AVOID DEATH OR SERIOUS INJURY

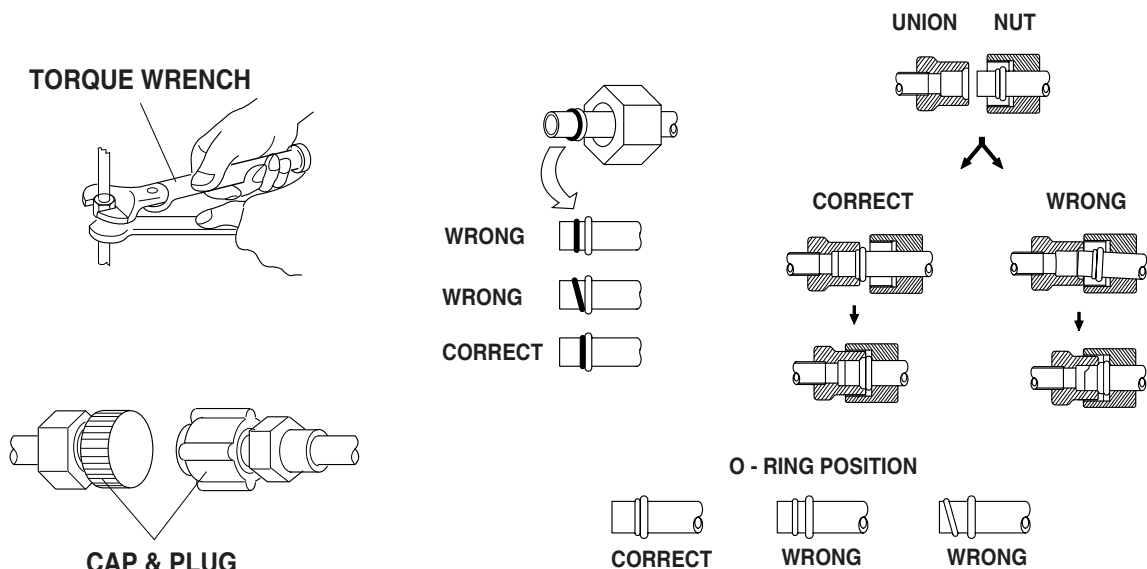
Always wear protective glasses and gloves when handling refrigerant. If refrigerant comes in contact with the skin or eyes, immediately flush with clean, running water and consult a physician.

Select a clean and well ventilated area to work.

The refrigerant container is under high-pressure and should be stored below 40°C (104°F). Be careful not to drop the container from a high location

The contents are under high-pressure and should not be used with compressed air or near an open flame.

Refrigerant Safe Handling Procedures



HDA6066L

Figure 14

The following procedures should be observed for safe handling of refrigerant during vacuum and charging process.

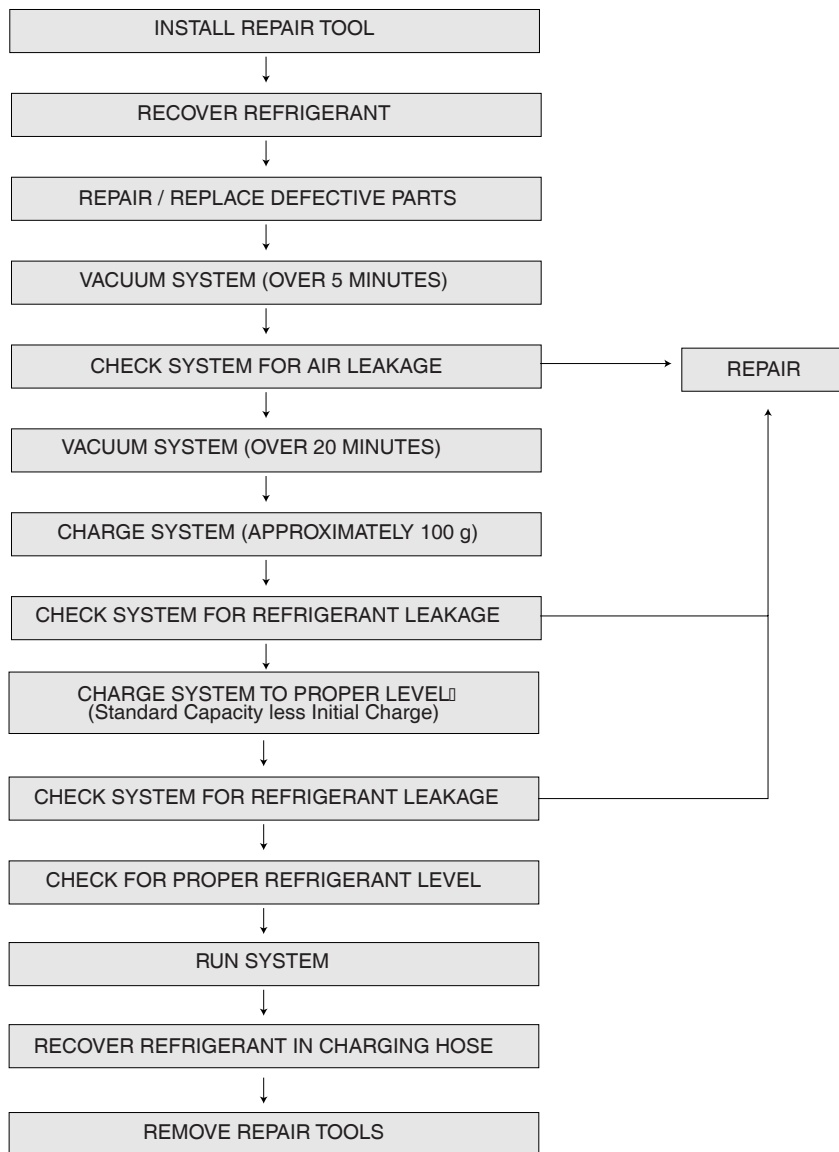
1. Use an approved recovery / charging device which can safely perform vacuum and charge work simultaneously.

2. The new refrigerant has improved cooling characteristics than the old type and care should be used not to overcharge the system.
3. Do not over tighten connections when working on refrigerant system.
4. The new refrigerant system standards require new tools, equipment and parts. Do not attempt to use equipment use in servicing the old refrigerant system.
5. The new refrigerant oil (PAG type) has a high moisture absorption characteristic. When the refrigerant system vacuum seal has been broken, immediately plug up all openings to prevent moisture from entering into the system.
6. When joining unions which use O-ring seals, lightly coat O-rings with refrigerant oil. Be careful not to drip oil on the threads of the nut.
7. Be certain the O-rings are seated properly on the refrigerant line lip. Always use new O-rings when reassembling parts. Do not reuse old O-rings.
8. Use a vacuum pump to evacuate refrigerant system of air.
9. When charging the refrigerant system with the engine running, do not open the high-pressure valve on the manifold gauge as the reverse flow of high-pressure refrigerant will rupture the hose.
10. When releasing the high-pressure hose after completing the charging process, quickly disconnect the hose to minimize refrigerant released to the air.

Repair and Replacement Procedure

1. Work Procedure.
 - A. Before repairing or replacing any refrigerant components first, return all refrigerant oil to the compressor and perform recovery procedures.
2. Operating Condition.
 - A. Run engine at maximum engine speed.
 - B. Select "HI" blower fan speed and select A/C switch to "ON."
 - C. Set the temperature control switch for maximum cooling and leave running for approximately 20 minutes.

NOTE: *The manifold gauge dial pointer can vary depending on the outdoor temperatures.*



HDA6067L

Figure 15

Refrigerant Recovery

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Refrigerant Recovery Tank

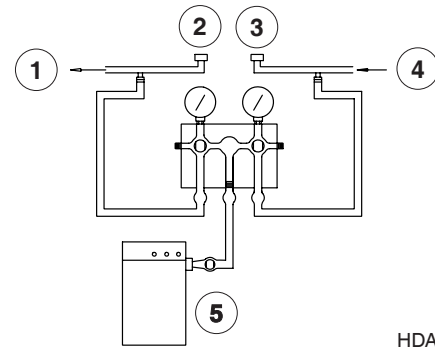
1. Attach the manifold gauges and the refrigerant recovery unit to the refrigerant lines as shown.

NOTE: Be careful not to switch the connections for the low and high-pressure valves.

2. Open the high-pressure valve slowly to release the refrigerant to the recovery unit.

NOTE: Open the valve slowly, while checking to see that refrigerant is not leaking out.

3. When the manifold gauge dial falls below 3.5 kg/cm² (50 psi), slowly open the low-pressure valve.
4. Open both the high and low-pressure valves slowly until the manifold gauge dials indicates 0 kg/cm² (0 psi).



HDA6067L

Figure 16

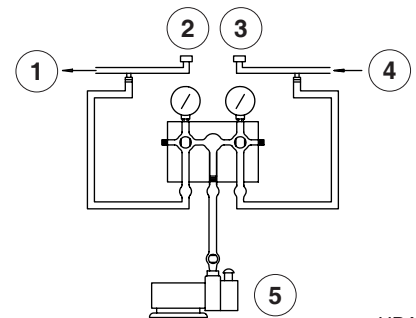
Vacuumping Refrigerant System

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Vacuum Pump

1. Vacuumping Procedure.

NOTE: When the A/C system has been exposed to the air, it must be vacuumed out. Perform vacuum process for 30 minutes for complete moisture and air evacuation.

- A. Attach the manifold gauges and vacuum pump to the refrigerant system as shown.
- B. Turn on the vacuum pump and open both valves.
- C. When the low-pressure gauge shows approximately 710 mmHg, close both valves and turn off vacuum pump.



HDA6068L

Figure 17

2. Check system for vacuum leak.

Allow system to sit for 10 minutes and check whether the system is holding the pressure. If the pressure has dropped, it must be repaired before proceeding to the next step.

3. Vacuuming Procedure.

If the system is holding the pressure and it has not changed for 10 minutes, vacuum out the system for an additional 20 minutes.

- A. Turn on the vacuum pump and slowly open both valves.
- B. Allow vacuum pump to run for additional 20 minutes until the low-pressure gauge dial reads approximately 750 mmHg.
- C. Close both valves and stop the vacuum pump.

4. Installation of Refrigerant Container.

Reference Number	Description
1	Handle
2	Hose Connection
3	Mounting Disk

- A. Before mounting valve on the container, make sure the handle is in the counterclockwise most position, with the puncture pin retracted and the mounting disk is in the raised position.
- B. Attach the manifold gauge center hose to the valve assembly.
- C. Turn the disk in the clockwise direction and securely mount valve onto refrigerant container.
- D. Turn the valve handle in the clockwise direction and puncture the container seal with the pin.
- E. Once the can has been punctured, turn the handle in the counterclockwise direction so the refrigerant can flow into the manifold gauge center hose. At this time, do not open the low and high-pressure valves of the manifold gauge.
- F. Press the manifold gauge low side valve to eliminate the trapped air in the hose.

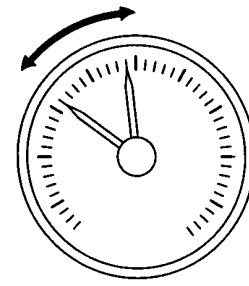


Figure 18

HDA6069L

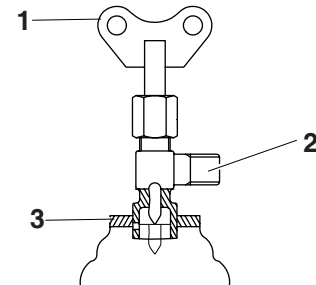


Figure 19

HDA6070L

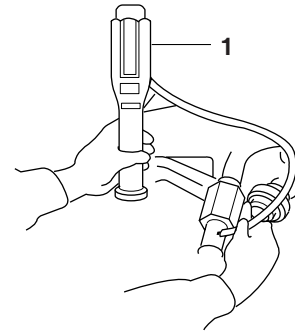
Leakage Check

NOTE: Perform the leakage check after completing vacuuming process.

1. After attaching the manifold gauge, open the high side valve.
2. Charge system until the low side gauge dial indicates a pressure of 1 kg/cm² (14 psi) and close the high side valve.
3. Using a refrigerant leak detector or soapy water check each joint for leakage.

Reference Number	Description
1	Refrigerant Leak Detection Device

4. If a leak is detected, check for O-ring damage or correct tightening torque and replace or repair as necessary.
5. If no leaks are detected, proceed with the charging process.



HDA6071L

Figure 20



WARNING

AVOID DEATH OR SERIOUS INJURY

For accurate refrigerant leak detection, perform leak detection procedure in a well ventilated area.

Refrigerant Charging

1. Perform the vacuuming procedure, vacuum holding and leaking tests as described in the proceeding headings.

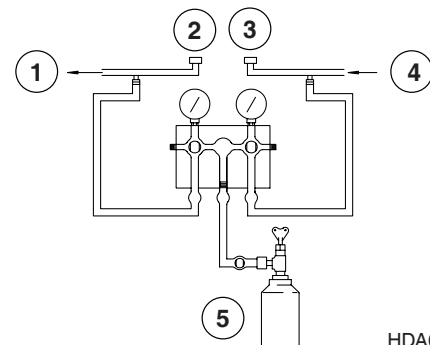
NOTE: First charge the refrigerant system with 100 g (3.5 ounces) of refrigerant with the engine off. Then using the manifold gauges as a guide fully charge the system with the engine running.

When exchanging refrigerant containers, press the manifold gauge low side valve to eliminate air from the charging hose.

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Refrigerant Supply Container

2. Charge the system by opening the manifold gauge low side valve.

Initial charge amount: 100 g (3.5 ounces).



HDA6072L

Figure 21

3. If refrigerant does not flow freely into system, try starting engine first before operating air conditioner.
 - Temperature control switch setting: Maximum Cooling
 - Blower Speed Setting: Hi (3 step)
 - Engine Speed: 1,300 - 1,500 rpm



WARNING

AVOID DEATH OR SERIOUS INJURY

When charging refrigerant system with the engine running;

- Always keep refrigerant supply container in the upright position.

Never open the high side pressure valve.

4. Open the manifold gauge low side valve and charge system to standard capacity.

Gauge Dial	Standard Reading
High Side Gauge	13 - 20 kg/cm ² (185 - 285 psi)
Low Side Gauge	1.5 - 3.5 kg/cm ² (21 - 50 psi)

NOTE: These standards are for outside temperatures between 30° - 35°C (86° - 95°F). The gauge readings may vary for extreme temperature conditions.



WARNING

AVOID DEATH OR SERIOUS INJURY

- When outside temperature is low, warm the refrigerant supply container with warm water not exceeding 40°C (104°F). Do not allow water to come in contact with the charging adapter valve handle.
 - When outside temperature is high, cool off refrigerant supply container and condenser to aid the refrigerant charging process.
-

5. Close low-pressure side valve.
6. Shut off engine and close refrigerant supply container adapter valve. Disconnect manifold gauge hoses from vehicle.

Inspecting System for Leakage

After completing charging procedures, clean all joints and connections with a clean dry cloth. Using a refrigerant leak detecting device or soapy water, inspect system for leaks starting from the high-pressure side.

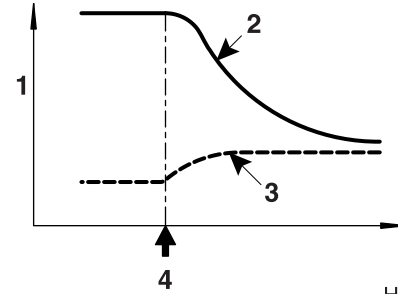
NOTE: When the refrigerant circulation has been stopped the high-pressure will start to decrease and the low-pressure will start to increase until they are equalized. Starting the inspection from the high side will result in a accurate test.

Reference Number	Description
1	Pressure
2	High-pressure
3	Low-pressure
4	Compressor Stop

Inspection Procedure

- High-pressure side.
Compressor outlet → condenser inlet → receiver dryer inlet → air conditioner unit inlet
- Low-pressure side.
Compressor inlet → air conditioner unit outlet
- Compressor.
Compressor shaft area, bolt hole area and magnetic clutch area.
- Receiver dryer.
Pressure switch and plug area.
- Connection valve area.
Inspect all valve areas.
Verify all valves are capped to prevent leaking.
Check for foreign material inside of valve cap.
- Interior of air conditioner unit.
After stopping engine, insert detector probe into drain hose. (Leave inserted for 10 seconds minimum.)

NOTE: When inspecting leakage from the air conditioner unit, perform the inspection in a well ventilated area.



HDA6073L

Figure 22

Electrical System

Edition 1

MEMO

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Electrical System

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

OVERVIEW

The electrical system for this equipment is DC 24 volts. The rated voltage for all electric components is 24 volts with the exception of the stereo and the air-conditioning control actuator. The system contains two 12 volt batteries connected in series and a three phase AC generator with a rectifier. The electric wiring used in the system is easily identifiable by the insulator color. The color symbols used in the electrical system are listed in the following chart.

Electric Wire Color

Symbol	Color
W	White
G	Green
Or	Orange
B	Black
L	Blue
Lg	Light green
R	Red
Gr	Gray
P	Pink
Y	Yellow
Br	Brown
V	Violet

NOTE: *RW: Red wire with White stripe
R - Base Color, W - Stripe Color*

NOTE: *0.85G: Nominal sectional area of wire core less insulator = 0.85 mm² (0.03 in²).*

ELECTRIC SUPPLY SYSTEM

The electric power circuit supplies electric current to each electric component. It consists of a battery, battery relay, starter switch, circuit breaker, fusible link and fuse box.

The negative terminal of the battery is grounded to the vehicle body.

Even when the starter switch is in the "OFF" position, electric current is supplied to the following components through battery, to the fusible link, and then to the fuse box.

1. Cabin light, No. 1 terminal of DC-DC converter (back up for stereo memory).
2. "B" terminal of starter switch and No. 22 terminal of air conditioner control panel (back up)
3. No. 23 and No. 68 terminals of transmission controller (back up for memory)
4. "B" terminal of blinker unit (for hazard warning light)
5. The source terminal of electric power of engine control unit (ECU).

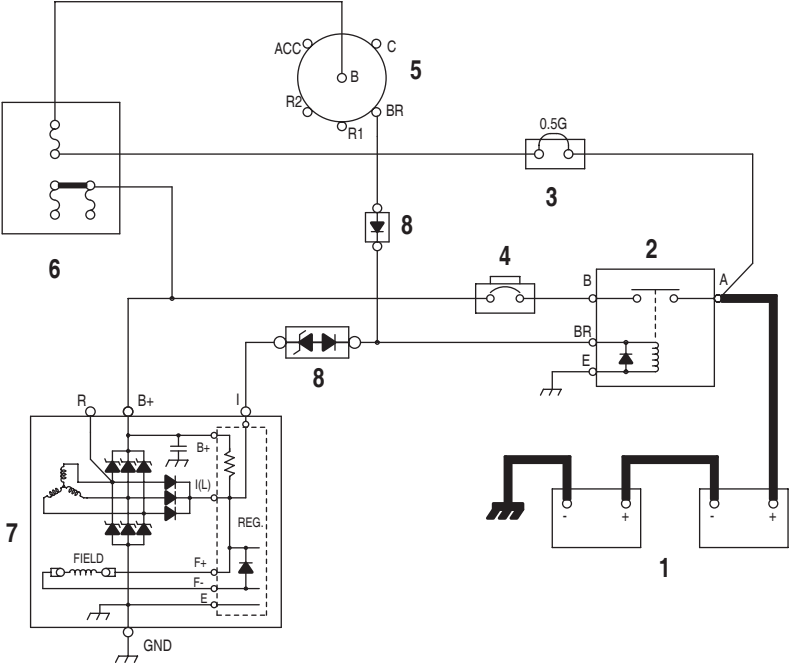
When the starter switch (5) is in the "PREHEAT, ON and START" positions, the current flows from the battery (1), to the fusible link (3), to the fuse box (6), to the starter switch (5) "B" terminal/starter switch "BR" terminal, to the diode (8), and then to the battery relay (2) "BR" terminal. which activates the coil of the battery relay (2) and the electric supply system is energized.

When the battery relay's contacts are connected, all electric devices can be operated.

While the engine is not running, the electric power for all electric devices are supplied by the battery. Once the engine is started the power is supplied from the alternator.

STARTER SWITCH CONNECTION

PST	TML	B	BR	R1	R2	C	ACC
OFF		○					
PREHEAT		○	○	○			
ON		○	○				○
START		○	○		○	○	○



FG006702

Figure 1 ELECTRICAL POWER CIRCUIT DIAGRAM

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker

Reference Number	Description
5	Starter Switch
6	Fuse Box
7	Alternator
8	Diode

ENGINE STARTING CIRCUIT

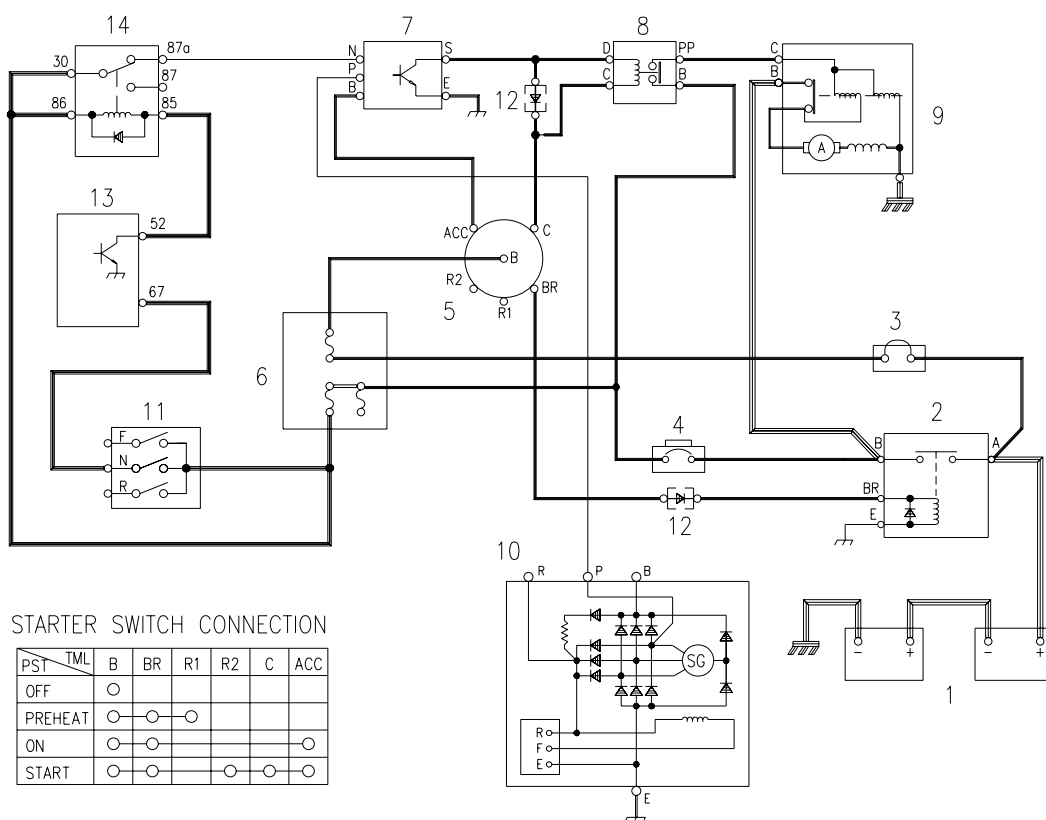
Operation During Start Process

When the starter switch is turned to the start position, the safety start relay (14) is opened by the current flow from the connected "52" and "67" terminal of the transmission controller (13) and the "S" and "E" terminal of the starter controller (7) are connected. At this time the contacts in the starter relay (8) are closed by the current flow from the battery (1), to the fusible link (3), to the "B" terminal of the starter switch (5), to the "C" terminal of the starter switch (5), to the "C" terminal of the starter relay (8), to the "D" terminal of starter relay (8), to the "S" terminal of starter controller (7), to the "E" terminal of the starter controller, and then to the ground.

The contact point "B" and "PP" of starter relay (8) are connected, the pinion gear of the starter (9) is pushed forward and makes contact with the ring gear of the flywheel and the internal contacts of the starter are connected.

The current flows from the battery (1), to the "A" terminal of the battery relay (2), to the "B" terminal of the battery relay (2), and then to the "B" terminal of the starter (9). The starter motor is rotated and the engine is started.

The engine can be cranked only when the transmission selector switch (11) is the neutral position. If the transmission selector switch (11) is in the forward or reverse, the current that flows the switch (11) to the starter controller (7) opens the path to ground for the starter relay (8). This prevents the start relay (8) from closing.



AJS0020L

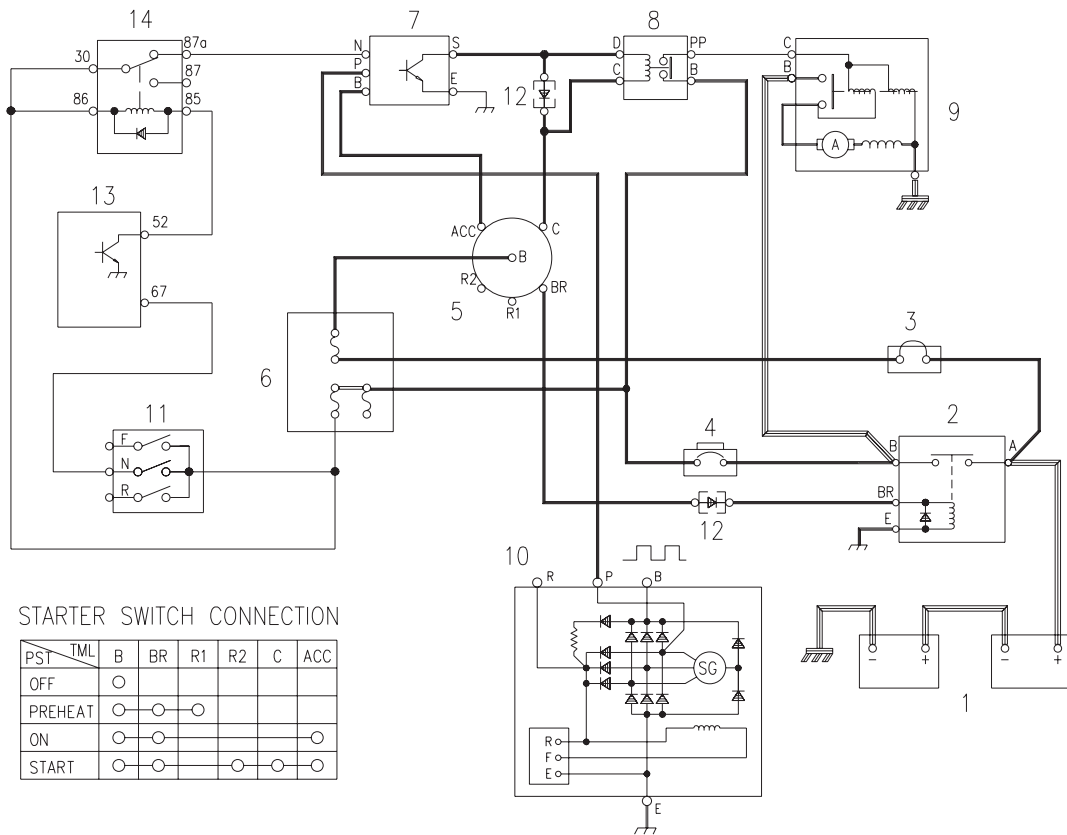
Figure 2 STARTER CIRCUIT (1) - WHILE STARTING

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box
7	Starter Controller

Reference Number	Description
8	Starter Relay
9	Starter
10	Alternator
11	Transmission Selector Switch
12	Diode
13	Transmission Controller
14	Safety Starter Relay

Operation After Start Process

Once the engine has been started, the belt driven alternator (10) generates a current. The output generated by the alternator is a square wave pulse voltage through the "P" terminal and the frequency of the pulse voltage is proportional to the rotation of the alternator. The starter controller (7) monitors the frequency of the output current. Once the frequency equivalent to 500 rpm is sensed the connection between "S" and "E" terminals and the connection between "B" and "PP" terminals are opened. As a result the rotation of the starter (9) is stopped. Once the engine is running, the starter (9) will not operate even if the starter switch (5) is moved to the start position, preventing possible damage to the starter (9).



BAS0090L

Figure 3 OPERATION OF START CIRCUIT (2) - IMMEDIATELY AFTER START

Reference Number	Description
1	Battery
2	Battery Relay
3	Fusible Link
4	Circuit Breaker
5	Starter Switch
6	Fuse Box
7	Starter Controller

Reference Number	Description
8	Starter Relay
9	Starter
10	Alternator
11	Transmission Selector Switch
12	Diode
13	Transmission Controller
14	Safety Starter Relay

ENGINE PREHEATING SYSTEM

This circuit uses a thermal switch to monitor engine temperature. An independently operating electronic preheat controller operates only when the engine is cold. It turns "ON" a grid type resistance heater between the engine air cleaner and intake manifold. Incoming air that is warmed before entry into the manifold and engine cylinder combustion chambers. This improves engine starting efficiency. See Figure 4.

The contacts inside thermal switch (9) are normally open. When the temperature of the coolant drops below 10°C (50°F), the contacts close. When starter key (1) is turned to the "PREHEAT" position, the closed contacts allow controller (7) to begin current flow to heating relay (11), which controls current flow (120 amps) to heating element (13). Controller (7) also turns "ON" the preheat indicator light in the operator's cab (8) after the heating element has been heated for 19 seconds. Heating element (13) will heat for 19 seconds each time the starter key is turned to the "PREHEAT" position.

The controller switches "OFF" current flow to the heater 15 seconds after the engine has started.

The heater remains "ON" for 15 seconds in order to promote more complete cylinder combustion, speed warm-up and reduce start-up cycle emissions.

A pulse signal is generated at alternator terminal "R" as soon as engine rpm exceeds 500 rpm.

The signal goes to controller terminal "2" to allow timing the 15 second shut off sequence.

NOTE: *As long as the starter switch is at the "PREHEAT" position, signal current between the "RI" starter terminal and controller terminal "8" sends a signal from the "5" terminal of the controller to the "C" of the preheat relay, closing the relay contacts to turn "ON" the heater. See Figure 4.*

When the engine is already warm, and coolant temperature is above 10°C (50°F), intake air preheating is not required. The contacts inside the thermal switch are closed at that temperature, cutting off controller current flow and turning "ON" the preheat indicator light at the top corner of the gauge panel as soon as the key is turned, not after 15 seconds.



Reference Number	Description
8	Preheat Relay
9	Glow Plug
10	Thermal Switch
11	Alternator
12	Instrument Panel
13	Diode

ENGINE STOP SYSTEM

The engine stop circuit consists of a starter switch (3), engine stop motor (6), and engine stop relay (5). There are two modes of operation - engine running and engine stop.

Operation In Engine Running Mode

When starter switch (3) is turned to "ON" position, the contact points "30" and "87" of engine stop relay (5) are closed due to current flowing from battery (1), to fusible link (2), to the "B" terminal of starter switch (3), to the "ACC" terminal of starter switch (3), to the "86" terminal of engine stop relay (5) to battery (1) and then to the ground. As a result, engine stop motor (6) is rotated by the current flow from battery (1) to fusible link (2) to fuse box (4) to the "B" terminal of engine stop motor (6) to the "P2" terminal of engine stop motor (6), to the "87" terminal of engine stop relay (5), to the "30" terminal of engine stop relay (5), to the "A" terminal of engine stop motor (6) to the "E" terminal of engine stop motor (6), and then to the ground. The engine stop motor opens (pushes) the fuel shutoff lever of the fuel injection pump and the system is in the running mode. The engine stop motor rotates 180° and comes to a stop due to the cam switch which shuts off the current to the motor.

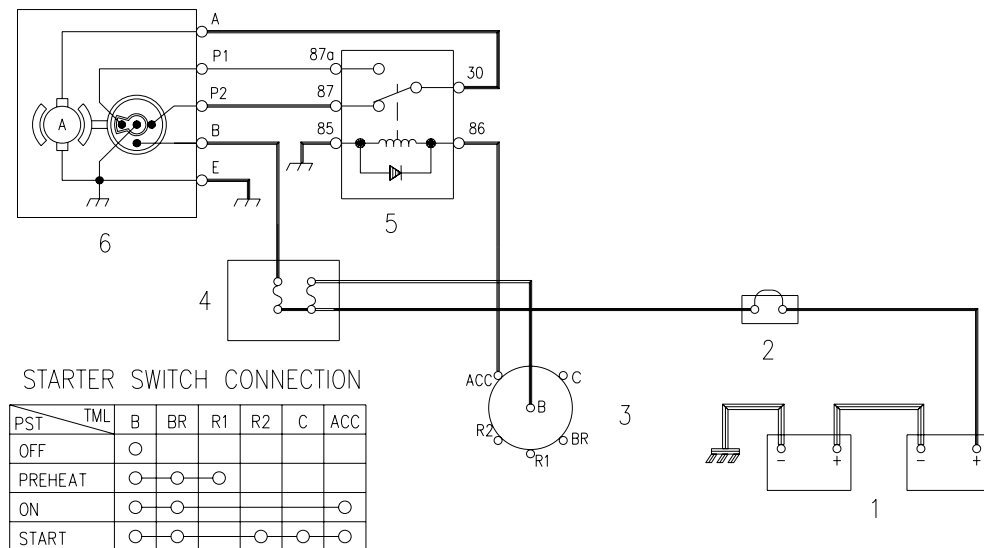


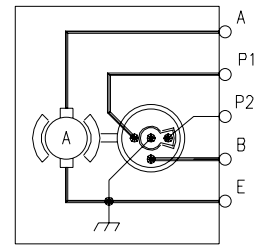
Figure 5 ENGINE STOP CIRCUIT - STOP MODE

AJS0050L

Reference Number	Description
1	Battery
2	Fusible Link
3	Starter Switch

Reference Number	Description
4	Fuse Box
5	Engine Stop Relay
6	Engine Stop Motor

When the starter switch is in the "ON" position, the internal components of the engine stop motor's cam switch is in the position shown.



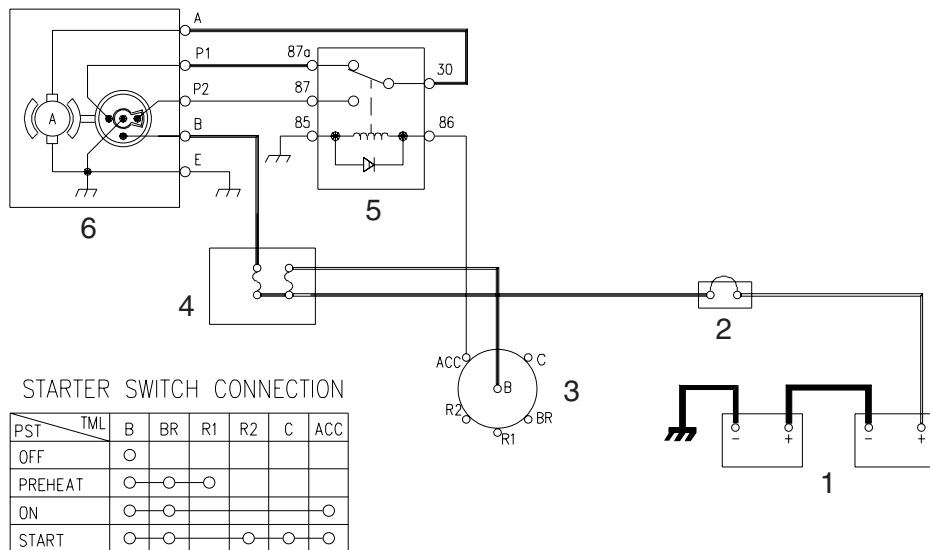
AJS0060L

Figure 6

Operation in Engine Stop Mode

When starter switch (3) is in the "OFF" position, the electric current flow to the coil of engine stop relay (5) is shut off.

As a result, the "30" and "87a" contact point of the engine stop relay are connected and current is supplied to the engine stop motor from battery (1), to fusible link (2), to fuse box (4) to the "B" terminal of engine stop motor (6), to the "P1" terminal of engine stop motor (6), to the "87a" terminal of engine stop relay (5), to the "30" terminal of engine stop relay (5), to the "E" terminal of engine stop motor (6), to the ground, and then the motor is rotated. The shutoff lever of the fuel injection pump, linked to the engine stop motor by a cable, is moved to the close (pull) position and the engine is stopped. The engine stop motor moves 180° from the running mode position and is stopped by the internal cam switch which cuts off the current to the motor.



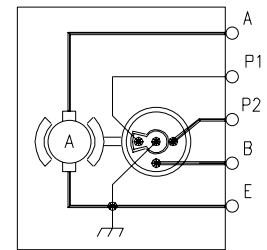
AJS0070L

Figure 7 ENGINE STOP CIRCUIT - STOP MODE

Reference Number	Description
1	Battery
2	Fusible Link
3	Starter Switch

Reference Number	Description
4	Fuse Box
5	Engine Stop Relay
6	Engine Stop Motor

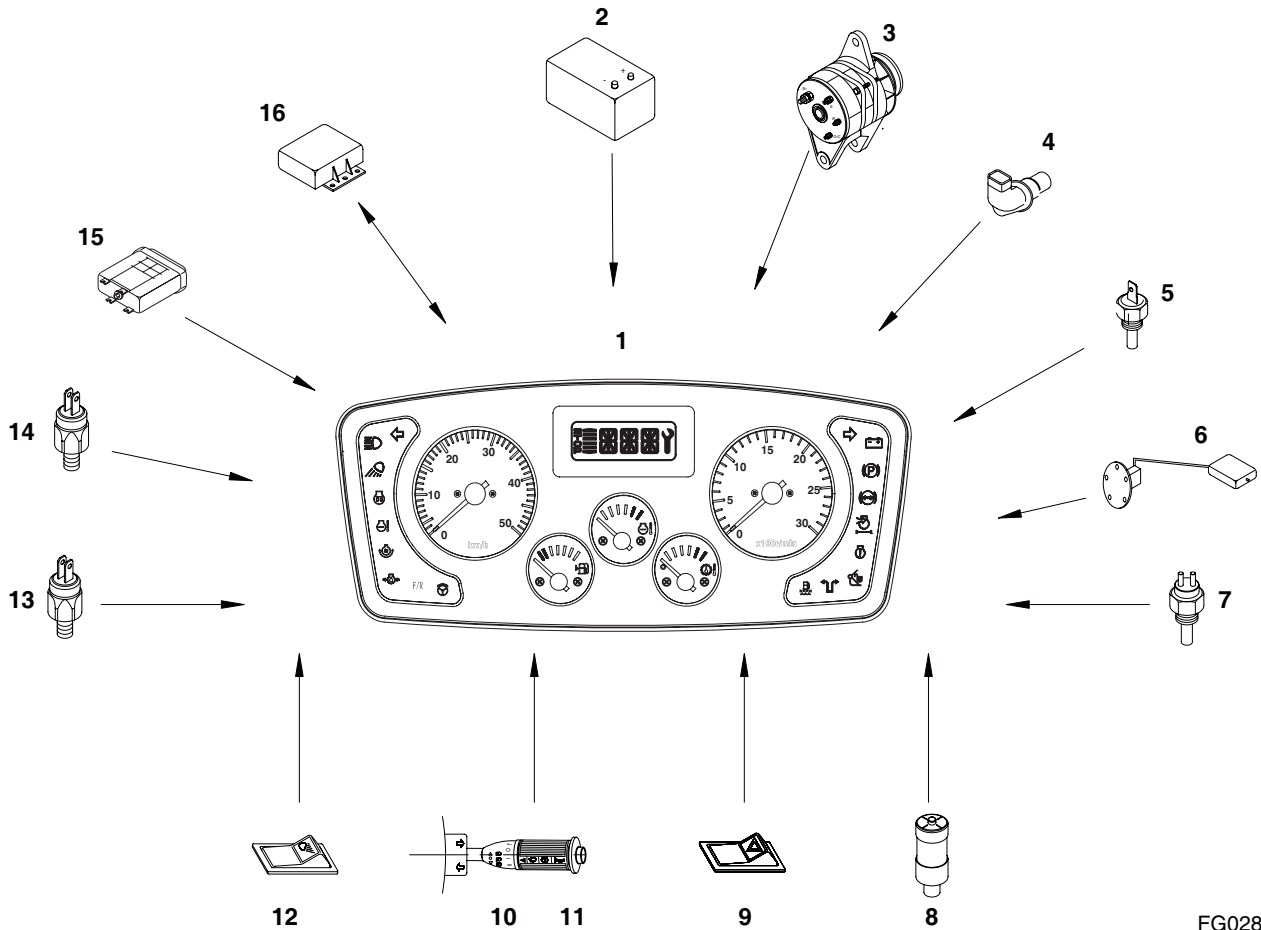
When the starter switch is in the "OFF" position, the internal components of the engine stop motor's cam switch is in the position shown.



AJS0080L

Figure 8

MONITORING SYSTEM



FG028659

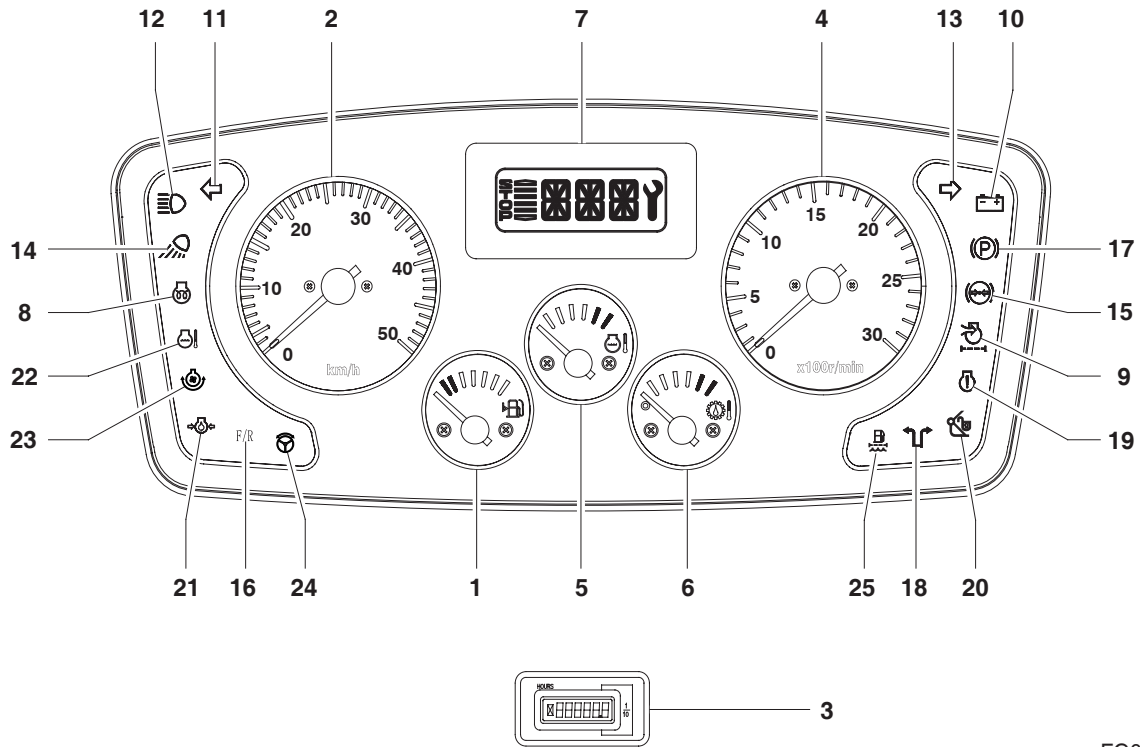
Figure 9

Reference Number	Description
1	Instrument Panel
2	Battery
3	Alternator
4	Speed Sensor
5	Coolant Temperature Sensor
6	Fuel Sensor
7	Transmission Oil Temperature Sensor
8	Air Cleaner Indicator

Reference Number	Description
9	Hazard Warning Light Switch
10	Turn Signal Light Switch
11	High Beam Switch
12	Working Light Switch
13	Brake Oil Pressure Switch
14	Parking Brake Pressure Switch
15	Transmission Control Unit
16	Control Unit

The monitoring system displays the various data and warning signals onto the instrument panel by processing the information gathered from the various sensors throughout the equipment.

Front Instrument Panel



FG024726

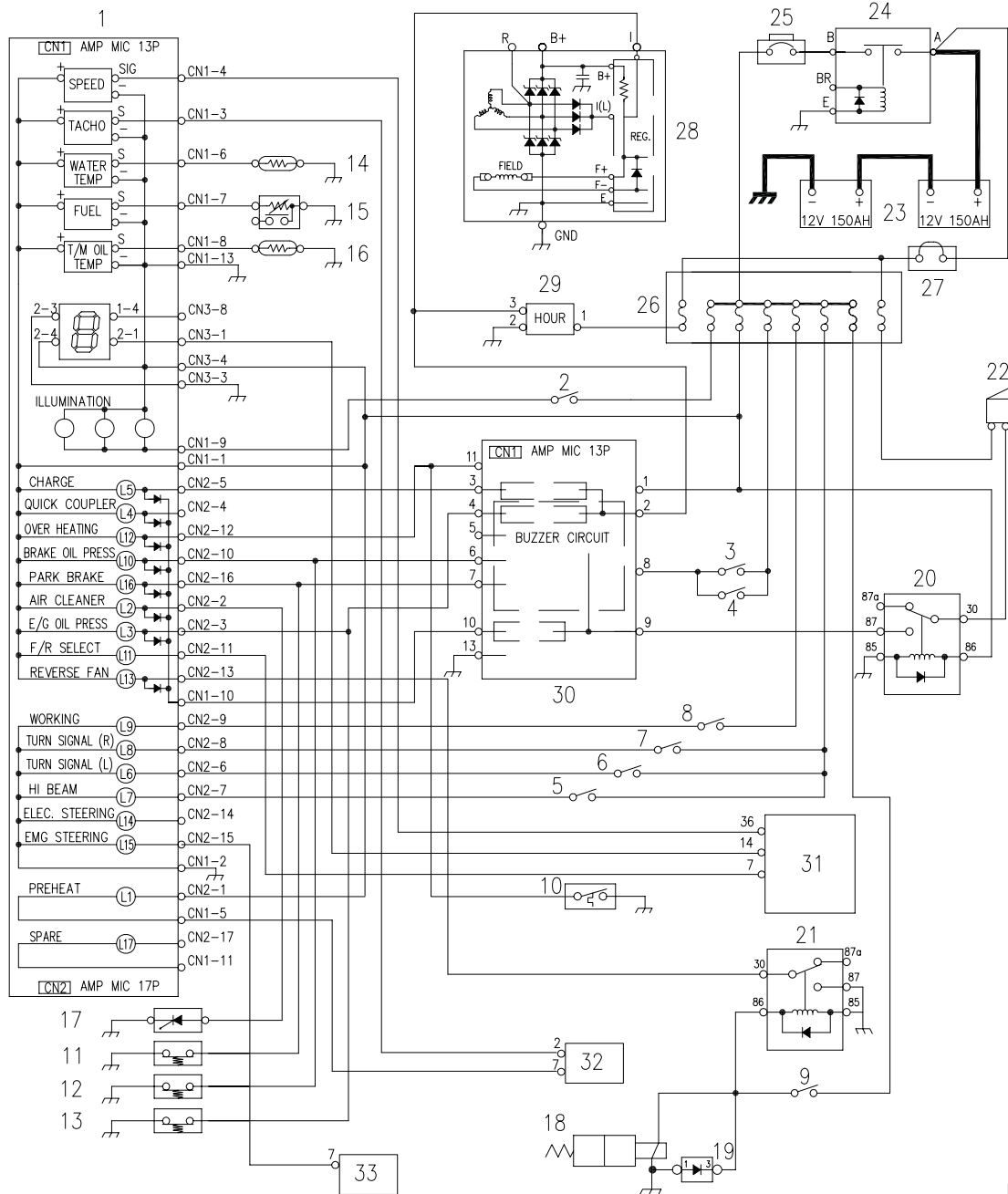
Figure 10

Gauges		Warning Lights	
1.	Fuel Gauge	8.	Preheat Indicator Light
2.	Speedometer	9.	Air Cleaner Clogged Warning Light
3.	Hour Meter	10.	Battery Warning Light
4.	Tachometer	11.	Left Turn and Hazard Warning Light
5.	Engine Coolant Temperature Gauge	12.	High Beam Indicator Light
6.	Transmission Oil Temperature Gauge	13.	Right Turn and Hazard Warning Light
7.	Transmission Display	14.	Work Light Indicator Light
		15.	Brake Fluid Pressure Warning Light
		16.	F/R (Forward/Reverse) Selector Indicator Light
		17.	Parking Brake Indicator Light
		18.	Emergency Steering Indicator Light (Optional)
		19.	Not Used
		20.	Not Used
		21.	Engine Oil Pressure Warning Light
		22.	Engine Coolant Temperature Warning Light
		23.	Reverse Fan Indicator Light
		24.	Not Used
		25.	Not Used

Function Check40

When the starter switch is turned to the "ON" position, all displays, switch lights and warning lights except turn and hazard warning light, high beam indicator, working light indicator and emergency steering indicator will be turned "ON" for two seconds and the warning buzzer will sound. Any lights which do not light up during the function check should be replaced.

Monitoring System Schematic



FG028586

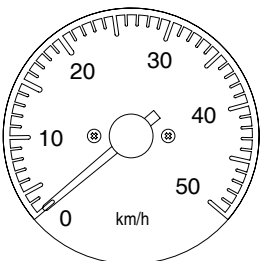
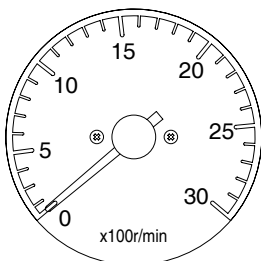
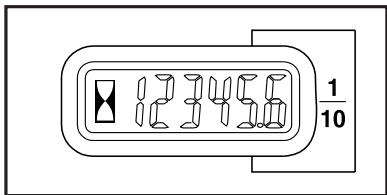
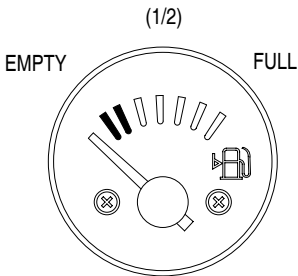
Figure 11

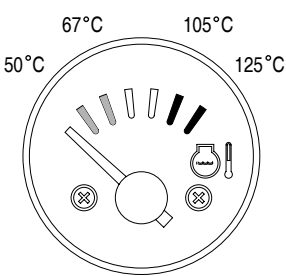
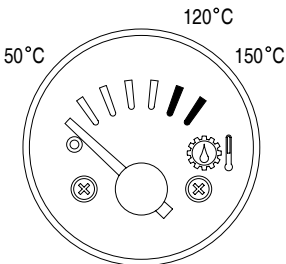
Reference Number	Description
1	Instrument Panel
2	Headlight Switch
3	Forward Lever Switch
4	Reverse Lever Switch
5	High Beam Switch
6	Left Turn Signal Switch
7	Right Turn Signal Switch
8	Work Light Switch
9	Reverse Fan Switch
10	Water Temp Switch
11	Parking Brake Pressure Switch
12	Brake Oil Pressure Switch
13	Engine Oil Pressure Switch
14	Coolant Temperature Sensor
15	Fuel Sensor
16	Transmission Oil Temperature Sensor

Reference Number	Description
17	Air Cleaner Indicator
18	Reverse Fan Sol-Valve
19	Diode
20	Alarm Relay2
21	Reverse Fan Relay
22	Pilot Buzzer
23	Battery
24	Battery Relay
25	Circuit Breaker
26	Fuse Box 2
27	Fusible Link
28	Alternator
29	Hour Meter
30	Control Unit
31	Transmission Controller
32	Preheat Controller
33	Emergency Steering Timer

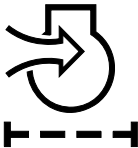
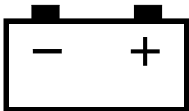
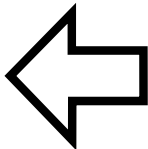
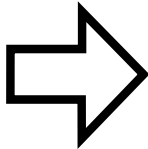
Operation

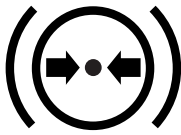
Instruments

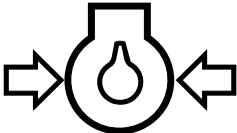
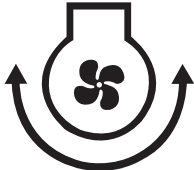
Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Speedometer		CN1-4 CN1-5	10 km/h- 861 Hz 20 km/h- 1722 Hz 30 km/h- 2583 Hz 40 km/h- 3443 Hz $*f = 86.085 \text{ V [Hz]}$ f : Frequency of T/M Controller v : Speed [km/h]
Tachometer		CN1-3	500 rpm - 90 Hz 1000 rpm - 179 Hz 1500 rpm - 268 Hz 2000 rpm - 358 Hz 2500 rpm - 447 Hz 3000 rpm - 537 Hz $*f = 0.179 \text{ N [Hz]}$ f : Frequency of alternator "P" terminal N : Engine rpm
Hour Meter	 HAOA601L		ALTERNATOR "I" Terminal voltage (24V)
Fuel Level Gauge		CN1-7	EMPTY - Above 90 Ohm 1/2 - 38 Ohm FULL - Below 10 Ohm

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Engine Coolant Temperature Gauge		CN1-6	50°C - Above 188.2 Ohm 67°C - 102 Ohm 105°C - 32 Ohm 125°C - Below 19.8 Ohm
Transmission Oil Temperature Gauge		CN1-8	50°C - Above 322.8 Ohm 120°C - 36.5 Ohm 150°C - Below 18.6 Ohm

Indicator Lights

Description	Symbol	Input Terminal	Operation	Remarks
Preheating		CN2 - 1 CN1 - 5	Lights up while the air heater is heated. (Terminal input is to 24V.)	
Air Cleaner		CN2 - 2	Lights up when air cleaner is clogged. (When the terminal input is grounded.)	
Charge	 HAQA610L	CN2 - 5	Lights up when not charging. (and "I" terminal output drops below 24V)	Under normal conditions, will turn "ON" before engine start-up and shut off once engine is running.
Left Turn and Hazard Light		CN2 - 6	Lights up when left turn signal or hazard light is operated. (Terminal input is to 24V)	
Right Turn and Hazard Light		CN2 - 8	Lights up when right turn signal or hazard light is operated. (Terminal input is to 24V)	
High Beam		CN2 - 7	Lights up when high beam is operated. (Terminal input is to 24V)	

Description	Symbol	Input Terminal	Operation	Remarks
Work Light		CN2 - 9	Lights up when work light is operated. (Terminal input is to 24 V)	Light off when the engine is started.
Brake Oil Pressure		CN2 - 10	Lights off when brake oil pressure increases over 65 kg/cm ² , and light turns "ON" when brake oil pressure drops below 60 kg/cm ² . (When terminal input is connected)	Under normal conditions, will turn "ON" before engine start-up and shut off once engine is running.
Parking Brake		CN2 - 16	Lights up when the parking brake switch is applied and parking brake pressure is above 65 kg/cm ² .	Under any conditions, will be light turns "ON" before engine start-up.
Forward / Reverse		CN2 - 11	Lights up when the F/R switch is "ON"	This is option parts.
Emergency Steering		CN3 - 15	Lights up when the vehicle speed is above 5 km/h and the steering pressure is below 10 kg/cm ² . (When the test switch is applied)	
Coolant Temperature		CN2 - 12	It lights when engine coolant temperature sensor resistant is below about 128 ohms.	

Description	Symbol	Input Terminal	Operation	Remarks
Engine Oil Pressure		CN2 - 3	It lights when engine oil pressure is below the reference.	After starting engine, if engine oil pressure is insufficient after 8 seconds, a warning buzzer will sound.
Reverse Fan		CN2 - 13	It lights when the Reverse Fan Switch is "ON".	Before switch on the Reverse Fan, must be shut off the engine. This system use only "KEY ON"

Initial Operation

Item	Input (Terminal)	Output (Operation and initial setting mode)
Initial Operation	CN 1-1	- All warning lights are turned "ON" and turned "OFF" after 2 seconds. (Except for turn signal indicator, high beam indicator, working light indicator and transmission cutoff indicator and emergency steering indicator. - Warning buzzer is activated and turned "OFF" after 2 seconds. - Monitoring system displays present condition.

Control Unit Operation

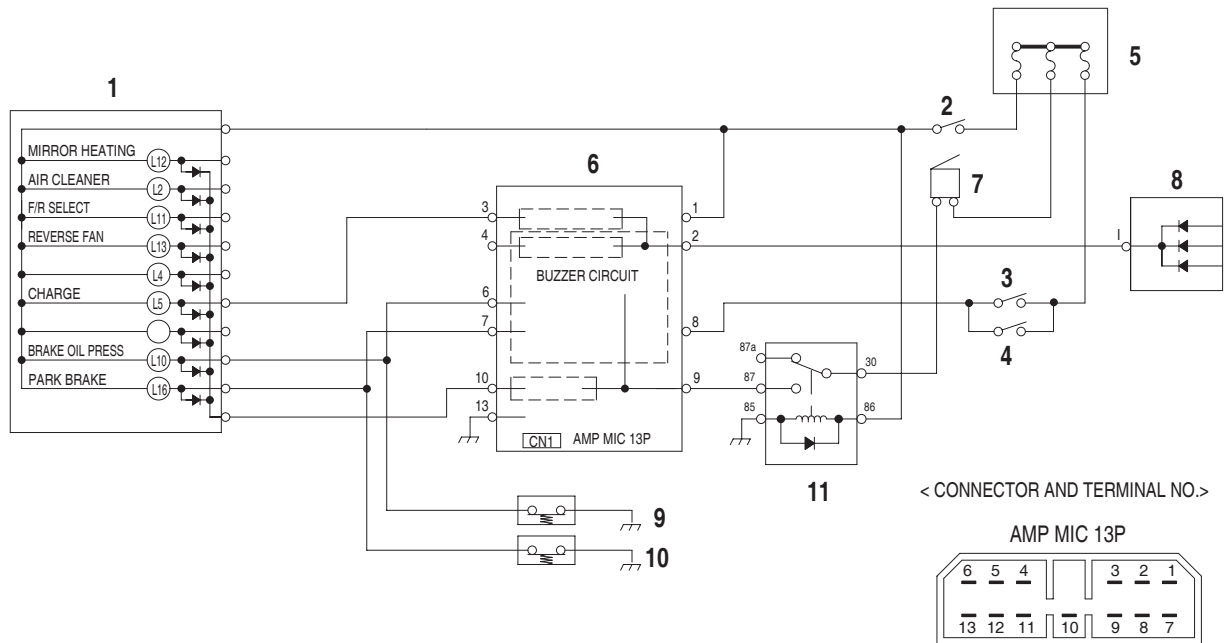


Figure 12

Reference Number	Description
1	Instrument Panel
2	Starter Switch
3	Forward Lever Switch
4	Reverse Lever Switch
5	Fuse Box
6	Control Unit

Reference Number	Description
7	Pilot Buzzer
8	Alternator
9	Brake Oil Pressure Switch
10	Parking Brake Pressure Switch
11	Alarm Relay 2

Characteristic of Operation

	Input		Output
1	When the starter switch is "ON."		All warning lights are turned "ON" and turned "OFF" after 2 - 2.5 seconds.
2	When "I" terminal voltage of alternator	is below 12 ± 1 V	Battery warning light turns "ON," L5
		is above 12 ± 1 V	Battery warning light turns "OFF," L5
3	When "I" terminal voltage of alternator is above 12 ± 1 V	Brake oil pressure switch is "ON."	Warning buzzer sounds immediately
		Forward or Reverse lever switch is "ON" and Parking brake pressure switch is "ON."	Warning buzzer sounds immediately

WINDSHIELD WIPER

Front windshield wiper

You can control windshield wiper by operating wiper washer switch (2).

1. Low speed wiper action (1st).

Wiper acts in low speed through fuse box (1) to the 15, 53 terminal of wiper switch (2) to the L,E terminal of wiper motor (5).

2. High speed wiper action (2nd).

Wiper acts in high speed through Fuse box (1) to the 15,53b terminal of wiper switch (2) to the H,E terminal of wiper motor (5).

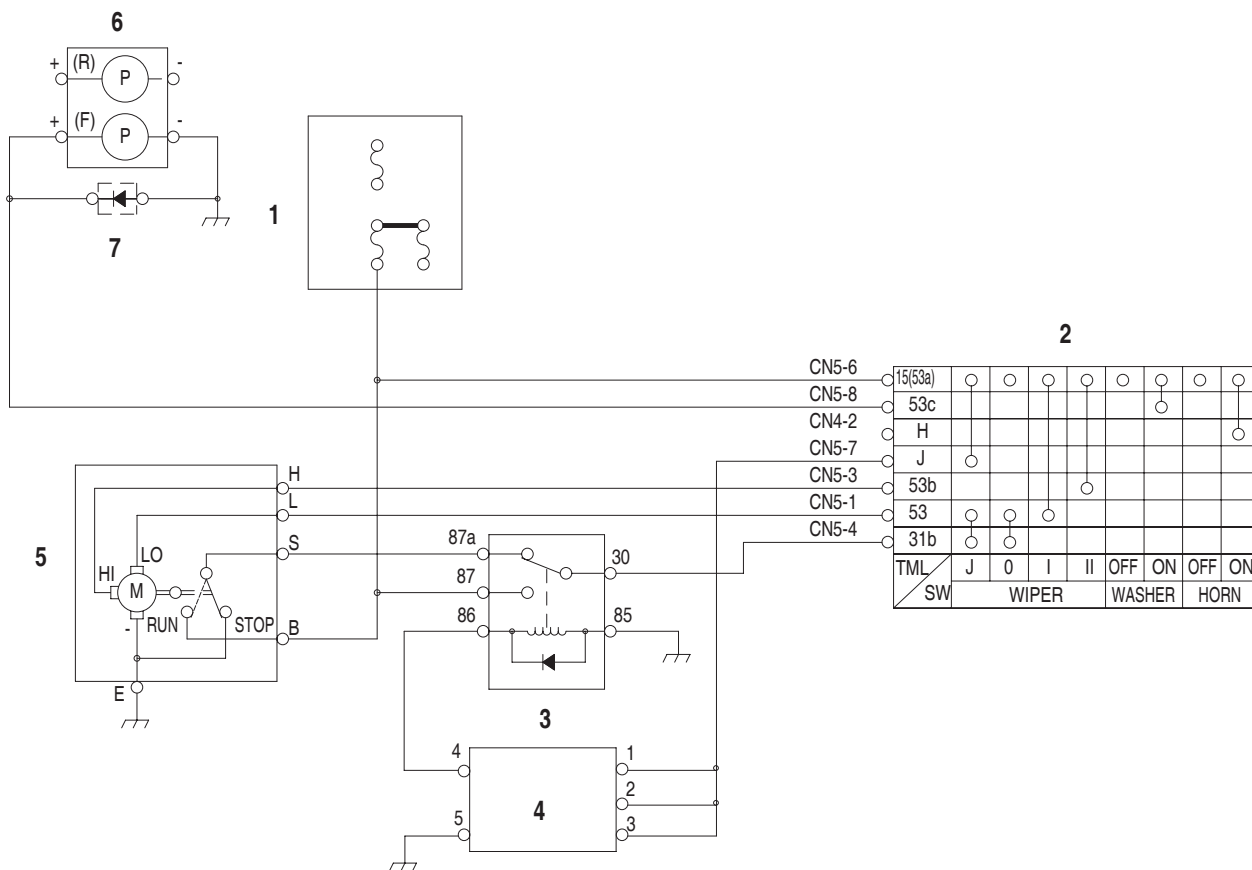
3. When you turn off switch during Low speed wiper action (1st) or High speed wiper action (2nd), electric currents flow through Fuse box (1) to the B,S terminal of wiper motor (5) to the 87a, 30 terminal of wiper relay (3) to the 31b, 53 terminal of wiper switch (2) - L,E terminal of wiper motor (5). Wiper acts until wiper rotates to the stop position, than the wiper stops.

4. Intermittent wiper action.

Fuse box (1) to the 15,J terminal of wiper switch (2) to the 1,4 terminal of wiper timer (4) are connected intermittently, and electric current flow into 86, 85 terminal of wiper relay (3) than 87 terminal and 30 terminal are connected.

Therefore, electric current flow through fuse box (1) to the 87, 30 terminal of wiper relay (3) to the 31b, 53 terminal of wiper switch (2) to the L,E terminal of wiper motor (5), and wiper operates intermittently in low speed.

Front Windshield Wiper Circuit



FG004463

Figure 13

Reference Number	Description
1	Fuse Box 2
2	Wiper Washer Switch
3	Wiper Relay
4	Wiper Timer

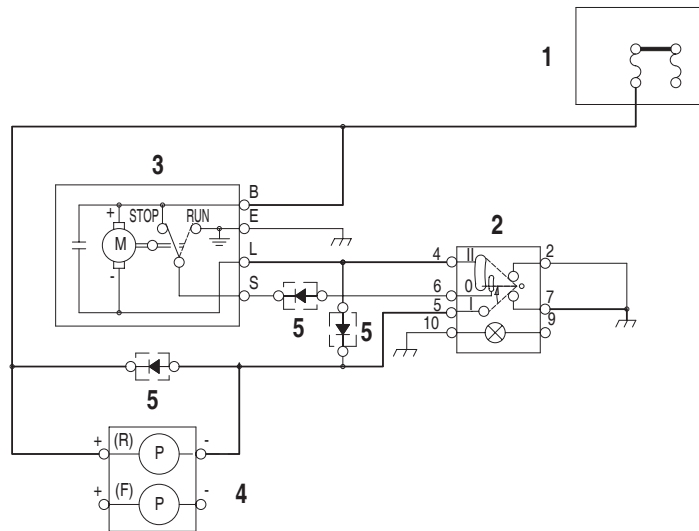
Reference Number	Description
5	Wiper Motor
6	Washer Tank
7	Diode

Rear Windshield wiper

You can control rear windshield wiper by pressing wiper washer switch (2) in the switch panel.

- 1st wiper action (Wiper and washer activate the same time, automatic return).

Fuse box (1), to the washer tank (4), to the 5,7 terminal of switch (20) are connected, then activates windshield washers. Also fuse box (1), to the B, L terminal of wiper motor (3), to the diode (5), to the 5, 7 terminal of switch (2) are connected, then activates wiper.



FG004464

Figure 14 REAR WINDSHIELD WIPER 1ST ACTION CIRCUIT

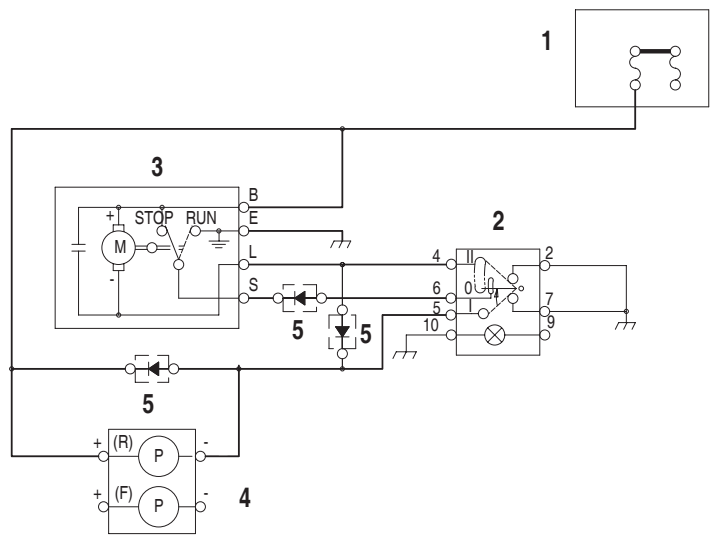
Reference Number	Description
1	Fuse Box 1
2	Wiper/washer Switch
3	Wiper Motor

Reference Number	Description
4	Washer Tank
5	Diode

- 2nd wiper action (Only wiper action).

Fuse box (1), to the B,L terminal of wiper motor (3), to the 4,2 terminal of switch (2) are connected, then activates wiper.

- When you turn off windshield wiper switch in 1st or 2nd position, electric current flows fuse box (1), to the B,L terminal of wiper motor (3), to the 4, 6 terminal of wiper switch (2), to the diode (6), to the S, E terminal of wiper motor (3).



FG004465

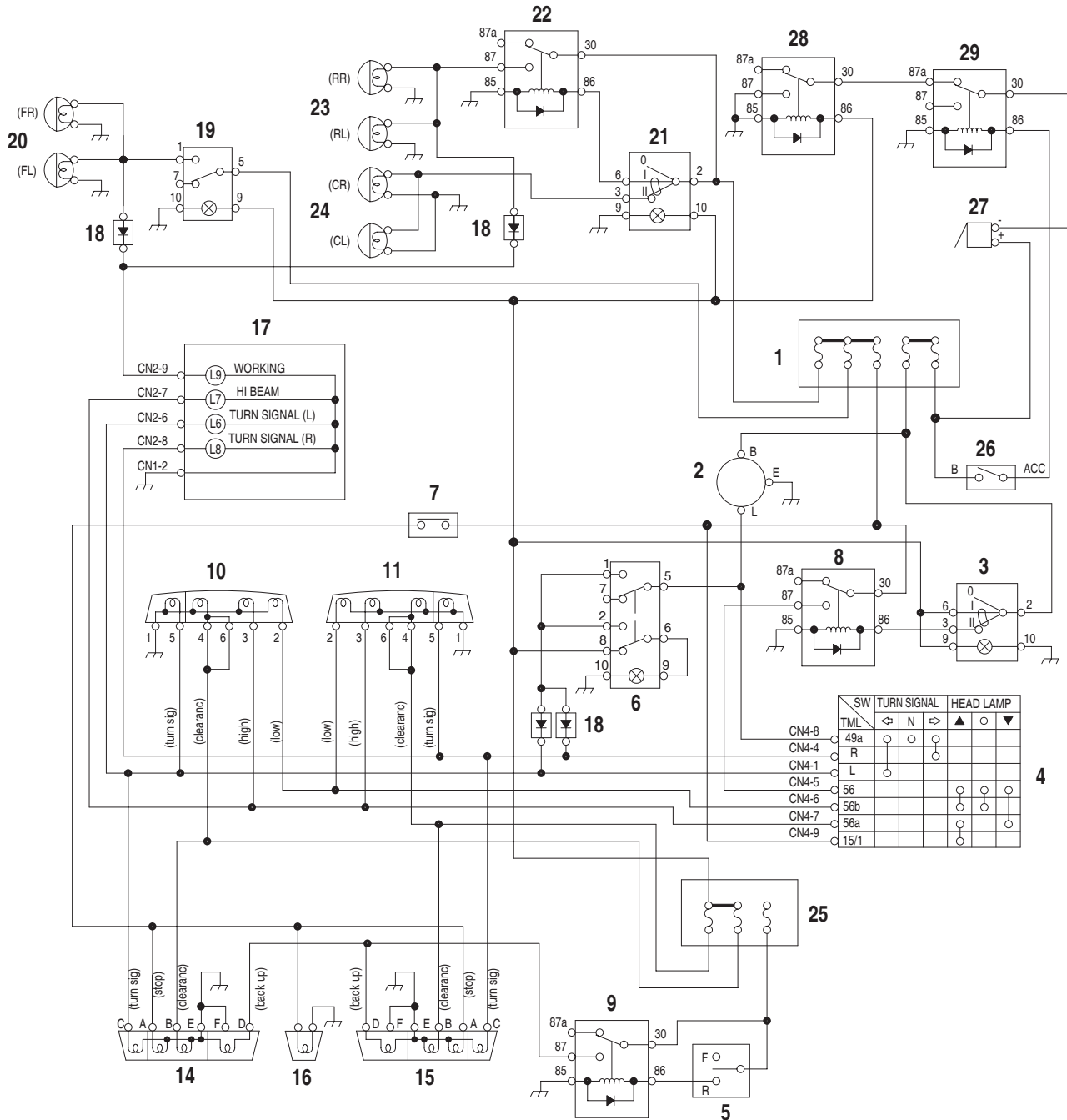
Figure 15 REAR WINDSHIELD WIPER STOP CIRCUIT

Reference Number	Description
1	Fuse Box 1
2	Wiper/washer Switch
3	Wiper Motor

Reference Number	Description
4	Washer Tank
5	Diode

LIGHTING SYSTEM

Light Circuit



FG004467

Figure 16 LIGHT CIRCUIT

Reference Number	Description
1	Fuse Box 1
2	Blinker Unit
3	Headlight Switch
4	Combination Switch
5	Shift Lever Switch
6	Hazard Switch
7	Stop Light Switch
8	Headlight Relay
9	Reverse Relay
10	Headlight (L)
11	Headlight (R)
14	Rear Combination Light (L)
15	Rear Combination Light (R)

Reference Number	Description
17	Instrument Panel
18	Diode
19	Front Working Light Switch
20	Front Working Light
21	Rear Working Light Switch
22	Working Light Relay
23	Rear Working Light 1
24	Rear Working Light 2
25	Fuse Box 2
26	Starter Switch
27	Pilot Buzzer
28	Alarm Relay 1
29	Alarm Relay 2

The lighting system consists of the headlight, the position light, the turn signal light, the hazard light, the stop light, the license plate light, the working light, the rotating beacon light (option) and the switches, which are used to turn "ON" the lights.

1. When the headlight switch (3) is in the first step, through the fuse box 1 (1) to the "2," "6" terminal of headlight switch (3), the following lights will be turned "ON."
 - A. The headlight (L) (10) and rear combination light (L) through the fuse box 2 (25).
 - B. The headlight (R) (11) and rear combination light (R) through the fuse box 2 (25).
 - C. The illumination lights through the "9" terminal of all kind of rocker switches include the headlight switch (3), the front working light switch (19), the rear working light (21) and the hazard switch (6).
 - D. The license plate light (16).
2. When the headlight switch (3) is in the second step, the current flows through the fuse box 1 (1), to the "2," "3" terminal of headlight switch (3) and to the "86," "85" terminal of headlight relay (8), and the "30," "87" terminal of headlight relay (8) is connected. As a result, through the fuse box 1 (1) to the "30," "87" terminal of headlight relay (8), the voltage is applied to the "56" terminal of combination switch (R) (4).
 - A. At this time if the combination switch (4) is in the "0" position, the current flows to the "56b" terminal and it allow the low light, which is in the headlight (L) (10) and the headlight (R) (11), to be light turns "ON."

- B. Also if the combination switch (4) is in the "t" position, the current flows to the "56a" terminal and it allow the high light, which is in the headlight (L) (10) and the headlight (R) (11), to be light turns "ON." At the same time the current flows to the "CN2-7" terminal of instrument panel (17) and the headlight indicator L7 will be turned "ON."
- C. And if the combination switch (4) is in the "s" position, the current flows to the "56b" terminal and it allows the low light, which is in the headlight (L) (10) and the headlight (R) (11), to be light turns "ON."
At the same time another current flows from the fuse box 1 (1) to the "15/1," "56b" terminal of combination switch (4) and the highlight, which is in the headlight (L) (10) and the headlight (R) (11) will be turned "ON," and the other current flows to the "CN2-7" terminal of instrument panel (17) and the headlight indicator will be turned "ON." The combination switch (4) is returned automatically.
3. When the combination switch (4) is in the "←" (or "→") position, the current flows from the fuse box 1 (1), to the blinker unit (2), to the "L" (or "R") terminal through "49a" terminal of combination switch (4), to the "C" terminal of front combination light (L) (12) and the rear combination light (L) (14) (or to the front combination light (R) (13) and the rear combination light (R) (15)). This current makes the turn signal light turn "ON." At the same time the current flows to the "CN2-6" terminal (or to the CN2-8 terminal) of instrument panel and the turn signal light indicator L6 (or L8) will be turned "ON."
4. If you operates the hazard light switch (6), the current flows from to the fuse box 1 (1), to the blinker unit (2), to the "5," "1" terminal of hazard switch (6), to the diode (18), to the front combination light (L) (12) and the front combination light (R) (13), to the "C" terminal of rear combination light (L) (14) and rear combination light (R) (15). This current makes the turn signal light turn "ON." At the same time through the "2," "6" terminal of hazard switch (6), the voltage is applied to the "9" terminal and the indicator light used to light the symbol will be turned "ON." Also the current flows to the "CN2-6," "CN2-8" terminal of instrument panel (17) and the turn signal light indicator "L," "L8" will be turned "ON."
5. When the shift lever switch (5) is in the "R" position, the contact points "30" and "87" of the reverse relay (9) are closed due to current flowing from the fuse box 2 (23), to the shift lever switch (5), to the "86" terminal of reverse relay (9) and to the ground. Thus the current flows from fuse box 2 (23), to the reverse relay (9) and to the "D" terminal of rear combination light (L) (14) and rear combination light (R) (15), and the reverse light will be turned "ON."

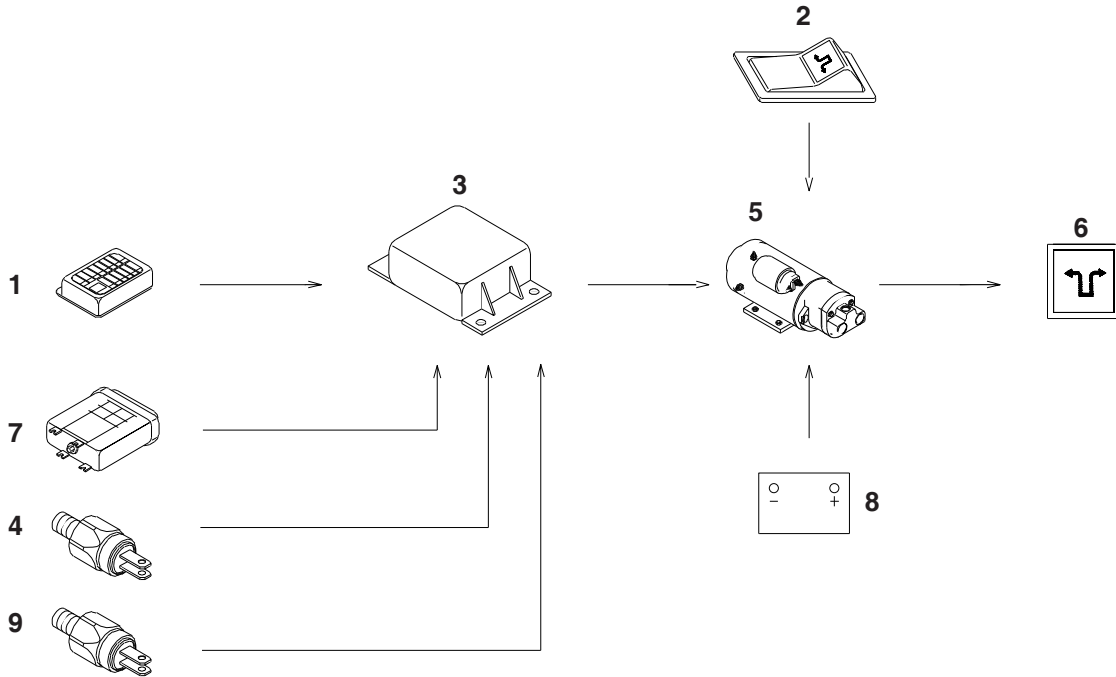
6. When the brake pedal is depressed and at the same time the stop light switch (7) is turned "ON," the current flows from fuse box 1 (1), to the stop light switch (7) and to the "F" terminal of rear combination light (L) (14) and rear combination light (R) (15), and the stop light will be turned "ON."
7. When the front working light switch (19) is in the "ON" position, the current flows from the fuse box 1 (1), to the "5," "1" terminal of front working light switch (19) and to the front working light (20).

This current makes the front working lights turn "ON." At the same time the working light indicator, L9," is turned "ON" due to the current flowing from the diode (8) to the "CN2-9" terminal of instrument panel (17).

8. When the rear working light switch (21) is in the second step, the contact points "30" and "87" of the working light relay (22) is closed due to the flowing current from the fuse box 1 (1), to the "2" and "6" terminal of the working light switch (21), to the "86" terminal of the working light relay (22) and to the ground. Thus the current flows from the fuse box 1 (1), to the working light relay (22) and to the rear working light 1 (23) mounted on right/left rear fender. As a result the rear working light (23) light turns "ON." At the same time the working light indicator "L9" light turns "ON" due to the current flowing from the diode (18) to the "CN2-9" terminal of the instrument panel.
9. When the rear working light switch (21) is in the second step, the contact points "30" and "87" of the working light relay (22) is closed due to the flowing current from the fuse box 1 (1), to the "2" and "6" and "3" terminal of the working light switch (21), the rear working (23) is operated like being described above clause "8" and the rear working light (24) mounted on the cabin light turns "ON" at the same time.
10. When the headlight switch (3) is in the first step or in the second step while the starter switch (26) is in the "OFF" position, the contact point "30," "87" of alarm relay 1 (28) is closed due to the excited current, which flows to the coil of alarm relay 1 (28) and the pilot buzzer (27) will sound.
But when the headlight switch (3) is in the first step or in the second step while the starter switch (26) is in the "ON" position, the contact point "3," "87" of alarm relay 2 (29) is closed due to the excited current, which flows to the coil of alarm relay 2 (29). At the same time the current is not supplied to the "30" terminal of alarm relay 1 (28) and the pilot buzzer will not sound any more.

EMERGENCY STEERING SYSTEM (OPTION)

Block Diagram



FG004925

Figure 17 EMERGENCY STEERING SYSTEM BLOCK DIAGRAM

Reference Number	Description
1	Fuse Box
2	Emergency Steering Switch
3	Emergency Steering Timer
4	Emergency Steering Pressure Switch
5	Emergency Steering Pump

Reference Number	Description
6	Emergency Steering Indicator
7	Transmission Controller
8	Battery
9	Main Steering Pressure Switch

When the speed of the vehicle exceeds 5 km/h and the main steering pressure is less than 3 kg/cm², an electrically powered hydraulic pump will be operated for a time limited 60 seconds and thus the emergency steering is possible.

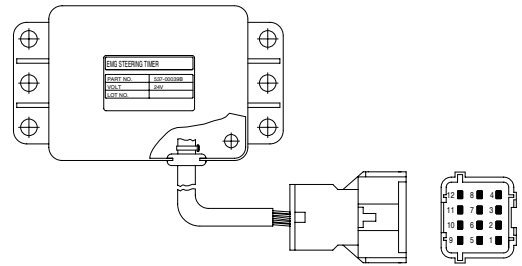
This system includes the electrically powered hydraulic pump, which is controlled by the emergency steering timer (3). The emergency steering timer (3) obtains signals from the main steering pressure switch (9) and the transmission controller (7).

When the emergency steering is activated, the emergency steering indicator (6) light turns "ON."

Emergency Steering System Components

Emergency Steering Timer

1. Obtains signals from the main pressure switch (9) and the transmission controller (7), and play a role in operating the emergency steering pump (5).
2. As the frequency signal of the transmission controller is differ from each machine, the reference frequency is 405 Hz which come under about 5 km/h.
3. When the starter switch is "ON," the characteristic of operation is following.

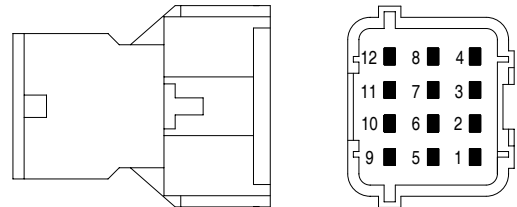


FG004921

Figure 18

Emergency Steering Timer Connector

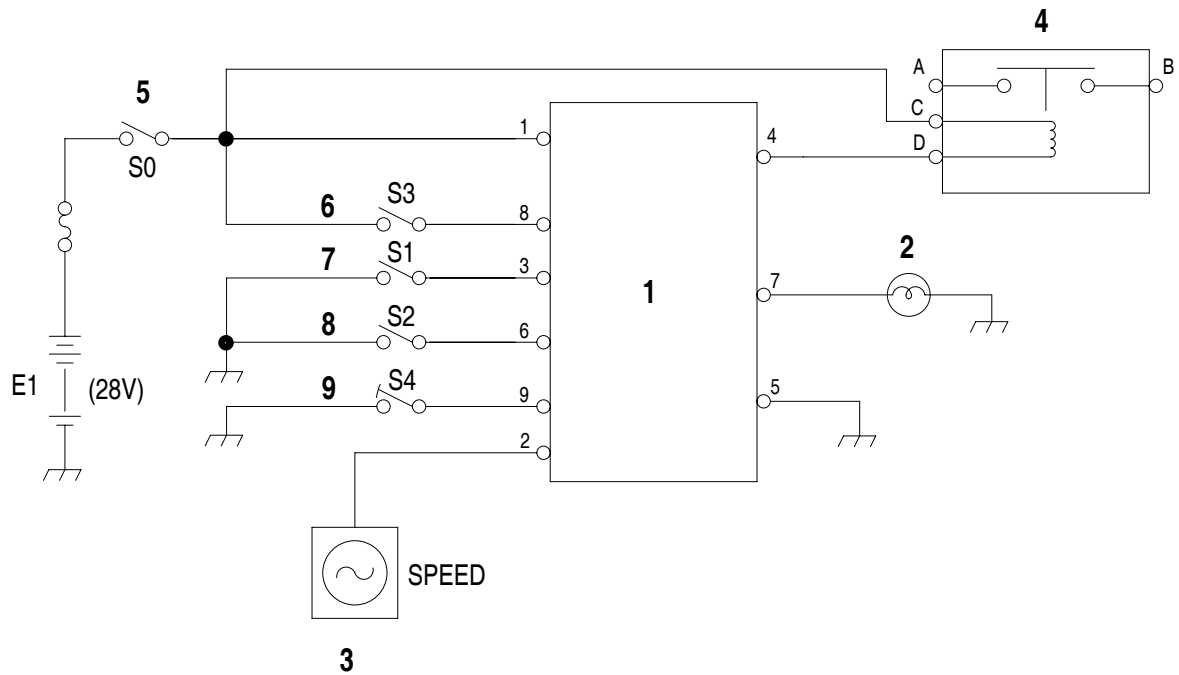
No.	Wire size and Color
1	0.85 LR
2	0.5 G
3	0.5 WB
4	0.85 W
5	0.85 B
6	0.5 WG
7	0.5 RW
8	0.5 BY
9	0.5 BL



FG004922

Figure 19

Emergency Steering Timer Circuit



FG004923

Figure 20

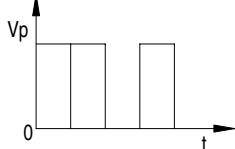
Reference Number	Description
1	Emergency Steering Timer
2	Emergency Steering Indicator
3	Transmission Controller (TCU)
4	Emergency Steering Pump
5	Starter Switch "ON"

Reference Number	Description
6	Starter Switch "START"
7	Main Steering Pressure Switch
8	Emergency Steering Pressure Switch
9	Emergency Steering Switch

Test Mode before Emergency Steering Start

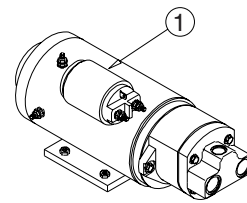
Input Condition			Output	
S0	S3	S4	Emergency Steering Pump	Lamp
OFF → ON	OFF	OFF	will be operated only one time for 3 seconds and stop.	will be lit only one time for 3 seconds. - will be put out when S2 is "ON". - will be blinked continually when S2 is "OFF"
OFF → ON	ON	OFF	OFF	putting out light
OFF → ON	-	ON	Pump will be operated equally with S4 "ON" time.	Lamp will be lit equally with S4 "ON" time.

Operating Character when Emergency Steering Normal Mode

Input Condition		Output		Remark
S1	Standard input Frequency	Emergency Steering Pump	Lamp	
ON	-	OFF	putting out light	$V_p = 20 \pm 5V$ Duty Cycle 50% 
OFF	When above 405 ± 30 Hz	will be operated only one time for 60 ± 10 seconds and stop.	will be lit only one time for 60 ± 10 seconds and put out.	
	When below 405 ± 30 Hz	OFF	putting out light	

Emergency Steering Pump

This is an electrically powered hydraulic pump and includes an emergency steering relay (1, Figure 21), which is excited by the signal of the emergency steering timer.

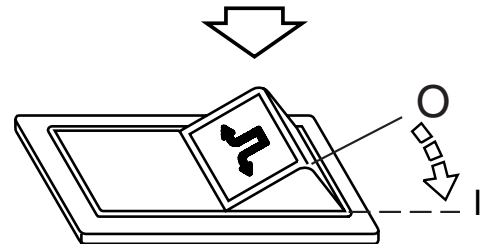


AJS0480L

Figure 21 EMERGENCY STEERING PUMP

Emergency Steering Switch

1. When the switch is in the "I" position, the emergency steering pump and the emergency steering indicator of the instrument panel are activated simultaneously.
2. The basic usage of this switch is testing function whether the emergency steering system is all right or not.



AJO0011L

Figure 22 EMERGENCY STEERING SWITCH



WARNING

AVOID DEATH OR SERIOUS INJURY

Make sure that no persons are near the machine when testing the function of the emergency steering system, there is a risk that someone may be crushed between the front and the rear frame.

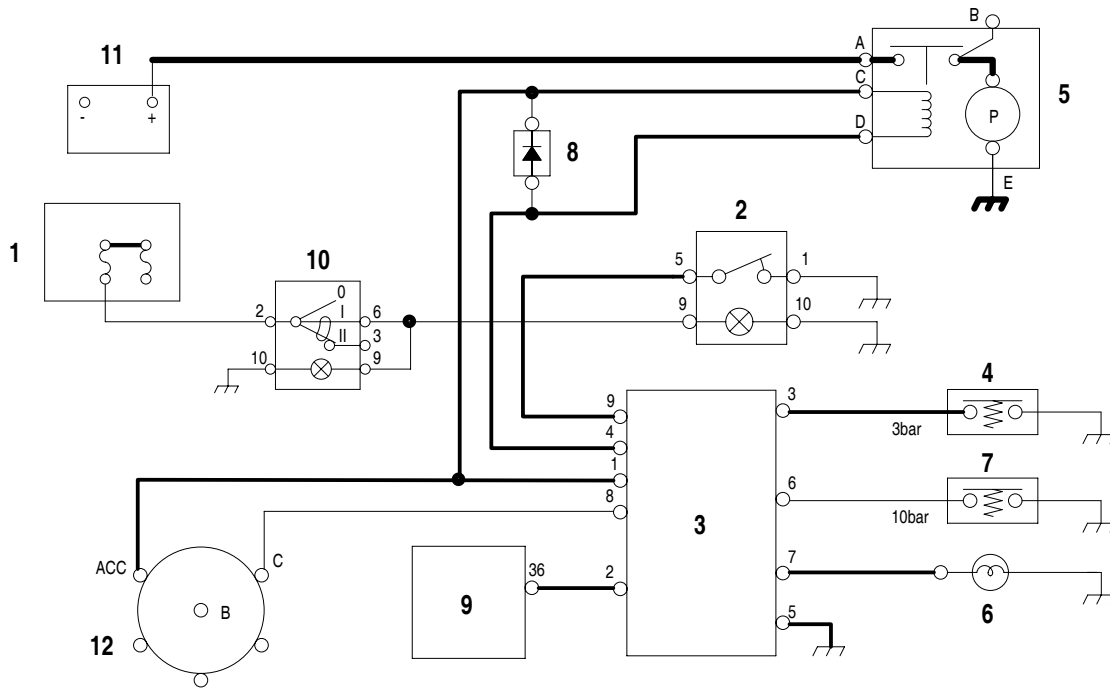
3. This returns automatically when not pressed down.

NOTE: *Because the emergency steering pump consumes high current, it's forbidden to use continuously to avoid discharging of battery and a risk of overheating.*

Emergency Steering System Electric Circuit

When the control signal, which is transmitted from the "36" terminal of the transmission controller, is inputted to the "2" terminal of the emergency steering timer (3) and the emergency steering pressure switch (4) is "OFF," the contact points "A" and "B" of the emergency steering pump (5) is closed due to the current flowing from the fuse box (1), to the "C" and "D" coil of the emergency steering pump (5), and to the "4" and "5" terminal of the emergency steering timer (3).

Thus the high current flows from the battery (11) to the "A" and "B" terminal of the emergency steering pump (5), which is operated. At the same time the emergency steering indicator light turns "ON" due to the current flowing from the "B" terminal of the steering pump (5), to the fusible link (7) and to the emergency steering indicator.



FG004924

Figure 23 EMERGENCY STEERING SYSTEM CIRCUIT

Reference Number	Description
1	Fuse Box
2	Emergency Steering Switch
3	Emergency Steering Timer
4	Main Steering Pressure Switch
5	Emergency Steering Pump
6	Emergency Steering Indicator
7	Emergency Steering Pressure Switch

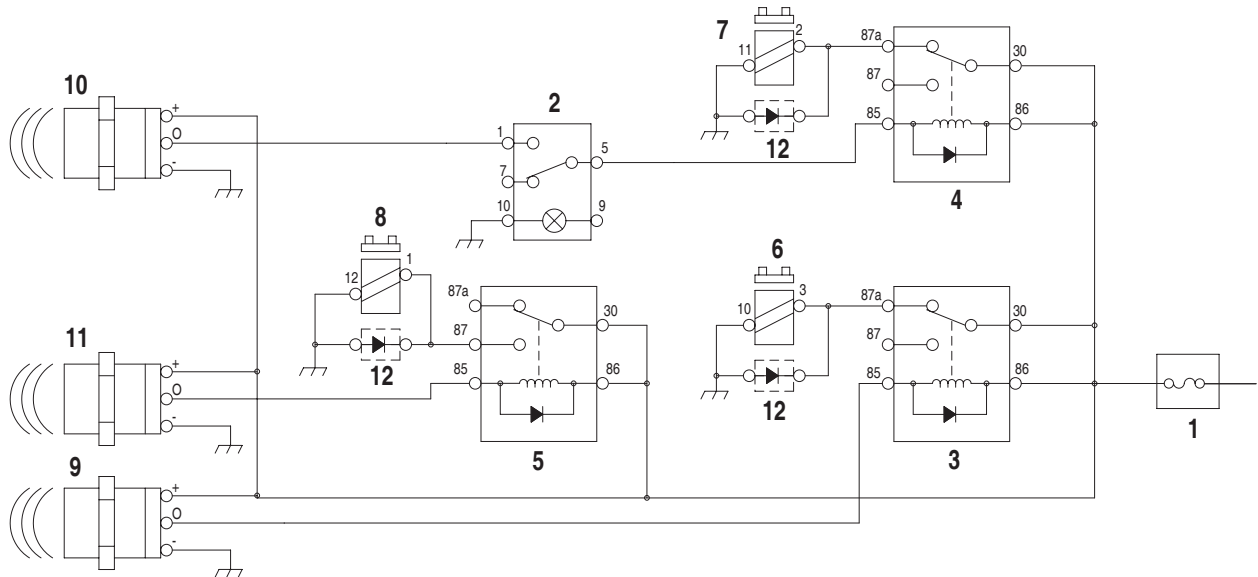
Reference Number	Description
8	Diode
9	Transmission Controller
10	Headlight Switch
11	Battery
12	Starter Switch
13	Emergency Steering Pressure Switch

ELECTRIC DETENT SYSTEM

The electric detent system separated into boom kick-out and return to dig.

An each part consists of magnetic locking lever and proximity switch detecting the position of bucket or boom.

Electric Circuit



FG004461

Figure 24 ELECTRIC DETENT CIRCUIT

Reference Number	Description
1	Fuse Box 2
2	Float Kick-out Switch
3	Raise Relay
4	Float Relay
5	Return to Dig Relay
6	Raise Magnetic

Reference Number	Description
7	Float Magnetic
8	Return to Dig Magnetic
9	Raise Proximity Switch
10	Float Proximity Switch
11	Return to Dig Proximity Switch
12	Diode 3ea

Boom Kick-out

When the work lever (joystick) is in the "FLOAT" (or "RAISE") position, lever is locked and boom is lowered (or lifted). When the boom is matched to setting position, lever locking is released and lever is returned to "NEUTRAL" position automatically and boom lowering (or lifting) is stopped.

1. Boom Raise Kick-out

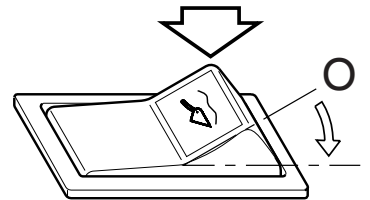
With the raise magnetic (5) is energized and the work lever (joystick) is held in "RAISE," then boom is approaching to the raise proximity switch (8). When the raise proximity switch (8) and the boom are matched, the contact points "30" and "87a" of the raise/float relay (3) is opened due to the current flowing from the fuse box (1), to the coil of the raise relay (3) and to the "0" and "-" terminal of the raise proximity switch (8).

As a result the magnetic (5) is de-energized and the locked lever is returned to "NEUTRAL" position, boom lifting is stopped.

2. Boom Float Kick-out (Option)

With the float kick-out switch shown in Figure 25, is in the "I" position and the float magnetic (6) is energized and the work lever (joystick) is held in "FLOAT," then boom is approaching to the float proximity switch (9).

When the float proximity switch (9) and the boom are matched, the contact points "30" and "87a" of the raise/float relay (3) is opened due to the current flowing from the fuse box (1), to the coil of the raise/float relay (3), to the terminal "5" and "1" of the float kick-out switch (2) and to the "0" and "-" terminal of the raise proximity switch (9). As a result the magnetic (6) is de-energized and the locked lever is returned to "NEUTRAL" position, and boom lowering is stopped.



HA002027

Figure 25

Return To Dig

After dumping, if the work lever (joystick) is in the "CROWD" position, the work lever (joystick) will be locked and the bucket will be crowded. When the bucket is matched to setting position, the lever is returned to the "NEUTRAL" position and bucket crowding will be stopped. After this operation, if the boom is lowered the bucket is in parallel with ground.

With the return to dig proximity switch (10) and the bucket positioner are matched, the contact points "30" and "87" of the return to dig relay (4) is closed due to the current flowing from fuse box (1), to the coil of the return to dig relay (4) and to the "0" and "-" terminal of the return to dig proximity switch (10).

In this states, if the work lever (joystick) is in the "CROWD" position, the lever is locked and the bucket positioner is approaching out of the return to dig proximity switch (10). That is, bucket is crowded. If the bucket positioner is out of the return to dig proximity switch (10), the float magnetic (9) is de-energized.

As a result the lever is returned to "NEUTRAL" position and bucket is set to the selected digging angle.

Proximity Switch

- Operating Distance: 10 ± 1 mm
- Operation Indicator Light: Lights up when the object is detected.

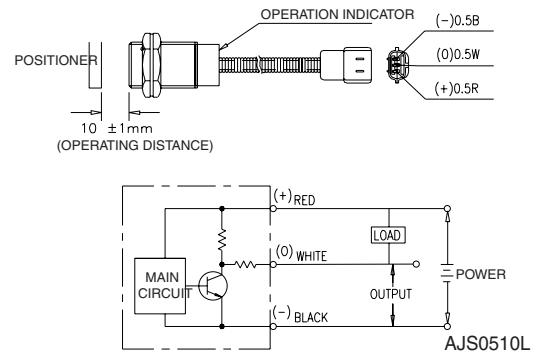
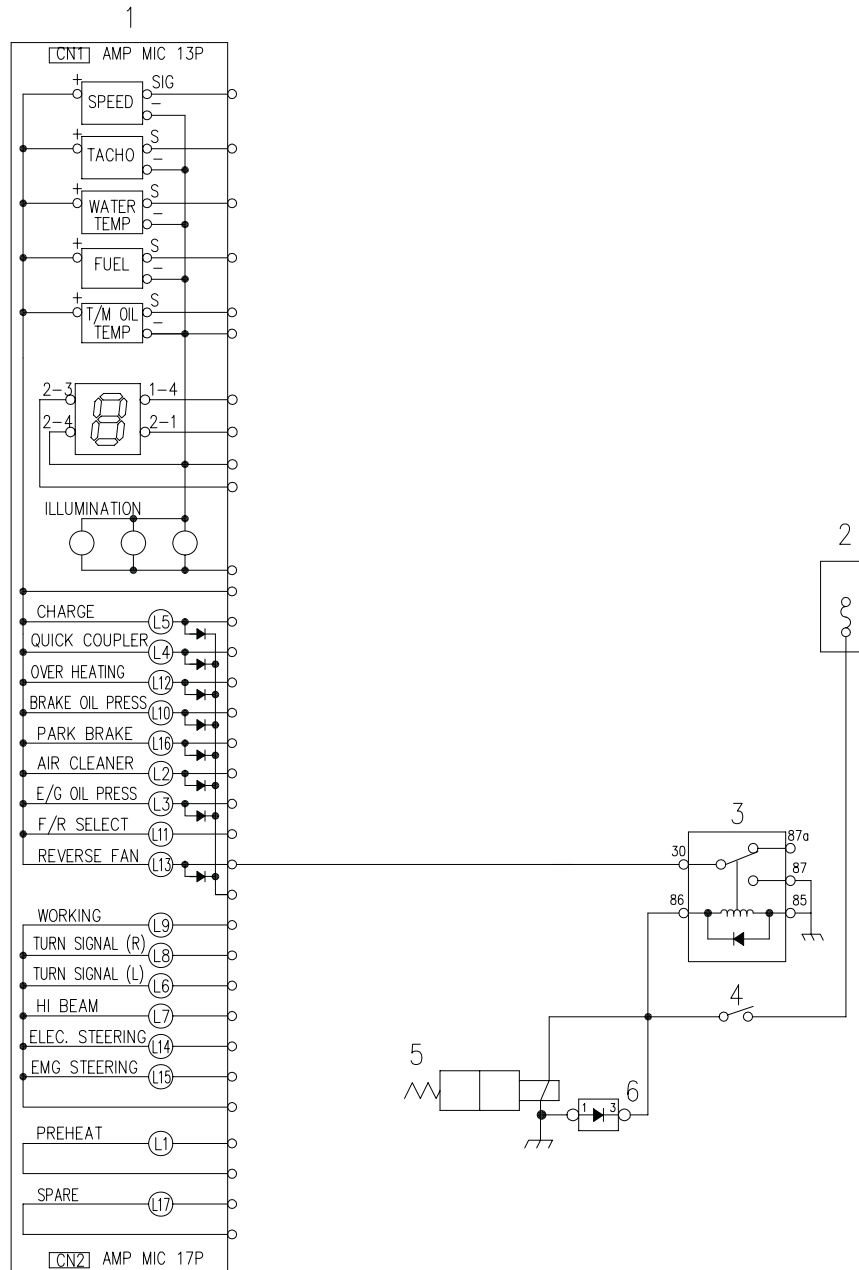


Figure 26

Reverse Fan System

Reverse Fan Circuit



FG028587

Figure 27

Reference Number	Description
1	Instrument Panel
2	Fuse Box
3	Reverse Fan Relay

Reference Number	Description
4	Reverse Fan Switch
5	Reverse Fan Sol-Valve
6	Diode

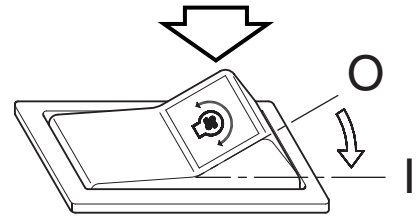
Reverse Fan Switch

This switch causes the radiator cooling fan to rotate in the reverse direction. The function of reversing the direction of the radiator cooling fan is effective in cleaning the radiator.

- O. "OFF" position.
- I. "ON" position.

Activate the switch for reverse rotation in the following order;

- A. Turn the starter switch "O" (OFF) → "I" (ON) and then turn the of the cooling fan reverse rotation switch "O" (OFF) → "I" (ON) and start the engine.
- B. For reverse operation, the cooling fan reverse rotation indicator light turns "ON" the same time.
- C. To return to forward rotation, shut down engine, change the position of the reverse switch "ON" → "OFF," and start the engine again.



FG004188

Figure 28



WARNING

AVOID DEATH OR SERIOUS INJURY

Never travel or work in the reverse fan rotation mode. This may cause damage to the cooling system. Make sure that this switch is in the "O" (OFF) position before starting the engine and operating the machine.

Electrical Schematic DL200A

Edition 1

MEMO

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MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or service. Untrained operators and failure to follow instructions can cause death or serious injury.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DL200A	10001 and Up

DL200A

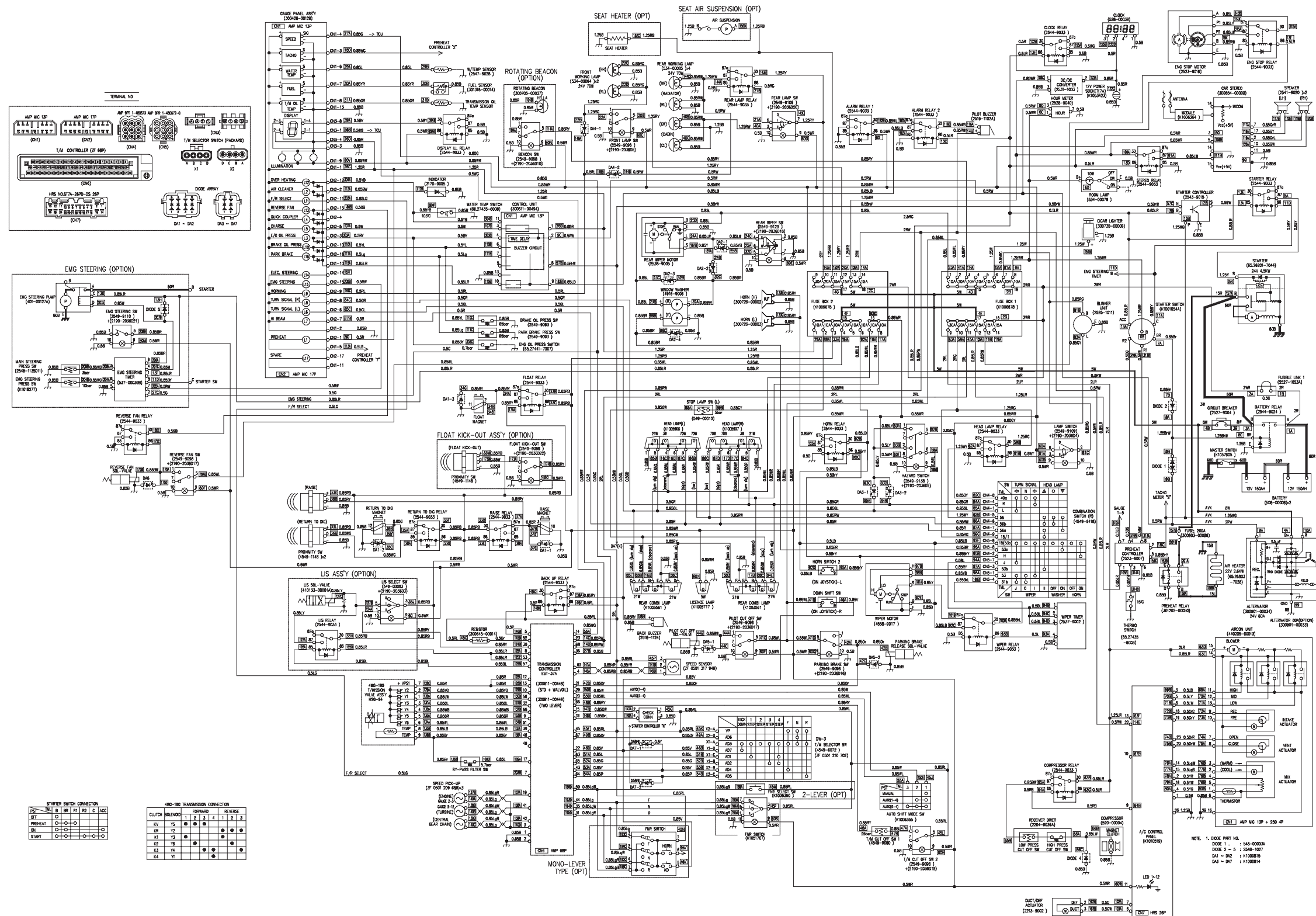


Figure 1

