

Table of Contents

1 Safety	1 Forestry Machine Maintenance Safety
2 Specifications	1 Specifications
3 General Maintenance	1 General Maintenance Instructions 2 Standard Torques
4 Engine	1 Engine 2 Engine Coolant Heater (Option)
5 Upper Structure	1 Cabin 2 Counterweight 3 Oil Tank 4 Fuel Tank 5 Main Pump 6 Drive Coupling (Main Pump) 7 Main Control Valve 8 Swing Device 9 Fan Pump for Oil Cooler 10 Fan Motor for Oil Cooler 11 Joystick Valve (Work Lever) 12 Travel Control Valve (with Damper) 13 Solenoid Valve 14 Accumulator 15 Gear Pump (Rotation) Two Pump 16 One Spool Valve
6 Lower Structure and Chassis	1 Swing Bearing 2 Center Joint 3 Travel Device 4 Track Assembly

7 Front

- 1 Boom and Stick
- 2 Cylinders

8 Hydraulic System

- 1 Hydraulic System
- 2 Hydraulic System Testing and Adjustment
- 3 Hydraulic System Troubleshooting

9 Electrical System

- 1 Electrical System

11 Schematic

- 1 Hydraulic Schematic/Electrical Schematic

Safety

Forestry Machine Maintenance Safety

Edition 1

MEMO

Table of Contents

Forestry Machine Maintenance Safety

Safety Instructions	1-1-5
Safety Messages	1-1-5
General	1-1-6
Transportation	1-1-16
Operation	1-1-18
Maintenance	1-1-35
Environment and Circumstances.....	1-1-51

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.

SAFETY MESSAGES

Replace with Safety Messages Section on pages III and IV in the HYUNDAI Operation & Maintenance Manual.

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 a machine.
- When working with other personnel on a work site, be sure that all personnel know 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 safety lever and seat belt. Use them properly.
- 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 excavating.
- 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 HYUNDAI for use on HYUNDAI machines. When installing and using optional attachments, read instruction manual for attachment, and general information related to attachments in this manual. Because HYUNDAI cannot anticipate, identify or test all attachments that owners may want to install on their machines, contact HYUNDAI 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 HYUNDAI distributor about auxiliary hydraulic kits for attachments installation. If you are in doubt about compatibility of a particular attachment with a machine, consult your HYUNDAI 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.

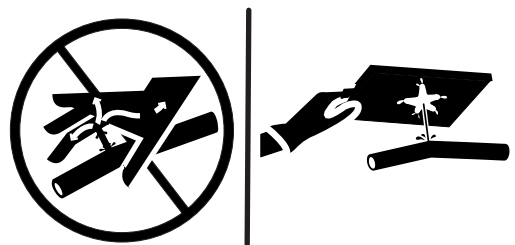


Figure 1

FG018457

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.

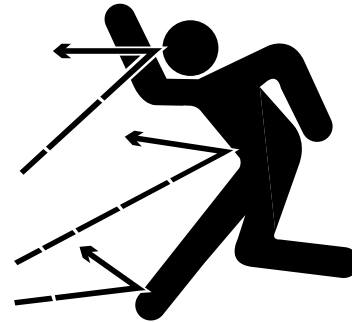
To prevent hot coolant from spraying out, stop engine and wait for coolant to cool. Using gloves, slowly loosen cap to relieve pressure.

Flying or Falling Objects

On work sites where there is a potential hazard that flying or falling objects can hit 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, could produce hazard of falling rocks or flying objects. Additional protection for operator's cabin could be required such as an Operator Protection Guard (OPG) or window guards. Contact your HYUNDAI 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.



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 and take the necessary corrective actions. Do not operate 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.



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, 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 dust mask when grinding painted parts.

Maintenance

The machine and some attachments have components that are at 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.



HDO1015I

Figure 8



FG018458

Figure 9

Electrical

Check all electrical wiring and connections for damage daily.

Keep battery terminals clean and tight. Repair or replace any damaged part 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 any flames or 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 & 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.

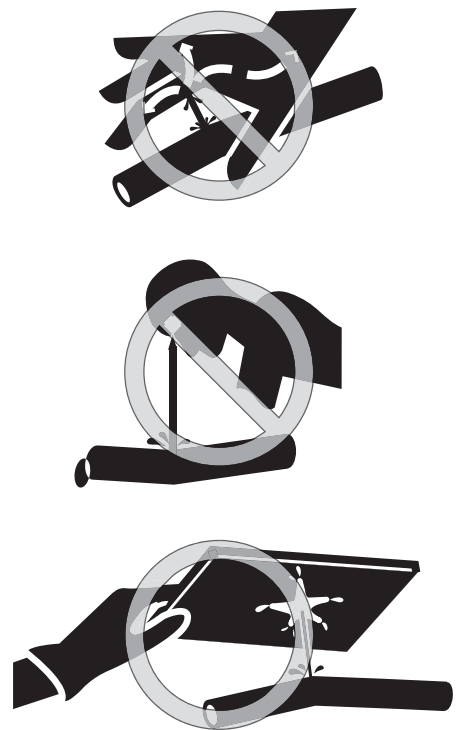
Hydraulic System

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.



EX1400129

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.

Always place plastic fuel containers on the ground before filling.

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.

Welding and Grinding

Always clean machine and attachment, set battery disconnect switch to "OFF" position, 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 dust mask when grinding painted parts.

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

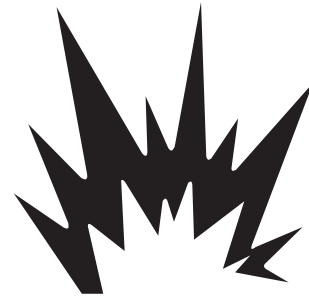
Repair such components in a well ventilated area away from flames or sparks.

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.



EX1400130

Figure 11



FG018458

Figure 12

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, guardrails 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.*



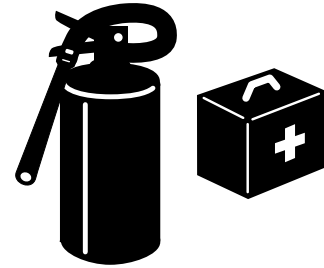
FG018459

Figure 13

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

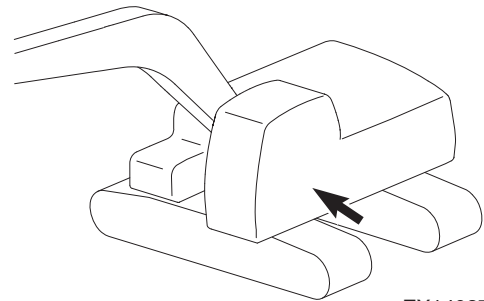
To be prepared in the event of a fire:

- 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



EX1403736

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 HYUNDAI distributor.*

Operator Protective Guards and Structures (Optional)

The machine may have different types of guards for operator protection. The type of guards might vary on the applications and work demands.

Inspect and check the guards daily to ensure no cracks, bent or loose. DO NOT modify the protective structure, guards by welding, grinding, drilling holes or adding attachments. Changes to the cabin can cause loss of operator protection from roll-over and falling objects, and result in death or serious injury.

Always wear your seat belt when operating machine.

Logging operation required the protection from flying debris and / or objects. When use a work tool create flying debris, install a front guard. Close the window and wear safety glasses.

Emergency Exit from Operator's Station

This machine is equipped with a glass breaking tool. It is found on left pillar of cabin. This tool can be used to break the glass to exit from cabin in an emergency. Grip handle firmly and use sharp point to break glass.

- Be careful also not to slip on broken pieces of glass on ground.



WARNING

AVOID DEATH OR SERIOUS INJURY

Protect your eyes when breaking the glass.

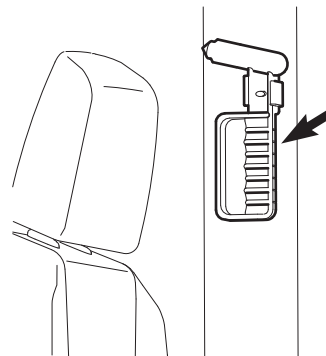


Figure 16

EX1300679

TRANSPORTATION

Obey State and Local Over-the-Road 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 forestry 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 & Maintenance Manual, for information on loading, unloading and towing.

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

Loading and Unloading

To prevent machine tipping or roll-over when loading or unloading machine, always do the following:

- Perform loading and unloading only on firm and 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 tracks and undercarriage. 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 travel lever.
- Never correct your steering on ramps. If necessary, drive off ramps, correct machine direction, then drive back onto ramps.
- When driving up or down ramps, the center of gravity of machine will change suddenly causing the tracks to drop down to the ramps or trailer. This will occur at the joint between the ramps and trailer. Travel slowly over this point.

- 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 safety lever is in LOCKED position.
- Check that work equipment and travel controls move freely, and work controls return to "NEUTRAL" when released.
- Check that attachment is properly attached and locked.

IMPORTANT

Only use Ultra Low Sulfur Diesel (ULSD) fuel and API CI-4/ACEA E5, E7 or API CJ-4/ACEA E9 grade engine oil with this machine.

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

Before moving machine, check position of undercarriage. The normal travel position is with idler wheels to front under cabin and drive sprockets to rear. When undercarriage is rotated in reversed position, directional or travel controls must be operated in opposite directions.

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.

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.

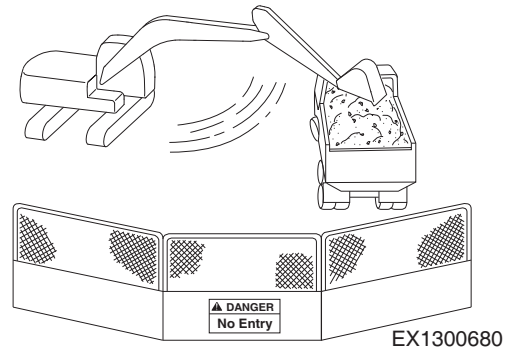


Figure 17

Mounting/Dismounting

Before getting on or off machine, if there is any oil, grease, or mud on handrails, guardrails, steps, or track shoes, 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.

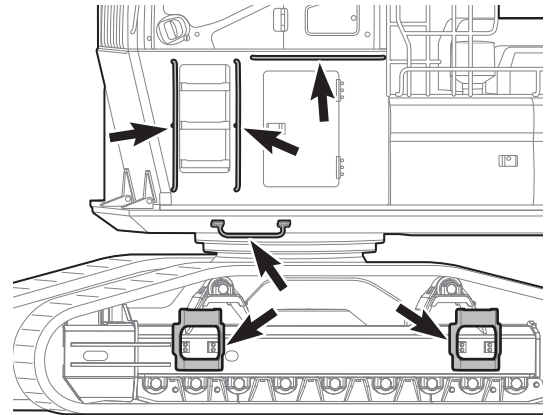
When getting on or off machine, always face machine. Maintain three-point contact (both feet and one hand or one foot and both hands) with handrails, guardrails, steps, and track shoes to ensure that you support yourself securely.

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

Securely latch door. If you grip handrail inside door when moving on top of track shoes, and door latch is not securely engaged, door may move and cause you to fall.

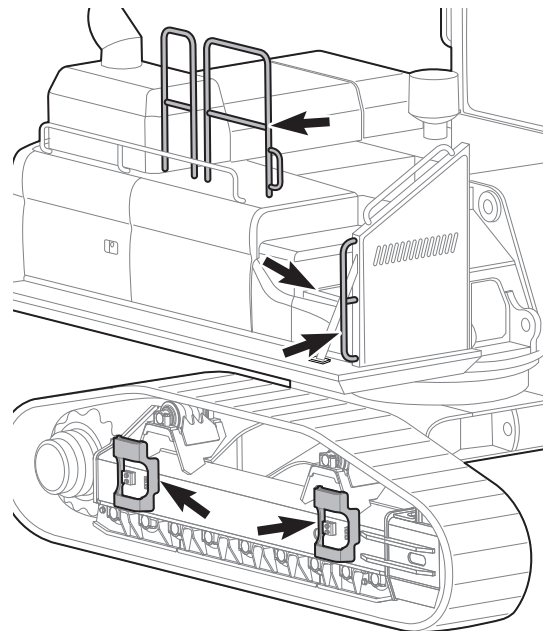
Use points marked by arrows in diagram when getting on or off machine.

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



EX1500971

Figure 18



EX1500972

Figure 19

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 equipment.

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.

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 safety lever securely in "LOCK" 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 HYUNDAI 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. 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 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 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 personnel and 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 swinging work equipment or 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 work site. Inspect and remove any obstacles around the machine that could be damaged and keep other personnel 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 HYUNDAI 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 all 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 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 & Maintenance Manual, for proper procedure in this manual.
- Connect positive (+) cable first when installing cables and disconnect negative (-) cable first when removing them.

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.

- Read and understand control pattern before operating. Check that movement of the machine matches display on control pattern label. If it does not match, replace it immediately with correct control pattern label.
- Check operation of work equipment, travel system and swing system.
- Check for any problem 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.

The boom and arm linkage can allow work tool or attachment to contact undercarriage or cabin. Be aware of position of work tool.

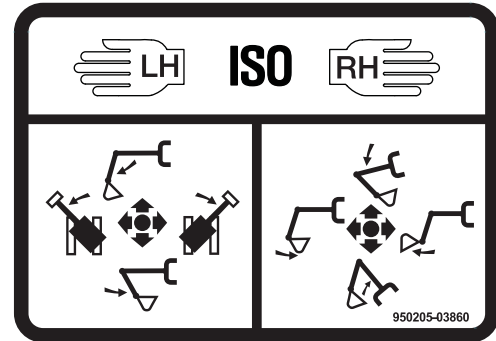
- Do not attempt to start engine by short-circuiting engine starting circuit. This can result in death or serious injury, or fire.
- When starting engine, sound horn as a warning to alert personnel in the work area.

If there is a warning tag or "DO NOT OPERATE" tag hanging from work levers (joysticks) or travel control levers, do not start engine or move levers.

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

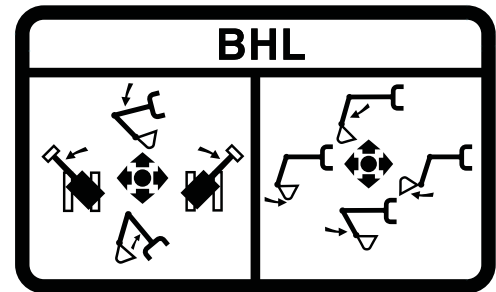
NOTE: *When starting engine in cold temperatures, "white engine exhaust smoke" from the tail pipe can occur until engine reaches normal operating temperatures.*

Also, a white residue, because of water vapor inside engine, can form at the engine oil fill location. These conditions will not affect engine performance or damage the engine or other exhaust system components.



EX1301191

Figure 20



EX1301192

Figure 21

Swinging or Traveling

As a machine operator, you should know and follow local, state and federal laws and regulations when operating on public roads or highways.

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 so, if necessary, swing upper structure slowly to check that there is no one behind machine before traveling in reverse.
- 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.

Be sure to observe above precautions even if a travel alarm or mirrors are installed.

- Check that travel 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.

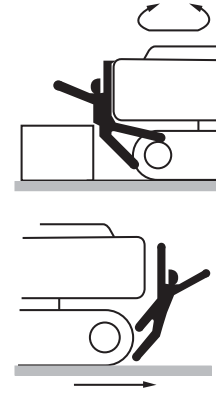


Figure 22

EX1400131

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

Do not operate attachments while traveling.

Do not change selected travel mode (FAST/SLOW) 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.

Do not operate steering controls 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.

Always operate within permissible water depth. Permissible water depth is up to centerline of upper track roller(s).

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.

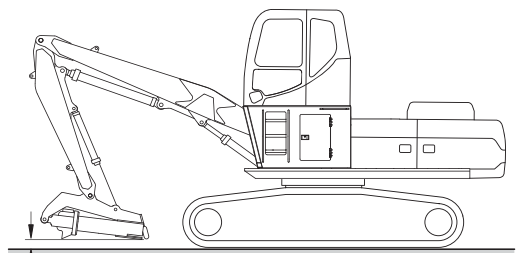
Never exceed maximum permitted load for bridges.

Always operate machine with idler wheels to front under cabin and drive sprockets to rear.

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

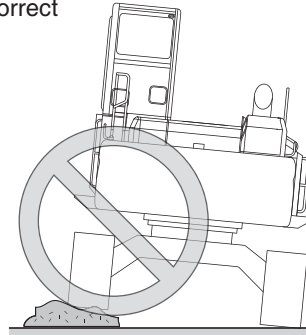
Keep height and length of attachment in mind.

Travel Posture



40 ~ 50 cm (16 ~ 20 in.)

Incorrect



EX1500910

Figure 23

Lifting and Logging

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.
- Forestry machine configuration and attachments.
- Weight, lifting height and swing radius.
- Safe rigging of load.
- Proper handling of suspended load.

Always watch load. Bring load close to the machine before traveling any distances or swinging load. Logs must be held securely within the grapple. Do not pinch with the grapple tines. It would lead to loss of control and dropped loads.

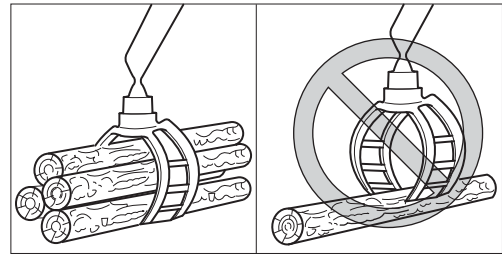
Lifting capacity decreases as load is moved further from the machine.

Set tracks at right angles to road shoulder or drop-off with sprocket at rear when performing operations to make it easier to move away from the work area.

Lifting and handling loads over the front and rear, rather than either side, has better stability of the machine.

Do not suddenly lower, swing, or stop work equipment. Haste can cause loss of stability and control. If tracks leave the ground, immediately lower the load and return the machine slowly to the ground.

- Do not move bucket or work tool over head of other personnel or over the operator's seat of dump trucks or other hauling equipment. The load may spill or bucket or work tool can hit dump truck causing property damage or cause death or serious injury.



EX1300849

Figure 24

Operation on Slopes

If the machine has to be used on a slope, pile soil to make a platform that will keep the machine as horizontal as possible.

Improper traveling on steep slopes could result in machine tipping, roll-over or sliding down the slope. Always fasten your seat belt.

When possible, operate machine up slopes and down slopes. Avoid operating machine across slope.

On hills, banks or slopes, carry bucket or work tool approximately 20 ~ 30 cm (8 ~ 12 in) above ground. In case of an emergency, quickly lower bucket or work tool 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 down slope.

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

Improper operation when working on slopes can cause a tip over. Use caution when swinging or operating work equipment on slopes.

Do not swing work equipment from uphill side to downhill side when bucket or work tool is loaded. This could cause machine to tip or roll-over.

In addition, lower bucket or work tool as far as possible, keep it pulled into front, and keep swing speed as slow as possible.

On slope, locate the drive sprockets downward the slope. Head the heaviest side of the machine uphill, as possible.

DO NOT mount a wire cable.

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.

- When traveling up a steep slope, extend work equipment to front to improve balance, keep work equipment approximately 20 ~ 30 cm (8 ~ 12 in) above ground, and travel at low speed.
- 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.

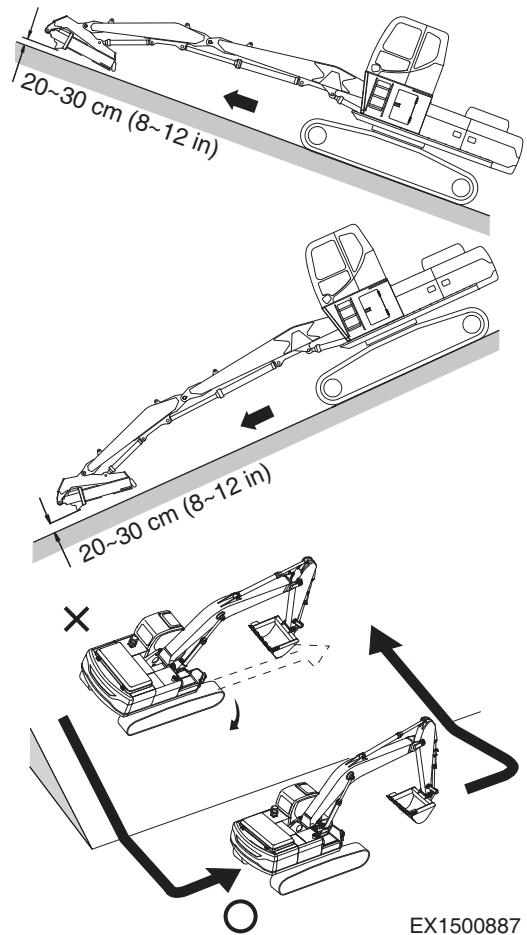


Figure 25

EX1500887

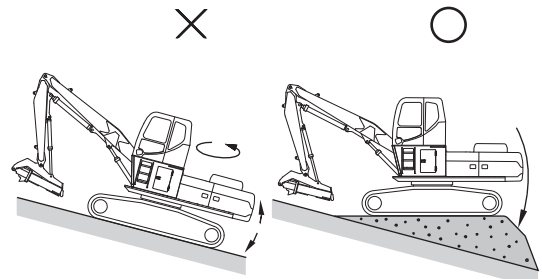


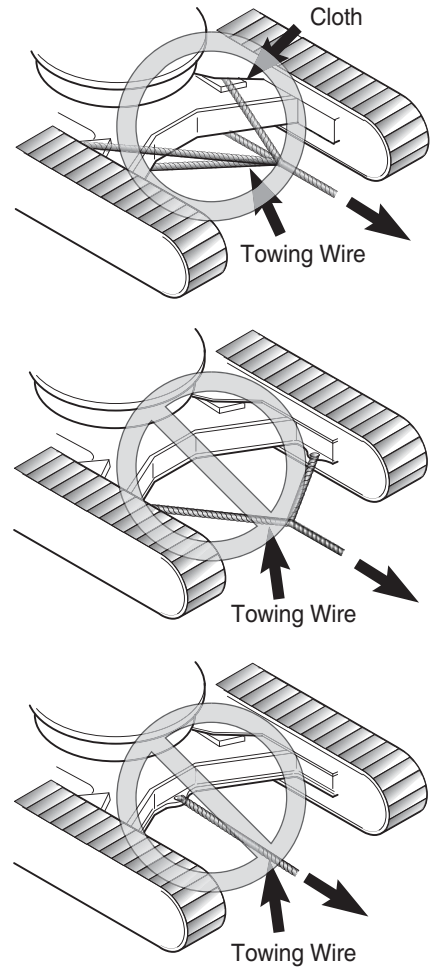
Figure 26

EX1300663

Towing

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 personnel, 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 HYUNDAI distributor.
- 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.



EX1400132

Figure 27

Attachment

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

The clamshell, grapple, or magnet can swing in all directions. Move work levers (joysticks) in a continuous motion. Failure to move work levers (joysticks) in a continuous motion can cause clamshell, grapple, or magnet to swing into cabin or into a person in work area. This 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 slips 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 tipping. This could result in death or serious injury.
- Do not use work equipment or swing mechanism to pull load in any direction. This could cause the work equipment to move suddenly if the load releases and can result in death or serious injury.

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 can cause high-pressure air, or hydraulic pressure, or some other media to be released to lower the equipment.

Wear appropriate personal protective equipment and follow the established procedure in the Operation Section of the manual.



EX1400133

Figure 28

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 five minutes before stopping the engine. This allows hot areas of engine to cool gradually.

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

Parking Machine

Avoid making sudden stops, or parking machine wherever it happens to be at end of workday. Park machine on firm and level ground away from traffic and away from high walls, drop-offs and any area of potential water accumulation or runoff. If parking on inclines is unavoidable, block crawler tracks to prevent movement. Lower bucket or other working attachment completely to ground, or to an overnight support saddle. To prevent unintended or accidental movement.

When parking on public roads, provide fences, 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, 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, safety lever must be moved to "LOCK" 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 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 safety lever to "LOCK" position before stopping off engine or immediately after engine stops running.

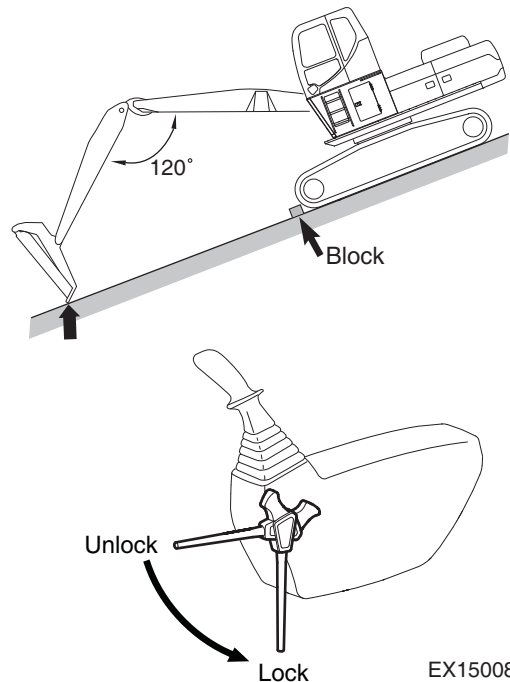


Figure 29

EX1500888

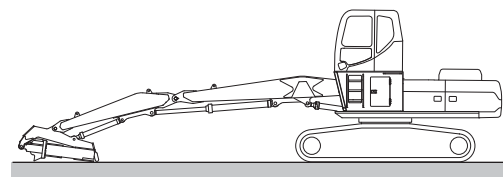


Figure 30

EX1300554

Preservation/Storing Machine

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

Conditions	Maintenance Required
Cleaning	Pressure wash undercarriage and track assemblies. 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 & 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 & Maintenance Manual, listed in this manual.

1. Complete the preceding steps.
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.
- Park machine where risk of theft, burglary and damage is minimized.
- Removing valuables from cabin such as cellular phone, computer, radio and bags.

See Operation & Maintenance Manual, for more information.

Check 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.)
- Inspect safety labels (decals). Replace if damaged, worn, or missing.

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 & 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 HYUNDAI equipment without instructions.
- Always lower bucket or work tool and blade to ground before doing any maintenance.
- Use correct procedure to lift and support forestry 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 open flame.
- Keep body, jewelry and clothing away from moving parts, electrical contact, hot parts and exhaust.
- Wear eye protection to guard from battery acid, compressed springs, fluids under pressure and flying debris when engines are 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 HYUNDAI replacement parts.
- Only authorized personnel should service and repair the machine. Do not allow unauthorized personnel into work area.
- Lower work equipment and stop engine before performing maintenance.
- Park machine on firm and level ground.
- Turn starter switch to "ON" position and keep safety lever in "UNLOCK" 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. Then move safety lever to "LOCK" position.
- 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 switch. If horn does not sound, the main power is shut off.)
- Put blocks under track 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 and you are exposed 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 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 procedure for placing equipment in servicing position.

Warning Tag

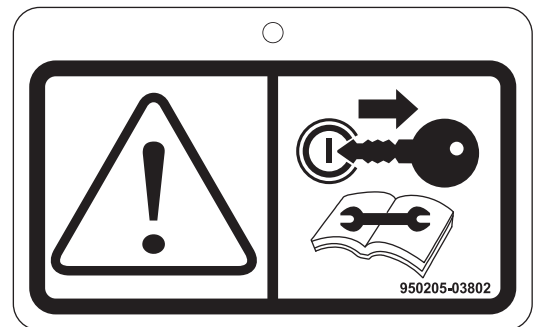
Alert others that service or maintenance is being performed by attaching a "DO NOT OPERATE" warning tag to the operator's cabin controls – and other machine areas, if required. Use of a chain or cable to keep the safety lever in the fully lowered "LOCK" position, complies with OSHA's lockout requirements.

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

- Always attach "DO NOT OPERATE" warning tag to work equipment control lever in the operator's cabin to alert others that you are performing service or maintenance on the machine. Attach additional warning tags on the machine, if necessary.
- Keep warning tags in tool box while it is not used. If there is not tool box or in the owner manual storage pocket.
- If any other 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 are available from your HYUNDAI distributor.



EX1301177

Figure 31

Cleaning

Clean machine before performing inspection and maintenance.

If inspection and maintenance are done when machine is dirty, it will become more difficult to locate problems, and you could slip on steps and work platform areas and injure yourself.

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, 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 substances, 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.

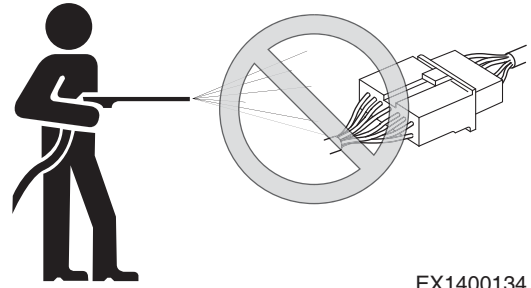


Figure 32

EX1400134

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 hit a service person in the eyes or face causing serious injury.

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 other personnel 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.

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.

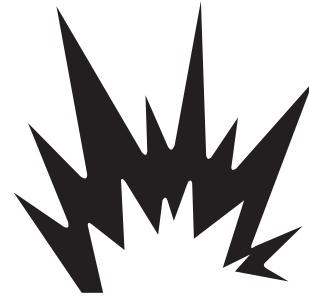
Clean all electrical connections and tighten all electrical connections. Check electrical wires daily for wires that are loose or frayed. Tighten all loose, and repair or replace all frayed, electrical wires before operating machine.

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



HDO1015I

Figure 33



FG018458

Figure 34

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 mouth.

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.

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.

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

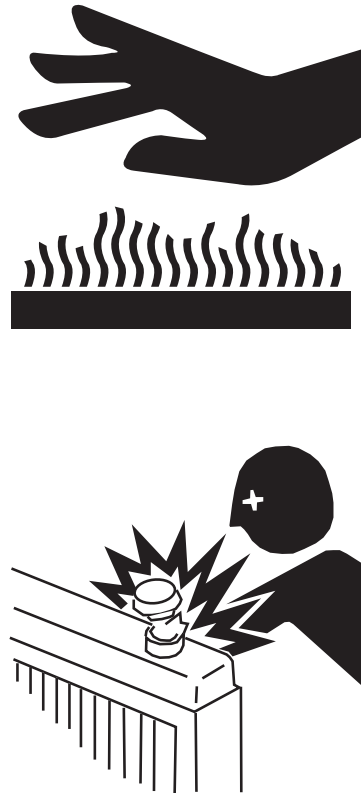


Figure 35

haae2090

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 plastics 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 place. 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 battery explosion, 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 result in 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.

Preparation for Electrical Welding on Body Structure

To prevent damage 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.

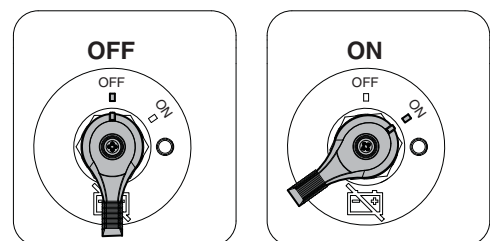


Figure 36

EX1500481

Warning for Counterweight and Front Attachment Removal



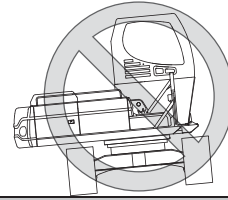
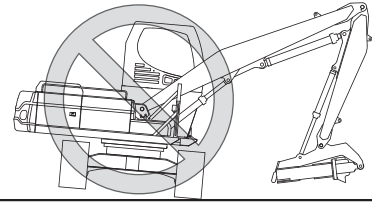
WARNING

AVOID DEATH OR SERIOUS INJURY

Removal of the machine counterweight, front attachment or any other part can affect the stability of the machine. This could cause unexpected movement, and result in death or serious injury.

Never remove counterweight or front attachment unless the upper structure is in-line with the lower structure.

Never rotate the upper structure once the counterweight or front attachment has been removed.



EX1500889

Figure 37

Lock Inspection Covers

When performing maintenance with inspection cover open, use lock bar to secure cover and prevent accidental lowering of the cover caused by wind or movement of the machine.

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 track shoes are 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.



Figure 38

ARO1380L

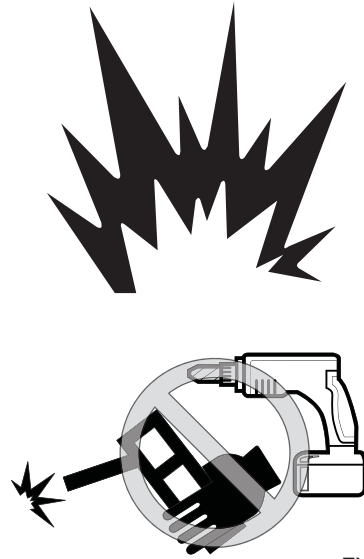
Accumulator

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 & 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. Contact your HYUNDAI 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.



EX1400135

Figure 39

Compressed Air

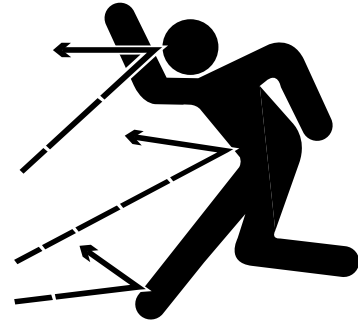
- When cleaning filters, radiator or other components with compressed air, there is a hazard of flying particles that can result in serious injury.
- Always wear safety goggles, dust mask, leather gloves, and other protective devices.

Track Tension Adjustments

Track adjusting systems use grease under high-pressure to keep track under tension. Grease under high-pressure can penetrate body and result in death or serious injury. Watch track or track spring to see if track is being loosened.

NEVER LOOSEN track tension grease valve. To release pressure from crawler frame track tension assembly, you should **NEVER** attempt to disassemble track adjuster or attempt to remove track tension grease valve assembly.

Keep your face and body away from grease valve. Refer to Operation & Maintenance Manual, for proper procedure in this manual or Shop Manual.



HAOA110L

Figure 40

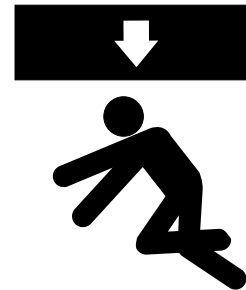
Supports and Blocking for Work Equipment

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

Lower work group to ground before leaving operator's seat.

Do not use hollow, cracked or unsteady wobbling supports.

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



HDO1042L

Figure 41

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 & 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. 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 & 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 HYUNDAI distributor for replacement parts.

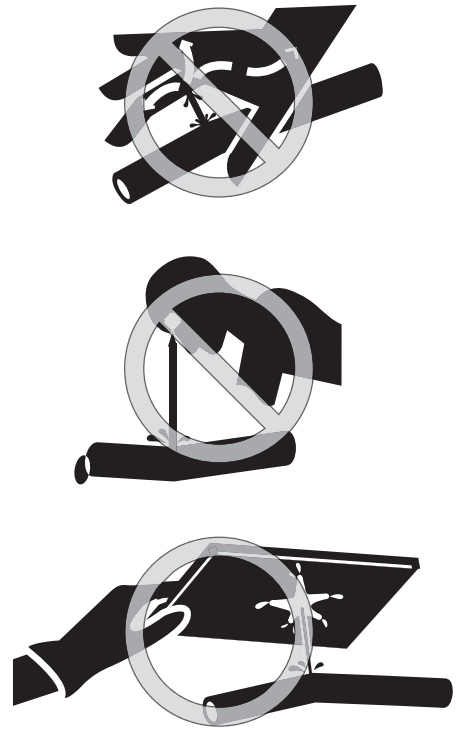


Figure 42

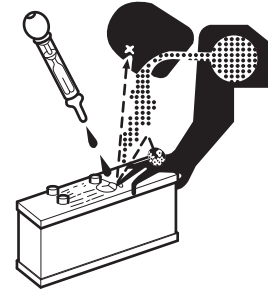
EX1400129

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, 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.



EX1400136

Figure 43

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.
- 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. Take care when working in a place where machine may tip over.
- Do not operate on soft ground or near riverbanks that could collapse or where ground may not support weight of forestry 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.

- Do not perform overhead demolition work. This can cause broken objects and debris to fall on top of machine causing death or serious injury, or property damage.

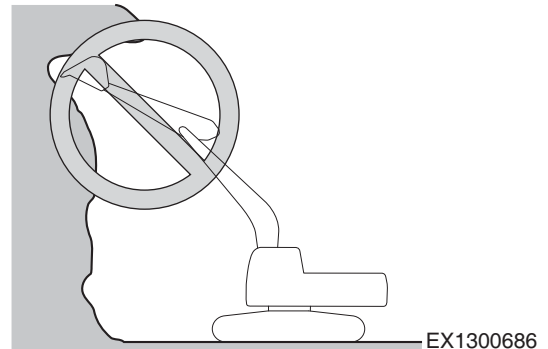


Figure 44

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.

Never rely on lift jacks or other inadequate supports when work is being done. Block tracks fore and aft to prevent any movement.

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.

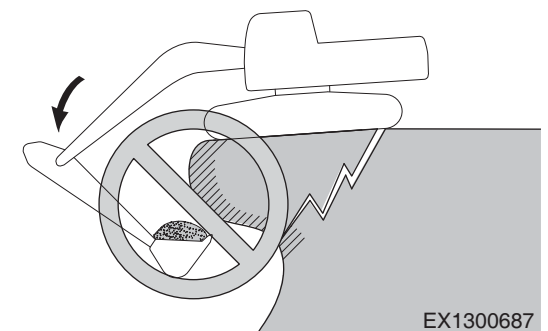


Figure 45

Drop-off or Edge

When working at edge of an working or near 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 roll-over, and to prevent ground, stockpiles, or banks from collapsing.

Do not travel too close to edge of a drop-off.

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 swing bucket or work tool over the top of personnel or over operator's cabin of dump truck.

Loose or Soft Ground

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

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. How far away from edge of trench excavated material must 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 or work tool, 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 damage 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.

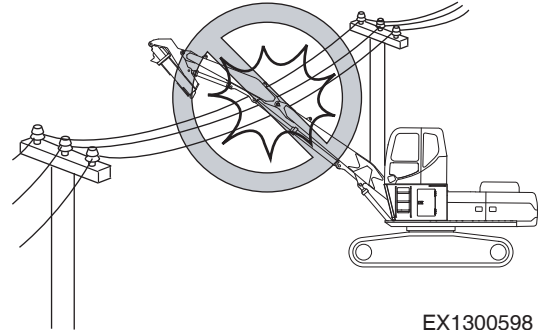


Figure 46

Underground Operation

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

Special equipment and engines may be required in some countries. Contact your HYUNDAI 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.

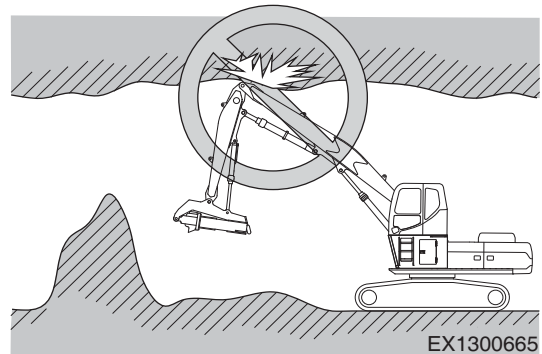


Figure 47

Working in Water

IMPORTANT

Do not exceed maximum permissible water depth. The water level must not reach higher than centerline of upper track roller(s) (1, Figure 48).

After working in water, lubricate all lubrication points on undercarriage, which have been underwater so water is removed. Check that no water has entered travel gearboxes and undercarriage components.

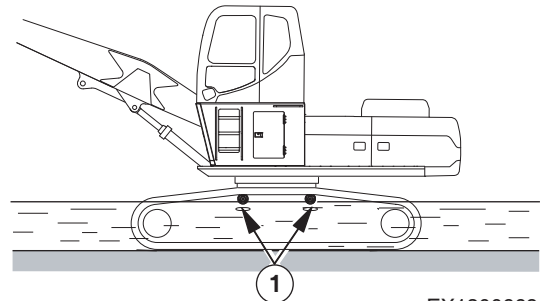


Figure 48

Working in Contaminated Environment

When working within area which is contaminated or where there is a health risk, check local regulations and contact your HYUNDAI 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 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 paragraphs detail checks to be made to be certain machine is capable of operating at these temperatures.

1. Preheat the engine before startup. Wait 3 - 4 seconds after preheating until voltage of the battery returns, and then actuate the key switch.
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. When temperature drops below -10°C, effectiveness of the battery is reduced accordingly. Insulation of the battery prevents this reduction, and supports improvement of starting power of the starter.



WARNING

**BATTERY EXPLOSION CAN CAUSE DEATH OR
SERIOUS INJURY**

Never attempt to directly heat the battery with open fire.

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 & Maintenance Manual, in this manual or Shop Manual for details.
5. Always keep the fuel tank fully filled after completion of operation. The fuel filter, if frozen, may interrupt the flow of fuel. Periodically remove water from the fuel tank, drain water from the filter, and replace the filter upon regular basis.

To prevent fuel from being clogged due to formation of wax in fuel, make sure that wax formation point of fuel is lower than atmospheric temperature.

6. Lubricate entire machine according to Operation & Maintenance Manual, in this manual or lubrication chart on machine.



WARNING

FUEL TANK EXPLOSION CAN CAUSE DEATH OR SERIOUS INJURY

Never attempt to heat the fuel tank with an open flame.

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 and functions to be sure they are operating correctly.
8. An extra outer air filter must be kept in operator's cabin to replace 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, 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. Make frequent inspections and services of 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 "Check Fuel Level" and "Check for Leaks in Fuel System", of Operation & 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 "Lubrication and Service Chart", in Operation & Maintenance Manual or 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 on other surfaces.
 - C. Protect all unfinished, exposed surfaces with a film of preservative 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 "Lubrication and Service Chart" of Operation & 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.

1. Keep all exposed surfaces coated with preservative 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 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 "Lubrication and Service Chart" of Operation & 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 products of combustion 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 49

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 regulations related to work site and working environment.
- Avoid brushing or grinding materials that contain asbestos.
- 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.

Disposal of Hazardous Materials

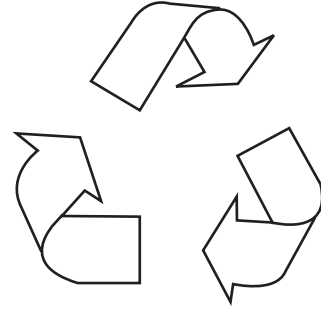
Physical contact with used motor oil or gear oil could create a health risk. Wipe oil from your hands promptly and wash off any remaining residue.

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 system, 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 regulations.

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



FG009156

Figure 50

Specifications

Specifications

Edition 1

MEMO

Table of Contents

Specifications

Safety Instructions	2-1-4
General Description	2-1-4
Component Locations.....	2-1-5
Log Loader	2-1-5
Road Builder.....	2-1-6
General Dimensions	2-1-10
Log Loader	2-1-10
Road Builder.....	2-1-12
General Specifications.....	2-1-13
Approximate Weight of Workload Materials..	2-1-14
Performance Tests	2-1-16
Purpose of Performance Tests.....	2-1-16
Kinds of Tests.....	2-1-16
Performance Standards	2-1-16
Precautions for Evaluation of Test Data.....	2-1-16
Definition of "Performance Standard".....	2-1-16
Preparation for Performance Tests	2-1-17
The Machine.....	2-1-17
Test Area.....	2-1-17
Precautions	2-1-17
Make Precise Measurement.....	2-1-17
Operational Performance Standard Table	2-1-18
Operational Performance Test	2-1-20
Hydraulic Cylinder Cycle Time	2-1-20
Travel Speed	2-1-22
Track Revolution Speed	2-1-23
Mistrack Check.....	2-1-25
Swing Speed	2-1-27
Swing Function Drift Check	2-1-28
Cylinder Creep	2-1-29

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.

GENERAL DESCRIPTION

The forestry machine has three main component sections:

- The Upper Structure
- The Lower Undercarriage and Track Frames
- The Forestry Machine Front-end Attachment

The following illustration identifies main components and their locations. (See Figure 1 on page -5.)

COMPONENT LOCATIONS

Log Loader

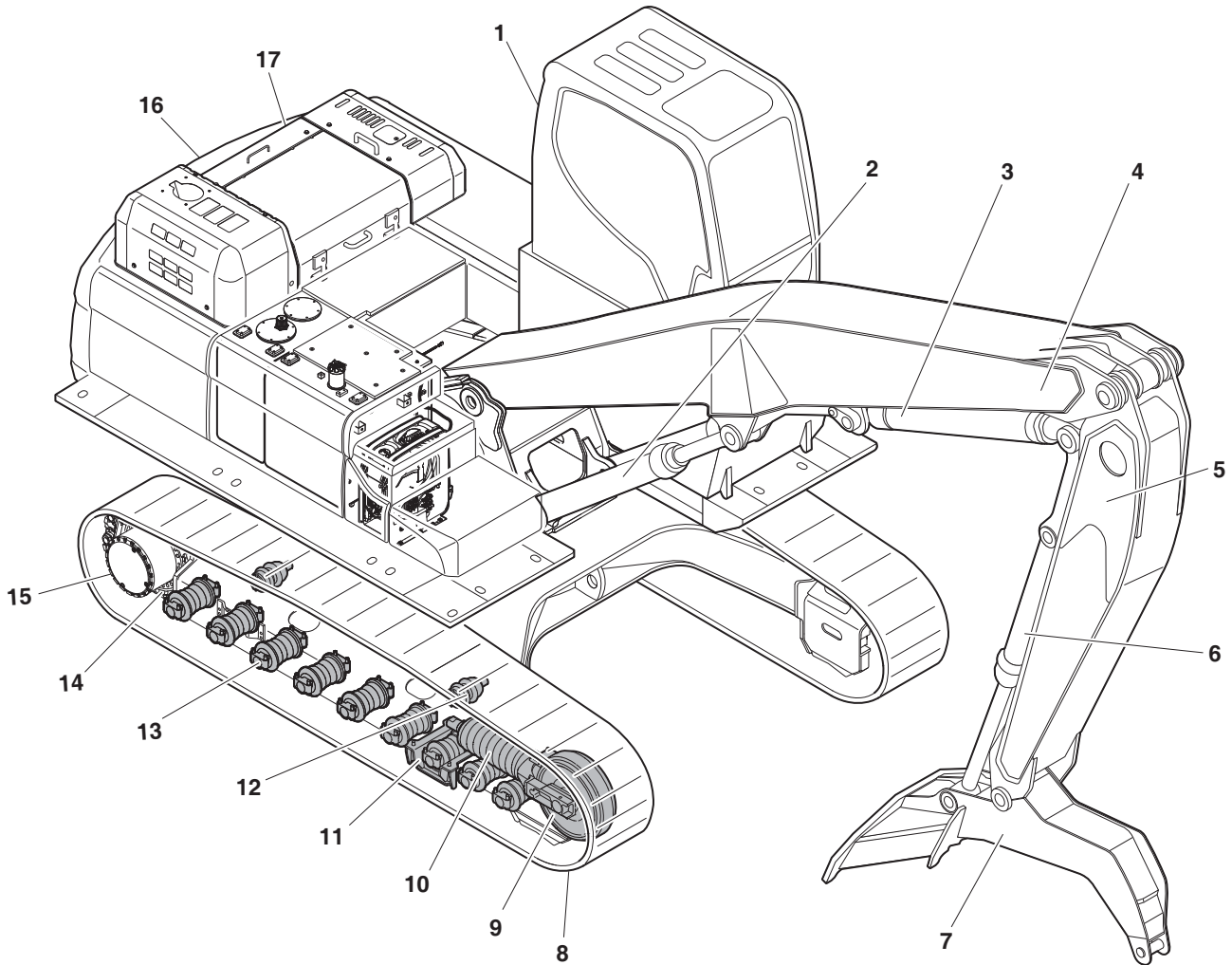


Figure 1

EX1500964

Reference Number	Description
1	Cabin
2	Hoist Cylinder
3	Arm Cylinder
4	Hoist
5	Arm
6	Heel Cylinder
7	Heel Rack
8	Track Link and Shoe
9	Idler

Reference Number	Description
10	Track Adjuster
11	Track Guard
12	Upper Roller
13	Lower Roller
14	Sprocket
15	Travel Motor
16	Counterweight
17	Hood

Road Builder

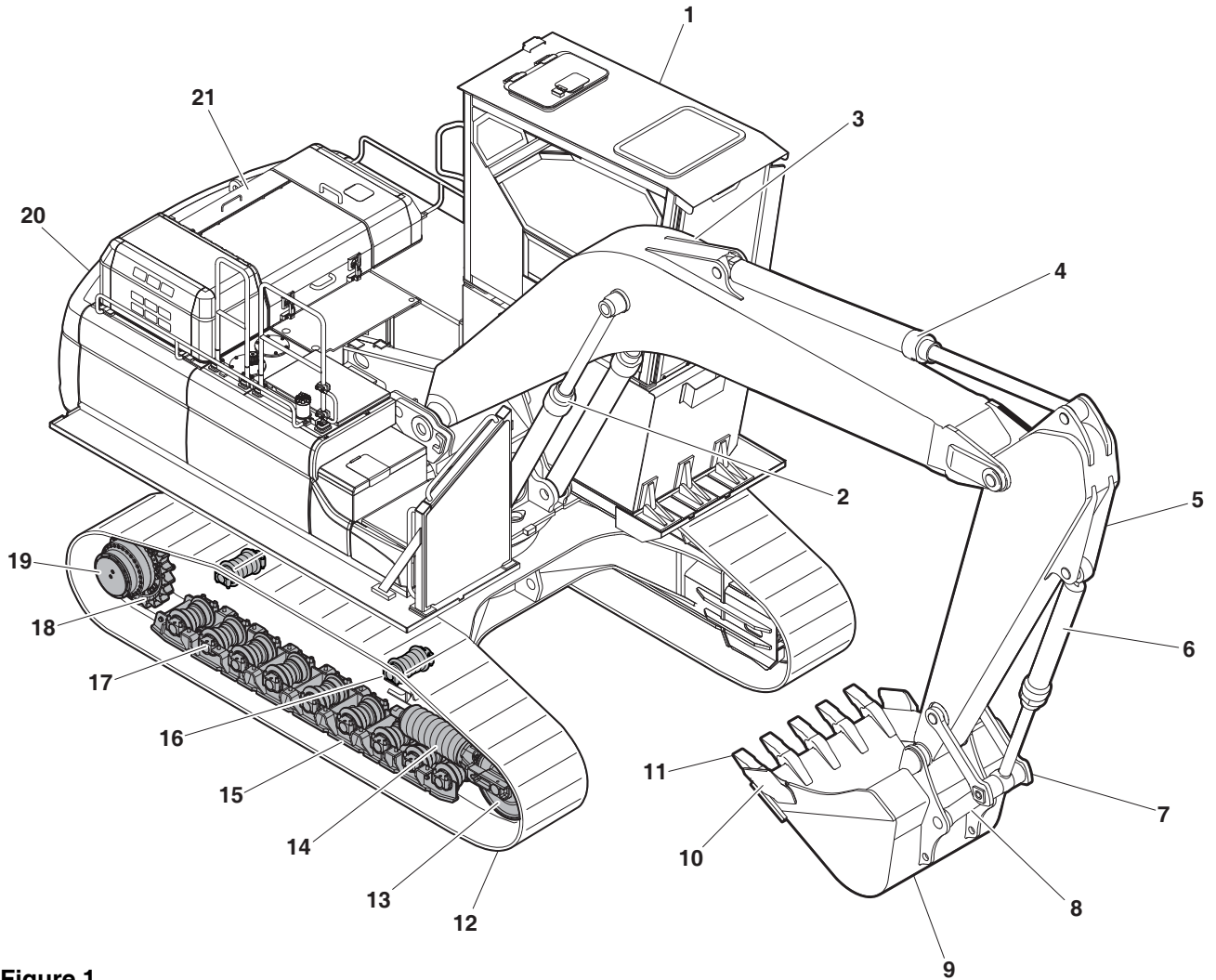
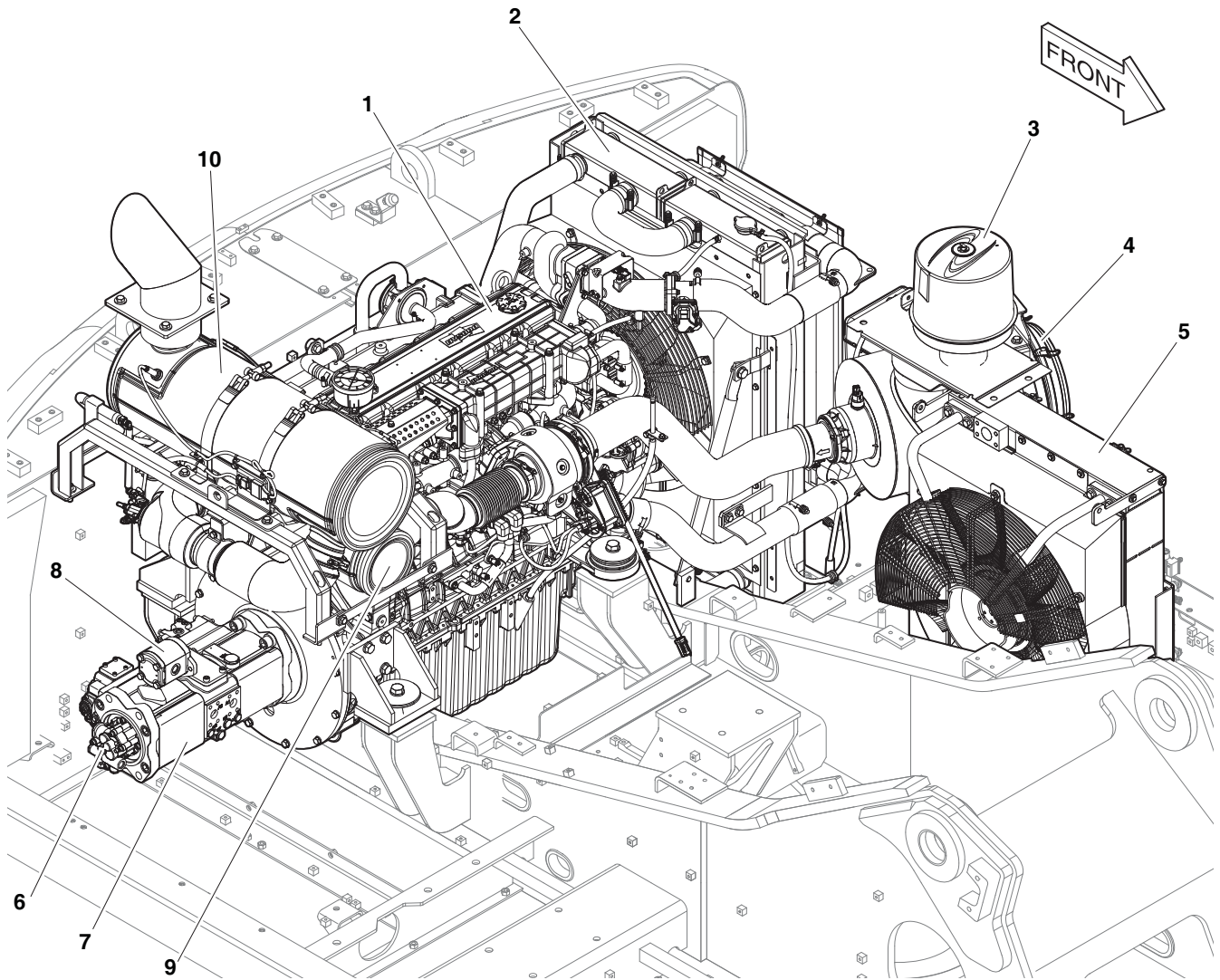


Figure 1

DS1902738

Reference Number	Description
1	Cabin
2	Boom Cylinder
3	Boom
4	Arm Cylinder
5	Arm
6	Bucket Cylinder
7	Guide Link
8	Push Link
9	Bucket
10	Side Cutter
11	Tooth Point

Reference Number	Description
12	Track Link and Shoe
13	Idler
14	Track Adjuster
15	Track Guard
16	Upper Roller
17	Lower Roller
18	Sprocket
19	Travel Motor
20	Counterweight
21	Hood



DS1603107

Figure 3

Reference Number	Description
1	Engine
2	Radiator
3	Precleaner
4	Air Cleaner
5	Oil Cooler

Reference Number	Description
6	Pilot Pump
7	Main Pump
8	Gear Pump (Rotating) - If Equipped
9	DOC
10	SCR

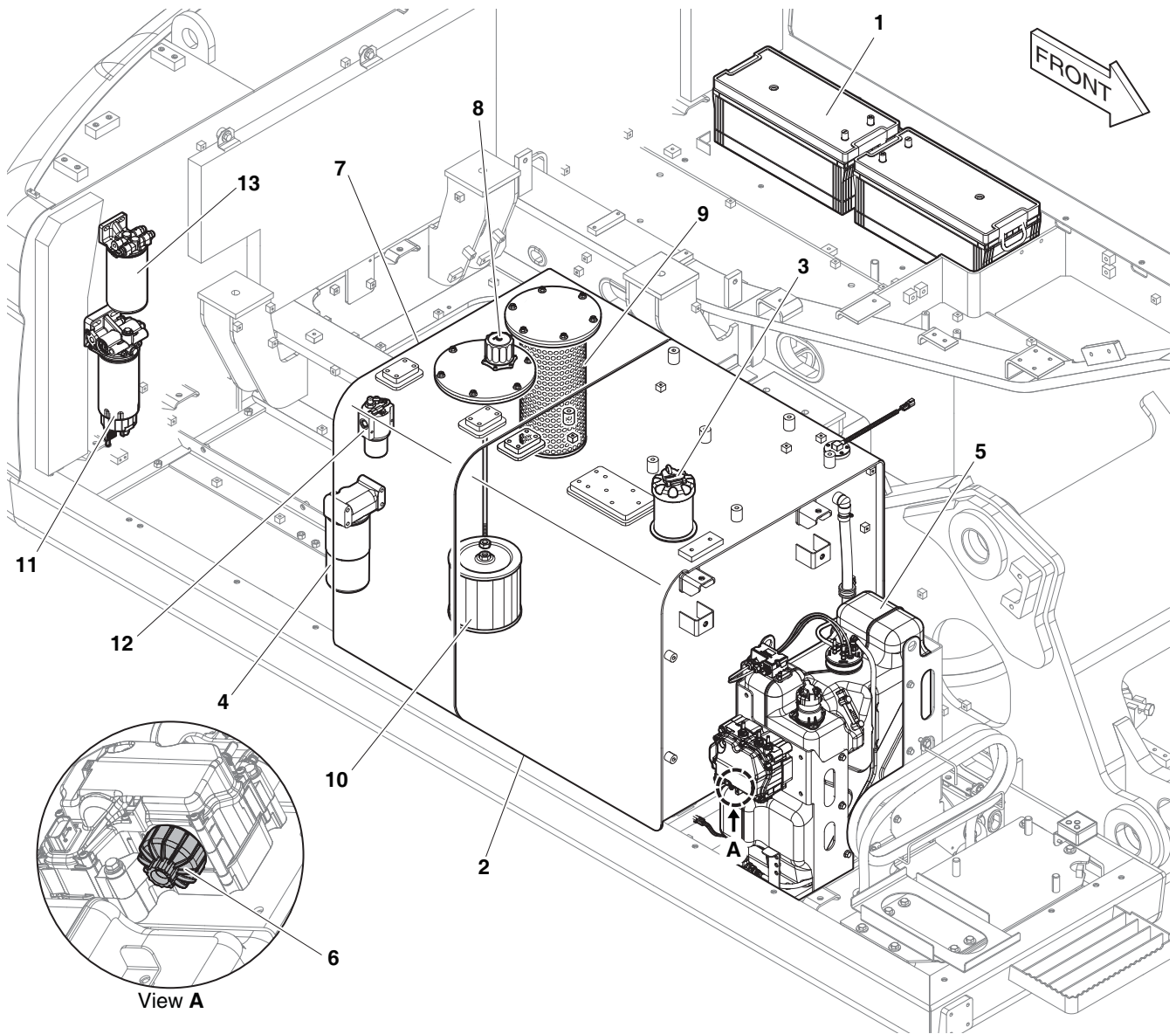
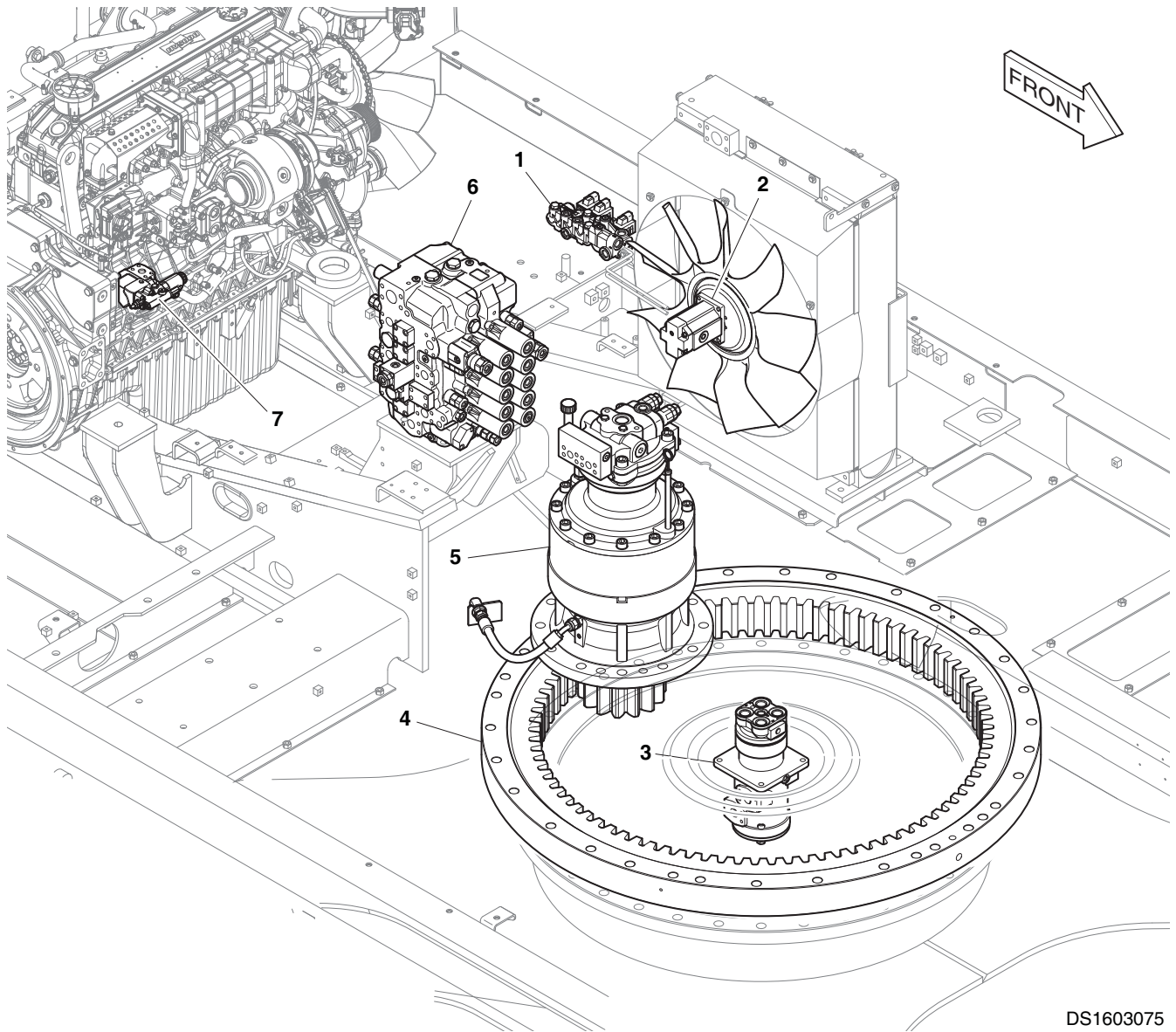


Figure 4

DS1603074

Reference Number	Description
1	Battery
2	Fuel Tank
3	Fuel Cap
4	Engine Oil Filter
5	Urea Tank
6	DEF (AdBlue) Filter
7	Hydraulic Oil Tank

Reference Number	Description
8	Air Breather
9	Return Filter
10	Suction Filter
11	Pre Fuel Filter and Water Separator
12	Pilot Filter
13	Main Fuel Filter



DS1603075

Figure 5

Reference Number	Description
1	Solenoid Valve
2	Fan Motor
3	Center Joint
4	Swing Bearing

Reference Number	Description
5	Swing Device
6	Control Valve
7	Fan Pump

GENERAL DIMENSIONS

Log Loader

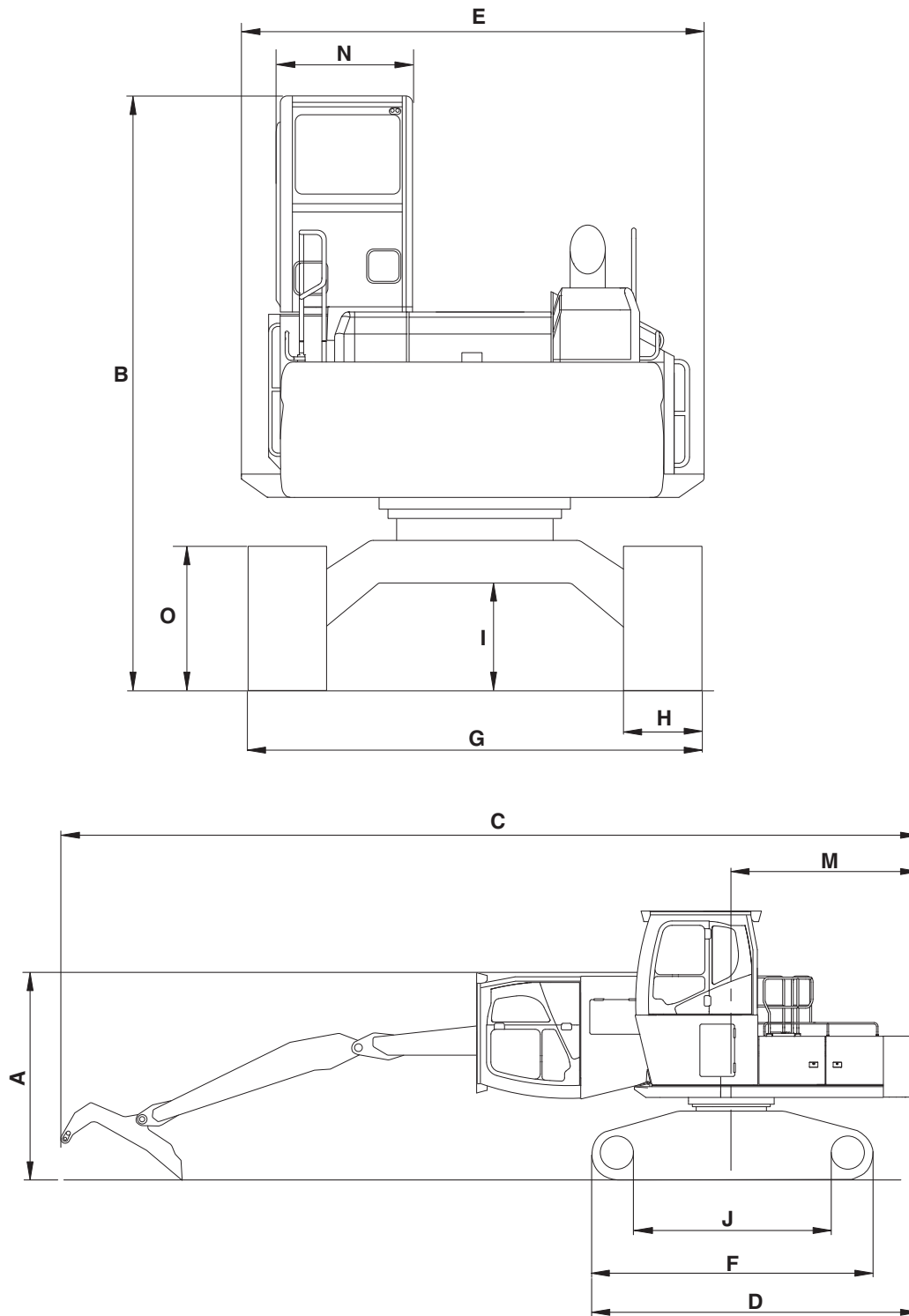


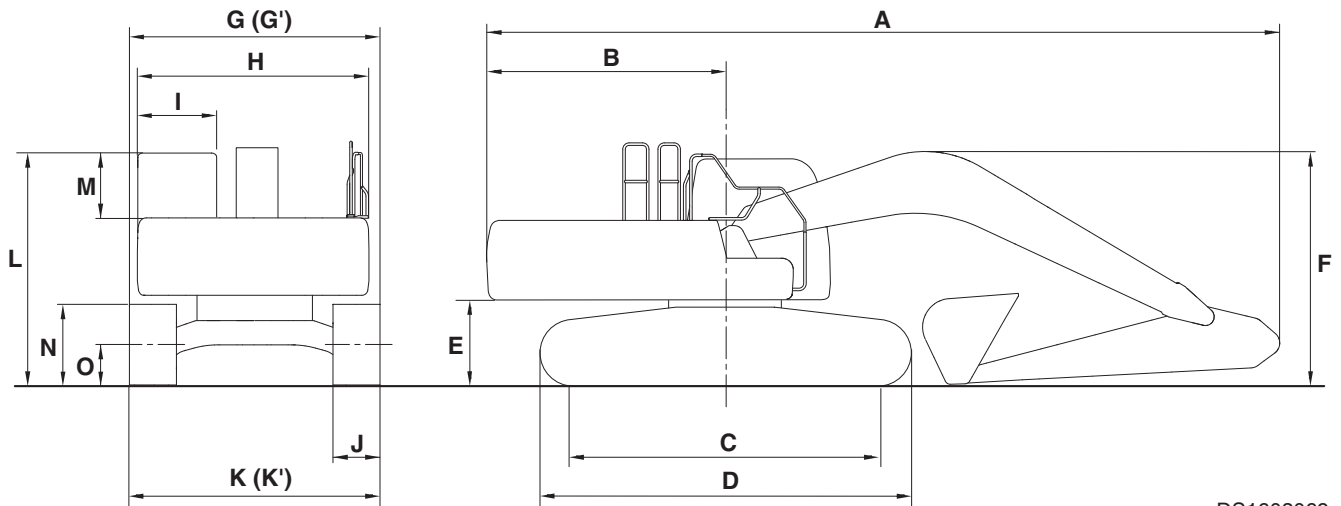
Figure 1

EX1500908

Dimension		6.3 m (20' 8") Boom
		3.912 m (12' 10") Arm
A	Shipping Height	3,604 mm (11' 10")
B	Overall Height	4,696 mm (15' 5")/**4,907 mm (16' 1")
C	Shipping Length	14,440 mm (47' 5")
D	Shipping Length (W/O Attachment)	5,710 mm (18' 9")
E	Upper Structure Width	3,480 mm (12' 0")
F	Track Length	4,920 mm (16' 2")
G	Shipping Width	3,600 mm (11' 10")
H	Undercarriage Width	700 mm (2' 4")
I	Car Body Clearance (W/O Grouser)	760 mm (2' 6")
J	Tumbler Distance	4,010 mm (13' 2")
M	Tail Swing Radius	3,235 mm (10' 7")
N	Cab Guard Width	1,105 mm (3' 8")/**1,140 mm (3' 9")
O	Track Height (W/O Grouser)	1,289 mm (4' 3")

** : Oregon Cabin

Road Builder



DS1603069

Figure 2

Dimension		6.245 m (20' 6") Boom
		3.1 m (10' 2") Arm
A	Shipping Length	10,628 mm (34' 10")
B	Tail Swing Radius	3,235 mm (10' 7")
C	Tumbler Distance	4,010 mm (13' 2")
D	Track Length	4,920 mm (16' 2")
E	Counterweight Clearance (W/O Grouser)	1,473 mm (4' 10")
F (Boom)	Shipping Height	3,571 mm (11' 9")
F (Hose)	Shipping Height	3,689 mm (12' 1")
G	Shipping Width (STD)	3,600 mm (11' 10")
G'	Shipping Width (Narrow)	-
H	House Width	3,576 mm (12' 0")
I	Cab Width	1,010 mm (3' 4")/**1,140 mm (3' 9")
J	Shoe Width	700 mm (2' 4")
K	Undercarriage Width	3,600 mm (11' 10")
L	Height Over Cab	3,381 mm (11' 1")/**3,695 mm (12' 1")
M	Cabin Height Above House	853 mm (2' 2")/**1,180 mm (3' 3")
N	Track Height (W/O Grouser)	1,289 mm (4' 3")
O	Car Body Clearance (W/O Grouser)	760 mm (2' 6")

** : Oregon Cabin

GENERAL SPECIFICATIONS

Items		Unit	Std.	Opt.1	Opt.2	Opt.3
Operating Weight		Ton	37.5	38.3	37.6	37.2
Bucket Capacity (SAE)		m ³	-		1.60	
Engine	Rated Power	KW/rpm	202 / 1,800			
	Max. Torque	Nm/rpm	1,275 / 1,300			
System Pressure (Work / Travel)		kg/cm ²	330 (350) / 330		350 (370) / 350	
Swing Speed		rpm	9.7			
Swing Torque		kg.m	9,831			
Travel Speed (High / Low)		km/h	4.2 / 2.7			
Gradeability		%(deg)	70 (35°)			
Shoe Width		mm	700 DG			
Ground Pressure		kg/cm ²	0.62	0.63	0.62	0.61
Working Range	Max. Digging Reach (High Lift)	mm	11,570		10,690 (10,670)	
	Max. Digging Depth (High Lift)	mm	3,740		7,015 (5,950)	
	Max. Digging Height (High Lift)	mm	13,135		10,340 (11,700)	
	Rear Swing Radius	mm	3,235			
	Min. Swing Radius (High Lift)	mm	4,450		4,230 (3,005)	
Transportation Dimension	Overall Length	mm	14,440		10,628	
	Overall Width	mm	3,600			
	Overall Height	mm	3,604		3,695	3,689
	Ground Clearance	mm	760			
	Track Length	mm	4,920			
	Track Gauge	mm	2,900			
Cabin	Riser Height	mm	1,200		-	
	Hyd. Tilting	deg	90°		-	
Option	<ul style="list-style-type: none"> • Boom: LL 6,300 mm, RB 6,245 mm • Arm: LL 3,912 mm, RB 3,100 mm • Heel: 990 mm • Bucket (SAE): H Class 1.60 m³ • Shoe: STD 700 mm (DG), OPT 700 mm (TG), 800 mm (DG) • Grapple: STD TC-52, OPT (TC-58, TC-66, RHLG-52, RHLG-64, RHLG-72) 					

- STD: LL Boom (6,300 mm), LL Arm (3,912 mm), Heel (990 mm), Non Rops CAB, 700 mm (DG) Shoe
- OPT 1: LL Boom (6,300 mm), LL Arm (3,912 mm), Heel (990 mm), Oregon CAB, 700 mm (DG) Shoe
- OPT 2: RB Boom (6,245 mm), RB Arm (3,100 mm), H Class Bucket (1.60 m³), Oregon CAB, 700 mm (DG) shoe
- OPT 3: RB Boom (6,245 mm), RB Arm (3,100 mm), H Class Bucket (1.60 m³), Rops CAB, 700 mm (DG) Shoe

APPROXIMATE WEIGHT OF WORKLOAD MATERIALS

IMPORTANT

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

Material	Density 1,200 kg/m ³ (2,000 lb/yd ³), or less	Density 1,500 kg/m ³ (2,500 lb/yd ³), or less	Density 1,800 kg/m ³ (3,000 lb/yd ³), or less	Density 2,100 kg/m ³ (3,500 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)	-	-	-
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)	-	-	-

Material	Density 1,200 kg/m³ (2,000 lb/yd³), or less	Density 1,500 kg/m³ (2,500 lb/yd³), or less	Density 1,800 kg/m³ (3,000 lb/yd³), or less	Density 2,100 kg/m³ (3,500 lb/yd³), or less
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)	-	-
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)	-	-
Sulfur, broken	529 kg/m ³ (891 lb/yd ³)	-	-	-

PERFORMANCE TESTS

Use operational performance test procedure to quantitatively check all system and functions on the machine.

Purpose of Performance Tests

1. To comprehensively evaluate each operational function by comparing the performance test data with the standard values.
2. According to the evaluation results, repair, adjust, or replace parts or components as necessary to restore the machine's performance to the desired standard.
3. To economically operate the machine under optimal conditions.

Kinds of Tests

1. Base machine performance test is to check the operational performance of each system such as engine, travel, swing, and hydraulic cylinders.
2. Hydraulic component unit test is to check the operational performance of each component such as hydraulic pump, motor, and various kinds of valves.

Performance Standards

"Performance Standard" is shown in tables to evaluate the performance test data.

Precautions for Evaluation of Test Data

1. To evaluate not only that test data is correct, but also in what range the test data is.
2. Be sure to evaluate the test data based on the machine operation hours, kinds and state of work loads, and machine maintenance conditions.

The machine performance does not always deteriorate as the working hours increase. However, the machine performance is normally considered to reduce in proportion to the increase of the operation hours. Accordingly, restoring the machine performance by repair, adjustment, or replacement shall consider the number of the machine's working hours.

Definition of "Performance Standard"

1. Operation speed values and dimensions of the new machine.
2. Operational performance of new components adjusted to specifications. Allowable errors will be indicated as necessary.

PREPARATION FOR PERFORMANCE TESTS

Observe the following rules to perform performance tests accurately and safely.

The Machine

1. Repair any defects and damage found, such as oil or water leaks, loose bolts, cracks etc, before starting to test.

Test Area

1. Select a hard and flat surface.
2. Secure enough space to allow the machine to run straight more than 20 m (65 ft 7 in), and to make a full swing with the front attachment extended.
3. If required, rope off the test area and provide signboards to keep unauthorized personnel away.

Precautions

1. Before starting to test, agree upon the signals to be employed for communication among coworkers.
Once the test is started, be sure to communicate with each other using these signals, and to follow them without fail.
2. Operate the machine carefully and always give first priority to safety.
3. While testing, always take care to avoid accidents because of landslides or contact with high voltage power lines. Always confirm there is sufficient space for full swings.
4. Avoid polluting the machine and the ground with leaking oil. Use oil pans to catch escaping oil. Pay special attention to this when removing hydraulic pipings.

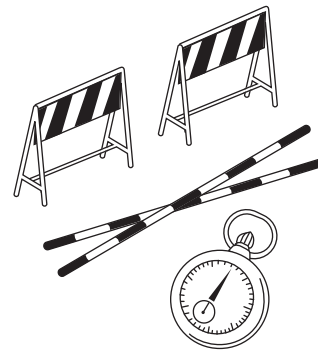


Figure 3

EX1302009

Make Precise Measurement

1. Accurately calibrate test instruments in advance to obtain correct data.
2. Perform tests under the exact test conditions prescribed for each test item.
3. Repeat the same test and confirm that test data obtained can be produced repeatedly. Use mean values of measurements if necessary.

OPERATIONAL PERFORMANCE STANDARD TABLE

Item	Model		Unit	Measuring Conditions	Performance Standard
Engine Speed	No Load	Power+ Mode	rpm	SPC Off	1,850 ±25
			rpm	SPC Off + A/I On	1,800 ±25
		Power Mode	rpm	SPC Off	1,700 ±25
		Standard Mode	rpm	SPC Off	1,650 ±25
		Economy Mode	rpm	SPC Off	1,600 ±25
		Low Idle	rpm	-	800 ±25
	Load (P+ Mode SPC Off)	1 Pump Relief	rpm	*Standard	above 1,800
		2 Pump Relief	rpm		above 1,800
	Revolution at Boom Up or Arm Dump	Power+ Mode	rpm	Dial Max. SPC Off	above 1,800
			rpm		1,680 ±25
		Standard Mode	rpm		1,630 ±25
		Economy Mode	rpm		1,580 ±25
		1300 rpm (Power+)	rpm	Adjust Dial, SPC Off	1,280 ±25
		Low	rpm	Dial Min.	Should not stop engine
Auto Idle	above Ambient Temp. 10°C	rpm	A/I On	800 ±30	
	below Ambient Temp. 10°C	rpm		800 ±30	
Fan Revolution Speed	High Idle	rpm	*Standard	1,388 ±50	
EPOS	EPPR Valve Current for Pump	Power+ Mode	mA	SPC Off Minimum Value at Arm Crowd	200 ±30
		Power Mode	mA		230 ±30
		Standard Mode	mA		280 ±30
		Economy Mode	mA		320 ±30
		Auto Idle	mA	Idle	650 ±30
		Low Idle	mA		700 ±30
Pressure Set	Main	Relief	bar	*Standard	323 +10
		Relief Power Up	bar		343 +10
	Swing	Relief (at Motor) (ΔP)	bar	*Standard	289 +10
		Relief (at Pump)	bar		305 +10
	Option	Relief (at Pump)	bar	*Standard 1 Pump Max. Flow	280 (Two-way) 80 (Rotating) ±25
	Front Speed	Boom	Up	sec	*Standard
Down			sec	5.3 ±0.5	
Arm		Crowd	sec	3.4 ±0.3	
		Dump	sec	5.5 ±0.6	
Bucket		Crowd	sec	2.8/2.1 (2 speed)	
		Dump	sec	4.7/4.0 (2 speed)	

Item	Model		Unit	Measuring Conditions	Performance Standard
Swing	Swing Speed	Swing Speed	sec	*Standard, Swing Single 3 Revolution, (SPC Off)	18.5 ±1.9
	Swing Coasting	Swing Coasting	mm	After 360° Swing, Empty Bucket, Bearing Outer Race	1036 (80.4°) ±207
Cylinder	Front (Weight Bucket)	Boom Down	mm/5min	Max. reach posture, bucket crowd posture, weight bucket (1.5 times of bucket capacity) should not be natural lowering at lock valve	below 5
		Arm Crowd	mm/5min		below 5
		Bucket Dump	mm/5min		below 20
Travel	Track Sag	Track Sag	mm	Jack Up Posture	385 ±15
	Travel Speed on Flat (20 m)	1st Gear	sec	*Standard	26.5 ±2.7
		2nd Gear	sec		17.5 ±1.8
	Jack-up (3 turns)	1st Gear	sec	*Standard	40.8 ±4.1
		2nd Gear	sec		26.8 ±2.7
	Travel Deviation (20 m)	1st Gear	mm	*Standard	below 150
		2nd Gear	mm	Forward/Reverse Each	below 150
	Hydraulic Fan	Max. Performance	Current	mA	*Standard
Fan Speed			rpm	1,300 +50	
Fan Motor Pressure			bar	100 ±5	
Min. Performance (A/C On)		Current	mA	300 ±30	
		Fan Speed	rpm	880 +50	
		Fan Motor Pressure	bar	36.7 ±5	
Min. Performance (A/C On)		Current	mA	500 ±30	
		Fan Speed	rpm	620 +50	
		Fan Motor Pressure	bar	10 ±5	

- Standard Condition: P Plus Mode, SPC On, Engine Dial Max. Auto Idle Off, Air Conditioner Off, Digging Mode, Oil 50 ±10°C, Coolant 80 +10°C

OPERATIONAL PERFORMANCE TEST

Hydraulic Cylinder Cycle Time

Summary

1. Check the overall operational performance of the front attachment hydraulic system (between the hydraulic pumps and each cylinder) by measuring the cycle time of the boom, arm, bucket, and bucket dump (open/close) cylinders with the empty bucket.
2. Bucket must be empty.

Preparation

1. Maintain the hydraulic oil temperature at $50 \pm 5^{\circ}\text{C}$ ($122 \pm 41^{\circ}\text{F}$).

Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
High Idle	Power Plus Mode	Digging Mode	OFF

2. Position the front attachment as described in the following. Then, measure the operating time until cylinder reaches the stroke end by fully moving the control lever.

A. Boom cylinder

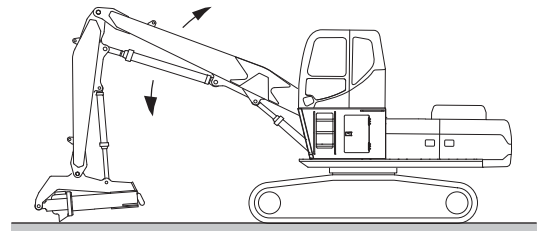
- 1) Boom up speed

Rapidly operate the bucket from the ground, and measure the time it takes for the boom to reach the end point.

- 2) Boom down speed

Rapidly operate the bucket with the boom reached the end point, and measure the time it takes for the bucket to reach the ground.

- 3) Measuring available displacement of the cylinder: Measure and record the extension of the cylinder rod from when the bucket is resting on the ground to when the boom cylinder is extended to its maximum length.



EX1505001

Figure 4

B. Arm cylinder

1) Arm crowd speed

Rapidly operate the arm while kept fully dumped (extended), and measure the time it takes for the arm to fold fully.

2) Arm dump speed

Rapidly operate the arm maintained in the fully folded position, and measure the time it takes for the arm to extend fully.

3) Measuring available displacement of the cylinder: Measure and record the extension length of the cylinder rod from the point at which the arm cylinder is fully extended (crowded) to the point at which the arm cylinder is fully folded (dumped).

C. Bucket cylinder

1) Bucket crowd speed

Rapidly operate the bucket while fully dumped (extended), and measure the time it takes for the bucket to fold fully.

2) Bucket dump speed

Rapidly operate the bucket while fully folded, and measure the time it takes for the bucket to extend fully.

3) Measuring available displacement of the cylinder: Measure and record the extension length of the cylinder rod from the point at which the bucket cylinder is fully extended (crowded) to the point at which the bucket cylinder is fully folded (dumped).

NOTE: Jack up the dozer of the wheel-type excavator and mini-excavator pointing forward, and measure the time taken to jack it up and to jack it back down. Measure and record the operating time of the boom swing (option) of the mini-excavator from right to left, or from left to right.

NOTE: Record the details of any abnormal noise heard during measurement, or any abnormal conditions observed during operation, on a blank measurement record sheet.

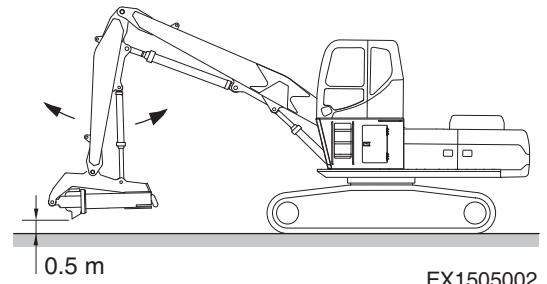


Figure 5

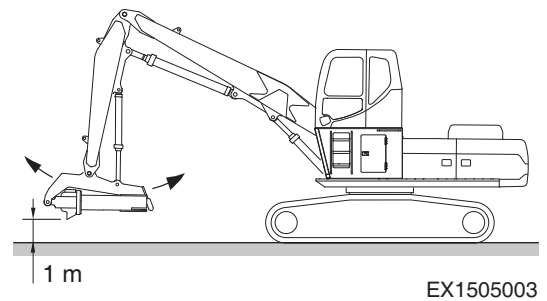


Figure 6

Travel Speed

Summary

Measure the time required for the excavator to travel a 20 m (65.6 ft) test track.

Preparation

1. Adjust the track sag on both side tracks equally.
2. Prepare a flat and solid test track 20 m (65.6 ft) in length with extra length of 3 ~ 5 m (9.8 ~ 16 ft) on both ends for machine acceleration and deceleration.

IMPORTANT

The bucket teeth will hit the boom if the bucket is rolled-in with the arm fully rolled-in.

As for this condition: arm fully rolled-in + bucket fully rolled-in, set the bucket at fully rolled-in and a perform arm roll-in operation.

3. Hold the bucket 0.3 ~ 0.5 m (12 ~ 20 in) above the ground with the arm and bucket rolled-in.
4. Maintain the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$ ($122 \pm 41^\circ\text{F}$).

Measurement

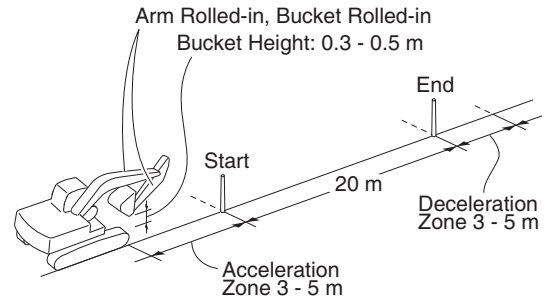
1. Measure both the slow and fast speeds of the machine.
2. Measurement conditions are as below.

Travel Mode Switch	Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	High Idle	Power Plus Mode	Digging Mode	OFF
High Mode	High Idle	Power Plus Mode	Digging Mode	OFF

3. Start traveling the machine in the acceleration zone with the travel levers to full stroke.
4. Measure the time required to travel 20 m (65.6 ft)
5. After measuring the forward travel speed, turn the upper structure 180° and measure the reverse travel speed.
6. Perform the measurement three times and calculate the average values.

Evaluation

Refer to "Operational Performance Standard Table" on page -18.



EX1301767

Figure 7

Track Revolution Speed

Summary

Measure the track revolution cycle time with the track raised off ground.

Preparation

1. Adjust the track sag of both side tracks to be equal.
2. Put the mark on the track to be measured, by using a piece of chalk.
3. Swing the upper structure 90° and lower the bucket to raise the track off ground. Keep the boom-arm angle between 90 ~ 110° as shown place blocks under the machine frame.



CAUTION

AVOID INJURY

Secure support the raised track using wooden blocks.

4. Maintain the hydraulic oil temperature at 50 ±5°C (122 ±41°F).

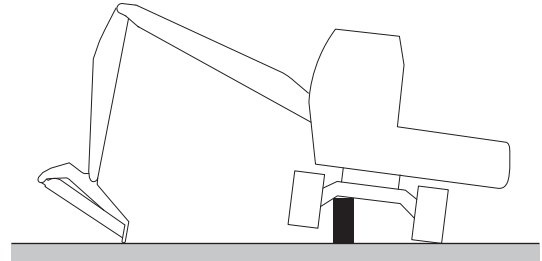
Measurement

1. Measure the both tracks on forward and reverse directions at each travel mode.
2. Measurement conditions are as below.

Travel Mode Switch	Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	High Idle	Power Plus Mode	Digging Mode	OFF
High Mode	High Idle	Power Plus Mode	Digging Mode	OFF

3. Operate the travel control lever of the raised track to full stroke.
4. Measure the time required for 3 revolutions in both directions after a constant track revolution speed is obtained.
5. Perform the measurement three times and calculate the average values.

NOTE: Record the details of any abnormal noise heard during measurement, or any abnormal conditions observed during operation, on a blank measurement record sheet.



EX1300535

Figure 8

Evaluation

Refer to "Operational Performance Standard Table" on page -18.

NOTE: *The measurement data obtained through the raised track revolution test may have wide variations. Therefore, the evaluation based on the results obtained from the 20 m travel speed check described before is more recommendable.*

Mistrack Check

Summary

1. Allow the machine to travel 20 m (65.6 ft). Measure the maximum tread deviation from the tread chord line drawn between the travel start and end points to check the performance equilibrium between both sides of the travel device systems (from the main pump to the travel motor).
2. If measured on a concrete surface, the tread deviation has a trend to decrease.

Preparation

1. Adjust the track sag of both tracks to be equal.
2. Provide a flat, solid test yard 20 m (65.6 ft) in length, with extra length of 3 - 5 m (9.8 - 16 ft) on both ends for machine acceleration and deceleration.

IMPORTANT

The bucket teeth will hit the boom if the bucket is rolled-in with the arm fully rolled-in.

As for this condition: arm fully rolled-in + bucket fully rolled-in, set the bucket at fully rolled-in and a perform arm roll-in operation.

3. Hold the bucket 0.3 - 0.5 m (12 - 20 in) above the ground the arm and bucket rolled-in.
4. Maintain the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$ ($122 \pm 41^\circ\text{C}$).

Measurement

1. Measure the amount of mistracking in both fast, and slow travel speeds.
2. Measurement conditions are as below.

Travel Mode Switch	Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
Low Mode	High Idle	Power Plus Mode	Digging Mode	OFF
High Mode	High Idle	Power Plus Mode	Digging Mode	OFF

3. Start traveling the machine in the acceleration zone with the travel levers at full stroke.

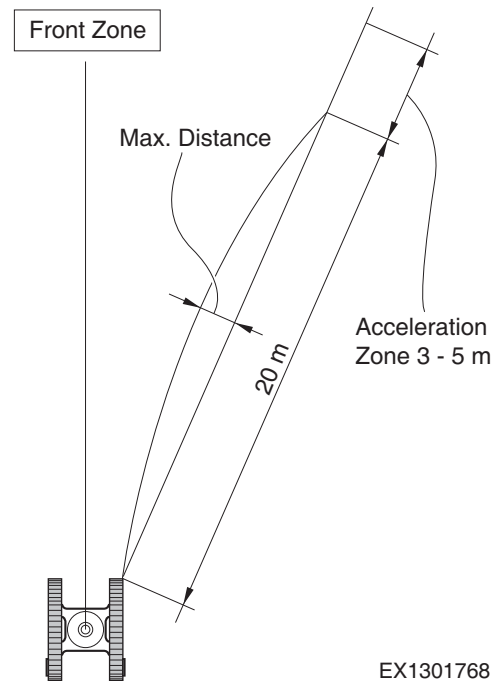


Figure 9

EX1301768

4. Measure the maximum distance between a straight 20 m (65.6 ft) tread chord line and the tread made by the machine.
5. After measuring the tracking in forward travel, turn the upper structure 180° and measure in reverse travel.
6. Perform the measurement three times and calculate the average values.

Evaluation

Refer to "Operational Performance Standard Table" on page -18.

Swing Speed

Summary

Measure the time required to swing three complete turns.

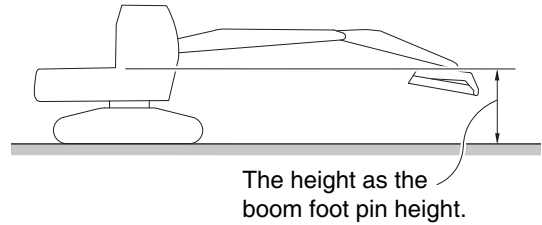
Preparation

1. Check the lubrication of the swing gear and swing bearing.
2. Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on slopes.
3. With the heel empty, position the front attachment as follows.

With the arm cylinder fully retracted, and the heel cylinder fully extended, raise the boom so heel pin height is flush with the boom foot pin height.

NOTE: *In case of no place to be measured, measure with the boom raised and the arm rolled-in.*

4. Maintain the hydraulic oil temperature at $50 \pm 5^{\circ}\text{C}$ ($122 \pm 41^{\circ}\text{F}$).



EX1505004

Figure 10



CAUTION

AVOID INJURY

Prevent personal injury. Always make sure that area is clear and that co-workers are out of the swing area before starting the measurement.

Measurement

1. Measurement conditions are as below.

Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
High Idle	Power Plus Mode	Digging Mode	OFF

2. Operate swing control lever fully.
3. Measure the time required to swing 3 turns in one direction. (Record the stopwatch measurement to the second decimal place.)
4. Operate swing control lever fully in the opposite direction and measure the time required for 3 turns.
5. Perform the measurement three times and calculate the average values.

Evaluation

Refer to "Operational Performance Standard Table" on page -18.

Swing Function Drift Check

Summary

Measure the swing drift on the bearing outer circumference when stopping after a 360° full-speed swing.

Preparation

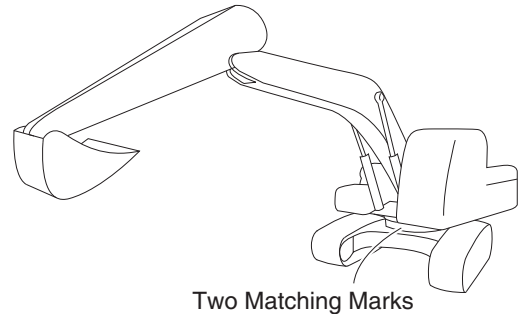
1. Check the lubrication of the swing gear and swing bearing.
2. Place the machine on flat, solid ground with ample space for swinging. Do not conduct this test on a slope.
3. With the bucket empty, position the front attachment as follow.
With the arm cylinder fully retracted, and the bucket cylinder fully extended, raise the boom so bucket pin height is flush with the boom foot pin height.
4. Put the matching marks on the swing bearing and on the track frame by using a tape, as illustrated.
5. Swing the upper structure 360°.
6. Maintain the hydraulic oil temperature at $50 \pm 5 \text{ }^\circ\text{C}$ ($122 \pm 41 \text{ }^\circ\text{F}$).



CAUTION

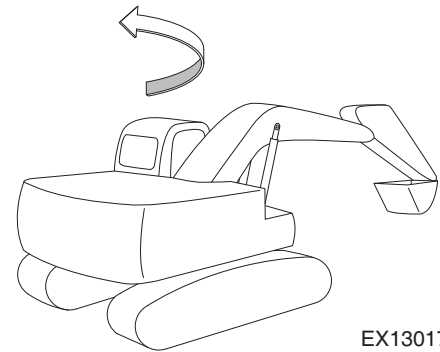
AVOID INJURY

Prevent personal injury. Always make sure that area is clear and that co-workers are out of the swing area before starting the measurement.



EX1301772

Figure 11



EX1301773

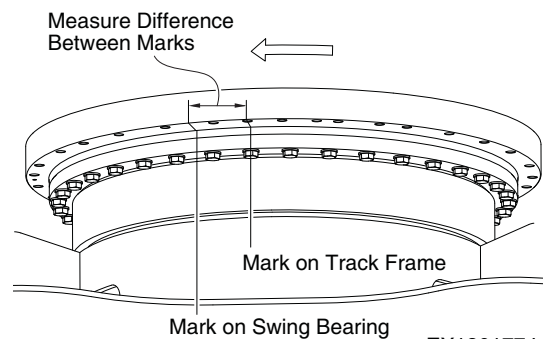
Figure 12

Measurement

1. Measurement conditions are as below.

Engine Control Dial	Power Mode Switch	Work Mode	Auto-idle Switch
High Idle	Power Plus Mode	Digging Mode	OFF

2. Operate swing control lever fully and return it to the neutral position when the mark on upper structure aligns with that on track frame after swinging 360°.
3. Measure the time distance between the two marks.
4. Align the marks again, swing 360°, and then test in the opposite direction.
5. Perform the measurement three times and calculate the average values.



EX1301774

Figure 13

Evaluation

Refer to "Operational Performance Standard Table" on page -18.

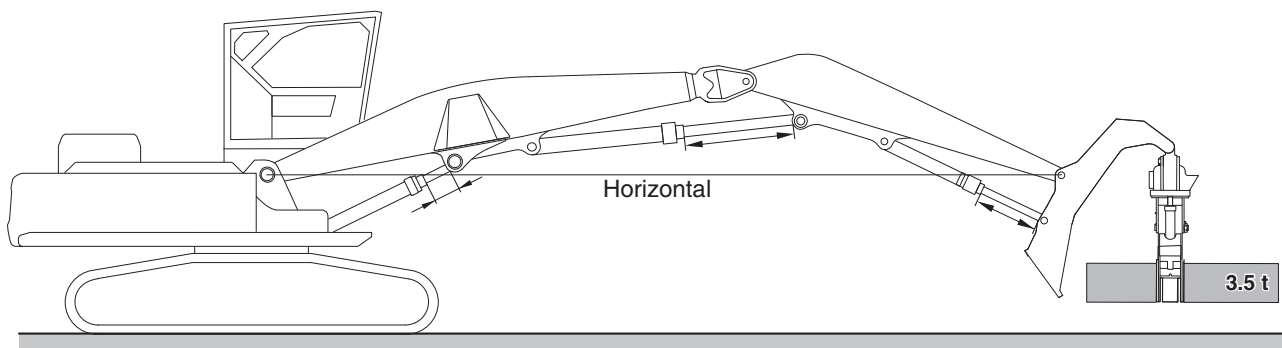
Cylinder Creep

Summary

To define how to measure the drift of each cylinder installed on a log loader's front end and standards to evaluate the measurement.

Preparation

1. Record the model type of the front end mounted on the machine under test. The standard front end type is the basic option for testing.
2. Position the machine on a level ground with a gradient of 1% or below.
3. It is recommended to perform the test indoor but an outdoor test is also possible when conducted at a wind speed of 2 m/s or less.
4. The test should be performed at an ambient air temperature of 20°C (68°F) in principle, but all test results are considered valid as long as they have been made at a hydraulic oil temperature higher than the reference value.
5. Maintain the hydraulic oil temperature at $50 \pm 5^\circ\text{C}$ ($122 \pm 41^\circ\text{F}$).
6. Prepare a tapeline.
7. The machine's posture (Figure 14)
 - A. Heel weight: Additional weight 3.5 ton to heel.
 - B. Position the arm cylinder with the rod 50 mm retracted from the fully extended position.
 - C. Position the heel rack "IN" posture.
 - D. The height of the heel pin is the same as the boom foot pin.

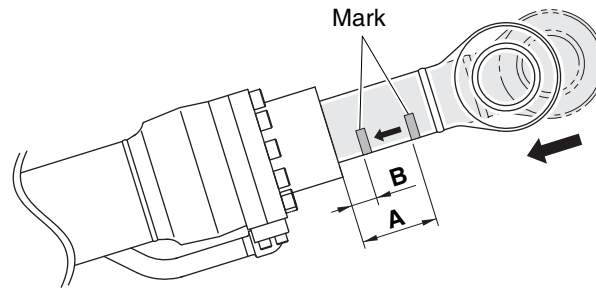


DS1702061

Figure 14 Log loader Posture with the Maximum Reach

Measurement

1. Stop the engine.
2. Before measuring the drift of the cylinder, measure the temperatures of the hydraulic tank and cylinder tube.
3. Mark in appropriate location of the cylinder.
4. Measure the distance A.
5. Wait for 5 minutes.
6. Measure the distance B.
7. Drift value of the cylinder can be calculated as follows:
 - $A - B$
8. After measuring the drift of the cylinder, measure the temperatures of the hydraulic tank and cylinder tube.



<Boom, Arm and Heel Cylinders Retraction "A-B">

Figure 15 How to Measure a Cylinder's Displacement

DS1702062

NOTE: *If the temperature of the hydraulic oil is found out of range for warming up ($50 \pm 5^{\circ}\text{C}/122 \pm 41^{\circ}\text{F}$) on the completion of the test, perform the test once again. And if the drift of a cylinder is measured to be high, measure its holding pressure.*

Evaluation

Refer to "Operational Performance Standard Table" on page -18.

General Maintenance

General Maintenance Instructions

Edition 1

MEMO

Table of Contents

General Maintenance Instructions

Safety Instructions	3-1-5
Welding Precautions and Instructions	3-1-6
Hydraulic System - General Precautions.....	3-1-7
Maintenance Service and Repair Procedure ..	3-1-9
General Precautions.....	3-1-9
Hydraulic System Cleanliness and Oil Leaks..	3-1-10
Maintenance Precautions for Hydraulic System Service	3-1-10
Oil Leakage Precautions	3-1-11
Cleaning and Inspection	3-1-12
General Instructions	3-1-12
Bearing Inspection.....	3-1-13

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.

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 HYUNDAI 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 then 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 filters 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's oil drain line 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 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.*

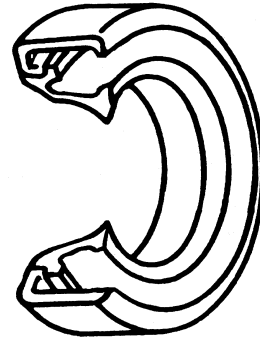


Figure 1

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 installed 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 normal condition.

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.

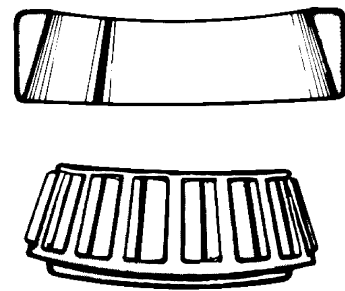


Figure 2

HASA620S

Bent Cage

Cage damage because of improper handling or tool usage.

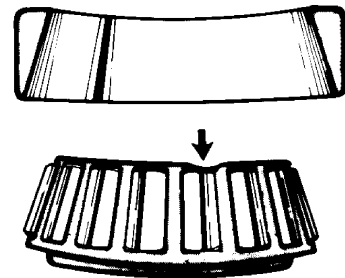


Figure 3

HASA460S

Replace bearing.

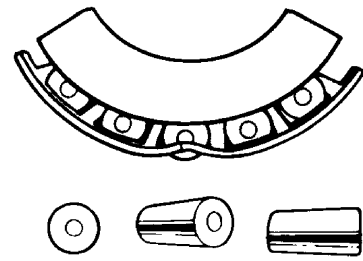


Figure 4

HASA470S

Galling

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

Replace bearing - check seals and check for proper lubrication.

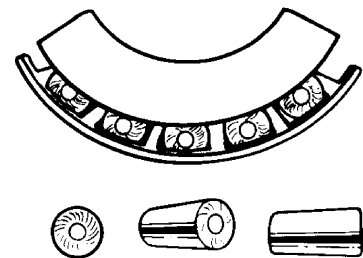


Figure 5

HASA480S

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.

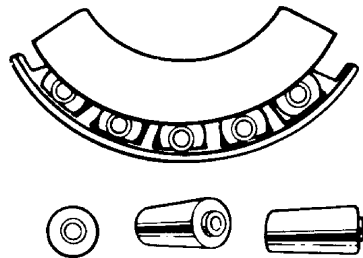


Figure 6

HASA490S

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.

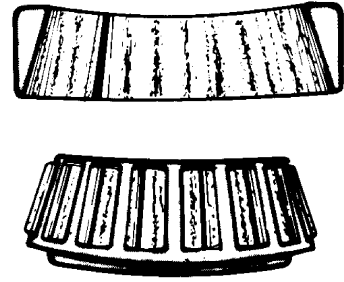


Figure 7

HASA500S

Misalignment

Outer race misalignment because of foreign object.

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

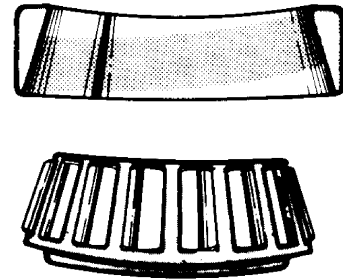


Figure 8

HASA510S

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.

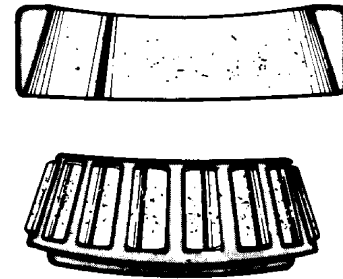


Figure 9

HASA520S

Fatigue Spalling

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.

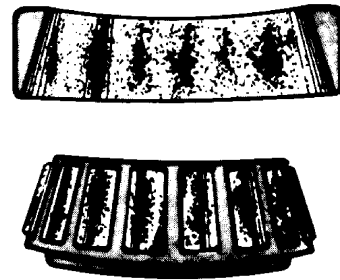


Figure 10

HASA530S

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.

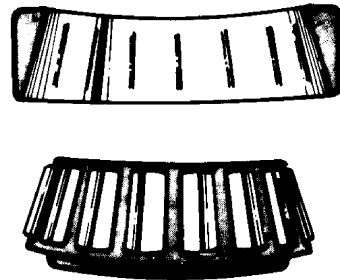


Figure 11

HASA540S

Cage Wear

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

Replace bearings - check seals.

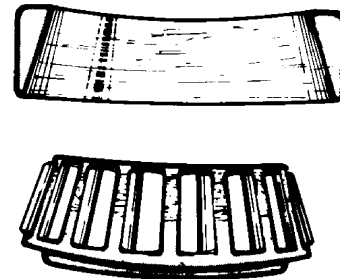


Figure 12

HASA550S

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.

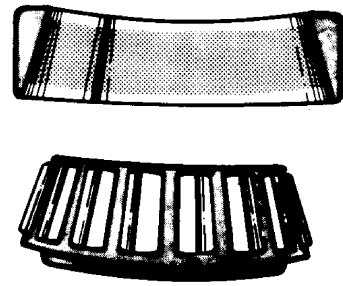


Figure 13

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.

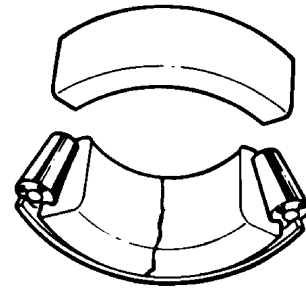


Figure 14

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.

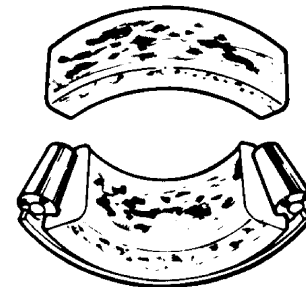


Figure 15

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.

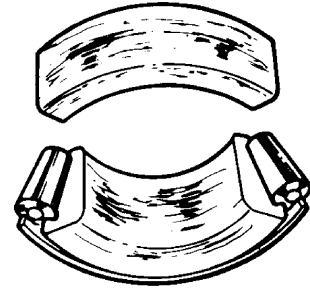


Figure 16

HASA590S

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.

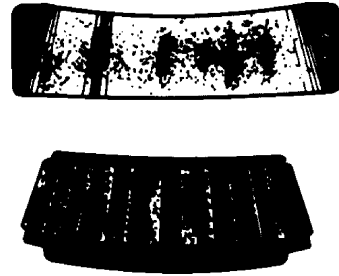


Figure 17

HASA600S

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.

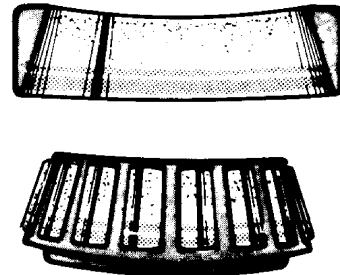


Figure 18

HASA610S

Standard Torques

Edition 1

MEMO

Table of Contents

Standard Torques

Safety Instructions	3-2-5
Torque Values for Standard Metric Fasteners	3-2-6
Torque Values for Standard U.S. Fasteners.....	3-2-7
Type 8 Phosphate Coated Hardware	3-2-9
Torque Values for Hose Clamps	3-2-10
ORFS Swivel Nut Recommended Torque ...	3-2-10
Torque Values for Split Flanges	3-2-11
Torque Wrench Extension Tools	3-2-12
Torque Multiplication	3-2-12
Other Uses for Torque Wrench Extension Tools.....	3-2-13
Tightening Torque Specifications (Metric)	3-2-14

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.

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 (133.81)	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 shoulders should install 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:

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

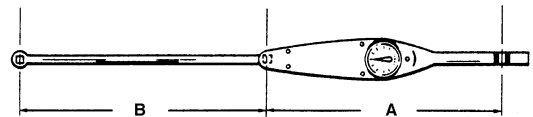


Figure 1

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. HYUNDAI 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 0.762 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.

Engine

Engine

Edition 1

MEMO

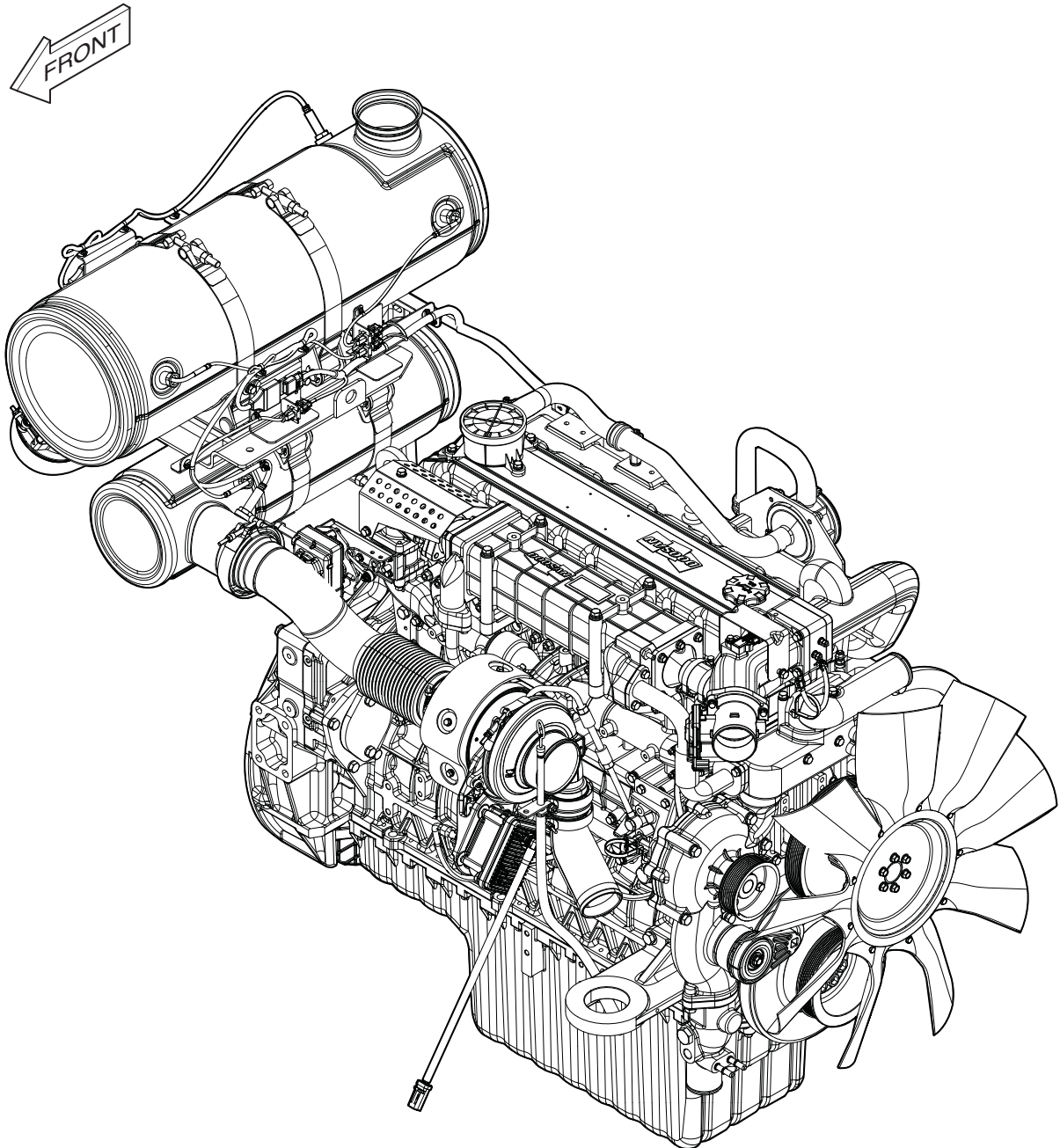
Table of Contents

Engine

Overview.....	4-1-5
General Information.....	4-1-6
General Description.....	4-1-6
Engine Maintenance.....	4-1-10
Inspection and Repair of the Engine.....	4-1-13
Engine Identification.....	4-1-15
Engine Data Plate.....	4-1-15
Engine Specification.....	4-1-17
Engine Performance Curves.....	4-1-18
Special Tools.....	4-1-19
Tightening Torques.....	4-1-23
Major Parts Tightening Torque.....	4-1-23
Tightening Torque for General Bolts.....	4-1-25
Tightening Torque of Plug Screw.....	4-1-26
Hollow Screw (4-Hole) Tightening Torque.....	4-1-26
Engine Disassembly.....	4-1-27
Engine Disassembly Procedure.....	4-1-27
Engine Assembly.....	4-1-42
Engine Assembly Sequence.....	4-1-42
Cylinder.....	4-1-65
General Information.....	4-1-65
Cylinder Head.....	4-1-65
Cylinder Block.....	4-1-70
Valve Mechanism.....	4-1-72
Actuating System.....	4-1-84
Camshaft.....	4-1-84
Piston.....	4-1-86
Connecting Rod.....	4-1-90
Crankshaft.....	4-1-92
Timing Gear.....	4-1-98

Lubrication system.....	4-1-99
General Information.....	4-1-99
Oil Pan.....	4-1-103
Oil Pump.....	4-1-105
Oil Filter	4-1-107
Exhaust System.....	4-1-110
Turbocharger	4-1-110
EGR (Exhaust Gas Recirculation) System.....	4-1-123
DNOx System.....	4-1-130
Cooling System	4-1-141
General information.....	4-1-141
Thermostat	4-1-142
Fuel System.....	4-1-146
General Information.....	4-1-146
Fuel High-pressure System Components	4-1-148
Injector.....	4-1-149
Common Rail.....	4-1-153
Fuel Injection Pump.....	4-1-158
Electrical System	4-1-161
Electrical Parts	4-1-161
Switches and Sensors.....	4-1-163
ECU (Electronic Control Unit).....	4-1-168
Starter.....	4-1-170
Engine Harness.....	4-1-172

OVERVIEW



DS1604230

Figure 1

GENERAL INFORMATION

General Description

This manual provides the most efficient methods for engine maintenance as well as quick, efficient methods to determine the cause of engine faults to ensure that any actions taken by professionally certified maintenance technicians are done in the most efficient and efficient way possible. If maintenance is performed by unskilled technicians, or maintenance without the specified tools and facilities, serious bodily injury or critical faults in engine performance may occur. Regular inspection and maintenance are required to maintain long-term optimal engine conditions and best performance. In the event that a part must be replaced, only genuine parts as defined by the parts the list (Parts Book) should be used. HYUNDAI shall not be held liable for any critical damage or faults which may be caused by the use of unauthorized or remanufactured parts. The maintenance methods stated in this Operation and Maintenance Manual are the most efficient and safest work procedures. Some work procedures require special tools.

For questions about genuine parts and special tools, please contact us.

This manual includes 'Danger', 'Warning', and 'Caution' in order to reduce possible injuries and engine faults which may occur while performing maintenance. If workers do not follow the instructions, critical faults in engine performance and operation or serious bodily injury may occurred. 'Danger', 'Warning', and 'Caution' instructions must be followed. However, we inform you that it is not possible to describe all possible and unexpected dangers which may arise while performing engine maintenance.

Cautions for Starting the Engine

1. Before starting the engine, please read this manual carefully and fully understand 'Danger', 'Warning', and 'Caution'. If you cannot fully understand it or have any question, please contact us.
2. For safety reasons, attach "Warning" signs around engines in operation to keep people other than workers from accessing the engines. Let engine operators know that they are responsible for the safety of the engine room.
3. Only authorized people may start and operate engines. Unauthorized people should not be allowed to handle engines.
4. Do not access running or rotating parts while the engine is in operation.
5. Be careful not to touch or contact the engine during operation since it becomes hot during operation.
6. Exhaust gas is poisonous. Fully ventilate before starting engine. If the space is airtight, ensure that it is well ventilated.

Cautions for Inspection and Repair

1. Inspection and repair of engine should be performed only when the engine is stopped. Otherwise, burns or safety accidents may occur, so do not perform inspection or repair while the engine is running.
2. If it is absolutely necessary to perform inspection or repair on the operating engine, do not get close to the rotating parts.



DANGER

AVOID DEATH

When accessories such as necklaces, rings, watches, or gloves become stuck in rotating parts while the engine is running, serious bodily injury may occur.



WARNING

AVOID DEATH OR SERIOUS INJURY

Do not exchange or disassemble a pipe or hose (from the engine fuel circuit, engine oil circuit, coolant circuit, or compressed air circuit) while the engine is running. The leaked liquid may cause bodily injuries.

3. Use an engine oil drain container that is large enough to prevent the overflow of engine oil while draining engine oil.
 4. Open the engine coolant cap after fully cooling the engine to exchange or replenish coolant.
-



WARNING

AVOID DEATH OR SERIOUS INJURY

If the coolant cap is opened while the engine is still hot, hot water will spurt out and may cause burns. Open the engine coolant cap after fully cooling the engine.

5. Fuel is highly flammable. Smoking or use of fire around an engine may cause fire.
-



WARNING

AVOID DEATH OR SERIOUS INJURY

Only refuel when the engine is stopped.

6. Mark and separately manage the containers for storing coolant from beverage containers for avoiding confusion. See a doctor immediately in case of drinking coolant.
7. Follow the instructions provided by the battery manufacturer when checking or handling batteries.



WARNING

AVOID DEATH OR SERIOUS INJURY

Battery fluid is corrosive and dangerous because of its explosiveness and toxicity. Therefore, it should only be handled by a skilled technician who specializes in battery fluid.

8. Only certified professional technicians should repair and maintain engines.
9. Only appropriate tools should be used. If the jaws of a wrench are worn out, the wrench might slip during use, causing safety accidents.
10. Do not allow other persons to stay or pass under an engine when lifting the engine with a crane. Before lifting the engine, ensure that there is no one around the engine and reserve enough safety space.
11. Before inspecting or replacing the electrical apparatus, disconnect the battery ground wire first. Connect the battery ground wire after completing all required work for checking or replacing the electrical apparatus in order to prevent a short circuit.
12. Before performing electric welding works, turn off engine, block the power supply to the engine, and remove the wire harness connector connected to the engine control unit (ECU).
13. Do not give any electric or mechanical shocks or perform welding works on the electrical apparatus or the ECU.

General Repair

1. Wait until the engine is properly cooled down before starting work, since you may get burned by the heated engine.

Before performing fuel line work, check the common rail pressure and engine temperature by using the failure diagnosis device.
2. Disconnect the battery ground wire from to prevent damage of wires and sensors caused by a short circuit.
3. Engine oil and coolant may damage paint and should be stored in a separate container and marked for safe management.
4. Store the disassembled parts in a specified space to avoid damage or pollution.

5. Use specified and special tools for efficient and safe repair.
6. If parts need to be replaced, use only genuine parts for replacement. Using unauthorized or remanufactured parts may cause critical damage and faults in engine performance.
7. Replace parts such as cotter pins, gaskets, O-rings, seal rings, oil seals, and washers with new ones during repairs. Reuse of parts may be the cause of engine faults and engine may not operate properly.
8. Group and store disassembled parts in disassembling order. The strength, shape, and screw torque of bolts and nuts are different according to their assembly position. Please divide and store them accordingly to these characteristics.
9. Clean disassembled parts to remove foreign substances before inspecting or reassembling parts. Use compressed air to clean the oil holes or holes.
10. Thinly spread oil or grease on rotating parts or parts requiring lubrication, before assembling them.
11. If required, use a specified adhesive to assemble gaskets to prevent water or oil from leaking.
12. Assemble bolts and nuts with the specified tightening torque.
13. After completing repairs, conduct a final inspection and perform a test operation to check if all works have been successfully completed.

Other Safety Instructions and Environmental Pollution

Observe the following instructions to protect workers from danger and to prevent the environmental pollution while performing engine repairs.

1. Good ventilation and low humidity should be maintained in the work space.
2. The workspace should be clean, in good order, and no flammables are allowed in the workshop.
3. Smoking is strictly forbidden in the workshop.
4. Workers should wear working clothes, protective goggles, and safety shoes.
5. Workers are not allowed to wear accessories such as necklaces, rings, watches, and earrings.
6. Start the engine in a well-ventilated space and fully ventilate the space before starting engine to prevent carbon monoxide poisoning.
7. Wait until the engine is properly cooled down before starting work, since you may get burned by the heated engine.

8. Do Not work on rotating or running parts once the engine has been started.
9. Discard oil according to the regulations set forth by the relevant authorities.
10. If engine oil or fuel leaks on the floor or is improperly discharged, serious environmental pollution of sea, river or underground water may occur.
11. Discard the undiluted anticorrosive agent, antifreeze, filter elements, and cartridges as special wastes.
12. Discard coolant and special waste according to the regulations of the appropriate authorities.



WARNING

AVOID DEATH OR SERIOUS INJURY

Failure to observe the regulations of the relevant authorities violates environmental pollution regulations and may be subject to legal penalties.

Use of Genuine Parts

An engine consists of many parts which are mechanically harmonized. To prevent engine faults in advance and use engines with best performance for a long period, maintenance and replacement of expendable parts should be conducted regularly.

Use of genuine parts is recommended. Using unauthorized or remanufactured parts may cause critical damage and faults to engine for which HYUNDAI shall not be held liable.

Engine Maintenance

Prevention of Damage and Abrasion

Using an engine for any purposes other than the designed purpose may cause critical faults in engine performance for which HYUNDAI shall not be held liable. For details concerning the usage and purpose of the engine, please direct questions to our Sales Team. Do not adjust, convert, or change the ECU without our authorization.

If a problem is found in an engine, figure out and solve the cause to prevent the critical faults in advance.

Use of genuine parts is recommended. Using unauthorized or remanufactured parts may cause critical damage and faults to engine for which HYUNDAI shall not be held liable.

Consider the following while managing engines.

1. Use clean, specified, and qualified fuel only. Use fuel recommended in this Operation and Maintenance Manual.



CAUTION

AVOID INJURY

Using inappropriate or unspecified fuel may cause critical damage and faults in engine performance.

2. Do not operate an engine without lubrication oil or coolant. Use only the products (engine oil, cooling water, anticorrosive agent, and etc) recommended by HYUNDAI.
 3. Always keep surroundings of the engine clean.
 4. Use fuel recommended in this Operation and Maintenance manual.
 5. Conduct inspections and exchanges regularly according to the regular inspection table.
 6. If the engine is overheated, do not stop it immediately, but operate it at idle status for five minutes or more to lower the engine temperature to the proper level.
-



WARNING

AVOID DEATH OR SERIOUS INJURY

If the radiator cap is opened while the engine is still hot, hot water will spurt out and may cause burns.

7. Check the engine oil level on a flat surface. Do not exceed the maximum on the oil level gauge.
-



CAUTION

AVOID INJURY

Immediately replenish engine oil when the engine oil level is below the lower limit of the engine oil gauge.

8. If there are gauges for battery, oil pressure and coolant and temperature, check if they indicate a normal status.
 9. Do not operate engine without coolant.
-



CAUTION

AVOID INJURY

Always use coolant mixed with antifreeze. If coolant without antifreeze is used, the coolant may freeze causing the coolant passage in the cylinder block to freeze and damaging the engine.

Prevention of Pollution

Consider the following to manage engine without causing environmental pollution.

1. Discharge oil and coolant using collection containers.
2. Discard oil and coolant according to the regulations of the relevant authorities.
3. Be careful not to let discharged oil and cooling water flow into the ground or the sewer. Otherwise, serious pollution of the drinking water source may occur.
4. Classify the oil, filters, and filter cartridges as environmental pollution wastes and discards them according to regulations.
5. Classify the antifreeze, cooling water, and anticorrosive agent as hazardous wastes and discards them according to the regulations.

Handling of Engine Oil

Prolonged and repeated contact of skin with engine oil may cause skin to dry out and contract, causing dermatitis. Engine oil includes substances toxic to the human body. Handle engine oil by observing the following safety rules:

1. Do not expose skin to new engine oil for a long time.
2. Always wear working clothes and gloves.
3. If skin comes in contact with engine oil, immediately wipe it off with water, soap or hand cleaners.
4. Do not clean skin with gasoline, fuel, thinner, or solvent.
5. Apply a skin protective cream after cleaning from oil.
6. Do not put oil-stained gloves or cloth in ones pocket.



WARNING

AVOID DEATH OR SERIOUS INJURY

Discard oil according to the regulations set forth by the relevant authorities. Disposing of discharged oil into the ground, sewers, drains, rivers, or the sea will cause serious environmental pollution. Violation of regulations regarding discard of engine oil without observing the handling regulations, will be punished.

Inspection and Repair of the Engine

Checking Engine Parts after Prolonged Operation

Wear, corrosion, or degradation of engine elements and assemblies may occur, causing lowered performance of engine parts. To maintain high engine performance, check the engine after prolonged operation to enhance the durability of the engine.

Unexpected faults may occur in some weak engine parts after normal operation of the engine, when operation time is prolonged. In this case, it is difficult to maintain high engine performance by simply repairing some parts. We recommend the entire part be replaced or repaired in order to find out the causes more accurately and maintain high engine performance.

To prevent engine failure in advance and use the engine safely for a long period, perform periodic replacements and inspections.

It is recommended to perform engine adjustments and preventive inspections during spring after the engine was exposed to winter or cold weather. This allows economic, long-term use of the engine without faults. As the following parts affect the engine output and performance, these parts should be regularly checked and inspected.

1. Parts affecting intake and exhaust
 - Air filter
 - Intercooler
 - Turbocharger, muffler
 - EGR cooler and valve
 - Other parts
2. Parts affecting lubrication and cooling
 - Air filter
 - Oil filter
 - Antifreeze
 - Other parts

Inspection and Repair of Turbocharger

As performance of supercharger significantly affects the engine performance, regular inspections and repairs should be performed and inspection and maintenance regulations should be observed.

Intake Unit

Be careful when handling the air filter in the intake unit. If oil level of the wet air filter is below the specified level, filtering performance is degraded. On the other hand, if the oil level is higher, oil may flow into the case, and it may become polluted. In regards to the dry air filter, intake resistance should be small to ensure the smooth intake of air.

Exhaust Unit

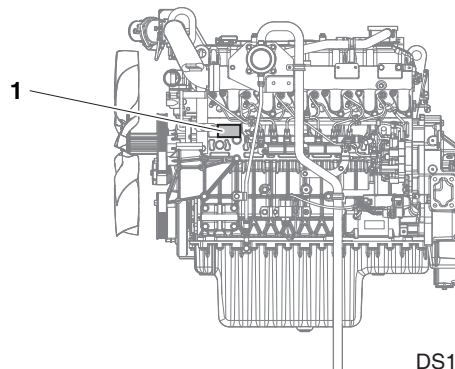
If exhaust emission is leaked from the part connecting the exhaust tube and the turbocharger, the supercharger efficiency is lowered, causing degraded engine output and, if serious, burning of related parts. As parts related to exhaust and turbocharger are used at high temperature, be careful not to mix the bolts and nuts with other parts when performing repair.

Lubrication System

Inspection and replacement of the lubrication system should be performed according to the replacement schedule of oil and oil filter. Overheated engine oil can affect not only the engine itself, but also the engine performance.

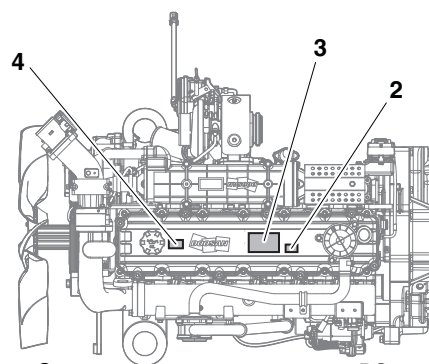
ENGINE IDENTIFICATION

Engine Data Plate



DS1604231

Figure 2



DS1604232

Figure 3

1. Engine Numbering

This decal indicates the model name and suffixes that contain the engine's information.

See Figure 2 for information on each set of numbers.

2. Quality Inspection Decal

This decal displays a barcode for checking the engine's basic information and quality data.

3. Emission Label

This decal shows information on the region's emission regulations.

4. Engine Oil

This decal specifies oil specification applicable to the engine.

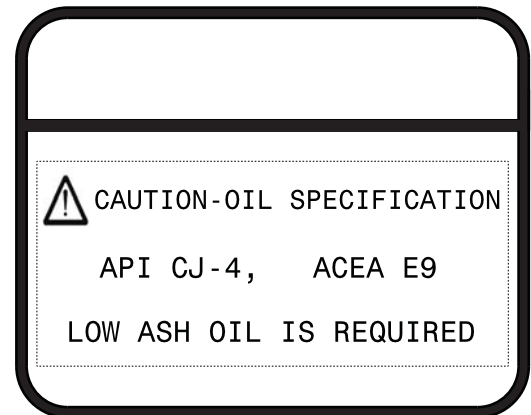


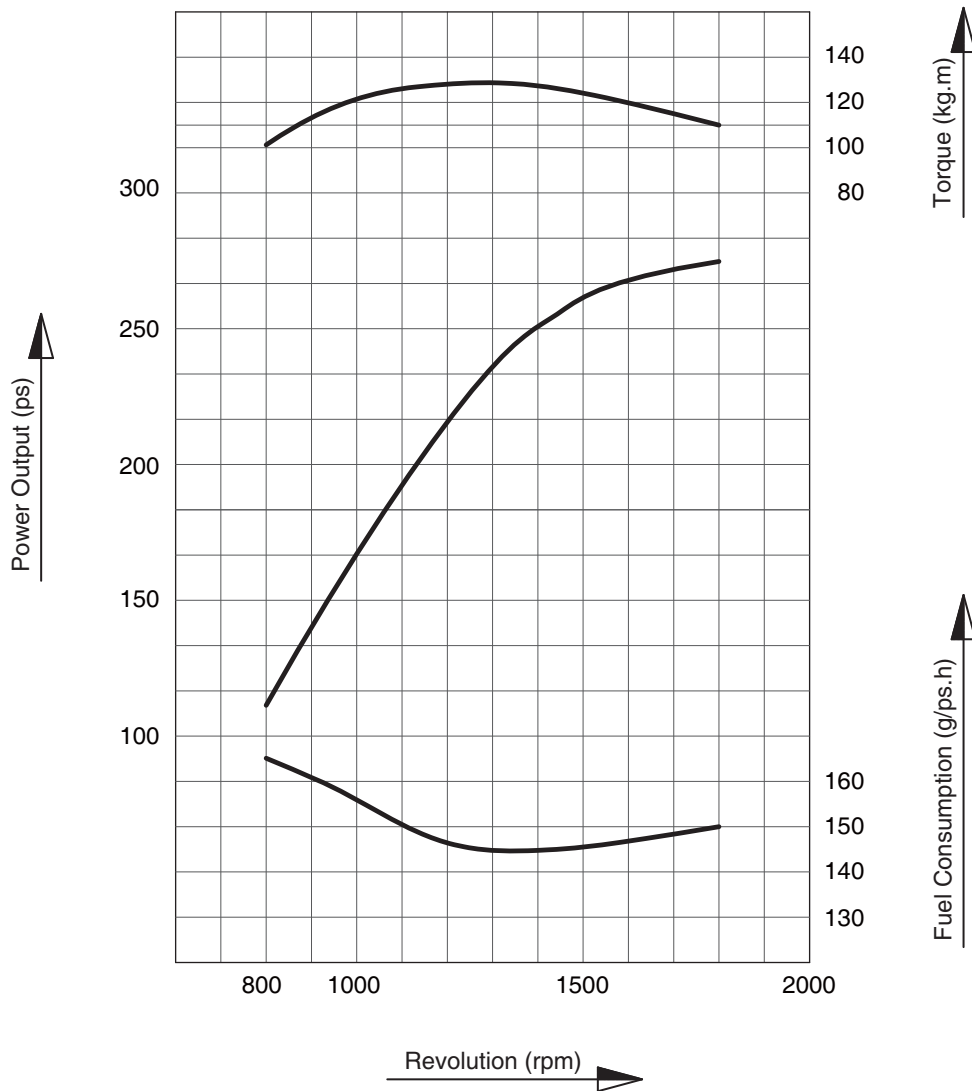
Figure 8

EX1403509

ENGINE SPECIFICATION

Items		Specification
Engine	Type	4-Cycle, Water Cooled, Turbocharge, Direct Injection, EGR
	Emission	US EPA Tier 4 Final (EU Stage IV)
	Model	DL08P
	Injection System	Extra High-pressure Fuel Injection System
	Rated Power	271 HP (275 PS) @ 1,800 rpm (SAE J1995)
Valve Clearance	Intake Valve	0.3 mm
	Exhaust valve	0.4 mm
Number of Cylinders and Configuration		6, Straight
Rotating Direction (View From Flywheel)		Counterclockwise
Oil Pressure	Max. Permitted	3 bar (3.1 kg/cm ² , 43.5 psi)
	Min. Permitted at Idling Speed	1.5 bar (1.5 kg/cm ² , 21.7 psi)
Using Lubrication Oil		API CJ-4
Oil Filter Type		Full Flow (Cartridge)
Interval Between Oil Changes		500 h
Working Principle		4 Stoke Engine
Cylinder Diameter		108 mm
Piston Stroke		139 mm
Displacement		7,640 cc
Compression Ratio		17.4:1
Low Idle Speed		800 rpm
High Idle Speed		1,900 rpm
Weight, without Coolant and Oil		855 kg
Cooling System	Volume, Excluding Radiator	13.3 L
	Number of Thermostats	1
	Thermostat, Opening Temperature	83°C
	Thermostat, Fully Open Temperature	95°C
Electrical System	Type	1-pin, 24 V, DC
	Starter Motor (Standard Equipment)	1-pin, 24 V, 6 kW
	Alternator (Standard Equipment)	1-pin, 24 V, 80 A

ENGINE PERFORMANCE CURVES

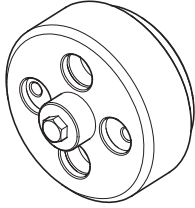
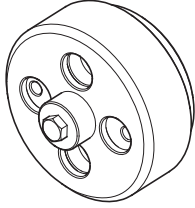
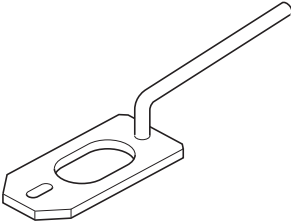
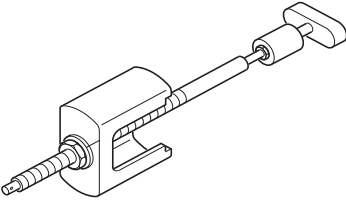
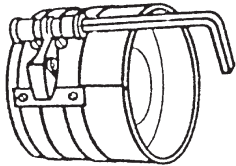


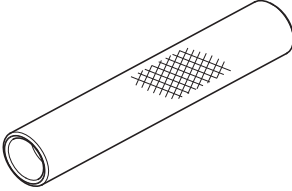
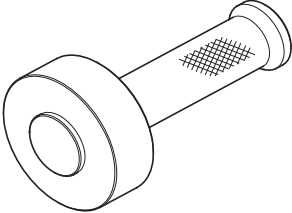
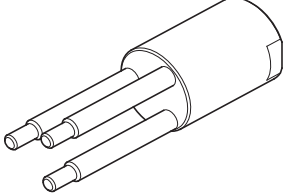
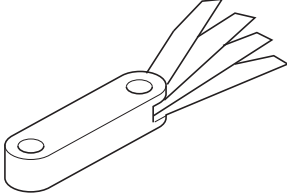
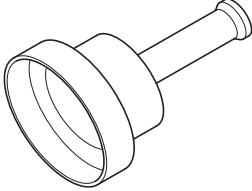
DS1604236

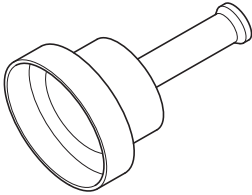
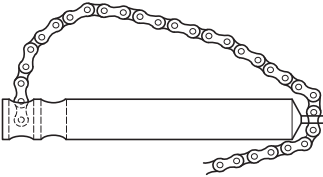
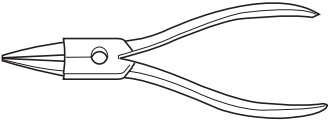
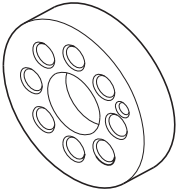
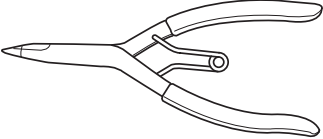
Figure 9

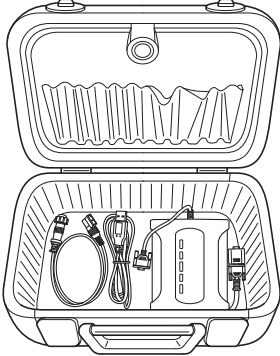
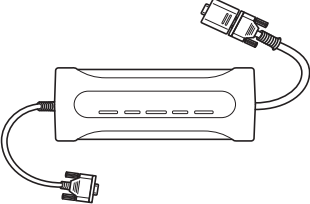
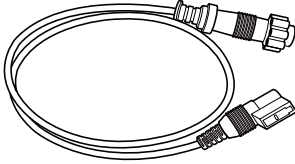
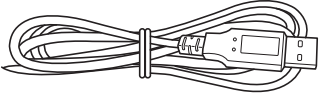
Test Evaluation Standard	KS-R1004
Engine Output (Rated)	271 HP (275 PS, 202 kW)/1,800 rpm
Torque (Max.)	1,275 N.m (130 kg.m, 940 ft lb)/1,300 rpm
Fuel Consumption (Max. Rated)	150 g/ps.hr

SPECIAL TOOLS

Number	Designation	Picture	Tool Board
860104-03982	Oil Seal Installation Jig (Front)	 <p>EX1403581</p>	
860104-03985	Oil Seal Installation Jig (Rear)	 <p>EX1403581</p>	
860104-03391	Valve Spring Compressor	 <p>EX1403582</p>	
EF.123-365A	Cylinder Liner Disassembly Tool	 <p>EX1403583</p>	
EF.120-208	Piston Inserting Tool (for all Engine Models)	 <p>EX1403585</p>	

Number	Designation	Picture	Tool Board
860104-03919	Valve Stem Seal Inserting Tool (for all Engine Models)	 <p>EX1403586</p>	
EF.121-181	Camshaft Hole Cover Punch	 <p>EX1403587</p>	
EF.121-252	Step Idle Gear Pin Installation Jig	 <p>EX1403588</p>	
60.99901-0027	Feeler Gauge	 <p>EX1403589</p>	
860104-03872	Wear Ring Punch (Front)	 <p>EX1403590</p>	

Number	Designation	Picture	Tool Board
860104-03871	Wear Ring Punch (Rear)	 <p>EX1403590</p>	
65.98801-0001	Filter Wrench	 <p>EX1403591</p>	
T7610001E	Snap Ring Pliers	 <p>EX1403592</p>	
EF.121-259	Crankshaft Gear Inserting Jig	 <p>EX1403593</p>	
T7621010E	Piston Ring Pliers	 <p>EX1403732</p>	

Number	Designation	Picture	Tool Board
860104-01045	Diagnostic Device	 <p>EX1403595</p>	
860104-01046	UVIM (CAN Module) (for Diagnostic Device)	 <p>EX1403597</p>	
860104-01047	14-pin Connector (for Diagnostic Device)	 <p>EX1403596</p>	
860104-01048	USB (for Diagnostic Device)	 <p>EX1403598</p>	

TIGHTENING TORQUES

Major Parts Tightening Torque

The specifications in the tables below show the major parts tightening torque for screws, nuts and unions. The values are to be used unless other values are specified in the inspection information. Always check whether there are special tightening torques given in the descriptions for the respective areas in the inspection information before using the general values for normal and special tightening torques respectively.

The following conditions apply:

- A tolerance of $\pm 15\%$ applies to all values unless otherwise specified.
- All contact surfaces are to be clean and free of paint.
- Bolts and nuts are normally not lubricated regardless of surface treatment. All exceptions are specified in the inspection information.

Major Parts	Tightening Torques		
	N.m	kg.m	ft lb
Cylinder Block Bearing Cap Bolt	294.2 \pm 19.6	30 \pm 2.0	217 \pm 14.5
Oil Spray Nozzle	44.1 \pm 5.9	4.5 \pm 0.6	32.5 \pm 4.3
Flywheel Housing Mounting Bolt	109.8 \pm 11.8	11.2 \pm 1.2	81.0 \pm 8.7
Crank Pulley Mounting Bolt	255 \pm 25.5	26.0 \pm 2.6	188.1 \pm 18.8
Shock Absorber	60.8 \pm 4.9	6.2 \pm 0.5	44.8 \pm 3.6
Flywheel Mounting Bolt	255 \pm 63.7	26.0 \pm 6.5	188.1 \pm 47.0
Connecting Rod Cap Bolt	176.5 \pm 17.7	18.0 \pm 1.8	130.2 \pm 13.0
Cylinder Head Bolt	58.8 \pm 90° \pm 90° + 90°	6.0 \pm 90° \pm 90° \pm 90°	43.4 \pm 90° \pm 90° + 90°
Cylinder Head Cover Bolt	30.4 \pm 7.6	3.1 \pm 0.78	22.4 \pm 5.6
Injector Cable Mounting Nut	0.1 ~ 0.2	0.1 ~ 0.2	0.7 ~ 1.4
Rocker Arm Bracket Mounting Bolt	60.8 \pm 10.8	6.2 \pm 1.1	44.8 \pm 8.0
Rocker Arm Adjusting Nut	49.0 \pm 4.9	5.0 \pm 0.5	36.2 \pm 3.6
Oil Pump Cover	21.6 \pm 4.9	2.2 \pm 0.5	15.9 \pm 3.6
Oil Pump Mounting Bolt	21.6 \pm 4.9	2.2 \pm 0.5	15.9 \pm 3.6
Oil Cooler Mounting Bolt	21.6 \pm 4.9	2.2 \pm 0.5	15.9 \pm 3.6
Oil Pan Mounting Bolt	30.4 \pm 7.6	3.1 \pm 0.78	22.4 \pm 5.6
Oil Drain Plug	98.1 \pm 9.8	10 \pm 1.0	72.3 \pm 7.2
Exhaust Manifold Mounting Bolt	58.8 \pm 14.7	6.0 \pm 1.5	43.4 \pm 10.8
Intake Manifold Mounting Bolt	43.1 \pm 10.8	4.4 \pm 1.1	31.8 \pm 8.0
Start Motor	78.5 \pm 19.6	8.0 \pm 2	57.9 \pm 14.5
Alternator Bracket Mounting Bolt	78.5 \pm 19.6	8.0 \pm 2	57.9 \pm 14.5
Engine Mounting Bracket	78.5 \pm 19.6	8.0 \pm 2	57.9 \pm 14.5

Major Parts	Tightening Torques		
	N.m	kg.m	ft lb
Fuel High-pressure Pump Gear Nut (CP Pump)	107.9 +10.8	11.0 +1.1	79.6 +8.0
Fuel Injector Mounting Bracket Bolt	34.3 ±3.4	3.5 ±0.35	25.3 ±2.5
Fuel High-pressure Pump Mounting Bolt (Cylinder Block)	43.1 +10.8	4.4 +1.1	31.8 +8.0
Fuel High-pressure Connector Nut	53.9 ±5.4	5.5 ±0.55	39.8 ±4.0
Common Rail Mounting Bolt	21.6 +5.4	2.2 +0.55	15.9 +4.0
Fuel High-pressure Pipe - High-pressure Fuel Connector	39.2 ±3.9	4.0 ±0.4	28.9 ±2.9
Fuel High-pressure Pipe - Common Rail	39.2 ±3.9	4.0 ±0.4	28.9 ±2.9
Fuel High-pressure Pipe - Fuel High-pressure Pump	39.2 ±3.9	4.0 ±0.4	28.9 ±2.9
Fuel Filter Mounting Bolt	43.1 ±10.8	4.4 ±1.1	31.8 ±8.0

Tightening Torque for General Bolts

Keep the following torque values for bolts not specified in the Tightening Torque for Major Parts table.

Dia. x Pitch (mm)	Hardness										
	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)
	Elastic Limit (kg/mm ²)										
	20	24	32	30	40	36	46	54	64	90	106
Tightening Torque (kg.m)											
M5	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	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	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	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	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	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	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 1.5	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	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 (132.26)	22.00 (158.12)
M16	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	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	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	15.50 (112.11)	16.00 (115.72)	24.50 (177.20)	21.00 (151.89)	30.00 (216.99)	30.00 (216.99)	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	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 1.5	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)

NOTE: The standard torque values specified above are based on 70% of a bolt's elastic limit. The tensile force is calculated by multiplying the tensile strength by the cross-sectional area of a screw. A special screw should be tightened to about 85% of the standard torque. For example, a screw coated with MoS2 should be tightened to about 60% of the standard torque.

Tightening Torque of Plug Screw

M10	M12	M14	M16	M18	M22	M24	M26	M30
5.0	5.0	8.0	8.0	10.0	10.0	12.0	12.0	15.0

Hollow Screw (4-Hole) Tightening Torque

M8	M10	M12	M14	M16	M18	M22	M26	M30	M38
0.8	1.8	3.0	4.0	5.5	6.5	11.0	16.0	20.0	35.0

ENGINE DISASSEMBLY

Engine Disassembly Procedure

CAUTION

AVOID INJURY

- Prepare the necessary tools and genuine parts before engine disassembly.
 - Prepare a shelf to keep removed parts.
 - Keep the working area well lighted and clean.
 - Keep your hands clean at all times during service.
 - Keep parts removed from the engine in the removal order.
 - Make sure that removed parts are not mixed and do not touch each other.
-

Disassemble the engine according to the following procedure:

1. Drain coolant.
 - A. Check that the engine and radiator is sufficiently cooled down.
 - B. Place a container in front of the coolant drain plug.
 - C. Remove the radiator cap.
 - D. Turn to open the drain valve on the bottom of the radiator to drain coolant.
 - E. Remove the coolant drain plugs from the cylinder block.
 - F. Drain coolant into the prepared container.
 - G. After draining coolant, install the drain plug.

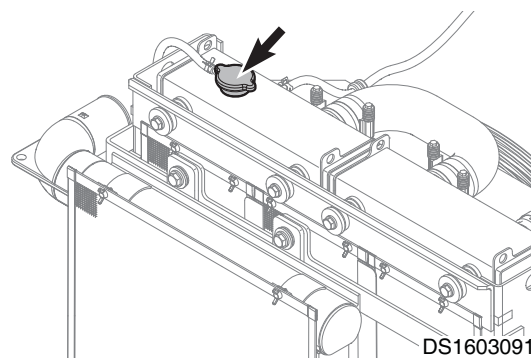


Figure 10

DANGER

AVOID DEATH

- Never open the radiator cap while the engine is hot. If opening the radiator cap while the engine is still hot, hot coolant may spurt, resulting in a severe burn. Open the radiator cap after confirming that the engine is sufficiently cooled down. After draining coolant, install the drain plug.
 - Put a label on the coolant container not to get mixed with other containers. If you swallow coolant, seek professional medical help immediately.
-

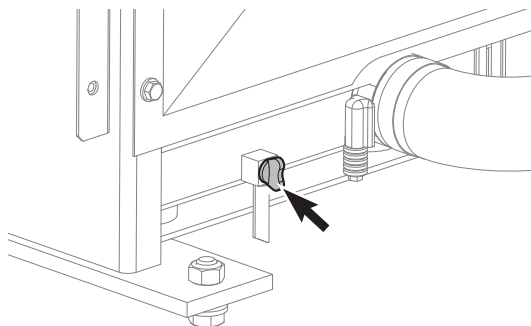


Figure 11



WARNING

AVOID DEATH OR SERIOUS INJURY

Used coolant should be discarded according to the local regulations. Never discard used engine oil to the ground, ditch, sewer, river, sea, etc. Such action can pollute the environment. Discarding used engine oil improperly can result in punishment due to violation of the corresponding regulation.

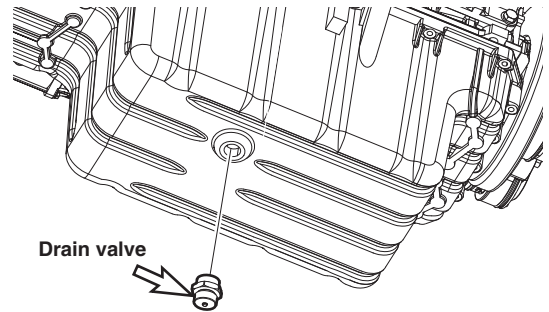


CAUTION

AVOID INJURY

When changing coolant, make sure that it is not left on any belt or electric part.

2. Separate the dipstick.
 - A. Pull out the dipstick.
3. Drain engine oil.
 - A. Place a container under the engine to collect drained engine oil.
 - B. Remove the drain plug from the oil pan and drain engine oil into the prepared container.
 - C. Remove the oil filler cap.
 - D. Remove the engine oil filter.
 - E. After draining engine oil, install the engine oil filter and drain plug.



DS1604049

Figure 12



WARNING

AVOID DEATH OR SERIOUS INJURY

Used oil should be discarded according to the local regulations. Never discard used engine oil to the ground, ditch, sewer, river, sea, etc. Such action can pollute the environment. Discarding used engine oil improperly can result in punishment due to violation of the corresponding regulation.

4. Remove the belt.
 - A. Unscrew the tension adjusting bolts and mounting bolts of the A/C compressor, air compressor and alternator.
 - B. Remove the belt.

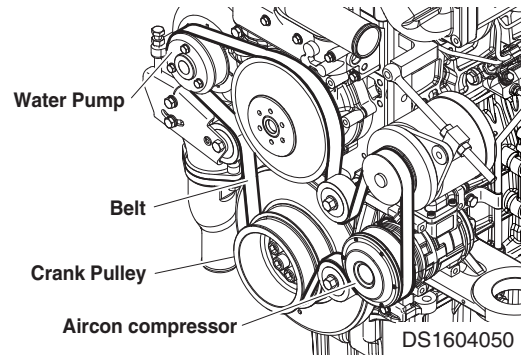


Figure 13

5. Remove the engine from the machine.
6. Disconnect the cables and harnesses of the engine from each sensor.
7. Remove the alternator and A/C compressor.
 - A. Unscrew the mounting bolt to remove the alternator.
 - B. Unscrew the idle puller mounting bolt to remove the A/C compressor.

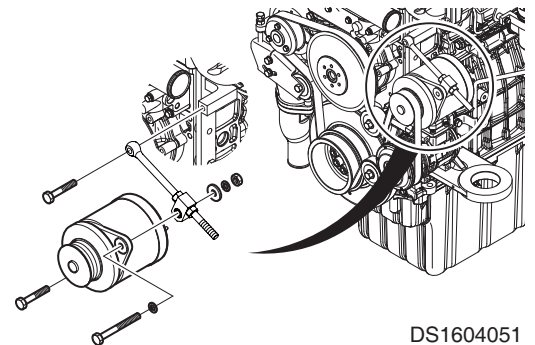


Figure 14

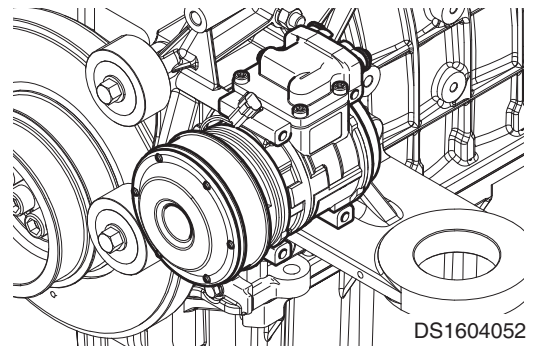


Figure 15

8. Remove the breather.
 - A. Unscrew the mounting clamp screw to disconnect the rubber hose.
 - B. Remove the breather valve assembly.

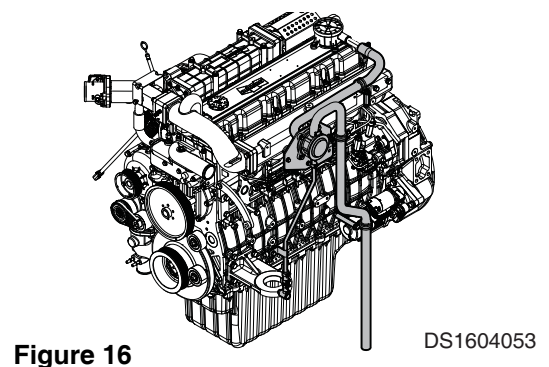


Figure 16

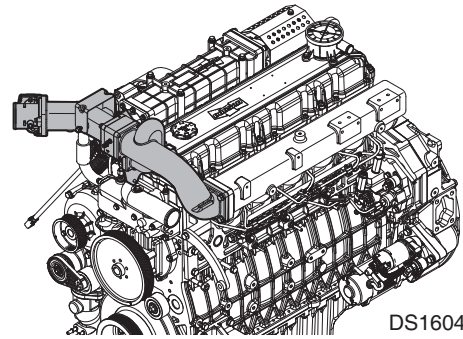
9. Disconnect the air pipe and remove the air heater.
 - A. Unscrew the mounting bolt to disconnect the air pipe and remove the air heater.



CAUTION

AVOID INJURY

Never let foreign materials enter the turbocharger.



DS1604054

Figure 17

10. Remove the fuel filter.
 - A. Unscrew the hollow screw from the fuel filter and disconnect the fuel hose.
 - B. Unscrew the fuel filter mounting bolt to remove the fuel filter.

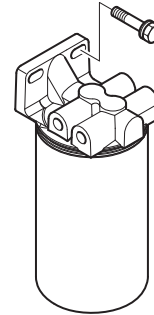
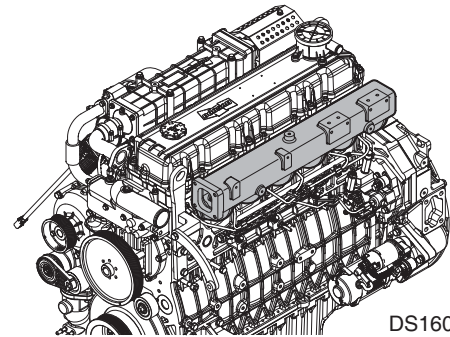


Figure 18

EX1403715

11. Separate the intake manifold.
 - A. Unscrew the intake manifold mounting bolts to remove the intake manifold from the cylinder block.
 - B. Remove the gasket and clean the gasket mounting surface thoroughly with a scraper.



DS1604055

Figure 19

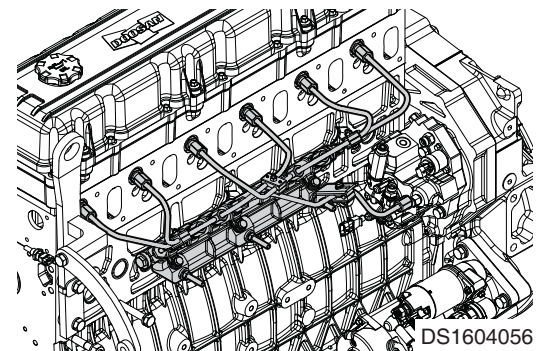
12. Remove the common rail and high-pressure pipe.
 - A. Disconnect the high-pressure pipe between the fuel high-pressure connector and common rail.
 - B. Unscrew the common rail mounting bolts to remove the common rail.



CAUTION

AVOID INJURY

- Seal the common rail thoroughly after removing it to prevent foreign materials from entering it.
 - Once the fuel high-pressure pipe is disconnected, it cannot be reused.
-



DS1604056

Figure 20

13. Remove the fuel high-pressure pump.
 - A. Unscrew the fuel high-pressure pump mounting bolts to remove the fuel high-pressure pump.



CAUTION

AVOID INJURY

Seal the fuel high pressure pump to prevent from mixing foreign material into inside of the fuel.

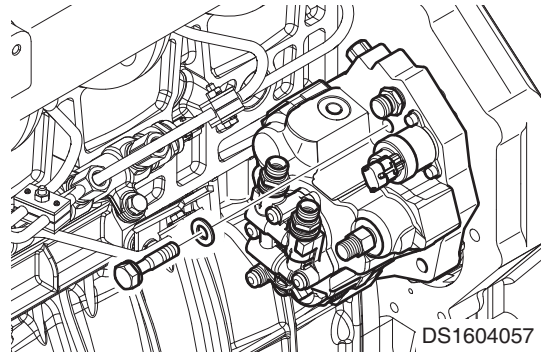


Figure 21

14. Remove the EGR valve.
 - A. Unscrew the EGR valve mounting bolts to remove the EGR valve and exhaust manifold.
 - B. Unscrew the mounting bolts to remove the exhaust pipe from the EGR cooler.
 - C. Disconnect the coolant pipe from the EGR valve.



CAUTION

AVOID INJURY

Seal the EGR valve and exhaust pipe thoroughly after removing them to prevent foreign materials from entering them.

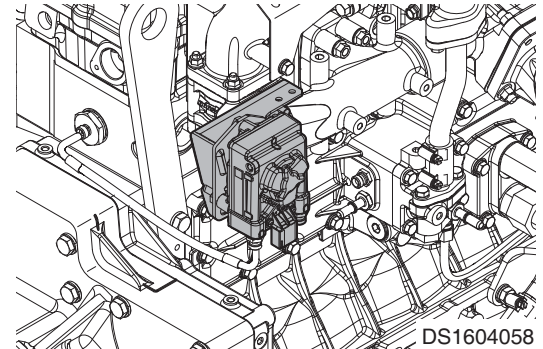


Figure 22

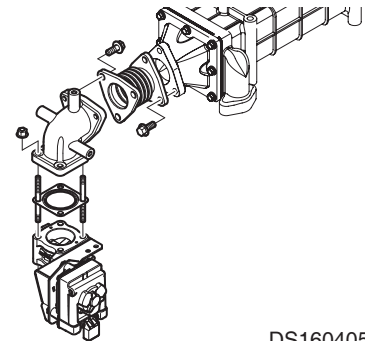


Figure 23

15. Remove the EGR cooler.
 - A. Unscrew the EGR cooler and bracket connecting bolt to separate the EGR cooler.
 - B. Disconnect the pipe and hose from the EGR cooler.



CAUTION

AVOID INJURY

Seal the EGR cooler thoroughly after removing it to prevent foreign materials from entering it.

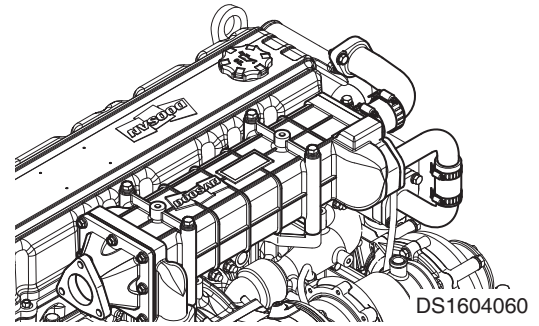


Figure 24

DS1604060

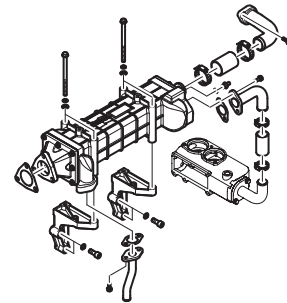


Figure 25

DS1604061

16. Remove the turbocharger.
 - A. Disconnect the intake stake from the turbocharger.
 - B. Disconnect the coolant hose from the turbocharger.
 - C. Disconnect the oil feed pipe and oil drain pipe between the cylinder block and turbocharger.
 - D. Unscrew the turbocharger mounting bolts to separate the turbocharger from the exhaust manifold.

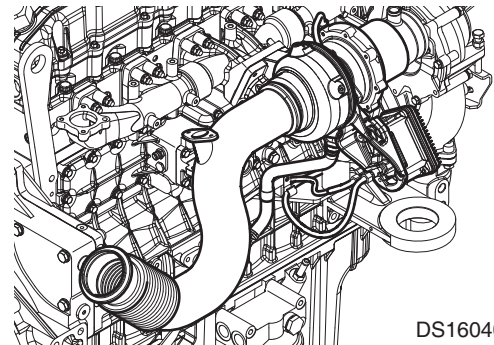


Figure 26

DS1604062

17. Remove the exhaust manifold.
 - A. Unscrew the exhaust manifold mounting bolts to remove the exhaust manifold.



CAUTION

AVOID INJURY

Do not reuse the removed gasket.

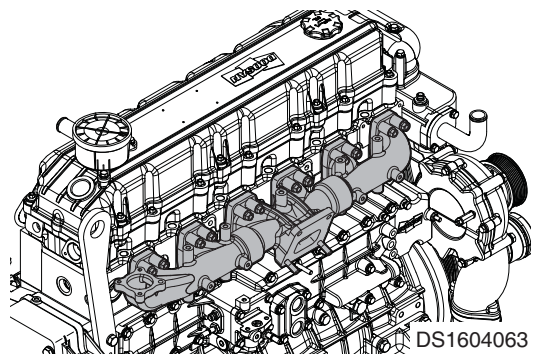


Figure 27

DS1604063

18. Disconnect the coolant pipe and thermostat.
 - A. Unscrew the coolant pipe mounting bolt to disconnect the coolant pipe from the thermostat housing.
 - B. Remove the coolant thermostat and O-ring.
 - C. Clean the gasket mounting surface of the coolant pipe with a scraper thoroughly.



CAUTION

AVOID INJURY

Make sure that the gasket residual does not enter the coolant passage.

19. Remove the coolant pump.
 - A. Unscrew the bracket mounting bolts for the coolant pump and oil cooler.
 - B. Unscrew the bolt (1 ea) for the oil cooler.
 - C. Unscrew the coolant pump mounting bolts to remove the coolant pump.
 - D. Remove the O-ring for the coolant pump.



CAUTION

AVOID INJURY

Do not reuse the O-ring.

20. Remove the start motor.
 - A. Unscrew the start motor mounting nut and remove the start motor with care. Be careful not to damage its gear.

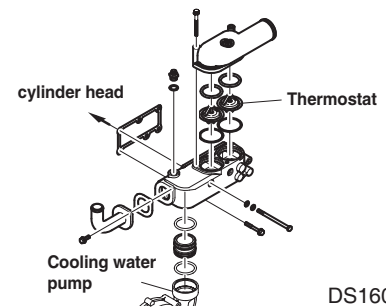


Figure 28

DS1604064

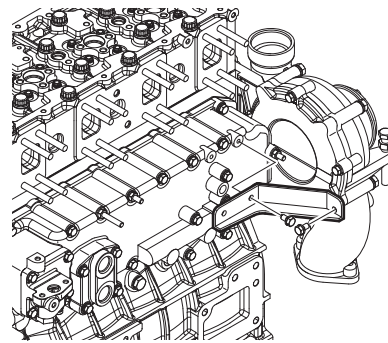


Figure 29

DS1604065

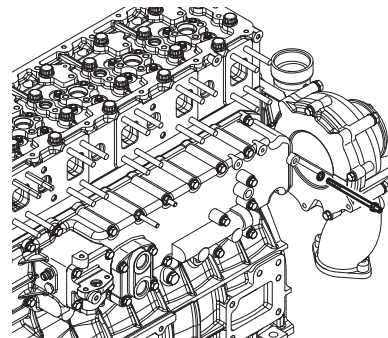


Figure 30

DS1604066

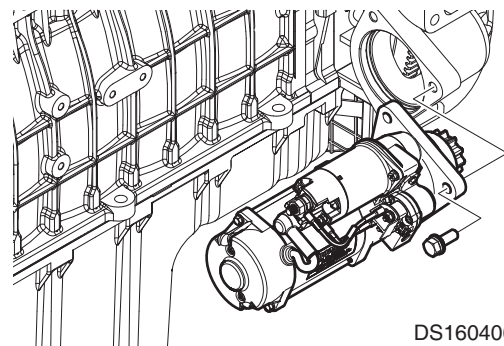
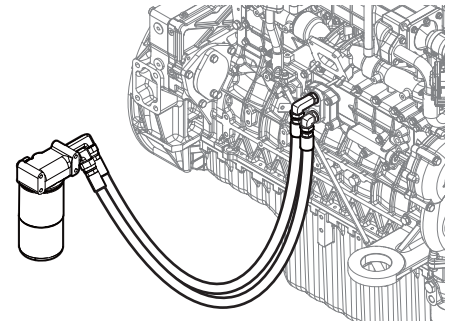


Figure 31

DS1604067

21. Remove the oil filter.

- A. Remove the oil filter cartridge using a special service tool.

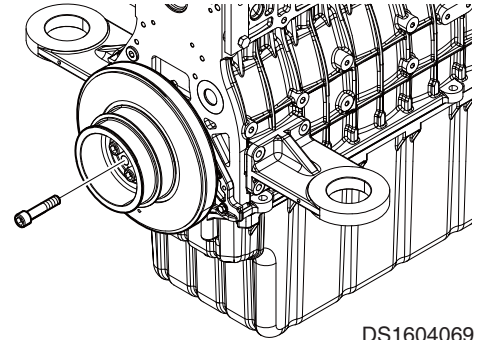


DS1604068

Figure 32

22. Remove the vibration damper.

- A. Unscrew the mounting bolts of the vibration damper and crank pulley in the reverse order to remove the vibration damper assembly.

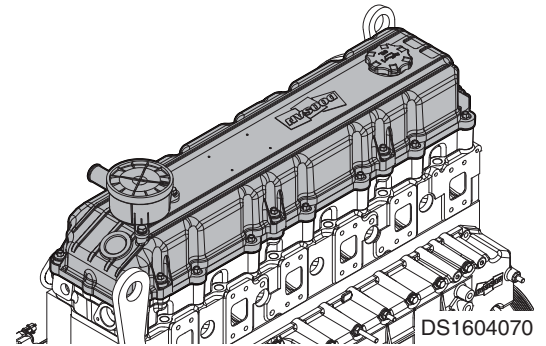


DS1604069

Figure 33

23. Remove the cylinder head cover.

- A. Unscrew the cylinder head cover mounting bolts to remove the cylinder head cover.
- B. Unscrew the intermediate cover mounting bolts to remove the intermediate cover.

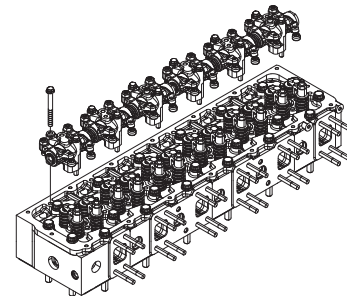


DS1604070

Figure 34

24. Remove the rocker arm.

- A. Unscrew the rocker arm bracket mounting bolts in the reverse order to remove the rocker arm assembly.



DS1604071

Figure 35

25. Remove the push rod.
 - A. Remove the push rod.

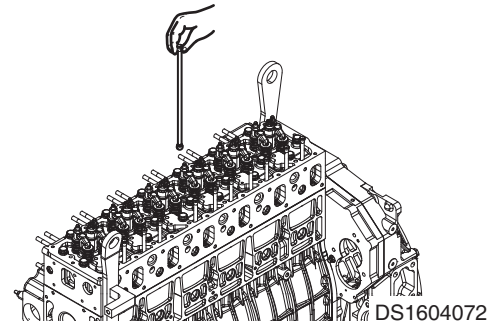


Figure 36

26. Remove the fuel injector.
 - A. Unscrew the fuel high-pressure connector mounting bolts to disconnect the fuel high-pressure connector.
 - B. Remove the harness from the injector.
 - C. Unscrew the injector mounting bracket bolts to remove the injector.

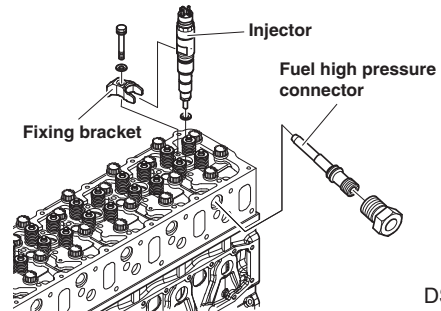


Figure 37

CAUTION

AVOID INJURY

Be careful not to damage the nozzle during removing the injector.

- D. Remove the seal ring from the nozzle hole from the cylinder head.

CAUTION

AVOID INJURY

To remove the injector, unscrew the fuel high-pressure connector mounting nut to disconnect the fuel high-pressure connector completely. Then, unscrew the caliper mounting bolt to remove the injector.

27. Remove the cylinder head.
 - A. Unscrew the cylinder head bolts in the reverse order of tightening to remove the cylinder head.
 - Step 1: Unscrew the bolt for 1 to 2 threads.
 - Step 2: Unscrew the bolt completely to remove it.
 - B. Remove the cylinder head bolts in these two steps.
 - C. Keep the removed bolts in order with care, being careful not to damage their threads.

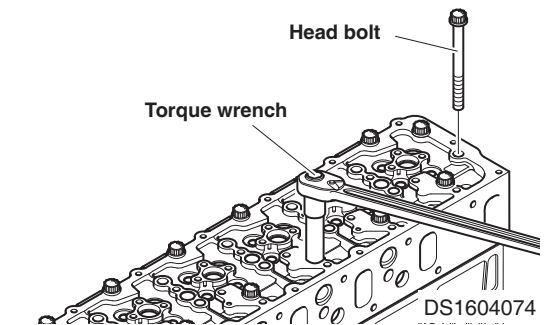


Figure 38



CAUTION

AVOID INJURY

Make sure that the bolts are not hit by each other.

- D. Remove the cylinder head gasket.
 - E. Remove foreign materials from the surface of the cylinder head and block.
-



CAUTION

AVOID INJURY

Be careful not to damage the mating surface.

- F. Unscrew the mounting bolt of the lifting hook from the cylinder head to remove the lifting hook.
28. Remove the valve and valve stem seal.
- A. Press the valve spring and retainer with the valve spring compressor to remove the valve cotter.
 - B. Remove the valve spring and retainer.
 - C. Remove the calipers.
 - D. Use a general service tool to remove the valve stem seal.
-



CAUTION

AVOID INJURY

Do not reuse the valve stem seal.

- E. Remove valve.
- F. Unscrew the mounting bolt of the lifting hook from the cylinder block to remove the lifting hook.

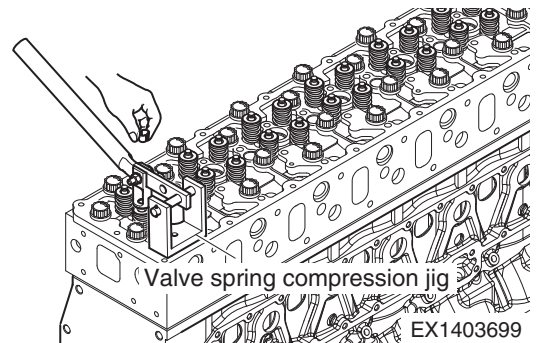


Figure 39

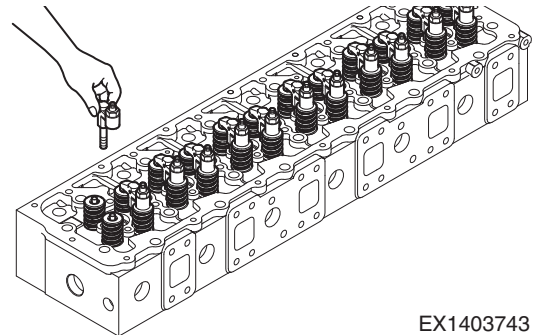


Figure 40

29. Remove the oil cooler.
 - A. Unscrew the oil cooler mounting bolts to remove the oil cooler.

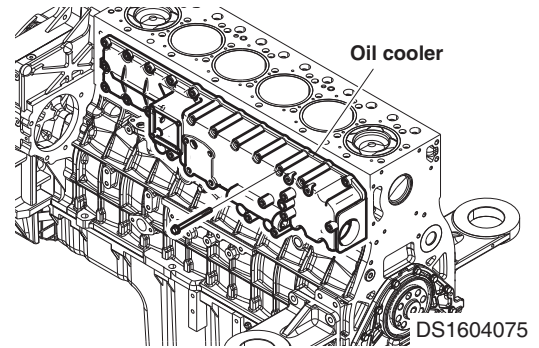


Figure 41

30. Remove the oil pan.
 - A. Unscrew the oil pan mounting bolts to remove the oil pan.
 - B. Remove the oil pan gasket.

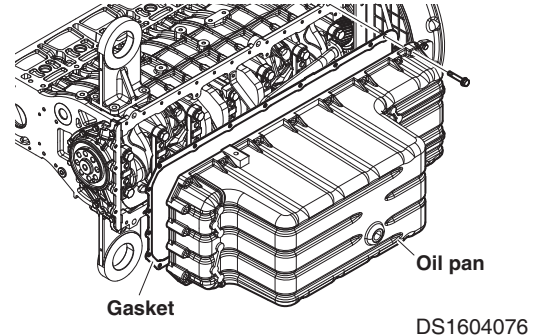


Figure 42

31. Remove the front oil seal and cover.
 - A. Remove the oil seal using a oil seal removing tool.
 - B. Unscrew the gear case cover mounting bolt to remove the oil seal cover.

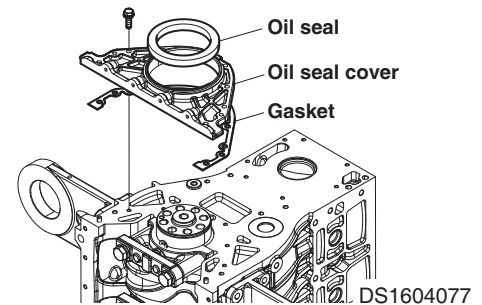


Figure 43

32. Remove the oil pump and disconnect the pipe.
 - A. Unscrew the oil suction pipe mounting bolt to remove the bracket.
 - B. Unscrew the oil pump pipe mounting bolts to disconnect the suction pipe and feed pipe.
 - C. Unscrew the oil pump mounting bolts to remove the oil pump.

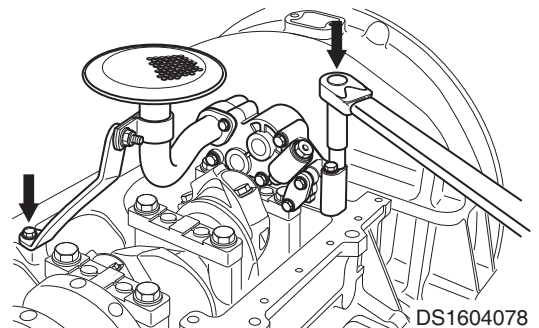
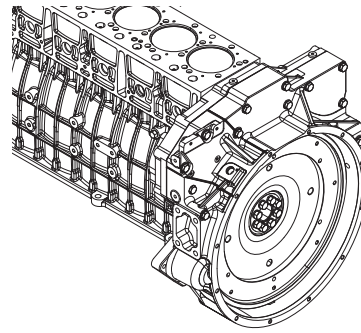


Figure 44

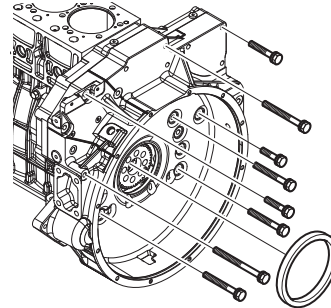
33. Remove the flywheel.
- A. Unscrew the flywheel mounting bolts and install the guide bolt to remove the flywheel.
 - B. Unscrew the bolts in the reverse order of their tightening to remove the flywheel.



DS1604079

Figure 45

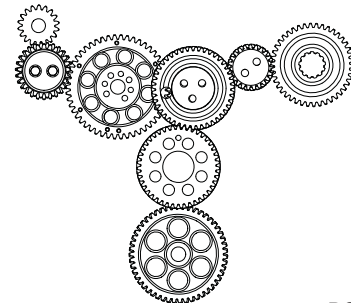
34. Remove the flywheel housing.
- A. Unscrew the flywheel housing mounting bolts to remove the flywheel housing.
 - B. Remove the flywheel housing oil seal.



DS1604080

Figure 46

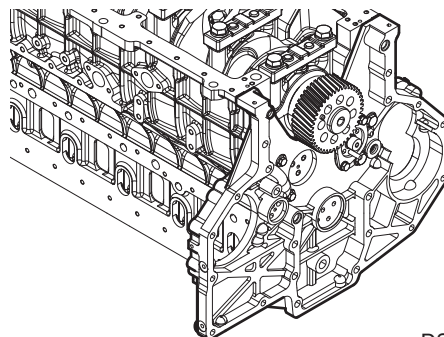
35. Remove the cam gear and idle gear.
- A. Unscrew the camshaft gear mounting bolts to remove the camshaft gear.
 - B. Unscrew the idle gear mounting bolts to remove the idle gear.



DS1604081

Figure 47

36. Remove the timing gear case.
- A. Unscrew the timing gear case mounting bolts.
 - B. Tap the left and right sides on the back of the contact surface of the timing gear case with a urethane hammer gently to remove the timing gear case.



DS1604082

Figure 48

37. Remove the piston and connecting rod.
- Unscrew the connecting rod cap bolts in the reverse order of their tightening.

NOTE: *Unscrew these bolts in two steps as the cylinder head bolts.*
 - Tap the top and bottom of the connecting rod cap with a urethane hammer lightly to remove the bearing cap and bearing.
 - Push the connecting rod from the oil pan side toward the cylinder head with a wooden stick to separate the piston assembly.
 - Keep the removed pistons in the corresponding cylinder order and make sure that they are not hit by each other.
 - Install the connecting rod caps to their corresponding connecting rods loosely. Be careful not to mix them.

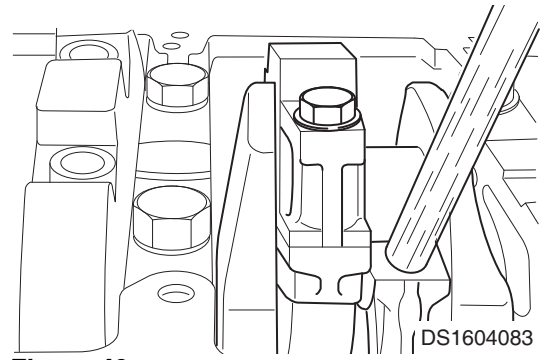


Figure 49

DS1604083

38. Remove the piston.
- Remove the snap ring of the piston pin using pliers.

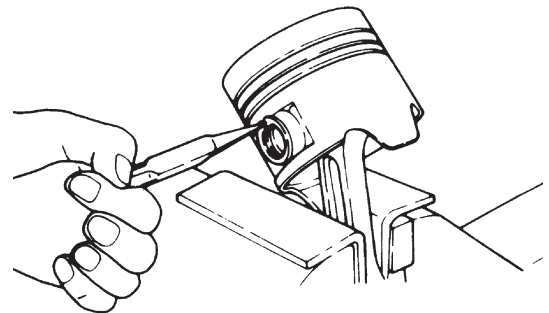


Figure 50

EX1403662

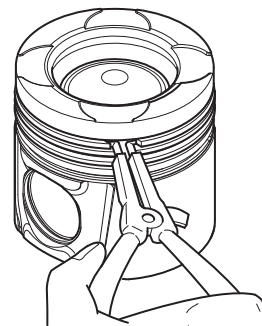
- Tap the piston pin with a wooden stick gently to remove the piston.



Figure 51

EX1403663

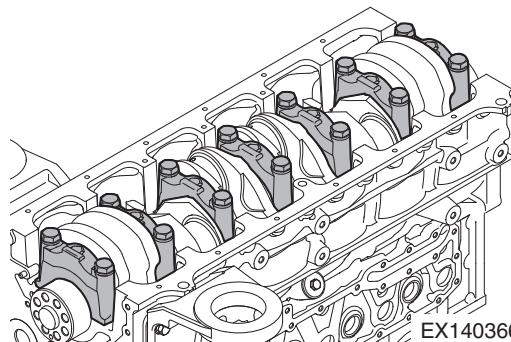
- C. Remove the piston ring using piston ring pliers.
- D. Remove carbon from the piston completely and clean it.



EX1403664

Figure 52

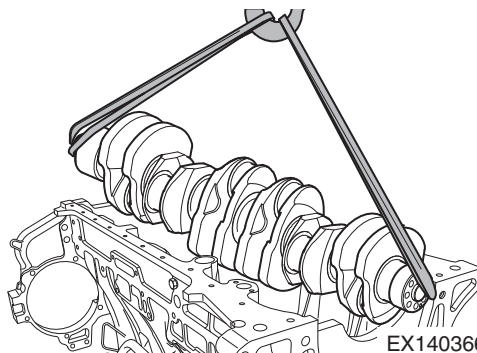
- 39. Remove the bearing cap.
 - A. Unscrew the bearing cap mounting bolts in the reverse order of their tightening to remove the bearing cap.
NOTE: *Unscrew these bolts with the same method for the cylinder head bolts.*
 - B. Keep the bearing caps in order.



EX1403665

Figure 53

- 40. Remove the crankshaft.
 - A. Fit the bolts to both sides of the crankshaft temporarily.
 - B. Connect a rope to the bolts and lift the crankshaft with a crane. Be careful not to damage the crankshaft.
 - C. Store the removed crankshaft on a safe special shelf so that it is not deformed or damaged.
 - D. Remove and store the main bearings in order.



EX1403666

Figure 54



CAUTION

AVOID INJURY

- **Make sure that the main bearing and bearing caps are not mixed.**
 - **Fit the main bearings to their bearing caps temporarily to prevent mixing.**
-

41. Remove the oil spray nozzle.
 - A. Unscrew the oil spray nozzle valve mounting screw to remove the oil spray nozzle.

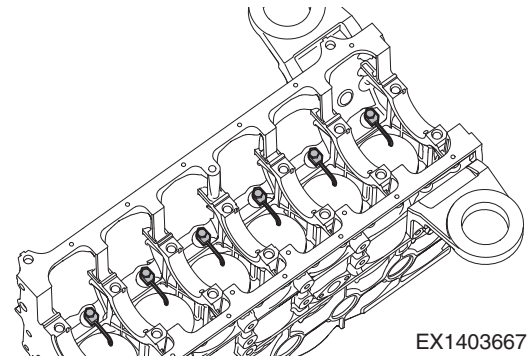


Figure 55

42. Remove the camshaft and tappet.
 - A. To prevent damage of the camshaft, pull it out while turning it.
 - B. Store the removed camshaft on a safe special shelf so that it is not deformed or damaged.
 - C. Remove the tappet.

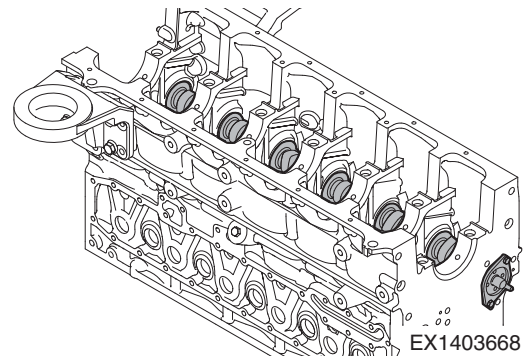


Figure 56



CAUTION

AVOID INJURY

Check for damage, scratch and wear. If any abnormal condition is found, replace it.

43. Remove the cylinder liner.
 - A. Be careful not to damage the cylinder block when removing the cylinder liner.
 - B. Remove the cylinder liner with its removing tool and hands.

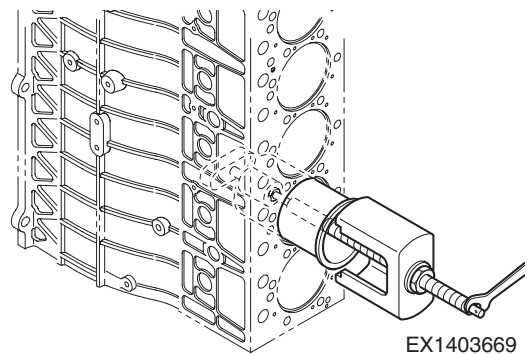


Figure 57

ENGINE ASSEMBLY

Engine Assembly Sequence



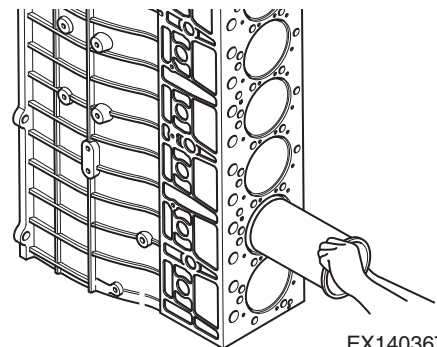
CAUTION

AVOID INJURY

- Clean all the removed parts thoroughly. Especially, clean the oil and coolant passages with compressed air thoroughly to eliminate any restriction.
 - Organize general tools and special service tools for engine assembly.
 - Prepare clean engine oil to apply onto moving parts.
 - Prepare service parts, such as sealant and gasket.
 - Replace any used gasket, seal ring and consumables with new ones.
 - Each bolt should be tightened to the specified torque according to the tightening order. Never over-tighten it.
 - After installing the engine components, check their proper operation.
 - After primary assembly, check if any bolt is loose.
 - Keep your hands clean at all times during work.
-

Assemble the engine according to the following procedure:

1. Install the cylinder block.
 - A. Place a wooden block or thick paper on the ground of the working area to prevent damage of the cylinder head mounting surface. Then, set the head mounting surface toward the ground.
2. Install the cylinder liner.
 - A. Stand the cylinder block with its flywheel side facing the ground.
 - B. Clean the flange mounting surface and inside of the liner with compressed air thoroughly.
 - C. After cleaning the cylinder liner, dry it completely and insert it into the cylinder block with hands.
 - D. Apply engine oil to the inside of the cylinder liner.



EX1403670

Figure 58

3. Install the oil spray nozzle.
 - A. Align the oil spray nozzle with the groove of the cylinder block using the oil spray nozzle installing jig.
 - B. Install the relief valve.
 - C. Tighten the mounting bolt to 44 N.m (4.5 kg.m, 32.5 ft lb).

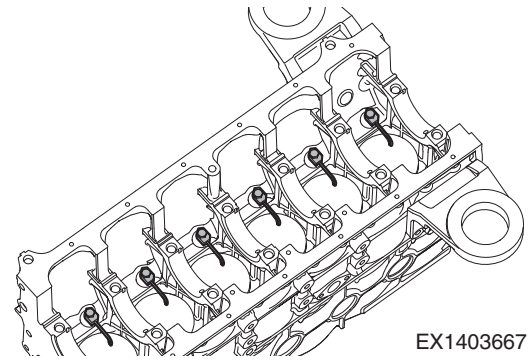


Figure 59

4. Install the crankshaft.
 - A. Make sure to align the holes of the main bearing with the machined oil holes (2 ea) on the cylinder block during installation.

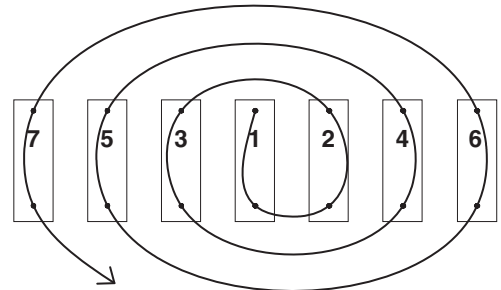


Figure 60

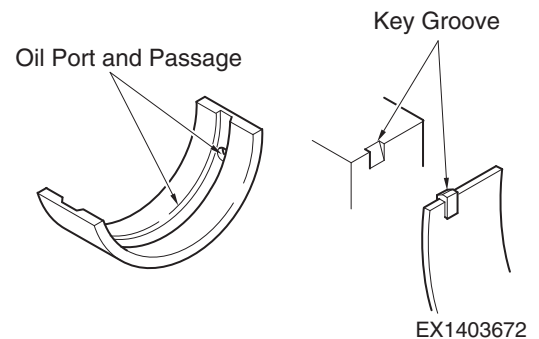


Figure 61

- B. Apply clean engine oil to the bearing surface.
- C. Heat the wear ring at 150°C for 10 minutes with a heater and install this front wear ring using an assembly jig.

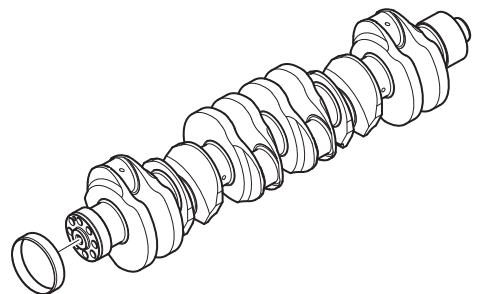


Figure 62

- D. Fit the bolts to both sides of the crankshaft temporarily. Then, place the crankshaft on the cylinder block using the mounting bolts.

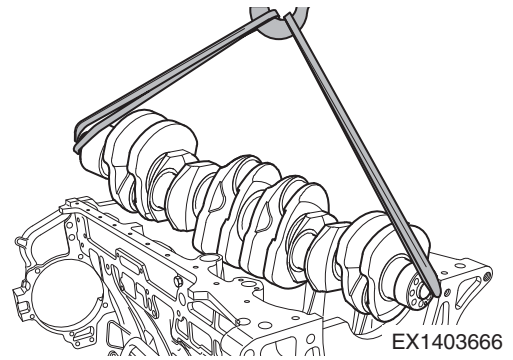


Figure 63

- E. Apply engine oil to the pin and journal of the crankshaft.
 F. After oil application, install the thrust washer with its oil groove facing the outside.

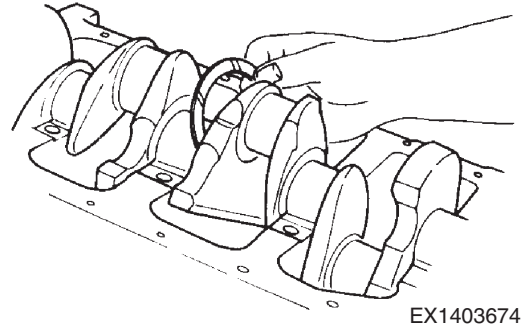


Figure 64

- G. Install the bearing and thrust washer to the bearing cap.

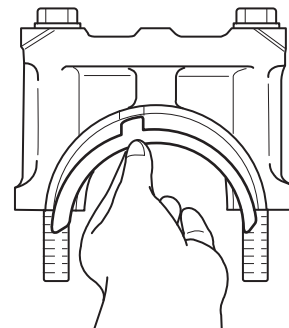


Figure 65

- H. Apply oil to the bearing and thrust washer.
 I. Install the bearing caps correctly by matching their numbers with the cylinder block numbers.
 J. Tighten the bearing cap bolts to the specified tightening torque in the specified order.
 K. Tighten both bolts evenly to set the bearing cap tight.
 L. Tighten the bolt according the following steps with a torque wrench:
- Step 1: Tighten the bolt to 49 N.m (5 kg.m, 36.2 ft lb) until it is tightly set against the surface.
 - Step 2: Tighten it to 147.1 N.m (15 kg.m, 108.5 ft lb) with a torque wrench.

Tightening Order

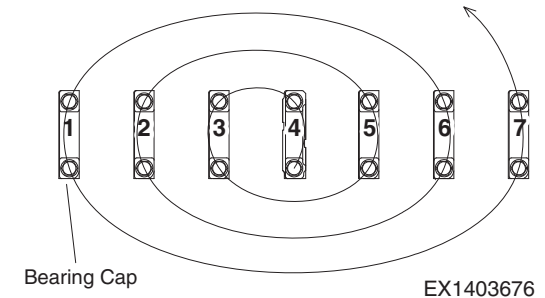


Figure 66

- Step 3: Tighten it to 245.1 N.m (25 kg.m, 180.8 ft lb) with a torque wrench.
- Step 4: Tighten it to 294.1 N.m (30 kg.m, 217 ft lb) with a torque wrench for the final time.

M. Tighten the bearing caps in the following order:
4-3-5-2-6-1-7.

N. Rotate the installed crankshaft for 2 to 3 turns to check its free motion.

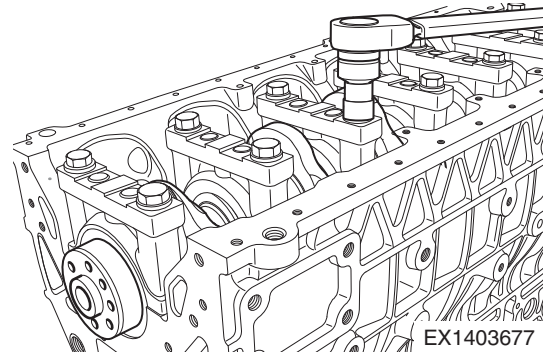


Figure 67

5. Install the tappet and camshaft.

- A. Cool a new bushing in dry ice for approx. 2 hours.
- B. Press the new bushing into the cam bushing position of the cylinder block using a bench press.
- C. After pressing it in, measure the inside diameter of the cam bushing to check for its deformation.
- D. Apply engine oil to the face of the tappet and insert the tappet into its hole of the cylinder block.
- E. Apply engine oil to the camshaft hole and camshaft journal sections of the cylinder block.
- F. Insert the camshaft into its hole of the cylinder block.

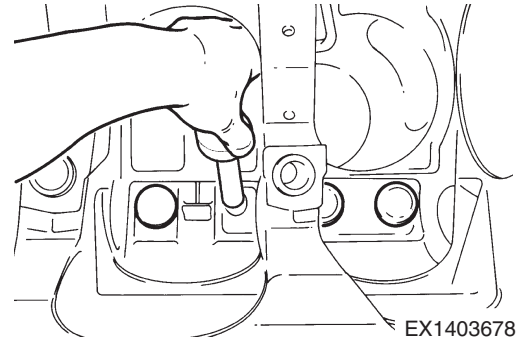


Figure 68

6. Install the timing gear case.

- A. Install the gasket to the cylinder block using a reference pin.
- B. Align the pin hole of the timing gear case with the reference pin.
- C. Install the timing gear case to the cylinder block.
- D. Set it tightly against the cylinder block by tapping its left and right with a urethane hammer.
- E. Tighten the timing gear case mounting bolts to 60.8 N.m (6.2 kg.m, 44.8 ft lb).

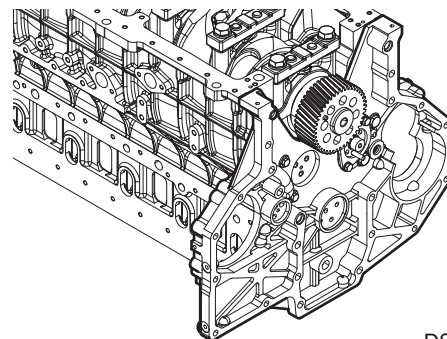


Figure 69



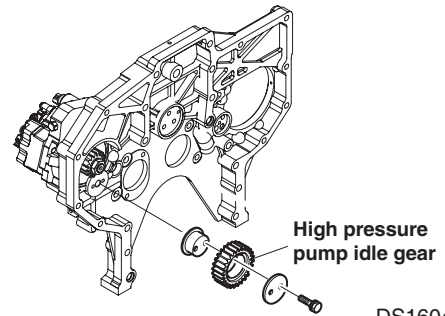
CAUTION

AVOID INJURY

When tightening the bolts, tighten the bolts on both ends first and tighten the remaining bolts.

7. Install the fuel high-pressure pump.
 - A. Install the fuel high pressure idle gear and air compressor idle gear onto the timing gear case.
 - B. In case of the disassembly of all sorts of the gear, check the position of the bolts, and assemble it to the correct position.

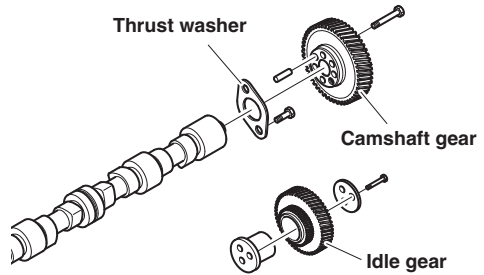
Torque	M8 (10.9T)	30.4 N.m (3.1 kg.m, 22.4 ft lb)
	M8 (10.9T)	30.4 N.m (3.1 kg.m, 22.4 ft lb)
	M10 (10.9T)	60.8 N.m (6.2 kg.m, 44.8 ft lb)



DS1604084

Figure 70

8. Install the gear system.
 - A. Install the thrust washer to the camshaft.
 - B. Install the cam gear, aligning it with the pin hole of the camshaft.
 - C. Tighten the camshaft thrust washer to 9.8 N.m (1.0 kg.m, 7.2 ft lb).
 - D. Tighten the camshaft gear mounting bolt to 30.4 N.m (3.1 kg.m, 22.4 ft lb).



DS1604085

Figure 71

! CAUTION

AVOID INJURY

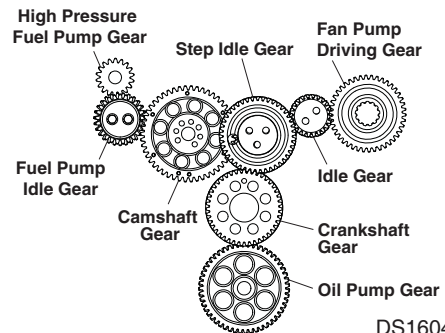
When installing the gears, install the camshaft gear, idle gear, fuel high-pressure pump idle gear and fuel high-pressure pump in this order.

- E. Install the idle gear while aligning the marks on the crankshaft gear, camshaft gear and idle gear.
 - Gear mark

Crankshaft Gear - Idle Gear (A)	"0" and "0"
Camshaft Gear - Idle Gear (B)	"2" and "1"

- F. Tighten the step idle gear to 60.8 N.m (6.2 kg.m, 44.8 ft lb).
- G. Tighten the fuel high-pressure pump idle gear to 60.8 N.m (6.2 kg.m, 44.8 ft lb).
- H. Use a feeler gauge to check the backlash and end play of the gear.
 - Backlash

Measuring Position	Standard (mm)
Camshaft Gear and Idle Gear	0.054 ~ 0.14
Fuel High-pressure Pump Gear and Idle Gear	0.054 ~ 0.14
Crankshaft Gear and Oil Pump Drive Gear	0.073 ~ 0.178



DS1604086

Figure 72

9. Install the flywheel housing.
 - A. Install a guide bar to the cylinder block temporarily.
 - B. Install the gasket to the cylinder block.
 - C. Use a dowel pin and guide bar to install the flywheel housing.
 - D. Tighten the mounting bolts to 109.8 N.m (11.2 kg.m, 81.0 ft lb) in the specified order.
 - E. Remove the guide bar.
 - F. Apply a thin film of engine oil to the outer surface of the oil seal and fit this seal into the flywheel housing.
10. Install the rear oil seal.
 - A. Align the oil seal with the crankshaft.
 - B. Install the oil seal using its jig.

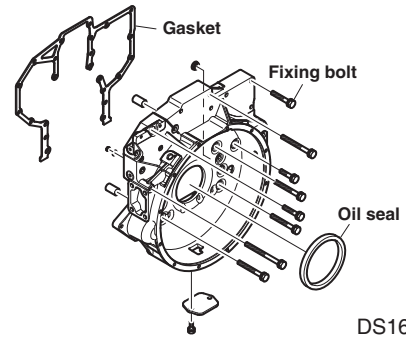


Figure 73

DS1604087

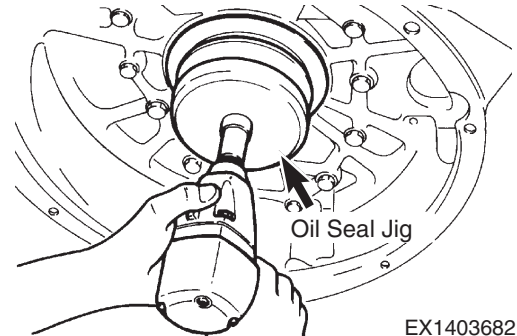


Figure 74

EX1403682

11. Install the flywheel.
 - A. Heat the ring gear with a gas burner evenly to expand it. Then, install it with a hammer.

⚠ CAUTION

AVOID INJURY

- **Make sure that the temperature of the ring gear does not exceed 200°C.**
 - **When installing the wear ring, heat it to 150°C with a heater, and apply loctite #262 to it, and use an assembly jig to install it.**
-

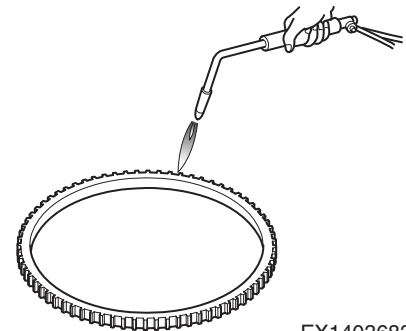


Figure 75

EX1403683

- B. The front of the wear ring can be identified by the mounting surface on the outer skirt.
- C. Fit a guide bar into the crankshaft bolt hole.
- D. Align the flywheel with the reference pin to install it temporarily.
- E. Apply adhesive (loctite #587) to the mounting bolt.

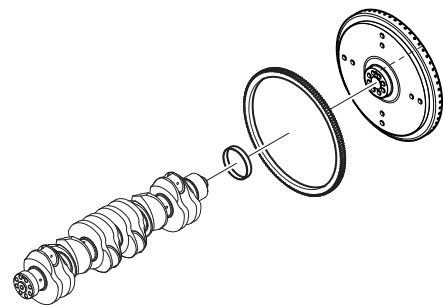
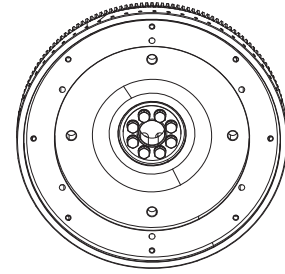


Figure 76

DS1604088

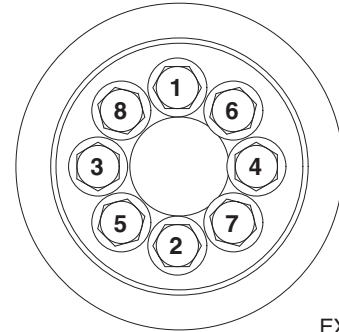
- F. Fit the bolts that have no guide pin in their holes. Then, remove the guide pin and fit the remaining bolt.



DS1604089

Figure 77

- G. Tighten the bolts (M14 x 1.5) to 255 N.m (26 kg.m, 188.1 ft lb) in the specified order.

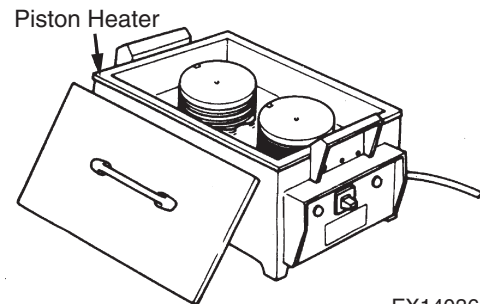


EX1403686

Figure 78

12. Install the piston and connecting rod.

- A. Heat the piston to approx. 100°C with a heater for 5 minutes.



EX1403687

Figure 79

- B. When installing the piston and connecting rod, the weight controlling section at the small end of the connecting rod and the oil gallery inlet (big hole side) of the piston should face the opposite direction.
- C. Apply oil to the pin hole of the piston and align this hole with the small end of the connecting rod. Then, tap the piston pin with a rubber hammer gently to install the connecting rod and piston.



EX1403663

Figure 80

- D. The openings of the snap rings should be set in the opposite direction (upwards and downwards).
- E. Install the snap ring. Check its mounting condition.

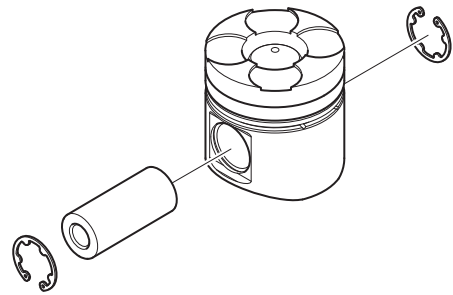


Figure 81

EX1403688

- F. Use piston ring pliers to install the piston ring to the piston.

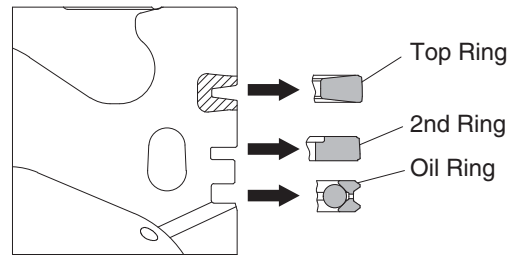


Figure 82

EX1403689

- G. Make sure to install the piston ring in the correct direction. The mark "Y" or "TOP" on the ring connection should face up.

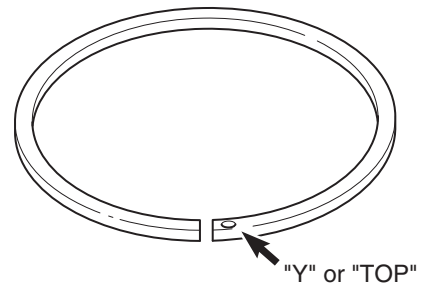


Figure 83

EX1403690

- H. Adjust each piston ring connection angle to 120° and fit a piston inserting jig into the piston.



CAUTION

AVOID INJURY

The connection of the piston ring should not be in the same direction with the pin.

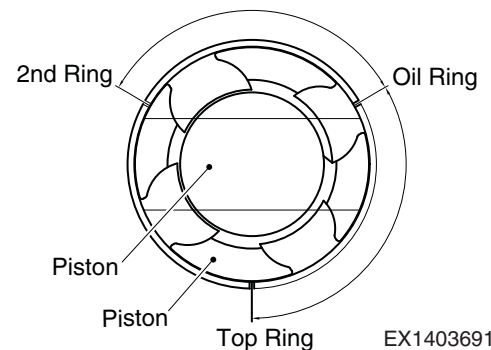


Figure 84

EX1403691

- I. Install the connecting rod bearing while aligning it with the key groove. Then, apply oil to the bearing and piston.
- J. Fit the piston so that the oil gallery inlet of the piston is in the same direction with the spray nozzle.
- K. Use a piston inserting tool to insert it into the cylinder liner. Be careful not to damage the ring by the tip of the liner.

⚠ CAUTION

AVOID INJURY

Make sure that the cylinder liner and piston are not damaged.

- L. Fit the bearing to the connecting rod cap and apply oil on it.
 - M. Check that the manufacturing serial numbers stamped on the connecting rod cap and connecting rod big end are the same.
-
- N. Install the connecting rod cap while aligning it with the reference pin.
 - O. Apply oil to the mounting bolt and install the bolt loosely.
 - P. Tighten the bolts to the specified tightening torque in the specified order using a torque wrench.
 - First stage: Coat engine oil over bolts.
 - Second stage: For the assembly of the connecting rod bolt, assemble with your hand until the head of the bolt contacts both sides of the bolt surface of the connecting rod, and then use the Torque wrench to tighten the bolt.
 - Third stage: With torque wrench, tighten up to about 98.1 N.m (10 kg.m, 72.3 ft lb).
 - Fourth stage: With torque wrench, tighten up to about 147.1 N.m (15 kg.m, 108.5 ft lb).
 - Fifth stage: With torque wrench, tighten finally up to 176.5 N.m (18 kg.m, 130.2 ft lb).
 - Q. Shake the bearing cap with a hand. If it does not move, loosen and tighten it again.

View from Crankshaft Pulley

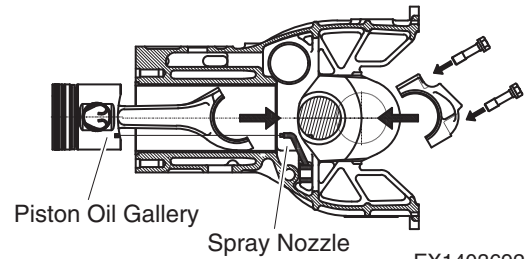


Figure 85

Install the Opening part of the Retaining ring on the Opposite Side of Upper/Lower Side

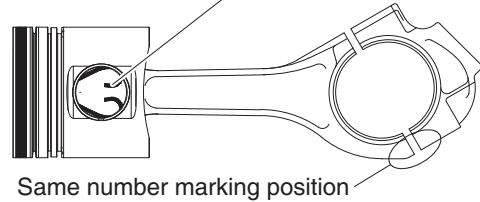


Figure 86

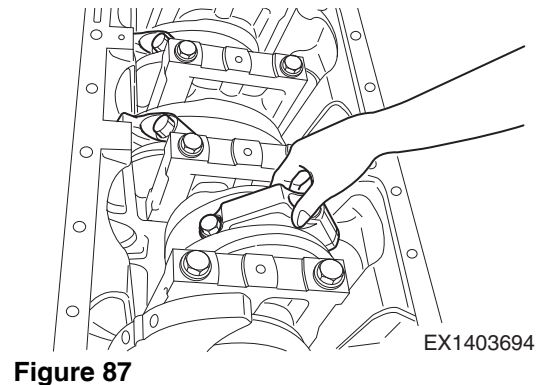


Figure 87

13. Install the oil pump and oil pipe.
 - A. Install the reference pin to the bearing cap No. 7.
 - B. Tap the oil pump with a urethane hammer gently to install it.
 - C. Fit the washer and tighten the mounting bolt (M8) to 21.6 N.m (2.2 kg.m, 15.9 ft lb).
 - D. Connect the oil feed pipe to the oil pump with the bolt.

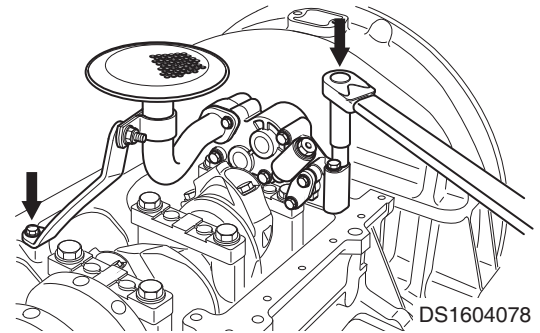


Figure 88

14. Install the front oil seal.
 - A. Apply engine oil to the inside of the oil seal before installing the oil seal to the cover.
 - B. Align a new oil seal with the center of the hole on the oil seal cover.
 - C. Use an installing jig to install the oil seal.
 - D. Tighten it to 21.6 N.m (2.2 kg.m, 15.9 ft lb).

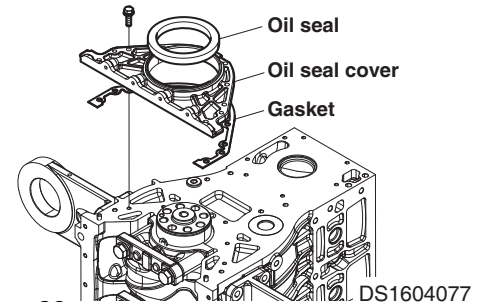


Figure 89

15. Install the oil pan.
 - A. Remove any protruded gasket on the timing gear case, cover, cylinder block and flywheel housing contact surface with a scraper thoroughly.



AVOID INJURY

Make sure any gasket does not enter the engine during work.

- B. Apply silicon on the surfaces where the used gasket was removed. Then, attach a new oil pan gasket.
- C. Install the oil pan.
- D. Tighten the bolts (4 ea) on both ends of the oil pan first and tighten the remaining bolts.
- E. Tighten the oil pan mounting bolt to 30.4 N.m (3.1 kg.m, 22.4 ft lb).



AVOID INJURY

Align the bolt holes with the gasket holes before tightening the bolts.

- F. Tighten the drain plug to 98.1 N.m (10 kg.m, 72.3 ft lb).

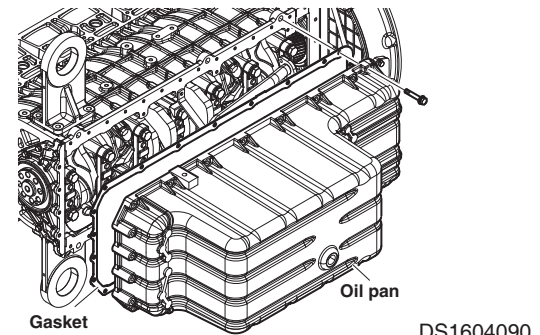


Figure 90

16. Install the crankshaft pulley and vibration damper.
 - A. Install the vibration damper to the crankshaft pulley.
 - B. Tighten the bolts in the correct order.
 - C. Tighten the vibration damper to 60.8 N.m (6.2 kg.m, 44.8 ft lb).
 - D. Tighten the crankshaft pulley to 255 N.m (26 kg.m, 188.1 ft lb).

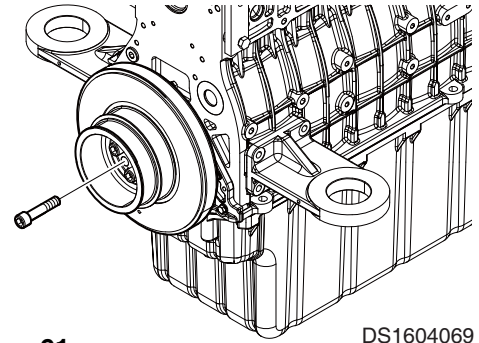
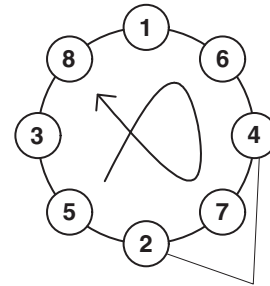


Figure 91

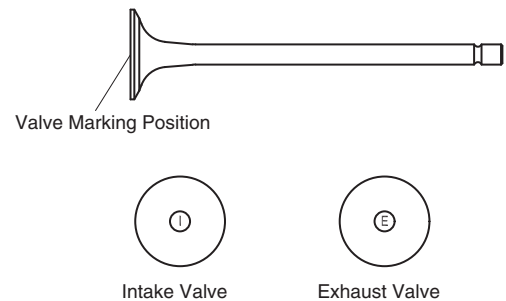
DS1604069



Bolt Tightening Order

EX1403697

17. Install the intake and exhaust valves.
 - A. Before installing the valve to the cylinder head, check the marks "I" and "E" on the valve head surface.



EX1403698

Figure 93

- B. Use a valve stem seal installing jig to install the valve stem seal to the valve guide.
 - C. Install the valve cotter by pressing the retainer with a valve spring compressing tool after installing the valve spring and retainer.
 - D. Tap the valve stem with a rubber hammer gently to check if the valve is corrected installed.

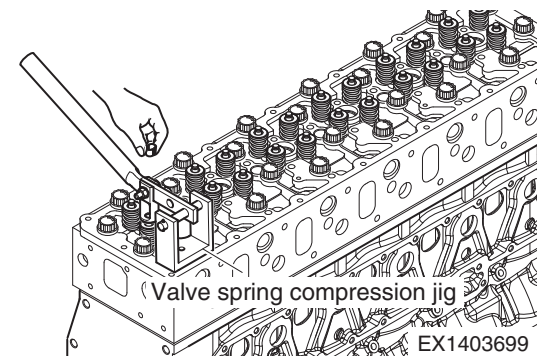


Figure 94

EX1403699

18. Install the cylinder head.
- A. Blow compressed air through the bolt hole of the cylinder head to remove any foreign materials.
 - B. Clean the gasket mating surface of the cylinder head thoroughly.

CAUTION

AVOID INJURY

Ensure that no foreign material enters the combustion chamber.

- C. Align the new gasket bolt hole with the reference pin on the cylinder block.
- D. When installing the gasket, its mark on the right should be upwards.

CAUTION

AVOID INJURY

Replace the gasket with a new one.

- E. Check if there is any foreign material in the combustion chamber.
- F. Install the cylinder head by aligning it with the retaining pin.

CAUTION

AVOID INJURY

- **Be careful not to damage the gasket.**
- **If the pin hole cannot be aligned, lift the head and then try to seat it again.**

- G. Install the cylinder head bolt.

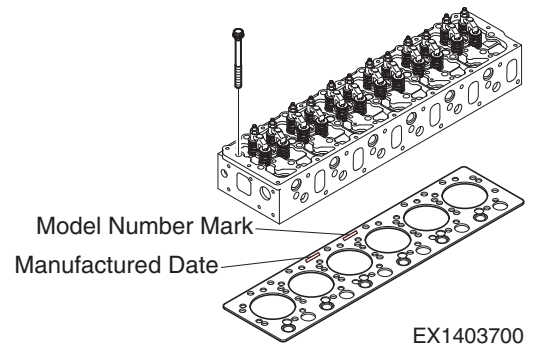


Figure 95

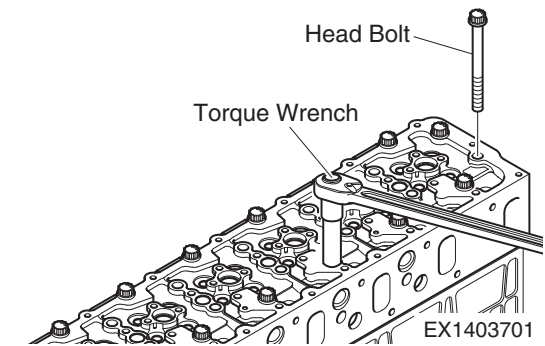


Figure 96

- H. Tighten the cylinder head bolts to the specified tightening torque in the specified order.
- Step 1: Tighten it for 1 to 2 threads with a hand, and then tighten it to 39.2 N.m (4 kg.m, 28.9 ft lb) temporarily.
 - Step 2: Tighten it to 58.8 N.m (6 kg.m, 43.4 ft lb) with a torque wrench.
 - Step 3: Tighten it for 90° with a torque wrench.
 - Step 4: Tighten it for 90° with a torque wrench.
 - Step 5: Tighten it for 90° with a torque wrench for the final time.

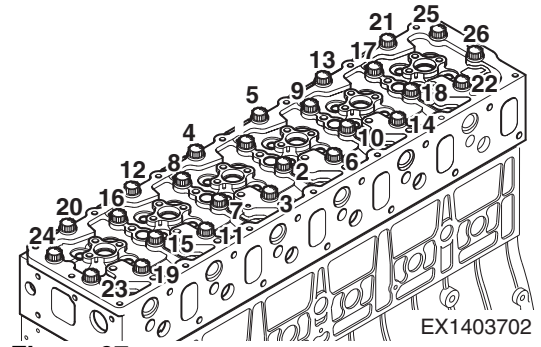


Figure 97

! CAUTION

AVOID INJURY

All the bolts should be tightened according to the above steps.

19. Install the push rod.
- A. Apply engine oil to the push rod.
 - B. Insert the push rod into the push rod hole of the cylinder head.

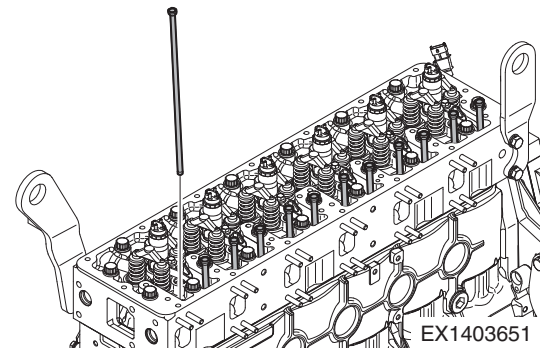


Figure 98

20. Install the injector.

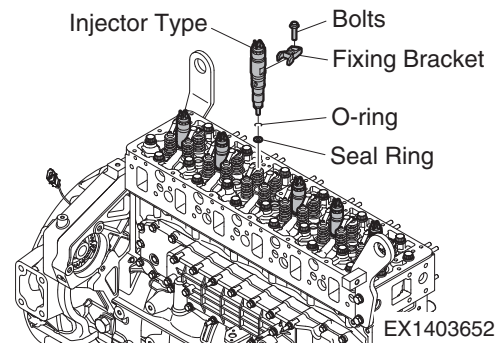


Figure 99

CAUTION

AVOID INJURY

- Clean all parts thoroughly and make sure that no foreign material enters any part.
- Especially, the fuel line between the common rail and injector is not equipped with a filtering function. Therefore, this section should be kept clean with care.
- Clean the drilling of the head for the fuel high-pressure connector and the hole for the injector thoroughly to remove any foreign materials from them.
- If the injector is removed, the fuel high-pressure connector should be replaced with a new one.
- If fuel collected in the fuel return line enters the combustion chamber during injector disassembly process, remove fuel by sucking it out with a hand pump or by cranking the engine with fuel flow blocked.

-
- A. Install the injector correctly according to the following steps:
- B. Fit the O-ring to the injector and apply engine oil to the outer circumference surface.
-

CAUTION

AVOID INJURY

Make sure that oil or foreign material is not on the fuel high-pressure connector hole on the side of the injector.

- C. Align the seal ring with the injector hole on the cylinder head. Then, insert the injector gently.
- D. Align the injector mounting bolt with the thread of the head. Then, tighten the bolt for 2 ~ 3 threads with a hand.

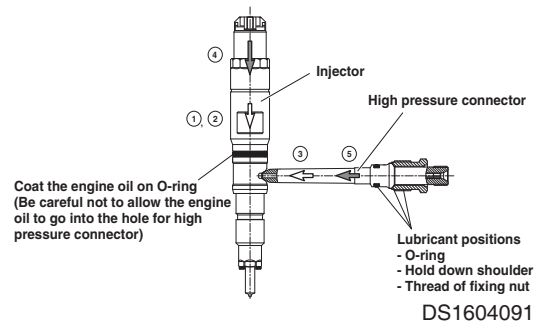
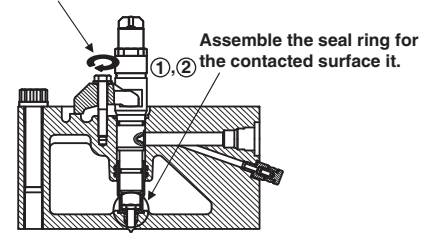


Figure 100

- E. Set the injectors to the mounting positions of the injector mounting brackets (1 & 2) with the mounting bolts. Then, tighten them temporarily.

Install the injector with pre-tightening torque and then loosen the fixing bolt.

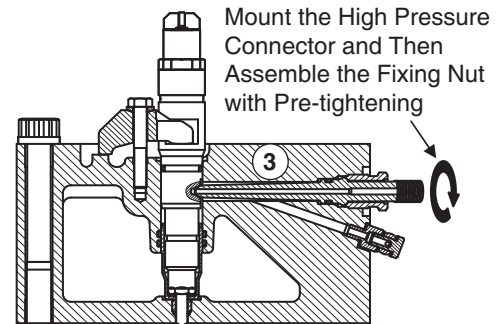


1st step : Installing injector & pre-tightening

DS1604092

Figure 101

- F. After tightening the injectors temporarily, unscrew the bolts of the mounting brackets enough to move the injectors freely without load.
- G. Set the fuel high-pressure connector (3) with its balls set vertically.



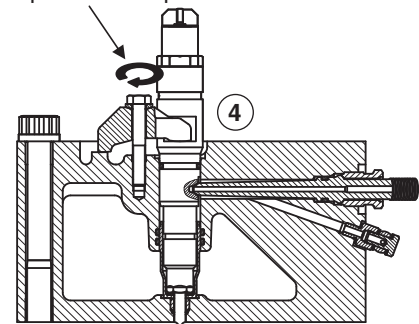
2nd Step : Installing High Pressure Connector and Temporarily Assembling

EX1403704

Figure 102

- H. Ensure that it is aligned with the groove in the hole on the side of the head on the intake manifold side.
- I. Align the fuel high-pressure connector through the hole on the side of the head, and push in the fuel high-pressure connector enough.
- J. Tighten the mounting nut (M22 x 15) of the fuel high-pressure connector for 2 ~ 3 threads with a hand.
- K. Tighten the injector mounting bracket bolt to 2.9 N.m (0.3 kg.m, 2.2 ft lb) with a torque wrench.
- L. Tighten the injector mounting bracket bolt to 14.7 +4.9 N.m (1.5 +0.5 kg.m, 10.8 +3.6 ft lb) using a torque wrench.
- M. Tighten the injector mounting bracket mounting bolt (4) to 30.4 ~ 34.3 N.m (3.1 ~ 3.5 kg.m, 22.4 ~ 25.3 ft lb)

Final Tighten the Fixing Bolt of Injector with Specified Torque

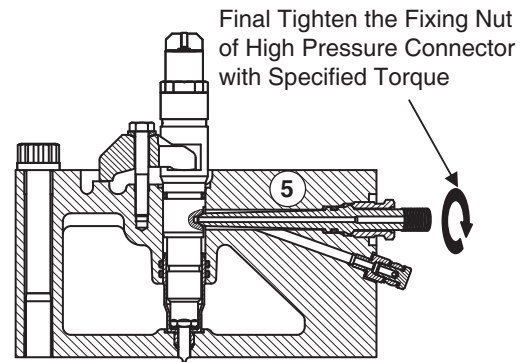


Final Step : Final Assemble Injector with Specified Torque

EX1403705

Figure 103

- N. Tighten the fuel high-pressure connector mounting nut (5) to 49 ~ 53.9 N.m (5 ~ 5.5 kg.m, 36.2 ~ 39.8 ft lb).



Final Step : Final Assemble High Pressure Connector with Specified Torque

EX1403706

Figure 104

21. Install the rocker arm.
- A. For rocker arm assembly, install the spring, rocker arm, bracket, rocker arm, spring, washer and snap ring in order.



CAUTION

AVOID INJURY

Install the rocker arm and bracket in the same direction.

- B. Apply oil to the rocker arm bushing and shaft.
- C. Use the mounting bolts to install the rocker arm and bracket onto the cylinder head.
- D. Tighten the bolts to 6.2 kgf.m diagonally.
- E. Install the valve clearance adjusting screw to the rocker arm temporarily.

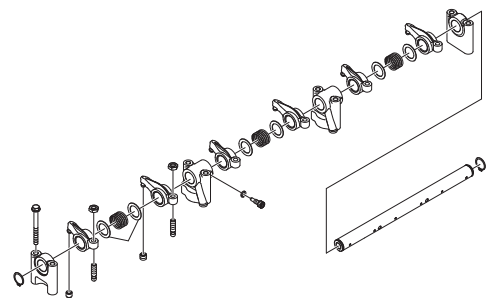


Figure 105

EX1403707

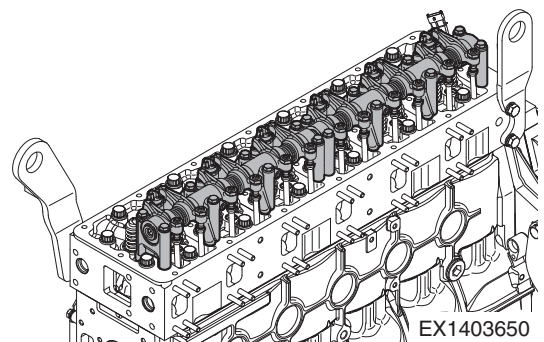


Figure 106

EX1403650

22. Install the intermediate cover.
 - A. Install a new gasket to the intermediate cover.
 - B. Tighten the mounting bolt to 30.4 N.m (3.1 kg.m, 22.4 ft lb).

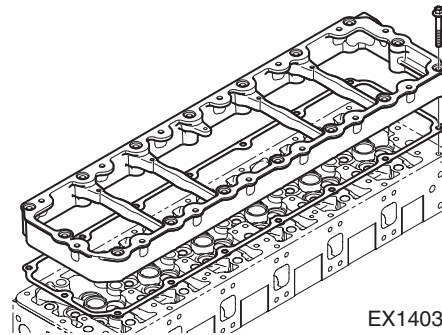


Figure 107

EX1403708

23. Install the cylinder head cover.
 - A. Install a new rubber gasket to the cylinder head cover.
 - B. Install the cylinder head cover to the cylinder head.
 - C. Tighten the mounting bolt to 30.4 N.m (3.1 kg.m, 22.4 ft lb).
 - D. Install the oil filler cap to the cylinder head cover.

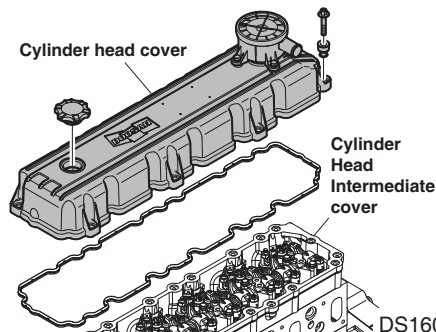


Figure 108

DS1604093

24. Install the oil cooler.
 - A. Install the oil cooler and gasket to the cylinder block.



CAUTION

AVOID INJURY

Make sure to install the gasket in the correct direction.

- B. Tighten the bolt to 21.6 N.m (2.2 kg.m, 15.9 ft lb).

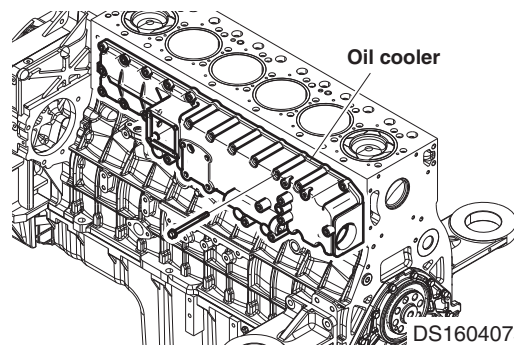


Figure 109

DS1604075

25. Install the oil filter.
 - A. Install the oil filter cartridge using a special service tool.



CAUTION

AVOID INJURY

The oil filter should be installed to the engine without oil in it. Never fill the new oil filter with oil drained from the used oil filter.

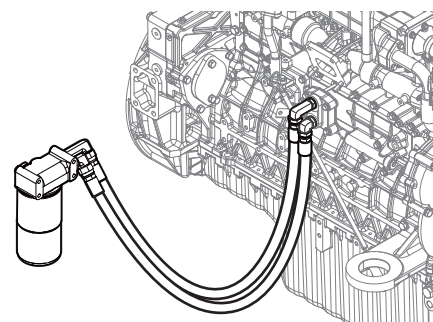
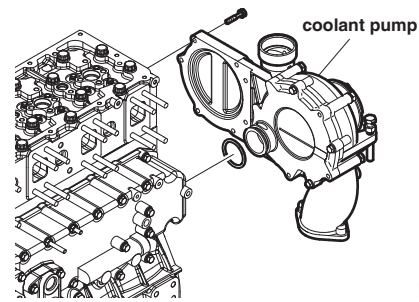


Figure 110

DS1604068

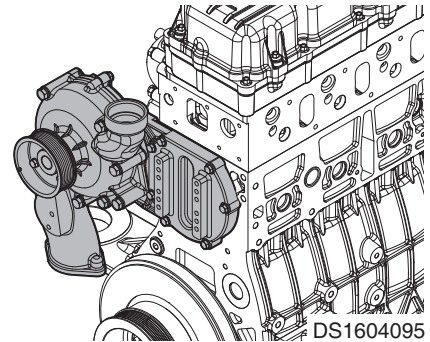
26. Install the coolant pump.
 - A. Install the coolant pump cover and coolant pump gasket.
 - B. Install the coolant pump to the cylinder block.



DS1604094

Figure 111

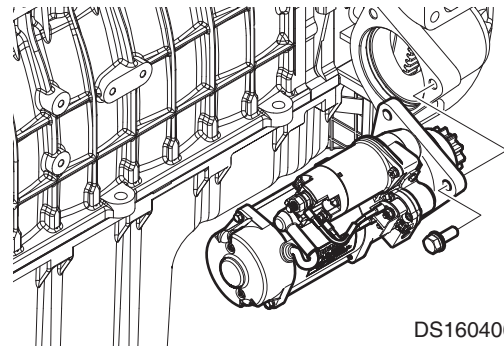
- C. Tighten the mounting bolt to 21.6 N.m (2.2 kg.m, 15.9 ft lb).
- D. Install the idle pulley bracket.



DS1604095

Figure 112

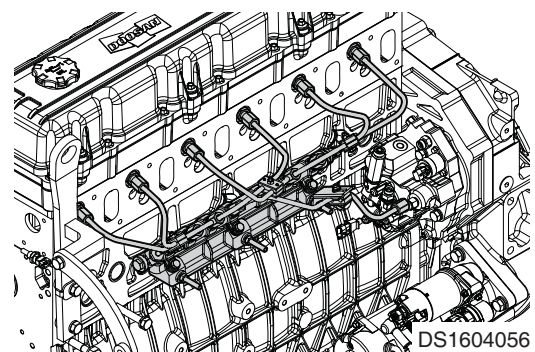
27. Install the start motor.
 - A. Install the start motor to the stud bolt of the flywheel housing.
 - B. Tighten the mounting nut to 78.5 N.m (8 kg.m, 57.9 ft lb).



DS1604067

Figure 113

28. Install the common rail and high-pressure pipe.
 - A. Install the common rail to the cylinder block.
 - B. Connect the fuel feed pipe between the common rail and fuel high-pressure connector.
 - C. Tighten the fuel high-pressure pipe on the common rail side to 39.2 N.m (4.0 kg.m, 28.9 ft lb).
 - D. Tighten the fuel high-pressure pipe on the fuel high-pressure connector side to 39.2 N.m (4.0 kg.m, 28.9 ft lb).
 - E. Tighten the common rail fuel high-pressure pipe from the fuel high-pressure pump to 39.2 N.m (4.0 kg.m, 28.9 ft lb).



DS1604056

Figure 114

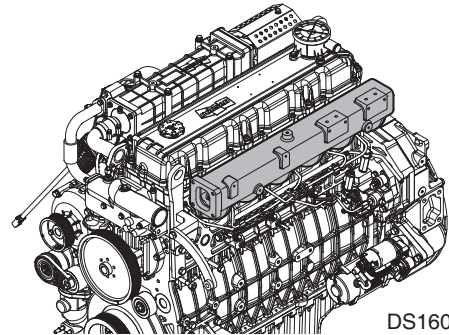
- F. Tighten the common rail mounting bolt to 21.6 N.m (2.2 kg.m, 15.9 ft lb).

! **CAUTION**

AVOID INJURY

- **Never reuse the fuel high-pressure pipe.**
 - **Tighten the fuel high-pressure pipe to the specified torque for a cylinder by cylinder.**
-

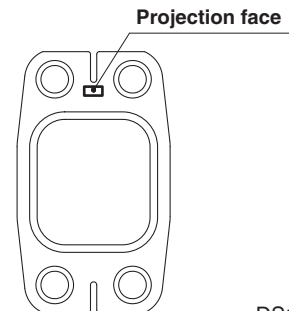
29. Install the intake manifold.
- A. Install a new gasket between the cylinder head and intake manifold.
- B. Tighten the mounting bolt to 43.1 N.m (4.4 kg.m, 31.8 ft lb).



DS1604055

Figure 115

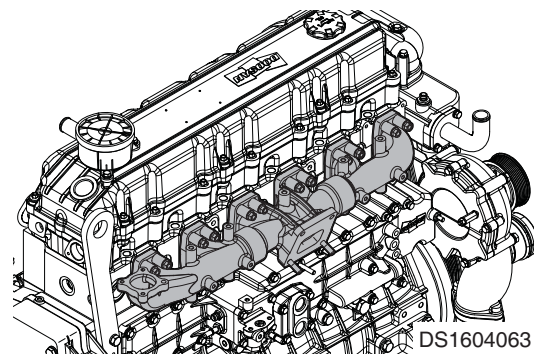
30. Install the exhaust manifold.
- A. Install the exhaust manifold gasket to the stud bolt of the cylinder head.
- B. Align the gas outlet of the cylinder head with the gasket hole.



DS1604096

Figure 116

- C. Install the exhaust manifold.
- D. Tighten the mounting bolt to 58.8 N.m (6.0 kg.m, 43.4 ft lb).



DS1604063

Figure 117

31. Install the turbocharger.
 - A. Install a new gasket to the stud bolt of the exhaust manifold.
 - B. Install the turbocharger.
 - C. Connect the oil feed pipe and drain pipe.
 - D. Tighten the clamp for the rubber hose to connect the air pipe and turbocharger.
 - E. Tighten the mounting bolt to 63.7 N.m (6.5 kg.m, 47.0 ft lb).

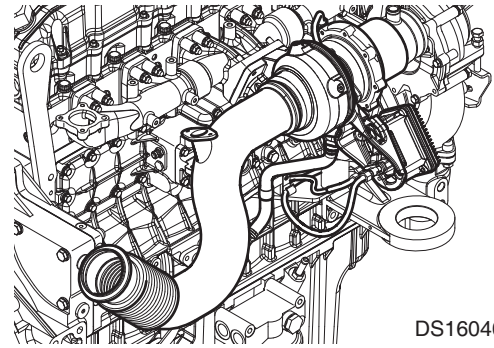


Figure 118

DS1604062

32. Install the coolant pipe and thermostat.
 - A. Install the gasket to the cylinder head.
 - B. Install the housing to the thermostat.
 - C. Install the O-ring to the thermostat.
 - D. Connect the coolant pipe.
 - E. Tighten the bolt to 21.6 N.m (2.2 kg.m, 15.9 ft lb).

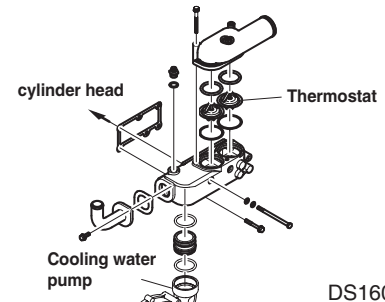


Figure 119

DS1604064

33. Install the EGR cooler.
 - A. Install the EGR cooler mounting bracket to the cylinder head with the mounting bolts.
 - B. Install the EGR cooler to the bracket with the mounting bolts.
 - C. Connect the pipe and hose to the EGR cooler.

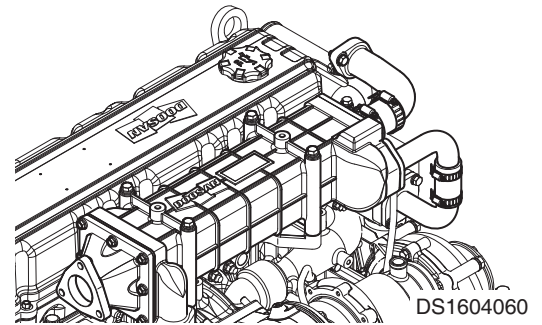


Figure 120

DS1604060

 **CAUTION**

AVOID INJURY

Do not reuse the gasket.

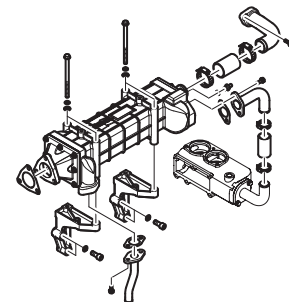


Figure 121

DS1604061

34. Install the EGR valve.
- A. Install the exhaust pipe to the EGR cooler with the gasket and secure it with the mounting bolt.
 - B. Install the EGR valve to the exhaust pipe with the gasket and secure it with the mounting bolt.



CAUTION

AVOID INJURY

Do not reuse the gasket.

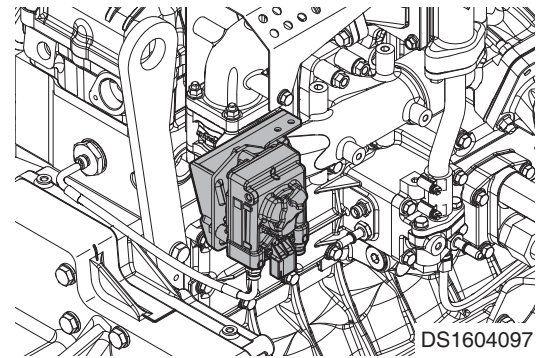


Figure 122

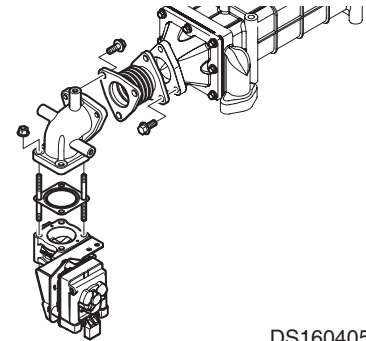


Figure 123

35. Install the ECU (Electrical Control Unit).
- A. Fix the ECU mounting plate.
 - B. Install the ECU.

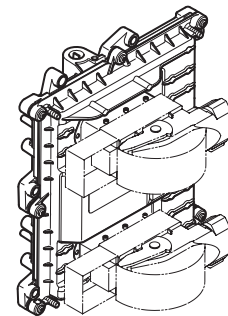


Figure 124

36. Install the crankshaft speed sensor and camshaft speed sensor.
- A. Measure the clearance between the mounting section of the crankshaft speed sensor and flywheel. Use shims to adjust this clearance to 1.0 mm.
 - B. Tighten the crankshaft speed sensor to 9.8 N.m (1.0 kg.m, 7.2 ft lb).
 - C. Measure the clearance between the mounting section of the camshaft speed sensor and timing gear. Use shims to adjust this clearance to 1.0 mm.
 - D. Tighten the camshaft speed sensor to 9.8 N.m (1.0 kg.m, 7.2 ft lb).

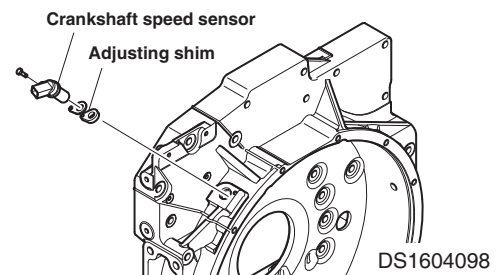


Figure 125

37. Install the fuel filter.
 - A. Fuel needs to flow through the following components in this order: fuel feed pump, fuel filter, fuel high-pressure pump and common rail. Connect the fuel feed pipe correctly according to the arrow direction mark on the head of the fuel filter to ensure correct fuel flow.
 - B. Tighten the fuel pipe to 29.4 N.m (3.0 kg.m, 21.7 ft lb).
 - C. Tighten the fuel temperature sensor to 21.6 N.m (2.2 kg.m, 15.9 ft lb).
 - D. Tighten the mounting bracket to 43.1 N.m (4.4 kg.m, 31.8 ft lb).

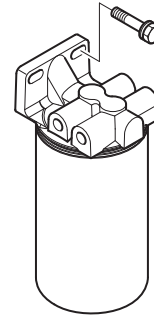


Figure 126

EX1403715

CAUTION

AVOID INJURY

A new fuel filter should be installed without fuel in it. Never add fuel in the used fuel filter or fuel tank to a new fuel filter.

38. Install the alternator and belt.
 - A. Install the alternator and A/C bracket. Then, secure them with the mounting bolts.
 - B. Install the alternator, A/C compressor and idle pulley.
 - C. Tighten the alternator mounting bolt to 78.5 N.m (8 kg.m, 57.9 ft lb).
 - D. Install the alternator and belt its tension with its adjusting bolt.
 - E. Install the belt and adjust its tension with its adjusting bolt.

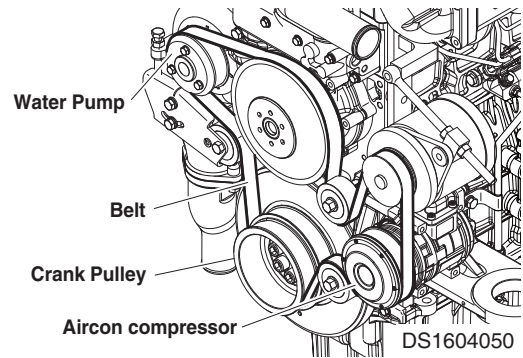


Figure 127

DS1604050

39. Connect the air pipe and install the air heater.
 - A. Install the air pipe, air heater and throttle valve.
 - B. Tighten the mounting bolt to 21.6 N.m (2.2 kg.m, 15.9 ft lb).

CAUTION

AVOID INJURY

Never let foreign materials enter the turbocharger.

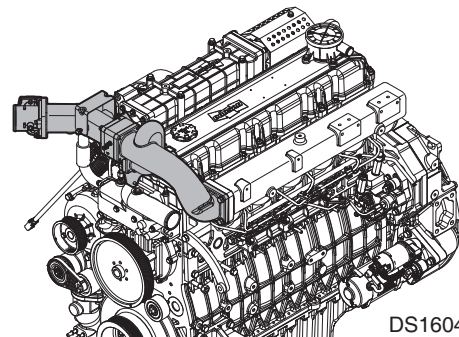
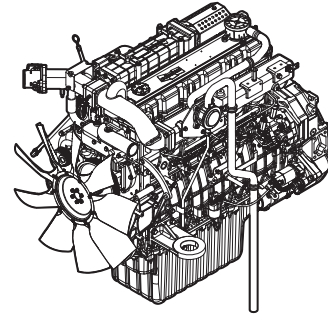


Figure 128

DS1604054

40. Fit the dipstick.
 - A. Apply adhesive (loctite #262) to the guide tube.
 - B. Install the guide tube and dipstick to the oil pan.



DS1604099

Figure 129

41. Connect the cables and harnesses of the engine to each sensor.
42. Mount the engine to the machine.
43. Add engine oil.
 - A. Open the oil filler cap on top of the cylinder head cover and add engine oil to it.

 **CAUTION**

AVOID INJURY

Make sure to use the recommended genuine oil.

44. Add coolant.
 - A. Open the radiator cap and add coolant.

 **CAUTION**

AVOID INJURY

Make sure to use the recommended coolant.

CYLINDER

General Information

HYUNDAI'S diesel engine is an air-cooled electronic control diesel engine that uses cooling fans, overhead valve, and turbocharger.

The high-pressure fuel generated from the fuel high-pressure pump is stored in the common rail. When a driver operates the vehicle, fuel injection timing and optimum fuel amount are decided based on the data set in the electronic control unit (ECU) and the solenoid valve of the injector installed in each engine cylinder is operated to inject fuel into the cylinder.

The cylinder block is made out of cast iron alloy and an anti-vibration and anti-noise crank case is mounted. In addition, the cylinder block and the timing gear case are designed as an integral structure to reduce the engine length and improve tightness. The cylinder head is an integral structure, too.

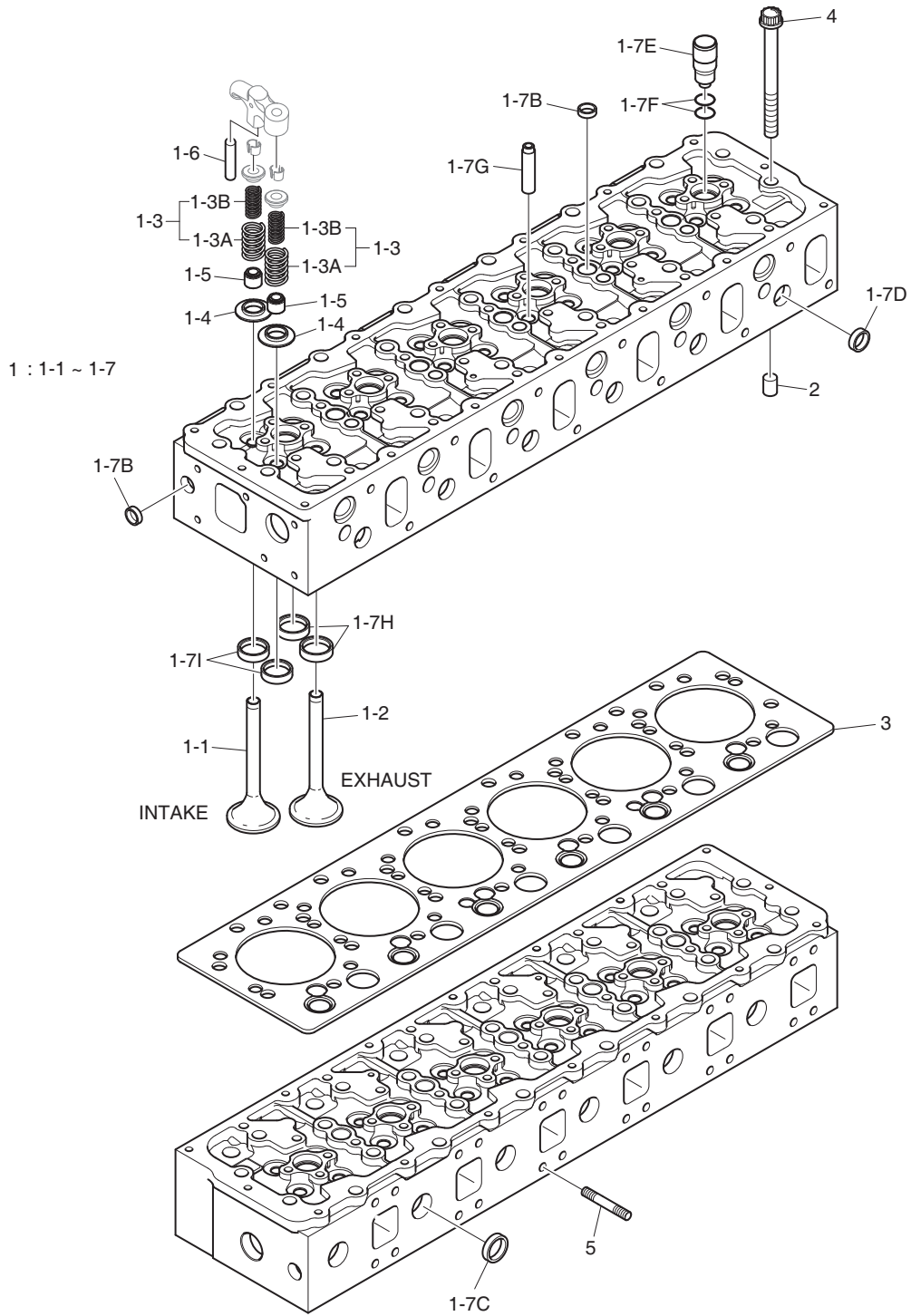
The forged crankshaft is an integral structure. The oil seals of the crankshaft and the flywheel prevents oil from permeating into the flywheel housing. The connecting rod is forged and its big end part vertically separated. Like a piston, the connecting rod can be disassembled through the upper side of the cylinder. The alloy-type prefabricated bearing is used for the moving part of the crankshaft and the connecting rod.

Cylinder Head

General Description

The cylinder head is a cover mounted on top of the cylinder, and it is bolted to the cylinder block with the head gasket in between, forming the combustion chamber with other components, including the pistons and cylinders. It has a oil passage for the lubrication and a coolant passage for reduction of frictional heat. This cylinder head is integrated to each cylinder and cannot be removed.

Parts List



DS1604237

Figure 130

Reference Number	Description
1	Cylinder Head Sub Assembly
1-1	Valve
1-2	Valve
1-3	Spring; Valve
1-3A	Spring; Valve
1-3B	Spring; Valve
1-4	Washer
1-5	Seal; Valve Steam
1-6	Pin; Caliper Guide
1-7	Cylinder Head Assembly
1-7B	Plug; Core

Reference Number	Description
1-7C	Plug; Core
1-7D	Core; Plug
1-7E	Bush; INJ. Nozzle
1-7F	O-ring
1-7G	Valve; Guide
1-7H	Seat; Intake Valve
1-7I	Seat; Exhaust Valve
2	Pin
3	Gasket; Cylinder Head
4	Bolt; Collared Hex
5	Bolt; Stud

Disassembly

1. After disassembling the cylinder head, keep it on a shelf in an organized way for later assembly.
2. Be careful not to damage the contact surface of the cylinder head gasket.
3. Remove the valve cotter, spring and spring seat using a valve spring compression tool.
4. Pull out the intake and exhaust valves.
5. Keep the removed parts in order.
6. Remove the valve stem seal.

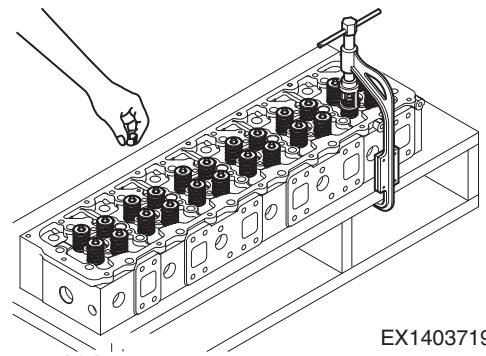


Figure 131

EX1403719

Assembly

1. Clean the cylinder head thoroughly.
2. Replace the valve stem seal with a new one.
3. Use a special service tool to install the stem seal to the valve guide of the cylinder head.
4. Apply engine oil to the valve stem and valve guide, and install the valve.



CAUTION

AVOID INJURY

Be careful not to damage the valve stem seal.

5. Install the valve spring seat to the valve guide on the cylinder head.
6. Install the inner and outer valve springs and place the spring seat on the top.
7. While pressing the valve spring with the valve spring compression tool, insert the valve cotter to install the valve.
8. After installing the valve, tap the valve gently with a urethane hammer to check if it is firmly installed.

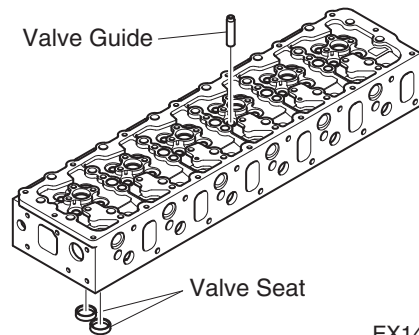


Figure 132

EX1403720

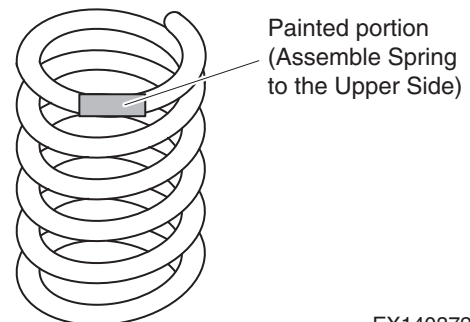


Figure 133

EX1403721

Inspection

Cylinder Head Inspection

1. Remove carbon from the bottom of the cylinder head.



CAUTION

AVOID INJURY

Be careful not to scratch the valve seat surface.

2. Visually check if the cylinder head is damaged.
3. A minute scratch or damage that cannot be found with the naked eyes can be found through the hydraulic pressure test or magnetic particle test.

Bottom Distortion

1. Use a straightedge and feeler gauge to measure the distortion of the cylinder head in 6 directions.
2. If any measured value is over the allowable service limit, correct it with a fine sandpaper or grinder.
3. If it is under the allowable limit, replace the cylinder head.
 - Distortion and height of cylinder head

	Standard	Allowable Limit
Cylinder Head Bottom Flatness	0.08 mm or below	0.15 mm
Head Height: t	114.9 ~ 115.1 mm	104.4 mm

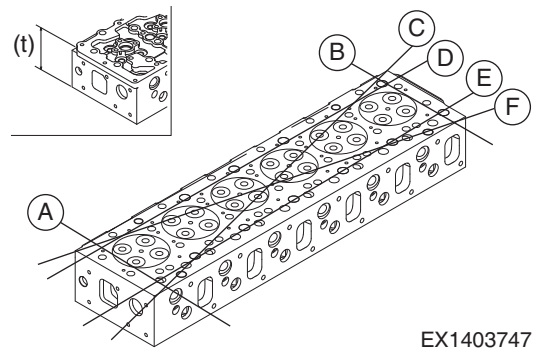


Figure 134

EX1403747

Flatness

1. Use a straightedge and feeler gauge to measure the flatness of the intake/exhaust manifold mounting surface of the cylinder head.

Standard	Allowable Limit
0.15 mm	0.3 mm

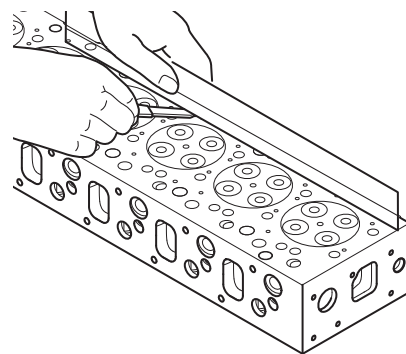


Figure 135

EX1403748

Cylinder Block

General Description

This forms a base for the engine body, and component shapes, including the crankshaft's and head's, and bolt holes are machined on it for their installation. It also has coolant and oil passage.

The cylinder block is cast in one piece, in compact graphite iron (CGI) and has all-in-one cylinder head. The cylinder bores have dry liners.

Parts List

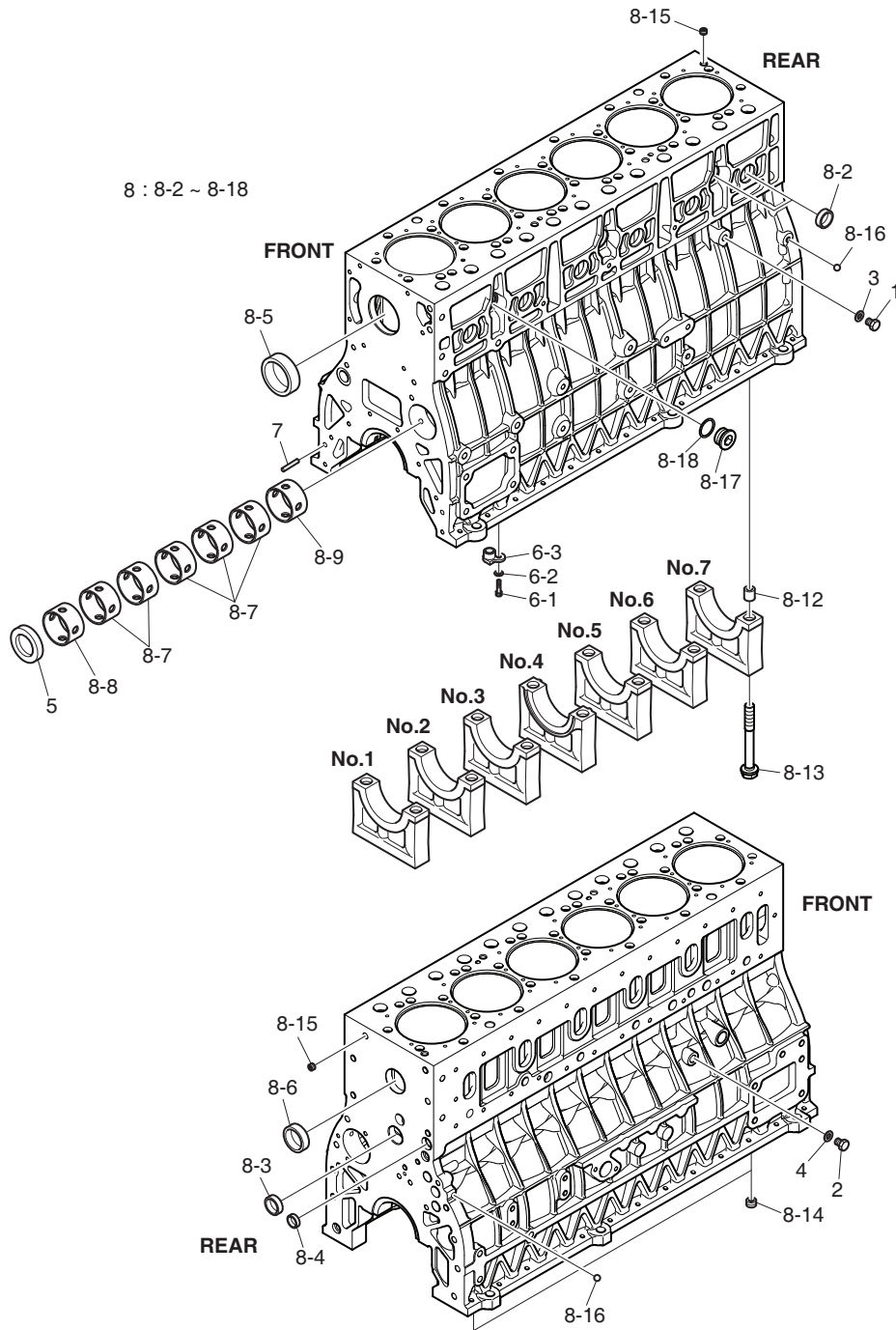


Figure 136

DS1604238

Reference Number	Description
1	Screw; Plug M12 x 1.5 x 20
2	Plug; Screw
3	Ring; Seal
4	Seal Ring
5	Cover; Core Hole
6	Flange, Connection
6-1	Bolt; Socket Head M6 x 14
6-2	Washer
6-3	Flange; Connection
7	Pin
8	Block Assembly, Cylinder
8-2	Plug; Core
8-3	Plug; Core
8-4	Plug; Core

Reference Number	Description
8-5	Plug; Core
8-6	Plug; Core
8-7	Bushing; Camshaft
8-8	Bushing; Camshaft
8-9	Bushing
8-10	Cap; Bearing
8-11	Cap; Bearing
8-12	Ring; Locating
8-13	Bolt; Collared Hex
8-14	Screw; Plug
8-15	Pin; Core
8-16	Ball; Steel
8-17	Drain Plug Assembly
8-18	Seal; Ring

Inspection

1. Cleanse the cylinder block and check if there is any cracked or damaged part with naked eye.
2. Replace the cylinder block if it is seriously cracked or damaged. Repair tiny cracks if existing.
3. Check if the oil path or coolant path is clogged or corroded.
4. Perform the hydrostatic test to check whether there is a crack or an air leakage.
5. Block the discharging outlets of the cooling water path and the oil path of the cylinder block and put pressure of 3.9 bar (4 kg/cm², 56.9 psi) on the inlet. Then sink the cylinder block in the 70°C water for 1 minute and check if air leaks.

Valve Mechanism

General Description

The valve mechanism consists of one or two camshafts, roller tappets, pushrods, rocker arms and valve tappets.

Straight engines have one camshaft and V engines have two camshafts, one for each cylinder line. In both cases the camshaft is driven by the timing gears and rotates at half the speed of the crankshaft.

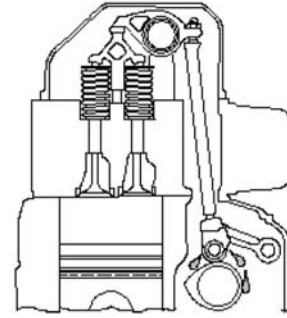
The camshaft has two cams per cylinder, one for the intake valves and one for the outlet valves.

One end of the push rod rests on the roller tappet, and the other end acts on the rocker arm. At one end of the rocker arm there is an adjusting screw. The lower ball-shaped end of the screw rests in the pushrod, making the tappet adjust to the camshaft movement.

The valve seat inserts are firmly pressed to a tight fit in the cylinder head. The material in the seat inserts is very strong, so the valve seats have a long service life. If required the valve seat rings can be replaced.

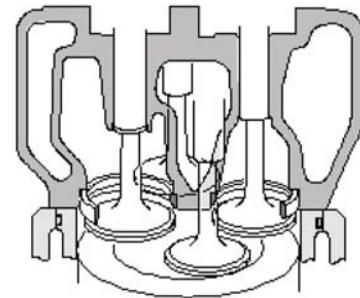
With four valves per cylinder the valve area is greater, which makes it easier to fill the cylinder with air. At the same time, less energy is consumed in forcing out the exhaust fumes.

The effort required for gas flow is reduced and engine efficiency is improved. This in turn leads to a reduction in fuel consumption.



EX1302148

Figure 137



EX1302149

Figure 138



WARNING

AVOID DEATH OR SERIOUS INJURY

Wear protective goggles to prevent injury to eyes.

Parts List

Valve

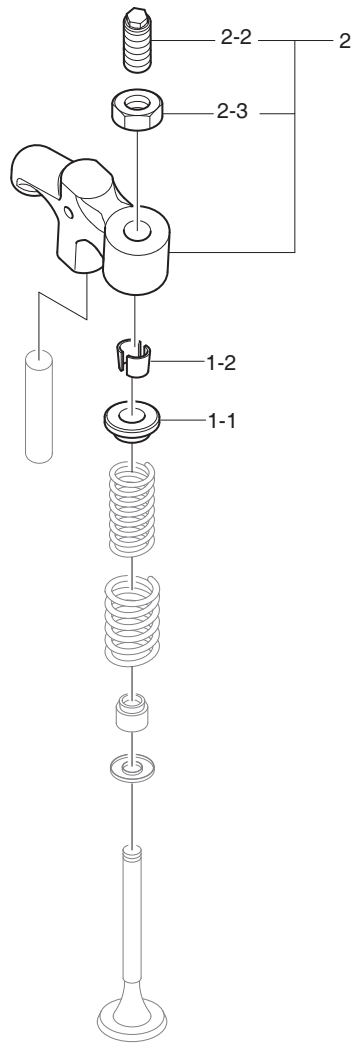


Figure 139

DS1604239

Reference Number	Description
1	Plate; Cotter Assembly
1-1	Plate; Valve Spring
1-2	Cotter; Valve

Reference Number	Description
2	Caliper
2-2	Screw; Adjust
2-3	Nut; Hex

Rocker Arm

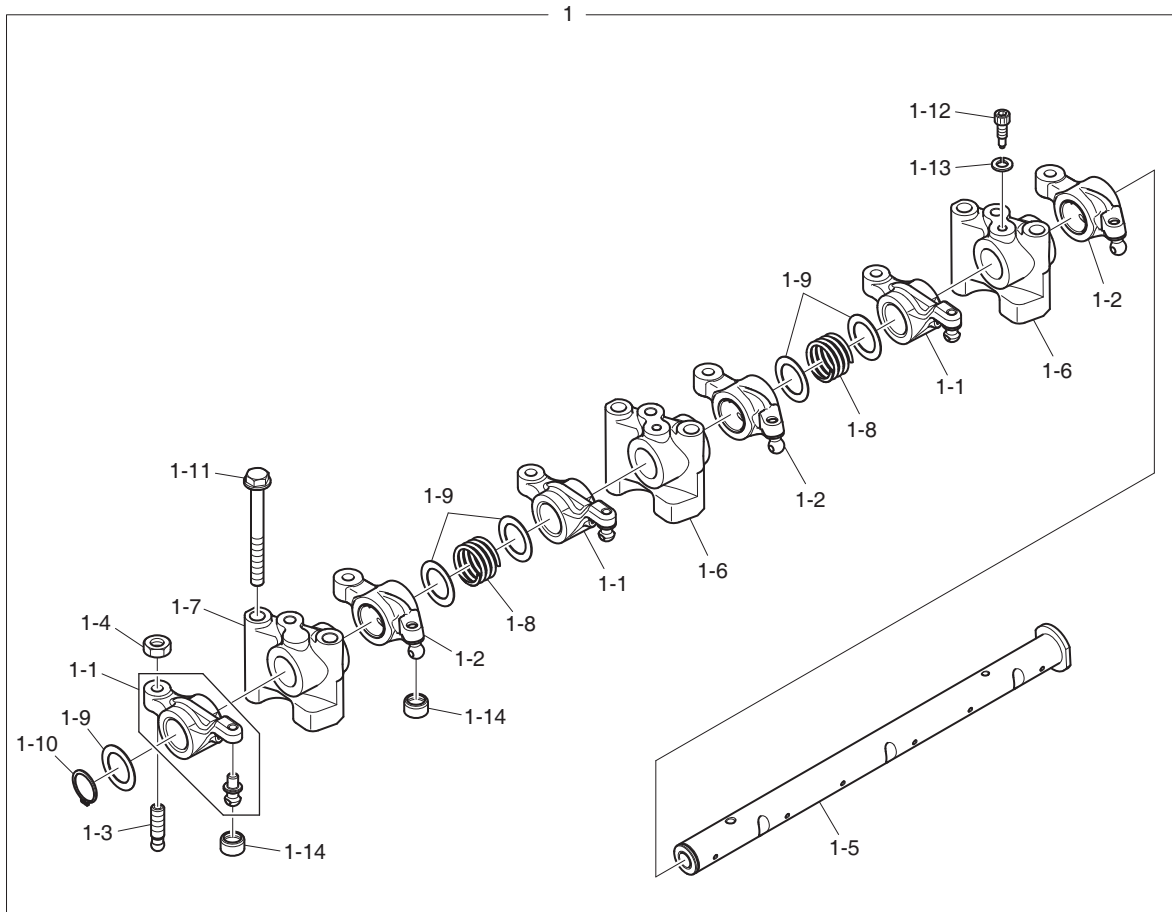


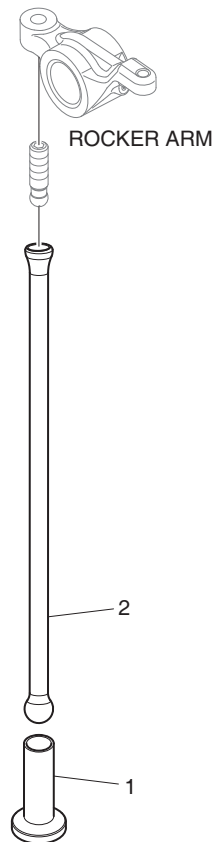
Figure 140

DS1604240

Reference Number	Description
1	Rocker Arm Shaft Assembly
1-1	Arm; Rocker
1-2	Arm; Rocker
1-3	Screw; Adjust
1-4	Nut; Hex
1-5	Shaft; Rocker Arm
1-6	Bracket; Rocker Arm
1-7	Bracket; Rocker Arm

Reference Number	Description
1-8	Spring; Compression
1-9	Washer
1-10	Ring; Snap
1-11	Bolt; Collared Hex
1-12	Bolt; Socket Head
1-13	Washer
1-14	Cap; Adjust Screw

Valve Tappet and Push Rod



DS1604241

Figure 141

Reference Number	Description
1	Tappet; Valve

Reference Number	Description
2	Rod; Push

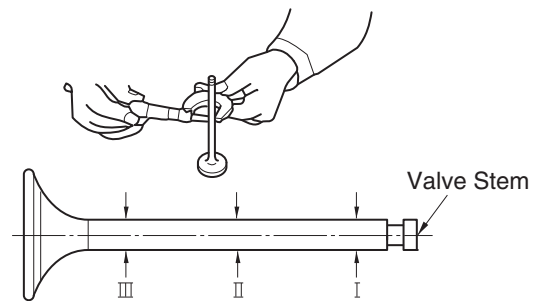
Valve Inspection

Wash the valve with clean engine oil and inspect it as follows:

Valve Stem O.D.

1. Measure the outside diameter of the valve stem at three location (upper, middle and lower points).
2. If the wear amount is over the allowable limit, replace the valve.

	Standard	Allowable Limit
Intake Valve Stem	$\phi 7.963 \sim \phi 7.977 \text{ mm}$	$\phi 7.93 \text{ mm}$
Exhaust Valve Stem	$\phi 7.950 \sim \phi 7.964 \text{ mm}$	$\phi 7.91 \text{ mm}$



EX1403749

Figure 142

Valve Seat Contact Surface

1. Check if the valve seat contact surface is scratched or damaged.
2. If necessary, correct the surface with sandpaper. If damage is severe, replace the seat.

Valve Head Thickness

1. Measure the thickness of the valve head.
2. If the measurement is below the allowable limit, replace the valve.

	Standard	Allowable Limit
Intake Valve (A)	3.3 ~ 3.7 mm	2.8 mm or below
Exhaust Valve (A)	3.3 ~ 3.7 mm	2.8 mm or below

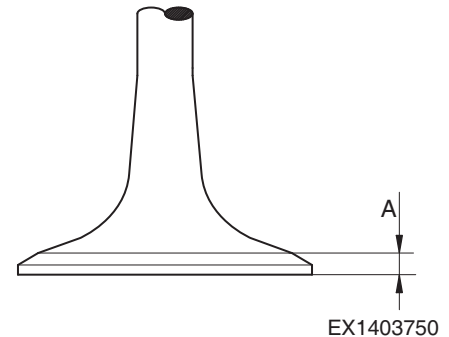


Figure 143

Valve Guide Inspection

1. Install the valve to the cylinder head.
2. Measure the clearance between the valve guide and valve with motion of the valve.
3. If the clearance is excessive, measure the size of the valve and replace either the valve or valve guide which is worn more.
 - Valve stem play

	Standard	Allowable Limit
Intake Valve	0.023 ~ 0.052 mm	0.1 mm
Exhaust Valve	0.036 ~ 0.065 mm	0.15 mm

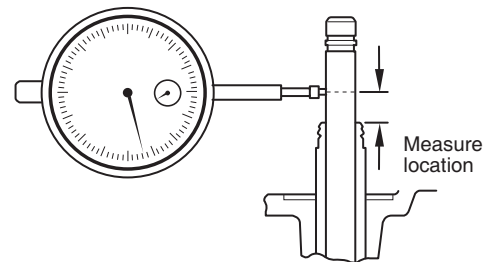


Figure 144

Valve Seat Inspection

Contact area on contact surface.

1. To check the wear level of the valve seat, measure the height of the contact surface from the intake/exhaust valves.
2. If the measurement is over the allowable limit, replace the seat.
3. Install the valve to the valve seat of the cylinder head.
4. Use a dial gauge to measure the amount of insertion of the valve from the bottom of the cylinder head.

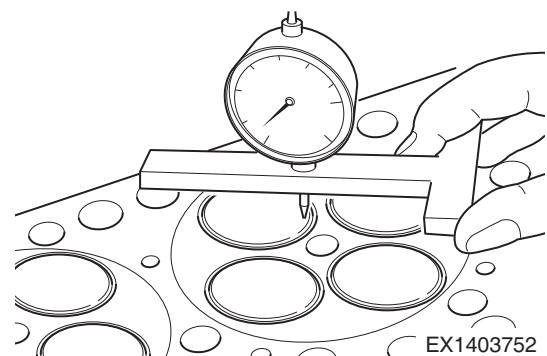


Figure 145

- Valve step portion

	Standard	Allowable Limit
Intake Valve (A)	0 ~ 0.4 mm	0.6 mm
Exhaust Valve (A)	0.3 ~ 0.7 mm	1.0 mm

- Valve angle

Intake valve (B)	Exhaust valve (B)
60°	45°

- If the amount of valve insertion is over the allowable limit, replace the valve seat.
- When removing the valve seat, arc weld two positions of the valve seat and use a special service tool to pull out the valve seat.

NOTE: When replacing the valve seat, it should be bored.

- When installing the valve seat, put it in dry ice for approximately two hours to cool it down.
- Use a bench press to press the valve seat into the cylinder head.
- Apply abrasive to the valve head contact surface of the valve seat.
- Rotate the valve to grind the valve seat until the valve is seated. Then, remove the abrasive thoroughly.

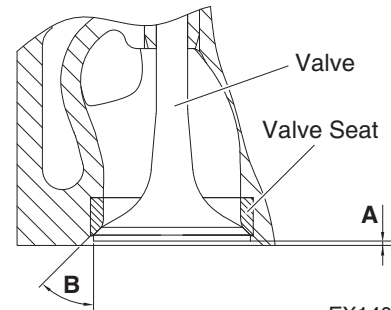


Figure 146

EX1403753

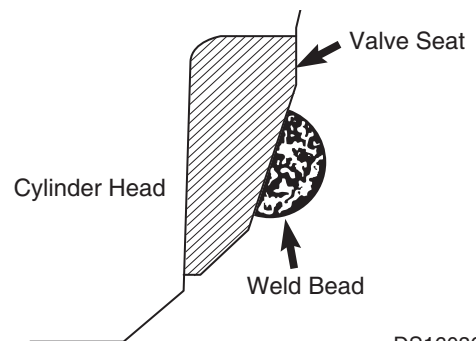


Figure 147

DS1603614

Valve Spring Inspection

- Visually check the outside of the valve spring.
 - Visually check if the valve spring is damaged. Replace it if necessary.
- Check the free length of the valve spring.
 - Use vernier calipers to measure the free length of the valve spring.
 - If the measurement is below the standard value, replace the valve spring.

Free Length of Spring	Standard
Intake Valve	57.9
Exhaust Valve	53.5

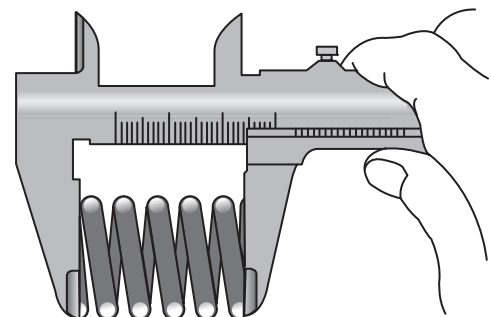


Figure 148

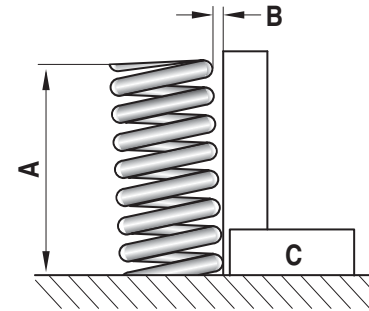
EX1403755

3. Check the squareness of the valve spring.

Reference Number	Description
A	Free Length
B	Squareness
C	Straightedge

- A. Use a surface plate and straightedge to measure the squareness of the valve spring.
- B. If the measurement is over the allowable limit, replace the valve spring.

	Specification	Allowable Limit
Valve Spring Squareness	1.6 mm or below	2.0 mm



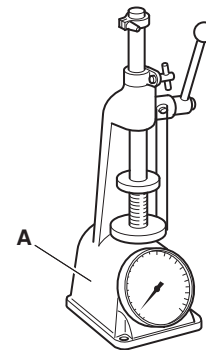
EX1403756

Figure 149

4. Check the tension of the valve spring.

- A. Use a spring tester (A) to measure the tension of the valve spring.
- B. If the measurement is below the allowable limit, replace the valve spring.

Item	Setting Length	Spring Tension	Allowable Limit	
Intake/ Exhaust Valves	Inside	37.1 mm	13.0 kg	±1.5 kg
		24.9 mm	21.4 kg	±2.0 kg
	Out	39.1 mm	21.0 kg	±2.0 kg
		26.9 mm	40.2 kg	±2.5 kg

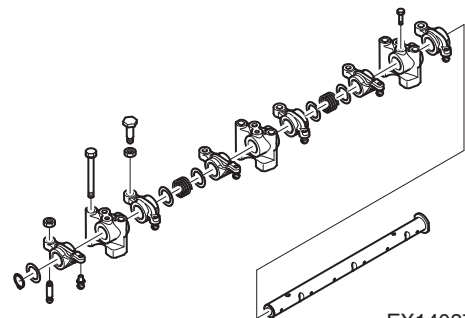


EX1403757

Figure 150

Rocker Arm Removal

1. Use pliers to remove the snap rings from both ends of the rocker arm shaft.
2. Remove the washer, rocker arm bracket, rocker arm spring and rocker arm in order.



EX1403758

Figure 151

Rocker Arm Installation

1. Install the rocker arm in the reverse order of its removal.



CAUTION

AVOID INJURY

- Check if there is any foreign material in the oil feed hole of the rocker arm shaft. Wash it cleanly.
 - Make sure to install the rocker arm in the correct position in the correct order.
-

Rocker Arm Inspection

Visual Inspection

1. Visually check the surface of the adjusting screw cap assembly which moves in contact with the valve stem. Check if the surface is scratched or has worn layers.
2. If the wear level is small, grind the surface with an oily whetstone or fine sandpaper. If the surface has severely worn layers, replace the rocker arm.

Rocker Arm Bushing I.D.

1. Use a micrometer or vernier calipers to measure the inside diameter of the rocker arm bushing.
2. Compare the measurement with the outside diameter of the rocker arm shaft. If the clearance is over the allowable limit, replace either the bushing or shaft which is worn more.

Standard	Allowable Limit
$\varnothing 24.991 \sim \varnothing 25.012$ mm	$\varnothing 25.04$ mm

	Standard	Allowable Limit
Clearance between Rocker Arm and Shaft	0.031 ~ 0.073 mm	0.14 mm or below

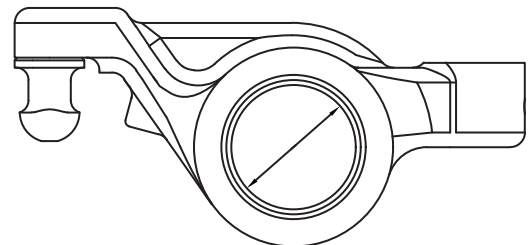


Figure 152

EX1403759

Rocker Arm Shaft Inspection

Deflection of Rocker Arm Shaft

1. Place the rocker arm shaft on two V-blocks and use a dial gauge to measure the deflection of the shaft.
2. If its deflection is minute, use a press to straighten it. If its deflection is over the allowable limit, replace it.

Allowable Limit	0.1 mm
-----------------	--------

Rocker Arm Shaft O.D.

1. Use a O.D. micrometer to measure the outside diameter of the rocker arm shaft at the location where the rocker arm was installed.
2. If the measurement is over the allowable limit, replace the rocker arm shaft.

Standard	Allowable Limit
$\phi 24.939 \sim \phi 24.960$ mm	$\phi 25.90$ mm

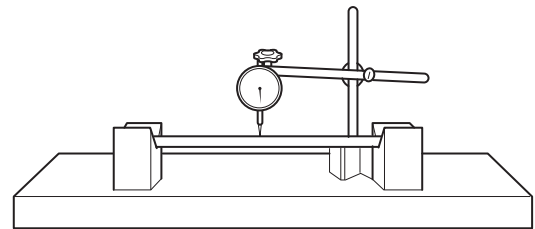


Figure 153

EX1403760

Valve Tappet Inspection

Tappet Clearance

1. Measure the outside diameter of the tappet and the inside diameter of the tappet hole of the cylinder block.
2. If the measurement is over the allowable limit, replace the tappet.

Standard	Allowable Limit
0.035 ~ 0.077 mm	0.13 mm

Visual Inspection of Tappet

1. Visually check the surface of the tappet which moves in contact with the camshaft. Check if the surface is cracked, scratched or damaged.
2. If such damage is minute, grind the surface with an oily whetstone or fine sandpaper. If its surface has severely damaged, replace it.

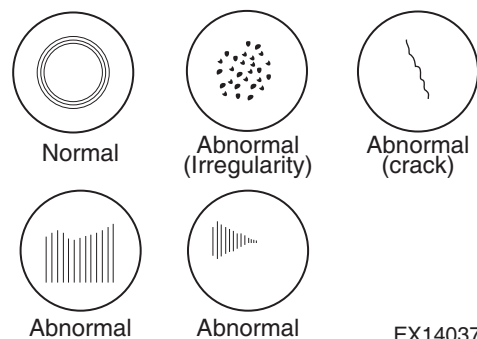


Figure 154

EX1403761

Tappet O.D.

1. Use a O.D. micrometer to measure the outside diameter of the tappet.
2. If the measurement is over the allowable limit, replace the tappet.

Standard	$\varnothing 19.944 \sim \varnothing 19.965 \text{ mm}$
----------	---------------------------------------------------------

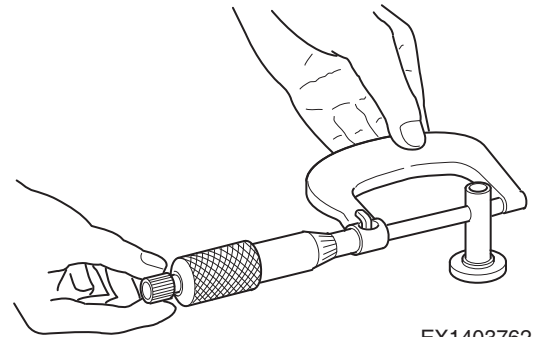


Figure 155

EX1403762

Push Rod Deflection Inspection

1. Place the push rod on the surface plate.
2. Measure its deflection with a feeler gauge while rolling it.
3. If the measurement is over the allowable limit, replace it.

Allowable Limit	0.3 mm or below
-----------------	-----------------

Push Rod Length	327.5 mm
-----------------	----------

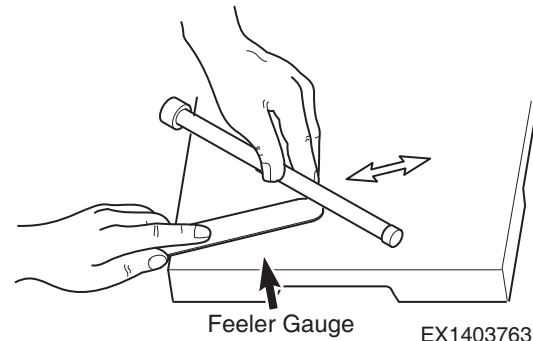


Figure 156

EX1403763

Valve Clearance

Adjust the valve clearance under the following conditions:

- When disassembling the engine or cylinder head,
- When loud noise is heard from the valve connection,
- When the fuel injection system is intact but the engine operates abnormally.

Valve Clearance Adjustment Procedure

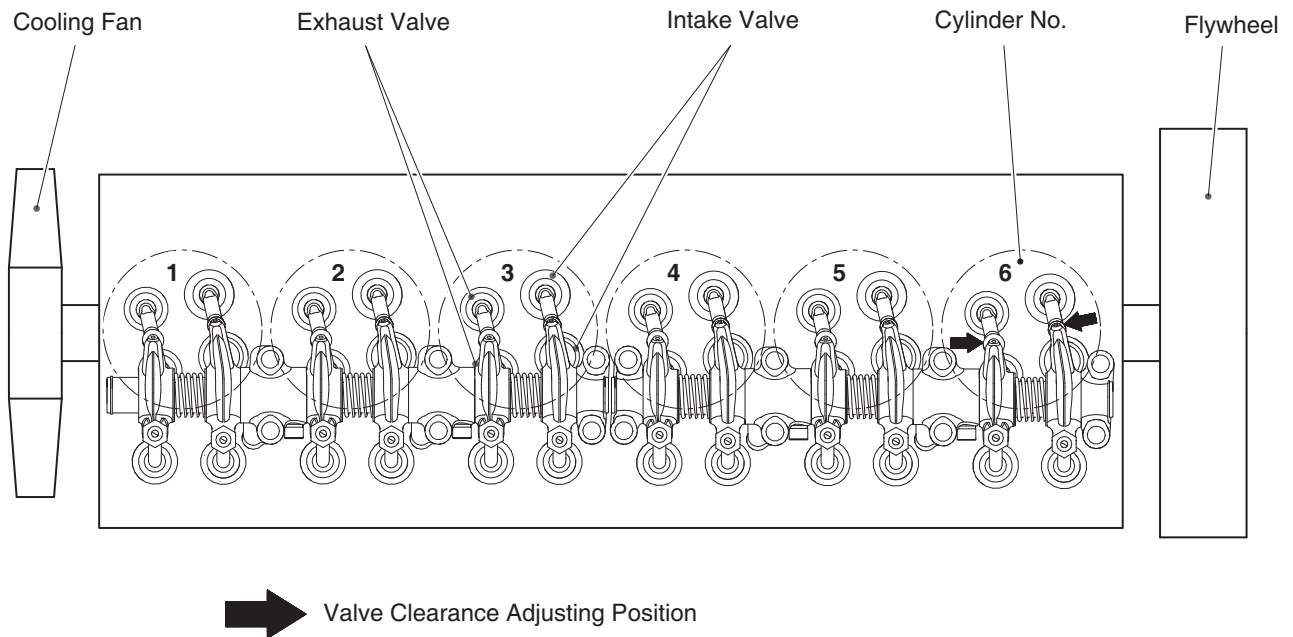


Figure 157

EX1403764

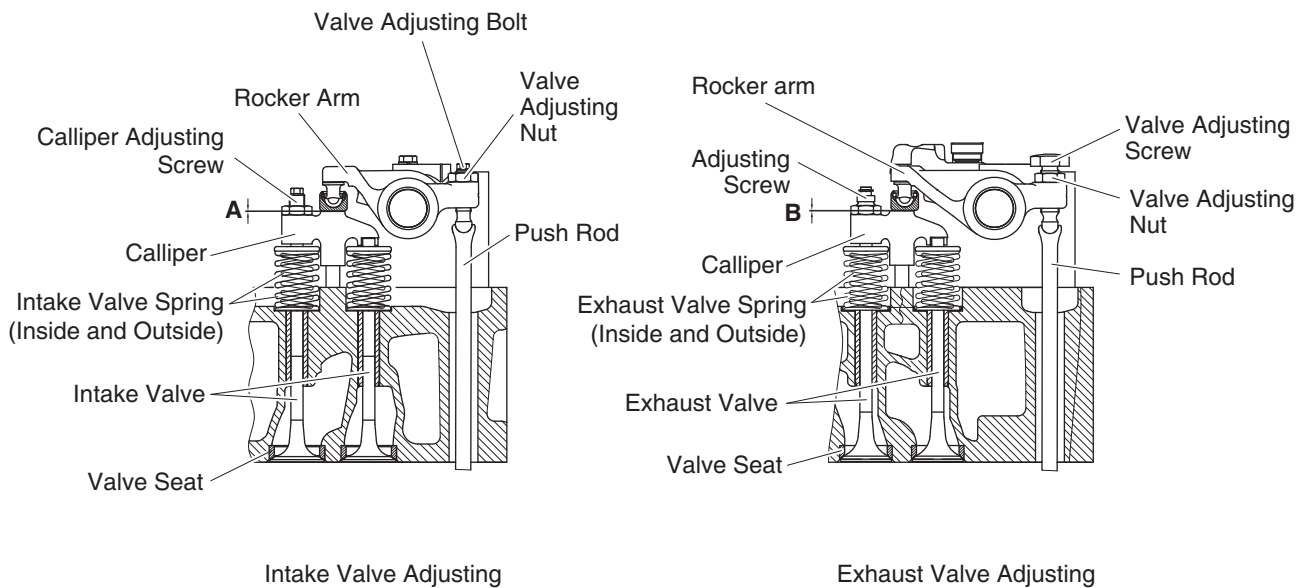


Figure 158

EX1403765

Method 1

1. Turn the crankshaft to set the piston of the cylinder No. 1 to the TDC on the compression stroke.

NOTE: *The cylinder No. 1 can be identified by the cooling fan.*

NOTE: *When the cylinder No. 1 is at the TDC on the compression stroke, valve overlap is occurred at the cylinder No. 6.*

2. Unscrew the rocker arm mounting nut at the cylinder No. 1.
3. Adjust the cylinder clearance with its adjusting nut. Then, tighten the mounting nut.

Intake Valve (mm)	Exhaust Valve (mm)
0.3	0.4

4. Turn the crankshaft to adjust the valve clearance for each cylinder at the TDC on the compression stroke.
5. According to the cylinder in the valve overlap period, adjust the valve clearance for the corresponding cylinder at the TDC on the compression stroke as follows:

Cylinder No. in Valve Overlap Period					
1	5	3	6	2	4
6	2	4	1	5	3
Cylinder No. for Valve Adjustment					

Method 2

1. Turn the crankshaft to set the valves of the cylinder No. 6 overlapped.

NOTE: *When the cylinder No. 1 is at the TDC on the compression stroke, valve overlap is occurred at the cylinder No. 6.*

NOTE: *The cylinder No. 1 can be identified by the cooling fan.*

2. Adjust the valve clearance marked with ' o ' in the table.
3. Rotate the engine for 1 turn (360°) in the engine rotating direction to set the valves for the cylinder No. 1 overlapped.

NOTE: *When the cylinder No. 6 is at the TDC on the compression stroke, valve overlap is occurred at the cylinder No. 1.*

4. Adjust the valve clearance marked with ' x ' in the table.
5. Check the valve clearance again, and adjust it as necessary.

Cylinder No.	1		2		3		4		5		6	
Valve	E	I	E	I	E	I	E	I	E	I	E	I
No. 1 TDC	o	o			o			o	o	o		
Turn 360°			x	x		x	x				x	x

ACTUATING SYSTEM

Camshaft

General Description

The task of the camshaft is to control the opening and closing of the intake and exhaust valves. On engines equipped with the injection system, the camshaft also provides the movement required to build up pressure in the injectors.

Camshaft Design

The camshaft has two or three cams per cylinder. There is always one for intake valves and one for exhaust valves. In some cases, there is also one for the injectors.

A cam can be described with the following terms; see picture:

Reference Number	Description
1	Cam Profile
2	Base Circle Diameter
3	The Largest Lift of the Cam Profile, Equivalent to the Maximum Movement of the Roller Tappet.

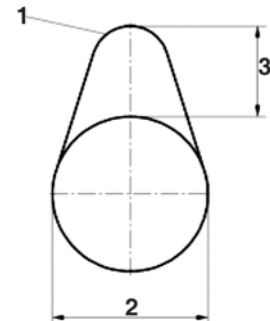


Figure 159

EX1302077

Function

The camshaft rotates at half the speed of the crankshaft so each group of cams can actuate the valves of their cylinder every other engine revolution during the exhaust stroke and intake stroke. Where applicable, the injectors are actuated in relation to injection timing.

Valve transition occurs at the arrow. This is when the exhaust valves are closing and the intake valves are starting to open. The time point when both the exhaust valves and the intake valves are open simultaneously is called valve overlap.

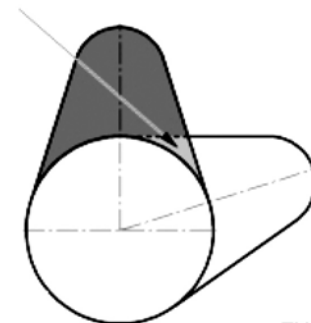


Figure 160

EX1302078

Camshaft Play

1. Move the camshaft gear to the opposite side of the cylinder block.
2. Use a feeler gauge to measure the clearance between the thrust plate and camshaft gear.
3. If the play is excessive, replace the thrust plate.

Standard	Allowable Limit
0.293 ~ 0.417 mm	0.5 mm

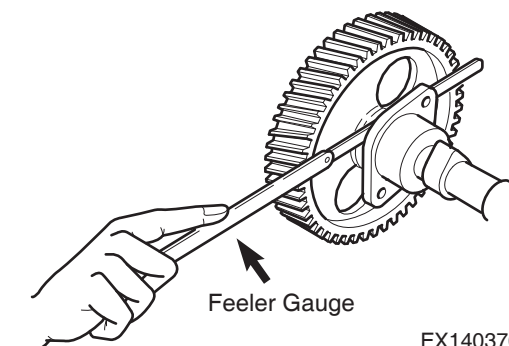


Figure 161

EX1403766

Inspection

Measure the height of the cam lobe.

1. Use a micrometer to measure the cam lobe height and journal diameter.
2. If the measurement is below the allowable limit, replace the camshaft.

		Standard	Allowable Limit
Cam Lobe Height (C)	Intake	48.796 mm	48.5 mm
	Exhaust	49.170 mm	48.87 mm
Cam Journal Diameter (A and B)		ø57.86 ~ ø57.88 mm	ø57.58 mm

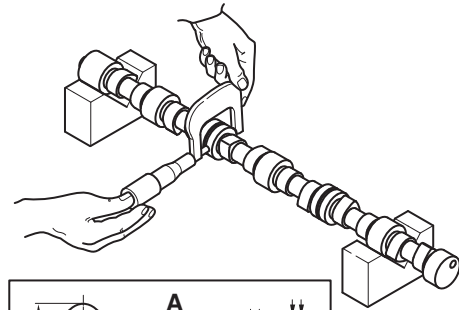


Figure 162

EX1403767

Check the cam surface.

1. Check if the cam surface is scratched or damaged.
2. Minutely worn layers or small damage can be corrected with an oily whetstone or fine oily sandpaper. If damage is severe, replace it.

Clearance between camshaft and bearing.

1. Use an O.D. micrometer to measure the outside diameter of the camshaft bearing section.
2. Use a cylinder I.D. gauge to measure the inside diameter of the camshaft bearing, and compare the measurement result with the outside diameter of the camshaft to calculate the clearance.
3. If the measurement is over the allowable limit, replace the camshaft bearing.

Standard	Allowable Limit
0.05 ~ 0.128 mm	0.18 mm

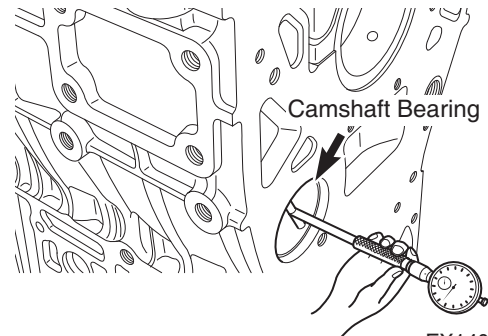


Figure 163

EX1403768

Camshaft deflection

1. Place the camshaft on two V-blocks.
2. Use a dial gauge to check the deflection of the camshaft. Correct it as necessary.
3. If its deflection is excessive and cannot be corrected, replace it.

Standard	Allowable Limit
0.05 mm	0.15 mm

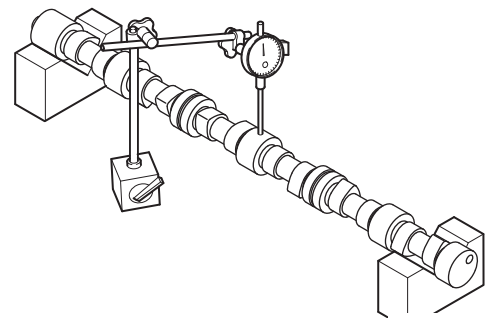


Figure 164

EX1403769

Piston

General Description

The piston moves in a reciprocating motion in the cylinder block to receive high-pressure high-temperature gas in the combustion stroke and produce rotating power for the crankshaft through the connecting rod. Its head is designed to withstand hot combustion gas and high pressure, and three to four piston rings are fitting around its top to ensure its sealing and to prevent oil entrance into the combustion chamber.

As it needs to move up and down in the cylinder at a high speed repeatedly, it needs to be light and robust and have low thermal expansion characteristic.

- The piston is an important component that receives higher combustion pressure, So it is necessary to scrap it if the head or pin hole part involves even a tiny scratch.
- Sometimes, the assembly can be done upside down since the shapes of the top and bottom side are similar. So, the assembly work requires attention.
- If the assembly is complete upside down, the piston may run abnormally, which leads to higher consumption of oil, increase of bypass gas, damage to the ring, and sometimes even stand burn of the engine. Therefore, the whole assembly process needs to take great care.

Parts List

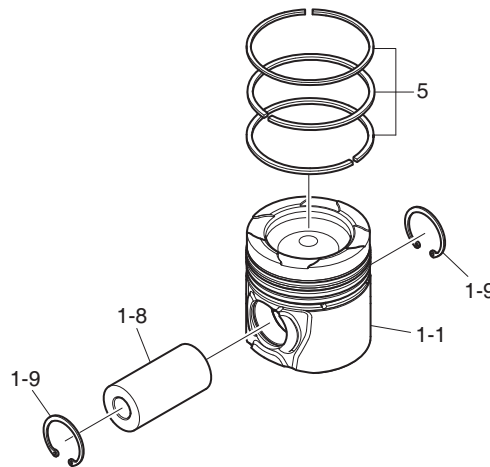


Figure 165

DS1604242

Reference Number	Description
1	Piston Assembly
1-1	Piston
1-8	Pin; Piston

Reference Number	Description
1-9	Ring; Locking
5	Ring Kit, Piston

Disassembly

Disassemble the piston according to the specified disassembly steps.

Assembly

Assemble the piston according to the specified assembly steps.

Piston Inspection

Visual inspection

1. Visually inspect the piston for a crack, scratch and wear.
2. Especially, check if the ring groove is worn.

Clearance between piston and cylinder liner

1. Use an O.D. micrometer to measure the outside diameter of the piston at the position 12 mm up from the bottom of the piston in the orthogonal direction of the piston pin hole.

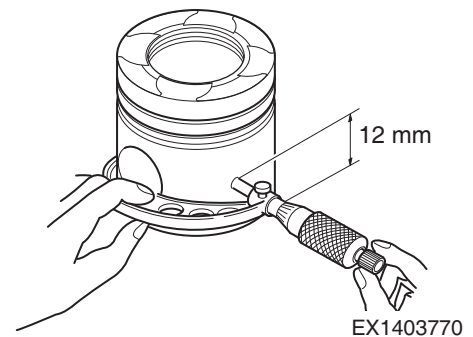


Figure 166

2. Use a cylinder I.D. gauge to measure the inside diameter of the cylinder liner.
3. Perform the measurement at 3 locations of the cylinder liner: the top ring contact section, middle section, and oil ring contact section around the B.D.C. in the 45° direction.
4. Calculate the average value from the measurement results and exclude the maximum and minimum values.
5. The clearance can be calculated by subtracting the outside diameter of the piston from the inside diameter of the cylinder liner.

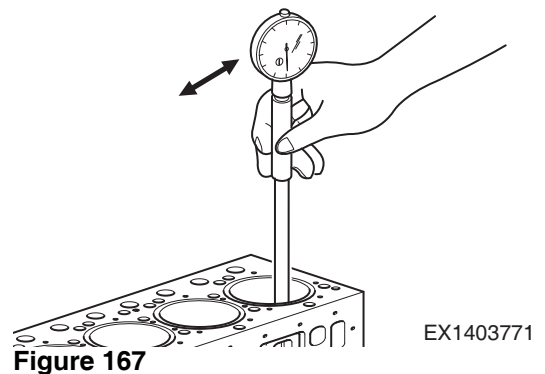


Figure 167

- If this value is over the allowable limit, replace either the piston or cylinder liner which is worn more.

Clearance between Piston and Liner	
Standard	0.213 ~ 0.249 mm

Piston Ring Inspection

Visual Inspection

If any worn or damaged piston ring is found during disassembling the engine, replace it with a new one.

Piston Ring Gap

- Insert the piston into the top of the cylinder at a right angle to the cylinder liner wall.
- Use a feeler gauge to measure the piston ring gap.

	Specification	Allowable Limit
Ring No. 1	0.30 ~ 0.50 mm	1.5 mm
Ring No. 2	1.20 ~ 1.35 mm	1.5 mm
Oil Ring	0.30 ~ 0.50 mm	1.5 mm

- If the piston ring gap is over the allowable limit, replace the piston ring with a new one.

Piston Ring Side Clearance

- Install the compression ring and oil ring to the piston's ring groove.
- Use a feeler gauge to measure the side clearance of the ring.

	Standard	Allowable Limit
Ring No. 1	-	-
Ring No. 2	0.07 ~ 0.105 mm	0.15 mm
Oil Ring	0.05 ~ 0.09 mm	0.15 mm

- If the measurement is over the allowable limit, replace the ring or piston.

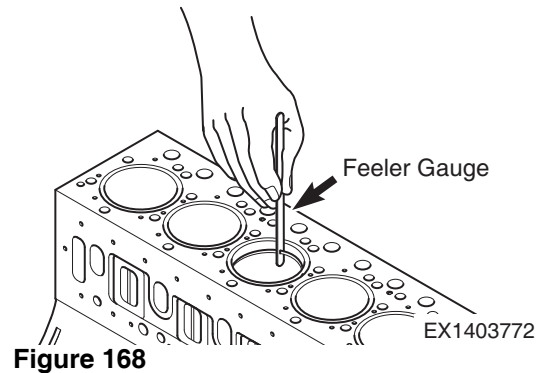


Figure 168

Piston Ring Tension

1. Use a tension gauge to measure the tension of the piston ring.
2. If the measurement is over the allowable limit, replace the piston ring.

	Standard
Ring No. 1	1.57 ~ 2.37 kg
Ring No. 2	1.50 ~ 2.25 kg
Oil Ring	5.09 ~ 6.91 kg

Piston and Piston Pin Inspection

1. Measure the wear amount of the piston pin.
2. If the measurement is over the allowable limit, replace the pin.

Standard Value for Piston Pin	Allowable Limit
ø43.994 ~ ø44.000 mm	ø43.94 mm

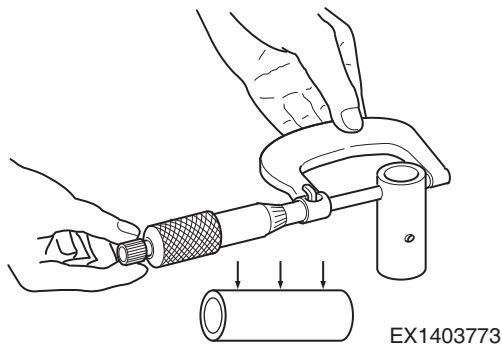


Figure 169

3. Measure the clearance between the piston pin and connecting rod bushing.
4. If the measurement is over the allowable limit, replace either one of them which is worn more.

Standard	Allowable Limit
0.008 mm	0.08 mm

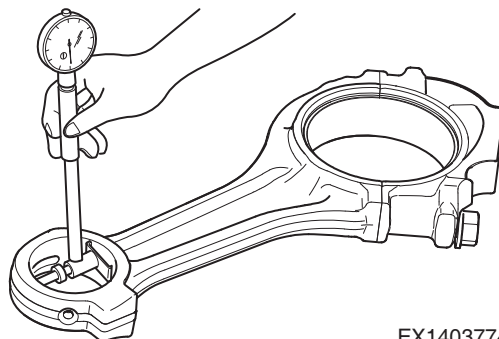


Figure 170

5. Check the mounting status of the piston and piston pin.

IMPORTANT

If the piston needs to be replaced, replace the piston pin as well.

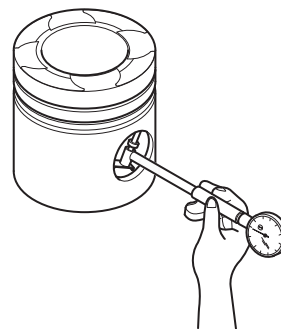


Figure 171

Connecting Rod

General Description

The connecting rod is designed to convert the vertical reciprocating motion of the piston into the rotating motion of the crankshaft. As it is subject to powerful explosive force, it needs to be rigid.

Its one end matched with the piston is called "small end" while its the other end matched with the crankshaft is called "big end." The big end is split in two parts which are put together with a bolt. As the big end is connected to the rotating crankshaft, its inner side is fitted with a replaceable metal bearing.

Parts List

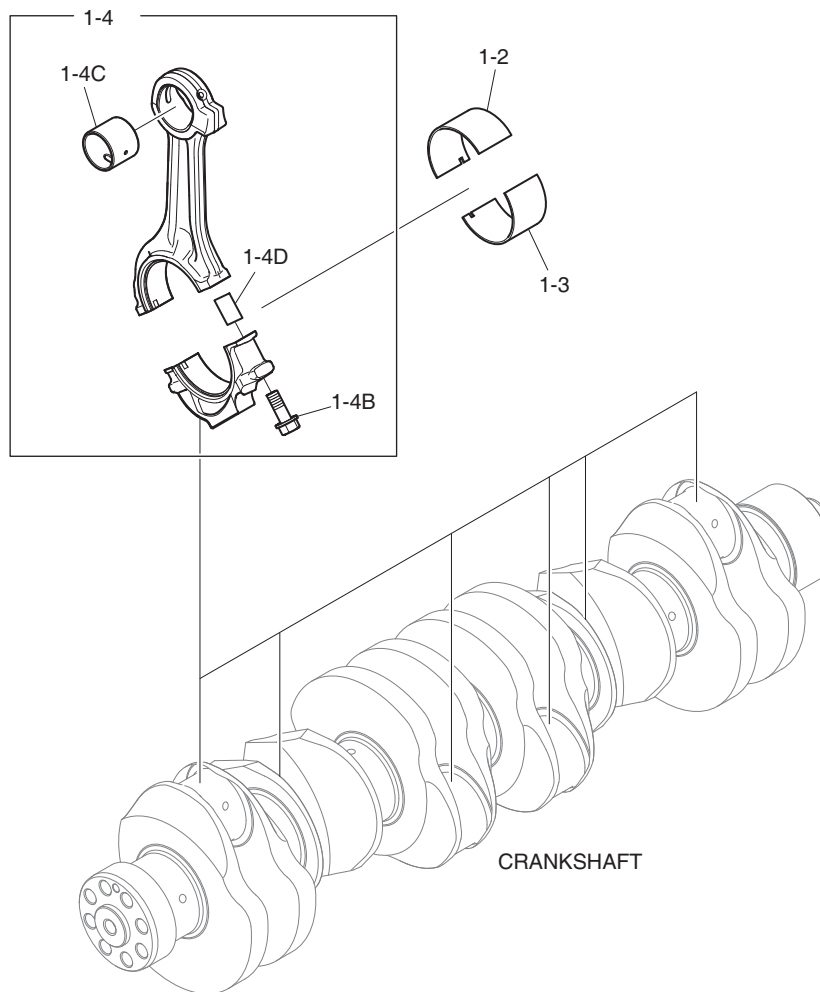


Figure 172

DS1604243

Reference Number	Description
1	Piston Assembly
1-2	Metal, Rod Con. (STD-upper)
1-2	Metal, Rod Con. (Upper-0.25)
1-2	Metal, Rod Con. (Upper-0.50)
1-3	Metal, Rod Con. (STD-low)
1-3	Metal, Rod Con. (Low-0.25)

Reference Number	Description
1-3	Metal, Rod Con. (Low-0.50)
1-4	Rod Assembly, Connecting
1-4B	Bolt; Connecting Rod
1-4C	Bushing, Connecting Rod
1-4D	Pin; Dowel

Inspection

Distortion

1. Check the distortion of the connecting rod.
2. Fit the connecting rod to its measuring device and use a feeler gauge to check its distortion.
3. If the connecting rod is distorted, do not reuse it, but replace it with a new one.

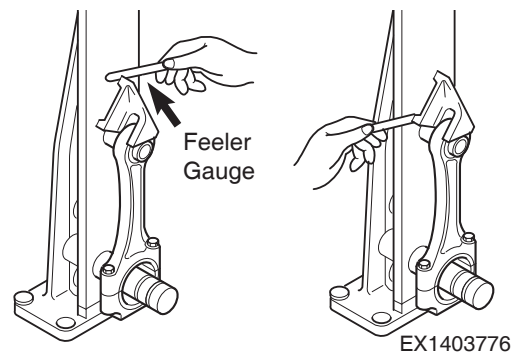


Figure 173

Hole Parallelization

1. Measure the parallelization of the small end bushing hole and big end bearing hole of the connecting rod.

NOTE: Use the connecting rod measuring device and feeler gauge for this measurement.

Standard	Allowable Limit
0.02 mm	0.1 mm or below

Wear

1. Install the connecting rod to the crankshaft.
2. Use a feeler gauge to measure the side clearance at the big end of the connecting rod.
3. Install the connecting rod to the piston.
4. Measure the side clearance at the small end of the connecting rod.
5. If the measurement is over the allowable limit, replace the connecting rod.

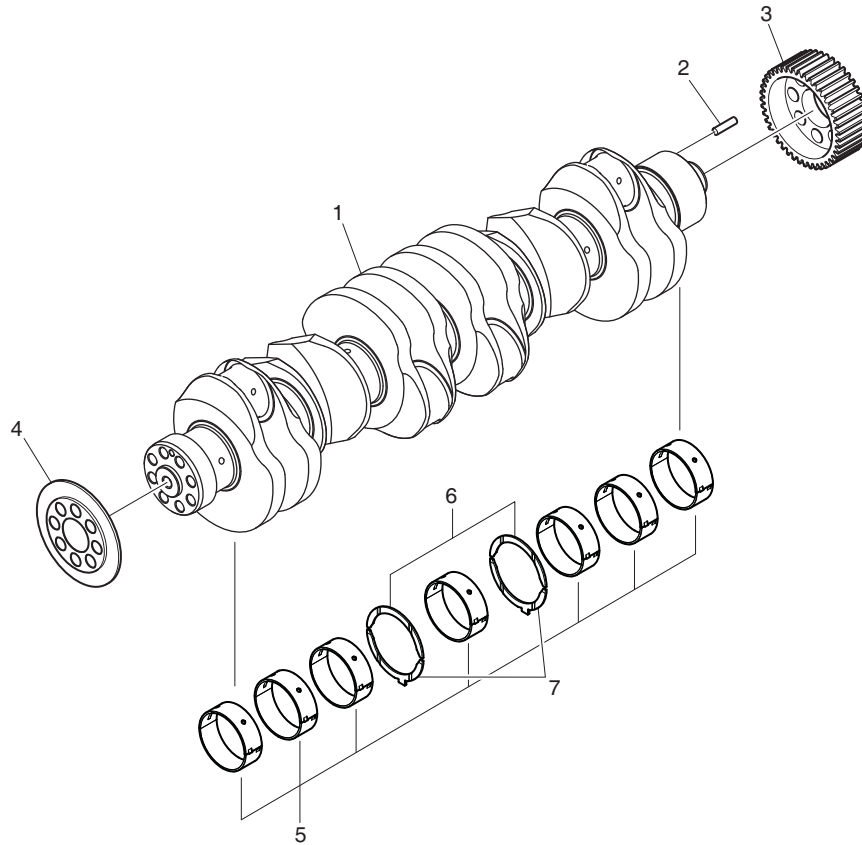
Standard	Allowable Limit
0.17 ~ 0.248 mm	0.50 mm

Crankshaft

General Description

The crankshaft is used to convert power from the piston to rotating torque through the connecting rod and transfer this torque through the flywheel. Other than in the explosion stroke, it transfers movement back to the piston, and it transfers rotating torque to it to drive the oil pump, water pump and high-pressure fuel pump.

Parts List



DS1604244

Figure 174

Reference Number	Description
1	Crankshaft
2	Pin; Dowel
3	Gear, Crankshaft
4	Holder, Oil Seal
5	Metal, Main

Reference Number	Description
5	Metal, Main (0.25)
5	Metal, Main (0.50)
6	Washer, Thrust
7	Washer, Thrust

Inspection

Inspection for Defect

1. Visually check the crankshaft journal and crank pin for a scratch or crack.
2. Perform the magnetic particle test or dye penetrant test (color check) to check the crankshaft for a crack. If the crankshaft is cracked, replace it.

Wear Measurement

1. Use a O.D. micrometer to measure the journal and pin of the crankshaft in the specified direction as illustrated to check its wear amount.
2. If the wear amount is over the allowable limit, grind the crankshaft to install an undersized bearing.
3. However, if the wear amount is within the allowable limit, correct it with an oily whetstone or fine oily sandpaper.

NOTE: Use a sandpaper soaked in oil.

	Standard	Allowable Limit
Journal O.D.	$\phi 83.966 \sim \phi 83.988$ mm	$\phi 82.966$ mm
Pin O.D.	$\phi 70.971 \sim \phi 70.990$ mm	$\phi 69.971$ mm

4. If the pin wear amount is over the allowable limit, grind the crank journal and crank pin and use an undersized bearing.

NOTE: Use a sandpaper soaked in oil to grind the crankshaft.

5. There are four types of undersized bearings. The crankshaft can be reused by grinding it according to the undersized bearing to be used.

- Standard
 - 0.25 (I.D.: 0.25 mm smaller than standard)
 - 0.50 (I.D.: 0.50 mm smaller than standard)
 - 0.75 (I.D.: 0.75 mm smaller than standard)
 - 1.00 (I.D.: 1.00 mm smaller than standard)

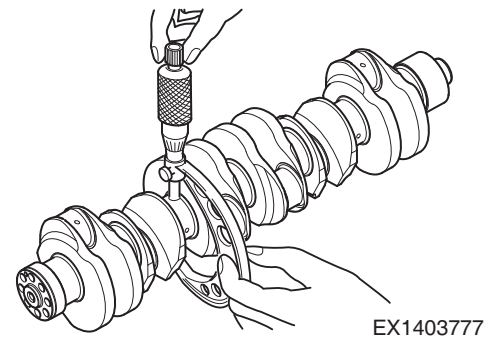


Figure 175

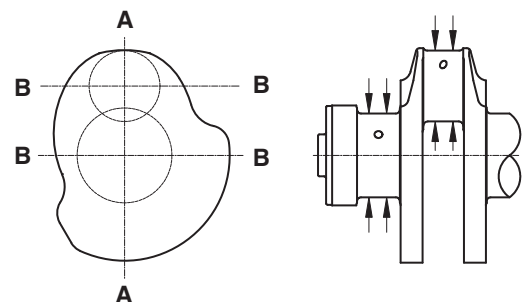
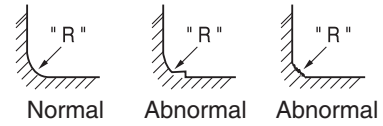
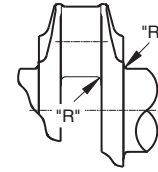


Figure 176

6. Standard for section "R"
 - Crank pin section "R": 4.5 °
 - Crank journal section "R": 4.0 °

IMPORTANT

When grinding the crankshaft, the section "R" at the end of the bearing should be precisely ground. There should be no step or rough surface.



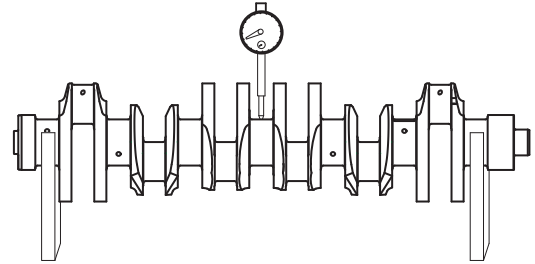
EX1403779

Figure 177

Crankshaft Deflection

1. Place the crankshaft on two V-blocks.
2. Place a dial gauge on the surface plate. While turning the crankshaft, measure the deflection of the crankshaft.

Standard	Allowable Limit
0.06 mm	0.1 mm or below



EX1403780

Figure 178

Crankshaft Bearing and Connecting Rod Inspection

Visual Inspection

Visually check the crankshaft bearing and connecting rod bearing for a scratch, abnormal wear or damage.

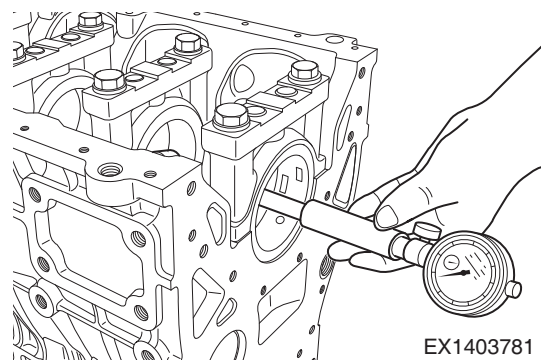
Oil clearance between crankshaft and bearing (method 1: using dial gauge):

1. Main bearing clearance
 - A. Install the main bearing to the cylinder block, tighten the bearing cap to the specified torque, and measure the inside diameter.

Torque	294.1 N.m (30 kg.m, 216.9 ft lb)
--------	----------------------------------

- B. Compare the inside diameter of the main bearing with the outside diameter of the crankshaft journal to calculate the oil clearance.

Main Bearing Oil Clearance	
Standard	Allowable Limit
0.052 ~ 0.122 mm	0.15 mm



EX1403781

Figure 179

2. Connecting rod bearing clearance

- A. Install the connecting rod bearing to the connecting rod bearing cap, tighten the bolt to the specified torque, and measure the inside diameter.

Torque	176.5 N.m (18 kg.m, 130.2 ft lb)
--------	----------------------------------

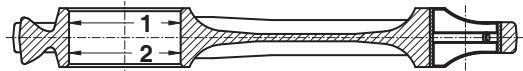
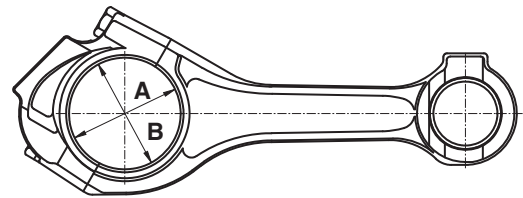
IMPORTANT

When tightening the connecting rod bolt, tighten it with a hand until its head touches the bolt seat of the connecting rod. Then, tighten it finally with a torque wrench.

- B. Compare the two values obtained from measurement of the inside diameter of the connecting rod bearing with the outside diameter of the crankshaft pin to calculate the oil clearance.

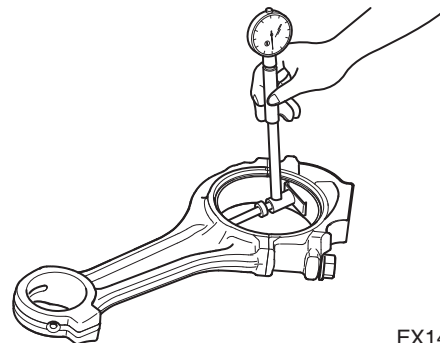
Standard	Allowable Limit
0.034 ~ 0.098 mm	0.15 mm

- C. If the clearance is over the allowable limit, grind the crankshaft journal and pin sections to install an undersized bearing.



EX1403782

Figure 180



EX1403783

Figure 181

Oil Clearance between Crankshaft and Bearing (Method 2: Using Plastigauge):

1. Install the crankshaft onto the cylinder block.
2. Place a plastigauge onto the journal and pin sections of the crankshaft.
3. Install the bearing cap and tighten the bolt to the specified torque.
4. Unscrew the bolt to remove the bearing cap.
5. Measure the thickness of the flat section of the plastigauge with a plastigauge measuring ruler.
6. This is the oil clearance.

Bearing Spread and Crush

1. Inspection

- A. When installing the bearing, check if a large crush is felt.

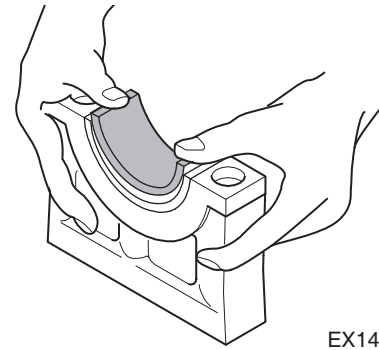


Figure 182

EX1403784

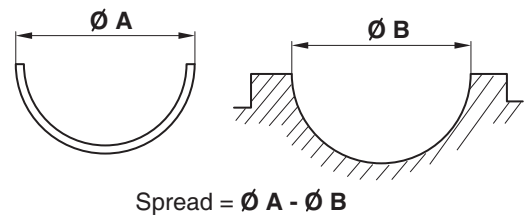


Figure 183

EX1403785

2. Bearing cap crush

- A. Install the bearing and cap to the cylinder block.
- B. Tighten the bolt to the specified tightening torque.
- C. Unscrew one bolt completely and use a feeler gauge to measure the clearance between the bearing cap and cylinder block.

Standard	0.08 ~ 0.110 mm
----------	-----------------

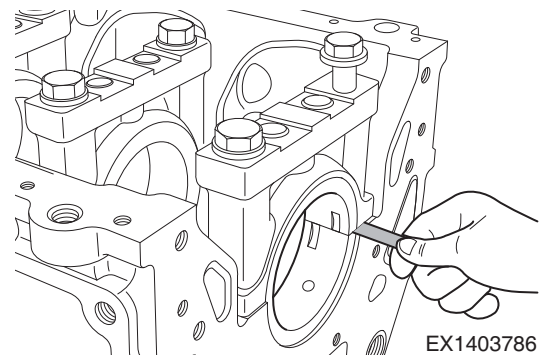


Figure 184

EX1403786

3. Connecting rod bearing crush

- A. Install the bearing and cap to the big end of the connecting rod.
- B. Tighten the bolt to the specified tightening torque.
- C. Unscrew one bolt completely and use a feeler gauge to measure the clearance between the bearing cap and connecting rod big end.

Standard	0.04 ~ 0.07 mm
----------	----------------

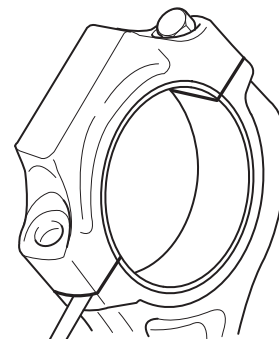


Figure 185

EX1403787

4. Axial play of crankshaft

- A. Install the crankshaft onto the cylinder block.
- B. Use a dial gauge to measure the axial play of the crankshaft.

Standard	Allowable Limit
0.15 ~ 0.289 mm	0.5 mm

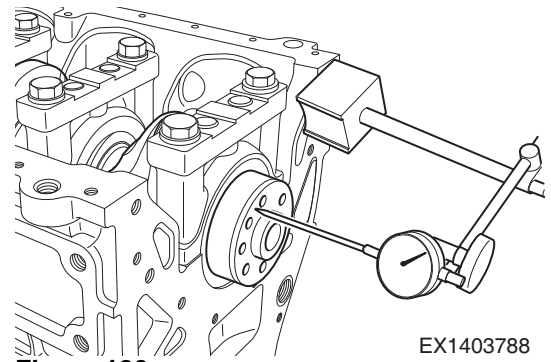


Figure 186

EX1403788

Timing Gear

Overview

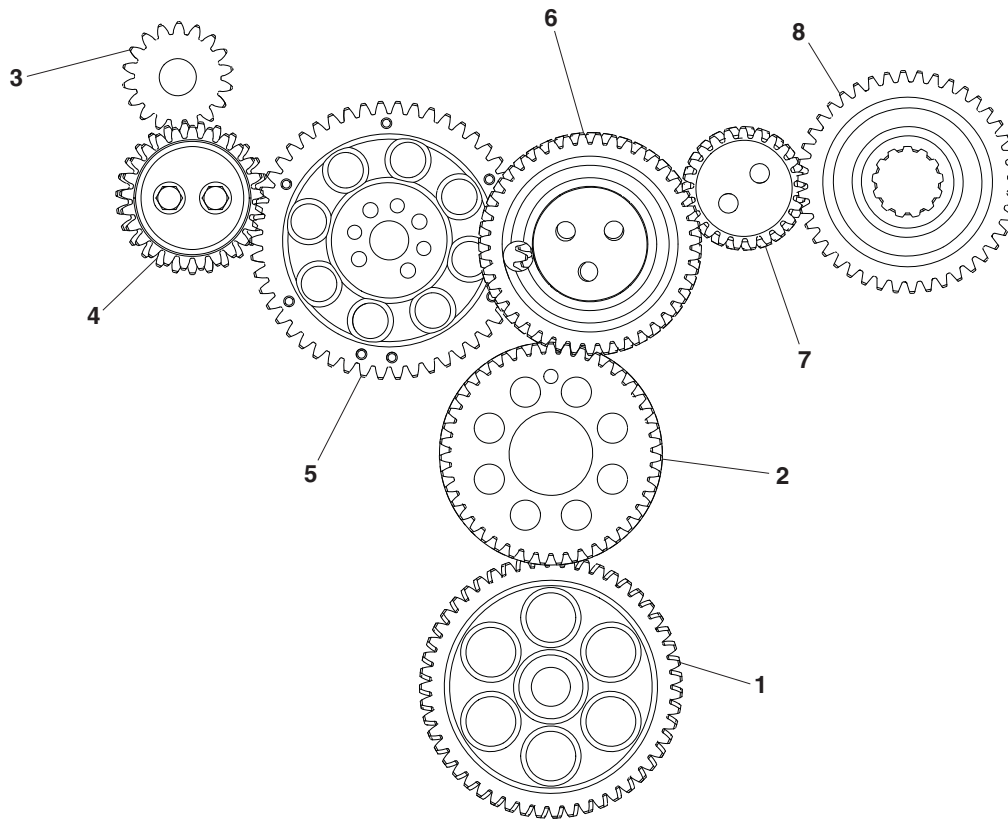


Figure 187

DS1604245

Reference Number	Description	Number of Teeth
1	Oil Pump Gear	51
2	Crankshaft Gear	43
3	Fuel Pump Gear	18
4	Fuel Pump Idle Gear	25
		27
5	Camshaft Gear	50

Reference Number	Description	Number of Teeth
6	Step Idle Gear	43
		25
7	Idle Gear	23
8	Fan Pump Driving Gear	43

Function

The timing gears are located at the rear end of the engine. Important components such as the unit injector and valve mechanism require precise control. They are attached to the rear end of the crankshaft, close to the flywheel, where the crankshaft rotation is the smoothest.

The crankshaft gear drives step idle gear. The step idle gear drives camshaft gear (5) and idle gear (7).

LUBRICATION SYSTEM

General Information

General Description

This engine is a forced lubrication type. Oil pressure is generated and supplied by rotation of the oil pump gear which is engaged with the crankshaft gear on the back of the cylinder block. The oil pump receives oil from the oil pan through the suction pipe to send it to the main passage of the cylinder block through the oil filter and oil cooler. Then, it is distributed to the crankshaft bearing, camshaft bearing and rocker arm for lubrication. Also, as the turbocharger is connected to the engine lubrication circuit, it receives oil for engine brake operation. Lubricant is sprayed around the cylinder block and timing gear. Each cylinder is equipped with its own oil spray nozzle to cool down the internal section of the piston. Engine oil is filtered by the oil filter.

Overview

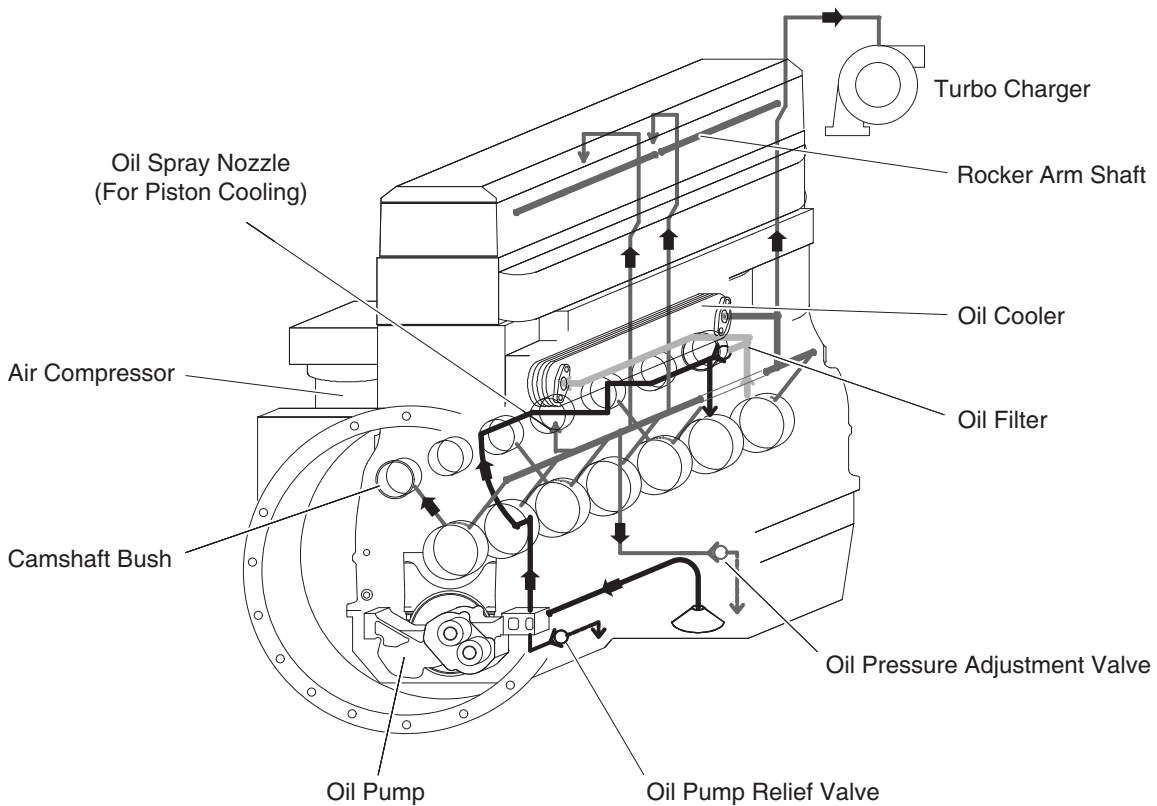


Figure 188

DS1604246

Purpose of Lubrication by Oil

1. Reduction of friction (Prevention of abrasion)

Lubrication maintains the least possible level of friction, and forms a stronger oil film in a critical state to prevent the surface friction on the perturbed section and subsequent defacement.
2. Sealing function

Prevents the leak of gas under a high-pressure in concurrence with the piston ring, just as in the cylinder lubrication.
3. Cooling function

Regionally absorbs the heat from parts located on higher spots, and discharge the heat again in a proper temperature through the oil cooler and other units
4. Stress dispersing function

Provides momentarily and regionally a great pressure to lubricated parts to destroy the oil film and raise adherence. At this point, the lubricant disperses the local pressure across the entire oil
5. Anti-rust function

Forms a lubricant film to keep any moisture from infiltrating into the lubricated surface to produce rust.
6. Oil purifying function

This absorbs alien materials such as carbon or metals produced at lubricated parts and store them in the oil filter

Applicable Oil

Use only specified engine oil according to the environment and condition of the area.

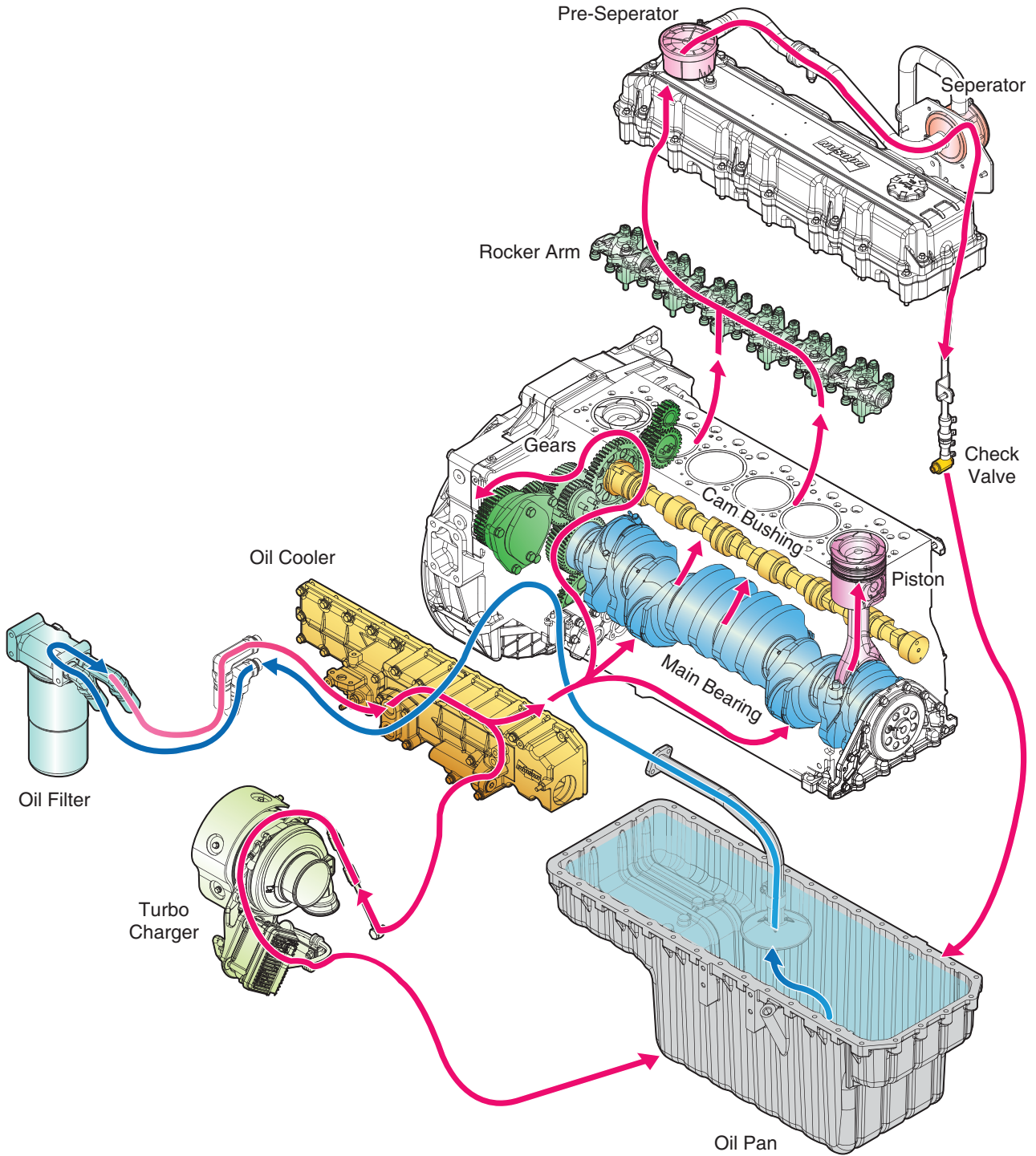
Ambient Temperature											
-58	-40	-22	-4	14	32	50	68	86	104	122	°F
-50	-40	-30	-20	-10	0	10	20	30	40	50	°C

Make sure to use proper engine oil according to the following recommendation.

Oil Classification	Oil Grade	Capacity (L/U.S.gal.)		
		Maximum	Minimum	Total
SAE 15W40	API CJ-4	39/10.3	26/6.9	42/11.1

NOTE: Make sure to use the recommended genuine oil.
Total capacity of engine oil includes 3.0 liter in engine.

Oil Lubricant Circuit



DS1604279

Figure 189

Oil Pan

Parts List

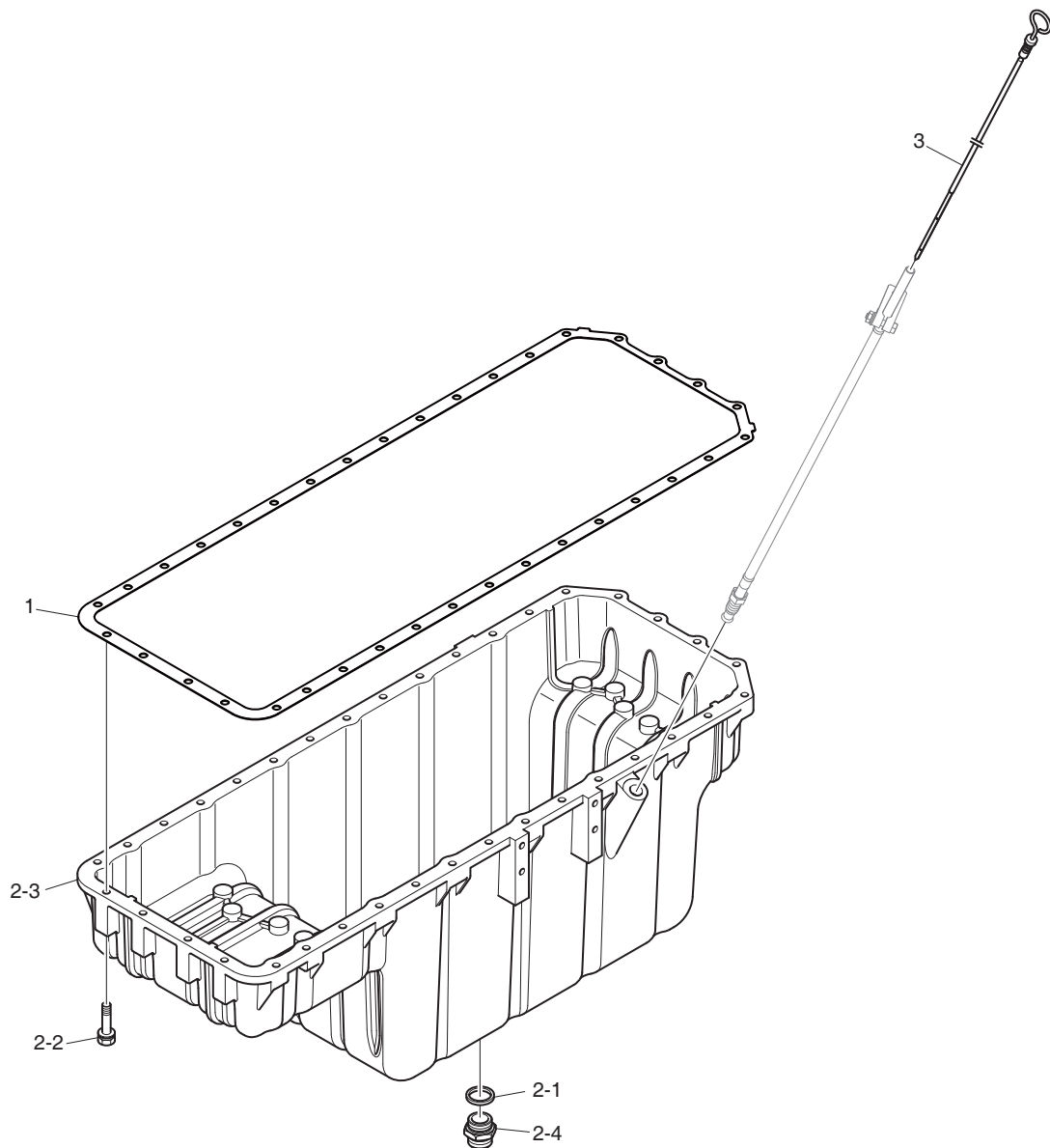


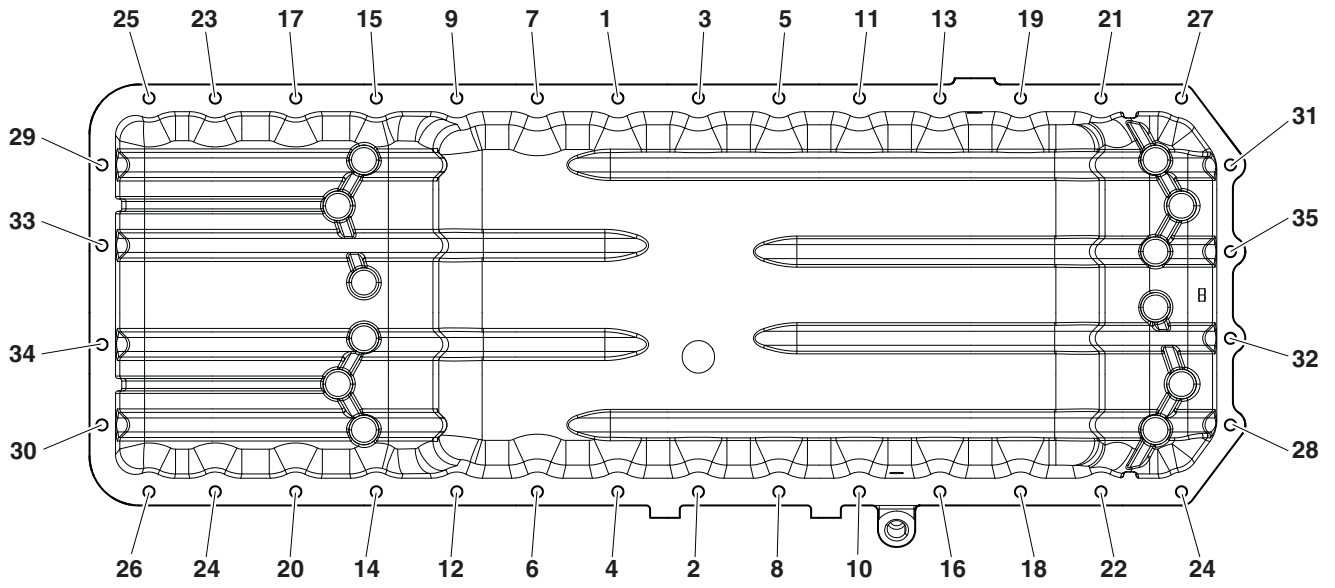
Figure 190

DS1604247

Reference Number	Description
1	Gasket, Oil Pan
2	Oil Pan Assembly
2-1	Seal; Ring
2-2	Bolt, Hex Flange

Reference Number	Description
2-3	Oil Pan
2-4	Joint; Drain
3	Gauge; Oil Level

Tightening Sequence



DS1604248

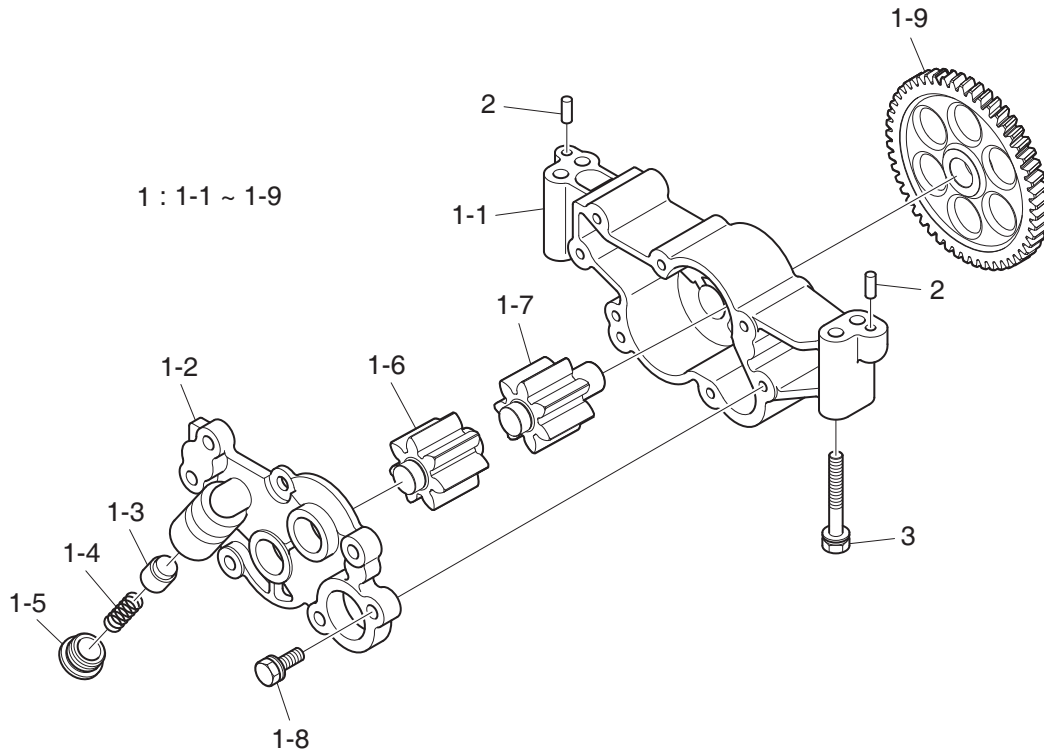
Figure 191

Oil Pump

General Description

Engine oil is sucked from the oil pan by the gear type oil pump and then all of the oil is forcibly delivered to the oil cooler and filter for filtering. The filtered oil passes through the main oil path of the cylinder block and lubricates bearing parts and the turbocharger of the engine in order to maintain normal engine performance.

Parts List



DS1604250

Figure 192

Reference Number	Description
1	Pump Assembly, Oil
1-1	Housing
1-2	Cover
1-3	Plunger
1-4	Spring, Compression
1-5	Screw, Plug

Reference Number	Description
1-6	Gear, Oil Pump
1-7	Gear, Oil Pump
1-8	Bolt Assembly
1-9	Gear, Oil Pump Drive
2	Pin, Dowel
3	Bolt Assembly

Disassembly

1. Remove the oil pump drive gear.
 - A. Loosen the screw to remove the oil relief valve.
 - B. Unfold the lock washer of the oil pump drive gear to remove the mounting nut and washer.
 - C. Remove the drive gear.
2. Unscrew the mounting nut of the oil pump cover to remove the oil pump cover.

NOTE: *The oil pump cover is fixed to the body with 2 retaining pins.*
3. Remove the drive gear and driven gear.

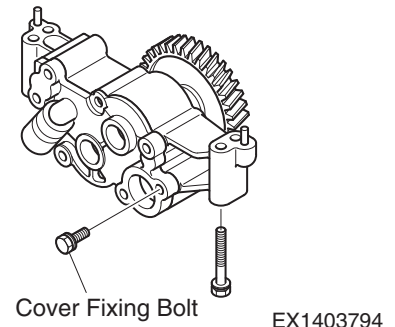


Figure 193

Assembly

Assemble in the reverse order of disassembly.

Inspection

1. Use a steel ruler and feeler gauge to measure the axial play of the oil pump gear. If the measurement is over the allowable limit, replace it.

Allowable Limit	0.055 ~ 0.105 mm
-----------------	------------------

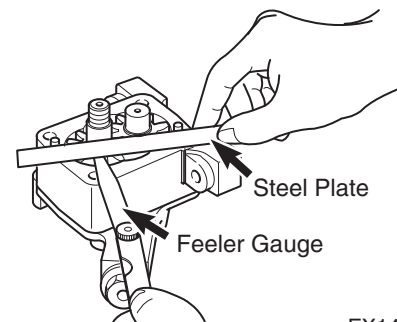


Figure 194

2. Use a feeler gauge to measure the backlash between the drive gear and driven gear of the oil pump. If the measurement is over the allowable limit, replace it.

Standard	0.312 ~ 0.476 mm
Allowable Limit	0.64 mm

3. Measurement of clearance between drive shaft and bushing
 - A. Measure the outside diameter of the drive shaft. If any measurement is below the allowable limit, replace the corresponding part.

Standard	$\varnothing 21.936 \sim \varnothing 21.95$ mm
Allowable Limit	$\varnothing 21.90$ mm

- B. Measure the inside diameter of the pump body bushing and the outside diameter of the shaft. Compare this measurement with the standard oil clearance value to determine the necessity of replacement.

Allowable Limit	0.075 ~ 0.127 mm
-----------------	------------------

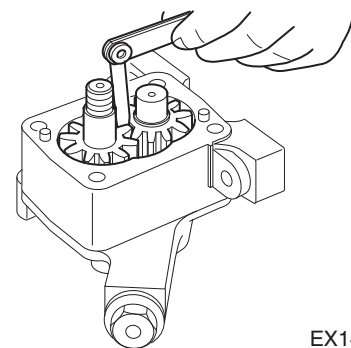


Figure 195

Oil Filter

General Description

As engine oil is sent from the oil pump to each part, it circulates in the engine for lubrication, rust prevention, cooling, cleaning, sealing and stress dispersion. After it circulates in the engine, it may contain foreign materials. Therefore, an oil filter is installed between the oil pan and cylinder or in the middle of the flow passage to remove foreign materials from it.

Parts List

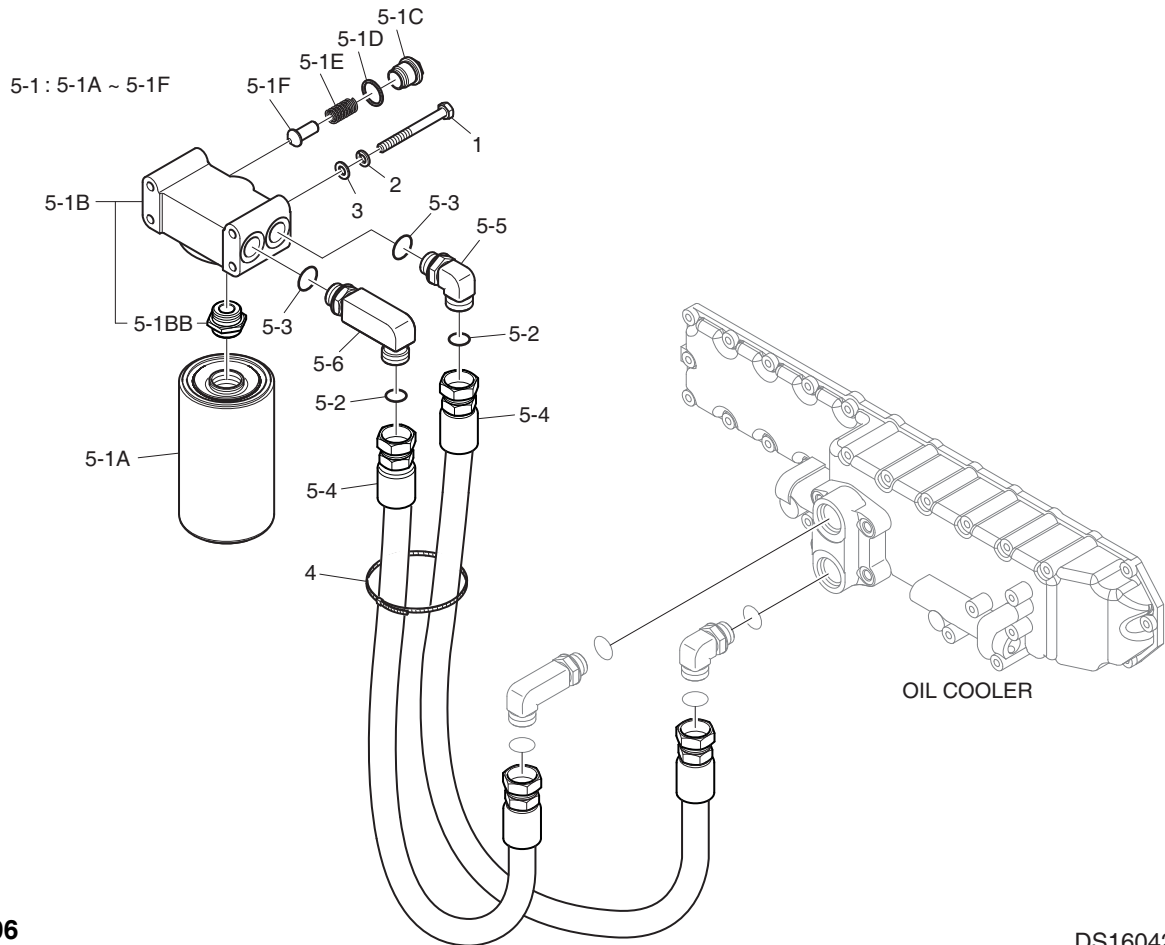


Figure 196

DS1604249

Reference Number	Description
1	Bolt; Hex
2	Washer; Spring
3	Washer; Plain
4	Cable Tie
5	Filter Assembly, Engine Oil
5-1	Filter Assembly, Engine Oil
5-1A	Cartridge, Oil Filter
5-1B	Head, Oil Filter
5-1BB	Cock; Oil Filter

Reference Number	Description
5-1C	Plug
5-1D	Seal; Ring
5-1E	Spring
5-1F	Ball; Steel
5-2	O-ring
5-3	O-ring
5-4	Hose, Oil Cooler
5-5	Adapter
5-6	Adapter

Replacing Oil Filter

1. Remove the oil filter using its service wrench.
2. Wipe the head and cartridge contact area of the oil filter clean.
3. Seat the cartridge of the oil filter properly.
4. Apply a small amount of oil to the O-ring section of the cartridge.
5. Fit a new oil filter loosely by screwing it with a hand.
6. Remove the oil filter using its service wrench.

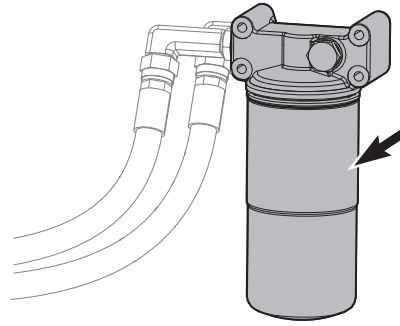


Figure 197

DS1603059

IMPORTANT

- When replacing the cartridge of the oil filter, make sure to use the specified genuine one.
 - The oil filter should be installed to the engine without oil in it. Never fill the new oil filter with oil drained from the used oil filter.
-

Troubleshooting

Phenomenon	Causes	Troubleshooting
Too much Oil Consumption	Bad oil	Replace oil with specified oil.
	Oil leakage from the oil seal ring and packing part	Replace it
	Worn or damaged piston and piston ring	Replace it
	Worn cylinder liner	Replace it
	Burnt piston ring	Replace it
	Worn valve guide oil seal, valve guide, or valve stem	Replace it
Low Oil Pressure	Bad oil	Replace oil with specified oil.
	Burnt oil pump relief valve	Replace it
	Clogged oil pump strainer	Cleanse the strainer
	Worn oil pump gear	Replace it
	Cracked oil delivery pipe of the oil pump	Replace it
	Defect oil pump	Repair or replace it
	Oil pressure gauge fault	Repair or replace it
	Worn bearings	Replace it
Contaminated Oil	Clogged oil filter	Replace the oil filter with a new one
	Gas leakage	Replace piston ring with a new one
	Bad oil	Replace oil with specified oil.

EXHAUST SYSTEM

Turbocharger

General Description

The turbocharger uses heat energy of exhaust gas in the engine to draw in high density air into the cylinders to increase the engine power.

Power of the engine is determined by the amount of fuel supply and the engine's efficiency.

A sufficient amount of air should be supplied to the cylinders to burn fuel completely and convert this energy to effective work.

Power of the engine is actually determined by the size of the cylinders. The larger the cylinders are, the more the air is delivered to burn more fuel, resulting in increase of engine power.

Supercharging is a process to compress and supply air into the engine's cylinders. The turbocharger is a device to supply extra air for combustion with energy of exhaust gas in the combustion chamber which is usually released and disappeared into the air.

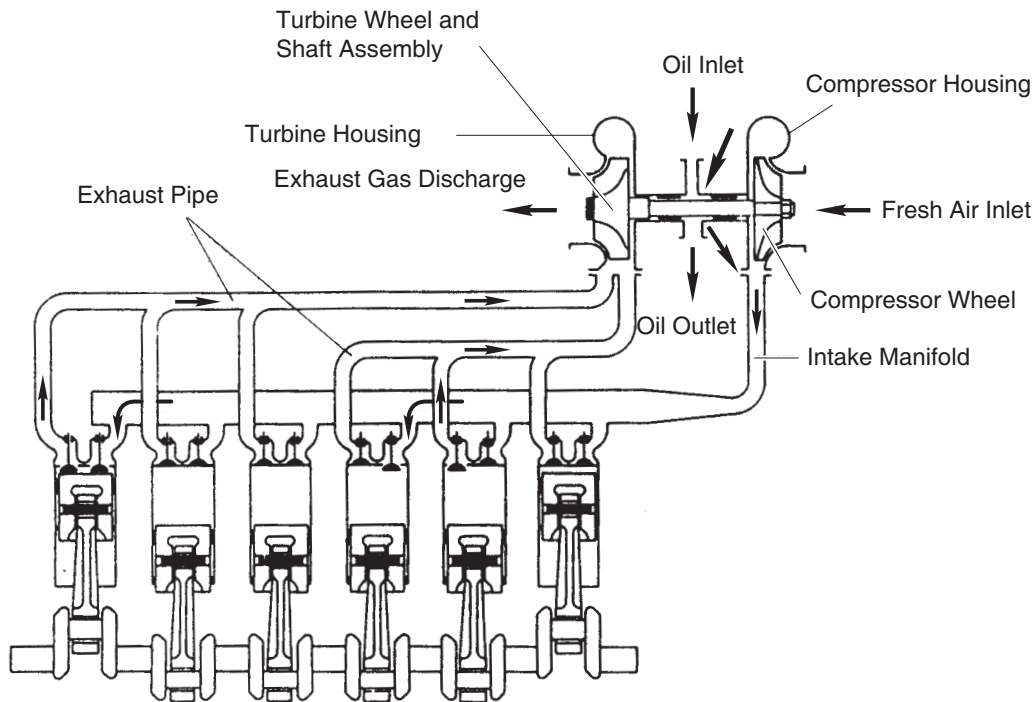


Figure 198

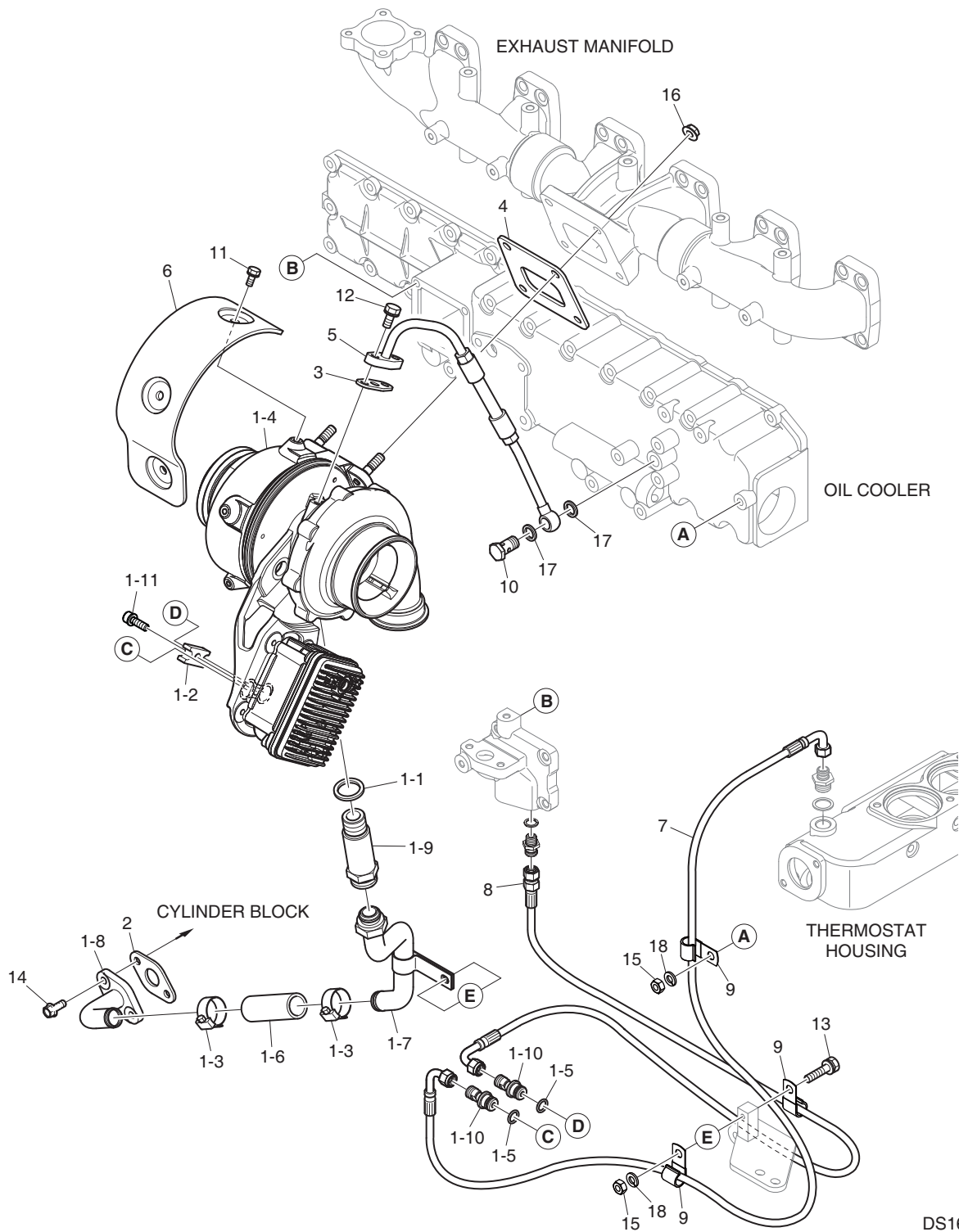
EX1403797

Function

1. Turbine:
As exhaust gas discharged from the combustion chamber passes through the turbine housing, its energy is transferred to the turbine blades to deliver the rotating force to the turbine shaft. These series of motions are occurred in a component called turbine. The turbine is equipped with the seal ring and heat shield to prevent exhaust gas from affecting its bearing.
2. Compressor:
As it is connected to the same shaft with the turbine, it rotates together to receive rotating force from the turbine shaft in order to receive, compress and send air to the intake manifold. This is the basic principle of a compressor.
3. Bearings:
Thrust bearing: The turbine wheel is applied with axial force. This axial force keeps the shaft from moving.

Journal bearing:
This bearing is a floating type and has double oil film on its inside and outside so that it can rotate independently. As its double oil film acts as a cushion, the sliding speed on the bearing surface becomes lower than the rotating speed of the shaft, ensuring dynamic stability.
4. Seal ring of compressor shaft:
The shaft is equipped with the seal plate and seal ring in a dual structure to prevent leakage of compressed intake air and lubricant.

Parts List



DS1604251

Figure 199

Reference Number	Description
1	Charger Assembly, Turbo
1-1	Ring; Seal
1-2	Holder
1-3	Clamp, Hose
1-4	Turbo Charger Assembly
1-5	O-ring
1-6	Hose, Oil
1-7	Pipe, Oil Return
1-8	Pipe, Oil Return
1-9	Adapter
1-10	Adapter
1-11	Bolt; Socket Head M8 x 25
2	Gasket; Pipe-block
3	Gasket; Flange
4	Gasket; Turbocharger

Reference Number	Description
5	Pipe, Oil; DL08
6	Screen; Heat
7	Fuel Hose Assembly
8	Fuel Hose Assembly
9	Clip; Hose
10	Screw; Hollow
11	Bolt Assembly M6 x 12
12	Bolt Assembly M8 x 22
13	Bolt Assembly M8 x 45
14	Bolt, Hex Flange
15	Nut
16	Nut
17	Ring; Seal
18	Washer

Structure

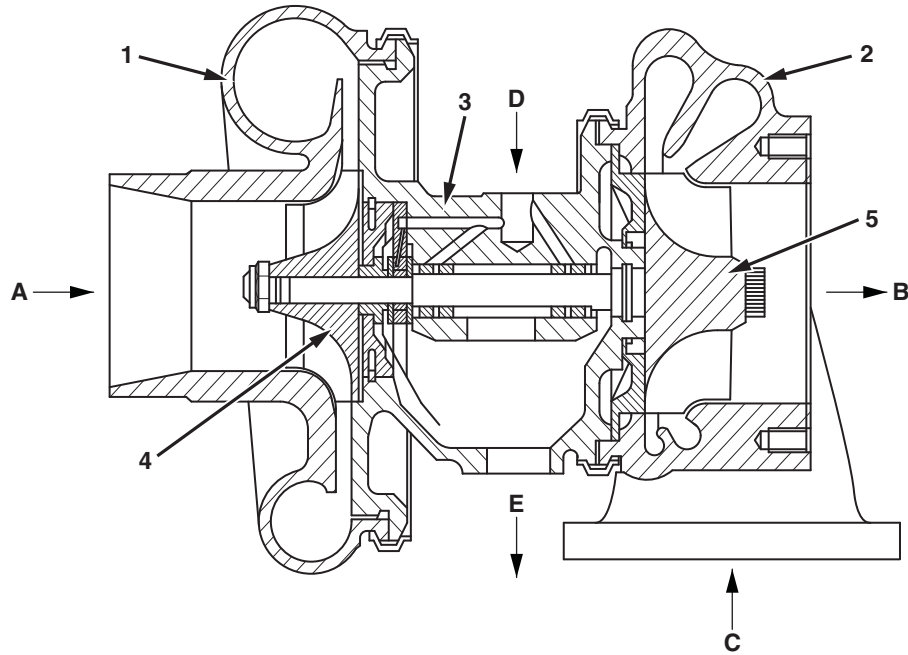


Figure 200

EX1403798

Reference Number	Description
1	Impeller Casing
2	Turbine Casing
3	Bearing Casing
4	Impeller
5	Turbine

Reference Number	Description
A	Intake Air Inlet
B	Gas Outlet
C	Gas Inlet
D	Oil Supply
E	Oil Discharge

Troubleshooting

Phenomenon	Causes	Troubleshooting
Noise or Vibration	Rotating part is contacted	Repair or replace it
	Unbalanced rotation of a rotor	Repair or replace it
	Burn	Repair or replace it
	Loose joint	Check or repair it
	Deformed or damaged intake unit hose	Replace it
	Poor clamping state	Adjust and tighten the clamp
	Contaminated or damaged air filter	Replace and check if the impeller of the turbocharger is damaged
	Leakage of coolant from the turbocharger or oil from the oil hose	Replace the hose and the gasket
	Leakage of gas from the exhaust manifold	Replace the gasket or tighten the fixing nut
	Poor turbo actuator operation	Replace the turbocharger
	Leakage from the engine block and the exhaust manifold	Check the engine
	Contaminated blowby gas and abnormal oil amount	Check the turbo impeller and the turbo intake and outlet
	Large gap of the turbocharger wheel, causing interference with the wall	Check if there is any sand or metallic foreign substance
	Damaged turbocharger wheel	Check if there is any sand or metallic foreign substance
	Damaged wheel and shaft of the turbocharger	Check if there is any sand or metallic foreign substance
Poor rotating force of the turbocharger wheel	Check if there is any sand or metallic foreign substance	

Phenomenon	Causes	Troubleshooting
Lowered Output	Leakage of gas from each part of the exhaust system	Check or repair it
	Clogged air filter element	Replace or clean it
	Contaminated or damaged turbocharger	Repair or replace it
	Leakage of air from the discharging part of the compressor shaft	Check or repair it
	Deformed or damaged intake unit hose	Replace it
	Poor clamping state	Adjust and tighten the clamp
	Contaminated or damaged air filter	Replace and check if the impeller of the turbocharger is damaged
	Poor turbo actuator operation	Replace the turbocharger
	Leakage from the engine block and the exhaust manifold	Check the engine
	Contaminated blowby gas and abnormal oil amount	Check the turbo impeller and the turbo intake outlet
	Large gap of the turbocharger wheel, causing interference with the wall	Check if there is any sand or metallic foreign substance
	Damaged turbocharger wheel	Check if there is any sand or metallic foreign substance
	Damaged wheel and shaft of the turbocharger	Check if there is any sand or metallic foreign substance
	Poor rotating force of the turbocharger wheel	Check if there is any sand or metallic foreign substance
Oil Leakage	Deformed or damaged intake unit hose	Replace it
	Poor clamping state	Adjust and tighten the clamp
	Contaminated or damaged air filter	Replace and check if the impeller of the turbocharger is damaged
	Leakage of coolant from the turbocharger or oil from the oil hose	Replace the hose and the gasket
	Poor turbo actuator operation	Replace the turbocharger
Oil Leakage	Leakage from the engine block and the exhaust manifold	Check the engine
	Contaminated blowby gas and abnormal oil amount	Check the turbo impeller and the turbo intake outlet
	Large gap of the turbocharger wheel, causing interference with the wall	Check if there is any sand or metallic foreign substance
	Damaged turbocharger wheel	Check if there is any sand or metallic foreign substance
	Damaged wheel and shaft of the turbocharger	Check if there is any sand or metallic foreign substance
	Poor rotating force of the turbocharger wheel	Check if there is any sand or metallic foreign substance

Phenomenon	Causes	Troubleshooting
Oil Consumption	Poor clamping state	Adjust and tighten the clamp
	Leakage of coolant from the turbocharger or oil from the oil hose	Replace the hose and the gasket
	Leakage from the engine block and the exhaust manifold	Check the engine
	Contaminated blowby gas and abnormal oil amount	Check the turbo impeller and the turbo intake outlet
	Large gap of the turbocharger wheel, causing interference with the wall	Check if there is any sand or metallic foreign substance
	Damaged turbocharger wheel	Check if there is any sand or metallic foreign substance
	Damaged wheel and shaft of the turbocharger	Check if there is any sand or metallic foreign substance
	Poor rotating force of the turbocharger wheel	Check if there is any sand or metallic foreign substance
Black and White Emissions	Deformed or damaged intake unit hose	Replace it
	Contaminated or damaged air filter	Replace and check if the impeller of the turbocharger is damaged
	Leakage of coolant from the turbocharger or oil from the oil hose	Replace the hose and the gasket
	Poor turbo actuator operation	Replace the turbocharger
	Contaminated blowby gas and abnormal oil amount	Check the turbo impeller and the turbo intake outlet
	Large gap of the turbocharger wheel, causing interference with the wall	Check if there is any sand or metallic foreign substance
	Damaged turbocharger wheel	Check if there is any sand or metallic foreign substance
	Damaged wheel and shaft of the turbocharger	Check if there is any sand or metallic foreign substance
	Poor rotating force of the turbocharger wheel	Check if there is any sand or metallic foreign substance
Blue Emissions	Leakage from the engine block and the exhaust manifold	Check the engine
Too much Fog	Oil leakage to the turbine or compressor	Repair or replace it
	Worn or damaged seal ring due to worn bearing	Repair or replace it
Too much Exhaust Emissions	Clogged air filter element	Replace or clean it
	Clogged air duct	Check or repair it
	Air leakage from the intake system	Check or repair it
	The turbocharger cannot rotate because of burning	Repair or replace it
	A turbine blade or compression wing contacts with the other one or is damaged	Repair or replace it
	Deformed or clogged exhaust system pipe	Check or repair it

How to Maintain Turbocharger

Cautions for Engine Operation

Observe the followings when starting, operating, and stopping an engine.

Item	Cautions	Reasons
Starting an Engine	Check the oil amount	
	Therefore, start the engine with the starter motor to check the rise of oil pressure (until the gradation of the oil pressure gauge moves or the pressure indicator lamp is turned on).	Overhasty start of engine leads to engine rotation without lubricating turbocharger and other engine parts, causing abnormal wear or burning of bearings.
	If you replace oil, oil filter cartridge, or lubrication system parts or use an engine in cold areas, or the engine has stopped for a long period, loosen the oil pipe joint at the inlet of the turbocharger and run the starter motor until oil flows out. After completing the work, tighten the oil pipe joint again and start the engine.	When an engine has stopped or kept cold for a long period, circulation of oil in the pipe gets poor.
After Starting an Engine	Operate the engine at idle for five minutes from starting it.	When the engine is suddenly loaded while the engine and the turbocharger have not been smoothly rotated after starting the engine, parts with insufficient oil may be burnt.
	Check if oil, gas, or air is leaked from each part. If so, take proper action.	Leakage of oil, gas, or air (especially oil) reduces oil pressure and loss of oil cause burning of bearings.
During Operation	check the following.	
	Oil pressure At idle: 1.5 ~ 3.0 kg/cm ² (1.5 ~ 3.0 bar, 21.3 ~ 42.7 psi) Fully loaded: 3.0 ~ 5.5 kg/cm ² (3.0 ~ 5.5 bar, 42.7 ~ 78.2 psi)	Too low oil pressure causes abnormal wearing or burning of bearings. Too high oil pressure causes oil leakage.
	When abnormal noise or vibration occurs, slowly reduce the rotate count until the engine stops and then figure out the causes.	Operating an engine with noise or vibration may cause irreversible damage of the engine.
Stopping an Engine	Operate the engine at idle for five minutes before stopping it.	Sudden engine stop after operating the engine under high load allows the heat from the red-heated turbine blade to be delivered to the bearing system. Then oil burns and the bearing metal and rotation shaft are burnt.

Cautions for Maintenance

1. When the rpm is rapidly increased after starting the engine, the journal bearings in the crankshaft is excessively rotated, the crankshaft is rotated at excessive speed before the journal bearing of the crankshaft is lubricated fully. If the turbocharger rotates in this situation, bearings are not smoothly cooled and lubricated, causing bearing burn and damage of the related parts.
2. Please operate the engine for two minutes or more in order to lubricate the turbocharger fully after replacing the engine oil or oil filter.
3. If an engine has been operated at high speed for a long period, fully operate the engine at idle and then stop the engine. Otherwise, the turbine wheel continuously runs without oil pressure in the turbocharger. Therefore, no oil film is created on the center bearings and the journal bearings of the turbocharger, causing bearing, wearing out and shortening of the turbocharger lifetime.
4. If an engine is not operated for a long period during cold weather or in areas with cold climate, operate the engine at idle after starting the engine until the engine oil pressure is normal.
5. The turbocharger turbine spins at high speed of 50,000 ~ 200,000 rpm. Therefore, lubrication of bearings may determine the turbocharger lifetime. Please use only recommended genuine engine oil and check and replace the engine oil periodically.
6. Prolonged usage of contaminated air cleaner may cause a critical damage of the turbocharger. Regularly check and replace the air cleaner.
7. A turbocharger is a very complex and precise part. Only certified and skilled technicians should work on it.
8. If a turbocharger is operated without intake and exhaust pipe, serious human injury may occur and critical faults of the engine performance may occur. Please operate a turbocharger only when all of parts are exactly mounted on the specified position.
9. Do not lift up a turbocharger by grabbing the actuator. The actuator may be damaged because of the weight of the turbocharger.
10. The weight of a turbocharger is about 4.0 kg or more. To lift up a turbocharger for installing or removing it, the worker should lower the center of gravity or press his body close to the turbocharger. Otherwise, worker may drop the turbocharger, causing damage of the part and injury.

Inspection Items during Disassembly/Assembly of Turbocharger

No.	Inspection Items	Possible Problem						Action
		Noise	Power Drop	Oil Leakage	Oil Consumption	White/black Smoke	Blue Smoke	
Before Removal								
1	Is the intake hose torn or deformed?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Replace hose
2	Is the clamp tightened firmly?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Tighten bolt/nut correctly
3	Is the air filter intact?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Replace air filter and check turbocharger impeller for damage
4	Does turbocharger or oil hose leak?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Replace hose and gasket
5	Is gas leaked from exhaust manifold gasket?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Replace nut and gasket
6	Do solenoid valve and EGR system intact?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Replace solenoid and EGR valve
7	Does the turbocharger actuator operate correctly?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Replace turbocharger
During Removal								
1	Is there a sign of leak between the engine block and exhaust manifold?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Check engine
2	Is the amount of oil and foreign material led with blow-by gas normal?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Check turbocharger impeller and turbocharger intake air outlet
3	Is there a sign of interference of the wheel with the wall due to excessive play of the wheel?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Check for foreign materials (sand, metallic object)
4	Is the wheel damaged?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Check for foreign materials (sand, metallic object)
After Removal								
1	Is the wheel damaged or is the shaft broken?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Check for foreign materials (sand, metallic object)
2	Does the wheel rotate properly?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Inspection

Daily Inspection and Service

It is important to handle the engine and maintain its optimum condition according to the instructions as the performance of the turbocharger is highly affected by the maintenance condition of the engine.

1. Intake system

In the intake system, the air filter should be maintained with care. For a wet type air filter, if the oil level is below the specified level, its filtering performance is deteriorated. On the other hand, if the oil level is too high, it sucks in oil and contaminates the case. Especially, if the rotor is contaminated, the precisely adjusted balance is destroyed and the bearing is applied with large force, resulting in vibration, seizure and abnormal wear. Therefore, the air filter should be well-maintained and handled with care. A

dry air filter should feature low possible intake air restriction.

2. Exhaust system

If exhaust gas is leaked from the exhaust pipe or turbocharger connection in the exhaust system, the turbocharger's performance is deteriorated. Extra care is needed to prevent a gas leak and seizure. A heat resisting steel nut is used for parts, which can become hot during driving, such as the turbine housing. Make sure not to mix it with a general nut, and apply screw's anti-seize compound to the specified mounting nut.

3. Lubrication system

In the lubrication system, the oil quality and the cartridge replacement interval of the oil filter should be monitored with care. Degraded engine oil can affect not only the engine body, but also the turbocharger negatively.

Periodic Inspection and Service

Check the turbocharger for its condition and contamination periodically.

1. How to check rotating condition of rotating part

When checking the rotating condition of a rotating part, check for abnormal noise. When using a sound bar, touch the turbocharger housing with its tip and rev up the engine slowly. If a high pitch note is continuously heard, it is abnormal. If abnormal condition is found, it is possible that the bearing or rotating part is defective. In this case, replace or repair the turbocharger.

2. How to check play of rotating part

Separate the turbocharger from the engine and check the axial play and circumferential play of the rotating part. When separating the turbocharger, make sure to seal the oil inlet and outlet with plastic tape.

- Axial play of rotating part

Reference Number	Description
A	Dial Gauge
B	Magnet Vice
C	Turbine Compartment
D	Move the Turbine Shaft in the Axial Direction.
E	Service Standard (0.038 ~ 0.093 mm)
F	Wear Limit (0.24 mm)

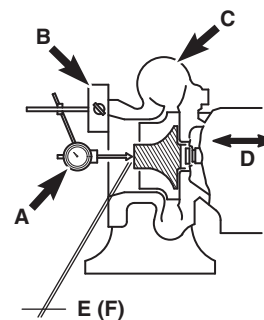
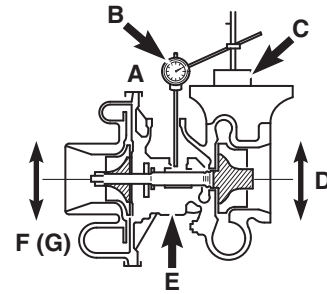


Figure 201

EX1403799

- Circumferential play of rotating part

Reference Number	Description
A	Oil Outlet
B	Dial Gauge
C	Magnet Vice
D	Move the Turbine Shaft to the Left and Right in the Circumferential Direction.
E	Standard Circumferential Play (0.326 ~ 0.496 mm)
F	Standard Wear (0.50 mm)



EX1403800

Figure 202

- If the axial or circumferential play is over the wear limit, replace or remove and repair the turbocharger.

3. Tips for turbocharger disassembly and inspection

Remove the turbocharger from the engine to clean or check it. Make sure to seal the oil inlet and outlet with plastic tape after its removal.

4. Cautions for turbocharger installation

When or after installing the turbocharger to the engine, make sure keep the followings: Make sure that no foreign material enters the turbocharger.

- Lubrication system

Before installation to the engine, add new oil through the oil filler hole and turn the turbine shaft with a hand to lubricate the journal bearing and thrust bearing.

Clean the pipes between the engine and oil inlet and between the pipe and oil outlet thoroughly and check them for damage and foreign materials.

Tighten each connection of the oil pipes firmly to prevent an oil leak.

- Intake system

Check if there is no foreign material in the intake system.

Install each connection of the intake system and air filter firmly to prevent an air leak.

- Exhaust system

Check if there is no foreign material in the exhaust system.

Make sure to use only heat resisting bolts and nuts. Be careful not to mix them with general bolts and nuts during assembly. Apply anti-seize compound to the bolt and nut before installing them.

Tighten each connection of the exhaust system firmly to prevent any gas leak.

EGR (Exhaust Gas Recirculation) System

General Description

The EGR (Exhaust Gas Recirculation) system recirculates a portion of exhaust gas back to the intake system to cool it down and supply it to the engine for re-combustion in order to reduce NOx emission.

To reduce NOx and other emissions from the engine, it circulates exhaust gas containing almost no oxygen toward the intake system to decrease the density of oxygen supplied to the engine and induce combustion at a low temperature. As a result, a reduced amount of NOx is produced.

This system is equipped with the EGR cooler to reduce the temperature of hot exhaust gas in order to reduce the amount of NOx and enhance engine combustion efficiency.

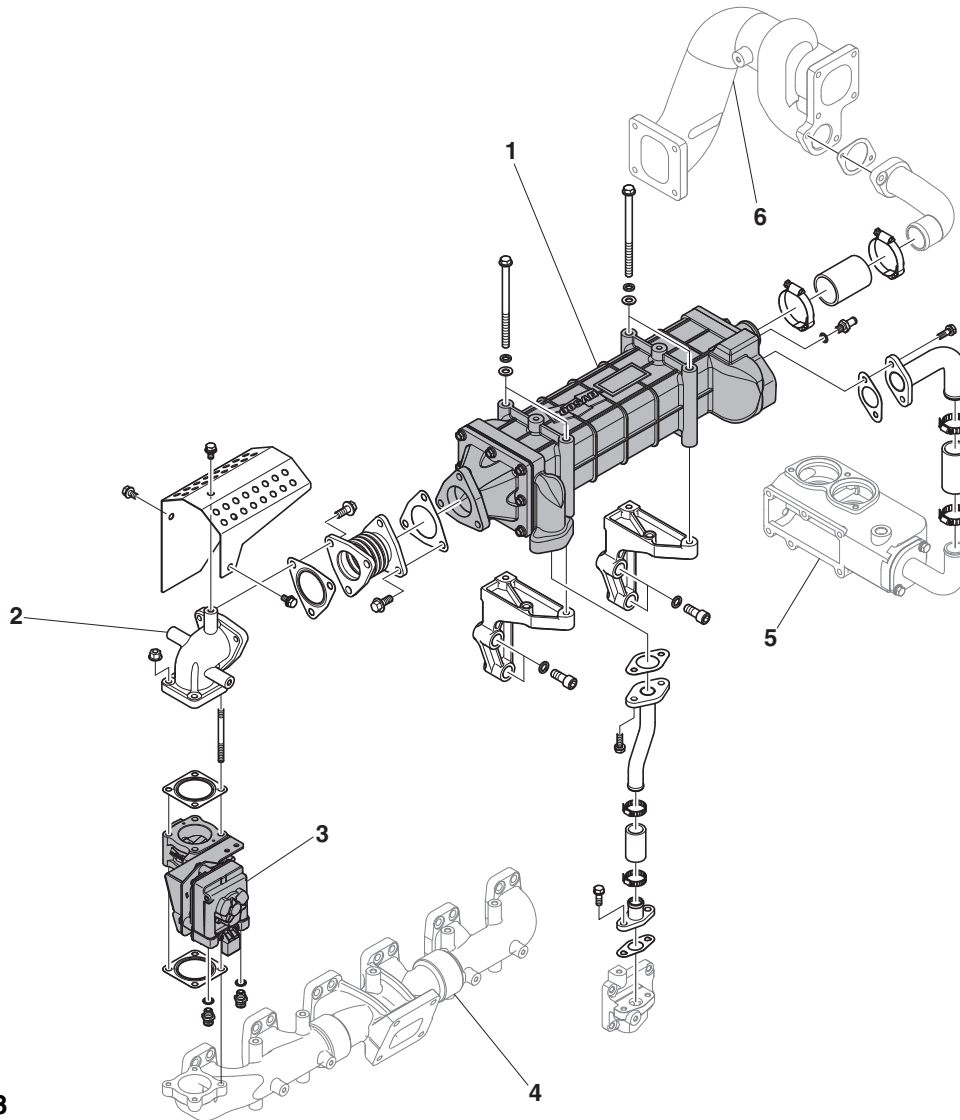


Figure 203

DS1604252

Reference Number	Description
1	EGR Cooler
2	Exhaust Pipe
3	EGR Valve

Reference Number	Description
4	Exhaust Manifold
5	Thermostat
6	Intake Stake

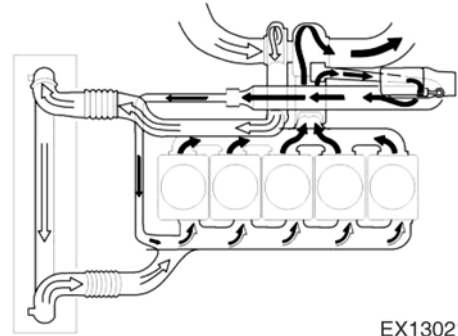
Function

The EGR system is active between approximately 900 rpm and the maximum engine speed with a positive torque and when the coolant temperature exceeds approximately 50°C.

The principle of the EGR system is that some of the exhaust gases are returned to the engine. The quantity of oxygen is reduced by mixing the intake air with exhaust gases resulting in a lower combustion temperature. In this way, the quantity of nitrogen oxides.

NOx, in the exhaust gases is reduced.

The reduced nitrogen oxide emissions make it possible to meet emissions regulations and to optimize engine power and fuel consumption.



EX1302110

Figure 204

Flow of Air and Exhaust Gases

Part of the exhaust gases leaving the engine by the exhaust manifold are led by the EGR valve through the EGR cooler, where they are cooled.

The cooled exhaust gases are drawn back to the intake and mixed with the intake air.

Controlling the Flow

The engine control unit controls the flow of exhaust gases. The control unit regulates EGR content, i.e. the volume of exhaust gases that are returned to the engine. The level is measured in percent 10% EGR content means that 10% of the total flow into the engine is exhaust gas and 90% is air.

The mass flow sensor detects and informs the control unit of how much air passes into the engine. The control unit also receives information from the charge air pressure and temperature sensors and the exhaust gas pressure sensor. The control unit uses information from the sensors to calculate the total volume of gas (air and exhaust gases) which enter the cylinders. By measuring the total volume of gases and subtracting from this the airflow from the mass flow sensor, the control unit calculates the EGR content.

To increase measurement accuracy and to avoid incorrect values, the control unit shuts the EGR valve for a preset time interval, to avoid any gases flowing back to the cylinders. The control unit compares the value from the mass flow sensor with the calculated gas volume entering the cylinders. These two values must be the same. If the values do not agree, the control unit calibrates the mass flow sensor. The system is set in motion when the engine is started and warmed up.

If a fault occurs in the system which results in the control unit not being able to control the components as expected, fault codes are generated and the control unit reduces the engine power until fault is rectified.

Cold Engine

The EGR valve is closed until engine has been warmed up. No exhaust gases are then circulated.

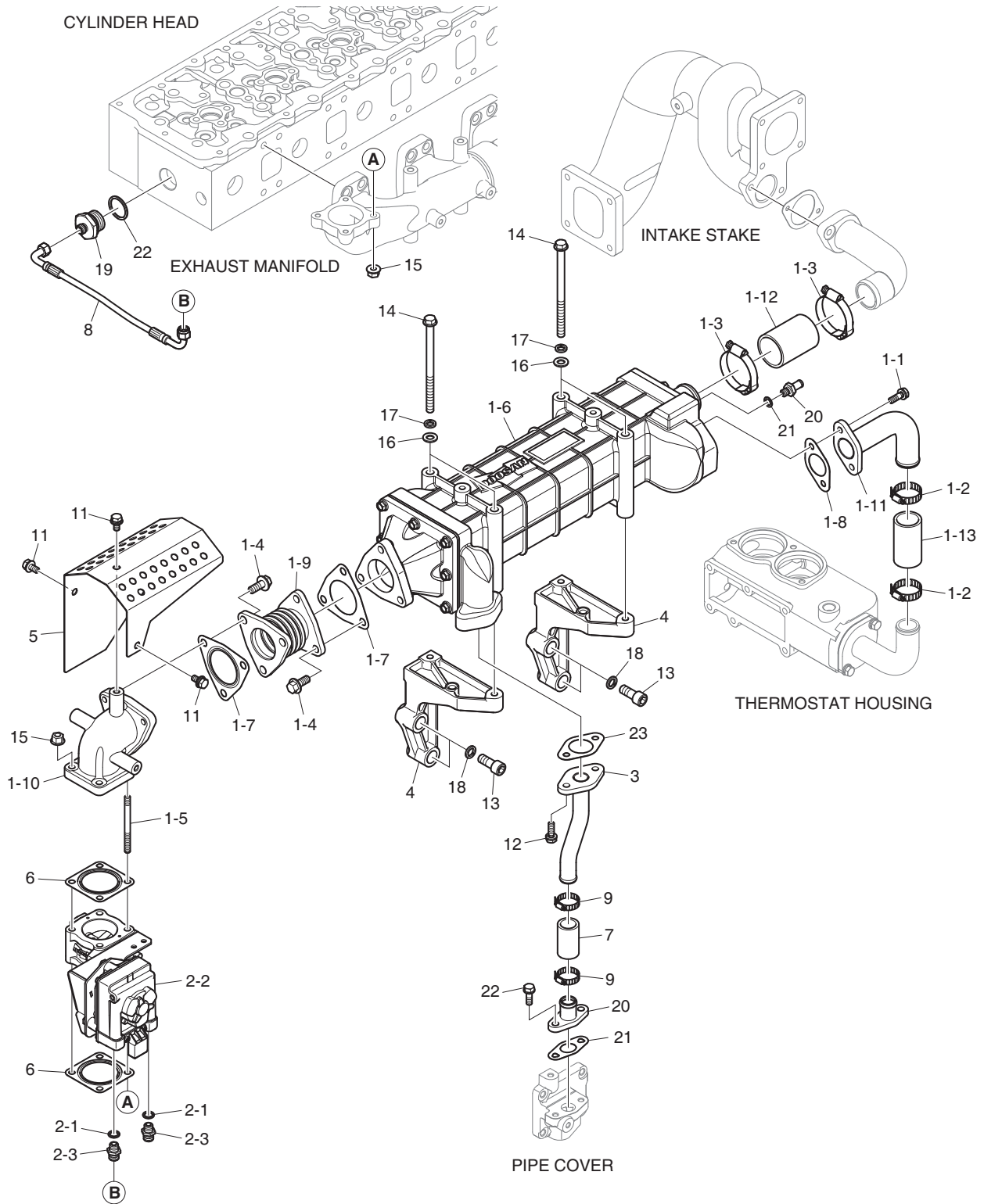
Warm Engine

Once the engine has been warmed up, the EGR valve is open and exhaust gases then circulate in the EGR system. Where the throttle is rapidly opened, the engine control unit reduces the EGR content. This is intended to compensate for the shortage of induction air that occurs before the turbocharger begins to charge.

Shut-off Conditions

- The control unit shuts down the EGR system if:
- The charge air temperature falls below a specific value. There is then a risk of freezing in the intake manifold.
- The engine is at such a high altitude that air pressure affects its performance.
- Coolant temperature is too high. At very high coolant temperature, the control unit closes the EGR valve to avoid loading the engine with additional heat from the EGR cooler.
- The white smoke limiter is active.
- There is a risk of the EGR system freezing if the ambient temperature is very low.

Parts List



DS1604253

Figure 205

Reference Number	Description
1	Cooler, EGR
1-1	Bolt Assembly M8 x 25
1-2	Clamp, Hose
1-3	Clamp; Hose
1-4	Bolt; Hex
1-5	Bolt; Stud
1-6	EGR Cooler Assembly
1-7	Gasket; EGR Cooler
1-8	Gasket; Water Pipe
1-9	Pipe; Exhaust
1-10	Pipe; Exhaust
1-11	Pipe; Water Outlet
1-12	Tube; Exhaust
1-13	Hose
2	Valve Assembly
2-1	Ring; Seal
2-2	Valve, EGR
2-3	Adapter
3	Pipe; Water Outlet

Reference Number	Description
4	Bracket; EGR Cooler
5	Screen, Heat
6	Gasket; EGR Valve
7	Hose
8	Tube Assembly
9	Clamp, Hose
11	Bolt, Hex Flange
12	Bolt Assembly M8 x 25
13	Bolt; Hex
14	Bolt; Hex
15	Nut
16	Washer; Plain
17	Washer; Spring
18	Washer; Spring
19	Nipple
20	Adapter, Connector
21	Ring; Seal
22	Seal; Ring
23	Gasket; Water Pipe

Disassembly

1. Remove the EGR valve and disconnect the elbow pipe.

NOTE: Perform the process with the heat shield and bellows pipe removed.



CAUTION

AVOID INJURY

As the EGR system is hot by exhaust gas, it should be disassembled after it is sufficiently cooled down.

- A. Remove the nut from the stud bolt.
 - B. The cooling pipe should be disconnected to remove the EGR valve.
2. Remove the EGR bracket.

NOTE: Components available for removal after removal of exhaust manifold

Assembly

Assemble in the reverse order of disassembly.



CAUTION

AVOID INJURY

Any used gasket should be replaced with a new one.

EGR Cooler Disassembly and Assembly

Disassembly

As the EGR system becomes hot by exhaust gas while the engine is running, it should be disassembled after it is sufficiently cooled down.

1. Disconnect the coolant inlet/outlet pipes and hoses.
2. Remove the gas pipe outlet and hose.
3. Remove the heat shield.
4. Disconnect the bellows pipe.
5. Remove the EGR cooler mounting bolts.
6. Remove the EGR cooler from the EGR bracket.

Assembly

Assemble in the reverse order of disassembly.



CAUTION

AVOID INJURY

Any used gasket should be replaced with a new one.

Checking EGR System

Leak test and functional inspection of the EGR system components

It is normal to find a certain amount of soot coating in engines with EGR systems.

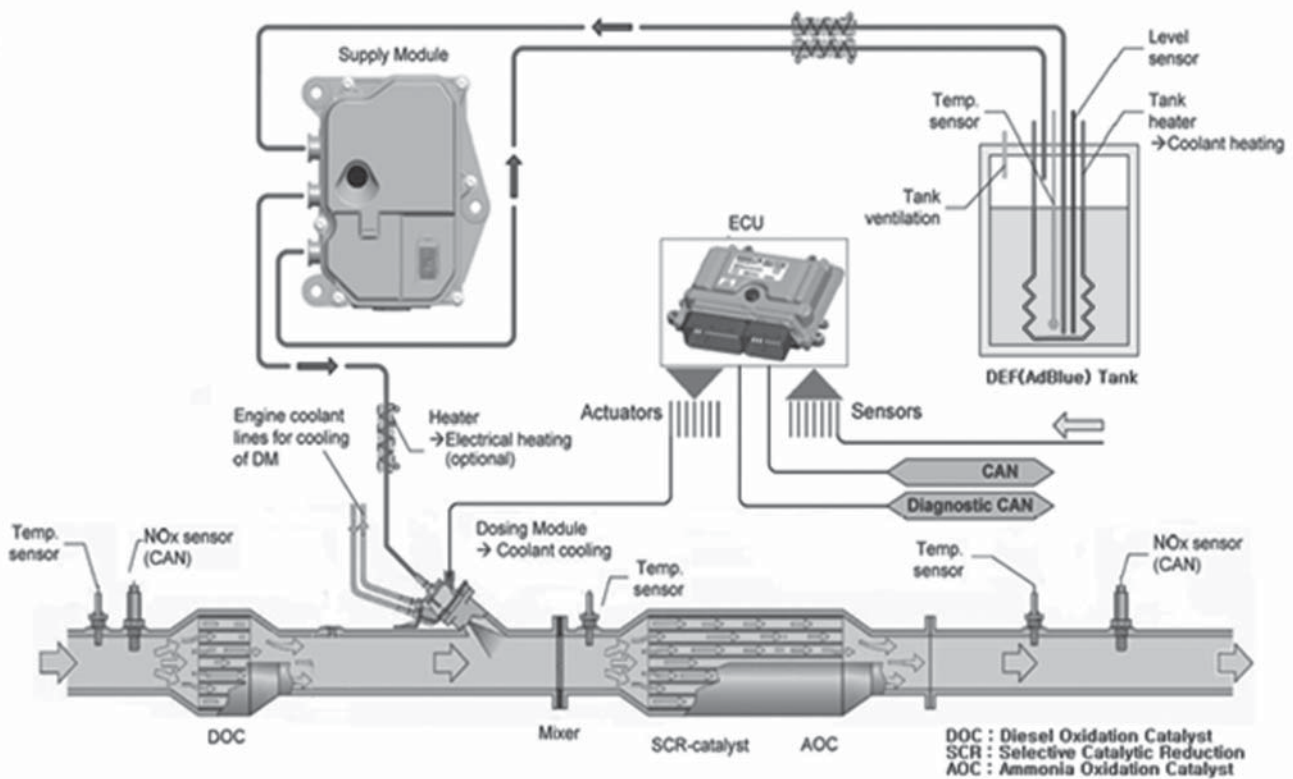
Component	How
EGR Valve	Search for heavy soot accumulation. Check that EGR valve is properly closed. Check that EGR valve springs back to the closed position.
The Pipe between the EGR Valve and the EGR Cooler	Check that there is no abnormally large leakage.
The Pipe between the Cooler and the Inlet Pipe	Check that there is no abnormally large leakage.
EGR Cooler	Searching for leakage in the EGR cooler.
The Hoses to and from the Air-cooled EGR Cooler	Check that there is no abnormally large leakage.
Control Cylinder to EGR Valve	Check using checking tool that EGR valve control cylinder is working properly.

If it does leak, the EGR components may need cleaning.

DNOx System

General Description

The HYUNDAI engine is equipped with the DOC (Diesel Oxidation Catalyst) and SCR (Selective Catalytic Reduction) systems in order to comply with Tier 4 final (and stage IV) emission control. This SCR system consists of the dosing module, supply module, ECU (Engine Control Unit) and other components. The DEF (Diesel Exhaust Fluid) is stored in the DEF tank. Once it is needed, it is pressurized by the supply module and is delivered to the dosing module under a certain level of pressure. The dosing module is attached to the exhaust manifold to spray DEF into the exhaust manifold in front of the SCR system.



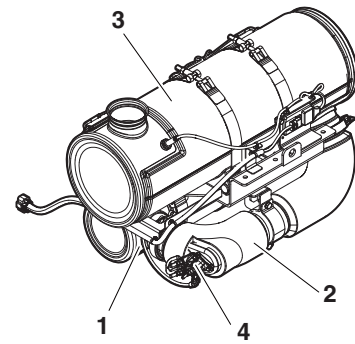
EX1403802

Figure 206

Aftertreatment Muffler and Catalyst

The aftertreatment muffler consists of the DOC muffler, SCR muffler, mixer pipe and other pipes. The DOC muffler contains DOC (Diesel Oxidation Catalyst) while the SCR muffler contains SCR (Selective Catalytic Reduction).

Reference Number	Description
1	DOC Converter
2	Mixer
3	SCR Muffler
4	Dosing Module

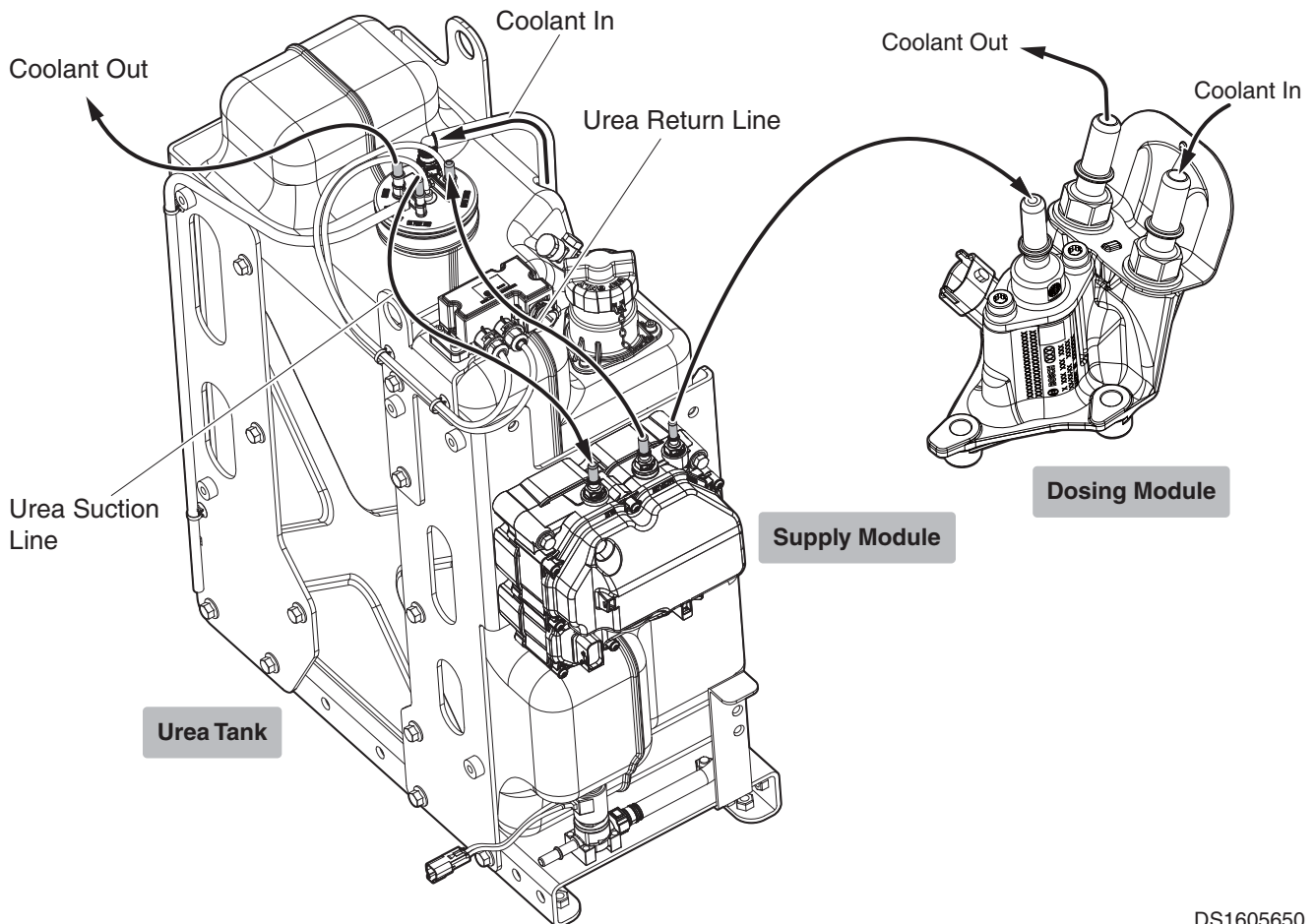


DS1604254

Figure 207

DNOx2.2 System

The DNOx2.2 system is used to reduce NOx in emissions by spraying urea into the SCR catalyst. It consists of the SM (Supply Module), which functions as a pump, DM (Dosing Module) to spray urea, DCU to control the overall system, urea tank to store urea and urea/cooling water line.

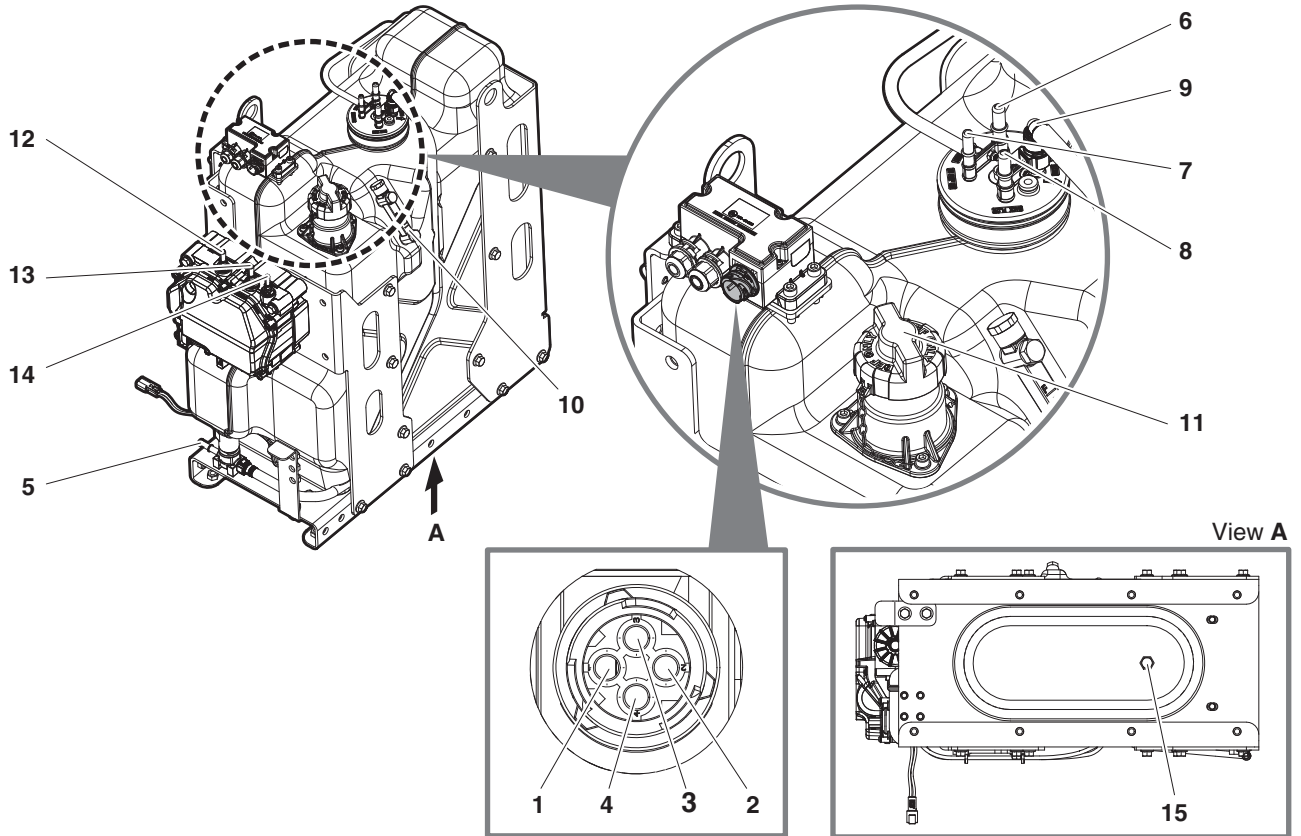


DS1605650

Figure 208

Urea Tank

The urea tank is used to store urea liquid. Connect lines to the specified positions. Also, be careful not to apply impact to the urea tank during its service.



DS1605651

Figure 209

Reference Number	Description
1	+24 V (Pin No. 1)
2	Ground (Pin No. 2)
3	CAN High (Pin No. 3)
4	CAN Low (Pin No. 4)
5	Coolant Inlet
6	Coolant Outlet
7	Urea Outlet
8	Urea Inlet

Reference Number	Description
9	Coolant Inlet
10	Level Indicator
11	Urea Tank Cap
12	Inlet
13	Backflow
14	Outlet
15	Drain Plug

IMPORTANT

The replacement interval of the DEF (urea solution) filter is different by the amount of foreign materials in DEF.

Make sure to use only the specified DEF and container and keep the surrounding area of the tank clean to prevent possible foreign materials.

1. Remove filter cover.

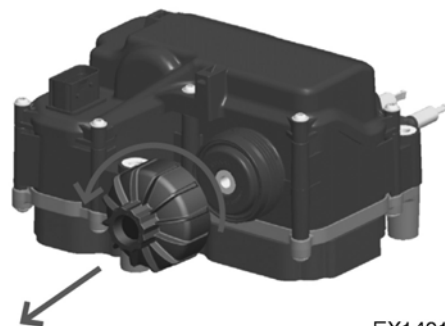


Figure 210

EX1401870

2. Remove equalizing element.

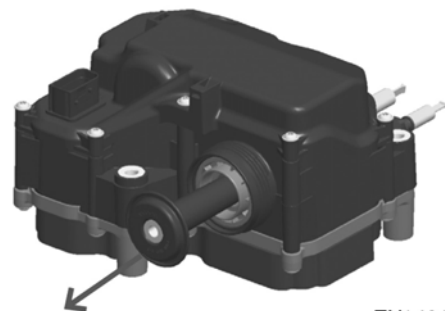


Figure 211

EX1401871

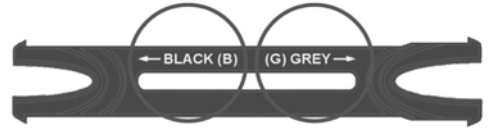
3. Check the color (gray/green) in the filter.



Figure 212

EX1401872

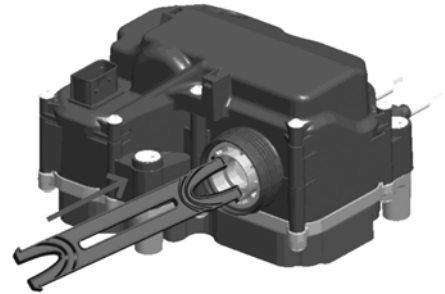
- Set the color of the mark on the end of the filter removing tool in the same direction with the filter color section.



EX1401873

Figure 213

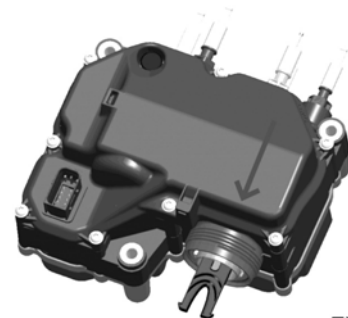
- Insert the end of the filter removing tool until a clicking sound is heard or engagement with the filter is felt.



EX1401874

Figure 214

- Pull the filter removing tool to remove filter.



EX1401875

Figure 215

- The surface must be kept clean. It can be cleaned with water only.



EX1401881

Figure 216

8. Apply oil to the O-ring and install a new filter.



CAUTION

AVOID INJURY

Use Mobil Velocite No. 6 oil from Bosch.



EX1401882

Figure 217

9. Install a new equalizing element.



EX1401883

Figure 218

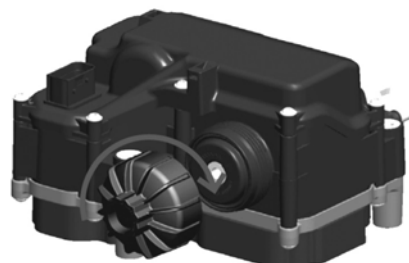
10. Tighten the filter cover to 20 N.m + 5 N.m.



CAUTION

AVOID INJURY

Check that filter surface is clean. It can be cleaned with water only.



EX1401884

Figure 219

Supply Module

The supply module is used to pressurize DEF in the DEF tank to a certain level and supply this pressurized DEF to the dosing module.

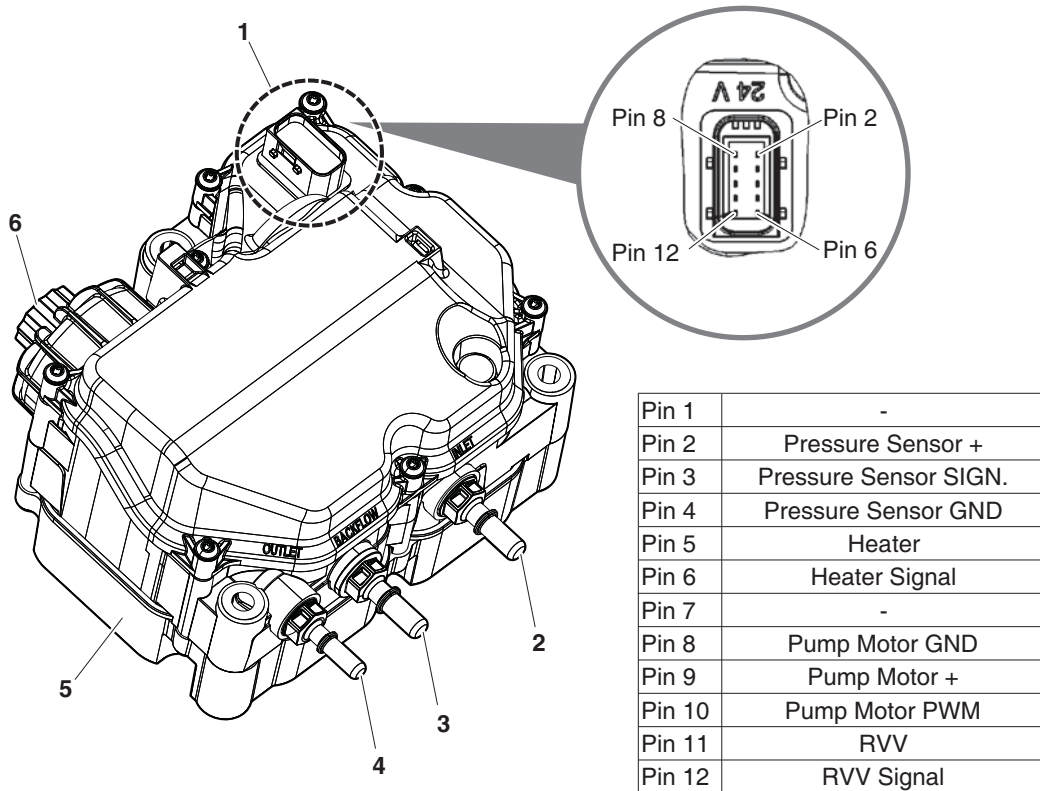


Figure 220

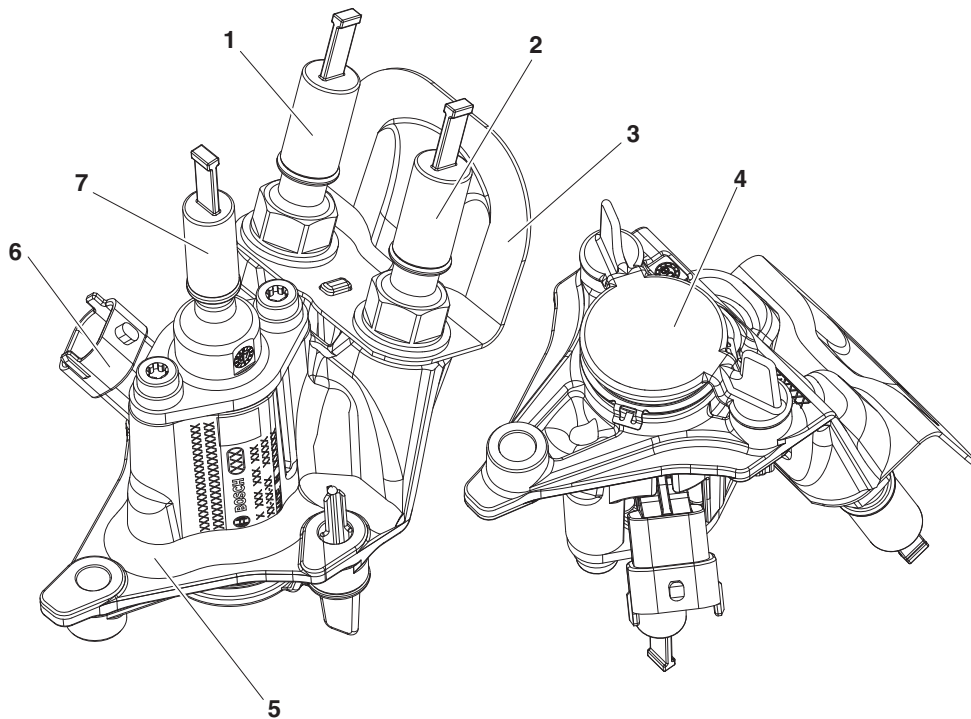
DS1605652

Reference Number	Description
1	Connector
2	Adblue Inlet
3	Adblue Backflow Outlet

Reference Number	Description
4	Adblue Outlet
5	Cover Plate
6	Filter Cover

Dosing Module

The dosing module is attached to the exhaust manifold in front of the SCR system to receive DEF from the supply module and spray it into the exhaust manifold.



EX1403807

Figure 221

Reference Number	Description
1	Coolant Outlet
2	Coolant Inlet
3	Head Shield
4	Protective Cap

Reference Number	Description
5	Cooling Adapter
6	Dosing Valve
7	Adblue Inlet

Checking DNOx2.2 System

Dosing Module

Dosing Module fault is caused by the high temperature exposure of nozzle tip injecting urea, electric harness contact failure, urea hose line break or poor contact, and more. Visual inspection of dosing module failure are as follows.

1. When replacing dosing module, dosing module and bolts is the leakage or damage caused by under tightening bolts or over tightening.
2. Electric connector misassembly or debris contamination inside of connector.
3. Urea leakage is caused by urea line misassembly.
4. Coolant leakage is caused by coolant line misassembly. The high temperature exposure of dosing module is caused by disconnected from the coolant line.
5. The high temperature exposure of dosing module is caused by gasket misassembly.
6. Urea leakage is caused by gasket reuse.

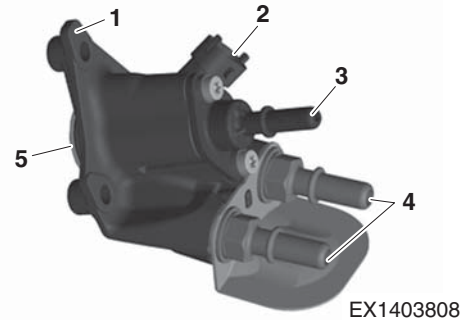


Figure 222

Supply Module

The supply module (SM) failure mode is associated with urea line and electric connector damage and poor connection. When replacing urea main filter regularly, supply module failure can occur caused by disassembly.



CAUTION

AVOID INJURY

When replacing new filter, open the package right before the replacement.

1. When connecting urea line, the failure caused by urea line misassembly.
2. Electric connector misassembly or debris contamination inside of connector.
3. When replacing supply module filter, the damage caused by not using the special tool. Also, it caused by filter remnants inside supply module filter.
4. When replacing filter, the urea cap damage is caused by over tightening and the filter detachment is caused by not tightening.

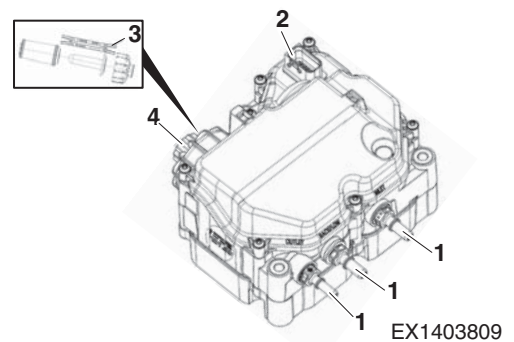
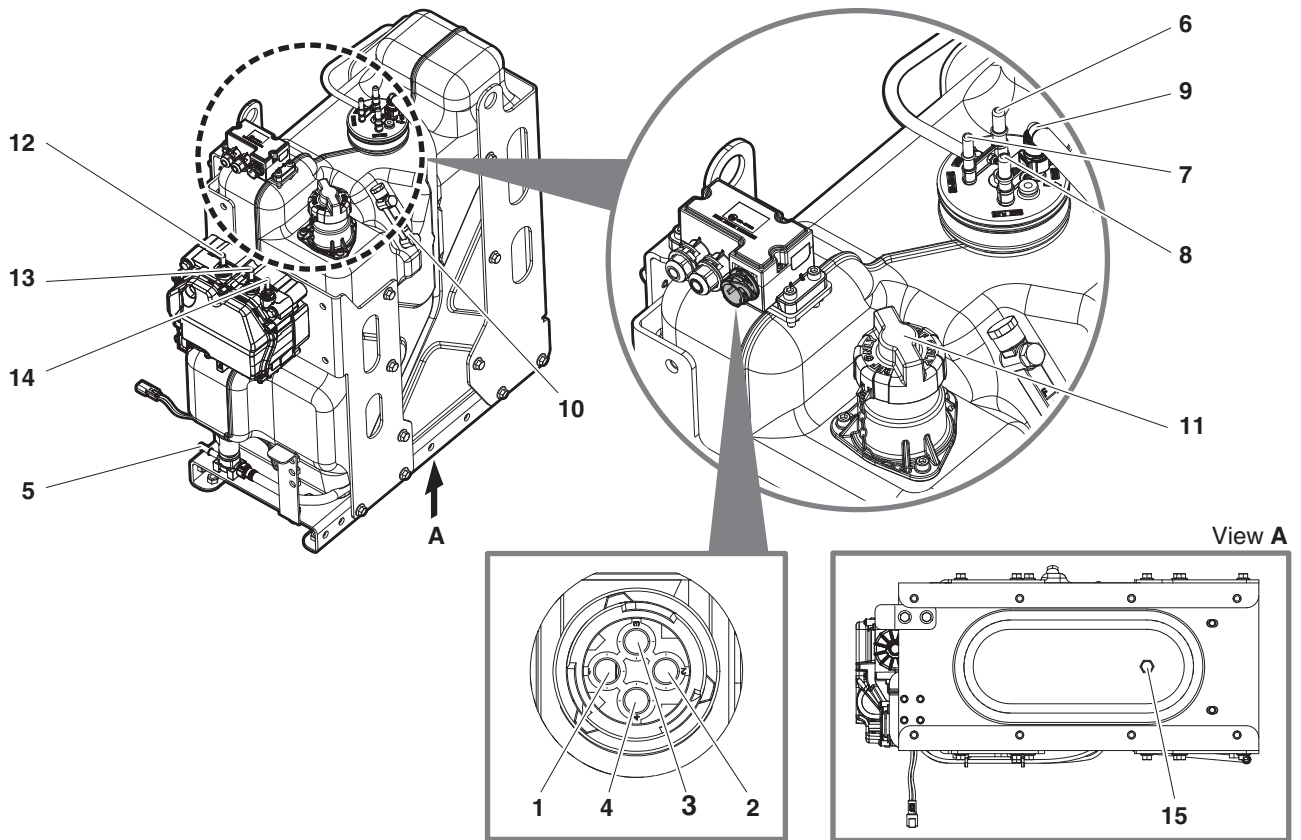


Figure 223

Urea Tank

Urea Tank is keeping the urea solution. Assembly connected line to correct location. When maintenance of urea tank, be careful not to external impacts.



DS1605651

Figure 224

1. Urea inlet hose and backflow hose are incompatible, do not use them together. Be careful to damage the connector, assemble the connector.



CAUTION

AVOID INJURY

Urea inlet hose is marked red color, backflow hose is marked yellow color.

2. Make sure that urea tank fixing bracket mount is tightened. If it is not tightened, it could occur the damage caused by vibration.
3. Make sure that the connection condition of tank temperature and level sensor connector. Be careful to damage connector and be contaminated debris.
4. Assembly coolant line to correct location. If it is not tightened, it could leak coolant.

5. Make sure that the connection condition of urea line heater (2-pin). Not running a heater in winter season there is a danger of frost.

Muffler and Other Pipes

It is no necessary to replace, disassemble and move mounted muffler and other pipes except by failure caused by external impact. Tighten the each parts at tightening torque not to leakage, when replacing, disassembling and moving muffler and other pipes caused by failure.

COOLING SYSTEM

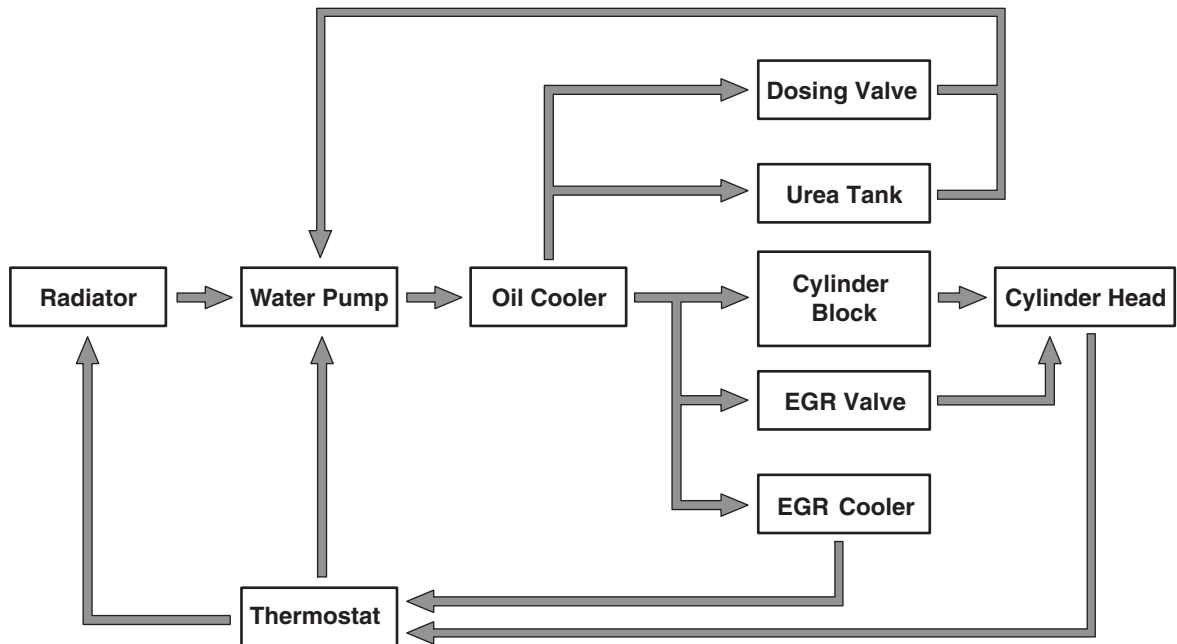
General information

General Description

This engine is a water-cooled type. Combustion heat from the combustion chamber and heat from engine oil are absorbed by coolant and dissipating them to the outside air to ensure optimum engine operation.

In the cooling system, coolant supplied from the coolant pump is sent to the oil cooler through the coolant pipe to absorb heat from oil before it passes through the coolant jacket of the cylinder block and through the cooling passage of the cylinder head to absorb combustion heat.

After this coolant absorbs oil heat and combustion heat, it is led to the thermostat through the coolant pipe. If the coolant temperature is below the valve opening temperature of the thermostat, the coolant flows into the coolant pump. If the temperature is over the opening temperature, it flows into the radiator. In the radiator, it releases heat and returns back to the coolant pump in a low temperature condition again.



DS1604256

Figure 225

Thermostat

General Description

The thermostat maintains water temperature in the engine consistently and prevents heat loss to improve heat efficiency of the engine.

When the coolant temperature is below the normal temperature, the thermostat is closed and the coolant is bypassed and directly flows into the water pump. When the coolant temperature reaches the normal temperature or is higher than the temperature, the thermostat is fully open and the bypass circuit is closed. So the coolant flows into the radiator.

CAUTION

AVOID INJURY

- The wax pellet type thermostat shows slower response to the change of cooling water than the bellows type thermostat. This happens because the heat capacity of the wax pellet type thermostat is larger than that of the bellows type thermostat. Therefore, to prevent a rapid increase in the engine coolant's temperature, you must first operate the engine at idle until the engine is fully warmed up. When the weather is very cold, do not operate the engine in an overloaded condition or at a high speed after starting the engine.
- When draining water from the engine cooler or injecting water to the engine cooler, work slowly to ensure that all air inside the cooler is expelled.
- When a defect is found in the thermostat, replace it with a new one.

Reference Number	Description
1	Heat Exchanger
2	Bypass Valve
3	Water Pump
4	Coolant Pipe

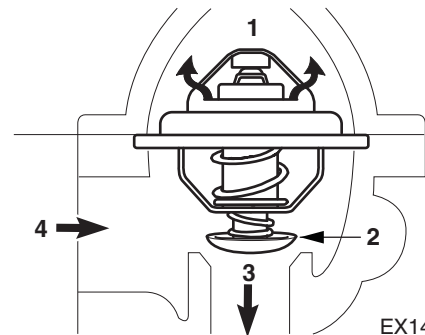


Figure 226

EX1403811

Parts List

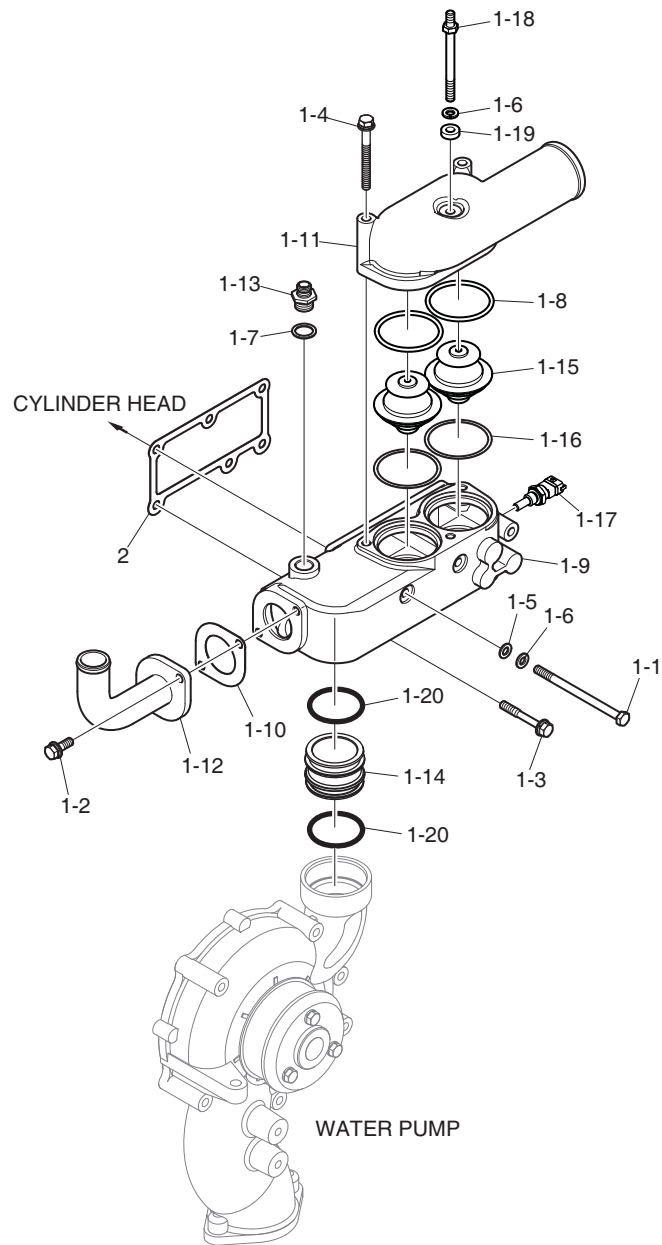


Figure 227

DS1604257

Reference Number	Description
1	Housing Assembly, Thermostat
1-1	Bolt M8 x 120
1-2	Bolt Assembly M8 x 25
1-3	Bolt Assembly M8 x 60
1-4	Bolt Assembly
1-5	Washer
1-6	Washer
1-7	Ring; Seal A18 x 24
1-8	O-ring
1-9	Housing; Thermostat
1-10	Gasket; Oil Cooler

Reference Number	Description
1-11	Pipe, Water
1-12	Pipe; Cooling Water
1-13	Adapter
1-14	Pipe; Cooling Water
1-15	Thermostat
1-16	Gasket
1-17	Sensor; Temp
1-18	Bolt; Stud
1-19	Washer
1-20	O-ring
2	Gasket; Thermostat Housing

Cautions for Replacement and Handling of Thermostat

1. Cautions for handling

A wax pellet type thermostat features relatively slow response for change in coolant temperature compared to a bellows type. This is because the wax pellet type has larger thermal capacity. Therefore, it needs to idle the engine sufficiently before running it in order to prevent surge of engine coolant temperature. In cold weather, never overload the engine or speed drive.

2. When adding or draining coolant to/from the engine cooling system, do it slowly to let air in the system escape.

3. Thermostat replacement

If any defect is found on the thermostat, replace it with a new one.

Thermostat inspection

1. Check if the wax pellet and spring are damaged.

2. Put the thermostat into water and heat the water gradually to check for operation of the thermostat.

If the thermostat starts to open at 83°C (water temperature) and it is fully open at 95°C, it is normal.

3. Check if there is any foreign material in the thermostat.

NOTE: Clean the inside of the thermostat using a air gun.

4. Check the hose for internal or external damage or foreign materials.

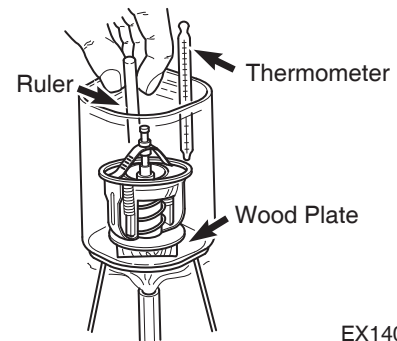


Figure 228

EX1403812

Troubleshooting

Phenomenon	Causes	Troubleshooting
Overheated Engine	Not enough coolant	Replenish the coolant
	Defective radiator cap	Replace it
	Contaminated radiator	Clean the exterior of the radiator
	Defective V-belt offset	Adjust or replace it
	Contaminated or damaged V-belt	Replace it
	Damaged impeller	Replace the water pump
	Defective impeller fix	Replace the water pump
	Bad water pump operation	Replace it
	Bad thermostat operation	Replace it
	Bad coolant flow	Clean the coolant path
	Improper injection time	Check it with the failure diagnosis unit
	Damaged cylinder head gasket	Replace it
Overcooled Engine	Bad thermostat operation	Replace it
	Too low ambient temperature	Heat the block
Leaking Coolant	Damaged radiator	Repair or replace it
	Loosened or damaged radiator connection	Repair or replace the connection
	Defective radiator cap	Replace it
	Badly mounted water pump	Repair or replace it
	Bad or damaged water pump gasket	Replace the gasket
	Badly mounted thermostat	Repair or replace it
	Bad or damaged thermostat gasket	Replace the gasket
	Damaged cylinder head gasket	Replace the gasket
	Damaged cylinder head or block	Replace it
Noise	Bad water pump bearing	Replace the bearing
	Bad or damaged cooling fan	Repair or replace it
	Bad rotation of the cooling fan	Replace it
	Defective V-belt offset	Adjust or replace it

FUEL SYSTEM

General Information

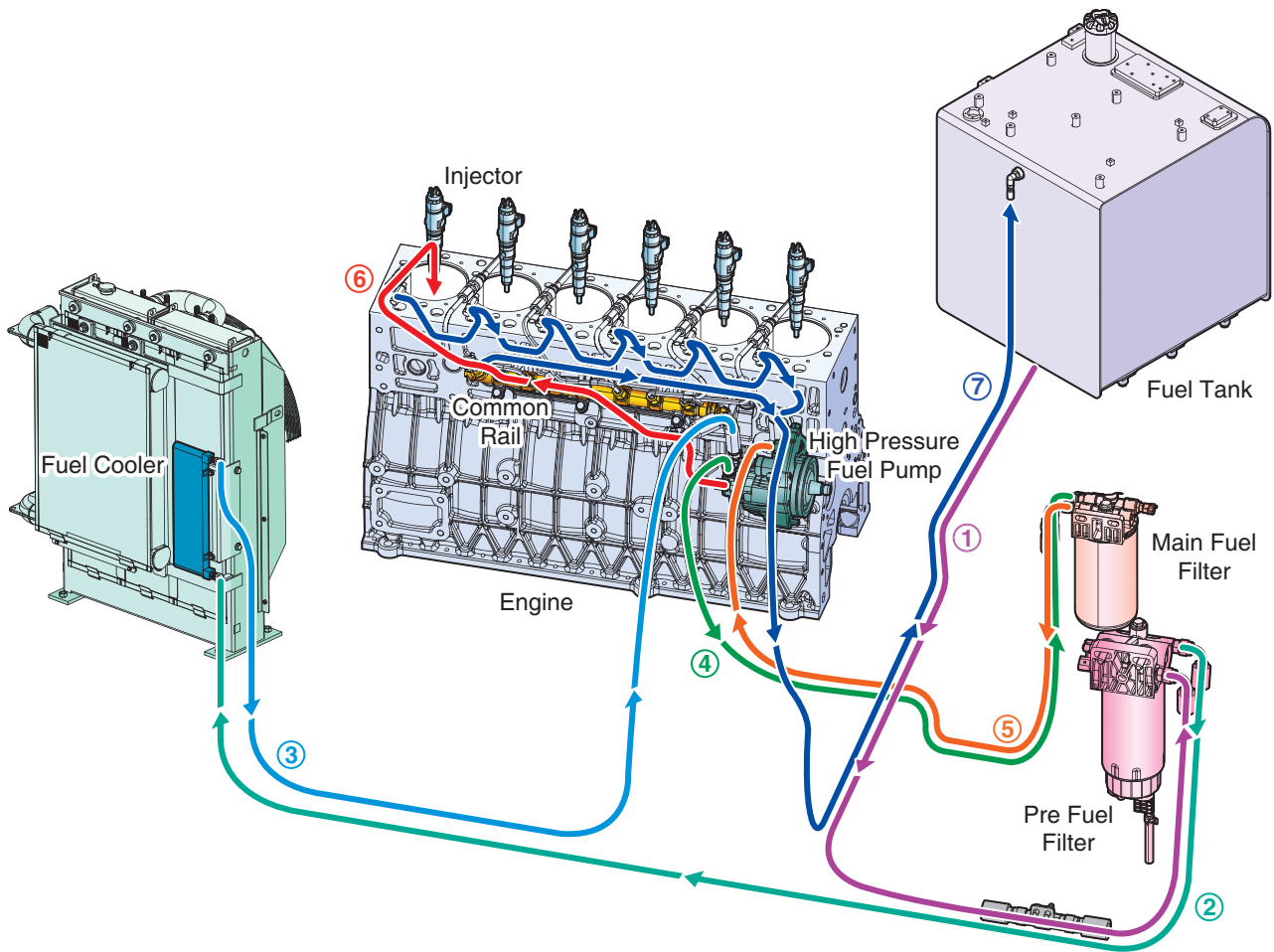
This diesel engine compresses air delivered into its cylinders and sprays fuel with its injection nozzles to burn fuel with compression heat.

When the high-pressure pump produces high-pressure fuel, this fuel is kept by the common rail and its injection timing and injection amount are calculated by the ECU (Electronic Control Unit). The ECU (Electronic Control Unit) operates the solenoid valves of the injectors on each cylinder to inject fuel.

This common rail fuel injection system has the high-pressure producing part and the fuel injection part separated. The ECU determines the fuel injection amount, injection timing and injection pressure according to the operating condition of the engine before injecting fuel into the cylinders in order to ensure optimum engine performance.

As the high-pressure pump produces high-pressure fuel, this fuel is kept by the common rail. When a driver operates the vehicle, the optimum fuel injection timing and injection amount are determined by the ECU (Electronic Control Unit) based on the preset data, vehicle speed and driving condition. Then the ECU operates the solenoid valves of the injectors on each cylinder to inject a proper amount of fuel into the cylinders.

The fuel tank should be made of non-corrosive material, and the fuel low-pressure pump should not leak at twice the operating pressure. Also, the pressure in the tank should not exceed 0.3 bar (0.3 kg/cm², 4.4 psi).



DS1604278

Figure 229

Fuel High-pressure System Components

The common rail fuel injection system consist of the low-pressure stage for low-pressure fuel delivery, high-pressure stage for high-pressure fuel delivery, and electronic control unit.

1. Fuel high-pressure pump

The fuel high-pressure pump pressurizes fuel up to approximately $1,835.5 \text{ kg/cm}^2$ (1,800 bar, 26,106.8 psi) and sends this pressurized fuel to the common rail (pipe shape) through the high-pressure line.

2. Common rail

Even after the injector uses fuel from the common rail to inject fuel, the fuel pressure in the common rail is still maintained at a constant level. The common rail pressure sensor detects the fuel pressure while the pressure control valve maintains the fuel pressure at the desired level. The fuel pressure in the common rail is controlled to max. $1,835.5 \text{ kg/cm}^2$ (1,800 bar, 26,106.8 psi) by the pressure control valve.

3. Injector

As the solenoid valve is operated, fuel flows to the injector nozzle which then sprays fuel directly into the combustion chamber. When the injector nozzle opens and sprays the commanded amount of fuel, the excess fuel is returned to the tank through the return line. Also, fuel returned from the fuel pressure control valve and low-pressure stage and fuel used to lubricate the high-pressure pump are returned back to the fuel tank through the return line as well.

4. Fuel high-pressure pipe

The fuel high-pressure pipe carries high-pressure fuel at $1,835.5 \text{ kg/cm}^2$ (1,800 bar, 26,106.8 psi). Therefore, this pipe is made of special material to be able to withstand the maximum pressure of the system and fluctuation of high pressure occurred during fuel injection. The high-pressure pipe has 8.0 mm of outside diameter and 3.5 mm of inside diameter. Also, the fuel high-pressure pipes installed between the common rail and injectors should be in the same length and they are installed as short as possible.

Injector

General Description

The injector uses the nozzle to inject fuel to the combustion chamber directly. To control the injection, the solenoid valve is used. Fuel is delivered as much as required from the open injector nozzle and the remaining fuel is returned to the fuel tank through the fuel return line. In addition, the fuel which has been used to lubricate the high-pressure pump and returned from the fuel pressure adjustment valve is returned to the fuel tank through the return line.

The solenoid valve controls the fuel injection timing and amount. The injector works instead of the nozzle and the nozzle holder mounted on the existing engine. Fuel is delivered to the injector through the high-pressure connector mounted on the cylinder head and then delivered to the valve control chamber through the delivery hole.

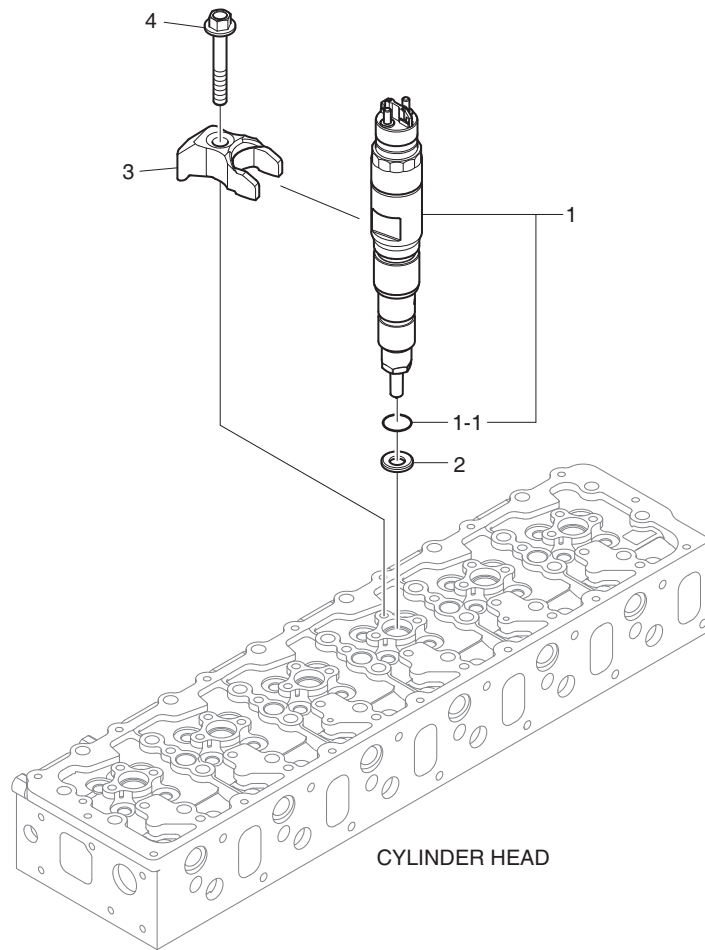
The valve control chamber is opened by the solenoid valve. It is connected to the fuel return line via the discharge hole. The hydraulic force which has been increased by the valve control plunger with closed discharge hole exceeds the pressure value of the nozzle needle. As a result, fuel delivery to the combustion chamber is blocked by the force given to the contact surface of the nozzle needle.

When the solenoid valve of the injector is pulled, the discharge hole is opened. This lowers the pressure in the control chamber and the hydraulic power given to the plunger. When hydraulic force is lower than the force given to the nozzle needle pressure, the nozzle needle is opened. Finally, fuel is injected to the combustion chamber through the injection nozzle hole.

The reason that the nozzle needle is controlled by hydraulic force is that the power required to open the needle quickly cannot be directly generated from the solenoid valve. Fuel control amount required to open the nozzle needle is added to the fuel amount injected. The used fuel is discharged to the fuel return line through the hole of the valve control chamber.

Fuel loss occurs on the nozzle needle, the valve plunger guide as well as the valve control chamber. The control leakage fuel and the fuel gathered from the line, which connects the over flow valve, the high-pressure pump, and the pressure control valve, is returned to the fuel tank through the fuel return line.

Parts List



DS1604258

Figure 230

Reference Number	Description
1	Injector Assembly
1-1	O-ring
2	Ring; Seal

Reference Number	Description
3	Fixture
4	Bolt; Collared Hex

How to Operate an Injector

Injector operation is classified into four operation stages to operate the engine and create pressure in the high-pressure pump.

1. The injector is closed (high fuel pressure state)
2. The injector is open (starting fuel injection).
3. The injector is fully open (injecting fuel).
4. The injector is closed (ending fuel injection). These operation stages are decided by balancing the force given to the injector components. If there is no pressure on the common rail or the engine is stopped, the injector nozzle does not work.
5. The injector is closed (pause state)

Under the pause state that no power is provided to the solenoid valve of the injector, the injector does not operate. The surface where the discharge hole exists is tightly closed with the valve ball by the force from a valve spring or magnet. High pressure in the common rail is kept by the fuel control valve and the same pressure is generated in the nozzle chamber of the injector. The common rail fuel pressure, which is applied to the end face of the valve control chamber of the injector, and the force of the spring at the nozzle of the injector are larger than the force to open the nozzle. Therefore, the injector is closed.

6. The injector is open. (starting fuel injection)

When power is supplied while the injector solenoid valve is closed, the fuel discharge hole is open by the pulling force of the solenoid valve. Almost simultaneous with that, the high current given to the solenoid valve is reduced to the low current. This is because the air gap of the electromagnet circuit gets smaller. Fuel in the valve control chamber flows to the discharge valve hole on the upper side and then goes into the fuel tank via the fuel return line. The discharge hole completely breaks the pressure balance and lowers the pressure in the valve control chamber. As a result, the pressure in the valve control chamber is lower than the nozzle chamber pressure which has been equal to the common rail pressure. The lowered pressure of the valve control chamber lowers the force from the control plunger. So the nozzle needle is open and fuel injection starts.

7. The injector is fully open. (injecting fuel)

The valve control plunger is stopped at the upper position because fuel is full as fuel flows from the fuel delivery hole. At this time, the injector nozzle is fully open and fuel is injected to the combustion chamber at the pressure equal to that of the common rail.

8. The injector is closed. (ending fuel injection)

As soon as the supply to the solenoid valve of the injector is blocked, the valve spring applies force to the armature downward and the valve ball closes the discharge hole. The armature consists of two components. The armature plate is guided by the driving shoulder and pressed downward. However, in this case, an overspring is used. It is a return spring that prevents the force from being applied to the armature and the valve ball. As the discharge hole is closed, fuel is delivered from the delivery hole and generates pressure in the control chamber. This fuel pressure is equal to the pressure of the common rail and puts pressure on the valve control plunger through the end face of the valve control plunger. As a result, the force of the spring is added to the pressure exceeding the pressure of the nozzle chamber. Therefore, the nozzle needle is closed. The speed of closing the nozzle needle is decided by the flow that passes through the delivery hole. As soon as the nozzle needle is positioned to the stop position, fuel injection is blocked.

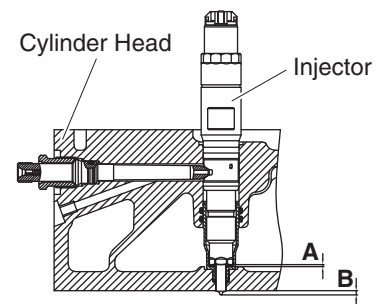
Injector Protrusion

1. Insert the seal ring to the cylinder head, and install the injector.

NOTE: Refer to the engine assembly instruction for installation steps.

2. Measure the protrusion of the injector from the cylinder head, and adjust it as necessary.

A (Seal Ring Thickness)	2.0 mm
B (Injector Protrusion)	2.24 ~ 2.97 mm



EX1403814

Figure 231

Common Rail

General Description

This common rail fuel injection system has the high-pressure producing part and the fuel injection part separated.

The ECU determines the fuel injection amount, injection timing and injection pressure according to the operating condition of the engine before injecting fuel into the cylinders in order to ensure optimum engine performance.

The common rail stores fuel under high pressure delivered from the high-pressure fuel pump.

Even after the injector draws fuel from the common rail, the pressure pulsation in the common rail is still maintained by the volume of the rail to keep the fuel pressure at a constant level.

The common rail pressure sensor detects the fuel pressure while the pressure control valve maintains the fuel pressure at the desired level. The fuel pressure in the common rail is controlled to max. 1,835.5 kg/cm² (1,800 bar, 26,106.8 psi) by the pressure control valve.

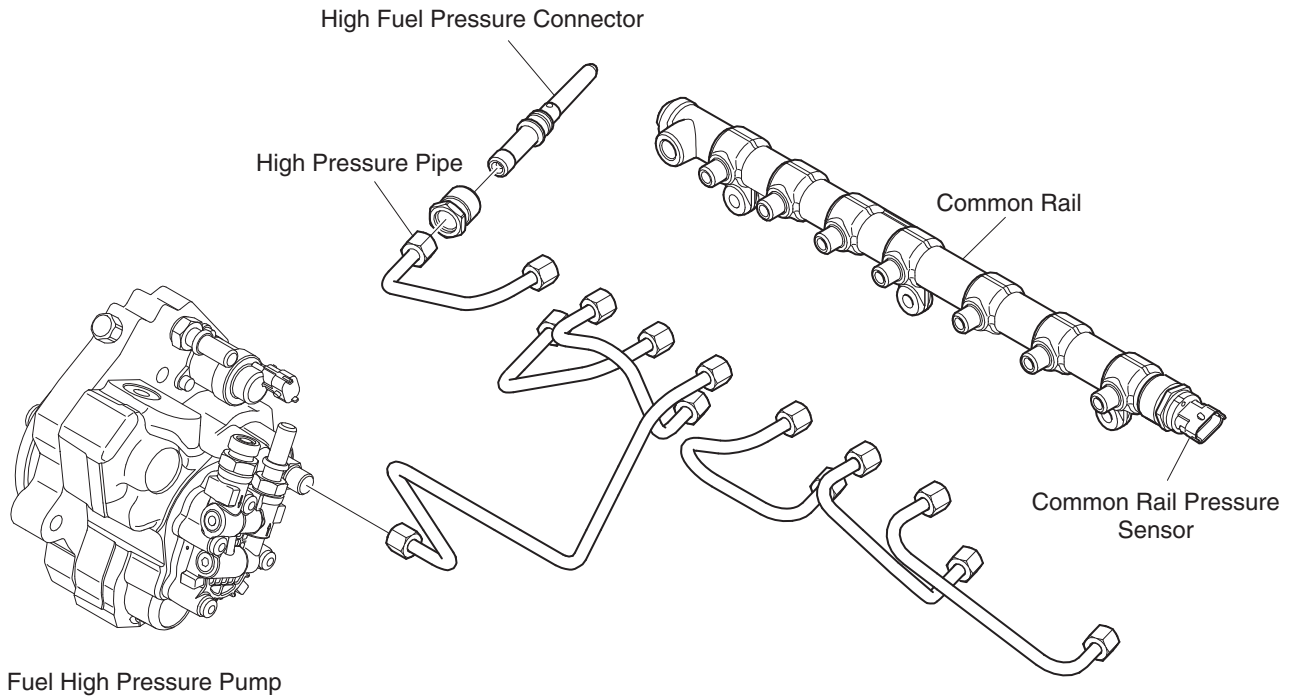
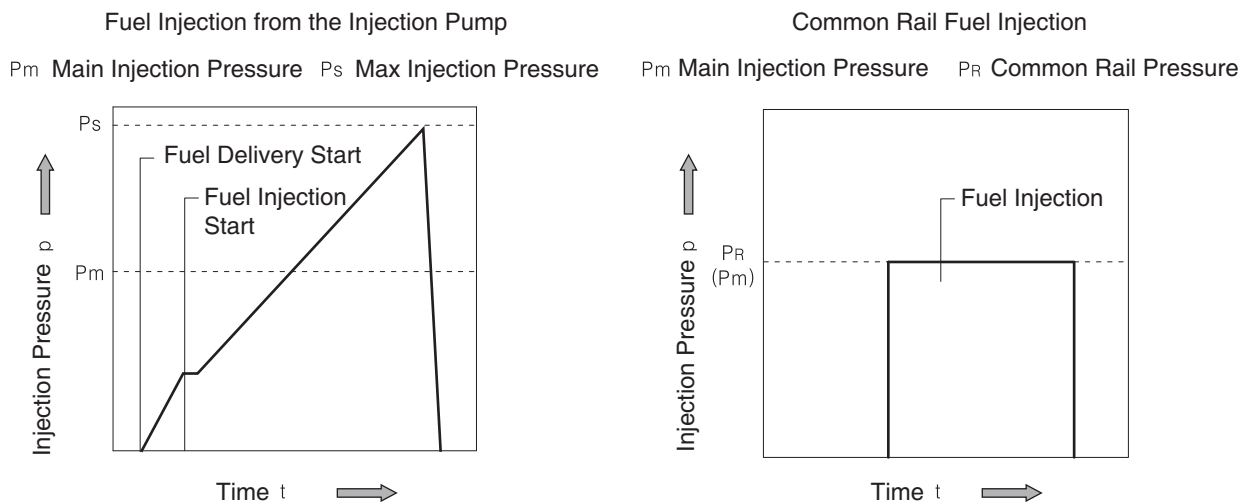


Figure 232

EX1403815

The common rail fuel injection system consists of the following main components:

1. ECU (Electronic Control Unit)
 2. Crankshaft speed sensor
 3. Camshaft speed sensor
 4. Accelerator pedal sensor
 5. Fuel temperature sensor
 6. Boost pressure and temperature sensor, oil pressure and temperature sensor
 7. Common rail pressure sensor
 8. Coolant temperature sensor
- As a driver depresses the accelerator pedal, the ECU (Electronic Control Unit) receives information from various sensors mentioned above to operate the engine and vehicle according to the operating condition instantly. Also, the ECU controls engine and open/closed circuits of the vehicle based on such information.
 - The crankshaft speed sensor detects the engine speed while information from the camshaft speed sensor is used to determine the ignition order. The potentiometer of the accelerator pedal sensor produces an electric signal to inform the ECU of how deep the pedal is depressed. Also, the turbocharger and intake pressure sensor are installed, the intake pressure sensor is used to measure the intake air pressure.
 - When the engine temperature is low in cold weather, the ECU receives information from the coolant temperature sensor and air temperature sensor to operate the engine ideally based on the current operating condition.



EX1403816

Figure 233

The common rail features the injection characteristics as follows:

1. Compared to the conventional system's injection characteristics, the common rail manages the fuel injection amount and injection pressure separately to satisfy with any engine condition in order to ensure optimum fuel injection.
2. In the initial fuel injection period, i.e. the ignition delay from the beginning of fuel injection until the beginning of combustion, the fuel injection amount should be adjusted to a low level.
3. The common rail system is a modular type and has the following major components for its injection characteristics:
 - A. Injector solenoid valve (installed to cylinder head)
 - B. Common rail
 - C. Fuel high-pressure pump
 - D. ECU (Electronic Control Unit)
 - E. Crankshaft speed sensor

Parts List

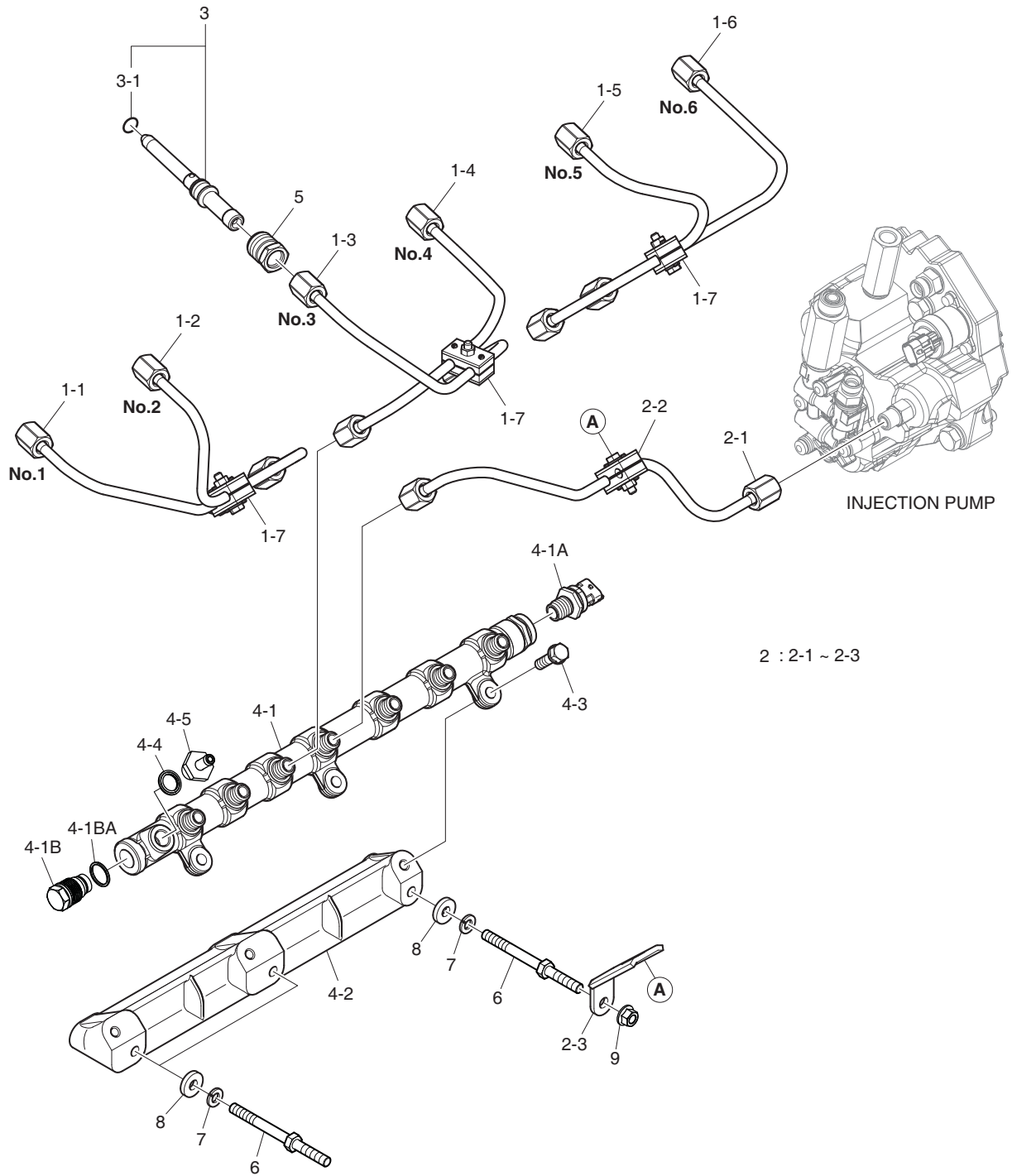


Figure 234

DS1604259

Reference Number	Description
1	Pipe Assembly, Injection
1-1	Pipe; Injection
1-2	Pipe; Injection
1-3	Pipe; Injection
1-4	Pipe; Injection
1-5	Pipe; Injection
1-6	Pipe; Injection
1-7	Clip; Pipe
2	Pipe Assembly, Injection
2-1	Pipe; Injection
2-2	Clip Assembly, Pipe
2-3	Holder
3	Connector; High Pressure
3-1	O-ring

Reference Number	Description
4	Rail, Common
4-1	Rail; Common
4-1A	Sensor; Pressure
4-1B	Valve, Pressure Limits
4-1BA	O-ring
4-2	Bracket; Common Rail
4-3	Bolt Assembly M8 x 30
4-4	Ring; Seal
4-5	Screw; Connection
5	Nut
6	Bolt; Stud
7	Washer
8	Washer
9	Nut

Fuel Injection Pump

General Description

The high-pressure fuel pump is a radial shaped piston type pump. Pressure is independently generated during the fuel injection process. The high-pressure fuel pump is directly connected to the engine crankshaft, thus it turns always in synchronization with the engine. Compared to the conventional injection system, the common rail injection system delivers a certain amount of fuel constantly.

The injector is connected to the common rail with the high-pressure pipe. It consists of the nozzle and solenoid valve which is energized by the ECU when the ignition switch is operated. When the ignition switch is blocked, the solenoid valve ends the injection operation.

As the switching (opening/closing) operation of the injector's solenoid valve is performed by high voltage and current, the injectors' solenoid valves are operated in sequence according to the preset value in the ECU. The crankshaft speed sensor and camshaft speed sensor are used to detect the engine speed in order to adjust the fuel injection timing and the beginning of fuel injection correctly.

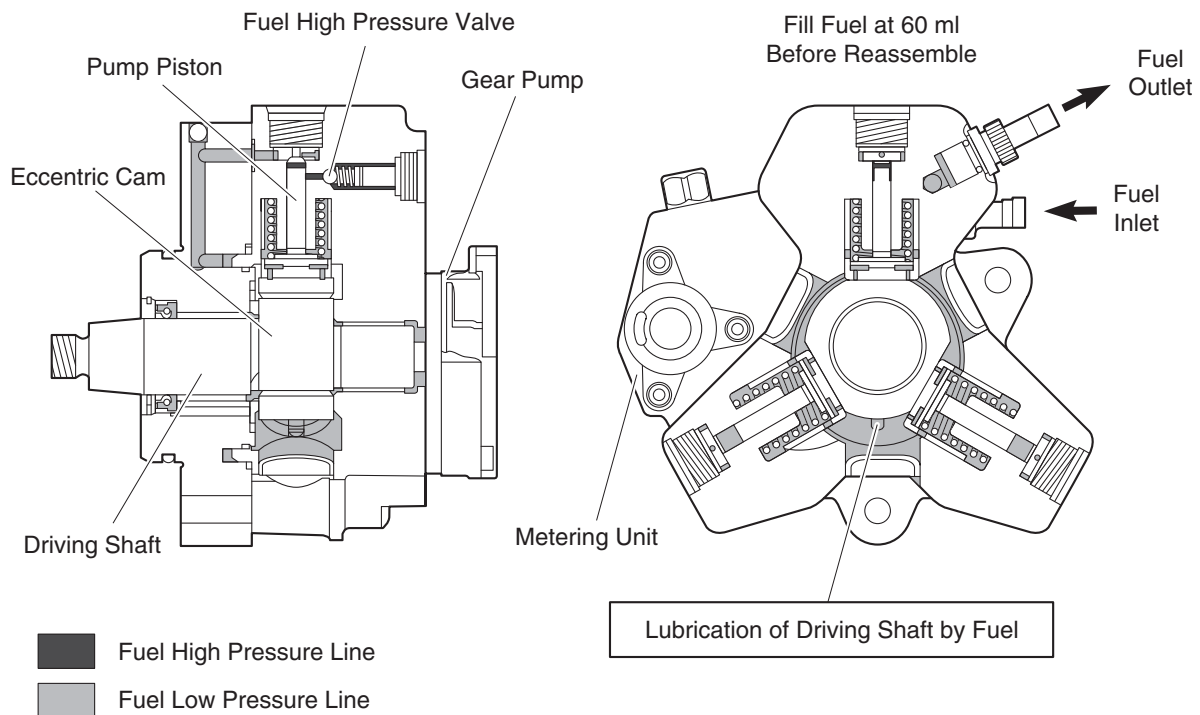


Figure 235

EX1403817

Function

The fuel high-pressure pump has both low pressure stage and high pressure stage. It carries high pressure fuel under any operating circumstance during the service life of the vehicle.

Also, it supplies a proper amount of fuel to the common rail to handle any harsh condition, such as abrupt vehicle start or rapid change of pressure in the common rail. The fuel high-pressure pump produces the system pressure required in the common rail constantly.

Structure Fuel High-pressure Pump

The fuel high-pressure pump has three pump pistons set 120° apart from each other in it to compress fuel in the circumferential direction. As every rotation creates three compression strokes, the pump drive system's stress is maintained steadily and it needs low driving force. The common rail needs low pump driving force which is only approximately 1/9 of force required for the conventional pump system.

Operation

The fuel feed pump supplies fuel to the high-pressure pump through the fuel inlet and safety valve. Then, this fuel is transferred to the high-pressure pump's lubrication and cooling circuits through the safety valve. The drive shaft is equipped with the eccentric cam to move the pump's piston up and down according to the shape of the cam.

If the fuel pressure delivered from the fuel feed pump exceeds the fully open pressure of the safety valve, fuel moves the pump piston downwards through the intake valve of the fuel high-pressure valve to the intake stroke position of the pumping chamber. When the pump piston passes the B.D.C., the valve is closed. Then, as fuel cannot escape the pumping chamber, it is compressed further over the delivered pressure.

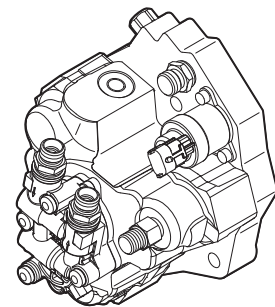
As soon as the fuel pressure reaches the common rail pressure, it opens the exhaust valve. Then, this compressed fuel enters the high-pressure circuit. The pump piston continues to carry fuel until it reaches the T.D.C. Then, as soon as the pressure drops, the exhaust valve is closed. Then, fuel left in the pumping chamber is depressurized and the pump piston moves downwards again. When the pressure in the pumping chamber drops below the pressure of the fuel feed pump, the intake valve opens and the above steps are repeated.

Fuel Return

The fuel high-pressure pump is designed to supply a large amount of fuel. While the engine is running at an idle speed or with partial load, excess fuel is returned to the tank through the pressure control valve.

Fuel High-pressure Pumping Cut-off Valve

When the switch of the fuel high-pressure pumping cut-off valve is turned off, the fuel amount delivered to the common rail is increased. When the switch is turned off, the fuel pumping solenoid valve is pulled, so the pin attached to an electric magnet keeps the valve open. Therefore, fuel led into the

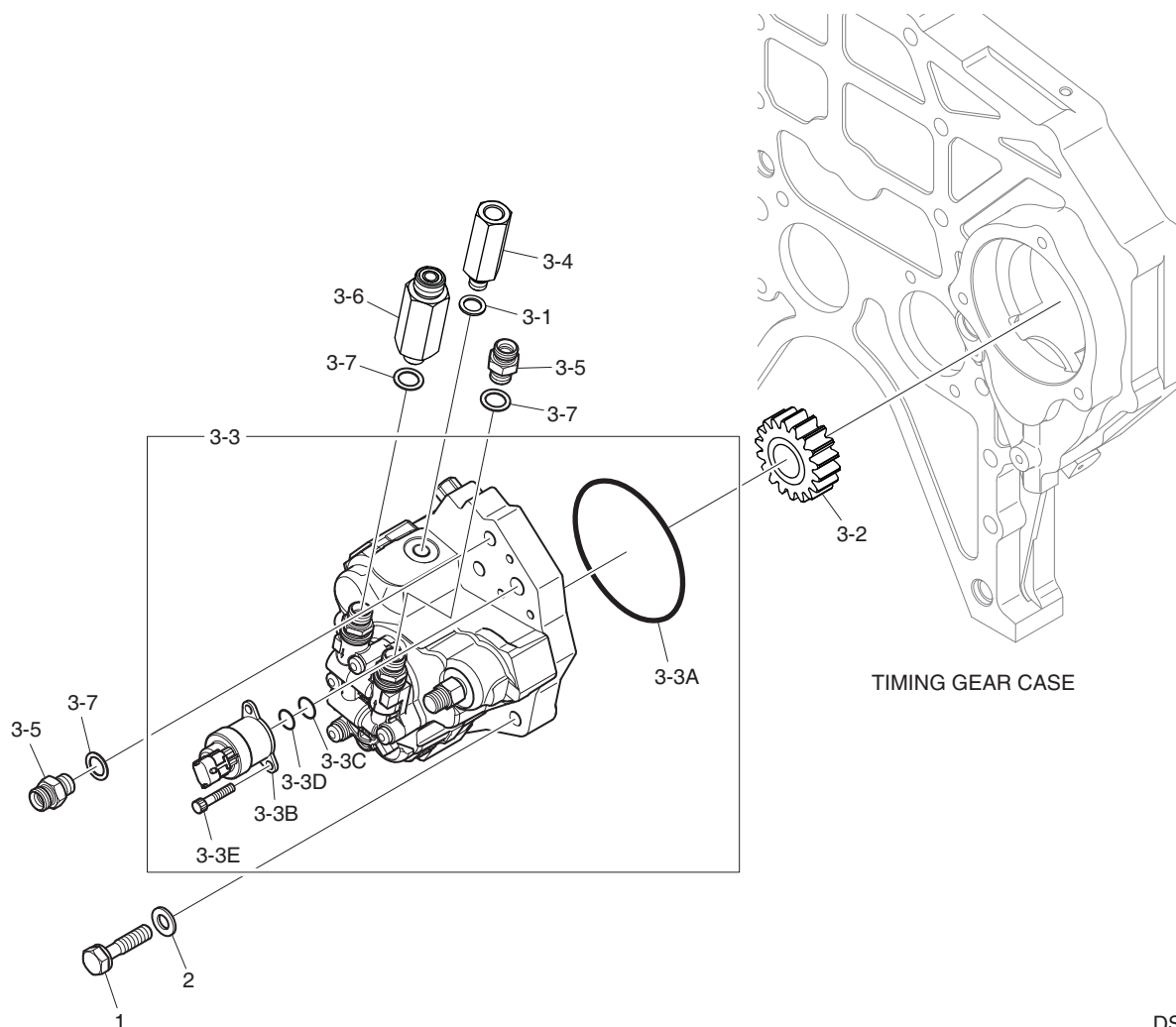


DS1604271

Figure 236

pumping valve cannot be compressed during the delivery stroke. As this fuel is returned to the low-pressure passage, no pressure is produced. Since the pumping cut-off valve is operated only with a small amount of force, it is possible to switch between the delivery phase and cut-off phase at short intervals.

Parts List



DS1604272

Figure 237

Reference Number	Description
1	Bolt Assembly M10 x 45
2	Washer; Plain
3	Injection Pump Assembly
3-1	Ring; Seal
3-2	Gear; Injection Pump Drive
3-3	Injection Pump Assembly
3-3A	O-ring
3-3B	Flow Meter; Fuel

Reference Number	Description
3-3C	O-ring
3-3D	O-ring
3-3E	Bolt
3-4	Adapter
3-5	Adapter
3-6	Adapter
3-7	Ring; Seal

ELECTRICAL SYSTEM

Electrical Parts

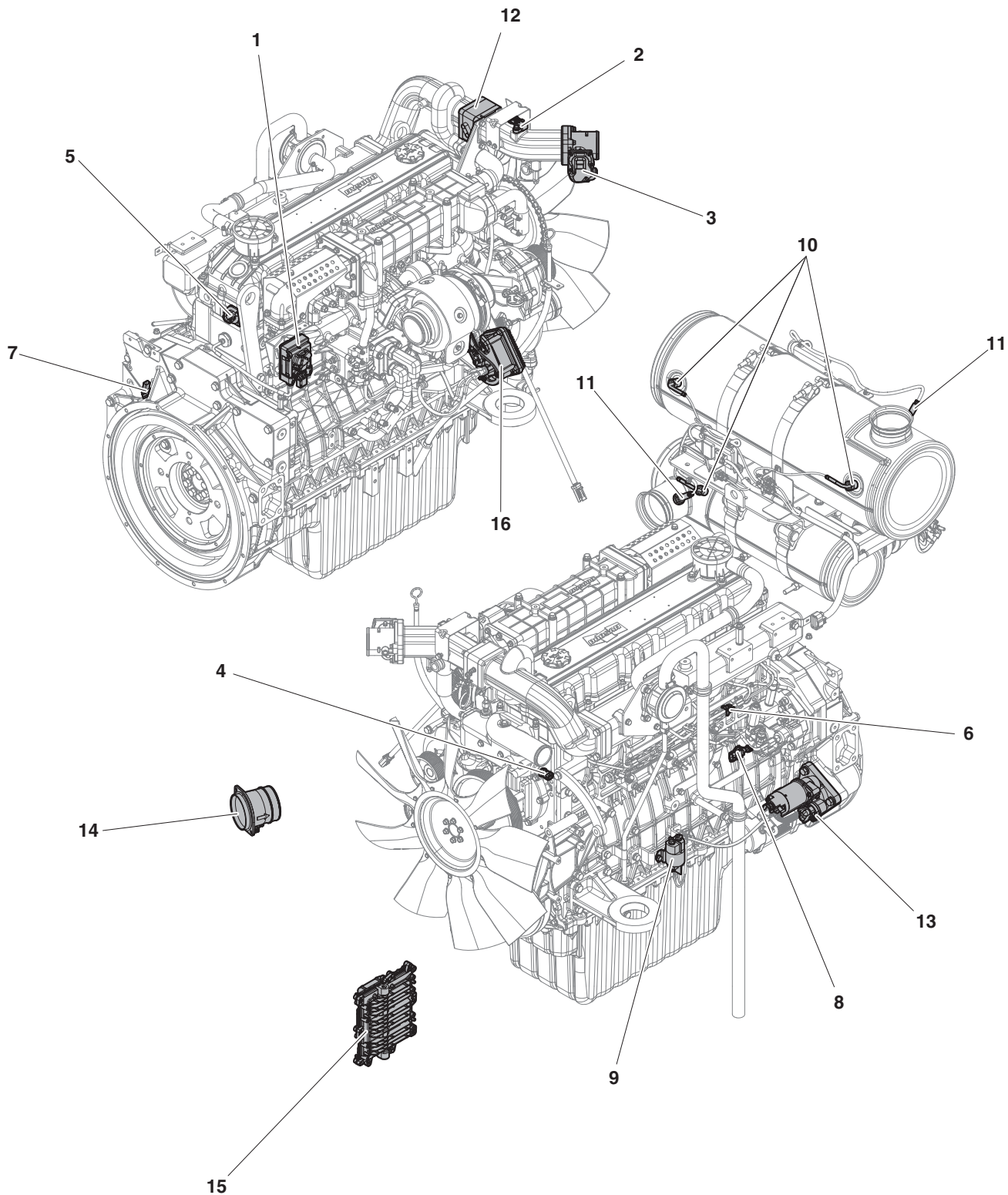


Figure 238


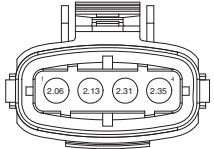
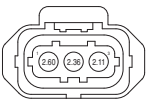

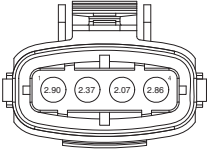
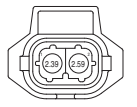
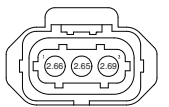
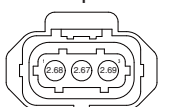
DS1604277

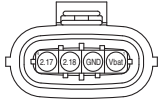


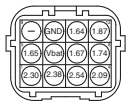

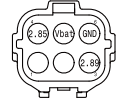
Reference Number	Description
1	EGR (Exhaust Gas Recirculation) Motion Sensor
2	Boost Pressure and Temperature Sensor
3	Throttle Valve Position Sensor
4	Coolant Temperature Sensor
5	Injector Connector
6	Rail Pressure Sensor
7	Crankshaft Speed Sensor
8	Camshaft Speed Sensor

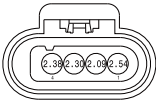
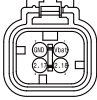
Reference Number	Description
9	Air Heater Relay
10	Exhaust Temperature Sensor
11	NOx Sensor
12	Air Heater
13	Starter
14	Mass Air Flow (MAF) Sensor
15	Engine Control Unit (ECU)
16	Variable Turbine Geometry (VTG)

Switches and Sensors

ECU (Electronic Control Unit)

Shape	Symbol	Pin No.	Circuit name
Fuel Metering Unit 	FMU	2.58	Fuel Metering Unit (O_V_MEU)
		2.83	Fuel Metering Unit (O_T_MEU)
Oil Press Temp Sensor 	OPTS	2.06	Oil Pressure/Temperature Sensor GND (G_R_OPS)
		2.13	Oil Temperature Sensor SIG (I_A_OTS)
		2.31	Oil Pressure/Temperature Sensor Voltage (V_V_5VSS1F)
		2.35	Oil Pressure Sensor SIG (I_A_OPS)
Rail Press Sensor 	RPS	2.60	Rail Pressure Sensor GND (G_R_RAILPS)
		2.36	Rail Pressure Sensor SIG (I_A_RAILPS)
		2.11	Rail Pressure Sensor Voltage (V_V_5VSS3B)
Throttle Plate Actuator / Position Sensor 	TVA	2.34	Throttle Valve Voltage (V_V_5VSS3C)
		2.29	Throttle Valve Motor - (O_T_DCNEG1)
		2.40	Throttle Valve GND (G_R_TVA)
		2.15	Throttle Valve SIG (I_A_TVA)
		2.05	Throttle Valve Motor + (O_T_DCPOS1)
Boost Press Temp Sensor 	BPTS	2.90	Boost Pressure/Temperature Sensor GND (G_R_BPS)
		2.37	Boost Temperature Sensor SIG (I_A_BTS)
		2.07	Boost Pressure/Temperature Sensor Voltage (V_V_5VSS1A)
		2.86	Boost Pressure Sensor SIG (I_A_BPS)
Coolant Temp Sensor 	CTS	2.39	Coolant Temperature Sensor SIG (I_A_CTS)
		2.59	Fuel Temperature/Coolant Temperature Sensor GND (G_R_AN18)
Crank Shaft Speed Sensor 	CRS	2.66	Crankshaft Speed Sensor POS (I_F_CRSPPOS)
		2.65	Crankshaft Speed Sensor NEG (I_F_CRSNNEG)
		2.69	Crankshaft/Camshaft Speed Sensor Protective GND (G_C_GND)
Cam Shaft Speed Sensor 	CAM	2.68	Camshaft Speed Sensor POS (I_F_CASPOS)
		2.67	Camshaft Speed Sensor NEG (I_F_CASNEG)
		2.69	Crankshaft/Camshaft Speed Sensor Protective GND (G_C_GND)

Shape	Symbol	Pin No.	Circuit name
EGR Valve 	EGR	Vbat	24 V Battery Voltage (O_V_RH32)
		GND	Body GND
		2.18	CAN 2 Low (B_D_CAN2L)
		2.17	CAN 2 High (B_D_CAN2H)
Injector Connector 	INJ	2.49	Cylinder 1, Injector 1 High (O_P_SVH11)
		2.73	Cylinder 1, Injector 1 Low (O_P_SVL11)
		2.51	Cylinder 1, Injector 3 High (O_P_SVH13)
		2.75	Cylinder 1, Injector 3 Low (O_P_SVL13)
		2.50	Cylinder 1, Injector 2 High (O_P_SVH12)
		2.74	Cylinder 1, Injector 2 Low (O_P_SVL12)
		2.27	Cylinder 2, Injector 3 High (O_P_SVH23)
		2.03	Cylinder 2, Injector 3 Low (O_P_SVL23)
		2.25	Cylinder 2, Injector 1 High (O_P_SVH21)
		2.01	Cylinder 2, Injector 1 Low (O_P_SVL21)
		2.26	Cylinder 2, Injector 2 High (O_P_SVH22)
		2.02	Cylinder 2, Injector 2 Low (O_P_SVL22)
Fuel Temp Sensor 	FTS	2.12	Fuel Temperature Sensor SIG (I_A_FTS)
		2.59	Fuel Temperature/Coolant Temperature Sensor GND (G_R_AN18)
Inter Connector for Vehicle 	Interconnector (HFM, FAN Clutch)	2.30	HFM Sensor GND (G_R_AMS)
		2.38	HFM Sensor Temperature SIG (I_A_IATS)
		2.54	HFM Sensor (I_A_IATS)
		2.09	HFM Sensor PWR (V_V5VCAH)
		1.65	Fan Speed Sensor GND (G_R_FSS)
		Vbat	24 V Battery Voltage
		1.67	Fan Speed Sensor PWR (O_V_5VSS2A)
		1.74	Fan Actuator Control SIG (O_V_RH21)
		GND	Body GND
		1.64	Fan Speed Sensor SIG (I_F_FSS)
		1.87	Fan Actuator Control SIG (O_T_FAN1)
Resistance 	Resistance	2.17	CAN 2 High (B_D_CAN2H)
		2.18	CAN 2 Low (B_D_CAN2L)
Inter Connector for Vehicle 	Interconnector	2.85	Ambient temperature sensor signal (I_A_ATS)
		2.89	Ambient temperature sensor GND (G_R_WFS)
		Vbat	24 V Battery voltage
		GND	Body GND

Shape	Symbol	Pin No.	Circuit name
HFM Sensor 	HFM Sensor	2.09	HFM sensor PWR (V_V5VCAH)
		2.38	HFM sensor temperature SIG (I_A_IATS)
		2.54	HFM sensor (I_A_IATS)
		2.30	HFM sensor GND (G_R_AMS)
VTG Connector 	VTG	2.17	CAN 2 HIGH (B_D_CANH2)
		2.18	CAN 2 LOW (B_D_CAN2L)
		Vbat	24 V Battery voltage
		GND	Body GND

Boost Pressure and Temperature Sensor

1. The boost pressure and temperature sensor is connected to the intake manifold with the O-ring to measure the absolute pressure and temperature in the intake manifold.
2. Its output signal is sent to the ECU which then calculates the boost pressure based on the programmed characteristic curve.

Engine Oil Pressure and Temperature Sensor

The engine oil pressure and temperature sensor detects the pressure and temperature of engine oil and sends these information to the ECU (Electronic Control Unit).

Engine Coolant Temperature Sensor

The engine coolant temperature sensor detects the temperature of engine coolant and sends this information to the ECU (Electronic Control Unit).

Common Rail Pressure Sensor

Fuel passes through the passage in the common rail before it heads to the common rail pressure sensor.

The tip of this pressure sensor is sealed with the diaphragm. After fuel is pressurized, it reaches the diaphragm of the sensor through the hole.

A sensor to convert a fuel pressure value into an electric signal is connected to this diaphragm. This sensor produces a signal by amplifying the detected value before it delivers the signal to the ECU (Electronic Control Unit) and evaluation circuit.

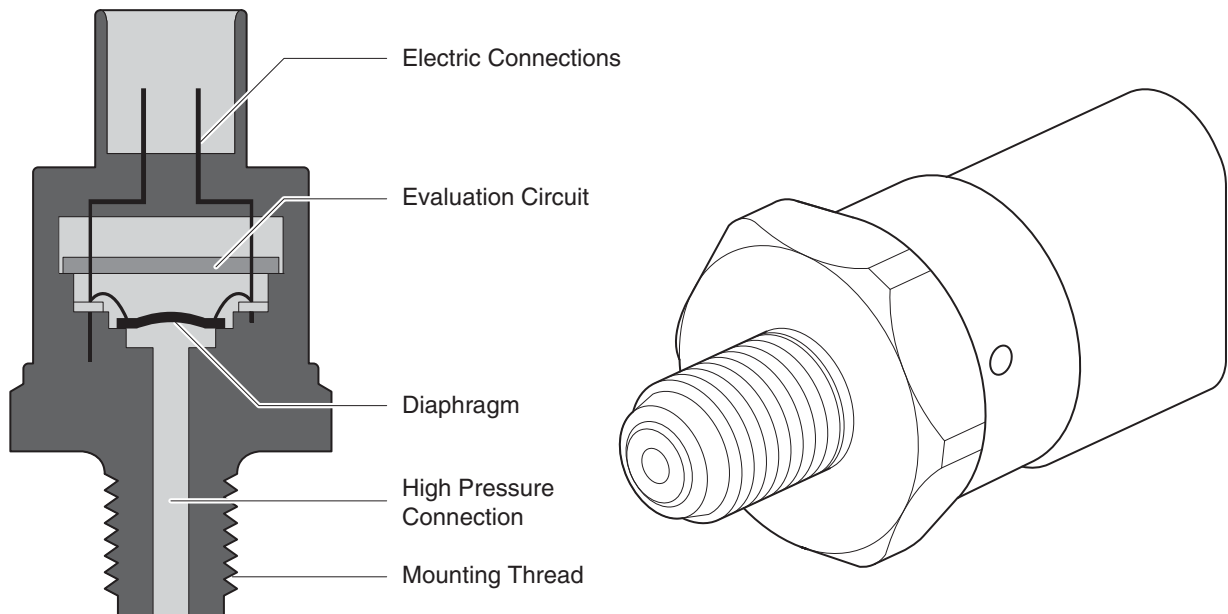


Figure 239

EX1403833

Crankshaft Speed Sensor

The position of the pistons in the combustion chamber has a major role in the fuel injection process.

All pistons in the engine are connected to the crankshaft by the connecting rod.

The flywheel housing is equipped with the crankshaft speed sensor to supply information for the position of all pistons.

This speed sensor detects the rotation per minute of the crankshaft, and this information is used by the ECU (Electronic Control Unit) for calculation as an important factor.

Camshaft Speed Sensor

The camshaft speed sensor is used to control the intake and exhaust valves of the engine.

This rotates at half speed of the crankshaft. When the piston is moving toward T.D.C., it determines whether the camshaft position is in the compression stage or in the exhaust stage.

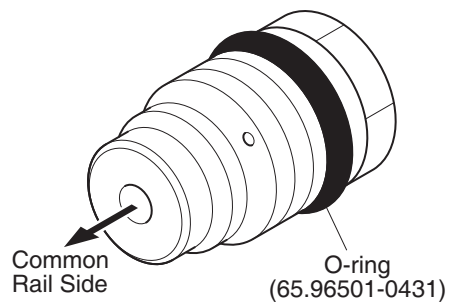
This information cannot be detected by the crankshaft speed sensor.

On the other hand, during normal operation, information supplied by the crankshaft speed sensor is enough to tell the condition of the engine.

In other words, if the camshaft speed sensor cannot detect the camshaft position while the engine is running, the ECU (Electronic Control Unit) receives engine condition information from the crankshaft speed sensor.

Pressure Limiter Valve

1. The pressure limiter valve is connected to the end of the common rail, and its body houses a conical plunger valve in it. This valve is normally closed by force of the spring at a normal operating pressure (1,800 bar (1,835.5 kg/cm², 26,106.8 psi)) to keep the pressure in the common rail.
2. As soon as the pressure exceeds the operating pressure limit, load is applied to the spring of the valve to keep the fuel pressure at a normal level. After fuel passes through the valve, it is returned to the fuel tank through the return pipe.



EX1404193

Figure 240

ECU (Electronic Control Unit)

ECU (Electronic Control Unit) Connector

There are two ECU (Engine Control Unit) connectors: one for connection to the vehicle and one for connection to the engine.

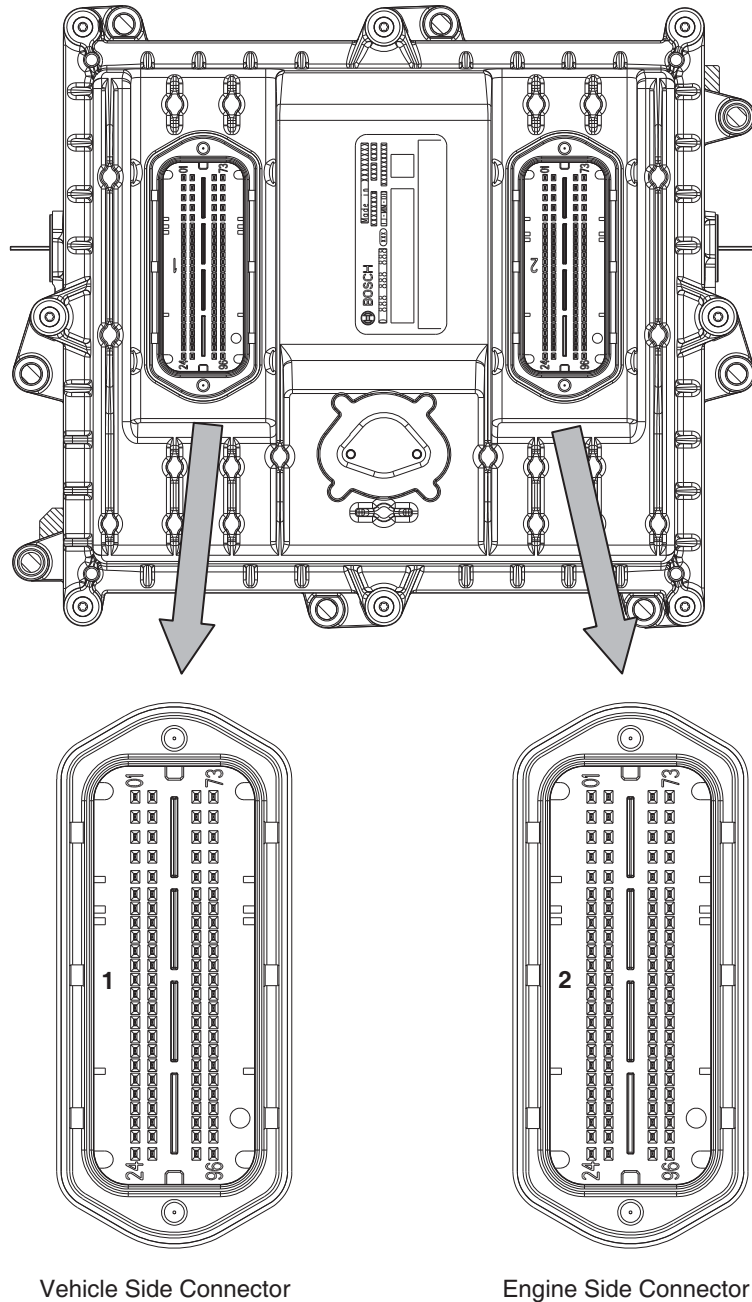


Figure 241

DS1605462

Operational Conditions of Electronic Control Unit (ECU)

Engine Start

1. Sets the reference temperature for determining preheat to the lowest temperature among coolant temperature, fuel temperature, intake air temperature, and oil temperature.
2. Sets the reference temperature for determining fuel volume by setting the engine cooling temperature.
3. Determines the appropriate fuel volume to start the engine, delivers the fuel to the engine, and measures the rpm signal by using the crankshaft rev-count sensor.

Vehicle Driving

Calculates the required data for driving a vehicle, such as CAN data and the rpm transferred from the vehicle control unit.

Driver-requested Adjustment of rpm

Controls the rpm based on request from the driver and controls the engine based on the rpm requested by the vehicle control unit.

Limp Home

1. A function that allows drivers to drive their vehicle to the repair center safely with the minimum conditions for driving the vehicle when a fault code occurs.
2. Limp Home function is applied under the following conditions.
 - Accelerator pedal has failed: Regardless of pressing the accelerator pedal, the vehicle is driven at a consistent RPM.
 - Sensor has failed: When sensors have failed, the vehicle is driven with the consistent alternative values.
 - Output is limited: According to the fault type, the fuel volume delivered to the engine is limited. The limit is classified into four levels. The fuel volume is limited according to the severity of the fault.
 - Diagnosis Information display lamp: Provides information of fault state to drivers for safe driving.

Failure Diagnosis

1. When a fault occurs, the failure diagnosis information display lamp on the gauge board is turned on.
2. With the failure diagnosis information display lamp, drivers can see the fault code.

NOTE: *It can be checked from the failure diagnosis information on the gauge board.*

3. It can be diagnosed by connecting the diagnosis unit to the check connector at the back of the driver's seat.

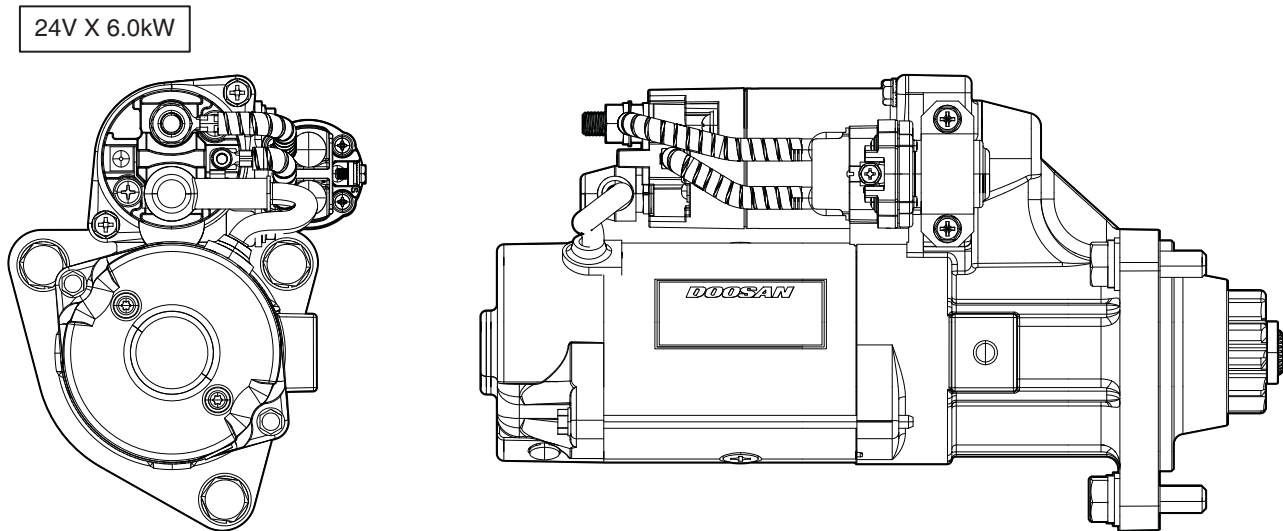
Driving Record

1. Writes the information related driving to the ECU.
2. The information on fuel consumption, engine use time, and ECU use time is written in the ECU.
3. The information can be monitored with the ECU diagnosis device.

Starter

General Description

The start motor is installed behind the flywheel housing. When disassembling the engine, soak the start motor's pinion gear and ring gear into fuel and clean them with a brush thoroughly. Then, apply grease to them prevent their corrosion.



DS1604273

Figure 242

IMPORTANT

The start motor should always be protected from moisture and humid condition.

Circuit Diagram

Circuit Diagram

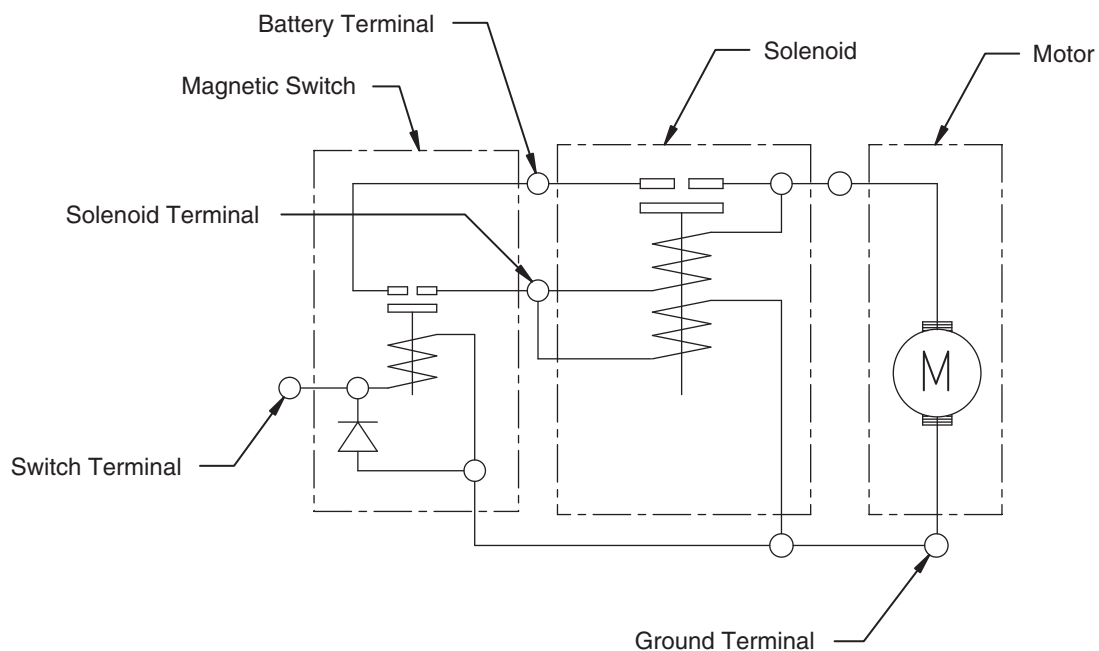


Figure 243

EX1403837

IMPORTANT

Before working on any electric system, make sure to disconnect the negative battery cable in advance. Connect the ground cable last after work to avoid a short circuit during work.

Engine Harness

Circuit Diagram

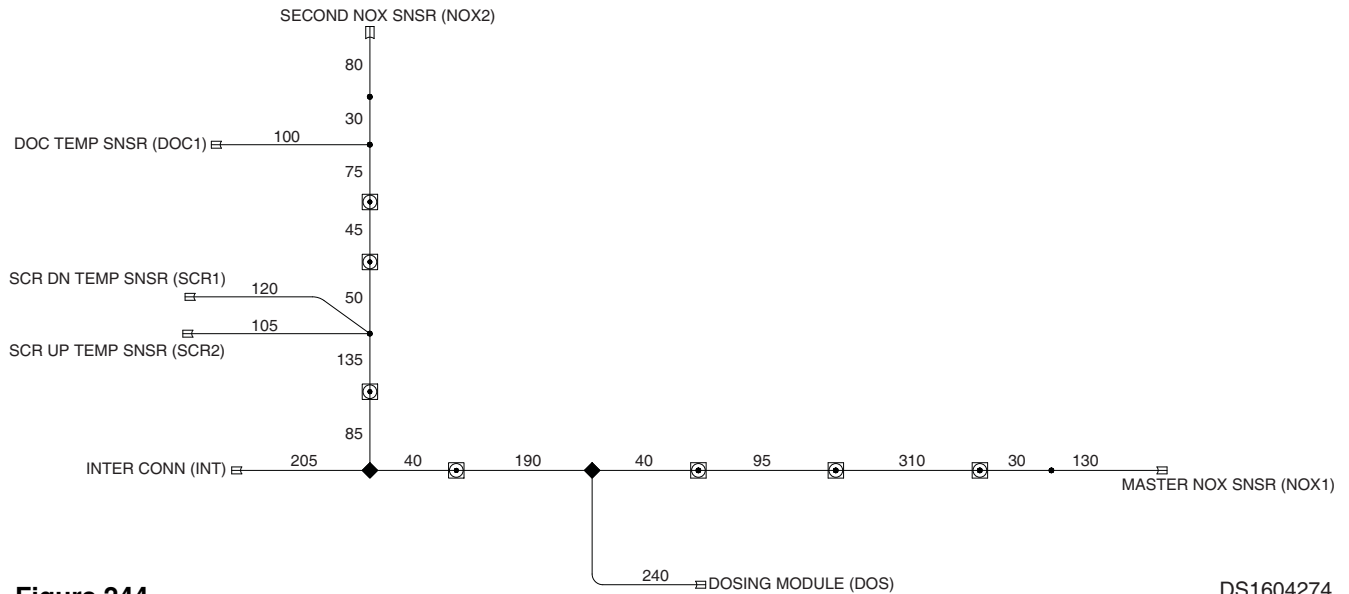


Figure 244

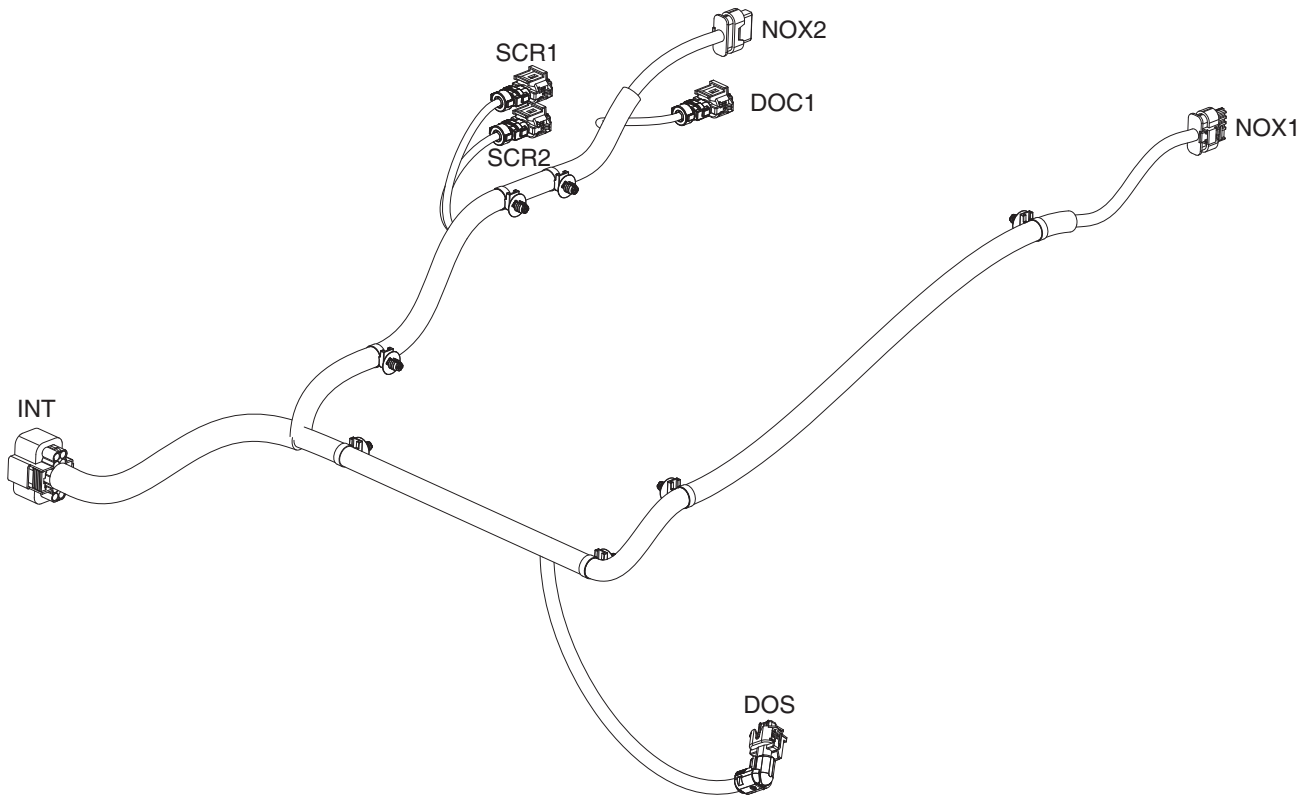
DS1604274

Aftertreatment Connector

Wiring Label	Wiring Size	Circuit Name	From		To		Remark
			Name	No	Name	No	
1.23	1.50	Dosing Valve High Side	a	1	b	1	
1.96	1.50	Dosing Valve Low Side	a	2	b	2	
1.16	0.75	DOC Upstream (T4) Signal	c	1	b	3	
1.18	0.75	DOC Upstream (T4) Ground	c	2	b	4	
1.32	0.75	SCR Upstream Signal	d	1	b	5	
1.43	0.75	SCR Upstream Ground	d	2	b	6	
1.09	0.75	SCR Downstream Signal	e	1	b	7	
300	0.75	SCR Downstream Ground	e	2	1.43	S01	SPLICE_1.43
301	0.75	Master NOx Sensor Ubatt	f	1	b	8	
302	0.75	Master NOx Sensor GND	f	2	b	9	
303	0.75	Master NOx Sensor CAN Low	f	3	b	11	
304	0.75	Master NOx Sensor CAN High	f	4	b	10	
305	0.75	Secondary NOx Sensor Ubatt	g	1	301		SPLICE_301
306	0.75	Secondary NOx Sensor GND	g	2	302		SPLICE_302
307	0.75	Secondary NOx Sensor CAN Low	g	3	303		SPLICE_303
308	0.75	Secondary NOx Sensor CAN High	g	4	304		SPLICE_304
309	0.75	GND NOX PIN2 Common	g	5	305		SPLICE_305

- a. Dosing Module (DOS)
- b. Inter Connector (INT)
- c. DOC Temperature Sensor (DOC1)
- d. SCR Upstream Sensor (SCR2)
- e. SCR downstream sensor (SCR1)
- f. Master NOx Sensor (NOX1)
- g. Secondary NOx Sensor (NOX2)

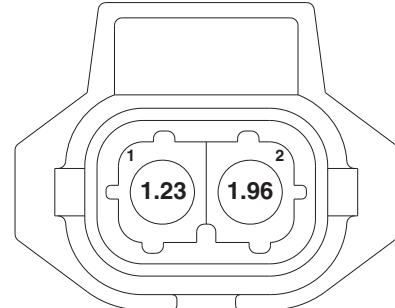
Harness



DS1604275

Figure 245

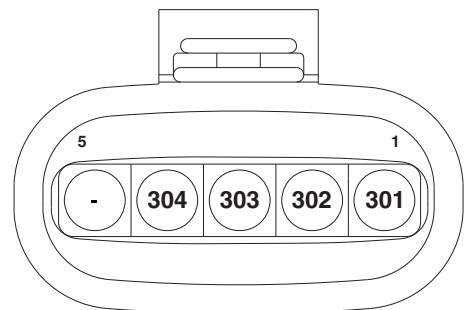
1. Dosing module (DOS)



EX1403850

Figure 246

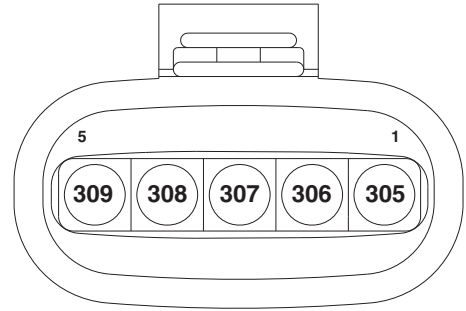
2. Master NOx sensor (NOx1)



EX1403851

Figure 247

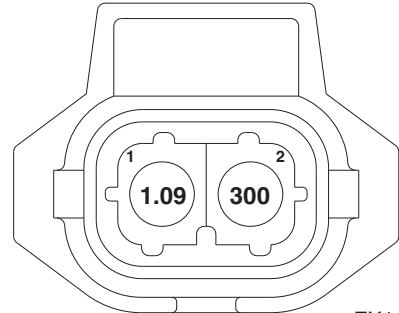
3. Secondary NOx sensor (NOx2)



EX1403852

Figure 248

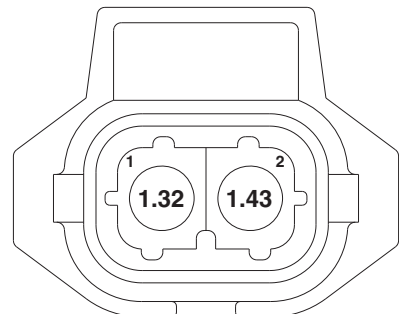
4. SCR downstream temperature sensor (SCR1)



EX1403853

Figure 249

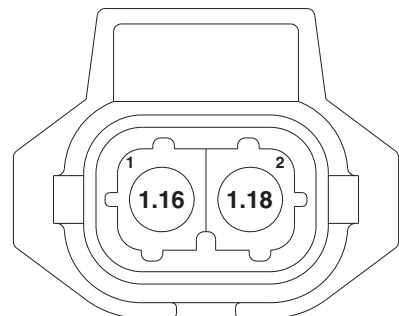
5. SCR upstream temperature sensor (SCR2)



EX1403854

Figure 250

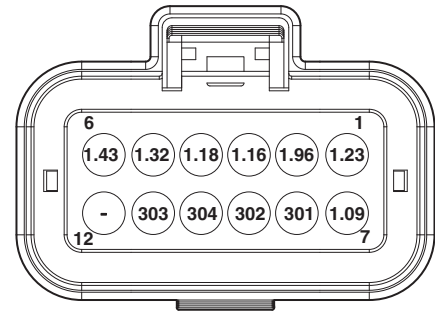
6. DOC temperature sensor (DOC1)



EX1403855

Figure 251

7. Inter connector (INT)



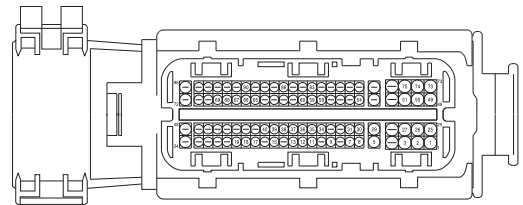
DS1604276

Figure 252

Connector

1. It is possible to identify the circuit number for the connector and engine wire harness information.
2. The wiring colors can be identified as follows:

Symbol	Color
B	Black
Brn	Brown
G	Green
Gra	Gray
L	Blue
O	Orange
P	Purple
RW	Red and White
W	White
Y	Yellow



EX1403857

Figure 253

3. The ECU pin No. means each pin number of an engine connector.
4. The sensor pin No. means each pin number of a sensor connector.

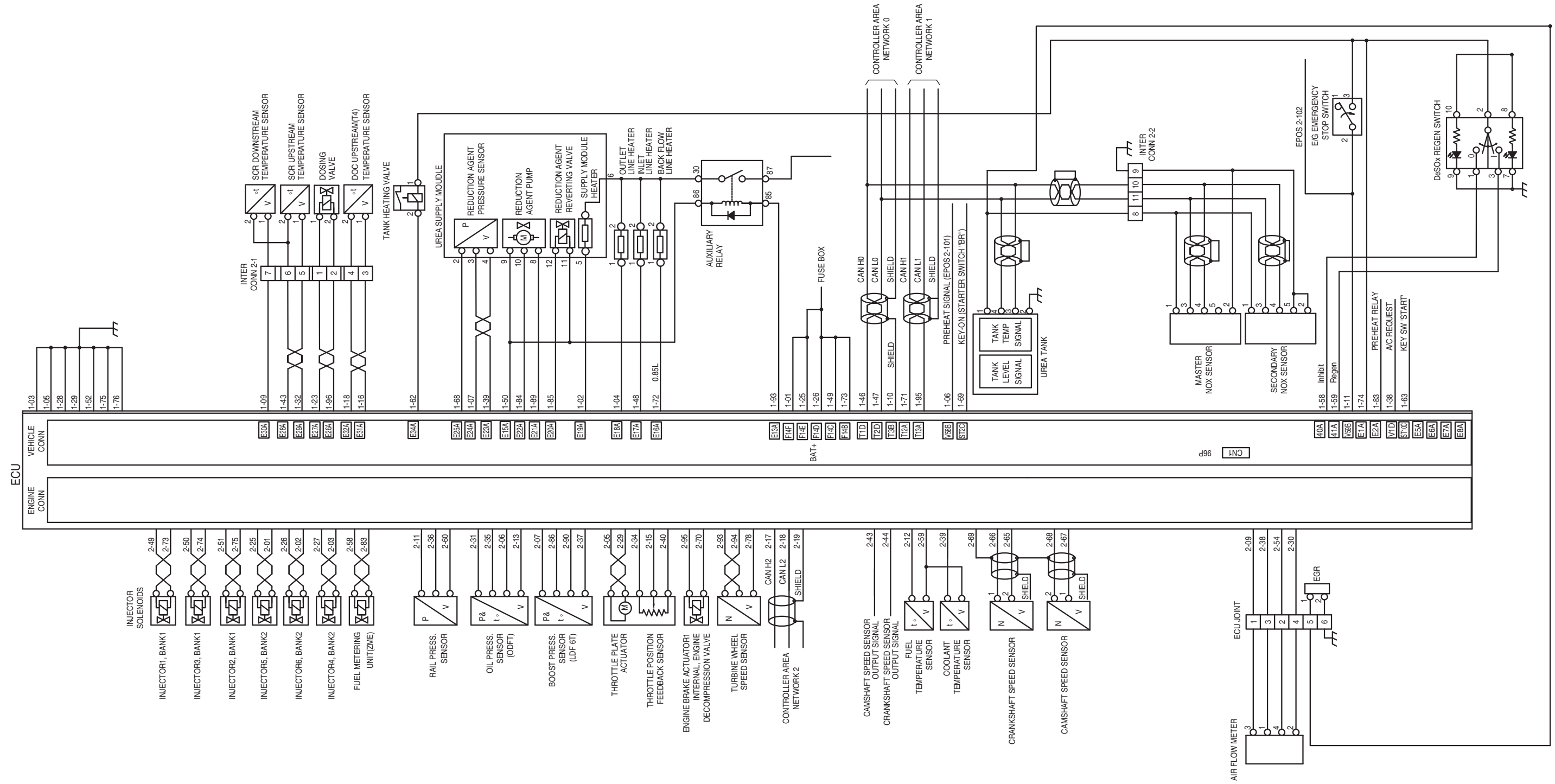
ECU (Engine Control Unit) Engine Connector

Pin Code	Size (mm ²)	Color	From	Pin	To	Pin
2.01	1.50	Y	ECU	1	Injector Connector (INJ)	10
2.02	1.50	G	ECU	2	Injector Connector (INJ)	12
2.03	1.50	L	ECU	3	Injector Connector (INJ)	8
2.05	1.0	R	ECU	5	Throttle Plate Actuator/ Position Sensor (TVA)	6
2.06	0.75	B	ECU	6	Oil Press Temp Sensor (OPTS)	4
2.07	0.75	O	ECU	7	Boost Press Temp Sensor (BPTS)	2
2.09	0.75	R	ECU	9	Inter Connector for Vehicle (ICV)	4
2.11	0.75	O	ECU	11	Rail Press Sensor (RPS)	3
2.12	0.75	R	ECU	12	Fuel Temp Sensor (FTS)	1
2.13	0.75	Brn	ECU	13	Oil Press Temp Sensor (OPTS)	3
2.15	0.75	B	ECU	15	Throttle Plate Actuator/ Position Sensor (TVA)	5
2.17	0.75	O	ECU	17	EGR Valve (EGR) (Pin 4)/ Resistance (R120) (Pin 1)	
2.18	0.75	W	ECU	18	EGR Valve (EGR) (Pin 3)/ Resistance (R120) (Pin 2)	
2.19	0.75	B	ECU	19	2.17/2.18	
2.25	1.50	W	ECU	25	Injector Connector (INJ)	9
2.26	1.50	W	ECU	26	Injector Connector (INJ)	11
2.27	1.50	W	ECU	27	Injector Connector (INJ)	7
2.29	1.0	Y	ECU	29	Throttle Plate Actuator/ Position Sensor (TVA)	2
2.30	0.75	Brn	ECU	30	Inter Connector for Vehicle (ICV)	1
2.31	0.75	R	ECU	31	Oil Press Temp Sensor (OPTS)	2
2.34	0.75	W	ECU	34	Throttle Plate Actuator/Position Sensor (TVA)	1
2.35	0.75	Y	ECU	35	Oil Press Temp Sensor (OPTS)	1
2.36	0.75	W	ECU	36	Rail Press Sensor (RPS)	2
2.37	0.75	Y	ECU	37	Boost Press Temp Sensor (BPTS)	3
2.38	0.75	O	ECU	38	Inter Connector for Vehicle (ICV)	2
2.39	0.75	W	ECU	39	Coolant Temp Sensor (CTS)	1
2.40	0.75	Brn	ECU	40	Throttle Plate Actuator/ Position Sensor (TVA)	3
2.49	1.50	W	ECU	49	Injector Connector (INJ)	1
2.50	1.50	W	ECU	50	Injector Connector (INJ)	5
2.51	1.50	W	ECU	51	Injector Connector (INJ)	3
2.54	0.75	W	ECU	54	Inter Connector for Vehicle (ICV)	3
2.58	0.75	R	ECU	58	Fuel Metering Unit (FMU)	1
2.59	0.75	B	ECU	59	Fuel Temp Sensor (FTS) (Pin 2)/Coolant Temp Sensor (CTS) (Pin 2)	
2.60	0.75	B	ECU	60	Rail Press Sensor (RPS)	1
2.65	0.75	O	ECU	65	Crank Shaft Speed Sensor (CSR)	2

Pin Code	Size (mm ²)	Color	From	Pin	To	Pin
2.66	0.75	W	ECU	66	Crank Shaft Speed Sensor (CSR)	1
2.67	0.75	Brn	ECU	67	Cam Shaft Speed Sensor (CAS)	1
2.68	0.75	Y	ECU	68	Cam Shaft Speed Sensor (CAS)	2
2.69	0.75	B	ECU	69	Crank Shaft Speed Sensor (CSR)/ Cam Shaft Speed Sensor (Pin 3) (CAS)	3
2.73	1.50	Gra	ECU	73	Injector Connector (INJ)	2
2.74	1.50	O	ECU	74	Injector Connector (INJ)	6
2.75	1.50	Brn	ECU	75	Injector Connector (INJ)	4
2.83	0.75	Brn	ECU	83	Fuel Metering Unit (FMU)	2
2.86	0.75	W	ECU	86	Boost Press Temp Sensor (BPTS)	1
2.90	0.75	B	ECU	90	Boost Press Temp Sensor (BPTS)	4
Vbat	0.75	R	Inter Connector for Vehicle (ICV)	5	EGR Valve (Pin 1)/ VGT Connector (Pin 1)	1
GND	0.75	B	Inter Connector for Vehicle (ICV)	6	EGR Valve (Pin 2)/ VGT Connector (Pin 2)	2
13B	1.25	O	Inter Connector 1 (INT 1)	7	Start S (STS)	1
145B	0.75	Brn	Inter Connector 1 (INT 1)	8	Air Heater RLY S (RLYS)	+
145F	0.75	R	Diode 5 (DIO 5)	K	145B	S01
146D	0.75	R	Inter Connector 1 (INT 1)	9	Air Heater RLY S (RLYS)	-
146C	0.75	B	Diode 5 (DIO 5)	A	146D	S01
99I	8.00	B	Alt E (GND)	1	Engine Earth (EGND)	1
4A	8.00	W	Alt B (BAT)	1	KL4A	
4J	5.00	W	KL4A	S01	Inter Connector 3 (INT 3)	1
4M	5.00	W	KL4A	S01	Inter Connector 3 (INT 3)	2
14A	1.25	W	Inter Connector 1 (INT 1)	1	ALT R (R)	1
9A	2.00	W	Inter Connector 1 (INT 1)	2	ALT I (I(L))	1
29C	0.75	Y	Inter Connector 1 (INT 1)	3	Compressor (COMP)	+
99H	0.75	B	99I	S01	Compressor (COMP)	-
99G	0.75	B	Diode 4 (DIO 4)	A	99I	
29B	0.75	W	Diode 4 (DIO 4)	K	29C	
98B	15.0	R	Air Heater RLY Y (RLYY)	1	Fuse A	
98C	15.0	R	Fuse B	1	Air Heater P (HTR+)	
101	1.25	W	Inter Connector 1 (INT 1)	4	Heater Check (H_CK)	1
119D	0.75	Brn	Inter Connector 1 (INT 1)	5	Fan Drive Control P/Valve (Fan)	1
120D	0.75	B	Inter Connector 1 (INT 1)	10	Fan Drive Control P/Valve (Fan)	2
1.23	1.50	L	Inter Connector for SCR (ICS)	1	Inter Connector 2 (INT 2)	1
1.96	1.50	B	Inter Connector for SCR (ICS)	2	Inter Connector 2 (INT 2)	2
1.16	0.75	Y	Inter Connector for SCR (ICS)	3	Inter Connector 2 (INT 2)	3
1.18	0.75	Brn	Inter Connector for SCR (ICS)	4	Inter Connector 2 (INT 2)	4
1.32	0.75	W	Inter Connector for SCR (ICS)	5	Inter Connector 2 (INT 2)	5
1.43	0.75	B	Inter Connector for SCR (ICS)	6	Inter Connector 2 (INT 2)	6
1.09	0.75	R	Inter Connector for SCR (ICS)	7	Inter Connector 2 (INT 2)	7
301	1.50	O	Inter Connector for SCR (ICS)	8	Inter Connector 2 (INT 2)	8
302	1.50	Gra	Inter Connector for SCR (ICS)	9	Inter Connector 2 (INT 2)	9

Pin Code	Size (mm²)	Color	From	Pin	To	Pin
303	0.75	O	Inter Connector for SCR (ICS)	11	Inter Connector 2 (INT 2)	11
304	0.75	W	Inter Connector for SCR (ICS)	10	Inter Connector 2 (INT 2)	10

ECU CIRCUIT



DS1604285

Engine Coolant Heater (Option)

Edition 1

MEMO

Table of Contents

Engine Coolant Heater (Option)

Disassembly and Assembly.....	4-2-5
Changing the Circulating Pump.....	4-2-5
Changing the Temperature Limiter.....	4-2-7
Changing the Temperature Sensor	4-2-8
Changing the Combustion Air Fan	4-2-10
Changing the Burner, Flame Monitor and Glow Plug ...	4-2-12
Changing the Burner Head.....	4-2-14
Changing the Heat Exchanger	4-2-16

DISASSEMBLY AND ASSEMBLY

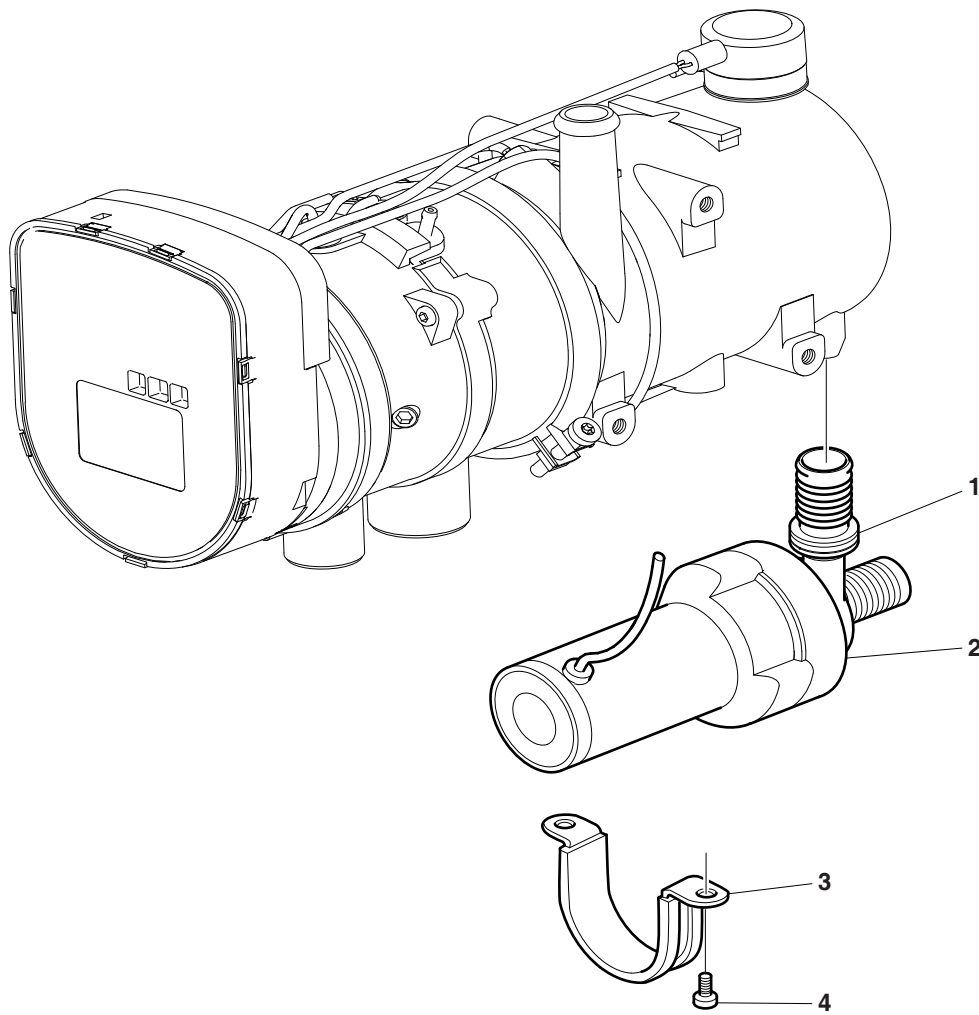
Changing the Circulating Pump

Removal

1. Remove heater.
2. Disconnect the electrical connections.
3. Remove screws (4, Figure 1).
4. Remove clip (3, Figure 1) and circulating pump (2, Figure 1).
5. Complete the work on stripped-down components.

Installation

1. Apply acid-free grease to the sealing ring (1, Figure 1).
2. Place the circulating pump (2, Figure 1) in the assembly position and attach with the clip (3, Figure 1) and screws (4, Figure 1).
3. Tighten the screws (4, Figure 1) to 3 Nm \pm 10%.
4. Connect the electrical connections.
5. Install the heater.



FG018670

Figure 1 Changing the Circulating Pump

Reference Number	Description
1	Sealing Ring
2	Circulating Pump

Reference Number	Description
3	Clip
4	Screw (2)

NOTE: *A Thermo 90 ST heater is shown. In the Thermo 90 S heater, the control unit can also be arranged on the combustion air fan without having any effect on changing the circulating pump.*

Changing the Temperature Limiter

Removal

NOTE: *The temperature limiter only has to be removed if it is being replaced with a new one.
The function must be checked in the installed condition.*

1. Remove heater.
2. Disconnect the electrical connections.
3. Remove clip (2, Figure 2) and pull off the protective cap (1, Figure 2).
4. Use a screwdriver to lever off the retaining spring and remove temperature limiter (3, Figure 2).
5. Complete the work on stripped-down components.

NOTE: *It is essential to install a new temperature limiter to replace a removed one!*

Installation

IMPORTANT

Incorrect installation will cause the heat exchanger to melt.

1. Insert the new temperature limiter (3, Figure 2) into the heat exchanger (4, Figure 2) and press in the retaining spring.

NOTE: *You must be able to hear and feel the spring clip into the groove. Only then is the temperature limiter in the correct installation position.*

If you do not hear and feel the spring clip in:

- Clean the contact surface of the temperature limiter on the heat exchanger
 - Clean the groove in the heat exchanger
 - Ensure that detent lugs are present on both sides of the spring. Install a new temperature limiter if necessary.
2. Put on the protective cap (1, Figure 2) and secure it with the clip (2, Figure 2).
 3. Tighten the clip to 1 Nm \pm 10%.
 4. Connect the electrical connections.
 5. Install the heater.

Changing the Temperature Sensor

Removal

1. Remove heater.
2. Disconnect the electrical connections.



WARNING

AVOID DEATH OR SERIOUS INJURY

Leaking hot coolant can cause burns.

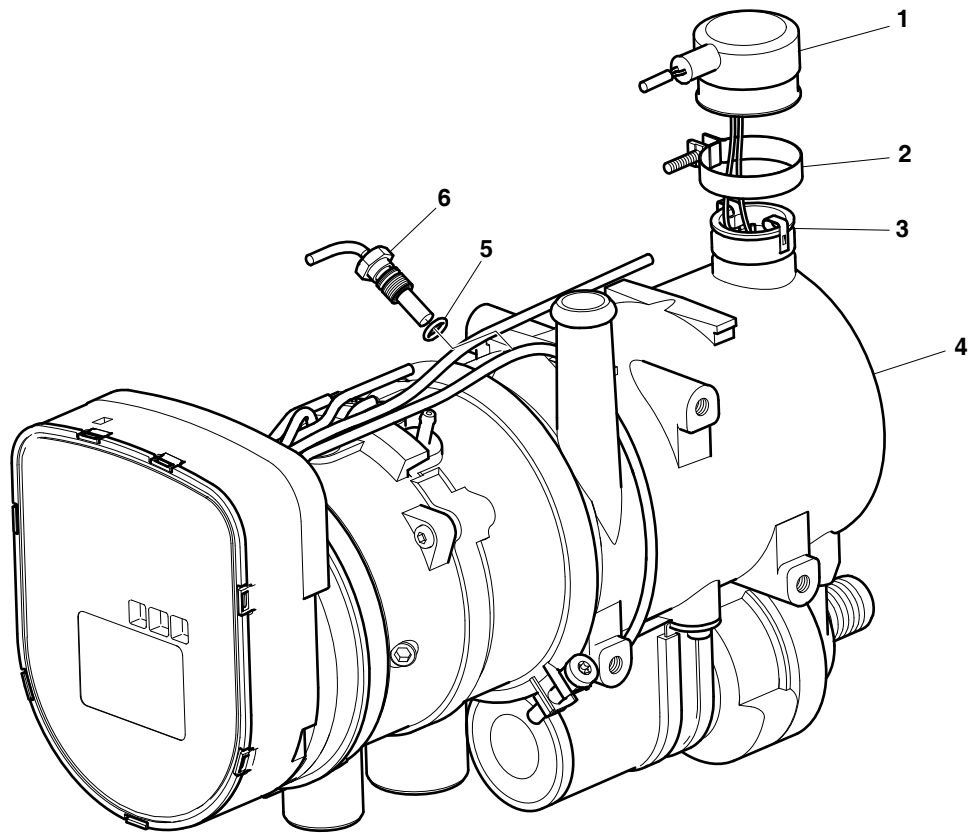
3. Unscrew and remove temperature sensor (6, Figure 2) and remove it with the round sealing ring (5, Figure 2).
4. Complete the work on stripped-down components.

Installation

1. Apply acid-free grease (Vaseline) to the round sealing ring (5, Figure 2).
2. Install the temperature sensor (6, Figure 2) with the round sealing ring (5, Figure 2) and screw it into the heat exchanger (4, Figure 2).

Tighten to 1.5 Nm \pm 10%.

3. Connect the electrical connections.
4. Install the heater.



FG018671

Figure 2 Changing the Temperature Limiter and Temperature Sensor

Reference Number	Description
1	Protective Cap
2	Clip
3	Temperature Limiter

Reference Number	Description
4	Heat Exchanger
5	Round Sealing Ring
6	Temperature Sensor

NOTE: *A Thermo 90 ST heater is shown. In the Thermo 90 S heater, the control unit can also be arranged on the combustion air fan without having any effect on changing the temperature sensor.*

Changing the Combustion Air Fan

Removal

1. Remove heater.
2. Disconnect the electrical connections.
3. Remove screws (2, Figure 3).
4. Pull the combustion air fan (1, Figure 3) off the burner head (4, Figure 3) and remove with the shaped sealing ring (3, Figure 3).

NOTE: *Remove control unit if necessary from the Thermo 90 S/Thermo 90 ST heater with flange mounted control unit.*

5. Complete the work on stripped-down components.

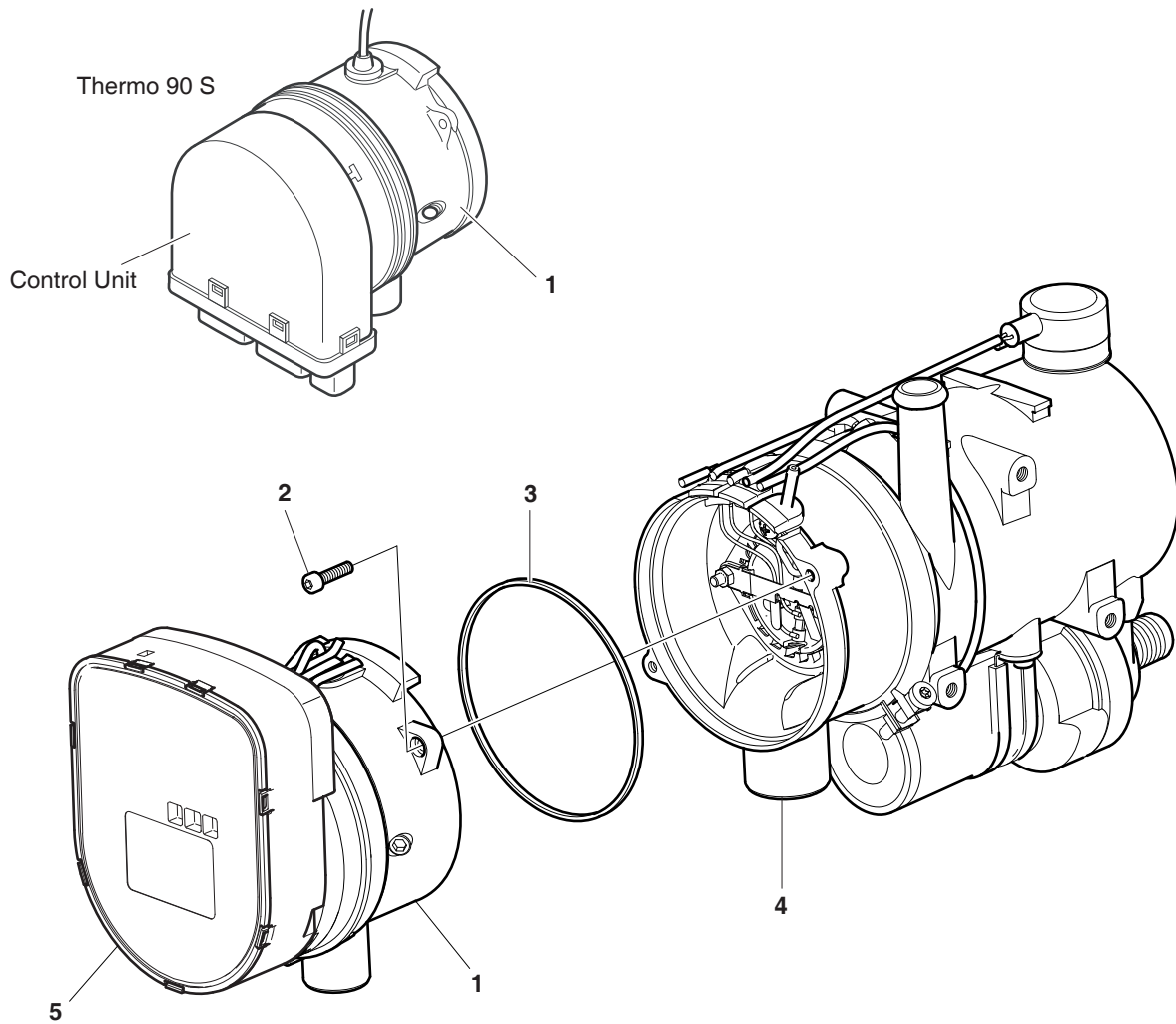
Installation

NOTE: *Insert the shaped seal (3, Figure 3) correctly and grease it (e.g. with Vaseline). Take care not to squash it.*

1. Install the new shaped sealing ring (3, Figure 3) onto the combustion air fan (1, Figure 3). Bring the fan into the assembly position and secure it with screws (2, Figure 3).
2. Tighten the screws (2, Figure 3) to 3 Nm \pm 10%.

NOTE: *Install the control unit if necessary on the Thermo 90 S/Thermo 90 ST heater with flange mounted control unit.*

3. Connect the electrical connections.
4. Install the heater.



FG018672

Figure 3 Changing the Combustion Air Fan

Reference Number	Description
1	Combustion Air Fan
2	Screw (2)
3	Shaped Sealing Ring

Reference Number	Description
4	Burner Head
5	Control Unit

NOTE: A Thermo 90 ST heater is shown.

Changing the Burner, Flame Monitor and Glow Plug

Removal

1. Remove heater.
2. Remove combustion air fan.
3. Remove screw (5, Figure 5) and washer (4, Figure 5).
4. Remove nuts (10, Figure 5) and pull off the bar (8, Figure 5).
5. Pull the grommets (11 and 12, Figure 5) out of the slots in the housing of the combustion pipe (3, Figure 5).
6. Pull the grommet (13, Figure 5) and burner (1, Figure 5) out of the burner head and remove with the swirl orifice (2, Figure 5).
7. Pull the flame monitor (7, Figure 5) and glow plug (6, Figure 5) from the burner (1, Figure 5) and remove.
8. Perform a visual check for assessing the burner.
9. Complete the work on stripped-down components.

Installation

1. Place the swirl orifice (2, Figure 5) onto the burner (1, Figure 5).
2. Carefully insert the flame monitor (7, Figure 5) and glow plug (6, Figure 5) into the burner up to the stop and push the grommets (11 and 12, Figure 5) into the slots in the housing of the burner pipe (3, Figure 5).
3. Insert the burner (1, Figure 5) and grommet (13, Figure 5) into the burner head (3, Figure 5).

IMPORTANT

During the following procedure, make sure that cables of the flame monitor (7, Figure 5) and the glow plug (6, Figure 5) are routed as shown in the figure.

4. Push the insulation (9, Figure 5) onto the bar (8, Figure 5) and bring the bar into the assembly position.

NOTE: *Route the cable of the flame monitor and the glow plug as shown in the figure!*

5. Secure the bar (8, Figure 5) using the nuts (10, Figure 5). Tighten the nuts to 3 Nm \pm 10%.
6. Secure the fuel line using the screw (5, Figure 5) and washer (4, Figure 5). Tighten the screw to 3 Nm \pm 10%.
7. Install the combustion air fan.
8. Connect the electrical connections.
9. Install the heater.

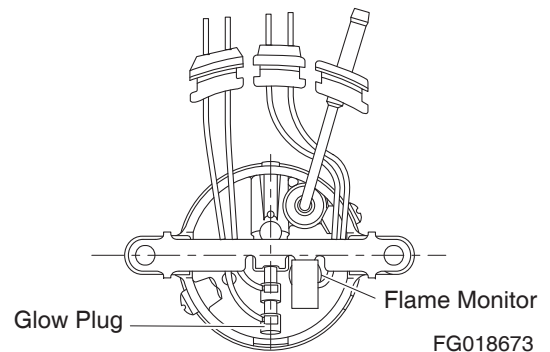
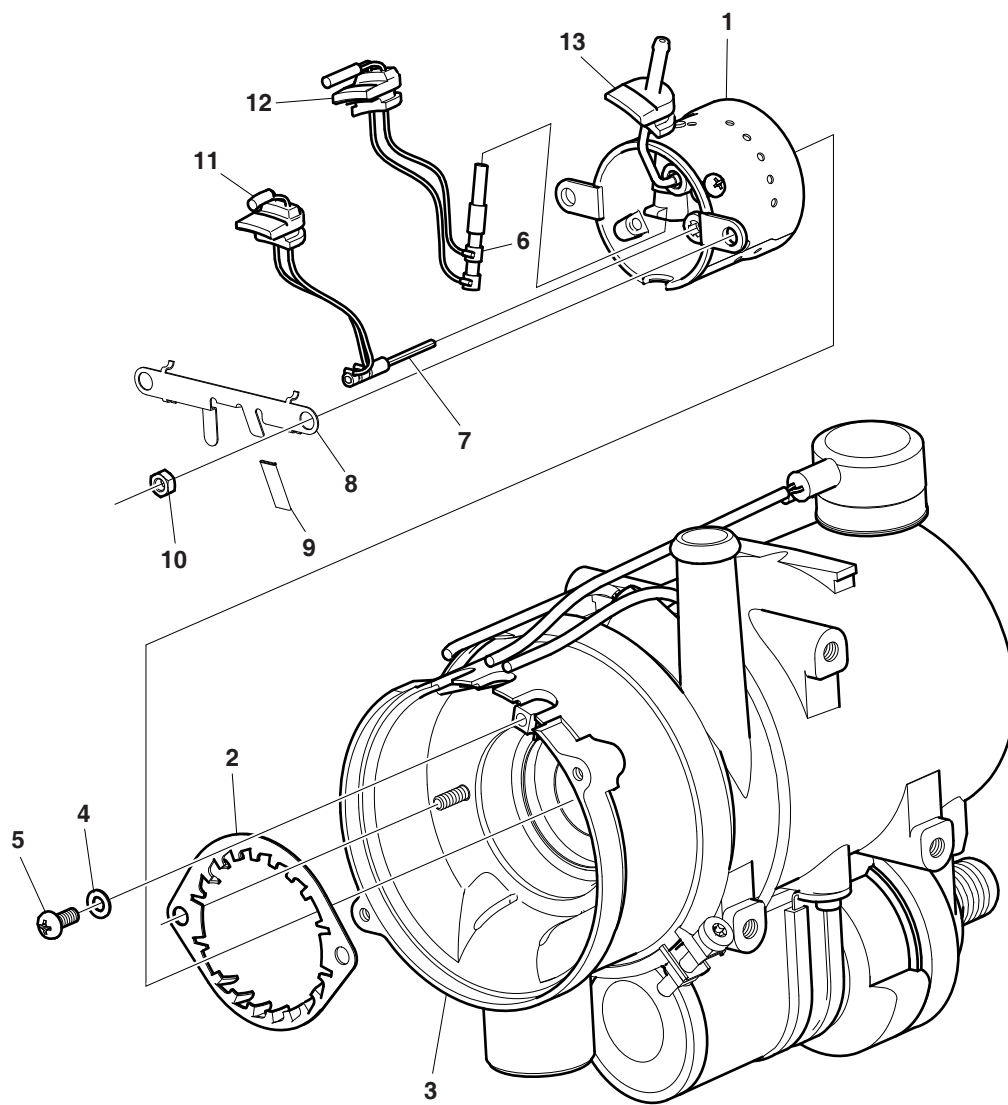


Figure 4



FG018674

Figure 5 Changing the Burner, Flame Monitor and Glow Plug

Reference Number	Description
1	Burner
2	Swirl Orifice
3	Burner Head
4	Washer
5	Screw
6	Glow Plug
7	Flame Monitor

Reference Number	Description
8	Bar
9	Insulation
10	Nut (2)
11	Grommet
12	Grommet
13	Grommet

NOTE: A Thermo 90 ST heater is shown. The figure can also be used for the Thermo 90 S heater.

Changing the Burner Head

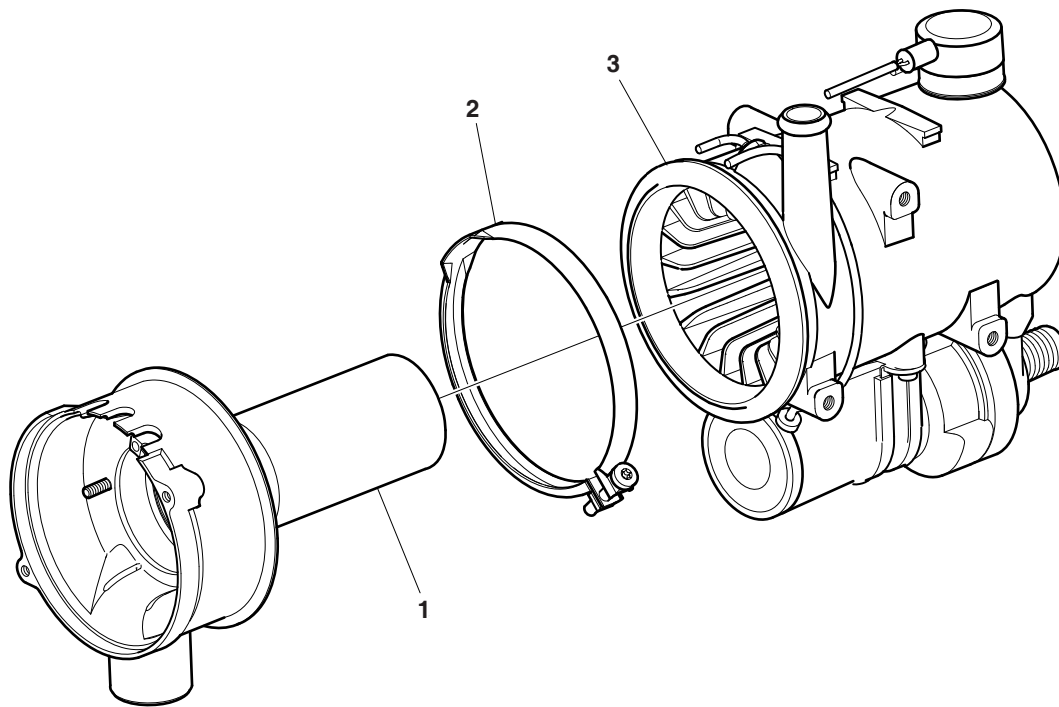
Removal

1. Remove heater.
2. Remove combustion air fan.
3. Remove burner, flame monitor and glow plug.
4. Remove mounting screw of the V-clamping collar (2, Figure 6) and pull off the clamping collar.
5. Pull out and remove burner head (1, Figure 6) from the heat exchanger (3, Figure 6).
6. Complete the work on stripped-down components.

Installation

NOTE: *The burner head and exhaust outlet port can also be aligned during installation in the machine.*

1. Guide the burner head (1, Figure 6) into the heat exchanger (3, Figure 6), align it if necessary and secure with the V-clamping collar (2, Figure 6).
2. If necessary, tighten the mounting screw of the V-clamping collar to 3 Nm \pm 10%.
3. Install the burner, flame monitor and glow plug.
4. Attach the combustion air fan.
5. Install the heater.



FG018675

Figure 6 Changing the Burner Head

Reference Number	Description
1	Burner Head
2	V-clamping Collar

Reference Number	Description
3	Heat Exchanger

NOTE: A Thermo 90 ST heater is shown. The figure can also be used for the Thermo 90 S heater.

Changing the Heat Exchanger

Removal

1. Remove heater.
2. Remove circulating pump.
3. Remove temperature limiter.
4. Remove temperature sensor.
5. Remove combustion air fan.
6. Remove burner, flame monitor and glow plug.
7. Remove burner head.
8. Remove plug and connector housing.
9. Complete the work on stripped-down components.

Installation

1. Clip the connector housing onto the heat exchanger and insert the plug into the connector housing.
2. Install the burner head.
3. Install the burner, flame monitor and glow plug.
4. Attach the combustion air fan.
5. Install the temperature sensor.
6. Install the temperature limiter.
7. Attach the circulating pump.
8. Install the heater.

Upper Structure

Cabin

Edition 1

MEMO

Table of Contents

Cabin

Safety Instructions	5-1-5
Cabin Identification	5-1-5
Falling Object Guards and Structures	5-1-5
Removal	5-1-6
Installation	5-1-11
Completing work	5-1-11
Removal and Installation of Cabin Glass.....	5-1-12
Removal of Cabin Glass.....	5-1-12
Installation of Cabin Glass.....	5-1-14
Installation of Upper Door Glass	5-1-17
Installation of Upper Front Glass.....	5-1-17

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.

CABIN IDENTIFICATION

Falling Object Guards and Structures

The machine may have different types of guards for operator protection. the type of guards might be vary on the applications and work demands.

Inspect and check the guards daily to ensure no cracks, bent or loose. DO NOT modify the protective structure, guards by welding, grinding, drilling holes or adding attachments. Changes to the cabin can cause loss of operator protection from roll-over and falling objects, and result in death or serious injury.

Always wear your seat belt when operating machine.

Logging operation required the protection from flying debris and/or objects. When use a work tool create flying debris, install a front guard. Close the window and wear safety glasses.

REMOVAL

1. Make the machine swing about 30° rightward on the flat ground as shown in (Figure 1) before lowering all the attachments on the ground and then stop engine.

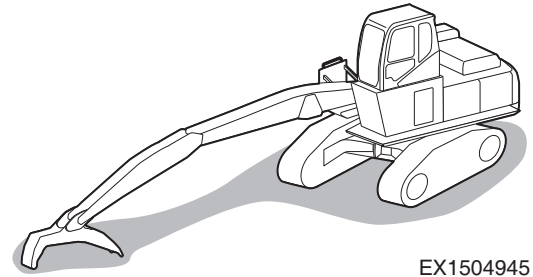


Figure 1

2. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 2)
3. Turn starter switch to "I" (ON) position.

! WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

4. To relieve pressure from accumulators, fully stroke work levers in all directions. Movement can occur.
5. Move safety lever to "LOCK" position. (Figure 2)
6. Turn key to "O" (OFF) position and remove from starter switch.
7. Attach maintenance warning tag on controls.
8. Turn battery disconnect switch to "OFF" position. (Figure 3)

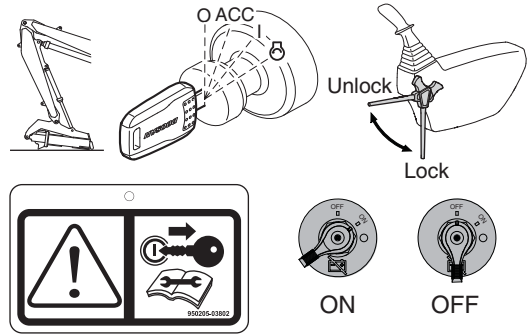


Figure 2

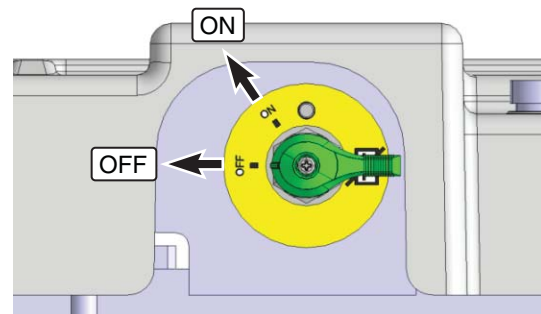


Figure 3

9. Open the cabin riser cover.
Disconnect washer hose.

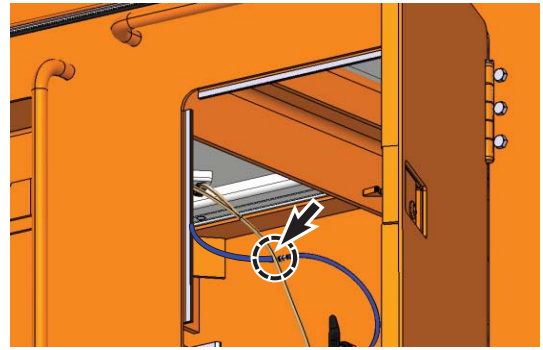


Figure 4 Bottom of Cabin

EX1504926

10. Remove floor mat from the cabin.

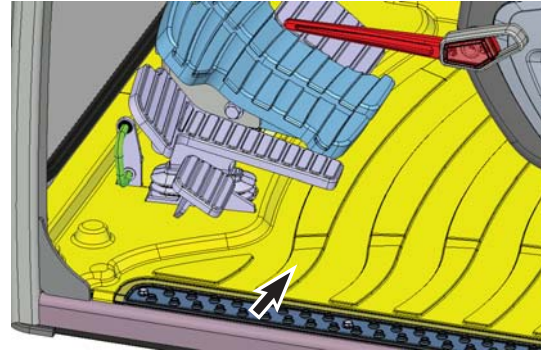



Figure 5

EX1505061

11. Remove cover (1, Figure 6), bolt and washer (2) with safety lever assembly (3) from control stand.

- Tool: 4 mm ()

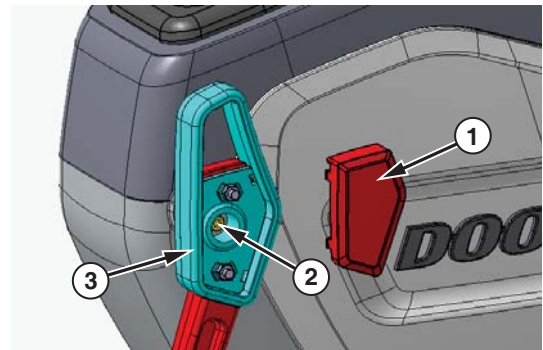


Figure 6

EX1403564

12. Remove duct covers (1 and 2, Figure 7).

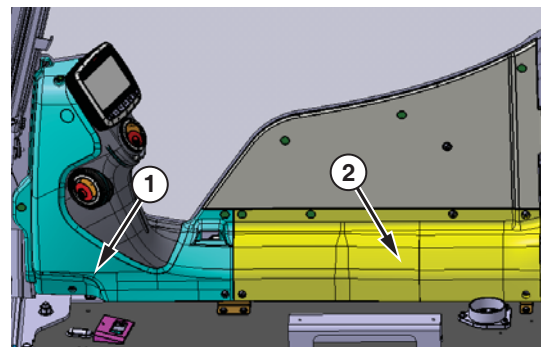


Figure 7

WE1400435

13. Disconnect wiper, monitor, sun sensor and hour meter connectors.

NOTE: Control console wiring harnesses and hydraulic piping lines that pass through the floor of the cabin do not need to be disassembled.

NOTE: If cabin is equipped with additional protective guards over cabin openings, they must be removed.

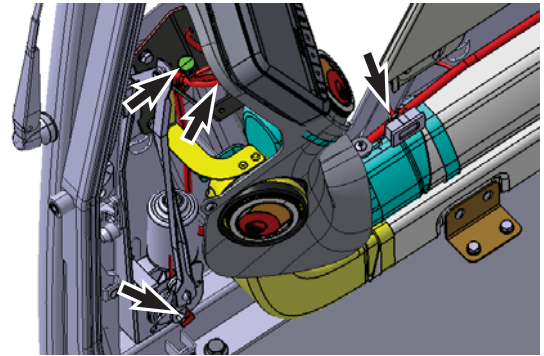


Figure 8

WE1400436

14. Remove air ducts (1 thru 6, Figure 9) on right-hand side of operator's cabin.

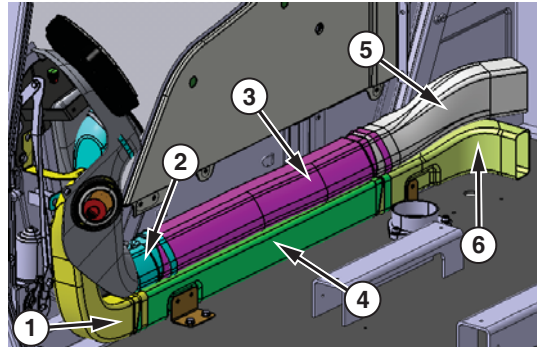


Figure 9

WE1400437

15. Remove glove box pad (1, Figure 10), and two bolts under pad.

Remove caps and bolts (2, Figure 10) (3 ea) from top of rear cover.

Remove bolts (3, Figure 10) (2 ea) from bottom of rubber mounts in rear cover.

Remove rear cover (4, Figure 10).

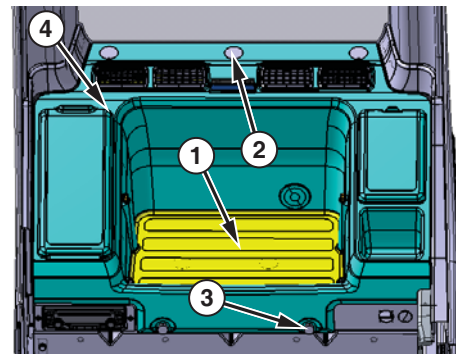


Figure 10

WE1400438

16. Remove air ducts (1 thru 3, Figure 11) and atmospheric air duct (4).

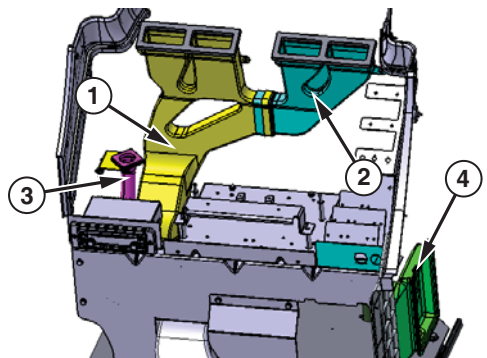


Figure 11

WE1400439

17. Remove all bolts (1, Figure 12) (17 ea) with brackets (2 thru 4) from body of operator cabin.

- Tool: 13 mm (🔧)
- Torque: 19.6 N.m (2 kg.m, 14.5 ft lb)

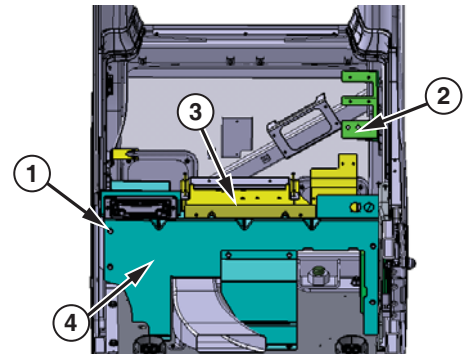


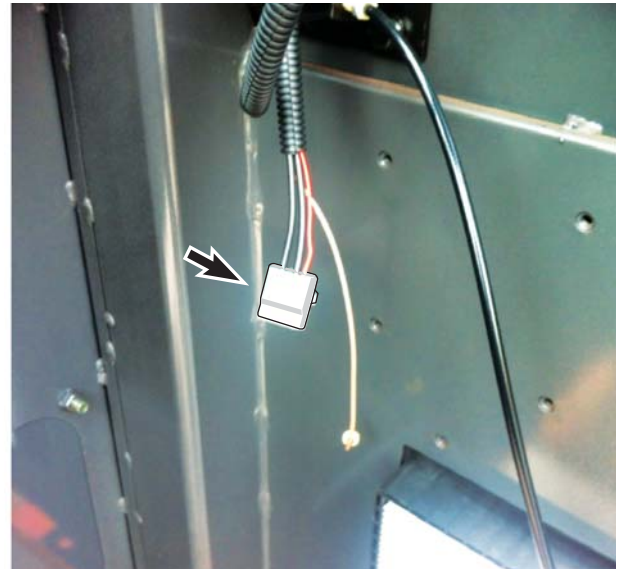
Figure 12

WE1400440

18. Disconnect connectors of interior lights, speakers and antenna.



Figure 13



WE1400441

19. Using a suitable lifting device, attach slings to four lift points on top of cabin (Figure 14)

- Lifting hole size: M12 x 1.75, depth: 15 mm
- Cabin weight: about 400 kg (882 lb)

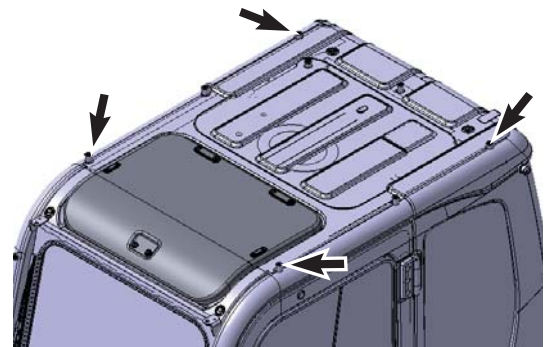


Figure 14

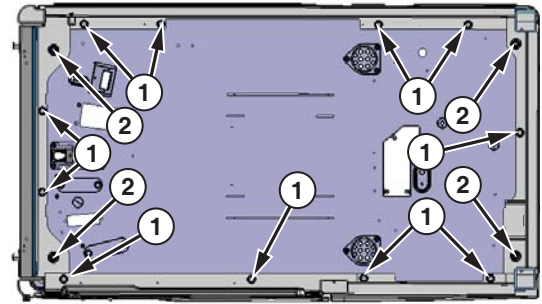
WE1400442

20. Remove bolts and washers (1, Figure 15) (11 ea).

- Tool: 19 mm (🔧)
- Torque: 88.3 N.m (9 kg.m, 65.1 ft lb)

21. Remove nuts and washers (2) (4 ea) from cabin floor.

- Tool: 24 mm (🔧)
- Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)



EX1504927

Figure 15

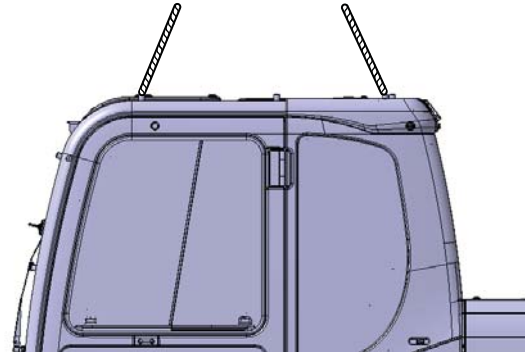
IMPORTANT

Continue lifting with assist crane to remove cabin shell. Lower shell to a prepared safe blocking support.

- Support size: about 2,000 x 2,800 mm

Check that all electrical connections have been disconnected and all other items unbolted.

Do not rapidly lift operator's cabin: The bottom of operator's cabin may come into contact with, and scratch, control stand cover.

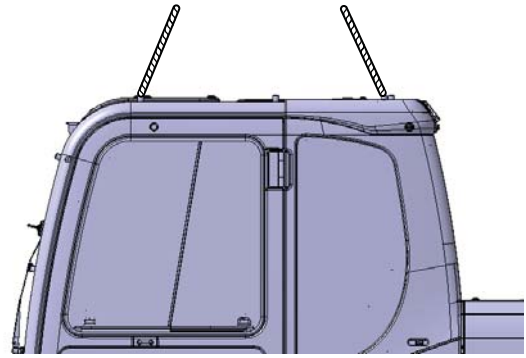


WE1400445

Figure 16

INSTALLATION

1. Using a suitable lifting device, attach slings to four (4) lift points on top of cabin (Figure 17).
 - Cabin weight: 400 kg (882 lb)
2. Lower cabin into position on cabin floor.



WE1400445

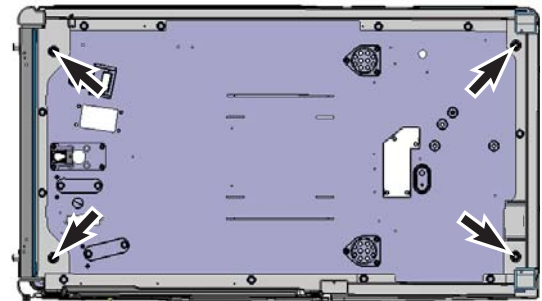
Figure 17

3. Install mounting nuts (Figure 18) (4 ea) and washers in four corners of cabin floor.

When install the nut, apply Loctite (#262) to nut.

- Tool: 24 mm (🔧)
- Torque: 205.9 N.m (21 kg.m, 151.9 ft lb)

Perform installation in the reverse order to removal.



EX1504928

Figure 18

COMPLETING WORK

1. Start the engine and run at low idle for about 5 minutes.
2. Perform the machine performance test.

REMOVAL AND INSTALLATION OF CABIN GLASS

Removal of Cabin Glass

Procedures to remove right-hand glass (1, Figure 19), rear left, glass, lower door glass and rear glass.



CAUTION

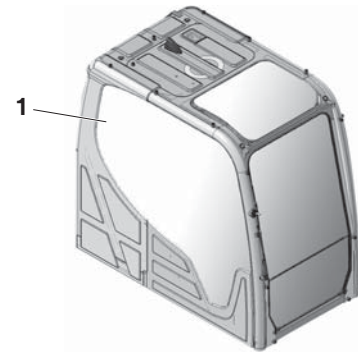
AVOID INJURY

When removing the broken or cracked glass, the glass shards can cause serious injury.

Before removing, use tape to hold the broken or cracked glass together.

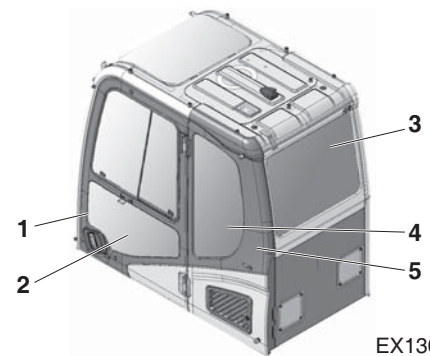
1. Remove resin panel, garnish or etc. around the glass.

Reference Number	Description
1	Garnish
2	Lower Glass of Door
3	Rear Glass
4	Rear Left-hand Glass
5	Resin Panel



EX1301295

Figure 19

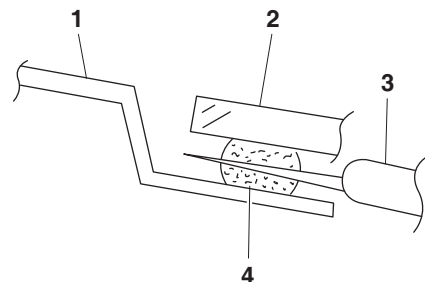


EX1301296

Figure 20

2. Prick a hole in the adhesive by using an awl (or cutter knife).

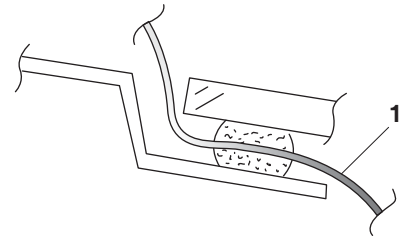
Reference Number	Description
1	Cabin
2	Cabin Glass
3	Awl
4	Adhesive



EX1301298

Figure 21

3. Pass a piano wire (1, Figure 22) (or a wire) through the hole.



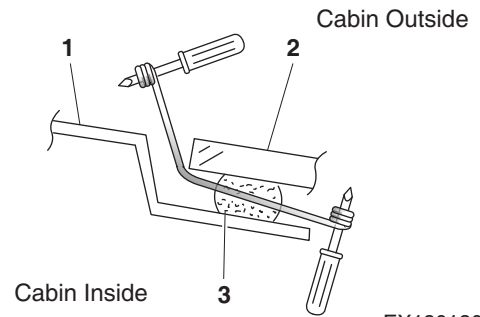
EX1301299

Figure 22

4. Wind both ends of the piano wire onto two screwdrivers. Draw the wire back and forth to cut the adhesive (3, Figure 23) between cabin (1) and glass (2).

Remove glass (2, Figure 23) from the cabin (1).

NOTE: *Piano wire is easily broken. If a part of the piano wire turns hot, change the position of the wire and continue cutting the adhesive.*



EX1301300

Figure 23

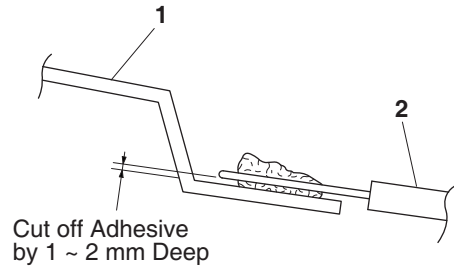
Installation of Cabin Glass

Procedures to install right-hand glass (1, Figure 25), rear, left-hand glass, lower door glass and rear glass.

1. Cut off the remaining adhesive leaving a layer of old adhesive 1 - 2 mm thick (Figure 24). The new adhesive will bond to the remaining adhesive.

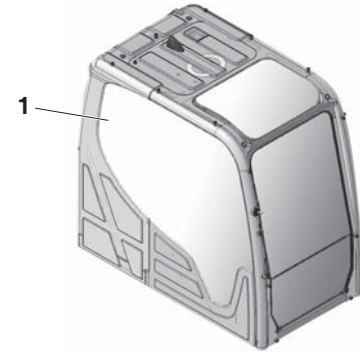
NOTE: Do not damage the cabin paint.

Reference Number	Description
1	Cabin
2	Knife



EX1301302

Figure 24

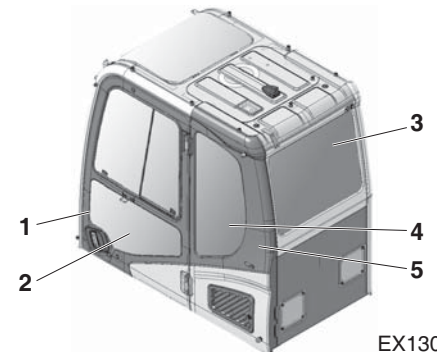


EX1301295

Figure 25

2. Clean the remaining adhesive and metal surfaces with a general purpose adhesive cleaner.

Reference Number	Description
1	Garnish
2	Lower Glass of Door
3	Rear Glass
4	Rear Left-hand Glass
5	Resin Panel



EX1301296

Figure 26

IMPORTANT

Primer must be shaken for about 1 minute and mix thoroughly before opening the cap.

After opening primer, apply primer as quickly as possible and replace the cap immediately after using.

After opening primer, all the contents must be used within 180 days (or 2 hours with the cap off).

3. Apply the damper on cabin body before applying adhesive.
4. Clean the mating edge of new glass by using clean rag and ethylalcohol.

IMPORTANT

Primer (Sika Primer W06G+P) must be shaken for about 1 minute and mixed thoroughly before opening the cap.

After opening primer, apply primer as quickly as possible and replace the cap immediately after using.

After opening primer, all the contents must be used within 180 days (or 2 hours with the cap off).

5. Using application brush, apply primer for glass (Sika Primer W06G+P) to the layer of old adhesive from step 1. Wait for about 15 minutes to let it dry. (Refer to position to apply primer (2, Figure 27).)

NOTE: *The painting primer must be applied evenly to leave no blemishes.*

Reference Number	Description
1	Cabin
2	Application Brush
3	Layer of Old Adhesive on Cabin

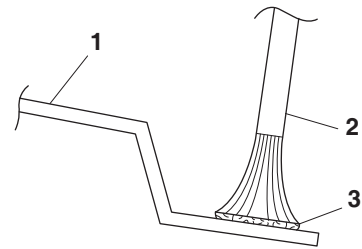
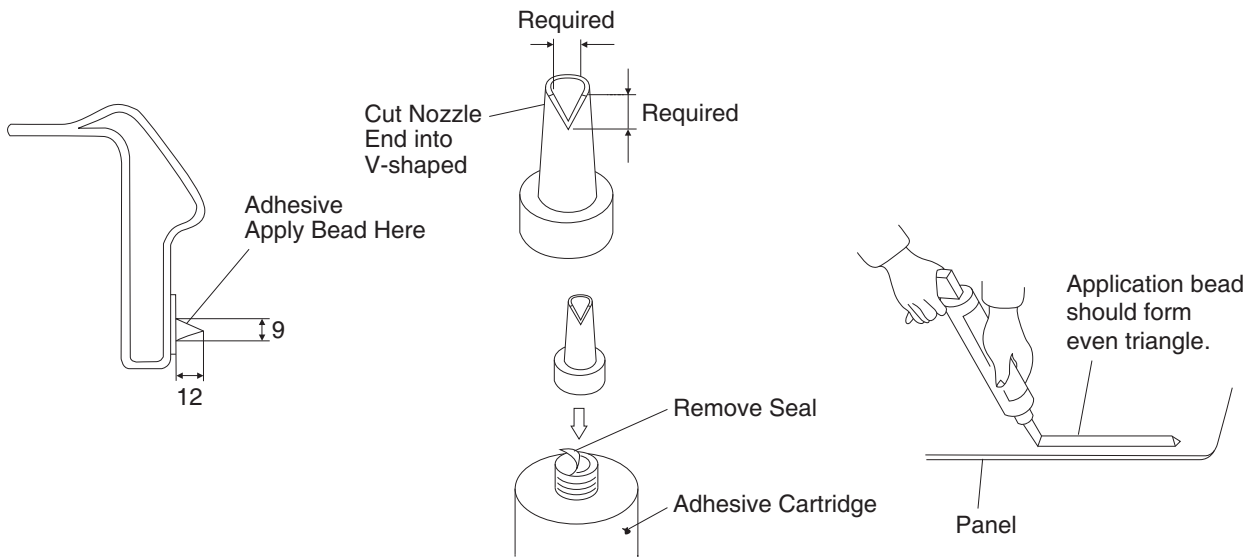


Figure 27

EX1301303

6. Cut off the nozzle of adhesive cartridge (Sika Tack-Drive) into V-shaped by using a knife.
7. Remove seal of cartridge. Install the V-shaped nozzle.
8. Install the cartridge to the manual caulking gun.
9. Apply adhesive to the adhesive position at cabin side so bead triangle will be even. (Refer to position to apply adhesive (3, Figure 27).)



EX1401037

Figure 28

NOTE: Unit: mm (1 mm = 0.039 in)

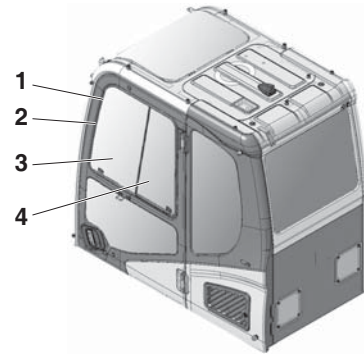
10. The required amount (just for reference) of adhesive and primer.

		Painted Surface or Adhesive Surface	Glass Surface
	Adhesive Sika Tack-drive 310 ml Cartridge	Primer Sika Activator DM-1 250 ml Can	Primer Sika Primer 206G+P 30 ml Bottle
Upper Front Glass	310 ml	0.75 ml	0.67 ml
Lower Glass of Door	150 ml	0.50 ml	0.45 ml
Rear Left-hand Glass	250 ml	0.65 ml	0.60 ml
Rear Right-hand Glass	100 ml	1.00 ml	0.90 ml
Rear Glass	210 ml	0.50 ml	0.45 ml

Installation of Upper Door Glass

1. Before installing the glass, remove garnish (2, Figure 29) around sash assembly (1) from the cabin inside for easy removal. Push the sash assembly by hands and remove sash outside.
2. Install glass (3, Figure 29) and glass (4) into the sash grooves.
3. Install the sash assembly, which the glass is installed on, onto the door from the outside of cabin.

Secure the sash assembly at the inside of cabin by using the garnish.



EX1301297

Figure 29

Installation of Upper Front Glass

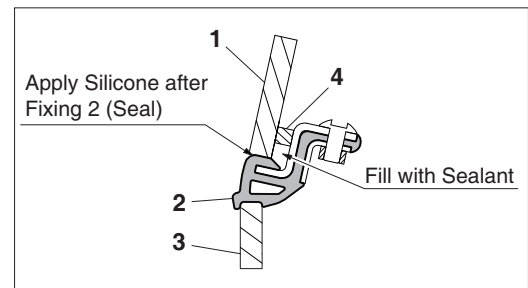
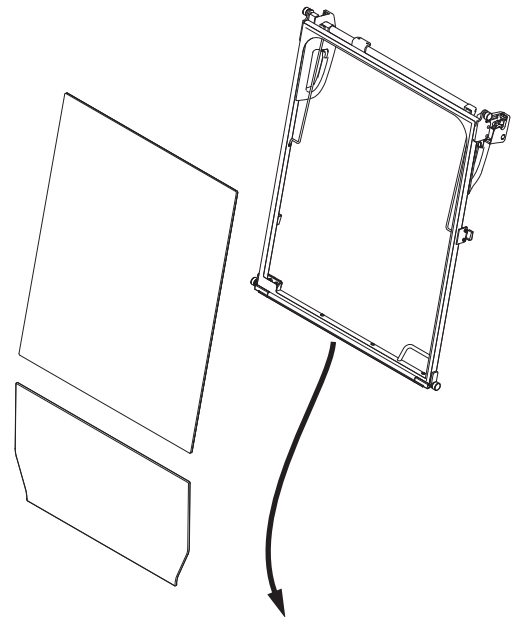
1. Stick seal to the lower side of front upper glass by using Cemedine SIKAFLEX 255 ultrafast.

Stick and secure both right and left ends (the thicker part) of seal to the glass by using Cemedine SIKAFLEX 255 ultrafast.

Stick the mating surface of seal and the glass by using Cemedine SIKAFLEX 255 ultrafast so no visible undulation or boss can be found.

NOTE: *Cemedine SIKAFLEX 255 ultrafast Glue-state adhesive, tubed.*

Reference Number	Description
1	Upper Glass
2	Seal
3	Lower Glass
4	Damper



EX1301304

Figure 30

Counterweight

Edition 1

MEMO

Table of Contents

Counterweight

Safety Instructions	5-2-5
General	5-2-6
Warning for Counterweight and Front Attachment Removal	5-2-6
Removal	5-2-8
Installation	5-2-9

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.

GENERAL

Warning for Counterweight and Front Attachment Removal



WARNING

AVOID DEATH OR SERIOUS INJURY

HYUNDAI warns any user, that removal of the counterweight from the machine, front attachment (boom and arm) or any other part, may affect the stability of the machine. This could cause unexpected movement, resulting in death or serious injuries.

Never remove counterweight or front attachment unless the upper structure is in-line with the lower structure.

Never rotate the upper structure once the counterweight or front attachment has been removed.

Before any attempt is made to begin removal or installation of the counterweight, the machine must be parked on a firm and level supporting surface, with no sloping surfaces or soft or muddy ground in the area where the assist lift crane will be working. Position all accessories in the overnight storage position.

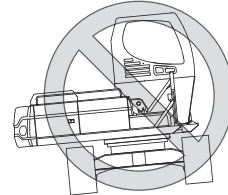
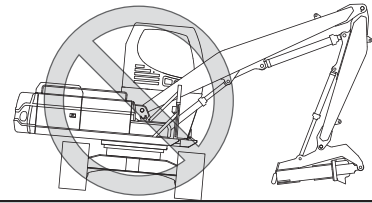


WARNING

AVOID DEATH OR SERIOUS INJURY

The weight of counterweight is given in the following table. Use only rated and approved slings and hardware when removal or installation lifts are being made. Lifting slings, shackles and all other hardware must be rigged safely. An assist crane that is rated above weight capacity is required.

- Weight of counterweight: 6,300 kg (13,900 lb)



EX1500889

Figure 1

Responsibility must be assigned to one person to be in charge of the lifting crew, and to verify that required safe lifting precautions have been taken before each part of this procedure has been started.

All members of the working crew should know and understand the signals that will be used between the lifting leader, the assist crane operator and the remainder of the work crew.

 **WARNING**

AVOID DEATH OR SERIOUS INJURY

If the upper structure deck has been unbalanced by removal of weight from one end only, traveling with the excavator, swinging the turntable, movement over bumps or sloping and uneven surfaces could cause loss of control resulting in tipping or rollover.

To maintain stability the counterweight must be removed only when the front attachment is taken off the machine.

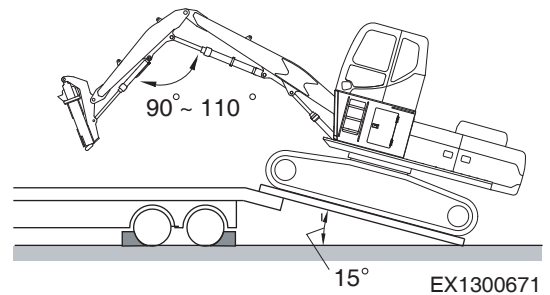


Figure 2

When loading a forestry machine on a trailer for transport after the front attachment has been removed, always go backwards up the loading ramp with the counterweight uphill (Figure 3).

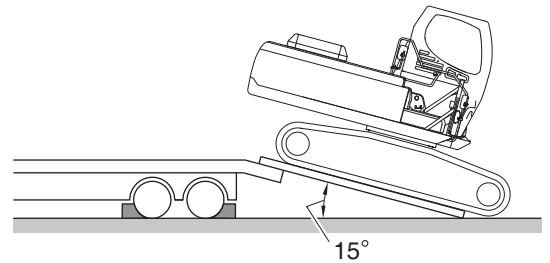


Figure 3

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Death or serious injury can occur from a counterweight falling during removal or installation. Do not allow personnel under or around the counterweight during removal or installation.

Use certified cables and shackles of adequate load rating. Improper lifting can allow the load to shift and cause death or serious injury.

1. Park on firm and level ground.
2. Lower front attachment (bucket) to ground.
3. Stop engine.
4. Move safety lever to "UNLOCK" position.
5. Turn starter switch to "I" (ON) position.




WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, use extreme care. Always have one person in the cabin at all times. Never leave the cabin with the engine running.

6. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
7. Move safety lever to "LOCK" position.
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Attach maintenance warning tag on controls.
10. Turn battery disconnect switch to "OFF" position.
11. Make sure all electrical and other items are disconnected.
12. Using a suitable lifting device capable of handling a heavy load, partially support counterweight from lifting holes (6, Figure 5), counterweight (1) before loosening four bolts (2). Stop lifting with assist crane as soon as lifting slings are taut.
13. Remove four bolts (2, Figure 5), washers (3) and shims (5) from counterweight (1).

- Tool: 60 mm ()

NOTE: Heat bolts, if necessary, to free them.

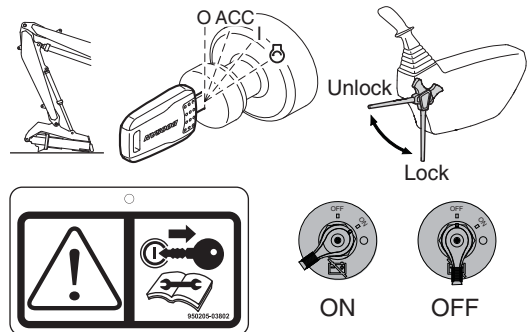


Figure 4

EX1504829

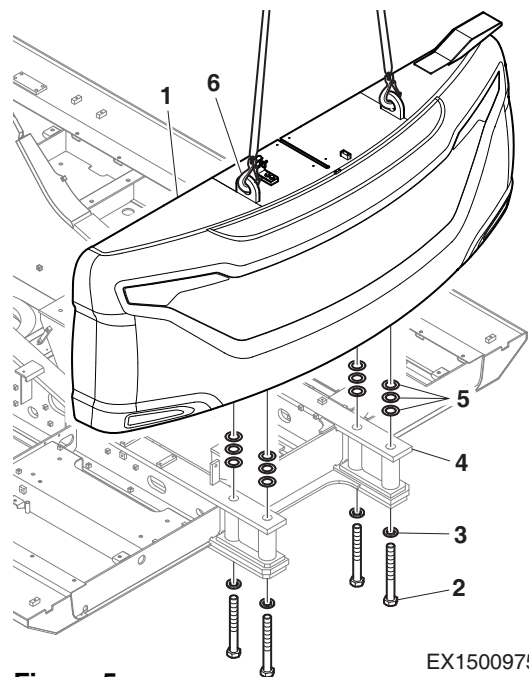


Figure 5

EX1500975


14. When bolts (2, Figure 5), washers (3) and shims (5) have been removed, lift counterweight (1) a very short distance above support frame (4) and stop. Check slings and make sure counterweight is being supported evenly.

INSTALLATION

1. Using suitable lifting device capable of handling the weight of the counterweight, support counterweight from lifting holes (6, Figure 6). Raise counterweight (1, Figure 6) into position just above support frame (4) leaving counterweight suspended. Verify that counterweight is level and even.

NOTE: Leave counterweight (1, Figure 6) suspended 3 mm (0.125") above support frame (4) until all four mounting bolts (2) are started in counterweight mounting holes.

2. Slide washers (3, Figure 6) onto bolts (2). Apply Loctite #242 to mounting bolt threads.
3. Install four bolts (2, Figure 6) with washers (3) into counterweight until washers contact support frame. Fully lower counterweight onto support frame and finish tightening bolts.

- Tool: 60 mm ()
- Torque: 2,451 N.m (250 kg.m, 1,808 ft lb)

NOTE: As assembling counterweight into main frame, adjust the gap of height between counterweight and side door assembly using shim (5, Figure 6) suitably.

4. Remove lifting device from counterweight lifting holes (6, Figure 6)
5. Make sure all electrical and other items are connected.
6. Turn battery disconnect switch to "ON" position.

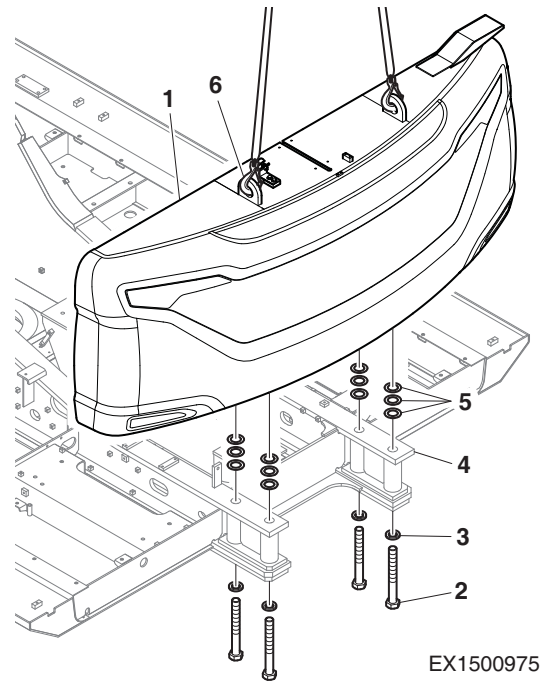


Figure 6

Hydraulic Oil Tank

Edition 1

MEMO

Table of Contents

Hydraulic Oil Tank

Safety Instructions	5-3-5
General	5-3-5
Specification	5-3-5
Air Breather	5-3-6
Removal	5-3-7
Installation	5-3-15
Completing Work	5-3-16

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.

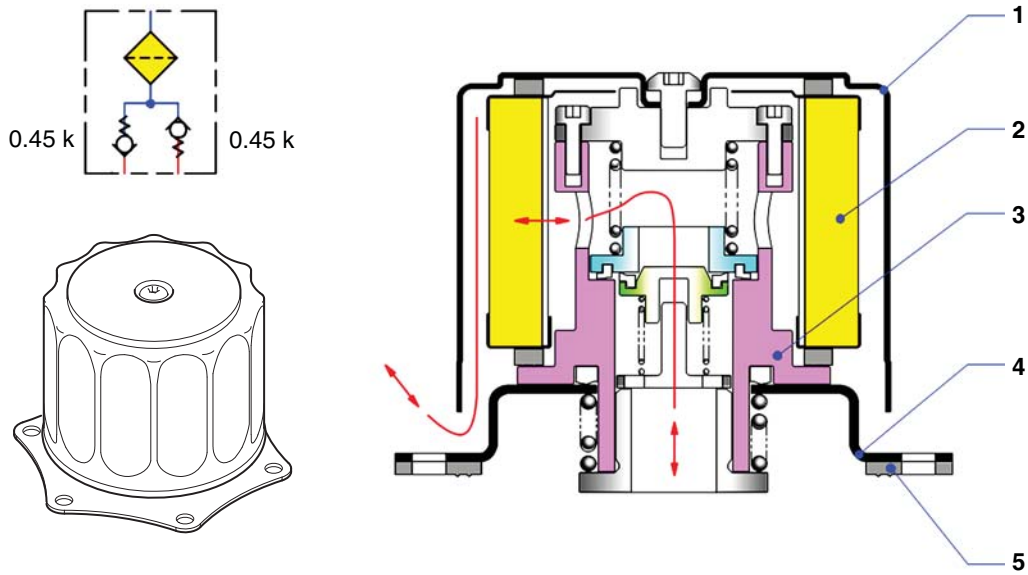
GENERAL

Specification

Volume (Full)	280 L (74 U.S. gal)
Optimum Volume	165 L (43.6 U.S. gal)

Air Breather

1. Structure of air breather



DS1903144

Figure 1

Reference Number	Description
1	Housing
2	Element
3	Body

Reference Number	Description
4	Flange
5	Gasket

2. Pressure release

Pulling the breather cap upward, the check valve 0.46 kg/cm^2 (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Make the machine swing about 60° rightward on the flat ground.
2. Front position: Positioned with stick cylinder fully extended and grapple and heel on ground as (Figure 3).
3. Lower all the attachments to ground.
4. Stop engine.

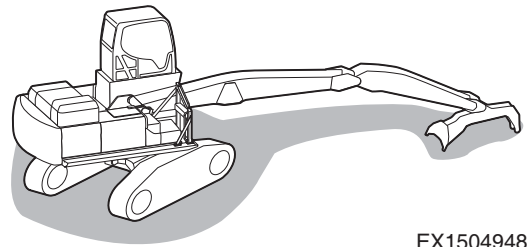


Figure 2

EX1504948

5. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 4)
6. Turn starter switch to "I" (ON) position.

! WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

7. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
8. Move safety lever to "LOCK" position. (Figure 4)
9. Turn key to "O" (OFF) position and remove from starter switch.
10. Attach a maintenance warning tag on controls.
11. Turn battery disconnect switch to "OFF" position. (Figure 5)

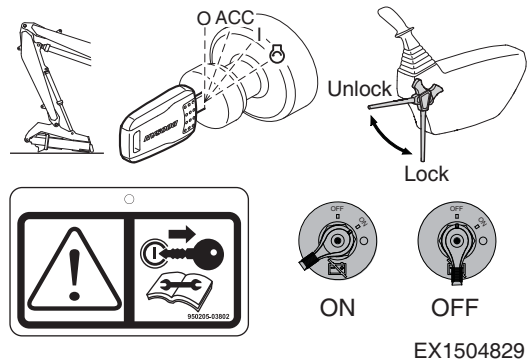


Figure 3

EX1504829

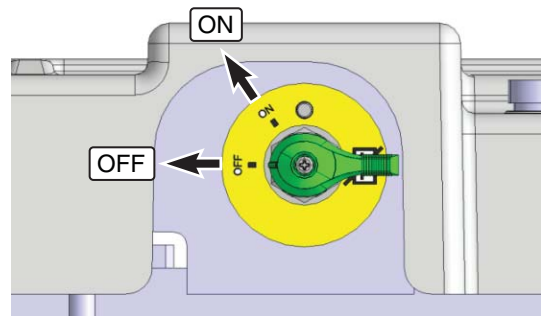


Figure 4

EX1504925

NOTE: *Removal (installation) procedure of the bolts.*

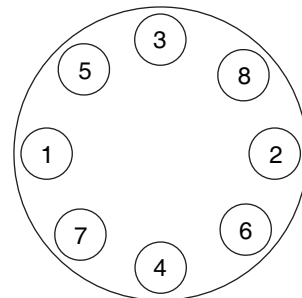


Figure 5

EX1401809

12. Remove bolts (1, Figure 7) (6 ea) with hand rail (2).

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

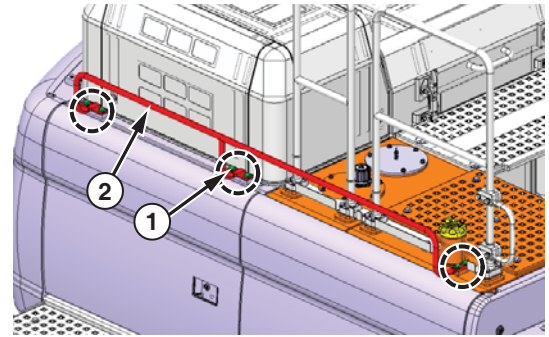


Figure 6

13. When removing the oil tank, it may interfere the pump room bonnet (2, Figure 8). So recommend to remove pump room bonnet.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

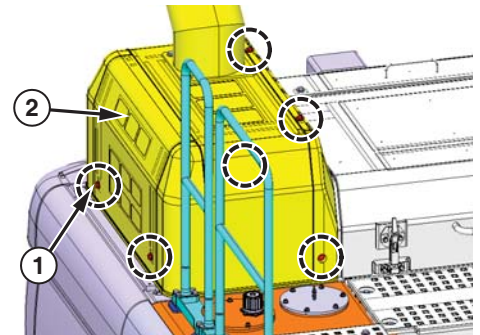


Figure 7

14. Oil drain method.

NOTE: Check the flow on the oil level gauge before draining the oil.

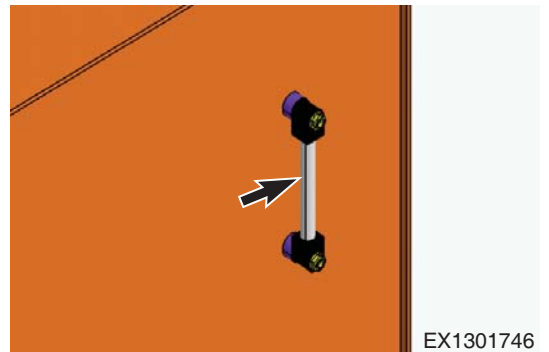


Figure 8

A. Remove cover on oil tank (bolt: 6 ea), drain hydraulic oil using oil pump. (Figure 10) Also pump oil from the suction pipe.

- Tool: 14 mm (🔧)
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

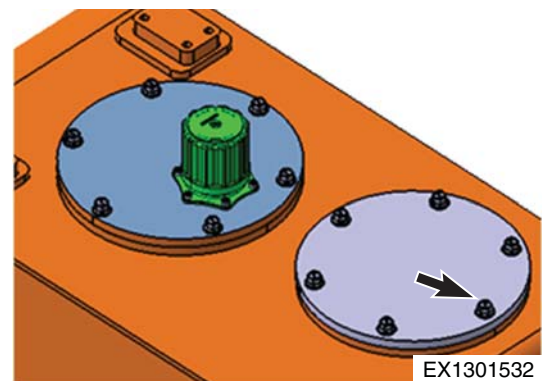


Figure 9

B. Drain hydraulic fluid using drain plug (without oil pump) (Figure 11).

- Tool: 27 mm (🔧)
- Torque: 93.1 N.m (9.5 kg.m, 68.7 ft lb)
- Hydraulic oil tank volume: about 280 L (74 U.S. gal)

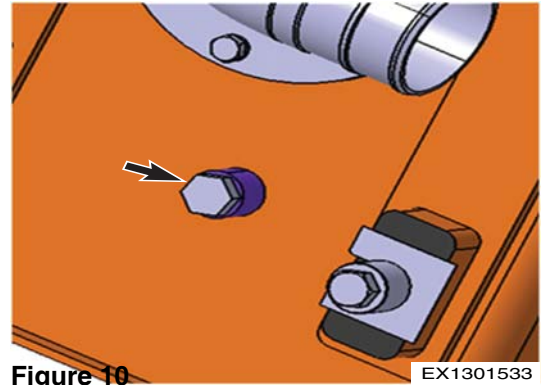


Figure 10

EX1301533

15. Remove bolts and washers (1, Figure 12) (8 ea) with the guardrail (2) (1 ea).

Remove bolts and washers (3, Figure 12) (4 ea) with cover of control valve (4).

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Control valve cover weight: 18 kg (39.7 lb)
- Guardrail weight: 10 kg (22 lb)

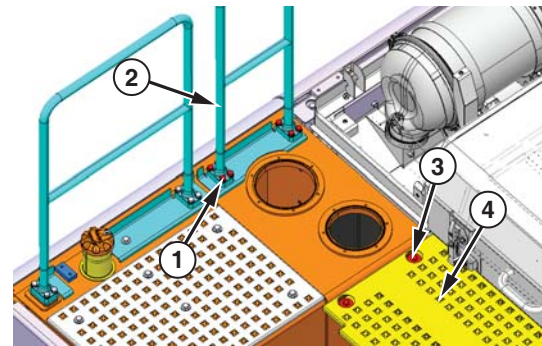


Figure 11

EX1504931

16. Install eyebolts (2 ea) on the oil tank.

And tie the rope to the bolts to lift oil tank.

- Thread of hole: M10 x 1.5

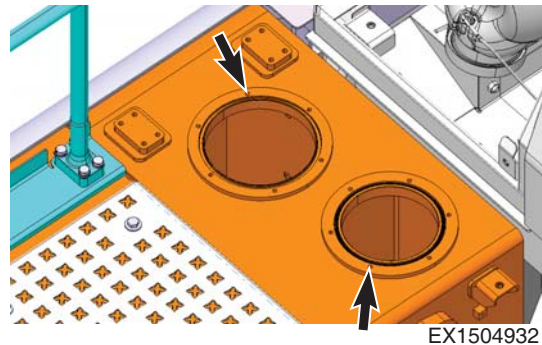


Figure 12

EX1504932

17. Remove bolts (1, Figure 14) (4 ea) with the tank front cover (2) from fuel tank.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Front cover weight: 5 kg (11 lb)

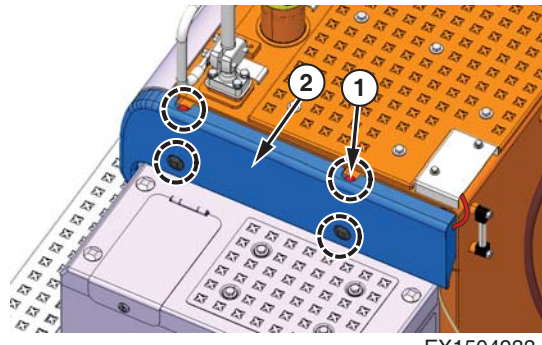


Figure 13

EX1504933

18. Open the right side door, remove bolts (2 ea) (Figure 15).

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

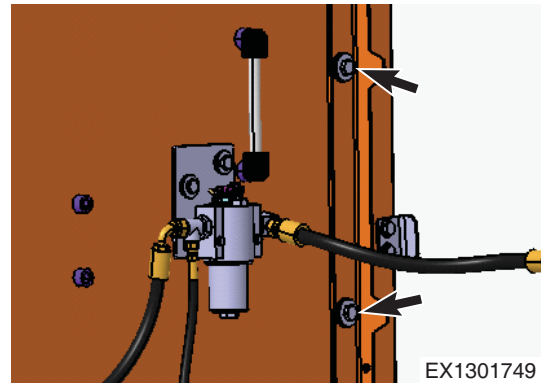


Figure 14

19. Open the urea side door.
Remove bolts (1, Figure 16) (2 ea) with tank side cover (2).

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Tank cover weight: 38 kg (83.7 lb)

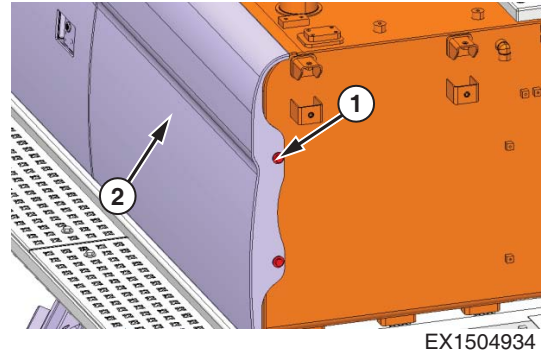


Figure 15

20. Remove bolts and washers (1, Figure 17) (4 ea) with under cover (2) on bottom of main frame.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Under cover weight: 13 kg (28.7 lb)

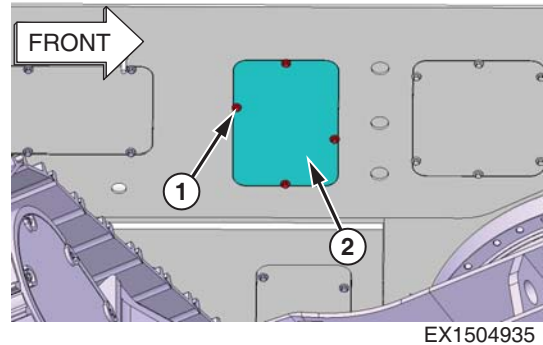


Figure 16 Bottom of Main Frame

21. Remove oil tank mounting bolts and spacers (1, Figure 18) (6 ea) from the main frame.

- Tool: 24 mm (🔧)
- Torque: 264.6 N.m (27 kg.m, 195.2 ft lb)

22. Remove bolts (2, Figure 18) (6 ea) with suction pipe from the oil tank.

- Tool: 17 mm (🔧)
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

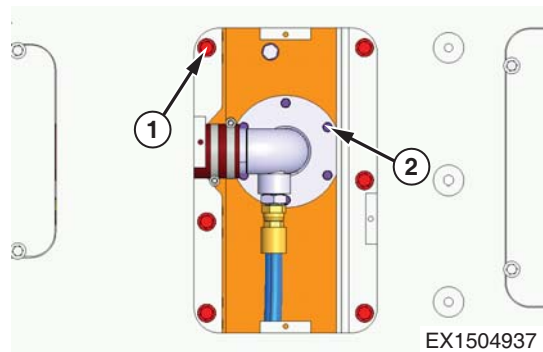


Figure 17 Bottom of Main Frame

23. Disconnect oil pressure switch harness.

How to disconnect the harness connector.

NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

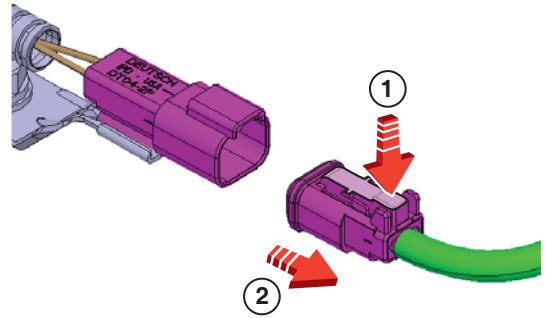


Figure 18

EX1504193

24. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.



Figure 19

EX1504170

25. Remove hoses and adapters (Figure 21) from the oil tank.

NOTE: Attach identification tags to the removed hoses for reassembly. disconnect hoses from the bottom to the top of tank, After disconnecting hoses plug them to prevent dirt or dust from entering.

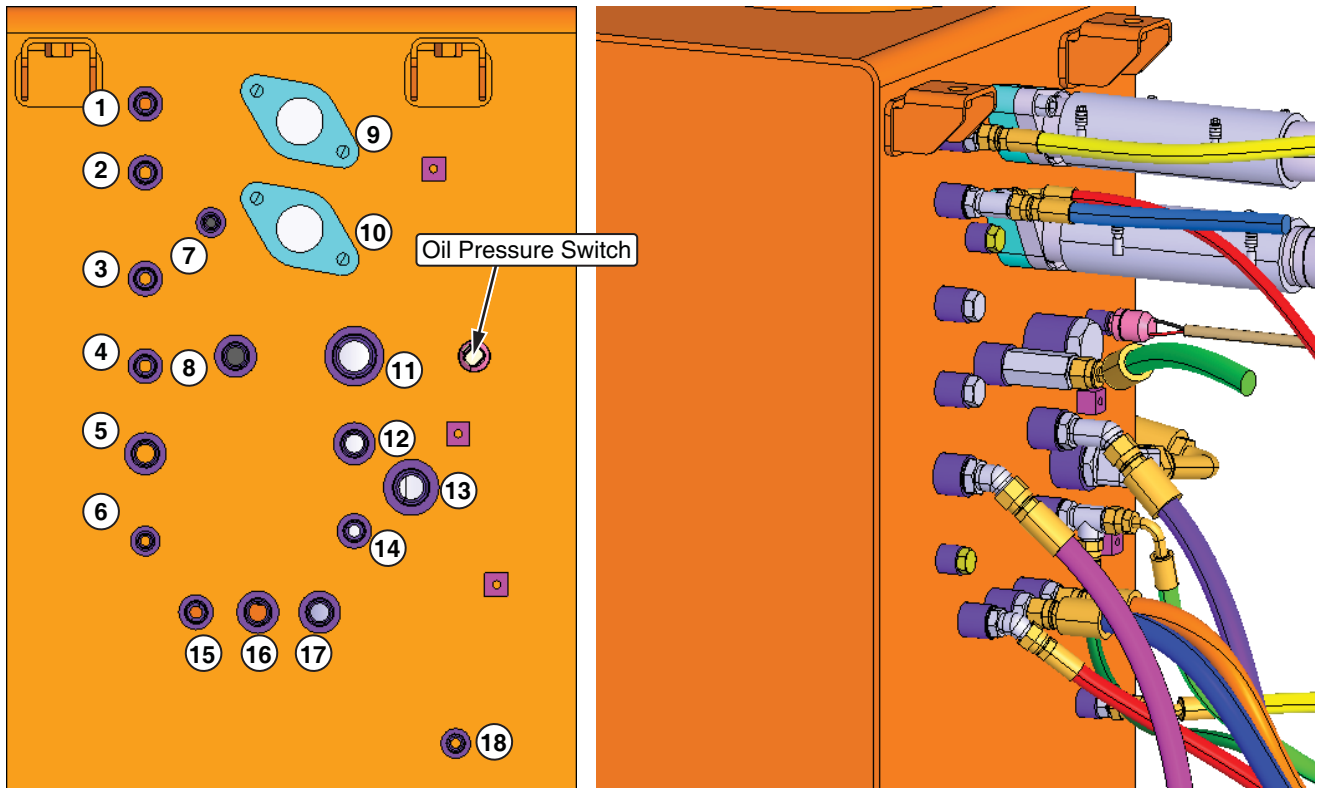
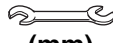



Figure 20

EX1504947

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
1	from Control Valve "DR2"	UNF 11/16"-16-2B	21	38.2	3.9	28.2
2	from Control Valve "DR1"	UNF 11/16"-16-2B	21	38.2	3.9	28.2
	from Control Valve "DR4"	UNF 9/16"-18-2B	17	28.4	2.9	20.9
5	from Control Valve for Grapple "T"	UNF 13/16"-16-2B	24	55.9	5.7	41.2
8	from Swing Motor "M"	UNF 13/16"-16-2B	24	55.9	5.7	41.2
9	from Radiator	Hole Distance 85 mm		107.9	11	79.6
10	from Control Valve "T1"	Hole Distance 85 mm		107.9	11	79.6
12	from Main Pump "Dr3"	UNF 13/16"-16-2B	24	55.9	5.7	41.2
13	from PTO Pump	UNF 1 3/16"-12-2B	36	124.5	12.7	91.8
14	from Fan Pump "L1"	UNF 11/16"-16-2B	21	38.2	3.9	28.2
	from Fan Motor "D"	UNF 9/16"-18-2B	17	25.5	2.6	18.8
15	from Solenoid Valve "T"	UNF 11/16"-16-2B	21	38.2	3.9	28.2
16	from Joint Sub Assembly "B19"	UNF 13/16"-16-2B	24	55.9	5.7	41.2
17	from Joint Sub Assembly "B20"	UNF 13/16"-16-2B	24	55.9	5.7	41.2
18	from Stop Valve "T"	UNF 11/16"-16-2B	22	38.2	3.9	28.2

- Fitting

Port	Name	Size		 (mm)	Torque		
		A	B(C)		N.m	kg.m	ft lb
1	Adapter	PF 3/8"	UNF 11/16"-16	22	49.0	5	36.2
2	Tee	PF 3/8"	UNF 9/16"-18, UNF 11/16"-16	22	49.0	5	36.2
3, 4	Plug	PF 3/8"		22	49.0	5	36.2
5, 12	Elbow	PF 1/2"	UNF 13/16"-16	27	93.1	9.5	68.7
6, 7	Plug	PF 1/4"		19	39.2	4	28.9
8	Adapter	PF 1/2"	UNF 13/16"-16	27	93.1	9.5	68.7
11	Plug	PF 1"		41	205.8	21	151.8
13	Elbow	PF 3/4"	UNF 1 3/16"-12	36	176.4	18	130.1
14	Tee	PF 3/8"	UNF 9/16"-18, UNF 11/16"-16	22	49.0	5	36.2
15	Elbow	PF 3/8"	UNF 11/16"-16	22	49.0	5	36.2
16, 17	Adapter	PF 1/2"	UNF 13/16"-16	27	93.1	9.5	68.7
18	Adapter	PF 1/4"	UNF 11/16"-16	19	39.2	4	28.9
1	O-ring	S8000145 (4D P14)	S8030061 (1B F-06)				
2		S8000145 (4D P14)	S8030061 (1B F-06), 2180-1216D11 (ID:7.65, W:1.78, 1B)				
3, 4		S8000145 (4D P14)					
5, 8, 12, 16, 17		S8000185 (4D P18)	S8030081 (1B F-08)				
6, 7		S8000115 (4D P11)					
9, 10		DS2856005 (1 1/2", ID:47.6, OD:54.6, 1B)					
11		S8000291 (1B P29)					
13		S8000235 (4D P22.4)	S8030125 (4D F-12)				
14		S8000145 (4D P14)	S8030061 (1B F-06), 2180-1216D11 (ID:7.65, W:1.78, 1B)				
15		S8000145 (4D P14)	2180-1216D11 (ID:7.65, W:1.78, 1B)				
18		S8000115 (4D P11)	S8030061 (1B F-06)				

* A: Opposite side of hose, B (C): Hose side

26. Using a crane, lift the hydraulic oil tank slowly.

- Oil tank weight: about 200 kg (440.9 lb)

IMPORTANT

Make sure there are no other electrical wires or hoses connected to tank.

INSTALLATION

NOTE: First of all, assemble the bolts and spacers (6 ea) of oil tank mounting to main frame. (Figure 22)

1. Install the oil tank with bolts and spacers (1, Figure 22) (6 ea) to the main frame.
 - Tool: 24 mm (🔧)
 - Torque: 264.6 N.m (27 kg.m, 195.2 ft lb)
2. Install the bolts (2, Figure 22) (6 ea) with suction pipe from the oil tank.
 - Tool: 17 mm (🔧)
 - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)
3. Perform installation in the reverse order of removal.
4. If removed the level gauge, install level gauge as the following torque.
 - Torque: 12.7 N.m (1.3 kg.m, 9.4 ft lb)
5. When assembling rod to suction filter, adjust the assembling length as (Figure 23).

Reference Number	Description
1	Suction Filter
2	Nut
3	Rod

- Torque (2 nut): 49 N.m (5 kg.m, 36.2 ft lb)

6. Location of air breather (1) must be as (Figure 24) when assembling cover (2).

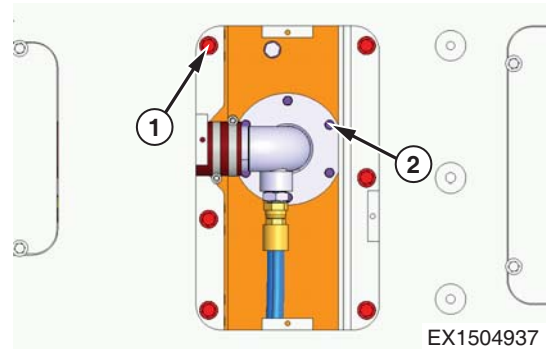


Figure 21 Bottom of Main Frame

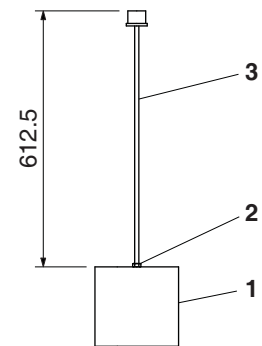


Figure 22

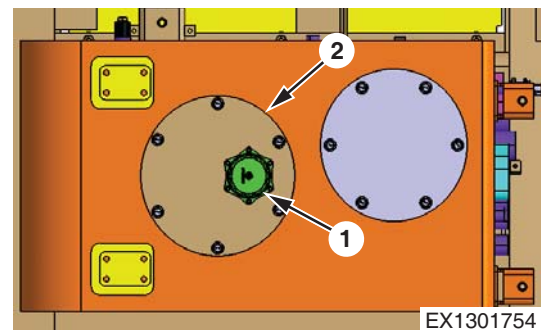
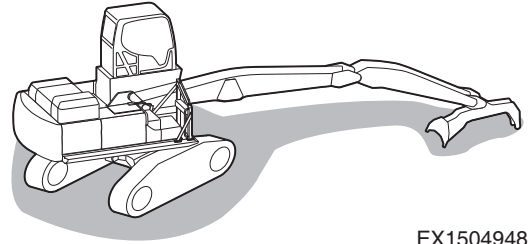


Figure 23

COMPLETING WORK

1. Hydraulic oil tank volume: about 280 L (74 U.S. gal)
2. Adjusting standard for hydraulic oil level
 - A. Front position: Positioned with stick cylinder fully extended and grapple and heel on ground as (Figure 25).
 - B. Engine condition: Low idle
 - C. Fill hydraulic oil until level gauge is positioned middle of low and high level. Adjust hydraulic oil level by drain plug which is under the tank if hydraulic oil level is above high.



EX1504948

Figure 24

Fuel Tank

Edition 1

MEMO

Table of Contents

Fuel Tank

Safety Instructions	5-4-5
General	5-4-5
Specification	5-4-5
Removal	5-4-6
Installation	5-4-12
Completing Work	5-4-13

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.

GENERAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Diesel fuel is highly flammable and can be potentially explosive. To prevent fires or explosion, keep arcs, sparks or other ignition sources away from diesel fuel or fuel containers.

Specification

Volume (Full)	500 L (132 U.S. gal)		
Tank Size (mm)	979 x 845 x 851		
Tank Weight	about 220 kg (Empty)		
Fuel Strainer Filter	Filtration Ratio	24 mesh	
	Working Oil Temp.	-40 - +80°C	
Fuel Cap	Check Valve	Positive Pressure	0.25 - 0.05 kg/cm ² (0.25 -0.05 bar, 3.63 - 0.73 psi)
		Negative Pressure	below 0.035 kg/cm ² (0.035 bar, 0.51 psi)
Fuel Sensor	Working Voltage	V max. 48 V	
	Working Current	I max. 300 mA	
	Rating Power	125 mW	

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Fire hazard!

Fuel is easily flammable.

- **Keep open flames and ignition sources away from the workplace.**

1. Look at fuel level display (Figure 2) on instrument panel in operator's cabin to see what it displays. The display is divided into seven separated segments. Also, look at level gauge on side of tank to estimate volume of fuel left in tank.

NOTE: *If possible, work excavator until available fuel supply in tank has been run down as far as possible.*

2. Make the machine swing about 60° rightward on the flat ground as shown in (Figure 3) before lowering all the attachments on the ground.

3. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 4)
4. Turn starter switch to "I" (ON) position.



WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

5. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
6. Move safety lever to "LOCK" position. (Figure 4)
7. Turn key to "O" (OFF) position and remove from starter switch.
8. Attach a maintenance warning tag on controls. (Figure 4)

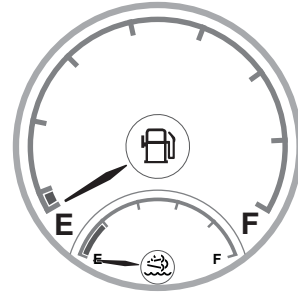


Figure 1

EX1300964

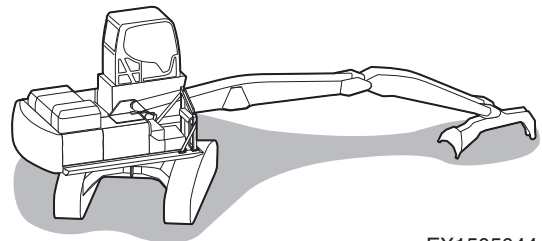


Figure 2

EX1505044

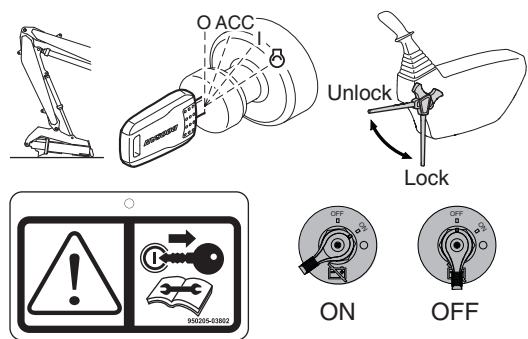
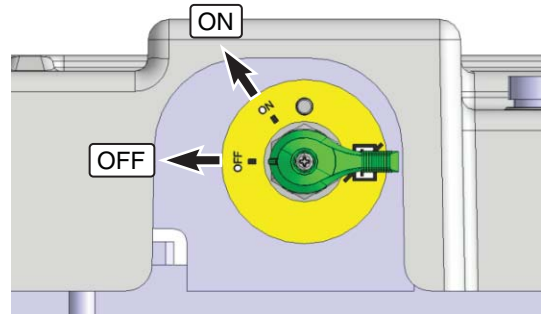


Figure 3

EX1504829

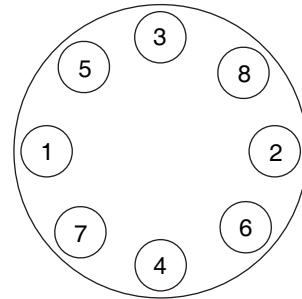
9. Turn battery disconnect switch to "OFF" position. (Figure 5)



EX1504925

Figure 4

NOTE: Removal (installation) procedure of the bolts.

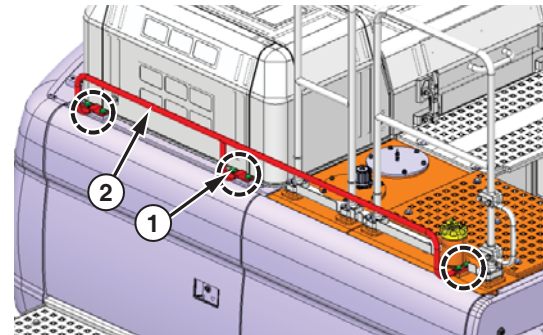


EX1401809

Figure 5

10. Remove bolts (1, Figure 7) (6 ea) with hand rail (2).

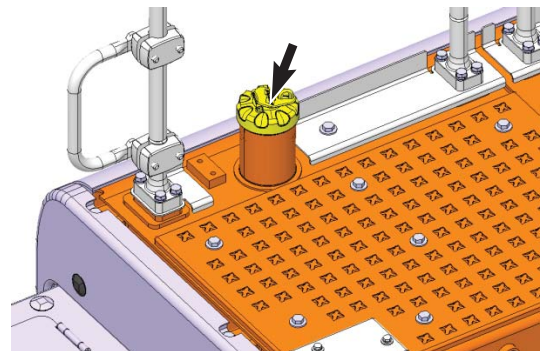
- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)



EX1504929

Figure 6

11. Clean area around fuel tank fill cap. Open fuel cap.



EX1504938

Figure 7

12. Open drain valve (Figure 9) right side door and carefully drain.

- Fuel tank capacity: 600 L (158.5 U.S. gal)

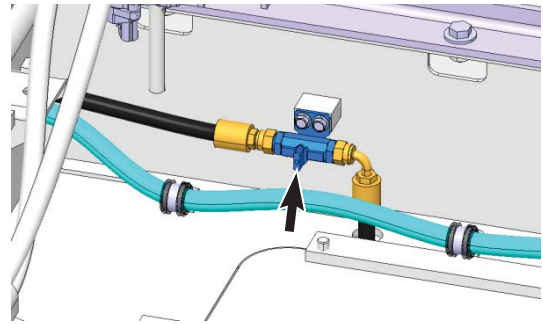


Figure 8

EX1504939

13. Remove bolts and washers (1, Figure 10) (8 ea) with the guardrail (2) (1 ea).

14. Remove bolts (3, Figure 10) (8 ea) and cover (4) from fuel tank.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Tank cover weight: 7 kg (15.4 lb)
- Guardrail weight: 15 kg (33.1 lb)

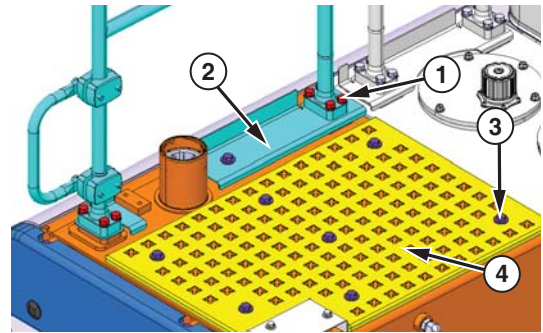


Figure 9

EX1504940

15. Remove bolts (1, Figure 11) (4 ea) with the tank front cover (2) from fuel tank.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Front cover weight: 5 kg (11 lb)

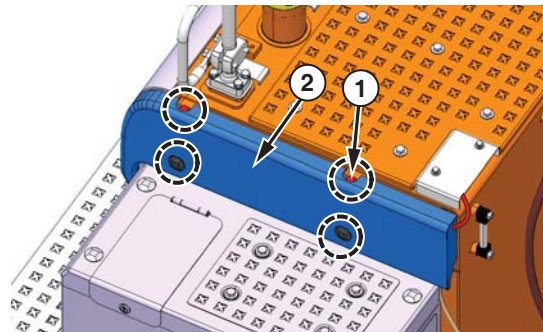


Figure 10

EX1504933

16. Open the right side door, remove bolts (2 ea) (Figure 12).

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

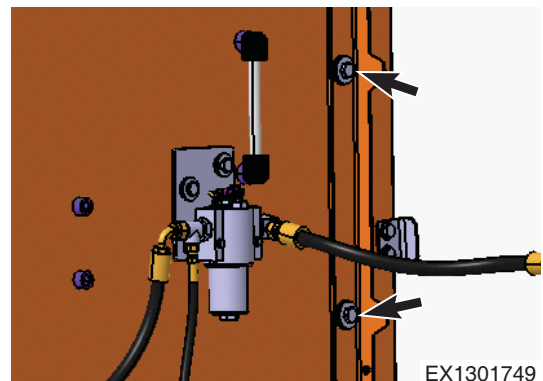
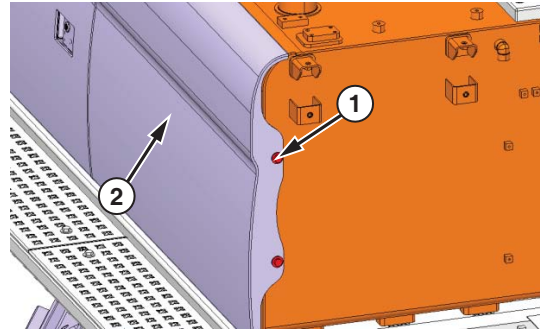


Figure 11

EX1301749

17. Open the urea side door.
Remove bolts (1, Figure 13) (2 ea) with tank side cover (2).

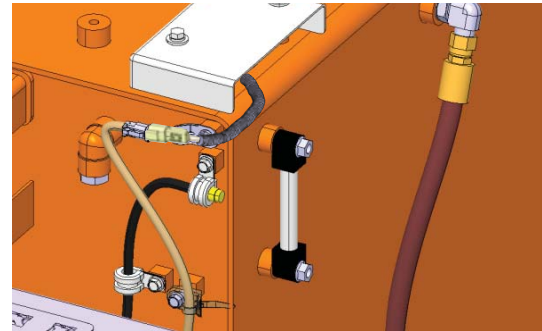
- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Tank cover weight: 38 kg (83.7 lb)



EX1504934

Figure 12

18. Disconnect the connector of fuel sensor (1, Figure 14).

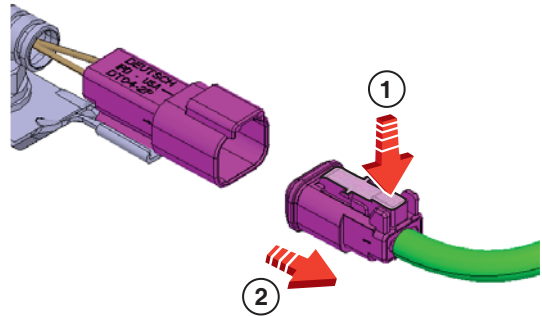


EX1504942

Figure 13

How to disconnect the harness connector.

NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

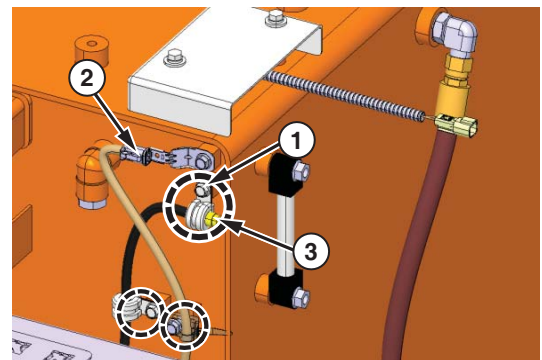


EX1504193

Figure 14

19. Remove bolts (1, Figure 16) (3 ea) and clips with harness (2), and DEF breather filter. (3)

- Tool: 12 mm (🔧)
- Torque: 20 N.m (2 kg.m, 14.8 ft lb)



EX1504943

Figure 15

20. Remove hose from fuel tank.

NOTE: Cap the open ends of hose with plug.

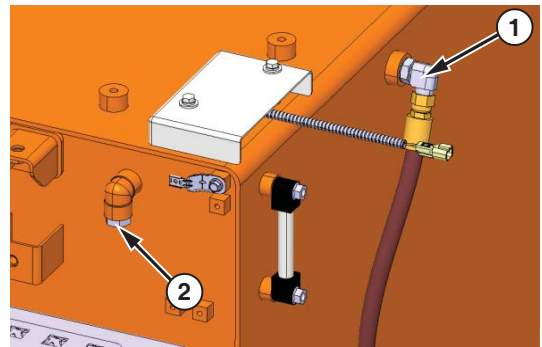




Figure 16

EX1504949

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
1	Return Line	13/16"-16UN	24	55.9	5.7	41.2
2	Plug	PF 1/2"	27	93.1	9.5	68.7

- Fitting

Port	Name	Plug/Flange Size (Hose)		 (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
1	Elbow	PF 1/2"	UNF 13/16"-16	27	93.1	9.5	68.7
1	O-ring	S8000145 (4D P14)	S8030081 (1B F-08)				
2		S8000185 (4D P18)					

* A: Opposite side of hose, B (C): Hose side

21. When disconnecting the hose, fuel left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.



Figure 17

EX1504170

22. Install eyebolts (2 ea) on the fuel tank.

And tie the rope to the bolts to lift tank.

- Thread of hole: M12 x 1.75
- Fuel tank weight: 215 kg (474 lb)

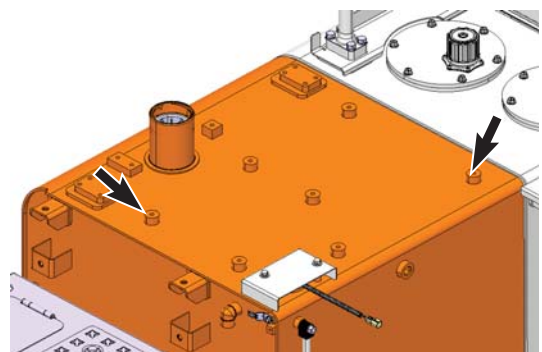

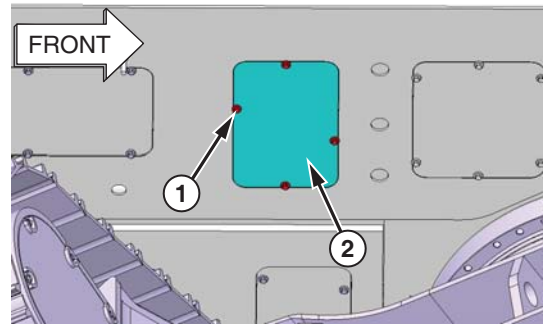


Figure 18

EX1504941

23. Remove bolts and washers (1, Figure 20) (6 ea) with under cover (2) on bottom of main frame.

- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Under cover weight: 15 kg (33.1 lb)

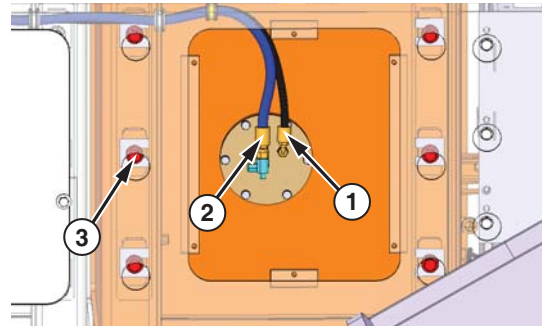


EX1504935

Figure 19

24. Remove hose from fuel tank


NOTE: Cap the open ends of hose with plug.




EX1504936

Figure 20

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
1	to Drain Valve	UNF 11/16"-16	22	38.2	3.9	28.2
2	Supply Line	UNF 13/16"-16	24	55.9	5.7	41.2

25. Remove fuel tank mounting bolts and spacers (3, Figure 21) (6 ea) from the main frame.

- Tool: 24 mm ()
- Torque: 264.6 N.m (27 kg.m, 195.2 ft lb)

IMPORTANT

Make sure there are no other electrical wires or hoses connected to tank.

Completely remove tank after inspection


- Fuel tank weight: 215 kg (474 lb)

NOTE: The clear level gauge on the side of the tank is easily damaged. Be careful of obstacles and wind gusts.

INSTALLATION

NOTE: First, assemble the bolts and spacers (6 ea) of fuel tank mounting to main frame. (Figure 22)

1. Install the fuel tank with bolts and spacers (3, Figure 22) (6 ea) to the main frame.

- Tool: 24 mm ()
- Torque: 264.6 N.m (27 kg.m, 195.2 ft lb)

NOTE: The clear level gauge on the side of the tank is easily damaged. Be careful of obstacles and wind gusts.

2. Connect fuel supply line (2, Figure 22) and drain valve line (1) to fuel tank.
3. Perform installation in the reverse order to remove.
4. Make sure fuel tank drain valve (Figure 23) right side door is closed.
5. Fill fuel tank and check for signs of leaks. Correct any problems found.
 - Fuel tank capacity: 500 L (132.1 U.S. gal)

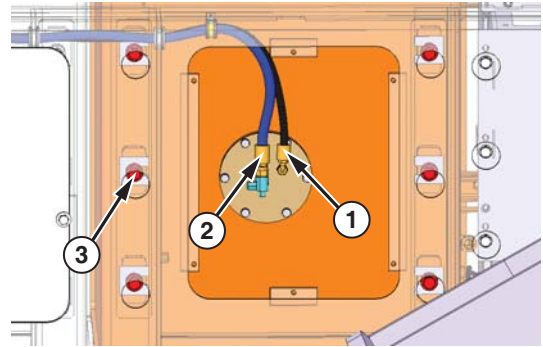


Figure 21

EX1504936

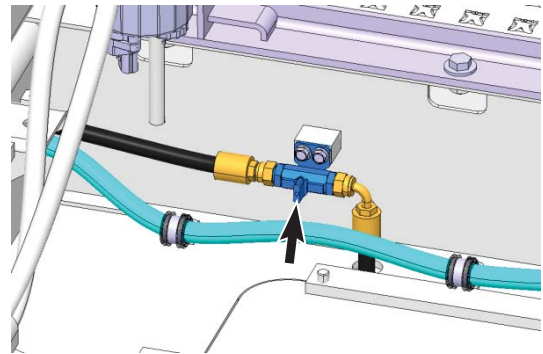


Figure 22

EX1504939

COMPLETING WORK

If engine does not start, the fuel system may need priming. Prime the fuel system using the following procedure:

1. Turn key to "OFF" position.
2. Open right side door and locate fuel filter.
3. Attach a clear plastic hose to the bleed nipple (1, Figure 25) on the fuel filter housing. Place the end of the plastic hose in a container that hose at least 3 L (0.8 U.S. gal.).
4. Loosen the hand pump handle (2, Figure 25).
5. Open the bleed nipple (1, Figure 25).
6. Pump (2, Figure 25) by hand until fuel comes out of the hose. This may take around 100 pump strokes. Depending on the installation, a significantly greater number of pump strokes may be required before fuel comes out.
7. Close the bleed nipple (1, Figure 25).
8. Start the engine and open the bleed nipple (1, Figure 25) carefully.
9. Check that fuel without air bubbles comes out of the hose. Normally, about 3 liters of fuel must be drained before no more air bubbles come through the hose.
10. Close the bleed nipple (1, Figure 25), remove hose and tighten the hand pump handle (2).

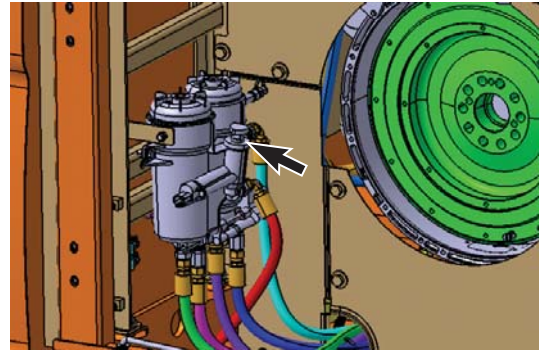


Figure 23

EX1400180

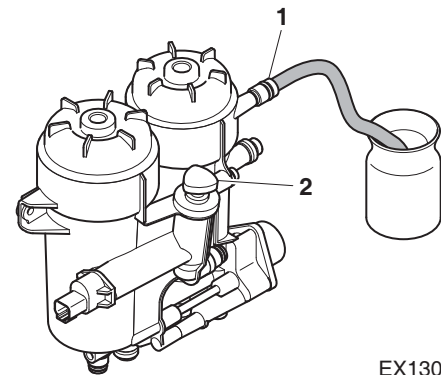


Figure 24

EX1302345

Main Pump

Edition 1

MEMO

Table of Contents

Main Pump

Safety Instructions	5-5-5
Axial Piston Pump	5-5-5
Specifications	5-5-5
Performance Curves	5-5-6
Overview	5-5-7
Port.....	5-5-8
Hydraulic Circuit	5-5-9
Section View.....	5-5-10
Theory of Operation	5-5-12
Tools.....	5-5-14
Tightening Torque	5-5-15
Removal	5-5-16
Installation	5-5-27
Completing Work.....	5-5-27
Disassembly	5-5-28
Reassembly.....	5-5-31
Troubleshooting.....	5-5-34
General Caution	5-5-34
Check the Casing of the Pump for Abnormalities....	5-5-34
Overload of Prime Mover	5-5-35
Extreme Decrease of Pump Delivery Flow and No Increase of Delivery Pressure	5-5-35
Abnormal Noises and Abnormal Vibrations.....	5-5-35
Maintenance Instructions	5-5-36
Replacement Standard of Worn Parts.....	5-5-36
Correction Criteria for Cylinder, Valve Plate and Swash Plate (Shoe Plate)	5-5-36
Regulator	5-5-37
Port and Hydraulic Circuit.....	5-5-37
Functional Explanation	5-5-37
Regulator Function Diagram	5-5-38
Negative Flow Control.....	5-5-38
Total Horsepower Control	5-5-41
Variable Horsepower Control	5-5-43

Adjustment	5-5-44
Adjustment of Maximum and Minimum Flows....	5-5-44
Adjustment of Maximum Flow	5-5-44
Adjustment of Minimum Flow	5-5-45
Summary of Regulator Adjustment Values	5-5-46
Tightening Torque	5-5-47
Tools.....	5-5-47
Section View.....	5-5-48
Disassembly	5-5-50
Cautions on Disassembly.....	5-5-50
Reassembly.....	5-5-53
Troubleshooting.....	5-5-56
Prime Mover is Overloaded.....	5-5-56
Maximum Flow Is Not Available	5-5-56
Pilot Gear Pump	5-5-57
Specification	5-5-57
Theory of Operation	5-5-57
Port and Hydraulic Circuit.....	5-5-57
Precaution	5-5-58
Tools.....	5-5-58

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

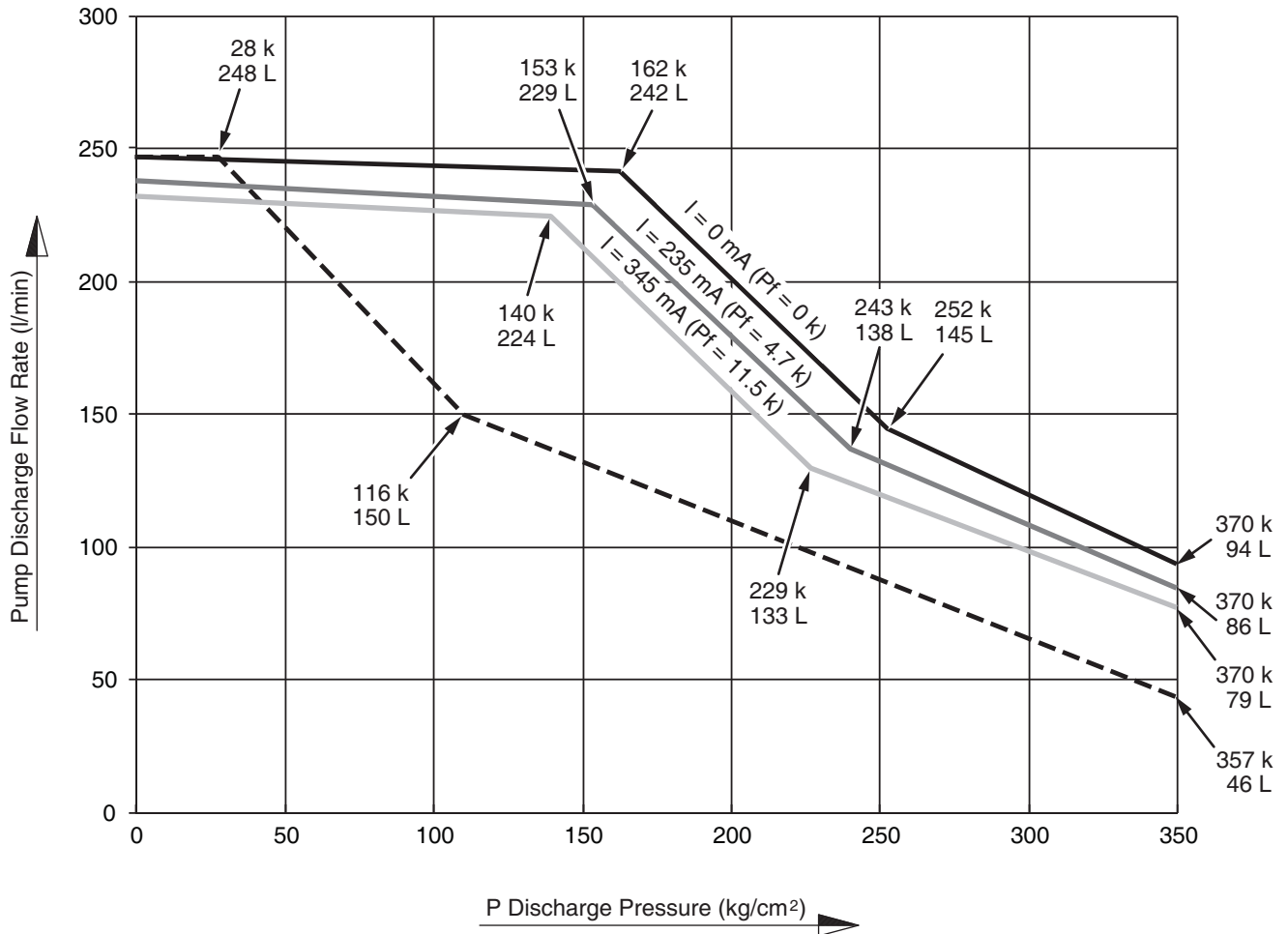
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

AXIAL PISTON PUMP

Specifications

Discharge-Capacity/rev	Double	138 x 2 cc/rev
Pressure	Rating	350 kg/cm ² (343 bar, 4,978 psi)
	Peak	400 kg/cm ² (392 bar, 5,689 psi)
Number of Revolutions	Peak. Self-priming	2,157 rpm
	Peak	2,500 rpm
Hydraulic Oil	Type	Anti-wear Type Hydraulic Oil
	Temperature Range	-20 - +95°C
	Viscosity Range	10 - 1,000 cst
	Filtration	10 μm
Weight		136 kg (300 lb)

Performance Curves



EX1504714

Figure 1

Mode	Engine Speed (rpm)	Input Current (mA)	Secondary Pressure bar (kg/cm ²)	Remark
Power Plus	1,900 (High)	200	1.96 (2.0)	Variable
	1,800 (Rated)			
Power	1,750	230	3.43 (3.5)	
Standard	1,650	275	6.37 (6.5)	
Economy	1,600	310	8.43 (8.6)	

Overview

The main pump consists of a main body in which there are two spline-coupled pumps, regulators for regulating flow rate and horsepower, an EPPR valve for controlling a power mode.

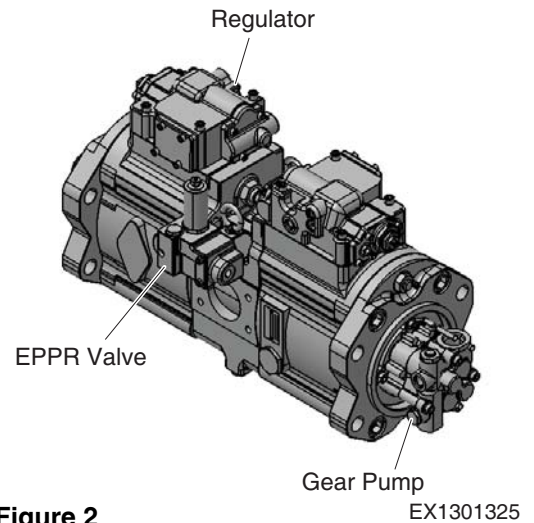
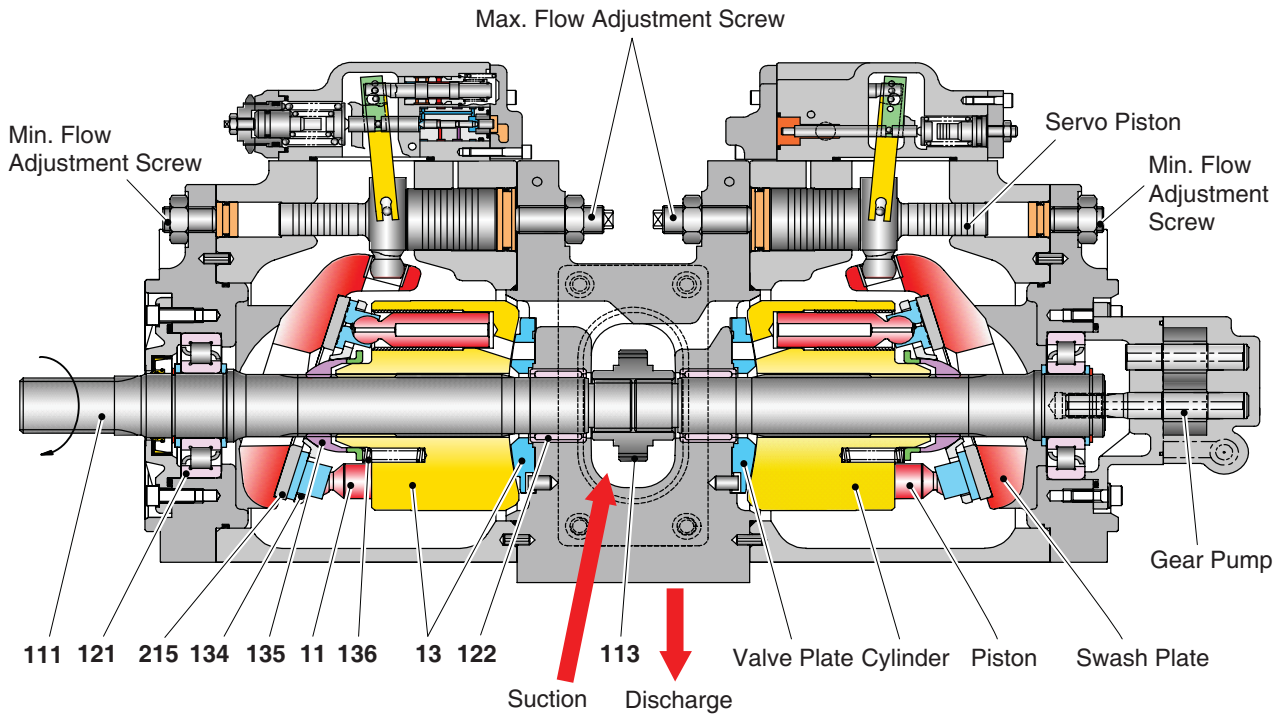


Figure 2

The pump is as follows, and further includes maximum and minimum flow regulating screws.

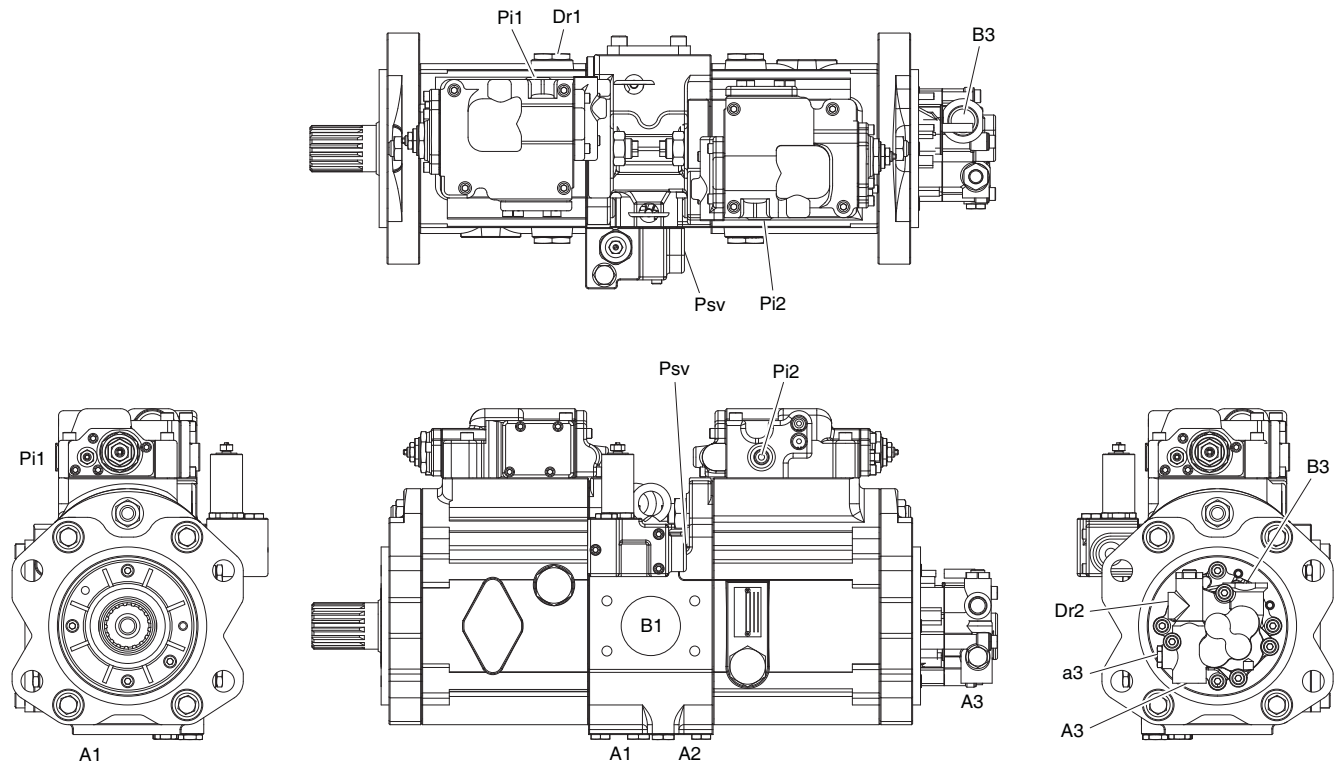


EX1301326

Figure 3

Port

Locations of ports for a suction, a delivery, a drain, a gauge, a pilot, etc. on the pump are shown and the locations of the ports can be seen in the following drawing. The symbols are the same as in the hydraulic circuit.

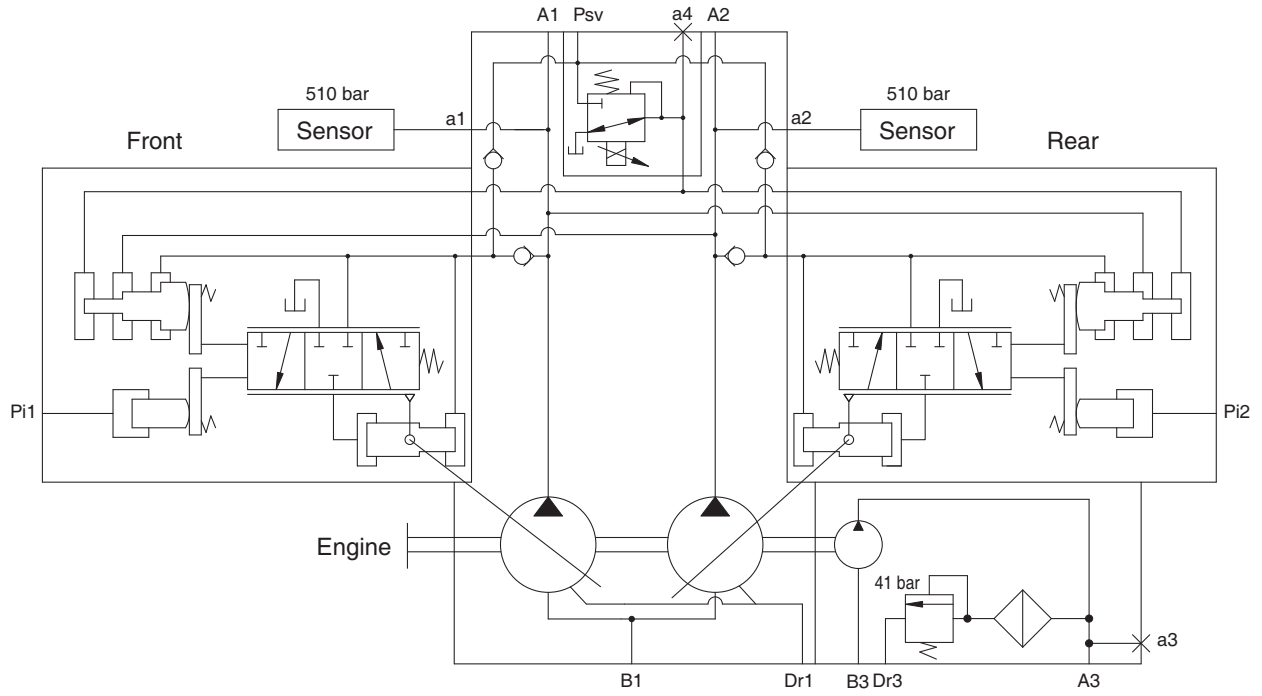


EX1301327

Figure 4

Port	Name	Size	Location
A1, A2	Delivery	SAE 6,000 psi 1"	Body
B1	Suction	SAE 2,500 psi 2 1/2"	Body
Dr1	Drain	PF3/4-20	Body
Pi1, Pi2	Pilot	PF1/4-15	Regulator (Front, Rear)
Psv	Servo Assist	PF1/4-15	EPPR Valve Block
A3	Gear Pump Delivery	PF1/2-19	Gear Pump
B3	Gear Pump Suction	PF3/4-20.5	Gear Pump
Dr2	Gear Pump Drain	PF3/8-16	Gear Pump
a3	Gauge	PF1/4-14	Gear Pump

Hydraulic Circuit



EX1301328

Figure 5

Section View

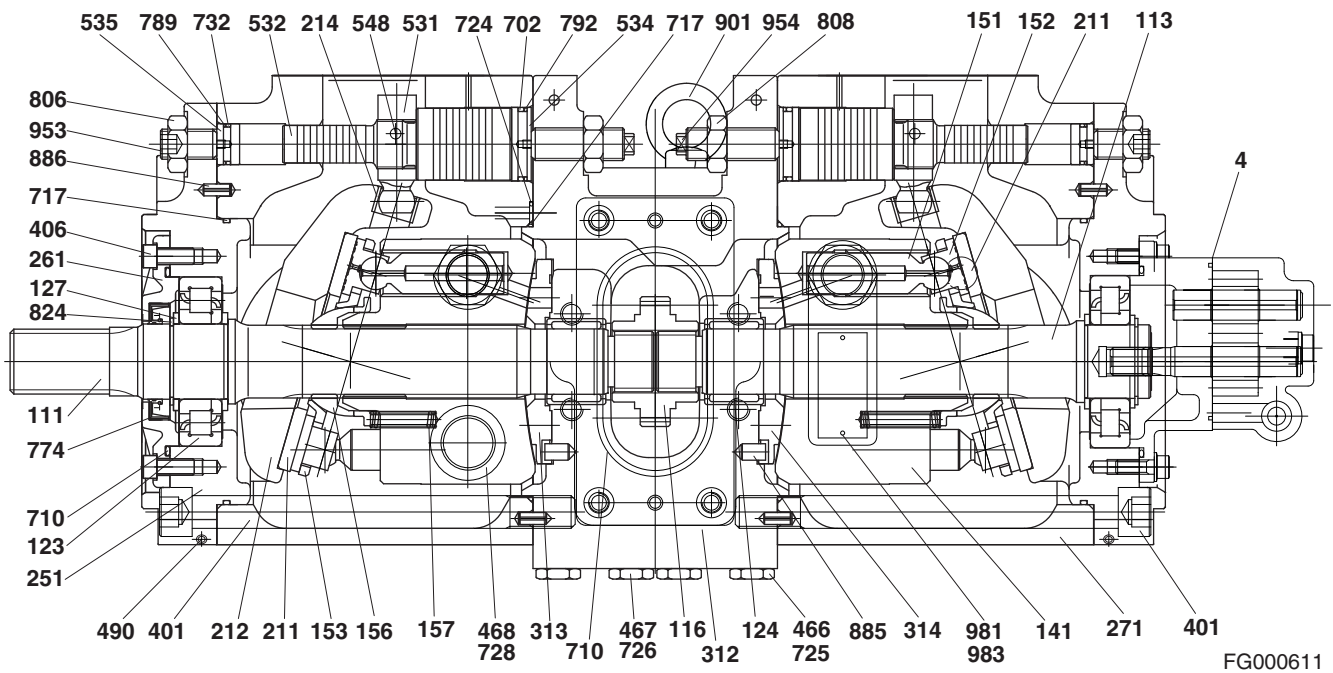
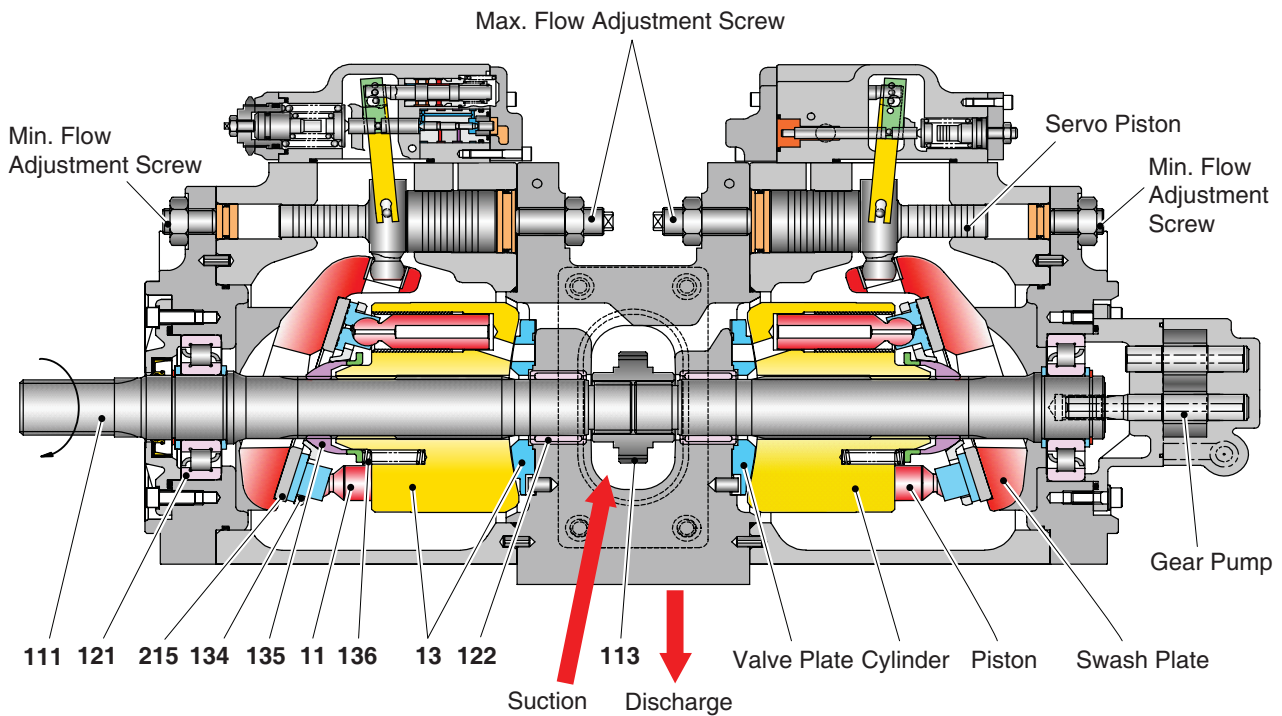


Figure 6

Reference Number	Description
04	Gear Pump
111	Driveshaft (F)
113	Driveshaft (R)
116	1st Gear
123	Roller Bearing
124	Needle Bearing
127	Bearing Spacer
141	Cylinder Block
151	Piston
152	Shoe
153	Set Plate
156	Spherical Bushing
157	Cylinder Spring
211	Shoe Plate
212	Swash Plate
214	Tilting Bushing
251	Swash Plate Support
261	Seal Cover (F)
271	Pump Casing
312	Valve Block
313	Valve Plate (R)
314	Valve Plate (L)
401	Hex Socket Head Bolt
406	Hex Socket Head Bolt
466	VP Plug
467	Plug
468	RO Plug

Reference Number	Description
490	Plug
531	Tilting Pin
532	Servo Piston
534	Stopper (L)
535	Stopper (S)
548	Feedback Pin
702	O-ring
710	O-ring
717	O-ring
719	O-ring
724	O-ring
725	O-ring
728	O-ring
732	O-ring
774	Oil Seal
789	Backup Ring
792	Backup Ring
806	Nut
808	Nut
824	Retaining Ring
885	Valve Plate Pin
886	Spring Pin
901	Eyebolt
953	Set Screw
954	Set Screw
981	Nameplate
983	Pin

Theory of Operation



EX1301326

Figure 7

- This pump assembly consists of two pumps connected by a spline coupling (113). The two pumps can be driven simultaneously as the rotation of the prime mover (engine) is transferred to the driveshaft (F) (111) on the front side. The suction port serves both the front pump and the rear pump. Since the front pump and the rear pump have the same structure and operational principle, the front pump is described in the following descriptions. The pumps may be classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function, the swash plate group that varies the delivery rates, and the valve cover group that changes over oil suction and discharge.
- The rotary group consists of a driveshaft (F) (111), a cylinder block (13), a piston and shoes (11), a set plate (134), a spherical bushing (135) and a cylinder spring (136). The driveshaft is supported by bearings (121 and 122) at both ends. The shoe is caulked to the piston to form a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and to take hydraulic balance so it slides lightly over the shoe plate (215). The subgroup is composed of a piston and shoe pressed against the shoe plate by the action of the cylinder spring by a retainer and a spherical bushing. Similarly, the cylinder block is pressed against a plate valve (13) by the action of the cylinder spring.

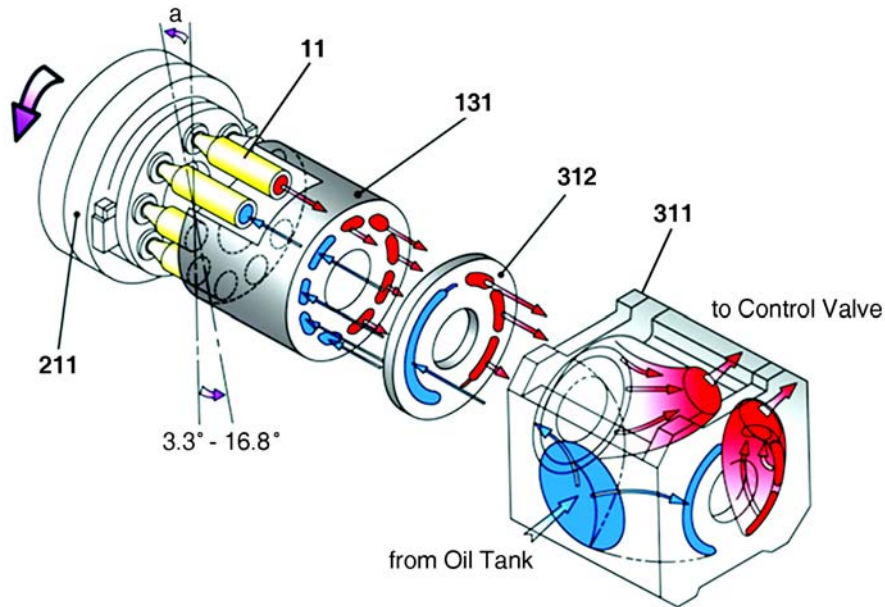


Figure 8

EX1401736

- The swash plate group consists of a swash plate (211), a shoe plate (215) and a piston (11). The swash plate is supported by a cylindrical part formed on the opposite side of the sliding surface of the shoe.
- The valve cover group consists of a main case (311), a plate valve (312) and a plate valve pin (352). The plate valve that has two cylindrical ports is mated to the main case, which feeds and collects oil to and from the cylinder block. The oil changed over by the plate valve is connected to an external pipeline through the main case. When the driveshaft is driven by the engine, it rotates the cylinder block by a splined coupling. If the swash plate is tilted, the pistons arranged in the cylinder block make a reciprocating motion with respect to the cylinder block, while they revolve with the cylinder block. Accordingly, while the cylinder block makes one revolution on a single piston, the piston performs a motion away from the plate valve (oil suction process) within 180 degrees, and makes a motion toward the valve plate (or oil discharging process) in the remaining 180 degrees. When the swash plate has no tilt angle (zero degrees), the piston neither strokes nor discharges oil.

Maximum Displacement Angle:

Minimum Displacement Angle (Operable Limit Angle):

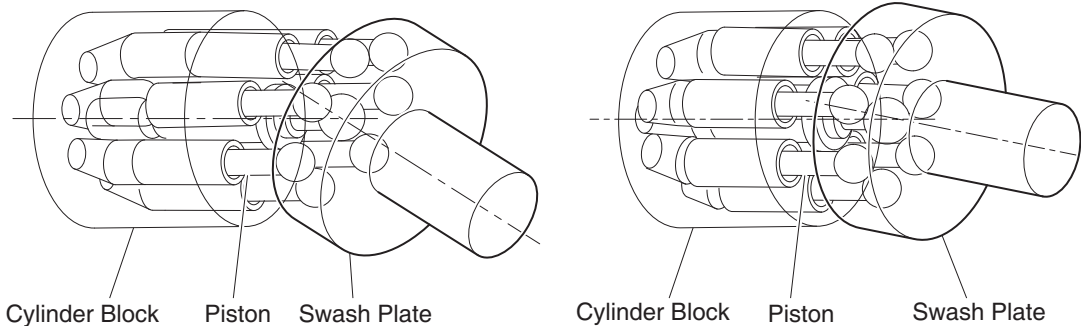
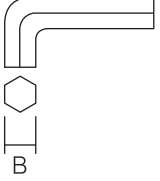



Figure 9

EX1301331

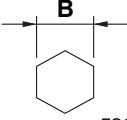
Tools

The tools necessary to disassemble/reassemble the pump are shown in the following list.

Tool Name and Size		Necessary Tool	Part Name			
Name	B		Hex Socket Head Bolt	PT Plug (PT Thread)	PO Plug (PF Thread)	Hex Socket Head Setscrew
Allen wrench 	4	O	M5	BP-1/16		M8
	5	O	M6	BP-1/8		M10
	6	O	M8	BP-1/4	PO-1/4	M12 M14
	17	O	M20 M22	BP-1	PO-1, 1 ¹ / ₄ , 1 ¹ / ₂	

Tool Name and Size		Necessary Tool	Part Name		
Name	B		Hex Headed Bolt	Hex Nut	VP Plug (PF Thread)
Double Ring Wrench, Socket Wrench, Double (Single) Open-end Wrench. 	19	O	M12	M12	VP-1/4
	24	O	M16	M16	
	30	O	M20	M20	
	36	O			VP-3/4
Adjustable Angle Wrench		O	Medium size, 1 set		
Screwdriver		O	Minus type screwdriver, medium size, 2 set		
Hammer		O	Plastic hammer, 1 set		
Retaining Ring Pliers		O	For retaining ring, TSR-160		
Steel Bar		O	Steel bar of key material approximately 10 x 8 x 200		
Torque Wrench		O	Capable of tightening with the specified torques		

Tightening Torque

Part Name	Size	Tightening Torque (kg.m)	Tool	
			Size (mm)	Name
Hex Socket Head Bolt (Material SCM435)	M5	0.7	B = 4	 Allen Wrench
	M6	1.2	5	
	M8	3	6	
	M10	5.8	8	
	M12	10	10	
	M14	16	12	
	M16	24	14	
	M18	34	14	
	M20	44	17	
PT Plug (Material S45C) Wind Seal Tape 1.5 - 2 Turns Around the Plug.	NPTF 1/16	1.2	4	Allen Wrench
	PT 1/16	0.7	4	
	PT 1/8	1.05	5	
	PT 1/4	1.75	6	
	PT 3/8	3.5	8	
	PT 1/2	5.0	10	
PF Plug (Material S45C)	PF 1/4	3.0	6	Allen Wrench
	PF 1/2	10	10	
	PF 3/4	15	14	
	PF 1	19	17	
	PF 1¼	27	17	
	PF 1½	28	17	

Removal



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Make the machine swing about 30° rightward on the flat ground as shown in (Figure 10) before lowering the all the attachments on the ground and then stop engine.

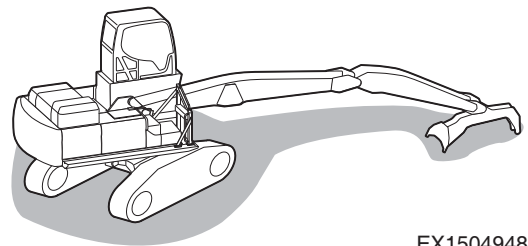


Figure 10

EX1504948

2. Move safety lever on "RELEASED" position. (Figure 11)
3. Turn starter switch to "I" (ON) position.



WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

4. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
5. Move safety lever to "LOCK" position. (Figure 11)
6. Turn key to "O" (OFF) position and remove from starter switch.
7. Hang a maintenance warning tag on controls.
8. Turn battery disconnect switch to "OFF" position. (Figure 12)

NOTE: *Removal (installation) procedure of the bolts.*

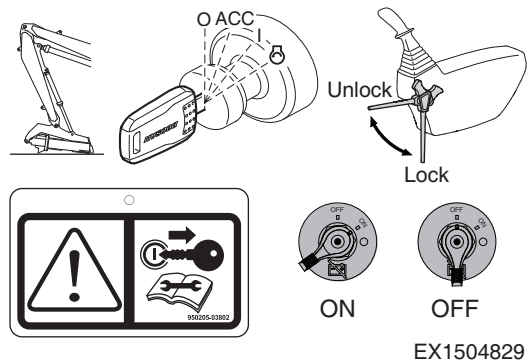


Figure 11

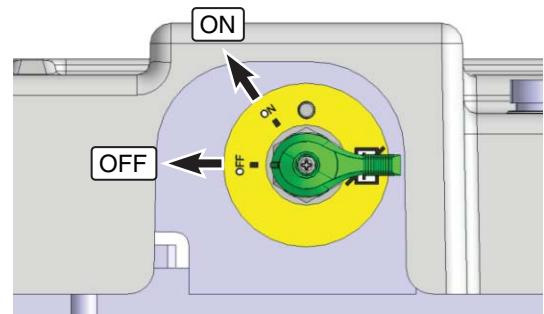


Figure 12

EX1504925

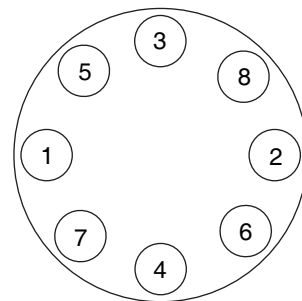


Figure 13

EX1401809



WARNING

AVOID DEATH OR SERIOUS INJURY


Release any pressure in the hydraulic oil tank before doing any work.

9. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank.


Pulling the breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.

10. Oil drain method

- A. Remove cover on oil tank (bolt: 6 ea) drain hydraulic oil using oil pump.

- Tool: 14 mm ()
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

- B. Drain hydraulic fluid using drain plug. (without oil pump)

- Tool: 27 mm ()
- Hydraulic oil tank capacity: approximately 280 L
- Torque: 93.2 N.m (9.5 kg.m, 68.7 ft lb)

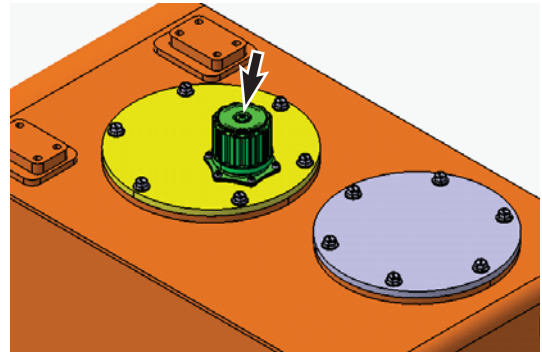


Figure 14

EX1403168

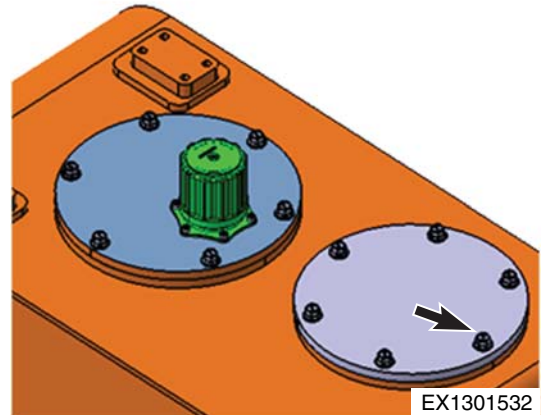


Figure 15

EX1301532

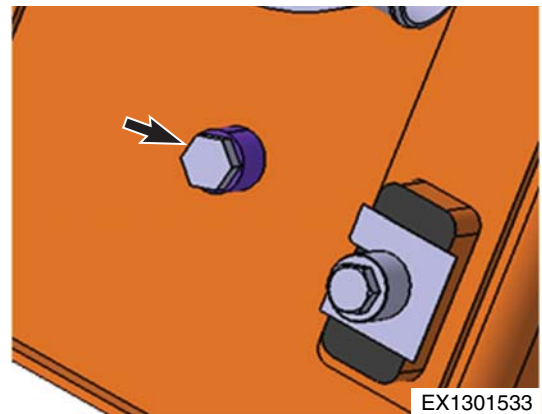
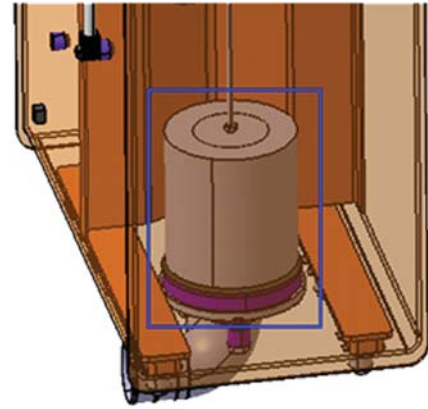


Figure 16

EX1301533

C. Plug the filter cap to location of suction filter.

Item	Part Number
Filter Cap	2188-1011



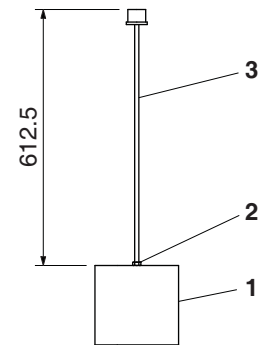
EX1301534

Figure 17

Reference Number	Description
1	Suction Filter
2	Nut
3	Rod

When install

- Torque (2 nut): 49 N.m (5 kg.m, 36.2 ft lb)

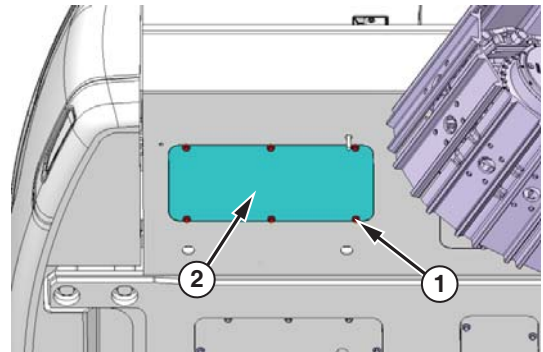


EX1301588

Figure 18

11. Remove bolt (11 ea) and remove under cover (2 ea) under pump side.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Cover weight: 22 kg (49 lb)



EX1505048

Figure 19

12. Remove bolt (6 ea) and remove engine cover of muffler side.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

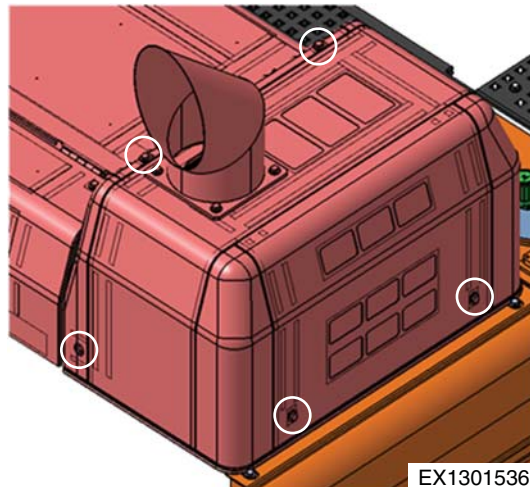


Figure 20

13. Disconnect the harness from SCR catalyst.

- Tool: 24 mm (🔧)

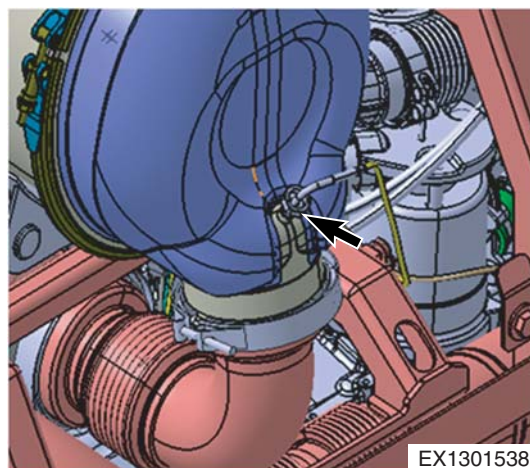


Figure 21

- Tool: 22 mm (🔧)

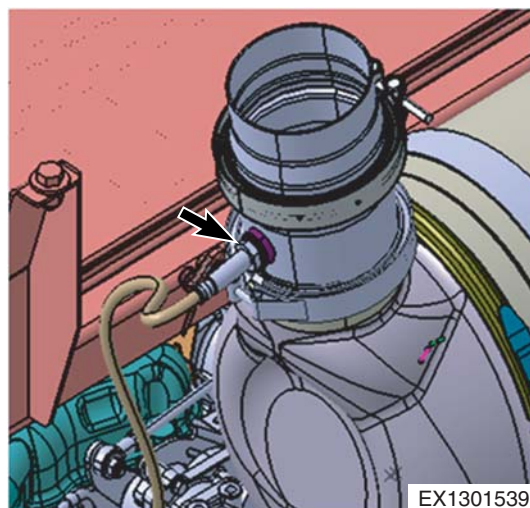


Figure 22

14. Disconnect the harness from DOC (Diesel Oxidation Catalyst) and hose connected UREA tank.

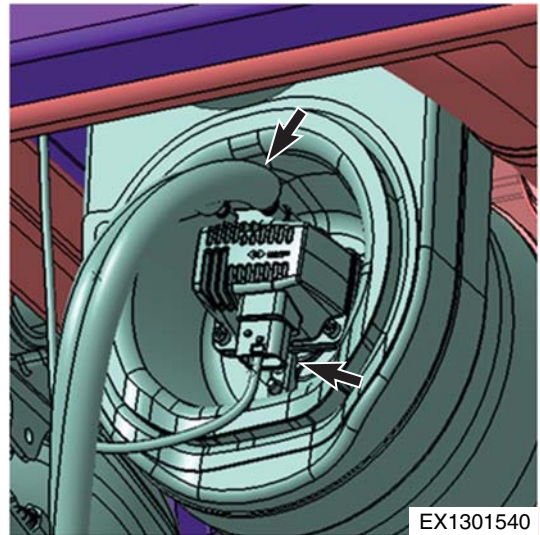


Figure 23

15. Open the clamp and remove SCR catalyst.

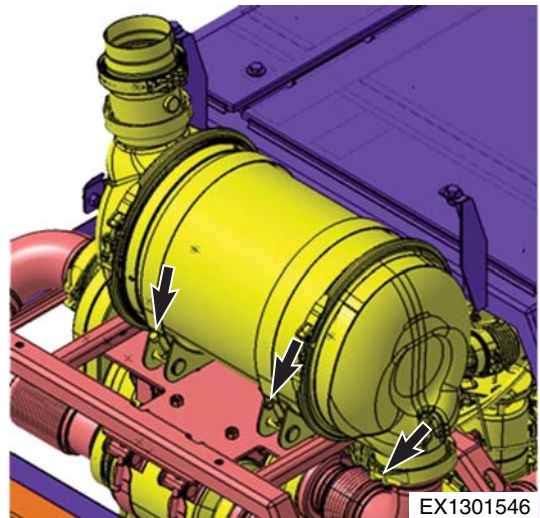


Figure 24

16. Open the clamp of DOC connected exhaust pipe.

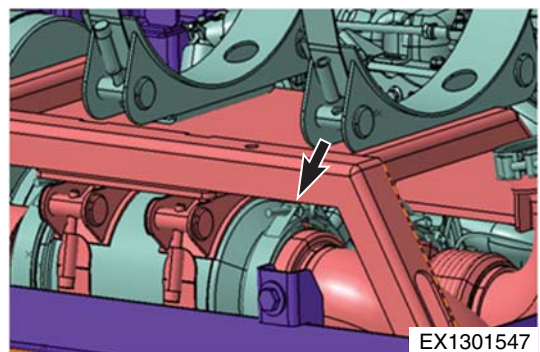


Figure 25

17. Remove bolt (4 ea) of SCR muffler mounting bracket, and then lift off all the parts assembled with muffler bracket.

- Tool: 10 mm (🔧)
- Weight: approximately 40 kg (88.2 lb)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

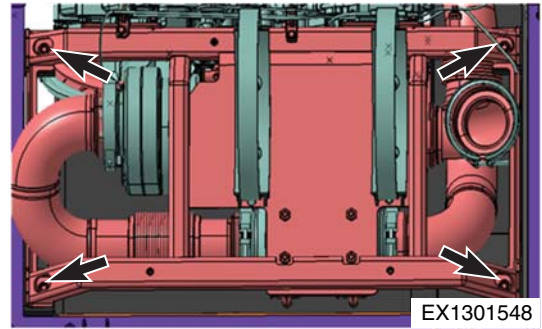


Figure 26

18. Remove bolt (4 ea) and remove right side door.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

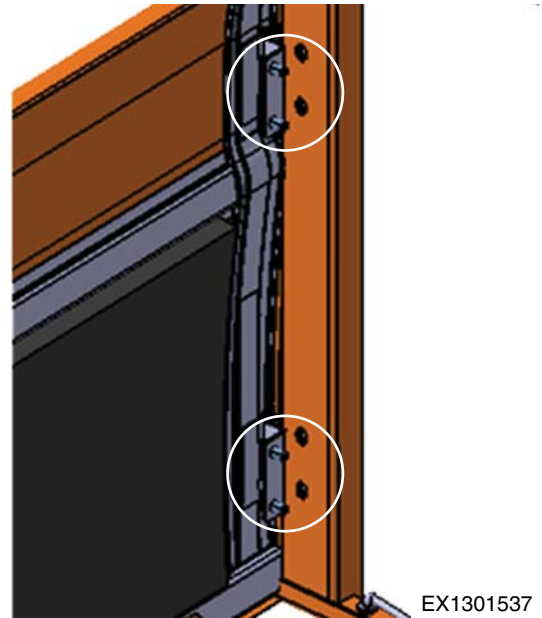


Figure 27

19. Remove bolts (6, Figure 28) (24 ea) related baffles, covers around pump and remove baffles and covers.

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Cover weight

Reference Number	Weight	
	kg	lb
1	4	8.8
2	7	15.4
3	2	4.4
4	0.73	1.6
5	3	6.6

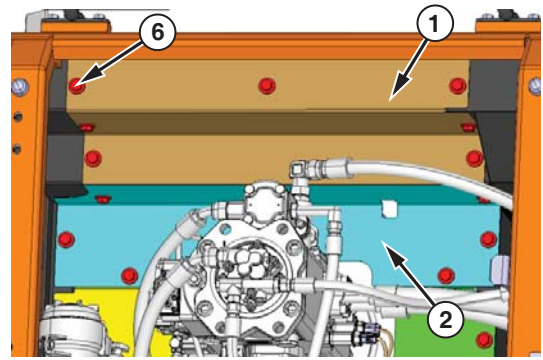


Figure 28 EX1505049

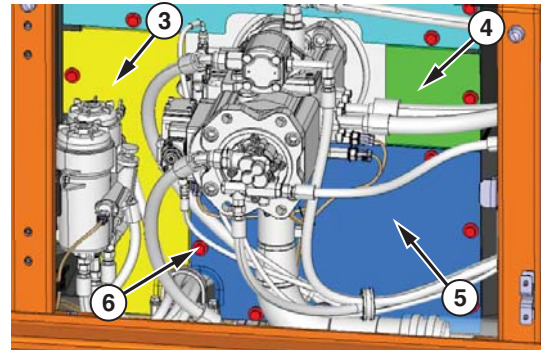


Figure 29 EX1505050

20. Disconnect the connector of main harness from EPPR valve and pressure sensor.

NOTE: *Be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

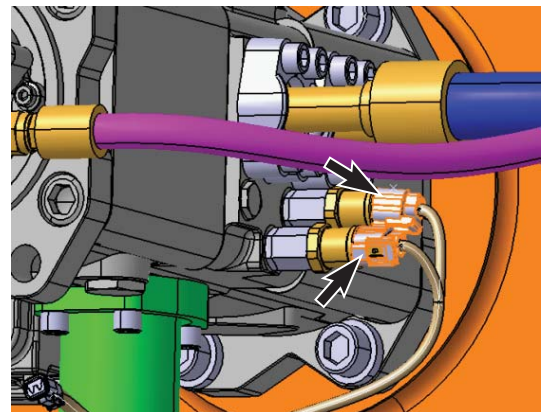


Figure 30 EX1301551

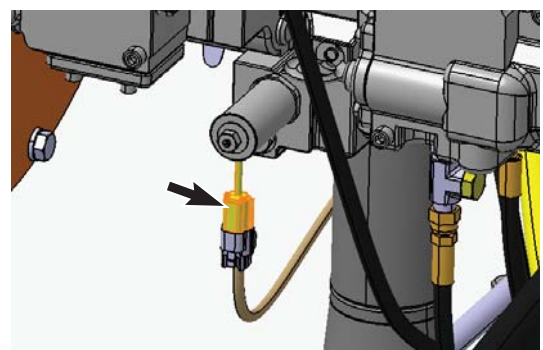


Figure 31 EX1302361


21. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.



Figure 32

EX1504170

22. Remove bolts (4 ea) and remove suction pipe of bottom of pump. Drain the hydraulic oil of suction pipe to bowl.

- Tool: 10 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

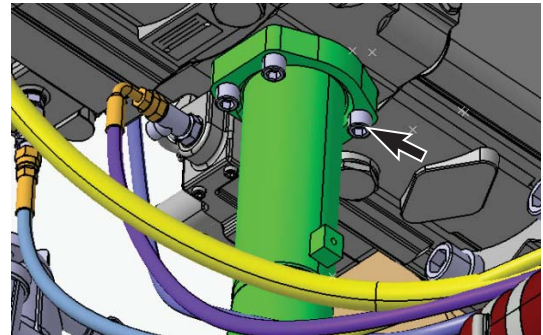


Figure 33

EX1301552

23. Disconnect the hoses from bottom to top of pump.

NOTE: After disconnecting hoses from pump, plug them to prevent dirt or dust from entering.

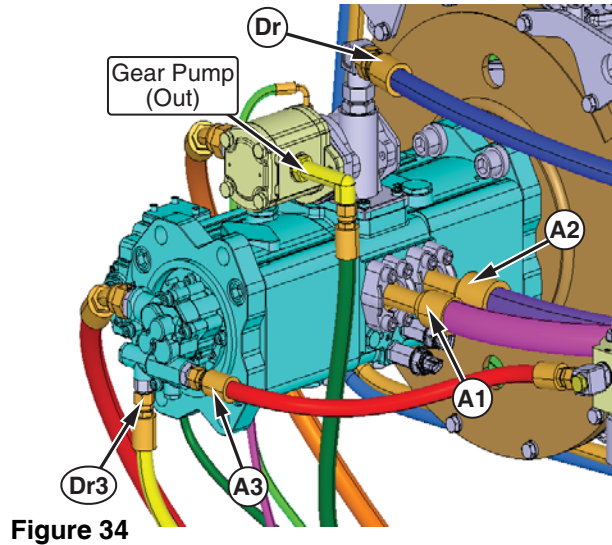
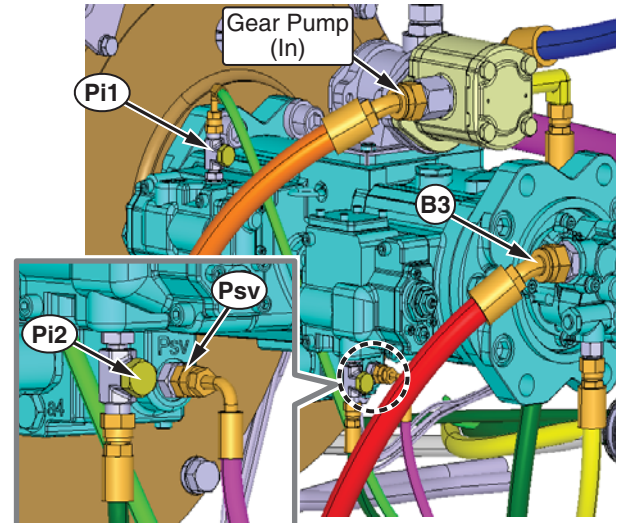
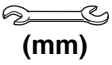



Figure 34

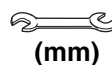


EX1505065

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	 (mm)	Torque		
					N.m	kg.m	ft lb
A1	to Control Valve "P1"	SAE 1"- 6000 psi, D25		10	107.9	11	79.6
A2	to Control Valve "P2"	SAE 1"- 6000 psi, D25		10	107.9	11	79.6
A3	to Pilot Filter	UNF 13/16"-16-2B	24		55.9	5.7	41.2
B3	from Suction Pipe	UNF 1 3/16"-12-2B	36		124.5	12.7	91.8
Dr	Drain (Oil Tank)	UNF 1 3/16"-12-2B	36		124.5	12.7	91.8
Dr3	Drain (Oil Tank)	UNF 13/16"-16-2B	24		55.9	5.7	41.2
Pi1	from Control Valve "ps1"	UNF 9/16"-18-2B	19		25.5	2.6	18.8
Pi2	from Control Valve "ps2"	UNF 9/16"-18-2B	19		25.5	2.6	18.8
Psv	from Pilot Filter	UNF 9/16"-18-2B	19		25.5	2.6	18.8
Gear pump (In)	from Suction Pipe	UNF 1 3/16"-12-2B	36		124.5	12.7	91.8
Gear pump (Out)	to One Spool Valve "P"	UNF 13/16"-16-2B	24		55.9	5.7	41.2

- Fitting

Port	Name	Plug/Flange Size (Hose)		 (mm)	Torque			
		A	B (C)		N.m	kg.m	ft lb	
A3	Adapter	PF 1/2"	UNF 13/16"-16	27	84.3	8.6	62.2	
B3	Adapter	PF 3/4"	UNF 1 3/16"-12	36	158.8	16.2	117.1	
Dr	Adapter	PF 3/4"	UNF 1 3/16"-12	36	158.8	16.2	117.1	
	Elbow	UNF 1 3/16"-12	UNF 1 3/16"-12	36	176.5	18	130.2	
Dr3	Adapter	PF 3/8"	UNF 13/16-16	22	44.1	4.5	32.5	
Pi1, Pi2	Adapter	PF 1/4"	PF 1/4"	19	35.3	3.6	26.0	
Psv	Adapter	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0	
Gear pump (In)	Adapter	PF 3/4"	UNF 1 3/16"-12	36	158.8	16.2	117.1	
Gear pump (Out)	Elbow	PF 1/2"	UNF 13/16"-16	27	84.3	8.6	62.2	
A1, A2	O-ring	DS2856003 (1", ID:33.2, OD:40.2, 1B)						
A3		S8000185 (4D P18)	S8030081 (1B F-08)					
A3		S8000185 (4D P18)	S8030081 (1B F-08)					
B3		S8000241 (1B P24)						
Dr		S8000241 (1B P24)	S8030125 (4D F-12)					
Dr3		S8000145 (4D P14)						
Pi1, Pi2, Psv		S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)					
Gear pump (In)		S8000235 (4D P22.4)	S8030125 (4D F-12)					
Gear pump (Out)		S8000185 (4D P18)	S8030081 (1B F-08)					

* A: Opposite side of hose, B (C): Hose side

24. Remove bolts (10 ea) of pump without top bolts (2 ea).

- Tool: 17 mm (🔧)
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

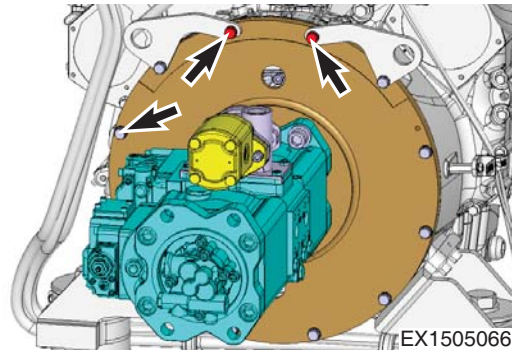


Figure 35

25. Attach a lifting device around pump. Raise the lifting device until the pump is supported prior to removing remaining bolts (2 ea).

- Weight (main pump + gear pump + PTO): about 176 kg (388 lb)

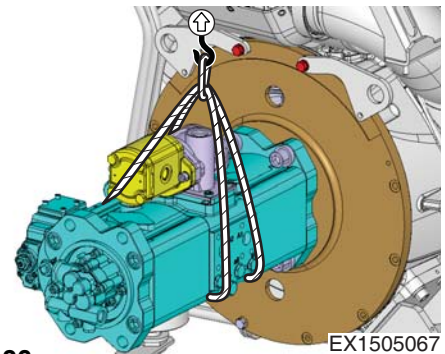


Figure 36

26. Remove remaining bolts (2 ea).

- Tool: 17 mm (🔧)
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)



CAUTION

AVOID INJURY

Be careful don't drop the pump.

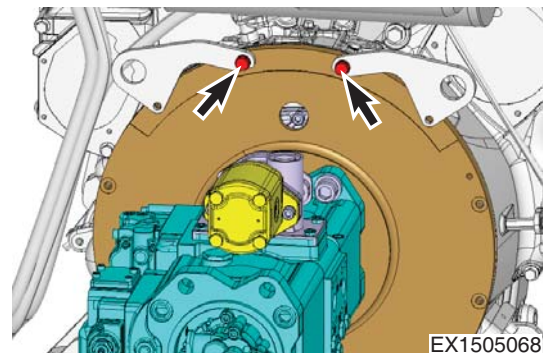


Figure 37

27. Lift the pump from engine slowly and carefully.

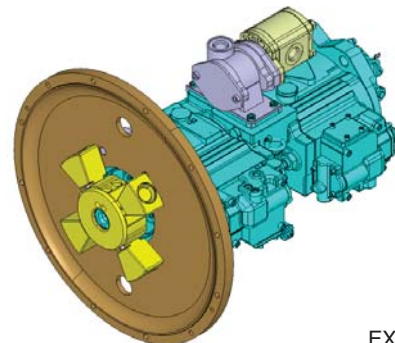


Figure 38

EX1505066

EX1505067

EX1505068

EX1505069

Installation

WARNING

INCORRECT INSTALLATION CAN CAUSE DEATH OR SERIOUS INJURY

Any change in the connections will lead to malfunctions (e.g. lift instead of lower).

- When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.
-

1. Perform installation in the reverse order to removal.
2. When installing the pump to engine, be careful assembling pump shaft and drive coupling. Refer to drive coupling installation.

Completing Work

1. If the hydraulic oil in the oil tank was removed, fill up the hydraulic oil tank.
-

IMPORTANT

Fill the oil tank with oil and maintain the temporary assembly condition of the adapter of the pump drain port. (Figure 39)

If oil comes out of the pump drain port, fully assemble the adapter.

- A. Start the engine and run at low idling.
- B. Operate the joystick lever and actuate the hydraulic cylinder 4 - 5 times very slowly, about 100 mm before the end of stroke.
- C. Operate the rod of cylinder to the end of stroke to relieve the hydraulic piping. (The air breather on oil tank is actuated to bleed the air)

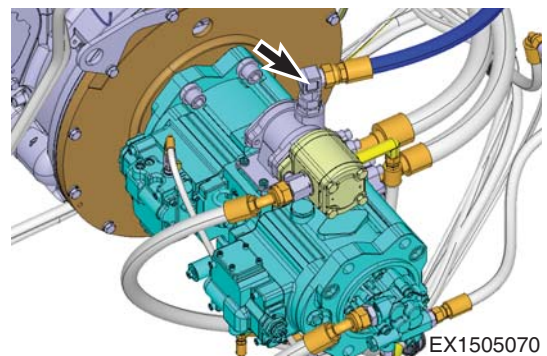


Figure 39

Disassembly

For disassembling the pump, read this section thoroughly and disassemble it in the following sequence. The figures in parentheses after part names show the items in Figure 6 construction of pump.

This maintenance manual describes the disassembling procedures for both the single pump and tandem type double-pump. Disassemble the pump, referring to the contents for its appropriate type.

In addition, for the double-pump, take care not to exchange parts from one pump with the same ones of the other pump.

1. Select place suitable to disassembling.

IMPORTANT

Select a clean place.

Spread a rubber mat or cloth on top of the overhaul workbench to prevent parts from being damaged.

2. Remove dust, rust, etc., from pump surface with cleaning oil or equivalent.
3. Remove drain port plug (468) and drain oil from pump casing.

IMPORTANT

For tandem type pump, remove plugs from both front and rear pumps.

4. Remove hex socket head bolts (412 and 413) and regulator.
5. Remove hex socket head bolts (401) which secure swash plate support (251), pump casing (271) and valve block (312).

IMPORTANT

If a gear pump is attached to rear face of pump, remove it before proceeding.

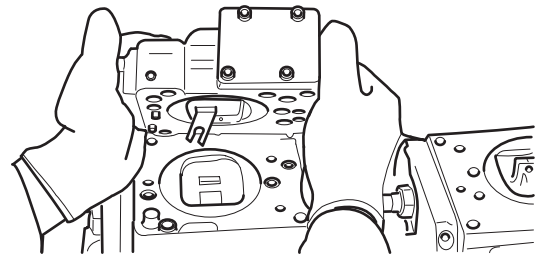


Figure 40

HDM3016P

- Place pump horizontally on workbench with its regulator-fitting surface down, and separate pump casing (271) from valve block (312).

IMPORTANT

Before laying this surface down, spread rubber mat on workbench to prevent this surface from being damaged.

- Pull cylinder (141) out of pump casing (271) straight over driveshaft (111). Pull out pistons (151), set plate (153), spherical bushing (156) and cylinder springs (157) simultaneously.

IMPORTANT

Do not damage sliding surfaces of cylinder, spherical bushing, shoes, swash plate, etc.

- Remove hex socket head bolts (406) and seal cover (F) (261).

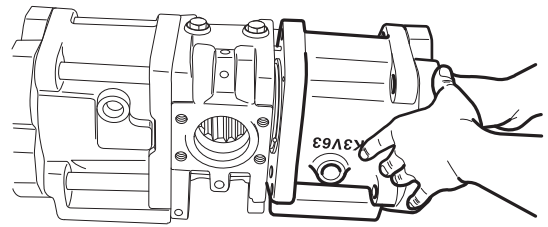
IMPORTANT

Install bolt into pulling-out tapped hole of seal cover (F), and cover can be removed easily.

Since oil seal is attached on seal cover (F), do not damage it when removing cover.

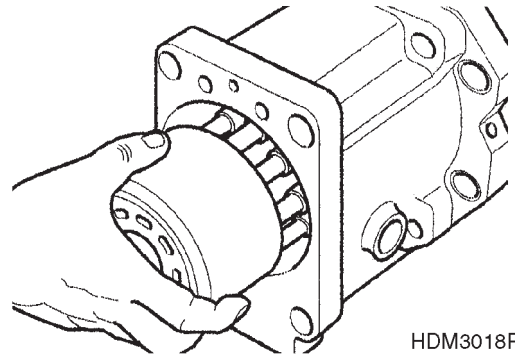
[In case fitting a gear pump, first, remove gear pump]

- Disengage swash plate (251) from pump casing (271) by gently striking the connecting flange part of swash plate at the shaft of pump casing with plastic hammer.



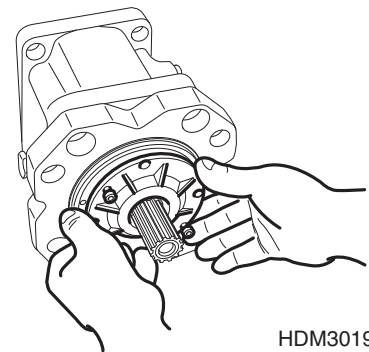
HDM3017L

Figure 41



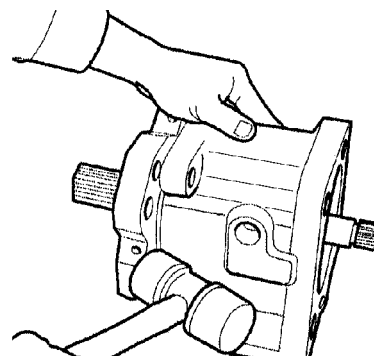
HDM3018P

Figure 42



HDM3019L

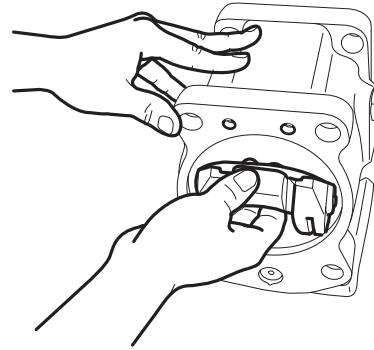
Figure 43



HDM3020P

Figure 44

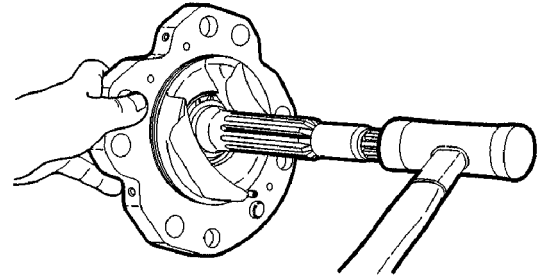
10. Remove shoe plate (211) and swash plate (212) from pump casing (271).



HDM3021L

Figure 45

11. Remove driveshaft from the swash plate support by gently striking the end of driveshafts (111, 113) with plastic hammer.



HDM3022P

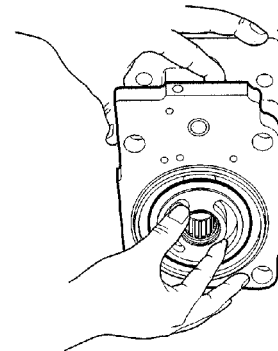
Figure 46

12. Remove valve plates (313 and 314) from valve block (312).

IMPORTANT

These may be removed in step 6.

13. If necessary, remove stopper (L) (534), stopper (S) (535), servo piston (532) and tilting pin (531) from pump casing (271). Remove needle bearing (124) and splined coupling (114) from valve block (312).



HDM3023P

Figure 47

IMPORTANT

When removing tilting pin, use a protector to prevent pin head from being damaged.

Since Loctite is applied to mounting areas of tilting pin and servo piston, do not damage servo piston.

Do not remove needle bearing if possible, except when it is considered to be worn out.

Do not loosen hex nuts of valve block and swash plate support. If loosened, flow setting will be changed.

Reassembly

For reassembling reverse the disassembling procedures, paying attention to the following items.

- A. Do not fail to repair parts damaged during disassembling, and prepare replacement parts in advance.
 - B. Clean each part fully with cleaning oil and dry it with compressed air.
 - C. Do not fail to apply clean oil to sliding sections, bearings, etc. before assembling them.
 - D. Replace seal parts, such as O-rings, oil seals, etc.
 - E. For fitting bolts, plug, etc., tighten them with torques shown in "Tightening Torque" on page 15.
 - F. For double-pump, take care not to exchange parts of the front pump with those of the rear pump.
1. Install swash plate support (251) in pump casing (271) by gently striking it with plastic hammer.

IMPORTANT

After servo piston, tilting pin, stopper (L) and stopper (S) are removed, install them on pump casing in advance for reassembling.

When tightening servo piston and tilting pin, use a protector to prevent tilting pin head and feedback pin from being damaged. In addition, apply Loctite (medium strength) to their threaded sections.

2. Place pump casing with its regulator-fitting surface down, fit tilting bushing of swash plate to tilting pin (531), and fit swash plate (212) to swash plate support (251) correctly.

IMPORTANT

Confirm with fingers of both hands that swash plate can be moved smoothly.

Apply grease to sliding sections of swash plate and swash plate support, so driveshaft can be easily installed.

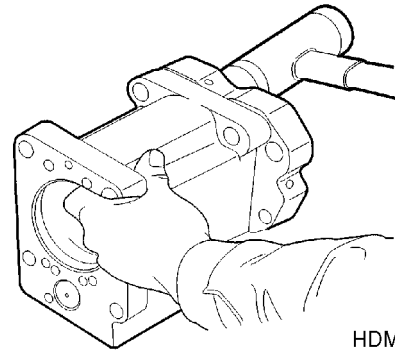


Figure 48

HDM3024P

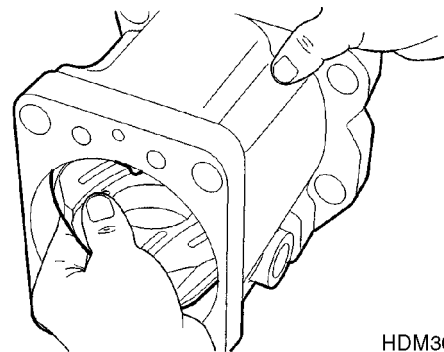


Figure 49

HDM3025P

3. On swash plate support (251), secure driveshaft (111), set bearing (123), bearing spacer (127) and retaining ring (824).

IMPORTANT

Do not tap driveshaft with hammer.

Use a plastic hammer to gently strike the rim of bearing to insert it and use a steel rod to insert it up to the end firmly.

4. Assemble seal cover (F) (261) to pump casing (271) and secure it with hex socket head bolts (406).

IMPORTANT

Lightly apply grease to oil seal in seal cover (F).

Assemble oil seal, taking full care not to damage it.

5. Assemble piston cylinder subassembly [cylinder (141), piston subassembly (151 and 152), set plate (153), spherical bushing (156) and cylinder spring (157)].

Align spline of retainer and cylinder.

Insert piston cylinder subassembly into pump casing.

6. Position valve plate (313) to valve block (312), entering pin into pinhole.

IMPORTANT

Do not mistake suction/delivery directions of valve plate.

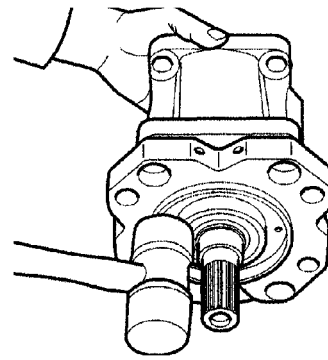


Figure 50

HDM3026P

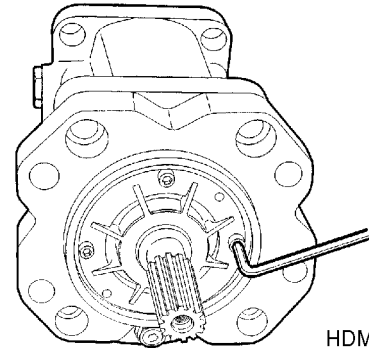


Figure 51

HDM3027P

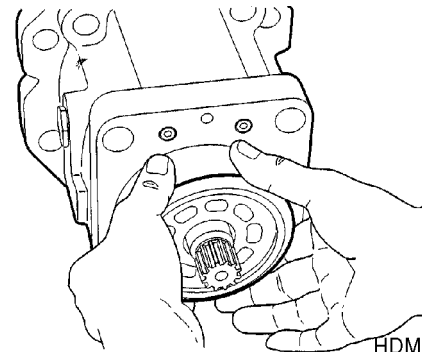


Figure 52

HDM3028P

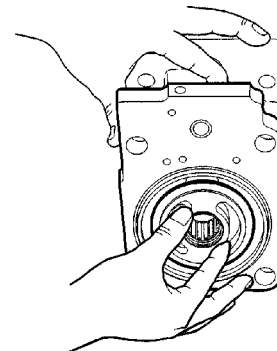


Figure 53

HDM3029P

7. Position valve block (312) in pump casing (271) and tighten hex socket head bolts (401).

IMPORTANT

Assemble the rear pump side first, to make the procedure easier.

Do not mistake direction of valve block.

Clockwise rotation (viewed from input shaft side) - Install block with regulator up and with delivery flange left, viewed from front side.

Counterclockwise rotation (viewed from input shaft side) - Install block with regulator up and with delivery flange right, viewed from front side.

8. Place feedback pin on tilting pin into feedback lever in regulator. Attach regulator with hex socket head bolts (412 and 413).

IMPORTANT

Do not mistake regulator of front pump for that of rear pump.

9. Install drain port plug (468).

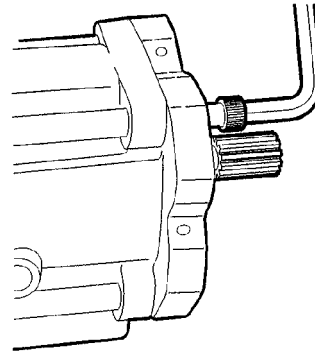


Figure 54

HDM3030P

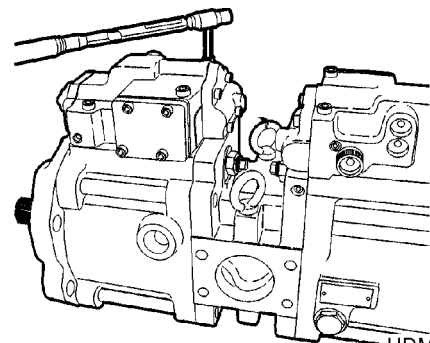


Figure 55

HDM3031P

Troubleshooting

General Caution

This section describes the countermeasures to be taken if any abnormality is detected during the operation of pump.

General caution must be taken as follows:

1. Judge the nature of the abnormality before starting work. Determine if the problem in the circuit is caused by the regulator, attached valves, or pump.
2. Read and understand the maintenance manual before disassembling and follow the disassembling procedures.
3. When a section is disassembled, work in a clean area and do not allow dust or debris to enter the pump.
4. Since the parts are finely finished, handle them carefully to prevent damage.

Check the Casing of the Pump for Abnormalities

The pump is often fitted with a regulator, accessory valves and associated pump. It can be difficult to find the cause of the failure. Investigate the following items, and the abnormal point will be revealed.

1. Check filter and drain oil.
Check filters for excessive amounts of abnormal impurities. Since the shoes and cylinder may give off worn metal particles, a small quantity may be detected there. However if an excessive amount of metal particles is found in the filters, the shoes may be damaged. Similarly, check drain oil in the pump casing
2. Existence of abnormal noises or vibrations.
Check the pump for abnormal noises and vibrations. If any, investigate whether a noise is in the regular frequency, such as hunting of the regulator or the relief valve of an accessory valve. If it is an abnormal vibration or noise, it may be the result of cavitation or damage inside the pump.
3. Case in which two pumps are used.
For the circuit with two single pumps or motors or for the duplex pump, exchange the piping of one pump with that of the other one. With the results of this exchange, it will be determined if the trouble is the problem of the circuit downstream from the pump or not.
4. Pressure measurement at various points.
If the failure is in a casing, do not unnecessarily open the pump to check, but measure pressures at various areas to investigate the abnormal position.

Overload of Prime Mover

No.	Possible Cause	Remedy	Remark
1	Is the speed pressure higher than their specified values?	Set them as specified.	
2	Is the torque setting of the regulator not high enough?	Reinvestigate the regulator.	See the instruction manual of the regulator.
3	Seizure or damage of a part inside the pump.	Replace the damaged part.	Check the filter and drain oil for abnormal worn metal particles.
4	Wrong installation of the regulator piping	Correct the regulator piping.	

Extreme Decrease of Pump Delivery Flow and No Increase of Delivery Pressure

No.	Possible Cause	Remedy	Remark
1	Failure of the regulator.	Repair the regulator.	See the instruction manual of the regulator.
2	Seizure or damage of a part inside the pump.	Replace the damaged part.	Check the filters and drain oil.
3	Failure of the accessory valve.	Check the accessory valves, especially the poppets, seats and springs.	See the instruction manual of the accessory valves.
4	Wrong installation of the regulator piping.	Correct the regulator piping.	

Abnormal Noises and Abnormal Vibrations

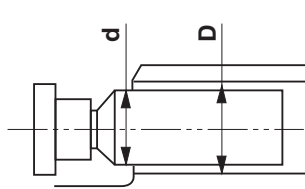
No.	Possible Cause	Remedy	Remark
1	Cavitation	Prevent cavitation. Check working oil for emulsion.	1. Low boost press. 2. Failure of the associated pump. 3. Air inflow through the suction pipe. 4. Increased suction resistance.
2	Damage in the swaging (caulking suction) of the shoe.	Replace the piston, shoe, shoe plate, etc.	
3	Damage of the cylinder block.	Replace the cylinder block.	
4	Wrong installation of the pump.	Correct installation.	
5	Hunting of the regulator.	Repair the regulator.	See the instruction manual for the regulator.
6	Hunting of the relief valve of the accessory valve.	Repair the accessory valve.	See the instruction manual for the accessory valve.

Maintenance Instructions

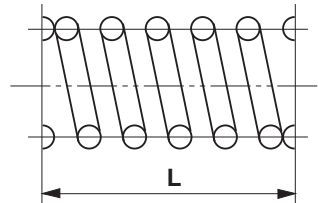
Replacement Standard of Worn Parts

When a part exceeds any of the following criteria, replace or readjust it. Always replace a part when it appears seriously damaged.

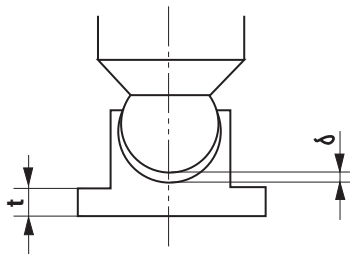
Part Name and Inspection Item	Standard Dimension/ Recommended Replacement Value	Countermeasures
Clearance between piston and cylinder bore (D-d)	0.043 / 0.070	Replace piston or cylinder.
Play between piston and shoe caulking section (δ)	0 - 0.1 / 0.3	Replace assembly of piston and shoe.
Thickness of shoe (t)	4.9 / 4.7	Replace assembly of piston and shoe.
Free height of cylinder spring (L)	41.1 / 40.3	Replace cylinder spring.
Combined height of set plate and spherical bushing (H-h)	23.0 / 22.0	Replace retainer or set plate.



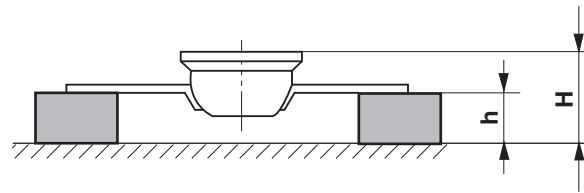
Clearance between Piston & Cylinder Bore : D-d



Free Height of Cylinder Spring : L



Play between Piston & Shoe : δ
Thickness of Shoe : t



Combined Height of Set Plate & Spherical Bush : H-h

EX1401737

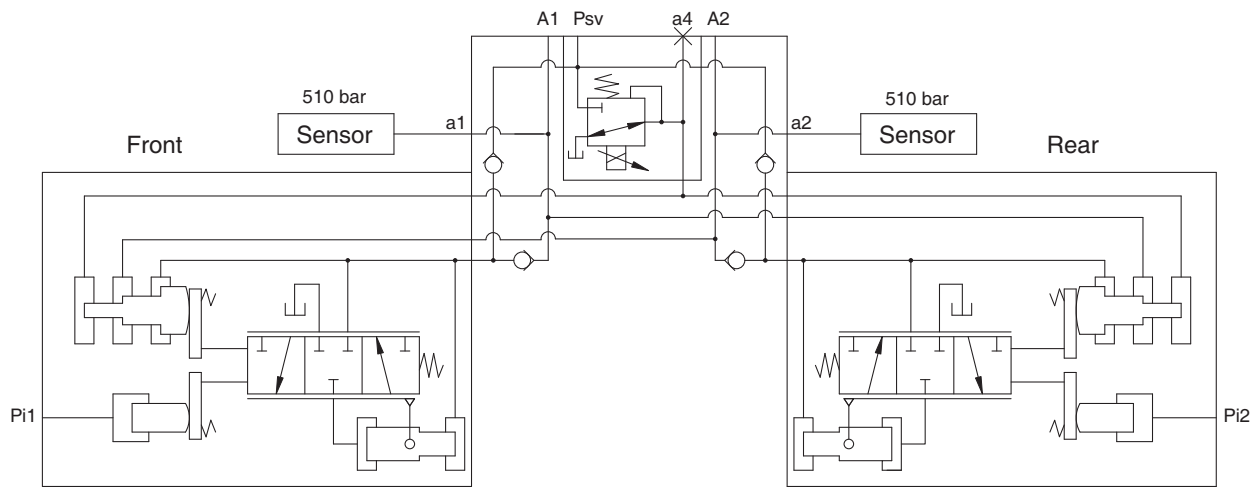
Figure 56

Correction Criteria for Cylinder, Valve Plate and Swash Plate (Shoe Plate)

Surface roughness for valve plate (sliding face), swash plate (shoe plate area) and cylinder (sliding face)	Surface roughness necessary to be corrected.	3-Z
	Standard surface roughness (Corrected value).	0.4-Z or lower (Lapping)

REGULATOR

Port and Hydraulic Circuit



EX1301333

Figure 57

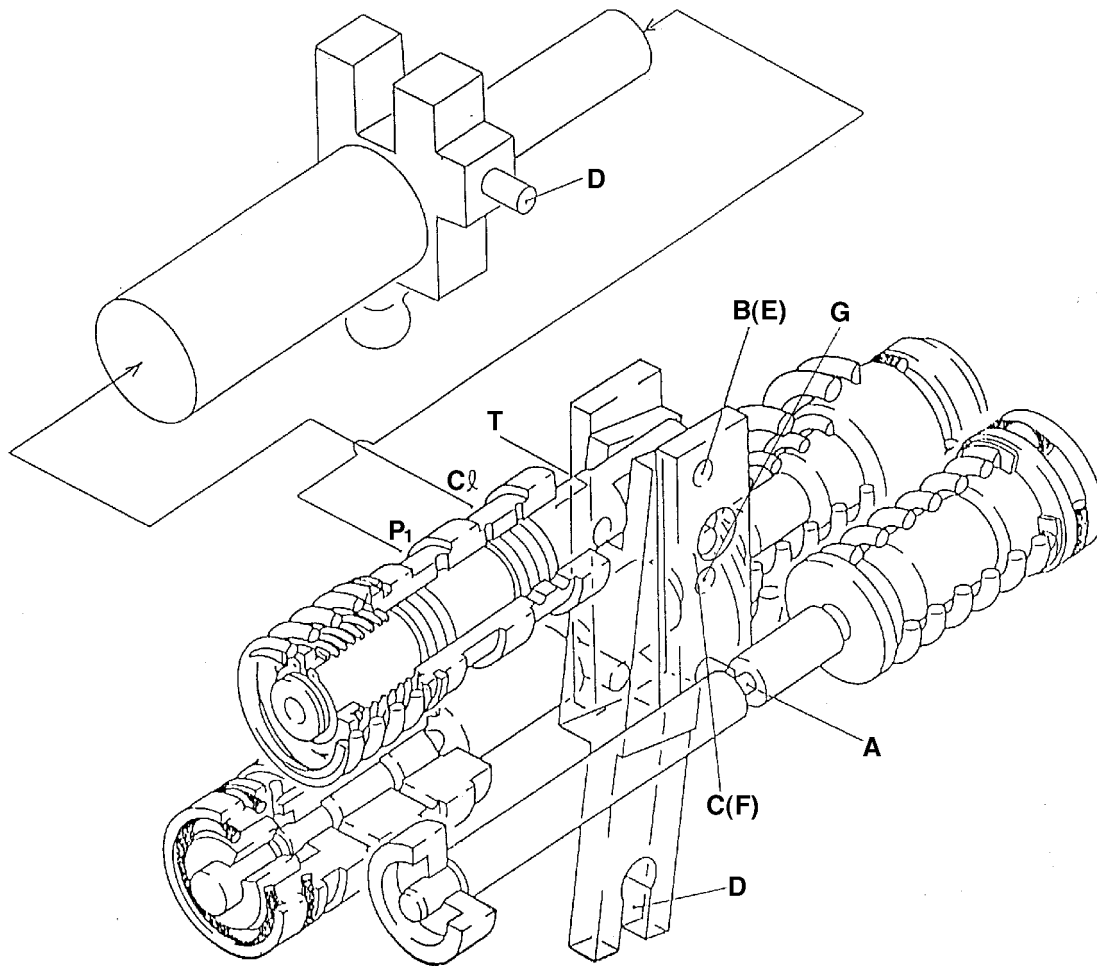
Symbol	Port Name	Port Size	Location
Pi1, Pi2	Pilot	PF 1/4	Regulator
a1, a2	Pressure Sensor	PF 3/8	Body
Psv	Servo Assist	PF 1/4	EPPR Valve Block

Functional Explanation

The regulator for in-line axial piston pump consists of the following control functions.

1. Negative flow control
2. Total cumulative horsepower control
3. Variable horsepower control

Regulator Function Diagram



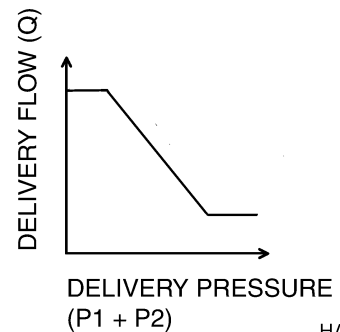
ARS0390S

Figure 58

Negative Flow Control

By changing the pilot pressure P_i , the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in Figure 59.

This regulator is a negative flow control in which the delivery flow Q decreases as the pilot pressure P_i rises. With this mechanism, when the pilot pressure corresponding to the flow required for the work is commanded, the pump discharges the required flow only, so it does not consume unnecessary power.



HAAD4140

Figure 59

Functional Explanation

1. Flow reducing function

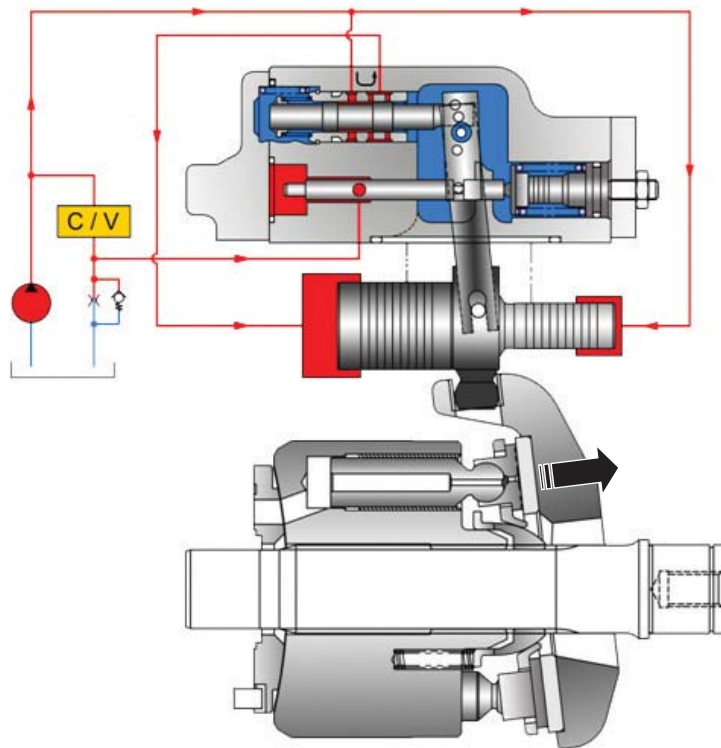


Figure 60

EX1400002

As the pilot pressure P_i rises, the pilot piston (643) moves to the right to a position where the force of the pilot spring (646) balances with the hydraulic force.

The groove (A) in the pilot piston is attached with pin (875) that is fixed to lever 2 (613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point B (fixed by the fulcrum plug (614) and pin (875)). Since the large-hole section (C, Figure 58) of lever 2 contains a protruding pin (897) fixed to the feedback lever (611), the pin (897) moves to the right as lever 2 rotates. Since the opposing-flat section (D) of the feedback lever is attached with the pin (548) fixed by the tilting pin (531) that swings the swash plate, the feedback lever rotates around the fulcrum of point D, as the pin (897) moves. Since the feedback lever is connected with the spool (652) by the pin (874), the spool moves to the right.

The movement of the spool causes the delivery pressure P_1 to connect to port C liter through the spool and to be admitted to the large-diameter section of the servo position. The delivery pressure P_1 that is constantly admitted to the small-diameter section of the servo piston moves the servo piston to the right because of the area difference, resulting in decrease of the tilting angle.

When the servo piston moves to the right, point D also moves to the right. The spool is fitted with the return spring (654) and is tensioned to the left at all times, and so the pin (897) is pressed against the large-hole section (C) of lever2. Therefore, as point D moves, the feedback lever rotates around the fulcrum of point C, and the spool is shifted to the left. This causes the opening between the sleeve (651) and spool (652) to close slowly, and the servo piston comes to a complete stop when it closes completely.

2. Flow Increasing function

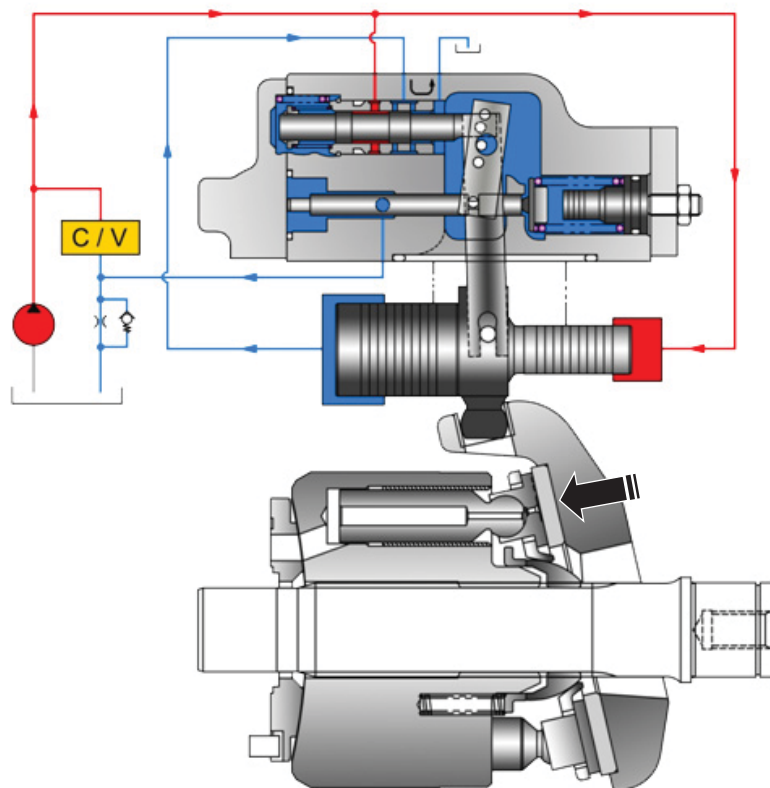


Figure 61

EX1400003

As the pilot pressure P_i decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point B. Since the pin (897) is pressed against the large-hole section (C) of lever 2 by the action of the return spring (654) by the spool (652), pin (874), and feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 2 rotates, and shifts the spool to the left. Port C liter opens a way to the tank port as the spool moves. This deprives the large-diameter section of the servo piston of pressure, and shifts the servo piston to the left by the discharge pressure P_1 in the small-diameter section, resulting in an increase in the flow rate.

As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

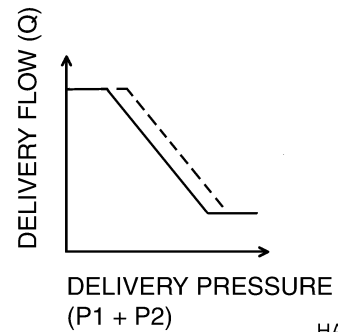
Adjustment of Flow Control Characteristic

The flow control characteristic can be adjusted with the adjusting screw.

Adjust it by loosening the hex nut (801) and by tightening (or loosening) the hex socket head screw (924).

Tightening the screw shifts the control chart to the right as shown in the Figure 62.

NOTE: *Adjusting values are shown in the attached Table. See "Summary of Regulator Adjustment Values" on page 46.*



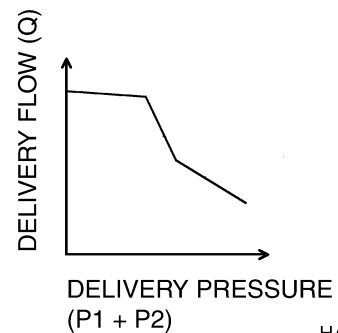
HAAD4130

Figure 62

Total Horsepower Control

The regulator decreases the pump tilting angle (delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P1 of the self pump and the delivery pressure P2 of the companion pump. (The input horsepower is constant when the speed is constant.)

Since the regulator is of the simultaneous total horsepower type that operates by the sum of load pressures of the two pumps in the tandem double-pump system, the prime mover is automatically prevented from being overloaded, irrespective of the load condition of the two pumps, when horsepower control is under way.



HAAD4110

Figure 63

Functional Explanation

Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles (displacement volumes) of the two pumps to the same values as represented by the following equation:

- $T_{in} = P1 \times q/2\pi + P2 \times q/2\pi = (P1 + P2) \times q/2\pi$

The horsepower control function is the same as the flow control function and is summarized in the following. (For detailed behaviors of respective parts, refer to the section of flow control).

1. Overload preventive function

When the self pump delivery pressure P1 or the companion pump delivery pressure P2 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force. The movement of the compensating rod is transmitted to Lever 1 by pin (875). Lever 1 rotates around the pin (875) (E) attached to the casing (601).

Since the large-hole section (F) of Lever 1 contains a protruding pin (897) attached to the feedback lever (611), the feedback lever rotates around the fulcrum of Point D as Lever 1 rotates, and then the spool (652) is shifted to the right.

As the spool moves, the delivery pressure P1 is admitted to the large-diameter section of the servo piston by Port C liter, causes the servo piston move to the right, reduces the pump delivery flow rate, and prevents the prime mover from being overloaded.

The movement of the servo piston is transmitted to the feedback lever by point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool and sleeve (651) is closed.

2. Flow Reset Function

As the self pump delivery pressure P1 or the companion pump delivery pressure P2 decreases, the compensating rod (623) is pushed back by the action of the springs (625 and 626) to rotate Lever 1 around point E. Rotating of Lever 1 causes the feedback lever to rotate around the fulcrum of point D and then the spool to move to the left. As a result, Port C liter opens a way to the tank port. This causes the servo piston to move to the left and the pump's delivery rate to increase.

The movement of the servo piston is transmitted to the spool by the action of the feedback mechanism to move it till the opening between the spool and sleeve is closed.

Low Tilting Angle (Low Flow) Command Preferential Function

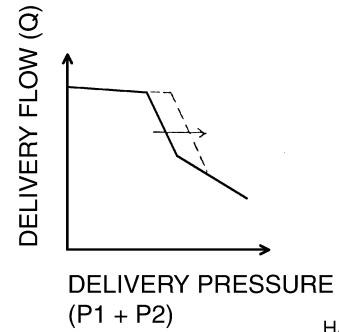
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool by the large-hole sections (C and F) of levers 1 and 2. However, since sections C and F have the pins ($\varnothing 4$) protruding from the large hole ($\varnothing 8$), only the lever lessening the tilting angle contacts the pin (897); the hole ($\varnothing 8$) in the lever of a larger tilting angle command is freed without contacting the pin (897). Such a mechanical selection method permits preference of the lower tilting angle command of the flow control and horsepower control.

Adjustment of Input Horsepower

Since the regulator is of total cumulative horsepower type, adjust the adjusting screws of both the front and rear pumps, when changing the horsepower set values. The pressure change values by adjustment are based on two pumps pressurized at the same time, and the values will be doubled when only one pump is loaded.

1. Adjustment of outer springs

Adjust it by loosening the hex nut (630) and by tightening (or loosening) the adjusting screw C (628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the Figure 64. Since turning the adjusting screw C by N turns changes the setting of the inner spring, return the adjusting screw CI (925) by NxA turns at first.

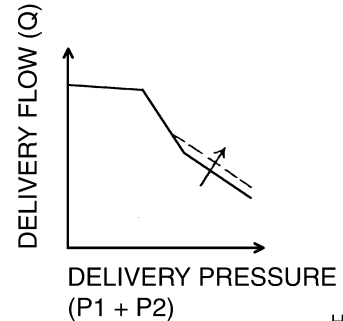


HAAD4090

Figure 64

2. Adjustment of inner spring

Adjust it by loosening the hex nut (801) and by tightening (or loosening) the adjusting screw CI (925). Tightening the screw increases the flow and then the input horsepower as shown in the Figure 65.



HAAD4100

Figure 65

Variable Horsepower Control

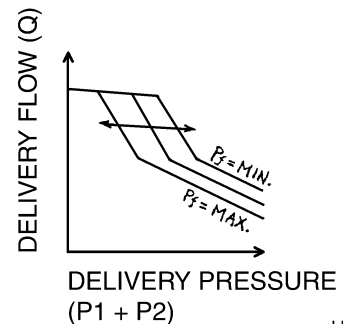
The set horsepower valve is shifted by varying the command current level of the proportional pressure reducing valve attached to the pump.

Only one proportional pressure reducing valve is provided. However, the secondary pressure Pf (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level. This function permits arbitrary setting of the Pump output power, thereby providing the optimum power level according to the operating condition.

Functional Explanation

The power shift pressure Pf controls the set horsepower of the pump to a desired level, as shown in the Figure 66.

As the power shift pressure Pf rises, the compensating rod (623) moves to the right by the pin (898) and compensating piston (621). This decreases the pump tilting angle and then the set horsepower in the same way as explained in the overload preventive function of the horsepower control. On the contrary, the set horsepower rises as the power shift pressure Pf falls.



HAAD4120

Figure 66

Adjustment

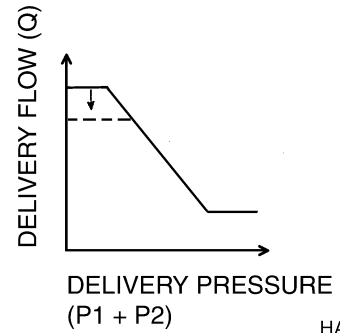
Adjustment of Maximum and Minimum Flows

The regulator can adjust the maximum and minimum flows with the adjusting screws.

NOTE: *Their respective adjustment values are shown in the attached Table. See "Summary of Regulator Adjustment Values" on page 46.*

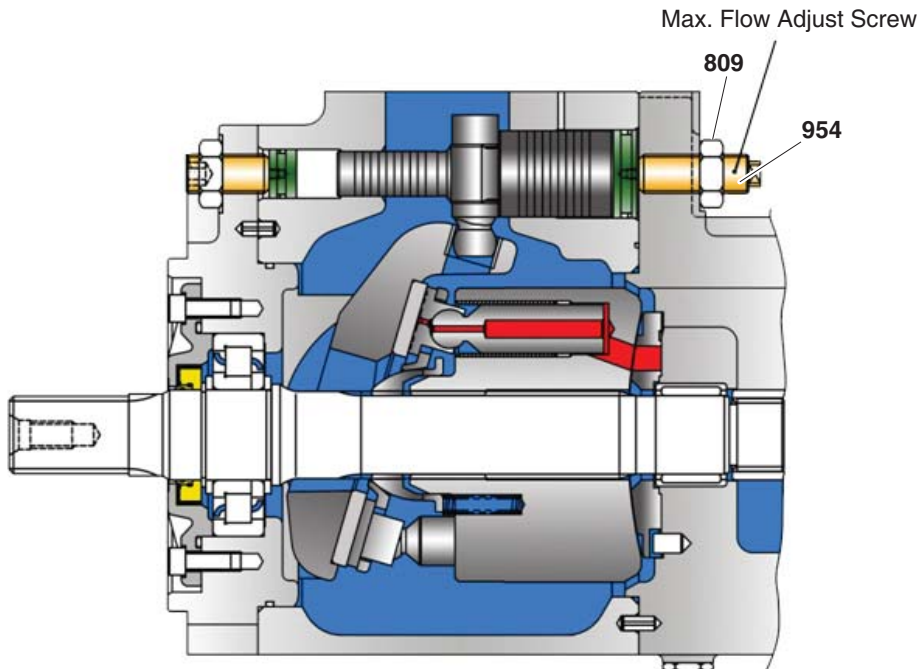
Adjustment of Maximum Flow

Adjust it by loosening the hex nut (809) and by tightening (or loosening) the set screw (954). The maximum flow only is adjusted without changing other control characteristics.



HAAD4150

Figure 67

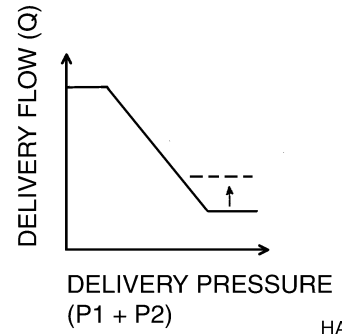


EX1400005

Figure 68

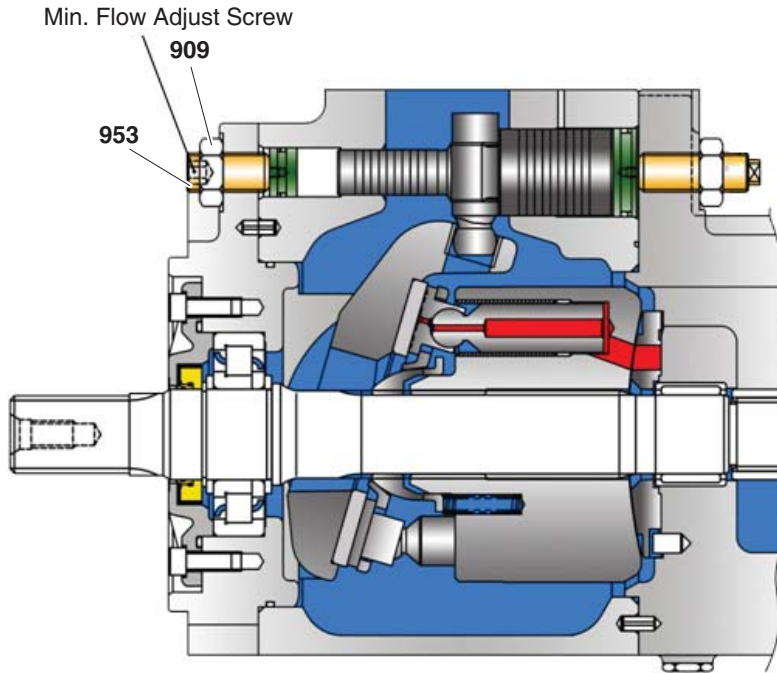
Adjustment of Minimum Flow

Adjust it by loosening the hex nut (909) and by tightening (or loosening) the hex socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed. However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure (or during relieving) may increase.



HAAD4160

Figure 69



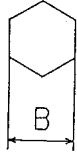
EX1400004

Figure 70

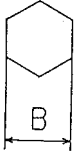
Summary of Regulator Adjustment Values

Item		Specification	
Speed		1,900 min ⁻¹	
Adjustment of Maximum Flow		Tightening amount of adjusting screw (954).	+1/4 Turn
		Flow change amount.	-5.9 lpm
Adjustment of Minimum Flow		Tightening amount of adjusting screw (953).	+1/4 Turn
		Flow change amount.	+4.7 lpm
Adjustment of Input Horsepower	Adjustment of outer spring.	Tightening amount of adjusting screw (C) (628).	+1/4 Turn
		Compensating control starting pressure change amount.	+19 bar
		Input torque change amount.	+6.9 kg.m
		A	1.9
	Adjustment of inner spring.	Tightening amount of adjusting screw (QI) (925).	+1/4 Turn
		Flow Change Amount	+11 lpm
		Input torque change amount.	+5.8 kg.m
Adjustment of flow control characteristic.		Tightening amount of adjusting screw (924).	+1/4 Turn
		Flow control starting pressure change amount.	+1.8 bar
		Flow change amount.	+15.4 lpm

Tightening Torque

Part Name	Size	Tightening Torque			Tool Name	
		Nm	kg.m	ft lb		
Hex socket head bolt (Material: SCM 435)	M 5	6.9	0.7	5.1	B = 4	 Allen wrench
	M 6	11.8	1.2	8.7	5	
	M 8	29.4	3	21.7	6	
	M 10	56.9	5.8	42	7	
	M 12	98.1	10	72.3	8	
	M 14	156.9	16	115.7	10	
	M 16	235.3	24	173.6	12	
	M 18	333.4	34	245.9	14	
	M 20	431.5	44	318.3	17	
PT filling plug (Material: S45C) Wind a seal tape 1 1/2 - 2 turns round the plug.	PT 1/16	6.9	0.7	5.1	4	Do.
	PT 1/8	10.3	1.05	7.6	5	
	PT 1/4	17.2	1.75	12.7	6	
	PT 3/8	34.3	3.5	25.3	8	
	PT 1/2	49	5	36.2	10	
PO plug (Material: S35C)	PF 1/4	29.4	3	21.7	6	Do.
	PF 1/2	98.1	10	72.3	10	
	PF 3/4	147.1	15	108.5	14	
	PF 1	186.3	19	137.4	17	
	PF 1 1/4	264.8	27	195.2	17	
	PF 1 1/2	274.6	28	202.5	17	

Tools

Name	Description
Allen Wrench	4, 5, 6 (Dimension B mm) 
Socket Wrench, Double-ended (Single-ended) Wrench	
Adjustable Wrench	Small size (max. 36 mm)
Screwdriver	
Plastic Hammer	
Torque Wrench	
Pliers	2 sets for retaining ring
Steel Bar	4 mm or less in dia., L=100 mm
Pincers	
Bolt	M4, L = about 50 mm

Reference Number	Description
412	Hex Socket Head Screw
413	Hex Socket Head Screw
436	Hex Socket Head Screw
438	Hex Socket Head Screw
496	Plug
531	Tilting Pin
548	Feedback Pin
601	Casing
611	Feedback Lever
612	Lever (1)
613	Lever (2)
614	Fulcrum Plug
615	Adjusting Plug
621	Compensating Piston
622	Piston Case
623	Compensating Rod
624	Spring Seat (C)
625	Outer Spring
626	Inner Spring
627	Adjusting Ring (C)
628	Adjusting Screw (C)
629	Cover (C)
630	Locknut
631	PF Sleeve
641	Pilot Cover
643	Pilot Piston
644	Spring Seat
645	Adjusting Ring (Q)
646	Pilot Spring
651	Sleeve

Reference Number	Description
652	Spool
653	Spring Seat
654	Return Spring
655	Set Spring
656	Block Cover
708	O-ring
722	O-ring
724	O-ring
725	O-ring
728	O-ring
730	O-ring
732	O-ring
733	O-ring
734	O-ring
735	O-ring
755	O-ring
756	O-ring
763	O-ring
801	Nut
814	Retaining Ring
836	Retaining Ring
858	Locking Ring
874	Pin
875	Pin
887	Pin
897	Pin
898	Pin
924	Adjusting Screw
925	Adjusting Screw (QI)

Disassembly

Cautions on Disassembly

Since the regulator consists of small precision finished parts, disassembly and assembly are rather complicated. For this reason, replacement of a regulator assembly is recommended, unless there is a special reason, but in case disassembly is necessary for an unavoidable reason, read through this manual to the end before starting disassembly.

NOTE: *The numbers in parentheses after part names represent those in the "Parts List".*

1. Choose a place for disassembly.

IMPORTANT

1. Choose a clean place.
 2. Spread rubber mat or cloth, on top of workbench to prevent parts from being damaged.
-
3. Remove dust, rust, etc. from surfaces of regulator with cleaning oil.
 4. Remove hex socket head screws (412,413) and regulator main body from pump main body.

IMPORTANT

Do not lose O-ring.

5. Remove hex socket head screws (488) and cover (C) (629).

IMPORTANT

Cover (C) is attached with adjusting screw (C), (QI) (628, 925), adjusting ring (C) (627), locknut (630), hex nut (801) and adjusting screw (924). Do not loosen these screws and nuts. If they are loosened, adjusted pressure flow setting will vary.

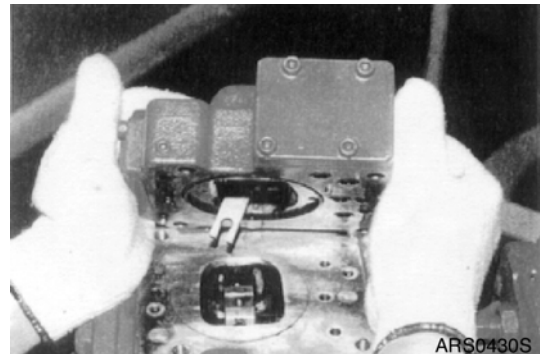


Figure 72

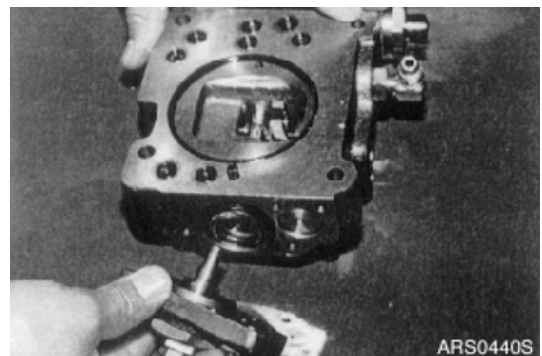


Figure 73

6. After removing cover (C) (629) subassembly, remove outer spring (625), inner spring (626) and spring seat (C) (624) from compensating section. Then draw out adjusting ring (Q) (645), pilot spring (646) and spring seat (644) from pilot section.

IMPORTANT

Adjusting ring (Q) (645) can easily be drawn out with M4 bolt.

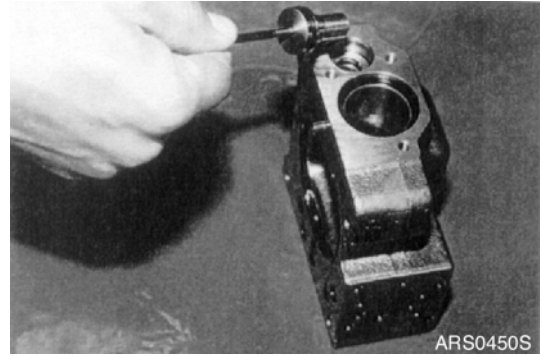


Figure 74

7. Remove hex socket head screws (436, 438) and pilot cover (641). After removing pilot cover, remove set spring (655) from pilot section.

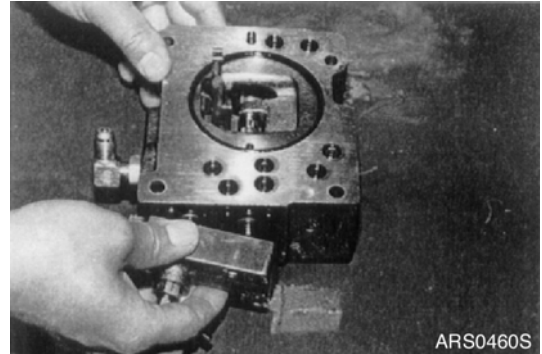


Figure 75

8. Remove retaining ring (814), spring seat (653), return spring (654) and sleeve (651).

IMPORTANT

Sleeve (651) is attached with retaining ring (836).

When removing retaining ring (814), return spring (654) may pop out. Take care not to lose it.



Figure 76

9. Remove locking ring (858), fulcrum plug (614) and adjusting plug (615).

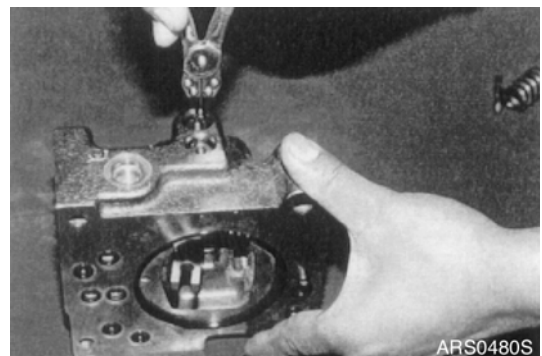


Figure 77

IMPORTANT

Fulcrum plug (614) and adjusting plug (615) can be easily taken out with M6 bolt.

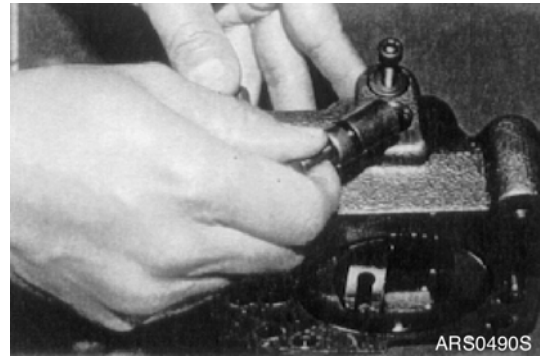


Figure 78

10. Remove lever (2) (613). Do not draw out pin (875).

IMPORTANT

Work will be promoted by using pincers.



Figure 79

11. Draw out pin (874) and remove feedback lever (611).

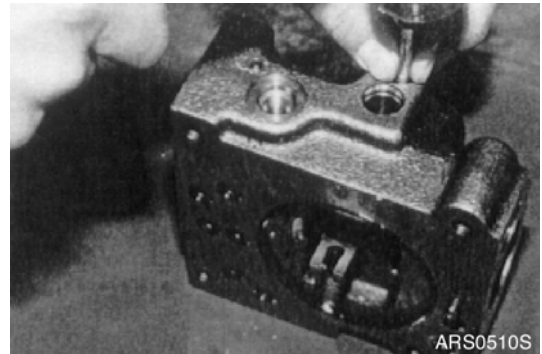


Figure 80

IMPORTANT

Push out pin (874) (4 mm (0.16 in) in dia.) from above with slender steel bar so it may not interfere with lever (1) (612).

12. Remove lever (1) (612). Do not draw out pin (875).
13. Draw out pilot piston (643) and spool (652).
14. Draw out piston case (622), compensating piston (621) and compensating rod (623).

NOTE: *Since component parts are small, do not lose them.*

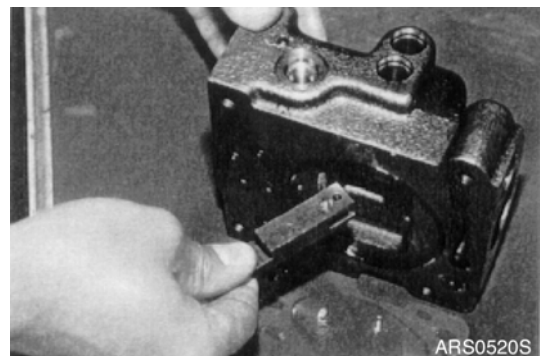


Figure 81

Reassembly

For assembly, reverse disassembly procedures, but pay attention to the following.

- A. Always repair parts that were scored at disassembly. Get replacement parts ready beforehand.
 - B. Mixing of foreign material will cause malfunction. Therefore, wash parts well with cleaning oil, let them dry with jet air and handle them in clean place.
 - C. Always tighten bolts, plugs, etc. to their specified torques.
 - D. Do not fail to coat sliding surfaces with clean hydraulic oil before assembly.
 - E. Replace seals such as O-rings with new ones as a rule.
1. Put compensating rod (623) into compensating hole of casing (601).
 2. Press fit pin in lever (1) (612) into groove of compensating rod and fit lever (1) to pin press fitted in casing.
 3. Install spool (652) and sleeve (651) into hole in spool of casing.

IMPORTANT

Confirm that spool and sleeve slide smoothly in casing without binding.

Pay attention to orientation of spool.

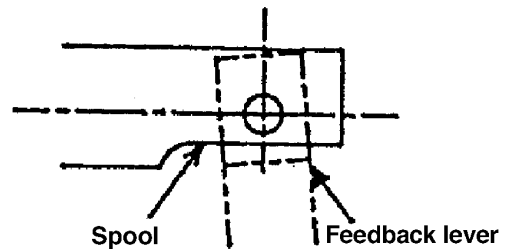


Figure 82

ARS0530S

4. Install feedback lever (611), matching its pinhole with pinhole in spool. Then insert pin (874).

IMPORTANT

Insert pin in feedback lever a little to ease operation.

Do not mistake direction of feedback lever.

5. Insert pilot piston (643) into pilot hole of casing.

IMPORTANT

Confirm that pilot piston slides smoothly without binding.

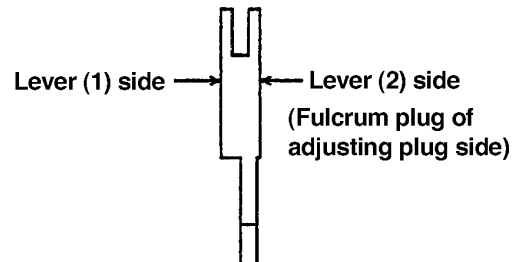


Figure 83

ARS0560S

6. Press fit pin in lever (2) (613) into groove of pilot piston. Then attach lever (2).

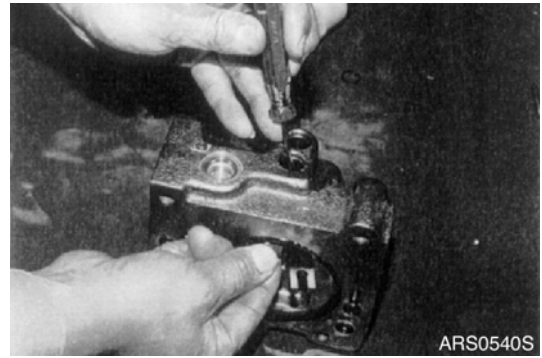


Figure 84

7. Install fulcrum plug (614) so pin pressed into fulcrum plug (614) can be inserted into pinhole of lever (2). Then attach locking ring (858).
8. Insert adjusting plug (615) and install locking ring.

IMPORTANT

Do not mistake inserting holes for fulcrum plug and adjusting plug.

Now move feedback lever to confirm that it has no large play and is free from binding.

9. Install return spring (654) and spring seat (653) into spool hole. Install retaining ring (814).

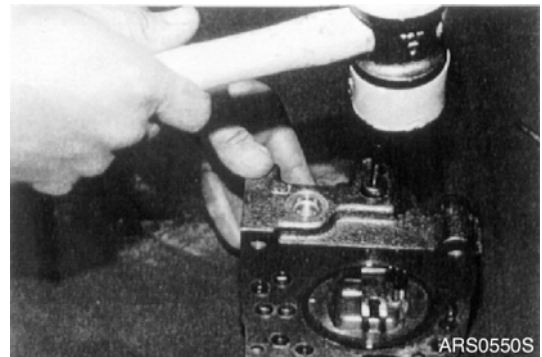


Figure 85

10. Install set spring (655) in spool hole. Slide compensating piston (621) and piston case (622) into compensating hole.
11. Install pilot cover (641) and secure it in place with hex socket head screws (436 and 438).

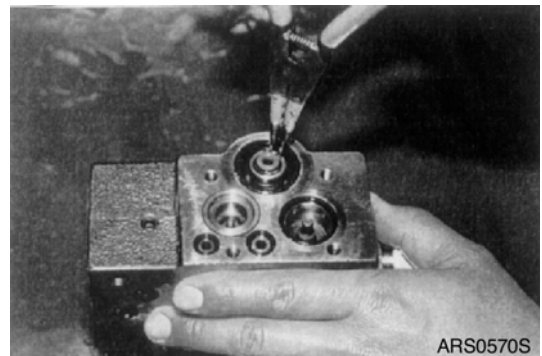


Figure 86

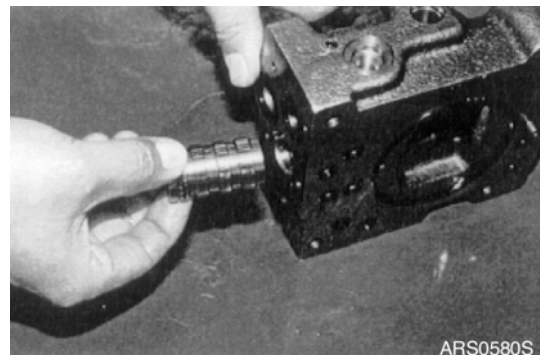


Figure 87

12. Insert spring seat (644), pilot spring (646) and adjusting ring (Q) (645) into pilot hole.
13. Install spring seat (624), inner spring (626) and outer spring (625) into compensating hole.

IMPORTANT

When fitting spring seat, do not mistake direction of spring seat.

14. Install cover (C) (629) with adjusting screws (628 and 925), adjusting ring (C) (627), locknut (630), hex nut (801) and adjusting screw (924). Secure them with hex socket head screws (438).

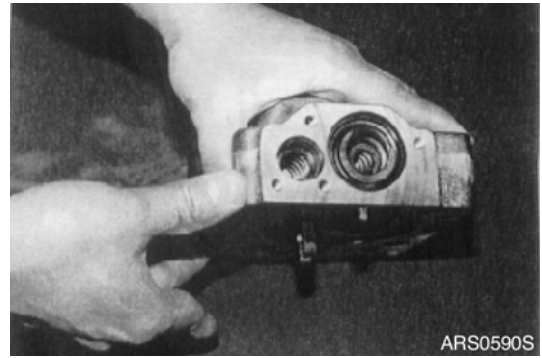


Figure 88



Figure 89

Troubleshooting

In case a functional fault probably resulting from the regulator occurs, disassemble and inspect it, referring to the maintenance manual.

Prime Mover is Overloaded

Determine which is faulty, the front pump or rear pump, by loading each pump independently. When both pumps are found faulty, investigate the following (1 and 2). Begin investigation with (3), when only one pump is found faulty. (1 and 2) are only for cases of the variable horsepower control.

1. Check that power shift command current I is normal.
2. The power shift pressure is low:
 - Check the amplifier dither.
 - Replace the proportional pressure reducing valve.
3. The compensating piston (621) and compensating rod (623) are stuck with each other:
 - Disassemble and clean the regulator.
4. The pin (898) is stuck:
 - Disassemble and clean the regulator.

Maximum Flow Is Not Available

1. Check that pilot pressure P_i is normal.
2. The pilot piston (643) is stuck:
 - Disassemble and clean the regulator.
3. The spool (652) is stuck:
 - Disassemble and clean the regulator.
4. The piston QMC stopper (647) and piston (648) are stuck with each other:
 - Disassemble and clean the regulator.
5. The spool (COV) (637) is stuck:
 - Disassemble and clean the regulator.

NOTE: *Replace faulty parts that are deeply scored.*
(1 and 2) are only for cases of the pilot control.
(4) is only for cases of the two-stage max. flow control.
(5) is only for cases of the cutoff control.

PILOT GEAR PUMP

Specification

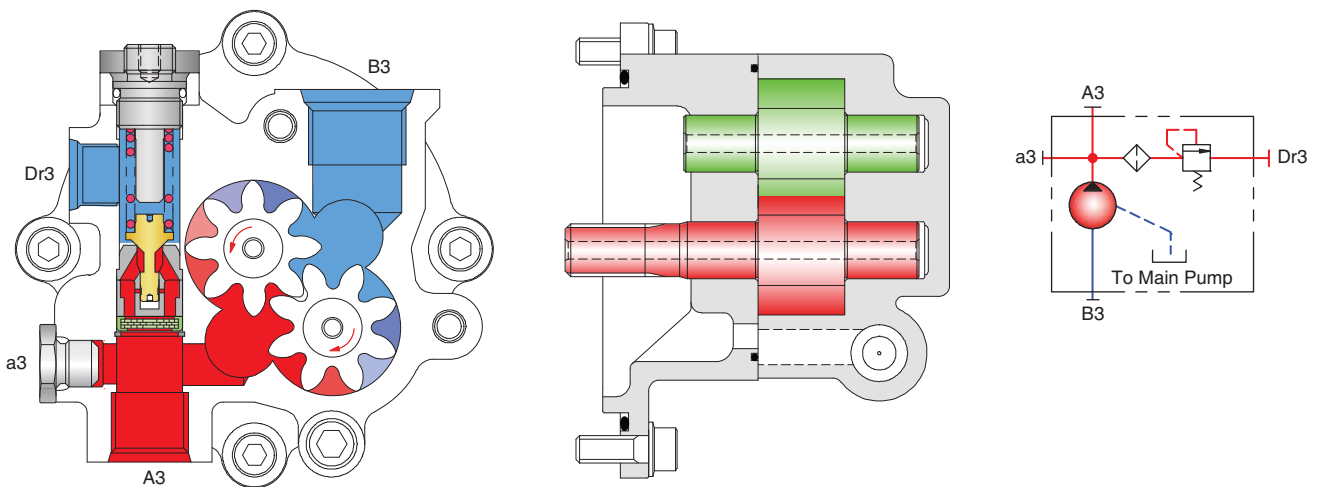
Max. Displacement	15 cm ³ /rev	
Max. Rated Speed	1,800 rpm	Clockwise Viewed from Shaft End
Rated Pressure	40 +2 kg/cm ² (39 +2 bar, 566 +29 psi)	
Max. Flow Rate	28.5 L/min (7.5 U.S. gpm)	
Max. Input Horsepower	4.0 PS	
Max. Input Torque	14.7 N.m (1.5 kg.m, 10.8 ft lb)	

Theory of Operation

When the gears of the intake disengage, a groove on the rotation gear is filled with a liquid.

Here, the liquid filling the space created by the gear casing and the plate follows the inner circumference of the casing in a direction of the discharge, and in the discharge hole, flows because of the engagement of the gears.

Port and Hydraulic Circuit



EX1301349

Figure 90

Symbol	Port Name	Port Size
A3	Delivery	PF1/2-19
B3	Suction	PF3/4-20.5
Dr3	Drain	PF3/8-18.6
a3	Gauge	PF1/4-15

Precaution

1. After assembling check that driving gear turns smoothly.
 - Torque: below 0.15 N.m (1.5 kg.cm, 0.11 ft lb)
2. When assembling, pour enough oil on the sliding surfaces.
3. The filter must be assembled with its non swazed surface firmly contacting with the bottom surface of recess.

Tools

Name	Description
Wrench	10 mm
Allen Wrench	6, 10 mm
Plastic Hammer	One Plastic Hammer
Pliers	and Hole Each

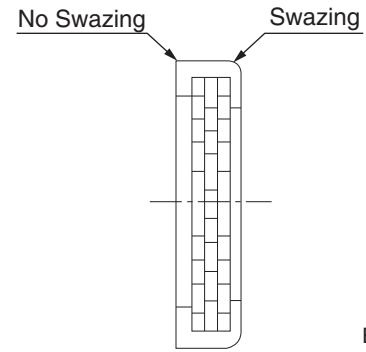


Figure 91

EX1301350

Drive Coupling (Main Pump)

Edition 1

MEMO

Table of Contents

Drive Coupling (Main Pump)

Safety Instructions	5-6-5
General	5-6-5
Specification	5-6-5
Section View	5-6-6
Tools.....	5-6-7
Disassembly	5-6-8
Reassembly	5-6-8

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.

GENERAL

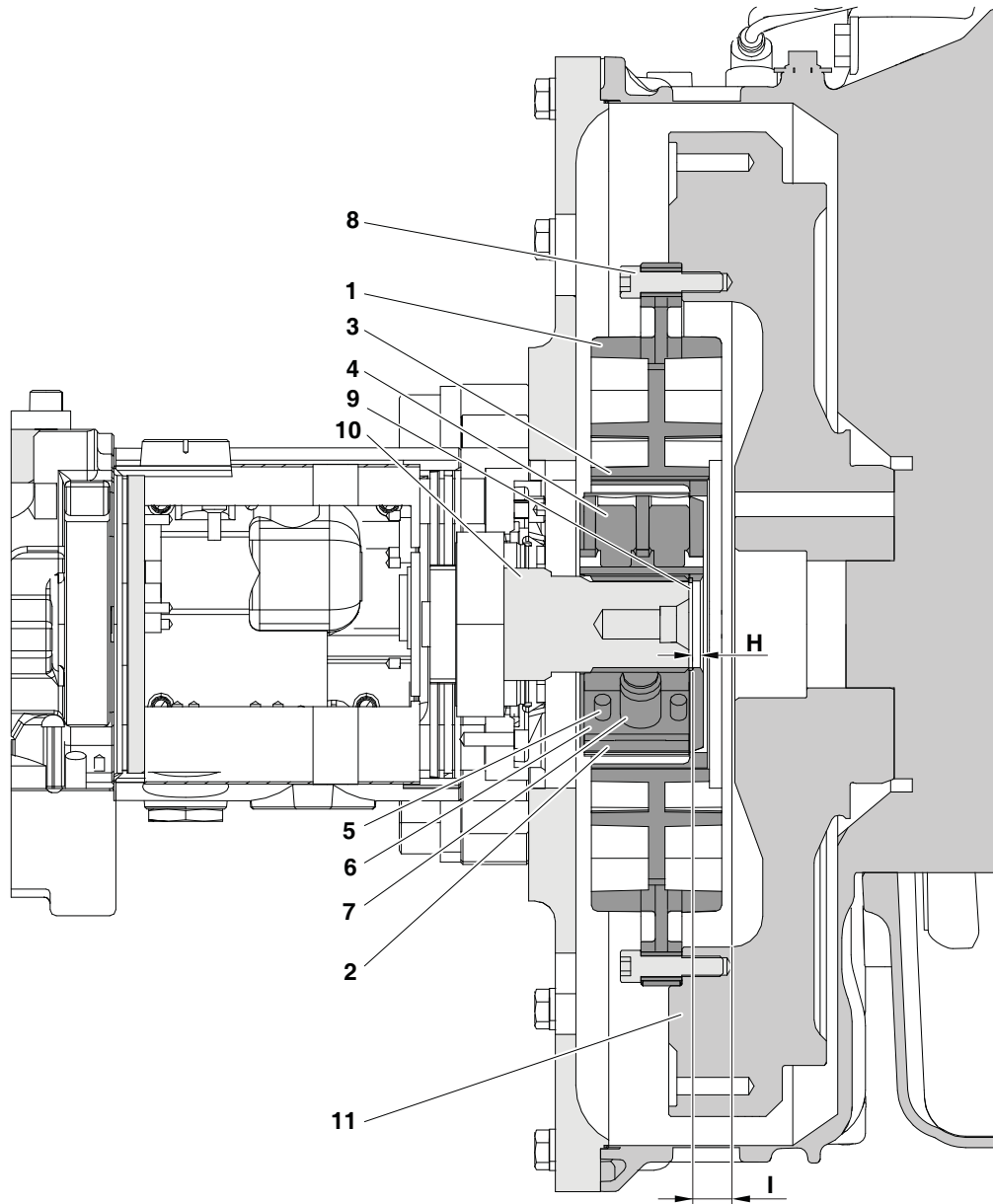
Specification

Condition in Use		
Operation rpm Range	800 - 1,800 rpm	
Max. Torque	1,765 Nm/1,300 rpm	
Max. Output	283 kW/1,800 rpm	
Specification		
Nominal Torque	3,432 N.m (350 kg.m, 2,531 psi)	
Max. Torque	4,903 N.m (500 kg.m, 3,616 psi)	
Alternating Torque	±1,471 N.m (±150 kg.m, ±1,084 psi)	
Max. Speed	3,600 rpm	
Max. Permissible Displacements	Radial	0.4 mm (0.015 in)
	Angular	0.5°
	Axial	±2 mm (±0.08 in)
Dynamic Torsion Spring Stiffness Cdyn	1.79 x 10 ⁶ kg.cm/Rad	
Mass Moment of Inertia	8.46 kg.cm. S ²	
Allowable Environment Temperature	-40 - +120 °C	

SECTION VIEW

Whenever the drive coupling for main pump is installed, the following mounting dimensions and installation procedures must be observed.

NOTE: *If these procedures are not followed, noise will occur and/or the service life of drive coupling or main pump will be reduced.*



EX140080

Figure 1 Drive Coupling Installation

Reference Number	Description	Qty.	Torque
1	Flange	1	
2	Hub	1	
3	Element	1	
4	Clamping Screw	2	196.1 - 215.7 N.m (20 - 22 kg.m, 144.7 - 159.1 ft lb)
5	Spring Pin	8	
6	Insert	4	
7	Bolt	4	431.2 - 480.5 N.m (44 - 49 kg.m, 318.3 - 354.4 ft lb)
8	Socket Bolt	8	49 N.m (5 kg.m, 36.2 ft lb)
9	Retaining Ring	1	
10	Pump Shaft	1	
11	Flywheel	1	

Symbol	Dimension	Remarks
H	7 mm (0.27 in)	Distance between from Pump Shaft to Coupling Hub
I	16 mm (0.63 in)	Distance between from Pump Shaft to Coupling Flange

Tools

Name	Description
Allen Wrench	8 mm, 10 mm, 17 mm
Plastic Hammer	One Plastic Hammer
Pliers	One for Shaft and Hole Each

DISASSEMBLY

When the pump is removed from an engine, the hub and insert would be attached on the pump.

1. After removing pump remove socket bolts (1, Figure 3) (4 ea) and remove insert (2) (4 ea).

-  : 17 mm

2. Remove clamp screw (3, Figure 3) (2 ea) and remove hub (4).

-  : 10 mm

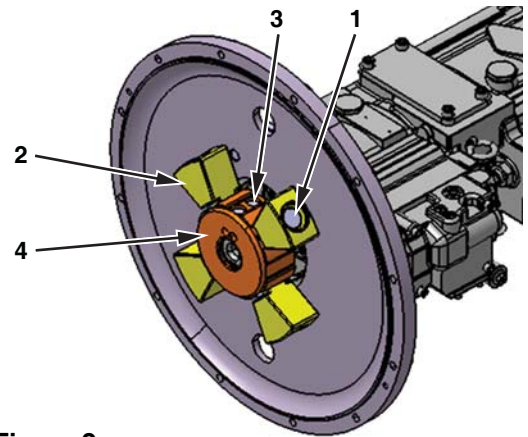


Figure 2

EX1400078

3. Remove socket bolts (2, Figure 4) (8 ea) and remove flange (1) and element (3).

-  : 8 mm

NOTE: Be careful not to lose the location socket bolt (2, Figure 4).

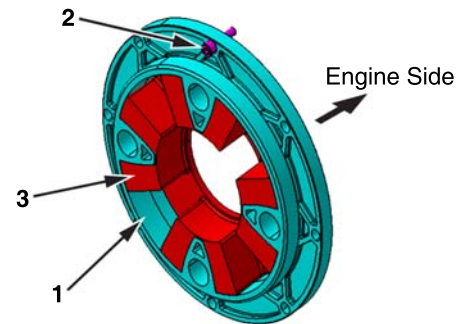


Figure 3

EX1301563

REASSEMBLY

1. Install flange (1, Figure 5) with socket bolts (2) (8 ea) to engine flywheel.

-  : 8 mm

- Torque: 49 N.m (5 kg.m, 36.2 ft lb)

NOTE: Careful assembling the bushing (3, Figure 5) (8 ea).

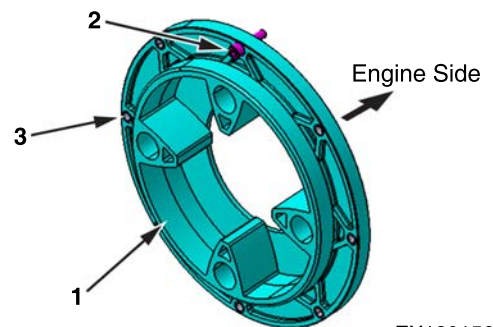


Figure 4

EX1301564

2. Assemble the insert (2, Figure 6) (4 ea) with socket bolts (3) (4 ea) to hub (attached by spring pin).

- Torque: 431.2 ~ 480.5 Nm
(44 ~ 49 kg.m, 318.3 ~ 354.4 ft lb)

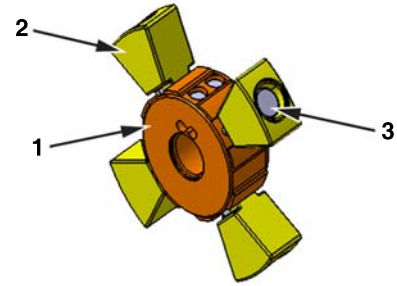


Figure 5

EX1301565

3. Slide hub into place on pump shaft (1, Figure 7) until retaining ring (2) in the hub touches the pump shaft (1) and secure it in position with clamping bolts (3).

- Torque: 196.1 ~ 215.7 Nm
(20 ~ 22 kg.m, 144.7 ~ 159.1 ft lb)

NOTE: Coat clamping bolts (3, Figure 7) with Loctite #262.

NOTE: Refer to "Dimension" on page -5-6-9 of "H", "I".

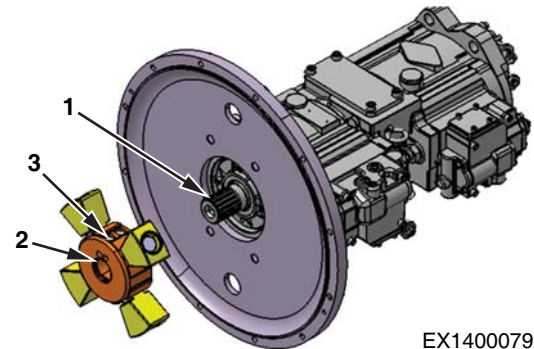


Figure 6

EX1400079

4. Install element (2, Figure 8) on the flange (1) on engine flywheel.
5. Install main pump and hub (3, Figure 8) by pushing it softly into element (2).

IMPORTANT

1. Bolts are coated against loosening with a bonding compound. Do not use any additional bonding compounds, oils or cleaning solvents on them.
 2. Element (2, Figure 8) is not resistant to bonding compounds, oil or grease. Be careful not to expose them to it.
 3. Remove oil or dirt from flywheel cover and pump shaft before assembly.
 4. Misalignment between pump and engine must be controlled to less than 0.5 mm (0.019 in).
-

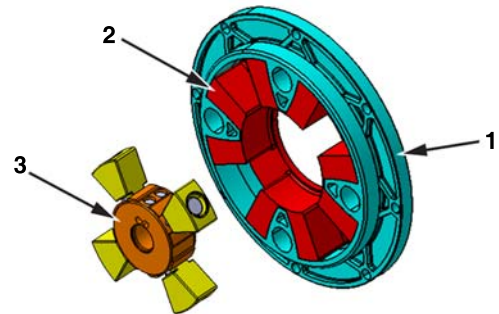


Figure 7

EX1301567

Main Control Valve

Edition 1

MEMO

Table of Contents

Main Control Valve

Safety Instructions	5-7-5
General	5-7-5
Specification	5-7-5
Overview	5-7-6
Theory of Operation	5-7-12
Cautions for Operation	5-7-40
Precaution	5-7-41
Tools and Torques	5-7-41
Removal	5-7-42
Installation	5-7-56
Completing Work	5-7-57
Disassembly	5-7-58
Caution on Disassembly	5-7-58
Sequence of Disassembly	5-7-59
Cleaning and Inspection	5-7-70
Cleaning	5-7-70
Inspection	5-7-70
Reassembly	5-7-71
Caution on Assembly	5-7-71
Sequence of Subassembly	5-7-72
Maintenance of Relief Valves	5-7-83
Troubleshooting, Testing and Adjustment	5-7-86
Troubleshooting	5-7-86
Adjustment of Valves	5-7-88

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

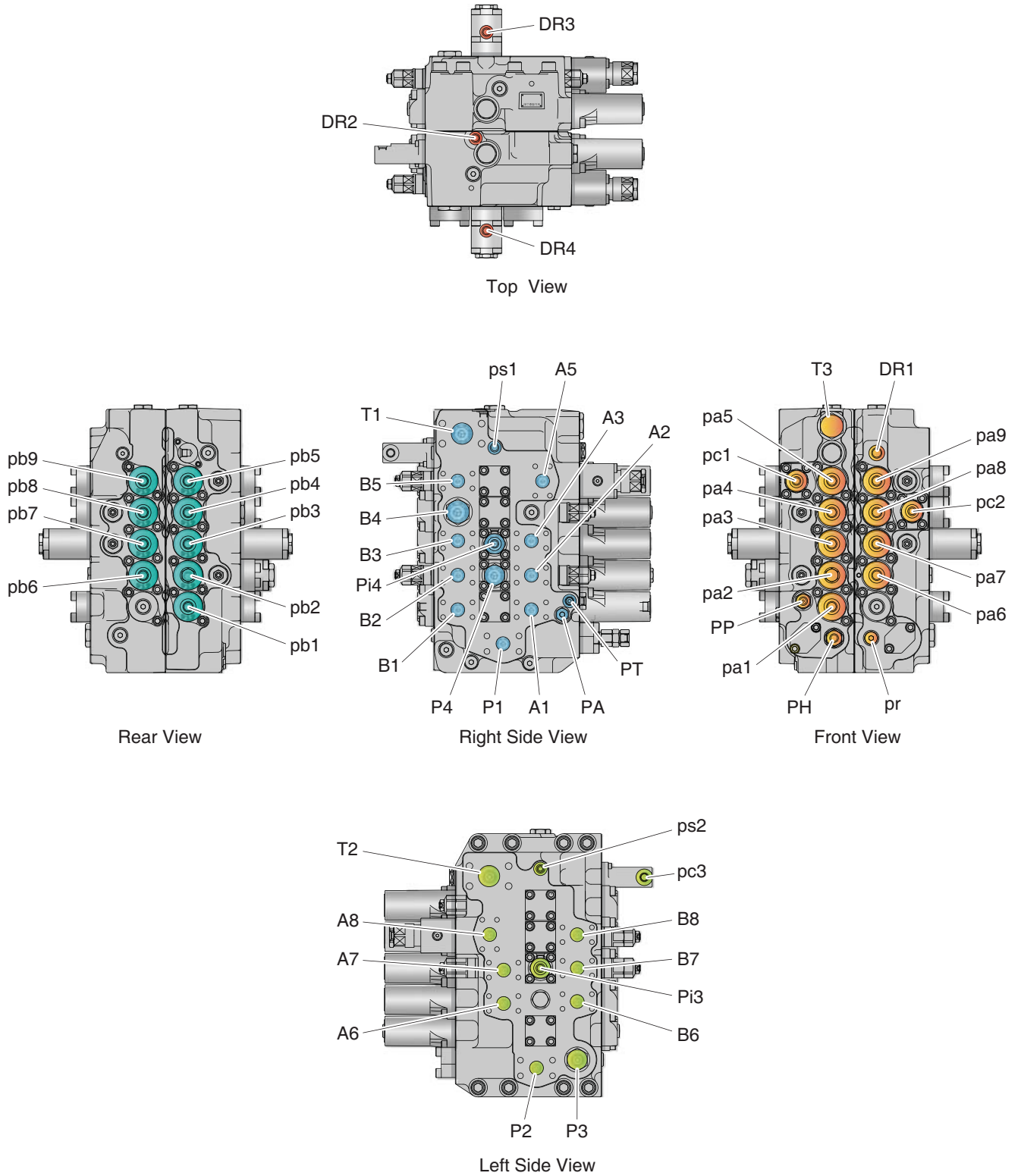
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

GENERAL

Specification

Control Method		Negative Control
Rated Flow		270 L/min (50 L/min in neutral)
Main Relief Pressure	High	343 bar (350 kg/cm ² , 4,978 psi) at 136 L/min
	Low	323 bar (330 kg/cm ² , 4,694 psi) at 156 L/min
Overload Relief Pressure	A2, B2, A5, B5, A8, B8	353 bar (360 kg/cm ² , 5,120 psi) at 20 L/min
	A7, B7	245 bar (250 kg/cm ² , 3,555 psi) at 20 L/min
Permitted Back Pressure		Max. Pressure of 15 bar or Less
		Used Pressure of 5 bar or Less
Permitted Use of Oil Temperature		Normally -20 ~ +80°C
		Highest 100°C
		(Use of the Rubber for NBR)
Weight		203 kg (447 lb)

Overview



EX1504778

Figure 1

Port

Port	Name	Size	
P3	Rear Pump High-pressure	PF 3/4"	
P4	Two Pump Flow Valve		
B4	Boom 2 (Plugged)	PF 1"	
T3	Swing Motor Make-up (C)		
P1	Front Pump High-pressure (A1)	27.76 x 57.15 (M12 x 1.75)	
P2	Rear Pump High-pressure (A2)		
A1	Travel Forward (RH)	SAE 1 3/4"	
B1	Travel Backward (RH)		
A2	Heel Cylinder Tube Side		
B2	Heel Cylinder Rod Side		
A3	Swing Motor Left		
B3	Swing Motor Right		
A5	Arm Cylinder Rod Side		
B5	Arm Cylinder Tube Side		
A6	Travel Forward (LH)		
B6	Travel Backward (LH)		
A7	Rotating Head		
B7	Rotating Rod		
A8	Boom Cylinder Tube Side		
B8	Boom Cylinder Rod Side		
T1	Return Line 1		35.71 x 69.85 (M12 x 1.75)
T2	Return Line 2		
PP	Pilot Pressure (40 bar)	PF 1/4"	
PT	Pressure Sensor (Auto Idle)		
pc3	Drain		
pc1	Lock Valve Pilot (Arm Crowd)		
pc2	Lock Valve Pilot (Boom Down)		
PA	Swing Parking Brake Port (SH) and Pressure Sensor		
PH	Pressure Up		
ps1	Negacon Pressure (pi1)		
ps2	Negacon Pressure (pi2)		
DR2	Drain 2		
DR3	Drain 3		
Pi3	Boom Up Priority		
Pi4	Boom Up Priority		
DR4	Drain 4		

Port	Name	Size
pa1	Travel Forward Pilot (RH)	PF 3/8"
pa2	Heel Cylinder Extended Pilot	
pa3	Swing Left Pilot	
pa4	Drain (Boom 2)	
pa5	Arm Dump Pilot	
pa6	Travel Forward Pilot (LH)	
pa7	Rotating Head Pilot	
pa8	Boom 1 Up Pilot	
pa9	Arm 2 Dump Pilot	
pb1	Travel Backward Pilot (RH)	
pb2	Heel Cylinder Contract Pilot	
pb3	Swing Right Pilot	
pb4	Boom 2 Up Pilot (pb8)	
pb5	Arm Crowd Pilot	
pb6	Travel Backward Pilot (LH)	
pb7	Rotating Rod Crowd Pilot	
pb8	Boom Down Pilot	
pb9	Arm 2 Crowd Pilot (pb5)	
DR1	Drain Port 1	
pr	Plugged	

Hydraulic Circuit

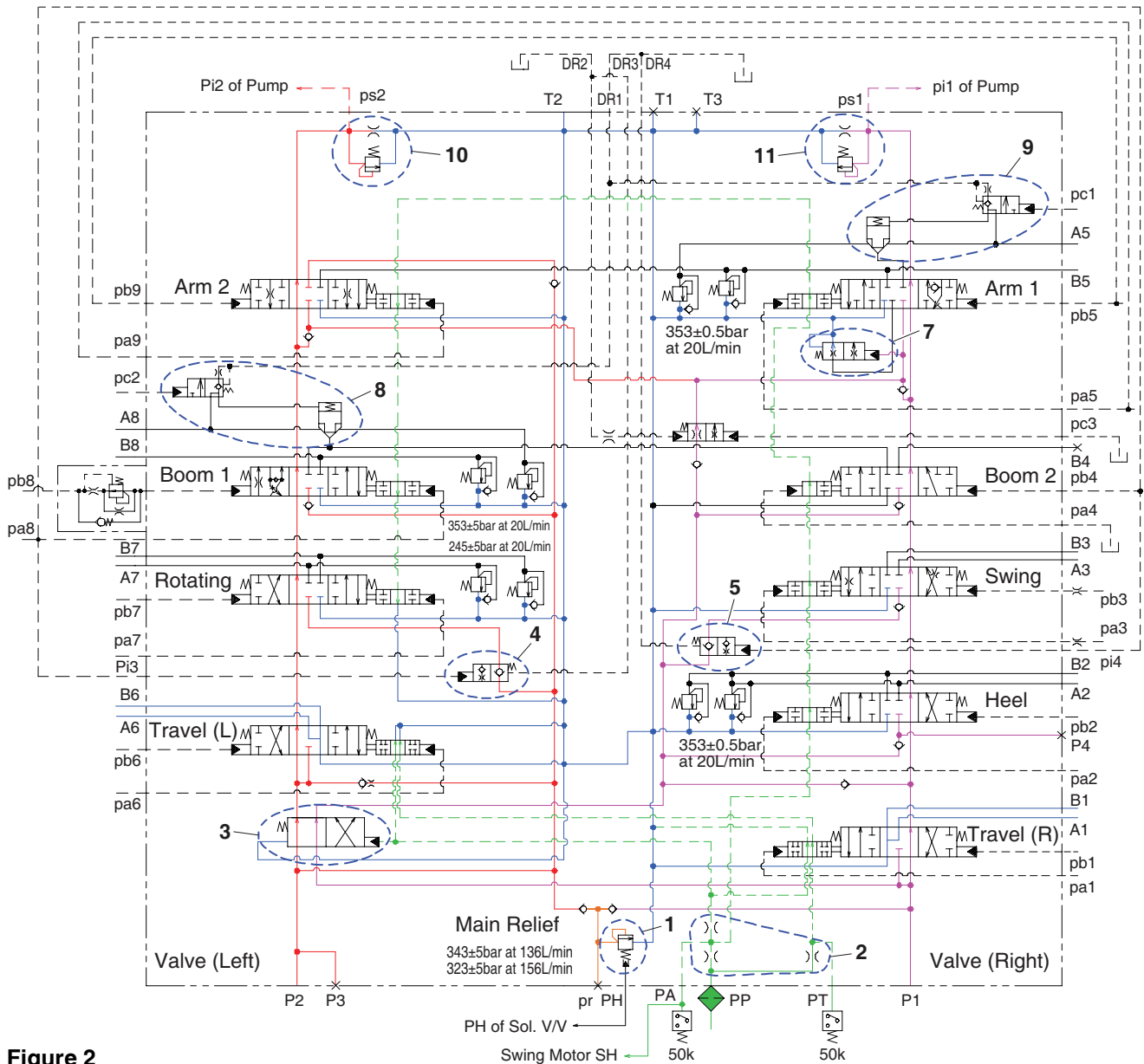


Figure 2

DS2003054

Reference Number	Description
1	Main Relief Valve
2	Orifice
3	Travel Straight Valve
4	Boom Priority Valve
5	Boom Priority Valve

Reference Number	Description
7	Arm Regeneration Valve
8	Boom Holding Valve
9	Arm Holding Valve
10	Negacon Valve
11	Negacon Valve

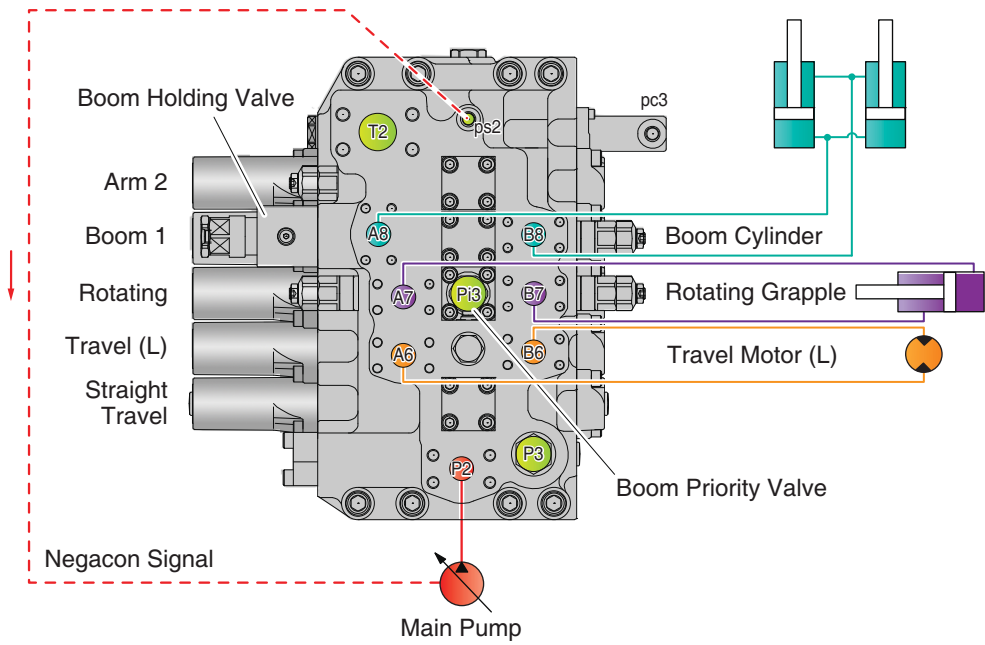
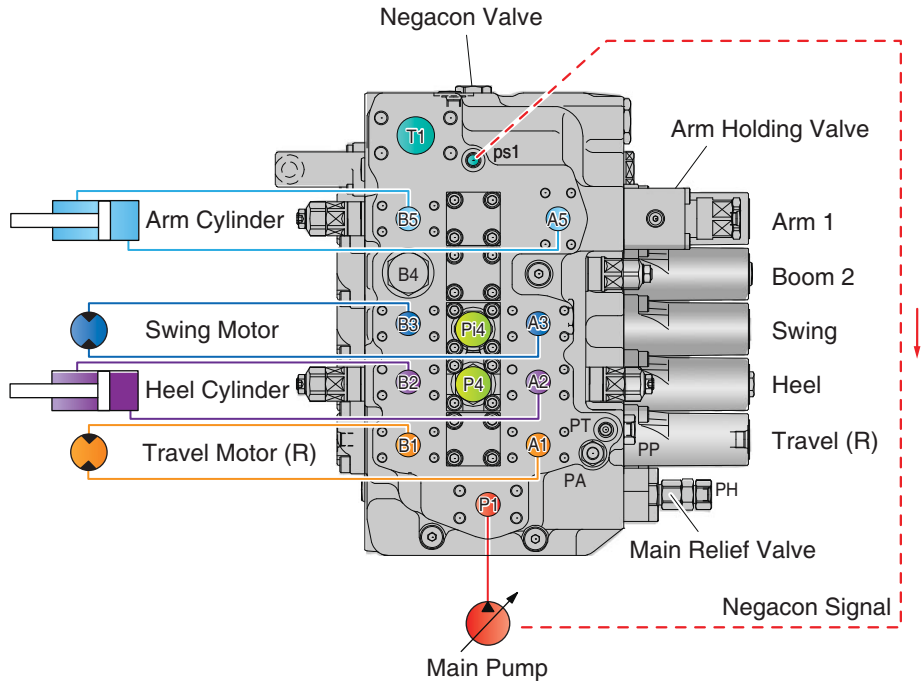


Figure 3

EX1504780

Theory of Operation

When All Spools are in Neutral

Neutral Passage

The oil supplied from the port (P1) enters into the tank passage (Ta) through the orifice (Lc1) of negative relief from the neutral passage (L1) and returns to ports (T1, T2 and T3).

The oil supplied from the port (P2) passes the tank passage (Ta) through orifice (Rc 1) of negative relief from the neutral passage (R1) and returns to port (T1, T2 and T3).

The pressure of chambers (L2 and R2) flowing over the negative relief, flows into pump from ports (ps1 and ps2), to control the volume of pump P1 and P2.

In addition, when excessive oil flows excessive into the neutral passage, the negative relief operates to prevent the abnormally high-pressure on ports (ps1 and ps2).

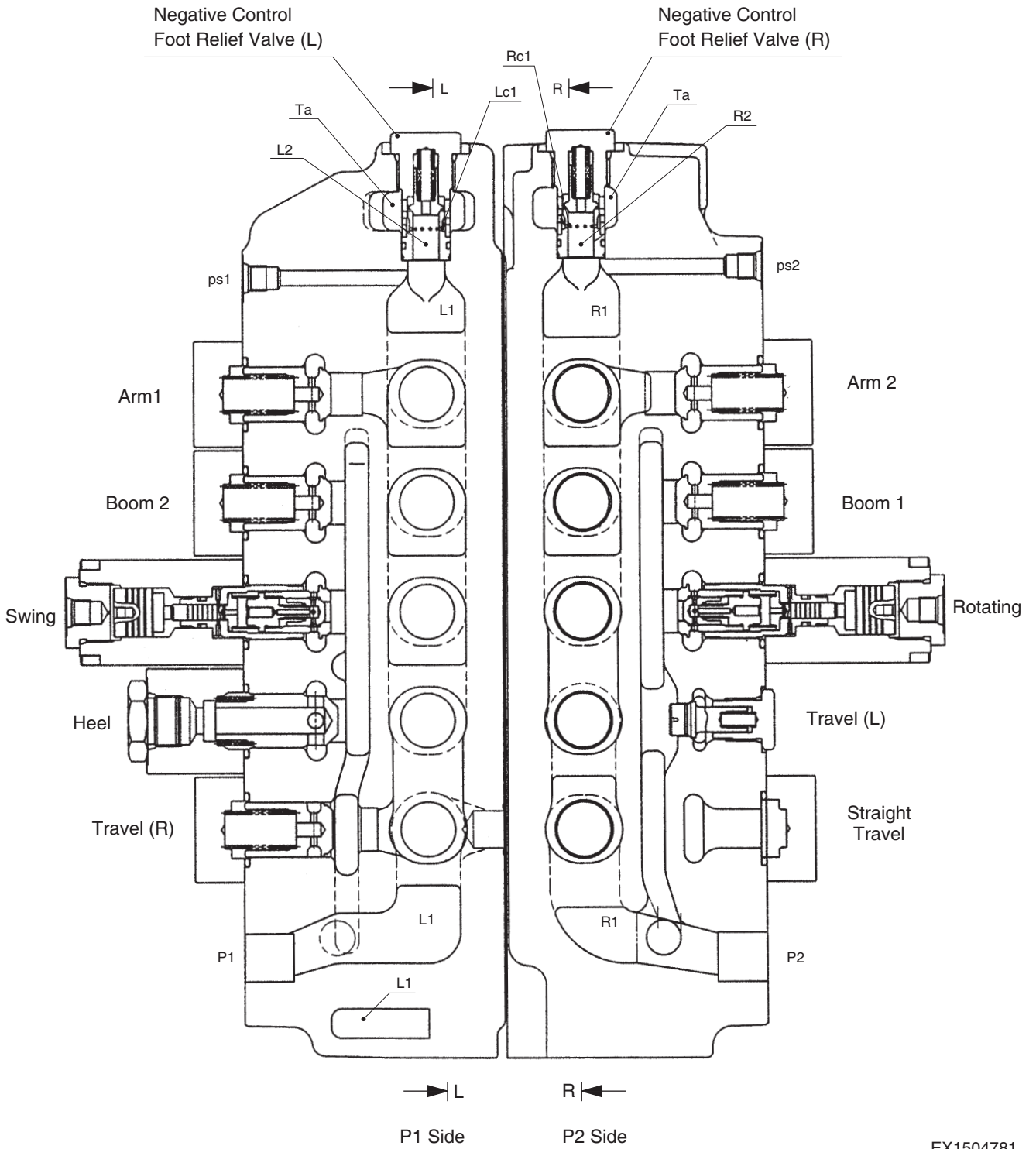


Figure 4

EX1504781

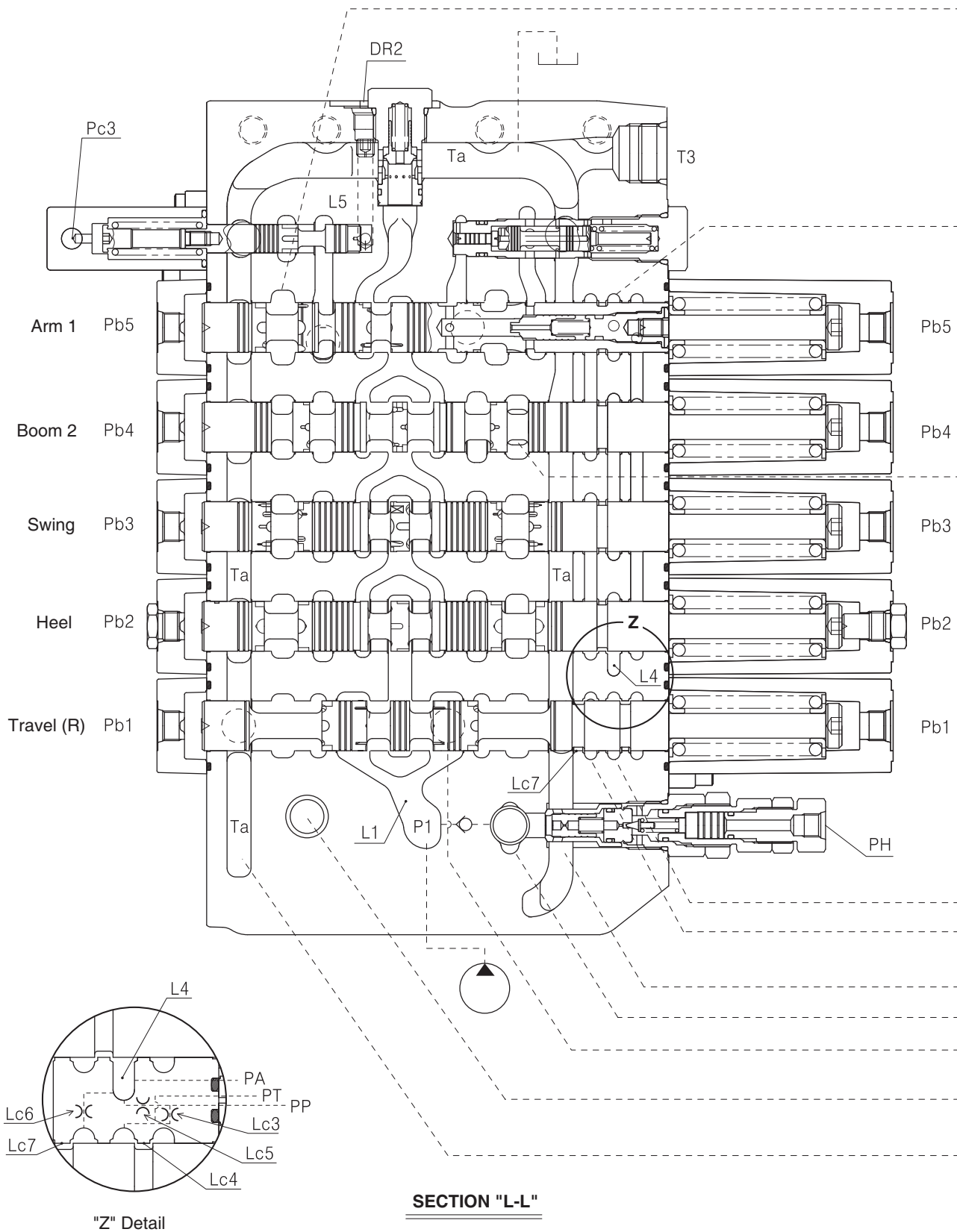
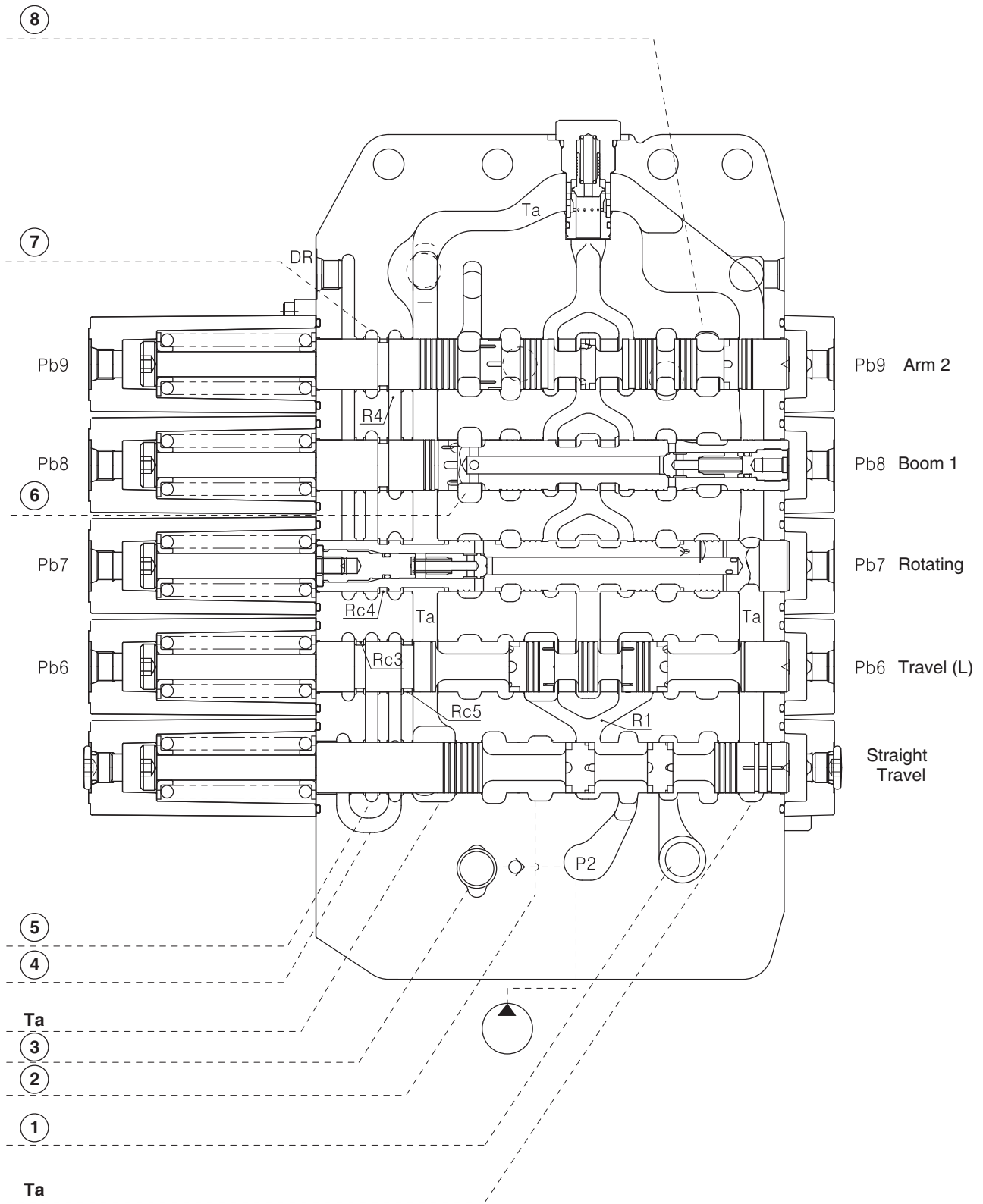


Figure 5

EX1504782



SECTION "R-R"

Figure 6

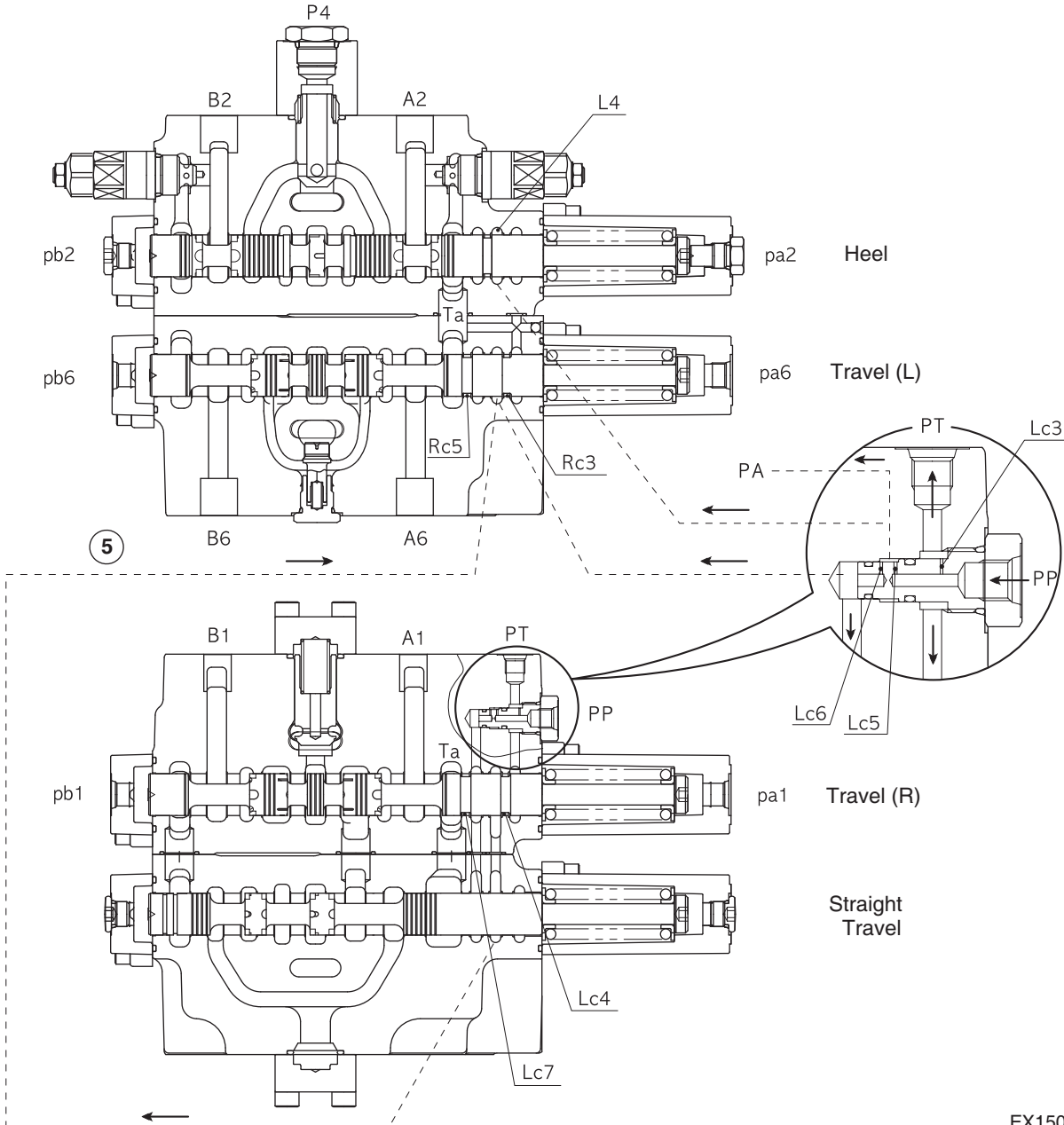
EX1504783

Signal Passage

Oil supplied to port (PP) flows through orifice (Lc3) to port (PT) and simultaneously flows through land (Lc4), passage (5), and land (Rc3) into tank passage (Ta).

The same oil supplied to port (PP), then flows through orifice (Lc5) into port (PA), and it also flows through passages (L4, 7 and R4) to bucket spool land (Rc4) and then flows into drain passage (DR).

The oil passing through orifice (Lc6) flows through land (Lc7) to tank passage (Ta) or flows through passage (4) to travel spool land (Rc5) and then flows into tank passage (Ta).



EX1504784

Figure 7

Single Operation

Travel Spool Shift

When shifting travel spool by increasing pressure of travel (Section 1) pilot port (Pb1 (Pa1)), oil supplied to port (P1) flows through neutral passage (L1) to spool and flows to port (B1 (A1)). Return oil flows through port (A1 (B1)), to spool and returns to tank passage (Ta).

When shifting travel spool by increasing pressure of travel (Section 6) pilot port (Pb6 (Pa6)), oil supplied to port (P2) flows through neutral passage (R1) to spool or passage (S6-1) and flows to port (B6 (A6)). Now, pressure of parallel passage (R3) and passage (S6-1) are equal, so poppet (S6-2) does not open. Return oil flows through port (A6 (B6)) to spool and returns to tank passage (Ta).

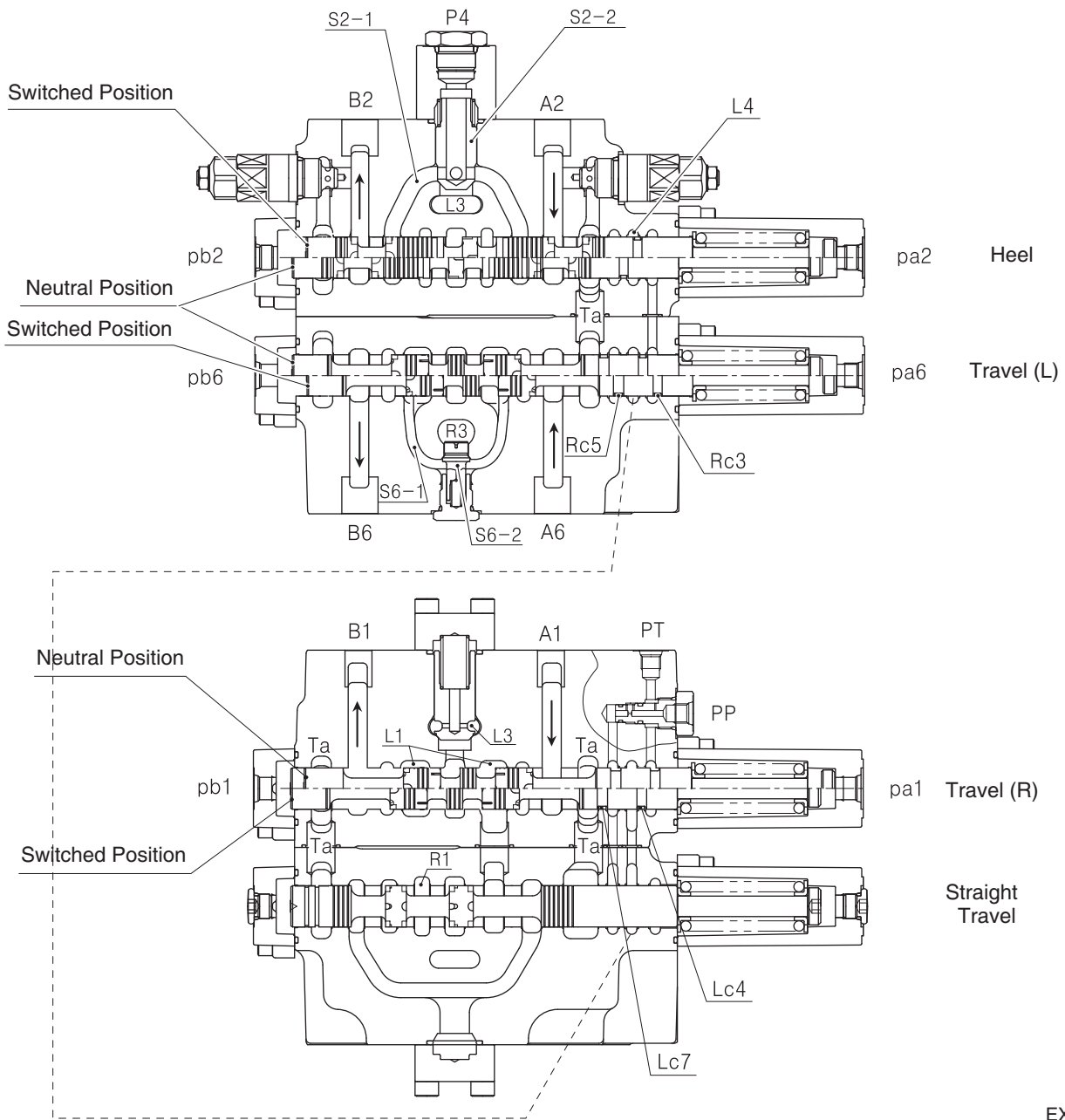
When shifting either spool (Section 1 or 6), land (Lc4) or (Rc3) is closed. Oil supplied from port (PP) does not flow into tank passage, so pressure at port (PT) rises.

Heel Spool Shift

When shifting heel spool by increasing pressure of heel pilot port (Pb2 (Pa2)), neutral passage (L1) is closed. Oil supplied to port (P1) flows through parallel passage (L3), load check valve (S2-2), passage (S2-1), and spool, it then flows to port (B2 (A2)).

Return oil flows through port (A2 (B2)) to spool and returns to tank passage (Ta).

When oil is also supplied from port (P4), it flows through load check valve (S2-2) and is combined at passage (S-1).



EX1504785

Figure 8

Swing Spool Shift

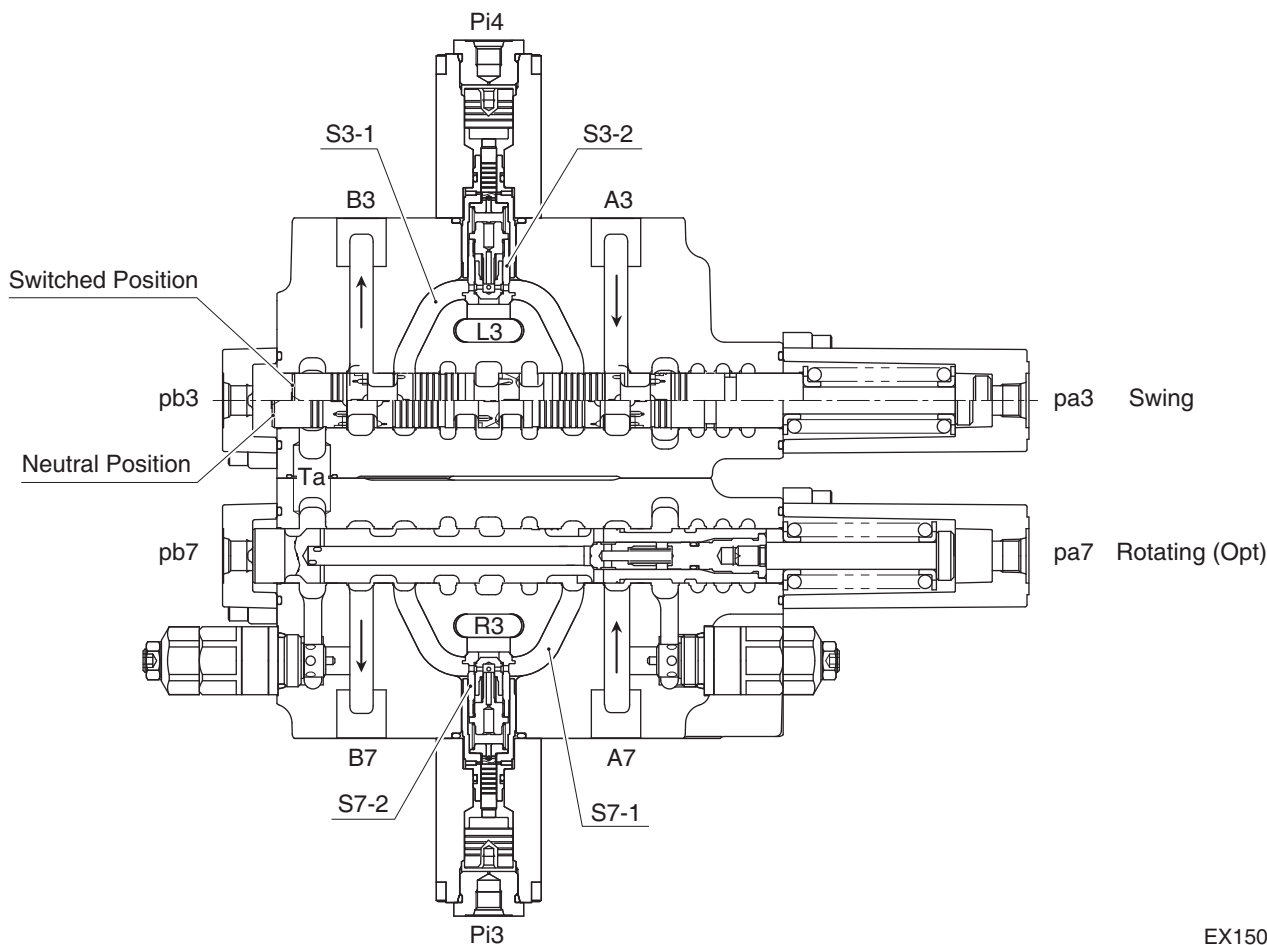
When shifting swing spool by increasing pressure of swing (Section 3) pilot port (Pb3 (Pa3)), neutral port (L1) is closed. Oil supplied to port (P1) flows through parallel passage (L3), load check valve (S3-2), passage (S3-1) and spool, it then flows to port (B3 (A3)). Return oil flows through port (A3 (B3)) to spool and is returned to tank passage (Ta).

Rotating Spool Shift

Oil flow control in rotating portion of valve is different from other sections because it has a regeneration function that works against pilot port pressure.

1. Rotating dump

When rotating spool is shifted by increasing pressure of pilot port (Pa7), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3), load check valve (S7-2), passage (S7-1), spool and into port (B7). Oil returns through port (A7) and spool to tank passage (Ta).



EX1504786

Figure 9

2. Regeneration

When rotating spool is shifted by increasing pressure of pilot port (Pb7), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3), load check valve (S7-2), passage (S7-1), spool and into port (A7).

Oil flows through port (B7) and one portion of the oil returns through spool to tank passage (Ta), and the other portion of oil flows through inside of spool, and pushes up load check, and then is combined at port (A7).

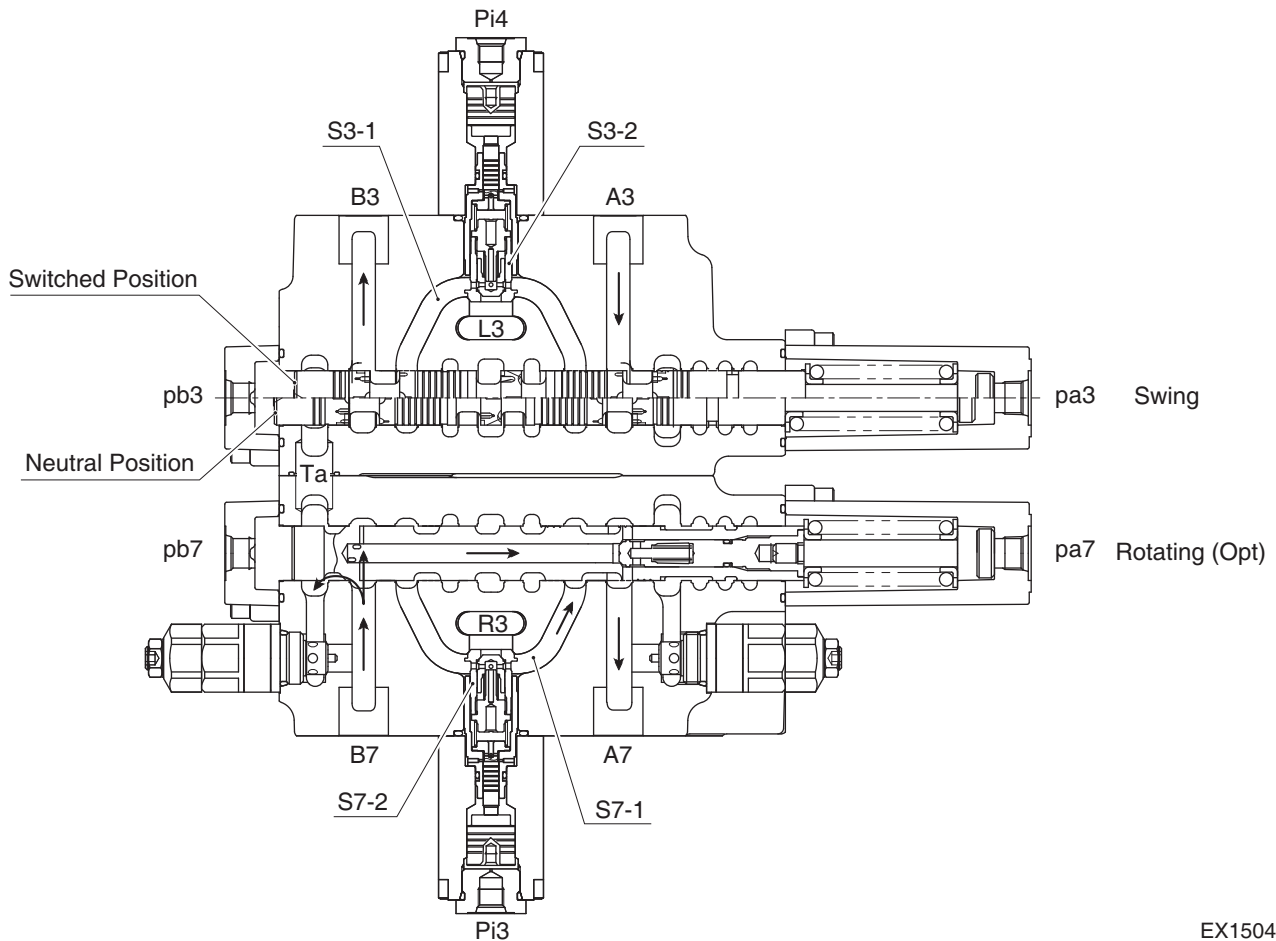


Figure 10

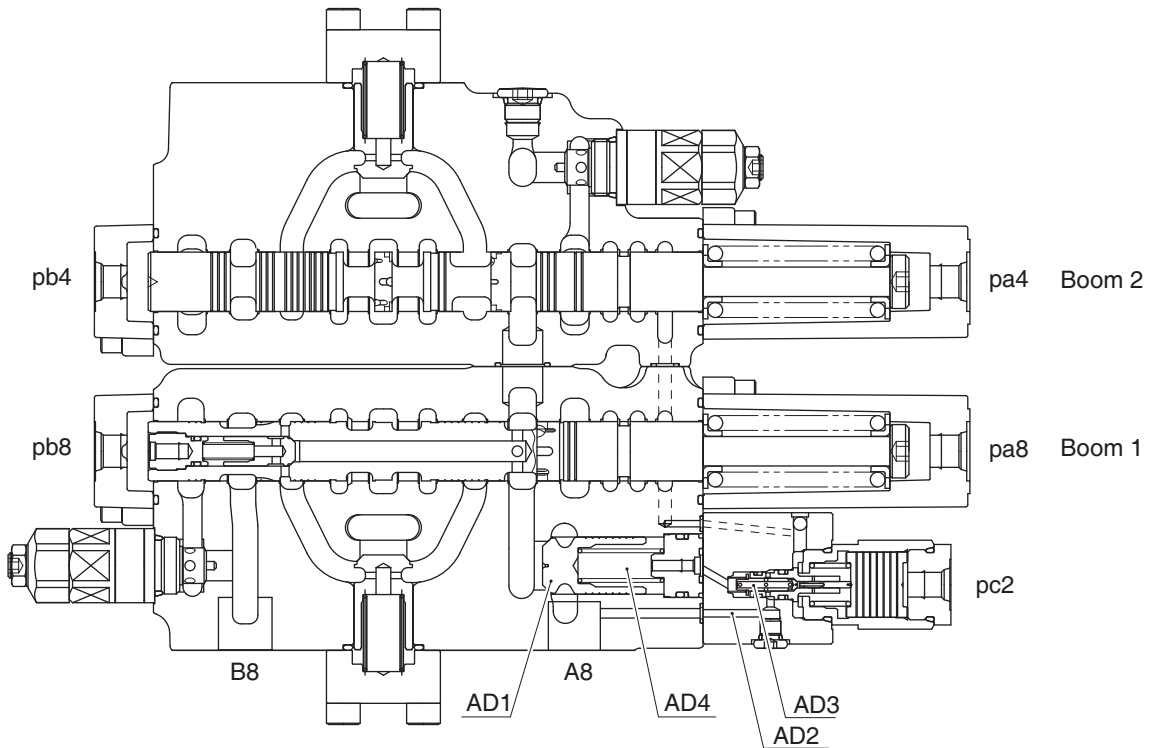
EX1504793

Boom Spool Shift

1. Neutral

This valve also works with antidrift valves that are installed on the bottom side of each boom cylinder.

When in neutral, poppet (AD1) is closed by port (A8) pressure that is sent through passage (AD2), spool (AD3) to spring chamber (AD4).



EX1504794

Figure 11

2. Boom up (2-pump confluence)

When boom 1 spool is shifted by increasing pressure of boom 1 (Section 8) pilot port (Pa8), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3) and load check valve (S8-2) to spool and flows into port (A8).

When boom 2 spool is shifted by increasing pressure of boom 2 (Section 4) pilot port (Pb4), neutral passage (L1) is closed. Oil supplied to port (P1) flows through parallel passage (L3), load check valve (S4-2), spool, and to passage (6) and joins at port (A8). Return oil flows from port (B8) to spool and returns to tank passage (Ta).

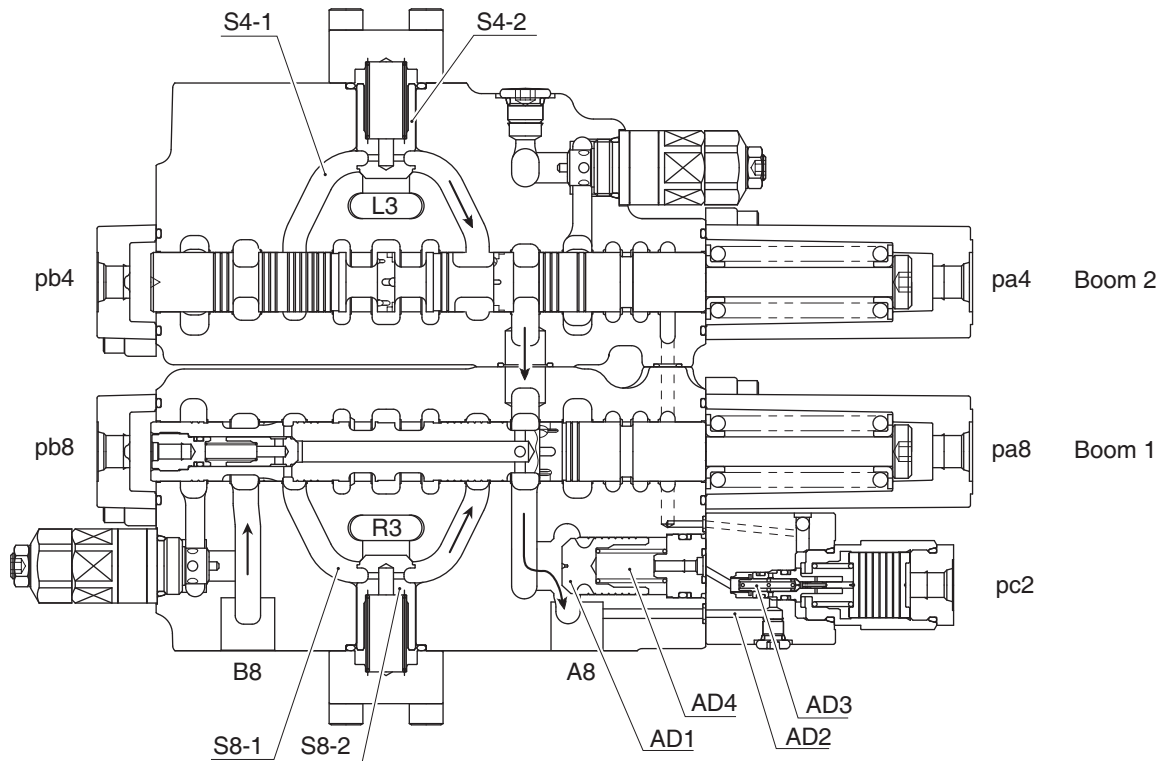


Figure 12

EX1504795

3. Boom down (regeneration)

When boom 1 (Section 8) spool is shifted by increasing pressure of boom 1 pilot port (Pb8), neutral passage (R1) is closed. Oil supplied to port (P2) flows through parallel passage (R3) and load check valve (S8-2) to spool and flows into port (B8).

When spool (AD3) of antidrift valve is shifted by increasing pressure of port (P2), poppet (AD1) is opened by decreasing of pressure of spring chamber (AD4), and return oil from port (A8) flows to tank passage. Some return oil opens poppet (S8-3) in boom 1 spool, flows through passage (S8-2), joins at port (B7), and then prevents cavitation of cylinder rod side.

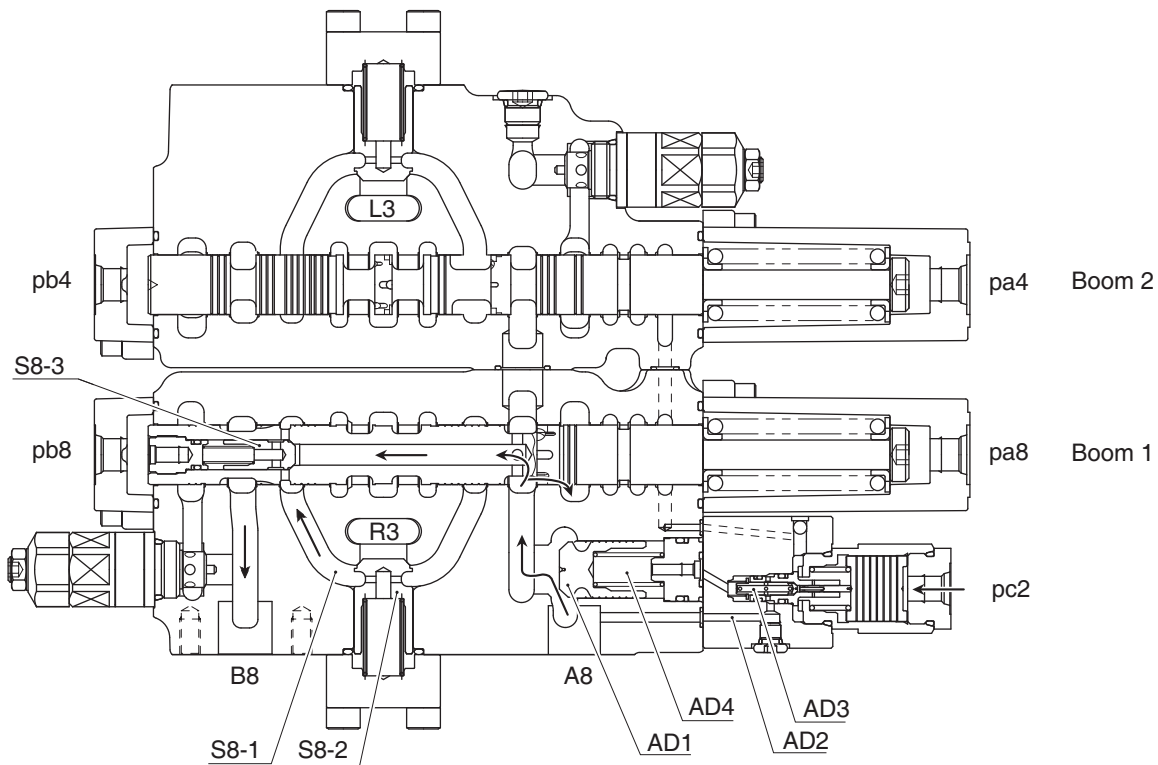


Figure 13

EX1504796

Arm Spool Shift

1. Neutral

This valve also works with an antidrift valve that is installed on rod side of the arm cylinder.

When in neutral, poppet (AD1) is closed by port (A5) pressure that is sent through passage (AD2), spool (AD3) and to spring chamber (AD4).

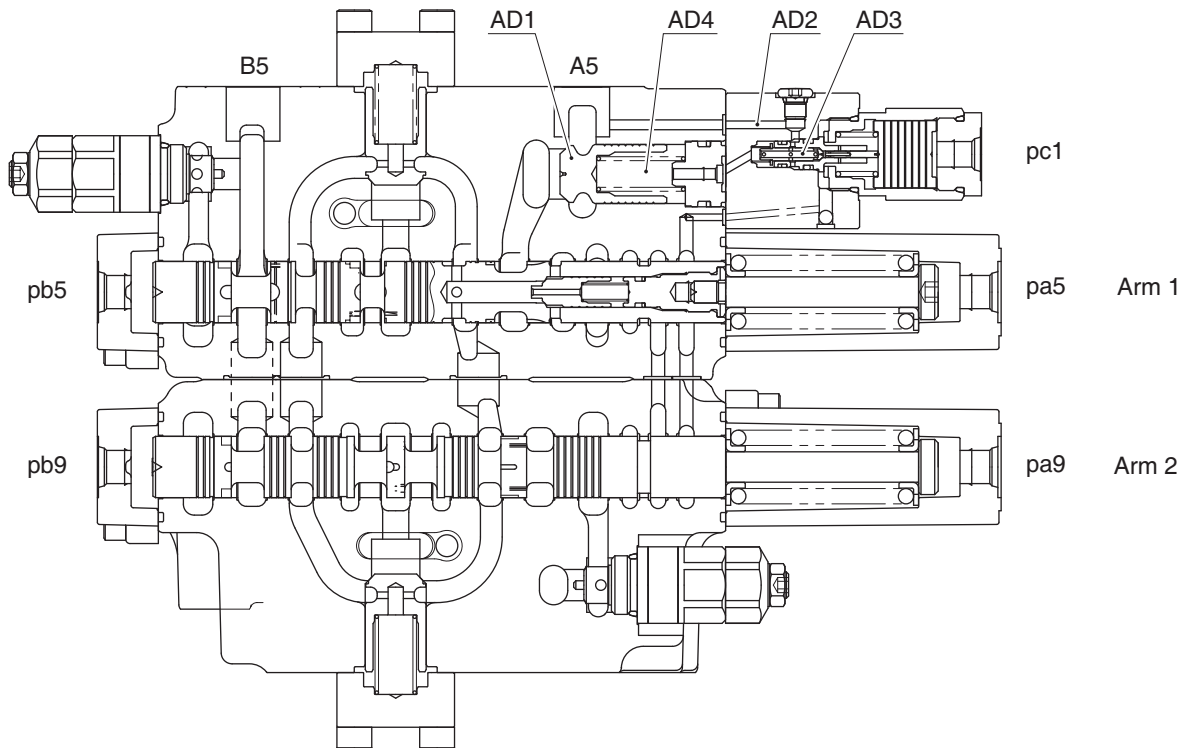


Figure 14

EX1504797

2. Arm Crowd

A. 2-pump confluence

When arm 1 spool is shifted by increasing pressure of arm 1 (Section 5) pilot port (Pb5), oil supplied to port (P1) flows through neutral passage (L1), load check valve (S5-2), passage (S5-1) and spool into port (B5).

When arm 2 spool is shifted by increasing pressure of arm 2 (Section 9) pilot port (pb9), oil supplied to port (P2) flows through neutral passage (R1), load check valve (S9-1), passage (S9-2), and spool to passage (8) and joins at port (B5).

The return oil from port (B5) flows through regeneration check valve in spool, and then flows to port B to regenerate, and some oil returns through variable regeneration release valve to tank (Ta).

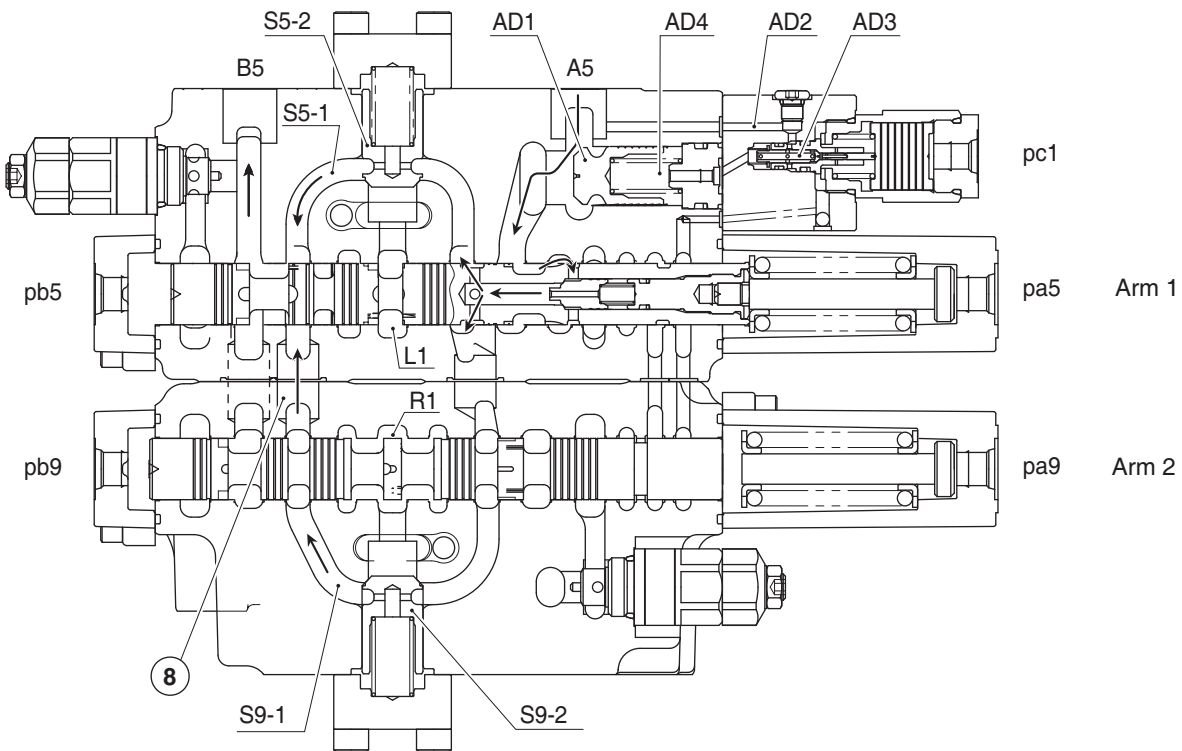


Figure 15

EX1504798

B. Variable regeneration

When crowding arm, after return oil from port (A5) flows through notch (a), one portion of the oil returns through fixed orifice (d), passage (e) and variable orifice (f) and to tank passage (Ta). The other portion of the oil flows through fixed orifice (b), regeneration check (c), and fixed orifice (i) in arm 1 spool, and joins in bridge passage (S5-1).

From there, if load pressure of port (B) is increased, it flows through regeneration release valve piston (g) and pushes regeneration release spool (h), as a result area of variable orifice (f) is increased, and oil returning to tank (Ta) is increased, and some oil to regenerate in port (B5) is decreased.

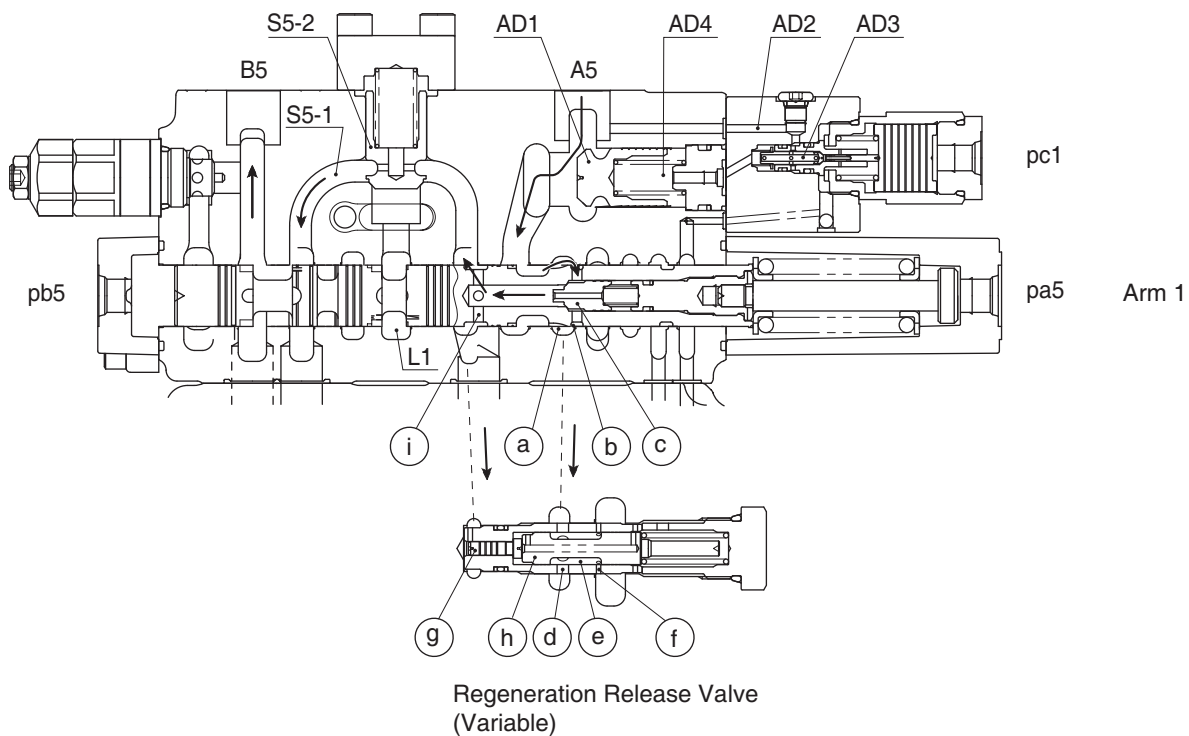


Figure 16

EX1504799

3. Arm dump (2-pump confluence)

When arm 1 spool is shifted by increasing pressure of arm 1 (Section 5) pilot port (Pa5), oil supplied to port (P1) flows through neutral passage (L1), load check valve (S5-2), passage (S5-1) and spool and into port (A5).

Oil supplied to port (P2) flows through neutral passage (R1), load check valve (S9-2), passage (S9-1), spool and passage (8) and joins at port (A5). Return oil from port (B5) returns through spool to tank passage (Ta).

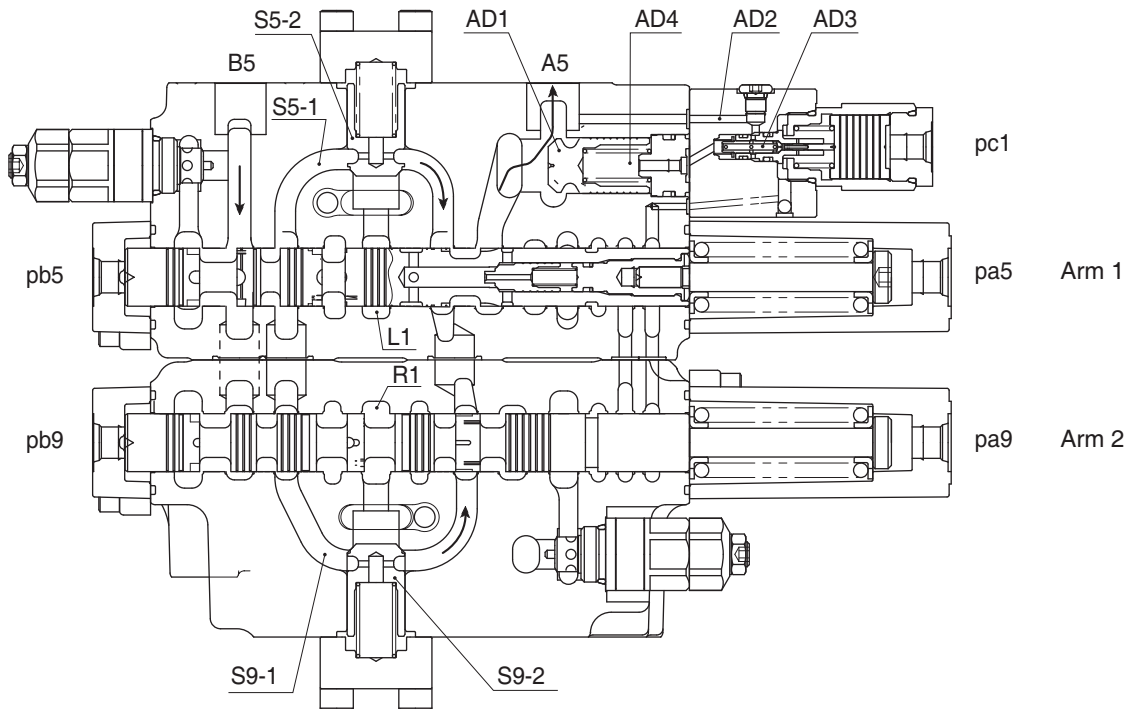


Figure 17

EX1504800

Parallel Orifice for Arm

The orifice, that is installed in parallel passage for arm 1, controls arm speed when operating in a combined operation. Oil supplied from parallel passage (L3) of arm 1 (Section 5) pushes open poppet (S5-3). It then flows through orifice (Lc8) of variable orifice spool, and then is connected to passage (L5). From here, flow of orifice (Lc8) can be varied by increasing or decreasing pressure against pilot poppet (Pc3).

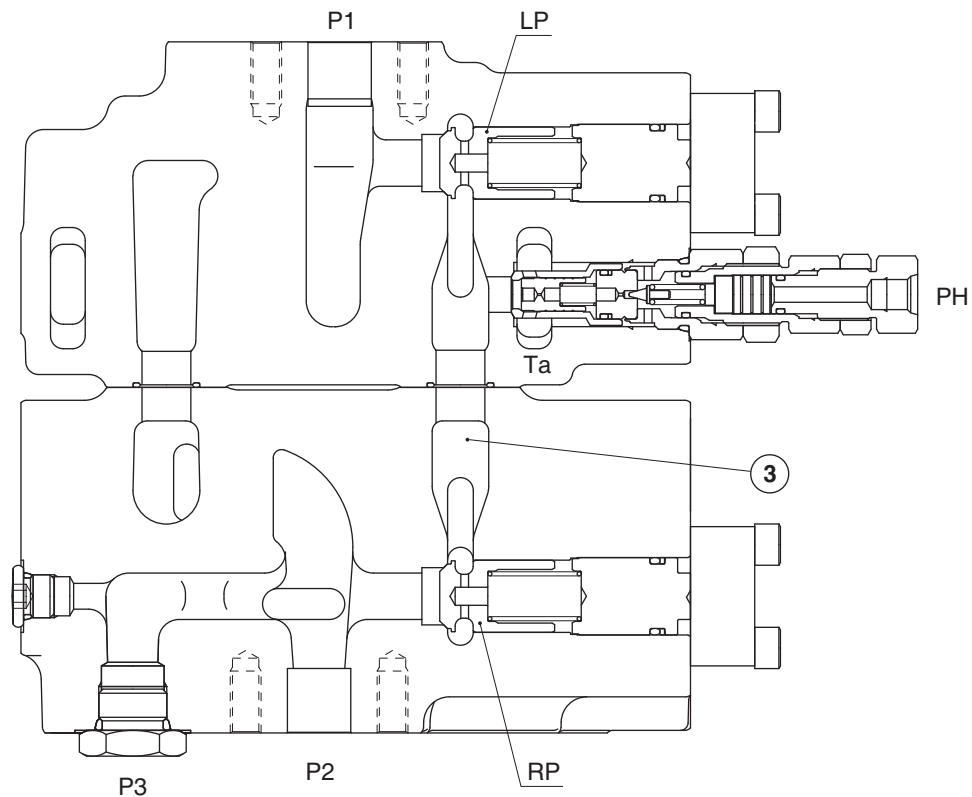
Relief Valve

1. Main relief valve

Oil supplied to port (P1) flows through poppet (LP). Oil supplied to port (P2) flows through poppet (RP) and passage (3). They join at the main relief valve. The highest pressure of pump (P1 and P2) is controlled by reaction of main relief valve.

2. Overload relief valve

The overload relief valve, that is installed in each cylinder port of boom 1, arm 1 and bucket, prevents pressure of actuator from increasing extremely high from outside forces. This relief valve, when pressure of cylinder port is negative, has a function to prevent cavitation by drawing oil from tank.



FG000631

Figure 18

Compound Operation

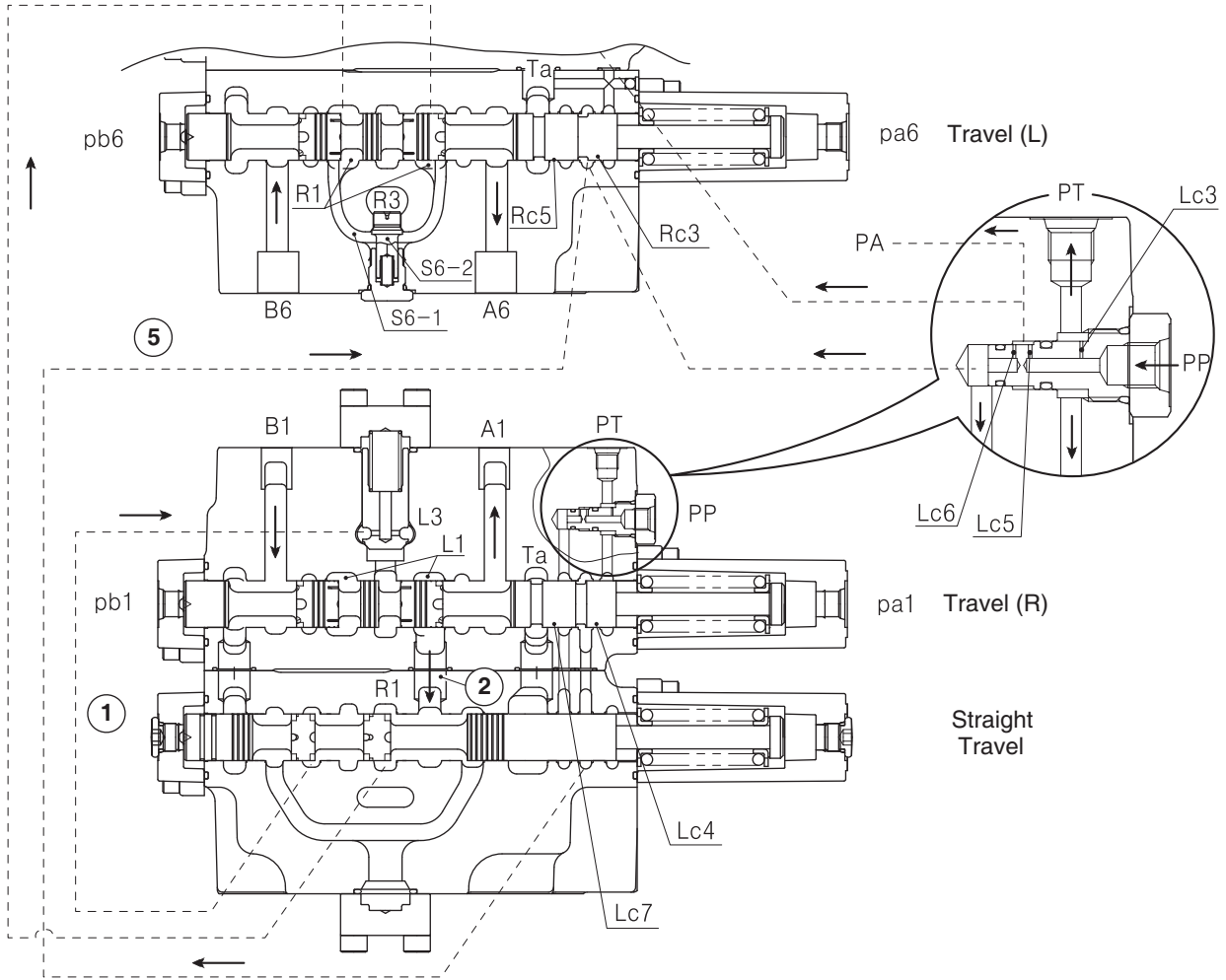
Travel Compound Operation

In the event of operating another function when the traveling left or right (when advancing, backing, or pivot turning) or operating for travel operation during the operation other than traveling, the oil supplied from the port (PP) is cut off from the tank passage (Ta) in the signal land part of the section other than the travel shifted from the land (Lc4), (Lc7), (Rc3), and (Rc5), and the pressure of the signal passage is increased to the relief set pressure of the oil origin for signal.

Because of the increase of the signal pressure, the spool before traveling is shifted to cause an increase of pressure in ports (PT and PA).

When the straight travel spool is shifted, the oil supplied from port (P1) flows to travel (section1) from neutral passage (L1) while oil supplied to port (P2) flows into travel (section 6) after passing through passage (2), straight travel spool head, and neutral passage (R1) flowing into the parallel passage (L3) after passing the straight travel spool head, and passage (1).

If the load pressure of section other than traveling is higher than the travel (Section 6) load pressure, some of the oil supplied from port (P2) pushes and opens poppet (S6-2), and it merged into the passage (S6-1) after passing the orifice of the poppet. The operation is made by oil supplied from travel (Section 1 and 6) port (P1), and work device other than traveling is operated by the oil supplied from the port (P2), and projection is prevented when operating with travel operation and other work device.



EX1504801

Figure 19

Rotating Compound Operation

A priority control valve is installed in rotating (Section 7). This valve controls oil flow entering rotating when operating during a combined operation with travel, boom 1, and arm 2 sections, on P2 side. If pressure at port (Pi3) is increased when operating rotating, piston (S7-6), piston (S7-5) and plug (S7-4) are pressed, and poppet assembly (S7-2) is seated on valve housing.

This causes oil flowing from parallel passage (R3) to open poppet (S7-3) in poppet assembly and flow into passage (S7-1). As a result, passage diameter is smaller during combined operation, than passage diameter during a single operation.

This smaller passage reduces flow of oil to port (A7, B7). Remaining oil flows through parallel passage (R3) and primarily flows to section being operated at P2 side during a combine operating procedure.

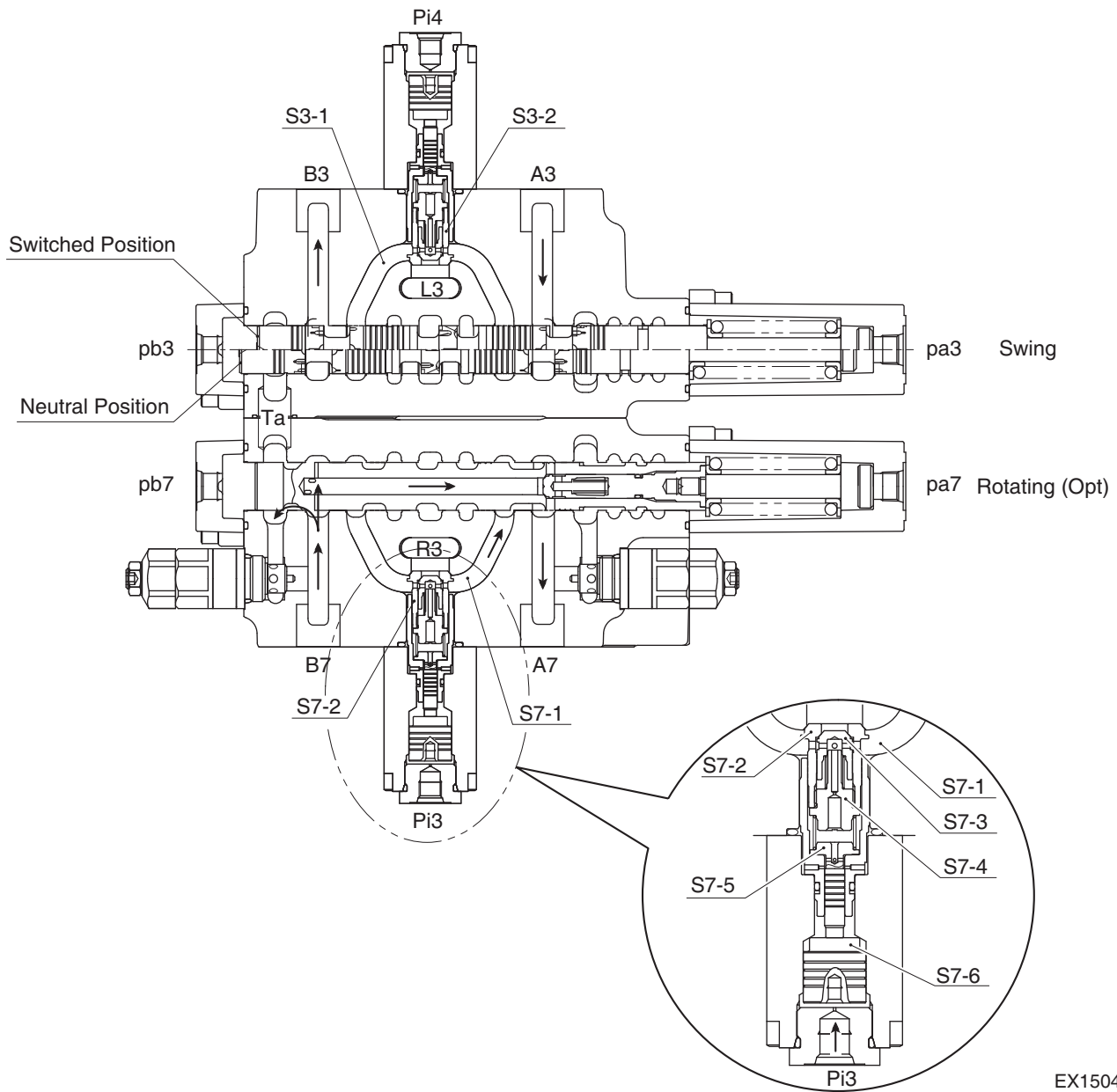


Figure 20

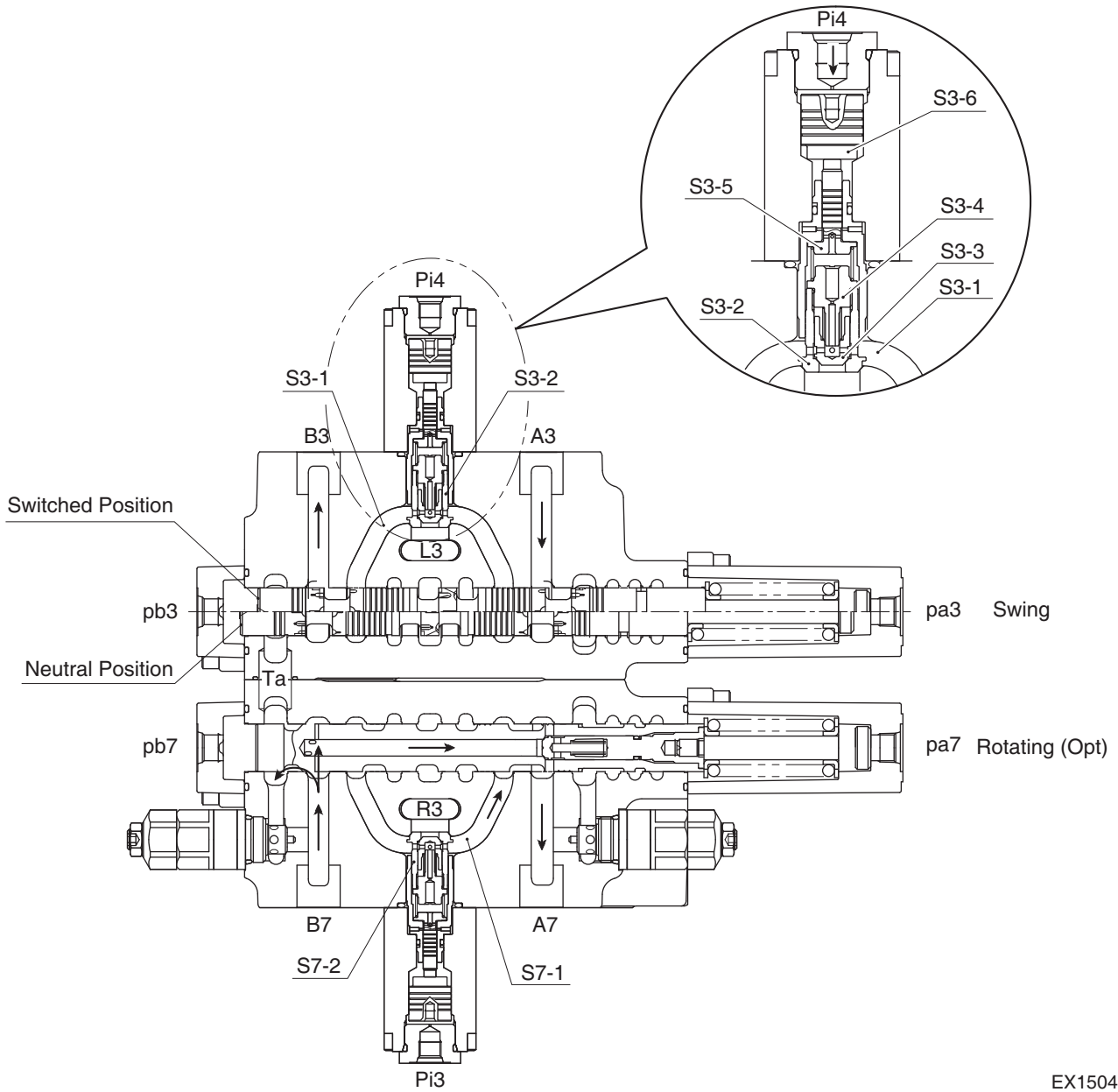
EX1504802

Swing Compound Operation

The valve's swing Section (Section3) is equipped with the control valve that adjusts the flux that flows into the swing when combined operating with the Section (travel, boom 2, arm 1) of P1.

If port (Pi) is pressurized when operating swing function, piston (S3-6) is pushed to have the poppet assembly (S3-2) to be pressed under the seat part of the valve housing through the piston (S3-5) and plug (S3-4). In this way, the oil in the parallel passage (L3) is flowing into the passage (S3-1) by pushing up the poppet (S3-3) inside the poppet assembly.

As a result, the passage at the time of compound operation is tightened more than when single operation that flux flowing into A3 (B3) is reduced, and the surplus flux is advanced to the section that P1 is simultaneously operated through the parallel passage (L3).



EX1504803

Figure 21

Antidrift Valve

The antidrift valve is installed on the cylinder port on the arm load (boom bore) for the natural antidrift of the arm (boom) cylinder. (For typical example, arm (A5) is shown.)

1. Neutral condition (maintaining port (A5))
 - A. The holding pressure of port (A5) is sent through passages (a, b, and c), and into spring chamber (d) of poppet (1). Now pressurized oil flow, from port (A5) is cut off by seats (S1 and S2).

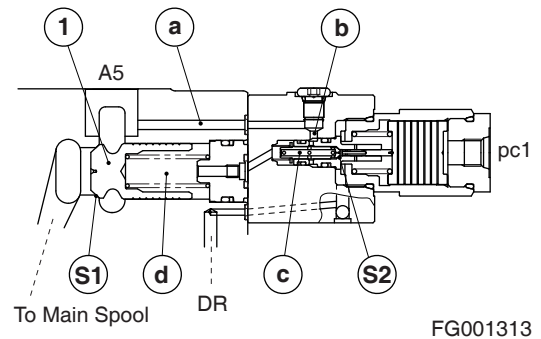


Figure 22

2. Oil passage cut off condition of the port (A5) and the spring chamber.
 - A. If port pc1 is pressurized, piston (2) is moved and spool (3) reacts.
 - B. Spool (3) activates poppet (4).
 - C. Then by moving poppet (4), port (A5) and spring chamber (d) is cut off by part (T1).

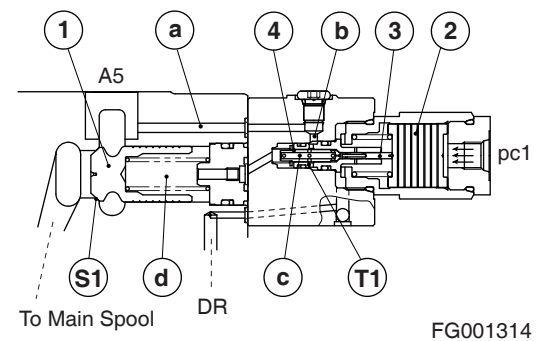


Figure 23

3. Main poppet operation condition.
 - A. When the piston (2) starts, the spring chamber (d) passes from the passage (c) to the passage (e) and connect the oil passage by the part (T2) to the drain chamber (DR).
 - B. The spring chamber (d) drains pressure and the main poppet (1) starts to unseat.

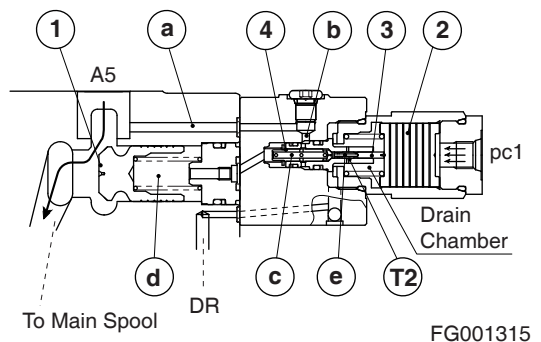
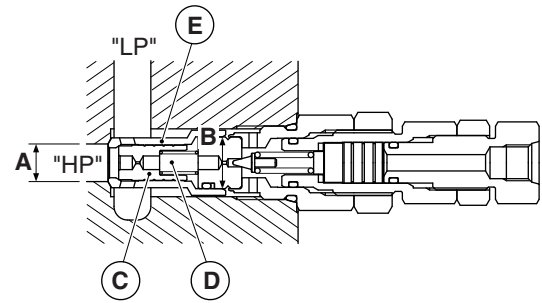


Figure 24

Main Relief Valve

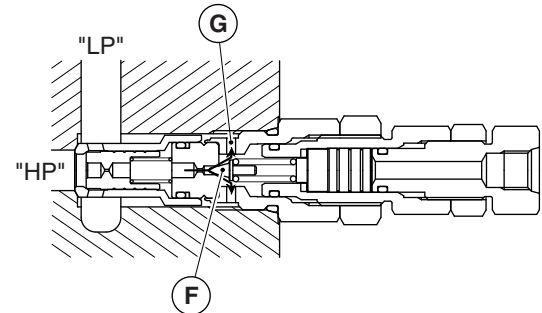
1. The main relief valve is between neutral oil passage (HP, Figure 28) and low-pressure oil passage (LP). Pressurized oil flows into neutral oil passage (HP) through orifice in the main poppet (C) to fill internal cavity (D). Because of the difference in areas between (A and B), on which hydraulic pressure acts, main poppet (C) seats on sleeve (E).



FG000639

Figure 25

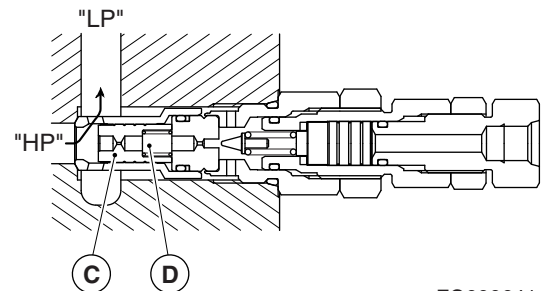
2. When pressure in neutral oil passage (HP) rises and exceeds relief valve setting, pilot poppet (F) opens. Pressurized oil flows through pilot poppet (F) into low-pressure oil passage (LP), passing through hole (G).



FG000640

Figure 26

3. As pilot poppet (F) opens, pressure in internal cavity (D) lowers to move main poppet (C) so pressurized oil flows into neutral oil passage (HP) and directly into low-pressure oil passage (LP).

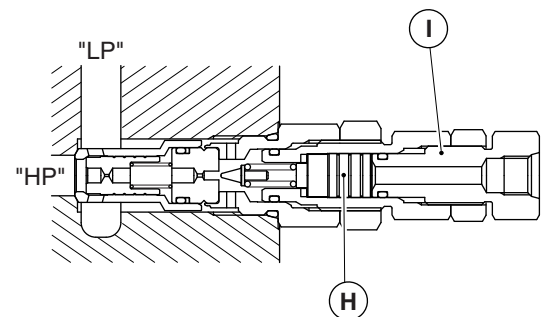


FG000641

Figure 27

4. Pressure up operation

If pressure is applied to pilot port "PH", piston (H) moves to the pressure setting position of plug (I) so the force of spring increases, thus increasing pressure in the neutral oil passage (HP).



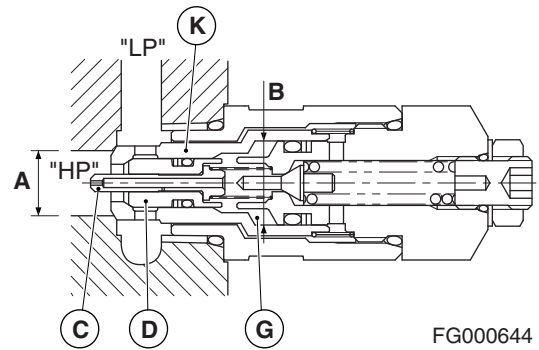
FG000642

Figure 28

Overload Relief Valve

Operation

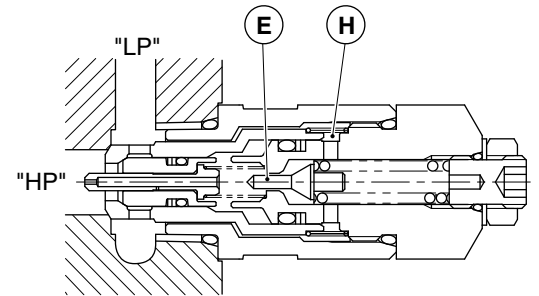
1. The overload relief valve is between cylinder port (HP) and low-pressure oil passage (LP). Pressurized oil at cylinder port (HP), flows through an orifice in piston (C), to fill internal cavity (G). Because of the difference in area between (A and B) on which the hydraulic pressure acts, main poppet (D) seats on sleeve (K).



FG000644

Figure 29

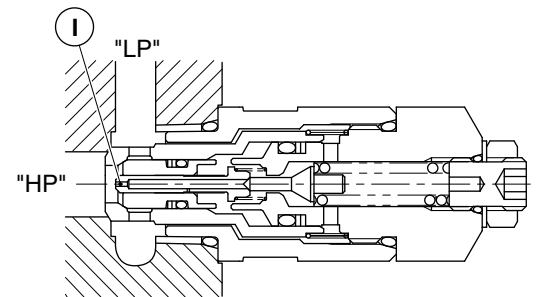
2. When pressure in cylinder port (HP) rises and exceeds the relief valve setting, pilot poppet (E) opens. Pressurized oil then flows through pilot poppet (E) into low-pressure oil passage (LP), passing through hole (H).



FG000645

Figure 30

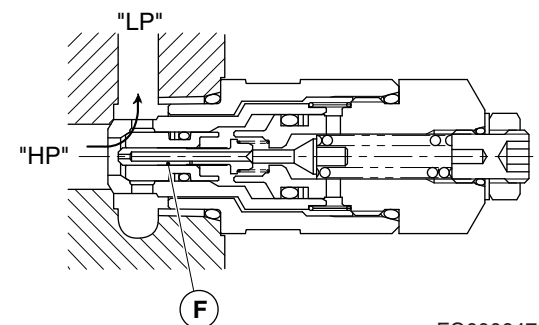
3. As pilot poppet (E) opens, pressurized oil flows through orifice (I) so pressure on back of piston (C) lowers to move piston (C). As a result, piston (C) seats on pilot poppet (E).



FG000646

Figure 31

4. Pressurized oil in passage (HP) flows through orifice (F) in piston (C) so pressure on back of main poppet (D) moves main poppet (D). Pressurized oil then flows into passage (HP) and directly into passage (LP).

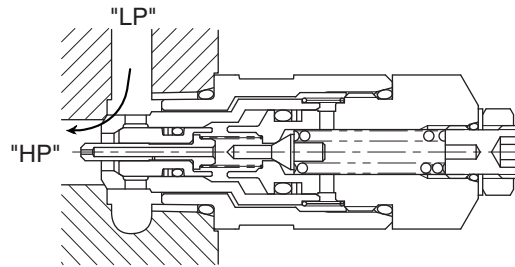


FG000647

Figure 32

Absorption Operation

An anticavitation unit is installed in cylinder port (HP) to prevent the development of cavitation. If pressure at cylinder port (HP) becomes lower than that of oil passage (LP), sleeve (K) moves so oil is supplied from the low-pressure oil passage (LP) to cylinder port (HP) to eliminate cavitation.



FG000648

Figure 33

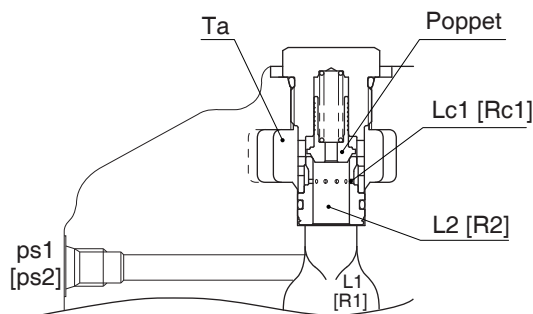
Low-pressure Relief Valve

1. Signal pressure

Oil supplied from pump port (P1 (P2)) flows through neutral passage (L1 (R1)), low-pressure relief valve passage (L2 (R2)), and orifice (Lc1 (Rc1)) to tank passage (Ta).

Now, pressure generated at passage (L2 (R2)) by orifice (Lc1 (Rc1)) moves to low-pressure relief signal port (Ps1 (Ps2)).

If main spool of upper reaches of L2 (R2) operates, signal pressure of Ps1 (Ps2) decreases because oil flowing to L2 (R2) decreases.



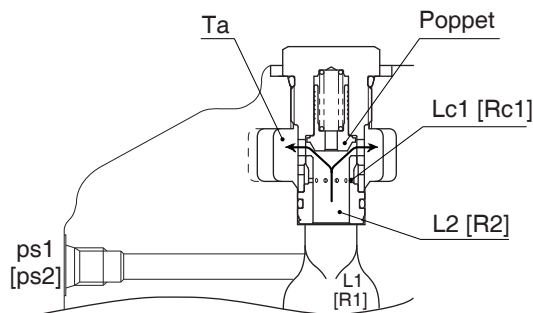
FG001319

Figure 34

2. Operation of relief

If excessive oil flows into passage (L2 (R2)), pressure generated at passage (L2 (R2)) by orifice (Lc1 (Rc1)) goes to back chamber of poppet, and poppet operates by the difference of pressurized area between passage and back chamber.

By operation of this poppet, oil flows from passage through plug and drill hole to tank passage (Ta). By this action, generation of excessive pressure in low-pressure relief signal port is prevented.



FG001320

Figure 35

Cautions for Operation

1. Before operating machine, make sure that oil passages and hydraulic oil are clean.
2. Relief valve pressure should not be raised above specified pressure setting.
3. The difference between main relief valve setting pressure and overload relief valve setting pressure should not be over 2.0 MPa (19.9 bar (290 psi)).
4. Before operating machine, the hydraulic system must be fully warmed up. If machine is operated with cold hydraulic oil and valve, be careful of the following, to prevent spool sticking because of heat shock.

NOTE: *Do not operate main relief valve or overload relief valve suddenly and continuously. Cycle oil through all actuators and warmed up cold hydraulic oil in the lines and components uniformly.*

NOTE: *Slight or compound work should not be suddenly operated at cold weather because heat is developed partly at all the orifices.*

PRECAUTION

Lower the work equipment to the ground and stop engine.

Operate the control levers and pedals several times to release the remaining pressure in the hydraulic piping

Loosen the breather slowly to release the pressure inside the hydraulic tank.

Escaping fluid under pressure can penetrate the skin causing serious injury.

When pipes and hoses are disconnected, catch the oil with an oil pan.

Tools and Torques

Tool	Torque
Allen Wrench 4	1.5 kg.m
Allen Wrench 5	0.9 ~ 1.1 kg.m
Allen Wrench 6	1.6 kg.m
Allen Wrench 8	4 ~ 4.5 kg.m
Allen Wrench 14	17 ~ 18 kg.m
Wrench 17	7.3 kg.m
Wrench 22	4 ~ 4.5 kg.m
Wrench 27	11 kg.m
Wrench 32	11 kg.m
Wrench 30	6 ~ 7 kg.m
Wrench 36	22 kg.m
Wrench 38	15 ~ 16 kg.m
Bit Wrench 4	
Bit Wrench 4	
Loctite 271	

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Make the machine swing about 30° rightward on the flat ground as shown in (Figure 39) before lowering the all attachments on the ground and then stop engine.

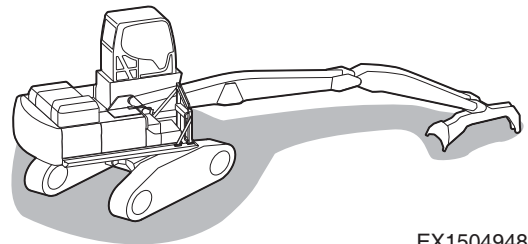


Figure 36

2. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 40)
3. Turn starter switch to "I" (ON) position.

! WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

4. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
5. Move safety lever to "LOCK" position. (Figure 40)
6. Turn key to "O" (OFF) position and remove from starter switch.
7. Attach a maintenance warning tag on controls.
8. Turn battery disconnect switch to "OFF" position. (Figure 41)

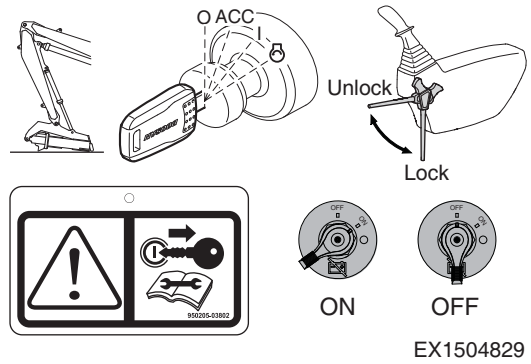


Figure 37

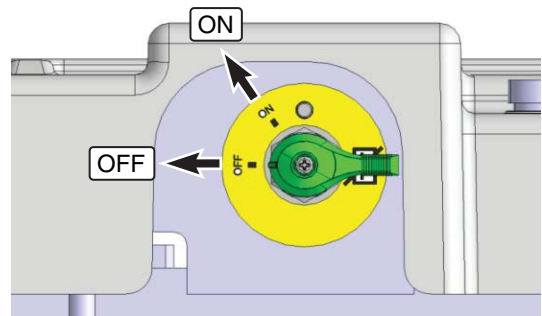


Figure 38

NOTE: *Removal (installation) procedure of the bolts.*

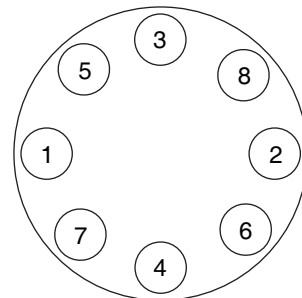



Figure 39



WARNING

AVOID DEATH OR SERIOUS INJURY

Release any pressure in the hydraulic oil tank before doing any work.

9. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
10. Oil drain method
 - A. Remove cover on oil tank (bolt: 6 ea) drain hydraulic oil using oil pump.
 - Tool: 14 mm ()
 - Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

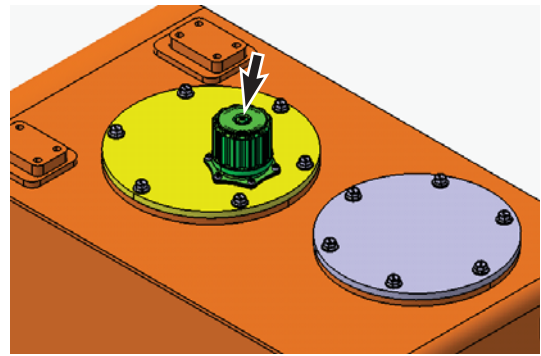


Figure 40

EX1403168

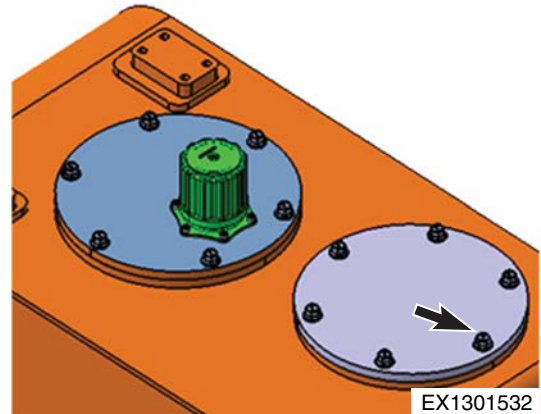



Figure 41

EX1301532

- B. Drain hydraulic fluid using drain plug. (without oil pump)
 - Tool: 27 mm ()
 - Hydraulic oil tank capacity: approximately 280 L
 - Torque: 93.2 N.m (9.5 kg.m, 68.7 ft lb)

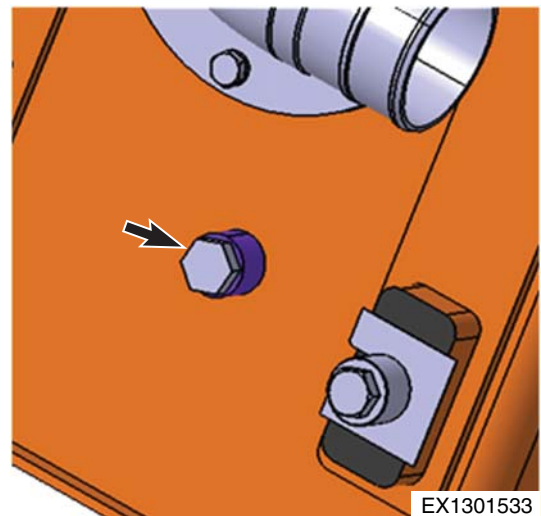
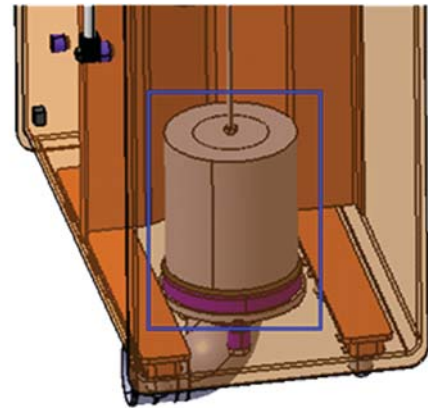


Figure 42

EX1301533

C. Plug the filter cap to location of suction filter.

Item	Part Number
Filter Cap	2188-1011



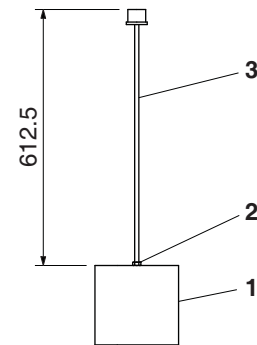
EX1301534

Figure 43

Reference Number	Description
1	Suction Filter
2	Nut
3	Rod

When installing

- Torque (2 nut): 49 N.m (5 kg.m, 36.2 ft lb)



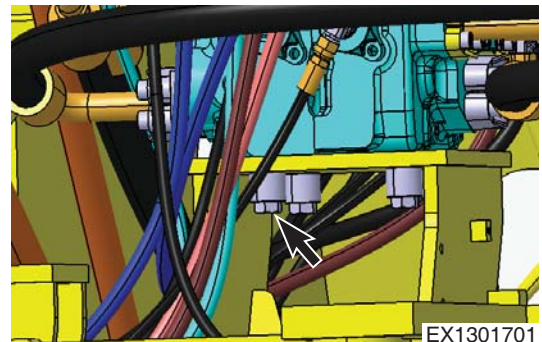
EX1301588

Figure 44

11. Loosen the main control valve mounting bolts from main frame bracket. (bolt: 4 ea) (Figure 48)

NOTE: Do not remove bolts completely to hold the position of control valve.

- Tool: 24 mm (🔧)
- Torque: 264.6 N.m (27 kg.m, 195.2 ft lb)

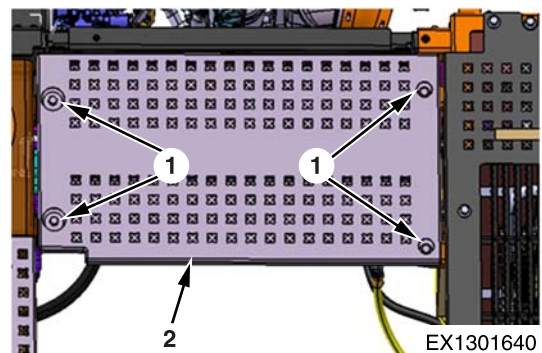


EX1301701

Figure 45

12. Open the engine cover and remove bolts and washers (1, Figure 49) (4 ea) with cover (2).

- Tool: 19 mm (🔧)
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)



EX1301640

Figure 46

13. Disconnect the harness connector (2 ea).

Port	Location
PT,PA	Right Side

NOTE: *be careful not to let water get into electrical components (sensor, connectors). If water gets into electrical system, this will cause an electrical short circuit and result in improper machine operation.*

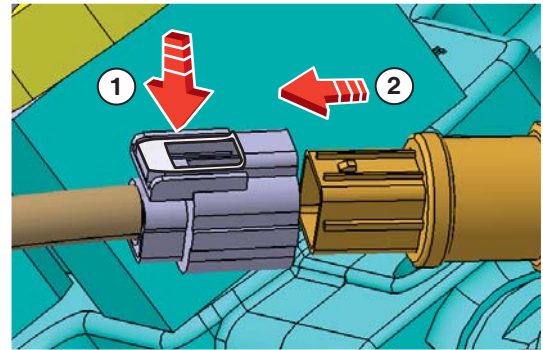


Figure 47

EX1402294

14. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.



Figure 48

EX1504170

15. Remove hoses, pipes and adapters from control valve.

NOTE: *Attach identification tags to the removed hoses for reassembling.*

After disconnecting hoses from main control valve, plug them to prevent dirt or dust from entering.

Disconnect the hoses from the bottom to top of control valve.

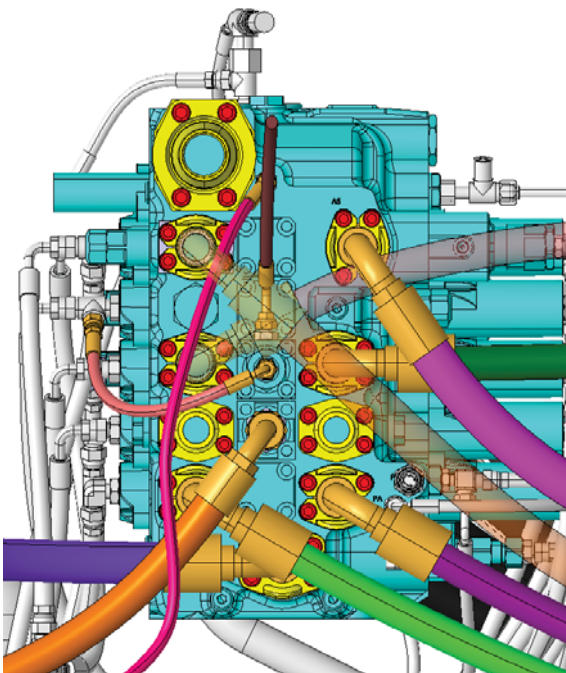
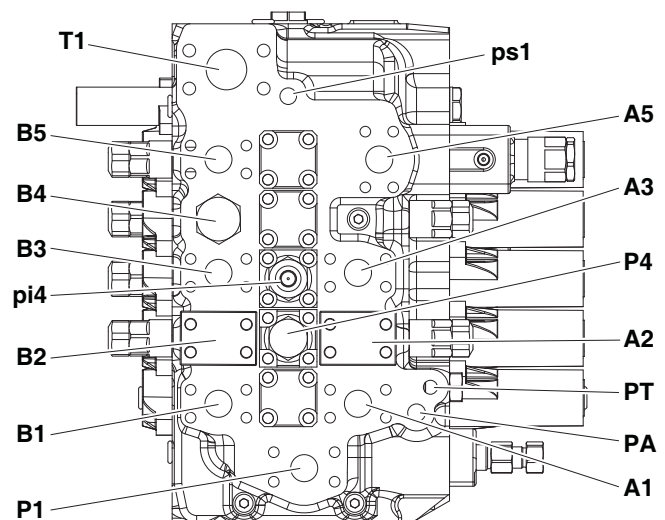


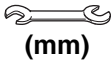

Figure 49



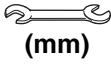

Right Side View

EX1505110

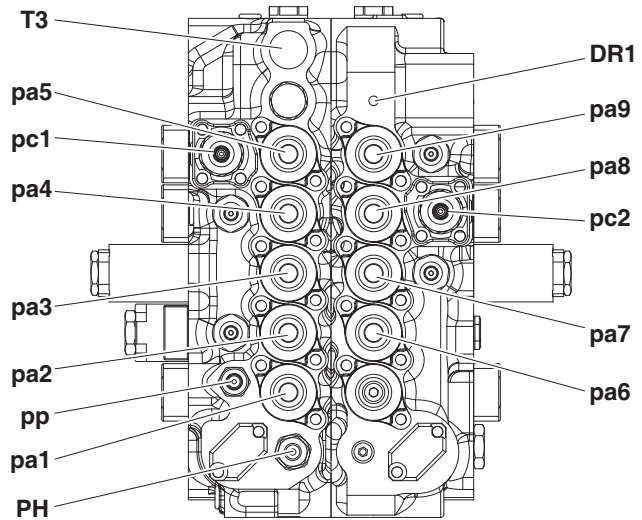
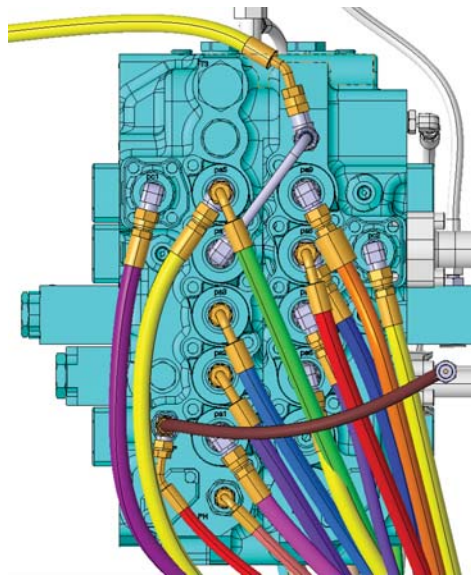
- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	 (mm)	Torque		
					N.m	kg.m	ft lb
P1	from Main Pump "A1"	SAE 1", D25.4		10	97.0	9.9	71.6
P4	from Stop Valve for Two Pump "B"	UNF 1 3/16"-12-2B	36		124.5	12.7	91.8
T1	to Oil Tank	SAE 1 1/2", D38.1		10	97.0	9.9	71.6
PT	Pressure Sensor	PF 1/4"	19		35.3	3.6	26.0
PA	to Swing Device "SH"	UNF 9/16"-18-2B	19		25.5	2.6	18.8
	Pressure Sensor	PF 1/4"	19		39.2	4	28.9
A1	to Center Joint (Spindle) "3"	SAE 1", D25.4		8	57.8	5.9	42.7
A2	to Heel Cylinder "Head"	SAE 1", D25.4		8	57.8	5.9	42.7
A3	to Swing Device "B"	SAE 1", D25.4		8	57.8	5.9	42.7
A5	to Stick Cylinder "Rod"	SAE 1", D25.4		8	57.8	5.9	42.7
B1	to Center Joint (Spindle) "4"	SAE 1", D25.4		8	57.8	5.9	42.7
B2	to Heel Cylinder "Rod"	SAE 1", D25.4		8	57.8	5.9	42.7
B3	to Swing Device "A"	SAE 1", D25.4		8	57.8	5.9	42.7
B5	to Stick Cylinder "Head"	SAE 1", D25.4		8	57.8	5.9	42.7
ps1	to Main Pump "Pi1"	UNF 9/16"-18-2B	19		25.5	2.6	18.8
pi4	Connect with "pb4"	UNF 9/16"-18-2B	19		25.5	2.6	18.8

- Fitting

Port	Name	Size		 (mm)	 (mm)	Torque		
		A	B(C)			N.m	kg.m	ft lb
T1	Block (Bolt)	M12 x 1.75			10	107.8	11	79.5
P4	Adapter	PF 3/4"	UNF 1 3/16"-12	36		158.8	16.2	117.1
PA	Tee	PF 1/4"	PF 1/4", UNF 9/16"-18	19		35.3	3.6	26.0
ps1, pi4	Adapter	PF 1/4"	UNF 9/16"-18	19		35.3	3.6	26.0
P4		S8000241 (1B P24)	S8030125 (4D F-12)					
T1		DS2856005 (1 1/2", ID:47.6, OD:54.6, 1B)	DS2856005 (1 1/2", ID:47.6, OD:54.6, 1B)					
PA		S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)					
P1, A1, A2, A3, A5, B1, B2, B3		DS2856003 (1", ID:33.2, OD:40.2, 1B)						
B5		DS2856003 (1", ID:33.2, OD:40.2, 1B)	DS2856003 (1", ID:33.2, OD:40.2, 1B)					
ps1, pi4		S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)					

* A: Opposite side of hose, B (C): Hose side




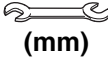
Front Side View

EX1505111

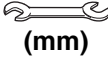
Figure 50

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
T3	from Swing Device "C"	UNF 1 7/16"-12-2B	41	169.5	17.3	125.1
DR1	Connect with "pa4" (Pipe)	UNF 11/16"-16-2B	22	49	5	36
	to Oil Tank	UNF 11/16"-16-2B	22	38.2	3.9	28.2
Pa1	Connect with Cabin Riser Joint Sub Assembly "B8" (from Pedal Valve "4")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
Pa2	Connect with Joint Sub Assembly "B1" (from Joystick Valve (RH) "3")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
Pa3	Connect with Joint Sub Assembly "B8" (from Joystick Valve (LH) "1")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
Pa4	connect with "DR1" (Pipe)	UNF 11/16"-16-2B	22	49	5	36
Pa5	Connect with Joint Sub Assembly "B4" (from Joystick Valve (LH) "4")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	from Shift Valve for Two Pump "PI"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
Pa6	Connect with Cabin Riser Joint Sub Assembly "B6" (from Pedal Valve "2")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
Pa7	Connect with Cabin Riser Joint Sub Assembly "B15" (from EPPR Valve for Grapple "B")	UNF 9/16"-18-2B	19	25.5	2.6	18.8
Pa8	Connect with "pb4"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	Connect with Joint Sub Assembly "B5" (from Joystick Valve (RH) "4")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
Pa9	from Shift Valve for Two Pump "A"	UNF 11/16"-16-2B	22	38.2	3.9	28.2

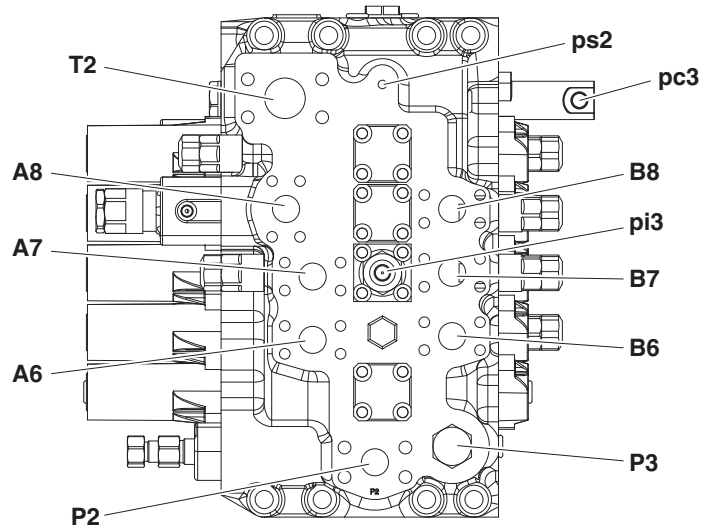
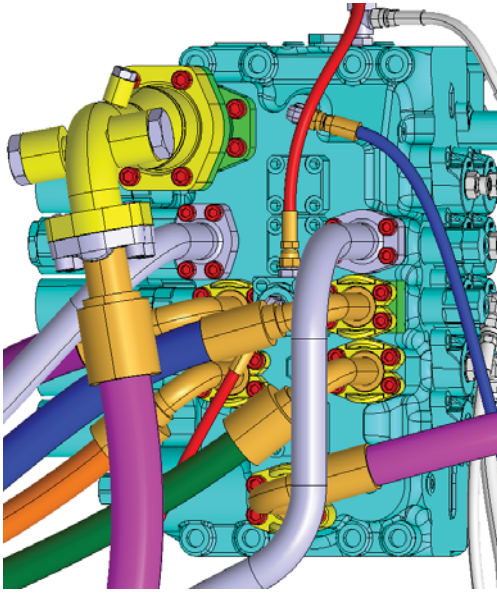
Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
pc1	Connect with Joint Sub Assembly "B3" (from Joystick Valve (LH) "2")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
pc2	Connect with Joint Sub Assembly "B7" (from Joystick Valve (RH) "2")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
pp	to Swing Device "PG"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
	from Solenoid Valve "P1"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
PH	from Solenoid Valve "PH"	UNF 9/16"-18-2B	19	25.5	2.6	18.8

- Fitting

Port	Name	Size		 (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
T3	Adapter	PF 1"	UNF 1 7/16"-12	41	185.2	18.9	136.6
DR1	Adapter	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
	Tee	UNF 11/16"-16	UNF 11/16"-16	22	49	5	36
Pa1, Pa4, Pa6, Pa9	Elbow	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
Pa2, pa3	Adapter	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
Pa5, Pa8	Tee	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
Pa7	Elbow	PF 3/8"	UNF 9/16"-18	22	44.1	4.5	32.5
pc1, pc2	Elbow	PF 1/4"	UNF 11/16"-16	19	35.3	3.6	26.0
PP, PH	Tee	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
T3	O-ring	S8000291 (1B P29)	S8030165 (4D F-16)				
DR1, Pa1, Pa2, Pa3, Pa4, Pa5, Pa6, Pa8, Pa9		S8000145 (4D P14)	S8030061 (1B F-06)				
Pa7		S8000145 (4D P14)	2180-1216D11 (ID:7.65, W:1.78, 1B)				
pc1, pc2		S8000115 (4D P11)	S8030061 (1B F-06)				
PP, PH		S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)				

* A: Opposite side of hose, B (C): Hose side

NOTE: *Be careful the assembly angle of elbow (pa4 port) when assemble the pipe connecting pa4 and DR1.*





Left Side View


EX1505112

Figure 51

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	 (mm)	Torque		
					N.m	kg.m	ft lb
T2	from Oil Cooler	SAE 1 1/2", D38.1		10	97.0	9.9	71.6
P2	from Main Pump "A2"	SAE 1", D25.4		10	97.0	9.9	71.6
P3	to Stop Valve for Two Pump "A"	UNF 1 3/16"-12-2B	36		124.5	12.7	91.8
A6	to Center Joint (Spindle) "1"	SAE 1", D25.4		8	57.8	5.9	42.7
A7	to Rotating (Grapple) Cylinder "Rod"	SAE 1", D25.4		8	57.8	5.9	42.7
A8	to Hoist Cylinder "Head"	SAE 1", D25.4		8	57.8	5.9	42.7
B6	to Center Joint (Spindle) "2"	SAE 1", D25.4		8	57.8	5.9	42.7
B7	to Rotating (Grapple) Cylinder "Head"	SAE 1", D25.4		8	57.8	5.9	42.7
B8	to Hoist Cylinder "Rod"	SAE 1", D25.4		8	57.8	5.9	42.7
ps2	to Main Pump "pi2"	UNF 9/16"-18-2B	19		25.5	2.6	18.8
pc3	connect with "Dr2"	UNF 9/16"-18-2B	19		25.5	2.6	18.8
pi3	connect with Joint Sub Assembly "B5" (from Joystick Valve (RH) "4")	UNF 9/16"-18-2B	19		25.5	2.6	18.8

- Fitting

Port	Name	Size		 (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
P3	Adapter	PF 3/4"	UNF 1 3/16"-12	36	158.8	16.2	117.1
ps2, pi3	Elbow	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
pc3	Adapter	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
T2	O-ring	DS2856005 (1 1/2", ID:47.6, OD:54.6, 1B)	2180-1026D31 (ID:69.44, W:3.53, Class1)				
P2, A6, A7, A8, B6, B8		DS2856003 (1", ID:33.2, OD:40.2, 1B)					
P3		S8000241 (1B P24)	S8030125 (4D F-12)				
B7		DS2856003 (1", ID:33.2, OD:40.2, 1B)	DS2856003 (1", ID:33.2, OD:40.2, 1B)				
ps2		S5110503 (ID:8.1, OD:12.7)	2180-1216D11 (ID:7.65, W:1.78, 1B)				
pc3, pi3		S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)				

* A: Opposite side of hose, B (C): Hose side

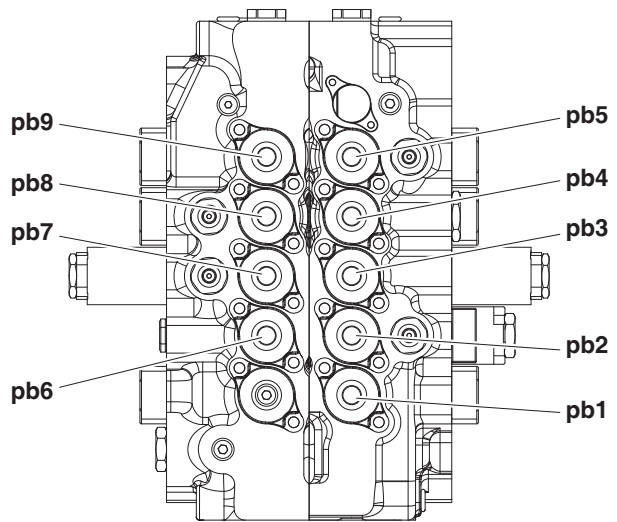
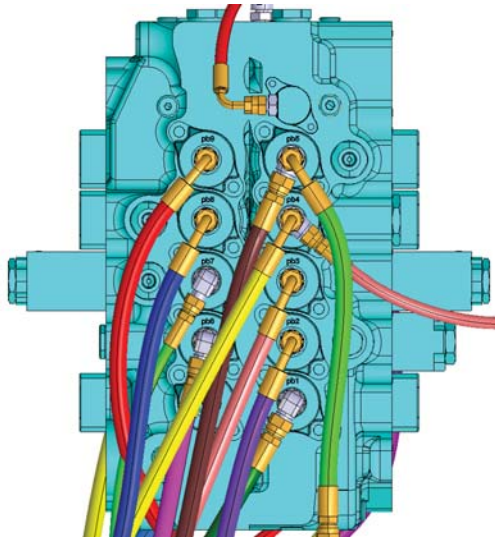
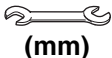


Figure 52


Rear Side View

EX1505113

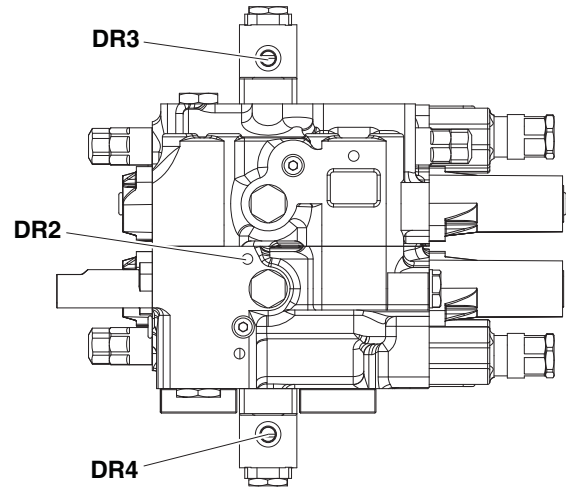
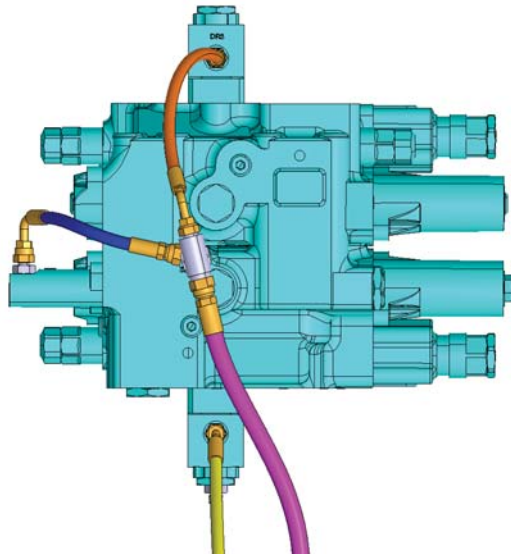
- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
pb1	connect with Cabin Riser Joint Sub Assembly "B7" (from Pedal Valve "3")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
pb2	connect with Joint Sub Assembly "B2" (from Joystick Valve (RH) "1")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
pb3	connect with Joint Sub Assembly "B6" (from Joystick Valve (LH) "3")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
pb4	connect with "pa8"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	connect with "pi4"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
pb5	from Shift Valve for Two Pump "P"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	connect with Joint Sub Assembly "B3" (from Joystick Valve (LH) "2")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
pb6	connect with Cabin Riser Joint Sub Assembly "B5" (from Pedal Valve "1")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
pb7	connect with Cabin Riser Joint Sub Assembly "B16" (from EPPR Valve for Grapple "P")	UNF 9/16"-18-2B	19	25.5	2.6	18.8
pb8	connect with Joint Sub Assembly "B7" (from Joystick Valve (RH) "2")	UNF 11/16"-16-2B	22	38.2	3.9	28.2
pb9	from Shift Valve for Two Pump "P"	UNF 11/16"-16-2B	22	38.2	3.9	28.2

- Fitting

Port	Name	Size		 (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
pb1, pb6	Elbow	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
pb2, pb9	Adppter	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
pb3	Adppter	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
pb4	Tee	PF 3/8"	UNF 9/16"-18, UNF 11/16"-16	22	44.1	4.5	32.5
pb5	Tee	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
pb7	Elbow	PF 3/8"	UNF 9/16"-18	22	44.1	4.5	32.5
pb8	Shockless Valve	PF 3/8"	UNF 11/16"-16	22	44.1	4.5	32.5
pb1, pb2, pb3, pb5, pb6, pb8, pb9	O-ring	S8000145 (4D P14)	S8030061 (1B F-06)				
pb4		S8000145 (4D P14)	S8030061 (1B F-06), 2180-1216D11 (ID:7.65, W:1.78, 1B)				
pb7		S8000145 (4D P14)	2180-1216D11 (ID:7.65, W:1.78, 1B)				

* A: Opposite side of hose, B (C): Hose side

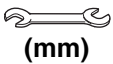


Top Side View

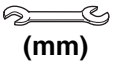
EX1505114

Figure 53

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
DR2	to Oil Tank	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	connect with "Pc3"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
DR3	connect with "DR2"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
DR4	to Oil Tank	UNF 9/16"-18-2B	19	25.5	2.6	18.8

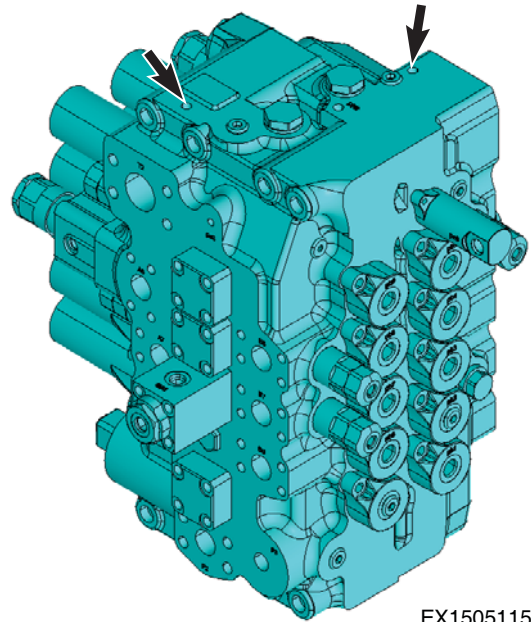
- Fitting

Port	Name	Size		 (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
DR2	Tee	PF 1/4"	UNF 11/16"-16, UNF 9/16"-18	19	35.3	3.6	26.0
		UNF 11/16"-16	UNF 11/16"-16, UNF 9/16"-18	22	49	5	36
DR3, DR4	Adapter	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
DR2	O-ring	S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B), S8030061 (1B F-06)				
DR3, DR4		S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)				

* A: Opposite side of hose, B (C): Hose side

16. Install eyebolts (2 ea) to lift in threaded holes on top of control valve. (Figure 57)

- Thread of hole: M10 x 1.5 (Depth 17 mm)
- Control valve weight: about 210 kg (463 lb)

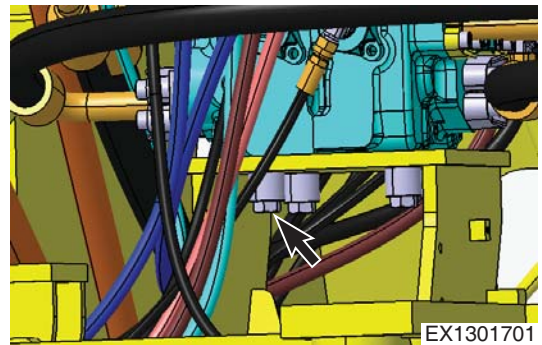


EX1505115

Figure 54

17. Remove main control valve mounting bolts from main frame bracket. (bolt: 4 ea) (Figure 58)

18. Lift the control valve by crane from frame slowly and carefully.



EX1301701

Figure 55

INSTALLATION



WARNING

INCORRECT INSTALLATION CAN CAUSE DEATH OR SERIOUS INJURY

Any change in the connections will lead to malfunctions (e.g. lift instead of lower).

- **When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.**

NOTE: First, assemble the bolts (4 ea) of main control valve mounting to main frame. (Figure 59)

1. Perform installation in the reverse order to remove.

IMPORTANT

After completing the work, check the oil level. Start the engine and check for any oil leaks.

2. Be careful not to apply stress on control valve when attaching piping and hoses. Unnecessary stress can cause spools to bind and the control valve from functioning properly.
3. Tighten the assembling bolts alternately and evenly to the specified torque.
4. If welding procedures are being performed near the control valve, the valve could be damaged by weld spatter and heat. Use adequate shielding to protect valve.
5. Valve ports must be covered with caps, plugs or tape to protect them from dust and other foreign materials, until pipe laying work is started.

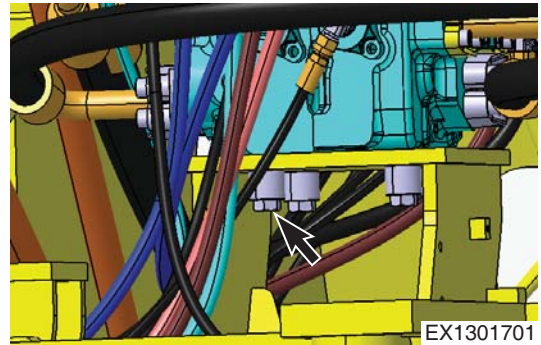


Figure 56

COMPLETING WORK

1. If the hydraulic oil in the oil tank was removed, refill the hydraulic oil tank.
2. Start the engine and run at low idling for about 5 minutes.
3. Operate the joystick lever and actuate the hydraulic cylinder 4 ~ 5 times very slowly, about 100 mm before the end of stroke.
4. Operate the rod of cylinder to the end of stroke to relieve the hydraulic piping. (The air breather of oil tank is actuated to bleed the air)

DISASSEMBLY

Caution on Disassembly

1. Stop engine when pressure of actuator is not indicated.

It is dangerous to disassemble control valve while it is under pressure. High-pressure oil can squirt out or components can spring out. When partially disassembling control valve that is on machine, be careful to follow the following caution.



WARNING

AVOID DEATH OR SERIOUS INJURY

Always relieve hydraulic pressure and fully lower bucket (or attachment) to the ground, before disassembly. Failure to follow instructions can cause sudden release of component parts or boom dropping, resulting in death or serious injury.

2. Vent pressurized air from hydraulic oil tank.
3. Clean all exterior surfaces of valve before to disassembly and protect it from dirt and foreign materials.
4. Match mark the disassembled parts to make sure of proper reassembling position.
5. Replace all sealing parts such as O-rings and backup rings with a new ones.
6. Do not replace spools, they are matched with valve housing and sleeve.

NOTE: *The further part numbers of an assembly part are shown as (assembly part number - further part number).*

Sequence of Disassembly

Disassembly of Main Spool Part

No.	Item	Tool	Torque
74	Socket Bolt	Allen Wrench 8	4 ~ 4.5 kg.m
72	Plug	Allen Wrench 8	4 ~ 4.5 kg.m
91	Plug	Wrench 22	4 ~ 4.5 kg.m

1. Remove socket head bolt (74, two places on each section, width across flats: 8 mm) and cap (8, ten places).
2. Remove plug assembly (72, width across flats: 8 mm) and plug (91, width across flats: 22 mm) according to necessity.
3. Remove O-ring (7, one place on each section) from valve housing (1 and 13).
4. Remove all spool subassemblies from valve housing

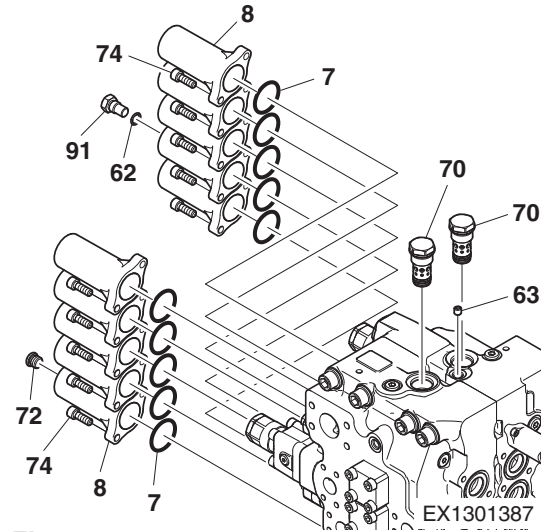


Figure 57

IMPORTANT

When removing spool, be careful not to damage it.

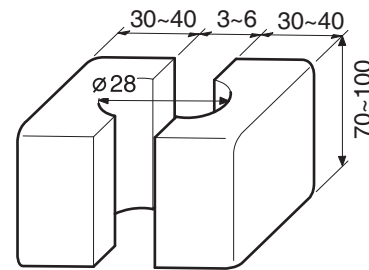
Attach label to each spool to install it in the correct position when reassembling.

5. Remove socket head bolt (74, two places on each section, width across flats: 8 mm) and cap (12, ten places).
6. Remove O-ring (7, one place on each section) from valve housing (1 and 13).
7. Disassembly of spool.

IMPORTANT

Work with spool gripped in vise with wood (see Figure 61) so as not to scratch outside diameter of spool.

Because Loctite is applied to threaded portion of spool end, heat outside surface of spool with industrial drier to release Loctite. Heat spool until spool end is easily loosened, and remove immediately after heating it to 200 - 250°C (392 - 482°F). If it overheated, change spring to new one.



FG001316

Figure 58

- A. Remove spool end (width across flats: 8 mm), spring seat and spring from spool assembly (2-6 and 14-17).

NOTE: There is a poppet, spring and plug in spool assembly. Do not disassemble unless absolutely necessary. If disassembly is necessary, heat spool outside surface to release Loctite in screw portion and remove plug. When reassembling, replace O-ring and backup ring to new ones.

Disassembly of Arm 1 Para-turn Spool Part

No.	Item	Tool	Torque
78	Socket Bolt	Allen Wrench 5	0.9 ~ 1.1 kg.m
22	Spool End	Allen Wrench 5	1.9 ~ 2.2 kg.m

1. Remove socket head bolt (78, width across flats: 5 mm) and cap (18).
2. Remove O-ring (23) from cap (18).
3. Remove spool (19) from valve housing under subassembly conditions.
4. Disassembly of spool.

IMPORTANT

Work with spool gripped in vise with wood (see Figure 61), so as not to scratch outside diameter of spool.

Because Loctite is applied to threaded portion of spool end, heat outside surface of spool with industrial drier to release Loctite. Heat spool until spool end is easily loosened, and remove immediately after heating it to 200 - 250°C (392 - 482°F).

If it is overheated, replace spring with a new one.

- A. Remove spool end (22, width across flats: 5 mm), spring seat (20) and spring (21) from spool (19).

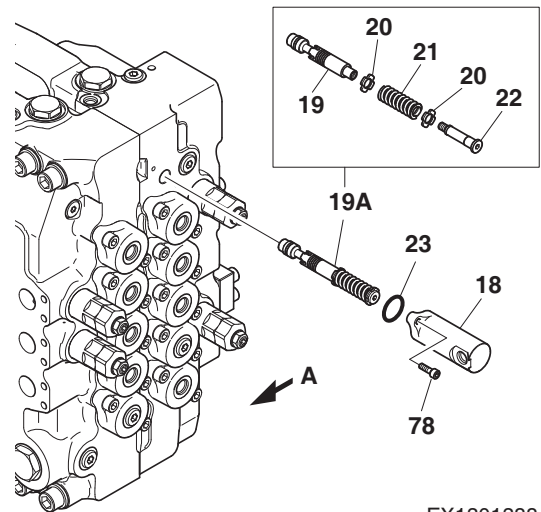


Figure 59

EX1301388

Disassembly of Arm Regeneration Release Valve Part

No.	Item	Tool	Torque
24	Plug	Wrench 5	11 kg.m

NOTE: The part including assembly is shown (assembly number -part number).



WARNING

AVOID DEATH OR SERIOUS INJURY

Always relieve hydraulic pressure and fully lower bucket (or attachment) to the ground, before disassembly. Failure to follow instructions can cause sudden release of component parts or boom dropping, resulting in death or serious injury.

1. Remove plug (24, width across flats: 32 mm) and O-ring (25).
2. Remove spring (26) and spool (27) from sleeve (28).
3. Remove sleeve (28) from valve housing.
4. Remove piston (29), O-ring (30) and backup ring (31) from sleeve (28).

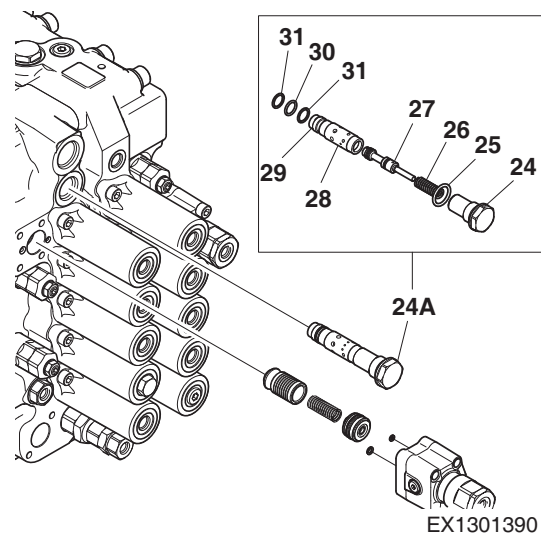
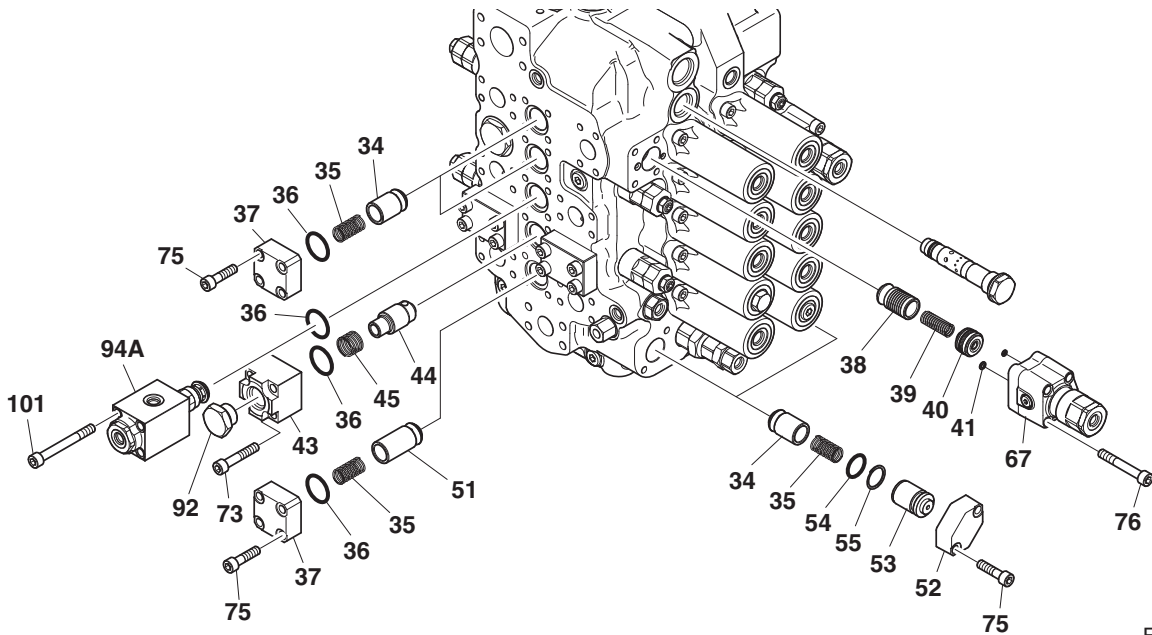


Figure 60

EX1301390

Disassembly of Load Check Valve Part



EX1301391

Figure 61

No.	Item	Tool	Torque
75	Socket Bolt	Allen Wrench 8	6.2 kg.m
73	Socket Bolt	Allen Wrench 8	6.2 kg.m
101	Socket Bolt	Allen Wrench 8	6.2 kg.m
46	Plug	Wrench 27	11 kg.m
72	Plug	Allen Wrench 8	7.7 kg.m
92	Plug	Wrench 36	22 kg.m
94	Plug	Wrench 36	22 kg.m



WARNING

AVOID DEATH OR SERIOUS INJURY

Always relieve hydraulic pressure and fully lower bucket (or attachment) to the ground, before disassembly. Failure to follow instructions can cause sudden release of component parts or boom dropping, resulting in death or serious injury.

1. Remove socket head bolt (75, four places on each section, width across flats: 8 mm) and flange (37, seven places).
2. Remove spring (35), poppet (34) (poppet (51)) and O-ring (36) from valve housing.



CAUTION

AVOID INJURY

Be careful, there is not a poppet and spring in travel straight valve section (Section H-H).

3. Remove socket head bolt (75, width across flats: 8 mm) and flange (52, two places).
4. Remove spacer (53) from valve housing. Remove O-ring (54) and backup ring (55) from spacer (53).
5. Remove spring (35) and poppet (34) from valve housing.
6. Remove plug (72, width across flats: 8 mm) (Section C-C).
7. Remove spring (33) and poppet (32) from valve housing.
8. Remove plug (72, width across flats: 8 mm) (Section L-L).
9. Remove spacer (57), spring (33) and poppet (32) from valve housing.
10. Remove plug (92, width across flats: 36 mm) (Section G-G).
11. Remove socket head bolt (73, four places, width across flats: 8 mm) and flange (43).
12. Remove spring (45), poppet (44) and O-ring (36) from valve housing.
13. Remove plug (46, width across flats: 27 mm) and O-ring (47).
14. Remove spring (48) and poppet (49) from valve housing.
15. Remove socket head bolt (101, four places, width across flats: 8 mm) from body (96, one places).
16. Remove body (96) from valve housing. Remove sleeve (99), piston (97), spring (98), poppet assembly (100), backup ring (103), and O-ring (104).
17. Remove O-ring (36).
18. Grip body (96) in vise. Remove plug (94), piston (95) and O-ring (102).

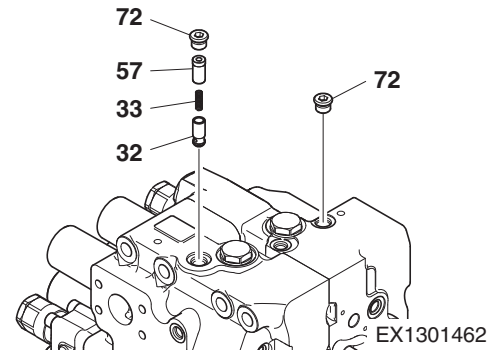


Figure 62

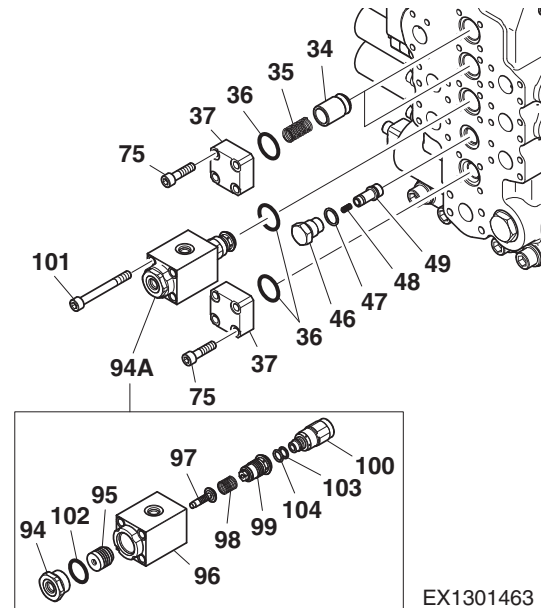


Figure 63

Disassembly of Antidrift Valve Part

No.	Item	Tool	Torque
67-3	Plug	Wrench 38	15 ~ 16 kg.m
67-14	Plug Assembly	Wrench 38	15 ~ 16 kg.m
67-15	Plug	Allen Wrench 4	1.5 kg.m
76	Socket Bolt	Allen Wrench 8	4 ~ 4.5 kg.m
78	Socket Bolt	Allen Wrench 5	0.9 ~ 1.1 kg.m

NOTE: The part including the assembly is shown (assembly number-part number).



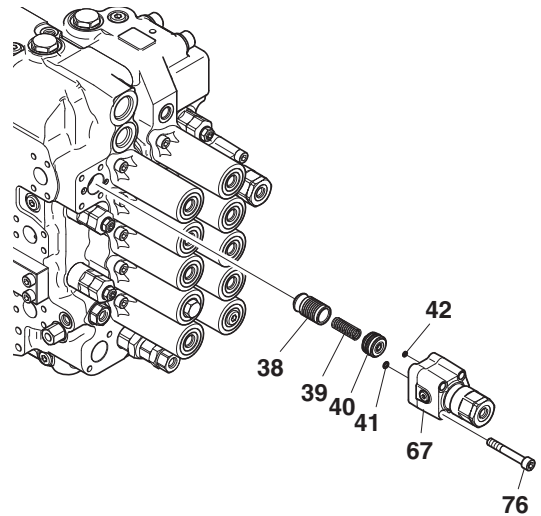
WARNING

AVOID DEATH OR SERIOUS INJURY

Always relieve hydraulic pressure and fully lower bucket (or attachment) to the ground, before disassembly. Failure to follow instructions can cause sudden release of component parts or boom dropping, resulting in death or serious injury.

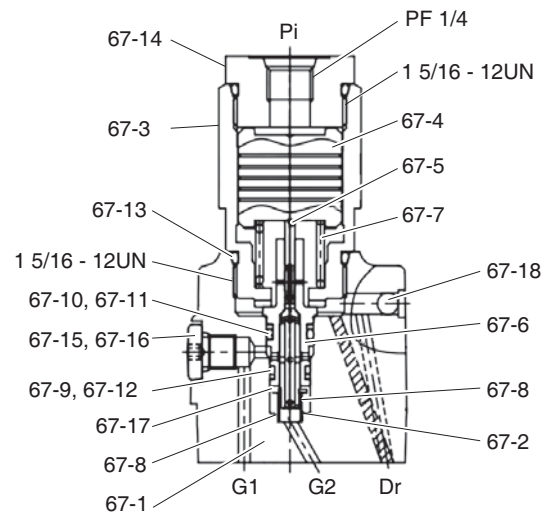
1. Remove socket head bolt assembly (76, four places per section, width across flats: 8 mm) and antidrift valve assembly (67, two places).
2. Remove O-ring (41 and 42) from valve housing. Remove O-ring (40-4) from spacer assembly.
3. Screw socket head bolt (78, M6*1) into spacer, and remove spacer assembly (40) from valve housing.
4. Remove O-ring (40-2) and backup ring (40-3).
5. Remove spring (39) and poppet (38) from valve housing.
6. Disassembly of antidrift valve assembly
 - A. Remove plug assembly (67-14, width across flats: 38 mm) and O-ring.
 - B. Remove piston (67-4), spool (67-5), and spring (67-7).
 - C. Slowly remove plug (67-3, width across flats: 38 mm) and O-ring (67-13).
 - D. Remove sleeve (67-6) and poppet (67-2) from body. Remove O-ring (67-9 and 10) and backup ring (67-11 and 12) from outside diameter of sleeve.
 - E. Pull spring seat (67-16) and spring (67-8) out of inside hole.
 - F. Remove plug assembly (67-15) if necessary.

NOTE: Do not remove steel ball (67-18) because it is pressed in body.



EX1301464

Figure 64



EX1401503

Figure 65

Disassembly of Relief Valve

WARNING

AVOID DEATH OR SERIOUS INJURY

Always relieve hydraulic pressure and fully lower bucket (or attachment) to the ground, before disassembly. Failure to follow instructions can cause sudden release of component parts or boom dropping, resulting in death or serious injury.

WARNING

AVOID DEATH OR SERIOUS INJURY

Do not loosen adjusting plug or change pressure setting.

No.	Item	Tool	Torque
68	Main Relief Valve	Wrench 32	8.8 kg.m
69	Overload Relief Valve	Wrench 32	8.8 kg.m
70	Foot Relief Valve	Wrench 32	11 kg.m

1. Remove overload relief valve (69, six places, width across flats: 32 mm).
2. Remove main relief valve (68, width across flats: 32 mm).
3. Remove relief valve assembly (70, two places, width across flats: 32 mm) and O-ring (70- 5 and 70-6).

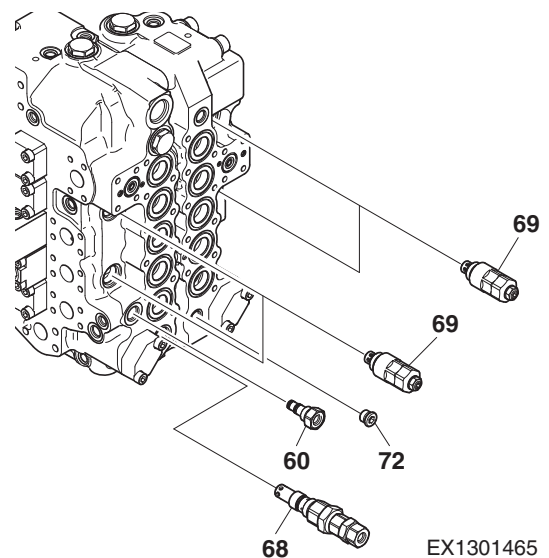
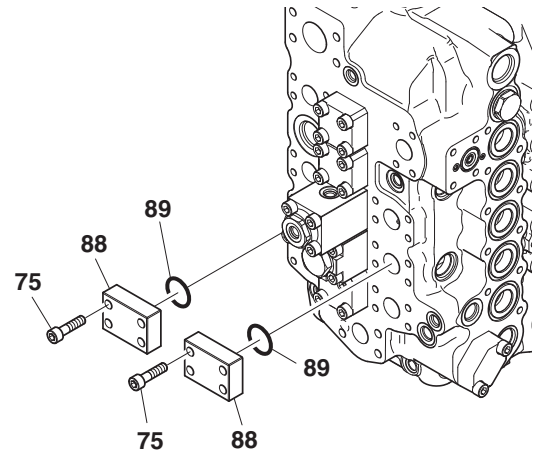


Figure 66

Disassembly of Option Section Part

No.	Item	Tool	Torque
75	Socket Bolt	Allen Wrench 8	6.2 kg.m

1. Remove socket head bolt (75, width across flats: 8 mm), cap (88, two places) and O-ring (89).



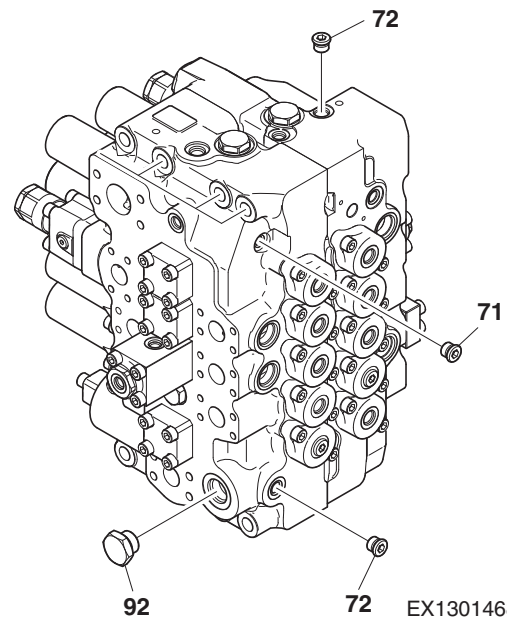
EX1301466

Figure 67

Disassembly of Other Plugs

No.	Item	Tool	Torque
60	Plug Assembly	Wrench 27	11 kg.m
61	Plug	Wrench 22	4 ~ 4.5 kg.m
63	Orifice Plug	Allen Wrench 5	1.6 kg.m
92	Plug Assembly	Wrench 36	22 kg.m
71	Plug Assembly	Allen Wrench 6	1.6 kg.m
72	Plug Assembly	Allen Wrench 8	7.7 kg.m

1. Remove plug assembly (60, width across flats: 27 mm) and O-ring (Section J-J).
2. Remove plug (61, width across flats: 22 mm) and O-ring (62) (Section K-K).



EX1301468

Figure 68

3. Remove orifice plug (63, width across flats: 5 mm) (Section A1-A1).
4. Remove plug assembly (92, width across flats: 36 mm) and O-ring.
5. Remove plug assembly (71, width across flats: 6 mm) and O-ring.
6. Remove plug assembly (72, width across flats: 8 mm) and O-ring.

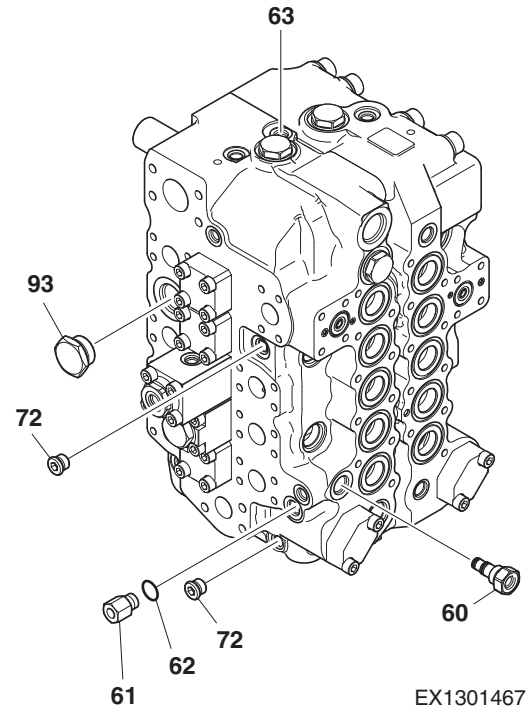


Figure 69

EX1301467

Disassembly of Valve Housing Bolt

No.	Item	Tool	Torque
77	Socket Bolt	Allen Wrench 14	17 ~ 18 kg.m

IMPORTANT

Do not disassemble combined bolt (77) if it is unnecessary.

If it is necessary to disassemble it, work by placing it horizontally on a workbench.

Prepare spare O-ring (65 and 66).

1. Remove socket head bolt (77, eight places, width across flats: 14 mm) and washer (81, eight places).

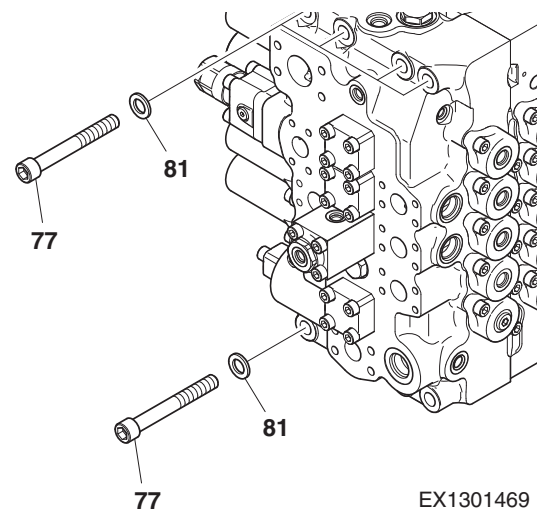
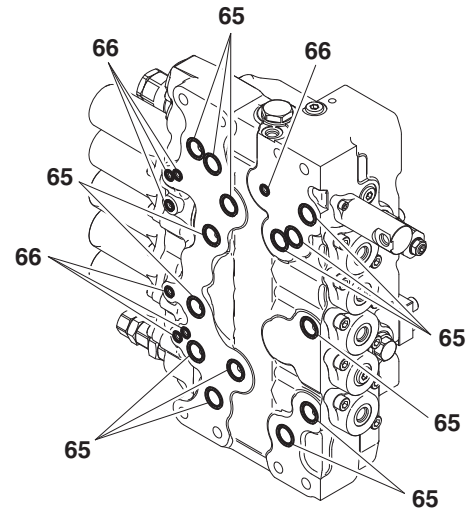


Figure 70

EX1301469

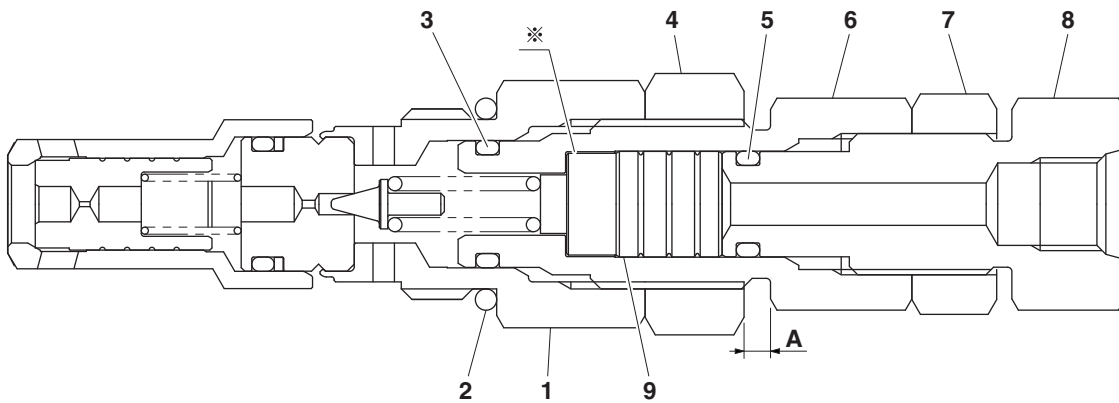
- Remove O-ring (65 and 66) from valve housing mating surface.



EX1301470

Figure 71

Disassembly of Main Relief Valve



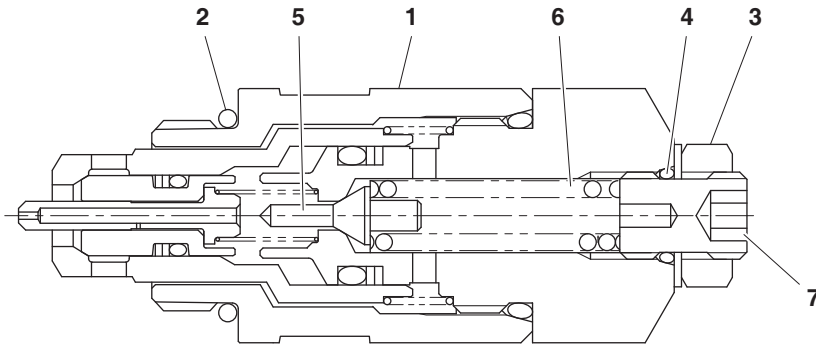
EX1301385

Figure 72

No.	Item	Tool	Torque
1	Plug	Wrench 32	8.8 kg.m
4	Nut	Wrench 36	8 ~ 9 kg.m
6	Plug	Wrench 27	11 kg.m
7	Nut	Wrench 30	6 ~ 7 kg.m
8	Plug	Wrench 27	Max. 2 kg.m

- This relief valve must be replaced as an assembly. When replacing it, remove plug (1, width across flats: 32 mm), and O-ring (2). If oil is leaking from nut (4), remove nut (4) and plug (1), and replace O-ring (3). If oil is leaking from nut (7), remove nut (7) and plug (8), and replace O-ring (3).

Disassembly of Overload Relief Valve



EX1301386

Figure 73

No.	Item	Tool	Torque
1	Cap	Wrench 31.75	8.8 kg.m
3	Locknut	Wrench 17	7.3 kg.m
7	Adjuster	Allen Wrench 6	

1. This relief valve must be replaced as an assembly. When replacing it, remove cap (1, width across flats: 32 mm) and O-ring (2). If oil is leaking from nut (4), remove nut (4) and plug (1), and replace O-ring (3). If oil is leaking from nut (7), remove nut (7) and plug (8), and replace O-ring (3).

NOTE: *This relief valve must be replaced as an assembly. When replacing it, Remove cap (1, width across flats: 32 mm) and O-ring (2). If oil is leaking from adjusting kit (3), remove adjusting kit (3), and replace O-ring (4).*

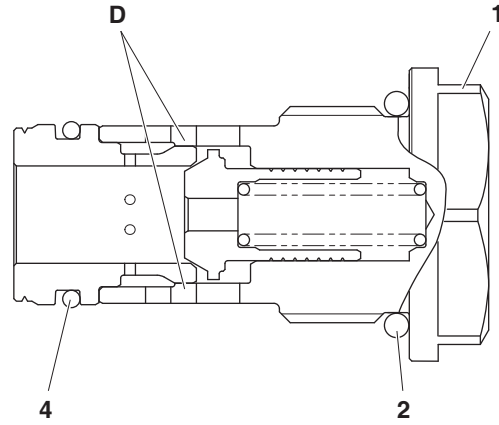


CAUTION

AVOID INJURY

When disassembling adjuster kit, be careful not to let parts spring out or lose poppet because of spring force.

Instruction of Disassembly and Assembly of Low-pressure Relief Valve



EX1401504

Figure 74

No.	Item	Tool	Torque
1	Plug	Wrench 32	8.8 kg.m
2	O-ring		
4	O-ring		

1. This unit has press install portion (D) and it must be replaced as a complete assembly.

CLEANING AND INSPECTION

For general cleaning and inspection procedures, refer to "General Maintenance Procedures" section.

Cleaning

Clean all parts thoroughly using a suitable cleaning fluid and dry them with moisture free compressed air. Put them on a clean paper or a vinyl for inspection.

Inspection

Inspect all parts for scratches, notches and other defects.

1. Inspect load check seat surface of valve housing for scratches, scores, dirt, notches and corrosion. Remove small scratches with oilstone.
2. Inspect exterior surface of spool for scratches and notches. Remove small scratches with oilstone.
3. Sliding parts must be moved lightly and foreign materials must be removed in all grooves and passages.
4. Replace any springs that are damaged, heavy deformed or worn.
5. If relief valve malfunction, inspect it using relief valve maintenance procedure.
6. Replace all O-rings and backup rings with new.
7. After disassembling cap or plug, check whether there are paint chips around body hole or plug. If paint chips penetrate into valve, they can cause malfunction or valve to leak.

REASSEMBLY

Caution on Assembly

Caution on Handling O-ring

1. Do not use O-ring which has any defect or scratches from handling.
2. Apply grease or hydraulic oil to installation portion of O-ring grooves and O-ring to ease installation.
3. Do not stretch O-ring beyond permanent set.
4. When installing O-ring, be careful not to twist it. (A twisted O-ring, is very difficult to return to its original shape after installing it. This could also cause a leak.)

Caution on Handling Spool

1. Rated torque must be kept because over torque of screw portion, can cause a malfunction of spool.
2. Be careful that each spool, spring and spool end must be reassembled like before disassembling.

Method of Painting the Adhesives (Screw Part and Arm Screw Part of Parts Requiring the Adhesiveness)

NOTE: *Male and female screw threads of parts which need to adhere.*



CAUTION

AVOID INJURY

When working with Loctite, work in a place that is well ventilated.

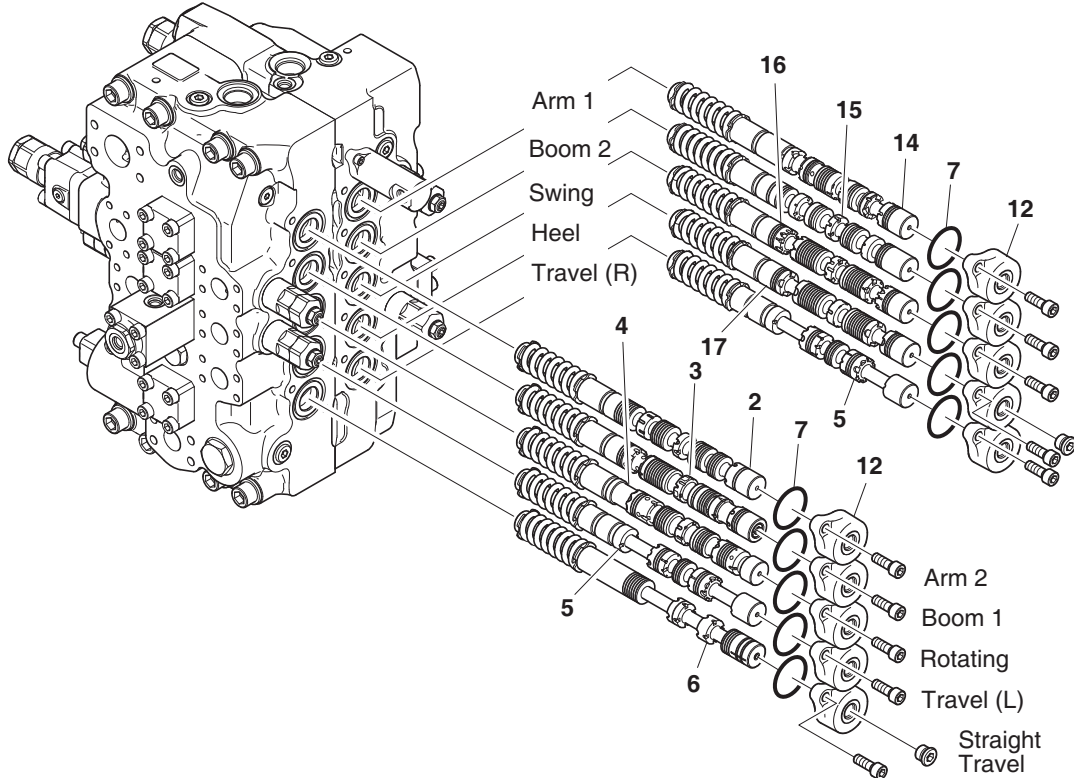
-
1. Cleaning (removal of grease)
Remove grease with steam, acetate, etc. or clean with an alkali cleanser.
 2. Dry
Dry Loctite surface with moisture free air or naturally. If it is not completely dried, the effect of Loctite is weakened.
 3. Primer painting
Slightly spray Loctite Primer T effect promoter to Loctite surface and leave it for three or five minutes to dry.
 4. Loctite application
Lightly apply Loctite #274 or equivalent to two or three threads of spool female inlet. Now, be careful not to touch coated part to spring seat.

Sequence of Subassembly

IMPORTANT

Check number of each part, installation position and tools needed before reassembling.

Assembly of Spool (Main Spool)



EX1504804

Figure 75

1. Apply Loctite to threaded portion of spool (2 ~ 6 and 14 ~ 17) and install spring seat, spring and spool end.
2. After gripping spool in vise with wood (that is used when disassembling it), tighten spool end. Tightening torque: 2.04 ~ 2.24 kg.m (15 ~ 16 ft lb). Bit Wrench 8.

IMPORTANT

Be careful not to get Loctite into spool by over applying it.

Be careful that spool operation does become deteriorated by over torquing spool end.

When reassembling it and A56, be careful because there are two different types of springs.

Assembly of Arm 1 Para-turn Spool

1. Apply Loctite to threaded portion of spool (19) and install spring seat (20), spring (21) and spool end (22).
2. After gripping spool in vise with wood (that is used when disassembling it), tighten spool end. Tightening torque: 1.94 ~ 2.24 kg.m (14 ~ 16 ft lb). Bit Wrench 5.

IMPORTANT

Be careful not to get Loctite into spool by over applying it.

Be careful that spool operation does become deteriorated by over torquing spool end.

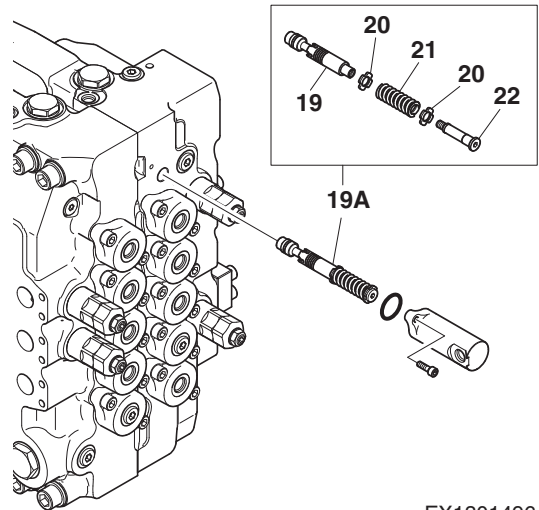


Figure 76

EX1301496

Assembly of Antidrift Valve

1. Install O-ring (67-9 and 67-10) and backup ring (67-11 and 67-12) in groove of sleeve (67-6).

IMPORTANT

Be careful of installation position of O-ring and backup ring.

If they are reversed, the O-ring will be damaged and drift speed of actuator can be increased.

2. Insert poppet (67-2) and spool (67-5) in sleeve hole.
3. Install spring seat (67-16) on small diameter of poppet end. Insert spring (67-8) and poppet assembly with sleeve into body (67-1).

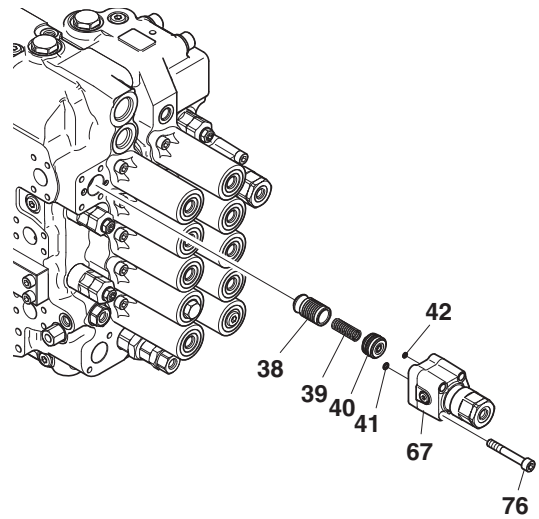
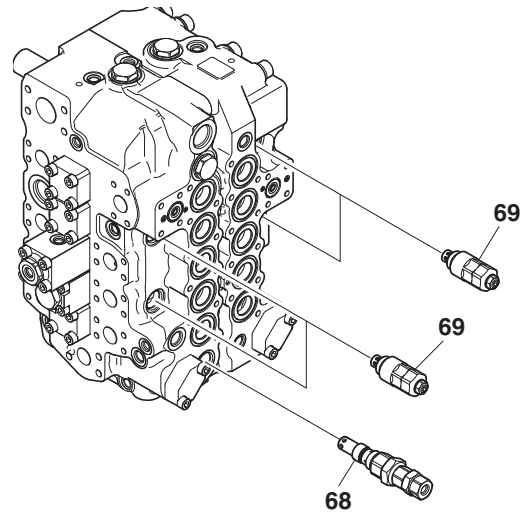


Figure 77

EX1301464

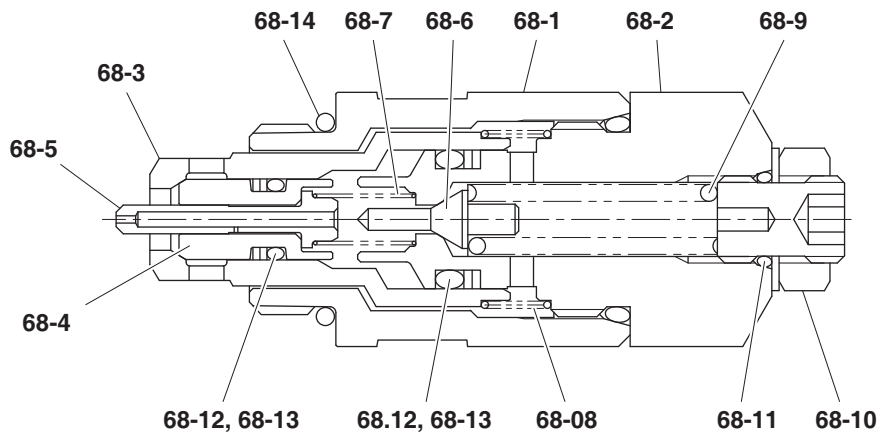
Assembly of Relief Valve

1. Install main relief valve (68). Tightening torque: 7.95 ~ 8.97 kg.m (58 ~ 65 ft lb). Wrench 32.
2. Install overload relief valve (69, six places) in each section. Tightening torque: 7.95 ~ 8.97 kg.m (58 ~ 65 ft lb). Wrench 32.
3. Install spring seat (68-7) on small diameter of poppet. Then insert spring (68-4) and them with sleeve to body (68-1). Tightening torque: 11 ~ 12 kg.m (76 ~ 83 ft lb). Wrench 27.



EX1301497

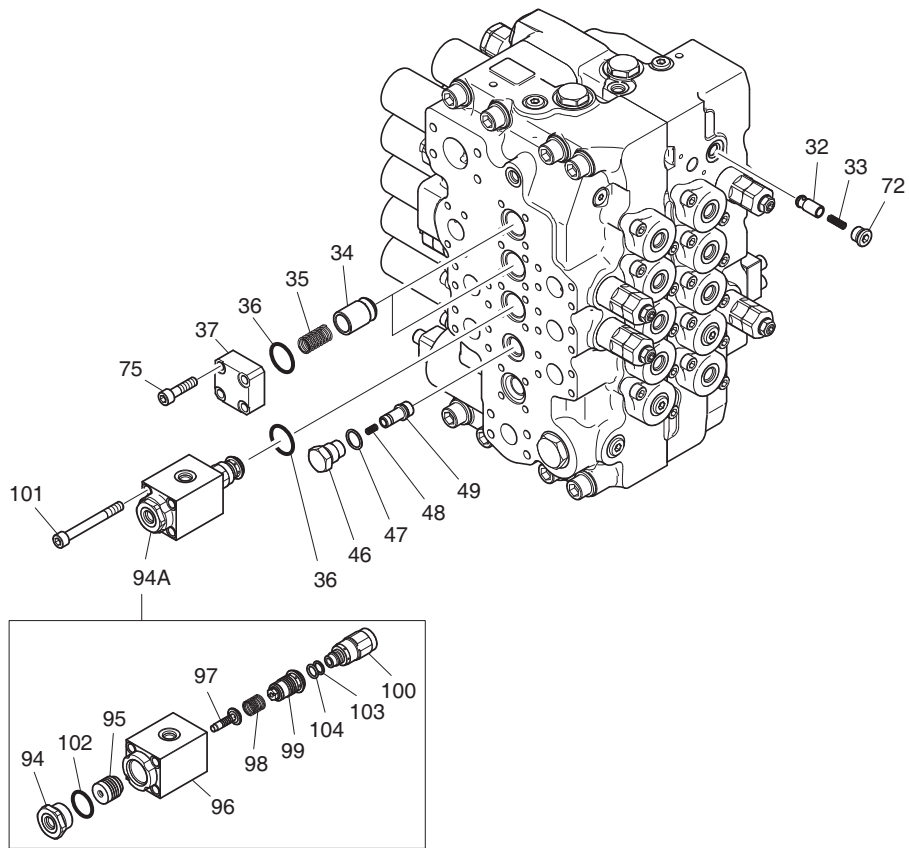
Figure 79



EX1301503

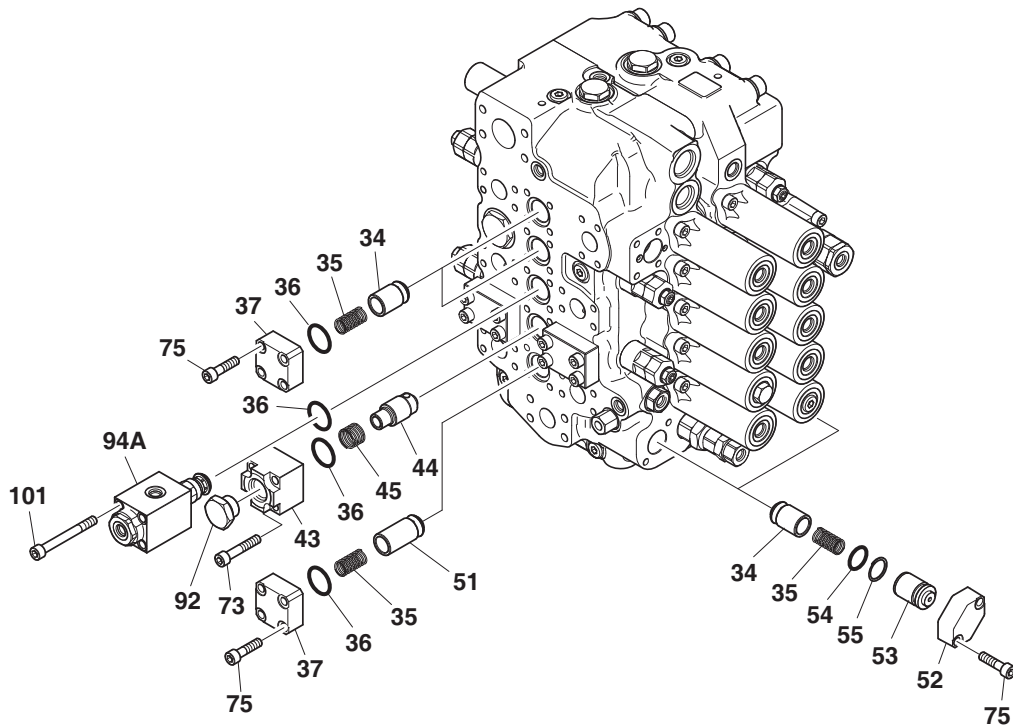
Figure 80

Assembly of Load Check Valve



EX1301498

Figure 81



EX1301499

Figure 82

1. Install O-ring (36) on arm (1 and 2, section D-D), boom (1 and 2, section E-E) and swing section (Section F-F). Install poppet (34) and spring (35). Mount flange (37) and install socket head bolt (75). Tightening torque: 5.91 ~ 6.53 kg.m (43 ~ 47 ft lb). Allen Wrench 8.
 2. Install O-ring (36) on travel section (Section H-H). Install poppet (51) and spring (35). Mount flange (37) and install socket head bolt (75). Tightening torque: 6 ~ 6.5 kg.m (43 ~ 47 ft lb). Allen Wrench 8.
 3. Install O-ring (36) on travel straight section (Section H-H). Mount flange (37) and install socket head bolt (75). Tightening torque: 6 ~ 6.5 kg.m (43 ~ 47 ft lb). Allen Wrench 8.
 4. Install poppet (34) and spring (35) in common (Section I-I). Insert spacer (53) with O-ring (54) and backup ring (55). Tightening torque: 6 ~ 6.5 kg.m (43 ~ 47 ft lb). Allen Wrench 8.
-

IMPORTANT

Be careful of installation position of O-ring and backup ring.

If they are reversed, the O-ring will be damaged and an oil leak can occur.

5. Install O-ring (36) on option section (Section G-G). Install poppet (44) and spring (45). Mount flange (43) and install socket head bolt (73). Tightening torque: 6 ~ 6.5 kg.m (43 ~ 47 ft lb). Allen Wrench 8.
6. Tighten flange assembly (92) with O-ring. Tightening torque: 21 ~ 23 kg.m (151 ~ 167 ft lb). Wrench 36.
7. Insert poppet (49) and spring (48) in travel section (Section G-G). Install plug (46) with O-ring (47). Tightening torque: 10.91 ~ 11.93 kg.m (79 ~ 86 ft lb). Wrench 27.
8. Bucket section (Section F-F)
 - A. Insert piston (95) and O-ring (102) on plug (94) and install in body (96). Tightening torque: 11 ~ 12 kg.m (76 ~ 83 ft lb). Wrench 36.
 - B. Insert backup ring (103), O-ring (104), spring (98) and poppet assembly (100) in sleeve (99), and install it to body (96).
 - C. Install O-ring (36) in valve housing and fasten body using socket head bolt (101). Tightening torque: 5.91 ~ 6.53 kg.m (43 ~ 47 ft lb). Allen Wrench 8.
9. Insert poppet (32) and spring (33) in arm 1 para turn part (Section C-C). Install plug assembly (72) with O-ring. Tightening torque: 7.44 ~ 8.06 kg.m (54 ~ 58 ft lb). Allen Wrench 8.

10. Insert poppet (32), spring (33), and spacer (57) in arm 2 para turn part (Section L-L). Install plug assembly (72) with O-ring. Tightening torque: 7.44 ~ 8.06 kg.m (54 ~ 58 ft lb). Allen Wrench 8.

Assembly of Antidrift Valve

1. Install O-rings (41 and 42) on surfaces of antidrift valve assembly of arm 1 section (Section D-D) and boom 1 section (Section E-E).
2. Insert poppet (38) and spring (39). Install spacer assembly (40) with O-ring and backup ring.

IMPORTANT

Be careful of installation position of O-ring and backup ring.

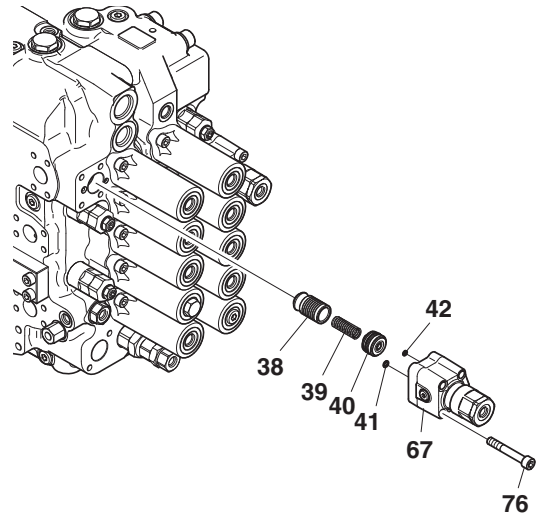
If they are reversed, the O-ring will be damaged and an oil leak can occur.

Check installing of O-ring (40-4) on spacer assembly and be careful of installation direction.

3. Install antidrift valve assembly (67, two places) and socket head bolt. Tightening torque: 3.98 ~ 4.49 kg.m (29 ~ 32 ft lb). Allen Wrench 8.

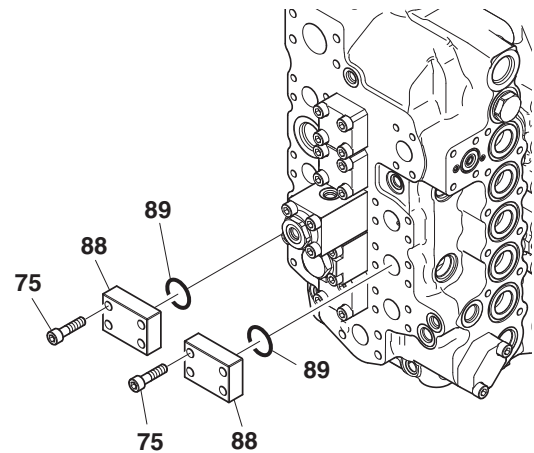
Assembly of Option Section Part

1. Install O-ring (89) on cap (88, two places) and fasten it in place with socket head bolt (75). Tightening torque: 5.91 ~ 6.53 kg.m (43 ~ 47 ft lb). Allen Wrench 8.



EX1301464

Figure 83



EX1301466

Figure 84

Assembly of Arm Regeneration Release Valve

1. Install O-ring (30) and backup ring (31, two places) on spool assembly (27).
2. Install piston (29) and spool (27) in sleeve. Insert sleeve in valve housing.
3. Install O-ring (25) on plug (27), insert spring (26) and install it in valve housing. Tightening torque: 11 ~ 12 kg.m (76 ~ 83 ft lb). Wrench 32.

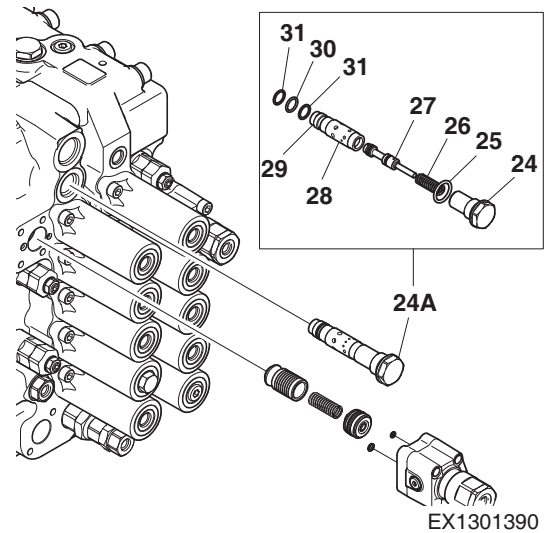


Figure 85

Assembly of Arm 1 Para-turn Spool

1. Install spool subassembly (19A) into valve housing.

IMPORTANT

After inserting spool, check to see if it slides easily.

2. Install O-ring (23) on cap (18) and fasten it in place with socket head bolt (78). Tightening torque: 0.90 ~ 1.10 kg.m (6.49 ~ 7.97 ft lb). Allen Wrench 5.

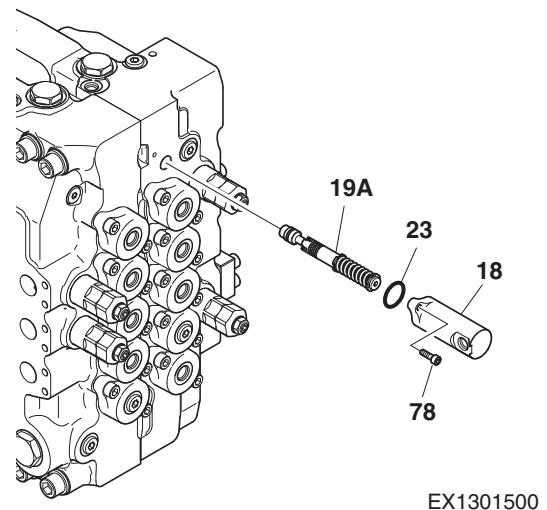


Figure 86

Assembly of Main Spool

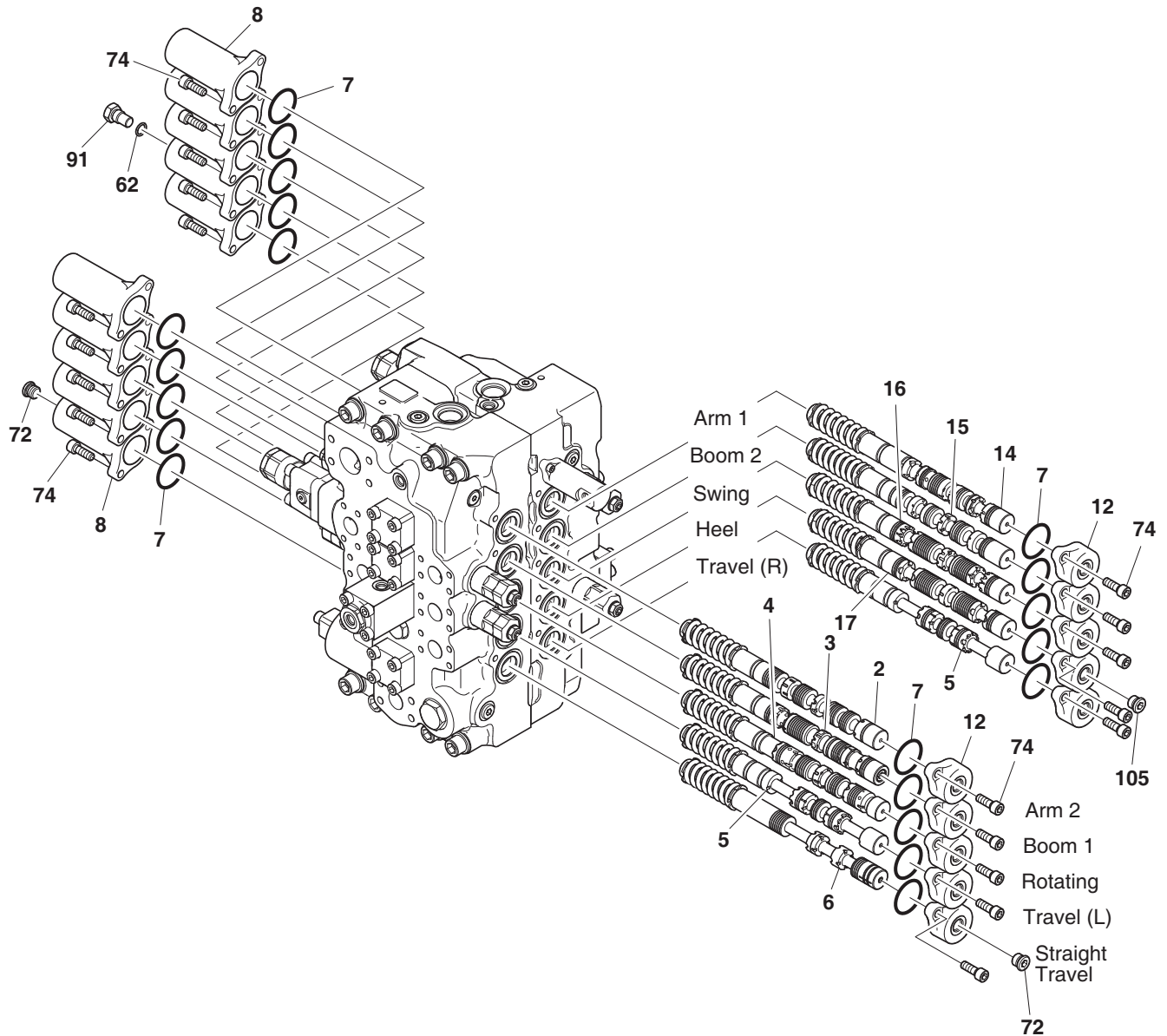


Figure 87

EX1504805

1. Install O-ring (7, twenty places) on mating surface of valve housing cap.
2. Install spool of subassembly condition (2-6 and 14-17) in same positions that they were remove from during disassembly

IMPORTANT

Align spool with hole and insert it slowly.

After inserting spool, check to see if it slides easily.

If spool is inserted when it is in a poor operating condition with a scratch, it can cause a improper operation of the spool.

3. Install cap (12, ten places) and fasten it in place with socket head bolt (74). Tightening torque: 3.98 ~ 4.49 kg.m (29 ~ 32 ft lb). Allen Wrench 8.
 4. Install cap (8, ten places) and fasten it in place with socket head bolt (74). Tightening torque: 3.98 ~ 4.49 kg.m (29 ~ 32 ft lb). Allen Wrench 8.
 5. Install O-ring on plug assembly (72) and tighten it to two sides of cap of travel straight section (Section H-H). Tightening torque: 3.98 ~ 4.49 kg.m (29 ~ 32 ft lb). Allen Wrench 8.
 6. Install O-ring (62) on plug assembly (91) and install it on long cap of spare section (Section G-G). Install O-ring (62) on plug assembly (105). Install plug assembly on short cap of spare section (Section G-G). Tightening torque: 3.98 ~ 4.49 kg.m (29 ~ 32 ft lb). Allen Wrench 8.
-

IMPORTANT

When tightening plug to cap, be careful not to over tighten. If it is over tighten, threads of cap can be damaged.

Assembly of Other Plugs

1. Install O-ring on plug assembly (60) and install. Tightening torque: 11 ~ 12 kg.m (76 ~ 83 ft lb). Wrench 27.
2. Install O-ring (62) on plug assembly (61) and install. Tightening torque: 4 ~ 4.5 kg.m (29 ~ 32 ft lb). Wrench 22.
3. Tighten orifice plug (63). Tightening torque: 1.4 ~ 1.8 kg.m (10 ~ 13 ft lb). Allen Wrench 5.
4. Install O-ring on plug assembly (92) and install. Tightening torque: 21 ~ 23 kg.m (151 ~ 167 ft lb). Wrench 36.
5. Install O-ring on plug assembly (71) and install. Tightening torque: 1.4 ~ 1.8 kg.m (10 ~ 13 ft lb). Allen Wrench 6.
6. Install O-ring on plug assembly (72) and install. Tightening torque: 7.5 ~ 8 kg.m (54 ~ 58 ft lb). Allen Wrench 8.

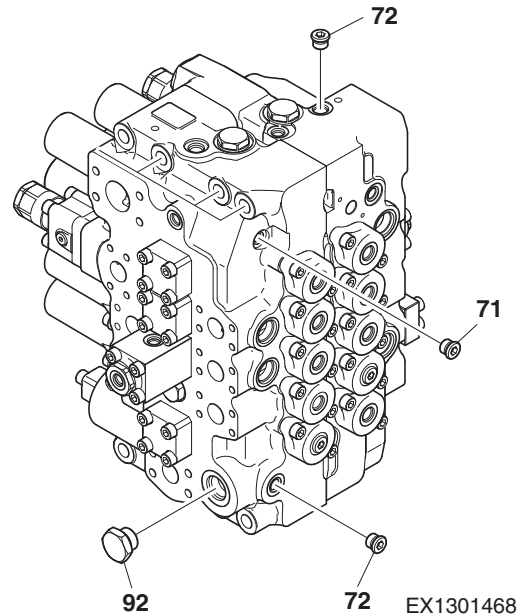


Figure 88

EX1301468

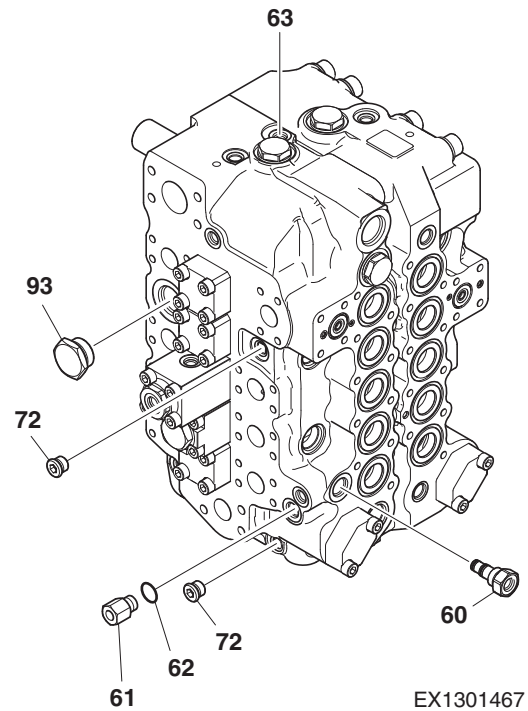
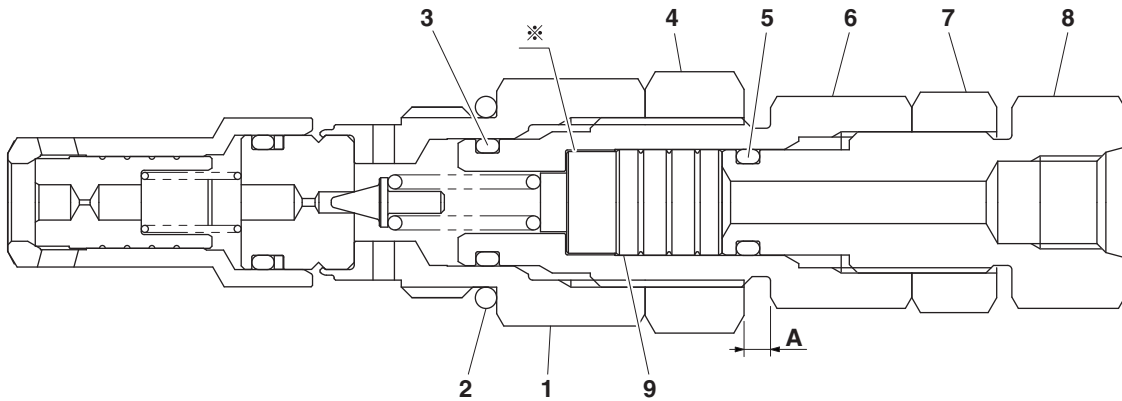


Figure 89

EX1301467

Maintenance of Relief Valves

Reassembly of Main Relief Valve



EX1301385

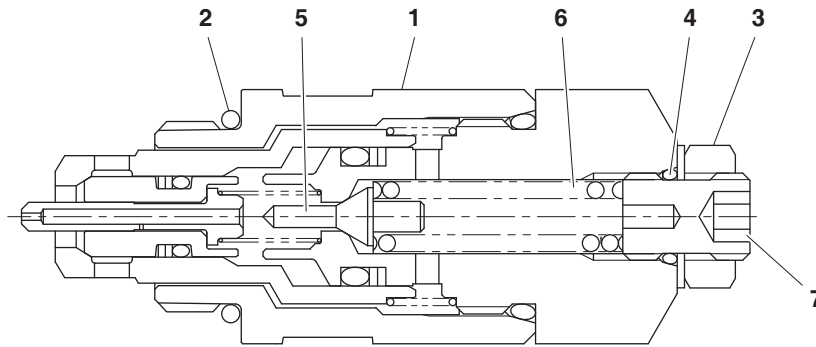
Figure 90

1. Check if there is dirt and paint chips around threads of plug (1, 6 and 8) and nut (4 and 7). Replace O-ring with new one. Clean installation portion of relief valve and valve housing. Install valve, and then tighten plug (1, width across flats: 32 mm). Tightening torque: 7.95 ~ 8.97 kg.m (58 ~ 65 ft lb). Wrench 32.

NOTE: *The torque values are based on use of lubricated threads.*

NOTE: *If relief valve was disassembled, adjust pressure by referring to "Maintenance of Relief Valves" on page -89.*

Reassembly of Overload Relief Valve (69, Total of 8 Places)



EX1301386

Figure 91

1. Check if there is dirt and paint chips around cap (1). Replace O-ring with new one. Clean installation portion of relief valve and valve housing. Install relief valve and tighten cap (1). Torque: 7.95 ~ 8.97 kg.m (58 ~ 65 ft lb). Wrench 32.

NOTE: *The torque values are based on use of lubricated threads.*

NOTE: *If relief valve was disassembled, adjust pressure by referring to "Maintenance of Relief Valves" on page -89.*

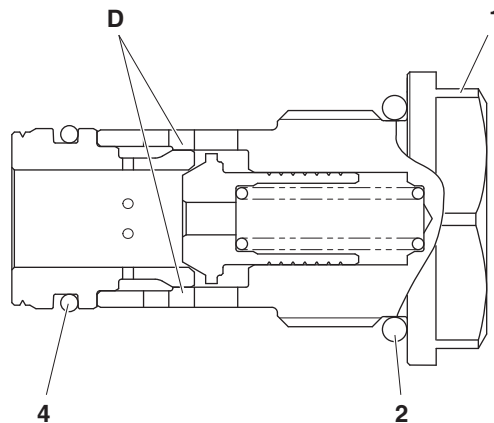


CAUTION

AVOID INJURY

In the event of disassembling the adjustment kit, be careful for popping out of parts by the spring or the loss of the poppet.

Reassembly of Low-pressure Relief Valve (70, Total of 2 Places)



EX1401504

Figure 92

1. Check if there is dirt and paint chips around plug (1). Replace O-ring (3) with new one. Install new O-ring (4) on sleeve (2). Clean installation portion of relief valve and valve housing. Tighten plug (1, width across flats: 32 mm) of relief valve. Torque: 11 ~ 12 kg.m (76 ~ 83 ft lb). Wrench 32.

NOTE: *The torque values are based on use of lubricated threads.*

IMPORTANT

Torque values must be measured when using lubricated threads.

TROUBLESHOOTING, TESTING AND ADJUSTMENT

Troubleshooting

Overall Control Valve

Problem	Possible Cause	Remedy
Spool does not move.	Oil temperature is abnormally increased.	Remove part with resistance of oil leakage within pipeline.
	Pollution of operation oil.	Replace operation oil and wash circuit at same time.
	Overly tighten pipe port joint.	Check Torque.
	Valve housing is skewed in loading.	Loosen and confirm loading bolt.
	Pressure is too high.	Check pressure of pump and cylinder port.
	Spool is bent.	Replace valve assembly.
	Return spring is damaged.	Replace damaged part.
	Spring or cap is not in line.	Loosen cap to release load.
	The temperature distribution in valve is inconsistent.	Warm up entire circuit.
	The valve is clogged by dust.	Remove (flushing) dust.
	The pilot pressure is insufficient.	Check pilot valve and pilot relief pressure.
Load is not maintained.	Oil is leaking from cylinder.	Check chamber part of cylinder.
	Oil is bypassed from spool.	Check groove of spool.
	Oil is leaking from overload relief valve.	Wash valve housing seat part and relief valve seat part.
	Oil is leaking from antidrift valve.	Disintegrate antidrift valve and wash seat part of each part. In event there is grooves on seat part, replace poppet or wrap poppet and seat part. In event of having malfunction in antidrift valve spool, spool and sleeve make pair that both shall be replaced.
When spool is shifted to up position from neutral, load is dropped.	The load check valve has dust.	Disintegrate check valve and wash.
	The poppet or seat part of check valve has groove.	Replace poppet or wrap poppet and seat part.

Relief Valve

Problem	Possible Cause	Remedy
Press does not increase.	Main poppet, sleeve or pilot poppet are stuck open and valve seat part has dust.	Replace relief valve.
Unstable relief pressure.	The seat part of pilot poppet has groove.	
	Piston or main poppet gets stuck.	
Abnormal relief pressure.	Abrasion of seat part by dust.	Reset pressure and tighten locking screw with regular Torque.
	Locking screw and adjustment equipment are loosened.	
Oil leakage.	Damage to relief valve seat part.	Replace relief valve.
	Each part is stuck with dust.	
	The O-ring is worn out.	Replace adjustment equipment or O-ring of loading part.

Overall Oil Pressure

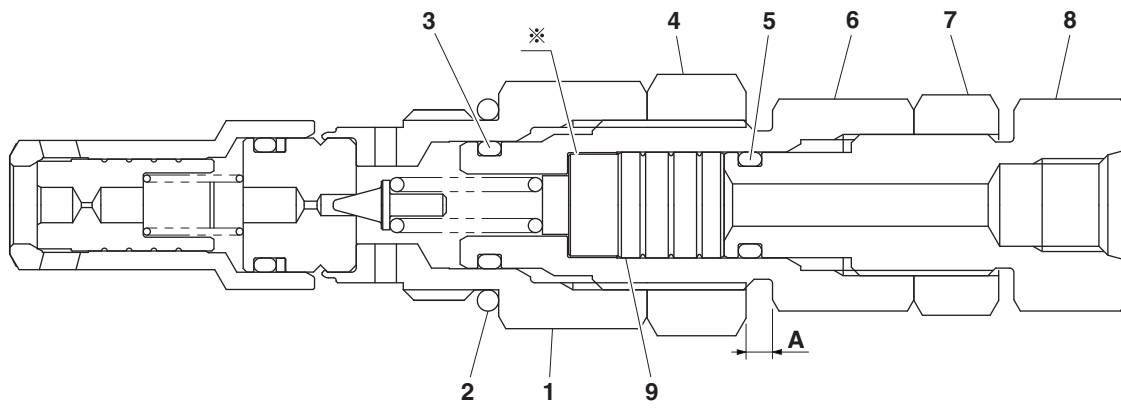
Problem	Possible Cause	Remedy
Oil pressure condition is bad or not operate at all.	Breakdown of pump.	Check pressure or replace pump.
	Breakdown of relief valve.	Replace relief valve.
	Breakdown of cylinders.	Repair or replace.
	Pump load pressure is significant.	Check circuit pressure.
	Valve has crevice.	Replace valve assembly.
	Spool does not make full stroke.	Check operation of spool.
	Tank surface is too low.	Add operation oil.
	Filter in circuit is clogged.	Wash or replace filter.
	Circuit pipeline is tightened.	Check pipeline.

Adjustment of Valves

Main Relief Valve

No.	Item	Tool	Torque
4	Locknut	Wrench 36	
7	Locknut	Wrench 30	
6	Plug	Wrench 27	2 kg.m
8	Plug	Wrench 27	

1. Connect an accurate pressure gauge to inlet port.
2. Start engine and maintain rated pump speed.
3. Shift control valve spool and read pressure gauge from stroke end of cylinder.
NOTE: *Shift a spool that actuator pressure setting of the overload relief valve is higher than the pressure of the main relief valve.*
4. High-pressure adjustment (1st stage).
 - A. Loosen locknut (7) and tighten plug (8) until piston contacts step (* mark) of plug (6). Plug (8) must be torque below 2.0 kg.m (15 ft lb). While plug (8) is tightened, plug (6) should not be turned. Distance A must be more than 4.0 mm (0.16 in). Tighten locknut (7).
 - B. Loosen locknut (4) and turn adjusting plug (6) clockwise to raise relief pressure of preceding step. Turn adjusting plug (6) counterclockwise to lower relief pressure. One turn varies pressure by approximately 284 bar (290 kg/cm², 4,119 psi). Tighten locknut (4) after pressure has been adjusted.
5. Low-pressure adjustment (second stage)
 - A. Loosen locknut (7) and turn adjusting plug (8) counterclockwise to lower relief pressure at state of 4. One turn varies pressure by approximately 213 bar (217 kg/cm², 3,089 psi). Tighten locknut (7) after pressure has been adjusted.
6. Recheck pressure setting by raising pressure once more.



EX1301385

Figure 93

Reference Number	Description
1	Plug
2	O-ring
3	O-ring
4	Hex Nut
5	O-ring

Reference Number	Description
6	Plug
7	Hex Nut
8	Plug
9	Piston

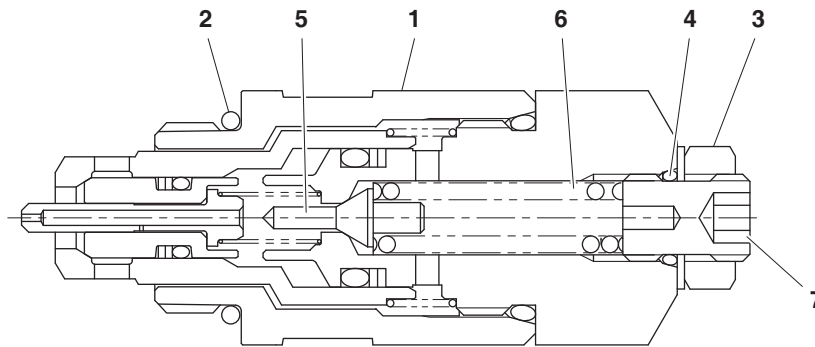
Overload Relief Valve

No.	Item	Tool
3	Locknut	Wrench 17
7	Adjuster	Allen Wrench 14

IMPORTANT

If pressure of main relief valve is higher than the specified pressure for it, change main relief valve assembly setting without adjusting overload relief valve.

1. Shift control valve spool and read pressure gauge from stroke end of cylinder.
2. Loosen locknut (3) and turn adjusting plug clockwise to raise pressure. Item number (69: six places). One turn varies pressure by approximately 212 bar (216 kg/cm², 3,074 psi).
3. Tighten locknut (3) after pressure has been adjusted. Locknut (3) must be torqued to 2.8 ~ 3.2 kg.m (20 ~ 23 ft lb).
4. Recheck pressure setting by raising pressure once more.



EX1301386

Figure 94

Reference Number	Description
1	Cap
2	O-ring
3	Locknut
4	O-ring

Reference Number	Description
5	Poppet
6	Spring
7	Adjuster

Swing Device

Edition 1

MEMO

Table of Contents

Swing Device

Safety Instructions	5-8-5
General	5-8-5
Specification	5-8-5
Swing Motor	5-8-5
Swing Reduction Gear	5-8-5
Pinion Gear	5-8-5
Parking Brake.....	5-8-5
Overview	5-8-6
Hydraulic Circuit	5-8-7
Theory of Operation	5-8-8
Hydraulic Motor	5-8-8
Valve Casing	5-8-9
Schematic of Operation of Reactionless Valve ..	5-8-13
Brake Part	5-8-14
Cautions for Operation	5-8-16
Inspection	5-8-16
Direction of Rotation.....	5-8-16
External Load at the End of Shaft	5-8-17
Hydraulic Oil and Temperature Range.....	5-8-17
Filter	5-8-18
Installation and Piping.....	5-8-18
Oil Filling and Air Ventilation	5-8-19
Instructions before Starting to Operate	5-8-19
Precaution	5-8-20
Tools for Disassembly and Assembly	5-8-20
Tightening Torque	5-8-20
Removal	5-8-22
Installation	5-8-27
Completing work.....	5-8-28
Section View	5-8-30
Swing Motor	5-8-30
Swing Reduction Gear	5-8-32
Section View.....	5-8-32

Disassembly	5-8-34
Swing Motor	5-8-34
Swing Reduction Gear	5-8-39
Reassembly	5-8-43
Swing Motor	5-8-43
Swing Reduction Gear	5-8-50
Troubleshooting	5-8-54
General Instructions	5-8-54
Examination of Hydraulic Motor	5-8-54
Troubleshooting.....	5-8-55
Maintenance Instructions	5-8-58
Replacement Standard of Worn Parts.....	5-8-58
Standard of Sliding Surface Correction	5-8-58

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.

GENERAL

Specification

Swing Motor

Type	Axial Piston
Displacement	172.1 cm ³ (0.006 ft ³)
Crossover Relief Valve Setting	289 bar (295 kg/cm ² , 4,195 psi)
Max. Supply Flow	370 L/min (98 U.S. gal)
Motor Shaft Speed	1,482 rpm
Motor Shaft Torque	792.4 N.m (80.8 kg.m, 584.4 ft lb)
Accessory Valves	Swing Reactionless Valve
Weight	65.5 kg (144.4 lb)

Swing Reduction Gear

Drive Type	2 - Stage Planetary Gear
Reduction Ratio	24.74
Max. Output Speed	60 rpm
Max. Output Torque	19,603 N.m (1,999 kg.m, 14,458 ft lb)
Weight	387 kg (853 lb)

Pinion Gear

Type	Spur Gear
Gear P.C.D	D 196 mm
No. of Teeth	14
Module	14

Parking Brake

Spool Cracking	13 bar (13 kg/cm ² , 185 psi)
Time Delay	5 sec

Overview

Swing device consists of a swing motor and swing reduction gear.

Swing motor include mechanical parking valve, relief valve, makeup valve and time delay valve.

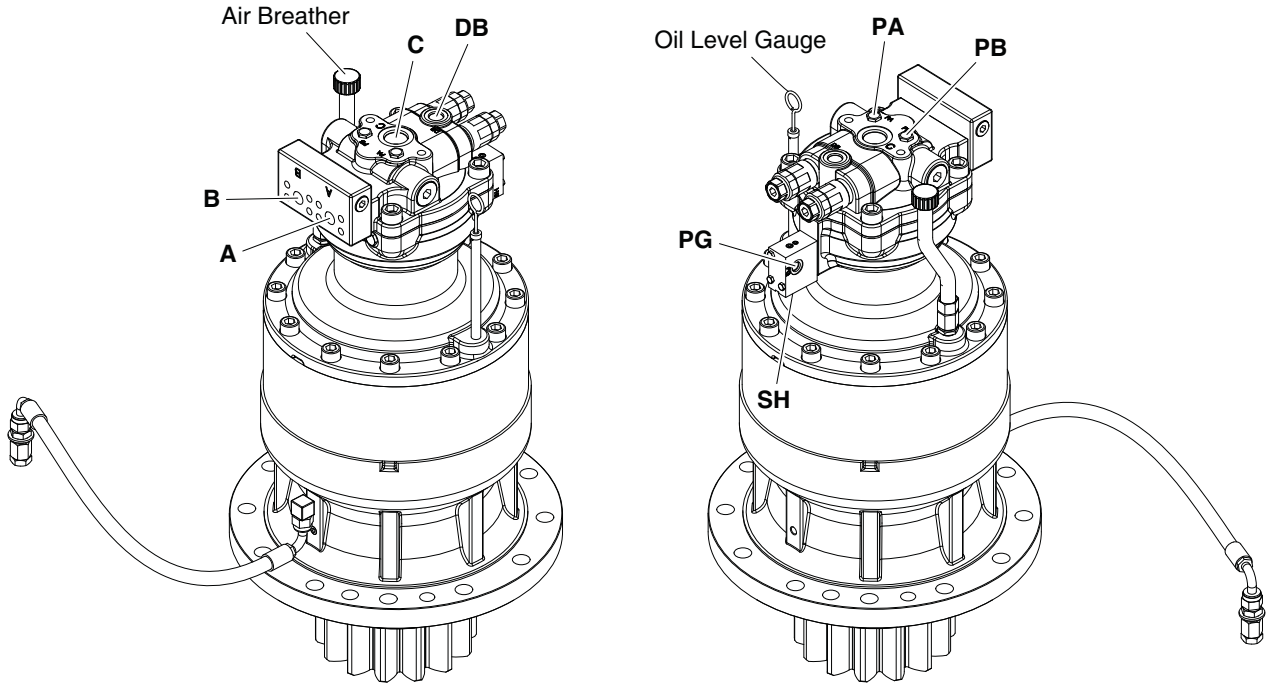


Figure 1

EX1504808

Port	Name	Size
A	High-pressure (Right)	22.2 x 47.6 Flange
B	High-pressure (Left)	
C	Make Up	PF 1", O-ring
DB	Motor Drain	PF 1/2", O-ring
SH	Brake Signal	PF 1/4", O-ring
PG	Brake Release	
Pa	Pressure Gauge	
Pb	Pressure Gauge	
	Air Breather	PT 1/2"
	Oil Level Gauge	PT 1/4"
	Oil Drain	

Hydraulic Circuit

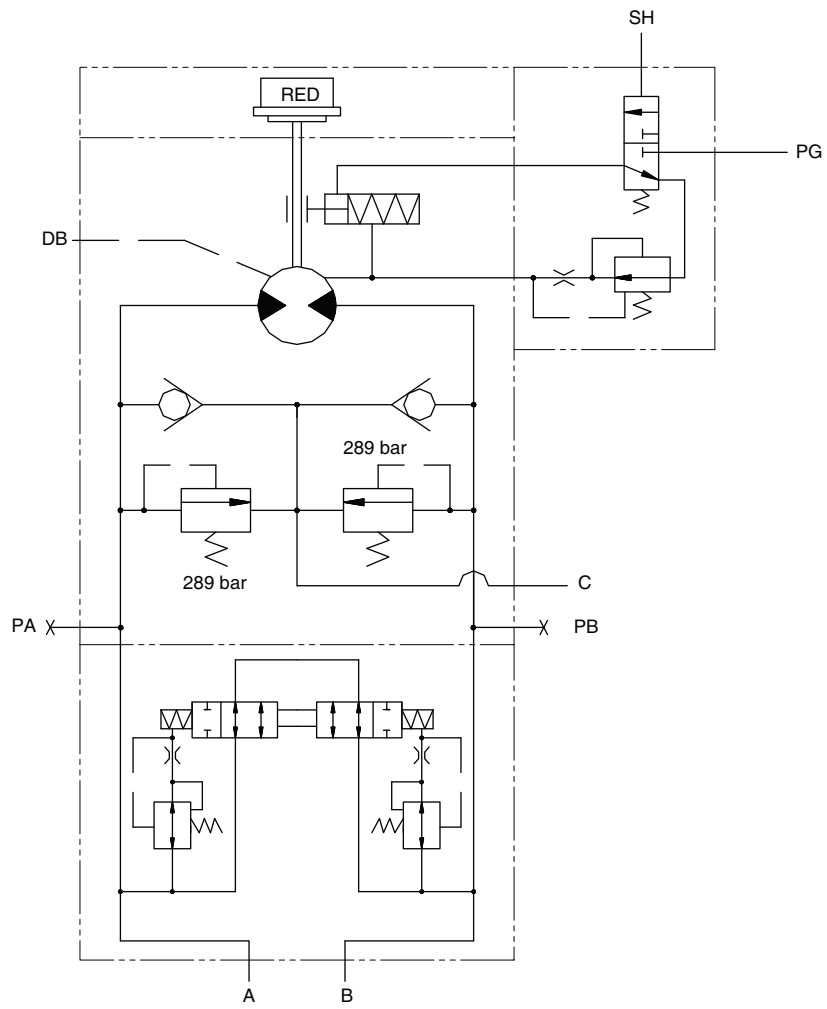


Figure 2

EX1504809

Theory of Operation

Hydraulic Motor

As shown in the figure below, the high-pressure oil entering the cylinder block through valve plate (112) inlet side port exerts pressure on the piston, generating axial force F . The force F is divided into the two vectors of force F_1 which is perpendicular to the swash plate (103) and F_2 which is perpendicular to the shaft, with the shoe (104-1) as the medium. With the piston and the medium, the force F_2 is transmitted to the cylinder block (108) and generates rotational torque to the output shaft. On the cylinder block, 9 pistons are arranged equidistantly, and rotational torque is transmitted to the output shaft by the multiple pistons connected to the inlet side of the high-pressure oil in consequences.

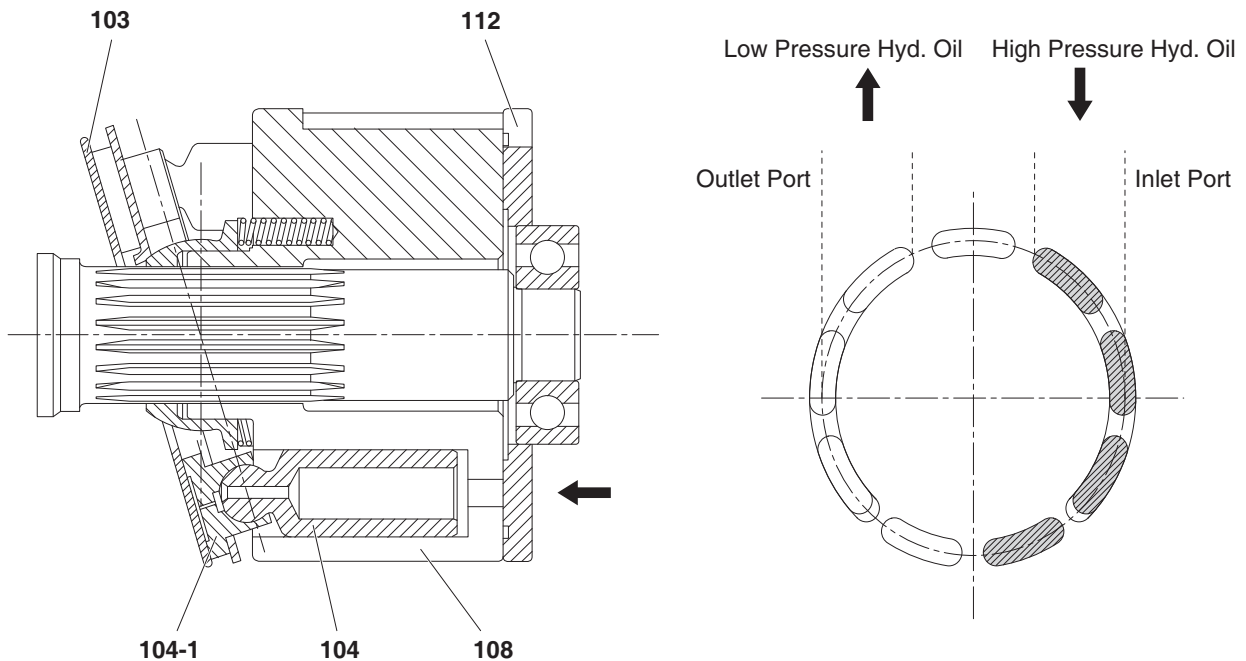
Reversing the direction of oil flow will reverse the direction of rotation of the output shaft.

Theoretical output torque T is calculated with the formula below;

$$T = \frac{P \times q}{2 \times \pi}$$

P : effective differential pressure (kg/cm^2)

q : volume per rotation (cc/rev)



EX1301620

Figure 3 Operation Diagram of Motor

Valve Casing

1. Anticavitation check valve

Since the system using this type of motor has no valve which has counterbalance function, the motor may rotate exceeding the feed oil flow.

To prevent cavitation, suck in deficient oil through the check valve.

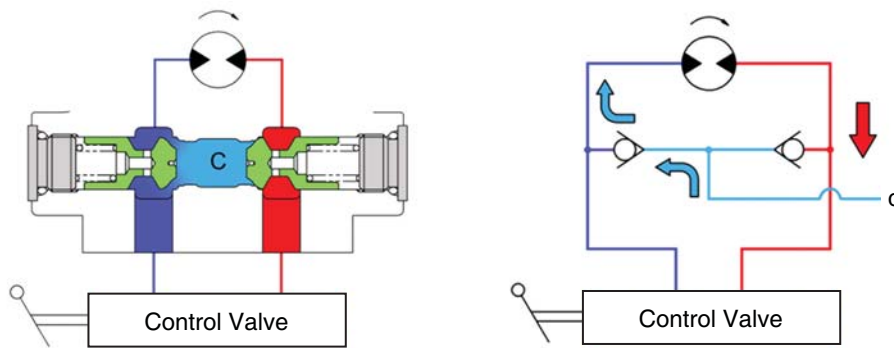


Figure 4

EX1301686

2. Relief valve

Lets assume that port P is pressurized from the tank pressure. Initially, ports P and R are at tank pressure.

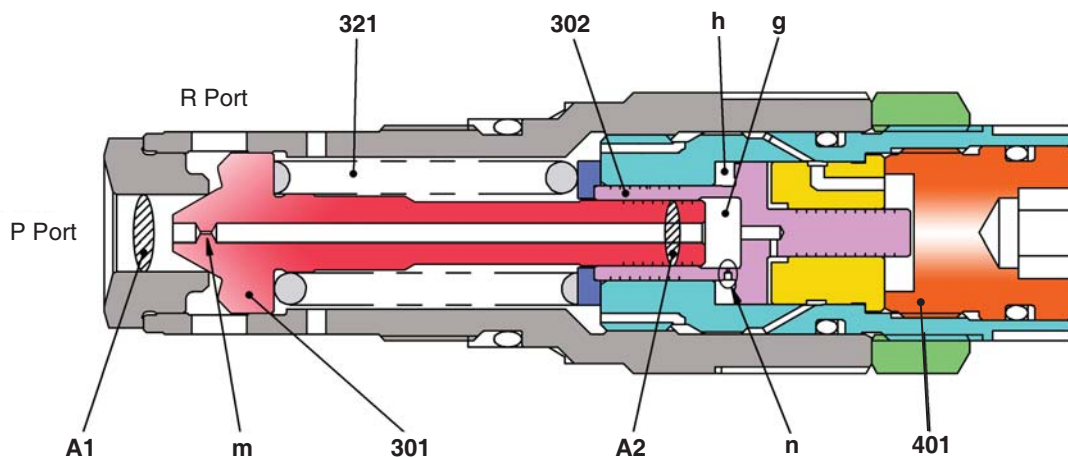


Figure 5

EX1403242

When the two forces; the force defined by the product of the area (A_1) of plunger (301) receiving pressure and pressure P_1 ; and the force defined by the product of spring (321) force (F_{sp}) and pressure-receiving area (A_2) of plunger (301) by the pressure P_g in the chamber g ; become the same, the relief valve starts to function.

Here, the P_g is the pressure in the chamber g which is pressurized by the oil through the orifice m , and when it reaches the pressure defined by the spring (321) pressing the piston (302), the piston starts to move to the left.

$$P_1 \times A_1 = F_{sp} + P_g \times A_2$$

$$P_1 = \frac{F_{sp} + P_g \times A_2}{A_1}$$

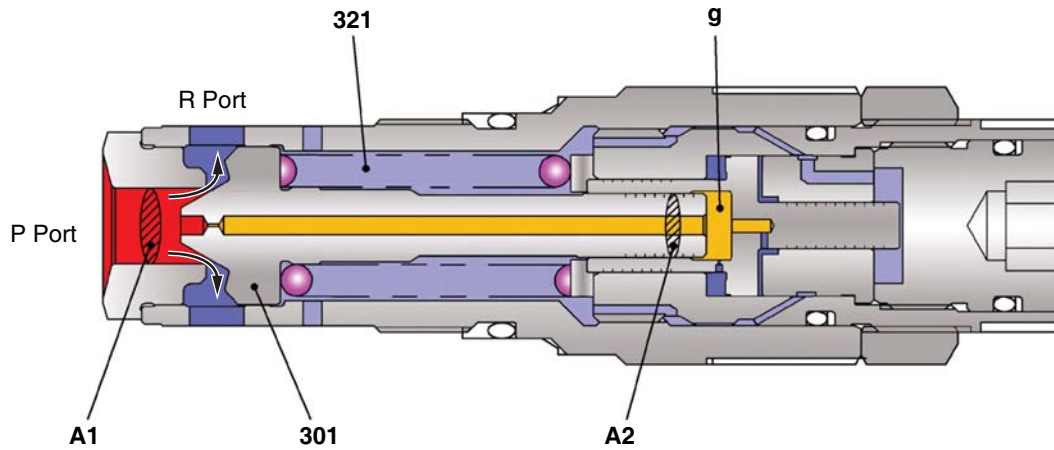


Figure 6

EX1301687

3. Chamber h acts as a damping chamber by the orifice (n) formed on the side of the piston (302).

By this, the pressure in the chamber g increases smoothly until piston (302) reaches the end of the adjustment plug (401).

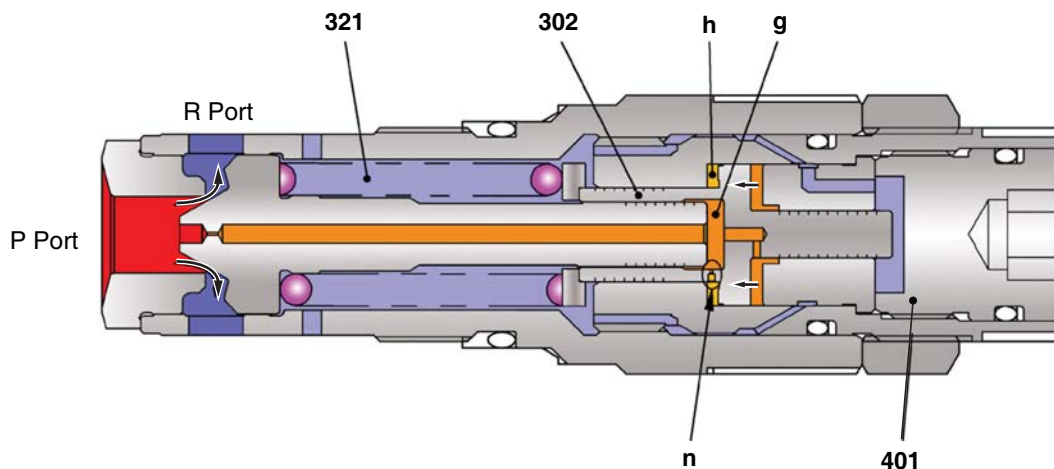


Figure 7

EX1403527

When the piston (302) reaches the end of the adjustment plug (401), it cannot move further to the left, thus, the pressure in chamber g becomes equal to P_s and the force of the spring (321) becomes $F_{sp'}$ (Figure 11).

Consequently, the pressure P varies as illustrated in (Figure 11).

The pressure P_s at the final stage is expressed with the equation below;

$$P_s \times A1 = F_{sp'} + P_s \times A2$$

$$P_s = \frac{F_{sp'}}{A1 - A2}$$

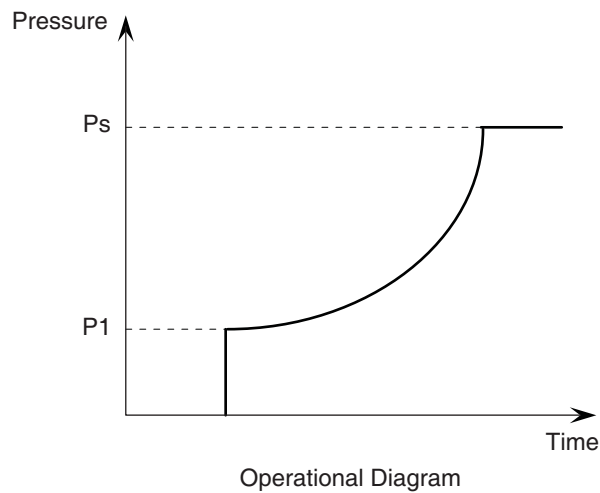
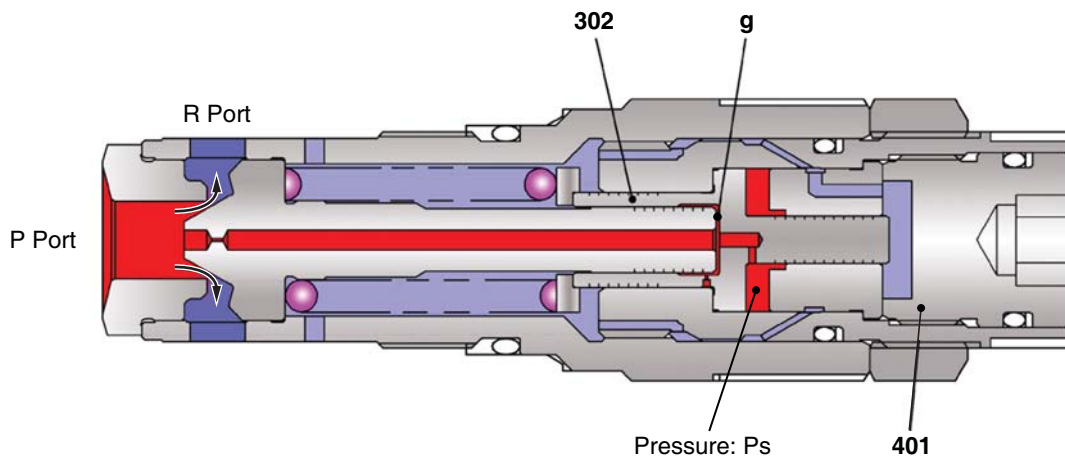


Figure 8 Relief Valve

EX1403528

4. Reactionless valve

When the direction switching valve of swing motor is switched, high-pressure oil is supplied to the port A (or port B) of the hydraulic motor. Then, the poppet of the reactionless valve moves to the right, blocks the bypass route and drives the rotating body (1, Figure 12).

Then, when the direction switching valve returns to neutral position, the ports at both sides of the hydraulic motor are blocked, but the rotating body would maintain its rotation because of inertia and the momentum of inertia is transmitted to the hydraulic motor through the reduction gear, generating brake pressure at the port B (or port A) which stops the rotating body and tries to reverse the direction of rotation.

By this brake pressure, the swing motor first stops and then tries to reverse its direction of rotation and the pressure at the port B tries to switch the poppet to the left, but the action is delayed by the orifice at the port A. Now, a bypass route is formed connecting the ports A and B through which the high-pressure oil flows from port B to the port A (2, Figure 12).

And, the poppet on the port B side moves to the left until it blocks the bypass route (3, Figure 12).

As described above, in the process of reverse pressure generation at the port B, the high-pressure oil is bypassed to the port A to prevent reverse rotation and stop the swing motor right away.

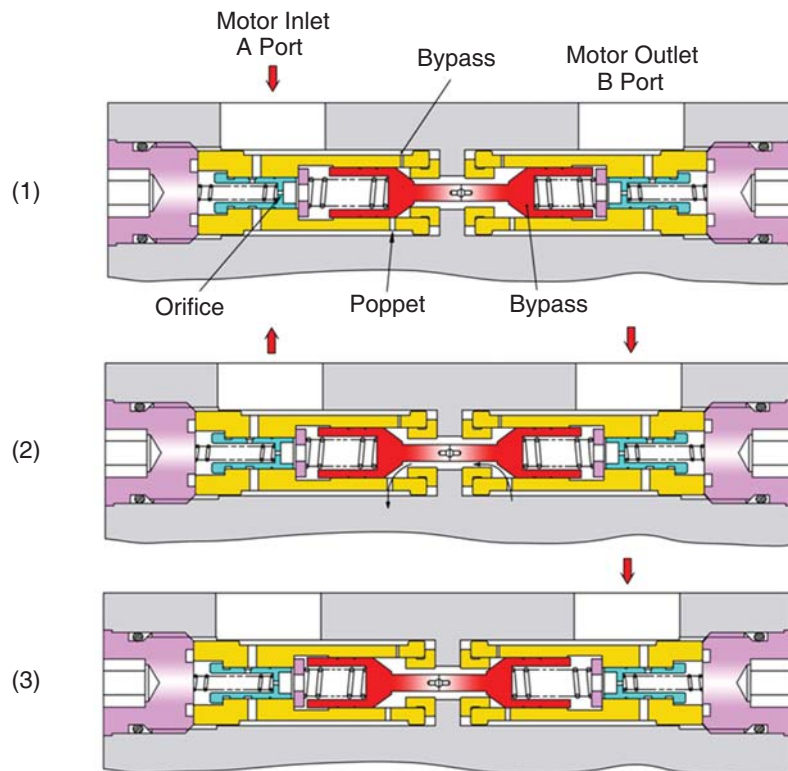


Figure 9 Principle of Operation of Reactionless Valve

EX1301726

Schematic of Operation of Reactionless Valve

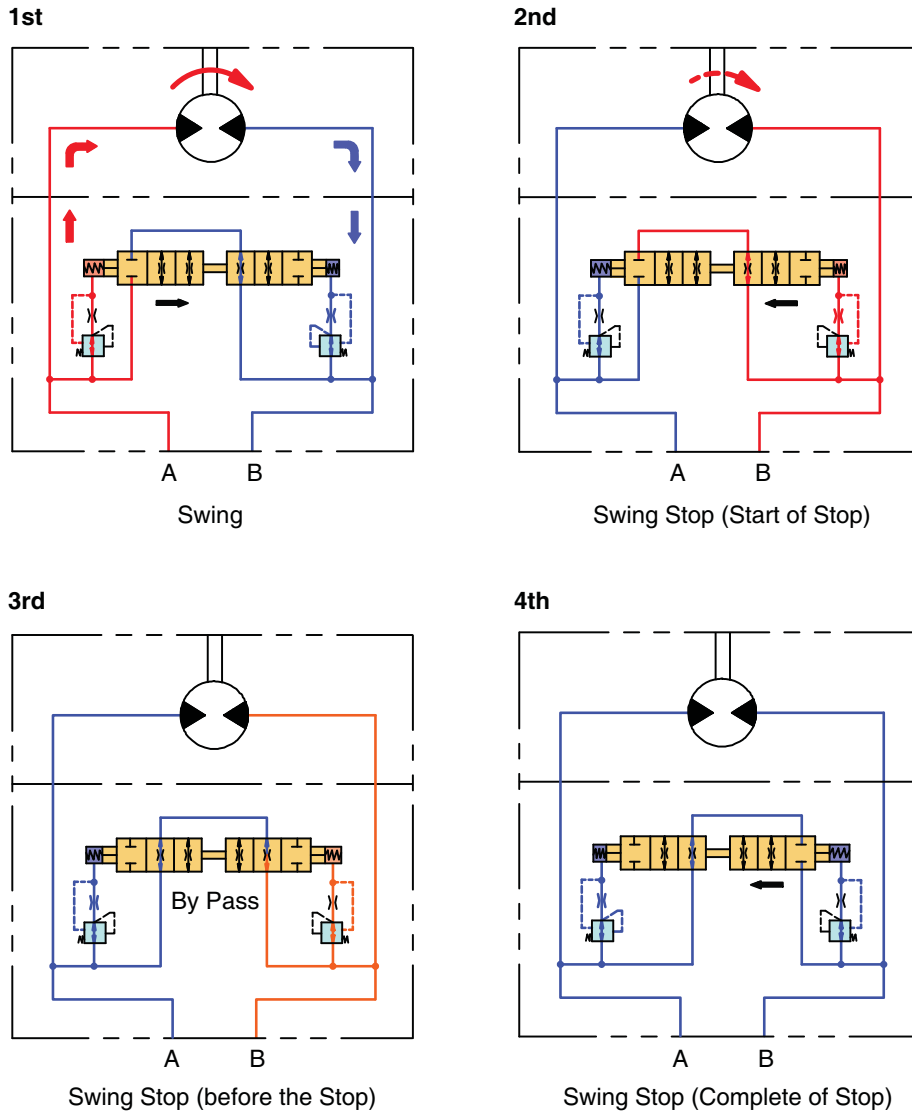


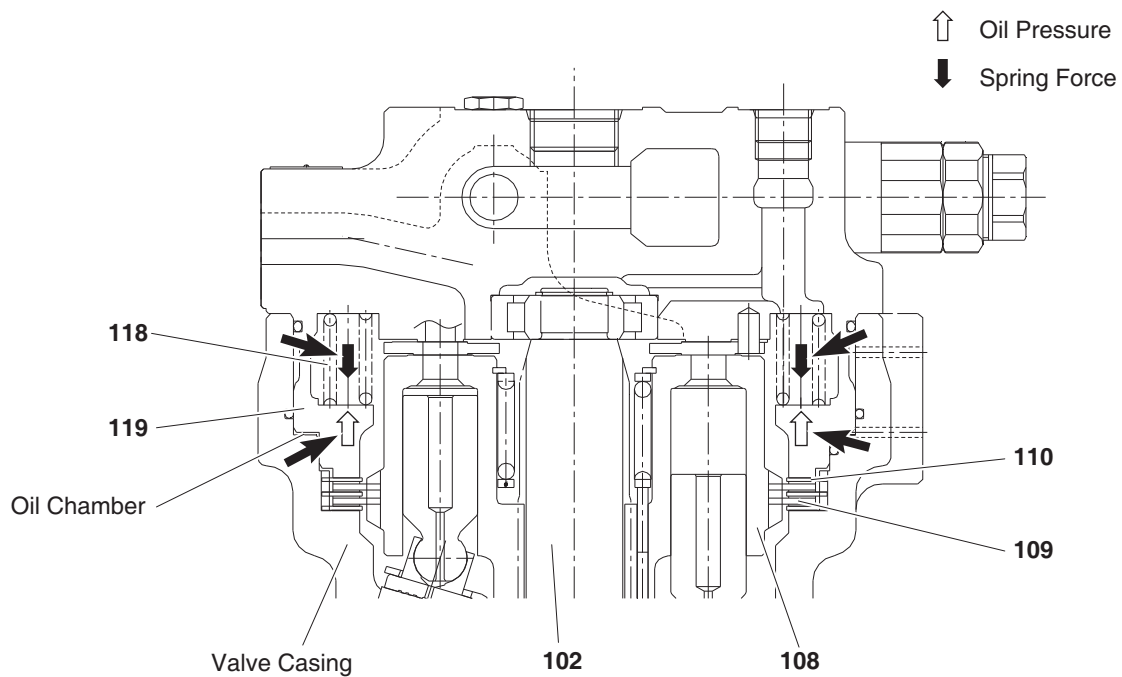
Figure 10

EX1301690

Brake Part

The cylinder block (108) is connected with the driveshaft (102) by spline joint, and rotation of the separation plate (110) in circumferential direction is restricted by the circular arc grooved on the casing (115). When the friction plate (109), engaged with the outer circumference of the cylinder with gears, is pressed to the casing (115) by the brake spring (118) with the separation plate (110) and brake piston (119) as the media. Friction force is generated between the friction plate and casing, separation plate and brake piston. This friction force restricts and brakes the driveshaft.

When brake release pressure is applied to the oil chamber formed between the brake piston and casing and this pressure overcomes the spring force, the brake piston moves and the friction plate is separated from the casing, and the brake is released.



EX1301622

Figure 11 Operation Diagram of Brake

1. Parking brake operating

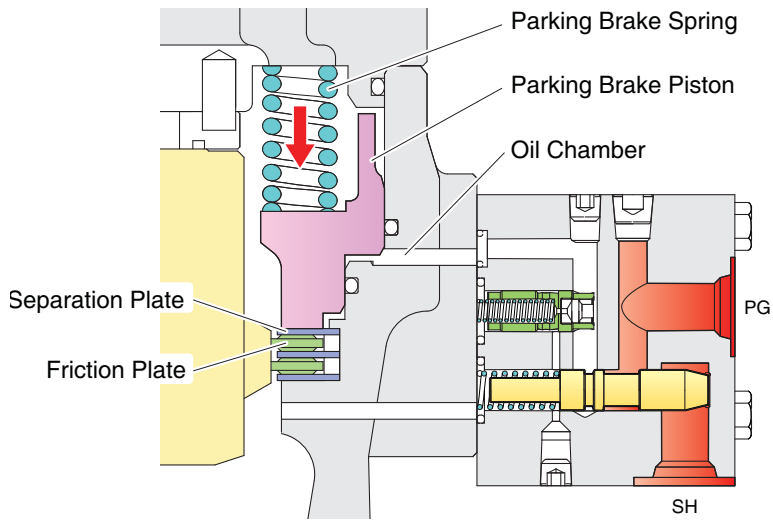
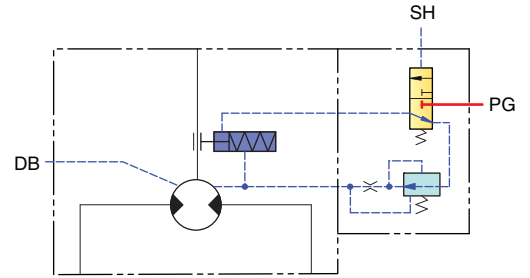


Figure 12



WE1400028

2. Parking brake release

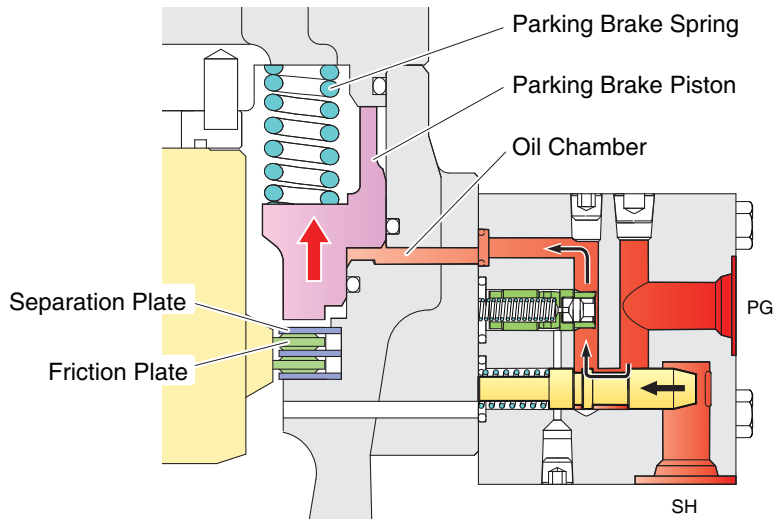
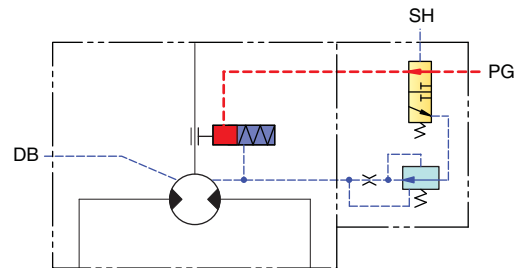


Figure 13



WE1400029

Cautions for Operation

Inspection

Please check the followings before installing a new motor:

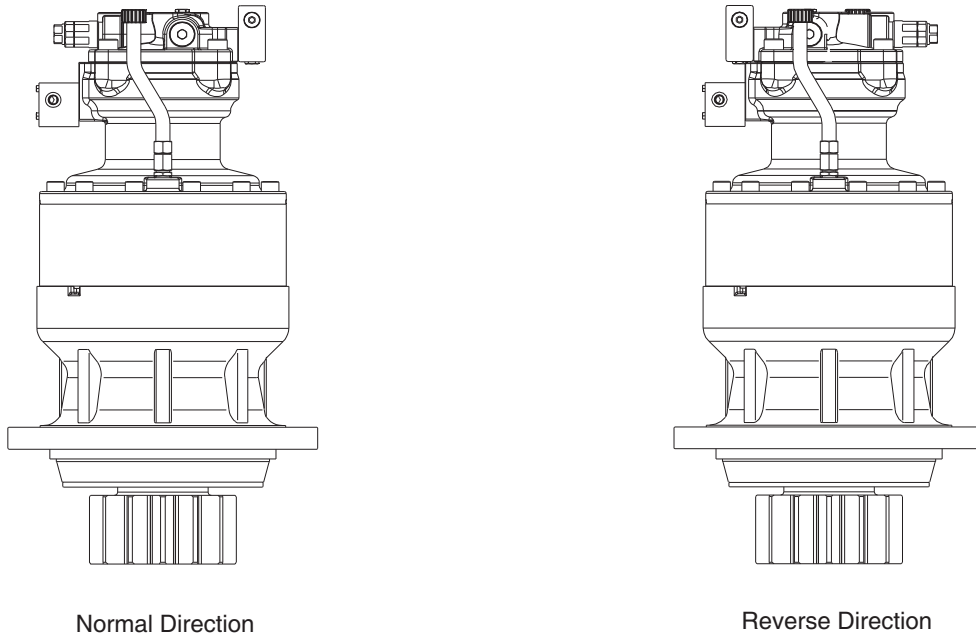
1. Check if there is any part damaged or missing (during transportation).
2. Check if there is any loose joint.
3. Check that flange surfaces and the drain port cover are properly assembled and there is no dust or other particle in the motor.

Direction of Rotation

The relationship between the directions of oil flow and shaft rotation is presented in Figure 17 and Table.

The direction of rotation differs by the direction of the slope of casing.

Be careful for the direction of swing which is differentiated by the shape of casing and direction of flange.



EX1504810

Figure 14

Classification	Inlet	Outlet	Direction of the Rotation of the Shaft Seen at the End of the Shaft
Normal Direction	A	B	Right (Clockwise)
Reverse Direction	B	A	Left (Counterclockwise)

External Load at the End of Shaft

In principle, the end of the motor shaft must be free of any external radial or thrust load.

Hydraulic Oil and Temperature Range

1. Oil type

The recommended oil is mineral type hydraulic oil added with extreme pressure additive, foam suppressor, antioxidant, and desiccant, having high viscosity index.

2. Optimal viscosity and temperature range of hydraulic oil (Figure 18)

Maximum viscosity range is 10 - 1000 cSt, however, recommended range is 10 - 200 cSt to obtain optimal efficiency.

Temperature range is restricted between -25 - 100°C to protect oil seals and O-rings. The highest recommended temperature is 60°C or lower to prevent degeneration of the oil and seals.

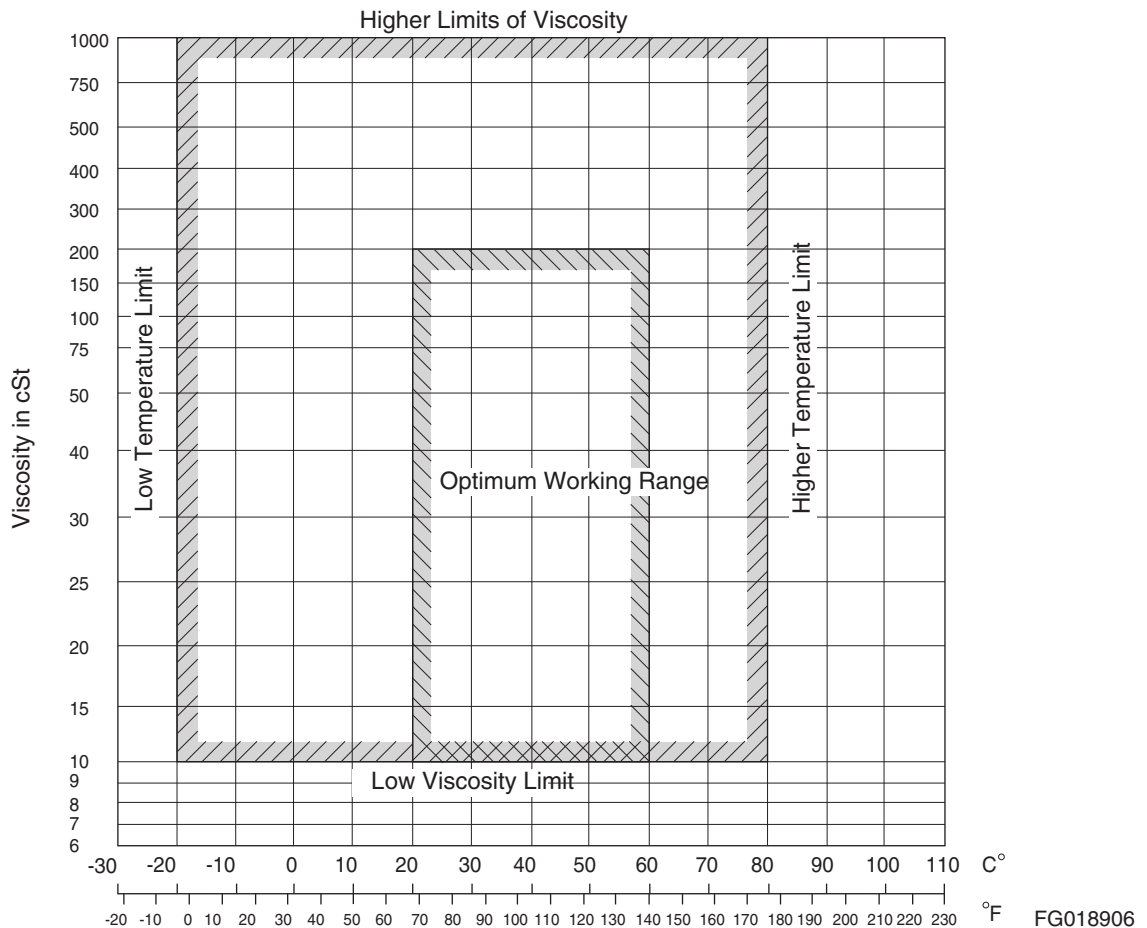


Figure 15 Optimum Viscosity and Temperature Range

3. Other types of oils than mineral oils

Please contact us to use phosphoric acid ester, water-glycol, or fatty acid ester oils.

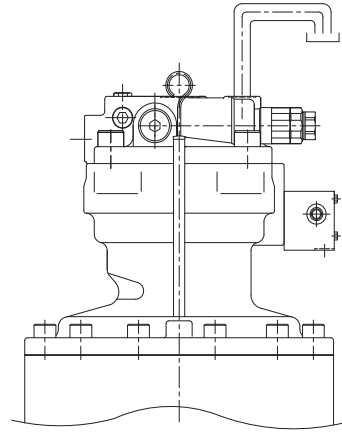
Filter

Dust or metal particles in hydraulic oil accelerate wear of sliding surfaces or can cause sticking. Install 10 μm filter in the oil circuit to remove particles from the oil.

Regarding contamination, NAS Class 9 or lower or 2 - 4 mg/100 cc in Millipore Filter contamination rating is recommended.

Installation and Piping

1. In principle, the motor shaft should face downward.
2. The deviation of centerline from the driven part must be 0.05 mm or less.
3. The tightening torque of the bolts used in mounting the motor to bracket must be according to the specifications on the outline drawings.
4. The casing must be always filled with oil.
The position of the oil drain of the motor must be as shown in (Figure 19) to allow the casing be full of oil.
5. The maximum allowable pressure in the casing is 3 bar, however, 2 bar or less is recommended.
6. Clean the pipeline and perform flushing.
7. Avoid excessive force at pipe joints.
8. Drain pipe must be the same or larger than the port size of the motor, and as short as possible.



FG018907

Figure 16

Oil Filling and Air Ventilation

1. starting operation, fill the casing with oil through drain port.

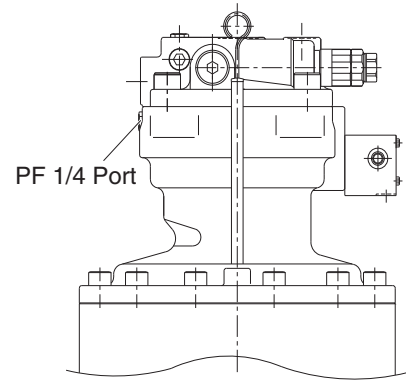
In the hydraulic motor, there are high-speed sliding motion parts, such as bearing, piston, shoe and spherical bushing. If oil is not fully filled, these sliding parts can cause sticking or damage.

The PF 1/4" port of the casing is for air vent.

2. Air inside the hydraulic oil circuit or motor can cause malfunction or damage, thus, must be removed completely.

Instructions before Starting to Operate

1. Check if there is any loose joint or other trouble in the pipeline.
2. Check that direction of rotation is correct.
3. Check oil leaks from the hydraulic motor.
4. Check if abnormal vibration occurs during rotation or operating direction switching valve.
5. Check if the oil temperature rise too fast.
6. Check that actual pressure is about the same as the setting value.



FG018908

Figure 17

PRECAUTION

Tools for Disassembly and Assembly

Tables 1 and 2 and Figure 21 presents the tools required for disassembly and reassembly. Since different bolts and plugs are used in different types, check and prepare necessary tools.

Table 1






Name	Size	Application Part	Tool (mm)
Hex Bolt	M6	Brake Valve	 (10)
Hex Socket Head Bolt	M20	Valve Casing	 (17)
Plug	M30	RO Plug	 (14)
Plug	PF 1/4	VP Plug	 (19)
Relief Valve	M33	Relief Valve	 (41)

Table 2

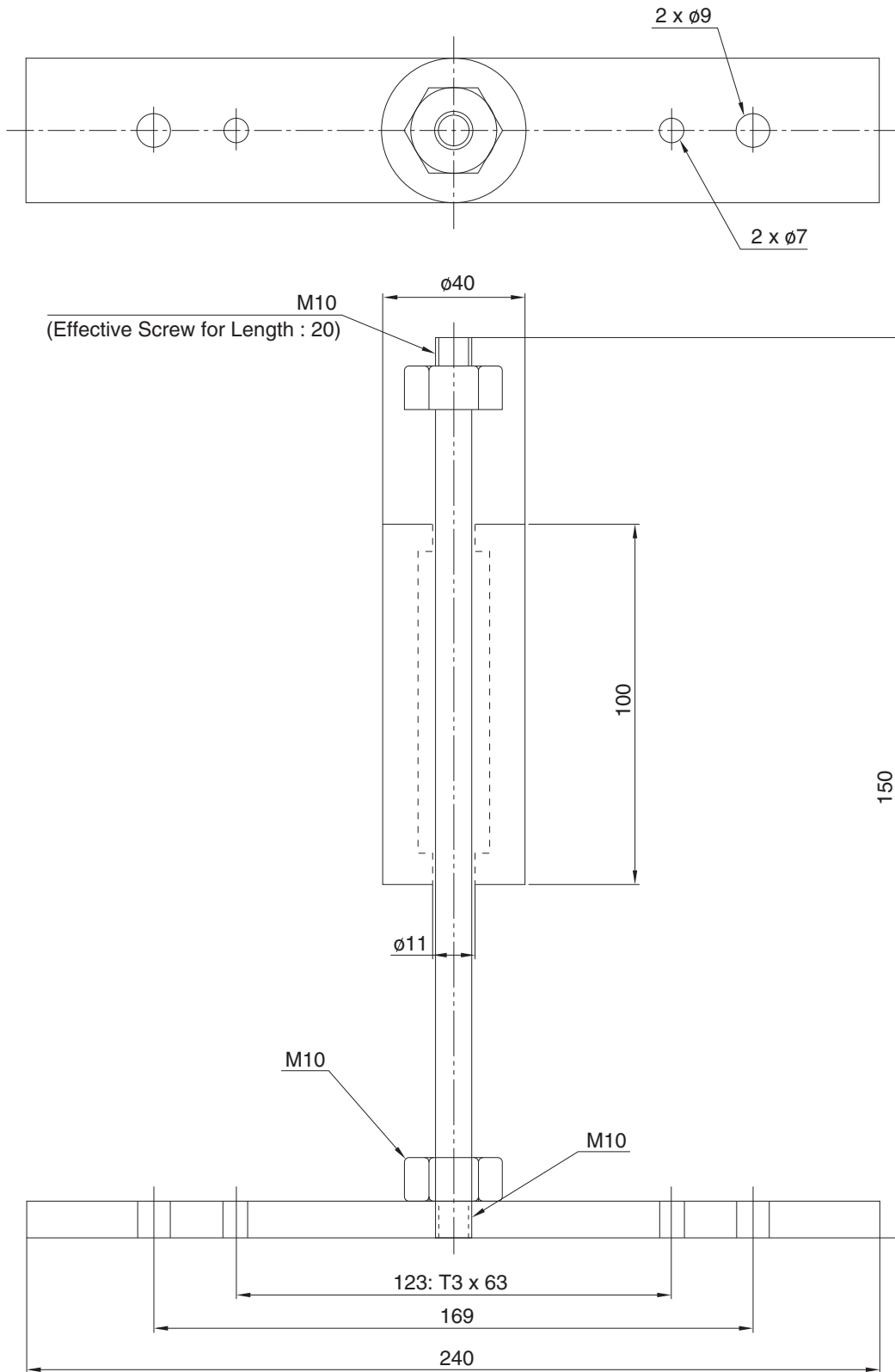
Tools		Specification	Size
Pliers	for stop ring		For ø45 shaft
	for lock ring		For ø100 hole For ø58 hole
Driver			Flat tip, 2 pcs.
Steel Rod			Approximately 10 x 8 x 200. 1 pc.
Hammer			Plastic and metal hammers, 1 each
Torque Wrench			Torque adjustment range <ul style="list-style-type: none"> • for 100 ~ 450 kg.cm • for 400 ~ 1,800 kg.cm • for 1,200 ~ 4,800 kg.cm
Slide Hammer Bearing Pliers			-
Brake Piston Puller			See next page

Tightening Torque

Table 3 presents the tightening torque of the bolts used in the hydraulic motor. Observe the specified torque when tightening the bolts.

Table 3

Reference No.	Bolt Size	Type	Tightening Torque		
			N.m	kg.m	ft lb
107	M6	Hex Bolt	11.8 ±2	1.2 ±0.2	8.7 ±1.4
146	M20	Hex Socket Head Bolt	431.5 ±64.7	44 ±6.6	318.3 ±47.7
123	M30	Ro Plug	220.6 ±24.5	22.5 ±2.5	162.7 ±18.1
128	PF 1/4	Plug	36.3 ±2	3.7 ±0.2	26.8 ±1.4
127	M33	Relief Valve	176.5 ±9.8	18 ±1	130.2 ±7.2



EX1301624

Figure 18 Tools for Brake Piston Disassembly

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

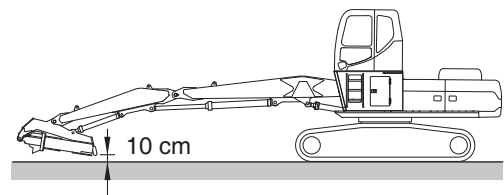
Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Park the machine on flat level ground.
2. Extend the boom and arm, as shown in Figure 22 and lower the boom until the attachment is 10 cm above the ground.
3. Stop the engine.



EX1505045

Figure 19

4. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 23)
5. Turn starter switch to "I" (ON) position.

! WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

6. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
7. Move safety lever to "LOCK" position. (Figure 23)
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Attach a maintenance warning tag on controls.
10. Turn battery disconnect switch to "OFF" position. (Figure 24)

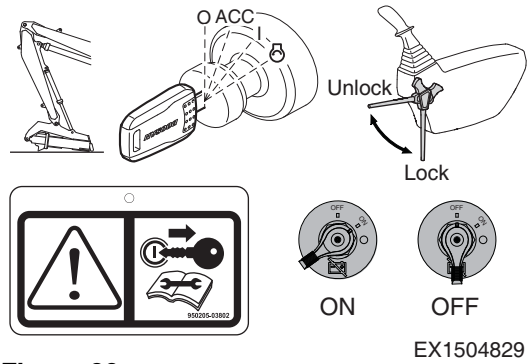


Figure 20

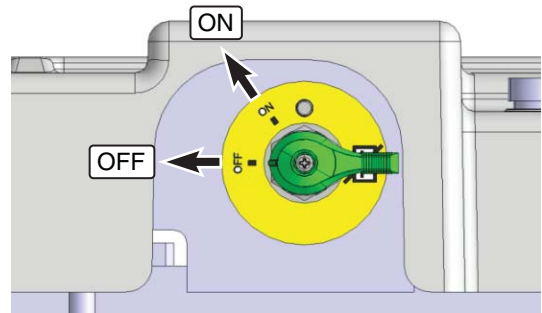


Figure 21

NOTE: *Removal (installation) procedure of the bolts.*

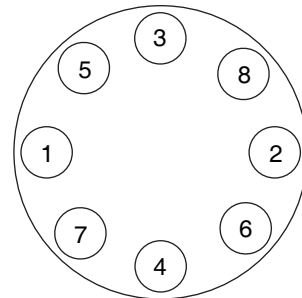


Figure 22

EX1504829

EX1504925

EX1401809



WARNING

AVOID DEATH OR SERIOUS INJURY

Release any pressure in the hydraulic oil tank before doing any work.

11. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank.
Pulling the breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
12. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.

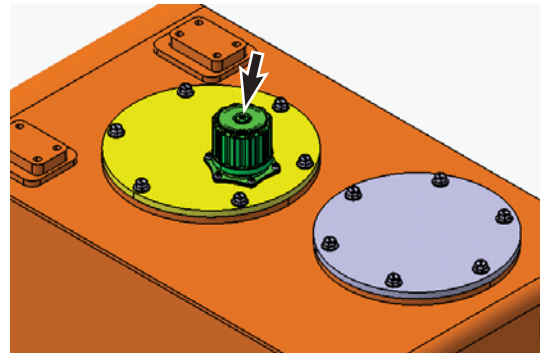


Figure 23

EX1403168



Figure 24

EX1504170

13. Remove hoses and adapters from swing device.

NOTE: Attach identification tags to the removed hoses for reassembling.
 After disconnecting hoses, plug them to prevent dirt or dust from entering.
 Disconnect the hoses from the bottom to upward of swing device.

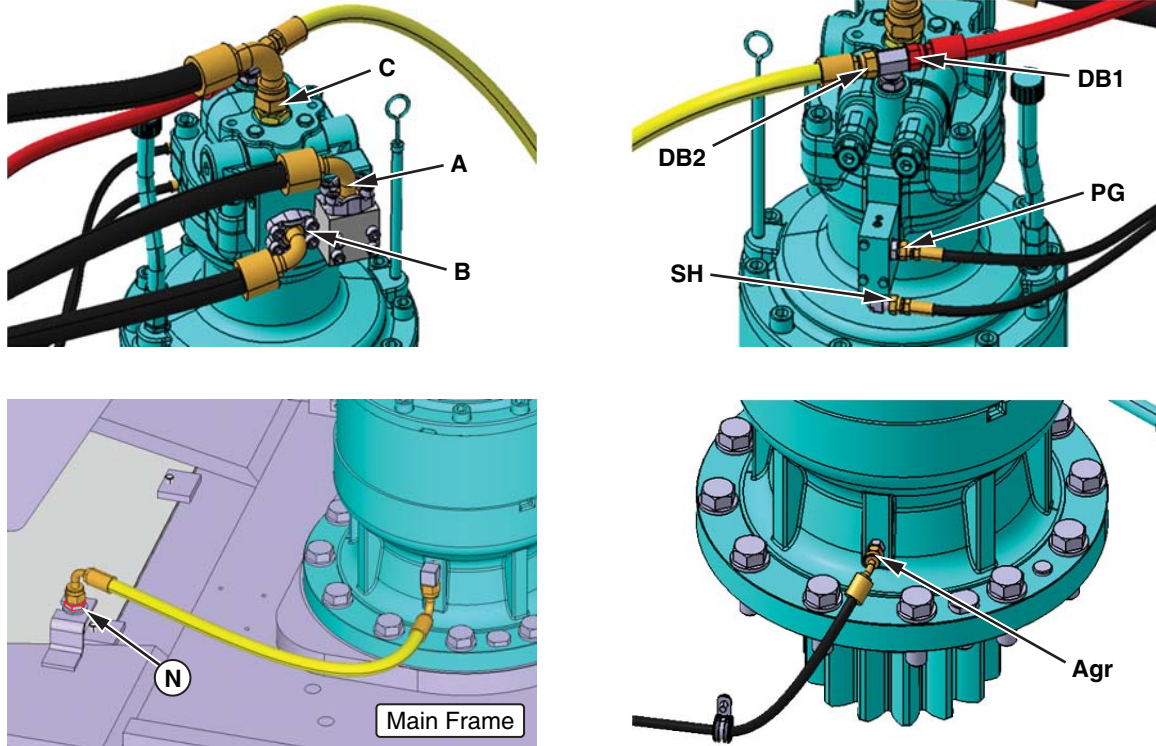





Figure 25

EX1505064

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	 (mm)	Torque		
					N.m	kg.m	ft lb
A	from Control Valve "B3"	SAE 3/4"-5,000 psi, D20		8	63.7	6.5	47.0
B	from Control Valve "A3"	SAE 3/4"-5,000 psi, D20		8	63.7	6.5	47.0
C	from Control Valve "T3"	UNF 1 7/16"-12-2B	41		169.5	17.3	125.1
DB1	to Oil Tank	UNF 13/16"-16-2B	24		55.9	5.7	41.2
DB2	from Center Joint "G"	UNF 13/16"-16-2B	24		55.9	5.7	41.2
PG	from Control Valve "PP"	UNF 9/16"-18-2B	17		25.5	2.6	18.8
SH	from Control Valve "PA"	UNF 9/16"-18-2B	17		25.5	2.6	18.8
Agr	Lubrication Hose	PF 1/4"	19		39.2	4	28.9

- Fitting

Port	Name	Size		 (mm)	Torque		
		A	B(C)		N.m	kg.m	ft lb
C	Adapter	PF 1"	UNF 1 7/16"-12	41	185.2	18.9	136.6
DB1, DB2	Tee	PF 1/2"	UNF 13/16"-16	27	84.3	8.6	62.2
PG	Adapter	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
SH	Elbow	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
Agr	Adapter	PT 1/4"	PF 1/4"	17	17.6	1.8	13.0
N	Nut	PF 1/2"		27	93.1	9.5	68.7
A, B	O-ring	DS2856002 (3/4", ID:25.3, OD:32.3, 1B)					
C		S8000291 (1B P29)	S8030165 (4D F-16)				
DB1, DB2		S8000185 (4D P18)	S8030081 (1B F-08)				
PG, SH		S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)				

* A: Opposite side of hose, B (C): Hose side

- Install the eyebolts (M12 x 1.5) (Figure 29).
- Attach a nylon sling onto the eyebolt.

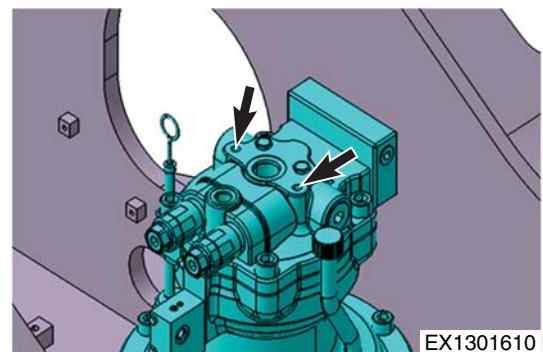



Figure 26

- Remove bolts and washers (1, Figure 30) (12 ea).
 - Tool: 36 mm ()
 - Torque: 931.6 N.m (95 kg.m, 687.1 ft lb)
- Remove plugs (2, Figure 30) (2 ea).
- Install the back bolt to the plug position to ensure that frame and swing device can be separated.
- Hoist and remove swing device from the frame.

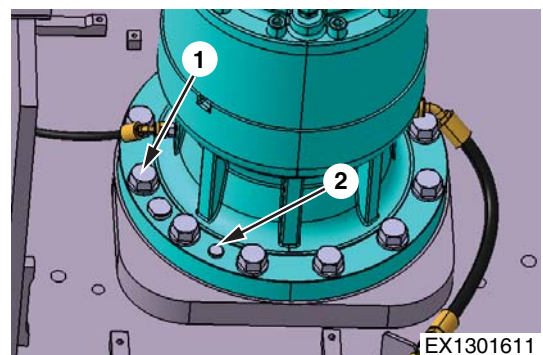


Figure 27

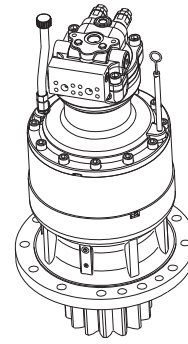
NOTE: When hoisting the swing device, the machine may float together. Hoist the swing device from the main frame by using a jacking bolt (M24, pitch 2.0 mm).

NOTE: When hoisting the swing device one part of swing device will contact with the main frame. Hoist the swing device a little and push to the front side while hoisting slowly.

20. Wind wire rope around the swing device, lift it up with a crane and wash with flushing oil.

After washing, dry with compressed air.

- Weight: about 387 kg (853 lb)



FG018911

Figure 28

INSTALLATION



WARNING

**INCORRECT INSTALLATION CAN CAUSE DEATH OR
SERIOUS INJURY**

Any change in the connections will lead to malfunctions (e.g. lift instead of lower).

- **When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.**
-
1. Perform installation in the reverse order to remove.
 2. When installing the hoses, install the drain hose first.
 3. When installing the swing device, slightly move the end of bucket to align it with the swing bearing gear if the swing device does not fit the gear.

COMPLETING WORK

IMPORTANT

If the air is not vented from the system, it will cause damage to the swing motor and bearings.

NOTE: *Perform this only when oil has been drained from swing motor.*

1. Stop engine.
2. Disconnect drain hose and fill swing motor case with hydraulic oil.
3. Connect the drain hose.
4. Start engine and set throttle at "LOW IDLE" and swing upper structure slowly two full revolutions to the left and right.
5. Stop engine and check hydraulic oil level. Fill hydraulic oil tank to "H" mark on sight gauge.
6. Check for leaks and clean all fill and venting locations.

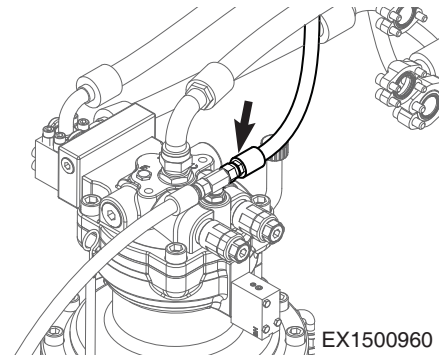


Figure 29

SECTION VIEW

Swing Motor

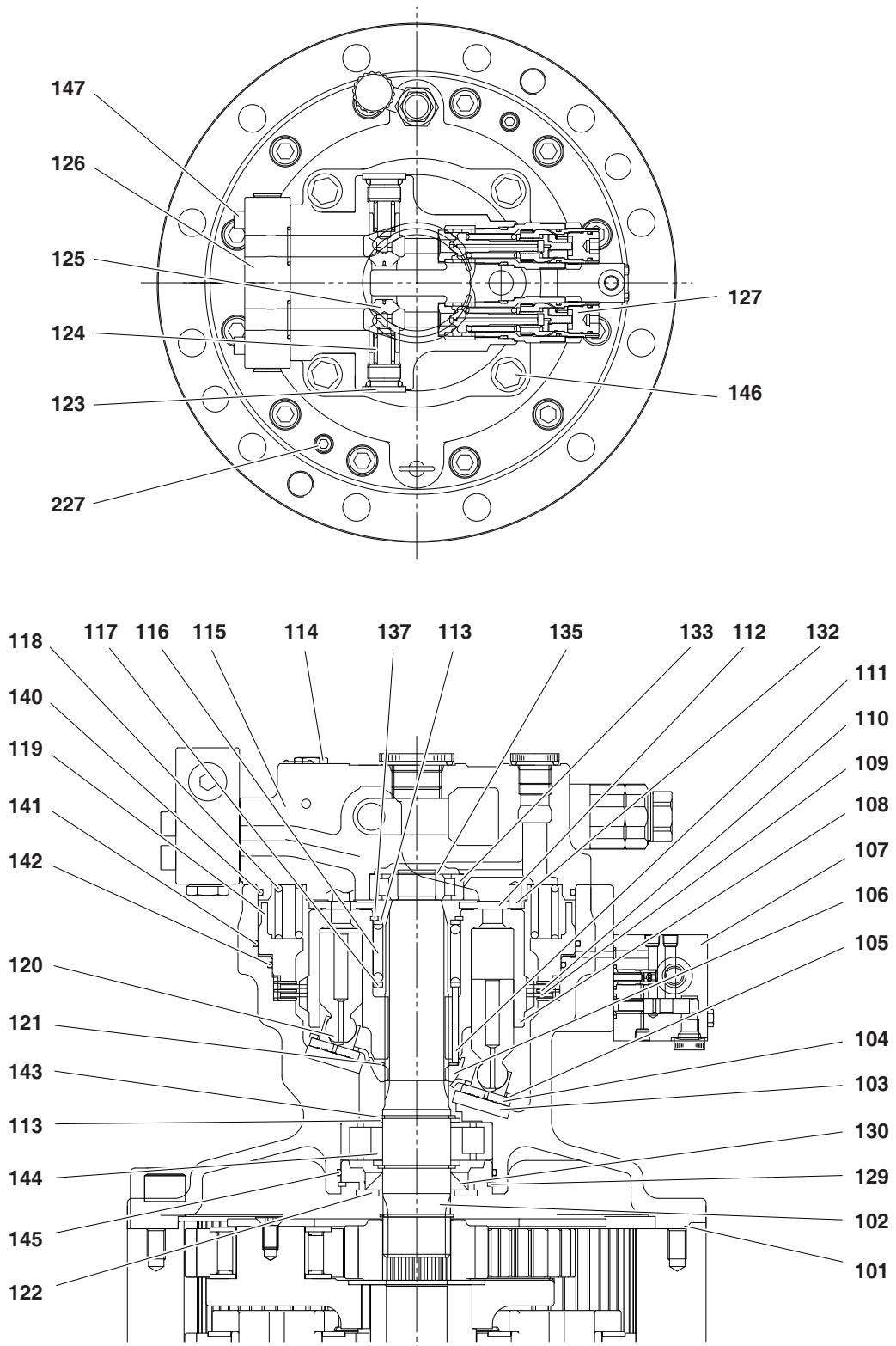


Figure 30

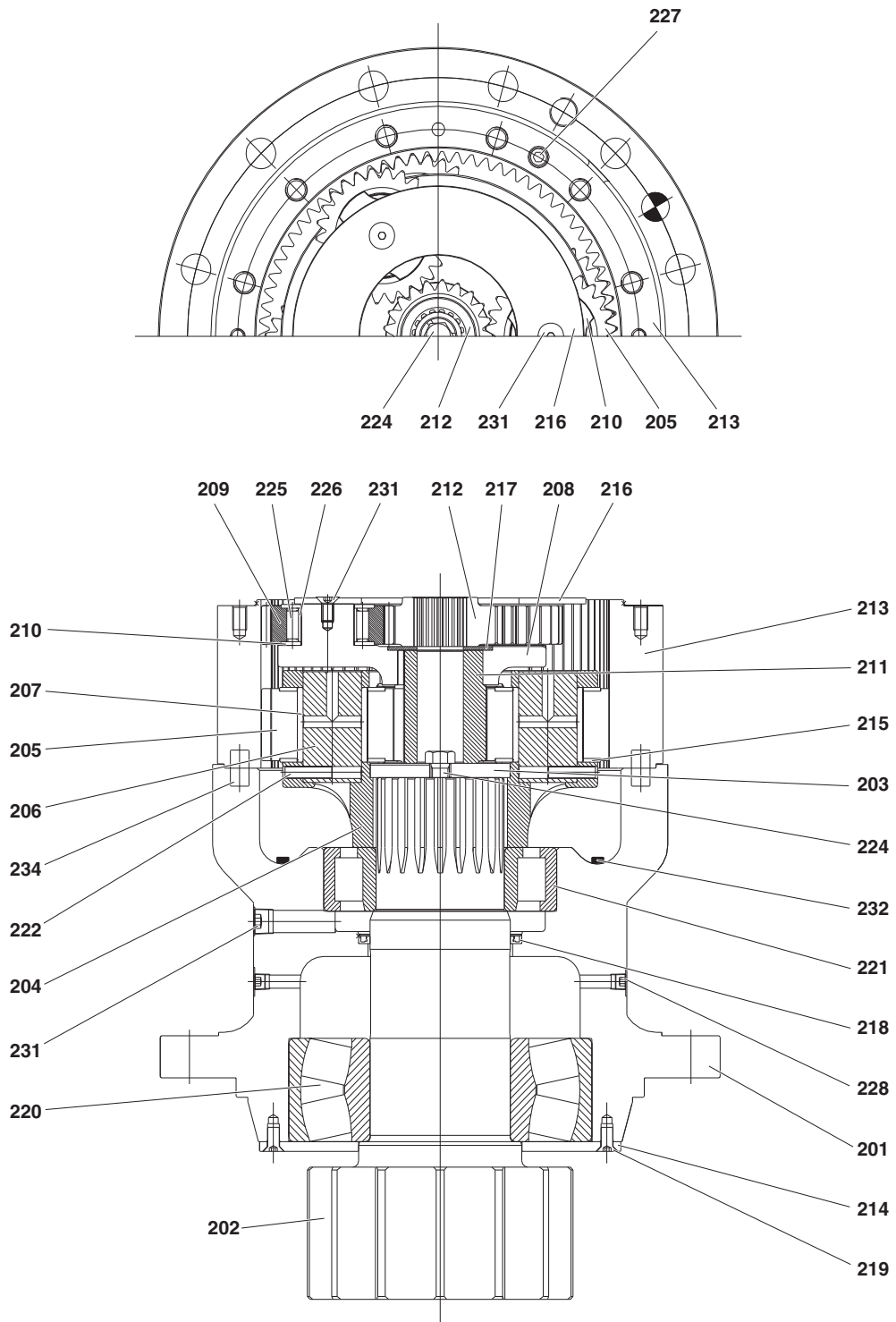
EX1301693

No.	Part Name
101	Casing A2
102	Driveshaft
103	Shoe Plate
104	Shoe
105	Retainer
106	Spherical Bushing
107	Brake Valve
108	Cylinder Block
109	Friction Plate
110	Separation Plate
111	Push Rod
112	Plate Valve
113	Spacer
114	VP Plug
115	Casing Valve
116	Cylinder Spring
117	Spacer
118	Brake Spring
119	Brake Piston
120	Piston
121	Spacer
122	Front Cover

No.	Part Name
123	Plug
124	Spring
125	Plunger
126	Swing Reactionless Valve Assembly
127	Relief Valve
129	Snap Ring
130	Oil Seal
132	Spring Pin
133	Roller Bearing
135	Snap Ring
137	Snap Ring
140	O-ring
141	O-ring
142	O-ring
143	Snap Ring
144	Roller Bearing
145	O-ring
146	Socket Bolt
147	Socket Bolt
227	Socket Bolt

Swing Reduction Gear

Section View



FG018894

Figure 31

No.	Part Name
201	Casing
202	Pinion Shaft
203	Preload Plate
204	No.2 Carrier
205	No.2 Planetary Gear
206	Pin
207	Bushing
208	No.1 Carrier
209	No.1 Planetary Gear
210	No.1 Thrust Washer
211	No.2 Sun Gear
212	No.1 Sun Gear
213	Ring Gear
214	Cover
215	No.2 Thrust Washer
216	Thrust Plate

No.	Part Name
217	Thrust Washer
218	Oil Seal
219	Screw
220	Spherical Roller Bearing
221	Cylindrical Roller Bearing
222	Spring Pin
224	Hex Bolt
225	Needle Bearing
226	Inner Ring
227	Socket Bolt
228	PT Plug
230	Screw
231	PT Plug
232	Magnet
234	Pin

DISASSEMBLY

Swing Motor

1. Wind wire rope around the motor, lift it up with a crane and wash with flushing oil.

After washing, dry with compressed air.

2. Drain the casing (101) through the drain port
3. Point the end of the driveshaft downward and attach it on a disassembly table for easy disassembling.

Now, mark the joint position of the casing (101) and valve casing (115), and remove swing reactionless valve block (126) from the motor.

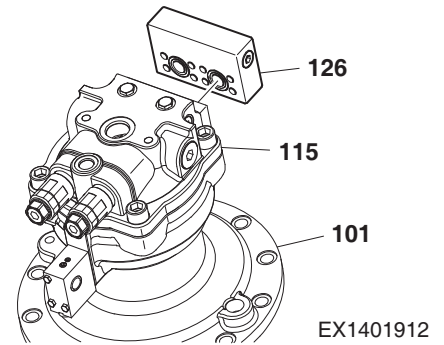


Figure 32

4. Remove brake switching valve (107).

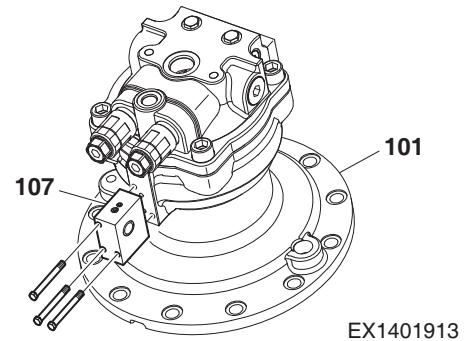


Figure 33

5. Unscrew the relief valve (127) and remove it from the valve casing (115).

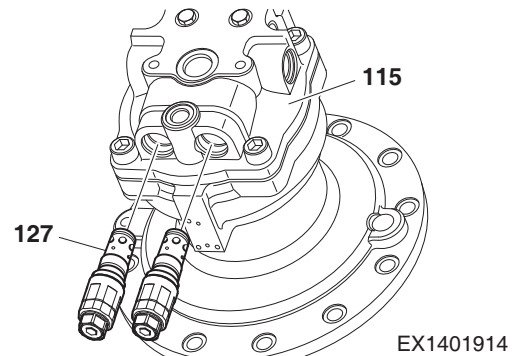


Figure 34

6. Separate the RO plug (123) from the valve casing (115) and remove spring (124) and plunger (125).

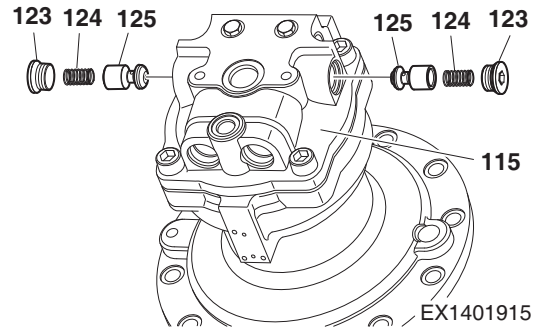


Figure 35

7. Unscrew the hex socket head bolt (146) and remove it from the valve casing (115).

(Due to the brake spring (118) force, valve casing is separated from the casing automatically when the bolt is removed.)

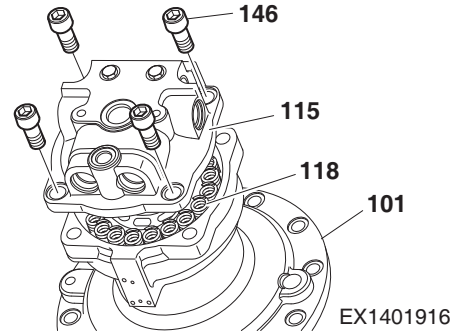


Figure 36

8. Remove brake spring (118) from the brake piston (119).

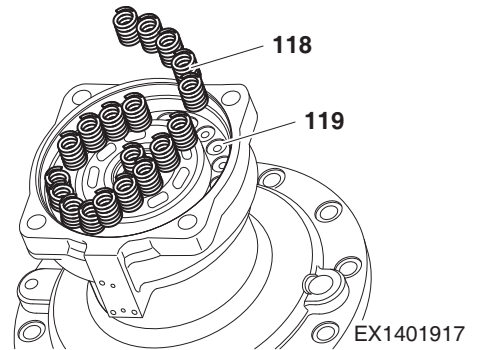


Figure 37

9. Using a jig, remove brake piston (119) from the casing (101).

When using the bolt hole of the brake piston, pull it straight upward.

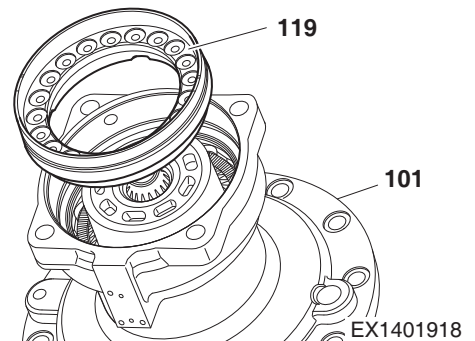


Figure 38

10. Remove O-rings (141, 142) from the casing (101).

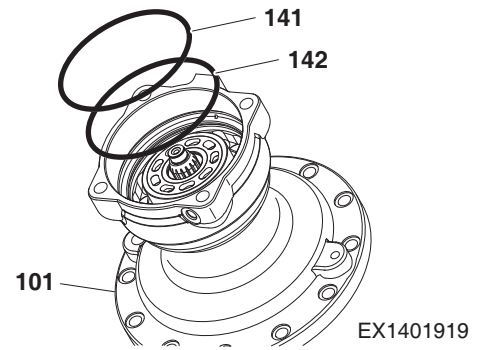


Figure 39

11. Place the motor horizontally, and remove cylinder block (108) from the driveshaft (102).

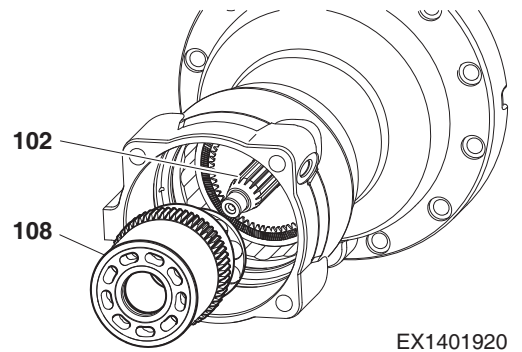


Figure 40

12. Then remove piston assembly (104), retainer (105), spherical bushing (106) and spacer F (113).

When taking out the cylinder block (108), take care not to drop the push rod (111).

Also take care not to damage the sliding surfaces of the cylinder block (108), spherical bushing (106) and shoe.

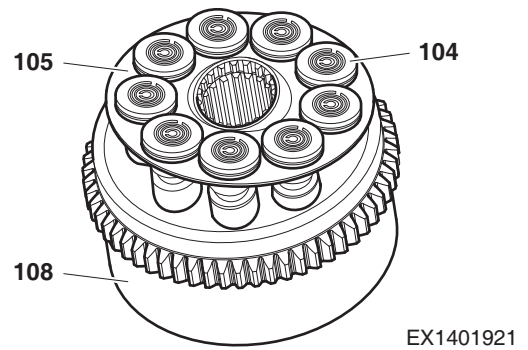


Figure 41

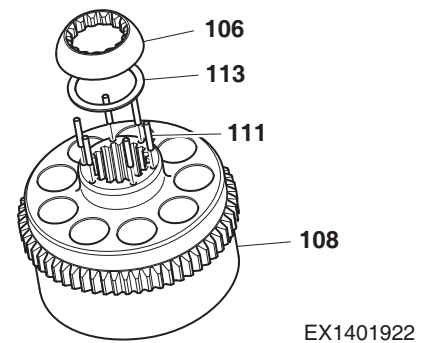


Figure 42

13. Remove two friction plates (109) and three separation plates (110) from the casing (101).

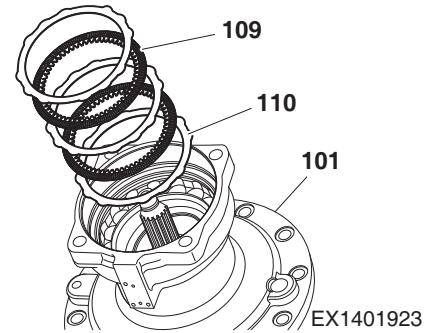


Figure 43

14. Remove shoe plate (103) from the casing (101).

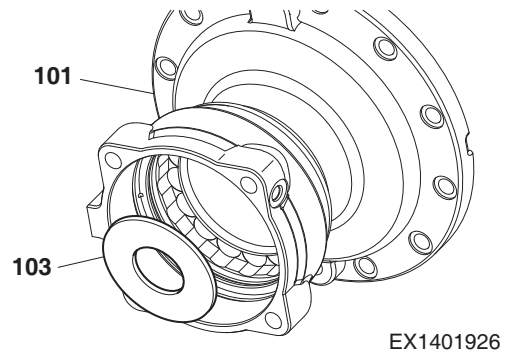


Figure 44

15. Take of retaining ring (129) with pliers and remove front cover (122) from the casing (101).

When removing the front cover, take care not to damage the sliding surface of oil seal (130).
(The front cover can be taken off with the driveshaft.)

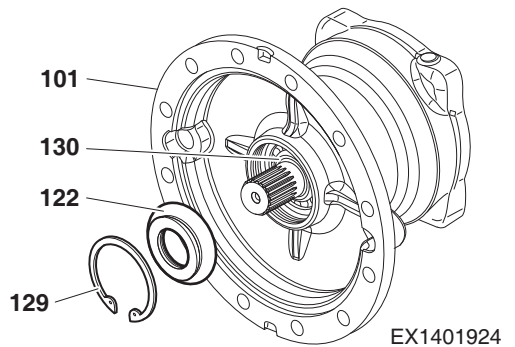


Figure 45

16. Remove end of the driveshaft (102) on the valve casing from the casing (101) by hitting with a plastic hammer, or a similar tool, lightly.

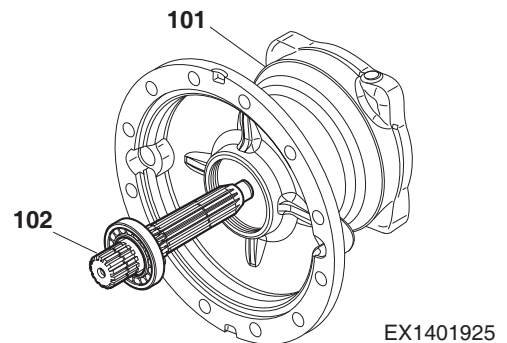
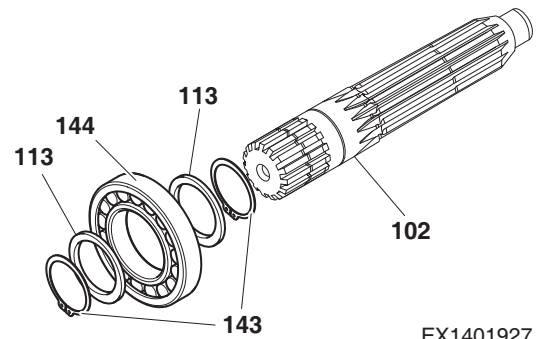


Figure 46

17. Perform the following procedures as necessary.

- 1) Remove retaining ring (143) and spacer (113) from the driveshaft (102), and remove inner race of the cylindrical roller bearing (144) using a press.

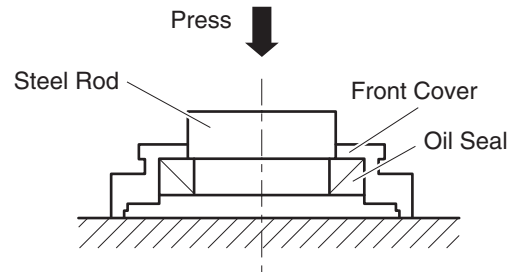
(The inner race of the cylindrical roller bearing may be hit with a steel rod, however, hit the inner race evenly so as not to damage the bearing. Do not reuse the disassembled bearing.)



EX1401927

Figure 47

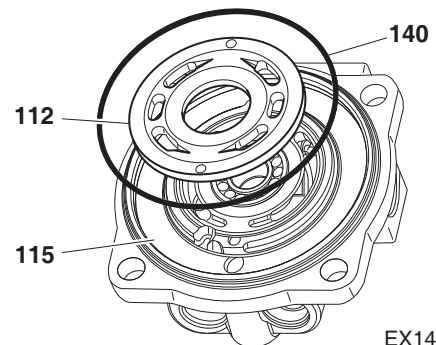
- 2) Remove oil seal (130) from the front cover (122) using a jig. (Do not reuse the oil seal.)



FG018954

Figure 48

- 3) Remove valve plate (112) from the valve casing (115) and O-ring (140).

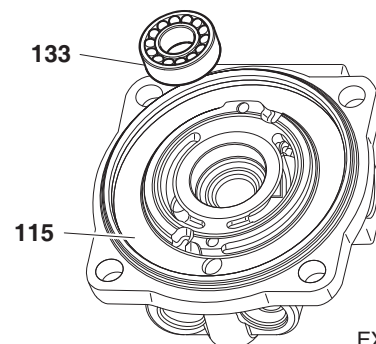


EX1401928

Figure 49

- 4) Remove cylindrical roller bearing (133) from the valve casing (115) using a plastic hammer bearing pliers.

Do not reuse the disassembled bearing.



EX1401929

Figure 50

Swing Reduction Gear

The disassembling procedures of the reduction gear are as follows.

The figure in the parenthesis after part name represents the number in the assembly drawing.

1. Wind wire ropes around the reduction lift it up with a crane and wash with flushing oil.
After washing, dry with compressed air
2. Remove PT 1/4 plug (228).

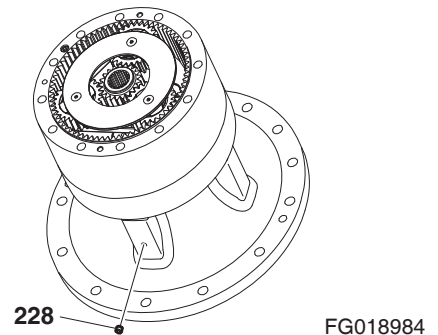


Figure 51

3. Remove No. 1 sun gear (212).

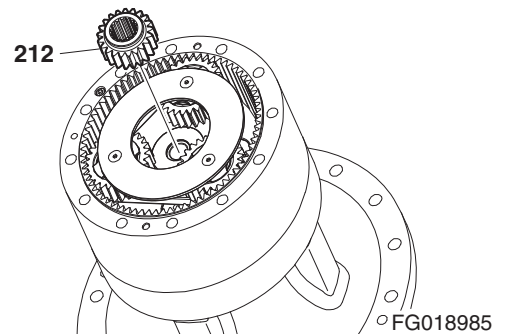


Figure 52

4. Remove No. 1 carrier subassembly.

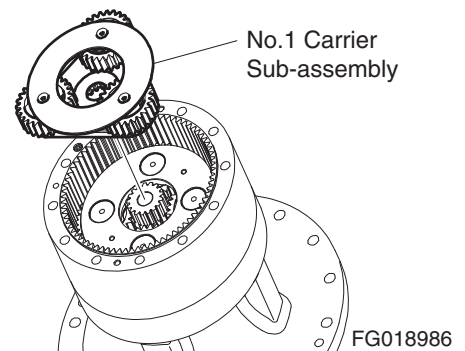


Figure 53

- Remove No. 2 sun gear (211).
Take care not to damage the gear while disassembling.

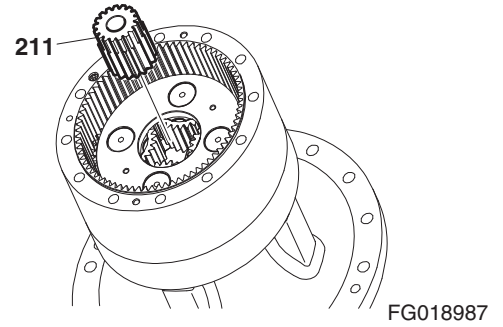


Figure 54

- Remove hex bolts (224).

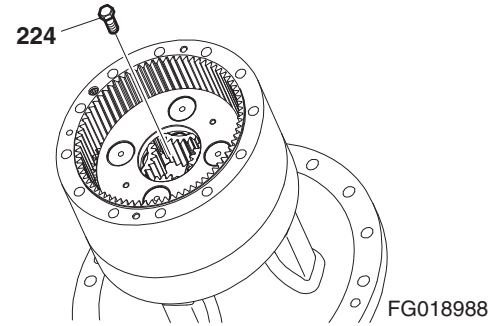


Figure 55

- Remove No. 2 carrier subassembly.

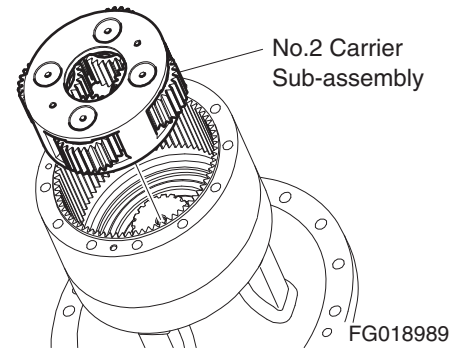


Figure 56

- Remove hex socket head bolts (227).

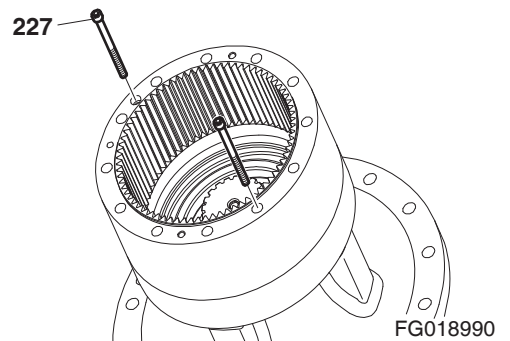


Figure 57

9. Install eyebolts in the two M10 bolt holes on top and remove ring gear (213).

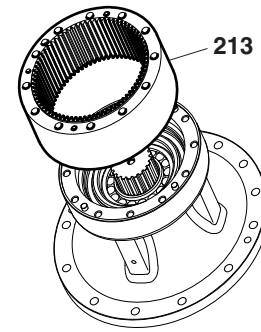


Figure 58

FG018991

10. Remove pin (234).

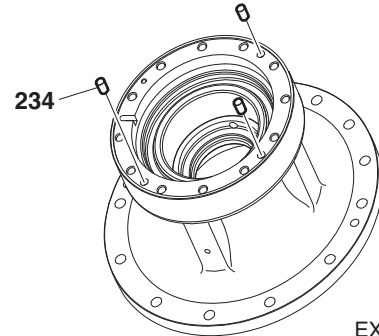


Figure 59

EX1401930

11. Remove magnet (235).

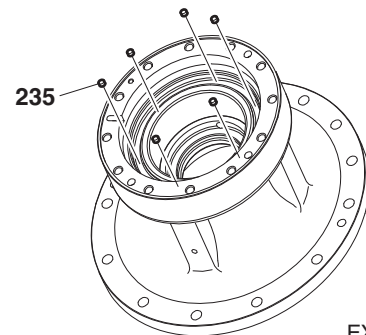


Figure 60

EX1401931

12. Remove hex socket head bolts (219).

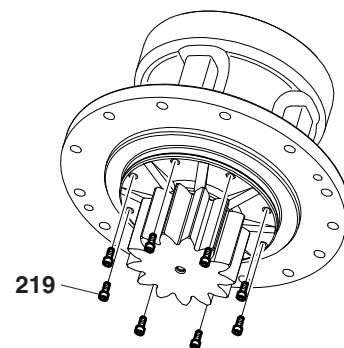


Figure 61

FG018994

13. On a work table, press down the pinion shaft (202) to disassemble the shaft subassembly.

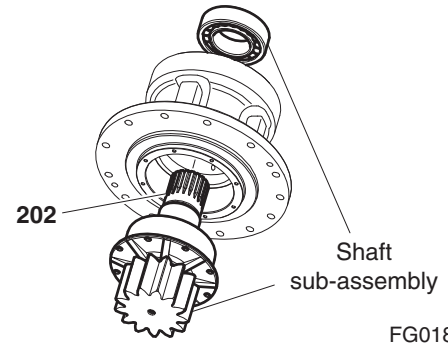


Figure 62

FG018995

14. Remove spherical roller bearing (220) and cover (214).

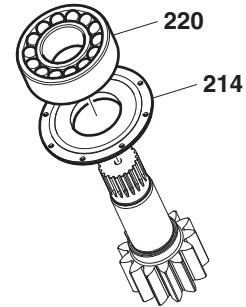


Figure 63

FG018996

15. Remove oil seal (218).

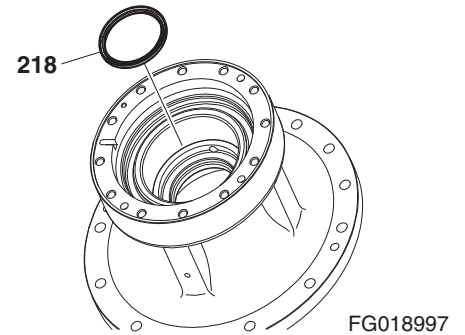


Figure 64

FG018997

Now, disassembling has been completed. Check that all the parts are in good condition.

REASSEMBLY

Swing Motor

Reassembling is in reverse order of disassembling. Take care of the following instructions.

- A. After disassembly, make sure to repair damaged parts and prepare the parts to be replaced.
 - B. Wash all the parts with wash fluid clean and dry with compressed air.
 - C. Apply clean hydraulic oil on the sliding surfaces and bearings.
 - D. Replace O-rings and oil seals, which is a principle.
 - E. Tighten screws, bolts and plugs at specified torque using a torque wrench.
1. Place the casing on an appropriate place.

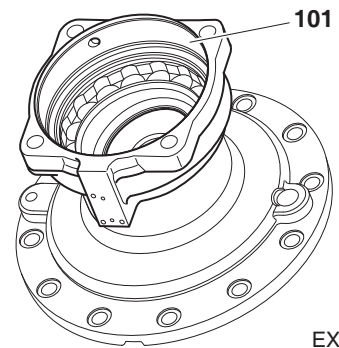


Figure 65

EX1401953

2. (This procedure applies when the cylindrical roller bearing has been removed.)

Install the retaining ring (143) and spacer (113) with the driveshaft (102), insert the collar of the cylindrical roller bearing (144) and assemble the inner race by shrinkage fitting. Then insert the spacer (106) and retaining ring (143).

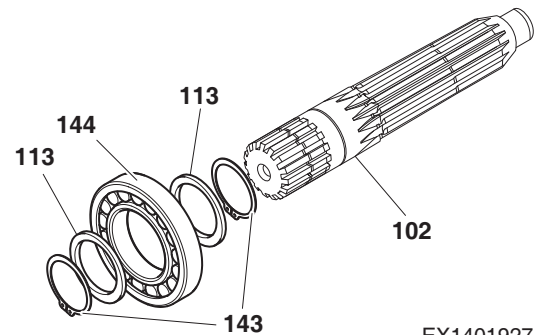
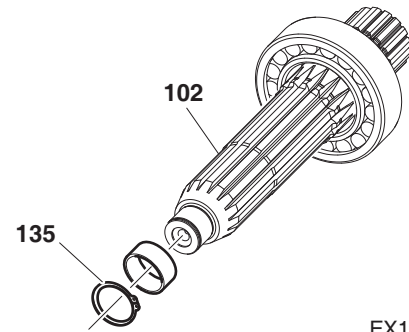


Figure 66

EX1401927

3. Assemble the inner race of the cylindrical roller bearing (133) on the driveshaft (102) by shrinkage fitting, and install the retaining ring (135).

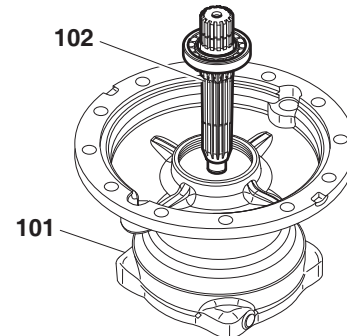


EX1401954

Figure 67

4. Insert the driveshaft (102) into the casing (101) with the output end assemble with the cylindrical roller bearing (144) upside, and assemble the outer race of the cylindrical roller bearing (133) by hitting lightly with a steel rod and hammer.

Hit the circumference of the outer race evenly until it is placed on the edge of the casing.



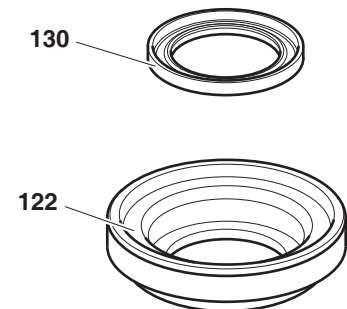
EX1401955

Figure 68

5. (This procedure applies when the oil seal has been removed.)

Insert the oil seal (130) into the front cover (122) using a jig. Take care of the correct direction of the oil seal. (Refer to the Structural Diagram)

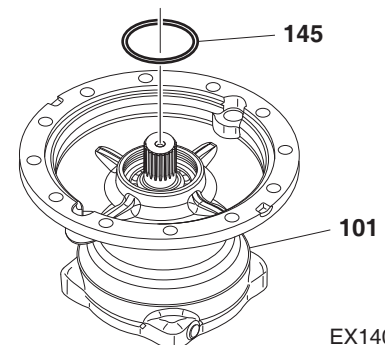
Insert the oil seal fully to the edge.



EX1401956

Figure 69

6. Insert the O-ring (145) into the casing (101).



EX1401957

Figure 70

7. Assemble the front cover (122) with the casing (101) by hitting lightly with a plastic hammer or a similar tool.

Apply grease thinly on the lip of the oil seal and insert the seal carefully not to damage the lip.

(Wrap the spline of the driveshaft with tape to protect the lip.)

Hit evenly and take care not to damage the circumferential surface.

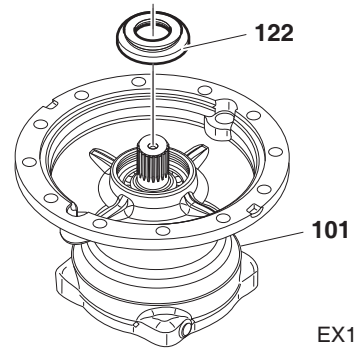


Figure 71

EX1401958

8. Insert the retaining ring (129) into the casing (101) using pliers.

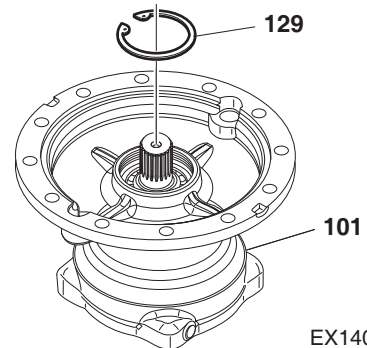


Figure 72

EX1401959

9. Assemble the shoe plate (103) with the casing (101).

Take care not to damage the sliding surface of the shoe plate (103). Larger-chamfered side must be inserted into the casing.

It is recommended to apply grease thinly on the contact surfaces to prevent falling apart.

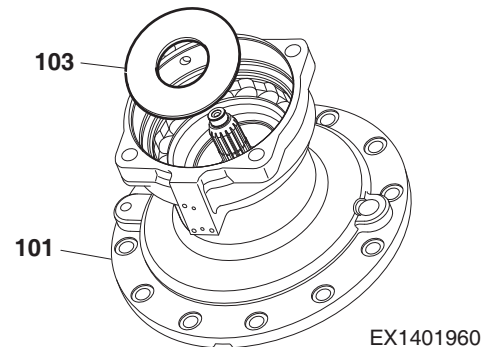


Figure 73

EX1401960

10. Insert the push rod (111) into the cylinder block (108). Place the spherical bushing (106) assembled with spacer F (113) on the cylinder block.

Take care not to damage the sliding surface of the cylinder block. (Insert two push rods into each hole.)

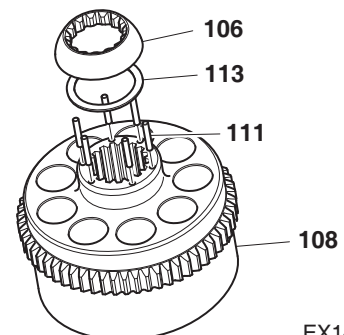


Figure 74

EX1401922

- Assemble the piston assembly (104) fitted with retainer to the cylinder block (108).

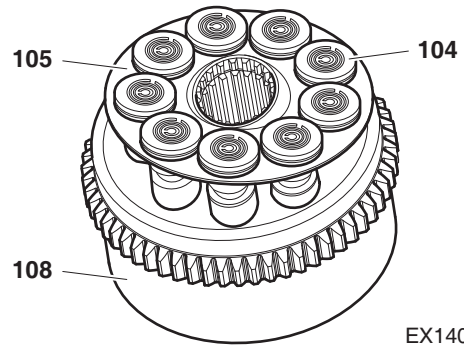


Figure 75

EX1401921

- Assemble the cylinder block (108) with the driveshaft (102).

(For this, arranging the phases of the spherical bushing and cylinder block spline makes it easier to insert onto the driveshaft.)

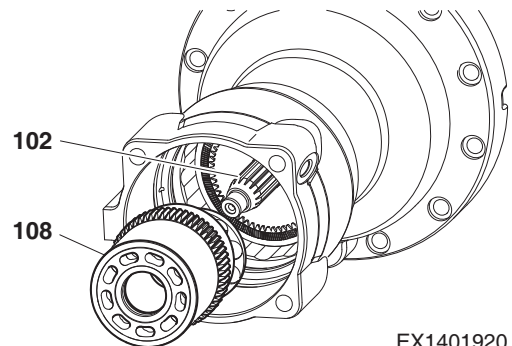


Figure 76

EX1401920

- Assemble the separation plate (110) and friction plate (109), in the said order, into the casing (101). Assemble the three separation plates and two friction plates.

(Assemble the parts of the friction plate cut-off with four gears at the same phase up and down.)

(Assemble the parts of the separation plate cut-off with four jaws at the same phase.)

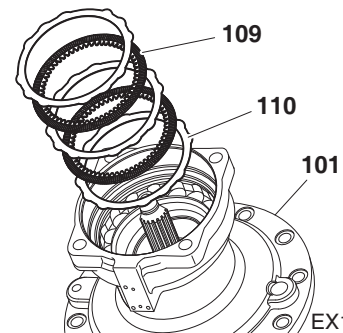


Figure 77

EX1401923

- Insert the O-rings (141, 142) into the casing (101).
(Apply grease thinly on the O-rings to prevent being cut during assembling the brake piston.)

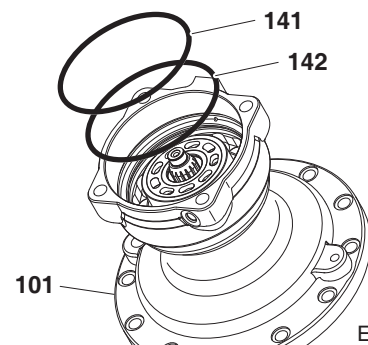


Figure 78

EX1401919

15. Assemble the brake piston (119) with the casing (101).
If the brake piston cannot be inserted because of the resistance of the O-ring, install an M8 hex bolt with the brake piston and hit it with a plastic hammer.

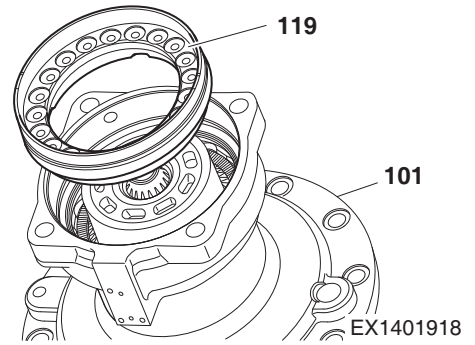


Figure 79

16. Assemble the brake spring (118) with the brake piston (119).

Check that a spring is at the seat of the brake piston.

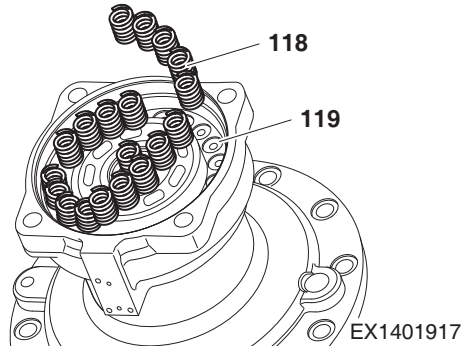


Figure 80

17. Assemble the valve plate (112) and insert the O-ring (140) into the valve casing (115).

Apply grease thinly on the contact surface of the valve plate to prevent fall off. Apply grease thinly on the O-ring.

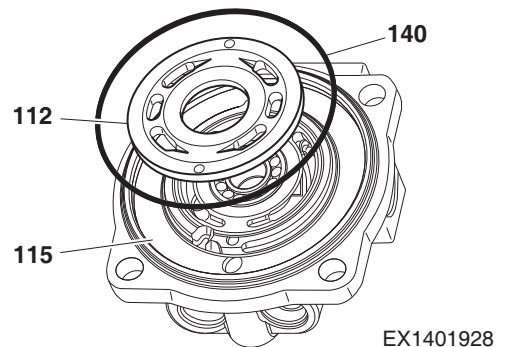


Figure 81

18. Assemble the valve casing (115) with the casing (101) and joint with hex socket head bolts (146).

Check that valve casing is in correct direction.

(Refer to the Outline Drawing)

Take care not to drop the valve plate.

Take care that brake spring does not fall over.

Tighten the hex socket head bolts with even force.

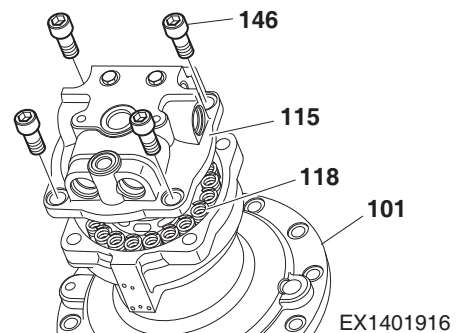


Figure 82

19. Insert the plunger (125) and spring (124) into the valve casing (115) and assemble the plug (123) inserted with O-ring with the valve casing (115).

Check that plunger works smoothly.

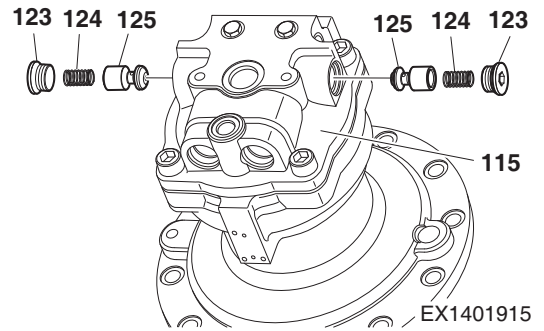


Figure 83

20. Apply grease thinly on the O-ring of the relief valve (127) and assemble it with the valve casing (115).

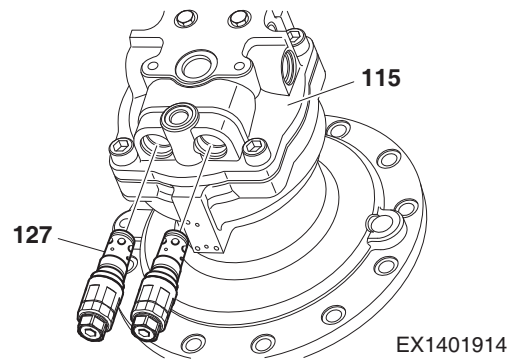


Figure 84

21. Assemble the brake valve (107) with the casing (101) and joint with hex socket head bolts.

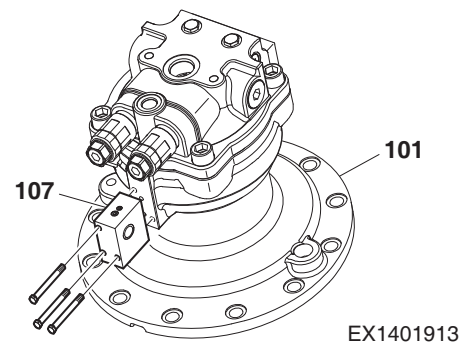


Figure 85

22. Assemble swing reactionless valve block (126) with the motor.

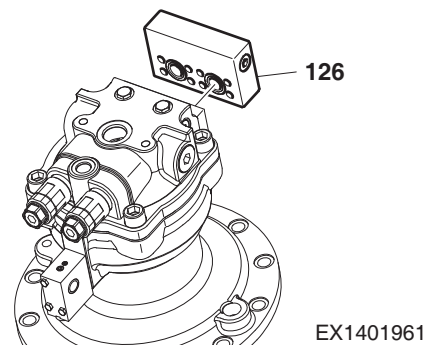


Figure 86

23. Wash the contact surface with the reduction gear with flushing oil and dry it with compressed air.

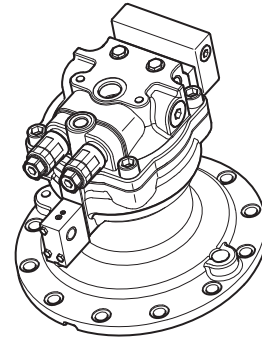


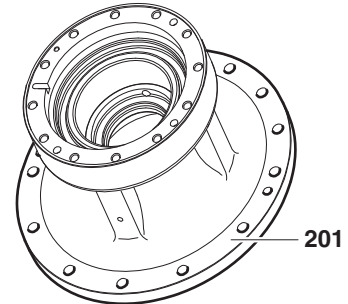
Figure 87

EX1401962

Swing Reduction Gear

Reassembling is in reverse order of disassembling. Take care of the following instructions.

- A. After disassembly, make sure to repair damaged parts and prepare the parts to be replaced.
 - B. Wash all the parts with wash fluid clean and dry with compressed air.
 - C. Apply clean hydraulic oil on the sliding surfaces and bearings.
 - D. Replace the oil seals, as a principle.
1. Place the casing (201) with the flange downside, on a work table.

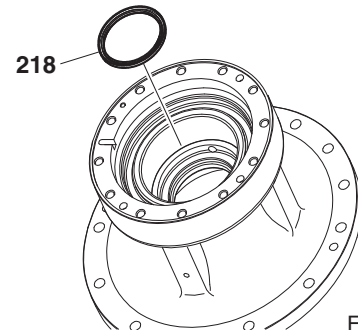


FG018998

Figure 88

2. Apply grease thinly on the outer circumference of the oil seal (218) and insert it using an assembly jig.

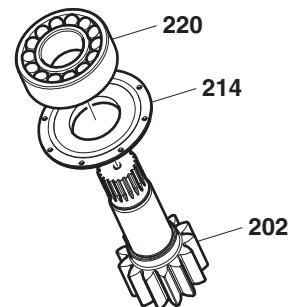
Take care not to damage the oil seal, and check correct assembly by visual inspection.



FG018997

Figure 89

3. Insert cover (214) into the pinion shaft (202) and press fit the spherical roller bearing (220) using a press.



FG018999

Figure 90

4. Until the bearing is completely inserted by the press, press fit the pinion shaft (202) subassembly into the casing (201).

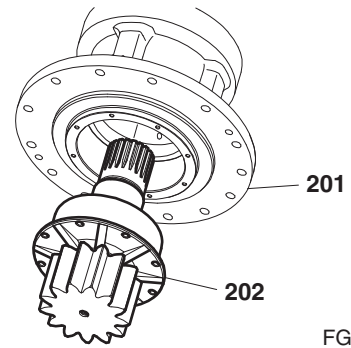


Figure 91

FG019000

5. Insert the cylindrical roller bearing (221) into the casing (201) using a press.

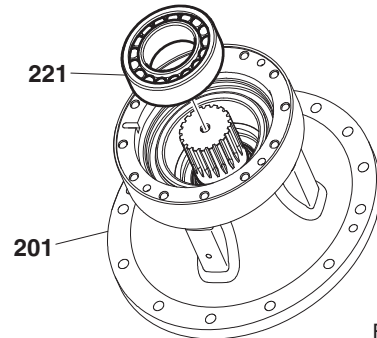


Figure 92

FG019001

6. Install the magnet (235).

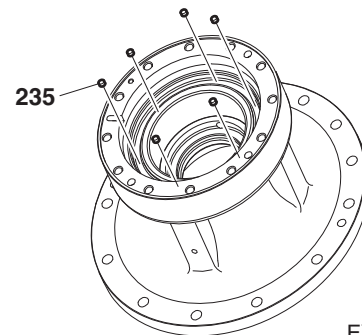


Figure 93

EX1401931

7. Assemble the pin (234).

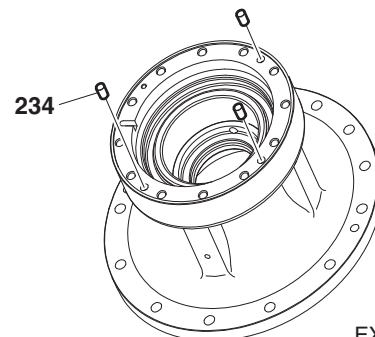


Figure 94

EX1401930

8. Checking the position pin (235), assemble the ring gear (213) with the casing (201).

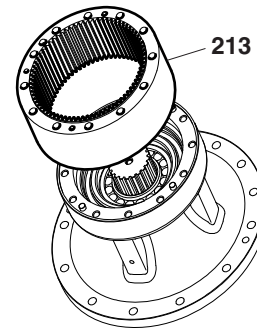



Figure 95

FG018991

9. Tighten the hex socket head bolts (227) (2 used).

- Tool: 8 mm ()
- Torque: 33 N.m (3.4 kg.m, 24 ft lb)

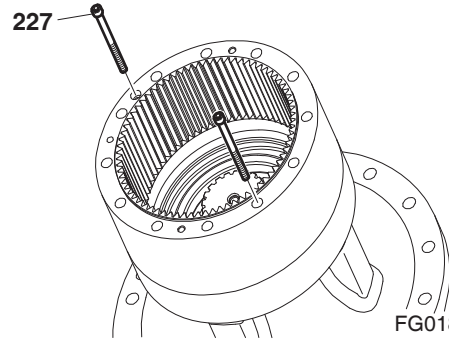


Figure 96

FG018990

10. Assemble the No. 2 carrier subassembly.
Take care not to damage the gear while assembling.

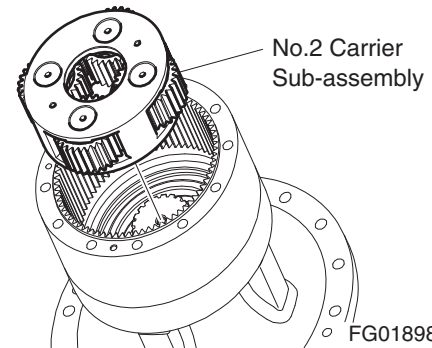



Figure 97

FG018989

11. Tighten the hex bolts (224).

- Tool: 24 mm ()
- Torque: 279.4 N.m (28.5 kg.m, 206 ft lb)

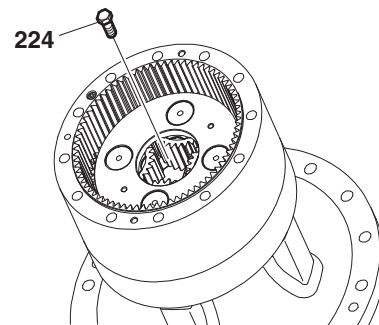


Figure 98

FG018988

12. Assemble the No. 2 sun gear (211).

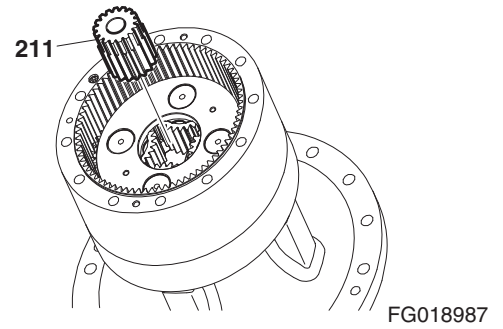


Figure 99

13. Assemble the No. 1 carrier subassembly.
Take care not to damage the gear while assembling.

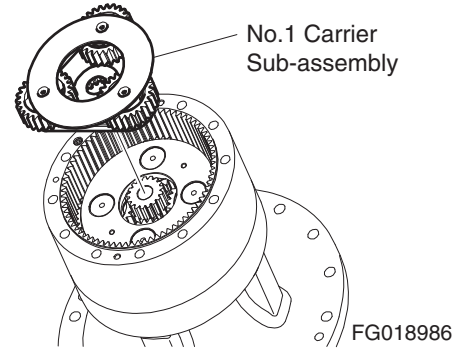


Figure 100

14. Assemble the No. 1 sun gear (212).

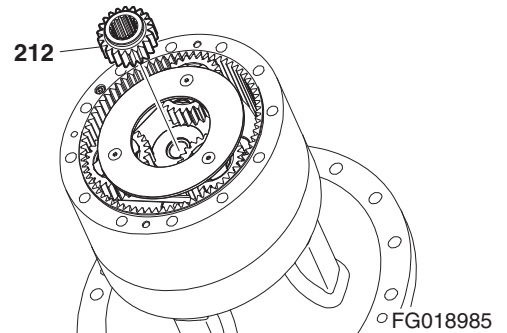



Figure 101

15. Assemble the PT 1/4 plug (228).

- Tool: 6 mm ()
- Torque: 19.6 N.m (2.0 kg.m, 14.4 ft lb)

Now, reassembly has been completed.

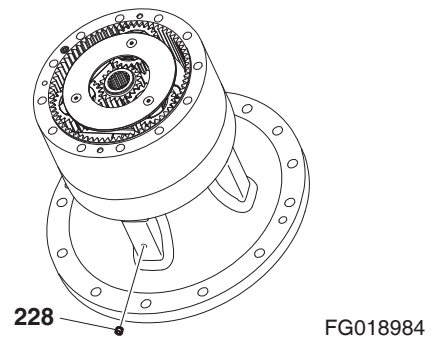


Figure 102

TROUBLESHOOTING

General Instructions

This section provides the corrective actions against any abnormality identified during hydraulic motor operation.

General instructions are as follows:

1. Think before taking action
Before taking any action, examine the characteristics of the problem, and if there had been similar trouble before.
In addition, examine once again that cause of the problem is the hydraulic motor.
2. Take care of foreign material
Foreign materials cause abnormal friction and wear. Take care to avoid foreign materials during disassembly and reassembly.
3. Parts handling
All the parts are precisely ground, thus, take utmost care not to damage.
4. Take care not to damage O-rings and gasket surfaces.
It is highly recommended to replace with new O-rings after disassembly.

Examination of Hydraulic Motor

It is very difficult to find out the cause of trouble in hydraulic oil circuit.

Check the items listed below, and examine the cause of the hydraulic motor.

1. Check oil quality in the casing
Remove drain plug and check the oil in the casing.
If the oil contains many metal particles, the cause of trouble may be a part in the hydraulic motor.
2. Abnormal noise
Check if the motor makes abnormal noise.
3. Pressure measurement of each parts
Before disassembly and inspection, measure the pressure of each parts and examine the problem.
4. Measure the drain quantity of the motor
 - 1) Lock the swing and supply high-pressure oil to the motor, and normal drain quantity must be approximately 25 LPM or less.
 - 2) Normal drain quantity in normal swiveling must be 2 LPM of less.

Troubleshooting

1. Hydraulic motor fails to rotate

Symptom	Possible Cause	Corrective Action
Pressure does not rise	<ol style="list-style-type: none"> 1. The setting of the relief valve in the circuit is incorrect. 2. Relief valve malfunction. <ol style="list-style-type: none"> 1) Plunger sticks 2) Plunger orifice clogged. 3. Plunger seat failure 	<ol style="list-style-type: none"> 1. Set up with correct value 2. <ol style="list-style-type: none"> 1) Plunger sticks 2) Plunger orifice clogged. 3. Check the seat and replace it if damaged.
Pressure rises up to normal level	<ol style="list-style-type: none"> 1. Overloaded. 2. Sticking of moving parts 3. Brake release pressure is not applied. 4. Brake piston is sticking. 5. Friction plate is sticking. 	<ol style="list-style-type: none"> 1. Remove load. 2. Check/repair piston, shoe, cylinder block, and valve plate. 3. <ol style="list-style-type: none"> 1) Check/repair the circuit. 2) Check the brake switching valve. 4. Disassemble and check 5. Disassemble and check Replace the sticking part.

2. The direction of rotation is reverse.

Symptom	Possible Cause	Corrective Action
Direction of rotation is reverse	<ol style="list-style-type: none"> 1. Motor rotates in reverse direction. 2. The inlet and outlet of pipeline are reverse. 	<ol style="list-style-type: none"> 1. Referring to Figure 12, assemble correctly. 2. Correct the pipeline.

3. Rotating speed fails to reach setting value.

Symptom	Possible Cause	Corrective Action
Rotating speed fails to reach setting value	<ol style="list-style-type: none"> 1. Insufficient incoming flow. 2. Temperature is too high and oil leaks too much. 3. Wear of damaged of sliding parts 	<ol style="list-style-type: none"> 1. Check pump discharge rate, circuit to the motor. 2. Reduce the oil temperature. 3. Replace the damaged part.

4. Insufficient brake torque

Symptom	Possible Cause	Corrective Action
Insufficient brake torque	<ol style="list-style-type: none"> 1. Friction plate is worn. 2. Brake piston is sticking 3. Brake release pressure cannot be removed. 4. The spline of the friction plate is damaged. 	<ol style="list-style-type: none"> 1. Disassemble and check. Replace the part if excessively worn. 2. Disassemble and check 3. <ol style="list-style-type: none"> 1) Check/repair the circuit. 2) Check the brake switching valve. 4. Disassemble and check Replace the damaged part

5. Hydraulic motor slips excessively

Check the drain quantity of the motor.

Normal drain rate is 500 cc/min.

Symptom	Possible Cause	Corrective Action
Excessive slip when external torque to drive the hydraulic motor is applied.	<ol style="list-style-type: none"> 1. Relief valve malfunction. Same as subclause 1). 2. Bad plunger seat 	<ol style="list-style-type: none"> 1. Same as subclause 1). 2. Replace the damaged part.

6. Oil leak

1) Leak at oil seal

Symptom	Possible Cause	Corrective Action
Leak at oil seal	<ol style="list-style-type: none"> 1. The lip is damaged by dust. 2. Worn or damaged shaft. 3. Oil seal lip is overturned because of excessively high-pressure in the casing. 4. Rusted shaft. 	<ol style="list-style-type: none"> 1. Replace the oil seal. 2. Change the relative position of the lip and shaft, or replace the lip. 3. Repair clogged pipeline. 4. Disassemble and correct it.

2) Oil leak at joint surface

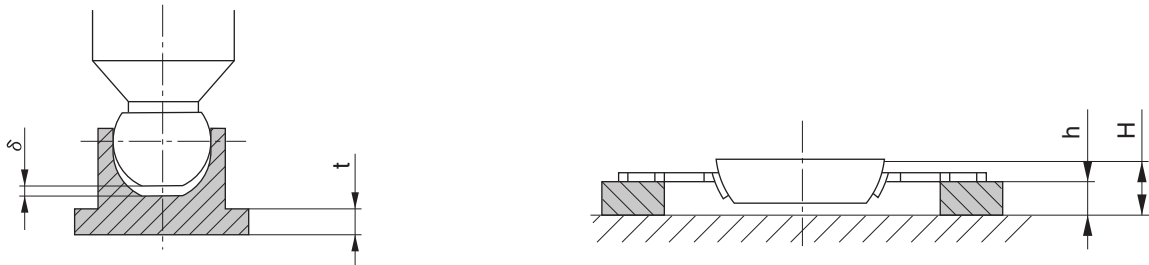
Symptom	Possible Cause	Corrective Action
Oil leak at joint surface	<ol style="list-style-type: none"> 1. O-ring is missing. 2. O-ring is damaged. 3. Seal surface is damaged. 4. Loose or damaged bolt. 	<ol style="list-style-type: none"> 1. Insert correctly and reassemble 2. Replace. 3. Disassemble and correct it 4. Tighten at specified torque or replace the bolt

MAINTENANCE INSTRUCTIONS

Replacement Standard of Worn Parts

When a part is worn exceeding the criteria below, adjust or replace the part. However, the criteria for parts with distinct damage are not defined.

Item	Standard Dimension (mm)	Replacement Criteria (mm)	Corrective Action
Clearance between the piston and cylinder block	0.028	0.058	Replace the piston or cylinder block
Clearance between the piston and shoe compressed part (δ)	0	0.3	Replace the piston or shoe assembly
Shoe thickness (t)	5.5	5.3	Replace the piston or shoe assembly
Assembled height of the retainer plate and spherical bushing (H-h)	6.5	6	Replace the retainer and spherical bushing set
Friction plate thickness	4	3.6	Replace



Piston and shoe clearance between the piston and shoe (δ)
Shoe thickness (t)

Assembled height of the retainer and spherical bush (H-h)

FG019002

Figure 103

Standard of Sliding Surface Correction

Correct or replace the part whose surface roughness of the sliding face exceeds the following criteria.

Part Name	Standard Roughness	Roughness Requiring Correction
Shoe	0.8 - Z (Ra = 0.2) (Lapping)	3 - Z (Ra = 0.8)
Shoe Plate	0.4 - Z (Ra = 0.1) (Lapping)	3 - Z (Ra = 0.8)
Cylinder	1.6 - Z (Ra = 0.4) (Lapping)	12.5 - Z (Ra = 3.2)
Valve Plate	0.8 - Z (Ra = 0.2) (Lapping)	6.3 - Z (Ra = 1.6)

NOTE: 1) All the sliding surfaces must be lapped to make the roughness below the standard roughness.

NOTE: 2) If the sliding surfaces of the retainer or spherical bushing are excessively rough, replace the parts by set unit.

Fan Pump for Oil Cooler

Edition 1

MEMO

Table of Contents

Fan Pump for Oil Cooler

Safety Instructions	5-9-5
General	5-9-6
Specification	5-9-6
Overview	5-9-7
Theory of Operation	5-9-8
Maintenance Guidelines	5-9-13
Sealing Driveshaft	5-9-14
Sealing Control Valve	5-9-16
Tools.....	5-9-16
Removal	5-9-17
Installation	5-9-21
Completing Work	5-9-21
Section View	5-9-22
EPPR Valve.....	5-9-22
Disassembly	5-9-23
Disassembly of Rotary Group	5-9-24
Disassembly of Control Device	5-9-25
Disassembly of Shaft/Bearings	5-9-26
Cleaning and Inspection	5-9-27
Reassembly	5-9-30
Adjustment of Taper Roller Bearing	5-9-31

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

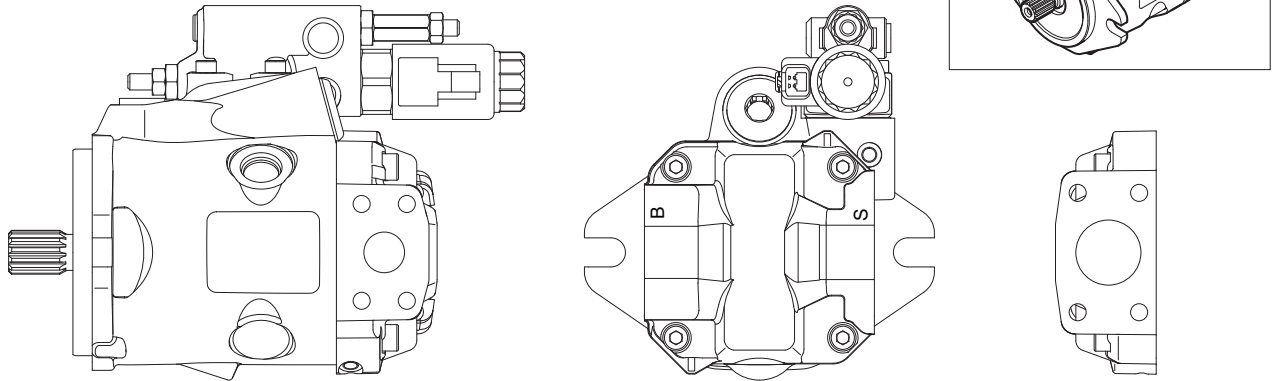
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

GENERAL

Specification

Max. Input Speed	1,800 rpm
Max. Displacement	18 cc/rev
Max. Flow at Max	32 L/min (8.5 U.S. gal) (Theoretical Value)
Pressure Setting on EPPR Valve	122 kg/cm ² (120 bar, 1,740 psi)
Min. Pressure Setting on EPPR Valve	16 kg/cm ² (16 bar, 232 psi)

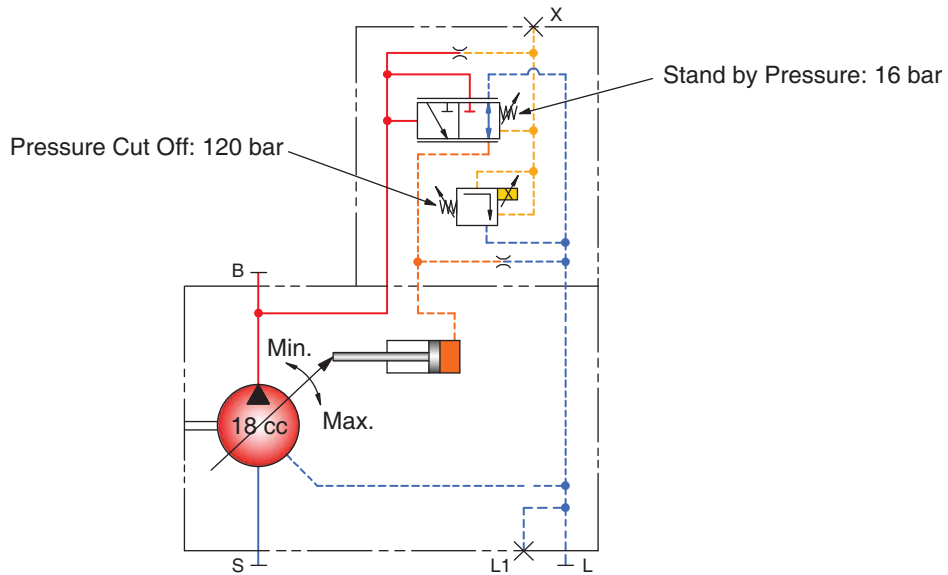
Overview



EX1301359

Figure 1

Port and Hydraulic Circuit



EX1401186

Figure 2

Port	Name	Size
B	Pressure	SAE 3/4
S	Suction	SAE 1 1/4
L	Case Drain	3/4-16UNF-2B

Theory of Operation

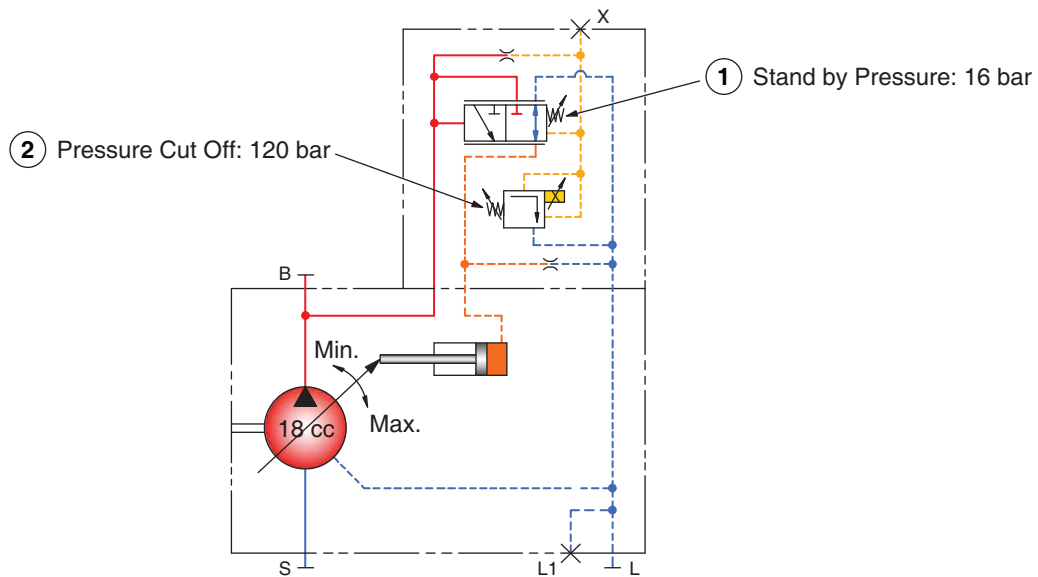
The (1, Figure 4) and (2) valves adjust the pump swivel angle in order to maintain the electrically set pressure level.

When the cutoff pressure is controlled, the P-I curve also shifts in response to the cutoff pressure (pressure measurement: X).

By controlling the discharge pressure according to the characteristics of the fan drive, volume control can be performed to control the speed of the fan.

- Stand by pressure: 16 bar
- Pressure cut off: 120 bar (at 0 mA)

Circuit



EX1401187

Figure 3

Control Section

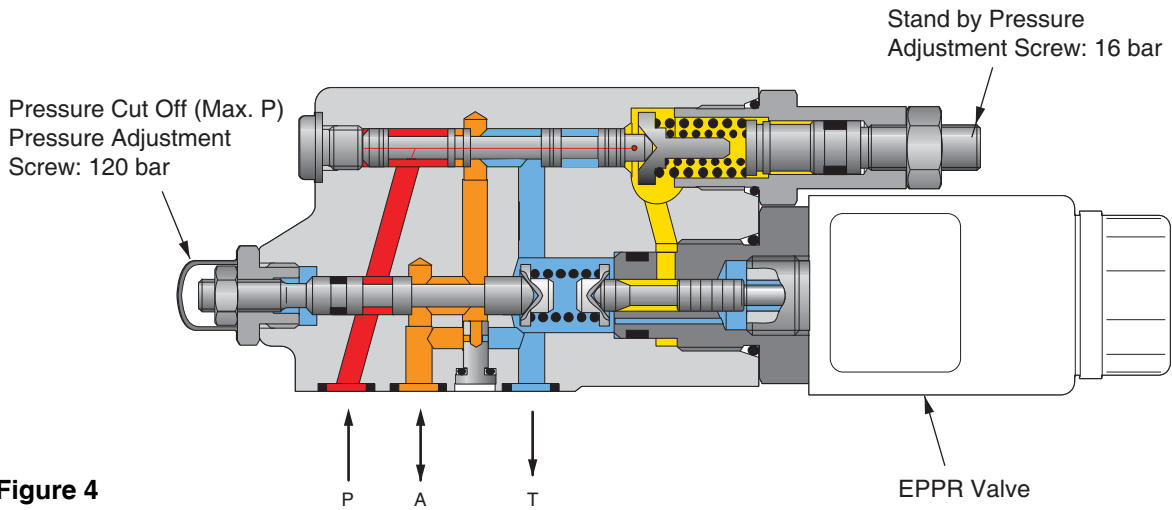


Figure 4

EX1401188

Circuit Diagram Related to Fan Drive

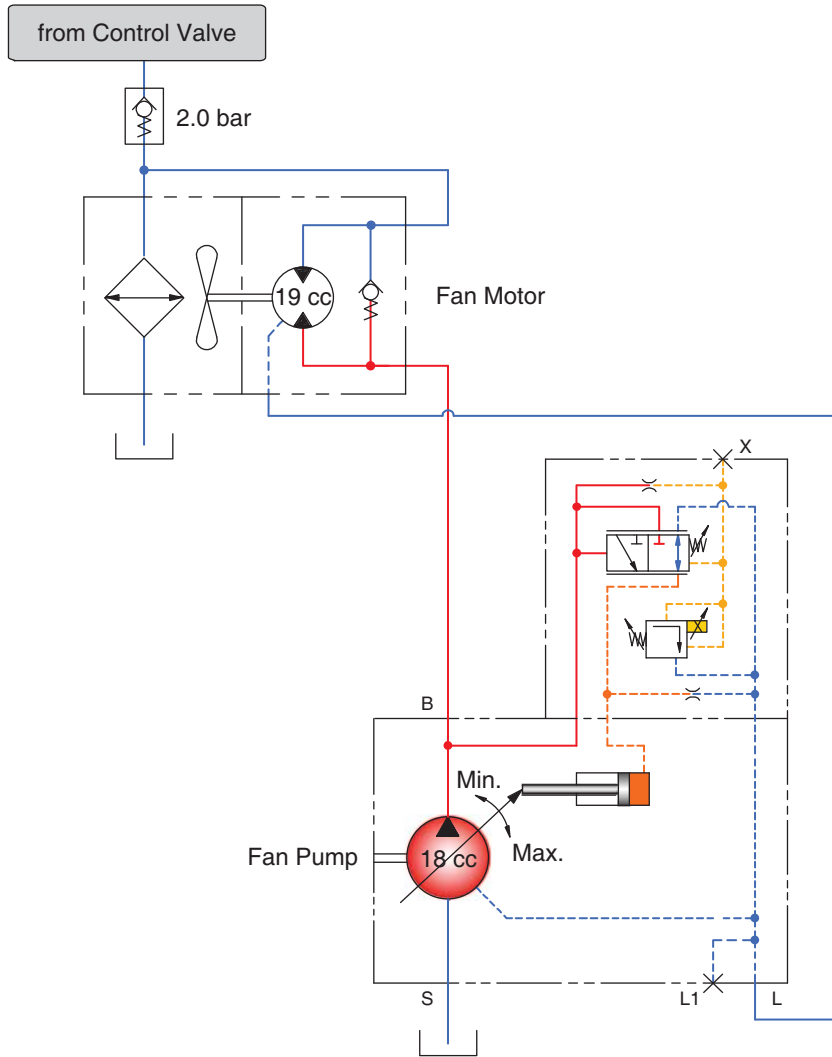


Figure 5

EX1301362

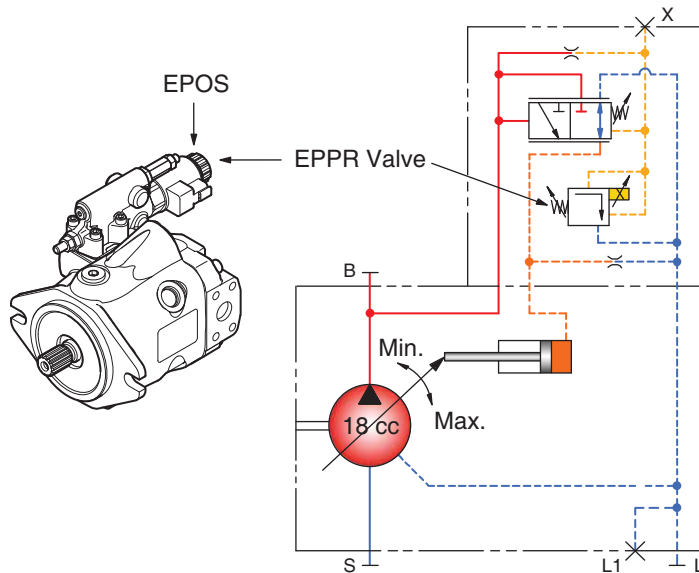
Pump EPPR Valve

With the EPOS, the speed of the cooling fan can be controlled according to the temperatures of the hydraulic oil and the engine coolant.

The speed of the fan can be controlled by controlling the value of current supplied to the EPPR valve (by changing the pressure).

Revolutions	1,200 ±50 rpm	Maximum Value (Standard)
Pressure	82 ±10 bar	
Electric current	160 ±20 mA	

EPPR Valve

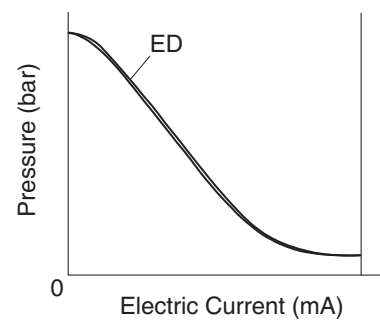


EX1301363

Figure 6

Control Curve (Pressure Compared to the Current Value)

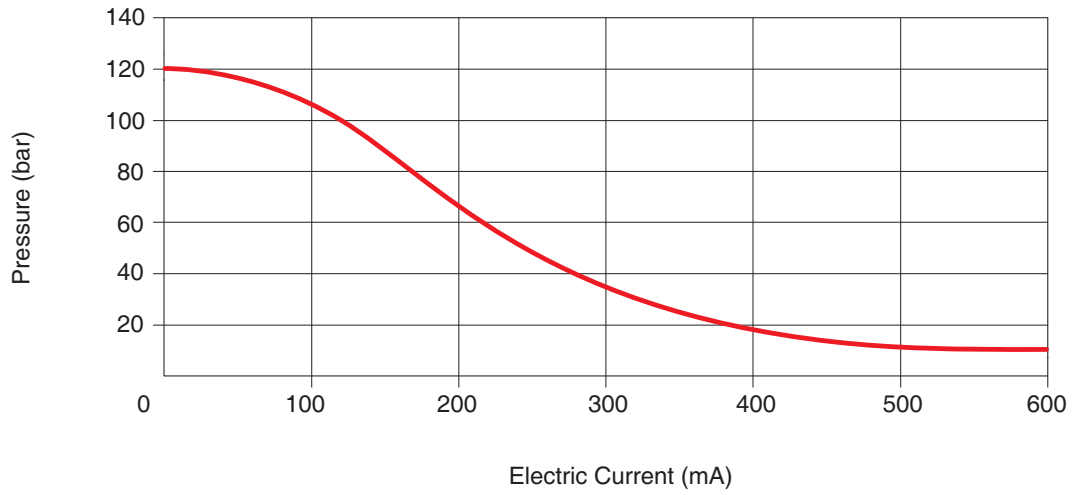
- ED: Pressure compared to the current value



EX1401295

Figure 7

Control Curve (Pressure Compared to the Current Value)



EX1401296

Figure 8

Current Value According to the Temperature

1. The EPOS receives information about operating oil temperature from the sensor.
2. Then, the EPOS calculates the proper current value through the proportional integral controller based on the operating oil's temperature (target temperature: 80°C).
 - Max./Min. current range: 650 ~ 160 mA
3. The calculated current value is sent to the control section of the fan pump to adjust the discharge pressure of the fan pump.
4. The fan's speed is adjusted according to the change in the fan pump's discharge pressure.

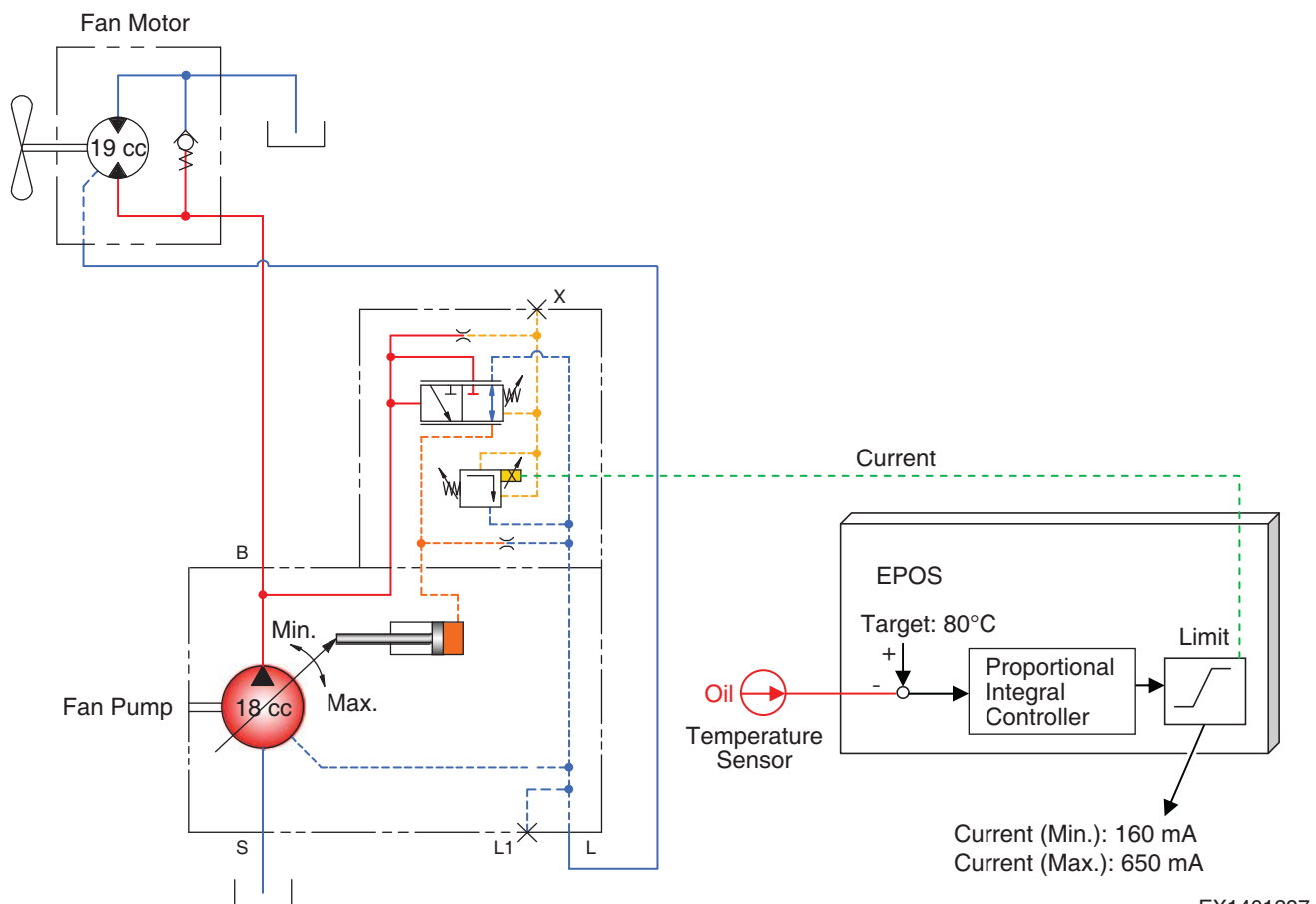
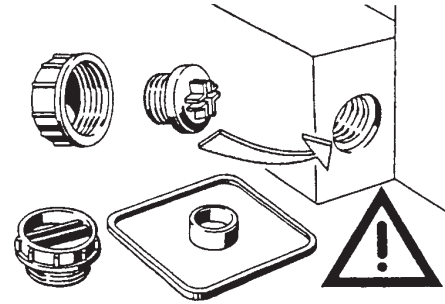


Figure 9

MAINTENANCE GUIDELINES

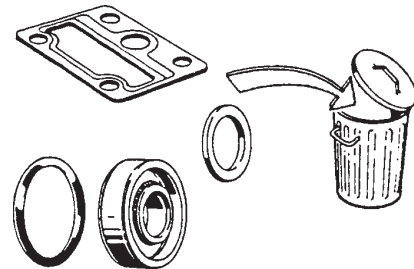
1. Close off all openings of hydraulic unit.



ASS0030L

Figure 10

2. Replace all seals.
Use only original replacement parts

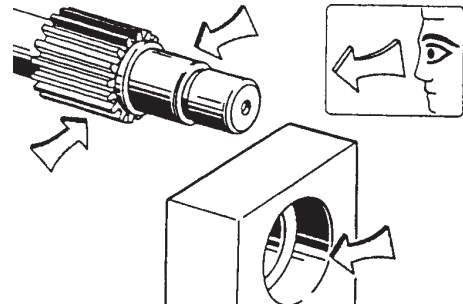


ASS0040L

Figure 11

3. Check all sealing and sliding surfaces for wear.

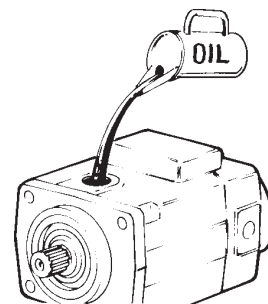
NOTE: Do not rework sliding surfaces using crocus cloth or other similar materials. It can damage the surface.



ASS0050L

Figure 12

4. Fill hydraulic unit with clean hydraulic oil before putting into operation.

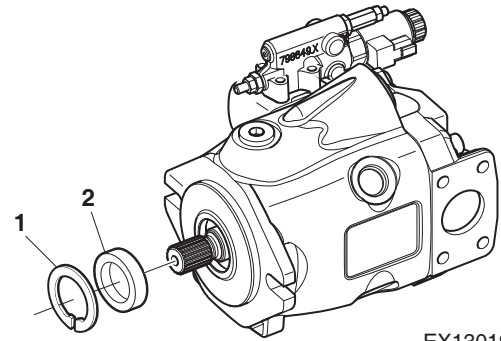


ASS0060L

Figure 13

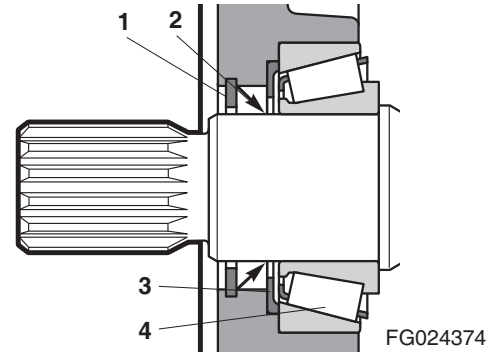
Sealing Driveshaft

Reference Number	Description
1	Retaining Ring
2	Shaft Seal
3	Ring
4	Bearing



EX1301961

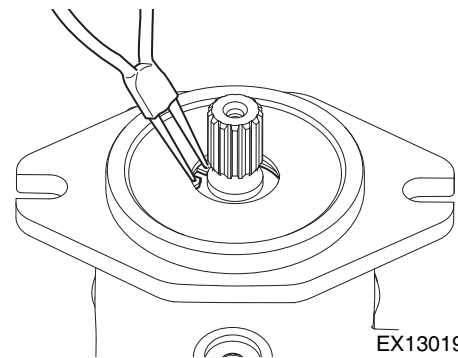
Figure 14



FG024374

Figure 15

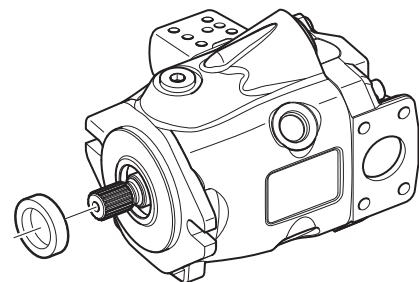
1. Protect driveshaft.
2. Remove retaining ring from pump body.
3. Remove shaft seal from front of pump body.



EX1301963

Figure 16

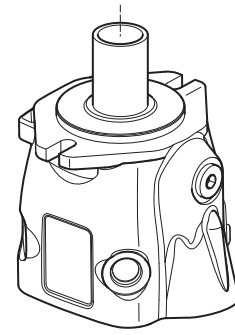
NOTE: *Change shaft seal and check its sliding surface (driveshaft) and housing. Grease sealing ring. Check that shaft seal is properly seated in housing.*



EX1301962

Figure 17

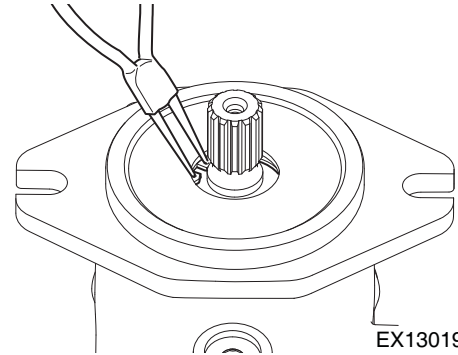
4. Press sealing ring carefully down just below retaining ring groove.



EX1301964

Figure 18

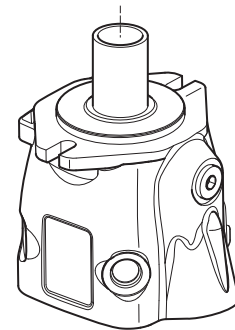
5. Install retaining ring in retaining ring groove.



EX1301963

Figure 19

NOTE: *Make sure that retaining ring is properly seated in groove.*



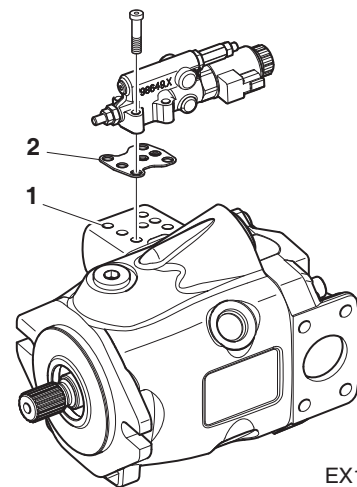
EX1301964

Figure 20

Sealing Control Valve

NOTE: Remove control valve. Measure dimension and write down.

1. Check sealing surface (1).
2. Check O-rings (2).



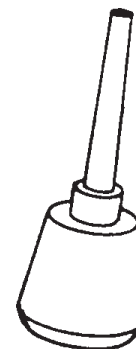
EX1301765

Figure 21

Tools

Loctite Types

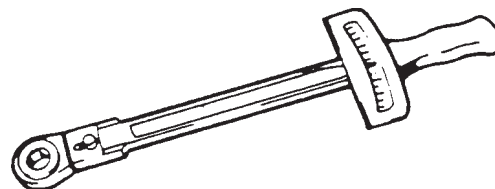
- For all break-off plugs: #601
- For all other parts: #242



FG024423

Figure 22

- Bolt tensile strength grade: 8.8, 10.9, 12.9



FG024424

Figure 23

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

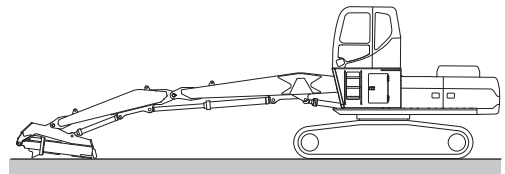
Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Park on firm and level ground.
2. Lower front attachment (bucket) to ground. (Figure 25)
3. Stop engine.



EX1300554

Figure 24

4. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 26)
5. Turn starter switch to "I" (ON) position.



WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

6. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
7. Move safety lever to "LOCK" position. (Figure 26)
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Attach a maintenance warning tag on controls.
10. Turn battery disconnect switch to "OFF" position. (Figure 27)

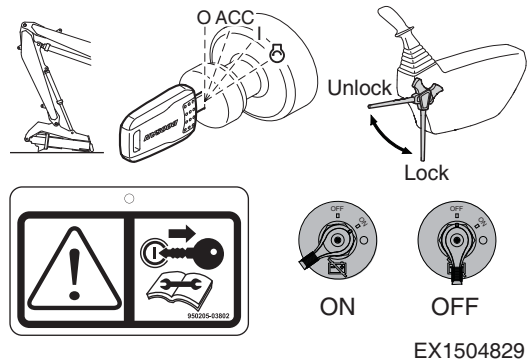


Figure 25

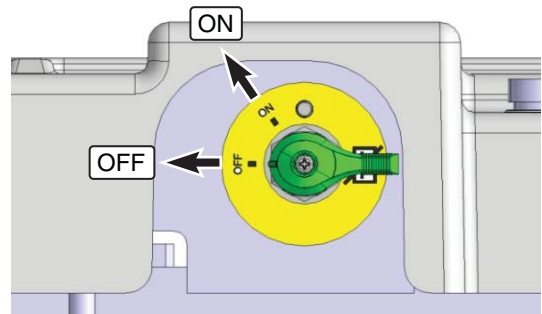


Figure 26

NOTE: *Removal (installation) procedure of the bolts.*

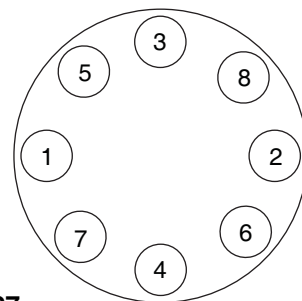



Figure 27



WARNING

AVOID DEATH OR SERIOUS INJURY

Release any pressure in the hydraulic oil tank before doing any work.

11. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
12. Remove set bolts (1, Figure 30) (5 ea) with under cover (2) from frame.
 - Tool: 19 mm ()
 - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
 - Under cover weight: about 20 kg (44.1 lb)
13. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.

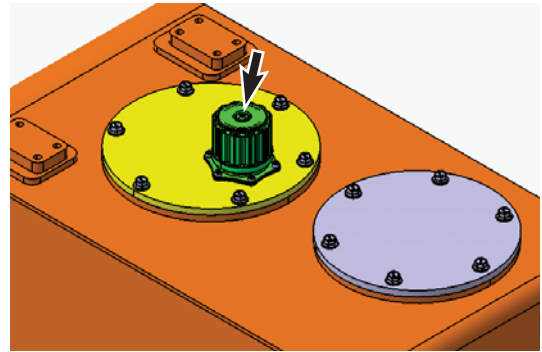


Figure 28

EX1403168

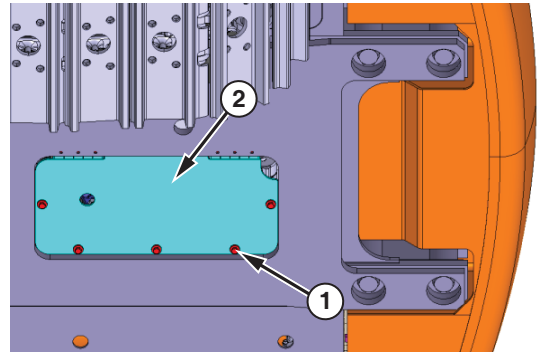


Figure 29

EX1505047



Figure 30

EX1504170

14. Remove hoses (Figure 32) (3 ea) from fan pump.

NOTE: Attach identification tags to the removed hoses for reassembling, and observe the assembly angle of hoses.
After disconnecting hoses, plug them to prevent dirt or dust from entering.

15. Disconnect the harness connector from EPPR Valve of fan pump.

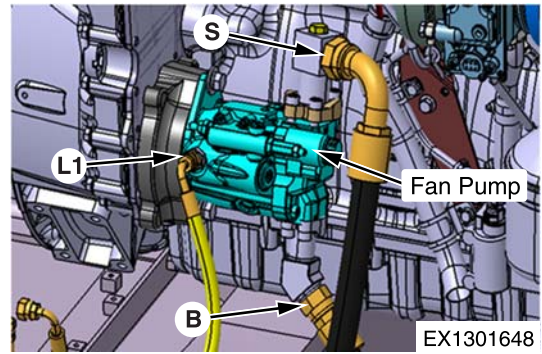





Figure 31


- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
S	from Oil Tank Suction Pipe	UNF 1 7/16"-12-2B	41	169.7	17.3	125.1
B	to Fan Motor "A"	UNF 1 3/16"-12-2B	36	124.5	12.7	91.9
L1	to Oil Tank (Drain)	UNF 11/16"-16-2B	20	38.2	3.9	28.2

- Fitting

Port	Name	Size		 (mm)	 (mm)	Torque		
		A	B (C)			N.m	kg.m	ft lb
S	Flange, Elbow (Bolt)	SAE 1 1/4"	UNF 1 7/16"-12		10	57.8	5.9	42.7
B	Flange, Elbow (Bolt)	SAE 3/4"	UNF 1 3/16"-12		10	57.8	5.9	42.7
L1	Adapter	UNF 3/4"-16	UNF 11/16"-16	24		72.0	7.3	53.0
S	O-ring	2180-1026D23 (ID:37.69, W:3.53, 1B)	S8030165 (4D F-16)					
B		2180-1026D2 (ID:24.99, W:3.53, 1B)	S8030125 (4D F-12)					
L1		2180-1026D13 (ID:16.36, W:2.21, 1B)	S8030061 (1B F-06)					

* A: Opposite side of hose, B (C): Hose side

16. Tie pump with rope to lift it.
17. Remove set bolts (1, Figure 33) (2 ea) with fan pump (2) from engine.
 - Tool: 19 mm ()
 - Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
 - Fan pump weight: about 12 kg (26.4 lb)

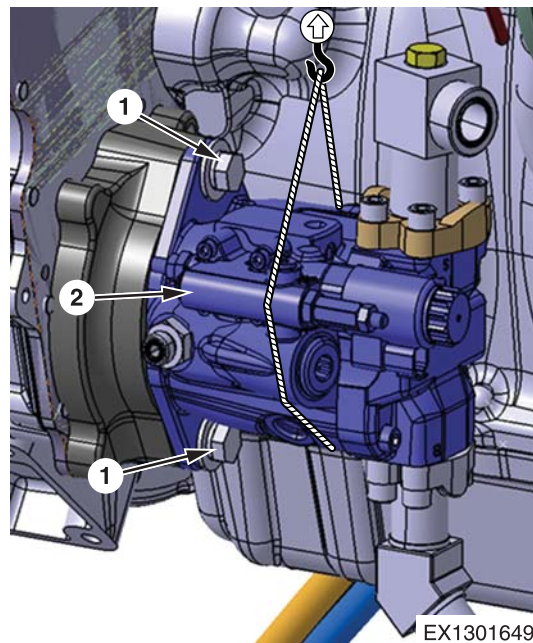


Figure 32

INSTALLATION

WARNING

INCORRECT INSTALLATION CAN CAUSE DEATH OR SERIOUS INJURY

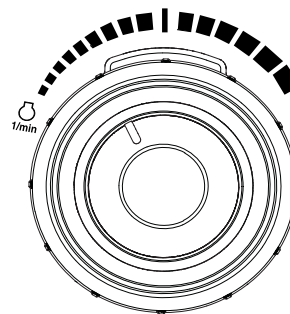
Any change in the connections will lead to malfunctions (e.g. lift instead of lower).

- When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.

1. Perform installation in the reverse order to remove.

COMPLETING WORK

1. Start engine and set throttle at "LOW IDLE".
2. Move safety lever to "UNLOCK" position.



FG018148

Figure 33

SECTION VIEW

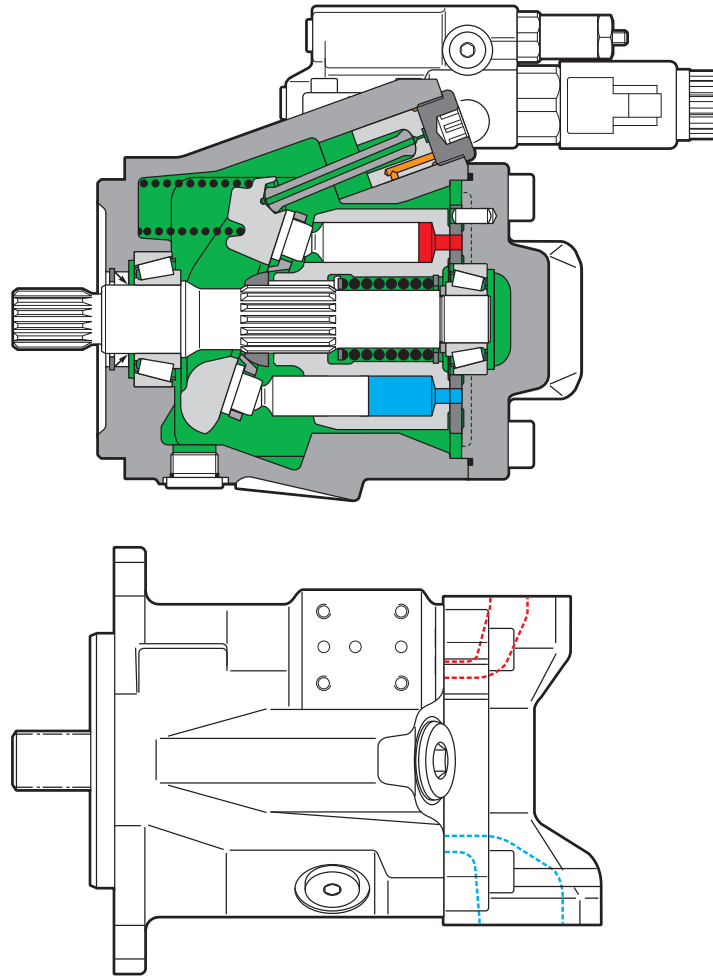


Figure 34

EX1301987

EPPR Valve

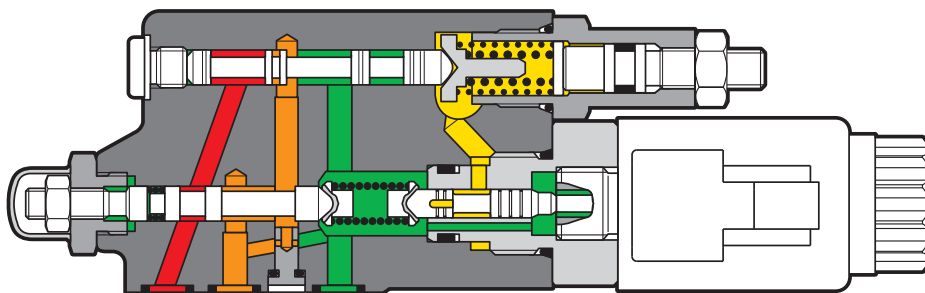
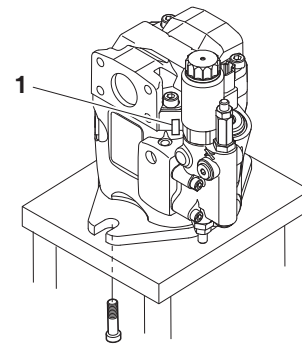


Figure 35

EX1301988

DISASSEMBLY

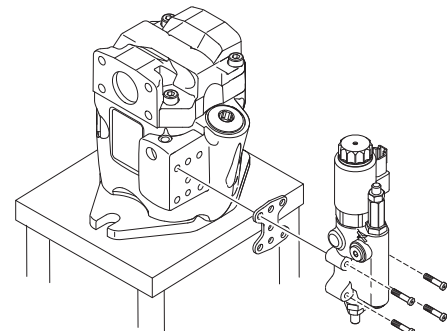
NOTE: Make alignment mark on connection plate and pump housing (1).



EX1301965

Figure 36

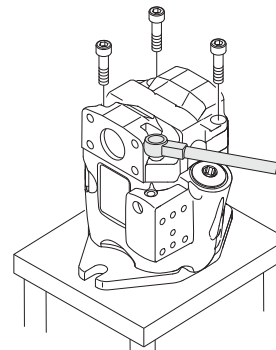
1. Remove four screws, EPPR valve and three O-rings from pump housing.



EX1301966

Figure 37

2. Remove four screws.

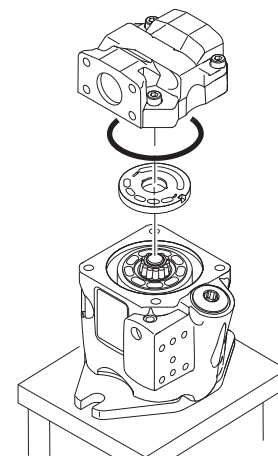


EX1301967

Figure 38

3. Remove connection plate, control plate and O-ring. Set aside on a clean work area.

NOTE: Control plate can fall when removing connection plate.



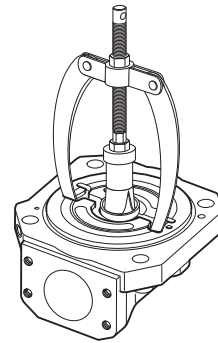
EX1301968

Figure 39

Disassembly of Rotary Group

1. Using a suitable puller, remove bearing from connection plate.

NOTE: Do not damage sealing surface.

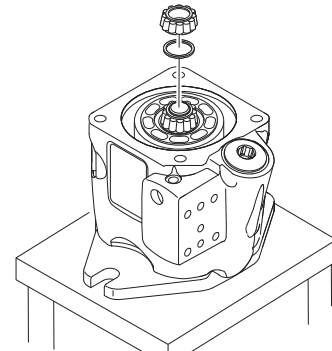


EX1301969

Figure 40

2. Remove bearing and shim.

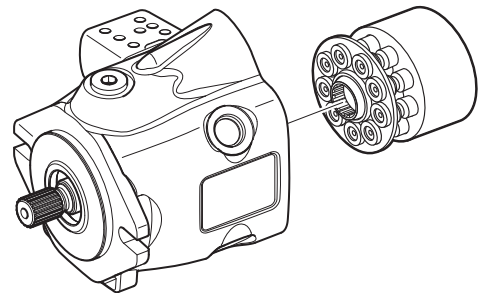
NOTE: Do not damage sealing surface.



EX1301970

Figure 41

3. Remove rotary group from pump housing in a horizontal position.



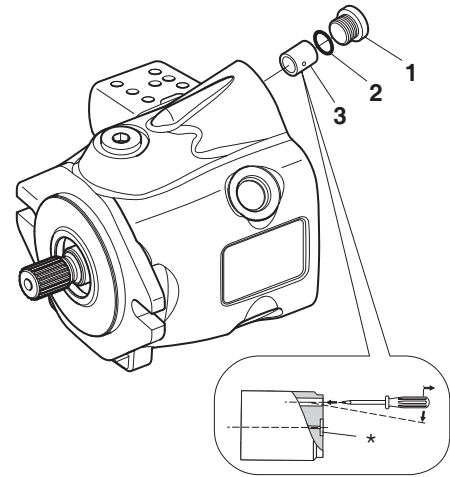
EX1301971

Figure 42

Disassembly of Control Device

1. Remove plug (1) from pump housing.

Remove control piston (2) from pump housing (flat surface*) with tool.



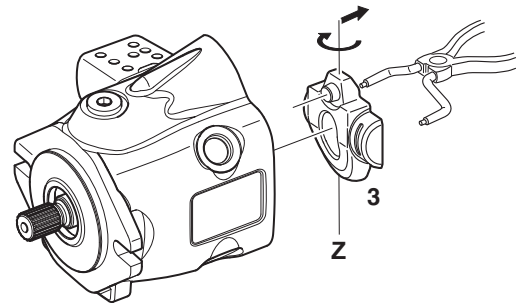
EX1301972

Figure 43

2. Remove swash plate from pump housing.

NOTE: Turn swash plate (3, Figure 45) inside housing slightly along Z-axis with tool.

Remove swash plate (3) from pump housing.

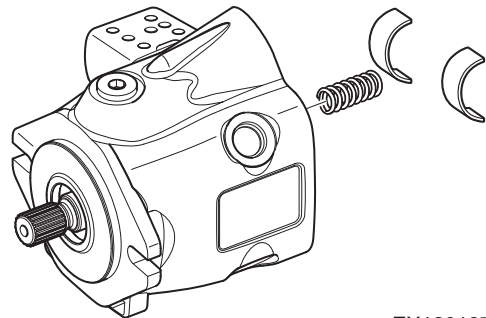


EX1301272

Figure 44

3. Remove bearing shells and bearing from pump housing.

NOTE: Note location of each bearing position in pump for installation.

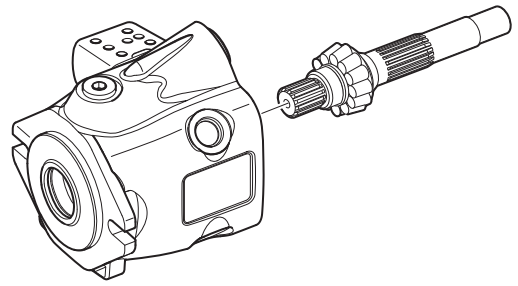


EX1301973

Figure 45

Disassembly of Shaft/Bearings

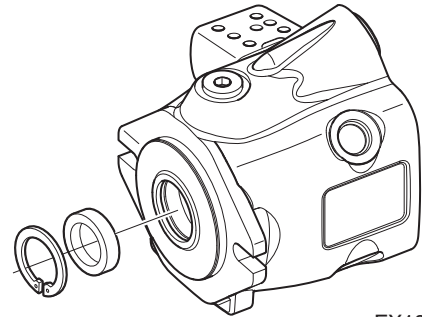
1. Remove driveshaft with bearing from pump housing.



EX1301974

Figure 46

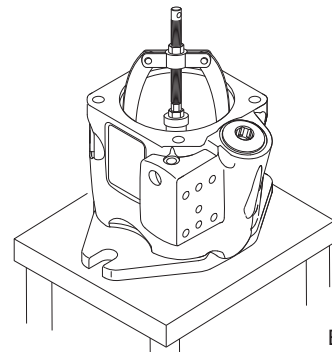
2. Remove retaining ring and shaft seal from pump housing.



EX1301975

Figure 47

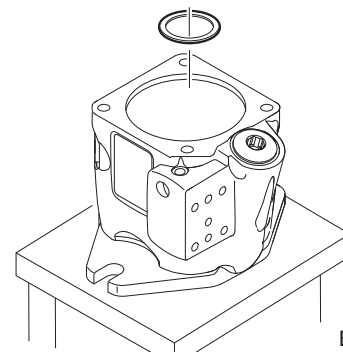
3. Using a suitable puller, remove outer race of tapered bearing from housing press seat.



EX1301976

Figure 48

4. Remove shim from pump housing.

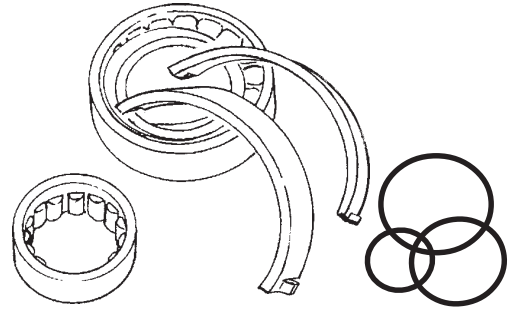


EX1301977

Figure 49

CLEANING AND INSPECTION

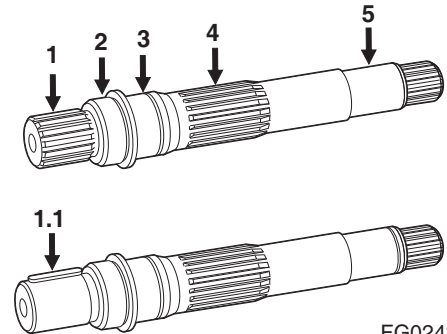
1. Replace all bearings and seals.



FG024394

Figure 50

Reference Number	Description
1	Fretting Wear on Splines
1-1	Key Set
2	Driveshaft Seal Wear Grooves
3	Bearing Seat
4	Splines for Cylinder Drive
5	Bearing Seat

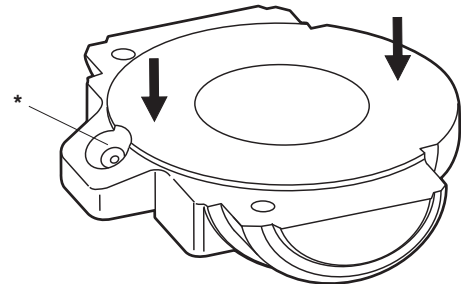


FG024395

Figure 51

2. Check that sliding surface is free of grooves.

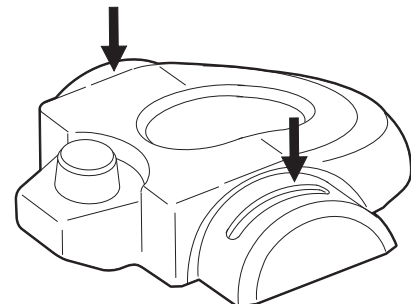
NOTE: Check for freedom of connector movement.



FG024396

Figure 52

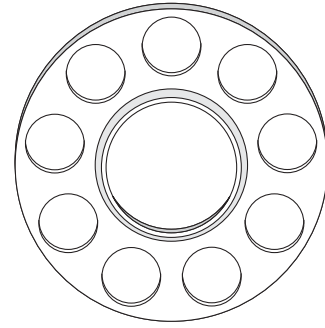
3. Check bearing surfaces.



FG024397

Figure 53

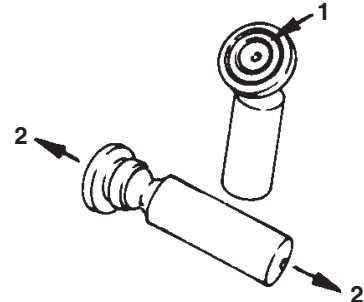
4. Check that retaining plate is free of grooves and there is no wear in slipper pad area.



FG024398

Figure 54

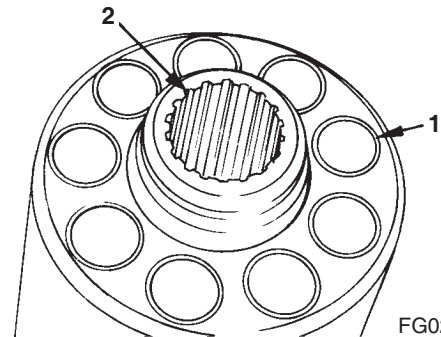
5. Check to see there are no scratches or metal deposits on sliding surface (1), and there is no axial play (2), (pistons must only be replaced as a set).



FG024399

Figure 55

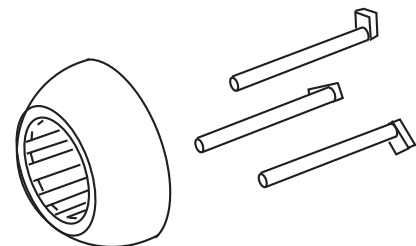
Reference Number	Description
1	Cylinder Bores
2	Splines



FG024400

Figure 56

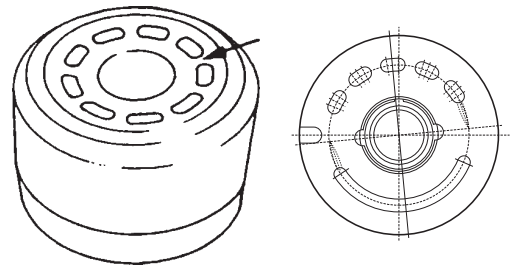
6. Grooves show no signs of wear.



FG024401

Figure 57

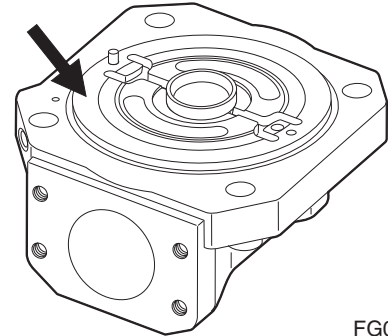
7. Cylinder sliding surface are free of grooves, no wear, no embedded foreign particles. That there are no scratches on control plate. (Only replace them as a set).



FG024402

Figure 58

8. Mounting surface - control plate is not damaged.



FG024403

Figure 59

REASSEMBLY

NOTE: Press in distance ring and outer racer with tool.

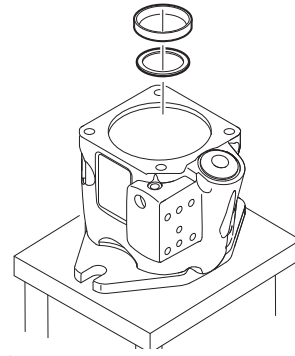


Figure 60

1. Assemble shaft in correct position in pump housing.

NOTE: Do not cut shaft seal!

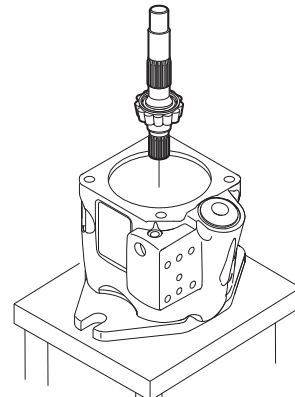


Figure 61

2. Press in outer racer of rear bearing into connection plate.

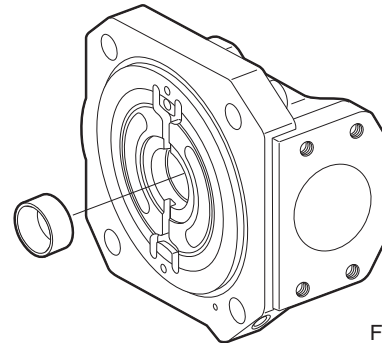


Figure 62

3. Align match marks to assemble connection plate on pump housing.

NOTE: Install four socket screws. See "Tools" on page -18.

4. Adjust the taper roller bearing set. See "Adjustment of Taper Roller Bearing" on page -33.

NOTE: After adjustment, remove connection plate again.

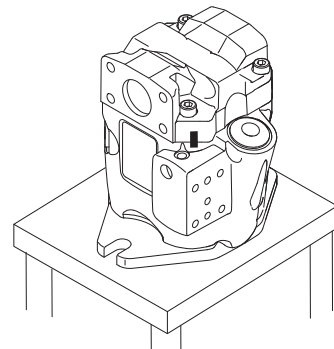
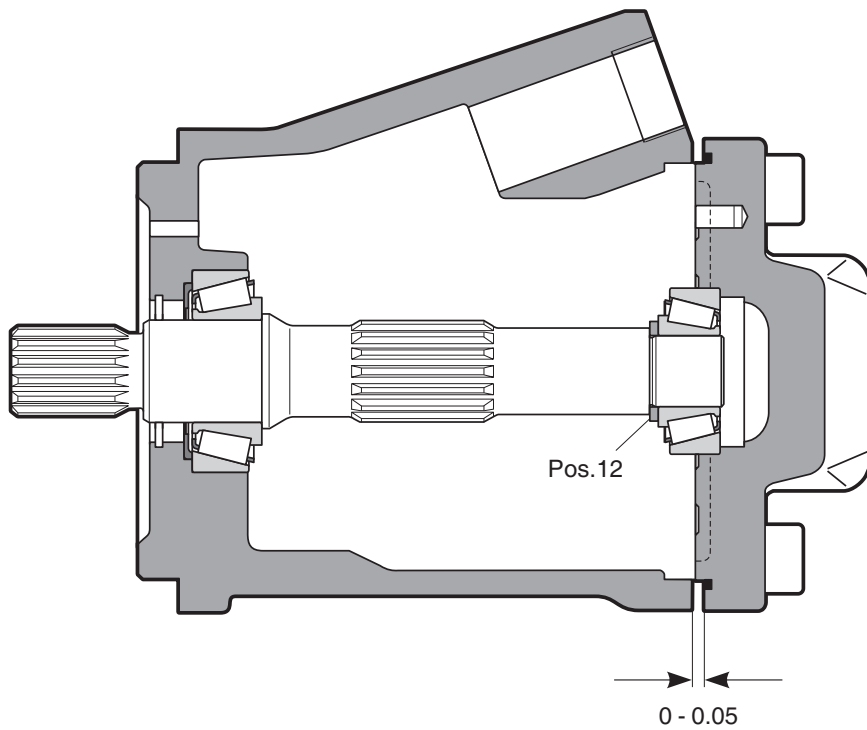


Figure 63

Adjustment of Taper Roller Bearing

Taper Roller Bearing Pretension



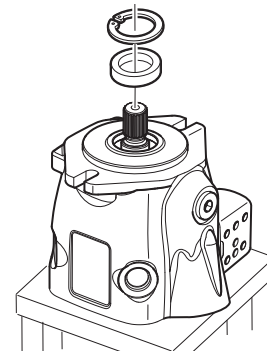
FG024408

Figure 64

Adjustment of taper roller bearing set

Preload of bearing from: 0 - 0.05 mm, grind Pos. 12 if necessary.

1. Install shaft seal. See "Sealing Driveshaft" on page -16.



EX1301981

Figure 65

2. Install bearing shells and spring in pump housing.

NOTE: Apply clean grease to help hold bearings in position.

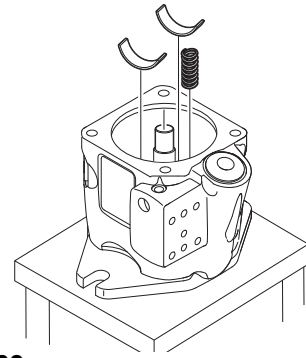


Figure 66

3. Assemble swash plate (3) in pump housing.
4. Install spring guide pin in correct position.

NOTE: Check for correct position of spring.

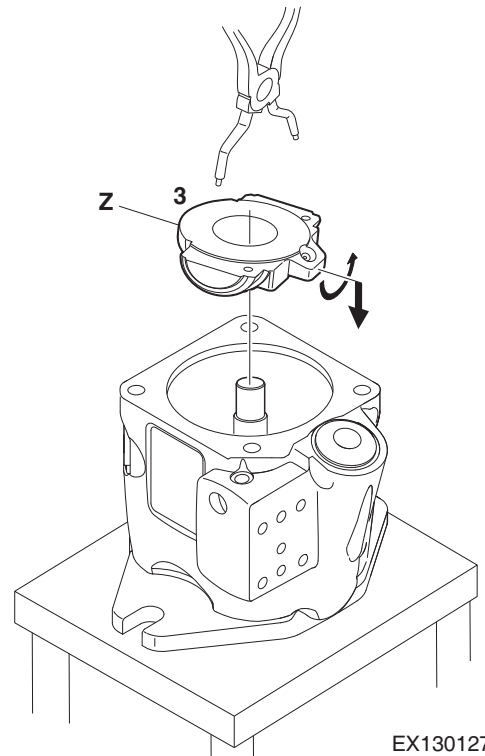


Figure 67

5. Coat plug (1) with Loctite #242.
6. Assemble adjust piston (2) and plug (1) in pump housing.
 - Torque (plug): 190 - 210 Nm
(19.4 - 21.4 kg.m, 140.1 - 154.9 ft lb)

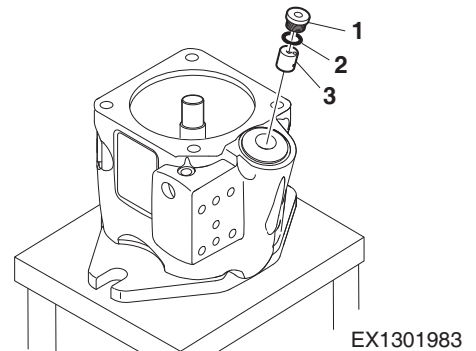
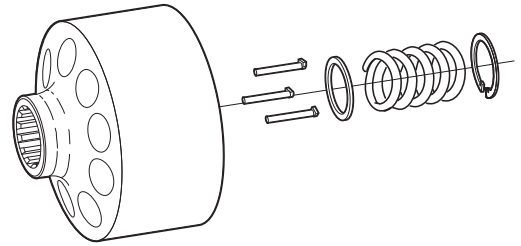


Figure 68

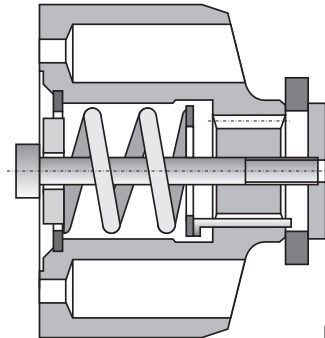
7. Install pressure pins using an assembly aid.



FG024413

Figure 69

8. Compress spring using a suitable device.

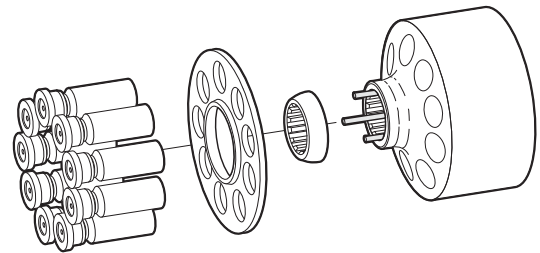


FG024414

Figure 70

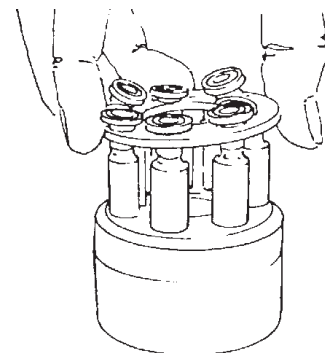
9. Assemble piston with retaining plate.

NOTE: Coat pistons and slipper pad with clean hydraulic oil.



FG024415

Figure 71



FG024416

Figure 72

10. Install rotary group!

NOTE: *Hold pistons by using an O-ring.*

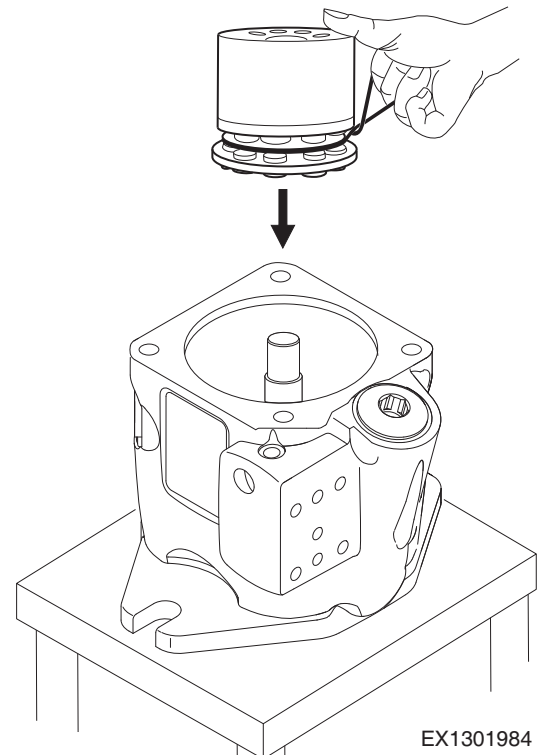


Figure 73

EX1301984

11. Install bearing and adjustment shim on shaft.

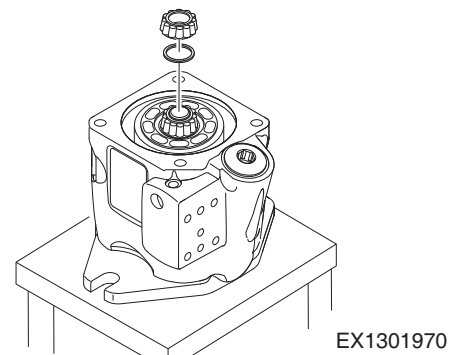


Figure 74

EX1301970

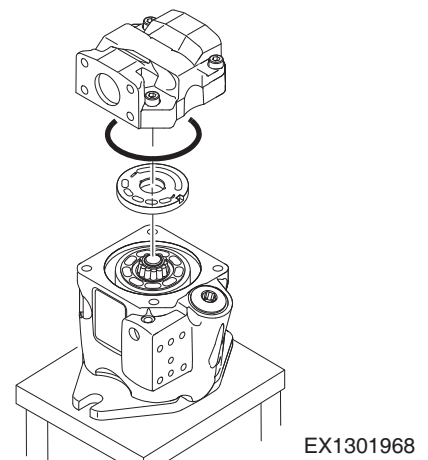


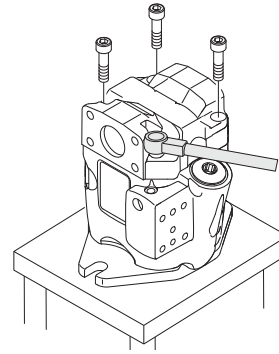
Figure 75

EX1301968

12. Align match marks, assemble connection plate on housing.

NOTE: *Check for correct position on housing.*

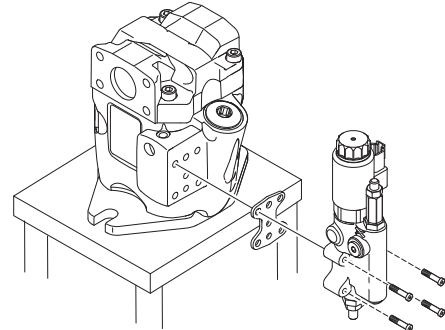
NOTE: *Tighten screws to proper specification. See "Tools" on page -18.*



EX1301967

Figure 76

13. Install seal and EPPR valve on housing.

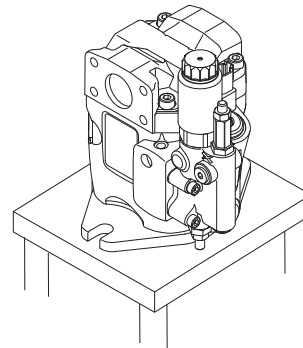


EX1301966

Figure 77

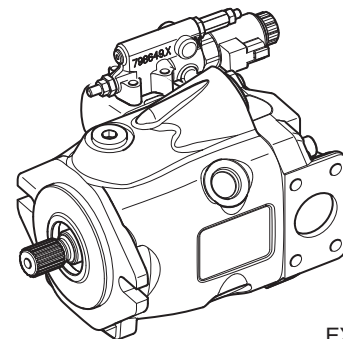
14. Finally assemble the pump.

NOTE: *Double check alignment of match mark.*



EX1301985

Figure 78



EX1301986

Figure 79

Fan Motor for Oil Cooler

Edition 1

MEMO

Table of Contents

Fan Motor for Oil Cooler

Safety Instructions	5-10-5
General	5-10-5
Specification	5-10-5
Overview	5-10-6
Parts List and Section View.....	5-10-7
Precaution	5-10-8
Tools.....	5-10-8
Removal	5-10-9
Installation	5-10-14
Completing Work	5-10-14
Disassembly	5-10-15
Reassembly	5-10-18
Reassembly.....	5-10-18
Assembly.....	5-10-19

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

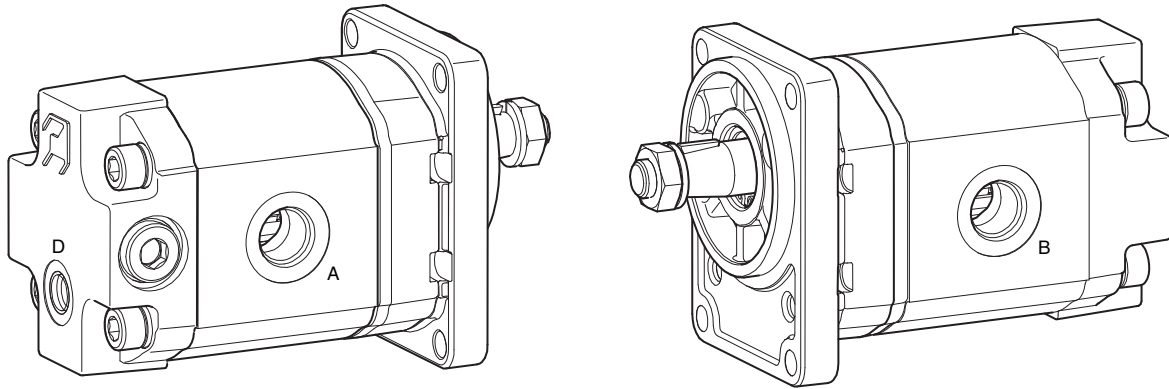
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

GENERAL

Specification

Direction of Rotation (Looking on the Driveshaft)		Reversible (R)
Displacement		19.09 cm ³ /rev
Max. Continuous Pressure	P1	204 kg/cm ² (200 bar, 2,900 psi)
Max. Intermittent Pressure	P2	224 kg/cm ² (220 bar, 3,190 psi)
Max. Peak Pressure	P3	244 kg/cm ² (240 bar, 3,480 psi)
Max. Drain Line Pressure on the Reversible Rotation Motors		5 kg/cm ² (5 bar, 73 psi)
Speed	Min. P1	500 min ⁻¹
	Max. P1	3,000 min ⁻¹
Weight		4 kg (8.8 lb)

Overview

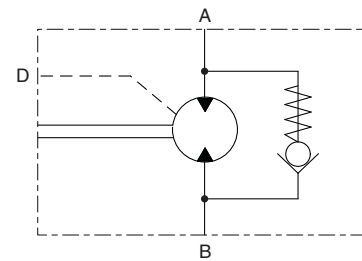


EX1301367

Figure 1

Port and Hydraulic Circuit

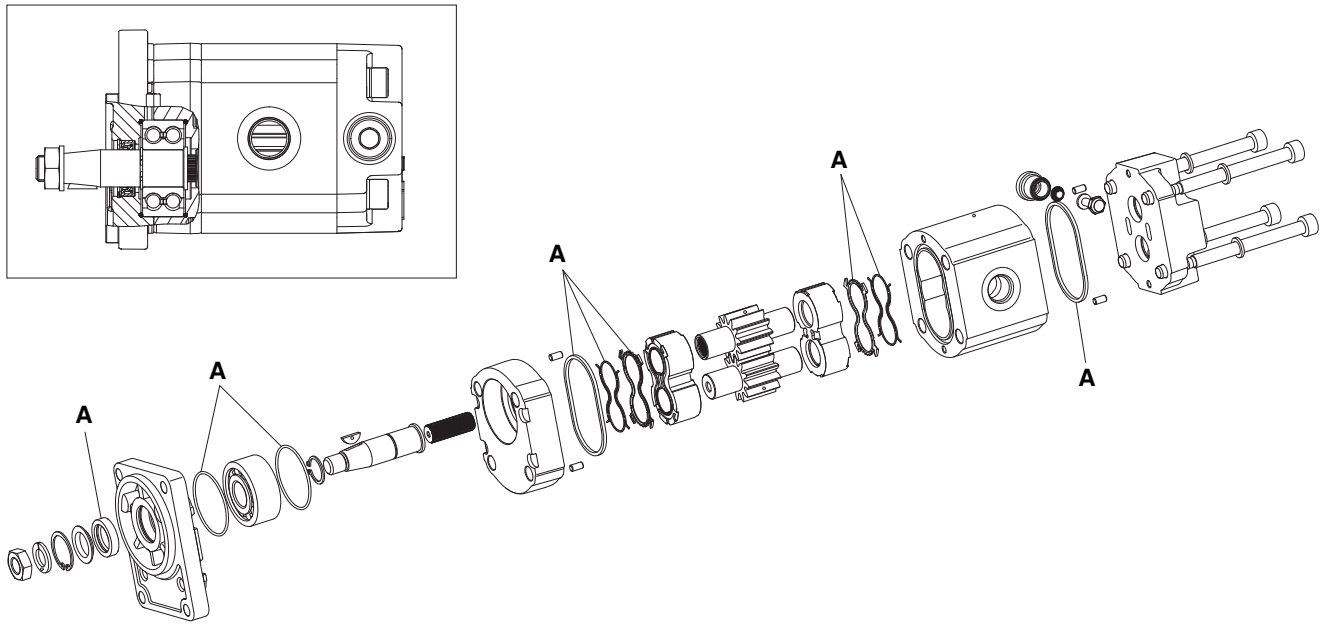
Port	Name	Size
A	Inlet	PF 1/2
B	Pressure	PF 1/2
D	Drain	PF 1/4



EX1301368

Figure 2

Parts List and Section View



EX1301369

Figure 3

Reference Number	Item	Part Number
A	Seal Kit for Motor	401107-01051

PRECAUTION

IMPORTANT

Check that spare parts have not been damaged in shipment.

Always work in a clean environment.

Wash all components in solvent and blow dry with compressed air before installing.

Do not damage rubber seals.

Avoid damaging precision machined surfaces.

Components should install into their housings without excessive force. If force is necessary, this normally means that component does not have correct tolerances or is aligned incorrectly.

When hand pressure is insufficient, only use a press or rubber hammer to install components.

Never strike components with metal hammers.

Steel bushing must be installed only with a suitable press.

Do not use hammers to install bearings.

Always respect direction of rotation when assembling components.

Tools

Name	Description
Wrench	22 mm
Allen Wrench	8 mm
Plastic Hammer	One Plastic Hammer

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

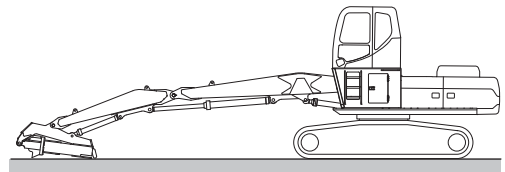
Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Park on firm and level ground.
2. Lower front attachment (bucket) to ground. (Figure 4)
3. Stop engine.



EX1300554

Figure 4

4. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 5)
5. Turn starter switch to "I" (ON) position.



WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

6. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
7. Move safety lever to "LOCK" position. (Figure 5)
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Attach a maintenance warning tag on controls.
10. Turn battery disconnect switch to "OFF" position. (Figure 6)

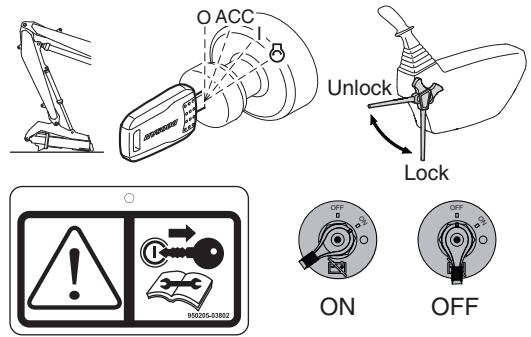


Figure 5

EX1504829

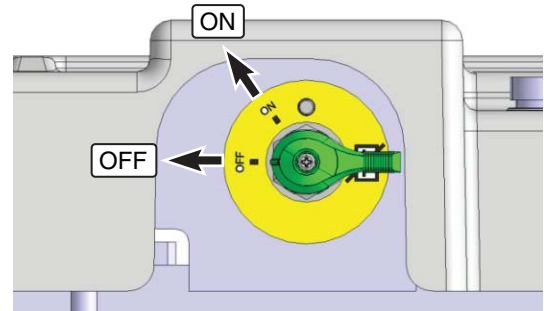


Figure 6

EX1504925

NOTE: *Removal (installation) procedure of the bolts.*

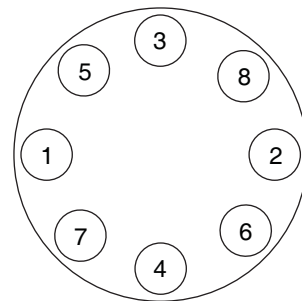


Figure 7

EX1401809




WARNING

AVOID DEATH OR SERIOUS INJURY


Release any pressure in the hydraulic oil tank before doing any work.

- Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.


- Remove bolts and washers (1, Figure 9) (4 ea) with cover (2).

- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

- Remove bolts and washers (1, Figure 10) (6 ea) with cover (2).

- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)

- Remove bolts (1, Figure 11) (4 ea) with fan guard (2) from oil cooler.

- Tool: 13 mm ()
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

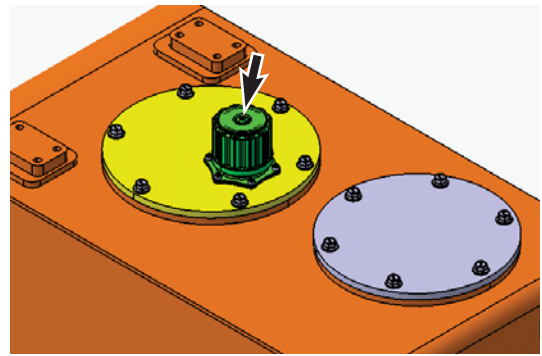


Figure 8

EX1403168

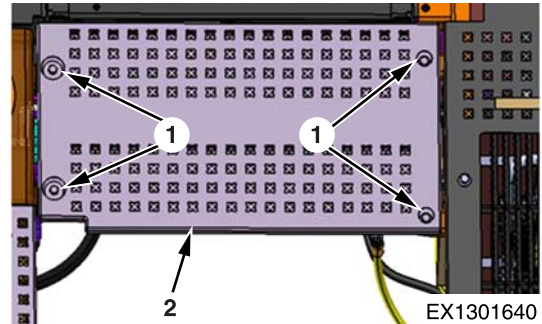


Figure 9

EX1301640

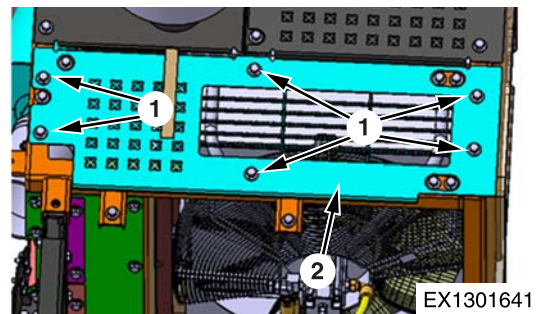


Figure 10

EX1301641

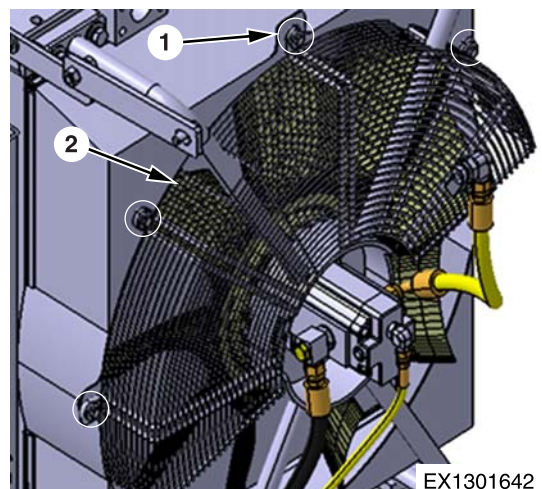


Figure 11



EX1301642

15. Remove bolts (1, Figure 12) (6 ea) and nut (2) with fan (3) from fan motor. (Input the hand into the fan)
16. Removed fan put in oil cooler shroud.

⚠ CAUTION

AVOID INJURY

Don't damage the core of oil cooler by fan.

- Tool (Bolt): 13 mm ()
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
- Tool (Nut): 22 mm ()
- Torque: 39.2 N.m (4 kg.m, 28.9 ft lb)

17. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.

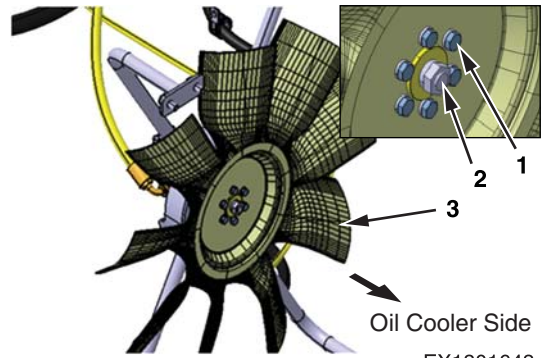


Figure 12



Figure 13

EX1504170

18. Remove hoses (Figure 14) (3 ea) from fan motor.

NOTE: Attach identification tags to the removed hoses for reassembling, and observe the assembly angle of hoses.

NOTE: After disconnecting hoses, plug them to prevent dirt or dust from entering.

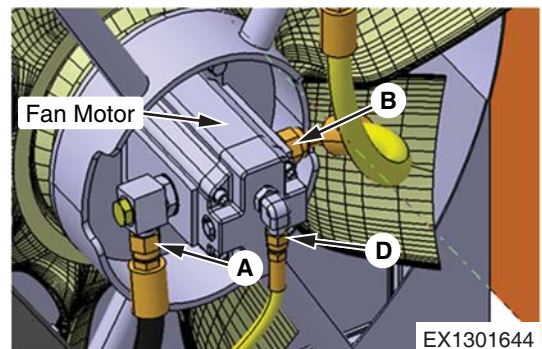

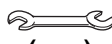


Figure 14

- Hoses and plugs ports


Port	Name	Plug/Flange Size (Hose)	 (mm)	Torque		
				N.m	kg.m	ft lb
A	from Fan Pump "B"	UNF 13/16"-16-2B	24	55.9	5.7	41.2
B	to Oil Tank (Return Pipe)	UNF 13/16"-16-2B	24	55.9	5.7	41.2
D	to Oil Tank (Drain)	UNF 9/16"-16-2B	19	25.5	2.6	18.8

- Fitting

Port	Name	Size		 (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
A	Elbow	PF 1/2"	UNF 13/16"-16	27	84.3	8.6	62.2
B	Adapter	PF 1/2"	UNF 13/16"-16	27	84.3	8.6	62.2
D	Elbow	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
A, B	O-ring	S8000185 (4D P18)	S8030081 (1B F-08)				
D		S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)				

* A: Opposite side of hose, B (C): Hose side

19. Remove bolts and washers (1, Figure 15) (4 ea) with fan motor (2) from bracket.

- Tool: 13 mm ()
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)
- Motor weight: about 4 kg (8.8 lb)

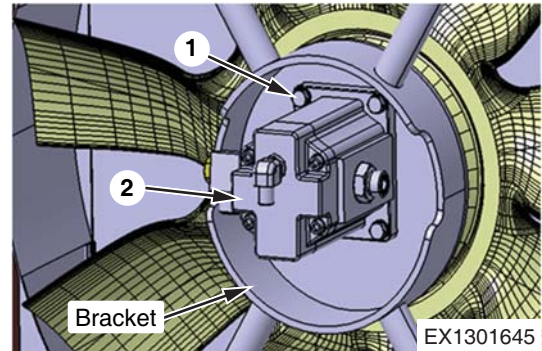


Figure 15

INSTALLATION

WARNING

INCORRECT INSTALLATION CAN CAUSE DEATH OR SERIOUS INJURY

Any change in the connections will lead to malfunctions (e.g. lift instead of lower).

- **When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.**
-
1. Perform installation in the reverse order to remove normally.
 2. The direction of plane of hub must be assembled towards fan motor direction.

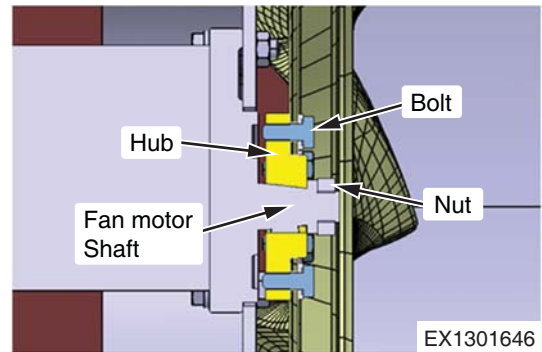


Figure 16 Fan Motor Section View

COMPLETING WORK

1. Start engine and set throttle at "LOW IDLE".
2. Move safety lever to "UNLOCK" position.

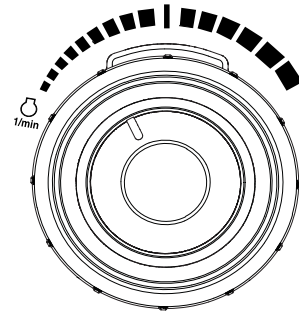


Figure 17

DISASSEMBLY

Rear Cover

1. Remove locknut and washer, key from shaft.

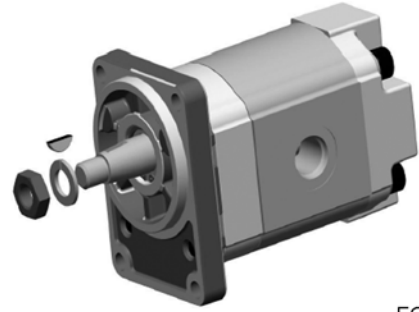


Figure 18

FG024352

2. Remove assembling bolts and washers from pump.

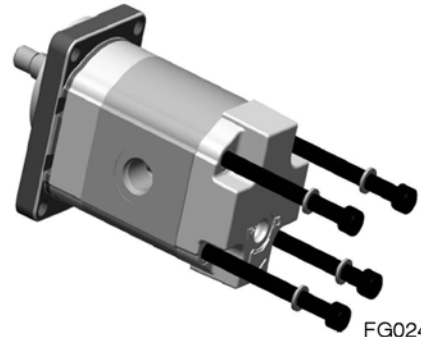


Figure 19

FG024353

3. Remove valves from cover.

NOTE: *Follow step 3 and 4 only when changing O-rings on plugs or valves.*

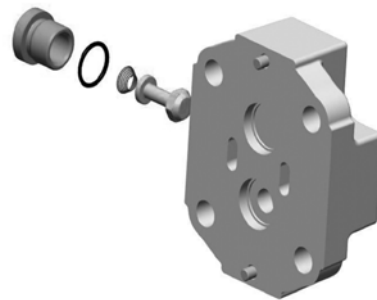


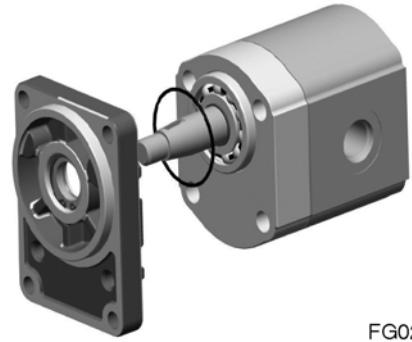
Figure 20

FG024354

Mounting Flange

1. Remove mounting flange and O-ring. Be careful to keep it as straight as possible during removal.

NOTE: *Make sure when removing it, that driveshaft and other components remain in position.*



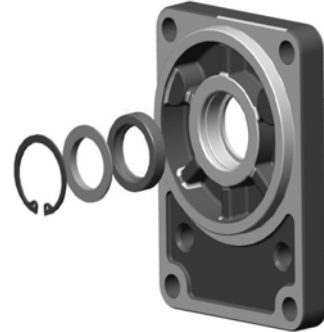
FG024355

Figure 21

2. Remove retaining ring from flange.
3. Remove shaft seals with a screwdriver.

NOTE: *Remove shaft seals only if required.*

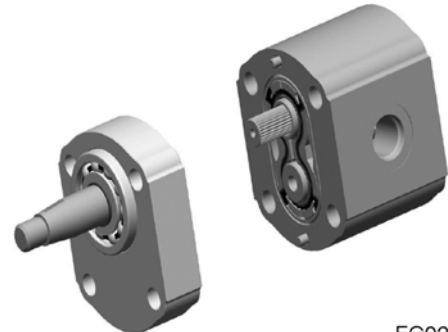
NOTE: *Replace all shaft seals. Do not reuse them.*



FG024356

Figure 22

4. Remove 2nd flange and bearing assembly from working section.



FG024357

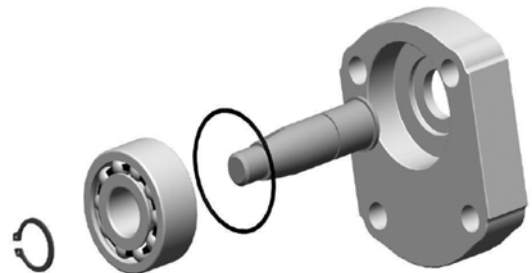
Figure 23

5. Remove bearing and shaft assembly from flange.

NOTE: *Only when O-ring inside must be changed.*

6. Remove retaining ring and bearing from rear of shaft.

NOTE: *Follow this step only if replacing bearing or shaft.*

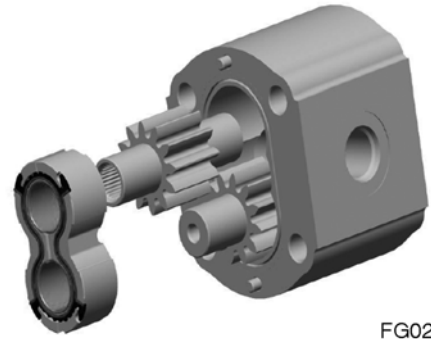


FG024358

Figure 24

Working Section

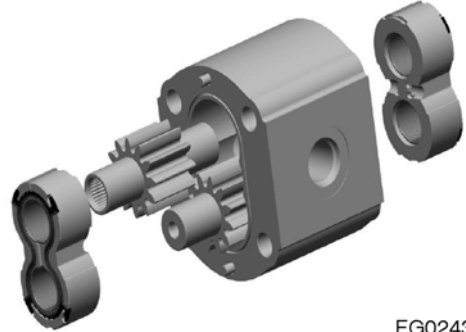
1. Remove pressure plate with O-ring and backup ring from working section.
2. Remove driving gear and driven gear as straight as possible from working section.



FG024359

Figure 25

3. Remove other pressure plate on rear side of working section.



FG024360

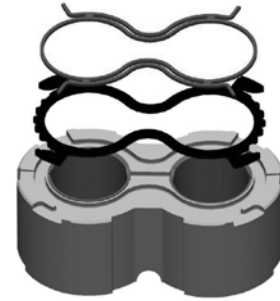
Figure 26

REASSEMBLY

Reassembly

Pressure Plates

1. Install O-ring into groove on aluminum pressure plate.
2. Install backup ring on O-ring.
3. Apply clean grease on O-ring and backup ring to hold them in position.

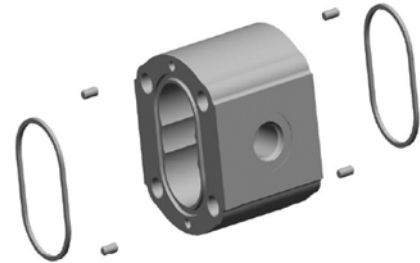


FG024361

Figure 27

Working Body

1. Apply clean grease on square rings to hold them in position.
2. Install square rings into grooves of working section.
NOTE: *Shape of square ring is different depending on direction of body.*
3. Install locator pins, if removed during disassembly.

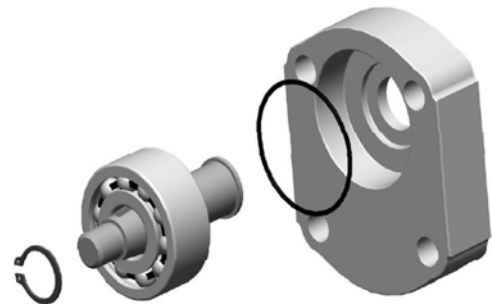


FG024362

Figure 28

Bearing Flange

1. Apply clean grease on O-ring and install in flange.
2. Install bearing and shaft assembly in flange.
NOTE: *Be careful not to damage bearing.*



FG024363

Figure 29

Mounting Flange

1. Install shaft seal and backup washer in flange.
2. Install retaining ring in groove. Make sure retaining is properly seated.
3. Install last shaft seal into flange facing out.
4. Apply clean grease on O-ring and install in flange.



Figure 30

Assembly

1. Install working body on rear cover.

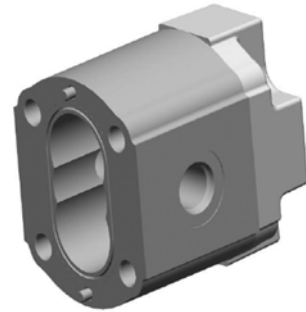


Figure 31

2. Install pressure plate until its face contacts rear cover.
3. Install driving gear and driven gear keeping them as straight as possible during assembling.

NOTE: Coat gears and inside of housing with clean hydraulic oil.

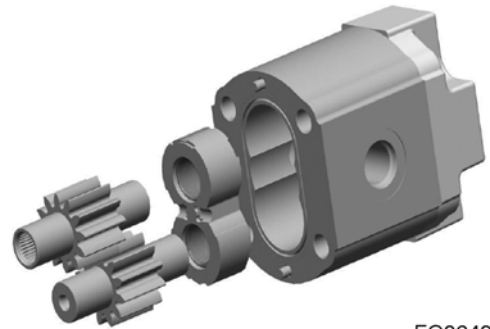


Figure 32

4. Install other pressure plates in working section.
5. Install shaft into driving gear.

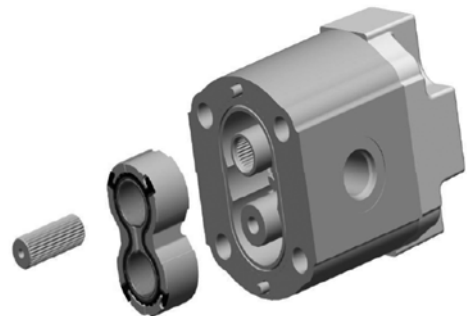


Figure 33

6. Install reassembled bearing flange on working housing.

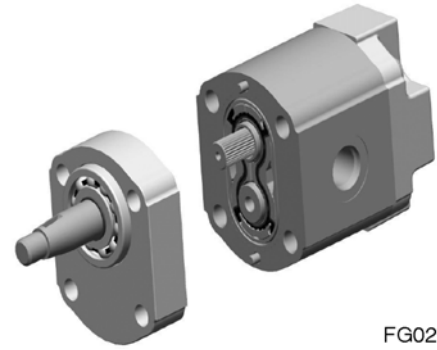


Figure 34

FG024368

7. Install reassembled mounting flange on bearing flange.

NOTE: *Apply clean grease on lips of shaft seals before assembling.*

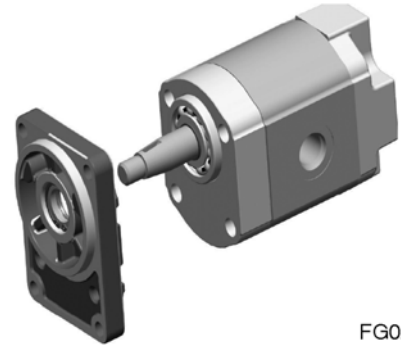


Figure 35

FG024369

8. Install bolts and tighten with in a crisscross pattern.

- Torque: 45 N.m (4.6 kg.m, 33.2 ft lb).

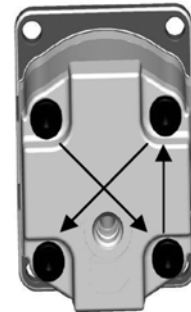


Figure 36

FG024370

9. Install key on shaft.
10. Install washer and nut on shaft.
11. Check that pump rotates freely when driveshaft is turned by hand. If not, a possible plate seal may be pinched.

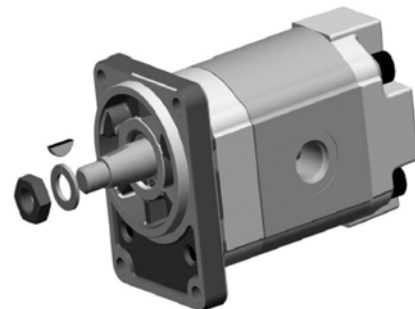


Figure 37

FG024352

Joystick Valve (Work Lever)

Edition 1

MEMO

Table of Contents

Joystick Valve (Work Lever)

Safety Instructions	5-11-5
General	5-11-5
Specifications	5-11-5
Overview	5-11-6
Theory of Operation	5-11-8
Tools and Torques	5-11-9
Section View	5-11-10
Removal	5-11-12
Installation	5-11-17
Completing work	5-11-18
Disassembly	5-11-19
Reassembly	5-11-23

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.

GENERAL

Specifications

Max. Primary Pressure	49 bar (50 kg/cm ² , 711.1 psi)
Max. Back Pressure	2.9 bar (3 kg/cm ² , 42.7 psi)
Rated Flow	20 L/min (5.3 U.S. gal)
Continuous Rated Current of Switch	DC30 V x 6 A
Internal Leakage	
Oil Temperature	50 ±5°C
Neutrality	30 ~ 150 cc
At Work (15 kg/cm ²)	30 ~ 400 cc

Performance

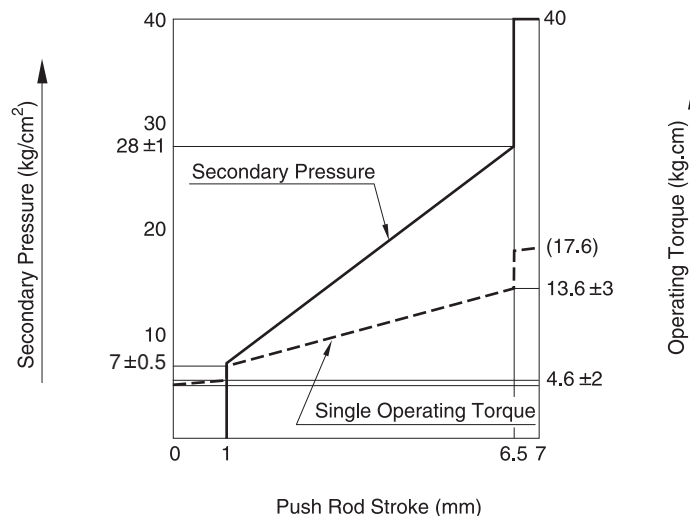


Figure 1

EX1504811

Overview

The pilot valve is a valve that controls the spool stroke, direction, etc of a main control valve.

This function is done by providing the spring at one end of the main control valve spool and applying the output pressure (secondary pressure) of the pilot valve to the other end.

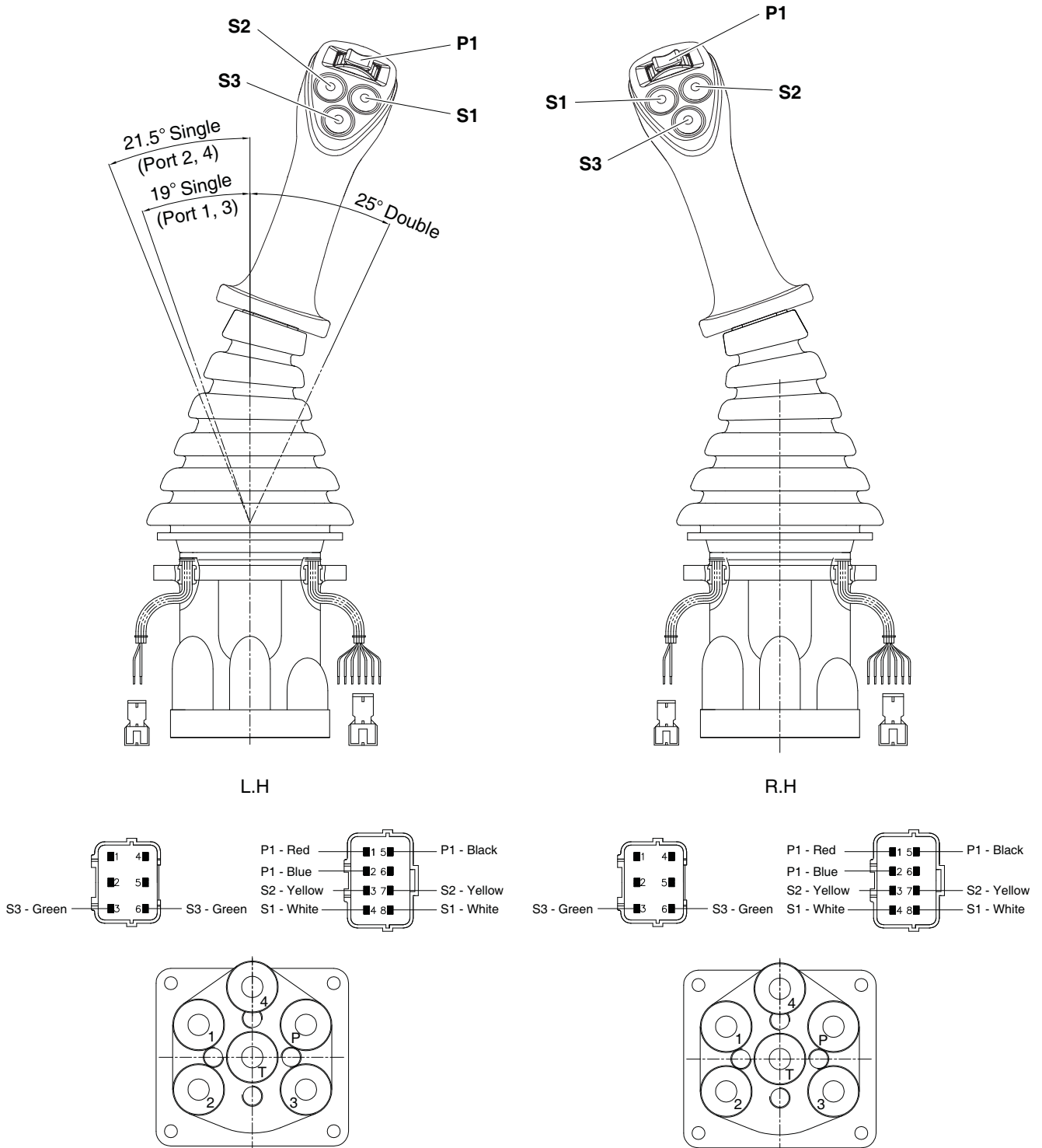


Figure 2

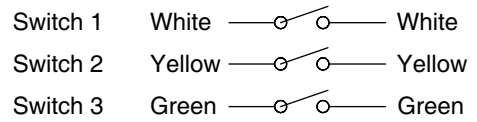
EX1403290

Port and Hydraulic Circuit

Switches

1. Push button switch

Switch	LH	RH
S1	Horn Button	Booster Button
S2	One Touch Deceleration Button	Spare Button
S3	Spare Button	

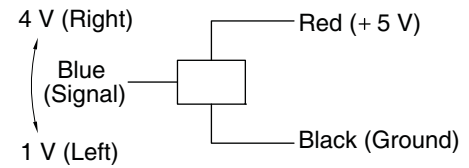


EX1301712

Figure 3

2. Proportional switch

Switch	LH	RH
P1	Rotating Switch	Two-way Switch

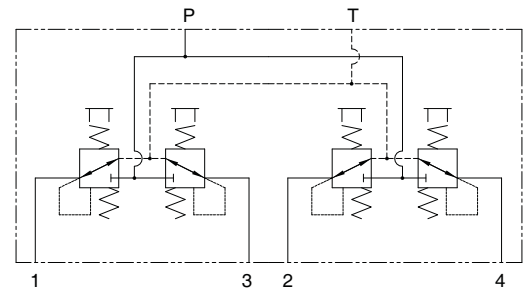


EX1301713

Figure 4

Ports

Port	LH	RH	Size
1	Left Swing	Bucket Crowd	PF 3/8"
2	Arm Dump	Boom Down	
3	Right Swing	Bucket Dump	
4	Arm Crowd	Boom Up	
P	Pilot Oil Inlet	Pilot Oil Inlet	
T	Pilot Oil Return	Pilot Oil Return	



EX1301711

Figure 5

Theory of Operation

Structure

The joystick valve contains four push rods, spring seat, spools and return springs, which are in the valve casing. Moves the spool of the main control valve by reducing the pressure of the pilot pump from a first pressure to a second pressure.

The housing has six ports, which include input port P, tank port T, and four secondary pressure ports.

The electric horn button is installed in the valve handle.

Gear pump pressure is used for operating control spools.

Function

1. Neutral position

When the joystick lever is in the neutral state, the spool is pressed upward by the return spring and the spring seat.

The P-port is blocked by the lower part of the spool, and the 4 operation ports are connected to the T-port by the upper part of the spool.

Reference Number	Description
1	Swash Plate
2	Push Rod
3	Balance Spring
4	Return Spring
5	Spool

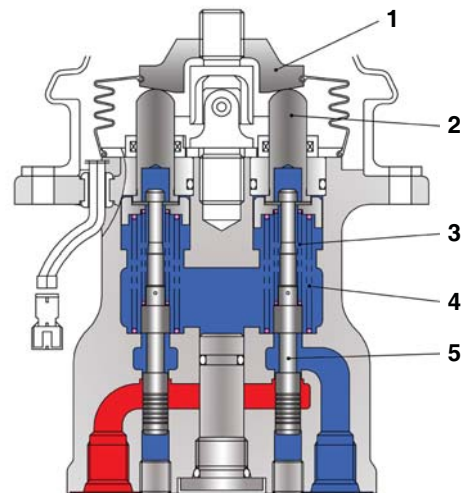


Figure 6

EX1301707

2. Half-operated state

When the joystick lever is moved, the push rod moves downward, and the force thereof is transferred to the spool through the spring seat and the control spring. When the spool moves, the first pressure is transferred to the operation ports through the spool.

When the lever spring stops in the halfway position, the force of the compressed spring and the hydraulic pressure caused by the second pressure applied upward because of the difference in area of the upper and lower ends of the spool create a state of equilibrium, and this pressure is transferred to the spool of the control valve. That is, the first pressure is transferred to the operation ports through the spool as a hydraulic pressure (second pressure) corresponding to the force of the compressed control spring.

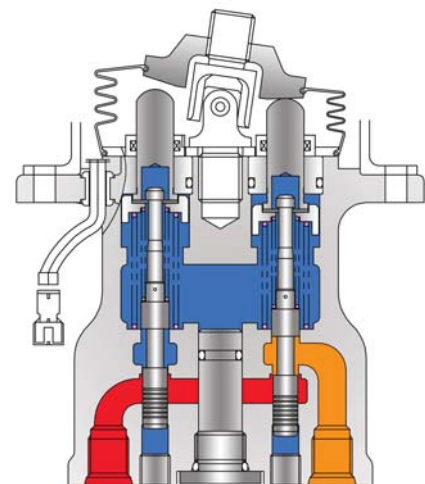


Figure 7

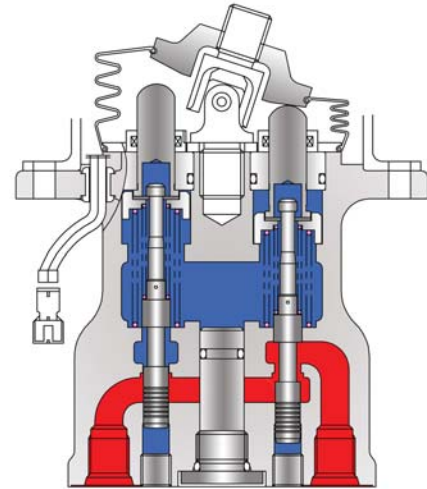
EX1301708

3. Fully operated state

When the joystick lever is moved to its full extent, the lower end of the push rod fully presses the spool seat to fully compress the control spring.

The first pressure is transferred to the operation ports through the spool, and the second pressure coming through the spool overpowers the force of the control spring, pushing the spool upward, and thus the spool is restricted from movement by the push rod.





That is, when the joystick lever is fully pressed, the control spring cannot perform its function and the spool is restricted, making the first pressure and the second pressure equal.



EX1301709

Figure 8

Tools and Torques

Reference Number	Description	Torque			Tool
		Nm	kg.m	ft lb	
2	Plug	36.3	3.7	27	PT1/8 ()
22	Swash Plate	162.8	16.6	120	27 mm ()
23	Hex Nut	162.8	16.6	120	22 mm ()
24	Nut	162.8	16.6	120	22 mm ()

SECTION VIEW

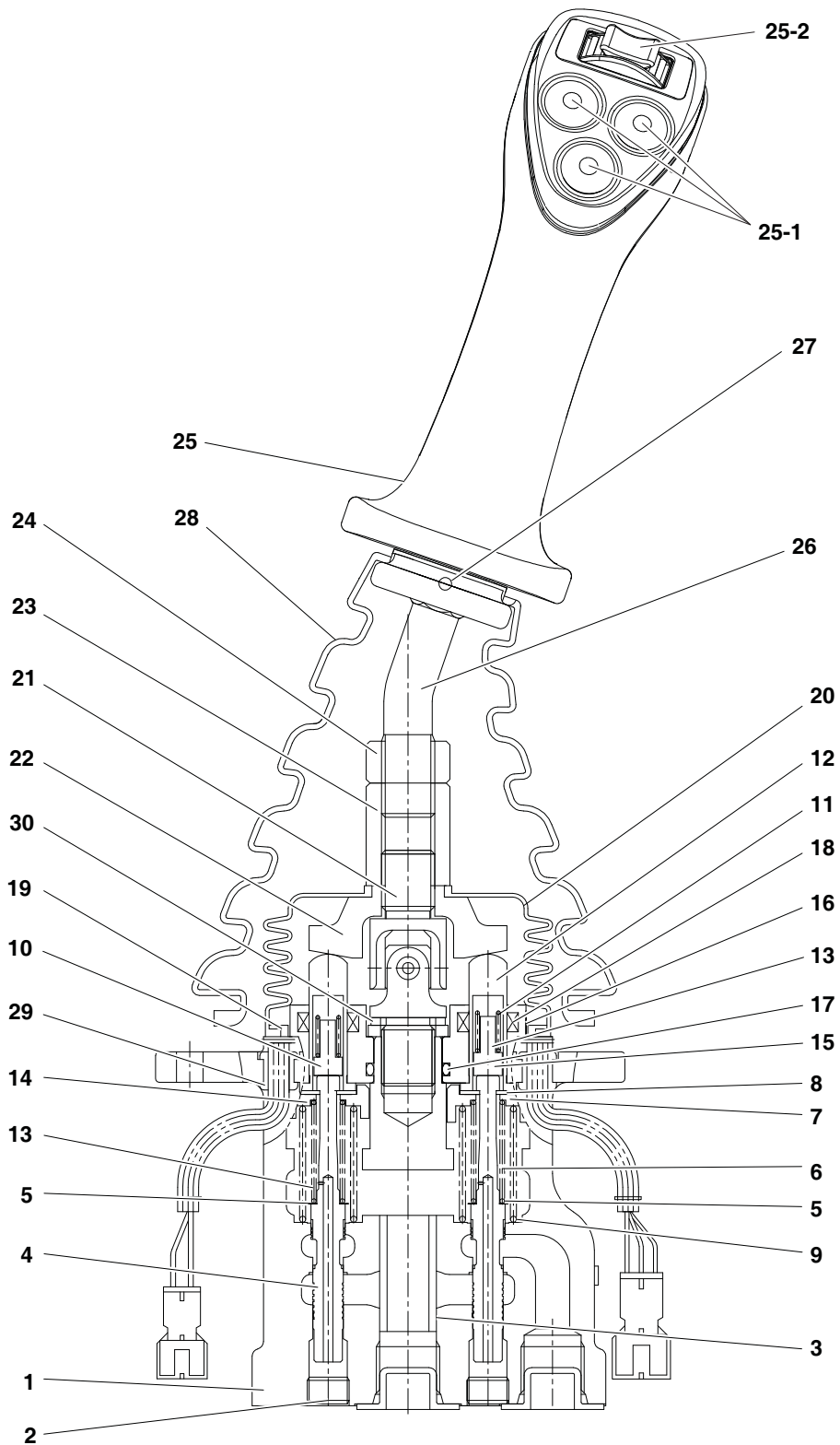


Figure 9

EX1403269

Reference Number	Description
1	Case
2	Plug
3	Bushing
4	Spool
5	Shim
6	Spring
7	Spring Seat
8	Stopper
9	Spring
10	Stopper
11	Spring
12	Push Rod
13	Spring
14	Spring Seat
15	Stopper
16	Plug

Reference Number	Description
17	O-ring
18	Rod Seal
19	Plate
20	Boot
21	Joint Assembly
22	Swash Plate
23	Nut
24	Nut
25	Joystick (LH)
	Joystick (RH)
25-1	Push Button Switch
25-2	Thumb Switch
26	Handle Bar
28	Bellows
29	Bushing
30	Washer

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Make the machine swing about 30° rightward on the flat ground as shown in Figure 11 before lowering the bucket on the ground and then stop engine.

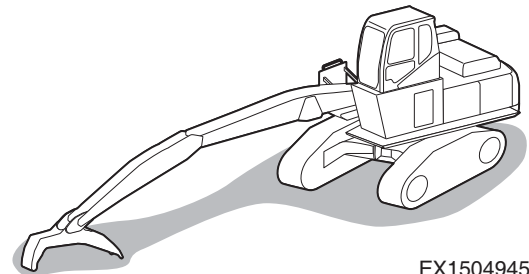


Figure 10

2. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 12)
3. Turn starter switch to "I" (ON) position.

! WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

4. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
5. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
6. Move safety lever to "LOCK" position. (Figure 12)
7. Turn key to "O" (OFF) position and remove from starter switch.
8. Attach a maintenance warning tag on controls.
9. Turn battery disconnect switch to "OFF" position. (Figure 13)

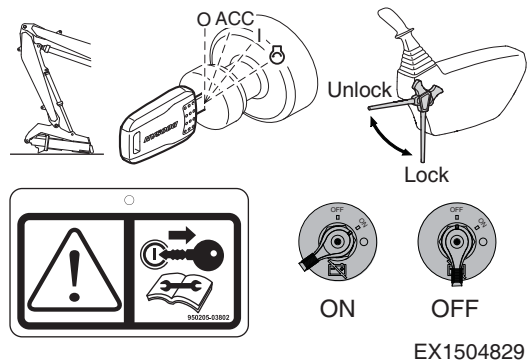


Figure 11

EX1504829

! WARNING

AVOID DEATH OR SERIOUS INJURY

Release any pressure in the hydraulic oil tank before doing any work.

10. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank.
Pulling the breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.

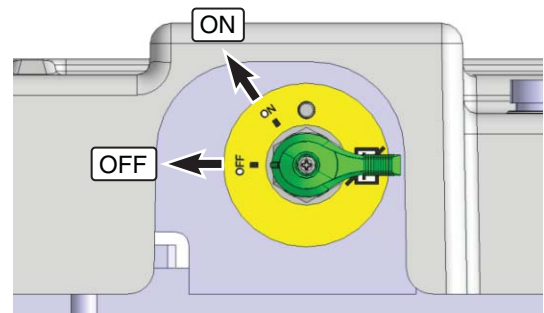


Figure 12

EX1504925

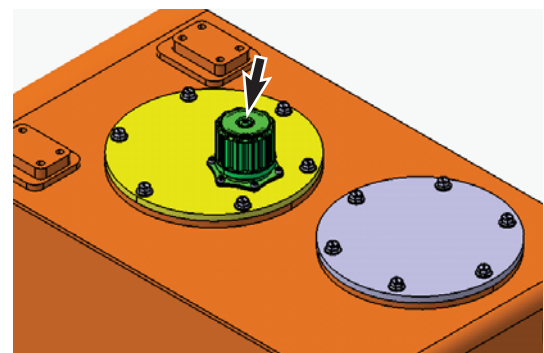



Figure 13

EX1403168

11. Remove bolts (3 ea) and washers (3 ea) and remove arm rest from bracket. (Right side)

Left side is same.

- Tool: 13 mm ()
- Torque: 29.4 N.m (3 kg.m, 21.7 ft lb)

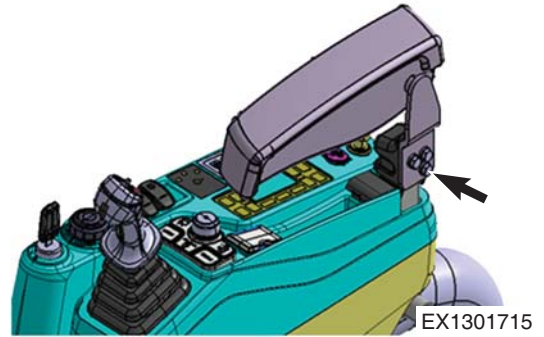


Figure 14

12. Remove screw with arm rest cover.

Left side is same.

- Tool: Phillips screwdriver

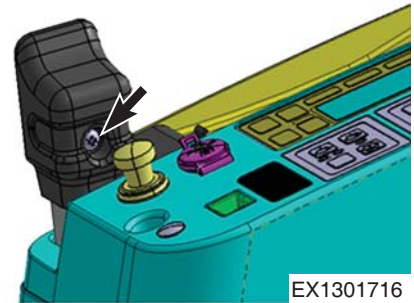


Figure 15

13. Remove rubber and screws, remove cover (1, Figure 17) from stand upper cover, and disconnect the connector of harness which connect with switches.

Left side is same.

- Tool: Phillips screwdriver

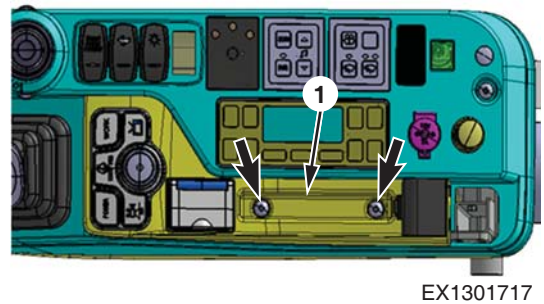


Figure 16 Stand RH

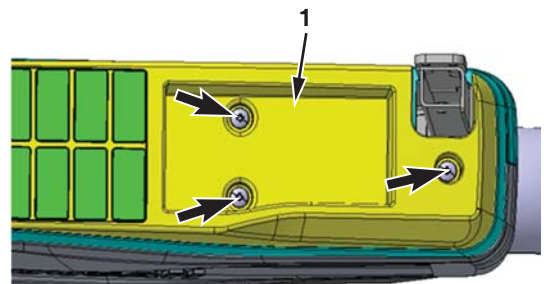


Figure 17 Stand LH

14. Remove screws (Figure 19) (3 ea) and bolt (2) remove upper cover (1, Figure 19) from bracket, and disconnect the connector of harness which connect with switches.

Left side is same.

- Tool: 3 mm (), phillips screwdriver

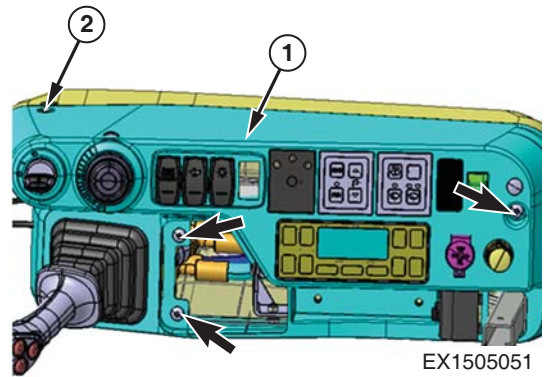


Figure 18 Stand RH

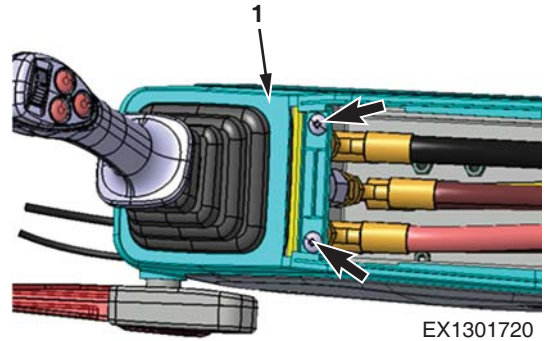


Figure 19 Stand LH

15. Remove screws (4, Figure 21) (2 ea), socket bolts and washers (3) (4 ea) of joystick valve (1).
16. Remove bracket (2, Figure 21) from control stand bracket.
17. Separate joystick valve from control stand.

Left side is same.

- Tool: 5 mm (), phillips screwdriver

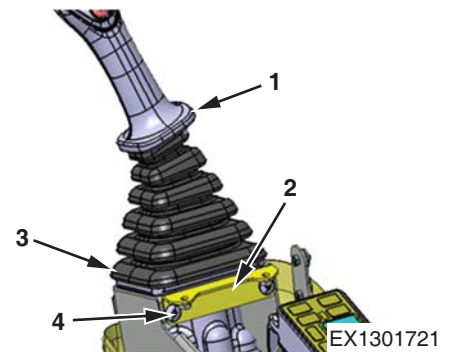


Figure 20 Stand RH

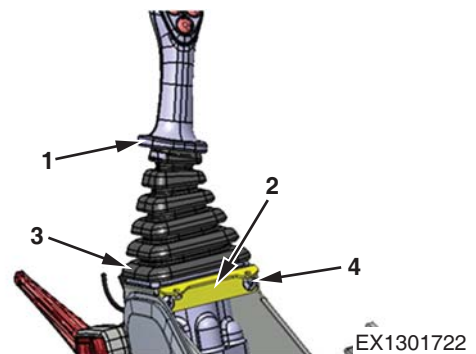


Figure 21 Stand LH

18. Remove hoses and adapters from joystick valve.

NOTE: Attach identification tags to the removed hoses for reassembling.

After disconnecting hoses from joystick valve, plug them to prevent dirt or dust from entering.

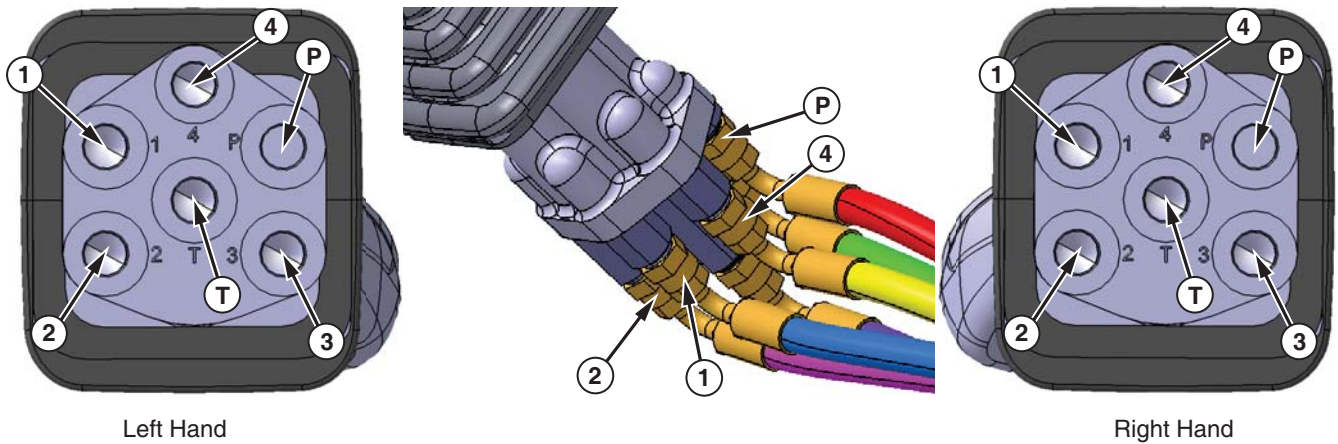


Figure 22

EX1403098

• Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	⌀ (mm)	Torque			
				N.m	kg.m	ft lb	
Left Hand	1	to Joint Sub Assembly "A8"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	2	to Joint Sub Assembly "A3"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	3	to Joint Sub Assembly "A6"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	4	to Joint Sub Assembly "A4"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	P	from PT Block "P"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	T	to PT Block "T" (Drain)	UNF 11/16"-16-2B	22	38.2	3.9	28.2
Right Hand	1	to Joint Sub Assembly "A2"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	2	to Joint Sub Assembly "A7"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	3	to Joint Sub Assembly "A1"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	4	to Joint Sub Assembly "A5"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	P	from PT Block "P"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	T	to PT Block "T" (Drain)	UNF 11/16"-16-2B	22	38.2	3.9	28.2

• Fitting

Port	Name	Size		⌀ (mm)	Torque			
		A	B		N.m	kg.m	ft lb	
Left/Right Hand	1, 2, 3, 4, P, T	Adapter	PF 3/8"	UNF 11/16"-16	22	40.2	4.1	29.6
	1, 2, 3, 4, P, T	O-ring	S8000145 (4D P14)	S8030061 (1B F-06)				

* A: Opposite side of hose, B: Hose side

19. Remove joystick valve from control stand.



Figure 23

EX1403099

INSTALLATION

WARNING

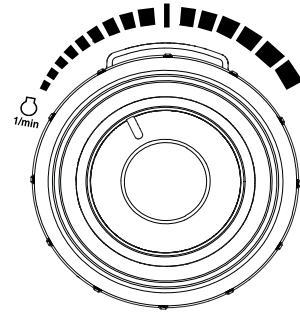
**INCORRECT INSTALLATION CAN CAUSE DEATH OR
SERIOUS INJURY**

**Any change in the connections will lead to malfunctions
(e.g. lift instead of lower).**

- **When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.**
-
1. Perform installation in the reverse order to remove.
 2. Keep the assembly angle when installing the hoses to joystick valve.

COMPLETING WORK

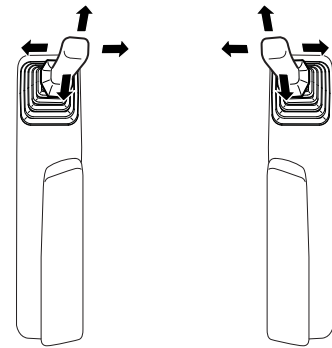
1. Start engine and set throttle at "LOW IDLE".
2. Move safety lever to "UNLOCK" position.



FG018148

Figure 24

3. Slowly cycle boom, arm, bucket cylinders and swing motor about five times without a load to vent air from pilot lines. Do this for five minutes.
4. Perform the machine performance test.

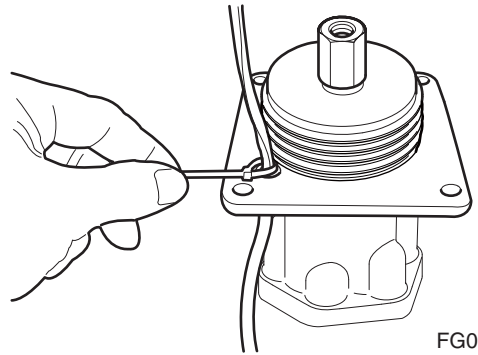


FG018384

Figure 25

DISASSEMBLY

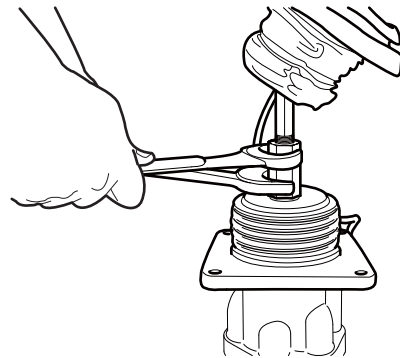
1. Remove lead wire from bushing (29).



FG013494

Figure 26

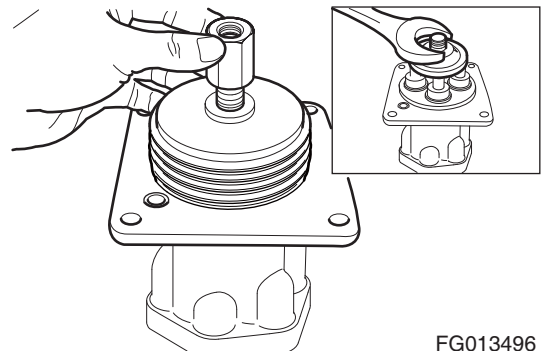
2. Remove lever assembly from case (1).



FG013495

Figure 27

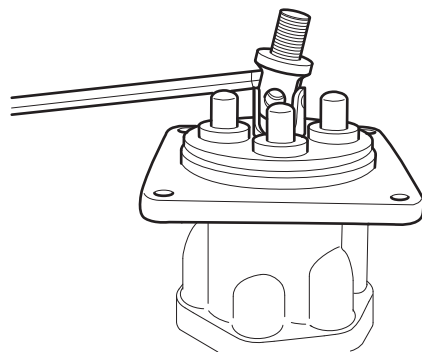
3. Remove hex nut (23) and swash plate (22) from case (1).



FG013496

Figure 28

4. Remove joint assembly (21) from case (1).



FG013497

Figure 29

5. Remove plate (19) from case (1).

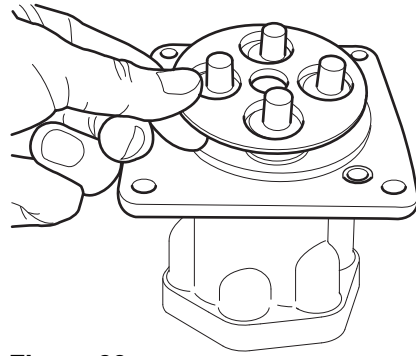


Figure 30

FG013498

6. Remove plug kit assembly, stopper and spring (11) from case (1).

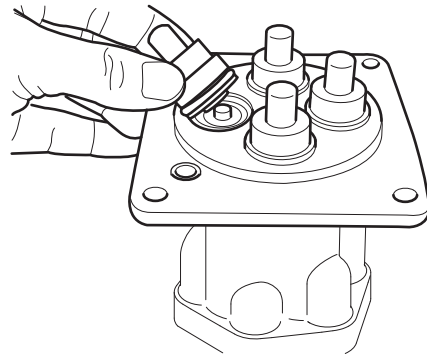


Figure 31

FG013499

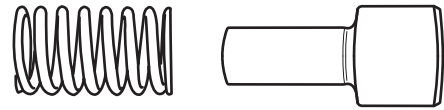


Figure 32

FG013501

7. Remove 4 spool kit assemblies from case (1).

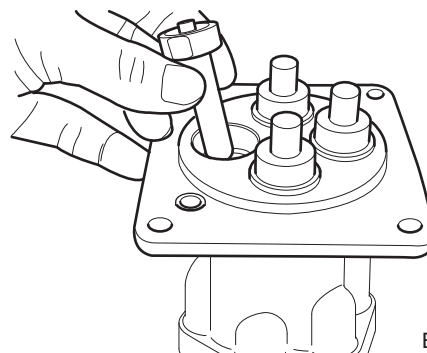


Figure 33

EX1301732

8. Remove spring (9) from (1).

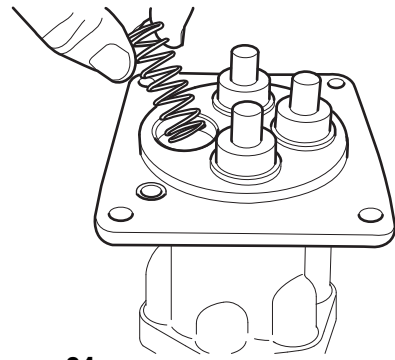


Figure 34

FG013510

9. Remove bushing (3) from case (1).

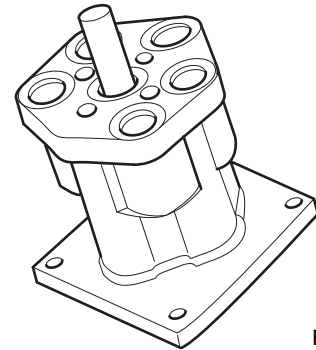


Figure 35

FG013506

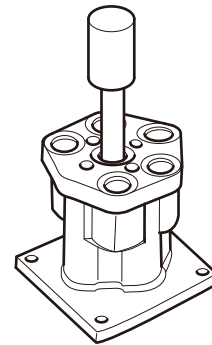


Figure 36

FG013508

10. Remove 4 plugs (2) from case (1).

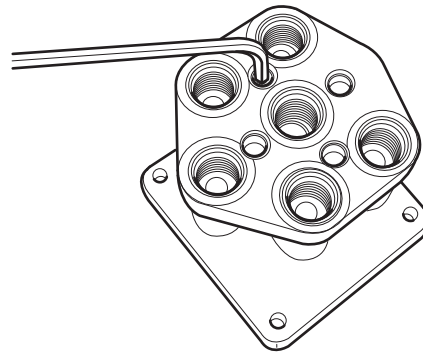


Figure 37

FG013504

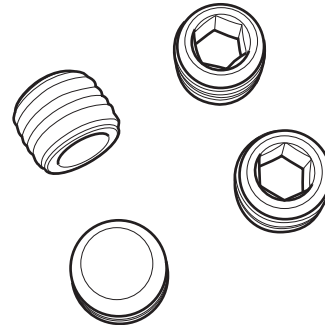


Figure 38

FG013507

REASSEMBLY

1. Install 4 plugs (2) into case (1).

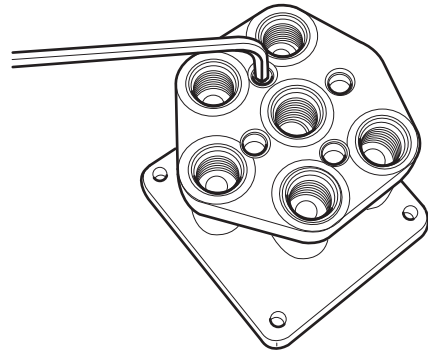


Figure 39

FG013504

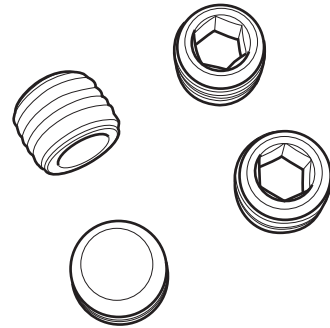


Figure 40

FG013507

2. Install bushing (3) into case (1) using jig.

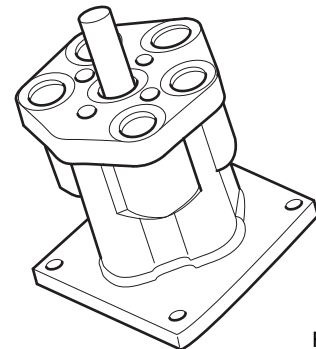


Figure 41

FG013506

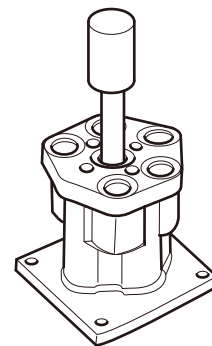


Figure 42

FG013508

3. Take care when assembling spool kit assemblies (1 and 3, 2 and 4). (They must be assembled in same way).

The assembly order is; spool (4), shim (5), spring (6), spring seat (7), and stopper (8).

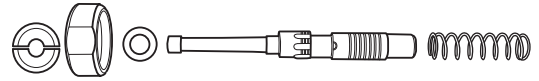


Figure 43

FG013509

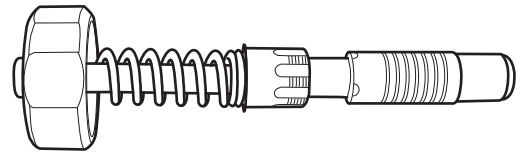


Figure 44

FG013503

4. Install spring (9) into case (1).

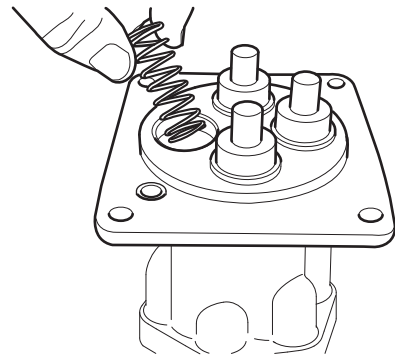


Figure 45

FG013510

5. Install spool kit assembly into case (1). (The same way is used for four parts.)

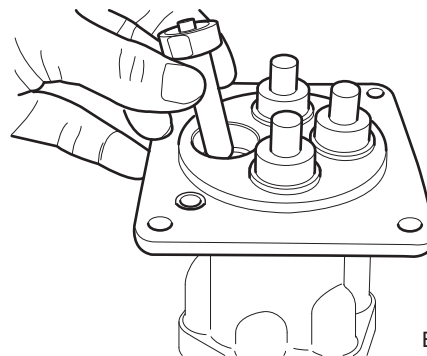


Figure 46

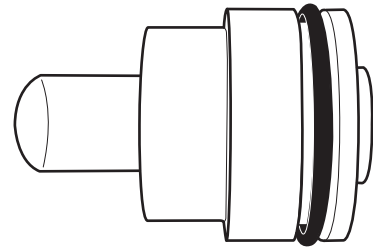
EX1301732

6. Assemble plug kit insert rod seal (18), O-ring (17), and push rod (12) into plug (16) in proper order.



FG013511

Figure 47

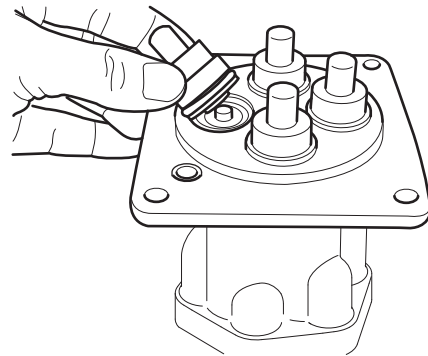


FG013512

Figure 48

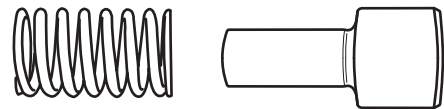
7. Install four springs (11) and stoppers and insert assembled set in case (1) to form a plug kit assembly.

NOTE: Pay attention to measurement specifications of stoppers (1 and 3, 2 and 4).



FG013499

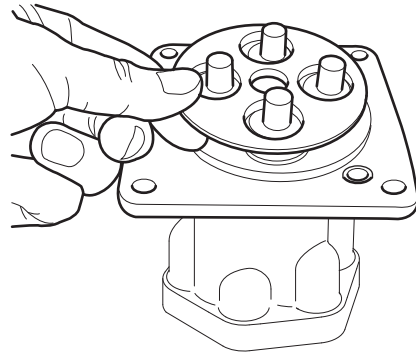
Figure 49



FG013501

Figure 50

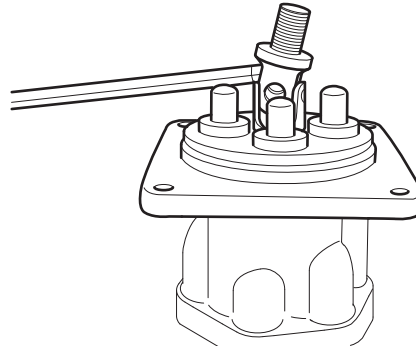
8. Install plate (19) into case (1).



FG013498

Figure 51

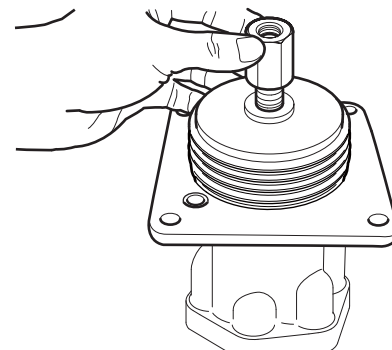
9. Install joint assembly (21) into case (1).



FG013497

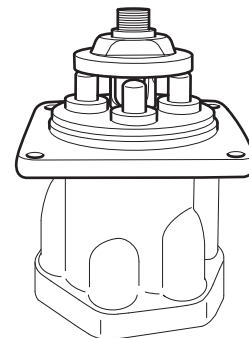
Figure 52

10. Install boot and swash plate (22) and hex nut (23) into case (1).



FG013513

Figure 53



FG013514

Figure 54

11. Insert bar and tighten it with a wrench to check balance of joint assembly.

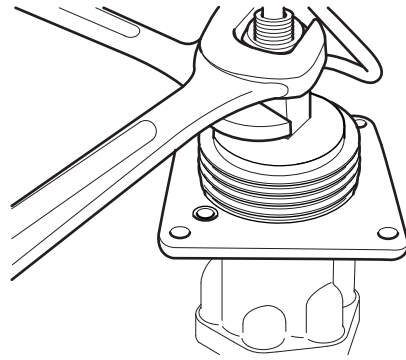


Figure 55

FG013515

12. Install bushing (29) into case (1).

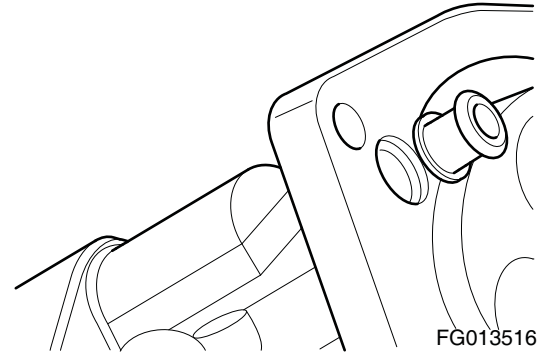


Figure 56

FG013516

13. Install lever assembly into case (1).

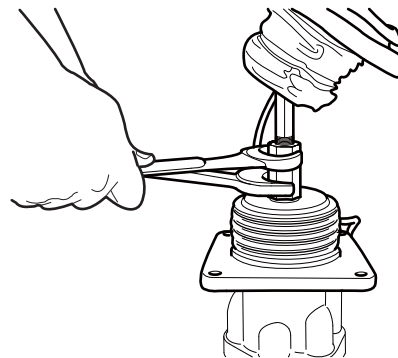


Figure 57

FG013495

14. Put lead wire in bushing (29), tie it, and arrange boot.

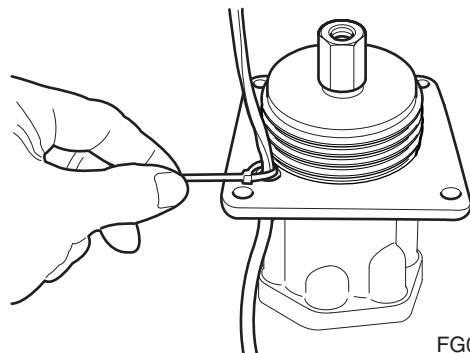


Figure 58

FG013494

15. Assemble connector assembly (30), and connect it to lead wire terminal, and properly route wiring.

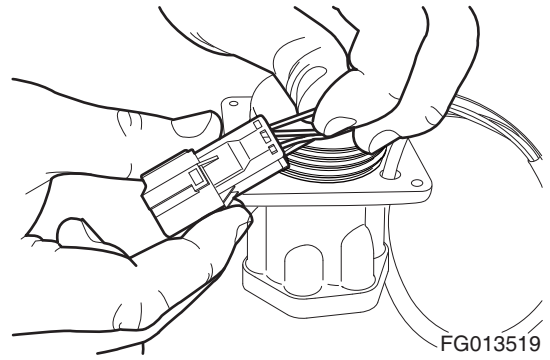


Figure 59

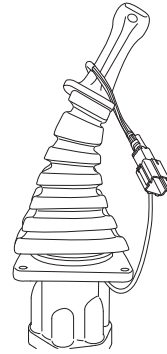


Figure 60

Travel Control Valve (with Damper)

Edition 1

MEMO

Table of Contents

Travel Control Valve (with Damper)

Safety Instructions	5-12-5
General	5-12-6
Specification	5-12-6
Overview	5-12-7
Theory of Operation	5-12-8
Tools and Torques	5-12-9
Section View	5-12-10
Removal	5-12-11
Installation	5-12-16
Completing Work	5-12-17
Disassembly	5-12-18
Reassembly	5-12-21
Troubleshooting	5-12-26

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

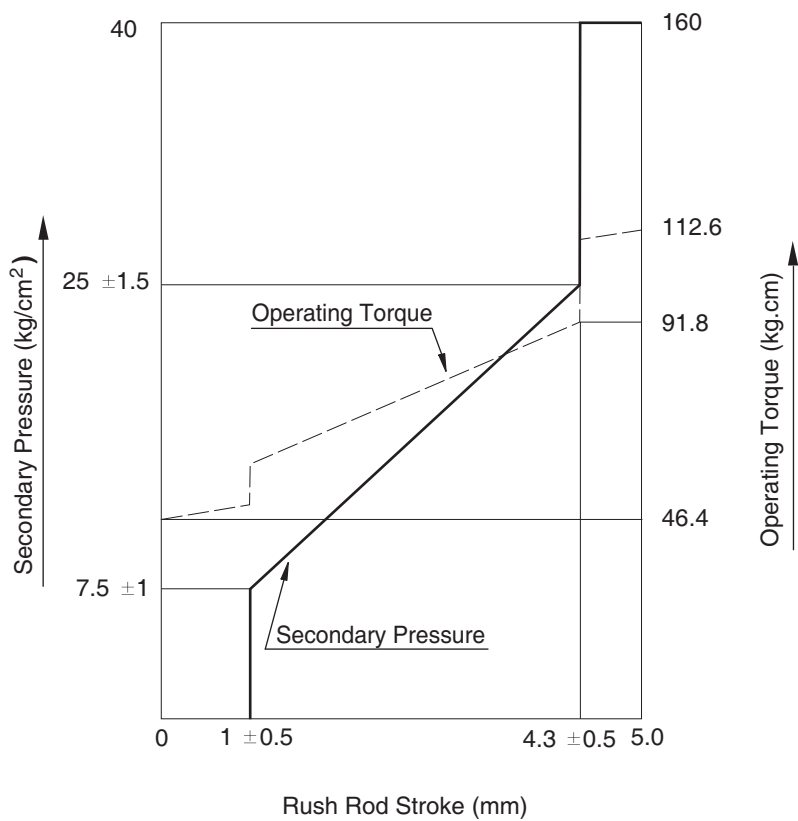
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

GENERAL

Specification

Type	Pilot (with Damper)
Pressure/Stroke Characteristic	7.4 ~ 25 bar (7.5 ~ 25 kg/cm ²) (@ 1 ~ 4.3 mm Stroke)
Max. Primary Pressure	98 bar (100 kg/cm ² , 1,422 psi)
Max. Back Pressure	2.9 bar (3 kg/cm ² , 42.7 psi)
Rated Flow	20 L/min (5.3 U.S. gal)
Weight	7.8 kg (17.2 lb)

Performance



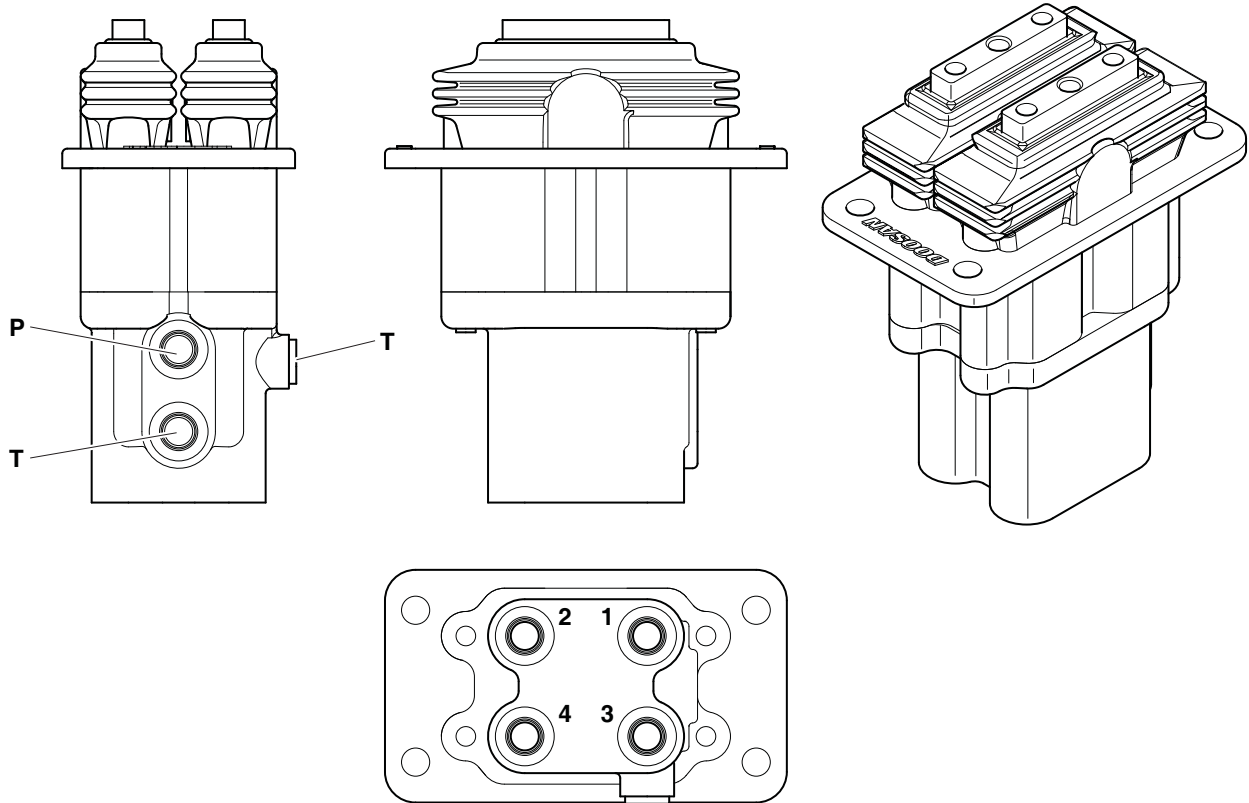
EX1300984

Figure 1

Overview

The pilot valve is a valve that controls the spool stroke, direction, etc of a main control valve.

This function is done by providing the spring at one end of the main control valve spool and applying the output pressure (secondary pressure) of the pilot valve to the other end.

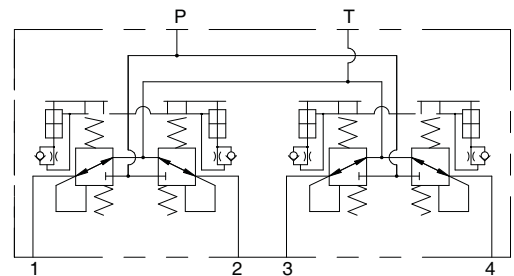


EX1301730

Figure 2

Port and Hydraulic Circuit

Port	Name	Size
1	Backward	PF 1/4" O-ring
2	Forward	
3	Backward	
4	Forward	
P	Pilot Oil Inlet	
T	Pilot Oil Return	



EX1301731

Figure 3

Theory of Operation

Structure

The casing (spacer) has oil inlet port P (primary pressure), and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1, 2, 3 and 4 provided at the bottom face.

Pressure Reducing Valve

1. Neutral position

If pedal is in neutral, spool is pushed up by return spring and spring seat. Port (P) is blocked by bottom part of spool and four operating ports (left forward and backward, right forward and backward) are connected to port (T) through inner hole of spool.

2. Half-operated state

If pedal is moved, push rod moves down, and they transmit this force through spring seat and control spring to spool. If spool is moved, primary pressure is transmitted through an inner hole of spool to operating port. If lever is stopped in middle position, compressed control spring force and secondary pressure transmitted through hole acts at bottom part of spool, balance is maintained by hydraulic force acted upward, and then this pressure is transmitted to traveling spool of control valve. That is, primary pressure is transmitted to operating port as secondary pressure equivalent to control spring force compressed by spool.

3. Fully operated state

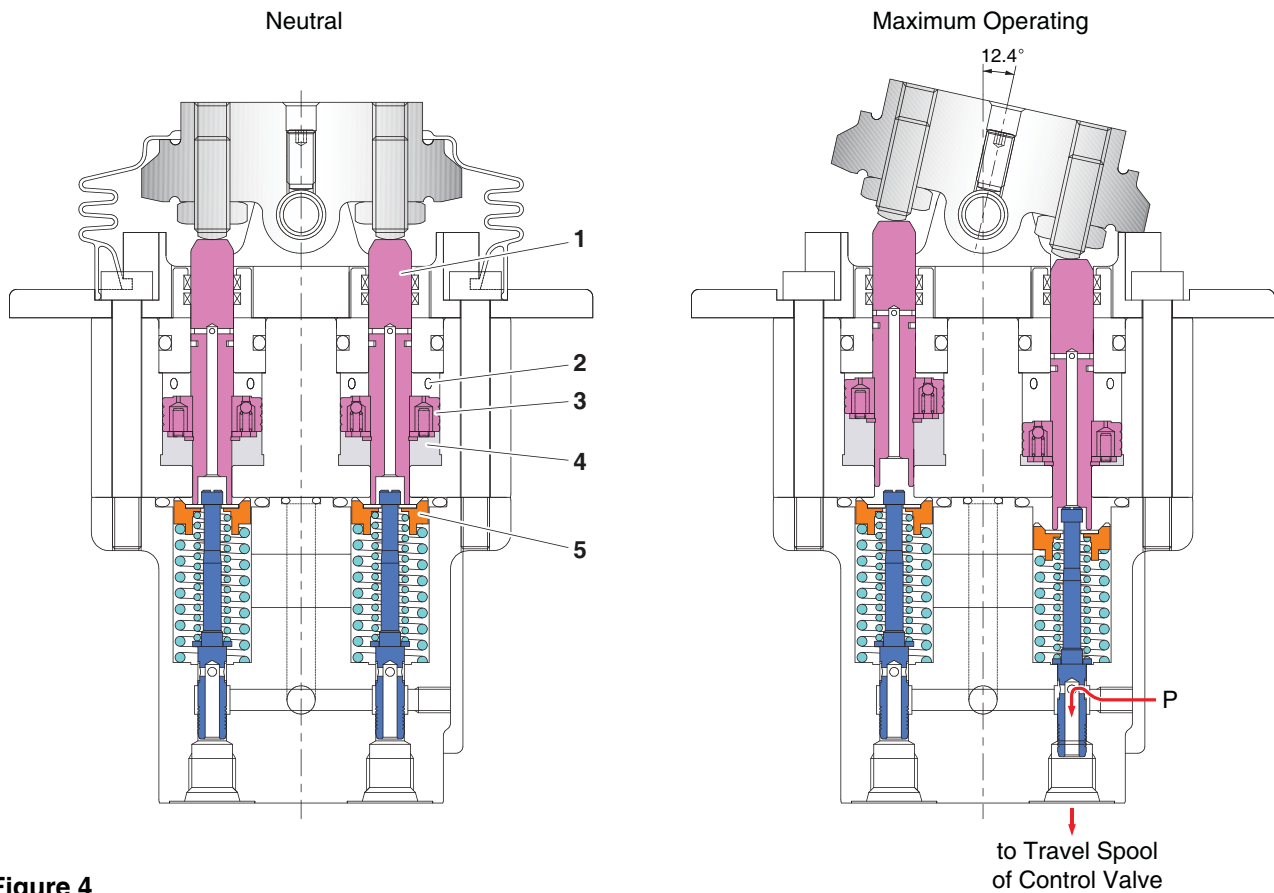
If pedal is moved to a maximum, bottom part of push rod presses spool seat to a maximum, and compresses control spring to a maximum. Primary pressure is transmitted through inner hole of spool to operation port, secondary pressure transmitted through spool overcomes control spring force and pushes spool up, but spool is restricted by push rod and does not move any more. That is, when pedal lever is moved to a maximum, control spring does not function, spool is restricted by push rod, and then primary pressure equalizes to secondary pressure.

Damper Mechanism

1. Operation When Operating Lever

When pushing pedal, pushing force pushing push rod and spool presses cylinder, return spring and hydraulic oil in cylinder is compressed, piston coming down with push rod compresses vibration prevention chamber of lower part, oil of vibration prevention chamber of lower part is flowed through orifice to oil pressure vibration prevention chamber of upperpart of low-pressure, now, ball check valve becomes closing condition because high-pressure operates to vibration prevention chamber of lower part.

2. Operation When Operating Lever In Neutral Condition
 Climbing restoring force acting on push rod, raises piston in oil pressure prevention chamber and compresses upper oil pressure prevention chamber. This compression operation of upper oil pressure prevention chamber prevents the push rod from quickly rising by restoring spring, and the damping force is generated.





EX1401585

Figure 4

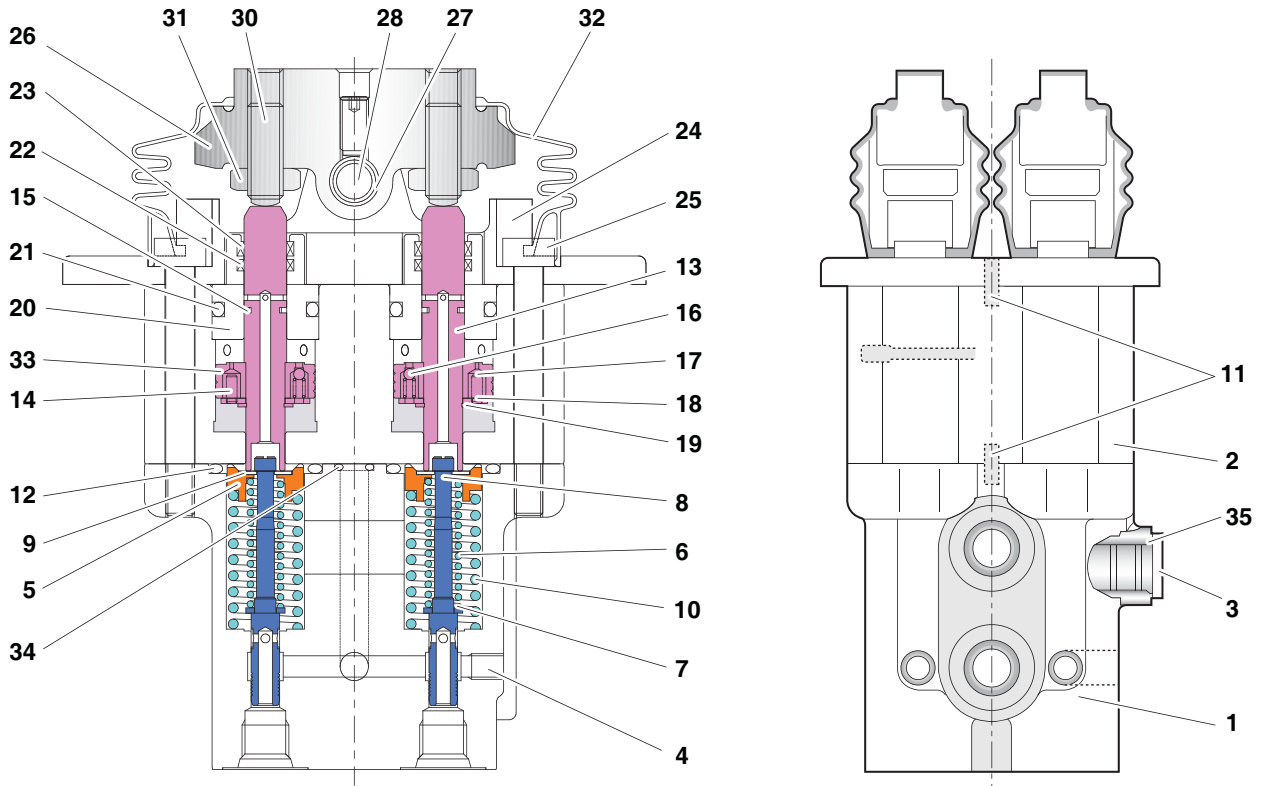
Reference Number	Description
1	Push Rod
2	Orifice
3	Piston

Reference Number	Description
4	Piston Chamber
5	Plug

Tools and Torques

Reference Number	Description	Size	Torque			Tool
			N.m	kg.m	ft lb	
25	Socket Bolt	M6	29.4	3	6	5 mm ()
31	Nut	M10	43.1	4.4	32	17 mm ()

SECTION VIEW



EX1401587

Figure 5

Reference Number	Description
1	Body (1)
2	Body (2)
3	Plug
4	Plug
5	Spring Seat
6	Spring
7	Spring Seat
8	Spool
9	Stopper
10	Spring
11	Spring Pin
12	O-ring
13	Push Rod
14	Spring Pin
15	Seal
16	Steel Ball
17	Spring

Reference Number	Description
18	Plate
19	Snap Ring
20	Plug
21	O-ring
22	Rod Seal
23	Dust Seal
24	Cover
25	Socket Bolt
26	Cam
27	Bushing
28	Camshaft
30	Set Screw
31	Hex Nut
32	Bellows
33	Piston
34	O-ring
35	O-ring

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Make the machine swing about 30° rightward on the flat ground as shown in Figure 7 before lowering the bucket on the ground and then stop engine.

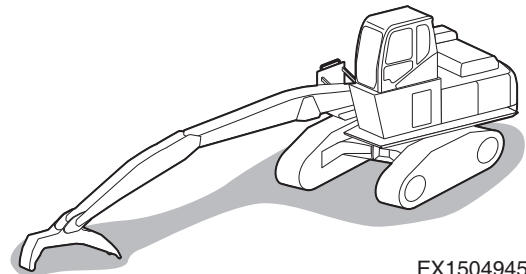


Figure 6

2. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 8)
3. Turn starter switch to "I" (ON) position.

! WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

4. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
5. Move safety lever to "LOCK" position. (Figure 8)
6. Turn key to "O" (OFF) position and remove from starter switch.
7. Attach a maintenance warning tag on controls.
8. Turn battery disconnect switch to "OFF" position. (Figure 9)

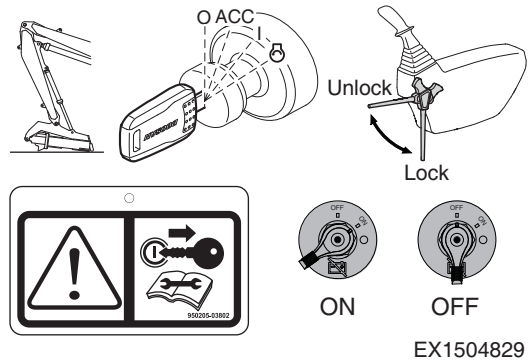


Figure 7

EX1504829

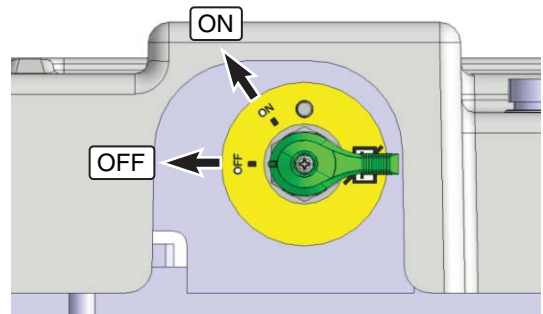


Figure 8

EX1504925

NOTE: Removal (installation) procedure of the bolts.

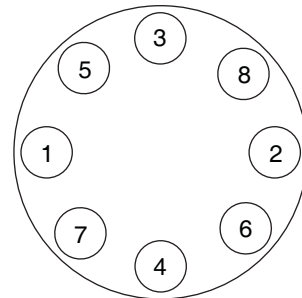


Figure 9

EX1401809



WARNING

AVOID DEATH OR SERIOUS INJURY

Release any pressure in the hydraulic oil tank before doing any work.

9. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank.

Pulling the breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.

10. Open the cabin riser cover (Figure 12).

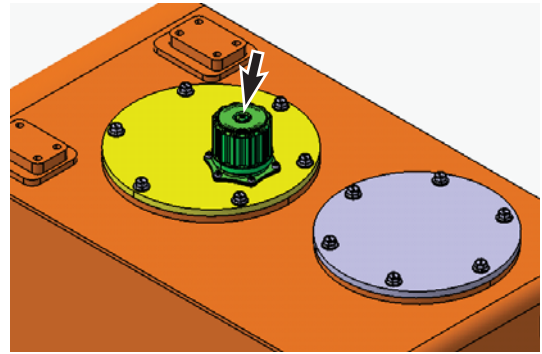


Figure 10

EX1403168

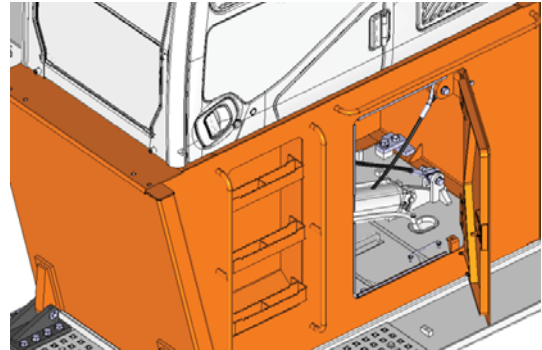


Figure 11

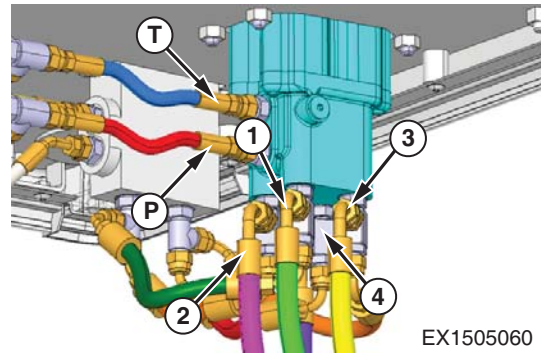
EX1505075

11. Remove hoses and adapters from travel control valve.

NOTE: Attach identification tags to the removed hoses for reassembling.

After disconnecting hoses from travel control valve, plug them to prevent dirt or dust from entering.

Disconnect the hoses from the bottom to top of travel control valve.



EX1505060

Figure 12 Bottom of Cabin

- Hoses and plugs ports

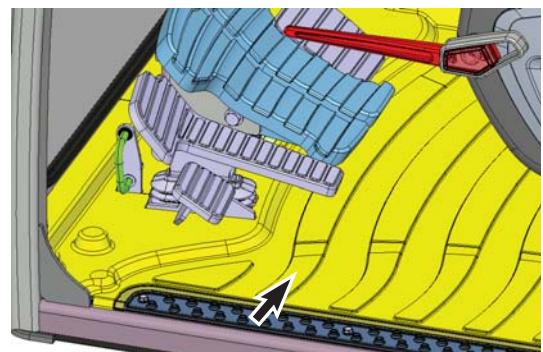
Port	Name	Plug/Flange Size (Hose)	Wrench (mm)	Torque		
				N.m	kg.m	ft lb
1	to Control Valve "pb6"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	from Straight Travel Pedal Valve "1"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
2	to Control Valve "pa6"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	from Straight Travel Pedal Valve "2"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
3	to Control Valve "pb1"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	from Straight Travel Pedal Valve "1"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
4	to Control Valve "pa1"	UNF 11/16"-16-2B	22	38.2	3.9	28.2
	from Straight Travel Pedal Valve "2"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
P	from PT Block "P"	UNF 9/16"-18-2B	19	25.5	2.6	18.8
T	to PT Block "T"	UNF 9/16"-18-2B	19	25.5	2.6	18.8

- Fitting

Port	Name	Size		Wrench (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
1, 2, 3, 4	Tee	PF 1/4"	UNF 11/16"-16, UNF 9/16"-18	19	35.3	3.6	26.0
P, T	Adapter	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
P, T	O-ring	S8000115 (4D P11)	2180-1216D11 (ID:7.65, W:1.78, 1B)				

* A: Opposite side of hose, B (C): Hose side

12. Remove floor mat from the cabin.



EX1505061

Figure 13

13. Remove bolts (1, Figure 15) (2 ea) and washers with foot rests (2) (1 ea) from floor plate.

- Tool: 17 mm (🔧)
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

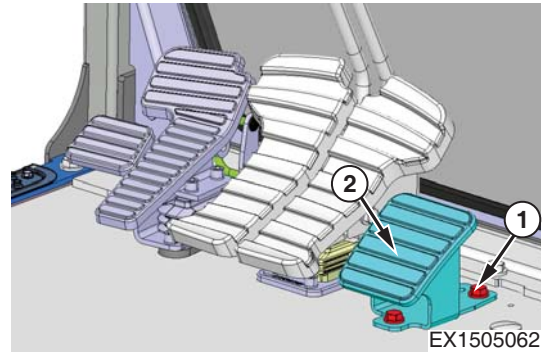


Figure 14

14. Remove bolts (1, Figure 16) (4 ea) and washers with travel pedals (2) (2 ea) from travel pedal bracket.

- Tool: 17 mm (🔧)
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

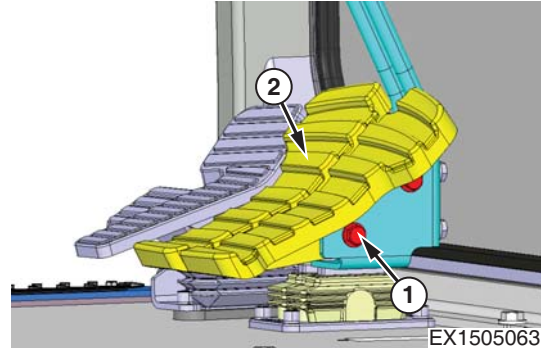


Figure 15

15. Remove bolts (1, Figure 17) (4 ea) and washers with travel pedal brackets (2) (2 ea) from travel control valve.

- Tool: 8 mm (🔧)
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

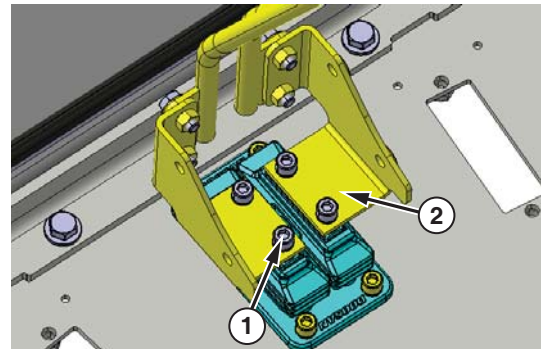


Figure 16

16. Remove bolts (1, Figure 18) (4 ea) and washers with travel control valve (2) from floor plate.

- Tool: 8 mm (🔧)
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

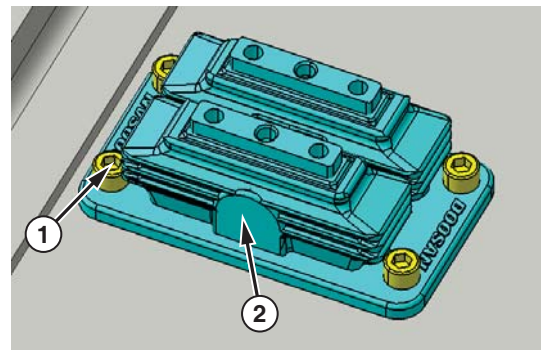


Figure 17

17. Remove travel control valve from floor plate.

- Valve weight: about 8 kg (17.6 lb)

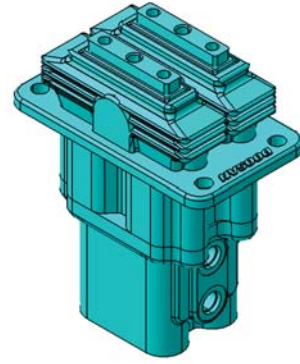


Figure 18

EX1402320

INSTALLATION



WARNING

**INCORRECT INSTALLATION CAN CAUSE DEATH OR
SERIOUS INJURY**

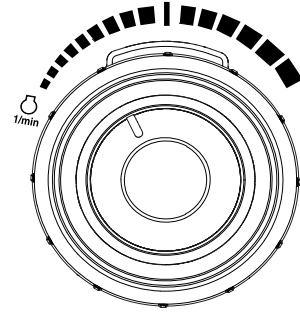
Any change in the connections will lead to malfunctions (e.g. lift instead of lower).

- **When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.**
-

1. Perform installation in the reverse order to removal.
2. When installing the hose, be install the drain hose first.

COMPLETING WORK

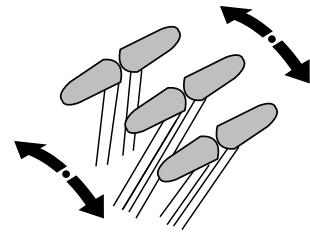
1. Start engine and set throttle at "LOW IDLE".
2. Move safety lever to "UNLOCK" position.



FG018148

Figure 19

3. Slowly push and pull both travel lever about five times without a load to vent air from pilot lines.

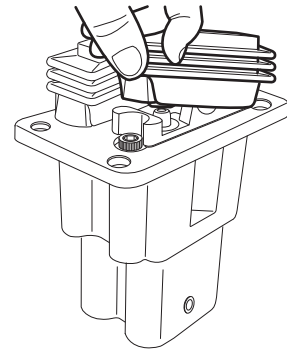


HAOB903L

Figure 20

DISASSEMBLY

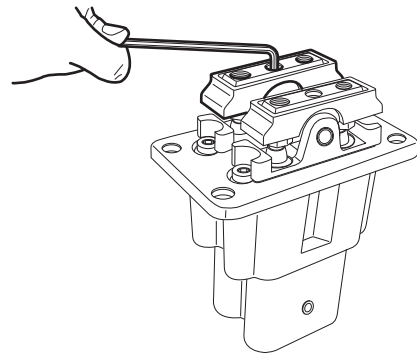
1. Remove bellows (32).



FG013535

Figure 21

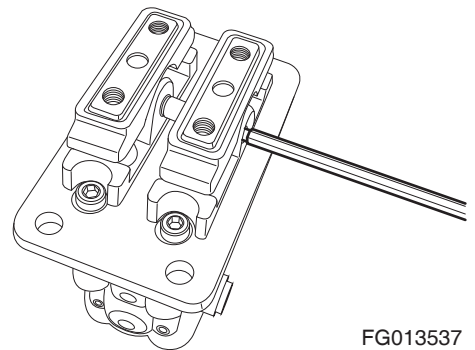
2. Remove set screw (29) from cam (26).



FG013536

Figure 22

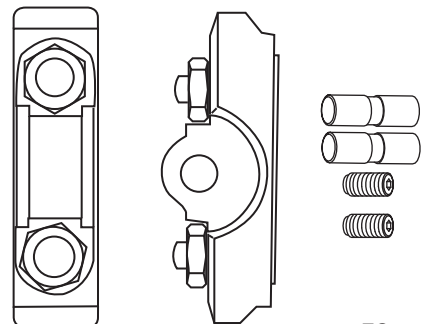
3. Remove camshaft (28) from cam (26).



FG013537

Figure 23

4. Remove hex nut (31) and set screw (30) from cam (27).



FG013538

Figure 24

- Remove hex socket head bolt (25) and cover (24) from each body (1 and 2).

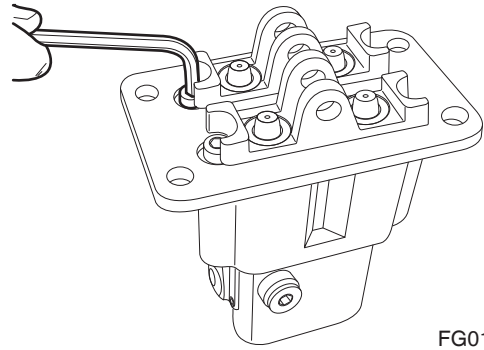


Figure 25

FG013539

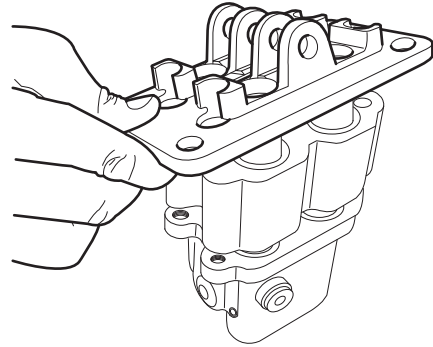


Figure 26

FG013540

- Remove push rod assembly from body (2).

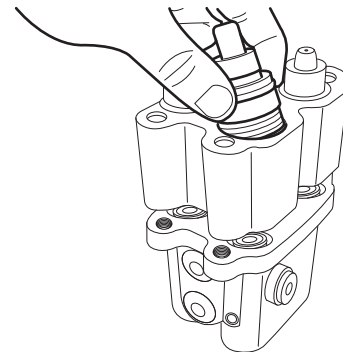


Figure 27

FG013541

- Remove body (2) from body (1).

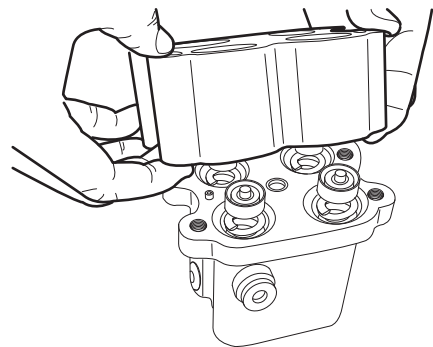
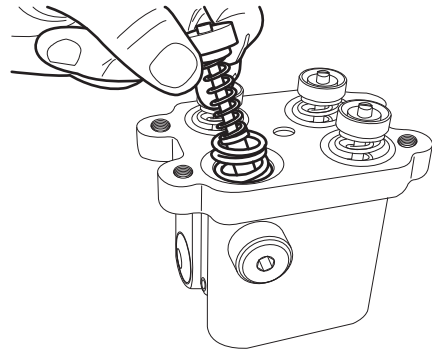


Figure 28

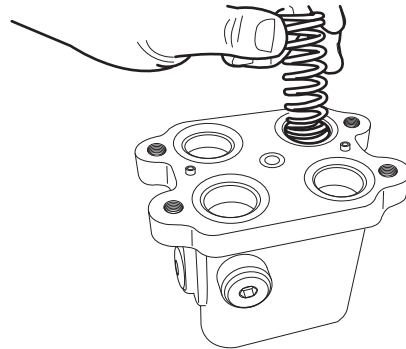
FG013542

8. Remove damper spool assembly and spring (10) from body (1).



FG013543

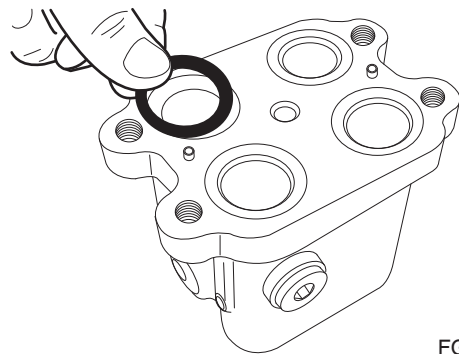
Figure 29



FG013544

Figure 30

9. Remove plug (3 and 4) and O-rings (12 and 34).

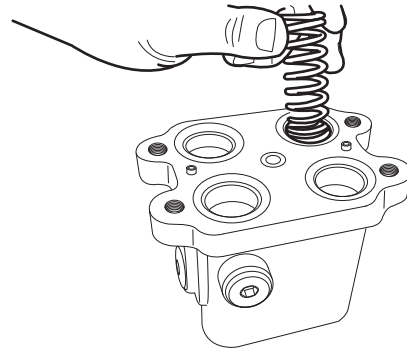


FG013545

Figure 31

REASSEMBLY

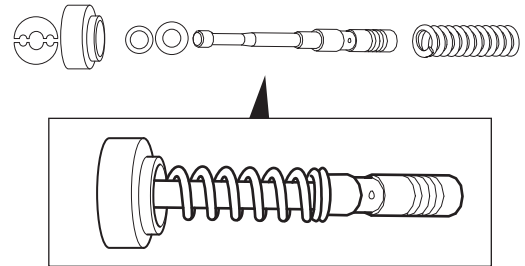
1. Insert spring (10) into body (1).



FG013544

Figure 32

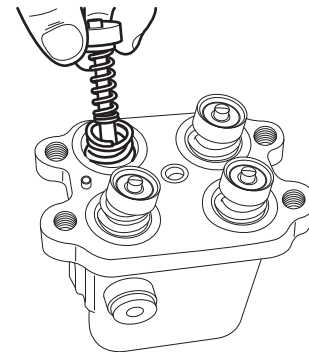
2. Assemble in proper order, damper spool (8), shim (7), spring (6), spring seat (5) and stopper (9).



FG013546

Figure 33

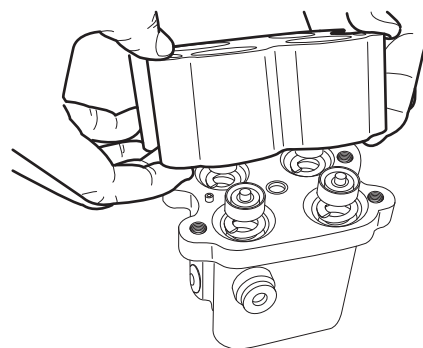
3. Install damper spool assembly into body (1).



FG013547

Figure 34

4. Assemble body (2) onto body (1).



FG013542

Figure 35

5. Assemble rod seal (22), dust seal (23) and O-ring (21) into plug (20).

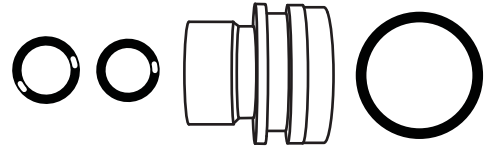


Figure 36

FG013548

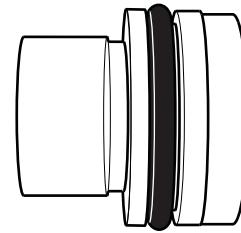


Figure 37

FG013549

6. Assemble seal (15), piston (33), steel ball (16), plate (18), spring (17) and retaining ring (19) into push rod (13).

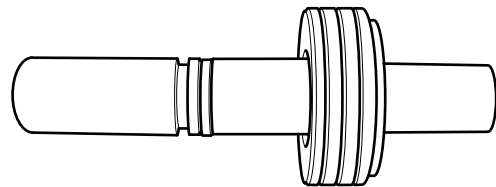


Figure 38

FG013550

7. Assemble push rod and plug.

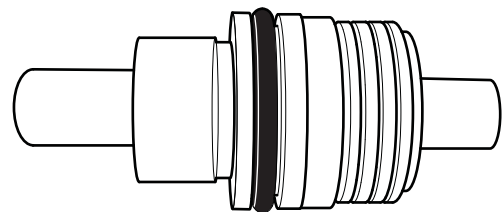
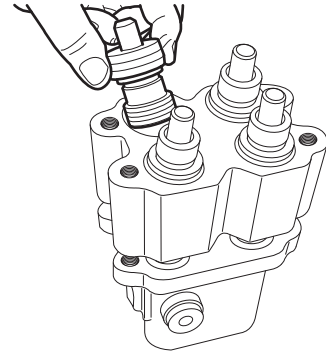


Figure 39

FG013551

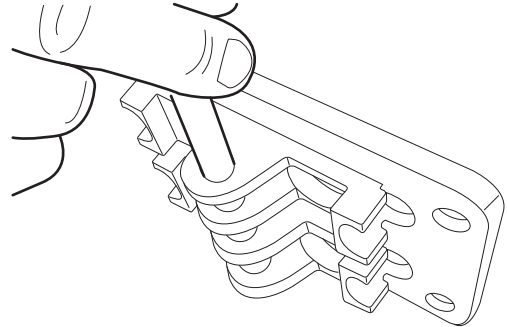
8. Install push rod assembly into body (2).



FG013552

Figure 40

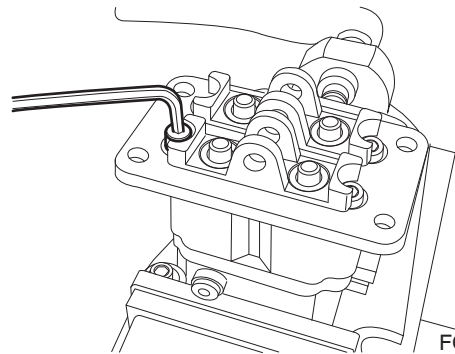
9. Install bushing (27) in cover (24) using jig.



FG013553

Figure 41

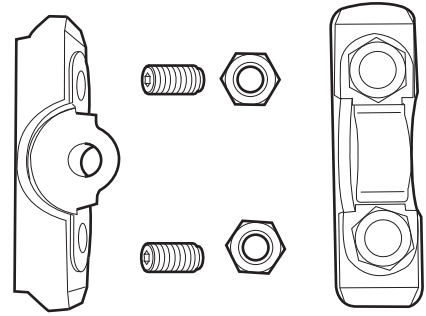
10. Assemble cover (24) onto each body (1 and 2) and install hex socket head bolt (25) using torque wrench.



FG013554

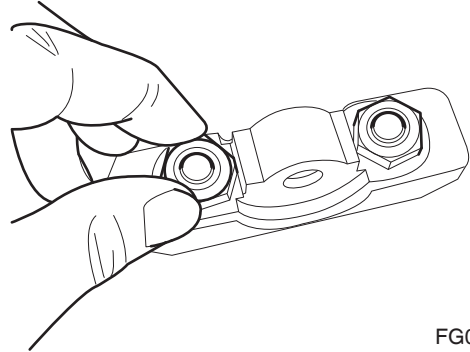
Figure 42

11. Install set screws (30) and hex nut (31) into cam (26) and tighten it.



FG013555

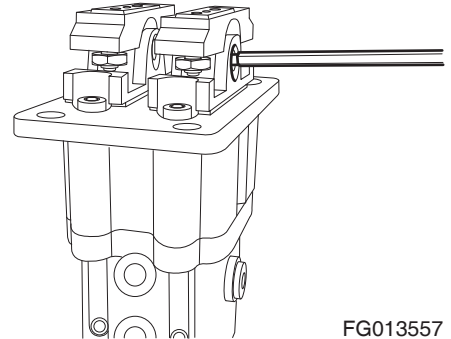
Figure 43



FG013556

Figure 44

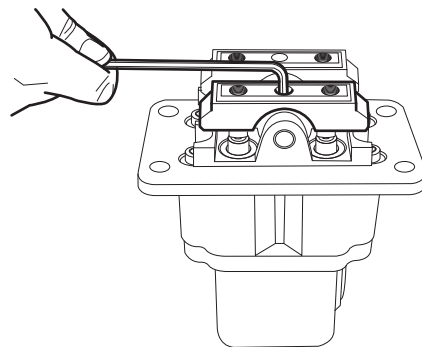
12. Position cam (26) on cover (24) and insert camshaft (29) using hammer.



FG013557

Figure 45

13. Install set screw (29) in cam (26) and tighten it using torque wrench.



FG013558

Figure 46

14. Check cam balance.

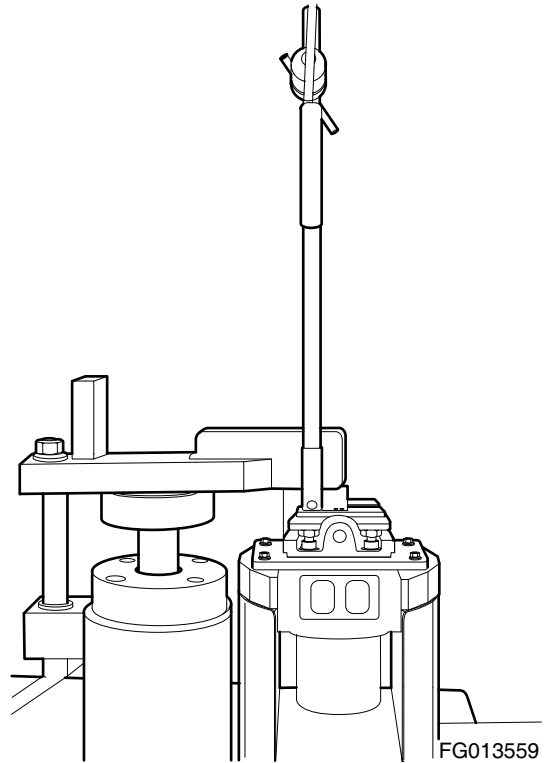


Figure 47

FG013559

15. Install bellows.

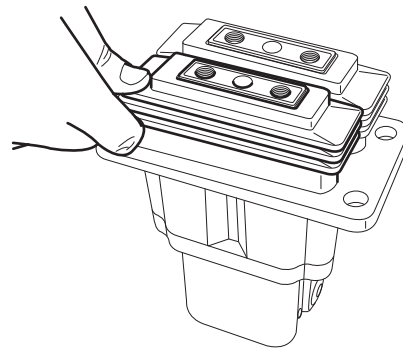


Figure 48

FG013560

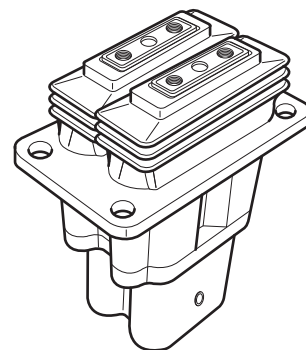


Figure 49

FG013561

TROUBLESHOOTING

At times it may be difficult to pinpoint the source of the problem. The following table lists some of the possible problems, possible causes and remedies. Refer to this table for possible causes and remedies to assist in correcting the sometimes difficult problems.

The table only lists some general problems, possible causes and their remedies. Often the problem is not caused by the failure of a single part but, may be the result of a combination of problems from related parts and their components. Possible problems other than the ones list are not being specified but that is not to say that these are the only possible problems that can occur. The technician must diagnose the problem, considering all possible causes and repair the source of the malfunction.

Problem	Possible Cause	Remedy
Secondary pressure will not increase.	Low primary pressure.	Adjust primary pressure.
	Defective secondary pressure select spring.	Replace with new spring.
	Gap between damper spool and casing is abnormally large.	Replace damper spool casing assembly.
	Defective operating parts and components.	Disassemble/reassemble and replace defective parts.
Unstable secondary pressure.	Jamming of interconnected parts.	Repair/replace cause of jamming.
	Unstable tank line pressure.	Install direct line to hydraulic tank.
	Air in hydraulic lines.	Vent air from system.
Abnormally high secondary pressure.	High tank line pressure.	Install direct line to hydraulic tank.
	Jamming of interconnected parts.	Repair/replace cause of jamming.
No dampening.	Air in piston chamber.	Vent air from system.
	Jamming of interconnected parts.	Repair/replace cause of jamming.
	Worn damper springs.	Replace with new parts.
	Worn damper spool and housing.	Replace damper spool and housing assembly.
	Defective/damaged check valve.	Disassemble and examine check valve.
	Worn damper spool orifice.	Replace damper spool.
Damper spool feels heavy.	Defective interconnected components.	Repair/replace defective parts.
	Restricted movement of damper spool.	Repair/replace damaged piston.

Solenoid Valve

Edition 1

MEMO

Table of Contents

Solenoid Valve

Safety Instructions	5-13-5
General	5-13-5
Specification	5-13-5
Overview	5-13-6
Parts List	5-13-8
Theory of Operation	5-13-9
Disassembly and Reassembly.....	5-13-10
Troubleshooting	5-13-11

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.

GENERAL

Specification

Pressure (Max.)	69 bar (70 kg/cm ² , 996 psi)
Flow (Max.)	23 L/min (6.1 U.S. gal)
Leakage	40 ml/min
Solenoid Coil	
Rated Voltage	DC 24 V
Operation Voltage Range	20 - 30 V
Surge Absorber	Built in
Connector Type	Deutsch DT-02 Series
	Housing Series: DT04-2P-Type molded
	Deutsch Terminals: Pin 1060-16-0122
Test	49 bar at 20 L/min

Overview

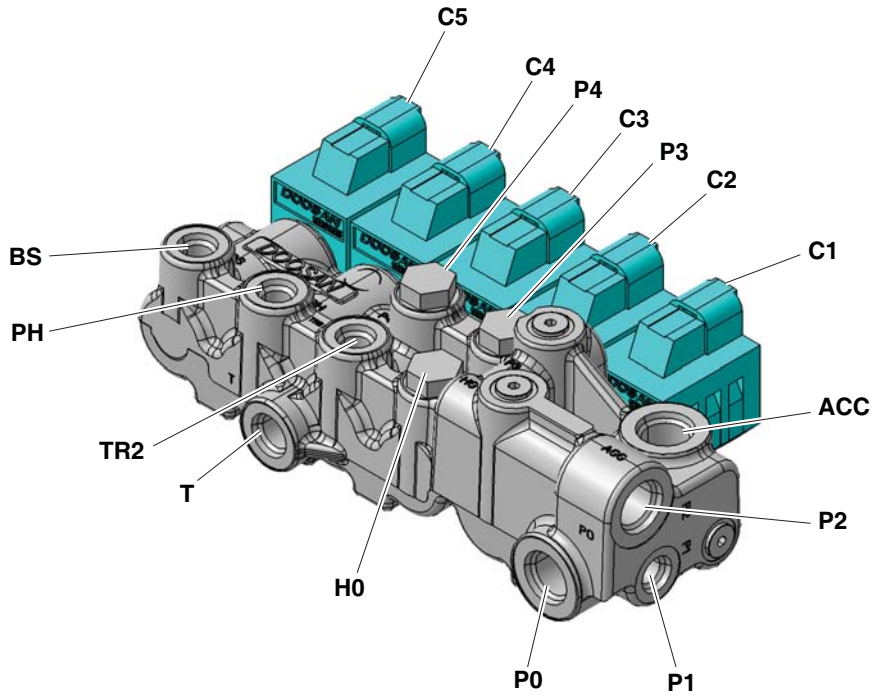


Figure 1

EX1301733

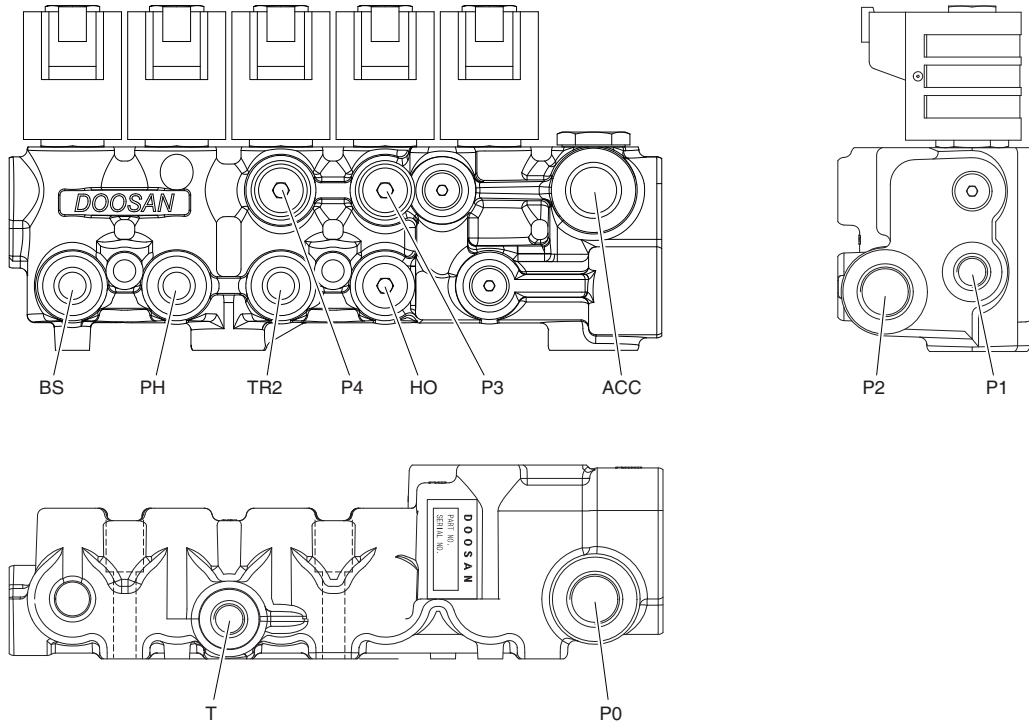


Figure 2

EX1504812

Port

Port	Name	Size
P0	Pilot Inlet	PF 1/2", O-ring
P2	Safety Cut-off	
ACC	Accumulator	
P1	Pilot Pressure	PF 1/4", O-ring
P3	Plugged	
P4	Plugged	
BS	Two Pump Mode Selection	
PH	Pressure Up	
TR2	Travel High/Low Speed	
H0	Breaker Pressure Supply	
T	Drain	PF 3/8", O-ring

Hydraulic Circuit

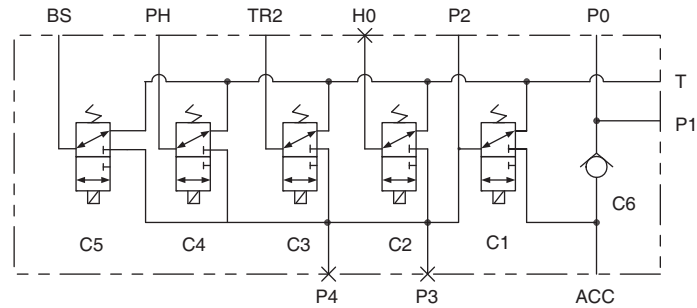
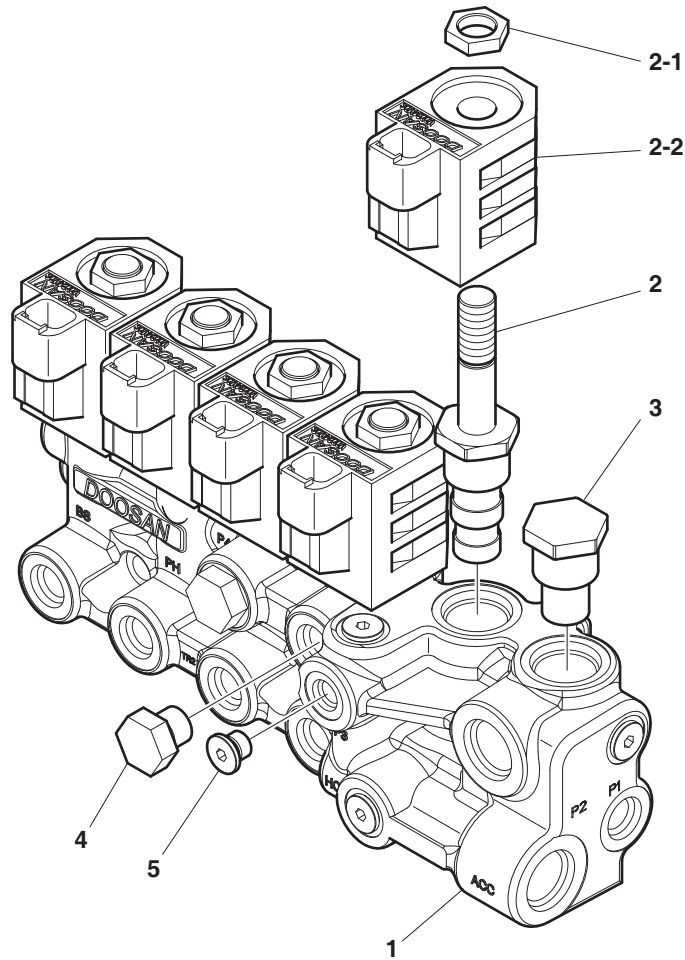


Figure 3

EX1301278

Parts List



EX1301275

Figure 1

Reference Number	Description	Size	Torque (kg.m)	Tool
2	Solenoid Valve	UNF 7/8 - 14"	3.5 ±0.25	Torque Wrench/1", Hex
2-1	Coil Locknut	UNF 1/2 - 20"	0.6	Torque Wrench/19 mm, Hex
2-2	Coil			
3	Check Valve	UNF 7/8 - 14"	3.5 ±0.25	Torque Wrench/1", Hex
4	Plug	PF 1/4	2.5 ±0.25	Torque Wrench/19 mm, Hex
5	Plug	PF 1/8	0.1 ±0.25	Torque Wrench/5 mm, Socket

Theory of Operation

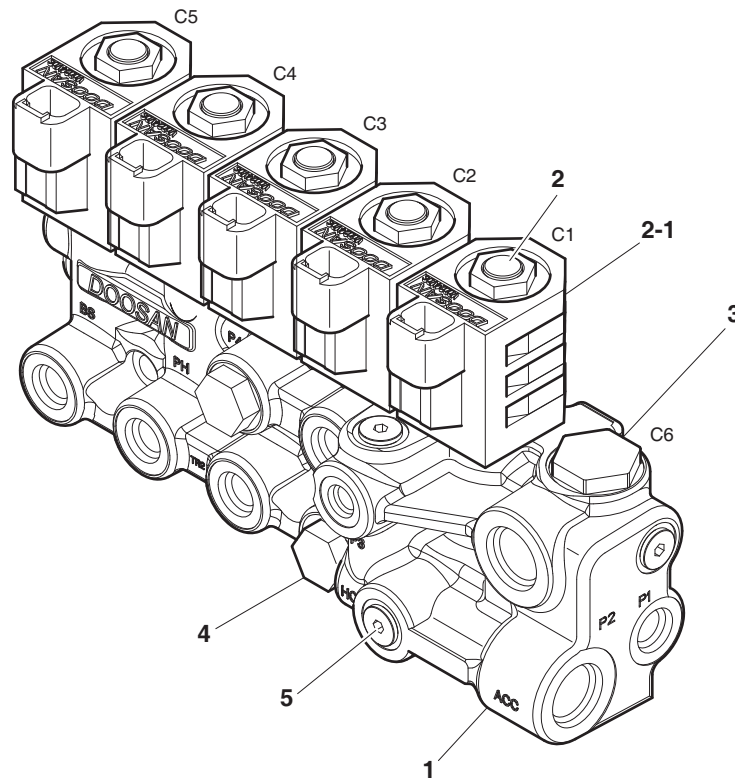


Figure 2

EX1301274

Reference Number	Description	Quantity	Remarks
1	Block Body	1	
2	Solenoid Valve	5	C1 ~ C5
2-1	Coil (Deutsch Type)	5	C1 ~ C5
3	Check Valve	1	C6
4	Plug	3	P3, P4, H0
5	Plug	6	

Reference Number	Function	Operations	Remarks
C1	Pilot Cut-off	Provides pressurized oil coming from the pilot pump for the pilot pressure supply solenoid valve to operate each work system.	
C2	Breaker Pressure Supply	Supplies pilot pressure for the pedal valve assembly and shuttle valve.	Optional
C3	High/Low Travel Speed	Sets low and high travel speed. Shifts speed between both depending on the state of the solenoid valve or a signal detected in the EPOS controller.	
C4	Main Pressure (Power Boost) Increase	Temporarily increases the pressure setting of the main relief valve, to increase the excavation power.	
C5	Two-pump Mode Selection	Supplies pilot pressure to two-pump valve that controls the two-pump function so it ready to work in the two-pump mode during breaker/shear mode.	

DISASSEMBLY AND REASSEMBLY

1. Choose a work area for disassembly.
NOTE: (1) *Choose a clean work area.*
(2) *Use a rubber mat or other protective covering on the workbench area to prevent damage or scratching of any precision machined components.*
2. For disassembly and reassembly, use torques and tools listed in tables.
3. The directions of disassembly and reassembly are same as the "Disassembly Direction" and "Reassembly Direction" as shown in Figure 1.
4. Disassembly and reassembly of the solenoid valve
 - A. Remove coil locknut (2-1) from solenoid valve (2).

IMPORTANT

Take care not to damage the solenoid valve (2) when removing the coil locknut.

If the solenoid valve (2) is damaged (bent or deformed), the solenoid valve may not operate.

- B. Remove coil (2-2) by hand.
- C. Remove solenoid valve (2).
- D. Check disassembled components for damage, and reassemble them in the reverse order of the disassembly.
- E. Do not use excessive torque when assembling the solenoid valve and coil.

IMPORTANT

Excessive torque can damage the solenoid valve.

5. Do not allow any contamination to enter the valve during disassembly and reassembly procedures.
6. Every component must be washed out before reassembly.

TROUBLESHOOTING

Symptoms	Causes	How to Check	Solutions
Malfunction of solenoid valve	Foreign substance, dirt and dust in solenoid valve.	Disassemble the solenoid valve and check if there is any contamination such as a foreign substance and sludge between the case and the spool.	Remove contaminant, wash, and assemble components.
	Tube or retainer of solenoid valve damaged.	Disassemble the solenoid valve and check if there is any deformation (bending or reduction) in the tube or the retainer.	Replace solenoid valve.
	Coil broken, short, or burned.	Disassemble the solenoid valve and check the coil resistance. Spec: 26.7Ω @ 20°C Disconnection: ∞ Short: Low or excessive resistance Disassemble the solenoid valve and check the outside of the coil to see if its casing is burned and melted.	Replace coil.
	Connector terminal ground defect.	Check if the connector (valve side) and housing (where harness is attached) are grounded properly.	Replace coil or housing.
Pilot pressure fails to generate;	Pilot pressure.	Remove plug of the "P5" port, install a pressure gauge, and check the pilot pressure discharged from the pilot pump when operating the pilot cut-off valve (C1).	Refer to "Causes" and "How to Check" of the solenoid valve above.
	Pilot relief valve.	Check if the relief valve installed in the pilot line operates properly. • Check if pressure is bypassing because of the presence of foreign substance.	Remove foreign substance, reassemble, and replace the relief valve.
	Pilot pump.	Check if the pilot pump works properly.	Replace the pilot pump.
Poor Actuator Performance	Pilot system.	Check any defect of the pilot system considering findings from "Pilot pressure fails to generate;" category.	Repair defect(s) accordingly.
	Solenoid valve.	Install a pressure gauge at each outlet port of the solenoid valve (H0, TR2, PH, and BS ports) and check the pressure value discharged from the pilot pump when operating the solenoid valve.	Refer to "Causes" and "How to Check" of the solenoid valve above.
	Main control valve.	Check if main control valve of each component works properly.	Repair according to findings.
	Other components.	Check if each component works properly.	Repair according to findings.

Accumulator

Edition 1

MEMO

Table of Contents

Accumulator

Safety Instructions	5-14-5
General	5-14-5
Specifications	5-14-7

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.

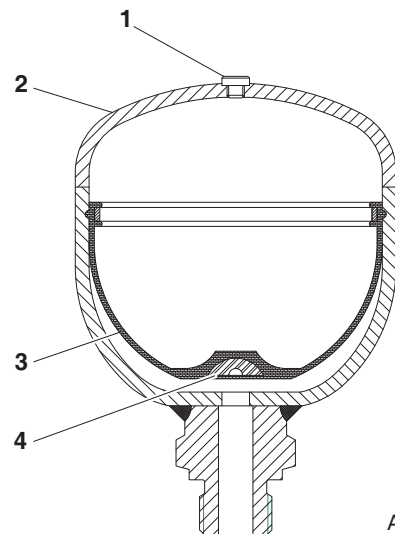
GENERAL

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	Screw Plug
2	Steel Pressure Vessel
3	Diaphragm
4	Fluid Valve

Accumulators are solidly constructed to resist the high operating pressures of the fluids they contain. There are only three main moving parts: a plug at the top allows precharging 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.



ARS1790L

Figure 1

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 port 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 must be stamped or marked on the accumulator's rating plate. Annual checks of actual precharge pressure must 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 counterpressure from system oil - the valve button on the bottom of the diaphragm eventually seals off 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 "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.

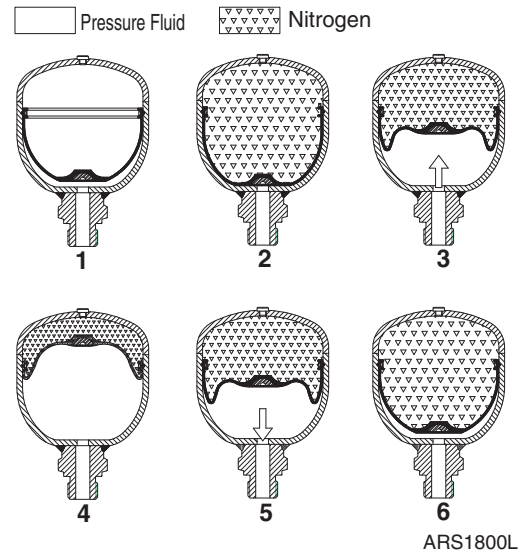


Figure 2

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
Pilot	9.8 bar (10 kg/cm ² , 142 psi)	320 cc (19.53 in ³)

Gear Pump (Rotation)

Edition 1

MEMO

Table of Contents

Gear Pump (Rotation)

Safety Instructions	5-15-5
General	5-15-5
Specification	5-15-5
Overview	5-15-6
Location	5-15-6
Single Gear Pump	5-15-7
Disassembly	5-15-7
Reassembly	5-15-9

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

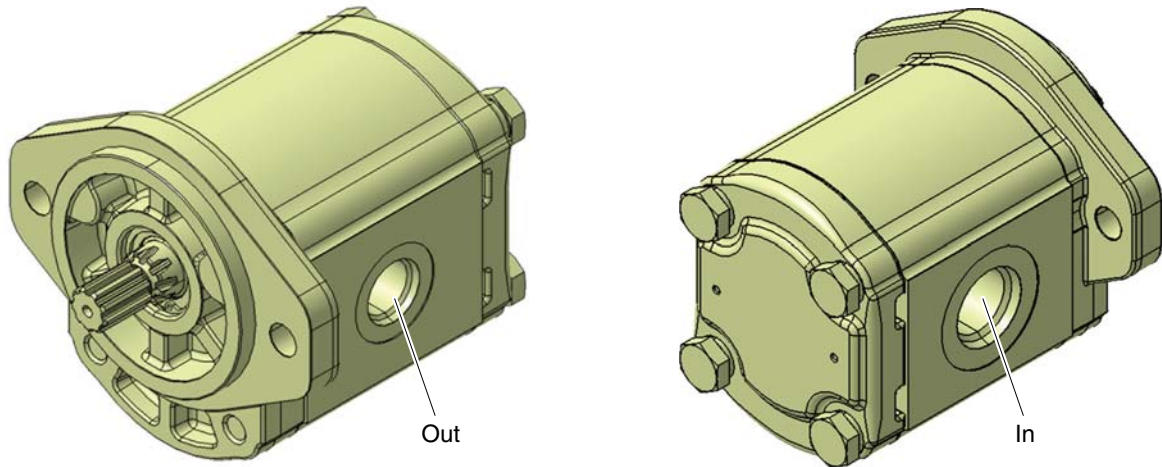
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

GENERAL

Specification

Direction of Rotation (Looking on Driveshaft)	Clockwise
Displacement	21.39 cm ³ /rev
Inlet Pressure Range for Pump	0.7 ~ 3 bar (0.7 ~ 3 kg/cm ² , 10.1 ~ 43.5 psi)
Max. Continuous Pressure	200 bar (204 kg/cm ² , 2,900 psi)
Max. Intermittent Pressure	220 bar (224 kg/cm ² , 3,190 psi)
Max. Peak Pressure	240 bar (244 kg/cm ² , 3,480 psi)
Weight	2.74 kg (6.04 lb)

Overview

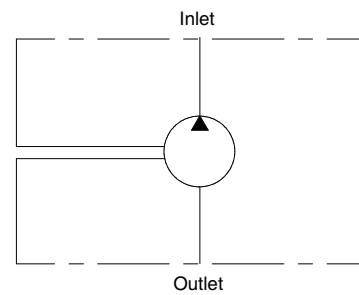


EX1301735

Figure 1

Port and Hydraulic Circuit

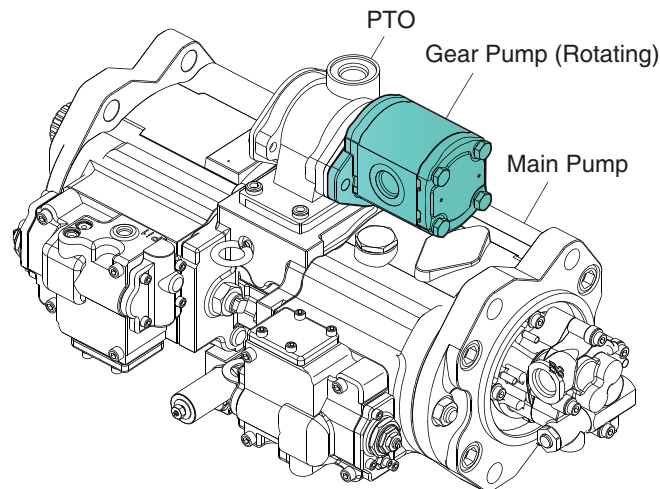
Port	Name	Size
In	Hydraulic Oil Inlet	PF 3/4 O-ring
Out	Hydraulic Oil Outlet	PF 1/2 O-ring



EX1301736

Figure 2

Location



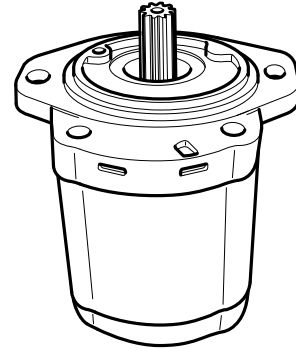
EX1504813

Figure 3

SINGLE GEAR PUMP

Disassembly

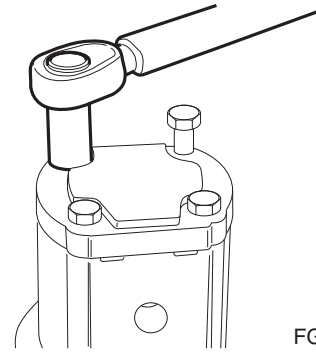
1. Clean exterior of pump.



FG001072

Figure 4

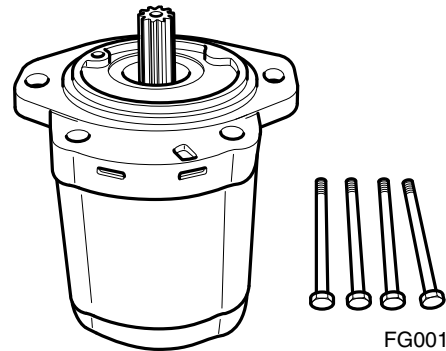
2. Remove clamp bolts.



FG001074

Figure 5

3. Cover sharp edges of driveshaft with adhesive tape and coat shaft end extension with clean grease, to avoid any damage to lip of shaft seal when removing mounting flange.



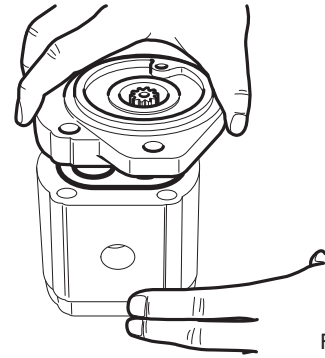
FG001073

Figure 6

4. Remove mounting flange taking care to keep flange as straight as possible during removal.

If mounting flange is stuck, tap around edge with rubber mallet to break it away from body.

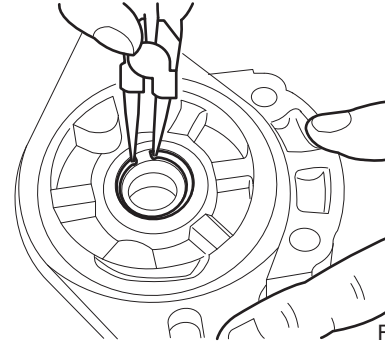
NOTE: *Make sure that while removing mounting flange, shaft and other components remain in position.*



FG001075

Figure 7

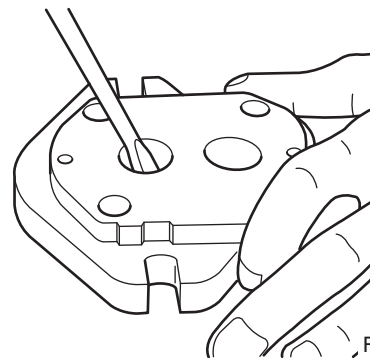
5. Remove retaining ring, if replacement is necessary.



FG000834

Figure 8

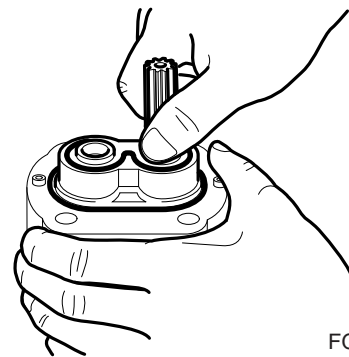
6. Remove shaft seal taking care not to damage surface of shaft hole, if replacement is necessary.



FG000835

Figure 9

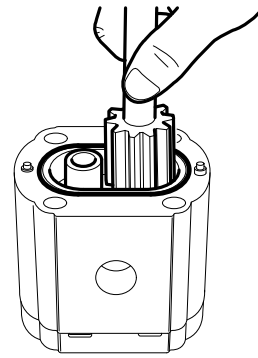
7. Pull drive gear up to facilitate removal of front plate.



FG001076

Figure 10

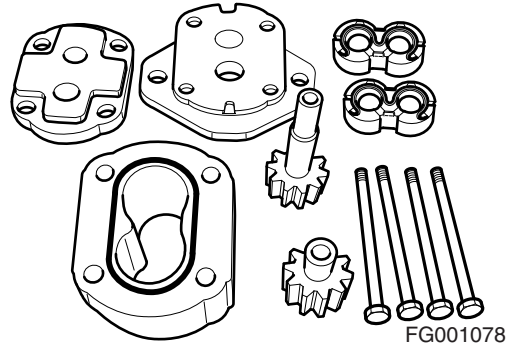
- Remove driving gear and driven gear, keeping gears as straight as possible.



FG001077

Figure 11

- Remove rear plate and end cover.

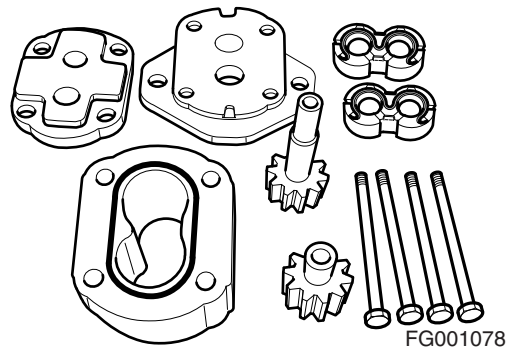


FG001078

Figure 12

Reassembly

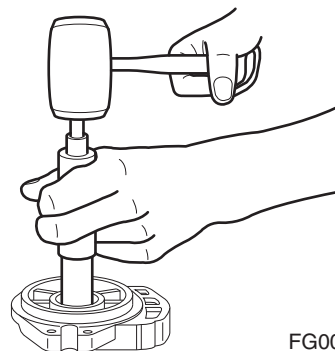
- Clean all components with care.



FG001078

Figure 13

- Using a suitable driver, install shaft seal in mounting flange.



FG000839

Figure 14

3. Install retaining ring in groove.

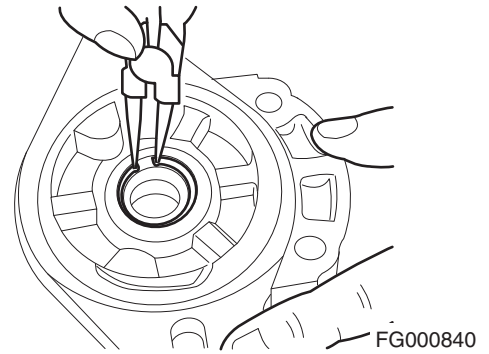


Figure 15

4. Install O-ring on both sides of rear section of body.

NOTE: *Coat O-rings with grease to hold O-rings in body.*

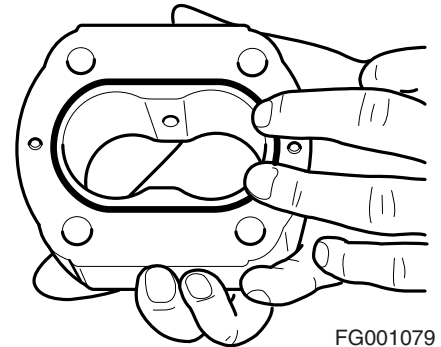


Figure 16

5. Install rear section body on rear cover.

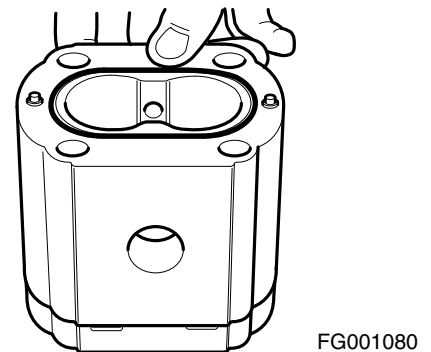


Figure 17

6. Install seals in pressure plate (s) groove. Then install backup ring in groove with seals. Coat seals with grease.

NOTE: *The front and rear pressure plates and seals and backup rings are the same.*

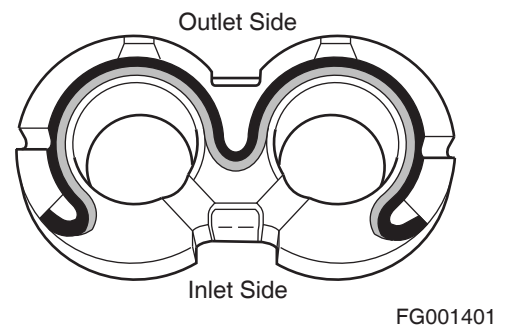
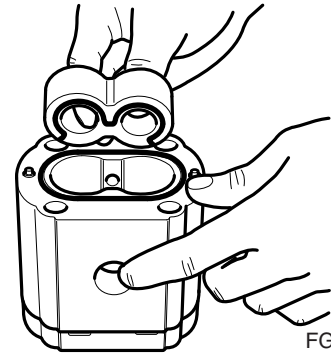


Figure 18

7. Insert pressure plate assembly into body while keeping it straight.

NOTE: Seal side should face to rear cover, opposite side of gears.

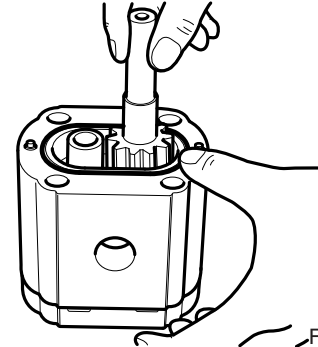
NOTE: Pay attention to installation direction of seal.



FG001081

Figure 19

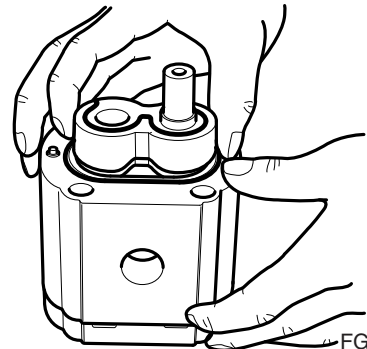
8. Install drive gear and driven gear.



FG001082

Figure 20

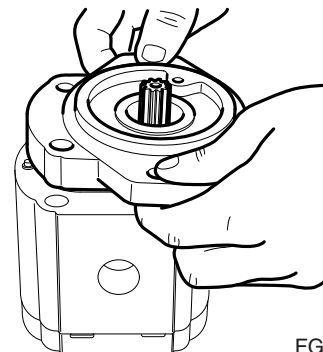
9. Insert pressure plate into body in proper direction.



FG001083

Figure 21

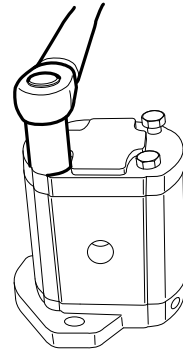
10. Locate mounting flange in right position.



FG001084

Figure 22

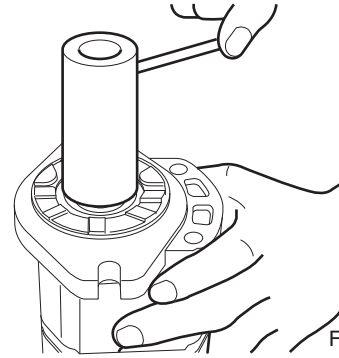
11. Tighten bolts with washer in a crisscross pattern to a torque value of 45 N.m (4.59 kg.m, 33.2 ft lb).



FG001085

Figure 23

12. Check that pump rotates freely when driveshaft is turned by hand. If not a pressure plate seal may be pinched.



FG000851

Figure 24

One Spool Valve (Rotating)

Edition 1

MEMO

Table of Contents

One Spool Valve (Rotating)

Safety Instructions	5-16-5
General	5-16-5
Specification	5-16-5
Overview	5-16-6
Theory of Operation	5-16-7
Disassembly and Assembly	5-16-9
General Cautions	5-16-9
Replacement of Spool	5-16-10
Replacement of Main Relief Valve	5-16-12
Replacement of Overload Relief Valve	5-16-13
Replacement of Sub-Block	5-16-15

MEMO

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

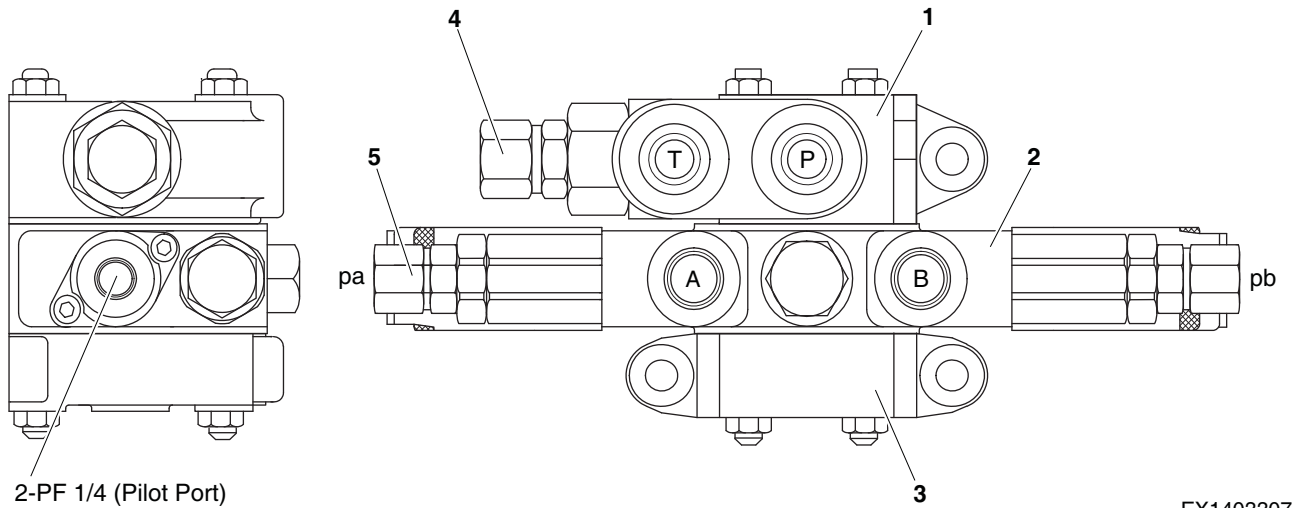
Instructions are necessary before operating or servicing machine. Read and understand the Operation and Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs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

GENERAL

Specification

Rated Pressure	83 bar (85 kg/cm ² , 1,209 psi)
Rated Flow	50 L/min (13 U.S. gal)
Internal Leakage	100 cc/min at 68 bar (69 kg/cm ² , 986 psi)
Main Relief Pressure Setting	78 bar (80 kg/cm ² , 1,131 psi)
Overload Relief Pressure Setting	98 bar (100 kg/cm ² , 1,421 psi)

Overview



EX1403307

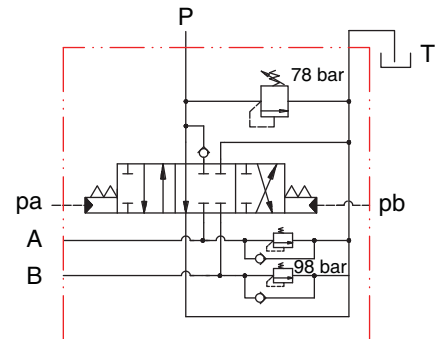
Figure 1

Reference Number	Description
1	Inlet Block
2	Work Block
3	T Block

Reference Number	Description
4	Main Relief Valve
5	Overload Relief Valve

Port and Hydraulic Circuit

Port	Name	Size
P	Pressure Input	PF 1/2
T	Drain	
A	Attach Pressure In/Out	PF 3/8
B	Attach Pressure In/Out	
Pa	Pilot Pressure	PF 1/4
Pb	Pilot Pressure	



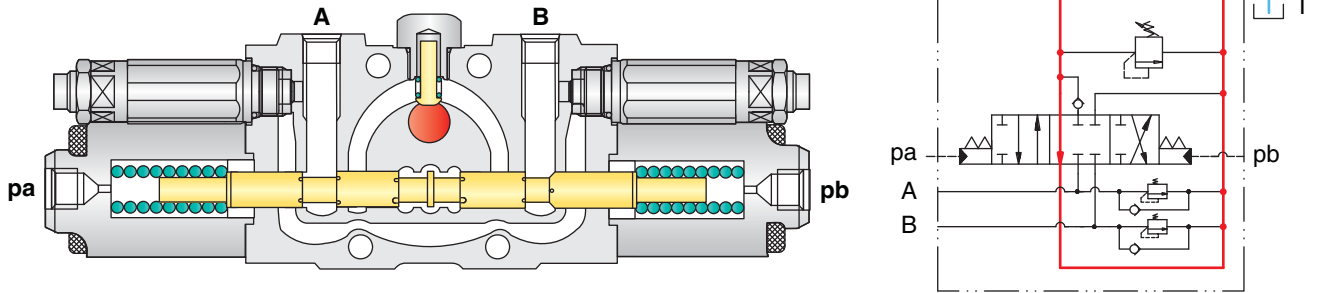
EX1403308

Figure 2

Theory of Operation

In the Neutral Condition

The hydraulic oil, supplied to the P port under the neutral condition, is to be flowed out to the tank passage through the "One Spool Valve".



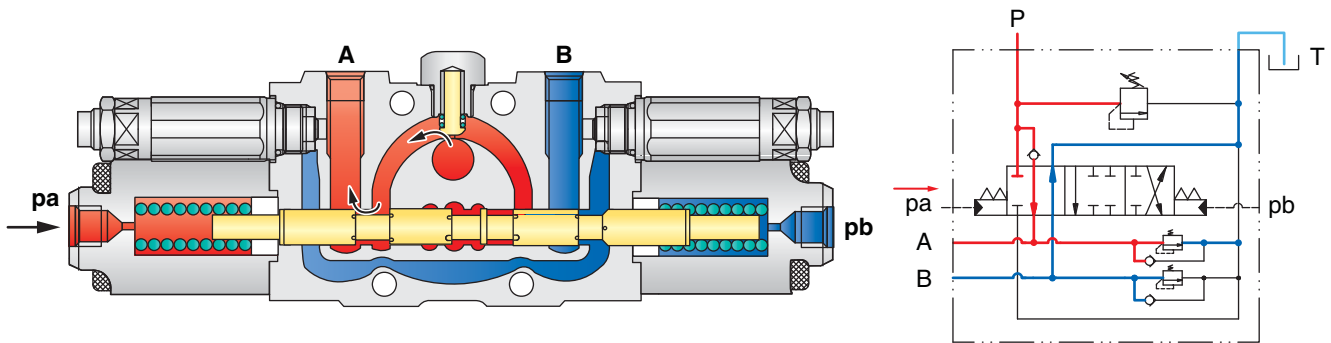
EX1403309

Figure 3

Spool Operation

1. When Pilot Pressure "Pa" is impressed

When pilot pressure is impressed at the "Pa" port, the pressured oil flowed from the P port is to be discharged to the A port through the load check poppet and the spool, as the hydraulic oil passage for bypass is blocked.



EX1403310

Figure 4

2. When Pilot Pressure "Pb" is impressed

When pilot pressure is impressed at the "Pb" port, the pressured oil flowed from the P port is to be discharged to the B port through the load check poppet and the spool, as the hydraulic oil passage for bypass is blocked.

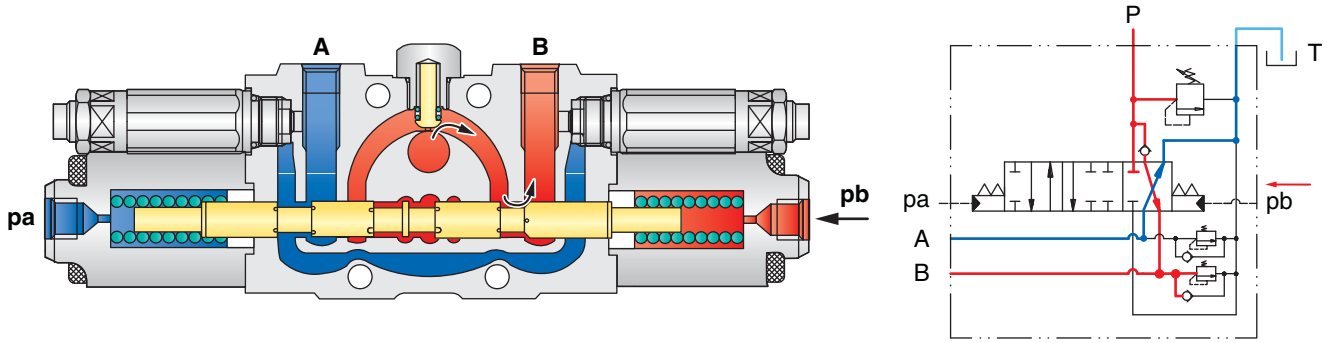


Figure 5

EX1403311

DISASSEMBLY AND ASSEMBLY

General Cautions

It is the principle that disassembly and assembly of this valve should be carried out by the manufacturer. In case disassembly and assembly is inevitably required elsewhere, the following cautions must be observed.

1. This valve is precisely processed and the gaps among each part are extremely tiny. This, disassembly and assembly should be performed very carefully so that any foreign material such as dust or sand can not intrude into the valve.
2. For disassembly, a technician should start disassembly after fully understanding the structure of the valve with structural drawings and reference drawings.
3. When the valve needs to be removed from a machine, be sure to put caps on each port and to wash the exterior of the assembly after checking the caps on each port again before assembling.
4. In case the disassembled parts need to be placed unassembled for a while, they must be treated with rust prevent oil and sealed to prevent rusting.
5. Do not hold a pilot cap, a relief valve and a overload relief valve when this valve needs to be moved.
6. Even in case disassembly and assembly is not performed smoothly, do not hit or treat any part of the product roughly.
7. After disassembly, attach ID tags to each part for accurate assembly.
8. For O-rings and back up-rings, it is the principle to use the new ones. And be sure not to damage one during assembly. (Apply a small portion of grease on the parts for smooth assembly.)
9. Fasten bolts, overload relief valves and main relief valves with the specified standard torque.
10. As various tests (relief characteristics test, leakage test, operational test, etc.) are essential after disassembly and assembly, do not disassemble this valve if those tests are not available.
11. Be careful not to damage the O-ring contacting parts of this valve for preventing oil leakage.
12. Be cautious about safety during operation as this valve assembly is heavy.

Replacement of Spool

 **CAUTION**

AVOID INJURY

For replacement of a spool, it must be replaced with a sub-assembly of spool.

 **CAUTION**

AVOID INJURY

During assembly operation of a spool sub-assembly, be careful so that a foreign material can not intrude into the sub-assembly.

1. Removing Pilot Cap

Unfasten the two bolts for the pilot cap with a L-wrench (5mm) and remove the cap along with the washer. (You can remove either of them.)

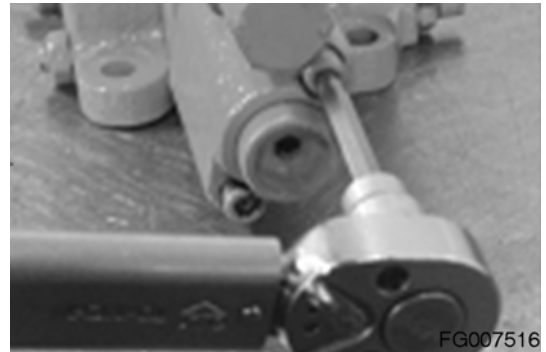


Figure 6



Figure 7

2. Removing Spool

After fixing the main body and removing the return spring and the spring seat first, pull the spool in the horizontal direction (parallel to the spool hole) to remove it from the main body.

Too much impressed force for disassembly may damage the spool. When the spool is stuck, therefore, push it back smoothly and try to pull the spool while rotating it.

While removing the spool, check which end has the mark.



Figure 8

3. Assembling Spool

Insert the spool into the fixed main body. (Overloaded force may damage the main body or the spool. When the spool is stuck, pull it back and press it smoothly while rotating it.)

Check the direction of the mark, identified during the disassembly operation.

Assemble the spring seat and the spring.



Figure 9



Figure 10

4. Assembling Pilot Cap (on Return Spring Side)

Cover the pilot cap on the return spring of the spool, previously assembled to the main body, and fasten it with two bolts at the specified standard torque using a torque wrench (5mm). Check if there is the O-ring on the contacting surface.

- Torque: 10.8 N.m (1.1 kg.m, 8 ft lb)

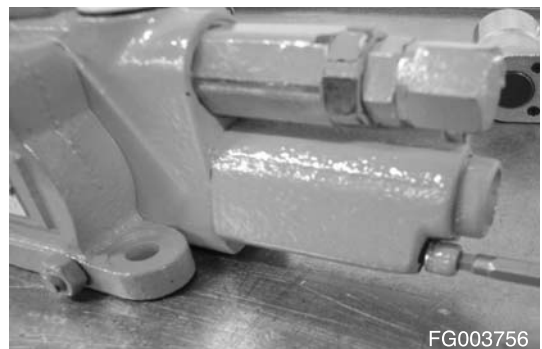


Figure 11

Replacement of Main Relief Valve

CAUTION

AVOID INJURY

Be careful not to damage the seat of the removed main relief valve.

CAUTION

AVOID INJURY

As the main relief valve is a very important part, related to performance and safety, and hard to be set for the pressure again, be sure to replace it with an assembly if needed, not disassembling it.

CAUTION

AVOID INJURY

During assembly of a main relief valve, be careful so that a foreign material cannot intrude into the main frame.

1. Removing Main Relief Valve

Fix the main body and remove the main relief valve by unfastening the hexagon bolt with a spanner (3 0mm). The spanner should hold the bolt as deeply as possible.



Figure 12



Figure 13

2. Assembling Main Relief Valve

Fasten the main relief valve to the main body at the specified standard torque using a torque wrench (30mm). Check if there is the O-ring on the contacting surface.

- Torque: 58.8 N.m (6 kg.m, 43.4 ft lb)

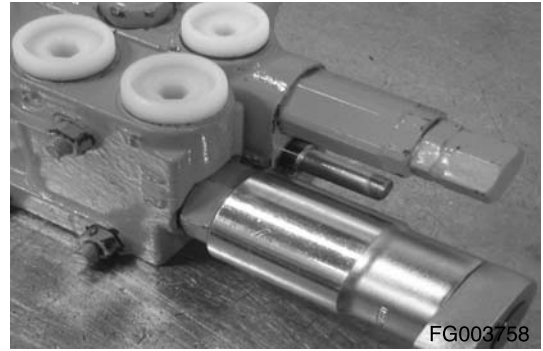


Figure 14

Replacement of Overload Relief Valve

CAUTION

AVOID INJURY

As the removed overload relief valves may have different setting values for each position, identify them for the original position with tags for accurate assembly.

CAUTION

AVOID INJURY

As the overload relief valve is a precision part, be cautious about damage or intrusion of foreign materials.

CAUTION

AVOID INJURY

As the overload relief valve is a very important part, related to performance and safety, and hard to be set for the pressure again, be sure to replace it with an assembly if needed, not disassembling it.

CAUTION

AVOID INJURY

During disassembly of a overload relief valve, be careful not to damage the return cap by the spanner.

1. Removing Overload Relief Valve

Fix the main body and remove the overload relief valve by unfastening the hexagon bolt with a spanner (22mm). The spanner should hold the bolt as deeply as possible.



Figure 15

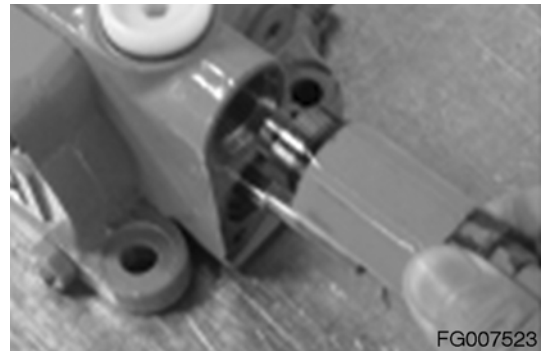


Figure 16

2. Assembling Overload Relief Valve

Fasten the overload relief valve to the main frame at the specified standard torque using a torque wrench (22mm). Check if there is the O-ring on the contacting surface.

- Torque: 39.2 N.m (4 kg.m, 28.9 ft lb)

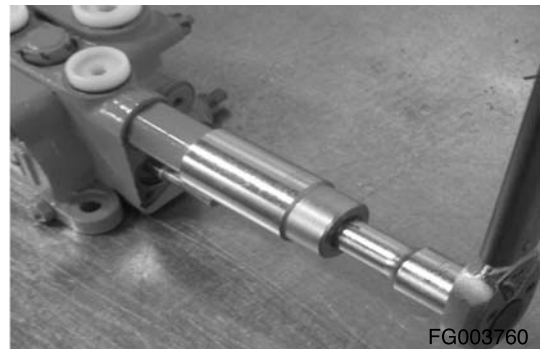


Figure 17

Replacement of Sub-Block



CAUTION

AVOID INJURY

During assembly of the sub-block assembly, be careful so that a foreign material cannot intrude into the main body.

1. Installation of Surface Plate

Install a surface plate on a workbench for replacement of the sub block assembly.



Figure 18

2. Removing Sub-Block Assembly

Place the main frame on the surface plate, installed on the workbench.

Remove the assembly by unfastening the four nuts, fixing it, with a spanner or a hexagon wrench (13 mm).



Figure 19

3. Replacing Block Assembly

Replace the faulty assembly with a new one and assemble the new one in order.

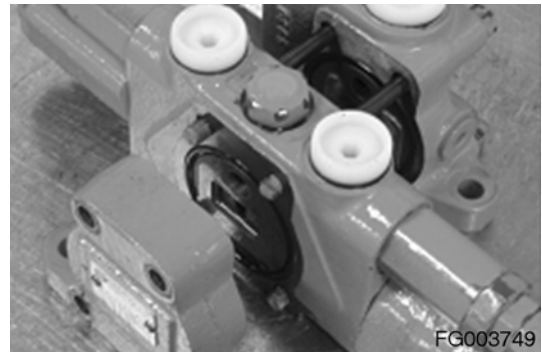


Figure 20

4. Assembling Nuts

Arrange the main frame and fasten the four nuts at the specified standard torque with a torque wrench (13 mm).

Before completely fastening the nuts, check if each sub-lock is properly arranged based on the surface plate.

- Torque: 20.1 N.m (2.05 kg.m, 14.8 ft lb)

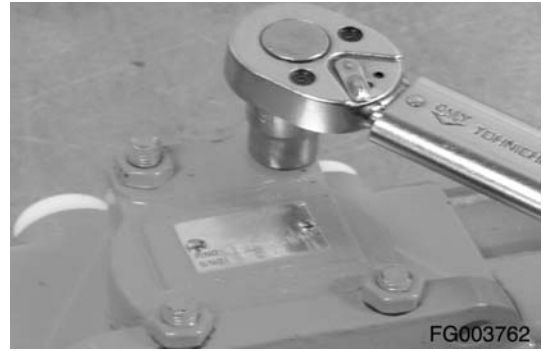


Figure 21

Lower Structure and Chassis

Swing Bearing

Edition 1

MEMO

Table of Contents

Swing Bearing

Safety Instructions	6-1-5
General	6-1-6
General Description	6-1-6
Parts List	6-1-6
Maintenance Guidelines	6-1-7
Disassembly	6-1-8
Reassembly	6-1-10

SAFETY INSTRUCTIONS



WARNING

AVOID DEATH OR SERIOUS INJURY

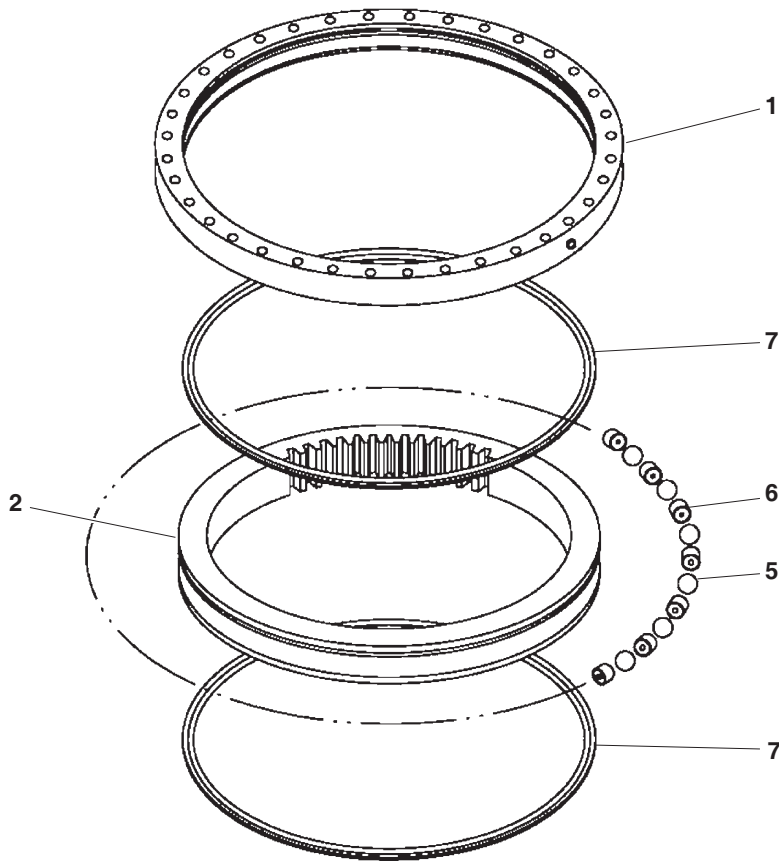
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

GENERAL

General Description

The swing bearing, which connects the upper structure with the lower structure, consists of a inner ring, outer ring and ball bearings. During swing movement, power from the swing motor is transferred to the pinion by planetary gears connected to gears on the inner ring, which is fixed in the undercarriage. Ball bearings turn the outer ring.

Parts List



FG1301305

Figure 1

Reference Number	Description
1	Outer Ring
2	Inner Ring
3	Tapered Pin
4	Plug

Reference Number	Description
5	Ball
6	Retainer
7	Seal

MAINTENANCE GUIDELINES

Operating Recommendation

The service life of the swing bearing may be extended if a daily effort is made to equalize usage over both ends of the excavator. If the excavator is used in the same operating configuration day in and day out (for example, with the travel motors always under the counterweight, or with the attachment over one side of the machine more than the other), the bearing's service life could be reduced. Repositioning the excavator during the work shift, to work the opposite end of the bearing, will provide a more even and gradual rate of wear and extended service life.

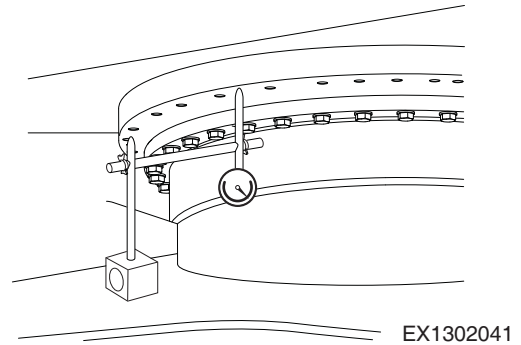


Figure 2

Measuring Swing Bearing Axial Play

Regular checks of bearing displacement must be made at least twice a year. Use a dial indicator. With the arm cylinders fully retracted and the bucket cylinders fully extended, position the arm tip pin height is flush with the boom foot pin height. (Figure 3)

Push the attachment against the ground to lift up the excavator above the ground and take measurements at 4 points, 90° apart, around the circumference of the bearing.

Record and keep all measurements. Play in the bearing should increase minimally from one inspection to the next.

Eventually, however, as the bearing begins to approach the limit of its service life, clearance increases become much more pronounced and the actual measured play in the bearing could exceed twice the value that was measured when the machine was new.

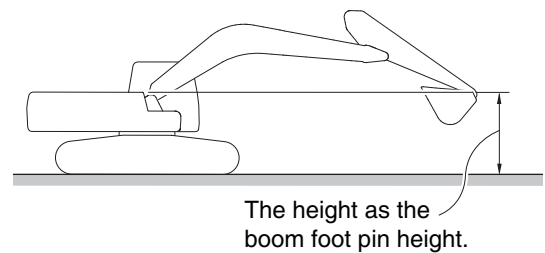


Figure 3 Measurement (h1)

Measuring Bearing Lateral Play

When vertical checks are made, the side to side play in the bearing can be checked by fully retracting the arm and bucket cylinders and extending the tip of the bucket as far forward as it will go. With the excavator parked on a flat, level surface and the bucket tip just off the ground, push against the bucket sideways to take up all the lateral clearance in the bearing. (Less than 100 lb of force must be required to move the bucket over all the way.) Check lateral play in both directions and record the values. When the bearing is beginning to approach the end of its service life, the measured lateral clearance should start to show increase in value.

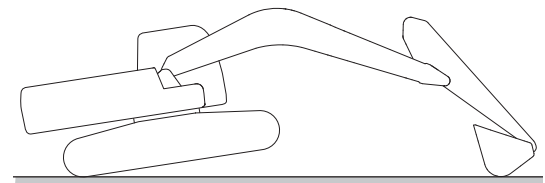
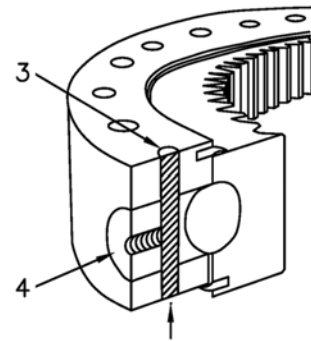


Figure 4 Measurement (h2)

DISASSEMBLY

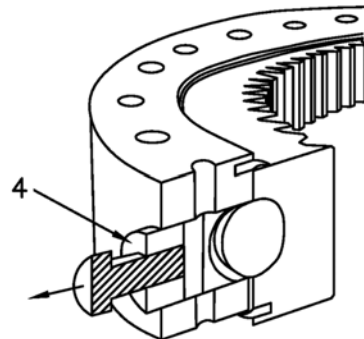
1. Remove tip of tapered pin (3, Figure 5) using grinder and tap lightly to remove debris.



FG003884

Figure 5

2. Remove plug (4, Figure 6) using a M10 x P 1.5 bolt.

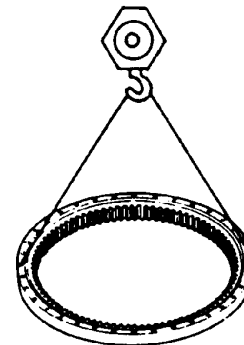


FG003885

Figure 6

3. Lift outer ring and check that inner ring can move freely. See Figure 7, if not, replace seal (7, Figure 8).

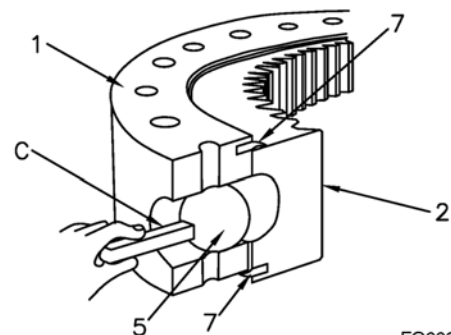
- Weight: 419 kg (924 lb)



1588A

Figure 7

4. Turn inner ring and use magnet bar (C, Figure 8) to remove steel balls (5).



FG003886

Figure 8

5. Turn inner ring and use wire (D, Figure 9) to remove retainers (6).

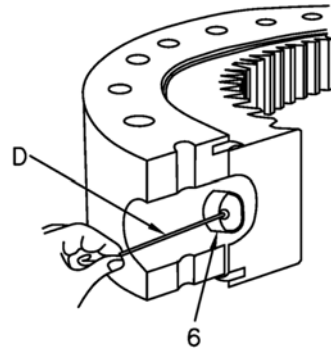


Figure 9

FG003908

REASSEMBLY

1. Clean (degrease) the seal groove for the outer and inner seals (7).

Apply instant glue to seal (7).

Install both seals respectively into position.

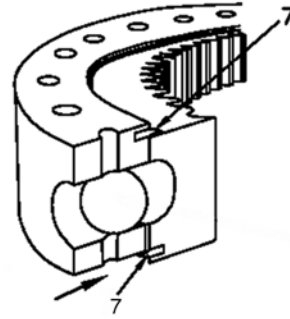


Figure 10

FG005123

2. Hoist the outer race by crane horizontally and match it with the inner race coaxially.

Rotating the outer race, insert balls (5), support (6) into the plug (4) hole one by one with a round bar.

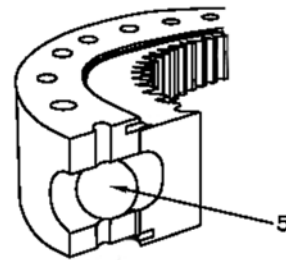


Figure 11

FG005225

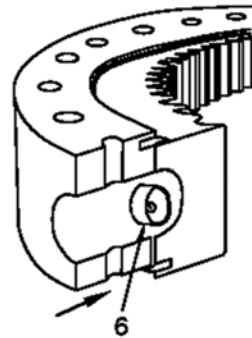


Figure 12

FG005124

3. Top plug (4) into outer race (1) and then, drive pin (3) into the pinhole.

Caulk the head of pin (3) with a punch.

Fill grease through the grease fitting.

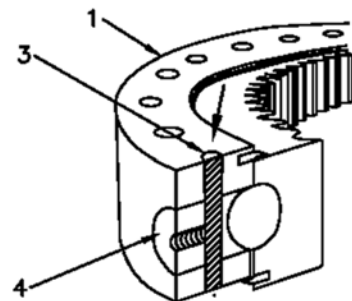


Figure 13

FG005125

Center Joint

Edition 1

MEMO

Table of Contents

Center Joint

Safety Instructions	6-2-5
General	6-2-5
General Description	6-2-5
Overview	6-2-6
Section View	6-2-7
Removal	6-2-8
Installation	6-2-14
Completing Work	6-2-14
Disassembly	6-2-15
Reassembly	6-2-18
Troubleshooting, Testing and Adjustment	6-2-20
Inspection	6-2-20
Testing	6-2-20

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.

GENERAL

General Description

The center joint is designed to allow hydraulic oil from the upper structure to flow to components in the lower structure.

It is capable of allowing continuous 360° rotation of the upper structure in relationship to the lower structure.

Overview

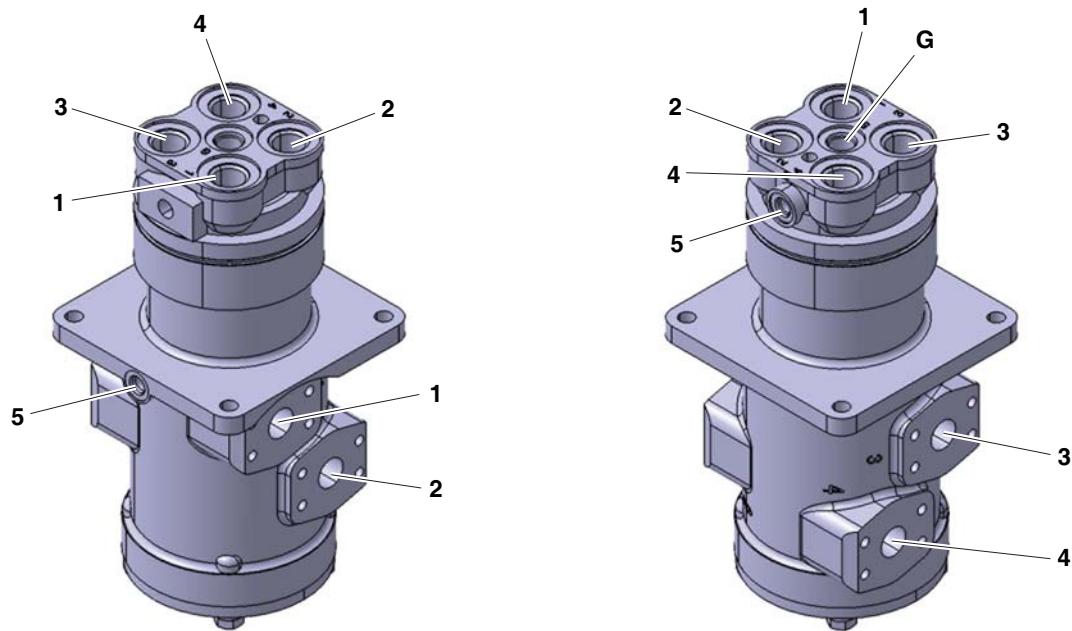
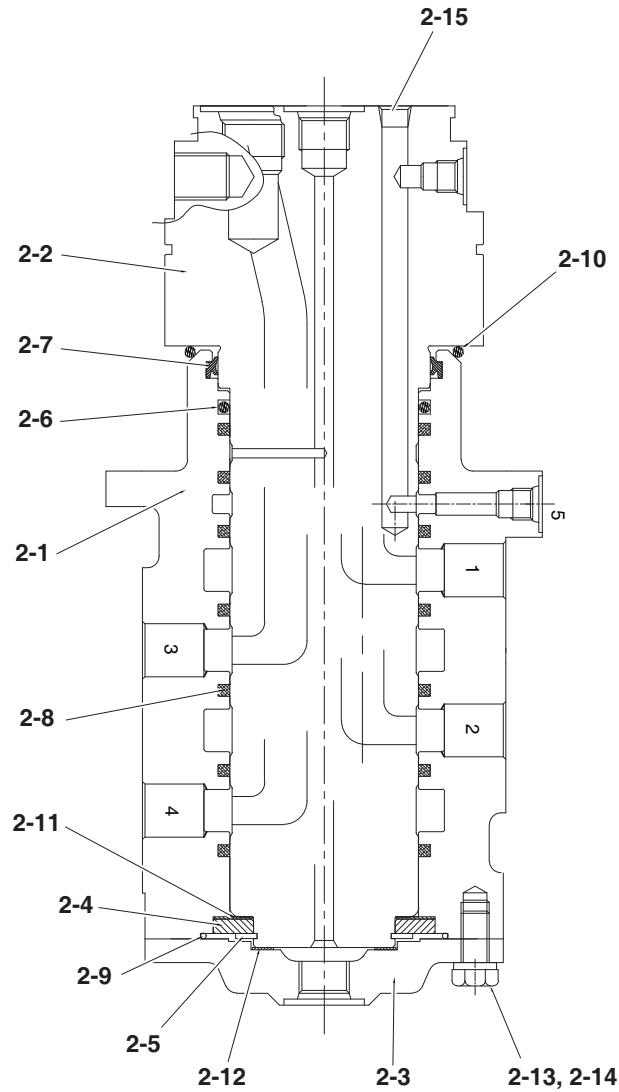


Figure 1

EX1301734

Port	Name	Size	
		Body	Spindle
1, 2	Traveling Right	SAE 1"	PF 3/4 O-ring
3, 4	Traveling Left	SAE 1"	PF 3/4 O-ring
5	Pilot	PF 1/4 O-ring	
G	Drain	PF 1/4 O-ring	

SECTION VIEW



EX1301738

Figure 2

Reference Number	Description
2-1	Hub
2-2	Spindle
2-3	Cover
2-4	Spacer
2-5	Retainer Ring
2-6	O-ring
2-7	Dust Seal
2-8	Slipper Seal

Reference Number	Description
2-9	O-ring
2-10	O-ring
2-11	Shim
2-12	Shim
2-13	Bolt
2-14	Spring Washer
2-15	Plug

REMOVAL



WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
 - If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.
-
-



WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

Hydraulic fluid is highly flammable.

- Keep open flames and ignition sources away from the workplace.
-
-

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Park on firm and level ground.
2. Lower front attachment (bucket) to ground. (Figure 4)
3. Stop engine.

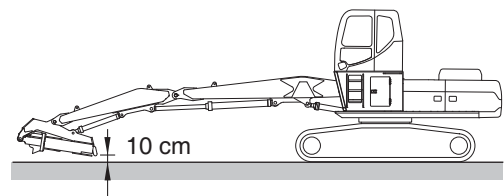


Figure 3

EX1505045

4. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 5)
5. Turn starter switch to "I" (ON) position.



WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

6. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
7. Move safety lever to "LOCK" position. (Figure 5)
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Attach a maintenance warning tag on controls.
10. Turn battery disconnect switch to "OFF" position. (Figure 6)

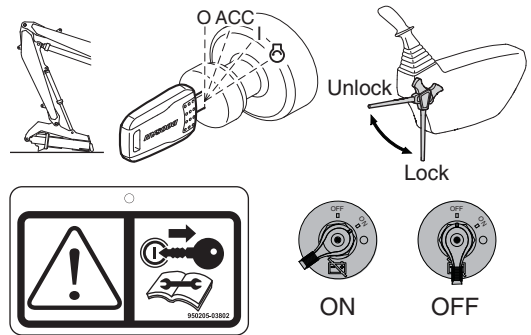


Figure 4

EX1504829

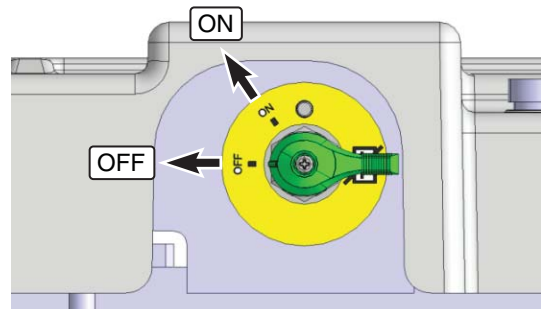


Figure 5

EX1504925

NOTE: Removal (installation) procedure of the bolts.

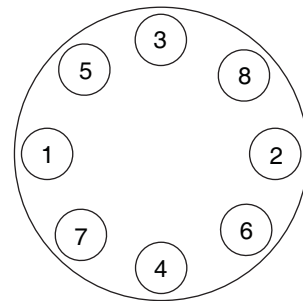


Figure 6


EX1401809



WARNING

AVOID DEATH OR SERIOUS INJURY

Release any pressure in the hydraulic oil tank before doing any work.

11. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank. Pulling the air breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.
12. Remove bolts (1, Figure 9) (6 ea) with under covers (2 ea) from frame.
 - Tool: 24 mm ()
 - Torque: 264.8 N.m (27 kg.m, 195.3 ft lb)
 - Under cover (1 ea) weight: about 30 kg (66.1 lb)
13. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.

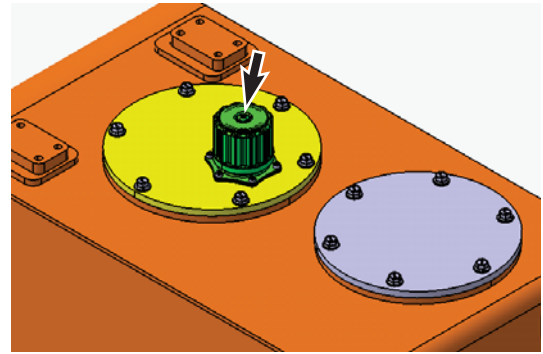


Figure 7

EX1403168

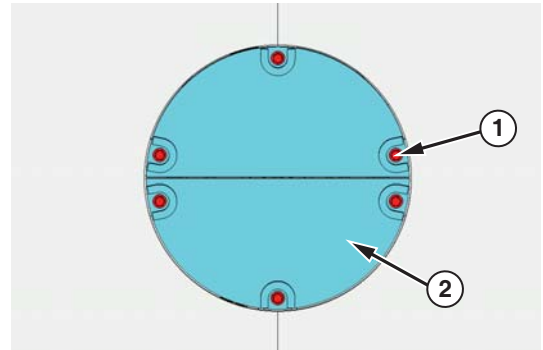


Figure 8 Bottom of Track Frame

EX1505046



Figure 9

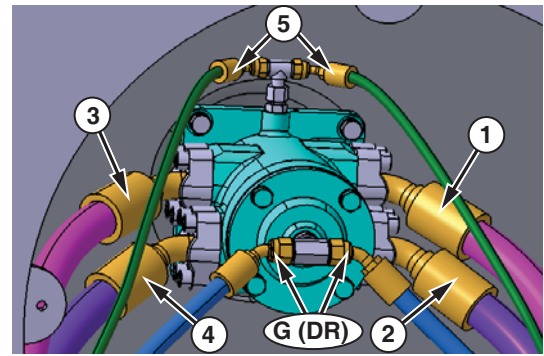
EX1504170

14. Remove hoses and adapters (Figure 11) from center joint.

NOTE: Attach identification tags to the removed hoses for reassembling.

After disconnecting hoses, plug them to prevent dirt or dust from entering.

Disconnect the hoses from the bottom to top of center joint.



EX1505076

Figure 10 Hub of Center Joint

• Hoses and plugs ports


Port	Name	Plug/Flange Size (Hose)	Wrench (mm)	Pipe (mm)	Torque		
					N.m	kg.m	ft lb
G (DR)	Drain (from Travel Device (LH, RH) "DR")	UNF 13/16"-16-2B	24		55.9	5.7	41.2
1	to Travel Device (LH) "A"	SAE 1", D24.5		10	107.8	11	79.5
2	to Travel Device (LH) "B"	SAE 1", D24.5		10	107.8	11	79.5
3	to Travel Device (RH) "B"	SAE 1", D24.5		10	107.8	11	79.5
4	to Travel Device (RH) "A"	SAE 1", D24.5		10	107.8	11	79.5
5	to Travel Device (LH, RH) "P1"	UNF 9/16"-18-2B	19		25.5	2.6	18.2

• Fitting


Port	Name	Size		Wrench (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
G (DR)	Tee	PF 1/2"	UNF 13/16"-16	27	84.3	8.6	62.2
5	Adapter	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
	Tee	UNF 9/16"-18	UNF 9/16"-18	19	25.5	2.6	18.8
0	O-ring	S8000185 (4D P18)					
1, 2, 3, 4		DS2856003 (1", ID:33.2, OD:40.2, 1B)					
5		S8000115 (4D P11)					

* A: Opposite side of hose, B (C): Hose side

15. Remove bolt (1, Figure 12) and clamp (2).

- Tool: 30 mm, 8 mm ()
- Torque (Clamp): 6 N.m (0.6 kg.m, 4.4 ft lb)

16. Remove bolts (3, Figure 12) (6 ea) with plates (4) (2 ea) and lubber cover (5).

- Tool: 14 mm ()
- Torque: 63.7 N.m (6.5 kg.m, 47 ft lb)

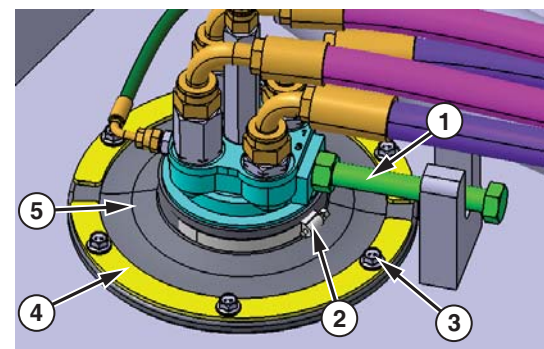


Figure 11

EX1403121

17. Remove hoses and adapters (Figure 13) from center joint.

NOTE: Attach identification tags to the removed hoses for reassembling.

After disconnecting hoses, plug them to prevent dirt or dust from entering.

Disconnect the hoses from the bottom to top of center joint.

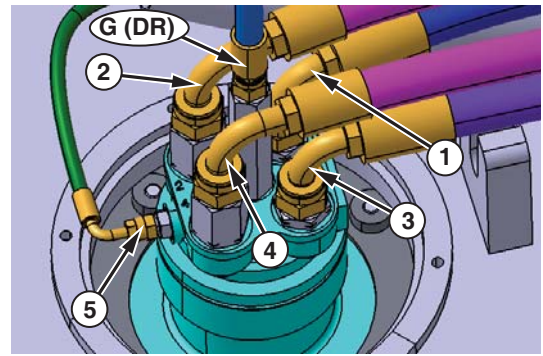


Figure 12 Spindle of Center Joint

EX1505077

- Hoses and plugs ports

Port	Name	Plug/Flange Size (Hose)	Wrench (mm)	Torque		
				N.m	kg.m	ft lb
G (DR)	Drain (Connect with Swing Device "DB")	UNF 13/16"-16-2B	24	55.9	5.7	41.2
1	from Control Valve "A6"	UNF 1 3/16"-12-2B	36	124.5	12.7	91.8
2	from Control Valve "B6"	UNF 1 3/16"-12-2B	36	124.5	12.7	91.8
3	from Control Valve "A1"	UNF 1 3/16"-12-2B	36	124.5	12.7	91.8
4	from Control Valve "B1"	UNF 1 3/16"-12-2B	36	124.5	12.7	91.8
5	from Solenoid Valve "TR2"	UNF 9/16"-18-2B	19	25.5	2.6	18.2

- Fitting

Port	Name	Size		Wrench (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
G (DR)	Adapter	PF 1/2"	UNF 13/16"-16	27	84.3	8.6	62.2
1, 2, 3, 4	Adapter	PF 3/4"	UNF 1 3/16"-12	36	158.8	16.2	117.1
5	Adapter	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
G (DR)	O-ring	S8000185 (4D P18)	S8030081 (1B F-08)				
1, 2, 3, 4		S8000235 (4D P22.4)	S8030125 (4D F-12)				
5		S8000115 (4D P11)	2180-1216D11				

* A: Opposite side of hose, B (C): Hose side

18. Install the eyebolts (PF 1/2) and tie with rope the center joint to remove it (Figure 14).

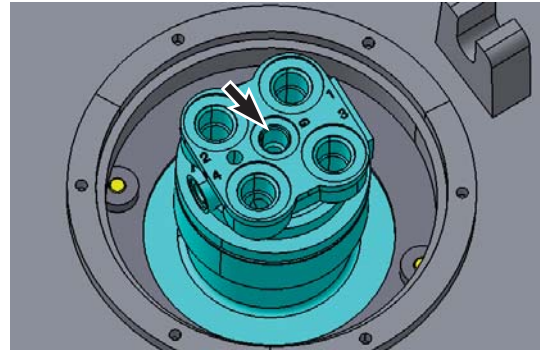



Figure 13

EX1402386

19. Remove bolts and washers (1, Figure 15) (4 ea).

- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.5 ft lb)

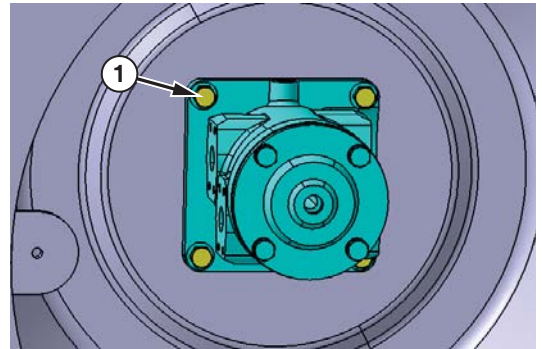


Figure 14 Bottom of Track Frame

EX1402387

20. Remove center joint from the frame slowly and carefully.

- Center joint weight: about 36 kg (79 lb)

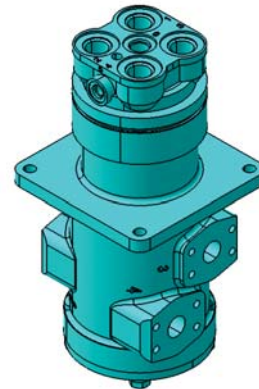


Figure 15

EX1402389

INSTALLATION



WARNING

**INCORRECT INSTALLATION CAN CAUSE DEATH OR
SERIOUS INJURY**

**Any change in the connections will lead to malfunctions
(e.g. lift instead of lower).**

- **When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.**
-

1. Perform installation in the reverse order to remove.
2. When installing the hoses, install the drain hose as first action.
3. To prevent the water from penetrating, apply silicon on the mounting part of center joint.

COMPLETING WORK

1. Start the engine and run at low idling for about 5 minutes.
2. Perform the machine performance test.

DISASSEMBLY

IMPORTANT

Do not unbolt the center joint from the lower frame until an adequate number of piping block off plates are available, for disconnected piping lines. Be sure that system pressure has been relieved - including the hydraulic accumulator and tank reserve pressure - before disassembly is started.



AVOID DEATH OR SERIOUS INJURY

Because of its weight, use a hoist or a similar device to lift the assembly.



AVOID DEATH OR SERIOUS INJURY

The hydraulic oil will be hot after machine operation. Allow the system to cool before attempting to service any of the hydraulic components.

1. Clean off the exterior of the swivel joint after it has been removed.
 2. Scribe or otherwise mark a line across the cover and the body of the center joint, to allow reassembly in the same configuration.
 3. Remove oil remaining in each port with air.
 4. Use a 19 mm wrench to loosen cover bolts and washers (13 and 14, Figure 17) and remove cover (3).
-
5. Remove the shim (12, Figure 18) and O-ring (9).

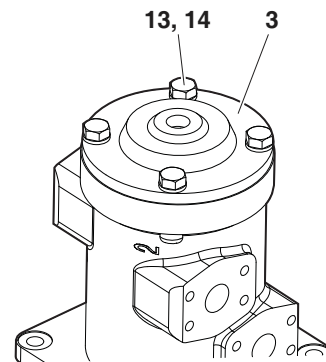


Figure 16

EX1402520

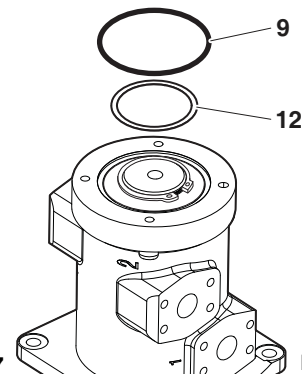


Figure 17

EX1402521

- Use a pliers to remove retaining ring and disassemble the spacer (4, Figure 19) and shim (11) at the back of the retaining ring (5).

IMPORTANT

Care must be taken not to make a scratch or damage the surface of the spindle when disassembling the spindle of the hub.

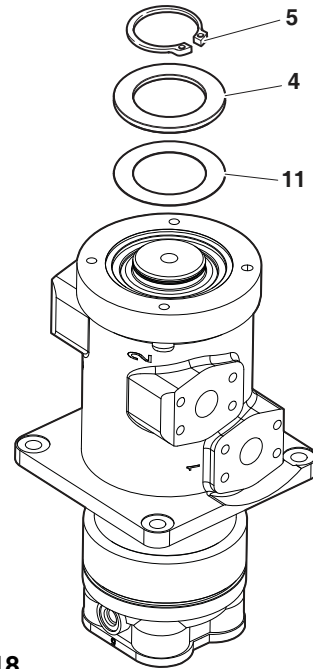


Figure 18

EX1402522

- Disassemble the spindle from the hub.
It can be disassembled easily by fixing the hub, tightening at least 2 ~ 10 mm eyebolts on the spindle, and lifting it with a hoist slowly. (Figure 20)
- If the spindle doesn't separate easily when the retaining ring are removed, use a wooden block and hammer to drive it out of the housing.

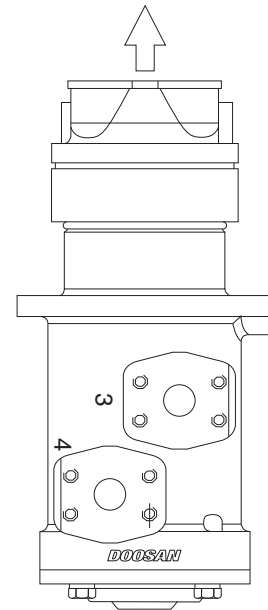


Figure 19

FG013230

IMPORTANT

Care must be taken not to damage the inside of the hub because it is likely to be damaged when disassembling the slipper seal. It may be disassembled more easily with a screwdriver whose tip is bent as shown in Figure 21.

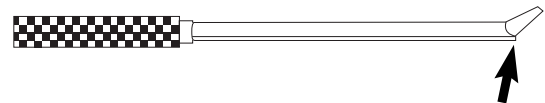
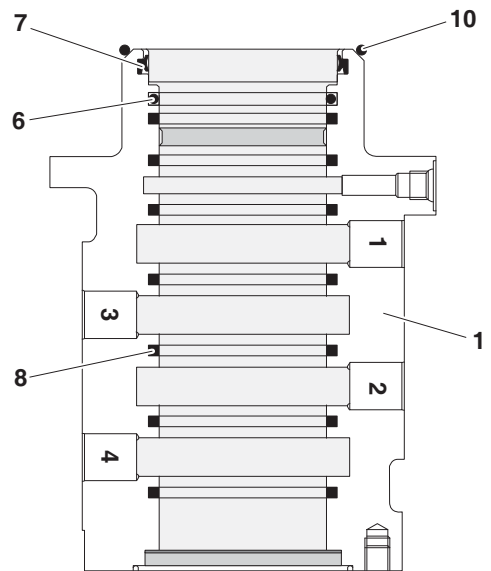


Figure 20

FG021966

9. Remove the O-ring (10, Figure 22) (1 ea), dust seal (7) (1 ea), O-ring (6) (1 ea) and slipper seal (8) (7 ea) from the hub (1).
10. Remove foreign substance on pieces disassembled and wash them out.
11. Replace disassembled O-rings, dust seal and slipper seals with new ones, for they cannot be reused.
12. Clearance between the spindle and body of the center joint must be tight. Replace or repair either component if there is more than 0.1 mm (0.0039") of measurable wear.



EX1402523

Figure 21

REASSEMBLY

IMPORTANT

Apply a very light film of white grease inner surface of the hub.

1. Assemble the slipper seal (8, Figure 23) (7 ea), O-ring (6) (1 ea), O-ring (6) (1 ea) and dust seal (7) (1 ea) into the hub.



CAUTION

AVOID INJURY

After assembling the slipper seal, a manual test must be performed to ensure that every part is assembled properly.

IMPORTANT

For any slipper seal which is protruded, press it with finger to seat it in its position. Care must be taken when using a driver or a metal tool, which can cause damage the seal.

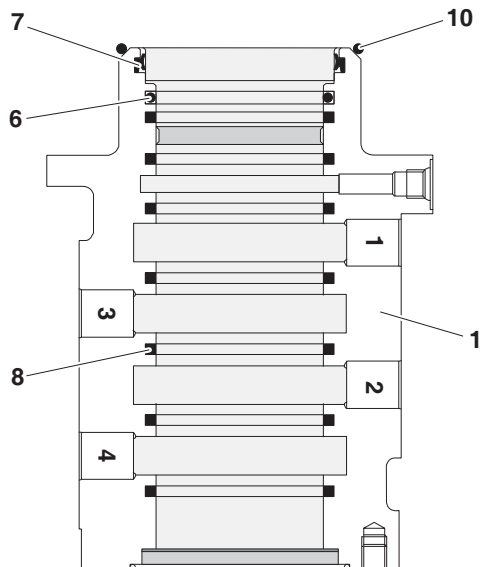
IMPORTANT

Applying oil to the surface of the spindle will help prevent damage to the slipper seal.

2. Fix the position of the spindle and press the hub carefully into spindle with both being parallel each other. (Figure 24)
3. Use a plastic (or rubber) hammer to tap the hub until it is inserted completely.

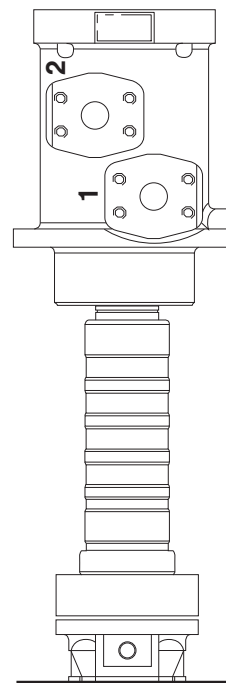
IMPORTANT

Tap the Hub in a zigzag pattern so it does not tilt to one side.



EX1402523

Figure 22



FG013243

Figure 23

- Assemble the shim (11, Figure 25), spacer (4) and install the retaining ring (5).

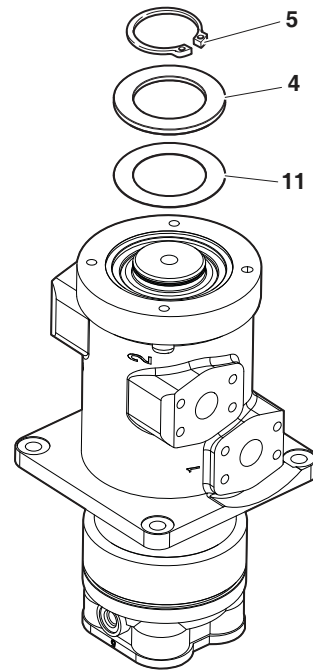


Figure 24

EX1402522

- Apply the grease inner surface of cover (3, Figure 26) to fix the shim (12). And install the O-ring (9) to hub.

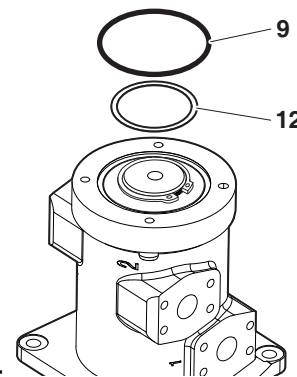



Figure 25

EX1402521

- Install the bolts and washers (13 and 14, Figure 27) with cover (3) to hub.

- Tool: 19 mm ()
- Torque: 107.8 N.m (11 kg.m, 79.5 ft lb)

- Prefill the center swivel with clean hydraulic fluid before reassembly of high-pressure and drain line piping. Clean and prefill piping line ends to reduce the amount of air in the system. Bleed air from the hydraulic system and check hydraulic tank fluid level.

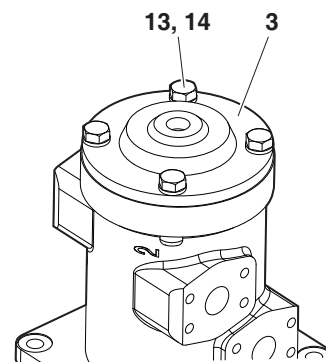


Figure 26

EX1402520

IMPORTANT

After the completion of the assembly, a start-up and a rotation torque test must be performed for the slipper seal to seat in its place properly.

TROUBLESHOOTING, TESTING AND ADJUSTMENT

Inspection

The center joint must be checked for evidence of external oil leakage every 2,000 operating hours. Leaking or defective O-rings are an indication that dirt and other contaminants could be getting inside the assembly, which will promote accelerated, abnormal wear and can cause early failure of the assembly.

If internal seals or other sliding surface components are worn and there is internal fluid leakage, complete overhaul and repair or replacement of the center joint may be required.

Testing

To check pressure through the center joint, make up a test kit from the following equipment list:

- 700 bar (10,000 psi) pressure gauge.
- Adapters, connectors, piping and flange block off plates conforming to those used in high-pressure piping connections of the excavator.
- A high-pressure relief valve with a setting pressure 1.5 times maximum system pressure.
- A stop valve.
- A manually operated, in-line changeover valve.

Install the changeover valve upstream from one of the stem high-pressure ports. Connect the pressure gauge downstream from one of the body ports. Install the stop valve between the changeover valve and the stem of the center joint. Other components must be installed according to the layout in the block diagram. The test kit is used to pressurize the center swivel above normal working pressure and lock in the higher pressure (as the stop valve is closed manually) for a leak down test.

NOTE: *The same type of kit can also be made up for the drain port (return line) side of the center joint. Use appropriate piping, connectors, test gauges, etc., and follow the same block diagram general layout (Figure 28).*

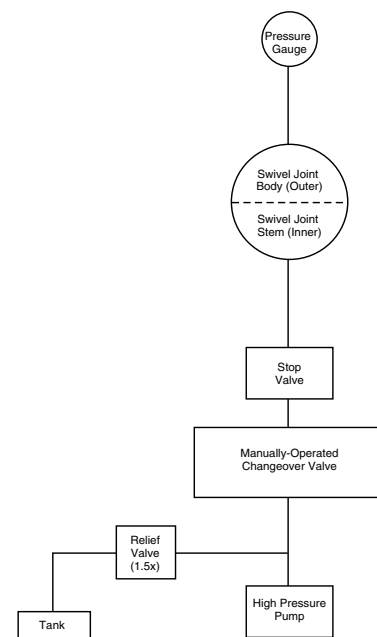


Figure 27

0370

Travel Device

Edition 1

MEMO

Table of Contents

Travel Device

Safety Instructions	6-3-5
General	6-3-5
Specification	6-3-5
Overview	6-3-6
Port.....	6-3-6
Hydraulic Circuit	6-3-7
Theory of Operation	6-3-8
Hydraulic Motor	6-3-8
Operation of Reduction Gear	6-3-15
Cautions for Operation	6-3-16
Installation Method	6-3-16
Piping	6-3-16
Hydraulic Oil	6-3-17
Lubricant.....	6-3-18
Maintenance/Service.....	6-3-19
Precaution	6-3-20
Tools for Disassembly and Assembly	6-3-20
Hydraulic Motor	6-3-20
Reduction Gear	6-3-21
Tightening Torque	6-3-22
Removal	6-3-23
Installation	6-3-29
Completing Work	6-3-29
Checkup After Assembly	6-3-30
Air Test for Reduction Gear.....	6-3-30
Air Test for Motor.....	6-3-30
Performance Test	6-3-31
If Test Equipment Is Available.....	6-3-31
Section View	6-3-32
Travel Motor	6-3-32
Travel Reduction Gear	6-3-34

Disassembly	6-3-36
General Caution Matters	6-3-36
Reduction Gear	6-3-36
Hydraulic Motor	6-3-42
Disassembly of Main Body of Motor Section.....	6-3-42
Disassembly of Valve Casing Subassembly	6-3-45
Disassembly of Cylinder Block Assembly	6-3-46
Cleaning and Inspection	6-3-47
Maintenance Standard	6-3-47
Changing Standard of Hydraulic Motor Part	6-3-47
Reassembly	6-3-49
General Caution Matters	6-3-49
Hydraulic Motor	6-3-49
Reassembling of Drive Shaft Subassembly	6-3-49
Assembly of Valve Casing Subassembly	6-3-49
Assembly of Valve Casing Subassembly	6-3-50
Assembly of Cylinder Subassembly	6-3-52
Reduction Gear	6-3-57
Troubleshooting	6-3-65

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.

GENERAL

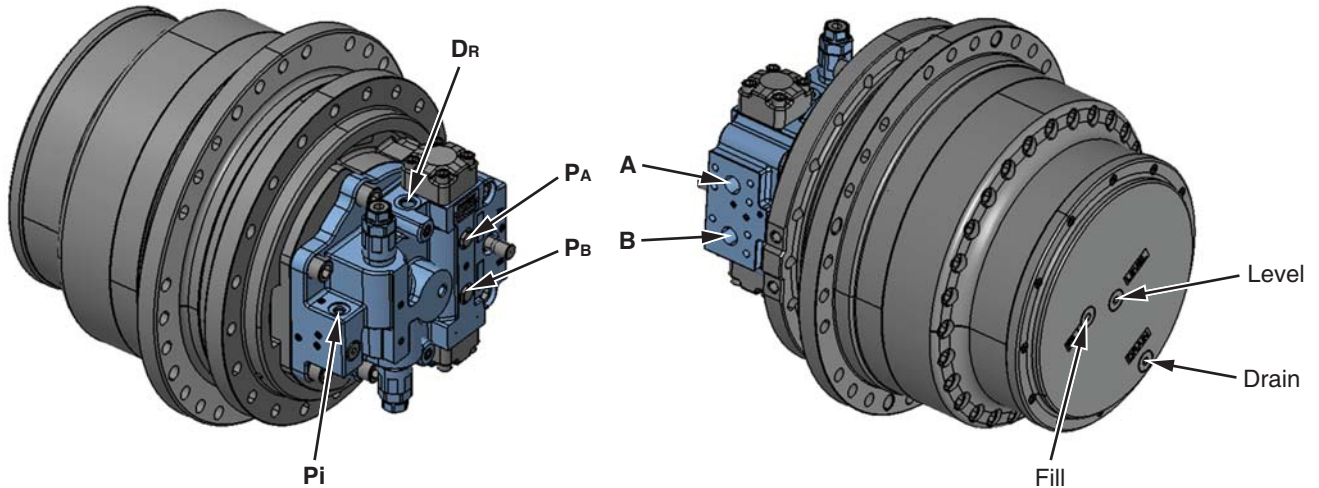
Specification

		1 Speed	2 Speed
Travel Motor	Type	Axial Piston 2-speed	
	Displacement	195 cc/rev	127 cc/rev
	Crossover Relief Valve Setting	328 bar (335 kg/cm ² , 4,764 psi)	
	Max. Supply Flow	250 L/min (66 U.S. gpm)	
	Motor Shaft Speed	1,276 rpm	1,966 rpm
	Motor Shaft Torque	1,004 N.m (102.4 kg.m, 741 ft lb)	654 N.m (66.7 kg.m, 482 ft lb)
Reduction Gear	Type	3 - Stage Planetary Gear	
	Reduction Gear Ratio	63.8	
	Max. Output Speed	20 rpm	30.8 rpm
	Max. Output Torque	64,115 N.m (6,538 kg.m, 47,289 ft lb)	44,404 N.m (4,258 kg.m, 32,750 ft lb)
	Weight	380 kg (Included Motor)	
Traveling Performance	Traveling Speed	3.1 km/hr	4.6 km/hr
	Traction Force (EFF. = 85% / 75%)	27.25 ton	24.05 ton
	Gradeability	70%	
Parking Brake	Control Type	Main Pressure, Mechanical	
	Brake Torque	35,743 N.m (3,645 kg.m, 26,362 ft lb)	
	Brake Release Pressure	10.4 ±1.5 bar (10.6 ±1.5 kg/cm ² , 151 ±21 psi)	

Overview

Travel device consists of a travel motor and gearbox.

Travel motor includes rotary parts, parking brake and high/low speed changeover mechanism.



EX1401861

Figure 1

Port

Port	Name	Size
A	Inlet, Outlet	SAE 1", 6000 psi, $\phi 25$, 27.8 x 57.2
B	Inlet, Outlet	SAE 1", 6000 psi, $\phi 25$, 27.8 x 57.2
Pi	Pilot (High-speed)	PF 1/4", O-ring
PA, PB	Gauge	
DR	Drain	PF 1/2", O-ring
	Fill	
	Level	
	Drain	
	Lifting	M16 - Depth 27

Hydraulic Circuit

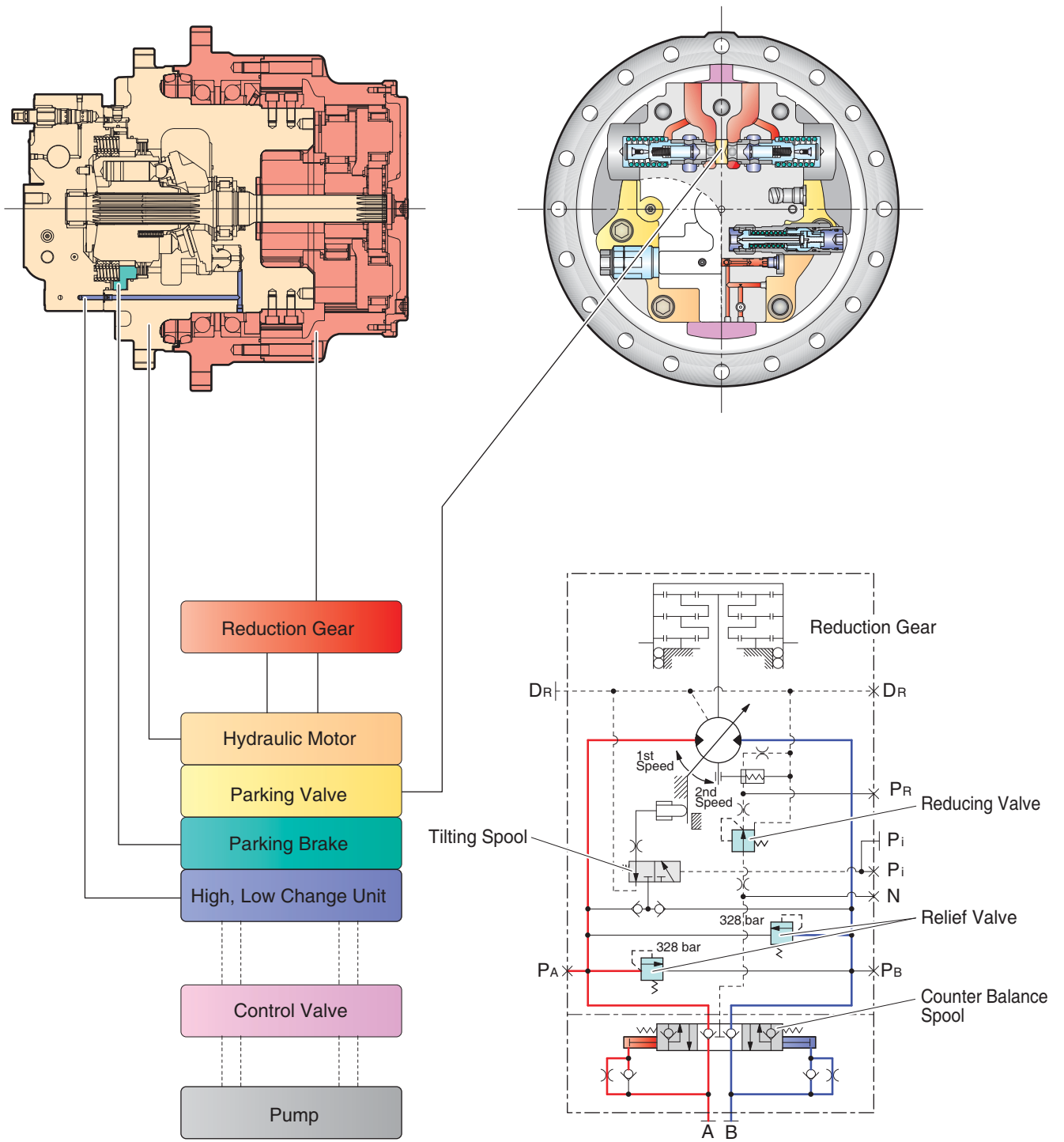


Figure 2

EX1504814

Theory of Operation

Hydraulic Motor

1. Generation of rotational force.

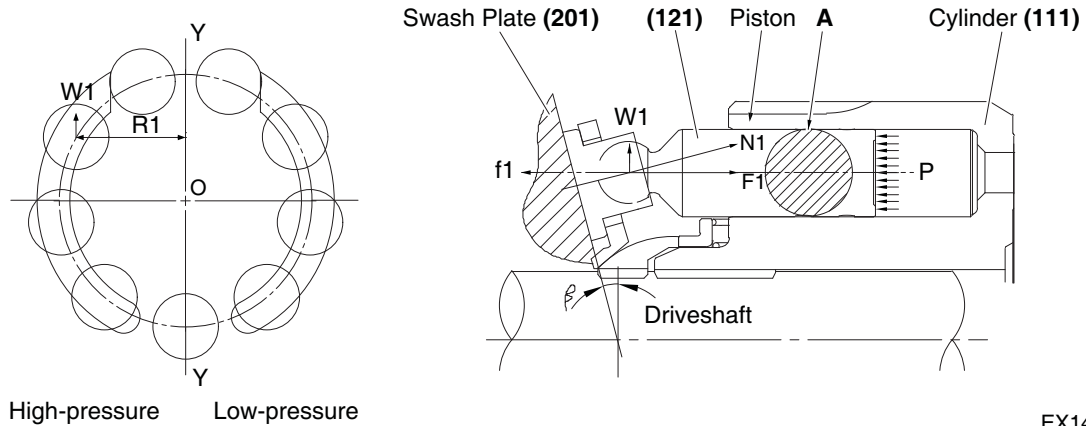


Figure 3

EX1401864

High pressure oil supplied from the hydraulic pump flows through valve casing (303) and valve plate (131) into cylinder block (111). (Refer to Figure 3 for indication numbers).

The internal design allows the high pressure oil to flow to one side of the center line "Y-Y" at the top and the bottom dead center piston (121).

The high pressure oil acts upon pistons and generates force "F1" ($F1 = P \times A$ (P: Supply pressure, A: Pressure area)). The force "F1" generates perpendicular force "N1" and radial force "W1" against swash plate (201), which has a tilting angle of " β ." "W1" generates torque "T" ($T = W1 \times R1$) against the line "Y-Y" of bottom and top dead center of piston.

The resultant ($\sum W1 \times R1$) of torques which are generated from pistons (4 ~ 5 ea.) of high pressure side by high pressure oil generates rotating force. This torque is transmitted to cylinder block (111) through piston, and then rotating force is transmitted to drive shaft because cylinder block is combined with drive shaft by spline.

2. Operation of relief valve

The relief valve operates as follows:

- A. The relief valve maintains constant starting pressure of hydraulic motor and, in response to accelerated speed of inertial object, bypasses excess oil flow at motor's input port to return circuit.
- B. If inertial object stops its movement, relief valve brakes delivery section to forcibly stop inertial object.

The chamber "A" is always connected to port "A" of motor. If pressure at port "A" is increased, and pressure becomes greater than spring pressure setting of poppet "A", poppet "A" is moved off seat "A" to allow oil to flow from chamber "A" to port "B."

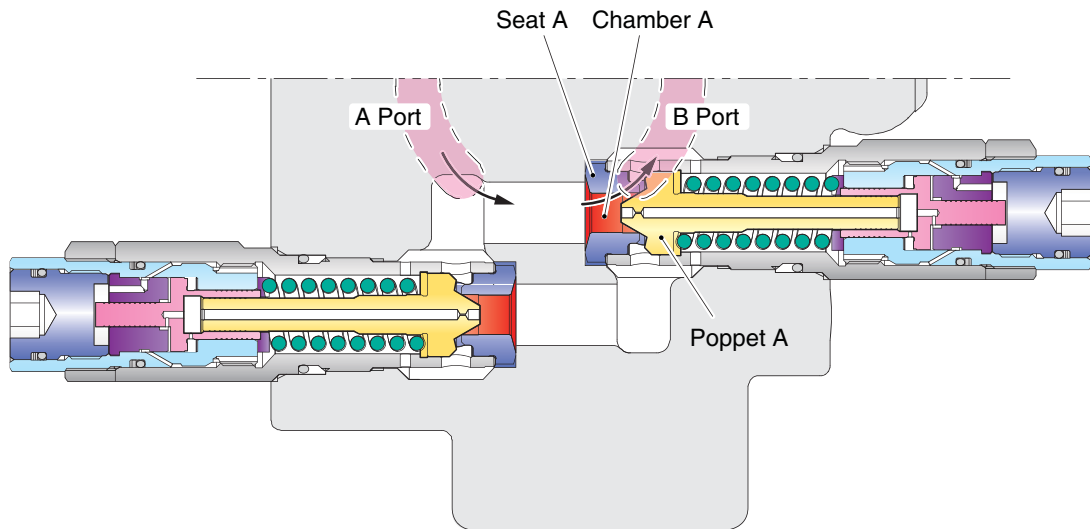


Figure 4

EX1401876

3. Parking brake operation

Pressurized oil opens counterbalance spool (22) in valve casing (303). Oil entering through counter balance spool (22) in valve casing (303), forces brake piston (702) to release the brake. When hydraulic oil pressure, is not present, the brake is spring applied by springs.

Braking force is generated by separator plate (741) and shaft casing (272), which are assembled to shaft casing (272), and friction plate (742), which is connected between brake piston (702) and periphery of cylinder block (111) by splines.

If hydraulic oil pressure is released, brake springs (705) cause brake piston to generate frictional force by pushing friction plates and separator plates together. This friction force restrains drive shaft (101) connected to cylinder block by splines and applies braking force.

NOTE: *When counterbalance spool is in travel mode (Position 1 or 3).*

The pressurized oil flowing from port A or port B is depressurized at reducing valve (351), passing through orifice A (545) and flowing into brake piston chamber. At this time, a minute amount of working oil is drained to orifice B (703), but as pressurized oil is always supplied from counterbalance valve, pressure of brake piston chamber always overpowers spring force and thus releases brake.

NOTE: *When counterbalance is in neutral position (Position 2).*

Since there is no supply of pressurized oil, pressure in piston chamber is decreased and brake spring force overpowers piston chamber pressure to force spool to return to neutral position. This causes motor to stop until brake is operated, so that damage to friction plates is prevented.

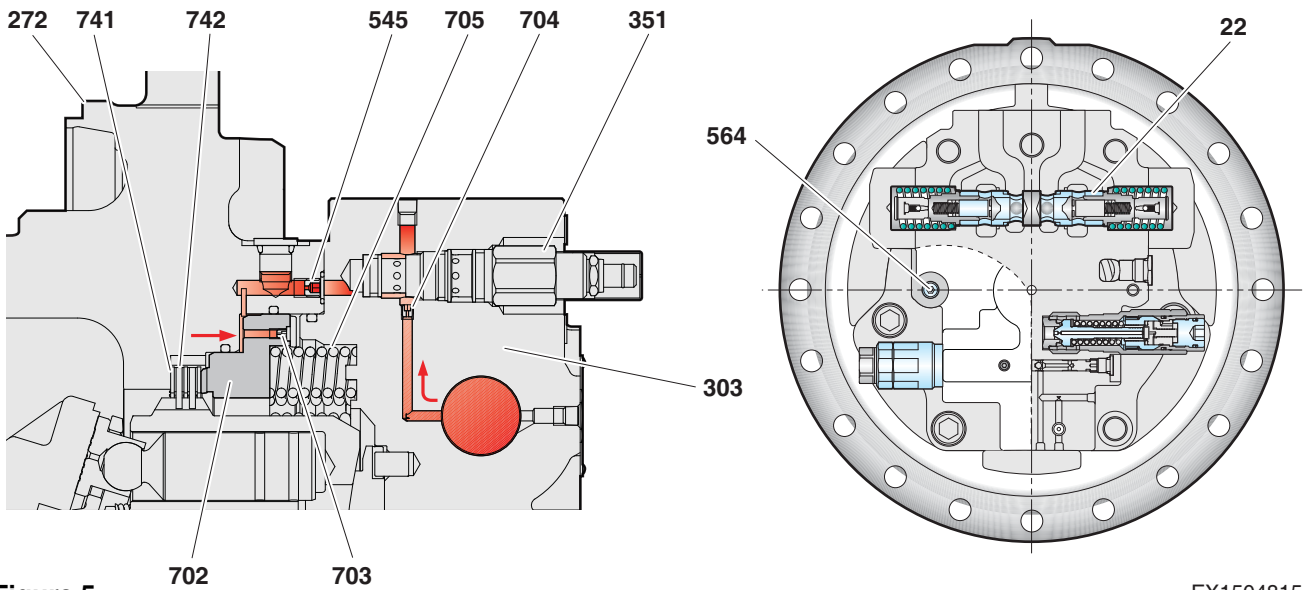
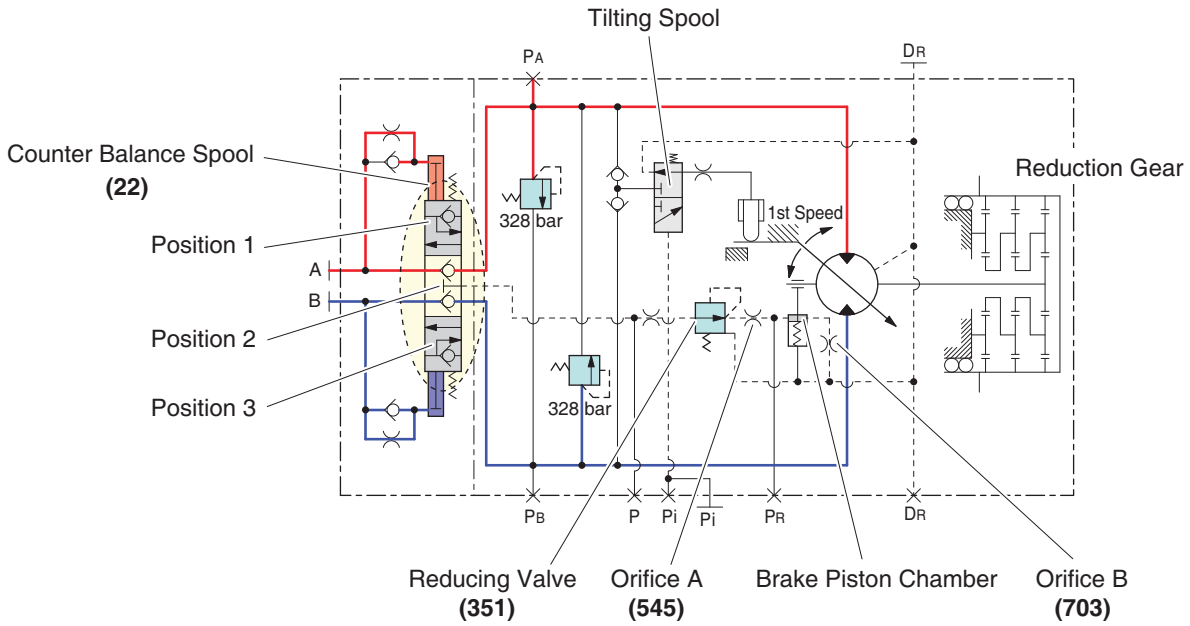



Figure 5

EX1504815

- How to release parking brake

Release Operation	Tool
Remove two plugs (564) from valve casing (303). Insert a bolt (M10 x 135 L) to tighten it to thread of brake piston, and brake will be released. This state becomes same as brake release pressure is applied.	 6 mm

If you release brake without applying brake release pressure, follow instructions below:



CAUTION

AVOID INJURY

If hydraulic motor does not rotate even after brake is released, pump or other part is suspected of malfunction and thus it is difficult to generate working pressure. At this time, if you haul system with hydraulic motor not disassembled, connect a short hose, etc. between pressure measurement ports PA and PB to maintain a low hauling speed.

4. Operation of counterbalance valve

Port (BV) is connected to hydraulic pump, while port (AV) is connected to tank. Pressurized oil from hydraulic pump passes through (BV) to (CV), from (CV) to (C), opening check valve poppet and supplying to hydraulic motor through (BM) port and then rotate the motor.

Also, if hydraulic pressure delivered from pump is increased, pressurized oil flowing from gallery (G) passes spring chamber (E), ball check valve, and then reaches damping chamber (M).

If pressure in chambers (E) and (M) overpowers spring (362) force which is designed to maintain neutral position of spool, spool moves in Right → Left direction.

Working oil in (N) chamber flows through orifice (Q) to (F) chamber, while working oil in chamber (F) passes (G) to (AV) and then is drained to tank.

If hydraulic pressure delivered from pump is lowered, pressure in (E) and (M) chambers also is lowered.

As a result, spool is returned in direction Left → Right by spring (362) of chamber (F).

Working oil in (M) chamber passes orifice (R) and is delivered to (E) chamber, while working oil in (E) chamber is delivered from path (G) to (BV) port. As a result, spool moves in direction of Left → Right.

If pressure in (BV) port is lowered down to tank pressure, pressure in (E) and (F) chambers also becomes same as tank pressure. As a result, spool returns to neutral position.

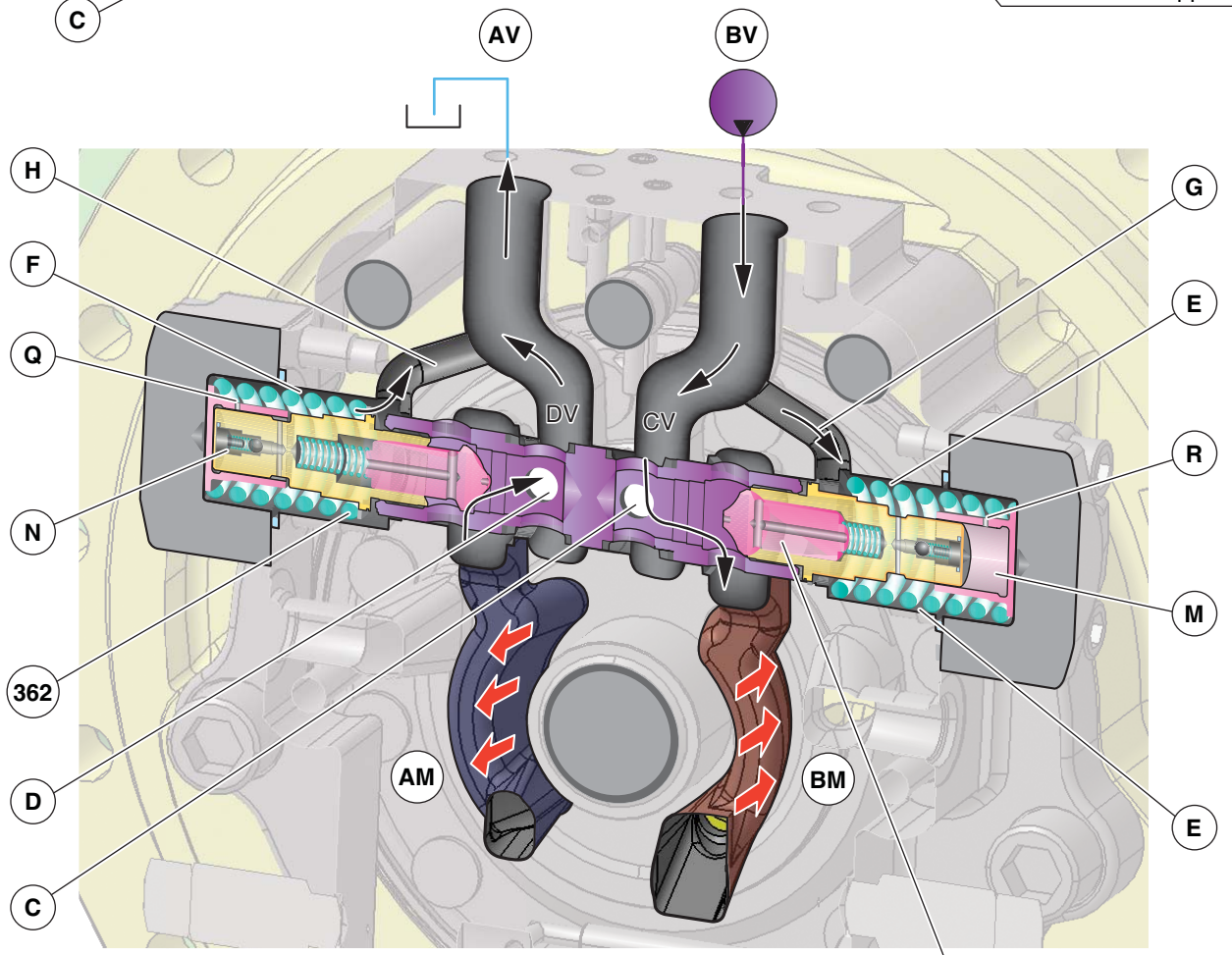
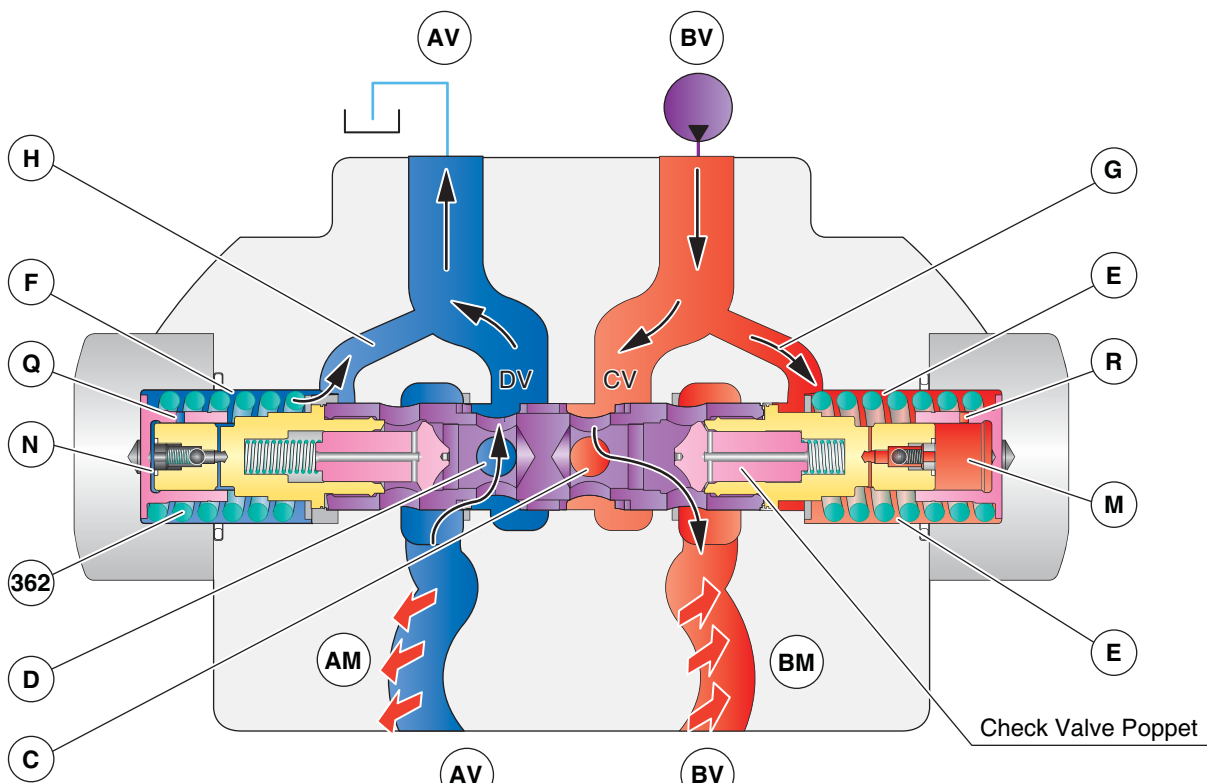


Figure 6

EX1402196

5. Operation of high-speed

This is a supporting device for swash plate (201) on which shoe slides. It has a hemispherical pivot ball (504) arranged along its both ends which bears load against swash stopper.

Changing in tilting angle of this swash plate changes capacity. This device has tilting pistons (502) arranged along swash stopper section and uses tilting control valve to control inflow/outflow of working oil from / to piston chamber, and thus it can determine tilting angle (large or small) of swash plate.

A. External pilot pressure $P_i = 0 \text{ kg/cm}^2$ (0 bar) (Large tilting)

High pressure acting to motor from high pressure select function assembled to valve casing (303) acts to P port of tilting spool (531). This pressure becomes save pressure.

As spool (531) assembled into tilting switching section is in tight contact with plug (571) through spring (533), high-pressure in P port gets blocked.

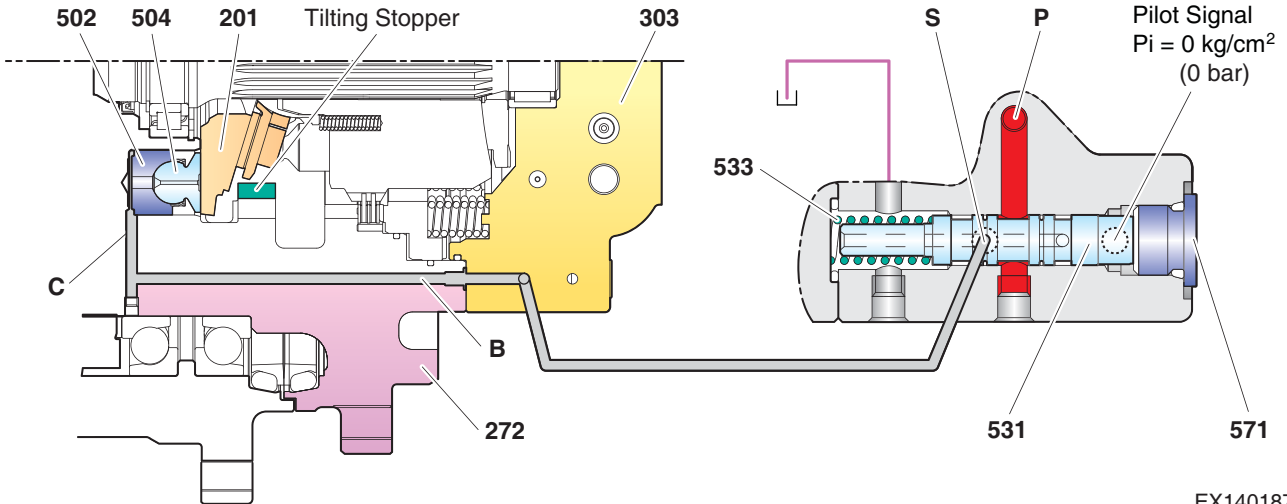


Figure 7

B. External pilot pressure $P_i \geq 20 \text{ kg/cm}^2$ (20 bar) (Small tilting)

If force acting to tilting spool (531) overpowers spring (533) force, spool is switched to left direction. High pressure oil passes P port to S port of tilting spool, path B, then acting to C chamber. The tilting piston (502) moves right through this high-pressure oil and swash plate moves right. The swash plate moves all way to position of tilting stopper of shaft casing (272) until it becomes fixed in that position.

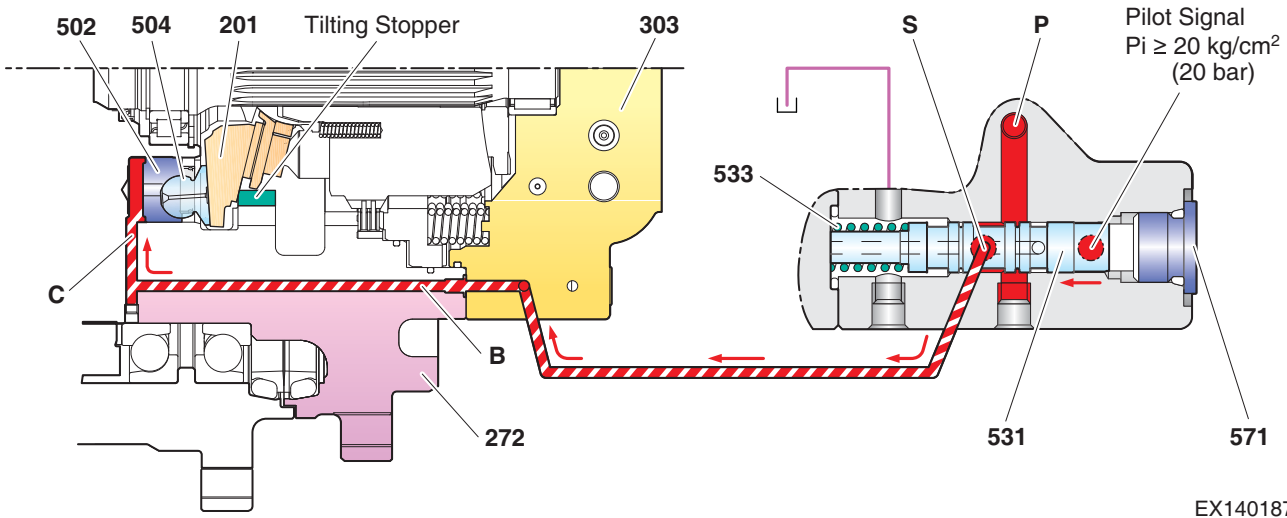


Figure 8

Operation of Reduction Gear

The reduction gear comprises 3-level planetary gear and differential gear as shown in Figure 11.

It has floating type sun gear, and therefore tooth profile error and carrier pin hole pitch variation may affect life of gear.

Input rotation of hydraulic motor is transmitted to No. 1 sun gear (S1) and No. 1 sun gear (S1) drives No. 1 planetary gear. As this No. 1 planetary gear (P1) attempts to rotate No. 1 ring gear (R1) by using force in same direction of tangential force as No. 1 sun gear (S1) but No. 1 ring gear is fixed, No. 1 planetary gear generates reaction force against rotation force to rotate No. 1 carrier (C1). In other words, No. planetary gear (P1) does not rotate but revolves. Rotation force of No. 1 carrier (C1) is transmitted to No. 2 sun gear(S2) through level 1 output. (The No. 1 carrier and No. 2 sun gear are connected through spline.)

On same principle as above, revolution of No. 2 planetary gear (P2) is transmitted to No. 3 sun gear through No. 2 carrier (C2). Here, as No. 3 pin supporting No. 3 planetary gear (P3) is fixed, No. 3 planetary (P3) rotates as well as revolves to drive No. 3 ring gear (R3). As a result, driving force of Nos. 1, 2, and 3 ring gears combines to drive rotary drum.

Reduction gear ratio is as follows:

$$i = \frac{(Zs1 + Zr1)(Zs2 + Zr2)(Zs3 + Zr3)}{Zs1 \times Zs2 \times Zs3} - 1$$

NOTE: *Z: dimensions of each gear*
Rotative direction is opposite to input side.

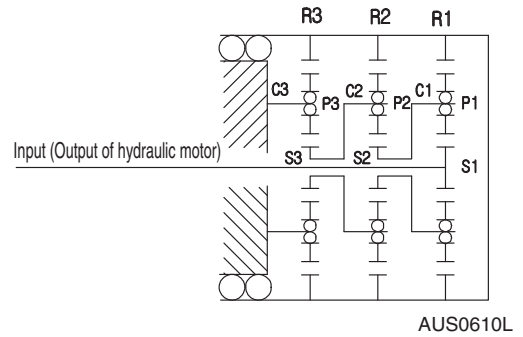


Figure 9

Cautions for Operation

Installation Method

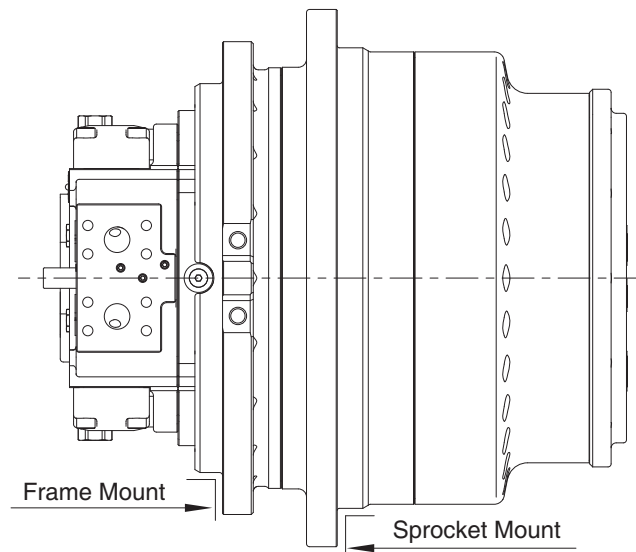


Figure 10

EX1401880

Tightening torque of mounting bolts

Classification	Qty.	Bolt Size	Tightening Torque		
			N.m	kg.m	ft lb
Frame Mount	26	M20 x 2.5 x 75	539	55	398
Sprocket Mount	24	M20 x 2.5 x 60	539	55	398

NOTE: The bolts must be Strength Class 10.9 equivalent or better. When assembling, do not hit the travel motor with hammer, etc., but use bolt holes. Take care not to damage the assembling part of the gearbox.

Piping

1. Turning direction is indicated in outside dimension drawing. Be careful of piping direction.

- Turning direction

Inlet	Outlet	Direction Seeing from Valve Casing
A	B	Left Turning
B	A	Right Turning

- Cover piping port with a cloth when transporting. When carrying out piping work, use care that foreign material does not enter system.
- The drain piping with plugs tightened at two places are supplied from factory. Use either of two plugs. Add a sufficient amount of oil into casing before piping work. In addition, carry out piping work so that drain pressure can be reduced.

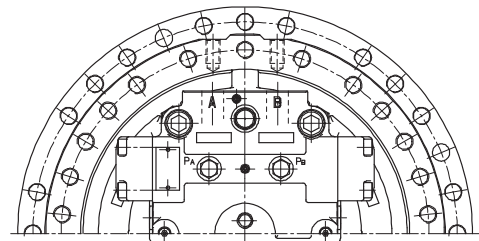


Figure 11

AUS1450L

4. Entry of foreign material into oil may cause premature wear on sliding parts, resulting in stick or seizure. To prevent such defects, be sure to install a filter of 10µm or less within circuit.

Hydraulic Oil

Because the hydraulic motor case is drained at the time of shipping, make sure to fill up the case with hydraulic oil before operation.

Selecting Hydraulic Oil

Take the followings into consideration when selecting the hydraulic oil for travel motor:

1. Use VG46-VG68 grade or equivalent.
2. Use wear resistant hydraulic oil.
3. Please contact us when hydraulic oil other than the one in the table below is to be used;

Grade	Viscosity (40°C)	46CST	68CST
	ISO VG	VG46	VG68

Inspection, Replacement of Hydraulic Oil

The standard replacement period of hydraulic oil is as follows (may vary by operating condition);

The table below shows the standard replacement period of hydraulic oil.

- Volume of hydraulic motor oil: about 2 ~ 2.5 L
- Replacement period: 2,000 hr or 1 year

Lubricant

The reduction gear is filled with lubricant (gear oil) at the time of shipping, however, check the oil level before operation.

1. Selecting gear oil

Use the gear oil with SAE #90 of equivalent extreme pressure additive (API Classification GL-5 Grade or better).

2. Replacement period of gear oil

A. First replacement (first time after starting operation): 250 hr

B. Second and later replacement: 1,000 hr or 1 year

However, if gear oil reduces fast than normal, find out and correct the cause before refilling oil.

3. Replacement volume of gear oil: 6 L (1.6 U.S. gal)

4. Replacement method of gear oil

5. Needed tool: 10 mm ()

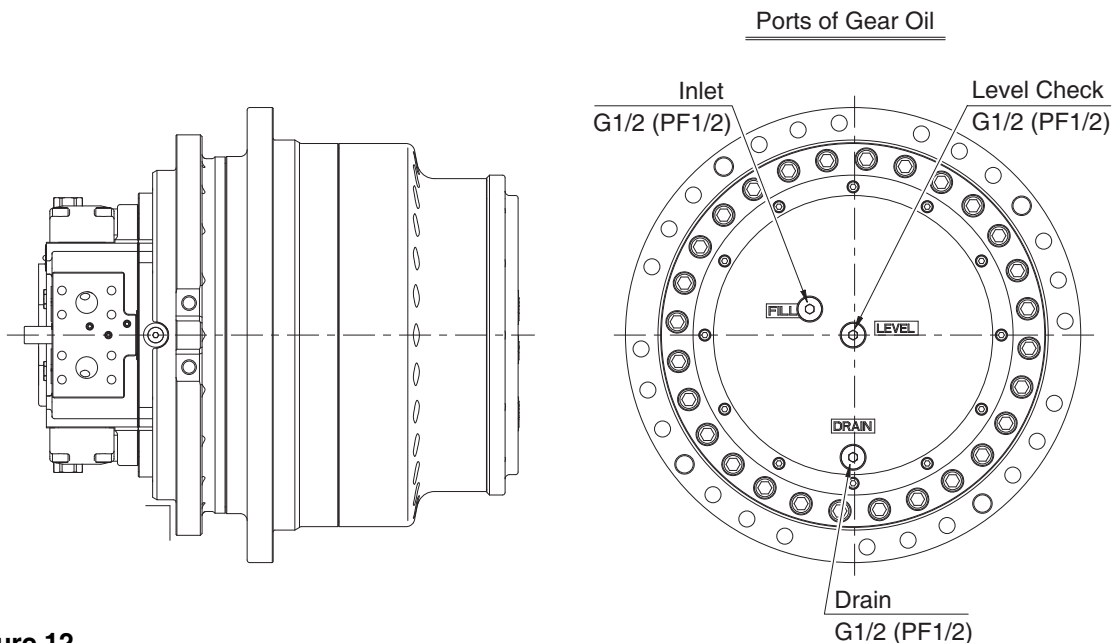


Figure 12

EX1401891

Added or replaced oil must be of the same kind. Do not mix with a different type or grade of oil.

- A. Let the oil refill port and drain port be perpendicular to the horizontal plane.
- B. For replacement, unplug the two ports and drain the gear oil.
- C. Refill gear oil until oil overflows from oil level check port.
- D. Wind Teflon or thread tape on the plug before plugging the ports again.

Maintenance/Service

Check the following items while operating the travel motor.

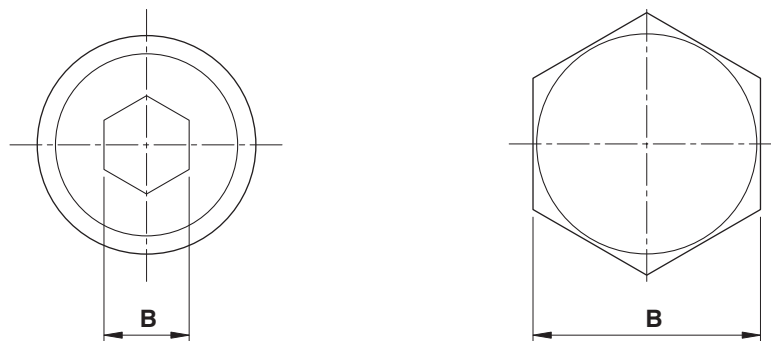
1. Stop the product before service or inspection except when checking the noise level of clause 3 below. Otherwise, you may get physical injury including burn.
 - A. Oil leak (hydraulic oil, gear oil)
 - B. Loose bolt
 - C. Abnormal noise
 - D. Abnormally high case temperature
(Standard external surface temperature of case during continuous operation: 80°C max.)
 - E. Replacement period of gear oil (See "Lubricant" on page -6-3-22.)
 - F. Hydraulic motor allowable drain: 0.5 lpm (pressure 5 bar (5 kg/cm²) max., at 25 rpm)
2. The case may be very hot right after operation. Measure the temperature with a contact type thermometer.

PRECAUTION

Tools for Disassembly and Assembly

Hydraulic Motor

Tool Name	B (mm)	Applying Part Name
Hex L-wrench	2	Orifice (703)
	2.5	Orifice (704)
	4	Plug (461), Orifice (545, 546)
	6	PT Plug (564), PF Plug (569)
	8	PF Plug (571)
	10	Socket Bolt (366)
	17	Socket Bolt (401, 402)
Socket Wrench Spanner	19	VP Plug (567)
	22.4	Reducing Valve (351)
	27	VP Plug (464)
	42	Relief Valve (350)
Pliers (for Hole TRP-90)		
Pliers (for Shaft)		
Hammer, Plastic Hammer		
Steel Bar (7 x 7 x 200)		Bearing (102, 103)
Monkey Wrench		
Toque Wrench		
Driver (JISB 4609)		
Jig for Assembling of Oil Seal		
Bearing		
Seal Tape		



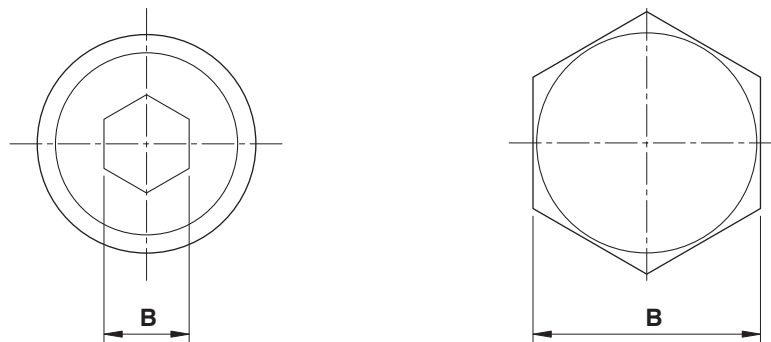
B Size (rear side width)

FG018759

Figure 13

Reduction Gear

Tool Name	B (mm)	Applying Part Name
Hex L-wrench	4	Socket Screw (54)
	84	Socket Bolt (30)
	10	Plug (32)
	14	Socket Bolt (29)
Pliers (for Shaft)		Snap Ring (44, 37)
Eye Bolt (M8)		Ring Gear (1)
Eye Bolt (M10)		No. 2 Carrier (6)
Eye Bolt (M16)		Housing (2)
Eye Bolt (M20)		Shaft Casing (272)
Hammer, Plastic Hammer		Also Wood Hammer Is Possible
Driver (-)		Jig for Assembling of Floating Seal
Press (1 ton)		Angular Bearing (33)
Depth Gauge (100 mm in Depth)		for Adjusting Washer (53)
Punch		Spring Pin, Set Screw Caulking
Torque Wrench		
Tap (M16)		for Removing Loctite from Threaded Part
Oilstone		Finish
Loctite (Three Bond 1373B)		Set Screw (54)
Loctite		Socket Bolt (29)
Jig for Assembling Nut Rings		Nut ring (47)



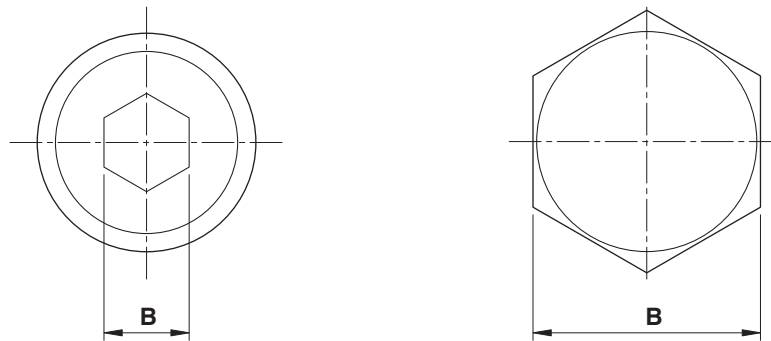
B Size (rear side width)

FG018759

Figure 14

Tightening Torque

Section	No.	Name	Size	B (mm)	Tightening Torque		
					N.m	kg.m	ft lb
Hydraulic Motor	366	Socket Bolt	M12 x 45	10	98.0	10.0	72.0
	401	Socket Bolt	NPTF 1/16	17	431.2	44.0	316.8
	402	Socket Bolt	M20 x 100	17	431.2	44.0	316.8
	461	Plug	NPTF 1/16	4	8.8	0.9	6.5
	464	VP Plug	PF 1/4	27	107.8	11.0	79.2
	545	Orifice	NPTF 1/16	4	6.9	0.7	5.0
	546	Orifice	NPTF 1/16	4	6.9	0.7	5.0
	564	Plug	PF 1/4	6	21.6	2.2	15.8
	567	VP Plug	PF 1/4	19	36.3	3.7	26.6
	569	Plug	PF 1/4	6	36.3	3.7	26.6
	571	Plug	PF 3/8	8	73.5	7.5	54.0
	703	Orifice	M4 x 0.7	2	3.9	0.4	2.9
	704	Orifice	M5 x 0.8	2.5	6.9	0.7	5.0
	Reduction Gear	29	Socket Bolt	M16 x 100	14	294.0	30.0
30		Socket Bolt	M8 x 20	6	34.3	3.5	25.2
32		Plug	PF 1/2	10	107.8	11.0	79.2
54		Set Screw	M8 x 16	6	49.0	5.0	36.0



B Size (rear side width)

FG018759

Figure 15

REMOVAL

WARNING

AVOID DEATH OR SERIOUS INJURY

Contact with hydraulic fluid can harm your health. (e.g. eye injuries, skin damage or poisoning, if inhaled).

- While performing removal and installation, wear safety gloves, safety glasses and suitable working clothes.
- If hydraulic fluid should come into contact with your eyes or penetrate your skin, consult a doctor immediately.

WARNING

FIRE CAN CAUSE SERIOUS INJURY OR DEATH

Hydraulic fluid is highly flammable.

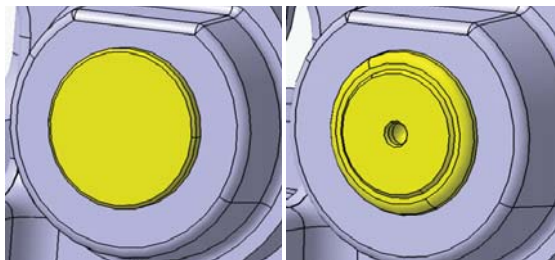
- Keep open flames and ignition sources away from the workplace.

IMPORTANT

Fluid such as engine oil, hydraulic fluid, coolants, grease, etc. must be disposed of in an environmentally safe manner. Some regulations require that certain spills and leaks on the ground must be cleaned in a specific manner. See local, state and federal regulations for the correct disposal.

1. Position machine on a smooth level surface with adequate space. Move machine until master pin is positioned at approximately 4 o'clock.

NOTE:



Regular Pin

Master Pin

EX1400095

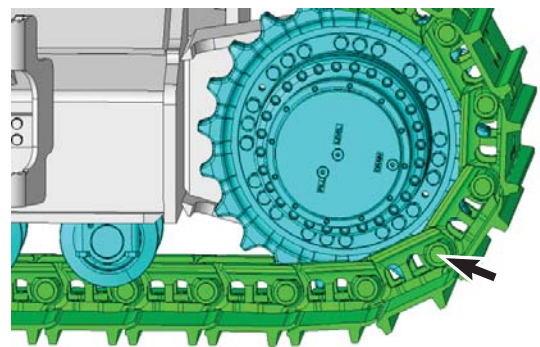


Figure 16

EX1505078

CAUTION


AVOID INJURY

Pressure of grease in adjuster cylinder is too high. Take precautions in opening valve against valve bounce or grease vent.

- Loosen grease valve, and then slacken the tension of track.

NOTE: *Since the inner pressure of the adjustment cylinder is high, loosen the grease valve slowly.*

If the grease does not come out adequately, start the engine and move the machine forwards and backwards.

- Tool: 27 mm ()
- Torque: 137 N.m (14 kg.m, 101 ft lb)

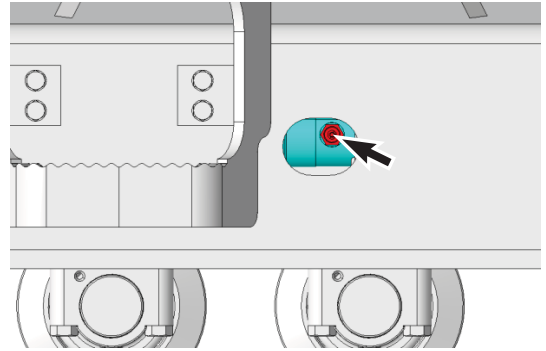


Figure 17

EX1505080

- Remove master pin using jig or tool.

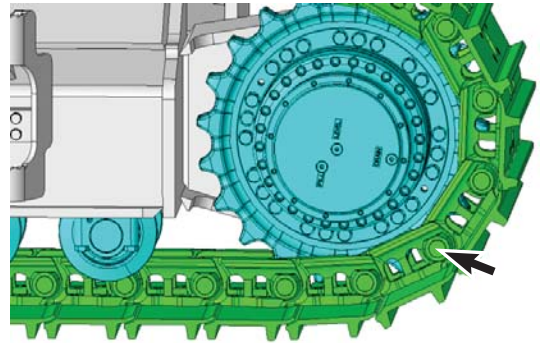


Figure 18

EX1505078

- Put two blocks under the track to widen the gap between sprocket and lower track.

NOTE: *The gap between sprocket and track link must be over 50 mm (2 in).*

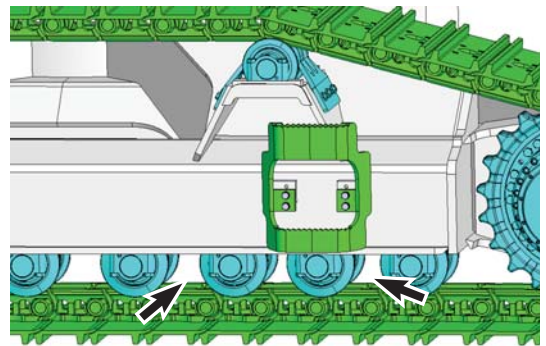


Figure 19

EX1505081

- Place travel device to the direction of the arrow slowly and remove upper track.

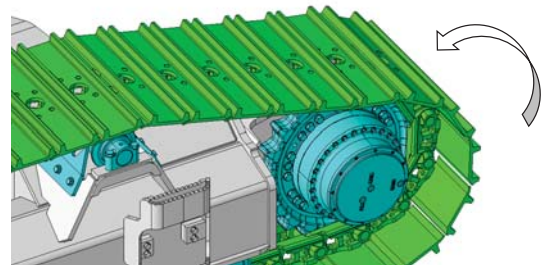


Figure 20

EX1505082

6. Turn the upper structure 90° and jack up the machine.
NOTE: *Jack up the machine until the track is slightly off the ground.*
 Set the angle between boom and arm in 90 ~ 110° and support the machine by using a block.
7. Stop engine.

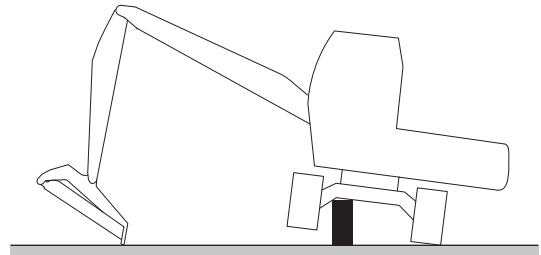


Figure 21

EX1300535

8. Move safety lever to "RELEASED" (UNLOCK) position. (Figure 24)
9. Turn starter switch to "I" (ON) position.



WARNING

AVOID DEATH OR SERIOUS INJURY

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cabin at all times. Never leave the cabin with engine running.

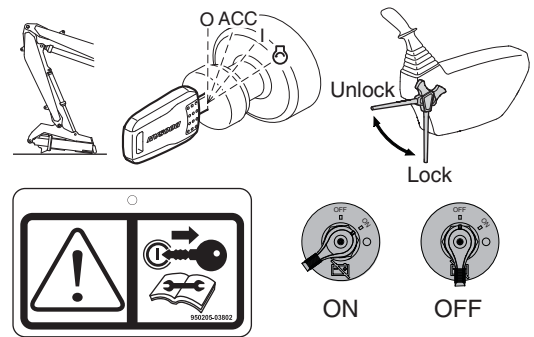


Figure 22

EX1504829

10. Operate the joystick levers and pedals several times to release the remaining pressure in the hydraulic piping.
11. Move safety lever to "LOCK" position. (Figure 24)
12. Turn key to "O" (OFF) position and remove from starter switch.
13. Attach a maintenance warning tag on controls.
14. Turn battery disconnect switch to "OFF" position. (Figure 25)

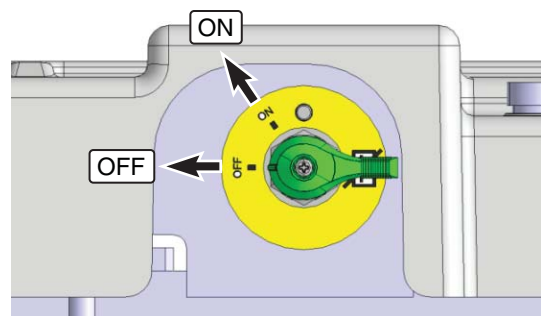


Figure 23

EX1504925

NOTE: Removal (installation) procedure of the bolts.

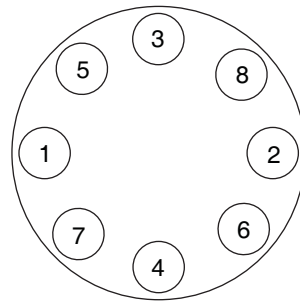


Figure 24

EX1401809



WARNING


AVOID DEATH OR SERIOUS INJURY

Release any pressure in the hydraulic oil tank before doing any work.

15. Loosen the oil tank air breather slowly to release the pressure inside the hydraulic oil tank.

Pulling the breather cap upward, the check valve (0.45 bar) opens, and the air is discharged to the atmosphere from the top of the hydraulic oil tank.

16. Remove bolt (24 ea) with sprocket from travel device (Figure 28).

- Tool: 30 mm ()
- Torque: 539.3 N.m (55 kg.m, 397.8 ft lb)
- Sprocket weight: 84 kg (185 lb)

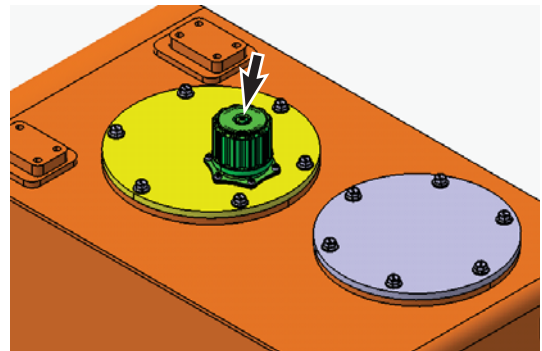


Figure 25

EX1403168

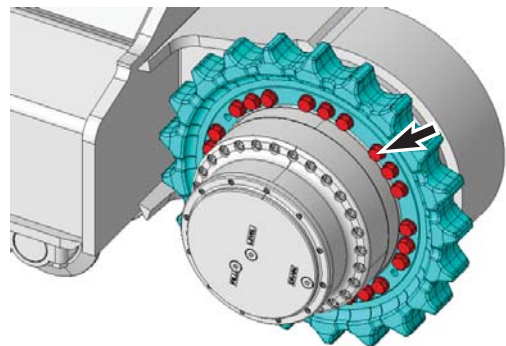



Figure 26

EX1505083

17. Remove cover from track frame (bolt: 6 ea, washer: 6 ea).

- Tool: 19 mm ()
- Torque: 107.9 N.m (11 kg.m, 79.6 ft lb)
- Weight: about 23 kg (50.7 lb)

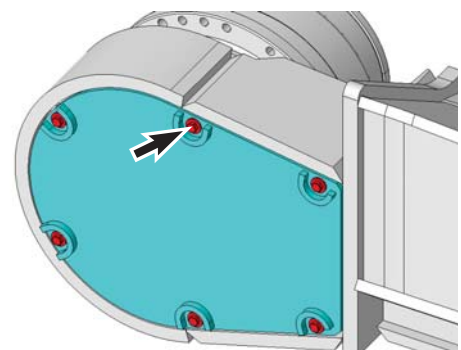


Figure 27

EX1505084

18. When disconnecting the hose, oil left in the hose may flow out. Therefore, place the end of the hose into a suitable container to prevent contamination of the ground and environment.



Figure 28

EX1504170

19. Remove hoses and adapters (Figure 31) from travel device.

NOTE: Attach identification tags to the removed hoses for reassembling.
After disconnecting hoses, plug them to prevent dirt or dust from entering.
Disconnect the hoses from the bottom to top of travel device.

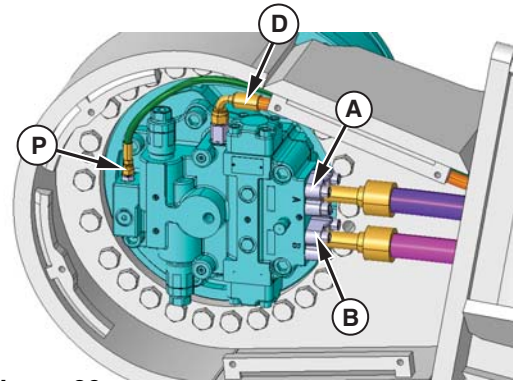
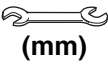



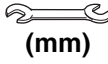
Figure 29

EX1505085

- Hoses and plugs ports


Port	Name	Plug/Flange Size (Hose)	 (mm)	 (mm)	Torque		
					N.m	kg.m	ft lb
A	Inlet, Outlet	SAE 1", 6000 psi, D25		10	107.9	11	79.6
B	Inlet, Outlet	SAE 1", 6000 psi, D25		10	107.9	11	79.6
D	Drain	UNF 13/16"-16-2B	24		55.9	5.7	41.2
P	Pilot	UNF 9/16"-18-2B	19		25.5	2.6	18.8

- Fitting

Port	Name	Size		 (mm)	Torque		
		A	B (C)		N.m	kg.m	ft lb
D	Adapter	PF 1/2"	UNF 13/16"-16	27	84.3	8.6	62.2
P	Adapter	PF 1/4"	UNF 9/16"-18	19	35.3	3.6	26.0
A, B	O-ring	DS2856003 (1", ID:33.2, OD:40.2, 1B)					
D		S8000185 (4D P18)					
P		S8000115 (4D P11)					

* A: Opposite side of hose, B (C): Hose side

20. Remove bolts (22 ea) from track frame except 4 bolts in the direction of 12 o'clock

- Tool: 30 mm ()
- Torque: 539.4 N.m (55 kg.m, 397.8 ft lb)

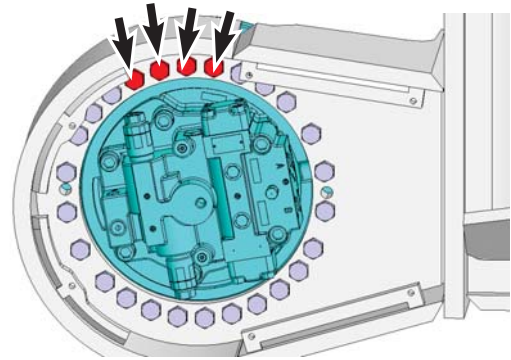


Figure 30

EX1505086

21. Install the sprocket bolts (2 ea) to travel device, and tie the rope to the bolts to lift it.

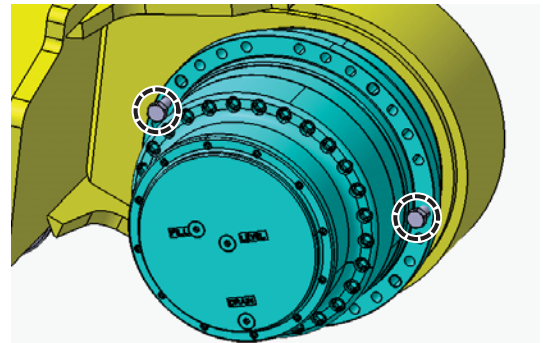


Figure 31

EX1401775

22. Remove remaining bolts (4 ea) of track frame side, and then hoist and remove travel device from track frame very slowly.

- Weight: about 380 kg (838 lb)

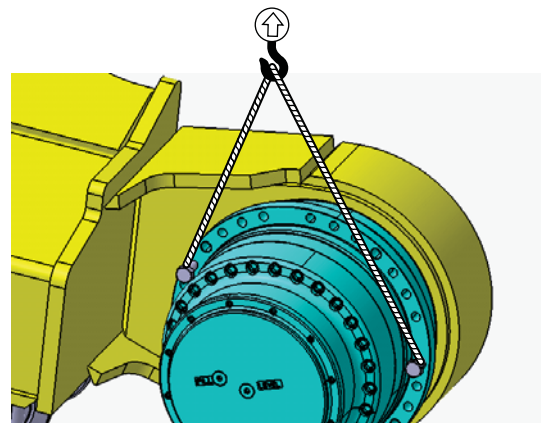


Figure 32

EX1401776

INSTALLATION

WARNING

INCORRECT INSTALLATION CAN CAUSE DEATH OR SERIOUS INJURY

Any change in the connections will lead to malfunctions (e.g. lift instead of lower).

- When connecting hydraulic components, observe the specified piping according to the hydraulic schematic diagram of the machine.
-

IMPORTANT

When replace the travel device, both sides of travel devices are same grades.

1. Perform installation in the reverse order to remove.
2. When installing the hoses, install the drain hose first.

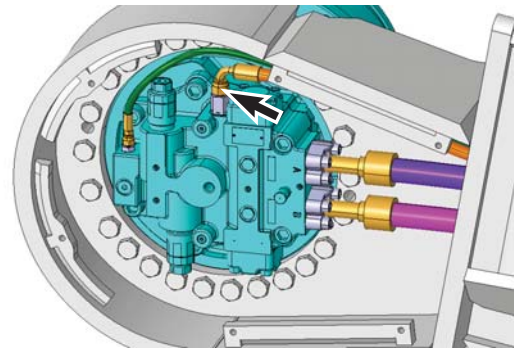


Figure 33

EX1505086

COMPLETING WORK

1. Air testing of reduction gear
Remove one of the plugs (32) of the reduction gear and apply compressed air 0.3 bar (0.3 kg/cm²) through the plug hole under water for two minutes. There must be no observable air bubble.
→ Refill gear oil 7 L (1.85 U.S. gal) (SAE #90 equivalent, API classification GL-5 Grade or better)
2. Air testing of hydraulic motor
Seal all the pipe ports of the hydraulic motor except one through which compressed air 0.3 bar (3 kg/cm²) is injected under water for two minutes. There must be no observable air bubble.
→ Hydraulic oil refill 2 ~ 2.5 L (0.53 ~ 0.66 U.S. gal)
3. Start the engine and run at low idle for about 5 minutes.
4. Perform the machine performance test.

Checkup After Assembly

Air Test for Reduction Gear

Remove one plug (32) from reduction gear section and apply compressed air 0.3 bar (0.3 kg/cm²) through threaded hole for 2 minutes under water. No air bubbles should be generated.

Air Test for Motor

Seal tightly all ports, except one location, of piping port of motor and apply compressed air 3 bar (3 kg/cm²) from opened port for 2 minutes under water. Air bubble should not be generated.

NOTE: *Working oil volume: 1.5 L*

PERFORMANCE TEST

Be sure to add a sufficient amount of working oil into motor case before carrying out performance test. Be sure to carry out performance test below after finishing servicing of TM motor.

If Test Equipment Is Available

If any built-in part has been replaced, be sure to carry out performance test after conducting test operation in accordance with following conditions:

1. Conditions for test operation
 - A. Rotating it right and left for 1 minute at no-load pressure of 20 rpm.
 - B. Rotating it right and left for 1 minute at no-load pressure of 10 rpm, 196 bar (200 kg/cm²).
 - C. Rotating it right and left for 1 minute on no-load pressure of 20 rpm.
2. Test conditions
 - A. Working oil: Wear-resistant working oil equivalent to ISO VG #46
 - B. Lube oil: Gear oil
 - C. Temperature
 - 1) Ambient temperature - Room temperature
 - 2) Working oil service temperature - 50 ±5°C
 - 3) Reduction gear case temperature - 40 ~ 80°C
 - D. Oil drain pressure: 0.8 bar (0.8 kg/cm²) or less

SECTION VIEW

Travel Motor

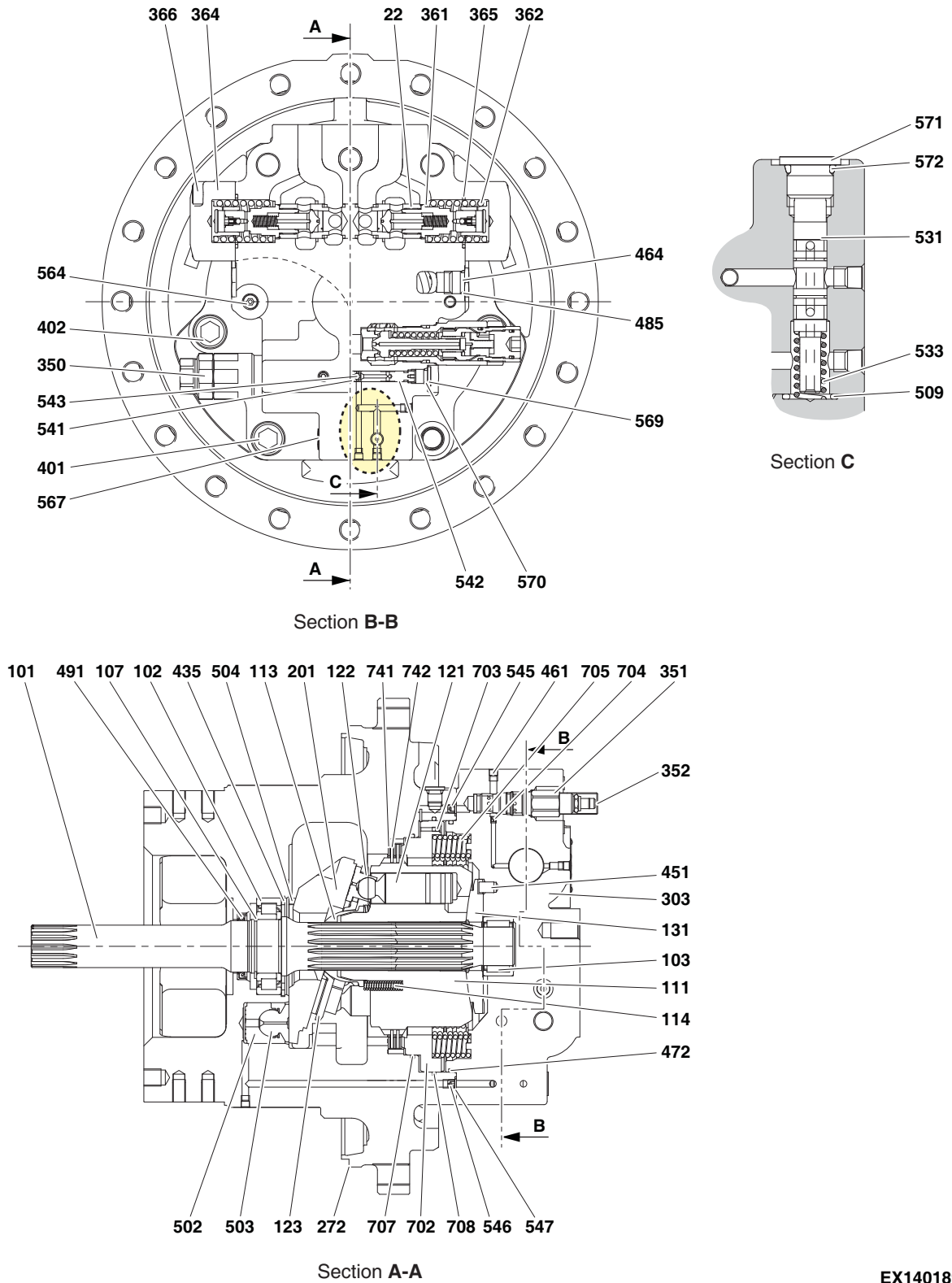


Figure 34

EX1401892

Reference Number	Description
22	Spool; Counter Balance
101	Shaft; Drive
102	Bearing; Roller
103	Bearing; Needle
107	Ring; Stop
111	Cylinder
113	Bush
114	Spring; Cylinder
121	Piston
122	Shoe
123	Plate; Set
131	Valve Plate
201	Plate; Swash
272	Case, Shaft
303	Valve Casing
350	Valve, Relief
351	Valve; Reducing
352	Cover
361	Washer
362	Spring; Counter Balance
364	Cover; Counter Balance
365	O-ring
366	Bolt; Socket M12 x 1.75 x 45
401	Bolt; Socket
402	Bolt; Socket
435	Ring; Snap
461	Plug
464	Plug
472	O-ring

Reference Number	Description
485	O-ring
491	Seal; Oil
502	Piston
503	Shoe
504	Ball; Pivot
509	O-ring
531	Spool; Tilting
533	Spring; Tilting
541	Seat
542	Stopper
543	Ball; Steel
545	Orifice
546	Orifice
547	O-ring
564	Plug
567	Plug
569	Plug
570	O-ring
571	Plug
572	O-ring
702	Piston, Brake
703	Orifice
704	Orifice
705	Spring; Brake
707	O-ring
708	O-ring
741	Plate; Separator
742	Plate; Friction
*	Seal Kit; Motor

*: 365, 472, 485, 491, 509, 547, 570, 572, 707, 708

Travel Reduction Gear

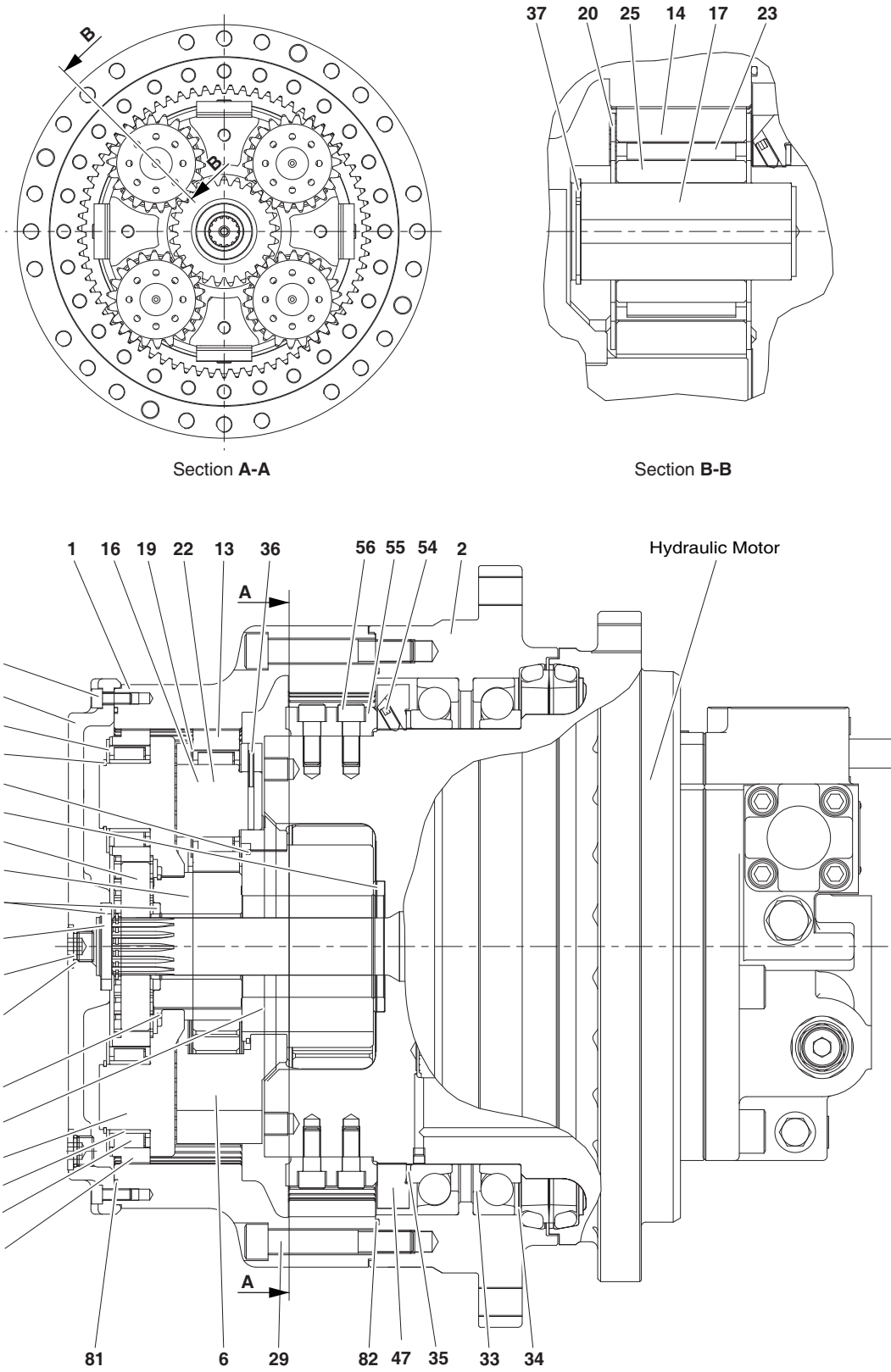


Figure 35

EX1401893

Reference Number	Description
1	Gear; Ring
2	Housing
4	Cover, Side
5	Carrier No. 1
6	Carrier No. 2
9	Gear; Sun No. 1
10	Gear; Sun No. 2
11	Gear; Sun No. 3
12	Gear; Planetary No. 1
13	Gear; Planetary No. 2
14	Gear; Planetary No. 3
16	Pin No. 2
17	Pin No. 3
18	Plate; Side E
19	Plate; Side A
20	Plate; Side F
21	Cage; Needle
22	Cage; Needle
23	Cage; Needle
24	Ring; Inner
25	Bush; Floating

Reference Number	Description
26	Ring; Thrust 60
27	Ring; Thrust 90
29	Bolt; Socket M16 x 100
30	Bolt; Socket
32	Plug
33	Bearing; Angular
34	Seal; Floating
35	Shim 1.0
36	Pin; Spring
37	Ring
44	Ring; Snap
45	Clip
46	Clip
47	Ring, Nut
54	Screw; Set
55	Stopper; Nutring
56	Bolt, Socket
81	O-ring
82	O-ring
83	O-ring

DISASSEMBLY

General Caution Matters

1. Use care so that contact surface of seals such as O-ring and oil seals, gears, pins, bearings, and sliding surface may not be damaged.
2. If disassembling this motor with it mounted on machine, use care that dust or foreign materials may not enter it.
3. The numbers in () behind part name indicate part indication No. on assembly cross section diagram.
4. The piping side of motor should be called Rear, while output side Front.

Reduction Gear

1. Choose a good place for disassembly work.
NOTE: *Choose a clean place. Place a rubber pad on work bench so that parts will not be damaged.*
2. Remove dust or foreign materials from surface of reduction gear.
3. Drain gear oil.
NOTE: *Drain gear oil into clean container and check it for contamination. Never reuse this gear oil.*
4. Place side cover (4) facing up and remove socket bolts (30). Remove side cover (4) and O-ring (81).



Figure 36

5. Remove No. 1 sun gear (9).



Figure 37

6. Remove No. 1 carrier (5) with No. 1 planetary gear (12) and No. 2 sun gear (10) assembled.



Figure 38

7. Disassemble No. 1 carrier subassembly.
 - A. Remove snap ring (44), disassemble side plate (18), No. 1 planetary gear (12), and needle cage (21).

NOTE: *If any flaking is found on surface of inner race (24), remove race from No. 1 carrier and replace it with a new one. At same time, replace No. 1 planetary gear and needle cage.*



Figure 39

- B. Remove snap ring (45), and remove No. 1 carrier (5) from No. 2 sun gear (10).

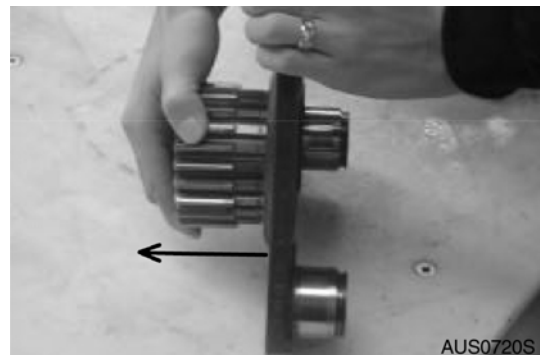


Figure 40

C. Remove thrust ring (26).



Figure 41

8. Disassemble No. 2 carrier (6), No. 2 planetary gear (13) and No. 3 sun gear (11).

NOTE: Attach two M10 eyebolts and lift No. 1 carrier with a crane.



Figure 42

9. Disassembly of No. 2 carrier subassembly.

A. Remove spring pin (36), and remove No. 2 pin (16) from No. 2 carrier.

NOTE: Check for following before disassembly, and if there is abnormality, disassemble it.

1. Check surface of planetary gear teeth for flaking or pitting.
2. Check for unusual noise or eccentricity while gently rotating planetary gear.



Figure 43

B. Remove side plate (19), No. 2 planetary gear (13), and needle cage (22) from No. 2 carrier.

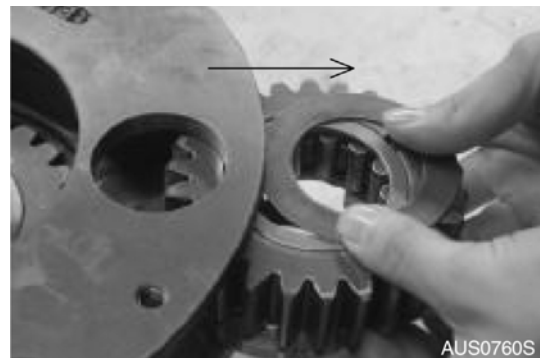


Figure 44

- C. Remove snap ring (46), and No. 2 carrier (6) from No. 3 sun gear (11).



Figure 45

10. Remove socket bolt (29), attach two M8 eyebolts, then use a crane to disassemble ring gear (1). Remove O-ring (82) from housing (2).

NOTE: Use a hex wrench and pipe to disassemble it. It has been coated with loctite for assembly.



Figure 46

11. Remove snap ring (37), and No. 3 pin (17) from shaft casing (272) on motor side.



Figure 47



Figure 48

12. Remove side plate (20), No. 3 planetary gear (14), needle cage (23), and floating bush (25) from shaft casing (272).



Figure 49

13. Remove set screw (54) from nut ring (047). Remove nut ring (47) from shaft casing (272).



Figure 50

NOTE: *After disconnecting nut ring from set screw, blow set screw assembly part to remove foreign materials and then disassemble nut ring by using jig for disassembling it.*



Figure 51

14. Remove housing (2), angular bearing (33), and floating seal (34) from shaft casing (272).

NOTE: *Attach two M16 eyebolts and use a crane to lift it.*



Figure 52

15. Remove floating seal (34) from housing (2). Do not damage it.

NOTE: *Be careful not to damage O-ring surface and seat.*



Figure 53

16. Remove floating seal (34) from shaft casing (272). Do not damage it.

NOTE: *Be careful not to damage O-ring surface and seat.*

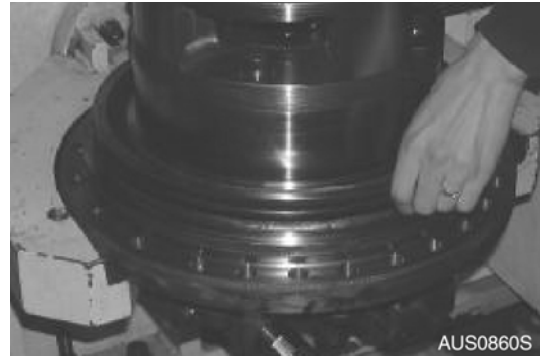


Figure 54

17. Remove angular bearing (33) from housing (2).

NOTE: *After disassembling bearing, it should be replaced.*



Figure 55

Hydraulic Motor

Disassembly of Main Body of Motor Section

1. Place output side of hydraulic motor facing down and fix it.



Figure 56

2. Remove relief valve (35), decompression valve (351), and adjustment cover (352) from valve casing (303). Remove plug.



Figure 57



Figure 58

3. After removing plug (564) from valve casing (303), insert M10 x 135 bolts into holes (2) for releasing brake restraint and tighten them to subassemble valve casing and brake piston.

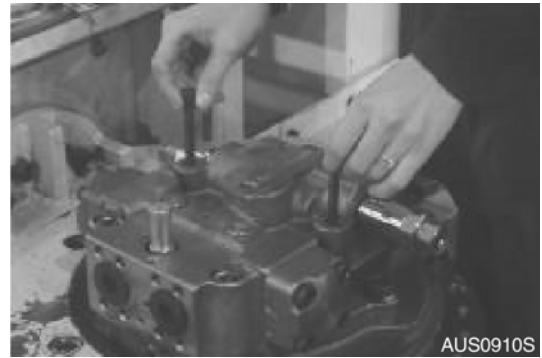


Figure 59

4. Remove socket bolts (401, 402) tightened with valve casing (303).



Figure 60

5. Remove socket bolts, and valve plate (131) together with valve casing subassembly.



Figure 61

6. Remove friction plate (742) and mating plate (741).

NOTE: *Be sure to place motor in a level position.*



Figure 62

7. Remove cylinder block and piston assembly

NOTE: *Be sure to place motor in level position.*

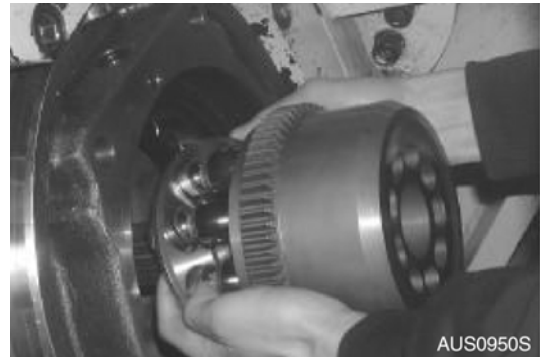


Figure 63

8. Remove swash plate (201).



Figure 64

9. Remove pivot ball (504) and tilting piston assembly.



Figure 65



Figure 66

10. Remove snap ring (435). Tap front side of drive shaft (101) with plastic hammer to remove it from shaft casing (272).

NOTE: *Do not disassemble roller bearing (102), if it does not need to be replaced.*

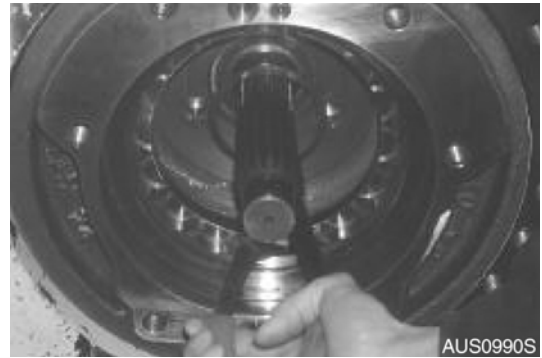


Figure 67

11. Remove oil seal (491) from shaft casing (272).

NOTE: *Never reuse oil seal (491). Replace it with a new one when assembling.*



Figure 68

Disassembly of Valve Casing Subassembly

1. Remove bolts for releasing brake restraint. Remove brake piston and valve casing.



Figure 69

2. Remove plug (571). Remove tilting spring (533) and tilting spool (531).



Figure 70

3. Remove socket bolt (366). Remove cover (364) and counterbalance valve assembly.

NOTE: *If counterbalance spool and counterbalance spring have been damaged, replace them with new ones.*

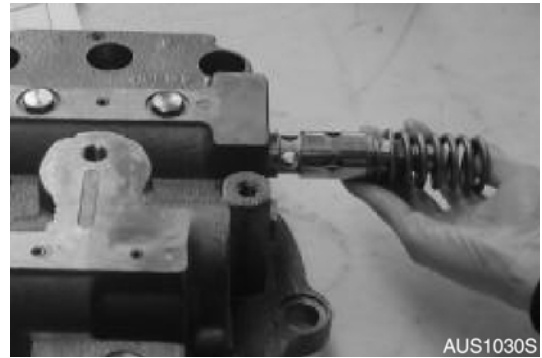


Figure 71

4. Remove plug (569) and high pressure select valve assembly.

NOTE: *Do not disassemble tilting switching system if it functions properly. Do not disassemble needle bearing (103) if it is OK.*



Figure 72

Disassembly of Cylinder Block Assembly

1. Remove cylinder block assembly with set plate (123), piston (121) and shoe (122) as one assembly.

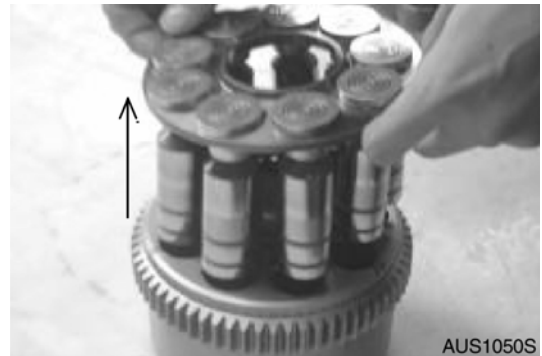


Figure 73

2. Remove spherical bushing (113) and cylinder spring (114).

NOTE: *The disassembly operation is up to here. Do not disassemble pin (451: for valve plate positioning) pressed into valve casing.*

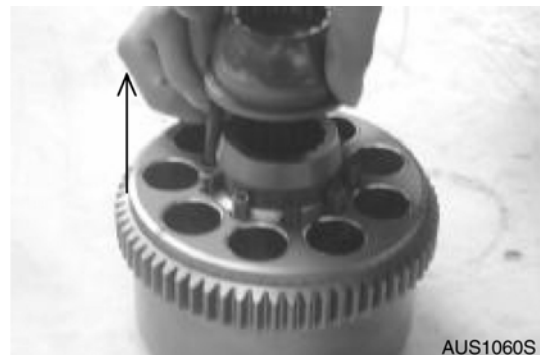


Figure 74

CLEANING AND INSPECTION

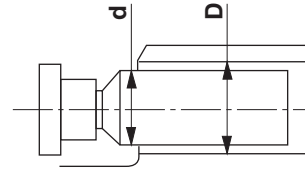
Maintenance Standard

Change parts with standard of following table. If parts have damages of external appearance, change without following table.

Changing Standard of Hydraulic Motor Part

Parts Name and Inspection Item		Standard Dimension	Recommended Value of Replacement	Remedy
Clearance (D-d) between piston and cylinder bore		0.52 mm	0.077 mm	Replace
Clearance between piston and shoe (δ)		0.1 mm	0.3 mm	
Shoe thickness		5.5 mm	5.3 mm	
Height (H-h) of spherical bushing and retainer place assembly		23.8 mm	23.3 mm	Replace with set
Free length of cylinder spring		40.9 mm	40.3 mm	Replace
Over pin diameter (4.5) of drive shaft	Drive spline	43.91 mm	43.31 mm	Even if one each of recommended value of replacement is not reached, replace.
	Cylinder spline	49.06 mm	48.46 mm	
Over pin diameter (4.5) of spline inside of cylinder and spherical bushing		35.25 mm	35.75 mm	Replace
Thickness of separate plate		1.5 mm	1.3 m	
Thickness of friction plate		3.9 mm	3.7 mm	
Free length of brake spring		42.4 mm	41.4 mm	
Base tangent length of cylinder outside (7 each)		50.02 mm	49.42 mm	
Over pin diameter (4.5) of inside gear of friction plate		152.97 mm	153.57 mm	
Roughness of sliding surface	Swash plate/shoe	0.4-Z	3-Z	Lap each
	Cylinder block/Valve plate	0.4-Z	3-Z	Joint lapping
Roller bearing/needle bearing				If there are flaking on sliding surface, replace.
O-ring/Oil seal				When disassembling, replace as a rule.
Kinds of bolt				If there are crushing parts, replace.

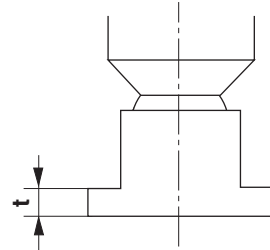
1. Clearance between piston and cylinder bore: $D-d$



EX1401904

Figure 75

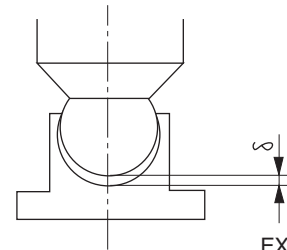
2. Thickness of shoe: t



EX1401905

Figure 76

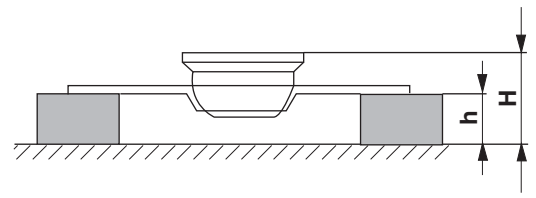
3. Vibration of vertical direction of piston and shoe: δ



EX1401906

Figure 77

4. Height difference of spherical bushing and pressure plate: $H-h$



EX1401907

Figure 78

REASSEMBLY

General Caution Matters

1. Clean each part with clean oil and then dry it with compressed air. Do not use an oil cloth, but if it is necessary to use one, be sure to use a clean one and use care that dust or dirt does not collect on it.
2. Use a torque wrench when tightening each bolt and plug. Apply tightening torque as shown in "Tightening Torque" on page 6-3-26.
3. If it is necessary to use a hammer, etc., use a plastic hammer to gently tap work piece into position.
4. Numbers in () behind part name indicate part indication No. on assembly cross section diagram.

Hydraulic Motor

Reassembling of Drive Shaft Subassembly

1. Press roller bearing (102) onto drive shaft (101).
Install snap ring (107).

NOTE: *Heat-fit roller bearing.*

NOTE: *Do not damage sliding part of oil seal of drive shaft. Use care that snap ring is properly seated into groove.*

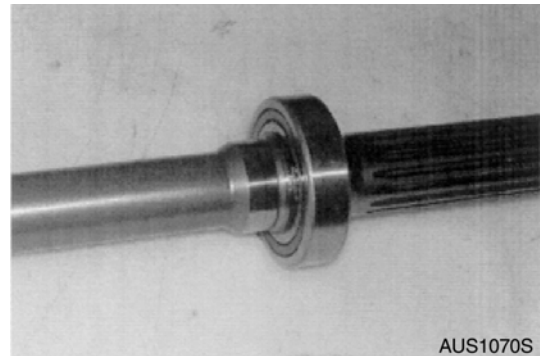


Figure 79

Assembly of Valve Casing Subassembly

1. Tighten plugs (461, 564) to valve casing (303) to specified torque.
 - Torque
 - Plug (461): 8.8 N.m (0.9 kg.m, 6.5 ft lb)
 - Plug (564): 21.6 N.m (2.2 kg.m, 15.8 ft lb)



Figure 80

2. Install pin (451).



Figure 81

3. Install needle bearing (103) (if assembling it newly) if removed during disassembly.



Figure 82

Assembly of Valve Casing Subassembly

1. Assemble seat (541), steel ball (543), stopper (542), and plug (569).

NOTE: *Be careful of assembly direction of seat and stopper.*

- Torque (Plug (569)): 36.3 N.m (3.7 kg.m, 26.6 ft lb)



Figure 83

2. Assemble counterbalance spool (360), washer (361), and counterbalance spring (362).

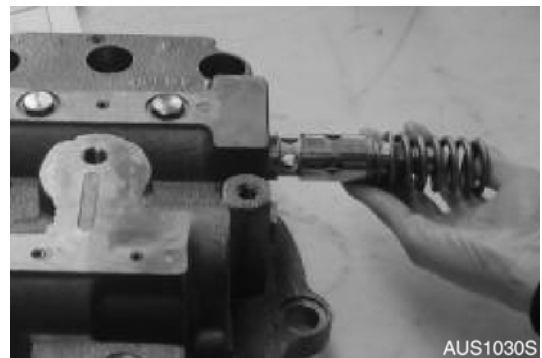


Figure 84

3. Attach cover (364) with socket bolt (366).
 - Torque (Socket bolt (366)): 98 N.m (10 kg.m, 72 ft lb)

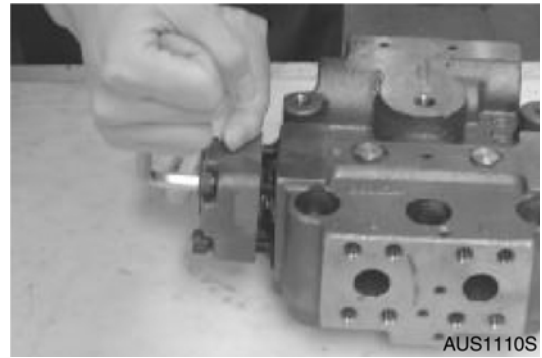


Figure 85

4. Install tilting spool (531), tilting spring (533), and plug (571).
 - Torque (Plug (571)): 73.5 N.m (7.5 kg.m, 54 ft lb)



Figure 86

5. Install orifice (703) into brake piston.
 - Torque: 3.4 N.m (0.4 kg.m, 2.5 ft lb)



Figure 87

6. Attach brake spring (705) to brake piston (702) and insert M10 x 135 socket bolts into holes for releasing brake restraint of valve casing (303) to assemble subassembly.

NOTE: After completing assembly of assembly, remove M10 x 135 L socket bolts (2).



Figure 88

Assembly of Cylinder Subassembly

1. Assemble cylinder spring (114) and spherical bushing (113) onto cylinder block (111).

NOTE: *Align cylinder with spline of spherical bushing.*

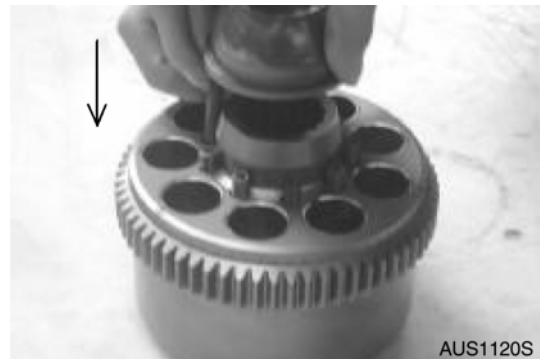


Figure 89

2. Insert piston (121) and shoe (122) assembly into plate (123) and assemble it on cylinder block.

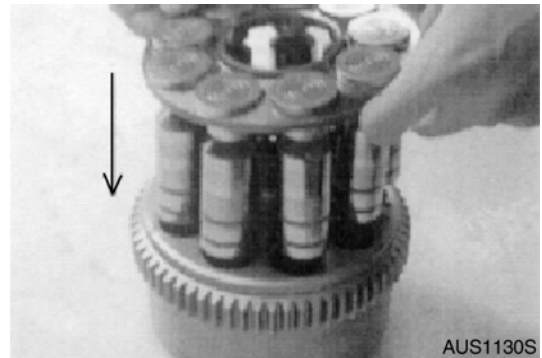


Figure 90

3. Assemble plug (461) and orifices (545 and 546) on shaft casing (272) to specified tightening torque.

- Torque:
 - Plug (461): 8.8 N.m (0.9 kg.m, 6.5 ft lb)
 - Orifices (545 and 546): 7 N.m (0.7 kg.m, 5 ft lb)



Figure 91



Figure 92

4. Use assembly jig for oil seal (491) to assemble oil seal (491) to shaft casing (272).



Figure 93

5. Fit drive shaft subassembly and assemble snap ring (435).

NOTE: Use key for outer race of roller bearing (102) and gently tap it with a hammer to assemble it.



Figure 94



Figure 95

6. Assemble tilting piston subassembly and pivot ball (504).



Figure 96



Figure 97

7. Coat rear side of swash plate (201) with and then assemble it to shaft casing (272).

NOTE: *Check swash plate for smooth movement.*



Figure 98

8. Turn shaft casing (272) so it is in a horizontal position and then assemble cylinder block subassembly.

NOTE: *Be care not to drop swash plate.*

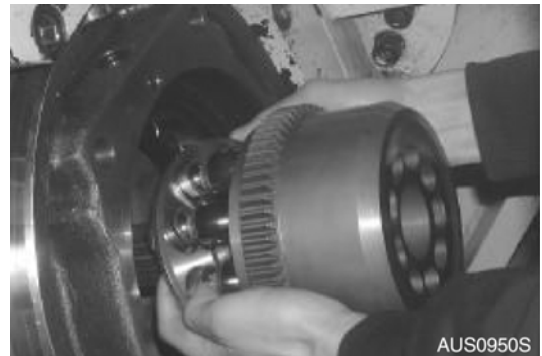


Figure 99

9. Turn shaft casing (272) so it is in a vertical position.



Figure 100

10. Assemble mating plate (741) and friction plate 742) onto shaft casing (272) and cylinder (111), respectively.



Figure 101

11. Assemble O-rings (707, 708) into shaft casing (272).

NOTE: *When reassembling, replace O-ring with a new one.*



Figure 102

12. Position valve plate (131, Figure 106) on valve casing subassembly and tighten socket bolts (401 and 402) to shaft casing.



Figure 103

NOTE: *Coat rear side of valve plate with grease, so that valve plate does not become disconnected.*

NOTE: *Use guide bolt.*

NOTE: *Coat needle bearing roller with grease, so that it can be easily assembled onto shaft.*

NOTE: *Use a crane when assembling valve casing to shaft casing.*

- Torque (Socket bolts (401 and 401)):
431.2 N.m (44 kg.m, 316.8 ft lb)



Figure 104

13. Assemble plug, relief valve (35), and decompression valve (351) into valve casing subassembly to specified torque.

- Torque
 - Relief valve (35):
176.4 N.m (18 kg.m, 129.6 ft lb)
 - Reducing valve (351):
44.1 N.m (4.5 kg.m, 32.4 ft lb)



Figure 105

14. Install adjustment cover (352).



Figure 106

15. Loosen bolts for releasing brake and then assemble plug (564).

- Torque (Plug (564)): 21.6 N.m (2.2 kg.m, 15.8 ft lb)



Figure 107

Reduction Gear

1. Assemble angular bearing (33) to housing (2).

NOTE: Use key and hammer to assemble angular bearings apiece at a time before pressing.

NOTE: When reusing housing, use M16 tap to completely remove adhesive such as Teflon from M16 thread.

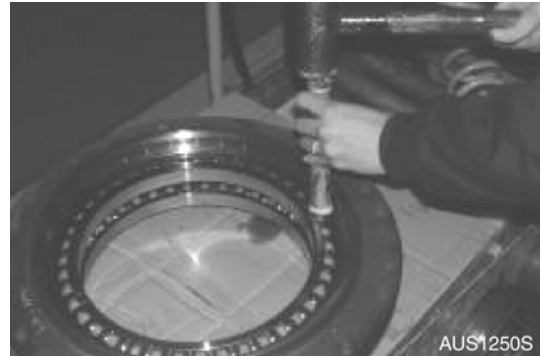


Figure 108

2. Assemble O-ring of floating seal (34) to seat and then to housing (2).

NOTE: Lightly coat O-ring with grease.

NOTE: When reassembling, use a new O-ring.



Figure 109

3. In same manner, assemble floating seal to shaft casing (272) of hydraulic motor.

NOTE: When reassembling, use a new O-ring.



Figure 110

4. Lift housing subassembly with floating seal facing down, and then insert inner diameter of angular bearing into outside of shaft casing.

NOTE: Do not damage sliding surface of floating seal.



Figure 111

- Position shim (35) on nut ring (47).

NOTE: Coat surfaces with grease between nut ring and shim.



Figure 112

- With bearing inserted, insert nut ring (47) with shim (35) into shaft casing. Use assembly jig to tighten it to specified torque.

NOTE: Tighten nut ring to shaft casing to maximum torque (490 N.m (50 kg.m)) and then disassemble it and reassemble it again to specified torque.

- Specified torque: 323.4 N.m (33 kg.m, 237.6 ft lb)



Figure 113

- Apply loctite in set screw hole of nut ring (47). Install set screw (54) in nut ring and caulk it to prevent it from backing out.

NOTE: Loctite specification: Three Bond 1373B.

- Specified torque: 49 N.m (5 kg.m, 36 ft lb)



Figure 114



Figure 115

8. Install thrust ring (27) on shaft casing (272).

NOTE: Use care to assembly direction for thrust ring (Guide groove should face up.).



Figure 116

9. Install needle cage (23) inside No. 3 planetary gear (14) and assemble side plate (20) on both sides, then insert gear assembly into shaft casing.

NOTE: Align pin hole of shaft casing with center of planetary gear.



Figure 117

10. Insert No. 3 pin (17) into shaft casing. Install snap ring (37).



Figure 118



Figure 119

11. Install O-ring (82) on housing (2), and lift ring gear (1) with a crane and position it on outer race of No. 3 planetary gear (14), then assemble housing (2).

NOTE: *Lightly coat O-ring with grease. When reassembling, use a new O-ring.*



Figure 120

12. Install socket bolts (29) to secure housing (2) and ring gear (1) together.

- Torque: 294 N.m (30 kg.m, 216 ft lb)

NOTE: *Use loctite: #636 on bolt threads.*



Figure 121

13. Assembly of No. 2 carrier subassembly

- A. Assemble No. 2 carrier (6) to No. 3 sun gear (11), and install clip (46).
- B. Place No. 2 carrier with No. 3 sun gear facing down.



Figure 122

- C. Install needle cage (22) inside No. 2 planetary gear (13). Place a side plate (19) on each side, then insert gear assembly into No. 2 carrier.



Figure 123

NOTE: *Align carrier pin with center of planetary gear.*



Figure 124

- D. Insert spring pin (36) into pin hole of No. 2 carrier and caulk it at two places with a punch so that it may not be fallen out.



Figure 125

14. Install two M10 eyebolts in No. 2 carrier subassembly. Using a crane, assemble No. 2 planetary gear and ring gear carefully.



Figure 126

15. Assembly of No. 1 carrier subassembly

- A. Fit inner race (24) in No. 1 carrier (5).

NOTE: *Heat inner race to ease installation.*



Figure 127

- B. Install No. 1 carrier (5) in No. 2 sun gear (10) and secure into position with clip (45).



Figure 128

- C. Position thrust ring (26) on No. 2 sun gear (10).

NOTE: Pay attention to assembly direction of thrust ring (Guide groove should face up.).



Figure 129

- D. Insert needle cage (21) inside No. 1 planetary gear (12), slide it into No. 1 carrier (6). Attach side plate (18), and install snap ring (44).



Figure 130

16. Carefully install No. 1 carrier subassembly and ring gear (1).



Figure 131

17. Position No. 1 sun gear (9) on motor shaft splines and engage No. 1 planetary gears.



Figure 132

18. Using ring gear (1) as a measuring surface, measure distance from it to top side of No. 1 sun gear.
- The dimension: A (the value after subtracting thickness of jig)



Figure 133

19. Using surface (P.C.I.D. 342) of side cover as measuring surface, measure depth from it to hole surface of P.C.S. 60.2.



Figure 134

- The dimension: B (the value after subtracting thickness of jig)
20. Select a thickness of washer (53) according to following formula:
- $1.5 \sim 2.0 = (B + A) - (\text{thickness of thrust} + \text{thickness of washer})$

NOTE: Maintain a clearance of 1.5 ~ 2.0 mm in shaft direction for No. 1 sun gear.

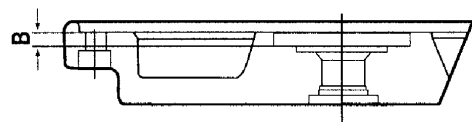


Figure 135

AUS1420S

21. Install washer (53) and thrust ring (26), which have been selected using above formula, on side cover (4).

NOTE: *Be sure to caulk thrust ring with guide groove facing up.*



Figure 136

22. Install new O-ring (81) on ring gear (1). Place side cover (4) onto ring gear, then tighten socket bolts (30) to specified torque.

- Specified torque: 34.3 N.m (3.5 kg.m, 25.2 ft lb)

NOTE: *When reassembling, use a new O-ring.*



Figure 137

23. Install plug (32) in side cover (4) to specified torque.

- Specified torque: 107.8 N.m (11 kg.m, 79.2 ft lb)



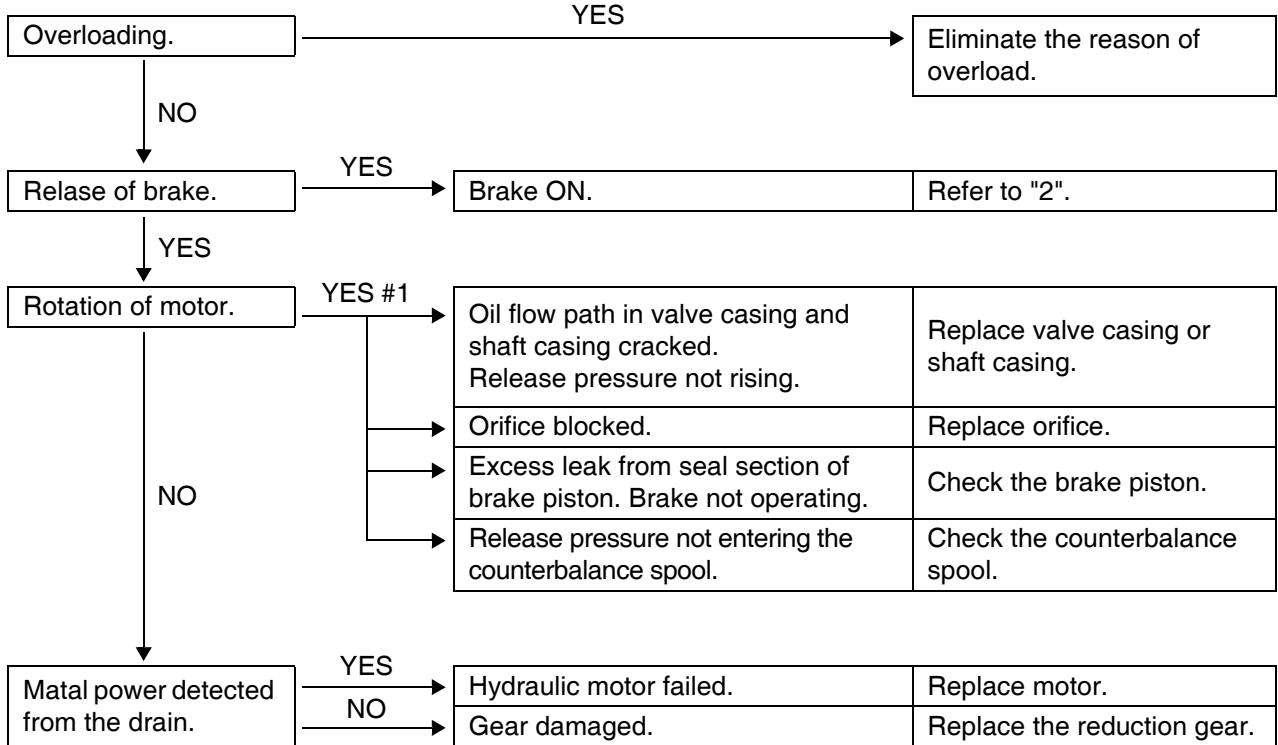
Figure 138

TROUBLESHOOTING

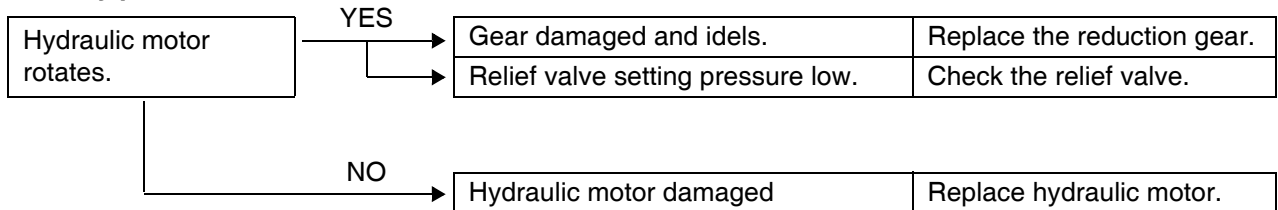
1. Travel motor does not rotate.

Check Item	NO	Cause	Remedies
------------	----	-------	----------

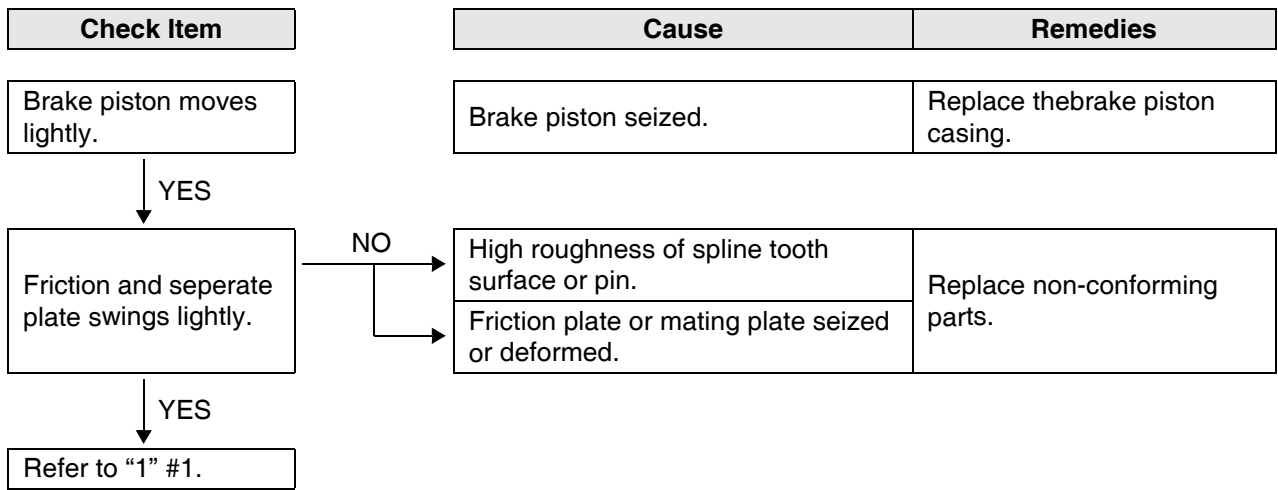
Delivery pressure rises.



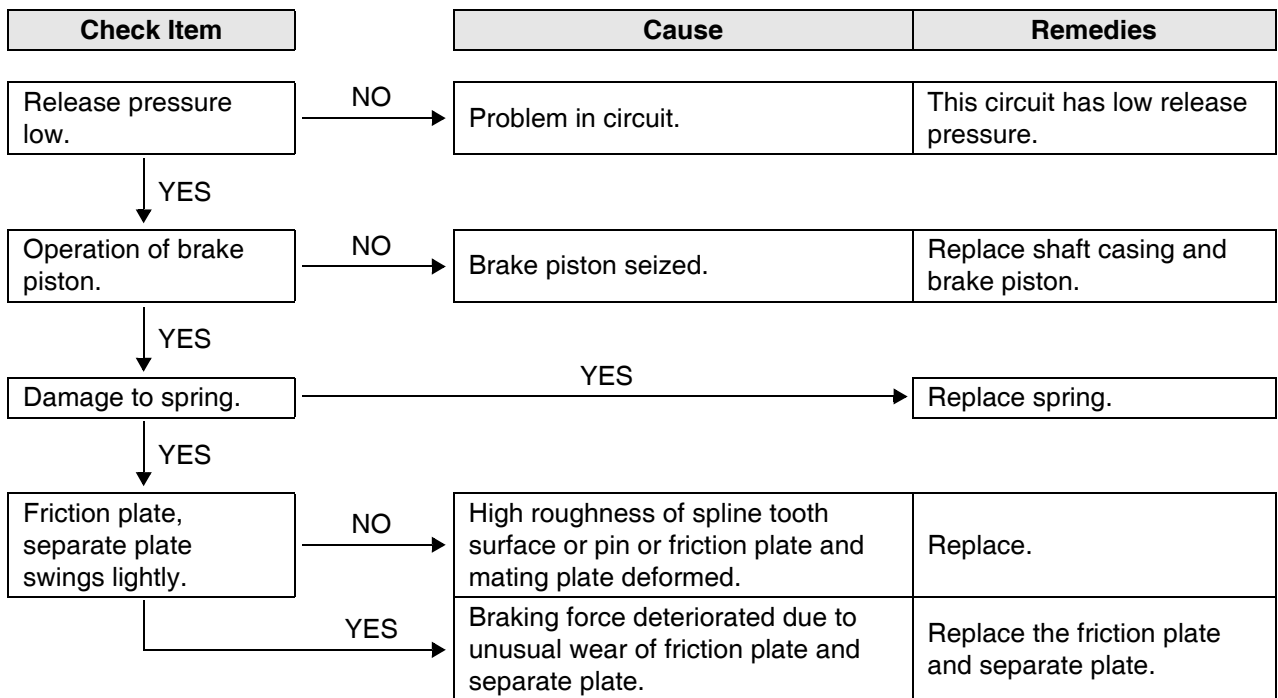
Delivery pressure does not rises.



2. Brake is not released.



3. Brake not engaged.



4. Oil leakage.

Check Item	Cause	Remedies
Oil leaks out assembled surface.	Loose bolt.	Tighten to the specified torque.
	O-ring damaged or poorly assembled.	Replace and reassemble O-ring.
	Poor roughness and flatness of assembled surface.	Replace any unstable part.
Oil leaks from the casing.	Abnormality in casting (Crack).	Replace.
Oil leaks from the floating seal.	Sliding surface damaged or seized	Replace.
	O-ring damaged and sealing force eteriorated.	Replace.
Oil leaks from the plug.	Plug loosened.	Tighten to the specified torque.
	Poor assembly of seal tape or O-ring.	Replace and reassemble seal tape and O-ring.

5. Temperature of casing is high (Atmospheric temperature +60°C or higher).

Check Item	Cause	Remedies
Reduction gearbox generates heat.		
Shortage of gear oil.	YES → Poor lubrication.	Supply the specified amount of gear oil.
	NO ↓	
Bearing damaged.	YES → Abnormal high temperature due to bearing damage.	Replace the bearing.
	NO → Gear damaged or broken.	Replace gear.
Unusual high-temperature of brake section.		
Release of brake.	YES → Bad precision of friction plate and mating plate.	Replace.
	NO → Brake engaged.	Refer to 2.

Track Assembly

Edition 1

MEMO

Table of Contents

Track Assembly

Safety Instructions	6-4-5
General	6-4-5
Track Tension	6-4-6
Track Shoes and Links	6-4-8
Track Removal	6-4-8
Track Installation	6-4-9
Track Shoe	6-4-10
Sprocket	6-4-12
Wear Limits and Tolerances	6-4-12
Front Idler	6-4-13
Front Idler Disassembly	6-4-13
Front Idler Reassembly	6-4-15
Upper Roller	6-4-16
Overview	6-4-16
Upper Roller Removal	6-4-17
Upper Roller Installation	6-4-17
Upper Roller Disassembly	6-4-18
Upper Roller Reassembly	6-4-19
Wear Limits and Tolerances	6-4-20
Lower Roller	6-4-21
Overview	6-4-21
Lower Roller Removal	6-4-22
Lower Roller Installation	6-4-22
Lower Roller Disassembly	6-4-23
Lower Roller Reassembly	6-4-24
Wear Limits and Tolerances	6-4-25
Track Adjuster	6-4-26
Disassembly	6-4-26
Assembly	6-4-27

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.

GENERAL

The track assembly is composed of the following major components:

1. Track
2. Front Idler
3. Upper Roller
4. Lower Roller
5. Track Spring and Track Adjuster

TRACK TENSION



WARNING

AVOID DEATH OR SERIOUS INJURY

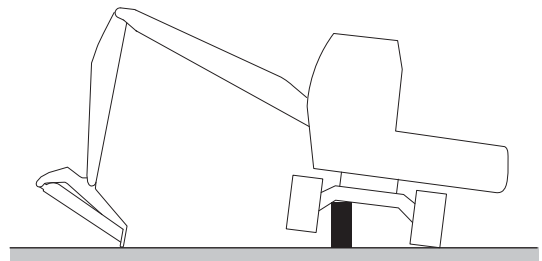
Measuring track tension requires two people. One person must be in the operator's seat, operating the controls while the other person makes dimensional checks. Block frame to make sure the machine won't move or shift position during service. Warm up the engine to prevent stalls, park the forestry machine in an area that provides level, uniform ground support and/or use support blocks when necessary.

The track adjusting mechanism is under very high-pressure. **NEVER** release grease pressure too fast. The track tension grease valve should never be loosened more than one (1) complete turn from the fully tightened down position. Bleed off grease pressure slowly. Keep your body away from the valve always. Always wear eye and face protection when adjusting track tension.

Track shoe link pins and bushings wear with normal usage, reducing track tension. Periodic adjustment is necessary to compensate for wear and it may also be required by working conditions.

1. Track tension is checked by jacking up one side of the forestry machine. See Figure 1. Place blocking under frame while taking measurement.

Turn the track backward 1 ~ 2 turns.



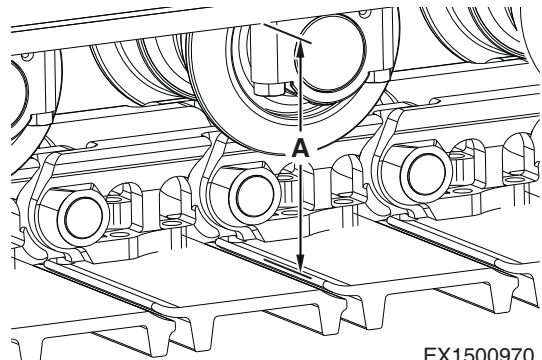
EX1300535

Figure 1

2. Measuring the distance (A, Figure 2) between the bottom of the side frame and the top of the lowest crawler shoe. Recommended tension for operation over most types of terrain is as below table.

NOTE: *Clean off the tracks before checking clearance for accurate measurements.*

3. Too little sag in the crawler track (less than clearance distance "A" on below table) can cause excessive component wear. The recommended adjustment can also be too tight causing accelerated stress and wear if ground conditions are wet, marshy or muddy.



EX1500970

Figure 2

- A track that is properly adjusted may have a different sag according to the track options. Contact your dealer for information.

Terrain Type	Distance "A"
Normal	365 ~ 395 mm (14.4 ~ 15.6 in)



WARNING

AVOID DEATH OR SERIOUS INJURY

The track adjusting mechanism is under very high-pressure. **NEVER** release grease pressure too fast. The track tension grease valve should never be loosened more than one (1) complete turn from the fully tightened down position. Bleed off grease pressure slowly. Keep your body away from the valve always. Always wear eye and face protection when adjusting track tension.

- Track tension adjustments are made through the grease fitting (1, Figure 3) in the middle of each side frame. Adding grease increases the length of an adjustment cylinder (2). Extending the adjustment cylinder, increases the pressure on the tension spring pushing the track idler wheel outward.
- If there is not enough slack or clearance in the tracks and the adjustment is too tight, the idler wheel and adjusting cylinder can be retracted by bleeding off grease through hole in adjustment cylinder (2, Figure 3).

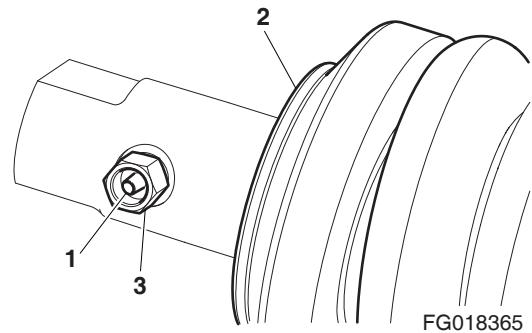
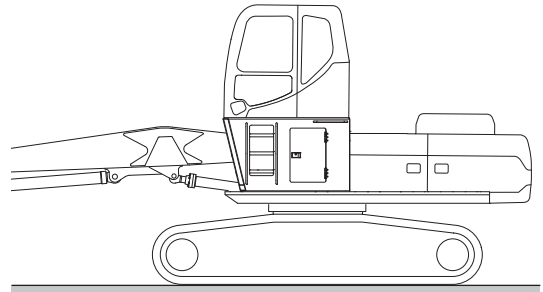


Figure 3

TRACK SHOES AND LINKS

Track Removal

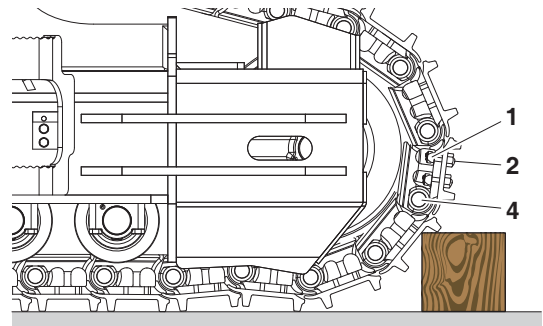
1. Position machine on a smooth level surface with adequate room for forward and reverse travel.



EX1504816

Figure 4

2. Move machine until master pin (4, Figure 6) is positioned at approximately 4 o'clock from top position on front idle roller.
3. Put a wooden block under track shoes, as shown.



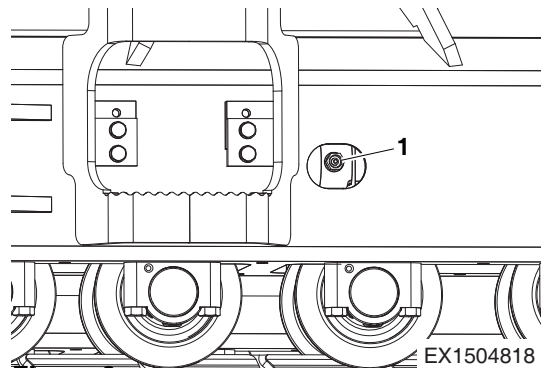
EX1504817

Figure 5

4. Loosen valve (1, Figure 7) for track adjuster to drain grease out. Use socket wrench 27 mm

NOTE: Loosen carefully, keeping face, hands, body away from the valve and nipple. Do not loosen valve Quickly.

5. Remove four nuts and bolts (1 and 2, Figure 6) holding shoe to link. Remove enough shoes to make access to master pin.
6. Remove master pin from master link by hammer or press. Remove pin after detaching shoe.

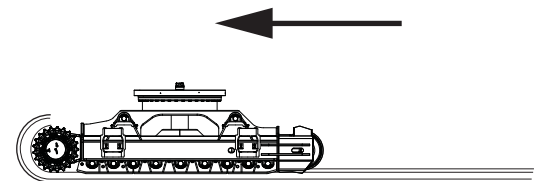


EX1504818

Figure 6

7. Move unit forward until entire track is laying on ground.

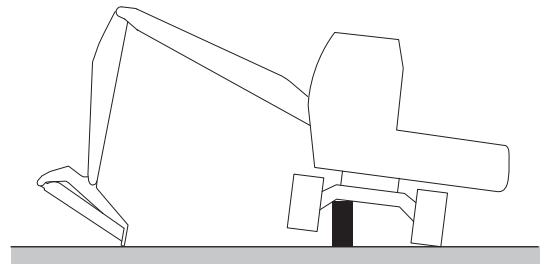
NOTE: Do not drive unit off track.



EX1504819

Figure 7

8. Rotate upper structure to 90° from track. Use bucket and boom to raise track frame off track.
9. Position blocking under frame.

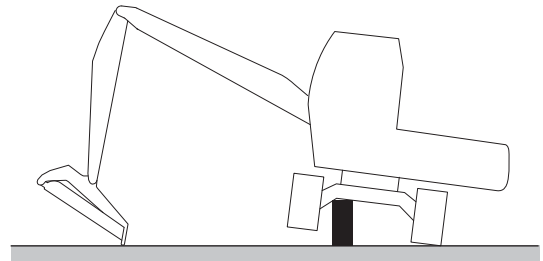


EX1300535

Figure 8

Track Installation

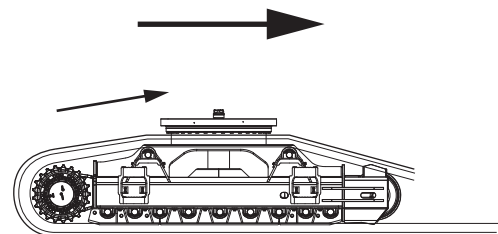
1. Lay rebuilt or new track into position under track frame. End of track must be positioned under drive sprocket.
2. With upper structure at 90° to track frame. Use bucket and boom to raise track frame off blocking.
3. With blocking removed, lower track frame onto track. Make sure all rollers are properly positioned on track.



EX1300535

Figure 9

4. Move unit forward while feeding track up over drive sprocket. Continue to pull track back until it engages front idle roller.
5. Align master links and install master pin.
6. Install four nuts and bolts (to fix track shoe).
7. Apply track tension. Refer to Track Tension on page -6" in this section for procedure.



EX1504820

Figure 10

Track Shoe

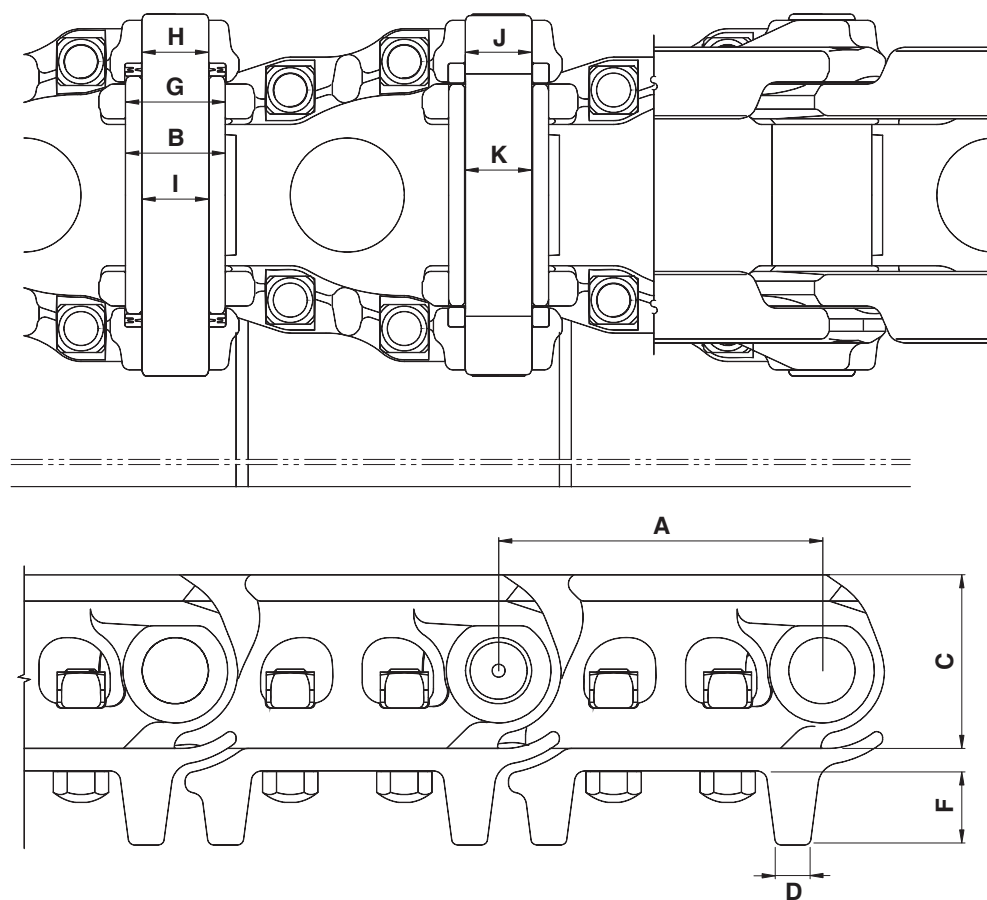


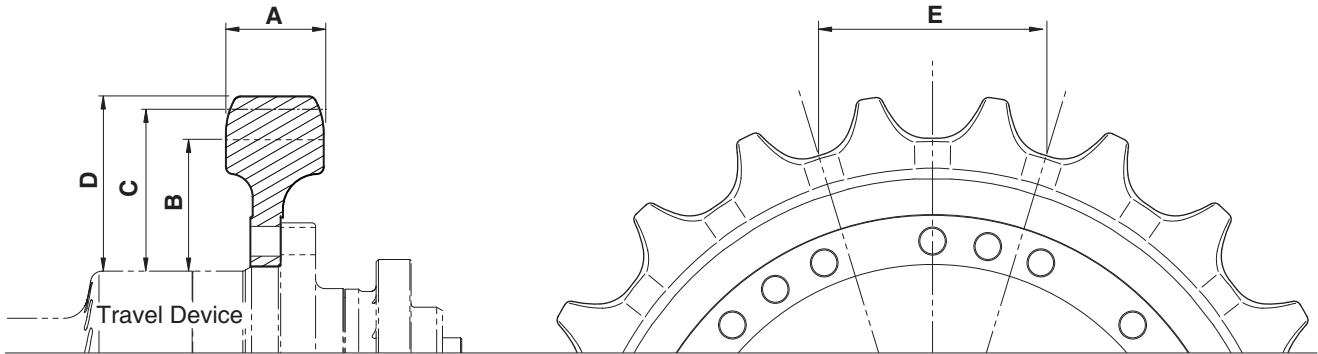
Figure 11

EX1504821

No.	Check Item	Standard Dimension			Recommended Limit for Maintenance		Limit for Use (Repair - P or Replace - R)
A	Link Pitch	216 mm (8.504")					
B	Bushing Outside Diameter	66.9 mm (2.634")			60 mm (2.362")		57 mm (R) (2.244")
C	Link Height	116 mm (4.567")			108 mm (4.252")		103 mm (P) (4.055")
D	Length at Tip	23 mm (0.906")					
F	Height of Tip	49.5 mm (1.949")			28 mm (1.102")		21 mm (0.827")
G	Interference Between Bushing and Link	Bushing	Tolerance	Link	Tolerance	Standard Interference	Repair Limit
		66.91 mm (2.634")	+0.050 0.0	66.5 mm (2.618")	+0.074 0.0	0.336 ~ 0.460	
H	Interference Between Regular Pin and Link	Regular Pin	Tolerance	Link	Tolerance	Standard Interference	Repair Limit
		44.75 mm (1.761")	+0.05 0.0	44.35 mm (1.746")	+0.05 0.0	0.35 ~ 0.45	
I	Clearance Between Regular Pin and Bushing	Regular Pin	Tolerance	Bushing	Tolerance	Standard Clearance	Repair Limit
		44.75 mm (1.761")	+0.05 0.0	45.45 mm (1.789")	+0.500 0.0	0.65 ~ 1.20	
J	Interference Between Master Pin and Link	Master Pin	Tolerance	Link	Tolerance	Standard Interference	Repair Limit
		44.6 mm (1.756")	+0.030 0.0	44.35 mm (1.746")	+0.05 0.0	0.200 ~ 0.280	
K	Clearance Between Master Pin and Bushing	Master Pin	Tolerance	Bushing	Tolerance	Standard Clearance	Repair Limit
		44.3 mm (1.744")	±0.050	45.45 mm (1.789")	+0.500 0.0	1.600 ~ 1.700	

SPROCKET

Wear Limits and Tolerances



EX1401952

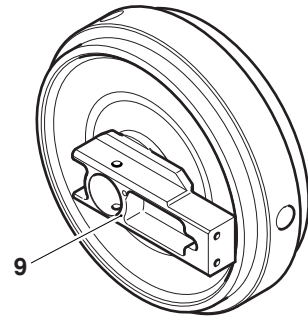
Figure 12

No.	Check Item	Standard Dimension	Allowable Limit for Maintenance	Limit for Use (Repair - P or Replace - R)
A	Tooth Width	84 mm (3.307")	-	-
B	Tooth Bottom Surface	108 mm (4.252")	105 mm (4.134")	104 mm (R) (4.094")
C	Pitch Circle Dimension	141.4 mm (5.567")	-	-
D	Tooth Top Land	146 mm (5.748")	143 mm (5.630")	141 mm (R) (5.551")
E	Accumulated Pitch Tolerance	216 mm (8.504")	-	-

FRONT IDLER

Front Idler Disassembly

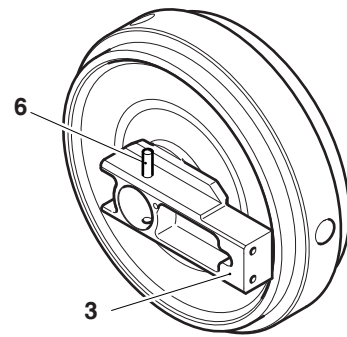
1. Remove plug (9, Figure 15) from idler assembly (1), and drain oil into a suitable container.



FG003914

Figure 13

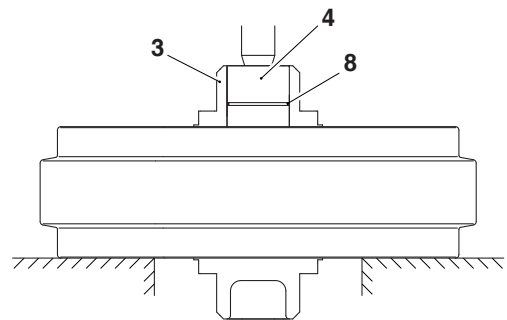
2. Separate the pin (6, Figure 16) from the bearing (3).



FG003915

Figure 14

3. Use a press to remove bearing from the axle (4). Separate the O-ring (8, Figure 17) from the axle.



FG001482

Figure 15

4. Detach the floating seal (7, Figure 18) from the idler (2) and bearing (3).

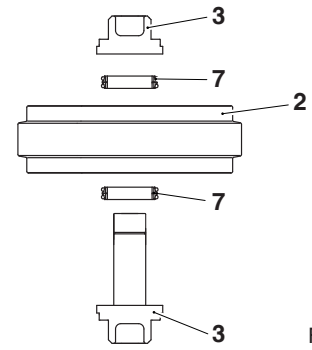


Figure 16

FG001483

5. Use a press to separate the axle (4, Figure 19), O-ring (8) and bearing (3).

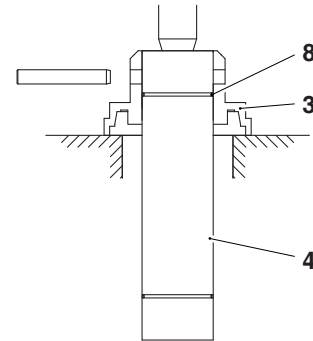


Figure 17

FG001484

6. Remove bushing (5, Figure 20) with the press and special tool (10, ST-1909).

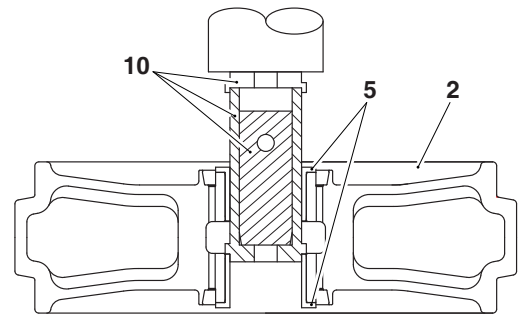


Figure 18

FG001485

Front Idler Reassembly

1. Degrease, clean and dry all parts before reassembly. Insert bushing (5, Figure 20) into the idler (2).
2. Grease O-ring (8, Figure 21) and insert it into the axle.
3. Align the bearing (3, Figure 21) and axle (4) holes and pin (6) them together.

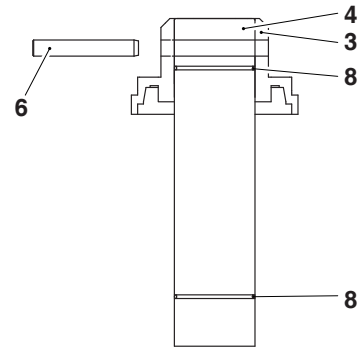


Figure 19

FG001486

4. Install floating seal (7, Figure 22) inside the idler (2) and bearing (3).

NOTE: Apply clean engine oil to the joint side of the floating seal. Apply grease to the floating seal O-ring.

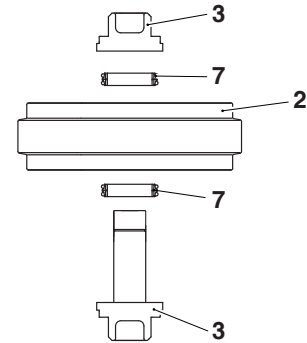


Figure 20

FG001483

5. Install idler (2, Figure 23) on the axle.
6. Install bearing (3, Figure 23) and pin (6) to the axle.

NOTE: Fill the idler assembly with new gear oil (ISO VG 220 EP/VI 130) with approximately 420 cc (14.2 oz).

7. Install plug (9, Figure 43) on the bearing.

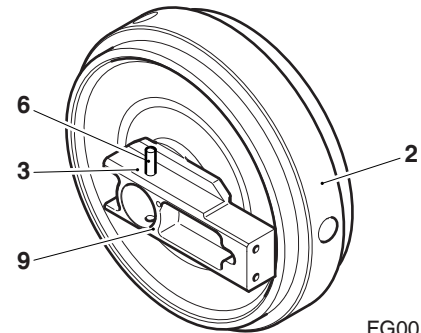


Figure 21

FG001488

UPPER ROLLER

Overview

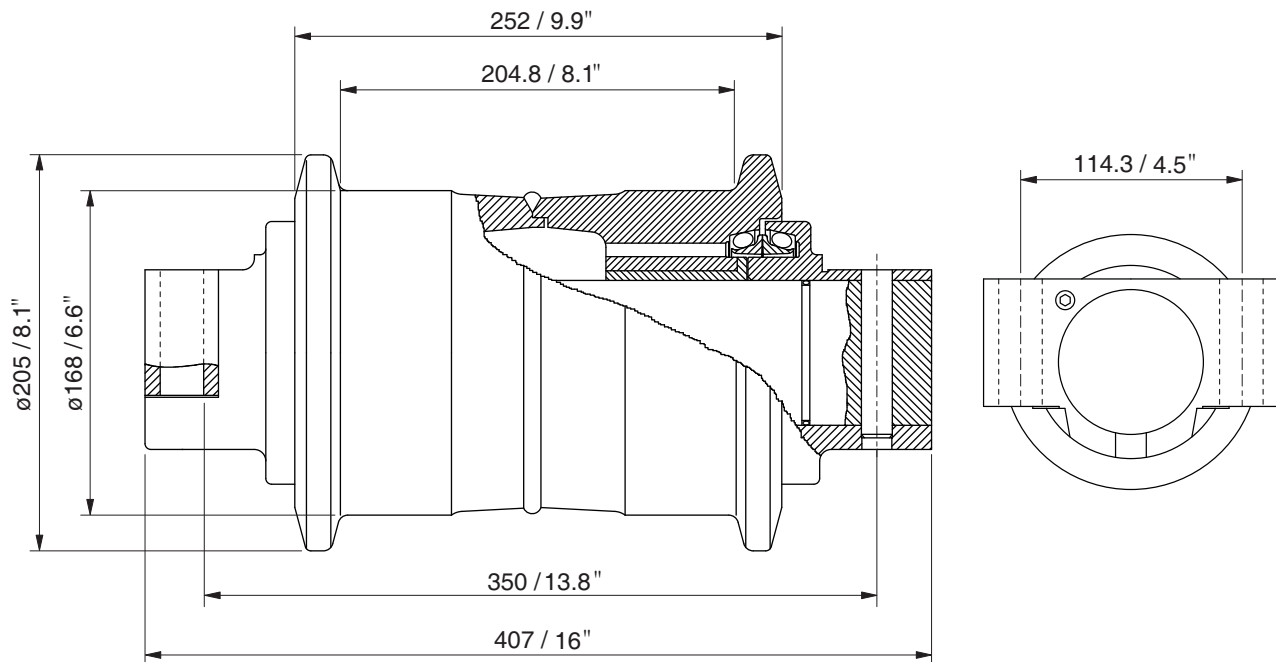


Figure 22


EX1504822

NOTE: Unit: mm (1 mm = 0.039 in)

- Wight: 40 kg (88 lb)

Upper Roller Removal

1. Relieve track tension (1, Figure 26). This will allow track to be raised so links clear top of roller.
2. Position a bottle jack on top of track frame and apply pressure to track shoe.
3. Remove mounting bolts (2, Figure 26) upper roller to track frame.

- Tool: 30 mm ()



WARNING

AVOID DEATH OR SERIOUS INJURY

The track adjusting mechanism is under very high-pressure. **NEVER** release grease pressure too fast. The track tension grease valve should never be loosened more than one (1) complete turn from the fully tightened down position. Bleed off grease pressure slowly. Keep your body away from the valve at all times. Always wear eye and face protection when adjusting track tension.

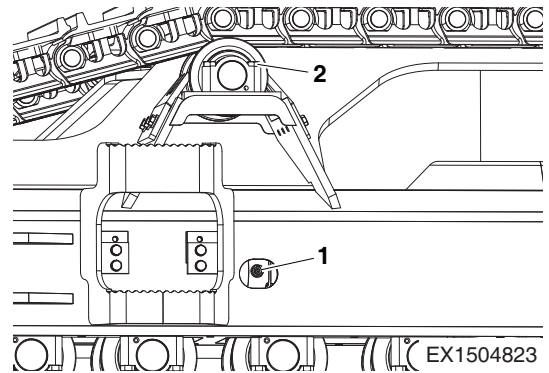


Figure 23

Upper Roller Installation

1. Perform installation in the reverse order of removal.
 - Torque (2, bolt): 539 N.m (55 kg.m, 398 ft lb)

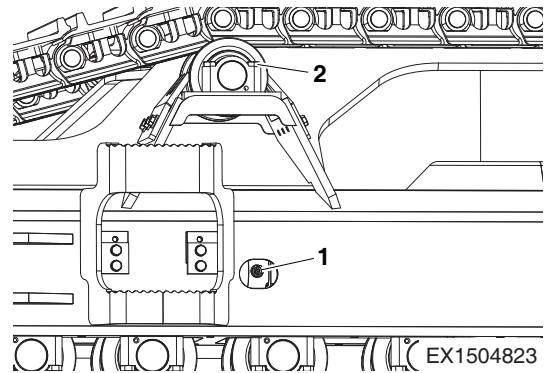
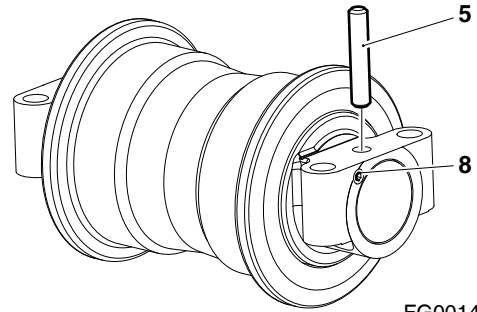


Figure 24

Upper Roller Disassembly

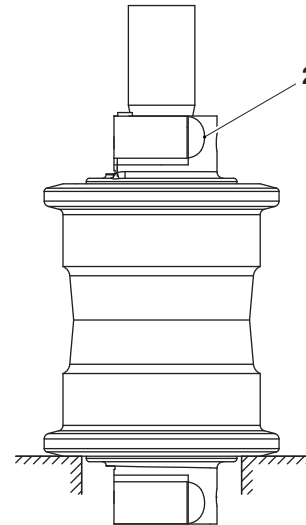
1. Remove plug (8, Figure 28) from the collar and drain oil.
2. Pull the pin (5, Figure 28) from the collar.



FG001489

Figure 25

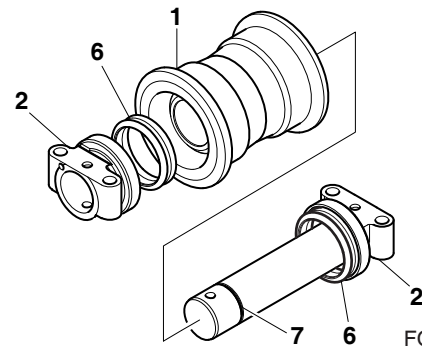
3. Separate the collar (2, Figure 29) from the axle, using press.



FG001490

Figure 26

4. Detach O-rings (7, Figure 30) from the axle.
5. Separate floating seals (6, Figure 30) from the collar and roller (1).
6. Detach collar (2, Figure 30) and O-rings (7) from the axle, using press.



FG001493

Figure 27

Upper Roller Reassembly

1. Degrease, clean and dry all parts before reassembly. Insert bushing (4, Figure 31) into roller.

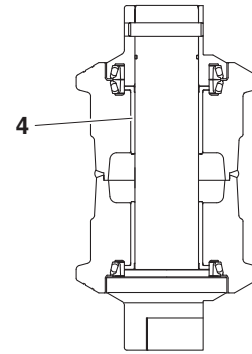


Figure 28

2. Apply grease to the O-rings (7, Figure 32) and insert into axle.
3. Align collar (2, Figure 32) and axle (3) pinholes and pin (5) the collar.

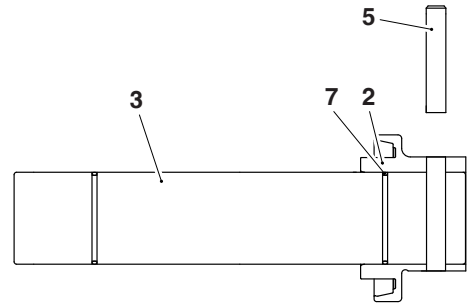


Figure 29

4. Insert floating seals (6, Figure 33) into the roller (1) and collar (2).

NOTE: Apply clean gear oil to the joint side of the floating seal. Apply grease to the floating seal O-ring.

5. Slide the axle inside the roller.

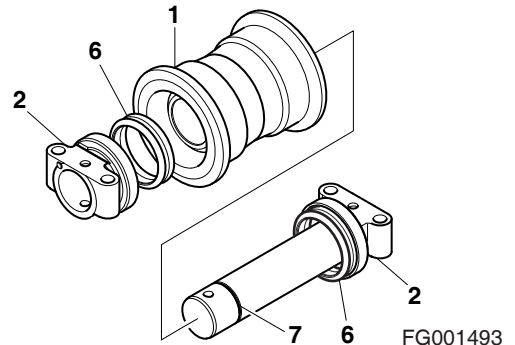


Figure 30

6. Install the collar (2, Figure 34), O-ring (7), and pin (5) on the remaining side.
7. Fill with clean engine oil (SAE #30) with approximately 550 ±30 cc (0.14 U.S. gal)
8. Install plug (8, Figure 34) on the collar.

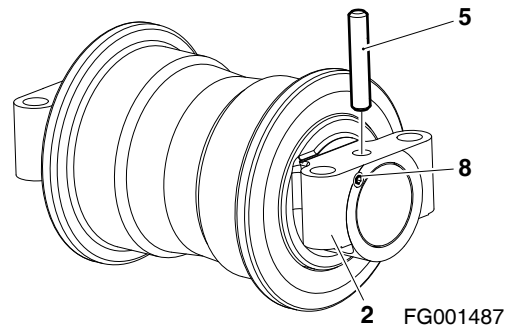
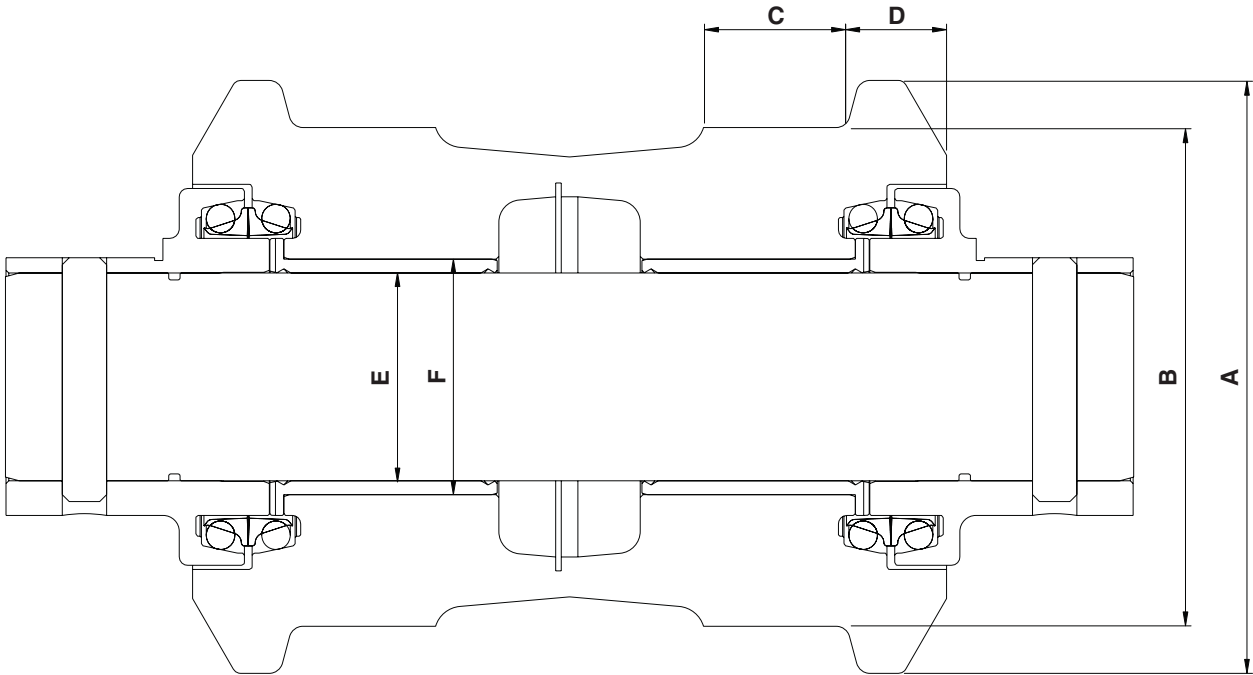


Figure 31

Wear Limits and Tolerances



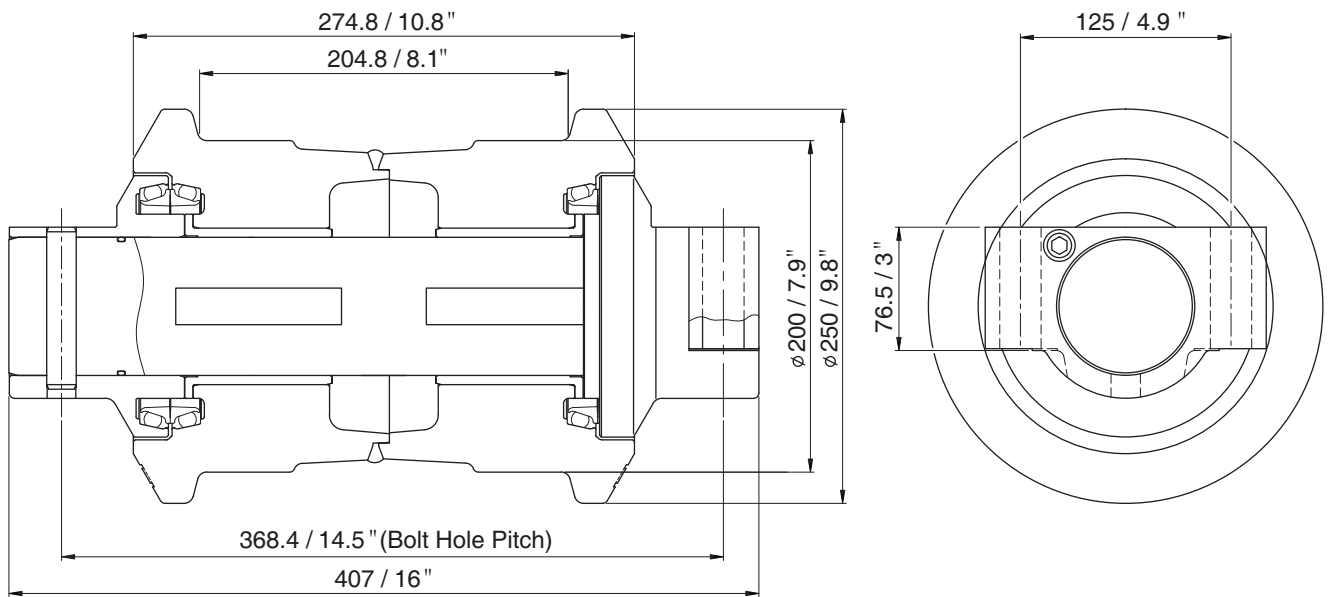
EX1504825

Figure 32

No.	Check Item	Standard Dimension	Recommended Limit for Maintenance		Limit for Use (Replace - R)	
A	Outside Diameter of flange	205 mm (8.071")				
B	Outside Diameter of Tread	168 mm (6.614")	156 mm (6.142")		152 mm [R] (5.984")	
C	Width of Tread	53.4 mm (2.102")	59.4 mm (2.338")		61.4 mm [R] (2.421")	
D	Width of Flange	23.6 mm (0.930")				
E	Clearance between shaft and bushing	Standard Dimension	Tolerance		Standard Interference	Repair Limit
		75 mm (2.953")	Shaft	Bush		
			0	+0.450	0.400 ~ 0.480	1.5 mm [R] (0.059")
			-0.03	+0.400		
F	Interference between roller and bushing	Standard Dimension	Tolerance		Standard Interference	Repair Limit
		85 mm (3.346")	Bush	Body		
			+0.159	+0.054	0.070 ~ 0.159	
			+0.124	0		

LOWER ROLLER

Overview





EX1504826

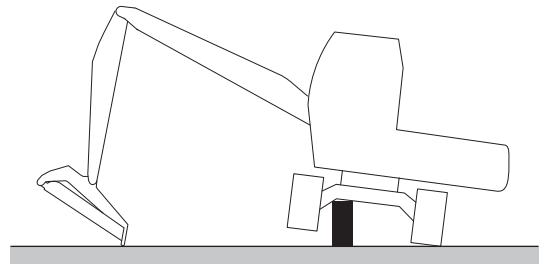
Figure 33

NOTE: Unit: mm (1 mm = 0.039 in)

- Weight: 75 kg (165 lb)

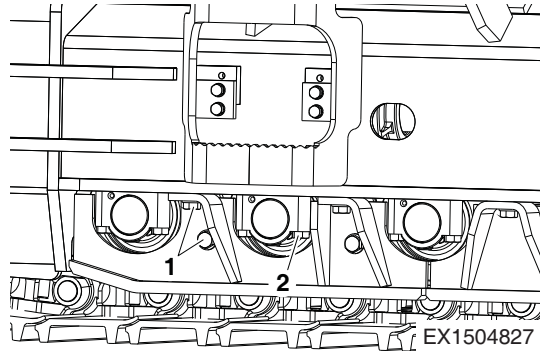
Lower Roller Removal

1. Relieve track tension. Refer to "Track Tension" in this section for procedure.
2. Swing upper structure at 90° to frame.
3. Using bucket raise track off ground and place blocking under frame.
4. Remove bolts (1, Figure 38) of track guard.
 - Tool: 32 mm ()
 - Torque: 735.5 N.m (75 kg.m, 542.5 ft lb)
5. Remove four bolts (2, Figure 39) and lower roller from track frame. There is an alignment pin on each end of lower roller.
 - Tool: 32 mm ()
 - Torque: 735.5 N.m (75 kg.m, 542.5 ft lb)



EX1300535

Figure 34

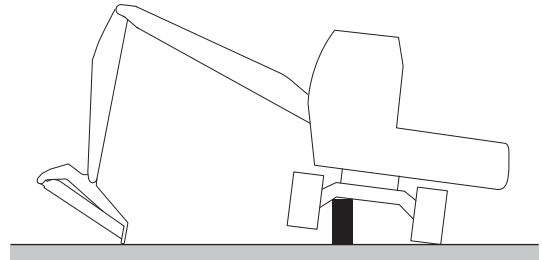


EX1504827

Figure 35

Lower Roller Installation

1. Install four bolts to hold lower roller to track frame.

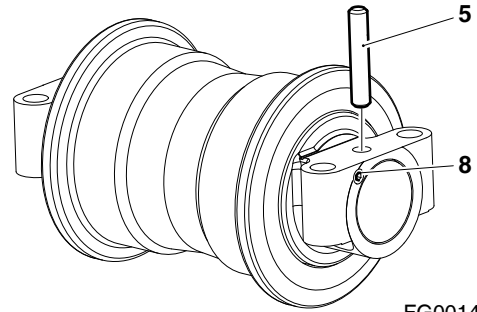


EX1300535

Figure 36

Lower Roller Disassembly

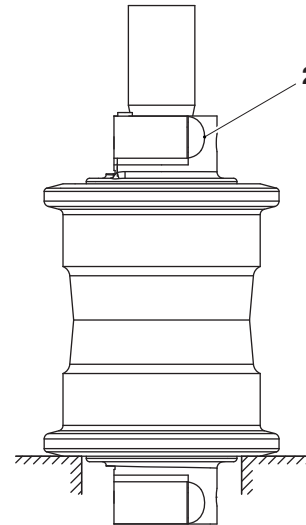
1. Remove plug (8, Figure 41) from the collar and drain oil.
2. Pull the pin (5, Figure 41) from the collar.



FG001489

Figure 37

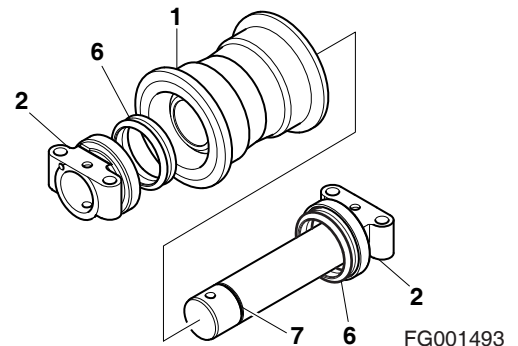
3. Separate the collar (2, Figure 42) from the axle, using press.



FG001490

Figure 38

4. Detach O-rings (7, Figure 43) from the axle.
5. Separate floating seals (6, Figure 43) from the collar and roller (1).
6. Detach collar (2, Figure 43) and O-rings (7) from the axle, using press.

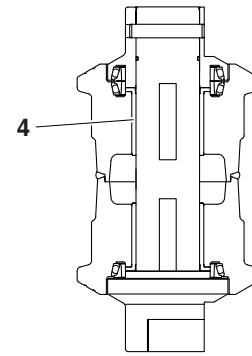


FG001493

Figure 39

Lower Roller Reassembly

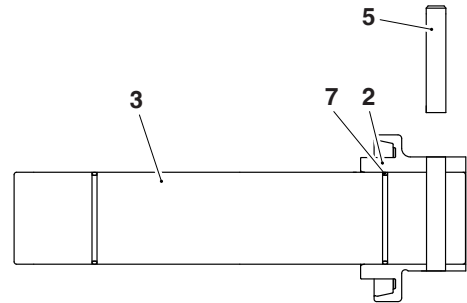
1. Degrease, clean and dry all parts before reassembly. Insert bushing (4, Figure 44) into roller.



FG019396

Figure 40

2. Apply grease to the O-rings (7, Figure 44) and insert into axle.
3. Align collar (2, Figure 45) and axle (3) pinholes and pin (5) the collar.



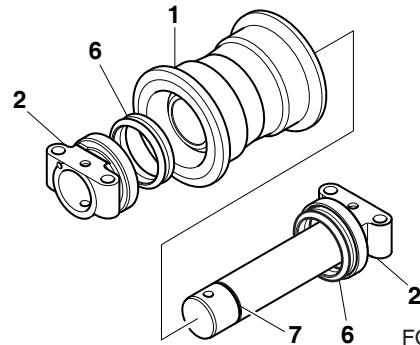
FG001492

Figure 41

4. Insert floating seals (6, Figure 46) into the roller (1) and collar (2).

NOTE: Apply clean gear oil to the joint side of the floating seal. Apply grease to the floating seal O-ring.

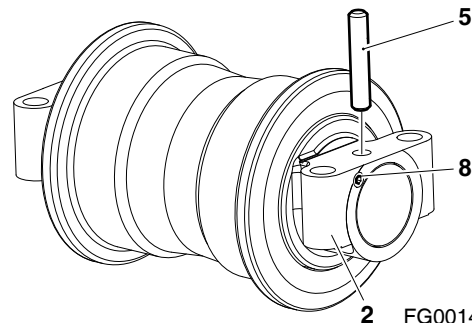
5. Slide the axle inside the roller.



FG001493

Figure 42

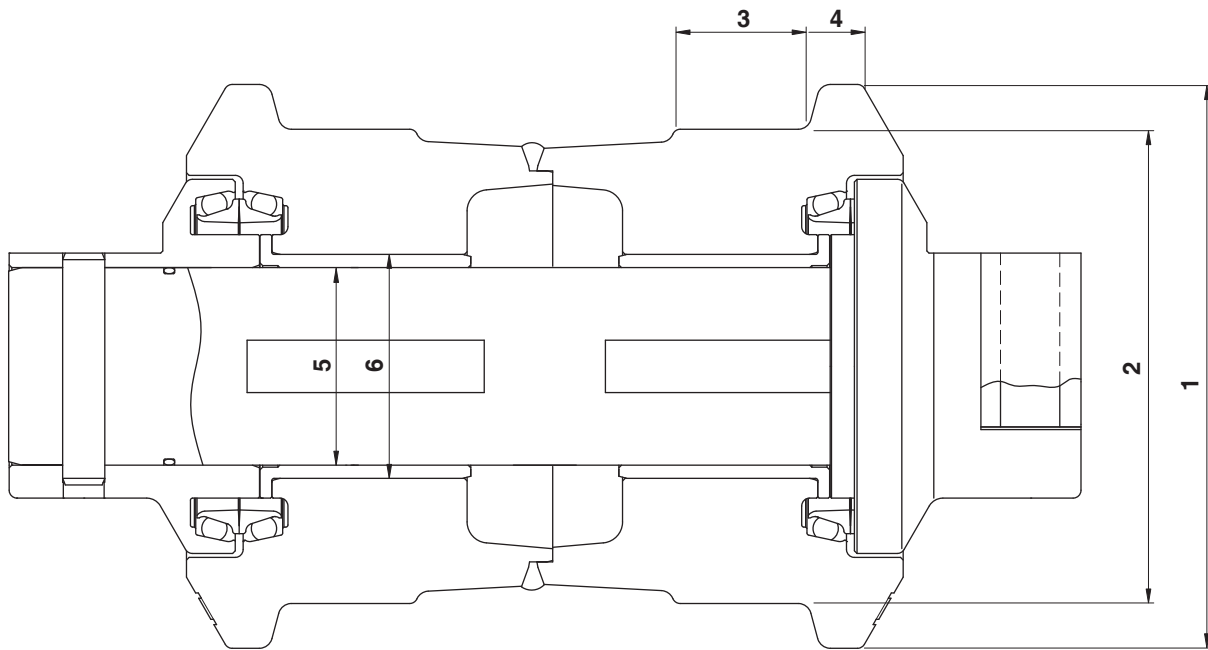
6. Install the collar (2, Figure 47), O-ring (7), and pin (5) on the remaining side.
7. Fill with clean engine oil (SAE #30) with approximately 480 ±30 cc (0.13 U.S. gal).
8. Install plug (8, Figure 47) on the collar.



2 FG001487

Figure 43

Wear Limits and Tolerances



FG018733

Figure 44

No.	Check Item	Standard Dimension	Recommended Limit for Maintenance		Limit for Use (Repair - P or Replace - R)	
1	Outside Diameter of Flange	214 mm (8.425")				
2	Outside Diameter of Tread	180 mm (7.087")	168 mm (6.614")		166 mm (P) (6.535")	
3	Width of Tread	51 mm (2.008")	57 mm (2.244")		60 mm (P) (2.362")	
4	Width of Flange	36 mm (1.417")				
5	Clearance Between Shaft and Bushing	Standard Dimension	Tolerance		Standard Clearance	Repair Limit
		75 mm (2.953")	Shaft	Hole		
6	Interference Between Roller and Bushing	Standard Dimension	Tolerance		Standard Interference	Repair Limit
		82 mm (3.228")	Shaft	Hole		

TRACK ADJUSTER

Disassembly

1. Apply pressure on spring (6, Figure 50) with a press.

NOTE: *The spring is under a large installed load.
This is dangerous, so be sure to set properly.*

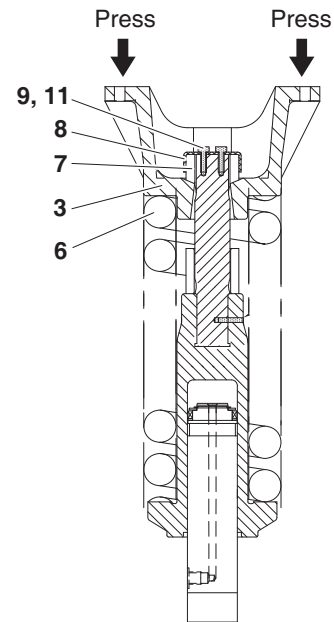
- Spring set load: 19,100 kg (42,108 lb)

2. Remove bolt (9, Figure 50), spring washer (11) and lock plate (8).

3. Remove lock nut (7, Figure 50).

NOTE: *Take enough notice so that the press which pushes down the spring, should not be slipped out in its operation.*

4. Tighten the press load slowly and remove bracket (3, Figure 50) and spring (6).

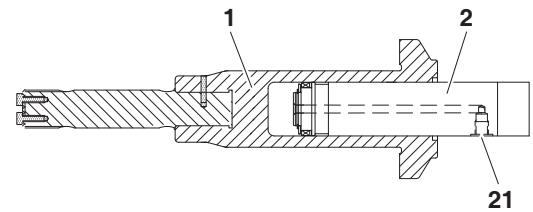


EX1400069

Figure 45

5. Remove piston rod (2, Figure 51) from body (1).

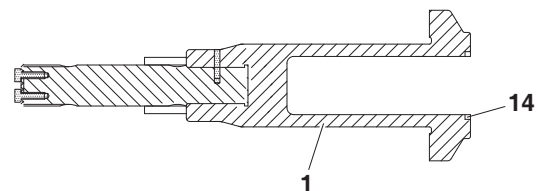
6. Remove grease valve (21, Figure 51) from piston rod (2).



EX1400070

Figure 46

7. Remove dust seal (14, Figure 52) from body (1).



EX1400071

Figure 47

- Remove stop ring (17, Figure 53), plate (16), backup ring (13), packing (12) and piston ring (15) from piston rod (2).

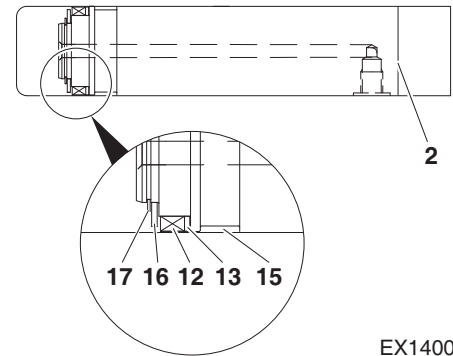


Figure 48

EX1400072

Assembly

- Install piston ring (15, Figure 54), packing (12), backup ring (13), plate (16) and stop ring (17) to piston rod (2).

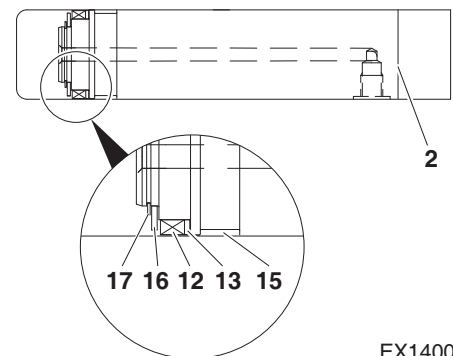


Figure 49

EX1400072

- Install dust seal (14, Figure 55) to body (1).

NOTE: When installing piston ring (15), packing (12), dust seal (14) take full care as not to damage the lip.

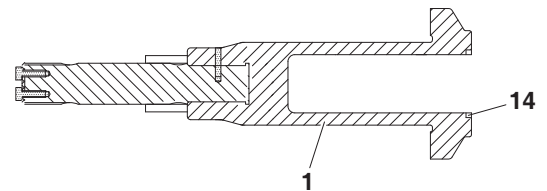


Figure 50

EX1400071

- Grease into body (1, Figure 56), then push in piston rod (2) by hand.

NOTE: Fill up "B" part with grease. Press fit the piston rod (2, Figure 56) by maximum to *105 mm. Remove air in the "B" part and the piston rod and install the grease valve (21).

NOTE: If air letting is not sufficient, it may be difficult to adjust the tension of crawler.

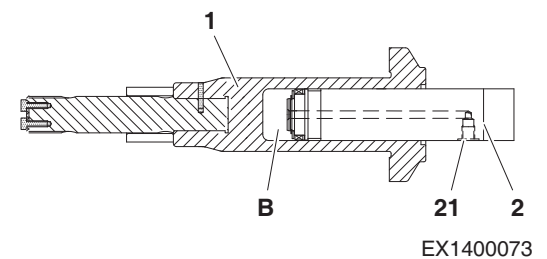


Figure 51

EX1400073

- Tool: 27 mm (🔧)
- Grease valve torque: 93.2 N.m (9.5 kg.m, 68.7 ft lb)

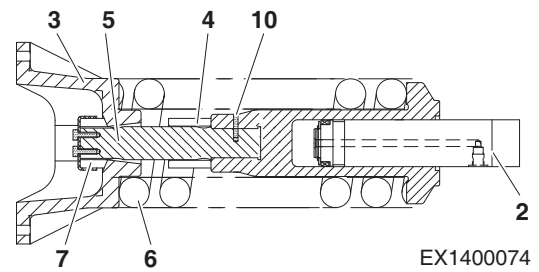
4. Install piston rod (2, Figure 57) to body, and assemble spacer (4) with the shaft (5) after assembling the shaft (5) with spring pin (10).
5. Install spring (6, Figure 57) and bracket (3) to body.
6. Apply pressure to spring (6, Figure 57) with a press and tighten lock nut (7).

NOTE: Apply sealant before assembling.

NOTE: During the operation, pay attention specially to prevent the press from slipping out.

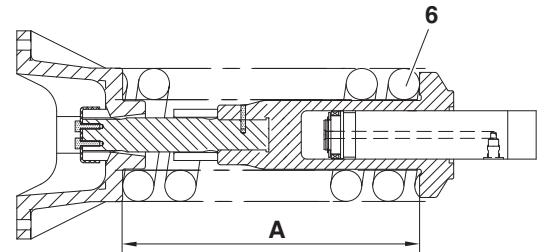
7. Tighten the press load and confirm the set length of spring (6, Figure 58).

- Length A: 522 mm (20.6 in)



EX1400074

Figure 52



EX1400075

Figure 53

8. After the setting of spring (6, Figure 59), install lock plate (8), spring washer (11) and bolt (9).

NOTE: Apply loctite on bolt (9, Figure 59).

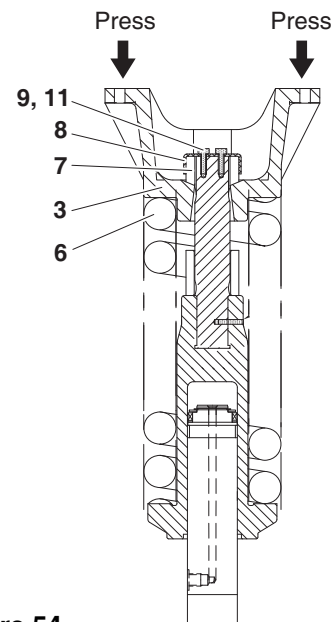


Figure 54

EX1400069

Front

Boom and Stick

Edition 1

MEMO

Table of Contents

Boom and Stick

Safety Instructions	7-1-5
Specifications	7-1-6
Size and Weight	7-1-7
Removal	7-1-8
Stick Removal	7-1-8
Boom Removal.....	7-1-10
Installation	7-1-11
Stick Installation	7-1-11
Boom Installation.....	7-1-11
Start-up Procedures	7-1-11

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.

SPECIFICATIONS

The table below has a complete listing of dimensional specifications for all mounting pins used on the front attachment.

NOTE: *Some mounting pins must be drilled and tapped for lubrication fittings and piping, or may have other required specifications.*

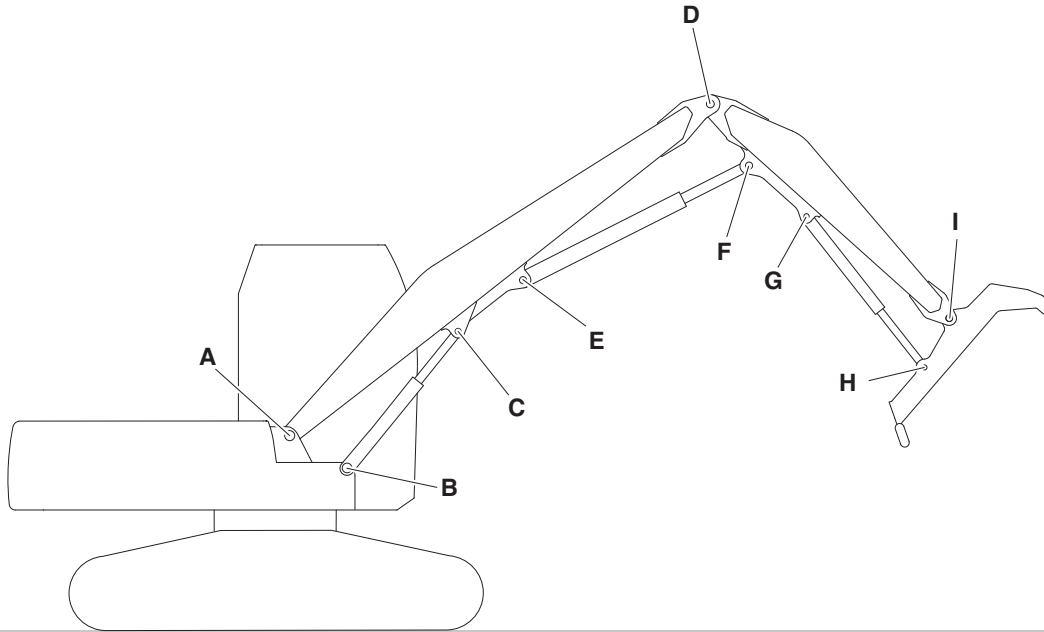


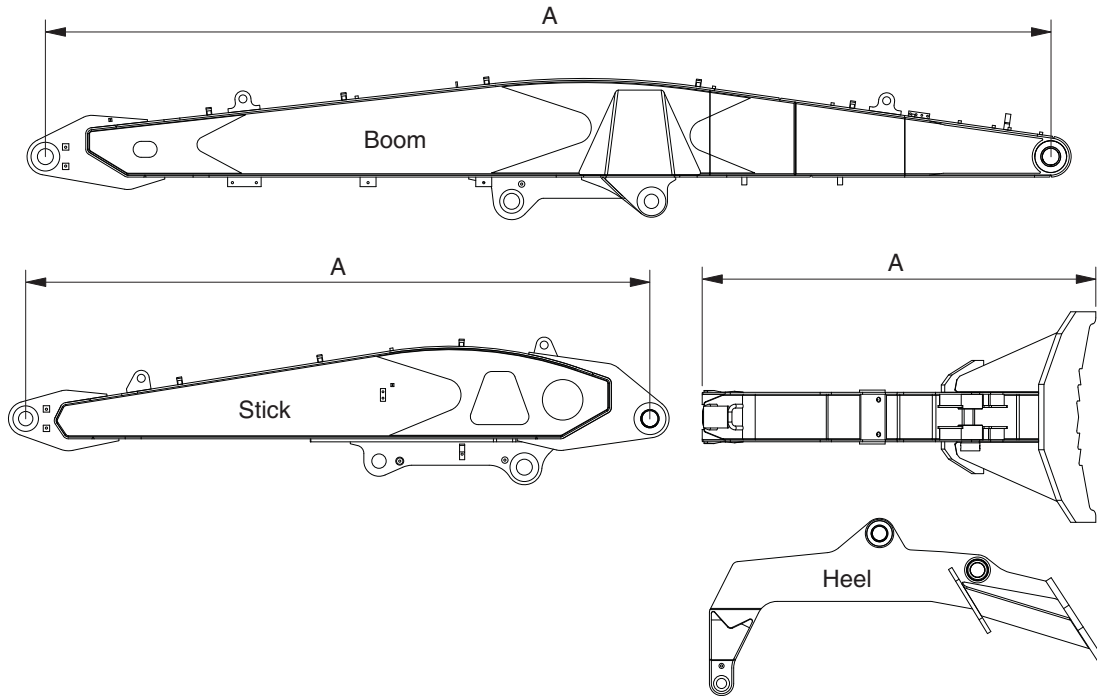
Figure 1

EX1300772

Mark	Measuring Part	Criteria					Remedy
		Standard Size	Tolerance		Standard Clearance	Clearance Limit	
			Pin	Hole			
A	Boom Foot	105 mm (4.134")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	1.5	Replace
B	Boom Cylinder Head	90 mm (3.543")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	1.5	
C	Boom Cylinder Rod	90 mm (3.543")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	1.5	
D	Boom End	100 mm (3.937")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	1.5	
E	Stick Cylinder Head	100 mm (3.937")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	1.5	
F	Stick Cylinder Rod	100 mm (3.937")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	1.5	
G	Heel Cylinder Head	90 mm (3.543")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	1.5	
H	Heel Cylinder Rod	90 mm (3.543")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	2.0	
I	Stick End	90 mm (3.543")	-0.10 -0.15	+0.18 +0.03	0.13 ~ 0.33	2.0	

Size and Weight

Item	Length (A)	Weight
Boom	6,300 mm (248 in)	2,170 kg (4,784 lb)
Stick	3,912 mm (154 in)	1,096 kg (2,416 lb)
Heel	2,466 mm (97 in)	634 kg (1,398 lb)



EX1504828

Figure 2

REMOVAL

DANGER

AVOID DEATH

HYUNDAI warns any user, that the removal of the counterweight from the machine, front attachment or any other part, may affect the stability of the machine. This could cause unexpected movement, resulting in death or serious injuries. HYUNDAI is not liable for any misuse.

Never remove counterweight or front attachment unless the upper structure is in-line with the lower structure.

Never rotate the upper structure once the counterweight or front attachment has been removed.

IMPORTANT

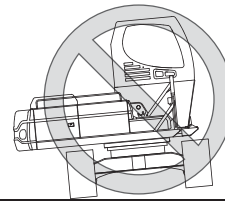
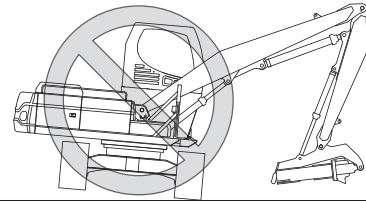
Always break down the front attachment by removing outermost sections first - the heel before the stick, the stick before the boom. Reinstallation of the attachment must begin with the boom and end with the heel.

Stick Removal

WARNING

AVOID DEATH OR SERIOUS INJURY

This procedure is only intended for routine removal or replacement of the attachment, while working under normal, safe operating conditions. In the event of a major structural collapse of some part of the attachment, an accident or complete loss of attachment hydraulic function, DO NOT proceed with attachment disassembly unless you are completely sure of what you are doing. Please call your local HYUNDAI distributor or HYUNDAI After Sales Service for assistance. DO NOT allow personnel to stand underneath a weakened or only partially supported attachment section. Keep clear of hydraulic lines that may have fluid escaping at high-pressure - it can cause severe or even fatal injuries.



EX1500889

Figure 3

Before beginning the disassembly of attachment mounting pins, disconnect the stick cylinder hydraulic hose couplings and put a clean plug in the end of each one. Use any reasonable precautions necessary to avoid introducing dirt or other contaminants into the hydraulic system. Wipe down coupling points before disconnecting hydraulic lines and use evaporative type solvent spray cleaner. Tag and mark hoses for reassembly, if necessary.

Complete the heel end removal procedure by pulling out the two heel linkage pins and the heel cylinder mounting pin, on the stick. Use an assist crane or hoist to lift the cylinder and relieve weight on mounting pins.

Park the forestry machine away from obstructions and all traffic on clear, flat, level ground. Extend the stick cylinder and crowd the stick into the boom. Partially retract the boom cylinder so the boom is stretched out in front of the forestry machine, as low to the ground as possible, with the stick crowded under the boom.

The tip of the stick point must be lowered to secure blocking that will safely support the weight of the stick. Place the blocking directly in front of the forestry machine and make sure that it will not be unbalanced with an initial weight load that is all to one end, under the stick point.

Shut off the engine and release hydraulic system pressure - move any of the control levers with the engine off to release pressure built up in the accumulator. Manually vent residual hydraulic pressure in the tank by moving the lever near the cap, on top of the reservoir.



WARNING

AVOID DEATH OR SERIOUS INJURY

Secure the swing lock and tag and lock out controls in the operator's cabin to keep anyone from moving or inadvertently starting the engine. Restrict access to the work site while sections of the attachment are in the air, or while they are being supported by the assist crane. The safe lifting capacity of the assist crane or hoist that is used must exceed the weight of the heaviest section of the attachment, the boom (approximately 2,170 kg [4,784 lb], not including the weight of accessories or fixtures).

Place a sling under the stick cylinder (the cylinder used to extend and retract the attachment stick, pinned to the top of the boom). Lift the sling so that the weight load on the rod end of the stick cylinder (pinned to the ears on the inner end of the stick) is released. Prepare blocking under the stick that will securely support the weight of the stick and stick cylinder.



CAUTION

AVOID INJURY

To make sure that polished surfaces of cylinder rod ends will not suffer accidental damage during disassembly or removal procedures, wrap exposed rod surfaces (especially those of boom cylinders) with a protective covering material. Immediately the following disassembly and removal, cylinder rods should always be fully retracted. This eases handling problems and avoids possible damage.

Remove retainers on the end of the mounting pin for the stick cylinder rod end. Use the assist crane to relieve the weight load and withdraw the pin. Lower the stick down to the blocking support for any continued disassembly procedures.

Boom Removal

NOTE: *Boom removal may be simplified if the shell of the operator's cabin is taken off the turntable deck first. Refer to the Operator's Cabin Removal procedure before continuing, if both components are to be removed from the forestry machine.*

After the heel, stick and stick cylinder have been removed, lower the end of the boom to a stable, secure blocking support.

Attach the assist crane sling to the body of either boom cylinder, break the mounting pin connection to the boom by tapping through the pin from the same side of the boom and repeat for the opposite cylinder.

Release hydraulic pressure and disconnect line couplings as previously outlined in the Stick Removal Procedure, observing the same precautions.

Disconnect wiring for work light assemblies and any other accessory lines or connections. Locate the sling of the assist crane near the center of gravity, optimum lift point for the boom, and use the crane to take pressure off the boom foot pin. Drive out the pin after disassembling retainers and carefully lift away the boom.



WARNING

AVOID DEATH OR SERIOUS INJURY

Traveling the forestry machine, swinging the turntable or movement over bumps or sloping, uneven surfaces could all produce loss of control and possible accidents or injuries, if the turntable deck has been unbalanced by removal of weight from one end only.

To maintain stability, the counterweight must be removed whenever the front attachment is taken off the machine.

INSTALLATION

Stick Installation

Reattach the base of the stick cylinder to the mounting point on top of the boom.



WARNING

AVOID DEATH OR SERIOUS INJURY

Before assembling the front attachment, make sure that individual boom, stick and heel sections are all compatible and can be used safely for work intended. Refer to the General Safety Pages, Lift Ratings, Working Range Diagrams and Weights of Materials sections in the Operation & Maintenance Manual. Consult your dealer or HYUNDAI After Sales Service for more information if you have any questions or require more information.

Begin with the stick securely supported on blocking in front of the forestry machine. Grease the mounting pin for the rod end of the stick cylinder and push it through the ears on the end of the stick. Attach a sling around that mounting pin and lift the stick with an assist crane until it is in position for the boom-stick pin connection to be made.

Relieve hydraulic pressure from all points of the system before any hydraulic lines are opened, then carefully assemble hydraulic connections to the stick cylinder.

Remove sling from around the rod end stick cylinder pin, withdraw the pin and lift the body of the stick cylinder to re-pin the mounting connection.

Boom Installation

Before reassembling the attachment, make sure to inspect all bushings and pivot points of each section. To avoid damaging the seats, bushings should never be hammered or chiseled out of their seats.

Installation is otherwise a reversal of the removal procedures.

START-UP PROCEDURES

Once the boom has been serviced, it must be lubricated as outlined in the initial start-up procedures of the operation manual. Refer to the appropriate Operation & Maintenance Manual for unit.

Cylinders

Edition 1

MEMO

Table of Contents

Cylinders

Safety Instructions	7-2-5
General	7-2-5
General Description	7-2-5
Theory of Operation	7-2-6
Seal of Cylinder	7-2-7
Special Tools and Materials	7-2-9
Piston Nut	7-2-9
Piston Jig	7-2-10
Steel Bushing Jig	7-2-11
Dust Wiper Jig	7-2-12
Slipper Seal Jig	7-2-13
Slipper Seal Straightening Jig	7-2-14
Rod Bushing (DD-bushing) Pushing-in Jig	7-2-15
Disassembly	7-2-16
Reassembly	7-2-21
Troubleshooting	7-2-25

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.

GENERAL

General Description

Essentially types of hydraulic cylinders are used on the forest machine. The cylinder that is used to operate the forest machine boom or arm (stick) is equipped with a cushion ring, which acts as a cushion only when the cylinder rod is fully retracted (and the bucket is pulled close to the arm).

Arm (stick) cylinder have a cushion or plunger for operation in both directions.

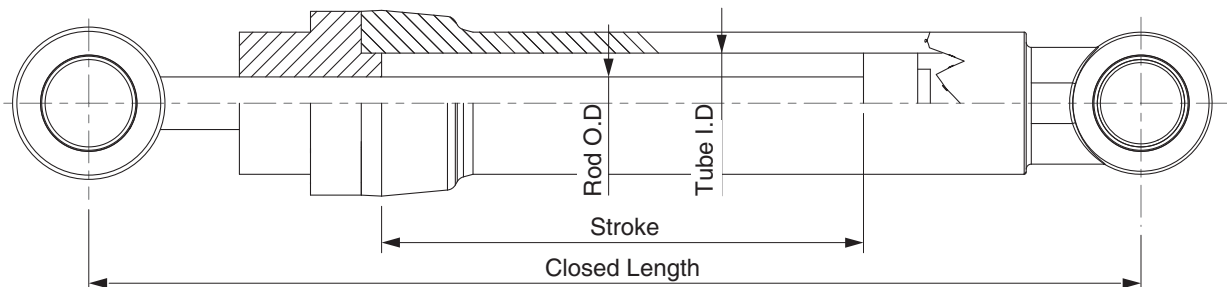


Figure 1

EX1400068

	Boom	Arm (Stick)	Heel
Quantity	2	1	1
Tube I.D	ø150	ø180	ø150
Rod O.D	ø100	ø120	ø100
Stroke (mm)	1,190	1,405	1,010
Closed Length (mm)	1,890	2,175	1,690
Head End Cushion	X	O	X
Rod End Cushion	O	O	X
Weight (kg/lb)	254/560	459/1,012	236/520

Theory of Operation

1	Piston
2	Oil Path A
3	Oil Path B

Cylinder piston rods are extended or retracted by oil flow to the back side of the cylinder (shown as "oil path A") or to the 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 D (Figure 6).

$$F_1 = P \times \frac{\pi D^2}{4}$$

(P: Pressure, $\pi = 3.14$, D: Cylinder Inside Diameter)

1	Cylinder Inside Diameter - D
2	Oil Path A
3	Oil Path B
4	Rod Diameter - R

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.

$$F_2 = P \times \frac{\pi(D^2 - R^2)}{4}$$

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 extend a cylinder than it does to retract it.

$$Q_1 = S \times \frac{\pi(D^2)}{4}$$

$$Q_2 = S \times \frac{\pi(D^2 - R^2)}{4}$$

$$Q_1 > Q_2$$

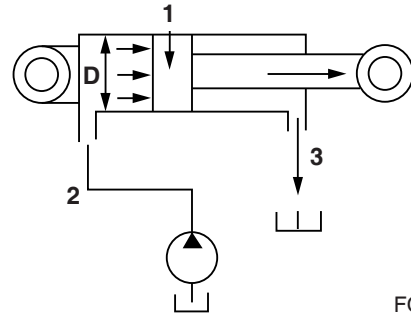


Figure 2

FG001456

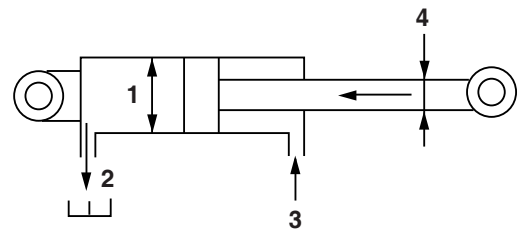


Figure 3

FG001458

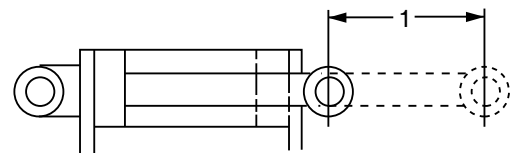


Figure 4

FG001459

Seal of Cylinder

- 1. Assembly location and shape of seals
 - A. Rod cover seal

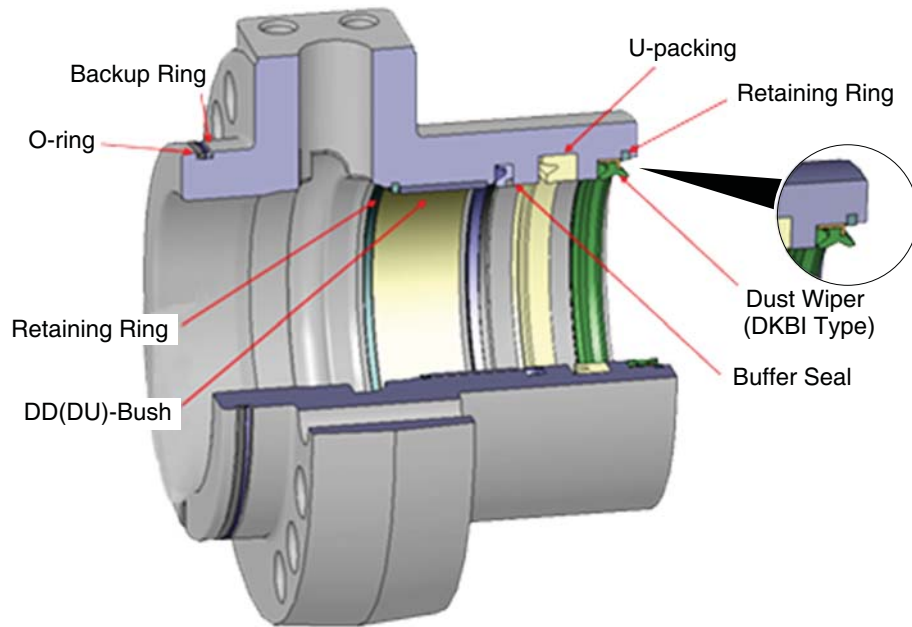


Figure 5

EX1301741

- B. Piston seal

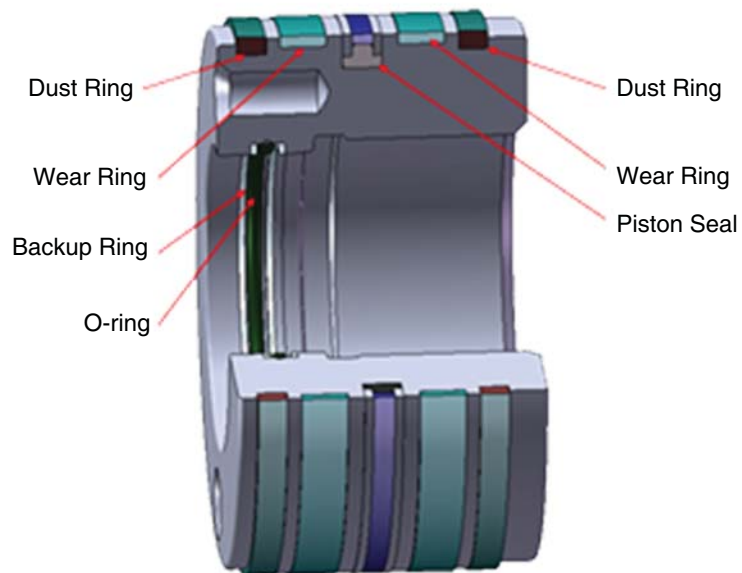


Figure 6

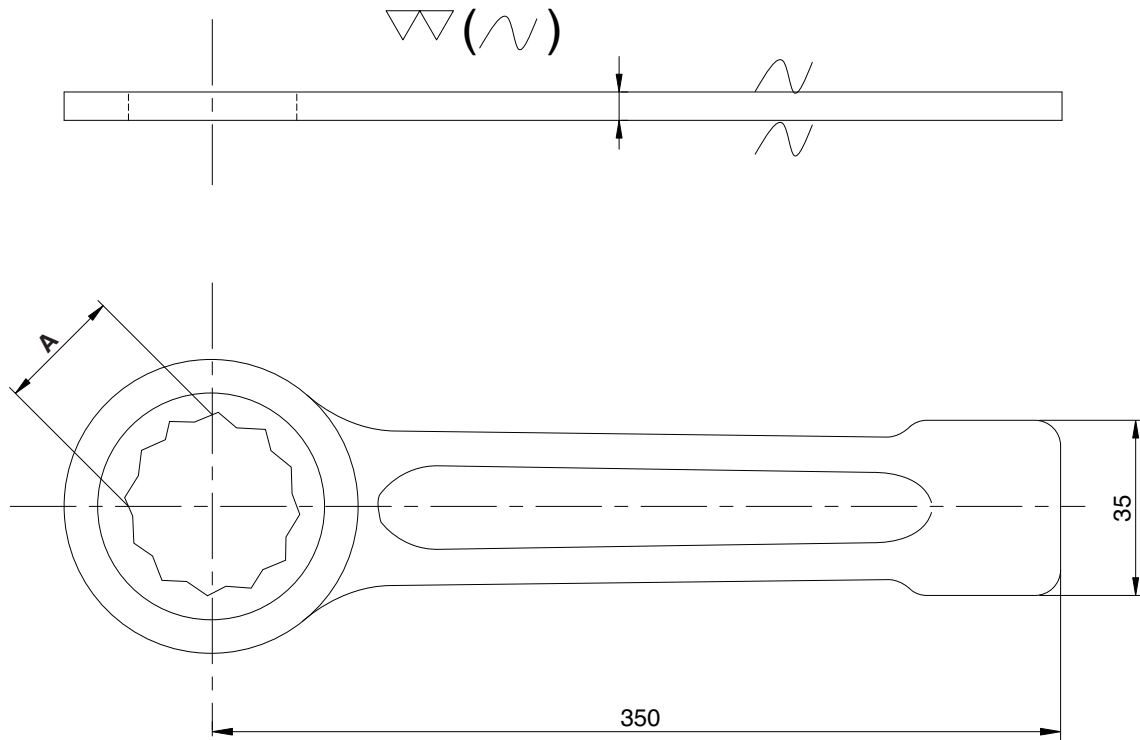
EX1301742

2. Seal function

No	Name	Function	Material
1	Piston Seal	Seal the hydraulic oil between the piston and the inner surface of the tube.	Slipper Seal, Glyd Ring, Compact Seal
2	Wear Ring	Prevents scratch on the inner surface of the tube and the rod surface caused by foreign materials, and eccentric center, and eccentric load, and plays role bearing keeping stable friction materials.	Phenol, Aramid
	(DU-bushing)		
3	Contamination	Protects the piston seal against the intrusion of foreign material to keep the functions of the seal intact.	Dust Ring, Slyd Ring
	Seal		
4	Rod Seal	Seals for preventing leak of hydraulic oil between the friction material and the cover of the rod.	U-packing, V-packing
5	Buffer Seal	Prevents surge/shock applied directly to the rod seal to extent lifecycle of the seal on the system for high-pressure.	Step Seal
6	Dust Seal	Prevents intrusion of foreign materials into the cylinder from outside environment to protect the rod seal.	Single Lip, Double Lip
	(Dust Wiper)		
7	O-ring	Prevents intrusion of foreign materials (e.g., rain and snow), and makes sealing between the inner surface of the tube and the rod cover, and between the rod and the inner diameter of the piston.	NBR
8	Backup Ring	Prevents disengaging U-packing and O-ring because of pressure and gap.	PTFE, Nylon

SPECIAL TOOLS AND MATERIALS

Piston Nut



FG018703

Figure 7

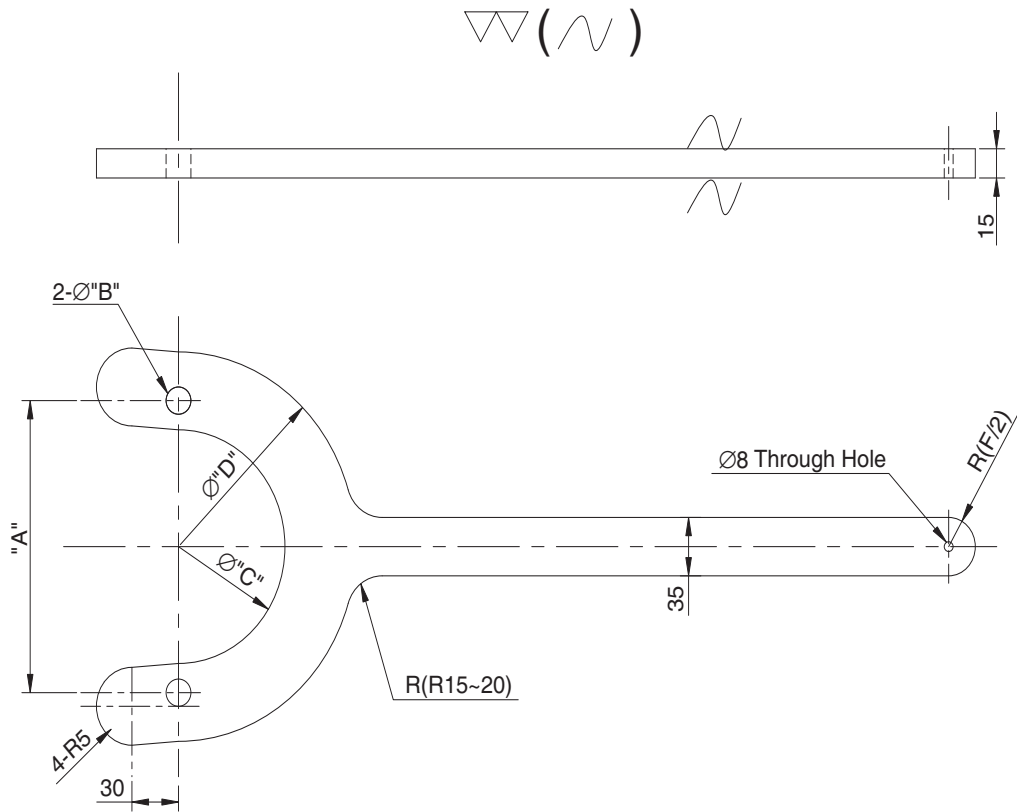
Material SM45C (AISI 1045)

Rockwell Hardened from 22 ~ 27

Oil Quench

Cylinder	A
Boom	111 mm (4.37 in)
Arm (Stick)	131 mm (5.16 in)
Heel	111 mm (4.37 in)

Piston Jig



ARS4740L

Figure 8

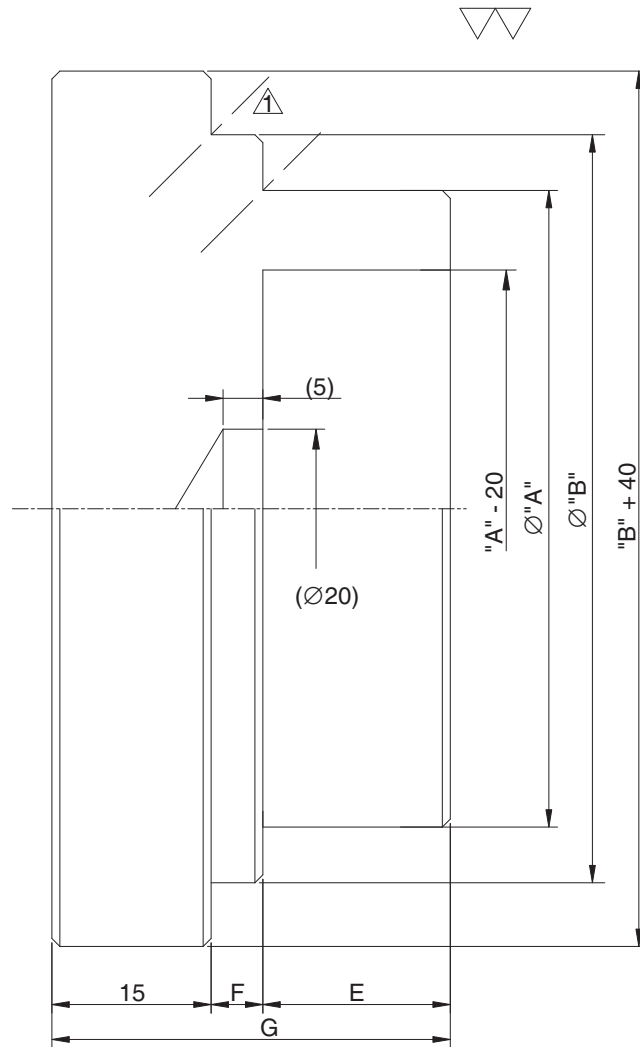
Material SM45C (AISI 1045)

Rockwell Hardened from 22 ~ 27

Oil Quench

Cylinder	A (± 0.1)	ϕB	ϕC	ϕD
Boom	120.0 mm (4.72 in)	14.0 mm (0.55 in)	90.0 mm (3.54 in)	150.0 mm (5.91 in)
Arm (Stick)	130.0 mm (5.12 in)	14.0 mm (0.55 in)	110.0 mm (4.33 in)	160.0 mm (6.31 in)
Heel	120.0 mm (4.72 in)	14.0 mm (0.55 in)	90.0 mm (3.54 in)	150.0 mm (5.91 in)

Steel Bushing Jig



ARS4750L

Figure 9

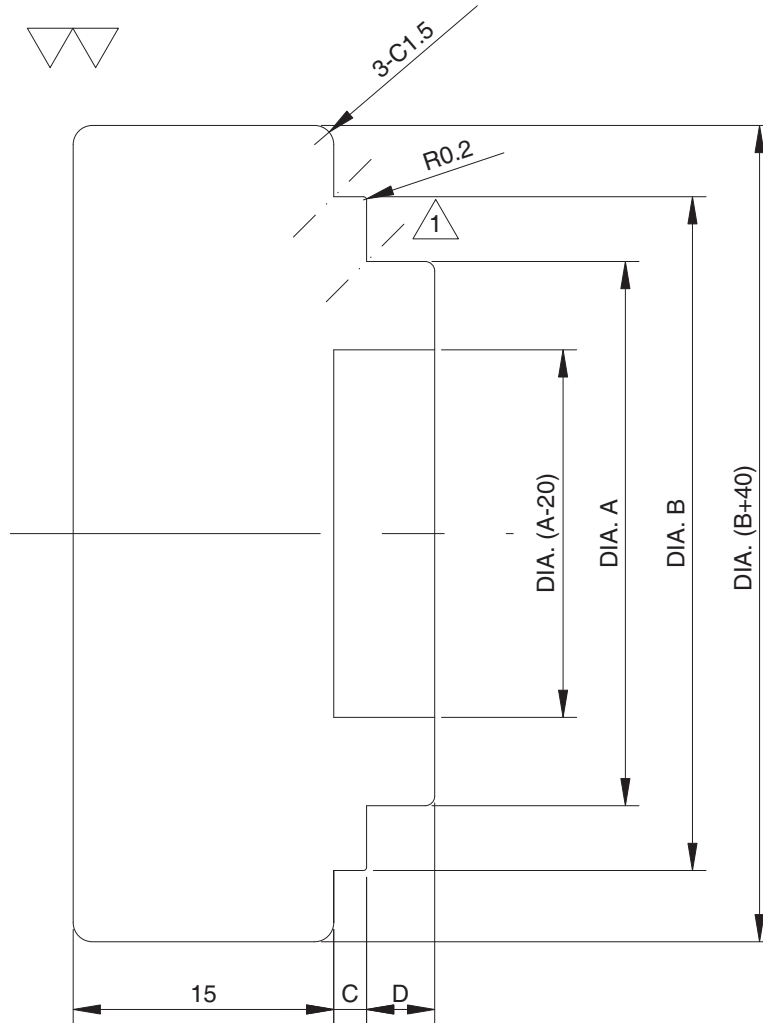
Material: SM45C which is done thermal refining <QT> HRC 22 ~ 28

Undefined Chamfer C/R = 0.5 Max.

1 Place: Final work to used DNMG Tip <Nose R0.4>

Cylinder	$\phi A_{-0.15}^{-0.05}$	$\phi B (\pm 0.1)$	E	$F_0^{+0.05}$	G
Boom	89.5 mm (3.52 in)	104.5 mm (4.11 in)	30.0 mm (1.18 in)	6.5 mm (0.26 in)	51.5 mm (2.03 in)
Arm (Stick)	99.5 mm (3.92 in)	114.5 mm (4.51 in)	30.0 mm (1.18 in)	7.5 mm (0.30 in)	52.5 mm (2.07 in)
Heel	89.5 mm (3.52 in)	104.5 mm (4.11 in)	30.0 mm (1.18 in)	6.5 mm (0.26 in)	51.5 mm (2.03 in)

Dust Wiper Jig



ARS4760L

Figure 10

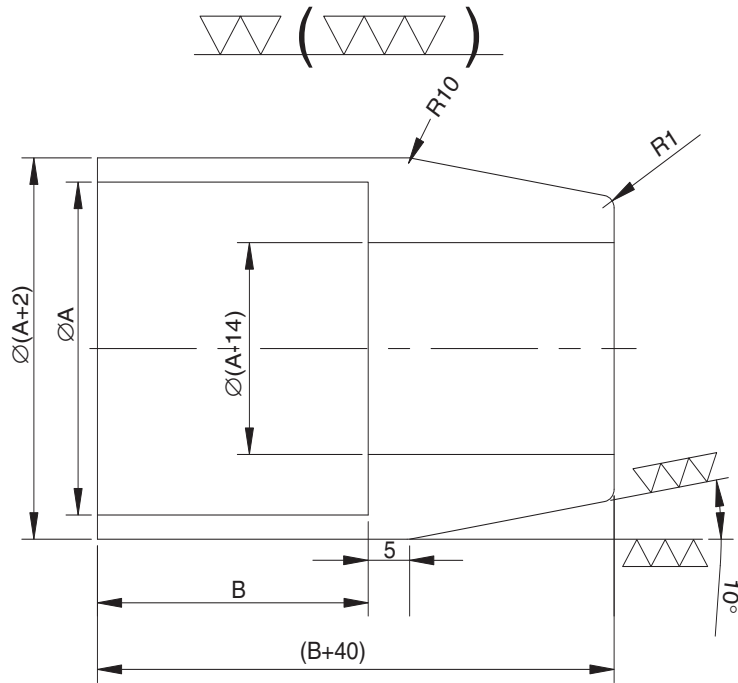
Material: SM45C which is done thermal refining <QT> HRC 22 ~ 28

Undefined Chamfer C/R = 0.5 Max.

1 Place: Final work to used DNMG Tip <Nose R0.4>

Cylinder	$\varnothing A_{-0.3}^{-0.2}$	$\varnothing B_{-0.3}^{-0.2}$	$C_{-0.1}^0$	D
Boom	99.0 mm (3.90 in)	114.0 mm (4.49 in)	5.5 mm (0.22 in)	8.5 mm (0.33 in)
Arm (Stick)	119.0 mm (4.69 in)	136.0 mm (5.35 in)	8.5 mm (0.33 in)	9.5 mm (0.37 in)
Heel	99.0 mm (3.90 in)	114.0 mm (4.49 in)	5.5 mm (0.22 in)	8.5 mm (0.33 in)

Slipper Seal Jig

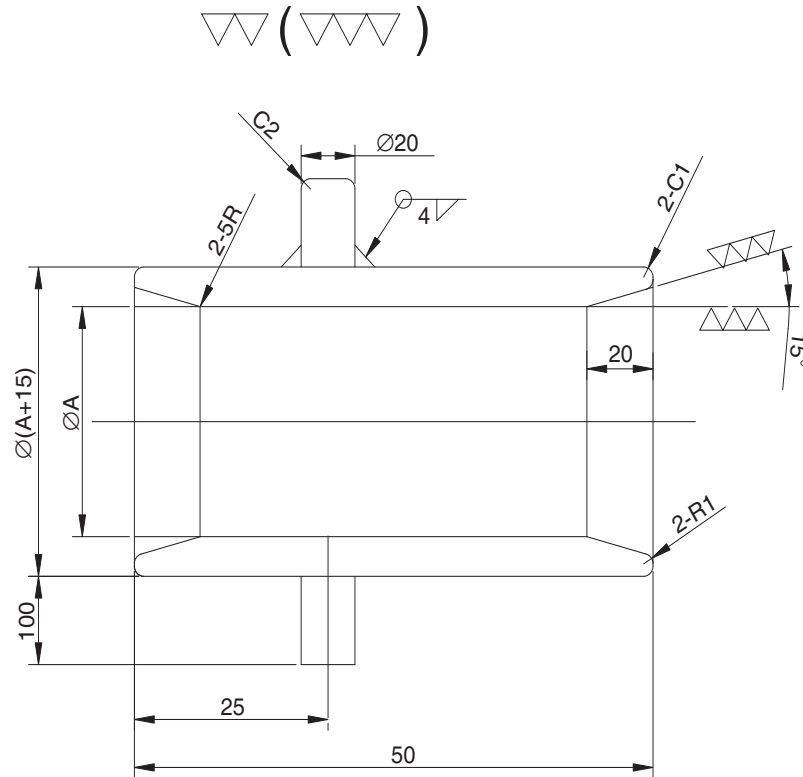


ARS4770L

Figure 11

Cylinder	$\varnothing A_{+0.1}^{+0.2}$	$B_{+0.1}^{+0.2}$
Boom	150.0 mm (5.91 in)	29 mm (1.14 in)
Arm (Stick)	180.0 mm (7.11 in)	42 mm (1.65 in)
Heel	150.0 mm (5.91 in)	29 mm (1.14 in)

Slipper Seal Straightening Jig

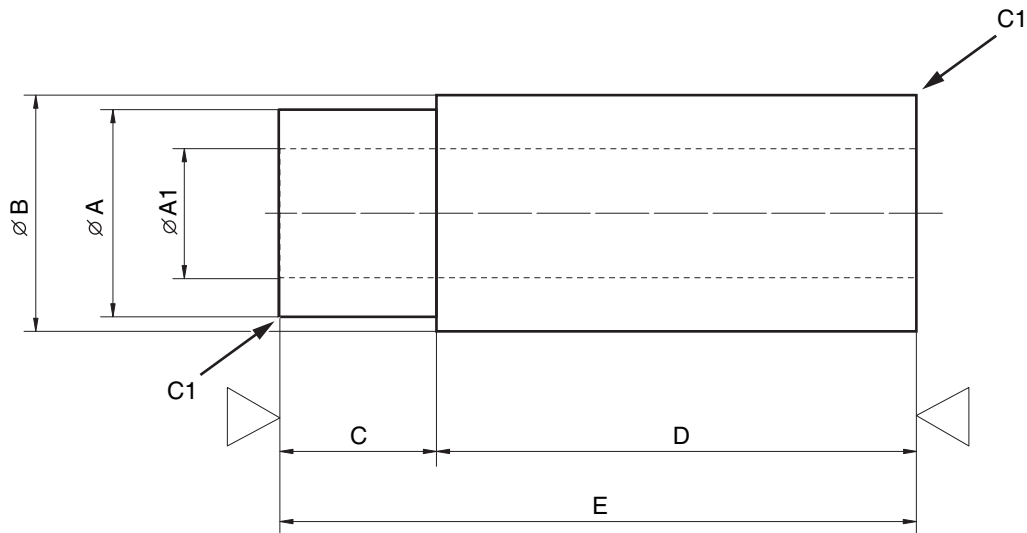


ARS4780L

Figure 12

Cylinder	$\varnothing A_{+0.1}^{+0.2}$
Boom	150.5 mm (5.93 in)
Arm (Stick)	180.5 mm (7.11 in)
Heel	150.5 mm (5.93 in)

Rod Bushing (DD-bushing) Pushing-in Jig



EX1301743

Figure 13

Inner diameter (A1): "A"-20 (no machining required on the inner diameter)

Cylinder	$\varnothing A^{+0.2}_{-0.1}$	$\varnothing B (\pm 0.1)$	C	D	G
Boom	99 mm (3.90 in)	104.8 mm (4.13 in)	30 mm (1.18 in)	75 mm (2.95 in)	105 mm (4.13 in)
Arm (Stick)	119 mm (4.69 in)	124.8 mm (4.91 in)	50 mm (1.97 in)	82 mm (3.01 in)	132 mm (5.21 in)
Heel	99 mm (3.90 in)	104.8 mm (4.13 in)	30 mm (1.18 in)	75 mm (2.95 in)	105 mm (4.13 in)

1. Assemble the rod bushing with the exclusive jig (if disassembled).

Push in the rod bushing in true vertical direction to prevent inclining of the bushing.

Apply small volume of operating oil on inner surface of the rod cover for facilitating pushing in.

2. Remove all of pushing-in residues generated during the pushing-in process.
3. Mount the retaining ring on the rod cover groove at the end of the rod bushing after cleaning to prevent disengagement of the rod bushing.

(Mount the retaining ring manually with pliers, and check if the ring is securely mounted.)

DISASSEMBLY



AVOID INJURY

Vent air from the hydraulic system before disconnecting cylinder piping connections. Use the lever on the reservoir, while the engine is running. Discharge the hydraulic accumulator and vent residual tank pressure after the engine is shut off. Pour clean replacement hydraulic fluid into the system if excessive fluid is lost.

1. Following removal of cylinder from excavator attachment, support cylinder on some type of sturdy work platform and drain all oil. Rotate cylinder so piping ports are on top, to allow trapped air to vent.

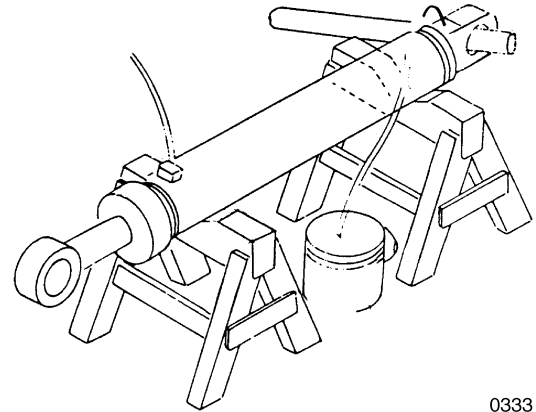


Figure 14

0333

2. Position piston rod so it is extended approximately one half meter (20").

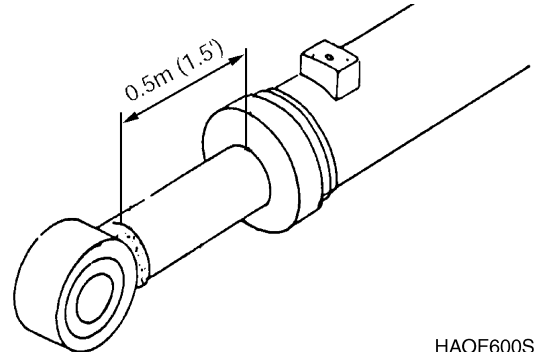


Figure 15

HAOF600S

3. Remove bolts (27) on the end of cylinder.

NOTE: Wrap a cloth or other protective material around piston rod, to avoid possibility of accidentally scratching or scoring rod surface while fasteners are being loosened and removed. Component parts (numbered in parentheses) are keyed to Figure 4.

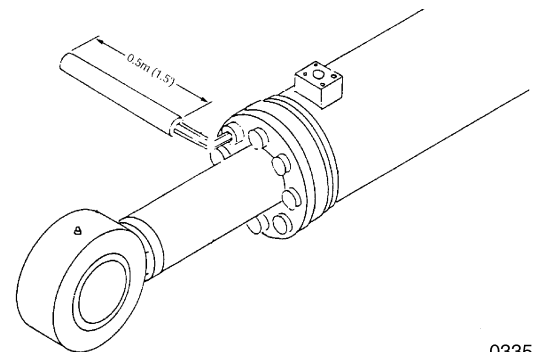
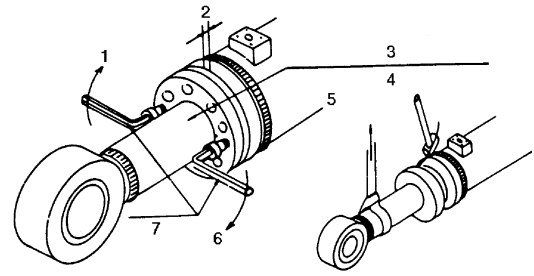


Figure 16

0335

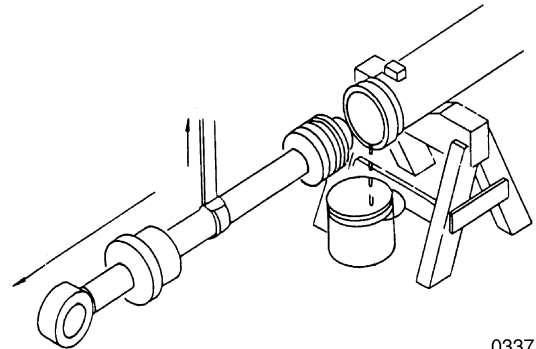
4. Tap two bolts into cover of cylinder head, 180° apart. Tighten them in a staggered, even sequence, to back off piston rod end cover from edge of cylinder wall. Look for adequate clearance between cover and end of cylinder wall before using a plastic or other soft faced hammer for final disassembly.



HAOF610S

Figure 17

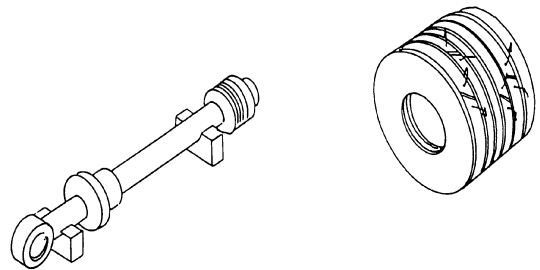
5. Begin withdrawing piston rod assembly, away from cylinder. Attach a lifting support when final 1/3 of rod is still inside barrel of cylinder. Prepare support blocks for piston rod before it has been completely withdrawn.



0337

Figure 18

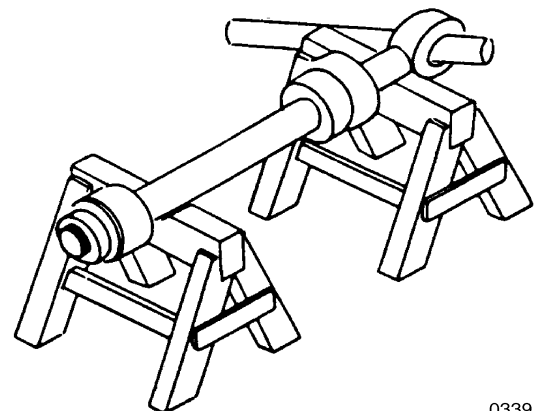
6. Lower piston rod to support blocks and detach wear ring (outer surface) (19) from end of rod.



HAOF620S

Figure 19

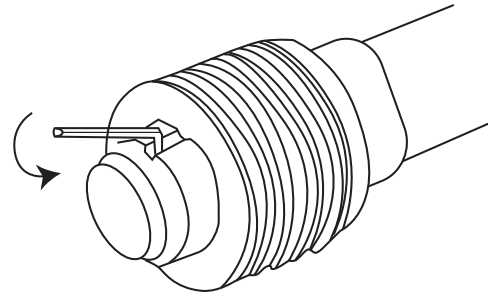
7. Immobilize piston rod by inserting a wooden or other nonscoring, nonmetallic support through end of rod.



0339

Figure 20

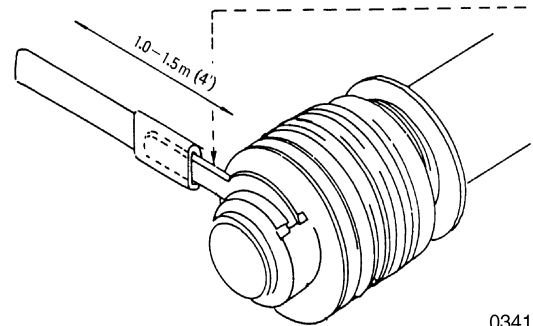
- Remove set screw using socket wrench.



HAOF340L

Figure 21

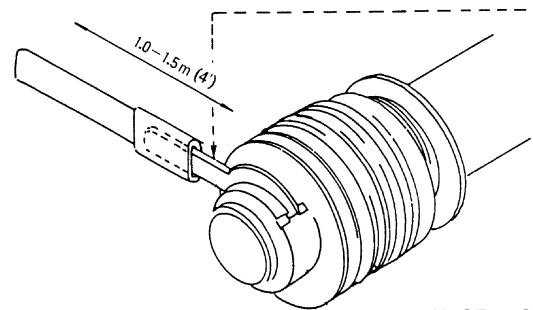
- Fabricate or purchase a piston nut removal wrench. (Dimensions are called off at beginning of this procedure. This tool may also be ordered through your local HYUNDAI Parts distributor). Remove nut from end of piston.



0341

Figure 22

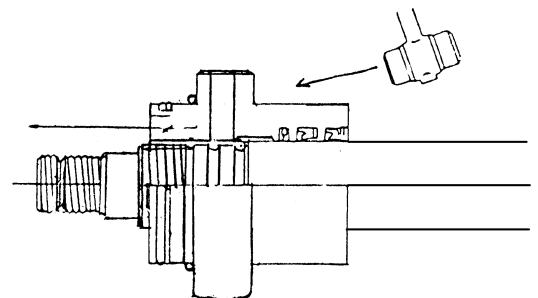
- Use second piston tool described at beginning of this procedure to separate piston. Detach cushion ring (16), taking care not to damage cushion ring.



HAOF630S

Figure 23

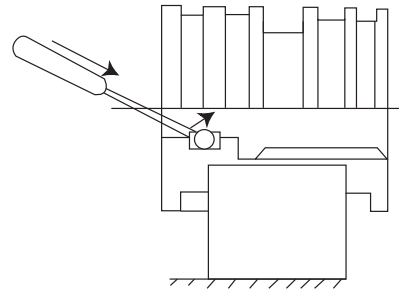
- Use a plastic hammer to evenly pull off rod cover (5) from end of piston rod. Be careful not to damage rod bushing (6) and dust wiper, U-packing and other seals.



HAOF350S

Figure 24

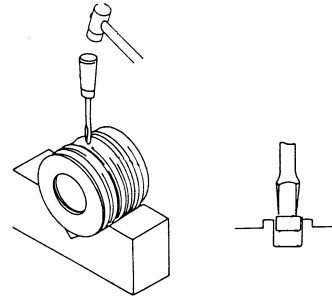
12. Use a dull, rounded tip tool to pry off O-ring (13) and backup ring (14).



HAOF37OL

Figure 25

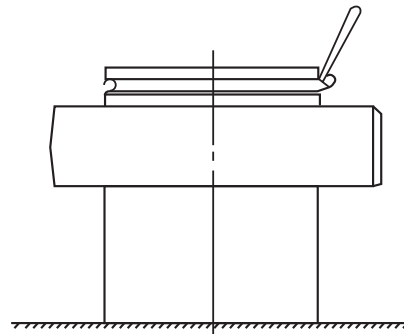
13. Find a screwdriver with an appropriate width tip to facilitate removal of slipper seal (18), wear ring (19) and slide ring (20) from piston (17).



0345

Figure 26

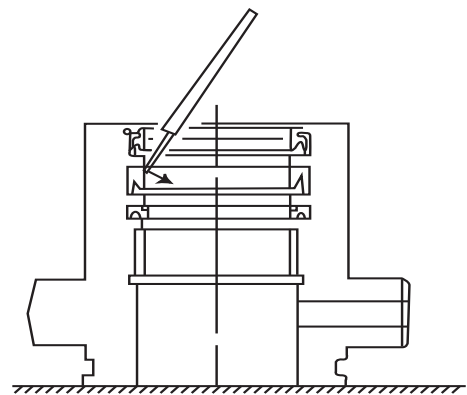
14. Remove O-ring (21) and backup ring (22) from cylinder head.



HAOF38OS

Figure 27

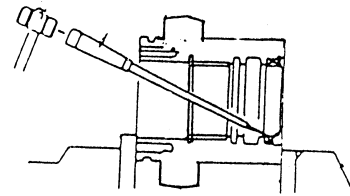
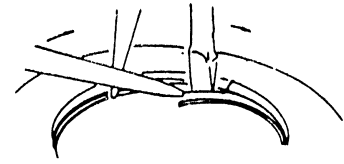
15. During disassembly of cylinder head, be careful not to damage buffer seal (8) and U-packing (9).



HAOF39OL

Figure 28

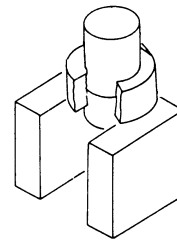
16. Disassemble retaining ring (12) and dust wiper (11).
Separate retaining ring (7) and rod bushing (6).



HAOF400S

Figure 29

17. Force out pin bushing (2), (4) from body of cylinder.



0349

Figure 30

REASSEMBLY

IMPORTANT

Before reassembly:

- Inspect and replace damaged or excessively worn parts.
- Clean parts and lubricate with clean hydraulic oil.
- Make sure work area is clean.

Replace any part that shows evidence of damage or excessive wear. Replacement of all O-rings and flexible seals is strongly recommended. Before starting the cylinder reassembly procedure, all parts must be thoroughly cleaned and dried, and/or prelubricated with clean hydraulic fluid. Prepare the work area beforehand to maintain cleanliness during the reassembly procedure.

NOTE: Reassemble the subassemblies of the cylinder in the following order:

1. Body of the cylinder.
 2. Piston rod.
 3. Piston assembly.
 4. Cylinder head assembly.
1. Reassemble pin bushing (2), (4) to piston rod and body of cylinder.

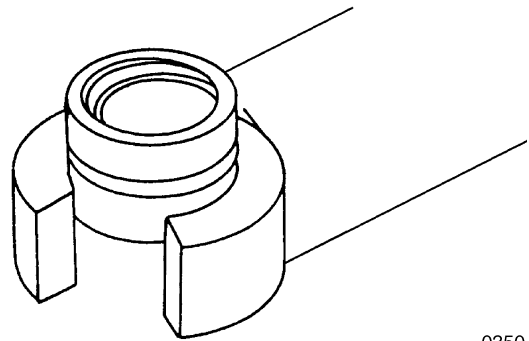
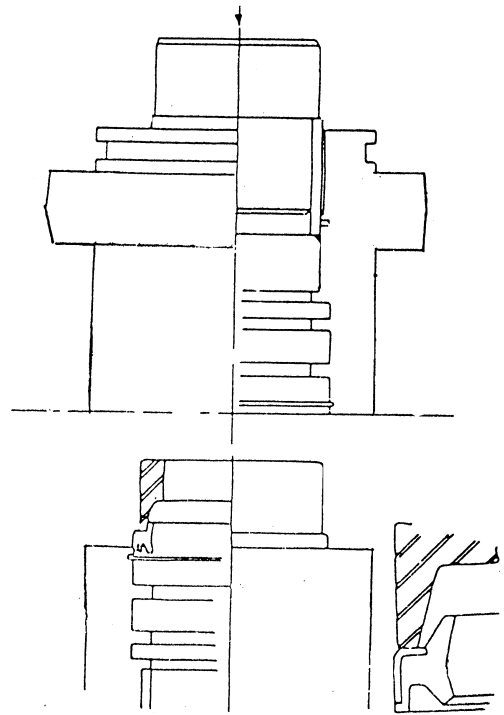


Figure 31

0350

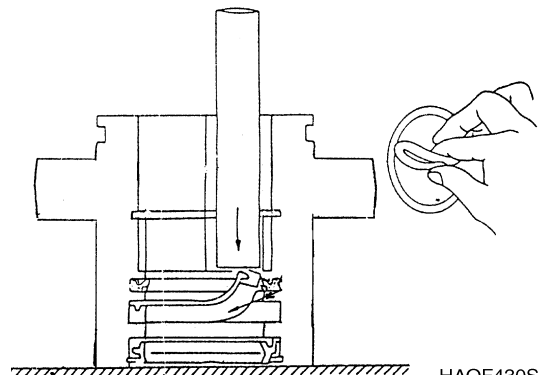
- Following reassembly of rod cover components, install the dust wiper (11) and rod bushing (6) to the rod cover (5). Insert retaining rings (7 and 12).



HAOF440S

Figure 32

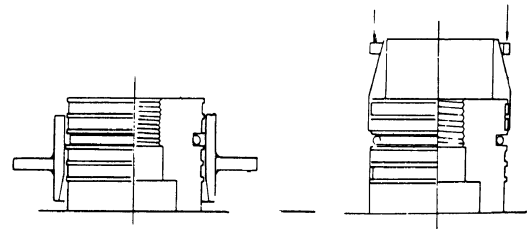
- Prelubricate O-rings and seals before reassembly (Figure 37).



HAOF430S

Figure 33

- Before starting to rebuild piston assembly, heat slipper seal for 5 minutes in an oil bath warmed to 150° - 180°C (302° - 356°F). Use special slipper seal jig (third item in list of specialized tools at the beginning of this procedure) to attach seal. Cool seal by pushing a retracting jig against seal for several minutes. Apply a strip of clean, see-through sealing tape around slipper seal to keep it free of dust.



0353

Figure 34

- Immobilize piston rod on solid support blocks. Assemble O-ring (21) and backup ring (22). Prepare to attach rod cover assembly to piston rod. Push rod cover by tightening piston nut (23).

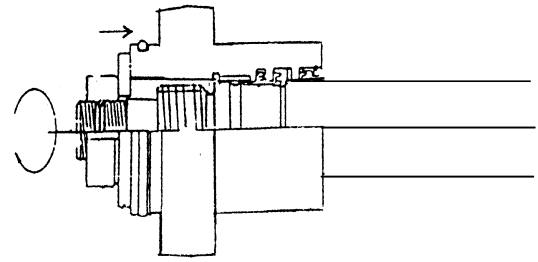


Figure 35

HAOF450S

- Assemble cushion ring (16) and attach piston assembly to piston rod.

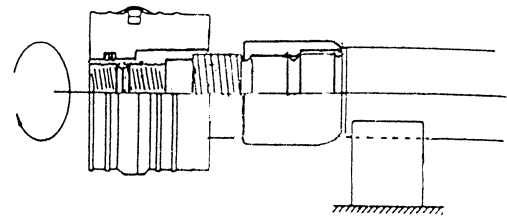


Figure 36

HAOF460S

- Use specially fabricate or factory sourced tool to tighten piston nut (23).

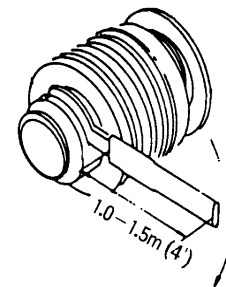


Figure 37

0356

- Assemble wear ring (19), slide ring (20) and set screw (24) to piston assembly.

Reference Number	Description
1	Set Screw

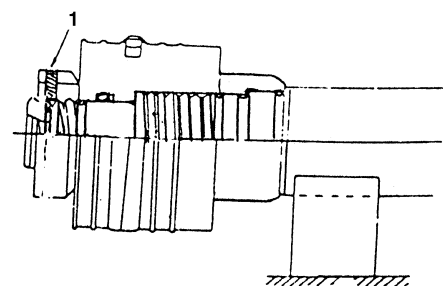


Figure 38

HAOF470S

9. Immobilize body of cylinder before reassembly.

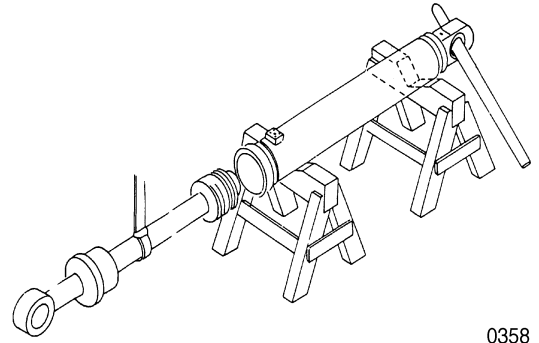


Figure 39

0358

Preapply fastener locking compound (Loctite #242 or #243 or an alternate manufacturer's equivalent product) to all end cover retaining bolts. Wrap a protective cushion around end of rod while tightening fasteners, to prevent possible damage to polished surface of rod, should a wrench slip during retightening.

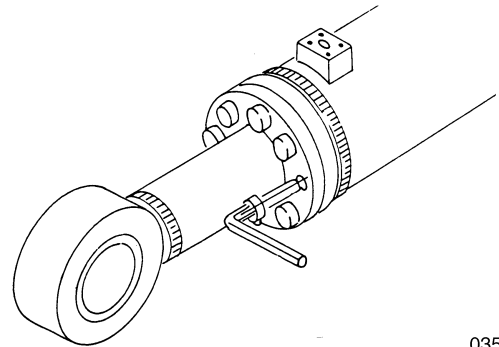


Figure 40

0359

TROUBLESHOOTING

Problem	Possible Cause	Remedy
Oil leaking between cylinder head and piston rod.	Foreign material in U-packing.	Remove foreign material.
	Scratches in U-packing.	Replace U-packing.
	Damage to U-packing.	Replace U-packing.
	Foreign material in dust wiper.	Remove foreign material.
	Scratches to dust wiper.	Replace dust wiper.
	Damage to dust wiper.	Replace dust wiper.
	Foreign material in seal O-ring.	Remove foreign material.
	Scratches in O-ring.	Replace O-ring.
	Damage to O-ring.	Replace O-ring.
	Scratches on sealing surface of piston rod.	If scratches are not deep, hone with an oil stone and lubricate. If scratches are deep, replace piston rod.
	Deep scratches on inner surface of bushing.	Replace bushing.
Oil leaking between cylinder head and cylinder tube.	Damage to O-rings.	Replace O-rings.
Oil leaking from welded area of cylinder tube.	Damage to welded area.	Replace cylinder tube.
Oil leaking between cylinder head and piston rod.	Foreign material in U-packing.	Remove foreign material.
	Scratches in U-packing.	Replace U-packing.
	Damage to U-packing.	Replace U-packing.
	Foreign material in dust wiper.	Remove foreign material.
	Scratches in dust wiper.	Replace dust wiper.
	Damage to dust wiper.	Replace dust wiper.
	Foreign material in O-ring.	Remove foreign material.
	Scratches in O-ring.	Replace O-ring.
	Damage to O-ring.	Replace O-ring.
	Scratch on sealing surface of piston rod.	If scratches are not deep, hone with an oil stone and lubricate. If scratches are deep, replace piston rod.
	Deep scratches on inner surface of bushing.	Replace bushing
Oil leaking between cylinder head and cylinder tube.	Damage to O-rings.	Replace O-rings.
Oil leaking from welded area of cylinder tube.	Damage to welded area.	Replace cylinder tube.
Cylinder drops from pull of gravity.	Light scratches on sealing surface of cylinder tube.	Hone out scratches with oil stone.
	Deep scratches on sealing surface of cylinder tube.	Replace cylinder tube.
	Deep scratches on sealing surface of piston O-rings.	Replace O-rings.
	Foreign material in U-packing.	Remove foreign material.

Problem	Possible Cause	Remedy
Cylinder drops from pull of gravity.	Scratches in U-packing.	Replace U-packing.
	Damage to U-packing.	Replace U-packing.
	Wear rings twisted.	Replace wear rings.
	Wear rings scratched.	Replace wear rings.
	Wear rings have other damage.	Replace wear rings.
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.
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 piston 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.

Hydraulic System

Hydraulic System

Edition 1

MEMO

Table of Contents

Hydraulic System

Safety Instructions	8-1-5
General	8-1-5
General Description	8-1-5
Hydraulic Schematic	8-1-6
General Description	8-1-6
Hydraulic Component and Oil Flow	8-1-8
Hydraulic Components	8-1-8
Safety Cutoff Valve Operation	8-1-10
Power Up Valve Operation	8-1-12
Travel High-speed Valve Operation	8-1-14
Swing Brake Release Operation	8-1-16
Two Pump Valve Operation	8-1-18
Travel Forward and Backward Operation	8-1-19
Boom Up Operation	8-1-20
Boom Down Operation	8-1-22
Arm (Stick) In Operation	8-1-24
Arm (Stick) Out Operation	8-1-26
Heel Rack In Operation	8-1-28
Heel Rack Out Operation	8-1-30

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.

GENERAL

General Description

The hydraulic system has several improvements over conventional hydraulic systems - including cross sensing total horsepower control - to maximize output efficiency.

The system features an electronically controlled output optimization system, which allows the operator to choose between two, distinctly different power modes: high output/rapid cycling maximum speed power mode, and a standard power mode for most types of general operation.

Electronic management of hydraulic control valves assists in optimizing the application speed and overall operator control of hydraulic actuators and functions.

HYDRAULIC SCHEMATIC

The hydraulic schematic(s) is available in the "Hydraulic and Schematic Shop Manual".

General Description

When referring to the schematic, refer to the following items:

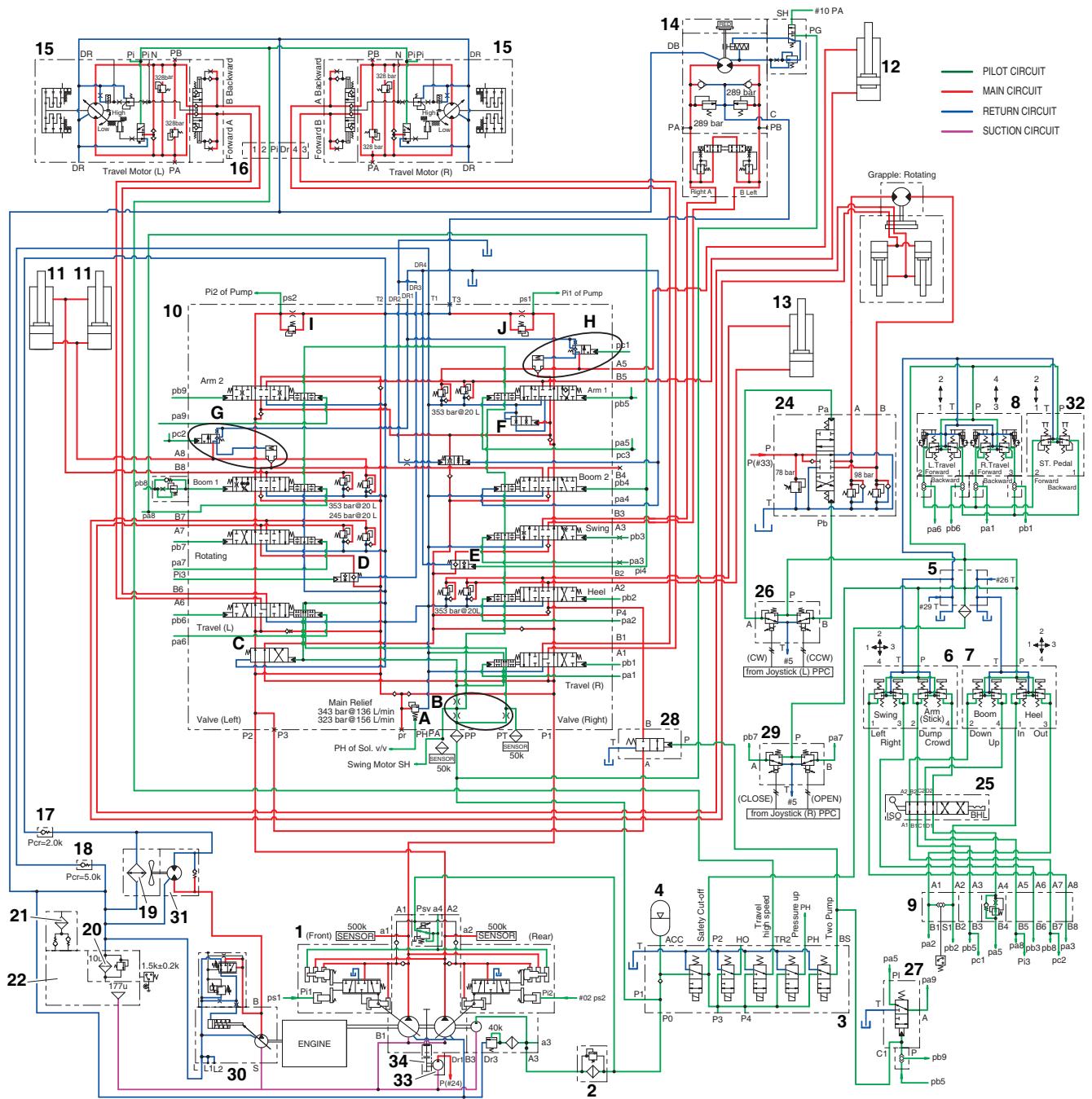
- As shown in the schematic, the main pump assembly is driven by the engine. Mechanical energy is converted to hydraulic power, generating the required hydraulic flow which drives the system. Two main pumps (a front pump and a rear pump) make up the main pump assembly.
- Hydraulic output from the front pump is transmitted to the right side of the control valve. Output from the rear pump is transmitted to the valve spools on the left side of the control valve. Hydraulic output from the pilot pump is used to control the pump and to operate pilot and solenoid valves.
- The right half of the hydraulic control valve, supplied by the front pump in the pump assembly, operates valve spools for right travel, swing, boom 2 and arm functions. The amount of oil flow to the actuators at the output end of each of those circuits is regulated through the movement of each individual valve spool.
- The left half of the hydraulic control valve, supplied by the rear pump in the pump, has control spools for left travel, rotating, boom and arm 2 operation.
- Two-stage operation is a feature of boom and arm function. All of these circuits can be operated using the output of only one half of the hydraulic pump assembly (one pump or the other), or – since both halves of the control valve have a spool and available circuit for these functions – the output of both pumps can be combined, allowing higher speed operation. Boom up, arm (stick) "IN" and "OUT" functions can operate in any one of the two available power modes – the standard or general duty mode, the high-speed/rapid cycling mode.
- Whenever the right travel or left travel control spools are shifted, output from the main pump assembly flows through the center joint to one or both of the axial piston motors driving the side frame crawler tracks. A pilot valve connected to the swash plate of each travel motor changes motor capacity (and output) in direct proportion to the position of the travel switch selected by the operator.
- The hydraulic reservoir return line and the pilot circuit both have 10 micron full flow filters. The disposable elements in these two canister type filters trap and remove impurities from the oil in the system. An 80 mesh, 177 micron reservoir intake strainer also helps maintain system cleanliness and must be cleaned each time hydraulic fluid

is drained and replaced. An oil cooler in the hydraulic system helps maintain the operating temperature of the system at approximately 50°C (122°F).

- Boom, Arm, and Heel cylinder circuit are also protected by overload relief valves. Whenever high-pressure is generated because of a shock or overload, excess pressure is dumped to the reservoir return circuit through the relief valve.

HYDRAULIC COMPONENT AND OIL FLOW

Hydraulic Components



DS2003055

Figure 1

Reference Number	Description
1	Main Pump
2	Pilot Filter
3	Solenoid Valve (Package)
4	Accumulator
5	PT Block
6	Joystick Valve (L)
7	Joystick Valve (R)
8	Pedal Valve
9	Joint Plate Sub Assembly
10	Control Valve
11	Hoist Cylinder
12	Stick Cylinder
13	Heel Cylinder
14	Swing Device
15	Travel Device
16	Center Joint
17	Restriction Valve
18	Restriction Valve
19	Oil Cooler
20	Full Flow Filter
21	Air Breather
22	Hydraulic Tank

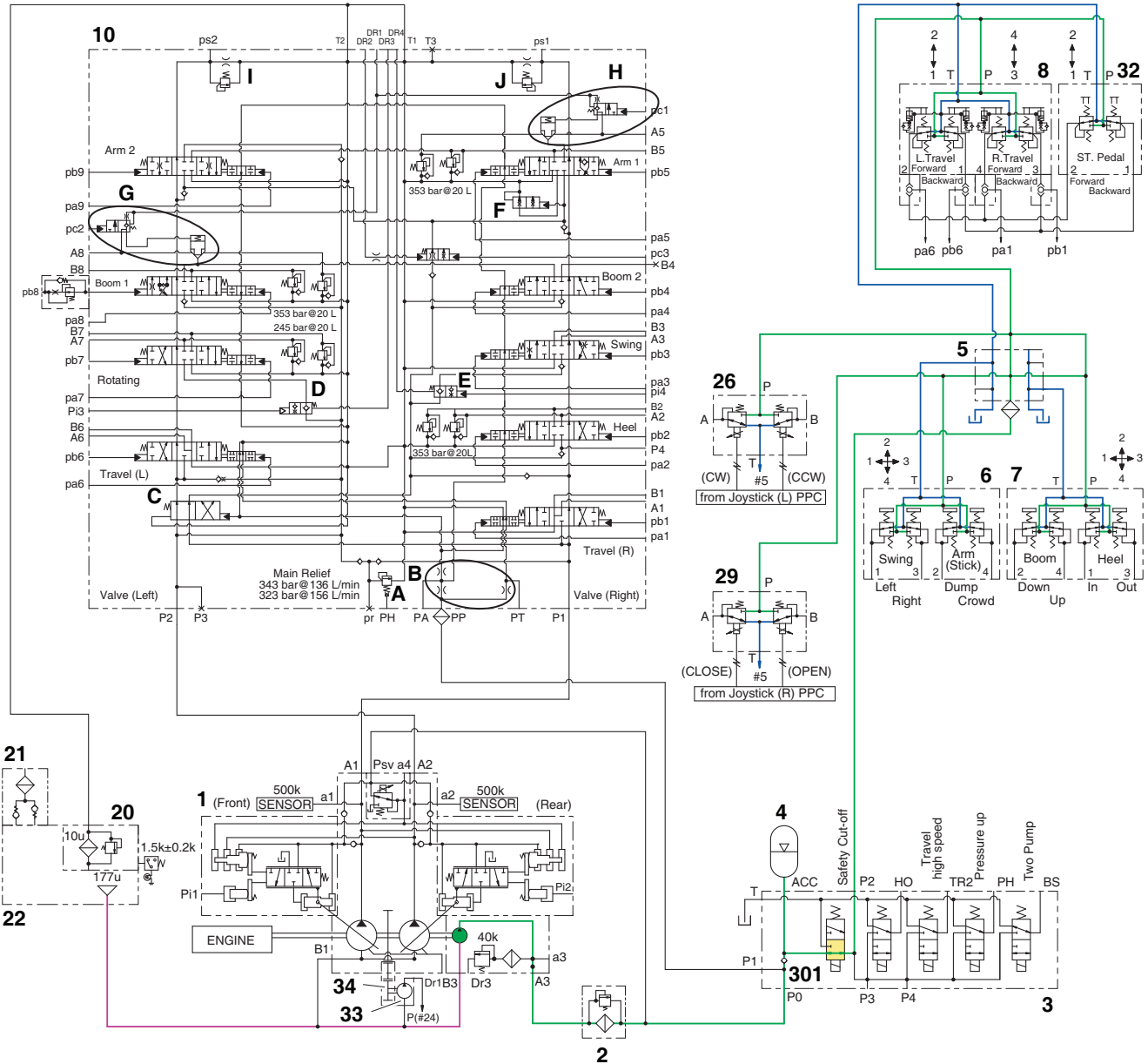
Reference Number	Description
24	Control Valve for Grapple
25	Pattern Change Valve
26	EPPR Valve for Rotating
27	Shift Valve for 2 Pump (Heel)
28	Stop Valve for 2 Pump (Heel)
29	EPPR Valve for Grapple
30	Fan Drive Pump (Oil Cooler)
31	Fan Drive Motor (Oil Cooler)
32	Straight Travel Pedal Valve
33	Gear Pump for Rotating
34	Power Take-off
A	Main Relief Valve
B	Orifice
C	Travel Straight Valve
D	Boom Priority Valve
E	Boom Priority Valve
F	Arm Regeneration Valve
G	Boom Holding Valve
H	Arm Holding Valve
I	Foot Relief Valve
J	Foot Relief Valve

SAFETY CUTOFF VALVE OPERATION

Oil from the hydraulic tank (22) fills accumulator (4) first after passing through pilot pump and pilot filter (2) and is supplied to the solenoid package valve (3).

If an electric signal is inputted to safety cutoff valve (301) installed to the solenoid package valve (3), the oil sent to main control valve (10), pedal valve (8, 32) and joystick valve (6, 7) is returned to hydraulic tank installed inside of pilot pump through relief valve.

Once safety cutoff valve is operated, any operation of machine is switched to safety mode and actuator will not operate even if joystick lever is moved.



DS2003056

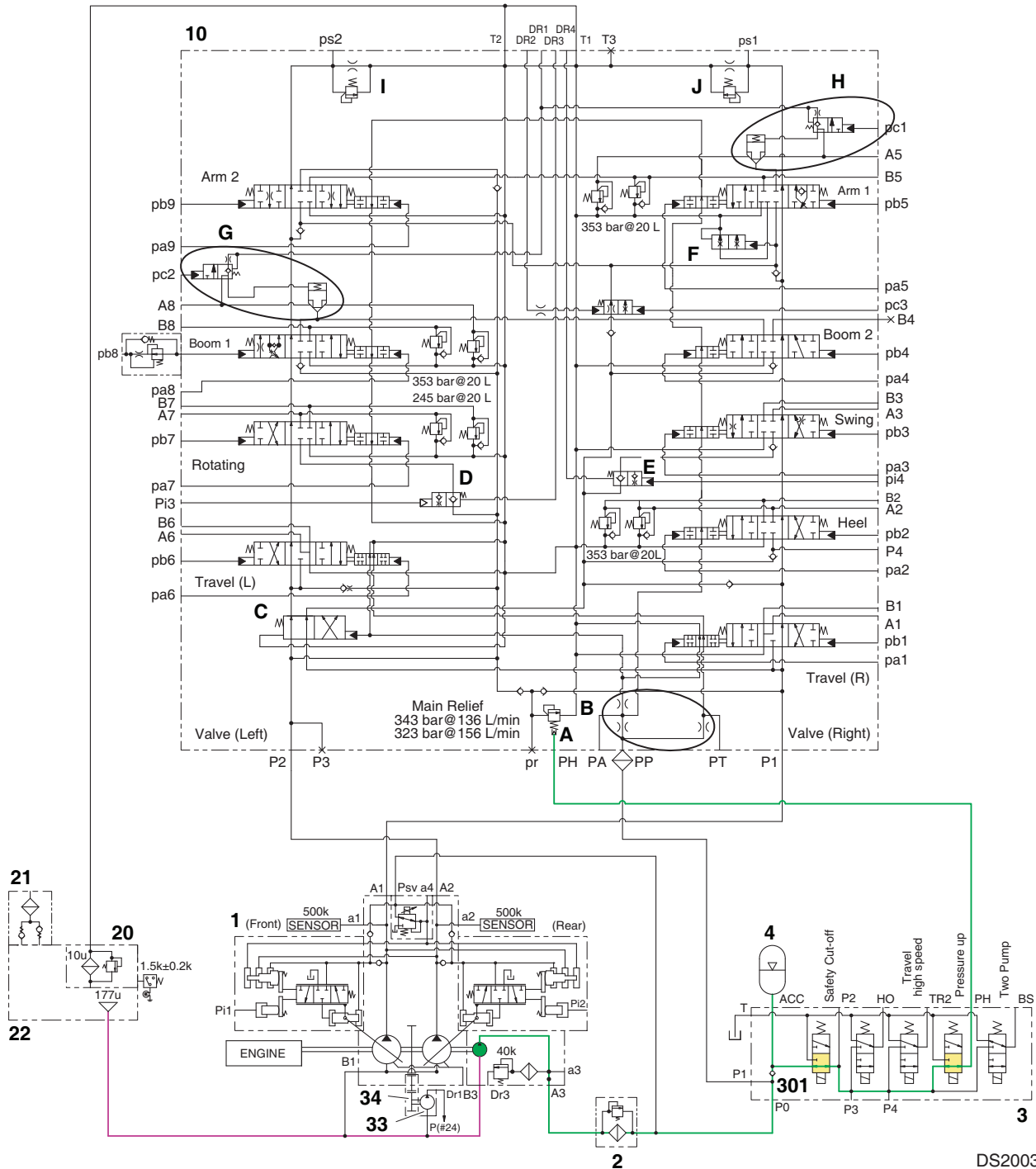
Figure 2

POWER UP VALVE OPERATION

Oil from the hydraulic tank (22) fills accumulator (4) first after passing through pilot pump and pilot filter (2) and is supplied to the solenoid package valve (3).

Pilot oil that passes through safety cutoff valve (301) of solenoid package valve (3) inside is supplied to main relief valve (A) "PH" port of main control valve (10) the following the signal of power up valve.

Once the oil is supplied to "PH" port of main control valve (10), the setting pressure of main relief valve is changed from 323 to 343 bar, increasing power of actuator.



DS2003057

Figure 3

If pressure is applied to the pilot port "PH", piston "H" moves to pilot poppet.

As a result, spring force of pilot poppet will increase, causing setting pressure increase of "HP" (From 323 to 343 bar).

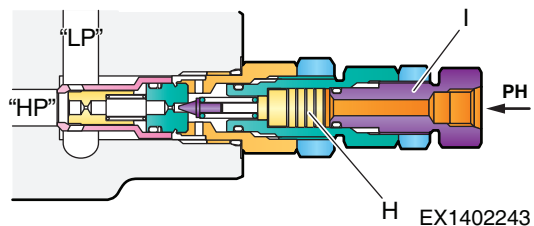


Figure 4

TRAVEL HIGH-SPEED VALVE OPERATION

Oil from the hydraulic tank (22) fills accumulator (4) first after passing through pilot pump and pilot filter (2) and is supplied to the solenoid package valve (3). Oil that passed through safety cutoff valve (301) of solenoid package valve (3) inside is supplied to travel motor's (15) "Pi" port the following the operation signal of travel high-speed valve (302), causing high-speed transfer spool (1501) to move. Oil from main pump (1) passes through oil passage of high-speed transfer spool (1501) and drives travel motor (15) while maintaining piston in high-speed position.

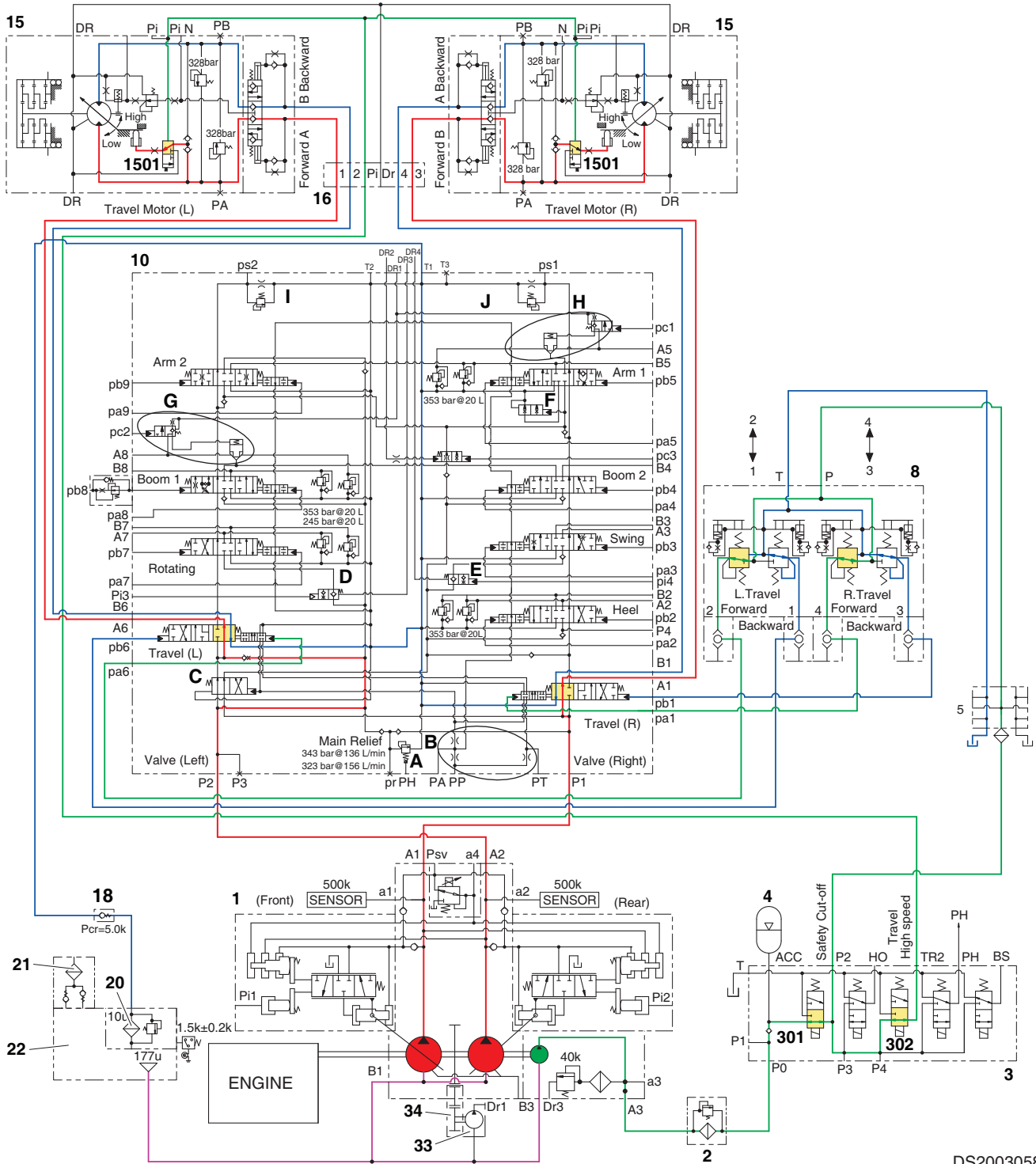


Figure 5

DS2003058

Operation of high-speed

This is a supporting device for swash plate (201) on which shoe slides. It has a hemispherical pivot ball (504) arranged along its both ends which bears load against swash stopper.

Changing in tilting angle of this swash plate changes capacity. This device has tilting pistons (502) arranged along swash stopper section and uses tilting control valve to control inflow/outflow of working oil from / to piston chamber, and thus it can determine tilting angle (large or small) of swash plate.

- External pilot pressure $P_i = 0 \text{ kg/cm}^2$ (0 bar) (Large tilting)
 High pressure acting to motor from high pressure select function assembled to valve casing (303) acts to P port of tilting spool (531). This pressure becomes save pressure. As spool (531) assembled into tilting switching section is in tight contact with plug (571) through spring (533), high-pressure in P port gets blocked.

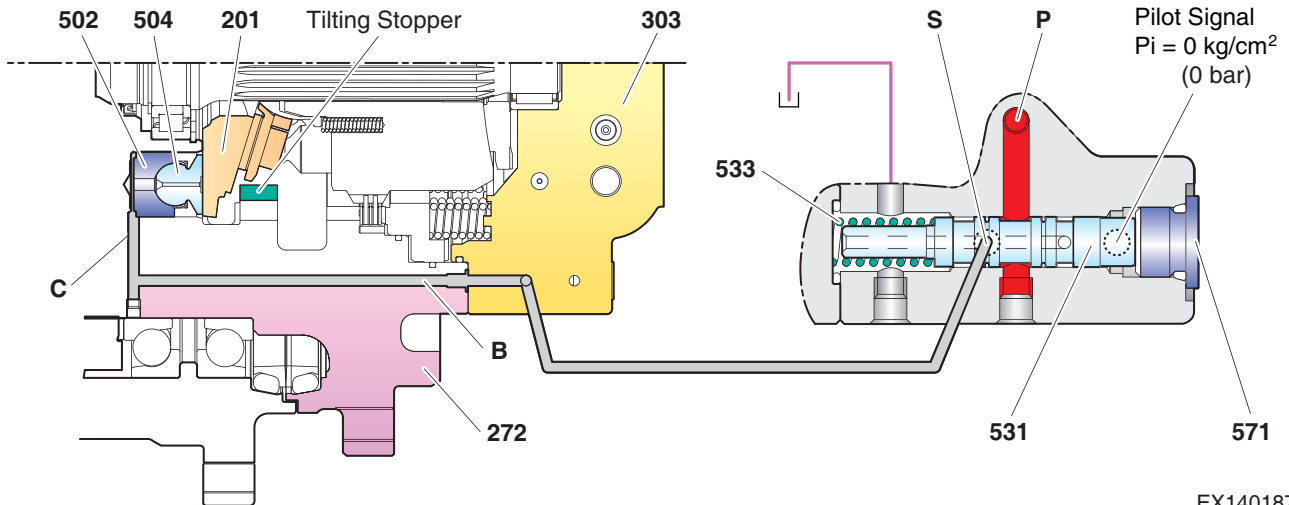


Figure 6

EX1401878

- External pilot pressure $P_i \geq 20 \text{ kg/cm}^2$ (20 bar) (Small tilting)
 If force acting to tilting spool (531) overpowers spring (533) force, spool is switched to left direction. High pressure oil passes P port to S port of tilting spool, path B, then acting to C chamber. The tilting piston (502) moves right through this high-pressure oil and swash plate moves right. The swash plate moves all way to position of tilting stopper of shaft casing (272) until it becomes fixed in that position.

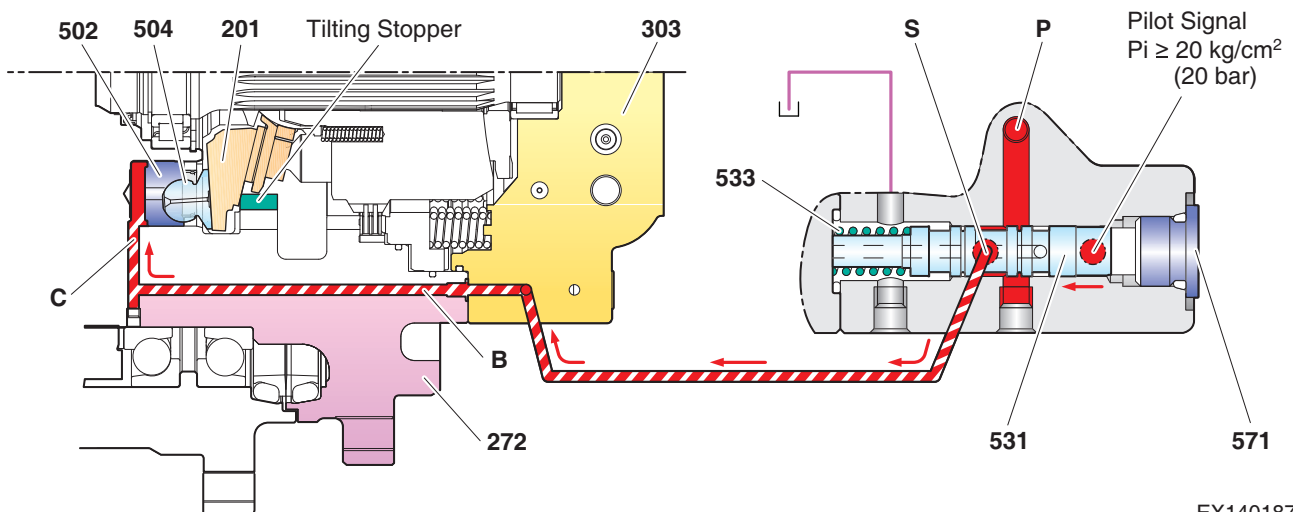


Figure 7

EX1401879

SWING BRAKE RELEASE OPERATION

Oil from the hydraulic tank (22) fills accumulator (4) first after passing through pilot pump and pilot filter (2) and is supplied to the solenoid package valve (3).

Oil that passed through safety cutoff valve (301) of solenoid package valve (3) inside moves swing spool of main control valve (10) the following the operation of joystick valve (6).

Once swing spool moves, pressure of oil supplied from solenoid package valve (3) to main control valve's (10) "PA" port increases and the oil is supplied to swing device's (14) "SH" port causing brake release spool to move. Then oil is supplied to swing device's (14) "PG" port connected to pilot pump and swing parking brake is released.

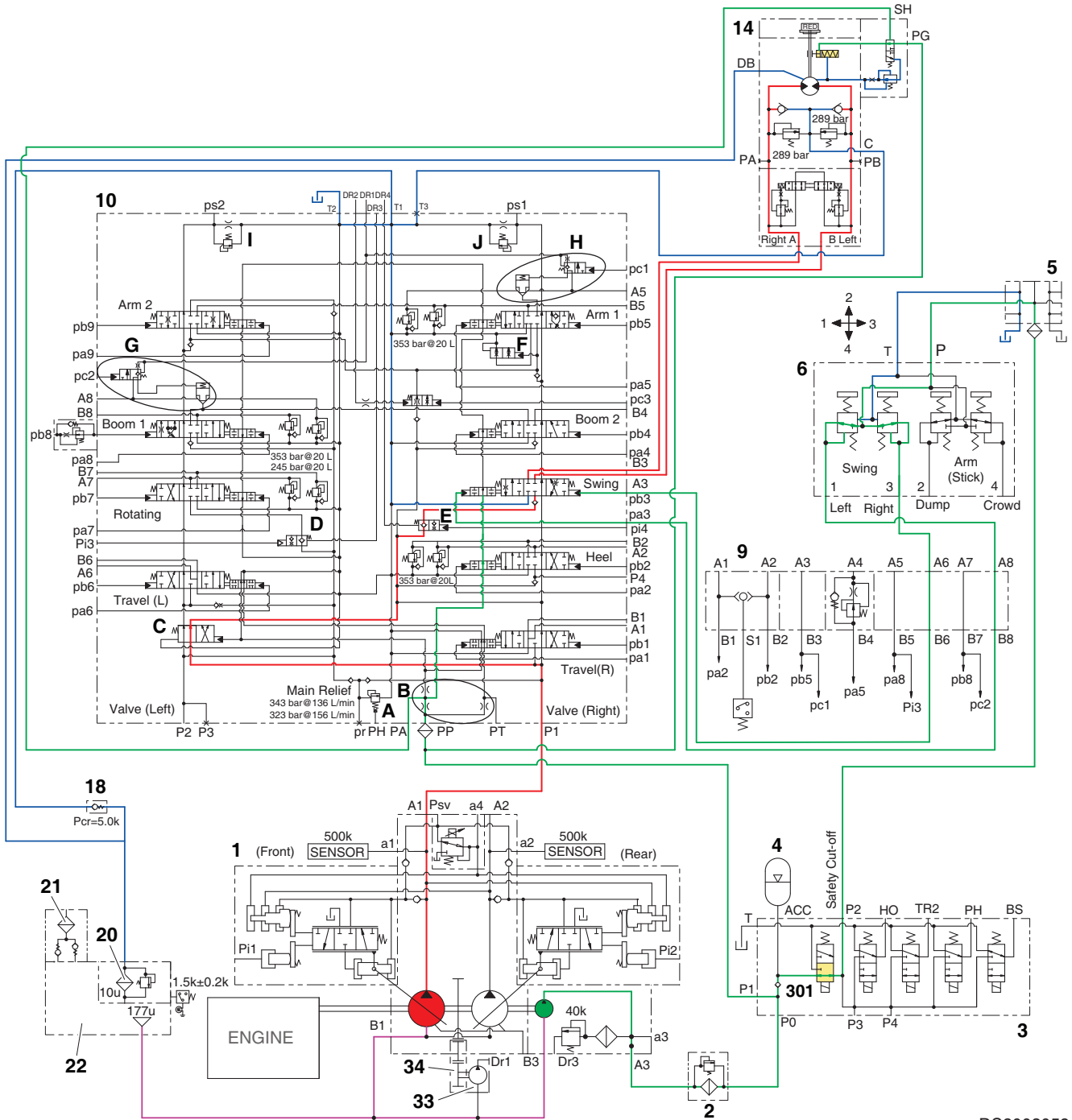


Figure 8

DS2003059

1. Parking brake operating

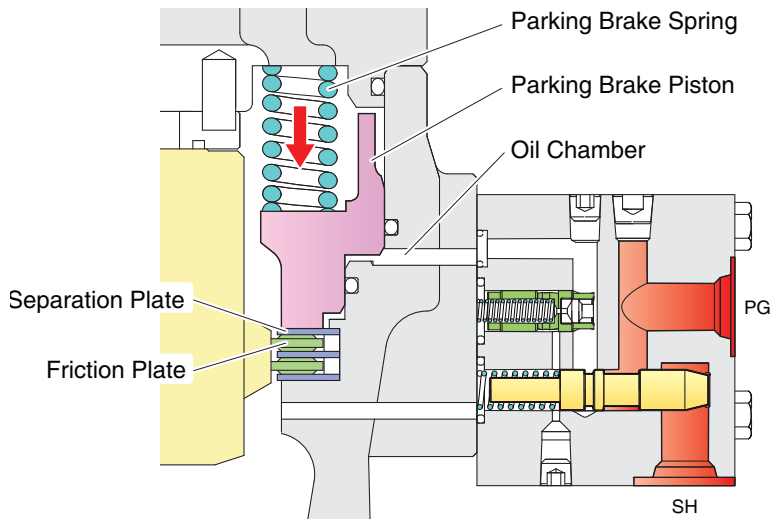
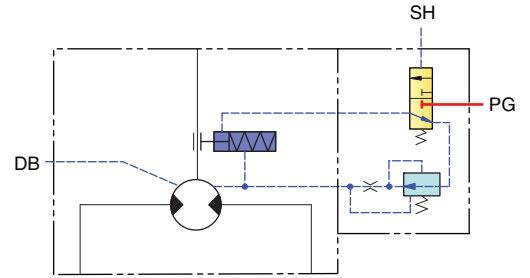


Figure 9



WE1400028

2. Parking brake release

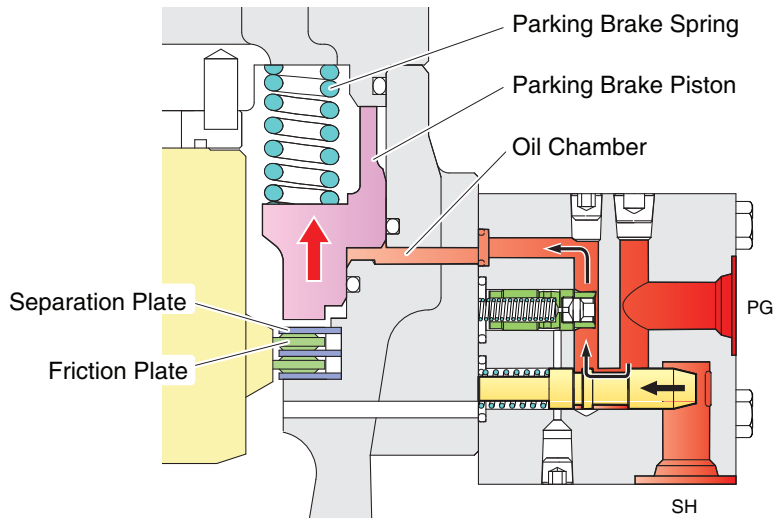
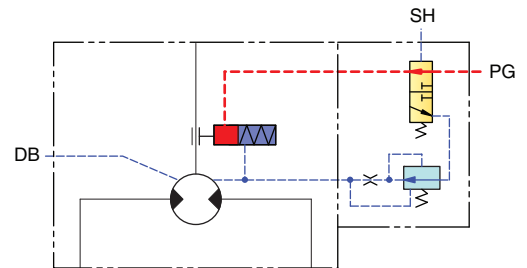


Figure 10



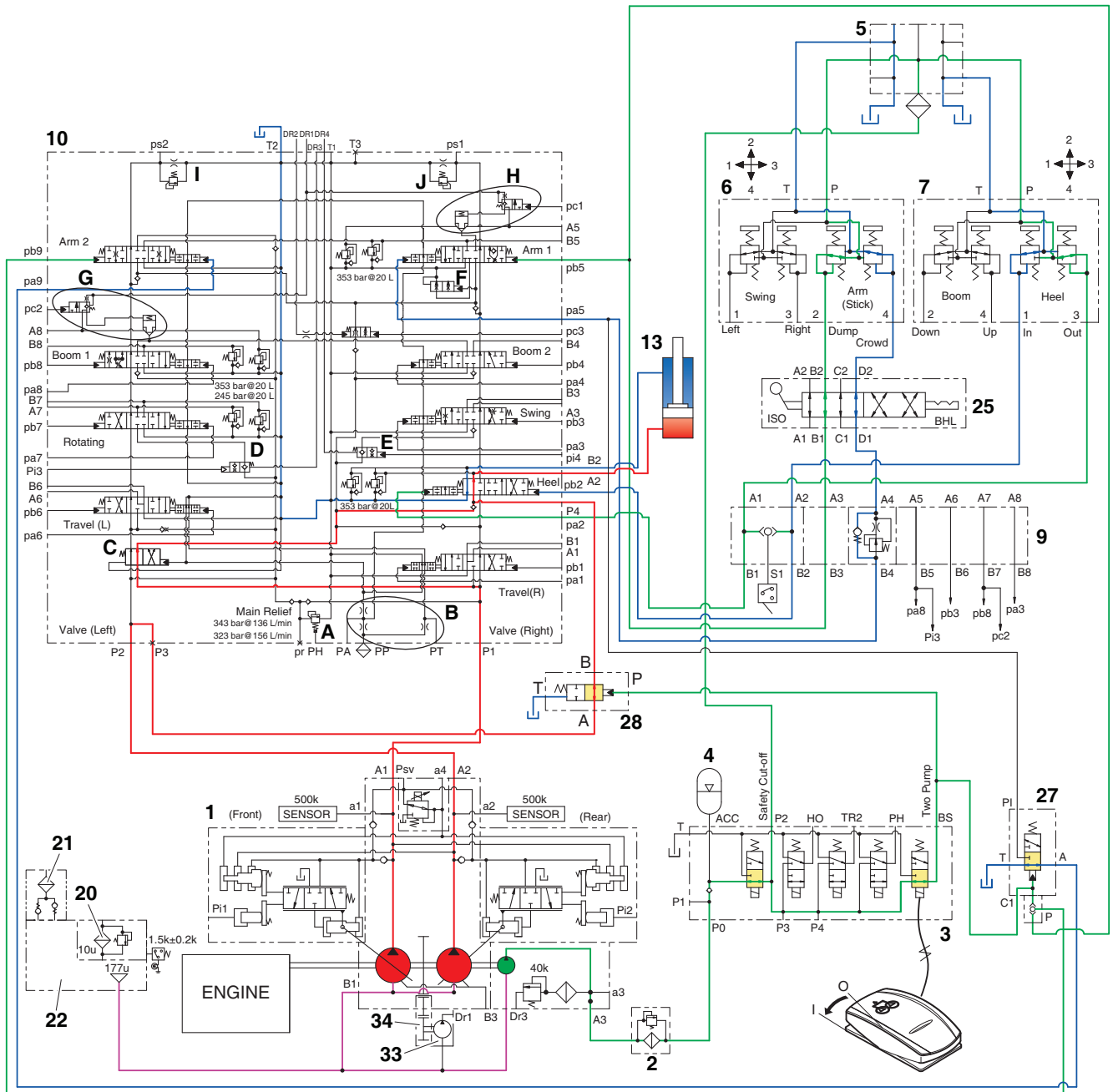
WE1400029

TWO PUMP VALVE OPERATION

When the two pump switch is set "ON", the two pump solenoid of the solenoid valve (3) is energized, switching its internal spool to open the port "BS".

Then, the pilot oil is applied to the stop valve (28) through the port "BS" to move the internal spool.

As a result, the main pump (1) "A2" oil at the port "P3" of the main control valve (10) passes through the stop valve (28) to be delivered to the port "P4" of the main control valve (10). Then, it joins the main pump (1) "A1" oil to be supplied for heel rack "IN/OUT" operation.



DS2003060

Figure 11

TRAVEL FORWARD AND BACKWARD OPERATION

When the travel levers are pushed forward or backward position, the travel spools in the main control valve (10) are moved to the forward or backward travel position by the pilot oil pressure from the pedal valve (8).

The oil from the each pump flows into the main control valve (10) and then goes to the each travel motor (15) through the center joint (16). The return oil from both travel motors (15) returns to the hydraulic oil tank (22) through the center joint (16) and the travel spools in the main control valve (10).

When this happens, the machine moves to the forward or backward.

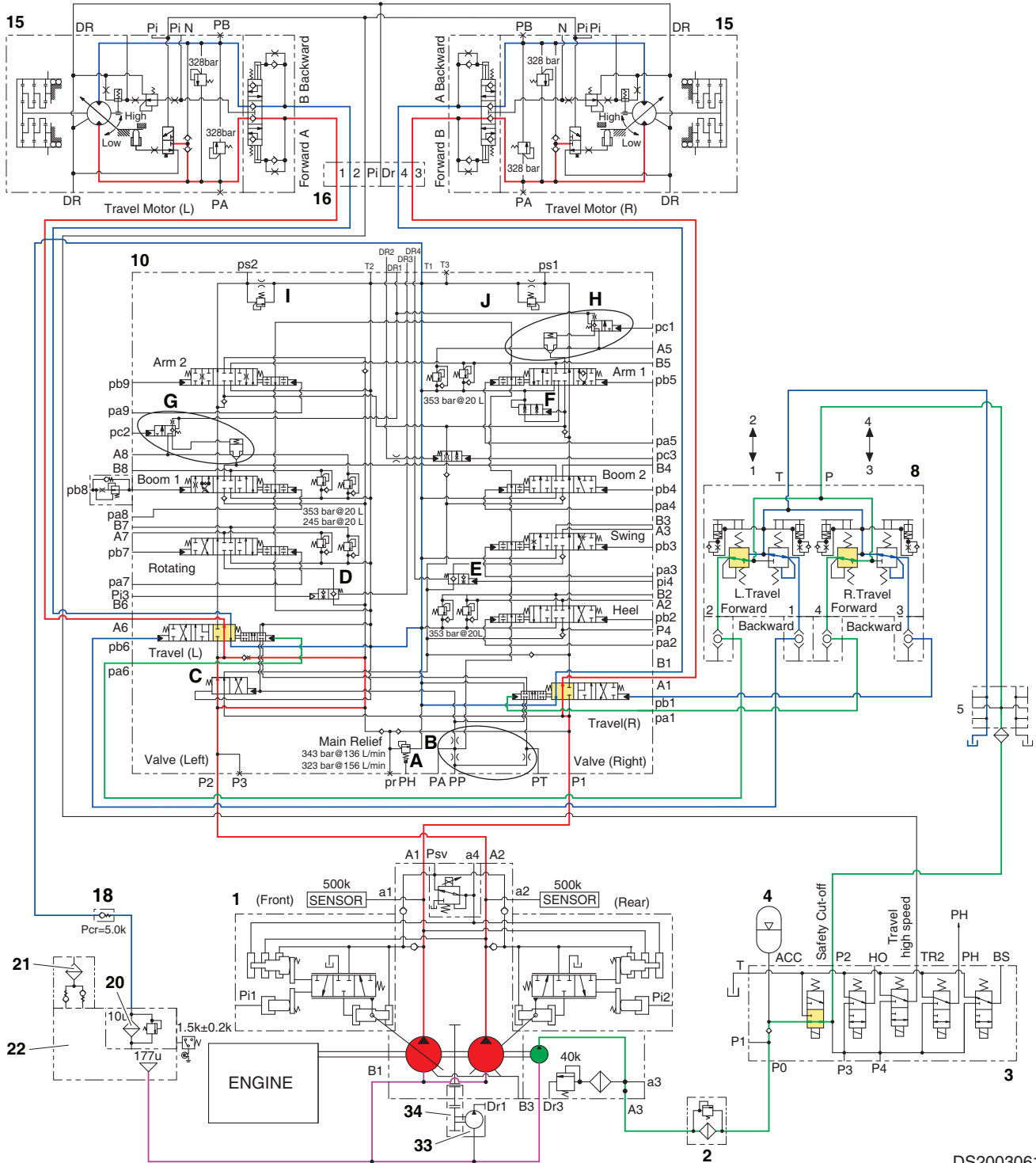


Figure 12

DS2003061

BOOM UP OPERATION

Oil supplied from hydraulic tank (22) passes through pilot pump connected to main pump (1) and pilot filter (2) and is supplied to solenoid package valve (3) after accumulator (4) is first filled with the oil.

If the pilot oil is supplied to boom spool of main control valve (10) by the operation of joystick valve (7), the spool is moved and oil passage of main pump (1) and the one on the boom cylinder (11) head side open.

Oil supplied from main pump (1) is supplied to boom cylinder (11) head through boom holding valve (G), causing the moving to take place.

If boom up operation is stopped, the oil in boom cylinder is obstructed by check of boom holding valve (G) and the moving of boom is blocked.

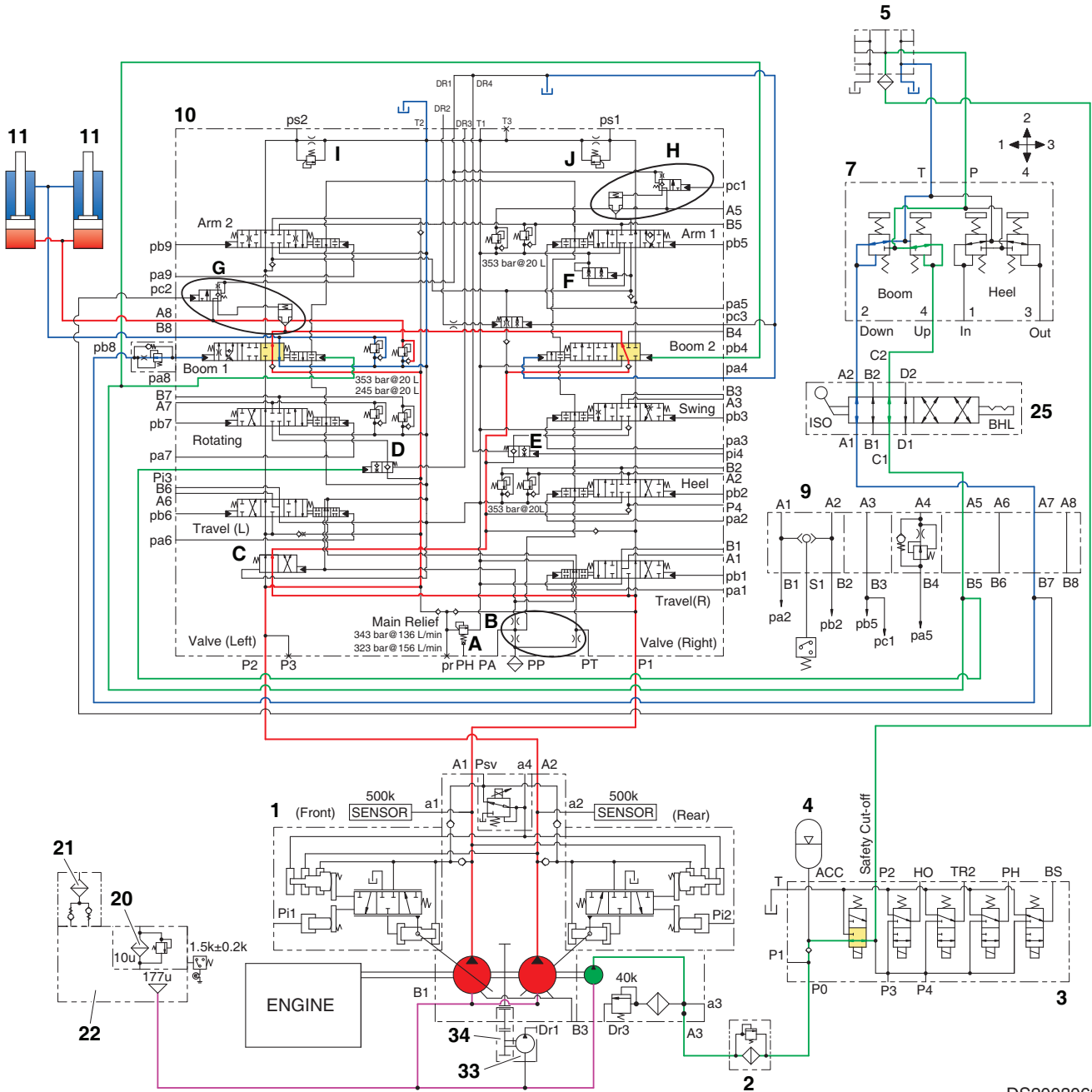
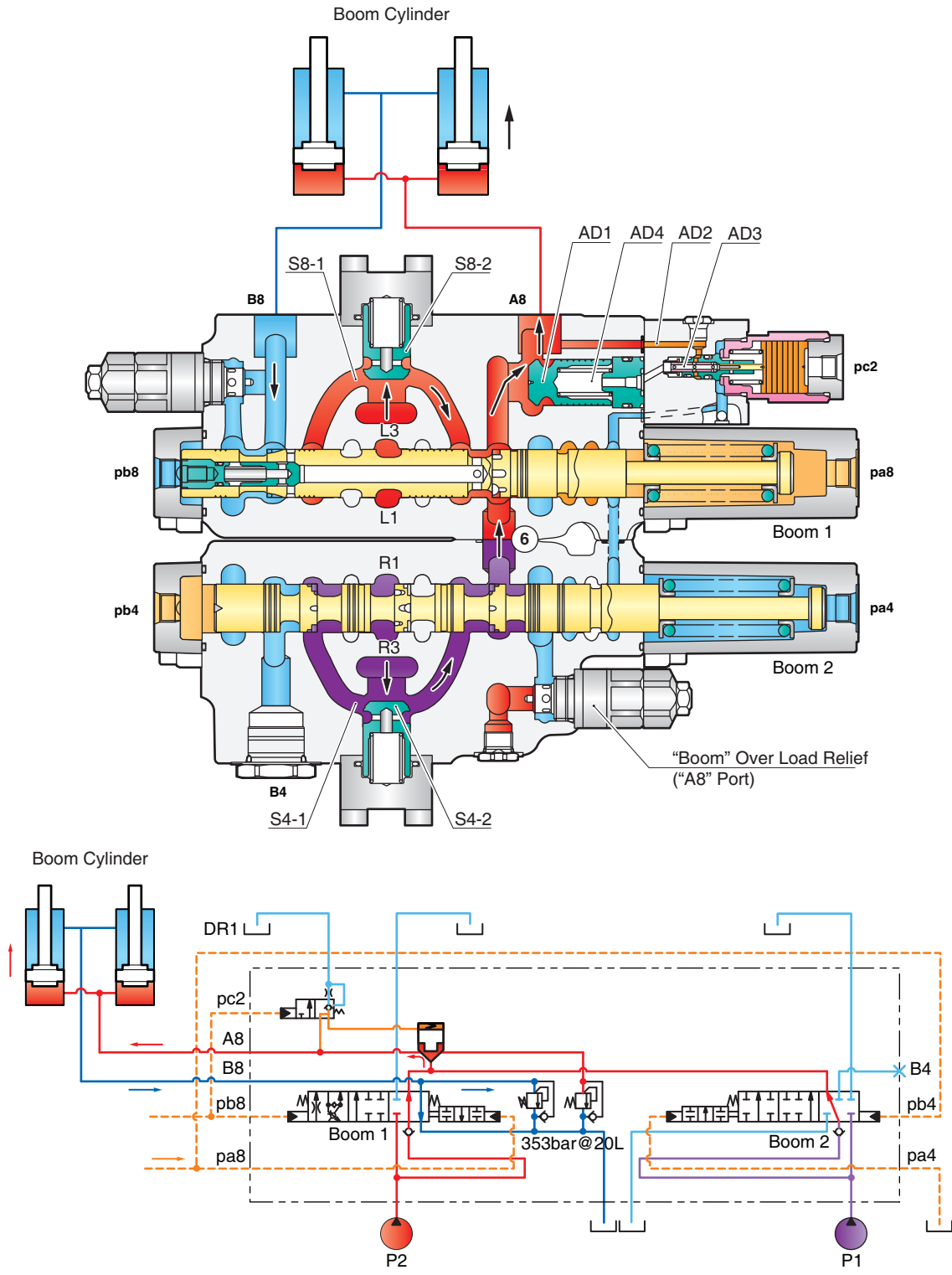


Figure 13

DS2003062



EX1404110

Figure 14

BOOM DOWN OPERATION

Oil supplied from hydraulic tank (22) passes through pilot pump connected to main pump (1) and pilot filter (2) and is supplied to solenoid package valve (3) after accumulator (4) is first filled with the oil.

If the pilot oil is supplied to boom spool of main control valve (10) by the operation of joystick valve (7), the spool is moved and oil passage of main pump and the one on the boom cylinder (11) rod side open.

Oil passage supplied from main pump (1) is supplied to boom cylinder (11) rod side after passing through boom holding valve (G), causing the moving to take place.

Rapidly occurring boom down causes short supply of oil in the cylinder rod side, in which case the oil in cylinder head side is supplied to rod side so oil cavitation may be prevented.

If boom down operation is stopped, the oil in boom cylinder is obstructed by check of boom holding valve (G) and the moving of boom is blocked.

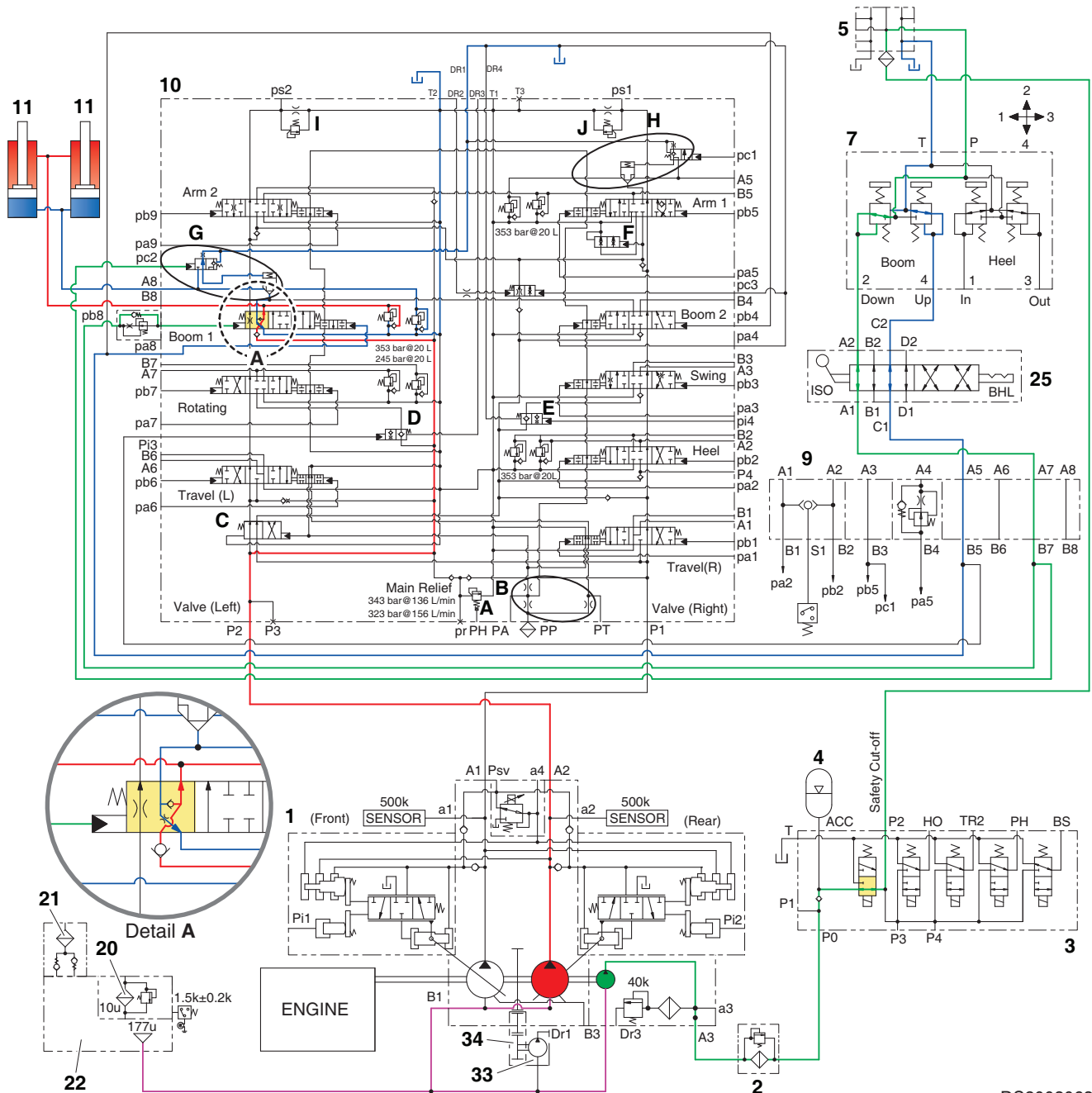


Figure 15

DS2003063

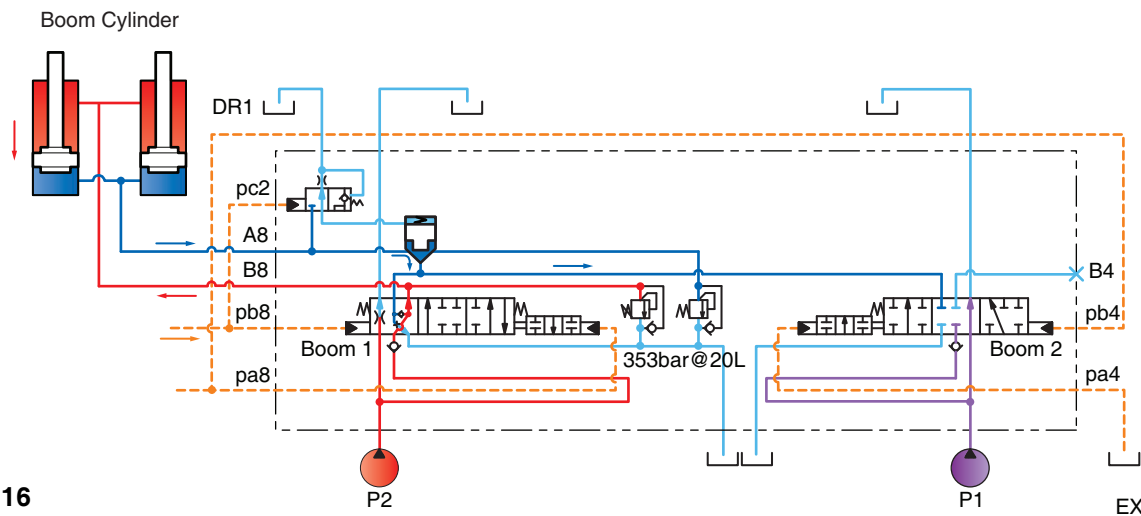
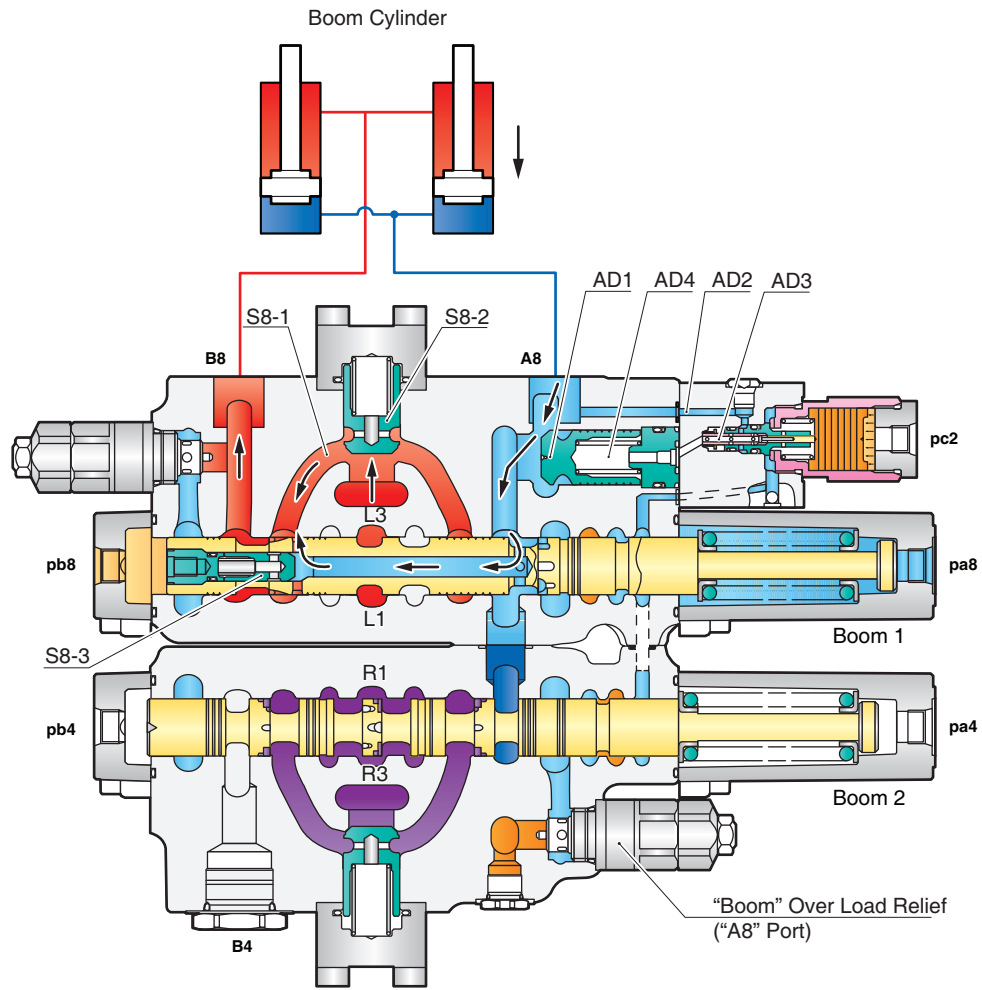


Figure 16

EX1404111

ARM (STICK) IN OPERATION

Oil supplied from hydraulic tank (22) passes through pilot pump connected to main pump (1) and pilot filter (2) and is supplied to solenoid package valve (3) after accumulator (4) is first filled with the oil.

If pilot oil is supplied to arm 1 and arm 2 dump spool of main control valve (10) by the operation of joystick valve (6), then spool is moved and main pump oil passage and arm cylinder rod oil passage open.

Oil supplied from front pump and rear pump of main pump is put together and is supplied to arm cylinder (12) rod direction after passing through arm holding valve (H), causing arm moving to take place.

If arm in action is stopped, the oil in arm cylinder is obstructed by check of arm holding valve (H) and the arm moving is blocked.

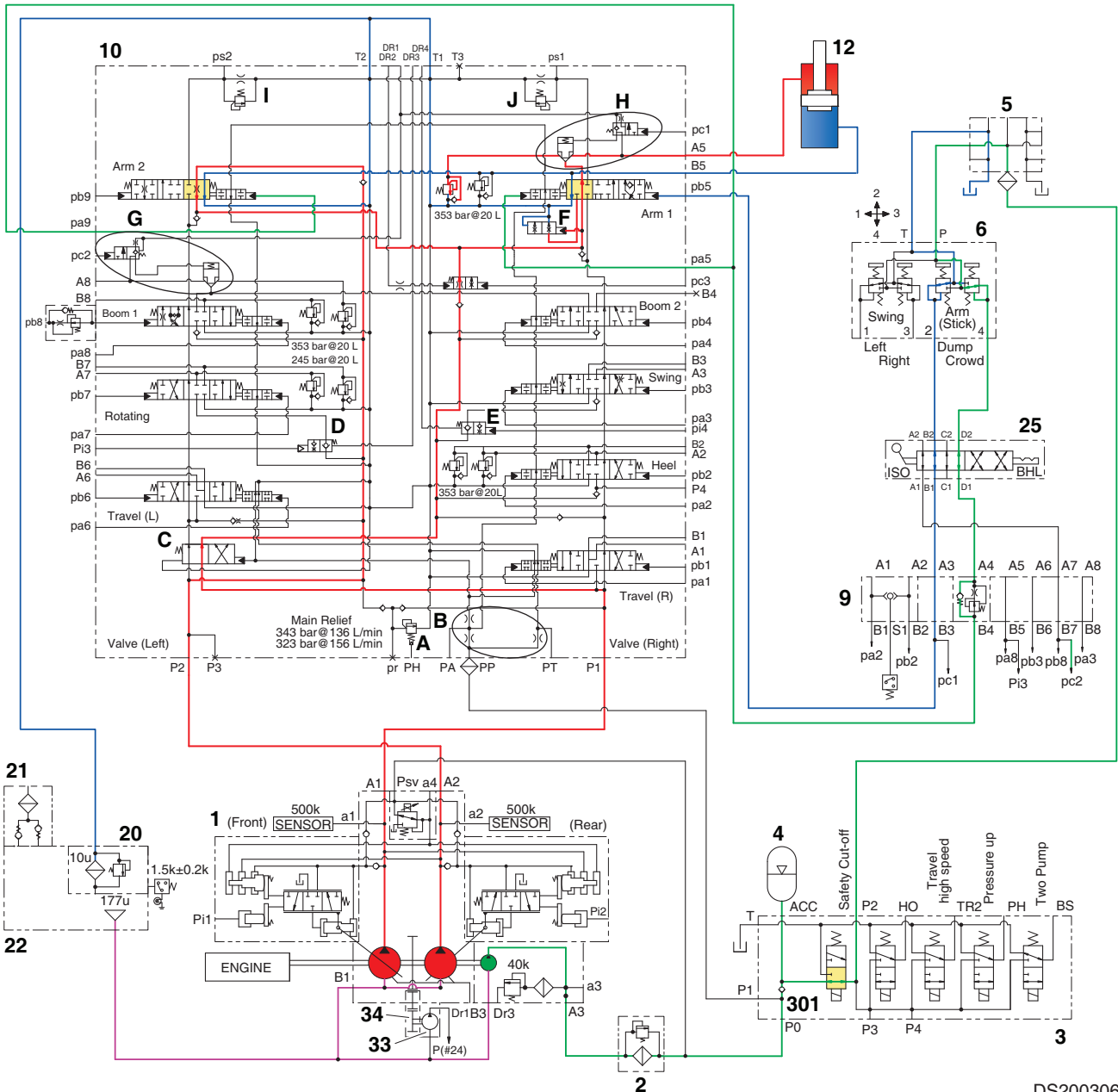


Figure 17

DS2003064

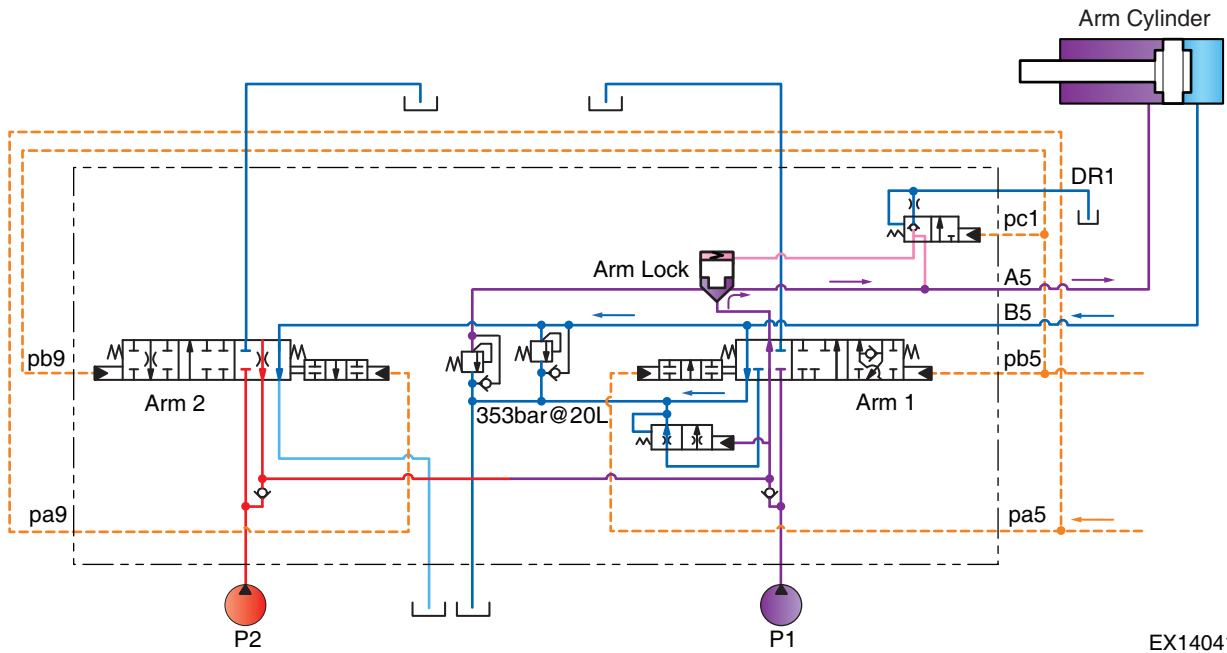
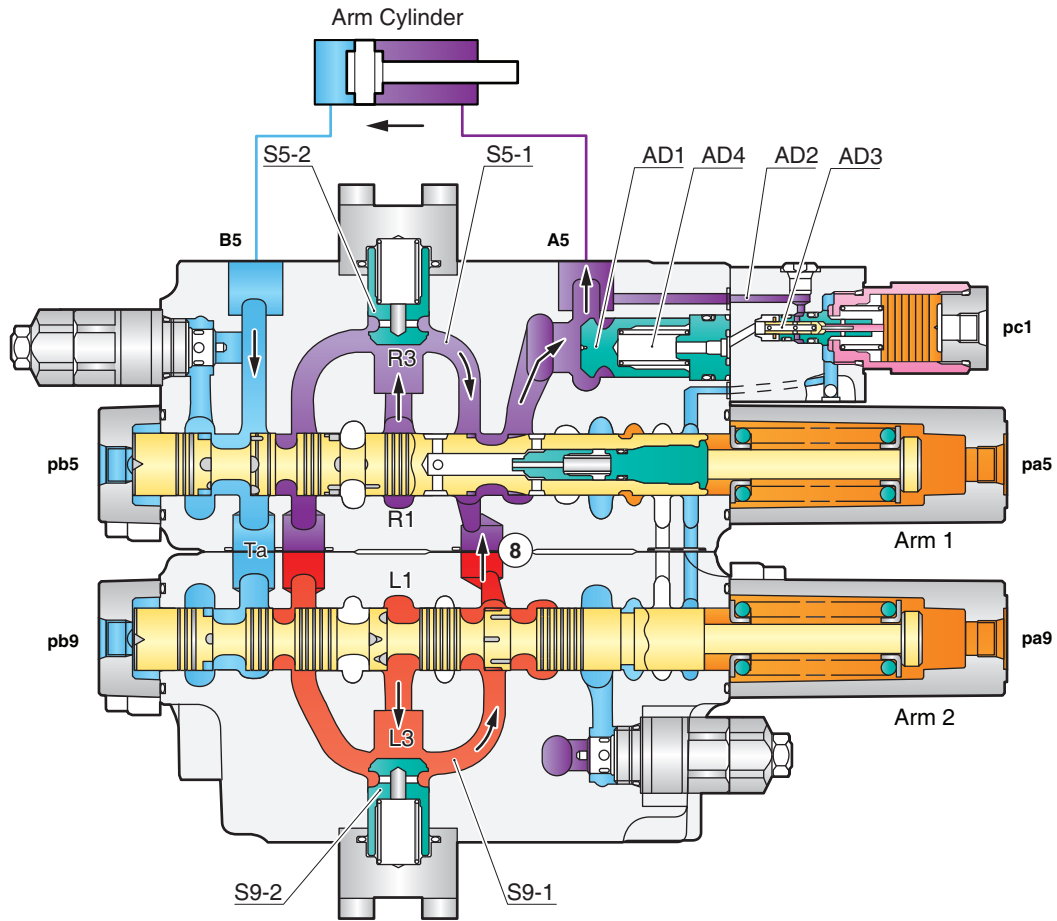


Figure 18

EX1404115

ARM (STICK) OUT OPERATION

Oil supplied from hydraulic tank (22) passes through pilot pump connected to main pump (1) and pilot filter (2) and is supplied to solenoid package valve (3) after accumulator (4) is first filled with the oil.

If pilot oil is supplied to arm 1 and arm 2 spool of main control valve (10) by the operation of joystick valve (6), then spool is moved and main pump (1) oil passage and arm cylinder (12) head oil passage open.

Oil passage supplied from main pump (1) is supplied to arm cylinder (12) head after passing through arm holding valve (H), causing the arm moving to take place.

Rapidly occurring arm crowd causes short supply of oil in the arm cylinder head, in which case the oil in arm cylinder rod is supplied to arm cylinder head so oil cavitation may be prevented.

If arm out action is stopped, oil in arm cylinder is obstructed by check of arm holding valve (H), and the moving of arm is blocked.

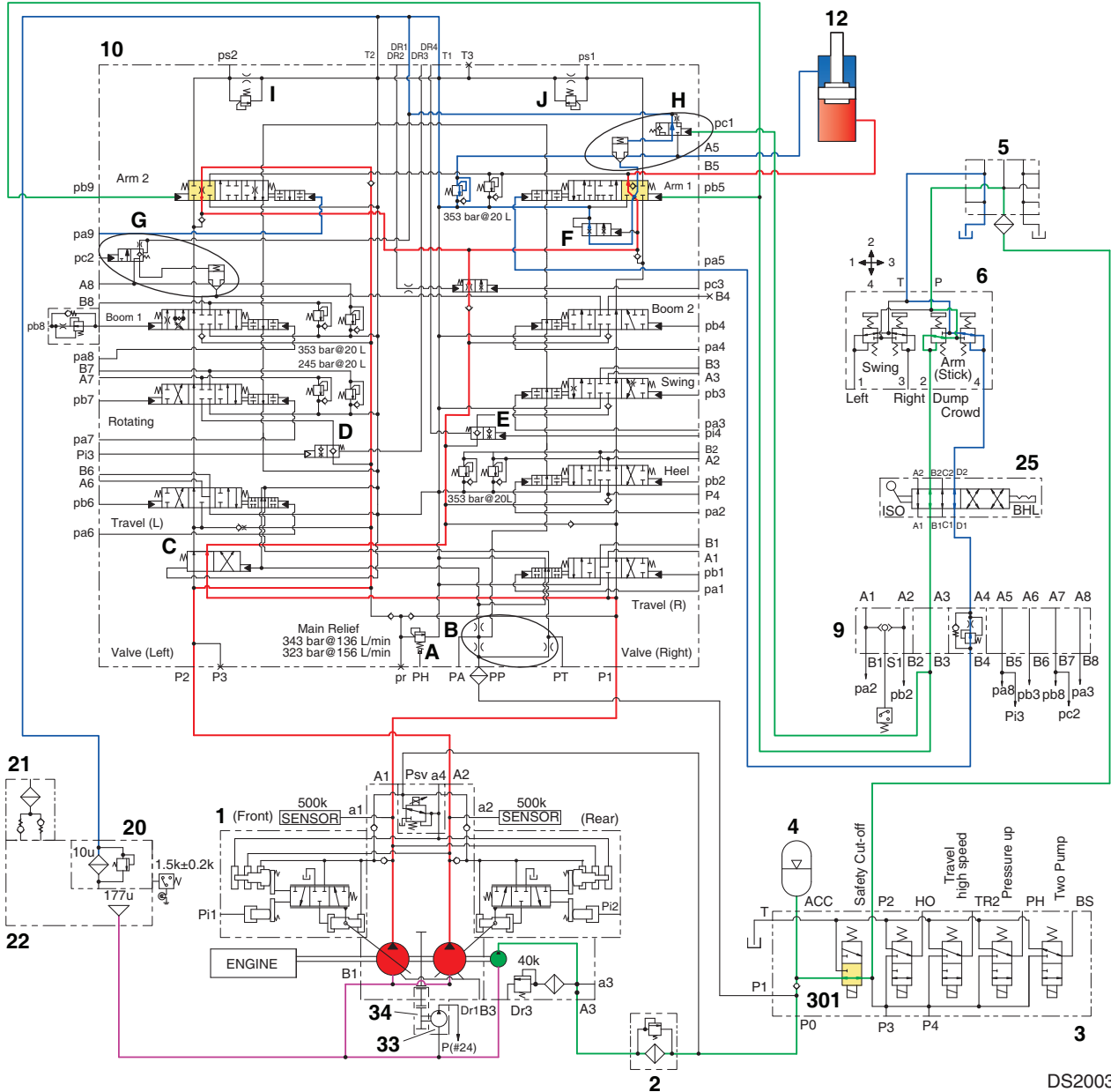
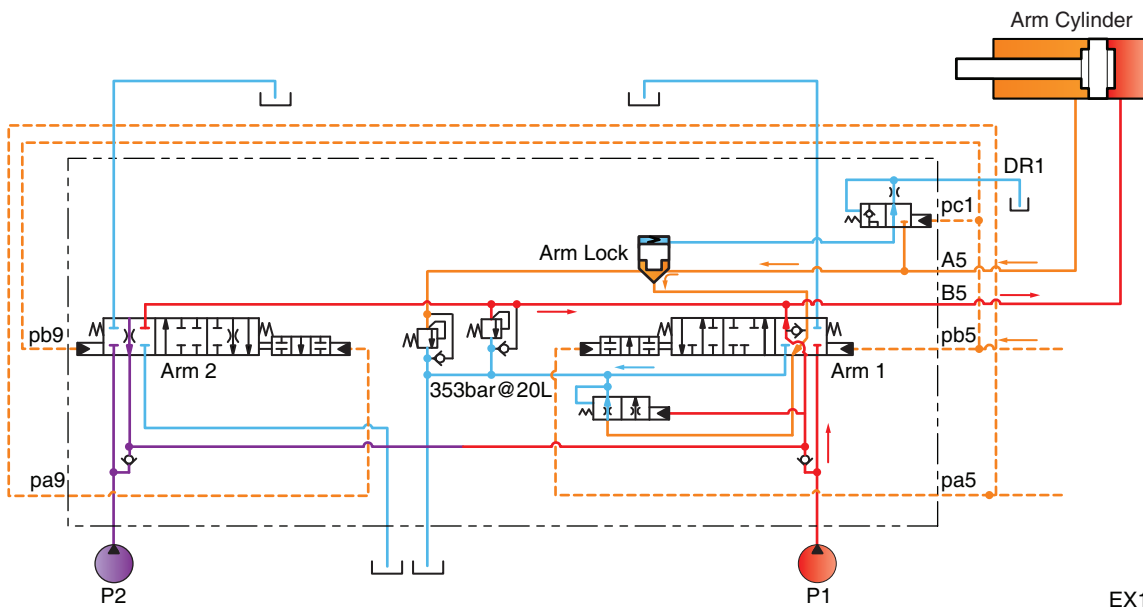
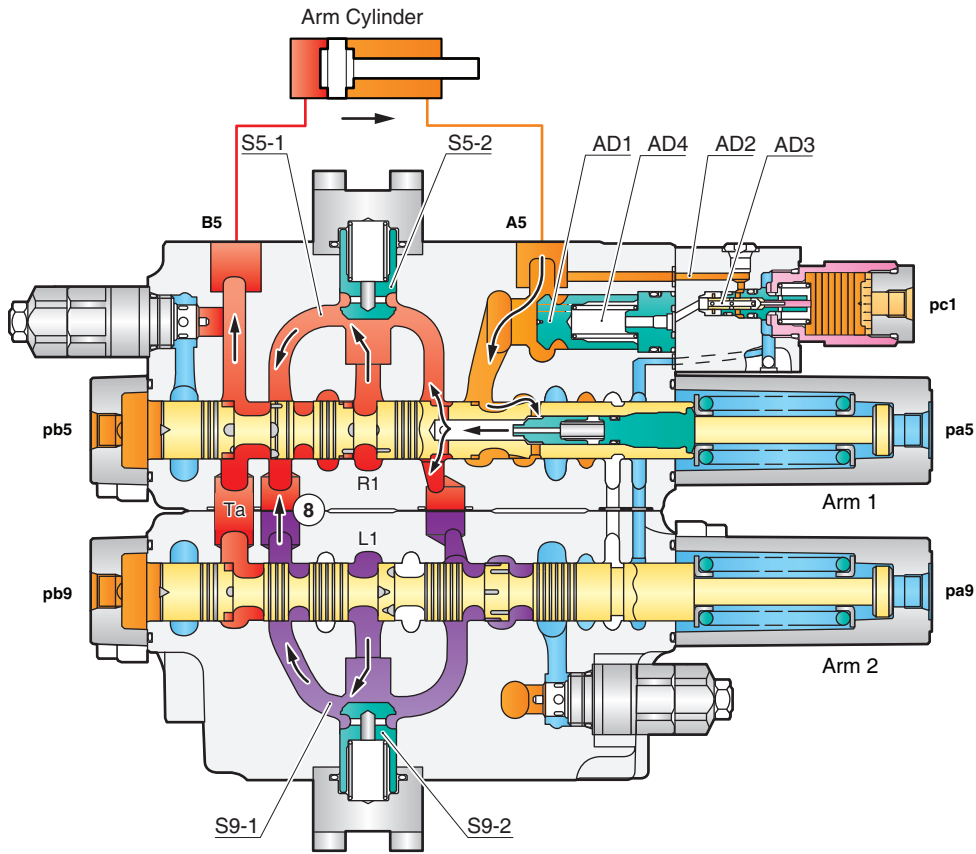


Figure 19

DS2003065



EX1404113

Figure 20

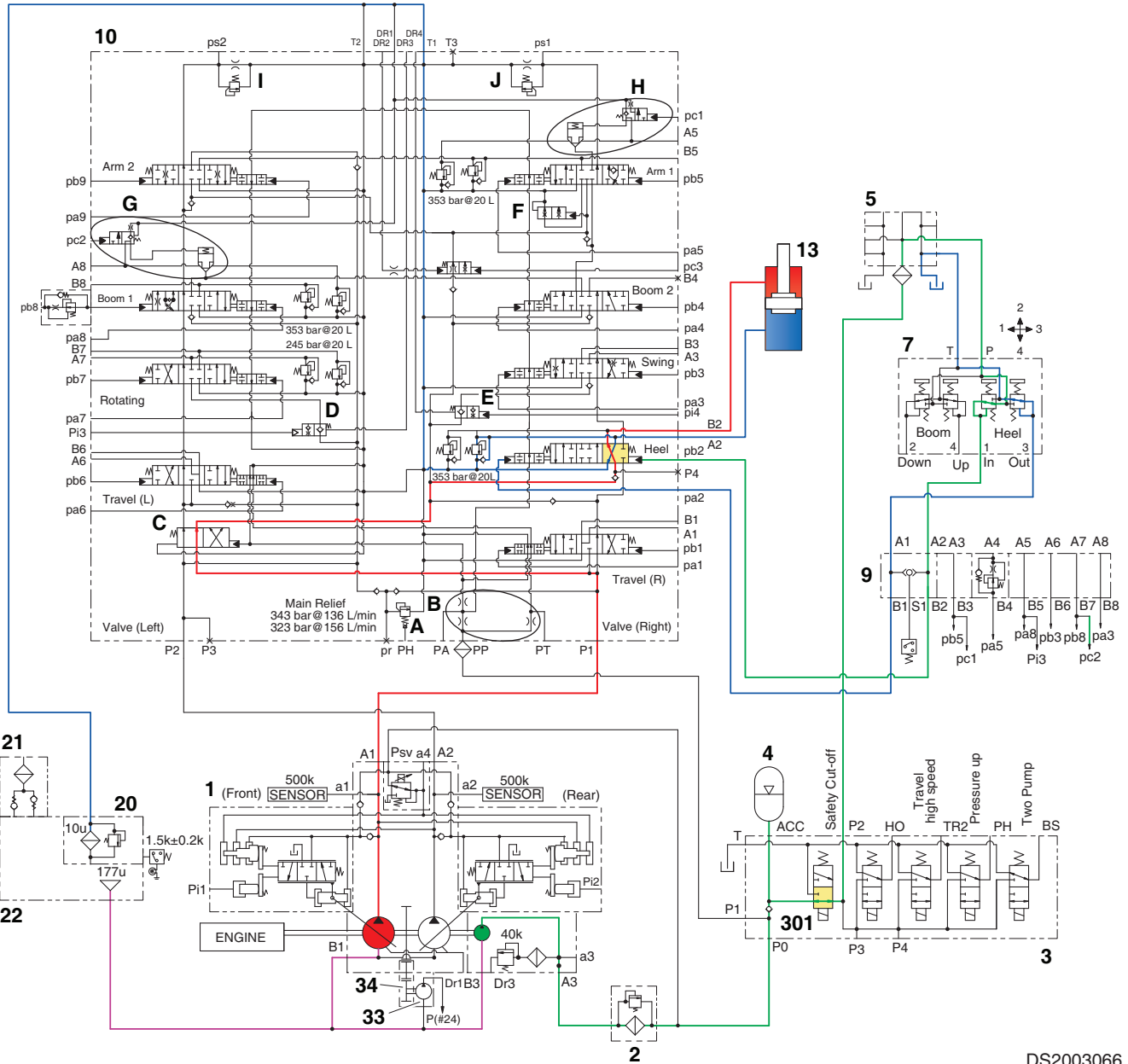
HEEL RACK IN OPERATION

Oil supplied from hydraulic tank (22) passes through pilot pump connected to main pump (1) and pilot filter (2) and is supplied to solenoid package valve (3) after accumulator (4) is first filled with the oil.

If pilot oil is supplied to heel spool of main control valve (10) by the operation of joystick valve (7), then spool is moved and main pump oil passage and heel cylinder rod oil passage open.

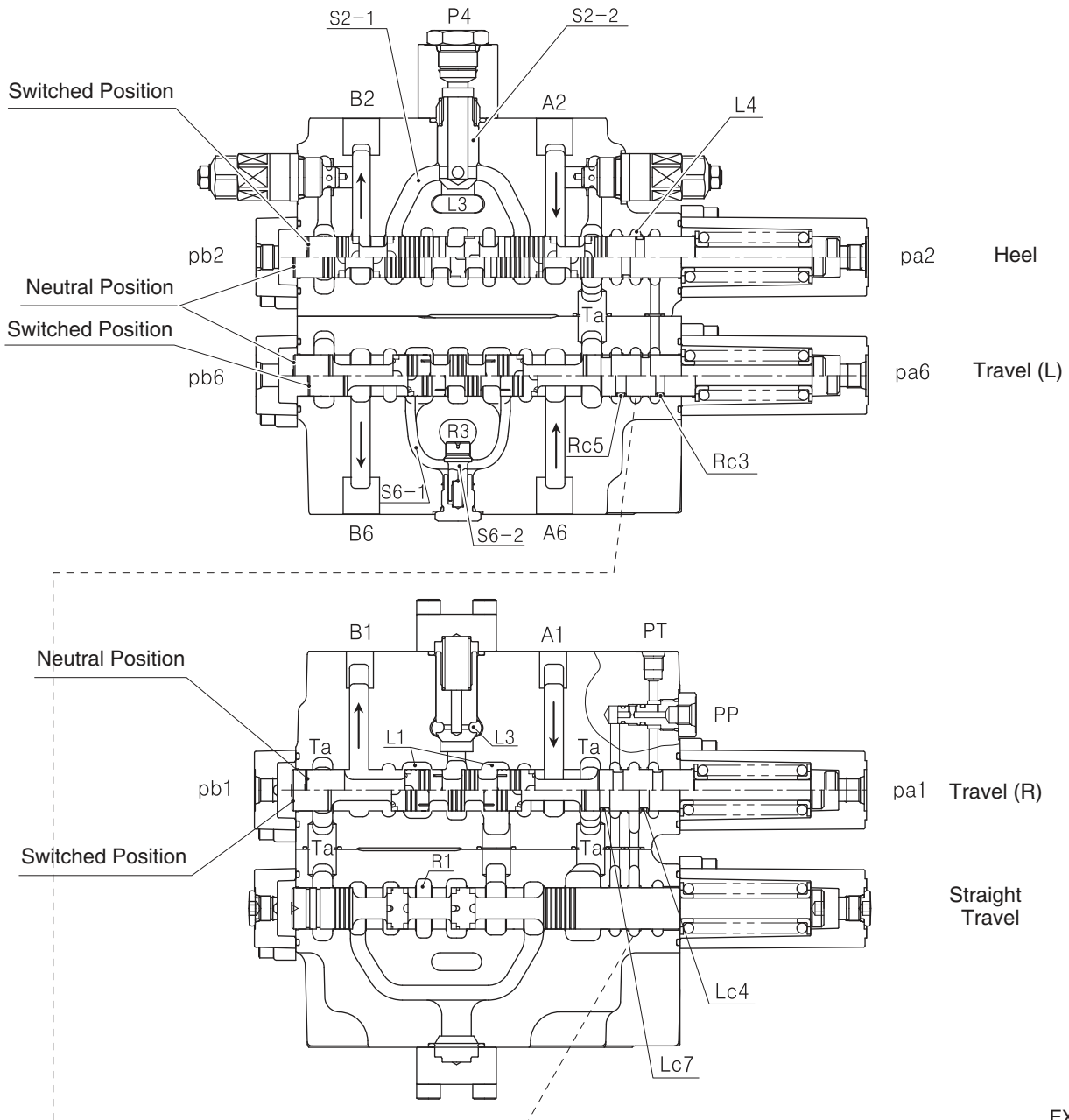
Oil supplied from front pump of main pump (1) is supplied to heel cylinder (13) rod direction causing heel moving to take place.

If boom operation takes place during heel rack in operation, oil flowing to heel spool of main control valve (10) is preferably supplied to boom spool, and, as a result, composite action in which boom operation has a priority takes place.



DS2003066

Figure 21



EX1504785

Figure 22

HEEL RACK OUT OPERATION

Oil supplied from hydraulic tank (22) passes through pilot pump connected to main pump (1) and pilot filter (2) and is supplied to solenoid package valve (3) after accumulator (4) is first filled with the oil.

If pilot oil is supplied to heel spool of main control valve (10) by the operation of joystick valve (7), then spool is moved and main pump oil passage and heel cylinder head oil passage open.

Oil supplied from front pump of main pump (1) is supplied to heel cylinder (13) head direction causing heel moving to take place.

If boom operation takes place during heel rack out operation, oil flowing to heel spool of main control valve (10) is preferably supplied to boom spool, and, as a result, composite action in which boom operation has a priority takes place.

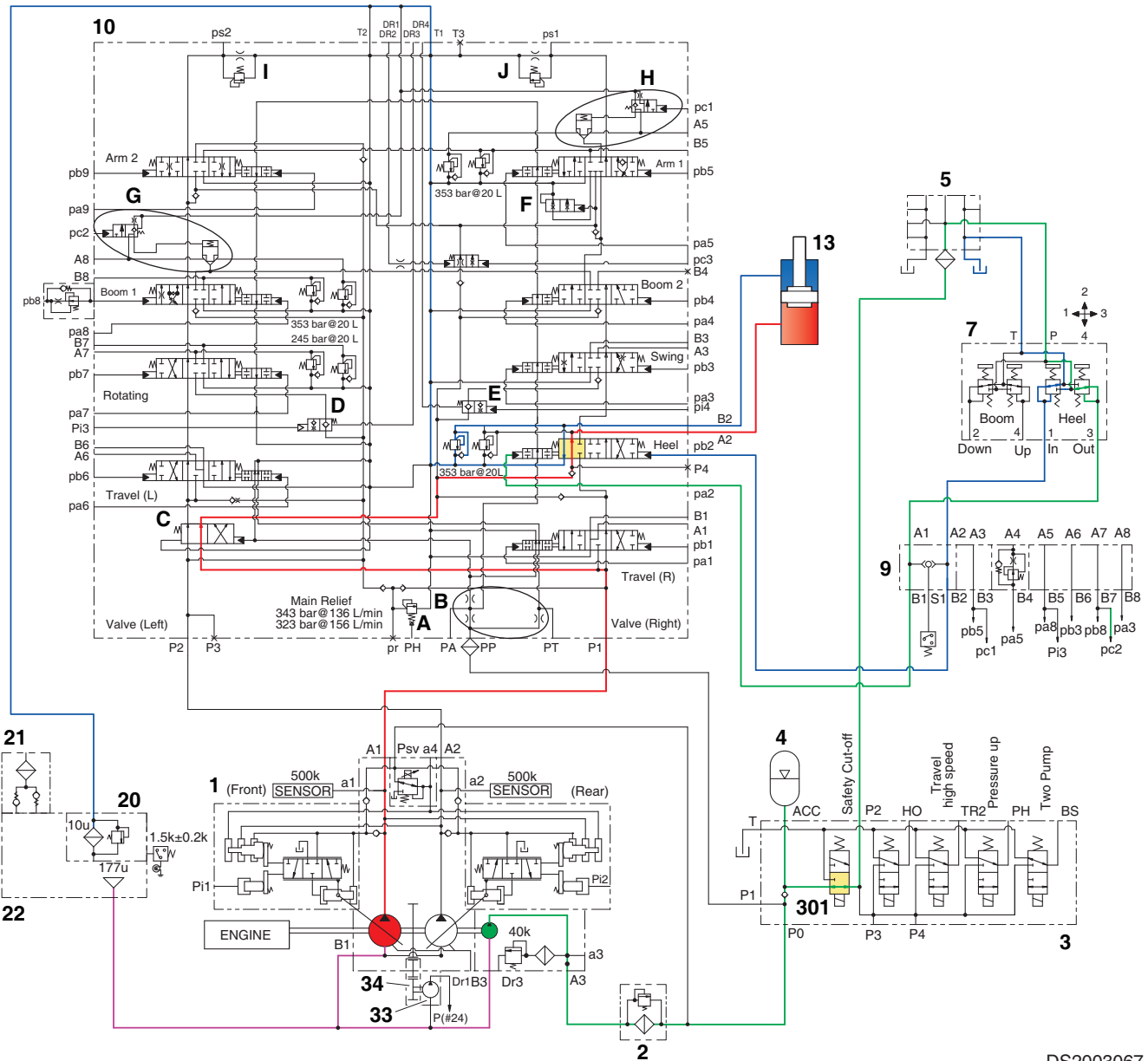
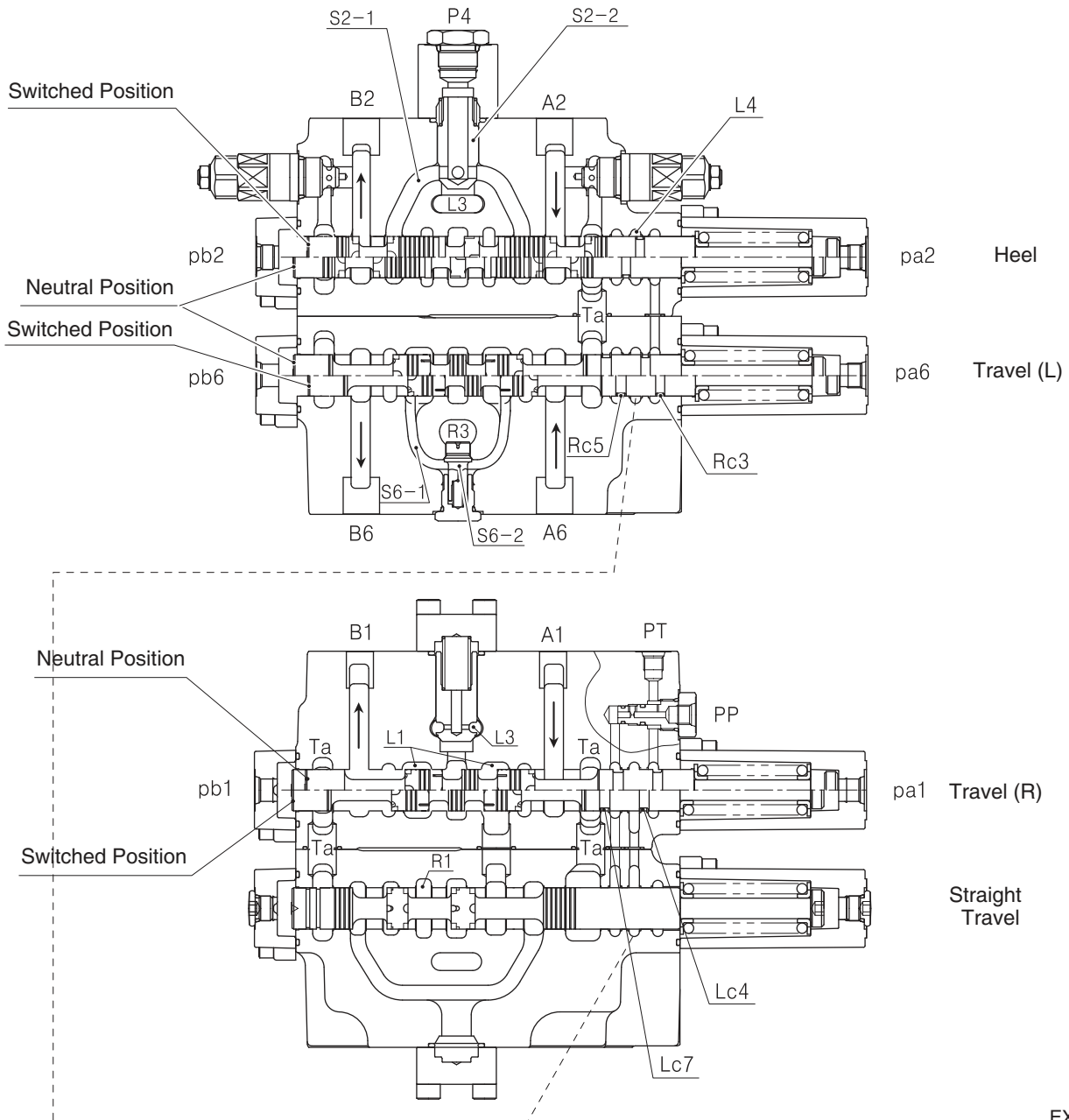


Figure 23

DS2003067



EX1504785

Figure 24

Hydraulic System Testing and Adjustment

Edition 1

MEMO

Table of Contents

Hydraulic System Testing and Adjustment

Safety Instructions	8-2-5
Procedural Troubleshooting Baseline Recommendations.....	8-2-6
Initial Checks and Tests to Establish Operating Condition of the Excavator	8-2-6
Pilot Pressure	8-2-8
Adjustment and Testing.....	8-2-8
Power Mode Valve	8-2-9
Current Signal and Hydraulic Pressure Adjustments	8-2-9
Pressure Up Valve.....	8-2-10
Checks and Adjustments.....	8-2-10
Pump Input Power Control	8-2-12
Pump Regulator Adjustment	8-2-12
Flow Meter and Flow Meter Kit Installation and Testing.....	8-2-15
Swing System Troubleshooting	8-2-17
Precautions/Initial Checks	8-2-17
Swing Relief Valve Checking and Adjustment	8-2-18

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.

PROCEDURAL TROUBLESHOOTING BASELINE RECOMMENDATIONS

Initial Checks and Tests to Establish Operating Condition of the Excavator

Troubleshooting Recommendations

An excavator that fails to deliver designed performance must be checked for the following:

- First hydraulic flow.
- Then hydraulic pressure in a specified order of priority through different points of the system.

To verify adequate available hydraulic flow, before any other tests are performed through the circuit:

Check engine operation -

- at 1,950 rpm with no load.
- at 1,950 rpm stall load.

If engine rpm drops excessively with a load or fails to surpass rated speed (1,900 rpm), performance problems may be because of inadequate hydraulic flow caused by lagging rotational speed.

NOTE: *Verify actual flow on the excavator against rated performance, with a flow meter.*

If engine tests meet specifications and adequate torque and horsepower are available at the pump drive flex coupling, pull out the electrical tray under the operator's seat to inspect the self-diagnostic display.

If the EPOS trouble code display is clear, check hydraulic functions in the following sequence:

- Pilot pressure.
- Negacon, negative control pressure.
- Main relief pressure (front and rear pump)
- Swing pressure.
- Port relief pressure (individual control functions; boom, arm, bucket, swing, and travel)
- Power boost circuit.
- Standard performance tests; cylinder speed, hydraulic motor (travel and swing) speed, cylinder oil tightness "permissible drift" test.

NOTE: *System specification performance tests of individual activator function are determined by flow rate through the component or circuit, not the control pressure or system pressure*

available to the actuator. Poor flow through the individual circuit may indicate that component is worn beyond tolerance limits, while all other hydraulic functions are adequate.

IMPORTANT

It is suggested that troubleshooter maintain the testing sequence of the preceding list. Checks and adjustments nearer the middle or the end of the list may depend on adequate functioning of systems tested nearer the top of the list.

PILOT PRESSURE

Adjustment and Testing



WARNING

AVOID DEATH OR SERIOUS INJURY

This procedure must be done with two people. To reduce the chance of accidental movement of the excavator, one person should properly seated at the operator's control stand while checks and adjustments are made.

Vent hydraulic pressure from the reservoir before breaking the seal on fittings to install two in-line "T-style" adapters and test gauges (60 bar/1,000 psi) at the gear pump outlet port, and at the joystick control valve pilot line.

Start the engine and turn the engine speed control dial to the maximum setting. After the excavator has been operated long enough to reach normal operating temperature, back off the engine control dial to minimum rated rpm speed. With all controls in neutral, make sure the left safety lever is in the up (UNLOCK) position and check pressure at the gear pump outlet port and at the joystick.

If gear pump pressure is outside the tolerance specified in the table, adjust gear pump relief pressure by loosening the locknut and turning the set screw in (clockwise) to increase pressure, or turning it out to decrease it.

NOTE: *Be aware that serial number changes and variation in the joystick assemblies used on different excavators could produce slight change in actual performance characteristics. Comparison of part numbers to serial numbers stamped on your assembly may be required, if questions or doubt exists.*

IMPORTANT

Refill the hydraulic fluid reservoir if there is any measurable loss of hydraulic oil during test gauge and adapter fitting installation.

Engine rpm	Pilot Pressure @ Pump	Pilot Pressure - Joystick
Minimum Speed Setting (full left) on Speed Control Dial	39 ±5 bar (40 ±5 kg/cm ² ; 569 ±71 psi)	23 ±1.5 bar (23.5 ±1.5 kg/cm ² , 334 ±21 psi)

POWER MODE VALVE

Current Signal and Hydraulic Pressure Adjustments



WARNING

AVOID DEATH OR SERIOUS INJURY

This procedure must be done with two people. To reduce the chance of accidental movement of the excavator, one person should properly seated at the operator's control stand while checks and adjustments are made.

The electromagnetic pressure proportioning control (EPPR) "power mode" valve is on the underside of the pumps (not visible in the harness connections drawing, because it is underneath the assembly), near the engine/pump flexible coupling, adjacent to the pump return line. To test and adjust power shift current and pressure through the power mode valve a multilead jumper harness is required. The jumper harness (which is available through HYUNDAI After Sales Service, or could be spliced together from commonly available, purchased parts) has extra leads so a VOM meter can be connected to the circuit. To set up the testing equipment, stop engine and disconnect the single electrical lead from the power mode valve. Attach the jumper harness to the terminal on the valve, connect the test leads of the multimeter to the extra leads on the harness and reconnect the valve electrical lead.

Vent the lever on top of the hydraulic tank to relieve pressure and connect an in-line "T-style" adapter to the valve pressure port. Install a 60 bar (1,000 psi) test gauge in the adapter. Restart the engine and increase engine rpm by turning the speed control to the maximum speed setting. Warm up the engine and hydraulic system until hydraulic oil temperature is at least 45°C (113°F). Select Power Mode on the Instrument Panel. Check current readings (in milliamps) on the VOM meter and hydraulic pressure gauge readings and make sure both conform to the values in the table below.

NOTE: If recorded values do not conform to the specified current or pressure in the table, back off the locknut on the end of the valve, turn the adjusting screw to 1/4 specified current and pressure. Retighten the valve locknut. Recheck current and pressure. Repeat.

Mode	Engine rpm	Current	Pressure
Power Plus	High Idle: 1,900 (Auto Idle OFF) 1,800 (Auto Idle ON)	200 ±20 mA Midrange value corresponding to engine rpm for both current and hydraulic pressure readings.	1.96 bar (2 kg/cm ² , 28psi)
Power	High Idle: 1,700	230 ±23 mA	3.43 bar (3.5 kg/cm ² , 49 psi)
Standard	High Idle: 1,650	275 ±28 mA	6.37 bar (6.5 kg/cm ² , 95 psi)
Economic	High Idle: 1,600	310 ±31 mA	8.43 bar (8.6 kg/cm ² , 122 psi)

PRESSURE UP VALVE

Checks and Adjustments



WARNING

AVOID DEATH OR SERIOUS INJURY

This procedure must be done with two people. To reduce the chance of accidental movement of the excavator, one person should properly seated at the operator's control stand while checks and adjustments are made.

Vent hydraulic pressure from the reservoir to install an in-line "T-style" adapter and test gauge (60 bar/1,000 psi) at the pilot pump signal port relief valve outlet.

Start the engine and turn the engine speed dial to maximum. When normal operating temperature is reached:

- Check pilot pressure and readjust it, if required:
- Select the Instrument Panel rear pump "pressure display".
- Select Power Mode.
- Stall the boom cylinder (towards the extend side).
- Read rear pump pressure on the Instrument Panel display.

Repeat all tests with and without "pressure up" selected through the console rocker switch and joystick button.

If the two-stage main relief valve was not set correctly and main relief high stage pressure ("pressure up") is outside the tolerance range, begin valve adjustment by loosening the outside (widest diameter) locknut on the relief valve. Turn the adjusting screw clockwise to increase pressure, or counterclockwise to decrease it. Pressure must be 343 bar (350 kg/cm², 4,978 psi), or up to 9.8 bar (10 kg/cm², 142 psi) higher.

Because one adjustment can affect the other, check low stage main relief pressure by repeating the cylinder stall test without "pressure up". Readjust standard relief pressure by turning the innermost (smallest diameter) screw clockwise to increase the setting, or counterclockwise to decrease it. Pressure must be at least 323 bar (330 kg/cm², 4,693 psi), but less than 343 bar (350 kg/cm², 4,978 psi).

IMPORTANT

Pressure adjustments and checks cannot be made if pilot pressure is outside the specified range. Refer to the pilot pump adjustment procedure if required, then proceed with any necessary adjustments to main relief pressure settings.

Power Mode	Operation	Main Pressure and Tolerance	Pilot Pressure and Tolerance
Power Mode	Neutral, No Operation	20 ~ 39 bar (20 ~ 40 kg/cm ² , 285 ~ 570 psi)	39 ±10 bar (40 ±10 kg/cm ² , 569 ±142 psi)
Power Mode	Cylinder Stall	323 ±5 bar (330 ±5 kg/cm ² , 4,693 ±71 psi)	39 ±10 bar (40 ±10 kg/cm ² , 569 ±142 psi)
Power Mode W/ Pressure Up	Cylinder Stall	343 ±10 bar (350 ±10 kg/cm ² , 4,978 ±142 psi)	39 ±10 bar (40 ±10 kg/cm ² , 569 ±142 psi)

NOTE: *The electrical pressure up (power boost) solenoid valve alongside the arm speed control solenoid, in compartment rear of the operator's cabin, must be operating correctly, or pressure tests and further adjustments cannot be made.*

PUMP INPUT POWER CONTROL

Pump Regulator Adjustment



WARNING

AVOID DEATH OR SERIOUS INJURY

This procedure must be done with two people. To reduce the chance of accidental movement of the excavator, one person should properly seated at the operator's control stand while checks and adjustments are made.

To perform these adjustments accurately the use of a flow meter is strongly recommended, as is consulting the factory (before starting work) to validate the need for making regulator adjustments. Vent hydraulic pressure from the reservoir before breaking the seal on fittings to install the flow meter kit. (Refer to "Flow meter Installation and Testing" procedure.)

IMPORTANT

Before starting this procedure or going onto make any changes of adjustment settings:

- **Verify engine output to the rated speed – 2,050 ±50 rpm.**
 - **Permanently mark setscrew positions at the current regulator control setting.**
-

Use a scribe or other permanent marker to identify a reference point on adjusting screws with a corresponding reference on the body of the valve. The adjustment process affects a complex balance and could require some time to complete. If adjustment has to be interrupted or postponed, reference marks at the adjustment point allow immediate restoration of original performance.

This adjustment procedure is normally performed:

- If the engine is being consistently overloaded (and engine troubleshooting shows engine performance to be at or above rated output).
- If reduced cylinder speed and diminished work performance provide an indication that rated, maximum pump flow may not be available (and all other troubleshooting gives no indication of other flaws or hydraulic system defects).
- If pump output is out of balance and one pump is failing to keep up with the output flow of the other.

To check pump imbalance without a flow meter, travel the excavator forward on flat, level terrain. If the machine veers off despite neutral control input and even, balanced track adjustment, the pump which supplies output to the track frame toward which the excavator is veering is weak.

Refer to the illustration of the pump regulator control valve (Figure 1) for the location of adjustment screws. There are two different adjustments, with the Negacon, negative control, adjustment screw. Each one of the adjustment procedures could affect the setting of the others.

Check and record the arm dump speed performance test before and after input power adjustment, whether or not a flow meter is used.

NOTE: *Regulator adjustments affect total cumulative horsepower, since each regulator compensates for the output of the other. It is not necessary to adjust both regulators at the same time, but after checking or adjusting one of them, the remaining unit should also be checked.*

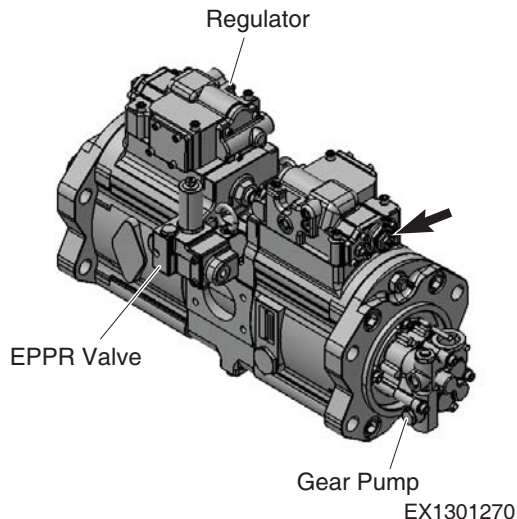


Figure 1

Start the engine and turn the engine speed dial to maximum. When normal operating temperature is reached, loosen the largest diameter locknut around the adjustment screw for the outer regulator spring. Tightening the screw shifts the P/Q (Pressure/Flow) control curve to the right, and increases compensating control pressure.

On the other hand, if the persistent cause of performance problems is engine overloading, decreasing the adjustment by turning the larger diameter adjusting screw out will decrease pump input horsepower. 1/4 turn on the adjusting screw is equal to approximately 17 horsepower.

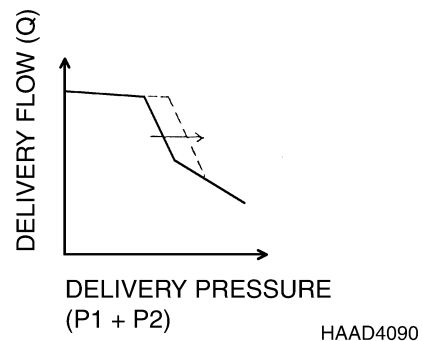


Figure 2

IMPORTANT

Because changing the position of adjusting screw also affects the setting of the adjustment for the inner spring, the smaller diameter adjusting screw, turn in the inner screw 198° (slightly more than 1/2 turn, 180°) before screw is backed out 1/4 turn (90°).

NOTE: *For each full turn of adjustment on the larger diameter screw, the square-tipped adjusting screw must be turned in the opposite direction 2.2 turns to avoid changing inner spring adjustment.*

Pump input power adjustments are normally made in small increments, 1/4 turn (90°) or less, each time.

Turning the square-tipped, smaller diameter screw clockwise moves the flow curve up, increasing flow and then input horsepower.

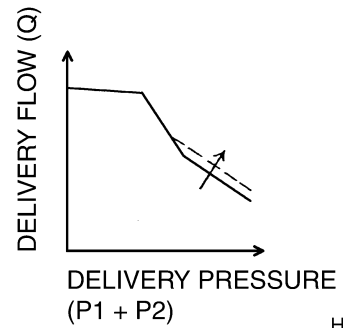


Figure 3

HAAD4100

The adjusting screw (Figure 1) affects the delivery rate (Q) of the pump. Tightening the adjusting screw decreases the maximum cut flow (as shown in Figure 4) while backing out the screw increases cut flow delivery rate.

Balance both pumps for equal output.

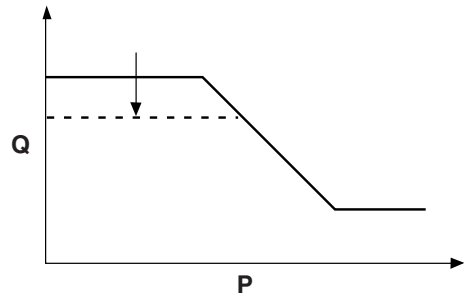


Figure 4

HDA3008L

FLOW METER AND FLOW METER KIT INSTALLATION AND TESTING

Checking regulator and pump output, to assess the output balance between the front and rear pumps and to verify operating adjustment of each regulator, will require installation of a flow meter.

The After Sales Service department of the nearest local HYUNDAI dealer can assist you with these tests or, if you prefer performing your own testing, they must be able to help in putting together a hose and fitting kit (or the required dimensions and specifications for hoses and fittings) to allow you to install a flow meter downstream from the main pump assembly.

Installation and Testing Procedure

- Stop engine and operate controls to release hydraulic pressure from the accumulator.
- Vent the reservoir to release all pressure from the hydraulic system.
- Remove guard panels from around the main pump assembly.
- Disconnect the main pump discharge output line. Install the input flange of the flow meter on the pump end of the output line.
- Cap off the unused (input) end of the pump discharge line with a blocking flange.
- Connect a premeasured length of hydraulic hose, between the output end of the flow meter assembly and the top of the reservoir. Use appropriate fittings and adapter flanges to guarantee a pressure tight seal.

NOTE: *Be sure to maintain even tightening torque on all flange fittings. Use Loctite brand "PST 545" (or an alternate manufacturer's hydraulic system joint seal) if required, to give an airtight seal.*

- An assistant – who must remain at the operator's control station always – should restart the engine and run it long enough (at minimum rpm) to deaerate the system and warm up the engine and hydraulic system to operating temperature.

Record the values of all test results in three columns, comparing 1) pump pressure (from the instrument panel display) with 2) measured flow, in gallons or liters per minute, from the installed flow meter. The third column of test results should provide a record of engine rpm measured during each of the following tests – with the engine speed control dial set at maximum, the power mode selector at Power Mode and the work mode selector at digging mode:

- Unloaded maximum engine speed baseline test (all controls in neutral).
- Front pump test – operate "travel right" lever. Record values at all specified pressures.
- Rear pump test – operate "travel left" lever. Record values at all specified pressures.

Record the values for each of the three tests (neutral, travel right and travel left) at the following pump pressure levels, with travel speed control set at "high-speed".

Engine rpm	Pressure	Flow
	98 bar (100 ±5 kg/cm ² (1,422 psi)	
	147 bar (150 ±5 kg/cm ² , 2,133 psi)	
	196 bar (200 ±5 kg/cm ² (2,844 psi)	
	294 bar (300 ±5 kg/cm ² (4,267 psi)	
	343 bar (350 ±5 kg/cm ² (4,975 psi)	
	*See below note.	

Compare recorded values with output shown in the P-Q curve in the specifications section of this book.

If test results do not meet specified values, pump output tests can be repeated using different control levers. Recheck front pump operation while stroking the bucket cylinder out lever, and the rear pump by actuating the swing control lever.

SWING SYSTEM TROUBLESHOOTING

Precautions/Initial Checks

1. Stop work. Release all weight or any load safely before proceeding. Avoid risking injury or adding to damage.
2. Stop engine and disengage control functions until initial tests are ready to be made.



WARNING

AVOID DEATH OR SERIOUS INJURY

Stop operation and park excavator whenever these problems are noticed:

1. **Equipment breakdown.**
 2. **Inadequate control response.**
 3. **Erratic performance.**
-

Stop the machine, put the boom and arm in the inoperative (overnight park) position and begin by making the fastest, simplest checks first:

- Check oil level.
- Check for overheating, oil leaks, external oil cooler clogging or broken fan belt. Consult service record for prior repair/service work.
- Drain some tank oil into a clean, clear container. Look for metal shavings/grit, cloudiness/water or foam/air bubbles in the oil.
NOTE: *Dispose of drained fluids in compliance with all applicable environmental laws and regulations.*
- Check for wobble through the engine/pump flex coupling. Run engine with the pump input hydraulic power control nut turned to the lowest power to check the engine.
- Investigate unusual operating noises or vibration. Check for loose bolts, connections.

Swing Relief Valve Checking and Adjustment

Make a check of operating pressures through the swing relief valve if:

- The swing motor fails to turn.
 - Swings in one direction only.
 - Swings but continues to coast.
 - There is drifting on a slope.
1. Check operation by connecting:
 - A. Two 490 bar (500 kg/cm², 7,112 psi) pressure gauges to the inlet and outlet measuring ports on top of the swing motor.

Pressure must be between 284 and 294 bar (4,124 psi and 4,267 psi), with both swing locks engaged. With swing locks released, during full acceleration and deceleration, pressure should approach 295 kg/cm² (4,196 psi) in each direction.
 - B. Connect a 98 bar (100 kg/cm², 1,422 psi) pressure gauge at the "SH" port of the hydraulic brake.

Pressure should always stay at or above 13 bar (185 psi) when operating swing, boom or arm.
 - C. Connect a 10 bar (10 kg/cm², 142 psi) gauge at the motor makeup valve.

Pressure should stay consistently above 2.5 bar (36 psi). If pressure drops below the recommended minimum level, forceful acceleration of the swing motor could lead to cavitation of the circuit and stalling, slowed rotation, noise and possible damage.
 2. If main inlet and outlet pressures were off in the preceding tests in Step 1, adjust swing relief valve pressure.

Following adjustment, repeat the operating pressure tests (with gauges connected to the inlet and outlet test ports on top of the swing motor) and check pressures with the swing locks engaged and released.

If pressure adjustment fails to restore adequate performance, proceed to the Troubleshooting – Swing table.
 3. If pressure tests were at recommended levels through the main inlet and outlet ports, and through the "SH" port of the swing brake, the causes of poor swing performance could include a faulty swing motor, drivetrain overloading or gearbox defect, or a problem in the brake assembly or swing control valve. Proceed to the troubleshooting information in the next procedure.

If pressure through the "SH" port was tested below the minimum 13 bar (185 psi) level, check the shuttle valve in the rear compartment behind cabin. When pressure through the port is at the recommended level, the brake release valve should disengage the swing brake, allowing the swing motor to rotate the excavator. If pressure adjustment to the valve has been restored but the brake still fails to release, the brake piston or friction plate may be frozen, requiring disassembly of the motor and parts repair/replacement.

4. If pressure tested at the motor makeup valve drops below recommended minimum level, and consequent problems with cavitation, stalling and surging are observed, check the restriction valve. If pressure adjustment to the valve has been restored but if problems with cavitation continues, disassemble the upper swing motor housing and clean or replace assembly components as required.

NOTE: *If all tested pressures are at or above recommended levels, and there are no mechanical problems in the drivetrain or in the motor/brake assembly, the problem will require further hydraulic troubleshooting. It's also possible that a defective joystick, an intermittent short in an electrical control circuit or a problem in the EPOS circuit is causing diminished swing performance. Pull out the EPOS indicator panel from underneath the operator's seat and perform the self-diagnostic test. Refer to the Electrical section of this book for more information.*

Hydraulic System Troubleshooting

Edition 1

MEMO

Table of Contents

Hydraulic System Troubleshooting

Safety Instructions	8-3-5
Hydraulic System.....	8-3-5
Unusual Noise Comes Out from Pump Connection ..	8-3-5
Engine Starts but Machine Does Not Operate	8-3-6
Hydraulic Oil is Cloudy	8-3-7
Hydraulic Oil Overheated	8-3-7
Hydraulic Pump Cavitation	8-3-8
Hydraulic Oil is Contaminated	8-3-8
Boom, Arm, Bucket Speed is Slow.....	8-3-9
Boom, Arm or Bucket Power is Weak	8-3-10
Cylinder Moves When Remote Control Valve is in the Neutral Position	8-3-10
TR (L), TR (R) Swing Does Not Operate When Remote Control Valve Operated.....	8-3-11
Swing Speed is Slow	8-3-12
Machine Swings but Does Not Stop.....	8-3-13
One Side Speed is Falls and the Machine Curves..	8-3-14
Machine Does Not Stop on a Slope	8-3-15
Travel Motor is Powerless (Travel Only)	8-3-15
Machine Makes a Curved Travel, When Travel and Actuator Operation are Executed a the Same Time	8-3-16
Does Not Travel is 2nd Speed or Auto Speed	8-3-16
Troubleshooting – Swing Gearbox	8-3-17
Troubleshooting – Hydraulic Problems.....	8-3-18
Troubleshooting – Control Valve	8-3-20
Troubleshooting – Travel Control Valve	8-3-21
Troubleshooting – Joystick Control Valve.....	8-3-22

SAFETY INSTRUCTIONS



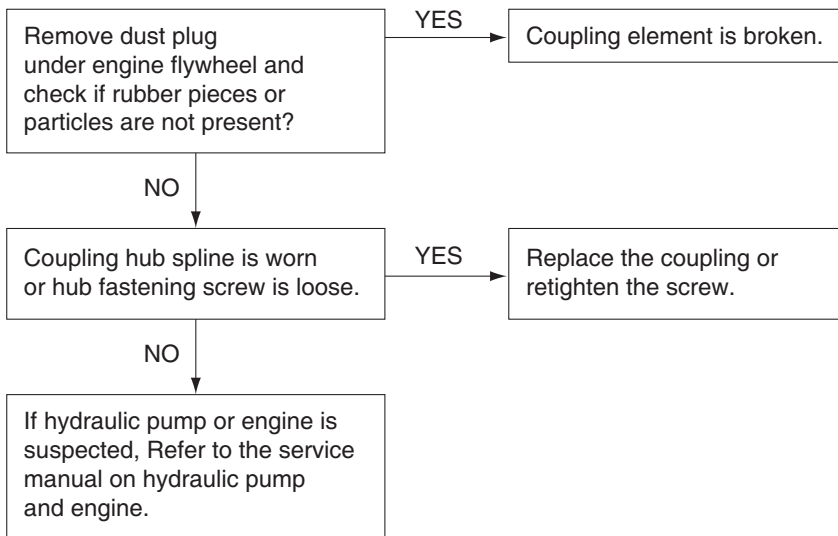
WARNING

AVOID DEATH OR SERIOUS INJURY

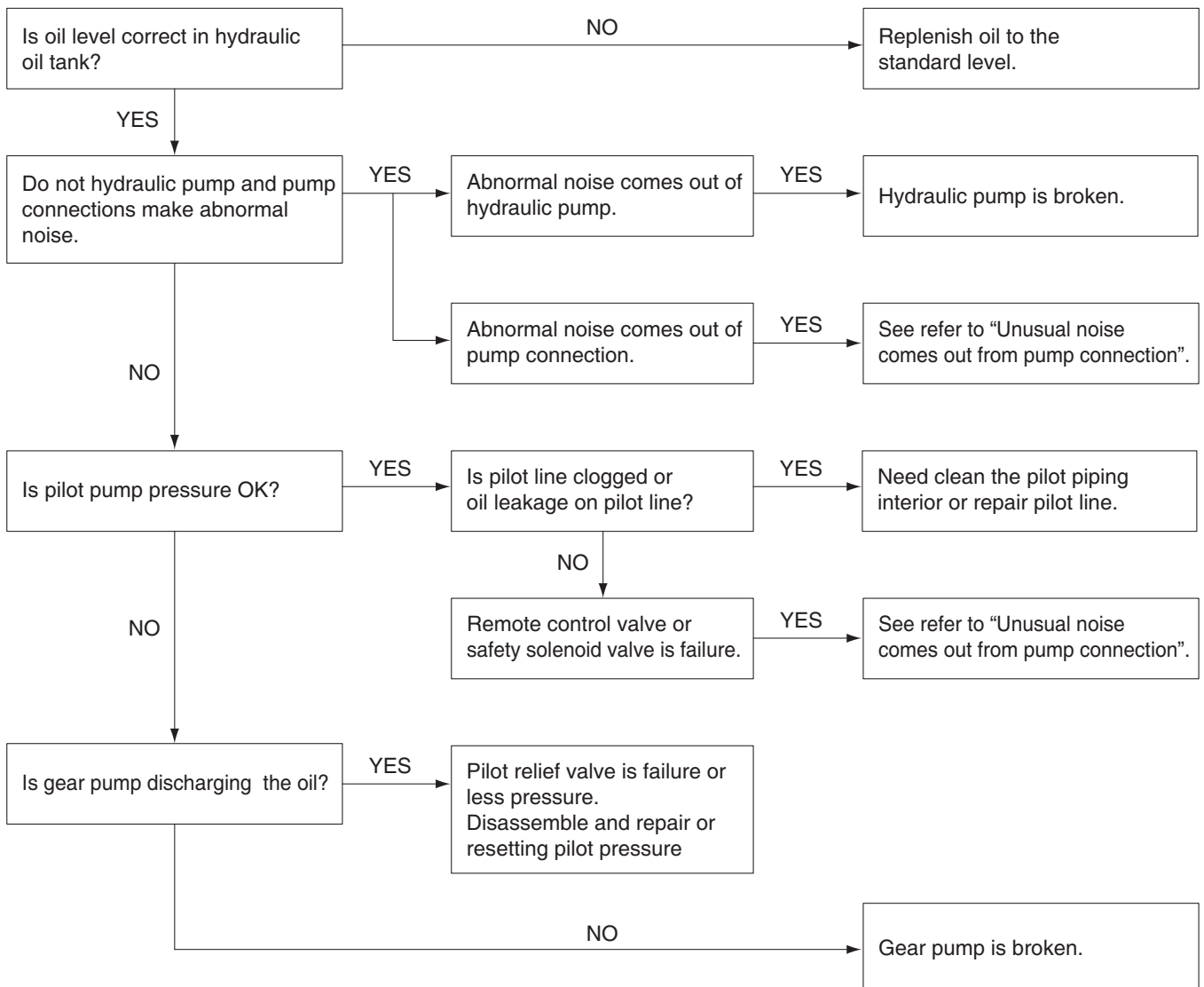
Instructions are necessary before operating or servicing machine. Read and understand the Operation & Maintenance Manual and signs (decals) on machine. Follow warnings and instructions in the manuals when making repairs, adjustments or servicing. Check for correct function after adjustments repairs or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

HYDRAULIC SYSTEM

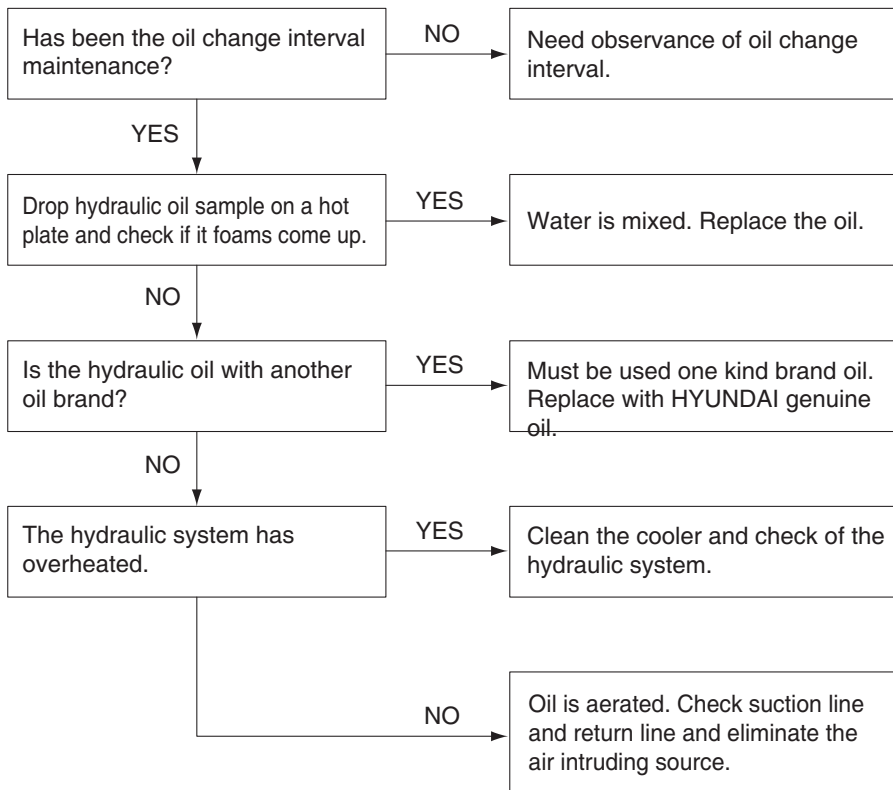
Unusual Noise Comes Out from Pump Connection



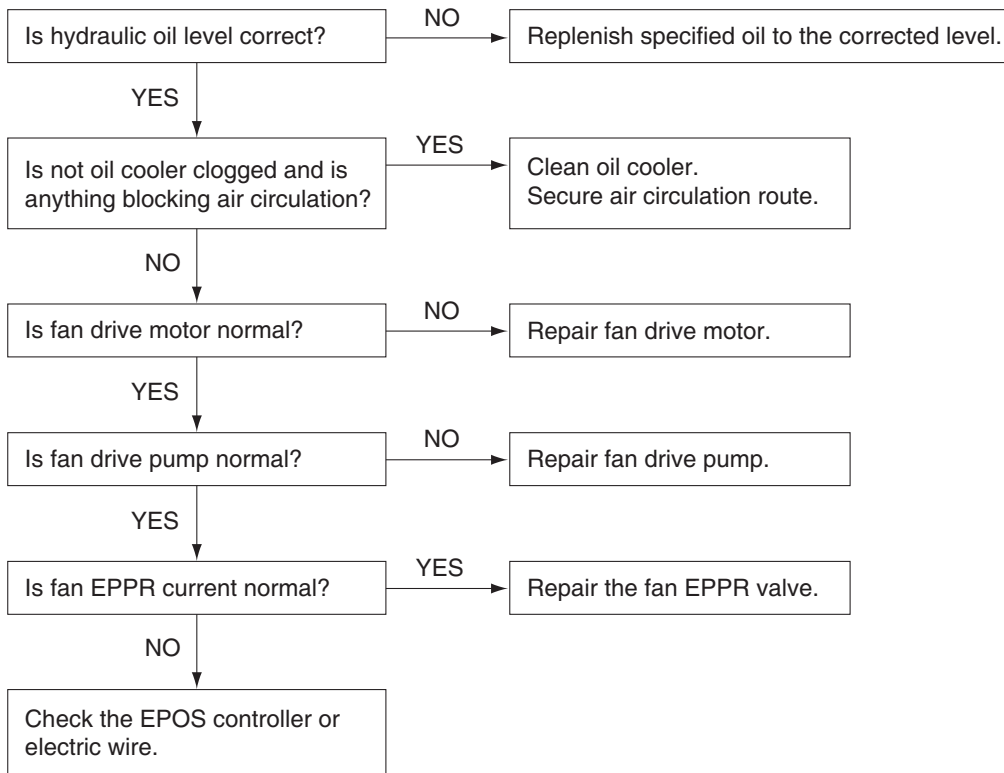
Engine Starts but Machine Does Not Operate



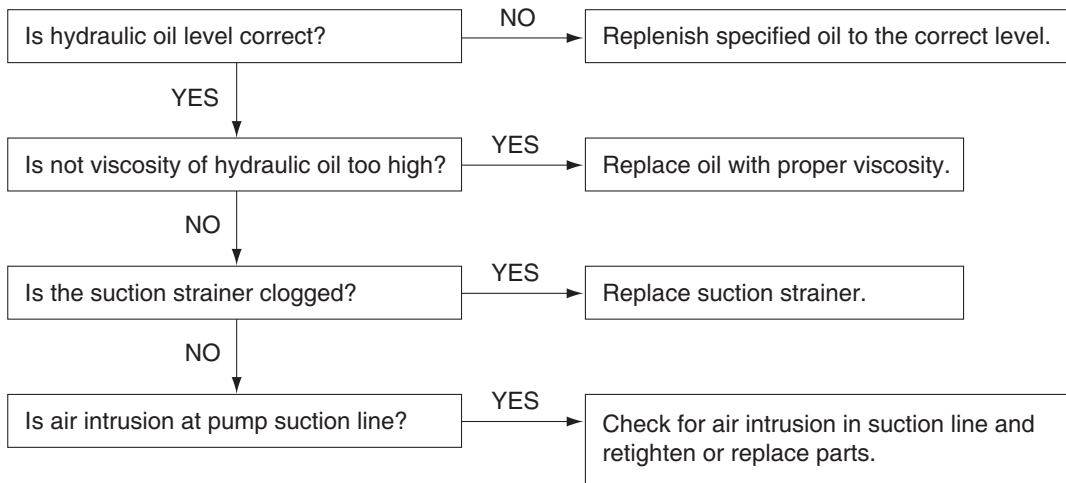
Hydraulic Oil is Cloudy



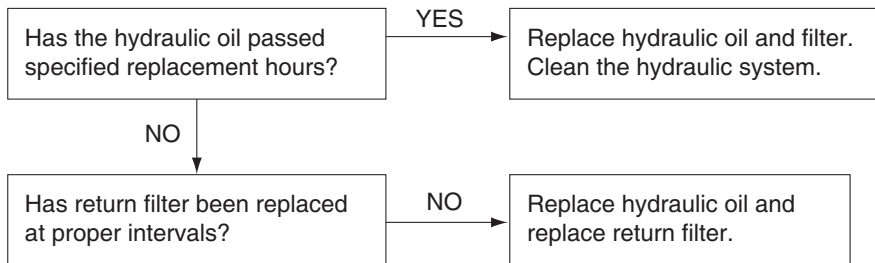
Hydraulic Oil Overheated



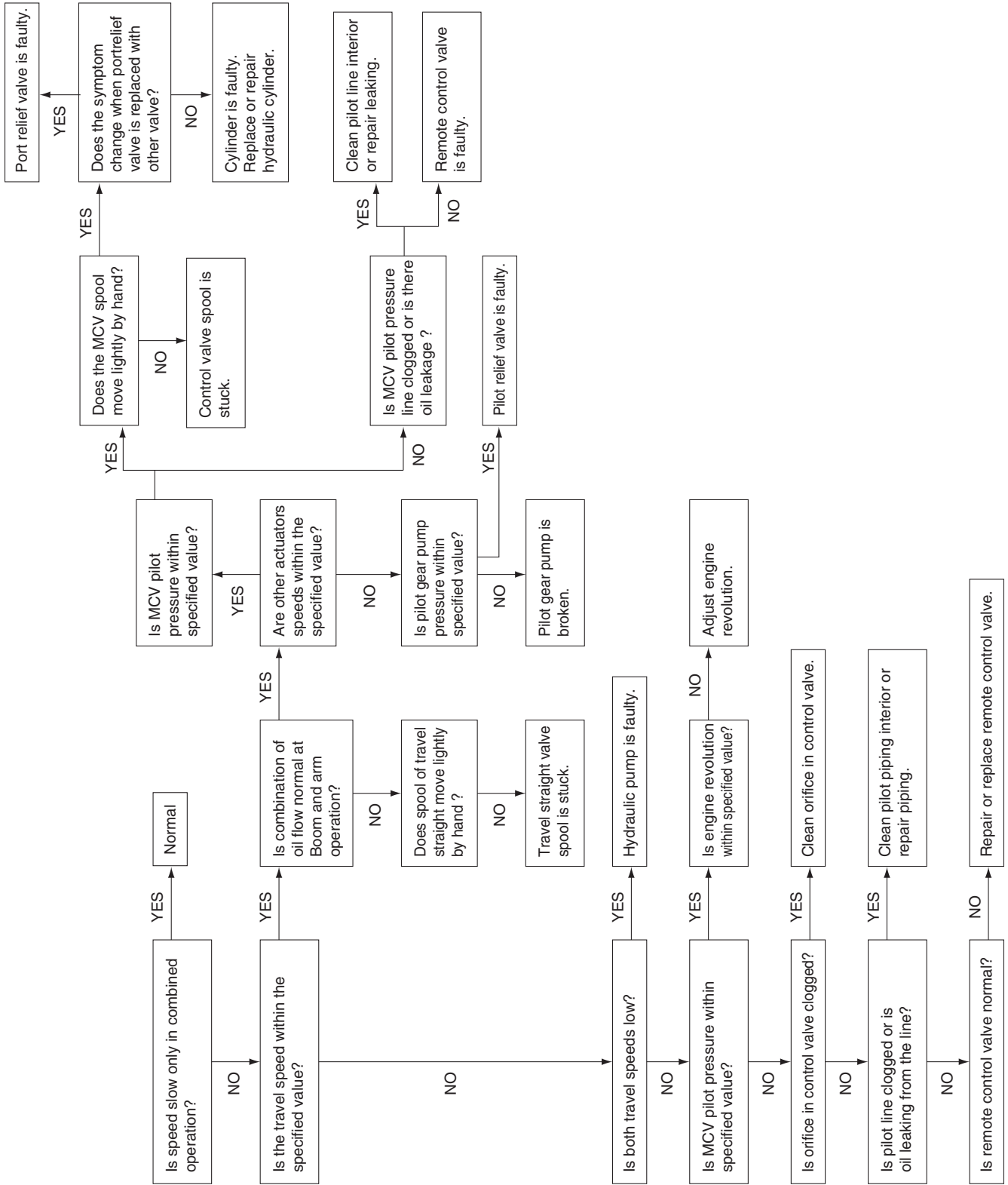
Hydraulic Pump Cavitation



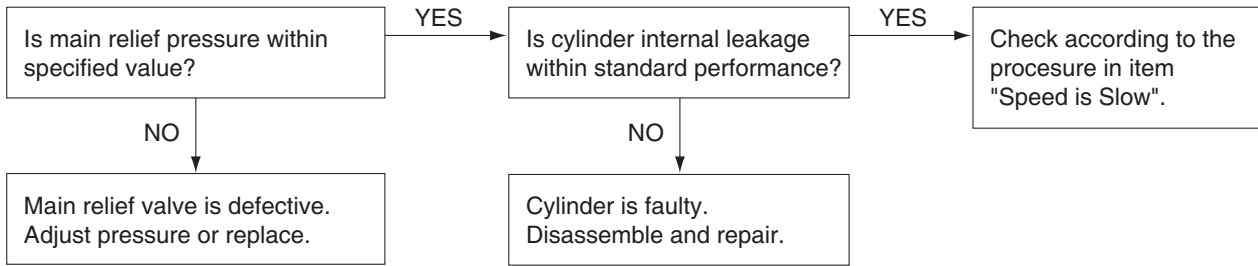
Hydraulic Oil is Contaminated



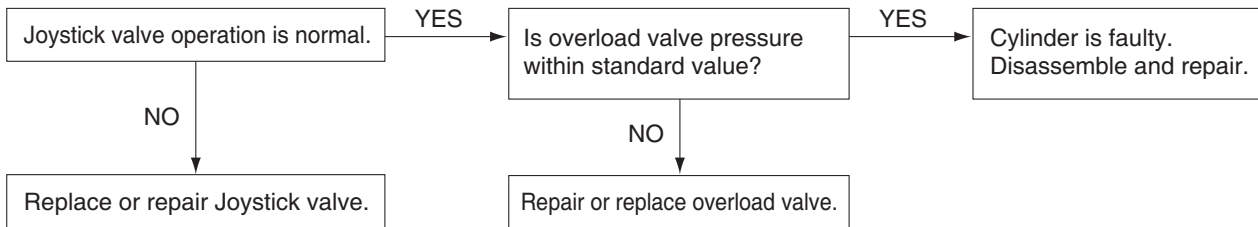
Boom, Arm, Bucket Speed is Slow



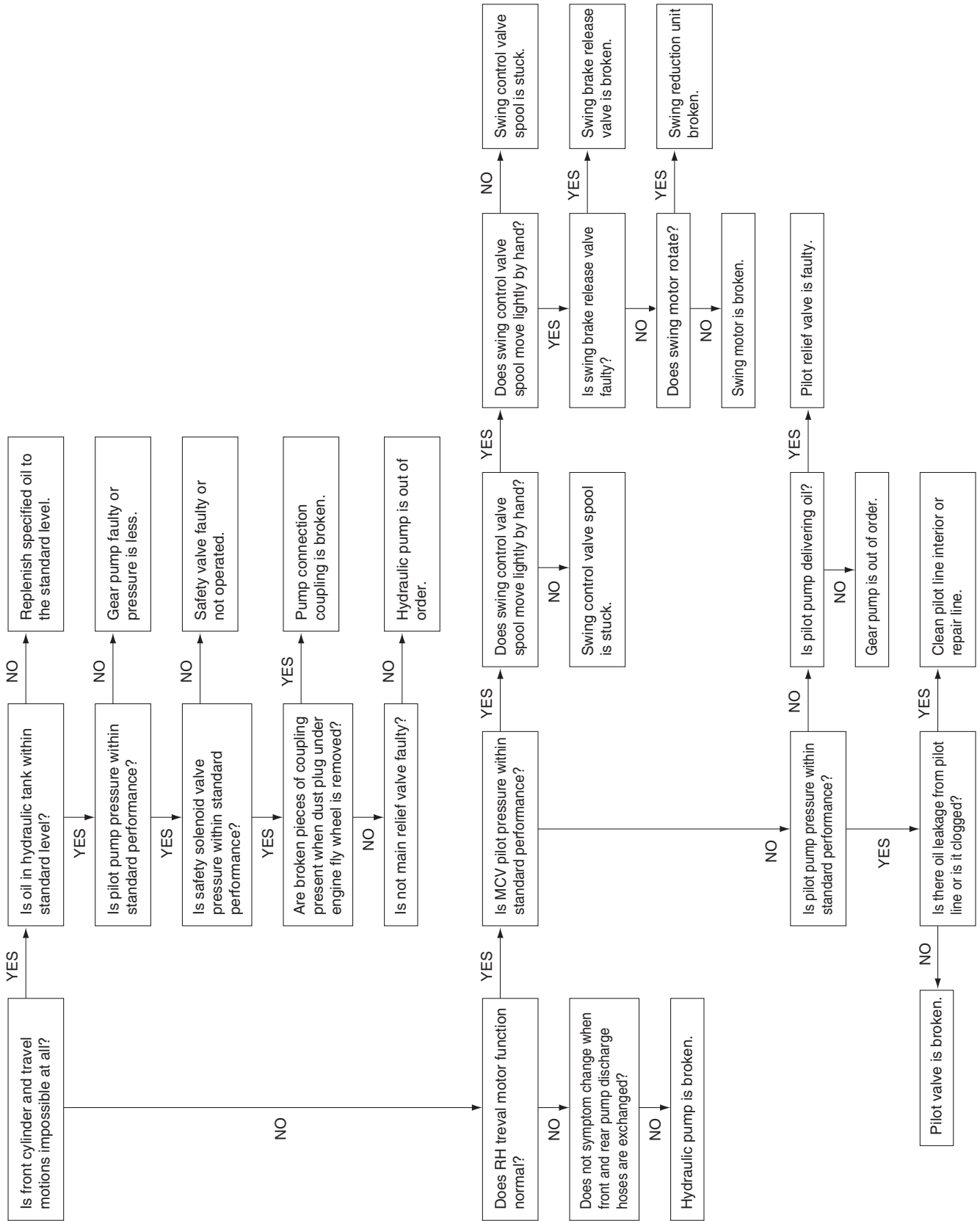
Boom, Arm or Bucket Power is Weak



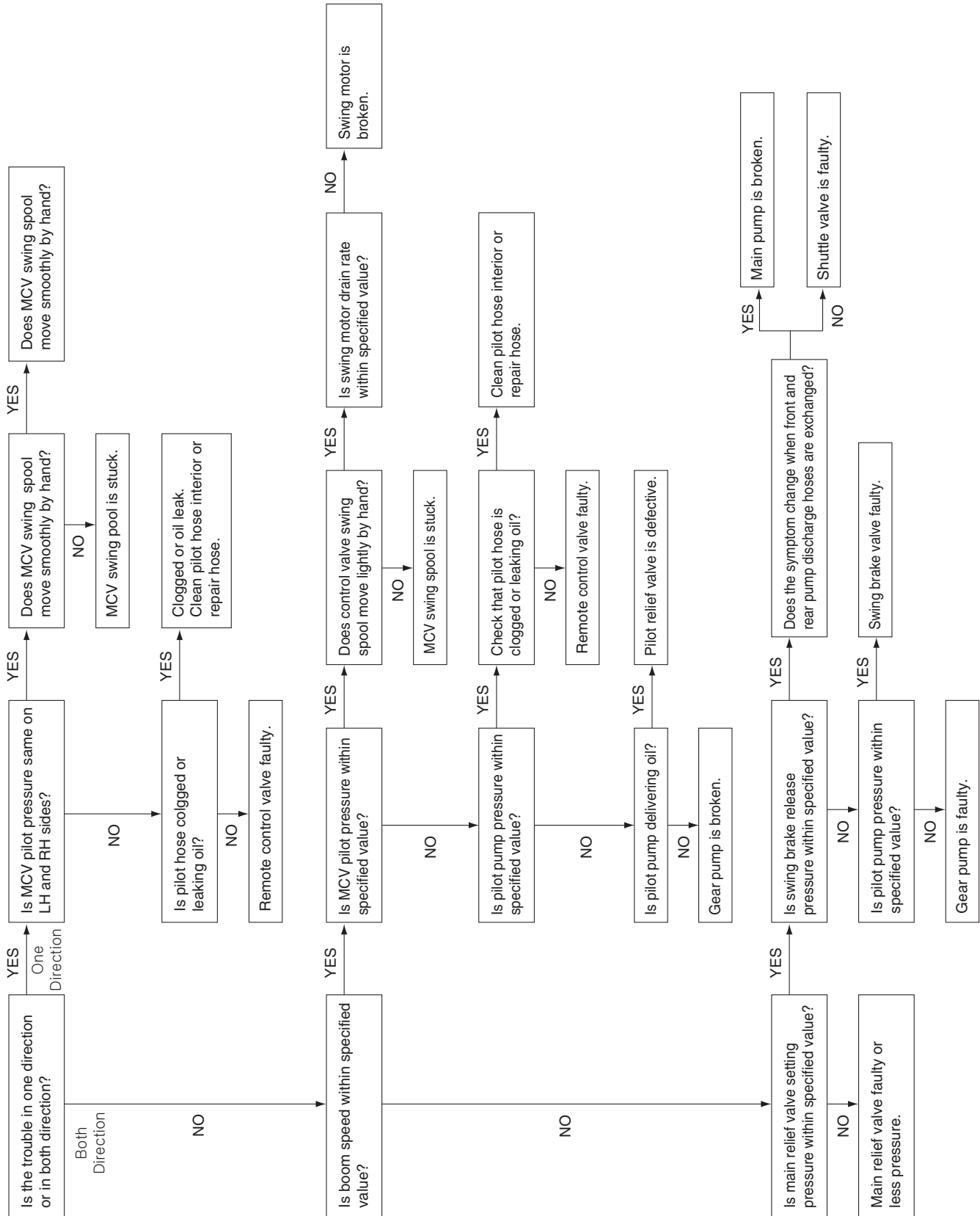
Cylinder Moves When Remote Control Valve is in the Neutral Position



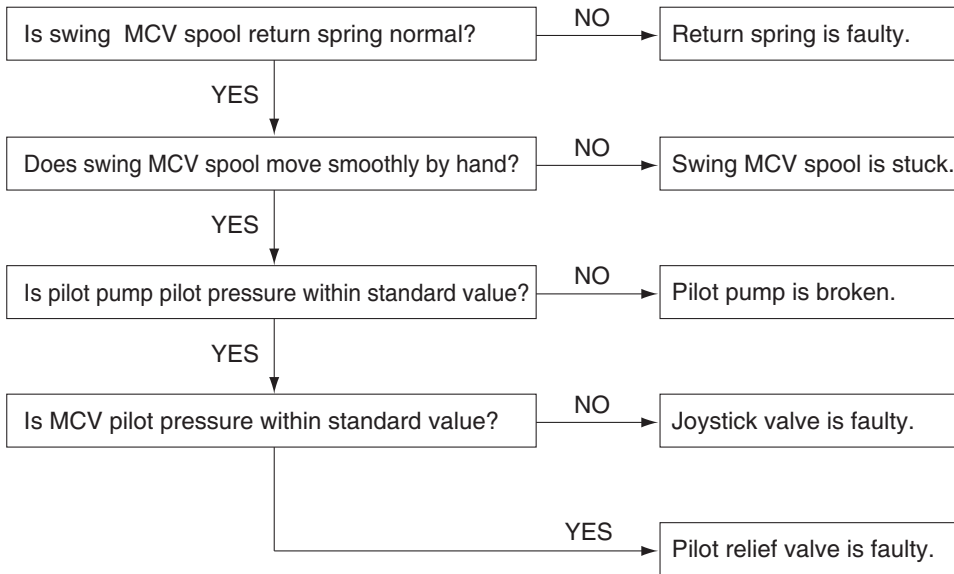
TR (L), TR (R) Swing Does Not Operate When Remote Control Valve Operated



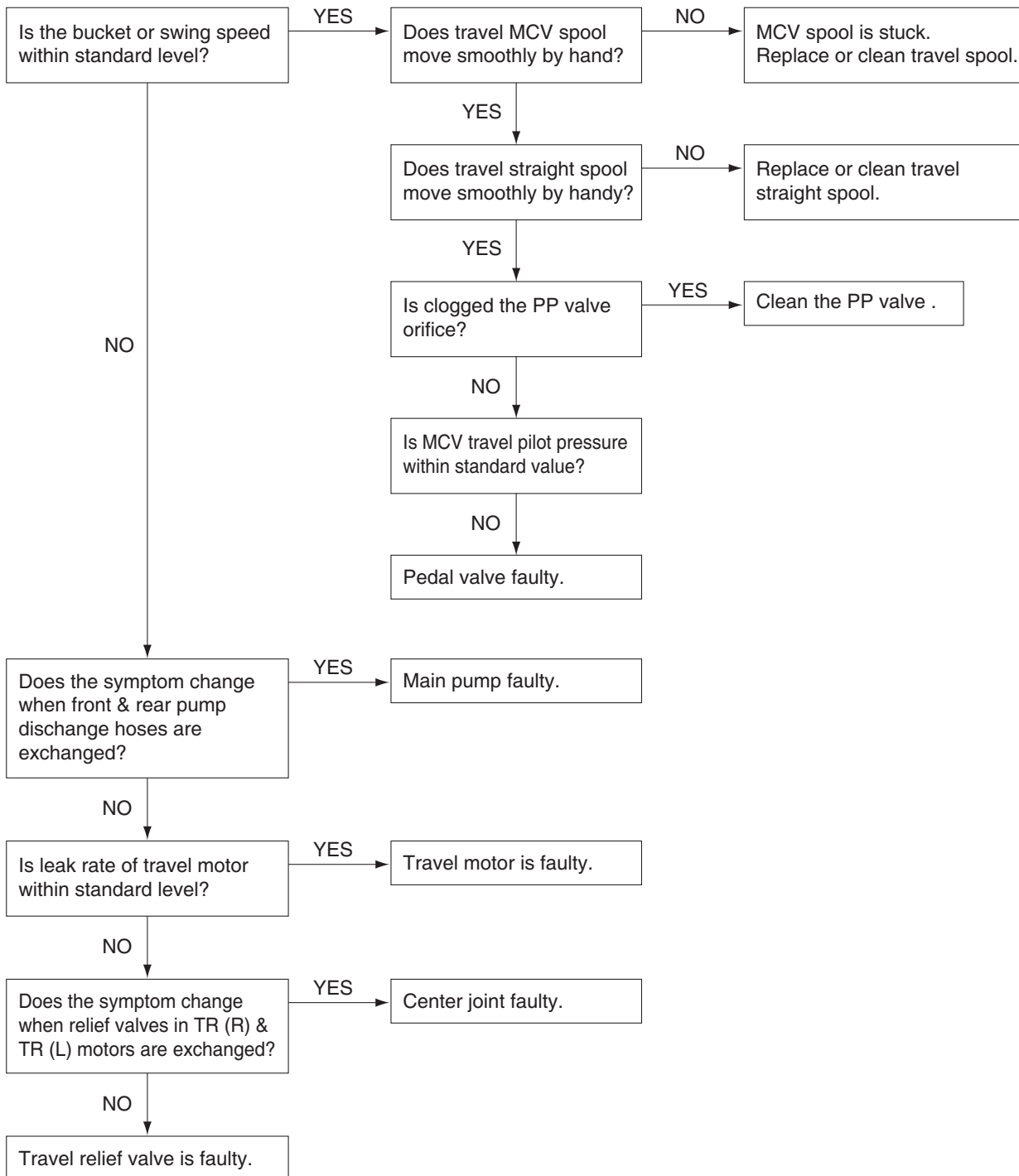
Swing Speed is Slow



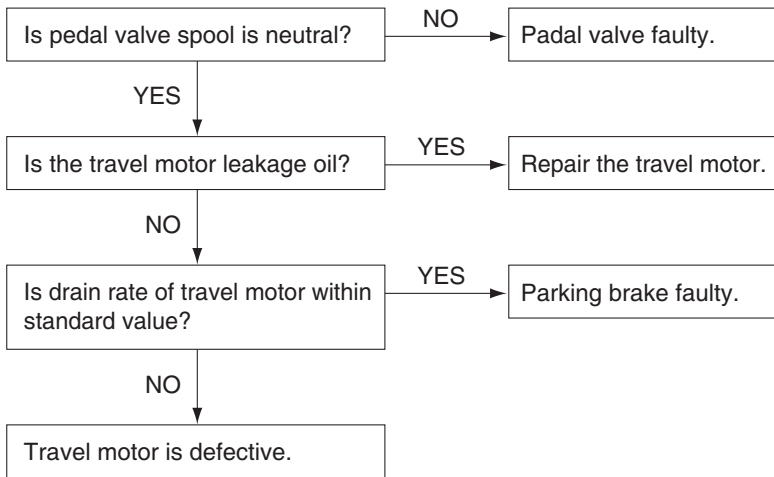
Machine Swings but Does Not Stop



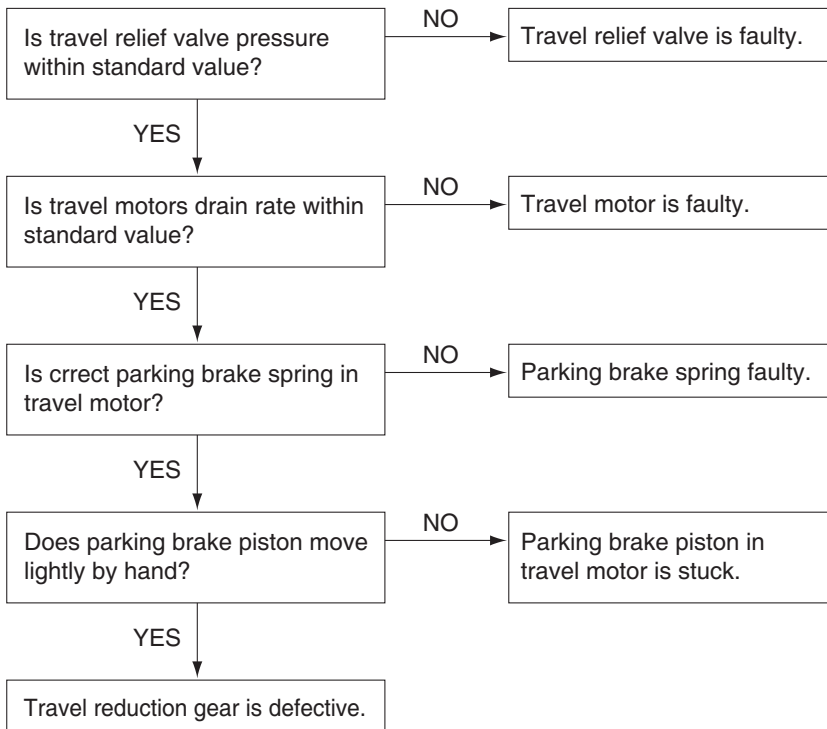
One Side Speed is Falls and the Machine Curves



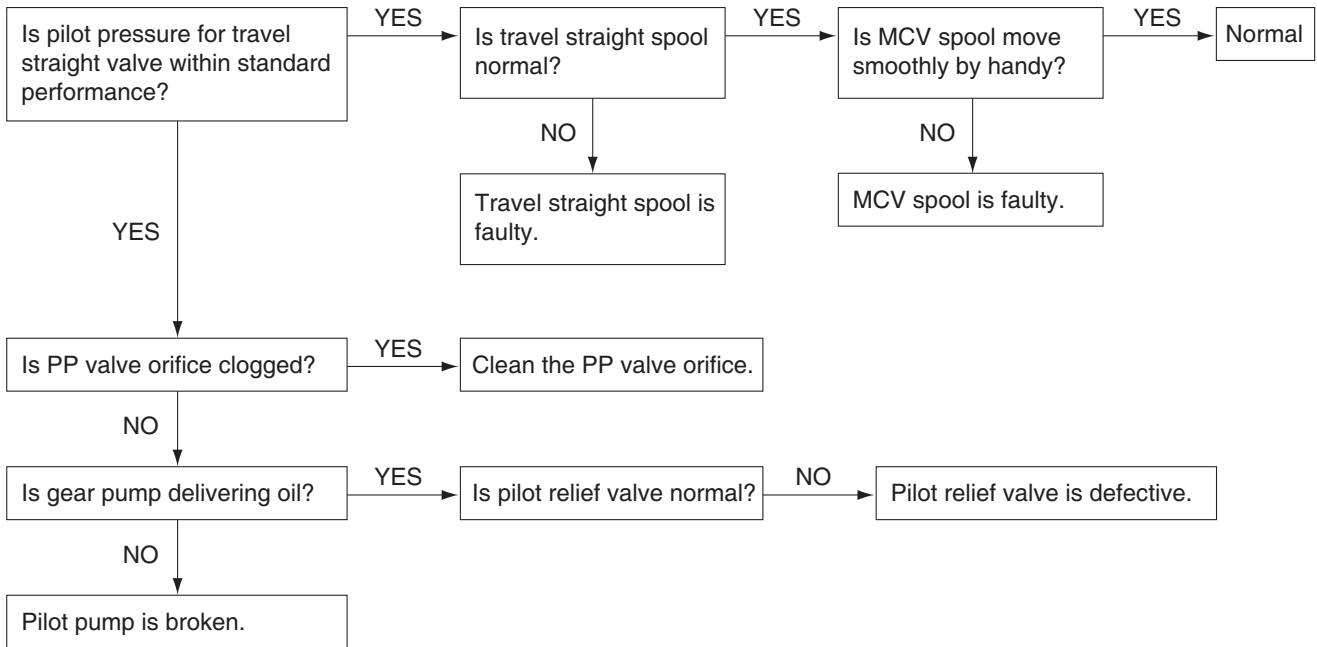
Machine Does Not Stop on a Slope



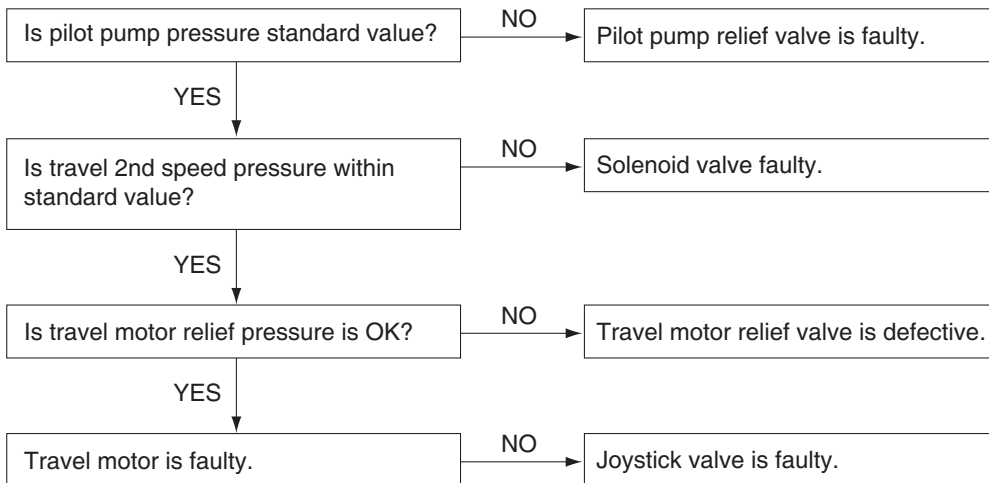
Travel Motor is Powerless (Travel Only)



Machine Makes a Curved Travel, When Travel and Actuator Operation are Executed at the Same Time



Does Not Travel in 2nd Speed or Auto Speed



TROUBLESHOOTING – SWING GEARBOX

Problem	Possible Cause	Remedy
Swing motor fails to operate and:		
Three pressure tests at motor, brake or makeup valve show low reading (s).	Swing relief valve defective. Brake release valve defective. Motor makeup valve defective.	Adjust pressure to recommended range in affected valve. OR Disassemble and clean valve assembly. Replace all valve components that show damage.
All three pressure checks are OK but left travel also fails to run.	Exchange front and rear pump inlet and outlet hoses to test pump function.	If swing and left travel are restored but right travel stops working, replace or repair P1 pump.
All three pressure tests are OK, but machine fails to swing at all.	Brake assembly or motor friction plate failing to release.	Check for binding. Disassemble and repair.
	Pilot (control) pressure low or swing control valve stuck.	Disassemble/Repair pilot pressure swing spool (305) and/or swing control valve.
	Swing motor defective.	Test motor drain rate. Replace/Repair motor.
	Gear train defective.	Refer to "Swing Gear Troubleshooting" procedure.
Swing functions but only at reduced rpm.	Causes listed above could also produce dragging swing, OR hot or wrong oil OR worn-out parts.	Check above list; then replace oil, test motor drain rate and check for "03" reading (EPOS self-test).
Left travel speed is also reduced.	Low output at P1 pump or external pilot piping leaks/is clogged.	Clean and repair piping or repair or replace pump P1.
Swing control movement is reversed.	Inlet/outlet piping reversed.	Reset controls or reverse piping.
Machine swings but continues moving past stopping point.	Swing control valve spool not centered.	Replace return spring; clean/ repair valve piston and spool.
	Pilot pressure may be outside range.	Disassemble, clean or replace pilot relief valve or pilot valve.
	Swing relief valve may be faulty.	Repair/Replace swing relief valve.
Swing movement is in one direction only.	Check to see that pilot pressure is the same right and left.	If pilot pressure is unequal, clean or repair piping or repair/replace valve.
	Swing control valve spool may be stuck.	Repair/Replace the swing control valve.
	Swing relief valve may be faulty.	Repair/Replace the swing relief valve.
No rotation and:		
Pressure at swing motor inlet increases.	Swing brake not releasing.	Check brake engagement and disengagement; check release pressure.
	Internal damage to gearbox drivetrain.	Replace broken gears and drivetrain assemblies.
	Overload.	Reduce load weight.

Problem	Possible Cause	Remedy
Pressure at swing motor inlet shows no increase, and the swing motor is making irregular noises.	Swing motor driveshaft damage.	Replace swing motor.
	Internal damage to gearbox drivetrain.	Repair/Replace broken or faulty assemblies.
Pressure at swing motor inlet shown no increase, but without irregular noises from the swing motor.	Hydraulic pump or valve problem.	Troubleshoot hydraulic system.
Oil Leakage:		
From driveshaft or from bolted connections or other assembled surfaces.	Oil seal damaged Assembly compound (joint sealer) old and not sealing, bolt not tight or flange warped.	Replace oil seal Disassemble and check mating surfaces. Reapply Loctite; torque bolts to specifications.
Excess heat:		
Gearbox casing becomes excessively hot, with or without irregular noise(s), during operation.	Low oil level.	Replace oil; refill to specified level.
	Bearings or gears worn but not completely inoperative.	Repair or replace gearbox.

TROUBLESHOOTING – HYDRAULIC PROBLEMS

Problem	Possible Cause	Remedy
Attachment cylinders, swing and travel motors are all inoperable. Loud noises are heard from main pump assembly.	Main pump (s) malfunction.	Repair or replace.
	Low oil level in hydraulic system.	Refill.
	Main pump inlet (oil supply) piping or hose damaged.	Repair or replace.
Attachment cylinders, swing and travel motors are all inoperable. No usual or loud noises can be heard.	Pilot pump malfunction.	Repair or replace.
	Pilot cutoff solenoid stuck.	Repair or replace.
	Pilot cutoff switch faulty.	Repair or replace.
	Engine/pump flex coupling damaged.	Replace flex coupling.
Sluggish performance of all hydraulic functions – attachment, swing and travel.	Main pump(s) damaged or worn.	Repair or replace.
	Main relief valve pressure off.	Readjust pressure.
	Low oil level in hydraulic system.	Refill.
	Hydraulic reservoir intake strainer clogged.	Clean.
	Pump inlet (supply side) piping or hose allowing air into hydraulic system.	Tighten connection.
Oil temperature abnormally high.	Oil cooler clogged or air circulation to cooler blocked.	Clean.
	Cooling fan belt tension too loose.	Readjust belt tension.
	Relief valve set too low.	Readjust valve.
	Relief valve in constant use.	Reduce or slow workload or cycling rate.
	Hydraulic oil severely neglected or incorrect for application.	Replace oil.

Problem	Possible Cause	Remedy
One circuit in hydraulic system inoperable.	Overload relief valve malfunction.	Readjust or replace.
	Oil leak at makeup valve.	Clean, repair.
	Control valve spool damaged.	Repair or replace.
	Dirt in control valve spool.	Clean or replace.
	Actuator (joystick, foot pedal) damaged or worn.	Repair or replace.
	Internal seal leak in cylinder.	Repair or replace.
	Cylinder rod damaged.	Repair or replace.
	Pilot valve or piping malfunction.	Repair or replace.
	Mechanical linkage frozen, loose or damaged.	Repair or replace.
Travel motors inoperable.	Center joint damaged.	Repair or replace.
	Parking brake not releasing.	Repair or replace.
	Travel motor worn or damaged.	Repair or replace.
	Travel motor pilot piping damaged.	Repair or replace.
Travel motors operate very slowly.	Track tension poorly adjusted Low oil in idlers or rollers.	Readjust tension Refill.
	Travel brake dragging.	Repair.
	Track frame out of alignment, deformed or twisted.	Repair.
Swing motor inoperable.	Swing brake not releasing.	Repair or replace.
	Relief valve malfunction.	Repair or replace.
	Pilot piping damaged.	Repair or replace.
Swing motor operates unevenly.	Swing gear, bearing or mounting loose or worn.	Repair or replace.
	Lubricant worn away, inadequate.	Grease.
	Swing relief valve may be faulty.	Repair/Replace the swing relief valve.

TROUBLESHOOTING – CONTROL VALVE

Check control valve problems only after other hydraulic circuit operational tests have been made. Refer to "Troubleshooting Baseline Recommendations" procedure. Pump flow, pilot pressure, Negacon pressure, main relief pressure, and port relief pressure should all be checked before starting to work on the control valve. Make sure the hydraulic system is refilled up to the required level and free of oil leaks or air in the system that could cause cavitation problems.

Problem	Possible Cause	Remedy
Main relief valve.	Particulate contamination.	Disassemble, clean main poppet.
	Broken or damaged spring.	Replace.
	Adjusting screw loose.	Readjust.
	Main poppet sticking.	Repair/replace.
	Clogged orifice in pilot passage to control valve.	Clean/replace.
Cylinder goes down in spool neutral.	Excessive clearance between casing and spool.	Replace spool or casing.
	Spool does not return to neutral/ sticking spool.	Check secondary pilot pressure.
	Spool does not return to neutral because of dirt or other contaminants.	Clean.
	Broken or damaged spring.	Replace.
	Main relief or port relief not operating properly.	See above.
	Impurities in pilot circuit.	Clean.
Cylinder drops before start at boom up operation.	Rod check valve damaged or clogged.	Clean/replace.
	Poppet sticking.	Clean/replace.
	Broken or damaged spring.	Replace.
Slow operation or response.	Excessive clearance between spool or casing.	Check pilot pressure and/or replace spool or casing.
	Sticking spool.	Clean/replace.
	Broken or damaged spring.	Replace.
	Main or port relief valve damaged.	Check pressure/replace.
Boom and arm cylinders do not perform normally in combined operation.	Priority valve faulty or spool sticking.	Check pilot pressure.
	Broken or deformed spring.	Replace.
	Excess clearance between right and left casing and valve spool.	Clean/replace.
	Clogged spool passage.	Clean/replace, replace filter.
Relief valve malfunctions:		
Pressure does not increase at all.	Main poppet or pilot poppet stuck open.	Clean/replace.

Problem	Possible Cause	Remedy
Irregular or uneven pressure.	Poppet seat damaged or pilot piston sticking to main poppet.	Clean/replace.
	Loose locknut and adjusting screw.	Readjust.
	Components worn out, past wear limits.	Replace.

TROUBLESHOOTING – TRAVEL CONTROL VALVE

Problem	Possible Cause	Remedy
Secondary pressure does not increase.	Low primary pressure.	Check primary pressure.
	Broken spring.	Replace spring.
	Spool sticking.	Clean, repair or replace.
	Excess spool to casing clearance.	Replace spool casing.
	Worn or loose universal joint (handle) subassembly.	Repair or replace U-joint subassembly.
Secondary pressure too high.	Dirt, other interference between valve parts.	Clean, repair or replace.
	Return line pressure too high.	Redirect return line.
Secondary pressure does not hold steady.	Dirt, other interference between valve parts, or worn spool sticking intermittently.	Clean, repair or replace.
	Interference or binding on spool return spring.	Clean, repair or replace.
	Interference, restriction or unsteady pressure in tank return line.	Repair or reroute tank return line.
	Air bubbles in piping (temporary) or air leak.	Vent air, or repair leak.
NOTE: Look for evidence of leaking oil.		

TROUBLESHOOTING – JOYSTICK CONTROL VALVE

Problem	Possible Cause	Remedy
Secondary pressure does not increase.	Low primary pressure.	Check primary pressure.
	Broken spring.	Replace spring.
	Spool sticking.	Clean, repair or replace.
	Excess spool to casing clearance.	Replace spool casing.
	Worn or loose handle subassembly.	Repair or replace handle subassembly.
Secondary pressure too high.	Dirt, other interference between valve parts.	Clean, repair or replace.
	Return line pressure too high.	Redirect return line.
Secondary pressure does not hold steady.	Dirt, other interference between valve parts, or worn spool sticking intermittently.	Clean, repair or replace.
	Interference or binding on spool return spring.	Clean, repair or replace.
	Unsteady pressure in tank return line.	Redirect return line.
	Air bubbles in piping (temporary) or air leak.	Vent air, or repair leak.
NOTE: <i>Look for evidence of leaking oil to help find damaged seals or gaskets that could be the cause of air leaks.</i>		

Electrical System

Electrical System

Edition 1

MEMO

Table of Contents

Electrical System

Introduction	9-1-7
Electrical Supply System	9-1-8
Engine Starting Circuit	9-1-10
Start Operation	9-1-10
After Start	9-1-12
Engine Preheating System	9-1-14
Engine Stop	9-1-16
Charging System	9-1-18
Monitoring System	9-1-19
Instrument Panel	9-1-20
Functional Check	9-1-20
Monitoring System Schematic	9-1-22
Operation	9-1-24
Instruments	9-1-24
Warning and Indicator Lights	9-1-26
Indication of Warning Lights	9-1-26
Indication of Multifunction Gauge	9-1-29
Initial Operation	9-1-31
Graphic Information Area Display	9-1-32
Overview	9-1-32
Main Menus for the Graphic Display Area	9-1-32
Menu Selector Buttons	9-1-32
User Menu	9-1-33
User Menu - Access and Escape Methods	9-1-33
Switch Operation Indication	9-1-70
Special Menu	9-1-73
Entering/Accessing and Exiting/Escaping Menus ...	9-1-73
Special Menu Selections	9-1-74
Failure Code	9-1-91
Failure Code at Machine	9-1-91
Failure Code at Engine Side	9-1-94

Electronic Hydraulic Control System (EPOS)	9-1-114
Control System Schematic	9-1-114
Power Plus Mode Control	9-1-116
Operation.....	9-1-118
Power Mode Control	9-1-120
i-CEPT (Intelligent Construction Equipment of Power) System	9-1-122
Smart Power Control (SPC).....	9-1-123
Operation.....	9-1-123
SPC Diagram	9-1-125
SPC Circuit.....	9-1-126
Engine Control System	9-1-127
Engine Control Dial	9-1-128
Engine Control.....	9-1-130
Automatic Deceleration Control (Auto Idle Control)	9-1-132
Engine Overheat Protection System	9-1-134
Power Boost Mode	9-1-137
Operation.....	9-1-137
Power Boost Control	9-1-138
Automatic Travel Speed Control.....	9-1-140
Automatic Travel Speed Control	9-1-142
Water in Fuel Warning System	9-1-143
Operation.....	9-1-143
Self-diagnostic Function	9-1-144
EPOS Controller.....	9-1-144
Air Conditioner System	9-1-146
Outline	9-1-146
Internal and External Filters	9-1-147
Air-Conditioning System Layout	9-1-148
Air Conditioner/Heater Circuit Diagram	9-1-149
Air Conditioner/Heater Unit	9-1-150

Ambient Air Temperature Sensor.....	9-1-155
Control Panel.....	9-1-156
Receiver Dryer	9-1-163
Troubleshooting	9-1-164
Refrigerant System Repairs	9-1-166
Refrigerant Safe Handling Procedures.....	9-1-166
Repair and Replacement Procedure	9-1-167
Refrigerant Recovery	9-1-169
Vacuuming Refrigerant System.....	9-1-169
Leakage Check	9-1-171
Refrigerant Charging	9-1-171
Inspecting System For Leakage.....	9-1-173
Wiper System	9-1-174
Wiper Circuit.....	9-1-174
Wiper Operation	9-1-175
Lighting System	9-1-178
Lighting System Circuit Diagram	9-1-178
Kind of Light	9-1-179
Operation.....	9-1-179
Overload Warning Device.....	9-1-180
Overload Warning Device Circuit Diagram.....	9-1-180
Audio Controller	9-1-181
Audio Controller Circuit Diagram.....	9-1-181

INTRODUCTION

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 electrical 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.

Electrical 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*

ELECTRICAL SUPPLY SYSTEM

The electric power circuit supplies electric current to each electric component. It consists of a battery, battery relay, starter switch, circuit breaker and fuse box.

The negative terminal of the battery is grounded to the machine body.

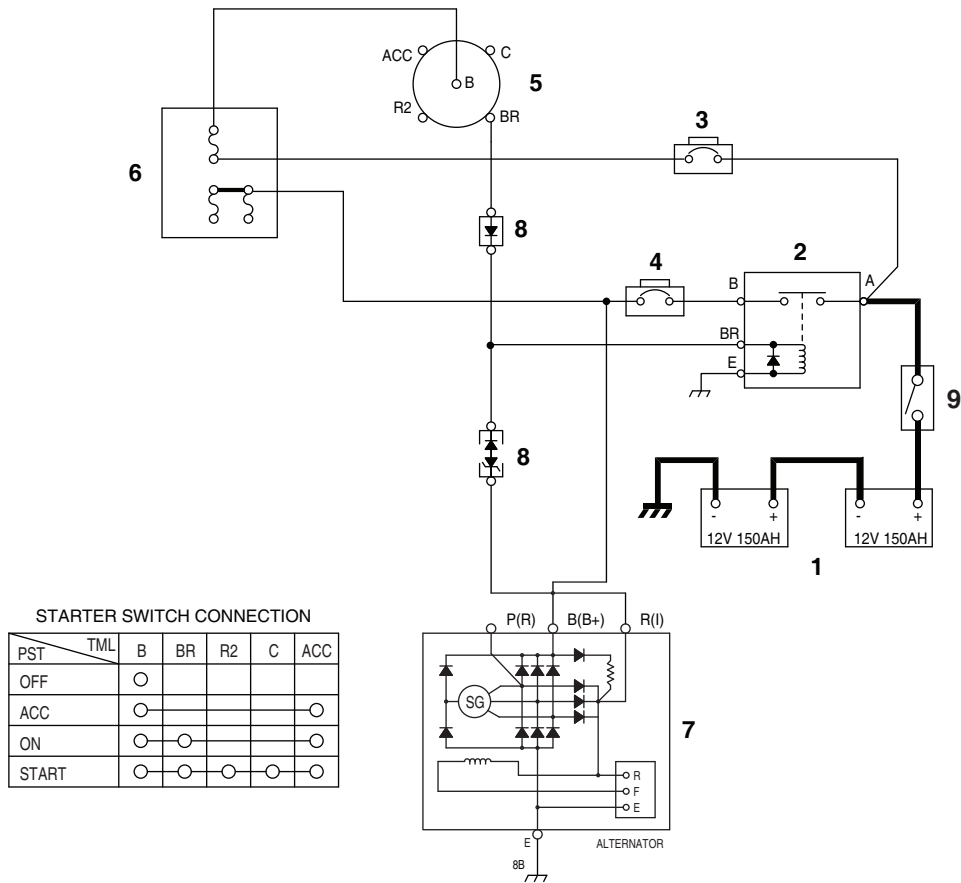
Even when the starter switch (5) is in the "OFF" position, electric current is supplied to the following components through battery (1) → master switch (11) → circuit breaker 1 (3) → fuse box (6).

1. Terminal "5" of stereo.
2. Terminal "B" of starter switch.
3. Hour meter.
4. Engine controller. (ECU + SCU)
5. Terminal "2" of fuel auto shutoff controller.
6. Terminal "6" of wiper motor.
7. Terminal "13" of wiper controller.
8. Terminal "CN7-5, CN7-6" of instrument panel controller.
9. Terminal "CN9-6" of air conditioner panel.
10. Cabin light
11. Terminal "3" of diesel heater timer.
12. Terminal "3" of diesel heater.
13. Terminal "1" of TMS controller.
14. Terminal "2" of ETP switch.
15. Terminal "9", "10" of AVM monitor. (Optional)
16. Terminal "1" of AVM ECU. (Optional)

When the starter switch (5) is in the "ON" or "START" positions, the current flows from the battery (1) → master switch (11) → circuit breaker 1 (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "BR" terminal of battery relay (2) which activates the coil of the battery relay 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 (7).



WE1501263

Figure 1 Electric Power Circuit Diagram

Reference Number	Description
1	Battery
2	Battery Relay
3	Circuit Breaker 1
4	Circuit Breaker 2
5	Starter Switch

Reference Number	Description
6	Fuse Box
7	Alternator
8	Diode
9	Master Switch

ENGINE STARTING CIRCUIT

Start Operation

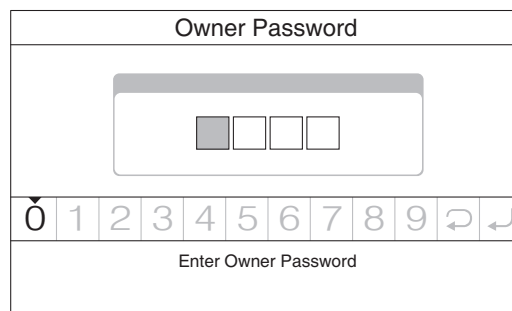
When the starter switch is turned to the "START" position.

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) → "B" terminal of the starter (9). The starter motor activates the engine to start.

If the instrument panel has the password function activated, input number should match the set number, otherwise the start circuit closes and the engine does not start.

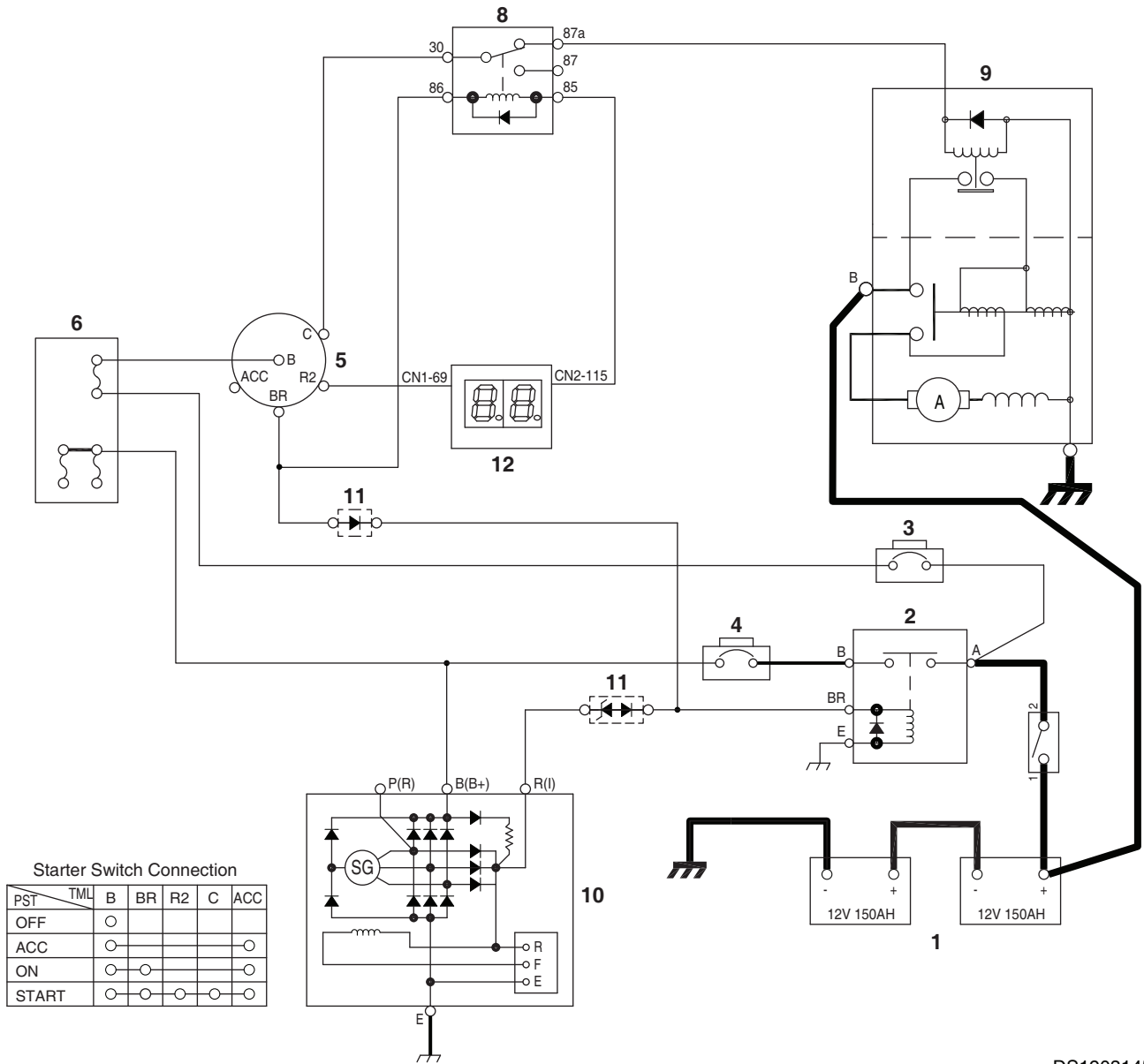
NOTE: *If the security system is "LOCKED," a four-digit password will be required to start the engine. If the system is "UNLOCKED," no password will be required and this display screen will not appear.*

In the event the security system is locked, current flows from battery (1) → circuit breaker (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "86" terminal of starter relay (8) → "CN1-15" terminal of EPOS (12) → ground. This current flow causes the coil in starter relay (8) to be activated, opening contacts at "87a" terminal. This prevents starter relay (8) from functioning.



EX1301416

Figure 2



DS1903145

Figure 3 Starter Circuit (1) - While Starting

Reference Number	Description
1	Battery
2	Battery Relay
3	Circuit Breaker
4	Circuit Breaker
5	Starter Switch
6	Fuse Box

Reference Number	Description
8	Starter Relay
9	Starter
10	Alternator
11	Diode
12	EPOS Controller

After Start

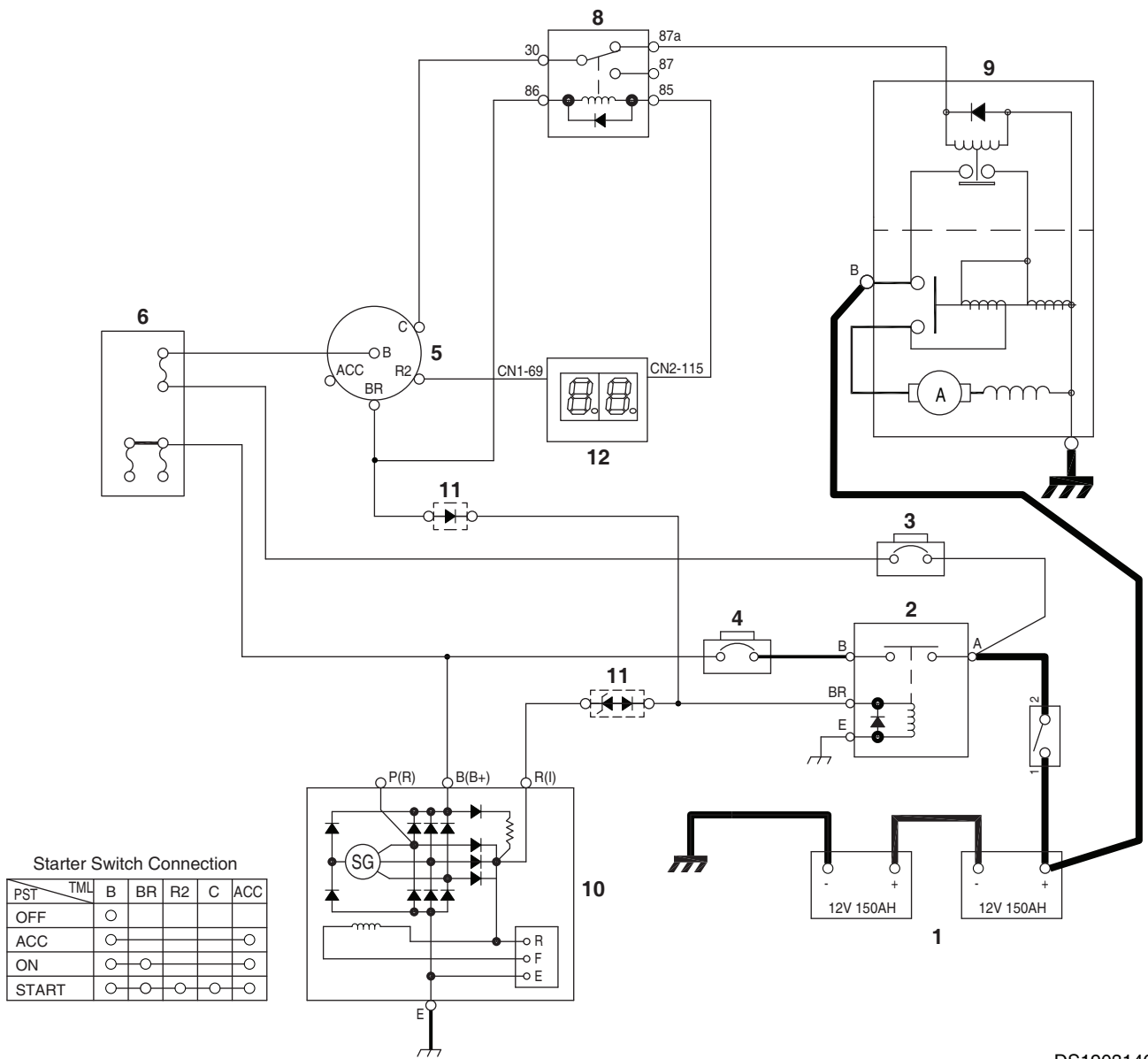
Once the engine has been started, the belt driven alternator (10) generates a current.

If EPOS senses the frequency is over 450 rpm via Speed sensor, current flows from battery (1) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "86" terminal of starter relay (8) → "CN2-115" terminal of EPOS (12) → ground.

This current flow causes the coil in starter relay (8) to be activated, opening contacts at "87a" terminal.

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.

Operation of the Start Circuit (2) - Immediately After Start



DS1903146

Figure 4 Operation of Start Circuit (2) - Immediately After Start

Reference Number	Description
1	Battery
2	Battery Relay
3	Circuit Breaker
4	Circuit Breaker
5	Starter Switch
6	Fuse Box

Reference Number	Description
7	Starter Controller
8	Starter Relay
9	Starter
10	Alternator
11	Diode
12	EPOS Controller

ENGINE PREHEATING SYSTEM

An air heater (8) is installed in the intake manifold of the engine. When the starter switch (5) is turned "ON," the current flows from the battery (1) → master switch (14) → circuit breaker 1 (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "1-69" terminal of engine controller (12), causing current to flow through "1-74" terminal of engine controller (12) → "C and D" terminals of preheat relay (7) → "1-83" terminals of engine controller (12) → ground.

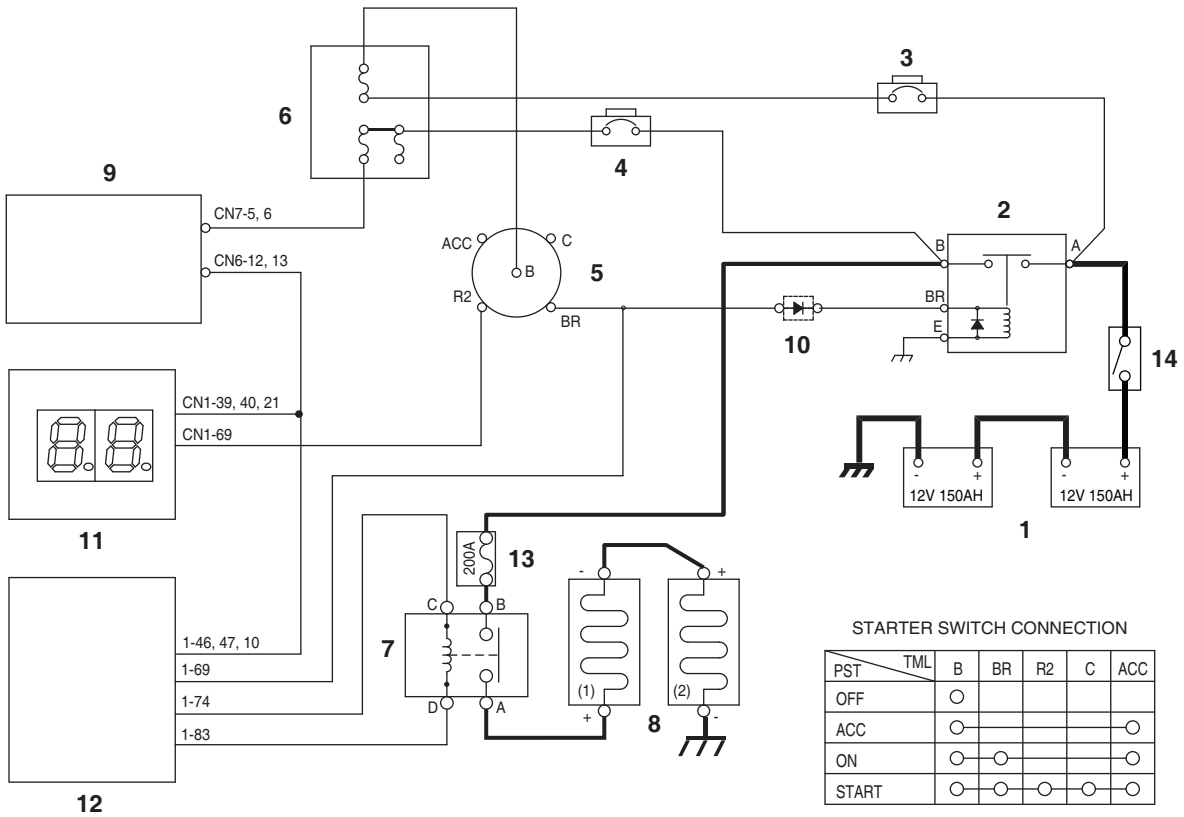
This current flow causes the coil in preheat relay (7) to be activated, closing contacts.

When the contacts of the preheat relay (7) are closed, the heating coils of the air heating device (8) are heated by current flowing from the battery (1) → master switch (14) → battery relay (2) → preheat relay fuse (13) → preheat relay (7) → air heater (8) → ground.

The duration of the heating cycle depends on the temperature of engine coolant. The preheat indicator light in the instrument panel (9) will turn "ON" during preheating cycle.

The preheat relay (7) is controlled by the engine controller (12) and operates only at temperatures of 10°C (50°F) and below.

The longer the preheating period, the lower the temperature of coolant is.



DS1603955

Figure 5 Engine Preheat Circuit

Reference Number	Description
1	Battery
2	Battery Relay
3	Circuit Breaker 1
4	Circuit Breaker 2
5	Starter Switch
6	Fuse Box
7	Preheat Relay
8	Air Heater

Reference Number	Description
9	Preheat Indicator Light (Gauge Panel)
10	Diode
11	EPOS Controller
12	Engine Controller
13	Preheat Relay Fuse
14	Master Switch

ENGINE STOP

When starter switch (5) is turned "ON" the engine controller (8) is activated. The engine controller monitors and controls the engine including the injector solenoid (9). It controls the fuel deliver rate and the injection timing for each cylinder.

NOTE: *There is an individual injector solenoid (9) for each of the cylinders. Only one solenoid is shown in Figure 7.*

When starter switch (5) is turned "OFF", the engine controller stops supplying power to the injector solenoid (9). This stops fuel from being injected into the engine cylinder, thus stopping the engine.

If the engine cannot be shut down using the starter switch (5), an engine emergency stop switch (10) is provided to stop engine. To activate the emergency stop switch, move it to "I" (EMERGENCY STOP) position.

The engine emergency stop switch (10) is in its "O" (OFF) position during normal operation. The switch must be moved and held in the "I" (EMERGENCY STOP) position until engine stops.

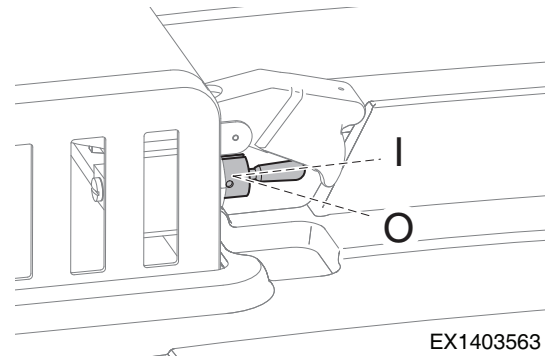
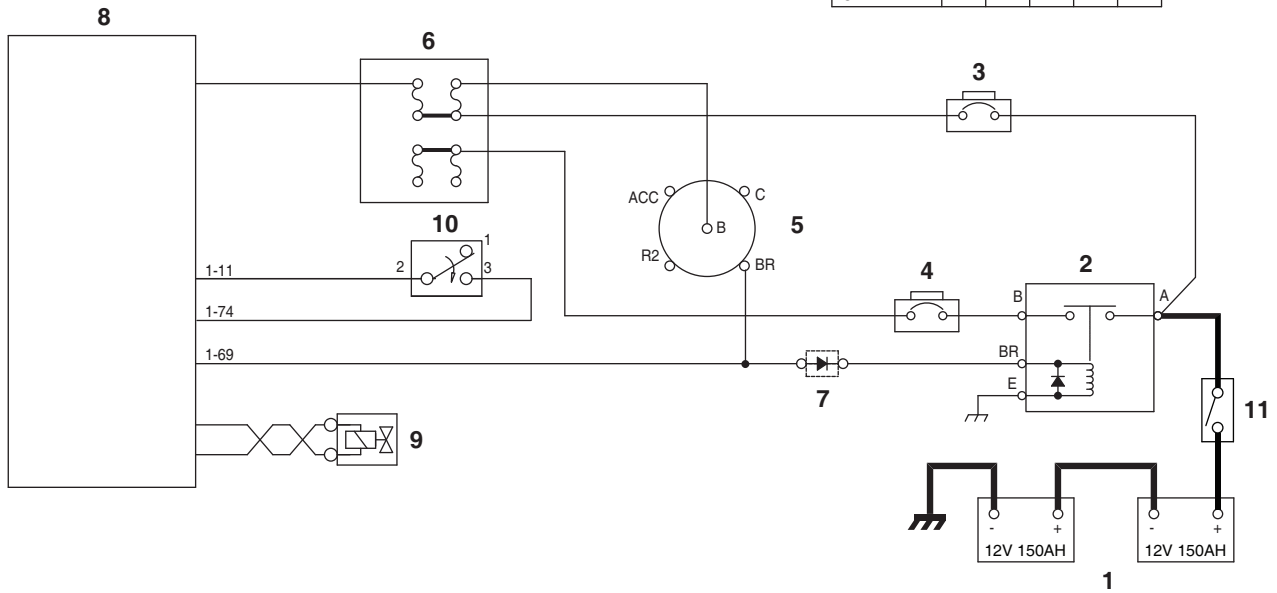


Figure 6 Engine Emergency Stop Switch

STARTER SWITCH CONNECTION

PST \ TML	B	BR	R2	C	ACC
OFF	○				
ACC	○				○
ON	○	○			○
START	○	○	○	○	○



WE1501265

Figure 7 Engine Stop Circuit

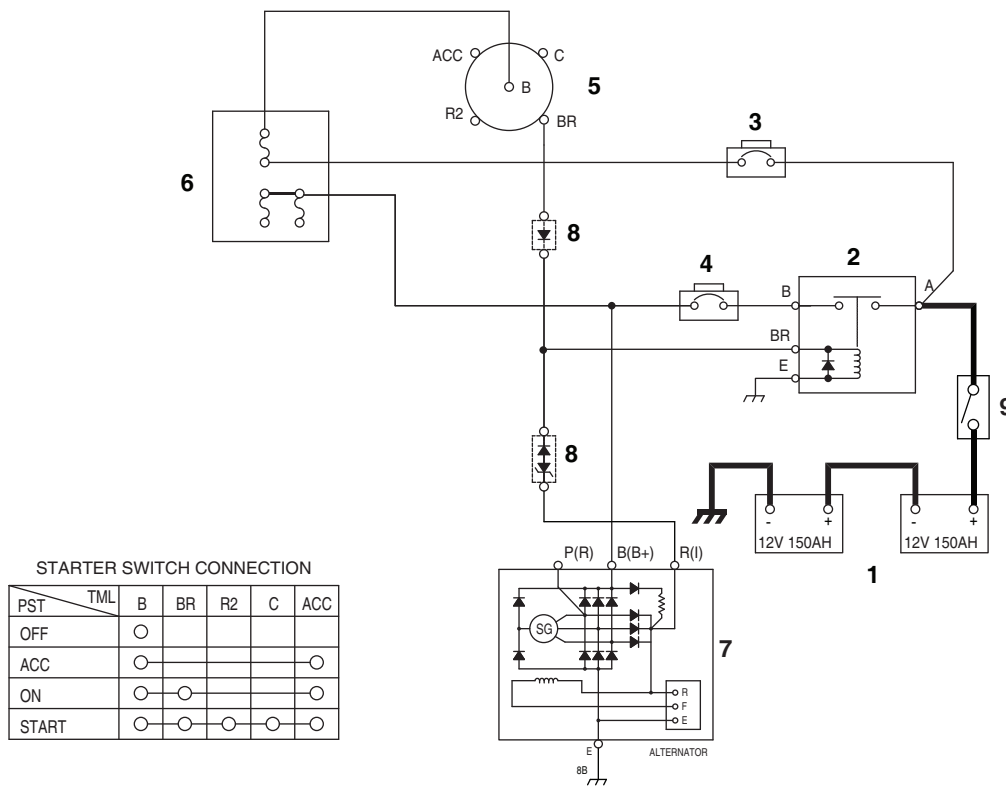
Reference Number	Description
1	Battery
2	Battery Relay
3	Circuit Breaker 1
4	Circuit Breaker 2
5	Starter Switch
6	Fuse Box

Reference Number	Description
7	Diode
8	Engine Controller
9	Injector Solenoid
10	Engine Emergency Stop Switch
11	Master Switch

CHARGING SYSTEM

When the starter switch (5) is turned to the "ON" position, an initial excitation current flows to the field coil of the alternator (7) through the battery relay (2) and circuit breaker (4). When the engine is started from this condition the alternator (7) starts charging. The current flows from the "B (B+)" terminal of alternator (7) → circuit breaker (4) → battery relay (2) → master switch (9) → battery (1).

The alternator also supplies electric current to other electrical components. When the alternator (7) starts to operate, a current flows from the "R (I)" terminal of alternator → diode (8) → battery relay (2) coil securing a path for the charging current to the battery (1). Thus preventing the possibility of a high voltage build up and possible damage to the electrical system.



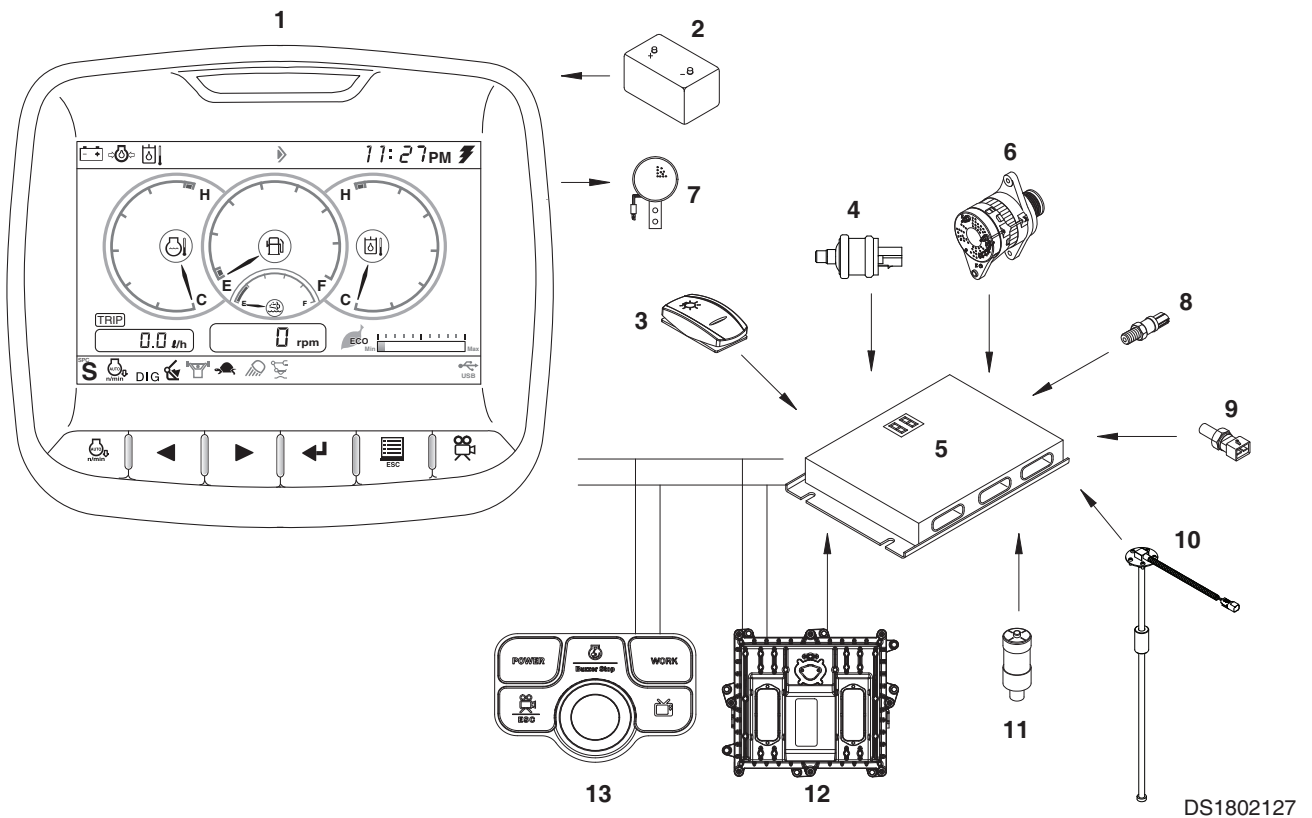
WE1501266

Figure 8 Charging Circuit

Reference Number	Description
1	Battery
2	Battery Relay
3	Circuit Breaker 1
4	Circuit Breaker 2
5	Starter Switch

Reference Number	Description
6	Fuse Box
7	Alternator
8	Diode
9	Master Switch

MONITORING SYSTEM



DS1802127

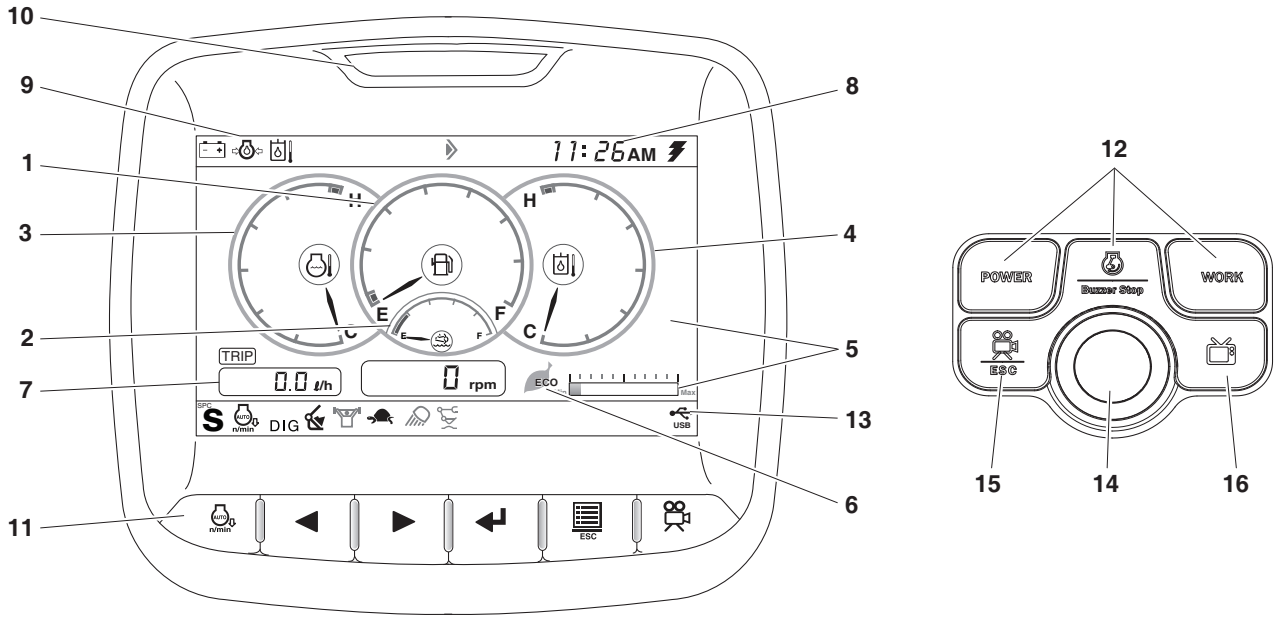
Figure 9

Reference Number	Description
1	Instrument Panel
2	Battery
3	Light Switch
4	Return Filter Switch
5	EPOS Controller
6	Alternator
7	Warning Buzzer

Reference Number	Description
8	Pump Discharge Pressure Sensor
9	Hydraulic Oil Temperature Sensor
10	Fuel Sensor
11	Air Cleaner Indicator
12	Engine Controller
13	Jog Switch Control Panel

The monitoring system displays the various data and warning signals onto the instrument panel by processing the information gathered from the EPOS controller. It displays information selected by the operator.

Instrument Panel



EX1300990

Figure 10

Reference Number	Description
1	Fuel Gauge
2	DEF (AdBlue) Level Gauge
3	Engine Coolant Temperature Gauge
4	Hydraulic Oil Temperature Gauge
5	Multifunction Gauge and Graphic Information Area
6	ECO Gauge
7	Trip Rate
8	Digital Clock

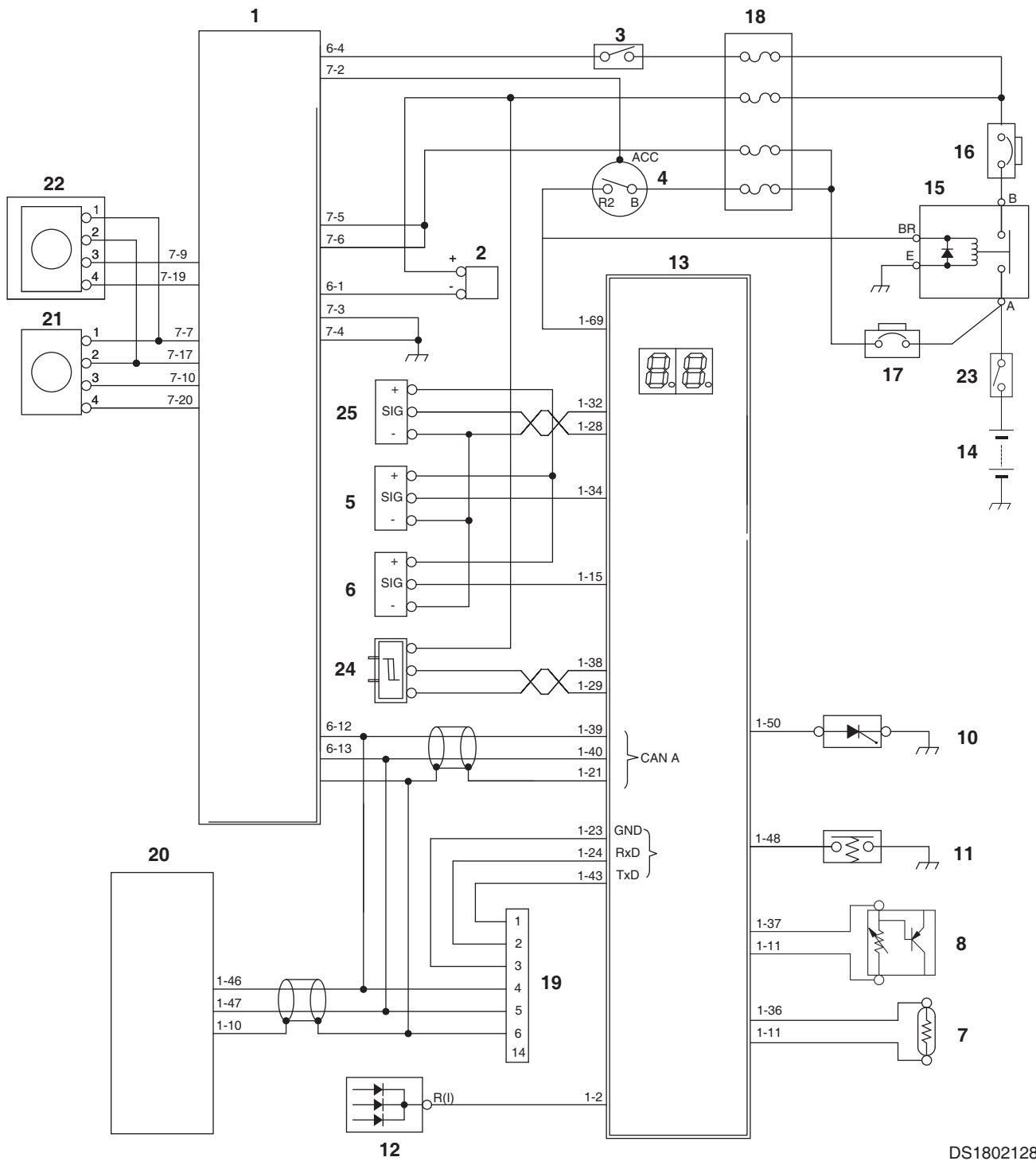
Reference Number	Description
9	Display Warning Symbols
10	Warning Light
11	Function Buttons
12	Mode Selector Buttons
13	Selector Function Display
14	Jog Switch
15	Camera Mode Selector/ESC Button
16	Multimedia Selector Button

Functional Check

When the engine starter switch is turned to "I" (ON) position, all gauge bands, switch/button indicator lights and warning lights will turn "ON" and the alarm buzzer will sound for about three (3) seconds.

During this functional check, a LOGO will appear on the multifunction gauge in the graphic information area (3 and 4, Figure 10).

Monitoring System Schematic



DS1802128

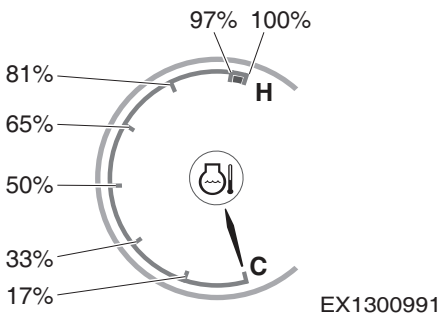
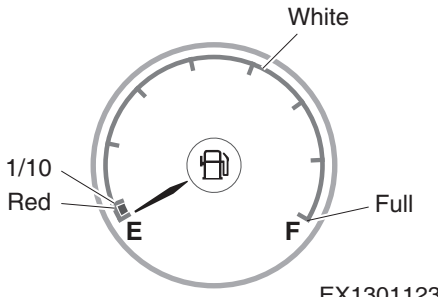
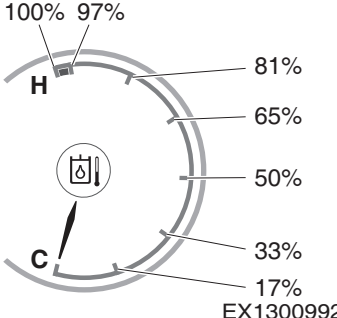
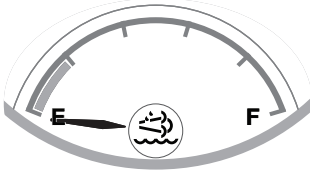
Figure 11


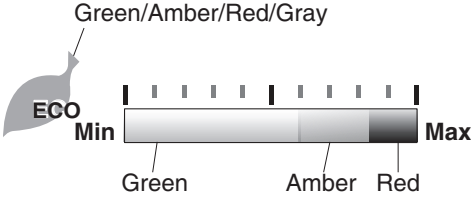

Reference Number	Description
1	Instrument Panel
2	Pilot Buzzer
3	Light Switch
4	Starter Switch
5	Front Pump Pressure Sensor
6	Rear Pump Pressure Sensor
7	Hydraulic Oil Temperature Sensor
8	Fuel Sensor
9	Pedal Pressure Switch (Optional)
10	Air Cleaner Indicator
11	Return Filter Switch
12	Alternator

Reference Number	Description
13	EPOS Controller
14	Battery
15	Battery Relay
16	Circuit Breaker 2
17	Circuit Breaker 1
18	Fuse Box
19	Check Connector
20	Engine Controller
21	Rearview Camera
22	Sideview Camera
23	Master Switch
24	Water in Fuel Sensor
25	OWD Sensor

OPERATION

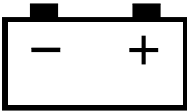
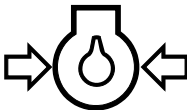



Instruments

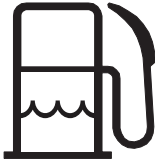


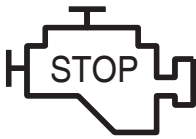


Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Coolant Temperature	 <p>EX1300991</p>	ECU-CAN Communication	17% (47°C) 33% (63°C) 50% (89°C) 65% (99°C) 73% (103°C) (Tropical Zone Mode) 81% (107°C) (Warning Start) 97% (110°C) 100% (112°C)
Fuel Level	 <p>EX1301123</p>	CN1-37 CN1-11	1/10 LCD (Red Zone) Blinking → over 5K ohms FULL → under 525 ohms
Hydraulic Oil Temperature	 <p>EX1300992</p>	CN1-36 CN1-11	17% (38°C) 33% (46°C) 50% (85°C) 65% (94°C) 81% (96°C) 84% (97°C) (Tropical Zone Mode) 97% (99°C) (Warning Start) 100% (100°C)
DEF (AdBlue) Level Gauge	 <p>EX1300993</p>	ECU-CAN Communication	5% → Min. 20% → Red Zone 100% → Max.





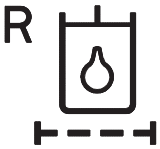

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Tachometer	 <p>EX1301378</p>	ECU-CAN Communication	
ECO Gauge	 <p>EX1300994</p>	EPOS-CAN Communication	<p>ECO symbol: The instant workload</p> <ul style="list-style-type: none"> - Green: Normal operation - Amber: Idling operation - Red: Heavy loading operation - Gray: ECO symbol off <p>ECO gauge: The average fuel efficiency for 1 minute</p> <ul style="list-style-type: none"> - Green: Fuel efficiency is good - Amber: Fuel efficiency is normal - Red: Fuel efficiency is not good
Trip Meter	 <p>EX1300995</p>	EPOS-CAN Communication	<p>Amount of fuel use (ℓ)</p> <p>Operating hours (hr)</p> <p>Average fuel efficiency (ℓ/hr)</p> <p>Daily average fuel efficiency (ℓ/hr)</p>


WARNING AND INDICATOR LIGHTS

Indication of Warning Lights



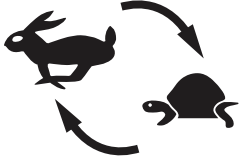

Description	Symbol	Input Terminal	Operation	Remarks
Charge	 <small>HAOA610L</small>	CN1-2	This symbol appears in case of no charge.	Normally, it lights when starting engine and is out after engine starts.
Engine Oil Pressure	 <small>HAOA620L</small>	ECU-CAN Communication	This symbol appears when engine oil pressure is below the reference.	After starting engine, if engine oil pressure is insufficient after 8 seconds, a warning buzzer will sound.
Engine Check	 <small>FG000045</small>	ECU-CAN Communication	This symbol appears in case of fault in engine system.	
Coolant Temperature	 <small>HAOD350L</small>	ECU-CAN Communication	This symbol appears when engine coolant temperature sensor resistant is above about 107°C.	
Preheating	 <small>HAOA639L</small>	EPOS-CAN Communication	This symbol appears during preheating.	Preheating period depends on coolant temperature. 20 sec preheating at 5°C.

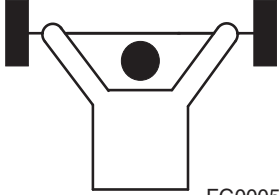



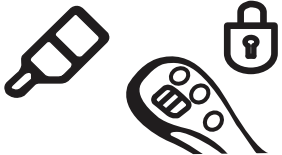

Description	Symbol	Input Terminal	Operation	Remarks
Water Separator	 DS1603475	CN1-29 CN1-38	The WIF sensor voltage is under 1.5 ± 0.5 V, because moisture is detected in fuel.	
DEF (AdBlue) Low	 FG019175	ECU-CAN Communication	Europe: 20%: Light on 0%: Flashes every 2 seconds America: 20%: Light on 10%: Flashes every 2 seconds 0%: Flashes every 0.5 second	
SCR Fault	 FG019176	ECU-CAN Communication	Alarm notifying abnormal operation at the post processing side of the SCR system. Check the ECU malfunction from the current malfunction information.	
Engine Stop	 FG019003	ECU-CAN Communication	This symbol appears in case of fault in the engine system.	
Quick Coupler	 EX1301541	CN1-77	This symbol appears when quick coupler is operated.	The warning buzzer sounds simultaneously when quick coupler is operated.
Vehicle Check	 CHECK EX1301542	EPOS-CAN Communication	This symbol appears when a breakdown occurs to the vehicle.	


Description	Symbol	Input Terminal	Operation	Remarks
Vehicle STOP	 <p>EX1301543</p>	EPOS-CAN Communication	This symbol appears when there is an irregularity in the vehicle.	
Hydraulic Oil Temperature	 <p>FG000056</p>	CN1-36 CN1-11	When hydraulic oil temperature is above about 98°C.	
Fuel Exhausted	 <p>FG000057</p>	CN1-37 CN1-11	When fuel is almost exhausted.	
Air Cleaner	 <p>FG000053</p>	CN1-50	When air cleaner is clogged.	
Return Filter	 <p>FG000054</p>	CN1-48	When return filter pressure is above about 1.50 bar (21 psi)	
Overload Warning	 <p>FG000253</p>	CN1-32 CN1-28	Warning buzzer also starts when boom pressure sensor output voltage is about 2.68 V while overload warning switch is "ON".	It flashes in case of 2.68 V and above and lights continuously in case of 2.77 V and above (and warning buzzer also starts).

Description	Symbol	Input Terminal	Operation	Remarks
Work Light	 HB4O2003	CN1-79	This symbol appears when work light turns "ON" (24 V applied).	

Indication of Multifunction Gauge

Description	Symbol	Input Terminal	Operation	Remarks
Low-speed Travel	 EX1301575		Basic run mode	
High-speed Travel	 EX1301577	CN1-80	This symbol appears when high-speed run mode switch is operated.	It only operates when the auto idle pressure is 10.5 bar or more during running and the high-speed run solenoid valve is operated.
Automatic Travel	 EX1301577	CN1-61 CN1-80	This symbol appears when the automatic run mode switch is operated.	When the auto idle pressure is 10.5 bar or more, dial voltage is less than 2.5 V and pump pressure is 153.7 bar during running, the high-speed run solenoid valve is operated.
Intelligent Floating Boom	 EX1301578	CN1-54	This symbol appears when the Intelligent floating boom switch is operated.	

Description	Symbol	Input Terminal	Operation	Remarks
Voltage step-up	 FG000554	CN1-81	This symbol appears when the voltage step-up switch is operated or the lift mode is selected.	If the Voltage step-up switch is operated or the lift mode is selected, the voltage step-up solenoid valve is operated.
Excavation mode	 EX1301579	Jog Switch CAN Communication	This symbol appears when the excavation mode is selected.	
Lift Mode	 EX1301580	Jog Switch CAN Communication	This symbol appears when the lift mode is selected.	
Breaker Mode	 EX1301581	Jog Switch CAN Communication	This symbol appears when the breaker mode is selected.	
Breaker Mode (Option)	 EX1301582	Jog Switch CAN Communication	This symbol appears when the breaker mode is selected.	It appears only for the vehicle with PE3C option.
Two-Way Mode	 EX1301583	Jog Switch CAN Communication	This symbol appears when the two-way mode is selected.	

Description	Symbol	Input Terminal	Operation	Remarks
Two-Way Mode (Option)	 EX1301584	Jog Switch CAN Communication	This symbol appears when the two-way mode is selected.	It appears only for the vehicle with PE3C option.
ISO Mode	<p style="text-align: center;">ISO</p> EX1301585	CN2-86	This symbol appears when the ISO mode is selected.	It appears only for the vehicle with pattern change option.
BHL Mode	<p style="text-align: center;">BHL</p> EX1301586	CN2-94	This symbol appears when BHL mode is selected.	It appears only for the vehicle with pattern change option.

INITIAL OPERATION

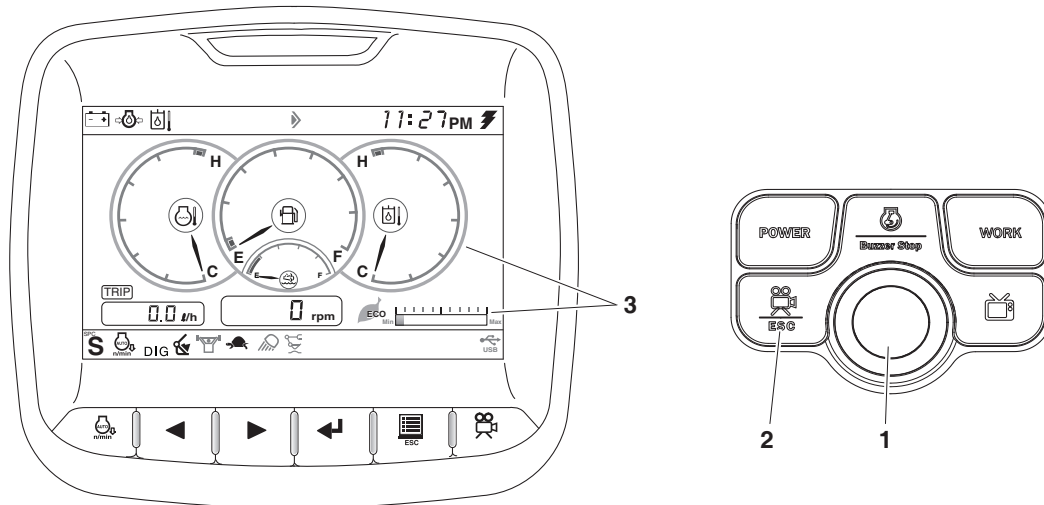
Item	Input (Terminal)	Output (Operation and Initial Setting Mode)
Initial Operation	When "CN7-2" is applied battery voltage (starter switch) shifts from "OFF" to "ON"	<ul style="list-style-type: none"> Warning buzzer is activated and turned "OFF" after about 3 seconds. Power mode: When Fuel Saving Mode is disabled, the power mode is the previous mode. When Fuel Saving Mode is enable, the power mode is standard mode or economy mode. Auto Idle: High Output (Activation). Display: Indicating coolant temperature, fuel level, hydraulic oil temperature, engine speed, DEF (AdBlue) level, trip meter. Clock: Current time display.

NOTE: Refer to method for setting clock in operation manual for setting time.

GRAPHIC INFORMATION AREA DISPLAY

Overview

Machine condition is displayed in the letter information display department. The information display department is divided into two menus. One is main menu for the user and the other is a special menu for the specialist. These menus can be changed from normal display mode by the jog switch.



EX1300996

Figure 12

Selector Buttons	Graphic Display Area
1. Jog Switch	3. Letter Information Display Department
2. Escape Button	

Main Menus for the Graphic Display Area

1. User menu: Language setting, Time setting, Filter/Oil information, Brightness adjustment, Password
2. Special menu: Information of machine status, fault information, Information of machine operation.

Menu Selector Buttons

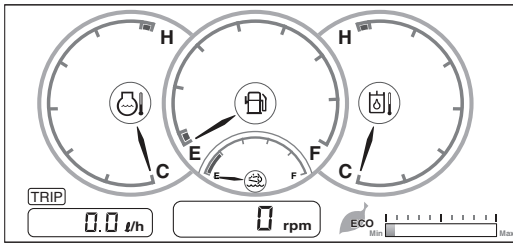
1. Jog Switch (1 on Figure 12): Move cursor and set menu.
2. Escape Button (ESC, 2 on Figure 12): Move a screen to previous menu or main menu.

USER MENU

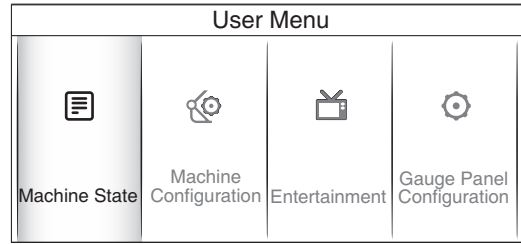
User Menu - Access and Escape Methods

Access Method

1. On the normal display screen, click on the jog switch to access the user menu screen.
2. Proceed to the user menu using the menu/esc button on the front of the dashboard.
3. Select the user menu from the launch menu.



<Normal Indication Monitor>



<Main Menu Monitor>

DS1601342

Figure 13

Escape Method

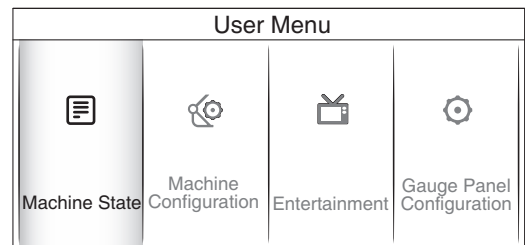
1. Press the ESC button to move to the normal display screen.
2. If 20 seconds have passed without the operation of the button, the normal display screen will be displayed.
3. Turning "OFF" the starter switch to cut off power, you will move to the normal display screen.

User Menu

Turn the jog switch and move the cursor to see a reversed display on the desired menu. Then, click on the jog switch to select the menu.

Machine State ↔ Machine Configuration ↔ Entertainment ↔ Gauge Panel Configuration

Press the ESC button to return to the previous screen.



DS1601343

Figure 14



WARNING

AVOID DEATH OR SERIOUS INJURY

Do not use machine state menu when traveling or operating.

1. Machine State

This is used to check the current machine state, filter/oil information, machine information, etc.

Turn the jog switch and move the cursor to see a reversed display on the desired menu. Then, click on the jog switch to select the menu.

Monitoring ↔ Filter/Oil Information ↔ Machine Information ↔ Fuel Efficiency Data

Press the ESC button to return to the previous screen.

A. Monitoring

The monitoring screen displays the information on machine pump pressure, voltage, fuel level, etc.

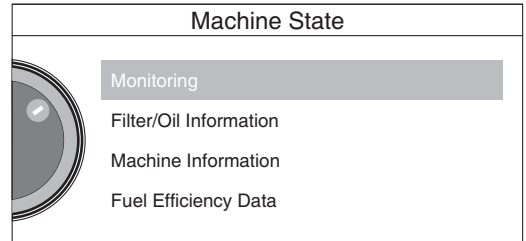
At the machine state, if the cursor is placed on Monitoring, click on the jog switch to display the Monitoring screen.

Press the ESC button to return to the previous screen.

B. Filter/Oil Information

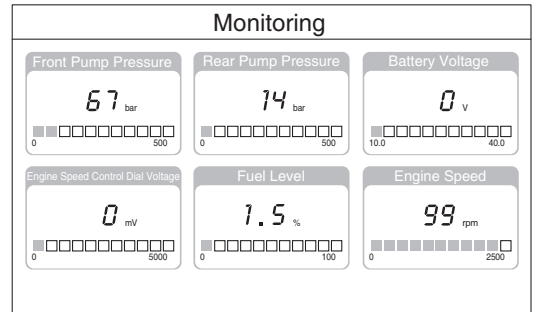
The screen displays the information on filter/oil use time, replacement period, and remaining time.

At the machine state, if the cursor is placed on the filter/oil information, click on the jog switch to display the filter/oil information.



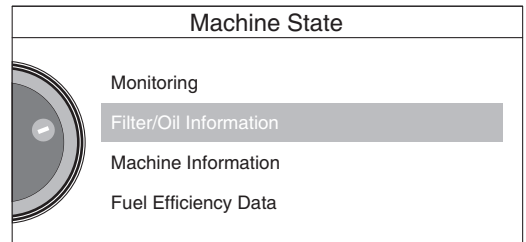
DS1601344

Figure 15



DS1601345

Figure 16



DS1601346

Figure 17

Reset Method/Replacement Period Change Method

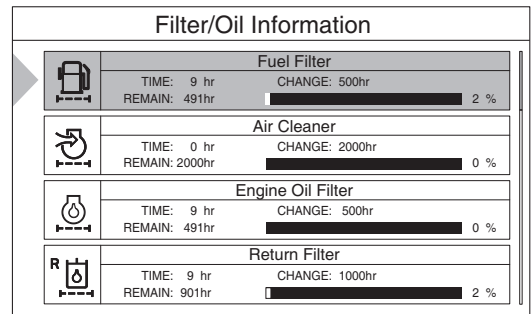
Move the cursor over the filter/oil item you wish to change using the jog switch or the ◀ and ▶ buttons on the front of the dashboard and click the jog switch or press the 'Enter' button on the front of the dashboard. A window for resetting/changing the filter/oil time will pop-up.

To reset the use time, move the cursor over 'clear' and click the jog switch or press the 'Enter' button on the front of the dashboard.

Turn the jog switch to locate it at YES. Then, click on the jog switch to reset the operation hour.

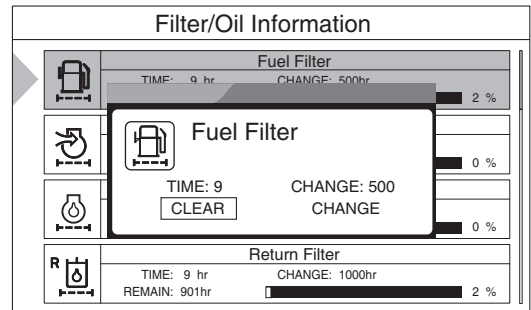
Turn the jog switch to locate it at NO. Then, click on the jog switch to allow the pop-up window to disappear without resetting the operation hour.

- The filter/oil use time shows the hours of operation after initializing the engine. It begins again with 0 hr after initialization the following the replacement of filter/oil.



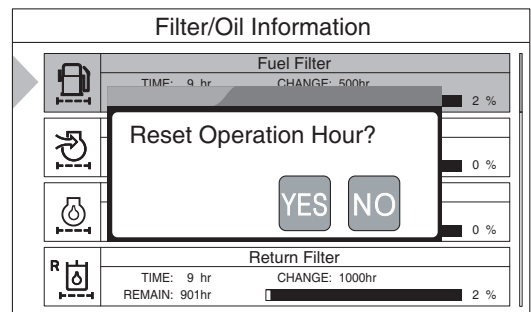
DS1601347

Figure 18



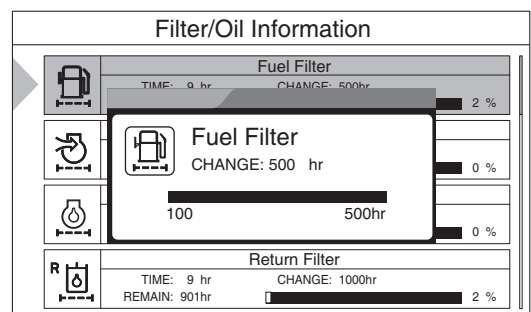
DS1601348

Figure 19



DS1601349

Figure 20



DS1601350

Figure 21

To change the filter/oil exchange period, move the cursor over 'change' in the window for resetting/ changing the filter/oil time and click the jog switch or press the 'Enter' button on the front of the dashboard.

After the exchange period change screen pops up, click the jog switch or press the 'Enter' button on the front of the dashboard and the exchange time will start flashing.

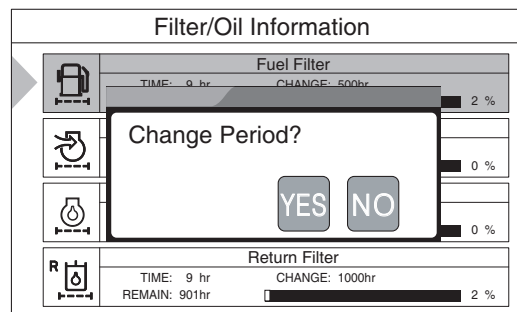
Next, change the exchange period using the jog switch or the ◀ and ▶ buttons on the front of the dashboard.

Then, turn the jog switch counterclockwise to reduce the period. Turn clockwise to extend the period.

With the replacement period change being completed, click on the jog switch to create a pop-up window to select the period change.

Turn the jog switch to locate it at YES. Then, click on the jog switch to change the replacement period.

Turn the jog switch to locate it at NO. Then, click on the jog switch to allow the pop-up window to disappear without the replacement period not being changed.



DS1601351

Figure 22

Filter/Oil Period Setup Table

Unit: hr

Kind	Replacement Period		
	Basic Setup Value	Minimum Available Setup Value	Change Value By Step
Fuel Filter	500	100	50
Air Cleaner	2,000	1,000	50
Engine Oil Filter	500	100	50
Return Filter	1,000	100	50
Pilot Filter	1,000	100	50
Engine Oil	500	100	50
Hydraulic Oil	2,000	1,000	50
Coolant	2,000	1,000	50

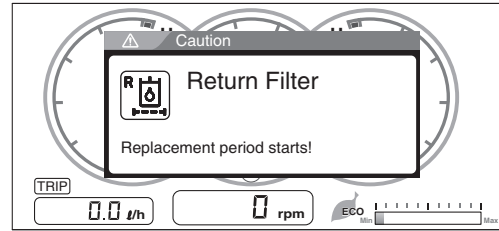
Symbol Description

Filter/ Oil Name	Fuel Filter	Air Cleaner	ENG Oil Filter	Return Filter	Pilot Filter	ENG Oil	HYD. Oil	Coolant
Icon								

DS1601604

Figure 23

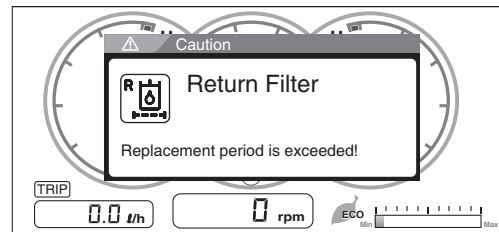
If the remaining time for filter/oil replacement is less than 10 hours, this pop-up window will be created. Press the ESC button or the jog switch to allow the pop-up window to disappear.



DS1601352

Figure 24

If the filter/oil replacement period is exceeded, this pop-up window will be created. Press the ESC button or the jog switch to allow the pop-up window to disappear.



DS1601353

Figure 25



WARNING

AVOID DEATH OR SERIOUS INJURY

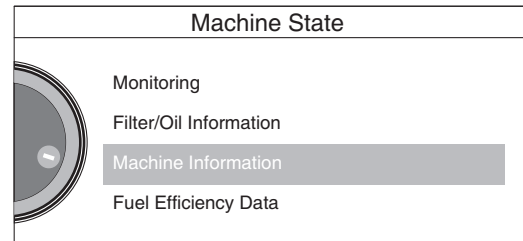
Do not use machine state menu when traveling or operating.

C. Machine Information

This is used to check the machine name, engine type and attachment options.

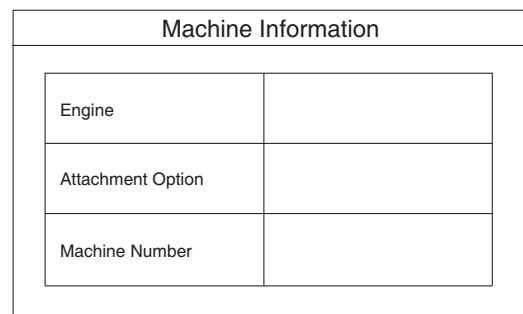
At the machine state, if the cursor is placed on the machine information, click the jog switch to access the machine information screen.

Click the ESC button to return to the previous screen.



DS1601354

Figure 26

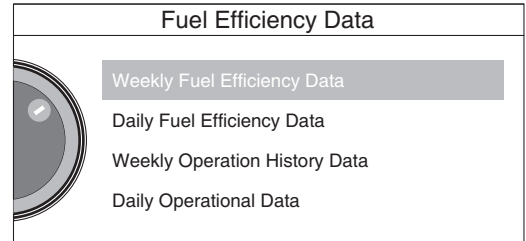


WE1500736

Figure 27

D. Fuel Efficiency Data

It is possible to check the weekly fuel efficiency data, daily fuel efficiency data, weekly operation history data and daily operation data.

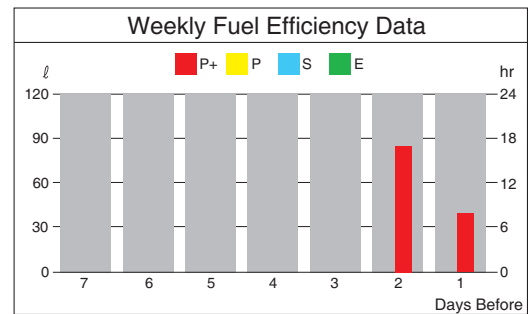


DS1601355

Figure 28

1) Weekly Fuel Efficiency Data

The amount of fuel used by each operating mode in a week can be checked.

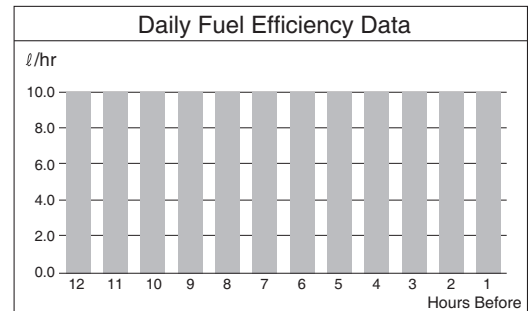


EX1402170

Figure 29

2) Daily Fuel Efficiency Data

The amount of fuel used in a day can be checked.



EX1402171

Figure 30

3) Weekly Operation History Data

The amount of fuel used, operating period and daily average fuel efficiency in a week can be checked.

Weekly Operation History Data			
Days Before	Amount of Fuel Used	Operation Period	Daily Average Fuel Efficiency
1	0 l	9.1 hr	0.0 l/hr
2	0 l	16.6 hr	0.0 l/hr
3	0 l	0.0 hr	0.0 l/hr
4	0 l	0.0 hr	0.0 l/hr
5	0 l	0.0 hr	0.0 l/hr
6	0 l	0.0 hr	0.0 l/hr
7	0 l	0.0 hr	0.0 l/hr

EX1402172

Figure 31

4) Daily Operational Data

The operation period, average fuel efficiency and amount of fuel used in a day can be checked.

Daily Operational Data	
Operation Period	150.3 hr
Average Fuel Efficiency	0.0 ℓ/hr
Amount of Fuel Used	0 ℓ

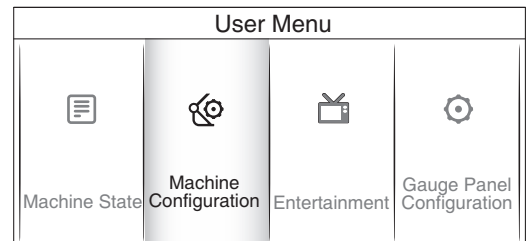
EX1402173

Figure 32

2. Machine Configuration

This is used when selecting the functions such as attachment setting, camera setting, emergency engine speed control dial, auto shut-off setting and option operation setting.

Turn the jog switch and move the cursor to see an reversed display on the desired menu. Then, click the jog switch to select the menu.

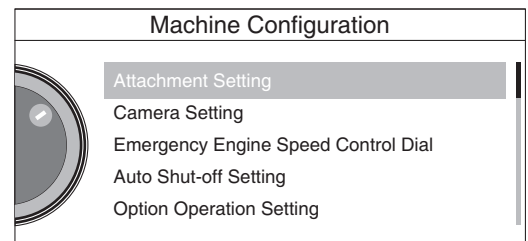


DS1601356

Figure 33

Attachment Setting ↔ Camera Setting ↔ Emergency Engine Speed Control Dial ↔ Auto Shut-off Setting ↔ Option Operation Setting ↔ Other Setting ↔ Breaker Operation Time Setting

Press the ESC button to return to the previous screen.



DS1601773

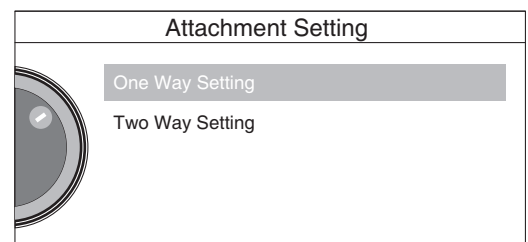
Figure 34

A. Attachment Setting (Optional)

In this menu, performance of the one-way and two-way select and setting items can be selected.

One Way Setting ↔ Two Way Setting

Press the ESC button to return to the previous screen.



DS1601774

Figure 35

1) One-way Select and Setting List

After proceeding to one-way setting, one-way select and setting screen will appear. When the cursor is placed on the list, operate the jog switch clockwise/counterclockwise to move the cursor.

Then, click on the jog switch to select one-way and setting item.

When turning the jog switch counterclockwise or pressing the Key 2 (◀), the cursor moves in the follows:

One-way 1 Select ← **One-way 1 Setting** ←
One-way 2 Select ← **One-way 2 Setting** ←
One-way 3 Select ← **One-way 3 Setting** ←
One-way 4 Select ← **One-way 4 Setting** ←
One-way 5 Select ← **One-way 5 Setting**

Once the cursor is placed on 1 Select, it does not move further to the left.

When turning the jog switch clockwise or pressing the Key 3 (▶), the cursor moves in the follows:

One-way 1 Select → **One-way 1 Setting** →
One-way 2 Select → **One-way 2 Setting** →
One-way 3 Select → **One-way 3 Setting** →
One-way 4 Select → **One-way 4 Setting** →
One-way 5 Select → **One-way 5 Setting**

Once the cursor is placed on 5 Setting, it does not move further to the right.

When the selection is completed, the "Select Complete!" pop-up window is displayed for 3 seconds, and the checkbox of the selected list is updated.

2) One-way Setting

The one-way setting screen is used to set up the max pressure, button type, max engine rpm and flow rate range.

When the cursor is placed on one-way setting button, click on the jog switch to access the one-way setting screen.

One Way Setting				
No	Selection	Setting	Flow	Pressure
1	<input checked="" type="radio"/>	Set	240 lpm	140 bar
2	<input type="radio"/>	Set	30 lpm	30 bar
3	<input type="radio"/>	Set	30 lpm	30 bar
4	<input type="radio"/>	Set	30 lpm	30 bar
5	<input type="radio"/>	Set	30 lpm	30 bar

DS1601775

Figure 36

One Way Setting				
No	Selection	Setting	Flow	Pressure
1	<input checked="" type="radio"/>	Set	240 lpm	140 bar
2	<input type="radio"/>			bar
3	<input type="radio"/>			bar
4	<input type="radio"/>			bar
5	<input type="radio"/>			bar

Select Complete!

DS1601776

Figure 37

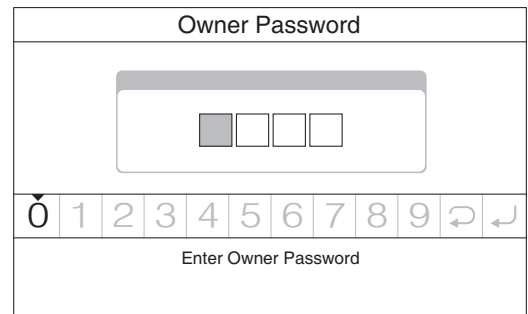
One Way Setting				
No	Selection	Setting	Flow	Pressure
1	<input type="radio"/>	Set	240 lpm	140 bar
2	<input type="radio"/>	Set	30 lpm	30 bar
3	<input type="radio"/>	Set	30 lpm	30 bar
4	<input type="radio"/>	Set	30 lpm	30 bar
5	<input type="radio"/>	Set	30 lpm	30 bar

DS1601777

Figure 38

If the system is set up as the owner's password locked, access the attachment setting list screen by using owner's password input screen.

On the owner's password input screen, press the ESC button to return to the previous screen.



EX1301416

Figure 39

Max Pressure

The maximum pressure of the one-way can be set.

The configurable max. pressure range is different by equipment.

The maximum pressure indication/setting resolution is 10 bar.

Max pressure(ATT) can be disabled if One-way option only.

Button Type

This item sets the applicability of the toggle of the breaker button when the breaker button is pressed once, and reset when pressed again.

If toggle is not selected, the breaker is only actuated while the breaker button is being pressed and held.

Max E/G Limit

The maximum engine rpm of the equipment can be set.

The configurable maximum engine rpm range is different by equipment.

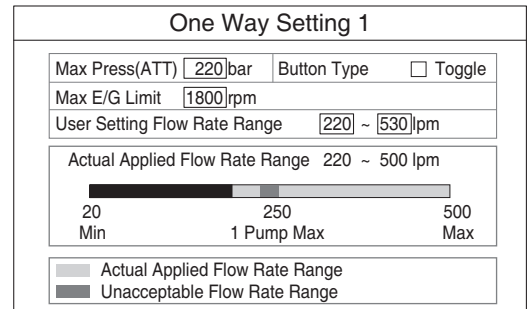
The maximum engine rpm setting resolution is 50 rpm.

User Setting Flow Rate Range

User Setting Flow Rate Range enables the user to set the minimum and maximum flow rates for the attachment according to its specifications.

The minimum value can be set between the machine's minimum flow rate and the user's set maximum flow rate. Its setting resolution is 10 lpm.

The maximum value can be set between the user's set minimum flow rate and 1000 lpm. It should also be at least 50 lpm higher than the user's set minimum flow rate. Its setting resolution is 5 lpm.



DS1603031

Figure 40

Actual Applied Flow Rate Range

Actual Applied Flow Rate Range is determined by the machine's possible flow rate range and the user's set flow rate range. Within this range, you can set the flow rate on the attachment setting pop-up of the Launch menu.

Flow Rate Gauge

Flow Rate Gauge displays the flow rate range set for the machine. This range is from the minimum flow rate of the machine to the maximum flow rate which can be rendered by 2-pump operation.

Actual Applied Flow Rate Range is displayed in orange, and Unacceptable Flow Rate Range in gray.

The numbers at the bottom of the gauge indicate the minimum flow rate of the machine, the maximum flow rate in 1-pump operation, and the maximum flow rate in 2-pump operation, respectively.

3) Two-way Select and Setting List

After proceeding to two-way setting, two-way select and setting screen will appear.

When the cursor is placed on the list, operate the jog switch clockwise/counterclockwise to move the cursor.

Then, click on the jog switch to select two-way and setting item.

When turning the jog switch counterclockwise or pressing the Key 2 (◀), the cursor moves in the follows:

Two-way 1 Select ← **Two-way 1 Setting** ←
Two-way 2 Select ← **Two-way 2 Setting** ←
Two-way 3 Select ← **Two-way 3 Setting** ←
Two-way 4 Select ← **Two-way 4 Setting** ←
Two-way 5 Select ← **Two-way 5 Setting** ←

When the cursor is on the 1 select, it does not move further.

When turning the jog switch clockwise or pressing the Key 3 (▶), the cursor moves in the follows:

Two-way 1 Select → **Two-way 1 Setting** →
Two-way 2 Select → **Two-way 2 Setting** →
Two-way 3 Select → **Two-way 3 Setting** →
Two-way 4 Select → **Two-way 4 Setting** →
Two-way 5 Select → **Two-way 5 Setting** →

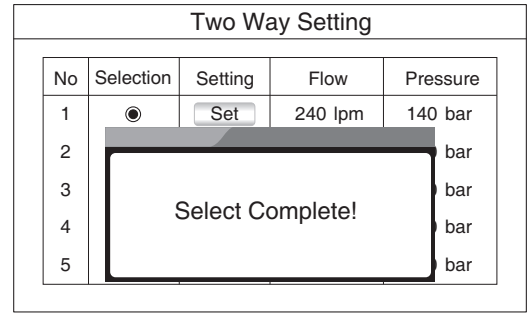
Two Way Setting				
No	Selection	Setting	Flow	Pressure
1	●	Set	240 lpm	140 bar
2	○	Set	30 lpm	30 bar
3	○	Set	30 lpm	30 bar
4	○	Set	30 lpm	30 bar
5	○	Set	30 lpm	30 bar

DS1601779

Figure 41

When the cursor is on the 5 setting, it does not move further.

When the selection is completed, the "Select Complete!" pop-up window is displayed for 3 seconds, and the checkbox of the selected list is updated.



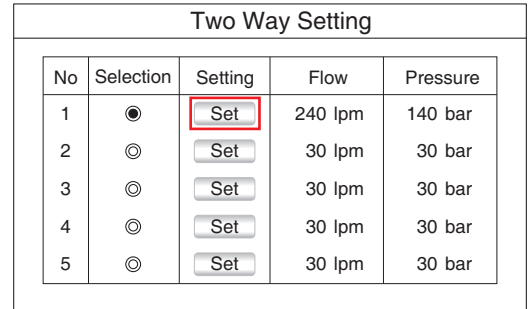
DS1601780

Figure 42

4) Two-way Setting

The two-way setting screen is used to set up the max pressure, max engine rpm and flow rate range.

when the cursor is placed on two-way setting button, click on the jog switch to access the two-way setting screen.

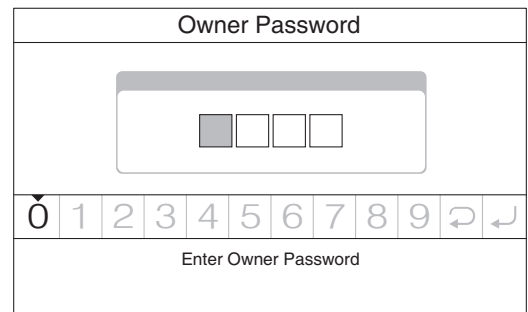


DS1601781

Figure 43

If the system is set up as the owner's password locked, access the attachment setting list screen by using owner's password input screen.

On the owner's password input screen, press the ESC button to return to the previous screen.



EX1301416

Figure 44

Max Pressure

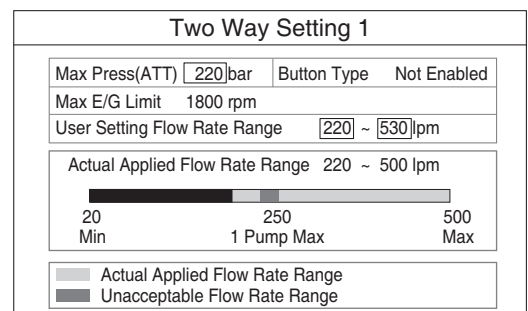
The maximum pressure of the two-way can be set.

The configurable max. pressure range is different by equipment.

The maximum pressure indication/setting resolution is 10 bar.

Button Type

As the button type is not used in two-way setting, it is displayed as not enabled.



DS1603032

Figure 45

Max E/G Limit

The maximum engine rpm of the equipment can be set.

The configurable maximum engine rpm range is different by equipment.

The maximum engine rpm setting resolution is 50 rpm.

User Setting Flow Rate Range

User Setting Flow Rate Range enables the user to set the minimum and maximum flow rates for the attachment according to its specifications.

The minimum value can be set between the machine's minimum flow rate and the user's set maximum flow rate. Its setting resolution is 10 lpm.

The maximum value can be set between the user's set minimum flow rate and 1000 lpm. It should also be at least 50 lpm higher than the user's set minimum flow rate. Its setting resolution is 5 lpm.

Actual Applied Flow Rate Range

Actual Applied Flow Rate Range is determined by the machine's possible flow rate range and the user's set flow rate range. Within this range, you can set the flow rate on the attachment setting pop-up of the Launch menu.

Flow Rate Gauge

Flow Rate Gauge displays the flow rate range set for the machine. This range is from the minimum flow rate of the machine to the maximum flow rate which can be rendered by 2-pump operation.

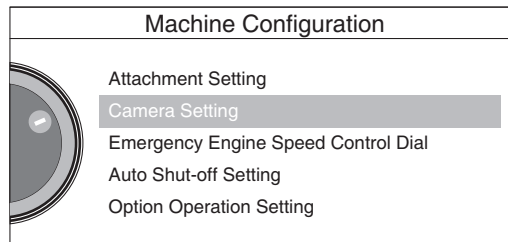
Actual Applied Flow Rate Range is displayed in orange, and Unacceptable Flow Rate Range in gray.

The numbers at the bottom of the gauge indicate the minimum flow rate of the machine, the maximum flow rate in 1-pump operation, and the maximum flow rate in 2-pump operation, respectively.

E. Camera Setting

The camera setting screen is designed to set up various cameras "ON/OFF" and normal/mirror.

From the machine configuration, select camera setting to access the camera setting list screen.



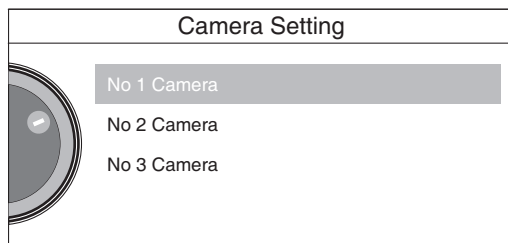
DS1601783

Figure 46

The camera setting list screen displays various camera states (ON/OFF, NORMAL/MIRROR).

Select a camera and click the jog switch to access the relevant camera setting screen.

Press the ESC button to return to the previous screen.

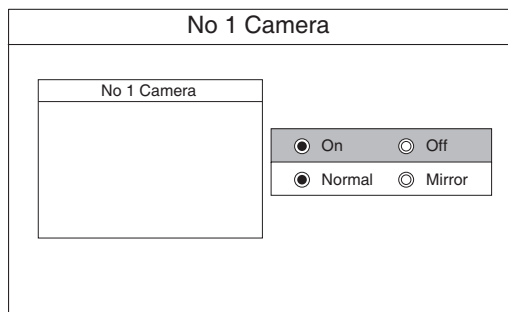


DS1601359

Figure 47

On the camera setting screen, set up the camera state (ON/OFF, NORMAL/MIRROR).

Also, see the actual image of the currently installed camera.



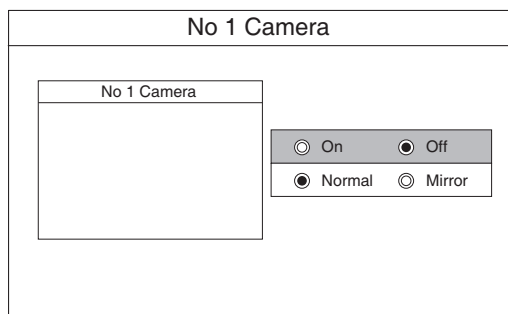
EX1301421

Figure 48

If a camera is not installed, the camera image section is shown as a blue screen.

If the cursor is placed on "ON/OFF", click on the jog switch to set up "ON" ↔ "OFF".

Turn the jog switch to locate the cursor at normal/mirror. Then, click on the jog switch to set up normal ↔ mirror.



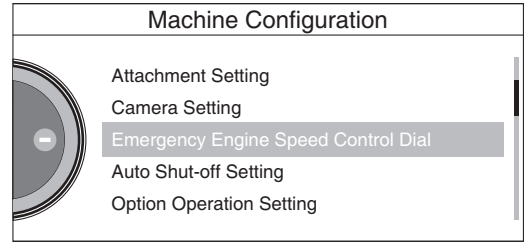
EX1301422

Figure 49

F. Emergency Engine Speed Control Dial

The emergency engine speed control dial screen provides a method whereby to use the gauge panel's jog switch and control the engine rpm, replacing the engine control dial.

From the machine configuration, select the emergency engine speed control dial to access it.

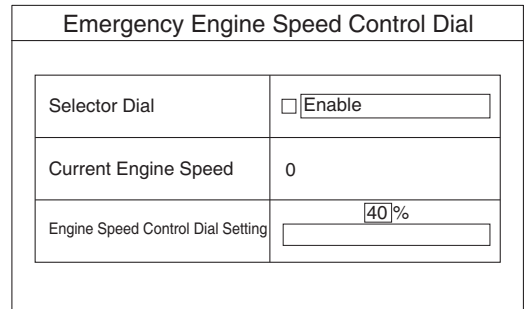


DS1601784

Figure 50

If you access the emergency engine speed control dial screen, the initial cursor is located at the selector dial.

If the selector dial is shown as disable, the cursor cannot be moved.



DS1601361

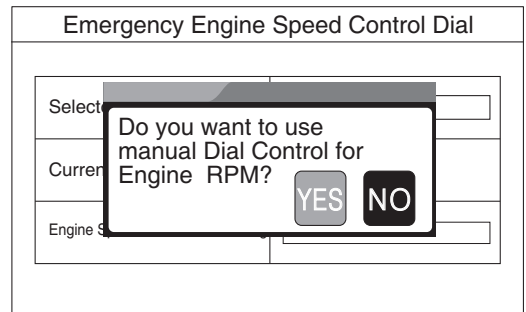
Figure 51

When the cursor is placed at the selector dial, if you click on the jog switch, a pop-up window will be created, saying "Do you want to use manual Dial Control for Engine rpm?".

Operate the jog switch and select "YES/NO" to determine whether to use jog shuttle for dial.

If you select "YES", then selector dial is enabled, causing the pop-up window to disappear.

If you select "NO", then selector dial remains disabled, causing the pop-up window to disappear.



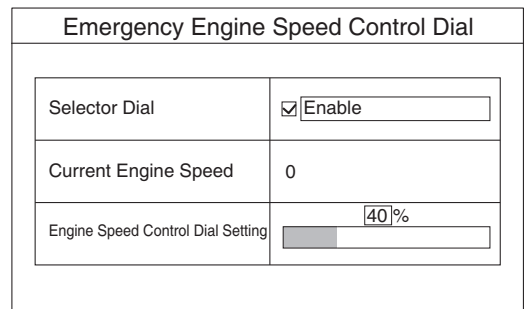
DS1601362

Figure 52

If the selector dial is shown as enable, operate the jog switch clockwise and move the cursor to the setting rpm dial. When the cursor is placed at the setting rpm dial, click on the jog switch to cause the cursor to flicker, changing into an editing mode to set up the rpm dial. When the cursor is placed at the editing mode, operate the jog switch clockwise/ counterclockwise, thus setting up the engine rpm.

When the cursor is at the editing mode, press the ESC button to disable the editing mode. When the cursor is not at the editing mode, press the ESC button to return to the previous screen.

Before keying off the gauge panel or disabling the selector dial, control the engine rpm only with the shuttle of the gauge panel's jog shuttle.



DS1601363

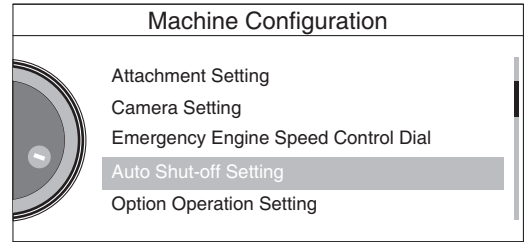
Figure 53

G. Auto Shut-off Setting

NOTE: *This function is not available in some models.*

In the auto shut-off setting screen, the engine of the equipment can be set to shut off automatically when the equipment is not operated for a preset time.

Select auto shut-off setting in the machine settings and proceed to the setting screen.



DS1601785

Figure 54

In the auto shut-off setting screen, the cursor will initially be over auto shut-off function in use.

NOTE: *This feature is off in factory defaults.*

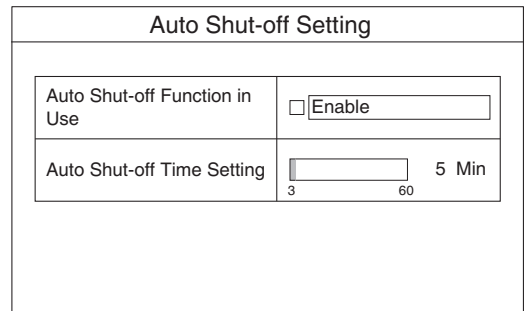
To use the feature, place the cursor over auto shut-off function in use and click the jog switch to select the feature.

The engine can be set to shut off automatically after a maximum of 60 minutes to a minimum of 3 minutes.

In factory defaults, the time is set to 5 minutes. Further, this feature is off in factory defaults.

The following conditions must be met if this feature is to be used.

Auto Shut-off (ASD) Active Condition



DS1601365

Figure 55

	Input									Output			
	Gauge Panel Menu	Auto Idle Mode	DeSOx Switch (SCR Regen Signal)	Pilot Cutoff Switch	Engine rpm	Coolant Temp.	Hydraulic Temp.	Dial Status	Time	Signal	Symbol	Pop-up	Alarm
Active	ON	ON	OFF	OFF	Low rpm	More than 50°C	More than 20°C	Normal	at Setting Time	Engine Stop Signal	ASD Operating Indicator "ON"	1 minute Before Stopping	10 seconds Before Stopping
Deactive	Except Above Condition									Time Count Reset			

When this feature is activated and the above conditions are met, "Engine will shut off" will pop up 1 minute before the engine shuts off.

Further, 10 seconds before the engine shuts off, the pilot buzzer will be activated to alert the user.



WARNING

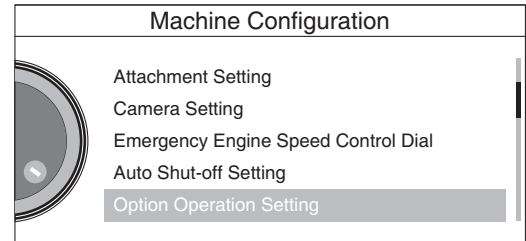
AVOID DEATH OR SERIOUS INJURY

When the auto shut-off feature is used, the engine shuts off automatically after the preset time, and thus particular care must be taken that no safety problems occur when it is used.

H. Option Operation Setting (Option)

When the two-way option is installed, the operation input signal of the attachment can be set to be used through either the joystick or the hydraulic pedal in the option operation setting screen.

Select option operation setting in the machine settings and proceed to the settings screen.



DS1601786

Figure 56

'Joystick Thumb Wheel' and 'Option Pedal' can be selected in option operation settings.

Joystick Thumb Wheel

The one-way/two-way operation signal can be input as a joystick manipulation signal.

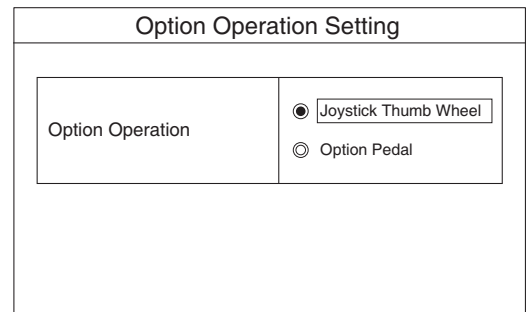
If this item is selected in a machine in which a hydraulic pedal is installed, the hydraulic pedal will be deactivated.

Option Pedal (Option)

This option is available only in machines with the two-way option with a hydraulic pedal installed.

The one-way/two-way operation signal can be input as a hydraulic pedal manipulation signal.

If this item is selected, the input signal of the joystick thumb wheel is deactivated.

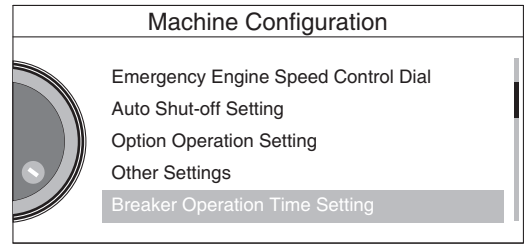


DS1603098

Figure 57

I. Breaker Operation Time Setting

This machine limits the continuous operation time of the breaker in order to prevent damages to its components.

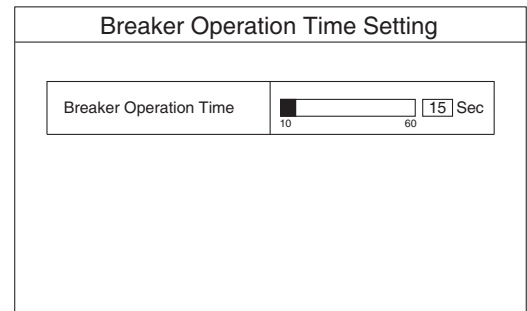


DS1601787

Figure 58

You can adjust this time limit in the page of Breaker Operation Time Setting.

- Setting Time Range: 10 - 60 sec
- Default Time: 15 sec



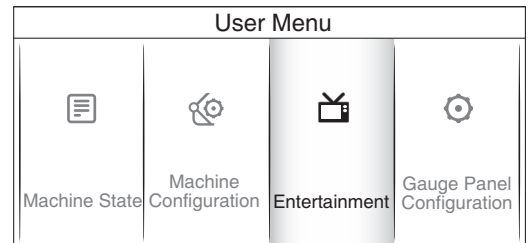
DS1601788

Figure 59

3. Entertainment

This menu is used to replay videos and MP3.

Turn the jog switch and move the cursor to see a reversed display on the desired menu. Then, click on the jog switch to select the menu.

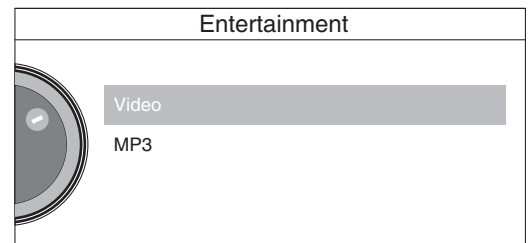


DS1601367

Figure 60

Video ↔ MP3

Press the ESC button to return to the previous screen.



DS1601368

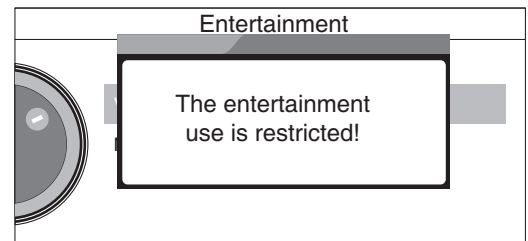
Figure 61

If the use of entertainment is limited, this pop-up window will be created.

To lift the use limits, you should change the limit setup in the Gauge Panel configuration.

The pop-up window will automatically disappear in 3 seconds. Press the ESC button or the jog switch to remove pop-up window.

For details, See [?\\$paratext>?](#) on page -5-.

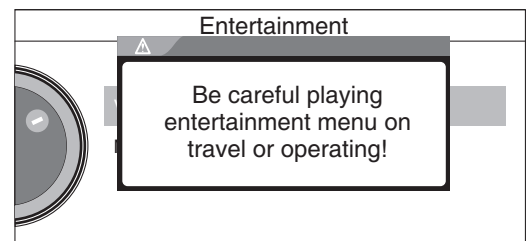


DS1601369

Figure 62

If the use of entertainment is not limited, this pop-up window will be created. The pop-up window will automatically disappear in 3 seconds.

Press the ESC button or the jog switch to remove pop-up window.



DS1601370

Figure 63



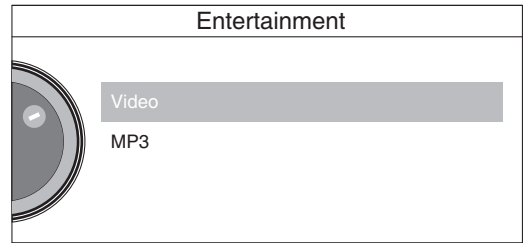
WARNING

AVOID DEATH OR SERIOUS INJURY

Listening to entertainment clips, such as video, music, etc., can cause an accident, resulting in death or serious injury. Do not play entertainment files when operating the machine.

A. Video

From the entertainment screen, select video to access it.



DS1601368

Figure 64

When there is no USB storage system, a pop-up window is displayed for 3 seconds, saying "USB Storage is not installed". and the video is not played.



DS1601371

Figure 65

When initially accessing the video player, the USB storage system file tree is displayed on the screen, operate the jog switch clockwise/counterclockwise to select and play a video.

If there is a video file that played last, it will automatically be replayed.



FG018511

Figure 66

If the format is not supported, a pop-up window is displayed for 3 seconds, saying "This file is not available!" and the video is not played.



EX1301451

Figure 67

Formats that can be supported are given below.

Formats that can be supported	
File Type	AVI, MP4, MKV, MOV
Supported Resolution	720*480, 720*384, 720*304, 704*448, 704*304, 640*480, 640*360, 640*272, 640*352, 672*288, 512*384, 576*432, 480*320, 480*360, 320*240
Supported Video Codec	H.264, MPEG4, Xvid, MPEG1/2
Supported Audio Codec	MP3
Supported File Size	Under 1.7 GB
Supported USB Format	FAT32

The screen composition of the video player is given below.

The top section displays the current playing time of the total playing time.

The screen center shows the video being played.

The bottom displays the video player function operation symbol and cursor.

The video player function operation symbol and jog switch are operated in the following order.

Play/Pause ↔ **Replay the Previous File** ↔ **Video Progress Bar** ↔ **Replay the Next File** ↔ **Video Files List**

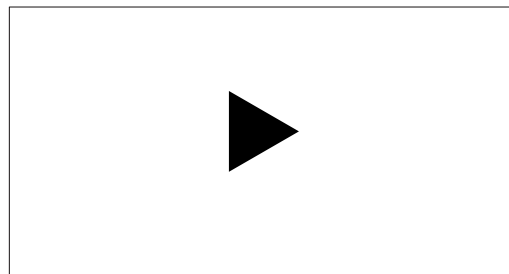
If no operation continues for more than 5 seconds, the video will automatically be converted into the whole screen.

On the whole screen, click on the jog switch or the ESC button to remove whole screen.



EX1301452

Figure 68



FG018214

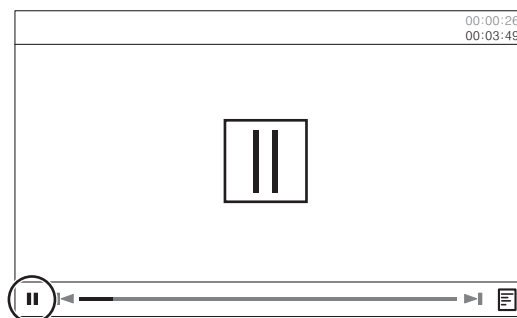
Figure 69

Play/Pause

Locate the cursor on the play/pause symbol and click on the jog switch to execute the video's play/pause functions.

With the play being on, click on the jog switch to display the pause symbol at the center of the screen, thus allowing the video to pause.

With the pause being on, click on the jog switch to cause the pause symbol at the center of the screen to disappear, resuming the video playing.

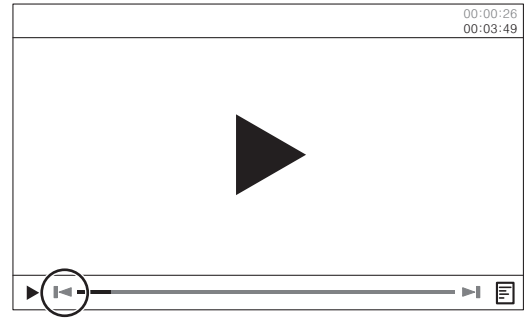


EX1301453

Figure 70

Replay the Previous File

Locate the cursor at the replay the previous file symbol and click on the jog switch to replay the previous file.



EX1301454

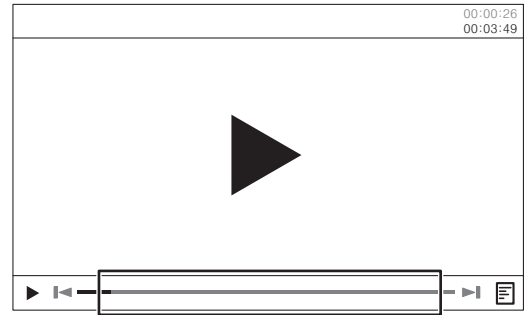
Figure 71

Locate the cursor at the video progress bar and click on the jog switch to convert into the fast forward/rewinding mode.

On the fast forward/rewinding mode, operate the jog switch clockwise/counterclockwise to conduct fast forward/rewinding.

Fast forward/rewinding can be conducted at an interval of 30 seconds per click during which the jog switch is turned.

On the fast forward/rewinding mode, press the ESC button to disable the fast forward/rewinding mode.



EX1301455

Figure 72

Replay the Next File

Locate the cursor at the replay the next file symbol and click on the jog switch to replay the next file.



EX1301456

Figure 73

Video Files List

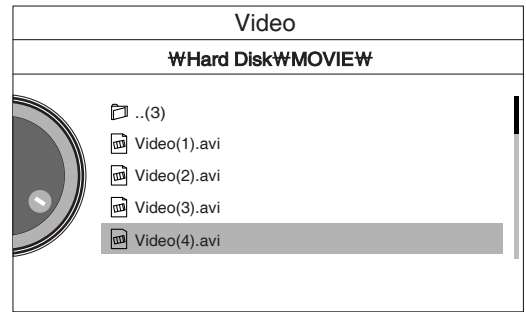
Locate the cursor at the video files list symbol and click on the jog switch to move to the video file list screen.



EX1301457

Figure 74

Select and replay a video.

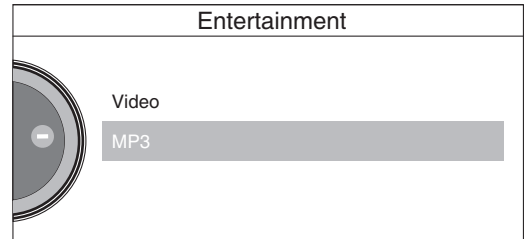


FG018557

Figure 75

B. MP3

From the entertainment screen, select MP3 to access it.



DS1601372

Figure 76

If there is no USB storage system, a pop-up window is displayed for 3 seconds, saying "USB Storage is not installed". and the MP3 player is not run.

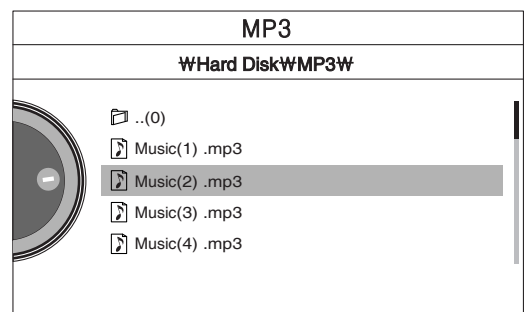


DS1601373

Figure 77

When initially accessing the MP3 player, the file tree screen of USB storage system is displayed. Operate the jog switch clockwise/counterclockwise to select and play an MP3 file.

If there is an MP3 file played last, the file will automatically be played.



FG018560

Figure 78

The screen composition of MP3 player is given below.

The top section displays the name of the file being played and the current playing time of the total playing time.

The screen center shows the album image of the file being played, the album name, the song name and the name of the next file to be played.

The bottom displays the MP3 player function operation symbol and cursor.

The MP3 player function operation symbol and jog switch are operated in the following order.

Play/Pause ↔ **Replay the Previous File** ↔ **MP3 Progress Bar** ↔ **Replay the Next File** ↔ **MP3 Files List** ↔ **Background MP3 Play**

Play/Pause

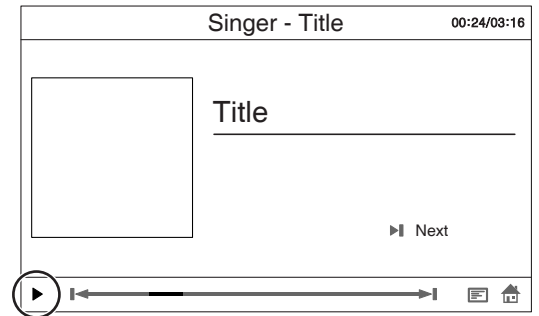
Locate the cursor at the play/pause symbol and click on the jog switch to execute the MP3 play/pause functions.

With play being on, click the jog switch to display the pause symbol at the center of the screen, causing the MP3 to pause.

With pause being on, click on the jog switch to cause the pause symbol at the center of the screen to disappear, resuming the MP3 playing.

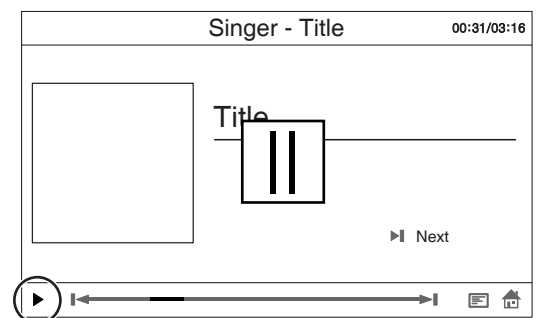
Replay the Previous File

Locate the cursor at the replay the previous file symbol, and click on the jog switch to replay the previous file.



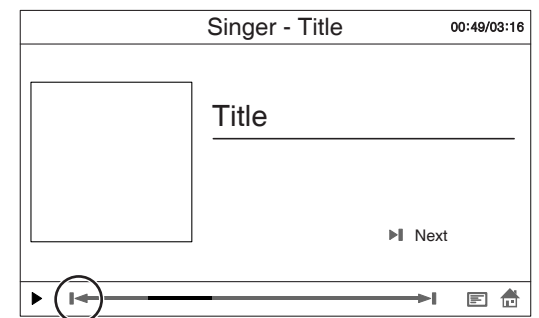
FG020124

Figure 79



FG020125

Figure 80



FG020126

Figure 81

Fast Forward/Rewinding

Locate the cursor at the video progress bar and click on the jog switch to convert into the fast forward/rewinding mode.

On the fast forward/rewinding mode, operate the jog switch clockwise/counterclockwise to conduct fast forward/rewinding.

Fast forward/rewinding can be conducted at an interval of 30 seconds per click during which the jog switch is turned.

On the fast forward/rewinding mode, press the ESC button to disable the fast forward/rewinding mode.

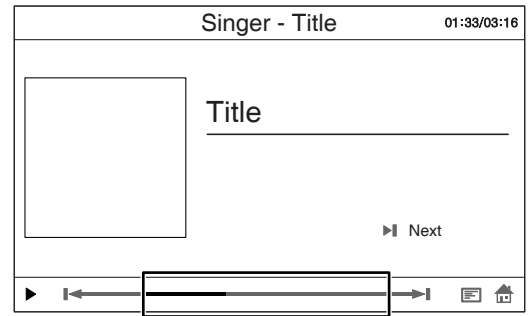
Replay the Next File

Locate the cursor at the replay the previous file symbol and click on the jog switch to replay the next file.

MP3 Files List

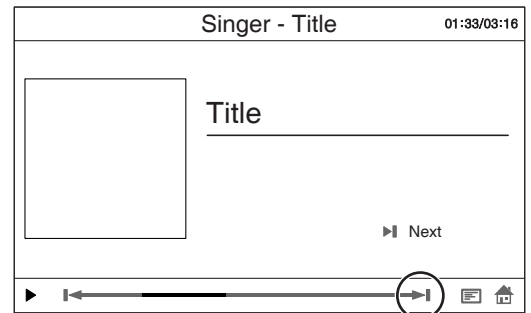
Locate the cursor at the MP3 files list symbol and click on the jog to move to the file list screen.

Select a file and replay the MP3.



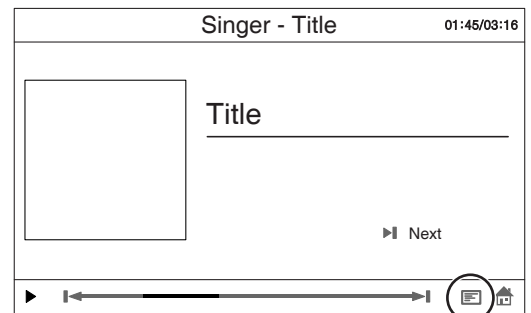
FG020127

Figure 82



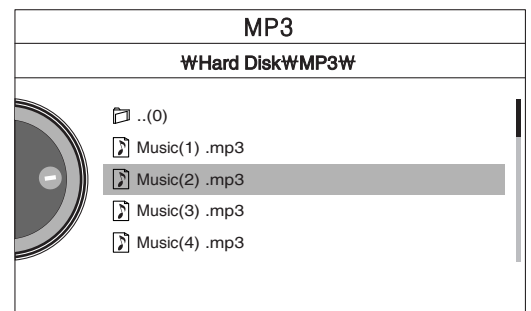
FG020128

Figure 83



FG020129

Figure 84

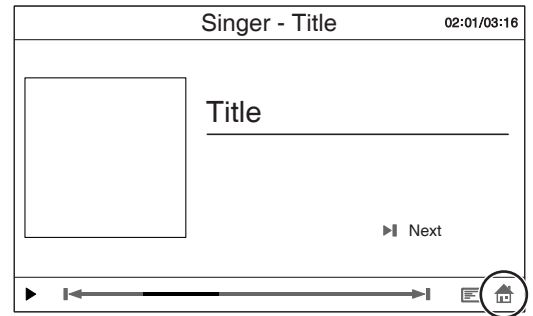


FG018560

Figure 85

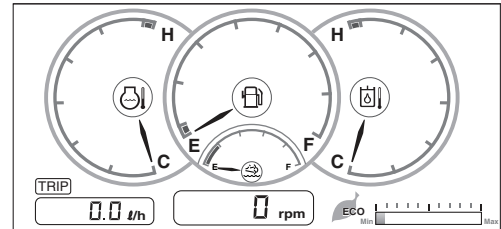
Background MP3 Play

Position the cursor on the "HOME" button and pressing the jog switch, MP3 is played by the initial screen.



FG020130

Figure 86



DS1601374

Figure 87

4. Gauge Panel Configuration

This menu is used to set up password, brightness, default screen and time, and to input service phone number. Turn the jog switch and move the cursor to see an reversed display on the desired menu. Then, click on the jog switch to select the menu.

Password Setting ↔ Brightness Setting ↔ Default Power Mode Setting ↔ Default Screen Setting ↔ Time Setting ↔ Service Phone Number Setting ↔ Unit Setting ↔ Language Setting ↔ Notification Setting ↔ Entertainment Use Setting

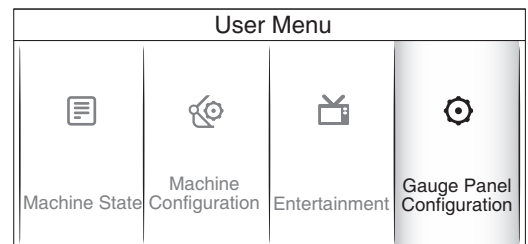
Press the ESC button to return to previous screen.

A. Password Setting

Password Setting

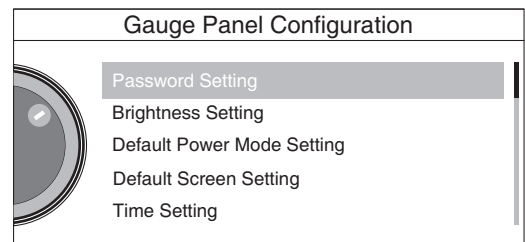
An owner passwords and operator passwords can be set (Only the owner password is selected in the default shipment state).

By using the password setting function, you can manage usage of operations and functions of the machine.



DS1601375

Figure 88



DS1601376

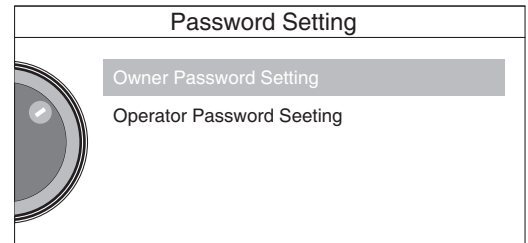
Figure 89

Owner Password Setting

1) Selection

An owner password can be set for managing functions of equipment and use privileges of the equipment for different operators.

To set an owner password, place the cursor over Owner Password Setting in the settings screen and click the jog switch (or press "Enter" on the keypad).



DS1603033

Figure 90

2) Password entry

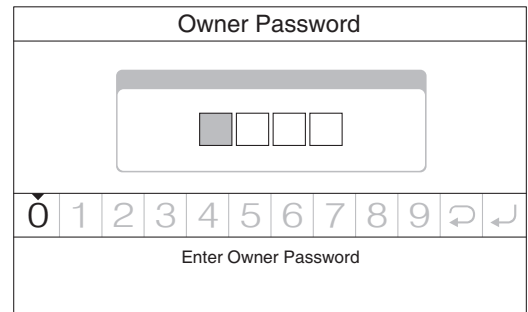
When the password entry screen appears, use the jog switch (or the keypad) to enter the password and move to the settings screen.

The default password is "1111".

How to enter the password

Rotate the jog switch to select digits from 0 to 9 below, and click Enter on the jog switch to input the password.

If the password is input incorrectly, use the ↶ button on the lower right to delete the input password.

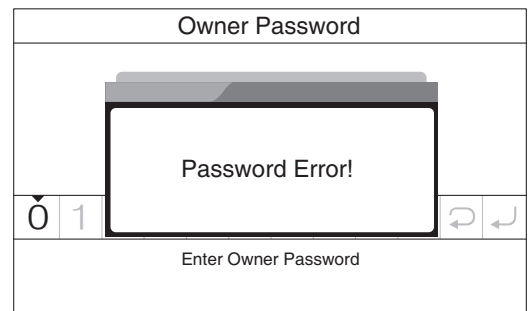


EX1301416

Figure 91

IMPORTANT

If the password is input incorrectly three times in a row, you will be redirected to the main screen and the system will not start for the next 10 minutes.

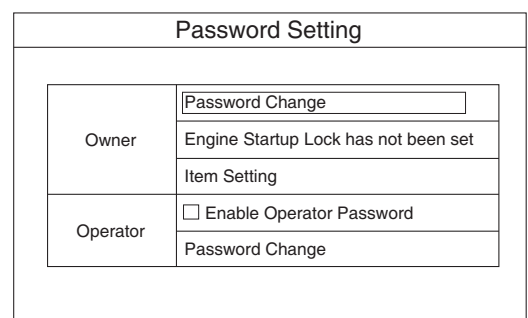


EX1301433

Figure 92

3) Structure

Owner password settings include password change, start-up restriction settings, function item settings, operator password use settings, and operator password change.

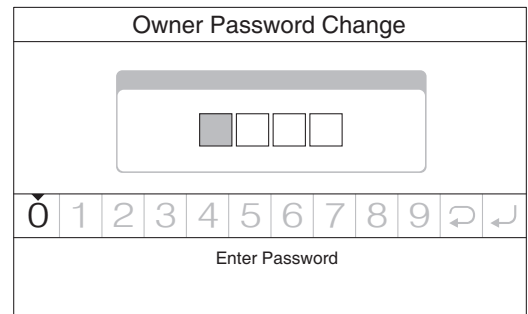


DS1603034

Figure 93

Password change

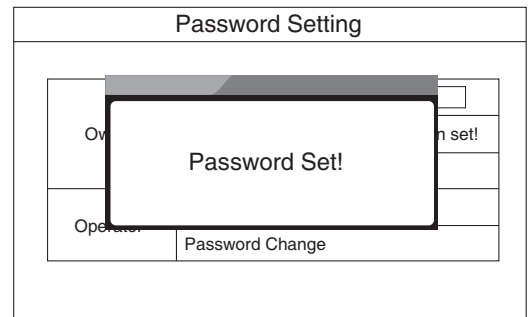
To change the owner password, select password change with the jog switch (or the keypad).



EX1301435

Figure 94

When the owner password has been changed, "Password Set!" will pop-up.



DS1603035

Figure 95

Item setting

Operator privileges and settings for engine start-up, attachment settings, and entertainment use settings can be set.

NOTE: *Permission, which gives certain operators permission to use certain features, can only be checked when use is checked.*

In this case, the operator has the same privileges as the owner, and the operator's settings take precedence in equipment settings.

NOTE: *This setting is off by default.*

- Engine startup
Setting of password input upon operation of equipment.
- Attachment setting
Setting of password input for attachment setting.
- Entertainment use setting
Setting of password input for entertainment (video/MP3) use setting.

Item	Enable Operator Password	Permission
Engine Startup	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Attachment Setting	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Entertainment Use Setting	<input checked="" type="checkbox"/>	<input type="checkbox"/>

DS1603036

Figure 96

Engine start-up setting

By selecting "Engine Start-up" among item settings the reentry time for password entry upon start-up of the equipment can be set.

NOTE: *No password for start-up of the equipment is set by default.*

- a) Always
Password is entered with each start-up.
- b) 1 min
If the system is started again within 1 minute from key-off after the password is input, the password is not requested again.
- c) 5 min
If the system is started again within 5 minutes from key-off after the password is input, the password is not requested again.

Operator password setting

- a) Operator password use setting
Sets use of the operator password.
- b) Operator password change
After setting use privileges for the operator password, the owner can change the operator password.

Operator Password Setting

- 1) Selection

If the owner checks operator password use in owner password setting, operator password setting will appear in the password setting screen so operator password can be set. (refer to "Owner Password Setting" on page -58).

To set a operator password, place the cursor over Operator Password Setting in the Password Setting screen and click the jog switch (or press "Enter" on the keypad).

- 2) Password entry

When the password input screen appears, input the password with the jog switch (or keypad) and move to the settings screen. (refer to "Owner Password Setting 2" on page 2-71.)

The default password is "1111".

Password Setting	
Owner	Password Change <input checked="" type="radio"/> Always <input type="radio"/> 1min <input type="radio"/> 5min Item Setting
	<input type="checkbox"/> Enable Operator Password
	Password Change
Operator	Password Change


DS1603037

Figure 97

Password Setting	
Owner	Password Change Engine Startup Lock has not been set! Item Setting
	<input checked="" type="checkbox"/> Enable Operator Password
	Password Change
Operator	Password Change

DS1603038

Figure 98

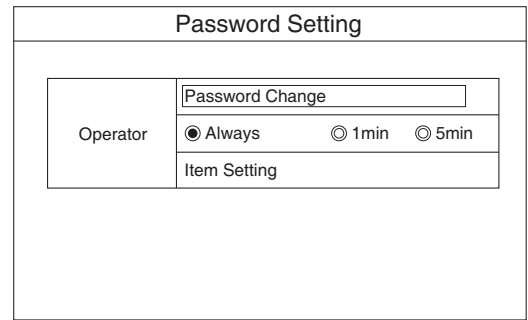
Password Setting	
	Owner Password Setting
	<input checked="" type="radio"/> Operator Password Setting

DS1603039

Figure 99

3) Structure

Operator password settings include password change, start-up restriction settings, and function item settings.

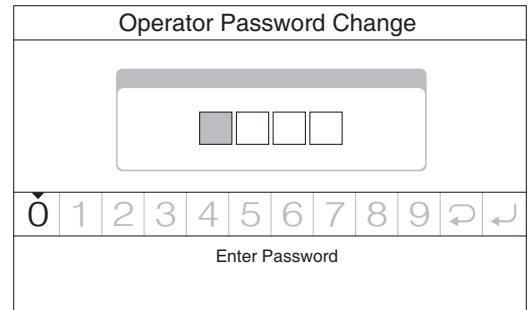


DS1603040

Figure 100

Password change

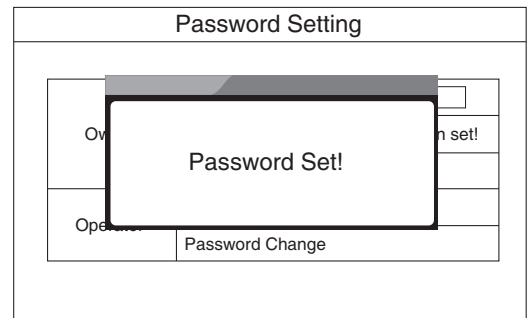
To change the operator password, select password change, and change the operator password using the jog switch (or keypad).



DS1603041

Figure 101

When the operator password is changed, "Password Set!" will pop-up.



DS1603042

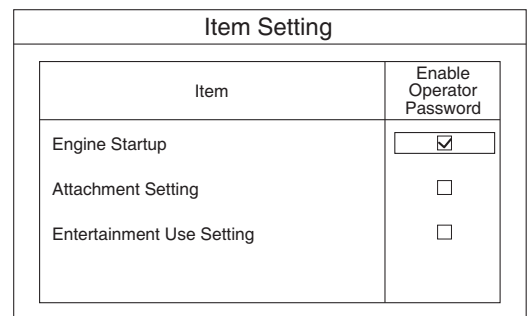
Figure 102

Item setting

Use of engine start-up, attachment setting, and entertainment use setting can be set.

NOTE: *This is only possible when permitted by the owner.*

- a) Engine startup
Setting of password input upon operation of equipment.
- b) Attachment setting
Setting of password input for attachment setting.
- c) Entertainment use setting
Setting of password input for entertainment (video/MP3) use setting.



DS1603043

Figure 103

Engine start-up setting

By selecting "Engine Start-up" among item settings the reentry time for password entry upon start-up of the equipment can be set.

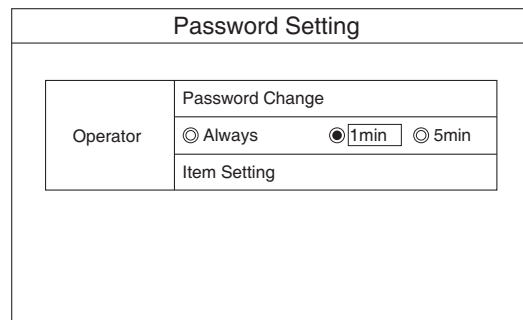
- a) Always
Password is entered with each start-up.
- b) 1 min
If the system is started again within 1 minute from key-off after the password is input, the password is not requested again.
- c) 5 min
If the system is started again within 5 minutes from key-off after the password is input, the password is not requested again.

NOTE: *If the owner uses the engine start-up feature but does not permit the operator to use it, the operator cannot select whether to use the feature, but can select the password reentry time.*

B. Brightness Setting

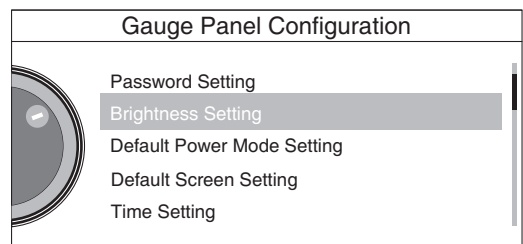
On the Gauge Panel configuration screen, when cursor is placed on brightness setting, click on the jog switch to display the screen brightness setting and camera brightness setting screen.

If you want to change the screen brightness, select the screen brightness setting to display the brightness adjustment screen.



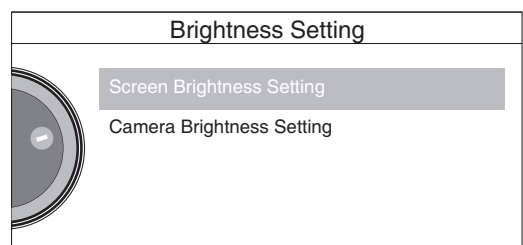
DS1603044

Figure 104



DS1601379

Figure 105



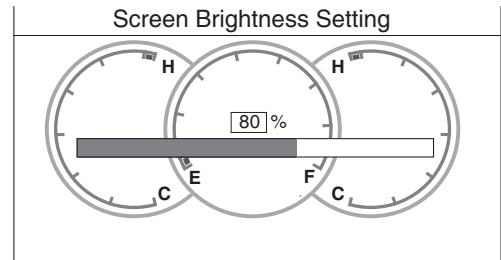
DS1601380

Figure 106

Turn the jog switch and adjust the brightness of 0 - 100% at an interval of 10%.

The screen brightness when manufactured is set as 80%.

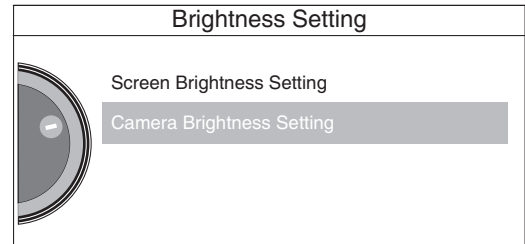
Press the ESC button to return to the previous screen.



EX1404972

Figure 107

If you want to change the camera screen brightness, select the camera brightness setting to display the camera screen brightness adjustment screen.



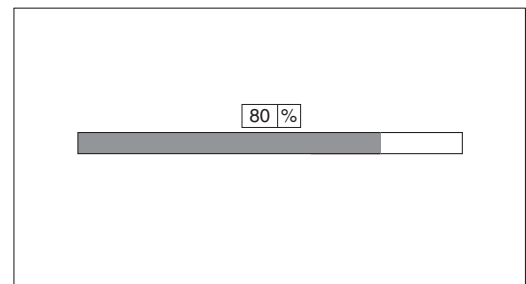
DS1601381

Figure 108

Turn the jog switch to adjust the brightness of 0 - 100% at an interval of 10%.

The camera screen brightness at the machine release time is set as 80%.

Press the ESC button to return to the previous screen.

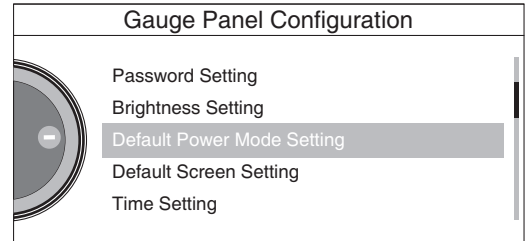


EX1404851

Figure 109

C. Default Power Mode Setting

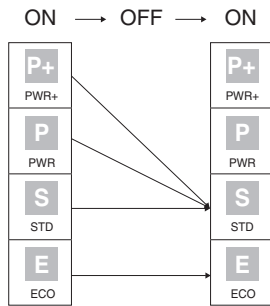
On the Gauge Panel configuration screen, when cursor is placed on default power mode setting, click on the jog switch to access the default power mode setting.



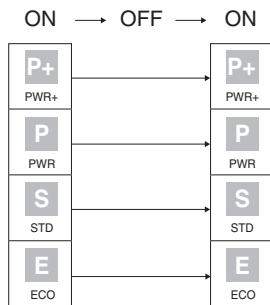
DS1603047

Figure 110

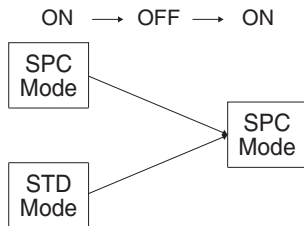
Fuel Saving Mode is Enable



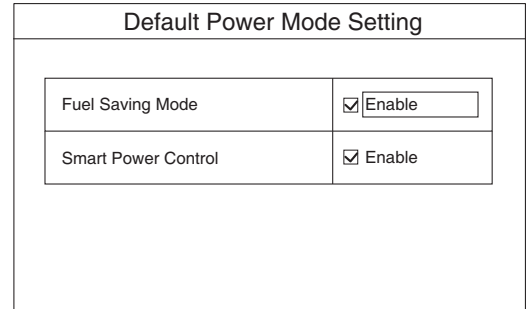
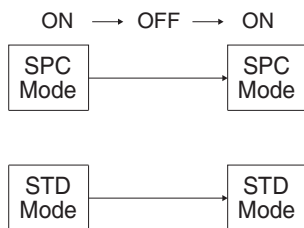
Fuel Saving Mode is Disable



Smart Power Control is Enable



Smart Power Control is Disable

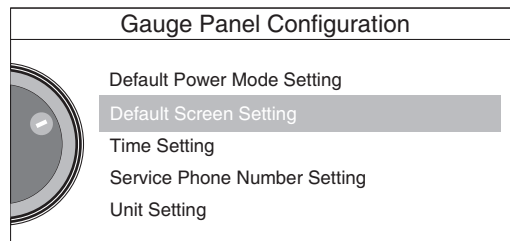


EX1301446

Figure 111

D. Default Screen Setting

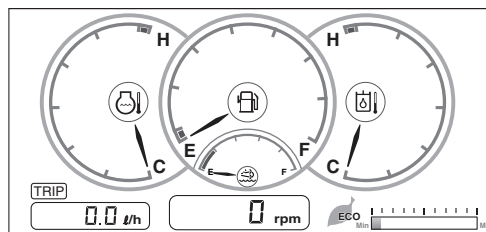
Sets the main screen display on the instrument panel.



DS1601384

Figure 112

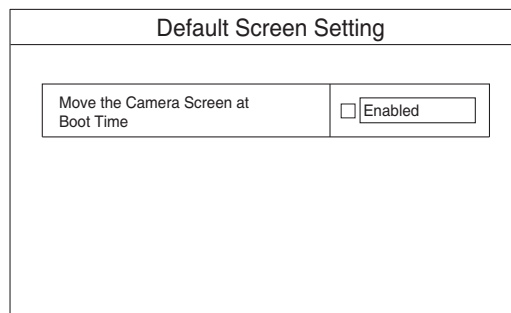
The initial screen shows basic information, including the fuel level, coolant temperature and hydraulic oil temperature.



DS1601385

Figure 113

Enter the "Default Screen Setting" menu and select "Enable" for this function. Then, the main screen shows the camera view next time the starter switch is turned to the ON position.



EX1402182

Figure 114



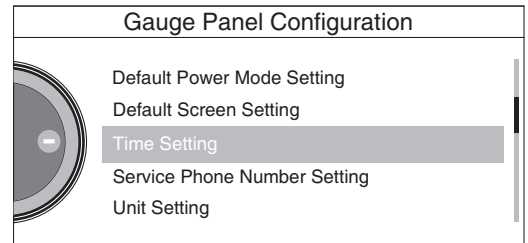
EX1402183

Figure 115

E. Time Setting

On the Gauge Panel configuration screen, when cursor is placed on time setting, click the jog switch to access the time setting.

Turn the jog switch and locate the cursor at a target of change. Then, click on the jog switch to change the target.



DS1601386

Figure 116

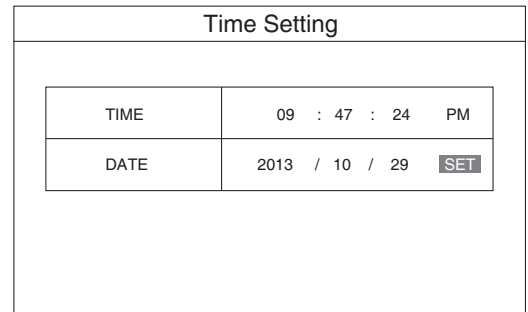
Turn the jog switch to change numbers of each item.

If the setup is completed, click on the jog switch to store the setup details.

When the time setting is completed, locate cursor to 'SET' and press the job switch.

If the SET button is not pressed, time setting would not be completed.

Press the ESC button to return to the previous screen.

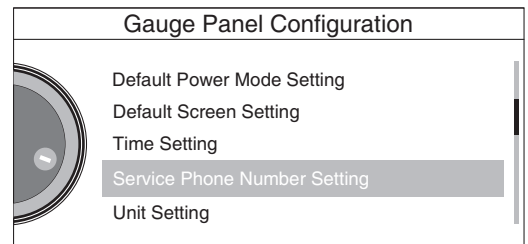


EX1301447

Figure 117

F. Service Phone Number Setting

On the Gauge Panel configuration screen, when cursor is placed on service phone number setting, click on the jog switch to access the service phone number setting.

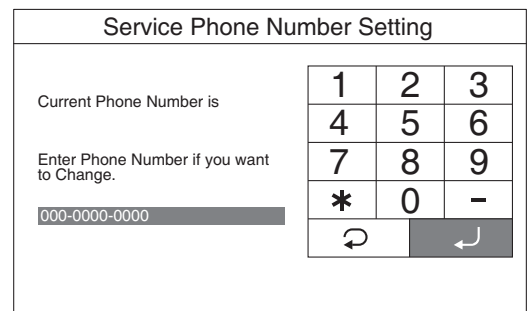


DS1601387

Figure 118

Turn the jog switch and locate the cursor at a desired number. Then, click on the jog switch to input the number. If number input is completed, press the ↵ key to enter the input phone numbers.

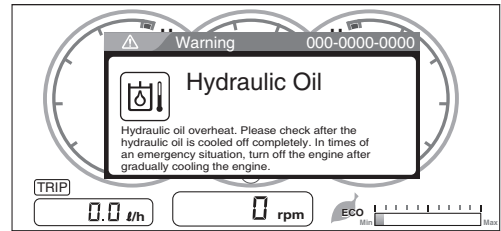
Use the ↶ key and delete erroneously input numbers.



EX1301448

Figure 119

When you input service phone numbers, if warning/ alarm is issued, check the input phone numbers in the pop-up window.

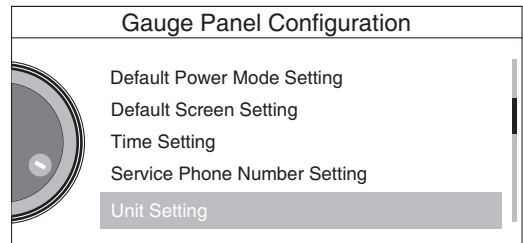


DS1601388

Figure 120

G. Unit Setting

On the Gauge Panel configuration screen, when cursor is placed on unit setting, click the jog switch to access the unit setting.



DS1601389

Figure 121

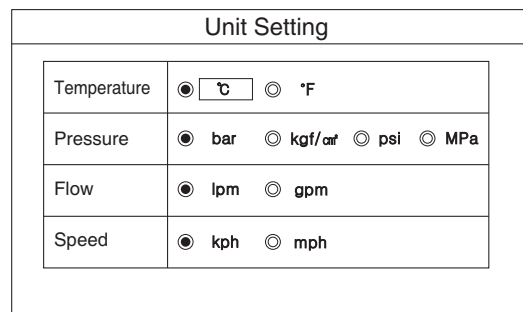
On the unit setting screen, change the units of temperature, pressure, flow rate, and speed. These figures at the machine release time are set as below:

Temperature: °C

Pressure: bar

Flow rate: lpm

Speed: kph

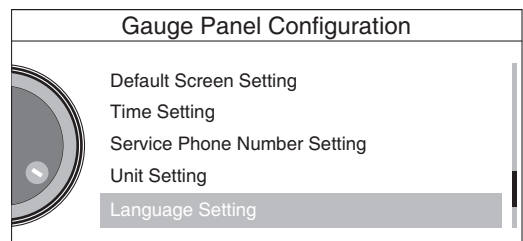


DS1603048

Figure 122

H. Language Setting

On the Gauge Panel configuration screen, when cursor is placed on language setting, click on the jog switch to access the language setting.



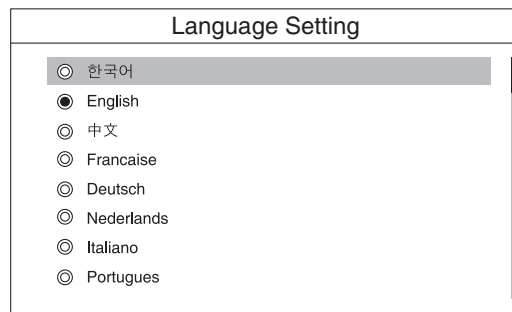
DS1601390

Figure 123

On the language selection screen, turn the jog switch and move the cursor to select a language. Then, click on the jog switch to adopt the selected language.

Press the ESC button to return to the previous screen.

Language
Korean, English, Chinese, Persian, Turkish, Indonesian, Polish, Arabic, Russian, Thai, Hindi, Japanese, French, German, Nederlands, Italian, Portuguese, Spanish, Finnish, Swedish, Norwegian, Danish, Vietnamese, Greek

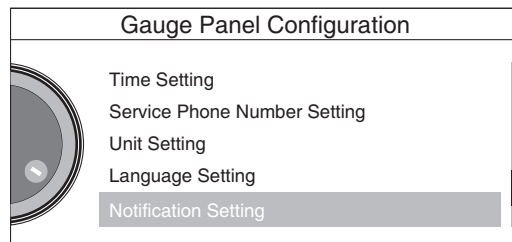


EX1301062

Figure 124

I. Notification Setting

On the Gauge Panel configuration screen, when cursor is placed on notification setting, click on the jog switch to access the notification setting.



DS1601391

Figure 125

Depending on the notification setting screen details, pop-ups are created on the main screen when warning/alarm is issued, when the switch is operated, and when the supplies replacement period expires.

On the notification setting screen, turn the jog switch and move the cursor to a desired location. Then, click on the jog switch to select enable or disable.

All notice items at the machine release time are set as Enable.

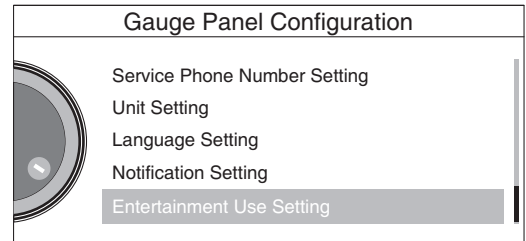
Notification Setting	
Warning Alarm Pop up	<input checked="" type="checkbox"/> Enable
Maintenance Notification Pop up	<input checked="" type="checkbox"/> Enable

EX1502448

Figure 126

J. Entertainment Use Setting

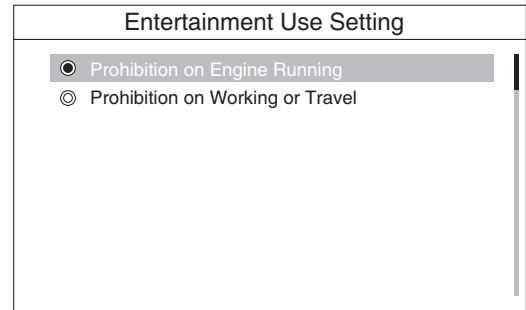
On the Gauge Panel configuration screen, when cursor is placed on entertainment use setting, click on the jog switch to access the entertainment use setting.



DS1601392

Figure 127

Depending on the entertainment use setting details, the use of video and MP3 is limited.



EX1301063

Figure 128

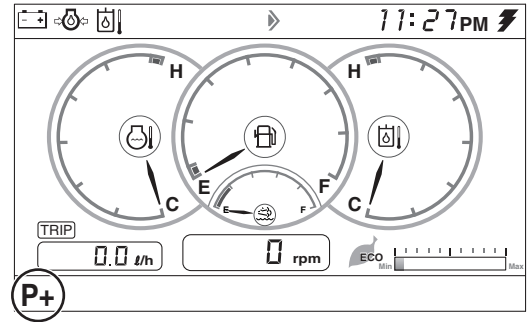
Switch Operation Indication

Enable

During the operation of switches for pressure increase, breaker, shear, travel, working light, parking, ram lock and quick coupler, this function indicates a relevant switch symbol at the left top or bottom. It displays the operation state on the screen.

Operation Indication Examples

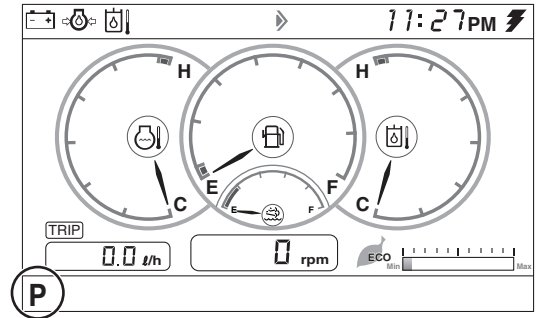
1. Power Plus Mode Selection



EX1301016

Figure 129

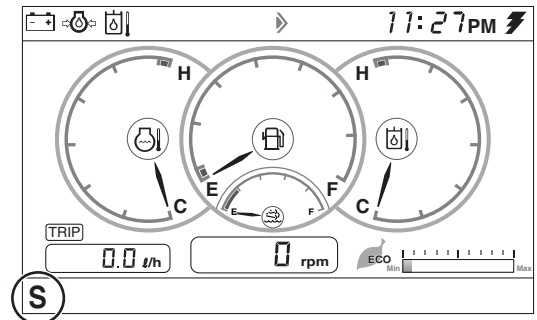
2. Power Mode Selection



EX1301017

Figure 130

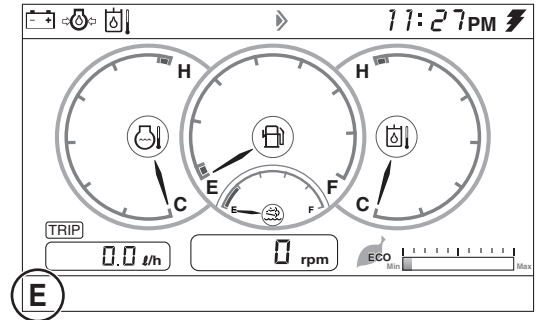
3. Standard Mode Selection



EX1301018

Figure 131

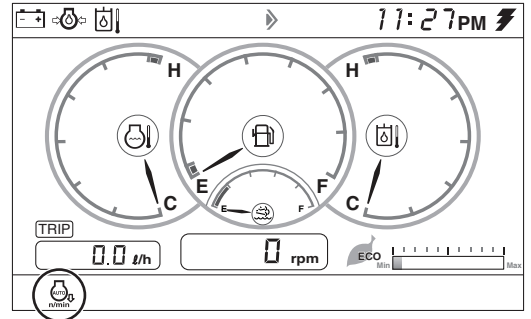
4. Economy Mode Selection



EX1301019

Figure 132

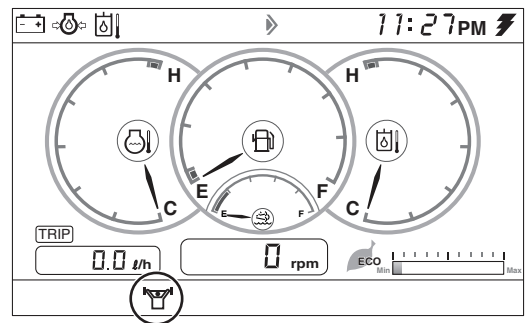
5. Auto Idle Selection



EX1301020

Figure 133

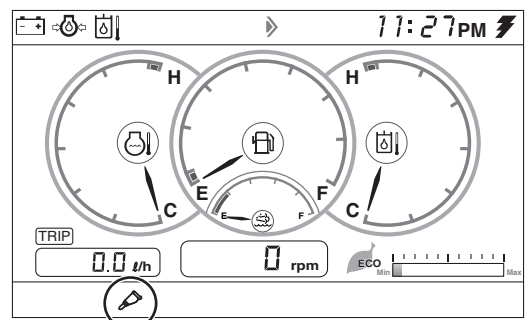
6. Power Boost Selection



EX1301021

Figure 134

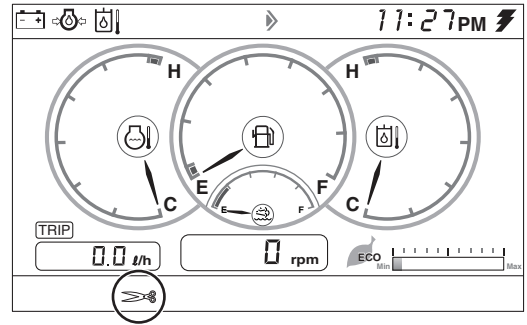
7. Breaker Selection (Optional)



EX1301022

Figure 135

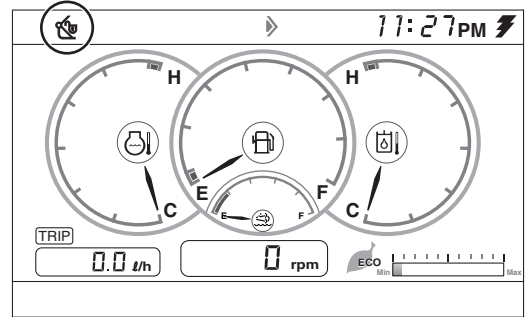
8. Shear Selection (Optional)



EX1301024

Figure 136

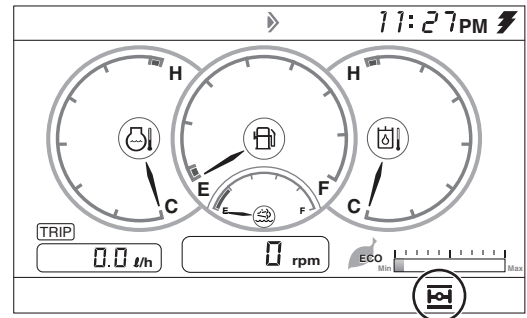
9. Quick Coupler Release System Activated (Optional)



EX1301023

Figure 137

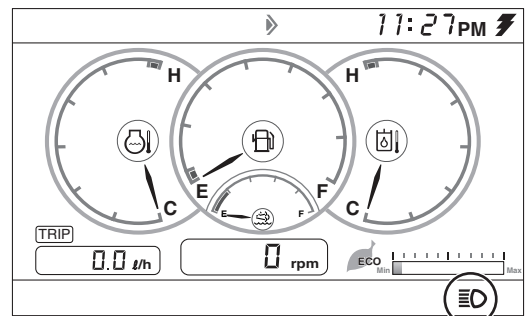
10. Ram Rock Operation Selection (Wheel Machine Only)



EX1301025

Figure 138

11. High Beam Light Selection (Wheel Machine Only)



EX1301026

Figure 139

SPECIAL MENU

In this menu, many types of operating conditions and functions can be accessed and displayed, including the EPOS controller. This menu is mainly used for machine testing and fault diagnostics.

The special menu offers five submenus:

1. Monitoring.
2. Graph.
3. Failure Information.
4. Operating Hour Information.
5. Machine Configuration.

Entering/Accessing and Exiting/Escaping Menus

Entering/Accessing Menus

When normal mode screen is displayed, if jog switch (1, Figure 140), power mode selector button (2, Figure 140) and multimedia button are pressed simultaneously for more than 3 seconds, normal mode screen (Figure 141) will be changed to special menu screen (Figure 142).

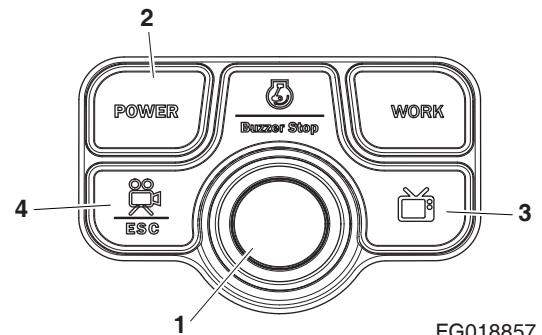


Figure 140

FG018857

Normal Mode Screen

NOTE: Normal mode screen display fuel gauge, engine coolant temperature gauge, hydraulic oil temperature gauge, ECO gauge and engine speed (rpm), DEF(AdBlue) gauge, trip meter.

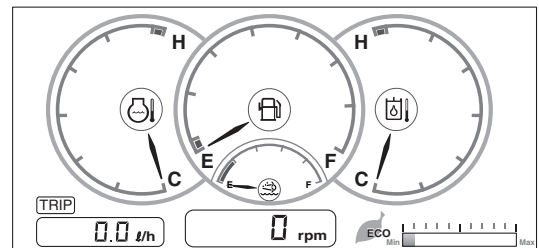


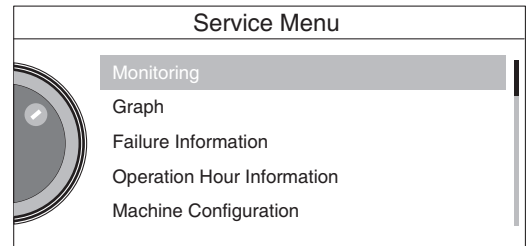
Figure 141

EX1301002

Special Menu Screen

NOTE: Displayed language on the special menu screen consists of Korean and English.

If any language except for Korean is selected during language selection mode of main menu, only English will be displayed on special menu screen.



DS1602670

Figure 142

Exiting/Escaping Menus

1. If escape button (ESC, 4 on Figure 140) is pressed the special menu screen will be returned to the normal mode screen.
2. If this special menu is "ON" without any activity, for more than 20 seconds, it will return to the normal mode screen.
3. After the turning starter switch to "OFF" position, turn it back to "ON" position, and the normal mode screen displayed once again.

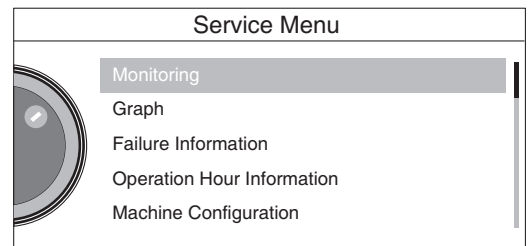
Special Menu Selections

Submenu Selection Method

Various submenus can be selected by turning the jog switch and moving the cursor to see a reversed display on the desired menu. Then, click on the jog switch to select the menu.

Press the ESC button to return to the previous screen.

Entering Submenus: When cursor is located on "Machine Info" of special menu screen, press "Enter (←, 3 on Figure 140)" button and the "Machine Info" will be displayed.

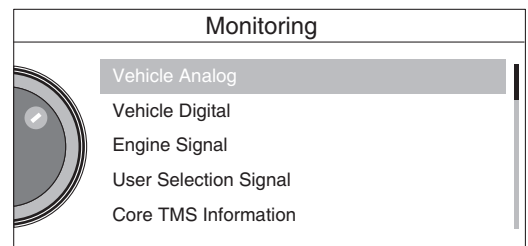


DS1602670

Figure 143

Monitoring

1. Entering Submenus: When cursor is located on "Monitoring" of special menu screen, press the jog switch and the "Monitoring" will be displayed.
2. Exiting Submenus: If escape button (ESC, 4 on Figure 140) is pressed display will be turned to previous screen.



DS1602671

Figure 144

Vehicle Analog Description

Analog Items	Display	Remark
1. Front Pump Pressure	bar	Front pump pressure
2. Rear Pump Pressure	bar	Rear pump pressure
3. Boom Cylinder Pressure	bar	Boom cylinder head pressure
4. Px Pressure	bar	Px pressure
5. Py Pressure	bar	Py pressure
6. Alternator Voltage	V	Indicating alternator voltage
7. Battery Voltage	V	Indicating battery voltage
8. Engine Speed Control Dial Voltage	mV	Indicating engine speed control dial voltage
9. WIF Sensor Voltage	mV	Indicating WIF sensor voltage
10. Flow Control Lever LH Voltage	mV	Indicating LH joystick thumb wheel switch voltage
11. Flow Control Lever RH Voltage	mV	Indicating RH joystick thumb wheel switch voltage
12. Fuel Level	%	Fuel residual quantity ratio of fuel tank
13. Hydraulic Oil Temperature	°C	Hydraulic oil temperature
14. Power Shift P/V 1	mA	Current in pump proportional valve
15. Coolant Fan Control P/V	mA	Current in coolant fan control proportional valve
16. Flow Control P/V	mA	Current in flow control proportional valve
17. 2-Way P/V (Open)	mA	Current in two-way (open) flow control proportional valve.
18. 2-Way P/V (Close)	mA	Current in two-way (close) flow control proportional valve.
19. Rotating P/V (CW)	mA	Current in rotating (CW) flow control proportional valve.
20. Rotating P/V (CCW)	mA	Current in rotating (CCW) flow control proportional valve.
21. Pressure Control P/V 1	mA	Current in 1 way pressure proportional valve.
22. Pressure Control P/V 2	mA	Current in 2 way pressure proportional valve.
23. i-CEPT 1	bar	Indicating Pi1 port pressure.
24. i-CEPT 2	bar	Indicating Pi2 port pressure.

Submenu Selections

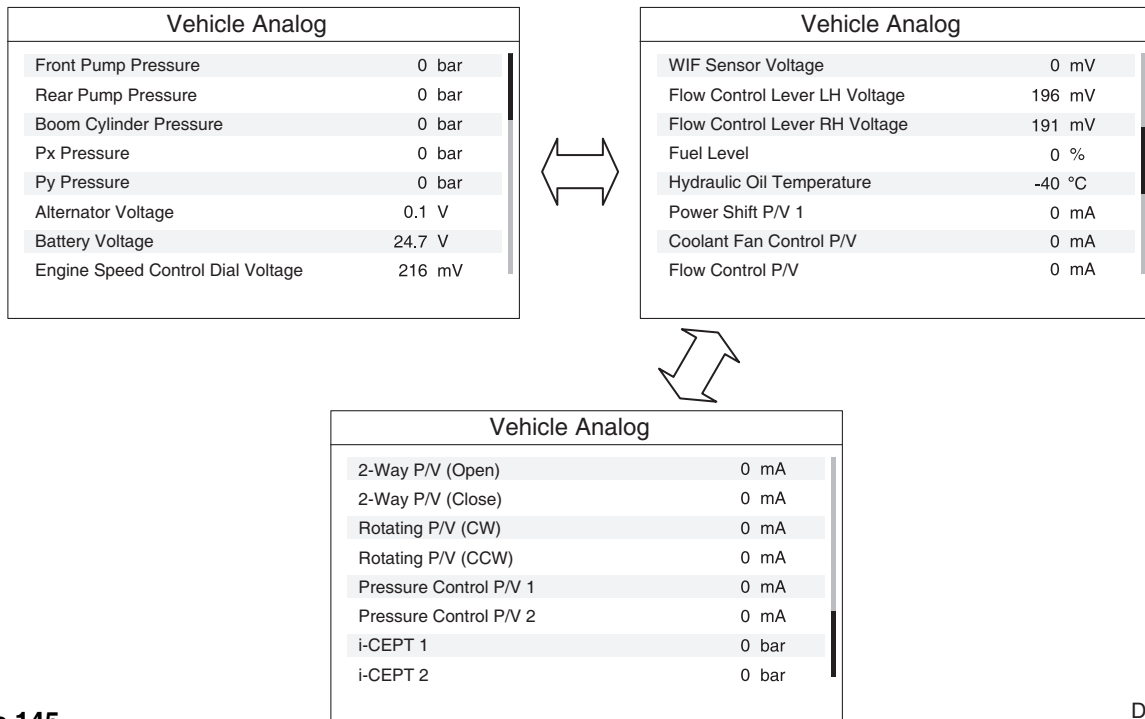


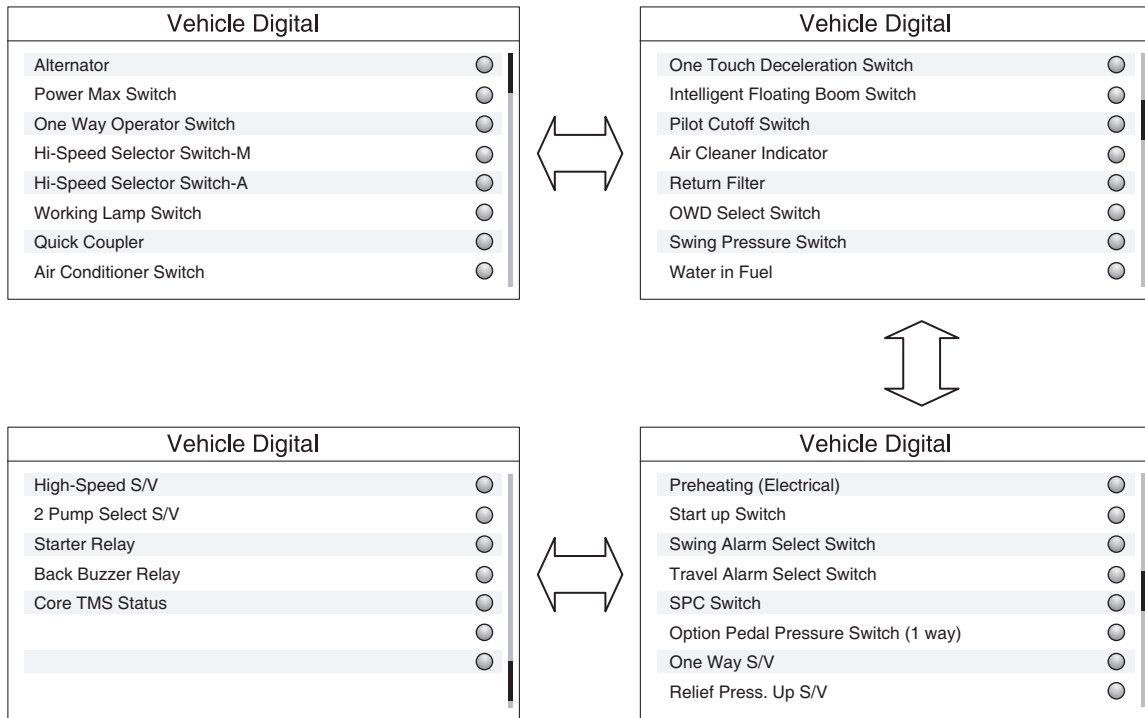
Figure 145

DS1603973

Vehicle Digital Descriptions

Digital Items	Mark	Remark
1. Alternator	ON/OFF	Lights up when output at alternator "R (I)" terminal is above 12 ±1 V.
2. Power Max Switch		Lights up when the boost button is "ON" with the work mode selected to "BOOST".
3. One Way Operator Switch		Lights up when the boost button is "ON" with the work mode selected to "BREAKER".
4. Hi-Speed Selector Switch-M		Lights up when the travel speed selector switch is set to "I" position.
5. Hi-Speed Selector Switch-A		Lights up when the travel speed selector switch is set to "II" position.
6. Working Lamp Switch		Lights up when the light switch is set to "II" position.
7. Quick Coupler		Lights up when the quick coupler switch is "ON".
8. Air Conditioner Switch		Lights up when the air-conditioning relay in the air-conditioning unit is "ON".
9. One Touch Deceleration Switch		Lights up when the one touches deceleration button is "ON".
10. Intelligent Floating Boom Switch		Lights up when the intelligent floating boom switch is set to "I" position or the "II" position.
11. Pilot Cutoff Switch		Lights up when the pilot cutoff switch is "ON".
12. Air Cleaner Indicator		Lights up when the air cleaner indicator contact is "ON".
13. Return Filter		Lights up when the return filter pressure switch is "ON".
14. OWD Select Switch		Lights up when the overload warning select switch is "ON".
15. Swing Pressure Switch		Lights up when the swing pressure switch is "ON".
16. Water in Fuel		Lights up when WIF sensor is "ON".
17. Preheating (Electrical)		Lights up when preheating is "ON".
18. Start up Switch		Lights up when the starter switch is "START"
19. Swing Alarm Select Switch		Lights up when the swing alarm select switch is "ON".
20. Travel Alarm Select Switch		Lights up when the travel alarm select switch is "ON".
21. SPC Switch		Lights up when the SPC switch is "ON".
22. Option Pedal Pressure Switch (1 way)		Lights up when the option pedal pressure switch is "ON".
23. One Way S/V		Lights up when the one way operating solenoid valve is "ON".
24. Relief Press. Up S/V		Lights up when the relief press up solenoid valve is "ON".
25. High-Speed S/V		Lights up when the high-speed solenoid valve is "ON".
26. 2 Pump Select S/V		Lights up when the 2 pump select solenoid valve is "ON".
27. Starter Relay		Lights up when starter relay is "ON".
28. Back Buzzer Relay		Lights up when the back buzzer relay is "ON".
29. Core TMS Status		Lights up when TMS is "ON".

Submenu Selections



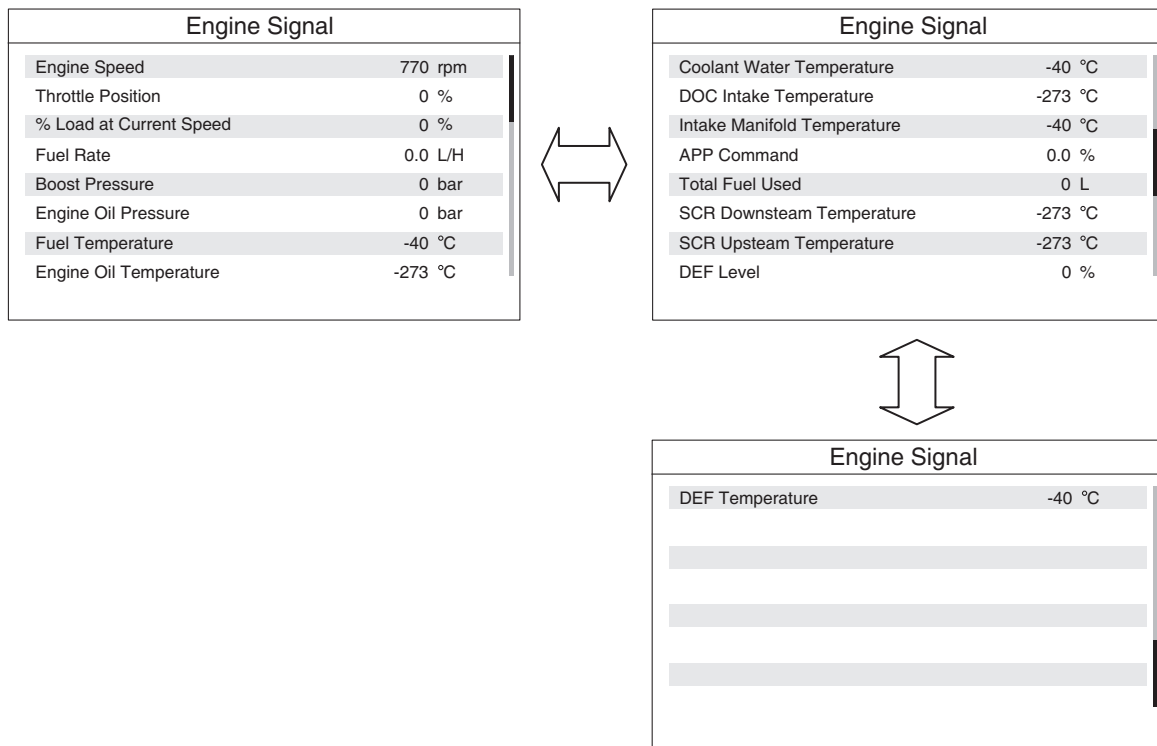
DS1802129

Figure 146

Engine Signal Description

Analog Items	Display	Remark
1. Engine Speed	rpm	Engine Speed
2. Throttle Position	%	Throttle Position
3. % Load at Current Speed	%	% Load at Current Speed
4. Fuel Rate	L/H	Fuel Rate
5. Boost Pressure	bar	Boost Pressure
6. Engine Oil Pressure	bar	Engine Oil Pressure
7. Fuel Temperature	°C	Fuel Temperature
8. Engine Oil Temperature	°C	Engine Oil Temperature
9. Coolant Water Temperature	°C	Coolant Water Temperature
10. DOC Intake Temperature	°C	DOC Intake Temperature
11. Intake Manifold Temperature	°C	Intake Manifold Temperature
12. APP Command	%	APP Command
13. Total Fuel Used	L	Total Fuel Used
14. SCR Downstream Temperature	°C	SCR Downstream Temperature
15. SCR Upstream Temperature	°C	SCR Upstream Temperature
16. DEF Level	%	DEF Level
17. DEF Temperature	°C	DEF Temperature

Submenu Selections



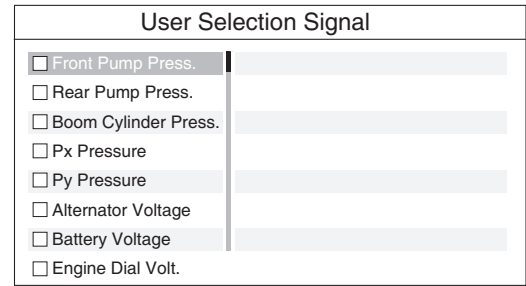
DS1603874

Figure 147

User Selection Signal

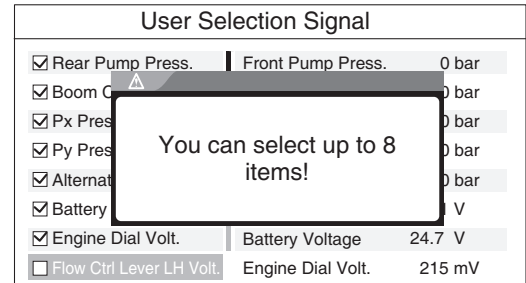
User can select signals of all monitoring items.

The maximum limit of monitoring signal is 8.



EX1301613

Figure 148



EX1301614

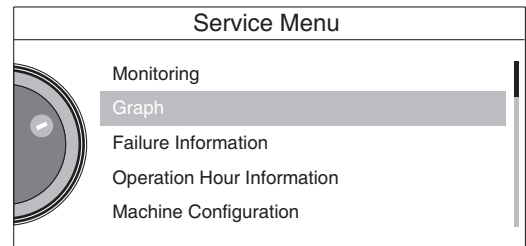
Figure 149

Graph

1. Entering Submenus: When a cursor is located in "Graph" of special menu screen press enter jog switch (1 on Figure 140) and "Graph" screen is displayed.
2. Exiting Submenus: If escape button (ESC, 4 on Figure 140) is pressed, this information screen will be returned to previous screen.

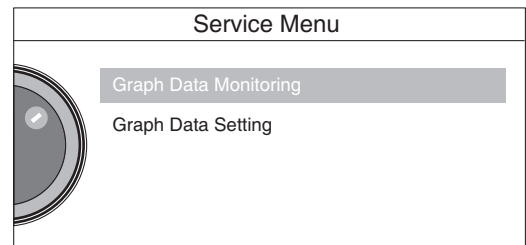
Graph Data Monitoring

Real time monitoring of the selected data.



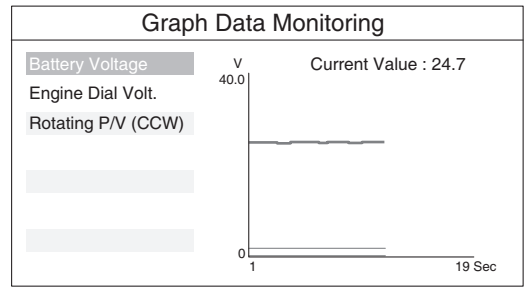
DS1602674

Figure 150



DS1602675

Figure 151



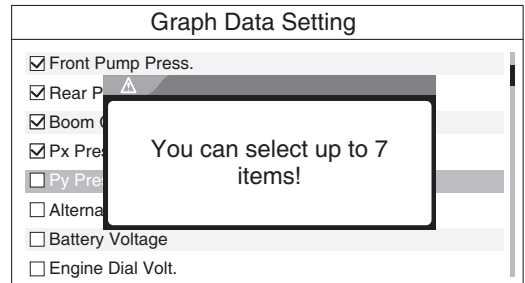
EX1301616

Figure 152

Graph Data Setting

User can be graph data setting.

The maximum limit of the graph data setting is 7.



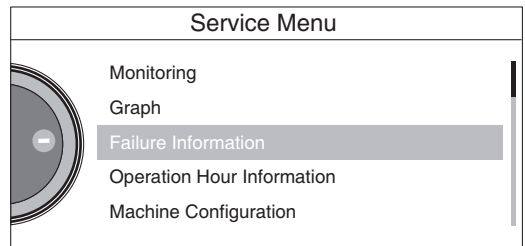
EX1301617

Figure 153

Failure Information

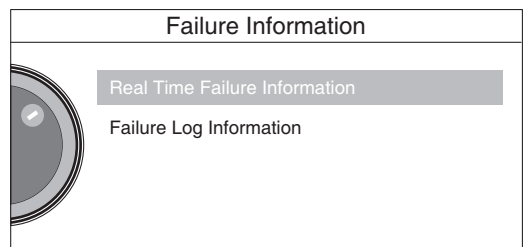
1. Entering Submenus: When a cursor is located in "Failure Info" of special menu screen press jog switch (1 on Figure 140) and "Failure Info" screen is displayed.
2. Exiting Submenus: If escape button (ESC, 4 on Figure 140) is pressed, this information screen will be returned to previous screen.

- * Real-time Failure: Current status of fault is displayed.
- * Failure Log: Memorized record of past fault is displayed.



DS1602676

Figure 154



DS1602677

Figure 155

A. Current fault information

Current status of fault is displayed (Failure code, fault contents).

When several faults are produced, fault information can be checked using the jog switch (1, Figure 140).

No: Number of currently occurring failure

Code: Display of current failure code

VXXyyy-zz: Method of displaying machine related failure code

- V: Display of machine related failure code
- XX: Display of failed part
- yyy: Serial number of failed part
- zz: FMI (Failure Mode Identifier) number

Eyyyyy-zz: Method of displaying engine related failure code

- E: Engine related failure code
- yyyyyy: Serial number of failed part
- zz: FMI (Failure Mode Identifier) number

* Method of displaying failed part of machine (VXX)

- 1) VCO: Communication related failure
- 2) VPV: EPPR valve related failure
- 3) VSV: Solenoid valve related failure
- 4) VRY: Relay related failure
- 5) VSP: Pressure sensor related failure
- 6) VSE: Sensor related failure except for pressure sensor
- 7) VS5: 5V sensor related failure
- 8) VAL: Other failures.

Example)

VPV001-05: EPPR valve (A) current is lower than normal current.

Description: Shows the description of the details of machine failure.

Refer to the failure information code for unique codes and FMI numbers.

This example shows one of two faults.

Real Time Failure Information		
NO	Code	Description
1	VCO002-11	THUMB WHEEL (LH)
2	VPV001-05	PUMP P/V (A), Current below normal
3	VPV010-05	FLOW CONTROL P/V (F) ROTATIN.
4	VSV001-05	BREAKER OPERATING S/V, Curen.
5	VSP011-04	ARM OUT PRESS. SENSOR, Voltag
6	VSP008-04	BOOM DOWN PRESS. SENSOR, Vo

Description
Pump P/V (A), Current below normal

EX1301618

Figure 156

B. Past failure information

Memorized record of past failure is displayed (Failure code, fault contents).

When several faults are produced, failure information can be checked using the jog switch (1, Figure 140).

NOTE: "Count: xxx": "xxx" means that totally counted number of the same fault.

"Occurrence Time": It indicates the period for which machine has operated until a fault takes place. (For more than two occurrences of the same fault, until first occurrence time.)

Failure Log Information				
NO	Code	Count	Occurrence Time	
5	VPV007-05	9	21 Hr	20 Min
6	VCO002-11	25	21 Hr	27 Min
7	VSP011-04	2	21 Hr	56 Min
8	VSP008-04	1	21 Hr	56 Min
9	VSV001-05	4	21 Hr	56 Min
10	VPV001-05	15	21 Hr	56 Min

Description
BREAKER OPERATING S/V, Current below normal

EX1301619

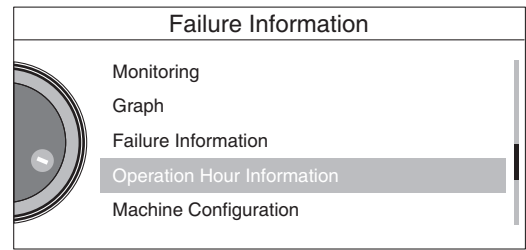
Figure 157

Information of Machine Operation

Accumulated operation hour of each mode and status is displayed.

Operation Hour Information

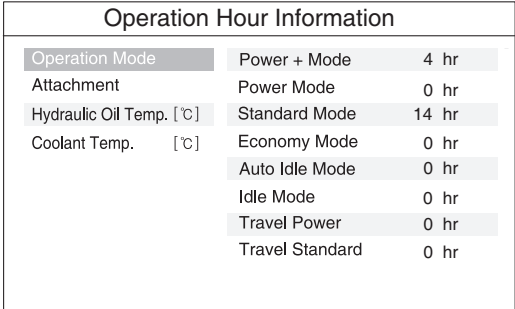
1. Entering Submenus: When a cursor is located in "Operation Hrs" of special menu screen (Figure 158) press jog switch (1 on Figure 140) and "Operation Hrs" screen will be displayed (Figure 159).



DS1602678

Figure 158

2. Operation Hours Screen



Operation Hour Information		
Operation Mode	Power + Mode	4 hr
Attachment	Power Mode	0 hr
Hydraulic Oil Temp. [°C]	Standard Mode	14 hr
Coolant Temp. [°C]	Economy Mode	0 hr
	Auto Idle Mode	0 hr
	Idle Mode	0 hr
	Travel Power	0 hr
	Travel Standard	0 hr

DS1602679

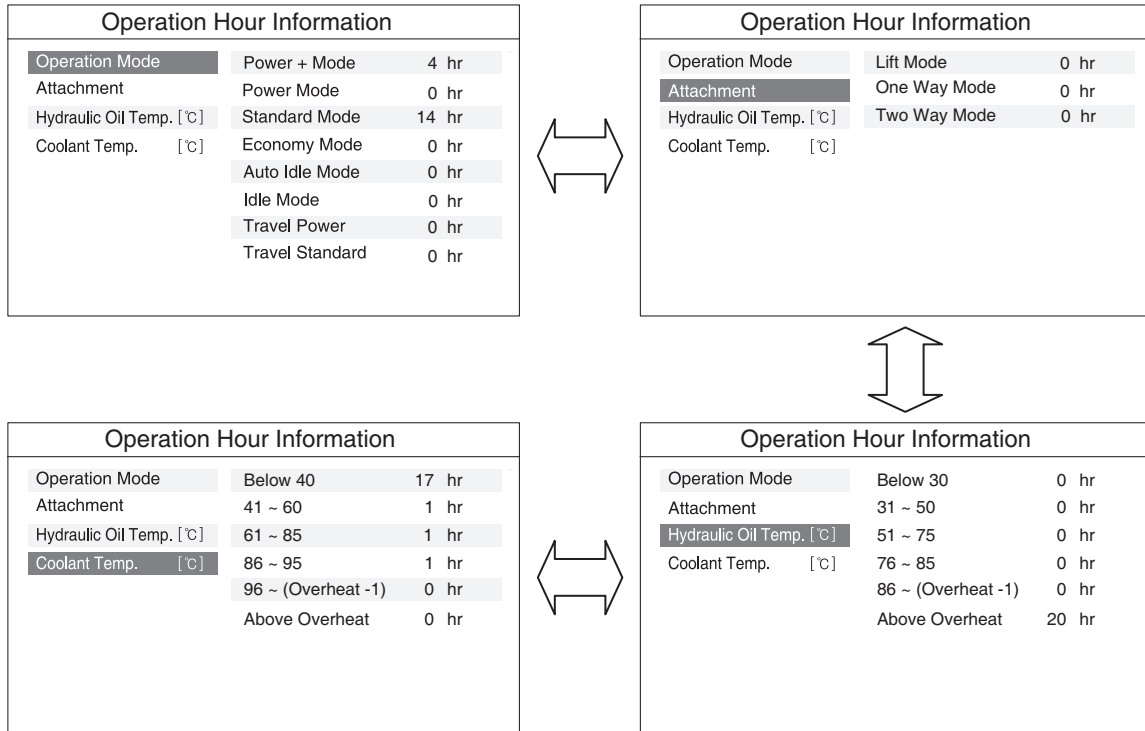
Figure 159

3. Exiting Submenus: If escape button (ESC, 4 on Figure 140) is pressed for more than 1 second, this information screen will be returned to previous screen.

Information contents of operation hour

Item	Information Contents	Detection Method
Power Plus Mode	Operation hours used Power Plus Mode are displayed.	Power Plus Mode status (Instrument panel) and Alternator signal (CN1-2) is "HI"
Power Mode	Operation hours used Power Mode are displayed.	Power Mode status (Instrument panel) and Alternator signal (CN1-2) is "HI"
Standard Mode	Operation hours used standard mode are displayed.	Standard Mode status (Instrument panel) and Alternator signal (CN1-2) is "HI".
Economy Mode	Operation hours used economy mode are displayed.	Economy Mode status (Instrument panel) and Alternator signal (CN1-2) is "HI"
Auto Idle	Operation hours used auto idle status are displayed.	Auto Idle Mode status (Instrument panel) and Alternator signal (CN1-2) is "HI"
Lift Mode	The operation hours for Lift Mode are displayed.	
One Way Mode	The operation hours for One Way Mode are displayed.	
Two Way Mode	The operation hours for Two Way Mode are displayed.	
Hydraulic Oil Temperature Distribution (°C (°F))	<p>Temperature of hydraulic oil is classified 6 steps, and operation hours of each step are displayed</p> <p>Under 30°C (87°F) 31 ~ 50°C (88 ~ 123°F) 51 ~ 75°C (124 ~ 168°F) 76 ~ 85°C (169 ~ 186°F) 86 ~ Overheat -1°C (187 ~ Overheat -1°F) Above Overheat</p>	<p>The resistance delivered from temperature sensor of hydraulic oil is classified 6 steps, and operation hours of each step are displayed. (Alternator output HI status)</p>
Coolant Temperature Distribution (°C (°F))	<p>Temperature of coolant is classified 6 steps, and operation hours of each step are displayed.</p> <p>Under 40°C (105°F) 41 ~ 60°C (106 ~ 141°F) 61 ~ 85°C (142 ~ 186°F) 86 ~ 95°C (187 ~ 204°F) 96 ~ Overheat -1°C (205 ~ Overheat -1°F) Above Overheat</p>	<p>The resistance delivered from coolant sensor is classified 6 steps, and operation hours of each step are displayed. (Alternator output HI status)</p>

Example of Machine Operation Info Screen



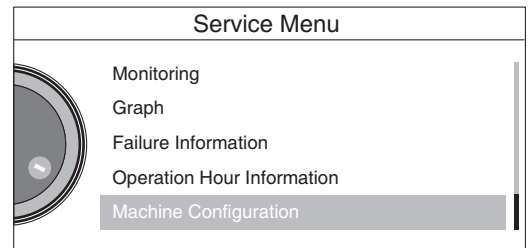
DS1602680

Figure 160

Machine Configuration

1. Machine Configuration

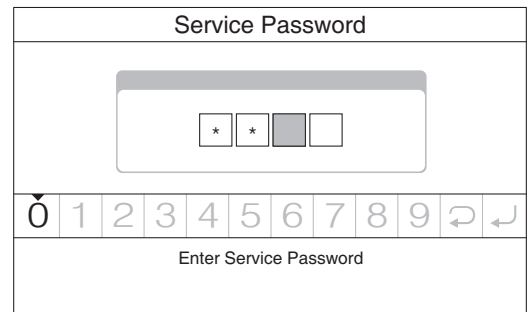
- A. Entering Submenus: When a cursor is located in "Machine Configuration" of special menu screen (Figure 161) press jog switch (1 on Figure 140) and "Machine Configuration" screen will be displayed (Figure 163).



DS1602681

Figure 161

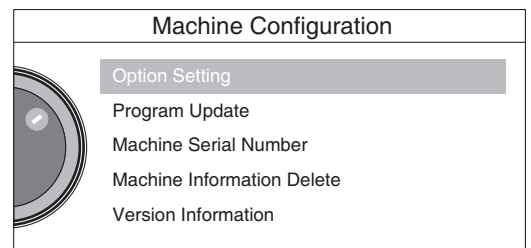
Entering service password is required when accessing the menu.



EX1301634

Figure 162

- B. Machine Configuration Screen (Figure 163).



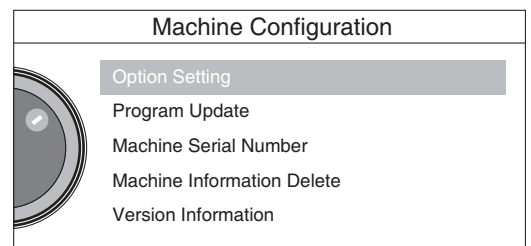
DS1602682

Figure 163

- C. Exiting Submenus: If escape button (ESC, 4 on Figure 140) is pressed, this information screen will be returned to previous screen.

Option Setting

1. Entering Submenus: When a cursor is located in "Option Setting" of special menu screen (Figure 164) press jog switch (1 on Figure 140) and "Option Setting screen" will be displayed (Figure 165)



DS1602682

Figure 164

2. Option Setting

- Attachment Option

When a cursor is located in check box of breaker or two-way, press jog switch (1 on Figure 140) and then, the check box light turns "ON".

- Two Pump Option

When a cursor is located in check box of two pump. Option, press jog switch (1 on Figure 140) and then, the check box light turns "ON".

- Two-way Option Pedal

Place the cursor on the check box for the two-way option pedal and select a function by pressing the jog switch.

NOTE: *Option setting can only be made for those vehicles with the option in question. Selecting a vehicle without the option can cause a problem in terms of performance and safety.*

3. Program Update

Entering Submenus: When a cursor is located in "Program Update" of special menu screen (Figure 166) press jog switch (1 on Figure 140) and "Program Update Screen" will be displayed (Figure 167).

NOTE: *When USB memory is installed in USB port, program update can be updated.*

Option Setting	
Attachment Option	<input type="checkbox"/> One Way <input checked="" type="checkbox"/> Two Way
Two Pump Option	<input type="checkbox"/> Enabled
Two Way Option Pedal	<input type="checkbox"/> Enabled
AVM Option	<input type="checkbox"/> Enabled
Gateway Option	<input type="checkbox"/> Enabled

Figure 165

DS1602683


Machine Configuration	
	Option Setting
	Program Update
	Machine Serial Number
	Machine Information Delete
	Version Information

Figure 166

DS1602684

Program Update	
Do not remove USB or shut down Instrument Panel. Software damage could occur.	
Current Version	V 0100 [2013.10.23]
Update Version	USB not Installed
Insert USB for update	

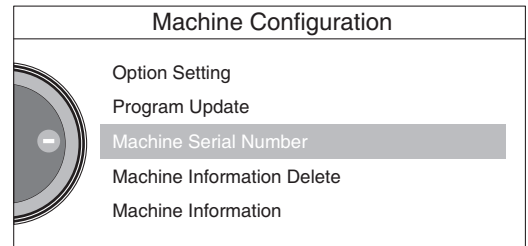
Figure 167

DS1602685

4. Machine Serial Number

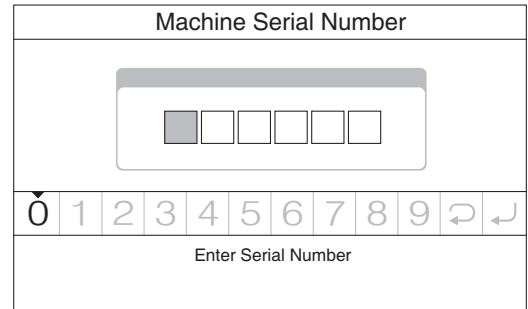
Entering Submenus: When a cursor is located in "Machine Serial Number" of special menu screen (Figure 168) press jog switch (1 on Figure 140) and "Machine Serial Number Screen" will be displayed (Figure 169).

Machine serial number can be input by turning the jog switch and pressing the jog switch.



DS1602686

Figure 168



DS1602053

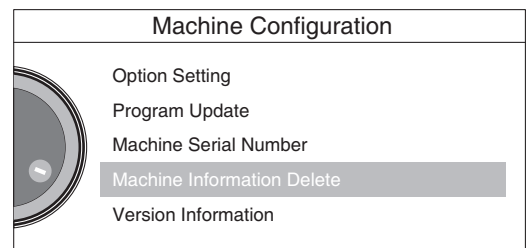
Figure 169

5. Machine Information Delete

Entering Submenus: When a cursor is located in "Machine Information Delete" of special menu screen (Figure 170) press jog switch (1 on Figure 140) and "Machine Information Delete Screen" will be displayed (Figure 171)

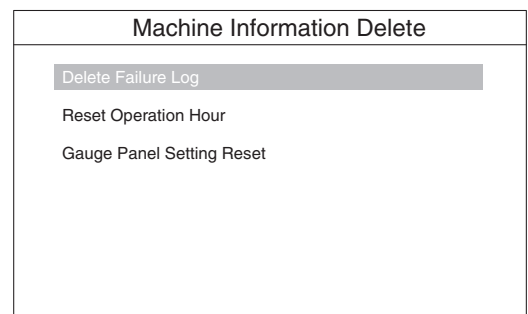
NOTE: When press jog switch (1 on Figure 140) in the selected menu the menu will be initialized.

- Delete Failure Log
- Reset Operation Hour
- Gauge Panel Setting Reset



DS1602687

Figure 170

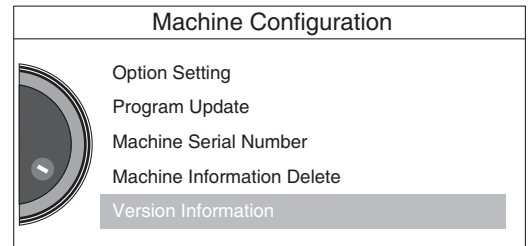


EX1501553

Figure 171

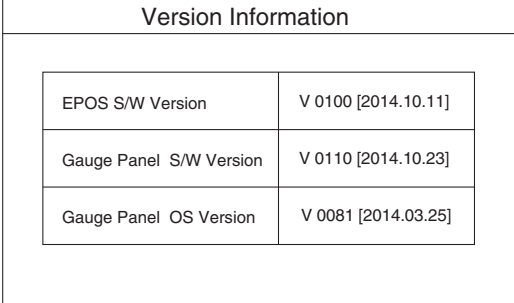
6. Version Information

Entering Submenus: When a cursor is located in "Version Information" of special menu screen (Figure 172) press jog switch (1 on Figure 140) and "Version Information Screen" will be displayed (Figure 173).



DS1602688

Figure 172



The image shows a screen titled "Version Information". It contains a table with three rows of version information.

Version Information	
EPOS S/W Version	V 0100 [2014.10.11]
Gauge Panel S/W Version	V 0110 [2014.10.23]
Gauge Panel OS Version	V 0081 [2014.03.25]

EX1501555

Figure 173

FAILURE CODE

Failure Code at Machine

GP (Graphic Panel): Code displays on Panel Gauge

FMI (Failure Mode Identifier): Code displays on DMS

DTC (Diagnostic Trouble Code): Code displays on Diagnostic tool

HEX: Hexadecimal, DEC: Decimal number

GP Display Code	SPN Name	FMI	GP Display Description	Measuring Point	Correct Value		Severity Level	Remark
					Active	Passive		
VCO001	Can (Gauge Panel)	11	Gauge Panel Communication Error	6-12/ 6-13		R = 60 ±5 Ω	4	It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line.
VCO002	Can (ECU)	11	E-ECU Communication Error	1-39/ 1-40			4	
VPV001	Pump P/V (A)	5	Current of Pump P/V (A) Is Below Normal	2-98/ 2-99		R = 13.5 ±2 Ω (25°C (77°F))	3	
		6	Current of Pump P/V (A) Is Above Normal					
VPV003	Flow Control P/V (C)	5	Current of Flow Control P/V (C) is Below Normal	2-108/ 2-109		R = 13.5 ±2 Ω (25°C (77°F))	3	
		6	Current of Flow Control P/V (C) is Above Normal					
VPV004	Fan Control P/V (D)	5	Current of FAN Control P/V (D) is Below Normal	2-110/ 2-111		R = 22.5 ±2 Ω (25°C (77°F))	3	
		6	Current of Fan Control P/V (D) is Above Normal					
VPV005	Press. Control 1 P/V (E)	5	Current of Press. Control 1 P/V (E) is Below Normal	1-26/ 1-27		R = 9.5 ±2 Ω (25°C (77°F))	3	
		6	Current of Press. Control 1 P/V (E) is Above Normal					
VPV006	Press. Control 2 P/V (F)	5	Current of Press. Control 2 P/V (F) is Below Normal	1-44/ 1-63		R = 9.5 ±2 Ω (25°C (77°F))	3	
		6	Current of Press. Control 2 P/V (F) is Above Normal					
VPV007	Flow Control P/V (C) 2-way RH-open	5	Current of Flow Control P/V (C) 2-way Rh-open Is Below Normal	1-6/ 1-25		R = 18 ±2 Ω (25°C (77°F))	3	
		6	Current of Flow Control P/V (C) 2-way RH-open is Above Normal					
VPV008	Flow Control P/V (D) 2-way RH-close	5	Current of Flow Control P/V (D) 2-way RH-close is Below Normal	2-82/ 2-83		R = 18 ±2 Ω (25°C (77°F))	3	
		6	Current of Flow Control P/V (D) 2-way RH-close is Above Normal					
VPV009	Flow Control P/V (E) Rotating CW	5	Current of Flow Control P/V (E) Rotating CW is Below Normal	1-7/ 1-8		R = 18 ±2 Ω (25°C (77°F))	3	
		6	Current of Flow Control P/V (E) Rotating CW is Above Normal					

GP Display Code	SPN Name	FMI	GP Display Description	Measuring Point	Correct Value		Severity Level	Remark
					Active	Passive		
VPV010	Flow Control P/V (F) Rotating CCW	5	Current of Flow Control P/V (F) Rotating CCW is Below Normal	2-90/ 2-91		R = 18 ±2 Ω (25°C (77°F))	3	
		6	Current of Flow Control P/V (F) Rotating CCW is Above Normal					
VSV001	Breaker Operating S/V	5	Current of Breaker Operating S/V is Below Normal	1-1/ 2-97	V = V_volt (Note 4)		3	
		6	Current of Breaker Operating S/V is Above Normal					
VSV002	Relief Press. Up S/V (B)	5	Current of Relief Press. Up S/V (B) is Below Normal	1-1/ 2-96	V = V_volt		3	
		6	Current of Relief Press. Up S/V (B) is Above Normal					
VSV003	High-speed S/V (C)	5	Current of High-speed S/v (C) is Below Normal	1-1/ 2-89	V = V_volt		3	
		6	Current of High-speed S/V (C) is Above Normal					
VSV007	Option Safety S/V	5	Current of Option Safety S/v is Below Normal	1-1/ 2-116	V = V_volt		3	
		6	Current of Option Safety S/V is Above Normal					
VSV011	2 Pump Select S/V (I)	5	Current of 2 Pump Select S/v (I) is Below Normal	1-1/ 2-104	V = V_volt		3	
		6	Current of 2 Pump Select S/V (I) is Above Normal					
VRY002	Alarm Relay	5	Current of Alarm Relay is Below Normal	1-1/ 2-119	V = V_volt		3	
		6	Current of Alarm Relay is Above Normal					
VSP001	Front Pump Press. Sensor	3	Voltage of Front Pump Press. Sensor is Above Normal	1-34/ 1-28	V = 1 V		2	It has to be measured in engine stop state
		4	Voltage of Front Pump Press. Sensor is Below Normal					
VSP002	Rear Pump Press. Sensor	3	Voltage of Rear Pump Press. Sensor is Above Normal	1-15/ 1-28	V = 1 V		2	It has to be measured in engine stop state
		4	Voltage of Rear Pump Press. Sensor is Below Normal					
VSP003	Owd Press. Sensor	3	Voltage of OWD Press. Sensor is Above Normal	1-32/ 1-28	V = 1 V		2	It has to be measured in engine stop state
		4	Voltage of OWD Press. Sensor is Below Normal					
VSP004	Px (Front) Press. Sensor	3	Voltage of Px (Front) Press. Sensor is Above Normal	1-33/ 1-29	V = 1 V		2	It has to be measured in engine stop state
		4	Voltage of Px (Front) Press. Sensor is Below Normal					
VSP005	Py (Travel) Press. Sensor	3	Voltage of Py (Travel) Press. Sensor is Above Normal	1-14/ 1-29	V = 1 V		2	It has to be measured in engine stop state
		4	Voltage of Py (Travel) Press. Sensor is Below Normal					

GP Display Code	SPN Name	FMI	GP Display Description	Measuring Point	Correct Value		Severity Level	Remark
					Active	Passive		
VSP006	Boom Up Press. Sensor	3	Voltage of Boom Up Press. Sensor is Above Normal	1-65/ 1-29	V = 1 V		2	It has to be measured in engine stop state
		4	Voltage of Boom Up Press. Sensor is Below Normal					
VSP010	Arm in Press. Sensor	3	Voltage of Arm in Press. Sensor is Above Normal	1-46/ 1-29	V = 1 V		2	It has to be measured in engine stop state
		4	Voltage of Arm in Press. Sensor is Below Normal					
VSE001	Oil Temp. Sensor	0	Oil Temp. Sensor Signal is Above Normal Range	1-36/ 1-11		R = 2.45 ±0.25 Ω (25°C (77°F)) R = 320 ±32 Ω (80°C (176°F))	3	
		3	Oil Temp. Sensor Voltage is Above Normal					
		4	Oil Temp. Sensor Voltage is Below Normal					
VSE002	Fuel Sensor	3	Fuel Sensor Voltage is Above Normal	1-37/ 1-11		Empty: 5 ±0.2 Ω Full: 500 ±10 Ω	3	
		4	Fuel Sensor Voltage is Below Normal					
VSE004	Wif Sensor	1	Wif Sensor Signal is Above Normal Range	1-38/ 1-29			3	
		3	Wif Sensor Voltage is Above Normal					
		4	Wif Sensor Voltage is Below Normal					
VS5001	Thumb Wheel (RH)	3	Thumb Wheel (RH) Voltage is Above Normal	1-30/ 1-10	V = 1.0 ±0.1 V V = 2.5 ±0.2 V neutral V = 4.0 ±0.1 V		3	
		4	Thumb Wheel (RH) Voltage is Below Normal					
VS5002	Thumb Wheel (LH)	3	Thumb Wheel (LH) Voltage is Above Normal	1-66/ 1-10	V = 1.0 ±0.1 V V = 2.5 ±0.2 V neutral V = 4.0 ±0.1 V		3	
		4	Thumb Wheel (LH) Voltage is Below Normal					
VS5005	Dial	3	Dial Voltage is Above Normal	1-31/ 1-10	V = 1.0 ±0.1 V V = 4.0 ±0.1 V		3	
		4	Dial Voltage is Below Normal					
VAL001	Alternator Potential	3	Alternator Potential Voltage is Above Normal	1-2	V = 27 ±0.1 V		4	
		4	Alternator Potential Voltage is Below Normal					

- NOTE:**
1. *Active value: Starter switch has to be turned "ON"*
Measuring points between component and wire harness have to be connected.
 2. *Passive value: Starter switch has to be turned "OFF"*
Measuring points between component and wire harness have to be disconnected.
 3. *Measuring points are engine controller's points and passive value is each component's value.*
 4. *V_batt: Source power of equipment.*

Failure Code at Engine Side

GP (Graphic Panel): Code displays on Panel Gauge

FMI (Failure Mode Identifier): Code displays on DMS

DTC (Diagnostic Trouble Code): Code displays on Diagnostic tool

HEX: Hexadecimal, DEC: Decimal number

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E000051-03	2E9	33	51	03	Throttle valve position sensor: DFC for throttle valve position sensor voltage SRC high	2	
E000051-04	2E8	33	51	04	Throttle valve position sensor: DFC for throttle valve position sensor voltage SRC low	2	
E000091-03	123	5B	91	03	Accelerator pedal position: Signal range check high for APP1	1	
E000091-04	122	5B	91	04	Accelerator pedal position: Signal range check low for APP1	1	
E000100-00	521	64	100	00	Oil pressure sensor: Maximum oil pressure error in plausibility check	3	
E000100-01	1521	64	100	01	Oil pressure sensor: Minimum oil pressure error in plausibility check	3	
E000100-03	1522	64	100	03	Oil pressure sensor: SRC high for oil pressure sensor	3	
E000100-04	1523	64	100	04	Oil pressure sensor: SRC low for oil pressure sensor	3	
E000102-03	238	66	102	03	Boost pressure sensor: SRC high for boost pressure sensor	3	
E000102-04	237	66	102	04	Boost pressure sensor: SRC low for boost pressure sensor	3	
E000105-03	113	69	105	03	Air inlet temperature: SRC high for charge air cooler downstream temperature	2	
E000105-04	112	69	105	04	Air inlet temperature: SRC low for charge air cooler downstream temperature	2	
E000105-05	1113	69	105	05	Air Inlet temperature: Diagnostic fault check for SRC high in engine inlet valve air temperature upstream sensor	2	
E000105-06	1112	69	105	06	Air Inlet temperature: Diagnostic fault check for SRC low in engine inlet valve air temperature upstream sensor	2	
E000108-00	2227	6C	108	00	Barometric pressure sensor in ECU: Physical range check high for environment pressure	3	
E000108-01	1227	6C	108	01	Barometric pressure sensor in ECU: Physical range check low for environment pressure	3	
E000108-03	2229	6C	108	03	Barometric pressure sensor in ECU: SRC high for environment pressure	3	
E000108-04	2228	6C	108	04	Barometric pressure sensor in ECU: SRC low for environment pressure	3	
E000110-00	116	6E	110	00	Coolant temperature: Physical range check high for coolant temperature	3	
E000110-01	1118	6E	110	01	Coolant temperature: Physical range check low for coolant temperature	2	
E000110-03	118	6E	110	03	Coolant temperature: SRC high for coolant temperature	3	
E000110-04	1119	6E	110	04	Coolant temperature: SRC low for coolant temperature	3	
E000110-12	1117	6E	110	12	Coolant temperature: Defect fault check for dynamic plausibility test of coolant temperature	3	
E000129-00	1093	81	129	00	Rail pressure sensor: Maximum rail pressure exceeded (1)	2	
E000129-01	1320	81	129	01	Rail pressure sensor: Check of minimum rail pressure	2	
E000129-03	193	81	129	03	Rail pressure sensor: Rail pressure sensor voltage above upper limit	3	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E000129-04	192	81	129	04	Rail pressure sensor: Rail pressure sensor voltage below lower limit	3	
E000129-05	191	81	129	05	Rail pressure sensor: Rail pressure raw value is above maximum offset	3	
E000129-06	1191	81	129	06	Rail pressure sensor: Rail pressure raw value is below minimum offset	3	
E000129-12	1095	81	129	12	Rail pressure sensor: Maximum rail pressure exceeded (2)	1	
E000129-31	1096	81	129	31	Rail pressure sensor: Maximum rail pressure exceeded (3)	1	
E000132-00	1101	84	132	00	Air mass flow sensor: Sensitivity drift high error for HFM sensor	1	
E000132-01	101	84	132	01	Air mass flow sensor: Sensitivity drift error low for HFM sensor	3	
E000132-03	103	84	132	03	Air mass flow sensor: SRC high error for raw value in HFM sensor	3	
E000132-04	102	84	132	04	Air mass flow sensor: SRC low error for raw value in HFM sensor	3	
E000132-12	100	84	132	12	Air mass flow sensor: SCB of hardware signal of HFM sensor	3	
E000132-31	1100	84	132	31	Air mass flow sensor: Battery voltage error of HFM sensor	2	
E000157-03	1255	9D	157	03	CP metering unit: Signal range check high error of metering unit	2	
E000157-04	1256	9D	157	04	CP metering unit: Signal range check low error of metering unit	2	
E000157-05	125B	9D	157	05	CP metering unit: Open load of metering unit output	3	
E000157-12	252	9D	157	12	CP metering unit: Over temperature of device driver of metering unit	3	
E000157-31	125A	9D	157	31	CP metering unit: Intermittent contact between ECU and MeUn	2	
E000158-00	563	9E	158	00	Battery: High battery voltage indication	2	
E000158-01	562	9E	158	01	Battery: Low battery voltage indication	2	
E000158-03	1563	9E	158	03	Battery: SRC high for battery voltage sensor	3	
E000158-04	1562	9E	158	04	Battery: SRC low for battery voltage sensor	3	
E000172-00	96	AC	172	00	Air mass flow sensor temperature: Physical range high error for air temperature sensor	2	
E000172-03	98	AC	172	03	Air mass flow sensor temperature: SRC high for air temperature sensor	2	
E000172-04	97	AC	172	04	Air mass flow sensor temperature: SRC low for air temperature sensor	2	
E000174-00	181	AE	174	00	Fuel temperature sensor: Physical range check high for fuel temperature	3	
E000174-01	180	AE	174	01	Fuel temperature sensor: Physical range check low for fuel temperature	2	
E000174-03	183	AE	174	03	Fuel temperature sensor: SRC high for fuel temperature sensor	2	
E000174-04	182	AE	174	04	Fuel temperature sensor: SRC low for fuel temperature sensor	2	
E000175-00	196	AF	175	00	Oil temperature sensor: Physical range check high for oil temperature	2	
E000175-01	195	AF	175	01	Oil temperature sensor: Physical range check low for oil temperature	2	
E000175-03	198	AF	175	03	Oil temperature sensor: SRC high for oil temperature	2	
E000175-04	197	AF	175	04	Oil temperature sensor: SRC low for oil temperature	2	
E000606-00	219	25E	606	00	Overspeed detection in component engine protection: Overspeed detection in component engine protection	2	
E000734-05	201	2DE	734	05	Solenoid powerstage 1 (cylinder 1): Open load of solenoid powerstage 1	2	
E000734-06	262	2DE	734	06	Solenoid powerstage 1 (cylinder 1): General short circuit of solenoid powerstage 1	3	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E000734-12	263	2DE	734	12	Solenoid powerstage 1 (cylinder 1): Special pattern for special cases of solenoid powerstage 1	2	
E000735-05	202	2DF	735	05	Solenoid powerstage 2 (cylinder 5): Open load of solenoid powerstage 2	2	
E000735-06	265	2DF	735	06	Solenoid powerstage 2 (cylinder 5): General short circuit of solenoid powerstage 2	3	
E000735-12	266	2DF	735	12	Solenoid powerstage 2 (cylinder 5): Special pattern for special cases of solenoid powerstage 2	2	
E000736-05	203	2E0	736	05	Solenoid powerstage 3 (cylinder 3): Open load of solenoid powerstage 3	2	
E000736-06	268	2E0	736	06	Solenoid powerstage 3 (cylinder 3): General short circuit of solenoid powerstage 3	3	
E000736-12	269	2E0	736	12	Solenoid powerstage 3 (cylinder 3): Special pattern for special cases of solenoid powerstage 3	2	
E000737-05	204	2E1	737	05	Solenoid powerstage 4 (cylinder 6): Open load of solenoid powerstage 4	2	
E000737-06	271	2E1	737	06	Solenoid powerstage 4 (cylinder 6): General short circuit of solenoid powerstage 4	3	
E000737-12	272	2E1	737	12	Solenoid powerstage 4 (cylinder 6): Special pattern for special cases of solenoid powerstage 4	2	
E000738-05	205	2E2	738	05	Solenoid powerstage 5 (cylinder 2): Open load of solenoid powerstage 5	2	
E000738-06	274	2E2	738	06	Solenoid powerstage 5 (cylinder 2): General short circuit of solenoid powerstage 5	3	
E000738-12	275	2E2	738	12	Solenoid powerstage 5 (cylinder 2): Special pattern for special cases of solenoid powerstage 5	2	
E000739-05	120B	2E3	739	05	Solenoid powerstage 6 (cylinder 4): Open load of solenoid powerstage 6	2	
E000739-06	1277	2E3	739	06	Solenoid powerstage 6 (cylinder 4): General short circuit of solenoid powerstage 6	3	
E000739-12	1278	2E3	739	12	Solenoid powerstage 6 (cylinder 4): Special pattern for special cases of solenoid powerstage 6	2	
E000977-03	694	3D1	977	03	Auto fan clutch PWM out: Short circuit to battery error of fan clutch PWM out	2	
E000977-05	481	3D1	977	05	Auto fan clutch PWM out: No load error of fan clutch PWM out	2	
E000977-06	693	3D1	977	06	Auto fan clutch PWM out: Short circuit to ground error of fan clutch PWM out	2	
E000977-12	1481	3D1	977	12	Auto fan clutch PWM out: Over temperature error of fan clutch PWM out	2	
E001207-00	669	4B7	1207	00	Engine ECU temperature: Physical range check high for ECU temperature sensor (1)	2	
E001207-01	668	4B7	1207	01	Engine ECU temperature: Physical range check low for ECU temperature sensor (1)	2	
E001207-03	1669	4B7	1207	03	Engine ECU temperature: SRC high for ECU temperature sensor	2	
E001207-04	1668	4B7	1207	04	Engine ECU temperature: SRC low for ECU temperature sensor	2	
E001207-12	166A	4B7	1207	12	Engine ECU temperature: Physical range check high for ECU temperature sensor (2)	2	
E001207-31	166B	4B7	1207	31	Engine ECU temperature: Physical range check low for ECU temperature sensor (2)	2	
E001322-12	300	52A	1322	12	Monitoring misfire detection multiple cylinder: Monitoring misfire detection multiple cylinder	2	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E001323-12	301	52B	1323	12	Injection misfire detection cylinder 1: Injection misfire detection cylinder 1	2	
E001324-12	302	52C	1324	12	Injection misfire detection cylinder 5: Injection misfire detection cylinder 5 - (P302)	2	
E001325-12	303	52D	1325	12	Injection misfire detection cylinder 3: Injection misfire detection cylinder 3 - (P303)	2	
E001326-12	304	52E	1326	12	Injection misfire detection cylinder 6: Injection misfire detection cylinder 6 - (P304)	2	
E001327-12	305	52F	1327	12	Injection misfire detection cylinder 2: Injection misfire detection cylinder 2 - (P305)	2	
E001328-12	306	530	1328	12	Injection misfire detection cylinder 4: Injection misfire detection cylinder 4 - (P306)	2	
E001482-12	D121	5CA	1482	12	Timeout error of CAN receive frame TCU: Timeout error of CAN-Receive-Frame TSC1TE	1	
E001639-03	527	667	1639	03	Auto fan clutch speed: Fan speed above maximum threshold	2	
E001639-04	528	667	1639	04	Auto fan clutch speed: Fan speed below minimum threshold	2	
E001639-12	526	667	1639	12	Auto fan clutch speed: Fan speed signal long period fault path	2	
E001761-00	103B	6E1	1761	00	Urea tank level sensor: Error of urea tank level sensor evaluation with physical range check high	1	
E001761-01	203B	6E1	1761	01	Urea tank level sensor: Error of urea tank level sensor evaluation with physical range check low	1	
E001761-03	203D	6E1	1761	03	Urea tank level sensor: DFC for SRC high error of the urea tank level sensor	3	
E001761-04	203C	6E1	1761	04	Urea tank level sensor: DFC for SRC low error of the urea tank level sensor	3	
E001761-12	103C	6E1	1761	12	Urea tank level sensor: Status of tank level	3	
E003031-00	205B	BD7	3031	00	Urea temperature sensor: Physical range check high for urea temperature sensor	2	
E003031-01	105B	BD7	3031	01	Urea temperature sensor: Physical range check low for urea temperature sensor	1	
E003031-02	115B	BD7	3031	02	Urea temperature sensor: Error tank temperature sensor plausibility max threshold	1	
E003031-03	205D	BD7	3031	03	Urea temperature sensor: SRC high for urea temperature sensor	3	
E003031-04	205C	BD7	3031	04	Urea temperature sensor: SRC low for urea temperature sensor	3	
E003031-12	115A	BD7	3031	12	Urea temperature sensor: Error tank temperature sensor plausibility min threshold	1	
E003031-31	115C	BD7	3031	31	Urea temperature sensor: Error urea tank temperature is overheated	2	
E003363-03	20B4	D23	3363	03	Urea tank heating valve (coolant valve): Short circuit to battery error for urea tank heating valve	3	
E003363-04	20B3	D23	3363	04	Urea tank heating valve (coolant valve): Short circuit to ground error for urea tank heating valve	3	
E003363-12	20B1	D23	3363	12	Urea tank heating valve (coolant valve): No load error for urea tank heating valve	3	
E003363-31	10B1	D23	3363	31	Urea tank heating valve (coolant valve): Over temperature error for urea tank heating valve	3	
E003464-00	12E1	D88	3464	00	Throttle valve control: Permanent governor deviation max for throttle valve	2	
E003464-01	12E2	D88	3464	01	Throttle valve control: Permanent governor deviation min for throttle valve	2	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E003464-12	2E1	D88	3464	12	Throttle valve control: DFC for throttle valve drift at open position	2	
E003509-02	643	DB5	3509	02	Monitoring of sensor supply voltage in ECU: Error sensor supplies 1	3	
E003059-31	699	BF3	3059	31	Monitoring of sensor supply voltage in ECU: Error sensor supplies 2	3	
E003509-12	653	DB5	3509	12	Monitoring of sensor supply voltage in ECU: Error sensor supplies 3	3	
E003510-03	1602	DB6	3510	03	Monitoring of 12 V sensor supply voltage in ECU: 12 V Sensor supply 1 voltage is too high	2	
E003510-04	1603	DB6	3510	04	Monitoring of 12 V sensor supply voltage in ECU: 12 V Sensor supply 1 voltage is too low	2	
E003511-03	6B2	DB7	3511	03	Sensor supply voltage monitoring 1: Over voltage on sensor supply 1	3	
E003511-04	6B1	DB7	3511	04	Sensor supply voltage monitoring 1: Under voltage on sensor supply 1	3	
E003512-03	6B5	DB8	3512	03	Sensor supply voltage monitoring 2: Over voltage on sensor supply 2	3	
E003512-04	6B4	DB8	3512	04	Sensor supply voltage monitoring 2: Under voltage on sensor supply 2	3	
E003513-03	16B2	DB9	3513	03	Sensor supply voltage monitoring 3: Over voltage on sensor supply 3	3	
E003513-04	16B1	DB9	3513	04	Sensor supply voltage monitoring 3: Under voltage on sensor supply 3	3	
E003516-00	206D	DBC	3516	00	Urea quality sensor: Diagnostic fault check for urea quality sensor whether physical signal above the maximum limit	3	
E003516-01	206C	DBC	3516	01	Urea quality sensor: Diagnostic fault check for urea quality sensor whether physical signal below the minimum limit	3	
E003519-05	1128	DBF	3519	05	SAE J1939 error for SCR catalyst reagent temperature 2 preliminary FMI: SAE J1939 error for catalyst reagent temperature 2 preliminary FMI message (open circuit)	3	
E003519-31	112A	DBF	3519	31	SAE J1939 error for SCR catalyst reagent temperature 2 preliminary FMI: SAE J1939 error for catalyst reagent temperature 2 preliminary FMI message (short circuit)	3	
E003520-00	1120	DC0	3520	00	SAE J1939 error for SCR catalyst reagent properties preliminary FMI: SAE J1939 error for diesel exhaust fluid properties preliminary FMI message	1	
E003520-01	1121	DC0	3520	01	SAE J1939 error for SCR catalyst reagent properties preliminary FMI: SAE J1939 error for diesel exhaust fluid properties preliminary FMI message	1	
E003520-05	1122	DC0	3520	05	SAE J1939 error for SCR catalyst reagent properties preliminary FMI: SAE J1939 error for diesel exhaust fluid properties preliminary FMI message (tank open circuit)	3	
E003520-06	206A	DC0	3520	06	SAE J1939 error for SCR catalyst reagent properties preliminary FMI: SAE J1939 error for diesel exhaust fluid properties preliminary FMI message	1	
E003520-12	1123	DC0	3520	12	SAE J1939 error for SCR catalyst reagent properties preliminary FMI: SAE J1939 error for diesel exhaust fluid properties preliminary FMI message	1	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E003520-31	1124	DC0	3520	31	SAE J1939 error for SCR catalyst reagent properties preliminary FMI: SAE J1939 error for diesel exhaust fluid properties preliminary FMI message (tank short circuit)	3	
E003532-05	203A	DCC	3532	05	SAE J1939 error for SCR catalyst tank level preliminary FMI: SAE J1939 error for SPN3532 catalyst tank level preliminary FMI (open circuit)	3	
E003532-31	1126	DCC	3532	31	SAE J1939 error for SCR catalyst tank level preliminary FMI: SAE J1939 error for SPN3532 catalyst tank level preliminary FMI (short circuit)	3	
E003597-03	1604	E0D	3597	03	Monitoring of internal 12 V supply voltage in ECU: Internal 12 V supply voltage is too high	2	
E003597-04	1605	E0D	3597	04	Monitoring of internal 12 V supply voltage in ECU: Internal 12 V supply voltage is too low	2	
E004332-12	1704	10EC	4332	12	Supply module monitoring 2: Detection of filled system in Init-State (supply module monitoring)	1	
E004334-00	204B	10EE	4334	00	Urea pump module pressure sensor: Physical range check high for urea pump module pressure sensor	1	
E004334-01	104B	10EE	4334	01	Urea pump module pressure sensor: Physical range check low for urea pump module pressure sensor	2	
E004334-03	204D	10EE	4334	03	Urea pump module pressure sensor: SRC error max for urea pump module pressure sensor	3	
E004334-04	204C	10EE	4334	04	Urea pump module pressure sensor: SRC error min for urea pump module pressure sensor	3	
E004334-12	1726	10EE	4334	12	Urea pump module pressure sensor: plausibility error min for urea pump module pressure sensor	3	
E004334-31	1725	10EE	4334	31	Urea pump module pressure sensor: Plausibility error max for urea pump module pressure sensor	3	
E004354-03	20BC	1102	4354	03	Backflow line heater: Short circuit to battery error for backflow line heater	3	
E004354-04	20BB	1102	4354	04	Backflow line heater: Short circuit to ground error for backflow line heater	1	
E004354-12	20B9	1102	4354	12	Backflow line heater: No load error for backflow line heater	3	
E004354-31	10B9	1102	4354	31	Backflow line heater: Over temperature error for backflow line heater	3	
E004355-03	20C0	1103	4355	03	Pressure line heater: Short circuit to battery error for pressure line heater	3	
E004355-04	20BF	1103	4355	04	Pressure line heater: Short circuit to ground error for pressure line heater	1	
E004355-12	20BD	1103	4355	12	Pressure line heater: No load error for pressure line heater	3	
E004355-31	10BD	1103	4355	31	Pressure line heater: Over temperature error for pressure line heater	3	
E004356-03	20C4	1104	4356	03	Suction line heater: Short circuit to battery error for suction line heater	3	
E004356-04	20C3	1104	4356	04	Suction line heater: Short circuit to ground error for suction line heater	1	
E004356-12	20C1	1104	4356	12	Suction line heater: No load error for suction line heater	3	
E004356-31	10C1	1104	4356	31	Suction line heater: Over temperature error for suction line heater	3	
E004357-03	20C8	1105	4357	03	Supply module heater: Short circuit to battery error for supply module heater	3	
E004357-04	20C7	1105	4357	04	Supply module heater: Short circuit to ground error for supply module heater	1	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E004357-12	20C5	1105	4357	12	Supply module heater: No load error for supply module heater	3	
E004357-31	10C5	1105	4357	31	Supply module heater: Over temperature error for supply module heater	3	
E004360-00	436	1108	4360	00	Urea catalyst upstream temperature: Physical range check high for urea catalyst upstream temperature	3	
E004360-01	1436	1108	4360	01	Urea catalyst upstream temperature: Physical range check low for urea catalyst upstream temperature	2	
E004360-03	438	1108	4360	03	Urea catalyst upstream temperature: SRC high for urea catalyst upstream temperature sensor	3	
E004360-04	437	1108	4360	04	Urea catalyst upstream temperature: SRC low for urea catalyst upstream temperature sensor	3	
E004363-00	43B	110B	4363	00	SCR downstream temperature: Physical range check high for urea catalyst downstream temperature sensor	3	
E004363-01	143B	110B	4363	01	SCR downstream temperature: Physical range check low for urea catalyst downstream temperature sensor	2	
E004363-03	43D	110B	4363	03	SCR downstream temperature: SRC high for urea catalyst downstream temperature sensor	3	
E004363-04	43C	110B	4363	04	SCR downstream temperature: SRC low for urea catalyst downstream temperature sensor	3	
E004363-12	143C	110B	4363	12	SCR downstream temperature: Diagnostic fault check for plausibility errors in urea catalyst downstream temperature	1	
E004365-05	205A	110D	4365	05	SAE J1939 error for SCR catalyst reagent tank 1 temperature preliminary FMI: SAE J1939 error for SPN 4365 catalyst reagent tank 1 temp prelim FMI (open circuit)	3	
E004365-31	112C	110D	4365	31	SAE J1939 error for SCR catalyst reagent tank 1 temperature preliminary FMI: SAE J1939 error for SPN 4365 catalyst reagent tank 1 temp prelim FMI (short circuit)	3	
E004375-12	1721	1117	4375	12	Urea pump motor 1: Pump motor speed deviation	1	
E004375-31	1722	1117	4375	31	Urea pump motor 1: Permanent pump motor speed deviation	3	
E004376-03	20A3	1118	4376	03	Urea reverting valve: Short circuit to battery error for urea reverting valve	3	
E004376-05	20A0	1118	4376	05	Urea reverting valve: No load error for urea reverting valve	3	
E004376-06	20A2	1118	4376	06	Urea reverting valve: Short circuit to ground error for urea reverting valve	3	
E004376-12	10A0	1118	4376	12	Urea reverting valve: Over temperature error for urea reverting valve	3	
E004376-31	10A2	1118	4376	31	Urea reverting valve: Reverting valve is blocked closed	1	
E004765-00	2080	129D	4765	00	DOC upstream temperature: Physical range check high for DOC upstream temperature sensor	3	
E004765-03	546	129D	4765	03	DOC upstream temperature: Diagnostic fault check for SRC high in DOC upstream temperature	3	
E004765-04	545	129D	4765	04	DOC upstream temperature: Diagnostic fault check for SRC low in DOC upstream temperature	3	
E005465-00	2263	1559	5465	00	Pressure control regulator: PCR governor deviation above limit	2	
E005465-01	1263	1559	5465	01	Pressure control regulator: PCR governor deviation below limit	1	
E520196-12	251	7F004	520196	12	Rail pressure monitoring 1: Maximum positive deviation of rail pressure exceeded	3	
E520197-12	C046	7F005	520197	12	Timeout error of CAN module C: Busoff error CAN C	3	
E520197-31	C054	7F005	520197	31	Timeout error of CAN module C: Error passive CAN C	3	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520199-02	336	7F007	520199	02	Crankshaft sensor: DFC for crankshaft signal diagnosis – disturbed signal	3	
E520199-05	335	7F007	520199	05	Crankshaft sensor: DFC for crankshaft signal diagnosis – no signal	3	
E520200-02	341	7F008	520200	02	Camshaft sensor: DFC for camshaft signal diagnosis – disturbed signal	2	
E520200-05	340	7F008	520200	05	Camshaft sensor: DFC for camshaft signal diagnosis – no signal	2	
E520200-12	1340	7F008	520200	12	Camshaft sensor: DFC for camshaft offset angle exceeded	2	
E520201-12	62F	7F009	520201	12	EEPROM erase error: EEP erase error based on the error in erasing of sector (for emulation only)	2	
E520202-12	162F	7F00A	520202	12	EEPROM read error: EEP read error based on the error in reading blocks from memory media	2	
E520203-12	89	7F00B	520203	12	Monitoring of PRV -1: Pressure relief valve reached maximum allowed opening count	2	
E520204-12	1630	7F00C	520204	12	EEPROM write error: EEP write error based on the error in storing the blocks in memory media	2	
E520205-03	1484	7F00D	520205	03	Monitoring in case of digital signal controlled fans: Short circuit to battery error of fan digital signal	2	
E520205-05	480	7F00D	520205	05	Monitoring in case of digital signal controlled fans: No load error of fan digital signal	2	
E520205-06	485	7F00D	520205	06	Monitoring in case of digital signal controlled fans: Short circuit to ground error of fan digital signal	2	
E520205-12	484	7F00D	520205	12	Monitoring in case of digital signal controlled fans: Over temperature error of fan digital signal	2	
E520206-12	C028	7F00E	520206	12	Timeout error of CAN module A: Busoff error CAN A	3	
E520206-31	C036	7F00E	520206	31	Timeout error of CAN module A: Error passive CAN A	3	
E520336-12	1000	7F090	520336	12	Engine temperature sensor plausibility 0: Air temperature monitoring plausibility check array 0	3	
E520337-12	1001	7F091	520337	12	Engine temperature sensor plausibility 1: Air temperature monitoring plausibility check array 1	3	
E520338-12	1002	7F092	520338	12	Engine temperature sensor plausibility 2: Air temperature monitoring plausibility check array 2	3	
E520339-12	1003	7F093	520339	12	Engine temperature sensor plausibility 3: Air temperature monitoring plausibility check array 3	3	
E520340-12	1004	7F094	520340	12	Engine temperature sensor plausibility 4: Air temperature monitoring plausibility check array 4	3	
E520341-12	1005	7F095	520341	12	Engine temperature sensor plausibility Tot: Air temperature monitoring plausibility check	3	
E520601-12	160B	7F199	520601	12	ECU hardware chip CY320 error: ECU hardware chip CY320 error	2	
E520602-12	C141	7F19A	520602	12	Hydraulic oil temperature CAN time out: Timeout error of CAN–Receive–Frame AAI	2	
E520603-12	C122	7F19B	520603	12	Timeout error of CAN receive frame DEC1V: Timeout error of CAN–Receive–Frame DEC1V	2	
E520604-12	607	7F19C	520604	12	ECU hardware chip CY146 error 1: ECU hardware chip CY146 error 1	2	
E520606-12	C10A	7F19E	520606	12	Timeout error of CAN receive frame EGR valve: Timeout error of CAN–Receive–Frame EGRerr	3	
E520607-12	D10B	7F19F	520607	12	EGR valve actuator communication error: EGR SRA error for communication loss 1	2	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520609-00	402	7F1A1	520609	00	Air control governor deviation error: Positive governor deviation above limit	1	
E520609-01	401	7F1A1	520609	01	Air control governor deviation error: Negative air control governor deviation below limit	2	
E520610-03	542	7F1A2	520610	03	Power stage for intake air heater: Short circuit to battery error of powerstage for intake air heater	2	
E520610-05	543	7F1A2	520610	05	Power stage for intake air heater: No load error of powerstage for intake air heater	2	
E520610-06	541	7F1A2	520610	06	Power stage for intake air heater: Short circuit to ground error of powerstage for intake air heater	2	
E520610-12	540	7F1A2	520610	12	Power stage for intake air heater: Over temperature error of powerstage for intake air heater	2	
E520611-12	D127	7F1A3	520611	12	Timeout error of CAN receive frame vehicle cut off switch: Timeout error of CAN-Receive-Frame AUXIO1	2	
E520612-00	C124	7F1A4	520612	00	Accel pedal CAN max error: Timeout error of CAN-Receive-Frame DEC1V	2	
E520613-12	D125	7F1A5	520613	12	Vehicle cutoff switch error: DFC for error at vehicle cut-off switch	1	
E520616-00	1564	7F1A8	520616	00	ECU power stage test: Powerstage diagnosis disabled due to high battery voltage	2	
E520616-01	1565	7F1A8	520616	01	ECU power stage test: Powerstage diagnosis disabled due to low battery voltage	2	
E520618-12	60B	7F1AA	520618	12	Monitoring of ADC - 1: Diagnostic fault check to report the NTP error in ADC monitoring	2	
E520624-12	1315	7F1B0	520624	12	Monitoring of injection - 1: Number of injections is limited by charge balance of booster capacity	1	
E520625-12	A0F	7F1B1	520625	12	Detection of failed engine start: Detection of failed engine start	1	
E520626-02	162D	7F1B2	520626	02	Injection bank short circuit 0: Time out of SCG measurement of injection bank 1	2	
E520626-06	162E	7F1B2	520626	06	Injection bank short circuit 0: Short circuit to ground monitoring test in injection bank 1	2	
E520626-12	62D	7F1B2	520626	12	Injection bank short circuit 0: Short circuit of Injection bank 1	3	
E520627-12	1607	7F1B3	520627	12	ECU hardware chip CY146 error 2: ECU hardware chip CY146 error 2	2	
E520632-00	1764	7F1B8	520632	00	Diagnostic fault check for supply module: Diagnostic fault check for supply module temperature duty cycle in failure range	3	
E520632-01	1765	7F1B8	520632	01	Diagnostic fault check for supply module: Diagnostic fault check for supply module heater temperature duty cycle in invalid range	3	
E520632-03	1767	7F1B8	520632	03	Diagnostic fault check for supply module: Diagnostic fault check period outside valid range	3	
E520632-05	1768	7F1B8	520632	05	Diagnostic fault check for supply module: Diagnostic fault check to detect faulty PWM signal	3	
E520632-06	1766	7F1B8	520632	06	Diagnostic fault check for supply module: Temperature measurement module not available	3	
E520632-12	1769	7F1B8	520632	12	Diagnostic fault check for supply module: Diagnostic fault check for supply module temperature duty cycle in failure range	3	
E520632-31	176A	7F1B8	520632	31	Diagnostic fault check for supply module: Diagnostic fault check for supply module temperature duty cycle in invalid range	3	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520633-02	161A	7F1B9	520633	02	ECU power stage module: Diagnostic fault check to report "WDA active" due to errors in query /response communication	2	
E520633-03	161C	7F1B9	520633	03	ECU power stage module: Diagnostic fault check to report "ABE active" due to overvoltage detection	2	
E520633-04	161B	7F1B9	520633	04	ECU power stage module: Diagnostic fault check to report "ABE active" due to undervoltage detection	2	
E520633-12	161D	7F1B9	520633	12	ECU power stage module: Diagnostic fault check to report "WDA/ABE active" due to unknown reason	2	
E520635-12	1306	7F1BB	520635	12	Rail PRV monitoring: Maximum rail pressure exceeded (4)	1	
E520635-31	1307	7F1BB	520635	31	Rail PRV monitoring: Maximum rail pressure exceeded (5)	1	
E520637-03	659	7F1BD	520637	03	Actuator relay0 error: Short circuit to battery error at actuator relay 0	2	
E520637-05	658	7F1BD	520637	05	Actuator relay0 error: Short circuit to ground error at actuator relay 0	2	
E520638-03	2671	7F1BE	520638	03	Actuator relay1 error: Short circuit to battery error at actuator relay 1	2	
E520638-05	2670	7F1BE	520638	05	Actuator relay1 error: Short circuit to ground error at actuator relay 1	2	
E520639-03	2686	7F1BF	520639	03	Actuator relay2 error: Short circuit to battery error at actuator relay 2	2	
E520639-05	2685	7F1BF	520639	05	Actuator relay2 error: Short circuit to ground error at actuator relay 2	2	
E520640-12	1045	7F1C0	520640	12	Actuator relay3 error: Short circuit to battery error at actuator relay 3	2	
E520641-12	160F	7F1C1	520641	12	Monitoring of complete ROM test: Diagnostic fault check to report multiple error while checking the complete ROM memory	2	
E520642-12	1610	7F1C2	520642	12	ECU shut off path error 1: Loss of synchronization sending bytes to the MM from CPU	2	
E520643-12	101A	7F1C3	520643	12	Monitoring of overrun: Diagnostic fault check to report the error due to over run	2	
E520644-00	1600	7F1C4	520644	00	Monitoring of voltage supply: Reported overvoltage of VDD5	2	
E520644-01	1601	7F1C4	520644	01	Monitoring of voltage supply: Reported undervoltage of VDD5	2	
E520645-03	68B	7F1C5	520645	03	ECU main relay: DFC for stuck main relay error	2	
E520645-05	68A	7F1C5	520645	05	ECU main relay: Early opening defect of main relay	2	
E520652-03	107C	7F1CC	520652	03	Forced regeneration switch: Plausibility test of regeneration switch	2	
E520652-12	107A	7F1CC	520652	12	Forced regeneration switch: Short circuit to battery error of regeneration switch	2	
E520653-03	107B	7F1CD	520653	03	Forced regeneration inhibit switch: Short circuit to battery error of regeneration inhibit switch	2	
E520654-12	161E	7F1CE	520654	12	MSC Errors of R2S2: Reported MSC-Errors of a R2S2	2	
E520656-12	C29D	7F1D0	520656	12	Timeout error of Upstream NOx Sensor: Timeout error of CAN-Receive-Frame AT1IG1	3	
E520657-12	C29E	7F1D1	520657	12	Timeout error of downstream NOx Sensor: Timeout error of CAN-Receive-Frame AT1O1	3	
E520662-00	2201	7F1D6	520662	00	Nox sensor plausibility error: DFC for plausibility error max for upstream NOx sensor	1	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520662-01	1201	7F1D6	520662	01	Nox sensor plausibility error: DFC for plausibility error min for upstream NOx sensor	1	
E520663-00	12FF	7F1D7	520663	00	SCR longterm adaption factor: Longterm adaption factor exceeds threshold	1	
E520663-01	1300	7F1D7	520663	01	SCR longterm adaption factor: Longterm adaption factor below threshold	1	
E520664-31	10EE	7F1D8	520664	31	ETA threshold error: DFC for SCR efficiency	3	
E520666-12	2BA8	7F1DA	520666	12	Monitoring of dosing release: Monitoring of the time until the dosing release is given	1	
E520669-06	1713	7F1DD	520669	06	Urea dosing valve: Short circuit to ground error in high side powerstage of urea dosing valve actuator	3	
E520669-12	1712	7F1DD	520669	12	Urea dosing valve: Dosing valve is blocked	3	
E520669-31	1714	7F1DD	520669	31	Urea dosing valve: Over temperature error on powerstage of urea dosing valve actuator	3	
E520670-12	170D	7F1DE	520670	12	Plausibility of urea quantity and pump Speed: Reporting of the error for the PUQP function	3	
E520671-02	D102	7F1DF	520671	02	Diagnostic fault check for EPA emergency function: DFC for non pause error of EPA emergency function	1	
E520671-12	D101	7F1DF	520671	12	Diagnostic fault check for EPA emergency function: DFC for check sum error of EPA emergency function	1	
E520672-12	1710	7F1E0	520672	12	limitation counter when the urea fill level is in the limitation range: Maximum number restarts allowed by restriction counter is exceeded	1	
E520673-12	170E	7F1E1	520673	12	Urea tank heating plausibility error: Stuck in range check of urea tank temperature sensor	1	
E520674-12	D10A	7F1E2	520674	12	Timeout error of CAN receive frame EGR valve error message: Timeout error of CAN-Transmit-Frame EGRVlv	3	
E520675-12	C40B	7F1E3	520675	12	EGR valve actuator initializing error: EGR SRA error during initialization	2	
E520676-12	D10C	7F1E4	520676	12	EGR valve actuator communication error 2: EGR SRA error for communication loss 2	2	
E520677-12	D40B	7F1E5	520677	12	EGR valve actuator overload error: EGR SRA error for overload	2	
E520678-12	D40C	7F1E6	520678	12	EGR valve actuator position deviation: EGR SRA error in position deviation	2	
E520679-12	D40D	7F1E7	520679	12	EGR valve actuator position estimation error: EGR SRA error in position estimation	2	
E520680-12	D40E	7F1E8	520680	12	EGR valve actuator shortcut detection: EGR SRA error for short detection	2	
E520681-12	D40F	7F1E9	520681	12	EGR valve actuator temperature alert: EGR SRA error for temperature alert	2	
E520682-12	D410	7F1EA	520682	12	EGR valve actuator temperature error: EGR SRA error in measurement of temperature	2	
E520683-12	D411	7F1EB	520683	12	EGR valve actuator temperature warning: EGR SRA error for temperature warning	2	
E520684-12	D412	7F1EC	520684	12	EGR valve actuator torque limitation error: EGR SRA error for torque limitation	2	
E520685-12	1608	7F1ED	520685	12	ECU hardware chip CY146 error 3: ECU hardware chip CY146 error 3	2	
E520686-12	1609	7F1EE	520686	12	ECU hardware chip CY146 error 4: ECU hardware chip CY146 error 4	2	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520687-12	160A	7F1EF	520687	12	ECU hardware chip CY146 error 5: ECU hardware chip CY146 error 5	2	
E520688-12	1316	7F1F0	520688	12	Monitoring of injection - 2: Number of injections is limited by quantity balance of high pressure pump	1	
E520689-12	1317	7F1F1	520689	12	Monitoring of injection - 3: Number of injections is limited by system	1	
E520690-12	1318	7F1F2	520690	12	Monitoring of injection - 4: Number of injections is limited by runtime	1	
E520691-02	1207	7F1F3	520691	02	Injection bank short circuit 1: Time out of SCG measurement of injection bank 2	2	
E520691-06	1209	7F1F3	520691	06	Injection bank short circuit 1: Short circuit to ground monitoring test in injection bank 2	2	
E520691-12	206	7F1F3	520691	12	Injection bank short circuit 1: Short circuit of injection bank 2	3	
E520693-12	62B	7F1F5	520693	12	Injection chip error: Injection chip error	2	
E520694-03	254	7F1F6	520694	03	CP metering unit - high side circuit error: Short circuit to battery in the high side of the MeUn	2	
E520694-04	253	7F1F6	520694	04	CP metering unit - high side circuit error: Short circuit to ground in the high side of the MeUn	3	
E520695-03	1254	7F1F7	520695	03	CP metering unit - low side circuit error: Short circuit to battery of metering unit output	3	
E520695-04	1253	7F1F7	520695	04	CP metering unit - low side circuit error: Short circuit to ground of metering unit output	3	
E520696-12	160C	7F1F8	520696	12	Monitoring of ADC - 2: Diagnostic fault check to report the ADC test error	2	
E520697-12	160D	7F1F9	520697	12	Monitoring of ADC - 3: Diagnostic fault check to report the error in voltage ratio in ADC monitoring	2	
E520698-12	60C	7F1FA	520698	12	Monitoring of communication module - 1: Diagnostic fault check to report errors in query /response communication	2	
E520699-12	160E	7F1FB	520699	12	Monitoring of communication module - 2: Diagnostic fault check to report errors in SPI communication	2	
E520700-12	1611	7F1FC	520700	12	ECU shut off path error 2: DFC to set a torque limitation once an error is detected before MoCSOP's error reaction is set	3	
E520701-12	1612	7F1FD	520701	12	ECU shut off path error 3: Wrong set response time	2	
E520702-12	1613	7F1FE	520702	12	ECU shut off path error 4: Too many SPI errors during MoCSOP execution	2	
E520703-12	1615	7F1FF	520703	12	ECU shut off path error 5: Diagnostic fault check to report that WDA is not working correct	2	
E520704-12	1616	7F200	520704	12	ECU shut off path error 6: OS timeout in the shut off path test. Failure setting the alarm task period	2	
E520705-12	1617	7F201	520705	12	ECU shut off path error 7: Diagnostic fault check to report that the positive test failed	2	
E520706-12	1618	7F202	520706	12	ECU shut off path error 8: Diagnostic fault check to report the timeout in the shut off path test	2	
E520707-03	1619	7F203	520707	03	ECU shut off path error of voltage detection: Diagnostic fault check to report the error in overvoltage monitoring	2	
E520707-04	1614	7F203	520707	04	ECU shut off path error of voltage detection: Diagnostic fault check to report the error in undervoltage monitoring	2	
E520708-12	1008	7F204	520708	12	Shut-off request of the injection cut-off: Injection cut off demand (ICO) for shut off coordinator	2	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520709-12	108C	7F205	520709	12	Monitoring of PRV -2: Pressure relief valve is forced to open; Perform pressure increase	2	
E520710-12	108D	7F206	520710	12	Monitoring of PRV -3: Pressure relief valve is forced to open; Perform pressure shock	2	
E520711-12	108E	7F207	520711	12	Monitoring of PRV -4: Pressure relief valve is open	3	
E520712-12	1036	7F208	520712	12	Monitoring of PRV -5: Quantity balance check if a successful PRV opening is ensured	2	
E520713-12	1037	7F209	520713	12	Monitoring of PRV -6: Averaged rail pressure is outside the expected tolerance range	2	
E520714-12	108F	7F20A	520714	12	Monitoring of PRV -7: Pressure relief valve reached maximum allowed open time	2	
E520715-12	1251	7F20B	520715	12	Rail pressure monitoring 2: Leakage is detected based on fuel quantity balance	3	
E520716-12	1252	7F20C	520716	12	Rail pressure monitoring 3: Maximum negative rail pressure deviation with metering unit on lower limit is exceeded	3	
E520717-12	87	7F20D	520717	12	Rail pressure monitoring 4: Minimum rail pressure exceeded	3	
E520718-12	88	7F20E	520718	12	Rail pressure monitoring 5: Maximum rail pressure exceeded	2	
E520719-12	1090	7F20F	520719	12	Rail pressure monitoring 6: Maximum rail pressure exceeded (second stage)	2	
E520720-12	1050	7F210	520720	12	Rail pressure monitoring 7: Setpoint of metering unit in overrun mode not plausible	3	
E520721-12	1257	7F211	520721	12	Rail pressure monitoring 8: Setpoint of metering unit in idle mode not plausible	3	
E520722-12	1214	7F212	520722	12	Plausibility check for NOx sensor: DFC for stuck in range error check for downstream NOx sensor	1	
E520722-31	2214	7F212	520722	31	Plausibility check for NOx sensor: DFC for peak plausibility check for downstream NOx sensor	1	
E520723-12	12E5	7F213	520723	12	Inducement count "Blocked EGR valve" level 1: Inducement level 1 is active due to "EGR valve blocked"	3	
E520724-12	12E6	7F214	520724	12	Inducement count "Blocked EGR valve" Level 2: Inducement level 2 is active due to "EGR valve blocked"	3	
E520725-12	12E7	7F215	520725	12	Inducement count "Blocked EGR valve" Level 3: Inducement level 3 is active due to "EGR valve blocked"	3	
E520726-12	12E8	7F216	520726	12	Inducement count "Blocked EGR valve" warning: Inducement warning is active due to "EGR valve blocked"	3	
E520727-12	12E9	7F217	520727	12	Inducement count "Interruption of dosing" level 1: Inducement level 1 is active due to "Interruption of dosing"	3	
E520728-12	12EA	7F218	520728	12	Inducement count "Interruption of dosing" level 2: Inducement level 2 is active due to "Interruption of dosing"	3	
E520729-12	12EB	7F219	520729	12	Inducement count "Interruption of dosing" level 3: Inducement level 2 is active due to "Interruption of dosing"	3	
E520730-12	12EC	7F21A	520730	12	Inducement count "Interruption of dosing" warning: Inducement warning is active due to "Interruption of dosing"	3	
E520731-12	12ED	7F21B	520731	12	Inducement count DEF level: Inducement warning information for reagent level	1	
E520732-12	12EE	7F21C	520732	12	Inducement count reagent "Consumption" level 1: Inducement level 1 is active due to "Reagent consumption"	1	
E520733-12	12EF	7F21D	520733	12	Inducement count reagent "Consumption" level 2: Inducement level 2 is active due to "Reagent consumption"	1	
E520734-12	12F0	7F21E	520734	12	Inducement count reagent "Consumption" level 3: Inducement level 3 is active due to "Reagent consumption"	1	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520735-12	12F1	7F21F	520735	12	Inducement count reagent "Consumption" warning: Inducement warning is active due to "Reagent consumption"	1	
E520736-12	12F2	7F220	520736	12	Inducement count "Reagent quality" level 1: Inducement level 1 is active due to "Reagent quality"	3	
E520737-12	12F3	7F221	520737	12	Inducement count "Reagent quality" level 2: Inducement level 2 is active due to "Reagent quality"	3	
E520738-12	12F4	7F222	520738	12	Inducement count "Reagent quality" level 3: Inducement level 3 is active due to "Reagent quality"	3	
E520739-12	12F5	7F223	520739	12	Inducement count "Reagent quality" warning: Inducement warning is active due to "Reagent quality"	3	
E520740-12	12F6	7F224	520740	12	Inducement count "Tampering" level 1: Inducement level 1 is active due to "Tampering"	3	
E520741-12	12F7	7F225	520741	12	Inducement count "Tampering" level 2: Inducement level 2 is active due to "Tampering"	3	
E520742-12	12F8	7F226	520742	12	Inducement count "Tampering" level 3: Inducement level 3 is active due to "Tampering"	3	
E520743-12	12F9	7F227	520743	12	Inducement count "Tampering" level warning: Inducement warning is active due to "Tampering"	3	
E520744-05	2E0	7F228	520744	05	Throttle valve H-bridge: Open load error for throttle valve powerstage	2	
E520744-12	2EB	7F228	520744	12	Throttle valve H-bridge: Over temperature error for throttle valve H-bridge	2	
E520745-03	2E3	7F229	520745	03	Throttle valve H-bridge short circuit 1: Short circuit to battery on out1 error for throttle valve H-bridge	2	
E520745-04	2E2	7F229	520745	04	Throttle valve H-bridge short circuit 1: Short circuit to ground on out1 error for throttle valve H-bridge	2	
E520746-03	12E3	7F22A	520746	03	Throttle valve H-bridge short circuit 2: Short circuit to battery on out2 error for throttle valve H-bridge	2	
E520746-04	12E4	7F22A	520746	04	Throttle valve H-bridge short circuit 2: Short circuit to ground on out2 error for throttle valve H-bridge	2	
E520747-00	2E4	7F22B	520747	00	Throttle valve control jammed: Jammed valve of throttle valve (open)	2	
E520747-01	2E5	7F22B	520747	01	Throttle valve control jammed: Jammed valve of throttle valve (close)	2	
E520750-12	12FC	7F22E	520750	12	Overheating protection: Diagnostic fault check to report the error due to cooling injection in over run	2	
E520751-12	1700	7F22F	520751	12	Supply module monitoring error (backflow line plausibility error): General backflow line plausibility error (supply module monitoring)	3	
E520752-12	1701	7F230	520752	12	Supply module monitoring (pressure check error): General pressure check error (supply module monitoring)	3	
E520753-12	1702	7F231	520753	12	Supply module monitoring (pressure stabilization error): Pressure stabilization error (supply module monitoring)	3	
E520754-12	1703	7F232	520754	12	Supply module monitoring 1: Monitoring of ECU over temperature regardless of the state (supply module monitoring)	2	
E520755-12	20E9	7F233	520755	12	Supply module monitoring (over pressure error 1): Monitoring of metering control malfunction max (supply module monitoring)	3	
E520757-12	20E8	7F235	520757	12	Supply module monitoring (under pressure error): Monitoring of metering control malfunction min (supply module monitoring)	3	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520758-12	1706	7F236	520758	12	Supply module monitoring (over pressure error 2): Monitoring of over pressure (supply module monitoring)	3	
E520759-12	124A	7F237	520759	12	Supply module monitoring (pressure build-up error): Monitoring of pressure build up error asymmetric (supply module monitoring)	3	
E520759-31	124B	7F237	520759	31	Supply module monitoring (pressure build-up error): Monitoring of pressure build up error symmetric (supply module monitoring)	3	
E520760-12	1708	7F238	520760	12	Supply module monitoring (pressure drop error): General pressure drop check error (supply module monitoring)	3	
E520761-12	1709	7F239	520761	12	Supply module monitoring (pressure reduction error): Monitoring of pressure reduction malfunction max (supply module monitoring)	3	
E520761-31	1708	7F239	520761	31	Supply module monitoring (pressure reduction error): Monitoring of underpressure error in afterrun state (supply module monitoring)	3	
E520762-12	170A	7F23A	520762	12	SCR catalyst downstream temperature sensor static plausibility: Error for SCR catalyst downstream temperature sensor static plausibility	1	
E520763-00	170B	7F23B	520763	00	Urea tank level plausibility error: Urea tank sensor indicates too high fill level	1	
E520763-01	170C	7F23B	520763	01	Urea tank level plausibility error: Urea tank sensor indicates too low fill level	1	
E520764-12	1711	7F23C	520764	12	Detection of SCR wrong temperature value: Detection of SCR wrong temperature value	1	
E520765-03	1715	7F23D	520765	03	Low side switch error of urea dosing valve: Short circuit to battery error in powerstage of urea dosing valve actuator	3	
E520765-06	1716	7F23D	520765	06	Low side switch error of urea dosing valve: Short circuit to ground error in powerstage of urea dosing valve actuator	3	
E520766-03	1717	7F23E	520766	03	High side switch error of urea dosing valve: Short circuit to battery error in high side powerstage of urea dosing valve actuator	3	
E520766-06	1718	7F23E	520766	06	High side switch error of urea dosing valve: Short circuit error in high side powerstage of urea dosing valve actuator	3	
E520767-12	1719	7F23F	520767	12	Supply module heater plausibility error 1: Error supply module heater plausibility	3	
E520768-12	171A	7F240	520768	12	Supply module heater plausibility error 2: Error urea supply module heater temperature sensor dynamic plausibility	3	
E520768-31	171B	7F240	520768	31	Supply module heater plausibility error 2: Error urea supply module heater temperature sensor cold start plausibility	1	
E520769-12	171C	7F241	520769	12	Supply module temperature sensor plausibility error: Error urea supply module temperature sensor dynamic plausibility	3	
E520769-31	171D	7F241	520769	31	Supply module temperature sensor plausibility error: Error urea supply module temperature sensor cold start plausibility	1	
E520770-12	171E	7F242	520770	12	Urea catalyst upstream temperature plausibility error: Error for SCR catalyst upstream temperature sensor plausibility max threshold	3	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520770-31	1720	7F242	520770	31	Urea catalyst upstream temperature plausibility error: Error for SCR catalyst upstream temperature sensor plausibility min threshold	1	
E520771-12	1723	7F243	520771	12	Urea pump motor 2: Pump motor not available for actuation	1	
E520772-03	208D	7F244	520772	03	Urea pump motor 3: Short circuit to battery error on powerstage for urea pump motor	3	
E520772-05	208A	7F244	520772	05	Urea pump motor 3: No load error on powerstage for urea pump motor	3	
E520772-06	208C	7F244	520772	06	Urea pump motor 3: Short circuit to ground error on powerstage for urea pump motor	3	
E520772-12	1724	7F244	520772	12	Urea pump motor 3: Over temperature error on powerstage for urea pump motor	3	
E520780-12	D126	7F24C	520780	12	SAE J1939 error for catalyst reagent concentration: SAE J1939 error for catalyst reagent concentration message	1	
E520781-12	D5A3	7F24D	520781	12	SAE J1939 error for urea tank: SAE J1939 error for urea tank level message	1	
E520781-31	D5A4	7F24D	520781	31	SAE J1939 error for urea tank: SAE J1939 error for urea tank temperature message	1	
E520782-12	D5AA	7F24E	520782	12	Timeout error of catalyst reagent concentration: Timeout error of CAN-Receive-Frame A1DEF1	3	
E520783-12	D5AB	7F24F	520783	12	Timeout error of catalyst tank level and temperature: Timeout error of CAN-Receive-Frame AT1T11	3	
E520784-12	D128	7F250	520784	12	SAE J1939 error for urea catalyst tank level indicator: SAE J1939 error for urea catalyst tank level indicator	1	
E520785-12	D146	7F251	520785	12	SAE J1939 error for catalyst reagent temperature2: SAE J1939 error for urea catalyst temperature2	1	
E520787-12	D148	7F253	520787	12	SAE J1939 error for catalyst tank level 2: SAE J1939 error for urea catalyst tank level 2	1	
E520788-12	107C	7F254	520788	12	Plausibility check for hardware switch interface of regeneration inhibition and regeneration demand switch: DFC for regeneration inhibition hardware switch and forced regeneration hardware switch plausibility test	2	
E520789-12	1302	7F255	520789	12	Diagnostic fault check to represent inducement override is active: Shows if inducement override is active	1	
E520790-12	1303	7F256	520790	12	Diagnostic fault check to represent level 1 is active due to repeat offense error: Repeat offense level 1 error	3	
E520791-12	1304	7F257	520791	12	Diagnostic fault check to represent level 2 is active due to repeat offense error: Repeat offense level 2 error	3	
E520792-12	1305	7F258	520792	12	Diagnostic fault check to represent level 3 is active due to repeat offense error: Repeat offense level 3 error	3	
E520794-05	2203	7F25A	520794	05	Monitoring of upstream Nox sensor: Open circuit monitoring for upstream Nox sensor	3	
E520794-06	2202	7F25A	520794	06	Monitoring of upstream Nox sensor: Short circuit monitoring for upstream Nox sensor	3	
E520795-05	2216	7F25B	520795	05	Monitoring of downstream Nox sensor: Open circuit monitoring for downstream Nox sensor	3	
E520795-06	2215	7F25B	520795	06	Monitoring of downstream Nox sensor: Short circuit monitoring for downstream Nox sensor	3	
E520796-12	1012	7F25C	520796	12	Diagnostic fault check to report the accelerator pedal position error: Diagnostic fault check to report the accelerator pedal position error	2	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520797-12	1013	7F25D	520797	12	Diagnostic fault check to report the engine speed error: Diagnostic fault check to report the engine speed error	2	
E520798-12	1014	7F25E	520798	12	Diagnostic fault check to report the plausibility error between level 1 energizing time and level 2 information: Diagnostic fault check to report the plausibility error between level 1 energizing time and level 2 information	2	
E520799-12	1015	7F25F	520799	12	Error in the plausibility of the start of energizing angles: Diagnostic fault check to report the error due to plausibility between the injection begin v/s injection type	2	
E520800-12	1016	7F260	520800	12	Error in the plausibility check of the ZFC energizing times: Diagnostic fault check to report the error due to non plausibility in ZFC	2	
E520801-12	1017	7F261	520801	12	Diagnosis fault check to report the demand for normal mode due to an error in the Pol2 quantity: Diagnosis fault check to report the demand for normal mode due to an error in the Pol2 quantity	2	
E520802-12	1018	7F262	520802	12	Diagnosis fault check to report the error to demand for an ICO due to an error in the Pol2 shut-off: Diagnosis fault check to report the error to demand for an ICO due to an error in the Pol2 shut-off	2	
E520803-12	1019	7F263	520803	12	Diagnosis fault check to report the error to demand for an ICO due to an error in the Pol3 efficiency factor: Diagnosis fault check to report the error to demand for an ICO due to an error in the Pol3 efficiency factor	2	
E520804-12	101B	7F264	520804	12	Diagnostic fault check to report the error due to injection quantity correction: Diagnostic fault check to report the error due to injection quantity correction	2	
E520805-12	101C	7F265	520805	12	Diagnostic fault check to report the plausibility error in rail pressure monitoring: Diagnostic fault check to report the plausibility error in rail pressure monitoring	2	
E520806-12	101D	7F266	520806	12	Diagnostic fault check to report the error due to torque comparison: Diagnostic fault check to report the error due to torque comparison	2	
E520807-02	1020	7F267	520807	02	Diagnosis of curr path limitation forced by ECU monitoring level 2: Diagnosis of set path limitation forced by ECU monitoring level 2	2	
E520807-12	101E	7F267	520807	12	Diagnosis of curr path limitation forced by ECU monitoring level 2: Diagnosis of curr path limitation forced by ECU monitoring level 2	2	
E520807-31	101F	7F267	520807	31	Diagnosis of curr path limitation forced by ECU monitoring level 2: Diagnosis of lead path limitation forced by ECU monitoring level 2	2	
E520808-12	1763	7F268	520808	12	Error dosing valve plausibility: Error dosing valve plausibility	3	
E520809-12	1038	7F269	520809	12	Monitoring of SCR DeSox: The demand for a desulphurization of the SCR catalyst is not fulfilled	2	
E520809-31	1039	7F269	520809	31	Monitoring of SCR DeSox: The engine operation mode was changed for a desulphurization of the SCR catalyst without being able to finish it successfully	2	
E520810-12	170F	7F26A	520810	12	Deviation from the dosing quantity detected during test injection: Deviation from the urea dosing quantity detected during test injection	1	
E520811-12	1130	7F26B	520811	12	Inducement emergency state: Shows if inducement emergency state is active	1	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520812-00	1131	7F26C	520812	00	Diagnostic fault check for urea quality temperature sensor: Diagnostic fault check for urea quality sensor temperature whether physical signal above the maximum limit	1	
E520812-01	1132	7F26C	520812	01	Diagnostic fault check for urea quality temperature sensor: Diagnostic fault check for urea quality sensor temperature whether physical signal below the minimum limit	1	
E520813-02	268C	7F26D	520813	02	Injector adjustment value error 1 (cylinder 1): Check of missing injector adjustment value programming 1	2	
E520814-02	2690	7F26E	520814	02	Injector adjustment value error 2 (cylinder 5): Check of missing injector adjustment value programming 2	2	
E520815-02	268E	7F26F	520815	02	Injector adjustment value error 3 (cylinder 3): Check of missing injector adjustment value programming 3	2	
E520816-02	2691	7F270	520816	02	Injector adjustment value error 4 (cylinder 6): Check of missing injector adjustment value programming 4	2	
E520817-02	268D	7F271	520817	02	Injector adjustment value error 5 (cylinder 2): Check of missing injector adjustment value programming 5	2	
E520818-02	268F	7F272	520818	02	Injector adjustment value error 6 (cylinder 4): Check of missing injector adjustment value programming 6	2	
E520819-12	1620	7F273	520819	12	ECU reset 0: Visibility of software resets 1	1	
E520820-12	1621	7F274	520820	12	ECU reset 1: Visibility of software resets 2	1	
E520821-12	1622	7F275	520821	12	ECU reset 2: Visibility of software resets 3	1	
E520822-12	1730	7F276	520822	12	Without empty pressure reduction: Pressure line heater error and temperature condition to perform an afterrun	2	
E520619-03	1047	7F1AB	520619	03	External actuator relay: Open load error at low side of external actuator relay	3	
E520619-04	1046	7F1AB	520619	04	External actuator relay: Short circuit to battery error at low side of external actuator relay	3	
E520619-05	1048	7F1AB	520619	05	External actuator relay: Short circuit to battery error at low side of external actuator relay	3	
E000970-31	1102	3CA	970	31	Engine emergency stop switch: DFC for engine emergency stop switch	1	
E003217-12	134	C91	3217	12	Dynamic monitoring of upstream Nox sensor O2 signal: DFC for dynamic monitoring of upstream Nox sensor O2 signal	1	
E003219-31	1203	C93	3219	31	Upstream Nox sensor heater temperature monitoring: Fault detection of heater availability for upstream Nox sensor	1	
E003227-12	140	C9B	3227	12	Dynamic monitoring of downstream Nox sensor O2 signal: DFC for dynamic monitoring of downstream Nox sensor O2 signal	1	
E003229-31	1204	C9D	3229	31	Downstream Nox sensor heater temperature monitoring: Fault detection of heater availability for downstream Nox sensor	1	
E520198-12	640	7F006	520198	12	Monitoring of air heater relay	2	
E520773-12	1727	7F245	520773	12	VGT actuator temperature fault: Temperature fault for VGT SRA	3	
E520774-12	1728	7F246	520774	12	VGT actuator OBSTRUCTION: Obstruction error for VGT SRA	3	
E520775-12	1729	7F247	520775	12	VGT actuator SPAN_LEARN_FAILURE: Learn failure error reported from VGT SRA	3	
E520776-12	172A	7F248	520776	12	VGT actuator IGNITION_VOLTAGE_FAULT: Ignition voltage fault of VGT SRA	3	
E520777-12	172B	7F249	520777	12	VGT actuator CAN_ERROR: CAN error of VGT SRA	3	
E520778-12	172C	7F24A	520778	12	VGT actuator INTERNAL_ELECTRICAL_FAULT: Internal electrical fault of VGT SRA	3	

GP Display Code	P Code DTC	DTC Code		FMI	GP Display Description	Severity	Remarks
		HEX	DEC				
E520779-12	172D	7F24B	520779	12	VGT actuator END_OF_LINE_LEARN_FAILURE: EOL learn failure of VGT SRA	3	
E520793-12	172E	7F259	520793	12	VGT actuator temperature warning: Temperature warning for VGT SRA	3	
E520614-12	C10C	7F1A6	520614	12	Timeout error of CAN-Receive-Frame VGTB2EDC	2	
E004339-12	1301	10F3	4339	12	NOx feedback controller reset: Monitoring of the SCR NOx governor	2	
E520823-03	1752	7F277	520823	03	Power stage for turbocharger: Short circuit to battery error for turbocharger powerstage	2	
E520823-12	1750	7F277	520823	12	Power stage for turbocharger: No load error for turbocharger powerstage	2	
E520823-31	1751	7F277	520823	31	Power stage for turbocharger: Over temperature error for turbocharger powerstage	2	
E520824-12	1754	7F278	520824	12	SAE J1939 error for upstream NOx sensor self-diagnosis: SAE J1939 error for upstream NOx sensor Self-diagnosis Status	2	
E520824-31	1755	7F278	520824	31	SAE J1939 error for upstream NOx sensor self-diagnosis: SAE J1939 error for upstream NOx sensor Self-diagnosis final result	2	
E520825-12	1756	7F279	520825	12	SAE J1939 error for downstream NOx sensor self-diagnosis: SAE J1939 error for downstream NOx sensor self-diagnosis status	2	
E520825-31	1757	7F279	520825	31	SAE J1939 error for downstream NOx sensor self-diagnosis: SAE J1939 error for downstream NOx sensor self-diagnosis final result	2	
E520826-12	1758	7F27A	520826	12	Urea reverting valve plausibility: Diagnostic fault check for plausibility errors in urea reverting valve	2	
E000518-12	D122	206	518	12	Timeout error of CAN receive frame machine controller: Timeout error of CAN-Receive-Frame TSC1VE	2	

FMI (Failure Mode Identifier)

FMI	Description
0	Data Valid but Above Normal Operational Range - Most Severe Level
1	Data Valid but Below Normal Operational Range - Most Severe Level
2	Data Erratic, Intermittent or Incorrect
3	Voltage Above Normal, or Shorted to High Source
4	Voltage Below Normal, or Shorted to Low Source
5	Current Below Normal or Open Circuit
6	Current Above Normal or Grounded Circuit
7	Mechanical System Not Responding or Out of Adjustment
8	Abnormal Frequency or Pulse Width or Period
9	Abnormal Update Rate
10	Abnormal Rate of Change
11	Root Cause Not Known
12	Bad Intelligent Device or Component
13	Out of Calibration
14	Special Instructions
15	Data Valid but Above Normal Operating Range - Least Severe Level
16	Data Valid but Above Normal Operating Range - Moderately Severe Level
17	Data Valid but Below Normal Operating Range - Least Severe Level
18	Data Valid but Below Normal Operating Range - Moderately Severe Level
19	Received Network Data in Error
20	Data Drifted High
21	Data Drifted Low
31	Condition Exists

ELECTRONIC HYDRAULIC CONTROL SYSTEM (EPOS)

Control System Schematic

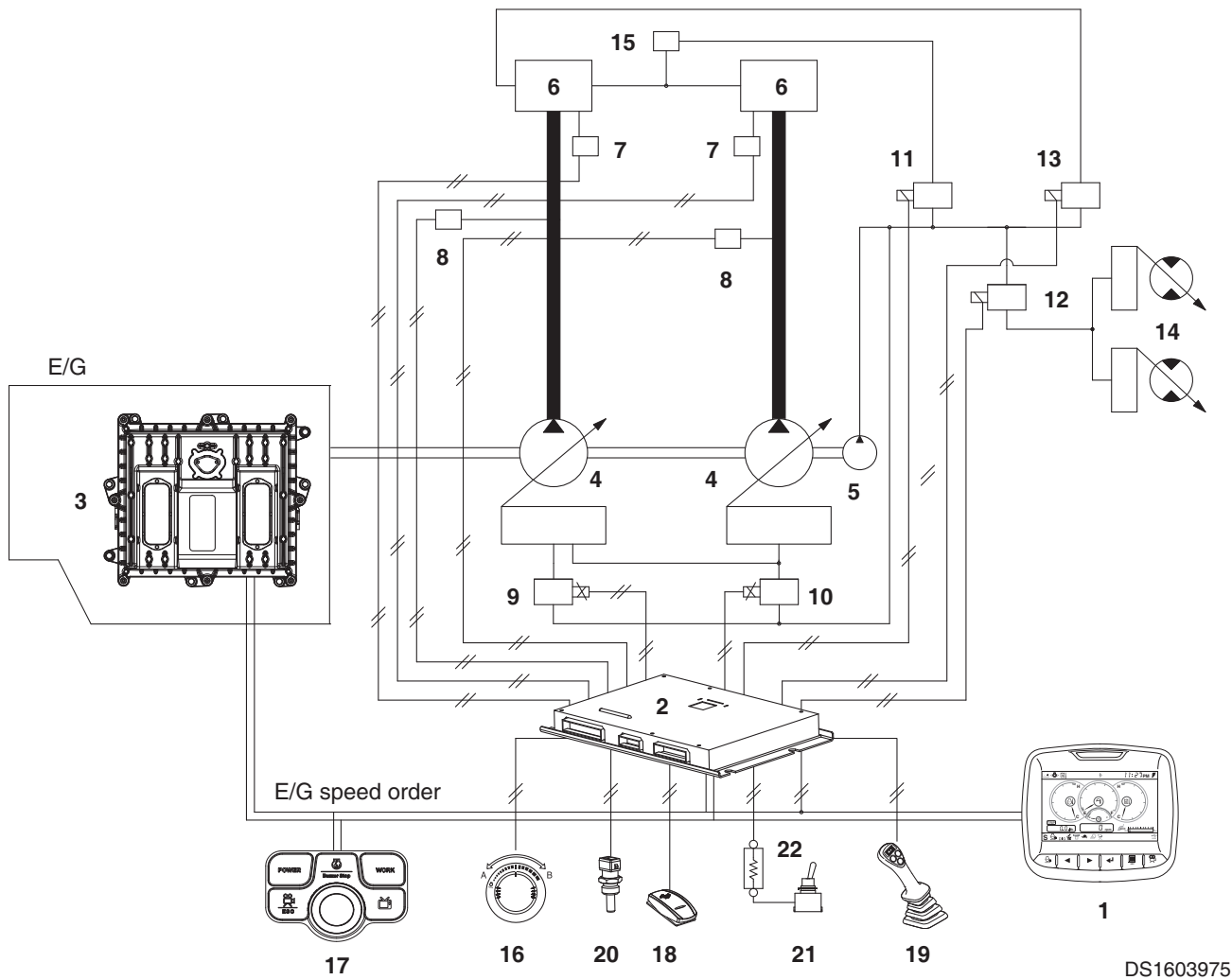


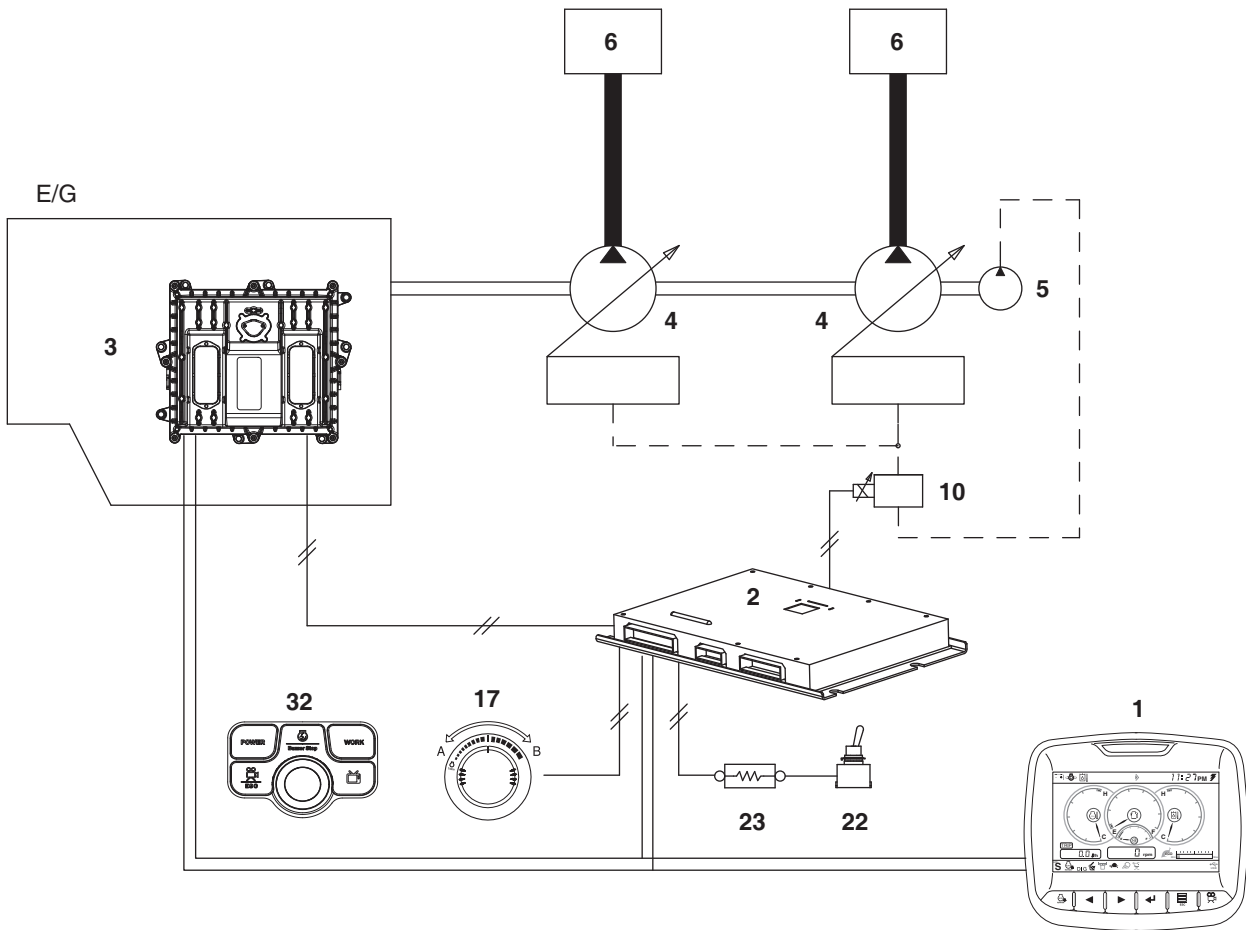
Figure 174

DS1603975

Reference Number	Description
1	Instrument Panel
2	EPOS Controller
3	Engine Controller (ECU)
4	Main Pump
5	Aux Pump
6	Control Valve
7	Pressure Switch
8	Pump Pressure Sensor
9	Electromagnetic Proportional Pressure Reducing Valve (Attachment)
10	Electromagnetic Proportional Pressure Reducing Valve (Mode Control)

Reference Number	Description
11	Solenoid Valve (Boost)
12	Solenoid Valve (High-speed)
13	Solenoid Valve (Breaker)
14	Travel Motor
15	Main Relief Valve
16	Engine Control Dial
17	Jog Switch Control Panel
18	Auto Travel Selector Switch
19	Boost Switch (Right Work Lever)
20	Sensor
21	Aux Mode Switch
22	Aux Mode Resistor

POWER PLUS MODE CONTROL



DS1602851

Figure 175

Reference Number	Description
1	Instrument Panel (Power Mode Selector Switch)
2	EPOS Controller
3	Engine Controller (ECU)
4	Main Pump
5	Aux Pump
6	Control Valve

Reference Number	Description
10	Electromagnetic Proportional Pressure Reducing Valve (Mode Control)
17	Engine Control Dial
22	Aux Mode Switch
23	Aux Mode Resistor
32	Jog Switch Control Panel

The Jog Switch Control Panel permits the selection of the appropriate engine power depending on the working condition. One of the four. Power Plus Mode, Power Mode, Standard Mode or Economy Mode setting can be selected. When the engine starter switch is turned "ON", the power mode is automatically defaulted to standard mode. The desired mode can be selected by pressing the jog switch on the jog switch control panel. When the power mode is selected, the indicator light will turn "ON" to display the selected mode.

The quantity of oil discharged by the pump and the engine speed are determined by the mode selected by the operator. The pump output in each mode is determined by the mode selection and is listed in the following table

Mode	Power Plus Mode	Power Mode	Standard Mode	Economy Mode
Output (%)	100%	Approximately 90%	Approximately 80%	Approximately 75%

Operation

1. Power Plus Mode

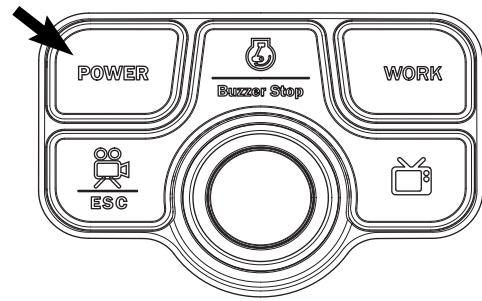
This mode must be selected for high-speed work. In this mode the engine output is most efficiently utilized because of the discharged oil volume being controlled based on the equivalent horsepower curve at various loaded pressures. The EPOS controller compares the target engine speed with the actual engine speed and controls the signal to the EPPR (Electromagnetic Proportional Pressure Reducing) valve which in turn varies the pump output quantity.

If the load increases, the engine speed will fall below the rated speed. When this occurs, the controller senses this decrease and immediately reduces the pump discharge volume to maintain the engine speed at the rated level.

On the other hand, if the load is decreased the controller increases the discharge volume of the pump to maintain the engine speed at the rated level.

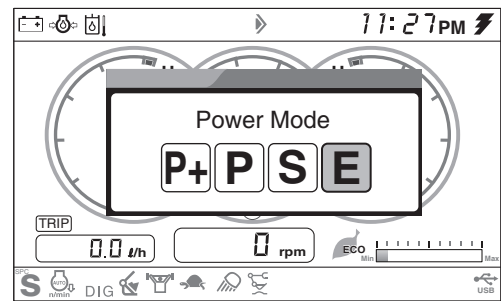
By repeating these control operations, the engine speed is maintained at the rated speed so maximum power can be generated.

In Power Mode, the EPOS controller receives engine speed signals from the engine control dial and the engine controller (ECU) and converts it to an operating signal current and is then transferred to the pump's EPPR valve. Now the EPPR valve converts the electric signal to the corresponding control pressure and sends it to the two pumps, adjusting the pump discharge volume to the desired level.



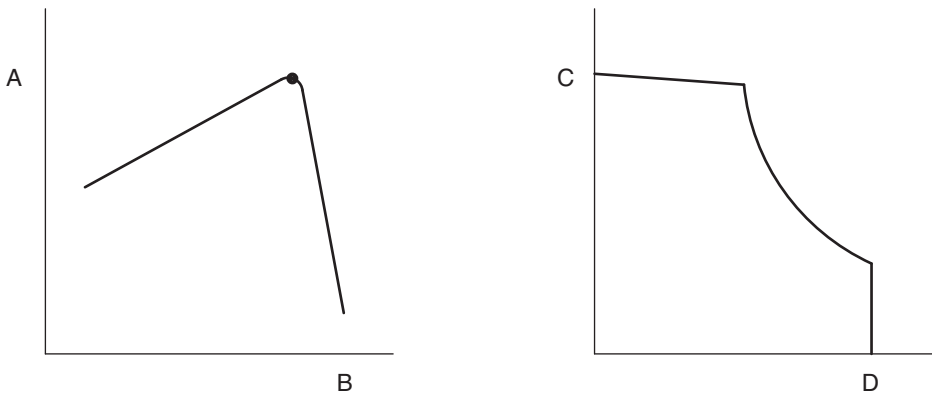
FG018900

Figure 176



EX1301028

Figure 177



FG000580

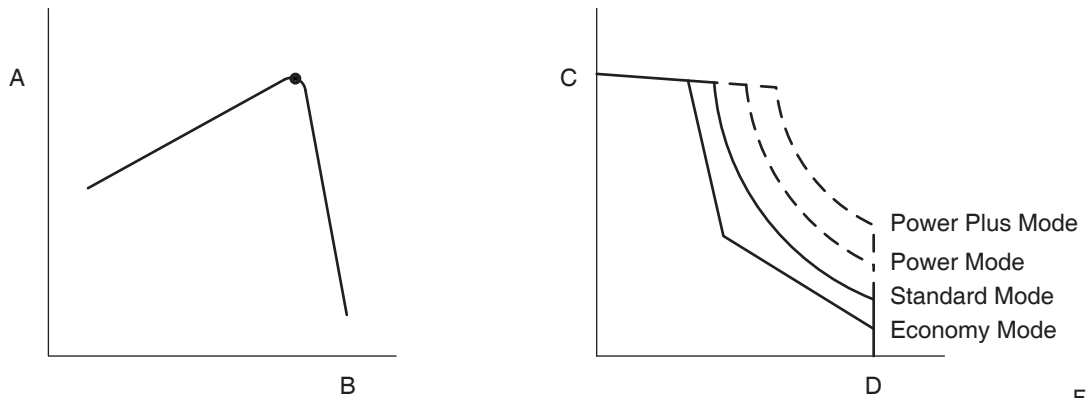
Figure 178

Reference Number	Description
A	Engine Horsepower (hp)
B	Engine Speed (rpm)
C	Pump Discharge Volume (lpm)

Reference Number	Description
D	Pump Discharge Pressure (kg/cm ²)

2. Power Mode, Standard Mode, Economy Mode

Power Mode, Standard Mode or Economy Mode is selected on the work type. When the standard/economy mode is selected it will reduce noise and fuel consumption in comparison with Power Plus Mode. The EPOS controller compares the target engine speed with the actual engine speed and controls the signal to the EPPR valve which in turn varies the pump output quantity and it is the same method with power volume.



FG018902

Figure 179

Reference Number	Description
A	Engine Horsepower (hp)
B	Engine Speed (rpm)

Reference Number	Description
C	Pump Discharge Volume (lpm)
D	Pump Discharge Pressure (kg/cm ²)

POWER MODE CONTROL

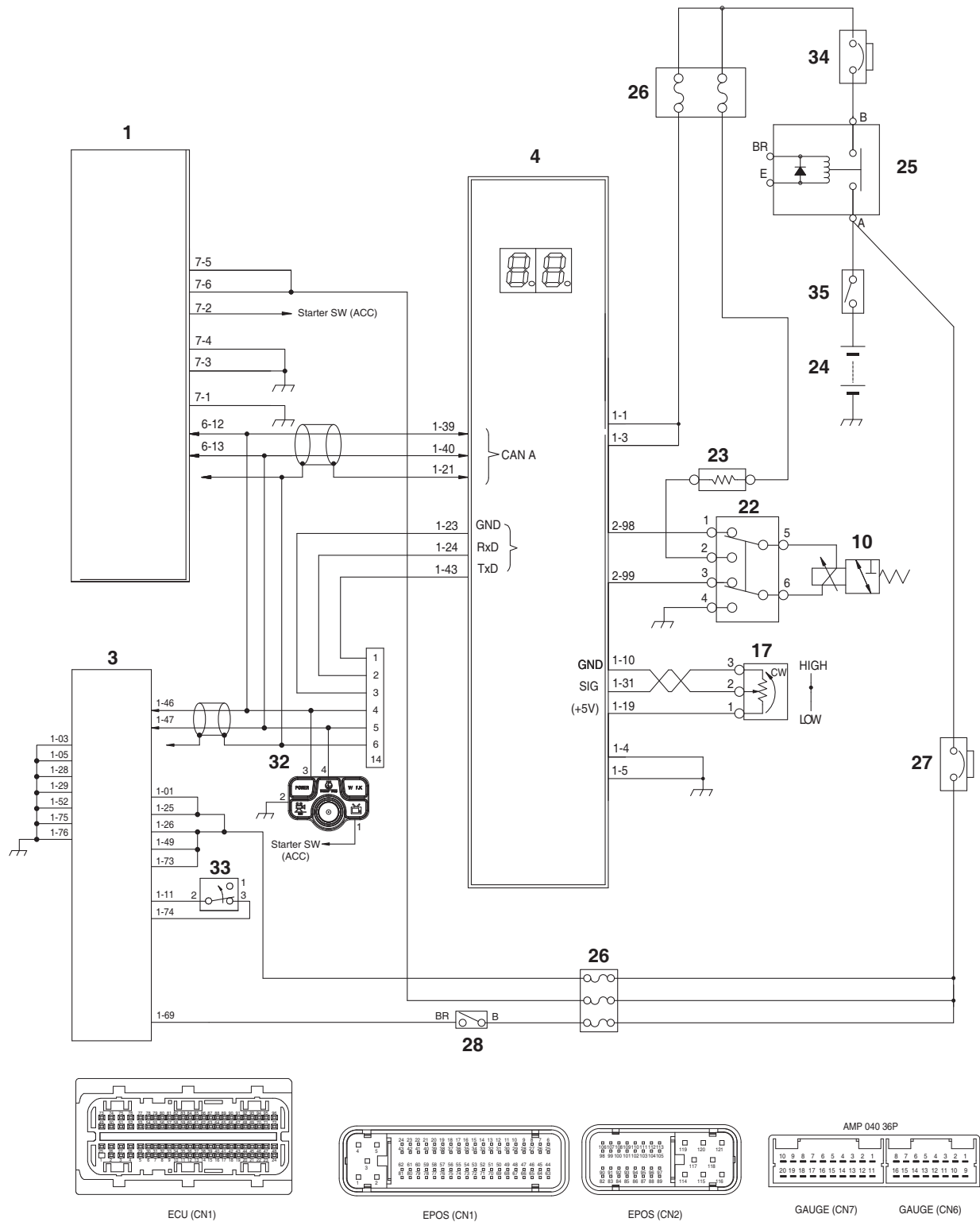


Figure 180

DS1603976

Reference Number	Description
1	Instrument Panel
3	Engine Controller
4	EPOS Controller
10	EPPR Valve (Electromagnetic Proportional Pressure Reducing)
17	Engine Control Dial
22	Aux Mode Switch
23	Aux Mode Resistor
24	Battery

Reference Number	Description
25	Battery Relay
26	Fuse
27	Circuit Breaker 1
28	Starter Switch
32	Jog Switch Control Panel
33	Engine Emergency Stop Switch
34	Circuit Breaker 2
35	Master Switch

i-CEPT (Intelligent Construction Equipment of Power) System

The i-CEPT system is designed to provide the torque value to the ECU for fuel amount control before the engine is loaded with the EPOS's detection of the pump pressure and calculation of the pump load. This function leads to enhancement of engine speed drop and recovery performance, resulting in better fuel efficiency. To detect the pump pressure, four pressure sensors are installed to the ports (P1, P2) and (Pi1, Pi2). In case of pressure sensor malfunction, the i-CEPT function is deactivated.

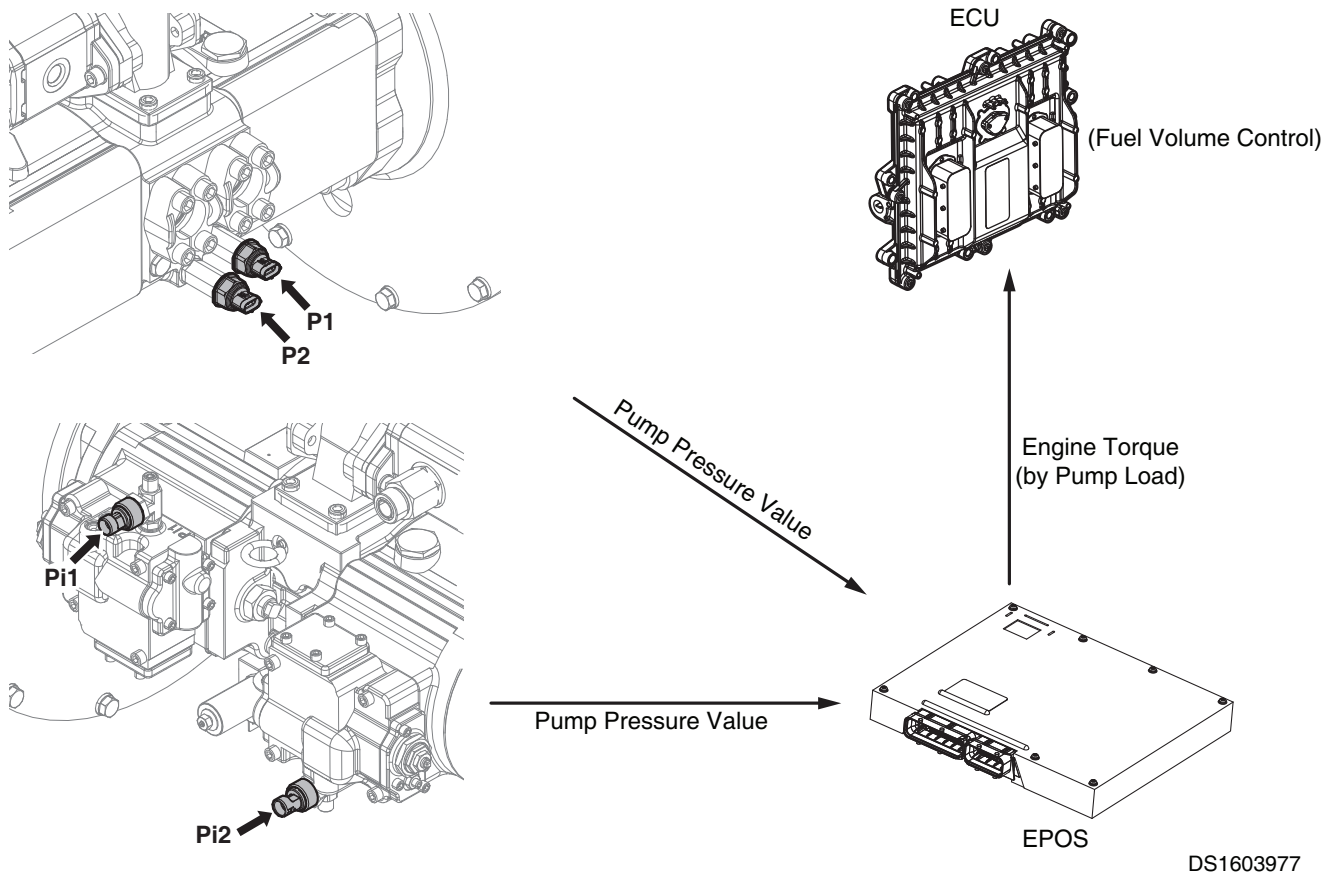


Figure 181

SMART POWER CONTROL (SPC)

The SPC (Smart Power Control) function controls engine speed to reduce fuel consumption by determining high and low load during excavation operation.

When SPC mode is selected, the engine rpm is reduced by 100 rpm from the working mode. In excavation work, the engine rpm will increase linearly to the speed of selected mode depending on the required pump output.

The selection and release of the SPC function can be made with the SPC switch on the R.H stand.

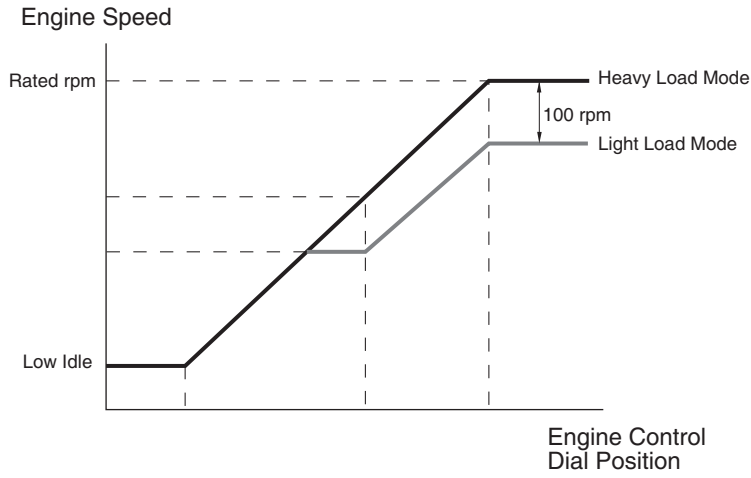
When the start-up switch is turned on, the power mode is automatically set to SPC Standard or SPC Mode. In this status, use the button switch on the instrument panel or jog switch to select SPC Power Plus Mode, SPC Power Mode, SPC Standard Mode, or SPC Economy Mode. When a mode is selected, the corresponding symbol appears at the bottom left of the instrument panel.

Operation

Smart Engine Speed Control

This function controls engine speed according to the required pump output.

The engine speed is classified into Heavy load mode and Light load mode and matched automatically according to the workload. The variable range of the engine speed is set by 100 rpm that does not cause any problem in operation sequence. The workload is determined with information of pump sensors.



“Smart Engine Speed Control”
All the engine speed to match automatically depend on working load condition

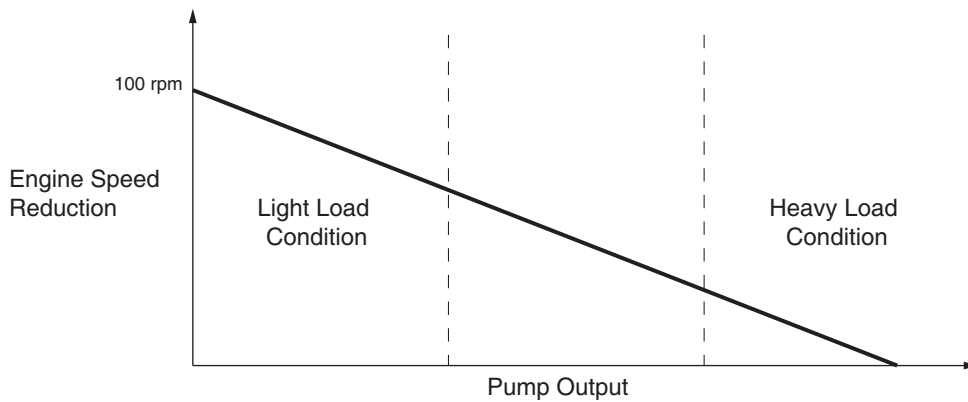
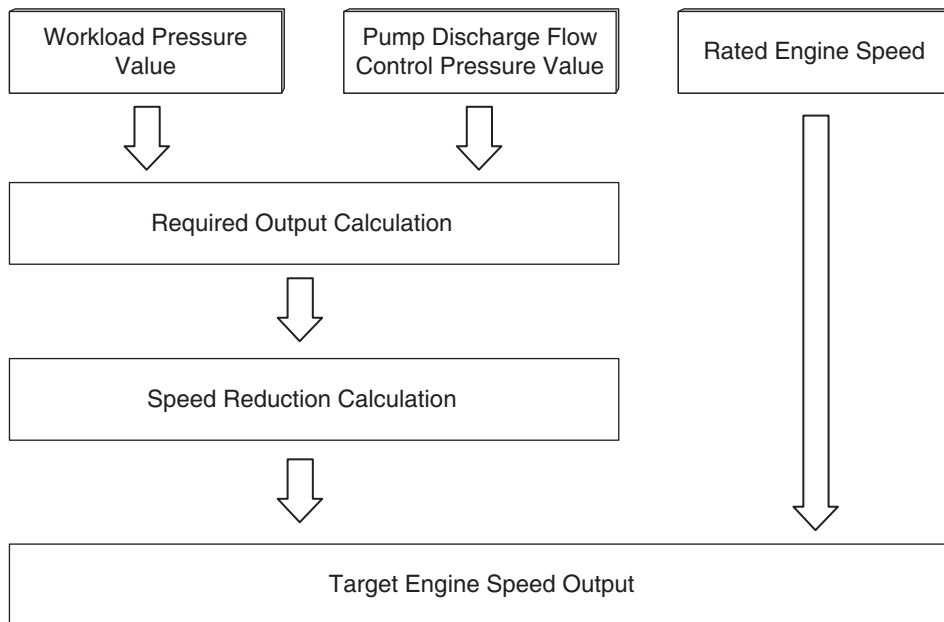
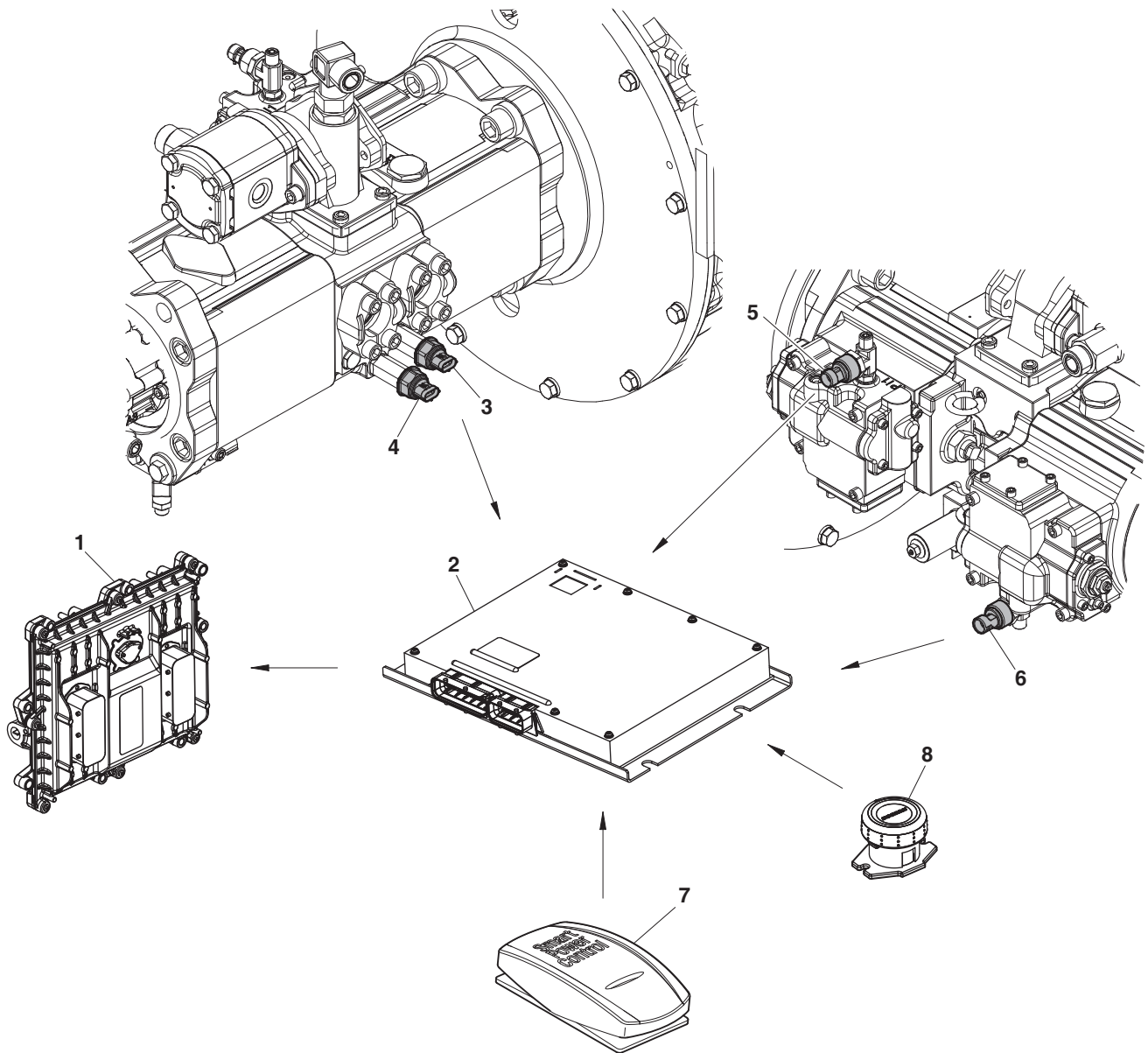


Figure 182

DS1603956

SPC Diagram



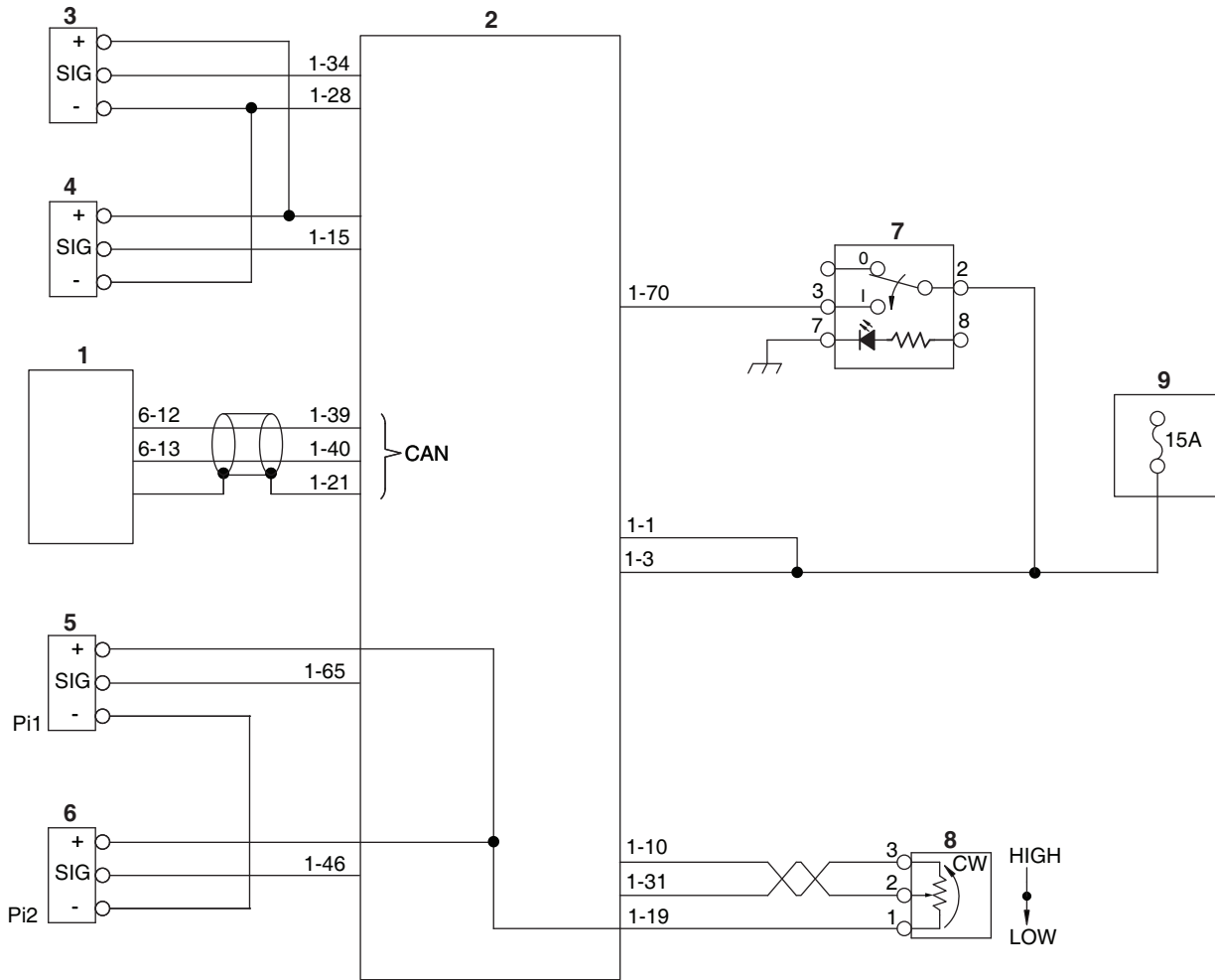
DS1603953

Figure 183

Reference Number	Description
1	Engine Control Unit
2	EPOS Controller
3	Pressure Sensor (Font Pump)
4	Pressure Sensor (Rear Pump)

Reference Number	Description
5	Pressure Sensor (SPC Front)
6	Pressure Sensor (SPC Rear)
7	SPC Switch
8	Engine Control Dial

SPC Circuit



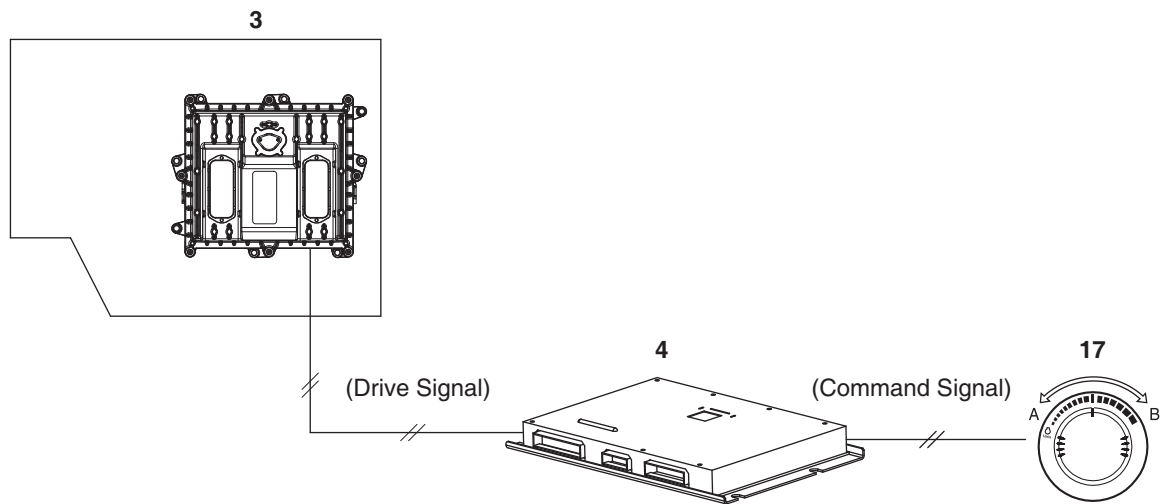
DS1603957

Figure 184

Reference Number	Description
1	Engine Control Unit
2	EPOS Controller
3	Pressure Sensor (Font Pump)
4	Pressure Sensor (Rear Pump)
5	Pressure Sensor (SPC Front)

Reference Number	Description
6	Pressure Sensor (SPC Rear)
7	SPC Switch
8	Engine Control Dial
9	Fuse Box

ENGINE CONTROL SYSTEM



DS1602853

Figure 185

Reference Number	Description
3	Engine Controller
4	EPOS Controller

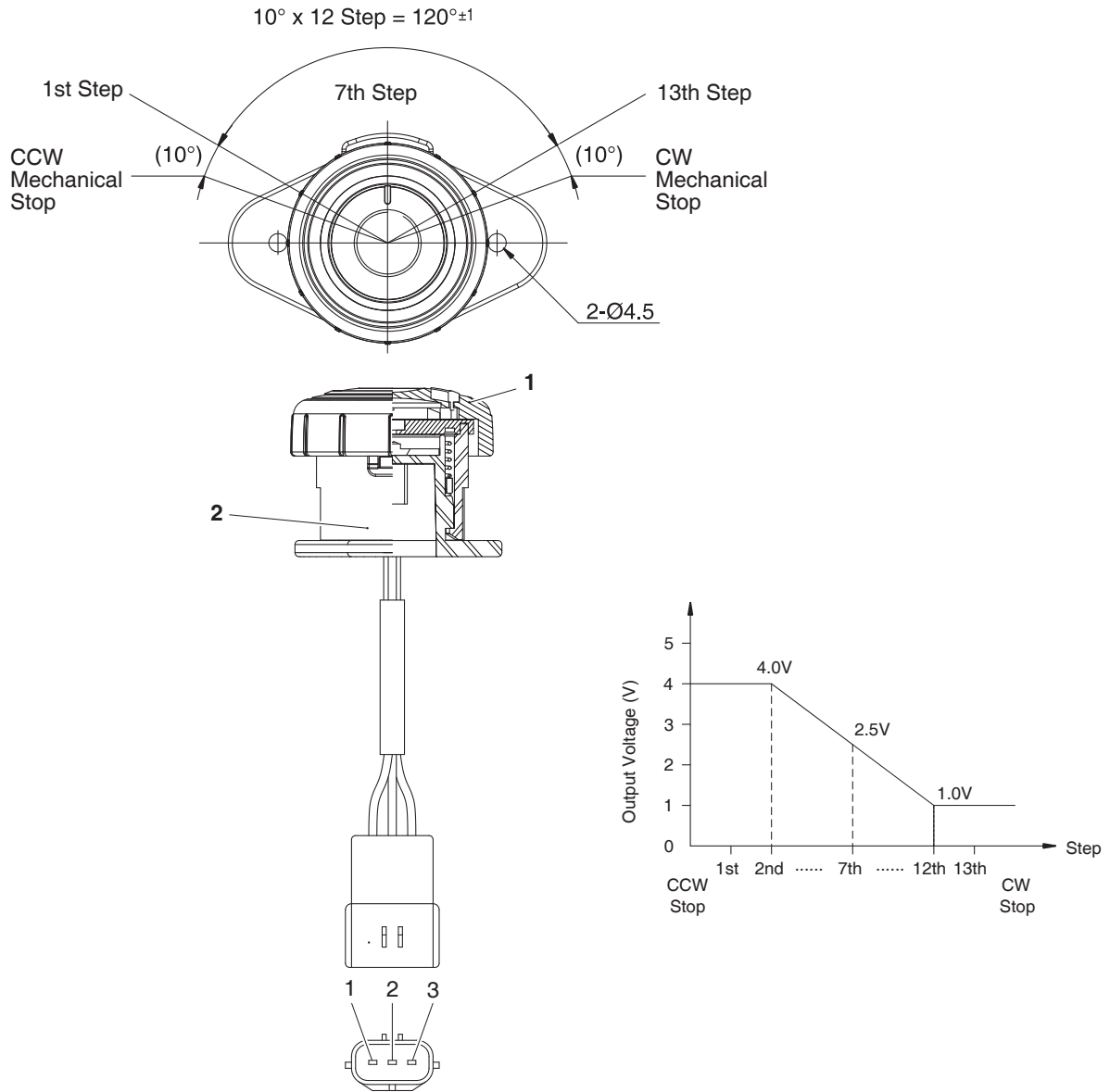
Reference Number	Description
17	Engine Control Dial

When the engine control dial is moved the output voltage changes according to the dial position.

The EPOS controller converts this output voltage of dial to digital signal and sends it to the engine controller by CAN line. According to the dial command, the quantity of fuel injection is adjusted.

Power Output Value Using Ramp and Power

Engine Control Dial



FG018941

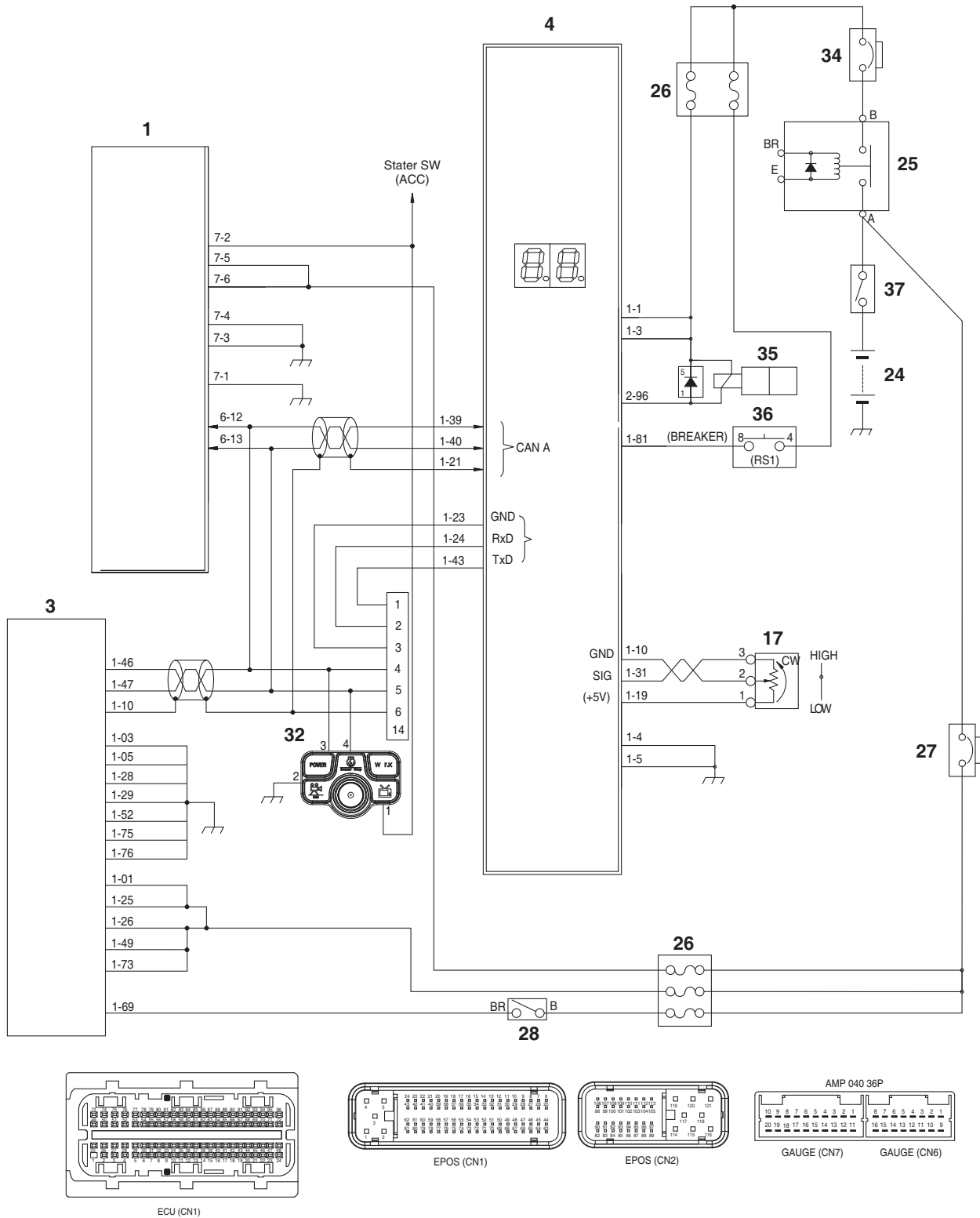
Figure 186

Reference Number	Description
1	Knob

Reference Number	Description
2	Hall Effect Sensor

The engine control dial has a built in potentiometer. When the control knob is moved the output voltage (through "2 and 3" terminals) will vary from the 5 V supplied from the EPOS controller as shown in the graph.

Engine Control



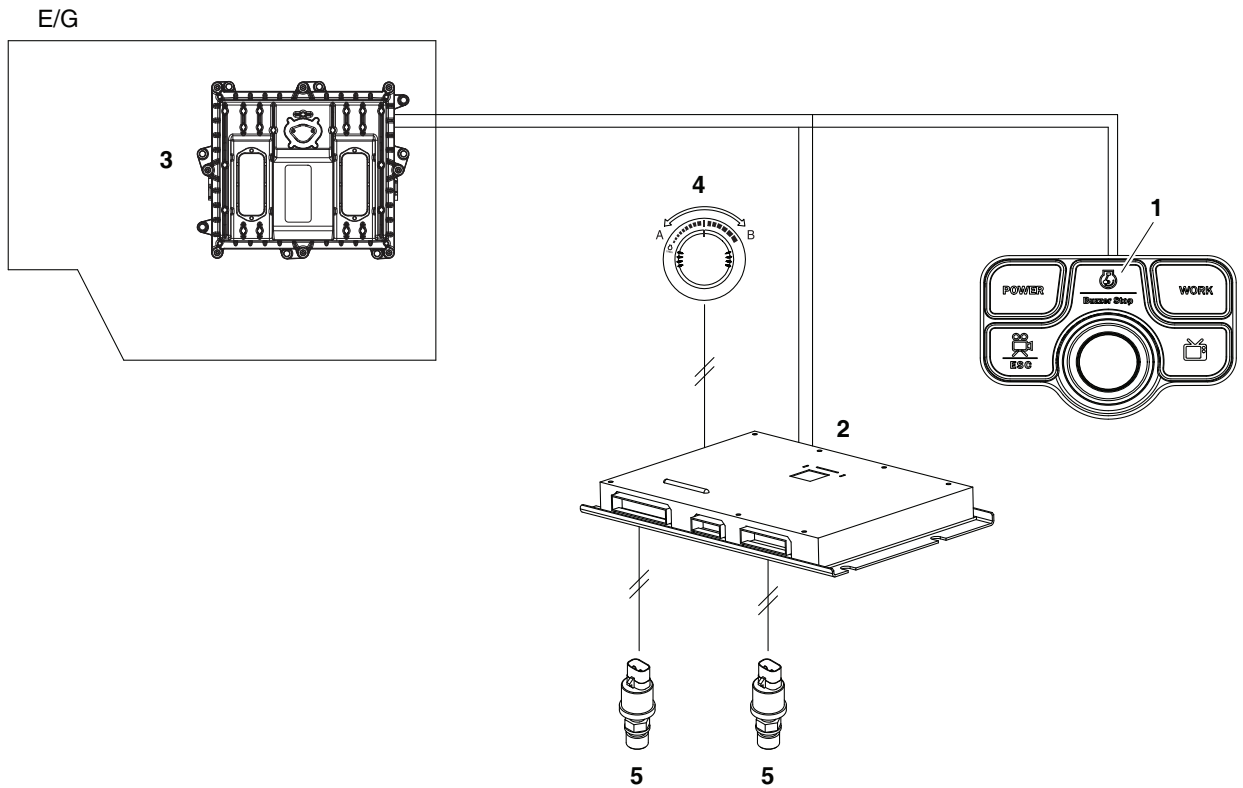
DS1603978

Figure 187

Reference Number	Description
1	Instrument Panel
3	Engine Controller
4	EPOS Controller
17	Engine Control Dial
24	Battery
25	Battery Relay
26	Fuse
27	Circuit Breaker 1

Reference Number	Description
28	Starter Switch
32	Jog Switch Control Panel
34	Circuit Breaker 2
35	Solenoid Valve (Pressure Up)
36	Power Boost Switch (Top of Right Work Lever)
37	Master Switch

AUTOMATIC DECELERATION CONTROL (AUTO IDLE CONTROL)



DS1602855

Figure 188

Reference Number	Description
1	Jog Switch Control Panel (Auto Idle Switch)
2	EPOS Controller

Reference Number	Description
3	Engine Controller
4	Engine Control Dial
5	Pressure Sensor

If the machine is idling without the controls being operated or is waiting for a dump truck the engine speed is automatically lowered. Once the controls are operated and work is being started the machine will be restored to the previous settings. As a result, noise and fuel consumption will be reduced. This function can be selected or canceled through the Auto Idle Selector Switch on the instrument panel.

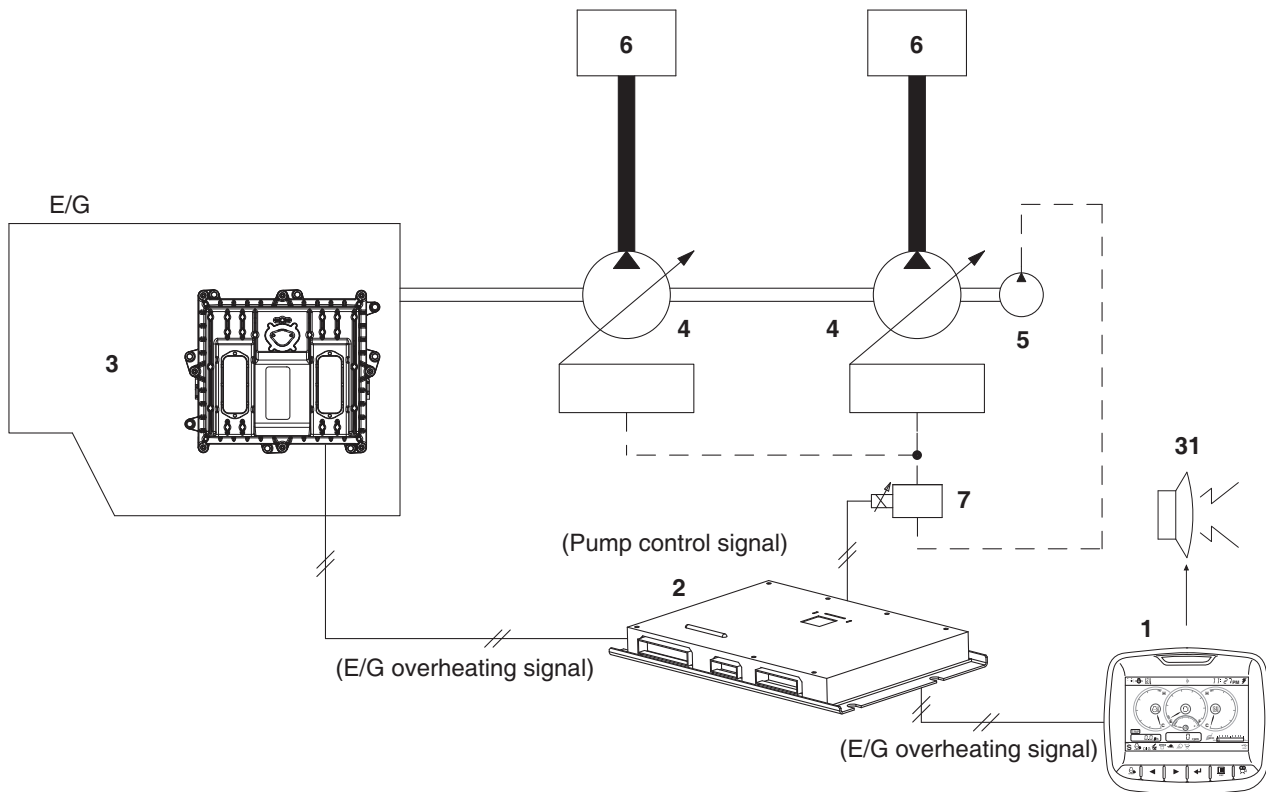
The initial setting at start-up is with this switch in the select position. Approximately 4 seconds after this function is selected, if all work levers are in the neutral position, the EPOS controller compares the automatic reduction signal with the signal set by engine control dial. The lower of the two signals is selected, the EPOS controller sends a signal to the engine controller to control the engine speed.

The neutral status of the machine is detected by the two pressure sensors.

Auto idle logic is as below table.

Location	Auto Idle Release pressure	Auto Idle Operating Pressure	Remark
SH (Swing Motor)	15.5 bar (15.8 kg/cm ² , 224 psi) over	11 bar (11 kg/cm ² , 160 psi) below	Joystick Signal
PT (Control Valve)	23 bar (23.5 kg/cm ² , 334 psi) over	14 bar (14.2 kg/cm ² , 203 psi) below	Travel Signal

ENGINE OVERHEAT PROTECTION SYSTEM



DS1602856

Figure 189

Reference Number	Description
1	Instrument Panel
2	EPOS Controller
3	Engine Controller
4	Main Pump
5	Aux Pump

Reference Number	Description
6	Control Valve
7	EPPR Valve (Electromagnetic Proportional Pressure Reducing Valve)
31	Warning Buzzer

When the engine coolant temperature increases to over 107°C (225°F), the engine controller detects it from the sensor mounted in the coolant line and will send a signal to the EPOS controller. The EPOS controller sends an overheat signal to the instrument panel turning "ON" the warning light and buzzer simultaneously.

When coolant temperature falls below 100°C (212°F), normal operation will resume.

1. Coolant Overheat Prevention System

The engine controller detects the engine coolant temperature with the temperature sensor in the coolant line. If the coolant is overheated, the engine controller send the overheat signal to the EPOS controller which conveys the signal to the instrument panel.

If the coolant is overheated, the pump output is reduced to prevent engine overheat.

When the coolant temperature reaches about 103°C (217°F), the pump output is reduced to 85% into the Tropical mode. A pop-up screen appears on the instrument panel to inform the operator of the mode shift.

If the coolant temperature exceeds 107°C (224°F), the engine controller sends coolant overheat signal to the EPOS controller which conveys the signal to the instrument panel.

Receiving the engine overheat signal, the instrument panel turns on the warning light and triggers the buzzer for warning.

The engine controller controls the engine speed to low speed range.

In summary, in case of engine coolant overheat, the system selects tropical mode, triggers warning buzzer, shifts to standard power mode, reduce engine speed, and reduces pump output.

When the coolant temperature is lowered to 100°C (212°F) or below, the system resumes normal operating condition.

2. Hydraulic Oil Overheat Prevention System

During operation, the EPOS controller monitors the hydraulic oil temperature with the hydraulic oil temperature sensor. If the hydraulic oil is overheated, the EPOS controller sends the overheat signal to the instrument panel.

When the hydraulic oil is overheated, the pump output is reduced to prevent engine overheat.

When the hydraulic oil temperature reaches about 97°C (206.6°F), the pump output is reduced to 85% into the Tropical mode. A pop-up screen appears on the instrument panel to inform the operator of the mode shift.

If the hydraulic oil temperature exceeds 99°C (210.2°F), the EPOS controller sends hydraulic oil overheat signal to the instrument panel.

Receiving the hydraulic oil overheat signal, the instrument panel turns on the warning light and triggers the buzzer for warning.

In addition, the EPOS controller sends a signal back to the engine controller and shifts the power mode to the standard mode.

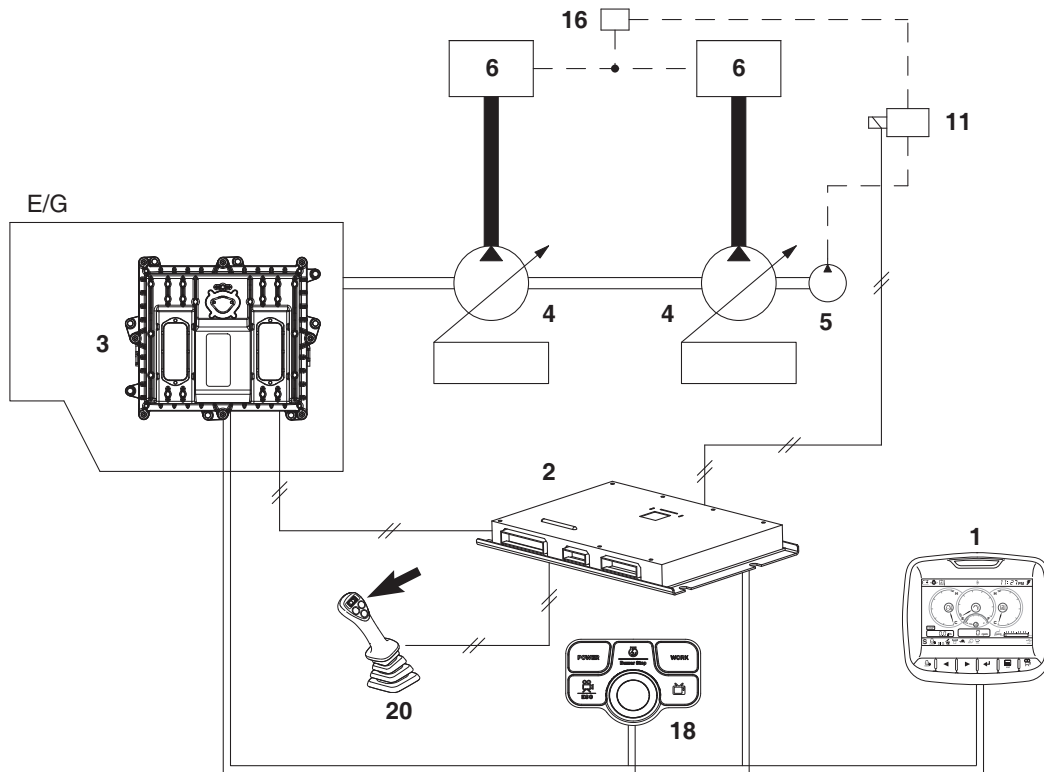
The engine controller controls the engine speed to low speed range.

In summary, in case of hydraulic oil overheat, the system selects tropical mode, triggers warning buzzer, shifts to standard power mode, reduce engine speed, and reduces pump output.

When the hydraulic oil temperature is lowered to 91°C (196°F) or below, the system resumes normal operating condition

POWER BOOST MODE

Operation



DS1602857

Figure 190

Reference Number	Description
1	Instrument Panel
2	EPOS Controller
3	Engine Controller
4	Main Pump
5	Aux Pump
6	Control Valve

Reference Number	Description
11	Solenoid Valve (Boost)
16	Main Relief Valve
18	Jog Switch Control Panel
20	Power Boost Switch (Top of Right Work Lever)

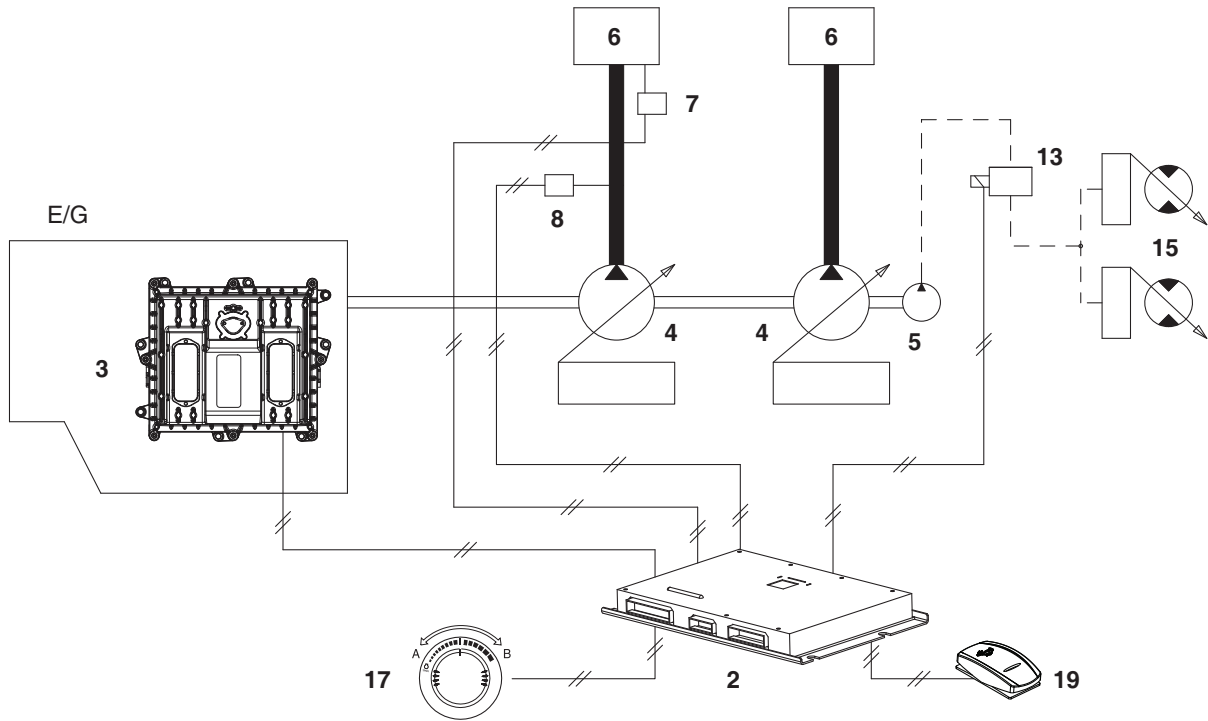
The Power Boost function is used to temporarily increase the main relief pressure to enhance excavation ability. When the Work Mode is set to "BOOST" by the jog switch control panel and the power boost button on the right-hand work lever (joystick) is pressed during work, the EPOS controller will activate the power boost solenoid valve and increase the relief valve pressure from 343 to 363 bar (4,980 - 5,260 psi) for 7 seconds. The excavation ability is increased by approximately 6%. When the power boost function is in activated, a power boost symbol appears on the information display department of instrument panel.

NOTE: Do not use this switch for more than 10 seconds.

Reference Number	Description
1	Instrument Panel
3	Engine Controller
4	EPOS Controller
17	Engine Control Dial
24	Battery
25	Battery Relay
26	Fuse
27	Circuit Breaker 1

Reference Number	Description
28	Starter Switch
32	Jog Switch Control Panel
34	Circuit Breaker 2
35	Solenoid Valve (Pressure Up)
36	Power Boost Switch (Top of Right Work Lever)
37	Master Switch

AUTOMATIC TRAVEL SPEED CONTROL



DS1602859

Figure 192

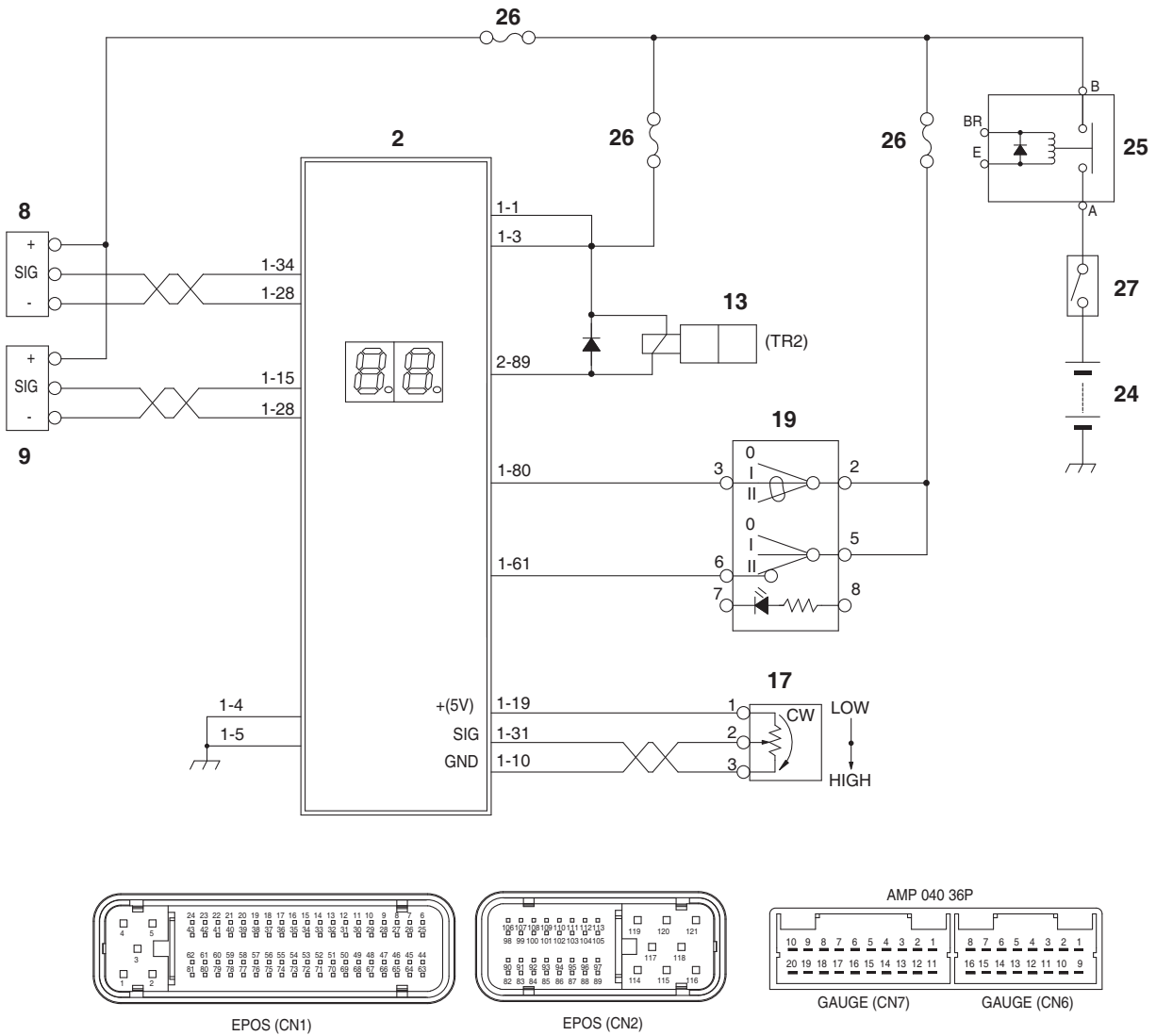
Reference Number	Description
2	EPOS Controller
3	Engine Controller
4	Main Pump
5	Aux Pump
6	Control Valve
7	Pressure Switch

Reference Number	Description
8	Pump Pressure Sensor
13	Solenoid Valve (High-speed)
15	Travel Motor
17	Engine Control Dial
19	Selector Switch for Automatic Travel

If the automatic travel speed control switch is set to "OFF" position, the travel motor will run in the I-speed (low speed) range. If the selector switch is set to "I" position, the travel motor will run in the II-speed (high-speed) range. If the selector switch is set to "II" position, the EPOS controller will monitor the main pump discharge pressure and automatically select the "ON" - "OFF" status of the II-speed travel solenoid valve based on the travel load. The travel speed is changed between the I-speed and the II-speed mode.

The travel load is monitored by the two pressure sensors in the discharge lines of the front (upper) and rear (lower) pumps. When the travel load is high-pressure over 294 bar (4,300 psi) the solenoid valve is turned "OFF" and I-speed (low) is selected. In the case when the travel load is low (pressure under 156 bar (2,280 psi), the solenoid valve will be turned "ON" and the II-speed will be selected. But, if the engine speed control switch dial is set below approximately 1,400 rpm, the travel speed will be set to I-speed mode.

Automatic Travel Speed Control



DS1603979

Figure 193

Reference Number	Description
2	EPOS Controller
8	Pressure Sensor (Front Pump)
9	Pressure Sensor (Rear Pump)
13	Solenoid Valve (High-speed)
17	Engine Control Dial
19	Selector Switch For Automatic Travel

Reference Number	Description
24	Battery
25	Battery Relay
26	Fuse
27	Master Switch

WATER IN FUEL WARNING SYSTEM

Operation

If the fuel contains a significant concentration of water, it can cause engine performance deterioration and shorten the service life of the engine, after a long time operation.

To protect the engine in case that operator ignores "Water In Fuel (WIF)" warning and keeps operating the equipment, which can deteriorate the engine, a sound warning system is added to induce the operator to remove water in the fuel.

1. Buzzer Sound at WIF Warning

If the fuel contains significant ratio of water, the WIF sensor of the water-oil separator sends a signal to the EPOS controller which relays the signal to the instrument panel. The instrument panel turns on the warning light and pop-up window on the screen, and triggers the buzzer so operator can remove water from the fuel.

If the operator resets the warning pop-up and buzzer without removing the water from the fuel, the warning pop-up window reappears on the instrument panel screen and the buzzer sounds again after 30 seconds from the reset.

2. Power Output Reduction by Water in Fuel

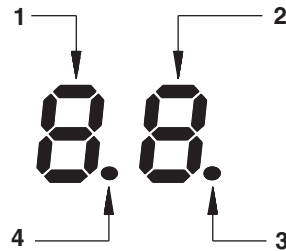
If the operator fails to remove water from the fuel for one hour from the first WIF warning, the power of the equipment is reduced so operator remove water from the fuel.

Restricted Function	Engine Speed	Pump Output
Limited	1,200 rpm	70%

SELF-DIAGNOSTIC FUNCTION

EPOS Controller

The system operation status and malfunction codes can be checked through the display on top of the EPOS controller box the rear cover behind the operator's seat.



FG000588

Figure 194

Reference Number	Description
1	Upper Digit
2	Lower Digit
3	Engine Speed Monitor LED (Flash Interval Increases With Engine Speed.)

Reference Number	Description
4	Power Monitor (Stays "ON" While Power Is In Normal Range,)

1. Power Monitor

This LED is turned "OFF" when the input voltage to the EPOS controller is below 18.5 ± 1 V or above 32.5 ± 1 V. Stays "ON" while in normal range.

2. Engine Speed Monitor

This LED light flashes according to the engine speed. The flashing interval is proportional to the engine speed.

3. Normal Operation Display Readout

Mode		Display		System Condition
		Higher Digit	Lower Digit	
Power Mode	P+, P	9 HAOH340L	- FG018940	Normal Operation Power Mode
	S	8 FG018938	- FG018940	Normal Operation Standard Mode
	E	7 HAOH350L	- FG018940	Normal Operation Economy Mode
Work Mode	Digging	- FG018940	0 HAOH370L	Normal Operation Digging Mode
	Lift	- FG018940	3 FG018939	Normal Operation Lift Mode

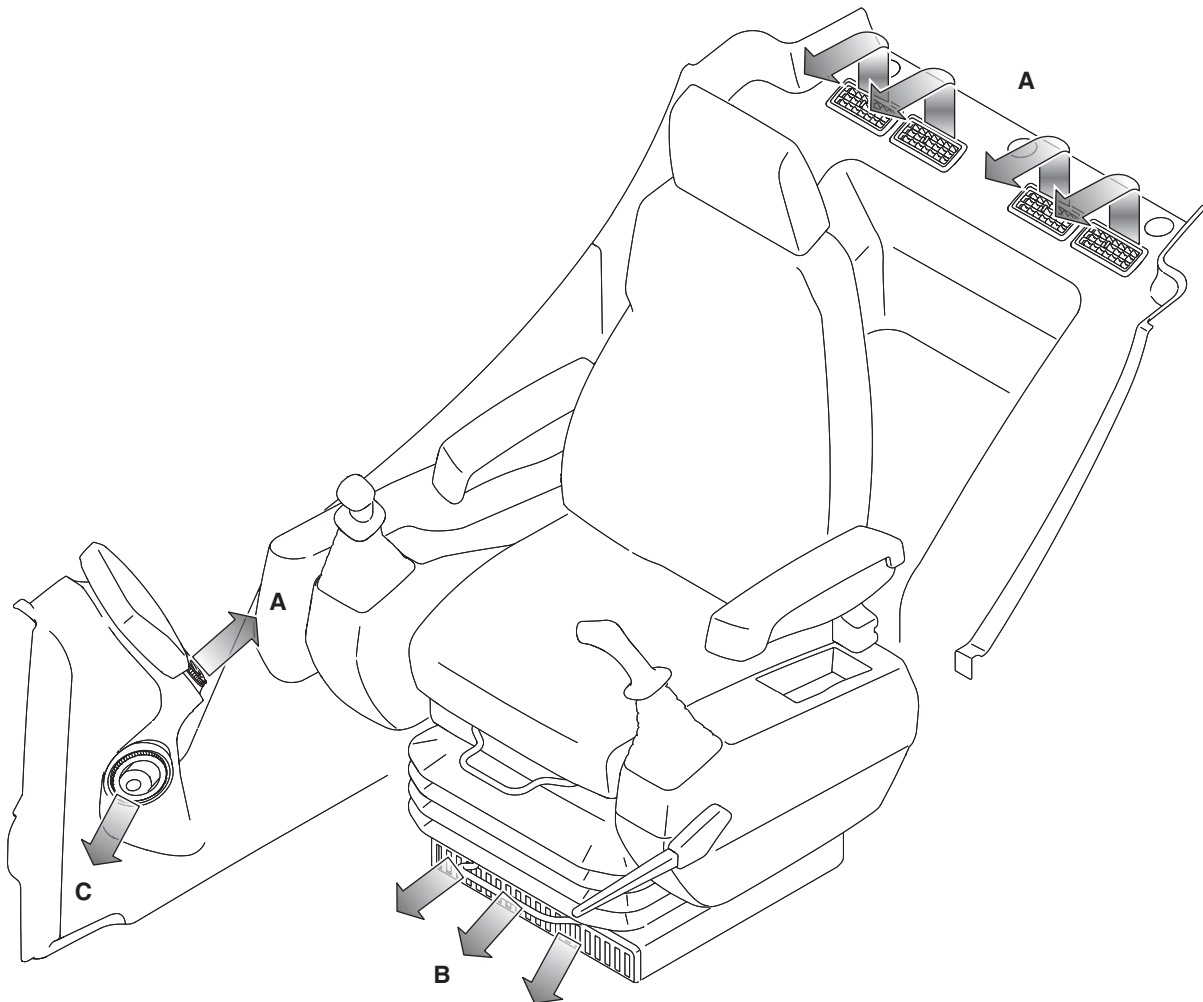
4. Communication Monitor

What are shown in the 7-SEGMENT LED are same as those in the Error Codes.

Error Code	Indication Code	Fault Location
V201	01	Communication error in instrument panel.
V202	02	Communication error in engine controller.

AIR CONDITIONER SYSTEM

Outline



EX1301100

Figure 195






Solid-type heater and air conditioner are installed in the cover behind the operator's seat.

Temperature of the operator's cabin is adjusted automatically to the temperature set by operator.

(Please refer to the Operation & Maintenance Manual for detailed full automatic control.

Vent mode selects the direction of discharged air.

Outlets by vent modes

Modes					
Outlets	A	A+B	B	B+C	C

Internal and External Filters

Internal and external air purification filters are installed for the operator's room.

Filters must be cleaned every 500 hours.

If machine operates in an excessively contaminated environment, filters must be cleaned more frequently and if necessary, replaced with new ones.

How to Check Internal Air Filter

1. Remove cover by pulling knob outward on top of the left and right of the filter which is inside the left rear part of the cabin.
2. Remove inner filter by pulling knob outward while pressing the upperpart and lower part of the filter handle.
3. Replace with new one.
4. Reassemble filter in reverse order.

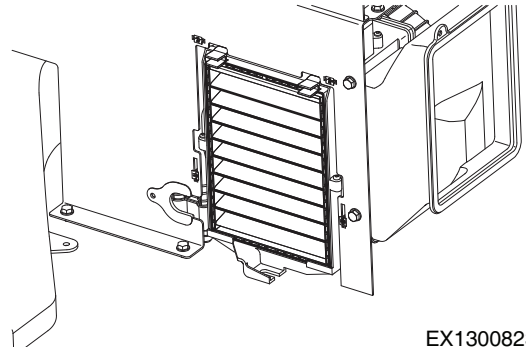


Figure 196

EX1300823

How to Check External Air Filter

NOTE: All right and left call outs are based on the operator being seated in the operator's seat facing the front.

1. Open the cover by using the starter KEY in the left side of the cabin.

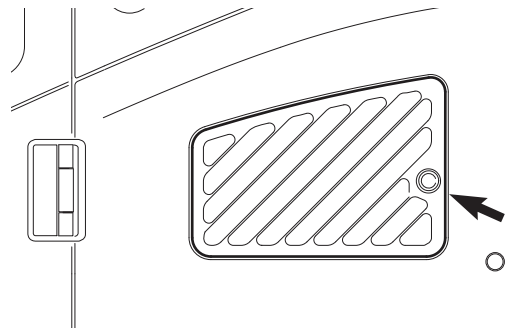


Figure 197

EX1300825

2. Remove filter (Figure 198) and replace with new one.
3. Reassemble in reverse order.

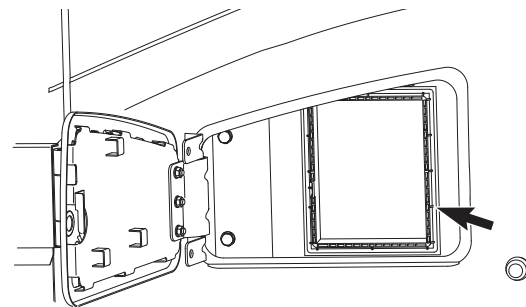
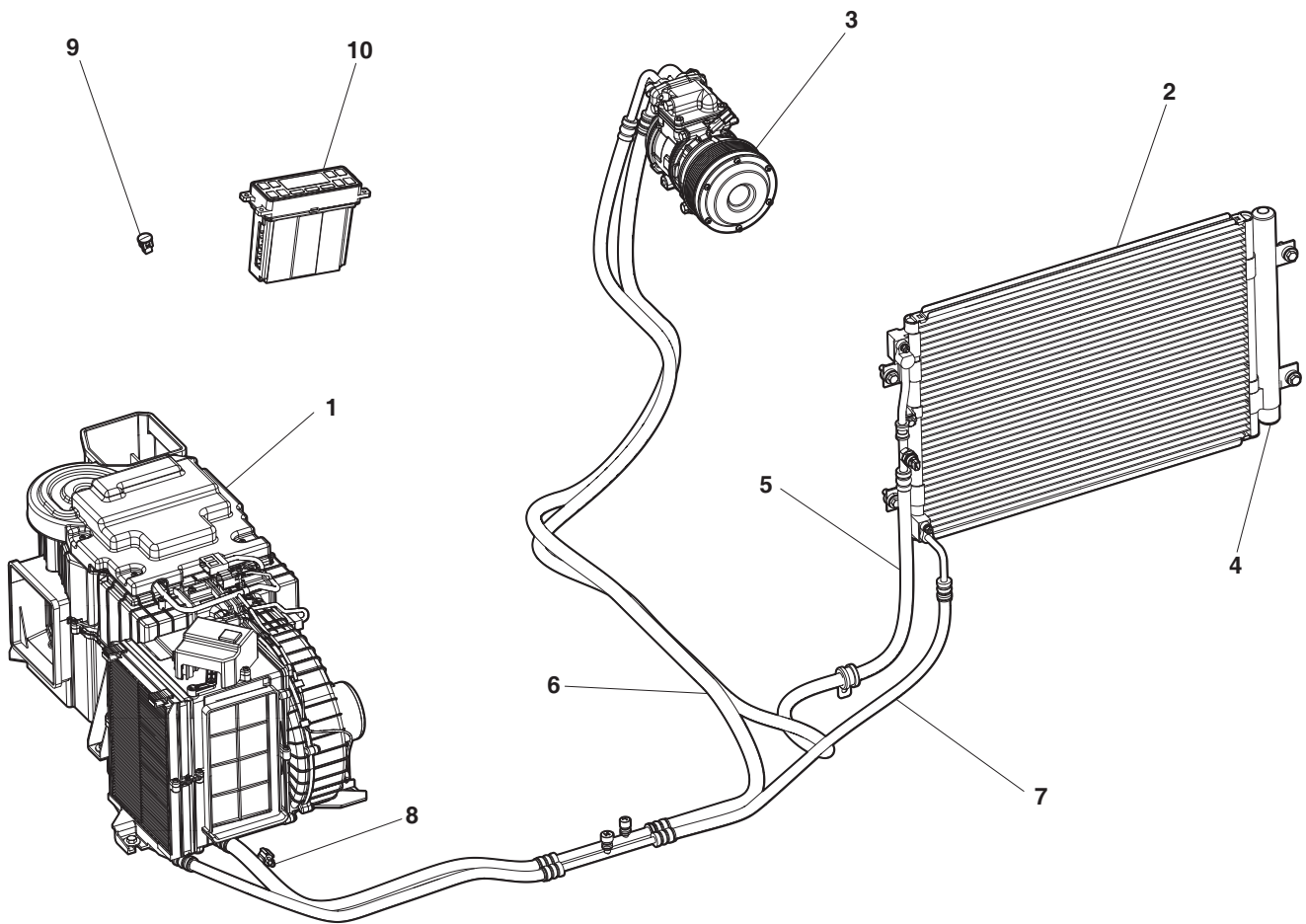


Figure 198

EX1403389

Air-Conditioning System Layout



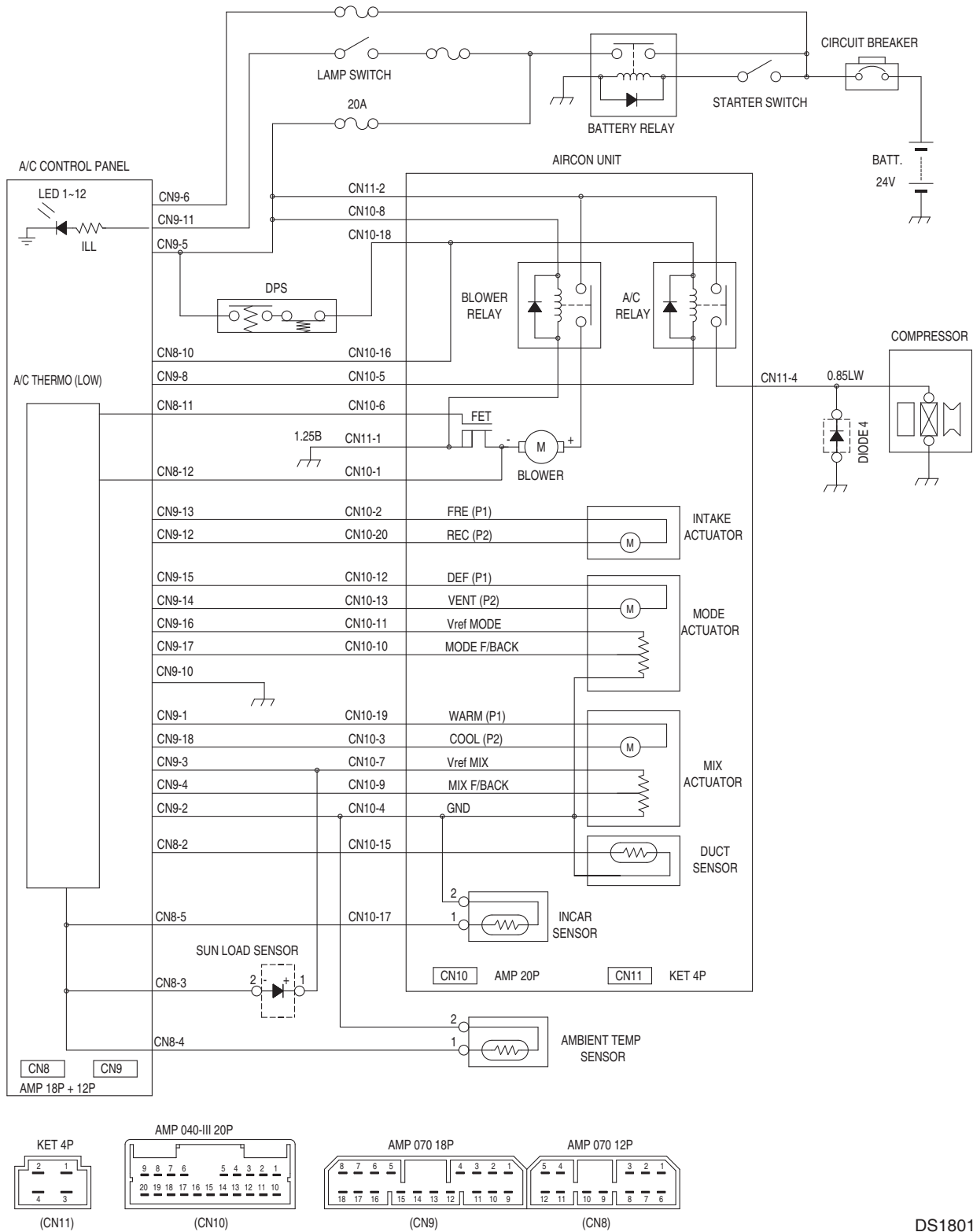
DS1801725

Figure 199

Reference Number	Description
1	Air Conditioner/heater Unit
2	Condenser
3	Compressor
4	Receiver Dryer
5	Discharge Hose

Reference Number	Description
6	Suction Hose
7	Liquid Hose
8	Ambient Temperature Sensor
9	Sun Sensor
10	Control Panel

Air Conditioner/Heater Circuit Diagram

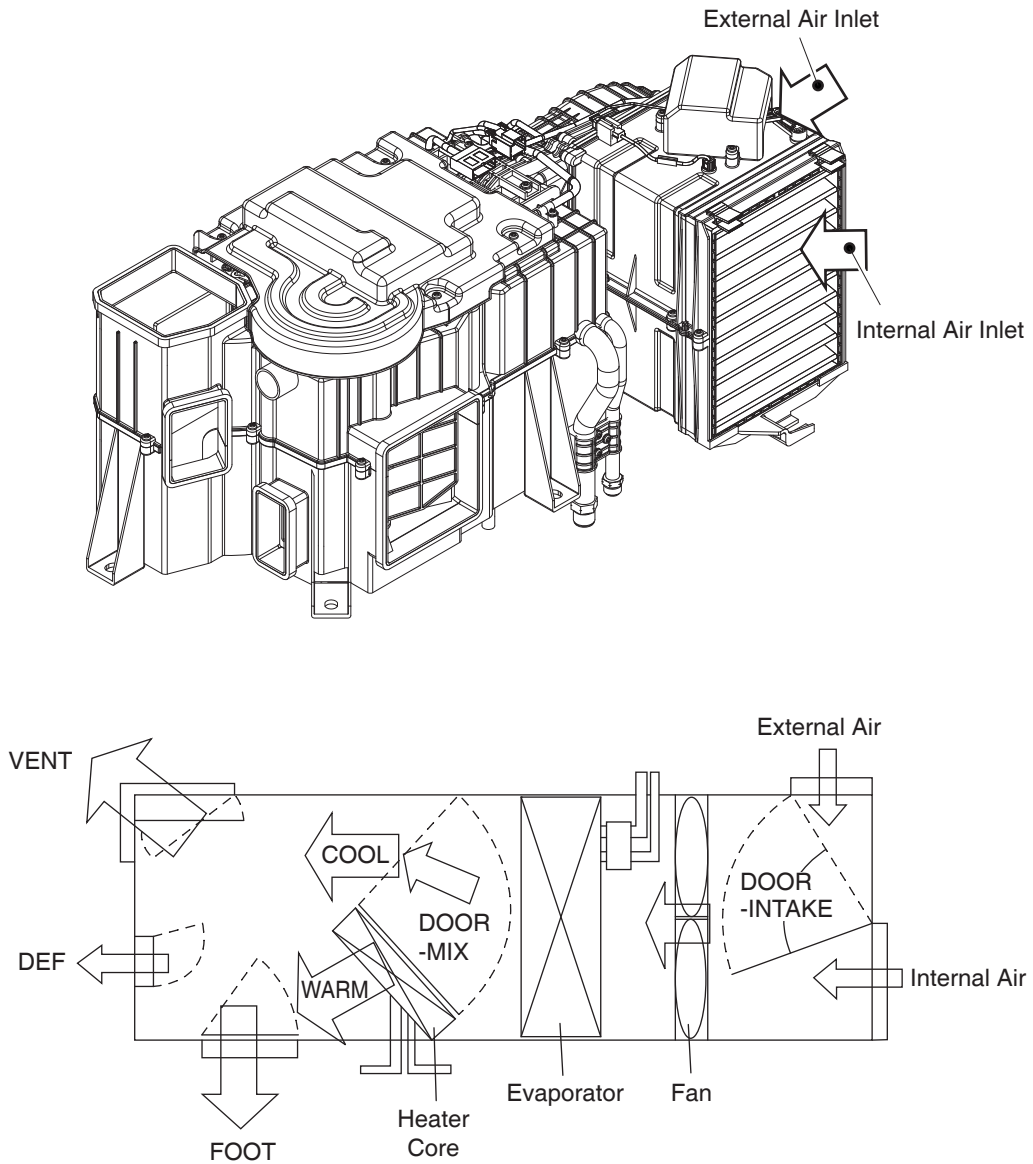


DS1801735

Figure 200

Air Conditioner/Heater Unit

Airflow Diagram



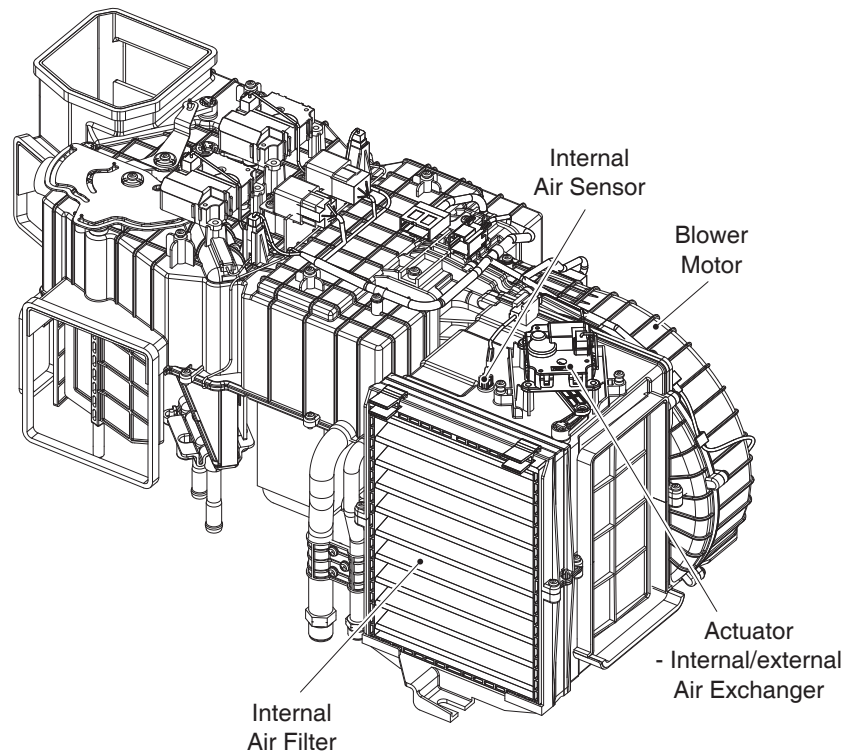
FG016942

Figure 201

Door Open by Vent Modes

Door	Mode				
	Vent	Bi-level	Foot	Def/foot	Def
Vent	100	60	0	0	0
Foot	0	40	100	80	60
Def	0	0	0	20	40

Main Components



FG016943

Figure 202

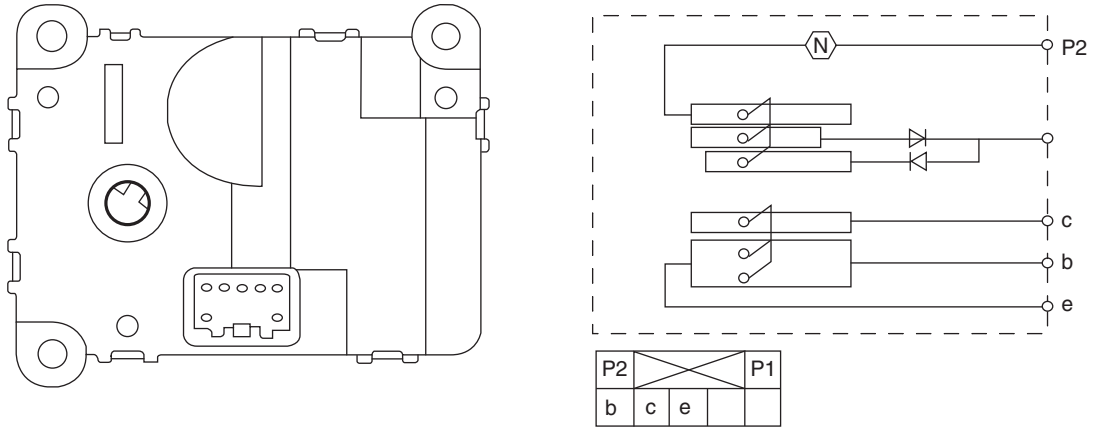
Actuator - Airflow Direction Control

Change of discharged airflow according to selected airflow direction mode

Change of airflow direction: Direction changes in the order of VENT → BI-LEVEL → FOOT → FOOT/DEF → VENT.

Actuator - Temperature Control

Change of discharged air temperature by controlling the position of temperature control door.



FG001361

Figure 203

Actuator - Airflow Direction Control

Airflow Direction Mode	Output Terminal	Voltage
Vent	c (+): CN10-10 b (-): CN10-4	0.5 ±0.2V
Bi-level		1.3 ±0.2V
Foot		2.45 ±0.2V
Foot/def		3.5 ±0.2V
Def		4.5 ±0.2V

Actuator - Temperature Control

Set Temperature	Output Terminal	Voltage
Max cooling	c (+): CN10-9	Below 0.4V
Max heating	b (-): CN10-4	Above 4.5V

Actuator - Internal/External Air Exchange

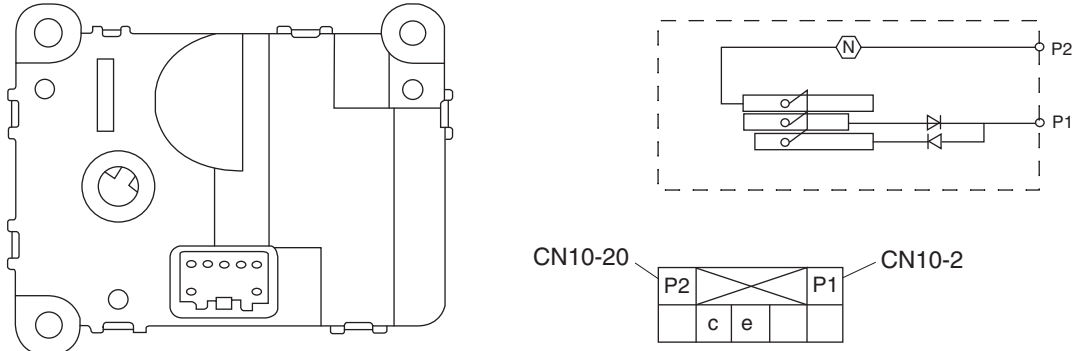


Figure 204

FG001055

Mode	Output Terminal	Output
Intake	P1 (+), P2 (-)	Moving of exchange door by selecting intake.
Recirculate	P1 (-), P2 (+)	Moving of exchange door by selecting recirculate.

Airflow Control Module

Airflow is controlled through the control of voltage between GATE and SOURCE.

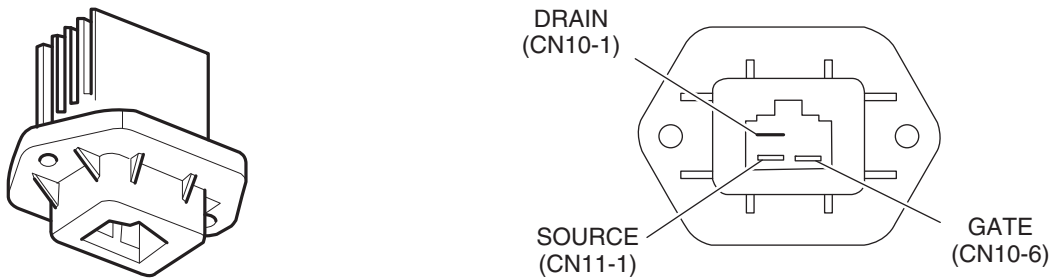


Figure 205

FG001056

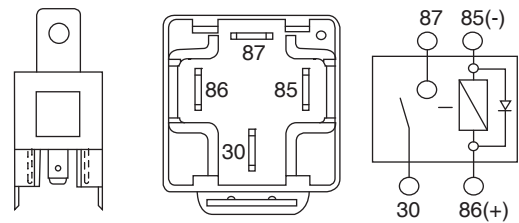
Airflow	Output Terminal		Output
1st	CN11-2	CN10-1	10 ±0.5V
2nd			12.5 ±0.5V
3rd			15 ±0.5V
4th			17.5 ±0.5V
5th			20.0 ±0.5V
6th			22.0 ±0.5V
7th			More than 25V

Input voltage is 27.5V.

The airflow is based on manual set.

Relay - Blower: Power is supplied to the blower motor when the system is turned "ON".

Specifications	
Rated voltage	24V
Rated current	20A

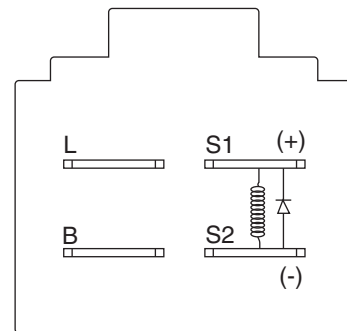


FG001057

Figure 206

Relay - A/C: Power is supplied to the magnetic clutch of the compressor.

Specifications	
Rated voltage	24V
Rated current	10A



FG001058

Figure 207

Duct Sensor: It is inserted in the core of the evaporator to prevent freezing of the evaporator.

The sensor consist of negative characteristic thermistor that resistant value increases and decreases when the temperature rises and falls, respectively.

Temperature (°C)	Resistance (KΩ)
0	11.36 ±0.1
2	10.39 ±0.2
2.5	10.17 ±0.2
3	9.95 ±0.2
3.5	9.73 ±0.2
4	9.52 ±0.2
5	9.12 ±0.2
10	7.36 ±0.15
25	4.02 ±0.08
30	3.33 ±0.07

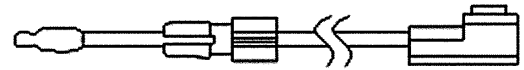


FG001059

Figure 208

Internal Air Temperature Sensor: Built in the internal air filter, it senses the internal temperature.

Temperature (°C)	Resistance (KΩ)
-15	218.2 ±7.5
0	97.83 ±0.9
15	47.12 ±0.7
25	30.0 ±0.36
35	19.60 ±0.3



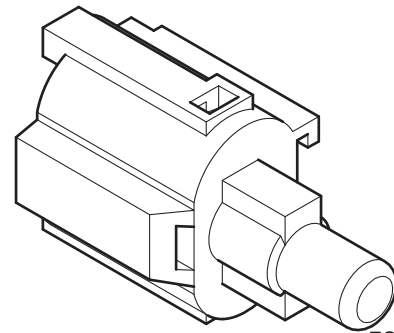
FG001061

Figure 209

Ambient Air Temperature Sensor

Built at the bottom of the cockpit, it senses the temperature of external air.

Temperature (°C)	Resistance (KΩ)
-10	163 ±4.9
0	96.9 ±2.9
10	59.4 ± 1.8
20	37.4 ±1.1
25	30 ±0.9
30	24.2 ±0.7



FG001064

Figure 210

Sun Sensor

Built beside the socket of spare power, it senses the quantity of the sun radiation to regulate discharge temperature and airflow as set by operator.

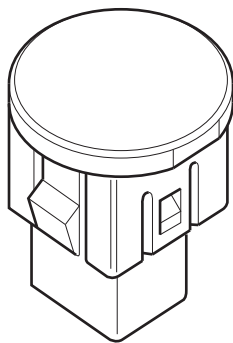
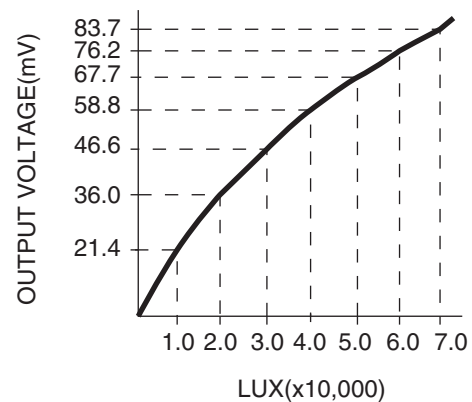


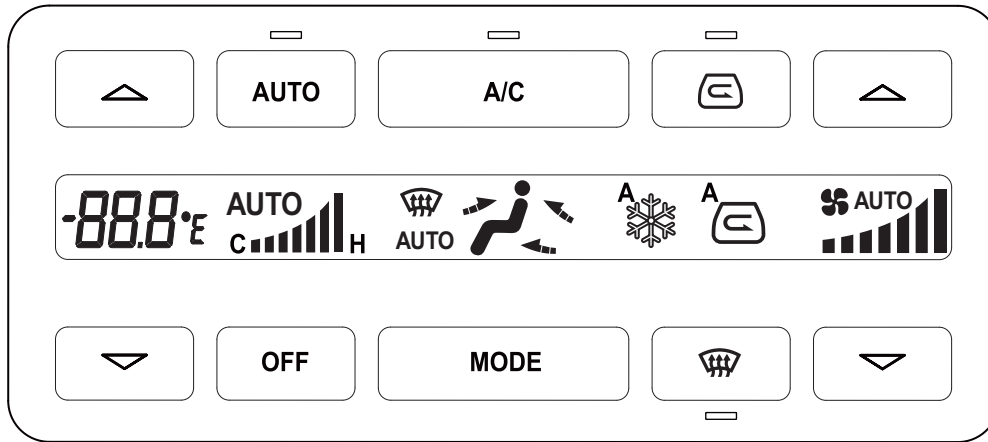
Figure 211



FG001062

Control Panel

Appearance and Terminal Arrangement



DS2100298

Figure 212

Refer to "Air Conditioner and Heater" of operation manual.

Terminal Terms

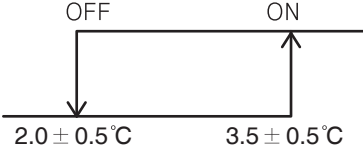
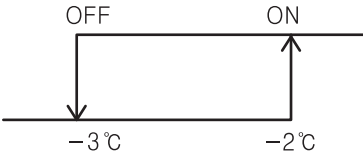
CN	Term No.	Terms
CN9	1	Temperature control (warm)
	2	Sensor ground
	3	Temperature control Power (5V)
	4	Mix feedback
	5	Power (KEY "ON")
	6	Backup
	7	-
	8	A/C output (LOW)
	9	-
	10	Ground
	11	Illumination
	12	Intake/Recirculate (Recirculate)
	13	Intake/Recirculate (Intake)
	14	Airflow direction control (VENT)
	15	Airflow direction control (DEF.)
	16	Airflow direction control Power (5V)
	17	Airflow direction control (feedback)
	18	Temperature control (cool)

CN	Term No.	Terms
CN8	1	-
	2	Duct sensor
	3	Sun sensor
	4	Ambient air temperature sensor
	5	Internal air temperature sensor
	6	-
	7	-
	8	-
	9	-
	10	D.P.S CHECK
	11	Airflow module (gate)
	12	Blower motor (feedback)

Control Logic

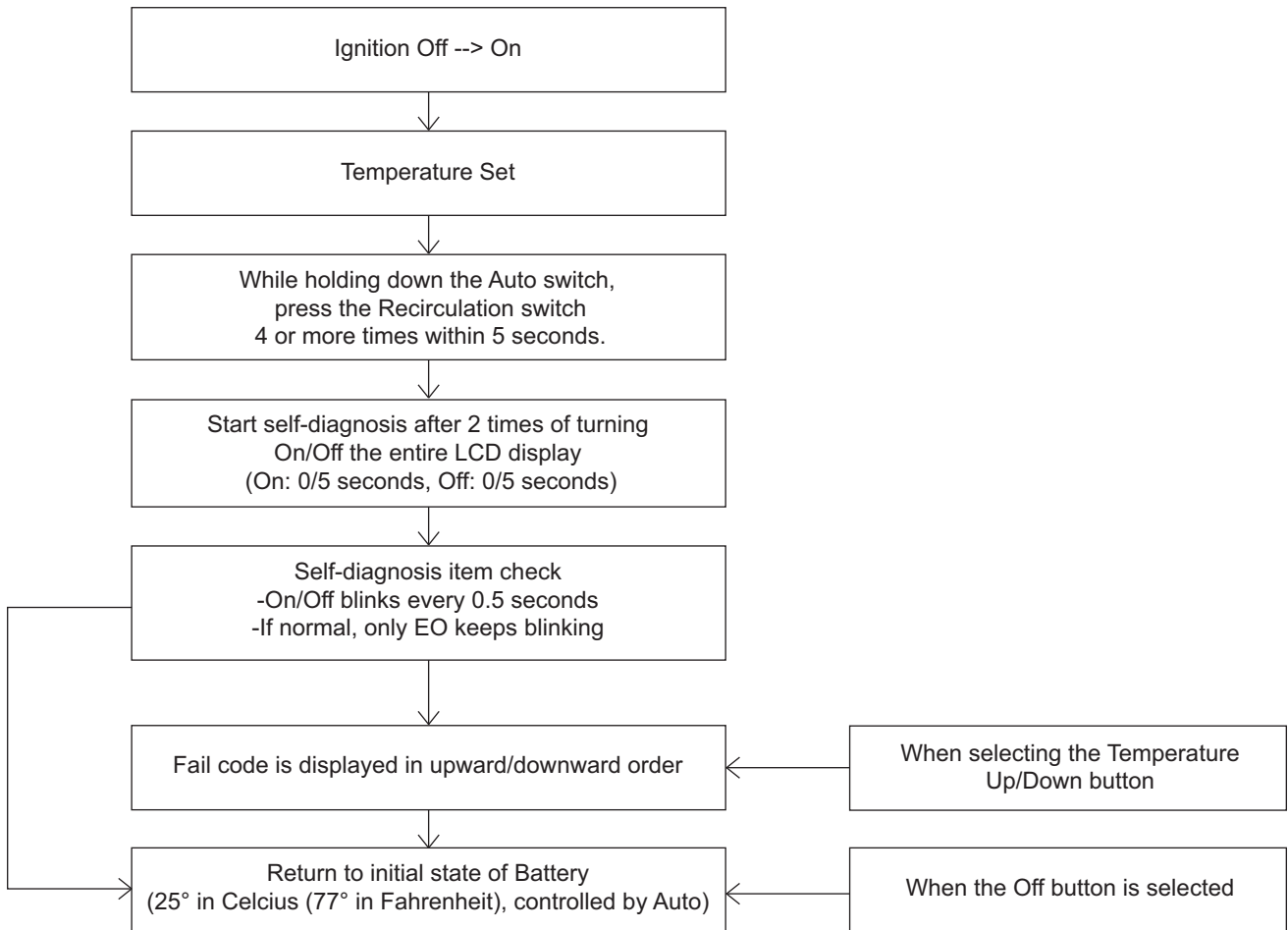
Categories	Inputs	System Operation																		
Auto	Set temperature Internal air temperature sensor Ambient air temperature sensor Sun sensor	<ol style="list-style-type: none"> Automatically adjust room temperature as set and then next items. Temperature, airflow direction, Recirculate/Intake, Airflow, Compressor Auto mode is released when manually setting any switch except, Temperature Control switch in Auto mode. Upon the releasing of Auto mode, all of functions except selected switch are controlled automatically. 																		
Sensor compensation	Set temperature Internal air temperature sensor Ambient air temperature sensor	<ol style="list-style-type: none"> In case of sensor fault, the following defaults are applied: Internal air temperature sensor: 25°C, Ambient air temperature sensor: 25°C, Duct sensor: -2°C Temperature control actuator: - Set Temperature 17 - 24.5°C: Max cooling, Set Temperature 25 - 32°C: Max heating Airflow direction mode actuator - VENT: VENT fix, modes other than VENT: Fixed to DEF * Sun sensor is not compensated. 																		
Max cooling/heating control	Auto Setting	<ol style="list-style-type: none"> Set Temperature 32°C: Max heating Set Temperature 17°C: Max cooling <table border="1" style="margin-left: 40px;"> <thead> <tr> <th></th> <th>Max Cooling (17 °C)</th> <th>Max Heating (32 °C)</th> </tr> </thead> <tbody> <tr> <td>Temp Control Actuator</td> <td>FULL COOL</td> <td>FULL HOT</td> </tr> <tr> <td>Air Flow</td> <td>MAX HI</td> <td>AUTO HI</td> </tr> <tr> <td>Compressor</td> <td>Forced ON</td> <td>OFF</td> </tr> <tr> <td>Intake/Recircle</td> <td>Recircle</td> <td>Intake</td> </tr> <tr> <td>Wind Direction Mode</td> <td>VENT</td> <td>FOOT</td> </tr> </tbody> </table> <p>* Max cooling/heating control is possible only in Auto mode.</p>		Max Cooling (17 °C)	Max Heating (32 °C)	Temp Control Actuator	FULL COOL	FULL HOT	Air Flow	MAX HI	AUTO HI	Compressor	Forced ON	OFF	Intake/Recircle	Recircle	Intake	Wind Direction Mode	VENT	FOOT
	Max Cooling (17 °C)	Max Heating (32 °C)																		
Temp Control Actuator	FULL COOL	FULL HOT																		
Air Flow	MAX HI	AUTO HI																		
Compressor	Forced ON	OFF																		
Intake/Recircle	Recircle	Intake																		
Wind Direction Mode	VENT	FOOT																		

Categories	Inputs	System Operation
Starting Control of Cooling	Auto mode Duct sensor	<ol style="list-style-type: none"> 1. Prevention of discharge of hot air before discharge temperature drops enough in hot summer weather 2. Start conditions (AND condition) <ol style="list-style-type: none"> A. A/C on (AUTO or manual) B. Temperature sensed by the duct sensor is above 30°C C. Airflow: Auto mode 3. One time control in the cycle of engine OFF → engine run 4. Initial cooling control is executed when the Auto switch is "ON" in the manual status (A/C "OFF" and manual control of airflow) in 5 seconds after engine run. 5. Initial cooling control must be before max cooling. 6. Release condition (OR condition) <ol style="list-style-type: none"> A. A/C "OFF" B. Airflow: Manual control C. Release is possible with the "OFF" switch but not allowed within 12 seconds (after Start "ON") while the system is off using the "OFF" switch and during the time of initial cooling control.
Starting control of heating (1)	Internal air temperature sensor Auto mode Set Temperature	<ol style="list-style-type: none"> 1. Start condition (AND condition) <ol style="list-style-type: none"> A. When airflow direction mode is one of the following modes in the Auto or manual control mode - BI-LEVEL, FOOT or FOOT/DEF B. The ambient air temperature sensor measures the ambient air temperature and determines that the appropriate engine temperature has been reached after a certain period of time. C. Airflow: Auto mode D. Set temperature > Internal air temperature + 3°C * Airflow falls gradually up to 12 seconds when operation released. 2. One time control in the cycle of engine OFF → engine run 3. Initial heating control must be before max heating. 4. Airflow is controlled only when the airflow direction is in the manual mode and BI-LEVEL, FOOT, or FOOT/DEF is set. 5. Operation release (OR condition) <ol style="list-style-type: none"> A. Only airflow is released if it is selected manually. B. When handling the airflow direction mode switch, only airflow direction is released but the airflow control is performed only for the remaining period of the starting control of heater. C. When Max Cooling (17°C) is selected.

Categories	Inputs	System Operation
Compressor control	Duct sensor	<ol style="list-style-type: none"> <li>Function: Magnetic clutch of compressor is turned "ON/OFF" depending on temperature of the duct sensor to prevent the freezing of the evaporator with A/C being "ON". <li>Control pattern. 
	External temperature sensor	<ol style="list-style-type: none"> <li>Function: Prevention of compressor in winter. <li>Control pattern.  <p>*Only for Auto mode.</p>

Self-diagnosis

How to start self-diagnosis



DS2100299

Figure 213

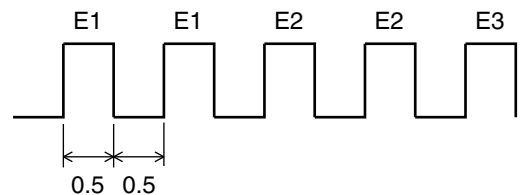
Error codes

Code	Description
E0	Normal
E1	Internal air temperature sensor short
E2	Internal air temperature sensor open
E3	Ambient air temperature sensor short
E4	Ambient air temperature sensor open
E5	Duct sensor short
E6	Duct sensor open
E7	Sun sensor short
E8	Sun sensor open
E9	
E10	
E11	D.P.S open
E12	Position error of airflow direction actuator
E13	Position error of temperature control actuator

NOTE: *The position error means that it fails to move to designated place in 40 seconds.*

Sun sensor displays E8 in case of no sunlight.

2 and more fails: Codes concerned blinks twice at a time.



FG001067

Figure 214

Ambient Temperature Display

Selection of both the SEL and MODE switch for more than 3 seconds indicates the ambient temperature in the set temperature display department.

- Range of temperature display: -40 - +60°C

NOTE: *Display of ambient temperature may be released in the same way for its entry way.*

It returns automatically to default mode 5 seconds after entering the ambient air temperature display mode.

Receiver Dryer

The receiver dryer reserves refrigerant enough to ensure smooth freezing cycle responding immediately to the change of level in the freezing cycle.

As liquid refrigerant from the condenser may contain refrigerant gas with bubbles whose presence in the expansion valve decreases the freezing power excessively, it separates liquid and gas and sends liquid only to the expansion valve.

Water in refrigerant shall be eliminated with dryer and through filter.

- Volume of refrigerant: 800 ± 20 grams

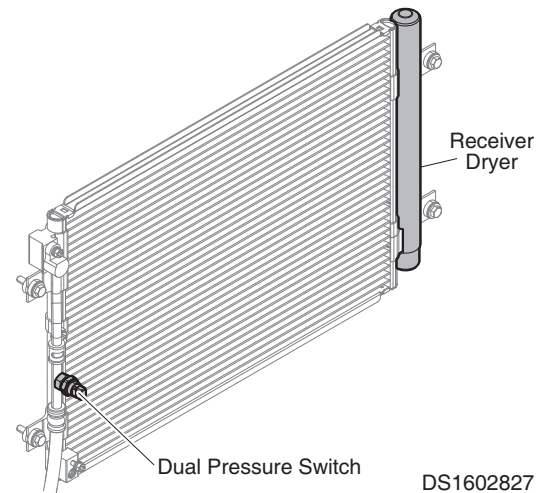
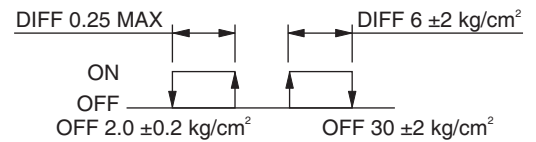


Figure 215



DS1801635

Figure 216

TROUBLESHOOTING

Refrigerant Pressure Check

1. Open all doors and windows.
2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 rpm.

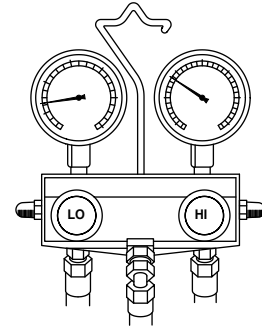


Figure 217

4. Check high/low-pressure of refrigerant.

1	High-pressure: 8.0 - 10.0 bar (114 - 142 psi) Low-pressure: Approximately 1.0 bar (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 bar (327 psi) Low-pressure: Approximately 2.5 - 3.0 bar (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 bar (285 - 356 psi) Low-pressure: Approximately 2.5 - 3.5 bar (36 - 50 psi)		
Possible Cause: Air in system.			
<ol style="list-style-type: none"> 1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system. <p>NOTE: <i>If the system has been exposed to the air for a long time, replace the receiver dryer.</i></p>			

4	High-pressure: Over 6 bar (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: 13.0 - 19.0 bar (185 - 270 psi) Low-pressure: 1.5 - 3.3 bar (21.3 - 46.9 psi)	No	Contaminated system, replace expansion valve. (Replace evaporator core assembly.)

5	High-pressure: Over 6 - 18 bar (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 must 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 time, replace the receiver dryer.</i>			

6	High-pressure: Over 22.0 - 23 bar (313 - 327 psi) Low-pressure: 2.5 bar (36 psi)		
Possible Cause: Refrigerant pressure problem because of 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 7.0 - 11.0 bar (100 - 156 psi) Low-pressure: 4.0 - 6.0 bar (57 - 85 psi)		
Possible Cause: Low refrigerant pressure because of poor compressor compression.			
Inspect and replace compressor if necessary.			

REFRIGERANT SYSTEM REPAIRS

WARNING

AVOID DEATH OR SERIOUS INJURY

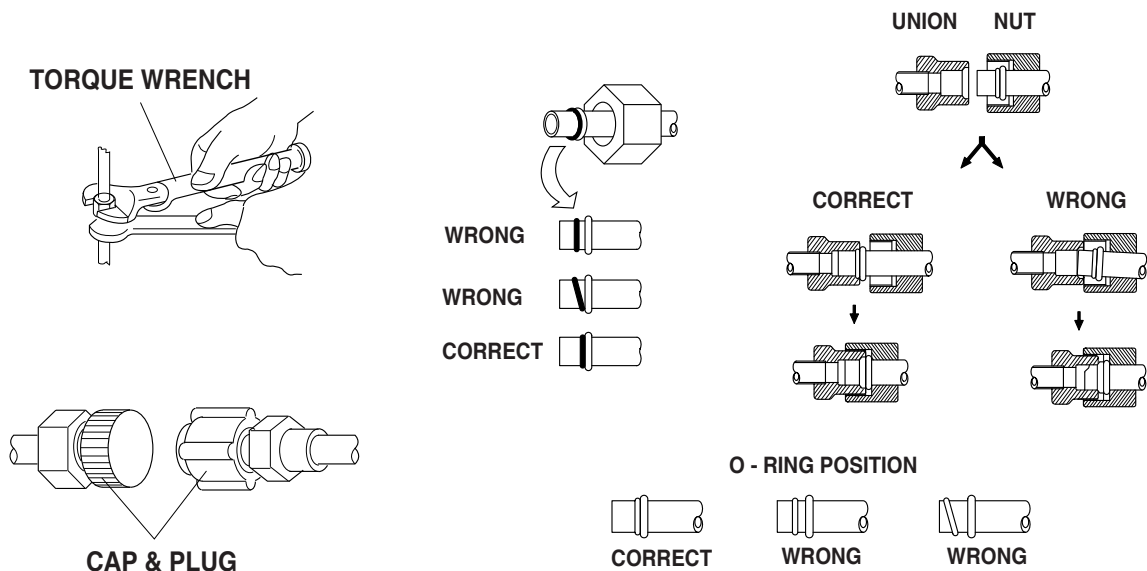
Always wear safety goggles and gloves when handling refrigerant. If refrigerant comes in contact with the skin or eyes, immediately flush with clean, running water and consult a physician.

Select a clean and well ventilated area to work.

The refrigerant container is under high-pressure and must 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 218

The following procedures must be observed for safe handling of refrigerant during vacuum and charging process.

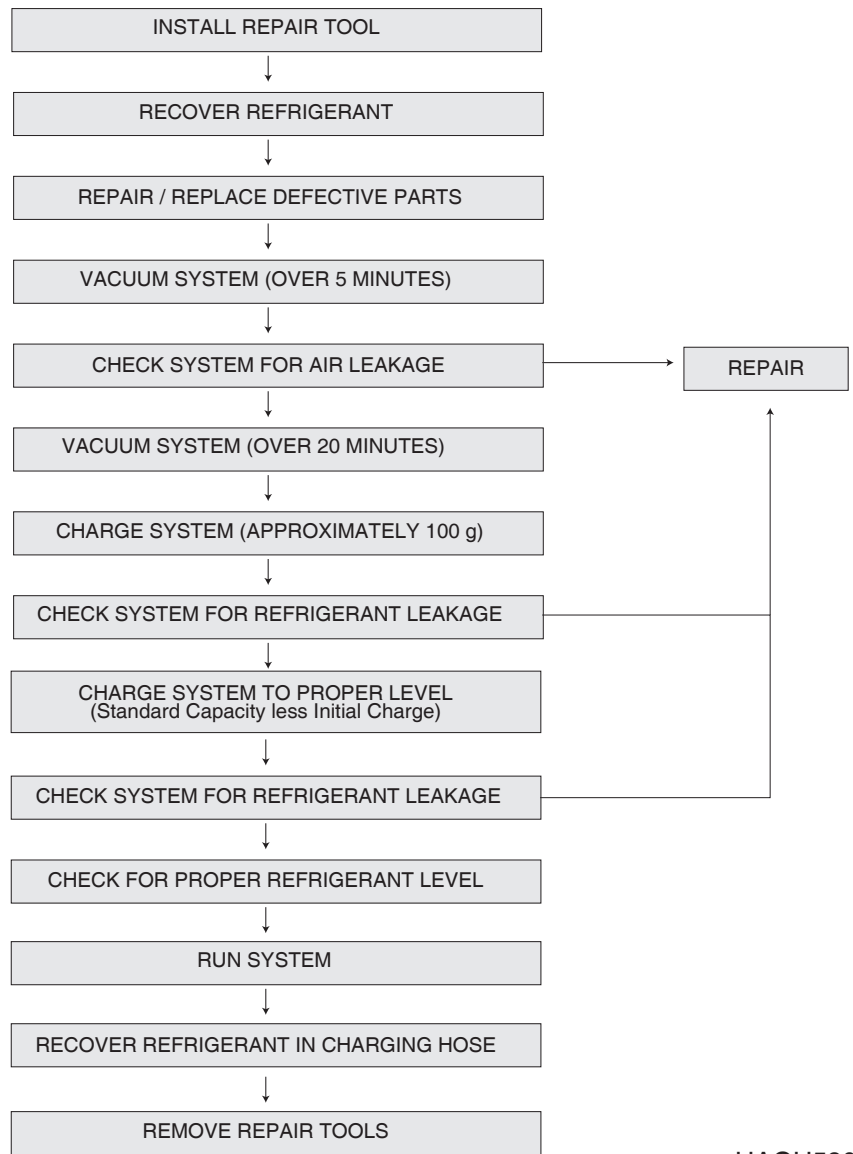
1. Use an approved recovery/charging device which can safely perform vacuum and charge work simultaneously.

2. The new refrigerant has improved cooling characteristics than the old type and care must 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 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.*



HAOH580

Figure 219

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 bar (50 psi), slowly open the low-pressure valve.
4. Open both the high and low-pressure valves slowly until manifold gauge dials indicates 0 bar (0 psi).

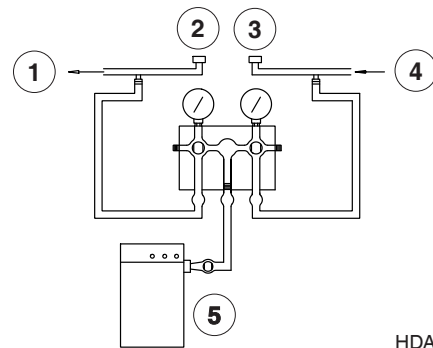


Figure 220

HDA6067L

Vacuating Refrigerant System

Reference Number	Description
1	To Compressor
2	Low-pressure Side
3	High-pressure Side
4	From Receiver
5	Vacuum Pump

1. Vacuating 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.

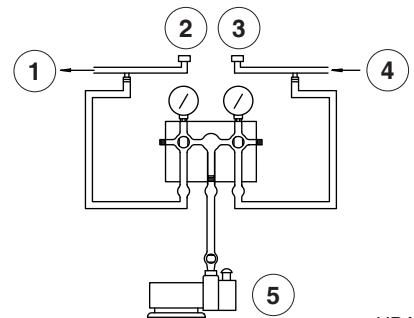


Figure 221

HDA6068L

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 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. Now, 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.

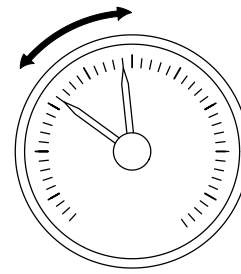


Figure 222

HDA6069L

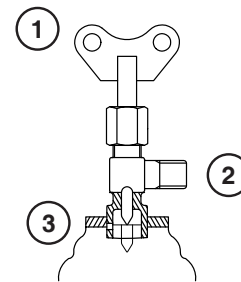


Figure 223

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 low side gauge dial indicates a pressure of 1 bar (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.

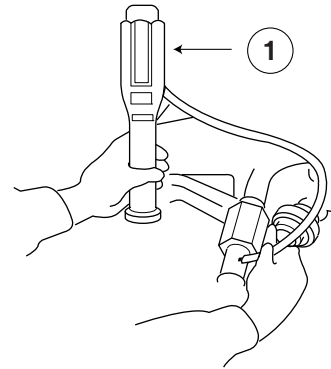


Figure 224

HDA60711



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 100g (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).

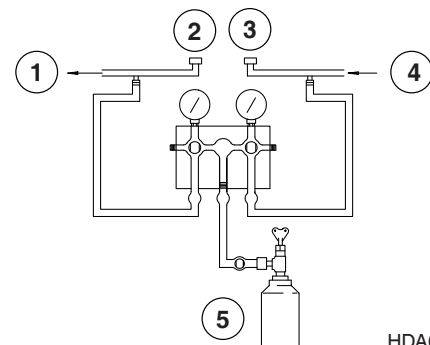


Figure 225

HDA6072L

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 bar (185 - 285 psi)
Low Side Gauge	1.5 - 3.5 bar (22 - 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.*

IMPORTANT

- **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 machine.

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 an accurate test.*

Reference Number	Description
1	Pressure
2	High-pressure
3	Low-pressure
4	Compressor Stop

Inspection Procedure

1. High-pressure Side
Compressor outlet → condenser inlet → receiver dryer inlet → air conditioner unit inlet.
2. Low-pressure side
Compressor inlet → air conditioner unit outlet.
3. Compressor
Compressor shaft area, bolt hole area and magnetic clutch area.
4. Receiver dryer
Pressure switch and plug area.
5. Connection valve area
Inspect all valve areas.
Verify all valves are capped to prevent leaking.
Check for foreign material inside of valve cap.
6. Interior of air-conditioning unit.
After stopping engine, insert detector probe into drain hose. (Leave inserted for 10 seconds minimum.)

NOTE: *When inspecting leakage from the air-conditioning unit, perform the inspection in a well ventilated area.*

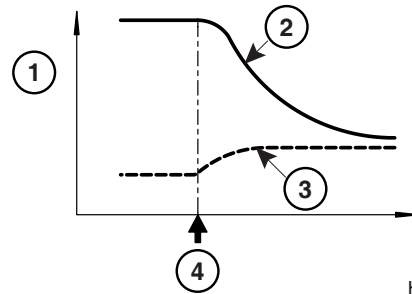


Figure 226

HDA6073L

WIPER SYSTEM

Wiper Circuit

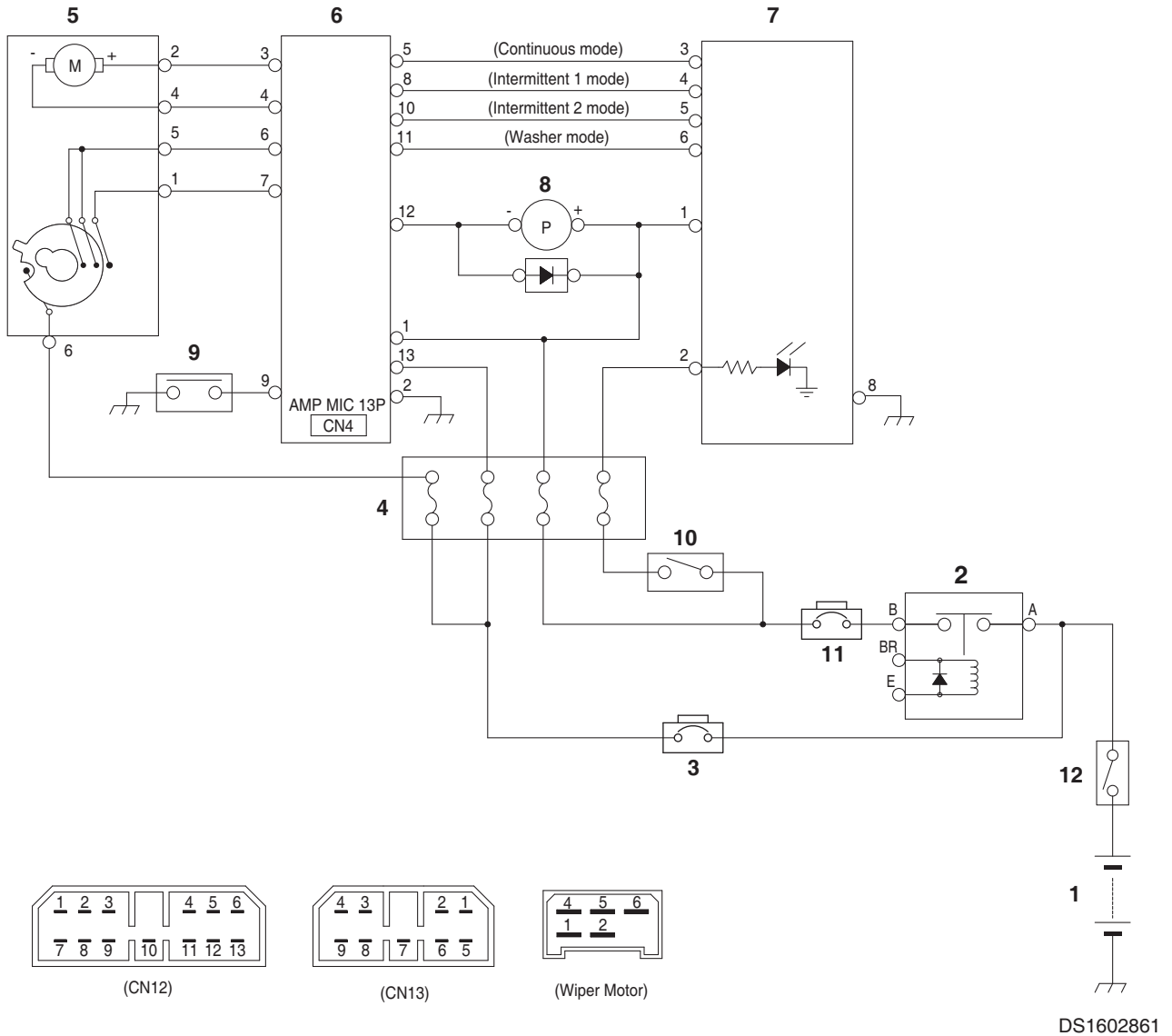


Figure 227

Reference Number	Description
1	Battery
2	Battery Relay
3	Circuit Breaker 1
4	Fuse Box
5	Wiper Motor
6	Wiper Controller

Reference Number	Description
7	Wiper Switch Panel
8	Window Washer
9	Wiper Cutoff Switch
10	Light Switch
11	Circuit Breaker 2
12	Master Switch

Wiper Operation

Continuous operation

- Operation of wiper motor

Pressing the successive operation switch on the wiper switch panel (7) changes the voltage of the "5" terminal of the wiper controller (6) from HIGH (about $5.5 \pm 0.5V$) to LOW ($0+0.5V$) and current flows by the "3" terminal of the wiper controller (6) → the "2" and "4" terminals of the wiper motor (5) → the "4" terminal of the wiper controller (6) to run the wiper motor (5) continuously.

- Stop of wiper motor

Pressing again the successive operation switch on the wiper switch panel (7) changes the voltage of the "5" terminal of the wiper controller (6) from LOW ($0+0.5V$) to HIGH (about $5.5 \pm 0.5V$). As the "5" and "6" terminals of the wiper motor are connected still that power is supplied to "6" terminal of the wiper controller (6),

However, the controller (6) runs the wiper motor continuously and then rotates the motor reversely by letting current flow by the "4" terminal of the wiper controller (6) → the "2" and "4" terminals of the wiper motor (5) → the "3" terminal of the wiper controller (6) when the "1" and "6" terminals of the wiper motor (5) are connected and thus power voltage is supplied to "7" terminal of the wiper controller (6).

The Wiper motor (5) stops reverse revolution when the contact of a cam switch connected to "6" terminal of the wiper motor (5) moves to an insulation area of the cam plate to disconnect the "5" and "6" terminals of the wiper motor (5).

When the wiper motor (5) stops, arm and blade connected to it move to the stop positions of the right pole in the cabin.

Intermittent operation

- Intermittent 1st (3-second)

Pressing once the Intermittent switch in the switch panel (7) changes voltage of the "8" terminal in the wiper controller (6) from HIGH (about 5.5 ± 0.5 V) to LOW ($0+0.5$ V) and current flows through the "3" terminal in the wiper controller (6) → the "2" and "4" terminals in the wiper motor (5) → the "4" terminal in the wiper controller (6) to start the cycle that wiper stops 3 seconds after every operation.

- Intermittent 2nd (6-second)

Pressing twice the Intermittent switch in the switch panel (7) changes voltage of the "10" terminal in the wiper controller (6) from HIGH (about 5.5 ± 0.5 V) to LOW ($0+0.5$ V) and current flows through the "3" terminal in the wiper controller (6) → the "2" and "4" terminals in the wiper motor (5) → the "4" terminal in the wiper controller (6) to start the cycle that wiper stops 6 seconds after every operation.

- Stopping the intermittent action

Pressing three times the Intermittent switch in the switch panel (7) while the wiper is operating stops the action of the wiper motor.

NOTE: *The wiper system does not work when the wiper cutoff switch (9) is "ON".*

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box
4	Light Switch
5	Cabin Light Switch
6	Headlight Relay (Work Light Indicate Light)
7	Work Light Relay
8	Front Cabin Light Relay
9	Rear Cabin Light Relay

Reference Number	Description
10	Instrument Panel
11	EPOS Controller
12	Headlight (2 ea.)
13	Work Light (2 ea.)
14	Front Cabin Light (4 ea.)
15	Rear Cabin Light (2 ea.)
16	Rear Work Light (1 ea.)
17	Master Switch

NOTE: The "*" mark are optional parts.

Kind of Light

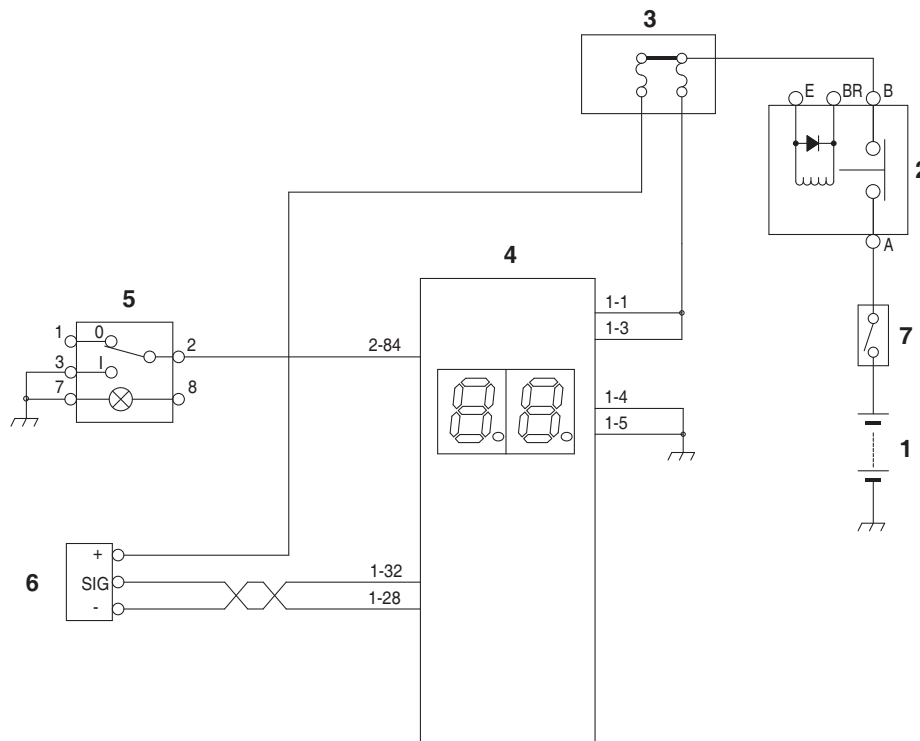
The lighting system is consists of headlights, work lights, cabin lights (optional), relays and switches.

Operation

Switch	Position	Connected Terminal of switch	Activated Relay	Lit Light
Light Switch	1	"2-3" Terminal	-	Illumination Light of Switch
	2	"2-3" Terminal	-	Illumination Light of Switch
		"5-6" Terminal	Headlight Relay	Headlight (2 ea.)
			Work Relay	Work Light (2 ea.) Symbol Light of Work Light
Cabin Light Switch	1	"2-3" Terminal	Front Cabin Light Relay	Front Cabin Light (2 ea.) or Front Cabin Light (4 ea.)
	2	"2-3" Terminal	Front Cabin Light Relay	Front Cabin Light (2 ea.) or Front Cabin Light (4 ea.)
		"5-6" Terminal	Rear Cabin Light Relay	Rear Cabin Light (2 ea.)

OVERLOAD WARNING DEVICE

Overload Warning Device Circuit Diagram



DS1603980

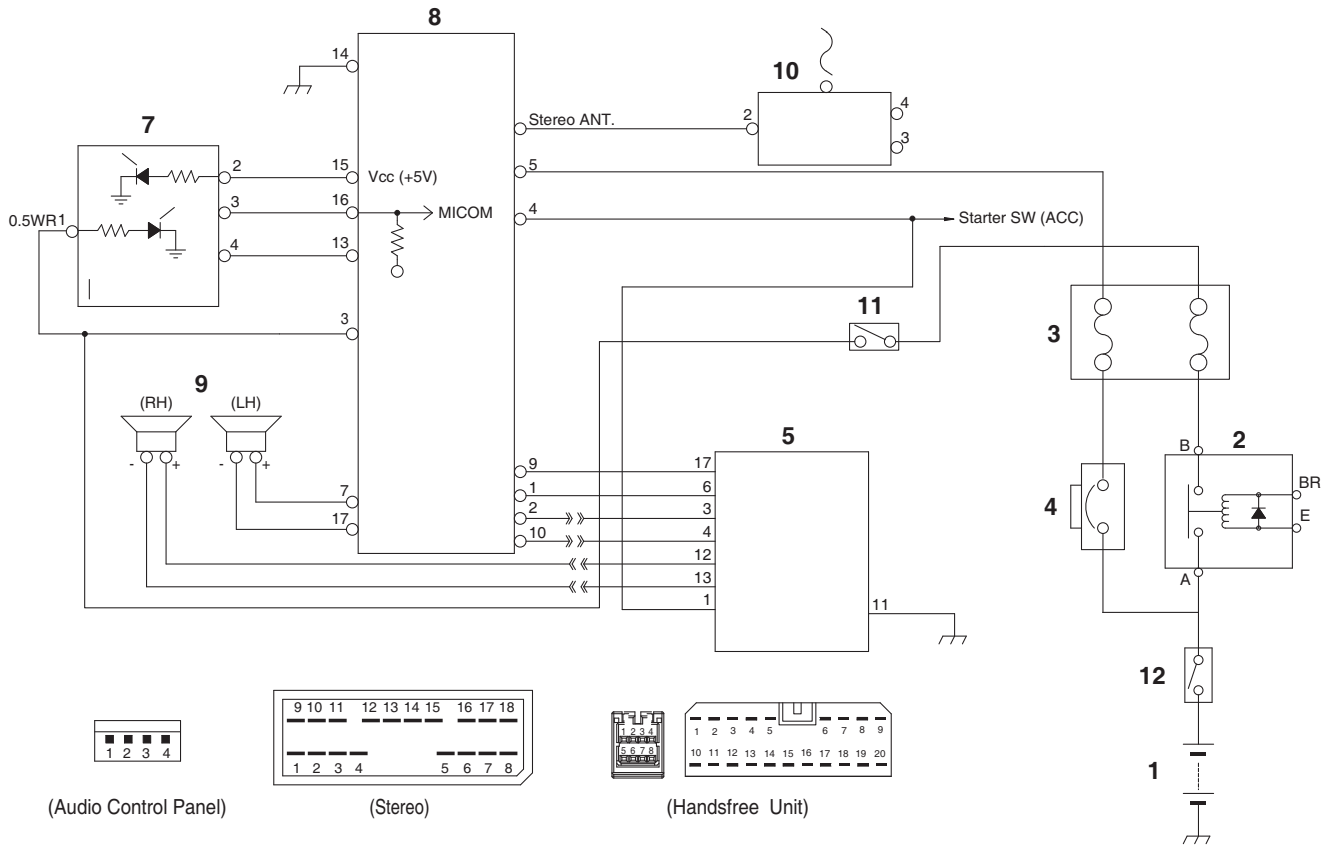
Figure 229

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box
4	EPOS Controller

Reference Number	Description
5	OWD Selector Switch
6	Pressure Sensor
7	Master Switch

AUDIO CONTROLLER

Audio Controller Circuit Diagram



(Audio Control Panel)

(Stereo)

(Handsfree Unit)

DS1603887

Figure 230

Reference Number	Description
1	Battery
2	Battery Relay
3	Fuse Box
4	Fusible Link
5	Hands-free Unit
7	Audio Control Panel

Reference Number	Description
8	Stereo
9	Speaker
10	Antenna Module
11	Light Switch
12	Master Switch

Operations by Audio Control Panel

Switch	Connected Terminal of switch	Measured values	Operations
PWR	"3-4"	4.36 ±0.2V	Stereo ON, OFF
▲		1.24 ±0.2V	Volume up
▼		0 + 0.2V	Volume down
SCAN		2.49 ±0.2V	Frequency selection

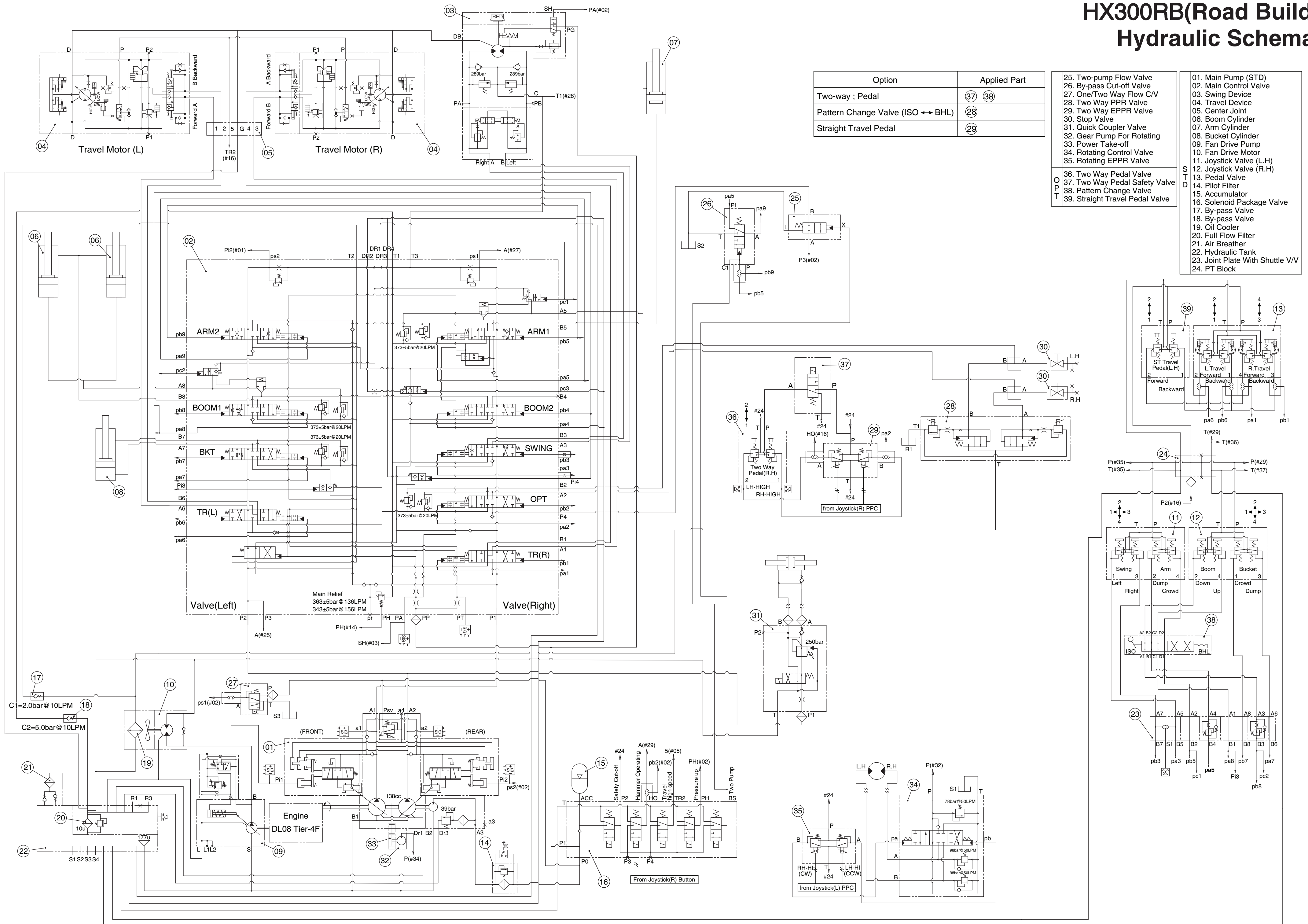
Schematic

Hydraulic Schematic / Electrical Schematic

Edition 1

MEMO

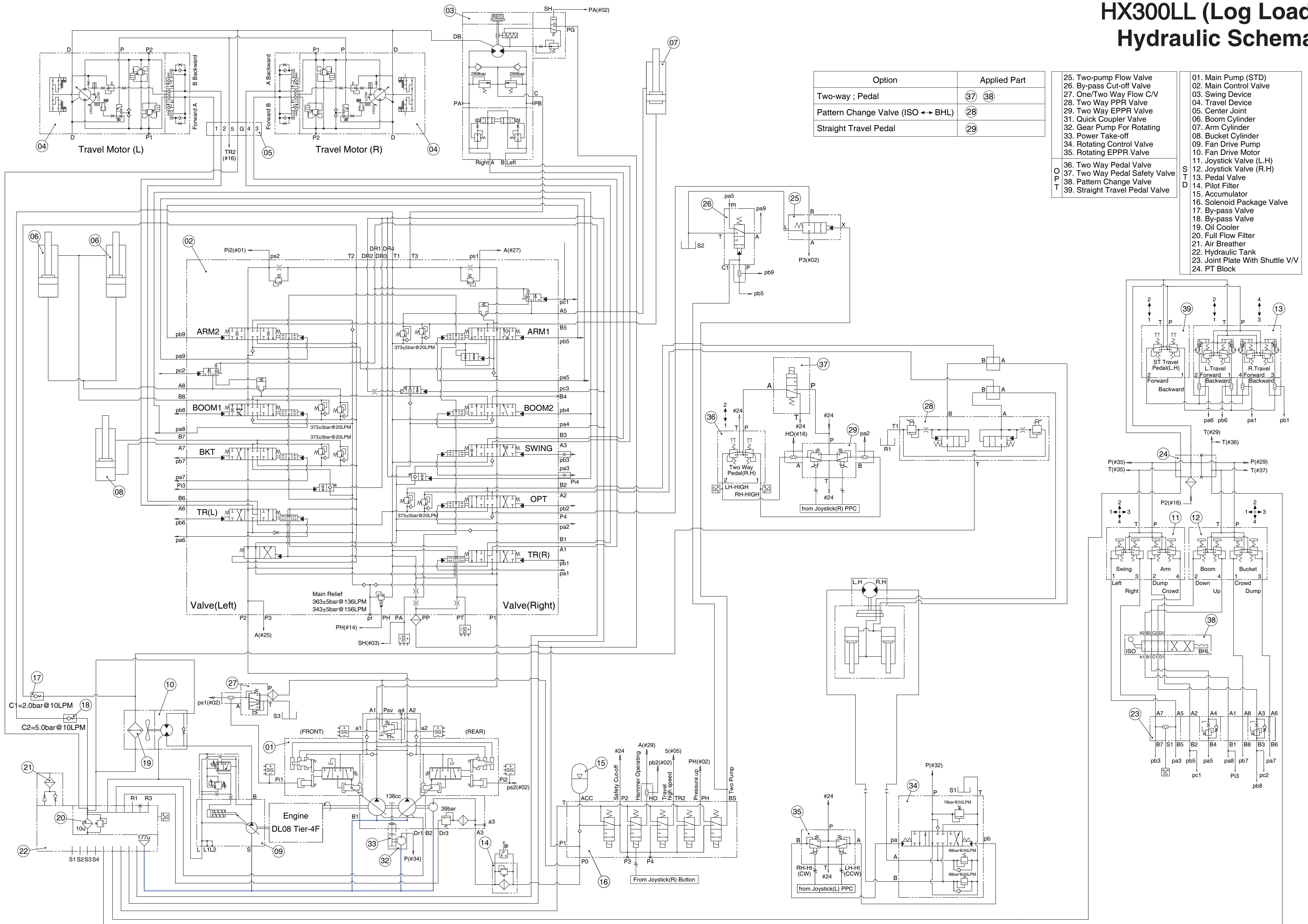
HX300RB(Road Builder) Hydraulic Schematic



Option	Applied Part
Two-way ; Pedal	37 38
Pattern Change Valve (ISO ↔ BHL)	28
Straight Travel Pedal	29

- | | |
|----------------------------|----------------------------------|
| 25. Two-pump Flow Valve | 01. Main Pump (STD) |
| 26. By-pass Cut-off Valve | 02. Main Control Valve |
| 27. One/Two Way Flow C/V | 03. Swing Device |
| 28. Two Way PPR Valve | 04. Travel Device |
| 29. Two Way EPPR Valve | 05. Center Joint |
| 30. Stop Valve | 06. Boom Cylinder |
| 31. Quick Coupler Valve | 07. Arm Cylinder |
| 32. Gear Pump For Rotating | 08. Bucket Cylinder |
| 33. Power Take-off | 09. Fan Drive Pump |
| 34. Rotating Control Valve | 10. Fan Drive Motor |
| 35. Rotating EPPR Valve | 11. Joystick Valve (L,H) |
| | 12. Joystick Valve (R,H) |
| | 13. Pedal Valve |
| | 14. Pilot Filter |
| | 15. Accumulator |
| | 16. Solenoid Package Valve |
| | 17. By-pass Valve |
| | 18. By-pass Valve |
| | 19. Oil Cooler |
| | 20. Full Flow Filter |
| | 21. Air Breather |
| | 22. Hydraulic Tank |
| | 23. Joint Plate With Shuttle V/V |
| | 24. PT Block |

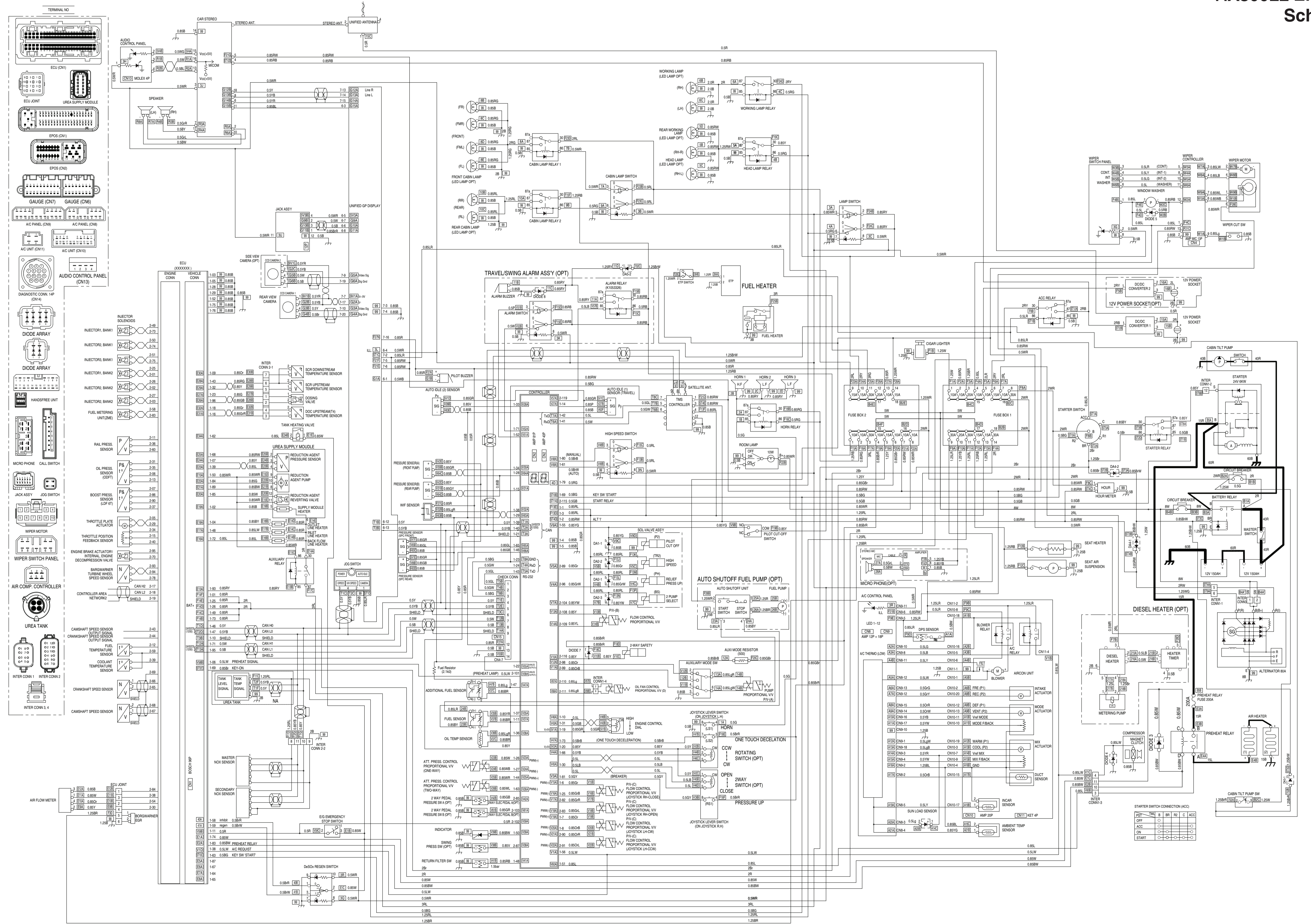
HX300LL (Log Loader) Hydraulic Schematic



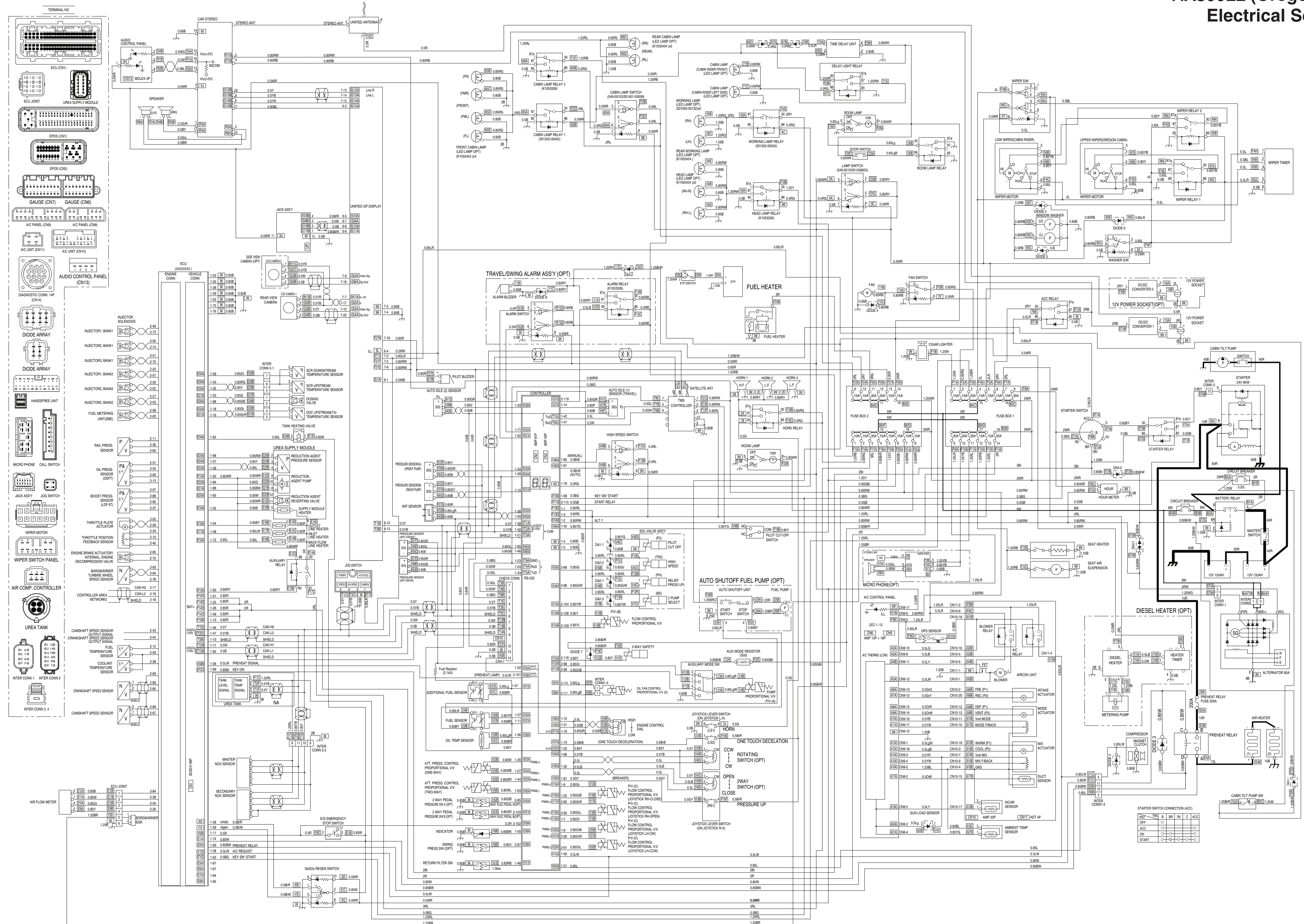
Option	Applied Part
Two-way ; Pedal	37 38
Pattern Change Valve (ISO ↔ BHL)	28
Straight Travel Pedal	29

- | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> 25. Two-pump Flow Valve 26. By-pass Cut-off Valve 27. One/Two Way Flow C/V 28. Two Way PPR Valve 29. Two Way EPPR Valve 31. Quick Coupler Valve 32. Gear Pump For Rotating 33. Power Take-off 34. Rotating Control Valve 35. Rotating EPPR Valve | <ul style="list-style-type: none"> 01. Main Pump (STD) 02. Main Control Valve 03. Swing Device 04. Travel Device 05. Center Joint 06. Boom Cylinder 07. Arm Cylinder 08. Bucket Cylinder 09. Fan Drive Pump 10. Fan Drive Motor 11. Joystick Valve (L,H) 12. Joystick Valve (R,H) 13. Pedal Valve 14. Pilot Filter 15. Accumulator 16. Solenoid Package Valve 17. By-pass Valve 18. By-pass Valve 19. Oil Cooler 20. Full Flow Filter 21. Air Breather 22. Hydraulic Tank 23. Joint Plate With Shuttle V/V 24. PT Block |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

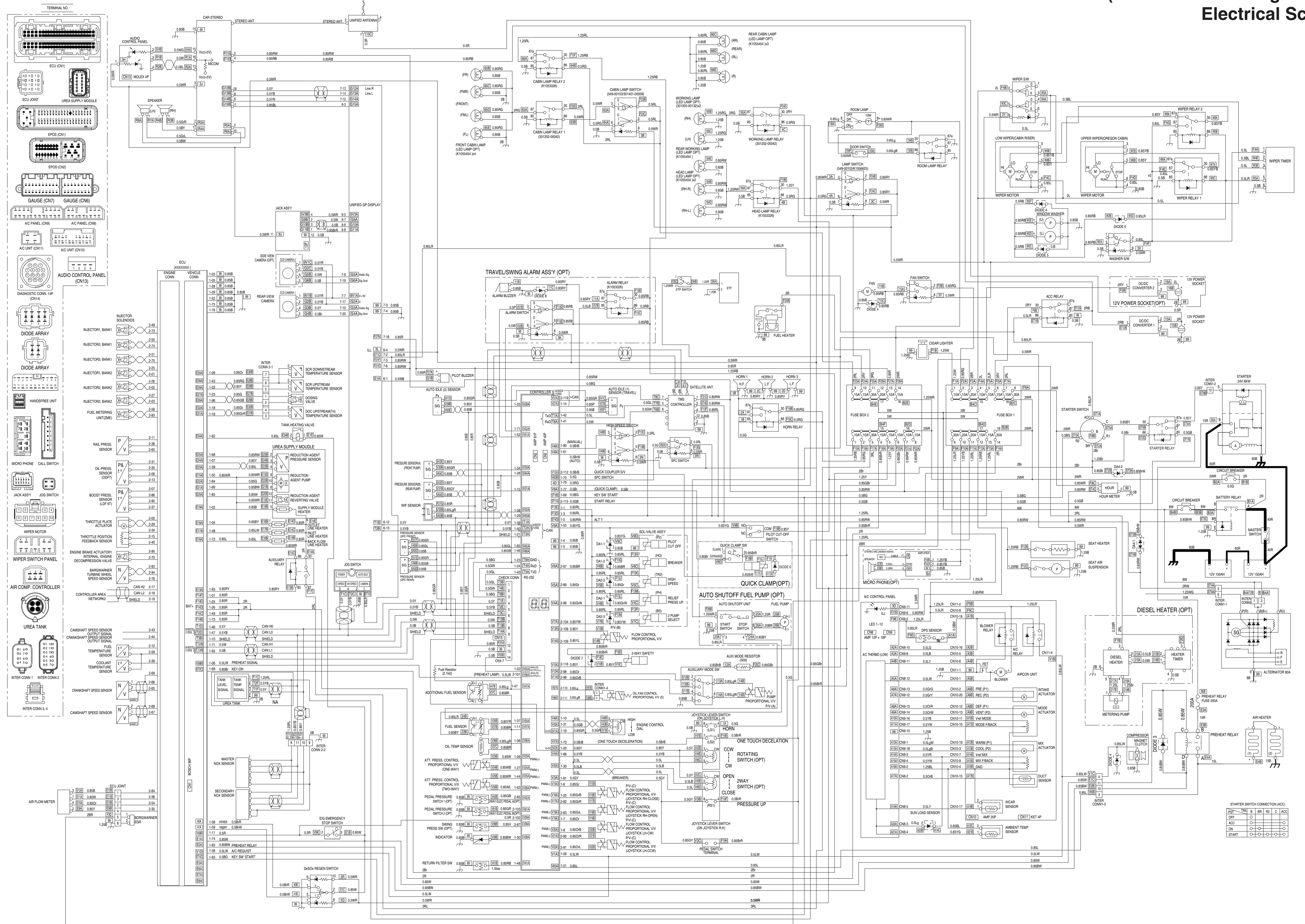
HX300LL Electrical Schematic



HX300LL (Oregon Cabin) Electrical Schematic



HX300RB (Road Builder - Oregon Cabin) Electrical Schematic



HX300RB(Road Builder - ROPS) Electrical Schematic

