SHOP MANUAL

model SK16

KOBELCO

APPLICABLE No. SK16 PFA1

Book code No. **S5PFA101E**
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1-10 Air Release of Hydraulic Equipment

When operating the machine after disassembly or parts replacement of the hydraulic equipment, piping, etc., be sure to release air from the hydraulic system. This is necessary to prevent seizure and cavitation of the hydraulic equipment. If the air is left in the hydraulic system, the air is compressed or expanded depending on the load, having an adverse effect on the smooth operation of the hydraulic equipment and shortening the service life.

1. Air Release of Variable Displacement Piston Pumps

1) Make sure that all joints and fitting are not loosened.
2) Put a specified quantity of hydraulic oil into the hydraulic oil tank.
   Note :
   1. Set the machine at the oil level check position.
   2. Keep the oil supply cap of the hydraulic oil tank removed.
3) Run the engine at low idling speed for 5 to 10 minutes.
4) Check the oil level in the hydraulic oil tank. If the oil level is lower than the specified level, supply the hydraulic oil to the tank after stopping the engine.
5) Run the engine again at low idling speed for a few minutes.
6) Check the oil level and supply the hydraulic oil to the specified level. Then install the oil supply cap.

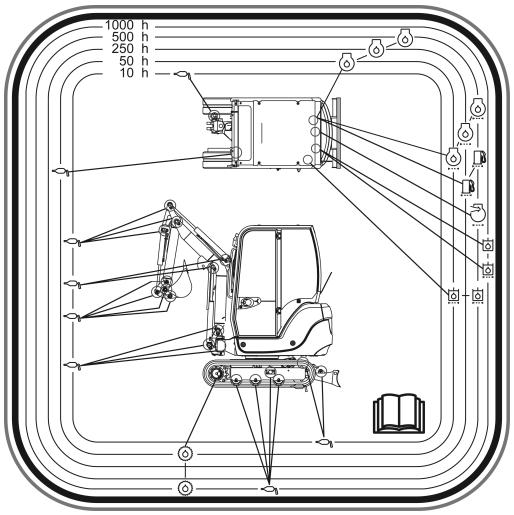
2. Air Release of Each Hydraulic Component

Run the engine at medium speed and activate the respective circuits for about 10 to 15 minutes.

2. TECHNICAL DATA

Item			Unit	SK16
Undercarriage				
	Rubber track	Shoe width	mm	230
		Lug height	mm	17
		Core metal pitch	mm	72
	Track carrier roller (Upper roller)	Manner of support	-	Guide
		Quantity (One side)	pcs.	1
	Number of shoe slide plates (One side)		pcs.	-
	Track roller (Lower roller)	Quantity (One side)	pcs.	3
		Bearing	-	Ball bearing
		Sealing	-	Shaft seal
	Idler wheel	Quantity (One side)	pcs.	1
		Bearing	-	Ball bearing
		Sealing	-	Shaft seal
	Number of sprocket teeth		pcs.	14
	Track tension adjustment		-	Grease cylinder

Periodic servicing points of the machine (greasing, filtres...)



= Hydraulic oil

= Engine oil

= Hydraulic oil return filter

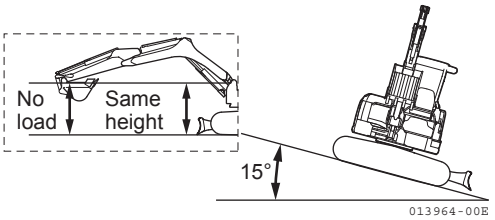
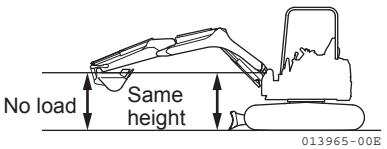
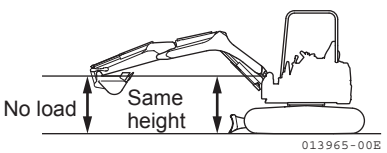
= Side movement reducers

= Greasing points

= Air filter

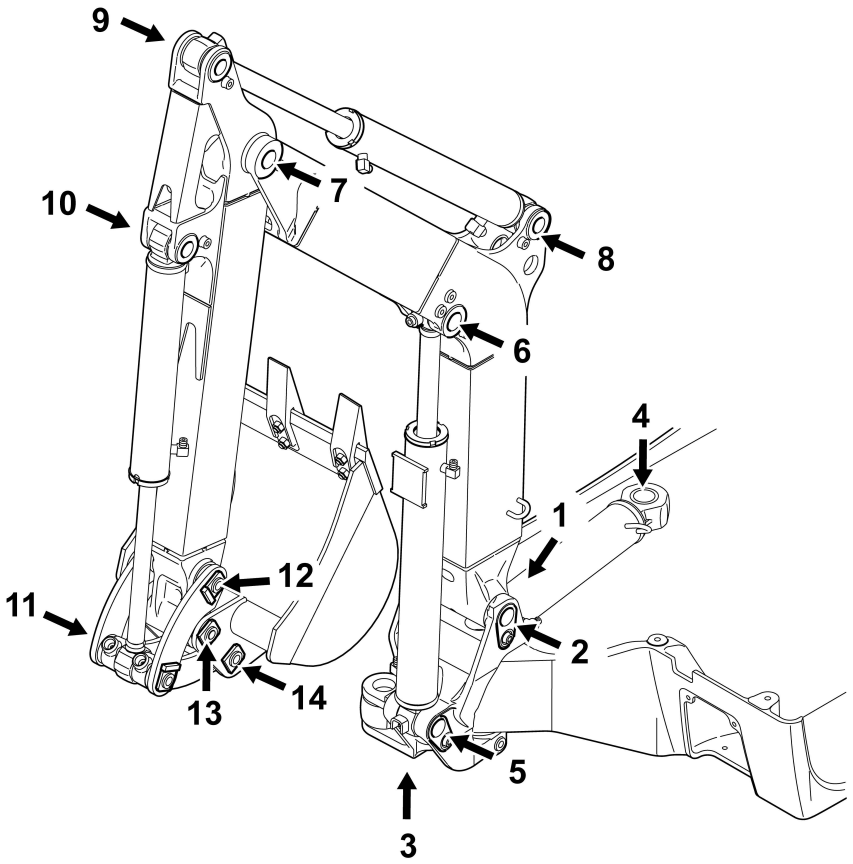
= Fuel filter

3. SERVICE STANDARDS

Applicable model			SK16	
Item	Measuring condition	Unit	Standard	Allowable
Machine performance				
Drift of cylinders				
Boom swing drift (Cylinder rod extension)	Machine position  • Engine: stopped • Hydraulic oil temp.: 50 to 60 °C • Site: Firm, flat ground • Make the boom and bucket pins the same height. • Park the machine on a slope with an inclination of 15 degrees and turn the upperstructure 90 degrees to the crawler and engage the swing lock. • Measure the cylinder rod extension after 10 min.	mm	<5	8
Swing drift at stopping	Machine position  • Engine: Rated speed • Hydraulic oil temp.: 50 to 60 °C • Site: Firm, flat ground • Make the boom and bucket pins the same height. • Make match marks on the outer race and the inner race of the swing bearing (or the track frame). • Measure shifted distance between both marks after making one turn with no load.	degrees	<30	45
Swing time	Machine position  • Engine: Rated speed • Hydraulic oil temp.: 50 to 60 °C • Site: Firm, flat ground • Make one idling turn with no load, then measure the time necessary to make 5 turns.	sec. [rpm]	30 [9,7]	34 [9,9]

3-6 Implement

3-6-1 Front Attachments

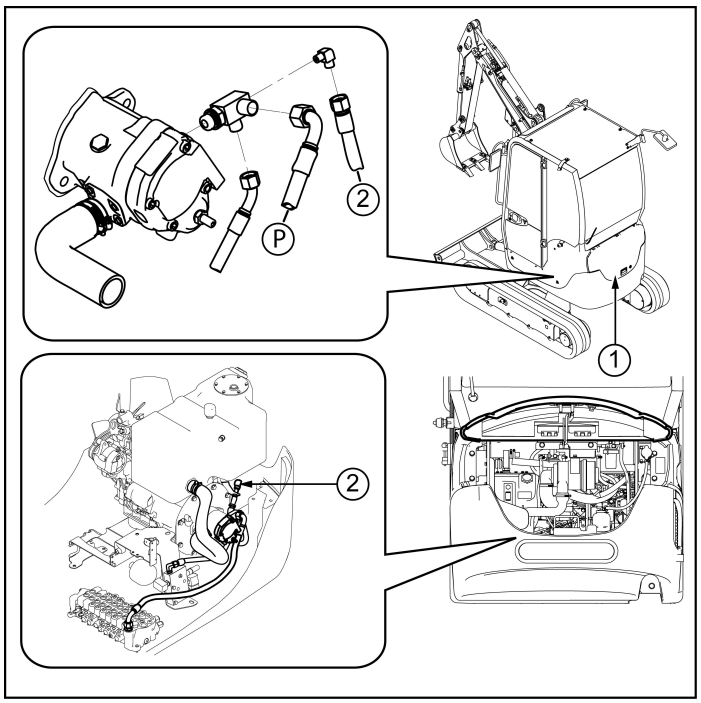


Unit : mm

No.	Measuring point	Applicable model SK16	Wear limit	
			Pin	Bore of bush or hole
1	Boom swing fulcrum	Ø 50	-0,5	+0,5
2	Boom fulcrum	Ø 35		
3	Boom swing cylinder, rod	Ø 40		
4	Boom swing cylinder, bottom	Ø 40		
5	Boom cylinder, bottom	Ø 35		
6	Boom cylinder, rod	Ø 35		
7	Arm fulcrum	Ø 35		
8	Arm cylinder, bottom	Ø 30		
9	Arm cylinder, rod	Ø 30		
10	Bucket cylinder, bottom	Ø 30		
11	Bucket cylinder, rod	Ø 30		
12	Link "A" arm	Ø 30		
13	Bucket fulcrum	Ø 30		
14	Bucket "link A"	Ø 30		

Note : *Allowable clearance is 1 mm*

3) Measuring points on the primary relief valve



(1) Open rear bonnet 1.

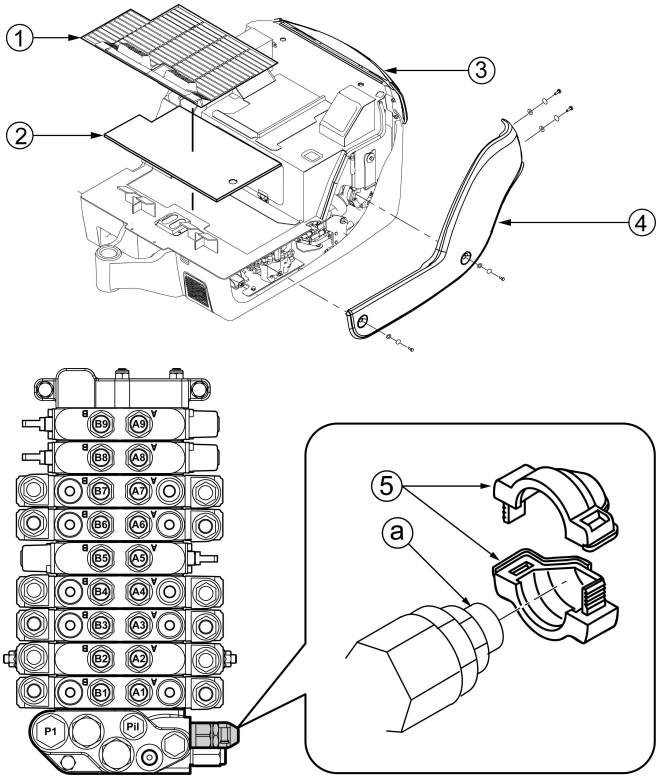
(2) Remove the plug from the pressure port 2 and install the oil pressure gauge.

(3) To check the pressure of the system relief valve (P) in the control valve, retract the bucket cylinder to its stroke end, hold the lever and read the gauge.

4) Adjustment Procedure on the primary relief valve

The pressure of the hydraulic circuit sets through the primary relief valve of the control valve.

WARNING
The pressure is factory setting, all necessary adjustment must be done by KOBELCO dealer.



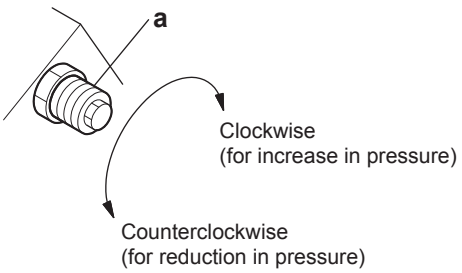
(1) Remove floor mat **1** and step **2**.

(2) Open the rear bonnet **3**.

(3) Remove the left cover of the machine **4**.

(4) To adjust the pressure of the hydraulic circuit, it is necessary to break the plastic cap **5** on the control valve.

(5) Adjust the pressure if necessary by turning the adjusting screw **a** on the hydraulic control valve until you reach the correct pressure.



⚠ WARNING

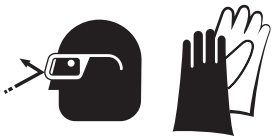
FUME / BURN HAZARD!

- **Always read and follow safety related precautions found on containers of hazardous substances like parts cleaners, primers, sealants and sealant removers.**

- **Failure to comply could result in death or serious injury.**

⚠ CAUTION

COOLANT HAZARD!



- **Wear eye protection and rubber gloves when you handle long life or extended life engine coolant. If contact with the eyes or skin should occur, flush eyes and wash immediately with clean water.**

- **Failure to comply may result in minor or moderate injury.**

⚠ CAUTION

FLYING OBJECT HAZARD!

- **ALWAYS wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.**

- **Failure to comply may result in minor or moderate injury.**

⚠ CAUTION

Be sure to secure the engine solidly to prevent injury or damage to parts due to the engine falling during work on the engine.

⚠ CAUTION

PINCH HAZARD!

Carefully rotate the alternator toward the cylinder block while loosening the V-belt. Failure to comply may result in minor or moderate injury.

⚠ CAUTION

If any oil pump component clearance exceeds its limit, the oil pump must be replaced as an assembly.

NOTICE

- Only use diesel fuels recommended by Yanmar for the best engine performance, to prevent engine damage and to comply with EPA / ARB warranty requirements.
- Only use clean diesel fuel.
- NEVER remove the primary strainer (if equipped) from the fuel tank filler port. If removed, dirt and debris could get into the fuel system causing it to clog.

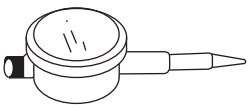
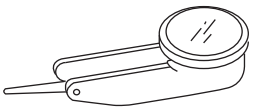
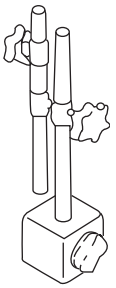
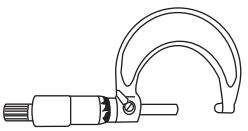
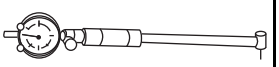
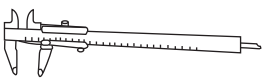
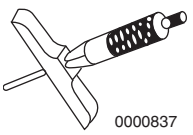
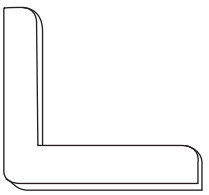
NOTICE

If any problem is noted during the visual check, the necessary corrective action should be taken before you operate the engine.

NOTICE

NEVER hold the key in the START position for longer than 15 seconds or the starter motor will overheat.

4-2-3 Measuring Instruments

No.	Instrument Name	Application	Illustration
1	Dial Indicator (Available Locally)	Measure shaft bend and end play	 0000831
2	Test Indicator (Available Locally)	Measurements of narrow or deep portions that cannot be measured by dial gauge	 0000832
3	Magnetic Stand (Available Locally)	For holding the dial gauge when measuring.	 0000833
4	Micrometer (Available Locally)	For measuring the outside diameters of crankshaft, pistons, piston pins, etc.	 0000834
5	Cylinder Bore Gauge (Available Locally)	For measuring the inside diameters of cylinder liners, bearing bores, etc.	 0000835
6	Calipers (Available Locally)	For measuring outside diameters, depth, thickness and width	 0000836
7	Depth Micrometer (Available Locally)	For measuring of valve recession	 0000837
8	Square (Available Locally)	For measuring valve spring inclination and straightness of parts	 0000838

Valve Face and Valve Seat

Always check the clearance between the valve and valve guide before grinding or lapping the valve seats. *See "3-2 Engine Service Standard" section for the service limit.* If the clearance exceeds the limit, replace the valve and / or valve guide to bring the clearance within the limit.

Roughness or burrs will cause poor seating of a valve. Visually inspect the seating surfaces of each valve and valve seat to determine if lapping or grinding is needed.

Visually inspect all valve faces and valve seats for pitting, distortion, cracking, or evidence of overheating. Usually the valves and valve seats can be lapped or ground to return them to serviceable condition. Severely worn or damaged components will require replacement.

Coat the valve seat with a thin coat of bluing compound. Install valve and rotate to distribute bluing onto the valve face. The contact pattern should be approximately centered on the valve face **(Figure 4-2-20, (1))** and even in width.

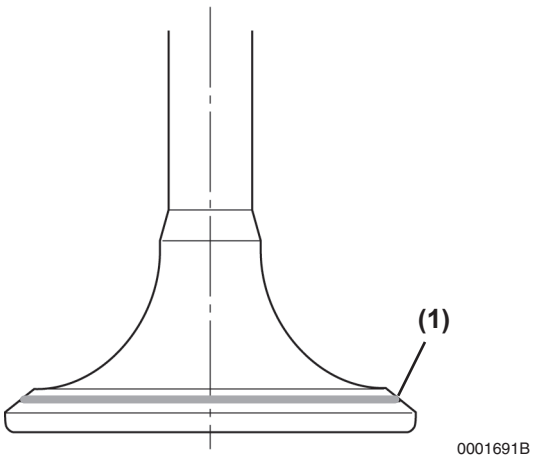


Figure 4-2-20

Also visually inspect the valve seat for even contact.

Light cutting can be performed by the use of a hand-operated cutter **(Figure 4-2-21, (3)).**

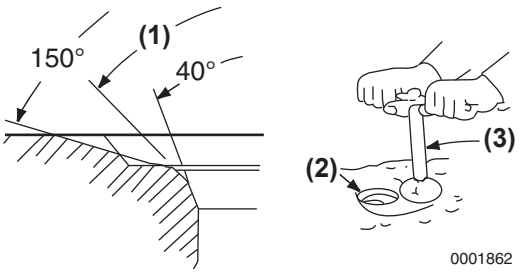


Figure 4-2-21

Valve seat diameter can be adjusted by top-grinding with a 150° stone to make the seat diameter smaller, and bottom-grinding using a 40° stone to make the seat diameter larger. Once the seat location has been corrected, grind and lap the seat angle **(Figure 4-2-21, (1))** to specification. *See "3-2 Engine Service Standard" section for the service limit.*

Grind the valve face and / or valve seat only enough to return them to serviceable condition. Grinding is needed if the valve and the valve seat do not contact correctly. Check the valve recession after grinding.

If the valve or seat require grinding, lap the valve after grinding. Lap the valve face to the valve seat using a mixture of valve lapping compound and engine oil.

Be sure to thoroughly wash all parts to remove all grinding powder or compound.

Inspection of Valve Springs

Inspect the valve springs. If damage or corrosion is seen, or if measurements exceed the specified limits, replace the springs. Record the measurements.

Fractures

Check for fractures on the inside and outside portions of the springs. If the valve spring is fractured, replace the valve spring.

Corrosion

Check for corrosion of spring material caused by oxidation.

6. Clean the engine by washing with solvent, air or steam cleaning. Carefully operate to prevent any foreign matter or fluids from entering the engine, fuel system, or electrical components remaining on the engine.
7. Drain the engine oil into a suitable container. Remove oil filter.
8. Remove the cylinder head. *See Disassembly of Cylinder Head on page 4-2-7.*
9. Remove the fuel injection pump from the gear case only if it must be sent out for repair, or will interfere with other procedures such as “hot tank” cleaning. *See Removal of Fuel Injection Pump on page 4-3-9*.
10. Remove the starter motor. *See Removal of Starter Motor on page 4-6-6.*

Disassembly of Camshaft and Timing Components

Discard all gaskets, O-rings and seals. Use new gaskets, O-rings and seals on reassembly of camshaft and timing components.

Removal of Timing Gear Case Cover

1. Remove the bolt and washer retaining the crankshaft pulley.

IMPORTANT

Use care not to damage the threads in the end of the crankshaft when removing the crankshaft pulley.

2. Remove the crankshaft pulley with a gear puller.
3. Remove the bolts that retain the gear case cover to the cylinder block and oil pan.
4. Remove the gear case cover **(Figure 4- 2-39, (1))**.
5. Remove the dowel pins **(Figure 4-2-39, (3))** and O-ring **(Figure 4-2-39, (2))**.

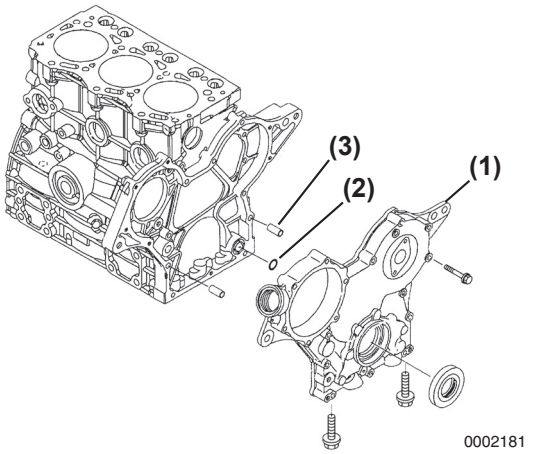
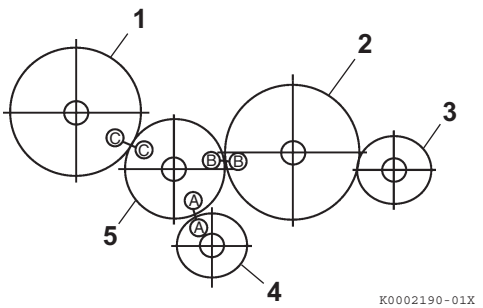


Figure 4-2-39

Checking Timing Gear Backlash

Prior to removing the timing gears, measure the gear backlash and determine the gear wear.

Note: Check the backlash between each pair of mating gears. If not within specification, replace both mating gears. Do not allow the gear being checked to move axially as excess end play could cause a false reading. *See "3-2 Engine Service Standard" section for the service limit.*



1 – Fuel Injection Pump Drive Gear
2 – Camshaft Drive Gear
3 – Auxiliary Drive Gear (Optional)
4 – Crankshaft Drive Gear
5 – Idler Gear

Figure 4-2-40

Inspection of Pistons, Piston Rings and Wrist Pin

Notes:

- On an engine with low hours, the pistons, piston rings may be reused if they are found to be within specifications. The pistons and piston rings must be reinstalled in the same cylinders from which they were originally removed.
- On an engine with high hours, the pistons rings should be replaced and the cylinder honed *(See Honing and Boring on page 4-2-39)* or replaced. The piston should be replaced as necessary.

1. Clean piston ring grooves using a piston ring groove cleaning tool. Follow manufacturer's instructions for correct operation.
2. Wash the pistons in an appropriate solvent using a soft brush.
3. Visually inspect each piston for cracks. Pay particular attention to the ring lands between the piston ring grooves.
4. Measure the diameter of the piston skirt at 90° to the wrist pin bore as shown **(Figure 4-2-64)**. Measurements must be taken at a specified distance **(Figure 4-2-64, (1))** from the bottom of the piston, based on engine model. Record the measurements. *See "3-2 Engine Service Standard" section for the service limit.*

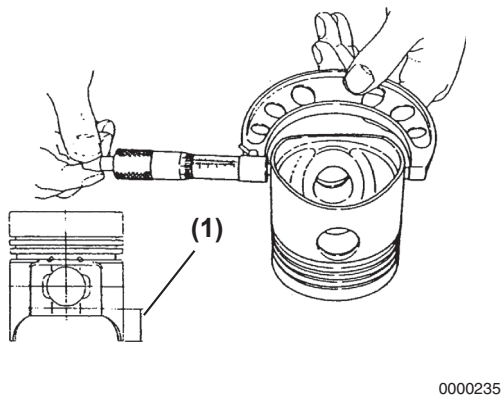


Figure 4-2-64

5. Subtract the piston measurement from the greatest measurement acquired during cylinder inspection *(see Inspection of Cylinder Block on page 4-2-33)* to obtain piston-to-cylinder clearance. Record the measurements. *See "3-2 Engine Service Standard" section for the service limit.*
6. Measure the diameter of the wrist pin bore on both sides of the piston **(Figure 4-2-65)**. *See "3-2 Engine Service Standard" section for the service limit.* Record the measurements.

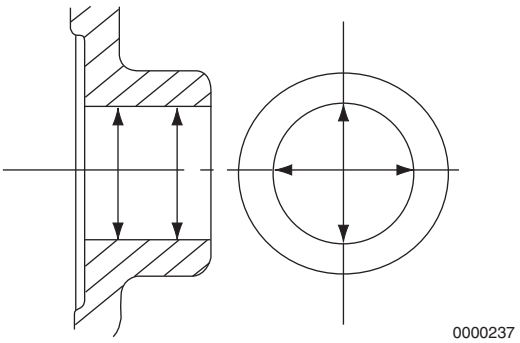


Figure 4-2-65

7. Measure the outside diameter of the wrist pin in three places and at 90° **(Figure 4-2-66)**. *See "3-2 Engine Service Standard" section for the service limit.* Record the measurements.

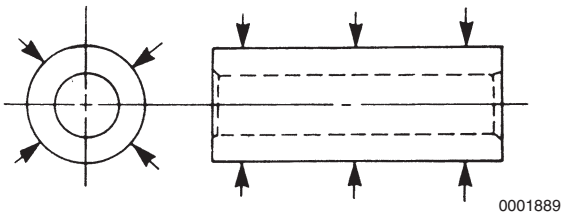


Figure 4-2-66

8. Using a micrometer, measure the thickness of each piston ring. *See "3-2 Engine Service Standard" section for the service limit.* Record the measurements.

   Notes:

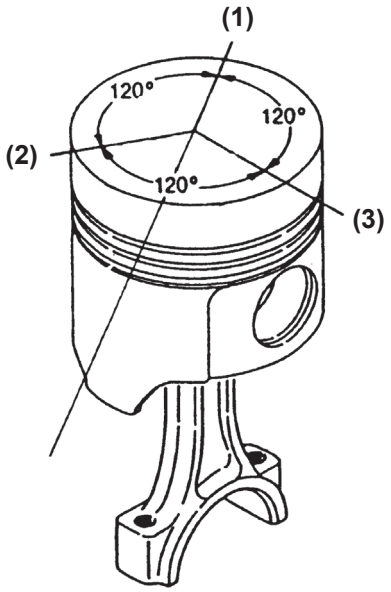
   - On an engine with low hours, the pistons, piston rings and cylinders may be reused if they are found to be within specifications.
   - On an engine with high hours, the pistons rings should be replaced and the cylinder honed *(See Honing and Boring on page 4-2-39)* or replaced. The piston should be replaced as necessary.
9. Place each compression piston ring in the groove as shown **(Figure 4-2-67)**. Use a feeler gauge to measure the clearance between the piston ring and the piston ring land. Record the measurements. *See "3-2 Engine Service Standard" section for the service limit.* Replace the piston if not within specification.

Installation of Pistons

IMPORTANT

Do not allow the connecting rod to contact the crankshaft journal during piston installation. Damage to the crankshaft bearing journal may result.

1. Lubricate piston, piston rings, and cylinder with clean engine oil or assembly lubricant.
2. Rotate the crankshaft so the crankpin for the piston being installed is near bottom dead center.



1 – Top Compression Ring End Gap
2 – Second Compression Ring End Gap
3 – Oil Ring End Gap

Figure 4-2-92

IMPORTANT

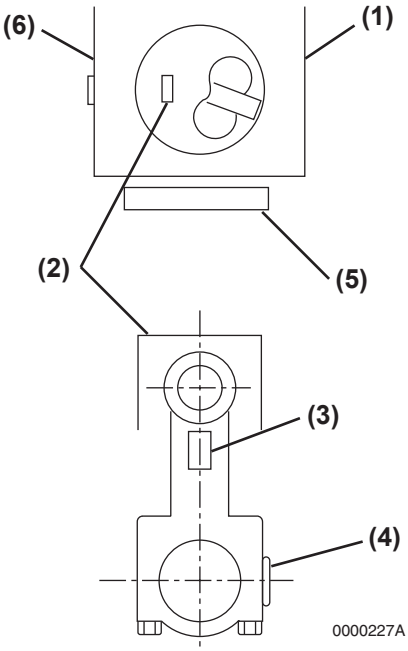
*Ensure piston ring gaps are located correctly **(Figure 4-2-92)**.*

3. Using a piston ring compressor, compress the piston rings.

IMPORTANT

*The piston and connecting rod must be reinstalled with the correct orientation. When installed correctly, the identification mark **(Figure 4-2-93, (2))** stamped into the top of the piston will be on the same side of the engine as the fuel injection pump **(Figure 4-2-93, (1))** and the embossed mark **(Figure 4-2-93, (3))** cast into the connecting rod beam will face the flywheel end of the engine **(Figure 4-2-93, (5))**.*

4. Carefully reinstall the piston and rod assembly. Be sure the match marks **(Figure 4-2-93, (4))** stamped into the connecting rod and cap are facing the fuel injection pump side of the cylinder block, and the piston identification mark **(Figure 4-2-93, (2))** stamped into the piston top is facing the camshaft side **(Figure 4-2-93, (6))**. The embossed mark cast into the connecting rod beam **(Figure 4-2-93, (3))** will be facing the flywheel end of the engine **(Figure 4-2-93, (5))**.



1 – Fuel Injection Pump Side of Engine
2 – Piston Identification Mark
3 – Embossed Mark on Connecting Rod
4 – Rod and Cap Match Marks
5 – Flywheel End of Engine
6 – Camshaft Side of Engine

Figure 4-2-93

5. Reinstall the bearing insert **(Figure 4- 2-94, (1))** in the connecting rod and cap.

1 – High-Pressure Fuel Injection Lines
2 – Fuel Return Line Nut
3 – Fuel Return Line
4 – Fuel Injector
5 – Gasket
6 – Protector
7 – Fuel Return Hose
8 – Fuel Injection Pump Drive Gear Nut
9 – Lock Washer
10 – Fuel Injection Pump Drive Gear Assembly (DO NOT remove or loosen the four bolts that fasten the injection pump drive gear to the injection pump drive gear hub!)
11 – Fuel Injection Pump
12 – Lube Oil Line
13 – Mechanical Fuel Supply Pump (Optional on some models)
14 – Fuel Return Fitting
15 – Low Pressure Fuel Inlet Fitting
16 – Fuel / Water Separator
17 – Electric Fuel Supply Pump
18 – Fuel Filter
19 – Fuel Filter Mount

4-3-7 Fuel Injection Lines

Removal of High-Pressure Fuel Injection Lines

NOTICE

Remove or install the high-pressure fuel injection lines as an assembly whenever possible. Disassembling the high-pressure fuel injection lines from the retainers or bending any of the fuel lines will make it difficult to reinstall the fuel lines.

Note: To prevent “rounding” the fuel line nuts always use a “line” or “flare nut” wrench.

1. Close any fuel valves in the fuel supply line.
2. Clean the area to keep contaminants from entering the fuel system.
3. Place a drain pan under the fuel injection pump to catch any spillage.
4. Loosen the fuel line nuts at the fuel injection pump.
5. Next, loosen the fuel line nuts at the fuel injectors. Use one wrench to hold the fuel return line nut and fuel return line from rotating. Use a second wrench to loosen the fuel line nut **(Figure 4-3-4)**. Repeat with the remaining fuel injectors.

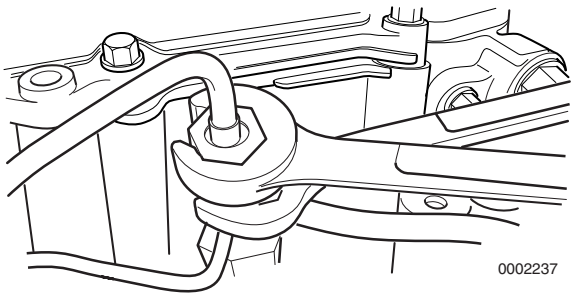


Figure 4-3-4

6. Finish loosening all the fuel line nuts and remove the high-pressure fuel lines as an assembly being careful not to bend any of the fuel lines. Be sure to protect the fuel system from contamination by plugging or covering all open connections.
7. Plug or cap all openings to minimize leakage and prevent contamination.

Fuel Injection Timing Chart

Model	VM			
Engine Speed (rpm)	2000 to 2100	2200	2300 to 2600	2700 to 3000
Injection Timing BTDC ±1	15°		16°	18°

11. Remove all high-pressure fuel injection lines. *See Removal of High-Pressure Fuel Injection Lines on page 4-3-7.*
12. Turn on all fuel supply valves.

Note: As the injection pump injects fuel to a cylinder only once every two engine revolutions, it may be necessary to rotate the crankshaft twice to see fuel being pumped from the timing tool or delivery valve of the cylinder you are using to check injection timing.

13. Install the “spill-timing” tool **(Figure 4-3-28, (1))** onto the delivery valve for the cylinder being checked. *See Measuring Instruments on page 4-3-4.*

Note: If a timing tool is not available, timing can be checked by watching the fuel in the delivery valve itself.

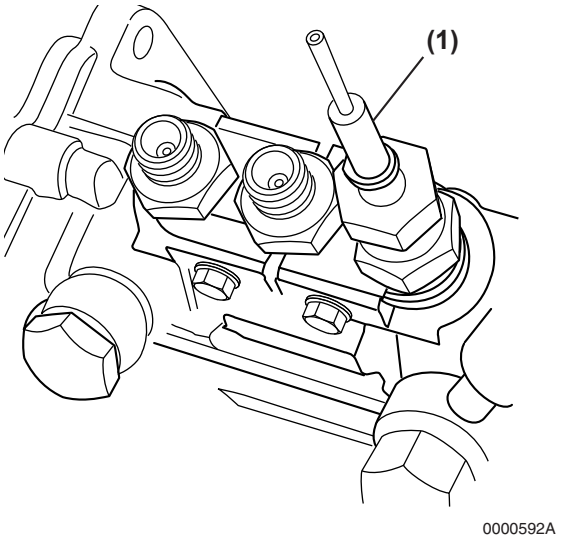


Figure 4-3-28

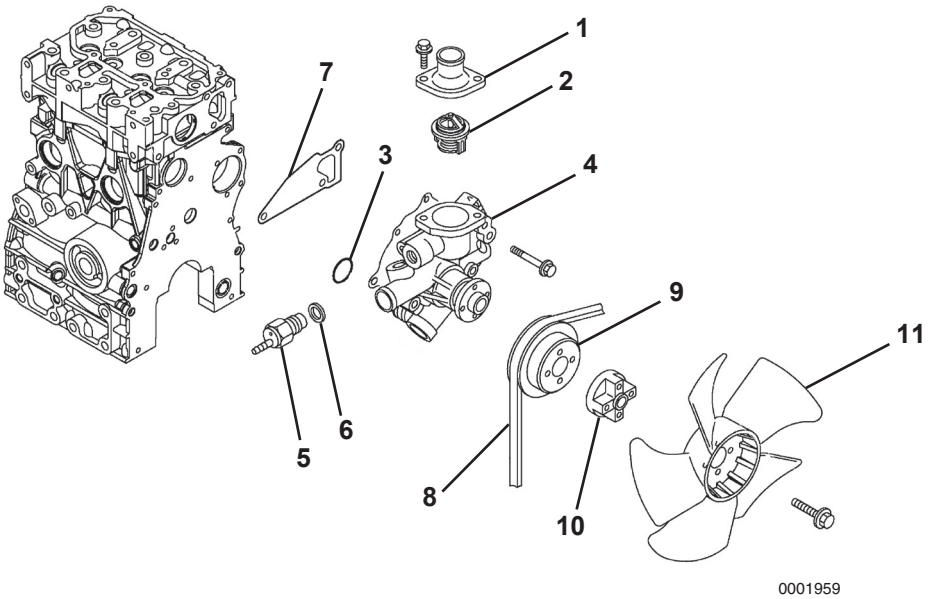
Note: The following references to the direction of rotation are made facing the cooling fan end of the engine and are adjusted by turning the crankshaft.

14. Slowly rotate the crankshaft clockwise using a wrench on the crankshaft pulley bolt until fuel is pumped from the nozzle of the “spill-timing” tool or delivery valve.
15. Slowly rotate the crankshaft clockwise approximately two more revolutions until the timing grid on the flywheel (for the cylinder being checked) is at approximately 30° BTDC.

Note: The fuel injection pump injects fuel to a cylinder only once every two engine revolutions.

16. “Flick” the nozzle of the timing tool with a finger to remove bubbles and establish a fuel level of approximately 1/2 the height of the nozzle.
17. Very slowly rotate the crankshaft clockwise until the fuel level in the nozzle of the “spill timing” tool, or in the delivery valve, just begins to move. Immediately stop rotating the crankshaft.
18. Check the position of the flywheel target timing mark **(Figure 4-3-27, (1))** on the flywheel grid in relation to the timing reference mark **(Figure 4-3-27, (2))** on the flywheel housing or back plate. If the two marks are aligned, the fuel injection timing is correct. If the marks do not align, the fuel injection timing must be adjusted. *See Adjusting Fuel Injection Timing on page 4-3-18.*
19. Repeat Steps 13-17 two or three times to verify timing.
20. Remove the “spill-timing” tool.
21. Reinstall the shut-off solenoid.
22. Reinstall the high-pressure fuel injection lines. *See Installation of High-Pressure Fuel Injection Lines on page 4-3-8.*
23. Replace the flywheel inspection port cover.
24. Prime the fuel system. Operate the engine and check for leaks.

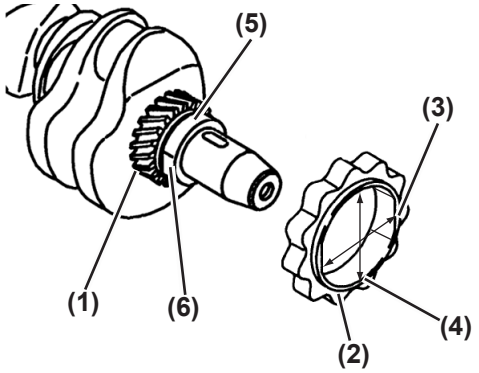
4-4-4 Engine Coolant Pump Components



1 – Thermostat Cover
2 – Thermostat
3 – Special O-Ring
4 – Engine Coolant Pump
5 – Temperature Switch
6 – Gasket
7 – Engine Coolant Pump Gasket
8 – V-Belt
9 – Engine Coolant Pump V-Pulley
10 – Spacer
11 – Engine Coolant Fan

Figure 4-4-2

Check Inner Rotor and Gear Boss Clearance



1 – Crank Gear
2 – Inner Rotor
3 – Inside Width Across Flats of Inner Rotor
4 – Overall Inside Diameter of Inner Rotor
5 – Overall Inside Diameter of Gear Boss
6 – Outside Width Across Flats of Gear Boss

Figure 4-5-10

Record the measurement.

Reassembly of Oil Pump

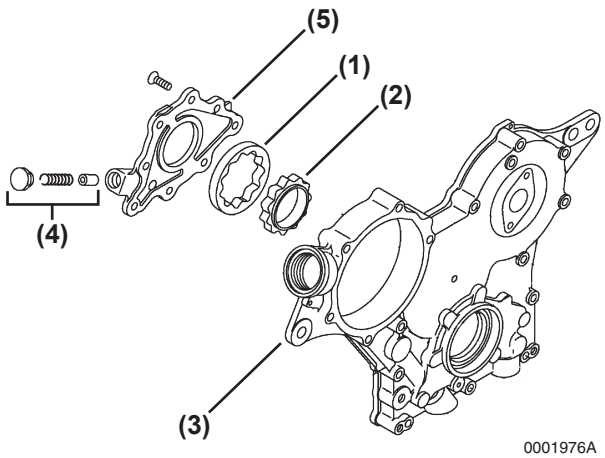


Figure 4-5-11

1. Lubricate the outer rotor **(Figure 4-5-11, (1))**, inner rotor **(Figure 4-5-11, (2))** and pump bore in the gear case cover **(Figure 4-5-11, (3))** with clean engine oil.
2. Reinstall the outer rotor in the gear case. The dot mark on the face of the outer rotor must face up toward the oil pump cover.
3. Reinstall the inner rotor into the gear case cover with the dot mark also facing up. Make sure that the pilot on the back side of the inner rotor fits into the bore in the gear case cover and the top surface of the inner rotor is flush with the top surface of the outer rotor.
4. Reinstall the oil pressure regulator valve **(Figure 4-5-11, (4))** into the oil pump cover **(Figure 4-5-11, (5))**. Apply LOCTITE® 242 (red) to the valve plug, following the manufacturer's instructions.
5. Reinstall the oil pump cover **(Figure 4-5-11, (5))**. Apply LOCTITE 290 (green) or LOCTITE 262 (red) to the oil pump cover screws. Tighten the pump cover screws to 52 - 70 in·lb (5.9 - 7.9 N·m, 0.6 - 7.9 kgf·m).
6. Reinstall the crankshaft pulley and gear case cover. *See Removal of Timing Gear Case Cover on page 4-2-24.*
7. Reinstall the engine coolant pump V-pulley **(Figure 4-5-12, (3))**, spacer **(Figure 4-5-12, (2))**, engine cooling fan **(Figure 4-5-12, (1))** and engine cooling fan guard (if equipped).

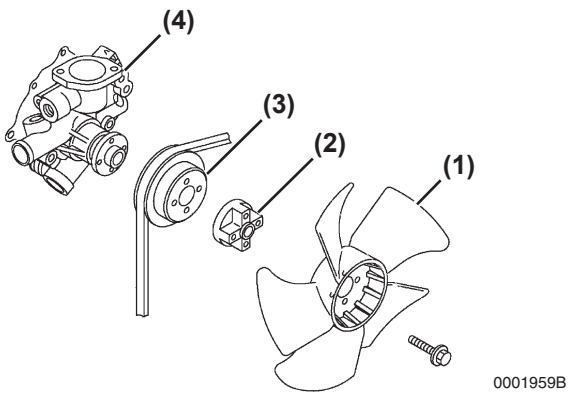


Figure 4-5-12

8. Reinstall the V-belt. Tighten the V-belt to the proper tension.

Field Coil

Field Coil Continuity Test

Check for continuity between the field coil terminals using a multimeter **(Figure 4-6-18)**. The multimeter should indicate continuity.

If the multimeter does not indicate continuity, replace the field coil assembly.

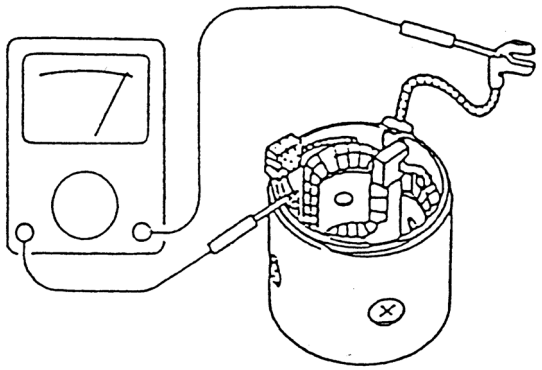


Figure 4-6-18

Field Coil Insulation Test

Check for continuity between either field coil terminal and the yoke using a multimeter **(Figure 4-6-19)**. The multimeter should not indicate continuity.

If the multimeter indicates continuity, replace the field coil assembly.

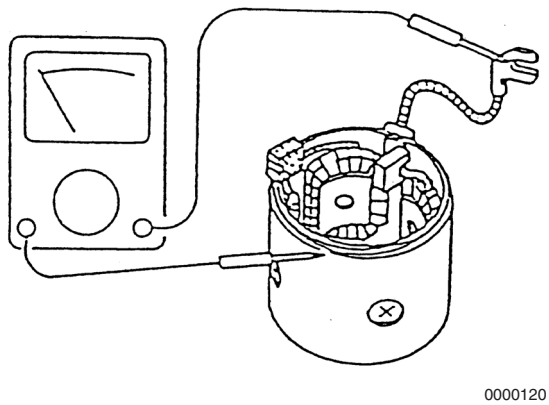


Figure 4-6-19

Measure Brush Length

Measure the length of the brush **(Figure 4-6-20)**. Replace the brush if the length is less than the limit. *See Starter Motor Specifications on page 4-6-2 for service limit.*

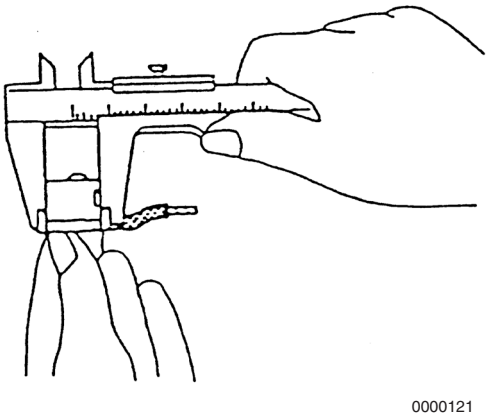


Figure 4-6-20

Brush Holder

Brush Holder Insulation Test

Check for continuity between each brush holder and the base using a multimeter **(Figure 4-6-21)**. The multimeter should not indicate continuity.

If the multimeter indicates continuity, replace the brush holder.

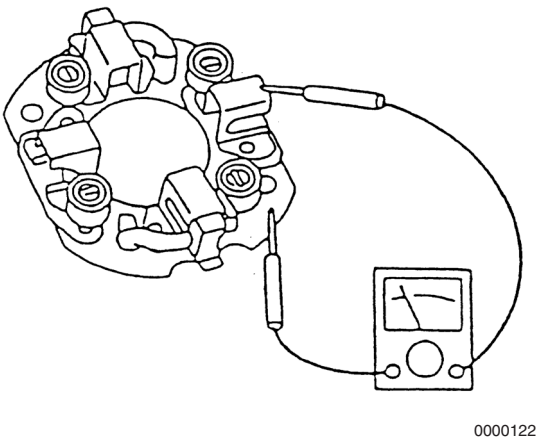
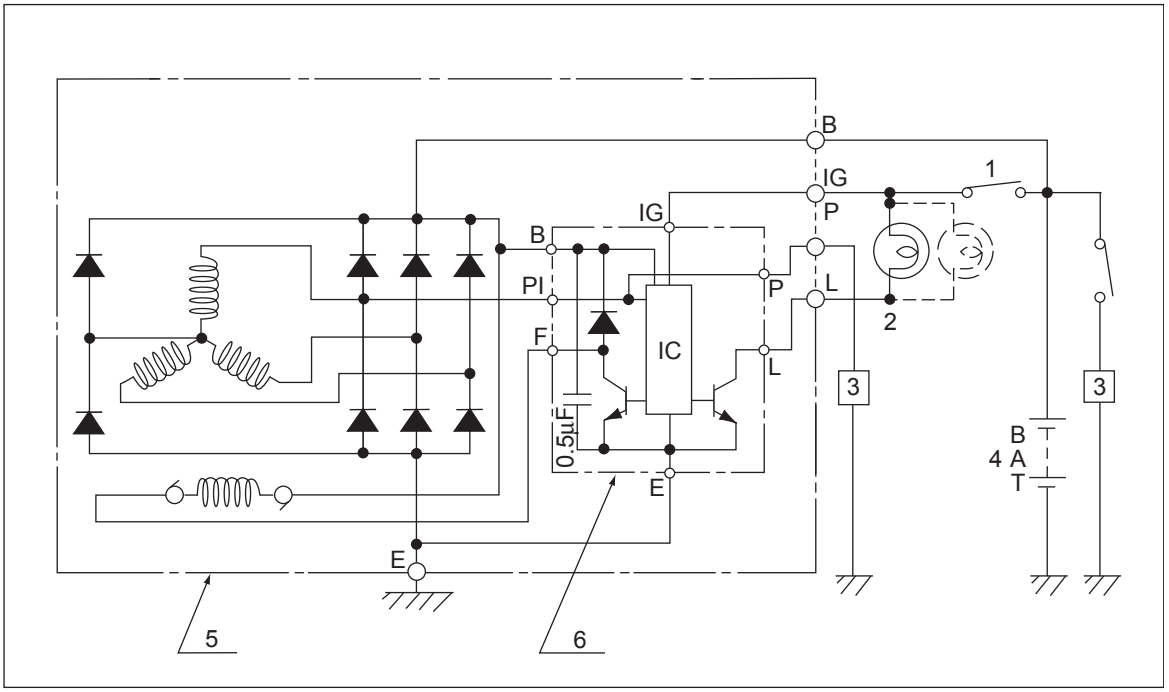


Figure 4-6-21

4-7-6 Alternator Wiring Diagram



1 – Key Switch
2 – Charge Lamp (3.4 Watts Max.)
3 – Load
4 – Battery
5 – Alternator Assembly
6 – IC Regulator Assembly

Figure 4-7-2

NOTICE

Do not short-circuit the charging system between alternator terminals IG and L. Damage to the alternator will result.

NOTICE

Do not connect a load between alternator terminals L and E. Damage to the alternator will result.

NOTICE

Do not remove the positive (+) battery cable from alternator terminal B while the engine is operating. Damage to the alternator will result.

Standard Compression Pressure

Engine compression pressure list (reference value)

Compression Pressure at 250 rpm (250 min^{-1})		**Deviation Between Cylinders**
Standard	Limit	
3.43 ± 0.1 MPa; 35 ± 1 kgf/cm^2	2.75 ± 0.1 MPa; 28 ± 1 kgf/cm^2	0.2 to 0.3 MPa; 2 to 3 kgf/cm^2

Engine Speed and Compression Pressure (Use for Reference)

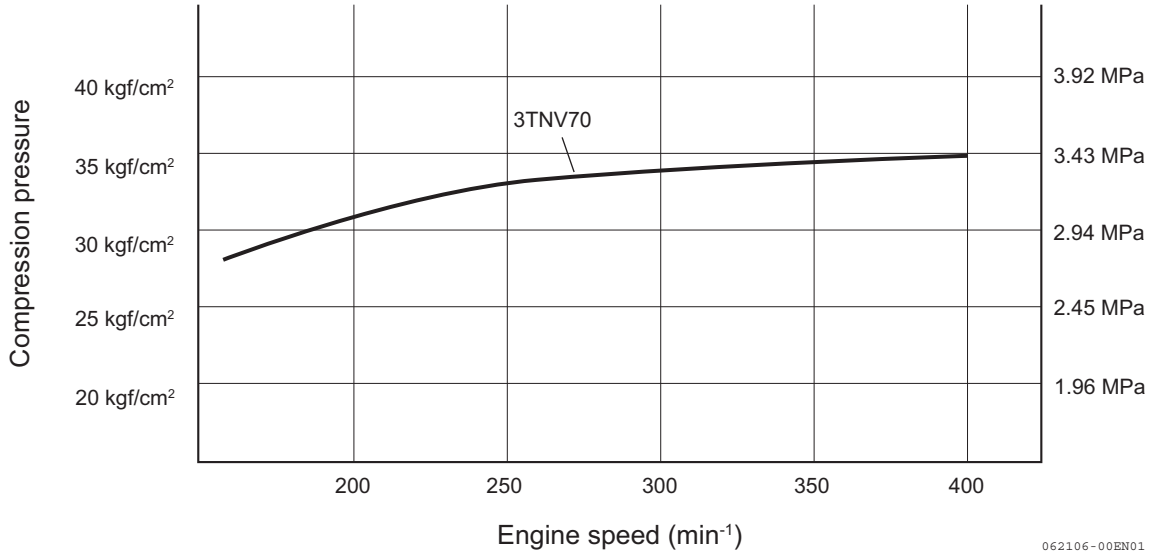
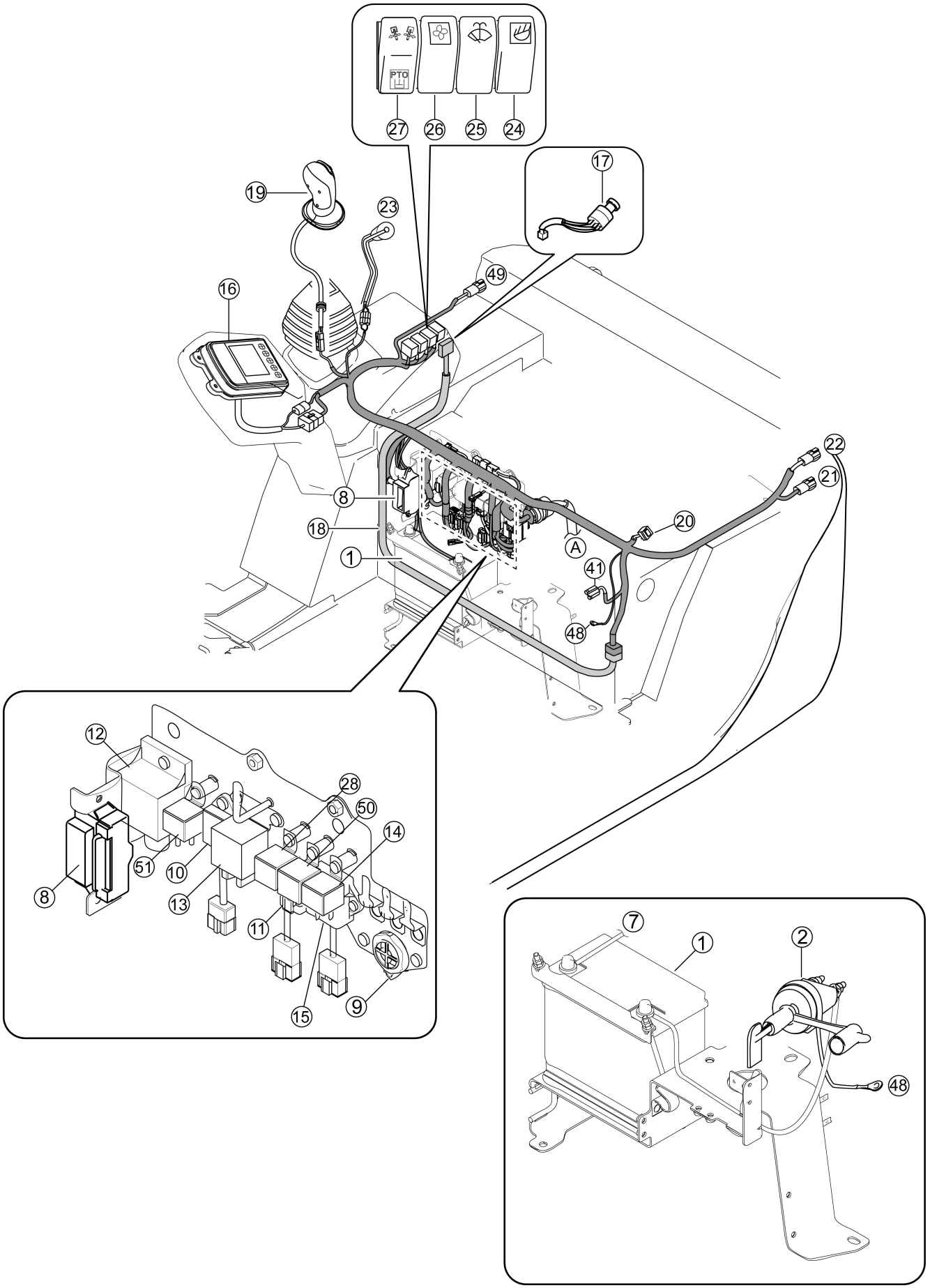


Figure 4-9-2

2) Harness B and C



5-2-2 Battery charge

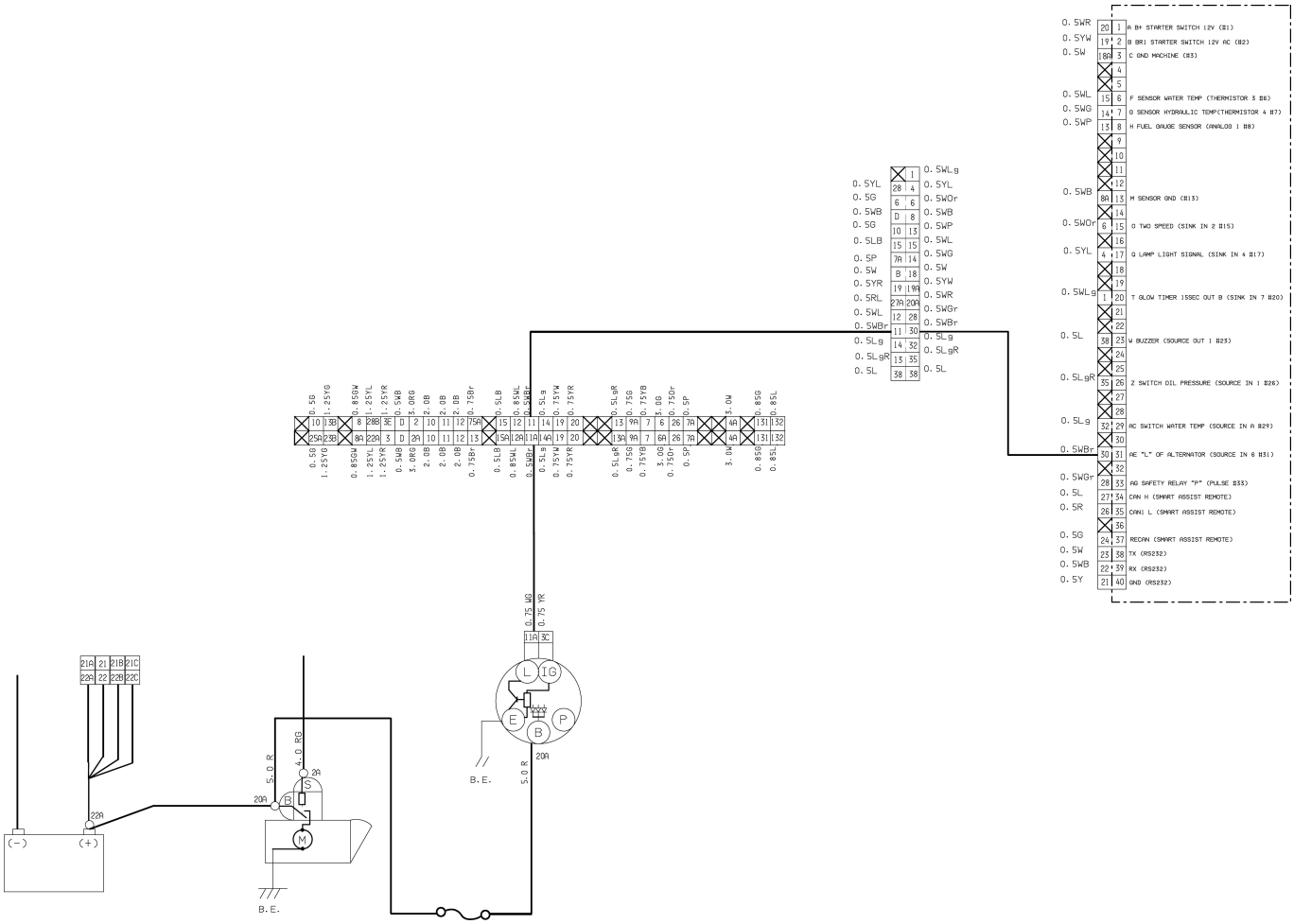
The electric current generated by the generator **7** flows to the battery + terminal to be charged.

↓

The battery charge alarm calls for poor battery charging.

The electric current flows from the generator **7** to the battery **1** through the slow blow fuse (Charge) to charge the battery.

When the voltage generated by the alternator decreases, the logical circuit in the alternator is turned on so that the terminal of the battery charge alarm in the LCD monitor and that of the alternator are connected to raise alarm over poor charging. (Generator **7** → Lead wire **W/G** → LCD monitor **31**)



6. HYDRAULIC SYSTEM

1) Hydraulic Pump

The pump is linked to the flywheel of the engine through the coupling. The number of revolutions of the hydraulic pump is identical to the engine speed.

cm^3 / rev

No.	Pump		SK16
1	Variable pump	P	13,2

2) Oil Flow

The pump takes in oil through the suction filter from the hydraulic oil tank and discharges it.
The discharged oil flows to the port P of the cut-off valve and to the port P of the control valve.
The flow from the port P of the inlet section feeds the arm cylinder, the swing motor, the boom, bucket, blade cylinders, the PTO (option), the boom swing, the left and right travel motor through the appropriate sections of the control valve.
Due to the closed center of the sections of the control valve, the oil pressure increases until the differential valve setting pressure (15 bar), then oil flows through port T of the control valve back to the hydraulic oil tank.

3) System Relief Valve

The system relief valves of the control valve regulate the discharge pressure of the pump.

4) Cut-off valve

When the lock lever is set to the "LOCK" position, the spool in the Safety part of the cut-off valve returns the pilot oil to the tank through the port T of the cut-off valve. The oil flows through the cut off valve relief valve back to the hydraulic oil tank.

Therefore, the implement does not operate and the machine does not travel even when the control or travel lever is operated.

6-2-5 Boom Swing

The P.T.O/Boom swing switch controls the proportional solenoid valve through the output current of the solenoid driver in the remote control lever.

1) Right Boom Swing

(1) Pilot oil flow

When the boom swing switch is moved to the right, the pilot oil from the pump flows through the cut-off valve to the port P of the proportional valve. Pilot oil flows through the port B of the proportionnal valve to the port P2 of the selector valve and then from the port C4 to the port Pb7 of the boom swing section to move its spool.

(2) Oil Flow from Hydraulic Pump

The oil discharged from the pump flows to the boom Swing section through the port P of the inlet section. The oil flows through the port B7 to the rod port of the boom swing cylinder to retract its cylinder rod, swinging the boom to the right.

The return oil from the bottom port of the boom swing cylinder flows back to the hydraulic oil tank through the port A7 and T of the control valve. Some return oil from the port T flows directly to the tank while the remaining flows back to the tank through the oil cooler and the return filter.

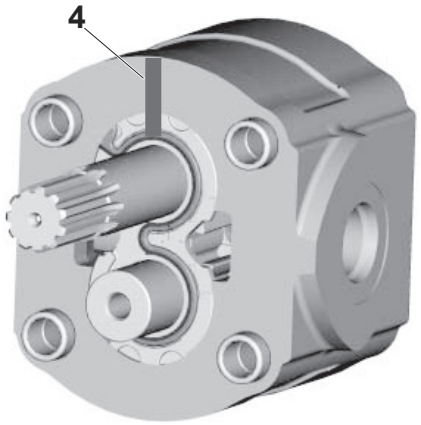
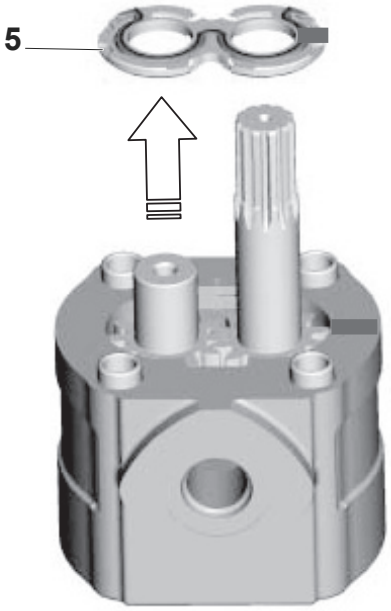
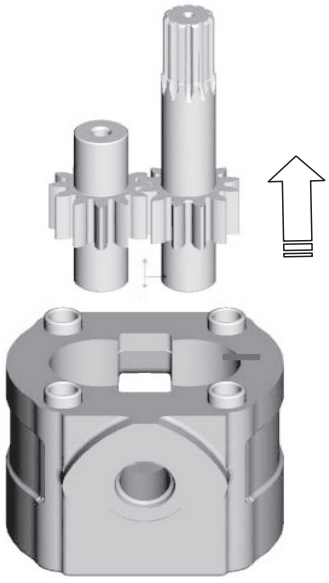
2) Left Boom Swing

(1) Pilot oil flow

When the boom swing switch is moved to the left, the pilot oil from the pump flows through the cut-off valve to the port P of the proportional valve. Pilot oil flows through the port A of the proportionnal valve to the port P1 of the selector valve and then from the port C1 to the port Pa7 of the boom swing section to move its spool.

(2) Oil Flow from Hydraulic Pump

The oil discharged from the pump flows through the port P of the inlet section to the boom swing section. In this operation, the oil flows in the opposite direction to the oil flow in the right boom swing operation with regard to the boom swing cylinder.

Procedure	
5. Use a marker to draw a reference mark (4) on the plate and body. It will be used later, during reassembling.	
6. Remove the upper plate (5).	
7. Remove the gears. **Note** Rotate the gears by hands during removal to remove it easier.	

Visual defects

Malfunction	Probable Cause	Additional Checks	Remedy
Spool leaking oil	(1) Spool seals defective		Replace spool seals
	(2) Tongue seal or spool adapter seal defective		Replace tongue seal or spool extremity seal
Oil leakage at secondary valves	Seals defective		Remove pressure relief valve, anti-cavitation check valve or plug and replace seal
Oil leakage between elements	Seals plates defective		Remove working sections and replace seals plates
Oil leaking from hydraulic operator housing	(1) Seal between housing and body defective		Replace seal
	(2) Tightness of adjustable stop nut defective	Check nut tightening torque	Tighten to torque 30 ± 10% N.m. or replace nut and screw

6-4-3 Fundamental Rules

When removing the block, all openings must be plugged immediately to prevent any contamination of the hydraulic system.
When replacing the block, remove the plastic plugs from the openings and lines just before making the connections.
Do not tighten connectors to a torque greater than that specified in the assembly instructions.
Check the hydraulic installation's oil quality and filtration capacity during all servicing/maintenance operations. The use of Teflon tape, hemp and joint filler is prohibited.
Hydraulic lines and connections must not be under any strain whatsoever.

6-4-4 Removal / Installation of the SX 10 Control Block

1) General Recommendations

CAUTION :

Before removing the sx 10 control block from the machine, the block and its surroundings must be thoroughly cleaned (do not direct the jet of a pressure washing unit directly at the unit).

No impurities must enter the hydraulic system. plastic plugs are to be fitted on lines and orifices immediately following their removal.

Wear protective clothing and use suitable equipment to prevent accidents, particularly concerning the hydraulic fluid.

Use the lifting eyes and suitable handling equipment.

Set all actuators connected to the machine in neutral position (on the ground, at lower limit ...) to avoid accidents which could result from uncontrolled movements of the equipment when the hydraulic system is disconnected.

With the machine off, release the pressure remaining in the system by manipulating all of the distribution spools. This is performed by moving the handle in all directions.

Procedure	
Tongue replacement (if necessary) Beforehand, heat the spool to 200°C in an oven or, failing that, with a heat gun. **Wear thick protective gloves when handling the hot spool.** ***CAUTION :*** *Do not use a welding torch to heat the tongue as spool deformation may result.* ***Note :*** *Keep the load hold check valve located inside each spool side clean.* Loosen the tongue using an open end wrench (6 mm open end spanner). ***Note :*** *Keep the load hold check valve located inside each spool side clean.* Reassembly : - replace tongue seal - apply a droplet of Loctite 262 on the end of the tongue thread, - torque: 5 ± 10% N.m. ***CAUTION :*** *Wait for 8 hours before using the machine to let the Loctite 262 dry completely.*	

6-5 Pilot Valve

6-5-1 Remote Control Valve

Pilot valve unit for arm rest installation
Type 4TH5

Maintenance Instructions

1) Foreword

This manual deals with the instructions relative to servicing and maintenance operations for the hydraulic pilot control unit 4TH5 for the inspections and servicing operations associated with the hydraulic system of the machine to which they are connected. Please consult the maintenance manual supplied by the equipment manufacture.
It is recommended that only qualified personnel perform the installation, connection and maintenance of this device, and that all operations shall be carried out in compliance with the technical standards in force and the cleanliness regulations specific to this type of installation.

To ensure maximum performance and safety during maintenance operations we advise you to **Read this manual thoroughly**

All information, illustrations, instructions and characteristics contained in this document are based on the latest prod-uct information available at the time of publication. In its attempts to maintain a high-quality product, MANNESMANN REXROTH reserves the right to make design or technical modifications at any time and without prior notification.

2) Safety Instructions

Please pay a special attention to the signals of safety alerts and special instructions in this manual. They are indi-cated in the following manner:

Indicates information or instructions which must be followed to guarantee your safety during opera-tions.

CAUTION :
Warning against possible equipment damage.
Note :
Useful information.

6-6-2 Disassembly

The listed item numbers refer to the sectional drawing and the spare parts list on page 6-6-1.
Fix the motor in a holding tool, with the motor shaft pointing downwards.

Item	Part to remove	Comments
9	Screw (2 off)	
116	Valve block	
8 & 10	O-ring	
44	Screw (4 off)	
16	Valve housing	
19	Disc valve	
22	Spacer	
18	Balance plate	Half fill balance plate center hole with hydraulic oil. Rapidly press mandrel (Ø14.5) into hole. The balance plate will now be pressed out by the oil and can be removed.
46 ,47 & 48	O-ring	
24	Spring washer	
20	Channel plate	
21	Valve drive	
42	Gear wheel set	Carefully lift out the gear wheel set. Hold one hand underneath to prevent gear wheel rollers from sliding out.
48	O-ring	
43	Cardan shaft	
61	Intermediate plate	
50	Seal ring	
56	Nut	Bearing nut is locked.
49	O-ring	
54	Shaft	Fix the bearing housing in a press and push shaft out of bearing housing.
57 & 55	Roller bearing and spacer	Press roller bearing and spacer out of bearing housing.
39 & 45	Shaft seal and back-up ring	Take the shaft seal and back-up ring out of bearing housing.

6-6-3 Cleaning

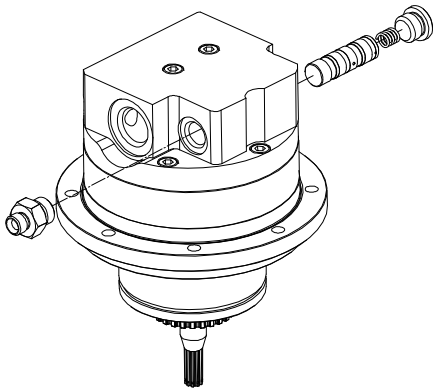
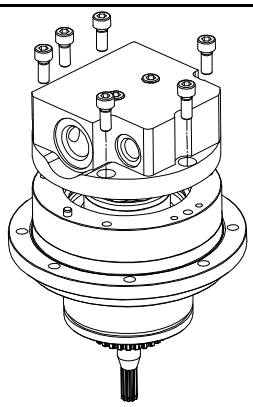
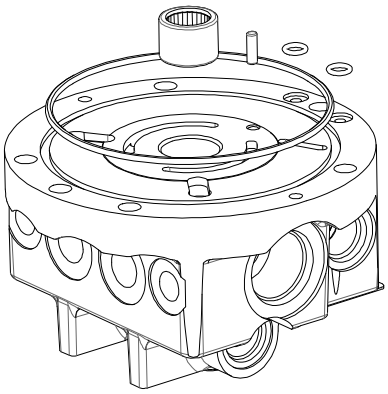
Clean all parts carefully in low aromatic kerosene.

6-6-4 Inspection & Replacement

Check all parts carefully and make any replacement necessary.

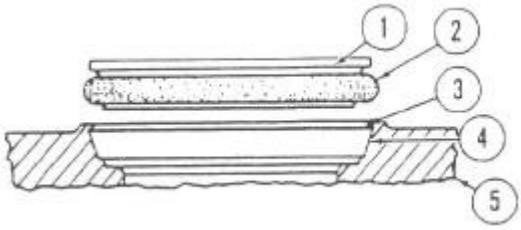
6-6-5 Lubrication

Before assembly, lubricate all parts with hydraulic oil and grease rubber parts with vaseline.

Procedure	
The following valve parts may now be removed by hands: plugs with O-Rings, springs, valve piston and the other plug.	
Remove the six head socket cap screw and relatives washers securing the motor cover. Remove the cover and the two dowel pins. ***Note :*** *Remove the dowel pins is optional.*	
Remove from the motor cover the O-Ring, the O-rings, the pin and the roller bearing with a bearing puller. ***Note :*** *Remove the dowel pins is optional.*	

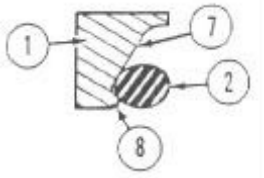
6-7-5 Installation Procedure Duo-Cone Seals

Seal rings, torics, and housings must be clean and free of any oil film, dust, or other foreign matter. Use a solvent that evaporates quickly, leaves no residue, and is compatible with the rubber toric rings. The recommended solvent is 1-1-1 Trichloroethane. (Note: Follow all safety guidelines for use on the solvent's Material Safety Data Sheet). Ring and housings should be wiped with a solvent-soaked lint free cloth or paper towel.

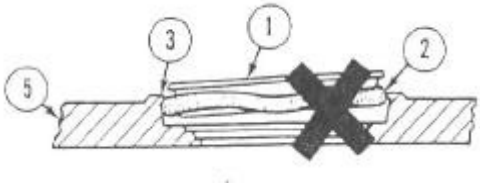


1.Seal Ring
2.Rubber Toric Ring
3.Housing Retaining Lip
4.Housing Ramp
5.Seal Ring Housing

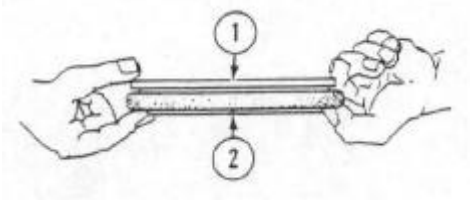
After all components have been wiped clean, the torics should be installed on the metal seal rings so that they rest in the radius on the tail of the metal ring. Insure that the torics are not twisted by inspecting the mold flash line on the outside diameter of the toric for for true circumferential tracking around the seal. Twisted torics will cause nonuniform face load that can result in leakage of lubricant and pumping of debris past the toric. If a twist is apparent, it can be eliminated by gently pulling a section of a toric radially away from the metal seal ring and letting it "snap" back. Repeating this in several places around the ring will eliminate any twist in the toric ring.



Put the toring ring 2 on seal ring 1, at the bottom of the seal ring ramp 7 and against the retaining lip 8.



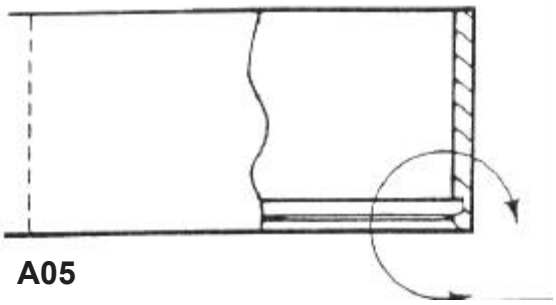
The toric ring 2 can twist if it is not wet all around during installation or if there are burrs or fins on the retaining lip 3 of the housing 5.



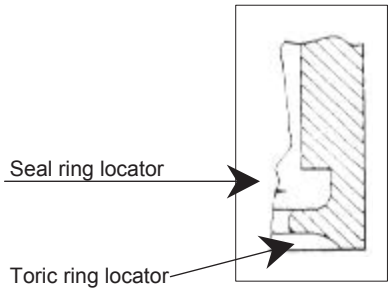
Eliminate toric twist by gently pulling a section of the toric 2 rapidly away from the seal ring 1 and letting it "sanp" back.

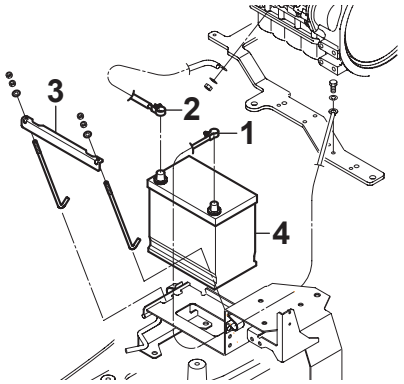
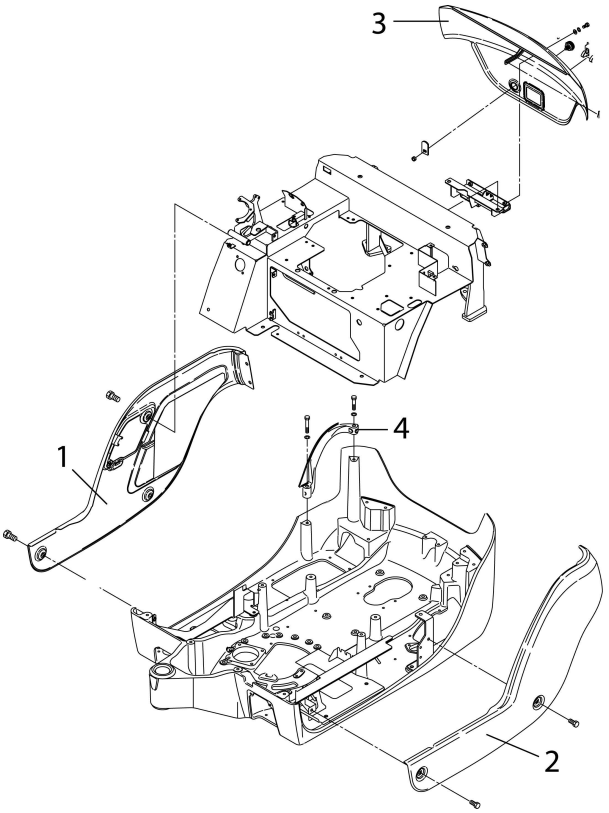
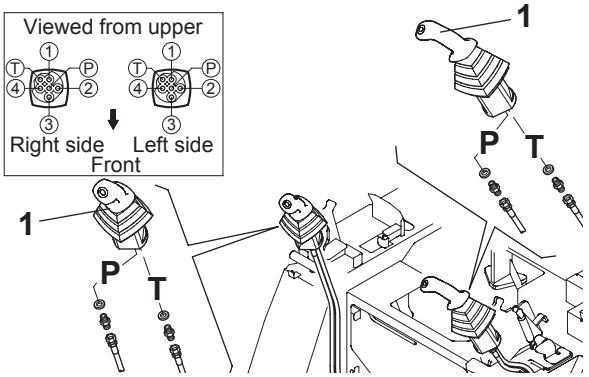
After the torics are installed on the seal rings, teh seal assembly is ready to be installed into the retainer housing. It is recommended to use installation tools available through Comer Industries (tool **A05**) to insure accurate assembly.

These durable installation tools are designed to locate on the toric ring and slide it past the housing retaining lip. A sedond locator is designed into larger seal installation tools to insure the proper seal stand out height. Improper seal assembly installation into the reatainer housing can result in poor seal performance due to nonuniform loding. Duo-Cone Seal installation tools help insure precise installation.



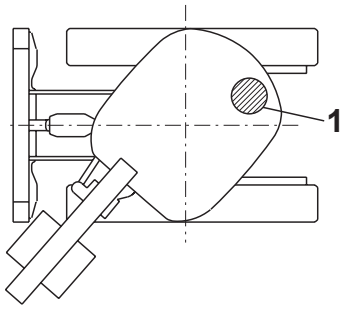
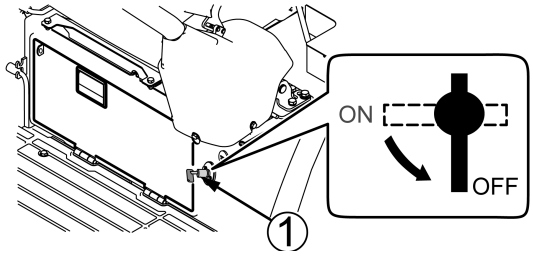
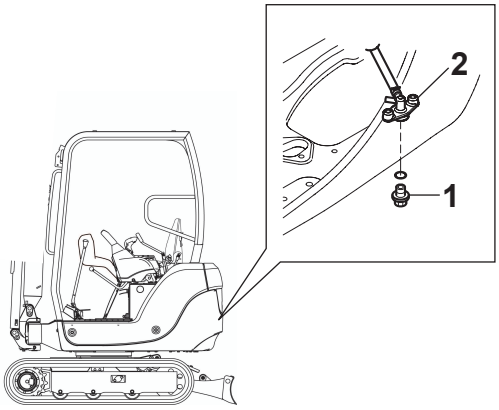
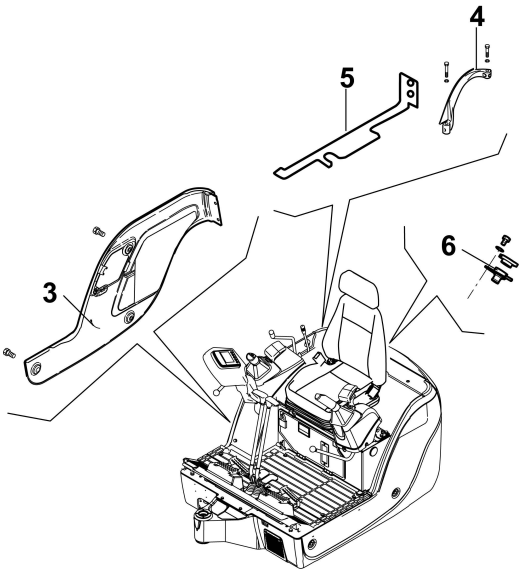
A05



Procedure	
(8) Disconnect the battery cable (negative) 1 and the battery cable (positive) **2** and remove the battery clamp **3**. Then remove the battery **4**.	
(9) Remove the cover R **1**, the cover L **2**, the bonnet **3** and the lim **4**.	
(10) Remove twelve pilot control hoses from both the remote control valves L and R **1**.	

7-1-5 Removal and Reinstallation of Radiator

1) Removal

Procedure	
(1) Swing the upperstructure so that the cooling fluid drain plug **1** is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine.	
(2) Turn the main switch **1** to the OFF position to disconnect the battery of the machine. Note : Place a MAINTENANCE IN PROGRESS label on the machine.	
(3) Remove the drain plug **1** from the two-way cock **2** for cooling fluid and drain the cooling fluid. Cooling fluid quantity: 3.2 L **Warning :** Put a container under coolant drain plug.	
(4) Remove the cover R **3**, the lim **4** and the radiator support **5.** (5) Remove the filler **6**.	

7-3-2 Adjustment of Accelerator Lever

1. Adjustment of Maximum Idling Speed

(1) Loosen the stopper bolt **1**, and then move the accelerator lever **4** back until the regulator handle **7** on the engine side touches the adjusting bolt **8** for the maximum idling speed in the governor case.

(2) Check that the maximum idling speed is within a specified range (2250 to 2300 rpm).

(3) Make adjustments with the accelerator cable **6** in the part **A** shown in the figure so that the stopper **9** for the maximum idling speed for the accelerator lever **4** will touch the accelerator arm **3**.

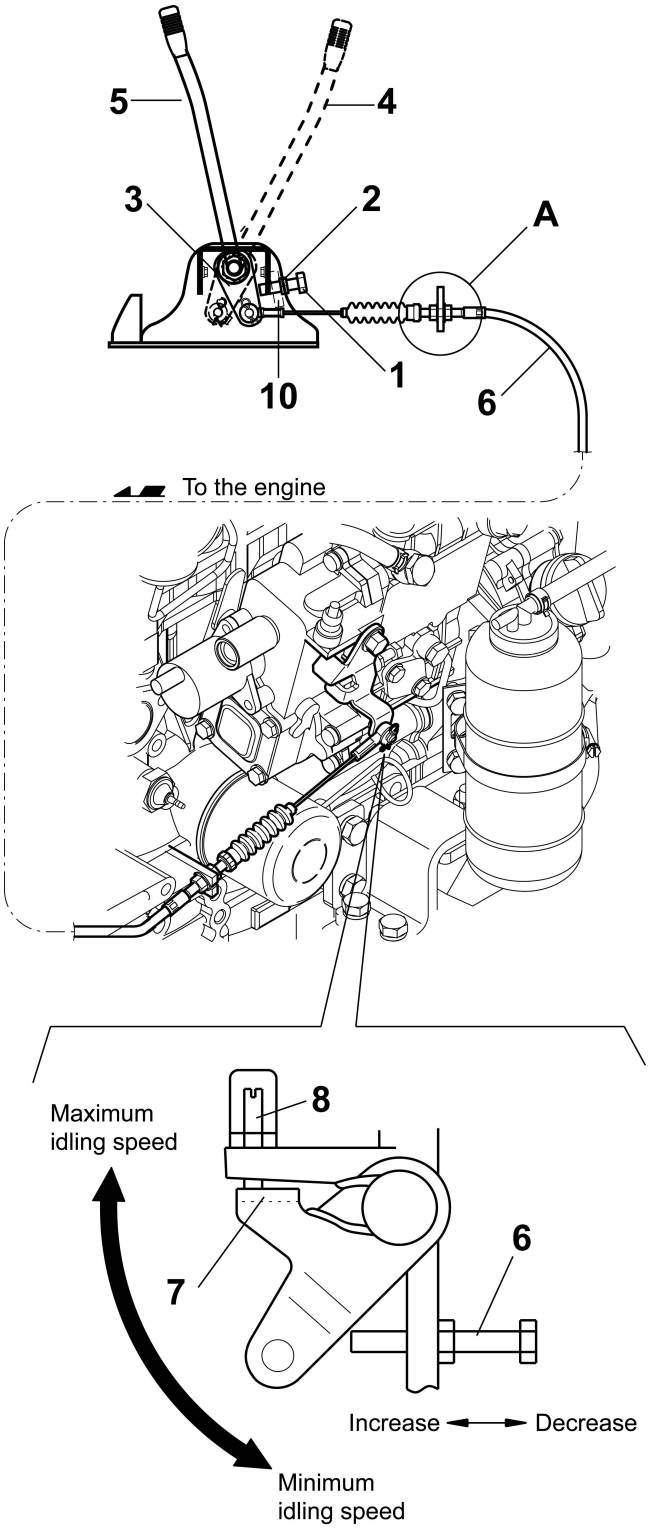
2. Adjustment of Minimum Idling Speed

(1) Move the accelerator lever **4** forward.

(2) When the regulator handle **7** on the engine side touches the stopper bolt **6** for the minimum idling speed, check whether the minimum idling speed is within a specified range (2250 to 2300 rpm).

(3) If the minimum idling speed is not within the range, make adjustments to the speed by tightening or loosening the stopper bolt **6**.

(4) After the adjustment of the minimum idling speed, screw in the stopper bolt **1** for the accelerator lever **4** until the bolt end touches the accelerator arm **3** and fix it with the nut **2**.



2) Reinstallation

Reinstall the control valve in the reverse order of the removal procedure.

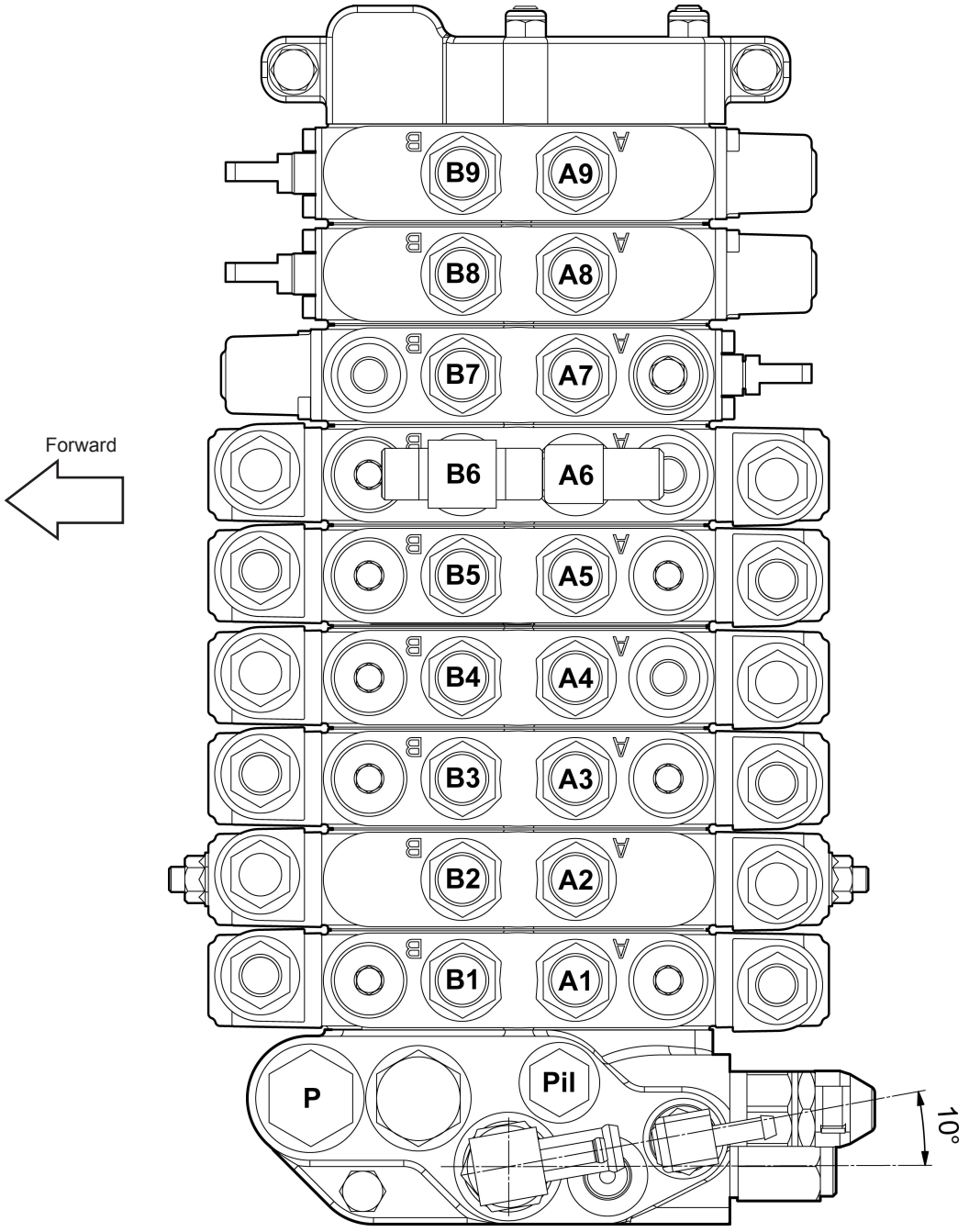
Notes :

[1] Install the hoses so that each of them is not in contact with any other hoses or parts.

[2] Hydraulic oil to be used :

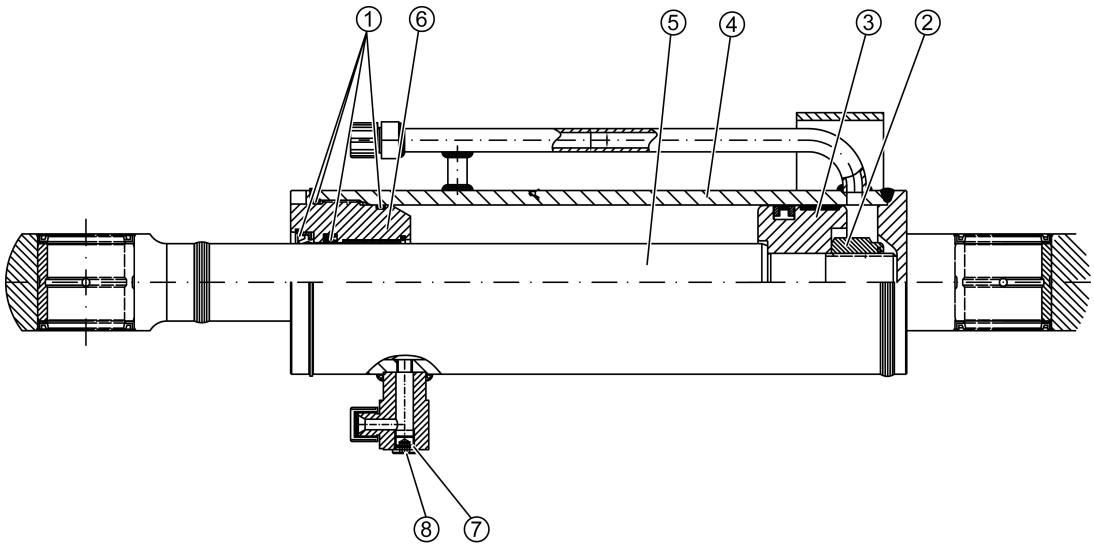
Type	*KOBELCO SUPER HYDRO OIL (VG 46 class) or its equivalent*
Quantity (total)	*28,5 L*

[3] After the installation of the control valve, raise the hydraulic oil temperature to 50 to 60 °C and operate the relief valves, to check for oil leak.



7-5-6 Disassembly and Reassembly of Hydraulic Cylinders

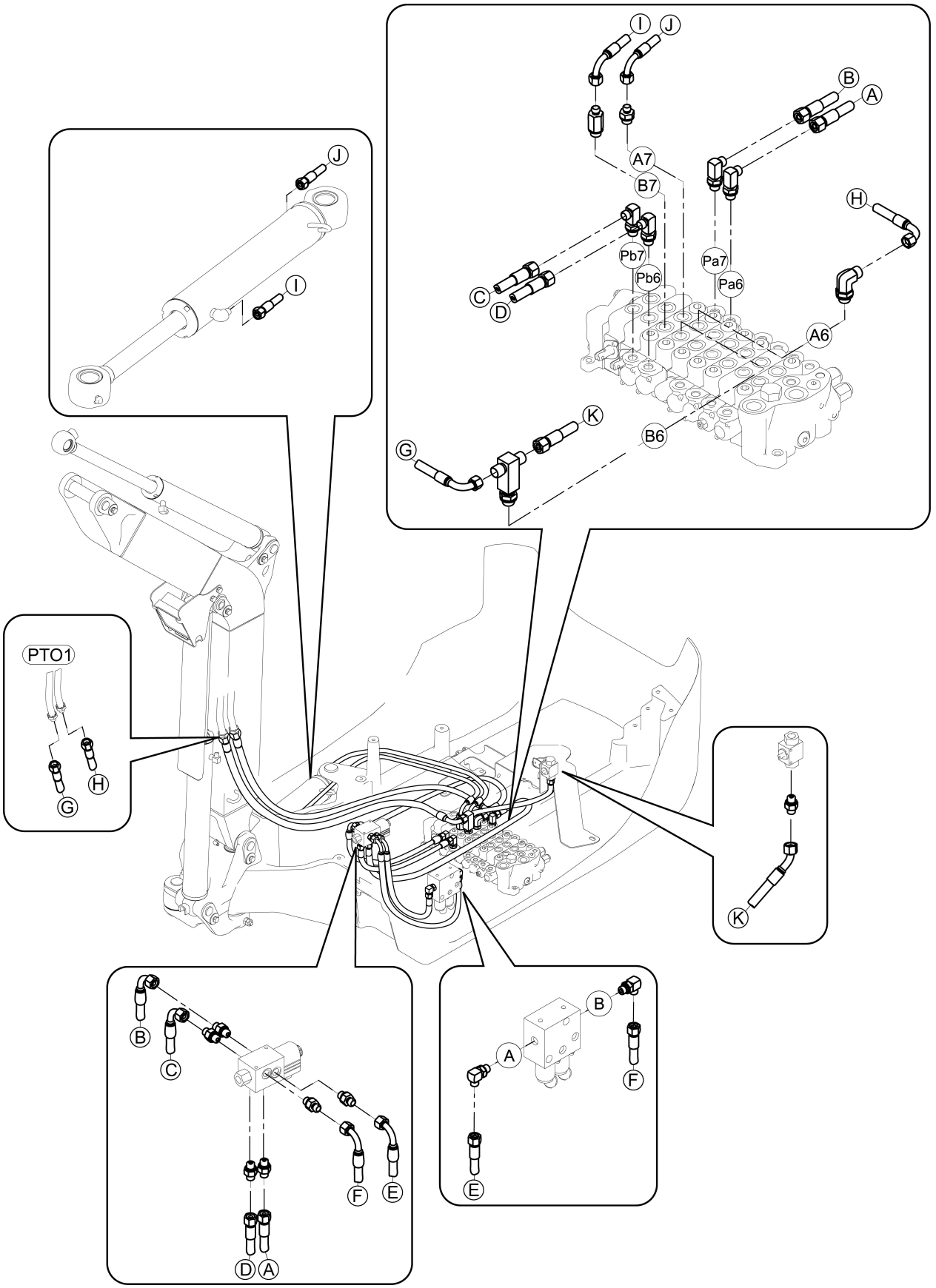
1) Sectional View and Component Parts



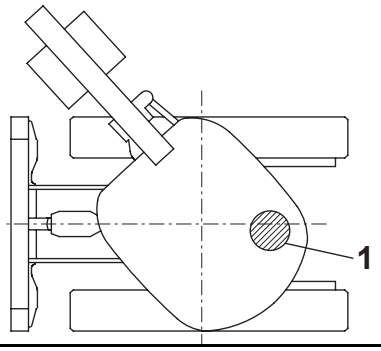
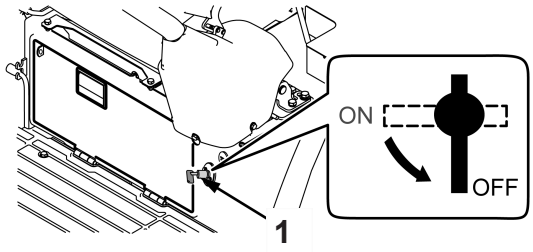
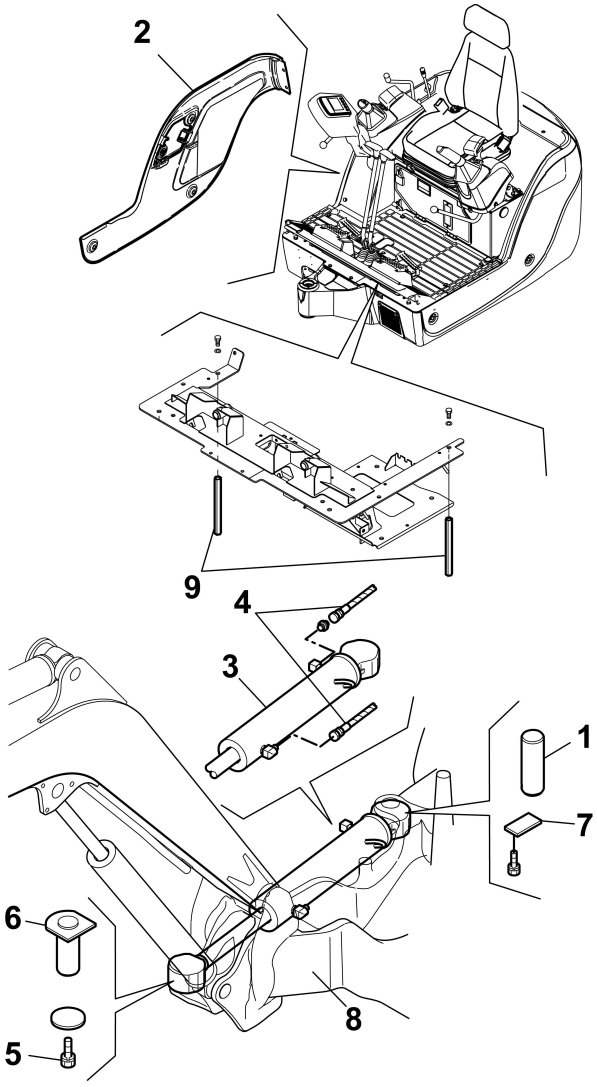
No.	Part
1	Seal kit, scrapper Bearing bush
2	Nut
3	Piston
4	Cylinder
5	Rod Assembly
6	Guiding bush
7	O-ring
8	Metal plug

4) PTO/Boom swing

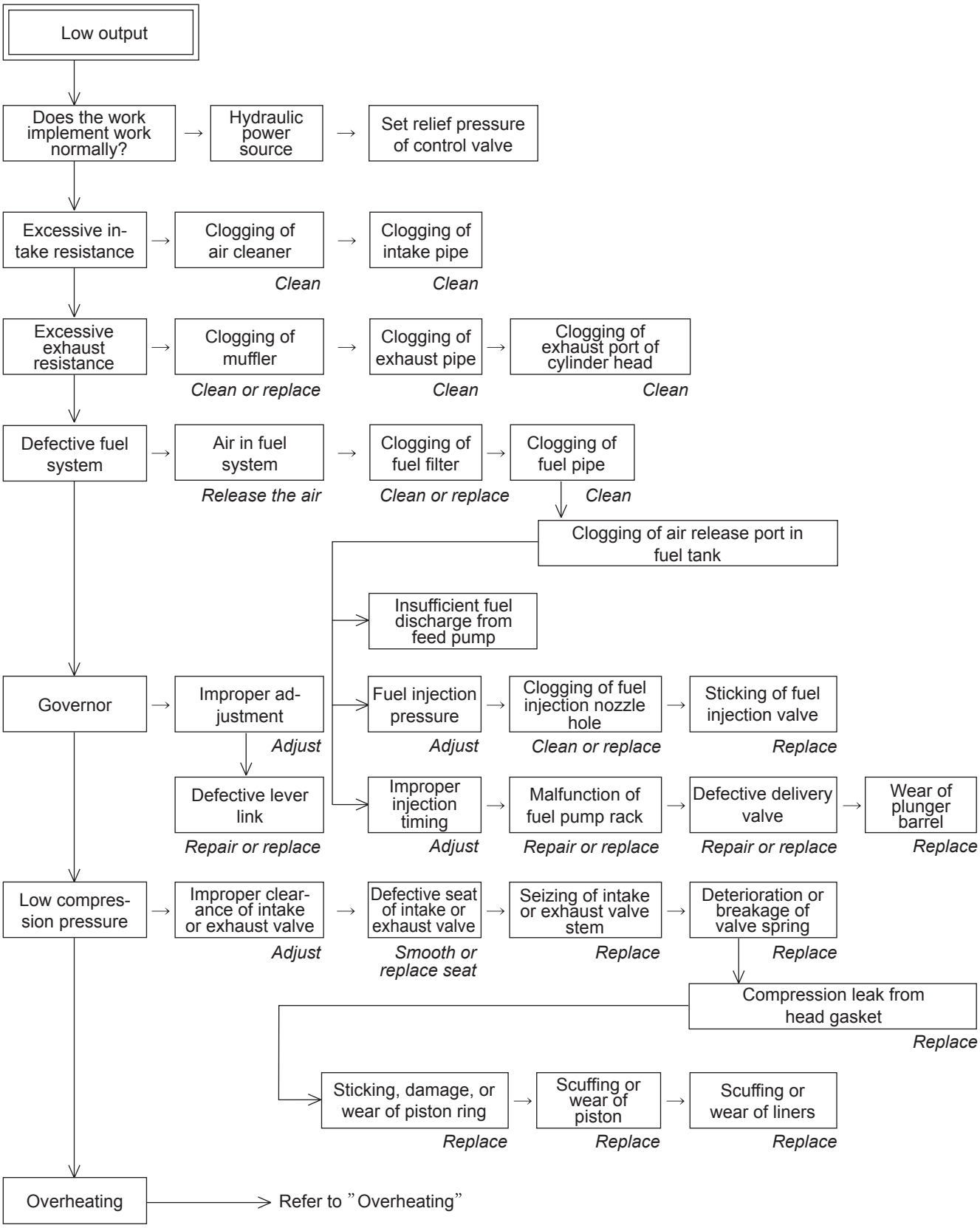
(PTO/Boom swing selector valve→Hydraulic manifold→PTO valve→control valve→PTO line)
(PTO/Boom swing selector→Control valve→Boom swing cylinder)

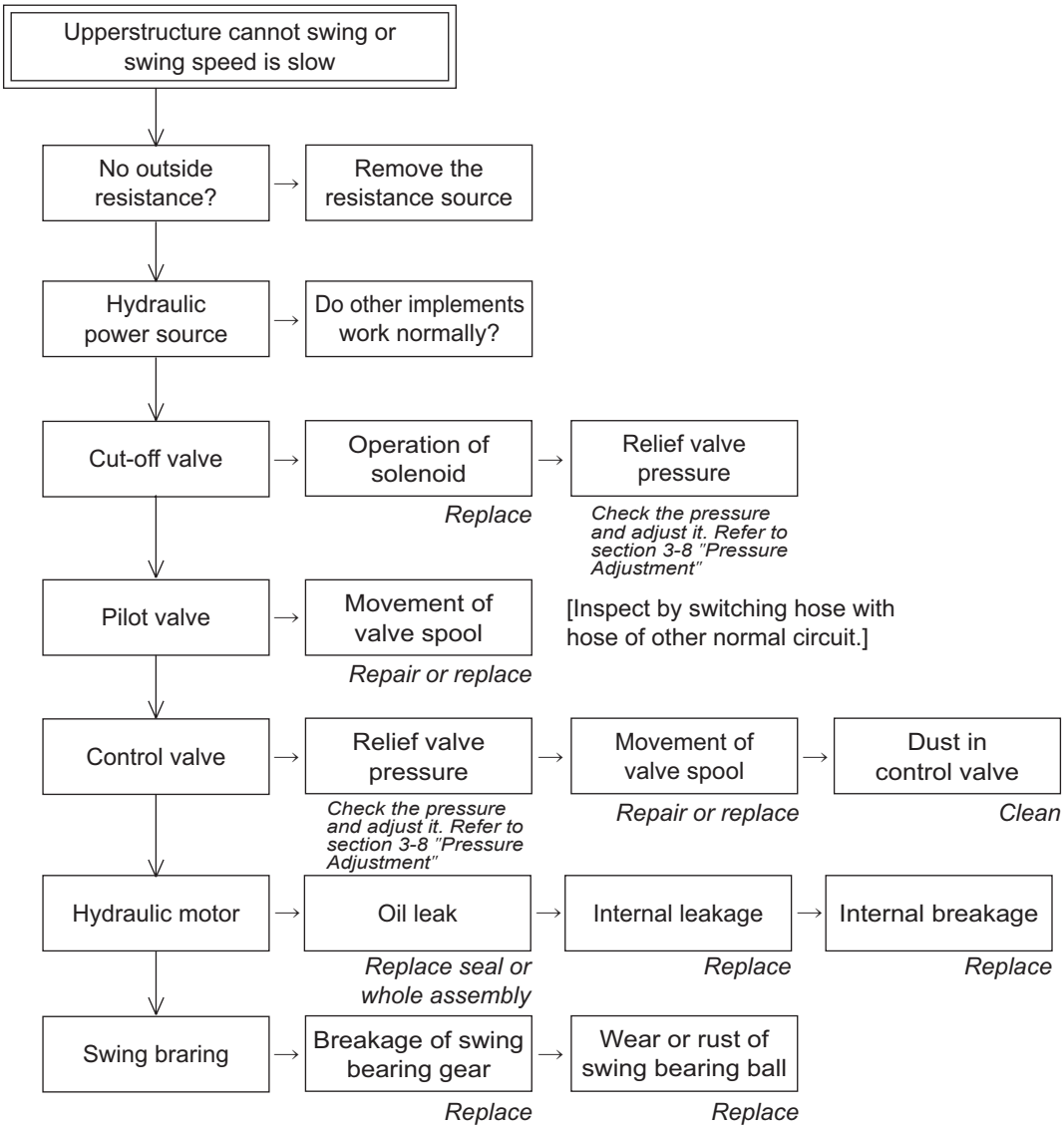


6) Removal of Boom Swing Cylinder

Procedure	
(1) Swing the upperstructure so that the pin **1** at the bottom end of the boom swing cylinder is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine.	
(2) Cut the main switch **1** to the OFF position to disconnect the battery of the machine. Note : Place a MAINTENANCE IN PROGRESS label on the machine.	
(2) Remove the frame cover R **2** and supports **9** to move the fuel tank outside from its original position. Then remove the hydraulic hoses **4** from the boom swing cylinder **3**. (3) Remove the bolt **5** (M12) and pull out the pin **6** at the rod end of the boom swing cylinder **3**. (4) Remove the plate **7** and pull out the pin **1** at the bottom end of the boom swing cylinder **3**. (5) Remove the boom swing cylinder **3** from the turning frame **8**.	

8. TROUBLESHOOTING




Upperstructure cannot swing or swing speed is slow
No outside resistance?
Remove the resistance source
Hydraulic power source
Do other implements work normally?
Cut-off valve
Operation of solenoid
Relief valve pressure
Replace
Check the pressure and adjust it. Refer to section 3-8 "Pressure Adjustment"
Pilot valve
Movement of valve spool
[Inspect by switching hose with hose of other normal circuit.]
Repair or replace
Control valve
Relief valve pressure
Movement of valve spool
Dust in control valve
Check the pressure and adjust it. Refer to section 3-8 "Pressure Adjustment"
Repair or replace
Clean
Hydraulic motor
Oil leak
Internal leakage
Internal breakage
Replace seal or whole assembly
Replace
Replace
Swing braring
Breakage of swing bearing gear
Wear or rust of swing bearing ball
Replace
Replace