

**YANMAR**

**SERVICE MANUAL**

**EXCAVATOR**

**SV100-1A**

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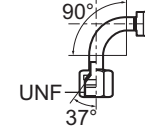
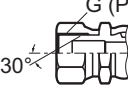
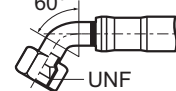
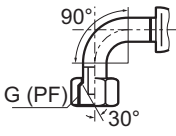
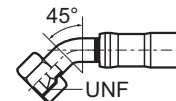
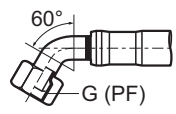
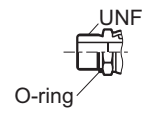
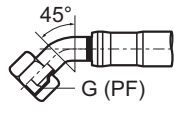

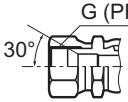
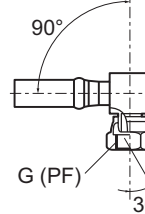
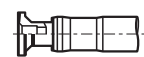
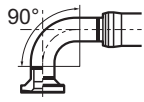
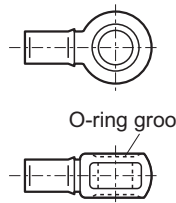
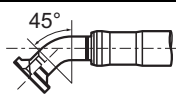
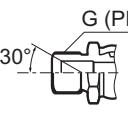
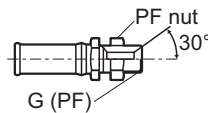
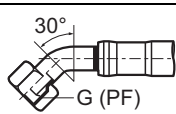
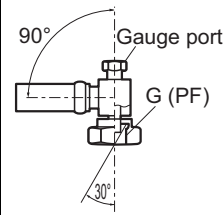

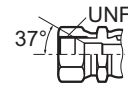
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# 1. GENERAL CAUTIONS FOR MAINTENANCE WORK

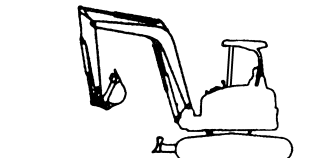
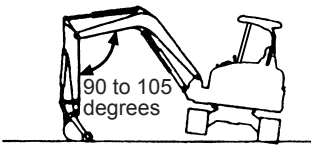
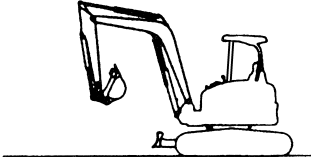
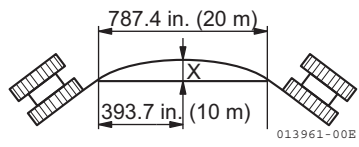
## 5 Combination of fitting

Fitting type	Code	Fitting type	Code
 <p>Taper pipe thread R (PT)</p>	A	 <p>90 degrees bent type. UNF thread with female 37 degrees seat</p>	P
 <p>Straight pipe thread G (PF) with male 30 degrees seat</p>	B	 <p>60 degrees bent type. UNF thread with female 37 degrees seat</p>	Q
 <p>90 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat</p>	C	 <p>45 degrees bent type. UNF thread with female 37 degrees seat</p>	R
 <p>60 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat</p>	D	 <p>UNF, thread with O-ring groove</p>	S
 <p>45 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat</p>	E	 <p>One-touch fitting (male)</p>	T
 <p>Straight pipe thread G (PF) with male 30 degrees seat</p>	F	 <p>90 degrees elbow straight pipe thread male 30 degrees seat</p>	V
 <p>O-ring flange type</p>	G		
 <p>90 degrees bent O-ring flange type</p>	H	 <p>Eyejoint with O-ring groove</p>	W
 <p>45 degrees bent O-ring flange type</p>	J		
 <p>Straight pipe thread, female 30 degrees seat with O-ring groove</p>	K	 <p>Straight pipe thread with jam nut female 30 degrees seat</p>	X
 <p>30 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat</p>	L	 <p>90 degrees elbow straight pipe thread with gauge port plug male 30 degrees seat</p>	Z
 <p>Taper pipe thread NPTF</p>	M		
 <p>UNF, thread with female 37 degrees seat</p>	N		
		Without fitting	Y
<p><b>Note :</b> According to the combination of bending or elbow fittings, some hoses require drawings or original hoses to locally manufacture.</p>			

## 2. TECHNICAL DATA

Item	Unit	SV100-1A		
<b>Engine</b>				
<b>Main specifications</b>				
Specific lubricating oil consumption	lbs./HP•h (g/kW•h)	-		
Compression pressure	PSI (MPa)	497.7 (3.4) at 250 rpm		
<b>Cylinder head</b>				
Intake valve	Open	bTDC	degrees	10 to 20
	Close	aBDC	degrees	48 to 58
Exhaust valve	Open	bBDC	degrees	45 to 55
	Close	aTDC	degrees	7 to 17
Intake valve clearance (Cold engine)			in. (mm)	0.0059 to 0.0098 (0.15 to 0.25)
Exhaust valve clearance (Cold engine)			in. (mm)	0.0059 to 0.0098 (0.15 to 0.25)
Intake valve seat angle			degrees	120
Exhaust valve seat angle			degrees	90
<b>Piston</b>				
First compression ring	Ring shape			Half keystone
	Ring quantity		pcs.	4
Second compression ring	Ring shape			Taper face
	Ring quantity		pcs.	4
Oil-ring	Ring shape			Bevel cutter (with coil expander)
	Ring quantity		pcs.	4
<b>Governor</b>				
Name				Electronic all speed type
Type				Centrifugal type
<b>Fuel feed system</b>				
Fuel filter				Filter paper with automatic air release device
Fuel filter filtration area			sq.in. (sq.cm)	775 (5000)
Oil/water separator				Float type
Feed pump				Plunger type (+ electric type)
<b>Lubrication system</b>				
Lubrication pump				Trochoid pump
LO pressure regulating valve opening pressure			PSI (MPa)	56.9 to 71.1 (0.39 to 0.49)
LO filter				Full flow filter
LO filter filtration area			sq.in. (sq.cm)	253 (1630)
Filter valve opening pressure			PSI (MPa)	11.4 to 17.1 (0.08 to 0.12)
Operating pressure of alarm switch			PSI (MPa)	5.69 to 8.53 (0.04 to 0.06)
<b>Cooling device</b>				
Cooling system				Water-cooling (Radiator)
Fan belt size				A43
Thermostat opening temperature			°F (°C)	159.8 (71)
Thermostat full-open temperature			°F (°C)	179.6 (82)
Radiator cap pressure			PSI (MPa)	12.80 (0.09)
Radiator fan			pcs. × Øin. (mm)	6 × Ø16.9 (Ø430)
Operating temperature of water temperature alarm switch			°F (°C)	224.6 to 235.4 (107 to 113)

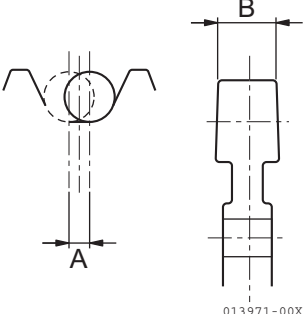
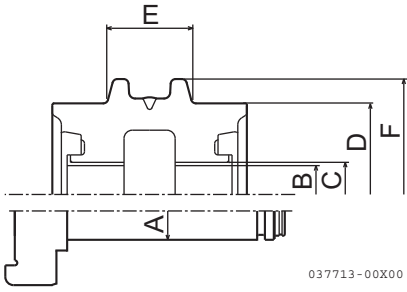
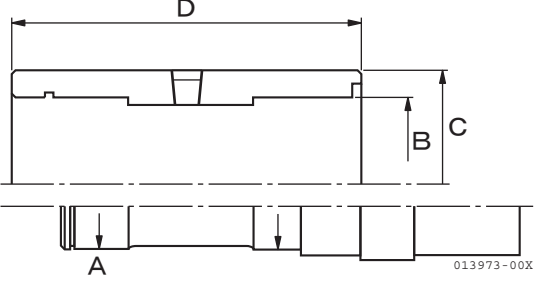
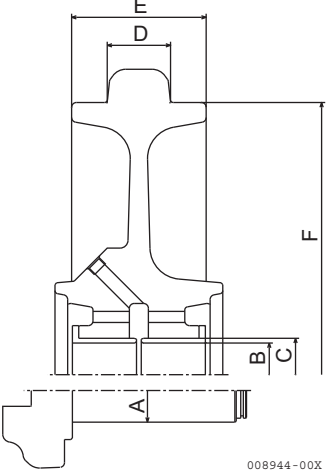
### 3. SERVICING STANDARDS

Applicable model			SV100-1A	
Item	Measuring condition	Unit	Standard	Allowance
<b>Machine performance</b>				
Travel speed	Machine position   <ul style="list-style-type: none"> <li>• Engine : maximum speed</li> <li>• Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C)</li> <li>• Site : Firm, flat ground</li> <li>• Traveling time for 787.4 in. (20 m) after an approach run of 196.9 in. (5 m) or more.</li> </ul>	sec.	High speed 16.6	19.6
			Low speed 29.4	32.4
Track speed	Machine position  90 to 105 degrees  <ul style="list-style-type: none"> <li>• Engine : maximum speed</li> <li>• Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C)</li> <li>• Site : Firm, flat ground</li> <li>• Travel lever : Full throttle (Floating crawler side)</li> <li>• Float one side of the crawler. Make a mark on the crawler. After turning the floating crawler side more than once, measure the time needed for 3 turns of the crawler.</li> </ul>	sec.	High speed 16	18
			Low speed 29	32
Track deviation	Machine position   <ul style="list-style-type: none"> <li>• Engine : maximum speed</li> <li>• Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C)</li> <li>• Site : Firm, flat ground</li> <li>• Measure the deviation (<math>\chi</math>) in a travel distance of 787.4 in. (20 m) after an approach run of 196.9 in. (5 m) or more.</li> </ul>  <small>013961-00E</small>	in. (mm)	11.8 (300) or less	14.2 (360) or less

### 3. SERVICING STANDARDS

#### 3-3-3 Common Specifications of Steel & Rubber Crawlers

[Unit : in. (mm)]

Applicable model	SV100-1A		
Part	Measuring position	Standard	Wear limit
Common specifications of steel & rubber crawlers			
(1) Sprocket 	A	0.33 (8.5)	-
	B	2.40 (61)	2.17 (55)
(2) Track roller & shaft 	A	Ø1.77 (Ø45)	Ø1.75 (Ø44.5)
	B	Ø1.77 (Ø45)	Ø1.79 (Ø45.4)
	C	Ø1.97 (Ø50)	-
	D	Ø4.72 (Ø120)	Ø4.57 (Ø116)
	E	2.76 (70)	2.60 (66)
	F	Ø6.30 (Ø160)	Ø6.14 (Ø156)
(3) Carrier roller & shaft 	A	Ø1.38 (Ø35)	-
	B	Ø3.15 (Ø80)	-
	C	Ø4.13 (Ø105)	Ø3.98 (Ø101)
	D	5.91 (150)	-
(4) Idler & shaft 	A	Ø2.17 (Ø55)	Ø2.15 (Ø54.5)
	B	Ø2.17 (Ø55)	Ø2.18 (Ø55.4)
	C	Ø2.44 (Ø62)	-
	D	2.76 (70)	2.52 (64)
	E	5.51 (140)	5.20 (132)
	F	Ø17.72 (Ø450)	Ø17.40 (Ø442)

# 3. SERVICING STANDARDS

## 3-7-4 Hydraulic Fitting

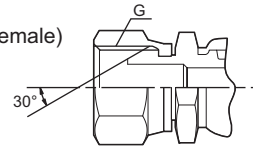
### (1) Tightening torque of parallel pipe thread

For 30° sheet type joint and the O-ring sheet type joint.

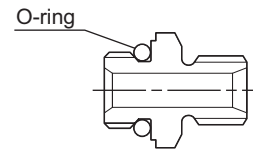
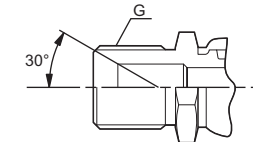
Unit : ft•lbf (N•m)

Nominal designation of screw thread G (PF)	Tightening torque
	Material : Steel, Cast iron
1/8	10.1 to 12.3 (13.7 to 16.7)
1/4	16.6 to 20.3 (22.6 to 27.5)
3/8	32.5 to 39.8 (44.1 to 53.9)
1/2	39.1 to 47.7 (53.0 to 64.7)
3/4	78.1 to 95.5 (106 to 129)
1	91.1 to 111.4 (124 to 151)
1 1/4	110.7 to 135.3 (150 to 183)
1 1/2	137.4 to 166.4 (186 to 226)

Example  
Parallel pipe thread (female)  
(male 30° sheet)



Parallel pipe thread (female)



017498-00E

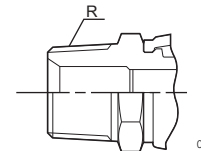
### (2) Tightening torque of taper pipe thread

Apply seal tape

Unit : ft•lbf (N•m)

Nominal designation of screw thread G (PF)	Tightening torque
	Material : Steel, Cast iron
1/8	5.1 to 6.5 (6.9 to 8.8)
1/4	7.2 to 10.8 (9.8 to 14.7)
3/8	21.7 to 28.9 (29.4 to 39.2)
1/2	28.9 to 36.2 (39.2 to 49.0)
3/4	36.2 to 47.0 (49.0 to 63.7)
1	50.6 to 65.1 (68.6 to 88.3)
1 1/4	72.3 to 86.8 (98.1 to 118)

Example  
Parallel pipe thread (female)



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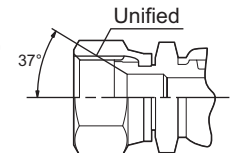
### (3) Tightening torque of unified screw thread

For 30° sheet type joint and the O-ring sheet type joint.

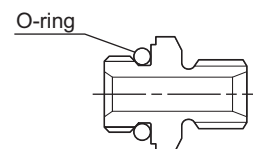
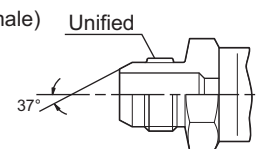
Unit : ft•lbf (N•m)

Nominal designation of screw thread G (PF)	Tightening torque
	Material : Steel, Cast iron
7/16-20UNF	13.0 to 15.9 (17.7 to 21.6)
9/16-18UNF	26.0 to 31.8 (35.3 to 43.1)
3/4-16UNF	32.5 to 39.8 (44.1 to 53.9)
7/8-14UNF	39.1 to 47.7 (53 to 64.7)
1 1-16-12UN	78.1 to 95.5 (106 to 129)
1 5/16-12UN	91.1 to 111.4 (124 to 151)
1 5/8-12UN	110.7 to 135.3 (150 to 183)

Example  
Unified screw thread (female)  
(male 37° sheet)



Example  
Unified screw thread (female)  
(male 37° sheet)



017502-00E

## 4. ENGINE

### WARNING

#### **SUDDEN MOVEMENT HAZARD!**

- Engaging the transmission or PTO at an elevated engine speed could result in unexpected movement of the equipment.
- Failure to comply could result in death or serious injury.

000006en

### WARNING



#### **BURN HAZARD!**

- Keep your hands and other body parts away from hot engine surfaces such as the muffler, exhaust pipe, turbocharger (if equipped) and engine block during operation and shortly after you shut the engine down. These surfaces are extremely hot while the engine is operating and could seriously burn you.
- Failure to comply could result in death or serious injury.

000015en

### WARNING



To prevent possible eye injury, always wear **SAFETY GLASSES** while servicing the engine.

000013en

### 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.

000014en

### WARNING

Never apply over 40 psi (2.8 kgf/cm) to the waste gate actuator.

000026en

### WARNING

- Never inject fuel toward you. Since the fuel is injected at high pressure from the nozzle, it may penetrate the skin, resulting in injury.
- Never inject fuel toward a fire source. Atomized fuel is highly flammable and may cause a fire or burn skin.

000028en

## 4. ENGINE

### CAUTION

If the waste valve does not meet specifications, replace the turbocharger or have it repaired by a qualified repair facility.

0000078en

### CAUTION

- NEVER attempt to modify the engine's design or safety features such as defeating the engine speed limit control or the diesel fuel injection quantity control.
- Modifications may impair the engine's safety and performance characteristics and shorten the engine's life. Any alterations to this engine may void its warranty. Be sure to use Yanmar genuine replacement parts.

0000079en

### CAUTION

Identify all parts and their location using an appropriate method. It is important that all parts are returned to the same position during the reassembly process.

0000080en

### CAUTION

Each pressure adjusting shim removed or added changes the pressure threshold by approximately 275 psi (1.9 MPa, 19 kgf/cm<sup>2</sup>). Adding adjusting shims increases the threshold pressure. Removing adjusting shims reduces the pressure threshold.

0000081en

### CAUTION

Do not rotate the crankshaft with the injection pump removed.

0000083en

### CAUTION

Keep the piston pin parts, piston assemblies, and connecting rod assemblies together to be returned to the same position during the reassembly process. Label the parts using an appropriate method.

0000088en

### CAUTION

Do not allow the honing tool to operate in one position for any length of time. Damage to the cylinder wall will occur. Keep the tool in constant up-and-down motion.

0000090en

### CAUTION

Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard or limit must be replaced.

0000119en

### CAUTION

Any part determined to not meet the service standard or limit before the next service, as determined from the state of current rate of wear, should be replaced even though the part currently meets the service standard limit.

0000120en

## 4. ENGINE

- 1 – Crankcase Breather Cover
- 2 – Diaphragm Spring
- 3 – Diaphragm Cup
- 4 – Crankcase Breather Diaphragm
- 5 – Oil Fill Cap
- 6 – Valve Cover Nut
- 7 – Valve Cover Nut O-Ring
- 8 – Valve Cover Gasket
- 9 – Support Bolt
- 10 – Rocker Arm Shaft Support
- 11 – Wave Washer
- 12 – Fuel Injector Retainer Bolt
- 13 – Valve Adjusting Screw (Primary)
- 14 – Valve Adjusting Screw Lock Nut (Primary)
- 15 – Rocker Arm Shaft Aligning Stud
- 16 – Fuel Injector Retainer
- 17 – Valve Stem Seal
- 18 – Valve Guide
- 19 – Cylinder Head
- 20 – Intake Valve
- 21 – Exhaust Valve
- 22 – Cylinder Head Gasket
- 23 – Fuel Injector Nozzle Protector
- 24 – Fuel Injector Nozzle Seat
- 25 – Valve Spring
- 26 – Valve Bridge Guide
- 27 – Spring Retainer
- 28 – Valve Keepers
- 29 – Valve Bridge
- 30 – Valve Bridge Seat
- 31 – Valve Adjusting Screw Lock Nut (Secondary)
- 32 – Valve Adjusting Screw (Secondary)
- 33 – Push Rod
- 34 – Rocker Arm Shaft
- 35 – Crankcase Breather Components
- 36 – Valve Cover

### Disassembly of 4-Valve Cylinder Head

Prepare a clean, flat working surface on a workbench large enough to accommodate the cylinder head assembly. Discard all gaskets, O-rings and seals. Use new gaskets, O-rings and seals on reassembly of the cylinder head.

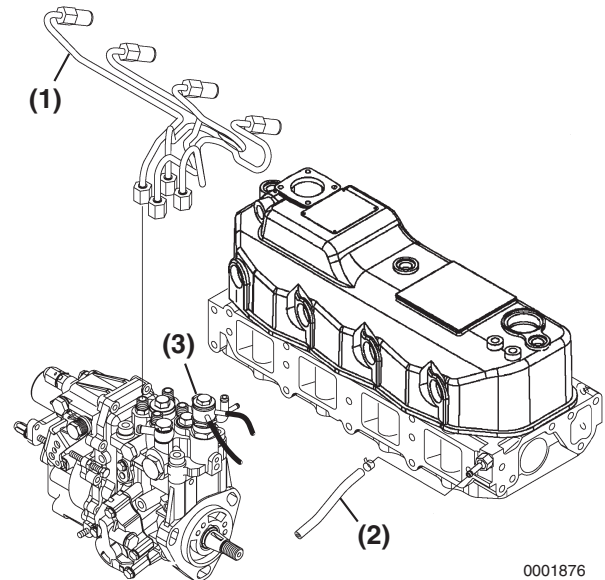
1. Drain the coolant from the engine into a suitable container.

#### CAUTION

Identify all parts and their location using an appropriate method. It is important that all parts are returned to the same position during the reassembly process.

0000080en

2. Remove the high pressure fuel injection lines (Figure 4-1-2, (1)). See *Removal of Fuel Injectors*.

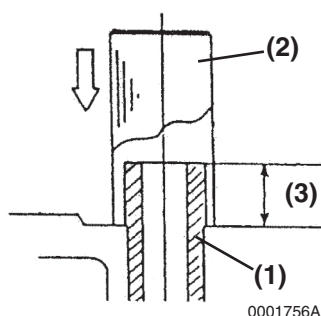


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Figure 4-1-2

## 4. ENGINE

- Finish installing the valve guides (**Figure 4-1-28, (1)**) into the cylinder head to the proper height (**Figure 4-1-28, (3)**) using the valve guide installation tool (**Figure 4-1-28, (2)**). See *Intake / Exhaust Valve and Guide*.



**Figure 4-1-28**

### Reassembly of Intake and Exhaust Valves

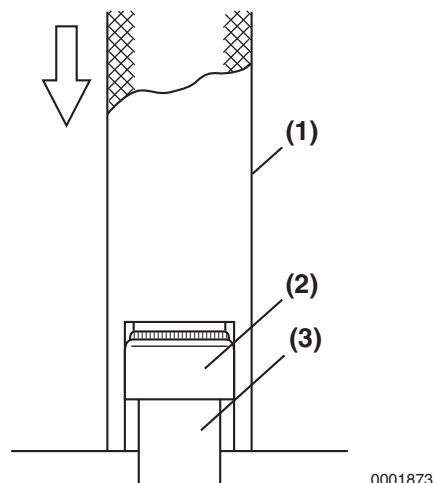
#### IMPORTANT

When installing valve stem seals, use new ones instead of reusing removed seals.

Exhaust valve and intake valve stem seals are different. They can be distinguished based on the paint marks on the outer side of the seal or the color of the seal spring (**Figure 4-1-29, (4)**). When installing each stem seal, take care to correctly position it.

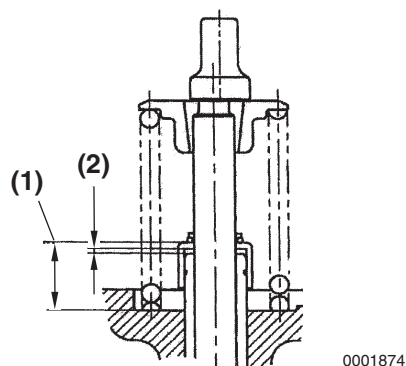
Marking	
Intake	Exhaust
None	Black (Seal Spring)

- Oil the lip of the valve stem seal (**Figure 4-1-29, (2)**). Using the valve stem seal installation tool (**Figure 4-1-29, (1)**), install a new valve stem seal on each of the valve guides (**Figure 4-1-29, (3)**).



**Figure 4-1-29**

- Measure the distance (**Figure 4-1-30, (1)**) from the cylinder head to the valve stem seal to ensure proper clearance (**Figure 4-1-30, (2)**) between the guide and seal. See "3-2 Engine Service Standard" section for the service limit.



**Figure 4-1-30**

- Place the cylinder head assembly on its exhaust port side.
- Place all the valves (**Figure 4-1-31, (5)**) in their proper location in the cylinder head.

## 4. ENGINE

- Remove the fuel injection pump from the gear case / front plate only if it must be sent out for repair, or will interfere with other procedures such as "hot tank" cleaning. If the fuel injection pump does not need to be repaired, leaving it mounted to the timing gear case or plate will eliminate the need to re-time it during reassembly. See *Fuel Injection Pump*.
- Remove the starter motor. See *Removal of Starter Motor*.

### Disassembly of Camshaft and Timing Components

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

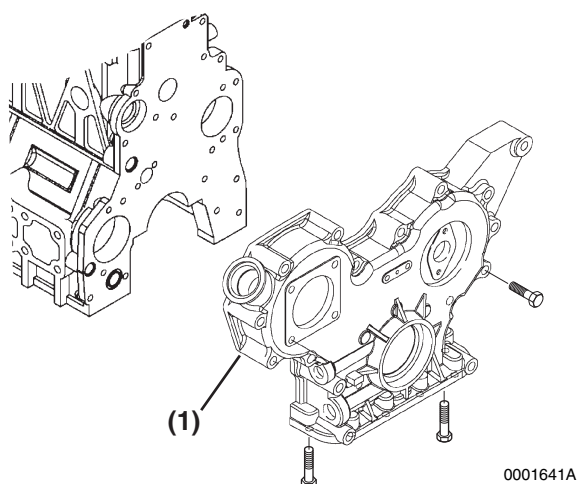
#### Removal of Timing Gear Case Cover

- 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.*

- Remove the crankshaft pulley using a gear puller.
- Remove the bolts that retain the gear case cover to the cylinder block and oil pan.
- Remove the gear case cover (**Figure 4-1-47, (1)**).



**Figure 4-1-47**

#### Checking Timing Gear Backlash

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

Check the backlash between each pair of mating gears (**Figure 4-1-48**). If not within specification, replace both mating gears. See "*3-2 Engine Service Standard*" section for the service limit.

Note: Do not allow the gear being checked to move axially as excess end play could cause a false reading.

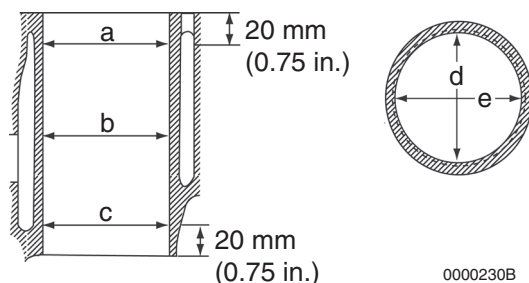
## 4. ENGINE

### Measure Crankshaft Bearing Oil Clearance

Oil clearance should be checked during disassembly to determine the extent of wear, and during assembly to ensure long engine life. The same procedure is done for both connecting rods and main bearings.

### Inspection of Cylinder Block

1. Ensure that oil passages are clear and unobstructed.
2. Check for discoloration or evidence of cracks. If a fracture is suspected, use the color check method or the Magnaflux method to determine if the cylinder block is fractured.
3. Inspect cylinders for roundness, taper, or evidence of scoring. Collect and record the measurements. Consider honing, reboring or replacing the cylinder block if the measurements are not within specification.
  - Take measurements at three places (**Figure 4-1-71**) (a, b, c), and in two directions (d and e) in each cylinder.



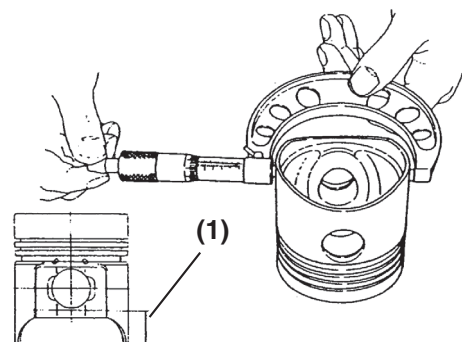
**Figure 4-1-71**

### Inspection of Pistons, Piston Rings and Wrist Pin

Notes:

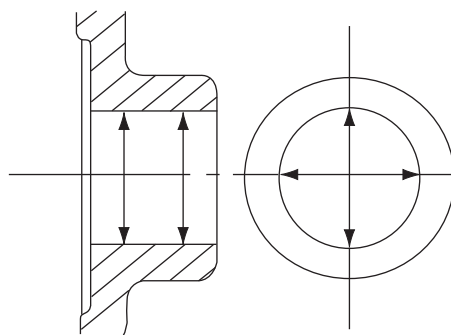
- On an engine with low hours, the pistons, piston rings may be reused if they are found to be within specifications. The pistons and piston rings must be reinstalled in the same cylinders from which they were originally removed.
- On an engine with high hours, the pistons rings should be replaced and the cylinder honed (*See Honing and Boring*) 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 4-1-72**). Measurements must be taken at a specified distance (**Figure 4-1-72, (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.*



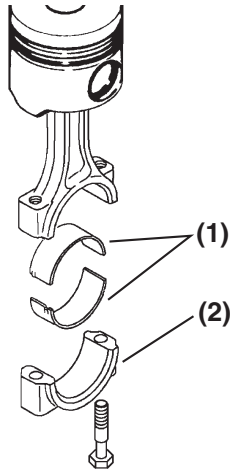
**Figure 4-1-72**

5. Subtract the piston measurement from the greatest measurement acquired during cylinder inspection (*see Inspection of Cylinder Block*) 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 4-1-73**). *See "3-2 Engine Service Standard" section for the service limit.* Record the measurements.



**Figure 4-1-73**

## 4. ENGINE



0001965

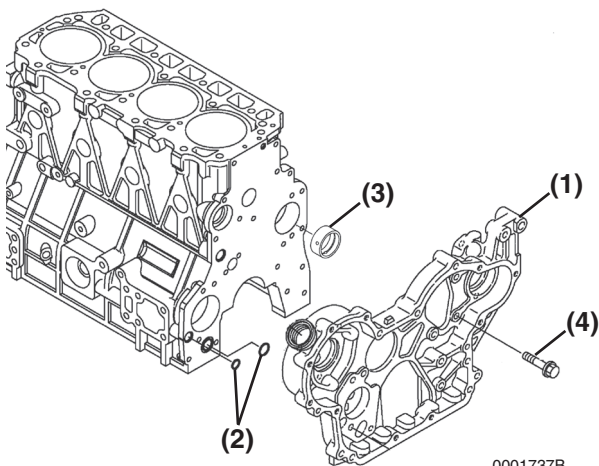
**Figure 4-1-99**

7. Reinstall the remaining pistons in their respective cylinders.

### Reassembly of Camshaft and Timing Components

#### Installation of Gear Case or Front Plate

1. If removed, install a new camshaft bushing (**Figure 4-1-100, (3)**) using the appropriate service tool.
2. Apply a continuous bead of ThreeBond Liquid Gasket No. 1212, Yanmar Part No. 977770-01212 to the mounting area of the gear case or front plate. Be sure to circle each bolt hole.
3. Install two new O-rings (**Figure 4-1-100, (2)**) in the cylinder block.



0001737B

**Figure 4-1-100**

4. Reinstall the gear case (**Figure 4-1-100, (1)**). Tighten the bolts to the specified torque.

#### Installation of Camshaft

Note: The gear housing or front plate must be reinstalled prior to installing the camshaft. See *Installation of Gear Case or Front Plate*.

1. If removed, reinstall the camshaft end plate (**Figure 4-1-101, (1)**), key, and timing gear (**Figure 4-1-101, (4)**) onto the camshaft using a press.

Note: Heat the gear to 356 - 392°F (180 - 200°C) and press onto the end of the camshaft.

2. Rotate the cylinder block so that gravity will keep the tappets (**Figure 4-1-101, (5)**) in place and out of the way of the camshaft lobes when the camshaft is being reinstalled.

Note: If the engine is not installed on an engine repair fixture, stand the engine upright on the flywheel end mounting flange.

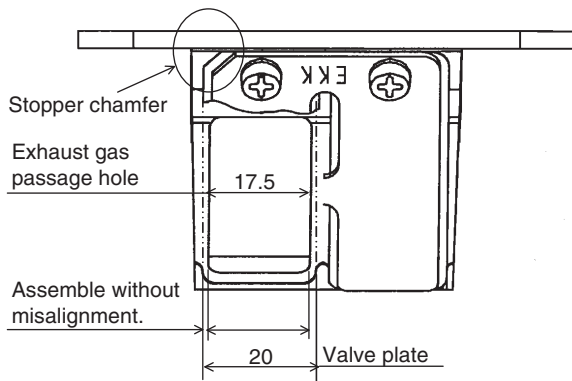
Note: The tappets are “mushroom” shaped and must be installed from inside the engine crankcase.

3. Lubricate the tappets with clean oil or assembly lube. Reinstall the tappets in their respective locations in the cylinder block. Push the tappets fully into the tappet bores so they will not interfere with the installation of the camshaft.

## 4. ENGINE

To remove deposited carbon, use carbon cleaner, kerosene, or some other liquid capable of removing carbon as well as a soft brush or cloth to clean the valves, taking care not to damage their parts.

Upon completion of carbon removal, wipe off water and liquid, make sure that the case, valve, and stopper are free of foreign matter, and then reinstall the valve and related parts.



**Figure 4-1-112**

### Precautions for Installation

1. The valve and stopper must be installed in their specific orientations. As shown in the figure above, install the valve and stopper so that they are located on the left-hand side of the lead valve.
2. Install the valve by tightening the machine screw while ensuring that it is evenly positioned inside the case window.
3. The machine screw must be tightened with torque of  $1.37 \pm 0.2 \text{ N} \cdot \text{m}$  ( $14 \pm 2 \text{ kgf} \cdot \text{cm}$ ).
4. After tightening the machine screw, mark it with a marker to indicate that it has already been tightened.

### EGR Cooler

The EGR cooler must be periodically cleaned every 1500 hours because the exhaust gas passage is subject to carbon deposition and the cooling water transit portion to scale deposition and these depositions gradually deteriorate the cooling of recirculated gas, thus resulting in higher gas temperatures and lower effective circulation amounts (EGR ratio).

To remove deposited carbon from the gas passage, use compressed air ( $0.19 \text{ MPa}$  ( $2 \text{ kg/cm}^2$ ) or lower). Then dip the gas passage in carbon cleaner, kerosene, or some other liquid capable of removing carbon; leave it dry and blow it with compressed air again.

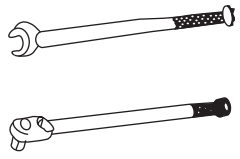
To clean the water transit portion, dip it in a solution of descaling detergent diluted with water and wash it.

### EGR Pipe and Other Connecting Elbows

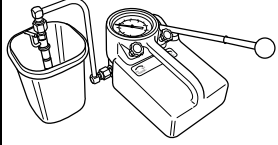
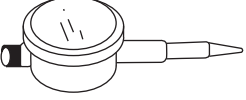
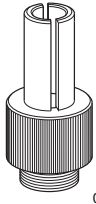
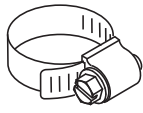
The exhaust gas passage is subject to carbon deposition when used over time. To remove deposited carbon from the gas passage, use compressed air ( $0.19 \text{ MPa}$  ( $2 \text{ kg/cm}^2$ ) or lower). If the exhaust gas passage is heavily fouled, clean it by dipping it in carbon cleaner, kerosene, or some other liquid capable of removing carbon.

## 4. ENGINE

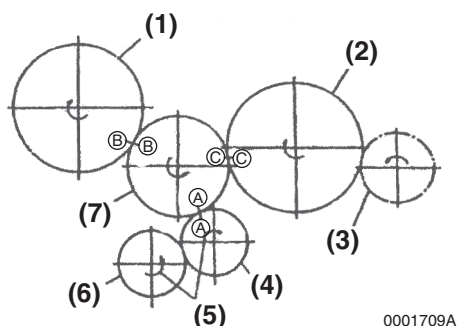
### 4-2-3 Special Service Tools

No.	Tool Name		Application	Illustration
1	Torque Wrench	Locally Available	For tightening nuts and bolts to the specified torque	 0000840

### 4-2-4 Measuring Instruments

No.	Instrument Name		Application	Illustration
1	Fuel Injector Tester	Locally Available	For observing injection spray pattern of fuel injection nozzle and measuring injection pressure	
2	Dial Indicator	Mituotoyo 2050SB - Locally Available	Check and adjust fuel injection timing	 0000831
	Extension Rod	Mituotoyo 303613 - Locally Available		
3	Fuel Injection Pump Plunger Adapter	(M16) Yanmar Part No. 158090-51841	Mount dial indicator to fuel injection pump	 0002690
4	Plunger Adapter Clamp	Yanmar Part No. 23000-013000	Clamps stem of dial indicator in plunger adapter.	 0002691

## 4. ENGINE



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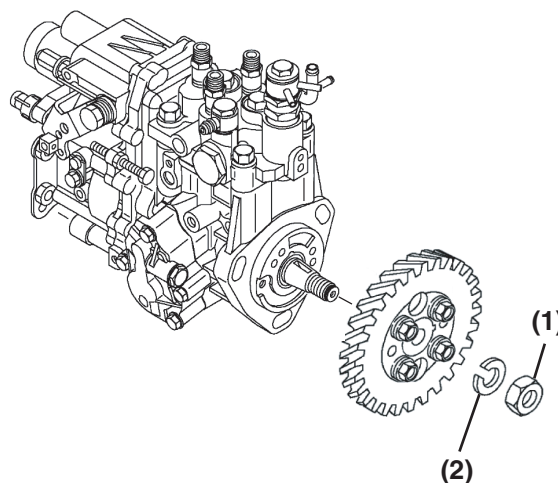
- 1 – Fuel Injection Pump Drive Gear
- 2 – Camshaft Drive Gear
- 3 – Auxiliary Drive Gear (Optional)
- 4 – Crankshaft Drive Gear
- 5 – Direction of Rotation
- 6 – Oil Pump Drive Gear
- 7 – Idler Gear

**Figure 4-2-133**

3. Install a new O-ring on the pump mounting flange. Apply grease to the O-ring to hold it in place during installation of the injection pump.

Note: Ensure the tapered surface of the fuel injection pump shaft is clean and dry.

4. Align the key on the fuel injection pump shaft with the keyway in the fuel injection pump drive gear hub. Reinstall the fuel injection pump into the fuel injection pump drive gear and gear housing. Reinstall the pump retaining nuts finger tight.
5. Reinstall the fuel injection pump drive gear lock washer (**Figure 4-2-134, (2)**) and nut (**Figure 4-2-134, (1)**). Do not lubricate the threads of the nut or shaft. Hold the crankshaft pulley bolt with a socket wrench and tighten the drive gear nut to the specified torque. See "3-7-2 Engine Tightening Torque" section for tightening torque.

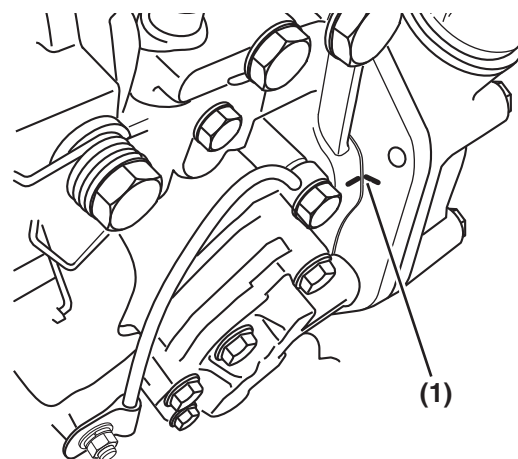


0000162B

**Figure 4-2-134**

### ***If reinstalling the original fuel injection pump:***

- Align the reference marks (**Figure 4-2-135, (1)**) previously made on both the fuel injection pump mounting flange and gear case or front plate.




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**Figure 4-2-135**

- Tighten the fuel injection pump retaining nuts to specification. See "3-7-2 Engine Tightening Torque" section for tightening torque.

## 4. ENGINE

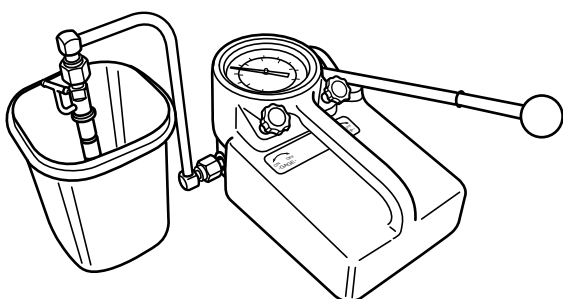
**⚠ CAUTION**



**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.

0000003en



**Figure 4-2-156**

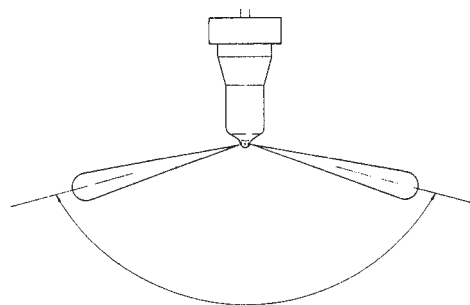
4. Pump the operating lever of the tester slowly, observing the pressure reading at the point where the fuel injector begins spraying fuel (**Figure 4-2-156**).

See **Figure 4-2-159** for injector ID location.

See "3-2 Engine Service Standard" section for correct pressure readings.

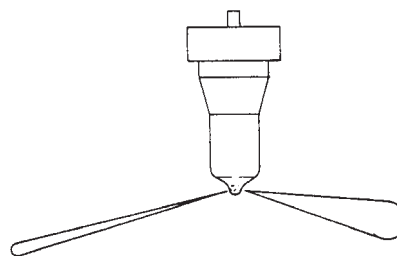
Note: The opening pressure of a new fuel injector will be approximately 725 psi (5 MPa; 51 kgf/cm<sup>2</sup>) higher than one that has been operated for five hours or longer.

5. Pump the operating lever slowly to hold the pressure steady at a point just below the opening pressure and hold it for 5 seconds. Observe the injector to see that it is sealing properly and is not "dripping". If fuel leaks from the return line fitting, check that the nozzle case nut is tight. Service or replace the injector if fuel continues to leak from either the return line fitting or nozzle.
6. Pump the operating lever more rapidly to repeatedly "pop" the injector and observe the spray pattern. The pattern should be a very fine uniform spray (**Figure 4-2-157**). If a dripping or an uneven pattern is seen (**Figure 4-2-158**), service or replace the injector.



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**Figure 4-2-157**



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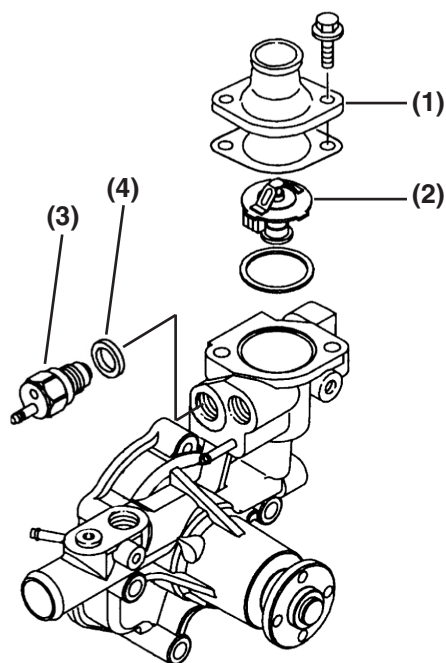
**Figure 4-2-158**

If the fuel injector fails any of these tests, it should be serviced or replaced as necessary. If the pressure is outside specified limits, adjust the pressure. See *Adjusting Fuel Injector Pressure*.

## 4. ENGINE

### Disassembly of Engine Coolant Pump

1. Remove the thermostat cover (**Figure 4-3-172, (1)**). Discard the gasket.



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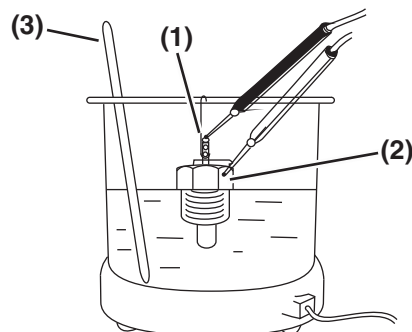
**Figure 4-3-172**

2. Remove the thermostat (**Figure 4-3-172, (2)**). Discard the O-ring. Remove the temperature switch (**Figure 4-3-172, (3)**) and gasket (**Figure 4-3-172, (4)**). Discard the gasket.

### Cleaning and Inspection

#### Temperature Switch

1. Check for proper operation of the temperature switch. Connect a continuity light or ohmmeter to the temperature switch. Connect one lead to the terminal of the switch (**Figure 4-3-173, (1)**) and the other lead to the metal portion of the switch (**Figure 4-3-173, (2)**).



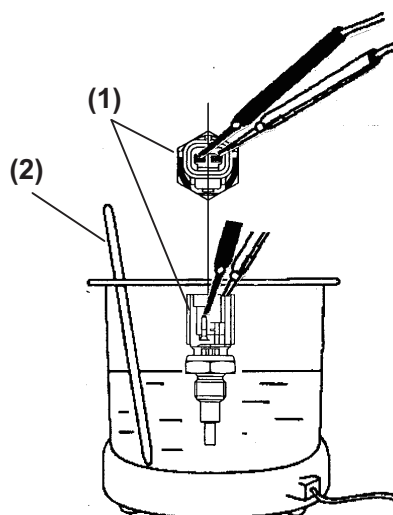
0000577A

**Figure 4-3-173**

2. Place the temperature switch and an accurate thermometer (**Figure 4-3-173, (3)**) in engine coolant.
3. Slowly increase temperature of the fluid using an external heat source.
4. The temperature switch is operating properly if the continuity light or ohmmeter indicates continuity when the fluid temperature reaches 225°F - 235°F (107°C - 113°C).

#### Water temperature sensor

1. Inspect the water temperature sensor to make sure that it is properly operating. As shown in the following figure, connect an electric resistor to the coupler of the water temperature sensor (**Figure 4-3-174, (1)**).



**Figure 4-3-174**

## 4. ENGINE

### 4-5 Turbocharger

#### 4-5-1 Before You Begin Servicing

#### **WARNING**



#### **ENTANGLEMENT HAZARD!**

- Stop the engine before you begin to service it.
- **NEVER** leave the key in the key switch when you are servicing the engine. Someone may accidentally start the engine and not realize you are servicing it. This could result in a serious injury.
- If you must service the engine while it is operating, remove all jewelry, tie back long hair, and keep your hands, other body parts and clothing away from moving / rotating parts.
- Failure to comply could result in death or serious injury.

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#### **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.

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#### **WARNING**

Never apply over 40 psi (2.8 kgf/cm) to the waste gate actuator.

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#### **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.

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#### **CAUTION**

For maximum engine life, Yanmar recommends that when shutting the engine down, you allow the engine to idle, without load, for five minutes. This will allow the engine components that operate at high temperatures, such as the turbocharger (if equipped) and exhaust system, to cool slightly before the engine itself is shut down.

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## 4. ENGINE

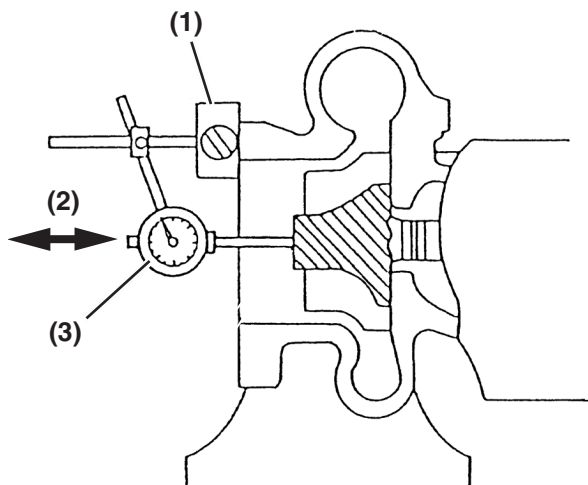
### Checking Rotor Play

Note: If rotor play measurements are not within specification, replace the turbocharger assembly or have it repaired by a qualified facility.

Rotor Play	Standard Dimension	Wear Limit
	RHF5	RHF5
End Play	0.0011 - 0.0024 in. (0.03 - 0.06 mm)	0.0044 in. (0.09 mm)
Run-out	0.0031 - 0.0051 in. (0.08 - 0.13 mm)	0.007 in. (0.17 mm)

#### To Check Rotor End Play:

1. Set up a dial indicator as shown (**Figure 4-5-195**).
2. Manually move the rotor end-to-end while observing indicated readings. Replace the turbocharger if end play measurements are outside specified limits. See *table above*.

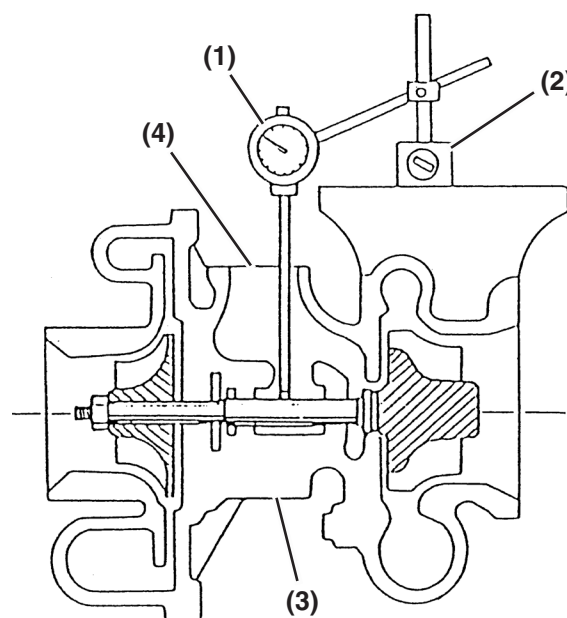


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**Figure 4-5-195**

#### To Check Rotor Run-out:

1. Set up a dial indicator as shown (**Figure 4-5-196**).
2. Manually rotate the rotor while observing indicated limits. Replace the turbocharger if run-out measurements are outside specified limits. See *table above*.



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**Figure 4-5-196**

### Waste Gate Valve Test

Before reinstalling the turbocharger, verify the operation of the waste gate valve. Poor waste gate operation will adversely affect the engine performance.

#### CAUTION

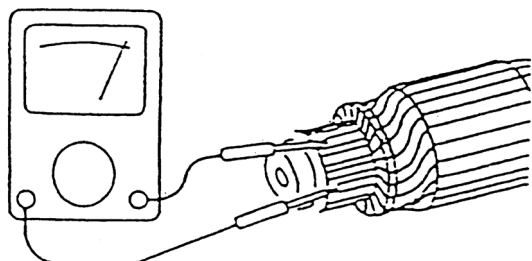
**If the waste valve does not meet specifications, replace the turbocharger or have it repaired by a qualified repair facility.**

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## 4. ENGINE

### **Armature Coil Continuity Test**

Check for continuity between the commutator segments using a multimeter (**Figure 4-6-212**). The multimeter should indicate continuity.



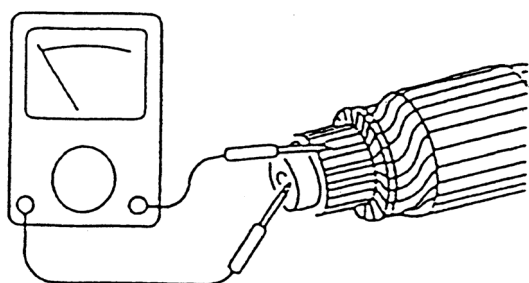
0000114

**Figure 4-6-212**

If the multimeter does not indicate continuity, replace the armature.

### **Armature Coil Insulation Test**

Check for continuity between a commutator segment and the shaft or armature using a multimeter (**Figure 4-6-213**). The multimeter should not indicate continuity.



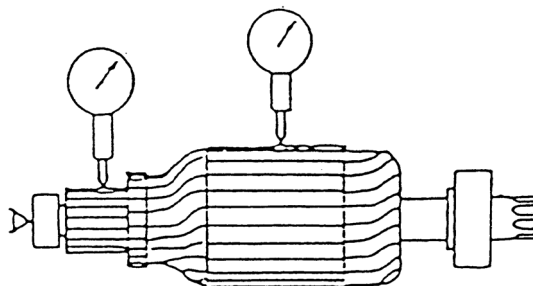
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**Figure 4-6-213**

If the multimeter indicates continuity, replace the armature.

### **Measure Armature and Commutator Run-Outs**

Measure the armature core run-out and the commutator run-out using a dial indicator (**Figure 4-6-214**). Replace the armature if either of the measurements is less than the limit.



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**Figure 4-6-214**

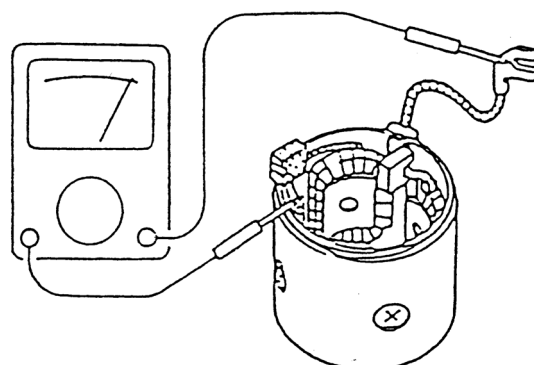
See *Starter Motor Specifications* for the service limit.

### **Field Coil**

#### **Field Coil Continuity Test**

Check for continuity between the field coil terminals using a multimeter (**Figure 4-6-215**). The multimeter should indicate continuity.

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



0000119

**Figure 4-6-215**

## 4. ENGINE

### 4-7-2 Introduction

This section of the *Service Manual* describes the servicing of the alternators. Yanmar Part No. 129423-77200 alternator is used in this section to show the service procedures for the representative alternator. For specific part detail, see the *Parts Catalog* for the engine you are working on.

### 4-7-3 Alternator Specifications

Yanmar Part Number	119626-77210
Mfg. Part Number	101211-2951 (Denso)
Nominal Output (13.5 Volts Heat)	55 A
Weight	6.17 lb (2.8 kg)
Revolution Direction (As Viewed From Pulley)	Clockwise
Rating	Continuous
Battery Voltage	12 V
Rated Revolution	5000 rpm ( $\text{min}^{-1}$ )
Operating Range	1070 to 18000 rpm ( $\text{min}^{-1}$ )
Grounding Characteristics	Negative (-) Side of Circuit
Integrated Regulator	IC Regulator
Outside Diameter of Pulley	2.64 in. (67.1 mm)
Belt Shape	Type A

## 4. ENGINE

### 4-8 Electronic Control System

#### 4-8-1 Engines Available with the Electronic Control System

4TNV98T-Z engine is equipped with the electronic control system.

#### 4-8-2 Before You Begin Servicing

##### **WARNING**

- Never use the E-ECU for other purposes than intended or in other ways than specified by Yanmar. Doing so could result in the violation of emission control regulations and will void the product warranty.
- Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

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##### **WARNING**

- Be sure to use the E-ECU in conjunction with the engines whose models or serial numbers are specified by Yanmar. Other E-ECU / engine combinations than specified will void the engine warranty.
- Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

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##### **WARNING**

- Replacing the fuel injection pump involves rewriting the fuel injection data in the E-ECU. Be sure to contact your local Yanmar dealer before replacing the fuel injection pump. Failure to rewrite the fuel injection data before replacing the fuel injection pump will void the engine warranty.
- Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

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##### **WARNING**

- Replacing the E-ECU involves migrating the fuel injection data to the existing E-ECU to the new unit. Be sure to contact your local Yanmar dealer before replacing the E-ECU. Failure to migrate the fuel injection data before replacing the E-ECU will void the engine warranty.
- Improper use or misuse of the E-ECU may result in death or serious injury due to an abrupt and unexpected increase in engine speed.

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# 5. HYDRAULIC SYSTEM

## 5-3 Circuit Operation

### 5-3-1 Boom

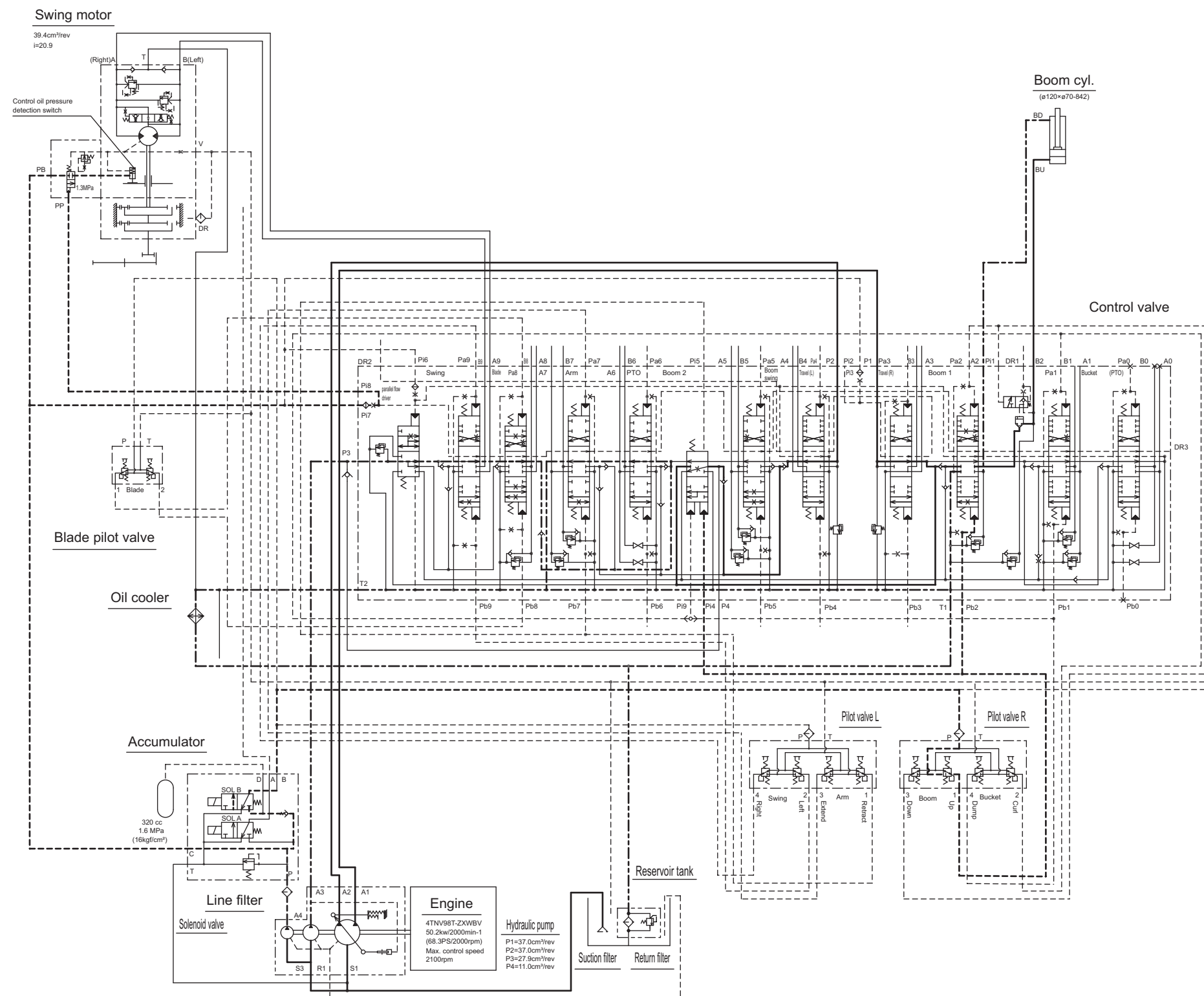
#### 1) Boom "Up"

##### (1) Pilot pressure flow

When the boom control lever is pulled back to raise the boom, the oil from the pilot pump P4 flows through the port B of the cut-off valve and the port 1 of the pilot valve (RH) to the port Pb2 of the boom section and the port Pi4 of the boom 2 section to move their spools.

##### (2) Oil flow from hydraulic pump

The oil discharged from the piston pump P1 flows to the boom section through the port P1 of the inlet section, while the oil discharged from the piston pump P2 flows to the boom section through the port P2 of the inlet section and the parallel passage, and combines with the oil from the piston pump P1. Then the combined oil opens the check valve of the anti-drift valve in the boom section and flows through the port B2 to BU of the boom cylinder to extend its cylinder rod, raising the boom. The return oil from BD of the boom cylinder flows back to the hydraulic oil tank through the port A2 of the boom section, the ports T1 and T2 of the control valve and the oil cooler.



077105-00EN00

# 5. HYDRAULIC SYSTEM

## 5-3-9 Simultaneous Operation of Boom Up and Arm Retract

### 1) Pilot Pressure Flow

When the arm control lever is pulled back to retract the arm while the boom is being raised, the boom 2 section receives the pilot pressure from the ports Pi4 and Pi5 at the same time to keep the spool in the neutral position.

### 2) Oil Flow from Hydraulic Pump

#### (1) Oil flow to boom section

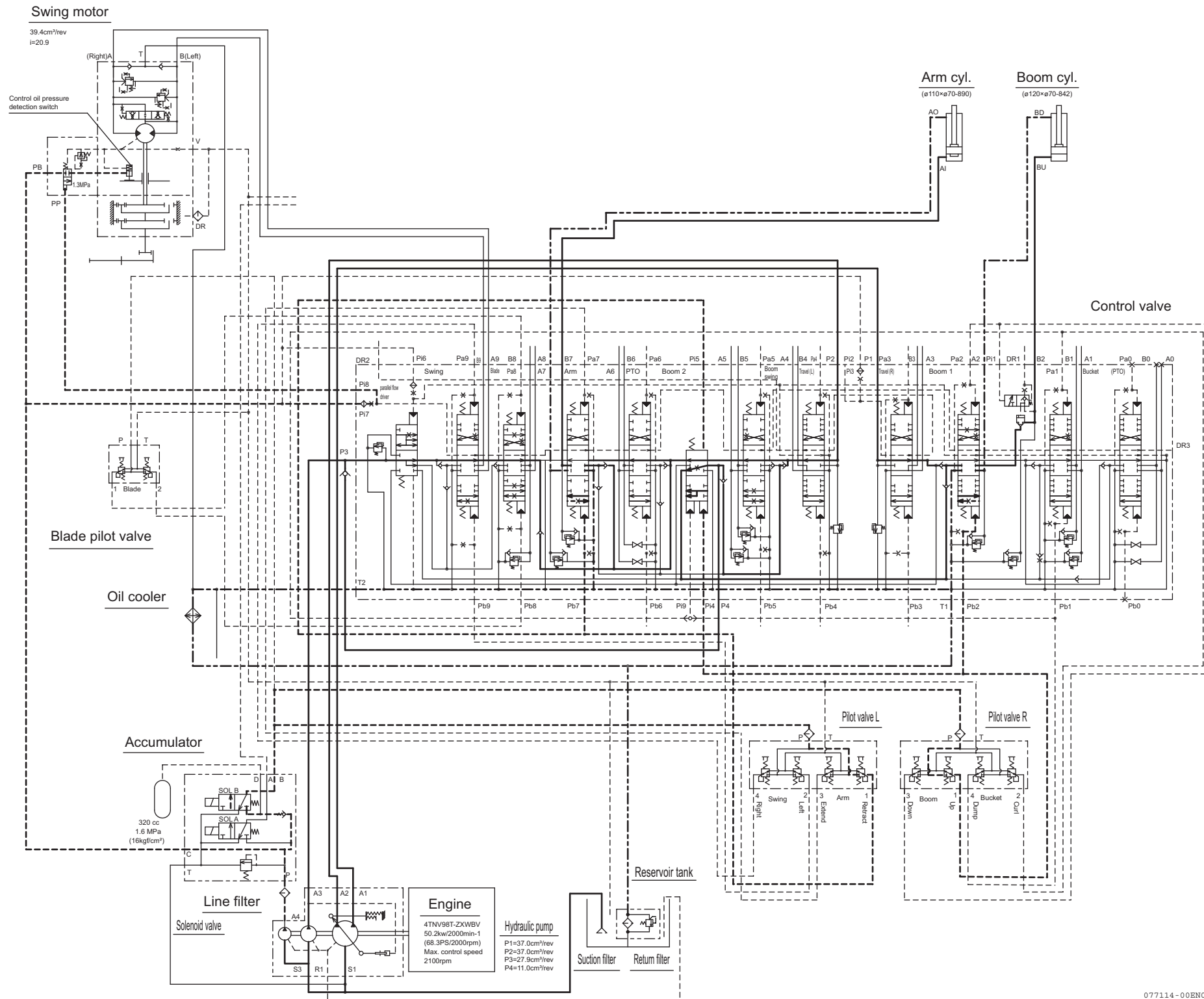
The oil from the piston pump P2 flows through the port P2 of the inlet section to the boom 2 section. Then the boom 2 section controls the oil from the piston pump P2 and allows some of the oil to flow through the parallel passage to the boom section to combine with the oil from the piston pump P1.

#### (2) Oil flow to arm section

The boom 2 section controls the oil from the piston pump P2 to the boom section. Therefore, the oil from the piston pump P2 can flow more smoothly to the arm section to combine with the oil from the pump P3.

When a load is applied to the arm, the oil flow is decreased due to the hose power control shift of the pump P3 and the boom speed is slowed down. To make up for the slowed speed, the oil from the pump P3 flows through the check valve, the boom 2 section, the parallel passage to the boom section to combine with the oil from the piston pump P1. This circuit increases the speed of the boom "up" operation.

Refer to Section "5-3-1 Boom" and Section "5-3-2 Arm" for the oil flow with regard to the boom and arm cylinders.



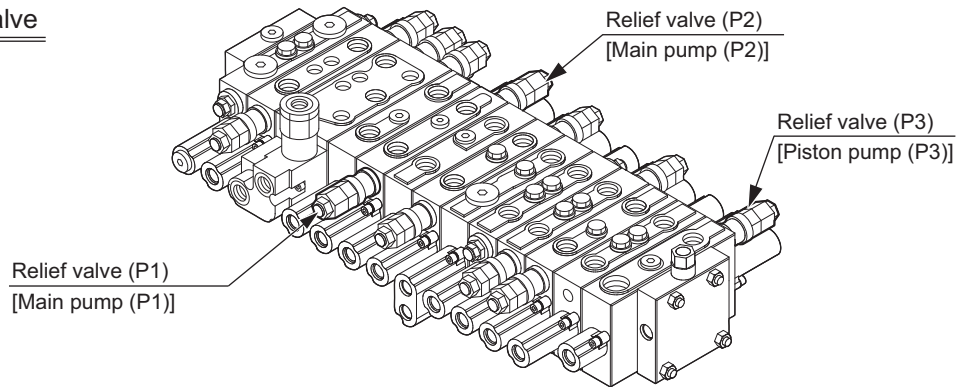
077114-00EN00

# 5. HYDRAULIC SYSTEM

## 4) Adjustment Procedure

- (1) To check the pressure of the system relief valve (for the piston pump P1) in the control valve, retract the bucket cylinder to its stroke end, hold the lever and read the gauge. Adjust the pressure if necessary.
- (2) To check the pressure of the system relief valve (for the piston pump P2), retract or extend the arm or boom swing cylinder to its stroke end, hold the lever and read the gauge. Adjust the pressure if necessary.
- (3) To check the pressure of the system relief valve (for the piston pump P3), extend the blade cylinder to its stroke end, hold the lever and read the gauge. Adjust the pressure if necessary.

### System relief valve

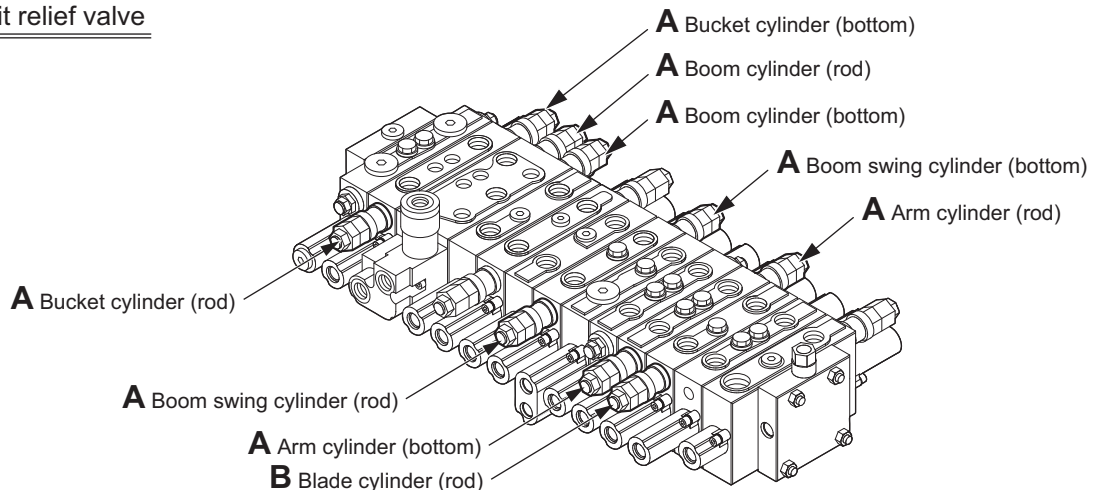


028439-00E

- (4) To adjust the pressure of each circuit relief valve, extend or retract the cylinder to its stroke end, hold the lever and read the gauge. Whether the pressure of the circuit relief valve is lower than that of the system relief valve can be read on the gauge.

Increase the pressure of the system relief valve and that of the circuit relief valve by turns, and lock the adjust screw when the specified pressure of the circuit relief valve is obtained. Then lower the pressure of the system relief valve to the specified pressure and lock the adjust screw.

### Circuit relief valve



028440-00E

## 5) Pressure Change by One Turn of Adjust Screw

	Pressure change PSI (MPa)	Number of adjust screw turns
System relief valve (P1, P2, P3)	2582 (17.8)	1/1
Circuit relief valve <b>A</b>	4119 (28.4)	1/1
Circuit relief valve <b>B</b>	2582 (17.8)	1/1



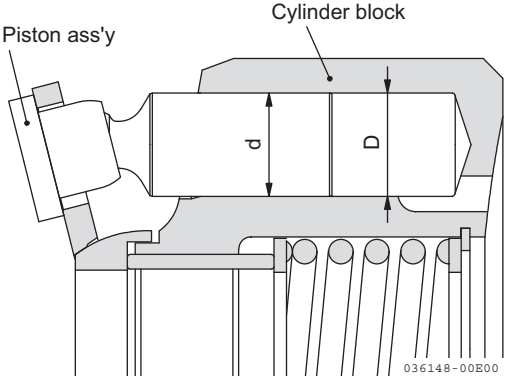
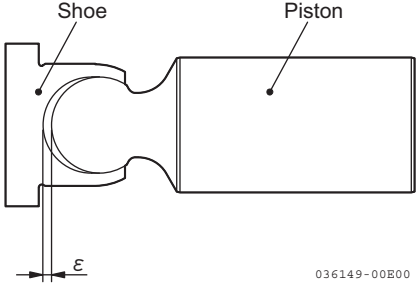
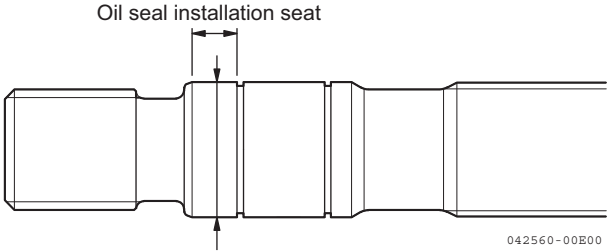
# 6. HYDRAULIC EQUIPMENT

## 6) Service Standard

Before inspection, wash the parts well and dry them completely.

Inspect the principal parts with care and replace them if you find excessive wear or damage that may cause a malfunction.

Replace deformed or damaged seals.

Procedure	
<p>(1) Piston assembly and cylinder block</p> <ul style="list-style-type: none"> <li>• Check the appearance visually.</li> <li>• Check that there are no flaws, galling or excessive wear, especially on moving parts.</li> <li>• Check that the clearance between the piston diameter and the cylinder block inside diameter is:  <math>D-d \leq 0.002 \text{ in. (0.06 mm)}</math></li> </ul>	
<p>(2) Piston shoe and piston</p> <ul style="list-style-type: none"> <li>• Check the play of the piston shoe.</li> <li><math>\epsilon \leq 0.007 \text{ in. (0.2 mm)}</math></li> </ul>	
<p>(3) Shaft</p> <ul style="list-style-type: none"> <li>• Check the wear of the oil seal mounting section.</li> <li>Wear <math>\leq 0.0009 \text{ in. (0.025 mm)}</math></li> </ul>	

## 6. HYDRAULIC EQUIPMENT

### 3. Controlling the hydraulic pilot section

#### 1) 4th P.T.O., bucket, travel, swing, P.T.O., arm, blade, and boom swing

##### (1) In neutral

The hydraulic oil discharged from the pump passes through the neutral passage and is discharged from the return port. The cylinder ports (A and B) of the hydraulic oil are closed.

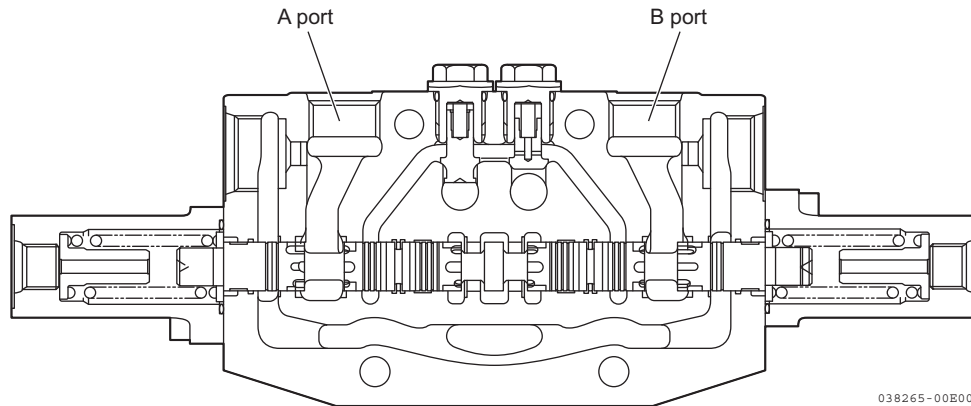


Fig. 1-1

##### (2) When the Pa port is pressurized

As shown in Fig. 1-2, when the Pa port is pressurized to switch the spool, the hydraulic oil flow in the neutral passage is closed and the load check valve is pushed up to let the hydraulic oil flow in the cylinder port "A". The return hydraulic oil in the cylinder port "B" flows to the tank passage through the throttle part of the spool and is discharged from the return port. The same is true when the Pb port is pressurized (there is no load check in the travel section).

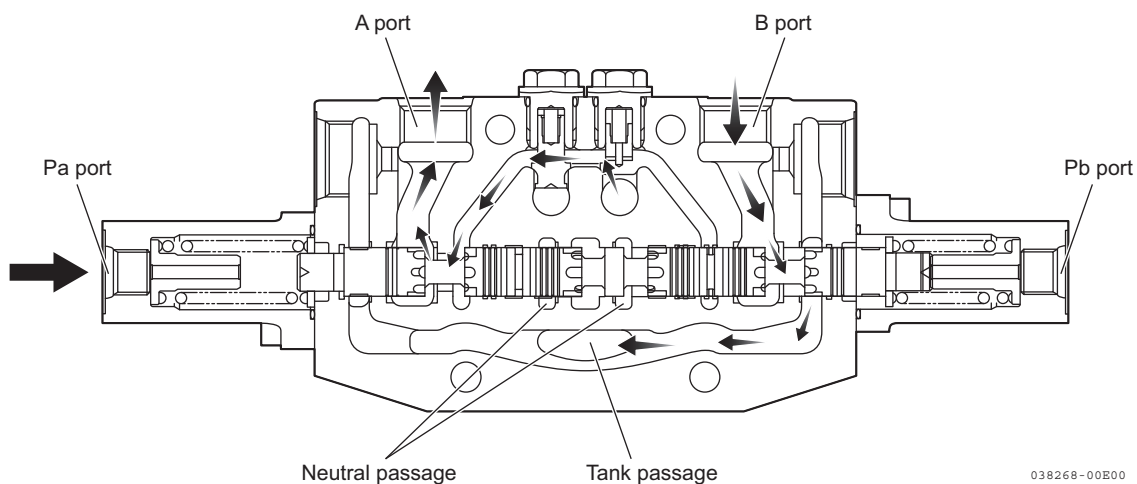


Fig. 1-2

# 6. HYDRAULIC EQUIPMENT

## 2) Disassembly of bucket section

Loosen the socket head bolt (hexagon diameter 0.2 in (5 mm)) **13** to remove the cap **3** in Fig. 2-4. Then, remove the spring seat **4**, spring **6**, spring seat **5** and O-ring **12**. After that, pull out the spool **2** from the valve housing **1**.

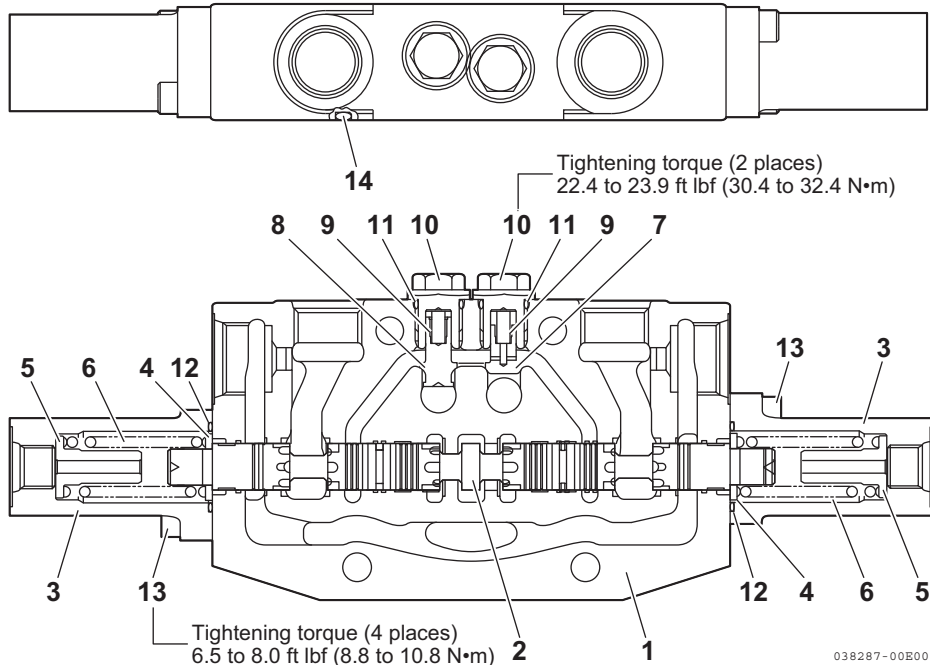


Fig. 2-4

## 3) Disassembly of boom 1 section

Loosen the socket head bolt (hexagon diameter 0.2 in (5 mm)) **20** to remove the anti-draft assembly **7** in Fig. 2-5. Then, remove the spring seat **4**, spring **6**, spring seat **5** and O-ring **13**. Loosen the socket head bolt (hexagon diameter 0.2 in (5 mm)) **14** to remove the cap **3** on the opposite side. Then, remove the spring seat **4**, spring **6**, spring seat **5** and O-ring **13**. After that, pull out the spool **2** from the valve housing **1**. After removing the cap **7**, pull out the spacer **17** by using a M4 (pitch: 0.7) thread in the spacer **17** (due to the large friction of the O-ring **18** and the backup ring **19**, it cannot be pulled out by hand). After that, remove the spring **16** and poppet **17**.

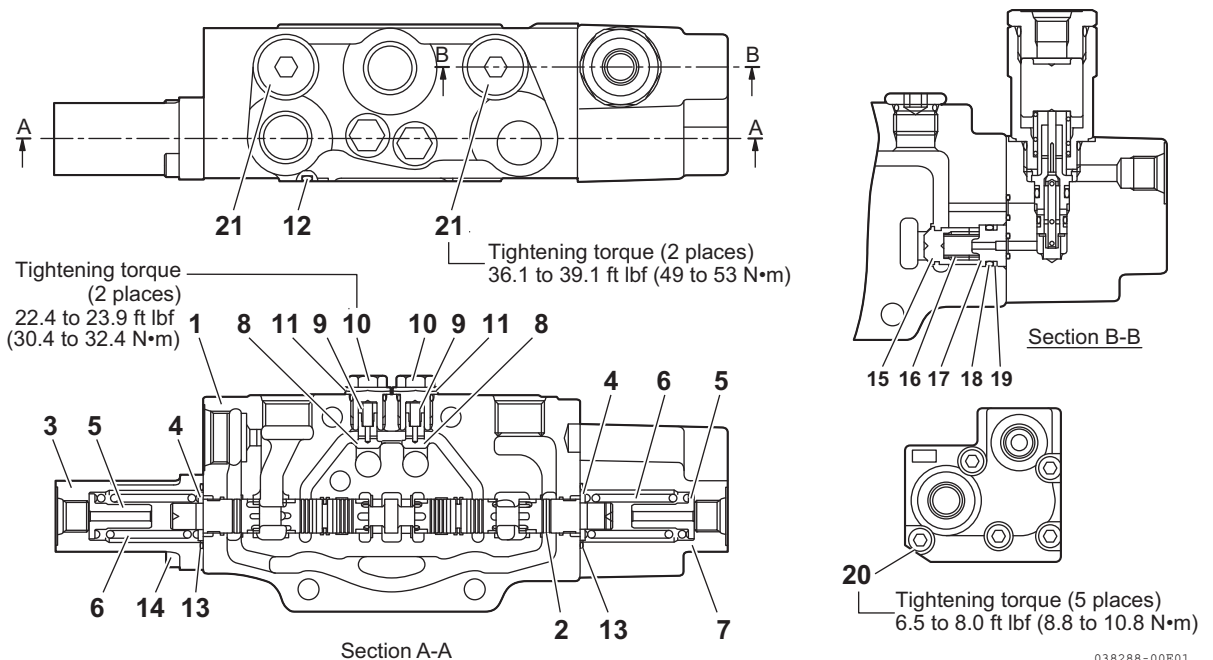


Fig. 2-5

## 6. HYDRAULIC EQUIPMENT

### **5) Installing the spool to the parallel flow divider (P3) section**

Install the O-ring **7** to the cap with filter **8** and install with the socket head bolt (hexagon hole diameter 0.2 in (5 mm)) **13** in Fig. 2-15.

**Tightening torque: 6.5 to 8.0 ft lbf (8.8 to 10.8 N•m)**

Pinch the spring **6** between the spring seats **4** and **5**, install the spool **2** to the valve housing **1** in the same direction prior to disassembly, install the cap **3** with the O-ring **7** with the socket head bolt (hexagon diameter 0.2 in (5 mm)) **13**.

**Tightening torque: 21.7 ft lbf (29.4 N•m)**

## 6. HYDRAULIC EQUIPMENT

### 2. Troubleshooting

#### **CAUTION :**

*Before starting any procedures of troubleshooting or removing the hydraulic pilot control unit, inspect the global machine's hydraulic system to eliminate all possible malfunctions not related to the pilot control unit.*

#### **Abnormal operation of equipment connected to the hydraulic pilot unit**

Malfunction	Probable case	Additional checks	Remedy
No machine movement (for hydraulic signal receivers only)	(1) Leak	See <Visual defects>	
	(2) Control valve seized or blocked		Replace pilot unit
Lack of speed of one or several machine movement(s) (for hydraulic signal receivers only)	(1) Poor pressure signal		Replace pilot unit
	(2) Leak	See <Visual defects>	
No machine movement (for electric signal receivers only)	(1) Electric function failure		Replace handle
	(2) Handle poorly connect	Check the connection	

#### **Abnormal Hydraulic Pilot Unit Operation**

Malfunction	Probable case	Additional checks	Remedy
Handle does not automatically return to neutral position:  (1) Manual return with friction	(1) Faulty cardan		Replace cardan
Handle does not automatically return to neutral position:  (2) Manual return without friction	(1) Lip seal too hard inside guide		Replace guides + plungers
	(2) Regulation unit setting spring broken	Remove the regulation unit for visual inspection	Replace pilot control unit
	(3) Regulation unit plater broken		
Handle turns	(1) Handle parts loose		Tighten all handle parts

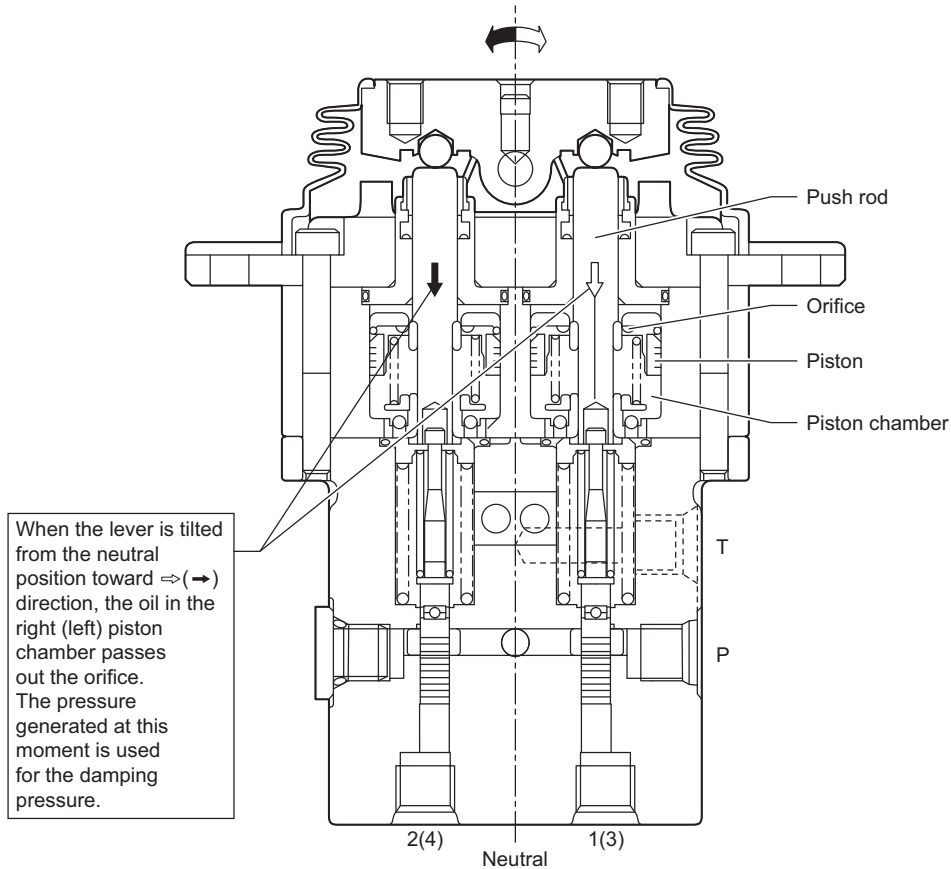
#### **Visual Defects**

Malfunction	Probable case	Additional checks	Remedy
Rubber boot damaged			Replace boot
Leak on arm rest originating from under the boot	Leak between guide and push buttons	Lift the boot to perform a visual inspection	Replace guides + plungers
Seepage on body	Porous body		Replace the pilot unit

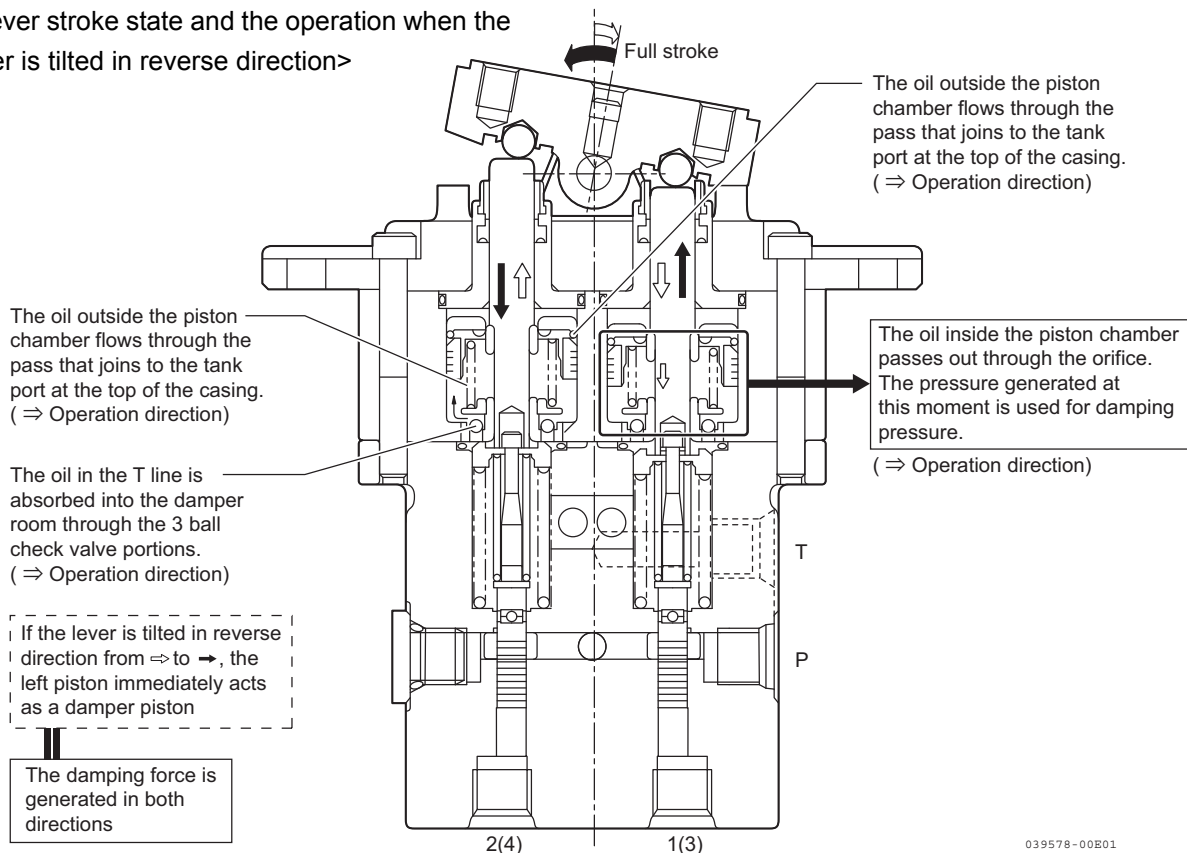
# 6. HYDRAULIC EQUIPMENT

## Damping operation explanation drawing

### (1) <Operation when the lever is tilted from the neutral position>



### (2) <Lever stroke state and the operation when the lever is tilted in reverse direction>



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## 6. HYDRAULIC EQUIPMENT

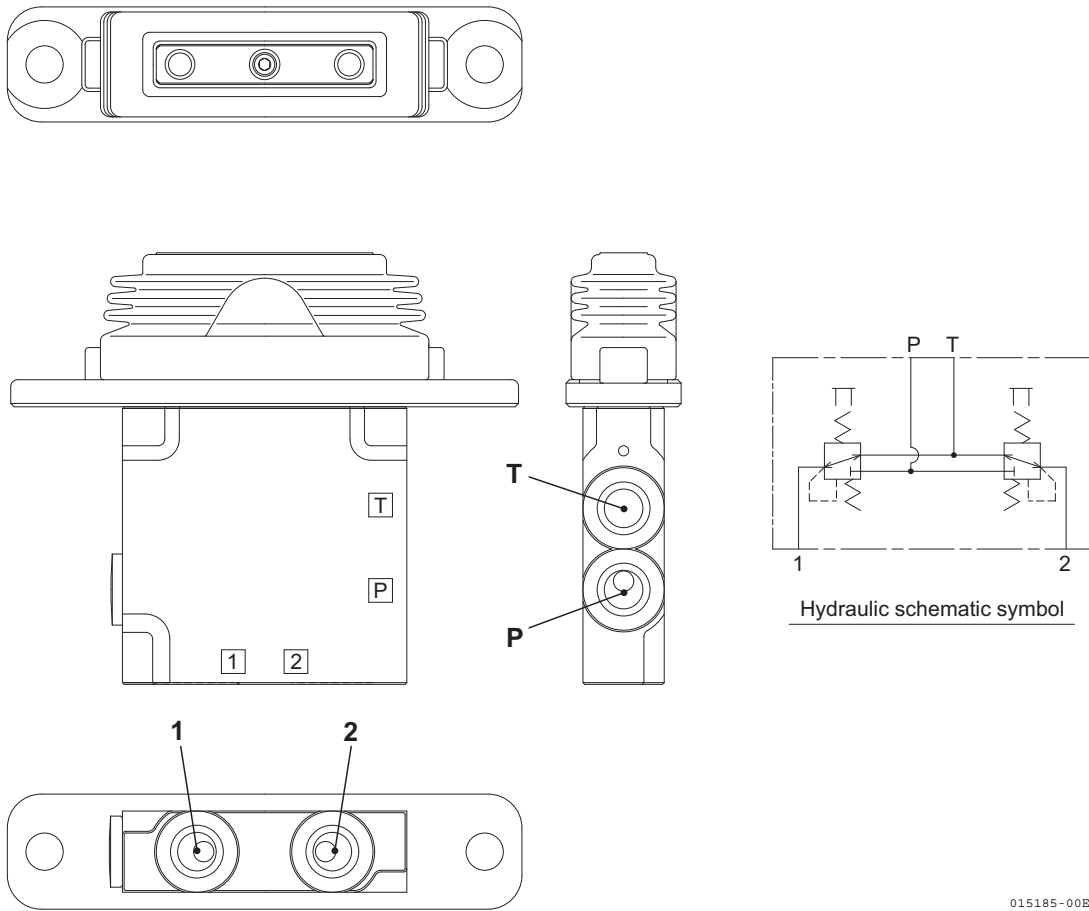
Procedure	
<p>(24) Preventing the parts from rusting Apply a rust inhibitor to the parts.</p> <p><b>Note:</b> <i>Leaving the parts without wiping the kerosene causes them to rust, resulting in degraded performance after assembled.</i></p>	

# 6. HYDRAULIC EQUIPMENT

## 6-3-3 Blade and Boom Swing Pilot Valve

### 1. Outline

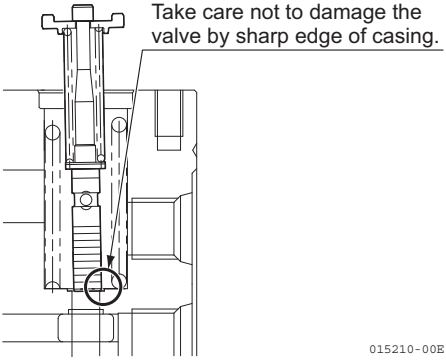
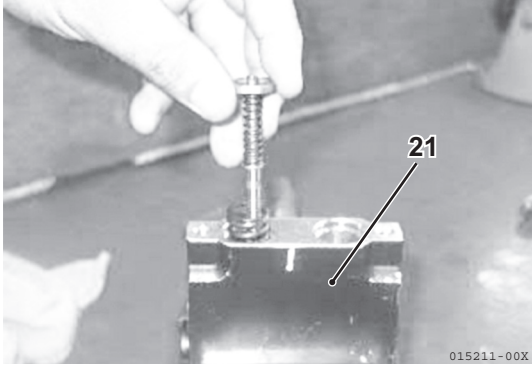
This valve is a remote control valve with a pressure reducing system. It consists of two pressure-reducing valves to regulate the secondary side pressure and control system for the valves. The secondary side pressure is controlled by the blade lever movement and it is proportional to the lever stroke.

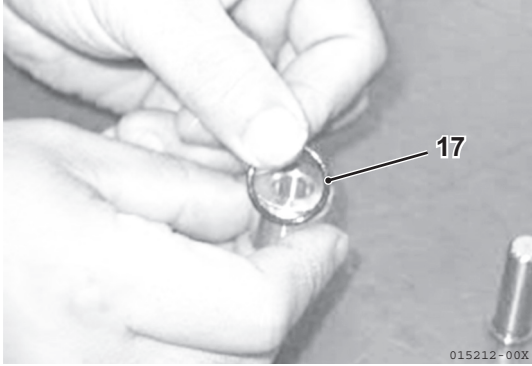


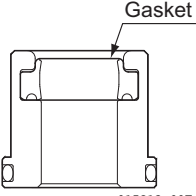
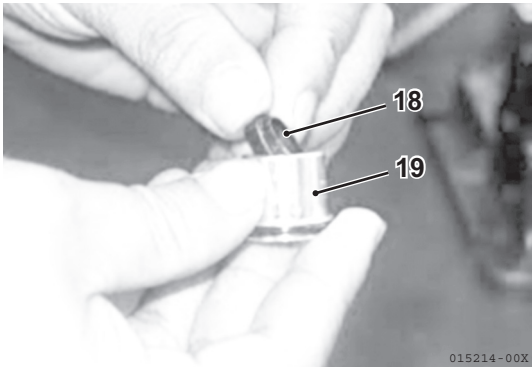
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Primary side pressure	Maximum 1000 PSI (6.9 MPa)
Secondary side pressure	0 to 420 PSI <Maximum control pressure> (0 to 2.9 MPa)
Back pressure limit	42 PSI (0.29 MPa)
Rated oil flow	2.64 GPM (10 L/m)

## 6. HYDRAULIC EQUIPMENT

Procedure	
<p>(4) Install pressure reducing valve sub-assembled at the steps (1) and (2) in casing <b>21</b>.</p> <p><b>Notes :</b></p> <ul style="list-style-type: none"><li>• Reinstall the part to the original position before disassembling.</li><li>• When installing pressure reducing valve, be careful not to excessively press the bottom of spool <b>11</b> to sharp edge of casing <b>21</b>.</li></ul>  <p>015210-00E</p>	 <p>015211-00X</p>

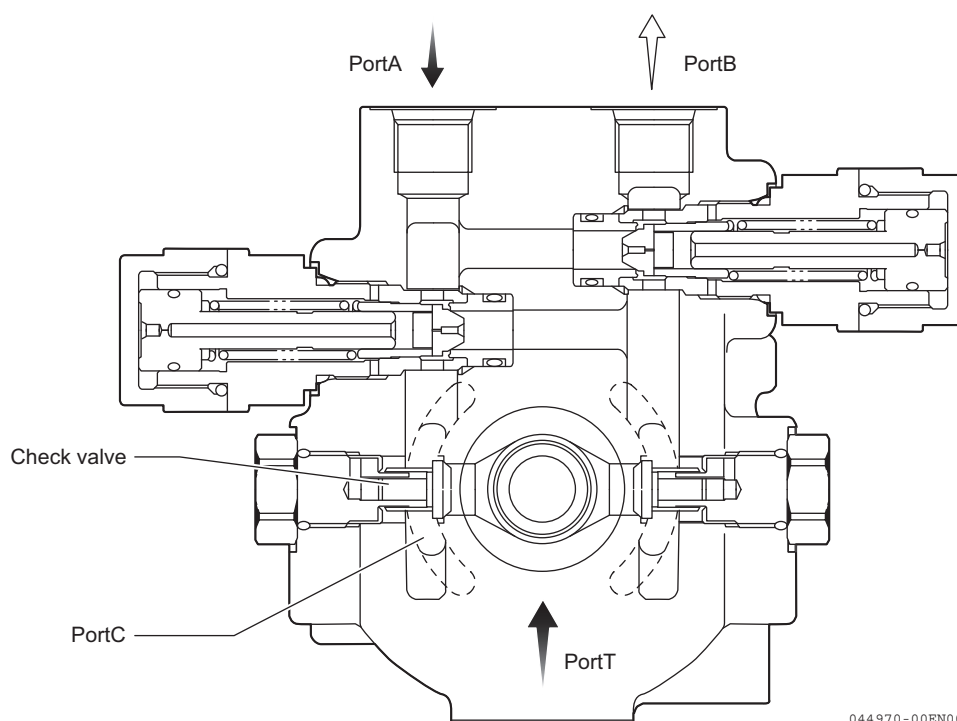
<p>(5) Install O-ring <b>17</b> on plug <b>19</b>.</p>	 <p>015212-00X</p>
--	--

<p>(6) Install gasket <b>18</b> on plug <b>19</b>.</p> <p><b>Notes :</b></p> <ul style="list-style-type: none"><li>• Take care of installation direction of gasket <b>18</b>.</li><li>• Coat grease on gasket <b>18</b> before installing.</li></ul>  <p>015213-00E</p>	 <p>015214-00X</p>
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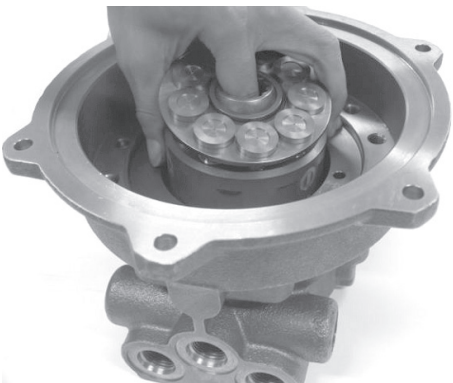
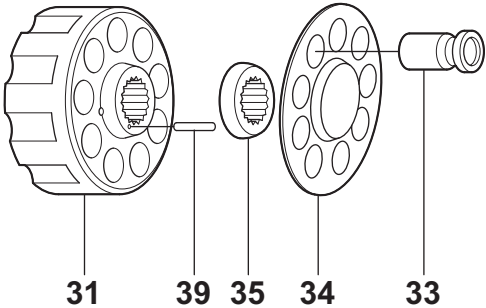
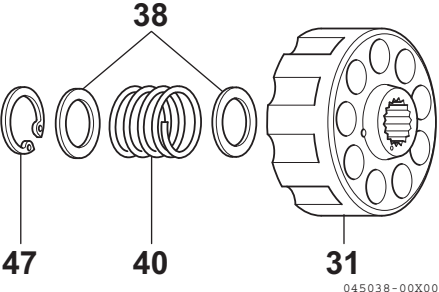

## 6. HYDRAULIC EQUIPMENT

### (2) Check Valve

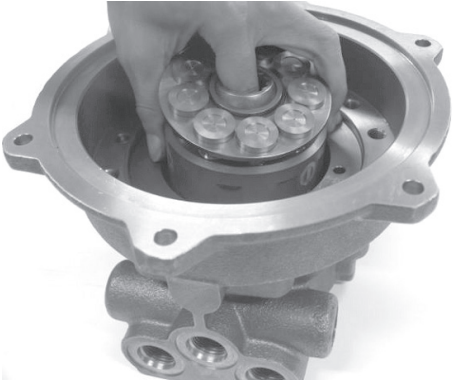
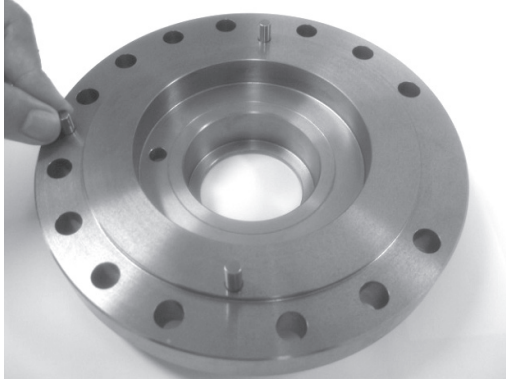

When the swing unit is slowed down with the control lever after accelerated, the amount of the oil supplied from the pump to the port **A** is reduced. At this time, if the swing unit is rotating at a relatively high speed, the swing motor is swung from the swing unit, pumping begins, the pressure in the part **C** becomes negative, and it becomes necessary to feed oil. If the pressure at the port **B** is smaller than the working pressure of the relief valve, all of the oil that has flowed into the part **C** through the port **A** is discharged into the control valve through the port **B**. Thus the amount of the oil from the control valve is smaller than the amount needed for the part **C**. To prevent cavitation caused by such a shortage of oil in the part **C**, oil is supplied to the part **C** through the port **T** and the check valve from the hydraulic oil tank.



## 6. HYDRAULIC EQUIPMENT

Procedure	
<p>(9) Remove three dowel pins <b>48</b> from plate S <b>29</b>.</p>	
<p>(10) Remove the cylinder barrel assembly.</p> <p><b>Note:</b></p> <ul style="list-style-type: none"> <li>• Be careful not to lose small parts because they often go missing.</li> <li>• Be careful not to drop valve plate <b>32</b> if it has been removed together with the cylinder barrel assembly.</li> </ul>	
<p>(11) Remove piston assemblies <b>33</b>, shoe holder <b>34</b>, barrel holder <b>35</b> and pins <b>39</b> from cylinder barrel <b>31</b>.</p>	 <p style="text-align: right;">045037-00X00</p>
<p>(12) Remove snap ring <b>47</b>, retainers <b>38</b> and spring C <b>40</b> from cylinder barrel <b>31</b>.</p>  <p style="text-align: center;">045038-00X00</p>	

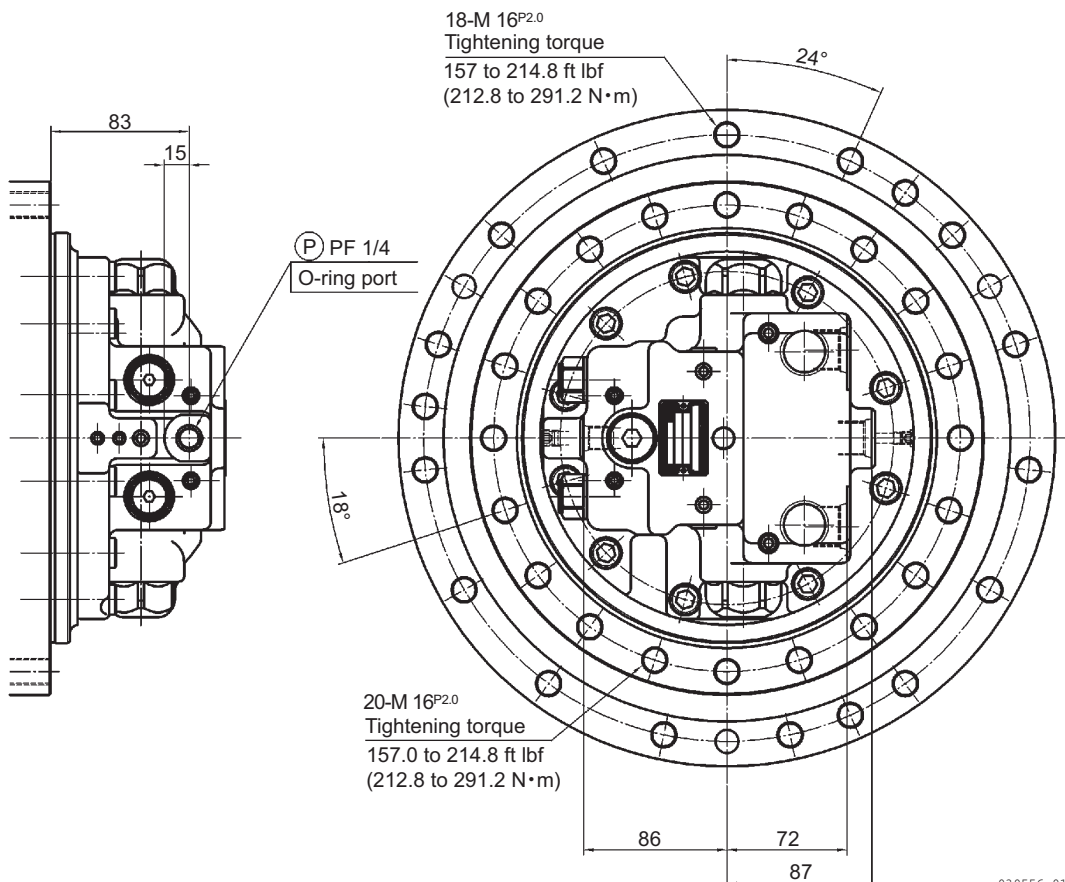
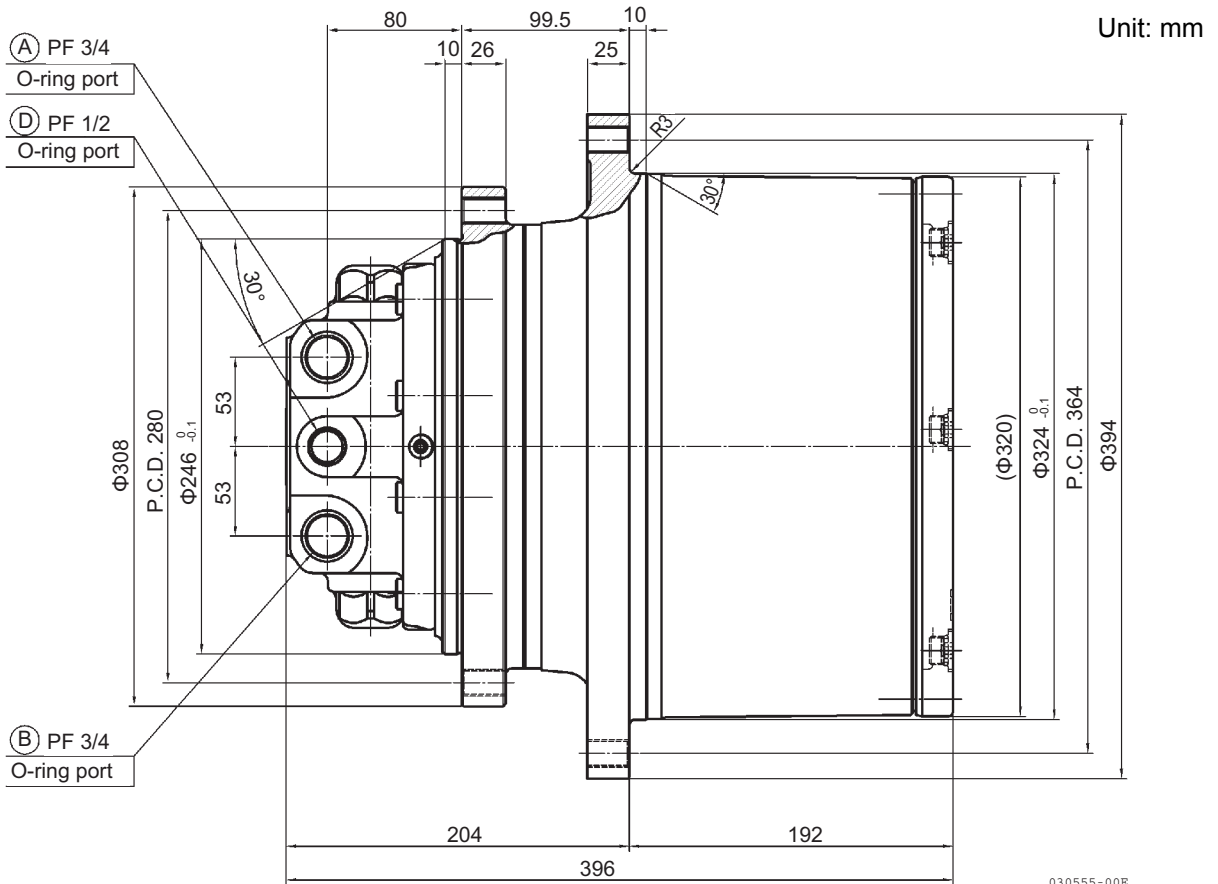
## 6. HYDRAULIC EQUIPMENT

Procedure	
<p>(9) Insert the cylinder barrel assembly into body H <b>28</b> while aligning its grooves with those of the disc plates.</p>	 A black and white photograph showing a hand placing a cylindrical assembly into a larger, flanged metal housing. The assembly consists of several smaller cylindrical components stacked together.
<p>(10) Insert three dowel pins 48 into the pin holes in plate S <b>29</b>.</p>	 A black and white photograph of a circular metal plate with several holes around its perimeter. A hand is shown inserting a small pin into one of the holes.
<p>(11) Install twenty springs B <b>44</b> into the holes in brake piston <b>43</b>.</p>	 A black and white photograph showing a hand installing a small spring into a hole in a complex, multi-layered metal assembly. The assembly has many small holes and components.

# 6. HYDRAULIC EQUIPMENT

## 6-5-2 External Dimensions and Circuit Diagram

### 1. External Dimensions



## 6. HYDRAULIC EQUIPMENT

### [2] Stop / Stall (Braking Operation)

If pressurized oil supply through the port **A** is suspended while traveling, the hydraulic force to push up the spool **323** is lost, and the spool **323** which is slid to left side, tries to return to the neutral position due to the spring **328** force.

At that time, through the oil in the chamber **a** tries to flow out to the port **A** side through the orifice **329**, its flow is restricted and some back pressure is generated by the throttle effect in the orifice **329** controlling the return speed of the spool **323**.

At the same time, the hydraulic motor tries to rotate with its inertia force even though the pressurized oil is suspended, and the return oil from the hydraulic motor tries to return to the port **B** side from the port **D** through the passages on spool groove and rear flange **301**.

When the spool **323** entirely return to neutral position, the passage on the hydraulic motor of the oil return side is completely closed by the spool **323**, and the hydraulic motor ceases its rotation.

While machine working, the brake valve smoothly stops rotation of the hydraulic motor which tries to rotate with its inertia force, by means of throttling the return side passage of the hydraulic motor, generating back pressure due to shape of the spool groove and controlling the return speed of the spool **323**.

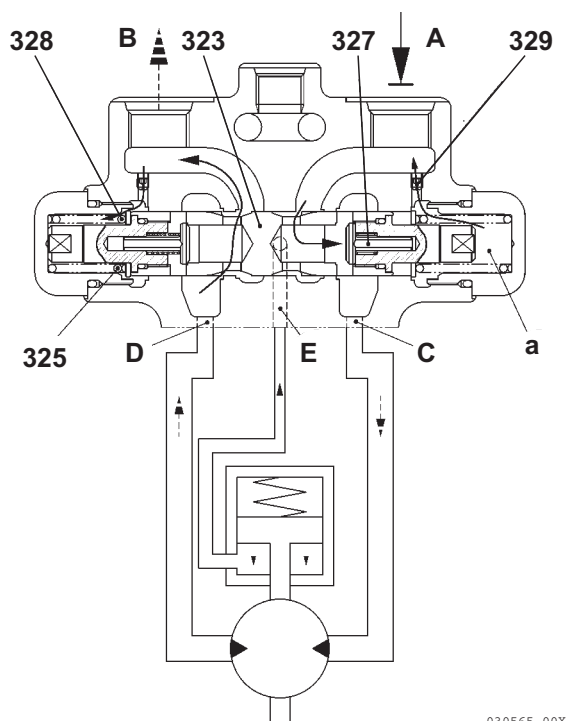
On the other hand, when braking is operated, the hydraulic motor tries to rotate with its inertia force and to intake oil with its pumping function.

However, because the intake side is closed its passage with the spool **323**, the oil supply is suspended.

This causes cavitation in the hydraulic motor.

To prevent the cavitation, the valve **327** is operated by very slight negative pressure to open the passages of port **A** side and intake port **C** of the hydraulic motor.

And when pressurized oil is supplied through the port **B**, each motion of the mentioned parts above becomes symmetrical right and left to stop the hydraulic motor.

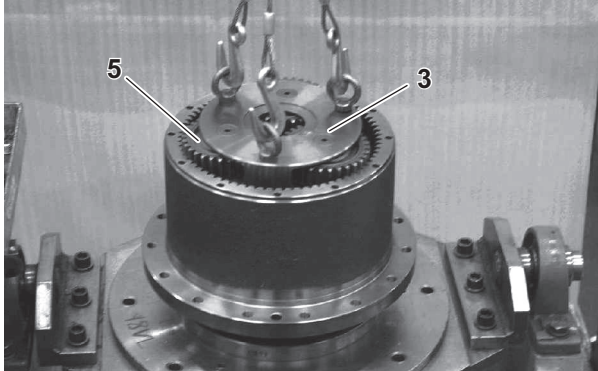


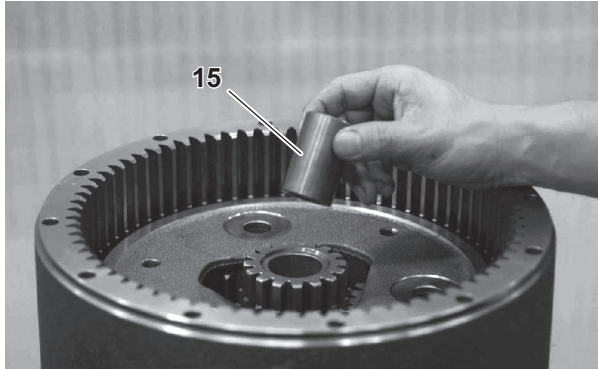
## 6. HYDRAULIC EQUIPMENT

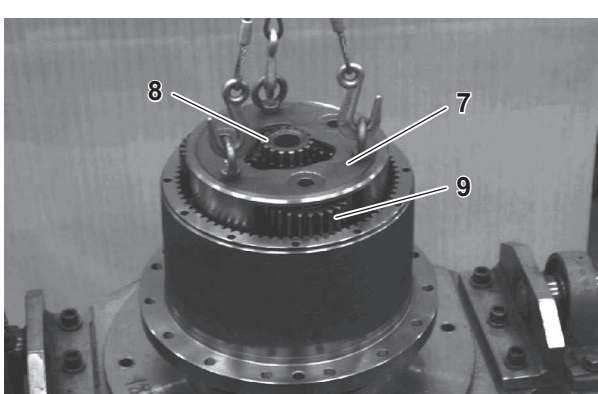
### Troubleshooting (Continued)


Problem 1	Problem 2	Possible cause	Action
Meanders when used as drive motor	Occurs at low pressure	Left-right ejection volume imbalance	Repair pump
		Left-right hydraulic motor drain volume imbalance	Replace motor assy
	Occurs at high pressure	Left-right ejection volume imbalance	Repair pump
		Left-right hydraulic motor drain volume imbalance	Replace motor assy
		Left-right brake valve operation imbalance	Replace brake valve
		Left or right control valve has low relief pressure	Set pressure correctly, or replace relief valve
Speed too slow	Pump ejection volume too low	Pump not operating property	Repair or replace pump
		High oil leakage outside pump	Repair or replace pump
	Volumetric eff. is no good	High oil leakage outside hydraulic motor	Replace motor assy
Abnormal sounds	From motor	Hydraulic motor or reduction gear damage	Replace motor assy
	From tubing	Tubing vibration occurring	Clamp tubing
2-speed switching does not function	Does not switch low to high speed	High pressure selection check valve malfunction	Inspect, repair or replace
		Switching valve malfunction	Repair or replace
		Pilot pressure too low	Set to required pressure
		2-speed switching piston malfunction	Repair or replace
	Does not switch from high to low speed	Switching valve malfunction	Repair or replace
		2-speed switching piston malfunction	Repair or replace

## 6. HYDRAULIC EQUIPMENT

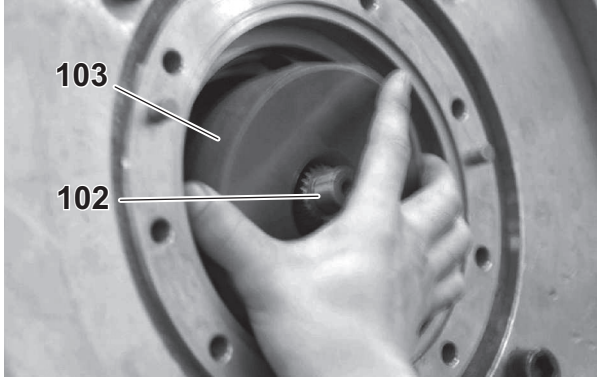
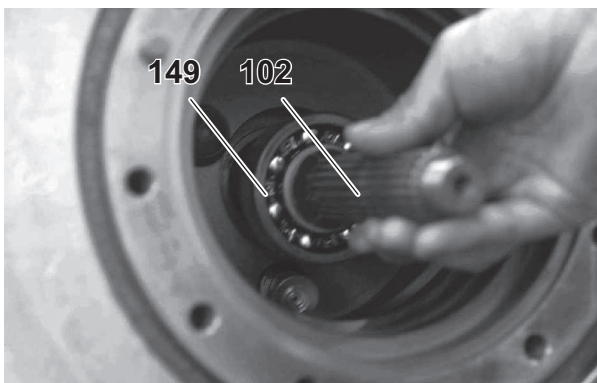
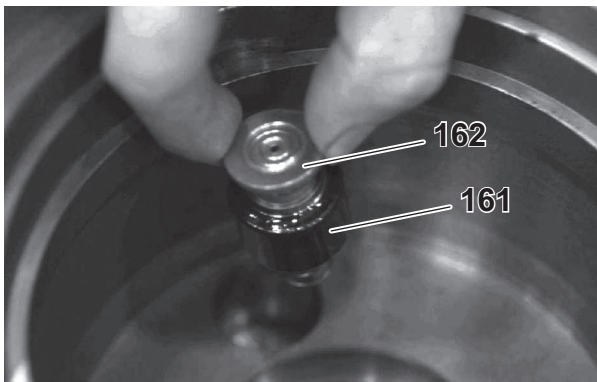
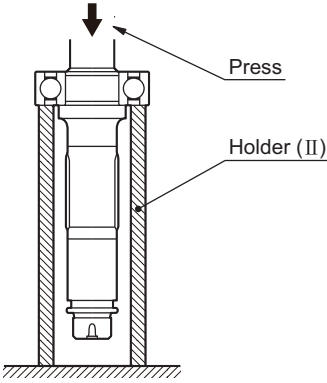
Procedure	
<p>(2) Fasten three eyebolts to the tapped holes of carrier (1) <b>3</b>. Attach a wire sling and hook in the eyebolts, lift carrier (1) assembly by crane.</p> <p><b>Note:</b> When carrier (1) assembly is lifted by crane, the edge of planetary gear (1) <b>5</b> could damage the internal teeth of hub <b>1</b>. Lift up slowly, and carefully.</p>	

<p><b>7. Removing coupling</b></p> <p>(1) Remove coupling <b>15</b> from shaft <b>102</b>.</p>	
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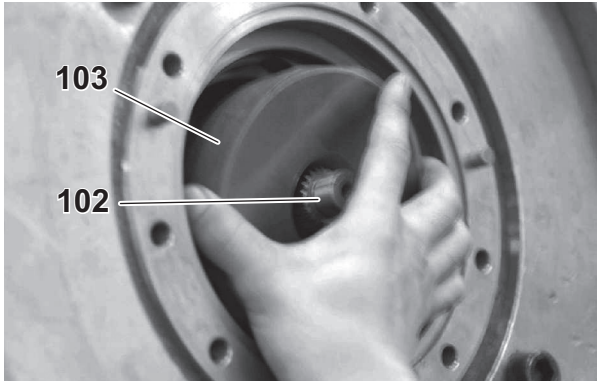
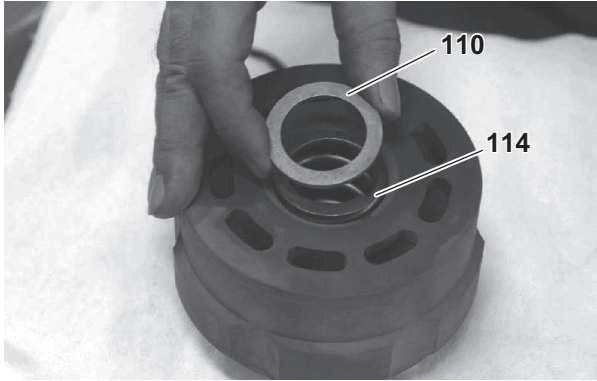

<p><b>8. 2nd stage reduction gear removal</b></p> <p>(1) Fasten three eyebolts to the tapped holes of carrier (2) <b>7</b>. Place a wire sling and hook in the eyebolts, lift carrier (2) assembly by crane.</p> <p><b>Note:</b> When carrier (2) assembly is lifted by crane, the edge of planetary gear (2) <b>9</b> could damage the internal teeth of hub <b>1</b>. Lift up slowly, and carefully.</p> <p>(2) Remove sun gear (2) <b>8</b> by hand.</p> <p><b>Note:</b> Be careful not to drop sun gear (2) <b>8</b>. It could be slippery by lubricant.</p>	
--	--

<p><b>9. Removing lock washer</b></p> <p>(1) Fix hub <b>1</b> and workbench with using three holes (<math>\phi 0.55</math> in. (14 mm)) of hub <b>1</b>.</p>	
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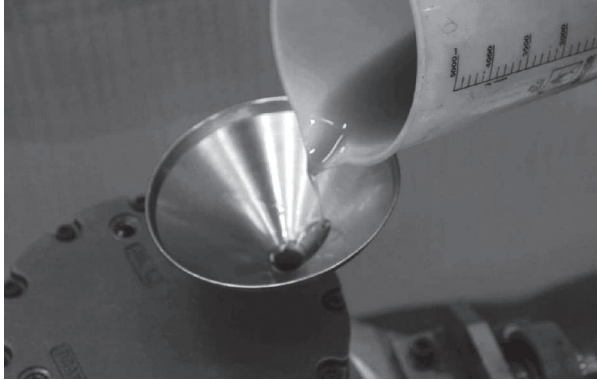
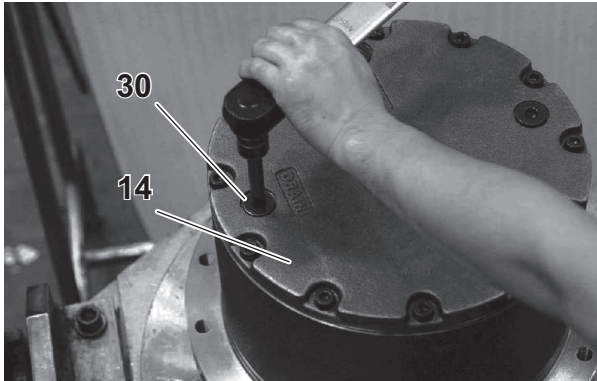
## 6. HYDRAULIC EQUIPMENT

Procedure	
<p><b>22. Removing swash plate</b></p> <p>(1) Remove swash plate <b>103</b> from shaft <b>102</b>.</p> <p><b>Note:</b> When removing swash plate <b>103</b>, ensure that pivots <b>167</b> are not adhered on swash plate <b>103</b>.</p>	
<p>(2) Pull out shaft <b>102</b> from spindle <b>2</b>.</p> <p><b>Note:</b> Be careful to lightly strike the tip of shaft <b>102</b> on the reduction gear side using a plastic hammer to allow shaft <b>102</b> come off easily. Otherwise shaft <b>102</b> may pop out.</p> <p>(3) Remove pivots <b>167</b> (2 pcs) and parallel pins <b>171</b> (2 pcs) from spindle <b>2</b>.</p>	
<p>(4) Blow compressed air through passage of spindle <b>2</b>. Take out 1st-2nd speed piston kit and spring <b>185</b> from spindle <b>2</b>.</p> <ul style="list-style-type: none"> <li>• Piston kit             <ul style="list-style-type: none"> <li>{ Piston <b>161</b></li> <li>{ Shoe <b>162</b></li> </ul> </li> </ul>	
<p><b>23. Removing ball bearing</b></p> <p><b>Note:</b> Ball bearing <b>149</b> is removed only when replacing.</p> <p>(1) Place holder (II) on the press bench and put shaft <b>102</b> into the holder (II).</p> <p>(2) Remove ball bearing <b>149</b> from shaft <b>102</b> by pressing on the shaft end with press.</p> <p><b>Note:</b> Do not reuse the removed ball bearing <b>149</b>.</p>	 <p style="text-align: right; font-size: small;">030589-00B</p>

## 6. HYDRAULIC EQUIPMENT

Procedure	
<p>(4) Insert swash plate <b>103</b> into spindle <b>2</b>.</p> <p><b>Note:</b> Apply lithium grease on swash plate <b>103</b> where mating surface of spindle <b>2</b>. Make sure that the locating pivots <b>167</b> of spindle <b>2</b> enter pivots' holes of swash plate <b>103</b>.</p>	
<p><b>7. Assembling cylinder block interior</b></p> <p><b>Note:</b> The sharp edge of snap ring <b>145</b> is turned and put into the entrance side of cylinder block <b>104</b>. Washer <b>110</b> which touches snap ring <b>145</b> turns and puts its sharp edge side into snap ring side.</p> <p>(1) Insert washer <b>110</b>, spring <b>114</b>, washer <b>110</b> and snap ring <b>145</b> in that order into cylinder block <b>104</b>.</p> <p>(2) Place cylinder block <b>104</b> on the press bench.</p>	
<p><b>CAUTION</b> When mounting snap ring <b>145</b>, if the tip of the pliers slips out of the hole of snap ring <b>145</b>, snap ring <b>145</b> could jump out.</p> <p><b>Note:</b> Press force of spring <b>114</b> is 253.6 lbf (1128 N) or more. Protect by covering cylinder block <b>104</b> with a vinyl sheet so the contact surface with timing plate <b>109</b> of cylinder block <b>104</b> does not become damaged.</p> <p>(3) Place holder ( I ) on washer <b>110</b>, and while clamping with the press, fit snap ring <b>145</b> in the snap ring groove of cylinder block <b>104</b> with the snap ring pliers.</p>	

## 6. HYDRAULIC EQUIPMENT

Procedure	
<p><b>22. Filling lubrication oil</b></p> <p>(1) Fill gear oil (lubrication oil) into the filling port.</p> <p><b>Note:</b> Supply 2.2 Qts. (2.1 L) of gear oil.</p>	
<p>(2) Attach plugs <b>30</b> to ports of cover <b>14</b>, tighten them with the specified torque.</p> <p><b>Tightening torque : 57.9 to 86.8 ft lbf (78.5 to 117.7 N•m)</b></p> <p><b>23. Removing reassembled motor from the workbench</b></p> <p>(1) Turn the workbench upside down. (The motor side of motor is turned up.)</p> <p>(2) Remove the bolts securing motor to the workbench.</p> <p>(3) Fasten two eyebolts (M16) to spindle <b>2</b>.</p> <p>(4) Place a wire sling and hook in the eyebolts, remove motor from the workbench with the crane.</p>	

## 6. HYDRAULIC EQUIPMENT

### 5. Troubleshooting

Trouble	Cause	Corrective measure
Unstable pressure in the circuit.	<ul style="list-style-type: none"> <li>• Malfunction of <b>3</b> plunger.</li> <li>• Have got contaminant.</li> </ul>	<ul style="list-style-type: none"> <li>• Disassemble and wash them.</li> <li>• Repair flaws.</li> <li>• If unrepairable, replace the valve assy.</li> </ul>
	<ul style="list-style-type: none"> <li>• Worn-out or breakage of the <b>7</b> spring.</li> </ul>	<ul style="list-style-type: none"> <li>• Renew <b>7</b> spring with new one.</li> </ul>
The pressure of the port A and B do not increase, when the SOL is on. (Relief valve works normally)	<ul style="list-style-type: none"> <li>• Shortage of the voltage.</li> </ul>	<ul style="list-style-type: none"> <li>• Check the voltage.</li> </ul>
	<ul style="list-style-type: none"> <li>• Malfunction of the coil of <b>5</b> or <b>6</b> solenoid.</li> </ul>	<ul style="list-style-type: none"> <li>• Replace <b>5</b> or <b>6</b> solenoid coil.</li> </ul>
	<ul style="list-style-type: none"> <li>• Malfunction of <b>2</b> spool.</li> </ul>	<ul style="list-style-type: none"> <li>• Disassemble and wash them.</li> </ul>
	<ul style="list-style-type: none"> <li>• Have got contaminant.</li> </ul>	<ul style="list-style-type: none"> <li>• Repair the flaws.</li> <li>• If unrepairable, renew the assy.</li> </ul>
The pressure of the port A and B do not drop, when the SOL is off. (Relief valve works normally)	<ul style="list-style-type: none"> <li>• The breakage of <b>1</b> spring.</li> </ul>	<ul style="list-style-type: none"> <li>• Replace <b>1</b> spring with new one.</li> </ul>
	<ul style="list-style-type: none"> <li>• Malfunction of <b>2</b> spool.</li> </ul>	<ul style="list-style-type: none"> <li>• Disassemble and wash them.</li> </ul>
	<ul style="list-style-type: none"> <li>• Have got contaminant.</li> </ul>	<ul style="list-style-type: none"> <li>• Repair the flaws.</li> <li>• If unrepairable, replace the valve assy.</li> </ul>
External leakage of oil.	<ul style="list-style-type: none"> <li>• The breakage of the O-ring.</li> </ul>	<ul style="list-style-type: none"> <li>• Replace O-rings with new ones.</li> </ul>

# 7. ADJUSTMENT AND REPAIR

## 7-1-2 Monitor and Alarm Systems

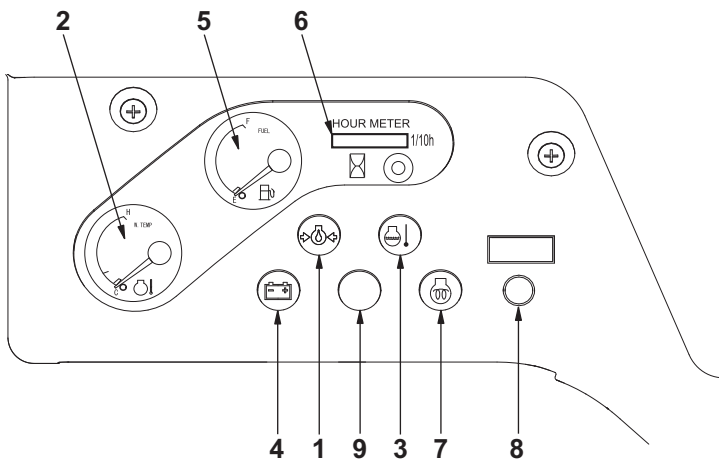
For safer machine operation, the operator needs to have a clear understanding of the machine's condition. However, it is difficult for the operator to keep an eye on every aspect of the machine he/she is operating.

Therefore, gauges and alarms are installed to warn the operator of any trouble of the machine at the early stage.

**Note :**

The monitors do not give a full assurance of the machine's condition. The indications shown on them should be used as a guide for daily check and periodic maintenance according to the operation and maintenance manual.

### 1) Part Name



- 1 Engine oil alarm lamp
- 2 Water temp. gauge
- 3 Water temp. alarm lamp
- 4 Battery charge alarm lamp
- 5 Fuel gauge
- 6 Hourmeter
- 7 Preheat pilot lamp
- 8 Engine trouble monitor lamp
- 9 Auto-deceleration indicator lamp

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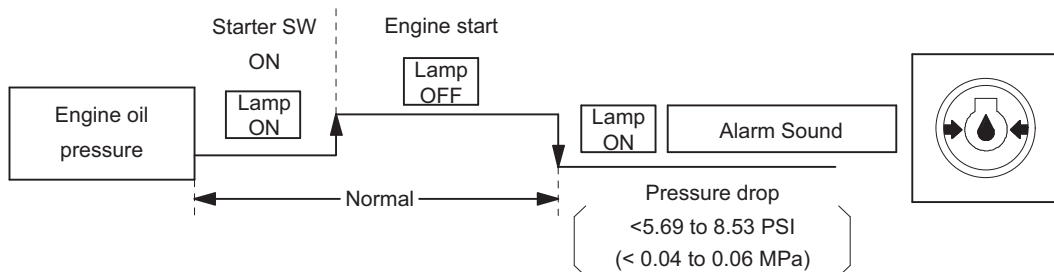
### 2) Function of Alarm Sensor

- All the lamps should go on for a few seconds when the starter switch is turned on.
- All the lamps should go off when the engine is running.
- The engine oil and battery charge alarm lamps should go on when the engine is stopped.
- The buzzer should sound when a lamp goes on while the engine is running.

### 3) Alarm Sensor Operation

#### (1) Lube oil pressure drop monitoring (L.O. switch)

When the engine oil pressure falls, the lamp goes on and the buzzer sounds.

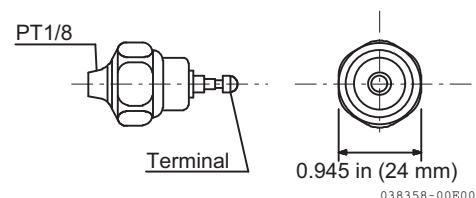


038357-00E00

The switch monitors the lube oil pressure drop of the engine and causes the engine oil pressure alarm lamp to go on and the alarm buzzer to sound.

Working pressure : 5.69 to 8.53 PSI (0.04 to 0.06 MPa)

Installation position : Engine block

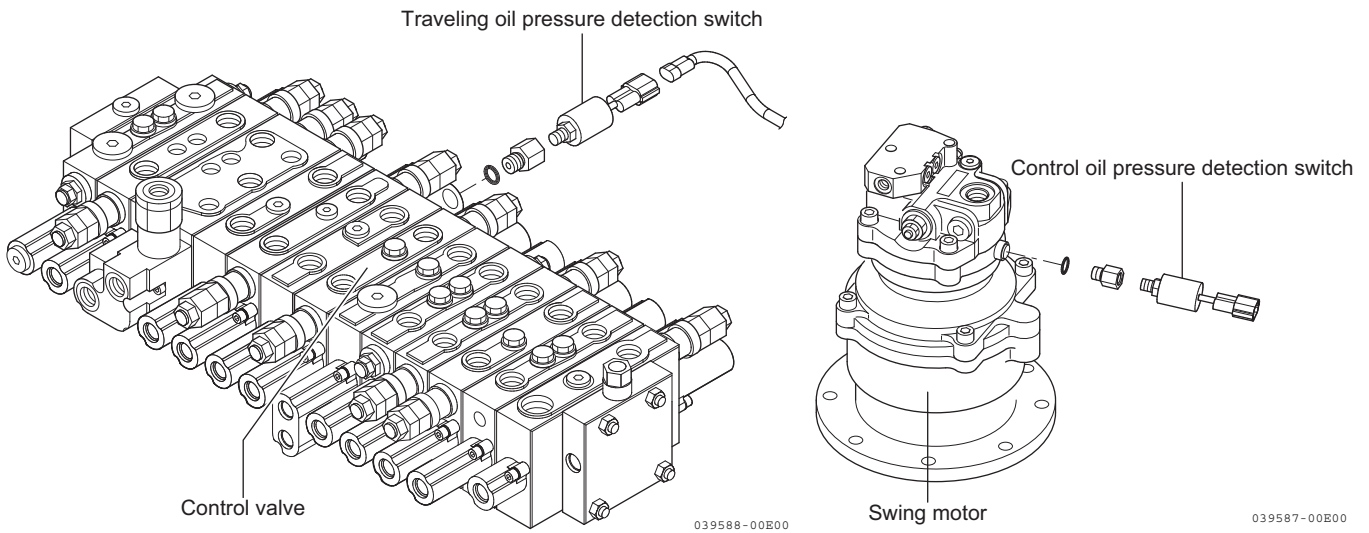


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# 7. ADJUSTMENT AND REPAIR

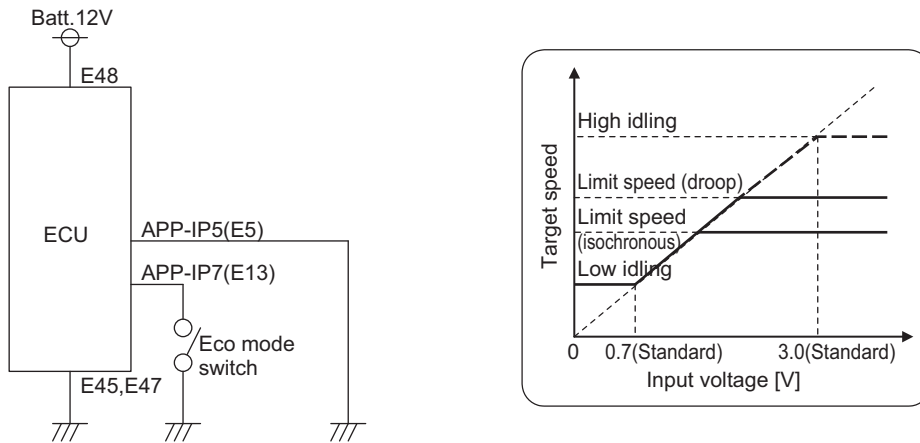
## Operation oil pressure switches



### (2) Eco-mode and High idling limitation

Electronic control governor has a feature which reduce the high idling speed when the APP-IP5 terminal is GND connected.

The speed for high idling limitation can be switched by the condition of Eco-mode switch as shown in this figure. The speed of limitation is the target speed at no load. The actual maximum speed is decided by the size of load.

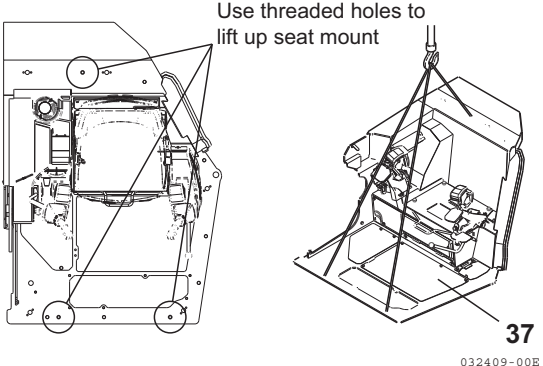


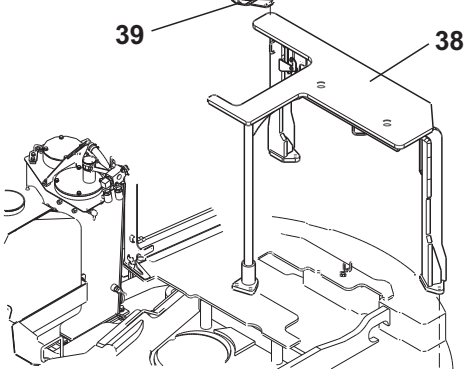
High idling limitation SW APP-IP5(E5)	Eco mode Switch	Limit speed
OFF	-	Speed command from the accelerator
ON	OFF	2100 [min <sup>-1</sup> ]
	ON	1900 [min <sup>-1</sup> ]

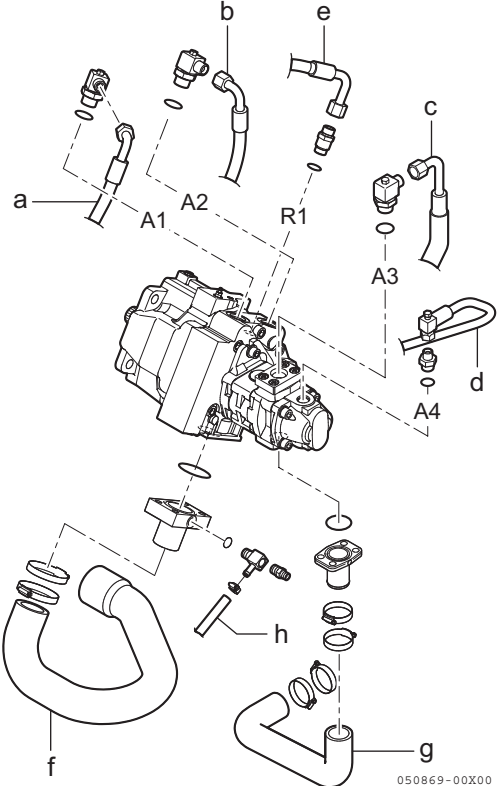
039581-00E00

### High idling limitation feature

## 7. ADJUSTMENT AND REPAIR

Procedure	
<p>(18) Lift seat mount <b>37</b> up to remove it.</p> <p><b>Note :</b> When lifting up seat mount, lift it up slowly and make sure that no harness and hose get caught.</p>	 <p>Use threaded holes to lift up seat mount</p> <p><b>37</b></p> <p>032409-00E</p>

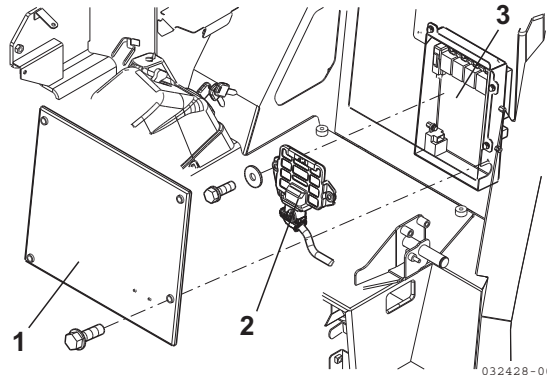
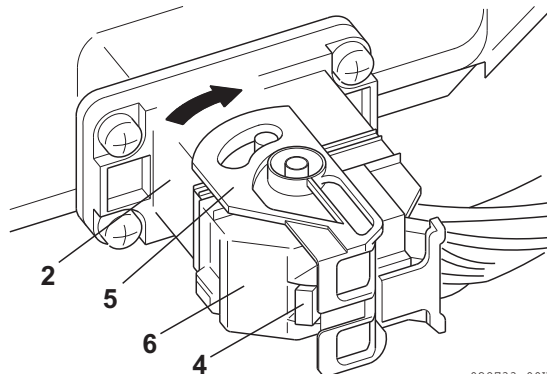
<p>(19) Remove stay B <b>39</b> from cabin mount bracket <b>38</b> and remove cabin mount bracket <b>38</b>.</p>	 <p><b>39</b></p> <p><b>38</b></p> <p>032410-00X</p>
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<p>(20) Disconnect the hydraulic hoses from the hydraulic pump.</p> <table border="0" data-bbox="199 1339 550 1496"> <tr> <td>a. Hose A1</td> <td>g. Hose S1</td> </tr> <tr> <td>b. Hose A2</td> <td>h. Hose S2</td> </tr> <tr> <td>c. Hose A3</td> <td>i. Hose S3</td> </tr> <tr> <td>d. Hose A4</td> <td></td> </tr> <tr> <td>e. Hose R1</td> <td></td> </tr> </table> <p><b>Notes:</b></p> <ul style="list-style-type: none"> <li>• Make a mark on the installation position of each hose in advance.</li> <li>• Remove the flange from the hydraulic pump.</li> <li>• Be careful not to lose the O-ring for the flange.</li> </ul>	a. Hose A1	g. Hose S1	b. Hose A2	h. Hose S2	c. Hose A3	i. Hose S3	d. Hose A4		e. Hose R1		 <p>a</p> <p>b</p> <p>c</p> <p>d</p> <p>e</p> <p>f</p> <p>g</p> <p>h</p> <p>A1</p> <p>A2</p> <p>A3</p> <p>A4</p> <p>R1</p> <p>S1</p> <p>S2</p> <p>S3</p> <p>050869-00X00</p>
a. Hose A1	g. Hose S1										
b. Hose A2	h. Hose S2										
c. Hose A3	i. Hose S3										
d. Hose A4											
e. Hose R1											

# 7. ADJUSTMENT AND REPAIR

## 7-1-11 Removal and Reinstallation of ECU

### 1) Removal

Procedure	
<p>(1) After moving operator's seat to forward, remove box cover 1.</p> <p>(2) Remove ECU 2 from controller box A 3.</p>	 <p>032428-00X</p>
<p>(3) While pressing lock button 4, turn cover 5 in the arrowed direction in the figure on the right.</p> <p>(4) Disconnect the harness connector 6 from ECU 2.</p>	 <p>029733-00X</p>

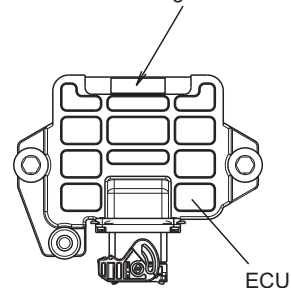
### 2) Reinstallation

Reinstall the ECU in the reverse order of the removal procedure.

#### Notes:

1. Use an appropriate ECU matched to the same model engine with the same serial number as indicated on the ECU.
2. Do not connect or disconnect the connector to or from the ECU for at least 6 seconds after the power is turned on or off.
3. Do not touch any connector pins with bare hands.  
Doing so might cause corrosion of the connector pins or static electricity, resulting in damage to the electronic circuit in the ECU.
4. Do not forcibly insert any devices such as the test probes of test equipment into female couplers (of the harness side). Doing so may cause contact failure of connector pins, resulting in malfunction.
5. Take care not to let water into the couplers when connecting or disconnecting connectors. Water can cause corrosion of connector pins, resulting in malfunction.
6. Take care not to drop the ECU. If it is dropped, do not use it.

The same item as engine model and engine serial No. shall be used

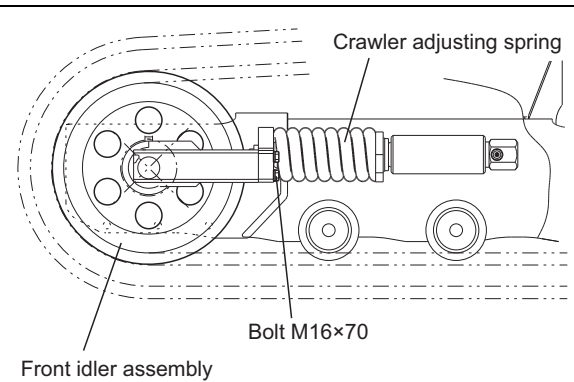


029734-00B

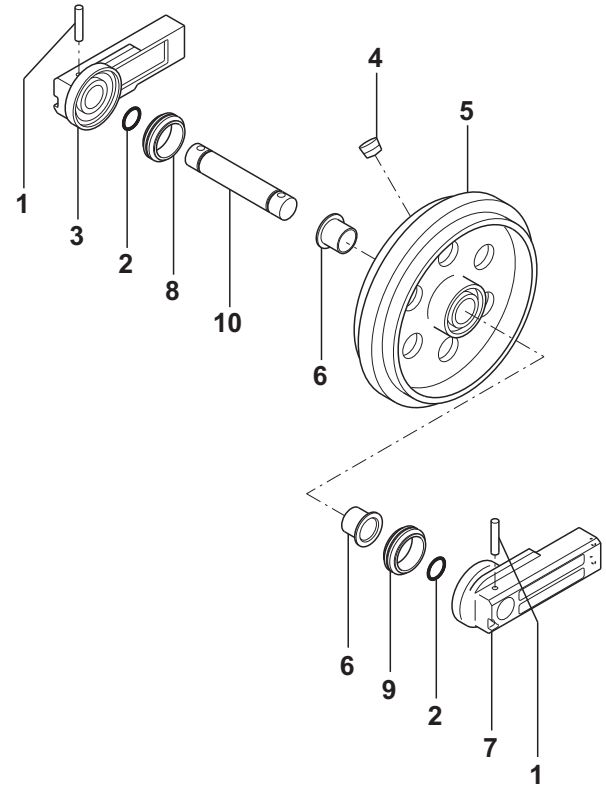
# 7. ADJUSTMENT AND REPAIR

## 2) Disassembly

Procedure							
(1) Remove the crawler adjusting spring.							
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2" style="text-align: center;">Installation bolt (M16) for crawler adjusting spring</td> </tr> <tr> <td style="text-align: center;">Adhesive</td> <td>Loctite 262 or its equivalent</td> </tr> <tr> <td style="text-align: center;">Tightening torque</td> <td>123.0 to 151.9 ft•lbf (166.7 to 205.9 N•m)</td> </tr> </table>		Installation bolt (M16) for crawler adjusting spring		Adhesive	Loctite 262 or its equivalent	Tightening torque	123.0 to 151.9 ft•lbf (166.7 to 205.9 N•m)
Installation bolt (M16) for crawler adjusting spring							
Adhesive	Loctite 262 or its equivalent						
Tightening torque	123.0 to 151.9 ft•lbf (166.7 to 205.9 N•m)						



032438-00B

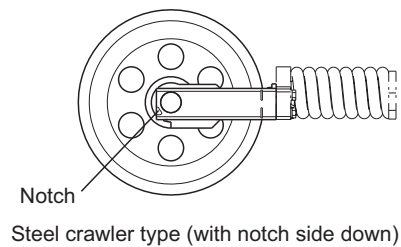
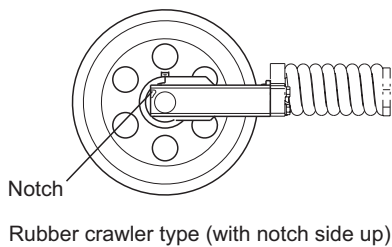
<p>(2) Remove screw plug R(PT)1/4 <b>4</b> from idler <b>5</b> and drain the oil.</p> <p>(3) Remove spring pin <b>1</b> from shaft <b>10</b> and remove idler seal cover B <b>7</b>.</p> <p>(4) Pull shaft <b>10</b> (with idler seal cover A <b>3</b>) out of idler <b>5</b> and remove floating seals <b>8</b> and <b>9</b>.</p> <p><b>Notes :</b></p> <ul style="list-style-type: none"> <li>• Since shaft <b>10</b> and idler seal cover A <b>3</b> are fixed by spring pin <b>1</b>, do not disassemble them unless necessary.</li> <li>• Measure the bore of bush <b>6</b>. if the measured value is within the allowable wear limit, do not remove the bush.</li> </ul> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <tr> <td style="width: 20%;">Type</td> <td>Engine oil SAE 30</td> </tr> <tr> <td>Q'ty</td> <td>0.159 Qts. (0.15 L)</td> </tr> </table> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <tr> <td colspan="2" style="text-align: center;">Screw plug R(PT)1/4</td> </tr> <tr> <td style="width: 20%;">Tightening torque</td> <td>6.5 to 7.2 ft•lbf (8.8 to 9.8 N•m)</td> </tr> </table>	Type	Engine oil SAE 30	Q'ty	0.159 Qts. (0.15 L)	Screw plug R(PT)1/4		Tightening torque	6.5 to 7.2 ft•lbf (8.8 to 9.8 N•m)	 <div style="text-align: right; font-size: small;">032439-00X</div>
Type	Engine oil SAE 30								
Q'ty	0.159 Qts. (0.15 L)								
Screw plug R(PT)1/4									
Tightening torque	6.5 to 7.2 ft•lbf (8.8 to 9.8 N•m)								

## 3) Reassembly

Reassemble the front idler in the reverse order of the disassembly procedure.

**Note :**

Apply the heavy duty grease to sliding portion of the idler.



032440-00B

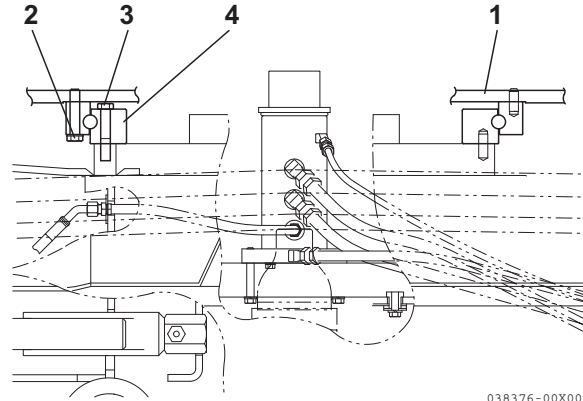
# 7. ADJUSTMENT AND REPAIR

## 7-4 Swing Bearing

### 7-4-1 Removal and Reinstallation of Swing Bearing

#### 1) Removal

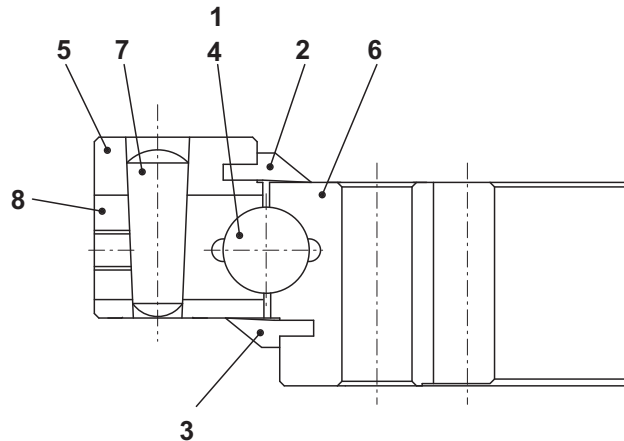
- (1) Remove the implement. Refer to Section "7-6-1 Removal and Reinstallation of Implement".
- (2) Remove the engine. Refer to Section "7-1-5 Removal and Reinstallation of Engine".
- (3) Remove the swing motor. Refer to Section "7-5-11 Removal and Reinstallation of Swing Motor".
- (4) Remove the hydraulic hoses of the swivel joint. Refer to Section "7-5-12 Removal and Reinstallation of Swivel Joint".
- (5) Suspend turning frame **1** at three points temporarily.
- (6) Remove bolts **2** (34 pcs.) for the outer race of the swing bearing.
- (7) Lift up turning frame 1.
- (8) Remove bolts **3** (36 pcs.) for the inner race of the swing bearing.
- (9) Remove the swing bearing **4**.



038376-00X00

#### 2) Exploded View and Component Parts of Swing Bearing

No.	Part	Q'ty
1	Steel ball	78
2	Seal A	1
3	Seal B	1
4	Support	78
5	Outer race	1
6	Inner race	1
7	Taper pin	1
8	Plug	1



038377-00X00

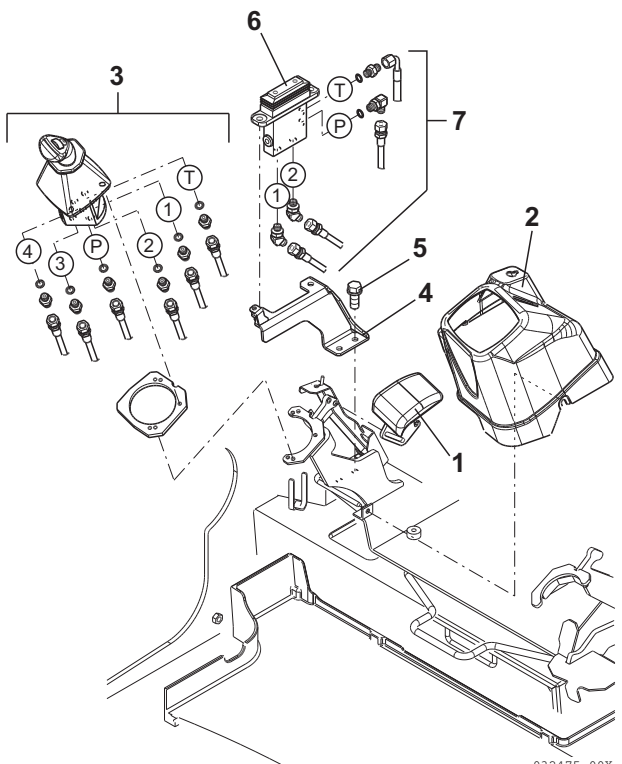
#### 3) Inspection

- (1) Check the gear tooth surfaces for the nicks, flaws, cracks, wear and breakage. Replace if the damage is excessive.
- (2) Check for abnormal sound. Clean, grease or replace if necessary.
- (3) Check for the play in the inner and outer races and rotation fluctuation. Refer to the service standards for repair or replacement.
- (4) Check for the grease leak from the swing bearing seal. Replace if the leakage is excessive.

# 7. ADJUSTMENT AND REPAIR

## 7-5-4 Removal and Reinstallation of Blade Pilot Valve

### 1) Removal

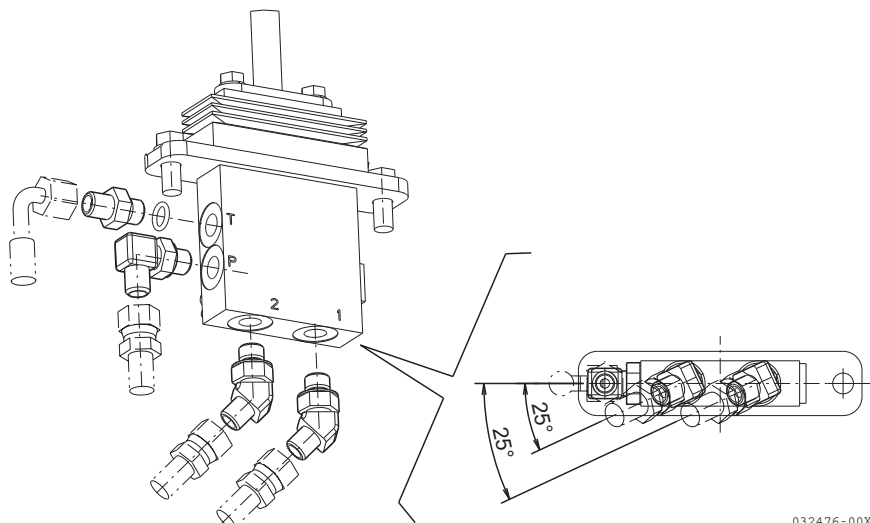
Procedure	
<p>(1) Remove arm rest R 1, lever box R 2 and remote control valve (with hoses) 3 from the seat mount.</p> <p>(2) Remove installation bolt 5 of blade valve stay 4 and remove blade valve stay (with blade pilot valve and pilot hoses) 4.</p> <p>(3) Disconnect hoses (H603BB092, G804CY110, H603BB116 and H603BB114) 7 from blade pilot valve 6. Then remove blade pilot valve 6 from blade valve stay 4.</p>	
<p><b>Note :</b> Make a mark on the installation position of each hoses in advance.</p>	<p>032475-00X</p>

### 2) Reinstallation

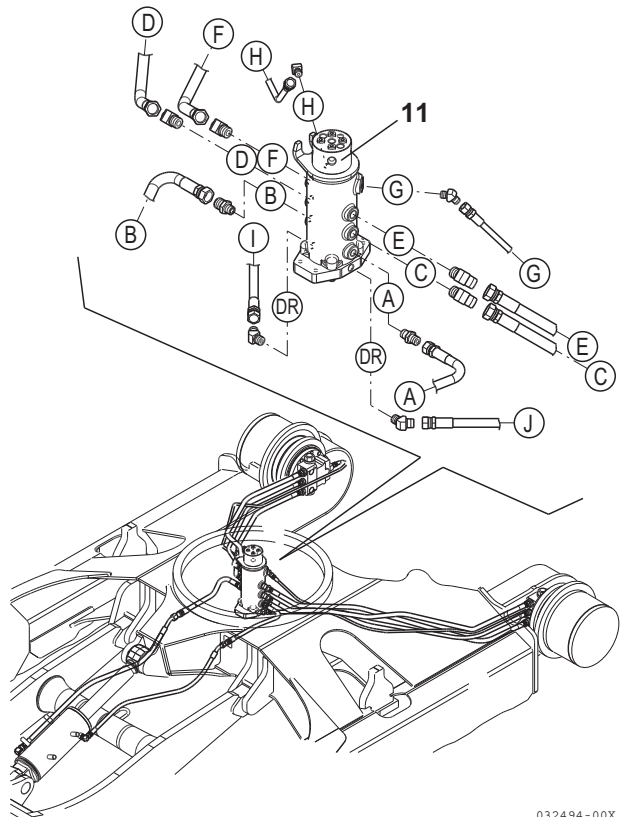
Reinstall blade pilot valve in the reverse order of the removal procedure.

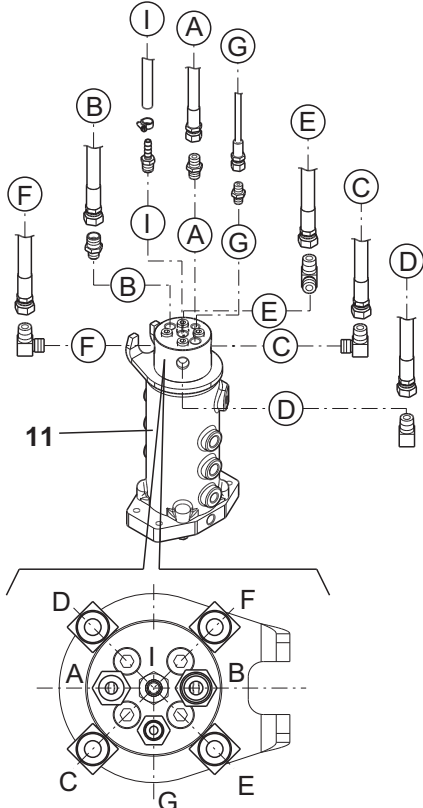
Installation of blade lever grip : Apply adhesive (Three bond 1324 or its equivalent) to about one third length of the thread portion from top of the lever.

### Connector and join setting angles



## 7. ADJUSTMENT AND REPAIR

Procedure											
<p>(6) Disconnect hydraulic hoses from the track frame side of swivel joint 11.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">G. High-speed (L)</td> <td style="width: 50%;">H. High-speed (R)</td> </tr> <tr> <td>E. Travel motor (L)</td> <td>F. Travel motor (R)</td> </tr> <tr> <td>C. Travel motor (L)</td> <td>D. Travel motor (R)</td> </tr> <tr> <td>A. Blade cylinder (Rod)</td> <td>B. Blade cylinder (Bottom)</td> </tr> <tr> <td>J. Drain (L)</td> <td>I. Drain (R)</td> </tr> </table> <p><b>Note :</b> Make a mark on the installation position of each hoses in advance.</p>	G. High-speed (L)	H. High-speed (R)	E. Travel motor (L)	F. Travel motor (R)	C. Travel motor (L)	D. Travel motor (R)	A. Blade cylinder (Rod)	B. Blade cylinder (Bottom)	J. Drain (L)	I. Drain (R)	 <p style="text-align: right; font-size: small;">032494-00X</p>
G. High-speed (L)	H. High-speed (R)										
E. Travel motor (L)	F. Travel motor (R)										
C. Travel motor (L)	D. Travel motor (R)										
A. Blade cylinder (Rod)	B. Blade cylinder (Bottom)										
J. Drain (L)	I. Drain (R)										

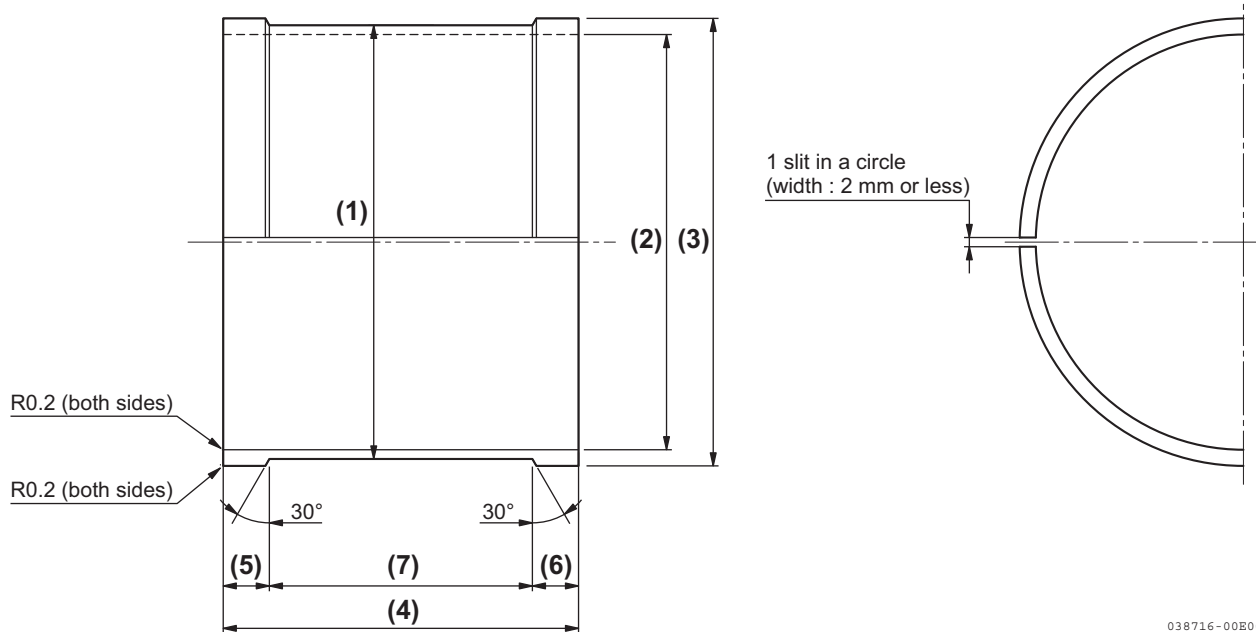
<p>(7) Disconnect hydraulic hoses from the turning frame side of swivel joint 11.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">A. Blade cylinder (Rod)</td> <td style="width: 50%;">B. Blade cylinder (Bottom)</td> </tr> <tr> <td>C. Travel motor (L)</td> <td>D. Travel motor (R)</td> </tr> <tr> <td>E. Travel motor (L)</td> <td>F. Travel motor (R)</td> </tr> <tr> <td>G. High-speed pilot</td> <td>I. Drain</td> </tr> </table> <p><b>Note :</b> Make a mark on the installation position of each hoses in advance.</p>	A. Blade cylinder (Rod)	B. Blade cylinder (Bottom)	C. Travel motor (L)	D. Travel motor (R)	E. Travel motor (L)	F. Travel motor (R)	G. High-speed pilot	I. Drain	 <p style="text-align: right; font-size: small;">032495-00X</p>
A. Blade cylinder (Rod)	B. Blade cylinder (Bottom)								
C. Travel motor (L)	D. Travel motor (R)								
E. Travel motor (L)	F. Travel motor (R)								
G. High-speed pilot	I. Drain								

# 7. ADJUSTMENT AND REPAIR

[2] Seal ring inserting jig (outer)

Material: PTR-FLE

Roughness: 1.6a



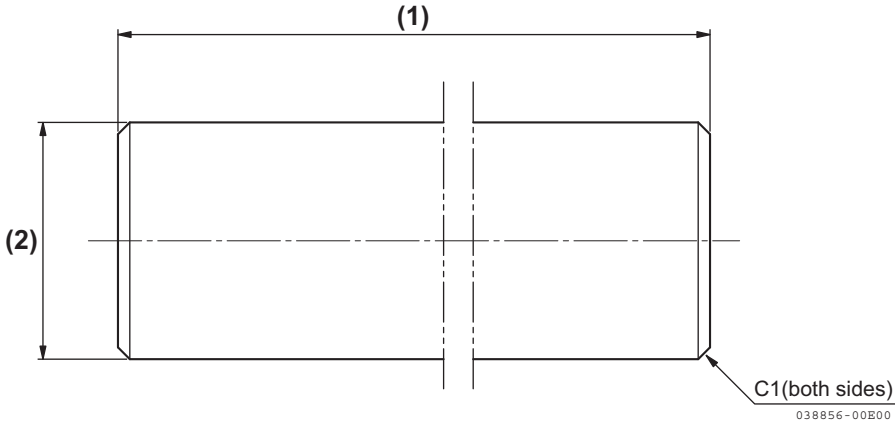
Unit: mm

Cylinder	Boom	Arm	Bucket
Tube diameter	Ø120	Ø110	Ø95
(1)	Ø117 +0.2/-0.2	Ø107 +0.2/-0.2	Ø94 +0.2/-0.2
(2)	Ø110 +0.2/-0.2	Ø100 +0.2/-0.2	Ø90 +0.2/-0.2
(3)	Ø120 +0.2/-0.2	Ø110 +0.2/-0.2	Ø97 +0.2/-0.2
(4)	97 +0.2/-0.2	95 +0.2/-0.2	77 +0.2/-0.2
(5)	13	13	10
(6)	13	13	10
(7)	71	69	57

# 7. ADJUSTMENT AND REPAIR

[4-5] Lever

Material: S25C or equivalent



Unit: mm

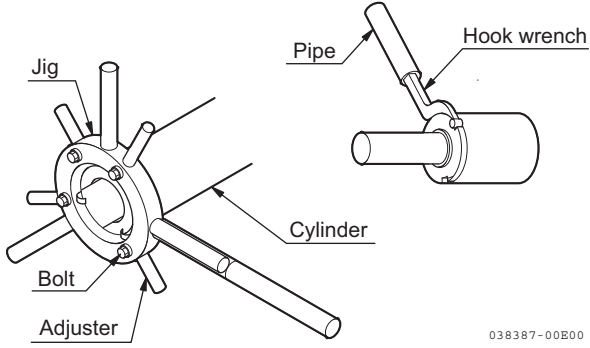
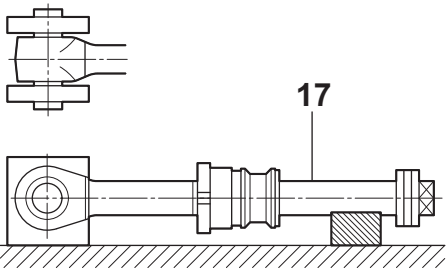
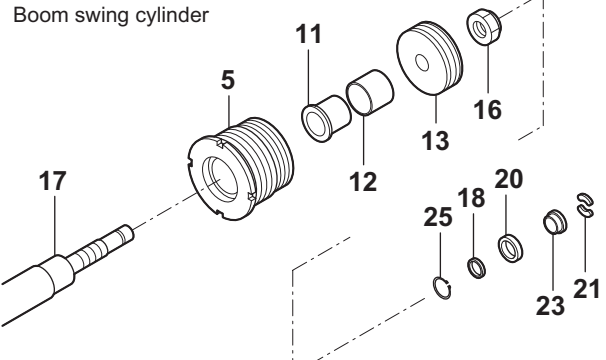
Cylinder	Boom	Arm	Bucket
Rod diameter	Ø70	Ø70	Ø60
(1)	270	270	200
(2)	Ø20	Ø20	Ø13

# 7. ADJUSTMENT AND REPAIR

## 2) Cautions for Disassembly and Reassembly

- (1) Parts are produced so accurately. Be careful not to damage any parts by dropping them or knocking them together.
- (2) If there are any burrs on the surface of the seal installation part or the O-ring groove, remove them.
- (3) Never use the lock washer removed once.
- (4) Replace once removed seals and O-rings with new ones.
- (5) Clean all the parts and dry them by air blow.

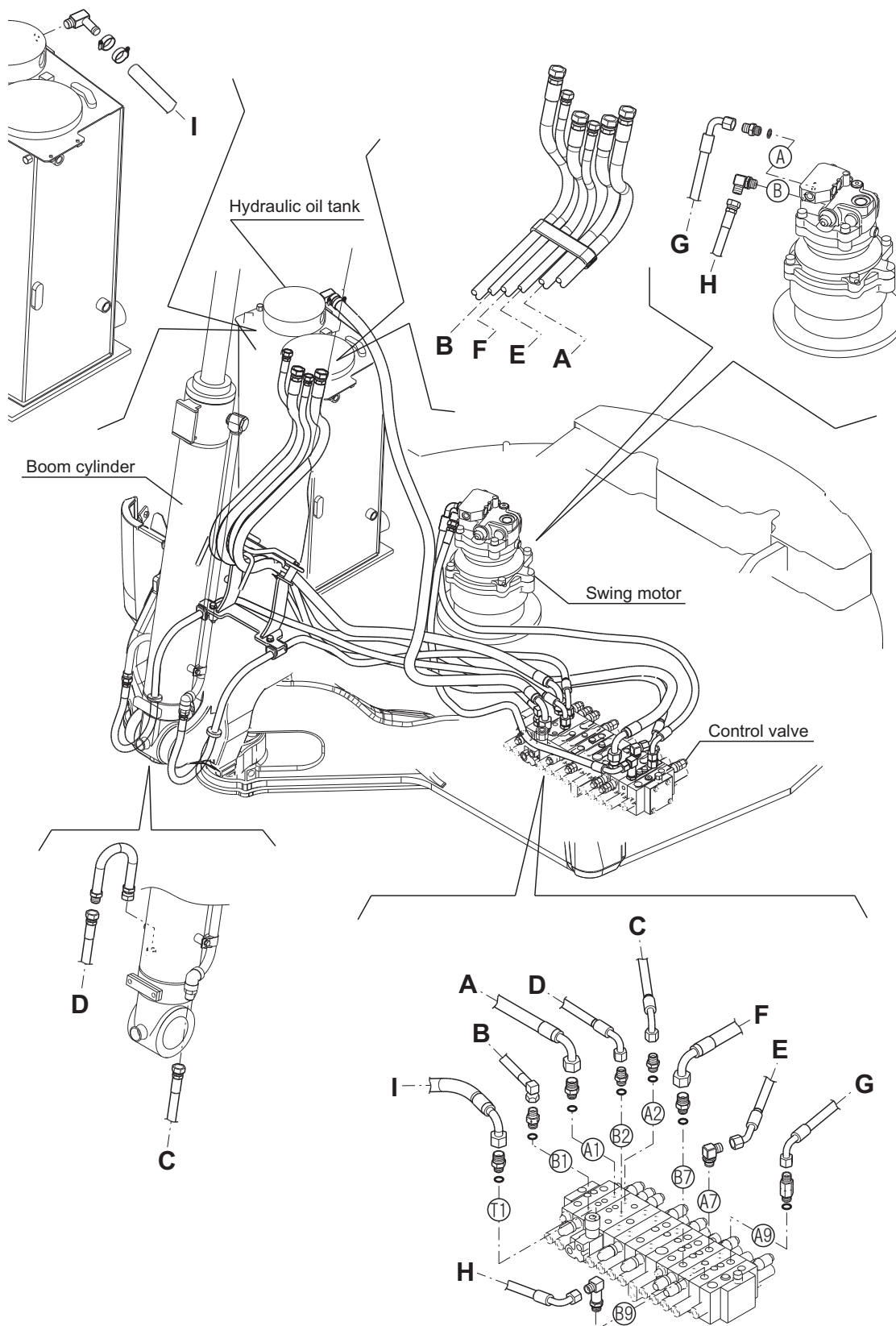
## 3) Disassembly

Procedure	
<p>(1) Drain the oil from the hydraulic cylinder.</p> <p>(2) Hold the cylinder in the bottom end or the pin hole on the bottom side, and put the rod side of the cylinder on a block.</p> <p>(3) Raise the pawl of lock washer <b>3</b> on head <b>5</b> to loosen head <b>5</b>.</p> <p><b>Note :</b> Use a hook wrench or a jig to loosen head <b>5</b>.</p>	 <p style="text-align: right;">038387-00E00</p>
<p>(4) Pull rod assembly <b>17</b> out of cylinder tube <b>10</b>, and then hold the cylinder rod assembly in the rod end or the pin hole on the rod side.</p>	 <p style="text-align: center;">Hold cylinder rod assembly.</p> <p style="text-align: right;">038388-00E00</p>
<p>(5) Disassembly of boom swing cylinder.</p> <p>[1] Take external snap ring C <b>25</b> off the groove, and then slide cushion collar <b>23</b> to remove stopper <b>21</b>, cushion collar <b>23</b>, cushion ring <b>20</b>, and external snap ring C <b>25</b> in order.</p> <p>[2] Remove U-nut <b>16</b>, then piston <b>13</b> and head <b>5</b>.</p>	<p>Boom swing cylinder</p>  <p style="text-align: right;">038389-00E00</p>

# 7. ADJUSTMENT AND REPAIR

## 4) Upperstructure

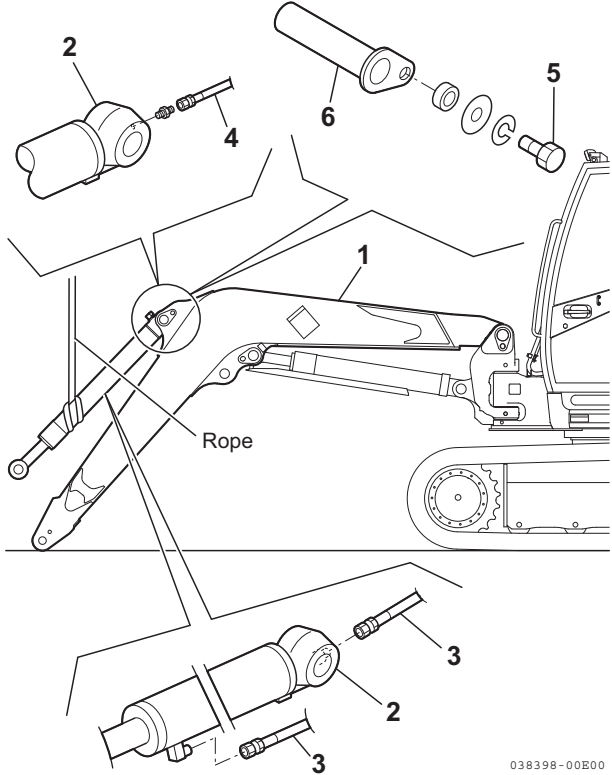
- Control valve ←→ implement and swing motor
- Control valve → hydraulic oil tank

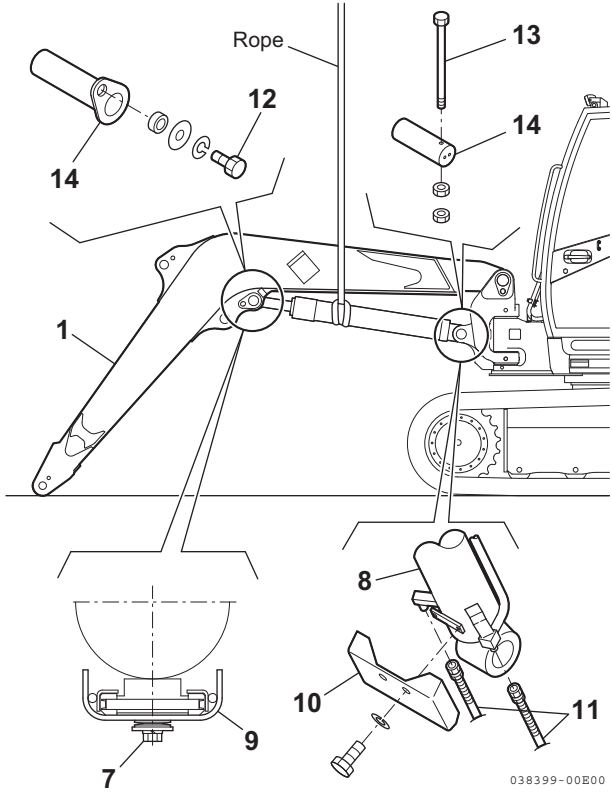


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## 7. ADJUSTMENT AND REPAIR

### [Removal of boom]

Procedure	
<p>(1) Lower boom <b>1</b> to place the top end of boom <b>1</b> on the ground. Then, put rope onto arm cylinder <b>2</b>.</p> <p>(2) Remove hydraulic hoses <b>3</b> from arm cylinder <b>2</b>.</p> <p><b>Note :</b> Put a plug into the hose connection port of arm cylinder <b>2</b> and the connection port of hydraulic hose <b>3</b>.</p> <p>(3) Disconnect grease hose <b>4</b> from the fulcrum part of arm cylinder bottom <b>2</b>.</p> <p>(4) Remove bolt (M14) <b>5</b> to pull out pin <b>6</b>, and lift up arm cylinder <b>2</b> to remove it from boom <b>1</b>.</p>	

<p>(5) Remove bolt (M10) <b>7</b> to remove slide cover <b>9</b> from boom cylinder <b>8</b>.</p> <p>(6) After putting rope onto boom cylinder <b>8</b>, remove guard <b>10</b> to remove hydraulic hoses <b>11</b> from boom cylinder <b>8</b>.</p> <p><b>Note :</b> Put a plug into the hose connection port of boom cylinder <b>8</b> and the connection port of hydraulic hose <b>11</b>.</p> <p>(7) Remove bolts (M14) <b>12</b> and (M12) <b>13</b> to pull out pins <b>14</b>, and lift up boom cylinder <b>8</b> to remove it from boom <b>1</b>.</p>	
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## 7. ADJUSTMENT AND REPAIR

### (4) Adjustment of lock release lever and wire

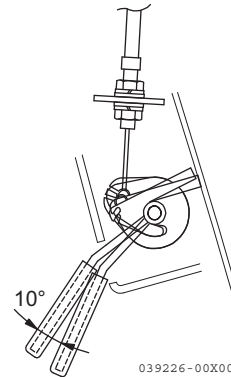
Adjust the right and left levers so that they can be released at approximately 10 degrees.

After setting the wire, move the nut to adjust.

When the right and left levers are adjusted in the same angle (approx. 10 degrees), fix the nuts.

#### Adjustment procedure

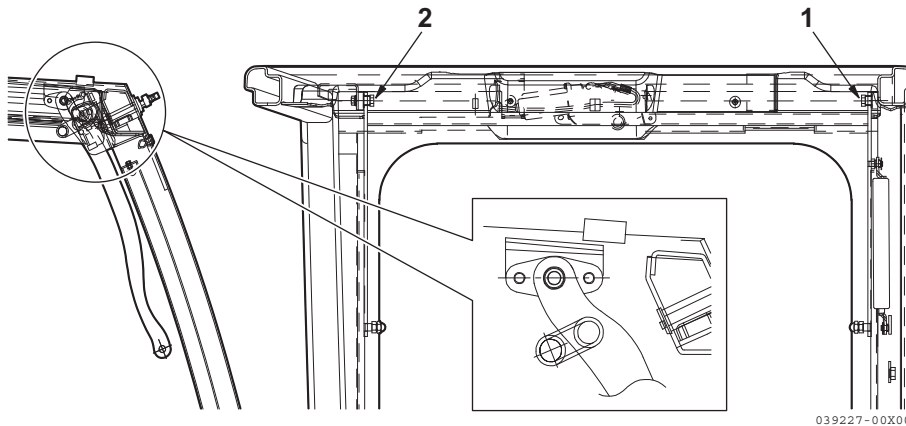
- [1] Install both ends of the wire to the lock and levers.
- [2] Tighten the nut on the lever side to fix the levers.
- [3] Pull the wire so that it can be in contact with the stopper.
- [4] Loosen the nut in the catch lock side to adjust the angle.



#### Note:

If you cannot adjust on the lock side only, also adjust on the lever side.

### (5) Adjustment of slide link



#### Adjustment procedure

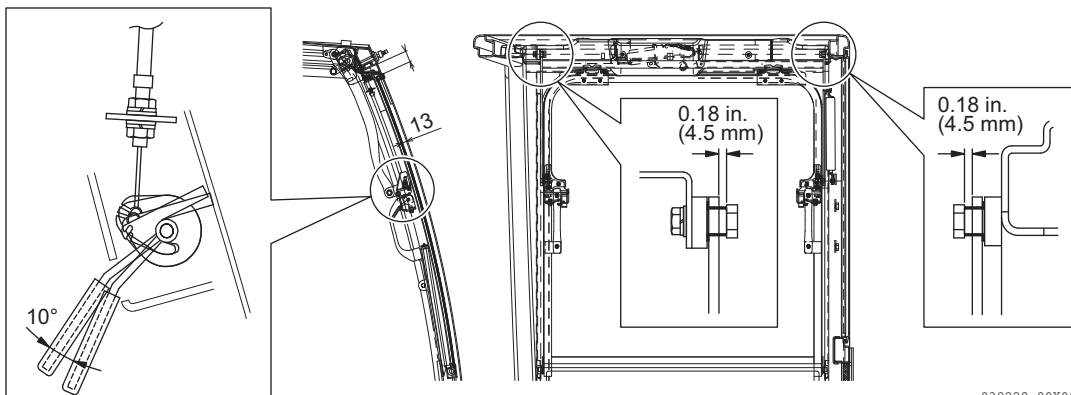
- [1] Install the link to the cabin body with the bolt in position 1.
- [2] Install the link to the seat screw with the bolt in position 2.
- [3] Adjust the seat screw in the position 2 and align it to the cabin line to install.

#### Note:

The slide link can be adjusted after installing the slide window (it can be adjusted in front, back, left and right by  $\pm 0.04$  in (1 mm)).

### (6) Dimensions of major parts

Clearance and play at slide window assembly



## 7. ADJUSTMENT AND REPAIR

### 2) Adjustment

#### (1) Adjustment of wiper blade stop position

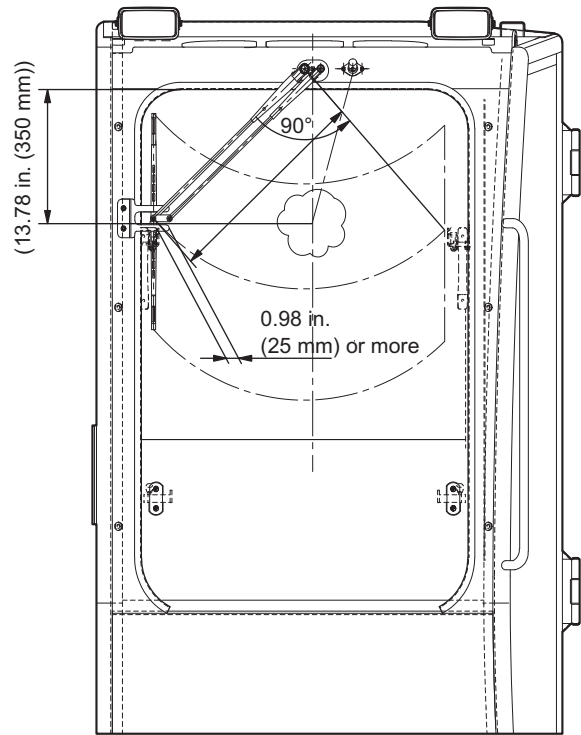
**Note:**

Perform the stop position adjustment after checking the wiper operation.

- [1] Loosen the arm installation nut and adjust it so that the bracket protrusion when the wiper blade caught in the bracket is 0.98 in. (25 mm) or over.
- [2] Tighten the arm installation nut and check the operation again. The bracket protrusion should be 0.98 in. (25 mm) or over when the wiper stopped.

\*This adjustment is best performed when the glass is half-dry.

If the wiper blade stop position was adjusted on dry or wetted glass, the bracket protrusion can be insufficient on half-dry glass.



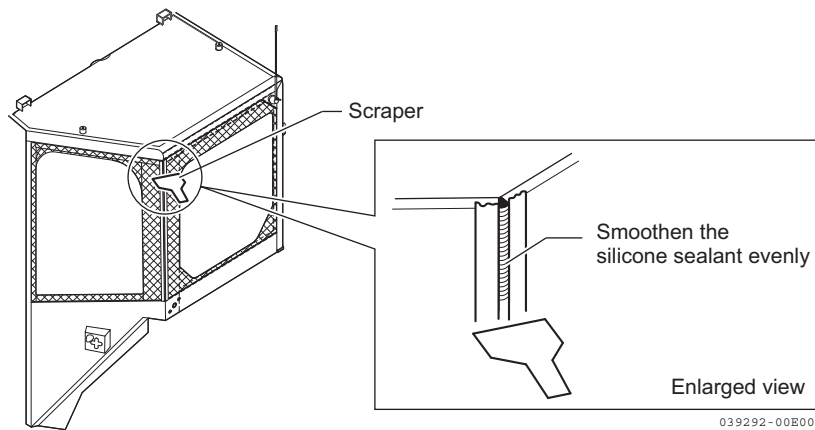
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#### (2) Adjustment of washer nozzle splash position

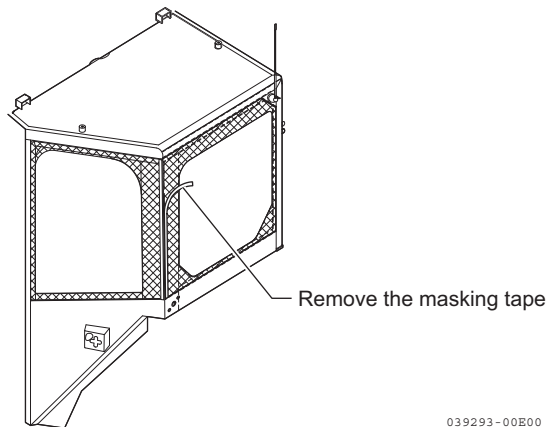
Adjust the angle of the washer nozzle so that it splashes on the position as shown in the right figure (centered and 13.78 in. (350 mm) from the top of the front windshield).

## 7. ADJUSTMENT AND REPAIR

(12) Smoothen the risen silicone sealant evenly with a scraper.



(13) Promptly remove the masking tape after smoothing the silicone sealant evenly.



### 3) Finishing

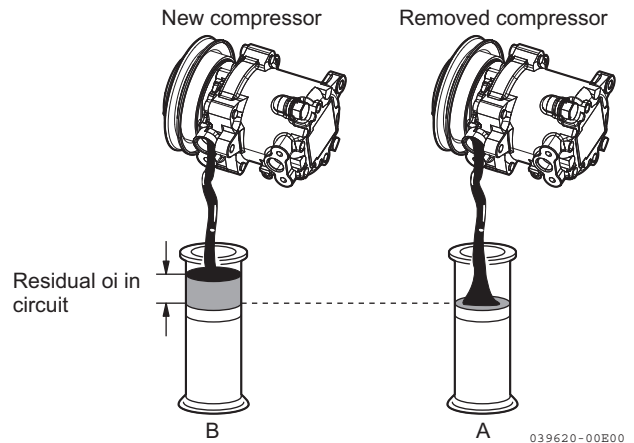
- It is easy to clean the silicone sealant before it is hardened.
  - \* It depends on the case, but it may be easier to clean after hardening.
- Clean the SikaTack-Drive after it is hardened.
  - \* If you try to wipe it off while it is still soft, the dirt may spread.
  - \* If you can wipe it off easily, it is acceptable to wipe it off immediately.
- If you scratch the cab with a cutter, repair it with paint.

## 7. ADJUSTMENT AND REPAIR

### A. At the time of replacing compressor

As the required amount of oil is enclosed in the compressor, the excess oil must be extracted from the new compressor at the time of compressor replacement in the following procedure:

- [1] Prepare 2 pieces of measuring cylinder and extract the oil to the measuring cylinder A from the removed compressor.
- [2] Extract the oil to the measuring cylinder B from the new compressor.
- [3] Compare the amount of oil in the measuring cylinders A and B and remove the excess oil from B, so the amount is equal to A.
- [4] Return the oil in the measuring cylinder B to the new compressor.



**Note:**

*As compressor oil tends to contain water content, promptly adjust the oil level and seal the compressor right after adjustment.*

### B. At the time of replacing other components

As the oil remains in the old parts at the time of parts replacement, refuel the new oil (compressor oil: ND-OIL8) as shown below:

Replacement Parts	Refuel quantity
Air conditioner unit or evaporator	Approx. 2.44 cu.in. (40 cc)
Condenser	Approx. 2.44 cu.in. (40 cc)
Receiver drier (from 2nd time onward)*	Approx. 1.22 cu.in. (20 cc)

\*At the first time of receiver drier replacement, the amount of oil taken from the circuit is in the allowable range, so refuel is unnecessary, but from second time onward, refuel the above-mentioned quantity.

### (4) Compressor driving belt

Refer to Section "7-1-8 Removal and Reinstallation of Fan Belt and Compressor Driving Belt" for the reinstallation procedure of the compressor driving belt.

Item		Compressor driving belt
Pressing force		22.05 lbf (98.1 N)
Slack	New belt	0.59 to 0.63 in. (15 to 16 mm)
	Used belt	0.75 to 0.79 in. (19 to 20 mm)
V-belt size		Law edge HM60

## 8. PERIODIC INSPECTION AND SERVICING

◇ : Check   ○ : Supply   ● : Replace   □ : Adjust (clean)   ■ : Oil & grease

Check & service items		Daily	Every 50 hrs	Every 250 hrs	Every 500 hrs	Every 1000 hrs	Every 1500 hrs	Every 2000 hrs	Every 3000 hrs
Fuel oil	Check & supply of oil to the tank	◇							
	Drain the fuel tank		□						
	Clean the oil/water separator		□						
	Replace the fuel filter element				●				
Lube oil	Check the quantity of engine oil	◇							
	Replace the engine oil		● 1st time	●					
	Replace the engine oil filter element		● 1st time	●					
Cooling water	Check & supply of cooling water	◇							
	Clean radiator fins			□					
	Check the fan-belt tension	◇ (□)							
	Replace the cooling water						● within one year		
	Clean & check the cooling water system							● within two years	
Rubber hose	Check & replace fuel oil pipe, cooling water pipe	◇						●	
Intake system	Clean air cleaner & replace element			□	●				
Cylinder head	Adjust the intake and exhaust valve clearance					□			
	Lapping the intake and exhaust valve							□	
	Retightening the cylinder head bolts					□			
Fuel injection valve	Check, clean and test fuel injection valve					□			
Turbocharger	Check turbocharger								◇ (□)
EGR system	Check, clean and test EGR valve								□
	Clean EGR lead valve								□
	Clean EGR cooler						□		
Crankcase	Check crankcase breather system						◇		

**Note :**

- When machine is used at dusty worksites, clean and replace filter element twice as often as specified in the table.
- Execution of periodic inspection and servicing is indispensable to assuring conformance to EPA emission control regulations.

Keep a record of the results.

# 10. TROUBLESHOOTING

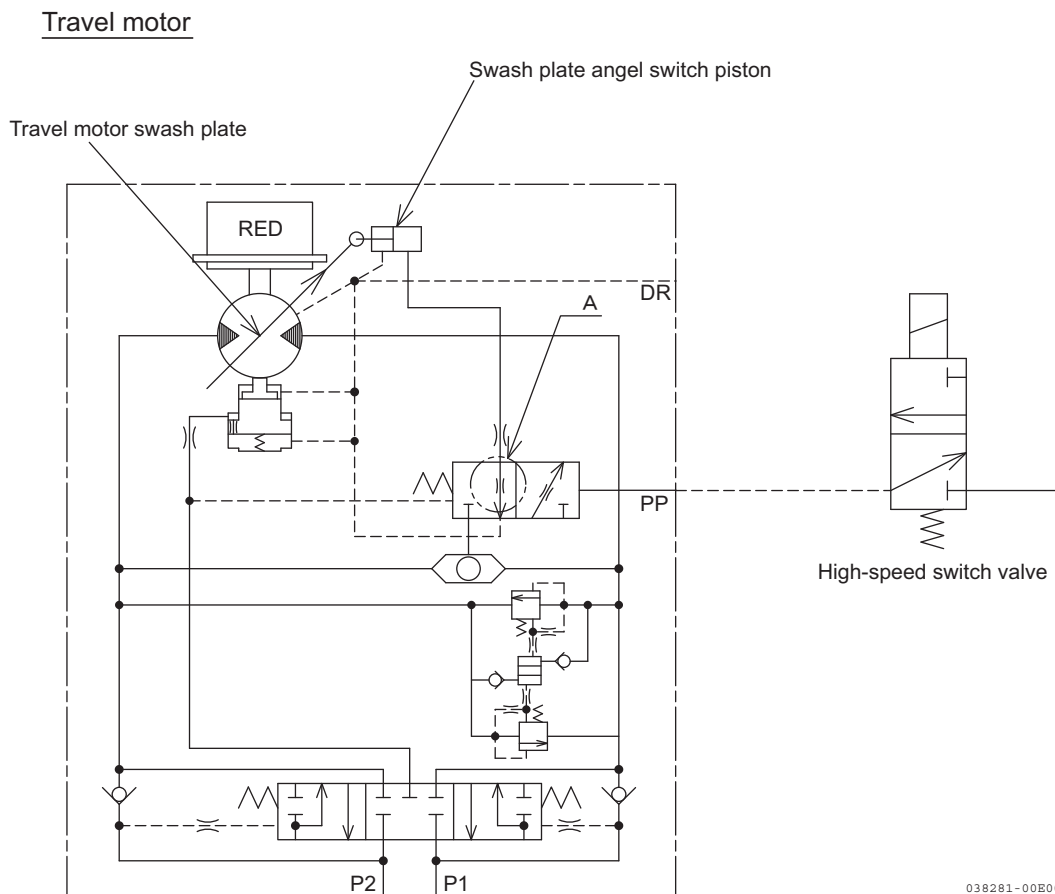
## 10-1-5 Time Lag on Travel Speed Switching

### Phenomenon

In cold temperatures, there is a time lag in switching from the high-travel speed to low-travel speed (with the travel automatic dual speed switch turned OFF.).

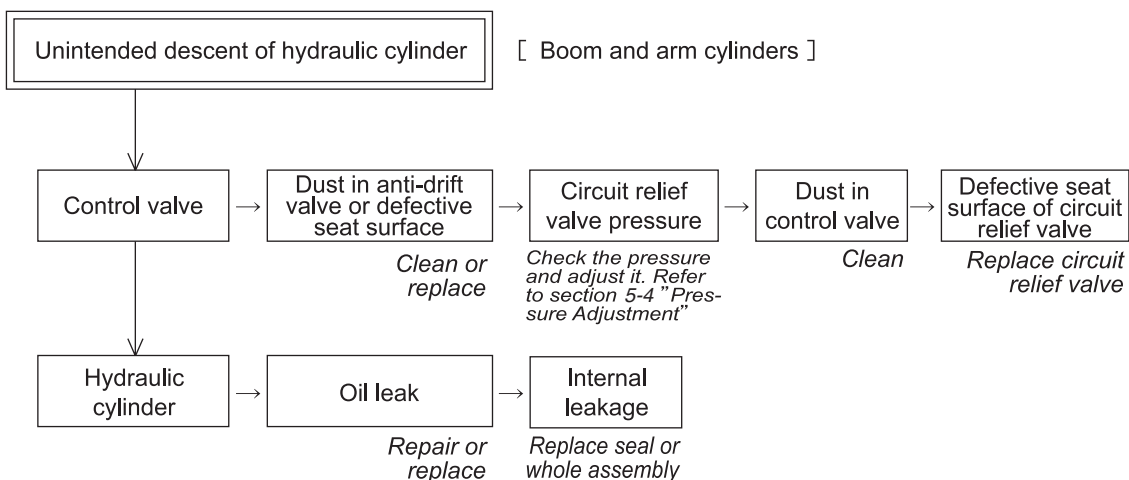
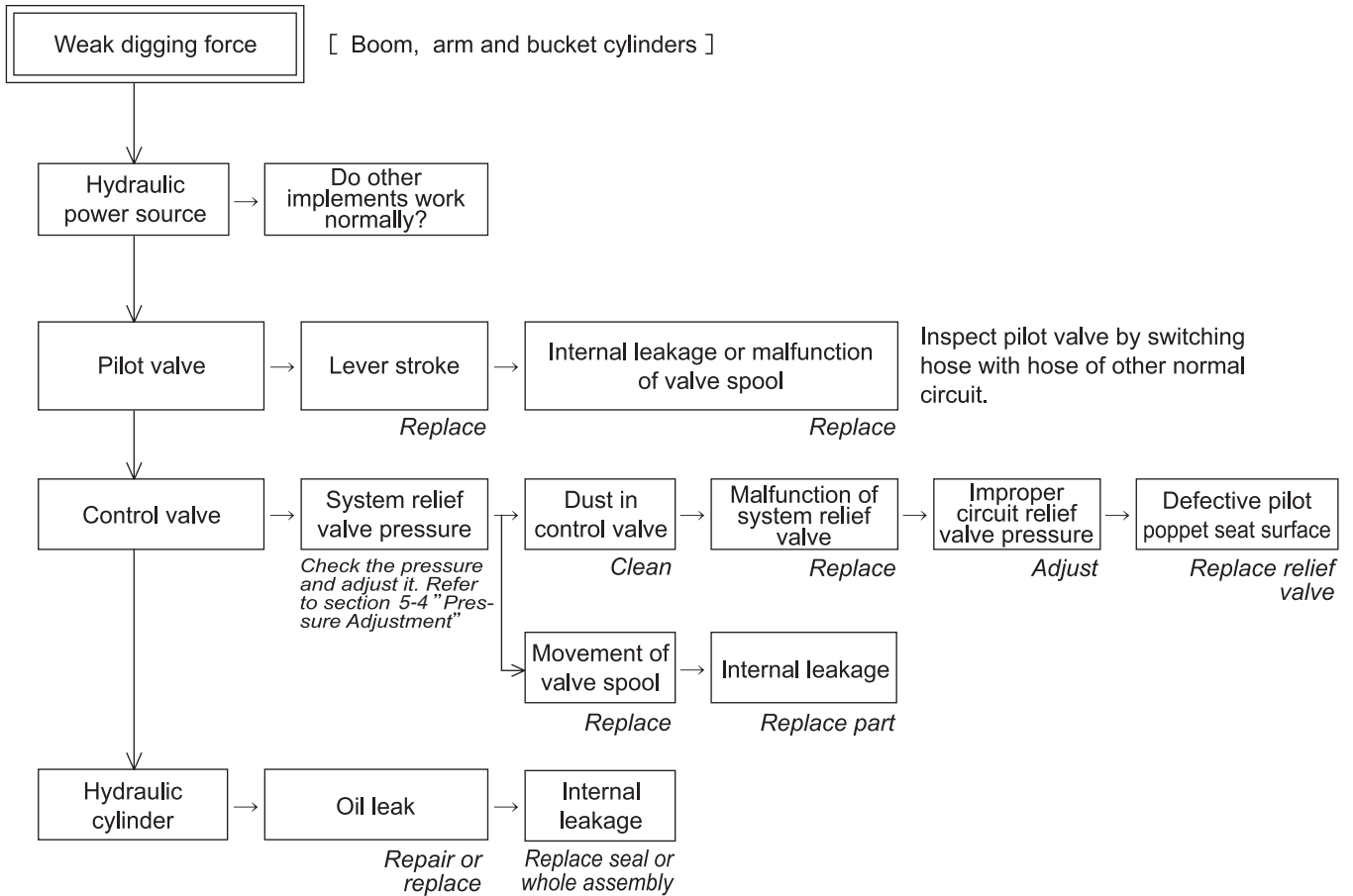
### Reason

The shock caused during switching from the high-speed to low-speed is lightened by the throttles of A. In cold temperatures, however, the passage resistance of the throttles becomes larger and it takes more time for the swash plate of the travel motor to return to the low speed.



# 10. TROUBLESHOOTING

## Work implements



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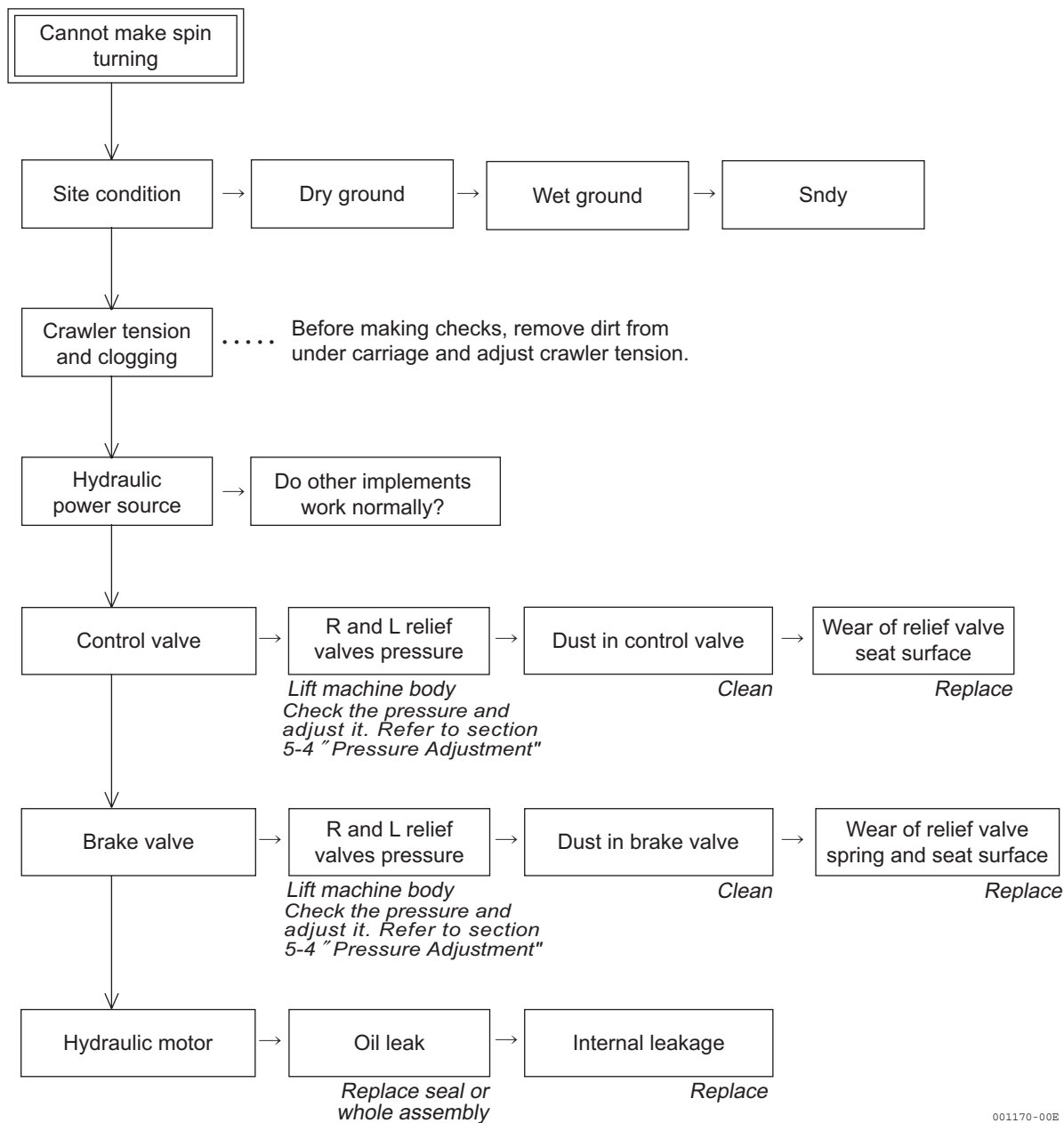
## Inspection procedure

Switch the hose with the hose of the other circuit using the control valve.

[1] No descent : Control valve is faulty.

[2] Descent : Cylinder is faulty.

# 10. TROUBLESHOOTING



001170-00E

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