TO THE READER

This manual has been printed for a skilful engineer to supply the necessary technical information to carry out service operations on this machine.

Carefully read this manual to obtain correct information regarding repair procedures.

For any question or remark, or in case of any error in the contents of this manual, please contact:

CNH ITALIA S.p.A.
Via Plava, 80
10135 TORINO - Italia

REFERENCE

Beyond this Service Manual, also refer to the documents listed below:

- Operator's Manual
- Parts Catalogue

COMPLETE SERVICE MANUAL

The Service Manual consists of one volume:

- E45B SR - E50B SR - Service manual for "Hydraulic Mini Excavators"

The Service Manual for "Hydraulic Mini Excavators" contains the necessary technical information to carry out maintenance and repair operations on the machine, the necessary tools to carry out maintenance operations, the information on service standards, the procedures for removal, installation, disassembly and reassembly.

The Service Manual relevant to the excavator models ***E45B SR - E50B SR*** consists in the following volume, which is identified through the relevant print no. as reported below:

VOLUME	MACHINE TYPE	PRINT NUMBER
Service Manual for "Hydraulic Mini Excavators"	E45B SR E50B SR	84526500A

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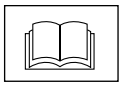
1.1 GENERAL PRECAUTIONS FOR REPAIRS

1.1.1 PREPARATION BEFORE DISASSEMBLING



(1) Understanding operating procedure
Read OPERATION AND MAINTENANCE MANUAL carefully to understand the operating procedure.

(2) Cleaning machines
Remove soil, mud, and dust from the machine before carrying it into the service shop to prevent loss of work efficiency, damage of parts, and difficulty in rust prevention and dust protection while reassembling.

(3) Inspecting machines
Identify the parts to be disassembled before starting work, determine the disassembling procedure by yourself considering the workshop situations etc., and request procurement of necessary parts in advance.

(4) Recording
Record the following items for communication and prevention of recurring malfunction.
   1) Inspection date and place.
   2) Model name, applicable machine number, and hourmeter read.
   3) Trouble condition, place and cause.
   4) Visible oil leakage, water leakage and damage.
   5) Clogging of filters, oil level, oil quality, oil contamination and loosening of connections.
   6) Result of consideration if any problem exists based on the operation rate per month calculated from hourmeter indication after the last inspection date.

(5) Arrangement and cleaning in service shop
   1) Tools required for repair work.
   2) Prepare space to place the disassembled parts.
   3) Prepare oil containers for draining oil etc.

1.1.2 SAFETY IN DISASSEMBLING AND ASSEMBLING

(1) Wear appropriate clothes with long sleeves, safety shoes, safety helmet and protective glasses.

(2) Suspend warning tag “DO NOT OPERATE” from the doorknob or the operating lever, and have a preliminary meeting before starting work.

(3) Stop the engine before starting inspection and maintenance to prevent the operator being caught in machine.

(4) Identify the location of a first-aid kit and a fire extinguisher, and also where to make contact in a state of emergency.

(5) Choose a hard, level and safe place, and place the attachment on the ground securely.

(6) Use a lifter such as a crane to remove heavy parts (20 kg [45 lbs] or more) from the machine.

(7) Use proper tools, and replace or repair defective tools.

(8) Support the machine and attachment with supports or blocks if the work is performed in the lifted condition.

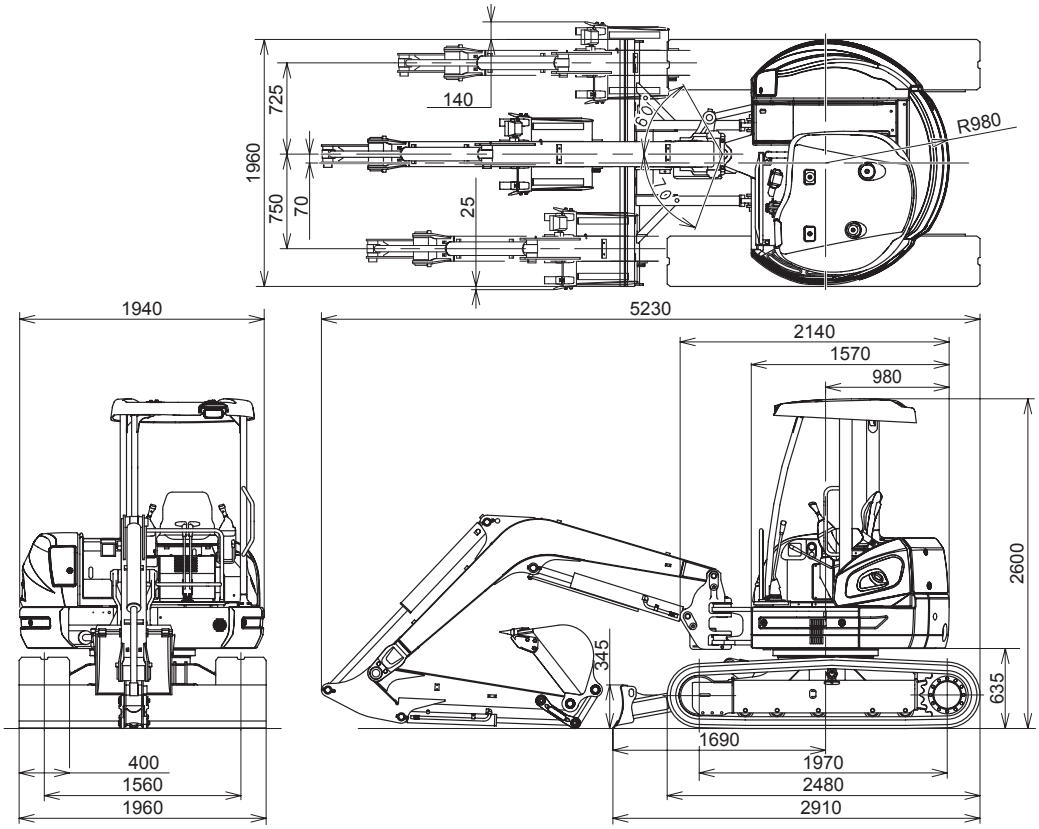
1.1.3 DISASSEMBLING AND ASSEMBLING HYDRAULIC EQUIPMENT

(1) Removing hydraulic equipment
   1) Before disconnecting pipes, release the hydraulic pressure of the system, or open the return side cover and take out the filter.
   2) Carefully drain oil of the removed pipes into a containers without spilling on the floor.
   3) Apply plugs or caps on the pipe ends to avoid oil spillage and dust intrusion.
   4) Clean off the external surface of the equipment before disassembling, and drain hydraulic and gear oil before placing it on the workbench.

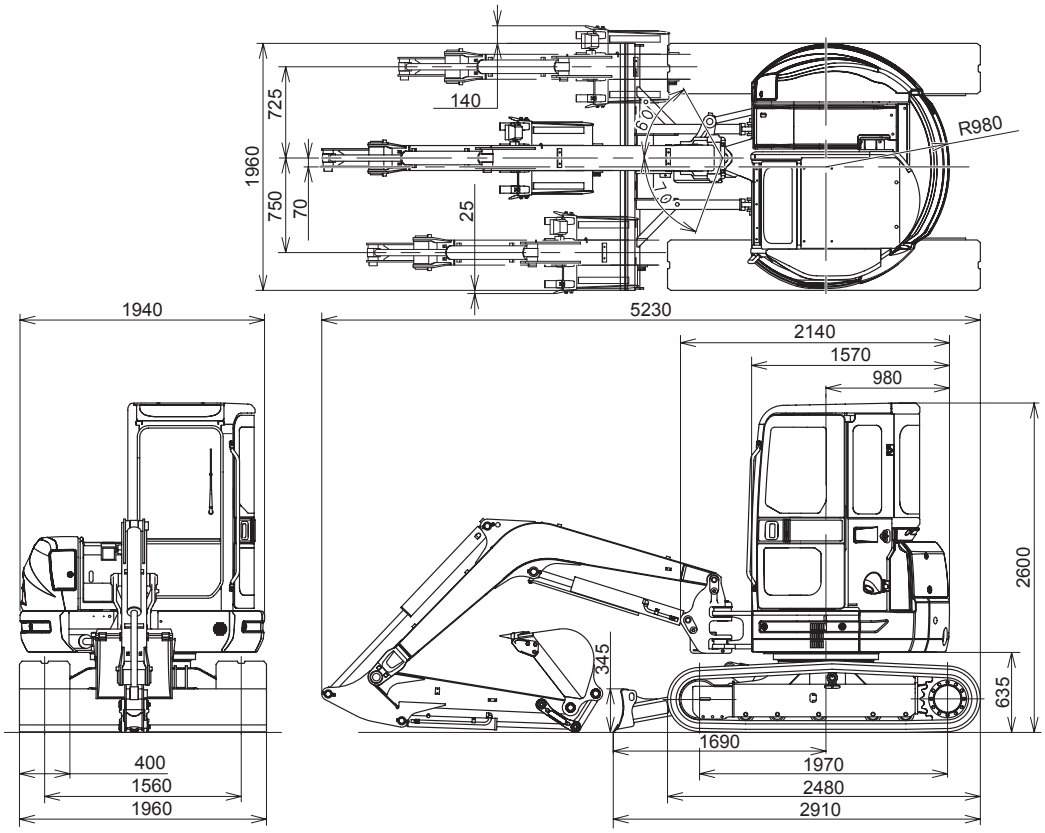
(2) Disassembling hydraulic equipment
   1) Do not disassemble, reassemble or modify the hydraulic equipment without the permission of the manufacturer, who is not responsible for the performance and function of the product after modification.
   2) When disassembling and reassembling for unavoidable reason, refer the work to qualified personnel who have the specific knowledge or completed the parts service training.
   3) Provide matching marks to facilitate reassembling work.
   4) Before starting the work, read the manual of disassembling procedure, if it is provided, and decide whether the work can be performed by yourself.

Unit: mm (in)

(3) E50B SR (CANOPY)



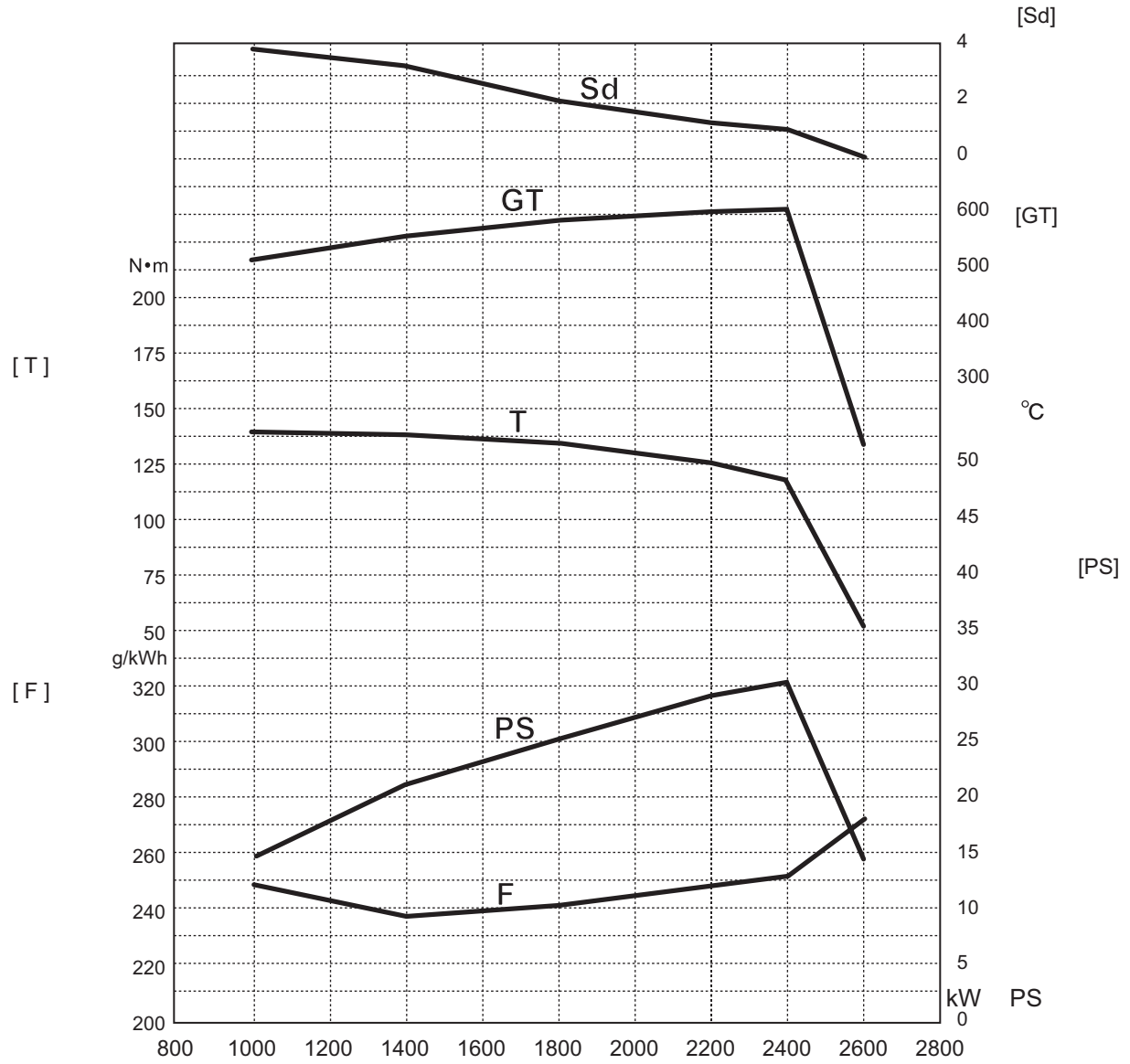
(4) E50B SR (CAB)



2.8.2 ENGINE PERFORMANCE CURVE

E45B SR - E50B SR

Model: 4TNV88A-XYB
Rated Output: 31.5 kW / 2400 rpm



$$\text{Fuel consumption volume} = \frac{F}{\rho \times 1000} \times P \times \alpha$$

$$= \frac{242}{0.835 \times 1000} \times 21.2 \times \alpha$$

$$= 8.81\ \alpha$$

F. Fuel consumption rate (g/kWh)
P. Shaft output (kW)
ρ. Specific gravity
α. Standard load factor (0.60 ÷ 0.70)

Fuel consumption in normal operation; 5.29 ÷ 4.35 l/h (load factor: (0.60 ÷ 0.70))

T. Shaft torque
F. Fuel consumption rate
PS. Power output
GT. Exhaust temperature
Sd. Smoke: Bosch

3.2.2 ARM MAINTENANCE STANDARDS

(1) Clearance of pin and bushing

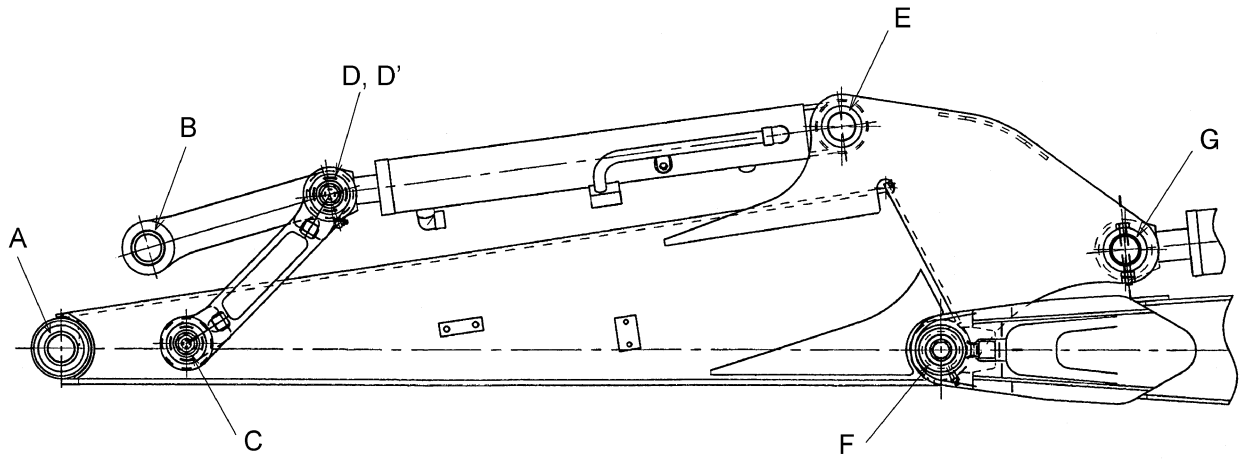


Fig. 3-5 Clearance of pin and bushing on dipper section

Unit: mm

Location	Piece	Standard dimensions			Play			Remedy
		Pin diameter	Tolerance on pin diameter	Tolerance on bushing bore diameter	Standard value	Standard value for repair	Serviceability limit	
A	Dipper point (Connected part of bucket)	ø45	–0.02 –0.05	+0.064 +0.005	0.025 ÷ 0.114	0.7	1.0	Replace bushing or pin
B	Bucket connecting rod (Bucket side)							
C	Bucket link (Connected part of arm)			+0.076 +0.035	0.055 ÷ 0.126			
D	Bucket connecting rod (Idler link side)			+0.073 +0.032	0.052 ÷ 0.123			
D'	Bucket cylinder (Rod side)			+0.25 +0.05	0.07 ÷ 0.30			
E	Bucket cylinder (Bottom side)							
F	Dipper foot (Connected part of boom)	ø60		+0.061 0	0.02 ÷ 0.111			
G	Arm cylinder (Rod side)	ø45		+0.25 +0.05	0.07 ÷ 0.30			

NOTE:

- The tolerance for bushing inside diameter means the dimension after fitting of it into place.
- The part number for pins may be changed owing to improvement, use them only for reference.

3.5.2 MAINTENANCE STANDARD

(1) Clearance of pin and bushing

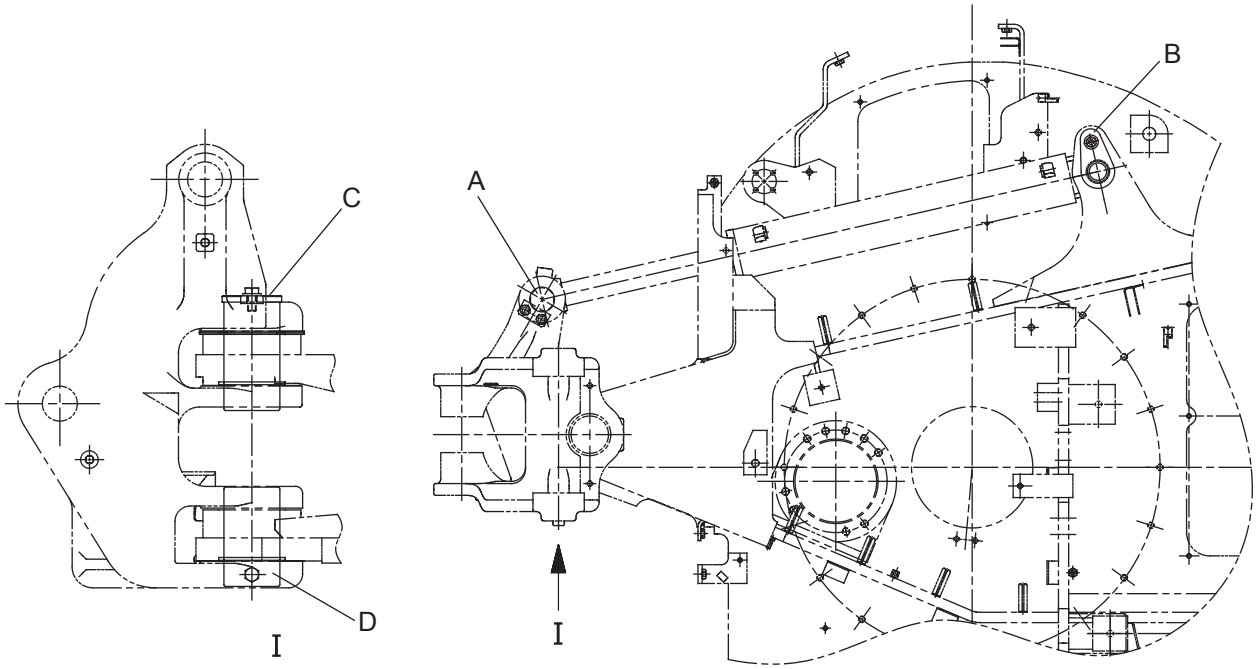


Fig. 3-13 Clearance of pin and bushing on swing portion

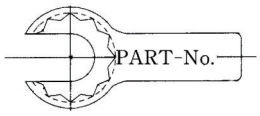
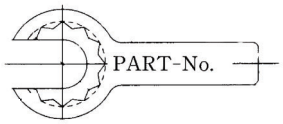
Table 3-14

Unit: mm

Ref.	Piece	Standard dimension			Play		
		Pin diameter	Tolerance on pin diameter	Tolerance on bushing bore diameter	Standard value	Standard value for repair	Serviceability limit
A	Swing cylinder (Rod side)	ø50	-0.02 -0.05	+0.150 0	0.02÷0.20	1.5	2.0
B	Swing cylinder (Bottom side)						
C	Swing center (Upper side)	ø80		+0.061 +0.009	0.029÷0.111		
D	Swing center (Lower side)						

NOTE: the tolerance for bushing inside diameter means the dimension after fitting of it into place.
The part number for pins may be changed owing to improvement, use them only for reference.

11.5 SPECIAL SPANNERS FOR TUBES

Applicable tube diameter mm	HEX mm	Dimensions of a special spanner mm
15	27	
18	32	
22	36	
28	41	

11.6 SPECIAL TOOLS

Unit: mm

No.	Name	Tools no.	Shape	Use
1	Torx driver (with tamper proof) T25 (for M5)	—		For instrument right cover

11.7 APPLICATION OF SCREW LOCKING AND SEALING COMPOUNDS

Service	Loctite	Features
Screw locking compound	#242	Low strength
	#262	Middle strength
	#271	High strength
Sealing compound	#515	Sealing

13.3 MEASURING ENGINE SPEED

13.3.1 MEASURING ENGINE SPEED

(1) Measuring instruments

1) Diesel Speedometer (1) (Measuring engine speed by means of applying a pick-up (2) to one of injection pipes)

2) Surface thermometer (measures the surface temperature generated by the probe when coming in contact with the surface of the hydraulic oil in the tank and in the radiator).

(2) Engine warming up operation

Start the engine and take the coolant temperature within the range of 60 to 90 °C (140 to 194 °F).
Check the coolant temperature with the coolant thermometer on the control panel. The white colour zone shows approximately 67 to 105 °C (152 to 221 °F) of temperature range.
Therefore, when the indicator is located at around centre of the white zone, it is suitable for the engine operation.

(3) Engine speed measurement

1) Apply the pick up of speedometer to one of convenient injection pipes. (Refer to Fig. 13-1)

2) Measure the engine speed at idling with no load, and compare it to the figure in the STANDARD VALUE TABLE.

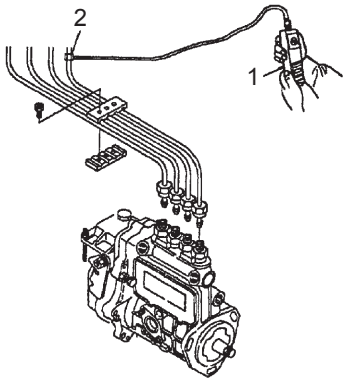
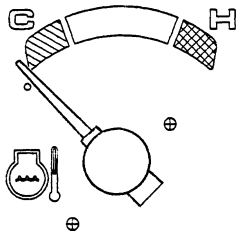


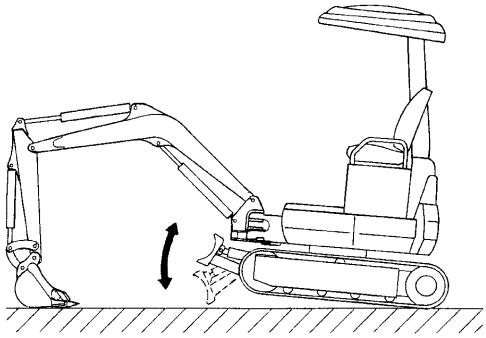
Fig. 13-1 Engine speed measurement (The above figure shows concept)



WATER TEMPERATURE

(5) Dozer cylinder speed

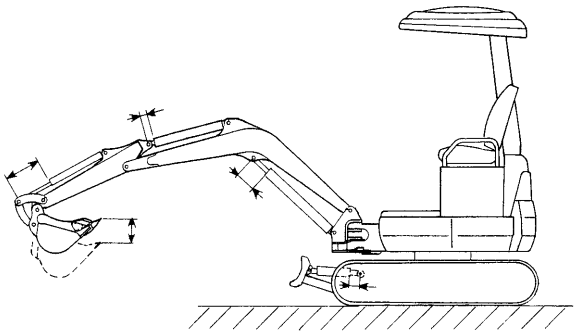
- Engine: high idling
- Hydraulic oil temperature: 50 ÷ 60 °C
- Measurement position: using the hoe attachment lift up the dozer blade side.
- Then, up and down the dozer blade with full stroke, measure the time required per stroke in each direction.



13.7.2 Gravity drift of cylinders

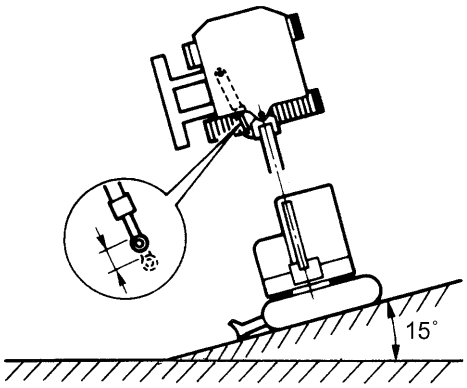
(1) Boom, arm, bucket, dozer, bucket tip

- Engine: stopped
- Hydraulic oil temperature: 50 ÷ 60 °C
- Measurement position: completely retract the dozer and arm cylinders, fully extend the bucket cylinder and position the bucket pin to the same height as the boom foot pin.
- Maintain the position for 10 minutes then measure the change of rod length and distance of the bucket tip.



(2) Swing cylinder

- Engine: stopped
- Hydraulic oil temperature: 50 ÷ 60 °C
- Gradient: 15° (Approx. 1/3.73)
- Measurement position:
  the same used to measure the slewing time.
- Slew the upper slewing structure and stop at right angle to the slope, then measure the change in rod length after 5 minutes.



22.3.3 TRAVEL OPERATING CIRCUIT (Refer to fig. 71-5)

Pilot oil hydraulic system with operating lever

22.3.3.1 2nd speed operating circuit (Independent-forward travel)

(1) Pilot circuit

1) Shifting signal for 2nd speed travel.
When the “Rabbit and Turtle” mark (at the power cut-off, it automatically takes back for 1st speed) on the knob of travel right lever is pushed down, it actuates the 1st and 2nd speed travel shifting valve of solenoid valve (13).
The pressurized oil signal for 2nd speed is generated from the A1 port of solenoid valve (13), and led to the P port on travel motor (4) through swivel joint (10), and shifts the 2-speed shifting valve (404).

2) Changing travel valve spool
The pilot secondary pressure is generated from pilot valve (12) by the operation for travel forward. The pressurized oil is led to the Pb7 and Pb6 ports on control valve (2) to shift the travel valve spool.

(2) Main circuit

1) Circuit up to travel motor (4)
The delivered oil from A1 and A2 ports on variable pump enters into the P1 and P2 ports of control valve (2), and led to the B7 and B6 ports through the travel valve.
Then it is led to the A and B ports on left and right travel motors respectively through the swivel joint (10).

2) Travel motor

a. The pressurized oil supplied to the travel motor shifts the spool of the counterbalance valve (brake valve) (408), releases the parking brake (403), opens the hydraulic circuit having closed by the check valve (407) and rotates the travel motor.
It actuates the speed shifting valve (404) when the 2nd speed signal is sent.
The high-pressure oil pumped through the shuttle valve (406) passes through the speed change valve (404), actuates the speed shifting piston (401) so that the engine rotates at high speed but with a low torque.

b. When the motor reaches near to a self-running condition (over-running) at going down a slope and so on, the oil pressure of supply side gets down to lower pressure, and the counter balance valve [brake valve] (408) spool moves to the neutral position with the spring force.
As the results, the passage in return oil side is throttled, and the motor speed is suppressed by a back-pressure, then the motor is controlled to the speed corresponding to the supplied oil volume of the pump.

c. The counterbalance valve spool is so designed that it is gradually shifted by a throttle effect to stop or start the motor absorbing shock at the start and stop of the machine.

d. When load increases during high speed travel, the speed automatically shifts to the 1st speed, resulting in low speed and high torque.

Group	Code	Part Name
Switch	SW-1	(KEY) STARTER SWITCH
	SW-2	WORKING LIGHTS SWITCH
	SW-3	2nd SPEED SELECTOR SWITCH
	SW-4	WIPER WASHER SWITCH
	SW-5	ENGINE COOLANT TEMPERATURE SWITCH
	SW-6	ENGINE OIL PRESSURE SWITCH
	SW-7	HORN SWITCH
	SW-9	LEVER LOCK SWITCH
	SW-10	HEATER SWITCH (OPT)
	SW-11	DECELERATION SWITCH
	SW-15	HIGH AND LOW PRESSURE SWITCH
	SW-16	CONDENSER SPEED SHIFT SWITCH
	SW-39	OVERLOAD PRESSURE SWITCH
	SW-40	OVERLOAD SWITCH

NOTE: the part number may be changed owing to modification, use them only for reference.

23.2.3.3 Relay box assy

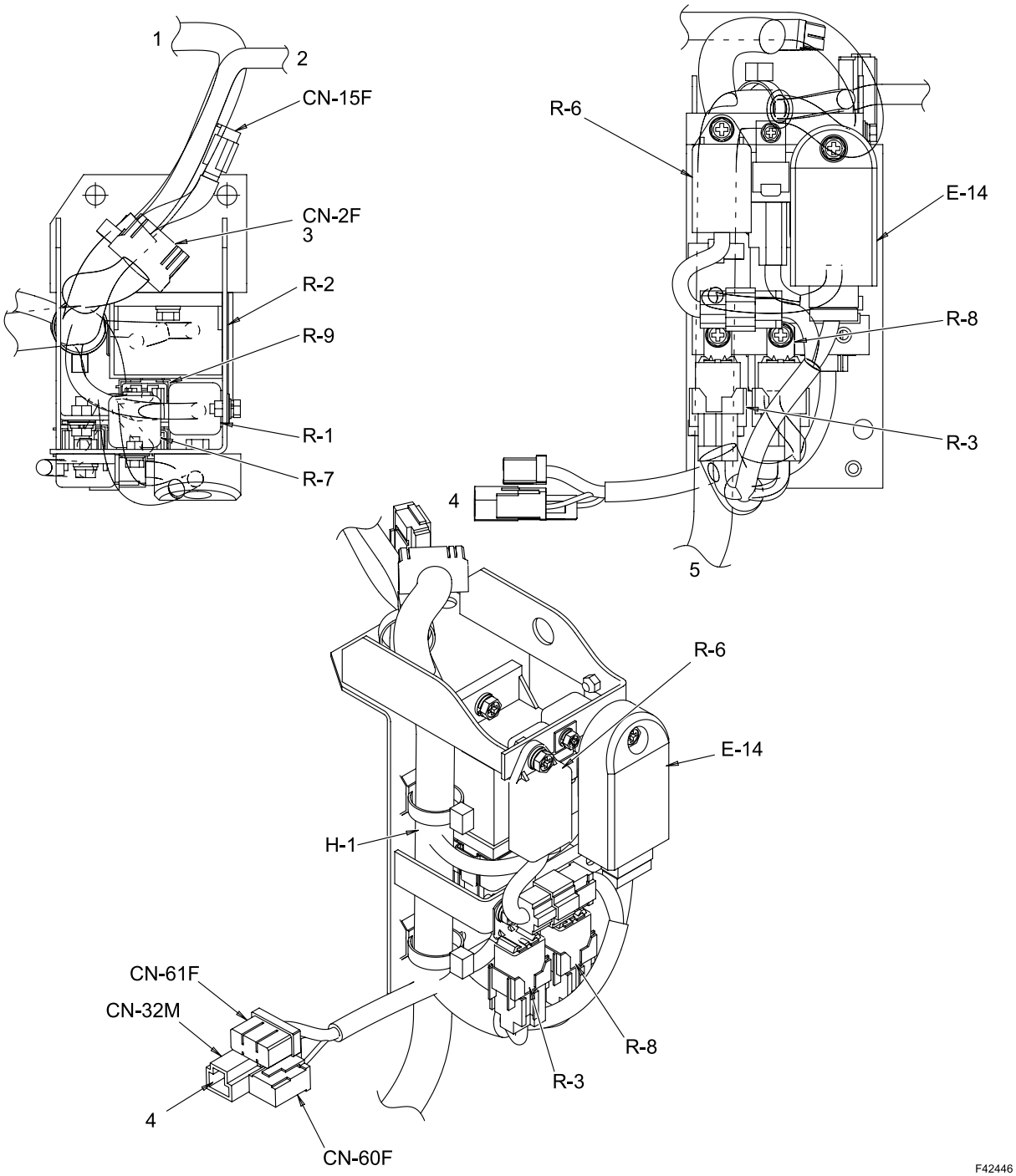


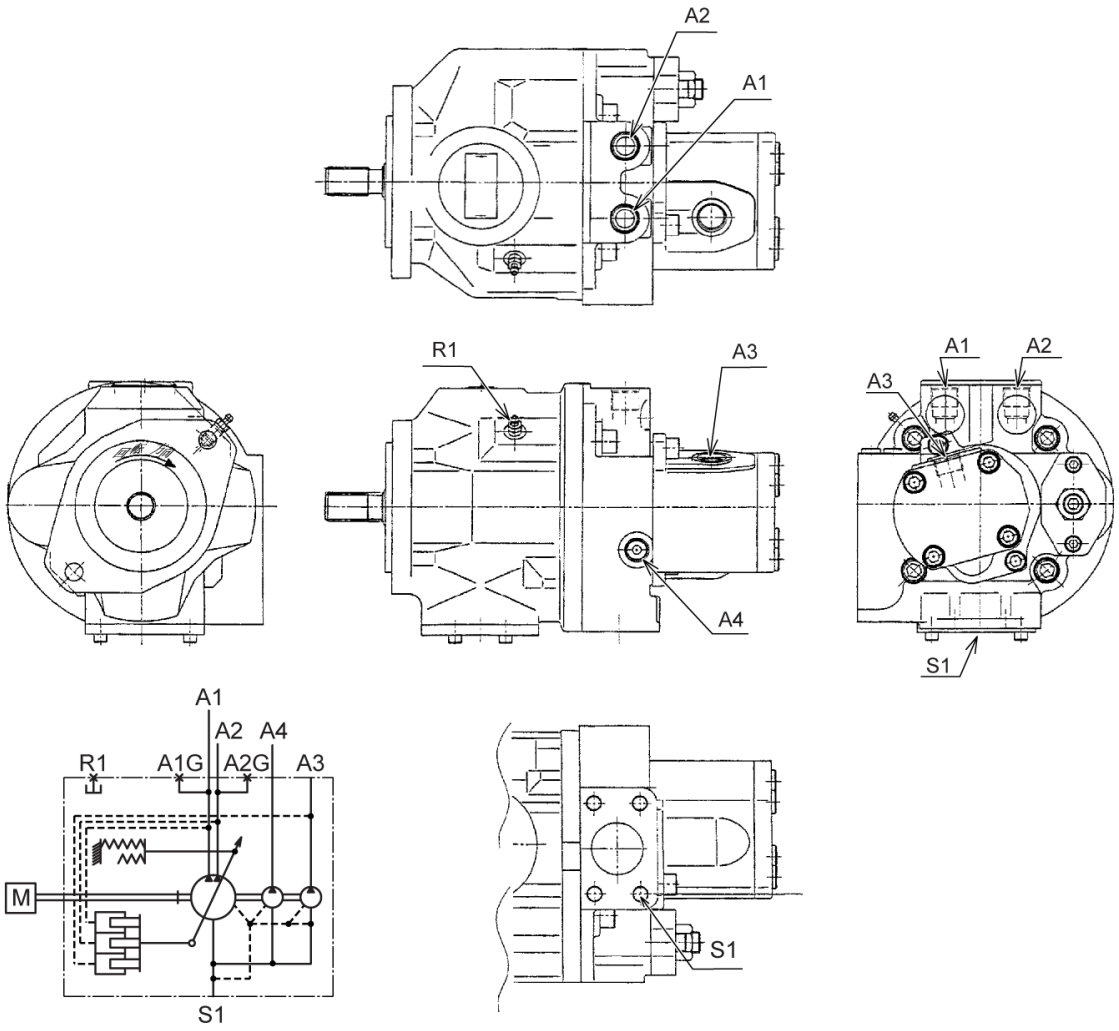
Fig. 23-8 Relay box

1. To decelerator and air heater
2. To horn switch and safety lock lever switch
3. To cab harness
4. To engine wiring harness
5. To frame

24.1 HYDRAULIC COMPONENTS

24.1.1 HYDRAULIC PUMP

24.1.1.1 TECHNICAL FEATURES



N00050

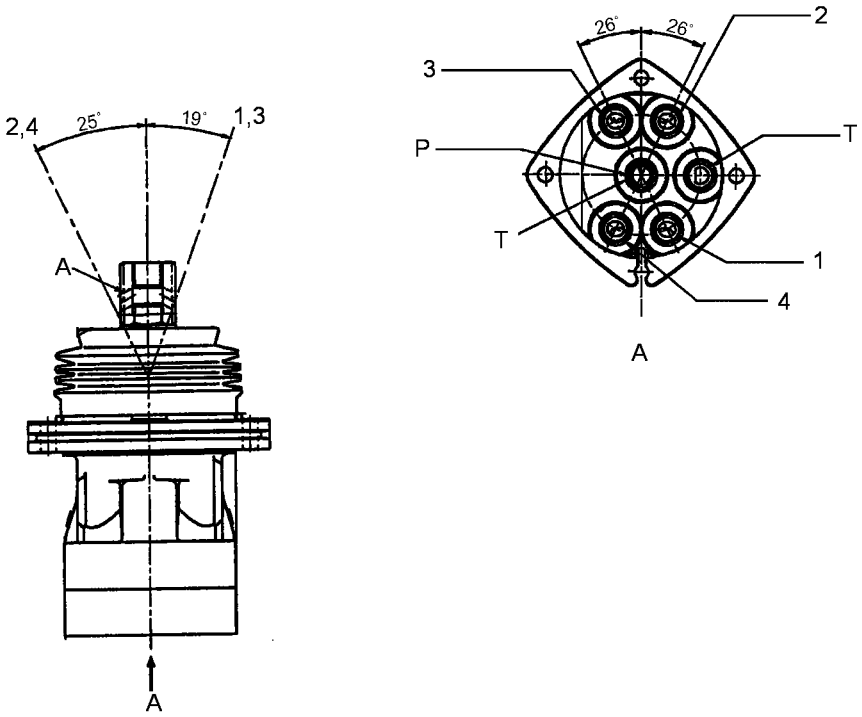
No.	Ports name	Dimensions
S1	Suction port	SAE 1 1/2
A1, A2	Delivery port	PF 1/2
A3	Delivery port	PF 1/2
A4	Pilot delivery port	PF 3/8
R1	Air bleed port (with breather valve)	M10 x 1.0

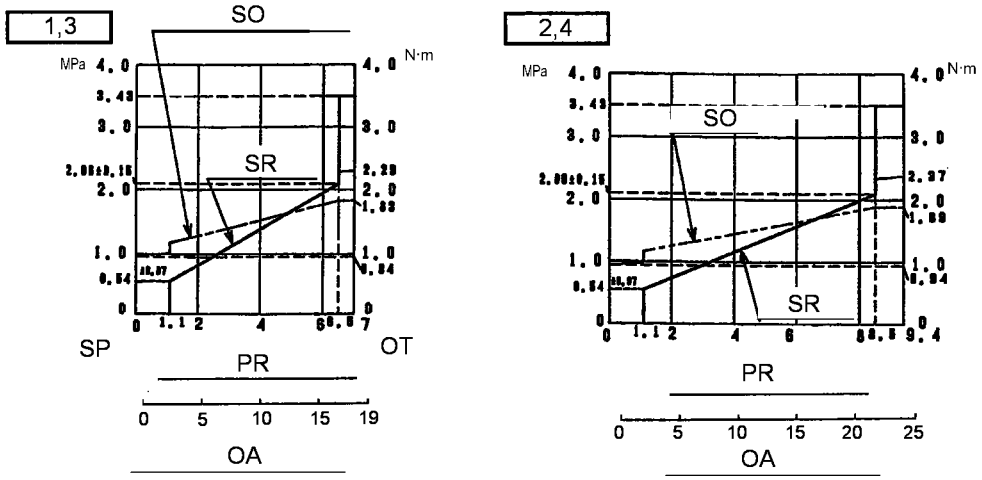
Fig. 24-1 Technical features

Pump	Model (type)	AP2D25LV1RS7		
		Piston pump P1 + P2	Gear pump P3	Trochoid pump P4
Working pressure	MPa	23.0	23	3.5
Displacement	cc/rev	23.8 × 2	14.1	5.1
Delivery flow	l/min	57.1 × 2	33.8	12.2
Control system		Total power shift control by tilting angle (power shift)		
Rating speed	rpm	2400		
Weight	kg	35.0		

24.1.2 ATTACHMENT CONTROL VALVE

24.1.2.1 TECHNICAL FEATURES





A. The adjust nut (opposing flats: 22): Fix adjust nut by means of spanner (opposing flats: 22) when the lever is installed. Then tighten the mating lock nut to 41 ± 0.3 Nm (30 ± 2.2 lbf•ft)

OA. Operation angle (degree)

OT. Operation torque (Nm)

PR. Push rod stroke (mm)

SP. Secondary pressure (MPa)

T. Tightening torque: 6-PF1/4
T= 29.4 ± 2.0 Nm (21.7 ± 1.47 lbf•ft)

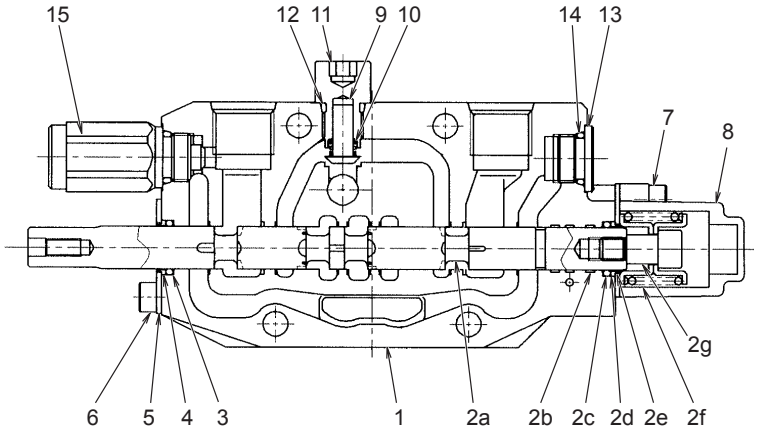
Maximum primary pressure	6.9 MPa (1000 psi)
Delivery	15 l/min (3.90 gal/min)
Weight	1.6 kg (4 lb)

The control valve is roughly classified into the following four sections.

- Manual operation section: swing
- Pilot operation section: travel right and left, boom, arm, bucket, slewing, independent travel and conflux, dozer blade, service(nibbler and breaker
- Accessory section: P1 and P2 inlets, and P3 inlet (common with independent travel and conflux)
- Accessory section (valve): P1, P2, P3 main relief, overload relief, anti cavitation, boom lock

* For respective operation section, only typical example is described.
  - Manual swing operation (No. 6)

No.	Name	Q.TY
1	Body	1
2a	Spool	1
2b	O-ring	1
2c	Dust wiper	1
2d	Oil seat retainer	1
2e	Spring seat	2
2f	Spring	1
2g	Spool end	1
3	O-ring	1
4	Dust wiper	1
5	Oil seat retainer	1
6	Screw M16 x 12	2
7	Screw M16 x 22	2
8	Cover	1
9	Load check valve	1
10	Spring (for check valve)	1
11	Plug (for check valve)	1
12	O-ring	1
13	Cap	1
14	O-ring	1
15	Anticavitation valve	1



5. Independent travel function

When both right and left travels is shifted, and one of boom, bucket and boom swing is shifted, the oil flows from the Pp1 port through the throttle into the pilot passage, in which pressure equals to the Pp1 port supply pressure because the pilot passage is shut off from the tank passage.

Then the Pp1 port supply pressure acts on the travel straight spool, and the spool moves until it contacts with the pilot cap overcoming the spring force.

Once the spool is shifted, the pressurized oil supplied from P3 passes through the parallel and by-pass passages of the slewing and dozer shifting sections, and passes through the spool of the P3 supply section and the land of main unit to flow into the second parallel passage of the P1 side and the parallel passage of the P2 side.

In addition, if the pressure of pilot passage is equal to the pressure of Pp1 port, the spools in the P1/P2 supply section are shifted too. Thereby P2 parallel passage is connected with P1 parallel passage.

After these shifting, the pressurized oil supplied to P1 and P2 actuates the right and left travel, and the pressurized oil supplied to P3 actuates the other attachments.

Therefore even if the travel and other attachment are simultaneously operated, the travel is correctly performed without deviating.

The arm or service operated in the flow conflux position without relating to the independent travel function can be simultaneously performed with the travel in the same operability as the independent travel function.

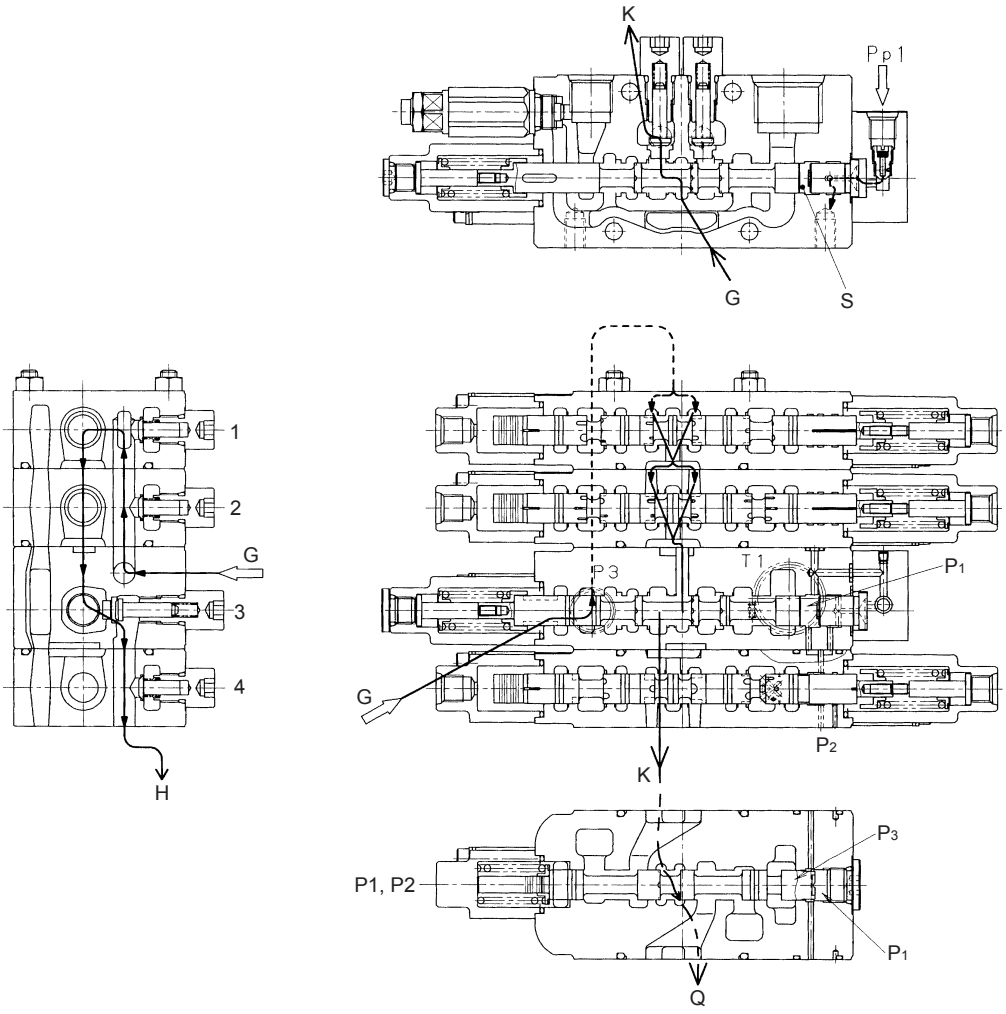


Fig. 24-16 Independent travel actuation

1. Dozer
2. Slewing
3. Supply and independent travel
4. Digging

G. From P3 pump
K. The parallel passage of P2 side
Q. To the parallel passage of P1 side
S. Pilot passage
P1. Pp1 pressure
P2. The oil from pump P3 is cut off by the operation of travel and attachment
P3. Travel straight spool and P1/P2 supply spool are shifted simultaneously, and P1 parallel passage connects with P2 parallel passage.

3) Action of hydraulic parking brake (P/B) timer
When the parking brake operates as the upper structure produces inertia, the hydraulic parking brake timer operates to delay the operation of the parking brake for a certain time length.

a) When the parking brake is released;
If the pressure flows into the brake release command secondary pilot pressure port (PP), it overcomes the force of spring (505) and pushes spool (502) to the positions in Fig. 24-24 and in the figure above. At this time, the brake release pressure on primary pressure port (PB), passes through the arrow in Fig. 24-24 above, and flows in the brake piston chamber, and releases it.

b) When the parking brake acts;
If the pilot pressure at the brake releasing command secondary pilot pressure port (PP) is blocked, spool (502) is pushed back to the position in the figure below by the force of spring (505). The brake release pressure at the brake releasing pressure port (PB) is blocked by spool (502) and block the pressure supply to the chamber of the parking brake piston. The pressure of the parking brake piston chamber is pushed out by the force of the spring in the parking brake and flows out to the DR port through the passage indicated by an arrow in the figure below: On that occasion, the oil that is flowing out is regulated by the orifice of piston (503), flows out to the DR port slowly, and delays the action of the parking brake for a certain time length.

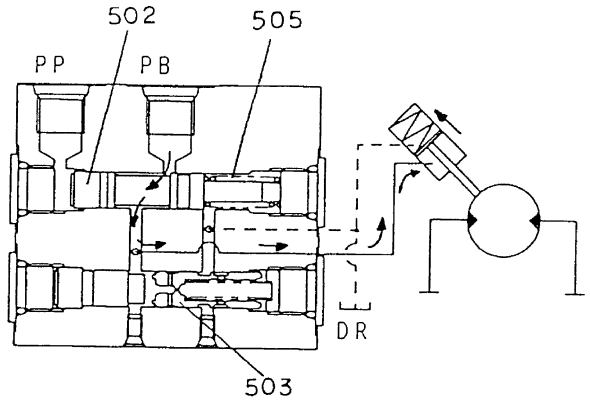
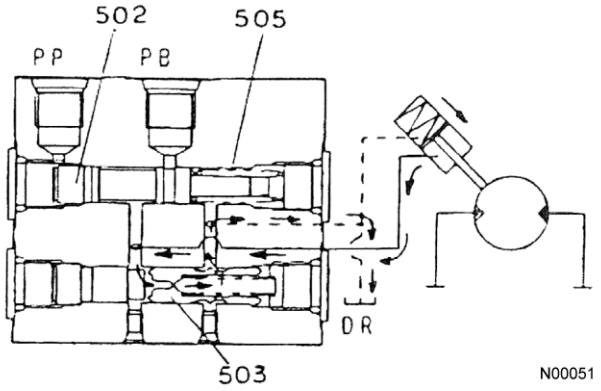


Fig. 24-24 Operation of hydraulic parking brake timer

When the brake releasing command secondary pilot pressure flow into port PP;



When the brake releasing command secondary pilot pressure is blocked at port PP;

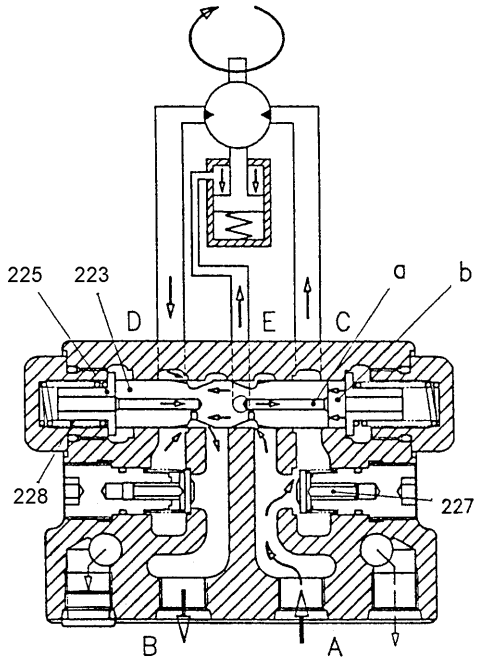
Fig. 24-25 Operation of hydraulic parking brake timer

c. Self-travelling

While machine is being operated, as the travel speed is increased due to steep slope, the oil flow rate of the hydraulic motor is higher than the supply flow rate of the hydraulic oil pump. The rotation of the hydraulic motor in this case is called a self-travelling (Overrun).

While self-travelling, the oil pressure is lowered similar to the stopping condition. Then brake valve is moved similar to the stopping condition, throttles passage in the return side of hydraulic motor, and generate backing pressure.

In addition, the force of inertia decreases the revolution of hydraulic motor to revolution having a balance with the supply flow rate of pump.

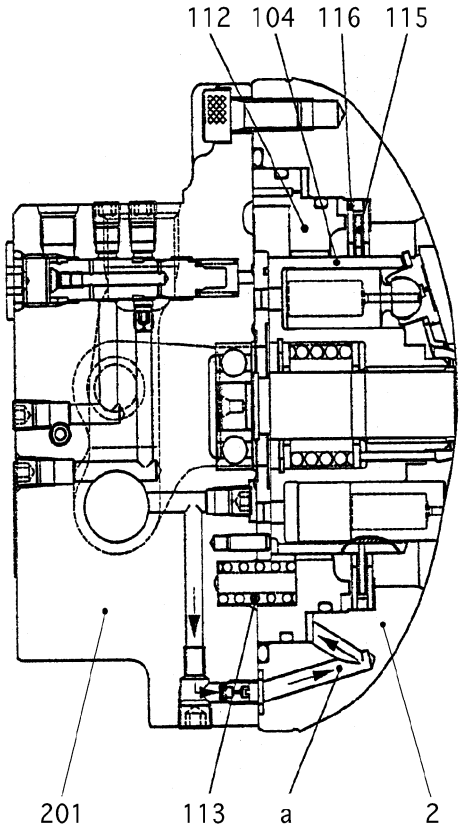


3) Parking brake

a. Traveling

The pressure oil led trough brake valve actuates on spool (223) of brake valve on the hydraulic motor section, opens passage to parking brake, and is led to cylinder chamber (a) compressed of spindle (2) and piston (112) on the reduction gear section.

If the pressure of oil which is 0.89 MPa (129 psi) or higher it exceeds the force of spring moving piston (112) toward rear flange (201) side. This movement of piston (112) reduces the push power to separator plate (116) and friction plate (115), and makes the movement of friction plate (115) which is installed to cylinder block (104) on hydraulic motor section free releasing the brake power to cylinder block (104).



Dozer cylinder

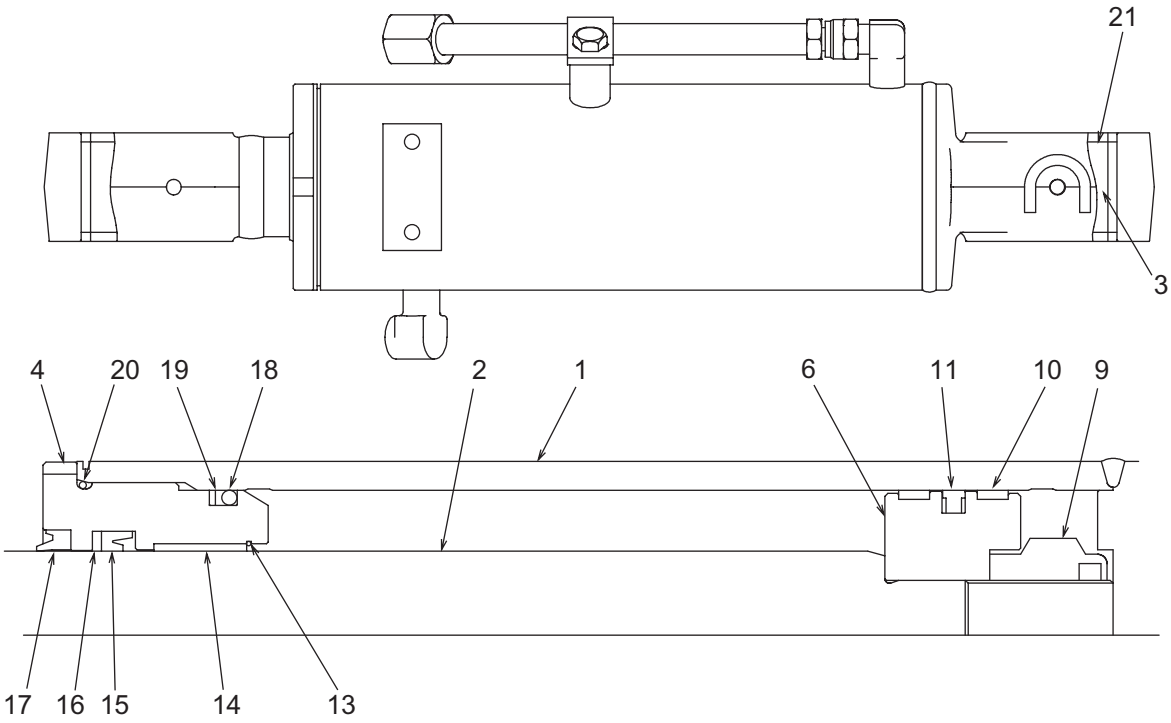
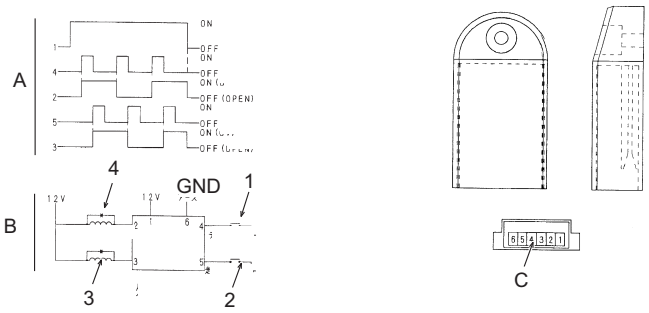
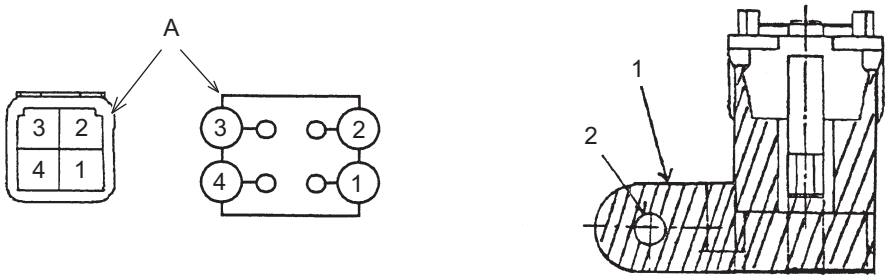
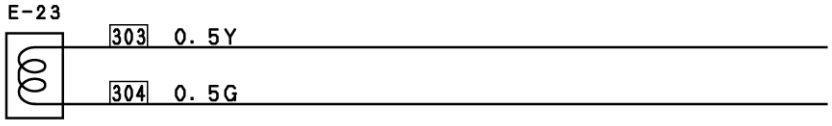
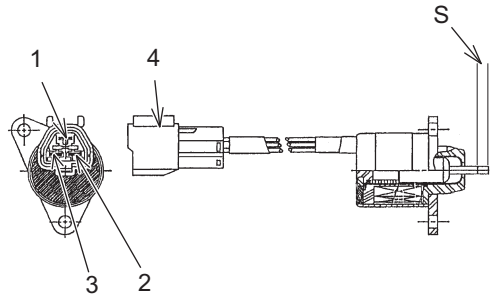


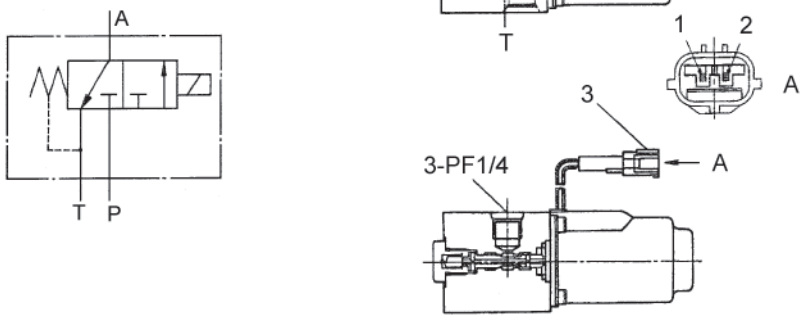
Fig. 24-34 Construction of dozer cylinder

No.	NAME	Q.TY
1	CYLINDER LINER	1
2	CYLINDER ROD	1
3	BUSHING	2
4	CYLINDER HEAD	1
6	PISTON	1
9	LOCKNUT	1
10	WEAR RING	1
11	SEAL RING	2
13	SEAL RING	1

No.	NAME	Q.TY
14	BEARING	1
15	SEAL RING	1
16	BACK-UP RING	1
17	DUST SEAL RING	1
18	O-RING	1
19	BACK-UP RING	1
20	O-RING	1
21	DUST SEAL RING	4

Name	Specifications
E-14 Relay	 No. | NAME 1 | Push button deceleration 2 | Travel 1,2 speed switch 3 | Travel 1,2 speed solenoid 4 | Deceleration relay solenoid A | Input / output operation B | Electric circuit C | Pin arrangement
E-15 Fuse box (For cooler)	 No. | NAME 1 | Bracket in the hatched area 2 | Hole for M6 A | Arrangement of terminals and circuit diagram
E-23 Antenna	 N00054

<table>
<tr><th>Name</th><th>Specifications</th></tr>
<tr><td>SV-3
Solenoid valve
Engine stop</td><td>


<table>
<tr><th>No.</th><th>NAME</th></tr>
<tr><td>1</td><td>Ground (black)</td></tr>
<tr><td>2</td><td>Pull coil (white)</td></tr>
<tr><td>3</td><td>Hold coil (red)</td></tr>
<tr><td>4</td><td>Connector</td></tr>
<tr><td>S</td><td>Stroke: 7.4 mm</td></tr>
</table>
<table>
<tr><td>Rated voltage</td><td>12 V DC</td></tr>
<tr><td>Nominal current</td><td>Pull coil: 36.5 A
Hold coil: 0.49 A</td></tr>
</table>
</td></tr>
<tr><td>SV-5
Solenoid valve
Power shift
(Air-con spec.)</td><td>


<table>
<tr><th>No.</th><th>NAME</th></tr>
<tr><td>1</td><td>Cord colour: earth black</td></tr>
<tr><td>2</td><td>Power source cord colour: red</td></tr>
<tr><td>3</td><td>Ampère mark II 2P</td></tr>
</table>
<table>
<tr><td>Rated voltage</td><td>12 V DC</td></tr>
<tr><td>Capacities</td><td>12 W</td></tr>
<tr><td>Operating pressure</td><td>4.9 MPa</td></tr>
<tr><td>Maximum delivery</td><td>160 l/min</td></tr>
</table>
</td></tr>
</table>

32. ATTACHMENT

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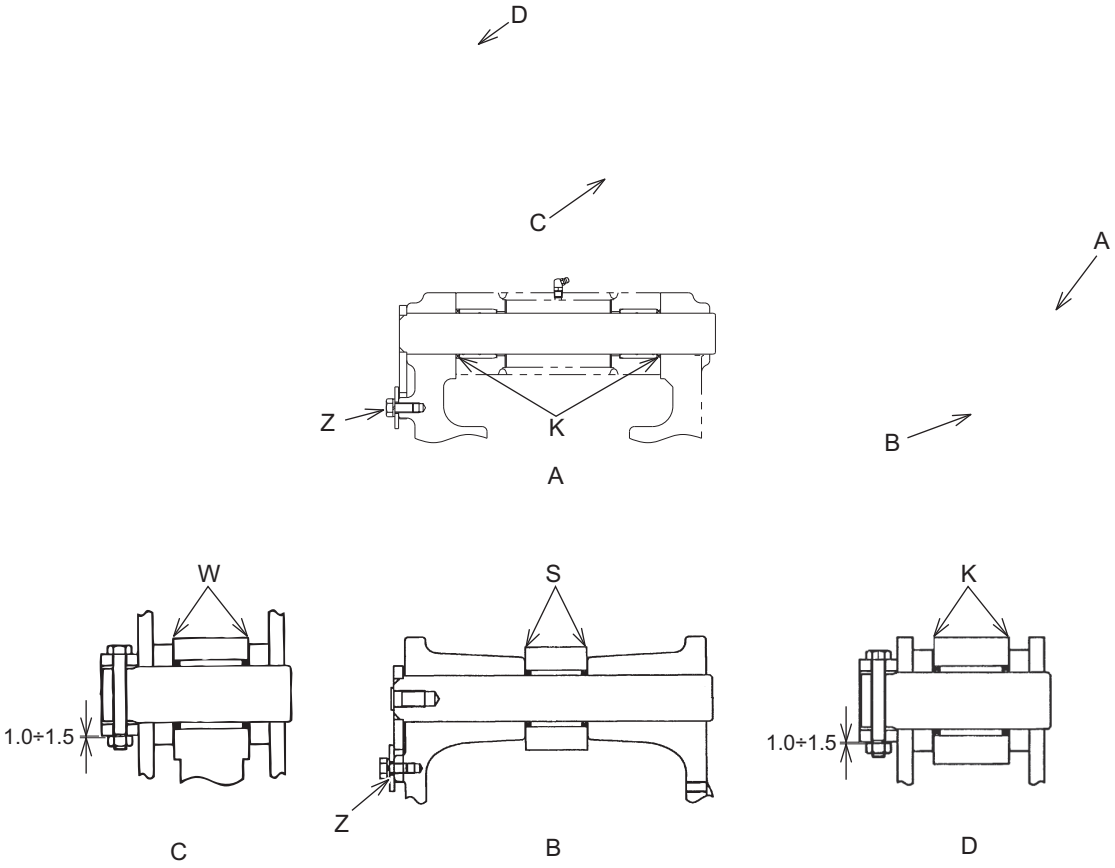


Fig. 32-16 Sectional view of installing pin

W. The total clearance must be between 0.5 mm and 0.9 mm after adjusting the shims

K. The total clearance must be between 0.1 mm and 0.5 mm after adjusting the shims

S. The total clearance must be between 0.5 mm and 1 mm after adjusting the shims

Z. Apply Loctite #262

(5) Disassembly of clevis portion:

1) Remove the seal ring (21) from the clevis portion of cylinder tube (1) and the cylinder rod (2).

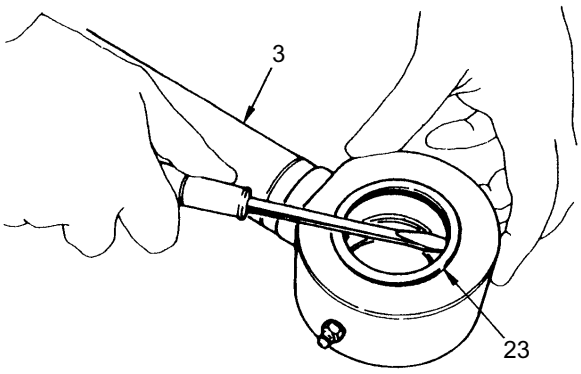


Fig. 32-31 Removing dust seal

2) Remove the pin (3).

• Using a metal block (28), push it out with a press machine.

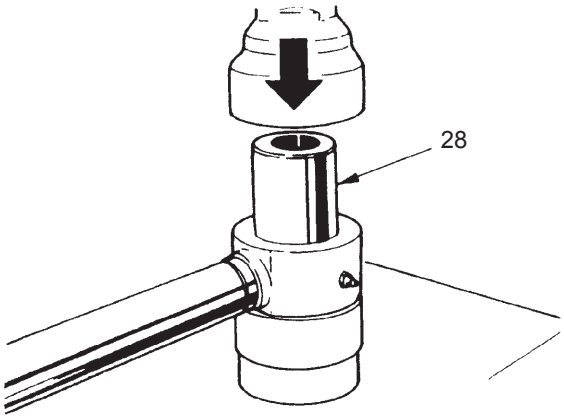


Fig. 32-32 Removing bushing

32.2.1.8 POSSIBLE CAUSES FOR TROUBLE AND REMEDY

Trouble Conditions	Major possible causes	Remedy
Oil leakage from sliding face of piston rod. (A ring shape oil is formed on piston rod and enlarged resulting dripping down of oil).	• Foreign matter is caught by U-ring or wiper ring at its inside periphery.	• Remove foreign matter.
	• Scuffing or fault on O-ring or wiper ring at its inside periphery.	• Replace each part with new one.
	• Scuffing on sliding face of piston rod.	• Grind sliding face with a fine oil stone. (less than 1.6S).
		• If leakage is not stopped by grinding, replace seals such as U-ring, etc. with new ones.
		• If leakage is not stopped by replacing seals, replace piston rod.
	• Peeling off of hard chrome plating.	• Re-plating of hard chrome on piston rod.
Oil leakage from outer periphery of cylinder head.	• Damage to the O-ring.	• Replace.
	• Damages on back-up ring.	• Replace.
Oil leakage from welded portion.	• Damages on welded portion on tube.	• Replace.
Piston movement due to leakage. (In case a static load equivalent to the product of the multiplication between the max. working pressure and the cylinder area is applied to the rod, the maximum movement of the piston is larger than 0,5 mm (0.019 in) for 10 minutes).	• Foreign matter is caught by sliding face of slide ring.	• Remove foreign matter.
	• Scuffing or faulty condition on sliding face of slide ring.	• Replace.
	• Scuffing on sliding face of seal ring assembly.	• Replace.
	• Damage to the O-ring.	• Replace.

33.1.4 BATTERY

33.1.4.1 PREPARATION FOR REMOVAL

(1) Remove the floor mats (5) and (8).
(2) Remove cover (4).
(3) Remove the cover assembly (5) on the left lower side

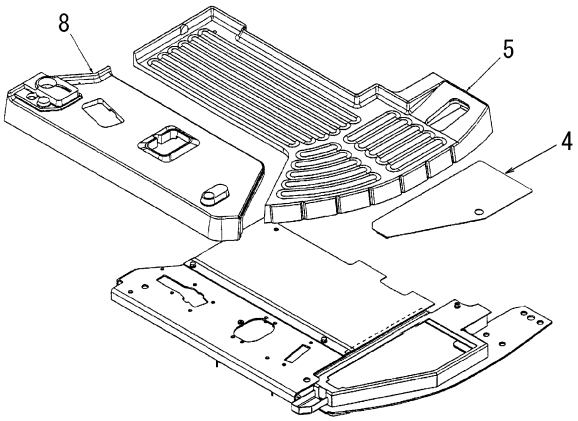


Fig. 33-17 Floor section removal preparation

33.1.4.2 REMOVAL

(1) Unclip and remove the rubber (5).
(2) Disconnect the negative side terminal of the cable
(3) Then, disconnect the positive side terminal of the cable

: 12 mm

⚠ CAUTION

Follow the removal procedure of battery cable. Firstly disconnect the grounding side cable. Connect the grounding side finally. Failure to do so may result in dangerous situation due to spark.

(4) Loosen the M8 nut (A3) to remove the plate (A2) and the rod (A1).

: 13 mm

(5) Take out the battery (B1) holding the straps attached to it.

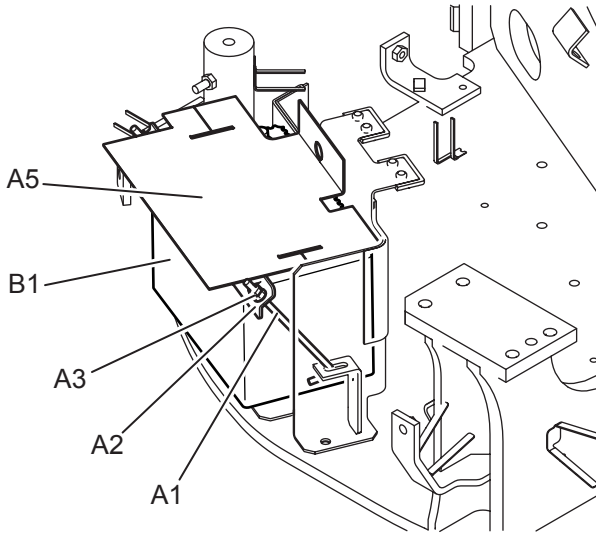


Fig. 33-18 Battery removal

33.1.4.3 INSTALLATION

Install the battery in reverse order of the removal.
Nut (7) M8:

: 13 mm
Tightening torque: 3.5 Nm

33.1.9.2 DISASSEMBLY

(1) Open the fuel filler cap (B2) and loosen the drain cock (B10) to drain fuel.
Tank capacity: 52 litre (13.70 gal)

(2) Disconnect the hoses (2) and (3) for the fuel inlet and outlet, the hose (B4) for the fuel supply port, and two air bleed hoses (A3).

(3) Loosen the M10x20 sems-screws (B9) to remove the flange (B11) together with the drain hose (B12).

: 17 mm (0.66 in)

(4) Disconnect connector (A13) for the level sensor.

(5) Remove two M10x20 capscrews (B7).

: 17 mm (0.66 in)

(6) Remove the fuel tank (A1) together with the bracket assembly (B14).

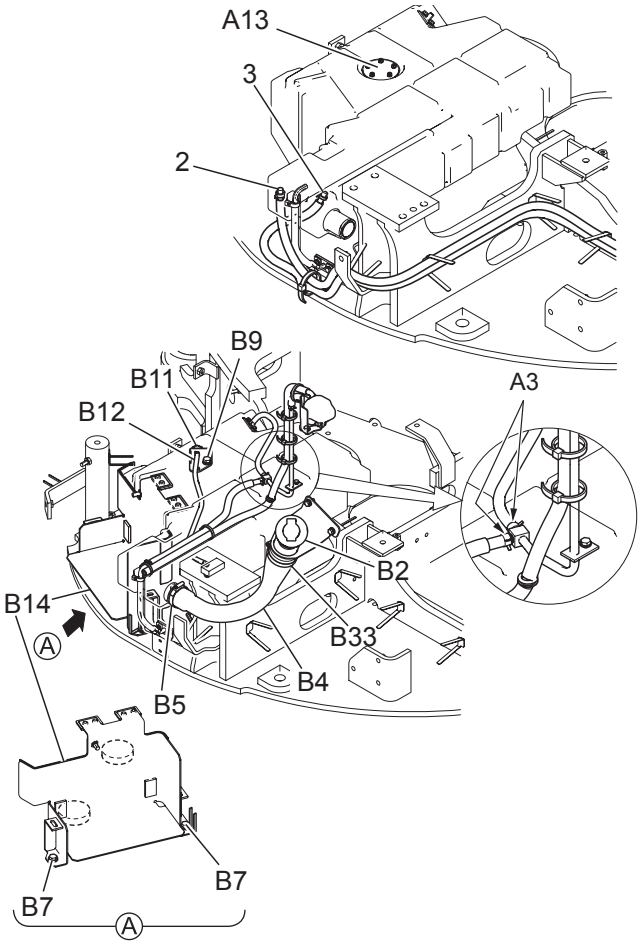


Fig. 33-31 Fuel tank removal

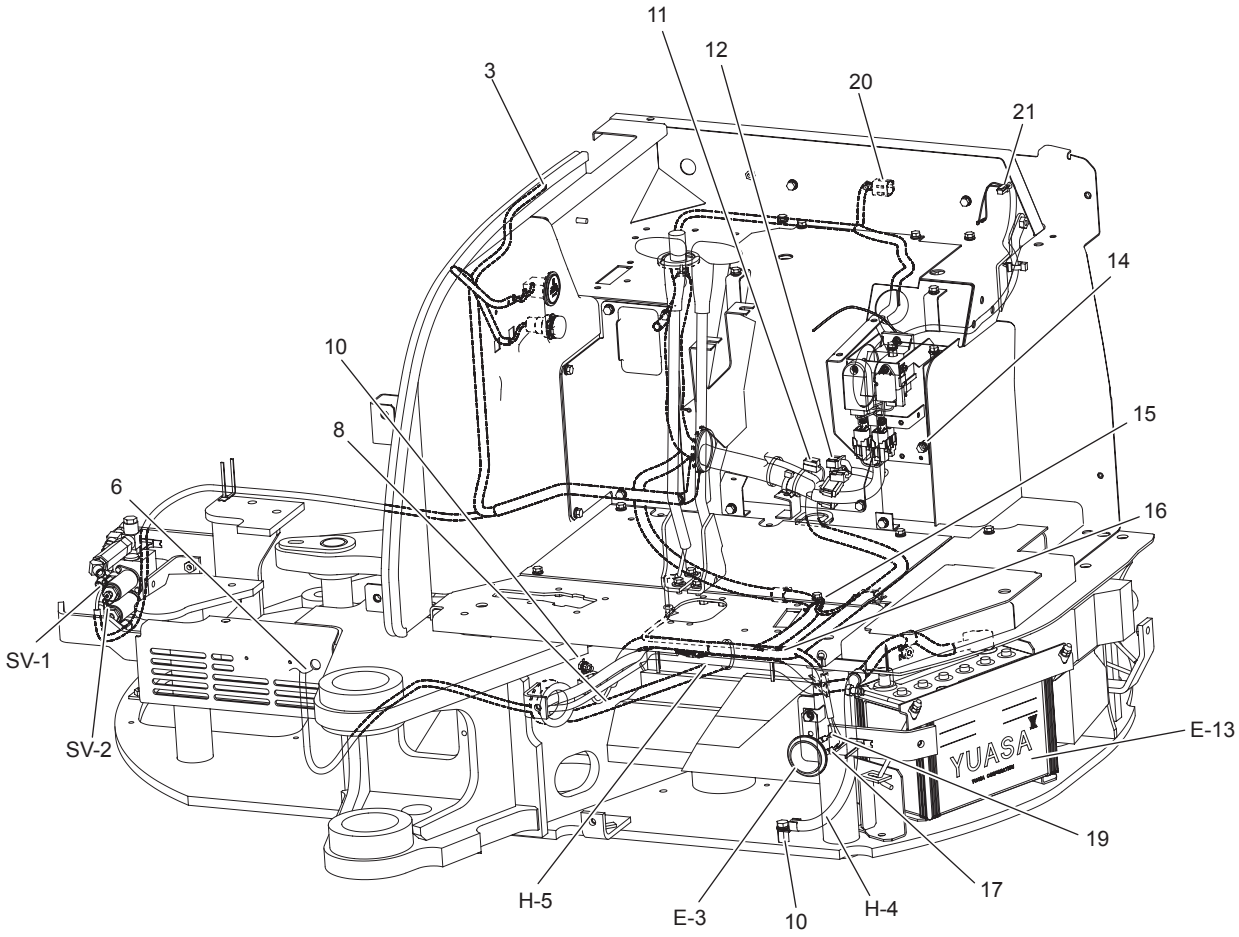
33.1.9.3 INSTALLATION

Assemble the fuel tank in reverse order of the removal and tighten the screws to the specified torque shown in the following table:

Piece	Name	Tool (mm) (in)	Torque (Nm) lbf•ft)
B7	Capscrew (M10)	17 (0.66)	46.1 (34)
B9	Sems-bolt (M10)	17 (0.66)	34 (25)
B5 B33	Clip	Screwdriver	0.49 ÷ 0.78 (0.36 ÷ 0.57) 0.36 ÷ 0.58 (0.26 ÷ 0.42)

(11) Disconnecting harness

See below drawing to disconnect the harness connected to the instrument harness and main harness.



3. To canopy light
6. To boom
8. GND connector
10. Ground
11. Connection with a heater relay harness. (OPT)
12. Connect main harness to eng. harness.
14. Relay assy
15. Connect with fuel sensor
16. Connect with two speed select sw.
17. PB (+)
19. B (-)
20. Connect with cab harness (cab spec.).
21. Connect with decel motor (OPT)

E-3. Horn
E-13 Battery
H-4. Starter cable
H-5. Battery ground cable
SV-1.Operating lever lock sol.
SV-2.Two-speed selection solenoid

(3) Loosen five M16x40 capscrews (1) to remove the slewing motor (A1).

: 24 mm [a long type approximately 300 mm in length required].
Weight: approximately 40 kg

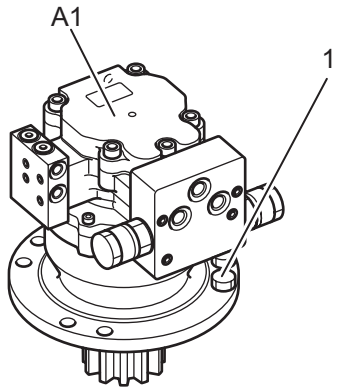


Fig. 33-66 Slewing motor removal

33.1.19.3 INSTALLATION

(1) Install the motor in reverse order of the removal according to the tightening torque shown below.

1) Apply Loctite #515 on the entire circumferential surface for mounting the slewing motor (1).
2) Install the capscrews (3) for fixing the motor. (A1)

: 24 mm
Tightening torque = 216.6 Nm
Apply Loctite #262 to the capscrew.

3) Connect the hoses
   - Fill the casing with hydraulic oil through the motor drain port prior to connecting drain piping.

Tightening torque

Thread size (PF)	Spanner used (mm)	O-ring type fitting	30° flare type fitting
1/4	19	36.3	29.4
3/8	22	73.5	49
1/2	27	108	78.5

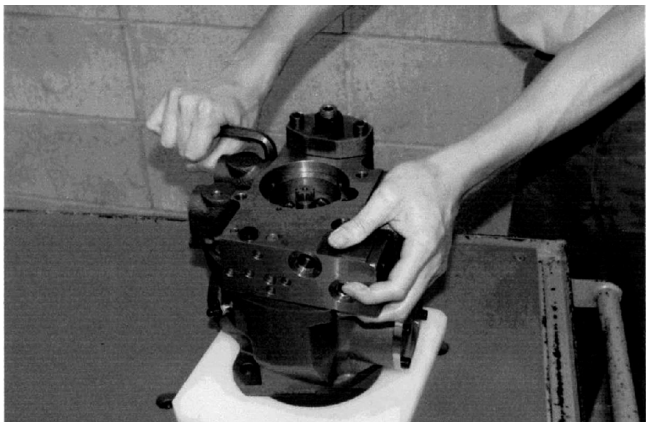
(2) Check the hydraulic oil tank for the oil level. Supply oil if necessary.

(3) At the start, run the motor in the low idling condition of the engine for a few minutes to check for oil leakage and abnormal noise.

(3) Disassembling main pump

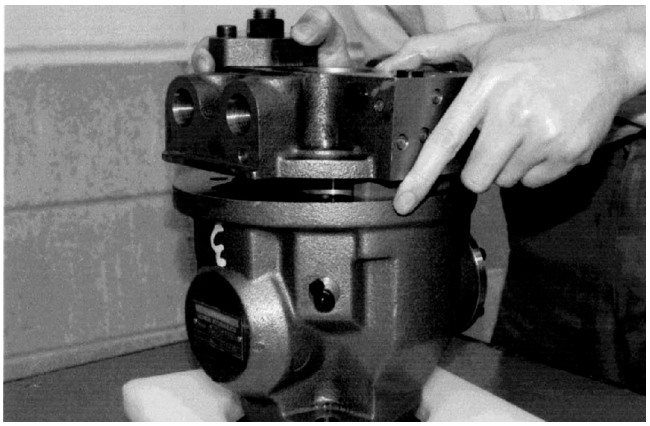
1) Removing cover
Remove three (M12x30) and one (M12x55) capscrews.

: 10 mm



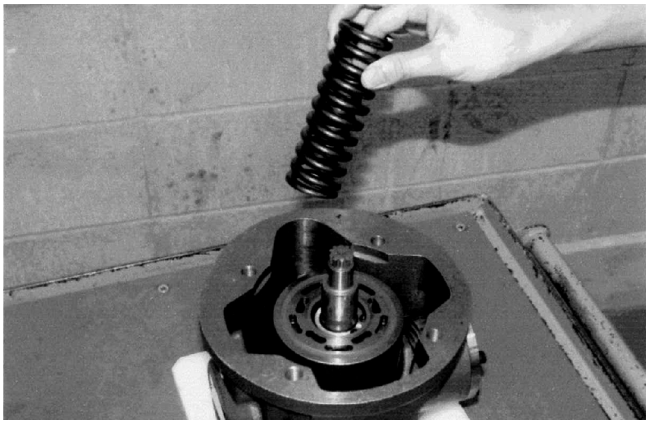
2) Removing the cover in a horizontal condition.

- Be careful because the control plate is provided to the back side.
When the cover is difficult to remove, knock lightly with a plastic hammer.

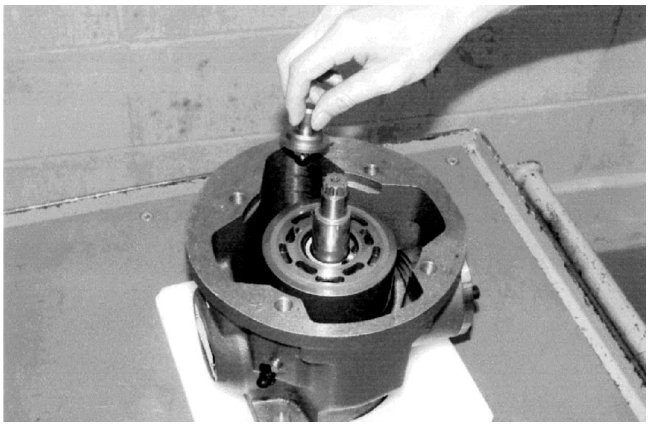


3) Removing control spring section

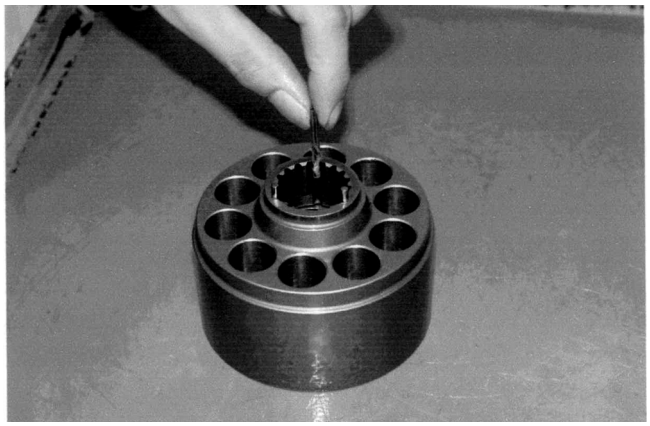
a) Remove two springs (inside and outside) and the guide.



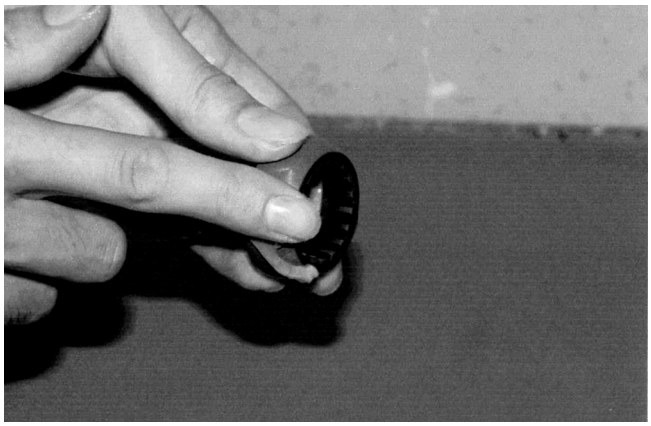
4) Remove the spring seat.



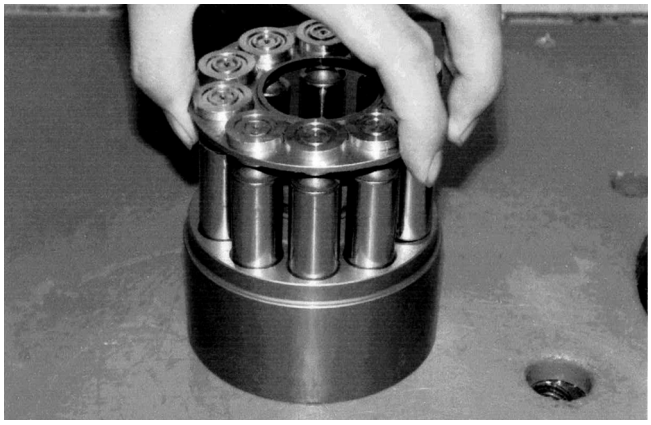
10) Apply grease on three parallel pins, fit it in the cylinder block.



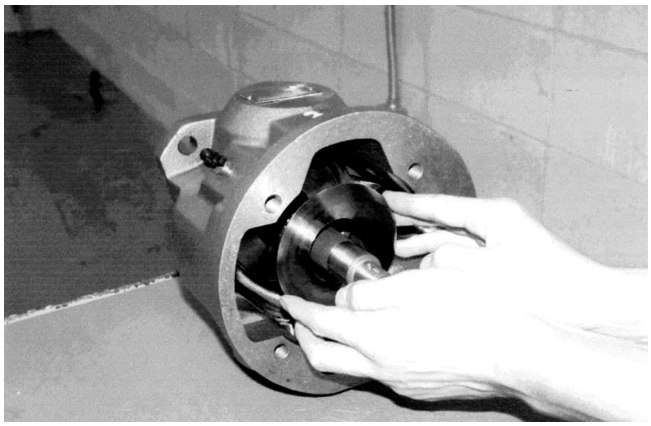
11) Apply grease on sphere portion of guide.

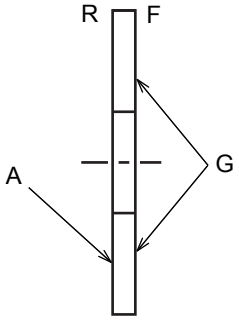


12) Install guide between retainer and cylinder block and insert pistons in the holes of cylinder block.



13) Assembling rotary group.
Install plate in hanger. In this case, apply grease on the rear surface of plate to prevent dropping.





A. Apply grease
G. Ground site
F. Front
R. Rear

33.2.2 CONTROL VALVE

33.2.2.1 TECHNICAL FEATURES

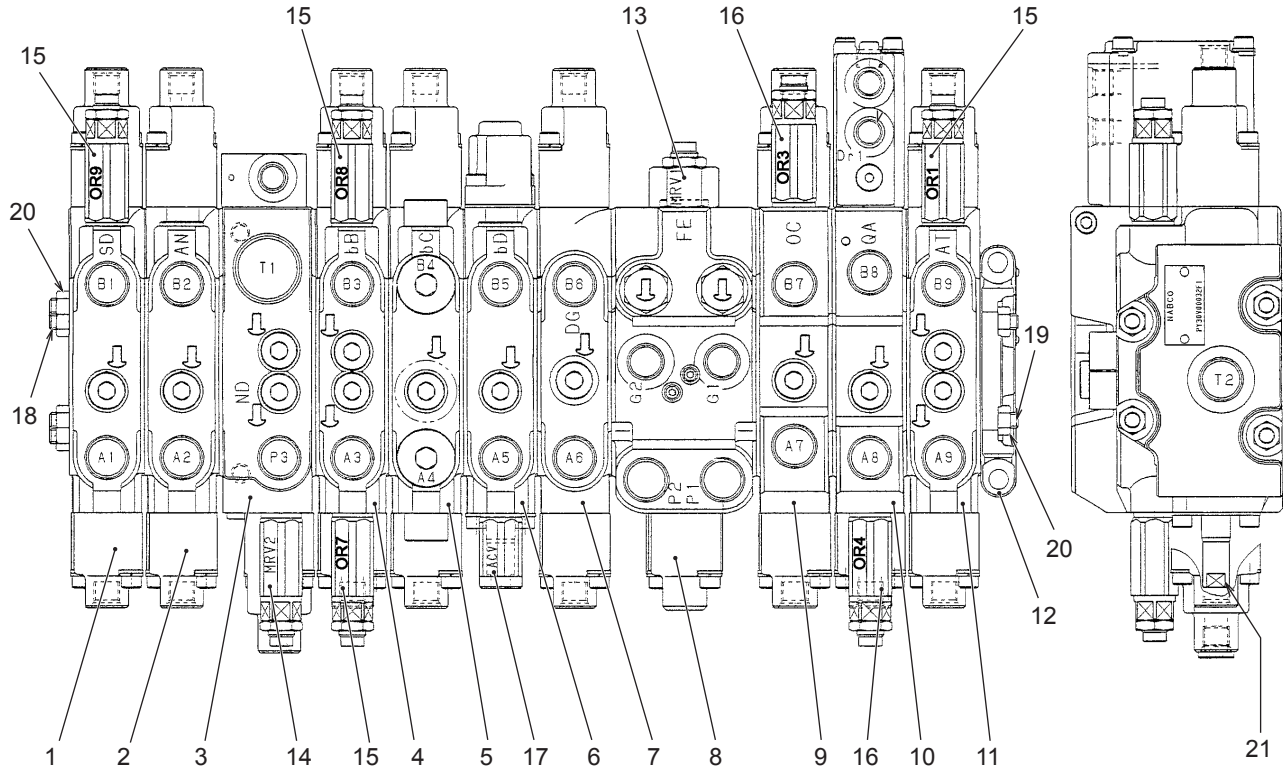


Fig. 33-79

No.	Name	Q.TY
1	Dozer section	1
2	Slewing section	1
3	P3 inlet and travel straight conflux section	1
4	Arm section	1
5	Service section	1
6	Swing section	1
7	Travel (right) section	1
8	P1 and P2 inlet section	1
9	Travel (left) section	1
10	Boom section	1
11	Boom lock section	1

No.	Name	Q.TY
12	End cover	1
13	Main pressure relief valve P1, P2	2
14	Main relief valve P3	1
15	Pressure relief valve	4
16	Pressure relief valve	2
17	Anticavitation valve	1
18	Tie bolt (L=303)	4
19	Tie bolt (L=143)	4
20	Nut	8
21	Manual operation	1

33.2.2.5 PRECAUTIONS WHEN ASSEMBLING

⚠ CAUTION

Precautions (Observe the following standards to guarantee safety).

(1) The unevenness of tightening torque and the contamination by dust during assembly may cause a failure. And observe the tightening torque specified in the description.

(2) When assembling, check up on the valve construction drawing, identify the number of part, and ensure that there is no installation error and omission of part, etc.

(3) After cleaning the parts required to use with cleaning solvent, immerse them in hydraulic oil as required and re-assemble them.

(4) Before applying Loctite, clean and decrease the surface sufficiently, and apply it to two threads.
(The application of an excessive quantity of Loctite may cause a malfunction resulting in it squeezing out).

33.2.2.6 PRECAUTIONS WHEN FITTING SEALS

⚠ CAUTION

Precautions (Observe the following standards to guarantee safety).

(1) Replace seals with new ones when assembling.

(2) Ensure that seals are free from deformation and flaw coming about when handling them.

(3) Apply grease or hydraulic oil to the seals and seal fitting section to make the sliding smooth, unless otherwise specified.

(4) Do not stretch the seals too much. Otherwise they may be permanently deformed.

(5) Pay attention not to roll the O-ring when fitting. Because it is difficult for the twisted O-ring to be restored naturally after fitting, and it may cause oil leakage.

33.2.2.7 ASSEMBLY WORK

(1) Perform assembling work referring to the drawings in “Disassembly” Section.

(2) Assembling procedure

1) Assembling the main frame of the switching section (See Fig. 33-79).
Put all sections of main frame in order as shown in Table 33-2 directing the actuator port downward.

SECTION (Block)	MARK AQ10
Dozer	SR
Slewing	AN
P3 inlet	ND
Arm	bB
Service	bC
B/Swing	bD
Travel right	DG
P1, P2 inlet	FE
Travel LH	OC
Boom	QA
Bucket	AT
End cover	HD

33.2.3.3.2 Disassembly

(1) Remove the handle lever (1) assembly and boot (2) from the casing (101).

(2) Clean the pilot valve with white kerosene.
- Screw a blind plug in each port in advance.

(3) Hold the pilot valve with a vise by applying a copper or lead sheet.

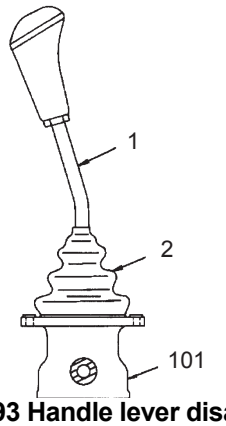


Fig. 33-93 Handle lever disassembly

(4) Apply wrenches to the adjusting nut (312) and the disk (302) across the flats to loosen and remove them.

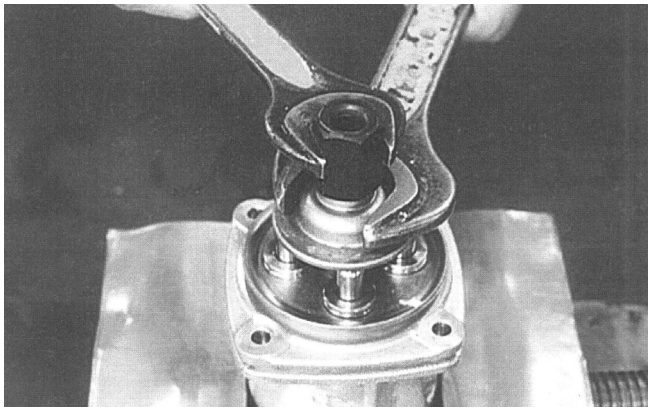


Fig. 33-94 Adjusting nut (312) removal

(5) Turn the joint (301) counterclockwise with a jig to loosen.

⚠ CAUTION

When pulling off the joint, be careful that the joint is no sooner loosened than the plate (151), plug (211) and push rod (212) may pop up if the return spring (221) is too strong.

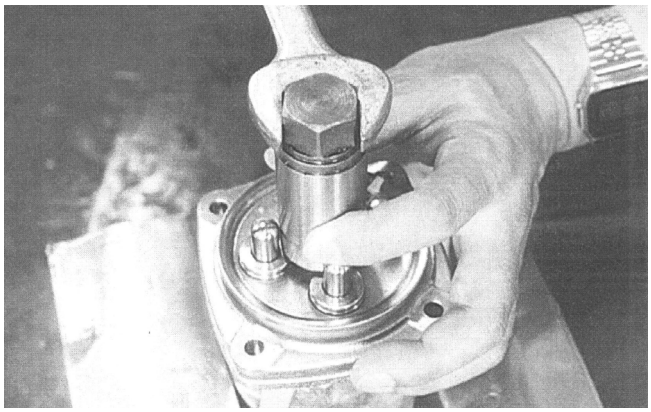


Fig. 33-95 Joint (301) removal

(6) Remove the plate (151).

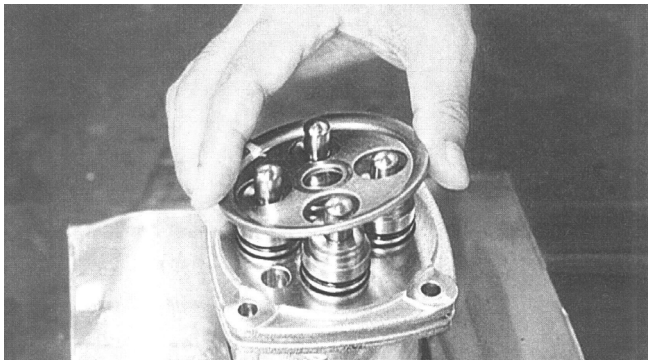


Fig. 33-96 Plate (151) removal

(10)Install piston (224).

(11)Place O-ring (212) in plug (202).

(12)Place packing (210) in plug (202).

- Pay attention to the direction when placing the packing (P) in.
- Apply grease slightly before placing packing (P) in.

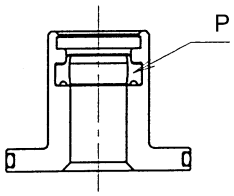


Fig. 33-117

(13)Place grease cup (203) in plug (202).

(14)Install push rod (214) on plug (202).

(15)Place the push rod subassembly which is assembled by the procedures in par. 11) to 14) in casing (102).

(16)Put cover (201) on the flat work bench, press bushing (414) with special jig 1, and press fit the bushing striking lightly.

(17)Fix the lower cover assembly which is assembled by the procedures in paragraph 2) to 6) with vise, and install the upper cover assembly which is assembled by the procedures in paragraph 7 to 15) on it.

(18)Install cover (201) on casing (102).

(19)Tighten socket bolt (271) to the specified torque.

(20)Install cam (420) on cover (201).

(21)Insert cam shaft (413) from the outside pressing cam (420).

(22)Apply Loctite #241 or equivalent to the thread of socket bolt.

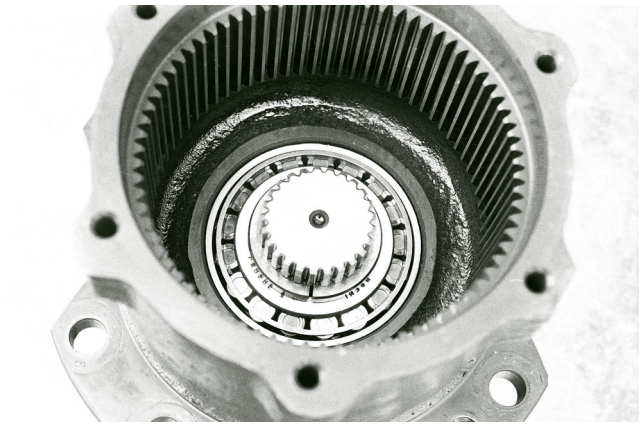
(23)Tighten socket bolt (472) to the specified torque.

(24)Incline cam (420), apply grease to the top end of push rod (214), and fill grease cup (203) of plug (202) with grease.

(25)After fitting the top end of bellows (501) in cam (402), fit the lower side in the groove of cover (201).

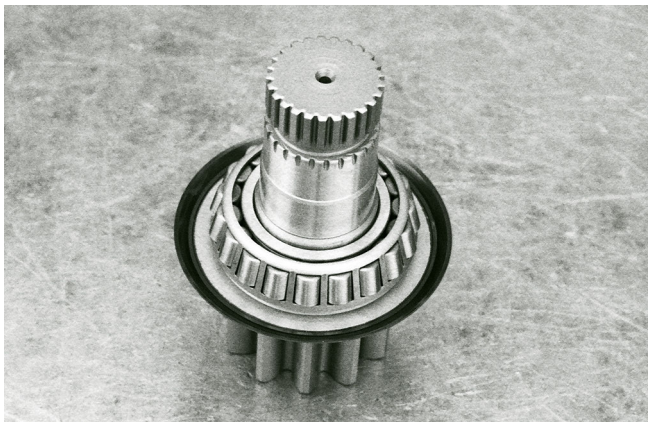
7) Remove ring (136) and split preload collar (114).

- Place the tip of a flat-blade screwdriver in the clearance between two preload collars and remove them by striking them with a hammer.
- Since their clearance to the straight roller bearing has been adjusted, separate the ring and the preloaded collars only if necessary.



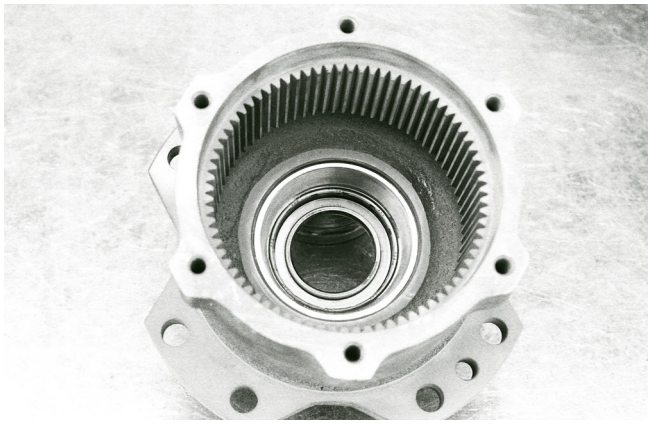
8) Remove pinion shaft (104).

- In order to keep the removing distance of pinion shaft, place a support of about 150mm under the flange of the casing and remove the pinion shaft by pressing the end face of it by press.
- Since their clearance to the straight roller bearing has been adjusted, separate them only if necessary.



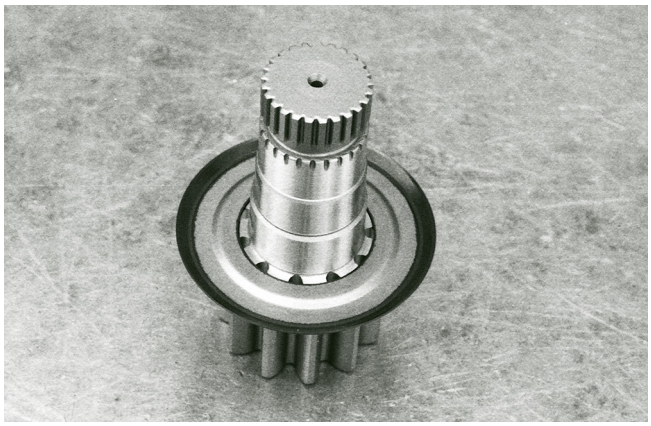
9) Remove the outer race of the straight roller bearings (115), (116) and oil seal (128).

- As the straight roller bearing and the outer race are difficult to remove, remove them only if necessary.
- Do not reuse the oil seal.

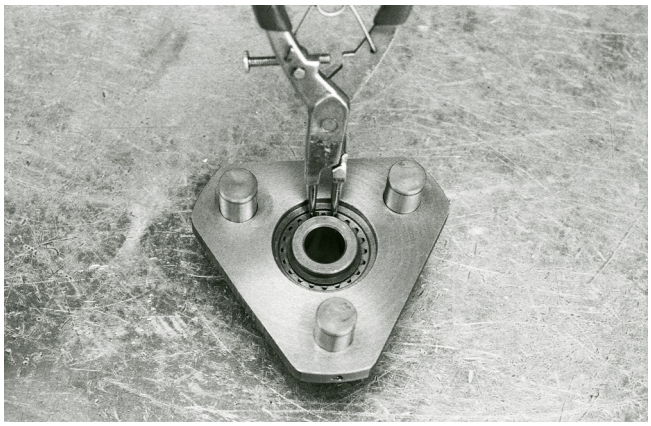


10) Remove the inner race of the straight roller bearing (115) and seal ring (112) from the pinion shaft.

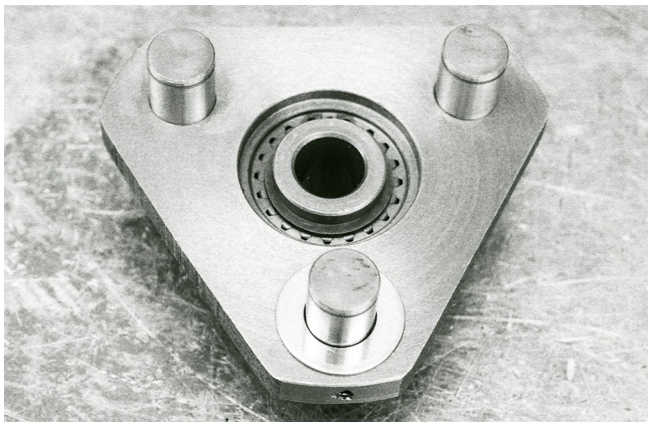
- The straight roller bearing is press-fitted into the inner race; separate them only if necessary.
- Do not reuse the oil seal.



13) Install the sun gear 1 (108) to back side of the carrier 2 (103) and fix it with the snap ring (123).

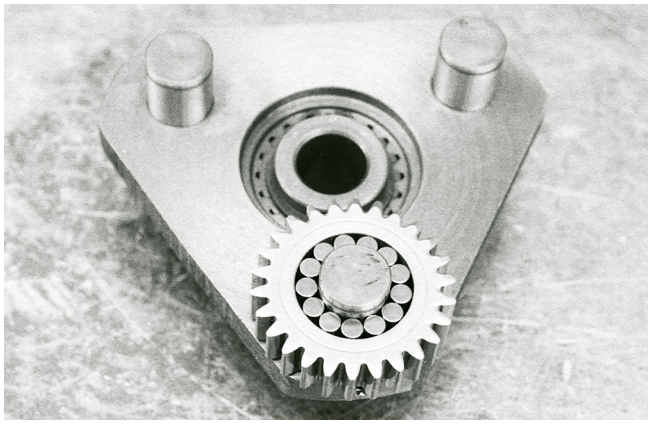


14) Install the thrust washer (119) on the pin 2 (111) of the carrier 2 (103).

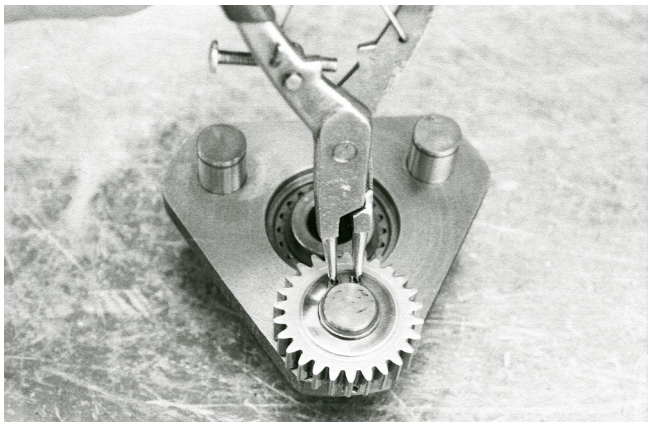


15) Install the spur gear 2 (107) and insert the roller (118).

- Number of rollers: 23 rollers by one spur gear (107).



16) Install the thrust washer (119), then fix the snap ring (124).



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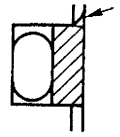
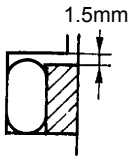
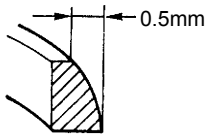
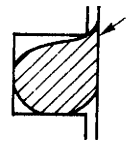
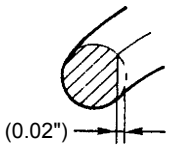
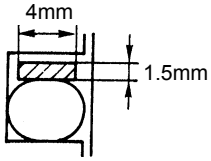
(3) Slipper seal

	Judgment criteria	Remedy
	• O-ring is excessively extruded from groove.	Replace
	• Slipper seal width is 1.5 mm or more smaller than the width of the seal groove.	Replace
	• Unequal wear of 0.5 mm or more.	Replace

(4) O-ring

	Judgment criteria	Remedy
	• O-ring is excessively extruded from groove.	Replace
	• Unequal wear of 0.5 mm or more.	Replace

(5) Backup ring

	Judgment criteria	Remedy
	• Thickness of 1.5 mm or less. Width of 4 mm or less.	Replace

31.1.2.4 MAINTENANCE STANDARD

(1) Rubber crawler

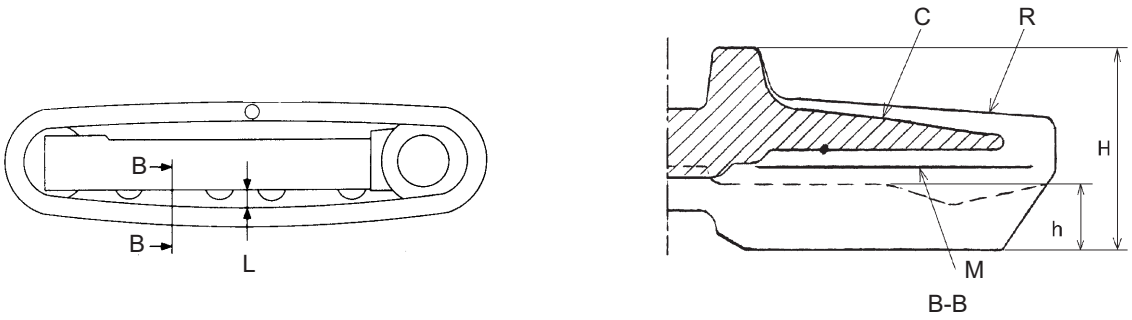


Fig. 34-21 Rubber crawler

L. Distance between the bottom of frame and top of rubber crawler
C. Core
R. Rubber cover
M. Centre line of steel frame

Unit: mm

ITEM	STANDARD VALUE	REPAIRABLE LEVEL	SERVICEABILITY LIMIT	REMEDY
Sag of rubber crawler L.	85 ÷ 95	—	—	Adjustment.
Cracks and notch on rubber crawler.	None.	Where the depth of them does not reach to the steel cords.	Where the depth of them reaches to the steel cords.	Replace.
Breakage of steel cord.	None.	None.	Exist.	Replace.
Contact surface of rubber crawler and lower roller.	None.	Where 10 percent of cores are visible from outside.	Where half of cores are visible from outside.	Replace.
Height (H).	94	—	70	Replace.
Lug projection (h).	25	—	0	Replace.

31.1.6 LOWER ROLLER

31.1.6.1 REMOVAL AND INSTALLATION PROCEDURES

Q.ty on one side: 4 pc.

31.1.6.1.1 Removing

(1) Slightly loosen capscrews (M16x35) (2) fastening lower roller assembly (1) to the lower frame.

: 24 mm

(2) As same as the case for removal of the crawler, loosen the grease nipple for crawler adjusting within one turn to discharge the grease, and release the tension on the crawler.

: 17 mm

(3) Lift the lower frame good enough to remove the lower roller, using the attachment.

(4) After lifting the lower frame to a proper height, place square lumber under the lower frame to stabilize the machine.

(5) Remove the capscrews (2) fastening the lower roller, and remove the lower roller assembly.

: 24 mm

Weight of lower roller assembly: 8.7 kg

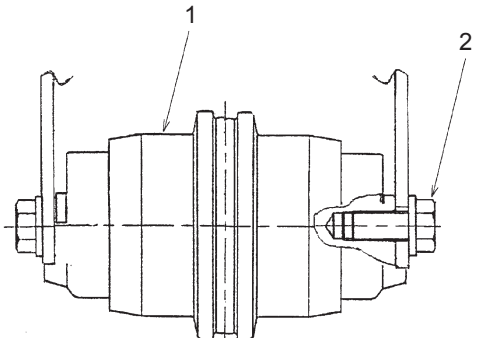


Fig. 34-35 Lower roller assembly

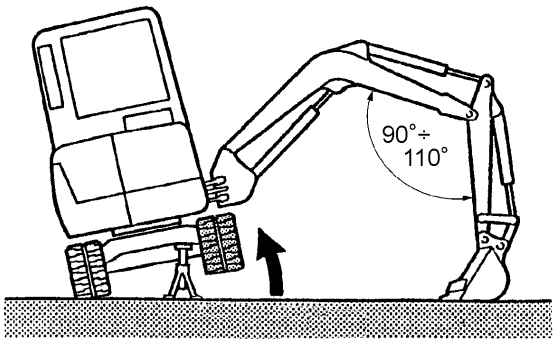


Fig. 34-36 Crawler removing posture

31.1.6.1.2 Installing

(1) Installing position of lower roller
Install the lower roller assembly so that the plug (3) directs outward from the machine.

(2) Coat the mounting capscrews (2) with Loctite #262 in advance.
Place the roller assembly (1) between the crawler and lower frame (4).
Fasten the capscrews (2) temporarily.

: 24 mm

(3) Lower the machine in full contact with the ground and tighten the capscrews (2) as specified.

: 24 mm,
Tightening torque = 208 Nm

(4) Tighten the grease nipple of the crawler adjuster.
Lift the machine, and adjust the crawler tension by feeding grease.

: 17 mm,
Tightening torque = 73.5 Nm

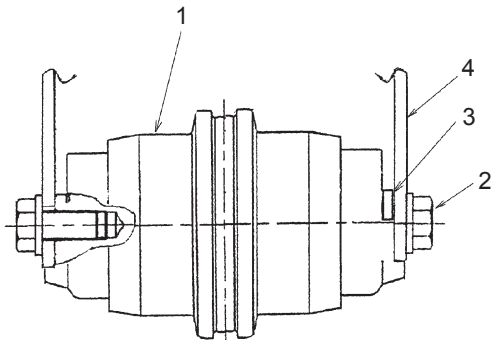


Fig. 34-37 Installing lower roller

(4) With idler (1) placed on the stand, tap bushing (2) lightly by hammer, while placing the bushing extruding rod (T) against the end face of bushing (2) evenly all round, till it comes out.

(5) Take out floating seals (4) from idler (1), collar (3). If you intend to re-use floating seals (4), confirm that there is no scoring and rusting on the contact surface and store the floating seals in pairs by placing thick paper between the sealing faces.

(6) Remove O-ring (7) from shaft (6).

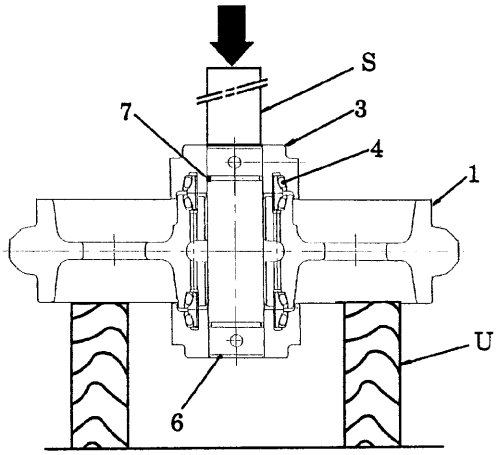


Fig. 34-57 Removing bushing

31.1.7.3.2 Assembly

(1) Align inner hole of idler (1) and bushing (2) and press fit it vertically with press.

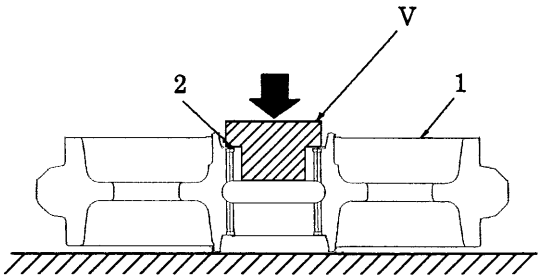


Fig. 34-58 Press fitting bushing (2)

(2) Fit O-ring (7) to O-ring groove on shaft (2).
- Coat grease to O-ring.

(3) Installation of collar (3) (See 32.2.1.3)
Press fit the O-ring installed side of shaft into collar (3), and drive pin (5).

(4) Fit one piece of two (2) pieces type floating seal (4) on each side of collar (3) and idler (1).

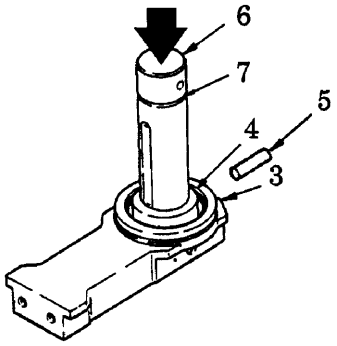


Fig. 34-59 Pressing in shaft (6)

(5) Insert shaft (6) into idler (1).
- Apply gear oil to shaft.

(6) Fit floating seal (4) on the other side of idler (1).

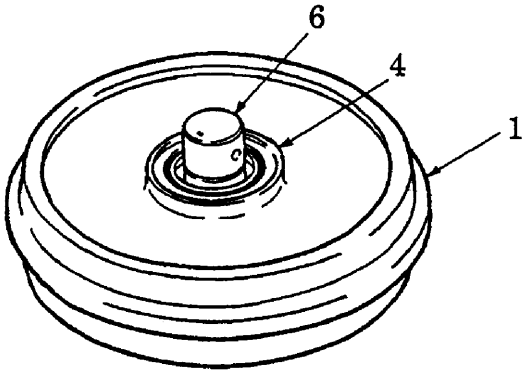


Fig. 34-60 Installing floating seal (4)

(3) Reconnect the hydraulic pipings as before, and tighten the joints to the specified torque.

• Fill the casing with hydraulic oil prior to perform drain piping.

Tightening torque Nm				
Port	Thread size (PF)	Spanner used mm	O-ring type fitting	30° flare type fitting
A,B	1/2	27	108	78.5
P	1/4	17	36.3	29.4
DR	3/8	22	73.5	49.0

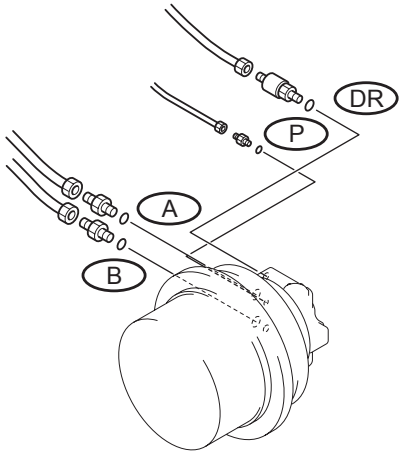


Fig. 34-82 Installing hydraulic pipings (Left-travel motor)

(4) Install the covers (A1) located inside the lower frame, and tighten capscrews (A4). (see Fig. 34-79).

: 17 mm

(5) Remove the wooden block (3) supporting the lower frame and install the crawler.

(6) Check the oil level in the reduction unit of travel motor [See Item (7) below] and replace or replenish oil as required.
Oil: GEAR OIL HYPOIDE 90
Volume of oil: 900 cc

: 8 mm

(7) Checking oil level in reduction unit

a. Stop the machine so that the drain plug (8) of the reduction unit is located in the lowest position.

b. Remove the level plug (7) and check the oil level and contamination. The oil level is proper if it is close to the plug bore. Replenish oil if necessary.

• When starting operation, operate motor in low idling and at low speed for several minutes, and check it for possible oil leakage and noise.

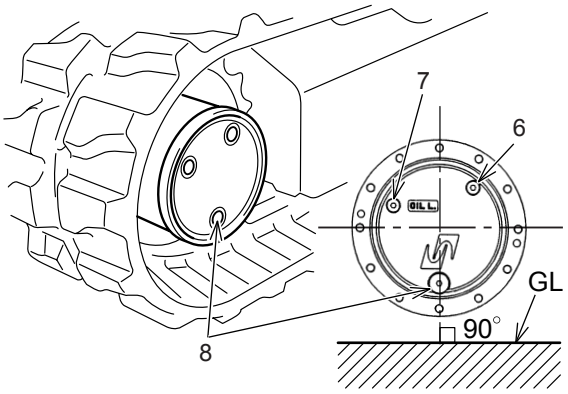


Fig. 34-83 Checking oil level

31.1.10.2 MAINTENANCE STANDARD

	ITEM	SPECIFICATIONS
TIGHTENING TORQUE	Sprocket fixing Capscrew M14	Apply Loctite #262 181 Nm
	Travel motor fixing Capscrew M14	
OIL	Specifications and grade	Gear oil HYPOIDE 90
	Volume	900 cc

31.2.1.3 DISASSEMBLY

31.2.1.3.1 PREPARATIONS FOR DISASSEMBLY

Prior to disassembling, carry out the following preparations:

(1) Workbench preparation
- Prepare workbench for travel motor.
- Prepare workbench which is rigid enough to disassemble or assemble internal parts of travel motor and has a wide area for placing them to prevent them from moving or dropping during the work.
- Cover workbench with rubber, vinyl, etc.

(2) Preparations of tools and materials
Prepare materials shown in 34.2.1.2.

31.2.1.3.2 GENERAL PRECAUTIONS FOR WORKING

⚠ WARNING

Internal parts during disassembly are slippery as they are smeared by hydraulic oil. Handle them with extreme care not to drop them.
Otherwise, you may be injured or they may be damaged.
Combustible material such as kerosene is used to clean the parts.
Handle it with extreme care not to cause fire or burns, as it catch fire easily.

(1) Prior to disassembly, make a good judgment on the features etc. of the generated abnormalities to work according to the disassembling procedure.

(2) All parts are manufactured in high precision. Therefore handle them with care not to bump them each other or drop them.

(3) Work patiently not to forcibly strike or pry the sticking parts during disassembly. Otherwise it may result in generating burrs, damages, and performance deterioration.

(4) Be careful not to leave the disassembled parts without appropriate protection. Otherwise they may be rusted by moisture and or contaminated by dust.

(5) Put a match mark on each mating surface of part during disassembly.

(6) Carry out the work putting every removed part in order, and taking care not to cause damage or loss.

(7) Sealing parts shall be replaced in principle, even though no damage is found on them. Keep them on hand prior to disassembly.

(8) Photos and figures of typical models are shown. Any partial difference between them and the product in use does not affect the disassembling procedure.

5) Remove the cylinder block (104) from the drive shaft (102).

6) Remove piston assembly [piston (105) and shoe (106)] and the retainer plate (107) from the cylinder block (104).

- When removing the cylinder block, hold the retainer plate (107) by both hands to remove it with the piston assembly.
- The piston (105) and the shoe (106) are squeezed at the spherical portion of the piston to make them one piece. It is not possible to remove the piston from the shoe without damaging the shoe. When replacement is required, replace the piston and bottom together (hereafter referred to as the piston assembly).

7) Remove the retainer plate (107) from piston assembly (105) and (106) [seven sets].

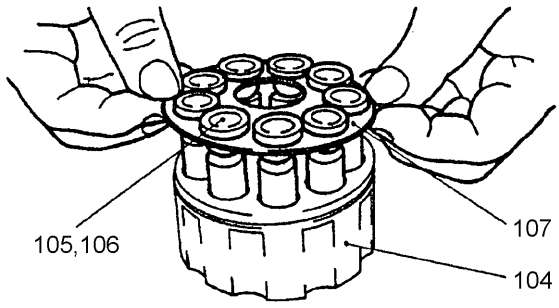


Fig. 34-127 Removing retainer plate (107)

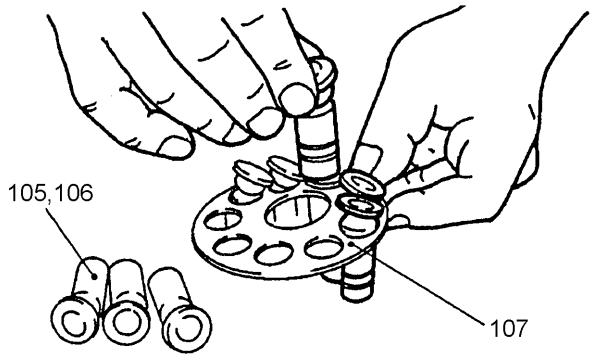


Fig. 34-128 Removing piston assembly (105) and (106)

8) Remove the thrust ball (108) from the cylinder block (104).

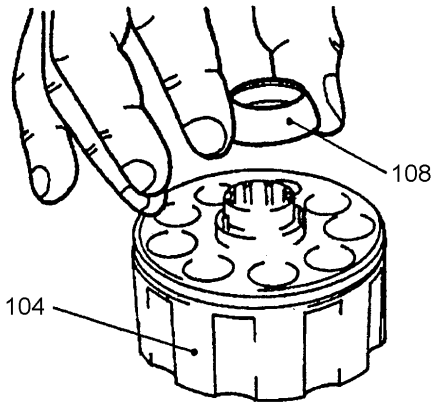


Fig. 34-129 Removing thrust washer (105)

9) Remove three rollers (151) from the cylinder block (104).

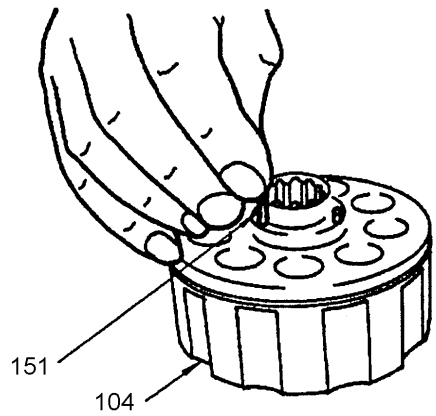


Fig. 34-130 Removing roller (104)

9) Turn over the travel motor. (Direct the motor side upward).

10) Remove the clamp plates from the workbench.

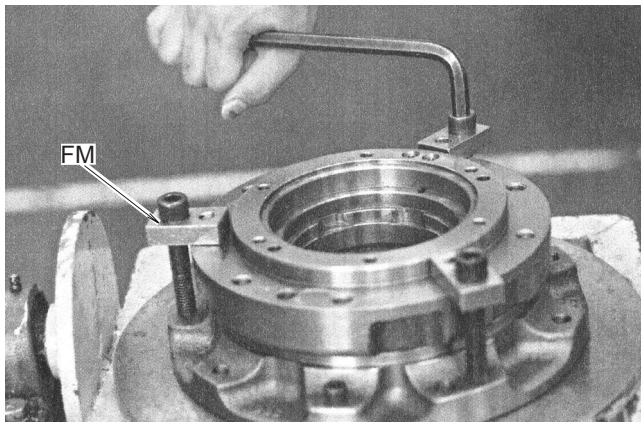


Fig. 34-160 Removing fixing plate

(3) Assembling motor parts inside spindle

1) Press fit the oil seal (132) into the spindle (2) using the oil seal press fit tool (RM3) and a hammer.

- Apply MG2 grease to the lip of the oil seal before installing.
- Be careful not to mistake the orientation of the oil seal.

2) Insert two parallel pins (177) into the pin holes of the spindle (2).

3) Apply Moly NLGI 2 grease to the semi-spherical surface of two pivots (167) and fit them to the parallel pins (177) installed to the spindle (2).

4) Apply grease to the spring pin (190) to install to the piston kit consisting of piston (161), shoe (162) and seal ring (163).

5) Apply grease to the sliding surface of the piston assembly to install to the piston hole of the spindle (2).

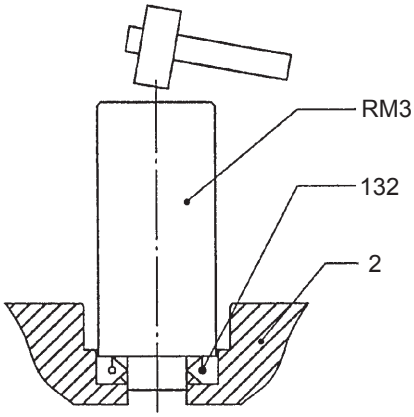


Fig. 34-161 Installing Oil seal (132)

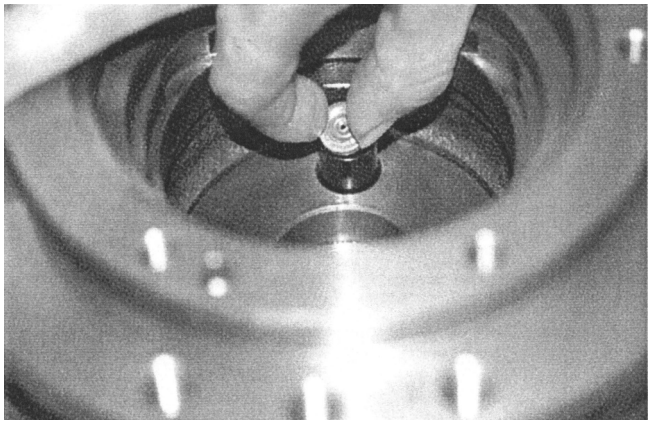


Fig. 34-162 Installing piston kit

(4) Inserting shaft

⚠ WARNING

Carefully carry out the insertion work using leather gloves to prevent possible burns.

1) Put the ball bearing (149) in a heating bath to heat it at 100 ± 10 °C for 10 minutes and then insert it onto the drive shaft (102).

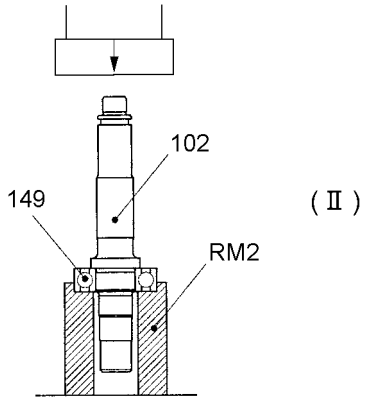


Fig. 34-163 Inserting bearing (149)

31.2.1.5 MAINTENANCE STANDARD

After disassembling GM motor, follow these standards to perform maintenance. Handle every part with care and, in particular, avoid damaging the moving and sliding portions.

(1) Replace any seal (O-ring, oil seal, and floating seal) once used even if no damage is found.

(2) Wear parts maintenance standard.

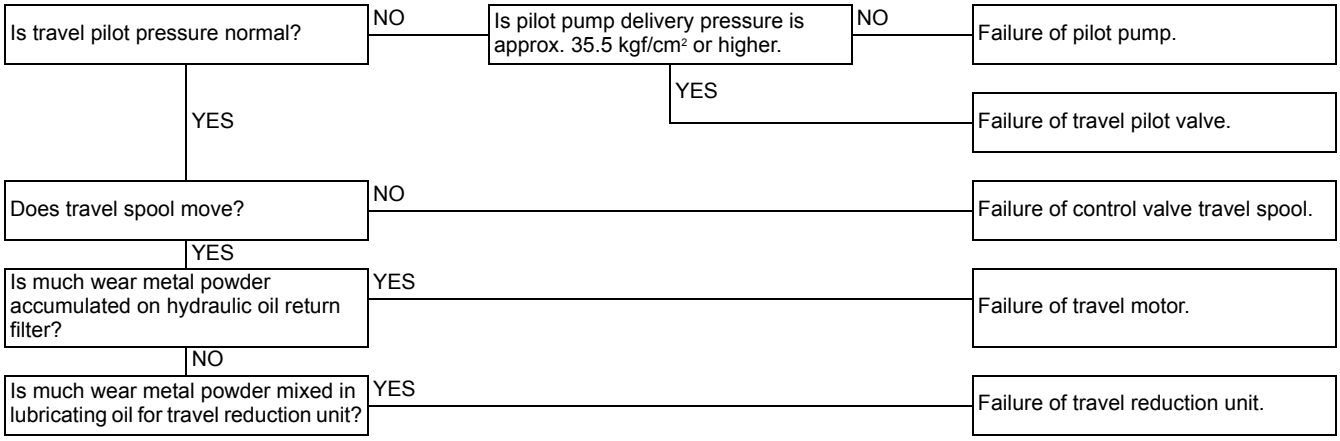
1) Replace any part heavily damaged visually.

2) Replace a part that shows the following abnormalities.

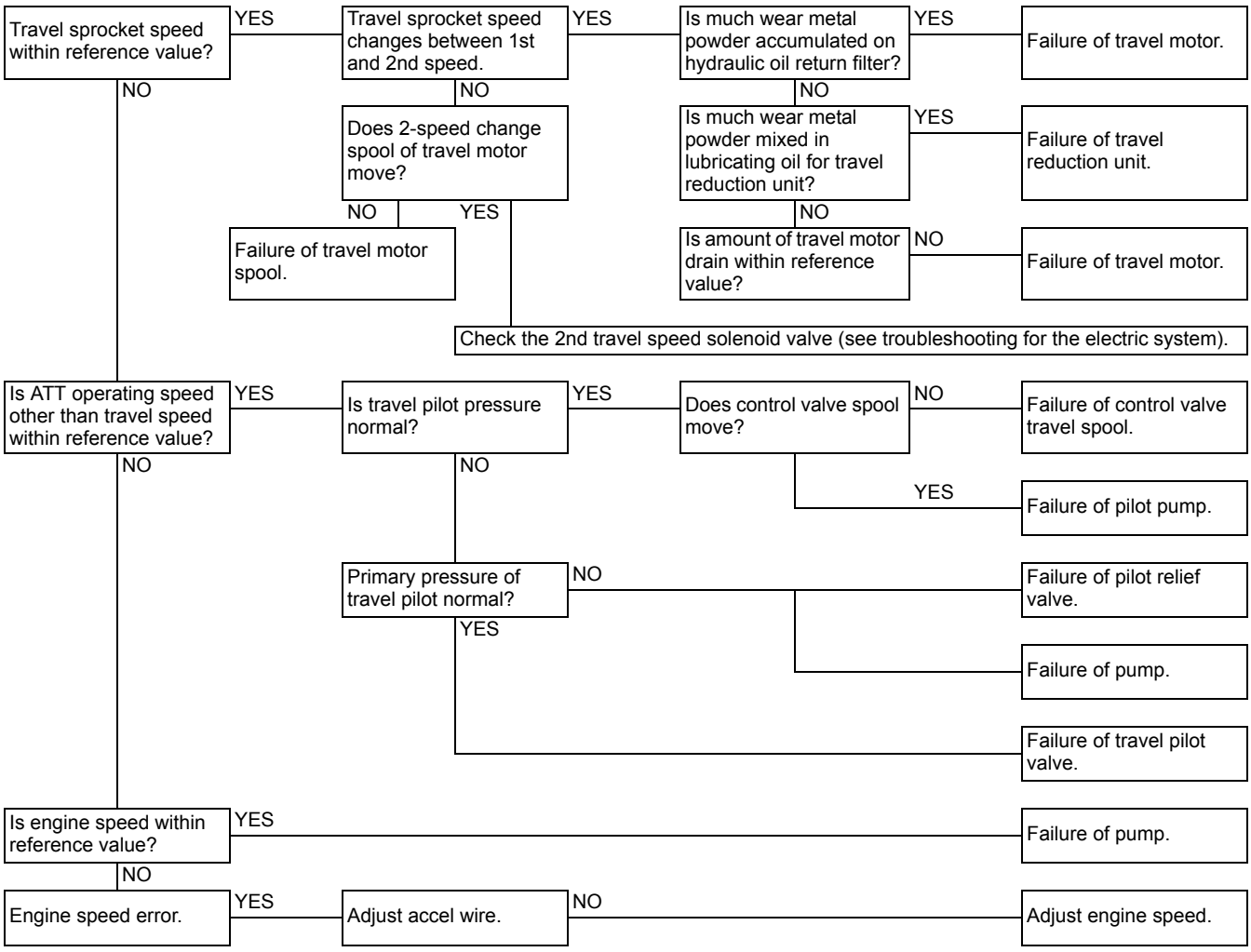
Item no.	Part name	Defect	Standard value (Standard dimension)	Allowable value (Criteria)
(1)	Hub	• Severe visual damage • Pitting recognized on ring gear tooth flank • Abnormal wear such as galling	–	–
(2)	Mandrel	• Severe visual damage • Abnormal wear such as galling.	–	–
(3) etc.	Carrier assembly	• Abnormal wear such as galling	–	–
(4) (6) (5) (7)	Sun gear 1 Sun gear 2 Planetary gear 1 Planetary gear 2	• Pitting recognized on tooth flank • Flaking recognized on bearing rolling surface	–	–
(9) (11) (12)	Thrust washer 1 Thrust collar 4 Thrust washer 3	• Sliding surface discoloured and/or abnormally worn	–	–
(24)	Main bearing	• Dent recognized • Flaking recognized • Uneven wear recognized	–	–
(27) (28)	Needle bearing	• Pitting recognized on roller • Abnormal wear on cage end surface	–	–
(29) (30)	Inner bearing cup	• Flaking recognized on bearing rolling surface	–	–
(201)	Rear flange	• Scratch recognized on valve (263) sliding surface	–	–
(102)	Shaft	• Oil seal (132) contacting surface worn • Spline worn	–	–
(103)	Swash plate	• Seizure is recognized	–	–
(104)	Cylinder block	• Spline worn • Bore severely worn • Scratch and uneven wear recognized on timing plate (109) sliding surface	–	–
(105) (106)	Piston assy Piston Shoe	• Clearance exists between piston (105) and bottom (106) • Abnormal and uneven wear recognized on shoe surface	Play 0.05 mm	Play 0.15 mm
(107)	Retainer plate	• Uneven wear recognized on shoe (106) sliding surface • Scratch and uneven wear recognized on thrust ball (108) sliding surface	–	–

42.3.2 TRAVEL OPERATION

42.3.2.1 Travel operational failure

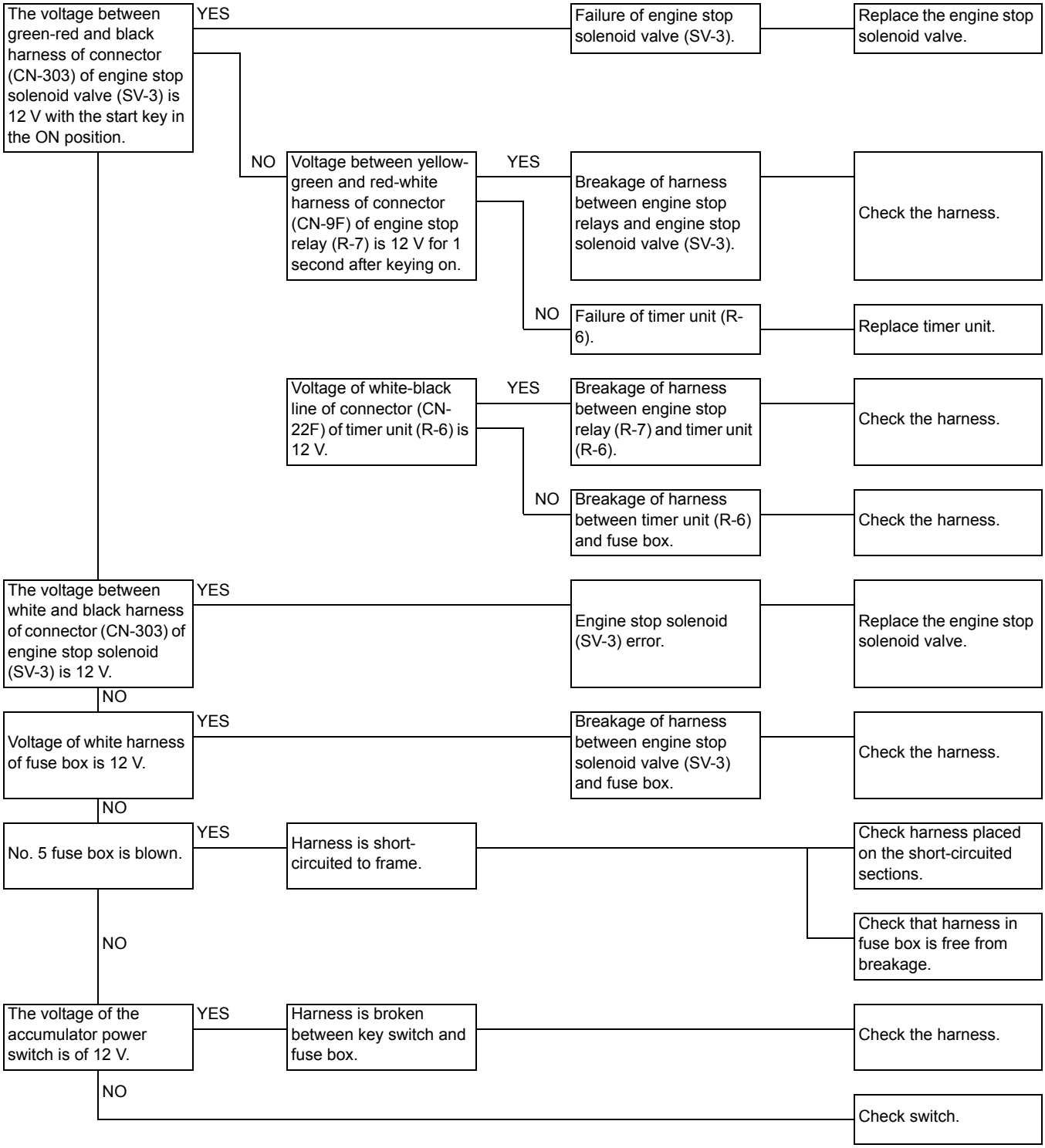


42.3.2.2 Travel speed is slow



(2)

Starter turns but engine does not start. (When key is ON position)



Classification	Group no.		Cause / Trouble	Engine dealer																
				Lubrication system			Cooling		Mechanical											
				Oil gets into combustion chamber through piston / valve guide	Check relief valve	Fuel mixed	Thermostat inspection	Oil cooler element damaged	Compression pressure low	Control rack movement not smooth	Governor spring fatigue	Crank shaft oil seal defective	Piston liner worn	Piston ring worn	Valve spring fatigue	Internal part seizure	Check fuel feed	Defective head gasket	Flywheel gear damaged
Trouble start	1	(1)	Starter does not rotate																	
		(2)	The starter motor rotates but does not start				○		○				○	○	○		○	○	○
Rotation trouble	2	(1)	Idling not smooth				○		○	○	○			○	○		○	○	
		(2)	Medium speed hunting																
		(3)	High speed not smooth							○	○								
			Not reach max. speed								○								
Performance drop	3	(1)	Engine output not enough				○		○					○					
			Overheating		○	○	○	○										○	
		(2)	Knocking at high temperature	○					○										
Other trouble	4	(1)	Large amount of black exhaust gas				○							○	○	○		○	
			White exhaust gas	○					○										
		(2)	Excessive oil consumption	○								○	○	○					
		(3)	Engine excessive fuel consumption						○										
		(4)	Engine not stop when key turned OFF																
		(5)	When key is turned OFF, power supply disconnected but engine not stop																

51. ENGINE

TABLE OF CONTENTS

(8) 4TNV94L

Engine name		Unit	4TNV94L					
Engine specification class		-	CL		VL			
Type		-	Vertical, in-line, 4-cycle, water-cooled diesel engine					
Combustion chamber		-	Direct injection					
Number of cylinders		-	4					
Cylinder bore stroke		mm x mm	94 x 110					
Displacement		L	3.053					
Continuous rating	Rotation speed	rpm	1500	1800	-			
	Output	kW	26.1	31.3	-			
Rated output	Rotation speed	rpm	1500	1800	2000	2200	2400	2500
	Output	kW	29.1	34.6	35.3	38.2	41.6	43.0
Maximum no-load speed (±25)		rpm	1600	1895	2180	2400	2590	2700
Order of ignition		-	1-3-4-2-1(No.1 cylinder on flywheel side)					
Power take off		-	Flywheel					
Rotating direction		-	Counterclockwise (viewed from flywheel)					
Cooling system		-	Radiator					
Lubrication system		-	Forced lubrication with trochoid pump					
Starting system		-	Electrical system					
Appropriate fuel		-	ASTM fuel No. 2-D type TT					
Applicable lubricant		-	SUPER GOLD 10W-30		SUPER GOLD 15W-40			
Lubricant capacity (oil pan)*	Total	L	10.2					
	Effective	L	4.5					
Coolant volume (engine only)		L	4.2					
Engine Dimensions ** (with flywheel housing)	Overall length	mm	719					
	Overall width	mm	498					
	Overall height	mm	717					
Engine mass (dry) ** (with flywheel housing)		kg	245		235			
Fan (standard)		mm	410 mm (16.41) O/D. 6 blades pusher type					
Crankshaft V pulley diameter and fan V-belt diameter (standard)		mm	130 x 130					

* Engine oil capacity may differ from the above depending on an engine installed on a machine unit.

** Engine mass and dimensions without radiator.

51.2 INSPECTION AND ADJUSTMENT

51.2.1 PERIODIC MAINTENANCE SCHEDULE

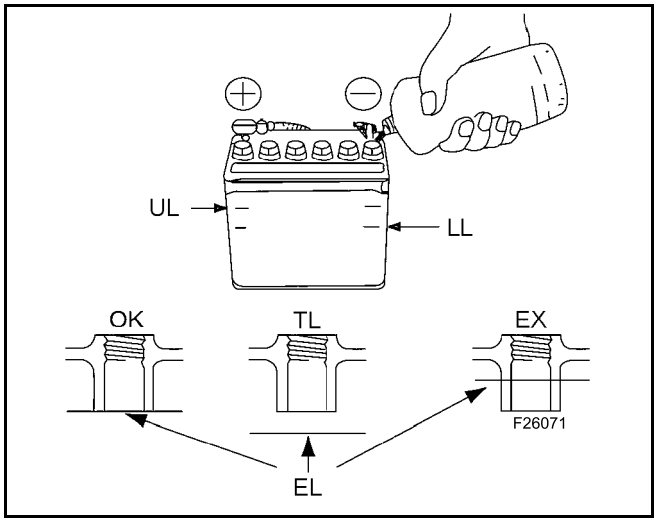
The engine periodic inspection timing is hard to determine as it varies with the application, load status, qualities of the fuel and lubricating oils used and handling status. General rules are described here.

❍: User-maintenance ■: Parts replacement ●: Shop-inspection

Classification	Piece	Daily	Maintenance period				
			Every 50 hours	Every 250 hours or 3 months	Every 500 hours or 6 months	Inspection every 1000 hours or one year	Every 2000 hours or two years
Whole	Visual check around the machine	❍					
Fuel system	Fuel tank level check and fuel supply	❍					
	Fuel tank drain		❍				
	Water separator (Option) draining		❍				
	Fuel system bleeding		❍				
	Water separator cleaning				❍		
	Fuel filter element replacement				❍		
Lubricating oil system	Lube oil level check and replenishment	❍					
	Lube oil replacement		■ 1st time	■ 2nd time and thereafter			
	Lube oil filter replacement						
Coolant pump	Coolant level check and replenishment	❍					
	Radiator fin cleaning			❍			
	V-belt tension check		❍ 1st time	❍ 2nd time and thereafter			
	Coolant change					■	
	Coolant/water path flushing and maintenance						●
Rubber hose	Fuel pipe and coolant pipe inspection and maintenance	❍					●
Injection governor	Inspection and adjustment of governor lever and accelerator	❍		❍			
Air intake system	Air cleaner cleaning and element replacement			❍	■		
	Diaphragm assy inspection					● (2 years)	
	Turbocharger blower cleaning*					●*	
Electrical system	Warning lamp and instruments function check	❍					
	Battery electrolyte level check and battery recharging		❍				
Cylinder head	Intake/exhaust valve head clearance adjustment					●	
	Intake/exhaust valve seat lapping						●
Fuel injection pump and nozzle	Fuel injection nozzle pressure inspection					●*	
	Fuel injection timing adjustment Fuel injection pump inspection and adjustment						●*

*EPA allows servicing the emission related parts every 1500 or 3000 hours

1. Electrolyte level
   - Check the electrolyte level (EL) in the battery. When the amount of fluid nears the lower limit (LL), fill with battery fluid (available in the market) to the upper limit (UL). If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode.
   - Battery fluid tends to evaporate more quickly in the summer, and the fluid level should be checked earlier than the specified times.
   - If the engine cranking speed is so slow that the engine does not start up, recharge the battery.
   - If the engine still will not start after charging, replace the battery.
   - Remove the battery from the battery mounting of the machine unit after daily use if letting the machine unit leave in the place that the ambient temperature could drop at -15°C or less. And store the battery in a warm place until the next use the unit to start the engine easily at low ambient temperature.



2. Battery charge

   Use a battery tester or hydrometer and check the battery condition. If the battery is discharged, recharge it.

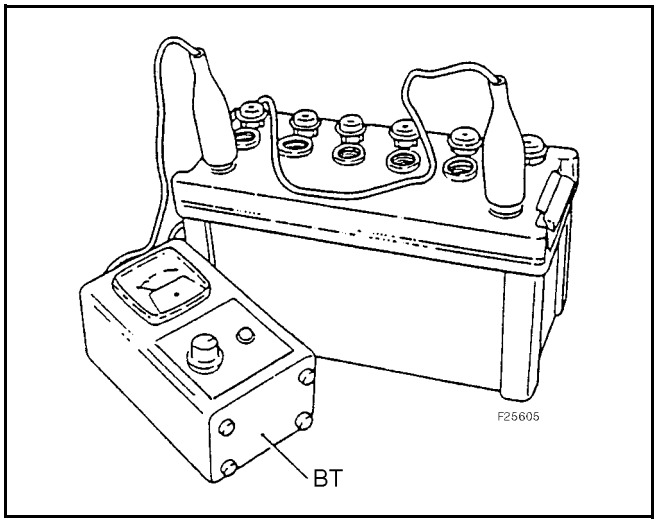
   (a) Measurement with a battery tester (BT)

   When checking the battery with the batter tester, connect the red clip of the tester to the battery positive (+) terminal and black clip to the battery negative (-) terminal by pinching them securely, and judge the battery charge level from the indicator position.

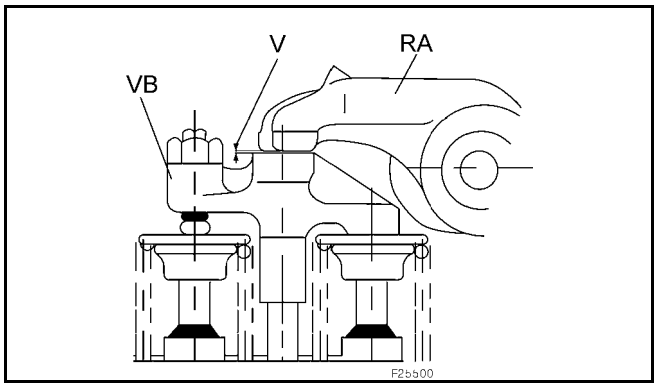
   Green zone: Normal

   Yellow zone: Slightly discharged

   Red zone: Defective or much discharged



- Valve clearance measurement
  In case of 2-valve cylinder head insert a thickness gauge between the rocker arm (RA) and valve cap, and record the measured valve (V) clearance. In case of 4-valve head insert a thickness gauge between the rocker arm (RA) and the valve bridge (VB), and record the measured valve (V) clearance. (Use it as the data for estimating the wear state).
- Adjusting other cylinders
  In case of 4-cylinder engines, turn the crankshaft by 180° and make adjustment for the no. 3 cylinder.
  Then adjust the no. 4 and no. 2 cylinders in this order. The cylinder to be adjusted first does not have to be the no. 1 cylinder.
  Select and adjust the cylinder where the piston is the nearest to the top dead centre after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 180° each time. In case of 3-cylinder engines, turn the crankshaft by 240° and make adjustment for the no. 3 cylinder.
  Then adjust the no. 2 cylinder in this order.



The cylinder to be adjusted first does not have to be the no. 1 cylinder.
Select and adjust the cylinder where the piston is the nearest to the top dead centre after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 240° each time.
The adjustment method of reducing the flywheel turning numbers (for reference):
For 3 cylinder engines
Set no.1 cylinder to the compression T.D.C.and adjust the clearance of the ● mark of the below table. Next, turn the flywheel once (the suction / exhaust valve of no. 1 cylinder is in the position of the overlap TDC at this time), and adjust the clearance of the ❍ mark.

Ignition order of 3 cylinder engines: 1→3 →2

Cylinder no. 1	1		2		3		
Valve	Inlet	Drain	Inlet	Drain	Inlet	Drain	
No. 1 compression T.D.C.	●	●	●			●	The first time
No. 1 overlap T.D.C.				❍	❍		The second time

For 4 cylinder engines
Set no.1 cylinder to the compression T.D.C.and adjust the clearance of the ● mark of the below table.
Next, turn the flywheel once, and adjust the clearance of the ❍ mark.

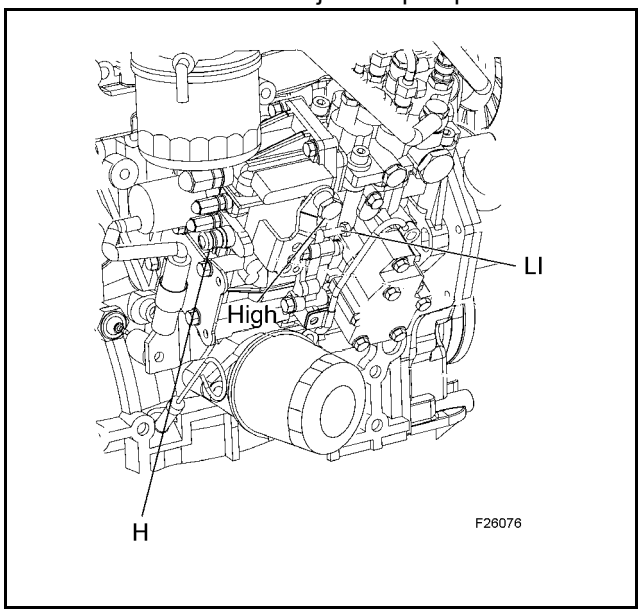
Ignition order of 3 cylinder engines: 1→3 →4 →2

Cylinder no. 1	1		2		3		4		
Valve	Inlet	Drain	Inlet	Drain	Inlet	Drain	Inlet	Drain	
No. 1 compression T.D.C.	●	●	●			●			The first time
No. 4 compression T.D.C.				❍	❍		❍	❍	The second time

51.2.3 ADJUSTING THE NO-LOAD MAXIMUM OR MINIMUM SPEED

1. After warming the engine up, gradually raise the speed and set it at the no-load maximum revolution.
2. If the no-load maximum revolution is out of the standard, adjust it by turning the high idle (H) limiting screw.
3. Then set the no-load minimum speed by adjusting the low idle (LI) limiting screw.

MP2 Fuel injection pump



Standards (Unit: rpm)

Engine specification class	Rating speed	No-load maximum	No-load minimum
CL	1500	1575-1625	1200 or more
	1800	1870-1920	
VL	2000	2180-2230	800 or more (1100 or more for 4TNV106(T))
	2200	2395-2445	
	2400	2590-2640	
	2500	2700-2750	
	2600	2785-2835	
	2800	2970-3020	
	3000	3185-3235	

Note) The engine speed may differ from the above standard depending on an engine installed on a machine unit.

Trouble symptom / Cause		Starting failure				Insufficient engine output			Strange exhaust gas colour		High knocking sound during combustion	Abnormal engine sound	Uneven combustion sound	Hunting		Corrective action
		Engine does not start.	Engine starts but stops soon			Exhaust colour			During work					During idling	During work	
			Exhaust smoke													
			None	Little	Much	Normal	White	Black	White	Black						
Air/Exhaust Gas System	Air cleaner clogged				❍			❍		❍			❍			Clean. (See 51.2.4)
	Engine used at high temperatures or at high altitude							❍		❍						Study output drop and load matching.
	Clogged exhaust pipe							❍		❍			❍			Clean.
Electrical system	Starter motor defective	❍														Repair or replace. (See chapter 51.8).
	Alternator defective	❍														Repair or replace. (See chapter 51.9).
	Open-circuit in wiring	❍														Repair. (See chapter 51.10).
	Battery voltage drop	❍														Inspect and change the battery. (See 51.2.2.3)

Trouble symptom / Cause		Large engine vibration	Difficulty in returning to low speed	Engine excessive fuel consumption	Lubricating oil				Much blow-by gas	Coolant		Air intake		Exhaust temperature rise	Corrective action
					Excessive consumption	Diluted with fuel	Mixture with water	Low L.O. pressure		Overheating	Low water temperature	Pressure drop	Pressure rise		
Air/Exhaust Gas System	Air cleaner clogged											❍			Clean. (See 51.2.2.4)
	Engine used at high temperatures or at high altitude			❍						❍		❍			Study output drop and load matching.
	Clogged exhaust pipe													❍	Clean.
Electrical system	Starter motor defective														Repair or replace. (See chapter 51.8).
	Alternator defective														Repair or replace. (See chapter 51.9).
	Open-circuit in wiring														Repair. (See chapter 51.10).
	Battery voltage drop														Inspect and change the battery. (See 512.2.3)

Step	Removal Parts	Observations
14	1. Remove lubricating oil pump.	
15	1. Remove starting motor from flywheel housing sing.	
16	1. Remove the flywheel mounting screw. 2. Remove the flywheel.	1. Carefully protect the ring gear from damage.
17	1. Remove flywheel housing. 2. Remove oil seal case with a screwdriver or the like by utilizing grooves on both sides of oil seal case.	1. Carefully protect the ring gear from damage mage.
18	1. Remove oil pan and spacer.	1. Put the cylinder block with the attaching surface of the cylinder head facing down. 2. Carefully protect the combustion surface of the cylinder block from damage. 3. For indirect injection system, be careful to the possibility of the tapped to drop off when the cylinder block is turned upside down, because the tappet is cylindrical in shape.
19	1. Remove idle gear shaft, and then remove idle gear. 2. Remove the mounting screw of thrust bearing through the hole of the camshaft gear. Remove camshaft assembly.	1. Turn the cylinder block aside and carefully prevent tappet from jamming on the cam. 2. Preheat camshaft gear and camshaft assembly to 180° 200° which are shrink fitted, before removing them.
20	1. Remove gear case flange.	
21	1. Remove lubricating oil strainer.	
22	1. Remove crankpin side cap of the connecting rod. While turning crankshaft, place piston in the bottom dead center (BDC).	1. Before extracting piston, remove carbon deposits from the upper wall of the cylinder using fine sandpaper, while taking care not to damage the inner surface of the cylinder. 2. Make sure that the No. of the protection of the connecting rod matches the No. of the cylinder. 3. Take care not to let crankpin metal fall when removing connecting rod crankpin side cap.

Point 7

Disassembly

- Keep the removed push rods by attaching tags showing corresponding cylinder Nos.

Reassemble

- Always apply oil to the contact portions of the push rods and clearance adjusting screws.

Point 8

Disassembly

- Loosen the cylinder head screws in two steps in the given order.
- Place the cylinder head assy on a paper board to prevent the combustion face from any damage.

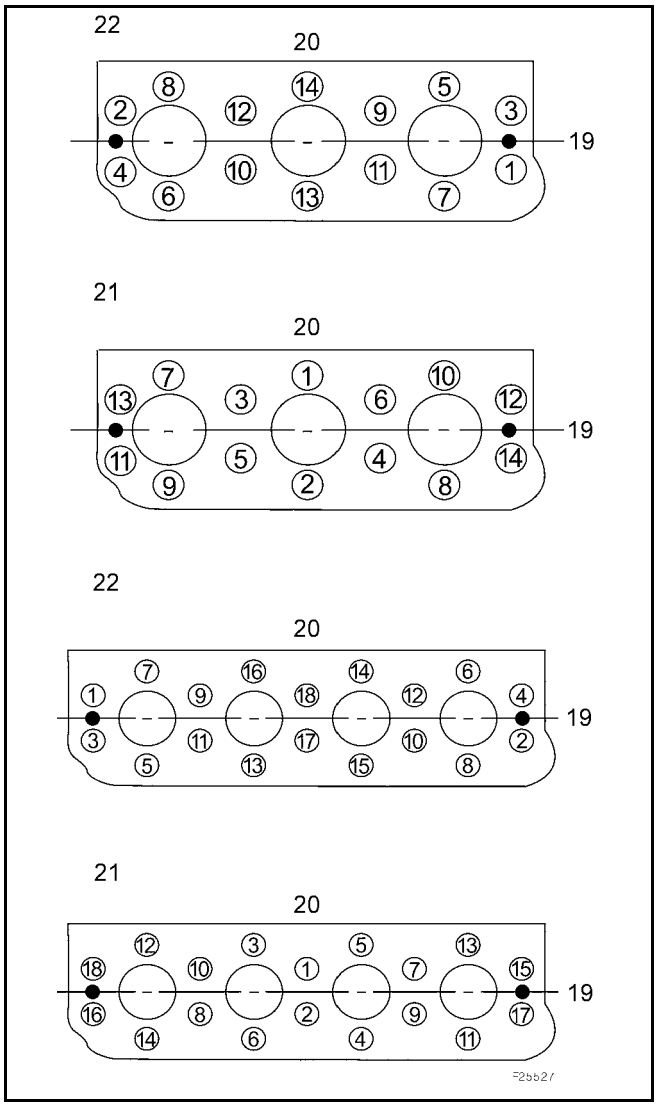
Reassemble

- Remove the head gasket with a new one.
- Uniformly install the head screws manually after applying oil on the threaded and seat portions.
- They shall be tightened in two steps in the reverse of the order for disassembly.
- Tightening torque

Nm

	TNV82A	TNV84-88
First step	30.0 ÷ 34.0	41.1 ÷ 46.9
Second step	61.7 ÷ 65.7	85.3 ÷ 91.1

	4TNV94L/98	4TNV106(T)
First step	49.0 ÷ 58.8	88.3 ÷ 98.1
Second step	103.1 ÷ 112.9	188.0 ÷ 197.8



19. Fan side
20. Camshaft side
21. Assembly
22. Disassembly

Point 9

Disassembly

- Carefully remove the fuel injection valve so as not to leave the top end protector from being left inside the cylinder.

Reassemble

- Replace the fuel filter element with a new one.

51.4.3.4 Servicing points

Point 1

Disassembly

- Remove the crankshaft pulley using a gear puller after removing the crankshaft pulley setscrew. When removing the pulley using the gear puller, use a pad and carefully operate so as not to damage the thread. Set the gear puller securely to prevent the pulley from being damaged.

Reassemble

- Apply grease MG2 to the oil seal lips. For the oil seal with double lips dust seal, further slightly apply engine oil on the lips so as not to damage them.
- Clean by wiping off any oil on both taper surfaces using detergent.
- Be sure to use the crankshaft pulley installing tool so as not to damage the oil seal lips. (See 51.4.3 (6) Oil seal replacement)
- When installing the crankshaft pulley, apply lube oil to the setscrew to tension it and carefully assemble so as not to damage the oil seal.

Nm

Model	Tightening torque
3TNV82A~TNV88	112.7 ÷ 122.7
4TNV94L/98/106(T)	107.9 ÷ 127.5

Point 2

Reassemble

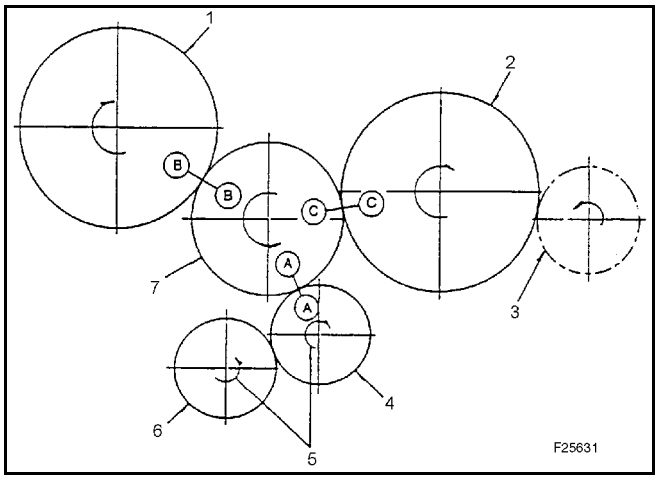
- When installing the gear case, do not forget to install the two reinforcing screws at the centre.
- Measure the backlash of each gear.

mm

3TNV82A~88	Standard value	Limit value
Crankshaft gear (4) Crankshaft gear (2) Fuel injection pump (1) Idle gear (7), PTO gear (3)	0,07 ÷ 0,15	0,17
Lubricating oil pump gear (6)	0,11 ÷ 0,19	0,21

4TNV94L-106(T)	Standard value	Limit value
Crankshaft gear (4) Crankshaft gear (2) Fuel injection pump (1) Idle gear (7), PTO gear (3)	0,08 ÷ 0,14	0,16
Balancer gear (only 4TNV106(T)).	0,12 ÷ 0,18	0,20
Lubricating oil pump gear (6)	0,09 ÷ 0,15	0,17

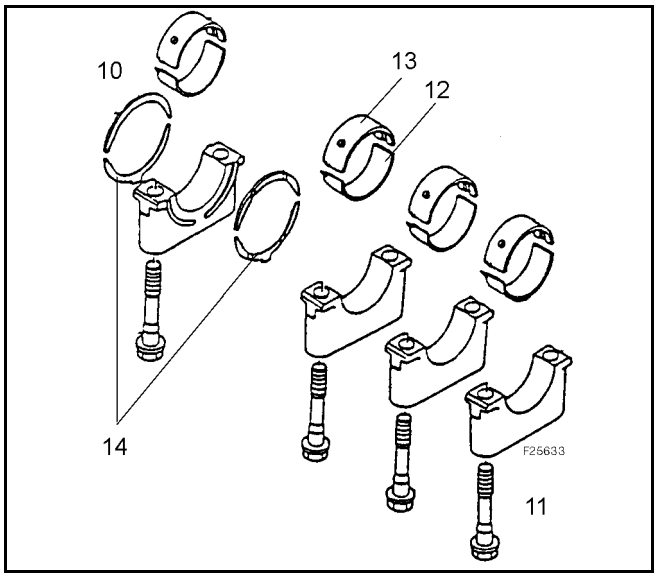
- Apply sealant and install the gear case by correctly positioning the two dowel pins.



5. Rotating direction

Disassembly

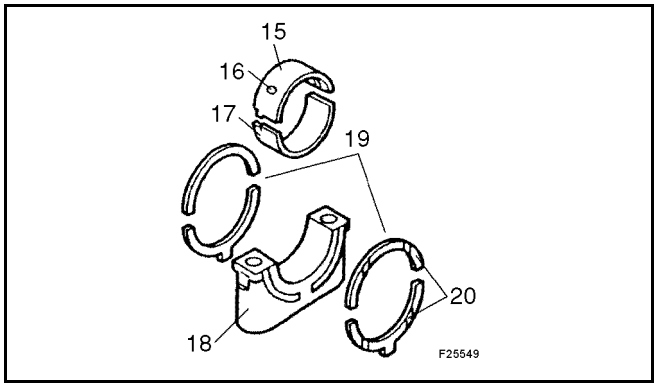
- Remove the bearing caps, cap side bearings, and thrust metals (14). Place each thrust metal with identification of the position and direction.
  The position number of reassembling is punched on a metal cap (except for both ends) and a cylinder block.



10. Flywheel side
11. Gear side
12. Cap side main bearing metals
13. Block side main bearing metals

Reassemble

- Carefully install each thrust metal so that the grooved one is positioned away from the cap.
- Do not confuse the upper (15) and lower (17) main bearing metals. The main bearing upper rings (block side) (15) have a hole (16), which the lower rings do not have.
  The “arrow” mark on the cap (22) shall face the flywheel. Tighten the screws of the cap of the main bearing (18).

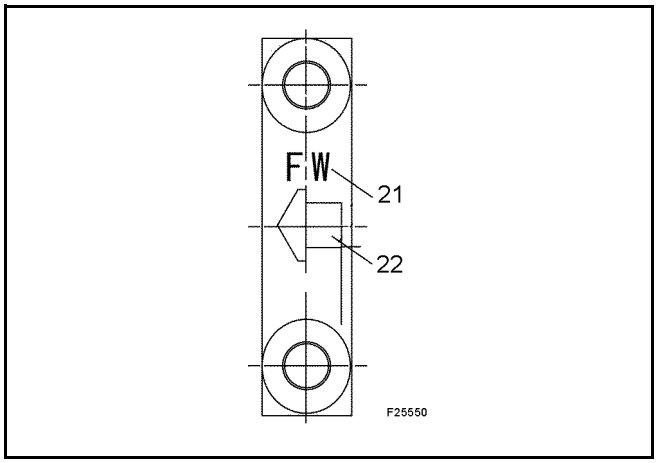


19. Thrust metal
20. Groove

Main bearing cap screw tightening torque (apply lube oil)

Nm

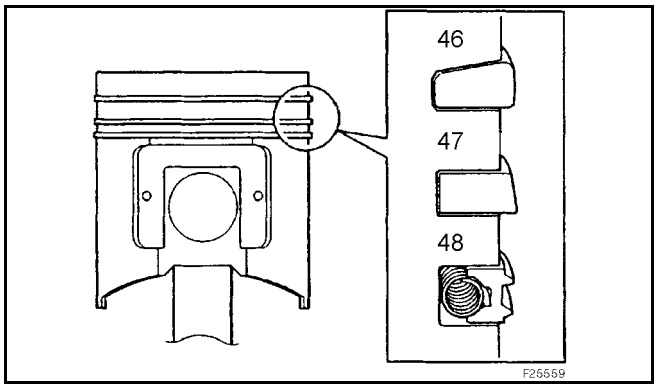
Model	Standard thickness
3TNV82A	76,4 ÷ 80,4
TNV84~88	93,2 ÷ 98,1
4TNV94L·98	108,1 ÷ 117,9
4TNV106(T)	186,2 ÷ 205,8



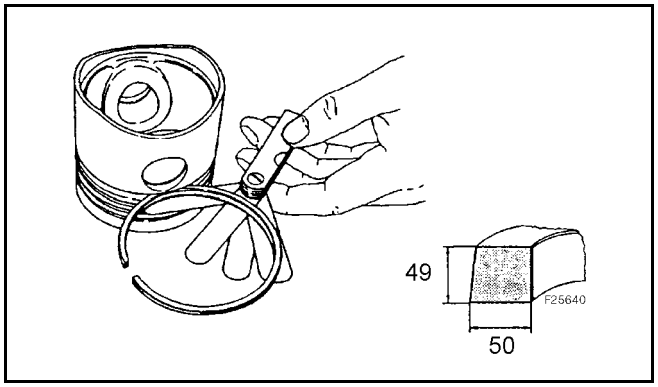
21. Mark

(c) Piston ring, ring groove and end clearance measurement

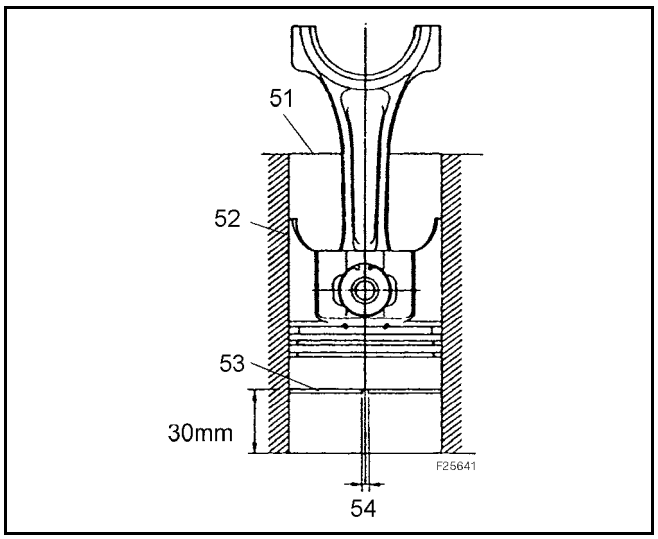
- Except for the top ring (46), to measure the piston ring groove width, first measure the width of the piston ring. Then insert the piston ring into the ring. Then insert the piston ring into the ring groove. Insert a thickness gauge in between the piston ring and groove to measure the gap between them. Obtain the ring groove width by adding ring width to the measured side clearance.
- To measure the end clearance, push the piston ring into the sleeve using the piston head, insert a thickness gauge in end clearance to measure. The ring shall be pushed in to approx. 30 mm above the bottom end of the cylinder. For the top ring, measure only the piston ring joint end clearance in normal state.



47. Second ring 48. Oil ring



49. Width 50. Shim



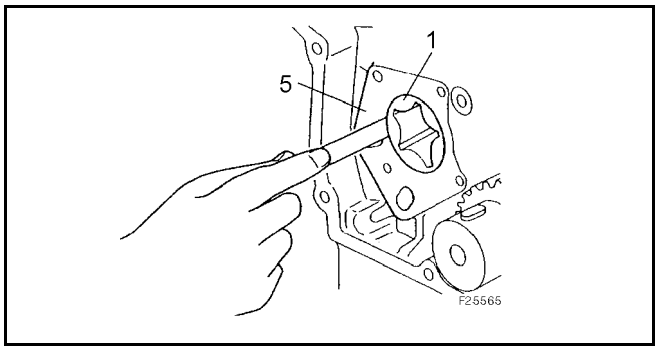
51. Head surface 53. Piston ring
52. Cylinder block 54. Joint end clearance

51.5.5 INSPECTION AND MEASUREMENT OF PARTS

51.5.5.1 Trochoid pump inspection and measurement

1. Outside clearance and side clearance of outer rotor

Insert a gap gauge between a outer rotor and a pump body, and measure the clearance.



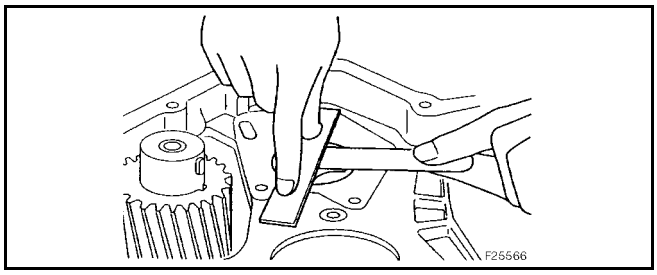
1. Outer case 5. Gear case

Outside clearance

mm

Model	Standard value	Limit value
3TNV82A~88	0.12 ÷ 0.21	0.30
4TNV94L/98	0.100 ÷ 0.155	0.25
4TNV106(T)	0.100 ÷ 0.165	0.25

When measuring a side clearance, put a right-angle gauge to the pump body, insert a gap gauge and measure the clearance.



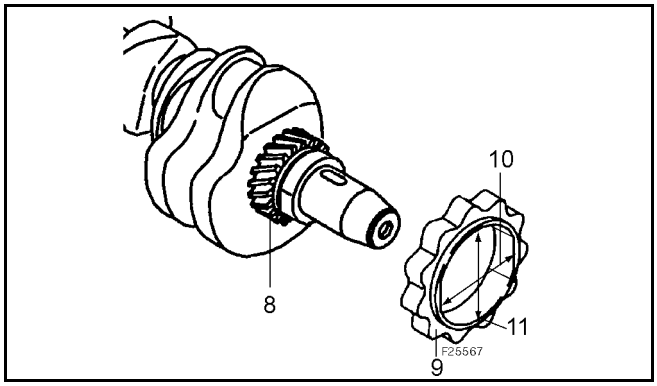
Side gap

mm

Model	Standard value	Limit value
3TNV82A~88	0.02 ÷ 0.07	0.12
4TNV94L/98	0.05 ÷ 0.10	0.15
4TNV106(T)	0.03 ÷ 0.12	0.17

2. Inner rotor and gear hub clearance (3TNV82A-4TNV88)

Piece	Piece	Standard dimension (mm)	Standard clearance (mm)	Standard clearance limit (mm)
Inside clearance of inner rotor	Gear hub diameter	53.05 ÷ 53.15	0.3 ÷ 0.5	0.6
	Rotor inner diameter	53.45 ÷ 53.55		
Width across flat clearance of inner rotor	Width across flats of gear hub	49.45 ÷ 49.75	0.2 ÷ 0.6	0.7
	Width across flats of rotor	49.95 ÷ 50.05		



8. Crank gear
9. Inner rotor
10. Width across flats of rotor
11. Rotor inner diameter

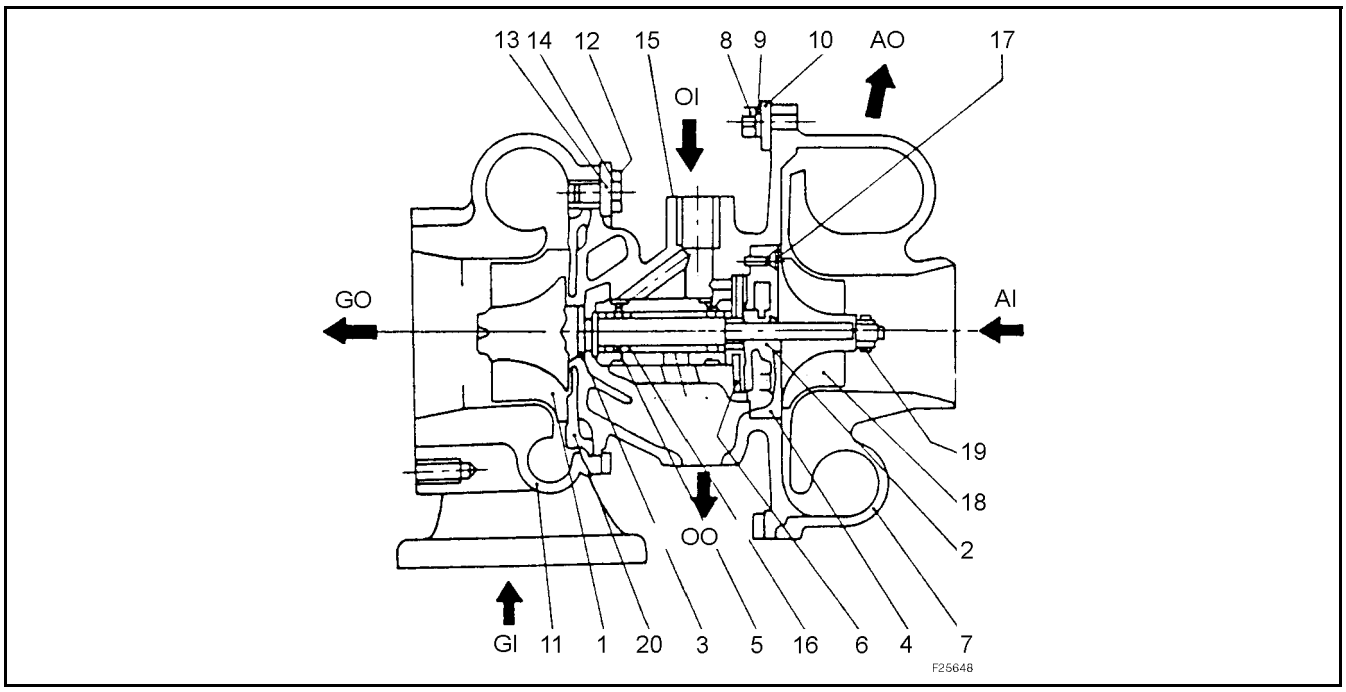
51.8 TURBOCHAGER: DISASSEMBLY, INSPECTION AND REASSEMBLY

51.8.1 STRUCTURE AND FUNCTIONS

51.8.1.1 Main specifications

Applicable engine model (application)	3TNV84T(CL, VM) 4TNV84T(CL)	3TNV84T(VM)	4TNV106T(CL, VM)
Turbocharger model	RHB31	RHB51	RHF5
Turbocharger specification	Standard (w/waste gate)		
Turbine type	Radial flow		
Blower (compressor) type	Centrifugal		
Lubrication method	External lubrication		
Max. continuous allowable speed	250.000	180.000	
Max. continuous allowable gas inlet temperature	750		
Dry weight N	24	41	46
Note) VM application is provided with the waste gate.			

51.8.1.2 Construction

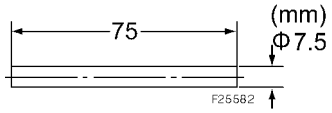
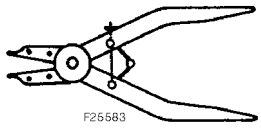
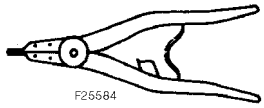
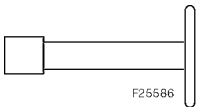
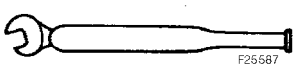
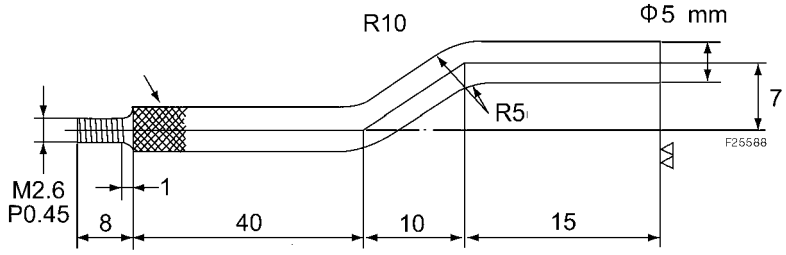


AI. Air inlet
AO. Air outlet
GI. Gas inlet
GO. Gas outlet
OI. Oil inlet
OO. Oil outlet

51.8.4 DISASSEMBLY PROCEDURE

51.8.4.1 Preparation for disassembly

In addition to the general tools, the following special tools are required for turbocharger disassembly and re-assembly:

Name	Use	Illustration
Bar	For removing thrust bearing and thrust bushing	 Material: Copper or brass
Pliers	For removing floating bearing circlip	
Pliers	For removing seal ring	
Torque driver for TORX screw (multifunctional type) 0.5 to 4.9 Nm	For thrust bearing installation (for M3): 1.3 Nm For seal plate installation (for M3): 1.3 Nm	Item sold on market 
Box wrench	For fixing turbine shaft (mm dodecagonal)	 Box only may be used.
Torque wrench (single purpose)	For following bolts and nuts: M8: mm, Nm M8: mm, Nm M5: mm, Nm	
Probe	For measuring play in axial and radial directions: to be installed on a dial gauge	

8. Rotor play measurement
   See the inspection procedure in section 8.3.2 for the measurement method.
   If the rotor play does not satisfy the standard, reassembly is necessary since assembly error or use of a wrong part is conceivable.
   Service standard of rotor play in axial direction
   RHF5 ..... 0.03 ÷ 0.06 mm
   RHB51 ..... 0.03 ÷ 0.06 mm
   RHB31..... 0.022 ÷ 0.053 mm
   Service standard of rotor play in radial direction
   RHF5 ..... 0.08 ÷ 0.13 mm
   RHB51 ..... 0.08 ÷ 0.13 mm
   RHB31..... 0.061 ÷ 0.093 mm

51.9.1.5 Inspection and Maintenance

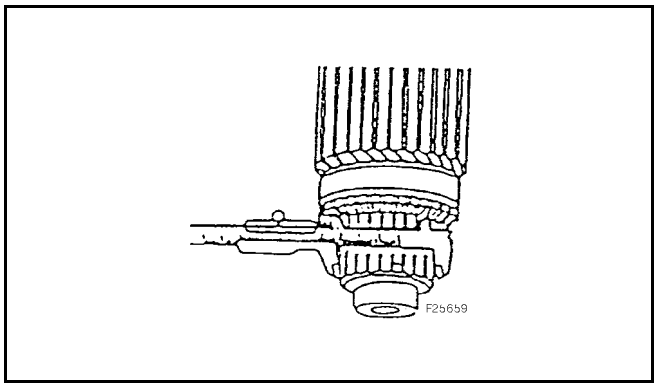
1. Rotor

(a) Commutator outside diameter

Measure the commutator outside diameter and replace the commutator if the measured value is less than the limit.

mm

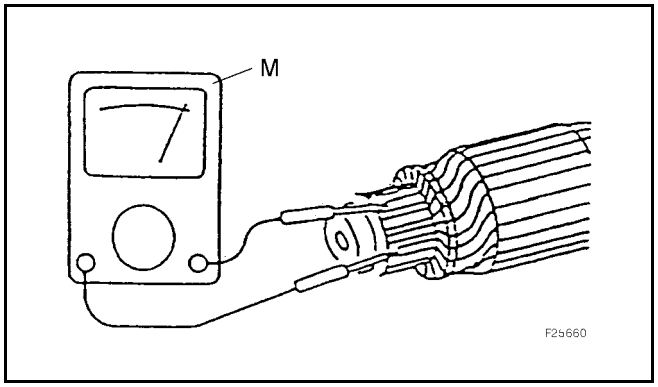
Standard value	Limit value
36.5	35.5



(b) Armature coil continuity test

Check continuity between commutator segments with a multimeter (M). Good if continuity exists.

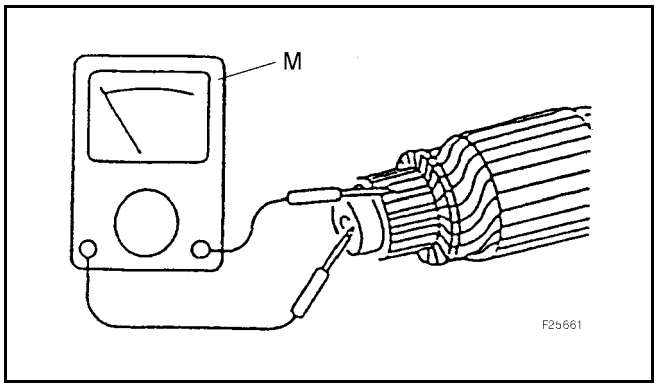
In case of no continuity (coil disconnection), replace the armature.



(c) Armature coil insulation test

Inspect the continuity between a commutator segment and the shaft or core with a multimeter (M). Good if no continuity exists.

If continuity exists (coil short circuit), replace the armature.

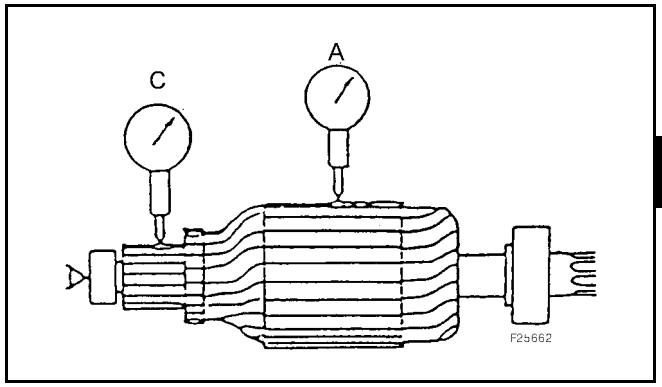


(d) Armature and commutator run-out

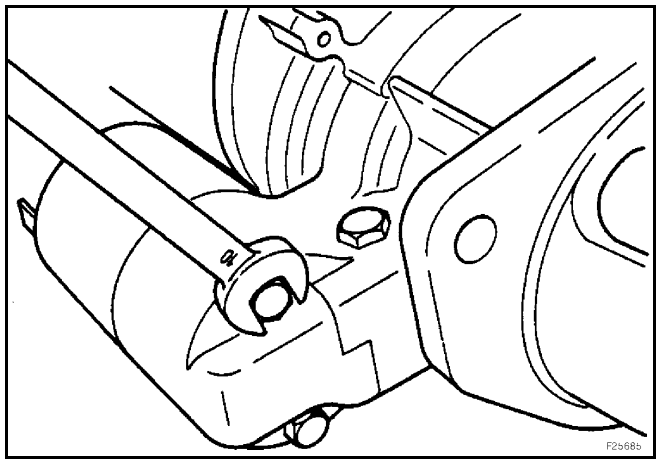
Use a dial gauge and measure the armature core run-out and commutator run-out. Correct or replace if the limit is exceeded.

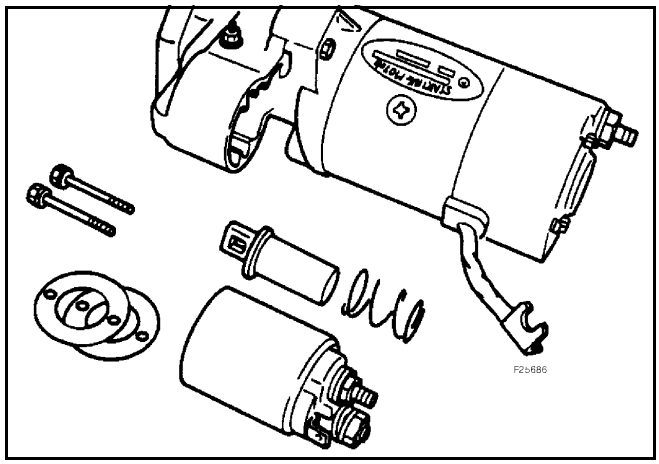
mm

	Standard value	Limit value
A. Armature	0.03	0.2
C. Commutator	0.03	0.2

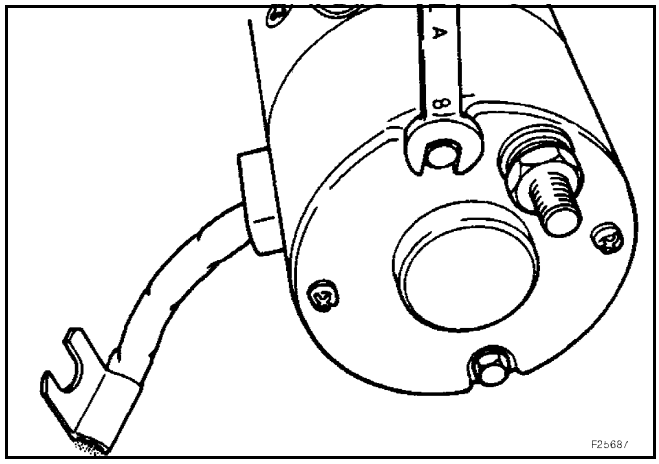


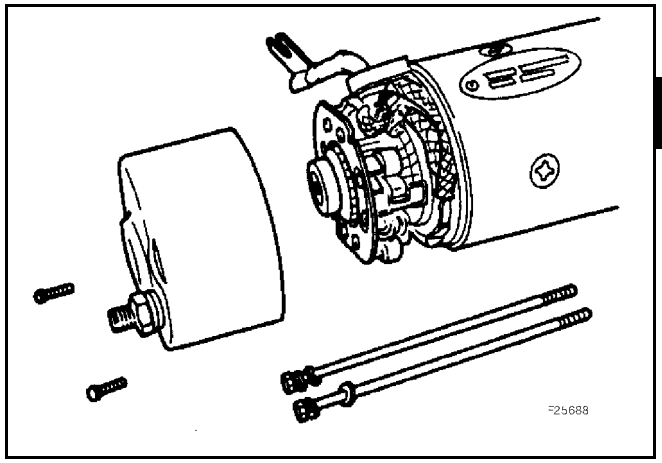
2. Removing magnet switch
   Remove the M6 bolts (10 mm x 2).





3. Removal of rear cover
   Remove the brush holder tightening screws (4 mm Ø x 2) and the M5 through bolts (x 2).
   Then, disconnect the rear cover from the yoke using a minus screwdriver.





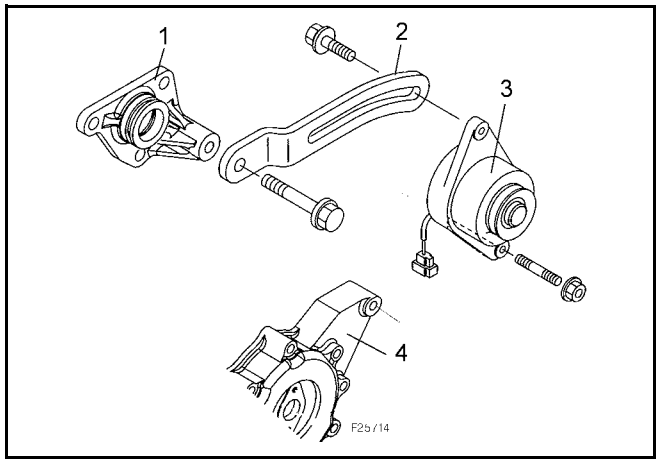
51.10 ALTERNATOR

As a representative example of alternator, the alternator of 40A is shown in this chapter.

51.10.1 THE 40A ALTERNATOR FOR 3TNV84 AND OTHER MODELS

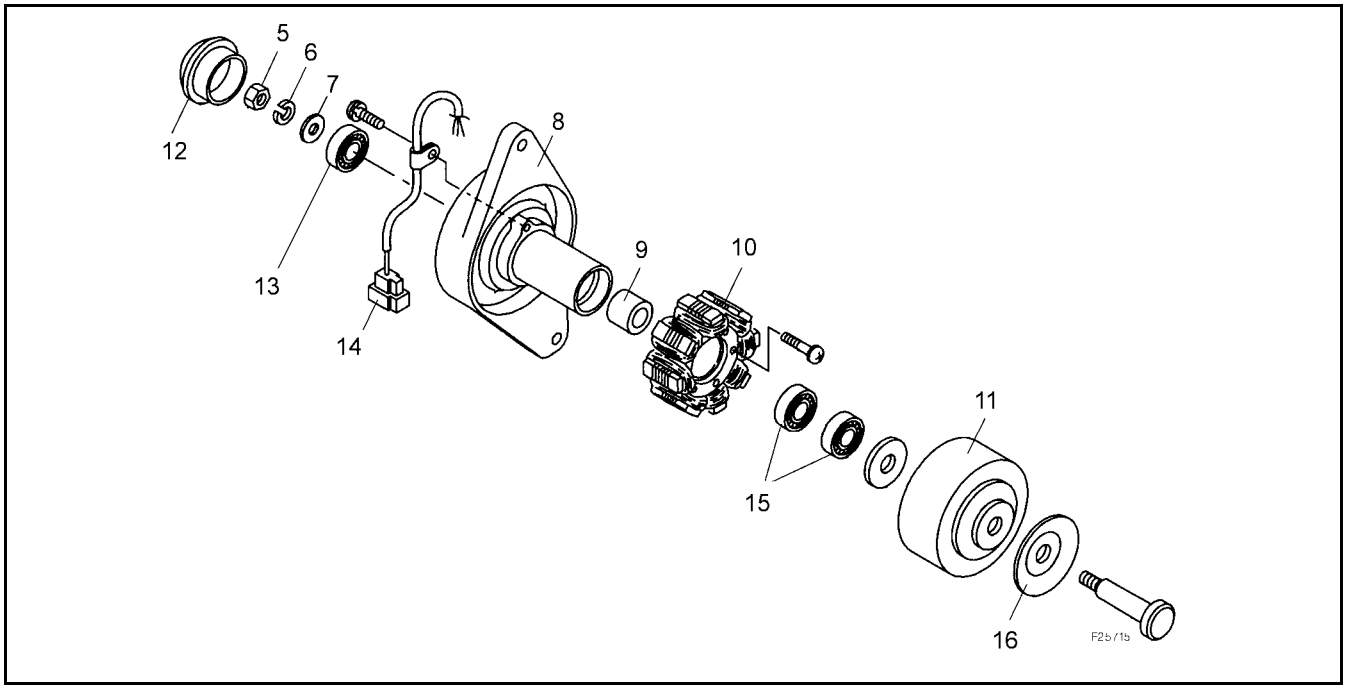
51.10.1.1 Components

1. Parts related to the alternator



1. Joint
2. V-belt adjuster
3. Generator
4. Gear case

2. Alternator components of the disassembly and assembly



5. Nut
6. Spring washer
7. Washer
8. Rear bracket
9. Spacer
10. Stator
11. Front bracket
12. Cover
13. Bearing
14. Coupler
15. Bearing
16. Pulley

4. When there is no safety relay
   Over-running (when the electric current flows for too long) is a major cause of starting failure. This burns the rotor and the clutch. Excessive work and failure of the key switch to return properly are the main causes of over-running. The user must be given sufficient warning about this.
   Be sure to use the safety relay to prevent over-running. This safety relay is supplied as an option.
   Consult Yanmar first when planning to install a safety relay at your own company. In the case of failure to consult with Yanmar, our warranty will not be applied to all the electrical equipment.

5. When there is too much rust due to the entry of water
   The water-proofing of the starting motor is equivalent to R2 of JIS D 0203. This guarantees that there will be no damage from the sort of exposure encountered in rain or when water is poured on from a bucket. You should, however, avoid the use of high-pressure washing and steeping in water.

6. Regarding the heat resistance of the starter motor
   The starter motor has heat resistance for an ambient temperature of 80° and surface temperature of 100°. Insulators must be installed to prevent overheating when used near high temperature parts such as the exhaust system.

7. Corrosion of magnet switch contact point by corrosive gas.
   When using equipment with a dry clutch, ammonium gas generated by friction is liable to corrode the contact of the magnet switch. Be sure to install a vent in the clutch case.

2. Crankshaft

mm

Inspection item			Standard value	Limit value
Bending (1/2 the dial gauge reading)			-	0.02
Crankpin	3TNV82A	Pin outside diameter	42.952 ÷ 42.962	42.902
		Metal inside diameter	43.000 ÷ 43.042	-
		Metal thickness	1.487 ÷ 1.500	-
		Tolerance	0.038 ÷ 0.090	0.150
	TNV84~88	Pin outside diameter	47.952 ÷ 47.962	47.902
		Metal inside diameter	48.000 ÷ 48.026	-
		Metal thickness	1.492 ÷ 1.500	-
		Tolerance	0.038 ÷ 0.074	0.150
	4TNV94L·98	Pin outside diameter	57.952 ÷ 57.962	57.902
		Metal inside diameter	58.000 ÷ 58.026	
		Metal thickness	1.492 ÷ 1.500	-
		Tolerance	0.038 ÷ 0.074	-
	4TNV106(T)	Pin outside diameter	63.952 ÷ 63.962	0.150
		Metal inside diameter	64.016 ÷ 64.042	63.902
		Metal thickness	1.984 ÷ 1.992	-
		Tolerance	0.054 ÷ 0.090	0.150
Crank journal	3TNV82A	Journal outside diameter	46.952 ÷ 46.962	46.902
		Metal inside diameter	47.000 ÷ 47.032	-
		Metal thickness	1.987 ÷ 2.000	-
		Tolerance	0.038 ÷ 0.080	0.150
	TNV84~88 Selective pairing	Journal outside diameter	53.952 ÷ 53.962	53.902
		Metal inside diameter	54.000 ÷ 54.020	-
		Metal thickness	1.995 ÷ 1.990	-
		Tolerance	0.038 ÷ 0.068	0.150
	4TNV94L·98 Selective pairing	Journal outside diameter	64.952 ÷ 64.962	64.902
		Metal inside diameter	65.000 ÷ 65.020	-
		Metal thickness	1.995 ÷ 2.010	-
		Tolerance	0.038 ÷ 0.068	0.150
	4TNV106(T) Selective pairing	Journal outside diameter	75.952 ÷ 75.962	75.902
		Metal inside diameter	76.014 ÷ 76.034	-
		Metal thickness	2.488 ÷ 2.503	-
		Tolerance	0.052 ÷ 0.082	0.150

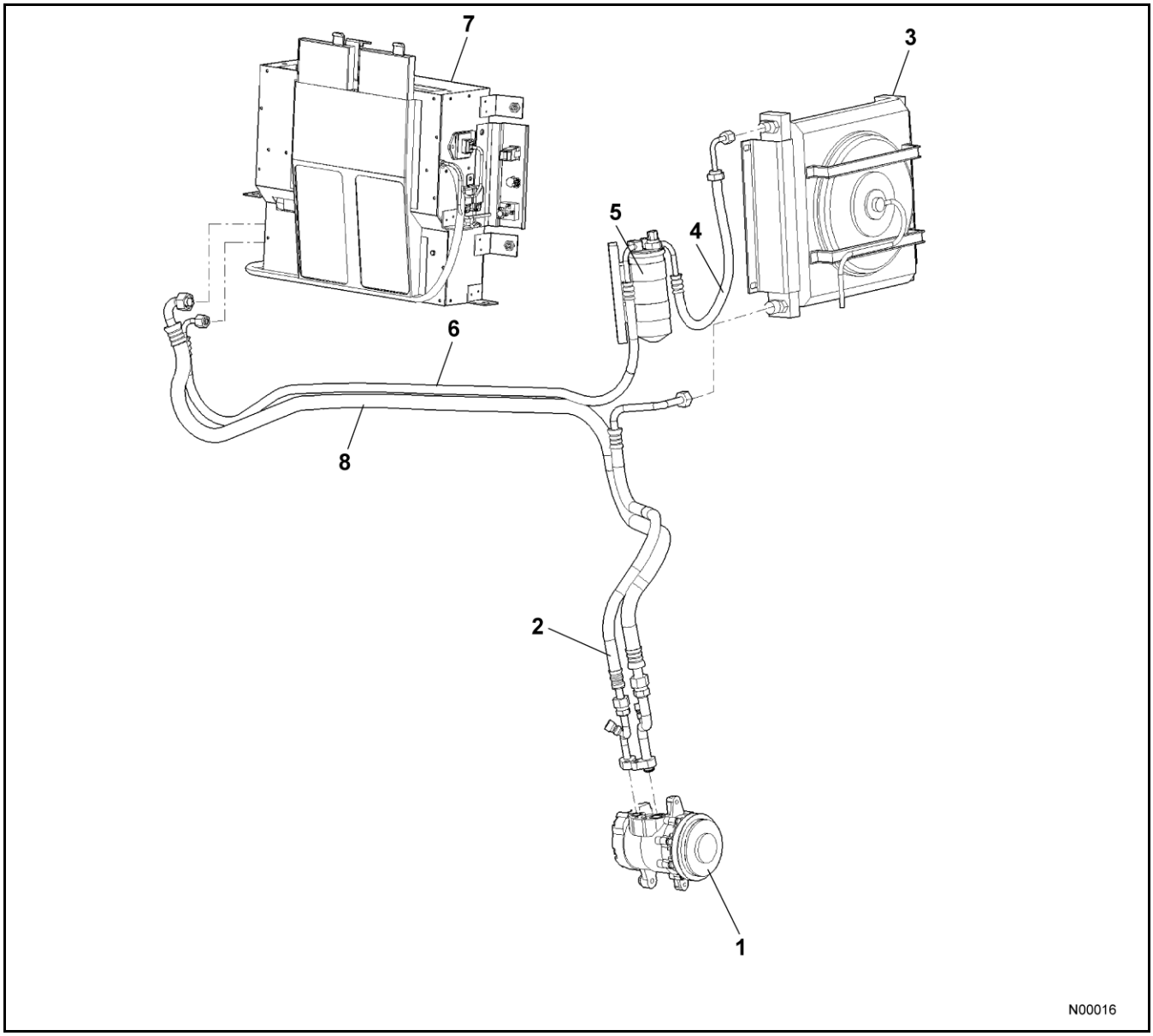
3. Thrust bushing

mm

Inspection item		Standard value	Limit value
Crankshaft side gap	All models	0.13 ÷ 0.23	0.28

61.1 DESCRIPTION AND OPERATION - AIR CONDITIONING SYSTEM

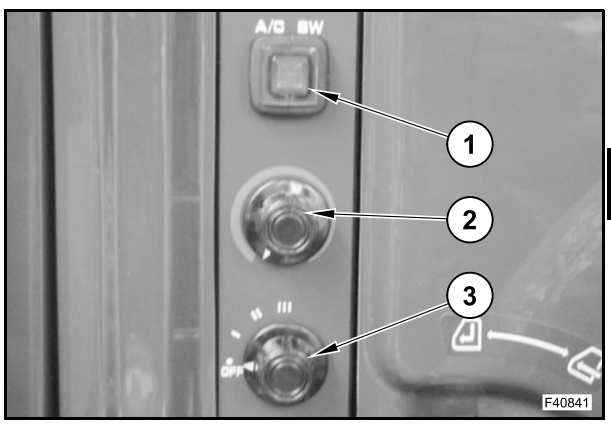
61.1.1 AIR CONDITIONING SYSTEM COMPONENTS



1. Compressor
2. Flexible hose
3. Condenser
4. Flexible hose
5. Receiver (dryer)
6. Flexible hose
7. Cooler unit/Evaporator
8. Flexible hose

The components installed in cabin activate the A/C system. They are:

1. A/C main power switch
2. Temperature control dial
3. Air flow control dial
   I = low
   II = medium
   III = high



61.3 AIR CONDITIONING REFRIGERANT CHECK AND FILLING

⚠ WARNING

Refrigerant with safety characteristics. This means that this refrigerant is non-flammable, non-explosive, nontoxic, non-irritating, tasteless and colourless. Nevertheless, it is necessary to take some precautions.

Avoid any contact with the refrigerant. In case of skin contact with the refrigerant, immediately treat the skin.

Wear the safety glasses to protect your eyes. If although these measures the coolant comes in contact with your eyes, rinse them immediately with cold and clean water and then obtain medical attention immediately.

Empty the system before carrying out repairs on it.

Do not let the refrigerant release in the surrounding areas.

To suck it, only use duly approved aspirators.

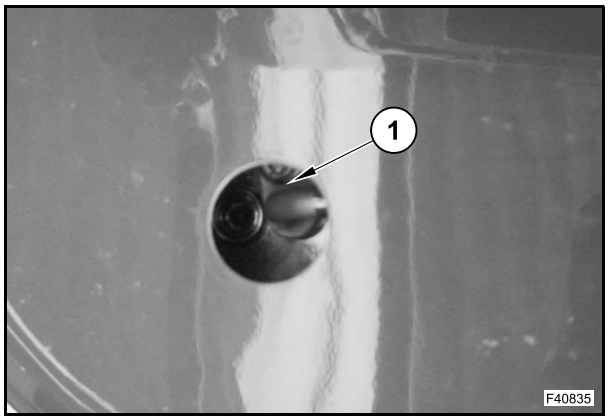
Regardless of the system being full of refrigerant or empty, heat determines a remarkable overpressure, which could not only damage the system, but also cause explosions.

Never expose the air conditioning components to a flame or a too hot heat source, to prevent fire or explosion hazard, with following emission of toxic gas.

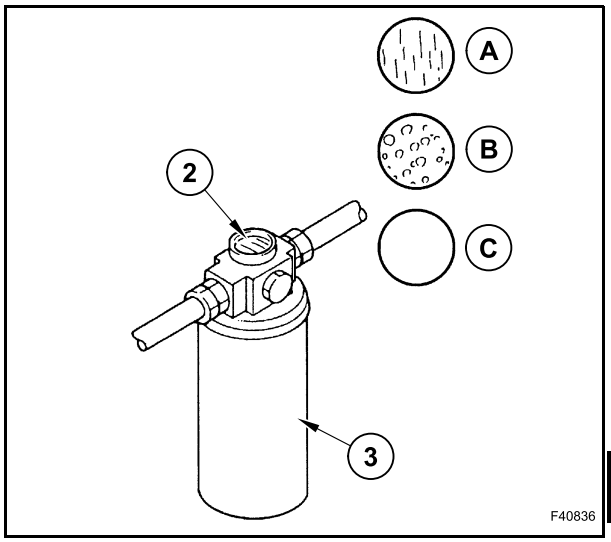
Empty refrigerant cylinders must not be discarded. When full, refrigerant cylinders must not be exposed to sun rays or other heat sources for a long time.

The maximum allowed temperature for a full refrigerant cylinder must not exceed 40 °C.

The lack of refrigerant causes low efficiency of cooling. Run the engine at high idling and rotate the cooler at high speed. Then remove the rubber cap (1), and inspect the flowing refrigerant condition from the sight glass (2) of the receiver dryer (3).

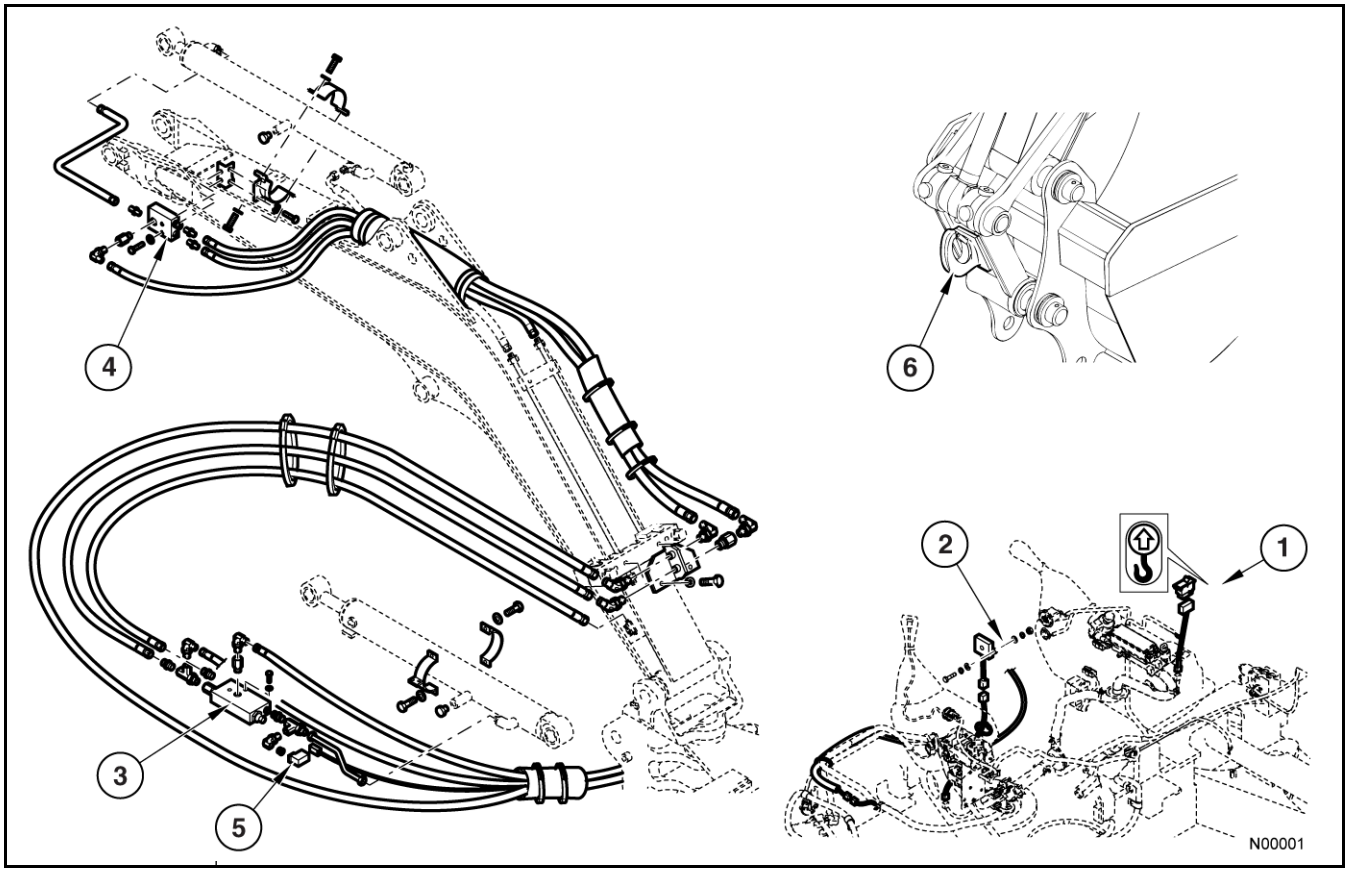


A. No bubbles: proper
B. Bubbles appeared (Bubbles appear continuously): insufficient
C. Transparent: over charged or no refrigerant



62.1 DESCRIPTION AND OPERATION - OBJECT HANDLING SYSTEM

DESCRIPTION

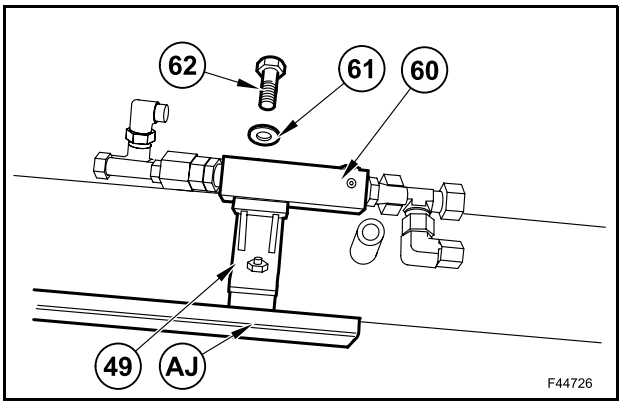


The object handling system (optional) is composed of:

- switch for activation of anti-tipping sensor (installed in cabin) (1)
- overload buzzer (installed in cabin) (2)
- boom holding valve (3)
- digging holding valve (4)
- overload pressure switch (5)
- loading hook (installed on connecting rod of bucket linkage) (6)
- liftable loads tables (located in cabin).

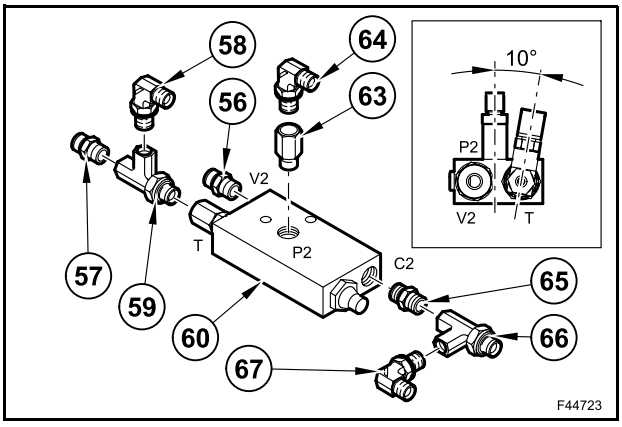
When one of the components is missing or damaged, the machine cannot be used to handle hanging loads.

8. Remove the valve (60) with the fittings from bracket (49) of cover (AJ), by removing screws (62) and washers (61).

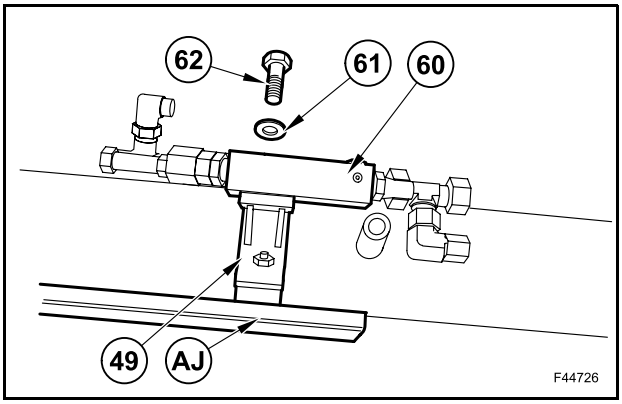


9. Preassemble the valve (60) of the boom cylinder:
   - in port C2, install the 1/2" straight fitting (65), the 1/2" union tee (66) and the 3/8"-1/2" 90°-fitting (67), and do not tighten to facilitate a subsequent orientation of the pressure switch;
   - in port V2, screw on the 1/2" straight fitting (56);
   - in port T, install the 1/4" union tee (59), the 3/8"-1/4" 90°-fitting (58) and the 1/4" straight fitting (57);
   - in port P2, tighten the 1/4" straight fitting (63) and the 1/4" 90°-fitting (64).

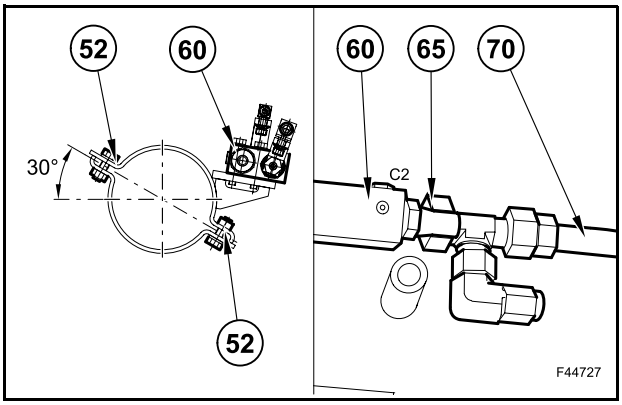
   Make sure that the fittings screwed in port P2 are turned clockwise (outwards) by 10° (see figure).



10. Assemble the new valve (60) together with the fittings onto the bracket (49) and fasten it by means of the hex. M8x50 screws (62) and the relevant D=8 washers (61).
    Apply some Loctite 262 and tighten the hex.
    M8x50 screws (62) to a tightening torque of 33 Nm.
    Reassemble the cover (AJ) of the boom cylinder.



11. Direct the brackets and the valve by turning them clockwise (outwards) by 30° (as shown in the figure).
    Connect the union tee 1/2" (65) on port C2 of valve (60) to the rigid pipe (70).
    Fix the final position of the valve, apply some Loctite 262 and tighten the hex. M10x30 screws (52) to a tightening torque of 31.5 Nm.



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