SHOP MANUAL
CX27B
HYDRAULIC EXCAVATOR
TABLE OF CONTENTS

1.1 GENERAL SAFETY INFORMATION

WARNING: *Do not operate or perform any maintenance on this machine until all instructions in the OPERATOR'S MANUAL and this MANUAL have been thoroughly read and understood.*

WARNING: *Improper operation or maintenance of this machine may cause accidents and could result in serious injury or death.*

WARNING: *Always keep the manual in storage.*
If it is missing or damaged, place an order with an authorized Distributor for a replacement.
If you have any questions, please consult your dealer.

1. Most accidents, which occur during operation, are due to neglect of precautionary measures and safety rules. Sufficient care should be taken to avoid these accidents. Erroneous operation, lubrication or maintenance services are very dangerous and may cause injury or death of personnel. Therefore all precautionary measures, NOTES, DANGERS, WARNINGS and CAUTIONS contained in the manual and on the machine should be read and understood by all personnel before starting any work with or on the machine.
2. Operation, inspection, and maintenance should be carefully carried out, safety must be given the first priority. The safety information contained in the manual is intended only to supplement safety codes, insurance requirements, local laws, rules and regulations.
3. Messages of safety appear in the manual and on the machine:

   All messages of safety are identified by either word of DANGER, WARNING, and CAUTION.

DANGER: *Shows an imminently hazardous situation which, if not avoided, will result in death or serious injury.*

WARNING: *Shows a potentially hazardous situation which, if not avoided, could result in death or serious injury.*

CAUTION: *Shows a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against possible damage to the machine and its components.*

4. It is very difficult to foresee every danger that may occur during operation. However, safety can be ensured by fully understanding proper operating procedures for this machine according to methods recommended.
5. While operating the machine, be sure to perform work with great care, so no damage to the machine or accidents will occur.
6. Continue studying the manual until all Safety, Operation and Maintenance procedures are completely understood by all persons working with the machine.

CHAPTER 2
SPECIFICATIONS
TABLE OF CONTENTS

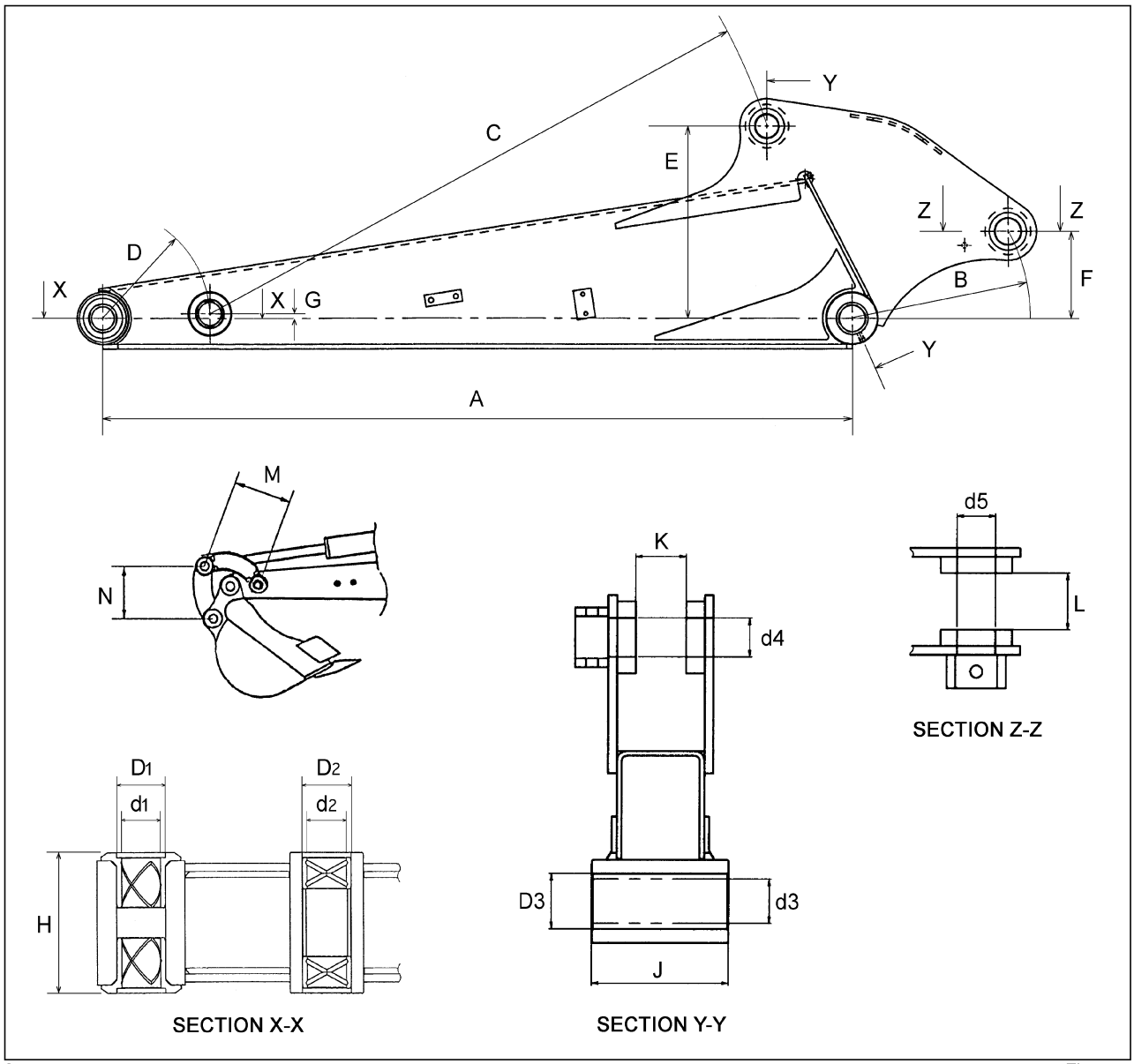
2.8 ENGINE SPECIFICATIONS

2.8.1 SPECIFICATIONS

Engine Model		3TNV82A-SYB	
Type		Vertical, 4-cycle water-cooled diesel engine	
No. of cylinders - Bore x Stroke		3 - 82 mm (3.23 in) × 84mm (3.31 in)	
Total displacement		1.330 liter (81 cu•in)	
Compression ratio		19.2	
Rated output		15.9 kW (21.6 PS) at 2200 rpm	
Maximum torque		79.0 ~ 86.0 N•m (58.3 ~ 63.4 lbf•ft) at 1320±100 rpm	
Low idling		1200±25 rpm	
High idling		2375±25 rpm	
Fuel consumption rate		242±10 g / kWh {178±7 g / PS•h}	
Allowable tilting angles		Continuous; 30° for all direction	
Rotating direction		Counterclockwise as seen from flywheel side	
Firing order		1-3-2-1	
Fuel injection timing (b.T.D.C.)		16±1°	
Fuel injection pressure		200 to 210 kg / cm^2 (2840 to 2980 psi)	
Valve action		Open	Close
Valve action	Intake valve	b.T.D.C. 15±5°	a.B.D.C. 45±5°
	Exhaust valve	b.T.D.C. 56±5°	a.B.D.C. 18±5°
Valve clearance	Intake valve	0.2 mm (0.008 in) in cold condition	
	Exhaust valve	0.2 mm (0.008 in) in cold condition	
Thermostat action		Start 71 ± 1.5°C (160 ± 3°F) / Full open 85°C (185°F)	
Compression pressure		3.16 ± 0.1 MPa (460 ± 14 psi) at 250 rpm	
Lubrication oil pressure		0.392 MPa (57 psi) at 2200 rpm	
Dimensions L x W x H		565 x 494 x 611 mm (22.2 x 19.4 x 24.1 in)	
Dry weight		128 to 138 kg (282 to 304 lb)	
Governor		Mechanical centrifugal governor (All speed type)	
Fuel filtration		cartridge type paper filter	
Lubrication system		Forced lubrication with trochoid pump	
Cooling system		Liquid cooling / Radiator	
Starter capacity		12 V x 1.7 kW	
Generator capacity		12 V x 40 A	
Starting aid		Air heater (12 V - 400 W)	
Cooling water capacity: Max / Engine		4.0 / 1.8 liter (1.06 / 0.48 gal)	
Engine oil volume: Max / Effective		5.5 / 1.9 liter (1.45 / 0.50 gal)	

3.2 ARM

3.2.1 ARM DIMENSIONAL DRAWINGS



SPW03000004E01

Figure 4

3.5 SWING

3.5.1 SWING BRACKET DIMENSIONAL DRAWINGS

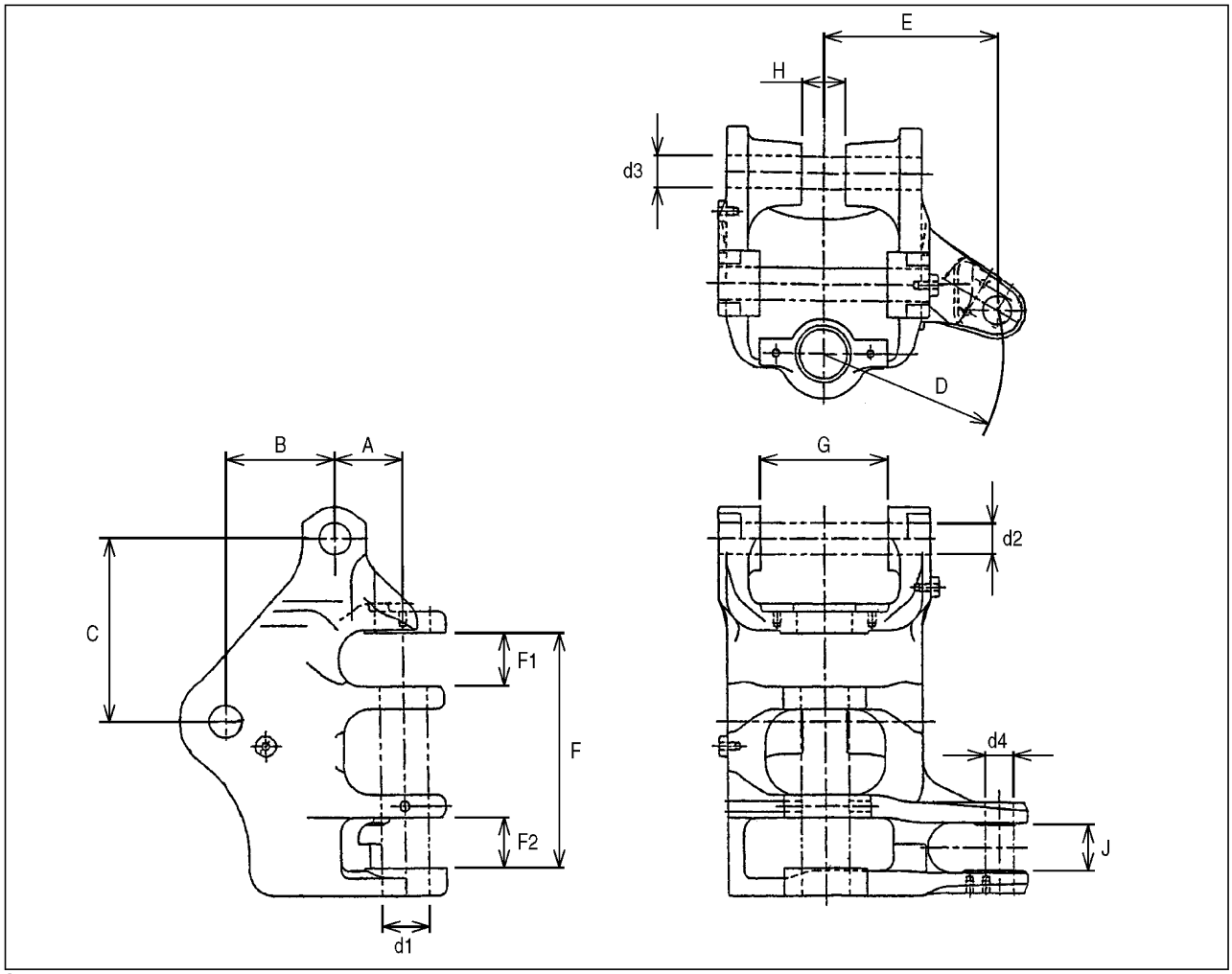


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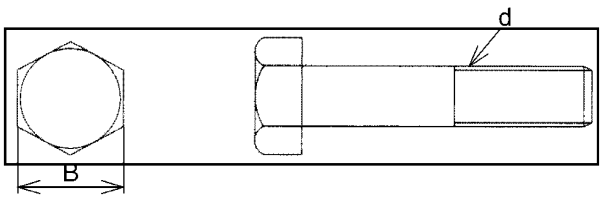
Figure 12

SWING BRACKET DIMENSIONS		
No.	NAME	DIMENSION
A	Distance between swing center pin and boom foot pin	70 (2.76)
B	Distance between boom foot pin and boom cylinder pin	136 (5.35)
C	- ditto -	228 (8.98)
D	Distance between swing center pin and swing cylinder pin	R222.5 (8.76)
E	- ditto -	215.5 (8.48)
F	Inside width of swing center	291 (11.46)
F1	- ditto -	66 (2.60)
F2	- ditto -	62.5 (2.46)
G	Inside width of boom foot	160 (6.30)
H	Inside width for installing boom cylinder	56 (2.20)
J	Inside width for installing swing cylinder	56 (2.20)
d1	Pin dia. of swing center	ø60 (2.36)
d2	Pin dia. of boom foot	ø40 (1.57")
d3	Pin dia. of boom cylinder	ø40 (1.75")
d4	Pin dia. of swing cylinder	ø35 (1.38")
Unit: MM. (in)		

11.2 SCREW AND TOOL SIZES

11.2.1 CAPSCREW

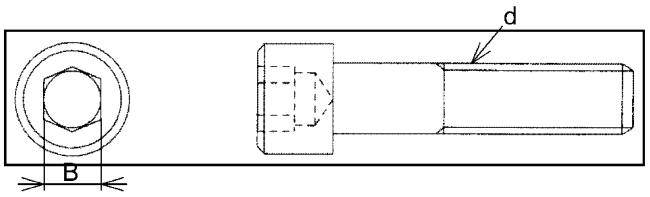
Nominal screw size (d)	B MM. Tool size	Nominal screw size (d)	B MM. Tool size
M6	10	M24	36
M8	13	M30	46
M10	17	M36	55
M12	19	M42	65
M16	24	M48	75
M20	30		



SPW11000001J01 Figure 2

11.2.2 CAPSCREW (SOCKET BOLT)

Nominal screw size (d)	B MM. Tool size	Nominal screw size(d)	B MM. Tool size
M6	5	M20	17
M8	6	M24	19
M10	8	M30	22
M12	10	M36	27
M14	12	M42	32
M16	14	M48	36
(M18)	14		



SPW11000002J01 Figure 3

CHAPTER 12

CX27B
HYDRAULIC EXCAVATORS

STANDARD MAINTENANCE TIME TABLE

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Book/Form Number 6-77890 NA

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Source Code No. S5PV0007E01-KO12

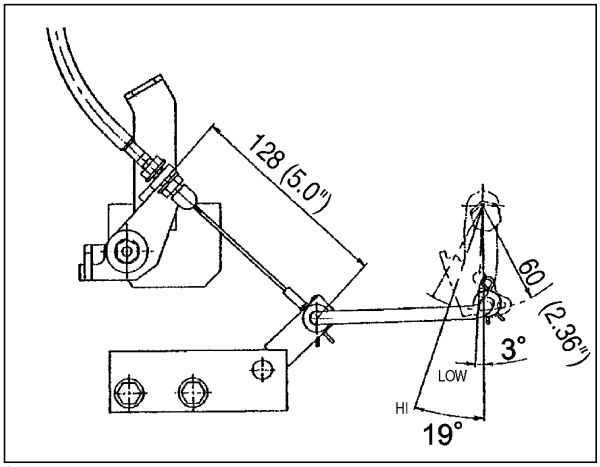
Group 03 - Upper Structure					
GROUP No.	**EQUIPMENT PORTION**	**WORK TO BE DONE**	**UNIT**	**REMARKS**	**UNIT: HOUR**
102	• Piping connector, hose	- ditto -	1 set	Include attaching hose's tag and plug	1.0
103	• Control cable, Yoke	- ditto -	1 set		0.2
104	• Fixing bolt	- ditto -	1 set		0.1
105	Control valve ASSY	O / H	1 pc.		3.0
	Other necessary works	Rem. / Inst.	1 set	Covers	0.1
		- ditto -	1 set	Hoses	0.2
110	**Slewing motor portion**			Refer to 33.1.20	
111	Slewing motor ASSY	Rem. / Inst.	1 pc.		1.0
112	• Piping connector, hose	- ditto -	7 pcs.	Include attaching hose's tag and plug	0.5
113	• Fixing bolt	- ditto -	1 pc.		0.3
114	Slewing motor ASSY	O / H	1 pc.		3.0
	Other necessary works	Rem. / Inst.	1 set	Floor plate, Covers	0.2
		Feed	1 pc.	Hyd. oil in motor	0.1
120	**Swivel joint portion**			Refer to 33.1.21	
121	Swivel joint ASSY	Rem. / Inst.	1 pc.	After removing slewing motor	2.5
122	• Under cover	- ditto -	1 pc.		0.1
123	• Piping connector, hose	- ditto -	1 set	Include attaching hose's tag and plug	1.5
124	• Stopper	- ditto -	1 pc.		0.1
125	• Fixing bolt	- ditto -	1 set		0.2
126	Swivel joint ASSY	O / H	1 pc.		2.0
	Other necessary works	Preparation	1 pc.	Removal / Inst. position. (Secure working space.)	0.1
			1 pc.	Canopy removal / inst. (for easy working)	0.2
			1 pc.	Floor plate cover (2) removal / inst.	0.1
130	**Upper frame portion**			Refer to 33.1.22	
131	Upper frame ASSY	Rem. / Inst.	1 pc.		1.0
132	• Fixing bolt	- ditto -	1 set	Apply sealant	0.3
133	• Upper frame slinging	- ditto -	1 pc.		0.3
134	• Cleaning	Cleaning	1 pc.		0.2
	Other necessary works	Rem. / Inst.	1 pc.	Canopy	0.2
		- ditto -	1 pc.	Guard (Cover, support)	1.5
		- ditto -	1 pc.	Counterweight	0.4
		Drain / Feed	1 pc.	Hydraulic oil	0.2
		Rem. / Inst.	1 set	Swivel joint hose	0.5
		- ditto -	1 set	Boom, Swing bracket	1.5

4. Speed Adjustment

   Low / High Idling Speed is low;

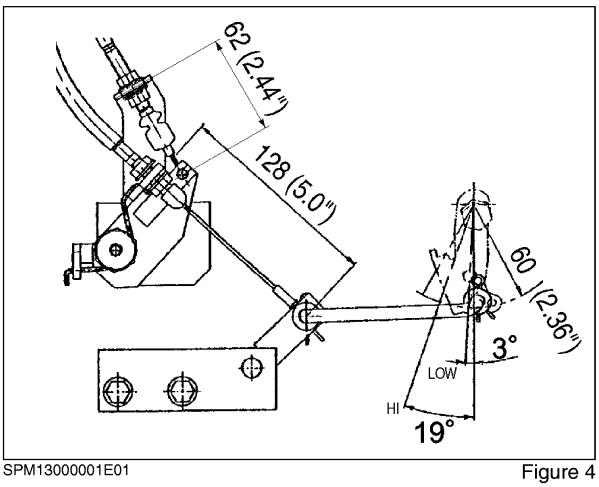
   The proper engine speed is obtained with the length of accelerator cable as shown. When the engine speed is lower than the standard speed, adjust the length of cable by loosening the capscrew (9) of throttle lever side.

NOTE: *If the proper high idling speed is not obtainable, see the engine service manual.*



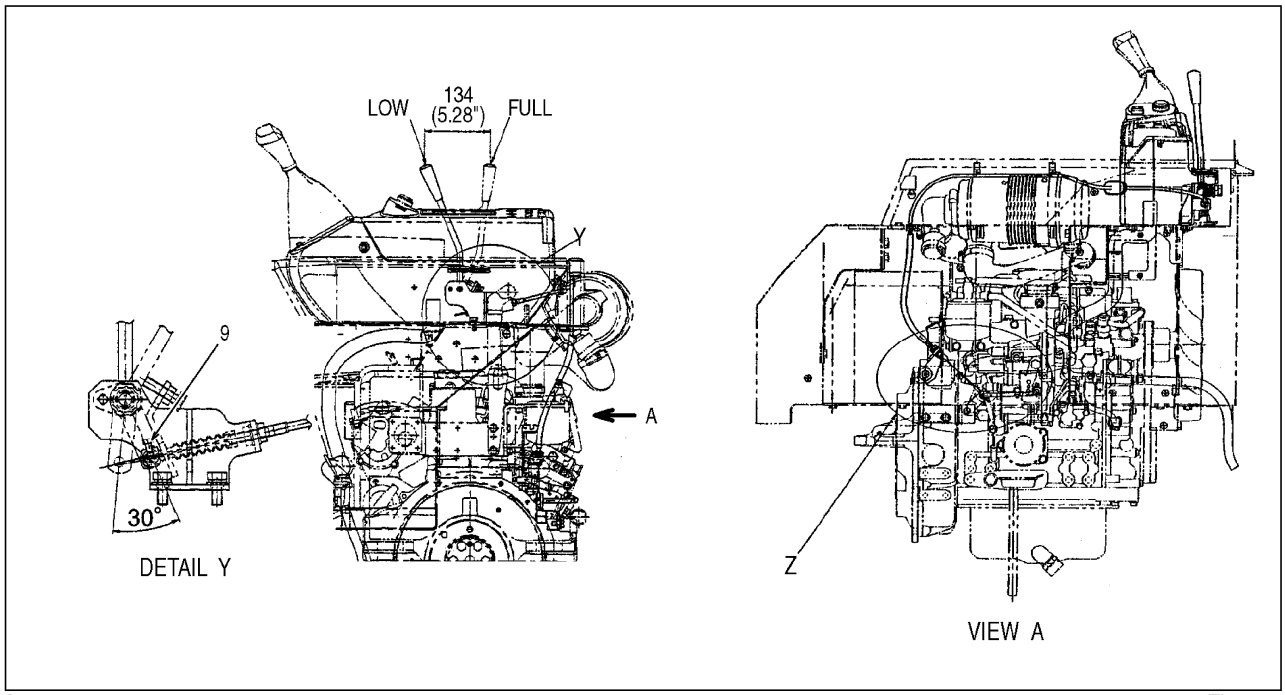
SPM13000002J01 Figure 3

DETAIL Z [STD]



SPM13000001E01 Figure 4

DETAIL Z [WITH DECEL]



SPM13000001J01 Figure 5

FIG. 13-2 ACCELERATOR CABLE ADJUSTMENT

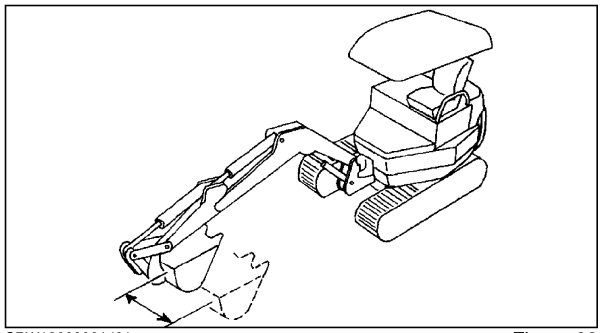
13.8 MEASURING SLEW BEARING PERFORMANCES

13.8.1 TEST PROCEDURE

1. Measure 3-time each
2. .Compare to the chart.

13.8.2 SLEW BEARING-BUCKET TIP PLAY

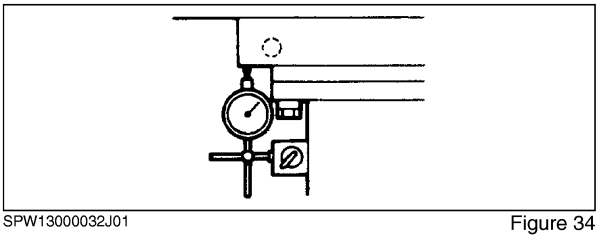
- Measurement Posture:
  Completely retract the arm cylinder and fully extend the bucket cylinder.
- Move the tip of the bucket from side to side (left and right) and measure the play.



SPW13000031J01 Figure 33

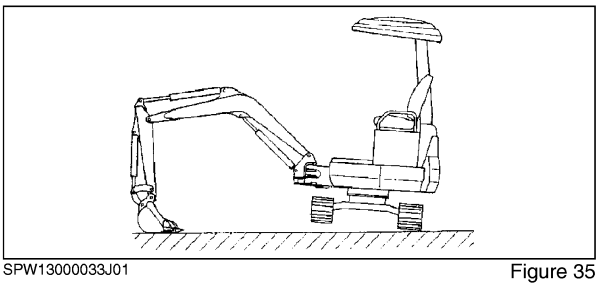
13.8.3 SLEW BEARING PLAY

1. Attach a dial gauge to the bottom face of the slew bearing's outer-race located in front of the upper slewing structure.



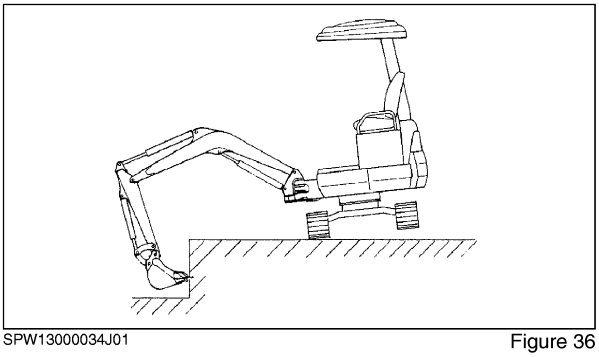
SPW13000032J01 Figure 34

2. Raise the track on one side off the ground and set the dial gauge to zero.



SPW13000033J01 Figure 35

3. Then raise the opposite track and read the dial gauge.



SPW13000034J01 Figure 36

22.1 SUMMARY

22.1.1 FUNCTION AND FEATURES OF HYDRAULIC CIRCUIT

The hydraulic circuits are built up with the following functions and features in order to achieve easy operation, safety and high working efficiency.

PERFORMANCE	DEVICE	FUNCTION	FEATURES
Easy Operation and Safety	Travel	Straight traveling Preventing overrunning of travel motor Parking brake	Straight traveling secured by independent travel function in combined operations Preventing overrunning on a slope Automatic braking at parking
	Slew	Slewing (with dozer) independent circuit Auto slewing parking brake Slewing shockless function	Constant slewing speed when operating in simultaneous operation condition Protecting against slewing drift on a slope Smooth feeling when starting and stopping slewing operation
	Attachment	Hydraulic pilot control system Dozer (with slewing) independent circuit. Multi-control valve	Responsive operability Secure the travel straight when travelling and working with dozer. Capable of selecting operation pattern from two types using one lever
	Others	Closed pressurized hydraulic oil tank Suction strainer Line filter in pilot circuit Return filter	Preventing contamination of hydraulic oil and improving self sucking up efficiency Removing dirt of suction side Preventing malfunction in pilot operating circuit Preventing contamination of hydraulic oil
High Working Performance	Pump	Total power control (Pumps: P1 + P2 + P3)	Effective use of engine power with variable pump (Power shifting by P3 pump)
	Travel	2 speeds traveling	Improving working efficiency with 2 travel speeds shifting
	Attachment	P3 pump oil flow conflux in arm or N & B operation	Speed increased by conflux P3 pump oil piping (when no dozer or slewing used)
Low fuel Consumption	Electricity	Push button deceleration	When waiting for dump truck, the engine speed is repeatedly changed and the fuel consumption and noise are reduced

CHAPTER 23

CX27B
HYDRAULIC EXCAVATORS

ELECTRICAL SYSTEM

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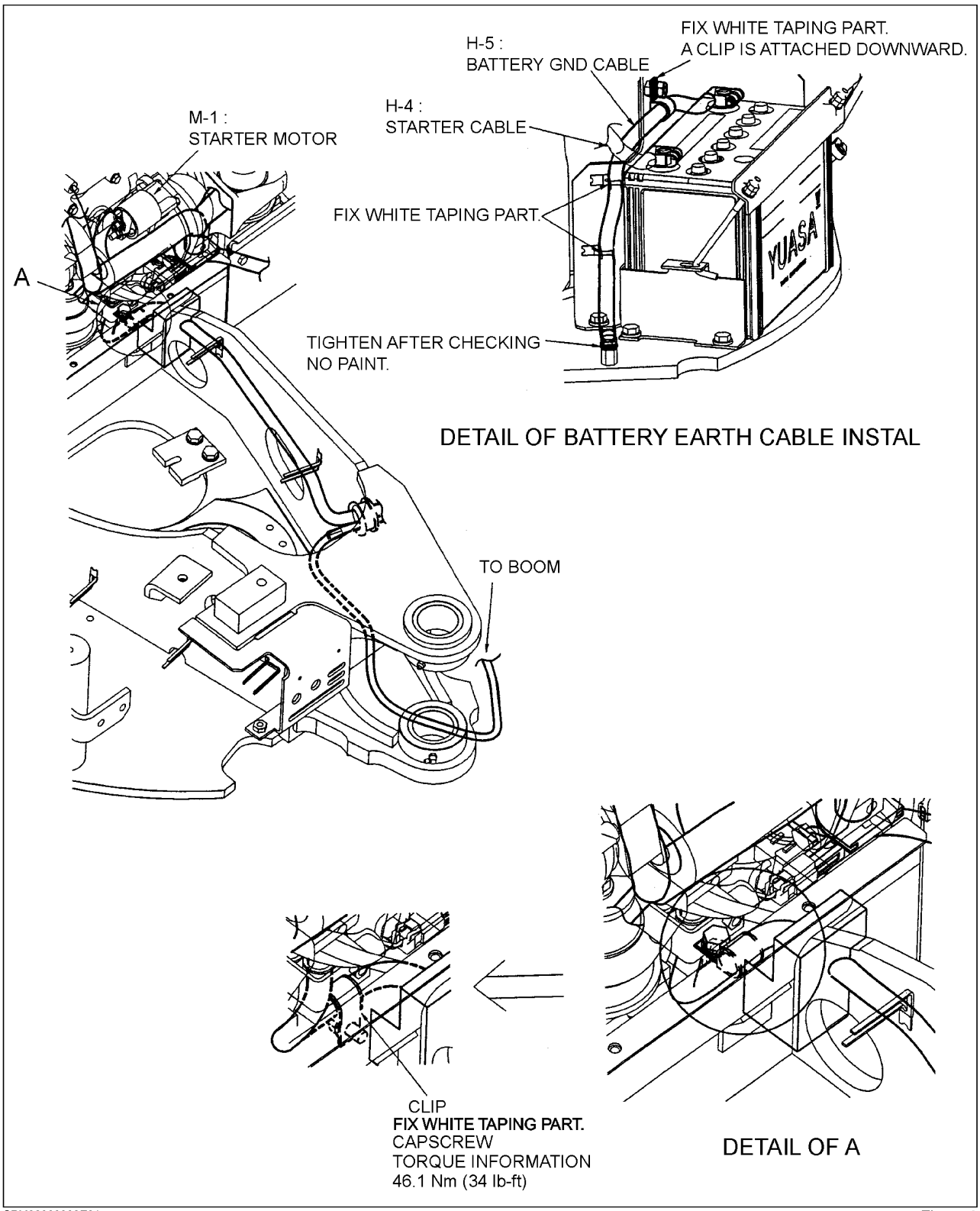

SPM23000003E01

Figure 9

FIG. 23-3 UPPER FRAME PORTION (3/7)

23.2.3.4 FUEL TANK PORTION

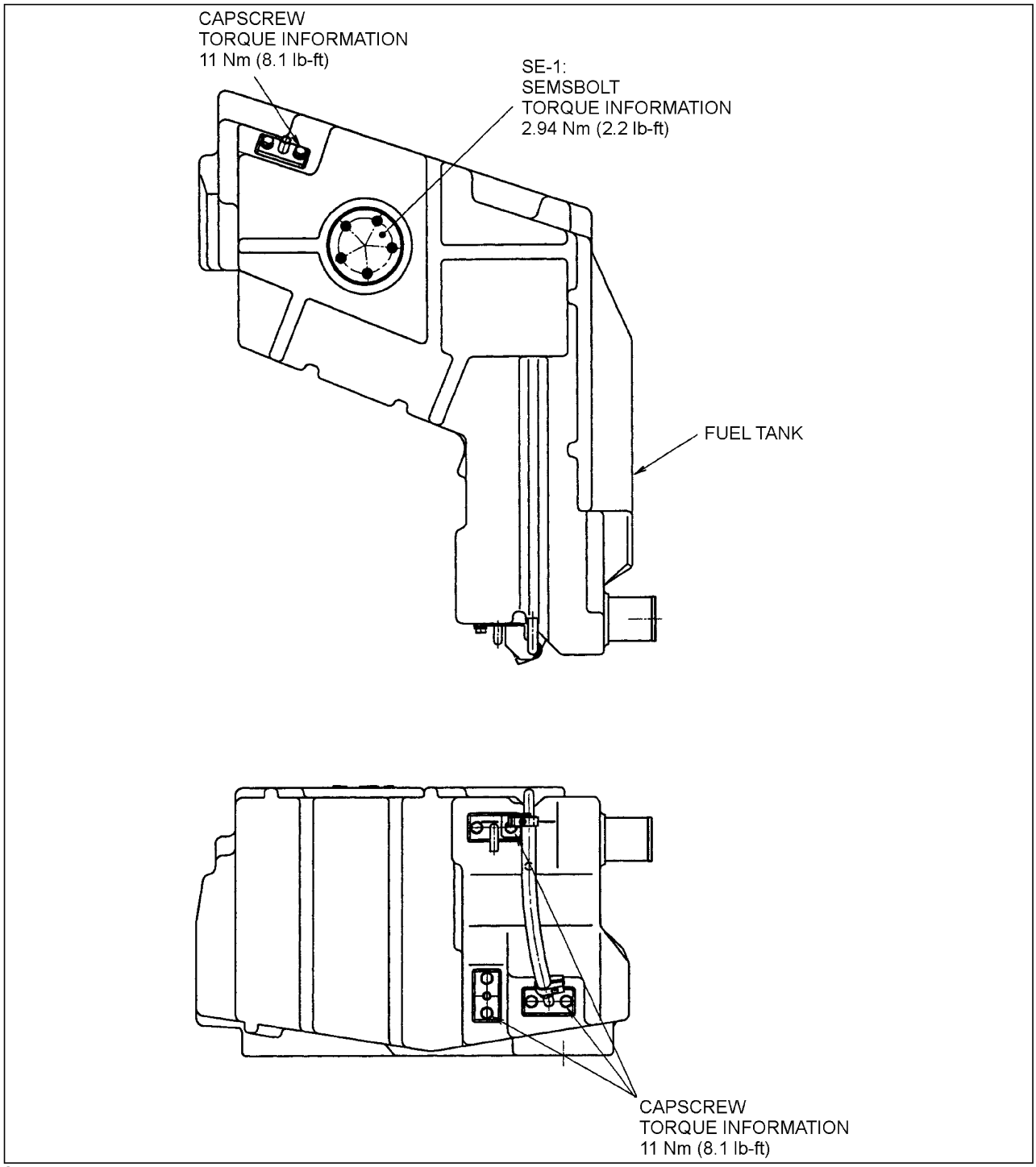

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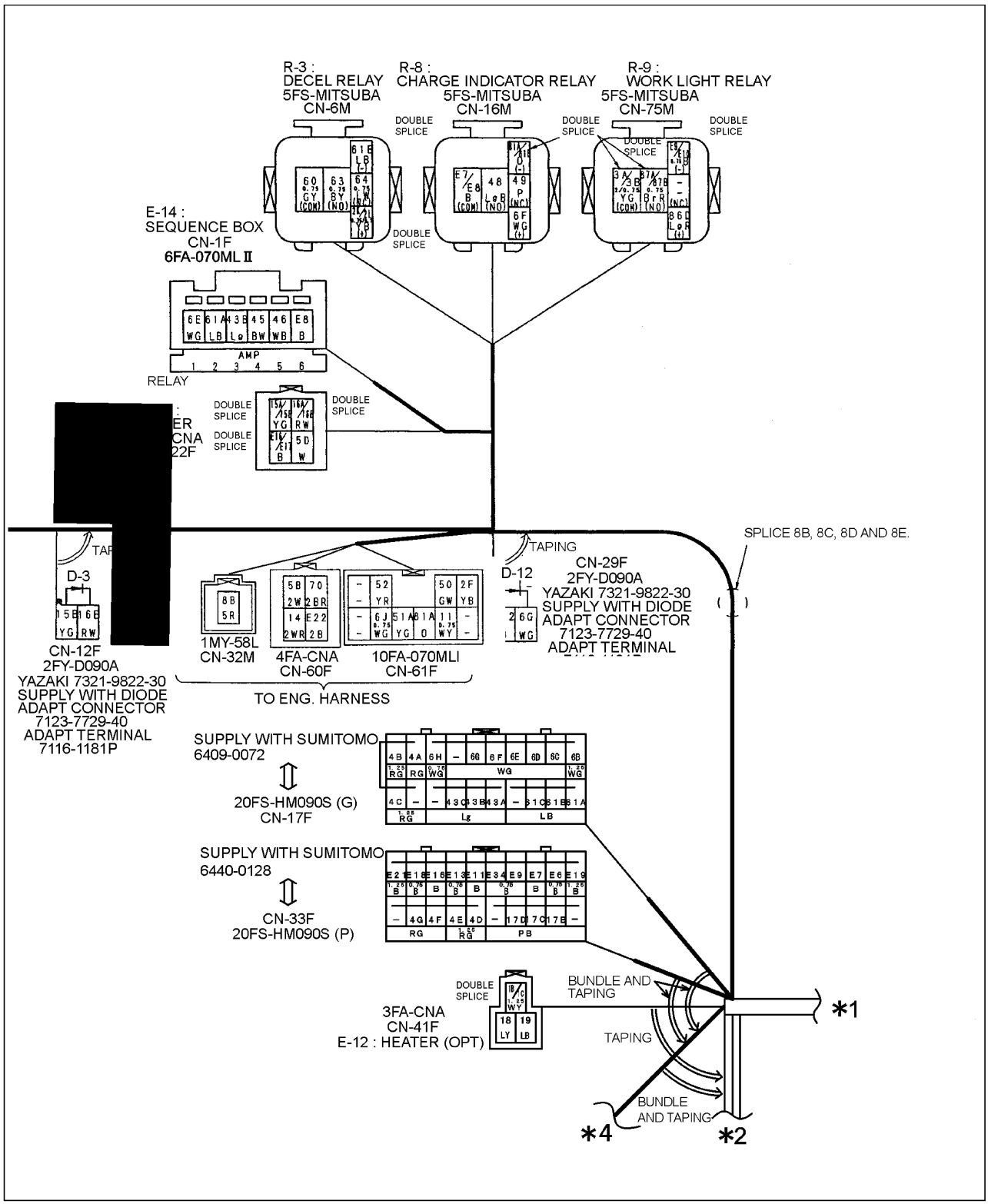
Figure 19

FIG. 23-13 FUEL TANK PORTION (1/2)

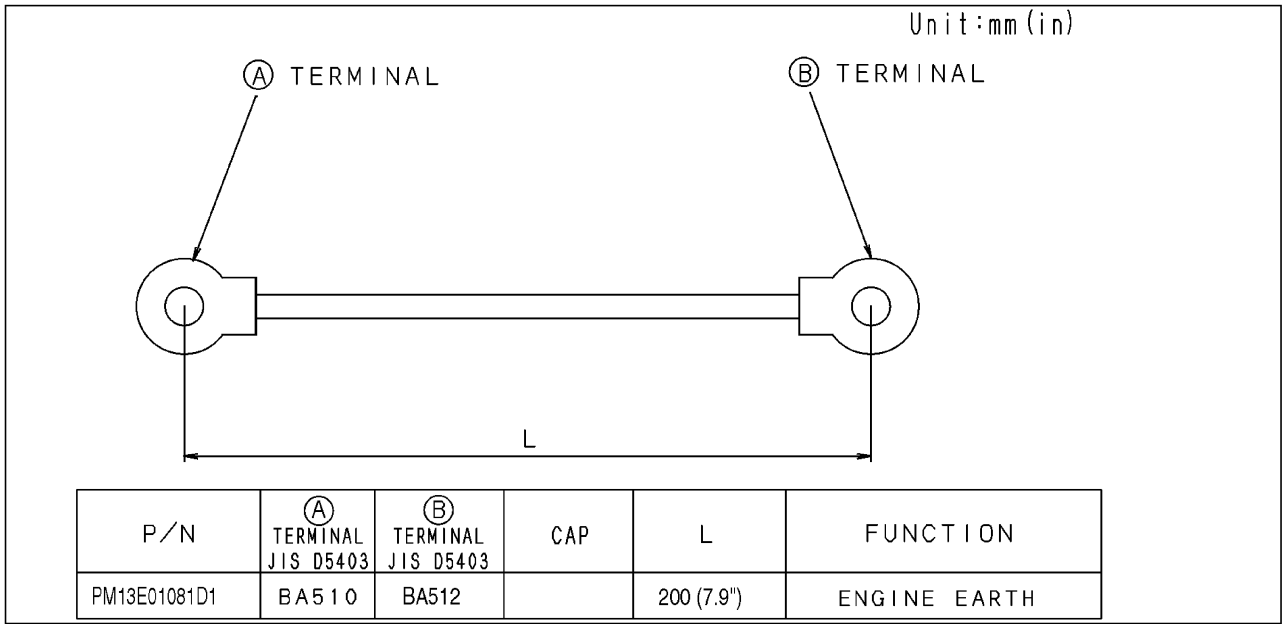


SPM23000019E01

Figure 28

FIG. 23-20 INST • MAIN HARNESS (NO. H-1) — (2/8)

23.2.4.5 ENGINE GROUND CABLE (NO. H-6)

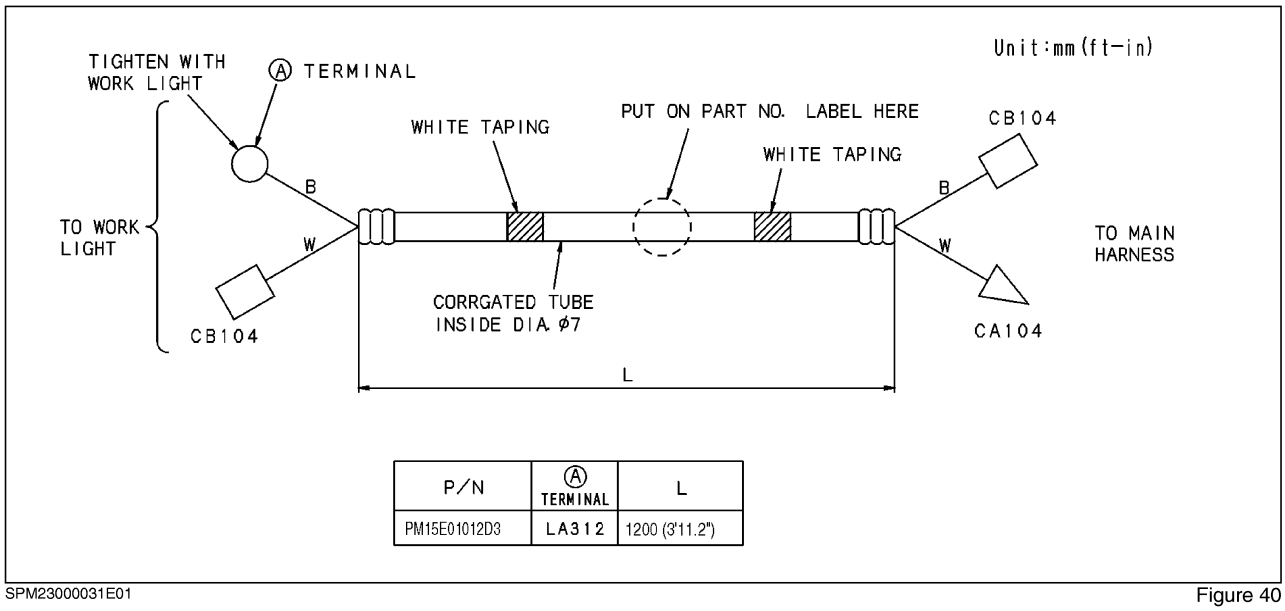


P/N	Ⓐ TERMINAL JIS D5403	Ⓑ TERMINAL JIS D5403	CAP	L	FUNCTION
PM13E01081D1	BA510	BA512		200 (7.9")	ENGINE EARTH

SPM23000030E01

Figure 39

23.2.4.6 BOOM HARNESS (NO. H-7)



P/N	Ⓐ TERMINAL	L
PM15E01012D3	LA312	1200 (3'11.2")

SPM23000031E01

Figure 40

CHAPTER 24

CX27B
HYDRAULIC EXCAVATORS

COMPONENTS SYSTEM

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Book/Form Number 6-77940 NA

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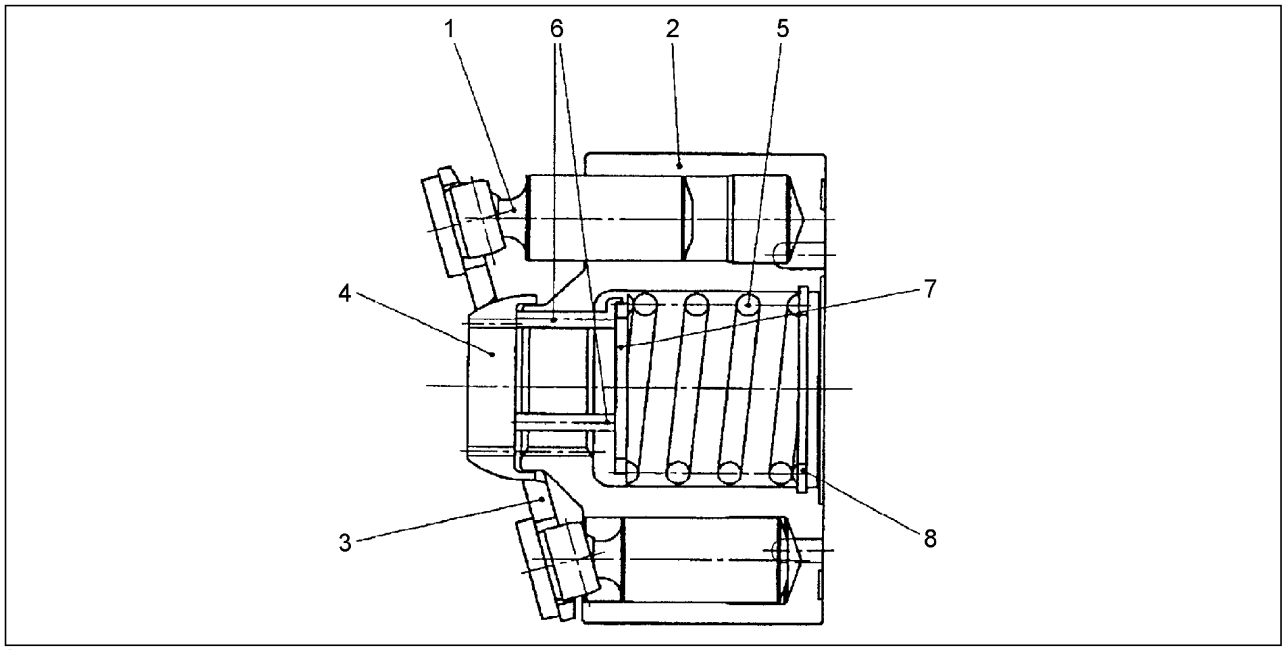
Source Code No. S5PV0007E01-KO24

24.1.1.3.3 ROTARY GROUP

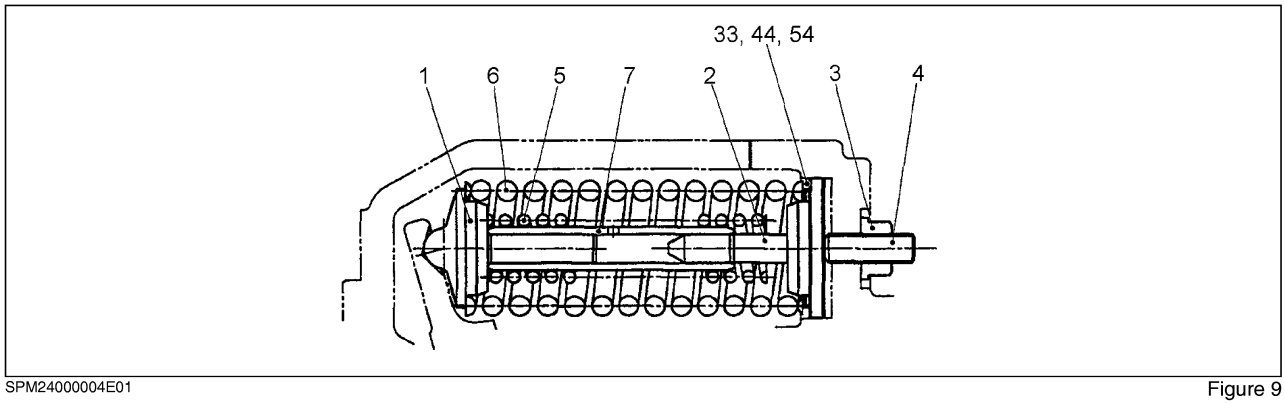


SPM24000038E01

Figure 8

No.	Name	Qty	No.	Name	Qty	No.	Name	Qty
1	Piston	10	4	Guide	1	7	Spring seat	1
2	Cylinder block	1	5	Spring	1	8	Snap ring (for hole)	1
3	Retainer	1	6	Parallel pin	3			

24.1.1.3.4 CONTROL SPRING



SPM24000004E01

Figure 9

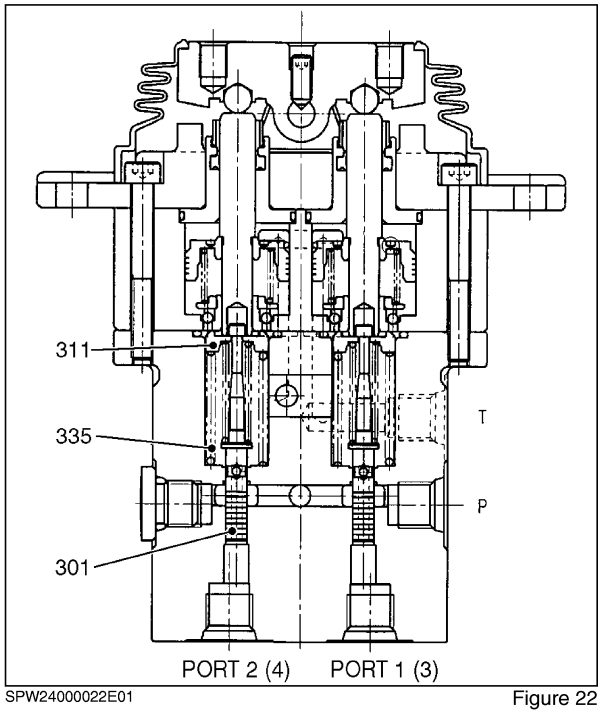
No.	Name	Qty	No.	Name	Qty
1	Spring seat	1	6	Spring	1
2	Spring seat	1	7	O-ring	1
3	Nut	1	34	Shim	2
4	Setscrew	1	44	Shim	2
5	Spring	1	54	Shim	2

24.1.3.2 OPERATION

24.1.3.2.1 REDUCING VALVE

1. When the lever is in neutral position (See Fig. 24-8)

   The spool is pushed up by the return spring (335) to the spring seat (311), and is in the neutral position and ports 1 and 2 are connected to the tank.



SPW24000022E01 Figure 22

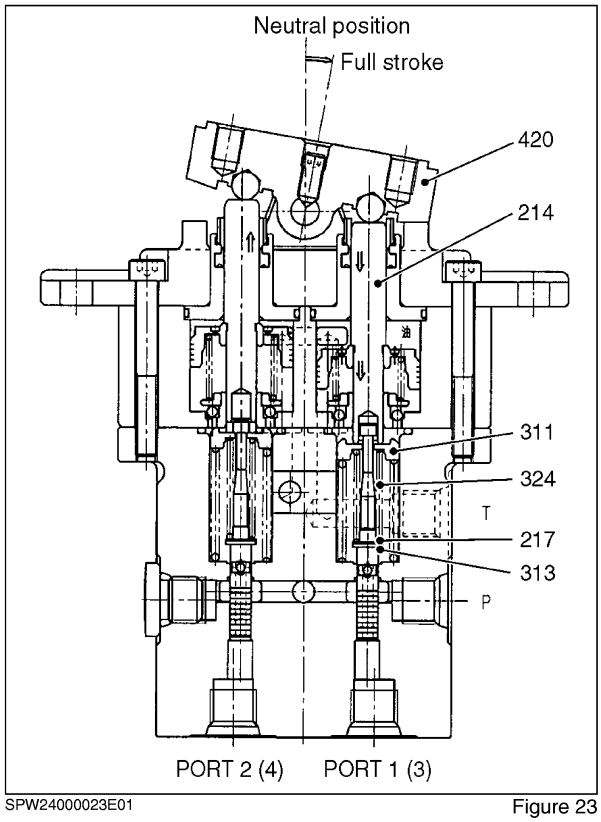
FIG. 24-8

2. Lever is tilted, (See Fig. 24-9)

   By rotating cam (420), push rod (214) on the port 1 side is pushed down, and the spool is moved down, spring (324) sets the secondary pressure, shim (217) and washer (313) are moved and port P is connected to the port 1. The supplied oil from the pilot pump flows into port 1 and generates pressure.

   When the pressure at port 1 rises to the pressure equivalent to the spring pressure for the secondary pressure setting set by tilting the control section, the hydraulic pressure applied to the spool equals the spring force and maintains port 1 at a constant delivery pressure.

   The spool on the port 2 side is held at neutral position, and the return oil from the control valve is discharged through port T.



SPW24000023E01 Figure 23

FIG. 24-9

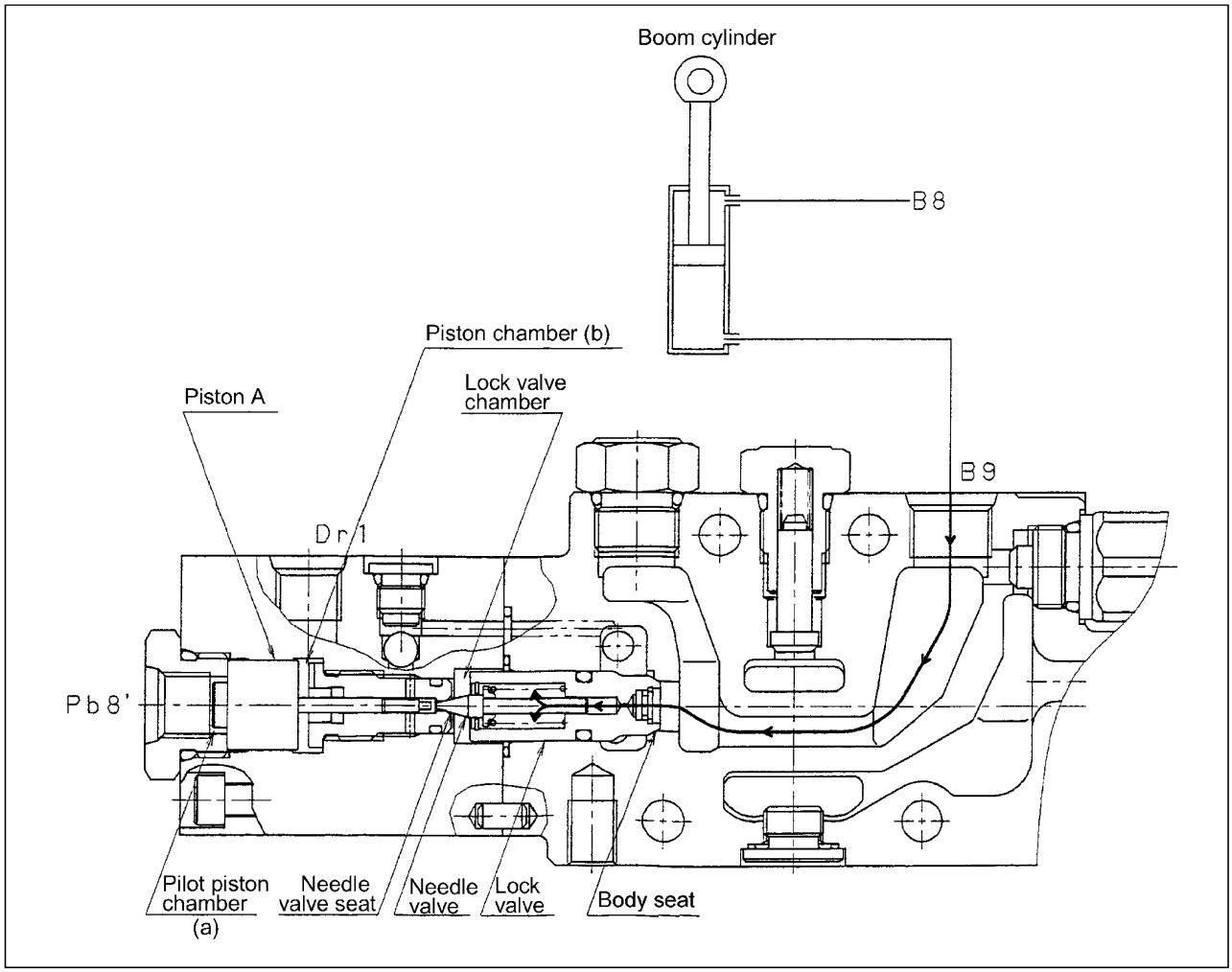
5. Function of Lock Valve

1. Piston Holding

When the boom spool is at neutral position, the pilot piston chamber (a) is connected to the drain passage through the pilot port (Pb8) for releasing lock valve. And the piston chamber (b) is also connected to the drain passage through the drain port (Dr1).

Piston (A) is held at the position shown in the figure.

The hydraulic pressure to hold the boom cylinder is applied to the lock valve chamber as shown in the figure, pressing the needle valve and lock valve to their seats respectively. This prevents leakage on the head side of boom cylinder, and also prevents the arm cylinder from movement due to leakage.

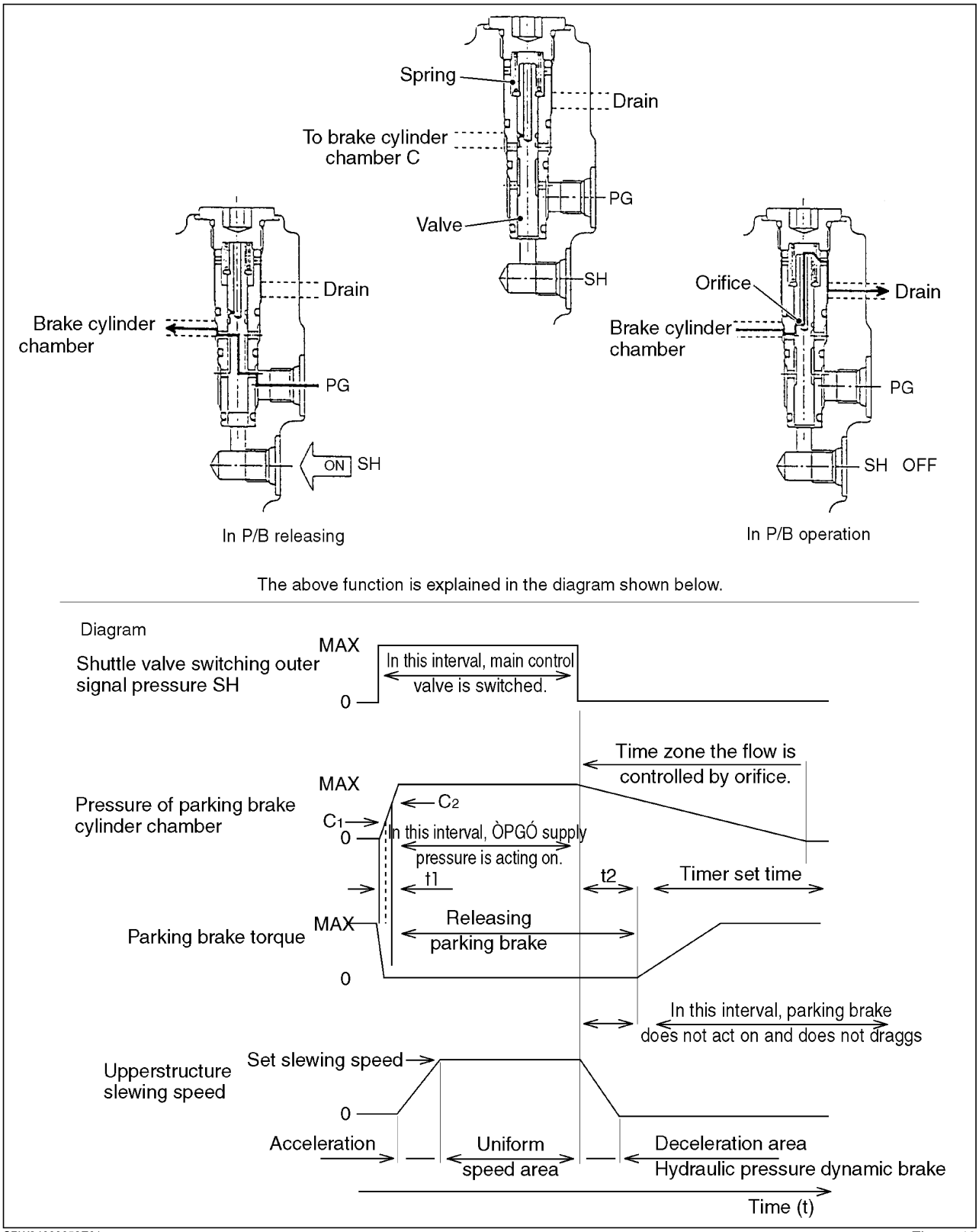


SPW24000038E01

Figure 34

FIG. 24-16 FUNCTION OF LOCK VALVE (PISTON HOLDING)

6. Hydraulic timer

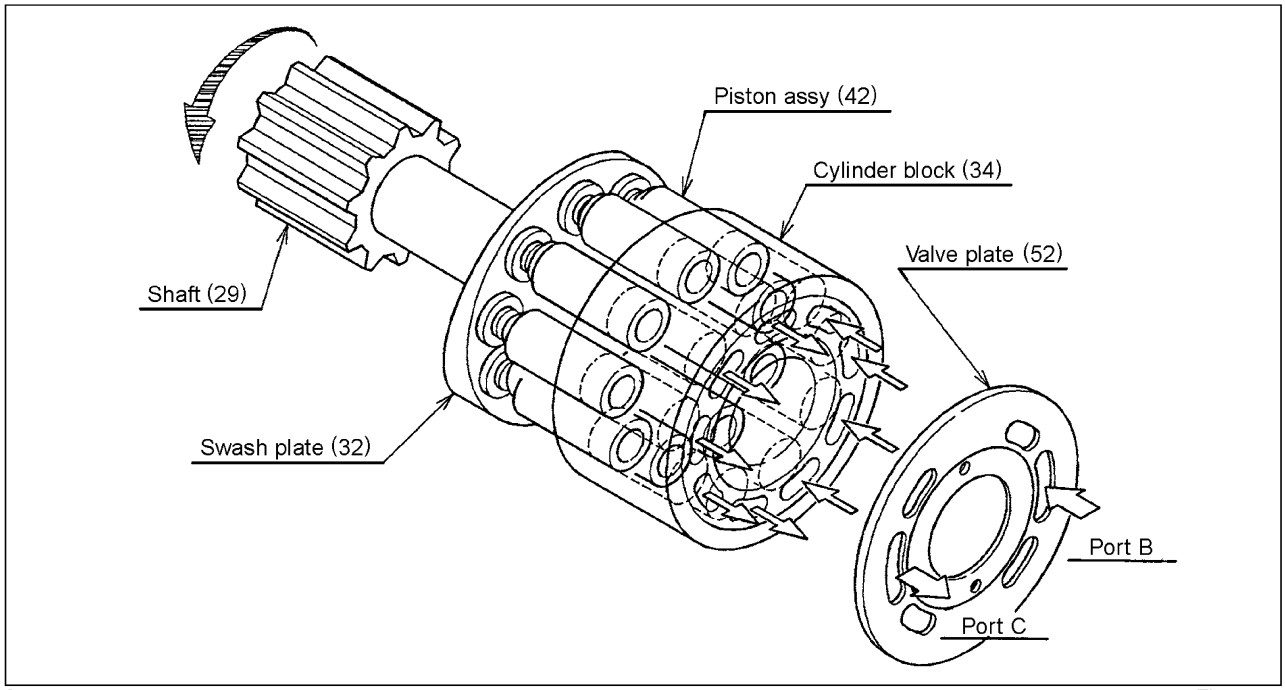


SPW24000052E01

Figure 49

FIG. 24-24

24.1.6.3.1 WORKING PRINCIPLE OF SWASH PLATE TYPE AXIAL PISTON MOTOR



SPM24000014E01 Figure 60

FIG. 24-30 STRUCTURE OF SWASH PLATE TYPE AXIAL PISTON MOTOR

Cylinder block (34) is equipped with nine piston Assy (42).
The end face of cylinder block (34) is in contact with valve plate (52) having two crescent ports B and C (high and low switching valve).
On leading high pressure oil (pressure P) to B port, swash plate (32) is pushed by the force corresponding to F=PA (A: piston receiving pressure area) per one piston assy (42).
Piston assy (42) receives the reaction against the force, and produces the force Ft in rotating direction of the reaction.
The sum total of the force in rotating direction of piston assy (42) on the high pressure side produces the rotation of cylinder block (34), and the torque is transmitted to shaft (29) through the spline resulting in the rotation of shaft (29).
The output torque and the speed of the piston motor obtained by the above operating principle is decided with pressure (P) fed into the motor and flow rate (Q) and can be found with the following equation.

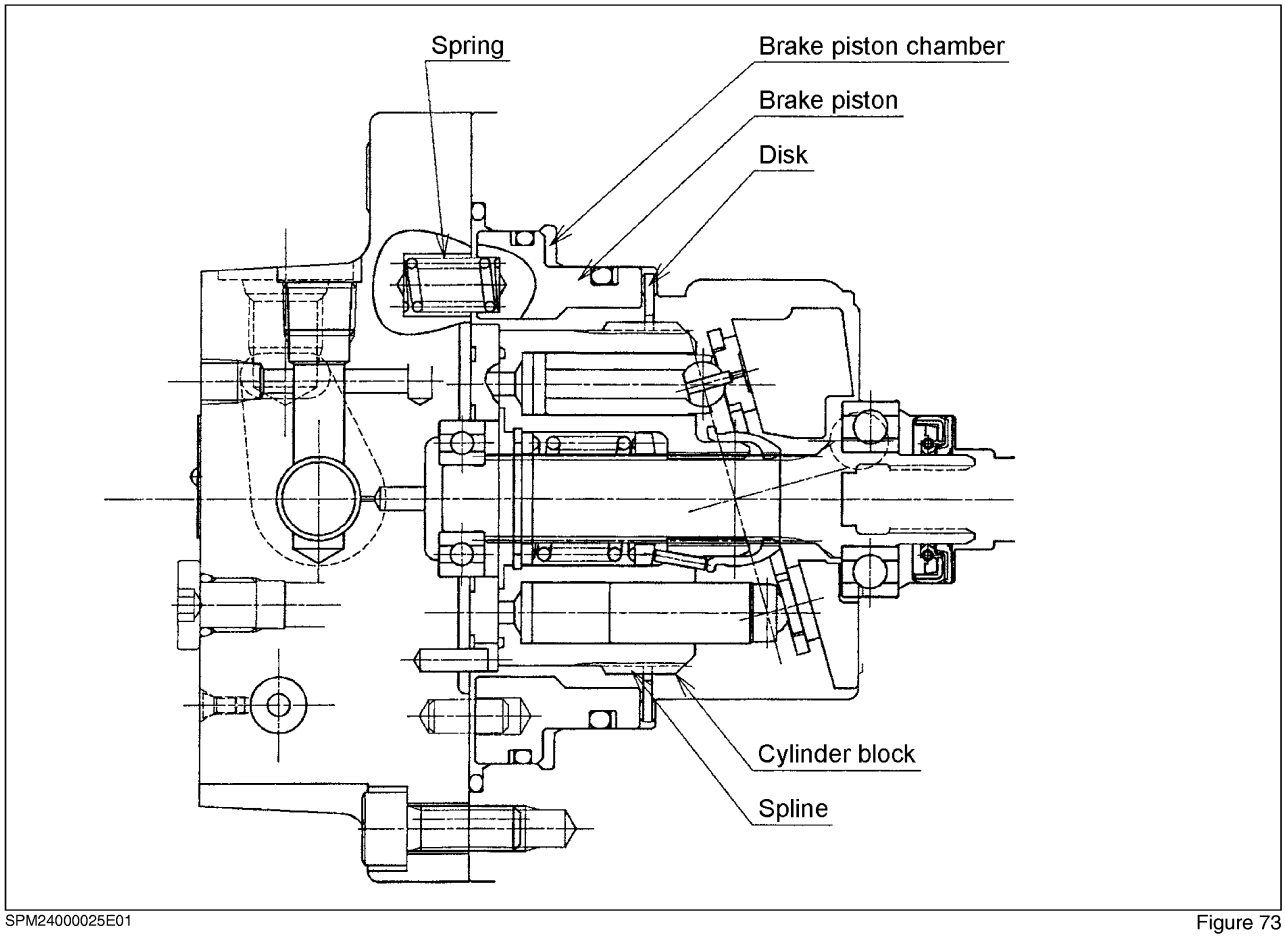
$$T=\frac{P\times D\times \eta m}{2\times \pi}$$

$$N=\frac{Q\times 10^{3}\times \eta v}{D}$$

T :Output torque (N·m)
N :Speed (rpm)
P :Working pressure (Mpa)
Q :Flow rate (L / min)
D :Theoretical displacement (cc / rev)
ηm :Mechanical efficiency
ηv :Volumetric efficiency

SPM24000033E01 Figure 61

24.1.6.3.6 WORKING PRINCIPLE OF PARKING BRAKE



SPM24000025E01

Figure 73

FIG. 24-41 STRUCTURE OF PARKING BRAKE

The parking brake is a kind of negative brake which consist of disk, brake piston and spring.
The cylinder block and disk are combined with a spline, and friction material is bonded on both sides of disk.
The disk generates frictional force between the flange holder and the brake piston by the force of spring and restricts the rotating force of the motor, achieving the best performance of the parking brake.
When the pressurized oil flows into the motor, the plunger moves and the parking brake release port is opened.
After the oil flows into brake piston chamber, the thrust “F” is generated, corresponding to the pressure receiving surface of brake piston and the thrust “F” becomes larger than the force of spring “f”, consequently the brake piston moves toward right.
Then, the disk rotates freely between the flange holder and brake piston, and parking brake is released.
When the motor is stopped, the plunger returns to the neutral position and the parking brake release port is closed.
Consequently the pressurized oil in brake piston chamber flows into motor case, the parking brake acts by the force of spring.

24.1.8.3 FUNCTION (EXAMPLE FOR BOOM CYLINDER)

1. Fundamental Function

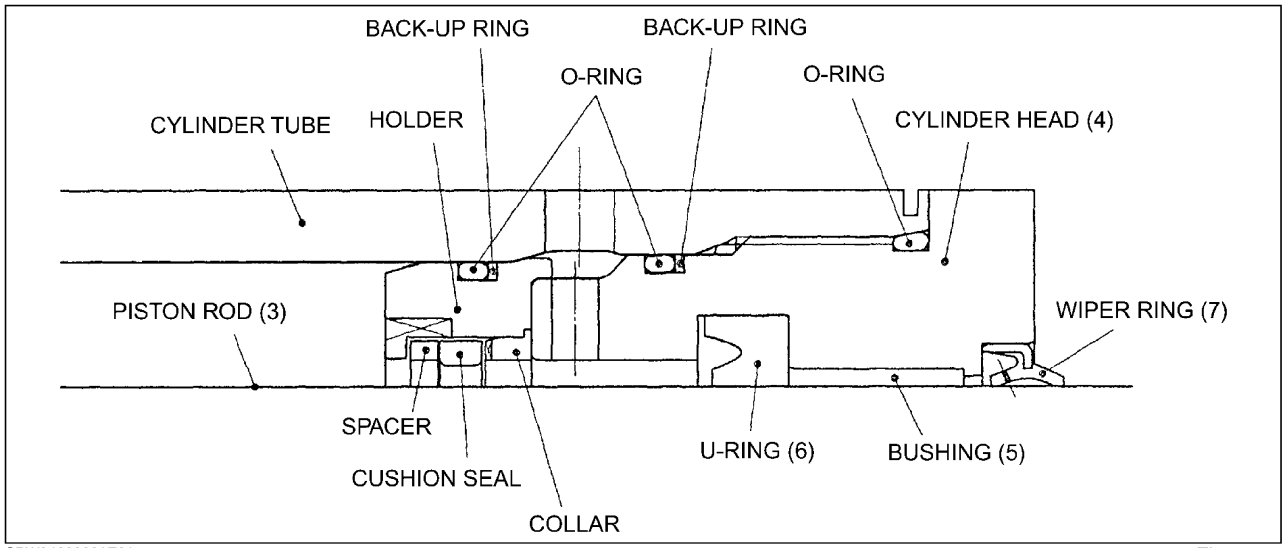
   This is a kind of hydraulic actuator that converts the energy in pressurized oil supplied by the hydraulic pump to a large force linear direction by means of the piston. Changing over the operating direction for either extension or retraction by means of actuating the valve lever to change over the direction of pressurized oil flow. Such conversion of energy force and change over the operating direction are of the fundamental function of this cylinder.

2. Function of each Part

   The following description is based on a cylinder with a typical structure (Boom cylinder).

   1. Cylinder Head Assy

      The cylinder head assy also works as a bearing by the means of a pressed bushing (5) in the cylinder head (4). Oil leakage is prevented by insertion of the U-ring (6) into the bore of cylinder head. The dust invasion is protected by pressing the wiper ring (7) into the bore of cylinder head.



SPW24000081E01

Figure 85

FIG. 24-51 CYLINDER HEAD ASSY

A. Bushing (5)

The bushing (5) is pressed into the bore on cylinder head to support the piston rod. The bushing (5) bears radial load imposed on the cylinder, and performs linear movement against the piston rod at high facial pressure, and minimized the eccentricity of piston rod that badly affects to the sealing effect by supporting its one end.

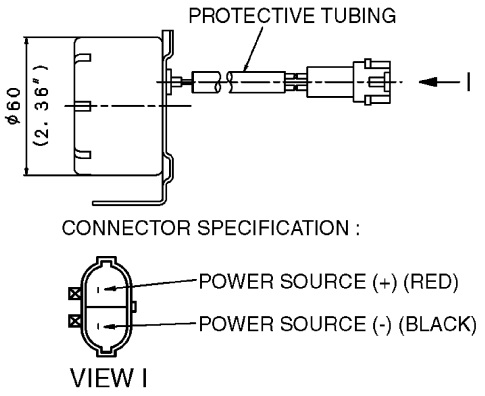
B. Wiper Ring (7)

The wiper ring (7) is located at the entrance where the piston rod comes in and out. Its function is to protect invasion of dust and water into the cylinder to secure good sealing effect of the U-ring (6), as well as to remove dust and mud adhered on the piston rod.

24.2.2.12 TRAVEL ALARM

Maker's Part No.	MAZIMA BA-102-12V
Rated voltage	DC12V
(Usage range)	9~15V
Rated current	Max 0.3A at rated voltage
Sound pressure at rated voltage	102 ± 4dB (Distance 1 m)

AMP ECONO SEAL MARK II
WATER PROOF
HOUSING : 174354-2
TERMINAL : 171661-1
HARNESS SEAL : 176886-2
RETAINER : 1-174355-1



SPW24000140E02

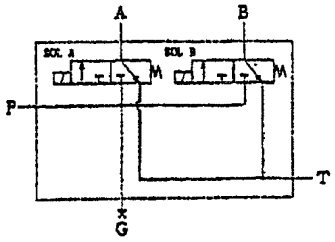
Figure 98

Specifications and Description

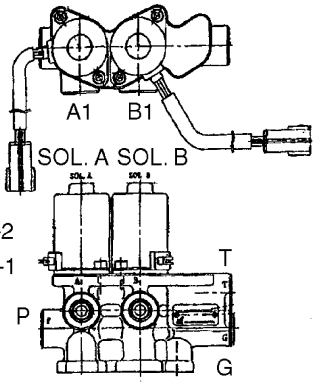
Code No. E-20
Parts Name ..... Travel alarm (Australia, China)
Parts No. PW53S00002F1
Use ..... Warning sound
Applicable Machines ..... PM07-07001~, PV10-27001~

24.2.2.31 NIBBLER SOLENOID

Rated voltage	DC12V
Consumption power	12W
Rated pressure	4.9MPa (710psi)



AMP Conector
Housing : 174354-2
Terminal : 173706-1



SPW24000136E01

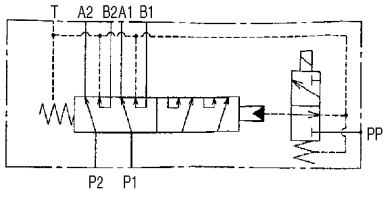
Figure 117

Specifications and Description

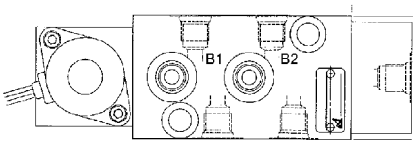
Code No. SV-9,10
Parts Name ..... Solenoid
Parts No. PY35V00005F1
Use ..... Nibbler open SOL., Nibbler close SOL. (North America)
Applicable Machines ..... PW11–30001~, PX12-11001~, PM07-07001~, PV10-27001~

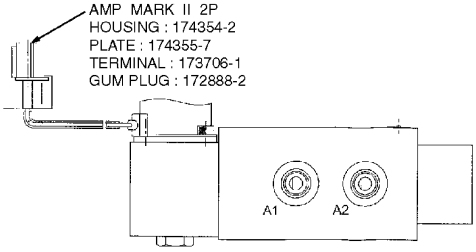
24.2.2.32 SLEW/SWING SELECT SOLENOID

Rated voltage	DC12V
Consumption power	12W
Rated pressure	4.9MPa (710psi)



HYDRAULIC CIRCUIT





SPW24000137E01

Figure 118

Specifications and Description

Code No. SV-12
Parts Name ..... Solenoid
Parts No. PE35V00001F2
Use ..... Slew/Swing select (North America)
Applicable Machines ..... PW11–30001~, PX12-11001~, PM07-07001~, PV10-27001~

SECTION 3
DISASSEMBLY AND ASSEMBLY

TABLE OF CONTENTS

CHAPTER 32
ATTACHMENTS
TABLE OF CONTENTS

32.1.5 SWING

32.1.5.1 PREPARATION FOR REMOVAL

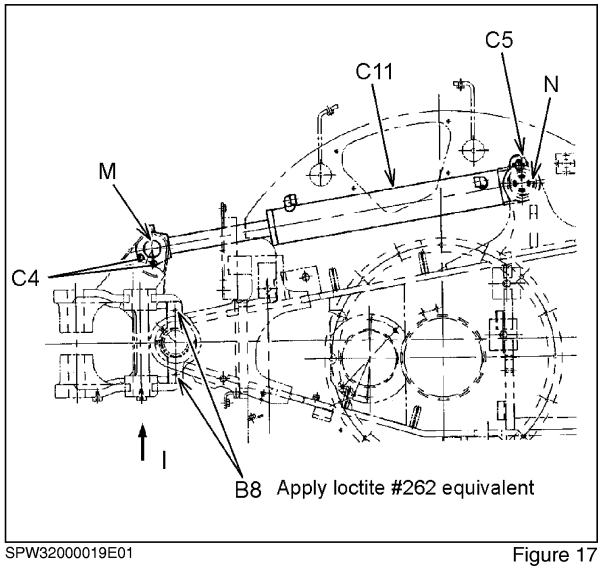
1. To make the removal easier, swing the boom around 30 degrees to the left.
2. Disconnect the hoses of bucket cylinder, arm cylinder and boom cylinder, and install plugs in all the openings.

: 22mm

32.1.5.2 REMOVAL OF SWING BRACKET AND CYLINDER

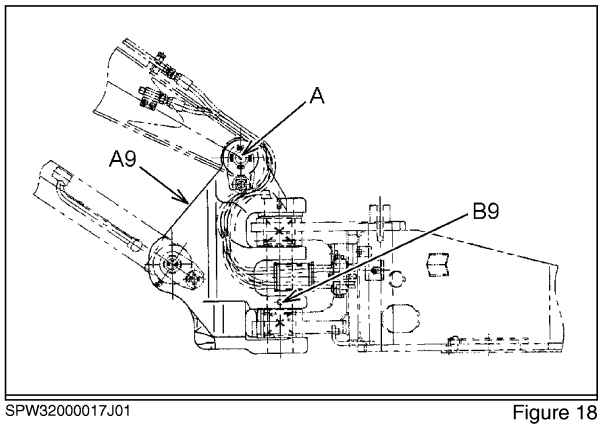
1. Removal of swing bracket (A9)
   1. Removing the capscrew (C4) securing pin (M) in swing cylinder (C11), remove the pin.

: 17mm



SPW32000019E01 Figure 17

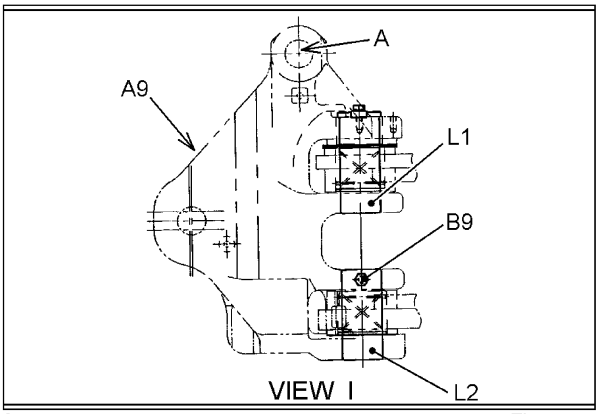
   2. Install the boom foot pin (A) in the swing bracket (A9), then lift it up.



SPW32000017J01 Figure 18

   3. Removing two capscrews (B8) (B9) securing pins (L1) (L2), remove pins (L1) (L2).

: 17mm



SPW32000018E01 Figure 19

FIG. 32-17 SWING PORTION

   4. Remove the swing bracket (A9).

      Weight of Swing Bracket: 59 kg (130 lbs).

2. Removal of Swing Cylinder (C11)
   1. Disconnect hoses for the swing cylinder, install plugs in the openings.

: 22mm

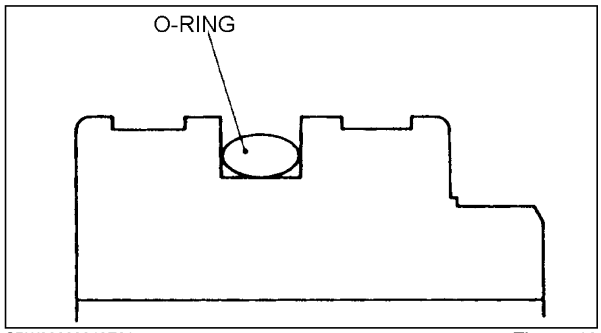
   2. Attach lifting equipment to the swing cylinder.
   3. Removing the capscrew (C5) securing pin (N), remove pin.

: 19mm

   4. Remove the swing cylinder (C11) from the front side.

      Weight of Swing Cylinder: 23 kg (51 lbs)

4. Assembly of piston portion:
   1. Install the O-ring for the seal ring assembly (18).



SPW32000046E01 Figure 46

FIG. 32-43 ASSEMBLING PISTON ASSEMBLY

   2. Set the sliding jig (C) on the piston (17), then quickly push the seal ring (18) with the pushing jig (D).

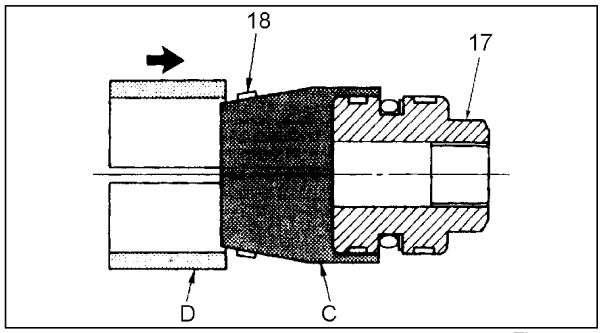
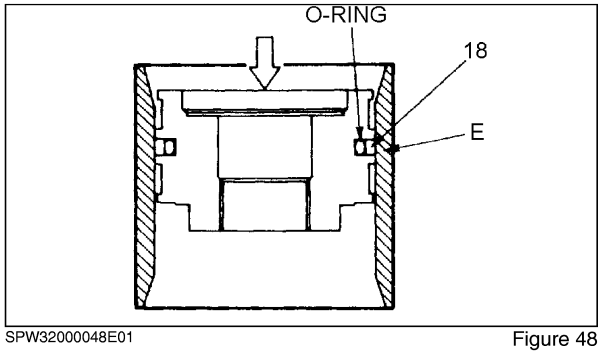


Figure 47

FIG. 32-44 ASSEMBLING PISTON ASSEMBLY

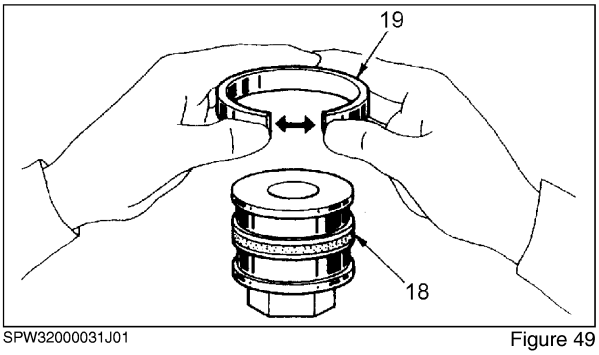
   3. Since the seal ring (18) is stretched during installation, reform it with jig (E).



SPW32000048E01 Figure 48

FIG. 32-45 REFORMING SEAL RING

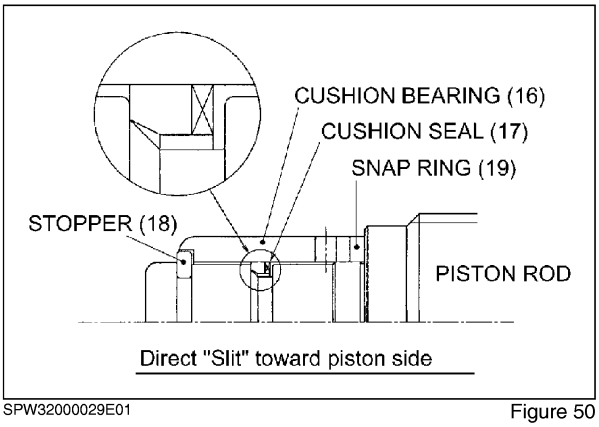
5. Install the slide ring (19).
   - Expand the split on the slide ring (19) as little as required to install it.



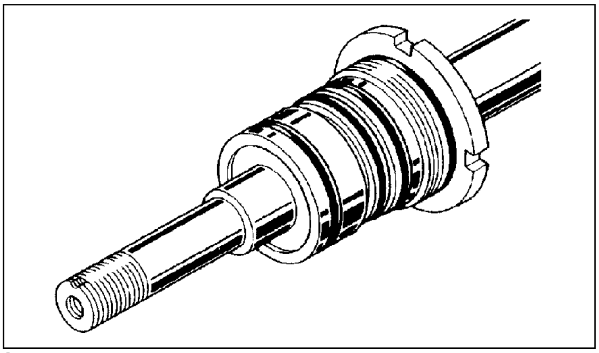
SPW32000031J01 Figure 49

FIG. 32-46 INSTALLING SLIDE RING

6. Installation of piston rod assembly:
   1. Clamp the piston rod end in a vise, support the piston end with a wooden block to hold the rod level.
   2. Installing procedures for cushion bearing of retraction side. (Only for arm cylinder)



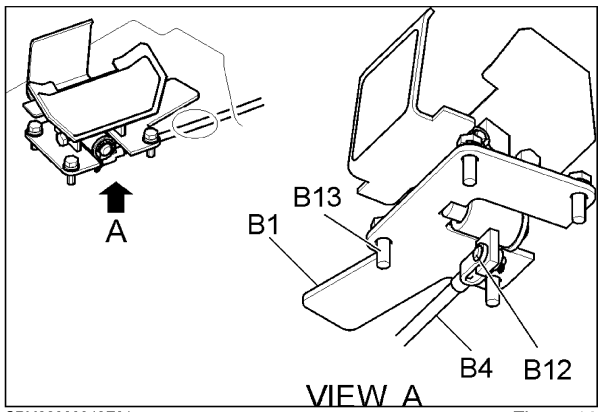
SPW32000029E01 Figure 50



SPW32000050J01 Figure 51

FIG. 32-47 INSTALLING HEAD AND HOLDER

CHAPTER 33
UPPER SLEWING STRUCTURE
TABLE OF CONTENTS



SPM33000042E01 Figure 16

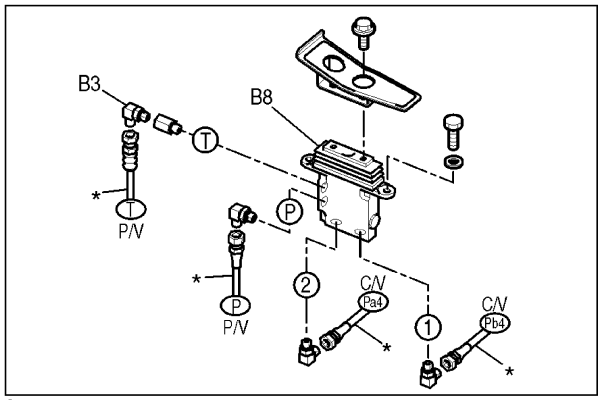
FIG.33-15 SWING CABLE DISCONNECTION

7. Removing swing pedal.

   Loosen four M8x25 bolts (B13) and pull support (B1) upward.

   : 13 mm

   Pull out pin (B12) and disconnect the control rod (B4).



SPW33000015J01 Figure 17

FIG. 33-16 PILOT PIPING REMOVAL

8. Release the pressure in the hydraulic system, remove N&B hoses.

   Disconnect hoses of the N&B valve (B8) and then plug the openings.

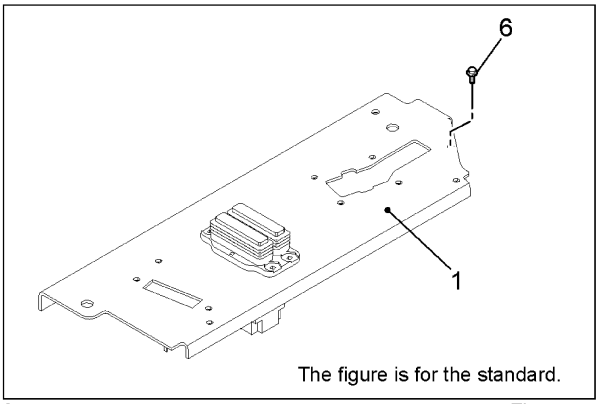
   - Attach a tag recording the valve connecting port to each of the disconnected hoses. For installation, tighten the hose fittings to the following torque:

		Tightening torque Nm (lb ft)	
Thread size (PF)	Spanner used (mm)	O-ring type fitting	30° flare type fitting
1/4	19	26.5 (20)	29.4 (22)

SPW33000309E01 Figure 18

NOTE: *Do not over torque, the pilot valve is made of aluminum.*

33.1.3.2 FLOOR PLATE REMOVAL



SPW33000016E01 Figure 19

FIG. 33-17 FLOOR PLATE (1) REMOVAL

1. Remove the M8×20 sems-bolt (6).

   : 13 mm

2. Remove the floor plate assembly (1).

33.1.3.3 INSTALLING FLOOR PLATE

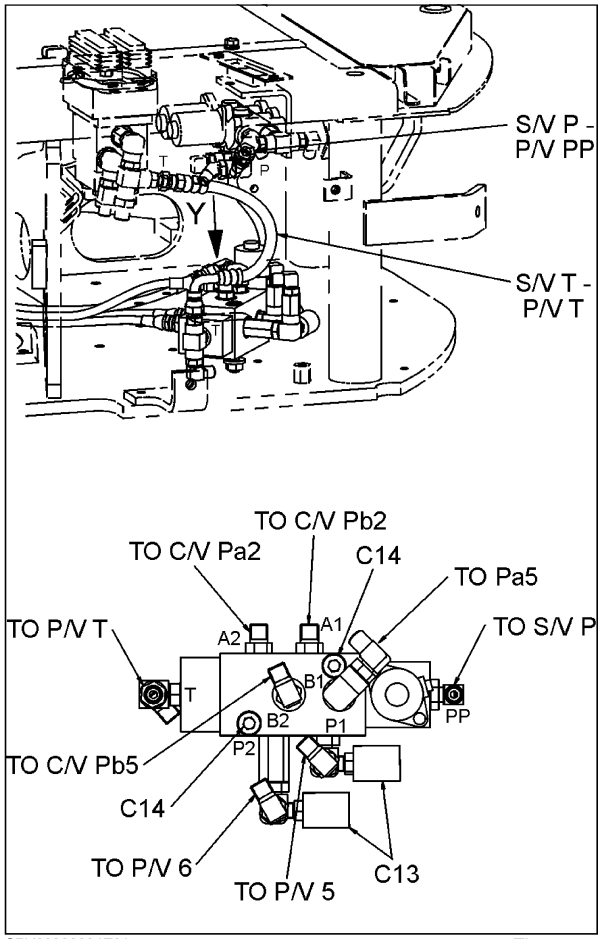
1. Assemble the floor plate in reverse order of the removal.

   Sems-bolt (6) M8:

   : 13 mm

   Tightening torque: 23.5 Nm (17 lb ft)

33.1.8.2.3 SLEW/SWING SELECT SOLENOID



SPV33000004E01 Figure 37

FIG. 33-32 SOLENOID VALVE REMOVAL

1. Disconnecting hoses

   Tag and disconnect all the hoses connected to the solenoid valve (C7). Plug and cap all lines and fittings.

2. Disconnecting connector

   Disconnect two connectors for solenoid valve (C7) and two pressure switches (C13).

3. Removing solenoid valve

   Loosen two M10×70 capscrews (C14) to remove the solenoid valve (C7).

   : 17 mm

33.1.8.3 INSTALLATION

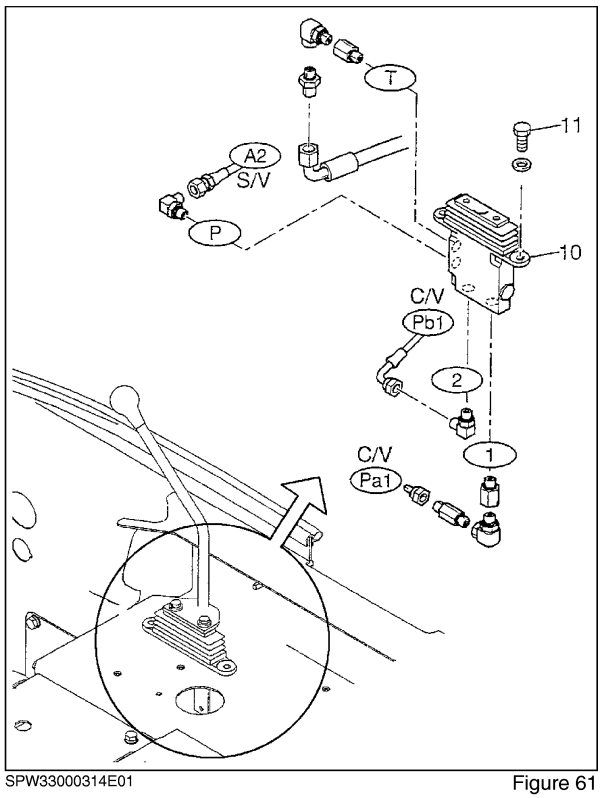
1. Install the solenoid valve in reverse order of the removal.

   Tighten the fittings at the following torque:

Item	Name	Tool (mm)	Torque N•m (lbf•ft)
A34	Capscrew (M8)	13	33.3 (25)
A35, C14	Capscrew (M10)	17	65.7 (48)
B15	Capscrew (M10)	17	21.5 (16)

		Tightening torque N•m (lbf ft)	
Thread size (PF)	Spanner used (mm)	O-ring type fitting	30° flare type fitting
1/4	19	36.3 (27)	29.4 (22)
3/8	22	73.5 (54)	49 (36)

SPV33000003E01 Figure 38



SPW33000314E01 Figure 61

FIG. 33-50 PILOT VALVE REMOVAL FOR DOZER

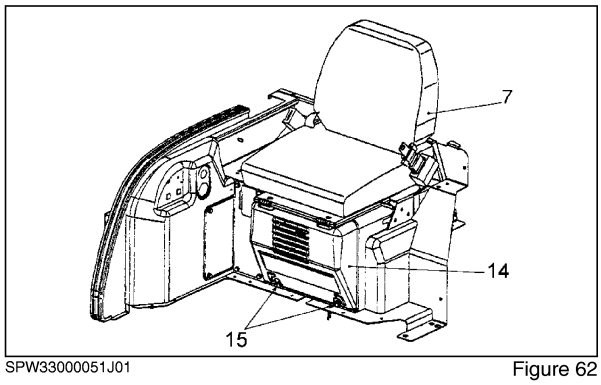
6. Pilot valve removal for dozer

   1. Disconnecting hoses

      Tag and disconnect all the hoses connected to the pilot valve. Plug and cap all lines and fittings.

   2. Removing pilot valve

      Loosen two M8×25 capscrews (12) to remove the pilot valve.



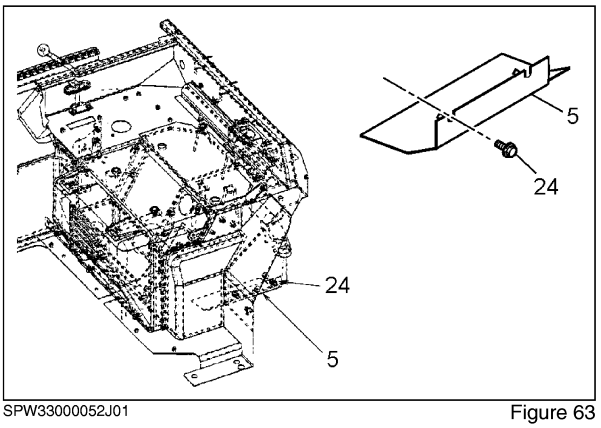
SPW33000051J01 Figure 62

FIG. 33-51 SEAT AND COVER REMOVAL

7. Removing seat and front stand cover

   Loosen four M8×20 sems-bolts (15) to remove the seat assembly (7) and the front stand cover (14) in one piece.

: 13 mm



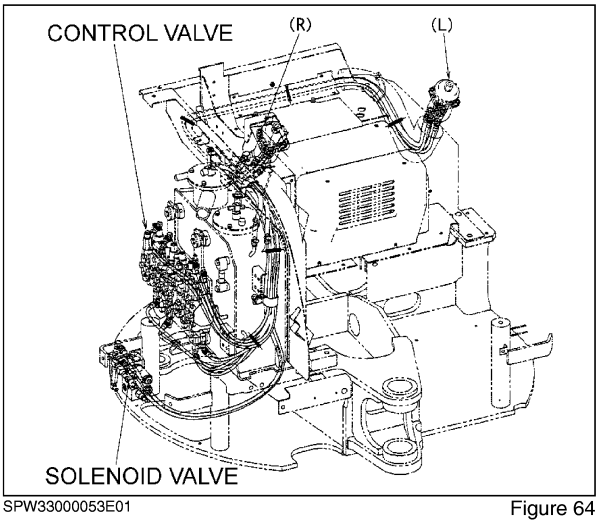
SPW33000052J01 Figure 63

FIG. 33-52 COVER REMOVAL

8. Removing heat insulation cover

   Loosen two M8×20 sems-bolts (24) to remove the cover (5).

: 13 mm



SPW33000053E01 Figure 64

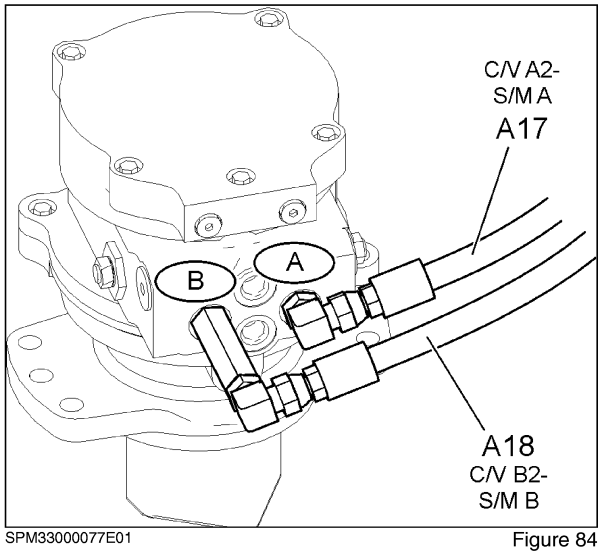
FIG. 33-53 PILOT HOSE DISCONNECTION

33.1.20 SLEWING MOTOR

33.1.20.1 REMOVAL PREPARATION

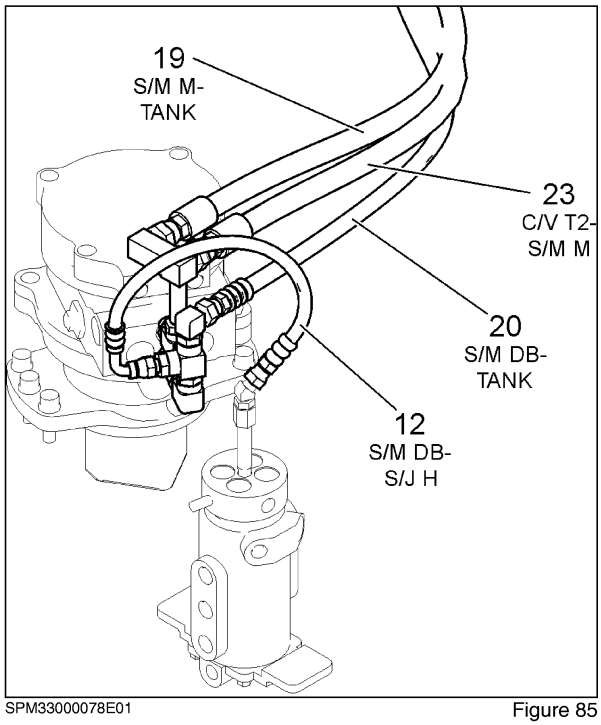
1. Remove the floor mat, the floor plate and the cover (See 33.1.3.1 (page 33-10)).
2. Release the residual pressure in the circuit and the pressure in the hydraulic tank.

33.1.20.2 REMOVAL



SPM33000077E01 Figure 84

FIG. 33-68 MAIN HOSE DISCONNECTION

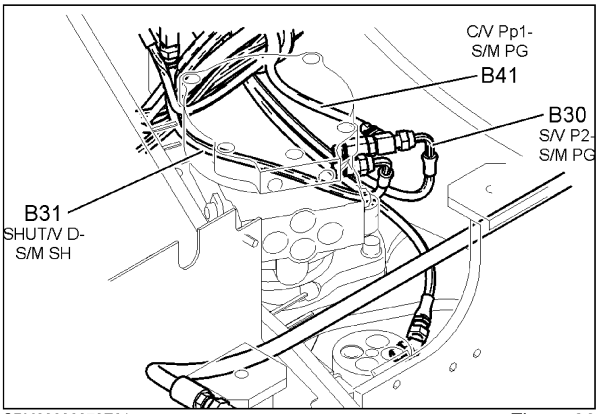


SPM33000078E01 Figure 85

FIG. 33-69 MAIN HOSE DISCONNECTION

1. Disconnect six hoses (A17), (A18), (12), (19), (20) and (23) connected to the slewing motor (See Fig. 33-68 and Fig. 33-69).

: 22 and 27 mm

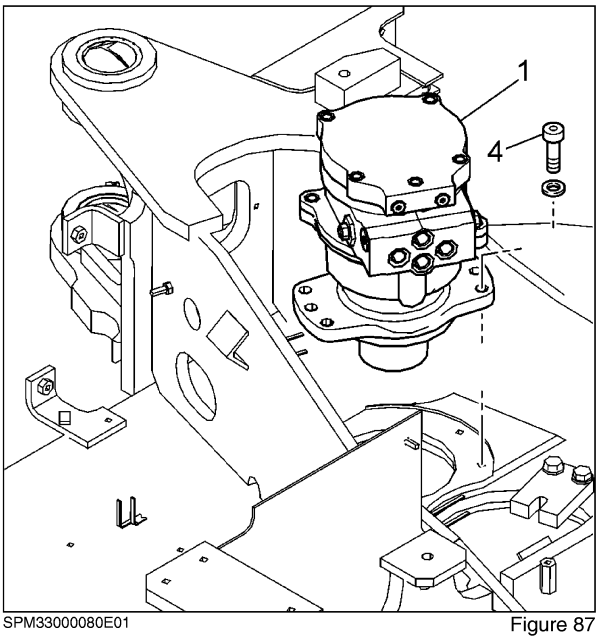


SPM33000079E01 Figure 86

FIG. 33-70 PILOT HOSE REMOVAL

2. Remove three pilot hoses (B30), (B31) and (B41) connected to the slewing motor.

: 19 mm



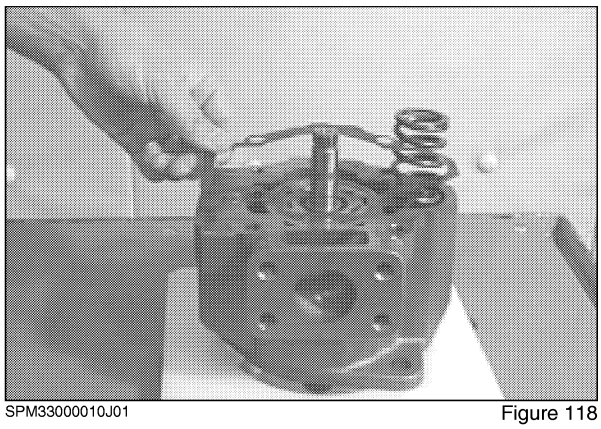
SPM33000080E01 Figure 87

FIG. 33-71 SLEWING MOTOR REMOVAL

3. Loosen five M12×40 capscrews (4) to remove the slewing motor.

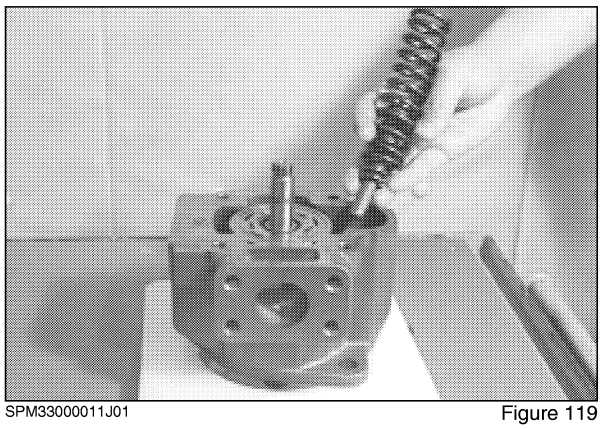
: 10 mm [approx. 300 mm (11.8") in length is required].

Weight: about 32 kg (71 lbs)



SPM33000010J01 Figure 118

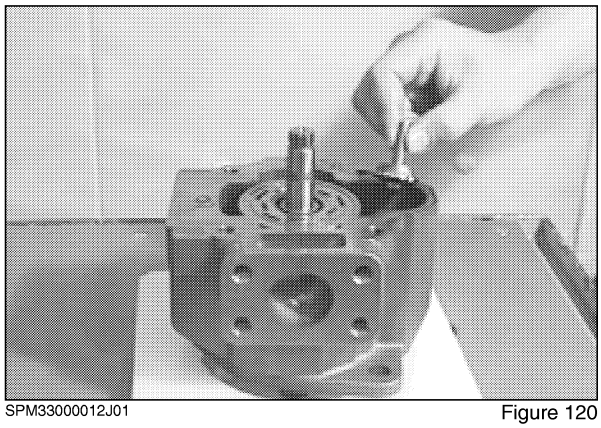
3. Remove the gasket.



SPM33000011J01 Figure 119

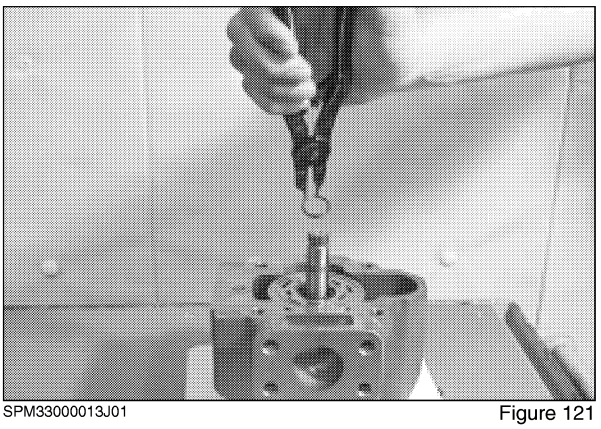
4. Removing control spring section

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



SPM33000012J01 Figure 120

B. Remove the spring seat.

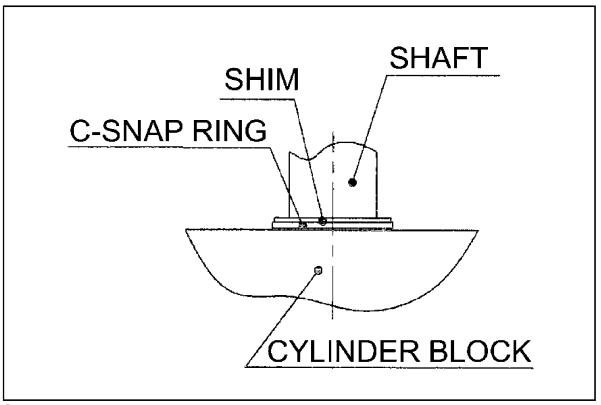


SPM33000013J01 Figure 121

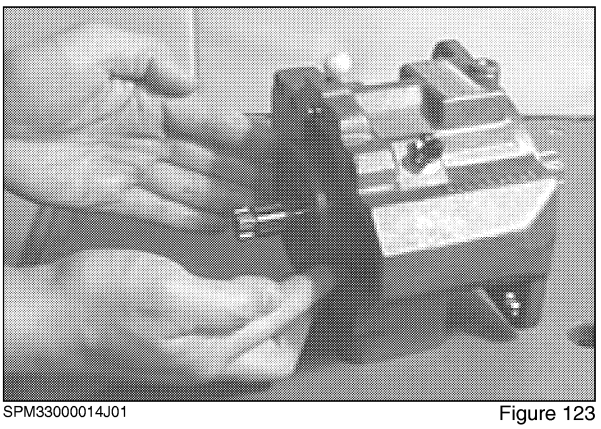
5. Removing rotary group

A. Remove the shim and then remove the C-snap ring (20) from the shaft.

Snap ring plier

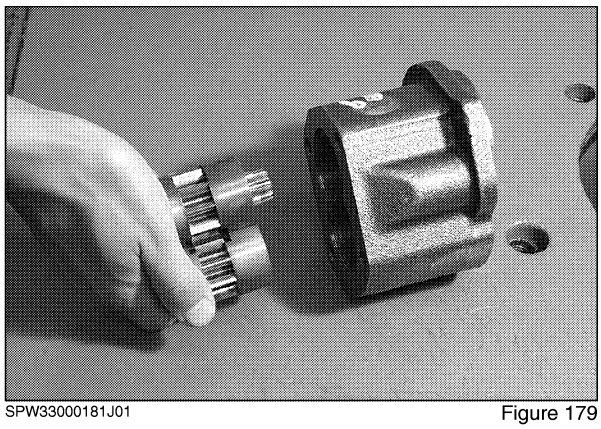


SPW33000118E01 Figure 122



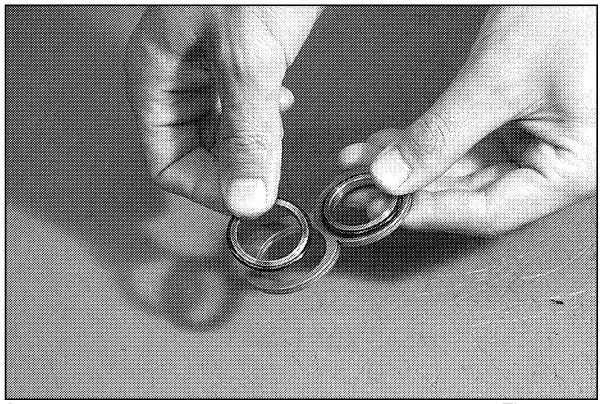
SPM33000014J01 Figure 123

B. Place the pump laterally and remove the rotary group from the shaft.



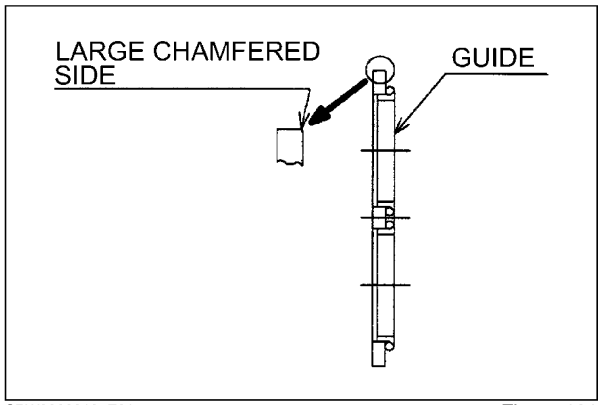
SPW33000181J01 Figure 179

C. Install the drive gear, driven gear and side plate into the housing.

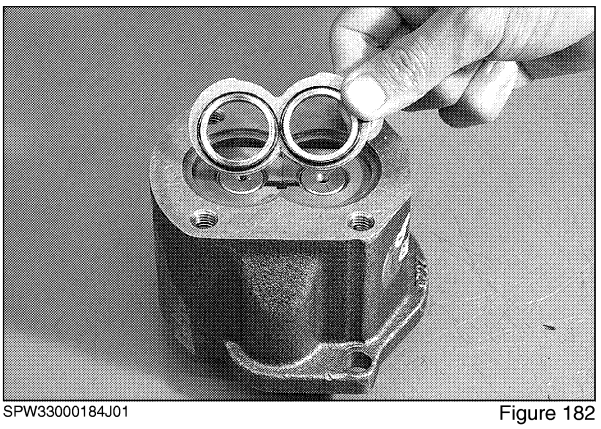


SPW33000183J01 Figure 180

D. Insert O-ring into the guide, and install it to the plate.



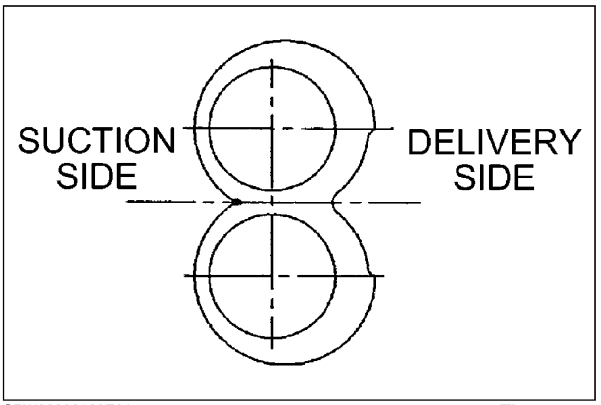
SPW33000187E01 Figure 181



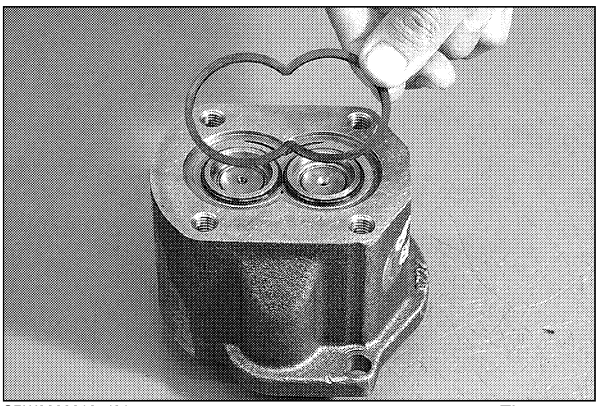
SPW33000184J01 Figure 182

E. Install the plate, guide and O-ring into the housing.

Make sure the suction and delivery direction are correct during installation.



SPW33000188E01 Figure 183



SPW33000185J01 Figure 184

F. Install the square ring.

33.2.4.1 ASSEMBLY

1. Perform assembly referring to the drawings in "Disassembly" Section.
2. Assembly procedure
   1. Assembling the valve body of the switching section (See Fig. 33-94 page 33-69).
      Put all sections of valve body in order as shown in Table 33-2 directing the ports down.

Table 33-2

SECTION (Block)	MARK	
	JAD 10	
Dozer	SR	
Slewing	GE	
P3 inlet • Travel straight	UO	
Arm	TP	
Service	FY	
B/Swing	FZ	
Travel RH	CX	
P1, P2 inlet	XD	
Travel LH	BR	
Boom	EO	
Boom lock	KE	
Bucket	VF	

NOTE: *The symbols are engraved on the upper surface of the valve body section (Port face)*

A. Make sure that the mating surfaces of section is free from dust, etc. and that the O-rings are in their groove.

B. Insert four bolts (18) through the valve body.

C. Tighten four M8 lock nuts (19) to the specified torque with a 13 mm socket.
T=16.7~17.7 Nm (12~13 lb ft)

NOTE: *Observe the specified torque. When the nut is not tightened to the specified torque, it may cause a distortion and oil leakage of the valve body.*

D. Do not tighten the nuts in a single torque, but torque the nuts several times. Tighten the nuts in a staggered pattern, tap the valve body with a plastic hammer so the sections will pull up uniformly.

2. Installing plug in the bottom of boom lock valve (See Fig. 33-90 page 33-69)
   Place the valve body on a bench with the actuator port of the valve down. Install a new O-ring (7) and tighten plug (8) to specified torque with a 6 mm Allen wrench.
   T=9.8 Nm (7 lb ft)
3. Assembling load check valve
   Put the valve body on the work bench with the actuator ports up.

NOTE: *Make sure the correct types of the load check valves are installed.*

A. Sections other than travel, P3 supply, boom lock valve and service (See Fig. 33-90 page 33-68).

B. Install load check valve (6) and spring (7) in the guide of the load check valve.

C. Hand tighten the plug so that the guide of the load check valve can be installed on the guide of plug (9).

NOTE: *Check that O-ring (8) is on the plug.*

D. Tighten to the specified torque with a 19 mm socket.
T=39.2 Nm (29 lb ft)

E. Travel, P3 supply, boom lock sections (See Fig. 33-90 page 33-68)

F. Service section (See Fig. 33-90 page 33-68)

G. Install the load check valve, apply grease to the spring (4) and install it in the plug guide.

H. Use a new O-ring (5) on plug (6).

I. Tighten to the specified torque with a 19 mm socket.
T=39.2 Nm (29 lb ft).

4. Installing RV and ORV.

NOTE: *Make sure to install the RV and ORV in the ports that they were removed from.*

A. Tighten the RV and ORV to the specified torque
T=39.2 Nm (29 lb ft)

5. Spool assembly

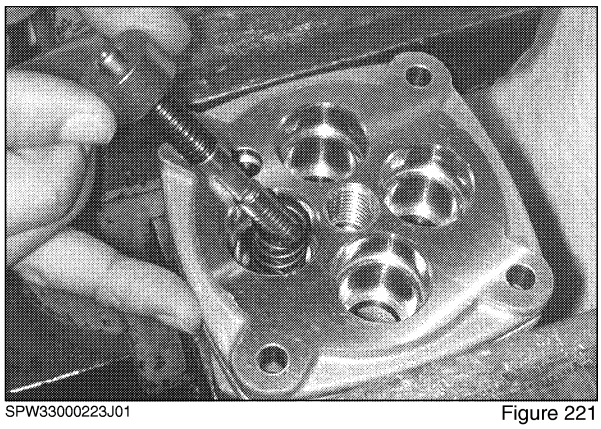
A. Hydraulic pilot type, (See Fig. 33-88 page 33-67)

B. Install spools in the sections making sure to use the correct spool for the section being assembled.

C. Use new O-rings (7) on the section.

D. Apply hydraulic oil to the spool before installation, do not force the spool, this could damage the spool and the section.

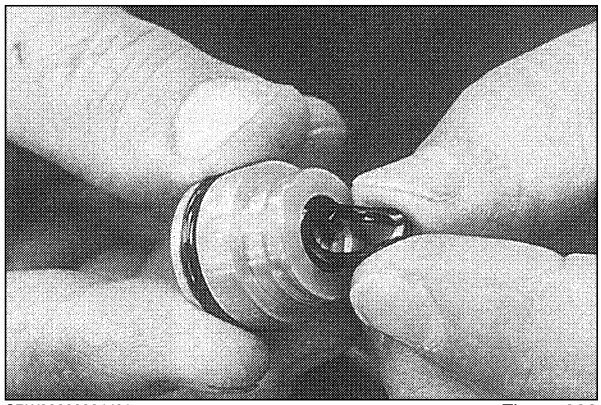
E. Check that the spool moves smoothly by hand.



SPW33000223J01 Figure 221

FIG. 33-109 INSTALLING SPOOL (221)

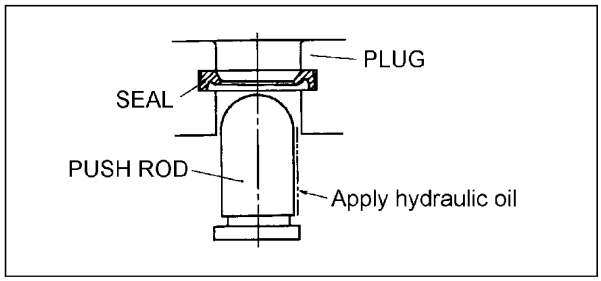
3. Install the return spring (211) into the casing (101). Install the pressure reducing valve assembly into the casing (101).



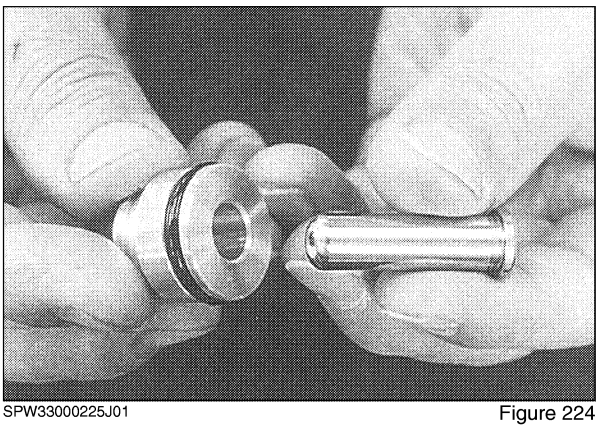
SPW33000224J01 Figure 222

FIG. 33-110 INSTALLING SEAL (213)

4. Insert the O-ring (214) and seal (213) into the plug (221).
   - Direct the lip of the seal (213) as shown below:



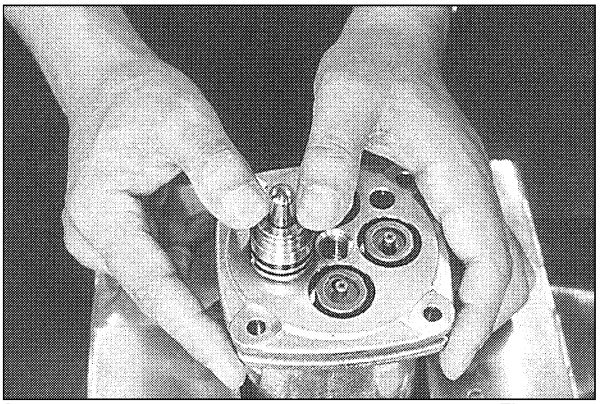
SPW33000228E01 Figure 223



SPW33000225J01 Figure 224

FIG. 33-111 INSTALLING PUSH ROD (212)

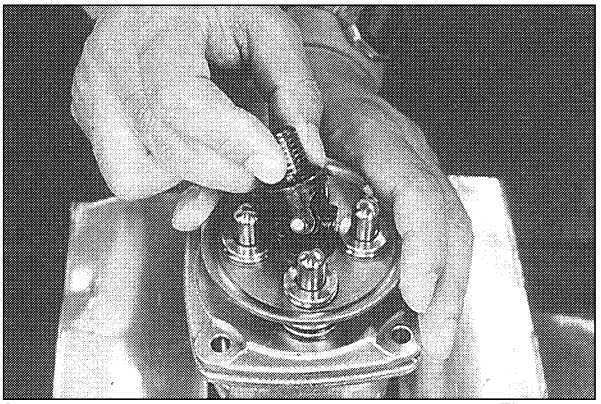
5. Install the push rod (212) into the plug (221).
   - Apply hydraulic oil to the surface of push rod.



SPW33000226J01 Figure 225

FIG. 33-112 INSTALLING PLUG ASSEMBLY

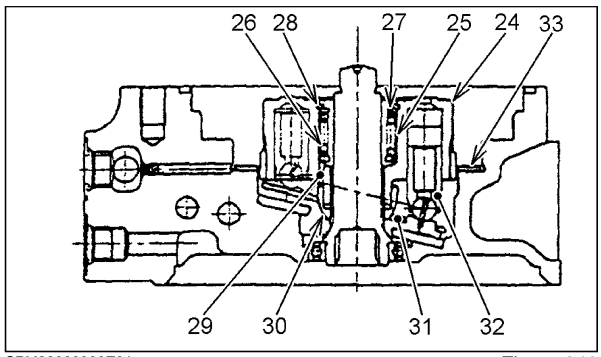
6. Install the plug assembly into the casing (101).
   - Do not use excessive force with the spool (201), the casing may be damaged.



SPW33000227J01 Figure 226

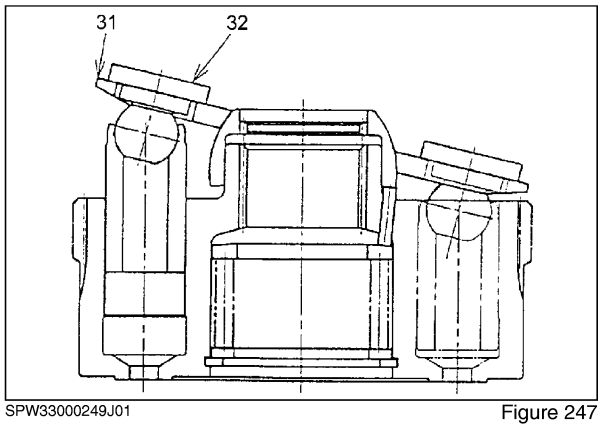
FIG. 33-113 INSTALLING PLUG ASSEMBLY

7. Install the four assemblies at the same time using the plate (151) and temporarily fasten with the joint (301).



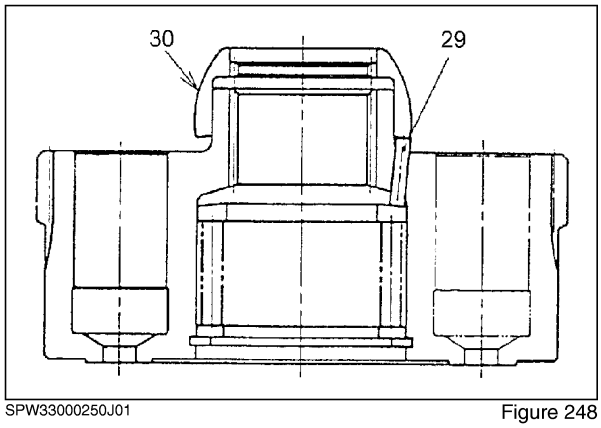
SPM33000006E01 Figure 246

8. Remove cylinder block (24), collar (25), spring (26), washer (27), snap ring (28), pin (29), retainer holder (30), retainer plate (31), piston assembly (32), and disk (33)



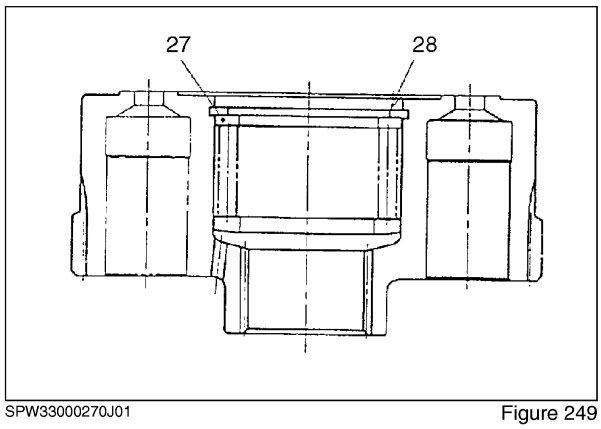
SPW33000249J01 Figure 247

9. Remove retainer plate (31) and piston assembly (32).



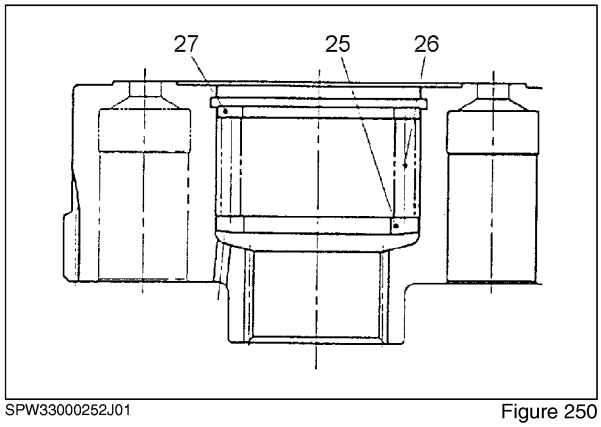
SPW33000250J01 Figure 248

10. Remove pin (29) and retainer holder (30).



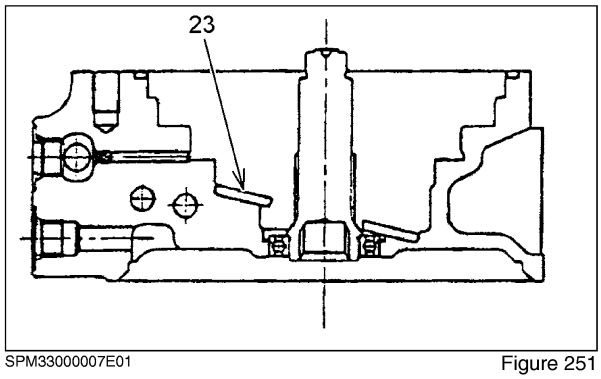
SPW33000270J01 Figure 249

11. Remove snap ring (28) and retaining washer (27).



SPW33000252J01 Figure 250

12. Remove collar (25), spring (26) and washer (27).



SPM33000007E01 Figure 251

13. Remove thrust plate (23).

Part name	Maintenance standard
Piston (53-14) Casing (20)	Severe flaw of sliding section and roughness of sliding surface Too large gap between piston and case hole Upper limit of diameter clearance: 0.04 mm (0.0016")
Spring (50) Spring (55)	Severe breakage and deformation
Plug (56, 53-6) Check valve (54) O-ring (53-8 to 53-11) (57) Back up ring (53-12, 53-13) O-ring (48-2 to 48-4) (51)	Flaw causing oil leakage, flaw causing insufficient sealing and permanent deformation.

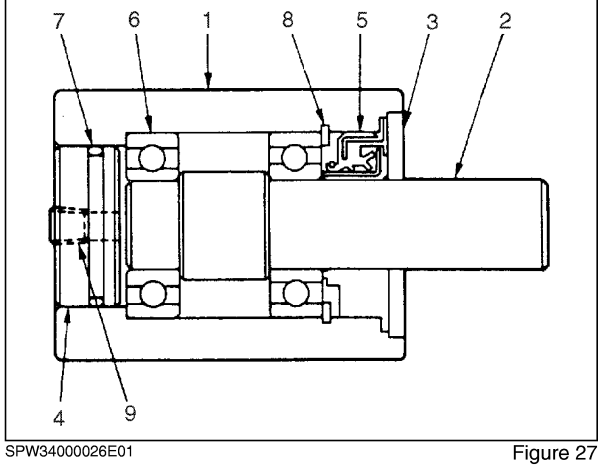
4. Others

Part name	Maintenance standard
Other plug and O-ring	Flaw causing oil leakage, flaw causing insufficient sealing and permanent deformation.

CHAPTER 34
TRAVEL SYSTEM
TABLE OF CONTENTS

34.1.3.2 CONSTRUCTION

No.	NAME	QTY	No.	NAME	QTY
1	ROLLER	1	6	BEARING	2
2	SHAFT	1	7	O-RING	1
3	SEAL COVER	1	8	SNAP RING	1
4	COVER	1	9	PLUG	1
5	SEAL	1			



SPW34000026E01 Figure 27

FIG. 34-25 CONSTRUCTION OF UPPER ROLLER

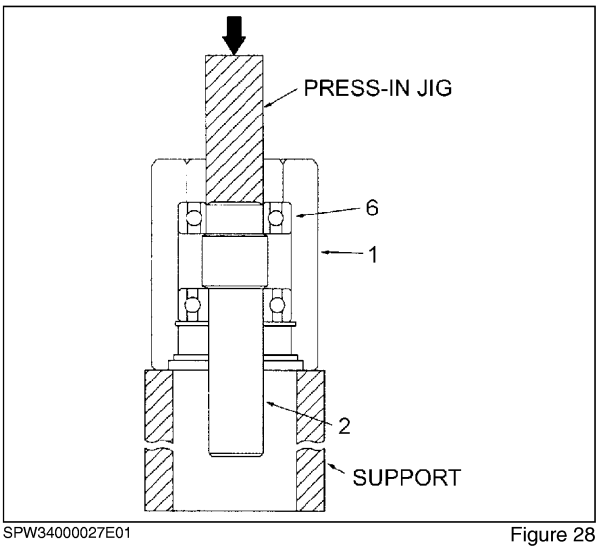
34.1.3.3 DISASSEMBLY AND ASSEMBLY

The seal cover (3) and cover (4) of both sides of upper roller are press-fit into the roller (1).
This portion is usually not disassembled and assembled. If it is necessary, do as follows:

34.1.3.3.1 DISASSEMBLING

1. Remove plug (9), and drain the oil.

   : 5mm
2. Remove seal cover (3) by drilling holes or cutting it, then remove seal (5).
3. Remove snap ring (8).
4. Remove cover (4) utilizing threaded hole (PT 1/8) and a slide hammer.

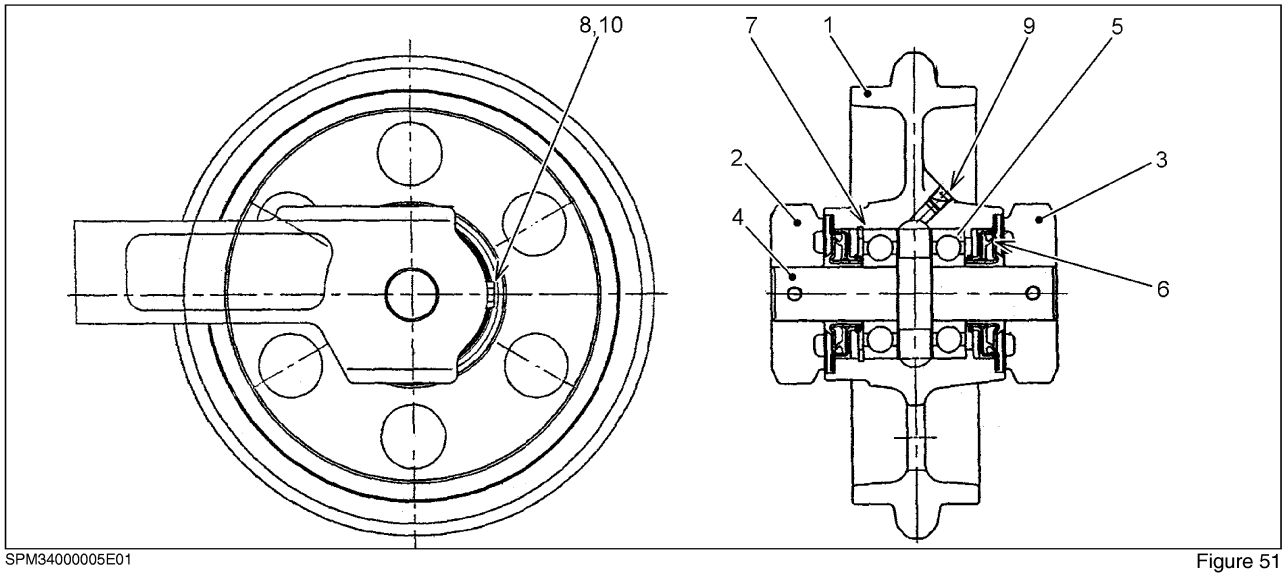


SPW34000027E01 Figure 28

FIG. 34-26 PRESSING OUT SHAFT

5. Place roller (1) with its end face on to the support base, and set the press-in jig. Pull out shaft (2) together with bearings (6) by means of a press machine or hammering.
6. If removal of bearings (6) from shaft (2) is required, remove them by using a gear puller.

34.1.5.2 CONSTRUCTION



SPM34000005E01 Figure 51

FIG. 34-47 IDLER ASSEMBLY CONSTRUCTION

No.	NAME	Q TY	No.	NAME	Q TY
1	Idler	1	6	Oil seal	2
2	Collar	1	7	Snap ring	1
3	Collar	1	8	Capscrew	2
4	Shaft	1	9	Plug: PT 1/8	1
5	Bearing	2	10	Washer	2

34.1.5.3 DISASSEMBLY AND ASSEMBLY

34.1.5.3.1 DISASSEMBLY

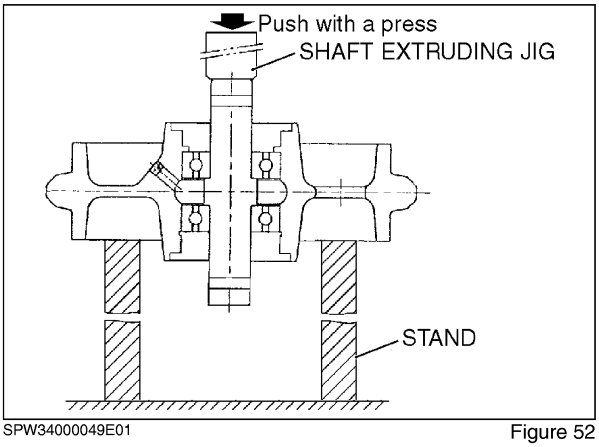
1. Remove the plug (9) and drain the oil. [Approx. 42 cc (2.7 cu in)]

   : 5mm

2. Remove the capscrew (8) and remove collars (2) and (3) from the shaft.

   : 13 mm

3. Remove the seals (6) and snap ring (7).



SPW34000049E01 Figure 52

FIG. 34-48 EXTRUDING SHAFT

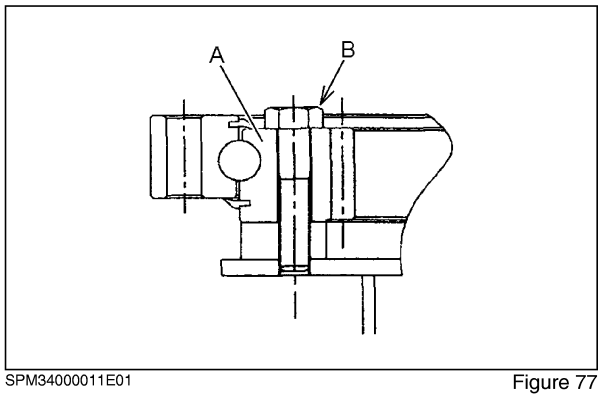
4. Place the idler (1) with a stand, use a jig on the shaft (4) and push it out together with the bearing (5).
   - If replacement of the bearing (5) is not necessary, do not remove the bearing from the shaft (4).

34.1.9 SLEWING BEARING

34.1.9.1 REMOVAL AND INSTALLATION PROCEDURES

34.1.9.1.1 REMOVING

1. Remove the upper slewing structure. (See Chapter 33 “Upper Slewing Structure”).



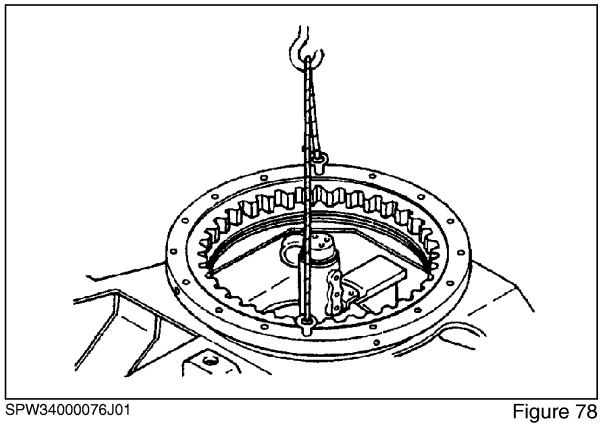
SPM34000011E01 Figure 77

FIG. 34-73 SLEWING BEARING

2. Remove capscrews (B) that fix the inner race of slewing bearing (A)

: 19mm

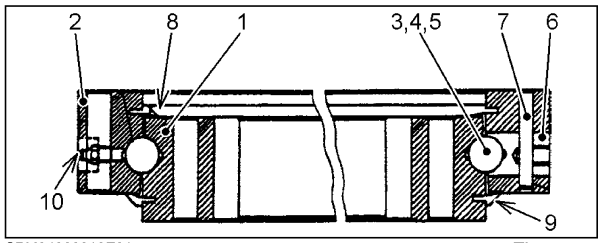
3. Remove the grease in the inner race of slewing bearing.



SPW34000076J01 Figure 78

FIG. 34-74 LIFTING SLEWING BEARING

34.1.9.2 CONSTRUCTION

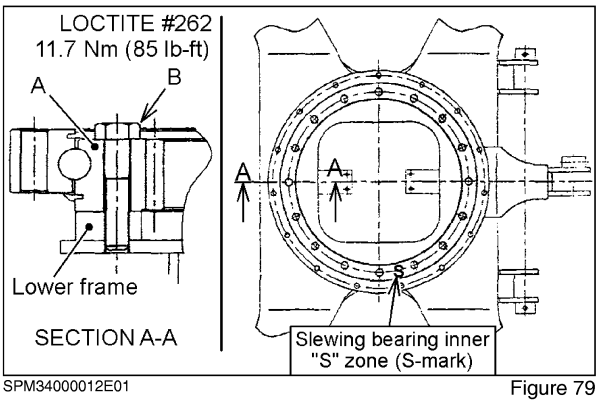


SPM34000013E01 Figure 80

4. Screw lifting-bolts in the slewing bearing (A), and lift it by crane.
Weight of slewing bearing assembly:
36 kgf (79 lbs)

34.1.9.1.2 INSTALLING

1. Before installing the slewing bearing, clean the bearing and the mating surface of the lower frame.



SPM34000012E01 Figure 79

FIG. 34-75 LOCATION OF “S” MARK TO INSTALL SLEWING BEARING

2. Lift up the bearing and place it on the lower frame, aligning the “S” mark engraved on the inner race as shown in Fig. 34-75.
3. Coat the threads of the capscrews (B) with Loctite #262 and tighten all capscrews temporarily.
4. Tighten the capscrews as per pattern in figure 34-75 to the specified torque.

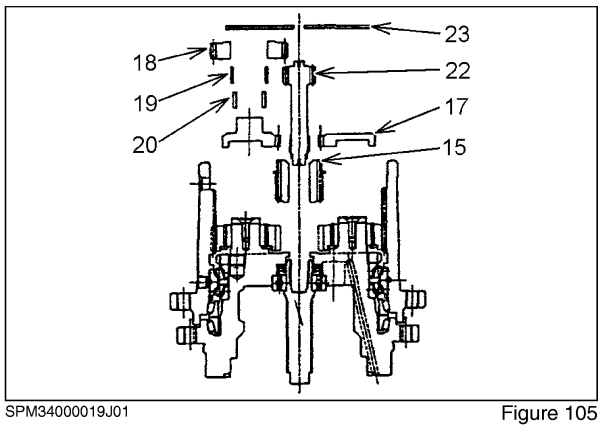
: 19mm

T=115 Nm (84.8 lb ft)

5. Fill the “grease bath” with “Lithium grease” 2.5 kg (5.5 lbs).
6. After installing the slewing bearing on the lower

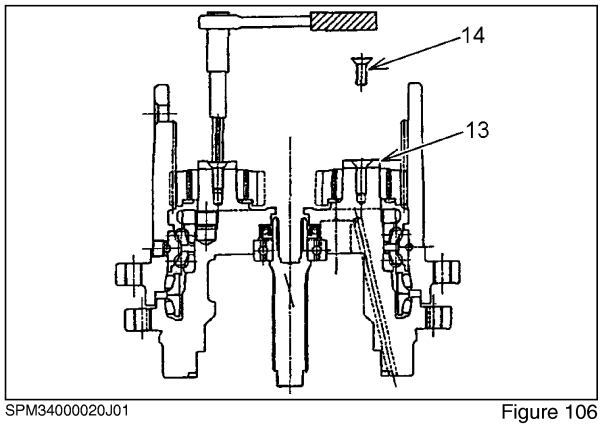
NAME	QTY	NAME	QTY
1. INNER RACE	1	6. PLUG	1
2. OUTER RACE	1	7. TAPER PIN	1
3. BALL	76	8. SEAL A	1
4. SPACER	62	9. SEAL B	1
5. SPACER/ADJUSTING	14	10. GREASE NIPPLE	1

FIG. 34-76 CROSS-SECTION OF SLEWING BEARING



SPM34000019J01 Figure 105

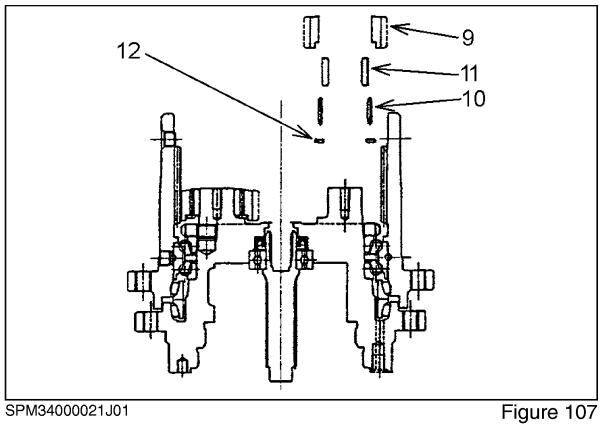
C. Remove sun gear (15), holder (17), planetary gear A (18), needle bearing (19), inner race (20), drive gear (22) and thrust plate (23).



SPM34000020J01 Figure 106

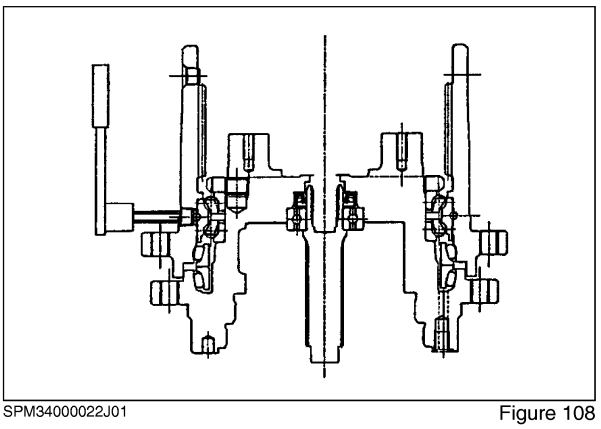
D. Remove thrust plate (13) and screw (14).

: 4 mm



SPM34000021J01 Figure 107

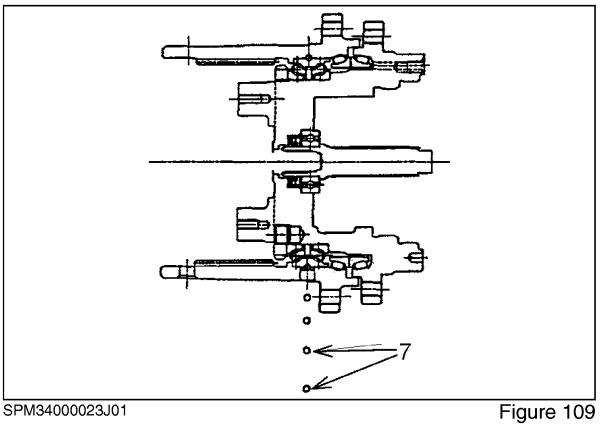
E. Remove planetary gear B (9), needle bearing (10), inner race (11) and thrust washer (12). Be careful not to damage the tooth surface of gear and the rolling section of the collar.



SPM34000022J01 Figure 108

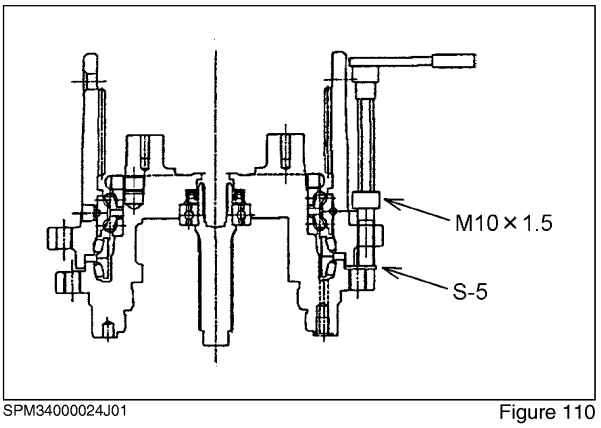
F. Remove plug PT1/8 (8).

: 5 mm



SPM34000023J01 Figure 109

G. Remove balls (7) through hole (8). Use piano wire to be sure that all balls (7) are out.
Steel ball: 109 pcs

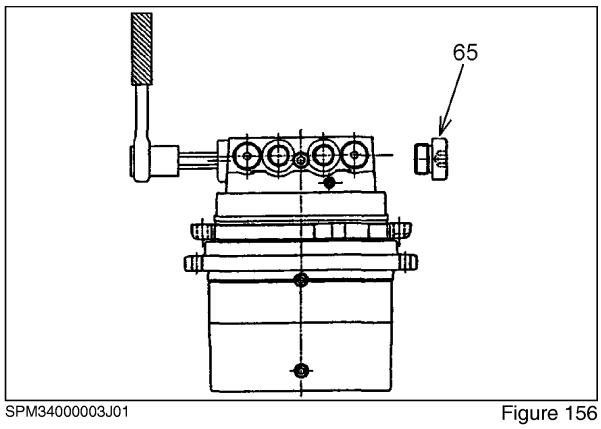


SPM34000024J01 Figure 110

H. Attach jig between flange holder (1) and housing (6), tighten 3 bolts M10× 1.5 uniformly from the housing side.

: 8 mm

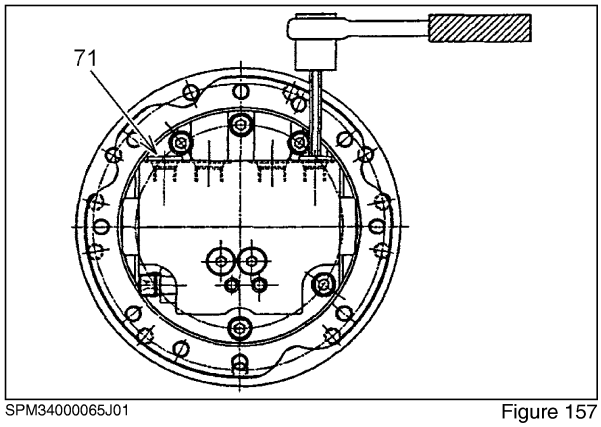
Jig: S-5



SPM34000003J01 Figure 156

R. Tighten cap (65) with O-ring (66).
Apply a light coat of grease to the O-ring.

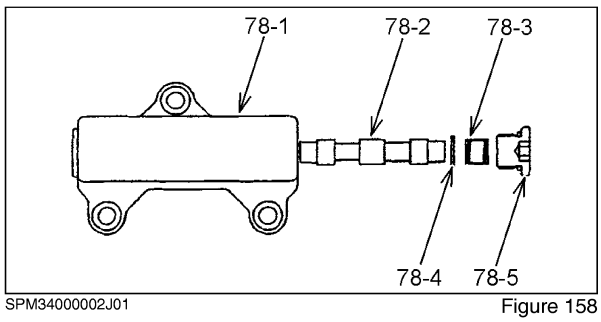
: 12 mm
Torque = 157 Nm (116 lb ft



SPM34000065J01 Figure 157

S. Tighten plug (71) with O-ring (72).
Apply a light coat of grease to the O-ring.

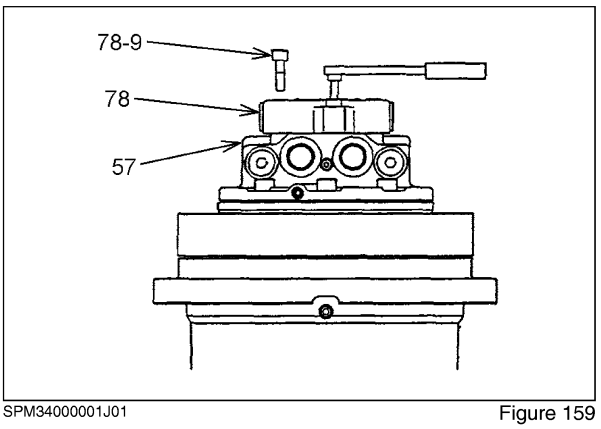
: 6 mm
Torque = 34 Nm (25 lb ft



SPM34000002J01 Figure 158

T. Install spool (78–2), spring (78–3) and spring seat (78–4) into valve body (78–1) and tighten plug (78–5).

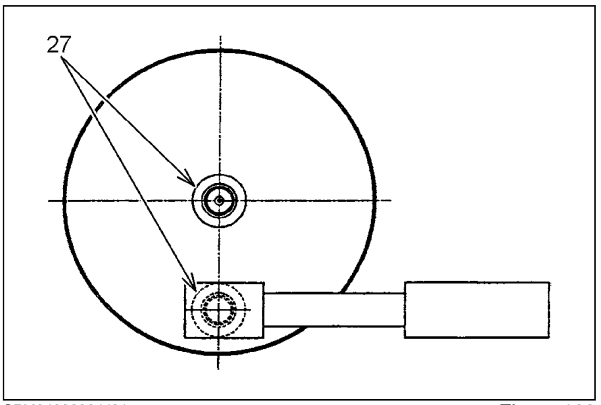
: 8 mm
Torque = 54 Nm (40 lb ft



SPM34000001J01 Figure 159

U. Install O-ring (78–7, 78–8) onto the valve body, install valve assy (78) onto base plate (57). Tighten bolt (78–9).

: 5 mm
Torque = 15 Nm (11 lb ft).



SPM34000064J01 Figure 160

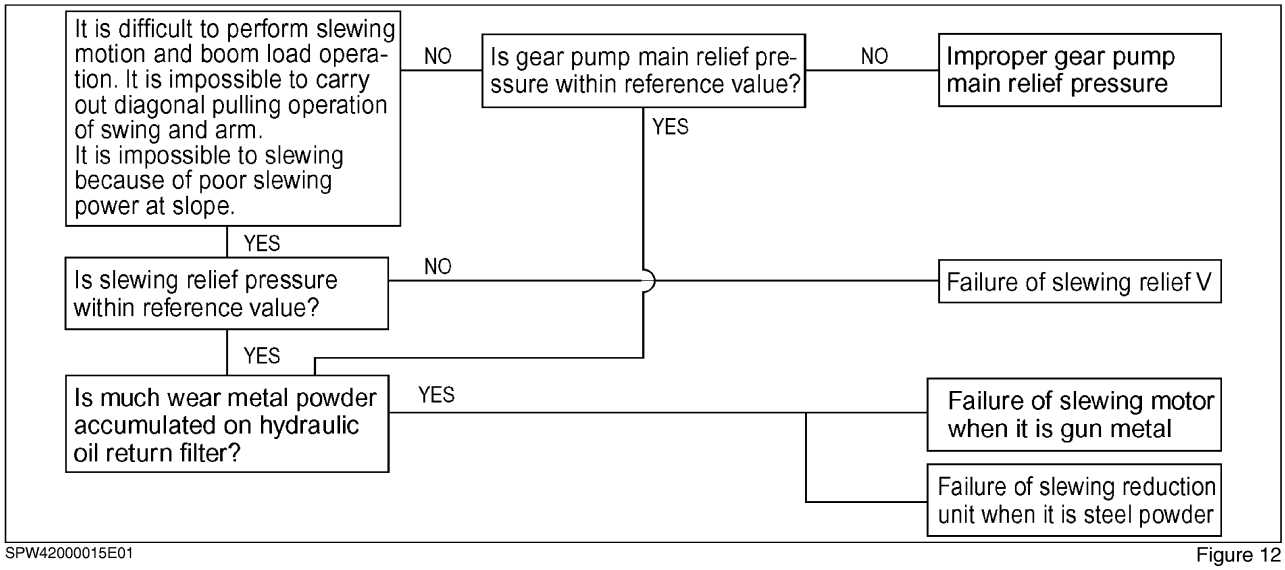
V. Pour 350cc of gear oil through plug (27). Tighten plug (27) with O-ring (28).

: 6mm
Torque = 34 Nm (25 lb ft).

W.

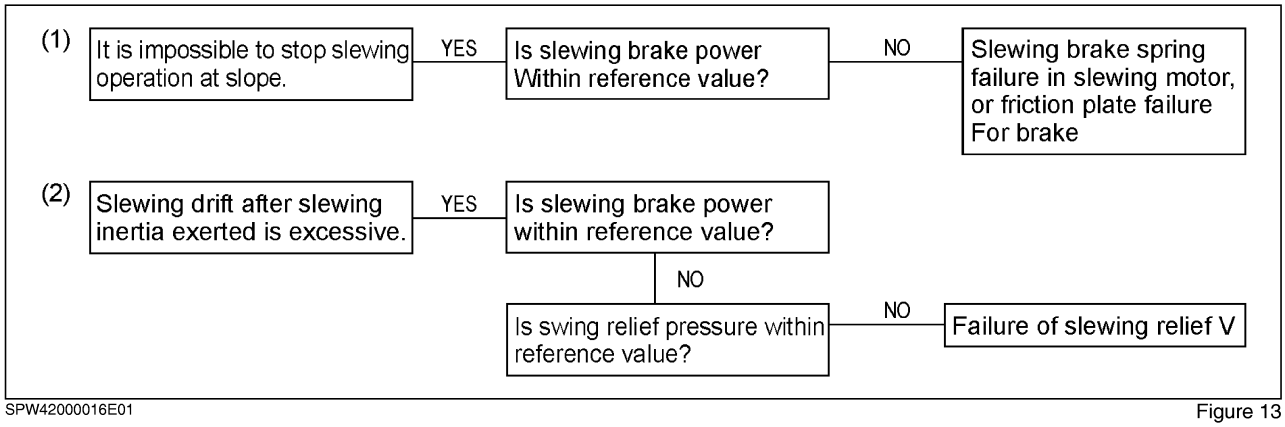
CHAPTER 42
TROUBLESHOOTING (HYDRAULIC SYSTEM)
TABLE OF CONTENTS

42.3.3.3 SLEWING POWER IS LOW



SPW42000015E01 Figure 12

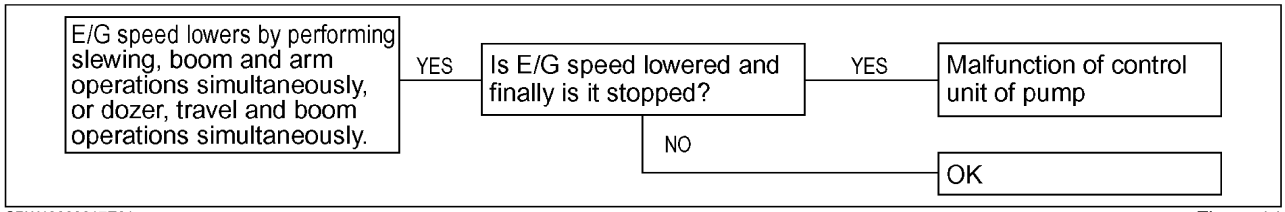
42.3.3.4 MALFUNCTION OF SLEWING OPERATION



SPW42000016E01 Figure 13

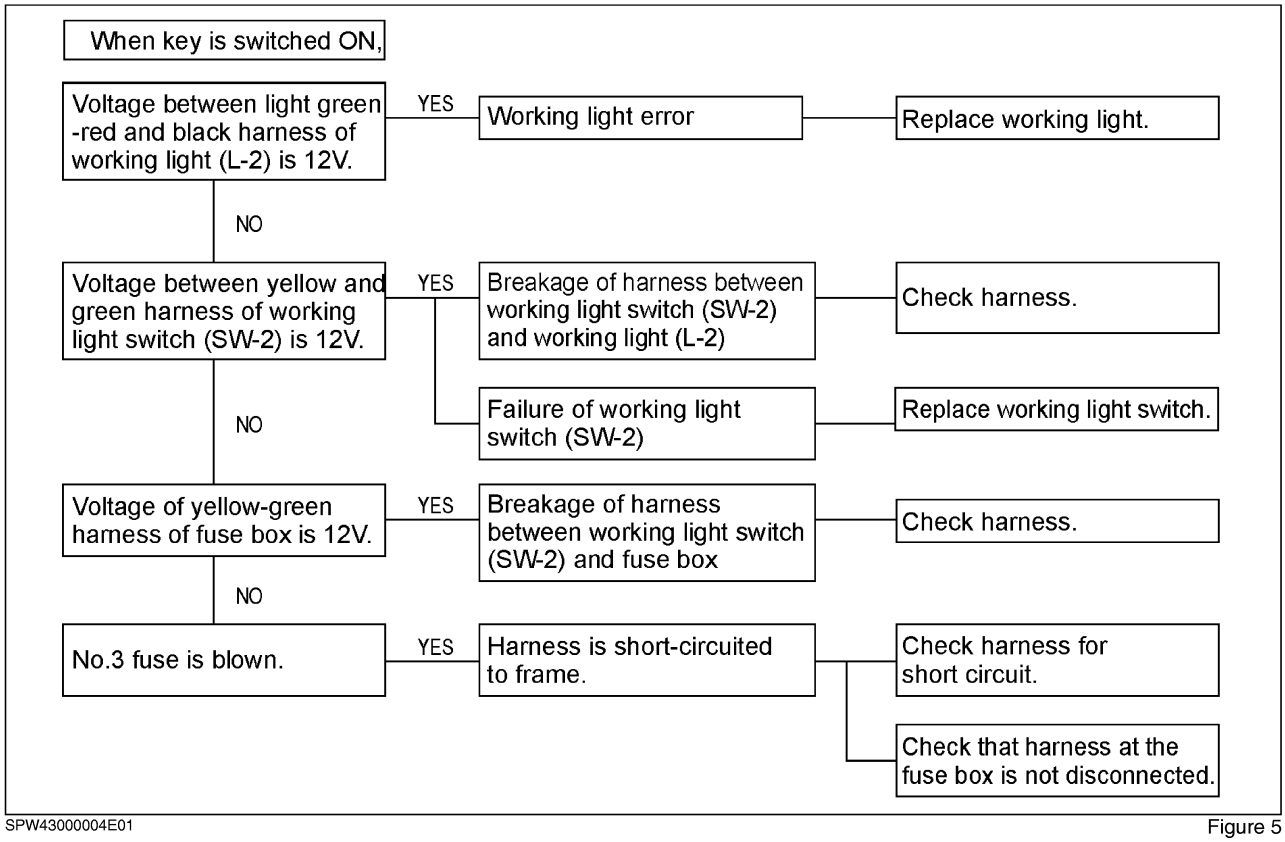
42.3.4 PUMP

42.3.4.1 ENGINE SPEED IS REDUCED DUE TO PUMP LOAD



SPW42000017E01 Figure 14

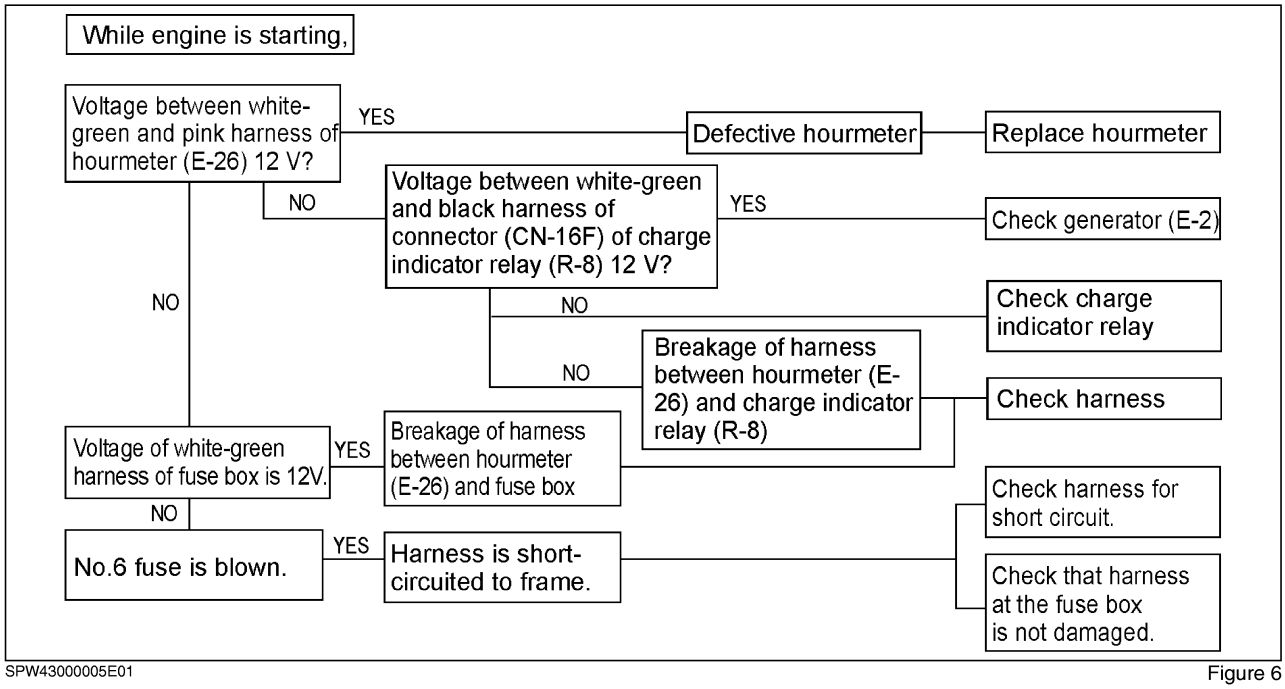
43.2.1.3 WORKING LIGHTS DO NOT WORK



SPW43000004E01

Figure 5

43.2.1.4 HOURMETER DOES NOT WORK



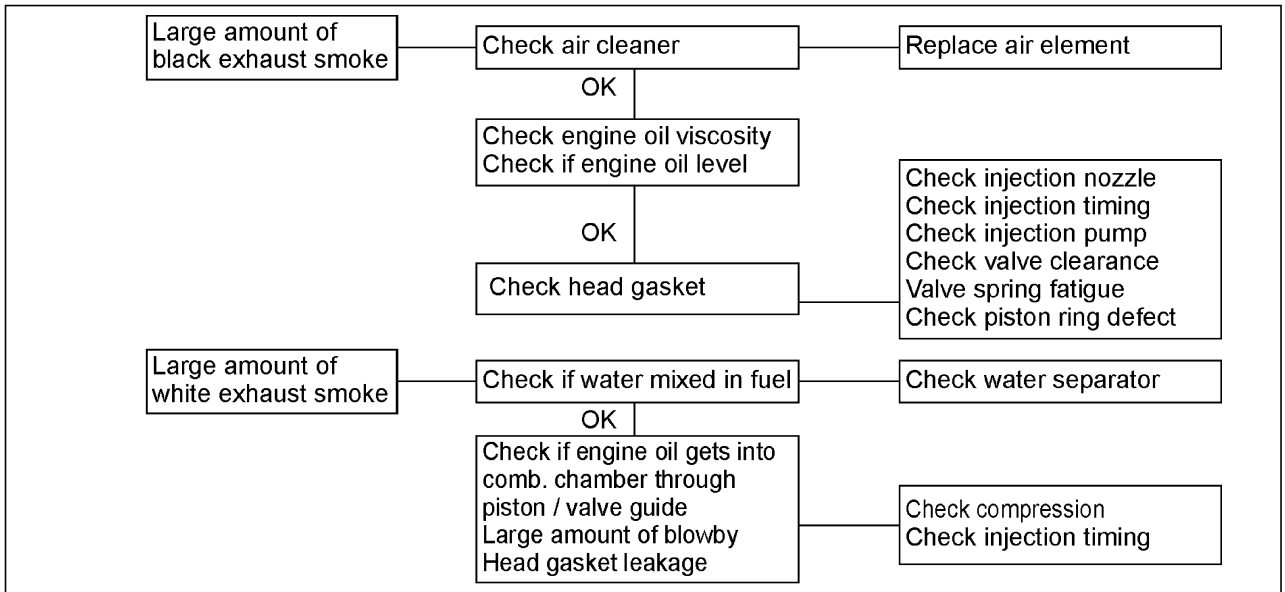
SPW43000005E01

Figure 6

CHAPTER 44
TROUBLESHOOTING (ENGINE)
TABLE OF CONTENTS

44.2.4 OTHER TROUBLE

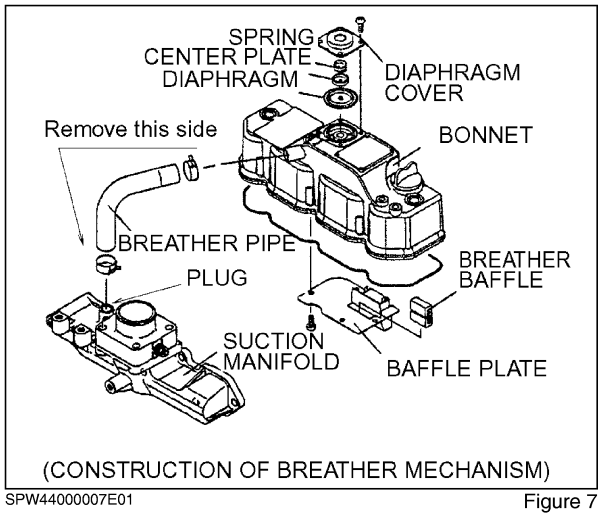
44.2.4.1 EXHAUST TROUBLE



Note: Check with the engine coolant temperature at or above 50°C (122°F).

SPW44000006E01

Figure 6



SPW44000007E01

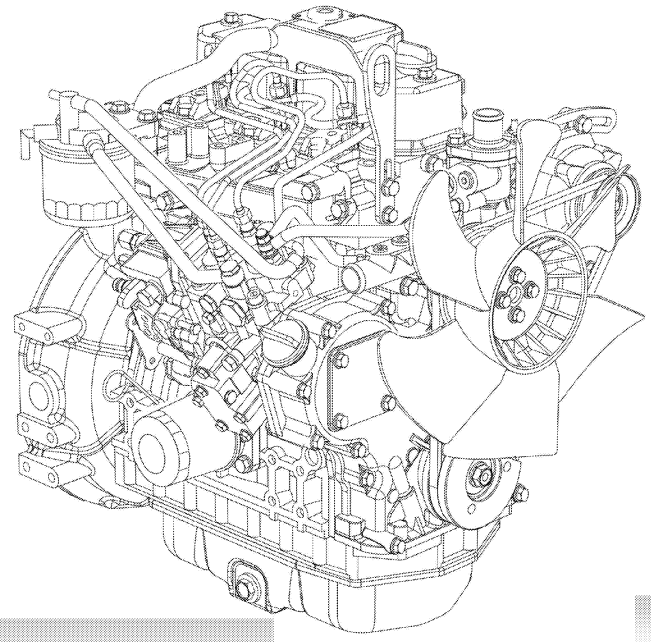
Figure 7

A recycling mechanism for blow-by gas is on the engine as shown. Remove and plug the intake manifold to check blow-by.

☆☆☆

YANMAR
M9961-02E050

YANMAR
SERVICE MANUAL
INDUSTRIAL DIESEL ENGINE
MODEL 3TNV·4TNV series
(Direct Injection System)



4TNV94L
4TNV98
4TNV98T

4TNV106
4TNV106T

3TNV82A
3TNV84(T)・4TNV84(T)
3TNV88・4TNV88

YANMAR CO.,LTD.

- Contents omitted in this manual
  Though the following jobs are omitted in the explanation in this manual, they should be conducted in actual work:
  3) Jacking up and lifting
  4) Cleaning and washing of removed parts as required
  5) Visual inspection

(3) Definition of Terms

[NOTICE]: Instruction whose negligence is very likely to cause an accident. Always observe it.

Standard: Allowable range for inspection and adjustment.

Limit: The maximum or minimum value that must be satisfied during inspection or adjustment.

(4) Abbreviations

Abbreviation	Meaning	Abbreviation	Meaning
Assy	assembly	T.D.C.	top dead center
Sub-Assy	sub-assembly	B.D.C.	bottom dead center
a.T.D.C	after top dead center	OS	oversize
b.T.D.C	before top dead center	US	undersize
STD	Standard	Min^{-1}	revolutions per minute
IN	Intake	PS	Output (metric horsepower)
EX	Exhaust	T	Bolt/nut tightening torque

(4) 3TNV88

Engine name		Unit	3TNV88								
Engine specification class		-	CL		VM						
Type		-	Vertical, in-line, 4-cycle, water-cooled diesel engine								
Combustion chamber		-	Direct injection								
Number of cylinders		-	3								
Cylinder bore×stroke		mm× mm	88×90								
Displacement		L	1.642								
Continuous rating	Revolving speed	Min^{-1}	1500	1800	-						
	Output	kW (hp)	12.3 (16.7)	14.8 (20.1)	-						
Rated output	Revolving speed	Min^{-1}	1500	1800	2000	2200	2400	2500	2600	2800	3000
	Output	kW (hp)	13.5 (18.4)	16.3 (22.1)	18.0 24.5)	19.9 (27.0)	21.6 (29.4)	22.6 (30.7)	23.5 (31.9)	25.2 (34.2)	27.1 (36.8)
Max. no-load speed (±25)		min^{-1}	1600	1895	2180	2400	2590	2700	2810	2995	3210
Ignition order		-	1-3-2-1(No.1 cylinder on flywheel side)								
Power take off		-	Flywheel								
Direction of rotation		-	Counterclockwise (viewed from flywheel)								
Cooling system		-	Radiator								
Lubrication system		-	Forced lubrication with trochoid pump								
Starting system		-	Electric								
Applicable fuel		-	Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.)								
Applicable lubricant		-	API grade class CD or CF								
Lubricant capacity (oil pan) *	Total	L	4.7								7.2
	Effective	L	1.8								3.5
Coolant water capacity (engine only)		L	2.0								
Engine dimensions ** (with flywheel housing)	Overall length	mm	589				564				
	Overall width	mm	486								
	Overall height	mm	622								
Engine mass (dry) ** (with flywheel housing)		kg	155								
Cooling fan (std.)		Mm	350 mm O/D, 6 blades pusher type								
Crankshaft V pulley diameter & Fun V pulley diameter (std.)		Mm	120×90				120×90				

* Engine oil capacity may differ from the above depending on an engine installed on a machine unit.
** Engine mass and dimensions without radiator

1.3.2 Lubricating oil

IMPORTANT:
Use of other than the specified engine oil may cause inner parts seizure or early wear, leading to shorten the engine service life.

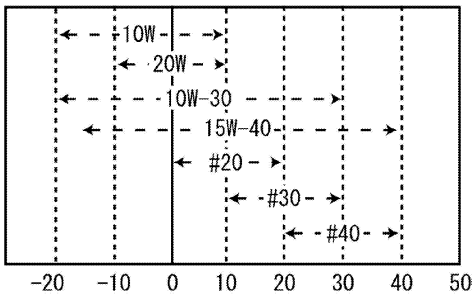
(1) Selection of engine lube oil

Use the following engine oil

- API classification ..... CD or CF
  (Standards of America Petroleum Institute)
- SAE viscosity ..... 10W-30 or 15W-40
  (Standard of Society of Automotive Engineering)

Engine oil with 10W30 or 15W40 can be used throughout the year.
(Refer to the right figure.)

Selection of viscosity
(SAE Service grade)



Atmospheric temperature (°C)

15W-40/10W-30 can be used almost throughout the year.

(2) Handling of engine oil

- Carefully store and handle the oil so as to prevent dust or dirt entrance. When supplying the oil, pay attention and clean around the filler port.
- Do not mix different types of oil as it may adversely affect the lubricating performance.

⚠ CAUTION

When touching engine oil by hand, the skin of the hand may become rough. Be careful not to touch oil with your hands without protective gloves. If touch, wash your hands with soap and water thoroughly.

1.3.3 Coolant water

Use clean soft water and be sure to add the Long Life Coolant Antifreeze (LLC) in order to prevent rust built up and freezing. If there is any doubt over the water guality, distilled water or pre-mixed coolant should be used.
The coolants / antifreezes, which are good performance for example, are shown below.

- TEXACO LONG LIFE COOLANT ANTIFREEZE, both standard and pre-mixed.
  Product codes 7997 and 7998
- HAVOLINE EXTENDED LIFE ANTIFREEZE / COOLANT
  Product code 7994

IMPORTANT:

- Be sure to add Long Life Coolant Antifreeze(LLC) to soft water. In cold season, the LLC is especially important. Without LLC, cooling performance will decrease due to scale and rust in the coolant water line. Without LLC, coolant water will freeze and expand to break the cooling line.
- Be sure to use the mixing ratios specified by the LLC manufacturer for your temperature range.
- Do not mix different types (brand) of LLC, chemical reactions may make the LLC useless and engine trouble could result.
- Replace the coolant water every once a year.

⚠ CAUTION

When handling Long Life Coolant Antifreeze, wear protective rubber gloves not to touch it. If LLC gets eyes or skin, wash with clean water at once.

IMPORTANT:
If the coolant water runs short quickly or when the radiator runs short of water with the Coolant recovery tank level unchanged, water may be leaking or the air tightness may be lost. Increase in the Coolant recovery tank water level during operation is not abnormal.
The increased water in the Coolant recovery tank returns to the radiator when the engine is cooled down.
If the water level is normal in the Coolant recovery tank but low in the radiator, check loosened clamping of the rubber hose between the radiator and Coolant recovery tank or tear in the hose.

Standard
Engine: The radiator shall be filled up.

(Unit: liter)

Model	Coolant water volume In an engine
3TNV82A	1.8
3TNV84(T) 3TNV88	2.0
4TNV84(T) 4TNV88	2.7
4TNV94L 4TNV98(T)	4.2
4TNV106(T)	6.0

Engine coolant water capacity may differ from the above volume depending on an engine installed on a machine unit.

(5) Fuel pipe and coolant water pipe inspection and maintenance
Check the rubber hoses for fuel and coolant water pipes cracked. If the cracked hose is found, replace it with new one. Check the loosened clamp. If found, tighten it.

(6) Inspection and adjustment of governor lever and accelerator
Make sure the accelerator of the machine unit can be operated smoothly before starting the engine. If it feels heavy to manipulate, lubricate the accelerator cable joints and pivots. Adjust the accelerator cable if there is a dislocation or excessive play between the accelerator and the governor lever. Refer to 3.2.3.

(7) Warning lamp & instruments function check
Before and after starting the engine, check to see that the alarm function normally. Failure of alarm cannot warn the lack of the engine oil or the coolant water. Make it a rule to check the alarm operation before and after starting engine every day. Refer to each manual for machine units in details.

2.2.2 inspection after initial 50 hours operation

Be sure to check the following points after initial 50 hours operation, thereafter every 250 hours or 3 months operation.

No.	Inspection Item
(1)	Lube oil and filter replacement
(2)	V-belt tension check

(1) Lube oil and filter replacement (1st time)

When an engine is still hot, be careful with a splash of engine oil which may cause burns. Replace engine oil after the engine oil becomes warm. It is most effective to drain the engine oil while the engine is still warm.

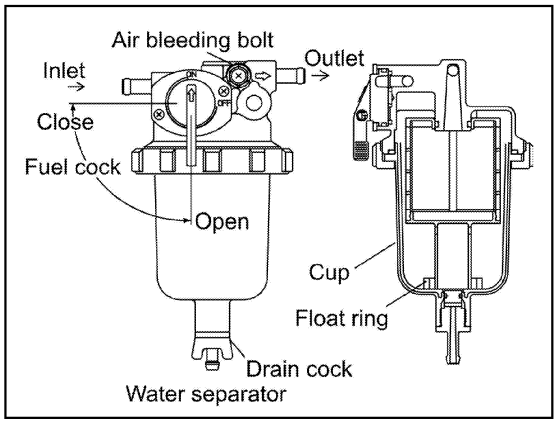
2.2.5 Inspection every 500 hours or 6 months

Be sure to check the following points every 500 hours or 6 months operation, whichever comes first.

No.	Inspection Item
(1)	Water separator cleaning
(2)	Fuel filter element replacement
(3)	Air cleaner cleaning and element replacement

(1) Water separator cleaning

Periodically wash the water separator element and inside cup with clean fuel oil.



1) Prepare a waste oil container.
2) Close the fuel cock.
3) Loosen the drain cock and drain.
   Refer to 2.2.3.(2)
4) Turn the retaining ring counter-clockwise and remove the cup.
   (Disconnect the coupler of the lead wire for drain sensor before removing the cup if it is with drain sensor).
5) Wash the element and inside cup with clean fuel oil. Replace the element with new one if any damaged.

Model	Applicable element Part No.
3TNV82A～ 4TNV106(T)	119802-55710

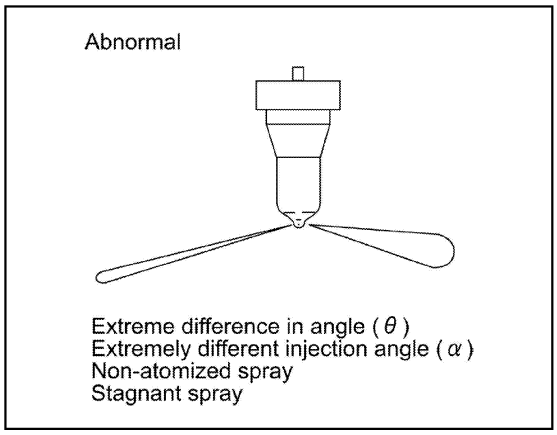
6) Insert the element to the bracket (O-ring) and after putting the float ring in the cup, install it to the bracket by tightening the retaining ring clockwise.

   Tightening torque: 15～20Nm (1.5～2.0kgf-m)

7) Close the drain cock (connect the coupler if with drain sensor).
8) Bleed the fuel system. Refer to 2.2.3.(3)

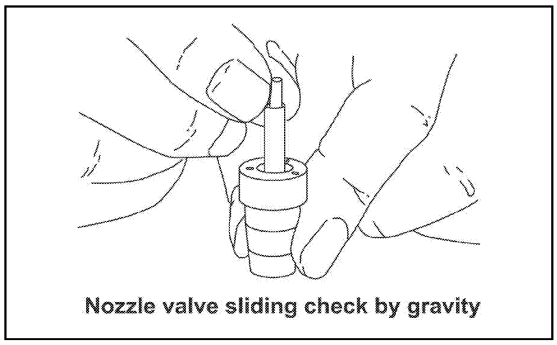
Spray and injection states

- Operate the nozzle tester lever at a rate of once or twice a second and check no abnormal injection.
- If normal injection as shown below cannot be obtained, replace the fuel injection valve.
- No extreme difference in angle(θ)
- No extreme injection angle difference(α)
- Finely atomized spray
- Excellent spray departure

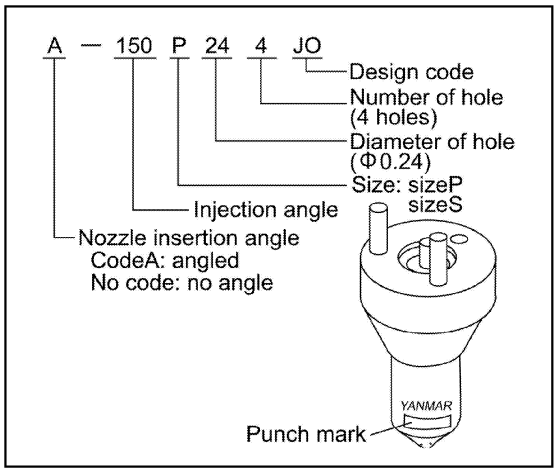


(c) Nozzle valve sliding test

Wash the nozzle valve in clean fuel oil. Place the nozzle body vertically and insert the nozzle into the body to about 1/3 of its length. The valve is normal if it smoothly falls by its own weight into the body. In case of a new nozzle, remove the seal peel, and immerse it in clean diesel oil or the like to clean the inner and outer surfaces and to thoroughly remove rust-preventive oil before using the nozzle. Note that a new nozzle is coated with rust-preventive oil and is pasted with the seal peel to shut off outer air.



(d) Nozzle punch mark



Cause \ Trouble symptom		Starting failure				Insufficient engine output			Poor exhaust color		High knocking sound during combustion	Abnormal engine sound	Uneven combustion sound	Hunting		Large engine vibration	Difficulty in returning to low speed	Excessive fuel consumption	Lubricating oil				Much blow-by gas	Cooling water		Air intake		Exhaust temperature rise	Corrective action
			Engine starts but stops soon.			Exhaust color			During work																					
		Engine does not start.	Exhaust smoke											During idling	During work				Excessive consumption	Dilution by fuel oil	Mixture with water	Low L.O. pressure		Overheat	Low water temperature	Pressure drop	Pressure rise		
			None	Little	Much	Ordinary	White	Black	White	Black																				
Cooling Water System	Excessive cooling effect of radiator								○									○							○				Defective thermostat (kept closed) (See 2.2.7 in Chapter2.)
	Insufficient cooling effect of radiator							○																○				○	Defective thermostat (kept opened)(See 2.2.7 in Chapter2.) or slipping fan belt (See 2.2.2-2) in Chapter2.)
	Insufficient coolant water level							○																○				○	Check water leakage from cooling water system. (See 2.2.1-4) in Chapter2.)
	Cracked water jacket																				○	○		○					Repair or replace.
	Slackened fan belt							○																○				○	Adjust the belt tension. (See 2.2.2-2) in Chapter2.)
	Defective thermostat							○	○															○	○				Check or replace. (See 2.2.7 in Chapter2.)
Lubricating System	Improper properties of lubricating oil	○	○			○													○			○	○						Use proper lubricating oil. (See 1.3.2 in Chapter1.)
	Leakage from lubricating oil piping system																		○			○							Repair.
	Insufficient delivery capacity of trochoid pump																					○							Check and repair. (See 5.5 in Chapter5.)
	Clogged lubricating oil filter																					○	○						Clean or replace.
	Defective pressure regulating valve																					○							Clean, adjust or replace.
	Insufficient lubricating oil level		○																			○							Add proper lubricating oil. (See 2.2.1-3) in Chapter2.)
Fuel system	Too early timing of fuel injection pump								○	○	○					○													Check and adjust. (See 2.2.7-4) in Chapter2.)
	Too late timing of fuel injection pump						○	○	○	○								○										○	Check and adjust. (See 2.2.7-4) in Chapter2.)
	Improper properties of fuel oil					○	○	○	○	○			○																Use proper fuel oil. (See 1.3.1 in Chapter1.)
	Water entrance in fuel system	○			○		○		○				○	○	○														Perform draining from the fuel filter. (See 2.2.3 and 2.2.5 in Chapter2.)
	Clogged fuel filter	○	○			○																							Clean or replace. (See 2.2.5 in Chapter2.)
	Air entrance in fuel system	○	○			○																							Perform air bleeding. (See 2.2.3 in Chapter2.)
	Clogged or cracked fuel pipe	○	○			○																							Clean or replace.
	Insufficient fuel supply to fuel injection pump	○	○			○																							Check the fuel tank cock, fuel filter, fuel pipe, and fuel feed pump.
	Uneven injection volume of fuel injection pump						○	○	○	○			○	○	○	○												○	Check and adjust.
	Excessive fuel injection volume									○								○	○				○	○			○	○	Check and adjust.
	Poor spray pattern from fuel injection nozzle						○	○	○	○			○	○	○	○		○											Check and adjust. (See 2.2.6 in Chapter2.)
	Priming failure	○																											Foreign matter trapped in the valve inside the priming pump. (Disassemble and clean.)
	Clogged strainer at feed pump inlet					○																							Clean the strainer.

4.1.3 Complete disassembly

Peripheral parts such as air cleaner, muffler and radiator differ in installation and types for each application. Therefore, description in this Chapter is started with the steps to be taken just after the peripheral parts have been removed.

Step	Removal Parts	Remarks
1	1) Thoroughly remove sand, dust, dirt and soil from the surface of the engine. 2) Drain coolant water and lubricating oil from the engine.	
2	1) Remove turbocharger and exhaust manifold. 2) Remove intake manifold and surge tank.	
3	1) Close the fuel cock valve of the fuel tank. 2) Remove high-pressure fuel pipe. 3) Remove fuel return pipe. 4) Loosen the tightening nut on fuel injection nozzle retainer and extract the retainer and fuel injection nozzle. *) Fuel injection nozzle for Indirect injection system is screwed type.	1) If nozzle seat is left on the cylinder head, remove the cylinder head before extracting nozzle seat. 2) To prevent dust from entering fuel injection nozzle, fuel injection pump and high-pressure fuel pipe, seal their respective threads with a tape or the like. 3) Whenever extracting fuel injection nozzle, replace nozzle protector with a new one.
4	1) Remove rocker arm cover assembly.	
5	1) Remove valve rocker arm shaft assembly. 2) Remove push rod.	1) Attach a tag to push rod for each cylinder No. to put the push rod in order. 2) Remove valve cap from the intake/exhaust valve head. 3) Note that tappet of the indirect injection system can be removed at the same time when push rod is extracted. 4) Attach a tag to tappet for each cylinder No. to put the tappet in order.
6	1) Remove fan mounting bolt, and then remove fan. 2) Loosen adjusting bolt for the V-belt adjuster, and then remove V-belt. 3) Remove alternator. 4) Remove the spacer for cooling fan and V-pulley.	1) Never turn down alternator vigorously toward the cylinder block. Otherwise, your finger may be nipped and alternator broken.
7	1) Remove lubricating oil filter assembly. 2) Extract dipstick form the oil dip-stick hole.	
8	1) Disconnect fuel return pipes to. 2) Remove fuel filter.	

Point9

[Disassemble]

- 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 injection valve protector with a new one.

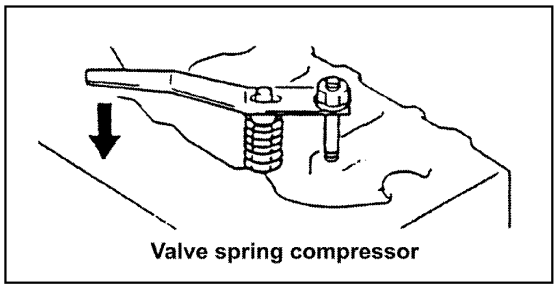
Point10

[Disassemble]

- When removing each intake/exhaust valve from the cylinder head, use a valve spring compressor (see 11.1-4 in Chapter 11) and compress the valve spring and remove the valve cotter.)
- Keep each removed intake/exhaust valve after attaching a tag showing the corresponding cylinder No.
- If cotter burr is seen at the shaft of each intake/exhaust valve stem, remove it with an oilstone and extract the valve from the cylinder head.

[Reassemble]

- Replace the stem seal with a new one when an intake/exhaust valve is disassembled.
- Carefully install each valve after oil application so as not to damage the stem seal.
- Different stem seals are provided for the intake and exhaust valves. Do not confuse them since those for exhaust valves are marked with yellow paint.
- After assembling the intake/exhaust valve, stem seal, valve spring, seat, and cotter, tap the head of the valve stem lightly for settling.
- Do not forget to install the valve cap.



Valve spring compressor

Point3: (Refer to 7.2.5 in chapter 7)

[Disassemble]

- Remove the mounting nut of the fuel injection pump drive gear, remove the gear using the gear puller, and remove the fuel injection pump. Do not forget to remove the stay on the rear side. When extracting the gear using the gear puller, use a pad at the shaft and carefully operate so as not to damage the thread.

[Reassemble]

- Tightening torque for fuel pump drive gear nut (without lube. Oil)

N·m(kgf-m)

Model	Tightening torque
TNV82A~88	78~88 (8.0~9.0)
4TNV94L/98/106(T)	113~123 (11.5~12.5)

Point4

[Reassemble]

- Assemble crankshaft gear A, fuel injection pump drive gear B and camshaft gear C at the same time by aligning with idle gear A, B and C marks.
- Install the idle gear shaft with the oil hole facing upward.

Point5

[Reassemble]

- Install the PTO drive gear with its inner spline side facing the flywheel.

Point6

[Disassemble]

- Install a bolt as a handle in the hole at the end face of the flywheel and remove carefully so as not to damage the ring gear.

[Reassemble]

Flywheel mounting bolt : apply lube oil

N·m(kgf-m)

Model	Tightening torque
3TNV82A~88	83.3~88.2 (8.5~9.0)
4TNV94L/98/106(T)	186.2~205.8 (19.0~21.0)

Point7

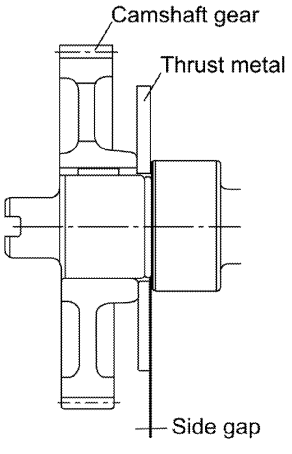
[Disassemble]

- Measure the camshaft side gap.

mm

Item	Standard	Limit
Side gap	0.05~0.20	0.30

- If the measured side gap exceeds the limit, replace the thrust metal.



Camshaft side gap

4.4.5 Parts inspection and measurement

(1) Cylinder block

Especially clean head surface, cylinder bores and oil holes, and check after removing any carbon deposit and bonding agent.

(a) Appearance inspection

Check if there is any discoloration or crack. If crack is suspected, perform color check. Sufficiently clean the oil holes and check they are not clogged.

(b) Cylinder bore and distortion

Measure at 20 mm below the crest of the liner, at 20 mm from the bottom end and at the center.

Roundness:

Roundness is found as follows though it is the simple method. Measure cylinder diameters of the A direction and the B direction on each section of a, b and c.

Roundness is the maximum value among those difference values.

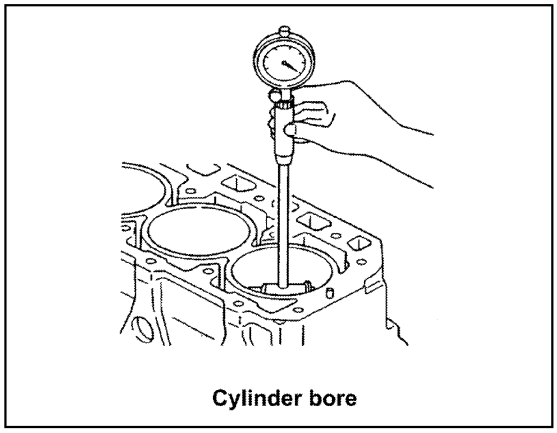
Cylindricity:

Cylindricity is found as follows though it is the simple method.

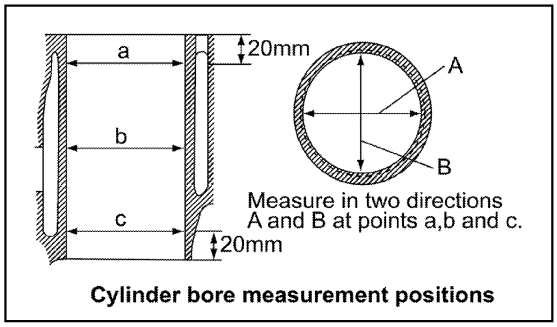
Measure cylinder diameters of a, b and c sections in the A direction, and calculate the difference in maximum value and minimum value of the measured diameters.

In the same way measure and calculate the difference in the B direction.

Cylindricity is the maximum value between those difference values.



Cylinder bore



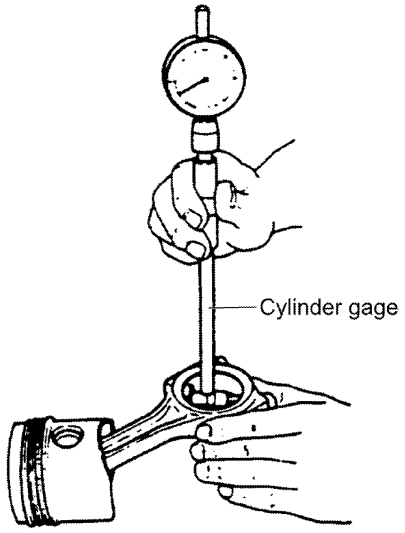
Cylinder bore measurement positions

mm

Item		Model	Standard	Limit
Cylinder inside diameter		3TNV82A	82.000~82.030	82.200
		TNV84	84.000~84.030	84.200
		TNV88	88.000~88.030	88.200
		4TNV94L	94.000~94.030	94.130
		4TNV98	98.000~98.030	98.130
		4TNV106(T)	106.000~106.030	106.130
Cylinder bore	Roundness	all TNV	0.01 or less	0.03
	Cylindricity			

(d) Rod big end measurement
Measure the crankpin and bushing according to 4.4.5.(2)(c) described above.
Calculate the oil clearance of a crank pin metal and a crank pin from the measured values of the crank pin metal inner diameter and the crank pin outside diameter.
Replace a crank pin metal if the oil clearance becomes about the limit dimension of the below table.
Correct by grinding if unevenly wear, roundness exceeding the limit or insufficient outside diameter is found. Also use an undersized metal. (Refer to the above (2) c.)

[NOTICE]
When measuring the inside diameter of the rod big end, install the crankpin metals in the rod big end not to mistake the top and bottom of the metals and tighten the rod bolts by the standard torque.



Rod bushing I.D. measurement

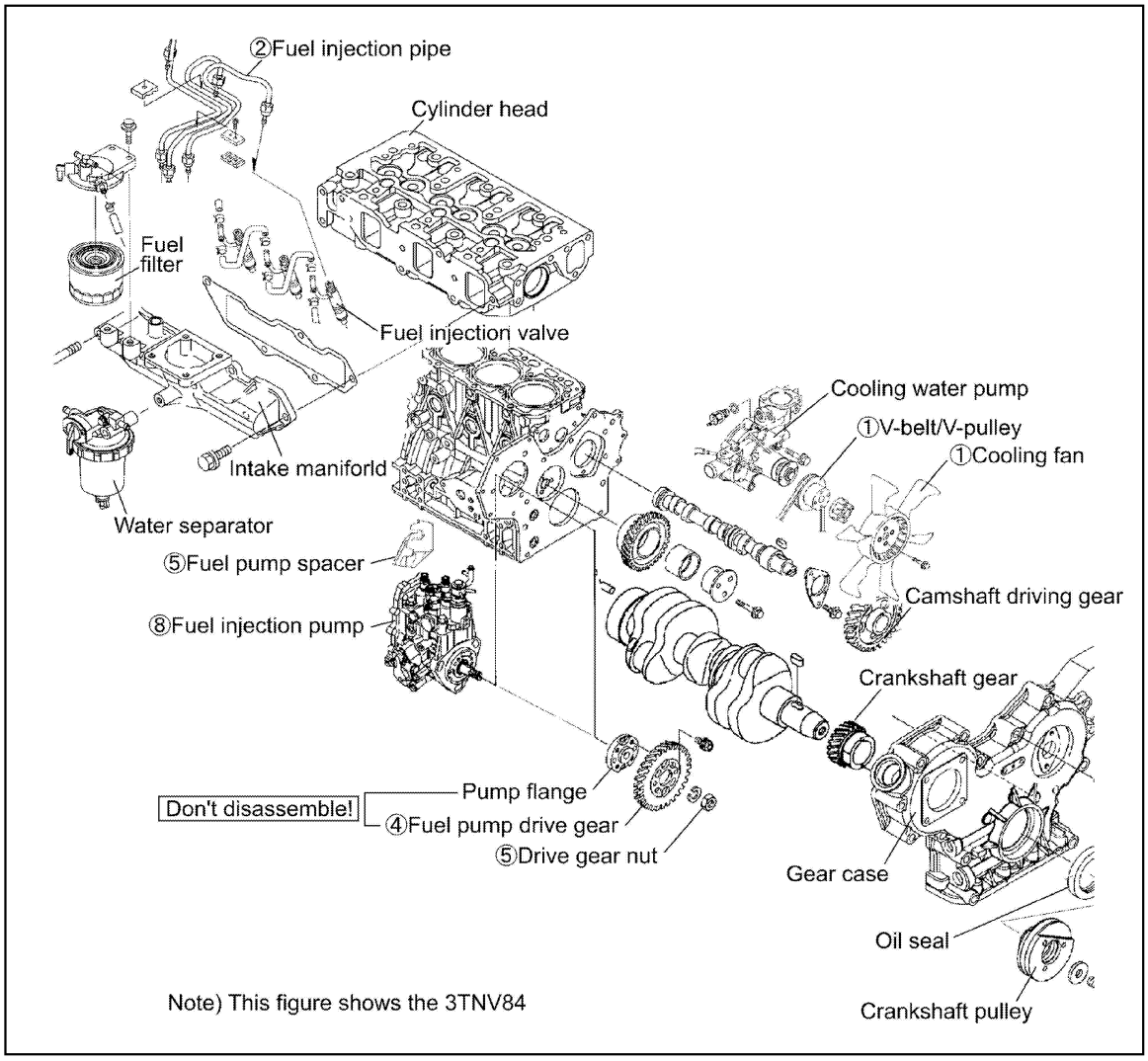
Tightening torque of rod bolt

Model	Tightening torque Nm(kgf-m)	Lubricating oil application (threaded portion, and bearing seat surface)
3TNV82A	37.2~41.2 (3.8~4.2)	Lube. oil applied
TNV84/88	44.1~49.0 (4.5~5.0)	
4TNV94L/98	53.9~58.8 (5.5~6.0)	
4TNV106(T)	78.5~83.4 (8..0~8.5)	

Standard of rod big end mm

Model	Item	Standard	Limit
3TNV82A	Rod I.D. bushing	42.952~42.962	42.902
	Crankpin O.D.	43.000~43.042	-
	Metal thickness	1.487~1.500	-
	Clearance	0.038~0.090	0.150
TNV84/88	Rod I.D. bushing	47.952~47.962	47.902
	Crankpin O.D.	48.000~48.026	-
	Metal thickness	1.492~1.500	-
	Clearance	0.038~0.074	0.150
4TNV94L/98	Rod I.D. bushing	57.952~57.962	57.902
	Crankpin O.D.	58.000~58.026	-
	Metal thickness	1.492~1.500	-
	Clearance	0.038~0.074	0.150
4TNV106(T)	Rod I.D. bushing	63.952~63.962	63.902
	Crankpin O.D.	64.016~64.042	-
	Metal thickness	1.984~1.992	-
	Clearance	0.054~0.090	0.150

7.2.2 External view and components



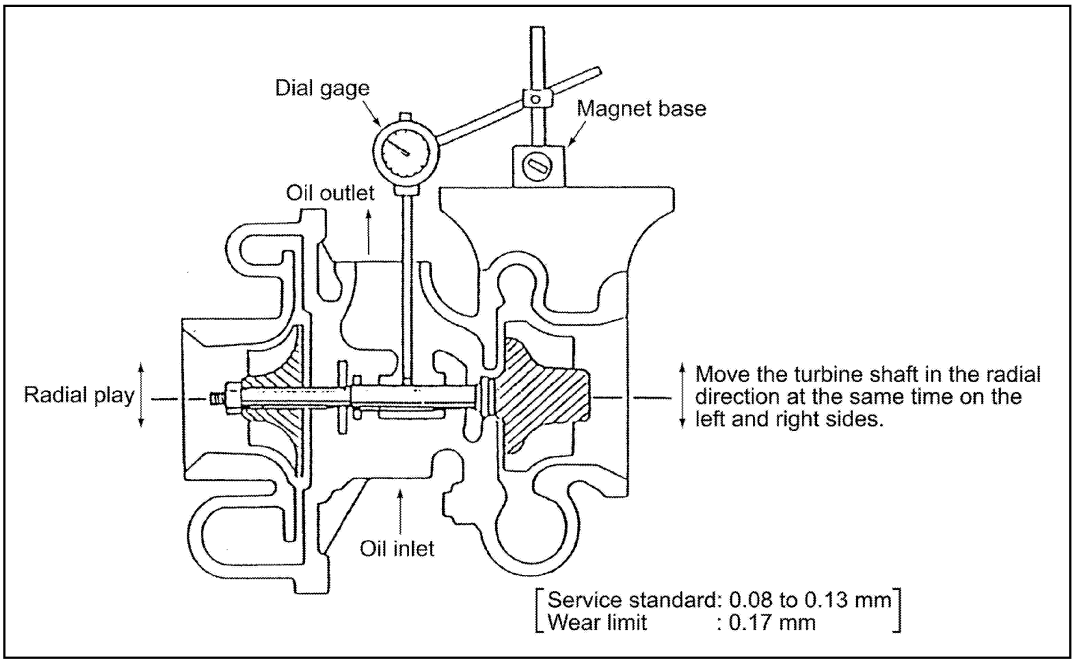
7.2.3 Disassembly procedure:

Disassembly from the engine body

1) Remove the cooling fan, pulley and V-belt.
2) Remove the fuel injection pipe, fuel oil piping, fuel return pipe and rear stay. See point 1 of 7.2.5.
3) Remove the fuel injection pump cover (the cover of the drive gear).
4) Make ID marks on the gearing part of the pump drive gear and the idle gear with paint and so on. See Point 2 of 7.2.5.
5) Loosen a fuel pump drive gear nut, and remove a pump drive gear from the fuel pump by using a gear puller. See Point 3 of 4.3.4.
6) Remove a drive gear nut carefully not to drop it to the inside of the gear case.
7) Record the installation angle of the fuel pump precisely by using a mark-off line and a sticker. See (4) of 2.2.7.
8) Remove the fuel injection pump. See Point 3 of 7.2.5.

8.3.3 Waste gate valve adjustment procedure

Rotor play in radial direction



It is indispensable to adjust the waste gate valve opening pressure and lift after its overhaul or inner parts replacement.
Negligence of this adjustment will adversely affect the engine performance.

[NOTICE]
If the adjustment is impossible, give up overhaul but replace the whole turbocharger assembly.

(1) Method for checking the waste gate valve opening pressure and lift

(a) Equipment
Prepare the equipment shown in the figure below.

(3) Thrust bearing installation

1) Fit thrust bushing on turbine shaft 1.
2) Apply lubricating oil on the bearing portion of thrust bearing 6 and install it in bearing housing 15.
3) Apply Locktite on the threaded portion of M3 Torx T machine screw 17 for thrust bearing installation, and use Torx torque driver for installation by tightening to the specified torque.

   Tightening torque: 1.3±0.1N-m (13±1kgf-cm)

(4) Seal plate installation

1) Fit the seal ring on oil thrower 2.
2) Insert oil thrower 2 into seal plate 4.

Note: The seal ring joint portion shall be positioned as illustrated at right.

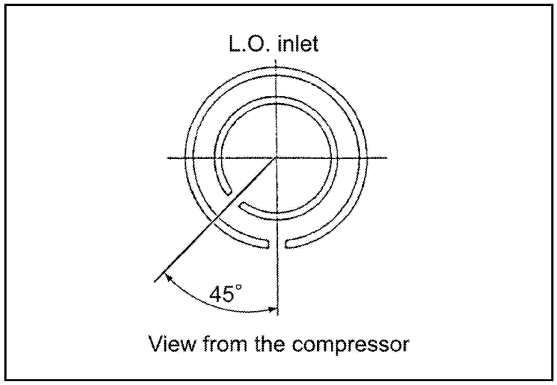
3) Apply liquid gasket (Three Bond No.1207) on the seal plate mounting surface on the compressor side of bearing housing 15.

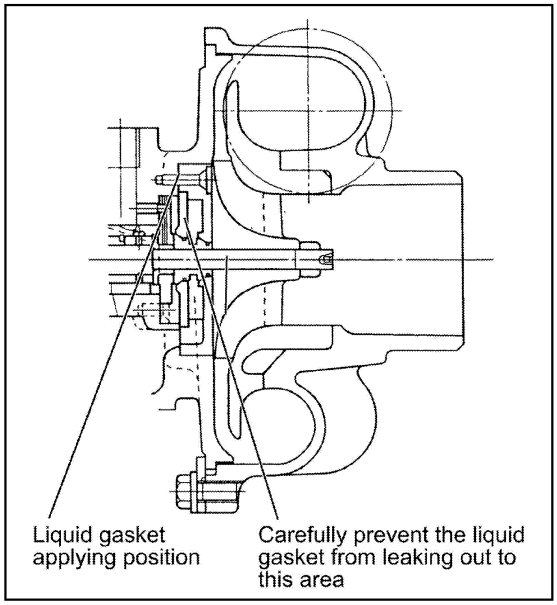
Note: See the illustration below for the applying position.

Applying thickness: 0.1~0.2 mm

4) Install seal plate 4 on bearing housing 15.
5) Apply Locktite on the threaded portion of M3 machine screw for seal plate mounting, and tighten it with a torque screwdriver.

   Tightening torque: 1.3±0.1N-m (13±1kgf-cm)





6) Yoke Assy.

7) Armature
Remove the brush holder. The armature and yoke assy can now be removed.

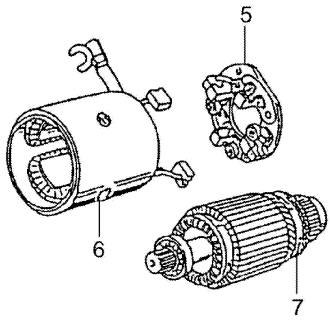


Fig. 4

8) Bolt M6 (2)

9) Magnetic switch
Remove bolt M6 (10 mm), and the magnetic switch can be removed.

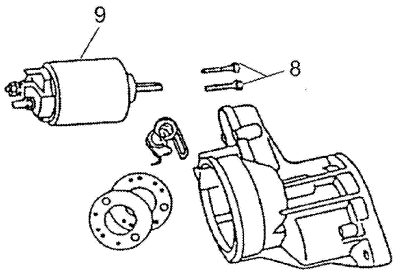


Fig. 5

10) Dust cover

11) Shift lever
Take the dust cover out from the gear case. The shift lever can be removed.

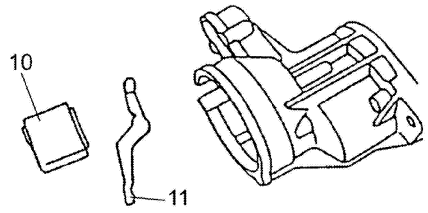


Fig. 6

9.1.8 Characteristic test

Since the characteristics can be checked roughly by means of a simple no-load test as explained below.

NOTE: Complete the test quickly since the rating of the starting motor is 30 seconds.

(1) No-load test

Fix the starting motor on a test bench and connect wiring as shown in Fig.31. When the switch is closed, a current flows in the starting motor, which is rotated at no-load. Measure the current, voltage and number of revolutions then and check if they satisfy the specified characteristics.

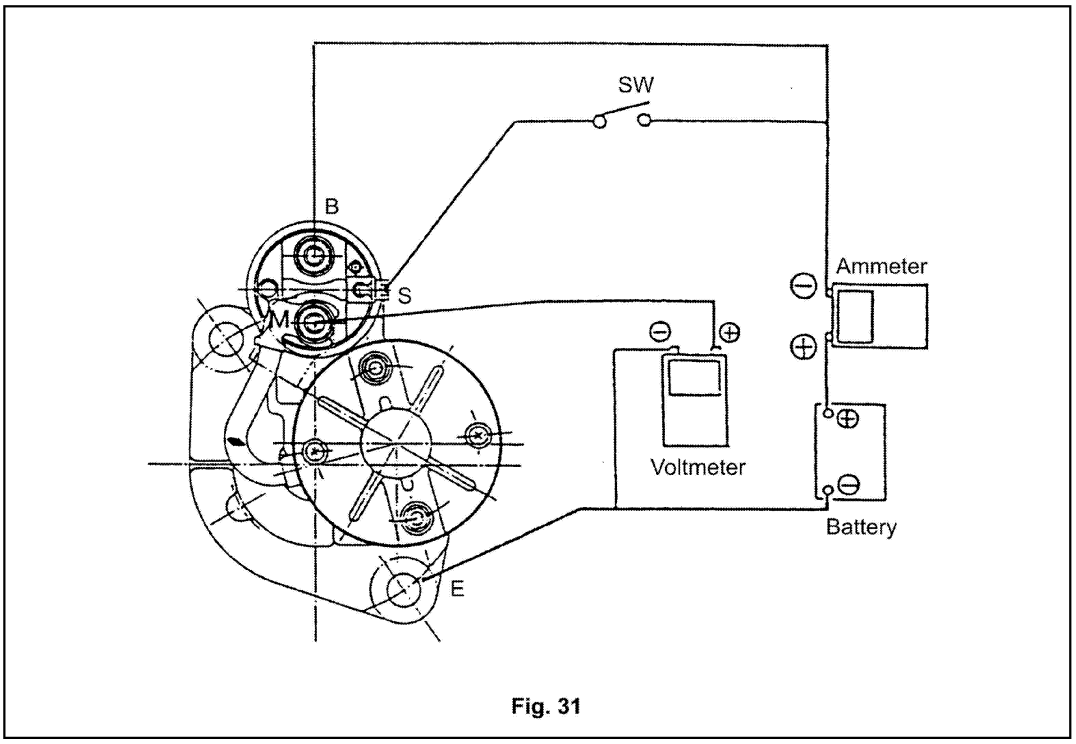
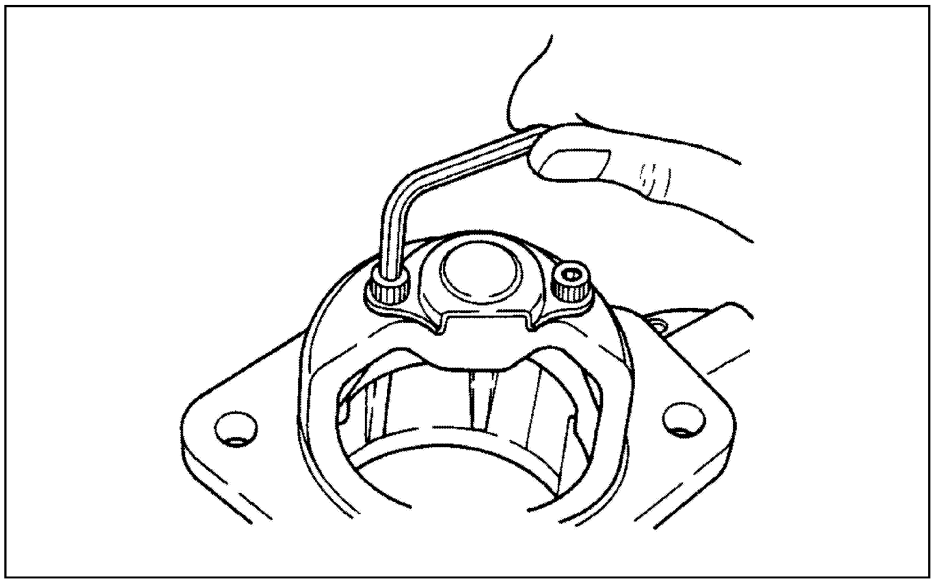
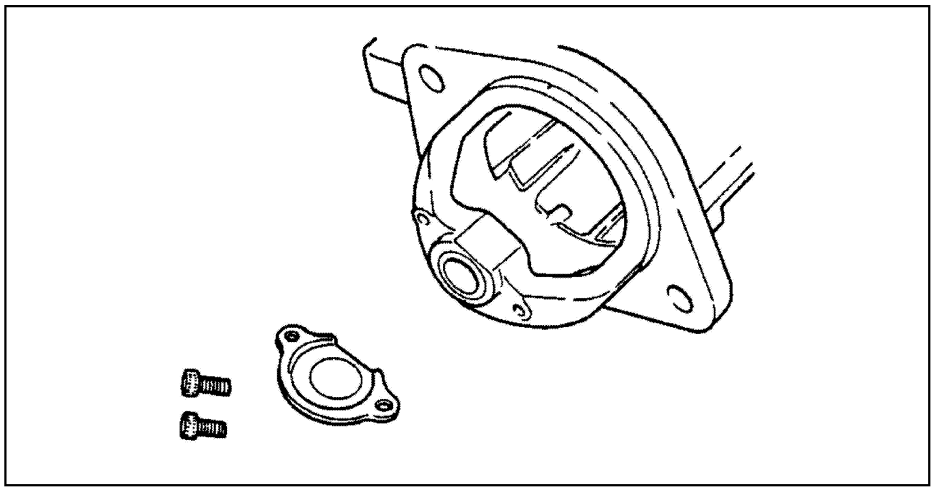


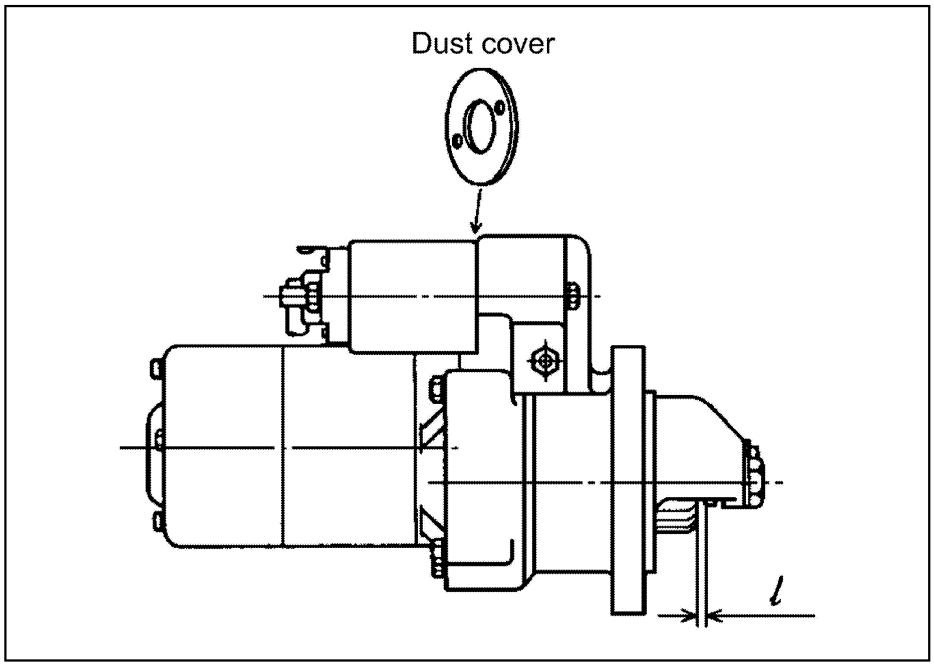
Fig. 31

(7) Removal of gear case dust cover

Remove the two M5 bolts (using 4 mm hexagon wrench) to disassemble the dust cover from the gear case.







9.2.9 Service standards

Brush	Spring force N(kgf)		31.4 (3.2)
	Standard / Limit height		18/6
Commutator	Outside diameter	Standard	37
		Limit	36
	Deflection	Limit	0.2
		Correction accuracy	0.05
	Depth of insulation mica	Limit	0.2
		Correction accuracy	0.5~0.8
Standard dimensions	Armature shaft diameter	Front	25
		Rear	12
	Bearing on gear case side	Gear shaft diameter	13.95~13.968
		Hole diameter	14.00~14.018
	Sliding portion of pinion	Shaft diameter	13.95~13.968
		Hole diameter	14.03~14.05
Ball bearing	Armature	Front	6905DDU
		Rear	6001DDU
Length L (pinion projection length)			0.3~1.5

12. SERVICE STANDARDS

12.1 Engine Tuning

No.	Inspection item			Standard		Limit	Reference page
1	Gap at intake/exhaust valve heads mm		TNV82A~98	0.15~0.25		-	2.2.6(4)
			4TNV106(T)	0.25~0.35		-	
2	V-belt tension mm at 98N (10kgf)	Between alternator and crank pulley	Used part	10~14		-	2.2.2.(2)
			New part	8~12		-	
		Between alternator and radiator fan	Used part	7~10			
			New part	5~8			
		Between radiator fan and crank pulley	Used part	9~13			
			New part	7~11			
3	Fuel injection pressure MPa (kgf/cm^2)	3TNV82A~TNV88(VM) 4TNV94L~106(T)		21.57~22.55 (220~230)		-	2.2.6.(3)
		3TNV82A~TNV88(CL)		19.6~20.6 (200~210)			
4	Compression pressure (at 250 min^{-1}) MPa (kgf/cm^2)	TNV82A		3.16(31)±0.1(1)		2.45(25)±0.1(1)	3.3
		TNV84		3.24(33)±0.1(1)		2.55(26)±0.1(1)	
		3/4TNV84T		2.94(30)±0.1(1)		2.45(25)±0.1(1)	
		TNV88-106		3.43(35)±0.1(1)		2.75(28)±0.1(1)	
5	Coolant water Capacity (Only engine body) (Liter)	3TNV82A,84		1.8		-	2.2.1.(4)
		3TNV84T,88		2.0		-	
		4TNV84(T),88		2.7		-	
		4TNV94L·98(T)		4.2		-	
		4TNV106(T)		6.0		-	
6	Lubricating oil capacity (oil pan) (Liter)	-		Full	Effective	-	2.2.1.(3)
		3TNV82A		5.5	1.9	-	
		3TNV84(T)/88		6.7	2.8	-	
		4TNV84(T)/88		7.4	3.4	-	
		4TNV94L/98(T)		10.5	4.5	-	
		4TNV106(T) (CL class)		14.0	9.0	-	
		4TNV106(T) (VM class)		14.0	7.5	-	
7	Lubricating oil pressure MPa (kgf/cm^2)	-		at rated speed		at low idle speed	-
		3TNV82A~98		0.29(3.0)~0.39(4.0)		0.06(0.6) or above	-
		4TNV98T 4TNV106(T) (VM, WO balancer)		0.39(4.0)~0.49(5.0)			
		4TNV106(T) (CL, WO balancer)		0.31(3.2)~0.49(5.0)			
		4TNV106(T) (VM, W balancer)		0.34(3.5)~0.44(4.5)			
8	Oil pressure switch operating pressure MPa (kgf/cm^2)			0.05±0.01 (0.5±0.1)		-	-
9	Thermostat			valve opening temperature deg. C		Full opening lift (mm) (temperature)	2.7
		All models		69.5~72.5		8 or above (85 deg.C)	
		All models option		80~84		10 or above (95 deg.C)	
10	Thermo switch actuating temperature (deg.C)			107~113		-	2.4.2