KOBELCO

SERVICE MANUAL

Crawler Excavator

SK55SRX Tier 4

S5PS0001E01

Issued September 2011

APPLICABLE:
SK55SRX . . . . . PS02-00101 and higher ~

1.1.3 DISASSEMBLING AND ASSEMBLING HYDRAULIC EQUIPMENT

(1) Removing Hydraulic Equipment

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

(2) Disassembling Hydraulic Equipment

1. Do not disassemble, reassemble or modify the hydraulic equipment without the permission of the manufacturer. The manufacturer is not responsible for the performance and function of the machine components after modification.
2. When disassembling and reassembling for unavoidable reason, refer the work to qualified personnel who have the specific knowledge or completed the parts service training.
3. Provide matching marks to facilitate reassembling work.
4. Before starting the work, read the manual for the disassembling procedure, if it is provided, and decide whether the work can be performed by yourself.
5. Always use the special jigs and tools if they are specified.
6. If it is hard to remove a part according to the procedure, do not try it by force, investigate the cause.
7. Place the removed parts in order and attach tags for easier reassembling.
8. Note the location and quantity of parts when disassembling.

(3) Inspecting Parts

1. Ensure the disassembled parts are free from seizure, interference and uneven contact.
2. Measure and record the wear condition of parts and clearance.
3. If the problem is found in a part, repair or replace it with a new one.

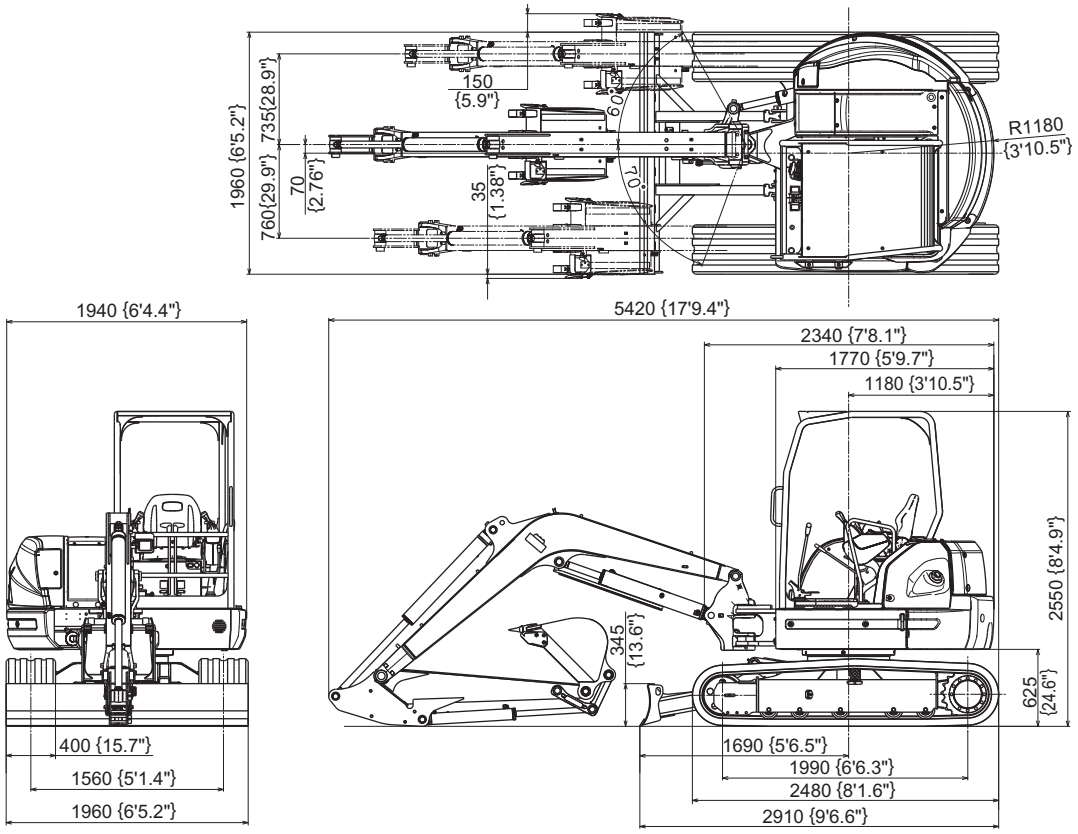
(4) Reassembling Hydraulic Equipment

1. Turn ON the ventilation fan or open windows to maintain good ventilation begore cleaning parts.
2. Perform rough and finish cleaning before assembling.
3. Remove washing oil by with pressurized air and apply clean hydraulic or gear oil for assembling.
4. Always replace the removed O-rings, backup rings and oil seals with new ones by applying grease in advance.
5. Remove dirt and moisture from and perform degreasing on the surfaces where liquid gaskets are applied.
6. Remove rust preventive agent from the new parts before use.
7. Fit bearings, bushings, and oil seals using special jigs.
8. Assemble the parts utilizing matching marks.
9. Ensure all the parts are completely assembled after the work.

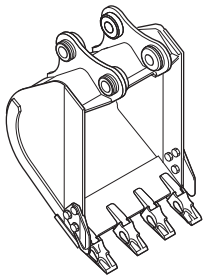
2.2 MACHINE DIMENSIONS

(1) SK55SRX (CANOPY)

Unit: mm (ft-in)



2.7 TYPE OF BUCKET

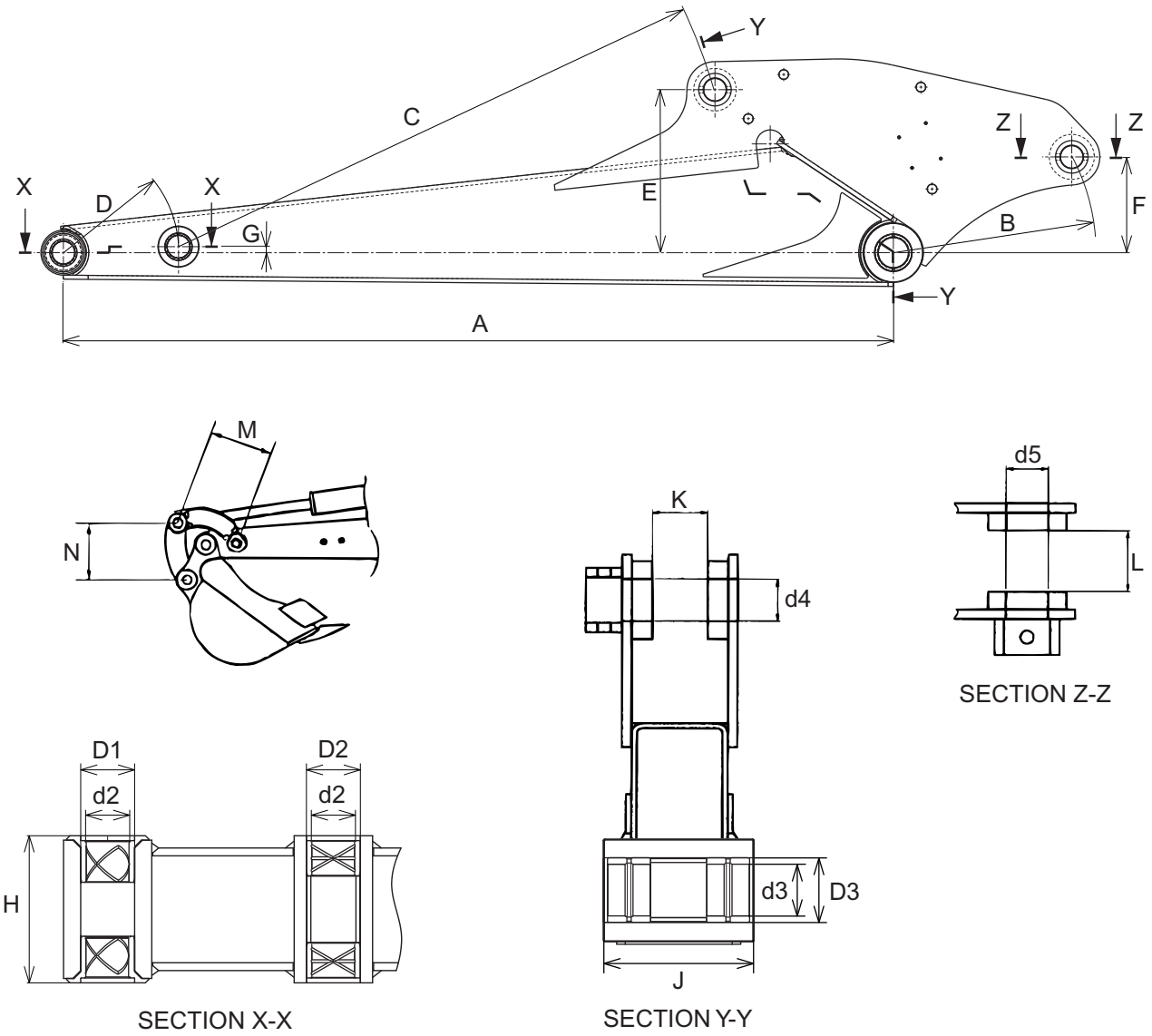
Type	Model	Heaped capacity m^3 (cu.yd)	Outer width mm (in)		Number of tooth	Weight kg (lb)	Remarks
			with side cutter	without side cutter			
Back hoe bucket 	SK55SRX	0.16 (0.21)	650 (25.3")	600 (23.6")	4	116 (256)	Standard size

Note

This table shows a standard bucket.

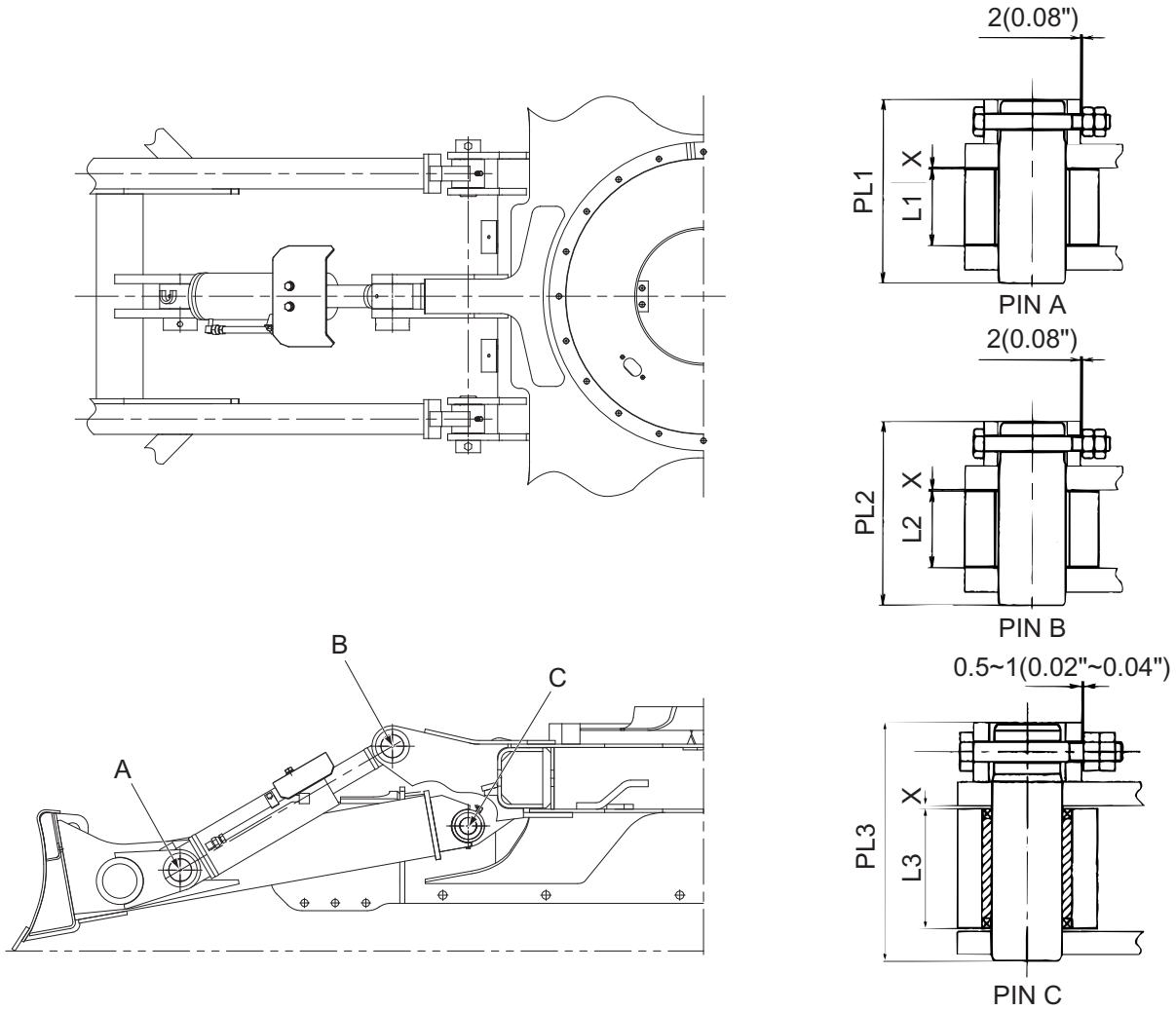
3.2 ARM

3.2.1 ARM DIMENSIONAL DRAWINGS



Arm Dimensional Drawings

3.4.2 DOZER MAINTENANCE STANDARDS



Dozer Maintenance Standards

(1) Clearance Of Pin And Bushing

Unit : mm (in)

Pos.	Item	Pin part No.	Standard dimension			Clearance			Remedy
			Pin dia.	Tolerance on pin dia.	Tolerance on bushing bore dia.	Standard value	Standard value for repair	Serviceability limit	
A	Dozer blade cylinder (Head side)	PY51B01107P1	ø55 (2.17)	–0.15 –0.21 (-0.0059) (-0.0083)	+0.20 +0.05 (+0.0079) (+0.0020)	0.20~ 0.46 (0.0079~ 0.0181)	1.5 (0.059)	2.0 (0.079)	Replace bushing or pin
B	Dozer blade cylinder (Rod side)								
C	Dozer blade foot	PH51B01001P1	ø40 (1.57)	–0.06 –0.09 (-0.0024) (-0.0035)	+0.215 +0.115 (+0.0085) (+0.0045)	0.175~ 0.305 (0.0069~ 0.0120)			

Note

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

Torque value Unit : N•m (lbf•ft)

Classification		4.8T		7T		10.9T	
Nominal size		No lubrication	Oil lubrication	No lubrication	Oil lubrication	No lubrication	Oil lubrication
M22	P=2.5	226±20 (167±15)	192±20 (142±15)	500±49 (369±36)	422±39 (311±29)	902±88 (665±65)	755±78 (557±58)
M24	P=3	294±29 (217±21)	235±29 (173±21)	637±69 (470±51)	520±49 (383±36)	1160±118 (856±87)	941±98 (694±72)
M27	P=3	431±39 (318±29)	353±39 (260±29)	941±98 (694±72)	765±78 (564±58)	1700±167 (1250±123)	1370±137 (1010±101)
M30	P=3.5	588±59 (434±44)	490±49 (361±36)	1285±127 (948±94)	1079±108 (796±80)	2300±235 (1700±173)	1940±196 (1430±145)
M33	P=3.5	794±78 (586±58)	667±69 (492±51)	1726±177 (1270±131)	1451±147 (1070±108)	3110±314 (2290±232)	2610±265 (1930±195)
M36	P=4	1030±98 (760±72)	863±88 (637±65)	2226±226 (1640±167)	1863±186 (1370±137)	4010±402 (2960±297)	3360±333 (2480±246)

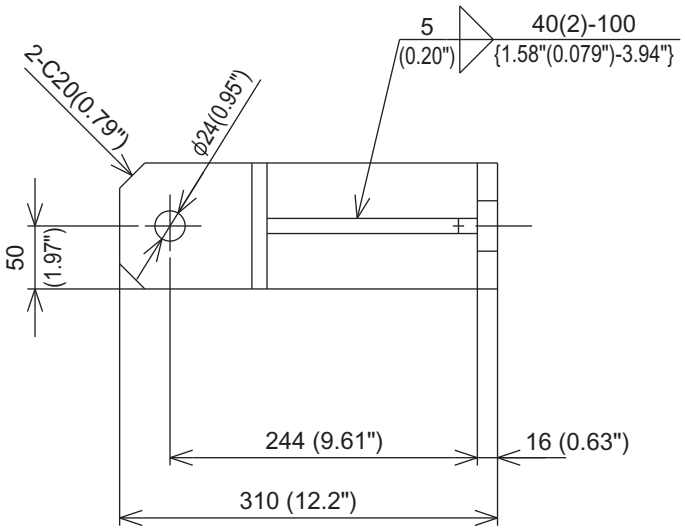
11.1.2 Metric Fine Thread Standard Tightening Torque values. Make certain to tighten all Capscrews & Nuts to proper torque values.

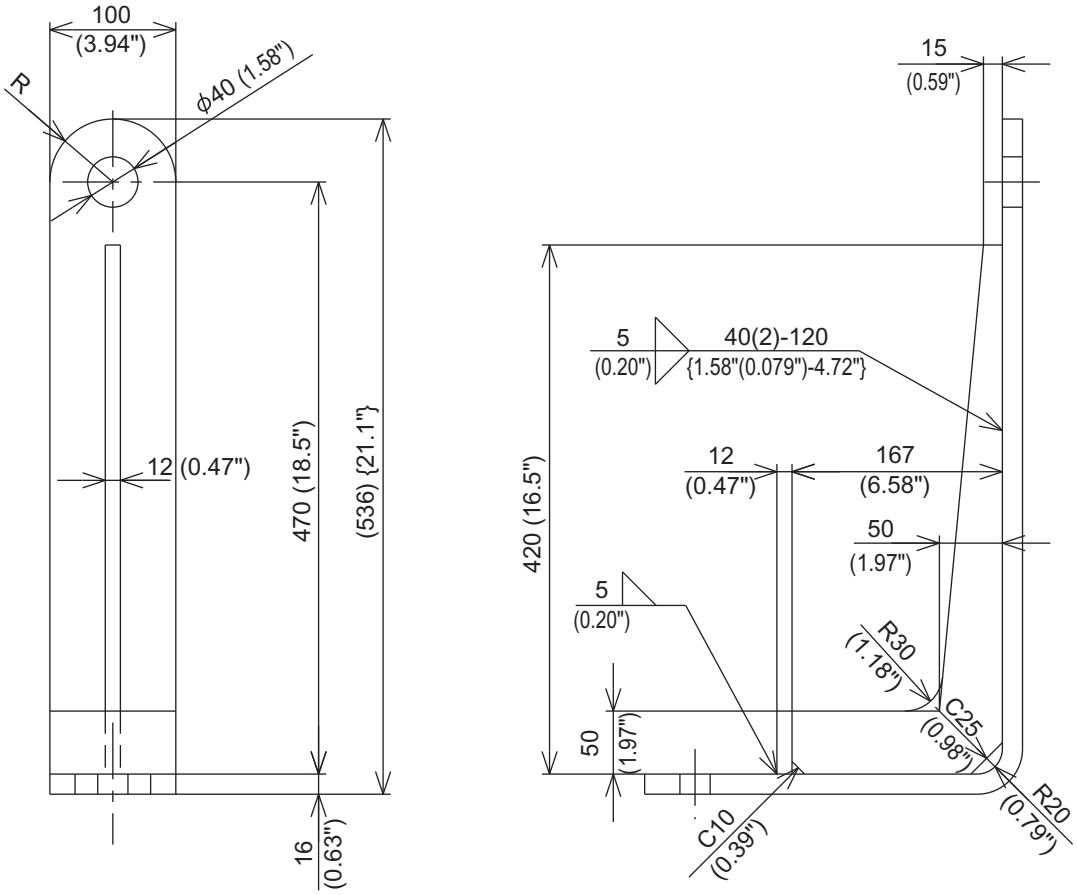
Torque value Unit : N•m (lbf•ft)

Classification		4.8T		7T		10.9T	
Nominal size		No lubrication	Oil lubrication	No lubrication	Oil lubrication	No lubrication	Oil lubrication
M8	P=1.0	11.3±1.1 (8.3±0.8)	9.5±1.0 (7.0±0.7)	24.5±2.0 (18.1±1.5)	20.6±2.0 (15.2±1.5)	44.1±3.9 (32.5±2.9)	37.3±3.9 (27.5±2.9)
M10	P=1.25	22.6±2.0 (16.7±1.5)	18.7±1.9 (13.8±1.4)	48.1±4.9 (35.5±3.6)	41.2±3.9 (30.3±2.9)	87.3±8.8 (64.4±6.5)	73.5±6.9 (54.2±5.1)
M12	P=1.25	39.2±3.9 (28.9±2.9)	33.3±2.9 (24.6±2.1)	85.3±8.8 (62.9±6.5)	71.6±6.9 (52.8±5.1)	154±16 (114±12)	129±13 (95.2±9.6)
M16	P=1.5	92.2±8.8 (68.0±6.5)	77.5±7.8 (57.2±5.8)	196±20 (145±15)	169±17 (125±13)	363±39 (268±29)	304±29 (224±21)
M20	P=1.5	186±19 (137±14)	155±16 (114±12)	402±39 (297±29)	333±29 (246±21)	726±69 (535±51)	608±59 (448±44)
M24	P=2	314±29 (232±21)	265±29 (195±21)	686±69 (506±51)	569±59 (420±44)	1240±118 (915±87)	1030±98 (760±72)
M30	P=2	637±59 (470±44)	530±49 (391±36)	1390±137 (1030±101)	1157±118 (853±87)	2500±255 (1840±188)	2080±206 (1530±152)
M33	P=2	853±88 (629±65)	706±70 (521±52)	1860±186 (1370±137)	1550±155 (1140±114)	3350±334 (2470±246)	2790±275 (2060±203)
M36	P=3	1070±108 (789±80)	892±88 (658±65)	2330±226 (1720±167)	1940±196 (1430±145)	4200±422 (3100±311)	3500±353 (2580±260)

11.10 UPPER FRAME LIFTING JIG

Q'ty : 2 sets
Material : Mild steel
Unit : mm (in)





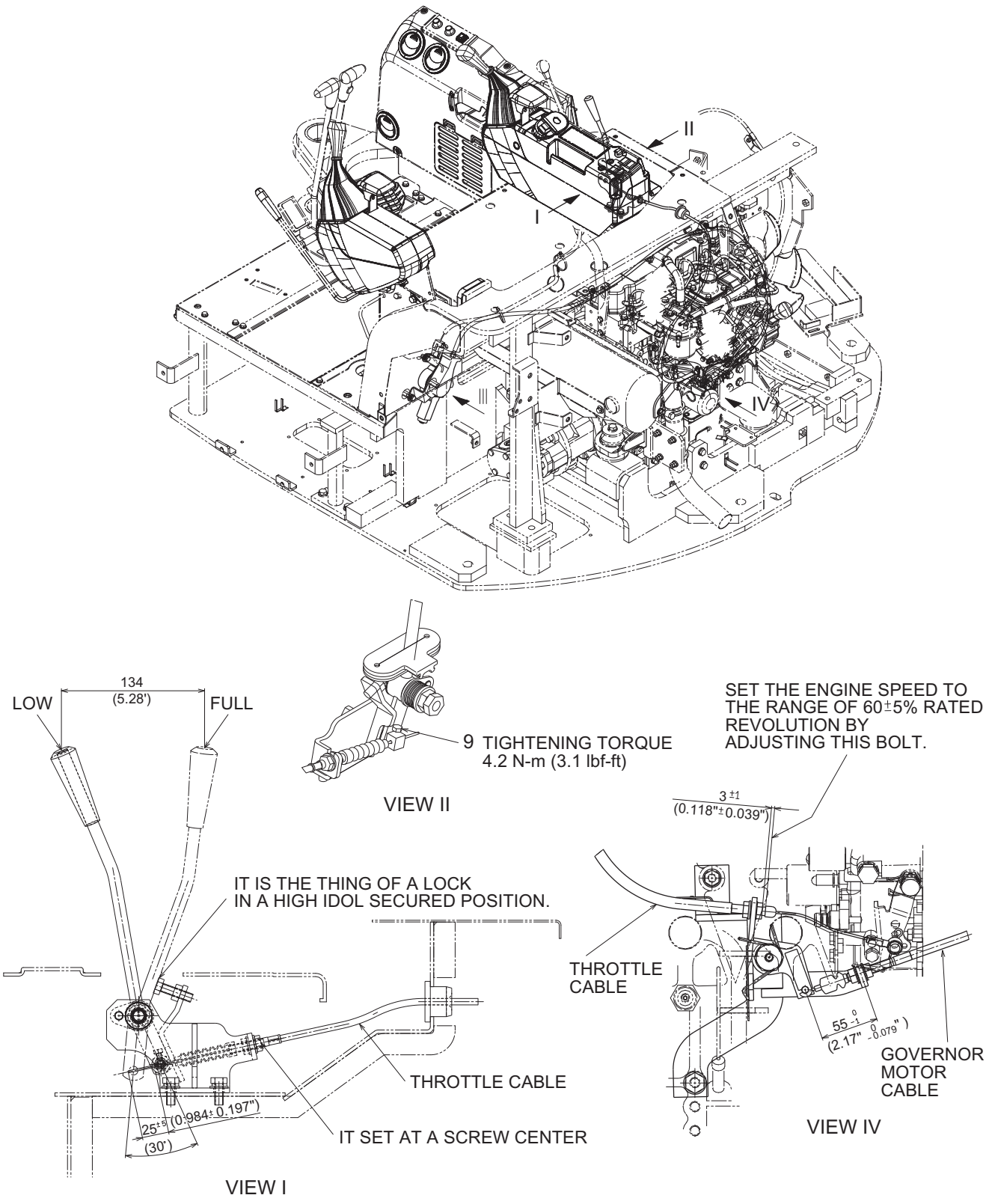
Upper Frame Lifting Jig

03 Upper Structure (4/4)

No.	EQUIPMENT PORTION	WORK TO BE DONE	UNIT	REMARKS	UNIT: HOUR
130	Upper frame portion			Refer to 33.1.22	
131	Upper frame ASSY	Rem./Inst.	1 pc.		1.0
132	-Fixing bolt	Rem./Inst.	1 set	Apply sealant	0.3
133	-Upper frame slinging	Rem./Inst.	1 pc.		0.3
134	-Cleaning	Cleaning	1 pc.		0.2
	Other necessary works	Rem./Inst.	1 pc.	Canopy	0.2
		Rem./Inst.	1 pc.	Guard (Cover, support)	1.5
		Rem./Inst.	1 pc.	Counterweight	0.4
		Drain / Feed	1 pc.	Hydraulic oil	0.2
		Rem./Inst.	1 set	Swivel joint hose	0.5
		Rem./Inst.	1 set	Boom	1.0

(4) Speed Adjustment

1. Low / High Idling Speed is low:
   The proper engine speed is obtained with the length of the accelerator wire as shown in the sketch. When the engine speed is lower than the standard speed, adjust the length of wire by loosening the capscrew (9) on throttle lever side.



Accelerator Wire Adjustment

CAUTION

However, if the proper high idling speed is not obtainable, consult with the engine manufacturer.

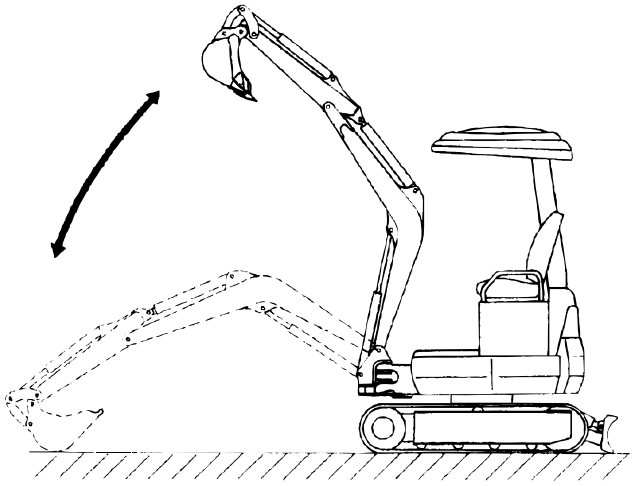
13.7 MEASURING ATTACHMENT OPERATING PERFORMANCES

TEST PROCEDURES
Measure 3-times each.
Apply average data of the above for judgement.

13.7.1 CYLINDER SPEED

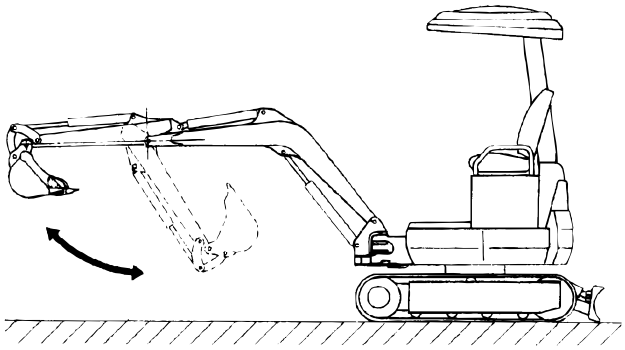
(1) Boom Cylinder Speed

- Engine: High Idle
- Hydraulic Oil Temp.: 50 to 60° C (122 to 140° F)
- Measurement Posture: Completely retract the arm cylinder, fully extend the bucket cylinder and place the dozer blade on the ground.
- Then measure the time required for the bucket to reach its highest point from its lowest point placing bucket on the ground. (Do not include the cushioning time.)



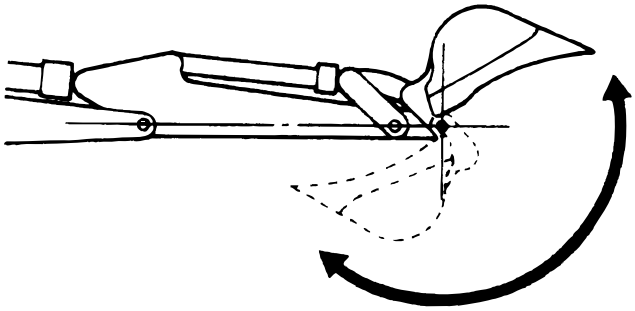
(2) Arm Cylinder Speed

- Engine: High Idle
- Hydraulic Oil Temp.: 50 to 60° C (122 to 140° F)
- Measurement Posture: Completely retract the arm cylinder, fully extend the bucket cylinder, position the arm horizontally and place the dozer blade on the ground.
- Then measure the time required for the arm cylinder to completely retract (extend) from a fully extended state (retracted state).

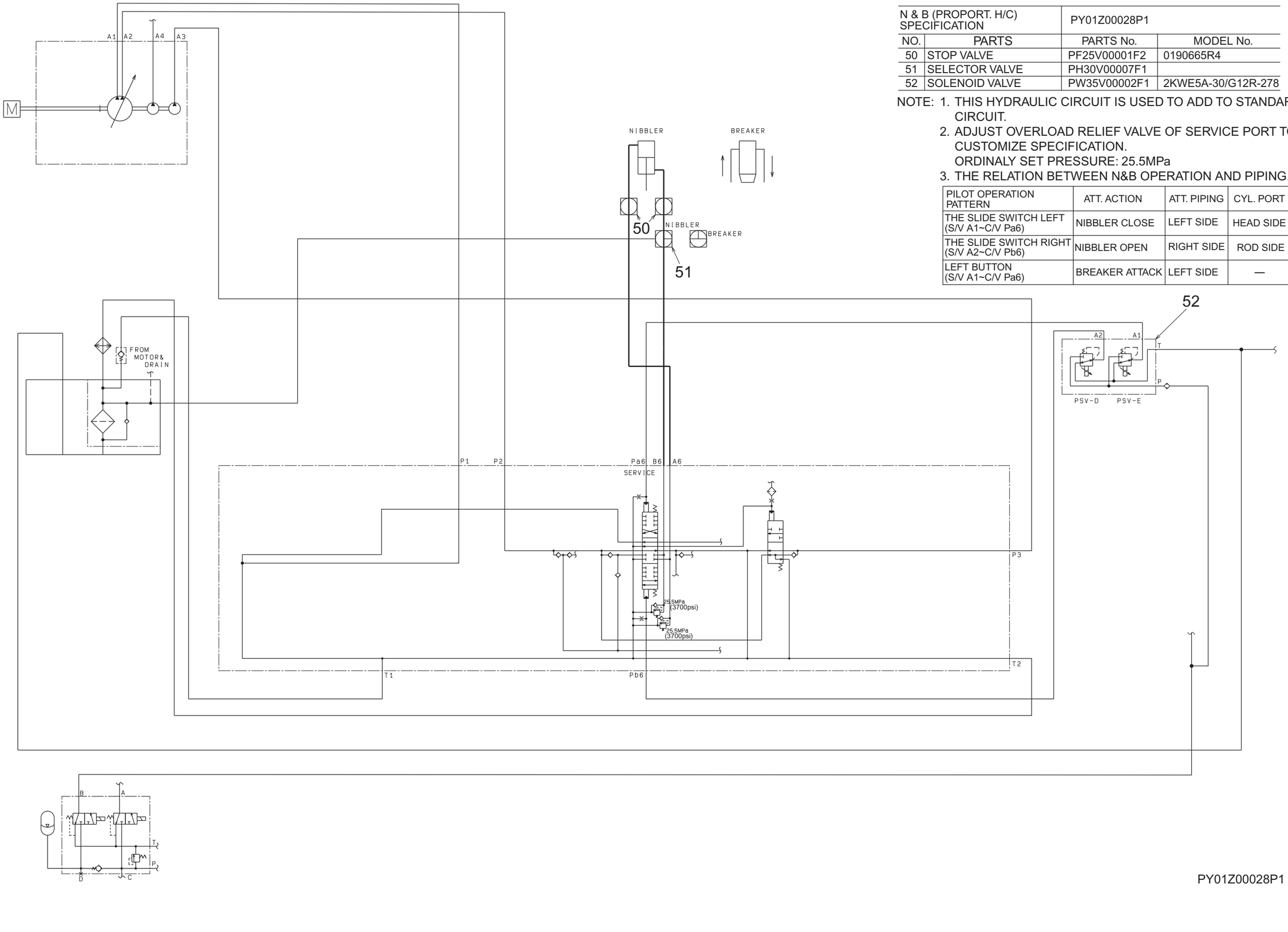


(3) Bucket Cylinder Speed

- Engine: High Idle
- Hydraulic Oil Temp.: 50 to 60° C (122 to 140° F)
- Measurement Posture: Completely retract the arm cylinder, position the arm horizontally and place the dozer blade on the ground.
- Then measure the time required for the bucket cylinder to completely retract (extend) from a fully extended state (retracted state).



22.2.2 N&B (PROPORT.H/C) SPECIFICATION



N & B (PROPORT. H/C) SPECIFICATION		PY01Z00028P1	
NO.	PARTS	PARTS No.	MODEL No.
50	STOP VALVE	PF25V00001F2	0190665R4
51	SELECTOR VALVE	PH30V00007F1	
52	SOLENOID VALVE	PW35V00002F1	2KWE5A-30/G12R-278

NOTE: 1. THIS HYDRAULIC CIRCUIT IS USED TO ADD TO STANDARD CIRCUIT.
2. ADJUST OVERLOAD RELIEF VALVE OF SERVICE PORT TO CUSTOMIZE SPECIFICATION.
ORDINALY SET PRESSURE: 25.5MPa
3. THE RELATION BETWEEN N&B OPERATION AND PIPING.

PILOT OPERATION PATTERN	ATT. ACTION	ATT. PIPING	CYL. PORT
THE SLIDE SWITCH LEFT (S/V A1~C/V Pa6)	NIBBLER CLOSE	LEFT SIDE	HEAD SIDE
THE SLIDE SWITCH RIGHT (S/V A2~C/V Pb6)	NIBBLER OPEN	RIGHT SIDE	ROD SIDE
LEFT BUTTON (S/V A1~C/V Pa6)	BREAKER ATTACK	LEFT SIDE	—

22.3.6 BOOM OPERATING CIRCUIT

Pilot oil hydraulic system with operating lever.

22.3.6.1 Boom UP Operating Circuit

(1) Pilot Circuit

1. Boom Spool Shifting
   When the operating lever is put at the boom up position, the pilot secondary pressure oil is generated from pilot valve (11). The pressurized oil entered into the Pb2 port on control valve (2) shifts the boom valve spool.

(2) Main Circuit

1. Supply Circuit for Cylinder (5)
   The oil delivered from the A1 port on the variable pump of pump assy (1) enters into the P1 port on control valve (2). The oil supplied from the B2 port through the boom valve and lock valve is entered into the head side of boom cylinder (5) to up the boom.

22.3.6.2 Boom Down Operating Circuit

(1) Pilot Circuit

1. Boom Spool Shifting
   When the operating lever is put at the boom down position, the pilot secondary pressure oil is generated from pilot valve (11), and enters into the Pa2 port on control valve (2) to shift the boom valve spool.
   At the same time, the pilot secondary pressure is led to the boom lock valve (206) to push up the check valve and open the oil path from the closed condition.

(2) Main Circuit

1. Supply Circuit for Cylinder (5) and Return Oil Circuit
   The pressurized oil delivered from the A1 port on the variable pump is led to the boom valve provided on control valve (2), and supplied to the rod side of boom cylinder (5) to down the boom.
   The oil returned from the head side of cylinder (5) enters into the B2 port on control valve (2), and returns to the tank through the boom lock valve (206) and boom valve.
   It's flow rate is restricted by the throttle effect in the boom valve, accordingly the boom is lowered at a stable speed.

a. Boom lock valve (206)
   This is of a check valve mechanism to prevent the boom from lowering due to its own weight while the boom valve is at the neutral position.

22.3.11 TRAVEL / BOOM COMBINED OPERATING CIRCUIT

At the combined operation of travel and boom at the same time, the straight traveling is secured with this function.

22.3.11.1 Travel (1st speed forward) / Boom Up Operating Circuit

(1) Pilot Circuit

The traveling/boom up is of the pilot oil hydraulic system with lever operation.
By means of pushing forward the travel operating lever and pulling this side of the boom up operating lever, the pilot secondary pressure shifts the travel valve spool and/or boom spool in the control valve (2).
Thus the pilot passage of the boom valve is closed to make the pressure of the oil from the Pi3 port equal to the supply pressure. Therefore, the hydraulic pressure overcomes the spring force of the independent travel valves to shift the valve spool.

(2) Main Circuit

The oil delivered from A1 and A2 ports on the variable pump enters into P1 and P2 ports on the control valve (2).
The whole amount of oil from the P1 and P2 ports is supplied to the travel motor in the same way as operating the independent travel. The oil flows from the travel valve through the B3 and B4 ports and the swivel joint (10) to the right and left travel motor (4).
The oil delivered from port A3 of the hydraulic pump (1) is supplied to the boom cylinder. Pressurized oil that flows out from the P3 port of control valve (2) enters into the boom valve through the switched travel independent valve.
The oil from the B2 port through the boom valves is supplied to the head side of the boom cylinder (5).

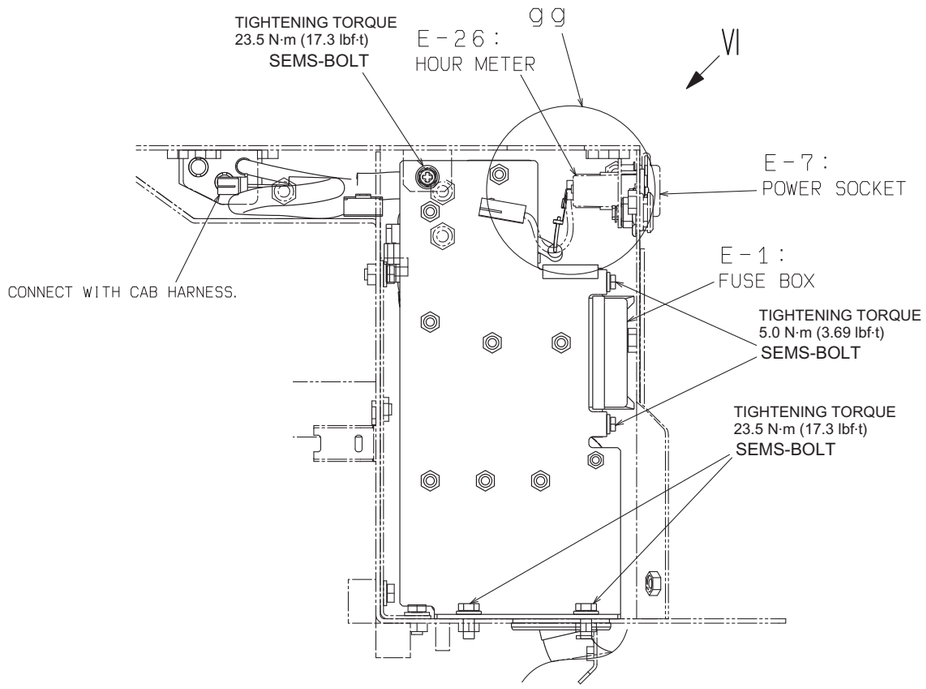
1. When the travel and other attachments (boom, arm, bucket, swing, and service (for N & B) are operated in combination, the independent travel and flow conflux valves are actuated. Thus the attachments are actuated only by oil supplied from the P3 port. Therefore the oil of the P1 and P2 ports is utilized only by the travel to secure stable travel in the combined operation.

23.2 ELECTRICAL EQUIPMENT & HARNESS

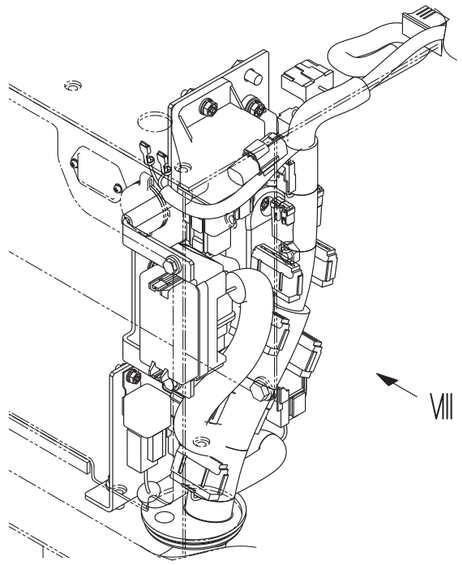
23.2.1 ELECTRICAL EQUIPMENT LIST

Group	Code	Part Name	Part No.
Controller	C-4	AIR CONDITIONER (FOR CAB)	A/C accessory
Diode	D-1	DIODE	YN02D01001P1
	D-2	DIODE	↑
	D-3	DIODE	↑
	D-4	DIODE	↑
	D-5	DIODE	↑
	D-12	DIODE	↑
	D-14	DIODE	↑
	D-18	DIODE	↑
	D-19	DIODE	↑
Electical Fittings	E-1	FUSE BOX	PY73E00002F1
	E-2	GENERATOR (ALTERNATOR)	E/G accessory (119626-77210)
	E-3	HORN	PY53S00002P1
	E-4	FUSIBLE LINK	PH73S00001P1
	E-6	GAUGE CLUSTER	PH59S00005F1
	E-7	POWER SOCKET	PF81S01001P1
	E-8	GLOW PLUG	E/G accessory (129008-77800)
	E-10	RADIO (OPT)	Cab accessory (YN54S00045P2)
	E-11	OVER LOAD BUZZER	YJ53S01001D3
	E-13	BATTERY	PH72S00006P1
	E-14	SEQUENCE BOX	PA24S00002P3
	E-18	COMPRESSOR	A/C accessory
	E-20	TRAVEL ALARM	PW53S00002F1
	E-26	HOUR METER	PA58S00001P1
	E-27	RECEIVER DRER	PW20M01071F1
	E-41	SPEAKER LEFT	YT54S00006P1
	E-42	SPEAKER RIGHT	↑
Light	L-1	ROOM LAMP (FOR CAB)	PW80S00007P1
	L-2	BOOM WORKING LIGHT LEFT (55W)	PM80S00008F1
	L-5	CAB / CANOPY WORKING LIGHT	PW80S00003F1
Motor	M-1	STARTER MOTOR	E/G accessory (129136-77011)
	M-2	WIPER MOTOR (FOR CAB)	Cab accessory (PM76S00001F1)
	M-3	WASHER MOTOR (FOR CAB)	Cab accessory (PW54C00001P1)
	M-4	DECELERATION MOTOR	PY20S00003F1
	M-6	FUEL PUMP	PW22P00001P1
Relay	R-1	BATTERY RELAY	PH24S00001P1
	R-2	SAFETY RELAY	PX24S00001P1
	R-3	DECELERATION RELAY (EU. NA. Aust.)	PA24E01001P1

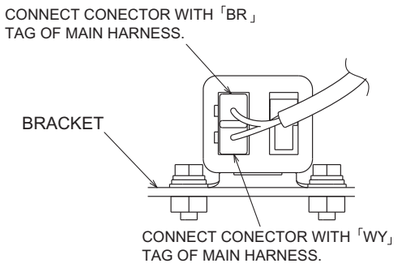
23.2.4.1 Upper Frame Portion: PY03E00003F1 (4/5)



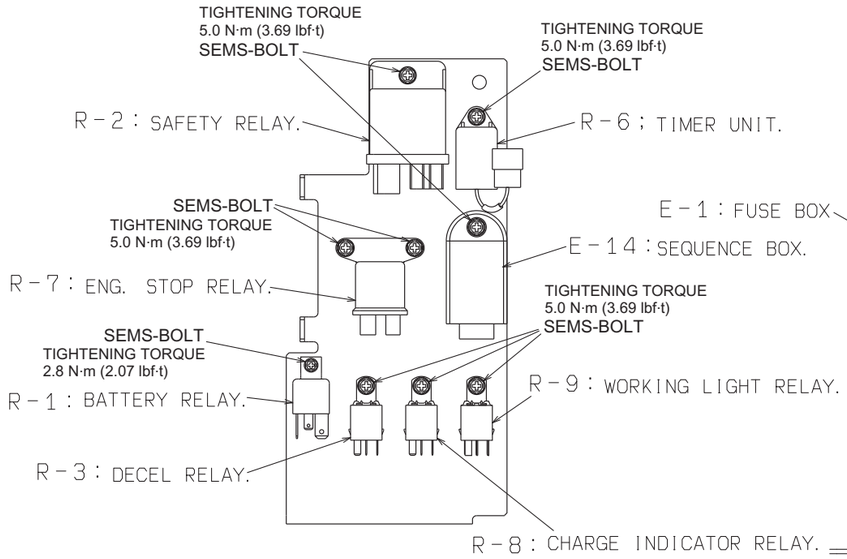
VIEW V



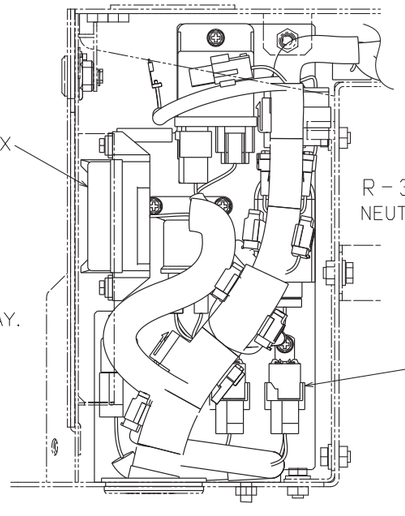
VIEW VI



DETAIL OF ENG. STOP RELAY INSTAL



DETAIL OF RELAY INSTAL



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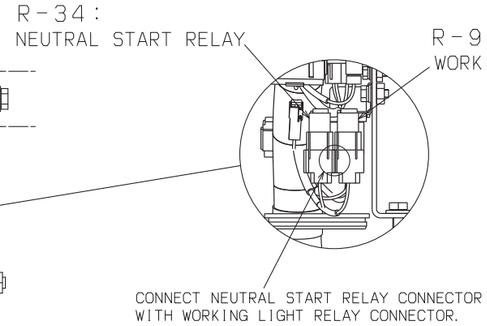
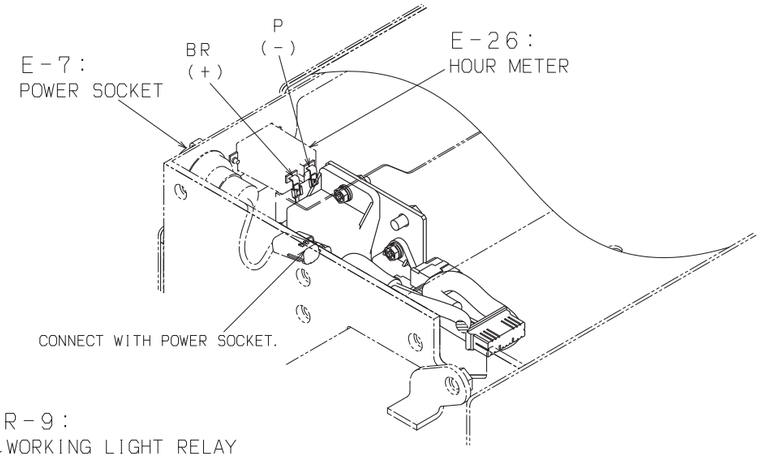
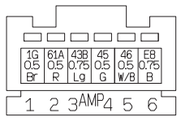




DETAIL gg

23.2.5.1 Main Harness (No. H-1: PY14E01015P1) (2/5)

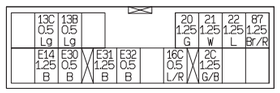
CN-1F



6FA-070ML2
CN-1F
E-14

SEQUENCE BOX

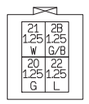
CN-2F



18FA-070ML1
CN-2F

TO HARNESS IN CAB

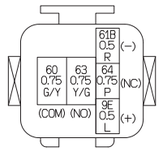
CN-3F



4FA-CNA_BR
CN-3F
SW-4

WIPER WASHER SW.(FOR CAB)

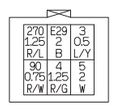
CN-6F



5FS-MITSUBA
CN-6F
R-3

DECEL RELAY

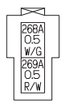
CN-8F



6FA-CNA
CN-8F

TO AIR CON. HARNESS

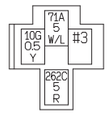
CN-9F



2FA-CNA
CN-9F
R-7

ENG. STOP RELAY

CN-10F

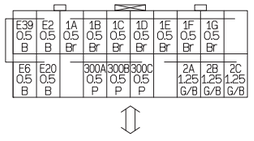


4FB-VF7
CN-10F
R-1

BATTERY RELAY

#3 E11 0.5 B + E12 0.5 B

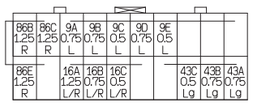
CN-14F



SUPPLY WITH SUMITOMO
6409-0072

20FS-SHM090_G
CN-14F
JC

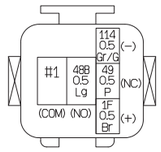
CN-15F



SUPPLY WITH SUMITOMO
6409-0072

20FS-SHM090_G
CN-15F
JC

CN-16F

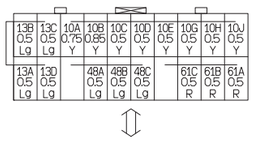


5FS-MITSUBA
CN-16F
R-8

CHARGE INDICATOR RELAY

#1 E7 0.75 B + E8 0.75 B

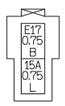
CN-17F



SUPPLY WITH SUMITOMO
6409-0072

20FS-SHM090_G
CN-17F
JC

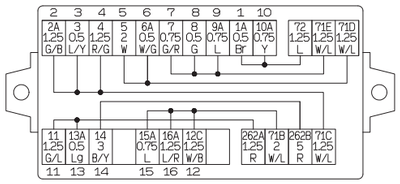
CN-19F



2FA-CNA
CN-19F

TO PROPORTIONAL HAND CONTROL

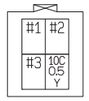
CN-20F



XPY73E00002S001
CN-20F
E-1

FUSE BOX

CN-22F



4FA-CNA
CN-22F
R-6

TIMER UNIT

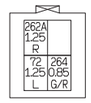
#1 268A 0.5 W/G + 268B 0.5 W/G
#2 269A 0.5 R/W + 269B 0.5 R/W
#3 E16 0.75 B + E17 0.75 B

CN-25F

2FY-312
CN-25F

TO KEY SW. HARNESS

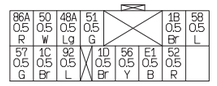
CN-26F



4FA-CNA
CN-26F

TO KEY SW. HARNESS

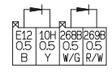
CN-27F



14FA-040ML1
CN-27F
E-6

GAUGE CLUSTER

CN-29F



YAZAKI 7321-9822

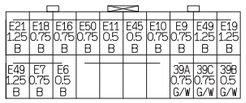
SUPPLY WITH DIODE

ADAPT CONNECTOR
7123-7144
ADAPT TERMINAL
7116-1181

4FY-DA+D
CN-29F
D-12/D-3

DIODE

CN-33F



SUPPLY WITH SUMITOMO
6409-0603

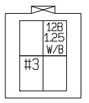
20FS-SHM090_BR
CN-33F
JC

CN-34F

2FS-HM090
CN-34F
SW-7

HORN SW.

CN-37F



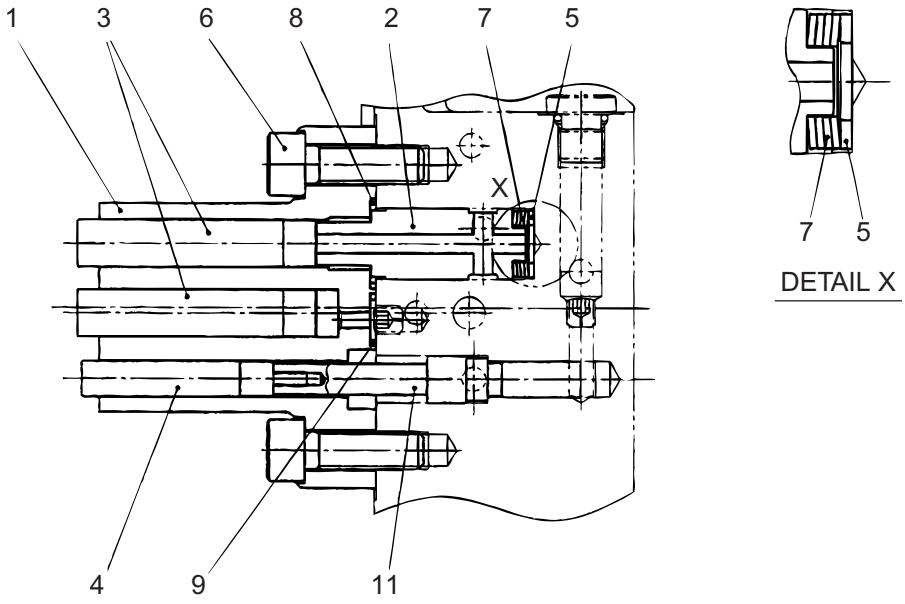
4FA-CNA_B
CN-37F
SW-2

WORK LIGHT SW.

#3 86A 0.5 R + 86B 1.25 R

Issue	Date of Issue	Applicable Machines	Remarks
First Edition	September, 2010	SK55SRX: PS02-00101~	S5PS2401E01 (KCM North America)

(7) Housing



No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	Cylinder	1	5	Spring seat	1	9	O-ring	1
2	Piston	1	6	Capscrew	2	11	Piston	1
3	Piston	2	7	Disk spring	3			

2. Damping Mechanism

(1) In case of neutral position,

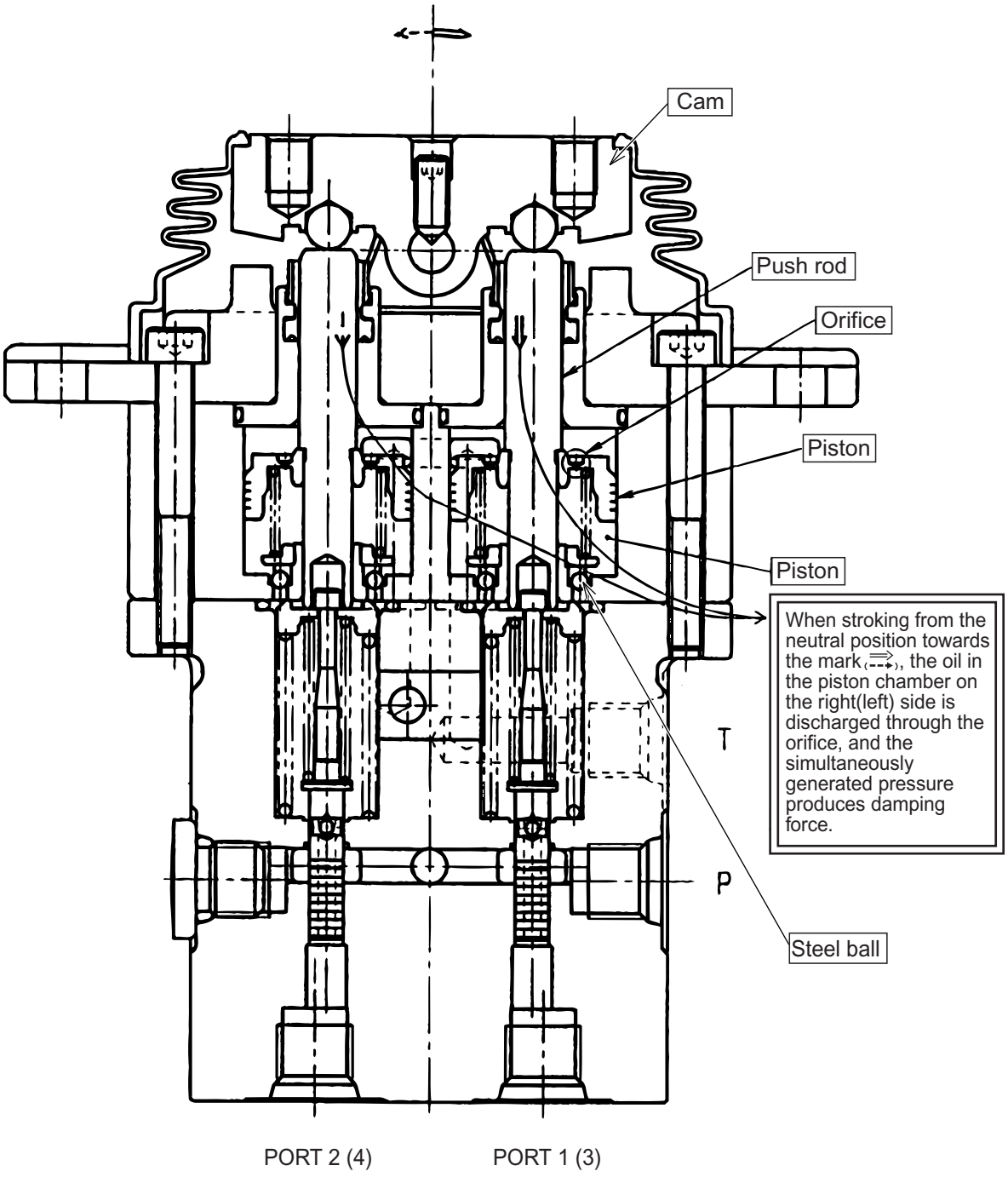
Push rod (214) is pushed up by damping spring (336) through piston (224), and holds at the position shown in Figure "Pilot Valve Sectional View".

(2) Where the control section is inclined from the neutral position,

By rotating the cam clockwise, the push rod on the port 1 side is pushed down, and the piston also moves down. Then, the oil in the damping piston chamber is discharged through the orifice, and simultaneously generated pressure produces damping force.

On the other hand, the push rod on the port 2 side moves up by the damping spring through the piston.

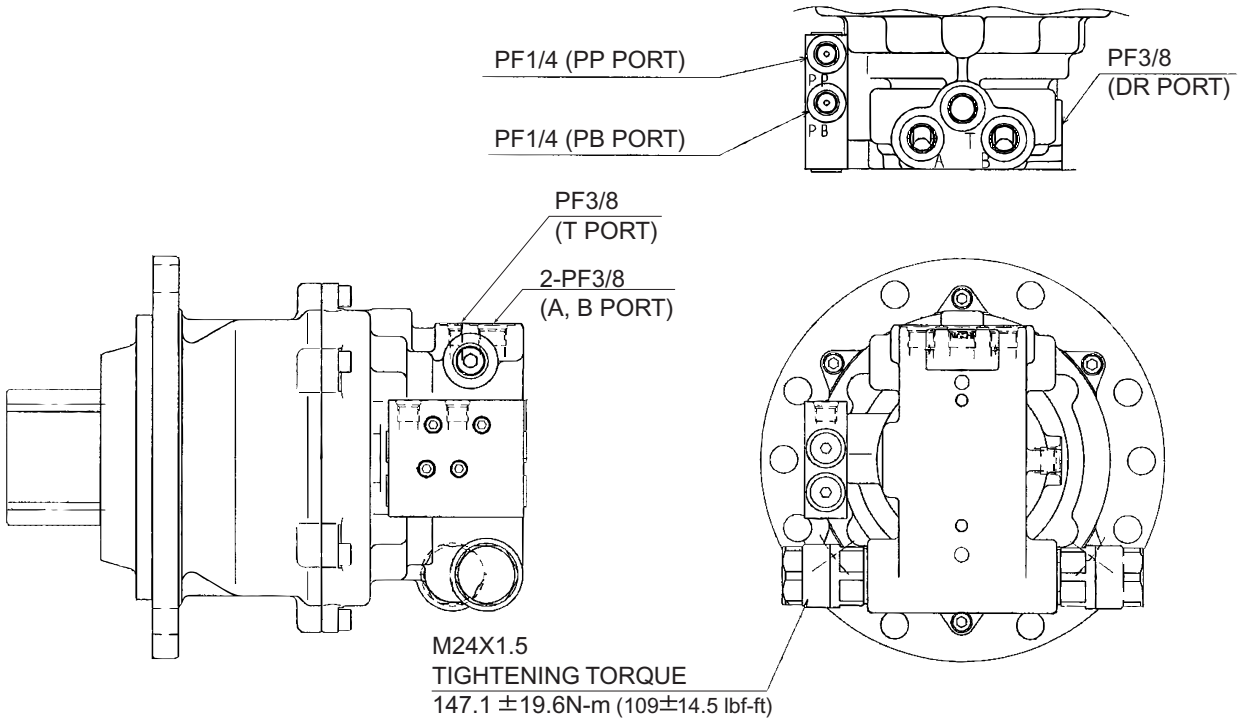
Then, oil is sucked from the tank into the damping piston chamber through three ball check valves. The oil outside of the piston chamber flows out through the passage leading to port T on the casing top end.



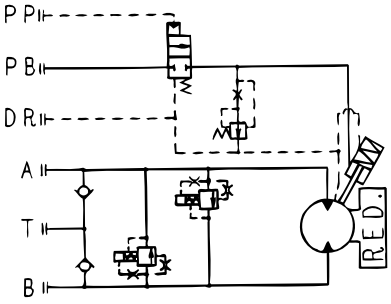
Operation When The Lever Is Stroked From The Neutral Position

24.1.5 SLEWING MOTOR

24.1.5.1 GENERAL VIEW



24.1.5.2 HYDRAULIC CIRCUIT



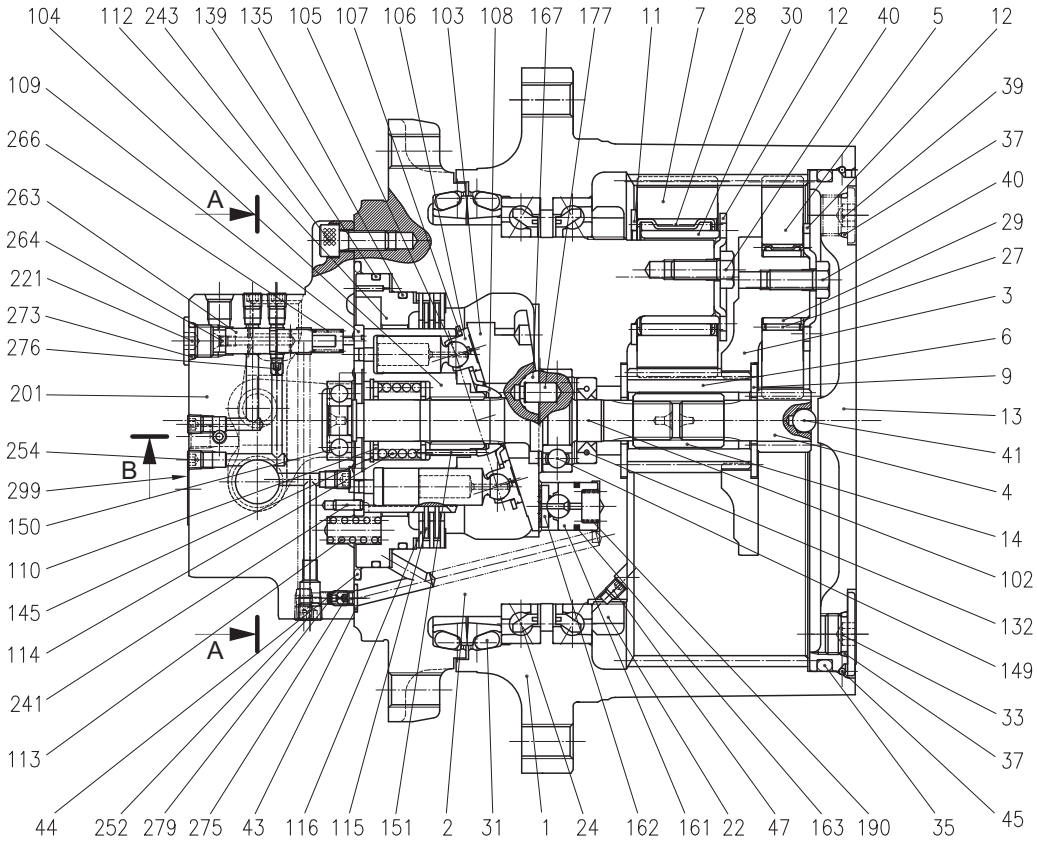
Port	NAME	Size
A	Main port	PF3/8
B	Main port	
T	Tank port	
DR	Drain port	PF1/4
PB	Slewing parking brake release port	
PP	Slewing parking brake pilot port	

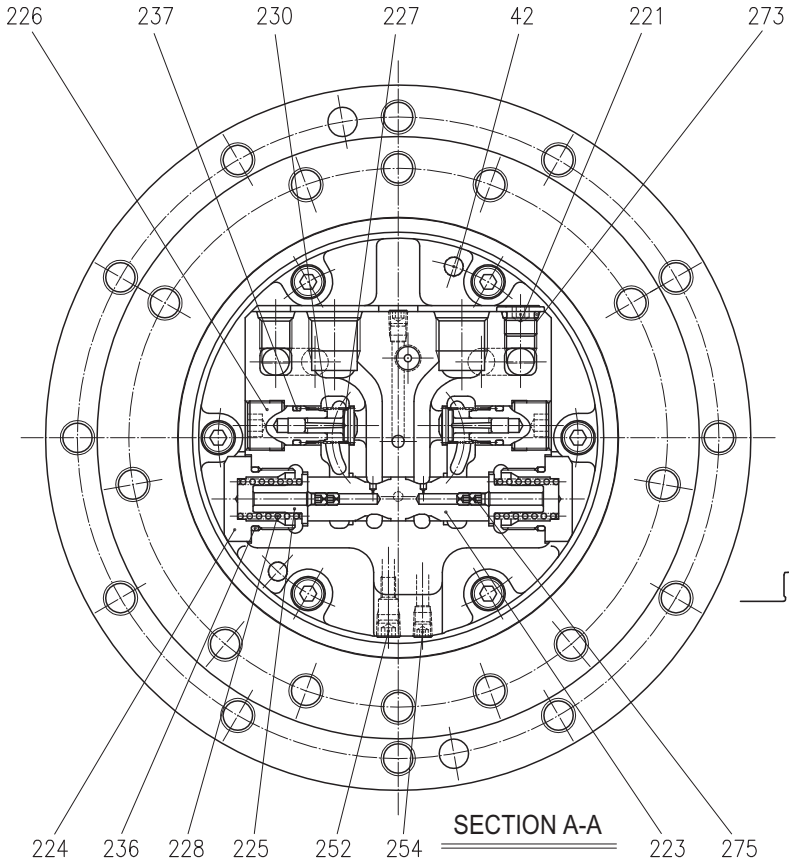
Rotational direction (Seen from shaft side) : Inlet B port : Clockwise
: Inlet A port : Counter clockwise

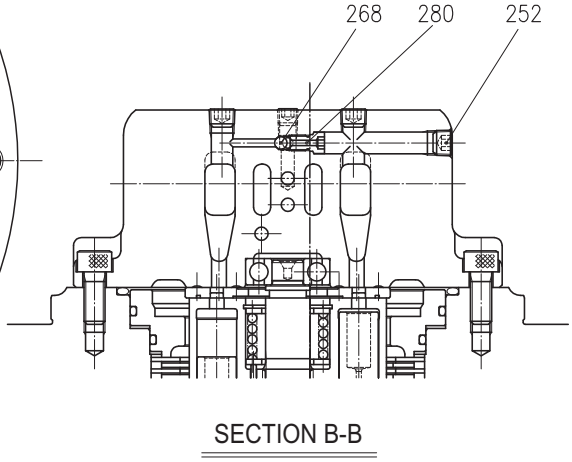
24.1.5.3 SPECIFICATIONS

Items			Specifications
Part No.			PY15V00014F1
Model (Type)	Slewing motor unit		PCR-3B-12A-FP-9093A
	Slewing motor		PM-1B-20B-FS2-9093A
Hydraulic motor	Displacement	cm^3/rev (cu-in/rev)	20.0 (1.22)
	Rated flow	L/min (gal/min)	33.8 (8.93)
Parking brake	Static friction torque	N-m (lbf-ft)	68.4 (50.5)
	Release pressure	MPa (psi)	Min 2.5 (363), Max 4.9 (710)
Relief valve	Set pressure	MPa (psi)	21.0 (3050) at 34l/min (9.0 gal/min)
	Cracking pressure	MPa (psi)	16.2 (2350) at 1l/min (0.26 gal/min)
Reduction unit	Reducting ratio		21.5
Weight (with Reduction unit)		kg (lb)	Approx. 37 (82)

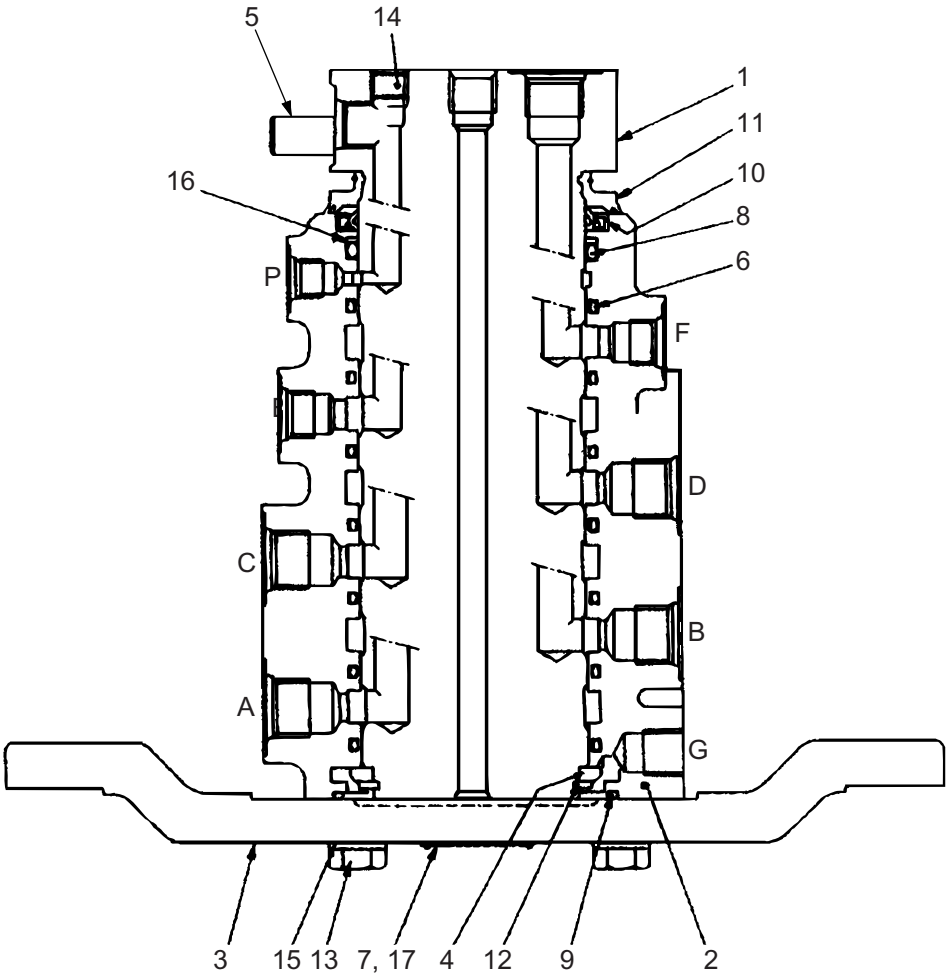
(2) Sectional View







24.1.7.3 CONSTRUCTION



Construction

No.	NAME	Q'TY	No.	NAME	Q'TY
1	STEM	1	10	DUST SEAL	1
2	BODY	1	11	DUST SEAL	1
3	FLANGE	1	12	SNAP RING	1
4	SPACER	1	13	BOLT (M10X30)	4
5	PIN	1	14	PLUG (PF1/4)	3
6	SLIPPER SEAL	7	15	SPRING WASHER	4
7	NAME PLATE	1	16	BACK-UP RING	1
8	O-RING	1	17	CLEVIS	2
9	O-RING	1			

24.1.7.4 OPERATION

The swivel joint is installed on the slewing center of the machine, and plays a role to continuously connect the oil circuit regardless of the slewing angle of the upper frame.

Group	Code	Part Name	Part No.
Relay	R-6	TIMER UNIT	PH25S00002P1
	R-7	E/G STOP RELAY	PX24S00003P1
	R-8	CHARGE INDICATOR RELAY	PA24E01001P1
	R-9	CAB / CANOPY WORKING LIGHT RELAY	↑
	R-31	HORN RELAY	PA24E01001P1
	R-34	NEUTRAL START RELAY	PM24S00001P1
Sensor	SE-1	FUEL SENSOR	PX52S00006F1
	SE-2	ENGINE THERMO SENSOR	PA24S00003P1
Solenoid	SV-1	LEVER LOCK SOL.	PY35V00008F1
	SV-2	2-SPEED SELECT SOL.	
	SV-3	E/G STOP SOL.	E/G accessory (119233-77932)
	SV-5	POWER SHIFT SOL. (Cooler Spec)	YJ35V00004F2
Proportional Solenoid Valve	PSV-D	NIBBLER OPEN PROPORTIONAL SOL.	PW35V00002F1
	PSV-E	NIBBLER CLOSE PROPORTIONAL SOL.	↑
	PSV-F	REVOLUTION LEFT (A1) PROPORTIONAL SOL.	↑
	PSV-G	REVOLUTION RIGHT (A2) PROPORTIONAL SOL.	↑
Switch	SW-1	KEY SWITCH	PW50S00005S001
	SW-2	WORKING LIGHT SW.	PV24E01001P2
	SW-3	2-SPEED SELECT SW.	YN03M01286S002
	SW-4	WIPER WASHER SW. (FOR CAB)	PY50S00004P2
	SW-5	E/G COOLANT TEMP. SW.	PM50S00006P1
	SW-6	E/G OIL PRESSURE SW.	E/G accessory (114250-39450)
	SW-7	HORN SW.	YN50E01001P1
	SW-9	LEVER LOCK SW.	PA50S00001P1
	SW-11	DECELERATION SW.	PM50S00005P1
	SW-14	AIR FILTER RESTRICTION SW.	PW11P00010S004
	SW-23	TRAVEL ALARM SELECT SW.	2479U1190F16
	SW-24	TRAVEL RIGHT (FORWARD) PRESSURE SW.	GB50S00049F2
	SW-25	TRAVEL RIGHT (REVERSE) PRESSURE SW.	↑
	SW-26	TRAVEL LEFT (FORWARD) PRESSURE SW.	↑
	SW-27	TRAVEL LEFT (REVERSE) PRESSURE SW.	↑
	SW-35	NIBBLER OPEN-CLOSE SW. (RIGHT)	PW03M01958F1
	SW-37	(A1,A2) REVOLUTION SW. (LEFT)	PW03M01959F1
	SW-39	OVER LOAD PRESSURE SW.	72117480 (DIN 43650)
	SW-40	OVER LOAD SW.	2479U1190F33

Note

The part number may be changed for modification, use them only for reference.

Code No. Parts Name Parts No. Use Applicable Machine	Specifications	Description

SE-1

Sensor

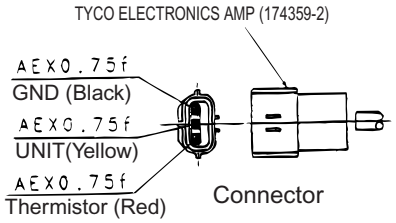
PX52S00006F1

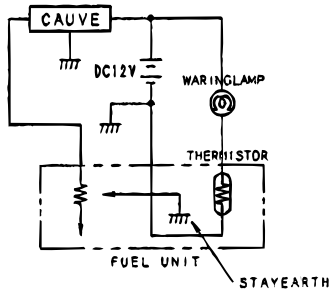
Fuel sensor

PW11-30001~
PX12-11001~
PH05-03501~
PJ04-03001~
PJ05-06001~
PJ06-08001~
PJ06-08890~
PJ06-09807~
PS02-00101~

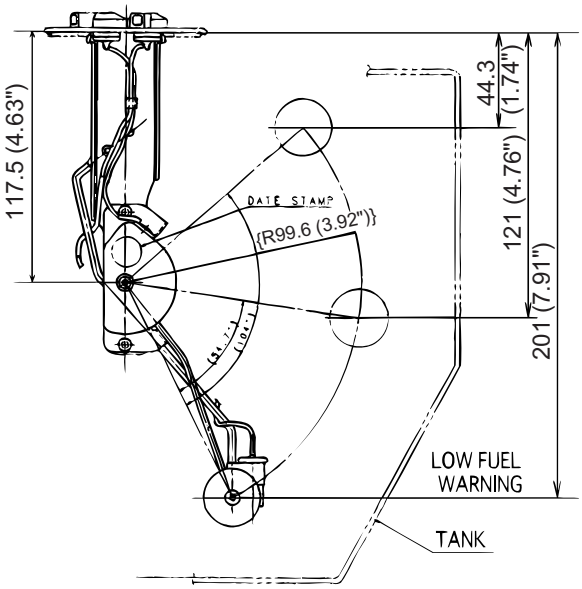
Rated voltage	12V

Float position	FULL	1/2	EMPTY
Resistance(Ω)	10	38	90
Allowable(Ω)	0 -4	-	+10 0





Circuit diagram



SE-2

Sensor

PA24S00003P1

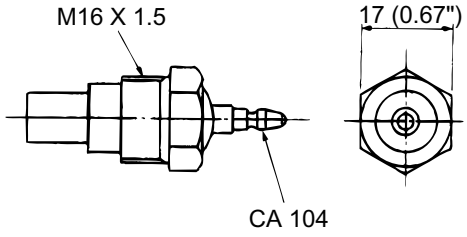
E/G thermo sensor

PX12-11001~
PH05-03501~
PJ04-03001~
PJ05-06001~
PJ06-08001~
PJ06-08890~
PJ06-09807~
PS02-00101~

Rated voltage	DC 12V
Type	Thermistor type

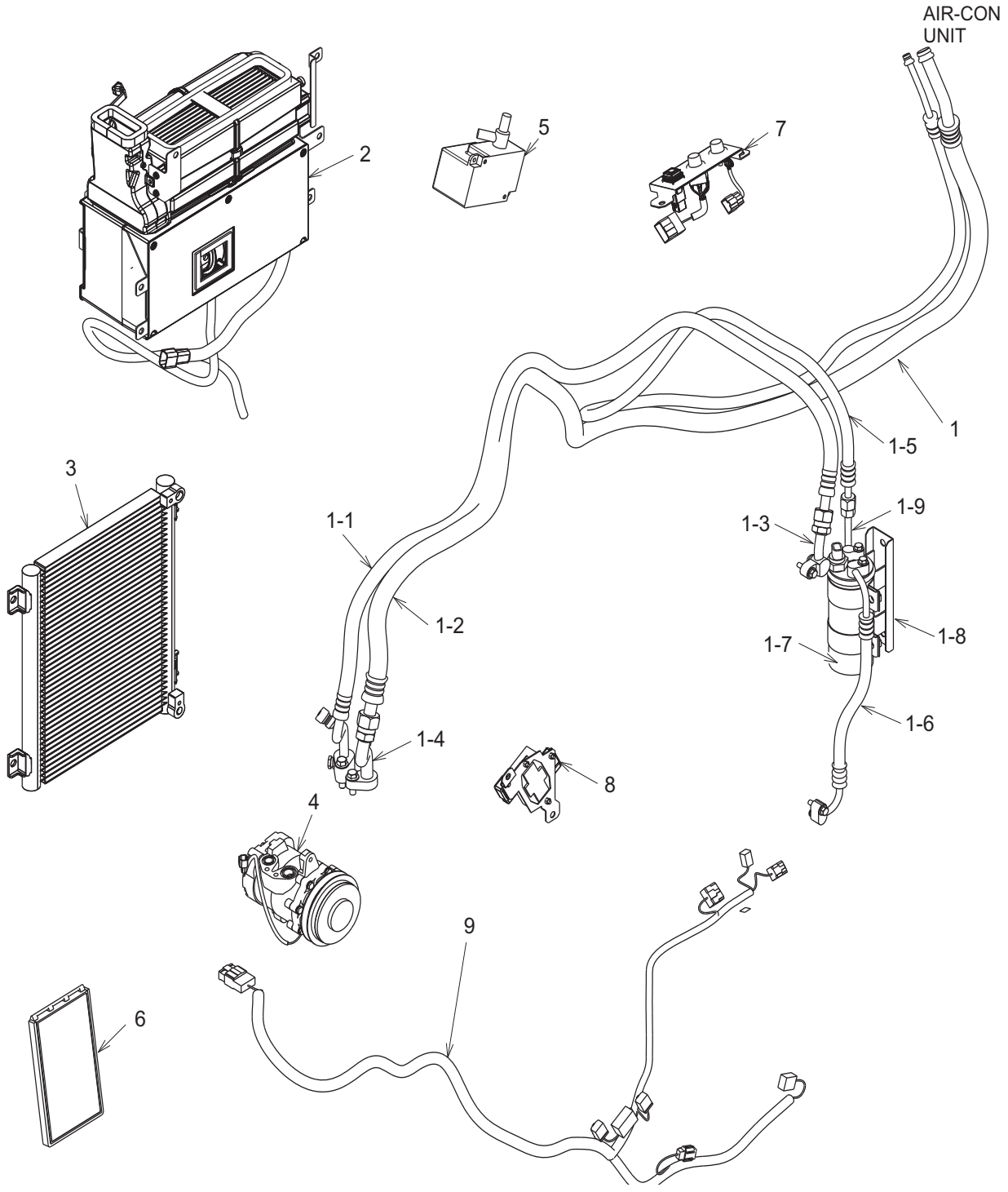
Temperature (℃)	(50)	80	100	(120)
Resistance value (Ω)	(153.9)	51.9	27.4	(16.1)

The figures in parentheses are reference values



25.2 COMPONENT AND CONSTRUCTION

25.2.1 COMPONENTS



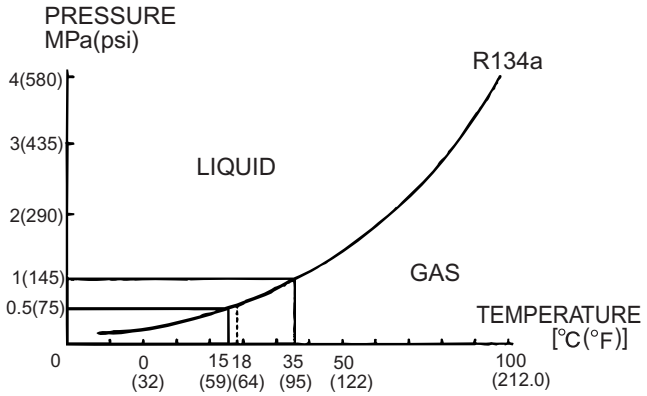
AIR CONDITIONER : PY20M00009F1 (02)

No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	AIR DRYER ASSY	1	1-6	HOSE ASSY	1	4	COMPRESSOR ASSY	1
1-1	HOSE ASSY	1	1-7	RECEIVER	1	5	CONTROL BOX	1
1-2	HOSE ASSY	1	1-8	BRACKET	1	6	FILTER	1
1-3	TUBE ASSY	1	1-9	TUBE ASSY	1	7	SWICH ASSY	1
1-4	TUBE ASSY	1	2	AIR CONDITIONER ASSY	1	8	RELAY ASSY	1
1-5	HOSE ASSY	1	3	CONDENSER	1	9	HARNESS	1

(2) Characteristics of Refrigerant (Right Fig.)

In general, the fluid (general term of gas and liquid) has the following qualities:

1. As a gas under a certain pressure is cooled down, it begins to condensate at a certain temperature to take a liquid state. The temperature at which condensation begins is unique to each substance (fluid) at a given pressure. The temperature determined by a given pressure is called saturation temperature.



Pressure-Temperature Characteristics Of R134a

2. Inversely to 1) above, the pressure at which a gas condenses for a temperature is determined. This pressure is called saturation pressure.
   The above Figure illustrates the relationships between the saturation temperature and the saturation pressure in the case of refrigerant R134a used in the air-conditioner. At the temperature and the pressure on the lower righthand side of the curve in the above Figure, the refrigerant takes a gaseous state, while at the temperature and the pressure on the upper lefthand side of the curve, the refrigerant takes a liquid state.
   Let us think of a case where an air-conditioner is operated in the midst of summer. As the refrigerant evaporates, it absorbs evaporation heat from the air of the compartment. In order to cool the inside of the compartment down to 25° C (77° F), the refrigerant must transform (evaporate) from a liquid to a gaseous state at a lower temperature. It can be seen from the above Figure that R134a under a pressure above the atmospheric pressure is capable of cooling the inside of the compartment sufficiently. (If a refrigerant that requires a pressure below the atmospheric pressure to cool it to a required temperature is used, air is mixed into the circuits, thereby deteriorating the performance of the cooling unit.) In the process in which gaseous refrigerant is brought back to a liquid state, the refrigerant is cooled and condensed by the outer air exceeding 35° C (95° F).
   Accordingly the refrigerant is capable of condensing at a pressure exceeding 1 MPa (145 psi), as seen from the above Figure.

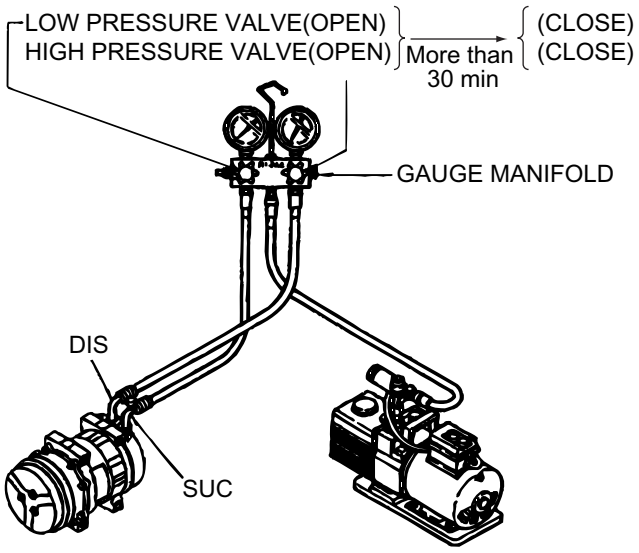
(2) Vacuum Making (See right Figure)

1. Open the high pressure valve (HI) and the low pressure valve (LO) of the gauge manifold.

2. Turn on the switch of the vacuum pump and make vacuum for more than 30 minutes.

3. When vacuum making for a specified duration is over (degree of vacuum : less than - 750 mmHg), close the high pressure valve and the low pressure valve of the gauge manifold.

4. Then turn off the vacuum pump.



Vacuum Making Operation

(3) Air-tightness Check

Close the high pressure valve and the low pressure valve of the gauge manifold, leave it as it is for more than five minutes and make sure that the gauge indication does not return toward 0.

⚠CAUTION

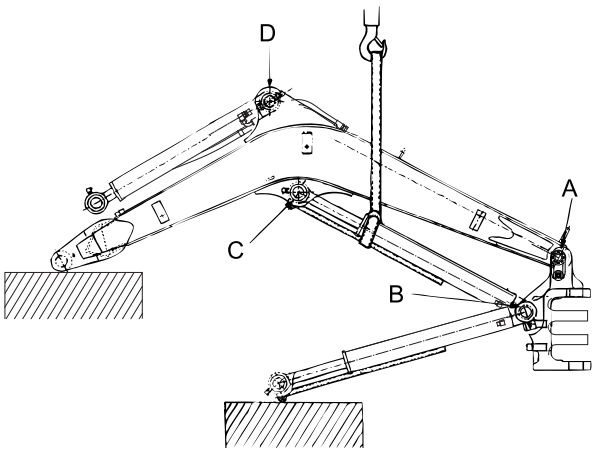
If the gauge indication goes toward 0, there is leaking somewhere. Retighten pipe joints, make vacuum again and make sure of no leakage.

Issue	Date of Issue	Applicable Machines	Remarks
First Edition	June, 2009	E10SR: PA03-05001~	S5PA3105E01 (NHK-EUR)
↑	March, 2010	CX27B: PV13-33292~	↑ (CASE-NA)
↑	↑	E27B: PV13-33292~	↑ (NH-NA)
↑	April, 2010	SK50SR-5: PJ06-09807~	↑ (KCM North America)
↑	↑	CX50B: PJ06-09807~	↑ (CASE-NA)
↑	↑	E50B: PJ06-09807~	↑ (NH-NA)
↑	↑	SK30SR-5: PW14-46519~ SK35SR-5: PX15-21105~	↑ (KCM S.E.ASIA&OCE)
↑	↑	CX31B: PW14-46519~ CX36B: PX15-21105~	↑ (CASE-AUS)
↑	↑	E30B: PW14-46519~ E35B: PX15-21105~	↑ (NH-AUS)
↑	↑	CX27B: PV13-33001~	↑ (CASE-Australia)
↑	↑	E27B: PV13-33001~	↑ (NH-AUS)
↑	May, 2010	SK40SR-5: PH07-06609~ SK50SR-5: PJ06-09807~	↑ (KCM S.E.ASIA&OCE)
↑	↑	E50B: PJ06-09807~	↑ (NH-AUS)
↑	↑	CX50B: PJ06-09807~	↑ (CASE-AUS)
↑	↑	SK27SR-5: PV13-33453~	↑ (NA)
↑	↑	CX27B: PV13-33453~	↑ (CASE-NA)
↑	↑	E27B: PV13-33453~	↑ (NH-NA)
↑	↑	SK20SR-5: PM10-10609~ SK27SR-5: PV13-33453~	↑ (KCM S.E.ASIA&OCE)
↑	↑	CX27B: PV13-33453~	↑ (CASE-Australia)
↑	↑	E27B: PV13-33453~	↑ (NH-AUS)
↑	September, 2010	SK55SRX: PS02-00101~	↑ (KCM North America)
↑	↑	CX55B: PS02-00101~	↑ (CASE-NA)
↑	↑	E55B: PS02-00101~	↑ (NH-NA)

32.1.4 BOOM

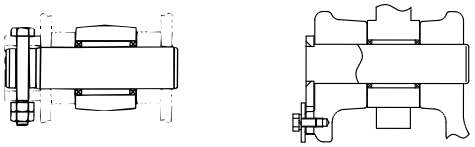
32.1.4.1 REMOVAL OF BOOM

(1) Let down the boom from which the arm was removed, and support the boom end with a stable stand.
(2) Disconnect all hoses from the bucket cylinder, arm cylinder and boom cylinder, and apply plugs to all the openings.
Tools: Spanner: 27 mm
(3) Disconnect the wiring for the working light at the connector.



Removal of Boom Cylinder

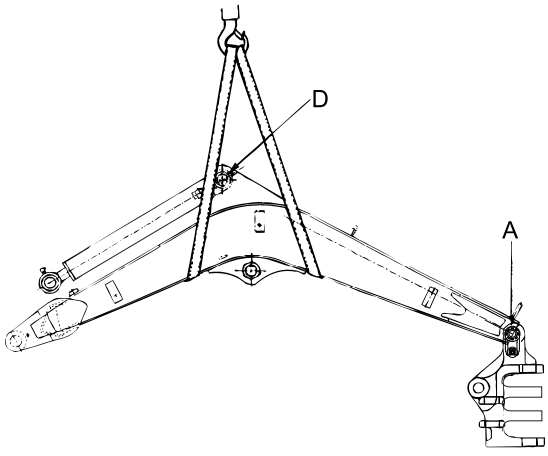
(4) Removal of Boom Cylinder
1. Temporarily lift up the boom cylinder with a nylon sling to prevent the boom cylinder from falling down.
2. Remove the capscrew and nuts that are preventing the rod pin (C) from coming off, remove the pin (C).
Tools: Spanner: 19mm
3. Retract the rod, then put the cylinder on a stable stand.
4. Remove the capscrew that is preventing the head pin (B) from coming off, remove the pin (B).
5. Remove the boom cylinder.
Weight:
64 kg (141 lbs) - SK55SRX



PIN (C) PORTION PIN (B) PORTION

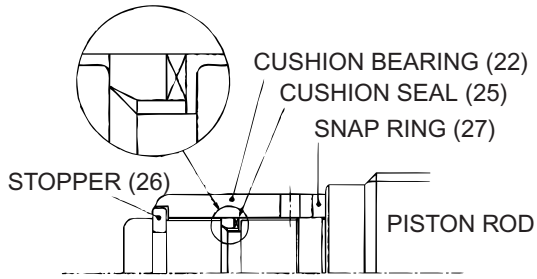
Sectional View of Installing Pin

(5) Removal of Boom assembly
1. Temporarily lift up the boom assembly in order not to exert any load on the boom foot pin (A).
Weight of boom assembly: approx.
240 kg (529 lbs) - SK55SRX
2. Removing the capscrew that is preventing the boom foot pin (A) from coming off, pull off the pin (A).
Tools: Spanner: 19 mm
3. Applying a sling to the boom assembly, remove the boom assembly.



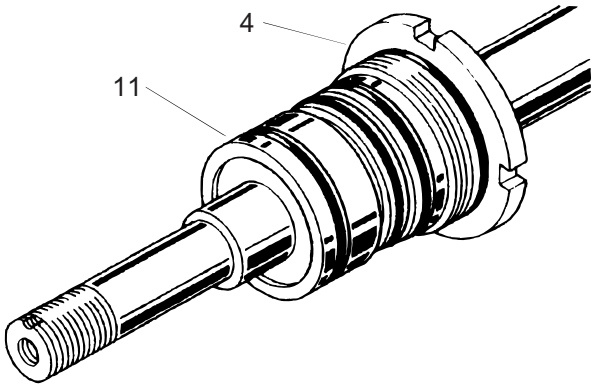
Removal of Boom assembly

3. Disassembling of cushion bearing on retraction side (head side). (Only for arm cylinder.)



Direct "Slit" toward piston side

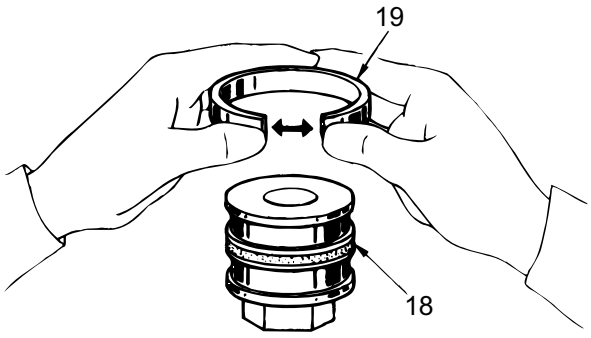
4. Remove cylinder head (4) and holder (11).
(Only boom and arm cylinders have a holder.)



Removing Cylinder Head and Holder

(3) Disassembly of piston assembly :

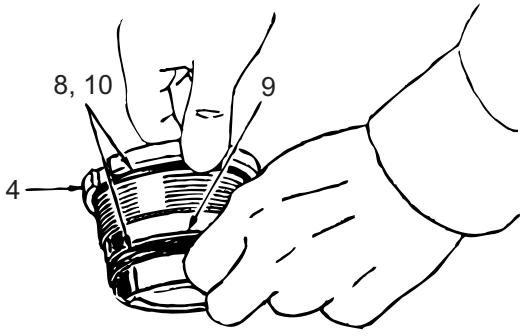
1. Remove the slide ring (19) from the piston (17).
-Expand the split on the slide ring (19) as minimum as required to pull it off for axial direction. (2 Points)
2. Remove the seal ring assembly (18).
-Cut off the seal ring (18) or remove it using a screw driver.



Disassembling Piston Assembly

(4) Disassembly of cylinder head assembly :

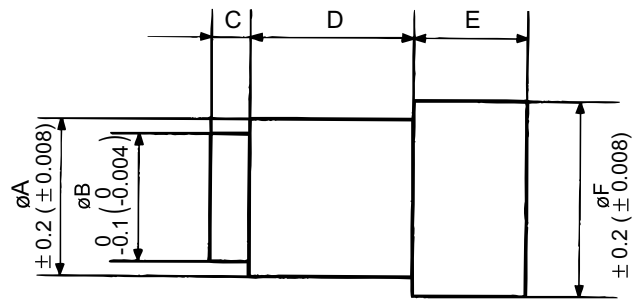
1. Remove the O-rings (8) and (10) and back-up ring (9) from the outer periphery of cylinder head (4).



Disassembling Cylinder Head Assembly

32.2.1.7 JIG LIST

(1) Installing Jig (A) for Press Fitting of Head Bushing.

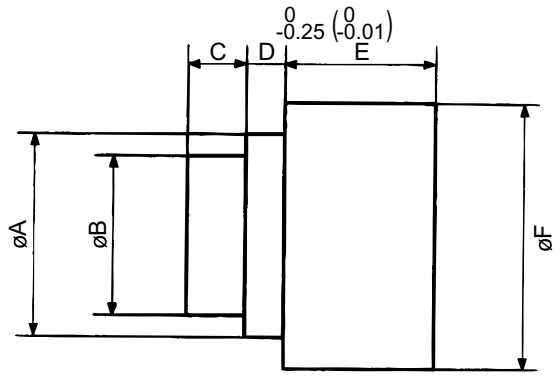


Material : SS410 or mild steel

Unit : mm (in)

Applicable Cylinder SK55SRX		Dimension
(Rod dia ;ø 45(1.77)) Bucket	A	49.0 (1.93)
	B	44.5 (1.75)
	C	25.0 (0.98)
	D	40.0 (1.57)
	E	30.0 (1.18)
	F	50.0 (1.97)
(Rod dia ;ø 50 (1.97)) Swing	A	53.0 (2.09)
	B	49.5 (1.95)
	C	25.0 (0.98)
	D	50.0 (1.97)
	E	30.0 (1.18)
	F	60.0 (2.36)
(Rod dia ;ø 55 (2.17)) Boom Arm Dozer	A	59.0 (2.32)
	B	54.5 (2.15)
	C	25.0 (0.98)
	D	50.0 (1.97)
	E	30.0 (1.18)
	F	65.0 (2.56)

(2) Installing Jig (B) for Press Fitting of Pin Bushing.



Material : SS410 or mild steel

Unit : mm (in)

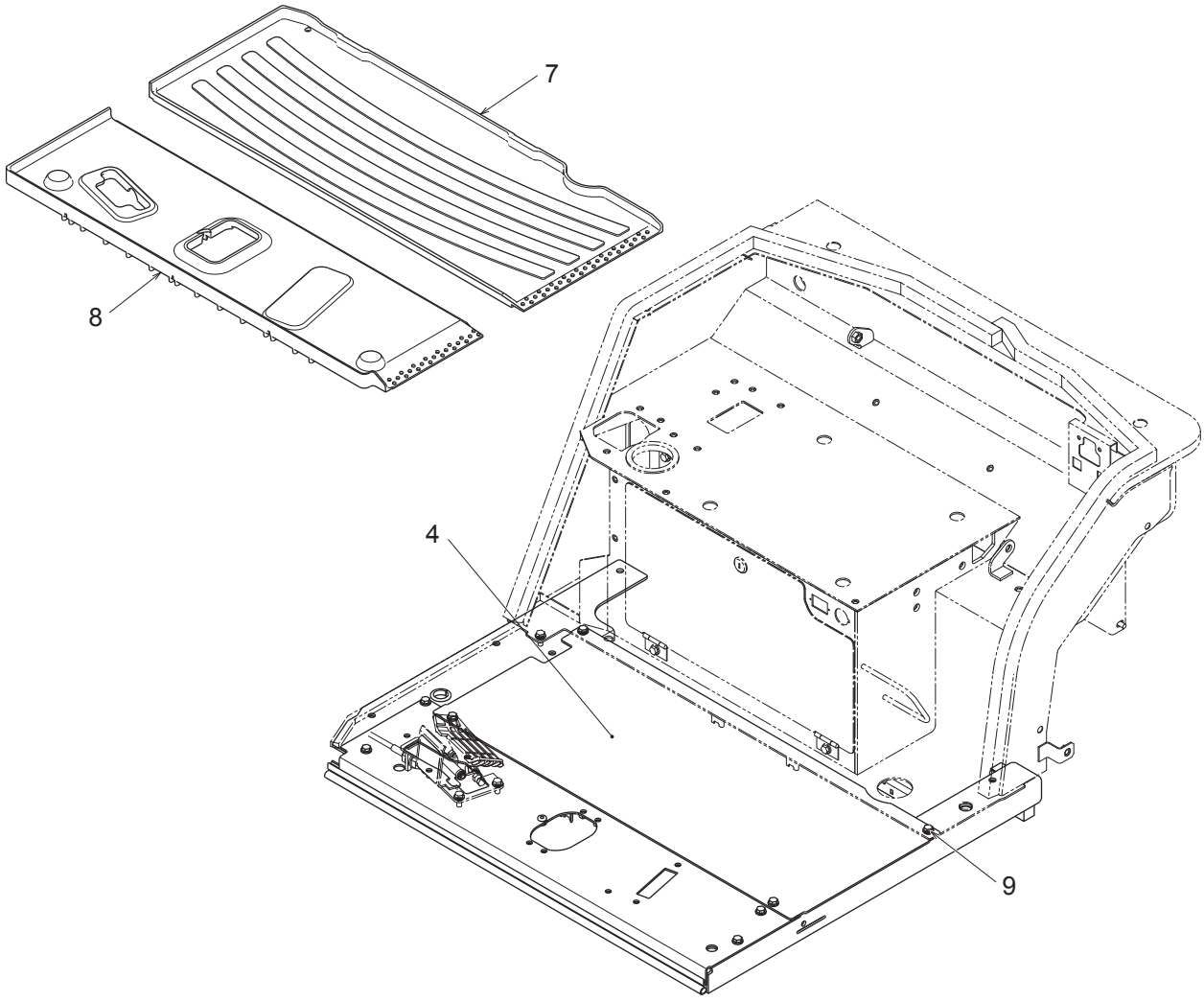
Applicable Cylinder SK55SRX		Dimension
(Pin dia ; ø45 (1.77)) Arm Bucket	A	54.0 (2.13)
	B	44.5 (1.75)
	C	10.0 (0.39)
	D	5.0 (0.20)
	E	30.0 (1.18)
	F	65.0 (2.56)
(Pin dia ; ø50 (1.97)) Boom Swing	A	59.0 (2.32)
	B	49.5 (1.95)
	C	10.0 (0.39)
	D	5.0 (0.20)
	E	30.0 (0.18)
	F	70.0 (2.76)
(Pin dia ; ø55 (2.17)) Dozer	A	64.0 (2.52)
	B	54.5 (2.15)
	C	10.0 (2.39)
	D	5.0 (0.20)
	E	30.0 (1.18)
	F	75.0 (2.95)

33.1.3 FLOOR PLATE ASSEMBLY

Remove floor plate together with the travel pilot valve assembly and the swing pedal as a unit.

33.1.3.1 FLOOR PLATE REMOVAL PREPARATION

(1) Remove the floor mats (7) and (8). (See Section 33.1.1.)
(2) Remove the cab. (See Section 33.1.1.)
(3) Loosen four M8 X 20 sems-bolts (9) to remove the floor plate (4).
Tools: Socket 13mm
(4) Disconnect electrical wiring for travel 2-speed selector switch from the connector portion.
If this machine was equipped with the travel alarm, disconnect the connectors on the electric wiring on the four pressure switches on the travel pilot valve.



Floor Plate Removal

CAUTION

Disconnect the terminal on the battery to prevent danger of a short circuit before performing these procedures.

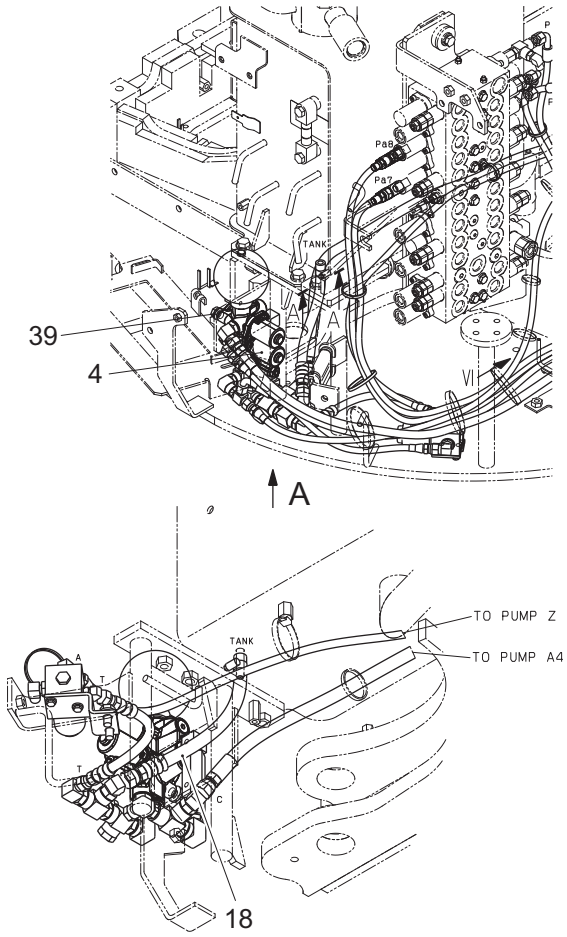
33.1.8 SOLENOID VALVE

33.1.8.1 REMOVAL PREPARATION

(1) Unlock and open the side cover assembly (2). See Section 33.1.2.1-(3).
(2) Remove the cover assembly (6). See Section 33.1.2.1-(4).

33.1.8.2 REMOVAL

(1) Disconnecting hoses
Disconnect all the hoses connected to the solenoid valve (4). Then attach plugs and caps and a tag to record the connecting port to each of their openings.
-Item (18) is a drain hose for the hydraulic oil tank. When disconnecting this hose oil will leak.
(2) Disconnecting connector
Disconnect two connectors connected to the main harness.
(3) Removing solenoid valve
Loosen two M10 X 20 sems-bolts (39) to remove the solenoid valve (4).
Tools: Spanner 17mm



VIEW A (from the back side)

Solenoid Valve Removal

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)
39	Sems-bolt (M10)	17	51 (37.6)

		Tightening torque N•m (lbf•ft)	
Thread size (PF)	Spanner used (mm)	O-ring type fitting	30º flare type fitting
1/4	19	26.5 (19.5)	29.4 (22)
3/8	22	48.5 (35.8)	49 (36)
1/2	27	70.5 (52.0)	—

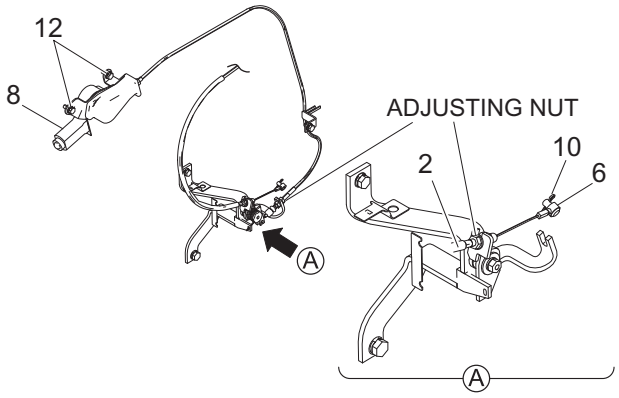
33.1.15 CONTROL STAND

33.1.15.1 DISASSEMBLY PREPARATION

(1) Remove the cab. See Section 33.1.1.
(2) Remove the floor covers (4). See Section 33.1.3.1.
(3) Remove the covers (2), (3), (4), (5), and (6), and the bonnet (1). See Section 33.1.2.
(4) Remove the counterweight. See Section 33.1.5.
(5) Remove the negative terminal of the battery.

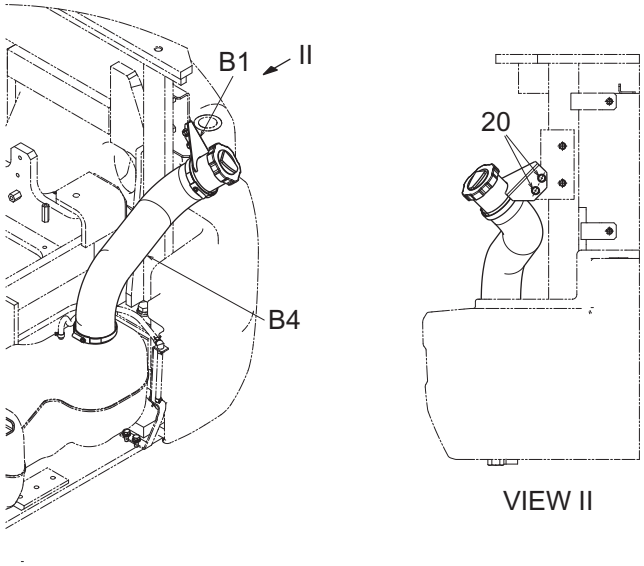
33.1.15.2 DISASSEMBLY

(1) Remove the air cleaner. See Section 33.1.12.
(2) Removing throttle cable (2)
1. Pull out the pin (10) and remove pin (6).
2. Loosen the adjusting nut (M8) to remove the cable.
(3) Removing deceleration motor
1. Disconnect the connector.
2. Loosen the adjusting nut (M8) to remove the cable.
3. Loosen three M8X20 sems-bolts (12) to remove the deceleration motor (8).
Tools: Socket 13mm



Control Cable Removal

(4) Removing filler neck (fuel supply port)
1. Pull out the hose (B4) connected to the fuel tank.
2. Loosen two M8 X 20 capscrews (20) to remove the filler neck (B1).
Tools: Socket 13mm



Filler Neck Removal

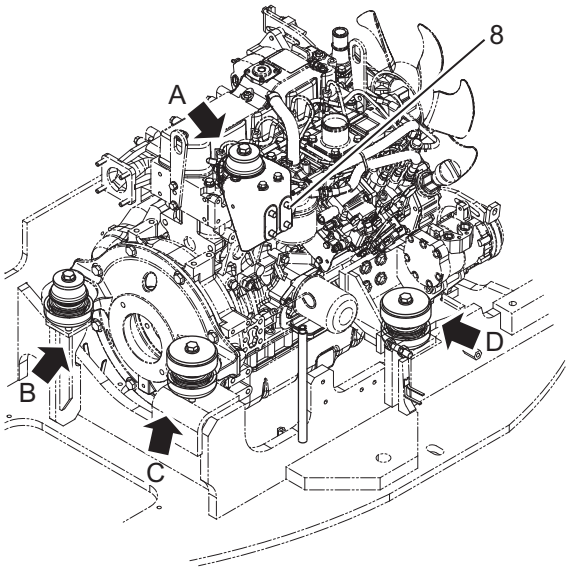
33.1.18.3 INSTALLATION

(1) Install the engine in reverse order of the removal.
See the following table for the tightening torque and the sealant.

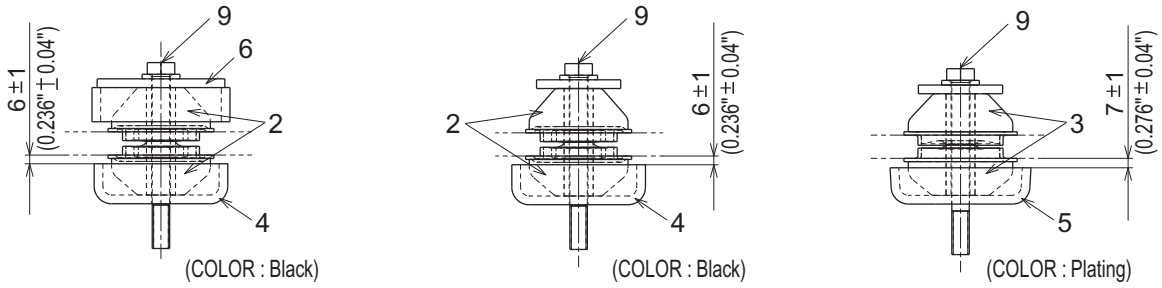
Tightening torque for related parts

Item	Name	Tool (mm)	Torque N-m (lb-ft)
8 and 11	Sems-bolt (M10)	19	46.1 (34) Apply Loctite #262
9	Capscrew (M12)	22	79.4 (59) Apply Loctite #262

- Use the rubber mount (2) with the identification color of "blue" (three places).
- Use the rubber mount (3) with the identification color of "black" (one place, part A).
- Use the rubber mount (4) with the identification color of "black" (three places).
- Use the rubber mount (5) with the identification color of "Plating" (one place, part A).



Engine Removal/Installation



WITH STOPPER UP AND DOWN (2 PLACES)
BLACK MOUNT RUBBER

Part C & D

WITH LOWER STOPPER,
BLUE MOUNT RUBBER

Part B

WITH LOWER STOPPER,
BLACK MOUNT RUBBER

Part A

Rubber Mount Setting

33.2.1.2 DISASSEMBLY AND ASSEMBLY

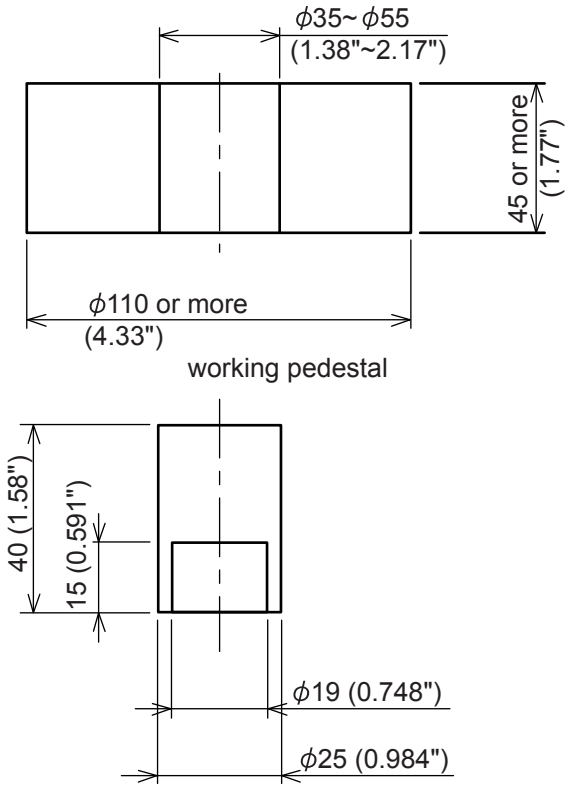
33.2.1.2.1 Tools and Jig

(1) Tools

Name	Q'ty	Size(Nominal)	Name	Q'ty	Size(Nominal)
Allen wrench	One each	4, 5, 6, 8 and 10	Torque wrench	1	Possible to tighten to the specified torque
Plastic hammer	1	Medium type	Socket wrench	1	10 Possible to tighten to the specified torque
Snap ring plier	1	For hole (for snap ring 72)	Grease	Small amount	
Snap ring plier	1	For shaft (for snap ring 28, 30)	Adhesive agent	Small amount	Loctite high tack sealant #98

(2) Jig

1. Work bench
   Plate which is used to place the pump facing downward.
   If the shaft end does not contact with work bench, the wood blocks are available instead of it.
2. Bearing assembling jig



33.2.1.2.2 Cautions during Assembling and Dissembling

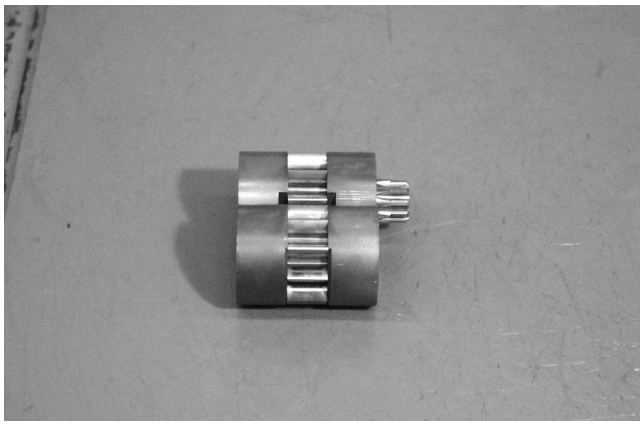
(1) Cautions for disassembling

1. Never attempt adjusting the adjusting screw unless absolutely necessary.
2. Take utmost care during disassembly not to knock or drop each part.

(2) Cautions for assembling

1. Wash each part thoroughly.
2. During assembling, take utmost care not to damage the part or allow foreign materials to enter.
3. As a rule, the O-ring and oil seal should not be reused.
4. In our assembly work, the torque wrench is used to control the torque. Be sure to use the torque wrench.

5. Remove the drive gear, idle gear, and side plate.

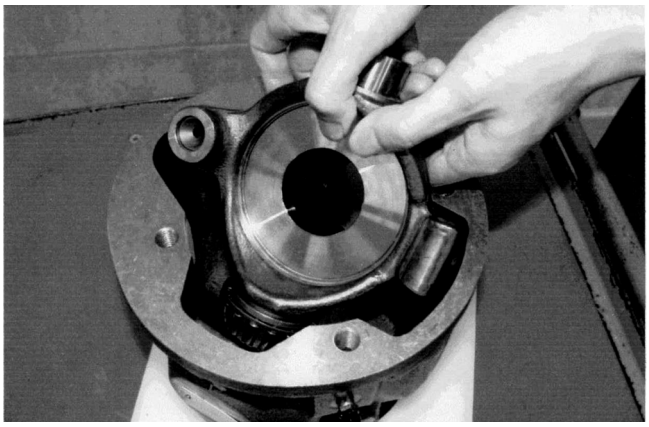


33.2.1.2.4 Assembly

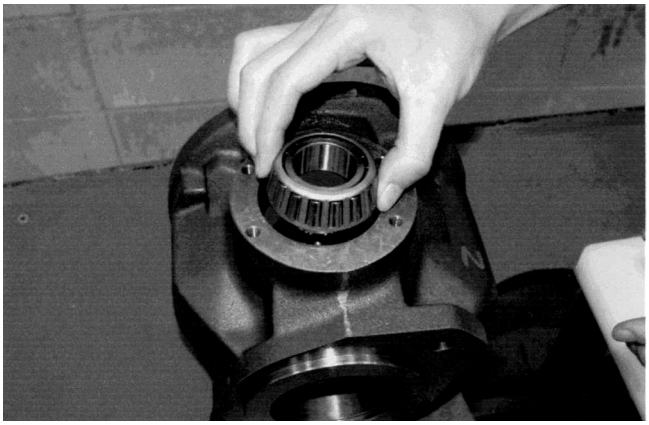
Assemble the main pump in reverse order of the disassembly.

(1) Assembly of main pump

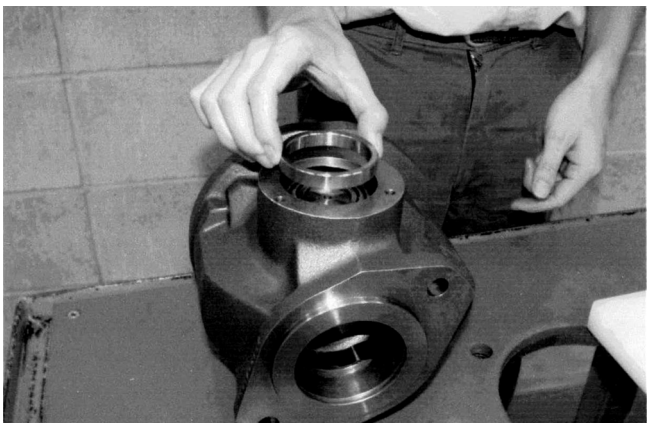
1. Installing hanger assy.
   Install hanger in housing.



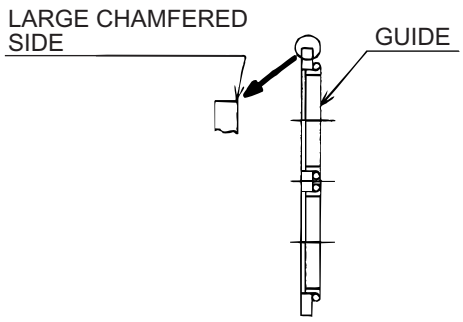
2. Install bearing.



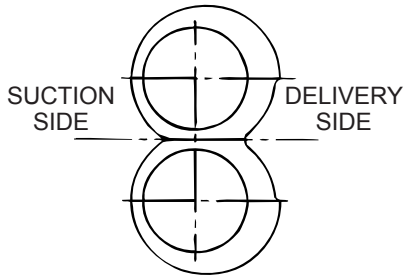
3. Install distance piece and check the preload on bearing is 0.1 ± 0.02mm (0.004 ± 0.0008") confirming the distance by means of a micrometer and depth micrometer.

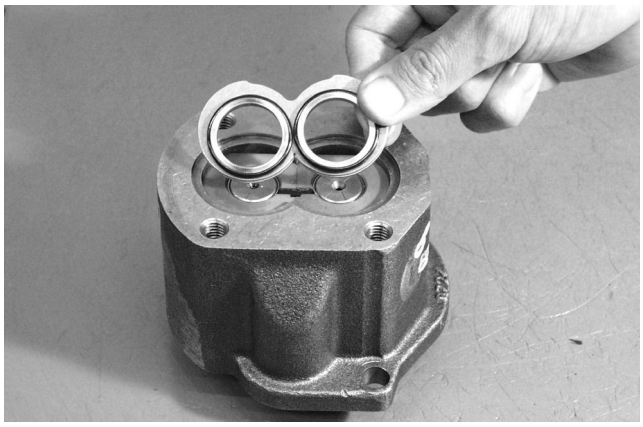


4. Insert O-ring into the guide, and install it to the plate.

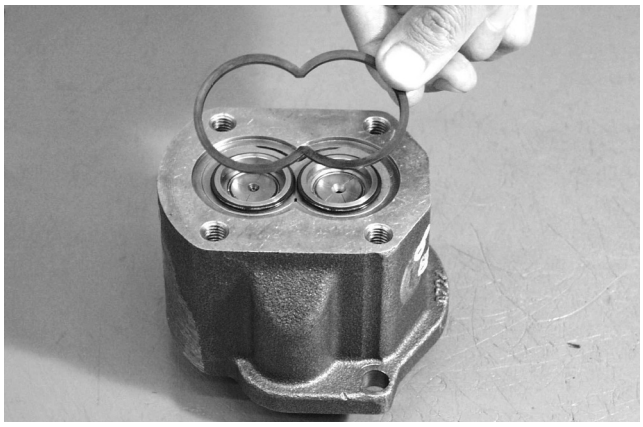


5. Install the plate, guide and O-ring into the housing.
   Then pay attention to the suction and delivery direction.





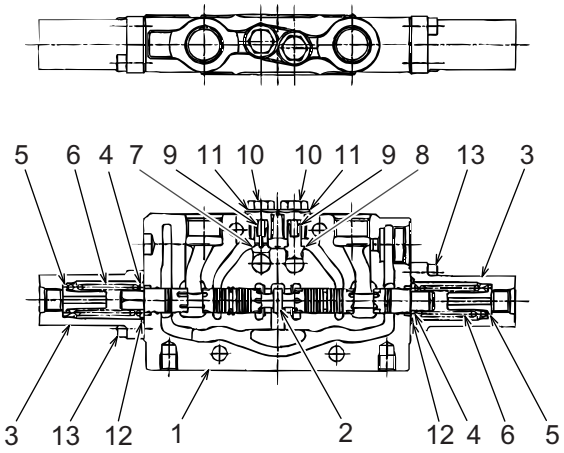
6. Fit the square ring.



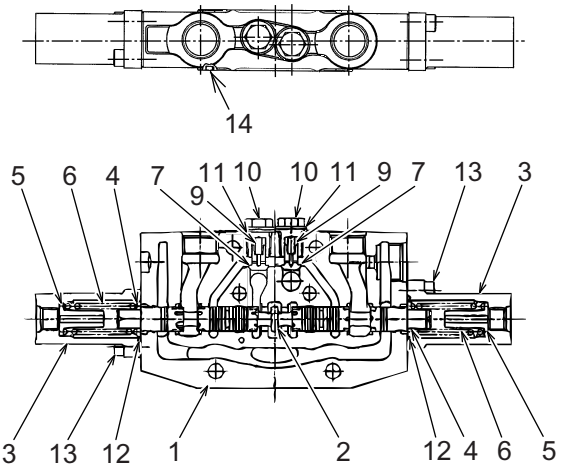
7. Install the cover to the housing.

(2) Disassembling Bucket, Travel Left, Travel Right, Service, Swing and Dozer Section

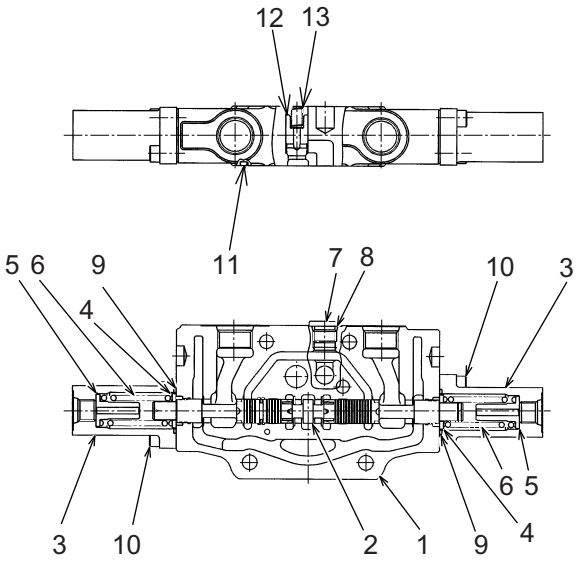
1. Loosen socket bolt (13) (opposing flats 5 mm), and remove cap (3). Remove spring seat (4), spring (6), spring seat (5), and O-ring (12). Then remove spool (2) from valve housing (1).
2. Remove caps (3) on other side by the same procedure. And the item number of socket bolts for travel right and left is (10) and O-ringw are (9).



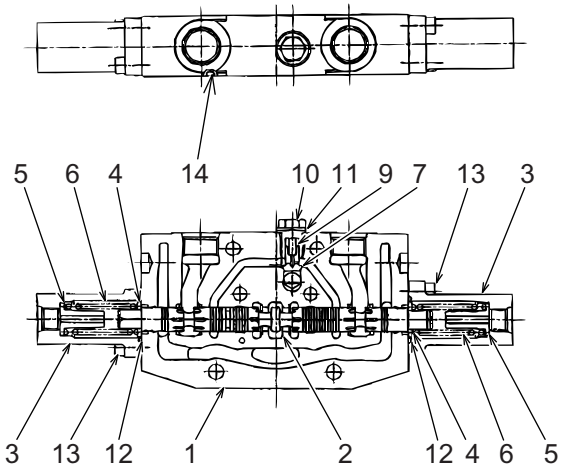
Bucket Section



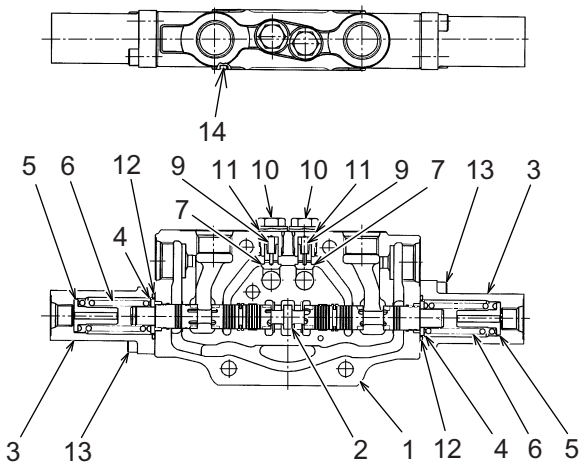
Service Section



Travel Right / Left section



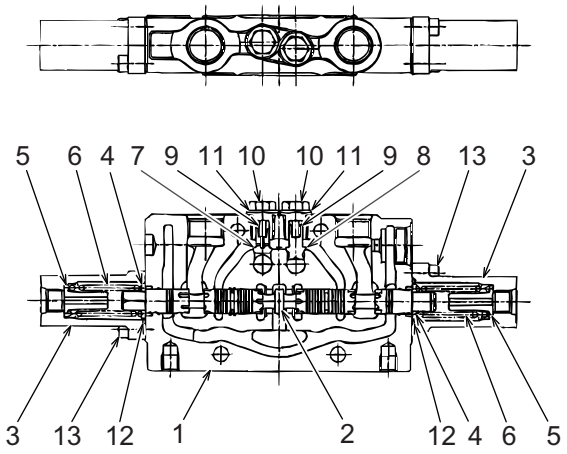
Slewing / Dozer Section



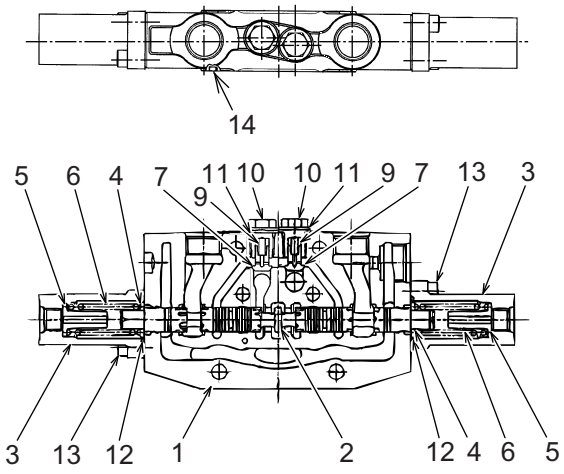
Arm Section

(2) Assembling Bucket, Travel Left, Travel Right, Service, Arm, Swing, and Dozer Section

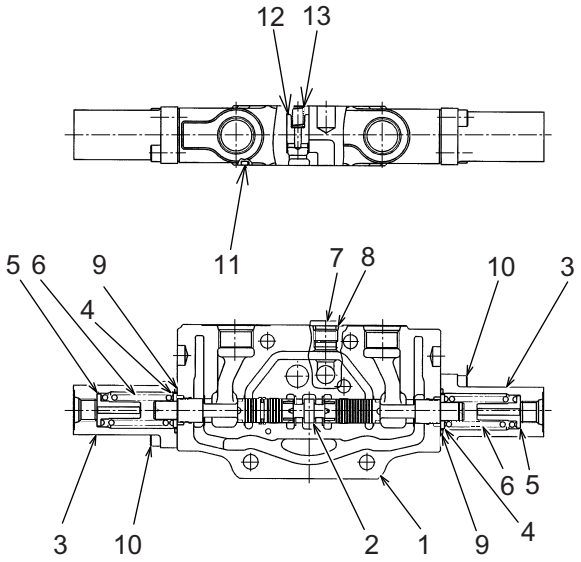
1. Put spring (6) between spring seats (4) and (5), and place spool in valve housing (1) to the position as it was and in the same direction before disassembling, and attach cap (3) with O-ring (12) fitted by using socket bolt (13) (opposing flats 5 mm).
2. Attach cap on other side by the same procedure. Then, the socket bolt for travel is (10) and O-ring is (9). Tightening torque: 8.8 to 10.8 N-m (6.5 to 8 lb-ft)



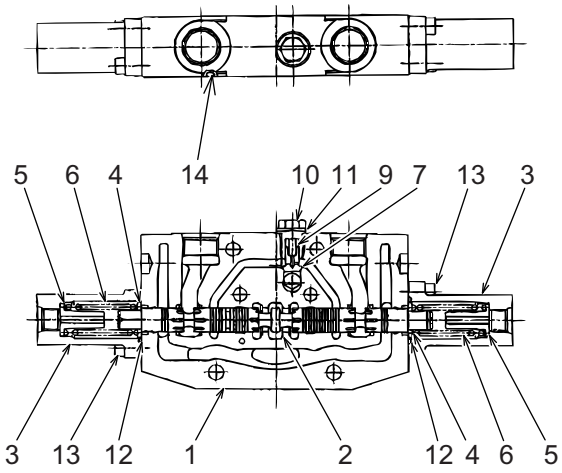
Bucket Section



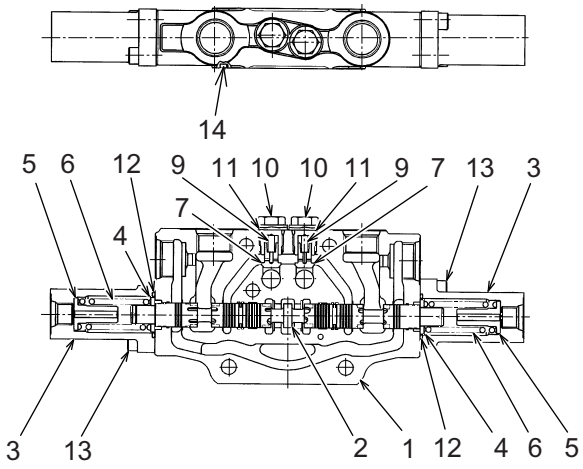
Service Section



Travel Right/Left Section



Slewing/Dozer Section

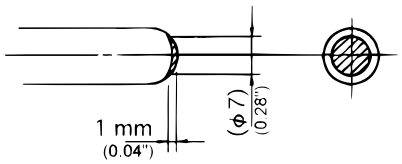


Arm Section

Tightening torque: 30 N-m (22 lb-ft)

d. Increase the pressure again and check that the pressure is maintained to the specified value.

33.2.3.5 Maintenance Standard

Maintenance item	Standard	Remarks
Amount of leakage	Replace with a complete set of pilot valve when the amount of leakage reaches more than 1000 cc/min (61 cu•in/min) or 2000 cc/min (122 cu•in/min) at the neutral position of the handle or during operation, respectively.	Condition : Primary pressure : 2.94MPa (427 psi) Oil viscosity : 23 mm^2/s
Spool	Replace with a complete set of pilot valve when an amount of wear at the sliding section is more than 10 μm (0.0004") in comparison with the non-sliding section.	The wear condition to the left is considered to correspond to the above amount of leakage.
Push rod	Replace when a wear amount of the tip is more than 1 mm (0.04"). 	
Unnecessary play in operation section	Replace when a play more than 2 mm(0.079") due to wear and so on is found on the disk (302) or joint section (301) of the operation section.	A play generated by loosening of tightening portion should be adjusted.
Action stability	Replace with a complete set of pilot valve when abnormal noise, hunting or primary pressure drop is generated during operation and the trouble cannot be remedied according to Section 33.2.3.6 TROUBLESHOOTING.	

Note

Replace seals such as O-rings with new ones after every disassembly.

(3) Disassembling Hydraulic Motor

1. Loosen the socket bolts (124), and take out the hydraulic motor assembly from the reduction gear body.

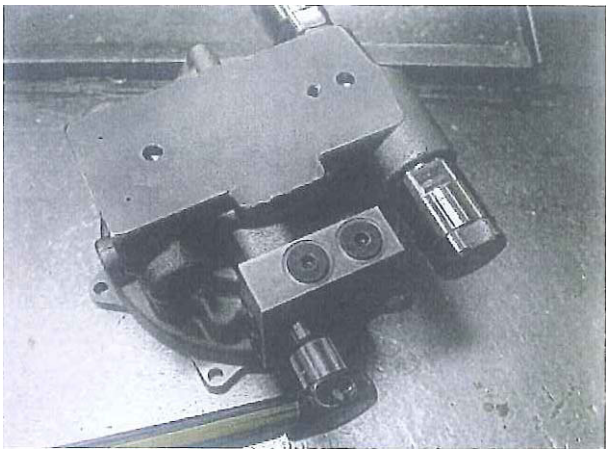
   Tools: Hexagon bar wrench: 6mm

Note

When taking out the hydraulic motor assembly from the reduction gear body, the drain port should be open.
When it is difficult to take out, insert the driver into the binding face to the body and take out the burr completely.

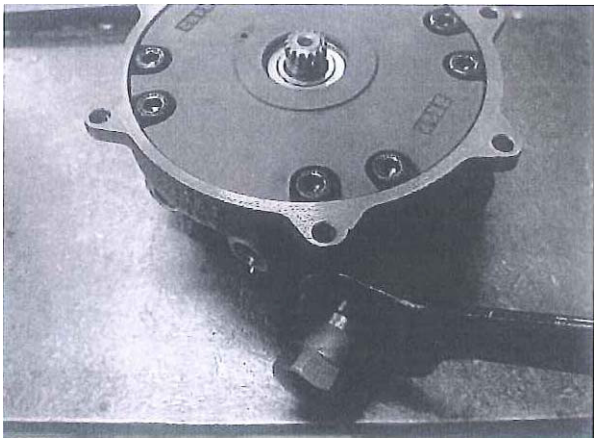
2. Loose the socket bolts (242), and take out the timer valve from the hydraulic motor assembly.

   Tools: Hexagon bar wrench: 5mm



3. Take out the relief valve assembly.

   Tools: Spanner: 36mm

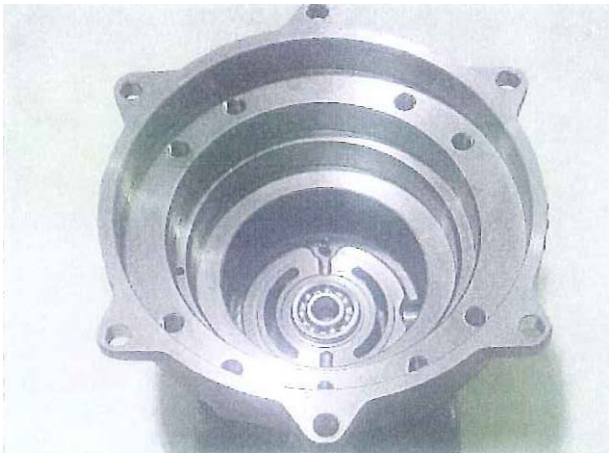


Note

Do not disassemble the relief valve assembly, unless it is necessary.

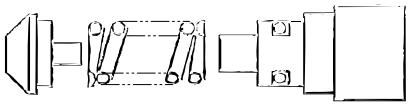
(5) Assembly of Hydraulic Motor

1. Press-fit the ball bearing (217) and spring pin (224) into the body H (201).



2. Insert the 2 check valves (246) (1pc/side), 2 springs (248) (1pc/side) and 2 plugs (247) (1pc/side) with O-ring (249) in that order into the body H (201).

   Tools: Hexagon bar wrench: 8mm
   Torque wrench



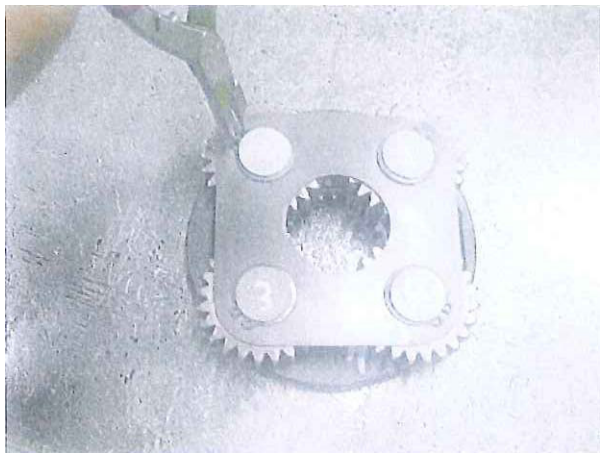
Note

Apply grease to the O-ring and assemble carefully.
Plug tightening torque: 58.8 ± 2.9 N-m (43.4 ± 2.14 lb-ft).

5. Place the 4 B1 gears (106) (1pc/pin) and the 92 needles 1 (111) (23pcs/pin) in that order onto the 4 pins of the carrier 1 (102).

6. Place the thrust plate 1 (115) and the 4 snap rings (120) (1pc/pin) to make up a carrier 1 kit.

   Tools: Snap ring plier: 22 dia. For shaft

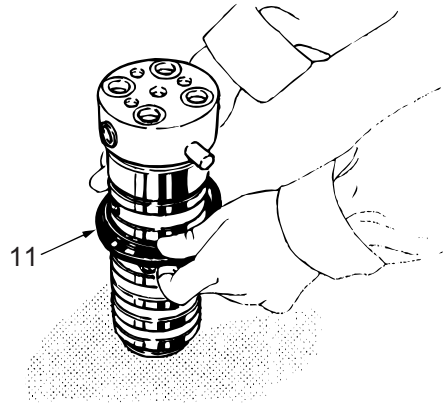


Note

Pay attention to the direction of the snap ring.
The edge side should be up.
Pay attention not to open the snap ring too much.
A snap ring which was opened too much will lose tension and will need to be replaced.

7. Place the 3 thrust washers 2 (118) (1pc/pin) and the 3 rings 2 (130) (1pc/pin) in that order onto the 3 pins of the carrier 2 (103).

(4) Remove dust seal (11) from the stem (1).

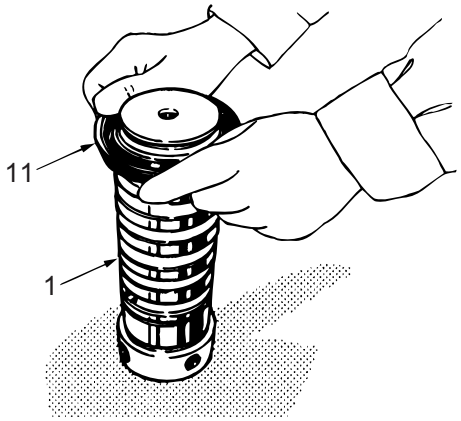


(5) Remove seal, etc. from the inside of the body.
Be sure of the position of the seal, etc., referring to the construction drawing.
Take out O-ring with a pointed tool like a gimlet.

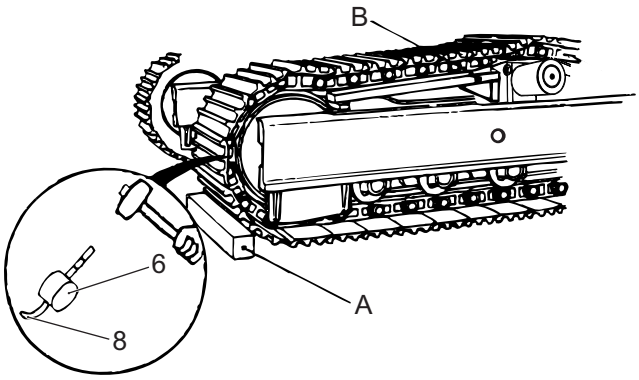
33.2.6.2.3 Assembling

(1) Insert seals in the body.
Check the seal position referring to the construction drawing.
Ensure that O-rings are free from twisting.
Do not deform or bend the slipper seal.

(2) Install dust seal (11) to stem (1).
Apply enough grease to the lip section of the dust seal.

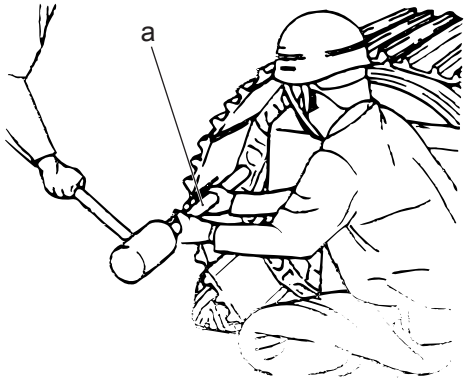


4. Straighten the curve of the lock pin, and draw out it striking it with a hammer.
   -Remove lock pin (8) with shoe plate.



Removing Lock Pin

5. Apply master pin drawing out jig (a) to the small diameter section of master pin (6), and draw it out striking it with a hammer.



Removing Master Pin

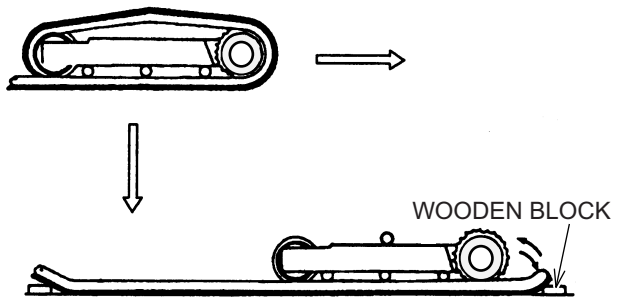
WARNING

-Especially pay attention to the front idler which may spring out due to the force of the spring when drawing out master pin (6) to repair broken parts relating to the front idler.
-Be careful not to be injured by flying debris, when a large hammer is used.

WARNING

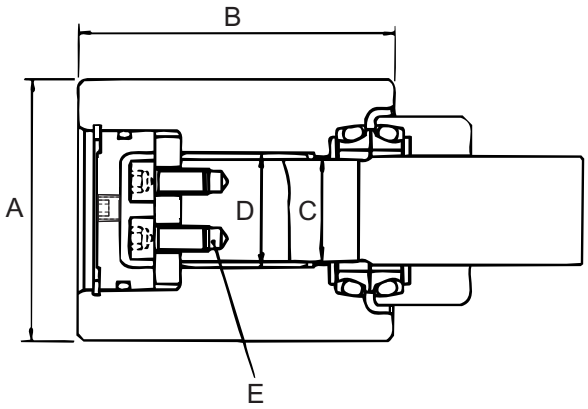
Do not approach the machine because the end of the crawler may drop just before extending the track link assembly to the ground while rotating the sprocket. Place a wood block just in case.

6. Move the machine back slowly, and remove the crawler extending it to the ground.
   Weight of steel crawler (One side):
   SK55SRX: 270 kg (595 lbs)



Removing Crawler

34.1.4 MAINTENANCE STANDARDS



Sectional View Of Upper Roller

Unit : mm (in)

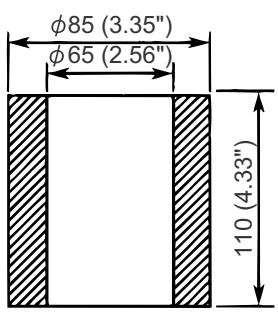
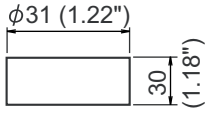
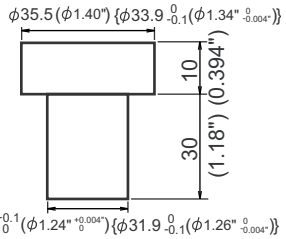
CODE	ITEM	STANDARD VALUE			REPAIRABLE LEVEL	SERVICE LIMIT	REMEDY
A	Tread dia.	ø82 (3.23)			ø73 (2.87)	ø70 (2.76)	Replace
B	Tread width	102 (4.01)			95 (3.74)	92 (3.62)	
C	Clearance between shaft and bushing	Basic dimension	Tolerance		Fit	Fit	Replace bushing
		ø32 (1.26)	Shaft	-0.025 (-0.001) -0.050 (-0.002)	Clearance 0.7 (0.03)	Clearance 1.0 (0.04)	
D	Interference between roller and bushing	ø36 (1.42)	Hole	+0.03 (+0.0012) 0	Interference 0 (0)	Clearance 0.01 (0.0004)	
E	Tightening torque of socket bolt	3.33 N•m (24.5 lbf•ft)					Apply Loctite #262
	Oil	Engine oil API CD class #30, 20cc (1.2 cu•in)					Replenish
	Roller rotation	Roller rotates smoothly by hand					Reassembly

34.1.5 TOOLS AND JIGS

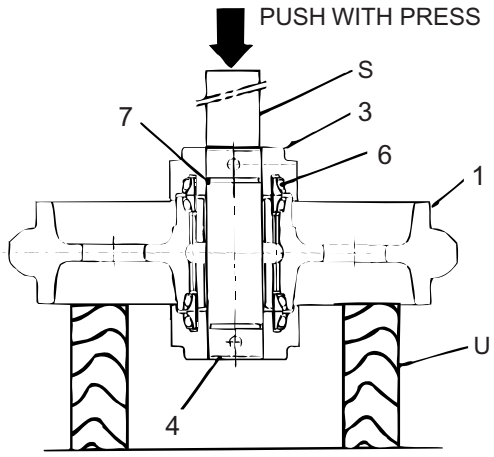
34.1.5.1 Tightening Tools

Tools	Opposing flats
Socket	17 mm
Allen wrench	5 mm, 6 mm

34.1.5.2 Jig

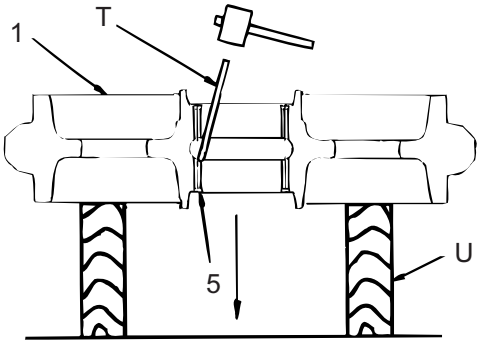
Symbol	Jig	Sketch	Symbol	Jig	Sketch
f	Stand jig		g	Fixing jig	
			h {j}	Fixing jig {Extruding jig}	

(3) Put idler (1) on repair stand (U), apply pushout jig (S) on shaft (4), push out shaft (4) with collar (3), then remove collar (3).



Extruding Shaft

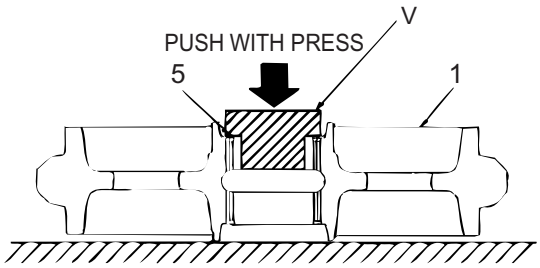
(4) With idler (1) placed on the stand (U), tap bushing (5) lightly with a hammer, while placing the bushing extruding rod (T) against the end face of bushing (5) evenly all round, till it comes out.
(5) Take out floating seals (6) from idler (1) and collar (3). If you intend to reuse floating seals (6), confirm that there is no scoring and rusting on the contact surface and store the floating seals in pairs by placing thick paper between the sealing faces.
(6) Remove O-ring (7) from shaft (4).



Removing Bushing (5)

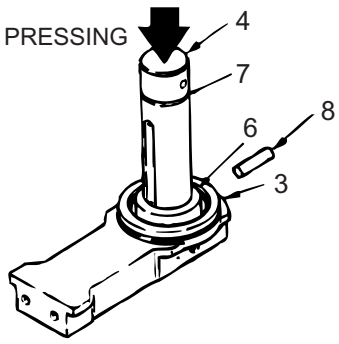
34.1.7.3.2 Assembly

(1) Align inner hole of idler (1) and bushing (5) and press fit it vertically with press.



Pressing in Bushing (5)

(2) Fit O-ring (7) to O-ring groove on shaft (4).
-Apply grease to O-ring
(3) Installing collar (3) (See 32.2.1.3)
Press fit the O-ring installed side of shaft into collar (3), and drive spring pin (8).
(4) Fit one piece of two (2) piece type floating seal (6) on each side of collar (3) and idler (1).

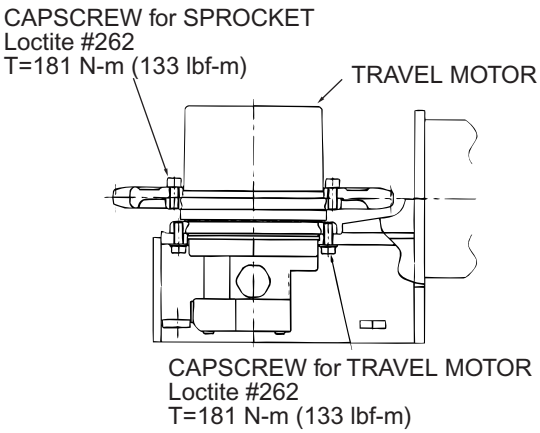


Pressing in Shaft (4)

34.1.10.1.2 Installing

(1) If there are burrs and dirt on fitting parts with which the travel motor are fastened, eliminate it beforehand. Place a wire sling in the travel unit the same way as in the removing, and install it to the lower frame.

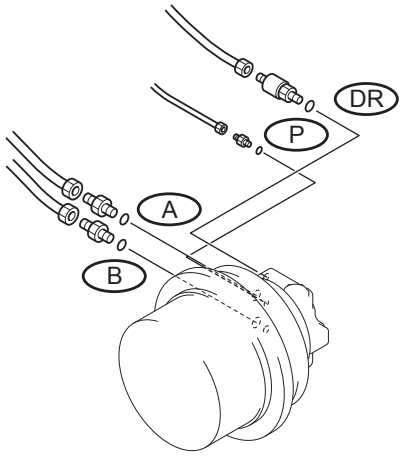
(2) Coat the threaded part of the mounting capscrews (B2) with Loctite #262 and tighten them.
Tools: Socket: 22 mm,
T=181 N-m (133 lb-ft)



Installing Travel Motor

(3) Reconnect the hydraulic pipings as before, and tighten the joints to the specified torque.
-Fill the casing with hydraulic oil prior to installing drain piping.

			Tightening torque N•m (lbf•ft)	
Port	Thread size (PF)	Spanner used (mm)	O-ring type fitting	30° flare type fitting
A,B	1/2	27	108 (80)	78.5 (58)
P	1/8	17	16.7 (12.3)	29.4 (22)
DR	1/4	19	36.3 (27)	49.0 (36)

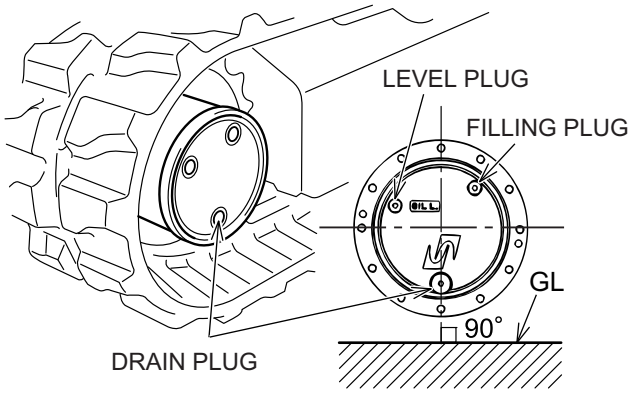


Installing Hydraulic Pipings (LH-travel motor)

(4) Install the covers (A1) located inside the lower frame, and tighten capscrews (A4).
(See Fig. Removing Cover and Travel Motor)
Tools: Spanner: 17 mm
T: 65.7 N-m (48.7 lb-ft)

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

(6) Check the oil level in the reduction unit of the travel motor [See Item (7) below] and replace or replenish oil as required.
Oil: GEAR OIL SAE #90 GL4
Volume of oil: 900 cc (55 cu-in)
Tools: Allen wrench: 8mm



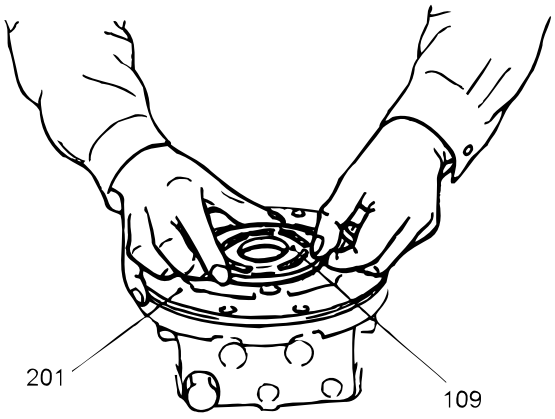
Checking Oil Level

(3) Tools

APPLICATION ITEM (Item in cross-sectional or exploded view)	NAME	SIZE	REMARKS	Q'TY
Disassembly and assembly	General workbench			1 set
Parts cleaning	Cleaning bath	For rough and finish cleaning		1 set
104 and 149	Workbench for press	Pressing capacity : 1.96 kN [440 lbs] or over		1 set
149	Heating bath	Heating capacity : 100C degrees or over (212F degrees) Volume 500 X 500 X 500 mm (20" X 20" X 20")		1 set
Drying after cleaning	Compressed air	Pressure (294~490 kPa) (43~71 psi)		

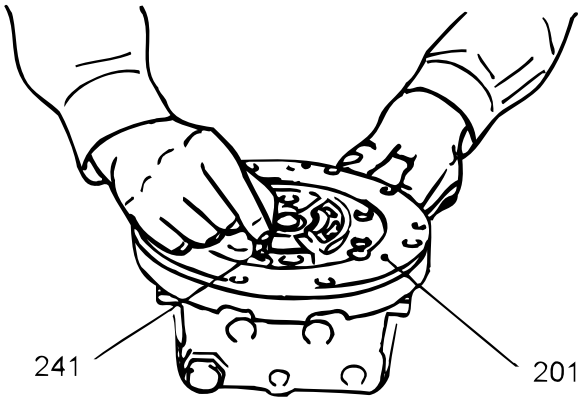
(9) Removing rear flange fittings

1. Place the rear flange (201) on the workbench, with the mating surface for the spindle (2) facing up.
2. Remove the timing plate (109) from the rear flange (201).
   -It may be hard to remove the rear flange as the mating surface of it is stuck with oil.
   Insert a spatula into the draft groove of the mating surface on the rear flange side and hold the timing plate up. Then the rear flange comes off.
   If a sharp tool like a screwdriver is put into the mating surface, the mating surface may be damaged and cause an oil leakage. Do not use sharp tools.



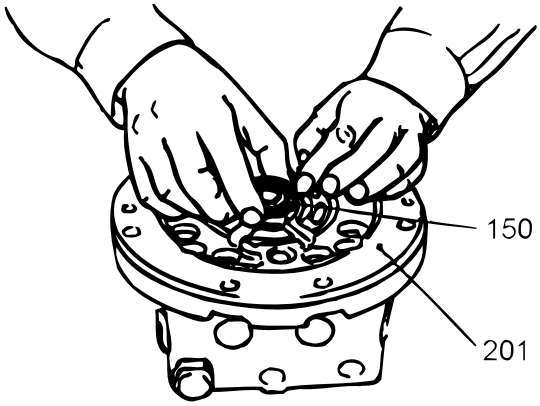
Removing Timing Plate (109)

3. Remove the parallel pins (241) from the rear flange (201).



Removing Parallel Pin (241)

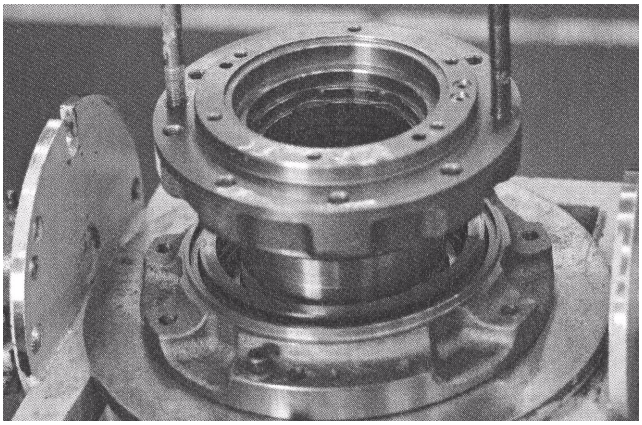
4. Remove bearing (150) from the rear flange (201).



Removing Bearing (150)

(18) Removal of spindle

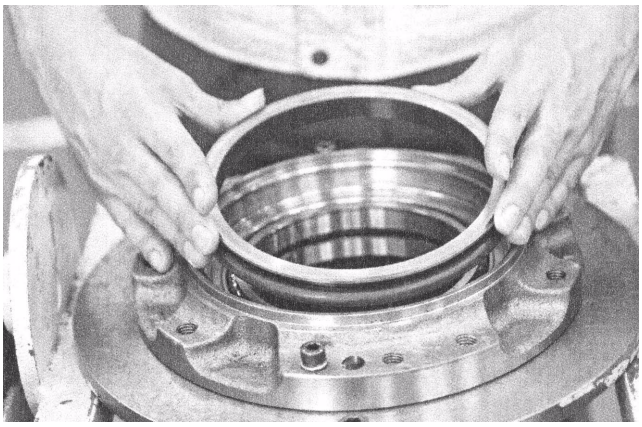
1. Turn over the travel motor. (Direct the motor side upward.)
2. Remove the clamp plates from the workbench.
3. Tighten two M12 eyebolts in the mounting thread holes of the spindle (2) in the diagonal position.
4. Hook a wire rope with hook to the M12 eyebolts, and lift by a crane to remove the spindle (2) from the hub (1). At this time, the floating seal (31) and oil seal (132) will be removed together with the spindle (2).



Removing Spindle (2)

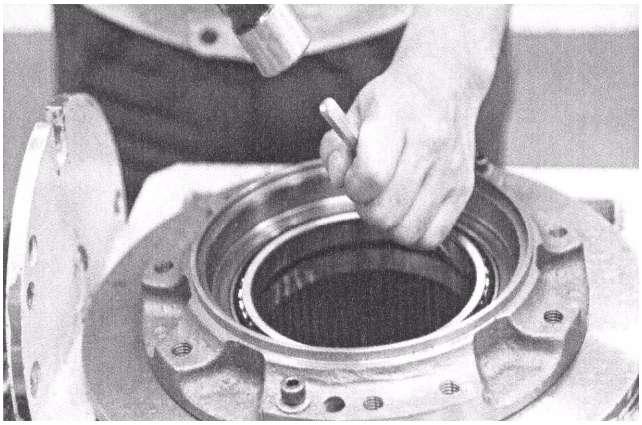
(19) Removing main bearing

1. Remove the floating seal (31) from the hub (1).
   -Do not reuse the removed floating seal (31).
2. Apply a punch between the inside periphery of the hub (1) and the main bearing (24) to remove the main bearing using a hammer.
   -When the fit section of the outer race of ball bearing (24) comes out of hub (1), the ball bearing drops from the hub.
   Therefore place a tray under the workbench and spread a rubber mat on the tray so as not to damage the parts.



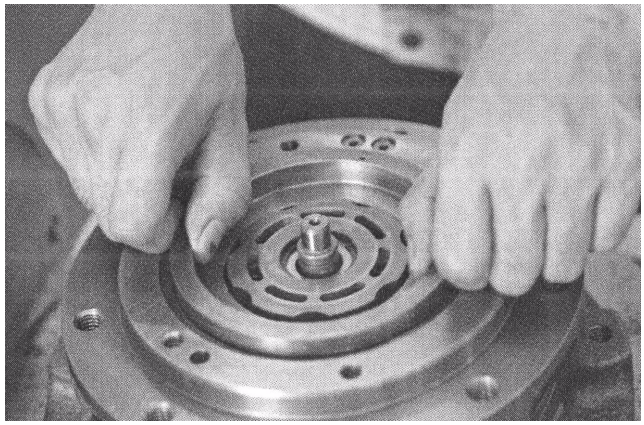
Removing Floating Seal (31)

3. Turn over the travel motor.
4. Tapping the end face of the outer race of ball bearing (24) with aluminum rod (pin punch) and hammer, remove the ball bearing from hub (1)
   -To avoid misalignment of the ball bearing, tap the bearing race end evenly at 3 or 4 points of the hub. And remove the ball bearing little by little.



Removing Ball Bearing (24)

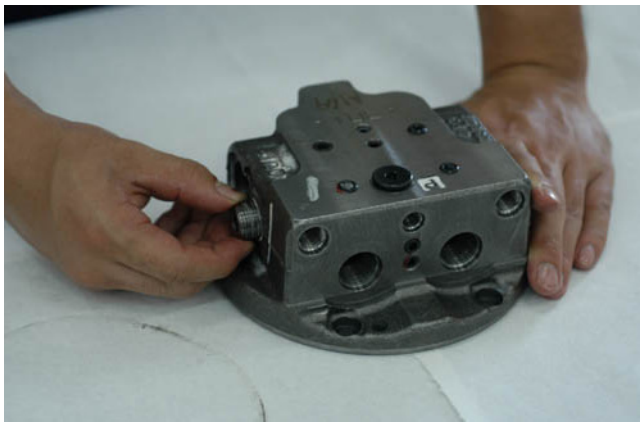
4. Install the piston (112) into the spindle (2).
   -If it is hard to fit the piston (112) into the spindle (2) due to the resistance of the O-rings (135) and (139), lightly tap the end face of the piston (112) with a plastic hammer.
   -Take care not to damage the O-rings when installing the piston (112).



Installing Piston (112)

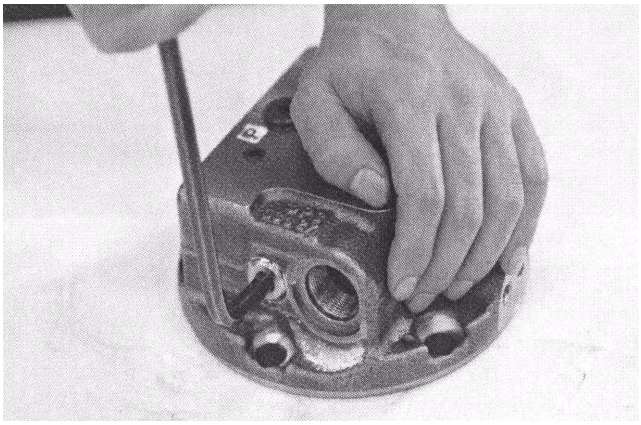
(8) Assembling brake valve parts inside rear flange

1. Fit two O-rings (237) to two plugs (226).
   -Coat the O-rings (237) with grease.
2. Install the valve (227) and spring (230) onto the plug (226), applying grease to them so as to connect all of them by adhesion of grease.
3. Insert the plug (226) with the valve (227) and spring (230) assembled in one piece, into the rear flange (201).



Inserting Plug (226)

- For insertion of the plug (226), place the rear flange (201) on the workbench, facing the tapped hole for plug mounting of the rear flange (201) upward and align the center of tapped hole with the plug center. This is intended to prevent the O-ring from being damaged and spring (230) from coming out of valve (227) due to contact between the bore of the rear flange and the valve.



Temporarily Tightening Plug (226)

34.2.1.6 Performance verification test

- After finishing maintenance of the the GM motor, carry out performance verification tests according to the procedures below:

(1) Measuring instruments to be used

1	Pressure gauge for 35 kgf/cm2 (500 psi)	2
2	Measuring cylinder (for 5 liters) (1.32 gal)	1
3	Stop watch	1

(2) Test procedure

1 Mounting and piping of GM motor

Mount the GM motor on the body (frame section) and connect piping. However, do not install the crawlers.
(Because the performance test (no-load run) of the GM motor is carried out.)

Note) 1. Connect piping so that a pressure gauge can be installed (in the main circuit) and an amount of drain of the hydraulic motor can be measured.
2. Mount the GM motor carefully using bolt holes without hammering.

2 Running-in of GM motor

	GM motor speed	Pressure	Rotating direction	Operating time
1	10 rpm	No load	Right and left	One minute or more each
2	20 rpm			

3 Performance verification test of GM motor

1 Preparation operation before testing ··· Run the machine for preparation until the following temperatures are approximately achieved:
- Hydraulic oil temperature 45-55ºC (113-131ºF)
- External temperature of reduction unit hub 40-80ºC (104-176ºF)

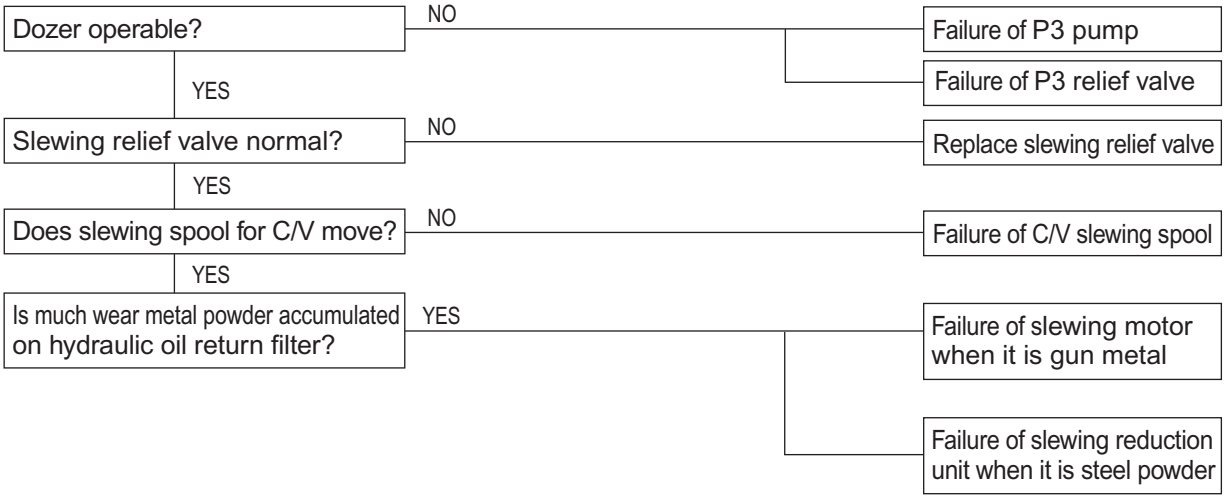
2 Verification test ··· Measure the following values to decide acceptance or rejection.
Acceptance criteria - GM motor drive pressure 1.57 MPa (228 psi) or lower at 10 rpm
Drain amount of hydraulic motor 0.5 L/min (0.13 gal) or less at 10 rpm

Accept → Install crawlers

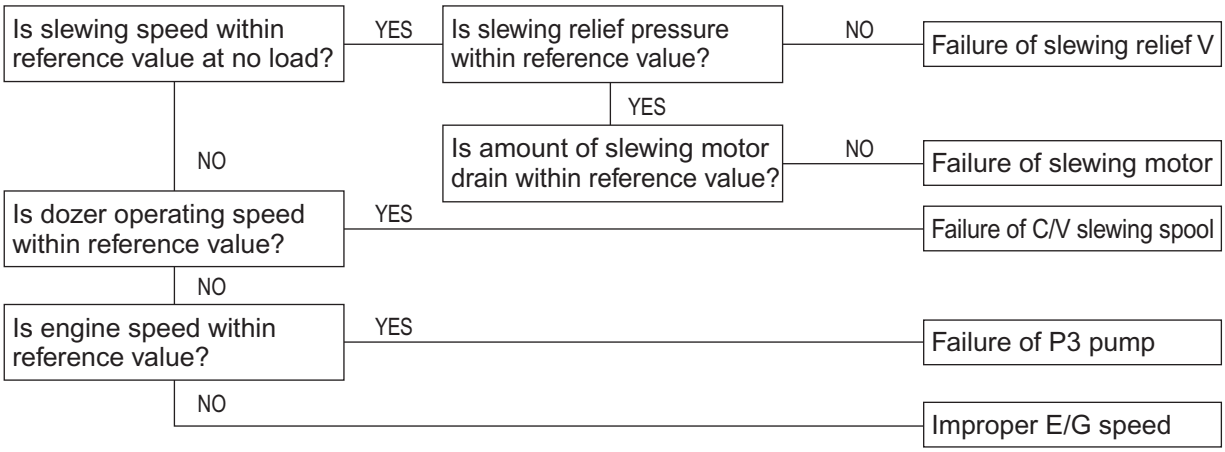
Reject → Disassemble and adjust again

42.3.3 SLEWING OPERATION

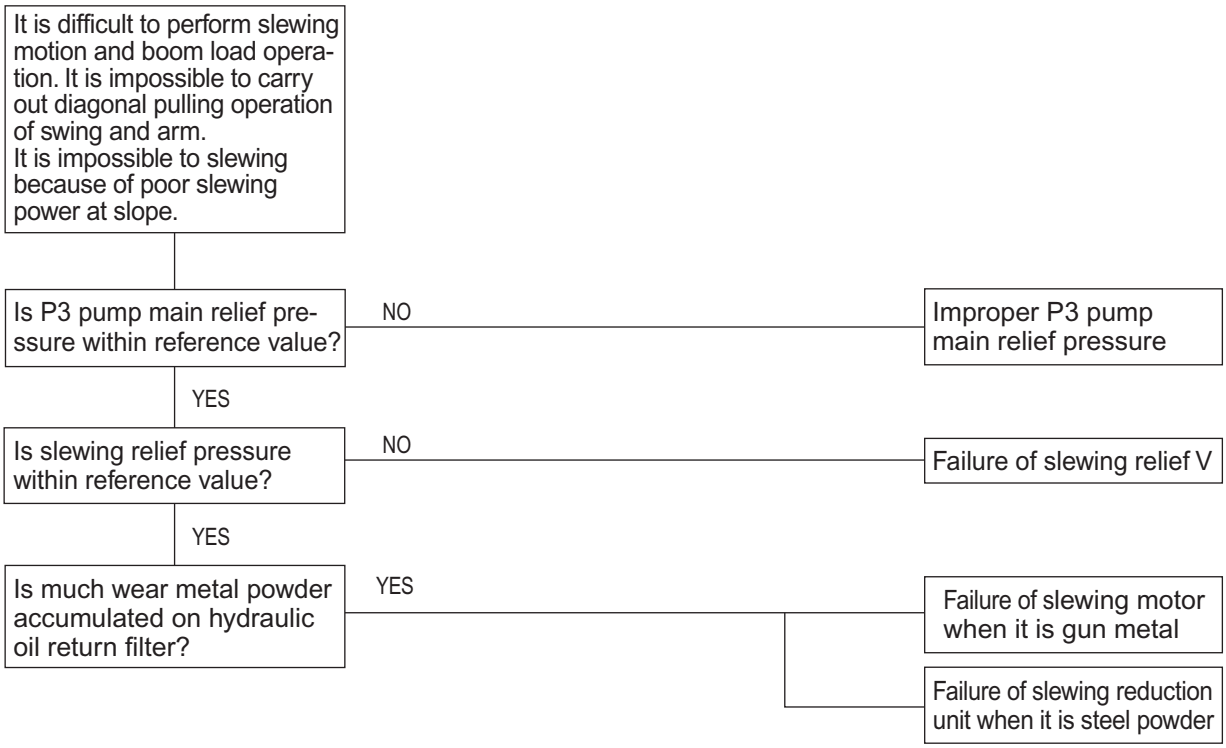
42.3.3.1 SLEWING OPERATIONAL FAILURE



42.3.3.2 SLEWING SPEED IS SLOW

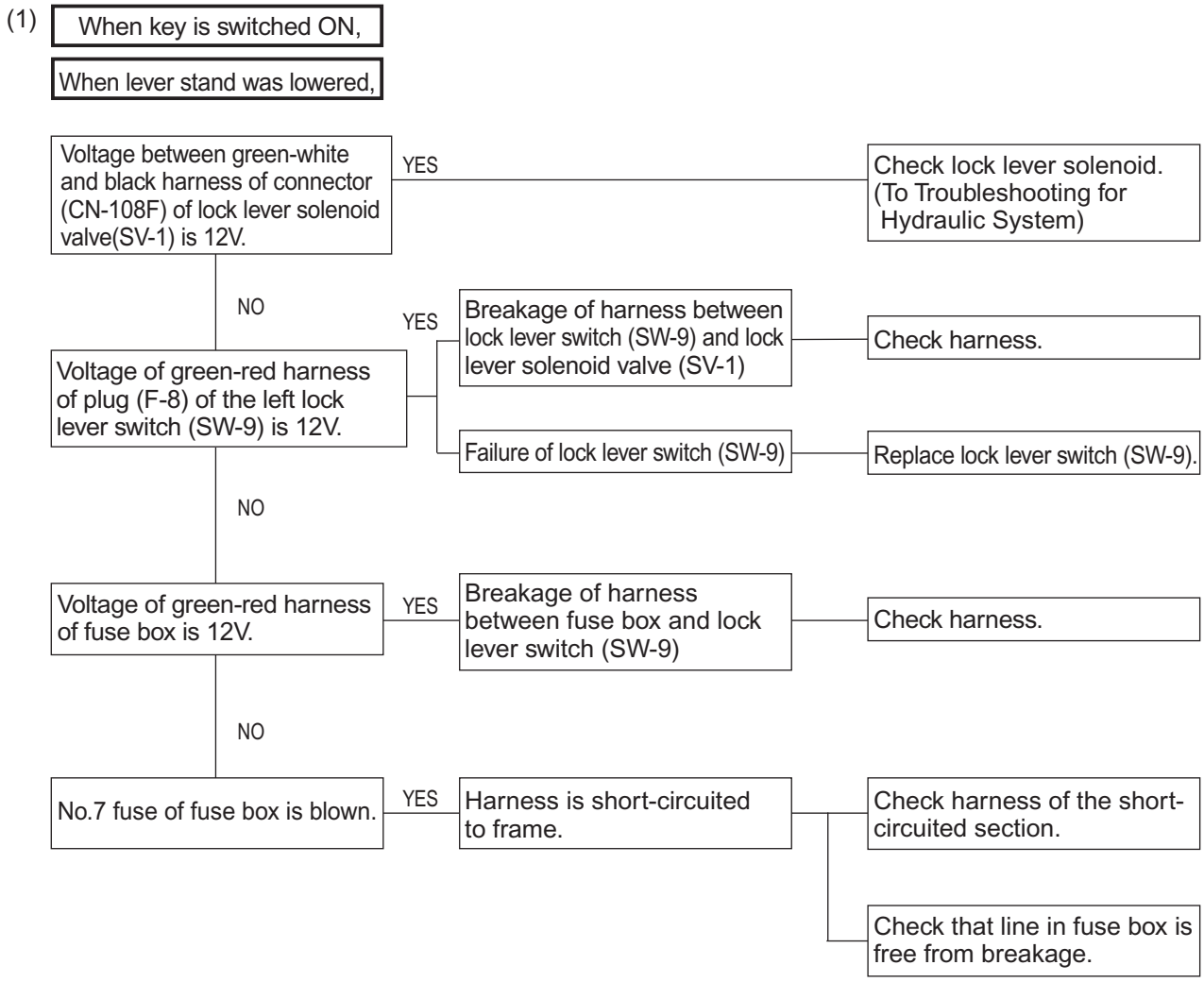


42.3.3.3 SLEWING POWER IS LOW

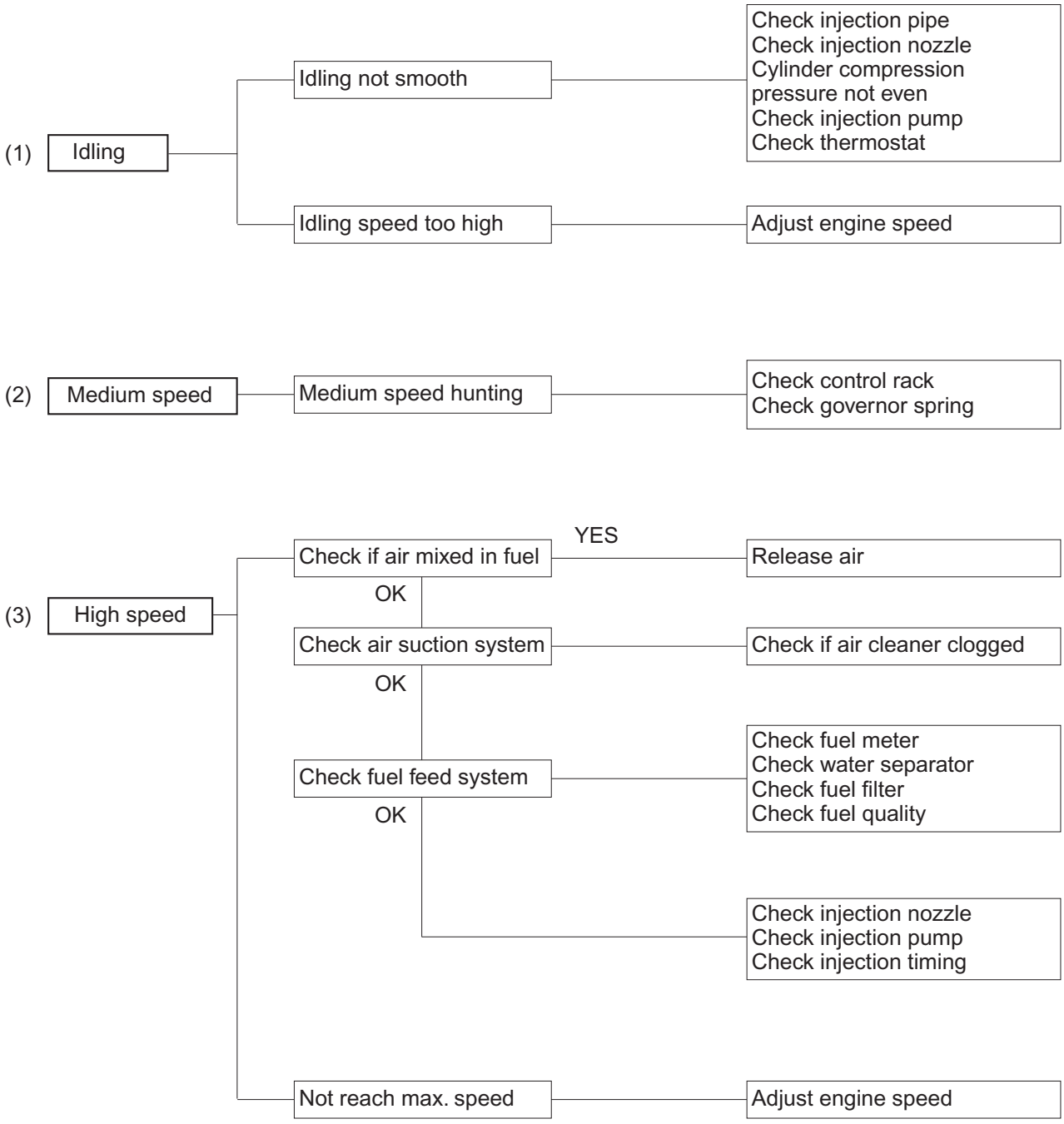


43.2.2 ATTACHMENT OPERATION

43.2.2.1 ALL CONTROLS DO NOT FUNCTION



44.2.2 E/G ROTATION TROUBLE



Note: Check the above items in the condition of coolant temperature at more than 50ºC. (122ºF)

This *Service Manual* has been developed for the exclusive use of service and repair professionals such as Yanmar authorized Distributors and Yanmar authorized Dealers. It is written with these professionals in mind and may not contain the necessary detail or safety statements that may be required for a non-professional to perform the service or repair properly and / or safely. Please contact an authorized Yanmar repair or service professional before working on your Yanmar product.

Disclaimers:

All information, illustrations and specifications in this manual are based on the latest information available at the time of publishing. The illustrations used in this manual are intended as representative reference views only. Moreover, because of our continuous product improvement policy, we may modify information, illustrations, and / or specifications to explain and / or exemplify a product, service, or maintenance improvement. We reserve the right to make any change at any time.

EMISSION SYSTEM WARRANTY

YANMAR CO., LTD. LIMITED EMISSION CONTROL SYSTEM WARRANTY - USA ONLY

Your Warranty Rights and Obligations:

California

The California Air Resources Board (CARB), the Environmental Protection Agency (EPA) and Yanmar Co., Ltd. hereafter referred to as Yanmar, are pleased to explain the **emission control system warranty** on your industrial compression-ignition engine. In California, model year 2000 or later off-road compression-ignition engines must be designed, built and equipped to meet the State's stringent anti-smog standards. In all states, 1998 and later non-road compression-ignition engines must be designed, built and equipped to meet the United States EPA emissions standards. Yanmar warrants the emission control system on your engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system, electronic control unit, exhaust gas recirculation (EGR) system and the air induction system. Also included may be hoses, belts, connectors and other emission-related assemblies.

Where a warrantable condition exists, Yanmar will repair your non-road compression-ignition engine at no charge to you including diagnosis, parts and labor.

Manufacturer's Warranty Period:

The model year 1998 or later certified and labeled non-road compression-ignition engines are warranted for the periods listed below. If any emission-related part on your engine is found to be defective during the applicable warranty period, the part will be replaced by Yanmar.

Engine Type	Warranty Period by Number of Years or Hours of Operation
Constant speed engines rated at or above 50 hp SAE (37 kW)	The warranty period is five (5) years or 3,000 hours of use, whichever occurs first. In the absence of a device to measure the hours of use, the engine has a warranty period of five (5) years.
Constant speed engines rated under 50 hp SAE (37 kW) with rated speeds greater than or equal to 3,000 rpm	The warranty period is two (2) years or 3,000 hours of use, whichever occurs first. In the absence of a device to measure the hours of use, the engine has a warranty period of two (2) years.
Engines rated at or above 26 hp SAE (19 kW)	The warranty period is five (5) years or 3,000 hours of use, whichever occurs first. In the absence of a device to measure the hours of use, the engine has a warranty period of five (5) years.
Engines rated under 26 hp SAE (19 kW)	The warranty period is two (2) years or 3,000 hours of use, whichever occurs first. In the absence of a device to measure the hours of use, the engine has a warranty period of two (2) years.

⚠ WARNING

SEVER HAZARD!

- Keep hands and other body parts away from moving / rotating parts such as the cooling fan, flywheel or PTO shaft.
- Wear tight-fitting clothing and keep your hair short or tie it back while the engine is running.
- Remove all jewelry before you operate or service the machine.
- NEVER start the engine in gear. Sudden movement of the engine and / or machine could cause death or serious personal injury.
- NEVER operate the engine without the guards in place.
- Before you start the engine make sure that all bystanders are clear of the area.
- Keep children and pets away while the engine is operating.
- Check before starting the engine that any tools or shop rags used during maintenance have been removed from the area.
- Failure to comply could result in death or serious injury.

0000002en

⚠ WARNING

EXHAUST HAZARD!

- NEVER operate the engine in an enclosed area such as a garage, tunnel, underground room, manhole or ship's hold without proper ventilation.
- NEVER block windows, vents, or other means of ventilation if the engine is operating in an enclosed area. All internal combustion engines create carbon monoxide gas during operation. Accumulation of this gas within an enclosure could cause illness or even death.
- Make sure that all connections are tightened to specifications after repair is made to the exhaust system.
- Failure to comply could result in death or serious injury.

0000003en

⚠ WARNING

ALCOHOL AND DRUG HAZARD!

- NEVER operate the engine while you are under the influence of alcohol or drugs.
- NEVER operate the engine when you are feeling ill.
- Failure to comply could result in death or serious injury.

0000004en

CAUTION

- When the engine is operated in dusty conditions, clean the air cleaner element more frequently.
- NEVER operate the engine with the air cleaner element(s) removed. This may allow foreign material to enter the engine and damage it.

0000026en

CAUTION

The maximum air intake restriction, in terms of differential pressure measurement, must not exceed 0.90 psi (6.23 kPa; 635 mmAq). Clean or replace the air cleaner element if the air intake restriction exceeds the above mentioned value.

0000046en

CAUTION

It is important to perform daily checks.

Periodic maintenance prevents unexpected downtime, reduces the number of accidents due to poor machine performance and helps extend the life of the engine.

0000060en

CAUTION

If the oil pump must be replaced, replace it as an assembly only. Do not replace individual components.

0000030en

CAUTION

Do not loosen or remove the four bolts retaining the fuel injection pump drive gear to the fuel injection pump hub. Do not disassemble the fuel injection pump drive gear from the hub. Correct fuel injection timing will be very difficult or impossible to achieve.

0000031en

CAUTION

The starter motor can be damaged if operated continuously longer than 10 seconds while performing the no-load test.

0000034en

CAUTION

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

0000035en

CAUTION

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

0000036en

CAUTION

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

0000037en

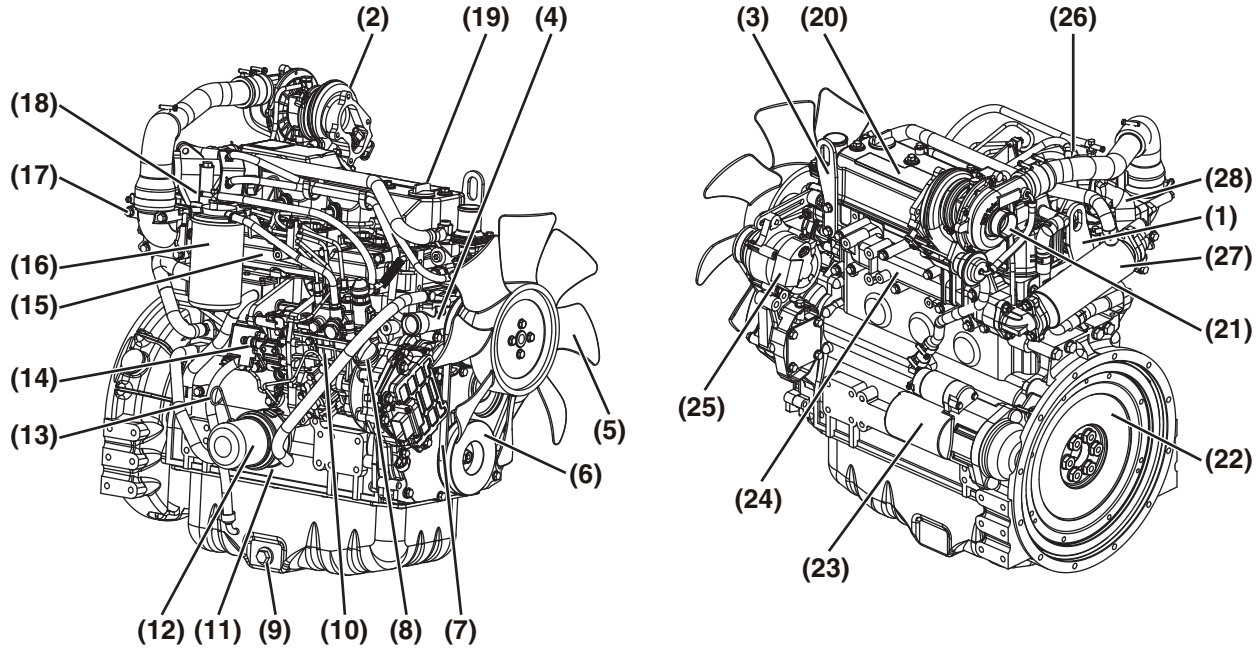
CAUTION

Do not turn the battery switch OFF while the engine is operating. Damage to the alternator will result.

0000038en

Figure 4-2 shows where the major engine components are located.

4TNV84T-Z, 4TNV98-E, 4TNV98-Z, 4TNV98T-Z



1 – Lifting Eye (Flywheel End)
2 – Turbocharger*
3 – Lifting Eye (Engine Cooling Fan End)
4 – Engine Coolant Pump
5 – Engine Cooling Fan
6 – Crankshaft V-Pulley
7 – V-Belt
8 – Side Filler Port (Engine Oil)
9 – Drain Plug (Engine Oil)**
10 – Fuel Injection Pump
11 – Engine Oil Cooler***
12 – Engine Oil Filter
13 – Dipstick (Engine Oil)
14 – Eco-governor
15 – Intake Manifold
16 – Fuel Filter
17 – Fuel Inlet
18 – Fuel Return to Fuel Tank
19 – Top Filler Port (Engine Oil)
20 – Rocker Arm Cover
21 – Air Intake Port (From Air Cleaner)
22 – Flywheel
23 – Starter Motor
24 – Exhaust Manifold
25 – Alternator
26 – EGR valve
27 – EGR cooler****
28 – EGR pipe

Figure 4-2

* Only applies to 4TNV84T-Z, 4TNV98T-Z.
** Engine oil drain plug location may vary based on oil pan options.
*** Not standard on all direct injection models.
**** Only applies to 4TNV84T-Z, 4TNV98T-Z.

⚠ DANGER

FIRE AND EXPLOSION HAZARD!

- Diesel fuel is flammable and explosive under certain conditions.
- Be sure to place the diesel fuel container on the ground when transferring the diesel fuel from the pump to the container. Hold the hose nozzle firmly against the side of the container while filling it. This prevents static electricity buildup which could cause sparks and ignite fuel vapors.
- NEVER place diesel fuel or other flammable material such as oil, hay or dried grass close to the engine during engine operation or shortly after shutdown.
- Failure to comply will result in death or serious injury.

0000014en

⚠ DANGER

FIRE AND EXPLOSION HAZARD!

- Diesel fuel is flammable and explosive under certain conditions.
- Before you operate the engine, check for fuel leaks. Replace rubberized fuel hoses every two years or every 2000 hours of engine operation, whichever comes first, even if the engine has been out of service. Rubberized fuel lines tend to dry out and become brittle after two years or 2000 hours of engine operation, whichever comes first.
- Failure to comply will result in death or serious injury.

0000015en

CAUTION

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

0000004en

3TNV84 (~ EPA Tier2)

Engine Model	3TNV84								
Version	CL			VM					
Type	Vertical In-line Diesel Engine								
Combustion System	Direct Injection								
Aspiration	Natural								
No. of Cylinders	3								
Bore × Stroke	84 × 90mm								
Displacement	1.496L								
Continuous Rated Output	min^{-1}	1500	1800						
	kW	11.3	13.5						
	PS	15.3	18.3						
Max. Rated Output (Net)	min^{-1}	1500	1800	2000	2200	2400	2600	2800	3000
	kW	12.4	14.8	16.4	18.1	19.7	21.3	23.0	24.6
	PS	16.8	20.1	22.3	24.6	26.8	29.0	31.3	33.5
High Idling	min^{-1}	1600 ± 25	1895 ± 25	2180 ± 25	2400 ± 25	2590 ± 25	2810 ± 25	2995 ± 25	3210 ± 25
Engine Weight (Dry) *with Flywheel Housing	161kg			155kg					
PTO Position	Flywheel End								
Direction of Rotation	Counterclockwise Viewed From Flywheel End								
Cooling System	Liquid-Cooled with Radiator								
Lubricating System	Forced Lubrication with Trochoid Pump								
Normal Oil Pressure at Rated Engine Speed	0.34 - 0.49 MPa			0.39 - 0.54 MPa					
Normal Oil Pressure at Low Idle Speed	0.06 MPa								
Starting System	Electric Starting (Starter Motor: DC12V (1.2 kW)) ***								
	Alternator: DC12V, 40A***								
	Recommended Battery Capacity: 12V, 55 Ah*** (5h rating)								
Dimensions (L × W × H)*	589 × 486 × 622mm			564 × 486 × 622mm					
Engine Oil Pan Capacity**	6.7/3.9L (Dipstick Upper Limit / Lower Limit)								
Engine Coolant Capacity	2.0L Engine Only								
Standard Cooling Fan	335mm O.D., 6 Blade Pusher-Type ***								
Crank V-pulley dia./ Fan V-pulley dia.	ϕ120/ ϕ90mm ***			ϕ110/ ϕ110mm ***					

* *Engine specifications without radiator.*

** *Engine oil capacity for a "Deep Standard" oil pan. Refer to the operation manual provided by the driven machine manufacturer for the actual engine oil capacity of your machine.*

*** *May vary depending on application.*

4TNV106T (~ EPA Tier2)

Engine Model	4TNV106T				
Version	CL			VM	
Type	Vertical In-line Diesel Engine				
Combustion System	Direct Injection				
Aspiration	Turbocharged				
No. of Cylinders	4				
Bore × Stroke	106 × 125mm				
Displacement	4.412L				
Continuous Rated Output	min^{-1}	1500	1800		
	kW	51.5	61.8		
	PS	70.0	84.0		
Max. Rated Output (Net)	min^{-1}	1500	1800	2000	2200
	kW	56.8	68.0	69.9	72.0
	PS	77.2	92.5	95.0	97.9
High Idling	min^{-1}	1600 ± 25	1875 ± 25	2205 ± 25	2420 ± 25
Engine Weight (Dry) *with Flywheel Housing	355 kg			340 kg	
PTO Position	Flywheel End				
Direction of Rotation	Counterclockwise Viewed From Flywheel End				
Cooling System	Liquid-Cooled with Radiator				
Lubricating System	Forced Lubrication with Trochoid Pump				
Normal Oil Pressure at Rated Engine Speed	0.31 - 0.49 MPa			With balancer: 0.34-0.44 MPa Without balancer: 0.39-0.49 MPa	
Normal Oil Pressure at Low Idle Speed	0.06 MPa				
Starting System	Electric Starting (Starter Motor DC12V (3.0 kW)) ***				
	Alternator: DC12V, 55A***				
	Recommended Battery Capacity: 12V, 88 Ah***				
Dimensions (L × W × H)*	808 × 629 × 866 mm			776 × 629 × 866 mm	
Engine Oil Pan Capacity**	14.0/5.0L (Dipstick Upper Limit / Lower Limit)			14.0/6.5L (Dipstick Upper Limit / Lower Limit)	
Engine Coolant Capacity	6L Engine Only				
Standard Cooling Fan	500mm O.D. 7 Blade Pusher-Type ***			500mm O.D.7 Blade Suction-Type***	
Crank V-pulley dia./ Fan V-pulley dia.	ϕ150/ ϕ150mm ***				

* *Engine specifications without radiator.*

** *Engine oil capacity for a "Deep Standard" oil pan. Refer to the operation manual provided by the driven machine manufacturer for the actual engine oil capacity of your machine.*

*** *May vary depending on application.*

4TNV98T-Z (complies with EPA Interim Tier4)

Engine Model		4TNV98T-Z							
Version		CL		VM					
Type		Vertical, 4-cycle water-cooled diesel engine							
Combustion System		Direct Injection							
Aspiration		Turbocharged							
No. of Cylinders		4							
Bore × Stroke		98 × 110mm							
Displacement		3.319L							
Continuous Rated Output	min^{-1}	1500	1800						
	kW	37.9	45.6						
	PS	51.5	62.0						
Max. Rated Output (Net)	min^{-1}	1500	1800			2200	2300	2400	2500
	kW	41.9	50.4			55.5	58.0	60.3	62.5
	PS	57.0	68.5			75.5	78.8	82.0	85.0
High Idling	min^{-1}	1530 ± 25	1830 ± 25			2350 ± 25	2450 ± 25	2550 ± 25	2650 ± 25
Engine Weight (dry) *with Flywheel Housing		258kg		245kg					
PTO Position		Flywheel End							
Direction of Rotation		Counterclockwise Viewed From Flywheel End							
Governor		Electronic governor (All-speed governor)							
Cooling System		Liquid-Cooled with Radiator							
Lubricating System		Forced Lubrication with Trochoid Pump							
Normal Oil Pressure	Rated Engine Speed	0.29-0.39 (3.0-4.0) MPa							
	Low Idle Speed	≥ 0.06 (≥ 0.6) MPa							
Starting System		Electric Starting (Starter Motor: DC12V (2.3kW)) ***							
Charging system		Alternator (DC12V/40A) ***							
Recommended Battery Capacity		12V-64Ah*** (5h rating)							
Starting aid device		Air heater (12VDC/500W)							
Engine Oil Pan Capacity**		10.2L/5.7L (Dipstick Upper Limit / Lower Limit)							
Engine Coolant Capacity		4.2L Engine Only							
Standard Cooling Fan		Resin F type pusher fan - ϕ430(UX) x 6							
Crank V-pulley dia./ Fan V-pulley dia.		ϕ130/ ϕ130mm							

* *Engine specifications without radiator.*

** *Engine oil capacity for a "Deep Standard" oil pan. Refer to the operation manual provided by the driven machine manufacturer for the actual engine oil capacity of your machine.*

*** *May vary depending on application.*

DANGER

FIRE AND EXPLOSION HAZARD!

- Diesel fuel is flammable and explosive under certain conditions.
- Only fill the fuel tank with diesel fuel. Filling the fuel tank with gasoline may result in a fire and will damage the engine.
- NEVER refuel with the engine running.
- Wipe up all spills immediately.
- Keep sparks, open flames or any other form of ignition (match, cigarette, static electric source) well away when refueling.
- NEVER overfill the fuel tank.
- Fill the fuel tank. Store any containers containing fuel in a well-ventilated area, away from any combustibles or sources of ignition.
- Failure to comply will result in death or serious injury.

0000005en

DANGER

FIRE AND EXPLOSION HAZARD!

- Diesel fuel is flammable and explosive under certain conditions.
- Before you operate the engine, check for fuel leaks. Replace rubberized fuel hoses every two years or every 2000 hours of engine operation, whichever comes first, even if the engine has been out of service. Rubberized fuel lines tend to dry out and become brittle after two years or 2000 hours of engine operation, whichever comes first.
- Failure to comply will result in death or serious injury.

0000015en

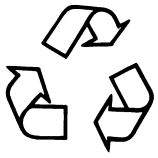
DANGER

FIRE AND EXPLOSION HAZARD!

- Diesel fuel is flammable and explosive under certain conditions.
- NEVER remove the fuel cap with the engine running.
- Failure to comply will result in death or serious injury.

0000011en

CAUTION



- **ALWAYS be environmentally responsible.**
- **Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.**
- **NEVER dispose of hazardous materials irresponsibly by dumping them into a sewer, on the ground, or into ground water or waterways.**
- **Failure to follow these procedures may seriously harm the environment.**

0000013en

CAUTION

Protect the air cleaner, turbocharger (if equipped) and electric components from damage when you use steam or high-pressure water to clean the engine.

0000014en

CAUTION

- **NEVER overfill the engine with engine oil.**
- **ALWAYS keep the oil level between the upper and lower lines on the oil cap / dipstick.**

0000015en

CAUTION

NEVER use high-pressure water or compressed air at greater than 28 psi (193 kPa; 19 686 mmAq) or a wire brush to clean the radiator fins. Radiator fins damage easily.

0000016en

CAUTION

NEVER attempt to adjust the low or high idle speed limit screw. This may impair the safety and performance of the machine and shorten its life. If the idle speed limit screws require adjustment, see your authorized Yanmar industrial engine dealer or distributor.

0000017en

CAUTION

Establish a periodic maintenance plan according to the engine application and make sure you perform the required periodic maintenance at the intervals indicated. Failure to follow these guidelines will impair the engine's safety and performance characteristics, shorten the engine's life and may affect the warranty coverage on your engine.

See Yanmar Limited Warranty in Warranty Section.

Consult your authorized Yanmar dealer or distributor for assistance when checking items marked with a ●.

0000024enTNVDISM

4. Check the V-belt for cracks, oil or wear. If any of these conditions exist, replace the V-belt.
5. Install the new V-belt. Refer to the table for proper tension.

New V-Belt Tension		
A	**B**	**C**
5/16 - 7/16 in. (8 - 12 mm)	3/16 - 5/16 in. (5 - 8 mm)	1/4 - 7/16 in. (7 - 11 mm)

6. After adjusting, run the engine for 5 minutes or more. Check the tension again using the specifications for a used V-belt.

Used V-Belt Tension		
A	**B**	**C**
3/8 - 1/2 in. (10 - 14 mm)	1/4 - 3/8 in. (7 - 10 mm)	5/16 - 1/2 in. (9 - 13 mm)

Every 50 Hours of Operation

After you complete the initial 50 hour maintenance procedures, perform the following procedures every 50 hours thereafter.

- **Drain Fuel Filter / Water Separator**
- **Check Battery**

Drain Fuel Filter / Water Separator

DANGER

FIRE AND EXPLOSION HAZARD!

- **Diesel fuel is flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **NEVER use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply will result in death or serious injury.**

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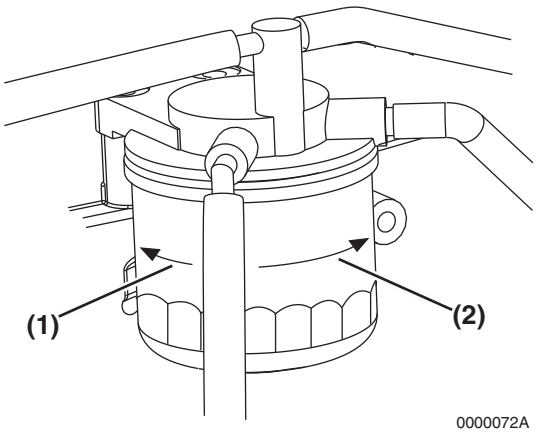

Figure 5-14

4. Clean the filter mounting surface and apply a small amount of diesel fuel to the gasket of the new fuel filter.
5. Install the new fuel filter. Turn to the right **(Figure 5-14, (2))** and hand-tighten it only until it comes in contact with the mounting surface. Tighten to 14 - 17 ft·lb (19.6 - 23.5 N·m; 2.0 - 2.4 kgf·m) or one additional turn using the filter wrench.

Applicable Fuel Filter Part No.		
	Standard	Dust proof *
3TNV82A, -4TNV98 3TNV82A-B, -4TNV98-B	119802-55801	129907-55801
4TNV98T, 4TNV98T-Z, -4TNV106T	123907-55801	

* Consult the operation manual for the driven machine for applicability of the dust proof filter.

6. Open the fuel cock of the fuel filter / water separator.
7. Prime the fuel system. *See Priming the Fuel System on page 4-15.*
8. Check for leaks.

Clean Fuel Filter / Water Separator

DANGER

FIRE AND EXPLOSION HAZARD!

- **Diesel fuel is flammable and explosive under certain conditions.**
- **NEVER use diesel fuel as a cleaning agent.**
- **Failure to comply will result in death or serious injury.**

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DANGER

FIRE AND EXPLOSION HAZARD!

- **Diesel fuel is flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **NEVER use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **Failure to comply will result in death or serious injury.**

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(Camshaft Cont.)

Inspection Item			Standard	Limit	Reference Page
4TNV94L, 4TNV98, 4TNV98T	Gear End	Bushing Inside Diameter	1.9681 - 1.9707 in. (49.990 - 50.055 mm)	1.9736 in. (50.130 mm)	*See Inspection of Camshaft on page 6-87.*
		Camshaft Outside Diameter	1.9655 - 1.9665 in. (49.925 - 49.950 mm)	1.7673 in. (49.890 mm)	
		Oil Clearance	0.0016 - 0.0051 in. (0.040 - 0.130 mm)	0.0094 in. (0.240 mm)	
	Intermediate	Bushing Inside Diameter	1.9685 - 1.9695 in. (50.000 - 50.025 mm)	1.9724 in. (50.100 mm)	
		Camshaft Outside Diameter	1.9650 - 1.9659 in. (49.910 - 49.935 mm)	1.9636 in. (49.875 mm)	
		Oil Clearance	0.0026 - 0.0045 in. (0.065 - 0.115 mm)	0.0089 in; (0.225 mm)	
	Flywheel End	Bushing Inside Diameter	1.9685 - 1.9695 in. (50.000 - 50.025 mm)	1.9724 in. (50.100 mm)	
		Camshaft Outside Diameter	1.9655 - 1.9665 in. (49.925 - 49.950 mm)	1.7673 in. (49.890 mm)	
		Oil Clearance	0.0020 - 0.0039 in. (0.050 - 0.100 mm)	0.0083 in. (0.210 mm)	
4TNV106, 4TNV106T	Gear End	Bushing Inside Diameter	2.2827 - 2.2854 in. (57.980 - 58.050 mm)	2.2876 in. (58.105 mm)	
		Camshaft Outside Diameter	2.2799 - 2.2811 in. (57.910 - 57.940 mm)	2.2785 in. (57.875 mm)	
		Oil Clearance	0.0016 - 0.0055 in. (0.040 - 0.140 mm)	0.0098 in. (0.250 mm)	
	Intermediate	Bushing Inside Diameter	2.2835 - 2.2846 in. (58.000 - 58.030 mm)	2.2876 in. (58.105 mm)	
		Camshaft Outside Diameter	2.2793 - 2.2805 in. (57.895 - 57.925 mm)	2.2779 in. (57.860 mm)	
		Oil Clearance	0.0030 - 0.0053 in. (0.075 - 0.135 mm)	0.0096 in. (0.245 mm)	
	Flywheel End	Bushing Inside Diameter	2.2835 - 2.2846 in. (58.000 - 58.030 mm)	2.2876 in. (58.105 mm)	
		Camshaft Outside Diameter	2.2799 - 2.2811 in. (57.910 - 57.940 mm)	2.2785 in. (57.875 mm)	
		Oil Clearance	0.0020 - 0.0047 in. (0.050 - 0.120 mm)	0.0091 in. (0.230 mm)	

Connecting Rod

Connecting Rod Small End

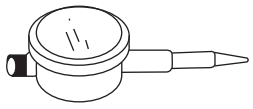
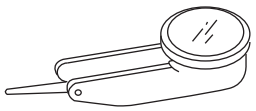
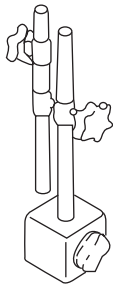
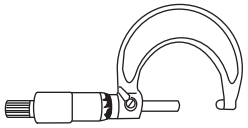
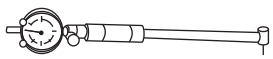
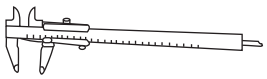
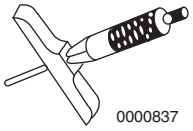
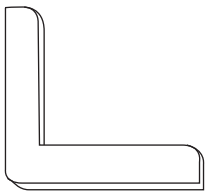
Model	Inspection Item	Standard	Limit	Reference Page
3TNV82A	Wrist Pin Bushing Inside Diameter	0.9065 - 0.9070 in. (23.025 - 23.038 mm)	0.9082 in. (23.068 mm)	*See Inspection of Connecting Rod on page 6-85.*
	Wrist Pin Outside Diameter	0.9053 - 0.9055 in. (22.995 - 23.000 mm)	0.9042 in. (22.967 mm)	
	Oil Clearance	0.0010 - 0.0017 in. (0.025 - 0.043 mm)	0.0040 in. (0.101 mm)	
3TNV84, 3TNV84T, 3TNV88, 4TNV84, 4TNV84T, 4TNV88	Wrist Pin Bushing Inside Diameter	1.0234 - 1.0251 in. (26.025 - 26.038 mm)	1.0263 in. (26.068 mm)	
	Wrist Pin Outside Diameter	1.0234 - 1.0236 in. (25.995 - 26.000 mm)	1.0223 in. (25.967 mm)	
	Oil Clearance	0.0010 - 0.0017 in. (0.025 - 0.043 mm)	0.0040 in. (0.101 mm)	
4TNV94L, 4TNV98, 4TNV98T	Wrist Pin Bushing Inside Diameter	1.1821 - 1.1826 in. (30.025 - 30.038 mm)	1.1838 in. (30.068 mm)	
	Wrist Pin Outside Diameter	1.1806 - 1.1811 in. (29.987 - 30.000 mm)	1.1795 in. (29.959 mm)	
	Oil Clearance	0.0010 - 0.0020 in. (0.025 - 0.51 mm)	0.0043 in. (0.109 mm)	
4TNV106, 4TNV106T	Wrist Pin Bushing Inside Diameter	1.4577 - 1.4582 in. (37.025 - 37.038 mm)	1.4594 in. (37.068 mm)	
	Wrist Pin Outside Diameter	1.4563 - 1.4567 in. (36.989 - 37.000 mm)	1.4552 in. (36.961 mm)	
	Oil Clearance	0.0010 - 0.0019 in. (0.025 - 0.049 mm)	0.0042 in. (0.107 mm)	

Connecting Rod Big End

Inspection Item	Standard	Limit	Reference Page
Side Clearance - All Models	0.0079 - 0.0157 in. (0.20 - 0.40 mm)	-	*See Inspection of Connecting Rod on page 6-85.*

See Special Torque Chart on page 6-25 for other specifications.

MEASURING INSTRUMENTS

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

Use a telescoping gauge and micrometer to measure the inside diameter at each end of the valve guide. Measure in three places and 90° apart **(Figure 6-18)**. *See Intake / Exhaust Valve and Guide on page 6-7 for the service limit.* Replace valve guides if not within specification.

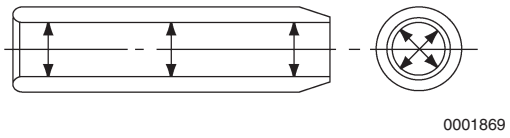


Figure 6-18

Inspection of Cylinder Head

Cylinder Head Distortion

Place the cylinder head flat and inverted (combustion side up) on the bench. Use a straight edge and a feeler gauge to measure cylinder head distortion **(Figure 6-19)**. Measure diagonally and along each side. *See Cylinder Head on page 6-6 for the service limit.*

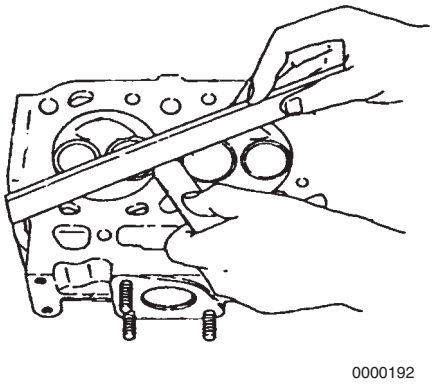


Figure 6-19

If distortion exceeds the service limit, resurface or replace the cylinder head. Remove only enough material to make the cylinder head flat, but do not remove more than 0.008 in. (0.20 mm).

Inspection of Intake and Exhaust Valves

Visually inspect the intake and exhaust valves. Replace any valves that are obviously discolored, heavily pitted or otherwise damaged.

Valve Stem Diameter

Use a micrometer to measure the valve stem diameter. Measure the valve stem near the combustion end and near the opposite end **(Figure 6-20, (1))**. *See Intake / Exhaust Valve and Guide on page 6-7 for the service limit.*

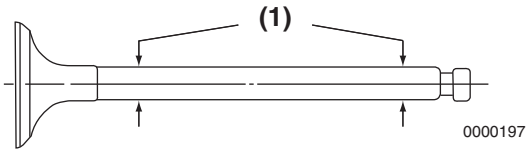


Figure 6-20

Valve Stem Bend

Place the valve stem on a flat inspection block or layout bed. Roll the valve until a gap can be observed between a portion of the valve stem and the surface of the block or bed. Use a feeler gauge to measure the gap **(Figure 6-21)**. *See Intake / Exhaust Valve and Guide on page 6-7 for the service limit.*

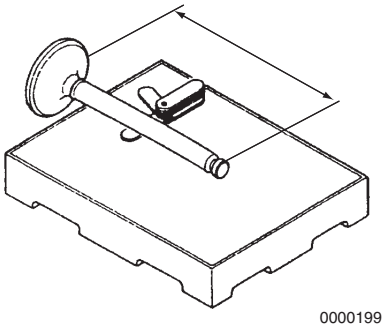


Figure 6-21

Valve Recession

Note: The valve guides must be installed to perform this check.

Insert the valves into their original locations and press them down until they are fully seated. Use a depth micrometer **(Figure 6-22)** to measure the difference between the cylinder head gasket surface and the combustion surface of each exhaust and intake valve **(Figure 6-23)**. *See Cylinder Head on page 6-6 for the service limit.*

Removal of Valve Cover

Note: The high pressure fuel injection lines and valve cover grommets must be removed prior to removing the valve cover. *See Removal of Fuel Injectors on page 7-35.*

1. Remove the high-pressure fuel lines.
2. Use a flat-blade screwdriver **(Figure 6-42)** to remove the fuel injection line grommets **(Figure 6-43, (1))** from the valve cover **(Figure 6-43, (3))** and fuel injectors **(Figure 6-43, (2))**. There is a notch at the 3 o'clock position in the valve cover opening to insert the screwdriver.

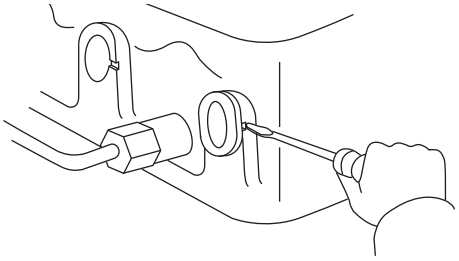


Figure 6-42

3. Remove the valve cover nuts **(Figure 6-43, (4))**.
4. Remove the O-ring **(Figure 6-43, (5))** on each valve cover nut.

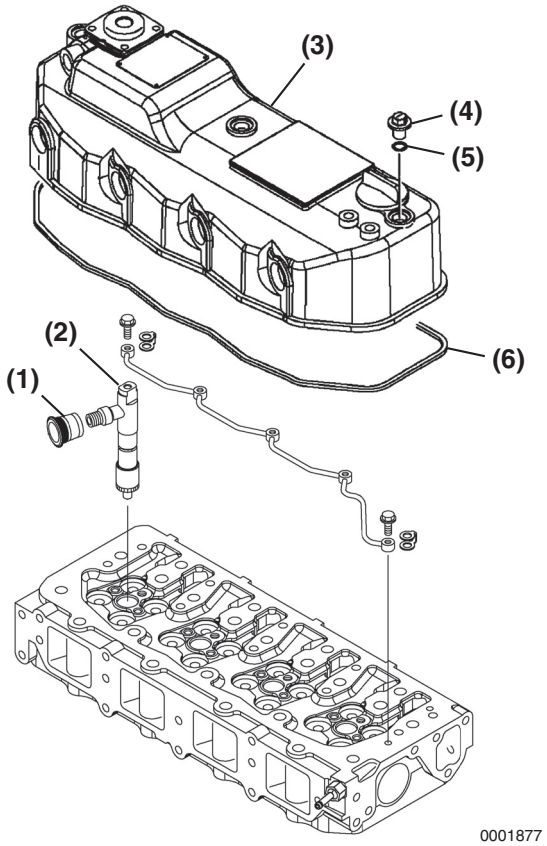


Figure 6-43

5. Remove the valve cover **(Figure 6-43, (3))**. Discard the valve cover gasket **(Figure 6-43, (6))**.
6. Inspect and clean the crankcase breather assembly. *See Inspect Crankcase Breather System on page 5-40.*

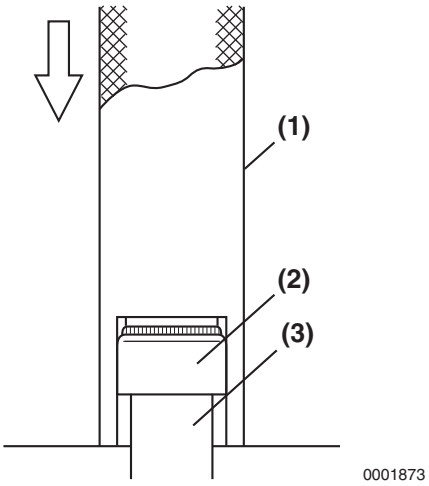


Figure 6-67

2. Measure the distance **(Figure 6-68, (1))** from the cylinder head to the valve stem seal to ensure proper clearance **(Figure 6-68, (2))** between the guide and seal. *See Intake / Exhaust Valve and Guide on page 6-7.*

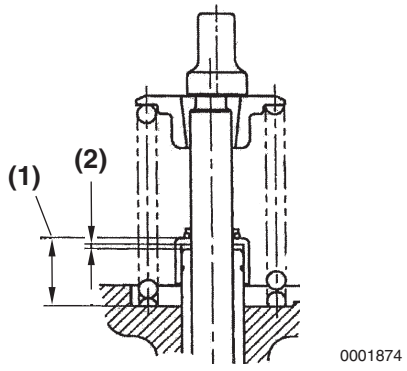


Figure 6-68

3. Place the cylinder head assembly on its exhaust port side.
4. Place all the valves **(Figure 6-69, (5))** in their proper location in the cylinder head.

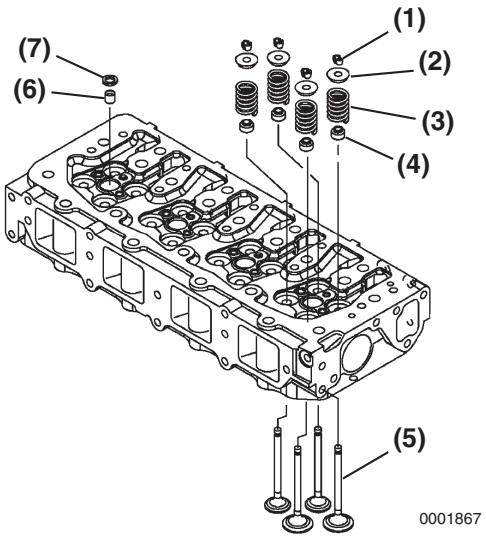


Figure 6-69

5. Place the cylinder head on the workbench with the combustion side down. Install the valve spring **(Figure 6-69, (3))** and spring retainer **(Figure 6-69, (2))**.
6. Using the valve spring compressor tool, compress the valve spring.
7. Insert the valve keepers **(Figure 6-69, (1))** and slowly release the tension in the valve spring. Repeat the steps on all the remaining valves.

Reassembly of Cylinder Head

1. Carefully clean both the combustion surface of the cylinder head and the top surface of the cylinder block. Then place a new cylinder head gasket **(Figure 6-70, (2))** on the cylinder block.
2. Position the cylinder head on the on the cylinder head gasket.

1 – Cylinder Block
2 – Camshaft Bushing
3 – Gear Case (3TNV94 - 4TNV106)
4 – Dowel (2 used)
5 – O-Ring
6 – Front Plate (3TNV82 - 4TNV88)
7 – Gear Case Cover (3TNV82 - 4TNV88)
8 – Front Crankshaft Seal
9 – Gear Case Cover (3TNV94 - 4TNV106)
10 – Tappets
11 – Camshaft
12 – Camshaft Gear Key
13 – Camshaft End Plate
14 – Camshaft Gear
15 – Idler Gear Shaft
16 – Idler Gear Bushing
17 – Idler Gear
18 – Oil Pickup O-Ring
19 – Oil Pickup
20 – Crankshaft
21 – Parallel Pin
22 – Crankshaft Gear Key
23 – Crankshaft Gear
24 – Crankshaft Pulley
25 – Main Bearing Inserts
26 – Main Bearing Cap
27 – Oil Pan
28 – Thrust Bearings
29 – Flywheel
30 – Connecting Rod Cap
31 – Connecting Rod Bearing Inserts
32 – Connecting Rod
33 – Wrist Pin Bushing
34 – Circlip
35 – Wrist Pin
36 – Piston
37 – Oil Ring
38 – Second Compression Ring
39 – Top Compression Ring
40 – Crankshaft Rear Seal
41 – Crankshaft Rear Seal Housing

Disassembly of Engine

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

CAUTION

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

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If the engine will be completely disassembled, the following preliminary steps should be performed:

1. Disconnect the battery cables at the battery. Always disconnect the negative (-) cable first.
2. Remove the throttle cable, electrical connections, intake and exhaust system connections, and fuel supply lines from the engine.
3. Remove the alternator. *See Removal of Alternator on page 12-12.*
4. Drain the engine coolant from the radiator and cylinder block. *See Drain, Flush and Refill Cooling System With New Coolant on page 5-36.* Remove the cooling system components from the engine.
5. Remove the engine from the machine. Mount the engine to a suitable engine repair stand having adequate weight capacity.

⚠ CAUTION

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

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6. Clean the engine by washing with solvent, air or steam cleaning. Carefully operate so as to prevent any foreign matter or fluids from entering the engine or any fuel system or electrical components remaining on the engine.
7. Drain the engine oil into a suitable container. Remove the oil filter.
8. Remove the cylinder head. *See 2-Valve Cylinder Head on page 6-34* or *4-Valve Cylinder Head on page 6-49.*

8. If necessary, remove the crankshaft gear **(Figure 6-110, (1)),** parallel pin **(Figure 6-110, (2))** and key **(Figure 6-110, (3))**. If using a gear puller, be careful not to damage the threads in the end of the crankshaft.

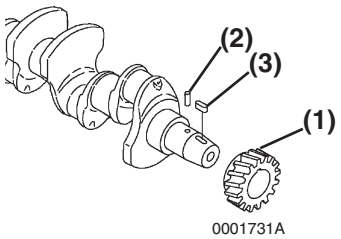

Figure 6-110

Inspection of Crankshaft and Camshaft Components

⚠ WARNING

FUME / BURN HAZARD!

- **Always read and follow safety related precautions found on containers of hazardous substances like parts cleaners, primers, sealants and sealant removers.**
- **Failure to comply could result in death or serious injury.**

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Thoroughly clean all components using a brush and appropriate solvent. Each part must be free of carbon, gasket material, metal filings and other debris.

Replacement of Crankshaft Oil Seals

1. Remove the seal **(Figure 6-111, (2))** from the cover **(Figure 6-111, (1))**.
2. Apply a continuous bead of ThreeBond Liquid Gasket No. 1212, Yanmar Part No. 977770-01212 to the outside diameter of a new oil seal **(Figure 6-111, (2)),** and install in the gear case cover**.** Apply lithium grease to the lip of the seal.

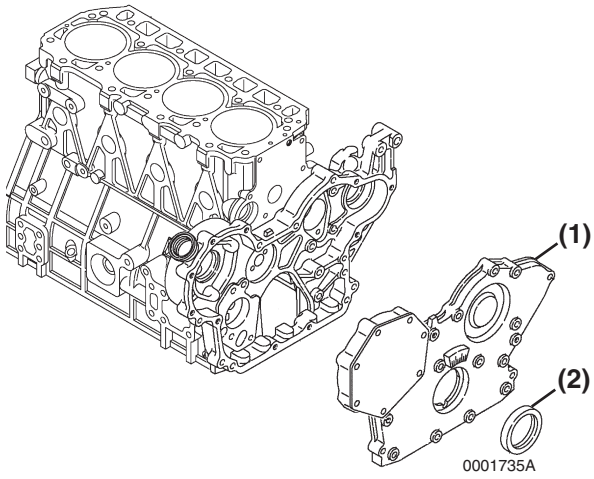


Figure 6-111

3. Remove the rear oil seal **(Figure 6-112, (3))** from the seal housing **(Figure 6-112, (2))**.
4. Apply a continuous bead of ThreeBond Liquid Gasket No. 1212, Yanmar Part No. 977770-01212 to the outside diameter of a new oil seal **(Figure 6-112, (2)),** and install in the housing**.** Apply lithium grease to the lip of the seal.

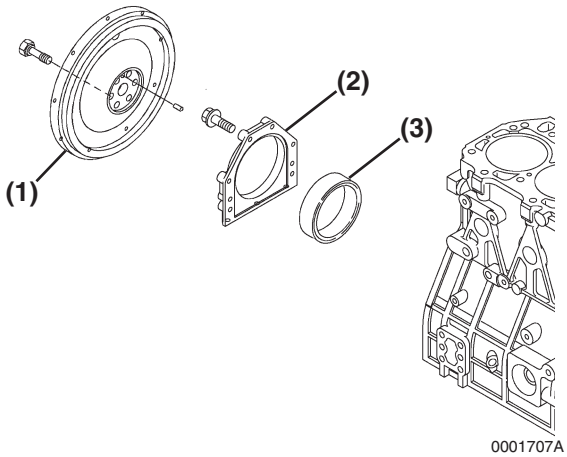


Figure 6-112

IMPORTANT

Always use a piston ring installation tool (expander) when installing piston rings. Never attempt to install piston rings by hand.

3. Reinstall the oil ring expander **(Figure 6-136, (4))**. Reinstall the oil ring **(Figure 6-136, (3))** with the end gap at 180° from the expander end gap**.**
4. Reinstall the second compression ring **(Figure 6-136, (2)).** This ring is identified by its dark color and tapered face profile**.**
5. Reinstall the top compression ring **(Figure 6-136, (1))**. This ring is identified by its silver color and barrel-shaped face profile.

IMPORTANT

*The oil ring expander **(Figure 6-136, (4))** end gap must be located 180° from the oil ring **(Figure 6-136, (3))** end gap.*

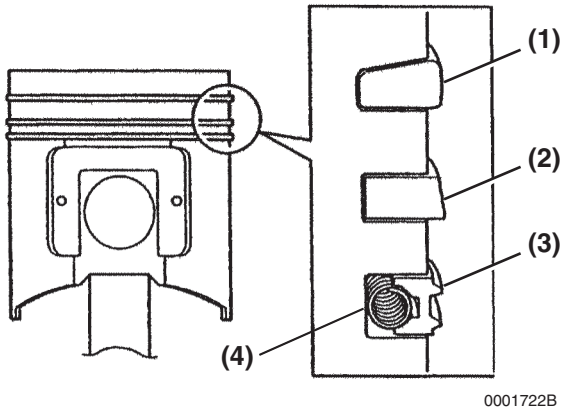
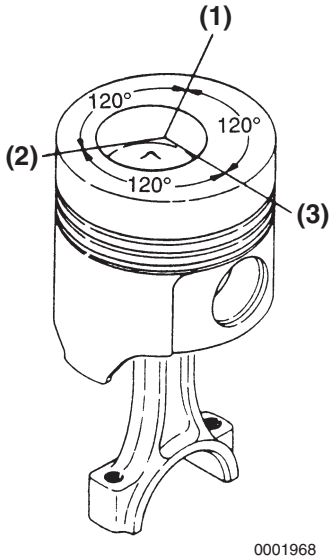


Figure 6-136

6. Stagger the piston ring end gaps at 120° intervals **(Figure 6-137, (1, 2, 3))**. Do not position the top piston ring end gap in line with the wrist pin.



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

Figure 6-137

Installation of Crankshaft

1. If removed, reinstall the keys and timing gear on the crankshaft.
2. Reinstall new bearing inserts **(Figure 6-138, (1))** and thrust bearing **(Figure 6-138, (2))** in the cylinder block and main bearing caps. Apply a liberal coat of clean engine oil to the bearings and crankshaft journals.
3. Place the crankshaft into the engine.

IMPORTANT

The main bearing caps are numbered and have arrows for proper positioning. The No. 1 cap is at the flywheel end. The arrows point toward the flywheel end of the engine.

4. Reinstall the main bearing caps **(Figure 6-138, (3))**.

EGR system

DANGER

SCALD HAZARD!

- NEVER remove the radiator cap if the engine is hot. Steam and hot engine coolant will spurt out and seriously burn you. Allow the engine to cool down before you attempt to remove the radiator cap.
- Tighten the radiator cap securely after you check the radiator. Steam can spurt out during engine operation if the cap is loose.
- ALWAYS check the level of the engine coolant by observing the reserve tank.
- Failure to comply will result in death or serious injury.

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WARNING

BURN HAZARD!

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

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WARNING

ENTANGLEMENT HAZARD!

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

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⚠ WARNING

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

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⚠ WARNING

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

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⚠ WARNING

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

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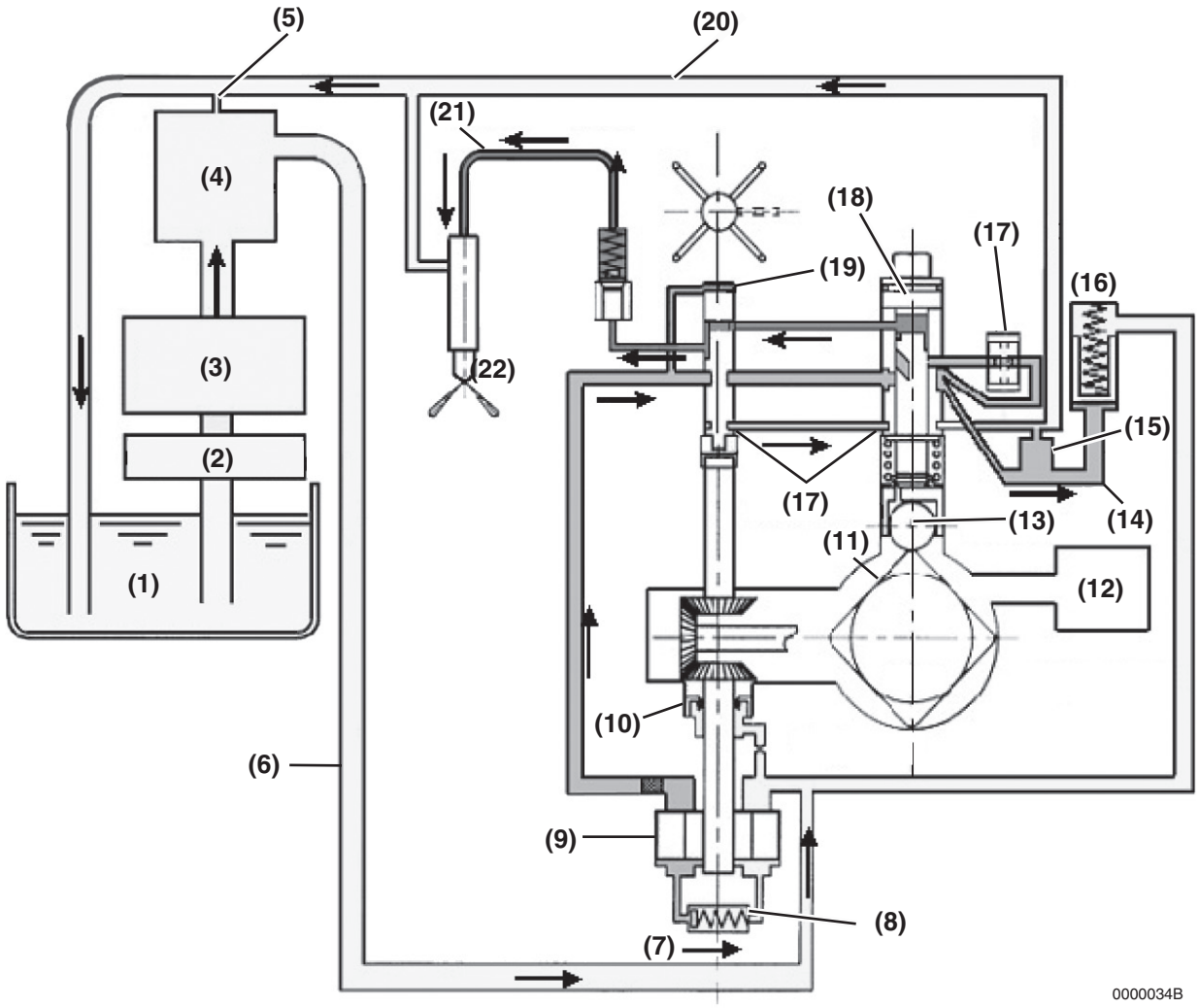
FUEL SYSTEM DIAGRAM



1 – Diesel Fuel Tank
2 – Fuel Filter / Water Separator
3 – Electric Fuel Pump
4 – Fuel Filter
5 – Air Bleed Orifice
6 – Fuel Supply Line
7 – Low Pressure Gallery
8 – Pressure Control Valve
9 – Trochoid Pump
10 – Oil Seal
11 – Fuel Injection Pump Cam
12 – Engine Crankcase
13 – Tappet
14 – High Pressure Gallery
15 – Overflow Orifice
16 – Accumulator
17 – Timer Piston
18 – Mono-Plunger
19 – Distributor Shaft
20 – Fuel Return Line
21 – High-Pressure Fuel Injection Lines
22 – Fuel Injector

Figure 7-4

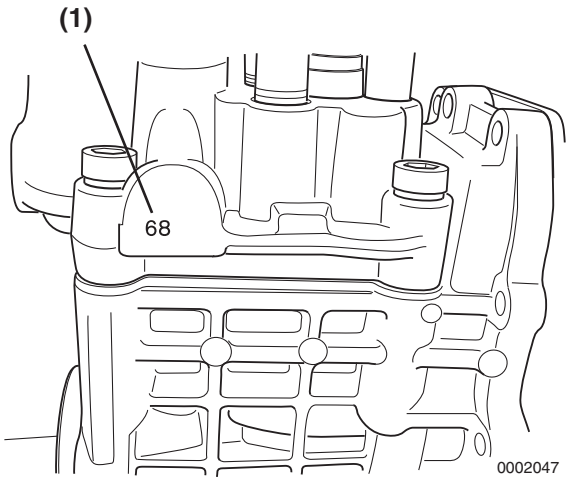


Figure 7-21

CAUTION

Do not rotate the crankshaft with the injection pump removed.

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25. If the fuel injection pump requires servicing, it must be sent to an authorized Yanmar FIE repair facility for repair and calibration, or replaced with a new fuel injection pump.

CAUTION

- **NEVER remove or attempt to remove the tamper-proof devices from the full-load fuel adjusting screw or the high-speed throttle limit screw on the fuel injection pump and governor assembly. These adjustments have been made at the factory to meet all applicable emissions regulations and then sealed.**
- **NEVER attempt to make any adjustments to these sealed adjustment screws. If adjustments are required, they can be made only by a qualified fuel injection shop that will ensure the injection pump continues to meet all applicable emissions regulations and then replace the tamper-proof seals.**
- **Tampering with or removing these devices may void the "Yanmar Limited Warranty."**

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Installation of Fuel Injection Pump

For electronically controlled engine

⚠ WARNING

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

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13. If the injection timing is correct, remove the dial indicator and adapter. Replace the pump plunger plug and its copper gasket and tighten to specifications. Replace the flywheel inspection port cover. Open the fuel supply valve and remove the clamp from the fuel supply hose and the fuel return hose.
14. Prime the fuel system. Operate the engine and check for leaks.

Adjusting Fuel Injection Timing

If the timing marks did not align when performing the *Checking Fuel Injection Timing on page 7-31*, the following steps must be performed to properly time the engine.

1. Leave the dial indicator installed in the fuel injection pump. Do not disturb the reading on the dial indicator.
2. Rotate the flywheel until the target timing mark **(Figure 7-46, (1))** and the timing reference mark **(Figure 7-46, (2))** on the flywheel housing or back plate are aligned.

IMPORTANT

Do not rotate the crankshaft during the remainder of this procedure.

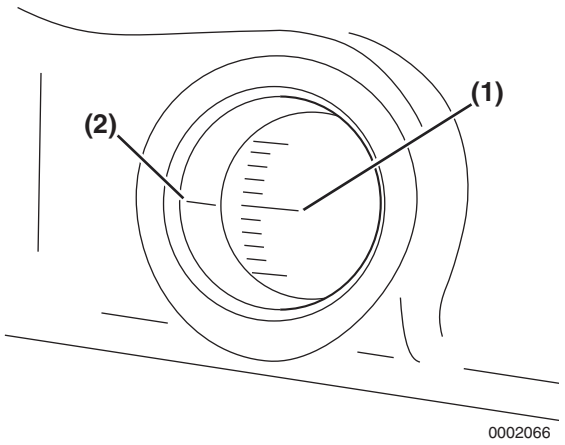

Figure 7-46

3. Note the reading on the dial indicator **(Figure 7-47, (1))**. If the reading is less than 2.5 mm (0.098 in.), the fuel injection timing is “retarded.” If the dial indicator reading is greater than 2.5 mm (0.098 in.), the fuel injection timing is “advanced.”

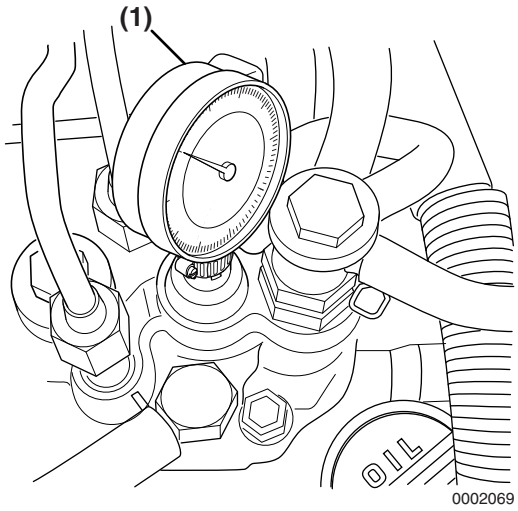

Figure 7-47

Note: Some model engines require the intake manifold and fuel injection pump insulator be removed to access the inner fuel injection pump retaining nuts.

4. Loosen the nuts fastening the fuel injection pump to the gear case or front plate. Loosen the rear bracket(s) on the fuel injection pump.

Note: Loosening the high-pressure injection line nuts on the fuel injection pump may make rotating the pump easier.

5. Rotate the fuel injection pump until the dial indicator reads 2.5 mm (0.098 in.).
6. To “advance” the injection timing, rotate the top of the fuel injection pump away from the engine.
7. To “retard” the injection timing, rotate the top of the fuel injection pump toward the engine.
8. When the dial indicator reads 2.5 mm (0.098 in.) of pump plunger lift and the target timing mark on the flywheel aligns with the reference mark on the flywheel housing or engine back plate, the injection timing is correct.

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Disassembly of Engine Coolant Pump

1. Remove the thermostat cover **(Figure 8-8, (1))**. Discard the gasket.

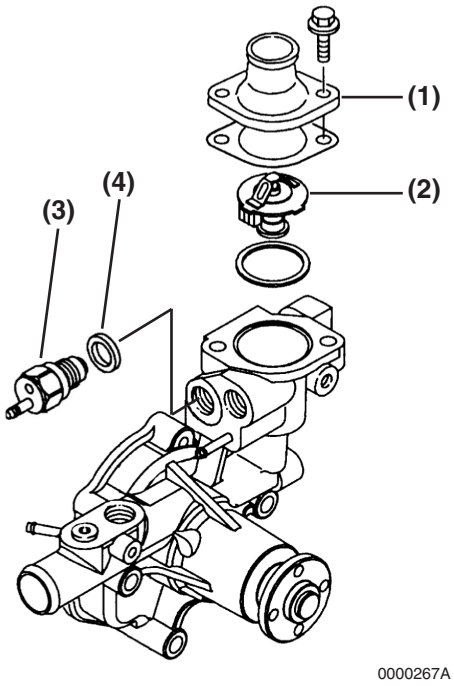

Figure 8-8

2. Remove the thermostat **(Figure 8-8, (2))**. Discard the O-ring. Remove the temperature switch **(Figure 8-8, (3))** and gasket **(Figure 8-8, (4))**. Discard the gasket.

Cleaning and Inspection

Temperature Switch

1. Check for proper operation of the temperature switch. Connect a continuity light or ohmmeter to the temperature switch. Connect one lead to the terminal of the switch **(Figure 8-9, (1))** and the other lead to the metal portion of the switch **(Figure 8-9, (2))**.

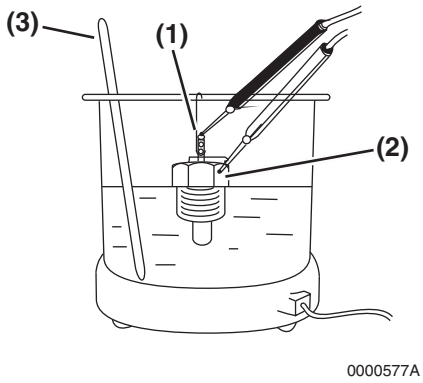

Figure 8-9

2. Place the temperature switch and an accurate thermometer **(Figure 8-9, (3))** in engine coolant.
3. Slowly increase temperature of the fluid using an external heat source.
4. The temperature switch is operating properly if the continuity light or ohmmeter indicates continuity when the fluid temperature reaches 225°F - 235°F (107°C - 113°C).

Water temperature sensor

1. Inspect the water temperature sensor to make sure that it is properly operating. As shown in the following figure, connect an electric resistor to the coupler of the water temperature sensor **(Figure 8-10, (1))**.

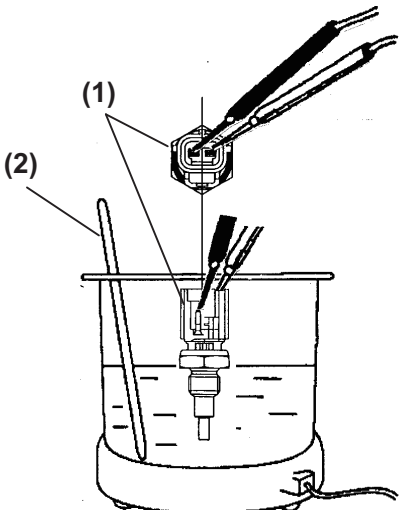

Figure 8-10

Outer Rotor Outside Clearance

Model	Standard	Limit	Reference Page
3TNV82A, 3TNV84, 3TNV84T 3TNV88, 4TNV84, 4TNV88, 4TNV84T	0.0047 - 0.0083 in. (0.12 - 0.21 mm)	0.0118 in. (0.30 mm)	Check Outer Rotor Outside Clearance on page 9-11
3TNV82A-B 3TNV88-B, 3TNV88-U 4TNV88-B, 4TNV88-U 3TNV84T-Z, 4TNV84T-Z	0.0035 - 0.0063 in. (0.09 - 0.16 mm)	0.0098 in. (0.25 mm)	Check Outer Rotor Outside Clearance on page 9-14
4TNV94L, 4TNV98, 4TNV98T 4TNV98-Z, 4TNV98-E 4TNV98T-Z	0.0039 - 0.0061 in. (0.100 - 0.155 mm)	0.0098 in. (0.25 mm)	Check Outer Rotor Outside Clearance on page 9-18
4TNV106, 4TNV106T	0.0039 - 0.0065 in. (0.100 - 0.165 mm)	0.0098 in. (0.25 mm)	

Outer Rotor Side Clearance

Model	Standard	Limit	Reference Page
3TNV82A, 3TNV84, 3TNV84T 3TNV88, 4TNV84, 4TNV88, 4TNV84T	0.0008 - 0.0028 in. (0.02 - 0.07 mm)	0.0047 in. (0.12 mm)	Check Outer Rotor Side Clearance on page 9-12
3TNV82A-B 3TNV88-B, 3TNV88-U 4TNV88-B, 4TNV88-U 3TNV84T-Z, 4TNV84T-Z	0.0020 - 0.0039 in. (0.05 - 0.10 mm)	0.0059 in. (0.15 mm)	Check Outer Rotor Side Clearance on page 9-15
4TNV94L, 4TNV98, 4TNV98T 4TNV98-Z, 4TNV98-E 4TNV98T-Z	0.0020 - 0.0039 in. (0.05 - 0.10 mm)	0.0059 in. (0.15 mm)	Check Outer Rotor Side Clearance on page 9-18
4TNV106, 4TNV106T	0.0012 - 0.0047 in. (0.03 - 0.12 mm)	0.0067 in. (0.17 mm)	

Outer Rotor to Inner Rotor Tip Clearance

Model	Standard	Limit	Reference Page
3TNV82A, 3TNV84, 3TNV84T 3TNV88, 4TNV84, 4TNV88, 4TNV84T	-	0.0063 in. (0.16 mm)	Outer Rotor to Inner Rotor Tip Clearance on page 9-11
3TNV82A-B 3TNV88-B, 3TNV88-U 4TNV88-B, 4TNV88-U 3TNV84T-Z, 4TNV84T-Z	-	0.0063 in. (0.16 mm)	Outer Rotor to Inner Rotor Tip Clearance on page 9-15
4TNV94L, 4TNV98, 4TNV98T 4TNV98-Z, 4TNV98-E 4TNV98T-Z	-	0.0063 in. (0.16 mm)	Outer Rotor to Inner Rotor Tip Clearance on page 9-18
4TNV106, 4TNV106T	-	0.0063 in. (0.16 mm)	

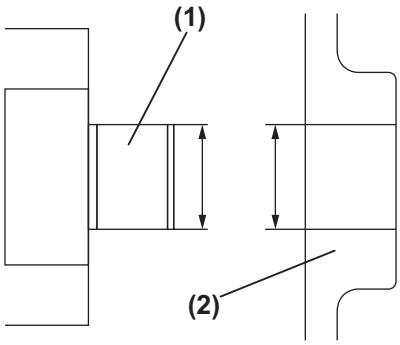

Figure 9-20

Record the measurement(s) and see Rotor Shaft Clearance <Trochoid type 3TNV82A-B - 4TNV88-B, 4TNV94L - 4TNV106T> on page 9-7 for the service limits.

Reassembly of Oil Pump

1. Apply clean lubricating oil to the lubricating oil pump body and inner rotor assembly as well as to the outer rotor.
2. Insert the outer rotor into the lubricating oil pump body and inner rotor assembly and install the cover.
3. Replace the packing with new one.
4. Install the lubricating oil pump assembly to the gear case flange by tightening the bolts with the specified torque.
5. Install the gear case cover. For more information, *See Installation of Gear Case Cover on page 6-97*.
6. Install the crank shaft pulley.
7. Install the cooling water pump V-pulley **(Figure 9-21, (1))**, spacer **(Figure 9-21, (2))**, cooling water fan **(Figure 9-21, (3))**, and fan guard (if equipped).

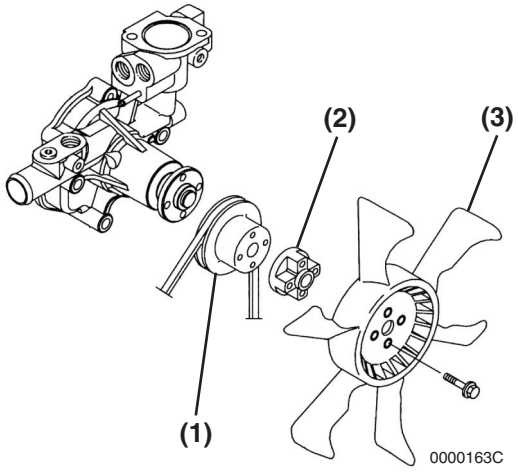

Figure 9-21

8. Install the V-belt. Adjust the belt to uniform tensile strength in accordance with the instructions given in *Check and Adjust Cooling Fan V-Belt on page 5-22*.

TROUBLESHOOTING

The following troubleshooting procedures apply to problems identified as turbocharger related. Consider all other troubleshooting possibilities before cleaning or removing the turbocharger.

Excessive Exhaust Smoke

Cause	Corrective action
Clogged air cleaner element	Clean or replace the air cleaner element
Blocked air intake port	Correct the condition
Leak from a joint in intake line	Correct the condition

Cause	Corrective action
1. Compressor impeller dirty	1. Wash the impeller blades.
2. Deposit of impurities in oil sticking on the turbine side seal portion to make turbine revolution heavy	2. Repair the turbocharger. Send to a qualified repair facility.
3. Sticking bearing:	
3a. Insufficient lubrication or clogged lubrication piping	3a. Repair turbocharger. Send to qualified repair facility.
3b. Excessively high oil temperature	3b. Inspect the lubricating oil line for problem. Correct the condition and replace lubricating oil.
3c. Unbalanced rotating part	3c. Repair the turbocharger. Send to a qualified repair facility.
3d. Insufficient warming up or sudden stop from loaded operation (no-load operation)	3d. Improper operation of the machine. Refer to the *Operation Manual*.
4. Contact or breakdown of turbine wheel or blower vane:	
4a. Excessive revolution	4a. Inspection and repair of each engine part
4b. Excessive exhaust temperature rise	4b. Inspection and repair of each engine part
4c. Foreign matter within turbocharger	4c. Clean the air cleaner and engine compartment. Repair the turbocharger. Send to a qualified repair facility.
4d. Worn bearing	4d. Repair the turbocharger. Send to a qualified repair facility.
4e. Incorrect assembly of turbocharger	4e. Repair the turbocharger. Send to a qualified repair facility.

Cause	Corrective action
Exhaust system gas leak prior to the turbocharger. Condition will decrease turbocharger revolutions.	Inspect the exhaust system for leaks. Correct the condition.
Deformed or clogged exhaust pipe. Condition will decrease turbocharger revolutions.	Correct the condition.

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STARTER MOTOR

⚠ WARNING

SHOCK HAZARD!

- **Turn off the battery switch (if equipped) or disconnect the negative battery cable before servicing the electrical system.**
- **Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors. ALWAYS keep the connectors and terminals clean.**
- **Failure to comply could result in death or serious injury.**

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Note: While starter motor design varies between models, the basic repair procedures are the same. The following procedures are typical and may differ from the stater being serviced.

Removal of Starter Motor

1. Disconnect the battery cables at the battery, negative (-) cable first.
2. Remove the electrical wires from the magnetic switch assembly.
3. Remove the starter mounting bolts **(Figure 11-2, (1))**. Remove the starter motor from the flywheel housing.

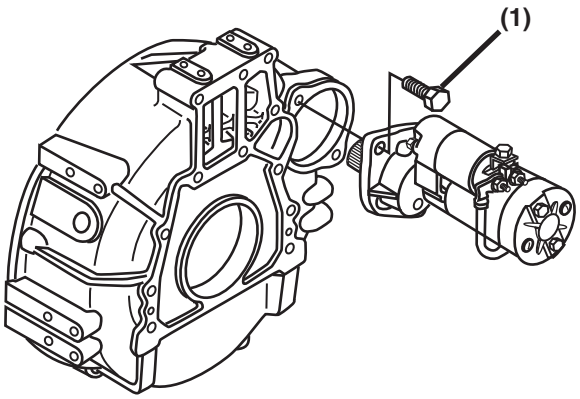

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Figure 11-2

Disassembly of Starter Motor

1. Loosen the M8 nut from the magnetic switch (solenoid) assembly **(Figure 11-3)**. Disconnect the wire from the magnetic switch.

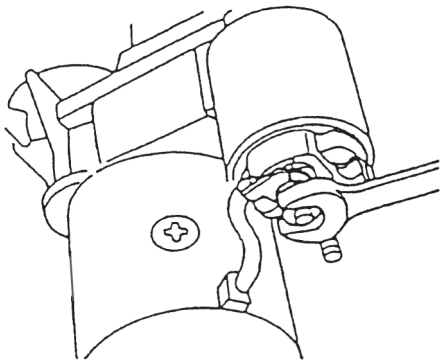

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Figure 11-3

2. Remove the two M4 bolts **(Figure 11-4, (1))** securing the rear cover **(Figure 11-4, (2))** to the brush holder assembly **(Figure 11-4, (3))**.

Installation of Starter Motor

1. Reinstall the starter motor to the flywheel housing.
2. Reinstall the starter mounting bolts **(Figure 11-36, (1))**. Tighten the bolts to specification. *See Tightening Torques for Standard Bolts and Nuts on page 4-46*.

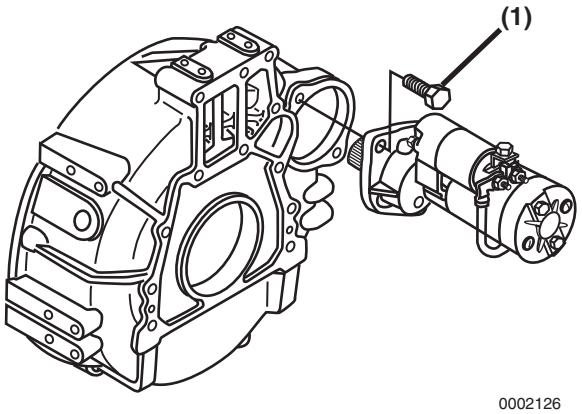
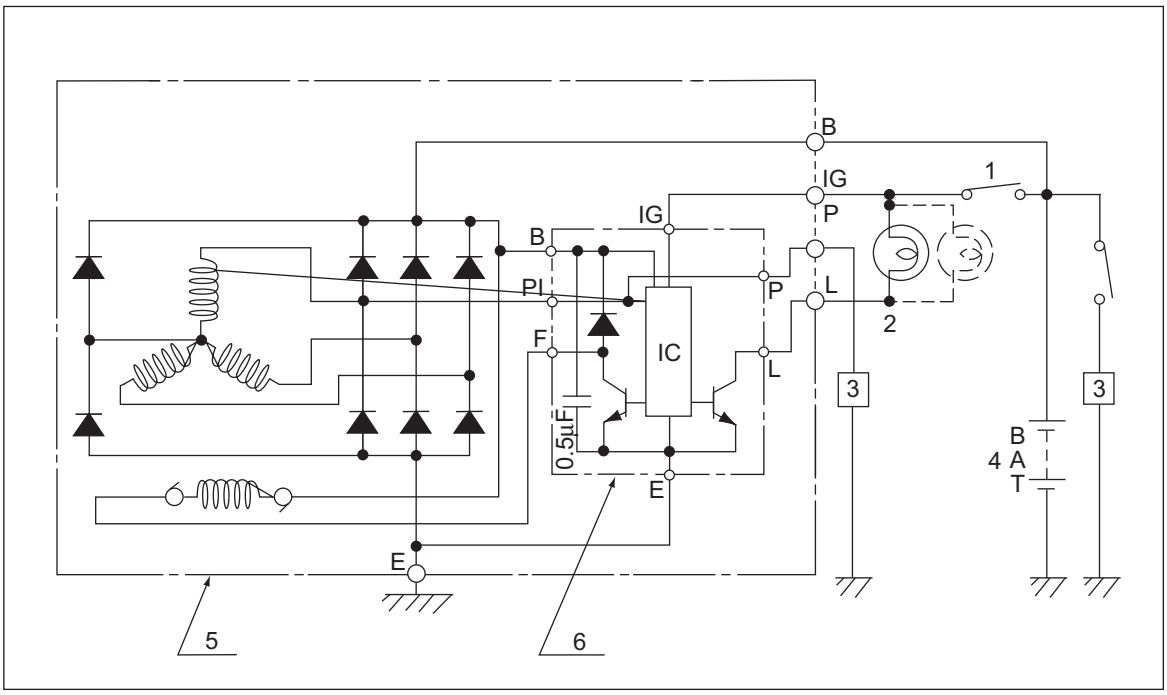


Figure 11-36

3. Reconnect the electrical wires to the magnetic switch assembly (solenoid). Be sure to place the cover over the battery positive (+) cable connection.
4. Reconnect the battery cables at the battery.

ALTERNATOR WIRING DIAGRAM



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

Figure 12-2

CAUTION

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

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CAUTION

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

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CAUTION

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

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TESTING OF DYNAMO

Use a circuit tester or multimeter to perform the following tests.

Testing Stator Coil Continuity

1. Disconnect the dynamo output wire connector.
2. Connect one meter lead to each of the stator wire terminals and read the meter.

Results: The meter reading should indicate continuity. If continuity is not indicated, the windings are open and the stator must be replaced.

Testing Stator Coil Short-to-Ground

1. Disconnect the dynamo output wire connector.
2. Test continuity between each stator wire terminal and engine ground.

Results: The meter reading should infinity. If the meter reading indicates continuity, the windings are shorted to ground and the stator must be replaced.

Testing Dynamo Regulated Output

1. Test and record the battery voltage with the engine not running.
2. Start the engine and operate it at normal operating rpm.
3. Again, check the battery voltage with the engine running.

Results: The meter reading with the engine running must be higher than with the engine not running.

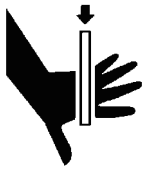
- If results are not correct, test the stator for continuity and shorts to the ground.
- Check the charging system wiring.
- If no problems are found in previous checks, replace the IC regulator.

DYNAMO

Removal of Dynamo

1. Disconnect the output wire connector from the dynamo.
2. Loosen the V-belt.

⚠ CAUTION



PINCH HAZARD!

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

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3. Remove the V-belt adjuster from the dynamo bolt **(Figure 12-23, (1))**.
4. Remove the nut **(Figure 12-23, (2))** from the gear case stud. Remove the dynamo.

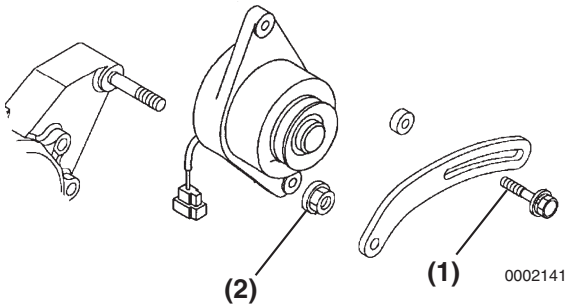

Figure 12-23