NEW HOLLAND

HYDRAULIC EXCAVATOR

E18B TIER 4

SERVICE MANUAL

S5PU0019E01

Issued 3 - 2010

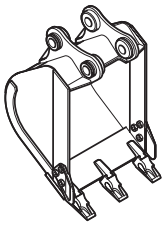
NEW HOLLAND CONSTRUCTION

Issue	Date of Issue	Applicable Machines	Remarks
	March 2010	E18SR : NATN16300~	(NH - NA)
↑	↑	E10SR : PA03-05001~	↑ (NHK-AUS)
↑	December, 2009	E18SR : PU09-08001~	↑ (NHK-EUR)
First Edition	June, 2009	E10SR : PA03-05001~	S5PA0105E01 (NHK-EUR)
↑	↑	E18SR : PU09-08001~	↑ (NH AUS)
↑	↑	E30B : PW14-45964~ E35B : PX15-20658~	↑ (NH-NA)

2. SPECIFICATIONS

Issue	Date of Issue	Applicable Machines	Remarks
First Edition	March 2010	E18B - NATN16300	(NH - NA)

2.7 TYPE OF BUCKET

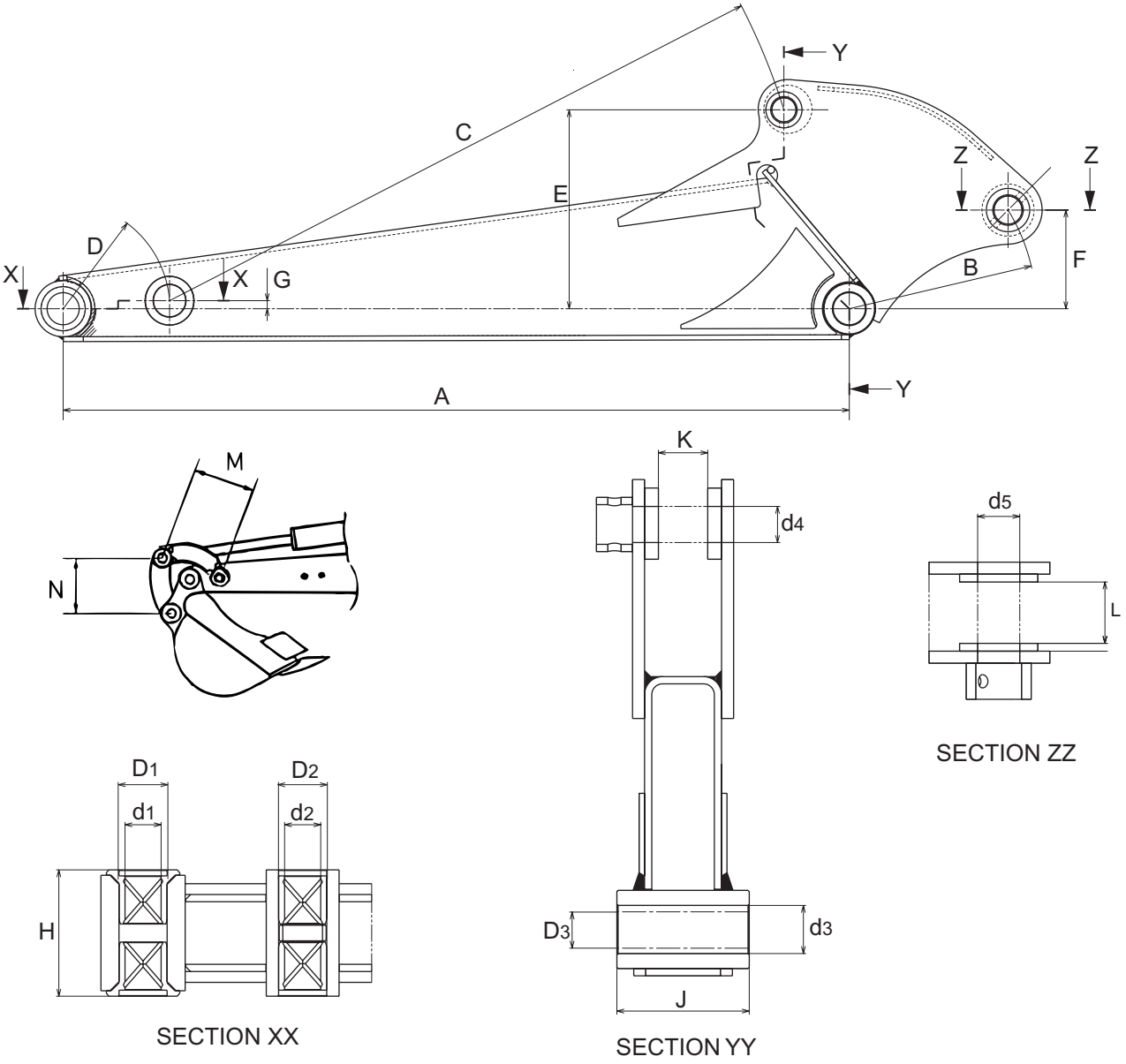
Type	Heaped Capacity m^3 (cu yd)	Outer width mm (in)		Number of tooth	Weight kg (lbs)
		with side cutter	without side cut		
Bucket 	0.044 (0.058)	450 (17.7")	420 (16.5")	3	35 (77)

Note

this table shows Japanese standard bucket.

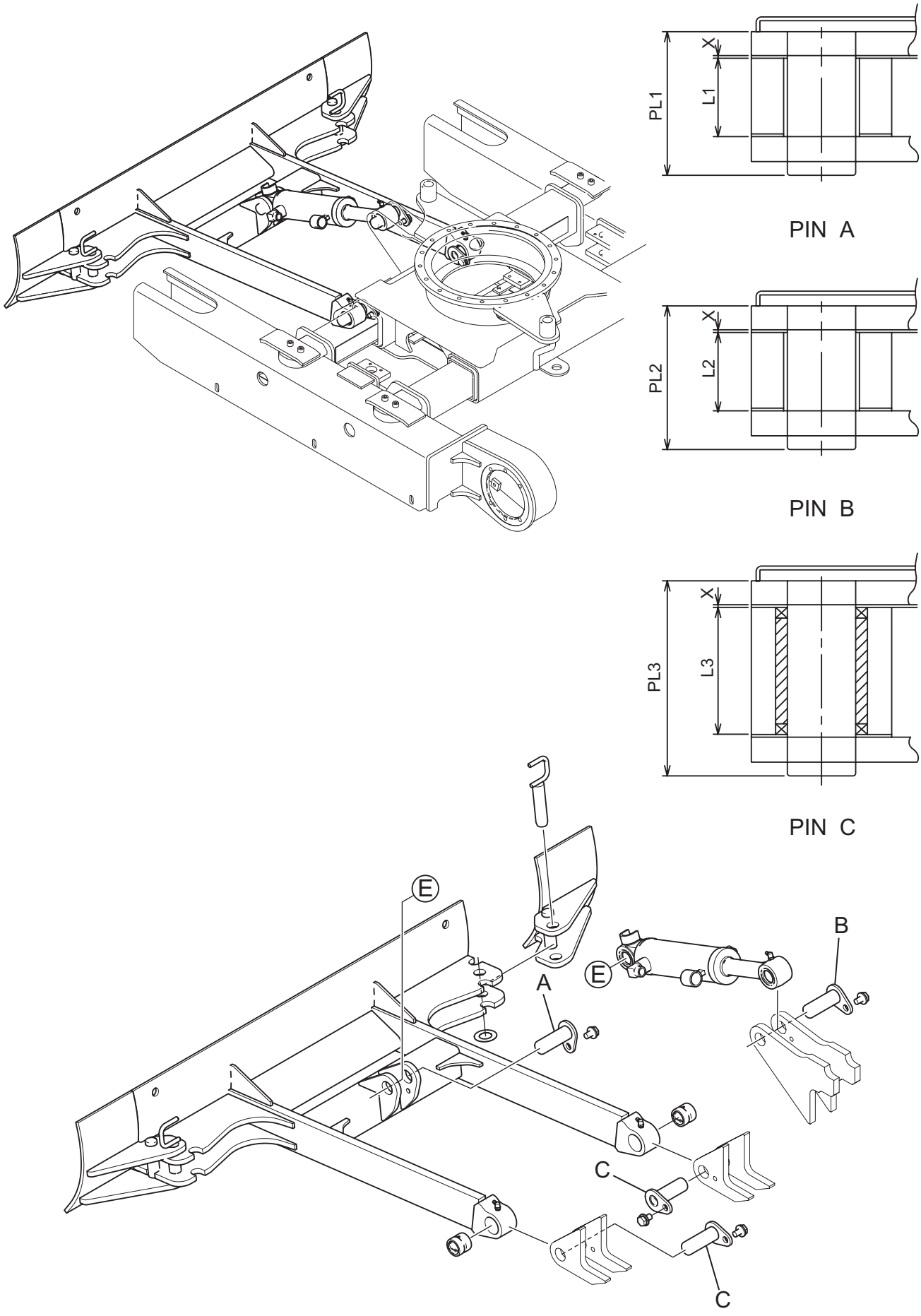
3.2 ARM

3.2.1 ARM DIMENSIONAL DRAWINGS



Arm dimensional drawings

3.4.2 DOZER MAINTENANCE STANDARDS



Dozer maintenance standards

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)

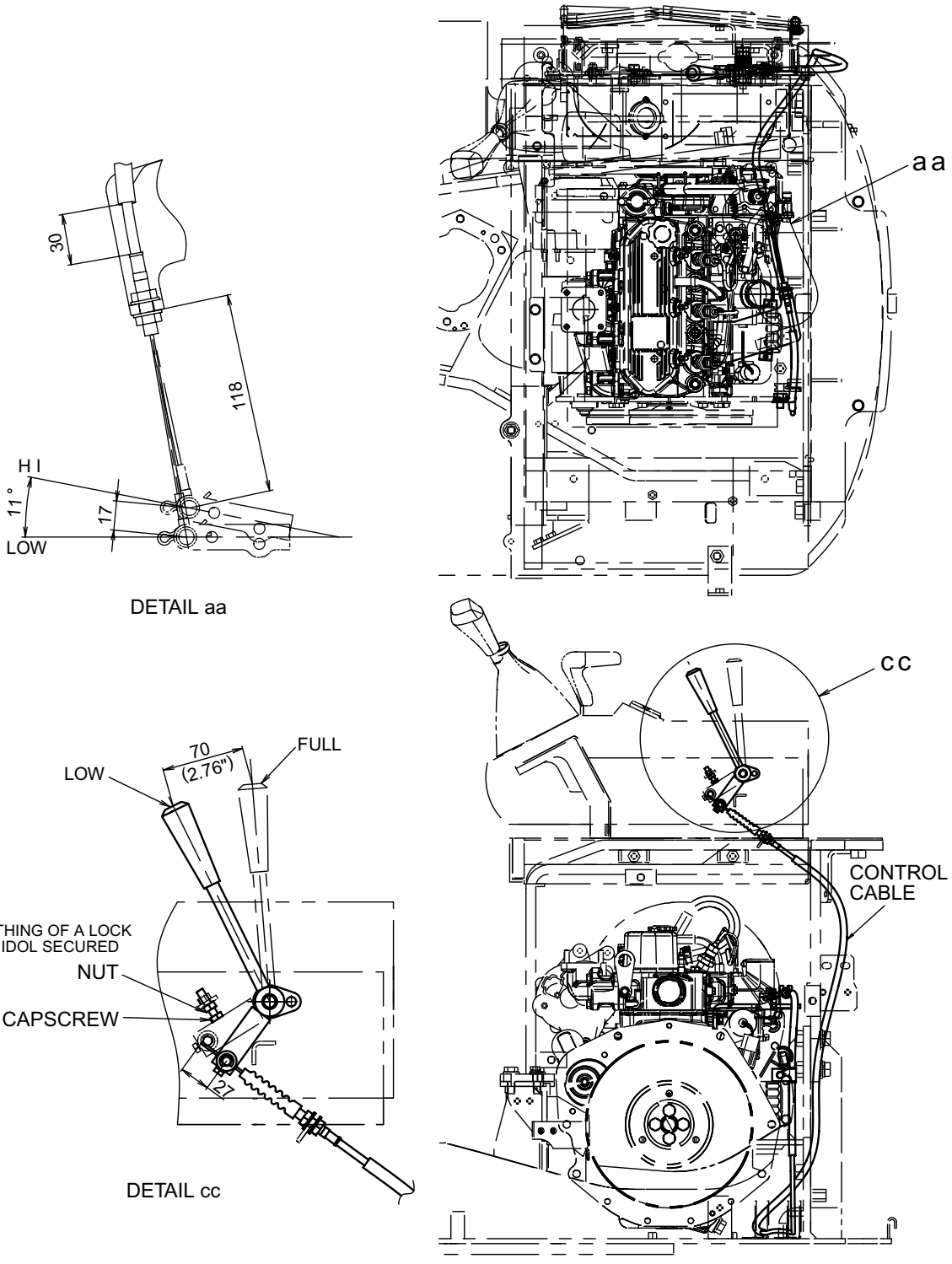
03 Upper structure (4/4)

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	- ditto -	1 set	Apply sealant	0.3
133	-Upper frame slinging	- ditto -	1 pc.		0.3
134	-Cleaning	Cleaning	1 pc.		0.2
	Other necessary works	Rem./Inst.	1 pc.	Canopy	0.2
		- ditto -	1 pc.	Guard (Cover, support)	1.5
		- ditto -	1 pc.	Counterweight	0.4
		Drain / Feed	1 pc.	Hydraulic oil	0.2
		Rem./Inst.	1 set	Swivel joint hose	0.5
		- ditto -	1 set	Boom	1.2

(4) Speed Adjustment

Low / High Idling Speed is low ;

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



Accelerator wire adjustment

CAUTION

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

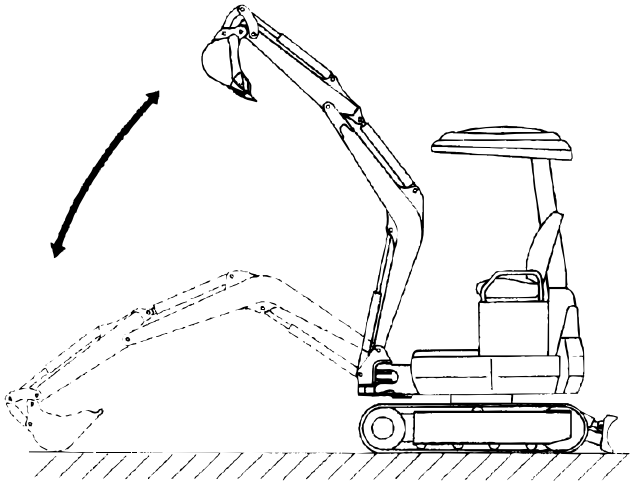
13.7 MEASURING ATTACHMENT OPERATING PERFORMANCES

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

13.7.1 CYLINDER SPEED

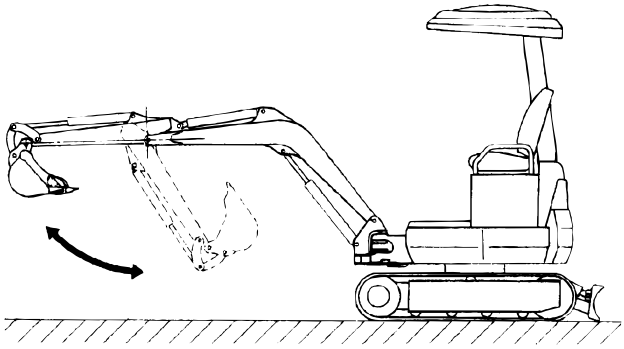
(1) Boom Cylinder Speed

- Engine : High Idle
- Hydraulic Oil Temp. : 50 to 60C degrees (122 to 140F degrees)
- 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 (lowest point) from its lowest point (highest point) placing on the ground. (Do not include the cushioning time.)



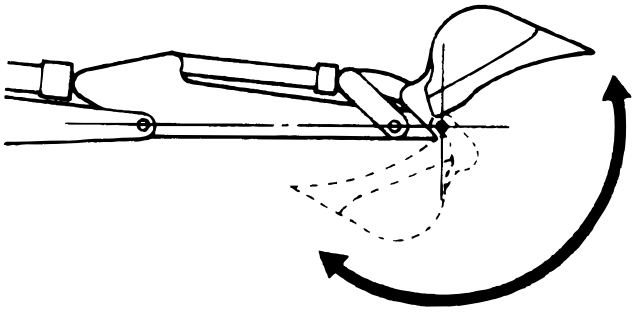
(2) Arm Cylinder Speed

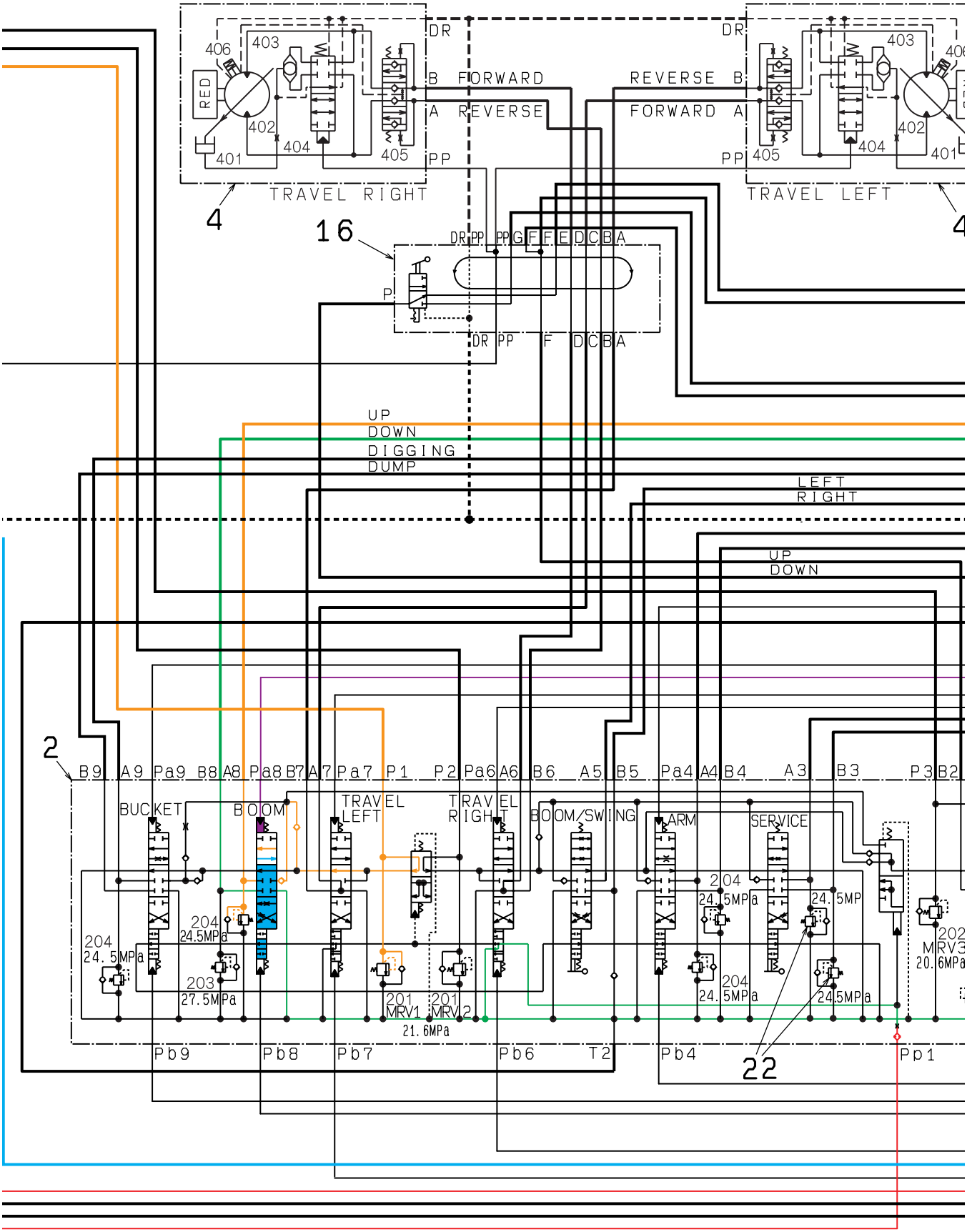
- Engine : High Idle
- Hydraulic Oil Temp. : 50 to 60C degrees (122 to 140F degrees)
- Measurement Posture : Completely retract the arm cylinder, fully extend the bucket cylinder, position the arm horizontally and place the dozer blade on the ground.
- Then measure the time required for the arm cylinder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



(3) Bucket Cylinder Speed

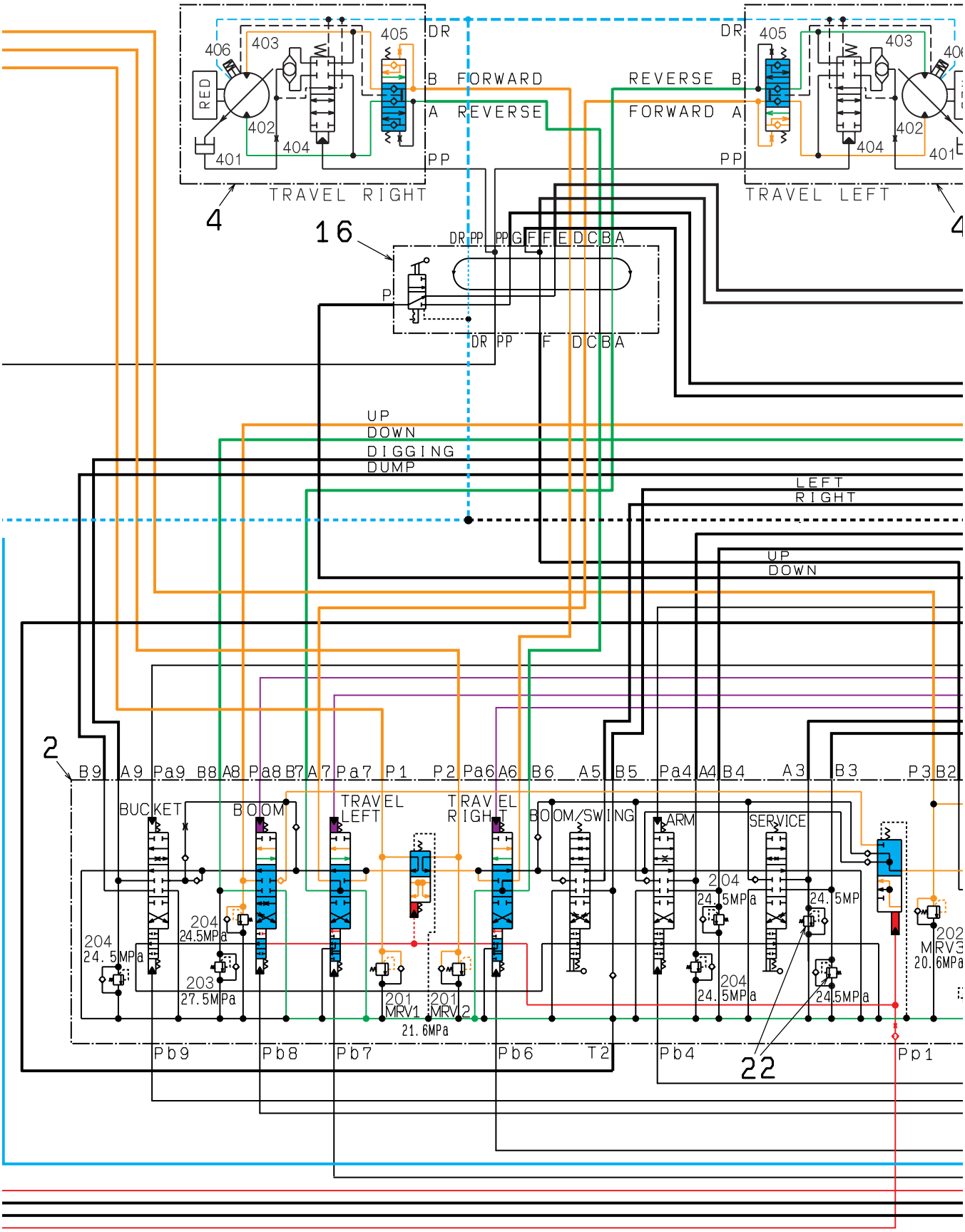
- Engine : High Idle
- Hydraulic Oil Temp. : 50 to 60C degrees (122 to 140F degrees)
- Measurement Posture : Completely retract the arm cylinder, position the arm horizontally and place the dozer blade on the ground.
- Then measure the time required for the bucket cylinder to completely retract (extend)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





No.	NAME	PRESSURE:MPa {psi}	No.	
201	MAIN RELIEF VALVE P1,P2	21.6 {3130}	204 22	OVER
202	MAIN RELIEF VALVE P3	20.6 {2990}	304	SLEW
203	OVER LOAD RELIEF VALVE	27.5 {3990}	13-1	PILOT

Boom circuit : Boom up operation



No.	NAME	PRESSURE:MPa {psi}	No.	
201	MAIN RELIEF VALVE P1,P2	21.6 {3130}	204 22	OVER
202	MAIN RELIEF VALVE P3	20.6 {2990}	304	SLEW
203	OVER LOAD RELIEF VALVE	27.5 {3990}	13-1	PILOT

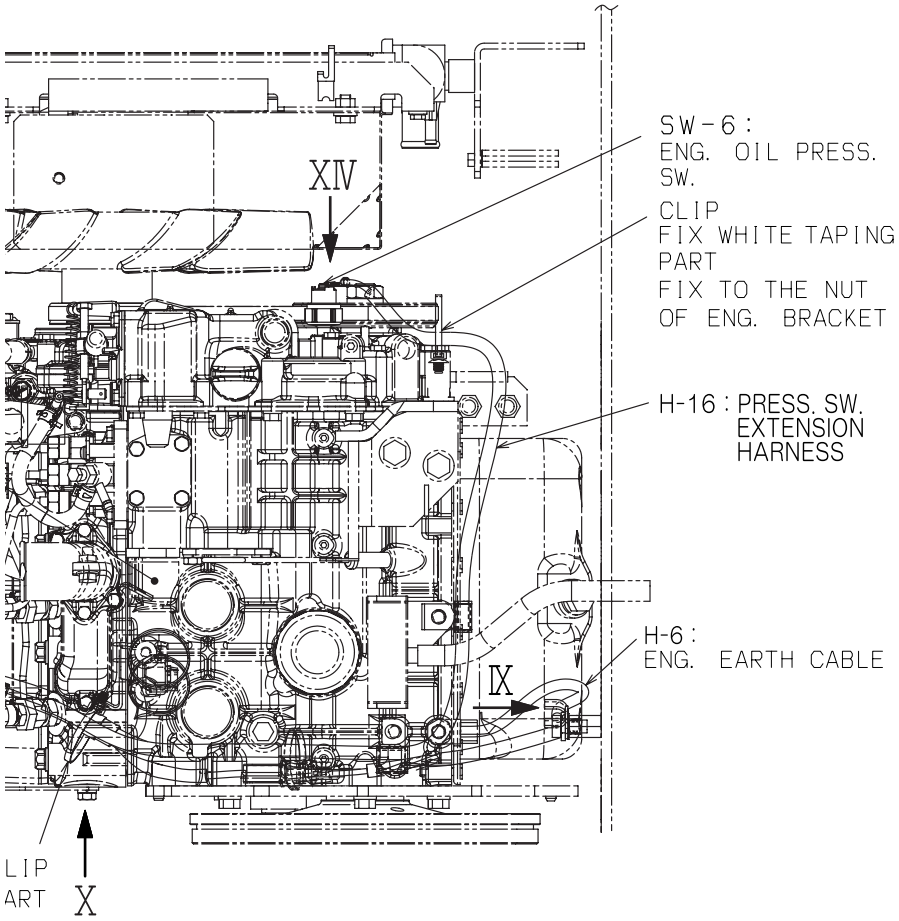
Combined operation circuit : Travel (forward) 1st speed / Boom up operation

23.2.2 HARNESS & CABLE LIST

Code	Name		Part No.	Remarks
H-1	Main Harness		PU13E01046P3	
H-4	Starter Cable (+)		PU13E01049P2	
H-5	Battery Ground Cable (-)		PU13E01050P1	
H-6	Engine Ground Cable		PU13E01051P1	
H-7	Boom Harness	Canopy	PU15E01004P3	
		Cab	PU15E01005P1	(OPT)
H-8	Key Switch Harness		PW50E01002P1	
H-9	Hand Rail Work Light Harness		PU11E01004P1	
H-10	Boom Work Light Extension Harness		PU13E01052P2	
H-11	Connection Harness with Cab		PU13E01061P1	(OPT.)
H-13	Travel Alarm Harness		PW13E01069P1	(OPT.)
H-14	Alarm Extension Harness		PU13E01056P1	(OPT.)
H-15	Heater Harness		PU13E01039P1	(OPT.)
H-16	Pressure SW. Extension Harness		PU13E01059P1	
H-17	Jamper Connector		PW14E01018P1	(OPT.)

Note

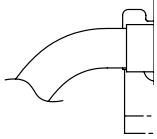
The part number may be changed owing to modification, use them only for reference.



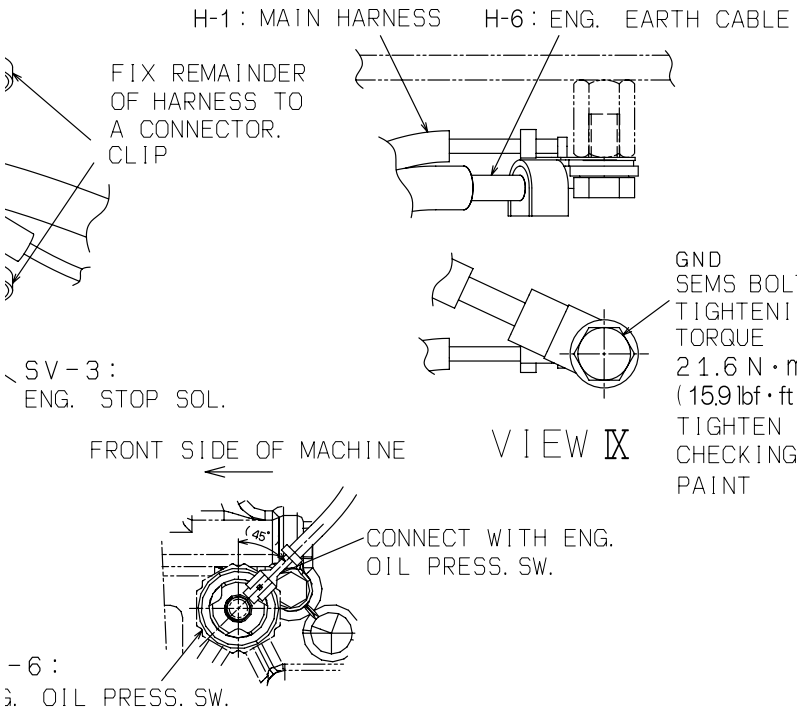
SW-5 :
ENG. WATER

E-8 : GL
TIGHTENI
1.0~1.
(0.74~1.1

SECTION C-C



VI

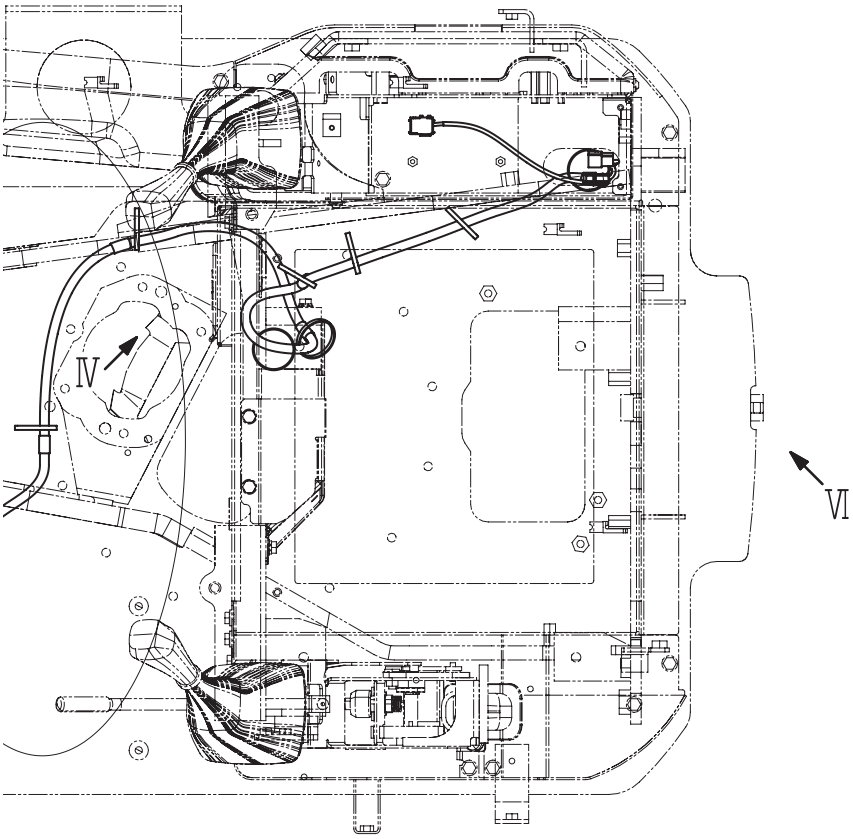


VIEW IX

VIEW XIV

CAP SCREW
TIGHTENING
TORQUE
10.7 N·m
(7.9 lbf·ft)

E-3 : HOR

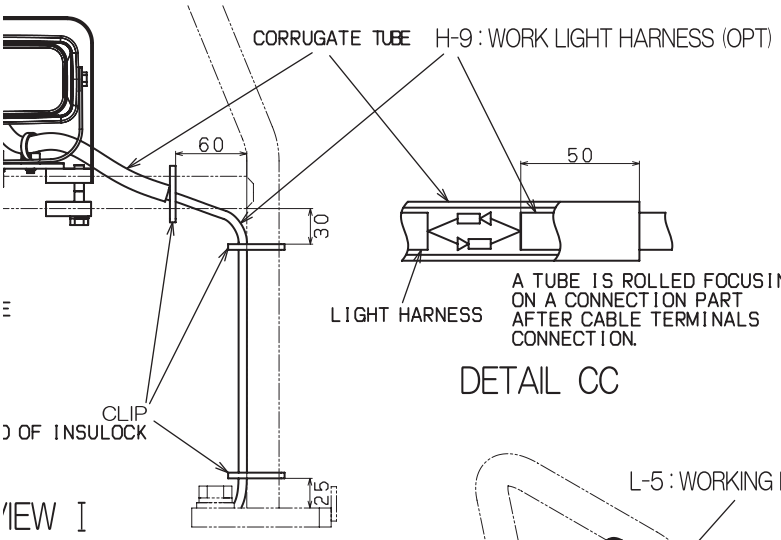


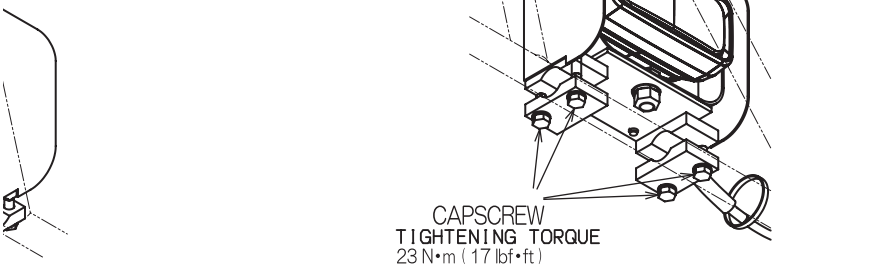
WHITE TAPING
POSITION TO BE A
THIS WHITE TAPIN

CLIP
FIX A MAIN
HARNESS WITH
CLIP.

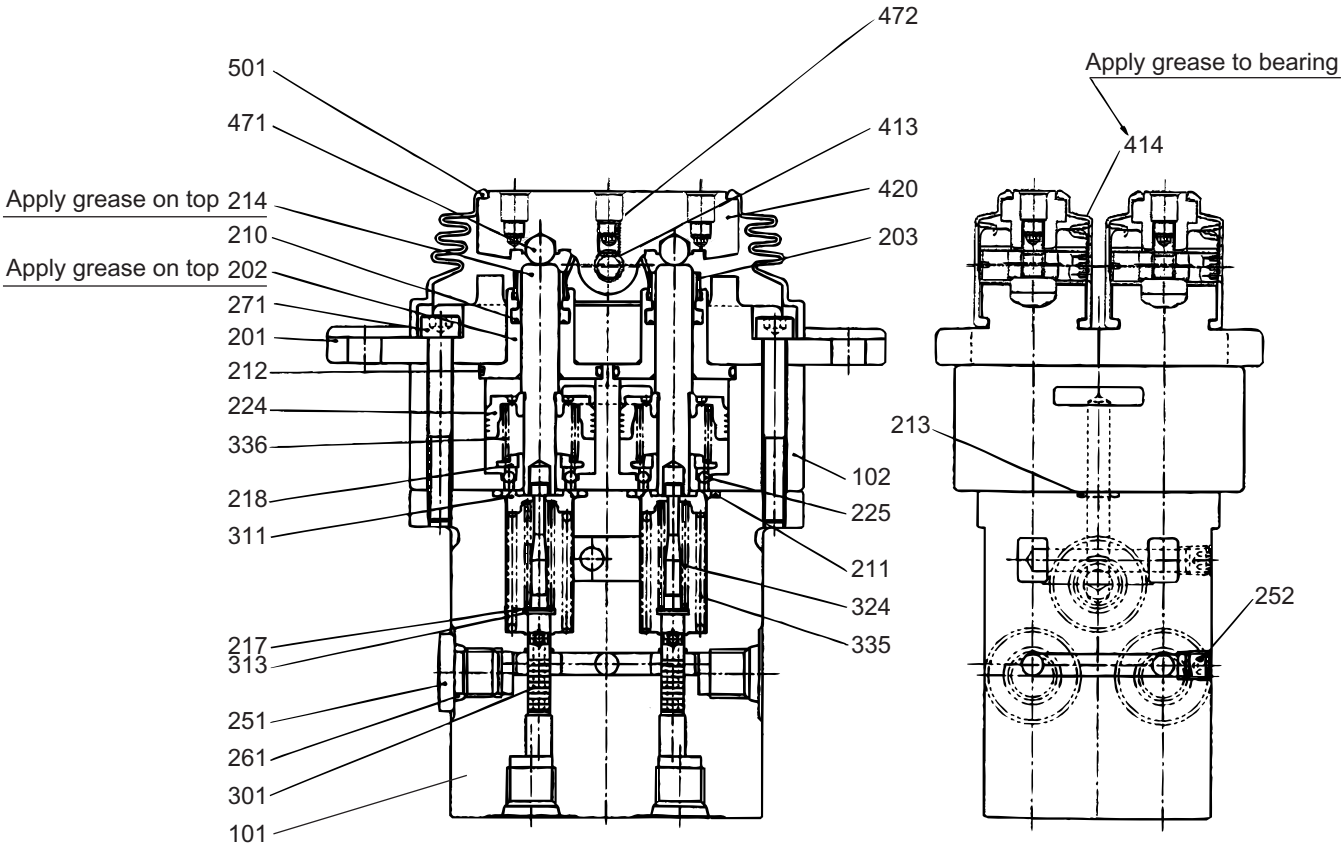
FIX WH
TAPIN

FIX
FOR





24.1.3.2 CONSTRUCTION



Pilot valve-Sectional view

Torque N-m (lbf-ft)	No.	NAME	Q'TY	Torque N-m (lbf-ft)	No.	NAME	Q'TY
	101	Casing	1	6.9 (5.1)	252	Plug	2
	102	Casing (Damper)	1		261	O-ring	3
	201	Cover	2	8.8 (6.5)	271	Capscrew	4
	202	Plug			301	Spool	4
	203	Grease cup			311	Spring seat	4
	210	Packing			313	Washer	4
	211	O-ring			324	Spring	4
	212	O-ring			335	Spring	4
	213	O-ring			336	Spring	4
	214	Push rod			413	Cam shaft	2
	217	Shim			414	Bushing	4
	218	Spring seat			420	Cam	2
	224	Piston			471	Steel ball	4
	225	Steel ball	12	6.9 (5.1)	472	Set screw	2
29.4 (21.7)	251	RO Plug	3		501	Boots (Bellows)	2

24.1.4.5 EXPLANATION OF OPERATION

(1) Neutral position

P1:

The oil delivered from the hydraulic pump flows from the P1 port of the control valve (hereafter called a C/V) into the left travel spool section through the passage of the supply section.

At the spool neutral position, the entered oil passes through the by-pass of the spool leading from the left travel to the boom because the spool does not cut off the by-pass and flows out to the tank circuit through the by-pass of the spool for the bucket and the by-pass leading to the tank.

P2:

The oil delivered from the hydraulic pump flows from the P2 port of C/V into the right travel spool section through the passage of the supply section.

At the spool neutral position, the entered oil passes through the by-pass of the spools for the right travel, boom swing and service, and flows out to the tank circuit through the by-pass circuit leading from the by-pass of the spool for service.

P3:

The oil delivered from the hydraulic pump flows from the P3 port into the control valve and then into the parallel passages to the dozer and the swing. The oil having entered the parallel passage flows through the by-pass passages of the slewing and dozer spools to the independent travel spool land portion, then through the P2 side second by-pass passage, and finally from the by-pass passage in the service switching section out into the tank passage.

WARNING

As the flow from the pump is fed into each line (P1, P2, P3), the switching sections of respective line shown below are in operable condition. Therefore, don't operate them except when working.

- P1 line: Left travel, Boom, Bucket
- P2 line: Right travel, Boom Swing, Service and Arm
- P3 line: Dozer, slewing [Service and Arm]

Pp1:

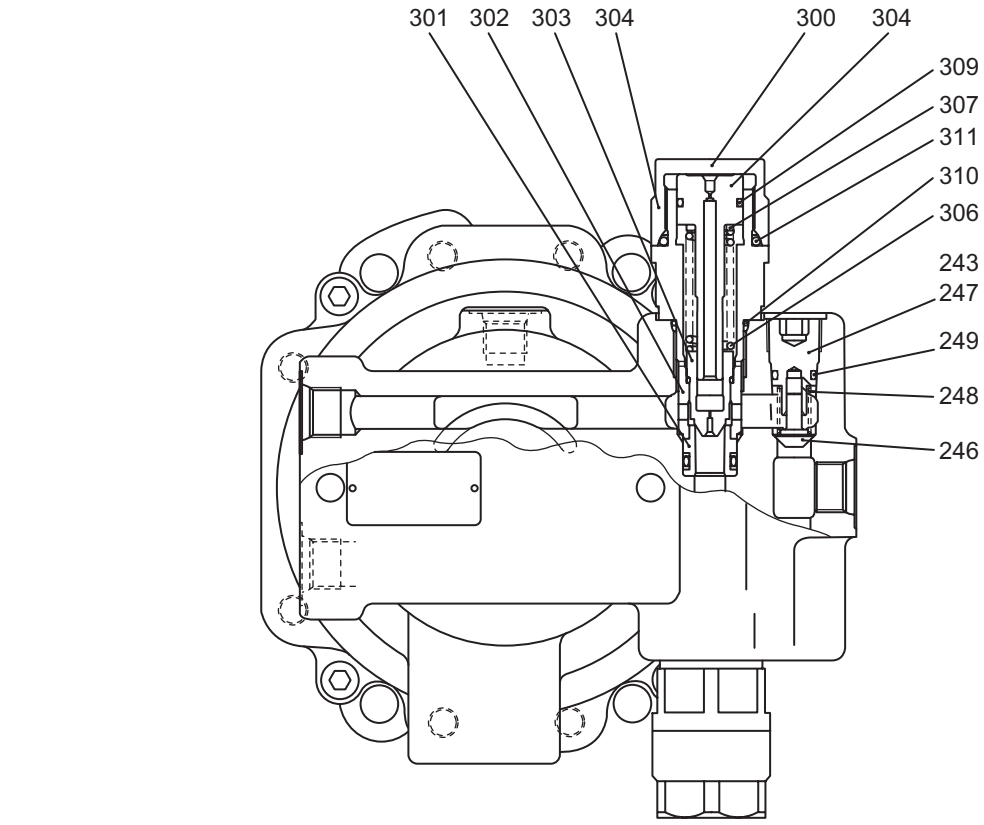
The pilot pressure supplied to the Pp1 port forces the oil to flow out through the orifice into the independent travel signal passage in the control valve.

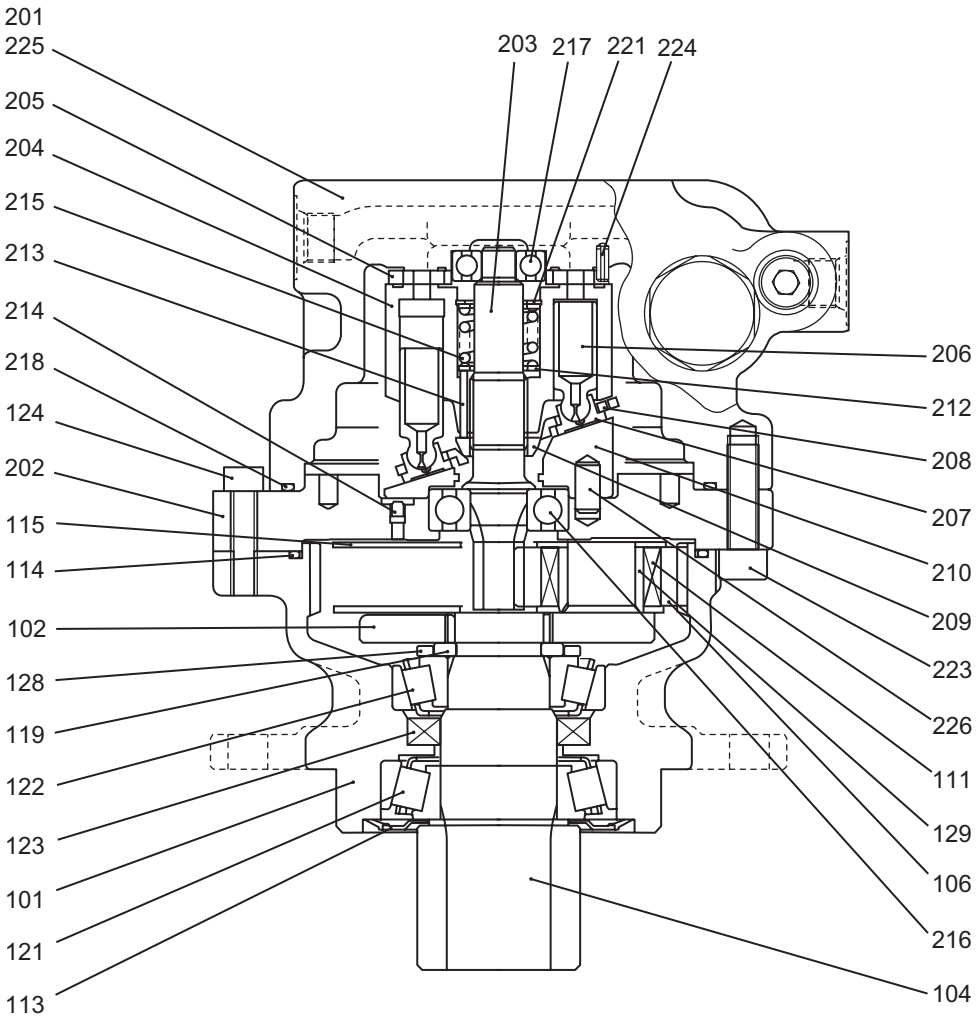
With the spool in the neutral position, the oil passes through the passages provided on the left and right travel spools and on the service spool, and flows out into the tank passage.

WARNING

When the engine is stopped (when each hydraulic pump is stopped), the actuator does not function even when being loaded by the self weight, because the pilot pressure does not act on the pilot control spool (except for the condition where the accumulator, etc. is attached and the pressure remains due to the pipe volume). On the spools of boom swing and dozer which directly actuates the spool, the port on the loaded side is led to the tank circuit with the operating direction making it unable to hold the load, consequently the actuator may be actuated causing danger. Therefore, even if the engine is stopped, when there are people around the machine or it may be in contact with implements, don't use the control lever.

24.1.5.4 CONSTRUCTION





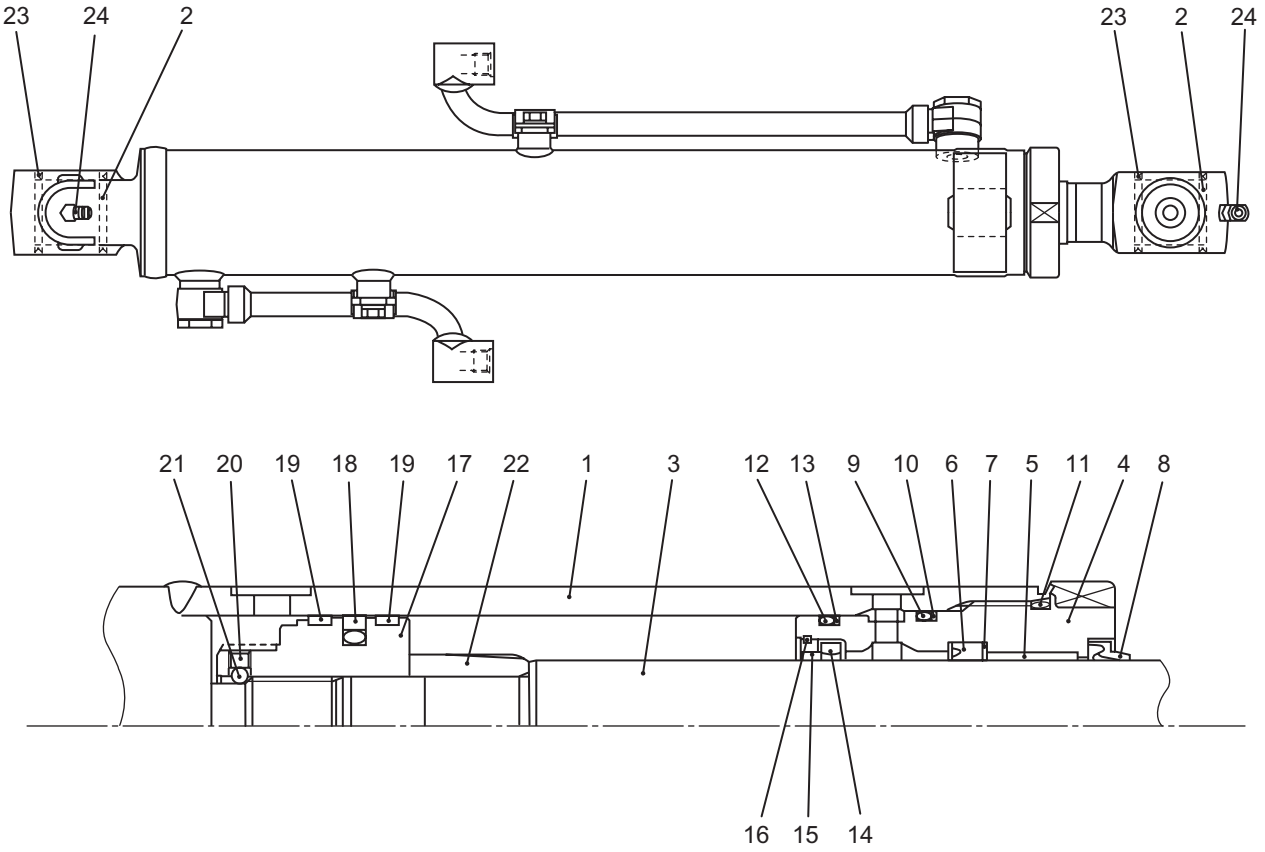
Body 1 sub assy group

No.	NAME	Q'TY	No.	NAME	Q'TY
301	BODY 1	1	312	PLUG	2
302	SPOOL	1	313	CHOKE	5
303	CHECK VALVE	2	314	RING	2
304	SPRING GUIDE	2	315	PLUG	8
305	SPOOL	1	316	PLUG	2
306	SHUTTLE SPOOL	1	317	O-RING	2
307	SPRING V1	2	318	O-RING	2
308	SPRING V2	2	319	O-RING	2
309	SPRING V3	1	320	CHOKE	2
310	PLUG	2	321	PIN	2
311	PLUG	2	322	PLUG	6

24.1.8.2 CONSTRUCTION AND FUNCTION

24.1.8.2.1 CONSTRUCTION

(1) Boom cylinder



Construction of boom cylinder

No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	CYLINDER TUBE ASSY	1	9	O-RING	2	17	PISTON	1
2	PIN BUSHING	2	10	BACK-UP RING	1	18	SEAL RING ASSY	1
3	PISTON ROD ASSY	1	11	O-RING	1	19	SLIDE RING	2
4	CYLINDER HEAD	1	12	O-RING	1	20	SETSCREW	1
5	BUSHING	1	13	BACK-UP RING	1	21	STEEL BALL	1
6	U-RING	1	14	CUSHION SEAL	1	22	CUSHION BEARING	1
7	BACK-UP RING	1	15	SPACER	1	23	DUST SEAL	4
8	WIPER RING	1	16	STOPPER	1	24	GREASE NIPPLE	2

Group	Code	Part Name	Part No.
Relay	R-1	BATTERY RELAY	PH24S00001P1
	R-2	SAFETY RELAY	E/G accessory (VA30L74-00100)
	R-3	STARTER RELAY	E/G accessory (VAMM431-28201)
	R-6	GLOW TIMER	E/G accessory (VAMM436-811)
	R-8	CHARGE INDICATOR RELAY	PA24E01001P1
	R-9	WORKING LIGHT RELAY (CAB SPEC.)	PM24S00001P1
	R-13	GLOW RELAY	E/G accessory (VAMM431-28201)
Sensor	SE-1	FUEL SENSOR	PU52S00013F1
Solenoid	SV-1	LEVER LOCK SOL.	PX35V00003F1
	SV-2	2-SPEED SELECT SOL.	
	SV-3	E/G STOP SOL.	E/G accessory (VA31A87-01050)
Switch	SW-1	KEY SWITCH	PW50S00007F1
	SW-2	WORKING LIGHT SW. (CAB)	PV24E01001P2
	SW-3	2-SPEED SELECT SW.	YN03M01286S002
	SW-4	WIPER WASHER SW. (CAB)	PY50S00004P2
	SW-5	E/G COOLANT TEMP. SW.	E/G accessory (VAMM432-104)
	SW-6	E/G OIL PRESSURE SW.	E/G accessory (VA31A90-00600)
	SW-7	HORN SW.	YN50E01001P2
	SW-9	LEVER LOCK SW.	PA50S00001P1
	SW-10	HEATER SW. (CAB)	PY50S00003P2
	SW-14	AIR FILTER RESTRICTION SW.	FILTER accessory
	SW-24	TRAVEL RIGHT (FORWARD) PRESSURE SW. (OPT)	GB50S00049F2
	SW-25	TRAVEL RIGHT (REVERSE) PRESSURE SW. (OPT)	↑
	SW-26	TRAVEL LEFT (FORWARD) PRESSURE SW. (OPT)	↑
	SW-27	TRAVEL LEFT (REVERSE) PRESSURE SW. (OPT)	↑

Note

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

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

SV-3

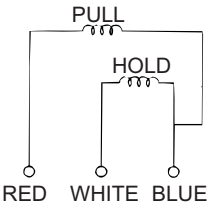
Solenoid

VA31A87-01050

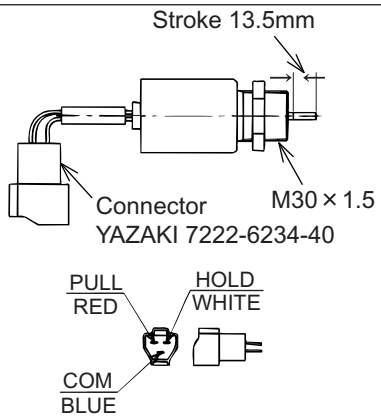
E/G stop

PU08-05001~
PU09-08001~

MITSUBISHI Part No.	VA31A87-01050
Rated voltage	12VDC
Rated current	Pull coil : 50A Hold coil : 1A



Circuit diagram



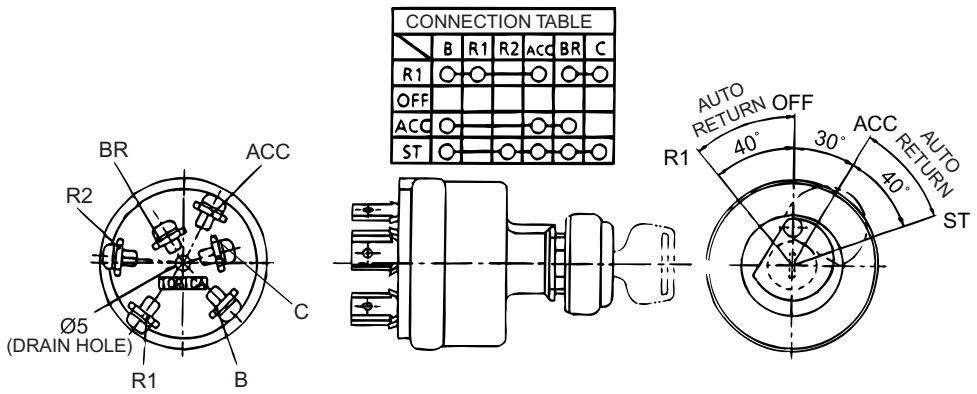
SW-1

Switch

PW50S00004F1

Key switch

PW12-40001~
PX13-15001~
PM08-08501~
PV11-30001~
PU08-05001~
PU09-08001~



SW-2

Switch

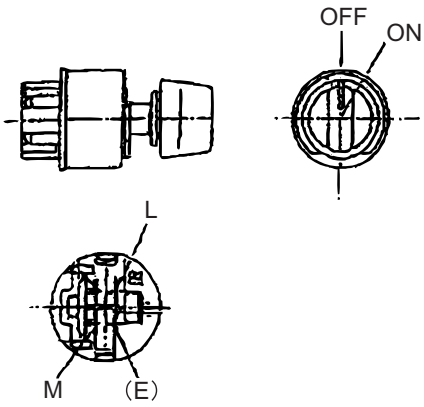
PV24E01001P2

Working light

PW12-40001~
PX13-15001~
PM09-09001~
PV12-31001~
PU08-05001~
PU09-08001~

Connection table				
	M	L	(E)	
OFF		○—○		
↕		○—○		
ON	○—○		○	L:70WX2 lamps

(Unconnected)



SW-3

Switch

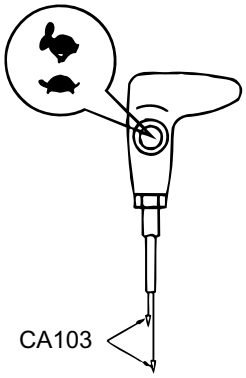
YN03M01286S002
(Right travel lever)

Trvel 1, 2 speed

PW12-40001~
PX13-15001~
PM08-08501~
PV11-30001~
PU08-05001~
PU09-08001~

Type	Buried in right travel lever

Switch & Marks

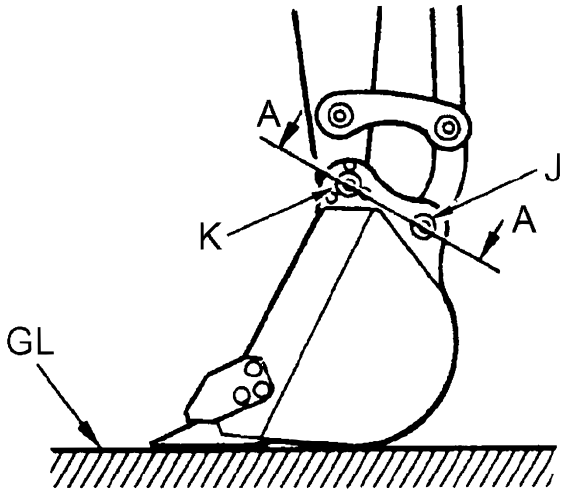


32.1.2 BUCKET

32.1.2.1 REMOVAL OF BUCKET

(1) Operate the operating lever and place the bucket on the ground, so the bucket and arm connecting pins are not loaded.

(2) Move the O-rings (3) toward the bucket bosses using a spatula.



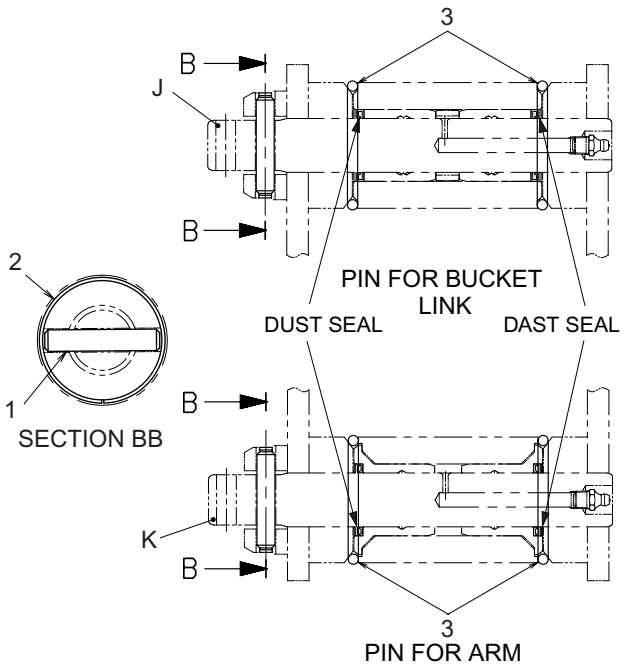
To place Bucket on ground

(3) In order to remove pin (K) which links arm and bucket, remove the ring (2) and the pin (1) by means of straight driver, and draw out pin (K).
- If the pin does not come off easily, the pin is loaded. Take off the load by manipulating the operating lever.
- Take care so the dust seal between the arm and the bucket bosses is not damaged.

(4) Adjust the bucket by manipulating the operating lever so the pin (J) between the bucket link and the bucket is not loaded.

(5) Remove the ring (2) and pin (1) then pull out the pin (J).

(6) Remove bucket assembly.
Weight :35kg (77 lbs)

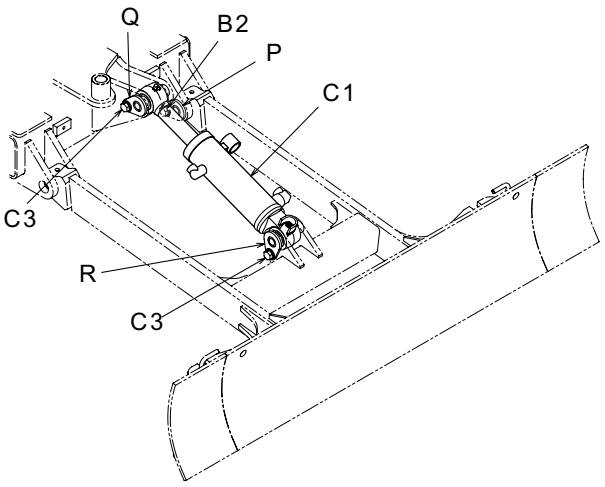


Assembly of pin (SECTION A-A)

32.1.6 DOZER

32.1.6.1 REMOVAL

(1) Put a support of appropriate height under the mounting side of dozer body, and make the dozer at a stable condition not to exert any load to the pin (P).
(2) Disconnect the hydraulic hoses and apply a plug to the connecting portions.
Tools: Spanner: 19mm
(3) Apply a nylon sling to the dozer cylinder (C1), and lift it up slightly not to exert any load to the pin (Q) of rod side.
(4) Remove the capscrew (C3) that are preventing the pin (Q) from coming out, of rod side. Remove the pin (Q), and support the cylinder (C1) with a wood block, etc.
Tools: Spanner: 19mm
(5) Remove the capscrew (B2) that are preventing the dozer body fixing pin (P) from coming out, and remove the two pins (P).
(6) Gradually move the machine to backward to remove the dozer.
Weight of dozer assembly : 90kg (198 lbs)
(7) If necessary, remove the dozer cylinder by means of removing the pin (R) of head side.
Weight of dozer cylinder :10kg (22 lbs)

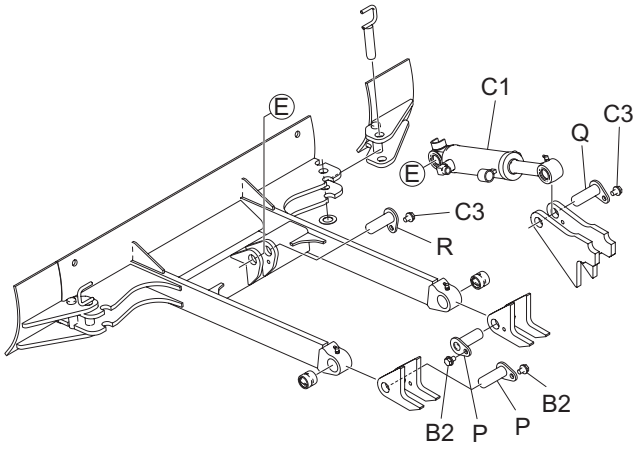


Removing/Installing Dozer

32.1.6.2 INSTALLATION

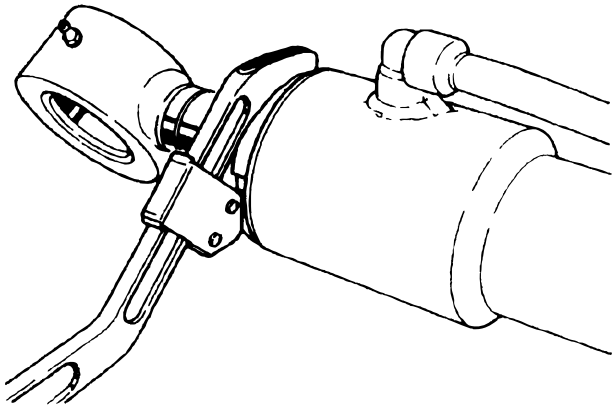
The installation is carried out with the reverse order of the removal paying attention for the following.

(1) Referring to the Section "ATTACHMENT DIMENSIONS" of Specifications, replace the worn-out bushings and dust seals to new ones.
(2) Before installing pin (P), (Q) and (R), apply grease to their shaft area.
(3) Applying loctite #262 to the stopper capscrews tighten them up.
Tools: Spanner: 19mm, T=115 N-m (254 lbf-ft)



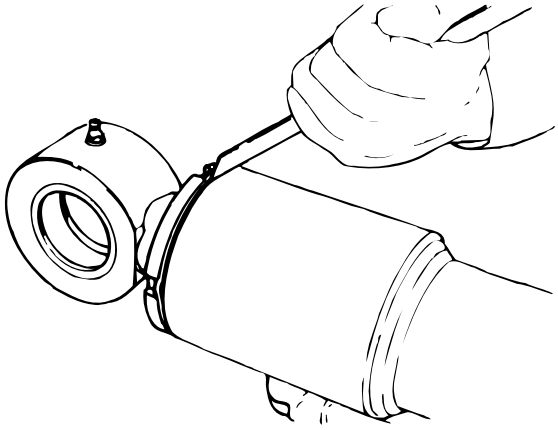
Installing Dozer

2. Install the cylinder head (4).
   - Apply hydraulic oil on the packings (seals) prior to install
   - Tightening torque for cylinder head ;See Table 32.2.1.6.(1)



Installing cylinder head

3. Bend the locking, fin on the tube to lock the cylinder head.



Assembling cylinder assembly

33. UPPER SLEWING STRUCTURE

Issue	Date of Issue	Applicable Machines	Remarks
↑	March 2010	E18B - NATN16300	(NH - NA)

(7) Removing rod of N&B pedal

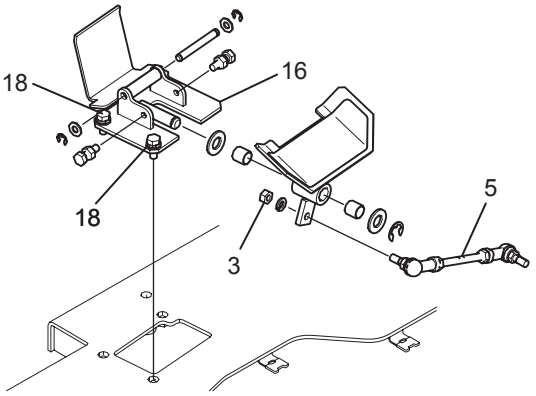
1.

Loosen three M8X20 sems-bolts (18) to pull out the support (16) upward.

Tools: Spanner: 13 mm

2.

Loosen M8 nut (3) and disconnect the control rod (5).



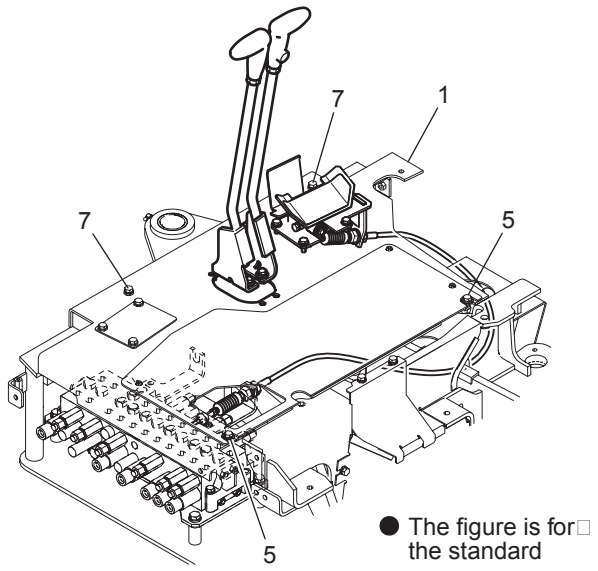
N&B rod disconnection

33.1.5.2 FLOOR PLATE REMOVAL

(1) Remove the two M8X20 sems-bolts (5) and two M8X70 capscrews (7).

Tools: Spanner: 13 mm

(2) Remove the floor plate assembly (1).



Floor plate (1) removal

33.1.5.3 ASSEMBLING FLOOR PLATE

(1) Assemble the floor plate in reverse order of the disassembly.

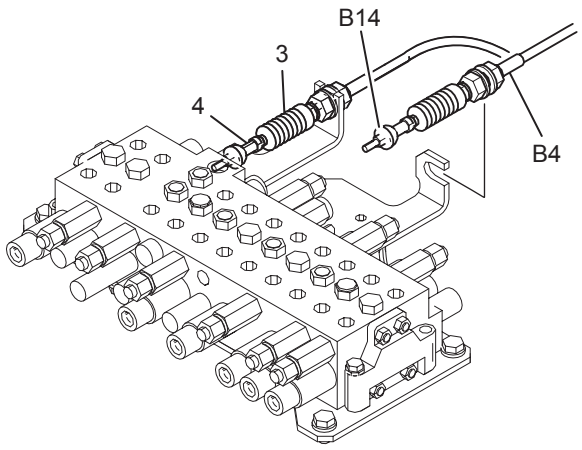
Sems-bolt (6) M8 :

Tools: Socket: 13 mm

Tightening torque : 23.5 N-m (17 lbf-ft)

(2) Disconnecting cables

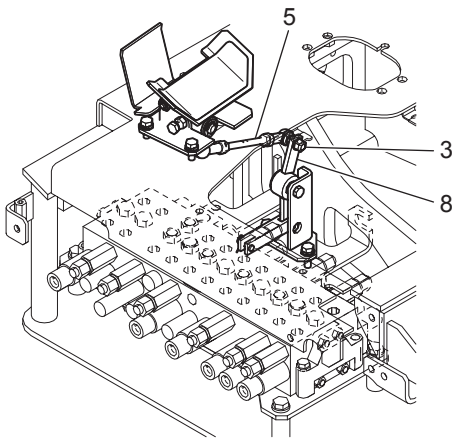
1. After loosening the lock nut, turn the rod end (4) to disconnect the dozer cable (3).
2. After loosening the lock nut, turn the rod end (B14) to disconnect the swing cable (B4).



Cable disconnection

(3) Removing rod

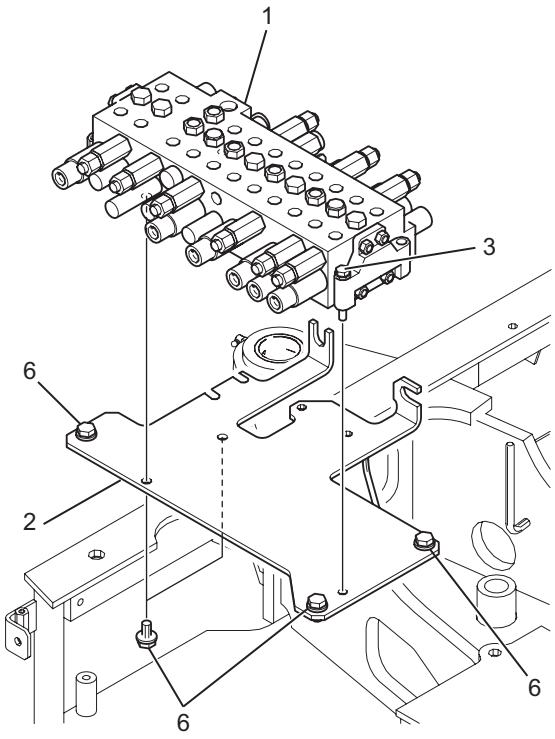
Remove the nut (3) to disconnect the rod (5) from the lever (8).
Tools: Spanner: 13 mm



Rod disconnection

(4) Removing control valve

1. Loosen three M10X20 sems-bots (6) to remove the control valve (1) with the bracket (2).
   Tools: Socket: 17 mm
   Weight of removed parts : Approx. 27 kg (60 lbs)
2. Loosen one M8X60 capscrew (3) and two M10X20 sems-bolts (6) to remove the control valve (1).
   Tools: Socket: 13, 17 mm
   Weight : Approx. 23 kg (51 lbs)



Control valve removal

33.1.17.3 INSTALLATION

(1) Install the pilot valve in reverse order of the removal to the following tightening torque :

1.

Attaching sems-bolts (14 : T=2.7 N-m (2.0 lbf-ft)).

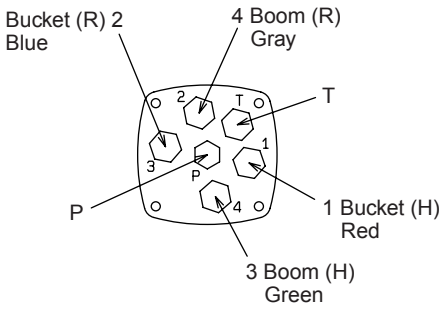
Attaching capscrew (B22) and (B26) : T=9.7 N-m (7.21 lbf-ft)

Tools: Torx driver (T25)

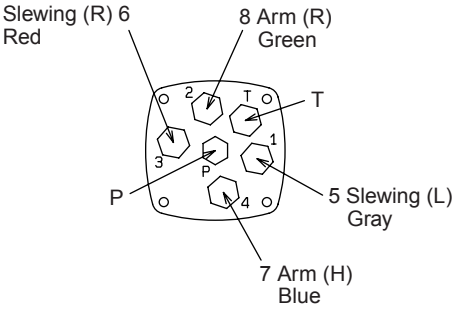
2.

Installing hoses, etc.

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



Right side



Left side

Pilot valve port location(View lower side)

Note

Take care of the tightening torque as the pilot valve is made of aluminum.

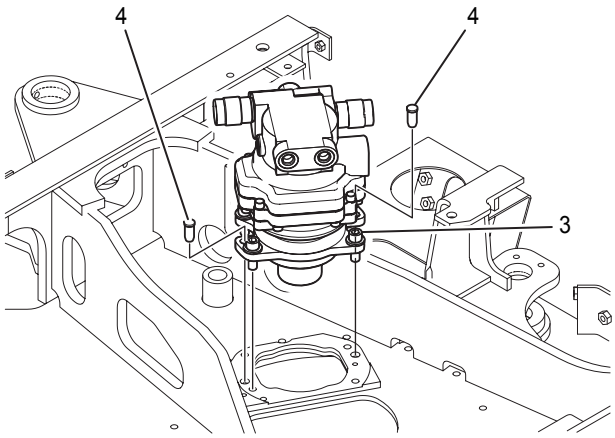
(2) Pressurize the hydraulic tank (See Section 33.1.7.3).

(3) Operate the attachment to check the performance.

(4) Check the tank and piping for oil leakage and oil level.

(3) Remove two pins (4).

(4) (4) Loosen four M12X45 capscrews (3) to remove the slewing motor.
Tools: Allen wrench: 10 mm [a long type approx. 300 mm (11.8") in length required].
Weight : about 23 kg (51 lbs)



Slewing motor removal

33.1.20.3 INSTALLATION

(1) Install the motor in reverse order of the removal according to the tightening torque shown below.
1.
Apply Loctite #515 on the entire circumferential surface for mounting the slewing motor (1).
2.
Attach two pins (4).
3.
Install the capscrews (3) for fixing the motor.
Tools: Allen wrench: 10 mm
T=115 N-m (85 lbf-ft)
Apply Loctite #262 to the capscrew.
4.
Connect the hoses
- Fill the casing with hydraulic oil through the motor drain port prior to connecting drain piping.

		Tightening torque N•m (lbf•ft)	
Thread size (PF)	Spanner used (mm)	O-ring type fitting	30º flare type fitting
1/4	19	36.3 (27)	29.4 (22)
3/8	22	73.5 (54)	49 (36)
1/2	27	108 (80)	78.5 (58)

(2) Feed grease to the pinion gear of the slewing motor.

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

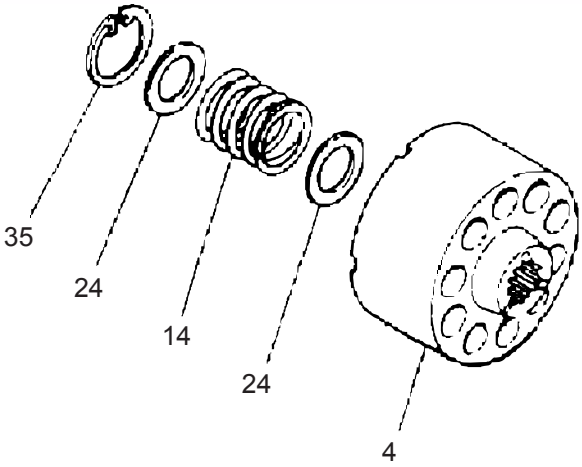
(4) At the start, run the motor in the low idling condition of the engine for a few minutes to check for oil leakage and abnormal noise.

(6) Disassembling of Cylinder barrel (4) kit

1.
Remove shoe holder (8) on which piston shoe assemblies (6) and (7) are set and disassemble it in the order of barrel holder (9).

2.
Remove needle (11) from cylinder barrel (4).

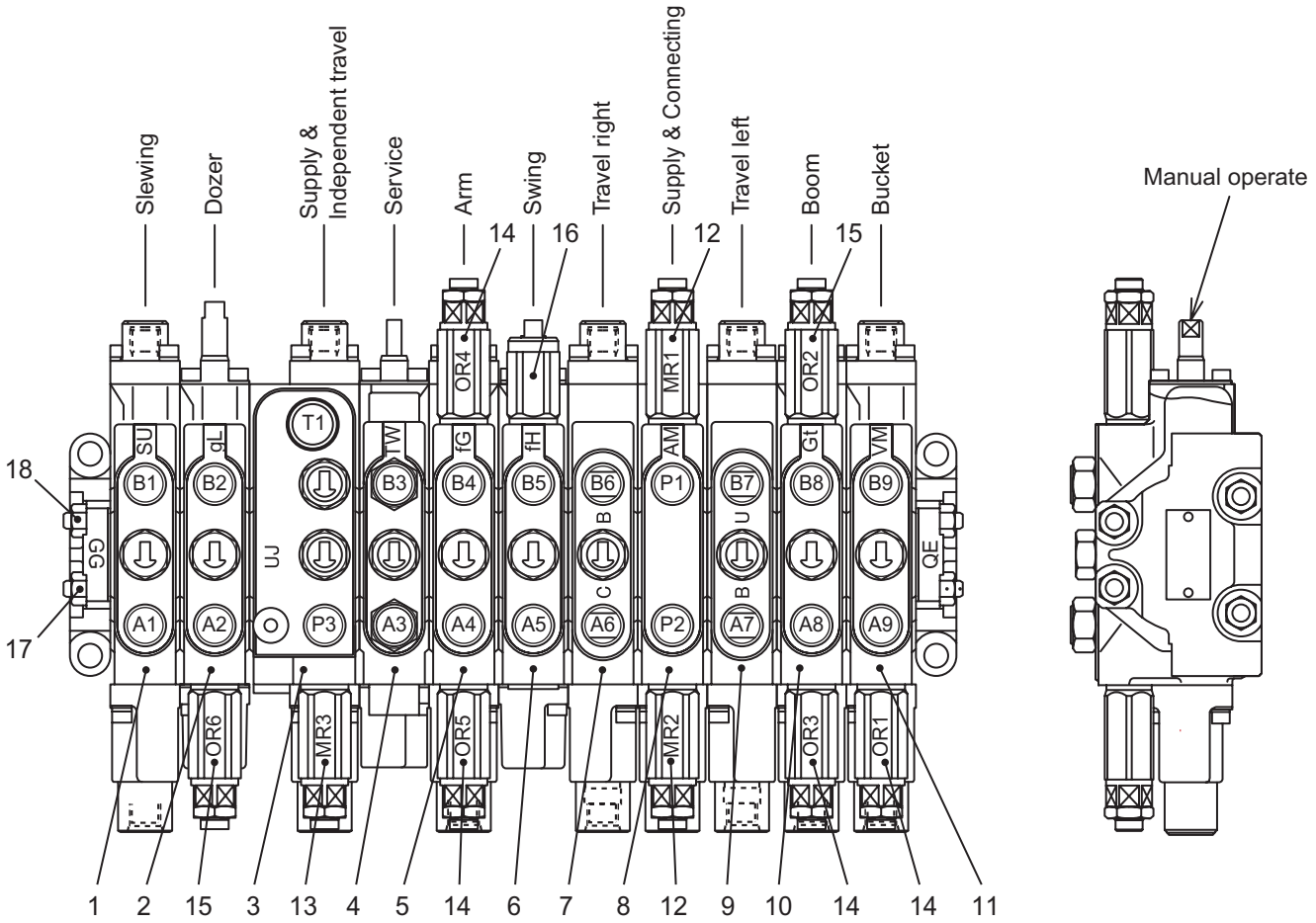
3.
Tank off snap ring (35), retainer (24), spring C (14) and retainer (24), which are set in the cylinder barrel (4) in this order.



33.2.2 CONTROL VALVE

33.2.2.1 CONTROL VALVE

(1) Outside view



No.	NAME	Q'TY	No.	NAME	Q'TY
1	Slewing section	1	10	Boom section	1
2	Dozer section	1	11	Bucket section	1
3	P3 inlet, independent travel & conflux section	1	12	P1, P2 Main relief valve	2
4	Service section	1	13	P3 Main relief valve	1
5	Arm section	1	14	Over load relief valve	4
6	Swing section	1	15	Over load relief valve	2
7	Travel (right) section	1	16	Anti cavitation valve	1
8	P1, P2 inlet straight	1	17	Tie bolt	4
9	Travel (left) section	1	18	Nut	8

33.2.2.5 PRECAUTIONS WHEN ASSEMBLING

CAUTION

Precautions (Observe the following for safety.)

(1) The unevenness of tightening torque and the contamination by dust during assembly may cause a failure. And observe the tightening torque specified in the description.
(2) When assembling, check up on the valve construction drawing, identify the number of part, and ensure that there is no installation error and omission of part, etc.
(3) After cleaning the parts required to use with cleaning solvent, immerse them in hydraulic oil as required and reassemble them.
(4) Before applying Loctite, clean and decrease the surface sufficiently, and apply it to two threads.
(Over application may cause a malfunction due to the squeezing out.)

33.2.2.6 PRECAUTIONS WHEN FITTING SEALS

CAUTION

Precautions (Observe the following for safety.)

(1) Replace seals with new ones when assembling.
(2) Ensure that seals are free from deformation and flaw coming about when handling them.
(3) Apply grease or hydraulic oil to the seals and seal fitting section to make the sliding smooth, unless otherwise specified.
(4) Do not stretch the seals too much. Otherwise they may be permanently deformed.
(5) Pay attention not to roll the O-ring when fitting. Because it is difficult for the twisted O-ring to be restored naturally after fitting, and it may cause oil leakage.

33.2.2.7 ASSEMBLY WORK

(1) Assembling main frame of switching section

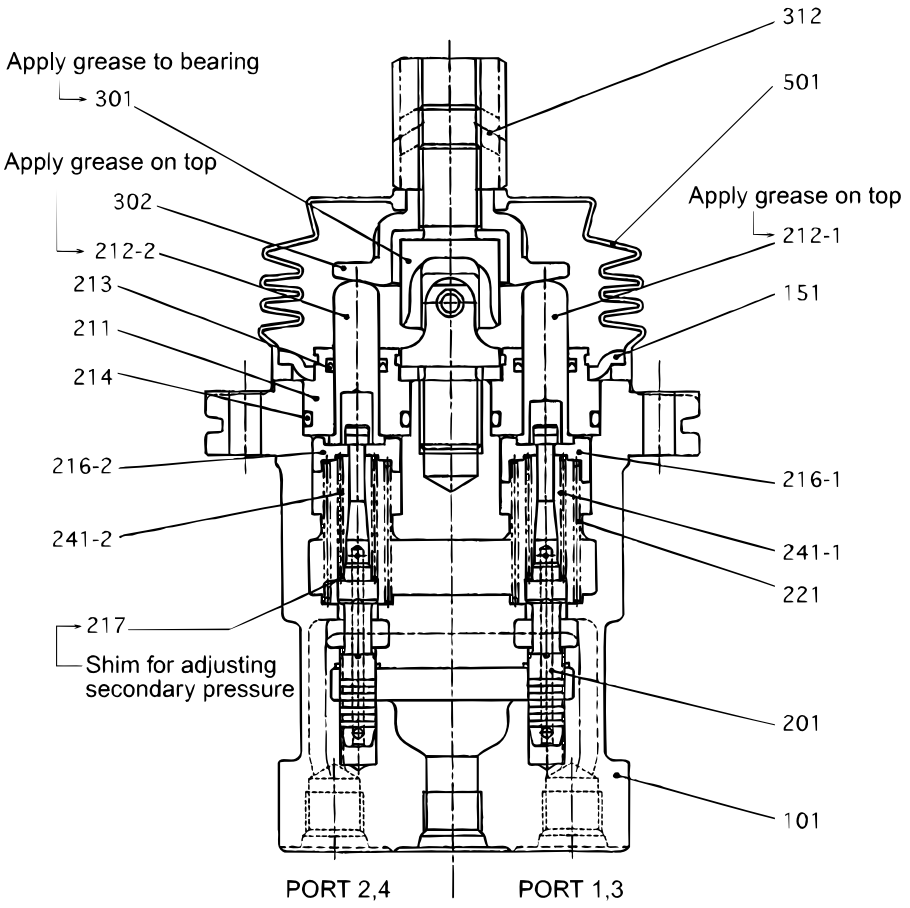
1. On a surface plate with clean rubber plates on it, place Comp. Bodies with actuator port machined surface facing downward in the order shown in "Orders of Assembling Bodies" on the next page.
At this time, set in the main body of identification sign VM in order of poppet valve (12) --> spring of poppet valve (13) --> plug of poppet valve (14), and tighten the plug of poppet valve (14) with the specified torque with spanner or a socket wrench of 14 mm.

CAUTION

- Then, check the mating surfaces in each Comp. Body for dust or the like and check whether O-rings shown in the delivery specifications are surely put in each groove for O-ring.
- Kinked O-rings could cause the leakage of hydraulic fluid to the outside due to the malfunction of sealing performance.
- If O-rings are not installed surely in O-ring grooves, there would be the nip of O-ring, resulting in the leakage of hydraulic fluid to the outside when assembling the Bodies.

33.2.3 PILOT VALVE (Attachment)

33.2.3.1 CONSTRUCTION

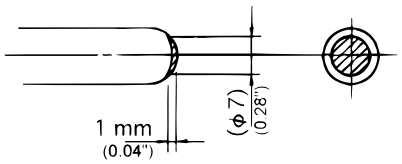


Pilot valve (Attachment)

Item	Thread size	Tightening Torque Table N-m (lbf-ft)
301	M14	47.1 (34.7)
302, 312	M14	68.6 (50.6)

Item	NAME	Q'TY	Item	NAME	Q'TY	Item	NAME	Q'TY
101	CASING	1	213	SEAL	4	241-1	SPRING	2
151	PLATE	1	214	O-RING; 1B P20	4	241-2	SPRING	2
201	SPOOL	4	216-1	SPRING SEAT	2	301	JOINT; M14	1
211	PLUG	4	216-2	SPRING SEAT	2	302	DISK	1
212-1	PUSH ROD	2	217	WASHER 2	4	312	ADJUSTING NUT; M14	1
212-2	PUSH ROD	2	221	SPRING	4	501	BELLOWS	1

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.	

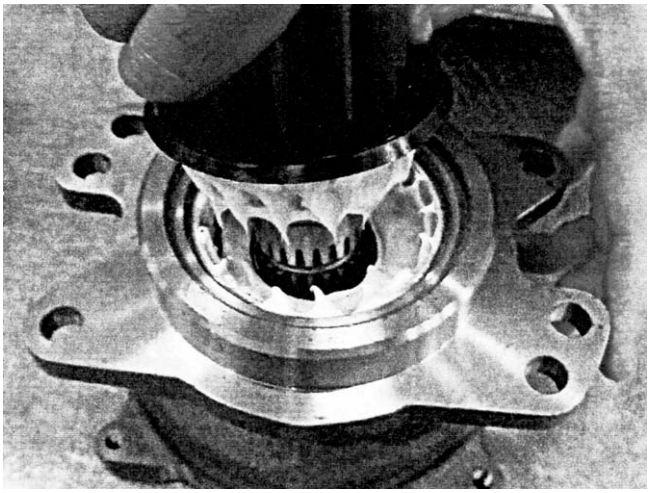
Note

Replace seal such as O-ring with new ones after every disassembly.

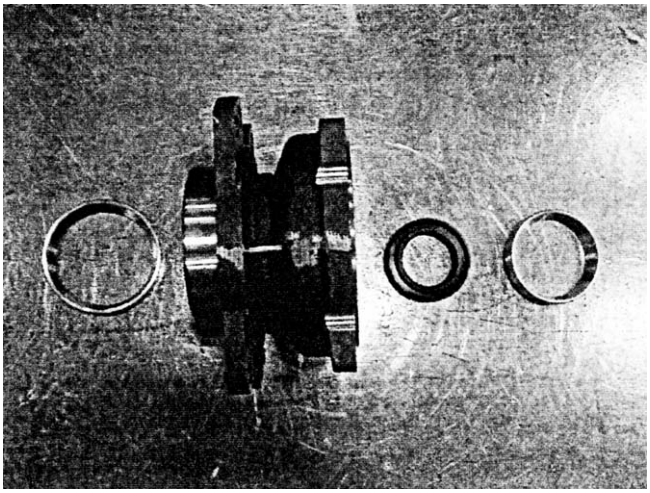
33.2.3.6 TROUBLESHOOTING

Phenomenon	Possible Cause	Corrective action
Secondary pressure does not rise.	1. Primary pressure is insufficient. 2. Springs (241-1, 241-2) are broken or fatigued. 3. Clearance between spool (201-1, 201-2) and valve body (101) is abnormally large. 4. Play of handle portion is too much.	1. Secure primary pressure. 2. Replace with new ones. 3. Replace assembly. 4. Disassembly and reassembly or replace handle portion.
Secondary pressure is unstable.	1. Sliding parts are caught. 2. Tank line pressure varies. 3. Air has contained into pipeline.	1. Correct. 2. Return directly to oil tank. 3. Release air.
Secondary pressure is high.	1. Tank line pressure is high. 2. Sliding parts are caught.	1. Return directly to oil tank. 2. Correct.

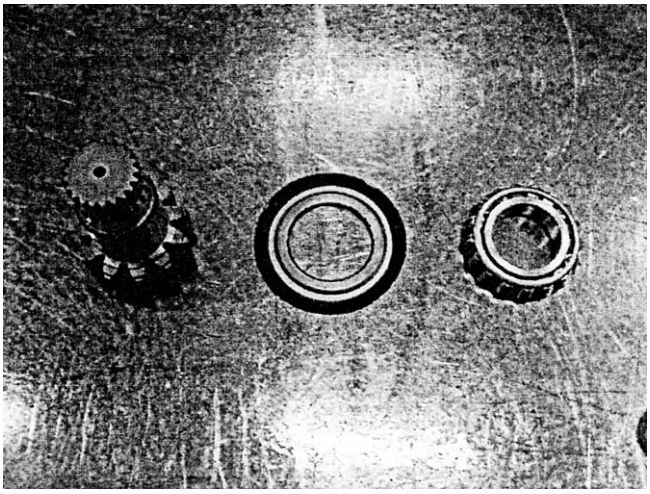
4. Take out the pinion shaft (104).
   - To secure the drawing space of the pinion shaft, attach the approximate 100 mm pad to the flange part, and push out the pinion shaft (104) by the press.
   - As pre-adjusted the gap with the bearing, do not disassemble unless it is necessary.



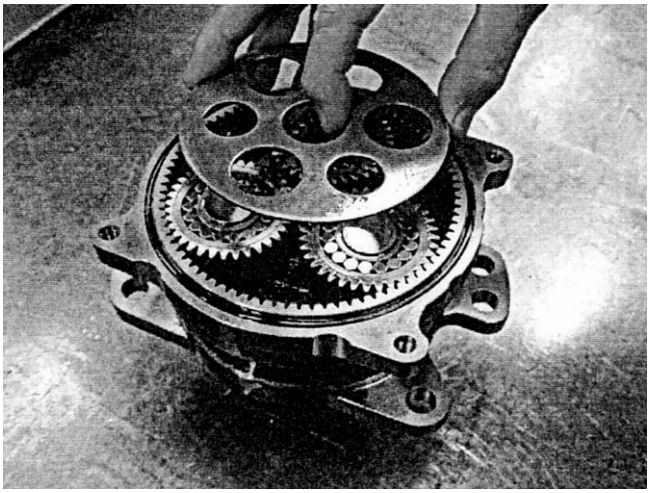
5. Take out the outer ring of the bearing (121, 122), and the oil seal (123).
   - As it is difficult to take put the outer ring of the bearing (121, 122), do not disassemble unless it is necessary.
   - Do not use again the oil seal.



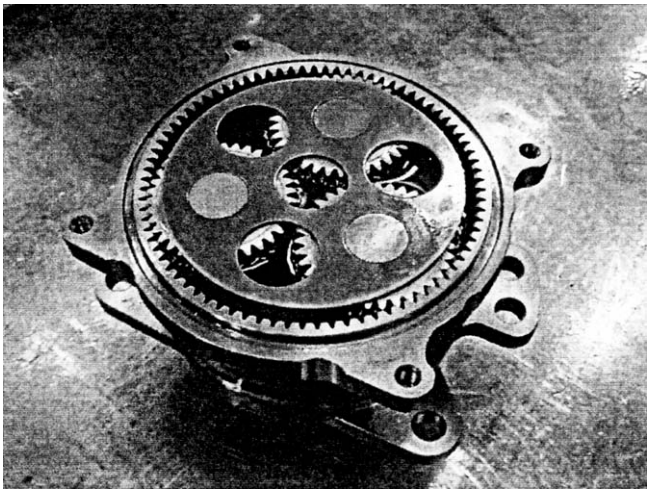
6. Take out the inner ring of the bearing (121) and the ring seal (113).
   - As the inner ring of the bearing (121) is press-fitting one, do not disassemble unless it is necessary.
   - Do not use again the ring seal (113).



15.Place the thrust plate (115) onto the carrier 1.
- Smaller size holes are aligned to the pins.



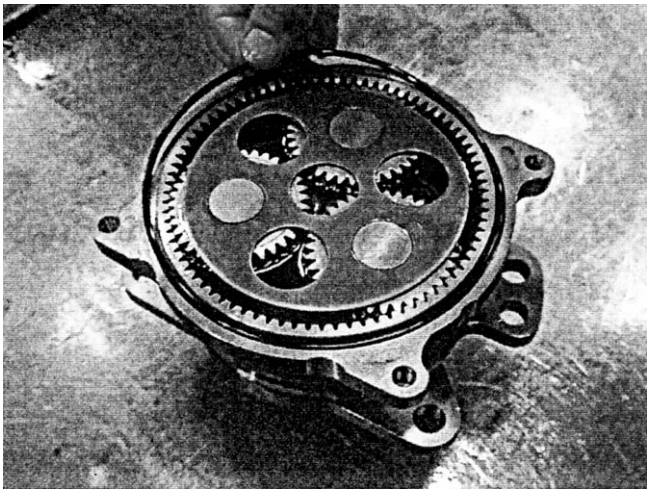
16.Fill the body with hydraulic oil.



CAUTION

Oil : ISO VG46 or equivalent.
Oil amount : 3 to 4 mm below the top thrust plate.
Wipe the oil off the flange surface if it is spilled.

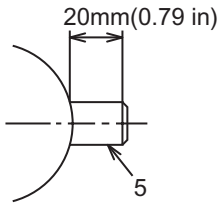
17.Place the O-ring (114) onto the body.



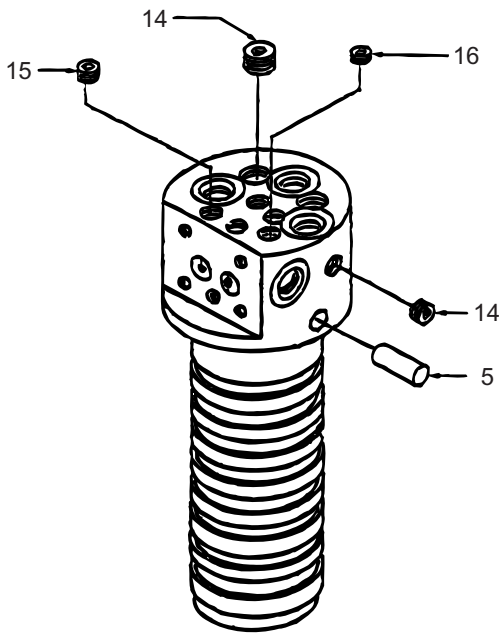
33.2.6.4 Assembly

33.2.6.4.1 Assembling Swivel Joint

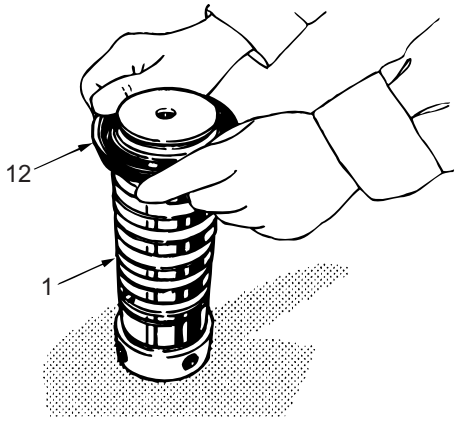
(1) Installing pin (5) :
When the pin (5) has been removed, tap it into the shaft (1) with a plastic hammer paying attention to the installing length.



(2) Installing plugs :
When plugs (14), (15) and (16) have been remover, install them with each specified tightening torque.
Plug (14) : Tools: Allen wrench: 6 mm, T=29.4 N-m (22 ft-lbs)
Plug (15) : Tools: Allen wrench: 5 mm, T=18.6 N-m (14 ft-lbs)
Plug (16) : Tools: Allen wrench: 4 mm, T=9.8 N-m (7.8 ft-lbs)

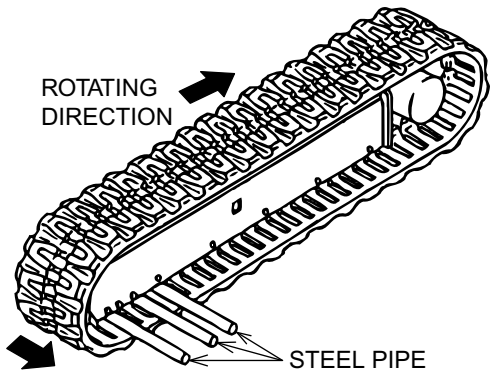


(3) Install the dust seal (12) to the shaft (1).
- Apply grease in plenty to the lip portion of dust seal (12).



(4) Installing seals :
Install the O-ring (7), backup ring (11) and slipper seal (6) into each groove on the body (2).
- Ensure each positioning of the seals referring to the structural drawing.
- Pay attention not to give any damages, scores and twisting to the seals.

3. Put steel pipes in the rubber crawler, turn the sprocket in the reverse direction slowly and when the rubber crawler has floated off the idler stop the rotating.
4. Slide the rubber crawler sideways, and remove it.

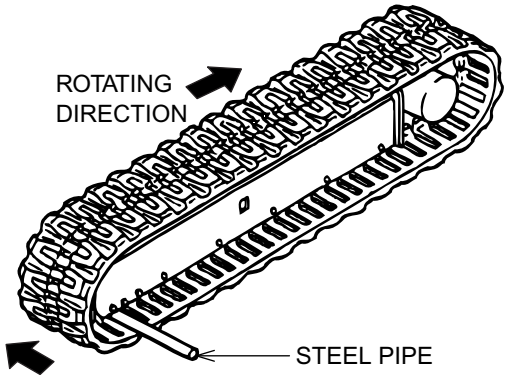


Removing rubber crawler

34.1.2.1.2 INSTALLING RUBBER CRAWLER

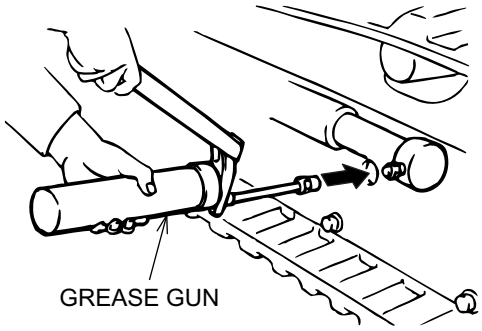
Installation work is performed in the reverse order of removal.

1. Engage the rubber crawler with the sprocket and mount it on the idler.
2. Put steel pipes in the rubber crawler, turn the sprocket in the reverse direction slowly and then the rubber crawler has floated off the idler, stop the rotating.
3. Slide the rubber crawler to the position to be set on idler exactly.



Installing rubber crawler

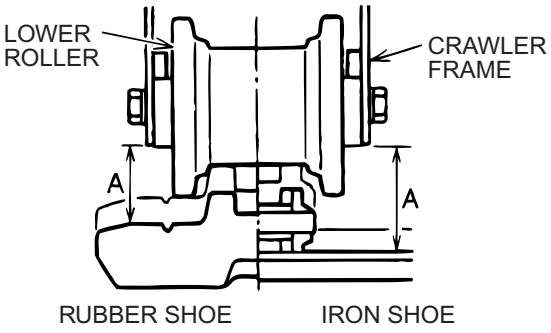
4. Confirm that the rubber crawler is engaged securely with the sprocket, idler and lower roller.
5. Tighten the grease nipple for the crawler adjuster, and adjust tension by feeding grease.
   Tools : Socket : 19mm,
   T=59 N-m (44 lbf-ft)



Feeding grease

Rubber shoe
Appropriate tension A : 45~50 mm (1.77~1.97 in)

Steel shoe
Appropriate tension A : 90~95mm (3.54~3.74 in)



Crawler tension

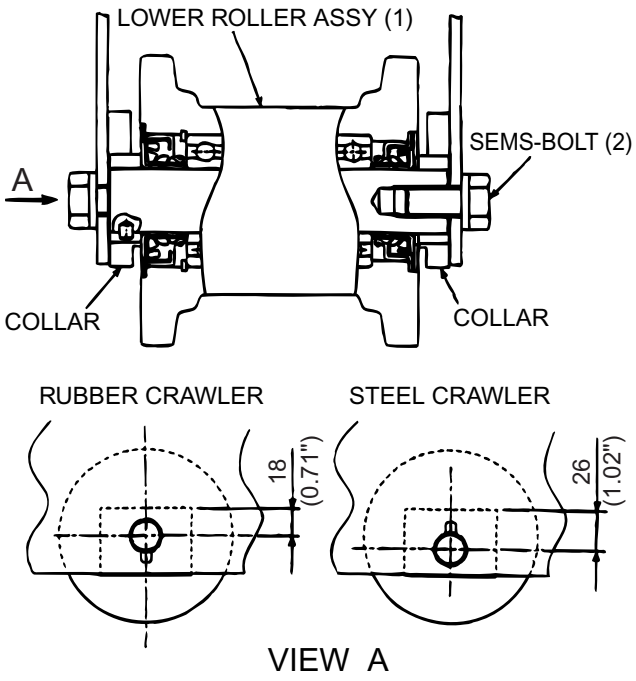
34.1.4.1.2 Installing

(1) Coat the mounting sems-bolt (2) with Loctite #262 in advance.

(2) Place the roller assembly (1) between the crawler and lower frame.
Fasten the sems-bolt (2) temporarily.
Tools : Socket : 19mm

(3) Lower the machine in full contact with the ground and tighten the sems-bolt (2) as specified.
Tools : Socket : 19mm, T=115 N-m (85 lbf-ft)

(4) Tighten the grease nipple of the crawler adjuster.
Lift the machine, and adjust the crawler tension by feeding grease.
Tools : Socket : 19mm, T=59 N-m (44 lbf-ft)



Installing lower roller

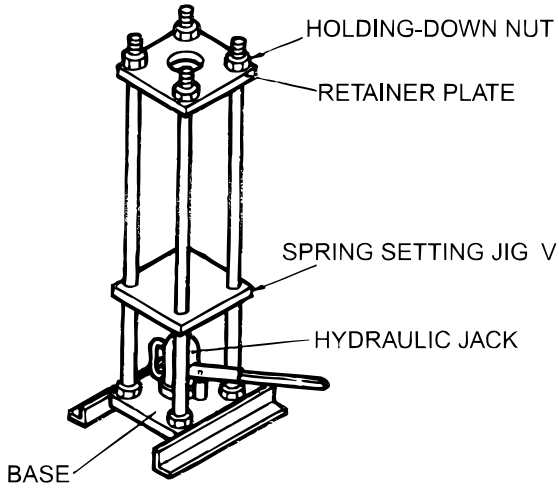
CAUTION

Select the position of collars according to kind of crawlers.

34.1.6.3 DISASSEMBLY AND ASSEMBLY

34.1.6.3.1 Disassembly

(1) Before disassembling and assembling the idler adjuster assembly, prepare spring setting jig (V).
Capacity of hydraulic jack : more than 5 tons (11000 lbf)

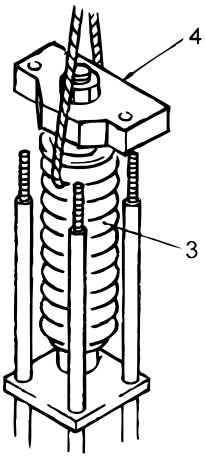


Spring set special jig (V)

WARNING

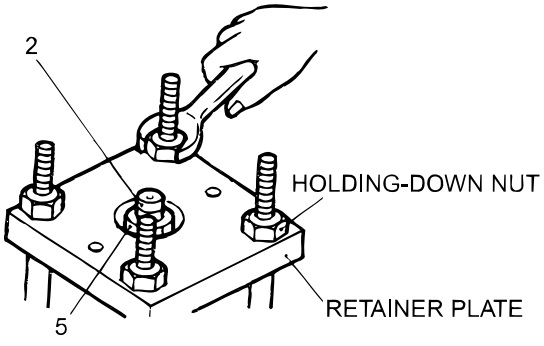
Large power is needed to set the spring. Prepare a special jig before disassembly and assembly.

(2) Place a hydraulic jack between the jig base and the stand.
(3) Loosen the holding-down nuts of the jig and draw out the retainer upward.
(4) Draw out piston (1) from grease cylinder (2) of the idler adjuster assembly.
(5) Taken out oil seal (10), O-ring (11) and back up ring (12) from grease cylinder (2).



Slinging work of idler adjuster

(6) Set the idler adjuster assembly on the stand of the jig (V), with its braket (4) side facing up.
(7) Fit retainer plate to braket (4) tighten holdingdown nuts alternately, and secure idler adjuster assembly.



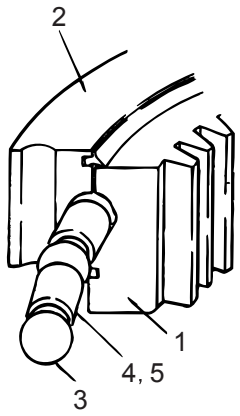
Fixing Holding-down nut

34.1.9.3.2 Assembling

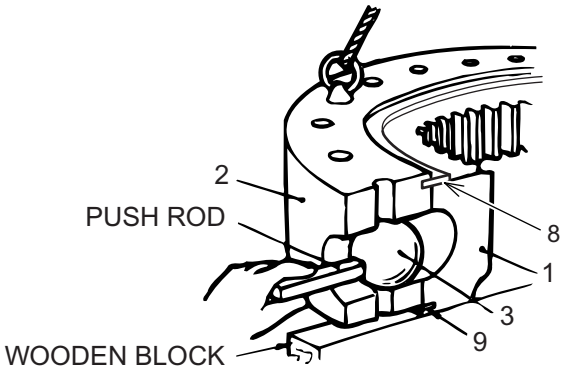
(1) Degrease thoroughly the groove for seal A (8) located in the inner circumference of outer race (2) and the groove for seal B (9) located in the outer circumference of inner race (1). Coat the grooves with adhesive Cyano Bond PO-1, fit seal B (9), and place inner race (1) on a surface table.

(2) Lift and lower outer race (2) slowly till the top surface of inner race (1) matches the bottom of the sealing groove of outer race (2). Place an adjusting washer under outer race (2) in order to support the outer race so the track surface of ball (3) is aligned.

(3) Insert balls (3) and spacers (4) (5) coating with grease (NLGI No.2 Lithium bace with MoS2) alternately through the hole for plug (6) on outer race (2).



Removing balls / spacers



Installing balls

WARNING

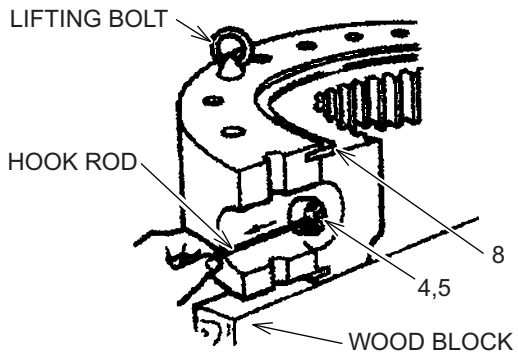
When forwarding balls (3) and spacers (4) (5), the raceways must be aligned completely. To achieve it, outer race (2) should be adjusted. It is very dangerous to put your finger into the plug bore directly ; always use a push rod or a hooked rod.

(4) Install plug (6) to outer race (2), confirming the direction and the position of the bore for taper pin (7).

(5) Push taper pin (7) into bore, and caulk the head of the taper pin with a punch.

(6) Coat seal A (8) with adhesive (Cyano Bond PO-1) and place it into groove of outer race (2).

(7) Confirm that grease nipple (10) is useful. Apply grease (NLGI-2 Ep type) and confirm that the outer race rotates smootkly and that the lip of the seal is not scored.
Grease amount : Approx. 50 g (1.8 oz)

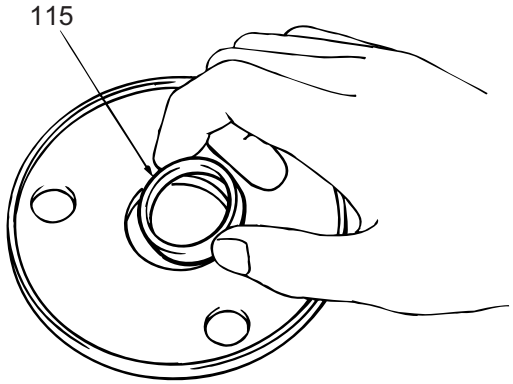


Installing spacer

34.1.9.4 MAINTENANCE STANDARDS

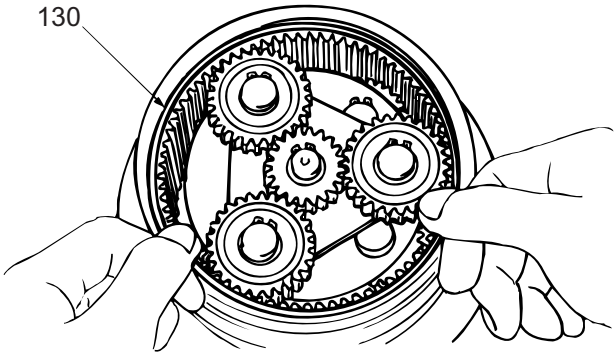
Regarding the maintenance standards for the wear of the slewing bearing, refer to the Article Measuring Slewing Performances in PM13 Maintenance Standards and Test Procedures.

4. Remove the slide ring (115) from the cover (102).



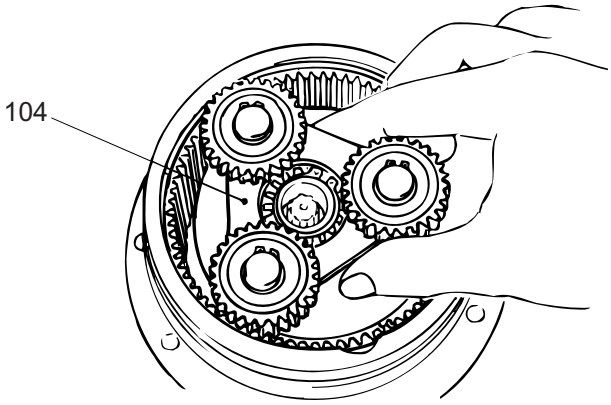
Slide ring (115) removal

5. Remove the O-ring (130).



O-ring (130) removal

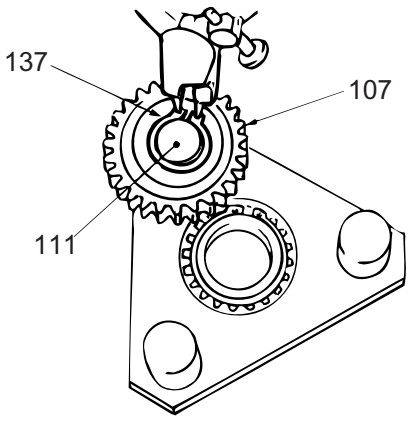
6. Remove the carrier 2 (104) assy.



Removing carrier 2 (104) assy

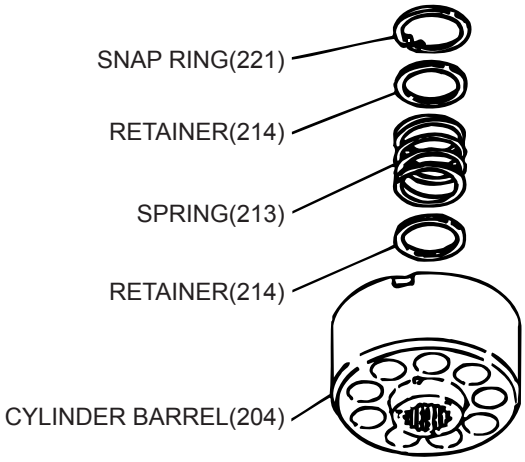
7. Disassembling carrier 2
a. Remove the snap ring (137) from the B2 pin (111).
b. Remove the thrust washer (121), the B2-gear (107), the needle (117) and the thrust washer (121) one after another.

   - Quantity
   Needle (117): 13/B2-gear: 1

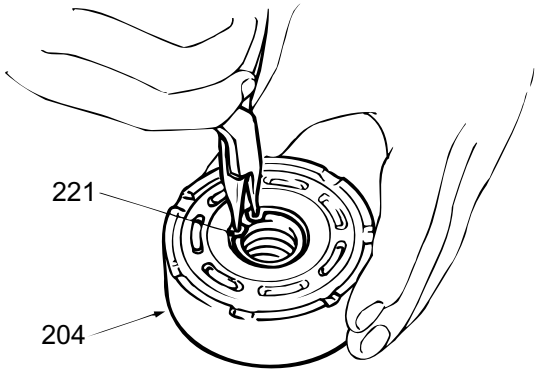


Snap ring (137) removal

13.Install the retainer (214), the spring (213) and the retainer (214) to the cylinder barrel (204) in this order, and fix by the snap ring (221).

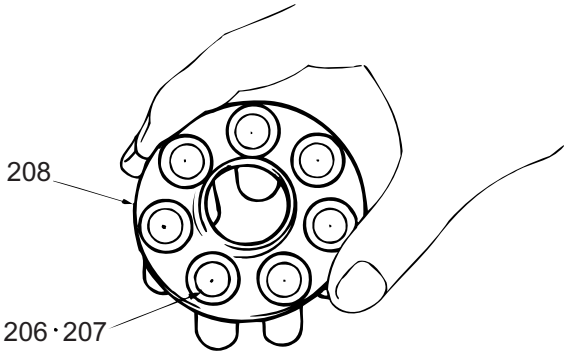


Installing parts to cylinder barrel (204)



Snap ring (221) installation

14.Assembling shoe holder (208) install the piston (206) and the shoe (207) assy to the shoe holder (208) to complete the shoe holder assy.



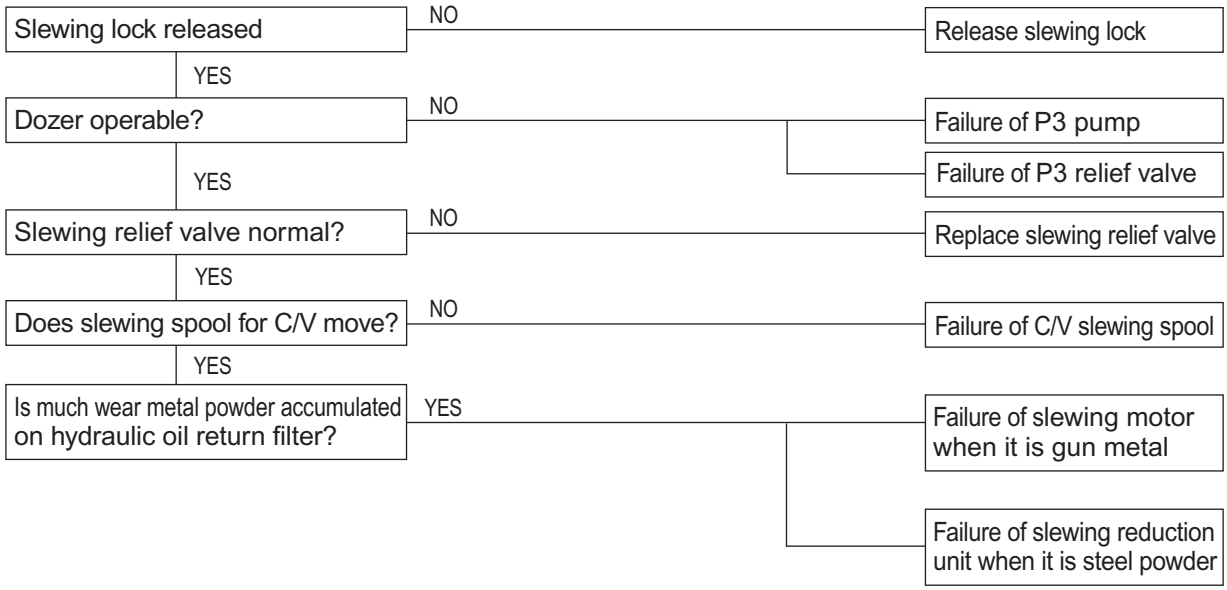
Shoe holder (208) assembly

(4) General precautions

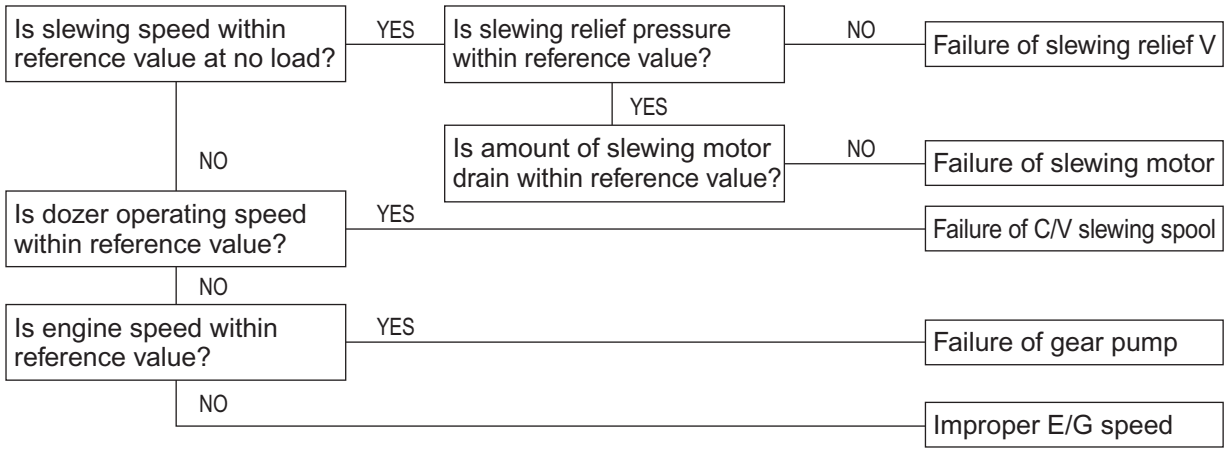
We recommend the user to prepare a check sheet for lubricating oil. Check oil leakage and loose bolts periodically to prevent trouble.

42.3.3 SLEWING OPERATION

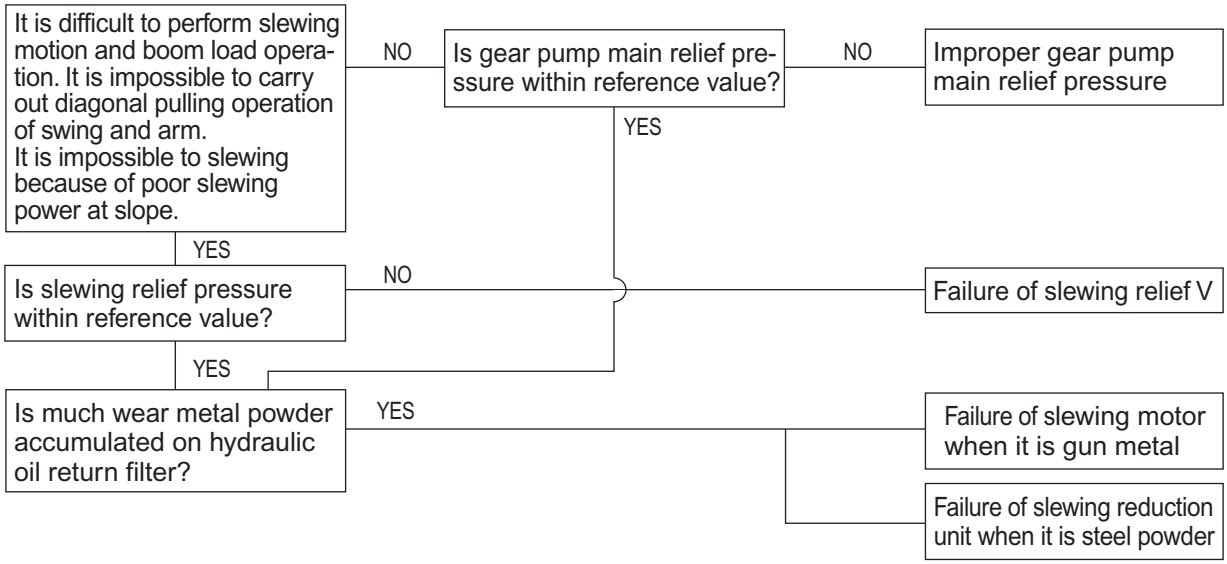
42.3.3.1 SLEWING OPERATIONAL FAILURE



42.3.3.2 SLEWING SPEED IS SLOW

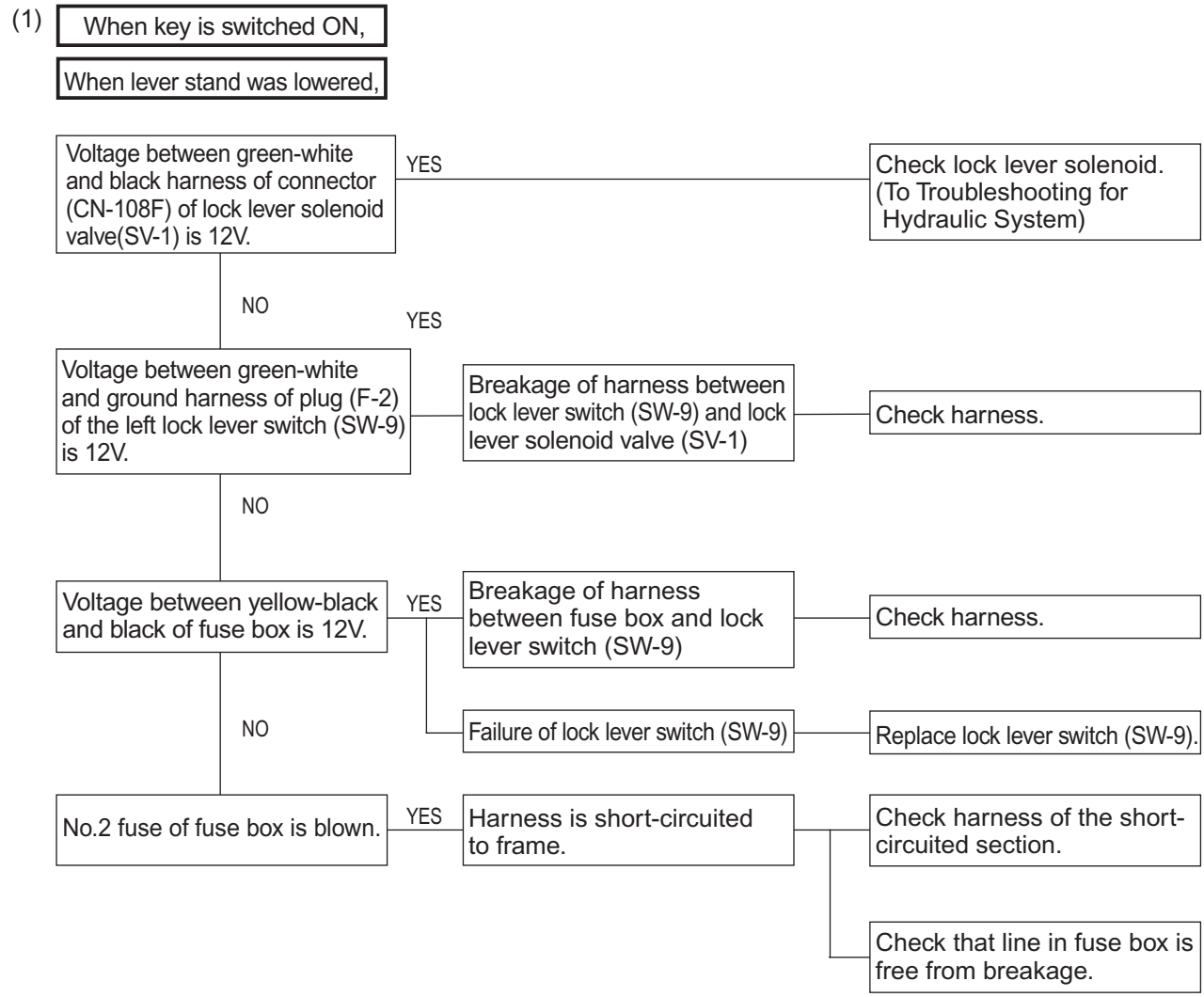


42.3.3.3 SLEWING POWER IS LOW

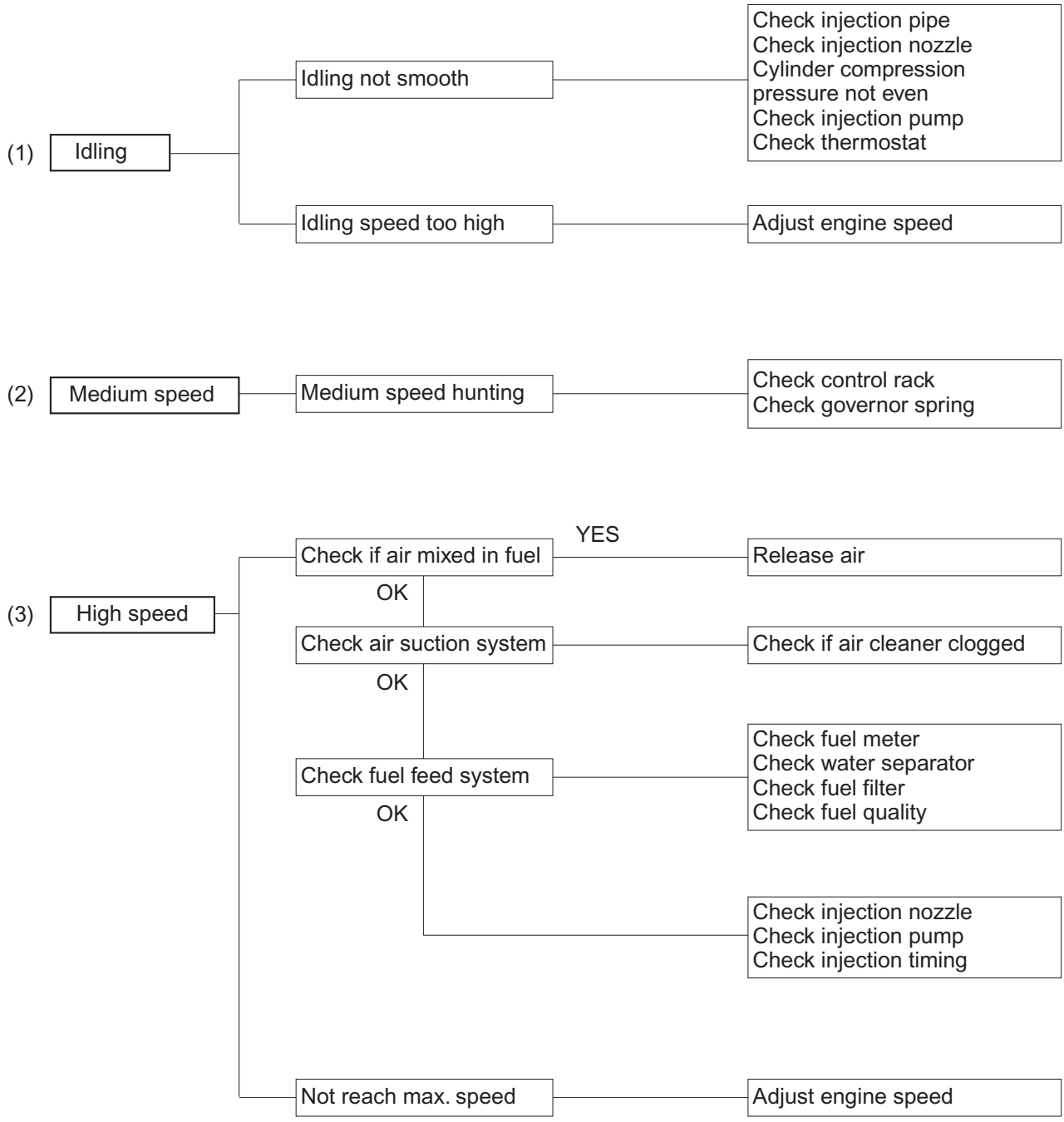


43.2.2 ATTACHMENT OPERATION

43.2.2.1 ALL CONTROLS DO NOT FUNCTION (Excluding swing, dozer and crawler width operations)



44.2.2 E/G ROTATION TROTUBLE



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

Terms Used in This Manual

Nominal

means the rated (design) size or magnitude of a part to be measured.

Standard

means the quantitative requirement for dimension of a part, clearance between parts and performance. This is given in a form of tolerance. Therfore, the values shown are not in agreement with the design values.

Limit

means that, if this value is reached, the part must be repaired or replaced with a new part.

Abbreviations

- BTDC: Before Top Dead Center
- ATDC: After Top Dead Center
- BBDC: Before Bottom Dead Center
- ABDC: After Bottom Dead Center
- TIR: Total Indicated Runout
- API: American Petroleum Institute
- ASTM: American Society for Testing and Materials
- JIS: Japanese Industrial Standards
- LLC: Long Life Coolant
- MIL: Military Specifications and Standards (U.S.)
- MSDS: Material Safety Data Sheet
- SAE: Society of Automotive Engineers (U.S.)

Units of Measurement

Measurements are based on the International System of Units (SI), and their converted metric values are indicated in parentheses {}. For metric conversion, the following rates are used.

- Pressure: 1 MPa ＝ 10.197 kgf/cm²
- Torque: 1 N·m ＝ 0.10197 kgf·m
- Force: 1 N = 0.10197 kgf
- Horsepower: 1 kW = 1.341 HP = 1.3596 PS
- Meter of mercury: 1 kPa = 0.7 cmHg
- Meter of water: 1 kPa ＝ 10.197 cmH_2O (cmAq)
- Rotational speed: $1min^{-1}$ ＝ 1 rpm

1. Maintenance service data

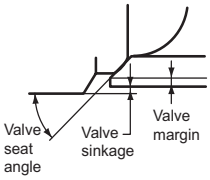
1.1 General

Table 2-1 Maintenance service data table - General Unit: mm [in.]

Inspection point			Nominal	Standard	Limit	Remark
Maximum rotation speed (rated rotation speed used as reference)			$2350\ ^{+50}_{+0}$ min^{-1}			Adjust governor setting.
Minimum rotation speed						
Compression pressure (at 280 min^{-1})				2.7 MPa {28 kgf/cm²} [398 psi]	Not acceptable at or below 2.2 MPa {22 kgf/cm²} [313 psi]	When oil and water temperatures at 20 to 30 °C [68 to 86 °F]
Lubricating oil pressure	Rotated speed			0.29 to 0.39 MPa {3 to 4 kgf/cm²} [42.7 to 56.9 psi]		Oil temperature at 60 to 70 °C [140 to 158 °F]
	Low idling			0.10 MPa {1.0 kgf/cm²} [14.2 psi]		
Valve timing	Inlet	Open		BTDC 18°		Values for checking valve timing Different from actual valve opening and closing timing
	Inlet	Close		ABDC 46°		
	Exhaust	Open		BBDC 46°		
	Exhaust	Close		ATDC 18°		
Valve clearance	Inlet			0.25 [0.0098]		When engine is cold
	Exhaust			0.25 [0.0098]		
Fuel injection timing (before TDC)				BTDC 15°		

1.2 Engine main part

Table 2-2 Maintenance service data table - Engine main part (1 / 3) Unit: mm [in.]

Inspection point			Nominal	Standard	Limit	Remark
Rocker	Rocker arm inside diameter		ø 12 [0.47]	12.013 to 12.035 [0.4730 to 0.4738]		
	Rocker shaft outside diameter		ø 12 [0.47]	11.470 to 11.984 [0.4516 to 0.4718]		
	Clearance betweenrocker arm and rocker shaft			0.029 to 0.065 [0.0011 to 0.0026]	0.2 [0.0079]	Replace rocker arm
Valve	Valve stem outside diameter	Inlet	ø 6.6 [0.259]	6.565 to 6.580 [0.2587 to 0.2593]	6.500 [0.2561]	
		Exhaust	ø 6.6 [0.259]	6.530 to 6.550 [0.2573 to 0.2581]	6.500 [0.2561]	
	Valve guide inside diameter	Inlet	ø 6.6 [0.259]	6.600 to 6.615 [0.2601 to 0.2606]		
		Exhaust				
	Clearance between valve stem and valve guide	Inlet		0.020 to 0.050 [0.0008 to 0.0020]	0.10 [0.0040]	Replace valve and valve guide
		Exhaust		0.050 to 0.085 [0.0020 to 0.0034]	0.15 [0.0059]	
Valve seat and valve	Valve seat angle		44°			
	Valve sinkage		0.5 [0.020]	0.4 to 0.6 [0.016 to 0.024]		
	Valve margin			1.0 [0.040]	0.5 [0.020]	
	Valve guide mounting length		14 [0.55]	13.5 to 14.5 [0.532 to 0.552]		

1. Basic tools

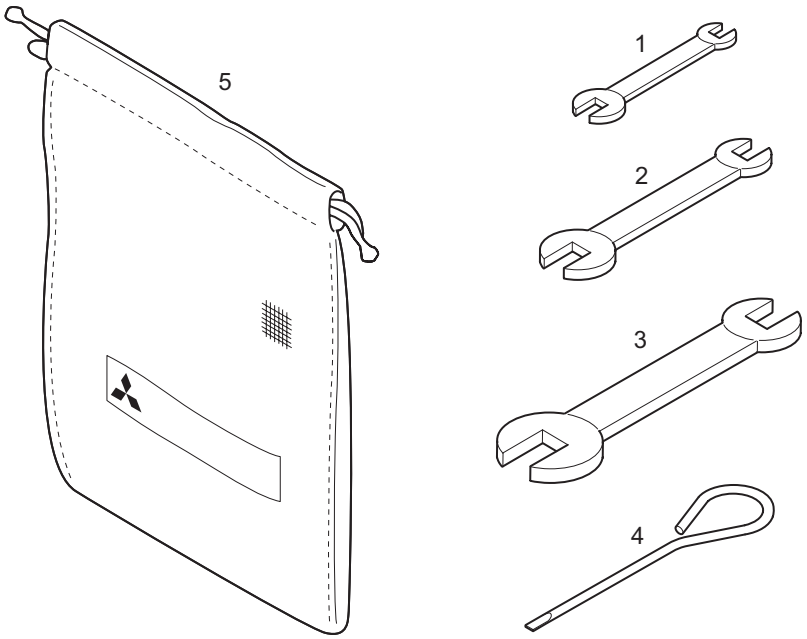


Table 3-1 Basic tools

No.	Tool name	Part No.	Remark
-	Tool set	MM413900	Includes 1 to 5
1	Spanner	MK96008010	Width across flats (8 mm × 10 mm) [0.32 × 0.39 in.]
2	Spanner	MK96012014	Width across flats (12 mm × 14 mm) [0.47 × 0.55 in.]
3	Spanner	MK96017019	Width across flats (17 mm × 19 mm) [0.69 × 0.75 in.]
4	Screwdriver	MM300110	(-)
5	Tool bag	MM300783	

1.4 Removing cylinder head assembly

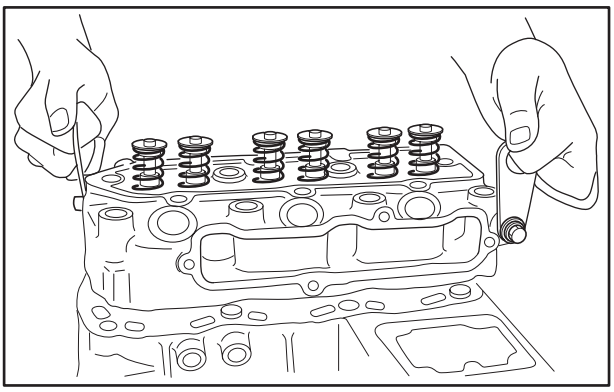
(1) Lift up the cylinder head assembly to remove.

Note: If the cylinder head assembly cannot be removed due to crimping of the cylinder head gasket, tap the thick area on the side of the cylinder head to give a shock.

(2) Remove the gasket from the cylinder head.

Note: (a) Be careful not to damage the fitting surfaces of the gasket when removing the gasket from the cylinder head.

(b) Before removing the cylinder head bolts, check the cylinder head components for any defects or faults. If any of them is faulty or defective, check the bolts for tightness with a torque wrench.



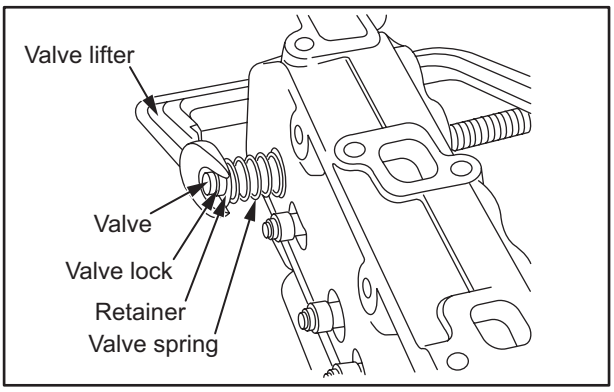
Removing cylinder head assembly

1.5 Removing valves and valve spring

(1) Use the valve lifter to compress the valve spring and remove the valve lock.

(2) Remove the retainer, valve spring and valve.

Note: Put match marks for easy identification of the installing position if the valve is to be reused. When reassembling, do not change the combination of the valve and valve seat.

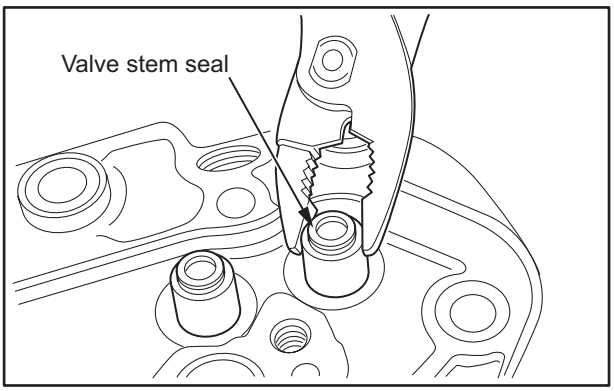


Removing valve

1.6 Removing valve stem seal

Grab the stem seal with pliers and remove.

Note: Be sure to replace the stem seal when reassembling the valve and valve spring.



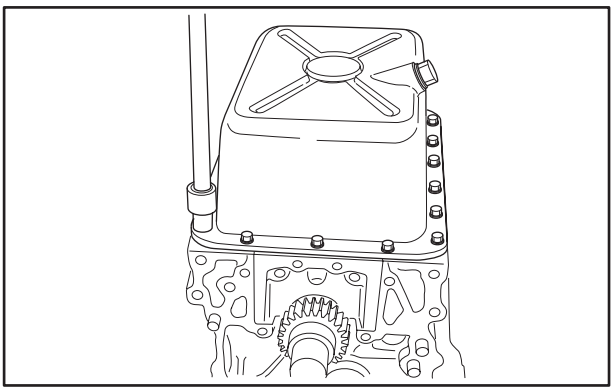
Removing valve stem seal

4.1 Removing oil pan

CAUTION

Do not insert a chisel or screwdriver between the oil pan and crankcase to remove the oil pan. It will deform the oil pan flange.

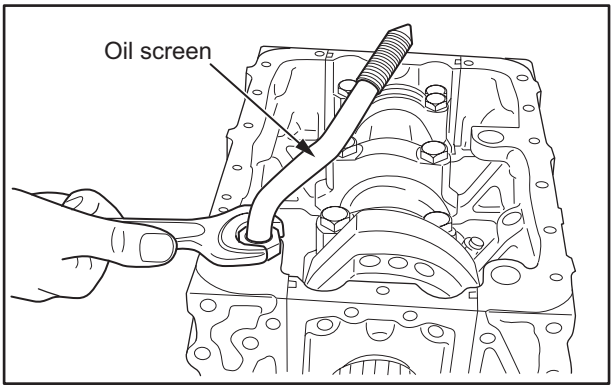
(1) Turn the engine around.
(2) Remove bolts from the oil pan.
(3) To remove oil pan, tap bottom corners of the oil pan with a plastic hammer.



Removing oil pan

4.2 Removing oil screen

Loosen the nut to remove the oil screen and gasket.

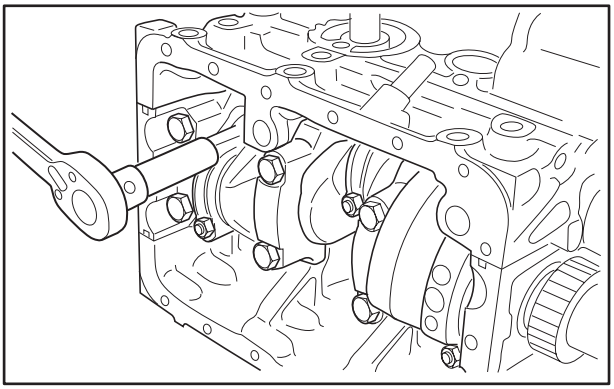


Removing oil screen

4.3 Removing connecting rod cap

(1) Lay the engine by its side.
(2) Mark the cylinder number on the connecting rod and connecting rod cap so that their combination is not changed when reassembling.
(3) Remove the connecting rod caps.

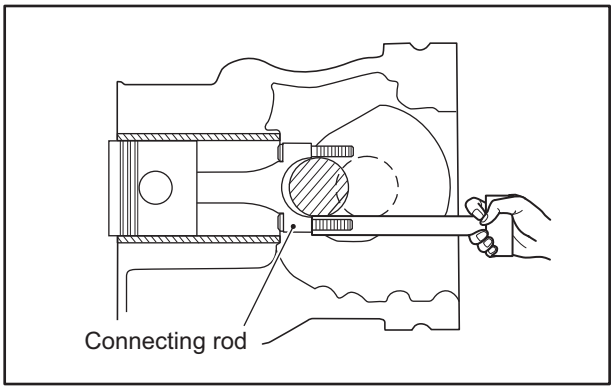
Note: Mark the cylinder No. and upper/lower on connecting rod bearings to ensure correct reassembling.



Removing connecting rod cap

4.4 Pulling out piston

(1) Turn the crankshaft and place the piston to top dead center.
(2) Push the mating surface of the connecting rod cap with a piece of wood such a handle of a hammer and push out the piston and connecting rod upward of the cylinder.

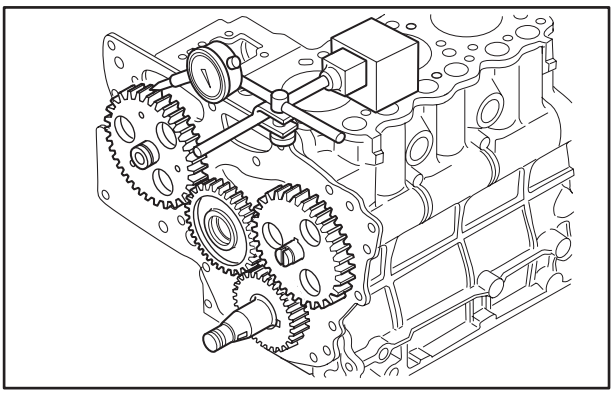


Pulling out piston

3. Inspecting and repairing gear case, timing gears and camshaft

3.1 Measuring backlash of timing gear

Measure the backlash of the timing gears by using one of the following two methods; measure the gear play with the dial gauge plunger applied to a tooth flank on the pitch circle at a right angle to the tooth axis, or measure the clearance between gears by inserting a feeler gauge between the gears at the tooth-to-tooth contacting area. Replace the faulty gear pair if the limit is exceeded.



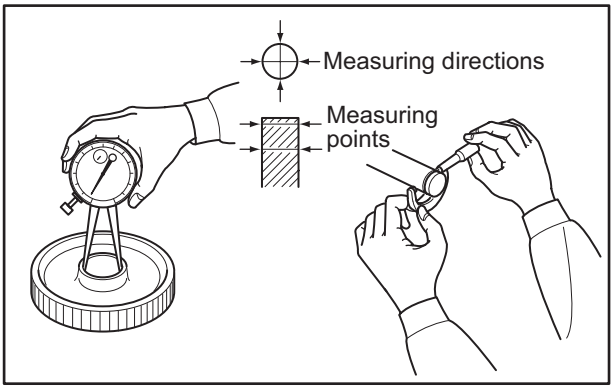
Measuring backlash of timing gears

Item		Standard	Limit
Timing gear backlash	Between crankshaft gear and idler gear	0.010 to 0.141 mm [0.0004 to 0.0056 in.]	0.30 mm [0.0118 in.]
	Between idler gear and valve camshaft gear	0.010 to 0.136 mm [0.0004 to 0.0054 in.]	
	Between idler gear and pump camshaft gear		

3.2 Measuring clearance between idler gear and idler shaft

Measure the inside diameter of the idler gear and outside diameter of the idler shaft. Replace the idler gear or idler shaft if the clearance exceeds the limit.

Item	Standard	Limit
Clearance between idler gear and idler shaft	0.030 to 0.066 mm [0.0012 to 0.0026 in.]	0.200 mm [0.0079 in.]



Measuring idler gear inside diameter and idler shaft outside diameter

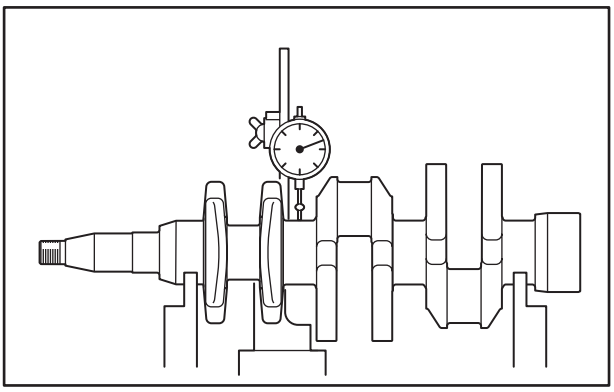
4.10 Measuring crankshaft runout

Support the crankshaft at the front and rear journals with V-blocks, and measure the crankshaft deflection (radial runout at the center journal) with a dial gauge. If the runout deviates from the standard only slightly, correct it by grinding the crankshaft. If the runout is a little large, straighten the crankshaft using a press.

Replace the crankshaft if the limit is exceeded.

If the crankshaft has been repaired by grinding or pressing, inspect its various parts for cracks and other harmful damage with a magnetic particle examination.

Item	Standard	Remark
Crankshaft runout	0.06 mm [0.0024 in.]	TIR



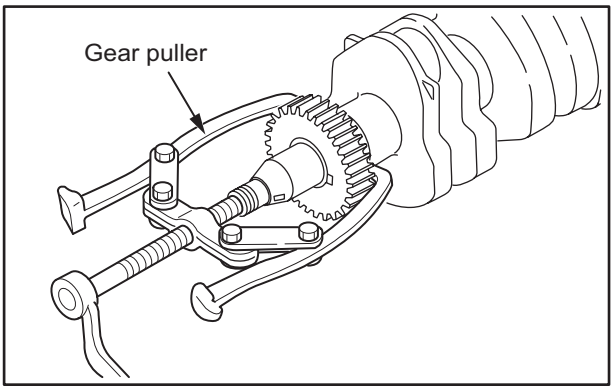
Measuring runout of crankshaft

4.11 Replacing crankshaft gear

4.11.1 Removing crankshaft gear

Using the gear puller, remove the gear from the crankshaft.

Note: Do not remove the gear by hitting it with a hammer.

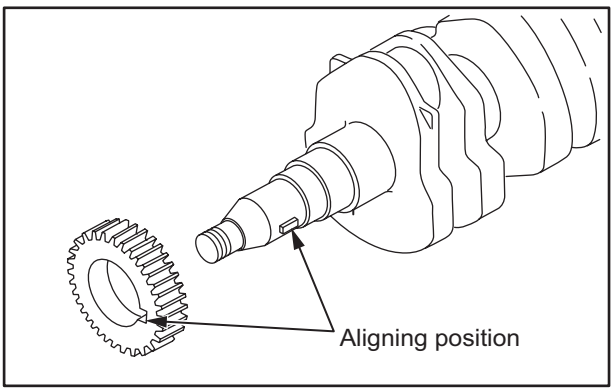


Removing crankshaft gear

4.11.2 Installing crankshaft gear

(1) Install the key on the crankshaft.

(2) Press-fit the gear fully in alignment with the key.

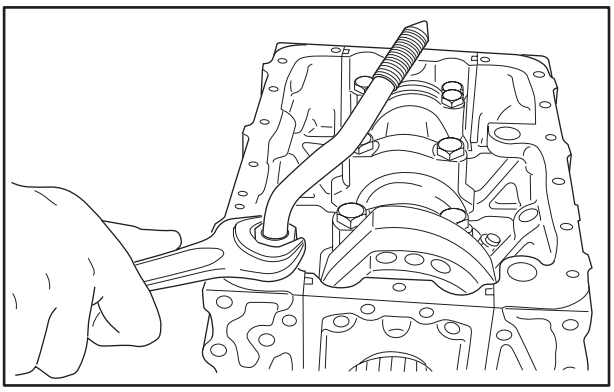


Installing crankshaft gear

1.11 Installing oil screen

(1) Turn the engine upside down to face up the oil pan mounting surface.

(2) Install the oil screen so that the tip of the screen does not contact the oil pan.

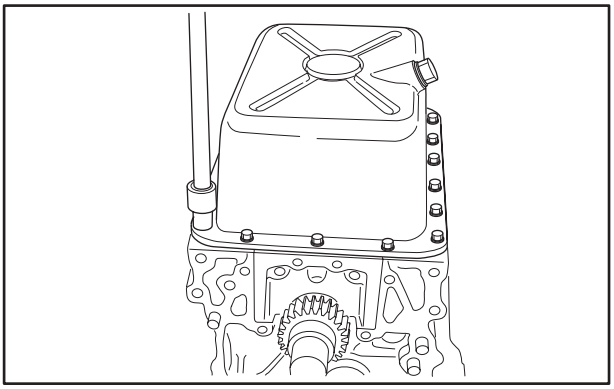


Installing oil screen

1.12 Installing oil pan

(1) Install new oil pan gasket.

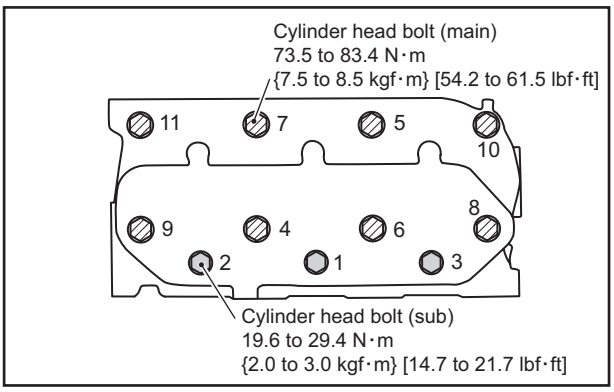
(2) Tighten oil pan bolts evenly and diagonally.



Installing oil pan

4.7 Tightening cylinder head bolts

In the numerical order as shown in the illustration, tighten cylinder head bolts progressively to the specified torque.

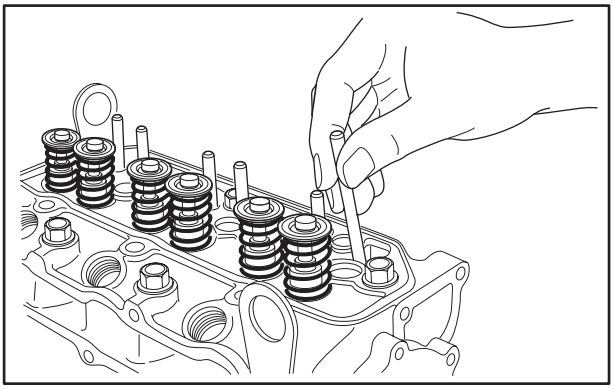


Tightening order of cylinder head bolts

4.8 Inserting pushrod

(1) Insert each pushrod into its hole in the cylinder head.

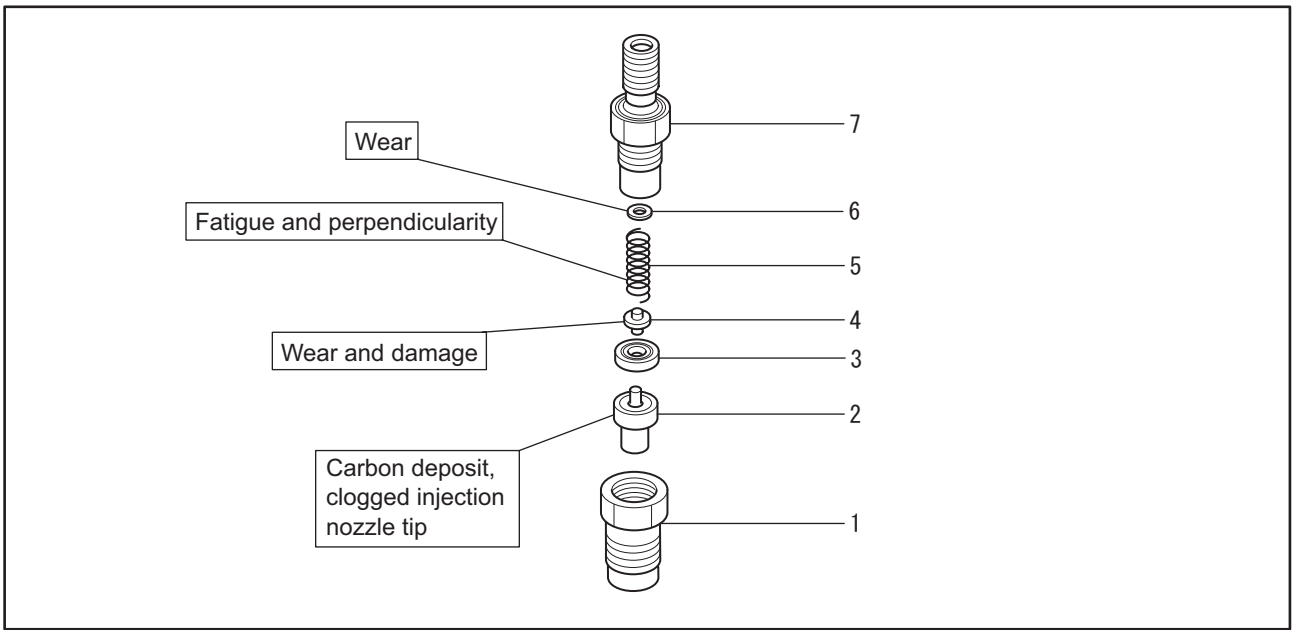
(2) Make sure that the ball end of each pushrod is placed correctly on the tappet cup.



Inserting pushrods

2. Disassembling, inspecting and reassembling fuel system

2.1 Disassembling and inspecting fuel injection nozzles



Disassembling and inspecting fuel injection nozzles

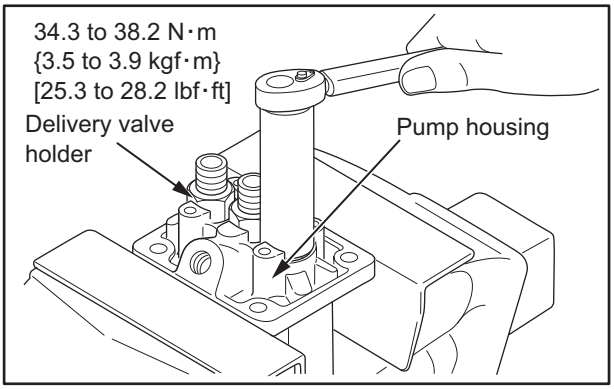
Disassembling sequence

1 Nozzle retaining nut
2 Nozzle tip assembly
3 Piece
4 Pin
5 Spring
6 Washer
7 Nozzle holder

2.5.7 Tightening delivery valve holder

(1) Place the pump housing upright, and grab the housing with a vise.

(2) Tighten the delivery valve holder to the specified torque.

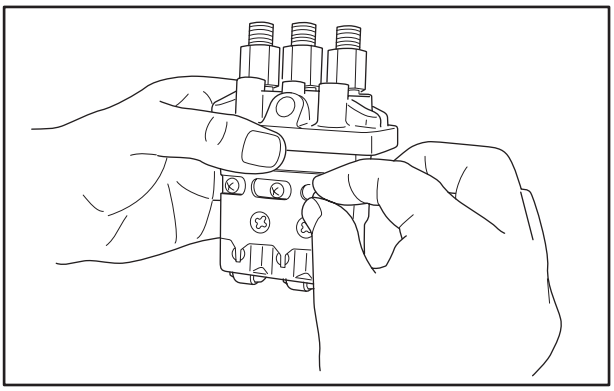


Tightening delivery valve holder

2.5.8 Inspecting control rack for smooth operation

(1) Remove the pump housing from the vise and check the control rack for smooth movement.
If the movement is not smooth, the following defects are suspected:
· Sliding of the element is poor.
· A foreign substance is present in the teeth of rack or sleeve.
· The valve holder is overtightened.

(2) Check the injection timing.



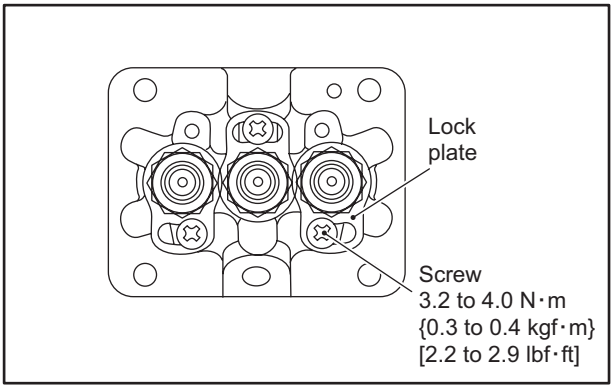
Checking sliding of control rack

2.5.9 Installing lock plate

(1) Grab the pump housing with a vise.

(2) Install the center lock plate first and then side lock plates later.

(3) Tighten the screws to the specified torque.

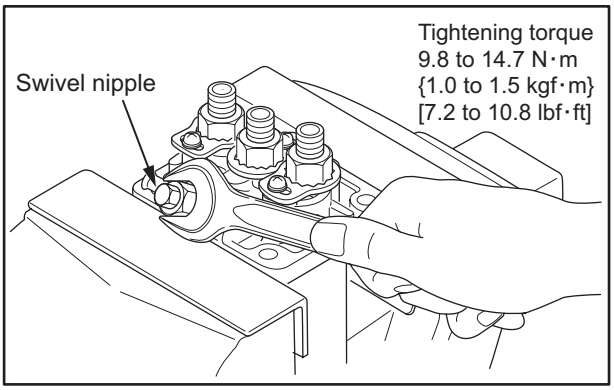


Installing lock plate

2.5.10 Installing swivel nipple

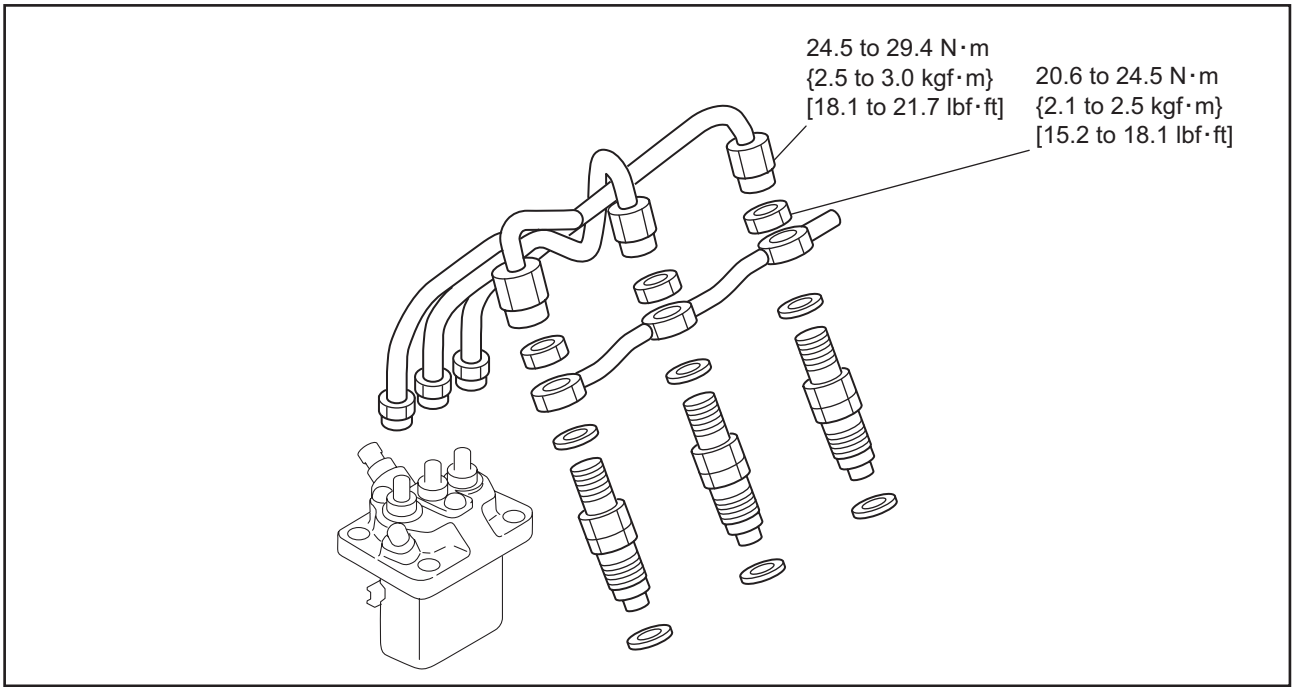
(1) Install the swivel nipple on the pump housing

(2) Tighten the hollow screw to the specified torque.



Installing swivel nipple

3.4 Installing fuel pipe and fuel injection nozzles

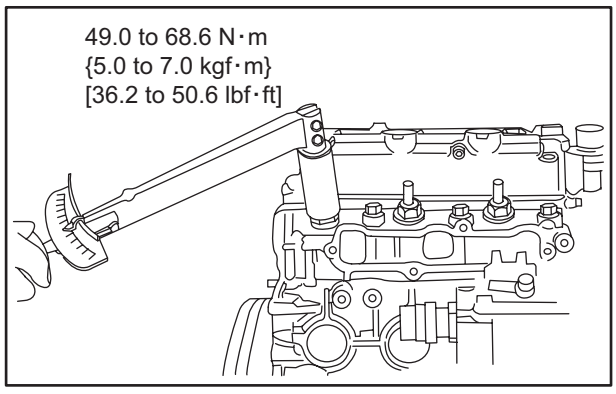


Installing fuel pipe and fuel injection nozzles

3.4.1 Installing fuel injection nozzle

(1) Clean the nozzle holder hole of cylinder head.

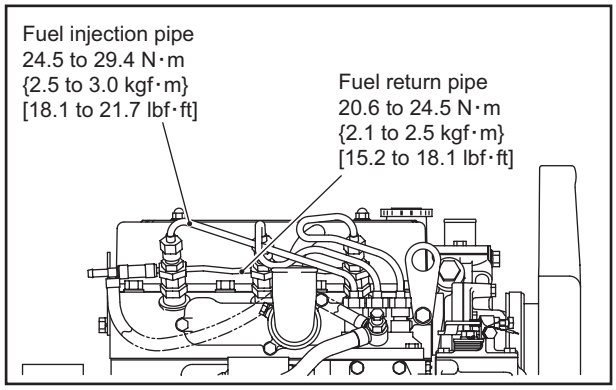
(2) Install the gasket to the nozzle tip and tighten the fuel injection pump.



Installing fuel injection nozzles

3.4.2 Installing fuel return pipe and fuel injection pipe

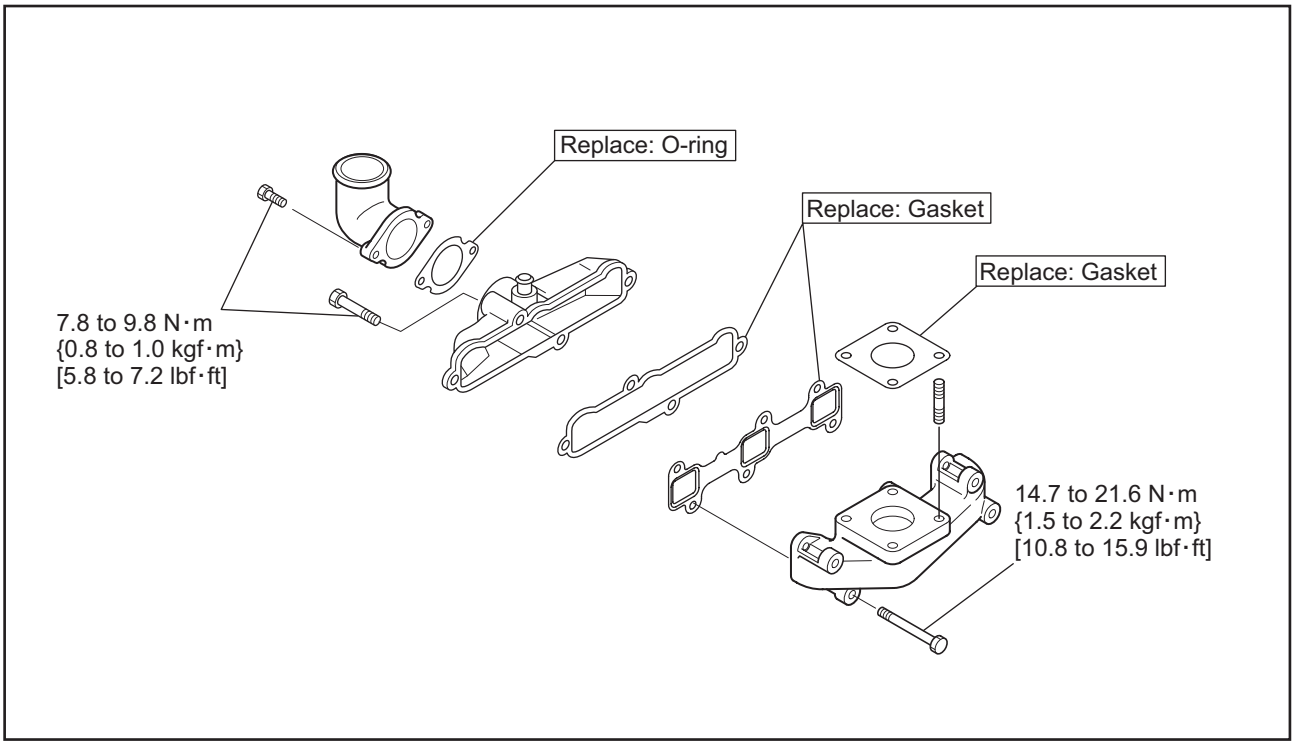
Install the fuel return pipe and fuel injection pipe.



Installing fuel return pipe and fuel injection pipe

3. Installing inlet and exhaust systems

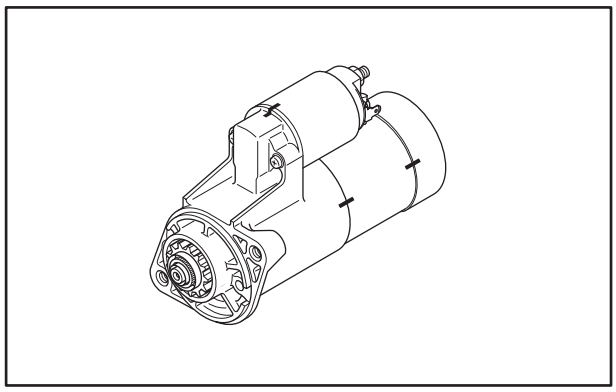
3.1 Installing intake cover and exhaust manifold



Installing intake cover and exhaust manifold

2.3 Preparation before disassembling

Mark the mating marks on magnet switch, front bracket, center bracket, yoke and rear bracket to each other for reassembly.



Preparatory work before disassembly

2.3.1 Removing pinion set

CAUTION

The starter generates heat if it is left with current being applied. Remove the pinion within 10 seconds.

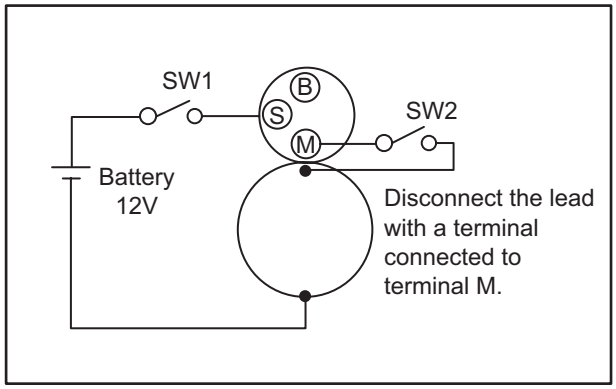
(1) Connect the starter to the circuit as shown in the illustration.

(2) Turn the switches SW1 and SW2 ON to move the pinion out and then turn the SW2 OFF to stop the rotation of the armature and the pinion.

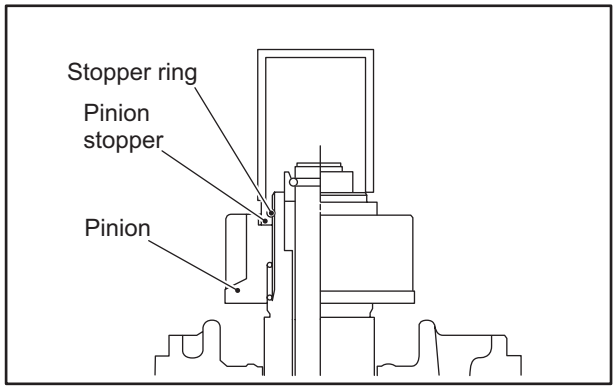
(3) Place an appropriate tube on the pinion stopper.
Tap the tube with a hammer to drop the pinion stopper to the clutch side. This will expose the stopper ring.

(4) Remove the stopper ring with pliers and remove the pinion.

Note: Do not reuse the stopper ring for reassembly.



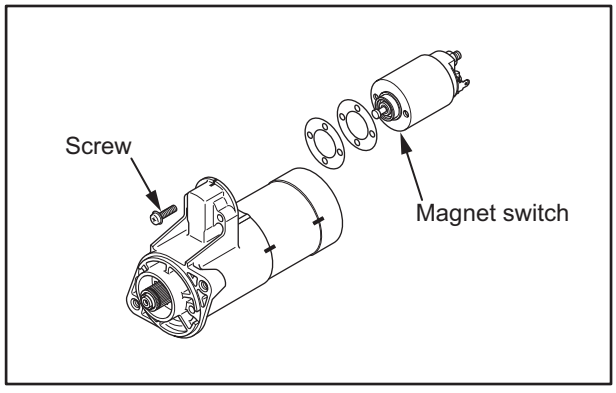
Connection to move the pinion forward



Removing pinion

2.3.2 Removing magnet switch

Disconnect the leads, and remove the magnet switch.



Removing magnet switch

2.5.8 Inspecting pinion clearance

CAUTION

Do not apply current continuously for longer than 10 seconds.

(1) Connect the starter to the circuit as shown in the illustration.

(2) When the switches SW1 and SW2 are turned ON, the pinion springs out to the cranking position and the armature rotates.

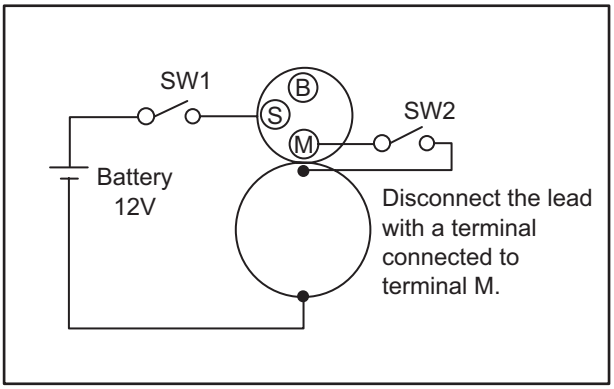
(3) Turn the switch SW2 OFF to stop the rotation of the armature.

(4) Gently push back the pinion in the out position with a finger and measure the distance over which the pinion has returned (movement amount).

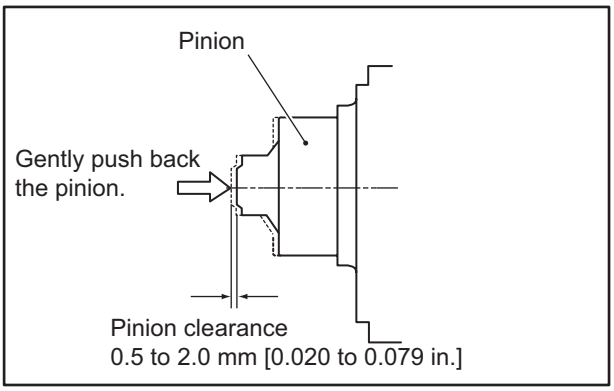
(5) If the measured value is out of the standard, increase or decrease the number of packings between the magnet switch and the front bracket for adjustment, or replace the lever with a new one.

Note: When the number of packings is increased, the pinion clearance becomes small.

Item	Standard
Pinion clearance	0.5 to 2.0 mm [0.020 to 0.079 in.]



Wiring during inspection of pinion clearance

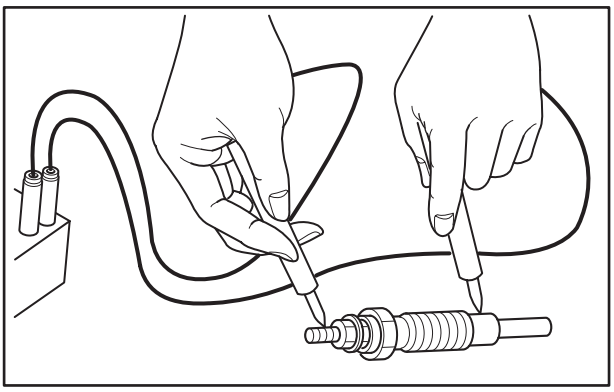


Inspecting pinion clearance

2.9 Inspecting glow plug

Check continuity between the terminal and the body as shown in the illustration. If no continuity is indicated, or the resistance is large, replace the glow plug with a new one.

Item	Standard
Resistance value	0.8 Ω



Inspecting glow plug

1.5 Bleeding fuel system

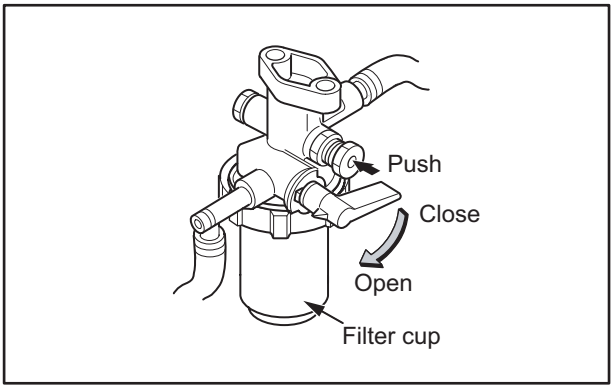
⚠ WARNING

Completely wipe off any spilled fuel from air vent screws with a cloth or the like, as spilled fuel can cause a fire.

Bleeding of the fuel system must be started from the place closest to the fuel tank: the fuel filter the first and the fuel injection pump the last.

1.5.1 Bleeding fuel filter

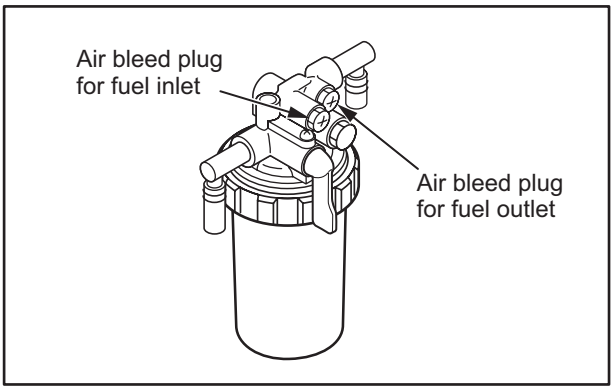
(1) Deliver fuel by solenoid pump.
(2) Place the cock of fuel filter in the "OPEN" position.
(3) Push and hold the button until the filter cup is filled with fuel.
(4) Stop the fuel delivery.



Bleeding fuel filter

1.5.2 Bleeding water sedimenter

(1) Loosen the water sedimenter's air bleed plug for fuel inlet.
(2) Deliver fuel by solenoid pump.
(3) Tighten air bleed plug for fuel inlet when the fuel flow from the air bleed plug becomes free of bubbles.
(4) Loosen air bleed plug for fuel outlet.
(5) Tighten air bleed plug for fuel outlet when the fuel flow from the air bleed plug becomes free of bubbles.
(6) Stop the fuel delivery.

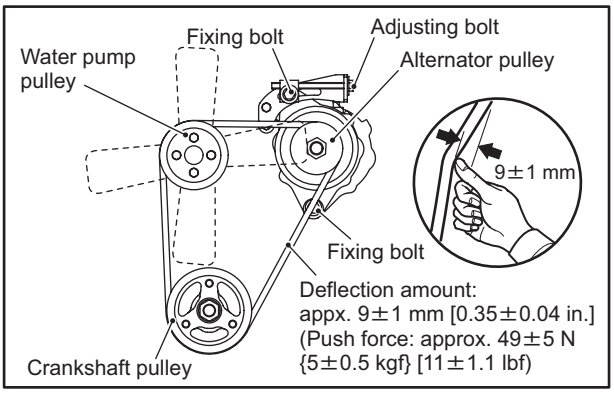


Bleeding water sedimenter

1.5.3 Adjusting V-belt tension

(1) Loosen the adjusting bolt and fixing bolt of the alternator. Loop the V-belt over the water pump pulley, alternator pulley and crankshaft pulley.
(2) Adjust the adjusting bolt so that the V-belt tension meets the specified value.

Belt tension (with pushing force of approx. 49 ± 5 N {5 ± 0.5 kgf} [11 ± 1.1 lbf])	Approx. 10 mm [0.39 in.]



Adjusting V-belt tension