



SERVICE MANUAL

MINI EXCAVATOR

ViO17-1

YANMAR

FOREWORD

This service manual outlines procedures for servicing YANMAR construction machinery. It contains specifications, servicing instructions and handling cautions. To obtain the maximum life and performance from YANMAR construction machinery, read this manual carefully and follow its instructions.

Please note that all dimensions and numerical values in this manual are for service reference, and are not inspection standards. Descriptions and specifications in this manual are subject to change without notice due to design improvements, etc.

GENERAL CAUTIONS FOR MAINTENANCE WORK

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1. GENERAL CAUTIONS FOR MAINTENANCE WORK

1. General Cautions for Maintenance Work

1-1 Correct Work

Correct work means the quickest possible completion of according to the correct procedures and the specified standards.

It is important when conducting certain operations always to bear in mind the equipment, tools, gauges, materials, oil and grease, etc. that you must have ready, as well as items to be checked, adjusted, or disassembled, and cautions to watch out for.

1-2 Safety Precautions

- (1) Never attempt servicing while engine is running or immediately after stopping operation.
- (2) Wear work cloths, safety shoes and helmet.
- (3) Check the equipment and tools before use. Especially, be sure to check the crane, lifting equipment and tools.
- (4) When working together with other persons, allocate everyone's share of job, arrange the signals and act in concert with the other persons.
- (5) The operation of the crane and slinging work must be performed by qualified persons.
- (6) Do not enter or pass under the raised load.
- (7) Lift and support the massive parts by crane before removing the installation bolts.
- (8) Disconnect cables from battery before repairing the electric system.
- (9) Remove the battery when welding the machine.

1-3 Preparations

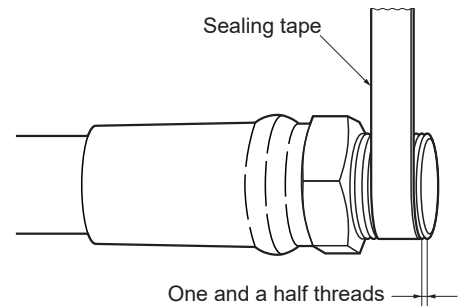
- (1) Check the service record of the machine. (That is, check how many months or hours the machine has been used since the preceding overhaul, what was the trouble then and what parts were replaced.)
- (2) Have all servicing tools ready, i.e., tools, measuring devices (which have received periodic maintenance), containers, oil & grease, etc.
- (3) Have the service literature (operation manual, parts catalog, etc.) ready.

1-4 Cautions for Disassembly and Reassembly

- (1) Clean the machine before disassembly.
- (2) Check and record the condition of the machine before disassembly :
 - Model, machine number, operation hours
 - Reasons for repair, history of repair
 - Contamination of filters
 - Fuel and oil condition
 - Damage to parts, etc.
- (3) Place alignment marks on the necessary parts to facilitate reassembly.
- (4) Clean all the removed parts and new replacement parts and put them in order.
- (5) Use new seals, split pins, etc. for reassembly.

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

- (6) Keep the parts apt to be damaged by water or oil apart from the oily or wet parts.
e.g.: Electrical parts, rubber parts, V-belts, etc.
- (7) Use the jig for press-fitting the bearings, bushes and oil seals. When using a hammer, use a pad block.
- (8) Clean the joint surface of all parts and keep them free from dust.
- (9) Wind the sealing tape securely, leaving a space of one or two threads from the tip of the male screw. The tape should have an overlap of about 10 mm.



1-5 Cautions for Removal and Installation of Hydraulic Equipment

- (1) Check that the hydraulic oil temperature is low enough.
- (2) Release air from the hydraulic tank to prevent the hydraulic oil from flowing out.
- (3) Be sure to plug open the ends of hydraulic components to prevent dust from entering.
- (4) Be sure to wipe hydraulic oil from the hydraulic components so that it will not be mistaken for an oil leak.
- (5) Take care not to damage the plating on the cylinder rod.
- (6) Remove or install cylinders with rods fully retracted.
- (7) Be sure to release air after installing the hydraulic cylinders.
 - Run the engine at a low speed. Extend and retract the cylinders 4 to 5 times up to 50 to 100 mm from the end of the stroke. Then, fully extend and retract.
- (8) Be sure to pressurize the hydraulic tank after installing the hydraulic components (in the case of the sealed hydraulic tank). Otherwise, hydraulic pumps might suffer cavitation and their life will be shortened.
 - To pressurize the hydraulic tank, fully extend each cylinder and tighten the oil filter port plugs.

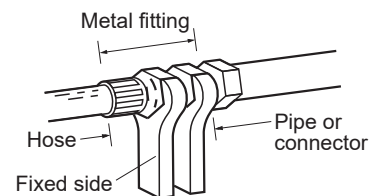
1-6 Cautions for Removal and Installation of Hydraulic Piping

- (1) Installation of hydraulic hose

Take care not to twist the hoses. (Judge whether or not the hose is twisted by the hose mark.) For hoses with a metal fitting, use two wrenches to prevent twisting.

Use one to fix the hose, and the other to tighten the fitting to the specified tightening torque. Carefully check that the hoses do not come in contact after tightening. If any contact is found, correct it or use tubes.

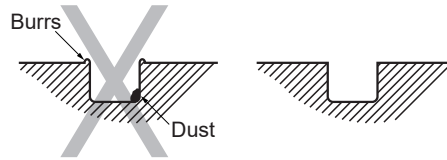
- (2) When installing hoses, first tighten to the specified torque and then loosen them a little. Then retighten to the specified torque.
 - Break in the installed parts before tightening (except those using seal tapes).
- (3) When installing pipes, turn the nuts more 1/4 to 1/2 turn after they reach the sharp torque rise point.
- (4) When installing or removing hoses, use two wrenches, one to fasten the hose and the other to tighten or loosen the hose to prevent twisting.
- (5) Check for oil leakage by applying max. pressure 5 to 6 times after attaching hydraulic hoses or pipes.



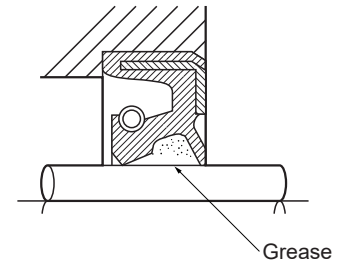
1. GENERAL CAUTIONS FOR MAINTENANCE WORK

1-7 Cautions for Handling Seals

- (1) Clean out grooves of O-rings. Remove burrs or dust if any.



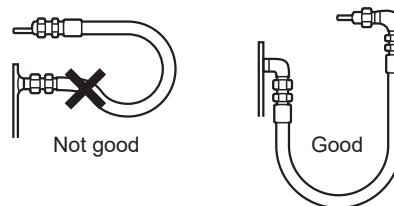
- (2) Take care not to twist O-rings. Correct by your finger if it is twisted.
- (3) Take care not to damage seals when inserting.
- (4) Handling of floating seals :
- Completely wipe off all the oil from the O-ring and housing after detaching the floating seals.
 - Before installing, apply a little gear oil to the matching face of the housing.
 - Turn the seals two or three times after installation to break them in.
- (5) Apply grease to the lip of the oil seals to prevent wear.



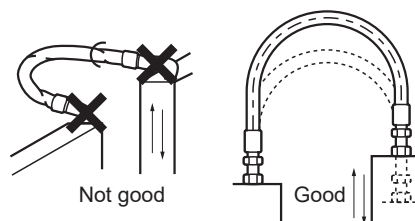
1-8 Correct Installation of Hydraulic Hose

In order to mount the hydraulic hose most effectively and economically, observe the following cautions.

- (1) When a hose is used at the minimum bending radius, use elbows to avoid sharp bending.

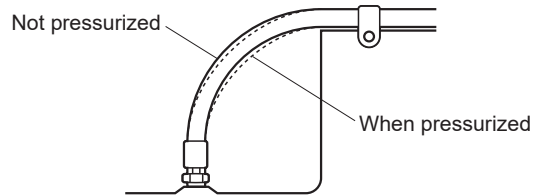


- (2) To prevent twisting, the hose should be bent in the same direction as it moves.

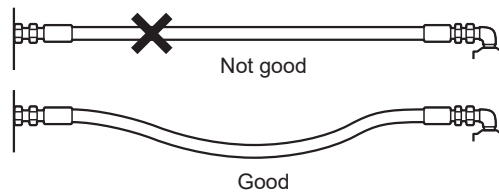


1. GENERAL CAUTIONS FOR MAINTENANCE WORK

- (3) When the hose is pressurized, the hose length varies slightly at the bend. Allow this change to occur and do not try to fasten the bend.



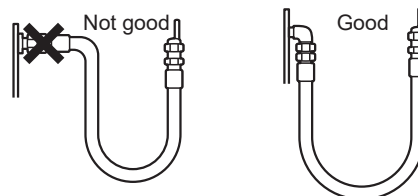
- (4) It is necessary for the hose to have ample slackness for elongation and contraction, because its length will change by +2 % to -4 % when used at high pressure.



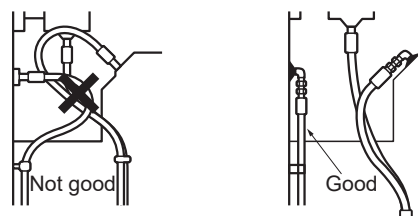
- (5) Use the proper adapters, not pipes, in order to reduce the number and length of joints and improve the external appearance.



- (6) Use an elbow to prevent excessive twisting or bending of the hose.

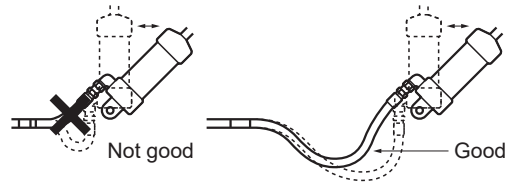


- (7) Use adapters to make the hose as straight as possible. The outside appearance can be improved by avoiding the use of hoses that are too long.

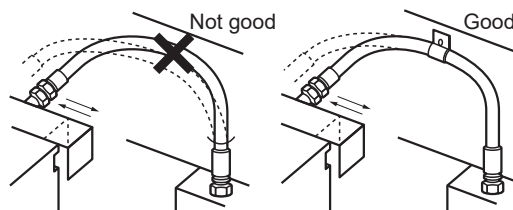


1. GENERAL CAUTIONS FOR MAINTENANCE WORK

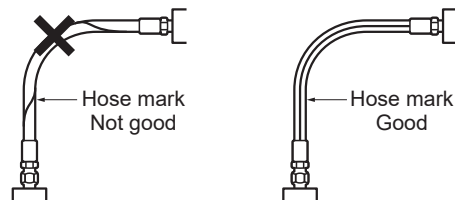
- (8) The hose should be slightly longer than is absolutely necessary. The extra allows smoother movement of the hose and prevents sharp bending.



- (9) When a bent hose is attached to two different planes, fix as shown in the diagram to prevent twisting.



- (10) Use the marking on the hose as a guide to prevent twisting during installation.
Twisting of metal fitting with union nuts should be with a wrench on the hexagonal parts.

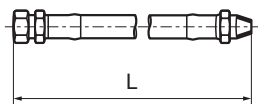


1. GENERAL CAUTIONS FOR MAINTENANCE WORK

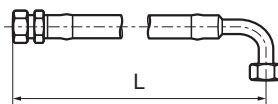
1) Type of Hose (Hose Dia. & Recommended Working Pressure)

Type of hose	Hose dia.	Inner dia. [in. (mm)]	Outer dia. [in. (mm)]	Working pressure [PSI (MPa)]
1 (SAE J517, 100R1)	02	0.25 (6.3)	0.53 (13.5)	2489 (17.2)
	03	0.37 (9.5)	0.69 (17.5)	1991 (13.7)
	04	0.50 (12.7)	0.81 (20.6)	1564 (10.8)
2 (SAE J517,100R7)	02	0.25 (6.3)	0.59 (15.1)	4266 (29.4)
	03	0.37 (9.5)	0.75 (19.1)	3484 (24.0)
	04	0.50 (12.7)	0.87 (22.2)	2986 (20.6)
1 (SAE J517, 100R6)	02	0.25 (6.3)	0.49 (12.5)	2986 (20.6)
	03	0.37 (9.5)	0.65 (16.6)	2489 (17.2)
	04	0.50 (12.7)	0.81 (20.7)	1991 (13.7)
2 (SAE J517,100R7)	03	0.37 (9.5)	0.68 (17.2)	2986 (20.6)
	04	0.50 (12.7)	0.84 (21.4)	2986 (20.6)
1 (SAE J517,100R6)	02	0.25 (6.3)	0.50 (12.7)	427 (2.9)
	03	0.37 (9.5)	0.63 (15.9)	427 (2.9)
	04	0.50 (12.7)	0.78 (19.8)	427 (2.9)
	05	0.63 (15.9)	0.91 (23.0)	427 (2.9)
	06	0.75 (19.0)	1.25 (31.8)	427 (2.9)
	10	1.00 (25.4)	1.50 (38.1)	427 (2.9)
	12	1.25 (31.8)	1.75 (44.5)	427 (2.9)
	14	1.50 (38.1)	2.04 (51.9)	427 (2.9)

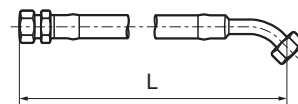
2) Total Length of Hose [Unit : in. (cm)]



3 digit indication in cm.



(Example) Nominal length 065 : Full length 25.6 in. (65 cm)



3) Hose Dia. (Unit : inch)

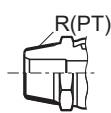
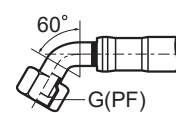
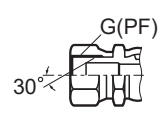
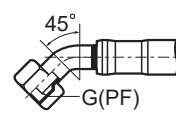
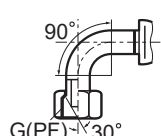
02....1/4"	05....5/8"	12....1 1/4"
03....3/8"	06....3/4"	14....1 1/2"
04....1/2"	10....1	

Note :

Please note that these code numbers are different from those for the equivalent diameters for special parts on the next page.

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

4) Combination of Fitting

Code No.	Fitting type						
1	A·B	A		Taper pipe thread R (PT)	D		60 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat
3	A·E						
4	B·B	B		Straight pipe thread G (PF) with male 30 degrees seat	E		45 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat
5	B·C						
6	B·E	C		90 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat			
7	B·D						

(Example) Part code 2 3 2 0 2 — 0 3 0 8 5 5

Rubber hose, high pressure type

SAE J517, 100R2

Nominal dia., 3 / 8"

Hose length, 33.5 in. (85 cm)

Straight pipe thread G (PF) with
male 30 degrees seat and 90 degrees bent type.
Straight pipe thread G (PF) with
male 30 degrees seat

List of pipe threads	
Symbol	Name
G (PF)	Straight pipe thread
R (PT)	Male taper pipe thread
Rc (PT)	Female taper pipe thread

Note :

All the hoses with fittings other than those listed above are special parts.

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

1-9 Specifications of Hydraulic Hose

Specifications of the hydraulic hoses can be known by the part descriptions as explained below. (For the parts number, please refer to our Parts Catalog.)

Description Hose P 2 06 AB 075 W

1 2 3 4 5 6 7 8

1 Part name

2 Hose material

- Rubber hose G
- Wear-resistant high pressure rubber hose H
- Plastic hose P
- Wear-resistant plastic hose..... F

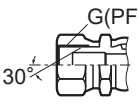
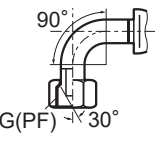
3 Recommended working pressure PSI(Mpa)

Over 2986 (20.6)	1
2489 to 2986 (17.2 to 20.6)	2
1991 to 2489 (13.7 to 17.2)	3
1564 to 1991 (10.8 to 13.7)	4
995 to 1564 (6.9 to 10.8)	5
427 to 995 (2.9 to 6.9)	6
213 to 427 (1.5 to 2.9)	7
Below 213 (1.5)	8

4 Nominal dia. (inch)

1 / 8"	02
3 / 16"	03
1 / 4"	04
3 / 8"	06
1 / 2"	08
5 / 8"	10
3 / 4"	12
1"	16

5 Combination of fitting

Fitting type	Code
 Taper pipe thread R (PT)	A
 Straight pipe thread G (PF) with male 30 degrees seat	B
 90 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	C
Without fitting	Y

* For the combination of fitting, refer to the list on the following page.

6 Total length (Unit : cm)

7 Hose protector

- Coil spring W
- Coil tube S
- Wire braid B
- Tube (Rubber) R
- Tube (Vinyl) V
- Sponge rubber P
- Hose cover K
- No protection Blank

8 Other accessories

- No accessories...Blank
- O-ring 1

List of pipe threads

Symbol	Name
G (PF)	Straight pipe thread
R (PT)	Male taper pipe thread
Rc (PT)	Female taper pipe thread

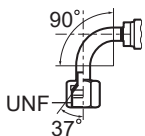
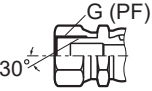
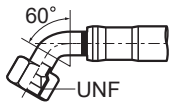
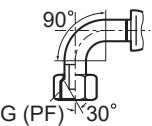
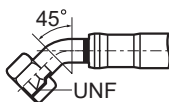
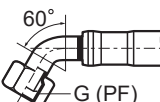
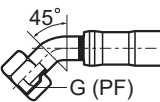
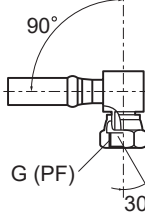
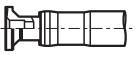
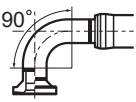
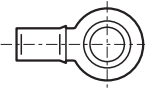
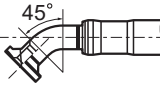
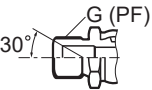
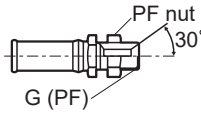
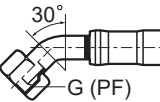
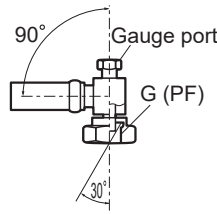
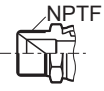
The example hose, P 2 06 AB 075 W stands for :

2 3 4 5 6 7

- 2 Material : Plastic
- 3 Working pressure : 2489 to 2986 PSI (17.2 to 20.6 MPa)
- 4 Nominal dia. : 3 / 8"
- 5 Fitting type : Taper pipe thread R (PT) and straight pipe thread G (PF) with male 30 degrees seat.
- 6 Length : 29.5 in. (75 cm)
- 7 Hose protector : Coil spring

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

5 Combination of fitting

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

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

1-10 Air Release of Hydraulic Equipment

When operating the machine after disassembly or parts replacement of the hydraulic equipment, piping, etc., be sure to release air from the hydraulic system. This is necessary to prevent seizure and cavitation of the hydraulic equipment. If the air is left in the hydraulic system, the air is compressed or expanded depending on the load, having an adverse effect on the smooth operation of the hydraulic equipment and shortening the service life.

1. Air Release of Variable Displacement Piston Pumps

- 1) Make sure that all joints and fitting are not loosened.
- 2) Put a specified quantity of hydraulic oil into the hydraulic oil tank.

Note :

1. *Set the machine at the oil level check position.*
2. *Keep the oil supply cap of the hydraulic oil tank removed.*
- 3) Run the engine at low idling speed for 5 to 10 minutes.
- 4) Check the oil level in the hydraulic oil tank. If the oil level is lower than the specified level, supply the hydraulic oil to the tank after stopping the engine.
- 5) Run the engine again at low idling speed for a few minutes.
- 6) Check the oil level and supply the hydraulic oil to the specified level. Then install the oil supply cap.

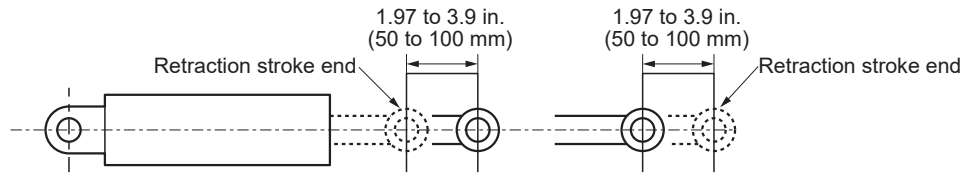
2. Air Release of Each Hydraulic Component

Run the engine at medium speed and activate the respective circuits for about 10 to 15 minutes.

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

3. Air Release of Hydraulic Cylinders

- 1) Set the Engine Speed at Low Idling Range.
- 2) Extend and Retract the Cylinder Up to 1.97 to 3.9 in. (50 to 100 mm) from Each Stroke End Slowly 4 or 5 Times.



Note :

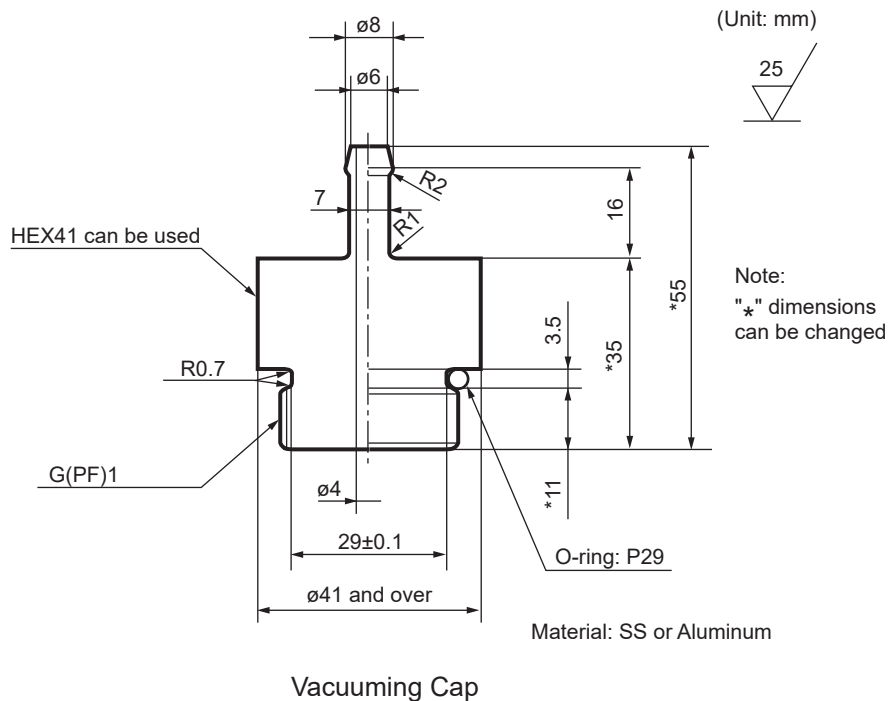
The extension and retraction stroke is up to 1.97 in. (50 mm) from each stroke end for the blade cylinder.

- 3) Then, Fully Extend and Retract the Cylinder 3 or 4 Times.

4. Air Release of Hydraulic Oil tank

Replace the oil supply cap of the hydraulic tank with the vacuuming cap.

Connect the vacuuming cap to the vacuum compressor, vacuum the air in the hydraulic oil tank.



CHAPTER 2

TECHNICAL DATA

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2. TECHNICAL DATA

2. Technical Data

2-1 Specifications

Item			Unit	ViO17-1
Main specifications of machine				
Dimensions				
Overall length (Transportation position) Short Arm / Long Arm			in. (mm)	136.22 (3460) / 137 (3480)
Canopy	Overall height	Transportation position	in. (mm)	90.55 (2300)
		Traveling position	in. (mm)	136.22 (3460)
	Overall width	Full machine width (Maximum/Minimum)	in. (mm)	50.39 (1280)/37.6 (955)
Tumbler center distance			in. (mm)	46.3 (1175)
Track gauge (Maximum/Minimum)			in. (mm)	41.3 (1050)/28.3 (720)
Minimum ground clearance			in. (mm)	6.89 (175)
Traveling performance				
Travel speed	Steel crawler	Low speed (Forward/Reverse)	km/hr	-
		High speed (Forward/Reverse)	km/hr	-
	Rubber crawler	Low speed (Forward/Reverse)	km/hr	2,1
		High speed (Forward/Reverse)	km/hr	4,3
Permissible water depth limit			in. (mm)	10.4 (265)
Work performance				
Bucket	Width (Standard)		in. (mm)	15.7 (400)
	(Standard. JIS heaped capacity)		cu.ft. (cu.m)	1.37 (0.04)
	Number of teeth / Installation method		pcs.	3 / Std. Quick hitch
Maximum digging depth	With blade raised		in. (mm)	89 (2260)
	With blade on the ground		in. (mm)	85 (2160)
Maximum depth of vertically digging short arm / long arm			in. (mm)	85.04 (2160) / 90.94 (2310)
Maximum dumping height short arm / long arm			in. (mm)	131.89 (3350) / 153.43 (3440)
Minimum front swing radius short arm / long arm (with boom in front)			in. (mm)	65 (1650) / 65.75 (1670)
Minimum front swing radius short arm / long arm (at 65 degrees right boom swing)		Cabin	in. (mm)	-
		Canopy	in. (mm)	44.5 (1130) / 44.88 (1140)
Rear end swing radius			in. (mm)	25.2 (640)
Boom swing angle	Cabin	Left	degrees	-
		Right	degrees	-
	Canopy	Left	degrees	42
		Right	degrees	65
Maximum digging force	Bucket		lbs. (kN)	3624 (16.1)
	Short Arm / Long Arm		lbs. (kN)	2163 (9.6) / 1939 (8.6)
Maximum tractive force (Oil pressure force) (rubber)			lbs. (kN)	3810 (16.9)
Maximum swing inclination angle (with standard bucket)			degrees	30

2. TECHNICAL DATA

Item			Unit	ViO17-1
Main specifications of machine				
Work performance				
Swing speed			rpm	9.5
Fuel consumption in practical operation			Gals/h (L/h)	0.53 (2.0)
Blade				
Blade	Width×Height	Side open	in. (mm)	50.4 (1280)×9.8 (250)
		Side close	in. (mm)	37.56 (950) X 9.8(250)
	Capacity	Side open	cu.ft. (cu.m)	2.8 (0.08)
		Side close	cu.ft. (cu.m)	2.1 (0.06)
	Lift above ground level		in. (mm)	10.2 (260)
	Digging depth		in. (mm)	8.1 (205)
Mean contact pressure				
JIS (operating)	Steel crawler	Cabin	PSI (KPa)	-
		Canopy	PSI (KPa)	-
	Rubber crawler	Cabin	PSI (KPa)	-
		Canopy	PSI (KPa)	4.35 (30)
Mass				
Operating mass	Steel crawler	Cabin	lbs. (kg)	-
		Canopy	lbs. (kg)	-
	Rubber crawler	Cabin	lbs. (kg)	-
		Canopy	lbs. (kg)	4035 (1830)
Base machine dry mass	Steel crawler	Cabin	lbs. (kg)	-
		Canopy	lbs. (kg)	-
	Rubber crawler	Cabin	lbs. (kg)	-
		Canopy	lbs. (kg)	3624 (1644)
Hydraulic equipment				
Hydraulic pump				
Drive method				Engine → Coupling → Pump (Direct drive)
Type of main pump				Variable displacement piston pump + Gear pump + Trochoid pump
Number of pumps				Variable displacement piston pump: 2 Gear pump: 1, Trochoid pump: 1
Theoretical discharge volume			cu.in./rev (cu.cm/rev)	0.49 (8)X2, 0.37 (6)X1, 0.56 (3.6)X1
Maximum allowable pressure			PSI (MPa)	-
Control valve				
Number of connected valves			pcs.	13
System relief set pressure	P1, P2		PSI (MPa)	2986 (20.6)
	P3		PSI (MPa)	2422 (16.7)
	P4		PSI (MPa)	421 (2.9)
Circuit relief set pressure	Boom (at rod end)		PSI (MPa)	3413 (23.5)
	Boom (at bottom end)		PSI (MPa)	4264 (29.4)
	Arm (at rod end)		PSI (MPa)	3413 (23.5)
	Arm (at bottom end)		PSI (MPa)	3413 (23.5)

2. TECHNICAL DATA

Item			Unit	ViO17-1
Hydraulic equipment				
Control valve				
Circuit relief set pressure	Bucket (at rod end)		PSI (MPa)	-
	Bucket (at bottom end)		PSI (MPa)	3555 (24.5)
	Boom swing (at rod end)		PSI (MPa)	-
	Boom swing (at bottom end)		PSI (MPa)	-
	Blade (at rod end)		PSI (MPa)	-
	Blade (at bottom end)		PSI (MPa)	-
	PTO1		PSI (MPa)	2321 (16) / 2321 (16)
	PTO2		PSI (MPa)	2321 (16) / 2321 (16)
Cylinder				
Boom	Stroke		in. (mm)	16.65 (423)
	Inside diameter		in. (mm)	Ø2.36 (Ø60)
	Piston rod diameter		in. (mm)	Ø1.38 (Ø35)
	Speed	Up (Ground → Max.)	sec.	2.4
		Down (Max. → Ground)	sec.	2.1
Arm	Stroke		in. (mm)	16.61 (422)
	Inside diameter		in. (mm)	Ø2.17 (Ø55)
	Piston rod diameter		in. (mm)	Ø1.38 (Ø35)
	Speed	Full stroke for digging	sec.	3.4
		Full stroke for dumping	sec.	2.3
Bucket	Stroke		in. (mm)	13.19 (335)
	Inside diameter		in. (mm)	Ø2.17 (Ø55)
	Piston rod diameter		in. (mm)	Ø1.18 (Ø30)
	Speed	Full stroke for digging	sec.	2.9
		Full stroke for dumping	sec.	2.1
Blade	Stroke		in. (mm)	4.72 (120)
	Inside diameter		in. (mm)	Ø2.36 (Ø60)
	Piston rod diameter		in. (mm)	Ø1.18 (Ø30)
	Speed	Up (Ground → Max.)	sec.	1.2
		Down (Max. → Ground)	sec.	1.1
Boom swing	Stroke		in. (mm)	11.6 (295)
	Inside diameter		in. (mm)	Ø2.56 (Ø65)
	Piston rod diameter		in. (mm)	Ø1.38 (Ø35)
	Speed	Full stroke to the right	sec.	3.6
		Full stroke to the left	sec.	3.1
Extension	Stroke		in. (mm)	13.4 (341)
	Inside diameter		in. (mm)	Ø2.17 (Ø55)
	Piston rod diameter		in. (mm)	Ø1.18 (Ø30)
	Speed	Max. track gauge	sec.	4.6
		Min. track gauge	sec.	8.2
Swivel joint				
Swivel joint port diameter×Number			inch×pcs.	1/4×21

2. TECHNICAL DATA

Item			Unit	ViO17-1
Hydraulic equipment				
Motor				
Swing motor	Type		-	Orbit motor
	Displacement		in³/rev cm³/rev	11.9 (195)
	Brake valve	Type	-	Cross relief valve
		Relief set pressure	MPa	2060 (14.2) to 2132 (14.7)
Travel motor	Type		-	Orbit motor
	Displacement (Low/High)		in³/rev (cm³/rev)	0.94 (490)/0.47 (245)
	Brake valve	Type	-	Counterbalance valve
		System pressure	PSI (MPa)	2987 (20.6)
	Type of reduction gear		-	-
Hydraulic oil tank				
Hydraulic oil amount (Tank capacity / Others)			L	16.5 / 9.5
Suction filter	Type		-	Strainer
	Filtration area		in² (cm²)	68.2 (440)
	Filtration accuracy		u	90
Return filter	Type		-	Bypass
	Filtration area		in² (cm²)	310 (2000)
	Filtration accuracy		u	10
	By-pass valve opening pressure		PSI (MPa)	0.15
Locking device				
Lever lock			-	Oil pressure controlled
Boom swing lock			-	Oil pressure controlled
Swing lock			-	Mechanical brake
Cut off valve				
Number of valves			pcs.	2
Relief set pressure (P4)			PSI (MPa)	421 (2.9)
Swing device				
Swing bearing			-	Planetary gear (with reduction mechanism)
Power transmission			-	Swing motor shaft gear → Swing gear
Type of brake			-	Oil pressure controlled
Brake mounting position			-	Swing motor

2. TECHNICAL DATA

Item		Unit	ViO17-1
Undercarriage			
Rubber track	Shoe width	in. (mm)	9.06 (230)
	Lug height	in. (mm)	0.71 (18)
	Core metal pitch	in. (mm)	2.83 (72)
Track carrier roller (Upper roller)	Manner of support	-	Guide
	Quantity (One side)	pcs.	1
Number of shoe slide plates (One side)		pcs.	-
Track roller (Lower roller)	Quantity (One side)	pcs.	3
	Bearing	-	Ball bearing
	Sealing	-	QLF
Idler wheel	Quantity (One side)	pcs.	1
	Bearing	-	Ball bearing
	Sealing	-	Shaft seal
Number of sprocket teeth		pcs.	13
Track tension adjustment		-	Grease cylinder

2. TECHNICAL DATA

Item			Unit	ViO17-1
Engine				
Main specifications				
Engine model		-	3TNV70-XBV	
Type		-	Vertical type series water-cooled 4cycle diesel engine	
Combustion system		-	Special swirl pre-combustion chamber	
Number of cylinders - Bore × Stroke		pcs. - in.×in. (mm×mm)	3 - 2.76 x 2,91 (70 x 74)	
Total displacement		cu.in. (cu.cm)	52.1 (854)	
Rated output / engine speed		HP/rpm (KW/rpm)	13.5/2200 (10.1/2200)	
Maximum torque / engine speed		ft•lbf/rpm (N•m/rpm)	34.7 to 38.2/1500 (47.1 to 51.8/1500)	
Specific fuel consumption		lbs./HP•h (g/PS•h)	0.448 (203)	
Maximum idling speed		rpm	2325 to 2375	
Minimum idling speed		rpm	1200 to 1250	
Lubricating method		-	Forced lubrication with trochoid pump	
Specific lubricating oil consumption		lbs./HP•h (g/PS•h)	0.0003 to 0.0015 (0.136 to 0.68)	
Compression pressure (at 250 rpm)		PSI (MPa)	469 (3.2) at 250 rpm	
Cylinder head				
Intake valve timing	Open	b TDC	degrees	7 to 17
	Close	a BDC	degrees	35 to 45
Exhaust valve timing	Open	b BDC	degrees	35 to 45
	Close	a TDC	degrees	7 to 17
Intake valve clearance (Cold engine)		in. (mm)	0.006 to 0.010 (0.15 to 0.25)	
Exhaust valve clearance (Cold engine)				
Intake valve seat angle		degrees	120	
Exhaust valve seat angle		degrees	90	
Piston				
Firstcompression ring	Ring shape	-	Barrel face (chrome-plated)	
	Ring quantity	pcs.	1	
Second compression ring	Ring shape	-	Tapered face	
	Ring quantity	pcs.	1	
Oil-ring	Ring shape	-	Bevel cutter (with coil expander)	
	Ring quantity	pcs.	1	

2. TECHNICAL DATA

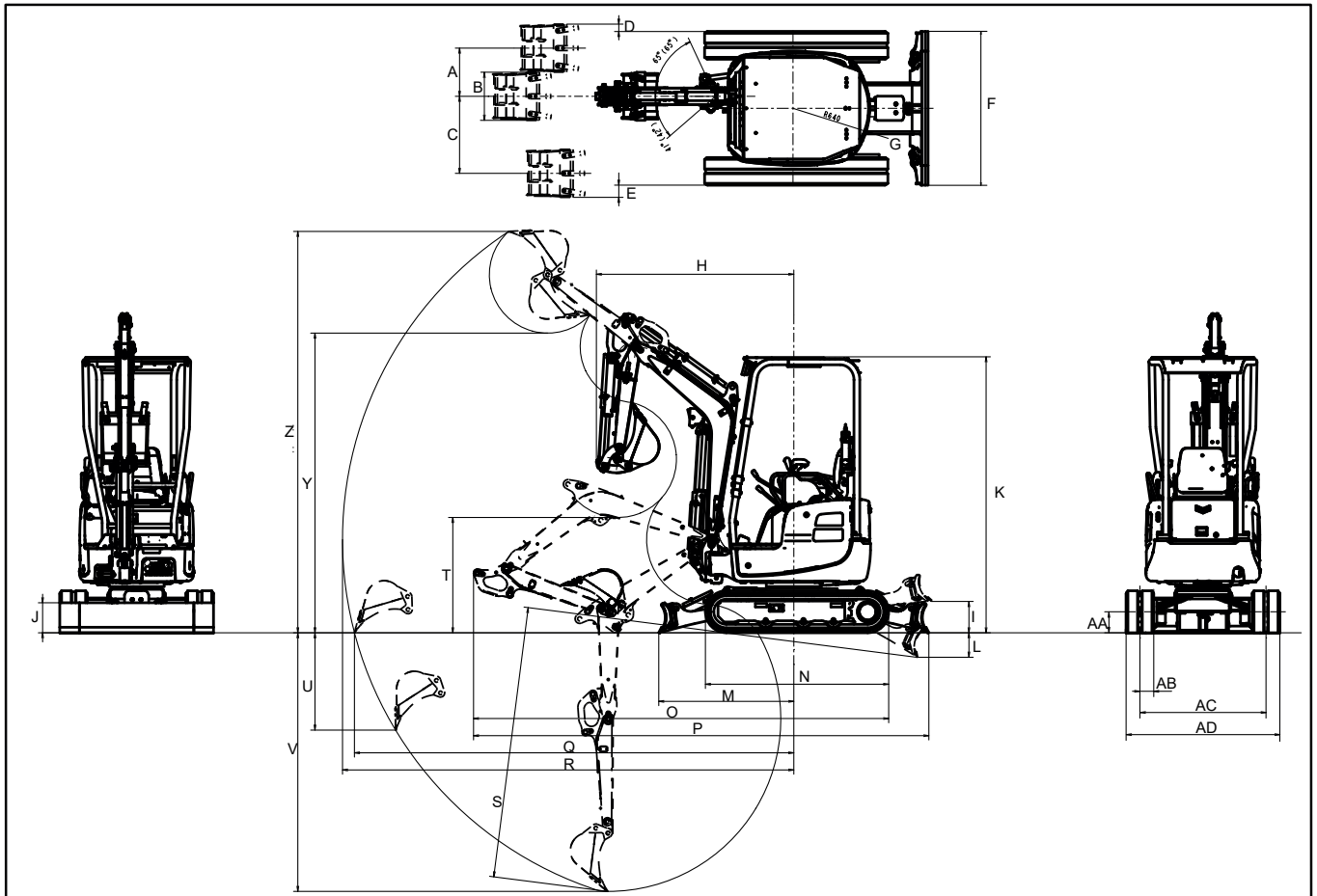
Item	Unit	ViO17-1
Engine		
Governor		
Name	-	Mechanical all speed type
Type	-	Centrifugal type
Fuel feed system		
Fuel filter	-	Filter paper with automatic air release device
Fuel filter filtration area	in ² (cm ²)	67.0 (432)
Oil/water separator	-	Mesh filter screen (100 mesh)
Feed pump	-	Electrical
Lubrication system		
Lubrication pump	-	Trochoid pump
LO pressure regulating valve opening pressure	PSI (MPa)	42.1 to 56.6 (0.29 to 0.39)
LO filter	-	Full flow filter
LO filter filtration area	in ² (cm ²)	124.1 (800)
Filter valve opening pressure	PSI (MPa)	11.4 to 17.1 (0.08 to 0.12)
Operating pressure of alarm switch	PSI (MPa)	5.69 to 8.53 (0.04 to 0.06)
Cooling device		
Cooling system	-	Water-cooling (Radiator)
Fan belt size	-	A35
Thermostat opening temperature	°F (°C)	159.8 (71)
Thermostat full-open temperature	°F (°C)	185 (85)
Radiator cap pressure	PSI (MPa)	12.80 (0.089)
Radiator fan	pcs. × Øin. (mm)	5 × Ø11.4 (Ø290)
Operating temperature of water temperature alarm switch	°F (°C)	224.6 to 235.4 (107 to 113)
Air cleaner		
Type	-	Cyclone type
Filtration area	ft. ² m ²	4.7 (0.44)
Fuel injection pump		
Injection pump type	-	YPES-3ML
Injection pump plunger diameter	in. (mm)	Ø0.24 (Ø6.0)
Injection pump cam lifting height	in. (mm)	0.28 (7.0)
Fuel injection timing (FIT)	degrees	15 to 17
Firing order		1→3→2
Nozzle		
Type		NP-DN0PDN161
Nozzle hole diameter × Number of holes	Øin. (mm) × pcs.	Ø0.04 (Ø1.0) × 1
Spray angle	degrees	5 to 10
Fuel injection pressure	PSI (MPa)	1784 to 1926 (12.3 to 13.28)

2. TECHNICAL DATA

Item		Unit	ViO17-1
Engine			
Turbocharger			
Type			-
Revolution speed		rpm	-
Turbocharging pressure		PSI (MPa)	-
Starting device			
Cold starting aids		-	Super quick glow
Starting aids capacity		V-W	DC 12-120
Battery type (JIS)		-	65B24L
Battery voltage - 5 hrs rate capacity		V-Ah	12-40
Electrical equipment			
Alternator	Type		AC generator magnet
	Nominal output	V-A	12-20
	Rated speed	rpm	3500
Regulator	Type		RS5121
	Regulation voltage	V	14.0 to 16.0
Starter motor	Type		Reduction type
	Nominal output	V-kW	12 - 1.4
	Engagement	-	Magnet shift
Stop motor	Type	-	1503ES-12S5SUC12S LC01
	Nominal output	V-A	12-41.5
Hour meter		V-W	12-12
Horn		V-W	12-48
Fuse		A × pcs.	40X1, 20X1, 15X2, 10X2, 5X1, 2X2
Monitor lamps	Seat Belt alarm lamp	V-W	12-2
	Engine oil pressure alarm lamp	V-W	12-2
	Water temperature alarm lamp	V-W	12-2
	Battery alarm lamp	V-W	12-2
	Pre heating lamp	V-W	12-2
	Working light lamp	V-W	12-2
	2nd speed lamp	V-W	12-2
Headlight		V-W	-
Boom light		V-W	12-27
Room lamp (for cabin)		V-W	-
Wiper motor (for cabin)		V-W	-
Cabin heater (for cabin)		V-W	-

2. TECHNICAL DATA

2-2 Outline Drawing and Working Area



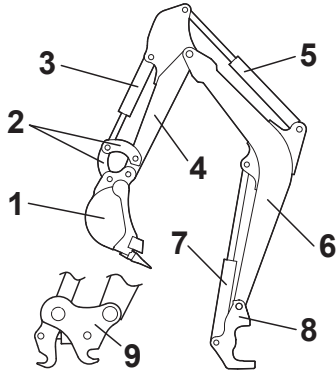
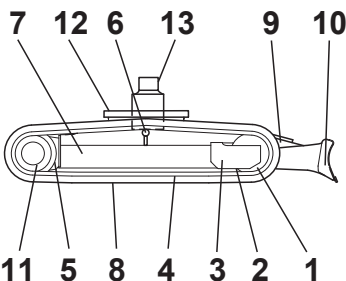
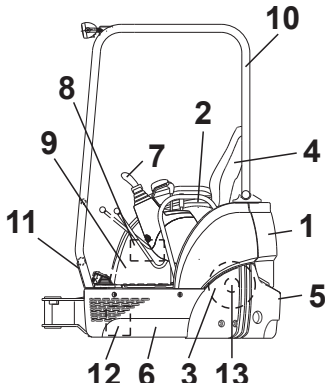
Unit : in(mm)					
A	15.8 (402)		O	136.1 (3457)	136.7 (3473)
B	15.7 (400)		P	149.2 (3791)	149.9 (3808)
C	25.2 (640)		Q	144 (3658)	149.9 (3806)
D	2.4 (62) ¹ – 8.9(227)		R	147.9 (3758)	153.6 (3901)
E	4 (102) ¹ – 10.5 (267)		S	89 (2261)	94.9 (2410)
F	37.5 (954) – 50.3 (1280) ¹		T	37.8 (961)	32 (813)
G	R25.2 (R640)		U	31.9 (811)	36.4 (924)
H <swing>	64.7 (1644) <44.4 (1130)>	65.63 (1667) <1142>	V	84.8 (2155)	90.7 (2305)
I	10.3 (261)		Y	98.3 (2497)	141.4 (2591)
J	9.8 (250)		Z	131.6 (3344)	135.3 (3438)
K Canopy	90.5 (2299)		AA	6.9 (175)	
L	8 (204)		AB	9.1 (230)	
M	44.2 (1124)		AC	28.3 (720) – 41.3 (1050) ¹	
N	60.1 (1526)		AD	37.4 (950) – 50.4 (1280) ¹	

1. Tracks spread value

2. TECHNICAL DATA

2-3 Weight List of Main Parts

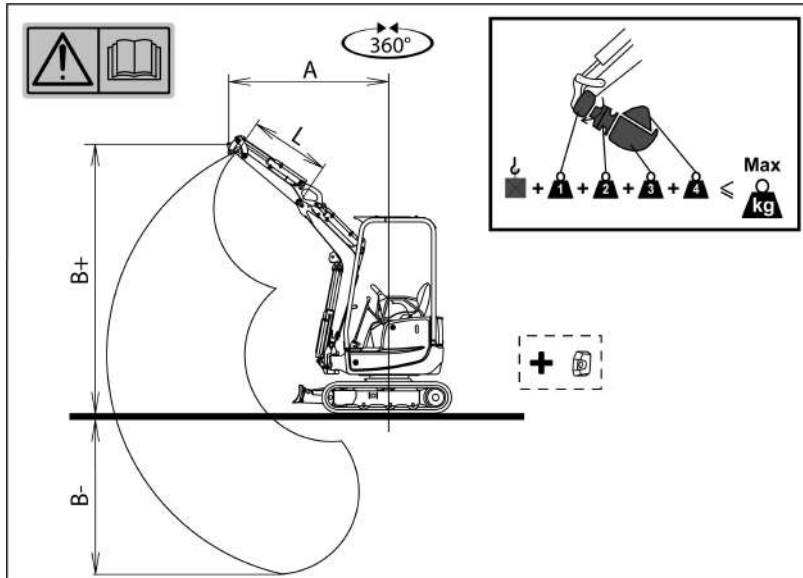
[Unit : lbs. (kg)]

Equipment	No.	Part	ViO17-1	
			Canopy	
			Rubber crawler	
Front implement				
	1	Bucket	Ass'y	83.8 (38)
	2	Bucket arm & link	Ass'y	44.1 (20)
	3	Bucket cylinder	Ass'y	22 (10)
	4	Arm short / long	Ass'y	67.7 (30.69) / 77 (34.94)
	5	Arm cylinder	Ass'y	27.7 (12.3)
	6	Boom	Ass'y	126.8 (57.5)
	7	Boom cylinder	Ass'y	30.6 (13.9)
	8	Boom bracket	Ass'y	55.8 (25.3)
	9	Quick coupler	Ass'y	—
Undercarriage				
	1	Idler	Ass'y	32.7 (14.82) × 2
	2	Crawler guard	Ass'y	—
	3	Crawler adjuster	Ass'y	—
	4	Track roller	Ass'y	8.8 (3.98) × 6
	5	Sprocket	Ass'y	11.0 (5.0) × 2
	6	Crawler guide	Ass'y	3.7 (1.66) X 2
	7	Track frame	Ass'y	170.1 (77.17)
	8	Rubber crawler	Ass'y	55 × 2
	9	Blade cylinder	Ass'y	17 (7.7)
	10	Blade	Ass'y	157.3 (71.34)
	11	Travel motor	Ass'y	52.9 (24) × 2
	12	Swing bearing	Ass'y	43.0 (19.5)
	13	Swivel & hose or fitting	Ass'y	30.9 (14)
Upperstructure				
	1	Engine hood	Ass'y	8.9 (4.05)
	2	Hydraulic oil tank & filters	Ass'y	29.6 (13.43)
	3	Engine		253.5 (115)
	4	Operator's seat & mount	Ass'y	96.36 (43.71)
	5	Counter weight	Ass'y	242.5 (110)
	6	Turning frame	Ass'y	549.4 (249.2)
	7	Controls (4 cables)	Ass'y	11 (5)
	8	Battery	Ass'y	26 (11.8)
	9	Fuel tank & piping	Ass'y	24.3 (11)
	10	Canopy & mount	Ass'y	140.5 (63.74)
	11	Swing lock, covers, steps and panels		66.1 (30)
	12	Swing motor	Ass'y	50.7 (23)
	13	Pump & mount and hoses	Ass'y	77.2 (35)
	-	Boom swing cylinder	Ass'y	28.2 (12.8)
	-	Control valve	Ass'y	61.7 (28)

2. TECHNICAL DATA

2-4 Lifting Capacity List

1) Canopy



Machine with canopy and rubber tracks.

A = Tilt from the rotation axis

B = Attachment point height

* = Hydraulic capacity limits of the lifting force

L = 950mm						L = 1100mm					
B \ A	Max	3m	2.5m	2m	1.5m	B \ A	Max	3m	2.5m	2m	1.5m
2.5m	*320	-	*310	-	-	2.5m	*275	-	*265	-	-
2m	235	-	*305	-	-	2m	220	235	*270	-	-
1.5m	205	225	*350	*390	-	1.5m	190	220	*315	-	-
1m	195	225	285	410	-	1m	180	210	295	385	-
0.5m	195	210	270	370	-	0.5m	180	205	265	370	-
0m	195	210	260	355	540	0m	180	200	255	360	500
-0.5m	215	-	255	350	535	-0.5m	195	200	260	340	520
-1m	255	-	-	355	540	-1m	220	-	250	340	525
-1.5m	*375	-	-	-	*565	-1.5m	300	-	-	350	515
B \ A	Max	3m	2.5m	2m	1.5m	B \ A	Max	3m	2.5m	2m	1.5m
2.5m	*325	-	*315	-	-	2.5m	*280	-	*265	-	-
2m	270	-	*310	-	-	2m	255	*295	*265	-	-
1.5m	240	255	*345	*390	-	1.5m	235	*300	*310	-	-
1m	225	250	325	445	-	1m	215	255	*375	*480	-
0.5m	220	240	310	430	-	0.5m	210	250	325	435	-
0m	225	235	310	405	610	0m	215	245	310	415	560
-0.5m	250	-	300	415	615	-0.5m	230	240	305	415	610
-1m	305	-	-	400	635	-1m	270	-	300	415	610
-1.5m	*375	-	-	-	*560	-1.5m	*390	-	-	410	585

+

 83 kg

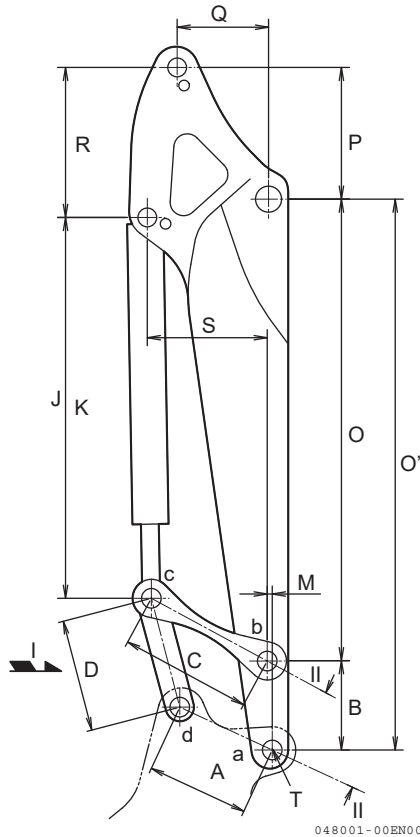
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kg

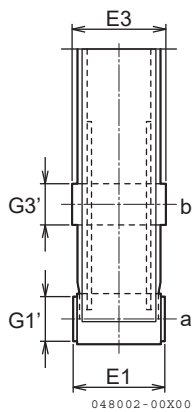
2. TECHNICAL DATA

2-5 Specifications for Attachment

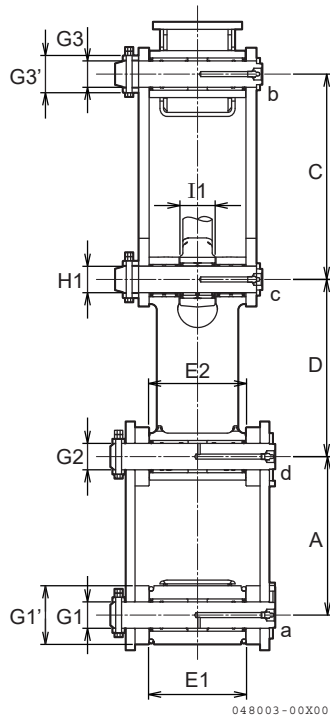
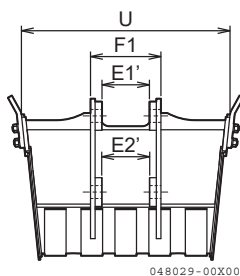
Unit: mm



Item/Model		ViO17-1	
Dimensions		Short	Long
A		109	
B		95	
C		200	
D		200	
E 1	External width of arm end boss	105	
E 1'	Internal width of bucket pin boss	106,5	
E 2	External width of bucket link boss	105	
E 2'	Internal width of bucket pin boss	106,5	
E 3	External width of bucket arm pivot pin boss	105	
F 1	External width of bucket arm	146,5	
G 1	Bucket pin diameter	30	
G 1'	Arm end boss diameter	70	
G 2	Bucket pin diameter	30	
G 3	Bucket arm pivot pin diameter	30	
G 3'	Bucket arm pivot pin boss diameter	57	
H 1	Bucket cylinder rod end pin diameter	30	
I 1	Bucket cylinder rod end boss thickness	40	
H 2	Bucket cylinder bottom pin diameter	30	
I 2	Bucket cylinder bottom boss thickness	40	
J	Cylinder length when it is fully retracted	591	
K	Cylinder length when it is fully extended	926	
M		5	
O		855	1005
O'		950	1100
P		207	
Q		129,5	
R		317	467
S		185	
T		-	



View in the direction of an arrow I of the arm



Cross-sectional view along the line II-II (a-d-c-b)

2. TECHNICAL DATA

2-6 Periodic Inspection and Servicing

Check/Adjust/Supply ◇

Clean □

Oil and grease ■

Replace ●

Oil sample ▲

+ = and

/ = or

Check & Service items		Daily	Every 50h	Every 100h	Every 250h	Every 500h *	Every 1000h *	Every 2000h **
General	Missing or broken parts	◇						
	Tightening of nuts and bolts	◇						
	Engine condition, exhaust and inlet hoses	◇						
	Machine overall	□						
	Operation manual		◇(1)			◇	◇	◇
Greasing	Greasing points	■						
	Swing gear and crown		■	■	■	■	■	■
	Bearing rollers and bearings, idler wheels	◇			■(2)	■	■	■
Engine	Diesel filter		●(1)		●	●	●	●
	Water separator	◇			●	●	●	●
	Oil	◇	▲(1)			▲	▲	▲
	Oil filter		●(1)			●	●	●
	Cooling fluid & leakage							●
	Radiator fins	◇+□						
	Belt		◇	◇	◇	◇	◇	●
	Fuel hose, coolant hose							◇/●
	Performance of engine control and engine speed		◇(1)			◇	◇	◇
	Governor lever and accelerator device		◇(1)			◇	◇	◇
	Air cleaner	□(3)			●(3)	●	●	●
	Intake and exhaust valves							◇
	Injectors and injection pressure							□+◇
	Crankcase breather system							◇
	Engine silent-bloc & bracket							◇
Travel	Tracks, rubber tracks & pads	◇						
	Track tension	◇						
	Play of travel lever		◇(1)			◇	◇	◇
	Performance of travel		◇(1)			◇	◇	◇
	Oil	◇	▲(1)			▲/●(4)	▲	▲
Hydraulic	Aspiration filter					□/●(4)	□/●(4)	□/●(4)
	Ventilation filter						●	●
	Hydraulic oil return filter		●(1)		●(4)	●	●	●
	Other filter				●(4)	●	●	●
	Accumulator		◇(1)			◇	◇	◇
	Pump pressure		◇(1)			◇	◇	◇
	Play of control lever		◇(1)			◇	◇	◇
	Low pressure		◇(1)			◇	◇	◇
	Blade control		◇(1)			◇	◇	◇
	Boom swing		◇(1)			◇	◇	◇
	Boom		◇(1)			◇	◇	◇
	Arm		◇(1)			◇	◇	◇
	Bucket		◇(1)			◇	◇	◇
	Options		◇(1)			◇	◇	◇
Electric	Time counter	◇	◇	◇	◇	◇	◇	◇
	Wire breakage, short circuits, loosened terminals	◇	◇	◇	◇	◇	◇	◇
	Digital monitor	◇	◇	◇	◇	◇	◇	◇
	Battery		◇(1)			◇	◇	◇
Final	Sign inspection card and return to YANMAR		◇(1)		◇	◇	◇	◇

* or annually first time occurs

** or two years

(1) First time 50-80h visit

(2) If machine does lot of digging line during one day (fiber, drop pipe, drainage...).

(3) If machine is used at dusty worksites.

(4) If a hydraulic hammer is used more than 30% of the machine operating time.

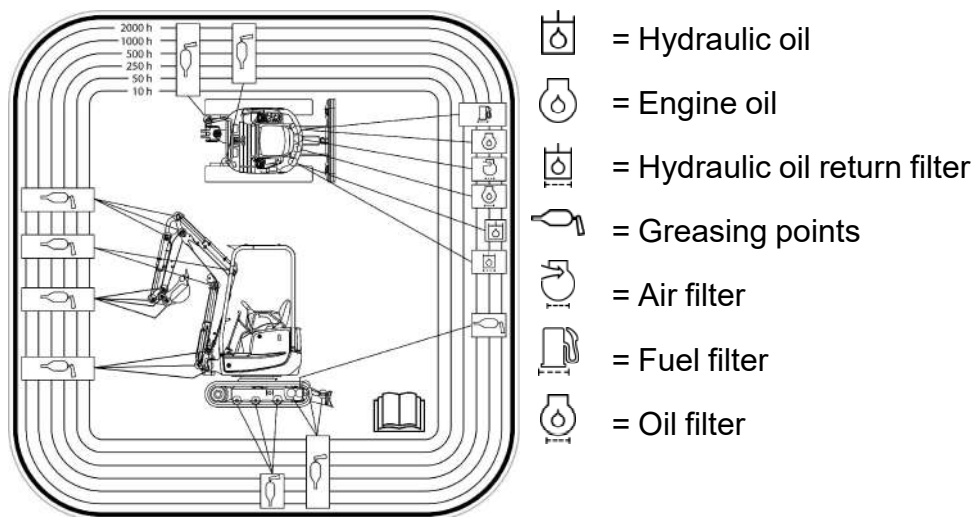
▲ Collect oil sample and keep analysis report. According to result replace oil if necessary.

2. TECHNICAL DATA

Scheduled maintenance points of the machine (lubrication, filters...)

IMPORTANT

These are frequencies : for example the operations to be carried out every 50 hours must be carried out at 50h, 100h, 150h, 200h, etc.



Dependent on technical modifications.

2. TECHNICAL DATA

2-7 Fuel, Lube Oil and Grease Recommended

Cooling fluid

Temperatures °C								Quantity prescribed (L)
-40	-20	0	20	40	60	80	100	
Long-life cooling fluid YANMAR POWER COOLANT B-6								3.1 radiator + engine + subtank

Engine oil

Temperatures °C								Quantity prescribed (L)
-3	-20	-10	0	10	20	30	40	
5W30								2.8
10W30								
15W40								

Fuel

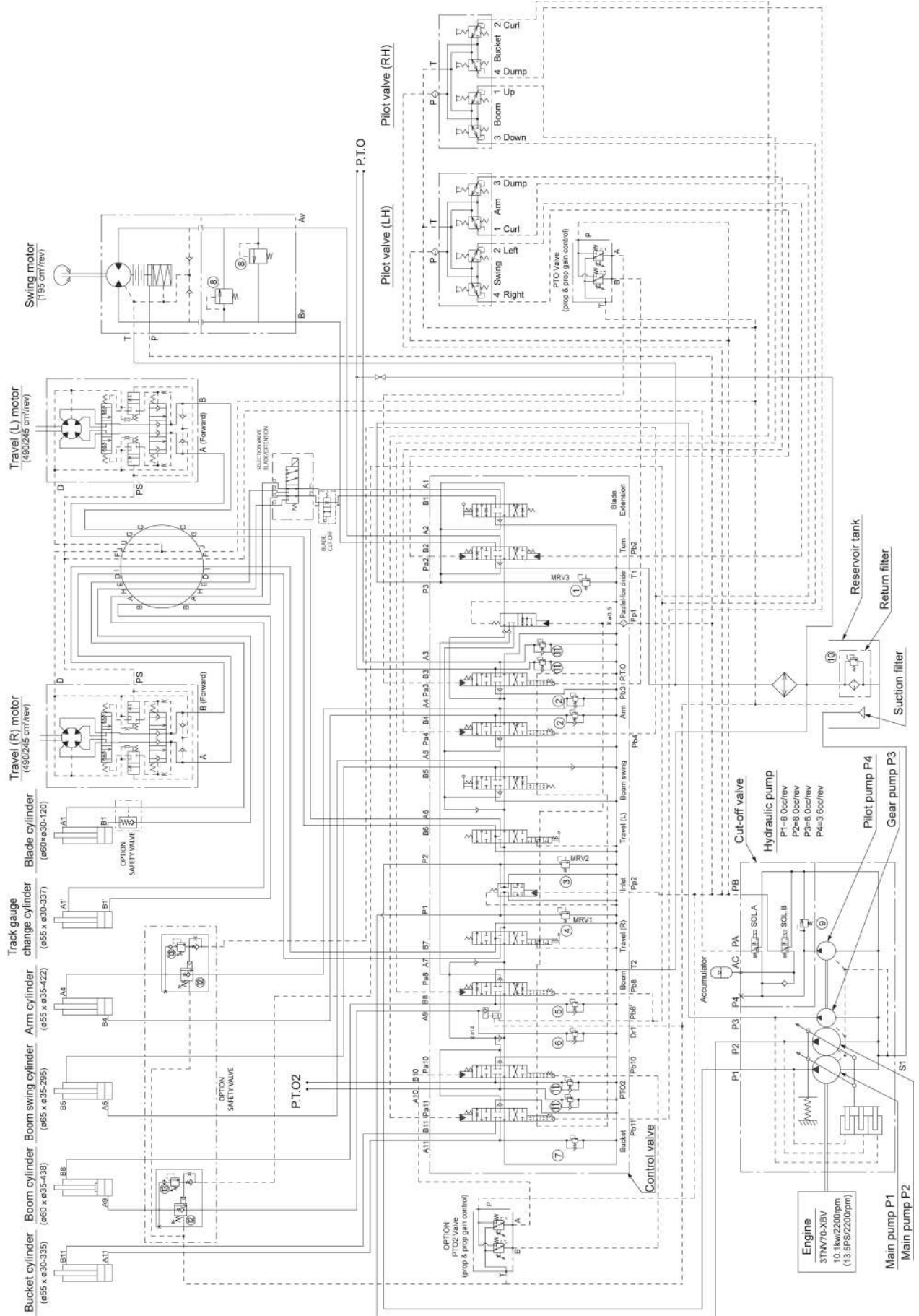
Temperatures °C							Quantity prescribed (L)
-20	-10	0	10	20	30	40	
No. 1-D / No. 2-D							20.0

Hydraulic oil

Temperatures °C							Quantity prescribed (L)
-20	-10	0	10	20	30	40	
VG46							16.5 in the tank
VG68							12.3 the rest

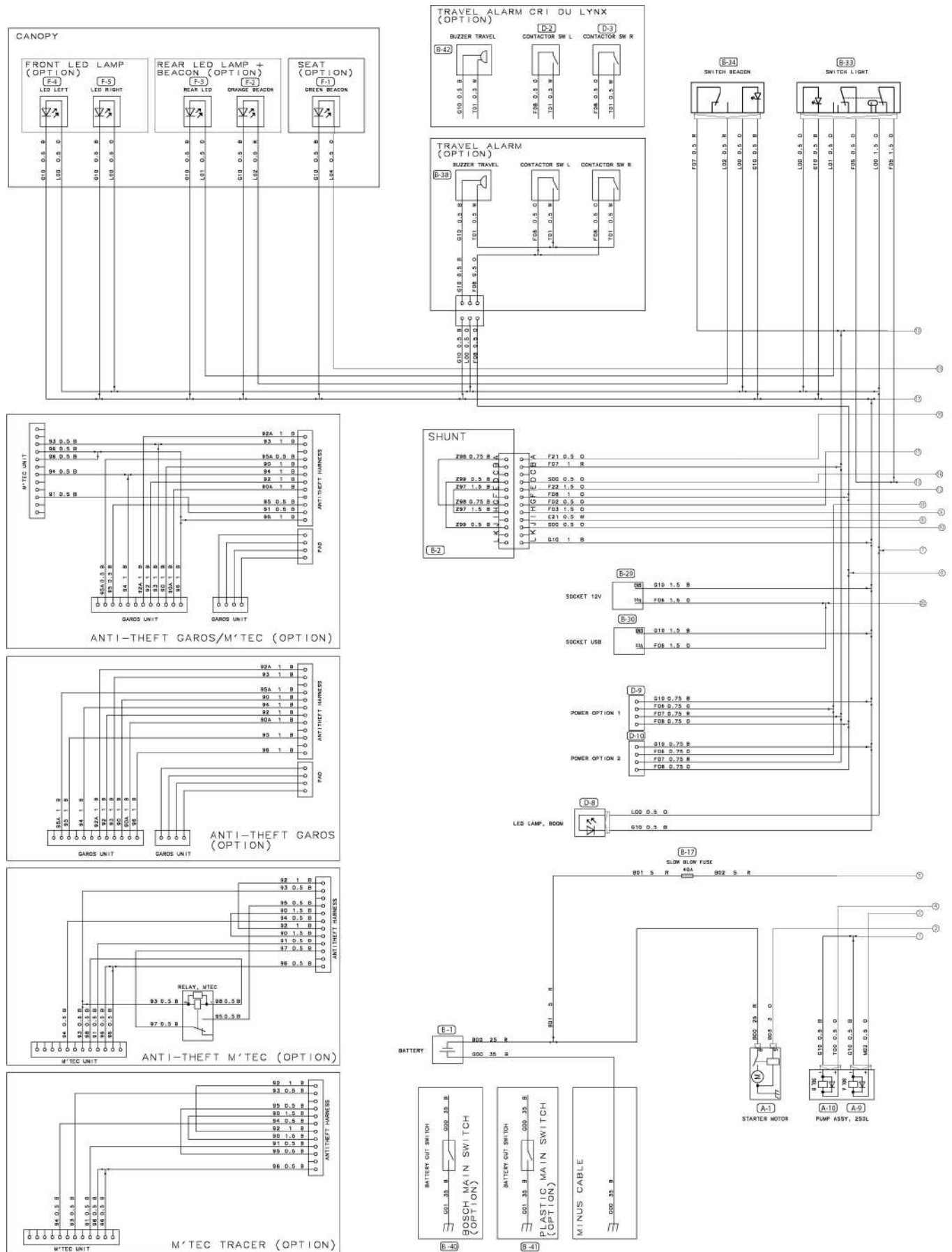
2. TECHNICAL DATA

2-8 Hydraulic Circuit Schematic

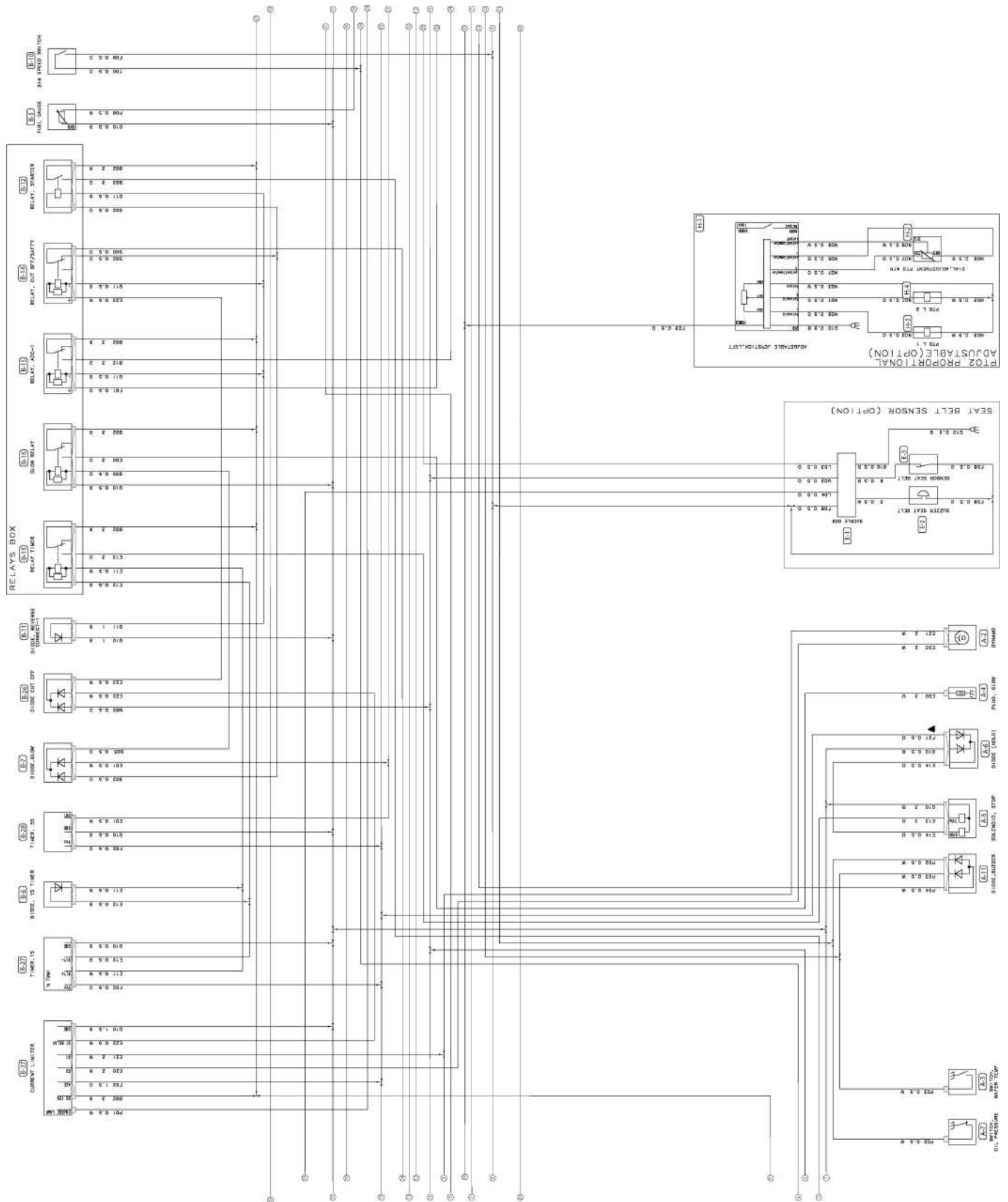


2. TECHNICAL DATA

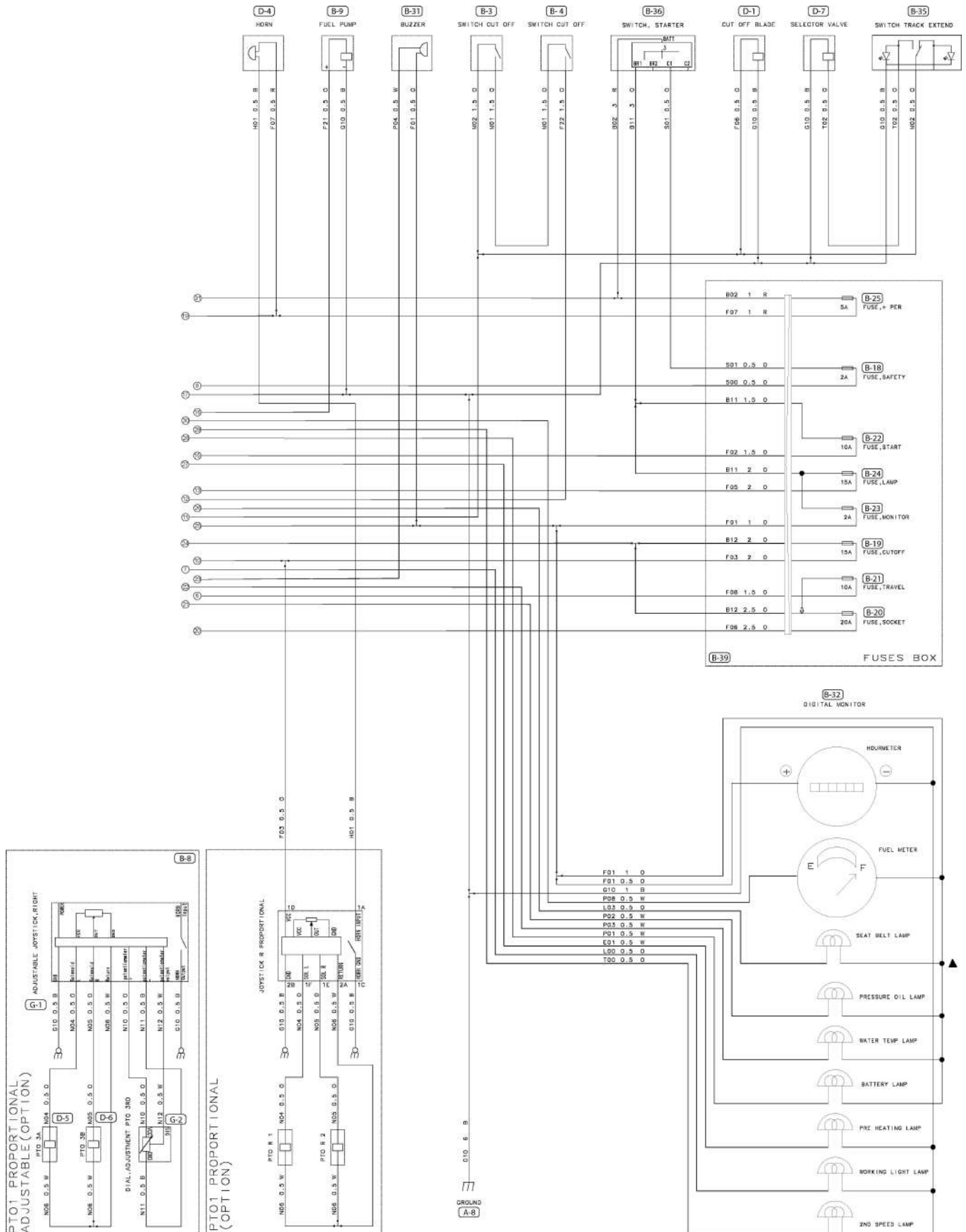
2-9 Wiring Diagram



2. TECHNICAL DATA



2. TECHNICAL DATA



CHAPTER 3

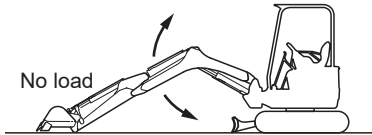
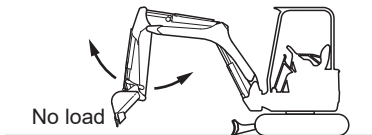
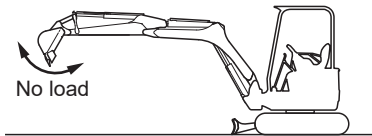
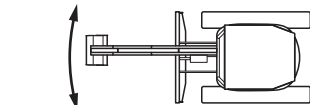
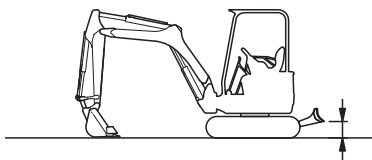
SERVICE STANDARDS

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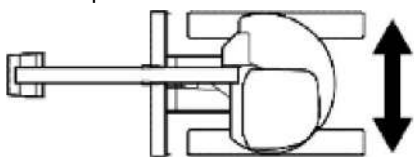
3. SERVICE STANDARDS

3. Service Standards

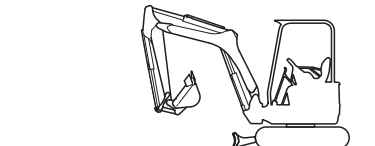
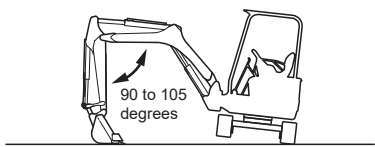
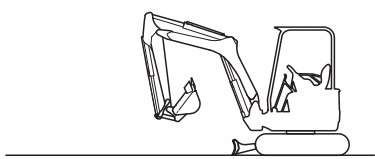
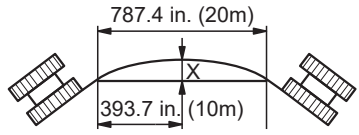
3-1 Machine Performance

Applicable model			ViO17-1		
Item	Measuring condition	Unit	Standard	Allowance	
Machine performance					
Working speed					
Boom speed	Machine position				
Max. cylinder extension	 • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Excluding cushion	Up	sec.	2.4	2.6
Bucket teeth grounded		Down		2.1	2.2
Arm speed	Machine position				
Max. cylinder retraction	 • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground	Extend	sec.	2.3	2.5
Max. cylinder extension		Retract		3.4	3.7
Bucket speed	Machine position				
Max. cylinder retraction	 • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground	Dump	sec.	2.1	2.3
Max. cylinder extension		Curl		2.9	3.0
Boom offset speed	Machine position				
Max. cylinder retraction	 • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Full stroke	Right swing	sec.	3.6	4.3
Max. cylinder extension		Left swing		3.1	3.7
Blade speed	Machine position				
Max. cylinder retraction	 • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground	Up	sec.	1.2	1.4
Blade grounded		Down		1.1	1.4

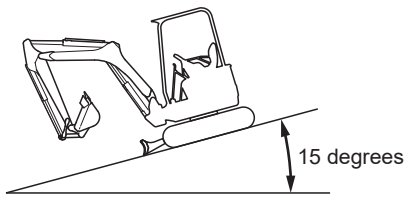
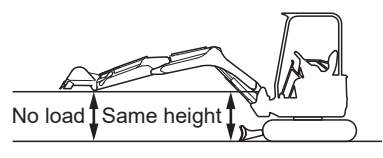
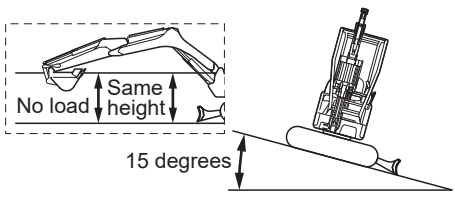
3. SERVICE STANDARDS

Applicable model			ViO17-1	
Item	Measuring condition	Unit	Standard	Allowance
Machine performance				
Working speed				
Crawler extension speed	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground	sec.	4.6	
Max. cylinder extension				
Max. cylinder retraction	Full stroke retraction		8.2	

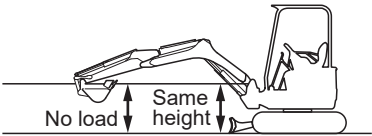
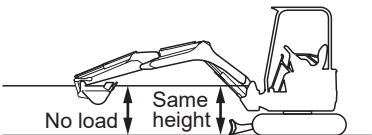
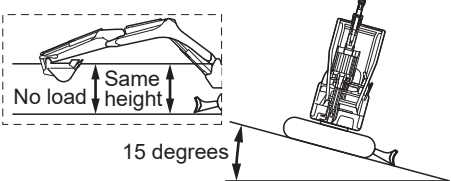
3. SERVICE STANDARDS

Applicable model			ViO17-1	
Item	Measuring condition	Unit	Standard	Allowance
Machine performance				
Travel speed	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Traveling time for 787.4 in. (20 m) after an approach run of 196.9 in. (5 m) or more.	sec./ 787.4 in. (20 m)	High speed 17.0	19.5
			Low speed 33.5	38.5
Track speed	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Travel lever : Full throttle (Floating crawler side) • Float one side of the crawler. Make a mark on the crawler. After turning the floating crawler side more than once at full throttle, measure the time needed for 3 turns of the crawler.	sec./ 3 rev.	High speed 8.4	9.7
			Low speed 16.6	19.1
Track deviation	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Measure the deviation (χ) in a travel distance of 787.4 in. (20 m) after an approach run of 196.9 in. (5 m) or more. 	in. (mm)/ 787.4 in. (20 m)	High speed 19.7 (500) or less	23.6 (600)
			Low speed 5.2 (132) or less	11.81 (300)

3. SERVICE STANDARDS

Applicable model			ViO17-1	
Item	Measuring condition	Unit	Standard	Allowance
Machine performance				
Traveling drift	Machine position  • Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Drift of the machine after 5 min. on a slope with an inclination of 15 degrees.	in. (mm) / 5 min.	4.72 (120) or less	7.09 (180)
Drift of cylinders				
Boom drift (Cylinder rod retraction)	Machine position  • Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Make the boom and bucket pins the same height. • Measure the retraction or extension of each cylinder rod after leaving the machine at the above position for 10 min. • Lift the blade to the highest position, and measure the cylinder rod extension after 10 min.	in. (mm) / 10 min.	0.16 (4) or less	0.59 (15)
Arm drift (Cylinder rod extension)			0.39 (10) or less	0.59 (15)
Bucket drift (Cylinder rod extension)			0.20 (5) or less	0.35 (9)
Blade drift (Cylinder rod extension)			0.16 (4) or less	0.35 (9)
Boom offset drift (Cylinder rod extension)	Machine position  • Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Make the boom and bucket pins the same height. • Park the machine on a slope with an inclination of 15 degrees and turn the upperstructure 90 degrees to the crawler and engage the swing lock. • Measure the cylinder rod extension after 10 min.	in. (mm) / 10 min.	0.08 (2) or less	0.30 (7.5)

3. SERVICE STANDARDS

Applicable model			VIO17-1	
Item	Measuring condition	Unit	Standard	Allowance
Machine performance				
Swing drift at stopping	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Make the boom and bucket pins the same height. • Make match marks on the outer race and the inner race of the swing bearing (or the track frame). • Measure shifted distance between both marks after making one turn with no load.	in. (mm) or degrees	3.94 (100) or less, 30 or less	6.89 (175) 45
Swing time	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Make one idling turn with no load, then measure the time necessary to make 5 turns.	sec. / 5 turns	31.3	37
Swing drift	Machine position  • Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Make the boom and bucket pins the same height. • Park the machine on a slope with an inclination of 15 degrees and turn the upperstructure 90 degrees to the crawler. • Make match marks on the outer race and the inner race of the swing bearing (or the track frame). • Measure shifted distance or angle between both marks after 5 min.	in. (mm)	(at engine stop) 0.12 (3)	5.51 (140)
			(at engine operating) 0.12 (3.1)	5.51 (140)

3. SERVICE STANDARDS

3-2 Engine

1) Nominal and Allowable Values

ViO17-1

Applicable model			3TNV70-X BV	
Item		Unit	Standard	Wear limit
Cylinder head				
Cylinder head distortion		in. (mm)	0.0020 (0.05) or less	0.0059 (0.15)
Valve seat angle	Intake	degrees (°)	120	—
	Exhaust		90	—
Valve seat width	Intake	in. (mm)	—	—
	Exhaust		—	—
Intake valve	Stem outside dia.	in. (mm)	Ø0.235 to 0.236 (Ø5.960 to 5.975)	0.232 (5.9)
	Guide inside dia.		Ø0.2362 to 0.2367 (Ø6.0 to 6.012)	0.239 (6.08)
	Oil clearance		0.0010 to 0.0020 (0.025 to 0.052)	0.006 (0.16)
Exhaust valve	Stem outside dia.	in. (mm)	Ø0.2341 to 0.2346 (5.945 to 5.960)	0.232 (5.9)
	Guide inside dia.		Ø0.2362 to 0.2367 (Ø6.0 to 6.012)	0.239 (6.08)
	Oil clearance		0.0016 to 0.0026 (0.040 to 0.067)	0.0067 (0.17)
Valve guide projection		in. (mm)	0.386 to 0.394 (9.8 to 10.0)	
Valve sinkage	Intake	in. (mm)	0.016 to 0.024 (0.4 to 0.6)	0.031 (0.8)
	Exhaust		0.016 to 0.024 (0.4 to 0.6)	
Valve head thickness	Intake	in. (mm)	0.035 to 0.043 (0.9 to 1.1)	0.020 (0.5)
	Exhaust		0.039 to 0.047 (1.0 to 1.2)	
Intake valve operating timing	Open	degrees (°)	b. TDC 7 to 17	—
	Close		a. BDC 35 to 45	—
Exhaust valve operating timing	Open	degrees (°)	b. TDC 36 to 45	—
	Close		a. BDC 7 to 17	—
Valve spring	Free length	in. (mm)	1.488 (37.8)	—
	Inclination	in. (mm)	—	0.051 (1.3)
	Tension [0.0394 in. (1 mm) compressed]	lbs. (kg)	25.33 (11.49)	
Intake / exhaust valve clearance		in. (mm)	0.006 to 0.010 (0.15 to 0.25)	—
Cylinder block				
Cylinder bore dia.		in. (mm)	2.7560 to 2.7570 (70.000 to 70.03)	2.6850 (68.20)
Cylinder bore dia.	L mark		2.9929 to 2.9933 (76.02 to 76.03)	
	M mark		2.9925 to 2.9929 (76.01 to 76.02)	
	S mark		2.9921 to 2.9925 (76.00 to 76.01)	
Roundness of cylinder sleeve bore			0.01 or less	0.00118 (0.03)
Cylindricity of cylinder sleeve bore			0.01 or less	0.00118 (0.03)

3. SERVICE STANDARDS

Applicable model			3TNV70-X BV		
Item		Unit	Standard	Wear limit	
Valve					
Intake / exhaust valve rocker arm	Shaft outside dia.		in. (mm)	Ø0.4711 to 0.4718 (11.966 to 11.984)	Ø0.4700 (Ø11.94)
	Bush inside dia.			Ø0.4724 to 0.4732 (12.000 to 12.020)	Ø0.4752 (Ø12.07)
	Oil clearance			Ø0.0006 to 0.0021 (0.016 to 0.054)	Ø0.0051 (Ø0.13)
Push rod bend		—		0.03mm or less	
Tappet	Stem outside dia.			Ø0.8239 to 0.8252 (20.927 to 20.960)	Ø0.8231 (Ø20.907)
	Guide inside dia.			Ø0.8268 to 0.8277 (21.000 to 21.021)	Ø0.8284 (Ø21.041)
	Oil clearance		Ø0.0016 to 0.0037 (0.04 to 0.094)	Ø0.0053 (Ø1.34)	
Piston					
Piston outside dia.		in. (mm)	Ø2.7543 to 2.7555 (69.960 to 69.990)	2.9890 (75.920)	
Piston outside dia.	L mark		Ø2.9911 to 2.9915 (75.975 to 75.985)		
	ML mark		Ø2.9909 to 2.9911 (75.970 to 75.975)		
	MS mark		Ø2.9907 to 2.9909 (75.965 to 75.970)		
	S mark		Ø2.9903 to 2.9907 (75.955 to 75.965)		
Minimum clearance between piston and cylinder			Ø0.0012 to 0.0020 (0.03 to 0.05)	—	
Top clearance			Ø0.2740 to 0.0331 (0.696 to 0.84)	—	
Piston pin	Outside dia.		Ø0.8659 to 0.8661 (21.995 to 22.0)	0.8648 (21.965)	
	Bush inside dia.		Ø0.8661 to 0.8665 (22.0 to 22.009)	0.8677 (22.039)	
	Oil clearance		Ø0 to 0.00055 (0.000 to 0.014)	0.0029 (0.074)	
Piston ring					
Top ring	Ring groove width	in. (mm)	Ø0.0610 to 0.0618 (1.55 to 1.57)	—	
	Ring width		Ø0.0579 to 0.0587 (1.47 to 1.49)	—	
	Clearance between groove and ring		Ø0.0024 to 0.0039 (0.060 to 0.10)	—	
	End gap		Ø0.0059 to 0.0118 (0.15 to 0.30)	0.0154 (0.390)	
Second ring	Ring groove width		Ø0.0622 to 0.0623 (1.580 to 1.595)	—	
	Ring width		Ø0.0563 to 0.0571 (1.43 to 1.45)	—	
	Clearance between groove and ring		Ø0.0005 to 0.0065 (0.013 to 0.165)	—	
	End gap		Ø0.0071 to 0.0130 (0.18 to 0.33)	0.0154 (0.390)	

3. SERVICE STANDARDS

Applicable model			3TNV70-X BV	
Item		Unit	Standard	Wear limit
Piston ring				
Oil ring	Ring groove width	in. (mm)	0.1185 to 0.1191 (3.01 to 3.025)	—
	Ring width		0.1169 to 0.1177 (2.970 to 2.990)	—
	Clearance between groove and ring		0.0008 to 0.0022 (0.020 to 0.055)	—
	End gap		0.0079 to 0.0177 (0.2 to 0.45)	0.0591 (1.5)
Connecting rod				
Crank pin side	Crank pin metal inside dia.	in. (mm)	Ø1.7717 to 1.7723 (Ø45.0 to 45.016)	—
	Crank pin metal thickness		0.0592 to 0.0594 (1.503 to 1.509)	—
	Crank pin outside dia.		Ø1.6517 to 1.6520 (Ø41.952 to 41.962)	1.6497 (41.902)
	Oil clearance		0.0008 to 0.0023 (0.020 to 0.058)	0.0047 (0.120)
Piston pin side	Bush inside dia.		Ø0.8671 to 0.8670 (Ø22.025 to 22.038)	0.8688 (22.068)
	Piston pin outside dia.		Ø0.8658 to 0.8661 (Ø21.991 to 22.0)	0.8647 (21.963)
	Oil clearance		0.0010 to 0.0019 (0.025 to 0.047)	0.0041 (0.105)
Twist and parallelism			0.0012 (0.03) or less for 3.937 (100)	0.0031 (0.08)
Cam				
Gear side	Cam shaft outside dia.	in. (mm)	Ø1.5724 to 1.5732 (Ø39.940 to 39.960)	1.5689 (39.85)
	Oil clearance		0.0016 to 0.0053 (0.04 to 0.135)	—
Intermediate	Cam shaft outside dia.		Ø1.5713 to 1.5722 (Ø39.910 to 39.935)	1.5689 (39.85)
	Oil clearance		0.0026 to 0.0045 (0.065 to 0.115)	—
Flywheel side	Cam shaft outside dia.		Ø1.5724 to 1.5732 (Ø39.940 to 39.960)	1.5689 (39.85)
	Oil clearance		0.0016 to 0.0033 (0.04 to 0.085)	—
Bend			0.00079 (0.02) or less	0.00197 (0.05)
Cam height	Intake cam		1.3439 to 1.3490 (34.135 to 34.265)	1.3343 (33.89)
	Exhaust cam		1.3439 to 1.3490 (34.135 to 34.265)	1.3343 (33.89)
Crank shaft				
Journal	Outside dia.	in. (mm)	Ø1.5736 to 1.5740 (Ø46.952 to 46.962)	1.5709 (46.902)
	Main metal thickness		0.0585 to 0.0591 (2.009 to 2.014)	—
	Oil clearance		0.0013 to 0.0023 (0.020 to 0.050)	0.0059 (0.120)
Bend		—	0.01 or less	

3. SERVICE STANDARDS

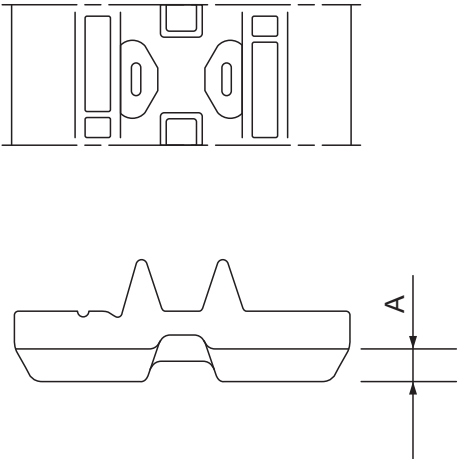
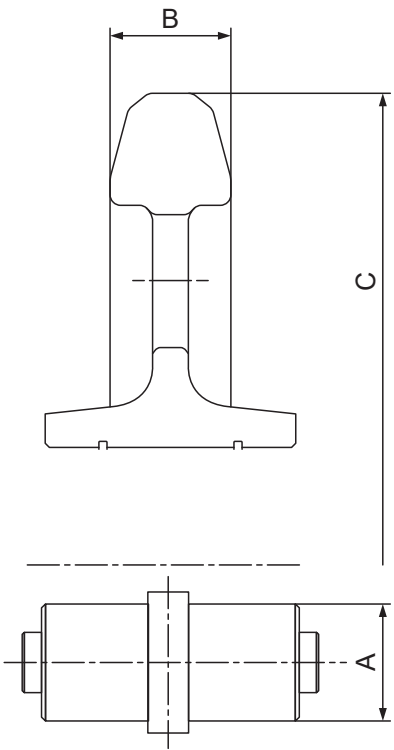
Applicable model			3TNV70-X BV	
Item		Unit	Standard	Wear limit
Side gap	Crank shaft	in. (mm)	0.0044 to 0.0098 (0.111 to 0.250)	—
	Cam shaft		0.0020 to 0.0059 (0.05 to 0.15)	—
	Connecting rod		0.0079 to 0.0157 (0.2 to 0.4)	—
	Idle gear		0.0020 to 0.0098 (0.05 to 0.25)	—
Backlash	Crank gear, cam gear, idle gear, fuel injection pump drive gear and lubricating	in. (mm)	0.0024 to 0.0047 (0.06 to 0.12)	—
Others				
Lube oil pump discharge volume		GPM (L/min)	3.96 (15) or higher	—
Oil pressure regulating valve opening pressure		PSI (kPa)	42.66 to 64.00 (294.2 to 441.3)	—
Oil pressure switch operating pressure		PSI (kPa)	5.69 to 8.53 (39.2 to 58.8)	—
Cooling water pump discharge volume		GPM (L/min)	13.21 (50) at 3350 min ⁻¹ (rpm)	—
Thermostat valve opening temperature	Temperature	°F (°C)	157.1 to 162.5 (69.5 to 72.5)	—
	Lift at opening	in. (mm)	0.315 (8.0) or more at 185°F (85°C) or higher	—
Thermo-switch operating temperature	ON	°F (°C)	224.6 to 235.4 (107 to 113)	—
	OFF		212 (100) or more	—

3. SERVICE STANDARDS

3-3 Undercarriage

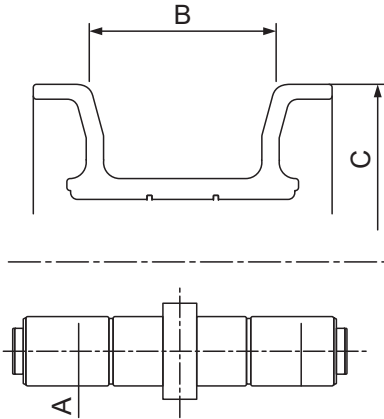
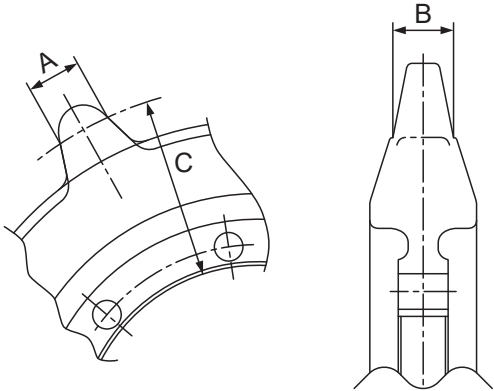
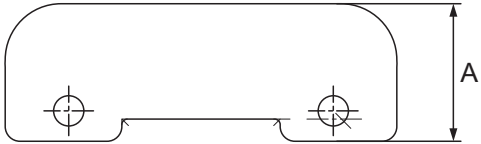
3-3-1 Rubber Crawler Specifications

[Unit : in. (mm)]

Applicable model	ViO17-1		
Part	Measuring position	Standard	Wear limit
Rubber crawler specifications			
(1) Rubber crawler 	A	0.71 (18)	0.31 (8)
	(2) Idler & shaft 		
	A	Ø1.18 (Ø30)	—
	B	Ø1.26 (Ø32)	Ø1.02 (Ø26)
	C	Ø10.67 (Ø271)	Ø10.43 (Ø265)

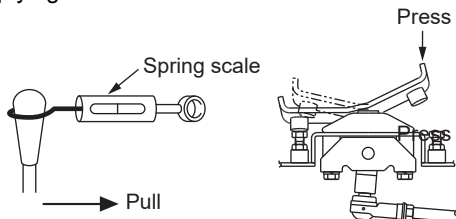
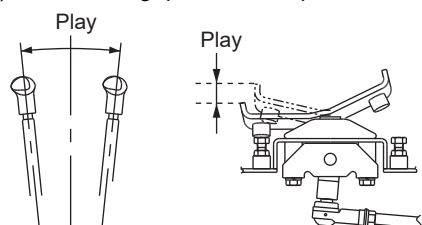
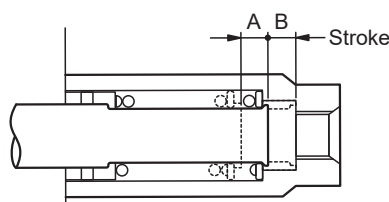
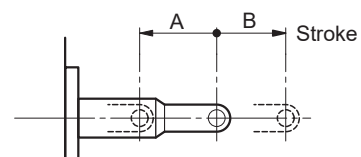
3. SERVICE STANDARDS

[Unit : in. (mm)]

Applicable model		ViO17-1		
Part		Measuring position	Standard	Wear limit
(3) Track roller & shaft 		A	Ø0.98 (Ø25)	-
		B	2.72 (69)	2.48 (63)
		C	5.12 (130)	4.88 (124)
(4) Sprocket 		A	0.79 (20)	0.39 (10)
		B	0.71 (18)	0.51 (13)
		C	3.13 (79.5)	-
(5) Slide plate 		A	1.38 (35)	1.18 (30)

3. SERVICE STANDARDS

3-4 Controls

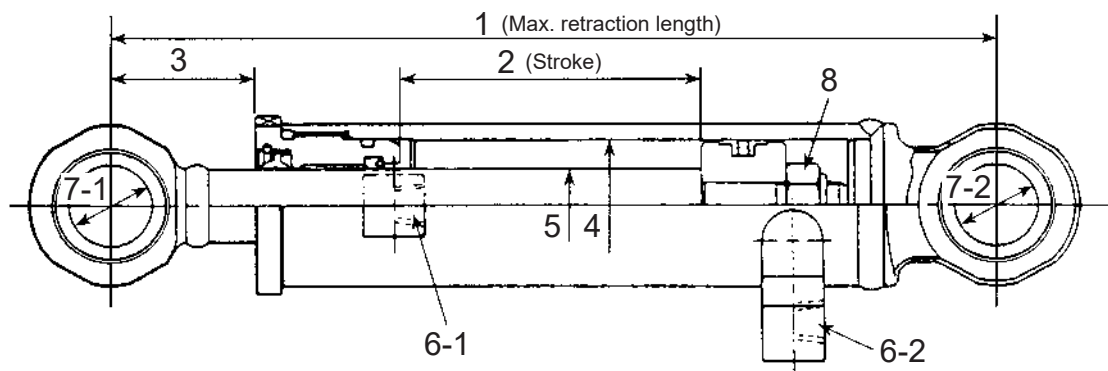
Applicable model		ViO17-1		
Item	Measuring conditions	Unit	Standard	Allowable limit
Controls				
Operating force				
Right control lever Boom (Up & Down)	• Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Lever operating force : Measure the force by hanging the spring scale on the lever grip. • Pedal operating force : Measure the force by applying load as shown below. 	lbs. (kg)	Up 3.7 (1.7) Down 3.3 (1.5)	3.7 (1.7)
Right control lever Bucket (Left & Right)			Left 4 (1.8) Right 3.1 (1.4)	4 (1.8)
Left control lever Arm (Up & Down)			Left 4 (1.8) Right 3.3 (1.5)	4 (1.8)
Left control lever Swing (Left & Right)			Left 3.1 (1.4) Right 3.3 (1.5)	3.7 (1.7)
Blade lever			3.1 (1.4)	7.06 (3.2)
Travel levers			Forward 3.75 (1.7) Reverse 2.87 (1.3)	Forward 4.85 (2.2) Reverse 3.97 (1.8)
			17.64 (8.0)	22.05 (10.0)
Boom swing pedal				
Play of control lever & pedal				
Right control lever (Front & rear / left & right)	• Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Play of each control lever and pedal : Measure the total play (front & rear and left & right) at the lever grip end or the pedal end. 	in. (mm)	0 (0)	—
Left control lever (Front & rear / left & right)			0 (0)	—
Blade lever			0 (0)	—
Travel levers			0.79 (20) or less	—
Boom swing pedal			—	—
P.T.O. pedal			—	—
Control valve				
Spool stroke				
Boom		in. (mm)	0.28 (7)	—
Bucket				
Arm				
Swing				
Parallel-flow divider				
Right travel		in. (mm)	0.28 (7)	—
Left travel				
Blade				
Boom swing				
Offset				

3. SERVICE STANDARDS

3-5 Hydraulic Equipment

3-5-1 Hydraulic Cylinders

ViO17-1



Unit : in. (mm)

Cylinder	No.	1	2	3	4	5	6-1 / 6-2	7-1 / 7-2		8	
								Standard	Allowable limit	Nut size (mm)	Tightening torque ft•lbf (N•m)
Boom		28.0 (712)	16.65 (423)	4.02 (102)	Ø2.36 (Ø60)	Ø1.38 (Ø35)	G1/4	Ø1.38 (Ø35)	Ø1.40 (Ø35.5)	M24	152.7 to 186.6 (207.0 to 253.0)
Arm		27.2 (690)	16.6 (422)	4.1 (103)	Ø2.17 (Ø55)	Ø1.38 (Ø35)	G1/4	Ø1.18 (Ø30)	Ø1.20 (Ø30.5)	M22	86.3 to 105.5 (1170 to 143.0)
Bucket		23.3 (591)	13.2 (335)	3.58 (91)	Ø2.17 (Ø55)	Ø1.18 (Ø30)	G1/4	Ø1.18 (Ø30)	Ø1.20 (Ø30.5)	M22	86.3 to 105.5 (1170 to 143.0)
Boom swing		21.7 (550)	11.6 (295)	2.60 (66)	Ø2.56 (Ø65)	Ø1.57 (Ø40)	G1/4	Ø1.57 (Ø40)	Ø1.59 (Ø40.5)	M22	270.1 to 234.4 (330.0 to 834.0)
Blade		15.4 (390)	4.72 (120)	4.13 (105)	Ø2.36 (Ø60)	Ø1.18 (Ø30)	G1/4	Ø1.18 (Ø30)	Ø1.20 (Ø30.5)	M24	152.7 to 186.6 (207.0 to 253.0)
Track gauge change		19.8 (503)	13.43 (341)	1.65 (42)	Ø2.17 (Ø55)	Ø1.18 (Ø30)	G1/4	Ø1.19 (Ø30.3)	Ø1.21 (Ø30.8)	M16	159.3 to 194.7 (216.0 to 264.0)

Nut for pipe

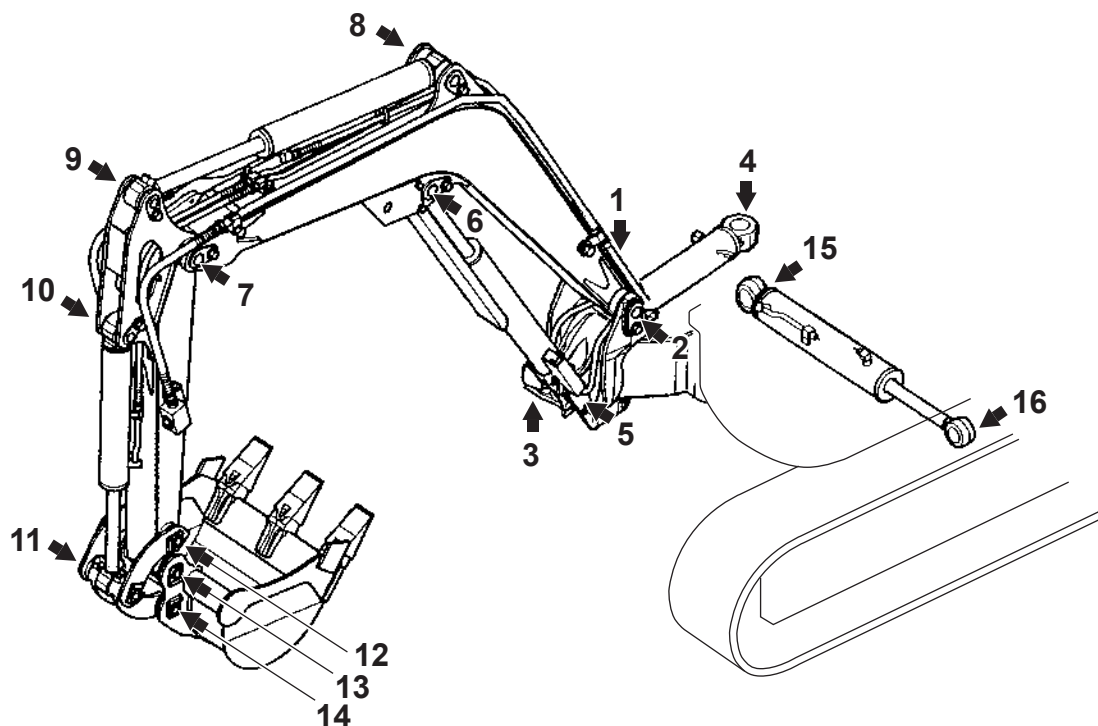
Symbol	Name
G (PF)	Straight pipe thread
R (PT)	Taper pipe thread (male)
Rc (PT)	Taper pipe thread (female)

3. SERVICE STANDARDS

3-6 Implement

3-6-1 Front Attachments

ViO17-1



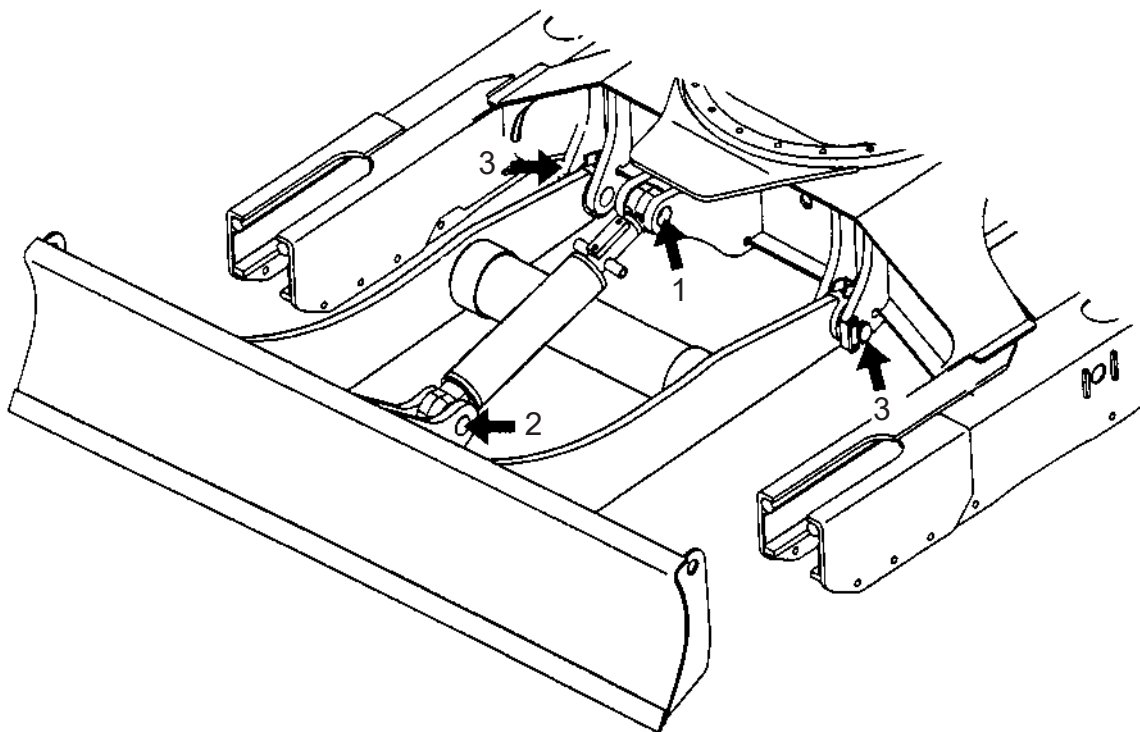
Unit : in. (mm)

No.	Applicable model : ViO17-1	Standard	Wear limit	
	Measuring point		Pin	Bore of bush or hole
1	Boom swing fulcrum	Ø1.57 (Ø40)	-0.02 (-0.5)	+0.02 (+0.5)
2	Boom fulcrum	Ø1.38 (Ø35)		
3	Boom swing cylinder, rod	Ø1.57 (Ø40)		
4	Boom swing cylinder, bottom	Ø1.57 (Ø40)		
5	Boom cylinder, bottom	Ø1.38 (Ø35)		
6	Boom cylinder, rod	Ø1.38 (Ø35)		
7	Arm fulcrum	Ø1.38 (Ø35)		
8	Arm cylinder, bottom	Ø1.18 (Ø30)		
9	Arm cylinder, rod	Ø1.18 (Ø30)		
10	Bucket cylinder, bottom	Ø1.18 (Ø30)		
11	Bucket cylinder, rod	Ø1.18 (Ø30)		
12	Link "A" arm	Ø1.18 (Ø30)		
13	Bucket fulcrum	Ø1.18 (Ø30)		
14	Bucket "link A"	Ø1.18 (Ø30)		
15	Track gauge change cylinder, bottom	Ø1.18 (Ø30)		
16	Track gauge change cylinder, rod	Ø1.18 (Ø30)		

Note : Allowable clearance is 0.04 in. (1.0 mm).

3. SERVICE STANDARDS

3-6-2 Blade Moving Device



Unit : in. (mm)

No.	Applicable model : ViO17	Standard	Wear limit	
	Measuring point		Pin	Bore of bush or hole
1	Blade cylinder, rod	Ø1.18 (Ø30)	-0.02 (-0.5)	+0.02 (+0.5)
2	Blade cylinder, bottom	Ø1.18 (Ø30)		
3	Blade fulcrum	Ø1.18 (Ø30)		

Note : Allowable clearance between pin and bore of bush or hole is 0.04 in. (1.0 mm).

3. SERVICE STANDARDS

3-7 List of Tightening Torque

3-7-1 Machine

Unit : ft•lbf (N•m)

Applicable model:		ViO17-1		
Equipment		Thread size	Tightening torque	Adhesive
No.	Tightening part			
Engine / Electrical equipment				
1	Engine mount vibroisolating rubber	Nut M10	18.1 to 23.9 (24.5 to 32.4)	4T torque
2	Engine mount vibroisolating rubber	Nut M14 (Fine screw thread)	50.6 to 61.5 (68.6 to 83.4)	
3	Engine × Engine mount	M10	32.6 to 43.4 (44.1 to 58.8)	Three Bond 1324
4	Engine stopper × Engine mount	M10	32.6 to 43.4 (44.1 to 58.8)	Three Bond 1324
5	Engine mount × Turning frame	M12	57.9 to 72.4 (78.5 to 98.1)	Three Bond 1324
6	Hose clip 60 (Intake hose installation)	—	1.63 to 1.85 (2.16 to 2.45)	
7	Battery holding clamp	Screw M8	13.9 to 17 (18,9 to 23,1)	
8	Fuel gauge unit	Pan head screw M5	0.89 to 1.11 (1.2 to 1.5)	
9	CW-T (A-B)	Hose band 30	1.63 to 1.85 (2.2 to 2.5)	
10	Battery cable terminals	Nut M6	2.17 to 2.89 (3.0 to 3.9)	
11	Air cleaner	M8	14.5 to 16.6 (19.6 to 22.6)	
12	Fuel tank band	Nut M10	1.85 to 2.15 (2.5 to 2.9)	18.1 to 23.9 ft•lbf (24.5 to 32.4 N•m) <Lock nut side>
13	Safety starter switch	Lock nut M18 (Fine screw thread)	21.7 to 25.3 (29.4 to 34.3)	
14	Drain plug		57.9 to 72.4 (78.5 to 98.1)	
15	Engine drain hose × Drain block	Hose clip	1.59 to 1.81 (2.16 to 2.45)	
Driving system				
1	Sprocket	M10	32.6 to 43.4 (44.1 to 58.8)	Three Bond 1324
Travel device				
1	Plugs (idler, adjust cylinder)	RC 1/8	33.2 to 40.6 (45 to 55)	
2	Idler seal cover × Crawler spring	M10	53.1 to 62.7 (72.0 to 85.80)	
3	Track roller tightening nut	M12	57.9 to 72.4 (78.5 to 98.1)	Three Bond 1324
4	Nipple valve	M16	-	
5	Shoe slide plate	M10	-	

3. SERVICE STANDARDS

Unit : ft•lbf (N•m)

Applicable model:		ViO17-1		
Equipment		Thread size	Tightening torque	Adhesive
No.	Tightening part			
Frame				
1	Swing bearing x upper carriage	M12 (10.9T)	79.6 to 94.9 (107.9 to 128.5)	Loctite 262
2	Swing bearing × track frame	M12 (10.9T)	79.6 to 94.9 (107.9 to 128.5)	Loctite 262
3	Swing bearing × track frame	M12 (10.9T)	79.6 to 94.9 (107.9 to 128.5)	Loctite 262
4	Track roller	M12 (10.9T)	79.6 to 94.9 (107.9 to 128.5)	Loctite 262
5	Plate shoe slide x track frame	M12 (10.9T)	79.6 to 94.9 (107.9 to 128.5)	Loctite 262
6	Travel motor x track frame	M12 (10.9T)	79.6 to 94.9 (107.9 to 128.5)	Loctite 262
7	Sprocket x travel motor	M12 (10.9T)	79.6 to 94.9 (107.9 to 128.5)	Loctite 262
8	Ext frame cylinder axis x track frame	M10 (10.9T)	79.6 to 94.9 (107.9 to 128.5)	Loctite 262
9	Tie down point (option) x upper carriage	-	-	
Other				
1	Safety switch (Cut-off lever)	M18	14.5 to 18.1 (19.6 to 24.5)	
2	Control levers x seat mount	M8x16	17 to 19.9 (23 to 27)	
3	Arm rest x arm rest bracket	M8x16	10.3 to 11.8 (14 to 16)	Threadlocker
4	Engine cover lock security nut	M10	33.9 to 39.8 (46 to 54)	
5	Grid x right cover	M6x12	7 to 8.5) (9.5 to 11,5)	
6	Air cleaner	M8x25	14.5 to 16.7 (19.6 to 22.6)	
7	Air cleaner hose clamp	-	1.8 to 2,2 (2.45 to 2.94)	
8	Canopy support x upper carriage	M20x50	296.5 to 320.1 (402 to 434)	ThreeBond 1324
9	Cabin x upper carriage	-	-	
10	Cabin x upper carriage	-	-	
11	Counterweight	M16x60 10.9	123.2 to 151.9 (167 to 206)	ThreeBond 1324
12	Additional counterweight	M20x150	238,2 to 293,5 (323 to 402)	

3. SERVICE STANDARDS

Applicable model		SV19VT		
Equipment		Thread size	Tightening torque N•m	Adhesive
No	Tightening part			
Hydraulic equipment				
1	Hydraulic oil tank breather	-	10.8 to 11.3 (14.7 to 15.3)	
2	Hydraulic oil tank temperature sensor	-	-	
3	Hydraulic oil gauge x Hydraulic oil tank	M10	7.2 to 7.6 (9.7 to 10.3)	
4	Drain plug x Hydraulic oil tank	-	-	
5	Strainer mount x Hydraulic tank	M8x12	17 to 19.9 (23 to 27)	
6	Strainer x Strainer mount	-	-	
7	Strainer x Suction hose x Suction pipe	Hose clip 60	1.8 to 2.6 (2.5 to 3.5)	
8	Suction hose x Hyd. pump inlet fitting	Hose clip 60	1.8 to 2.6 (2.5 to 3.5)	
9	Hydraulic pump inlet fitting	-	66.4 (90)	
10	Hydraulic pump outlet fitting	-	22.1 (30)	
11	Hydraulic pump x inlet flange	M10x25 10.9	14.8 (20)	
12	Radiator mount x Hydraulic oil tank	-	-	
13	Hydraulic cooler x Hydraulic hoses	Hose clip 25	2 to 2.4 2,7 to 3,3	
14	Hydraulic hoses x Return fitting	Hose clip 35	2 to 2.4 2,7 to 3,3	
15	Hydraulic hoses x Return fitting	Hose clip 22	2 to 2.4 2,7 to 3,3	
16	Hydraulic oil tank return fitting	-	21.7 (29.4) to 28.9 (39.2)	
17	Return filter x Hydraulic oil tank	M8x25	8.6 to 9.1 (11,7 to 12,3)	ThreeBond 1324
18	Drain return fitting	-	-	
19	Swivel joint x Lower carriage	M10x30	23.6 to 43.4 (44.1 to 58.8)	ThreeBond 1324
20	Swing motor x upper carriage	M12x40	59.9 to 72.3 (78.5 to 98.1)	ThreeBond 1324
21	Air cleaner hose clamp	-	1.8 to 2.2 (2.45 to 2.94)	
22	QHPP valve bracket x canopy mount	-	-	

3. SERVICE STANDARDS

Unit : ft•lbf (N•m)

Applicable model:			ViO17-1		
Equipment			Thread size	Tightening torque	Adhesive
No.	Tightening part				
Rigging					
1	Canopy × Turning frame (front)		M12	93.7 127	
2	Canopy × Turning frame (rear)		M20	285.5 to 296.4 (323.4 to 401.8)	

3. SERVICE STANDARDS

3-7-2 Engine

1) Tightening torque for major bolts and nuts

No	Item	Thread size × Pitch	Tightening torque Unit : ft•lbf (N•m)	Lubricating oil
1	Cylinder head bolt (class 1)	M9 × 1.25	39.8 to 42.7 (53.9 to 57.9)	Yes
2	Connecting rod bolt (class 1)	M7 × 1.0	16.6 to 20.3 (22.6 to 27.5)	Yes
3	Flywheel mounting bolt	M10 × 1.25	59.3 to 63.7 (80.4 to 86.4)	Yes
4	Metal cap bolt	M12 × 1.5	55.7 to 60.1 (75.5 to 81.5)	Yes
5	Crankshaft pulley fastening bolt	M12 × 1.25	61.5 to 68.7 (83.3 to 93.3)	Yes
6	Fuel injection nozzle retainer clamp nut	M20 × 1.5	36.2 to 39.1 (49.0 to 53.0)	No
7	Glow plug	M10 × 1.25	10.9 to 14.5 (14.7 to 19.6)	No
8	Governor weight support nut	M12 × 1.25	50.6 to 54.3 (68.7 to 73.7)	Yes
9	High pressure pipe nut	M12 × 1.25	21.7 to 25.3 (29.4 to 34.3)	No
10	Cam end nut (Fuel pump)	M12 × 1.75	43.4 to 50.7 (58.8 to 68.8)	Yes
11	Fop gear bolt	M8 × 1.0	2.43 to 2.73 (3.3 to 3.7)	No

3-7-3 Tightening Torque for General Bolts and Nuts

1) Tightening torque for major bolts and nuts

Item		Thread size × Pitch	Tightening torque [Unit : ft•lbf (N•m)]	Remarks
Hexagon head bolt (7T) Nut	Coarse thread	M6 × 1	7.23 to 8.68 (9.8 to 11.8)	1) Apply 80% of tightening torque when tightened to aluminum. 2) Apply 60% of tightening torque for 4T bolts and lock nuts. 3) Use fine screw threads for engine only.
		M8 × 1.25	16.6 to 21.0 (22.6 to 28.4)	
		M10 × 1.5	32.6 to 43.4 (44.1 to 58.8)	
		M12 × 1.75	57.9 to 72.3 (78.5 to 98.1)	
		M14 × 2	86.8 to 108.5 (117.7 to 147.1)	
		M16 × 2	123.0 to 151.9 (166.7 to 205.9)	
		M18 × 2.5	173.6 to 209.8 (235.4 to 284.4)	
		M20 × 2.5	238.7 to 296.6 (323.6 to 402.1)	
	Fine thread	M14 × 1.5	94.0 to 108.5 (127.5 to 147.1)	
		M16 × 1.5	155.5 to 177.2 (210.9 to 240.3)	
PT plug		1/8	7.23 (9.8)	
		1/4	14.5 (19.6)	
		3/8	21.7 (29.4)	
		1/2	43.4 (58.8)	
Pipe joint bolt		M8	9.4 to 12.3 (12.7 to 16.7)	
		M12	18.1 to 25.3 (24.5 to 34.3)	
		M14	28.9 to 36.2 (39.2 to 49.0)	
		M16	36.2 to 43.4 (49.0 to 58.8)	

3. SERVICE STANDARDS

2) Tightening torque for major screws

Screws : class 8.8

Size	thread lock	Tightening torque [Unit : ft•lbf (N•m)]			
		Nominal	Min		Max
M3	No	1.1 (1,5)	1 (1.3)	~	1.2 (1.65)
M4		2.2 (3)	2 (2.7)	~	2.4 (3,3)
M5		3.6 (4.9)	3.3 (4.4)	~	4 (5.4)
M6		6.3 (8.5)	5.6 (7.6)	~	6.9 (9.4)
M8		15.5 (21)	13.9 (18.9)	~	17 (23.1)
M10		30.2 (41)	27.2 (36.9)	~	33.3 (45.1)
M12		51.6 (70)	46.5 (63)	~	56.8 (77)
M14		82.6 (112)	74.3 (100.8)	~	90.9 (123,2)
M16		129.1 (175)	116.2 (157.5)	~	142 (192.5)
M20		259.6 (352)	233.7 (316.8)	~	285.6 (387.2)
M24		447 (606)	402.3 (545.4)	~	491.7 (666.6)
M27		657.9 (892)	591.1 (802.8)		723.7 (981.2)
M30		894.7 (1213)	805.2 (1091.7)		984.1 (1334.3)

Screws : class 10.9

Size	thread lock	Tightening torque [Unit : ft•lbf (N•m)]			
		Nominal	Min		Max
M3	No	1.5 (2)	1.3 (1.8)	~	1.6 (2.2)
M4		3.1 (4.2)	2.8 (3.8)	~	3.4 (4.6)
M5		5.3 (7.2)	4.8 (6.5)	~	5.8 (7.9)
M6		9.2 (12.5)	8.3 (11.2)	~	10.1 (13.8)
M8		22.1 (30)	19.9 (27)	~	24.3 (33)
M10	Yes	44.3 (60)	39.8 (54)	~	48.7 (66)
M12		72 (103)	68.4 (92.7)	~	83.6 (113.3)
M14		121.7 (165)	109.5 (148.5)	~	133.9 (181.5)
M16		189.6 (257)	170.6 (231.3)	~	208.5 (282.7)
M20		370.3 (502)	333.2 (451.8)	~	407.3 (552,2)
M24		636.5 (863)	572.9 (776.7)	~	700.2 (949.3)
M27		937.4 (1271)	843.7 (1143.9)		1031.2 (1398.1)
M30		1274.5 (1728)	1147.1 (1555.2)		1402 (1900.8)

3. SERVICE STANDARDS

Screws : class 12.9

Size	thread lock	Tightening torque [Unit : ft•lbf (N•m)]			
		Nominal	Min		Max
M5	Yes	6.2 (8.4)	5.6 (7.6)	~	6.8 (9.3)
M6		10.8 (14.6)	9.7 (13.2)	~	11.8 (16.1)
M8		25.8 (35)	23.2 (31.5)	~	28.4 (38.5)
M10		51.6 (70)	46.5 (63)	~	56.8 (77)
M12		89.2 (121)	80.3 (108.9)	~	98.2 (133.1)
M14		142.3 (193)	128.1 (173.7)	~	156.6 (212.3)
M16		221.3 (300)	199.1 (270)	~	243.4 (330)
M20		432.9 (587)	389.7 (528.3)	~	476.2 (645.7)
M24		744.9 (1010)	670.4 (909)	~	819.4 (1111)
M27		1096.8 (1487)	987.1 (1338.3)	~	1206.4 (1635.7)
M30		1491.3 (2022)	1342.2 (1819.8)	~	1640.5 (2224.2)

3. SERVICE STANDARDS

3-7-4 Hydraulic Hose Joint

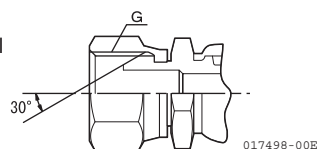
(1) Tightening torque for parallel pipe thread

(In case of 30°seat type joint and O-ring seat type joint)

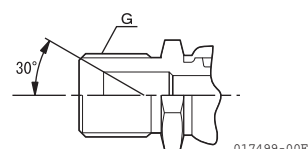
Unit : ft•lbf (N•m)

Nominal designation of screw thread G (PF)	Tightening torque
	Material of the other side: copper, cast iron
1/8	10.1 to 12.3 (13.7 to 16.7)
1/4	16.7 to 20.3 (22.6 to 27.5)
3/8	32.6 to 39.8 (44.1 to 53.9)
1/2	39.1 to 47.8 (53.0 to 64.7)
3/4	78.2 to 95.2 (106 to 129)
1	91.5 to 111.5 (124 to 151)
1 1/4	110.7 to 135.1 (150 to 183)
1 1/2	137.3 to 166.8 (186 to 226)

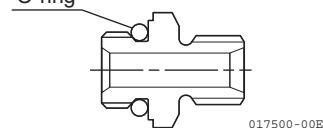
(Example)
Female parallel
pipe thread
(Male 30°seat)



Female parallel
pipe thread



O-ring



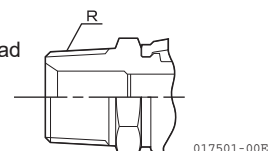
(2) Tightening torque for taper pipe thread

(Application of seal tape)

Unit : ft•lbf (N•m)

Nominal designation of screw thread R (PF)	Tightening torque
	Material of the other side: copper, cast iron
1/8	5.09 to 6.50 (6.9 to 8.8)
1/4	7.23 to 10.9 (9.8 to 14.7)
3/8	21.7 to 28.9 (29.4 to 39.2)
1/2	28.9 to 36.2 (39.2 to 49.0)
3/4	36.2 to 47.0 (49.0 to 63.7)
1	50.6 to 65.2 (68.6 to 88.3)
1 1/4	72.4 to 87.1 (98.1 to 118)

(Example)
Male taper pipe thread



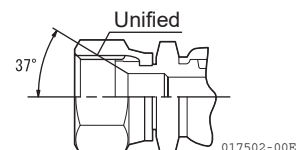
(3) Tightening torque for unified thread

(In case of 37°seat type joint and O-ring seat type joint)

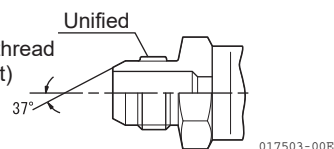
Unit : ft•lbf (N•m)

Nominal designation of screw thread	Tightening torque
	Material of the other side: copper, cast iron
7/16-20UNF	13.1 to 15.9 (17.7 to 21.6)
9/16-18UNF	26.1 to 31.8 (35.3 to 43.1)
3/4-16UNF	32.6 to 39.8 (44.1 to 53.9)
7/8-14UNF	39.1 to 47.8 (53.0 to 64.7)
1 1-16-12UN	78.2 to 95.2 (106 to 129)
1 5/16-12UN	91.5 to 111.5 (124 to 151)
1 5/8-12UN	110.7 to 135.1 (150 to 183)

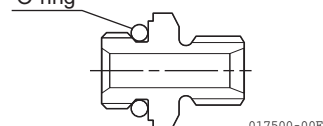
(Example)
Female unified
thread
(Female 37°seat)



(Example)
Male unified thread
(Male 37°seat)



O-ring



3. SERVICE STANDARDS

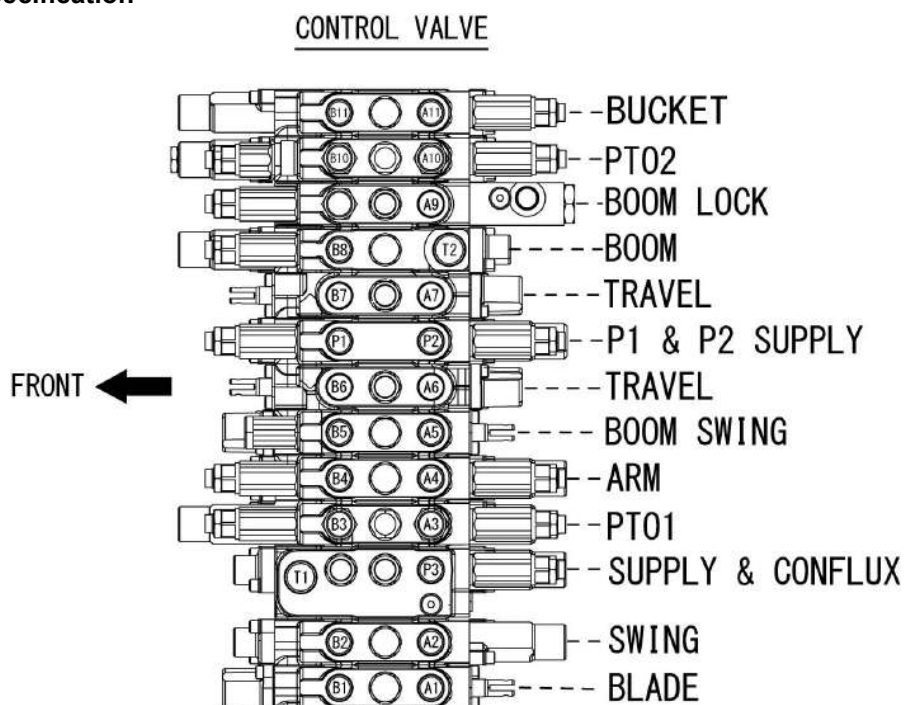
3-8 Pressure Adjustment

3-8-1 Relief Valves

1) Conditions

- (1) Engine: rated speed
- (2) Hydraulic oil temperature: 50 to 60°C
- (3) Pressure oil gauge capacity: 49 MPa

2) Relief Valve Specification

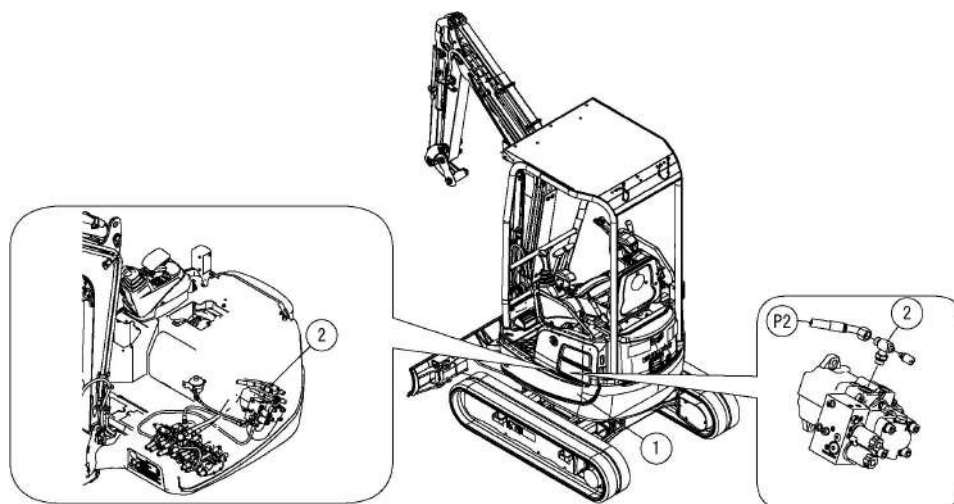


[Unit: Psi (MPa) at max rpm]

Control valve		Set pressure
		ViO17-1
System relief valve	P1, P2	2988 (20.6)
	P3	2422 (16,7)
Circuit relief valve	Boom (rod end)	3408 (23.5)
	Boom (bottom end)	4264 (29.4)
	Arm (rod end)	3408 (23.5)
	Arm (bottom end)	3408 (23.5)
	Bucket (rod end)	-
	Bucket (bottom end)	3553 (24.5)
	Boom swing (rod end)	-
	Boom swing (bottom end)	-
	Blade (rod end)	-
	Blade (bottom end)	-
	PTO (left)	2321 (16)
	PTO (right)	2321 (16)
	Extension (rod end)	-
	Extension (bottom end)	-
	PTO2 (left)	2321 (16)
	PTO2 (right)	2321 (16)

3. SERVICE STANDARDS

3) Measuring points on the primary relief valve MRV1



(1) Remove the cover 1.

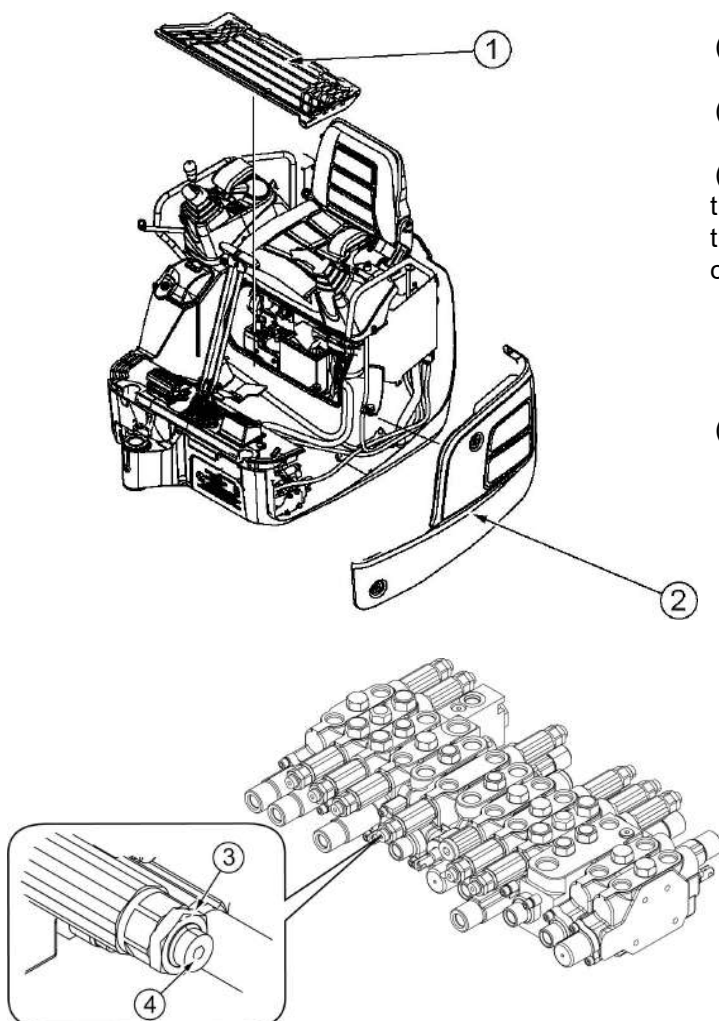
(2) Remove the plug from the pressure port 2 and install the oil pressure gauge.

(3) To check the pressure of the system relief valve MRV1 from P1 in the control valve, retract the bucket cylinder to its stroke end, hold the lever and read the gauge.

4) Adjustment Procedure on the primary relief valve MRV1

WARNING

The pressure is factory setting, all necessary adjustment must be done by YANMAR dealer.



(1) Remove floor mat 1.

(2) Remove the left cover 2.

(3) Adjust the pressure if necessary by unscrewing the locknut 3 and turning the adjusting screw 4 on the hydraulic control valve until you reach the correct pressure :

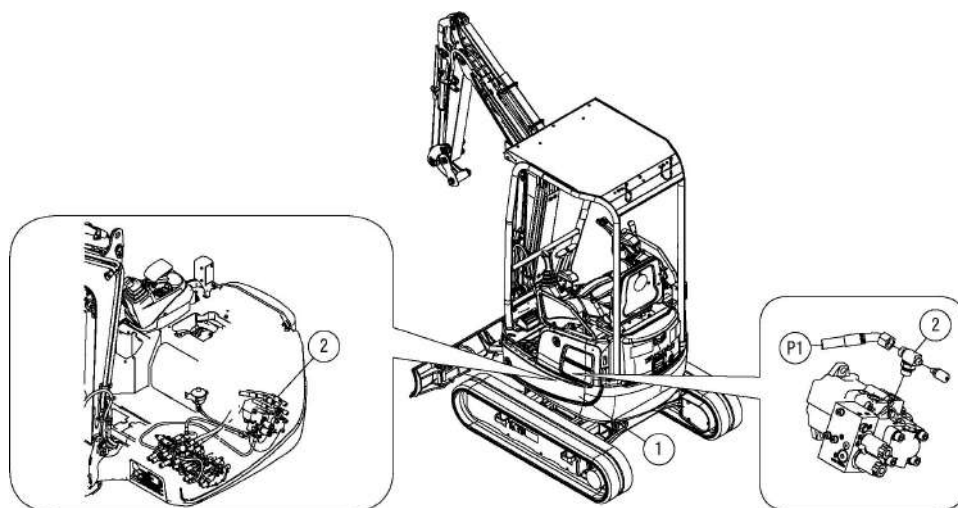
- Clockwise for increase in pressure

- Counterclockwise for reduction in pressure

(4) Tighten the locknut.

3. SERVICE STANDARDS

5) Measuring points on the primary relief valve MRV2



(1) Remove the cover 1.

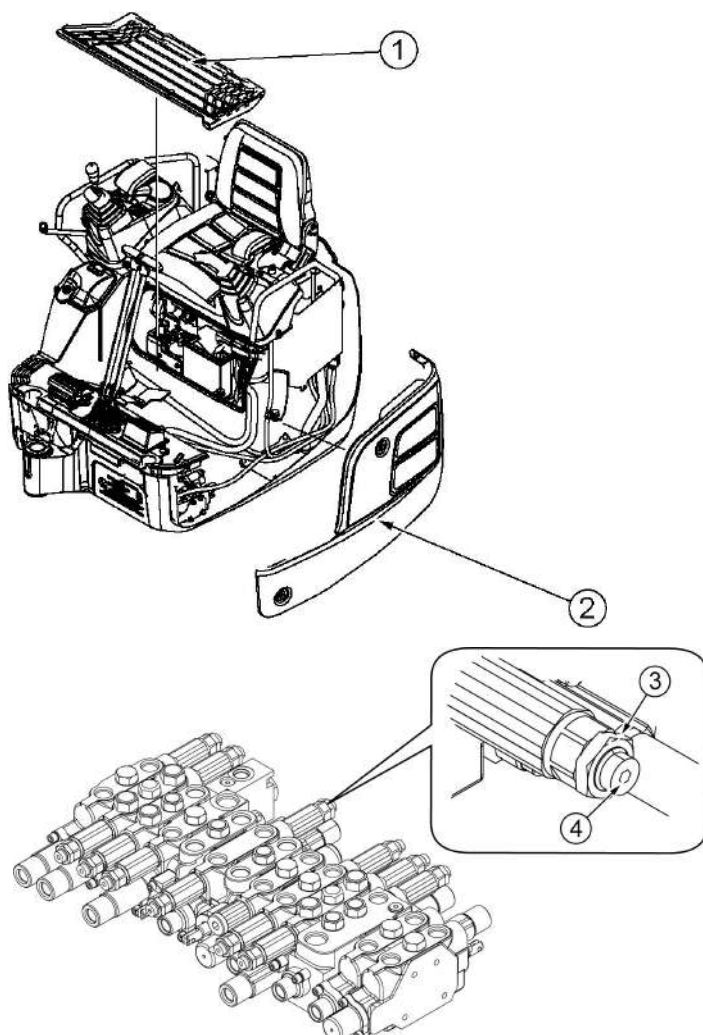
(2) Remove the plug from the pressure port 2 and install the oil pressure gauge.

(3) To check the pressure of the system relief valve MRV2 from P2 in the control valve, retract the arm cylinder to its stroke end, hold the lever and read the gauge.

6) Adjustment Procedure on the primary relief valve MRV2

WARNING

The pressure is factory setting, all necessary adjustment must be done by YANMAR dealer.



(1) Remove floor mat 1.

(2) Remove the left cover 2.

(3) Adjust the pressure if necessary by unsewing the locknut 3 and turning the adjusting screw 4 on the hydraulic control valve until you reach the correct pressure :

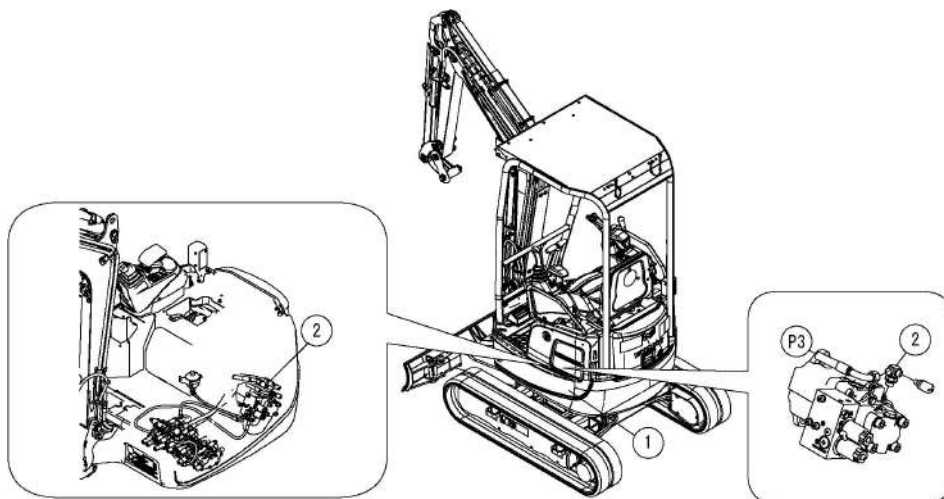
- Clockwise for increase in pressure

- Counterclockwise for reduction in pressure

(4) Tighten the locknut.

3. SERVICE STANDARDS

7) Measuring points on the primary relief valve MRV3



(1) Remove the cover 1.

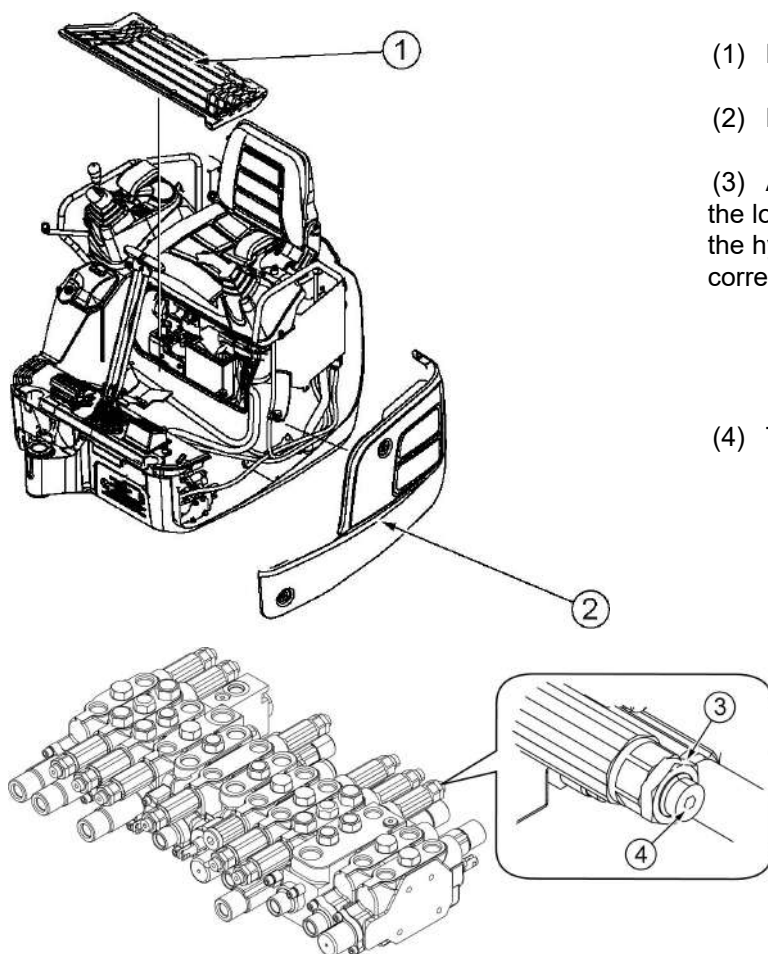
(2) Remove the plug from the pressure port 2 and install the oil pressure gauge.

(3) To check the pressure of the system relief valve MRV3 from P3 in the control valve, retract the blade cylinder to its stroke end, hold the lever and read the gauge.

8) Adjustment Procedure on the primary relief valve MRV3

WARNING

The pressure is factory setting, all necessary adjustment must be done by YANMAR dealer.



(1) Remove floor mat 1.

(2) Remove the left cover 2.

(3) Adjust the pressure if necessary by unsewing the locknut 3 and turning the adjusting screw 4 on the hydraulic control valve until you reach the correct pressure :

- Clockwise for increase in pressure

- Counterclockwise for reduction in pressure

(4) Tighten the locknut.

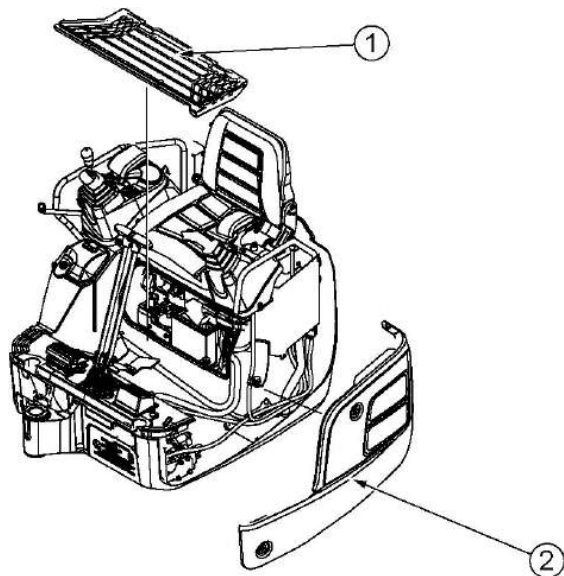
3. SERVICE STANDARDS

3-8-2 Cut-Off Valve

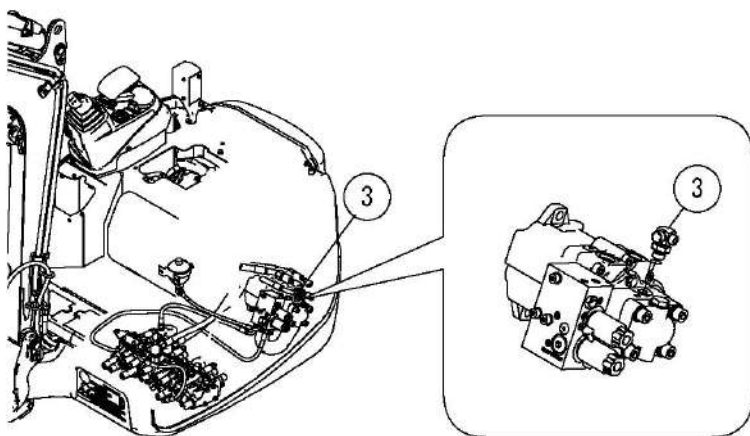
1) Conditions

- (1) Engine: rated speed
- (2) Hydraulic oil temperature: 122 to 140°F (50 to 60°C)
- (3) Set pressure: 421 Psi (2,9 MPa)

2) Measuring Procedure



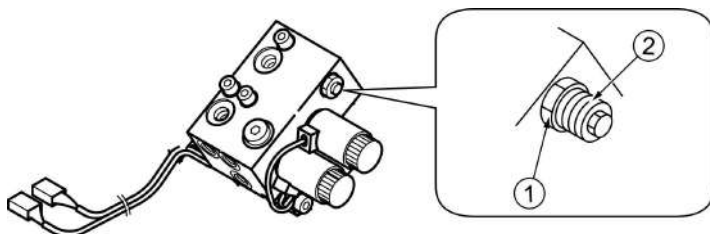
- (1) Remove floor mat **1**.
- (2) Remove the left cover **2**.
- (3) Remove the plug from the pressure port **3** and install the oil pressure gauge.
- (4) Move the lock lever to the "UNLOCK" position, and read the gauge.



3) Pressure Adjustment Procedure

WARNING

The pressure is factory setting, all necessary adjustment must be done by YANMAR dealer.



- (1) Adjust the pressure if necessary by unscrewing the locknut **1** and turning the adjusting screw **2** on the hydraulic control valve until you reach the correct pressure :
 - Clockwise for increase in pressure
 - Counterclockwise for reduction in pressure
- (2) Tighten the locknut.

CHAPTER 4

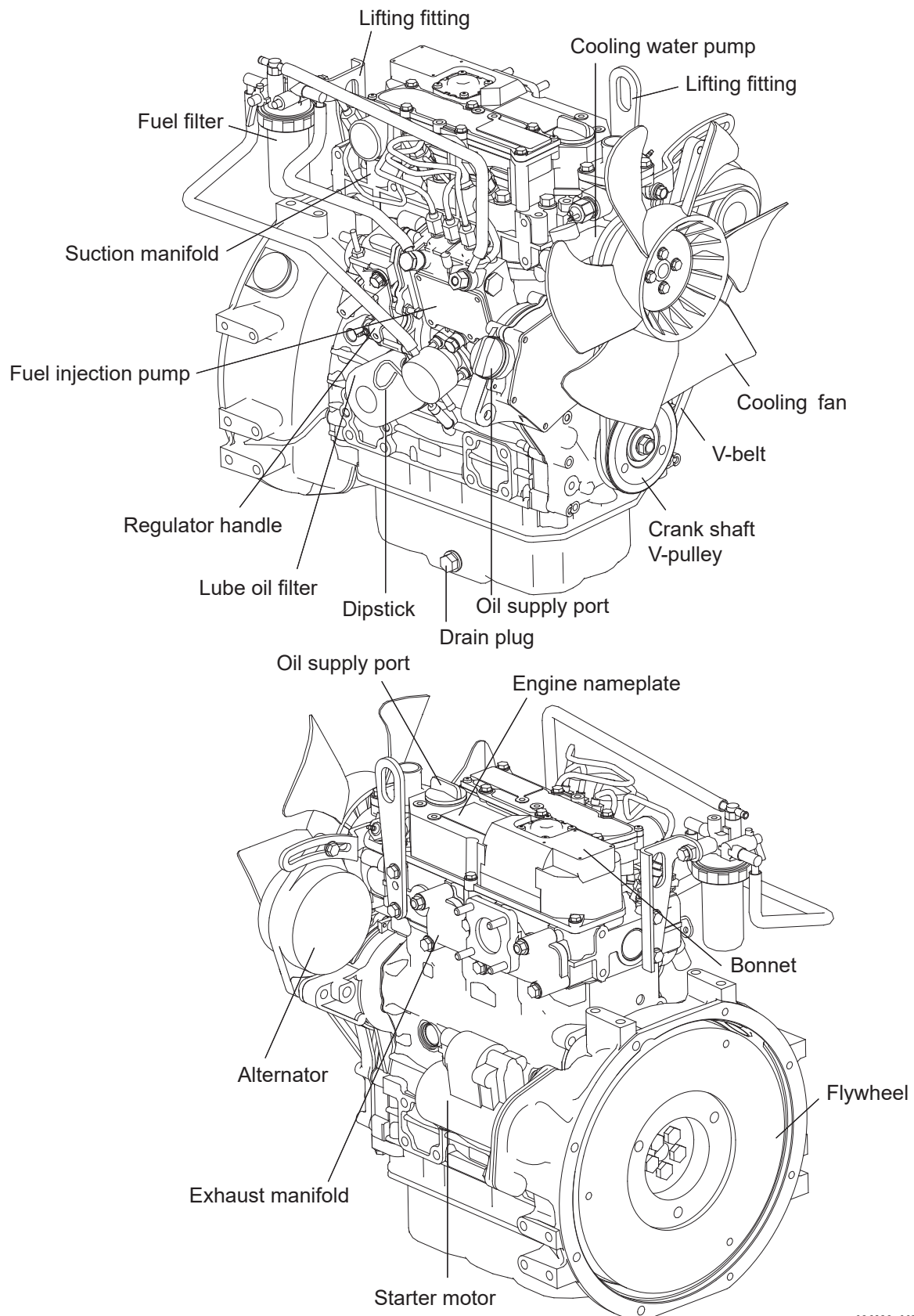
ENGINE

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4. ENGINE

4. Engine

4-1 Exploded View



026832-00E

4. ENGINE

4-2 Measurement, Inspection and Adjustment

4-2-1 Measuring the Compression Pressure

1) Measurement Procedure

- (1) Warm up the engine. Remove the fuel injection pipe and the fuel injection valve from the cylinder to be measured.
- (2) Crank the engine before attaching the compression gauge adapter.

Note :

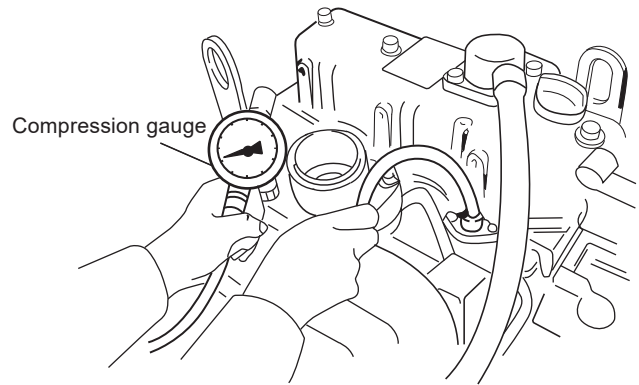
Crank the engine when the regulator handle has been turned to "STOP" position (no injection state).

- (3) Attach the compression gauge adapter and the compression gauge to the cylinder to be measured.

Note :

Never fail to attach the gasket to the tip of the adapter.

- (4) Crank the engine with the starter motor until the reading of the compression gauge is stabilized, according to the above step (2) and Note.



Measuring the compression pressure

[Engine compression pressure (Reference values)]

Compression pressure at 250 rpm PSI (MPa)		Variations of compression pressure among cylinders PSI (MPa)
Standard	Limit	
455.4 to 484.4 (3.14 to 3.34)	369.8 (2.55)	28.4 to 42.7 (0.2 to 0.3)

2) Trouble Diagnosis Through Measurement of Compression Pressure

Reduction in the compression pressure of the cylinder is one of the major causes of the increase in blow-by gas (which causes contamination and increased consumption of lubricating oil, and other trouble) and the engine starting failure. The compression pressure is influenced by the following factors :

- (1) Degree of the clearance between the piston and the cylinder ;
- (2) Degree of the clearance around the intake / exhaust valve seats ; and
- (3) Gas leak through the nozzle gasket or the cylinder head gasket.

This means that the compression pressure decreases as the engine parts are worn and lose durability through the use of the engine over a long period of time.

In addition, the compression pressure is also decreased by scratches on the cylinder or the piston which are caused by dust or other foreign matters drawn in through the soiled filter element of the air cleaner, and wear or breakage of any piston rings. Therefore, the condition of the engine should be diagnosed by measuring the compression pressure.

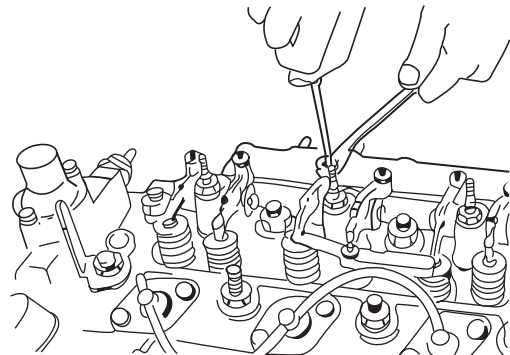
4. ENGINE

Causes and countermeasures to be taken when the compression pressure is less than the limit value.

No.	Item	Causes	Countermeasures
1	• Filter element of air cleaner	• Clogged filter element • Broken filter element • Defective filter element seal portion	• Clean the filter element. • Replace the filter element.
2	• Valve clearance	• Excessive or no valve clearance	• Adjust the valve clearance. (Refer to Section 4-2-2.)
3	• Valve timing	• Improper valve timing • Improper valve clearance	• Adjust the valve clearance. (Refer to Section 4-2-2.) • Inspect and adjust the valve rocker arm. (Refer to Sections 4-3-3, 4-3-6 and 4-3-8.)
4	• Cylinder head gasket • Nozzle gasket	• Gas leak through the gasket	• Replace the gasket. • Re-tighten the cylinder head and the nozzle at the specified torque. (Refer to Section 3-7-2 of Chapter 3.)
5	• Intake/exhaust valve • Valve seat	• Gas leak due to worn valve seats or trapped foreign matters • Sticking of valves	• Lap the valve seats. (Refer to Section 4-3-1 2.) • Replace the intake/exhaust valves.
6	• Piston • Piston ring • Cylinder	• Gas leak due to scratches or wear of the piston, piston ring or cylinder	• Do the honing and use oversize parts. (Refer to Sections 4-3-2 3) and 4-3-4 8).)

4-2-2 Adjusting the Valve Clearance

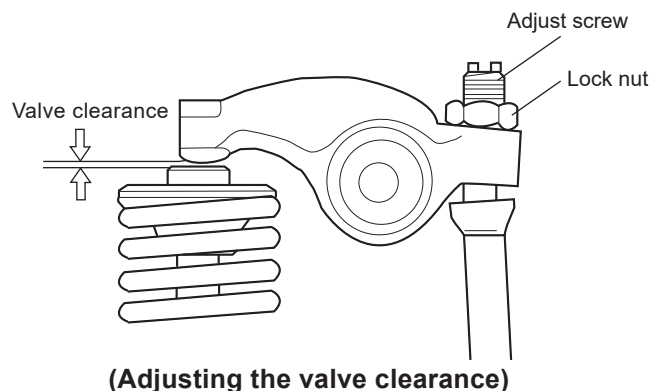
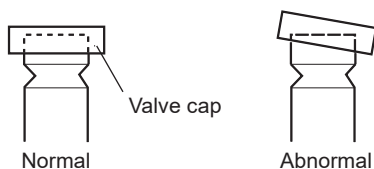
- (1) Inspect and adjust the intake / exhaust valve clearance while the engine is in the cold state.
- (2) Set the piston in the cylinder to be measured to the top dead center (TDC) of compression.
- (3) Loosen the lock nut and the adjust screw. Check that the valve cap is free from inclination or foreign matter.
- (4) Insert a thickness gauge between the rocker arm and the valve cap. Tighten the adjust screw until the clearance listed below is attained.



Intake / exhaust valve clearance	Refer to Section "3-2 1) Nominal and Allowable Values".
----------------------------------	---

Notes :

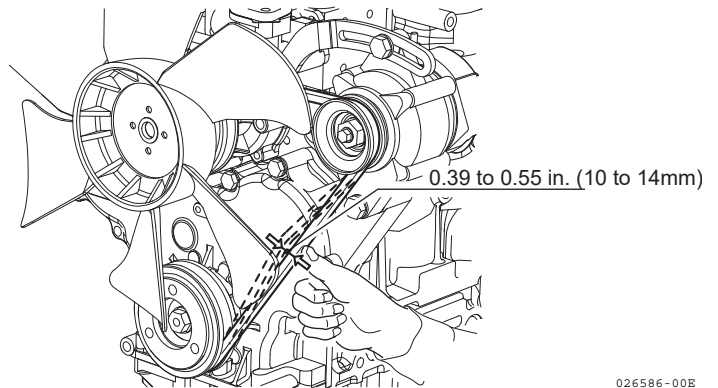
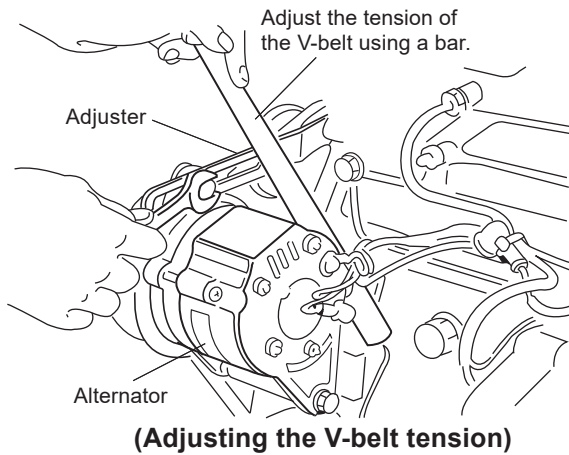
1. If the valve cap is worn or otherwise damaged in the head, replace it with a new one.
2. Check that the valve cap is fitted on the head of intake/exhaust valve.



4. ENGINE

4-2-3 Checking the V-belt Tension

Push the center of the V-belt between the alternator and the cooling water pump with a finger. If the slack is 0.39 to 0.55 in. (10 to 14 mm), the V-belt tension is proper. If not, adjust the V-belt tension using the adjuster at the alternator.



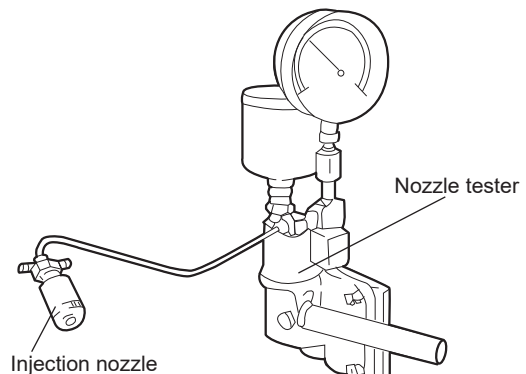
4-2-4 Checking the Fuel Injection Valve

1) Measuring the Fuel Injection Pressure

Note :

Thoroughly remove carbon deposits from the injection nozzle hole before the measurement.

- (1) Connect the fuel injection valve to the high pressure pipe of the nozzle tester.
- (2) While pumping the lever of the nozzle tester slowly, read the pressure gauge on the nozzle tester the moment the nozzle starts fuel injection.
(For the fuel injection pressure, refer to Section "2-1 Specifications".)
- (3) If the measured fuel injection pressure is lower than the specified value, replace the pressure adjusting shim with a thicker one.



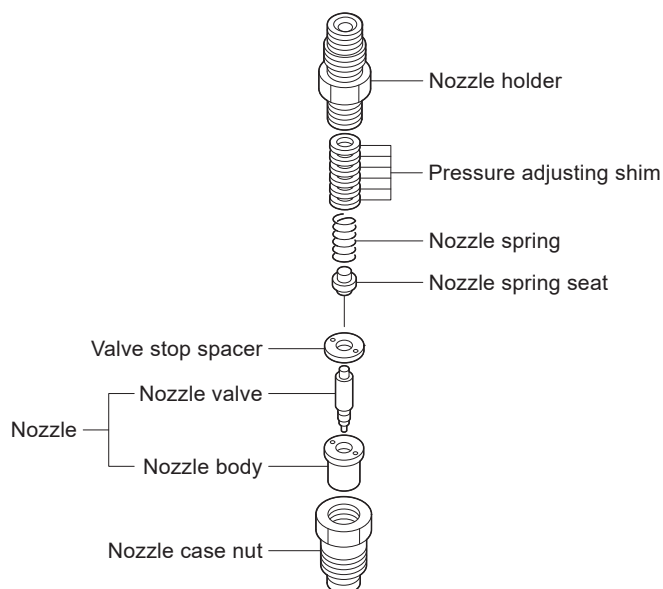
(Measuring the fuel injection pressure with a nozzle tester)

Types of pressure adjusting shim thickness [in. (mm)]	Fuel injection pressure adjustment
0.0039 (0.1) 0.0079 (0.2) 0.0118 (0.3) 0.0157 (0.4) 0.0197 (0.5)	The injection pressure will change by approximately 100-142 psi (0.69-0.98MPa; 7-10 kgf/cm ²) for every 0.004 in. (0.1 mm) shim thickness.

4. ENGINE

[Reference : Structure of fuel injection valve]

(Special swirl pre-combustion chamber)

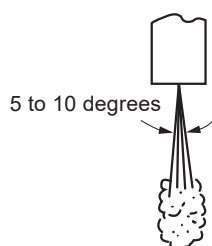


2) Checking the Spray Pattern

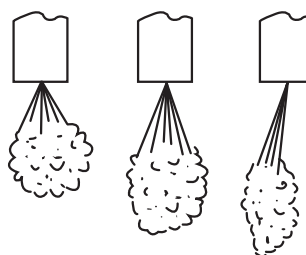
While pumping the lever of the nozzle tester once or twice per second at the specified fuel injection pressure (Refer to Section "2-1 Specifications".), check the spray pattern. If the spray pattern is not normal, clean or replace the nozzle.

- (1) Check that the pattern is neither like a stream nor slivered.
- (2) Check that fuel is sprayed conically around the nozzle center line and that the spray angle is 5 to 10 degrees.

[Normal spray pattern]



[Abnormal spray pattern]



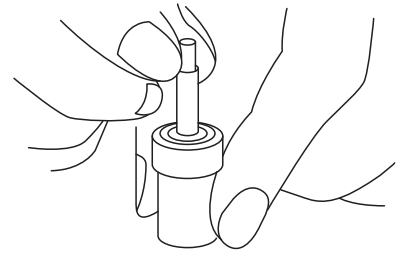
- (3) Spray fuel on a sheet of white paper placed about 11.8 in. (30 cm) below the nozzle. The injection spray should form a perfect circle.
- (4) No fuel should drip from the nozzle after injection.
- (5) Fuel should not ooze from the nozzle hole when the fuel injection pressure rises to a value that is a little lower than the specified value : 284 PSI (1.96 MPa).
- (6) Test the injection with a nozzle tester ; retighten the nozzle holder and test it again if there is excessive fuel leak from the overflow coupling. Replace the nozzle as a set if the fuel leak is still excessive.

4. ENGINE

3) Nozzle Valve Sliding Test

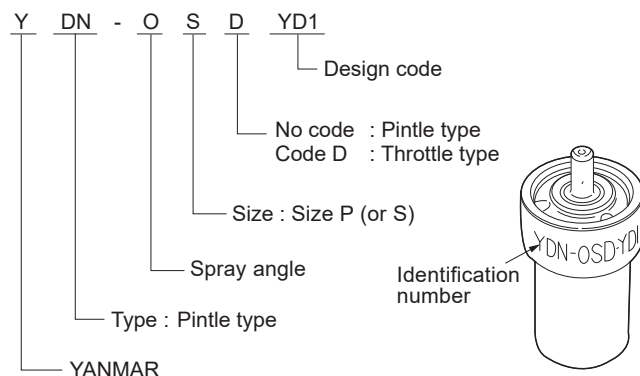
Thoroughly wash the nozzle valve using clean fuel. Hold the nozzle body vertical, and put the nozzle valve approx. 1 / 3 of its length into the body.

Check if the nozzle valve falls smoothly by self-weight when released. If so, the nozzle valve is good. In case of a new nozzle, remove the seal peel, and immerse it in clean light oil or the like to clean its inner and outer surfaces and thoroughly remove rust-preventive oil before using the nozzle. Note that a new nozzle is immersed in rust-preventive oil and then is pasted with a seal peel to shut off the outside air.



(Nozzle valve sliding test by self-weight)

4) Nozzle Body Identification Number



4-2-5 Checking and adjusting the Fuel Injection Timing

1) Replacing the Fuel Injection Pump

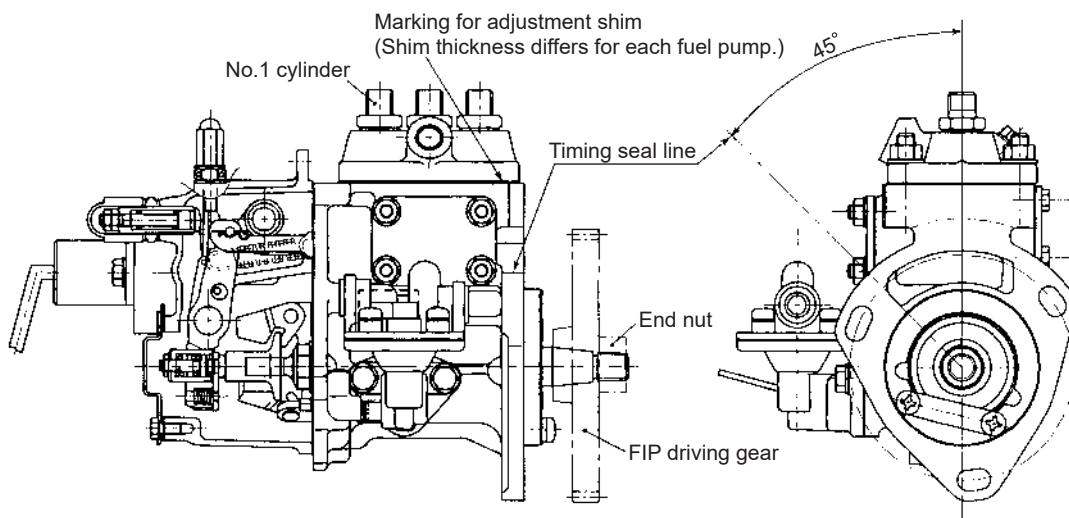
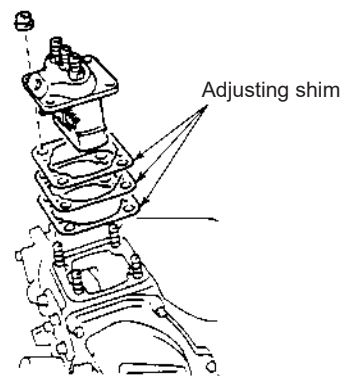
When the pump has become old and worn, replace the pump.

Replacing only the fuel pump

As with the standard engine, injection timing adjusting shims are inserted between the gear case and the fuel pump for adjustment. Check the injection timing with the FID method.

Note :

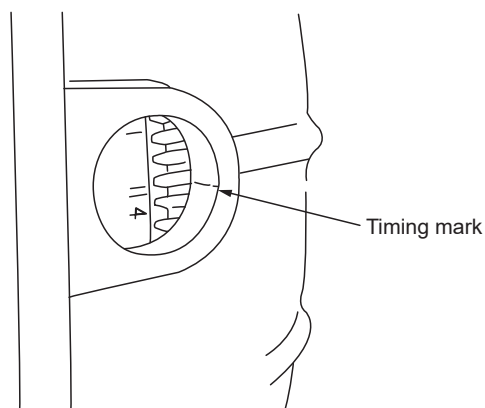
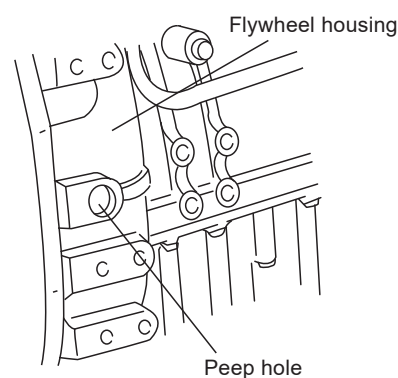
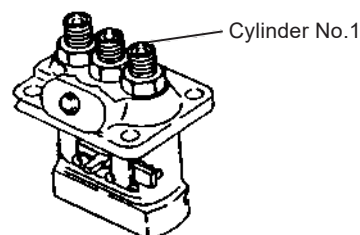
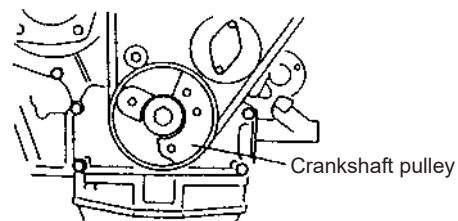
Do not separate the FIP coupling and driving gear.



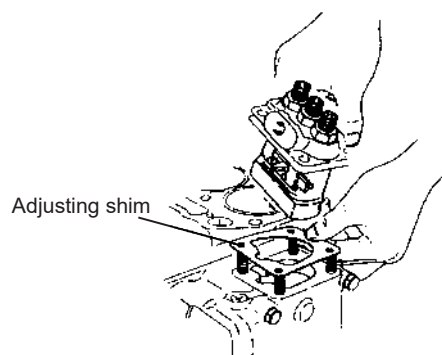
4. ENGINE

2) Checking and Adjusting the Fuel Injection Timing

- (1) Using the crankshaft pulley, turn the engine in the specified direction. Check the injection timing with the delivery valve spring holder of the fuel injection pump for the cylinder No.1. (Cylinder are numbered from No.1 sequentially from the flywheel side).
- (2) When the crankshaft is turned in the specified direction, the fuel level rises at the tip of the delivery valve spring holder. At that time, stop turning the crankshaft.
- (3) Check the timing mark imprinted on the flywheel through the peep hole in the flywheel housing.
(For the fuel injection timing, refer to Section "2-1 Specifications".)



- (4) If the fuel injection timing differs from the specified timing, remove the fuel injection pump to adjust the timing by increasing or reducing the adjusting shim thickness between the fuel injection pump and the gear case.
 - Increase the shim thickness to delay the injection timing.
 - Reduce the shim thickness to advance the injection timing.



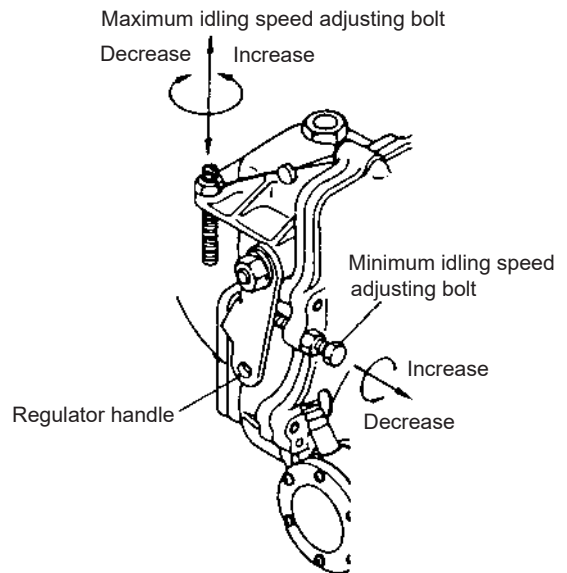
4. ENGINE

4-2-6 Adjusting the Maximum (or Minimum) Idling Speed

- (1) First warm up the engine. Then, gradually increase the engine speed up to the maximum idling speed. (Refer to Section "2-1 Specifications".)
- (2) If the maximum idling speed differs from the specified one, adjust the maximum idling speed using the maximum idling speed adjusting bolt.
- (3) Set the minimum idling speed to the specified value, (Refer to Section "2-1 Specifications".) by turning the minimum idling speed adjusting bolt.

Note :

The illustration shows the partial perspective view of the governor for the direct injection system.



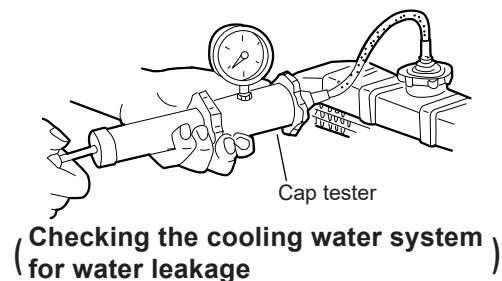
4-2-7 Checking the Cooling Water System and Radiator for Water Leakage

1) Checking the Cooling Water System for Water Leakage

Note :

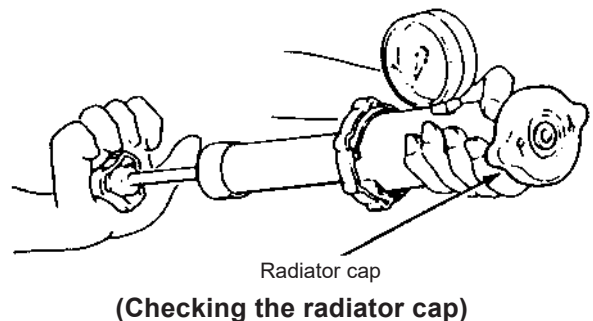
The cooling water system can be checked effectively while the engine is warm.

- (1) Supply cooling water up to the normal water level in the radiator. Attach the cap tester body to the radiator.
- (2) Start operating the cooling water pump, and set the pressure of the tester to 10.88 to 15.23 PSI (0.075 to 0.105 MPa). Any lower reading of the pressure gauge on the cap tester indicates water leakage from the cooling water system. Then, find out the portion of the cooling water system from which cooling water leaks.



2) Checking the Radiator Cap

Attach the radiator cap to a cap tester. Set the pressure of the tester to 10.88 to 15.23 PSI (0.075 to 0.105 MPa). Check if the cap is opened at the set pressure. If not, replace the cap, because it is defective.



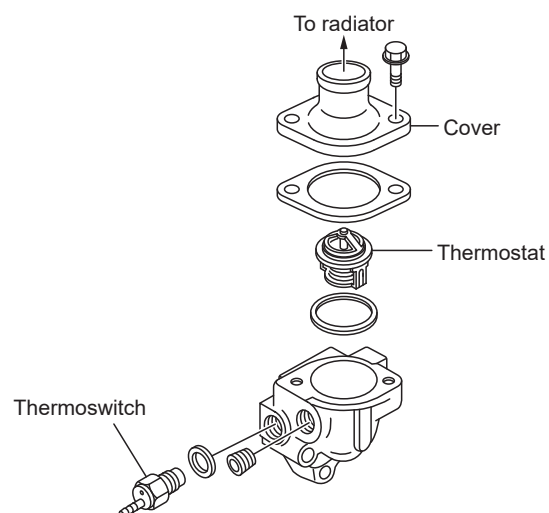
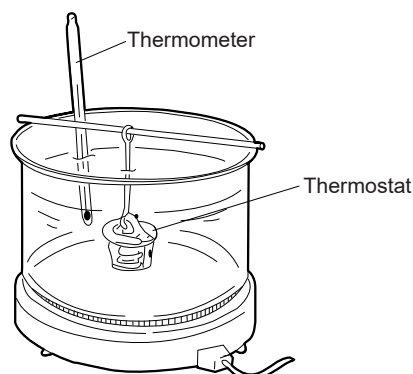
4. ENGINE

4-2-8 Checking the Sensors

1) Checking the Thermostat and the Thermoswitch

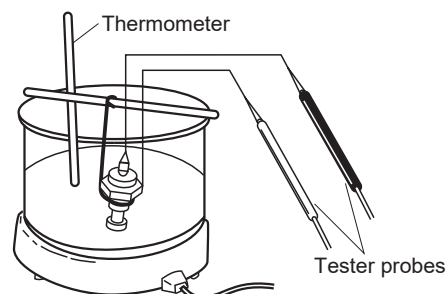
(1) Thermostat

Put the thermostat into the water in a container. While measuring the water temperature, heat the water. Check that the thermostat functions at a temperature of 157.1 to 162.5 °F (69.5 to 72.5 °C).



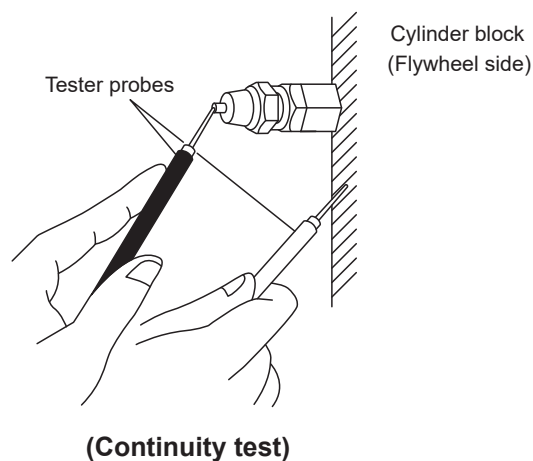
(2) Thermoswitch

Put the thermoswitch into the antifreeze or oil in a container. While measuring the liquid temperature, heat the liquid. If the tester shows continuity at a temperature of 224.6 to 235.4 °F (107 to 113 °C), the thermoswitch is normal.



2) Hydraulic Switch

Remove the connector from the hydraulic switch. While running the engine, bring the tester probes into contact with the switch terminal and the cylinder block. If the tester shows continuity, the hydraulic switch is defective.



4. ENGINE

4-3 Measurement Procedure, Service Data and Corrective Action

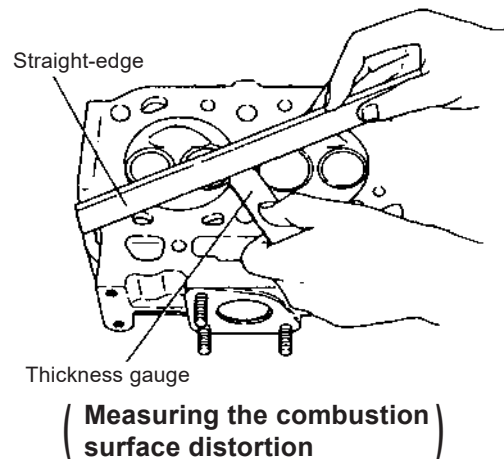
For the maintenance of all parts, make measurements according to the following measurement procedure. If any part is found to be defective or if any part is not within the allowable value, replace it with a new one. However, if it is expected that any part within the allowable value will exceed the value before the next maintenance based on the record of its use, be sure to replace such a part beforehand.

4-3-1 Cylinder Head

1) Checking the Combustion Surface for Distortion

- (1) Remove the intake / exhaust valves and the fuel injection valve from the engine. Clean the surface of the cylinder head.
- (2) Place a straight-edge along each of the four sides and each diagonal of the cylinder head. Measure the clearance between the straight-edge and the combustion surface with a thickness gauge.

Cylinder head combustion surface distortion	Standard	Wear limit
Refer to Section "3-2 1) Nominal and Allowable Values".		



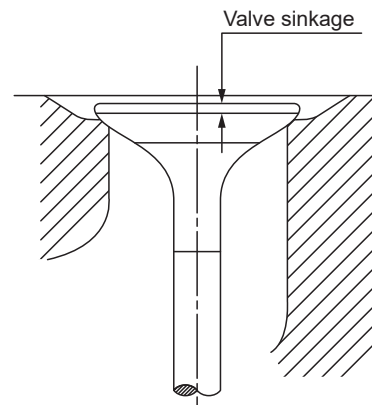
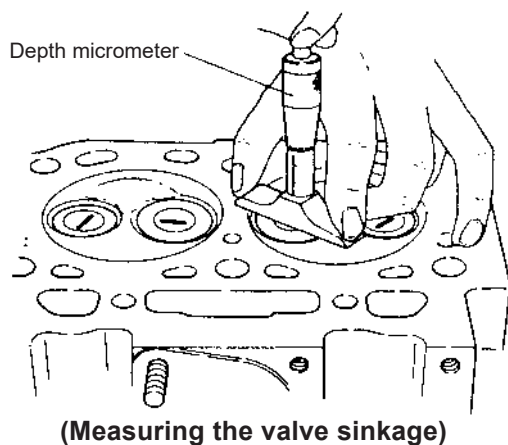
- (3) Visually check if the combustion surface is free from discoloration, cracks, and crazing. In addition, use the color check kit for cracks and crazing.

2) Intake / Exhaust Valve Seat

(1) Valve sinkage

Over long periods of use and repeated lappings, combustion efficiency may drop. Measure the sinking depth and replace the valve and valve seat if the valve sinking depth exceeds the standard value.

		Standard.	Wear limit
Valve sinkage	Intake valve	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Exhaust valve		

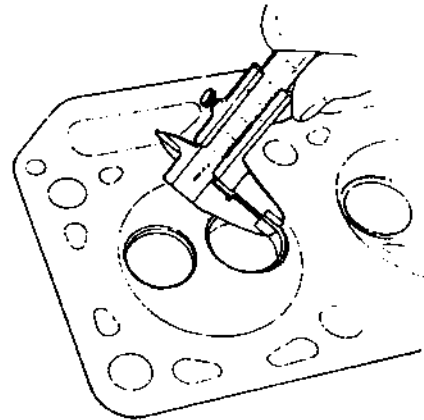


4. ENGINE

(2) Width and angle of the valve seat

Remove carbon deposits from the seat surface. Measure the seat width and angle using vernier calipers and an angle gauge respectively.

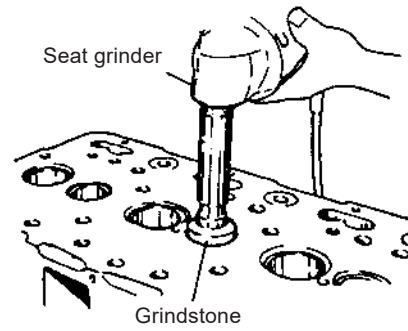
		Standard	Wear limit
Valve seat width	Intake	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Exhaust		
Valve seat angle	Intake		
	Exhaust		



(Measuring the valve seat width)

[Valve seat correction procedure]

- (1) If the seat surface is worn or roughened slightly, lap the seat surface to a smooth state with a valve compound mixed with oil.
- (2) If the seat surface is worn or roughened excessively, correct the seat surface using a seat grinder or a seat cutter, and finish it according to the above step (1).

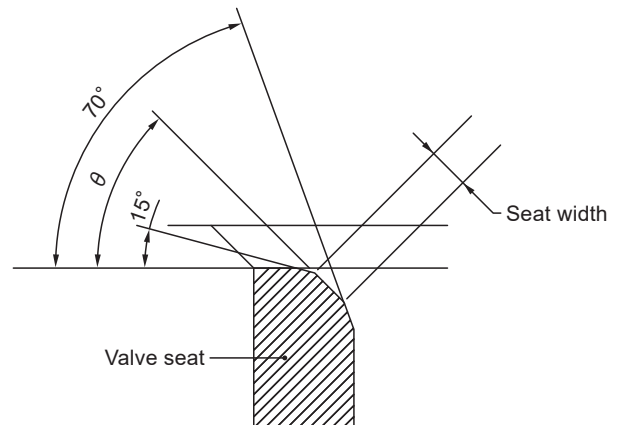


[Procedure for using seat grinder and seat cutter]

- (1) Correct the roughened seat surface with a seat grinder or a seat cutter.

Seat grindstone	Angle θ (degrees)
Intake valve	30
Exhaust valve	45

- (2) When the seat width is enlarged from the initial value, correct it by grinding the seat surface with a 70 degrees seat grinder or a seat cutter. Then, grind the seat surface with a 15 degrees grinder so that the seat width should be the standard value.



(Valve seat correction angle)

Note :

When using a seat cutter, apply pressure evenly taking care not to cut the seat surface unevenly.

- (3) Knead a valve compound with oil and finish the valve seat by lapping with the compound.

Note :

If any valve requires correction, be sure to measure the oil clearance between the valve stem outside dia. and the valve guide inside dia. If the oil clearance exceeds the wear limit, replace the valve or the valve guide before correcting the valve seat surface. (For the oil clearance between the valve and the valve guide, refer to the subsection 3 in this section.)

4. ENGINE

(4) Last, lap the valve using only oil.

Notes :

1. After correcting the valve seat, thoroughly clean the valve and the cylinder head using light oil or the like. Thoroughly remove the valve compound or the grindstone powder.
2. For slightly poor contact, take the steps (3) and (4) only.

3) Intake / Exhaust Valve

(1) Wear and bend of the valve stem

Replace the valve stem if bent or worn excessively. In this case, replace the valve guide together with the valve stem.

(2) Valve stem and valve guide

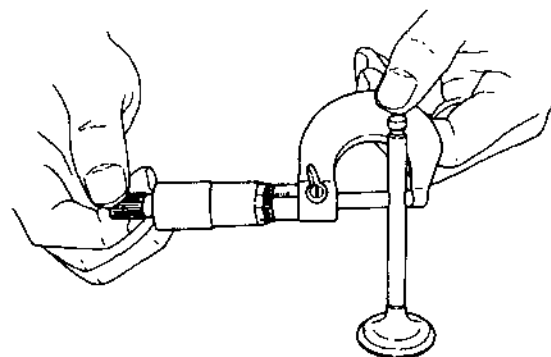
Oil clearance is the difference between the valve guide inside diameter measured with a three-point micrometer or a cylinder gauge and the stem outside diameter measured with a micrometer. If the oil clearance is near the wear limit, replace both the intake / exhaust valve and the valve guide with new ones.

Note :

Three-point micrometer : Used for an inside diameter of 0.157 to 0.315 in. (4 to 8 mm).

Cylinder gauge : Used for an inside diameter of 0.236 in. (6 mm) or more.

		Standard	Wear limit
Intake valve	Stem outside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Guide inside dia.		
	Oil clearance		
Exhaust valve	Stem outside dia.		
	Guide inside dia.		
	Oil clearance		



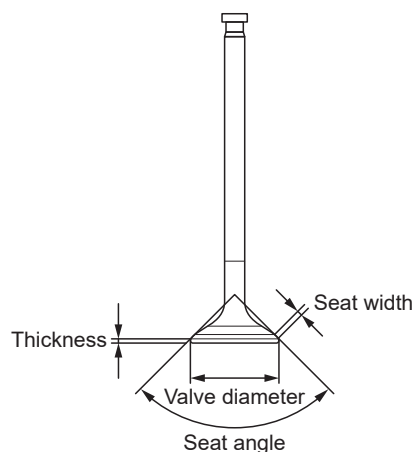
(Measuring the valve stem outside diameter)

(3) Thickness of valve head

Measure the thickness of the valve head with a micrometer.

If the measured value is near the wear limit, replace the valve with a new one.

		Standard	Wear limit
Thickness of valve head	Intake valve	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Exhaust valve		

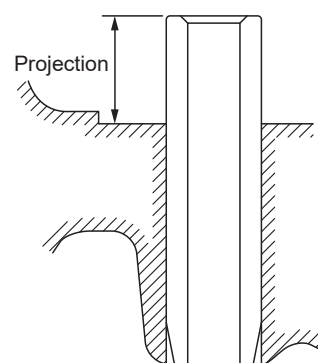
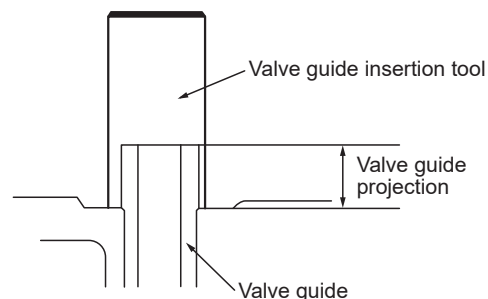


4. ENGINE

[Valve guide replacement procedure]

- (1) Extract the valve guide from the cylinder head using a valve guide extraction tool.
- (2) Put the valve guide into a container containing liquid nitrogen, ether or alcohol together with dry ice. Then, hit the sufficiently cooled valve guide to fit it into the cylinder head using a valve guide insertion tool.
- (3) After inserting the valve guide, finish the inside of the valve guide with a reamer.
- (4) Check the projection of the valve guide.

	Standard	Wear limit
Valve guide projection	Refer to Section "3-2 1) Nominal and Allowable Values".	

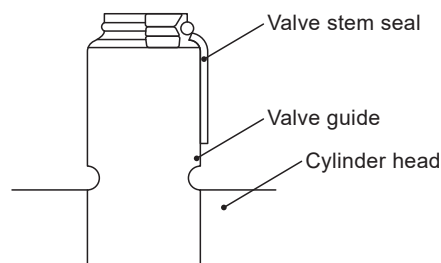


(Valve guide projection)

4) Valve Stem Seal

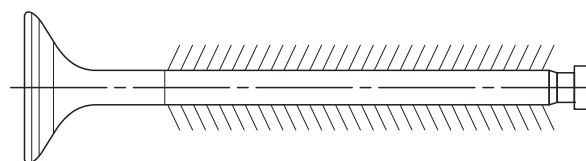
[Time of replacement]

- (1) When oil loss is found excessive.
- (2) When the valve stem seal is removed.
- (3) When the intake / exhaust valve is removed.



[Precautions on installation]

Before reinstalling the intake / exhaust valve, thoroughly remove the burrs on the valve stem surface and then apply sufficient lubricating oil to the valve stem.



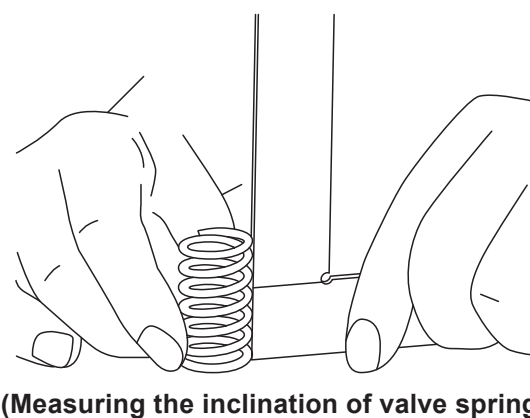
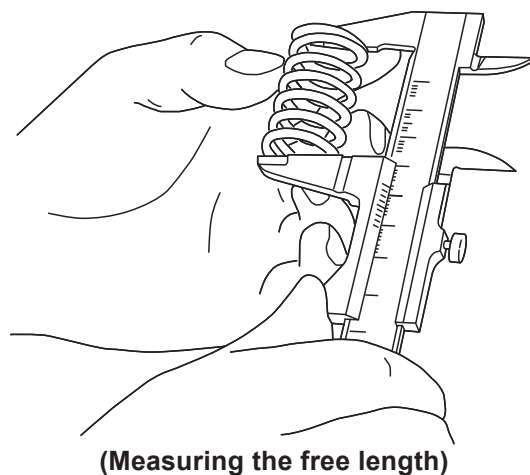
(Hatched portion indicates where to apply lubricating oil.)

4. ENGINE

5) Checking the Valve Spring

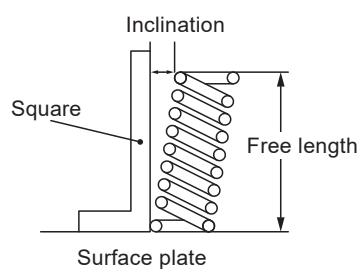
- (1) Visually check if the valve spring is free from flaws and corrosion.
- (2) Measure the free length (length of the spring) and inclination (squareness of the side of the coil).

		Standard	Wear limit
Valve spring	Free length	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Inclination		
	Tension [lbs. (kg)] [0.0394 in. (1 mm) compressed]		



6) Checking Valve Spring Holder and Cotter

Check the contact of the inner surface of the valve spring holder with the outer surface of the cotter as well as the contact of the inner surface of the cotter with the notch in the head of the valve stem. If such contact is uneven or if the cotter has sunk due to wear, replace the cotter with a new one.



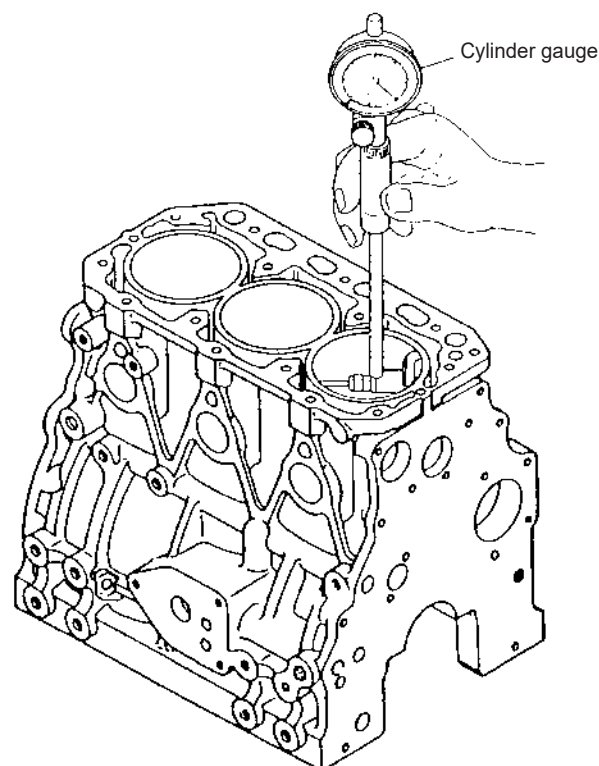
(Measuring the inclination of valve spring)

4. ENGINE

4-3-2 Cylinder Block

1) Checking the Cylinder Block

- (1) Visually check if the cylinder block is free from water leak, oil leak and cracks. If any portion of the cylinder block might be cracked, check the portion by color check.
- (2) Replace the cylinder block if badly damaged and unreparable.
- (3) Thoroughly clean each oil hole. Make sure that it is not clogged.



(Measuring the cylinder bore diameter)

2) Measuring the Cylinder Bore and the Distortion of the Cylinder

Measure each cylinder bore with a cylinder gauge. Measure the cylinder bore diameters at the point a, approx. 0.79 in. (20 mm) below the crest of the liner, and at the points b and c at equal intervals.

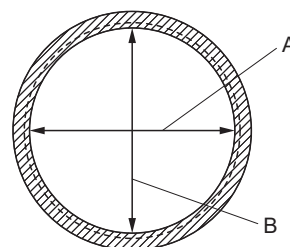
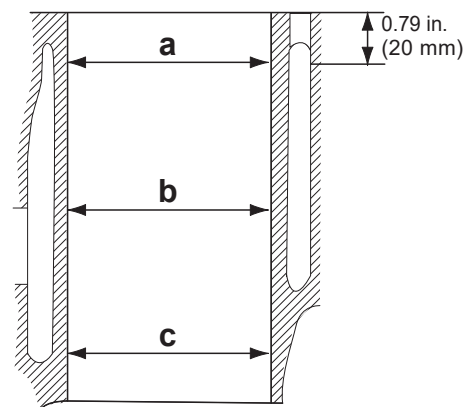
Obtain the distortion of the cylinder (the roundness and cylindricity of each cylinder) from the following measured values :

- Roundness :
Difference between the max. and min. bore values on the same cross section of each liner.
- Cylindricity :
Difference between the max. and min. bore values in the same direction of each liner.

Apply honing (honing and boring) if any measured value exceeds the allowable limit.

Note :

For oversized pistons and piston rings, refer to Section "4-2-4 Piston and Piston Rings".



Note : Measurement should be made at the points a, b and c in the directions of A and B

(Cylinder bore measuring points)

	Standard	Wear limit
Cylinder bore dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
Roundness of cylinder		
Cylindricity of cylinder		

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3) Honing

(1) Application of honing

Apply honing or boring to the cylinder if it is partially worn, flawed, or otherwise damaged. If the partial wear, flaw or other damage is minor, it can be repaired only by honing with a Flex-Hone. However, if it is not minor, apply honing after boring. In this case, taking the maximum wear into consideration, it is important to examine whether the cylinder can attain perfect roundness after honing and / or boring, and whether prepared oversized pistons and piston rings can be used. (For the oversized pistons and piston rings, refer to Section "4-2-4 Piston and Piston Rings".)

(2) Procedure for using the Flex-Hone

It is common practice to use the Flex-Hone for honing. The procedure for using it is described below. Any material needs a honing allowance of approx. 0.00004 in. (1 / 1000 mm) for honing with the Flex-Hone.

[1] Items to be prepared

Flex-Hone, power drill, and honing liquid

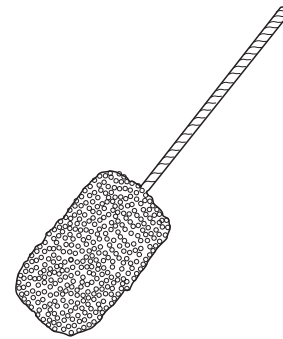
Flex-Hone Yanmar code No.	Applicable bore dia. [in. (mm)]
129400-92420	2.48 to 2.76 (63 to 70)

[2] Handling procedure

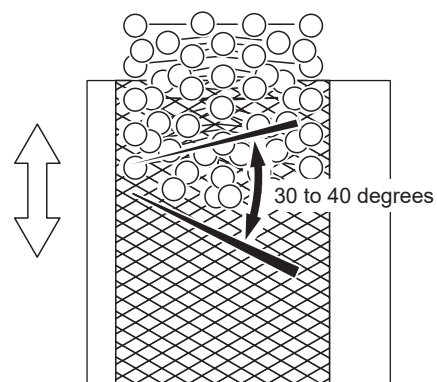
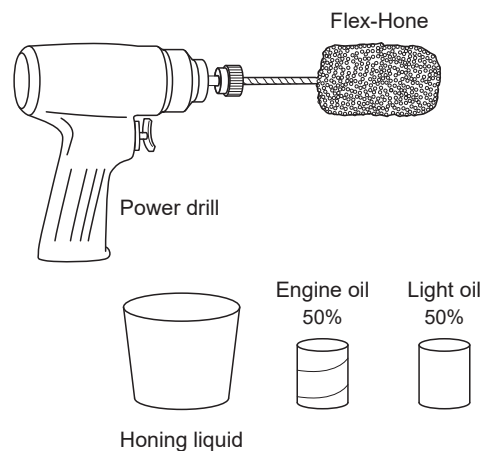
Soak the Flex-Hone in the honing liquid. Insert the Flex-Hone into the cylinder and move it up and down for about 30 seconds while turning it at a cross hatch angle of about 30 to 40 degrees. Then, extract the Flex-Hone while turning it.

Notes :

1. Use the Flex-Hone at a speed of 300 to 1200 rpm. Use of the Flex-Hone at a higher speed may be hazardous.
2. Never insert into or extract from the cylinder the Flex-Hone, with the power drill stopped.

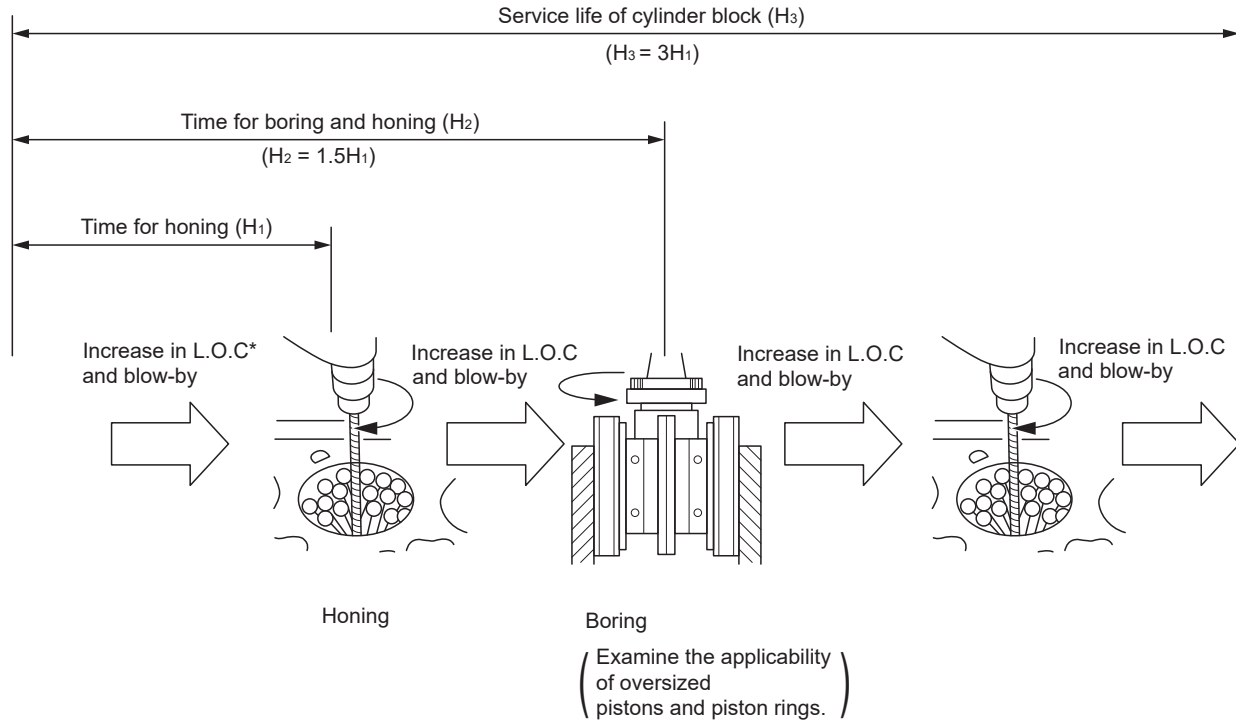


(Flex-Hone)



4. ENGINE

4) Overhaul of Cylinder (Reference)



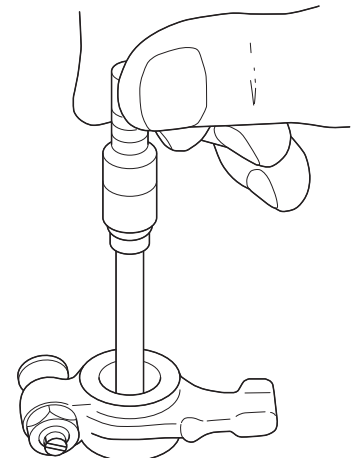
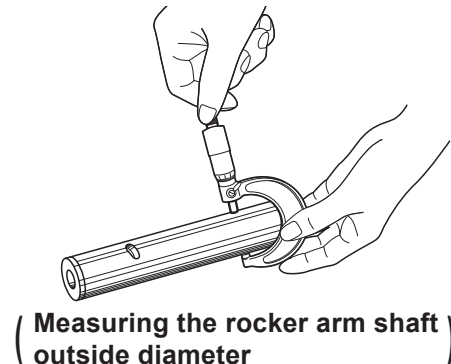
*L.O.C = lubricating oil consumption

4-3-3 Valve Rocker Arm

1) Measuring the Rocker Arm Shaft Outside Diameter and the Rocker Arm Bush Inside Diameter

Oil clearance is the difference between the rocker arm bush inside diameter measured with a cylinder gauge and the rocker arm shaft outside diameter measured with a micrometer. If the oil clearance is near the wear limit, replace the rocker arm shaft and the rocker arm with new ones.

		Standard	Wear limit
Intake / exhaust valve rocker arm	Shaft outside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Bush inside dia.		
	Oil clearance		

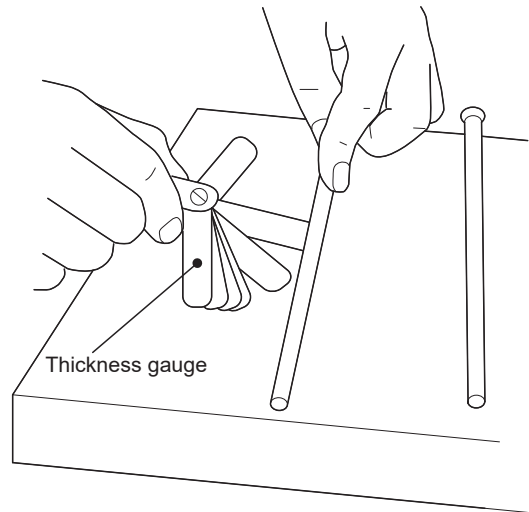


4. ENGINE

2) Checking the Push Rod Bend, Measuring the Tappet Stem Outside Diameter and Checking the Tappet Contact Surface

Put the push rod on the surface plate to check that there is no clearance between the push rod and the surface plate. Measure the tappet stem outside diameter with a micrometer.

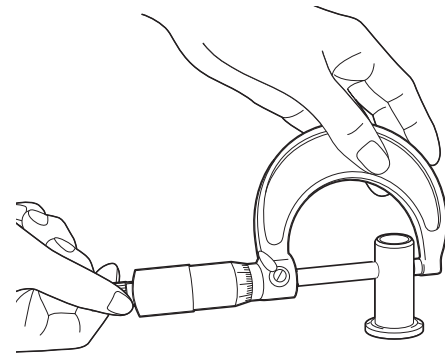
		Standard	Wear limit
Push rod bend		Refer to Section "3-2 1) Nominal and Allowable Values".	
Tappet	Stem outside diameter		
	Guide hole inside diameter		
	Oil clearance		



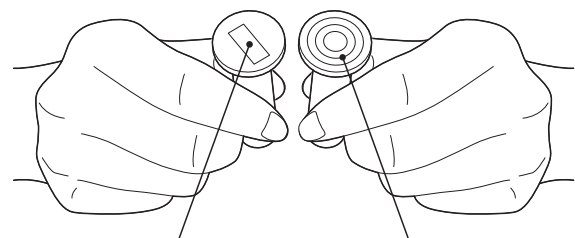
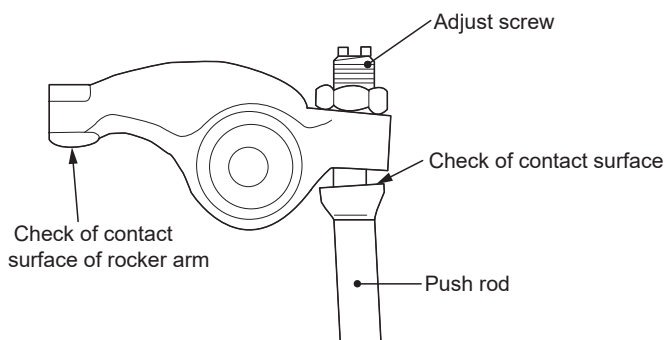
(Measuring the push rod bend)

3) Other Inspections

- (1) Valve rocker arm shaft spring
Check if the rocker arm shaft spring is free from corrosion and wear. If not, replace it with a new one.
- (2) Wear of intake/exhaust valve rocker arm and valve cap
Check the intake / exhaust valve rocker arm for the contact surface with the valve cap. If any of them is excessively worn or partially flaked, replace it.
- (3) Check the portion where the valve clearance adjust screw is in contact with the push rod. If the portion is worn or flaked, replace the push rod or the adjust screw.



(Measuring the tappet stem outside diameter)



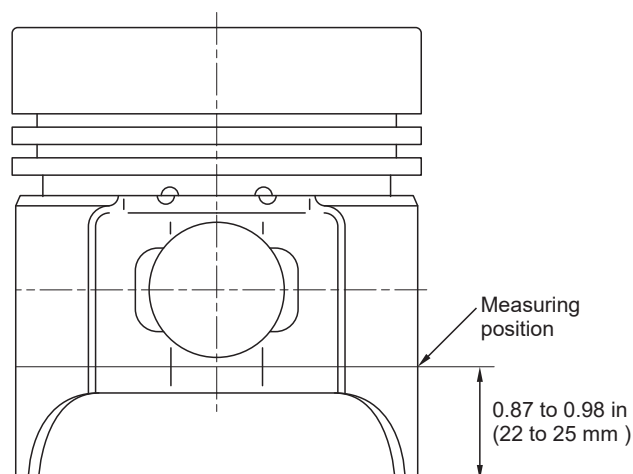
(Checking the tappet contact surface)

4. ENGINE

4-3-4 Piston and Piston Rings

1) Checking the Piston

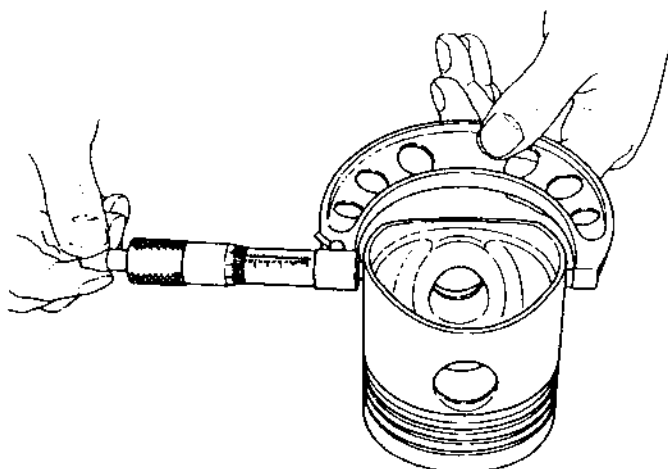
- (1) Remove carbon deposits from the head and combustion surface of the piston while taking care not to damage the piston. Check if there are any cracks or damage.
- (2) Check the outer surface and ring grooves of the piston, and replace it if worn or damaged.



2) Measuring the Piston Outside Diameter

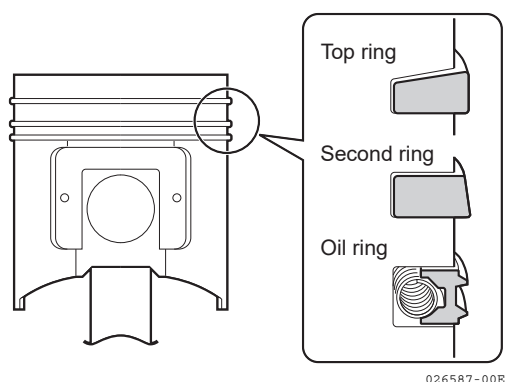
To measure the piston outside diameter, measure the long diameter of the oval hole in the vertical direction to the piston pin bush hole at a position which is 0.87 to 0.98 in. (22 to 25 mm) above from the lower end of the piston.

	Standard	Wear limit
Piston outside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
Minimum clearance between piston and cylinder		



(Measuring the piston outside diameter)

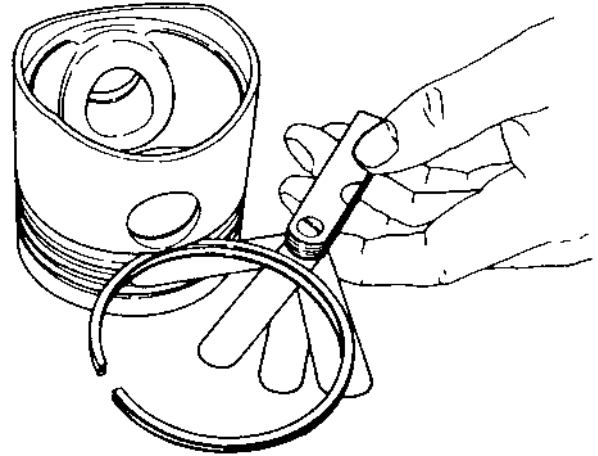
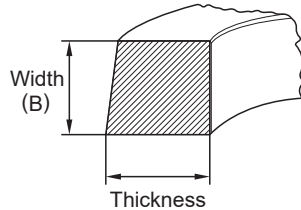
3) Shapes of Piston Rings



4. ENGINE

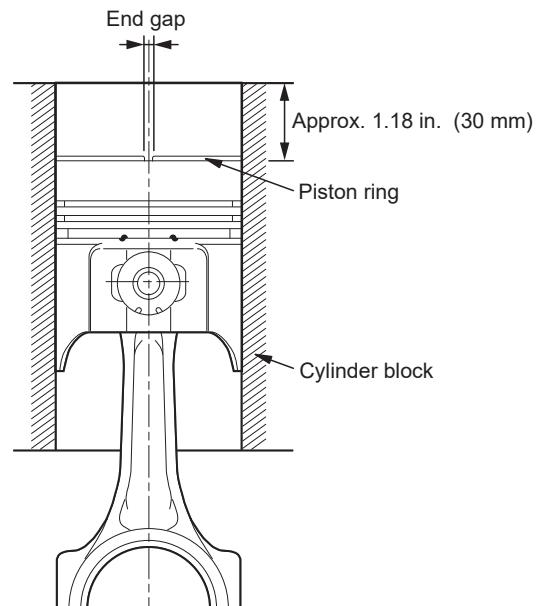
4) Measuring the Ring Groove Width, the Ring Width (B), and the End Gap

To measure the piston ring groove width, first measure the width (B) of the piston ring. Then, fit the piston ring into the ring groove after cleaning the groove carefully. Insert a thickness gauge between the piston ring and the groove to measure the clearance between them. Obtain the ring groove width by adding the ring width to the measured clearance.



(Measuring the ring groove width)

To measure the end gap, push the piston ring into the sleeve using the piston head, insert a thickness gauge between both ends of the piston ring. If the sleeve is worn, measure the end gap after pushing the piston ring into the sleeve to the portion which is less worn (approx. 1.18 in. (30 mm) from the lower end of the sleeve).



(Measuring the end gap)
(of piston ring)

		Standard	Wear limit
Top ring	Ring groove width	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Ring width (B)		
	Clearance between groove and ring		
	End gap		
Second ring	Ring groove width		
	Ring width (B)		
	Clearance between groove and ring		
	End gap		
Oil ring	Ring groove width		
	Ring width (B)		
	Clearance between groove and ring		
	End gap		

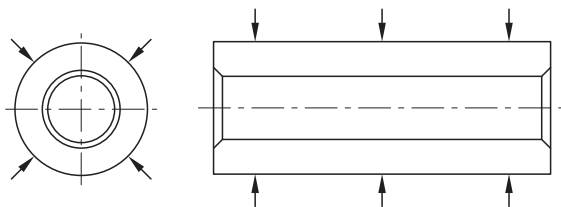
4. ENGINE

5) Installation of Piston Rings

- (1) Using a piston ring replacer, fit the piston ring into the ring groove, with the manufacturer's mark near the end of the piston ring facing upward (to the combustion chamber side). After fitting the piston ring, check that the piston ring moves smoothly. Be sure to place the end gaps of the top rings in the position not at right angle to the piston pin.
- (2) After fitting all the piston rings, shift the end gaps of them at 120 degrees intervals, so that they are not aligned along the piston. Apply lubricating oil to the piston pin before inserting it into the piston.

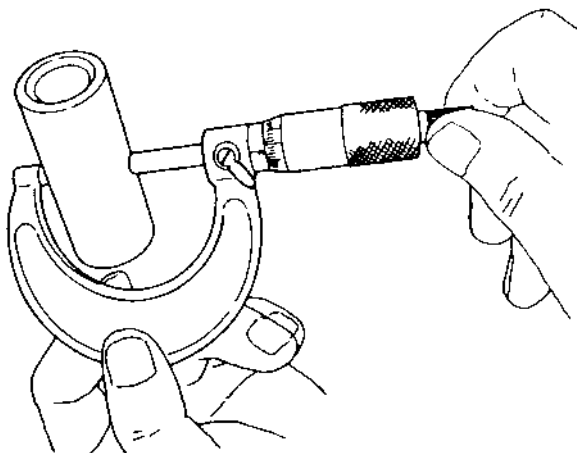
6) Measuring the Outside Diameter and Bush Hole Inside Diameter of the Piston Pin

Measure the outside diameter and bush hole inside diameter of the piston pin. Replace the piston pin if one or both of the measured values exceed the wear limit. Apply lubricating oil to the piston pin before inserting it into the piston.

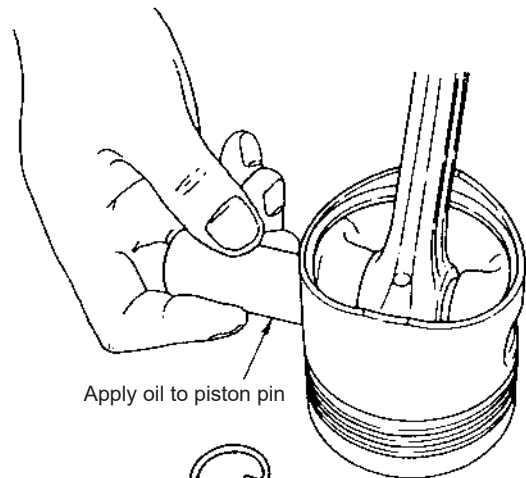
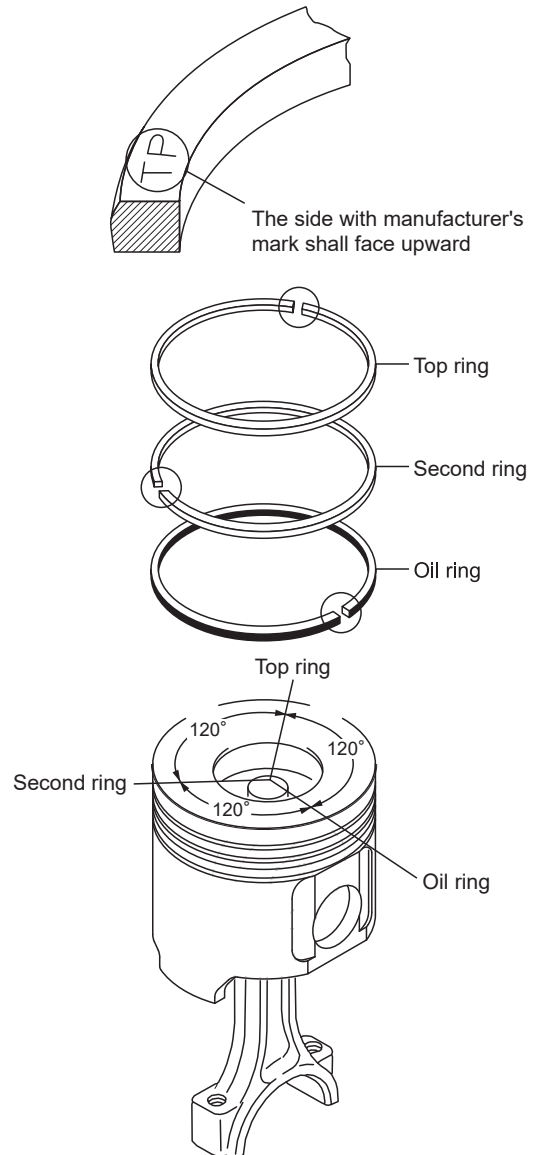


(Measuring points of the piston pin)
outside diameter

		Standard	Wear limit
Piston pin	Outside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Bush hole inside dia.		
	Oil clearance		



(Measuring the piston pin outside diameter)



(Inserting piston pin)

4. ENGINE

7) Top Clearance (Reference)

Top clearance
Refer to Section "3-2 1) Nominal and Allowable Values".

8) Oversized Piston and Piston Ring

(0.250S : Oversized by 0.0098 in. (0.25 mm))

Size classification	Piston assembly code (including piston ring assembly)	Piston ring assembly code
0.250S	Unsetting	119717-22950

4-3-5 Connecting Rod

1) Visual Inspection

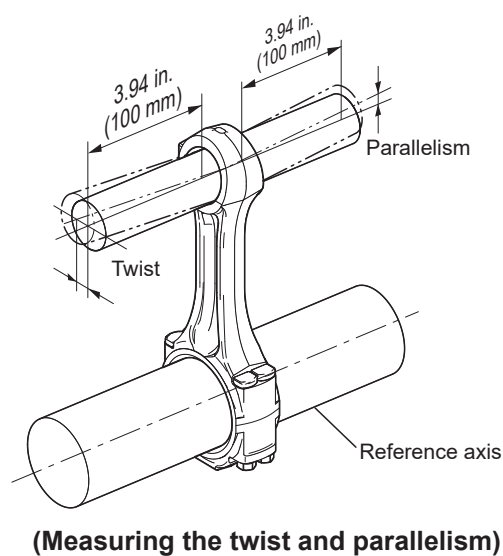
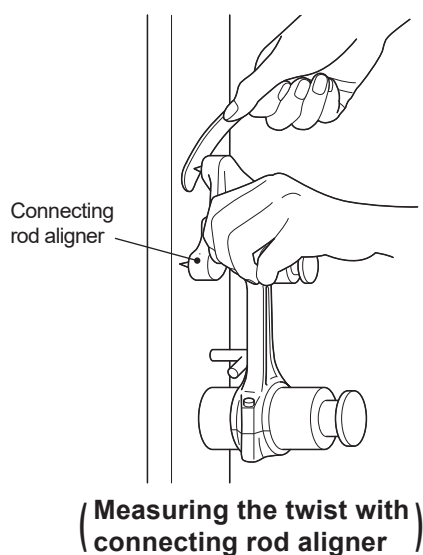
Inspect the following portions for cracks, distortion and discoloration :

- (1) Portions close to the boundaries between the chamfered parts of the large and small ends, and the I-beam section of the connecting rod
- (2) Portion around the oil hole in the bush at the small end

2) Measuring the Twist and Parallelism

Measure the twist and parallelism of the connecting rod with a connecting rod aligner.

Twist and parallelism
Refer to Section "3-2 1) Nominal and Allowable Values".



4. ENGINE

3) Measuring the Clearance Between the Crank Pin and Bush

To measure the oil clearance between the crank pin and the crank pin metal, measure the inside diameter of the crank pin metal and the outside diameter of the crank pin, and calculate the difference between them.

If the measured oil clearance exceeds or near the wear limit, replace the crank pin metal. If the crank pin is excessively or partially worn, grind the crank pin, and use an oversized crank pin metal.

Note :

To measure the inside diameter of the crank pin metal, install the metal into the large end of the connecting rod and tighten the rod bolts at a specified tightening torque, making sure that each half of the metal is set in the correct way.

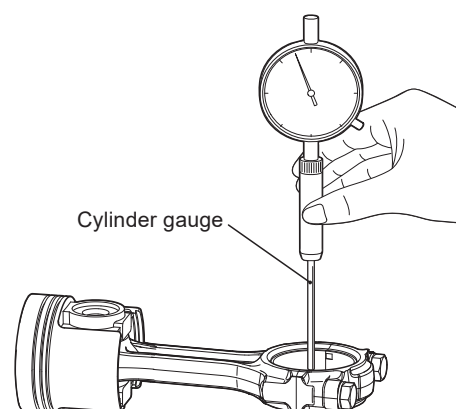
Rod bolt tightening torque (Apply lubricating oil to the rod bolt)	Refer to Section "3-7-2 Engine Tightening torque for major bolts and nuts".
---	---

		Standard	Wear limit
Crank pin side	Crank pin metal inside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Crank pin metal thickness		
	Crank pin outside dia.		
	Oil clearance		

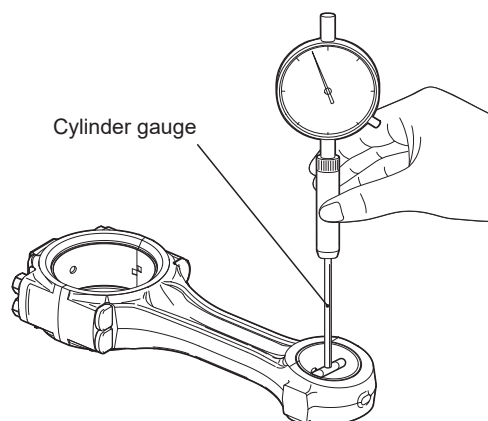
4) Measuring the Oil Clearance Between the Piston Pin Bush and the Piston Pin

To measure the oil clearance between the piston pin bush and the piston pin, measure the inside diameter of the piston pin bush and the outside diameter of the piston pin, and calculate the difference between them.

		Standard	Wear limit
Piston pin side.	Bush inside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Piston pin outside dia		
	Oil clearance		



(Measuring the inside diameter of the crank pin metal)



(Measuring the inside diameter of the piston pin bush)

4. ENGINE

5) Checking the Contact of the Crank Pin Metal

Apply a blue ink or a minium to the inside surface of the crank pin metal. Install the crank pin metal to the crank shaft, and tighten the rod bolts at a specified tightening torque (refer to the above 3 of this section) to check the contact of the metal. If the contacted surface of the metal occupies 75 % or more of the total surface, the crank pin metal is good in terms of contact.

6) Installing the Piston and the Connecting Rod

Install the piston with the connecting rod, with the marks at the large end of the connecting rod facing the fuel injection pump. Also, install the piston so that the recess of the combustion chamber is on the fuel injection pump side as seen from the top.

7) Side Gap of the Connecting Rod

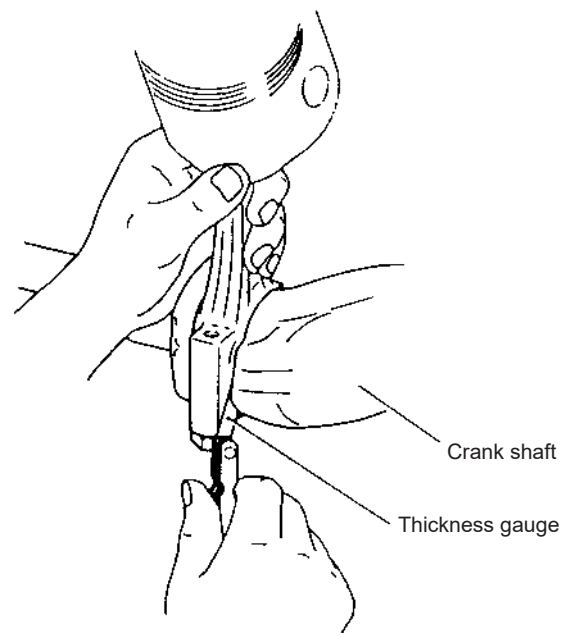
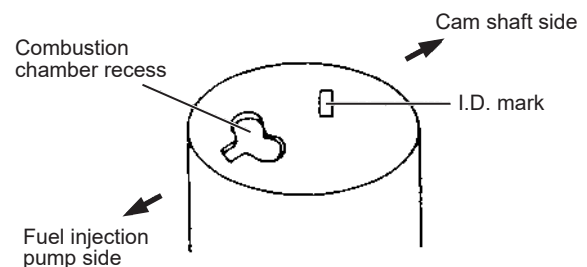
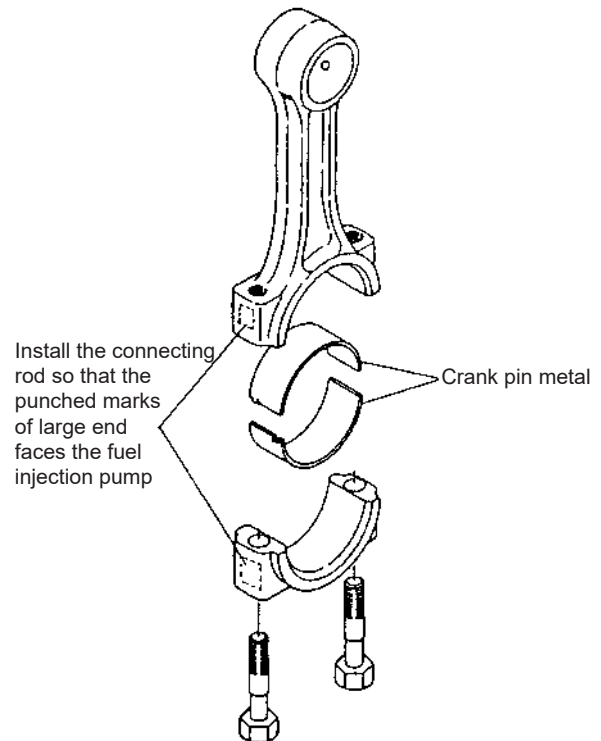
After installing the connecting rod to the crank shaft, tighten the rod bolts at a specified tightening torque (refer to the above 3 of this section). Measure the side gap by inserting a thickness gauge between the connecting rod and the crank arm. If the measured value exceeds the wear limit, replace the crank pin metal or the connecting rod.

Side gap	Refer to Section "3-2 1) Nominal and Allowable Values".
----------	---

8) Undersized Crank Pin Metal

Undersized by 0.0098 in. (0.25 mm)

Part code No.	119717-23610
Machining diameter of crank pin	φ41.702 to 41.712



(Measuring the connecting rod side gap)

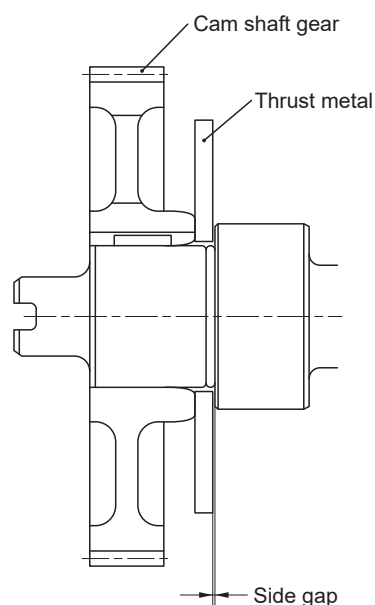
4. ENGINE

4-3-6 Cam shaft

1) Side Gap Around the Cam Shaft

Before extracting the cam shaft, contact a dial gauge with the cam shaft gear to measure the side gap around the cam shaft. If the measured value exceeds the wear limit, replace the thrust metal with a new one.

Side gap	Refer to Section "3-2 1) Nominal and Allowable Values".
----------	---



2) Checking the Cam Shaft Appearance

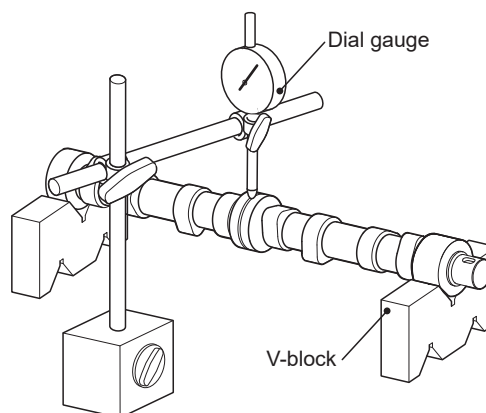
Check the cam shaft for the contact surface of the cam with the tappet, seizure and wear of the bearing, and damage of the cam gear.

3) Measuring the Bend of the Cam Shaft

Support the cam shaft with V-blocks. Using a dial gauge, measure the runout of the journal at the center of the cam shaft while rotating the cam shaft.

Take 50 % of the measured runout as bend.

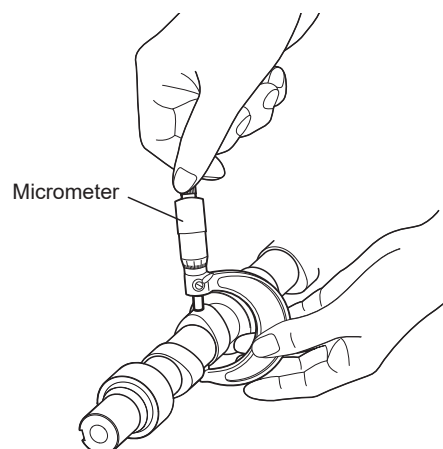
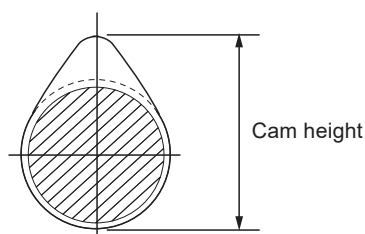
	Standard	Wear limit
Cam shaft bend	Refer to Section "3-2 1) Nominal and Allowable Values".	



(Measuring the cam shaft bend)

4) Measuring the Intake / Exhaust Cam Height

		Standard	Wear limit
Cam height	Intake cam	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Exhaust cam		



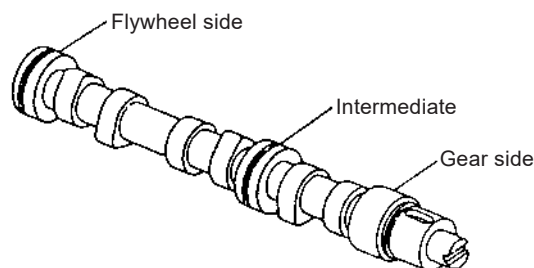
(Measuring the cam height)

4. ENGINE

5) Measuring the Outside Diameters of the Cam Shaft

Measure the outside diameters of the cam shaft with a micrometer. Calculate the oil clearance from the measured cam shaft outside diameter and the cam shaft bush inside diameter measured with a cylinder gauge after inserting the cam shaft bush into the cylinder block.

		Standard	Wear limit
Gear side	Cam shaft outside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Oil clearance		
Intermediate	Cam shaft outside dia.		
	Oil clearance		
Fly-wheel side	Cam shaft outside dia.		
	Oil clearance		



6) Extracting the Cam Shaft Bush

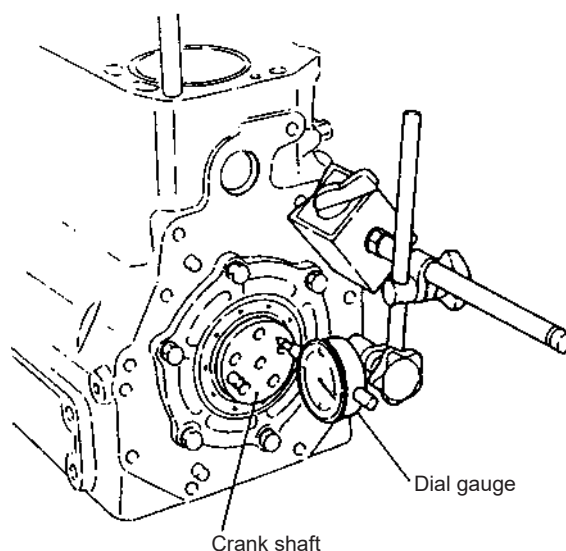
Extract the bush with a cam shaft bush tool.

4-3-7 Crank shaft

1) Side Gap Around the Crank Shaft

Before extracting the crank shaft and when installing it, contact a dial gauge with the end of the crank shaft. Press the crank shaft to each of the right and left sides in the axial direction to measure the side gap. Alternatively, insert a thickness gauge directly into the clearance between the thrust metal in the reference part and the thrust face of crank shaft to measure the side gap. If the measured value exceeds the wear limit, replace the thrust metal with a new one.

Side gap	Refer to Section "3-2 1) Nominal and Allowable Values".
----------	---



4. ENGINE

2) Color Check of Crank Shaft

Clean the crank shaft and check it using a color check kit or a magnetic inspector. Replace the crank shaft if it is cracked or badly damaged. If the damage is minor, correct it by re-grinding.

3) Checking the Metals

Check the metals for flaking, melting, seizure, and the state of the contact spur face. Replace any of the metals if it is damaged.

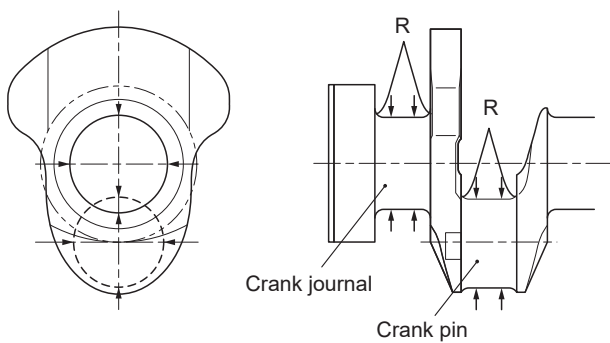
4) Bend of the Crank Shaft

Support the journals of the crank shaft with V-blocks at both ends. Measure the runout at the center journal with a dial gauge while rotating the crank shaft to check the bend of the crank shaft.

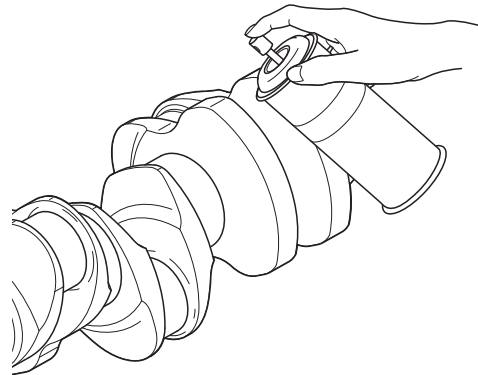
Bend	Refer to Section "3-2 1) Nominal and Allowable Values".
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5) Measuring the of Crank Pin and Journal

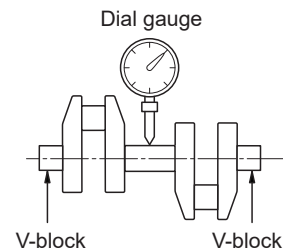
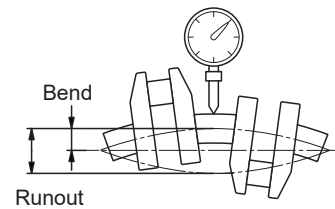
Measure the outside diameters, roundness, taper angles of the crank pin and journal. If the partial wear or the roundness exceeds the wear limit but the measured outside diameter is within the limit, correct it by regrinding. Replace the crank shaft with a new one, if it is unreparable. An under sized crank pin metal by 0.0098 in. (0.25 mm) is available. (Refer to Section 4-2-5, 4-2-8 in this chapter.)



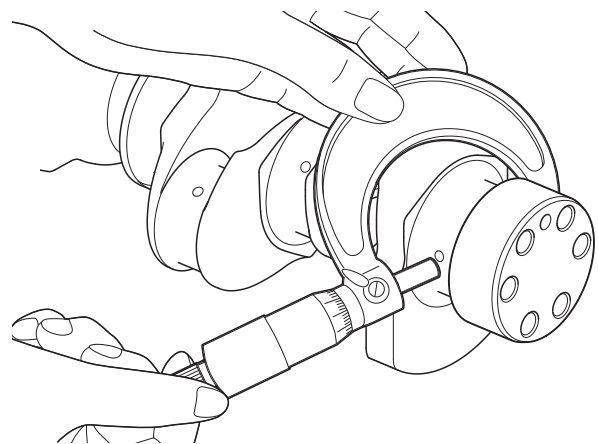
(Measuring points of the crank pin and journal)



(Inspection by color check)



(Measuring the crank shaft bend)

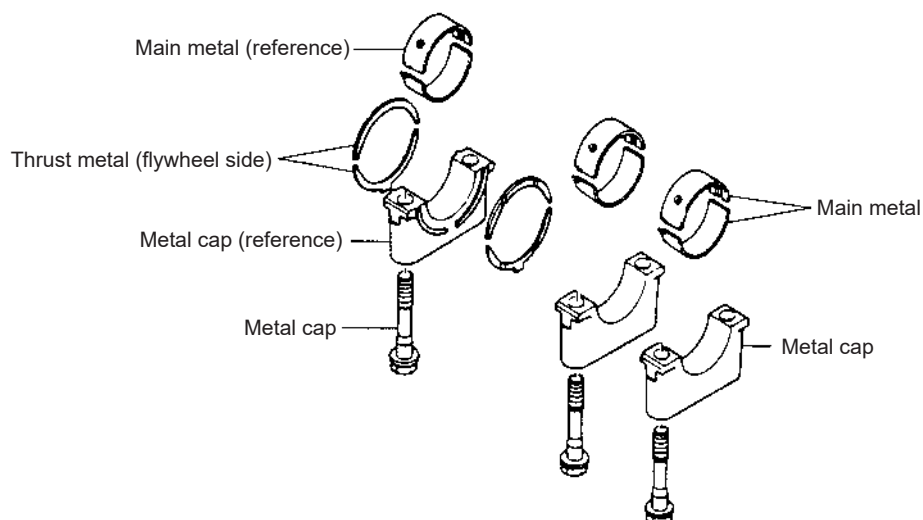


4. ENGINE

		Standard	Wear limit
Crank pin	Crank pin outside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
Crank journal	Outside dia.		
	Main metal thickness		
	Oil clearance		

6) Precautions for Installation of the Metal Caps

- (1) The lower half of the metal on the cap side has no oil groove.
- (2) The upper half of the metal on the cylinder block side has an oil groove.
- (3) Check the cylinder block alignment No.
- (4) Place the arrow mark of the cap on the flywheel side.
- (5) Place the main metal as a reference one on the flywheel side.



7) Undersized Main Metal by 0.0098 in. (0.25 mm) and Oversized Thrust Metal by 0.0098 in. (0.25 mm)

		Parts code No.
Main metal	Under size	719717-02911
Thrust metal	Over size	119810-02941

4. ENGINE

4-3-8 Gears

1) Checking the Gears

Check the teeth surfaces of each gear and replace the gear if the teeth are damaged, worn, or flaked.

2) Measuring the Backlashes

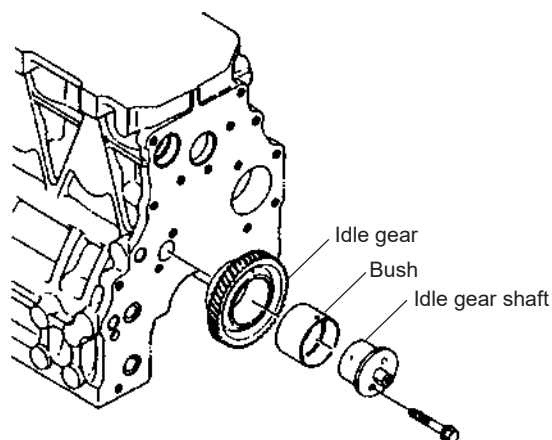
Apply a dial gauge onto the pitch circle of the gear, and measure the backlash.

		Standard	Wear limit
Backlash	Crank gear, cam gear, idle gear and fuel injection pump drive gear	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Lubricating oil pump gear		

3) Checking and Measuring the Idle Gear Shaft and the Idle Gear

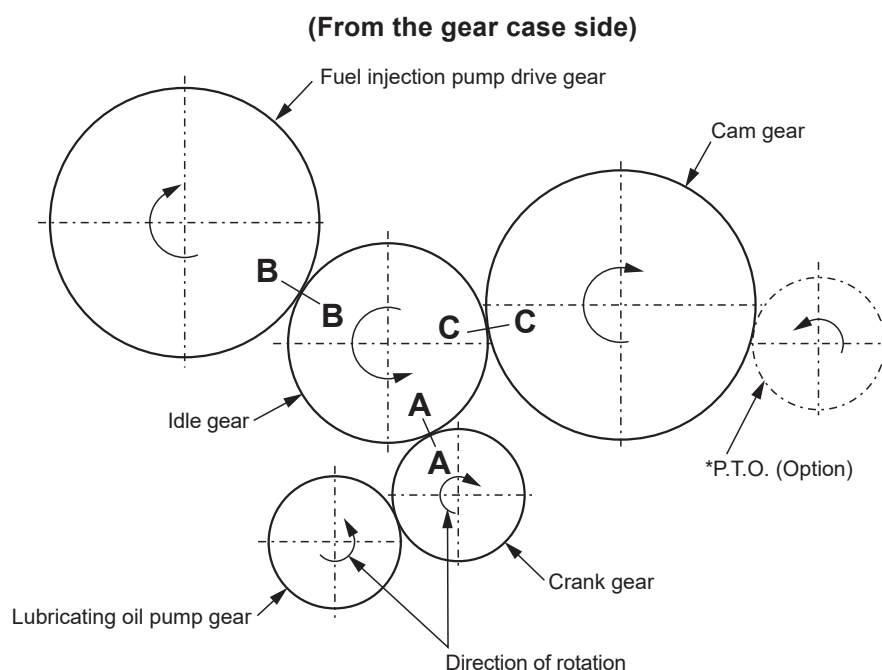
- Measure the idle gear bush inside diameter and the idle gear shaft outside diameter, and replace the bush or the idle gear shaft if the oil clearance exceeds the wear limit.
- Check that the oil holes in the idle gear shaft and the bush are aligned.

		Standard	Wear limit
Idle gear	Shaft outside dia.	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Bush inside dia.		
	Oil clearance		



4) Gear Train

After installing all the gears, check that the matchmarks A, B and C on the idle gear are aligned with those on the crank gear the fuel injection pump drive gear and the cam gear respectively.



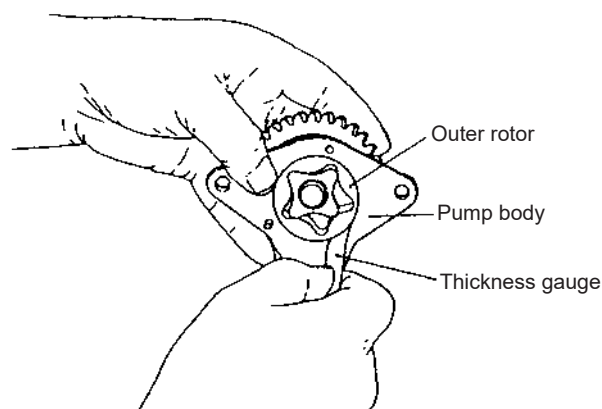
4. ENGINE

4-3-9 Trochoid Pump

1) Clearance Between Outer Rotor and Pump Body

Insert a thickness gauge between the outer rotor and the pump body to measure the clearance.

	Standard	Wear limit
Clearance between outer rotor and pump body	Refer to Section "3-2 1) Nominal and Allowable Values".	

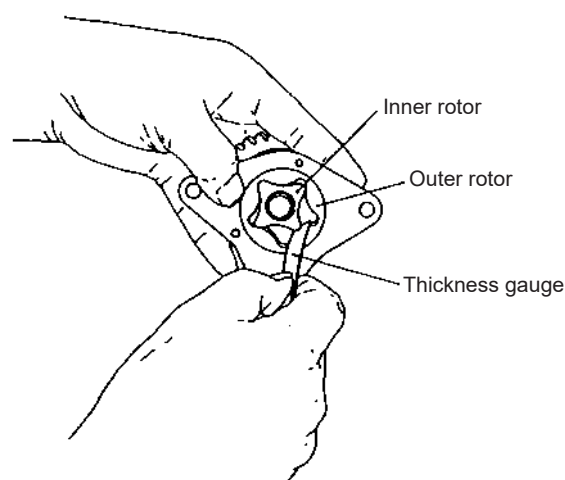


(Measuring the clearance between outer rotor and pump body)

2) Clearance Between Outer Rotor and Inner Rotor

Insert a thickness gauge between the top of the inner rotor tooth and the top of the outer rotor tooth to measure the clearance.

	Standard	Wear limit
Clearance between outer rotor and inner rotor	Refer to Section "3-2 1) Nominal and Allowable Values".	

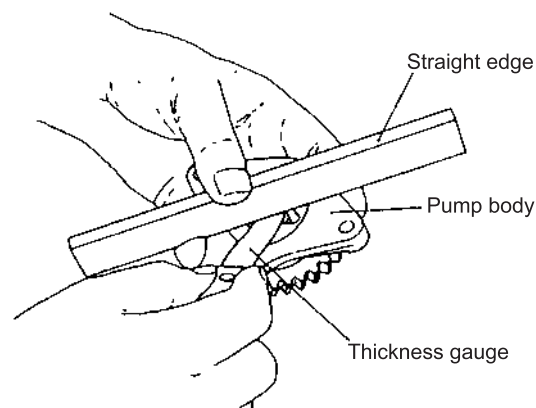


(Measuring the clearance between outer rotor and inner rotor)

3) Distortion Between Pump Body and Inner Rotor, Outer Rotor

Place a straight edge on the end face of the pump body and insert a thickness gauge between the straight edge and the rotors to measure the distortion.

	Standard	Wear limit
Distortion between the pump body and the inner and outer rotors	Refer to Section "3-2 1) Nominal and Allowable Values".	



(Measuring the distortion between pump body and inner and outer rotors)

4) Clearance Between Rotor Shaft and Side Cover Shaft Hole

Measure the rotor shaft outside diameter and the side cover shaft hole diameter, and calculate the difference between the hole diameter and the outside diameter.

	Standard	Wear limit
Clearance between rotor shaft and side cover shaft hole	Refer to Section "3-2 1) Nominal and Allowable Values".	

5) Others

- (1) Check for looseness of the engagement of the drive gear and the rotor shaft, and replace the entire assembly if there is looseness or play.
- (2) Push the oil pressure regulating valve piston from the drill hole side to check if the piston returns normally. Replace the entire assembly if the piston does not return due to the broken spring or any other trouble.
- (3) Check that the rotor shaft rotates smoothly when the drive gear is rotated.

4. ENGINE

4-4 Precautions for Reassembly

Reassemble the engine components in the reverse order of the disassembly procedure. Follow the precautions below particularly before and during the reassembly.

1) Cleaning the Components

Clean the cylinder block, the cylinder head, the crank shaft, and the cam shaft carefully so that they are free from chips, dust, sand, and other foreign matter.

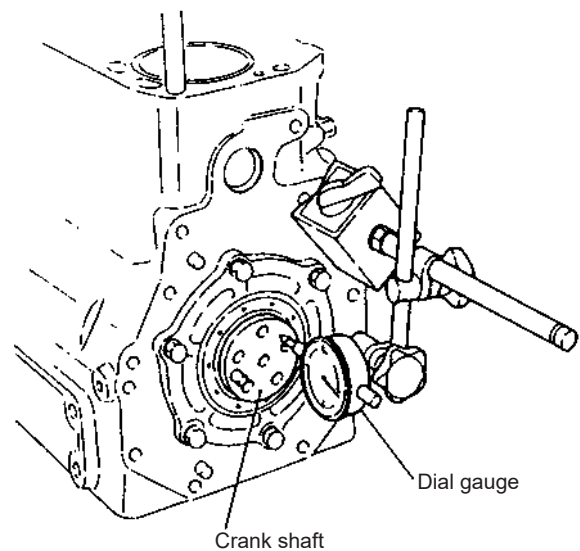
2) Parts to be Replaced in Reassembly

Be sure to replace the following parts with new ones in reassembly.

- (1) Valve stem seal
- (2) Head gasket packing
- (3) Nozzle protector of the fuel injection valve
- (4) All of the copper packings, O-rings and gasket packings.

3) Measuring the Side Gap Around the Crank Shaft

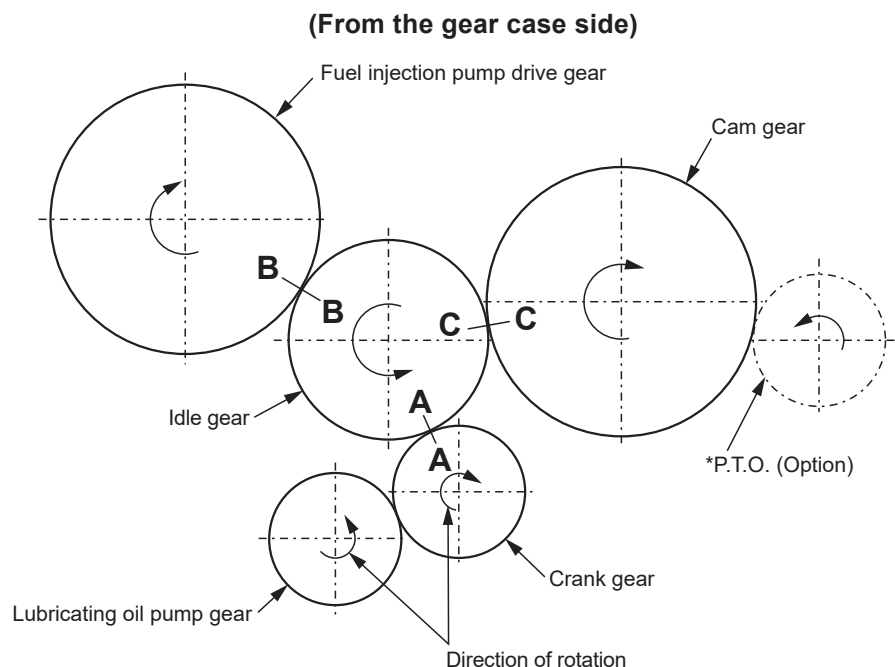
Apply a dial gauge to the end of the crank shaft. Press the crank shaft to each of the right and left sides in the axial direction to measure the side gap. Alternatively, insert a thickness gauge directly into the clearance between the reference thrust metal and the thrust surface of the crank shaft to measure the side gap. If the measured value exceeds the wear limit, replace the thrust metal with a new one.



Side gap	Refer to Section "3-2 1) Nominal and Allowable Values".
----------	---

4) Gear Train

After installing all the gears, check that the match marks A, B and C on the idle gear are aligned with those on the crank gear, the fuel injection pump drive gear and camshaft gear respectively, as shown below.



4. ENGINE

5) Where to Use Liquid Packing

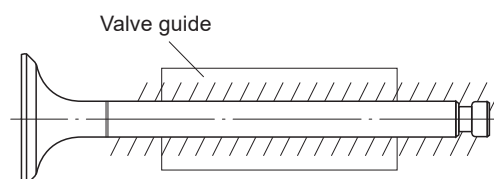
- (1) Between the cylinder block and the gear case flange
- (2) Between the gear case flange and the gear case cover
- (3) Oil pan mounting surface

Notes :

1. Use Three Bond No. 1212 (Yanmar part code : 97777-01212) as the liquid packing.
2. Apply the liquid packing so that there should no break halfway. Otherwise, oil leakage or other trouble may be caused.

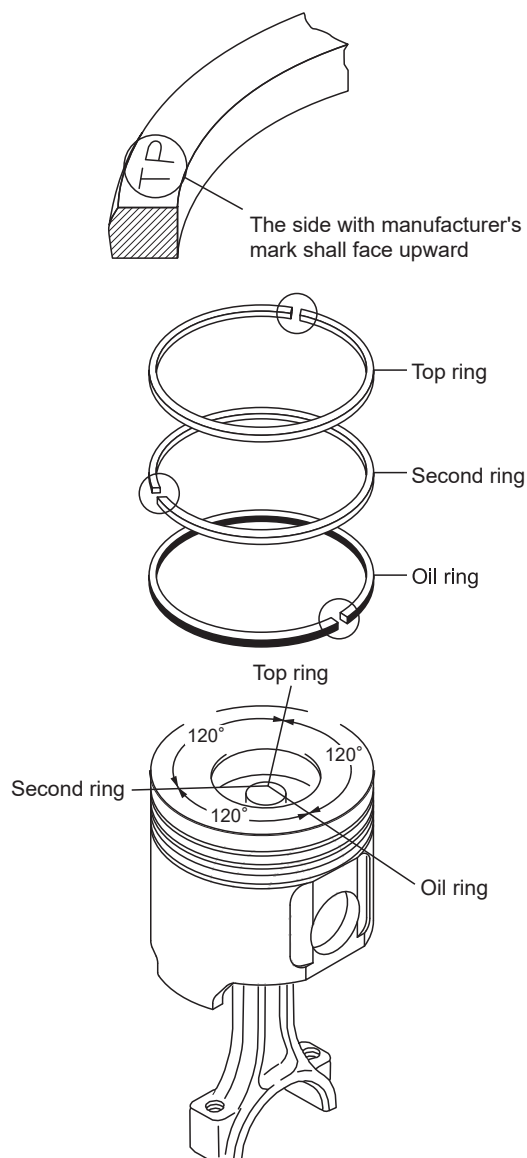
6) Applying Lubricating Oil to the Intake / Exhaust Valve Stem

Apply lubricating oil to the valve stem so that the oil spreads over the lower surface (hatched portion in the figure) of the valve guide, before reinstalling the valve stem.



7) Reinstalling the Piston Rings

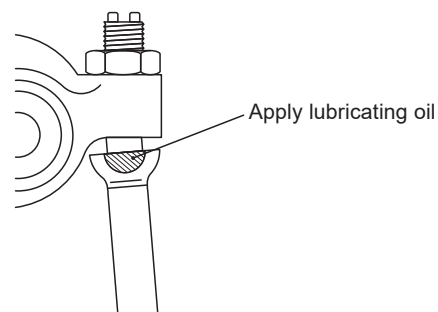
- (1) Fit the piston ring into the ring groove, with the manufacturer's mark near the end of the piston ring facing upward (to the combustion chamber side), using a piston ring replacer. After fitting the piston ring, check that it moves smoothly.
- (2) Install the piston their end gaps rings into their respective ring grooves so that their end gaps are shifted at 120 degrees intervals, making sure that they are not aligned along the piston. Be sure to place the end gaps of the top rings in the position not at right angle to the piston pin. Apply lubricating oil to the outside surface of the piston.



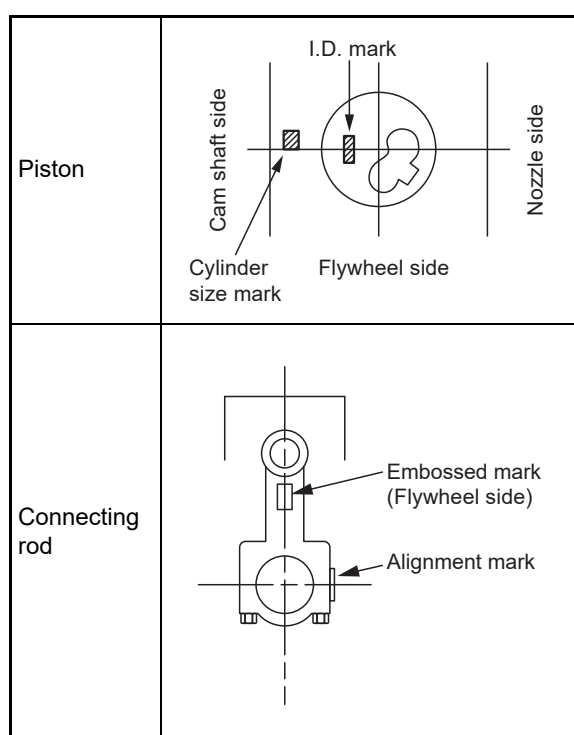
4. ENGINE

8) Applying Lubricating Oil to the Push Rod Adjust Screw Contact Portion

Apply lubricating oil to the hatched portion of the push rod as shown in the figure, before reassembly.

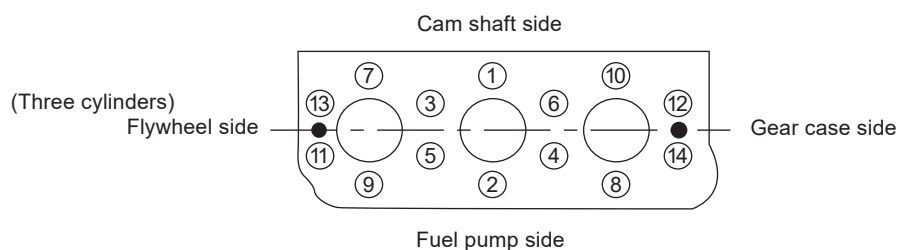


9) Installation Direction of the Piston and the Connecting Rod



10) Tightening Order and Tightening Torque of the Cylinder Head Bolts

Tighten the cylinder head bolts at a specified tightening torque in the numerical order as shown below.



Tightening torque	Refer to Section "3-7-2 Engine Tightening torque for major bolts and nuts".
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11) After Completing the Reassembly, Carry Out a Verification Run of the Engine to Check That There is No Water or Oil Leakage.

4. ENGINE

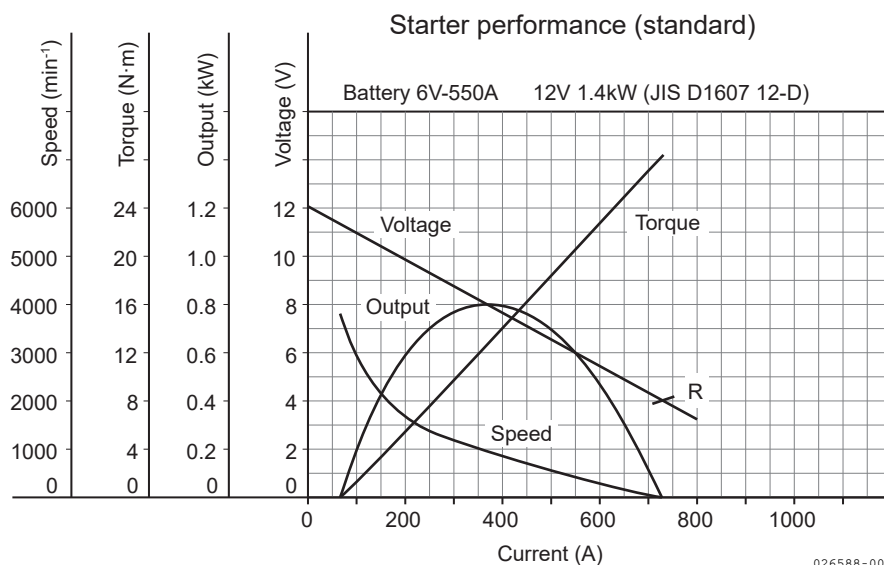
4-5 Electrical Equipment

4-5-1 Starter Motor

To start the engine, the starter motor rotates the ring gear installed on the engine flywheel with the pinion gear engaged with the ring gear so that the force generated by the rotation exceeds the resistance including the engine compression pressure and all frictional force. The starter motor consists of the following major parts : a motor which generates torque ; a pinion which transmits the torque to the engine ring gear ; a clutch ; and a magnetic switch which pushes out the pinion and turns on and off the principal current.

1) Specifications

Yanmar code			119540-77010
Applicable model			3TNV70-XBV
Starter motor model			RA1.4
Nominal output / Weight		kW / lbs. (kg)	1.4 / 8.4 (3.8)
Rotation direction (Viewed from pinion side)			Clockwise
Engagement method			Magnetic shift
No load	Terminal voltage / Current	V / A	11 / ≤ 90
	Speed	rpm	≥ 3000
Load characteristics	Terminal voltage / Current	V / A	2.4 / ≤ 500
	Torque	ft•lbf (N•m)	8.9 (12)
Clutch type			Over running
Pinion coming out voltage		V	≤ 8
Pinion DP or module / Number of pinion teeth			M2.54 / 15



4. ENGINE

4-5-2 Alternator

The alternator is a revolving-field type three-phase AC generator. The AC electricity generated by the alternator is converted to DC through the full-wave rectification by the diode and is stored in the battery.

Specification

Yanmar code		119910-77200
Applicable model		3TNV70-XBV
Alternator model		GP9191
Nominal output	A	20
Weight	lb(kg)	3.97(1.8)
Revolution direction (Viewed from pulley)		Clockwise
Rating		Continuous
Battery voltage	V	12
Rated speed	rpm	3500
Operating speed	rpm	1400 to 6600
Ground polarity		Negative
Regulator		Current limiter (Part code: 119653-77710)
Outside diameter of pulley	in. (mm)	A-Belt: 2.56 (65) Special M-Belt: 2.28 (58)
Belt shape		Type A or Type Special M

Regulator specifications

Yanmar code of current limiter Adjusted voltage (V)	119653-77710 14 to 15
Yanmar code of safety relay	119247-77100

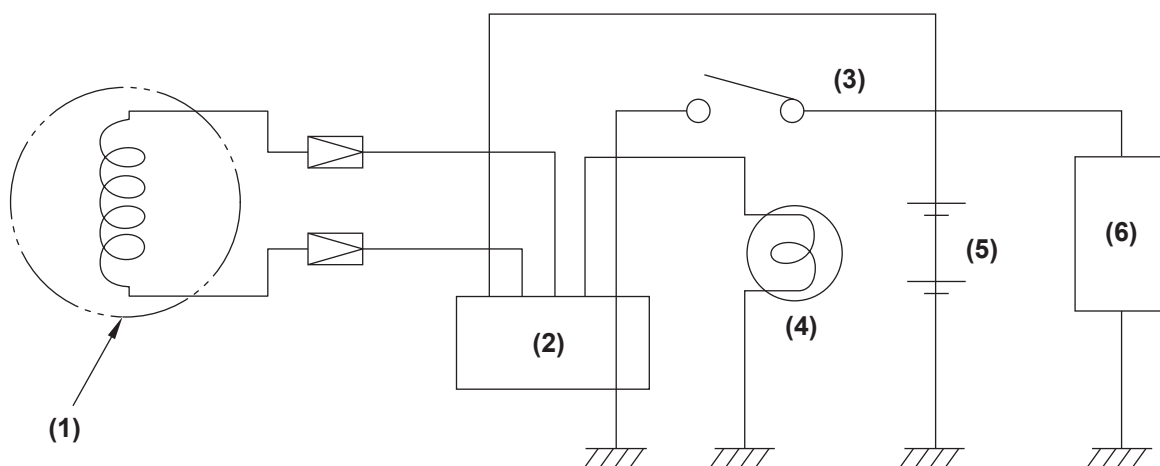


Figure 11-21

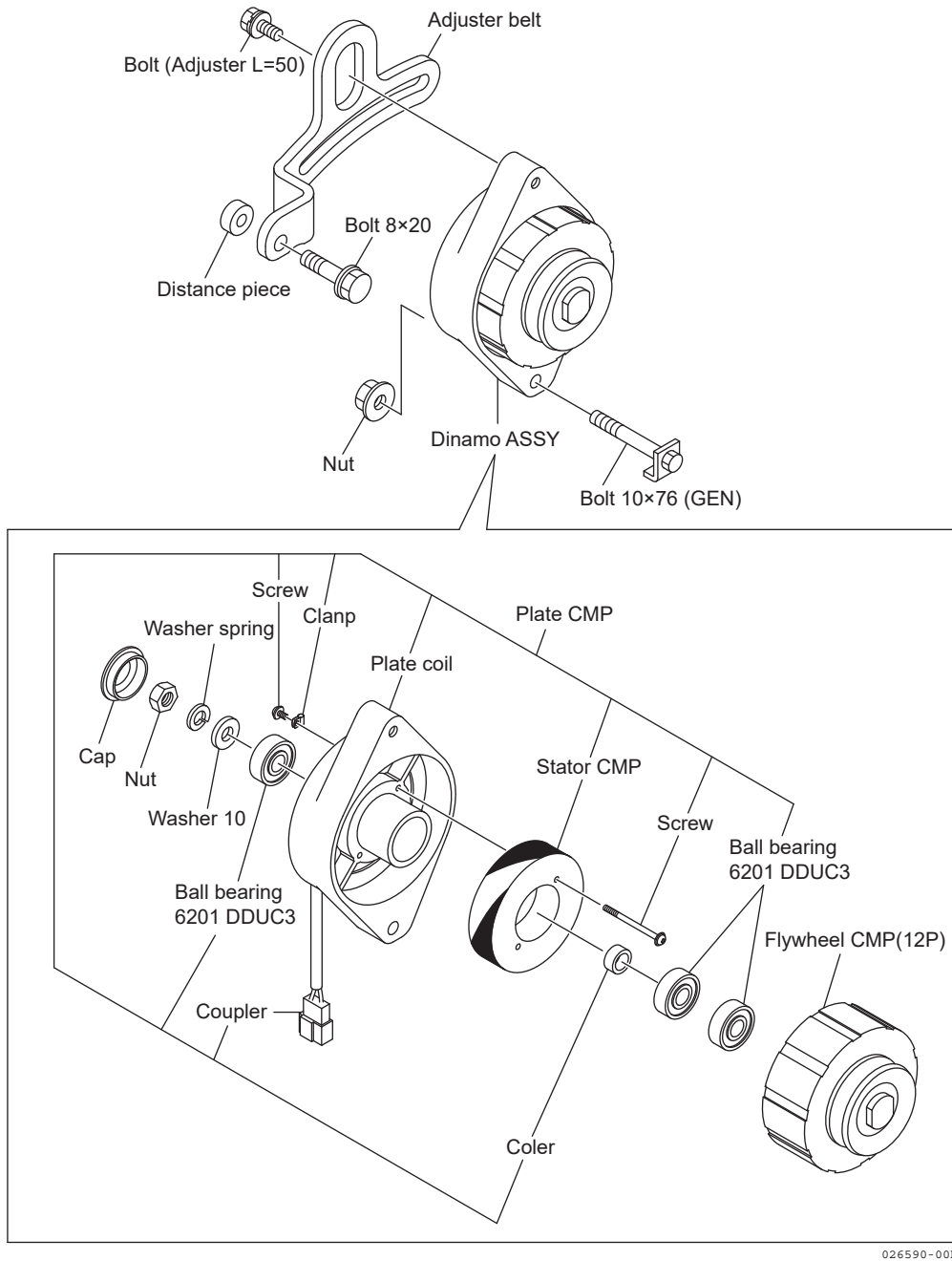
- 1 - Dynamo
- 2 - Current Limiter Assembly
- 3 - Key Switch

- 4 - Charge Lamp
- 5 - Battery
- 6 - Load

026589-00B

4. ENGINE

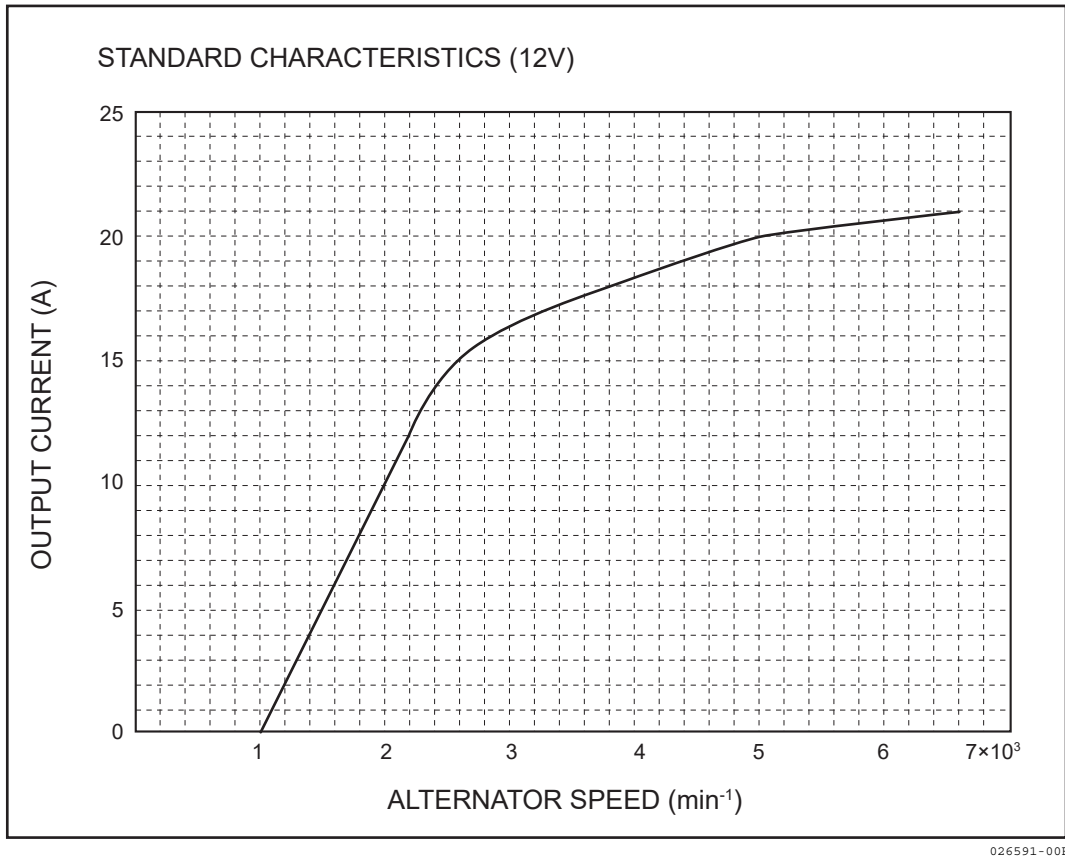
Components



026590-00B

4. ENGINE

Standard output



CHAPTER 5

ELECTRIC SYSTEM

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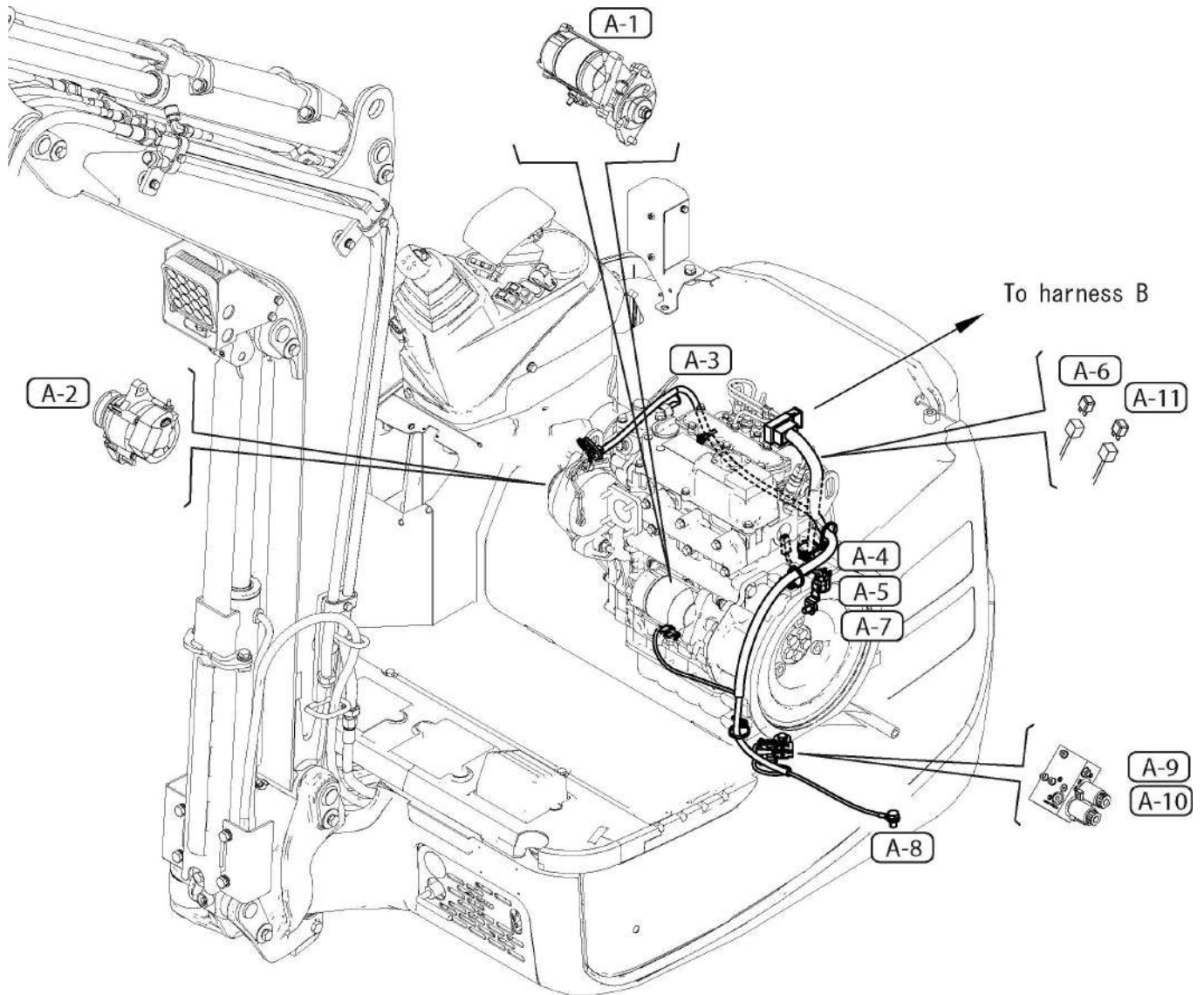
5. ELECTRIC SYSTEM

5. Electric System

5-1 Electric Equipment of Machine

5-1-1 Parts Layout of Electrical Equipment

1) Harness A

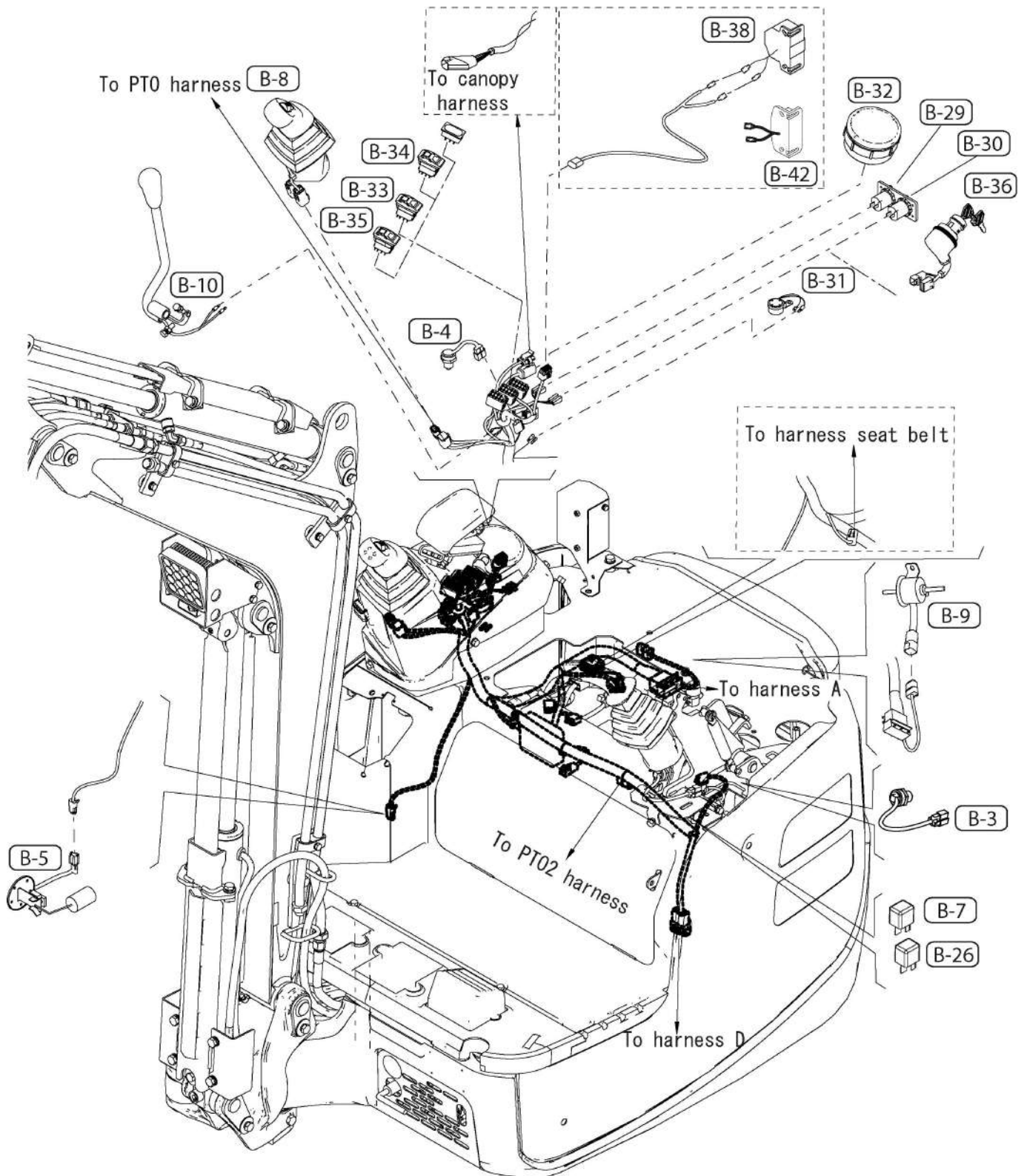


5. ELECTRIC SYSTEM

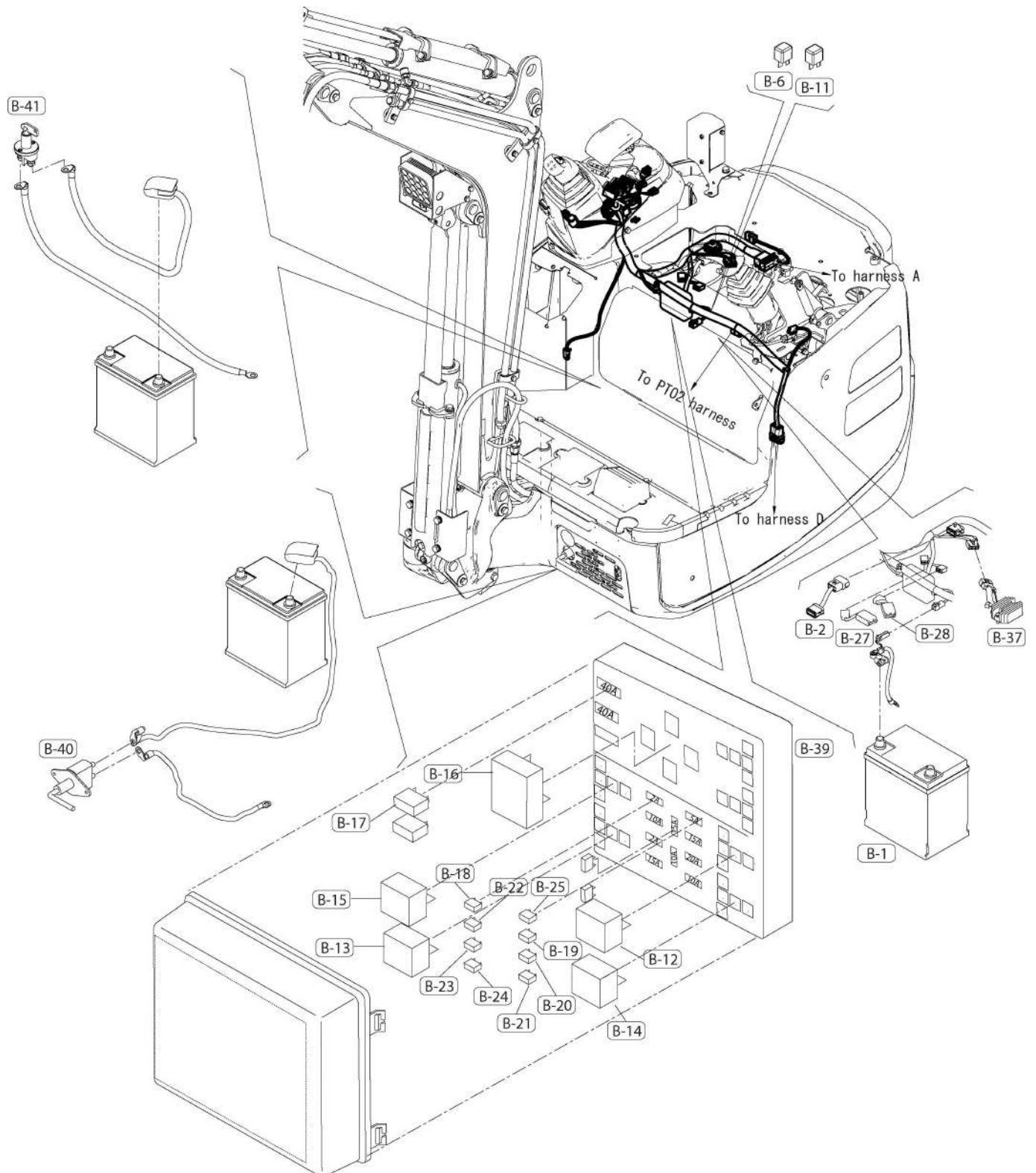
Ref. No.	Part	Ref. No.	Part
A1	Starter motor	A7	Switch oil pressure
A2	Dynamo	A8	Ground
A3	Switch water temp	A9	Valve cut off
A4	Plug glow	A10	Valve 2nd speed
A5	Stop solenoid	A11	Diode buzzer
A6	Diode hold		

5. ELECTRIC SYSTEM

2) Harness B



5. ELECTRIC SYSTEM

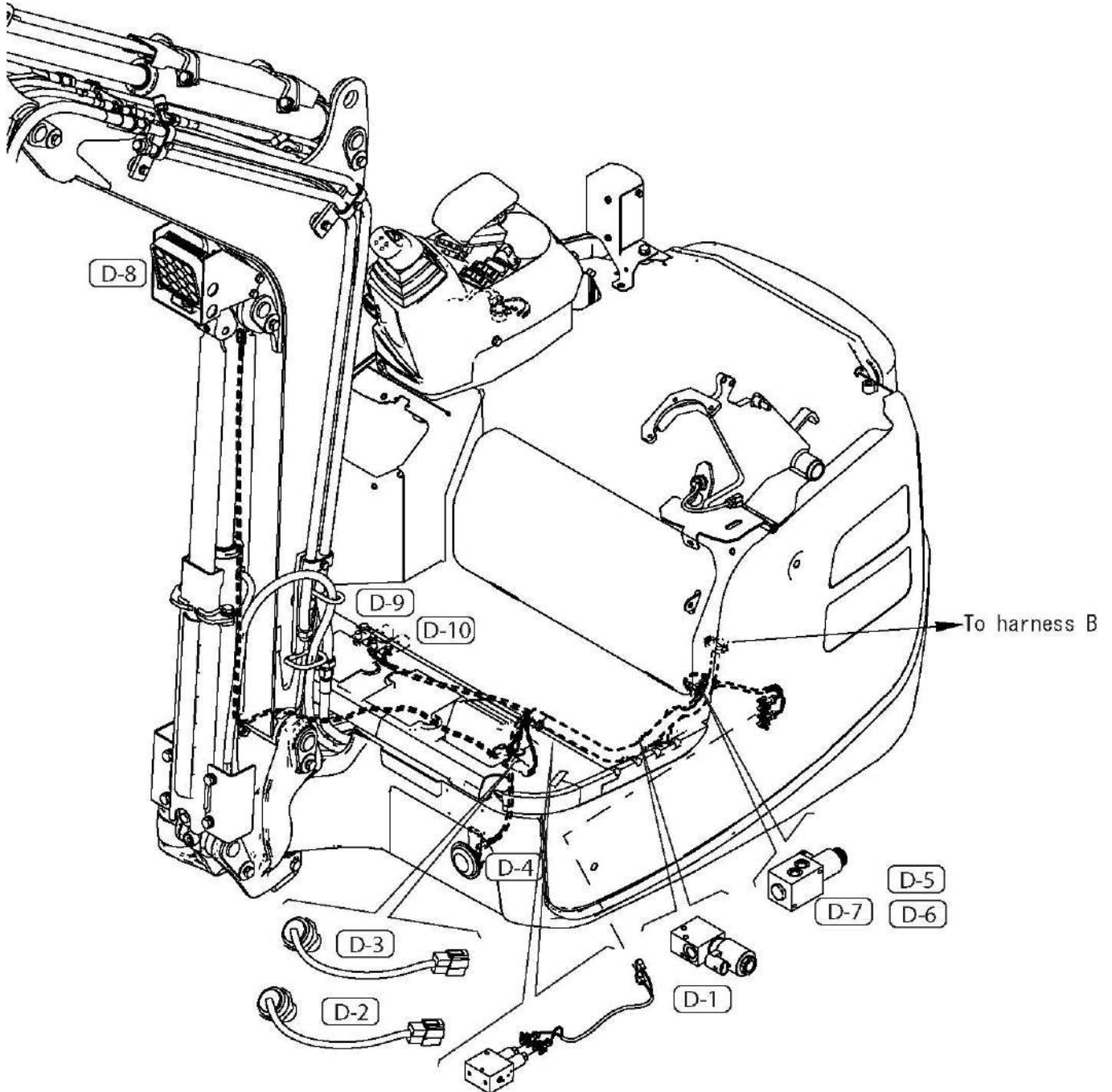


5. ELECTRIC SYSTEM

Ref. No.	Part	Ref. No.	Part
B1	Battery	B22	Fuse start
B2	Anti theft/shunt	B23	Fuse Monitor
B3	Cut off sw	B24	Fuse Lamp
B4	Cut off sw	B25	Fuse + PER
B5	Fuel gauge	B26	Diode cut off
B6	Diode timer 1s	B27	Timer 1s
B7	Diode glow	B28	Timer 3s
B8	Joystick R	B29	Socket 12V
B9	Feed pump	B30	Socket USB
B10	2nd Speed switch	B31	Buzzer
B11	Diode reverse connect-1	B32	Monitor cut off
B12	Relay starter	B33	Switch light
B13	Relay timer	B34	Switch beacon
B14	Relay cut off	B35	Switch Track extend
B15	Relay ACC1	B36	Switch, starter
B16	Relay glow	B37	Current Limiter
B17	Fuse main	B38	Travel alarm
B18	Fuse safety	B39	Fuses box
B19	Fuse cut off	B40	Main switch (metal)
B20	Fuse socket	B41	Main switch (plastic)
B21	Fuse travel	B42	Travel alarm Cri du lynx

5. ELECTRIC SYSTEM

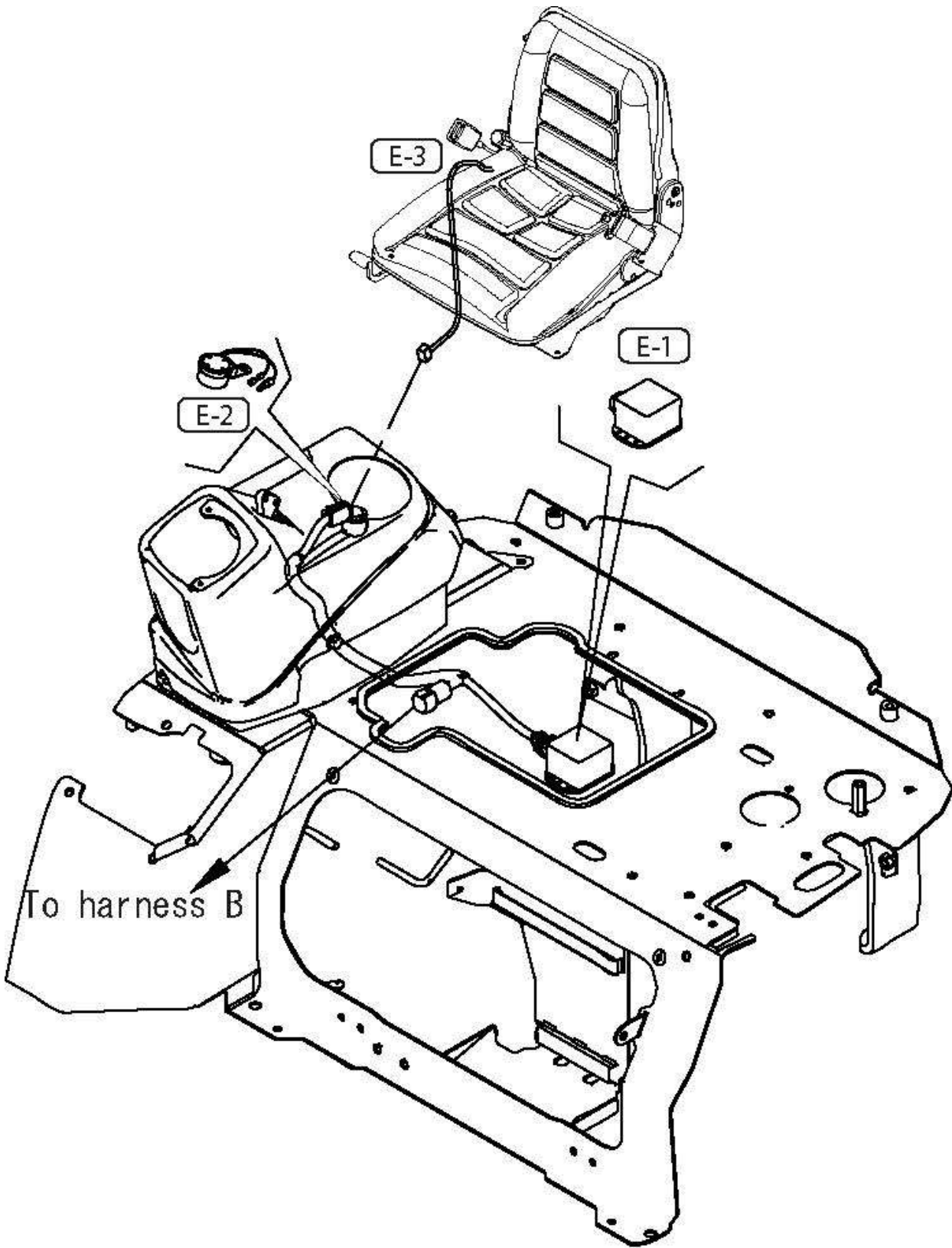
3) Harness D



Ref. No.	Part	Ref. No.	Part
D1	Cut off blade	D6	PTO 3B
D2	Travel sw left	D7	Selector valve
D3	Travel sw right	D8	LED lamp boom
D4	Horn	D9	Power option 1
D5	PTO 3A	D10	Power option 2

5. ELECTRIC SYSTEM

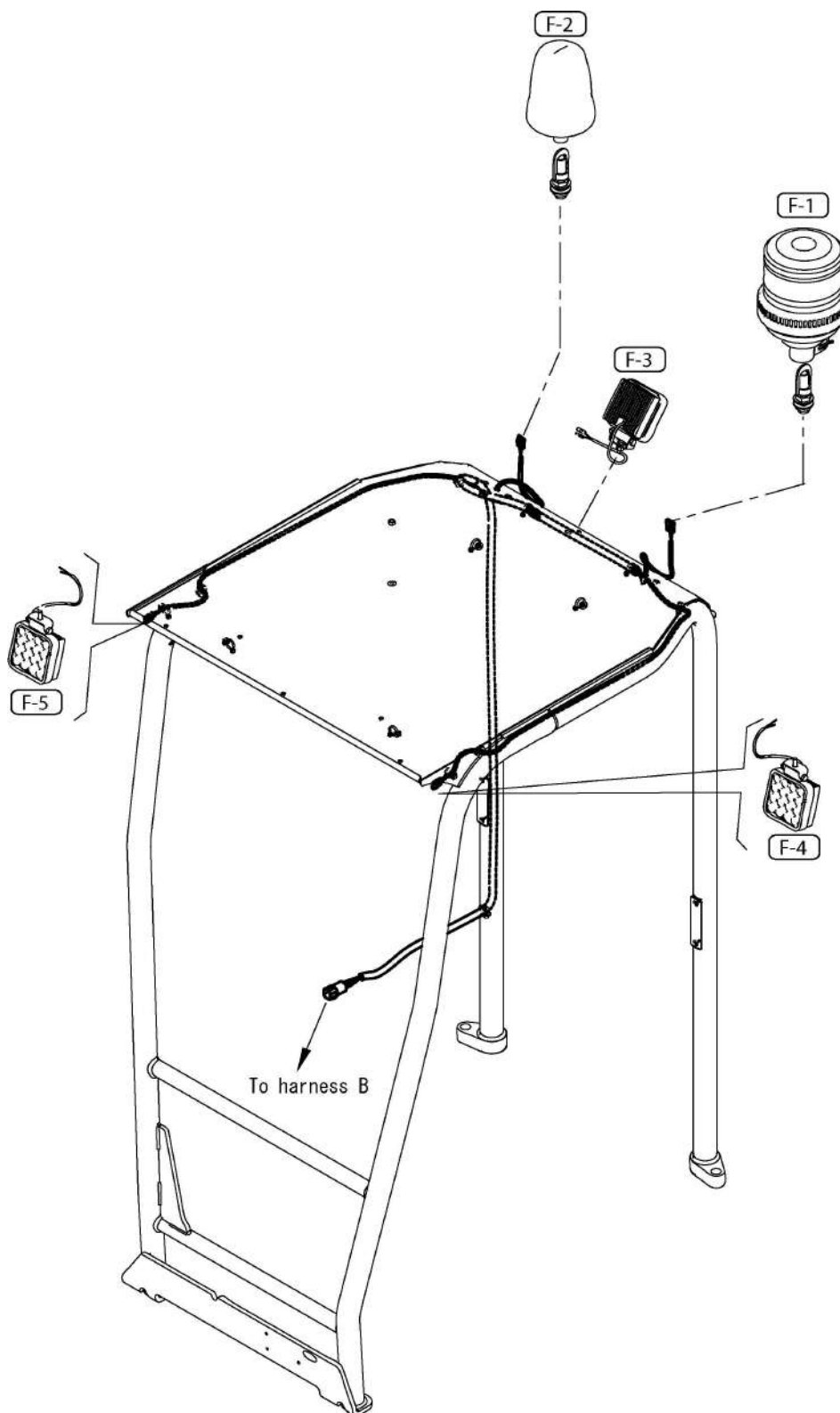
4) Harness seat belt



Ref. No.	Part	Ref. No.	Part
E1	Buckle box	E3	Sensor seat belt
E2	Buzze		

5. ELECTRIC SYSTEM

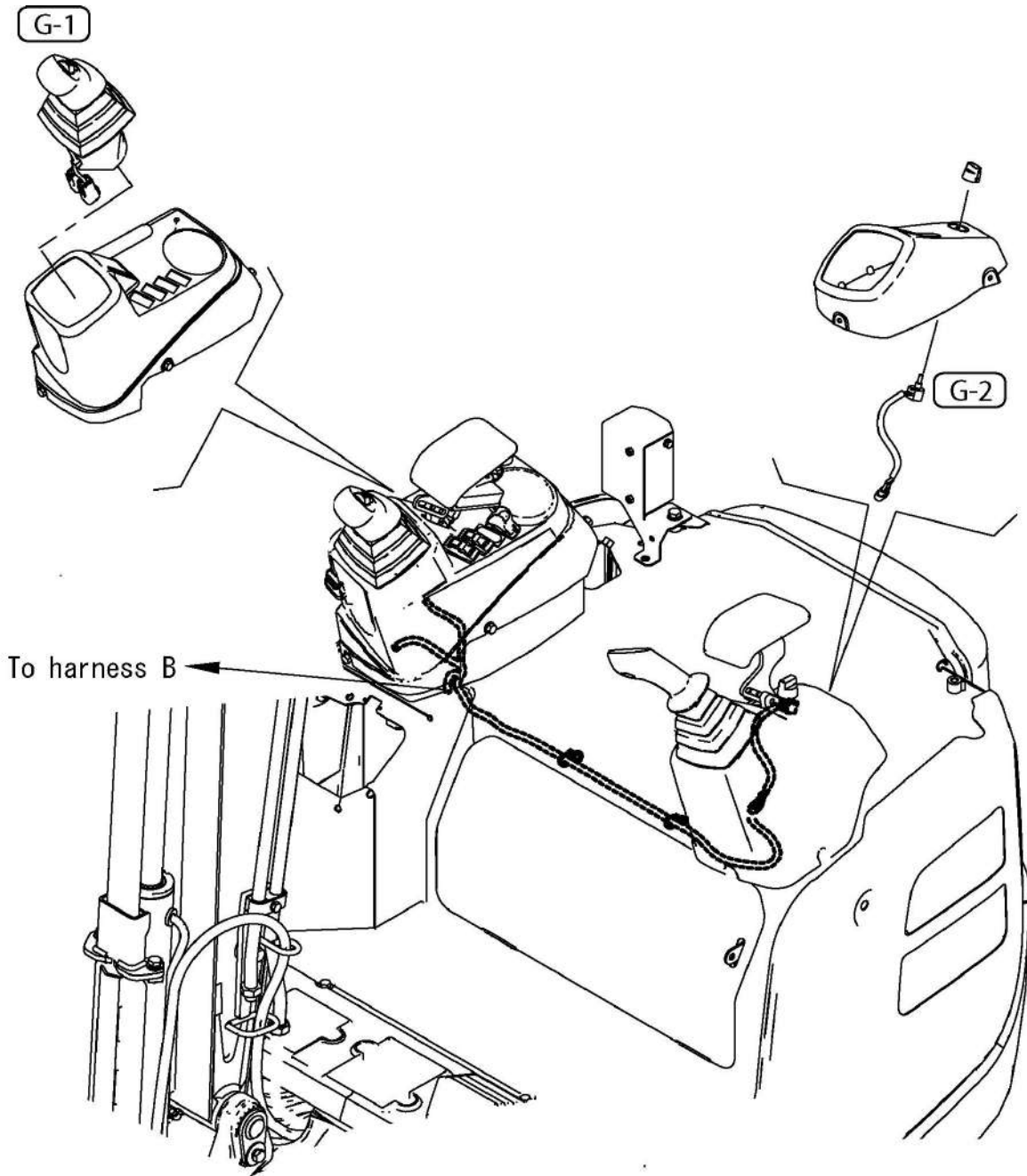
5) Harness canopy



Ref. No.	Part	Ref. No.	Part
F1	Green beacon	F4	Front LED left
F2	Orange beacon	F5	Front LED right
F3	Rear LED		

5. ELECTRIC SYSTEM

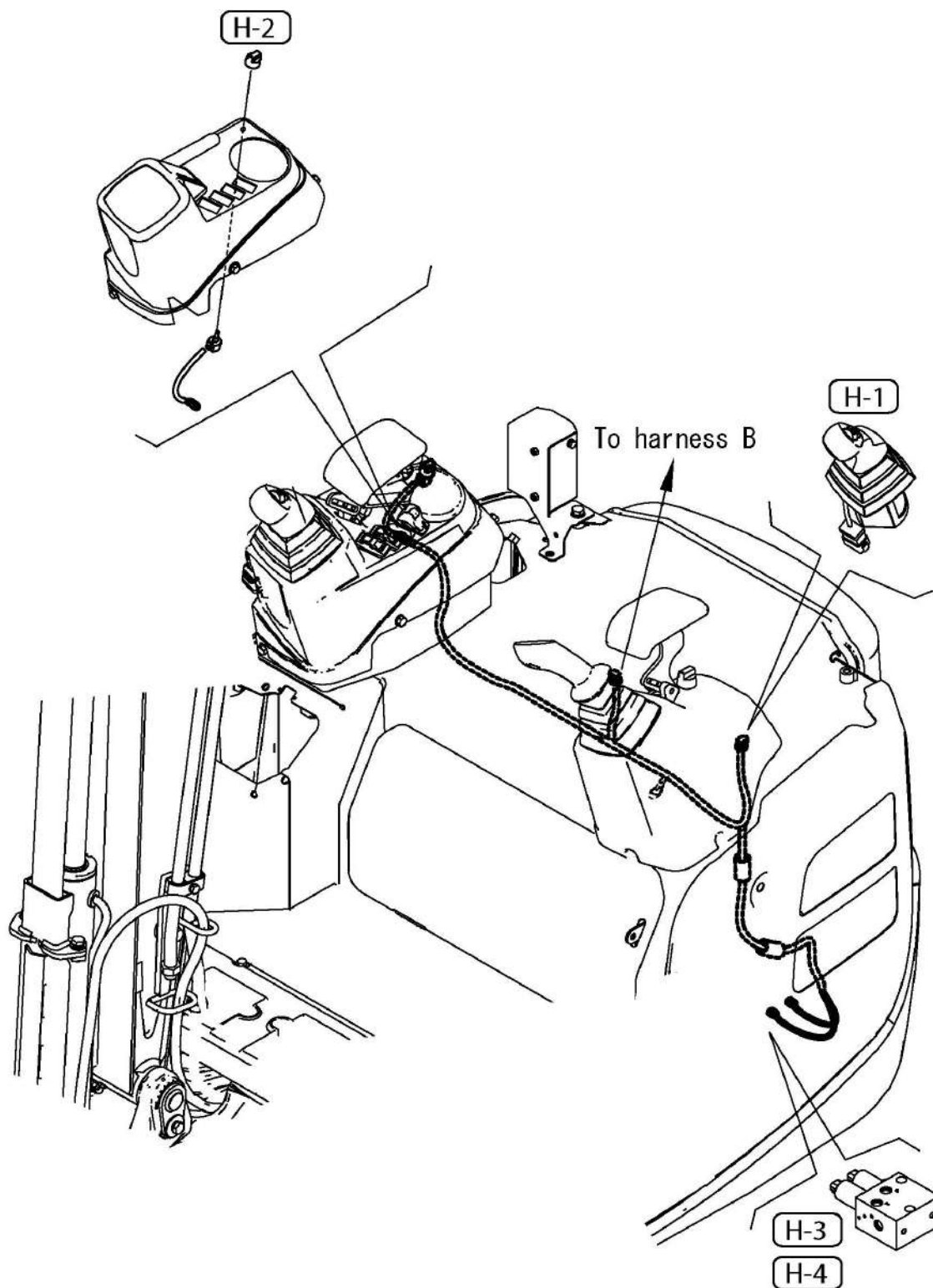
6) Harness PTO1



Ref. No.	Part	Ref. No.	Part
G1	Joystick	G2	Potentiometer

5. ELECTRIC SYSTEM

7) Harness PTO2



Ref. No.	Part	Ref. No.	Part
H1	Joystick left	H3	PTO L1
H2	Potentiometer	H4	PTO L2

5. ELECTRIC SYSTEM

5-2 Circuit Description of Engine Start and Stop

5-2-1 Engine Start and Stop

1. Engine Start

The starter switch **B36** is always supplied at B port with power from the battery flowing through the slow blow fuse **B17** (40A).

When the starter switch **B36** is turned to the position 2, the four lines C1, C2, BR1 and BR2 are powered.

The BR1 line goes through a 10A fuse (Engine) and powers the relay timer 3s **B28** which then powers the coil of the glow relay **B16** for 3s. The current flows to the stop solenoid **A5**. The stop solenoid core is pulled and held in this position which allows the feeding of fuel in the fuel injection valves.

The BR1 also powers the fuel feed pump **B9** and the solenoid stop **A5**.

The BR2 line is not connected.

The C1 line goes through a 2A fuse (Safety) and the switch of the cut off/safety relay **B14** which is controlled by the anti theft device. It then goes through the switch of the safety relay **B26**. If the lock levers are in the lock position (up) the starting order is sent to the relay **B12** of the starter motor **A1**. The starter motor is then powered by the battery and starts the engine.

Once the engine is started, the generator **A2** is driven by the engine. The generator sends a signal to the safety relay **B36** to avoid any new starting order while the engine is already running.

The C2 line is not connected.

2. Engine Stop

When the starter switch **B36** is turned to the position OFF, the stop solenoid core is no longer pulled and the feeding of fuel in the injection valves is stopped.

5-2-2 Battery charge

The electric current generated by the generator **A2** flows to the battery + terminal to be charged.



The battery lamp glows for poor battery charging.

The electric current flows from the generator **A2** to the battery **B1** through the slow blow fuse **B17** (Generator) to charge the battery.

When the voltage generated by the alternator decreases, the logical circuit in the alternator is turned on so that the battery lamp of the digital monitor **B32** turns on over poor charging.

CHAPTER 6

HYDRAULIC SYSTEM

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6. HYDRAULIC SYSTEM

6. Hydraulic System

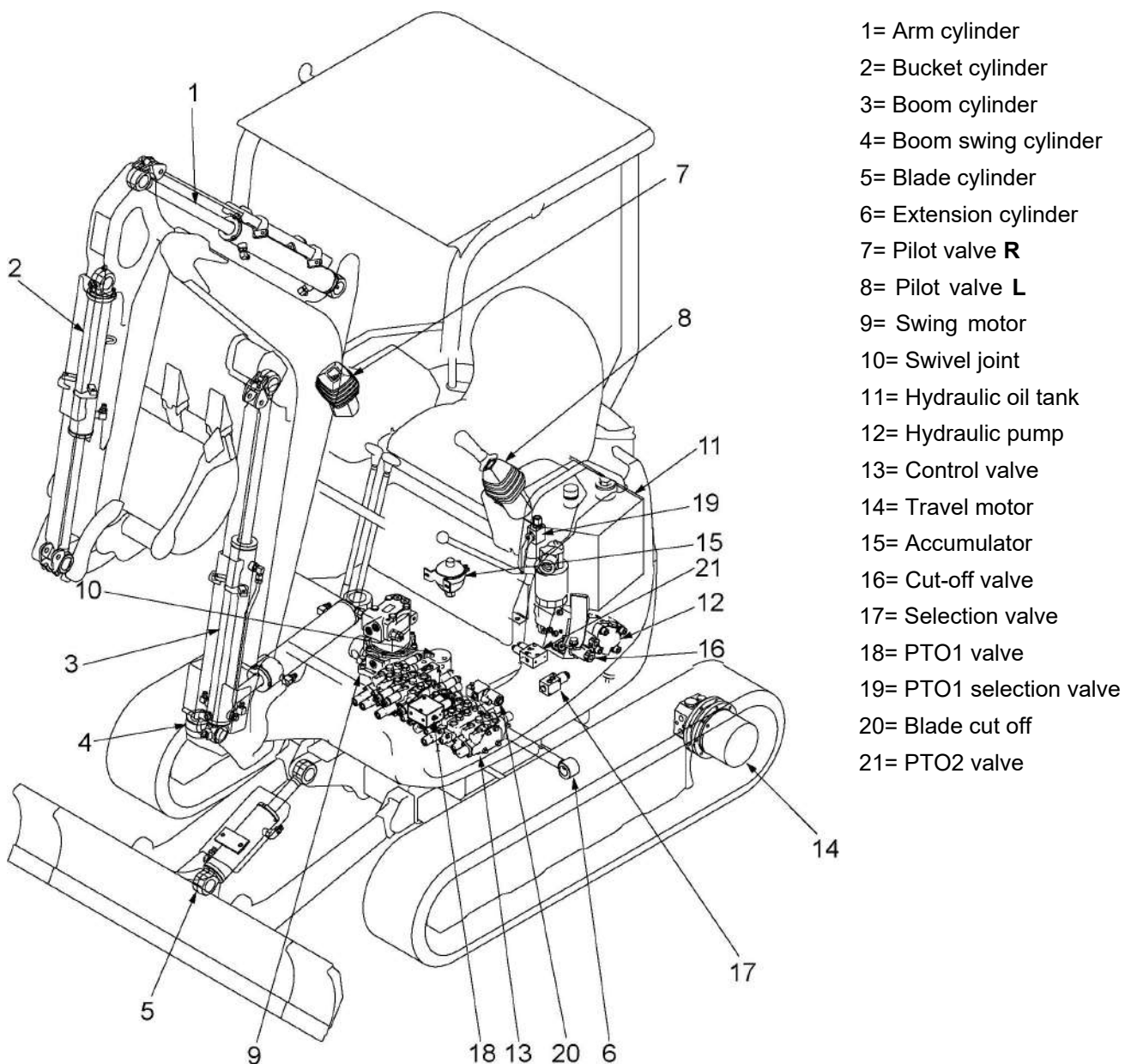
6-1 Outline

The hydraulic system consists of an engine, a gear pump, a cut-off valve, a control valve, a deviation valve, a PTO valve, a PTO2 valve, a QHPP valve, an accumulator, a boom cylinder, an arm cylinder, a bucket cylinder, a boom swing cylinder, a blade cylinder, an extension cylinder, a swing motor, a swivel joint, two travel motors and a hydraulic oil tank.

The oil discharged from the pump flows to the actuators through the control valve.

The hydraulic pilot control system comprises a cut-off valve, an accumulator and a pilot valve.

The oil discharged from the pump flows into the pilot ports of the control valve through the cut-off valve and the pilot valve.



6. HYDRAULIC SYSTEM

1) Hydraulic Pump

The variable displacement piston pumps, the gear pump and the pilot oil pump are linked to the flywheel of the engine through the coupling. The number of revolutions of each hydraulic pump is identical to the engine speed.

cu. in. (cu. cm) / rev

No.	Pump		Discharge volume
1	Piston pump	P1	0.488 (8.0)
2	Piston pump	P2	0.488 (8.0)
3	Gear pump	P3	0.366 (6.0)
4	Pilot pump	P4	0.220 (3.6)

2) Oil Flow

The pump takes in oil through the suction filter from the hydraulic oil tank and discharges it.

The discharged oil flows to the ports P1, P2 and P3 of the control valve.

The flow from the port P1 of the inlet section feeds the boom cylinder, the bucket cylinder, the right travel motor and the PTO2.

The flow from the port P2 of the inlet section feeds the arm cylinder, the left travel motor, the boom swing cylinder, the PTO1.

The flow from the port P3 of the control valve feeds the swing, the boom swing, the arm cylinder, the blade cylinder, the PTO1. It also feeds the boom cylinder, the PTO2, the bucket cylinder, and the frame extension cylinder.

Then oil flows through ports T1 and T2 of the control valve back to the hydraulic oil tank.

3) System Relief Valve

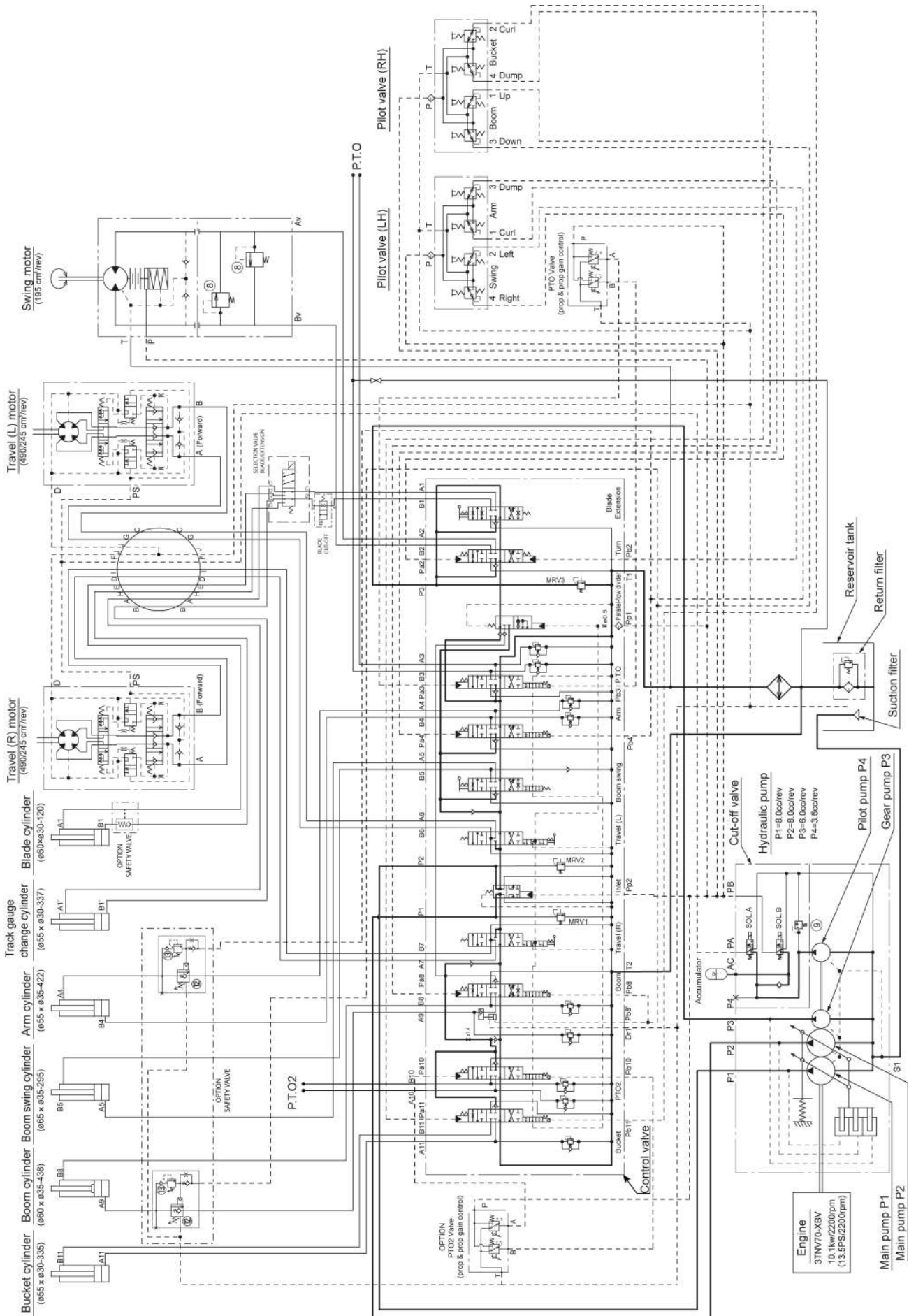
The system relief valves MRV1, MRV2 and MRV3 of the control valve regulate the discharge pressure of the pumps P1, P2 and P3.

4) Cut-off valve

When the lock lever is set to the "LOCK" position, the spool of the inlet section is in the neutral position, so that the oil from the piston pumps P1 and P2 flows back to the hydraulic oil tank through the return passage.

Therefore, the implement does not operate and the machine does not travel even when the control or travel lever is operated.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2 Circuit Operation

6-2-1 Boom

1) Boom "Up"

(1) Pilot oil flow

When the boom control lever is pulled back to raise the boom, the oil from the pump flows through the cut-off valve and the port 1 of the pilot valve (R) to the port Pa8 of the boom section to operate its spool.

(2) Oil flow from hydraulic pump

The oil discharged from the pump P2 flows to the boom section through the port P1 of the inlet section. The oil flows through the safety valve (option) and the port A9 to the rod port of the boom cylinder to extend its cylinder rod, raising the boom. The return oil from the bottom port of the boom cylinder flows back to the hydraulic oil tank through the port B8 and T2 of the control valve. The oil from the port T2 flows back to the tank through the return filter.

2) Boom "Down"

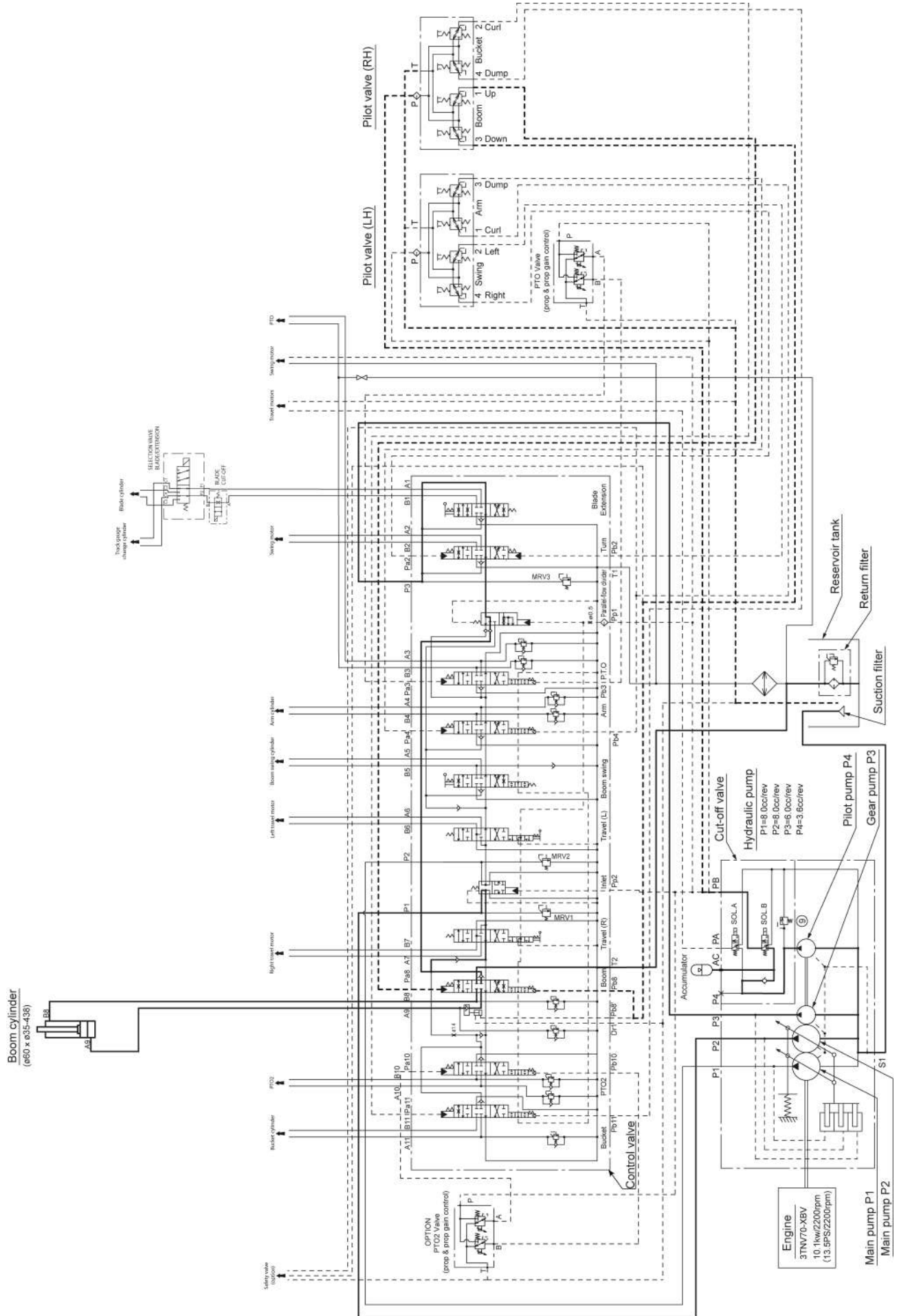
(1) Pilot oil flow

When the boom control lever is pushed forward to lower the boom, the oil from the pump flows through the cut-off valve and the port 3 of the pilot valve (R) to the port Pb8 of the boom section to operate its spool.

(2) Oil flow from hydraulic pump

The oil discharged from the pump P2 flows through the port P1 of the inlet section to the boom section. In this operation, the oil flows in the opposite direction to the oil flow in the Boom "Up" operation with regard to the boom cylinder.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-2 Arm

1) Arm "Retract"

(1) Pilot oil flow

When the arm control lever is pulled back to retract the arm, the oil from the pump flows through the port 1 of the pilot valve (L) to the port Pb4 of the arm section to operate its spool.

(2) Oil flow from hydraulic pump

The oil discharged from the pump P1 flows to the arm section through the port P2 of the inlet section or from the pump P3 of the conflux section to the arm section through the port P3 of the conflux section. The oil flows through the port B4 to the bottom port of the arm cylinder to extend its cylinder rod, retracting the arm. The return oil from the rod port of the arm cylinder flows back to the hydraulic oil tank through the port A4 and T1 of the control valve. The oil from the port T1 flows back to the tank through the oil cooler and the return filter.

2) Arm "Extend"

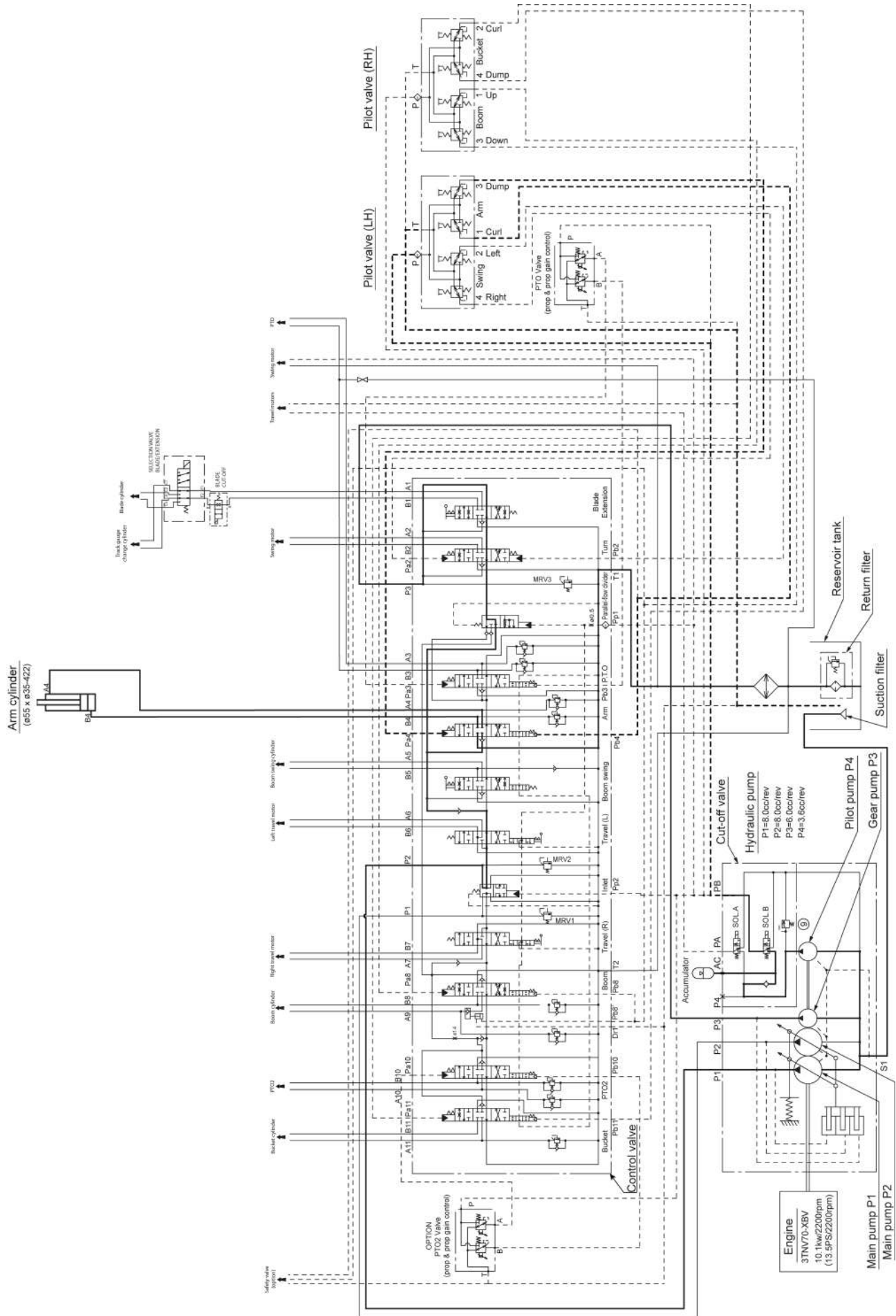
(1) Pilot oil flow

When the arm control lever is pushed forward to extend the arm, the oil from the pump flows through the port 3 of the pilot valve (L) to the port Pa4 of the arm section to operate its spool.

(2) Oil flow from hydraulic pump

The oil discharged from the pump the pump P1 flows to the arm section through the port P2 of the inlet section or from the pump P3 flows through the port P3 of the conflux section to the arm section. In this operation, the oil flows in the opposite direction to the oil flow in the Arm "Retract" operation with regard to the arm cylinder.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-3 Bucket

1) Bucket "Curl"

(1) Pilot oil flow

When the bucket control lever is moved to the left to curl the bucket, the oil from the pump flows through the cut-off valve and the port 2 of the pilot valve (R) to the port Pa11 of the bucket section to operate its spool.

(2) Oil flow from hydraulic pump

The oil discharged from the pump P2 and the pump P3 flows to the bucket section through the port P1 of the inlet section or the port P3 of the conflux section. The oil flows through the port A11 to the bottom port of the bucket cylinder to extend its cylinder rod, curling the bucket. The return oil from the rod port of the bucket cylinder flows back to the hydraulic oil tank through the port B11 and T2 of the control valve. The oil from the port T2 flows back to the tank through the return filter.

2) Bucket "Dump"

(1) Pilot oil flow

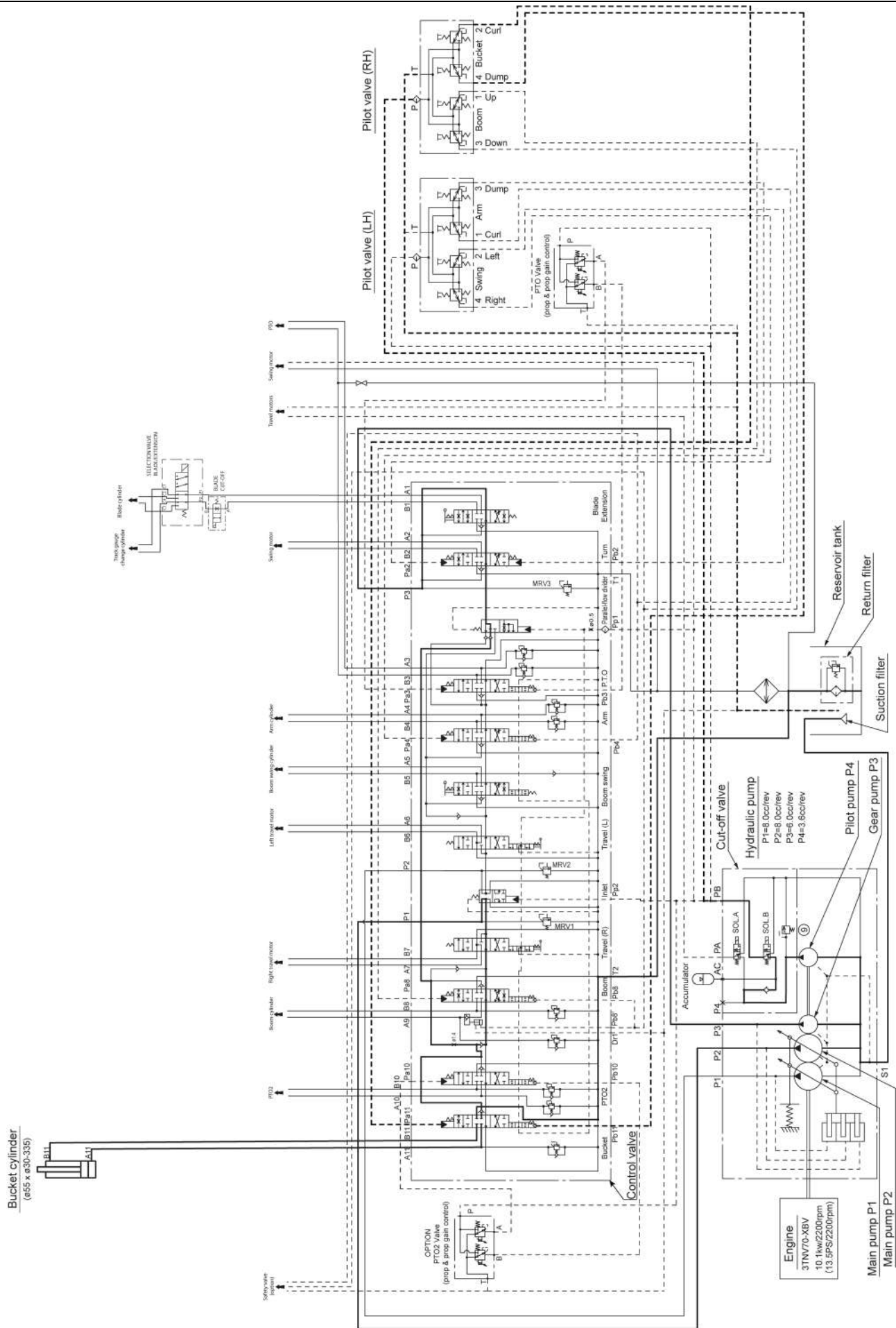
When the bucket control lever is moved to the right to dump the bucket, the oil from the pump flows through the cut-off valve and the port 4 of the pilot valve (R) to the port Pb11 of the bucket section to operate its spool.

(2) Oil flow from hydraulic pump

The oil discharged from the pump P2 and the pump P3 flows through the port P1 and the port P3 of the inlet section to the bucket section.

In this operation, the oil flows in the opposite direction to the oil flow in the Bucket "Curl" operation with regard to the bucket cylinder.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-4 Swing

1) Right Swing

(1) Pilot oil flow

When the swing control lever is moved to the right, the oil from the pump flows through the cut-off valve, the port 4 of the left pilot valve (L) to the port Pa2 of the swing section to move its spool.

(2) Oil flow from hydraulic pump

The oil discharged from the pump P3 flows to the swing section through the port P3 of the supply & conflux section. The oil flows through the port A2 to the port Av of the brake valve of the swing motor, so that the swing motor is rotated. The return oil from the port Bv of the brake valve flows back to the hydraulic oil tank through the port B2 and T1 of the control valve. The oil from the port T1 flows back to the tank through the oil cooler and the return filter.

2) Left Swing

(1) Pilot oil flow

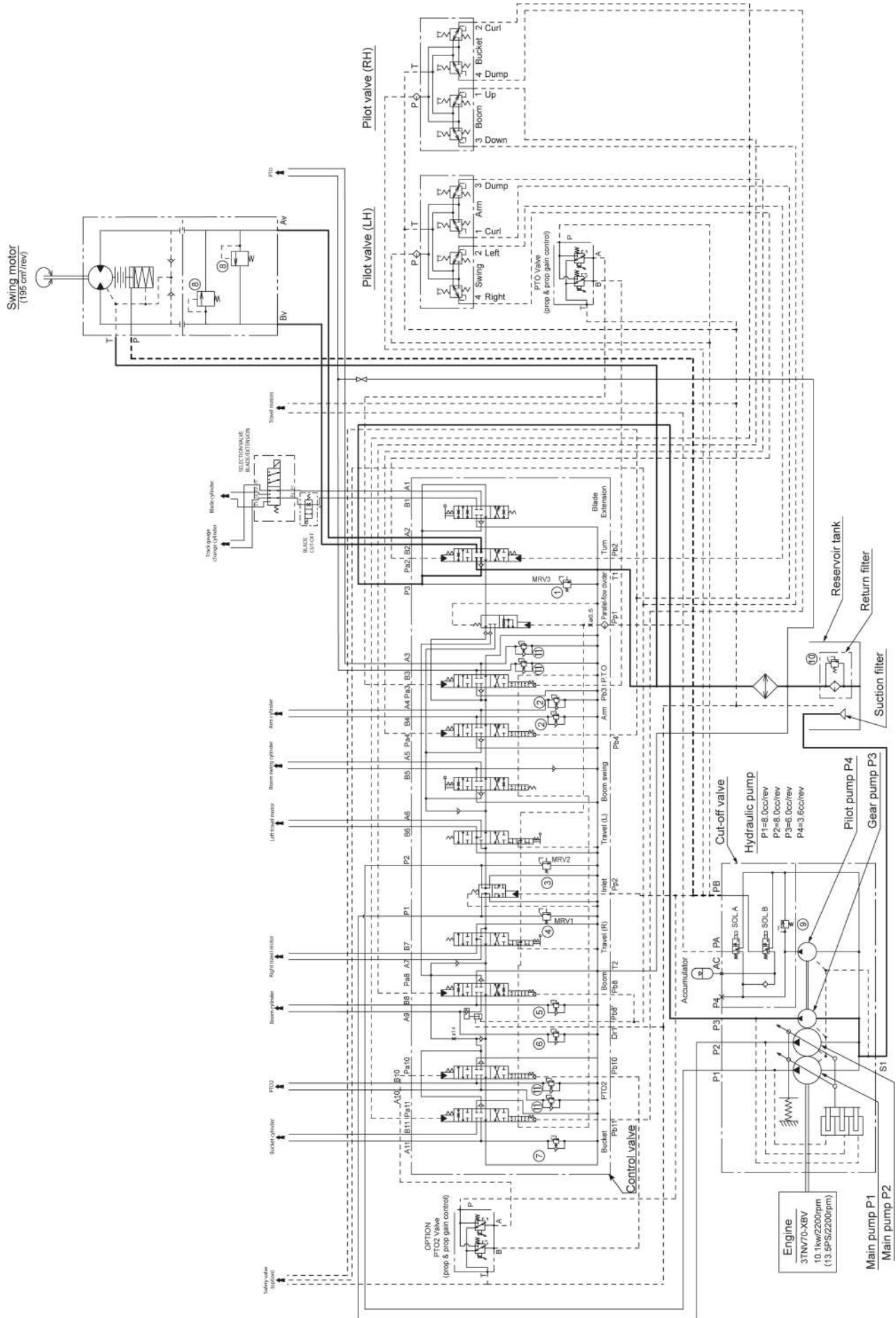
When the swing control lever is moved to the left, the oil from the pump flows through the cut-off valve, the port 2 of the left pilot valve (L) to the port Pb2 of the swing section to move its spool.

(2) Oil flow from hydraulic pump

The oil discharged from the pump P3 flows through the port P3 of the supply & conflux section to the swing section.

In this operation, the oil flows in the opposite direction to the oil flow in the Right Swing operation with regard to the swing motor.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-5 Boom Swing

The boom swing pedal is linked to the spool of the control valve through an L-ball and a rod.

1) Right Boom Swing

(1) Control

When the boom swing pedal is moved on the right, the spool is pushed forward.

(2) Oil Flow from Hydraulic Pump

The oil from the pump P1 flows through the port P2 of the inlet section and from the pump P3 through the port P3 of the supply & conflux section then through the port B5 of the boom swing section to B5 of the boom swing cylinder to retract its cylinder rod, swinging the boom to the right.

The return oil from the bottom port of the boom swing cylinder flows back to the hydraulic oil tank through the port A5 and T1 of the control valve. The oil from the port T1 flows back to the tank through the oil cooler and the return filter.

2) Left Boom Swing

(1) Control

When the boom swing pedal is moved on the left, the spool is pulled backward.

(2) Oil Flow from Hydraulic Pump

The oil discharged from the pump P1 and the pump P3 flows through the port P2 and P3 of the inlet section to the boom swing section. In this operation, the oil flows in the opposite direction to the oil flow in the right boom swing operation with regard to the boom swing cylinder.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-6 P.T.O. 1

The PTO1 switch controls the PTO1 proportional solenoid valve through the output current of the solenoid driver in the remote control lever.

1) Switching between Single Acting and Double Acting

Open or close the P.T.O. stop valve to select single or double acting of the P.T.O.

2) Single Acting P.T.O.

(P.T.O. stop valve is open)

(1) Control

When the PTO1 switch is moved to the left, the oil from the pilot pump P4 flows through the port PB of the cut off valve, then through the ports P and A of the PTO1 valve to the port Pa3 of the PTO1 section to move its spool.

(2) Oil Flow from Hydraulic Pump

The oil is discharged to the PTO1 section from the pump P1 through the port P2 of the inlet section or the pump P3 through the port P3 of the supply & conflux section. The oil flows through the port A3 to the PTO1 line to operate the accessory. The return oil from the PTO1 line flows back to the hydraulic oil tank through the opened P.T.O. 1 stop valve and through the ports B3 and T1 of the control valve.

3) Double Acting P.T.O.

(P.T.O. 1 stop valve is closed)

(1) Control

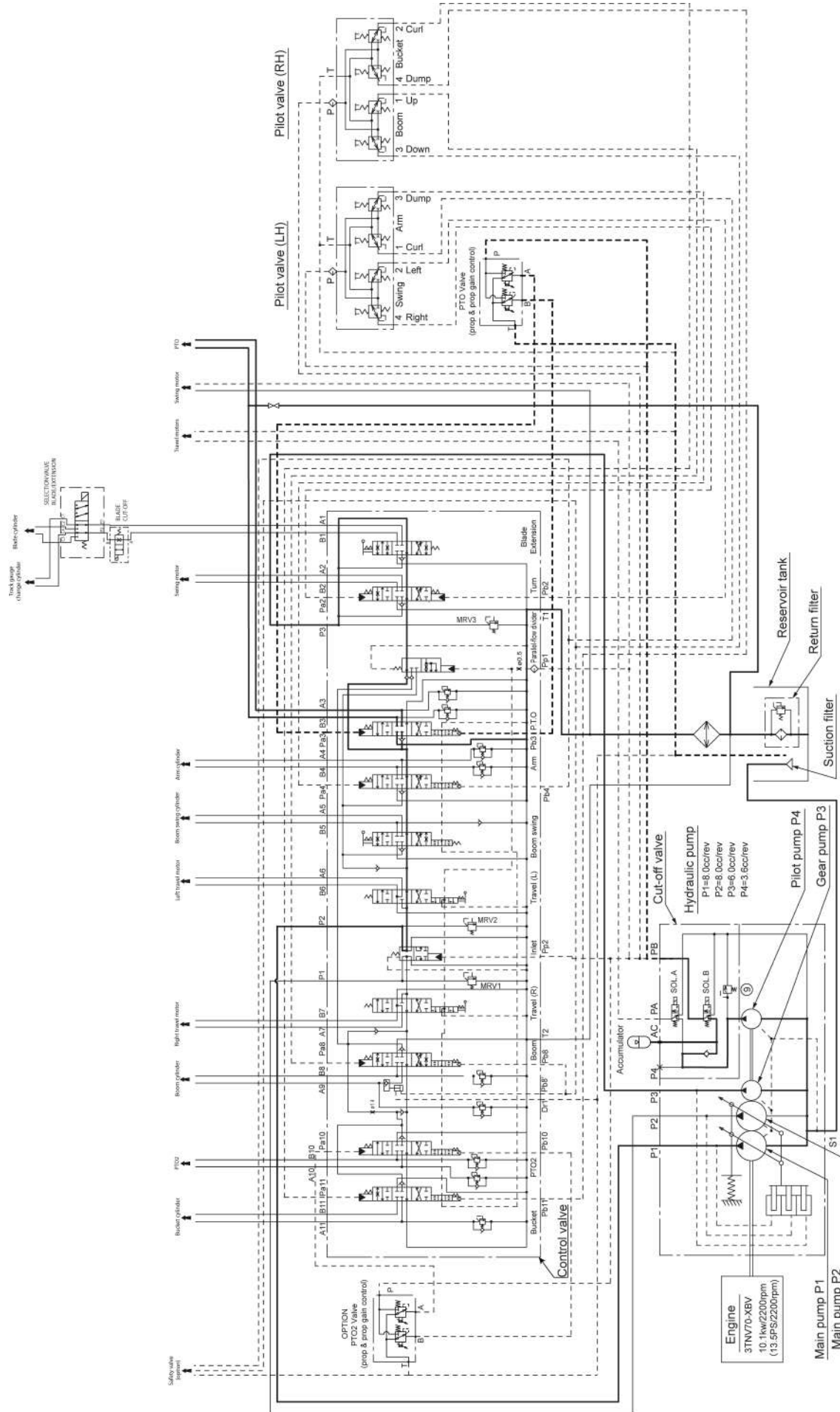
When the PTO switch is moved on the left, the spool is pushed forward and the oil flow is the same as the flow in "Single Acting P.T.O. 1"

When the PTO1 switch is moved on the right, the spool is pulled backward.

(2) Oil Flow from Hydraulic Pump

When the PTO1 switch is moved on the left, the oil flow is the same as the flow in "Single Acting P.T.O. 1" When the PTO switch is moved on the right, the oil flows in opposite direction to the oil flow when the PTO1 switch is moved on the left.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-7 Blade

The blade lever is linked to the spool of the control valve through a blade cable.

1) Blade "Down"

When the blade lever is pushed forward to lower the blade, the spool is pushed.

Oil Flow from Hydraulic Pump

The oil discharged from the pump P3 flows to the blade section through the port P3 of the supply & conflux section, the port B1 of the blade section, the ports B and A of the security valve, the ports P2 and C3 of the selector valve and the ports H of the swivel joint to the bottom side of the blade cylinder. The return oil from the rod port A1 of the blade cylinder flows back through the ports E of the swivel joint to the hydraulic oil tank through the ports C2 and P1 of the selector valve and A1 and T1 of the control valve. The oil from the port T1 flows back to the tank through the oil cooler and the return filter.

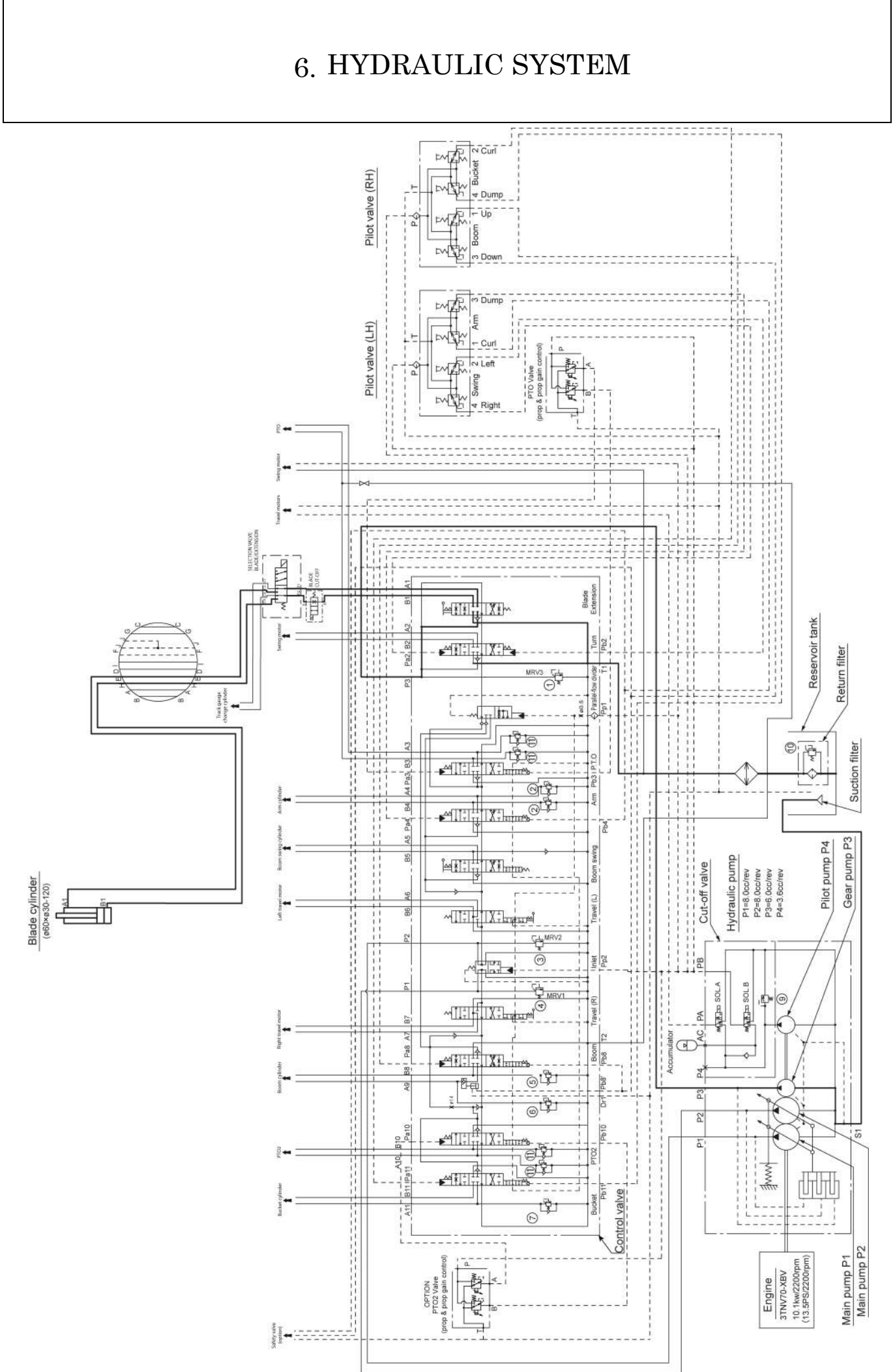
2) Blade "UP"

When the blade lever is pulled back to raise the blade, the spool is pulled.

Oil Flow from Hydraulic Pump

The oil discharged from the pump P3 flows through the port P3 of the supply & conflux section to the blade section. In this operation, the oil flows in the opposite direction to the oil flow in the blade down operation with regard to the blade cylinder.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-8 Lower frame extension

The lower frame extension is controlled through the blade lever. The blade lever is linked to the spool of the control valve through a blade cable.

1) Lower frame "Extend"

When the blade lever is pushed forward to extend the lower frame, the spool is pushed.

Oil Flow from Hydraulic Pump

The oil discharged from the pump P3 flows to the blade section through the port P3 of the supply & conflux section, the port B1 of the blade section, the ports B and A of the security valve, the ports P2 and C4 of the selector valve and the ports B of the swivel joint to the bottom side B1' of the extension cylinder through the safety valve (option). The return oil from the rod port A1' of the extension cylinder flows back through the ports A of the swivel joint to the hydraulic oil tank through the ports C1 and P1 of the selector valve and A1 and T1 of the control valve. The oil from the port T1 flows back to the tank through the oil cooler and the return filter.

2) Lower frame "Retract"

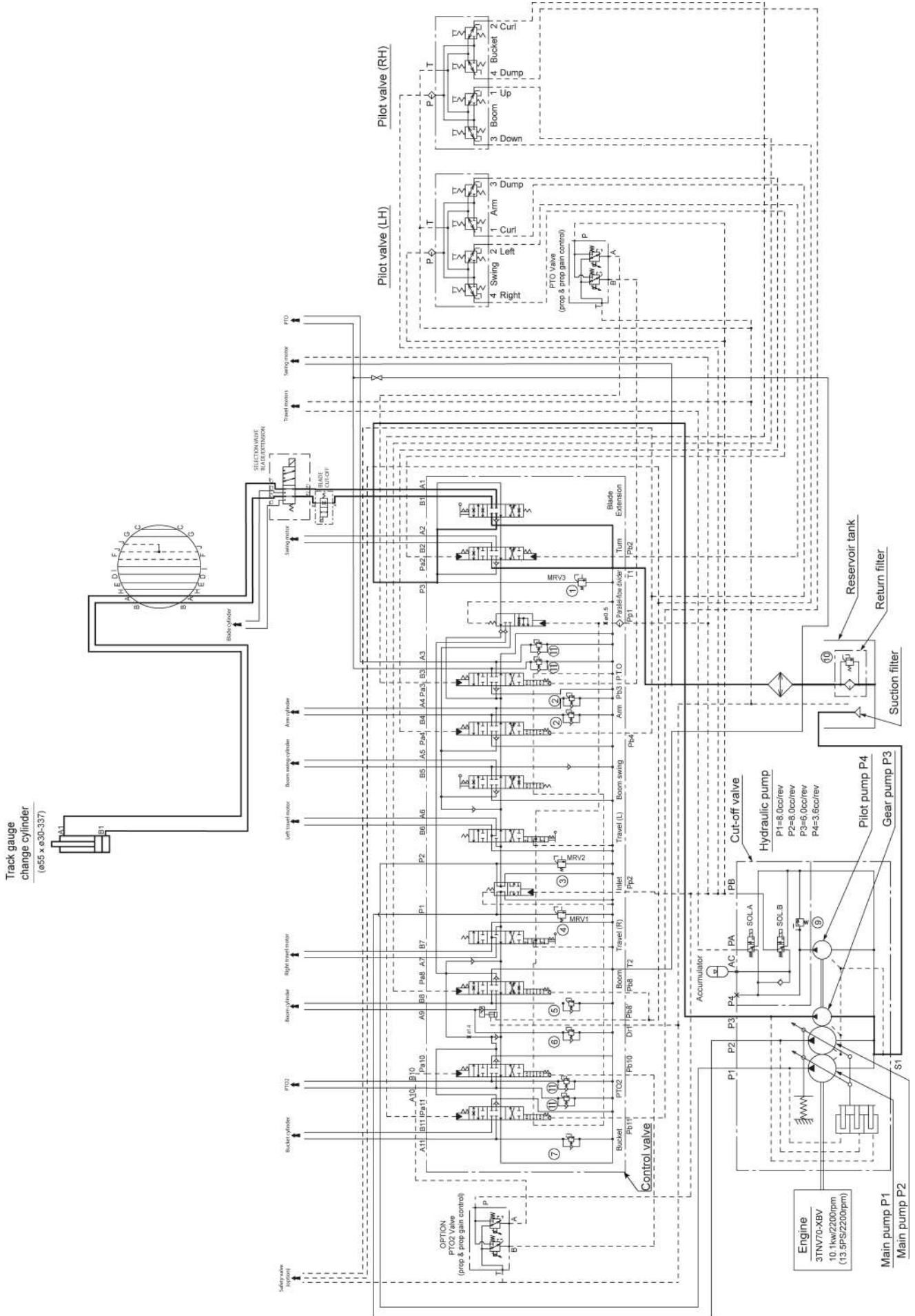
When the blade lever is pulled back to retract the lower frame, the spool is pulled.

Oil Flow from Hydraulic Pump

The oil discharged from the pumps P3 flows to the blade section through the port P3 of the supply & conflux section to the blade section.

In this operation, the oil flows in the opposite direction to the oil flow in the lower frame extension operation with regard to the extension cylinder.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-9 Travel

Each travel lever is linked to the spool of the control valve through an L-ball and a rod.

1) Forward Travel (Right)

When the right travel lever is pushed forward, the spool of the right travel section is pulled up.

Oil Flow from Hydraulic Pump

The oil from the pump P2 flows through the port P1 of the inlet section, the port B7 of the right travel section and the ports I of the swivel joint to the port B of the right travel motor to rotate it.

The return oil from the port A of the right travel motor flows back to the hydraulic oil tank through the ports D of the swivel joint, the port A7 of the right travel section and the port T2 of the control valve. The oil from the port T2 flows back to the tank through the return filter.

2) Forward Travel (Left)

When the left travel lever is pushed forward, the spool of the left travel section is pressed down.

Oil Flow from Hydraulic Pump

The oil from the pump P1 flows through the port P2 of the inlet section, the port B6 of the left travel section and the ports G of the swivel joint to the port A of the left travel motor to rotate it.

The return oil from the port A of the left travel motor flows back to the hydraulic oil tank through the ports G of the swivel joint, the port B6 of the left travel section and the port T1 of the control valve. The oil from the port T1 flows back to the tank through the oil cooler and the return filter.

3) Reverse Travel (Right and Left)

When the right or left travel lever is pulled back, the spool of the travel section is moved to the opposite direction to when the travel lever is pushed.

Oil Flow from Hydraulic Pump

The oil flows in the opposite direction to the oil flow in the Forward Travel operation with regard to the right or left travel motor.

4) High-Speed Function

When the high-speed travel switch is pressed, the signal is transmitted from the switch to the 2 Speed solenoid valve to increase the travel speed.

(1) Pilot oil flow

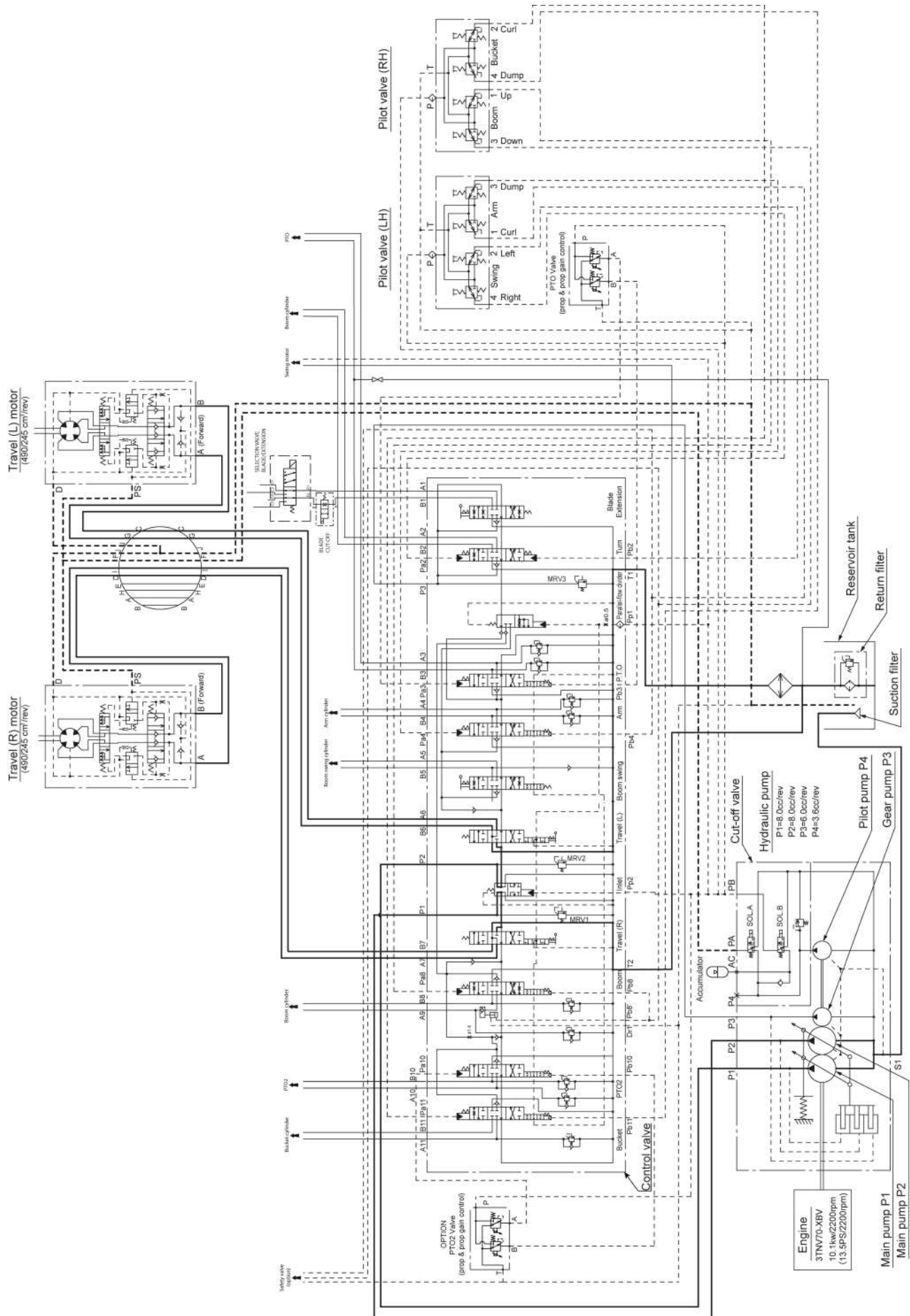
The oil from the pump flows through the port PA of the solenoid valve to the port F of the swivel joint and is divided into two flows to the ports PS of each travel motor.

(2) Increase in output speed of travel motor

The pilot oil from the pump moves the swash plate control piston to reduce the inclination angle of the swash plate, which shortens the piston stroke of the travel motor and decreases the travel motor capacity to increase its output speed. This increases the travel speed.

Meanwhile, the travel driving force weakens as the output torque of the travel motor becomes smaller due to the shortened piston stroke.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-2-10 P.T.O.2

The PTO2 switch controls the PTO2 proportional solenoid valve through the output current of the solenoid driver in the remote control lever.

1) Control

When the PTO2 switch is moved to the left, the oil from the pilot pump P4 flows through the port PB of the solenoid valve B, the port P and B of the PTO2 pilot valve to the port Pb10 of the PTO2 section to move its spool. When the PTO2 switch is moved to the right, the oil from the pilot pump P4 flows through the port PB of the solenoid valve B, the port P and A of the PTO2 pilot valve to the port Pa10 of the PTO2 section to move its spool.

2) Oil Flow from Hydraulic Pump

When the PTO2 switch is moved to the left, the oil is discharged to the PTO2 section from the pump P2 through the port P1 of the inlet section and the port P3 of the supply & conflux section. The oil flows through the port B10 to the PTO2 line to operate the accessory. The return oil from the PTO2 line flows back to the hydraulic oil tank through the ports A10 and T2 of the control valve.

When the PTO2 switch is moved to the right, the oil is discharged to the PTO2 section from the pump P2 through the port P1 of the inlet section and the port P3 of the supply & conflux section. The oil flows through the port A10 to the PTO2 line to operate the accessory.

The return oil from the PTO2 line flows back to the hydraulic oil tank through the ports B10 and T2 of the control valve.

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

6-3 Hydraulic Pump

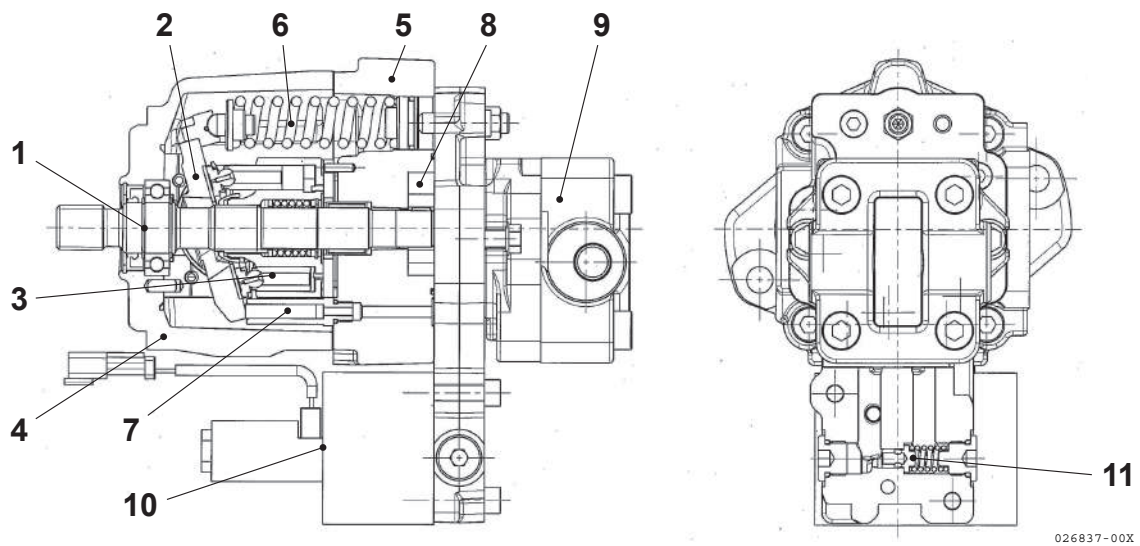
6.3.1 Outline

1) Piston Pump

The piston pump consists of a drive shaft, a swash plate, a rotary group, body H, a control spring, a control rod, a gear pump, a body S, a valve block assembly, a relief valve, and other components. It is a variable displacement piston pump that discharges two equivalent volumes for the pumps P1 and P2 by means of a rotary group.

One rotary group is divided into one intake port and two discharge ports. The gear pump P3 and the pilot pump P4 are connected to the piston pump via the coupling and these pumps and the piston pump share one intake port.

The control system is a simultaneous incline angle full horsepower control.



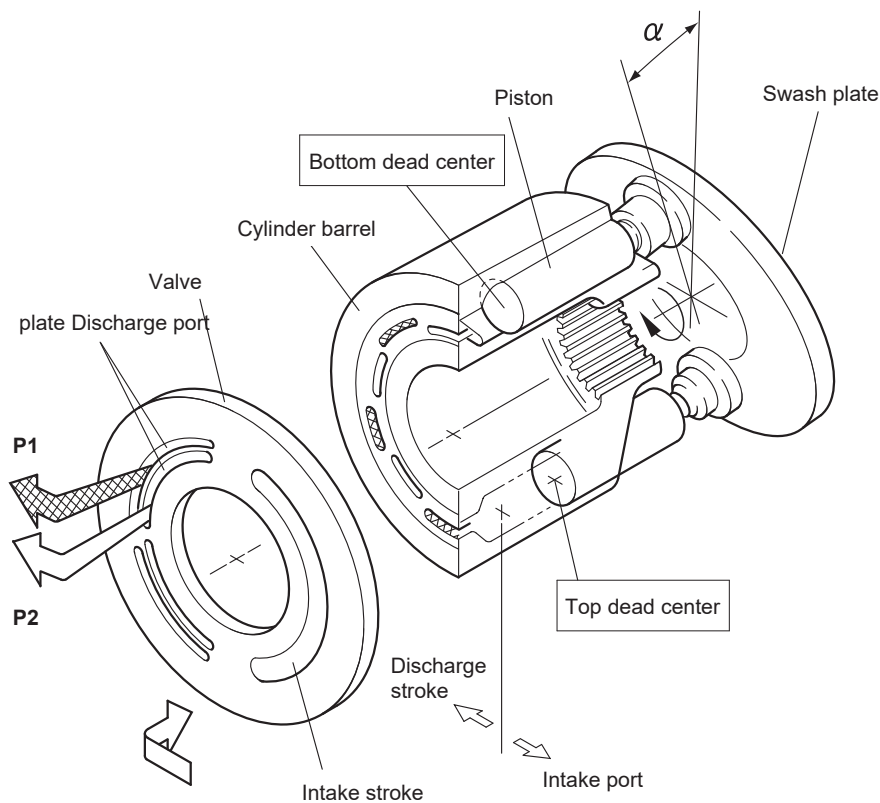
No.	Part
1	Shaft portion
2	Cradle portion
3	Rotary group portion
4	Housing
5	Port block
6	Control spring portion
7	Control piston portion
8	Trochoid pump portion (pilot pump)
9	Gear pump CMP (third pump)
10	Solenoid valve CMP
11	Relief valve

6. HYDRAULIC SYSTEM

6.3.2 Theory of Operation

1) Pump Function

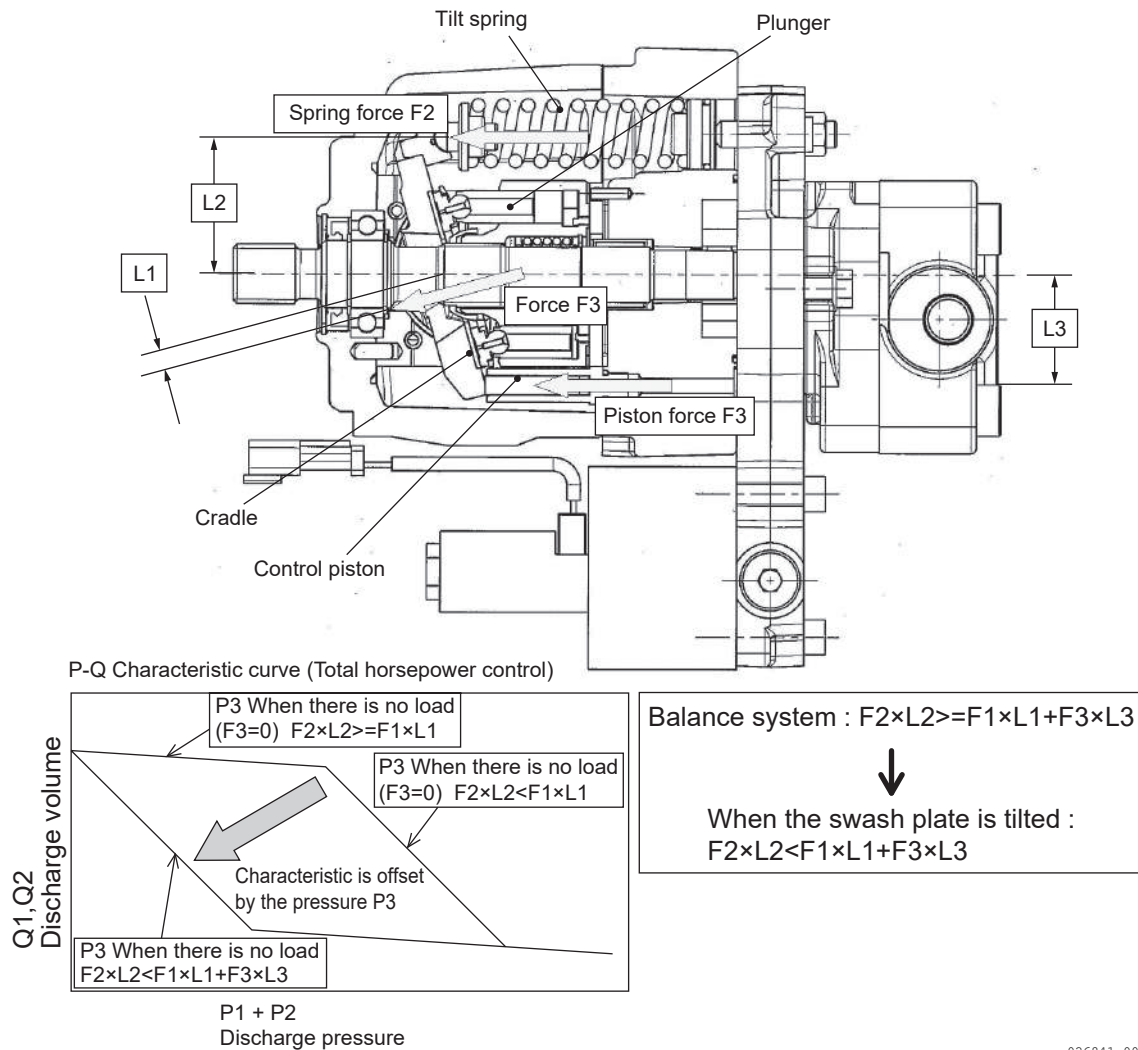
- The cylinder barrel, which is splined to the drive shaft, revolves with the shaft.
- The pistons installed into the cylinder barrel, following the swash plate, make a reciprocating motion, which causes the volume of the cylinder to change, thereby enabling the intake and discharge pump operations.
- As the pistons move from the bottom dead center to the top dead center, thereby increasing the volume, oil flowing from the intake port runs through the valve plate into the cylinder barrel. (Intake stroke)
- As the pistons move from the top dead center to the bottom dead center, thereby decreasing the volume, the oil in the cylinder barrel is discharged to the discharge port. (Discharge stroke)
- By changing the inclination of the swash plate, the piston stroke is changed and thus the displacement of the piston can be changed.
- Oil taken in from the inner port of the cylinder barrel is discharged from the inner discharge port of the valve plate.
- Oil taken in from the outer port of the cylinder barrel is discharged from the outer discharge port of the valve plate.



6. HYDRAULIC SYSTEM

2) Control Function

- The discharge volume of the pump is regulated by the inclination of the swash plate angle. The swash plate angle is controlled by a direct variable mechanism using a simple spring.
- The swash plate pivots on the ball behind it and the load F_1 applied from the piston is in the direction as shown in the below figure, which creates a clockwise moment with regard to the swash plate. To counteract this force, the spring force F_2 is applied in the opposite direction by the spring installed to set the horsepower at a constant level, so that a specified load can be obtained.
- With increase in the pressure, the above clockwise moment increases, and when it overcomes the counterclockwise moment by the spring force, it compresses the spring to reduce the swash plate angle. Thus, the discharge volume is decreased to maintain the horsepower at a constant level.
- When the pressure P_3 acts on the rod, a clockwise moment proportional to the pressure is created on the swash plate. This causes the P-Q characteristic curve to shift. Thus, the total horsepower, including the horsepower of the gear pumps, can be maintained at a constant level. (Total horsepower control mechanism)

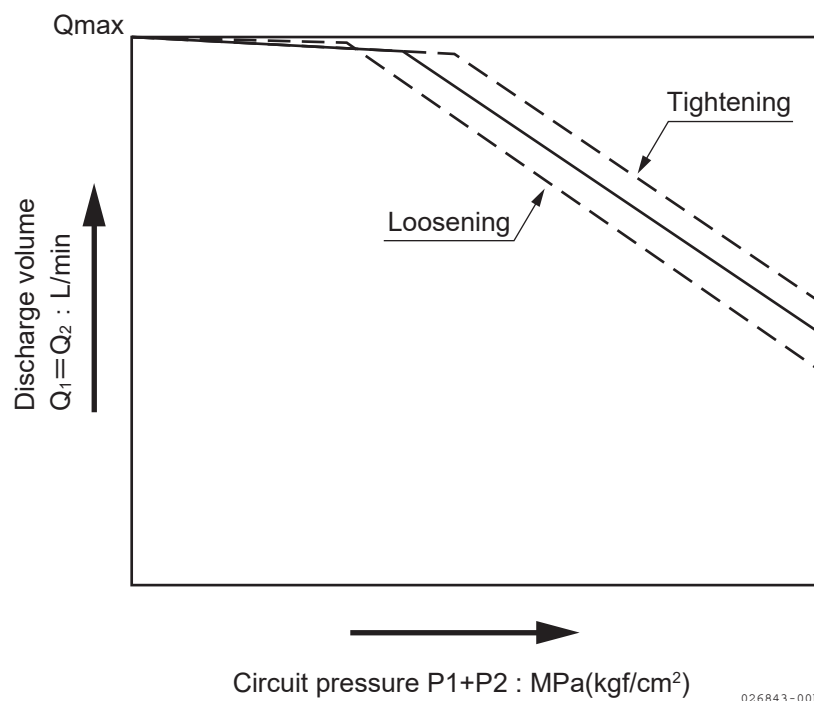
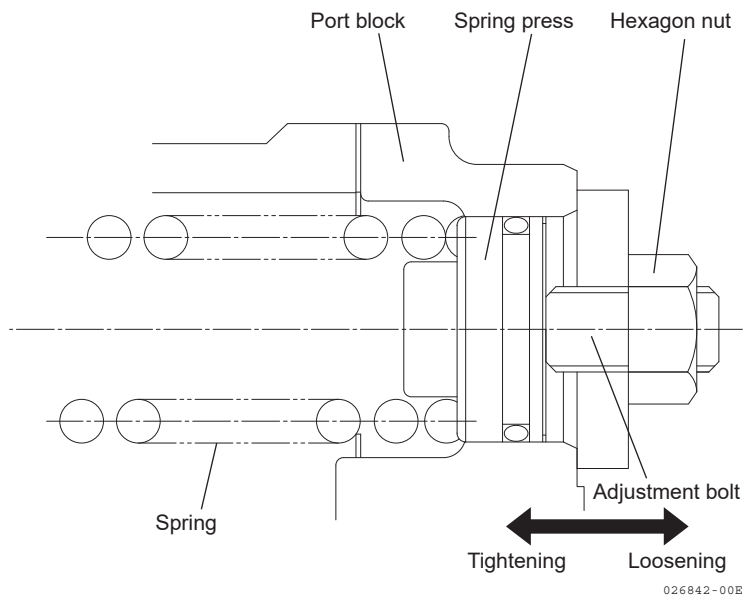


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6. HYDRAULIC SYSTEM

3) Torque Adjustment Procedure

- (1) Loosen the hexagon nut.
- (2) Set the horsepower diagram by either tightening or loosening the adjustment bolt.

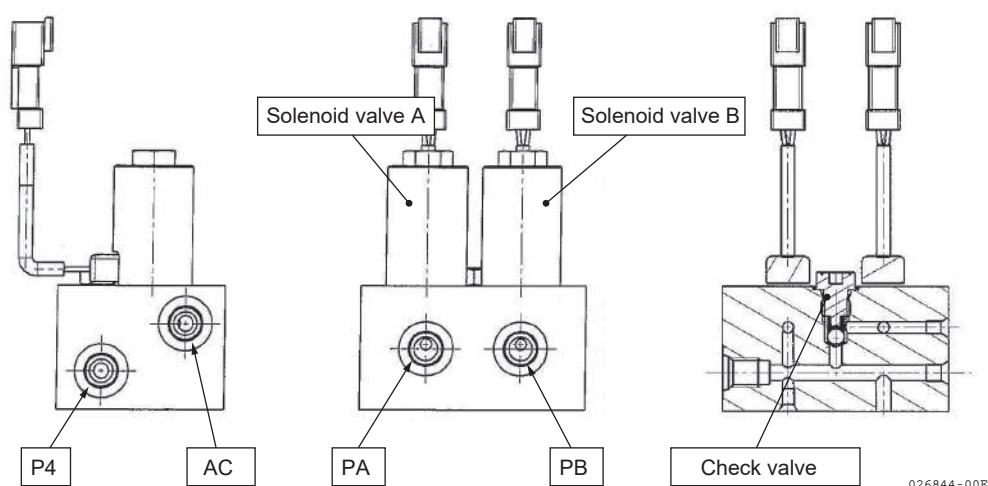


6. HYDRAULIC SYSTEM

4) Function of Solenoid Valve CMP

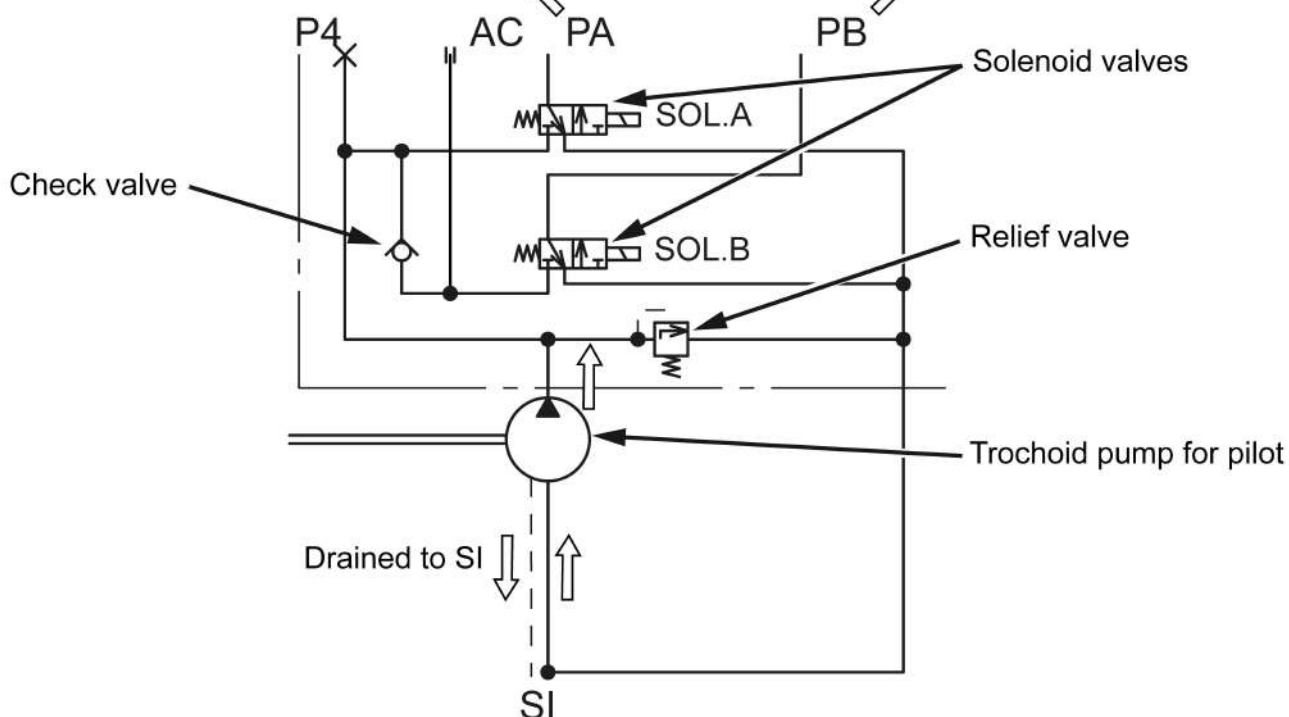
This pump has the solenoid valve CMP, which switches the oil from the pilot pump. The solenoid valve CMP has the multiple solenoid valves and check valves.

- (1) The solenoid valve A supplies the oil to the port PA when it is turned on. The solenoid valve A blocks the pilot pressure and releases the oil to the intake port through the relief valve of the pump when it is turned off.
- (2) The oil is guided to the solenoid valve B via the check valve. The oil passage between the check valve and solenoid valve B is divided and one side is connected to the solenoid valve and the other is connected to the port PAC.
- (3) The solenoid valve B supplies the oil to the port PB when it is turned on. The solenoid valve B blocks the pilot pressure and releases the oil to the intake port through the relief valve of the pump when it is turned off.



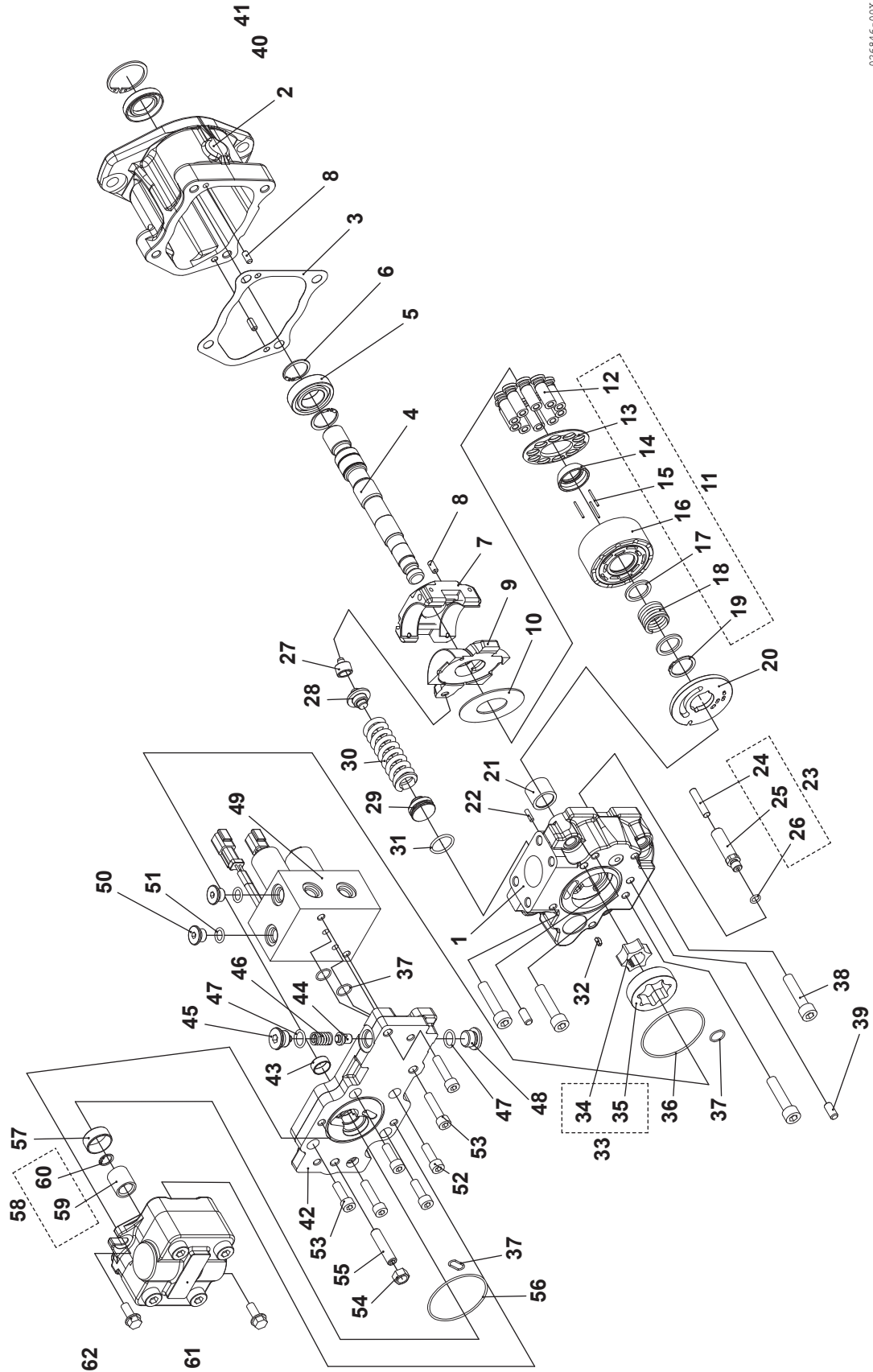
Supplied to the 2-speed valve of the travel motor
(operation of the 2-speed valve)

Supplied to the pilot valve
(turning on and off the pilot pressure)



6. HYDRAULIC SYSTEM

6.3.3 Exploded View and Component Parts



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6. HYDRAULIC SYSTEM

No.	Part	Q'ty	No.	Part	Q'ty
1	Port block	1	32	Key	1
2	Housing	1	33	Rotor SET	1
3	Packing	1	34	Inner rotor	1
4	Shaft	1	35	Outer rotor	1
5	Bearing	1	36	O-ring	1
6	S-shaped snap ring	2	37	O-ring	4
7	Cradle holder CMP	1	38	Hexagon socket head bolt	4
8	Parallel pin	3	39	Parallel pin	2
9	Cradle	1	40	Oil seal	1
10	Thrust plate	1	41	For C-shaped snap ring hole	1
11	Plunger block CMP	1	42	Control block	1
12	Plunger CMP	10	43	Bush	1
13	Retainer	1	44	Relief valve	1
14	Retainer press	1	45	Plug (relief valve)	1
15	Retainer press pin	3	46	Spring	1
16	Plunger block	1	47	O-ring	2
17	Spring bearing (plunger block)	2	48	Plug	1
18	Spring (plunger block)	1	49	Solenoid valve CMP	1
19	R-shaped snap ring	1	50	Plug	2
20	Valve plate	1	51	O-ring	2
21	Needle bearing	1	52	Hexagon socket head bolt	4
22	Parallel pin	1	53	Hexagon socket head bolt	3
23	Power piston SET	1	54	Small hexagon socket nut	1
24	Power piston	1	55	Set screw with hexagon socket	1
25	Stopper bolt	1	56	O-ring	1
26	O-ring	1	57	Collar (gear pump)	1
27	Step (spring)	1	58	Coupling SET	1
28	Spring press A	1	59	Coupling	1
29	Spring press B	1	60	For C-shaped snap ring hole	1
30	Tilt spring	1	61	Gear pump CMP	1
31	O-ring	1	62	Flange hexagon head bolt	2

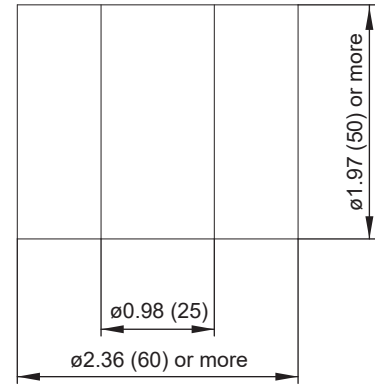
6. HYDRAULIC SYSTEM

4. Special Tool

[Unit : in. (mm)]

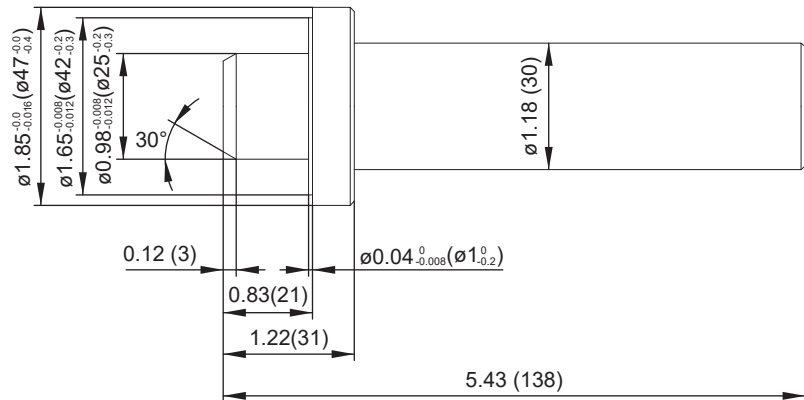
Plate for holding the pump with the shaft in downward

- Log or wooden block can be used as a substitute as long as the shaft ends do not touch.



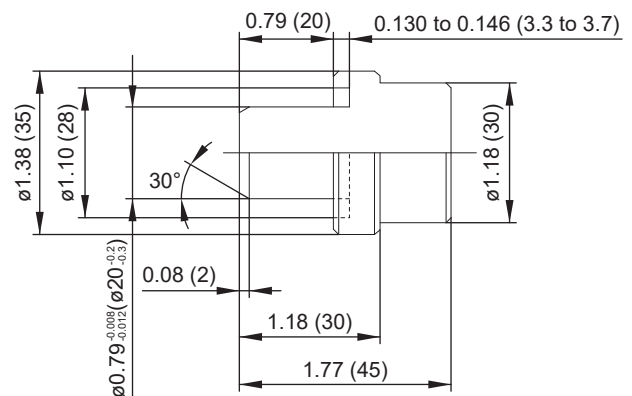
026847-00B

Oil seal installation jig



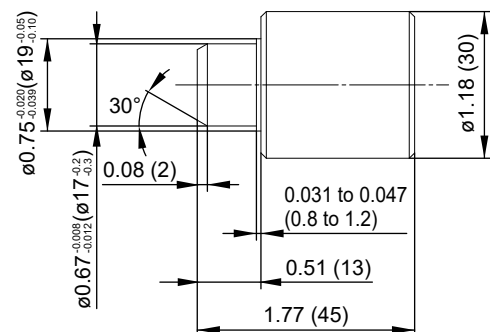
026848-00X

Needle bearing press-fitting jig



026849-00X

Bush press-fitting jig



026850-00X

6. HYDRAULIC SYSTEM

5. Disassembly and Reassembly

1) Precautions for Disassembly and Reassembly

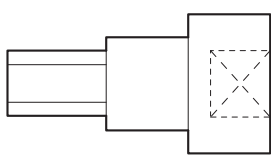
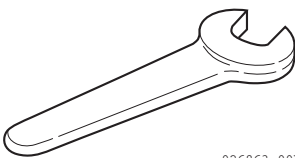
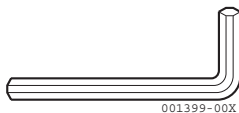
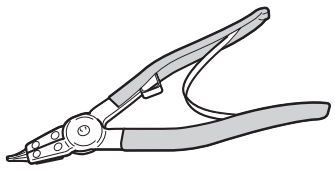
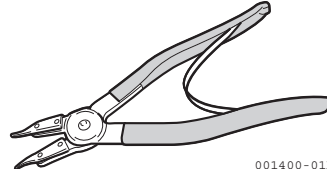
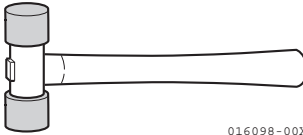
- (1) Since the parts of this hydraulic system are precision-made for tight clearances, be sure to perform disassembly and reassembly in a clean area that is free from dust.
- (2) Prepare clean tools and cleaning oil and handle the parts carefully.
- (3) First clean the external surface of the removed assemblies.
- (4) Before beginning disassembly, review the drawings of the internal construction and prepare the required parts according to the purpose and extent of the disassembly.
- (5) Never disassemble or readjust the adjust screws unless required. If they are disassembled or readjusted, it may cause the set horsepower to be changed and have a negative influence.
- (6) In principle, the removed seals and rings must be replaced with new ones. As some replacement parts are available only in subassemblies, refer to the parts catalog to prepare the necessary subassemblies in advance.
- (7) Handling of O-rings.
 - [1] Lubricate the O-rings and the O-ring fitting seats with clean grease or hydraulic oil.
 - [2] The O-rings may not be damaged in handling or distorted by heat.
 - [3] Do not permanently deform the O-rings.
 - [4] Avoid rolling the O-rings when fitting them.

A distorted O-ring may not return to its original shape, and therefore may cause oil leak.
- (8) Before beginning reassembly, check the mating surfaces of each section to be sure that there is no cleaning oil or hydraulic oil on the outer surface of the O-ring grooves.

If reassembly is performed without cleaning such oil, it may be mistaken for oil leak.
- (9) Use a torque wrench to tighten the bolts following the torque specification.
- (10) For the detachment of snap rings, care must be taken not to get injured by the fly out.
- (11) Do not use a metal hammer, as it may damage the parts.
- (12) For grease, the lithium system class 3 grease for bearing (JIS K 2220) or its equivalent is recommended.

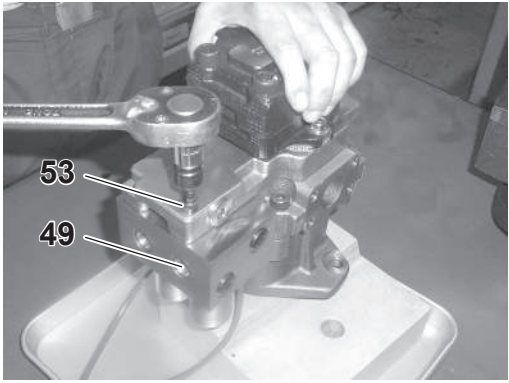
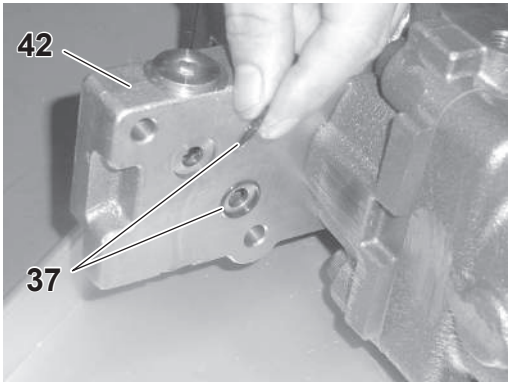
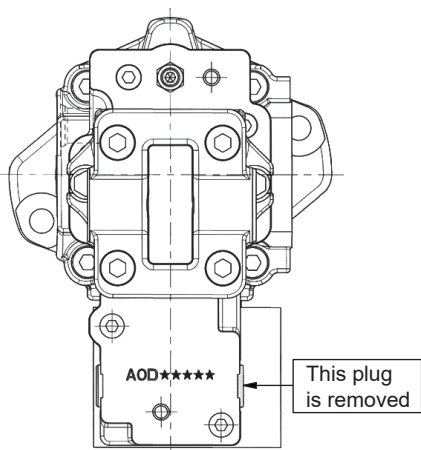
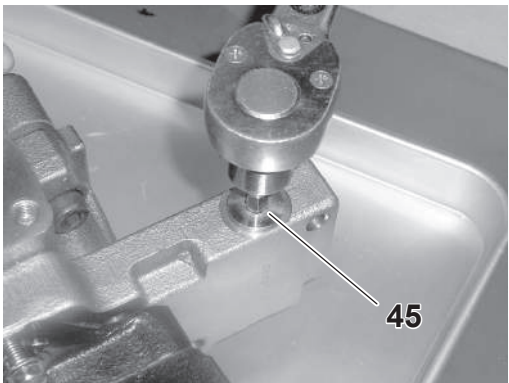
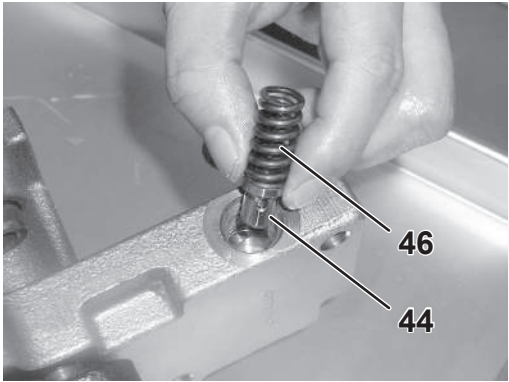
6. HYDRAULIC SYSTEM

2) Tools for Disassembly and Reassembly

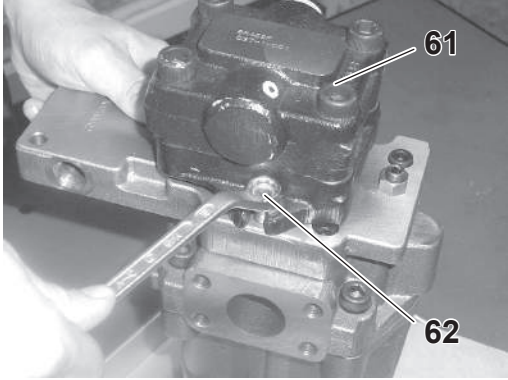
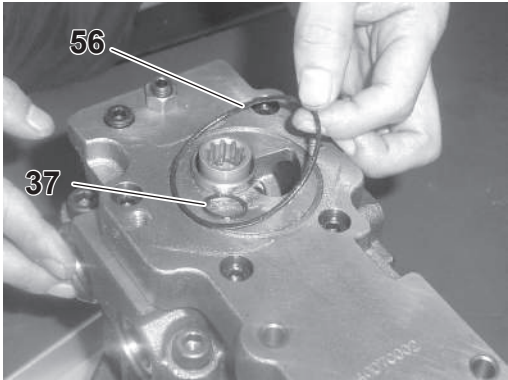
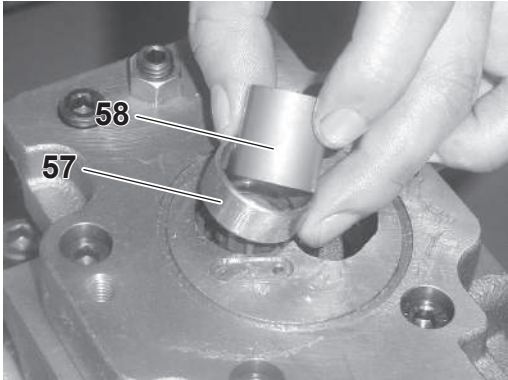
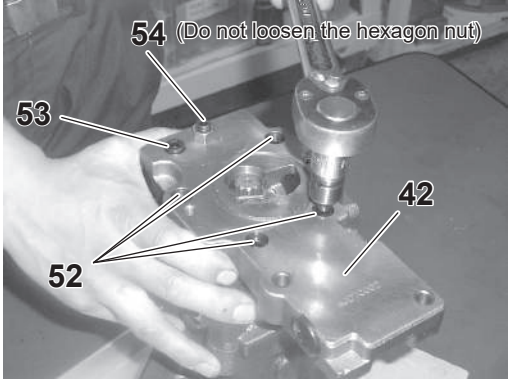
	Tools used	Parts used	Shape
Torque wrench	Tightening torque : 25N·m (2.5kgf·m)	M8 Hexagon socket head bolt G1/4 plug	 026861-00X
	Tightening torque : 34N·m (3.5kgf·m)	G3/8 plug	
	Tightening torque : 15N·m (1.5kgf·m) Width across flats : 13mm	G1/8 (stopper bolt)	 026862-00X
	Tightening torque : 25N·m (2.5kgf·m) Width across flats : 12mm	M8 Hexagon head bolt	
	Tightening torque : 45N·m (4.6kgf·m) Width across flats : 14mm	M10 Nut (adjustment bolt portion)	
Hexagon socket for torque wrench	Width across flats : 6mm	M8 Hexagon head bolt G1/4 plug	 024970-00X
	Width across flats : 8mm	G3/8 plug	
Wrench	Width across flats : 12mm	M8 Hexagon head bolt	 026863-00X
	Width across flats : 13mm	G1/8 (stopper bolt)	
	Width across flats : 14mm	M10 Nut (adjustment bolt portion)	
Hexagon wrench	Width across flats : 5mm	adjustment bolt	 001399-00X
	Width across flats : 6mm	M8 Hexagon socket head bolt G1/4 plug	
	Width across flats : 8mm	G3/8 plug	
Snap ring plier	For hole		  001400-01X
	For shaft		
Plastic hammer			 016098-00X
Hand press			

6. HYDRAULIC SYSTEM

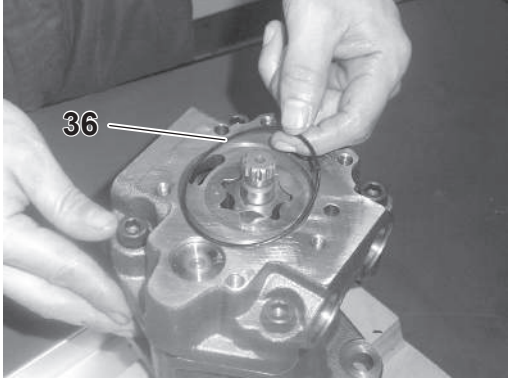
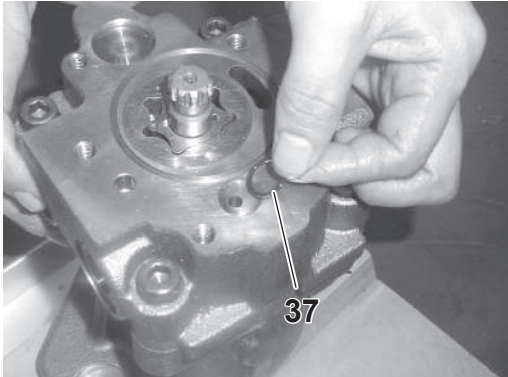
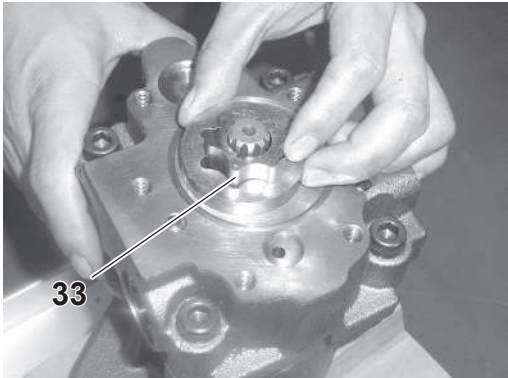
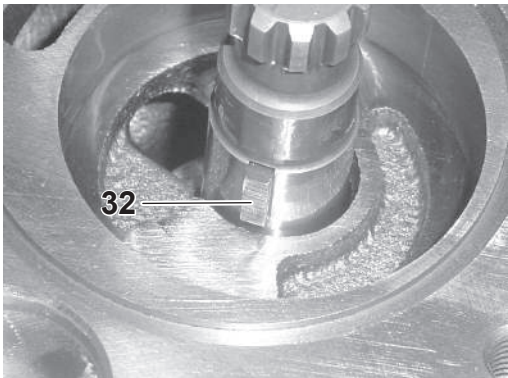
3) Disassembly

Procedure	
(1) Remove the two hexagon socket head bolts 53 to remove the solenoid valve CMP 49. Note: <i>Take care not to drop the valve.</i>	
(2) Remove the two O-rings 37 between the control block 42 and solenoid valve CMP 49.	
(3) Remove the plug 45 to remove the relief valve 44 and the spring 46.  The figure viewed from the gear pump CMP side 026851-00E Note: <i>Do not disassemble unless necessary.</i>	 

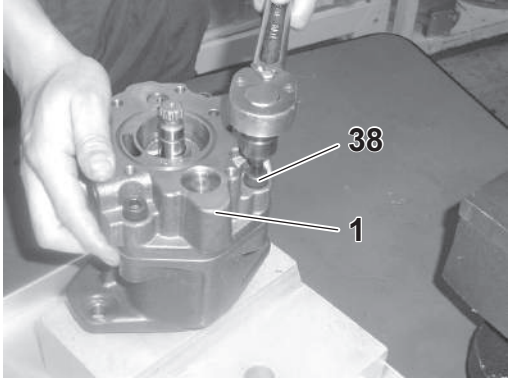
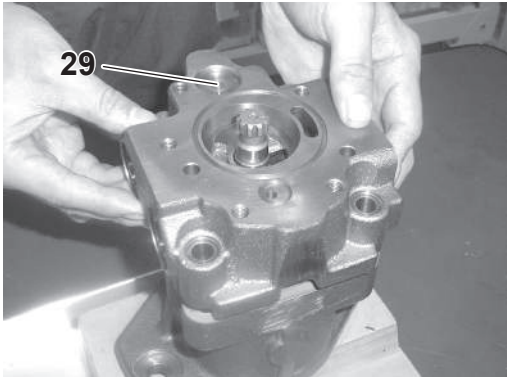
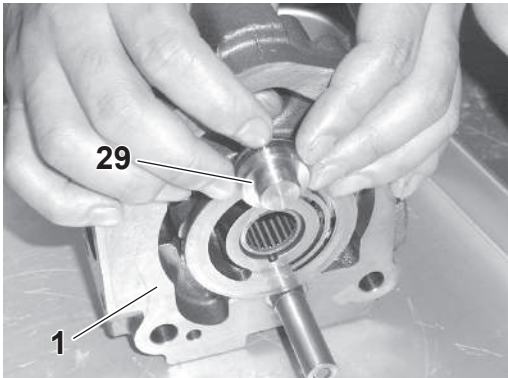
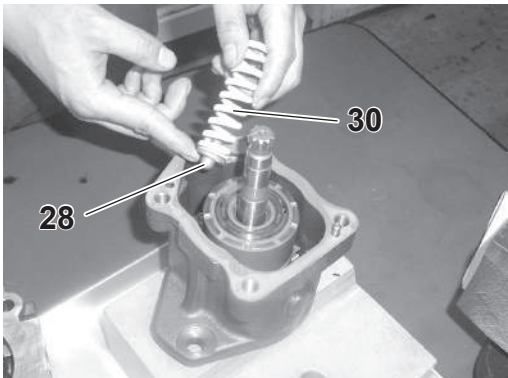
6. HYDRAULIC SYSTEM

Procedure	
(4) Remove the two flange hexagon head bolts 62 to remove the gear pump CMP 61.	
(5) Remove the O-rings 37 and 56, the collar 57, and the coupling SET 58.	 
(6) Remove the four hexagon socket head bolts 52 and the one hexagon socket head bolt 53 to remove the control block 42. Note: <i>Do not loosen the hexagon nut 54 as the output characteristic changes.</i>	

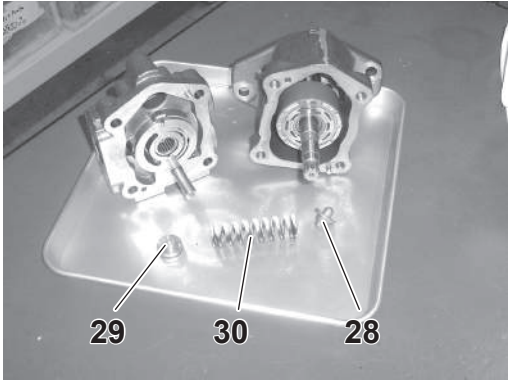
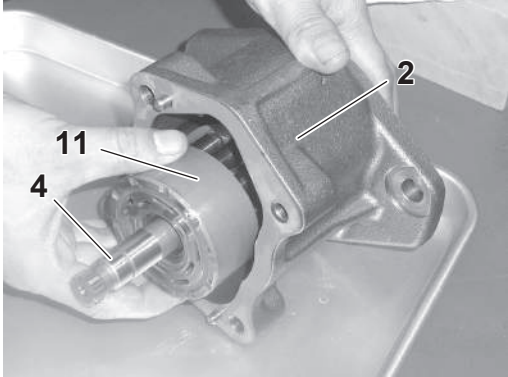
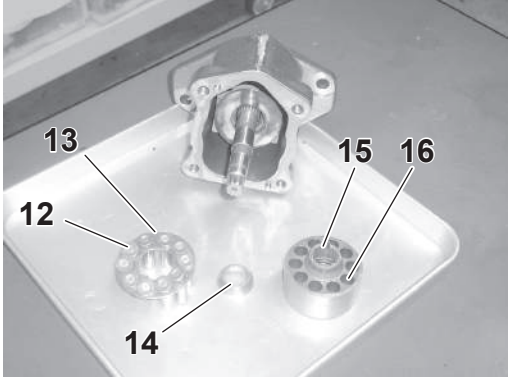
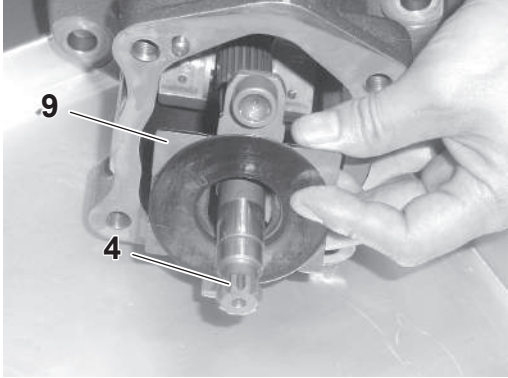
6. HYDRAULIC SYSTEM

Procedure	
(7) Remove the O-rings 36 and 37.	 
(8) Remove the rotor SET 33 to remove the key 32.	 

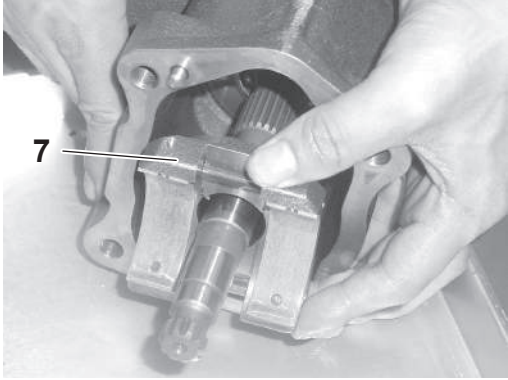
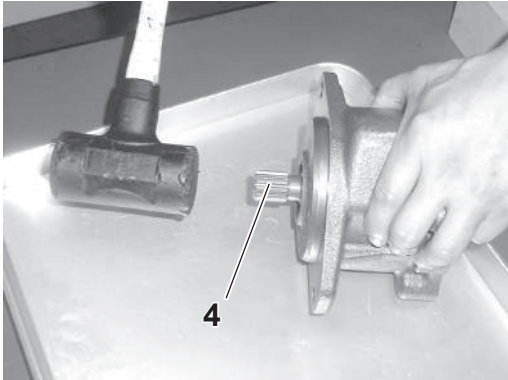
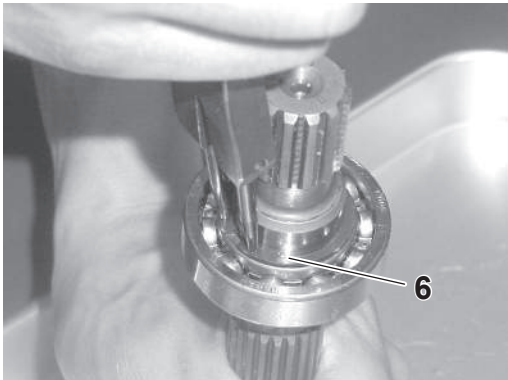
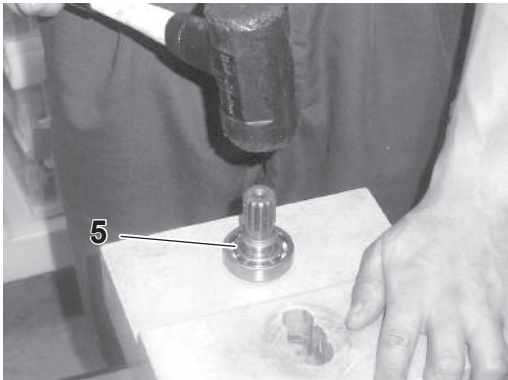
6. HYDRAULIC SYSTEM

Procedure	
(9) Remove the four hexagon socket head bolts 38 and the port block 1 to remove the spring press B 29.	  
(10) Remove the tilt spring 30 and the spring press A 28 in the housing.	

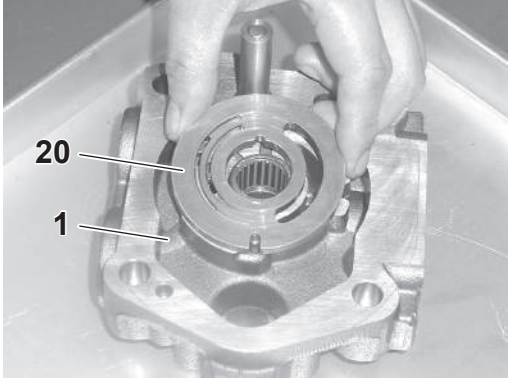
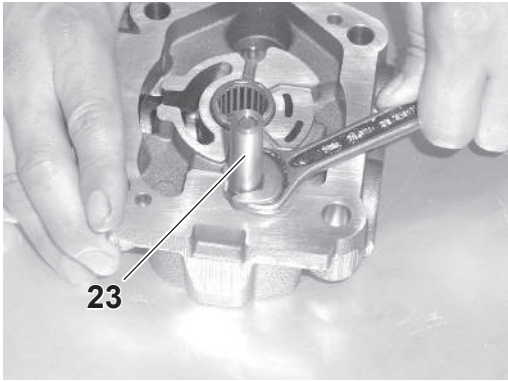
6. HYDRAULIC SYSTEM

Procedure	
(11)The removed condition.	 A black and white photograph showing three disassembled hydraulic components laid out on a white plastic tray. The components are labeled with numbers: 29 points to a small pin, 30 points to a coiled spring, and 28 points to a larger cylindrical part.
(12)Lay the housing 2 down and remove the plunger block CMP 11 from the shaft 4. Note: <i>Take care not to lose the retainer press pin 15 that may drop at this time.</i>	 A black and white photograph showing a hand removing a plunger block (labeled 11) from a shaft (labeled 4) inside a housing (labeled 2). The components are resting on a white plastic tray.
(13)The condition in which the plunger block CMP 11 is removed. • Plunger CMP 12 • Retainer 13 • Retainer press 14 • Retainer press pin 15 • Plunger block 16	 A black and white photograph showing the disassembled components from the previous step laid out on a white plastic tray. The components are labeled: 13 (retainer), 12 (plunger CMP), 14 (retainer press), 15 (retainer press pin), and 16 (plunger block).
(14)Remove the cradle 9 by pushing the shaft 4 through.	 A black and white photograph showing a hand pushing a shaft (labeled 4) through a cradle (labeled 9). The components are resting on a white plastic tray.

6. HYDRAULIC SYSTEM

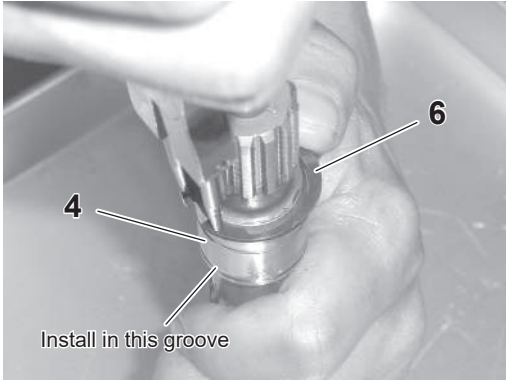
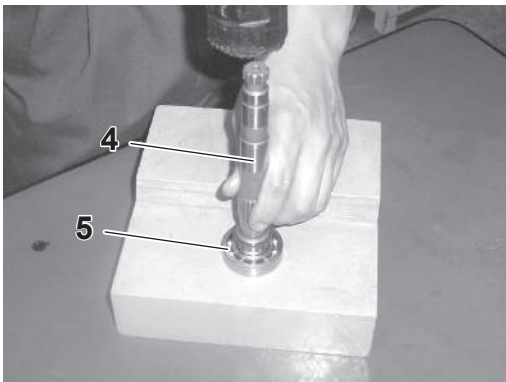
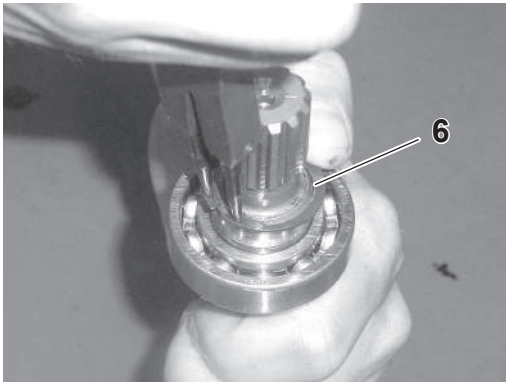
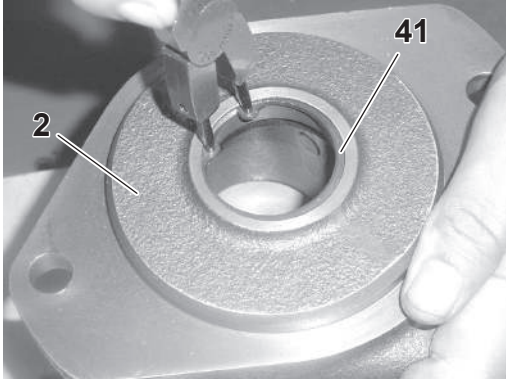
Procedure	
(15) Remove the cradle holder CMP 7 by pushing the shaft 4 through.	
(16) Remove the shaft 4 while tapping its tip lightly with a plastic hammer. Note: Cover the spline with a masking tape or the like to avoid cutting the lip portion of the oil seal 40 with the shaft spline.	
(17) Remove the one S-shaped snap ring 6 from the shaft 4 with a snap ring plier.	
(18) Remove the bearing 5 while tapping the end of the shaft 4 with a plastic hammer.	

6. HYDRAULIC SYSTEM

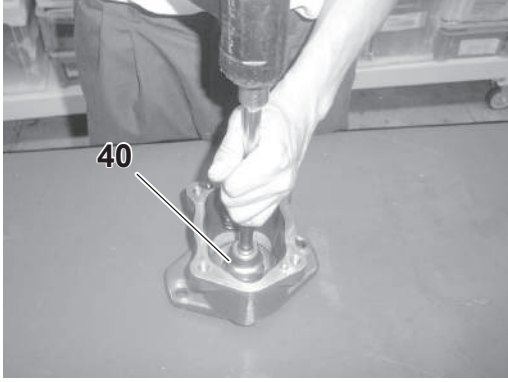
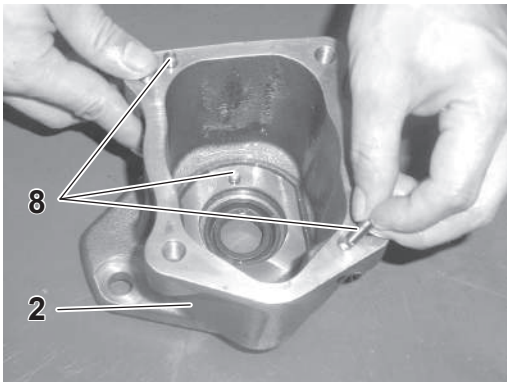
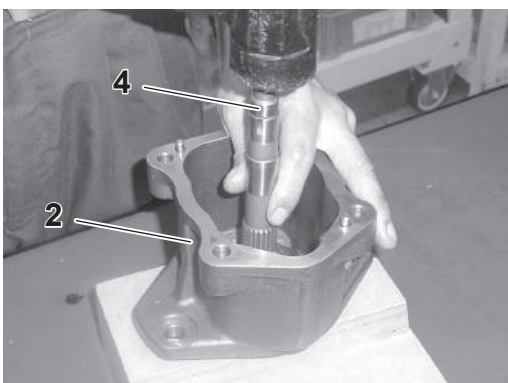
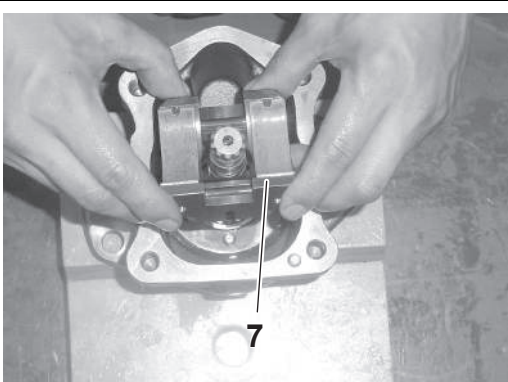
Procedure	
(19) Remove the valve plate 20 from the port block 1.	
(20) Remove the power piston set 23 from the port block 1. Note: <i>Do not disassemble unless necessary.</i>	

6. HYDRAULIC SYSTEM

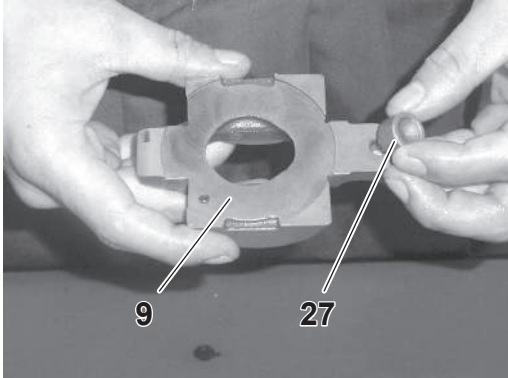
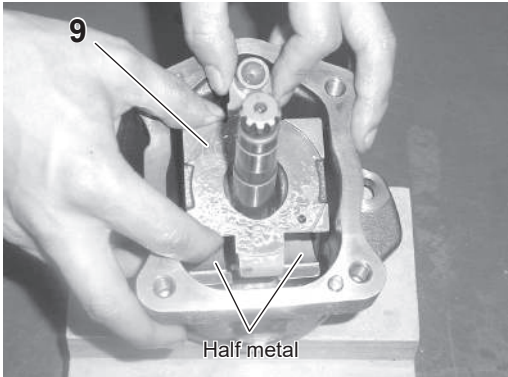
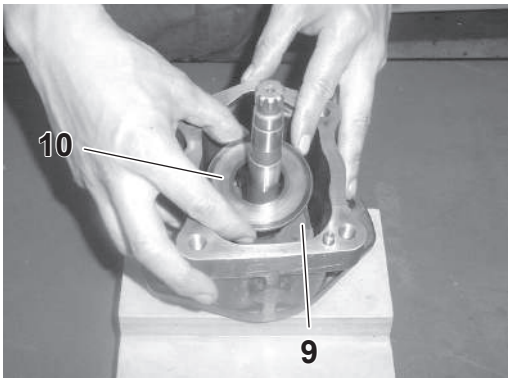
4) Installation

Procedure	
(1) Install the one S-shaped snap ring 6 to the shaft 4 with a snap ring plier.(Install in the groove in the lower side of the photograph.)	
(2) Tap and drive the end of the shaft 4 with a plastic hammer by using the bearing 5 as a base.	
(3) Install the one S-shaped snap ring 6 with a snap ring plier and fix the bearing 5.	
(4) Install the snap ring 41 to the housing 2 with a snap ring plier.	

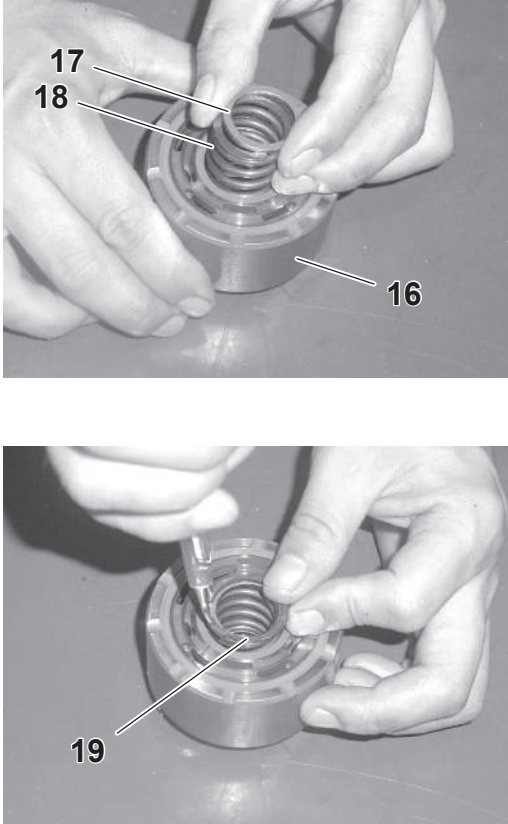
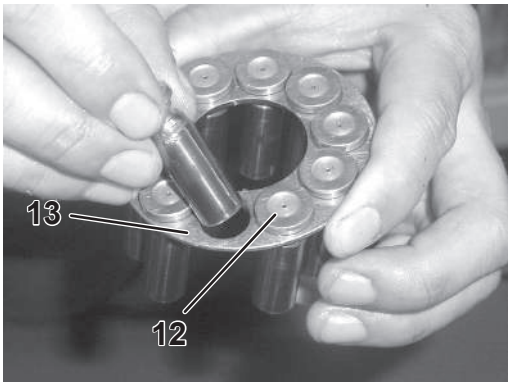
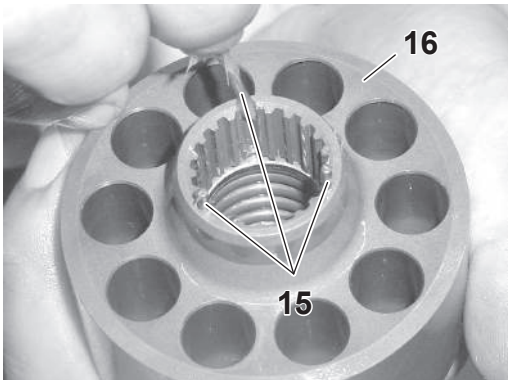
6. HYDRAULIC SYSTEM

Procedure	
(5) Install the oil seal 40 to the housing 2 vertically with a plastic hammer by using an oil seal installation jig. Note: <i>Apply grease to the oil seal lip portion.</i>	
(6) Install the three parallel pins 8 to the housing 2.	
(7) Install the shaft 4, in which the bearing is fixed, to the housing 2 with a plastic hammer. Note: <i>Cover the spline with a masking tape or the like to avoid cutting the lip portion of the oil seal 40 with the shaft spline.</i>	
(8) Install the cradle holder CMP 7 to the housing 2. Note: • Apply grease or hydraulic oil to the half bearing. • Confirm that the cradle holder CMP is not rising.	

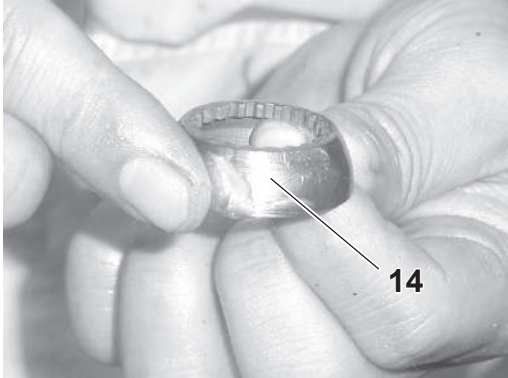
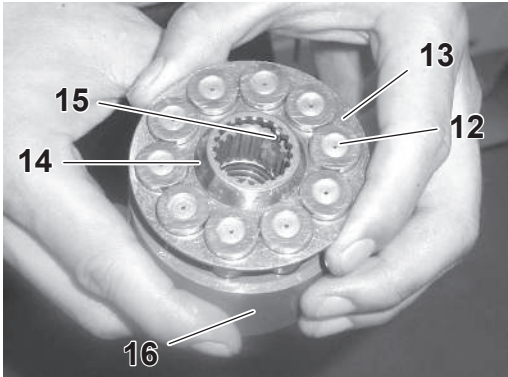
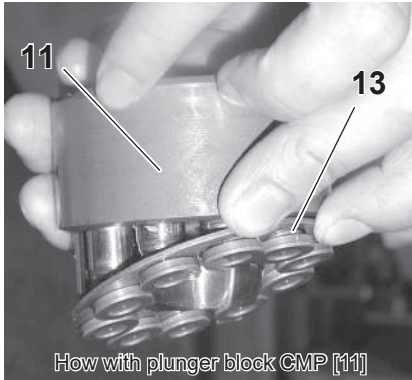
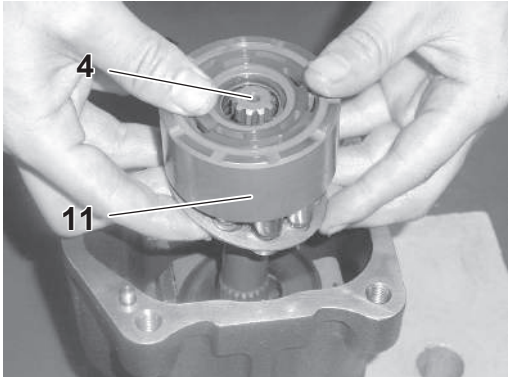
6. HYDRAULIC SYSTEM

Procedure	
(9) Install the step 27 to the cradle 9.	
(10) Install the cradle 9 on the half bearing of the cradle holder CMP 7. Note: <i>Install exactly along the dent of the half bearing.</i>	
(11) Install the thrust plate 10 to the cradle 9. Note: <i>Apply hydraulic oil to the thrust plate at the time of installation.</i>	

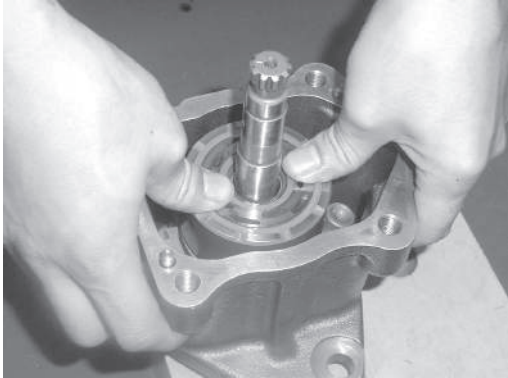
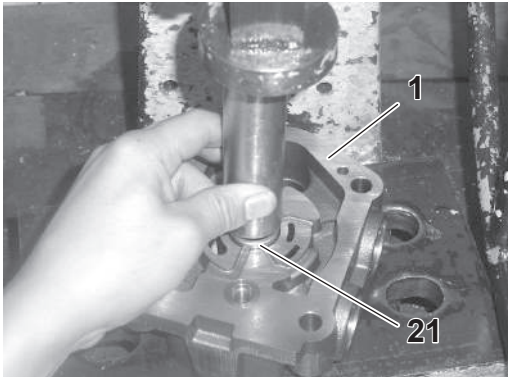
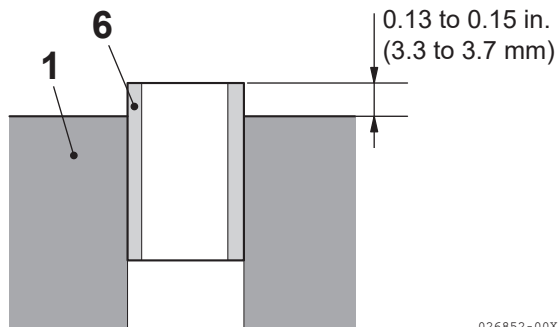
6. HYDRAULIC SYSTEM

Procedure	
(12) Installation of the plunger block CMP (1) Install the spring bearing 17 and the spring 18 to the plunger block 16 and fix it with the R-shaped snap ring 19. Note: <i>Install in the order of the spring bearing, the spring, and the spring bearing to the plunger block.</i>	
(13) Installation of the plunger block CMP (2) Install the ten plunger CMPs 12 to the retainer 13.	
(14) Installation of the plunger block CMP (3) Install the three retainer press pins 15 to the plunger block 16 after applying grease.	

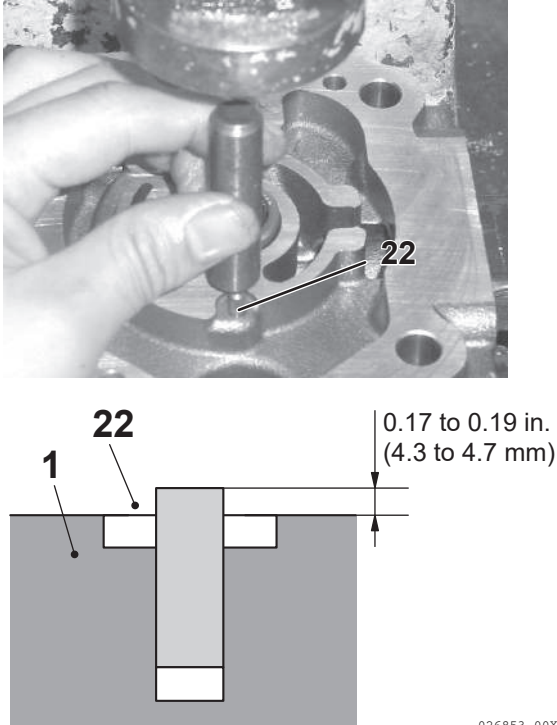
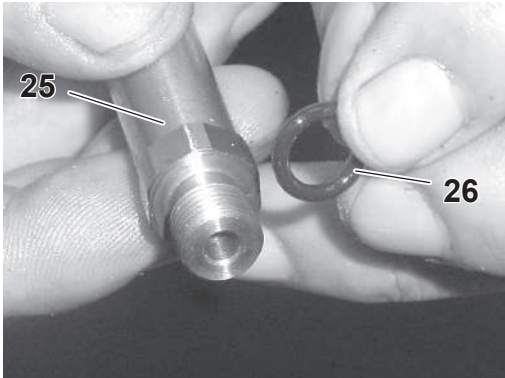
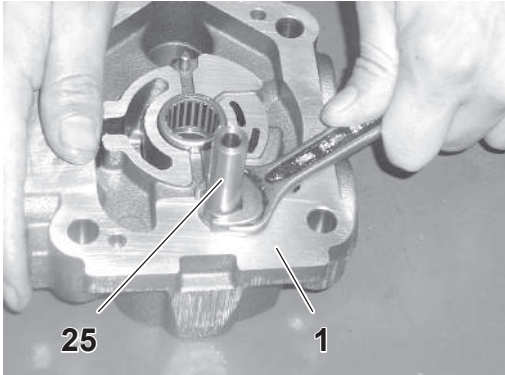
6. HYDRAULIC SYSTEM

Procedure	
(15)Installation of the plunger block CMP (4) Apply grease to the sphere portion of the retainer press 14.	
(16)Installation of the plunger block CMP (5) Place the retainer press 14 to the pins 15 on the plunger block 16, and insert the plunger CMP 12 to the plunger hole while the retainer 13 is in the installed condition. Note: <i>Do not tap the plunger CMP with a hammer or the like.</i>	
(17)Align and install the plunger block CMP 11 to the spline of the shaft 4. By pressing the retainer 13 with middle fingers and index fingers, as seen in the lower right figure, the plunger block CMP 11 is unlikely to fall apart at the time of installation. Note: <i>Take care not to lose the retainer press pin 15 that may drop at the time of installation.</i>	 How with plunger block CMP [11] 

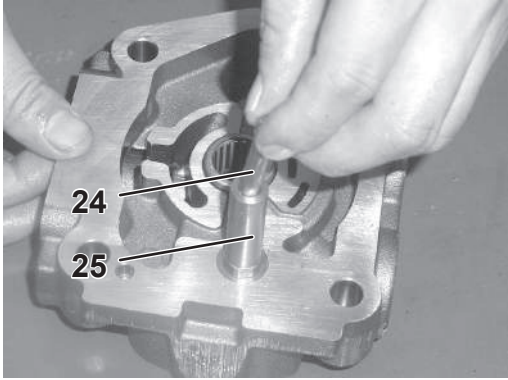
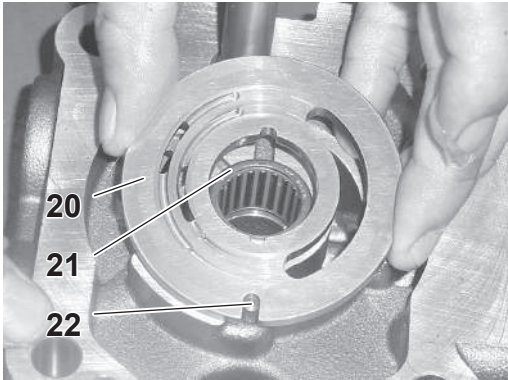
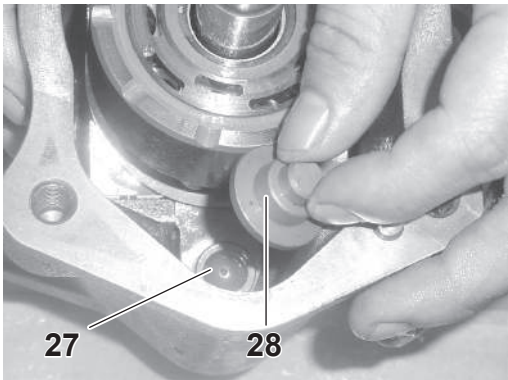
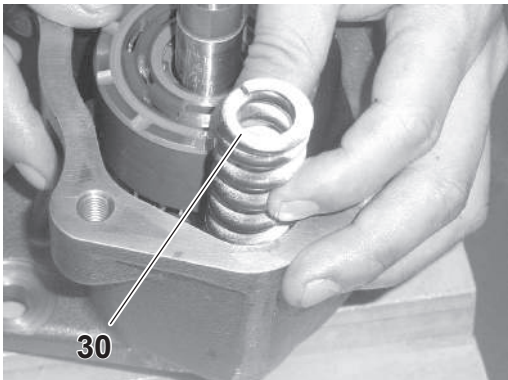
6. HYDRAULIC SYSTEM

Procedure	
(18) Confirm that the spring in the plunger block works after the installation of the plunger block CMP. Note: <i>Apply hydraulic oil to the bottom of the plunger block after the confirmation.</i>	
(19) Press-fit the needle bearing 21 to the port block 1 vertically with a hand press by using a needle bearing installation jig. Injection height: 0.13 to 0.15 in. (3.3 to 3.7 mm) from the valve plate fitting face	  026852-00X

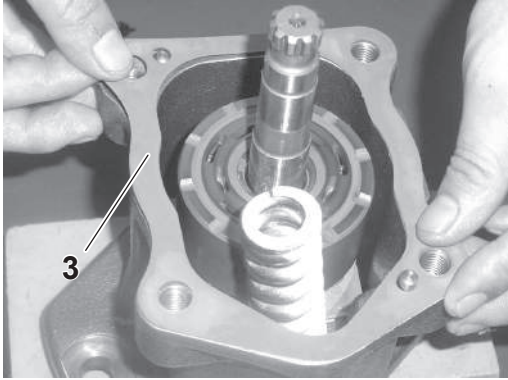
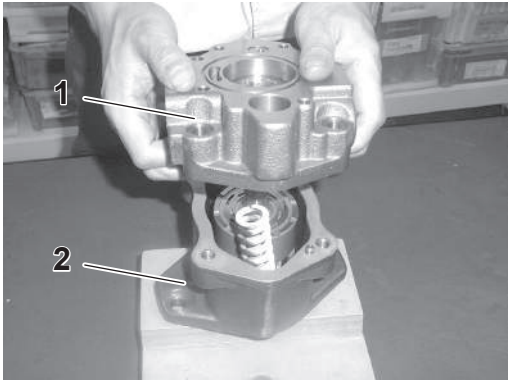
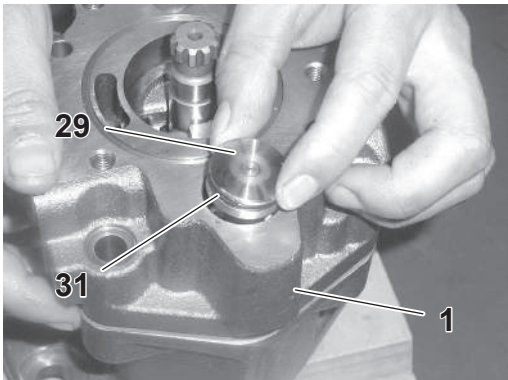
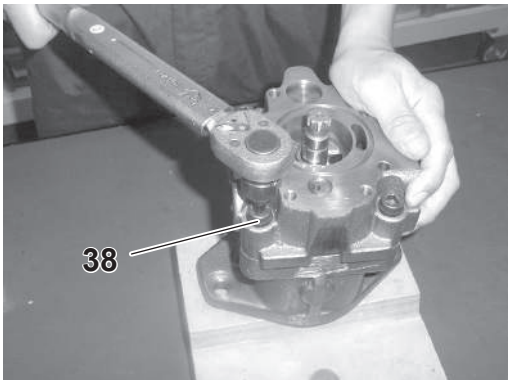
6. HYDRAULIC SYSTEM

Procedure	
(20) Press-fit the positioning parallel pin 22 of the valve plate 20 installation to the port block 1 vertically with a hand press. Injection height: 0.17 to 0.19 in. (4.3 to 4.7 mm) from the valve plate fitting face	 026853-00X
(21) Install the O-ring 26 to the stopper bolt 25.	
(22) Install the stopper bolt 25 to the port block 1. Tightening torque: 10.0 to 12.2 ft·lbf (13.5 to 16.5 N·m)	

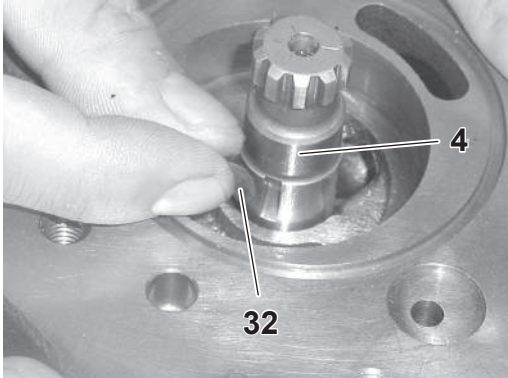
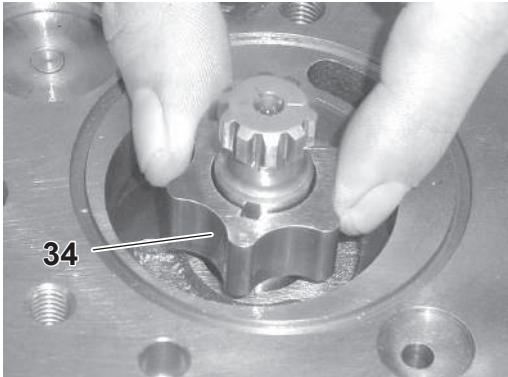
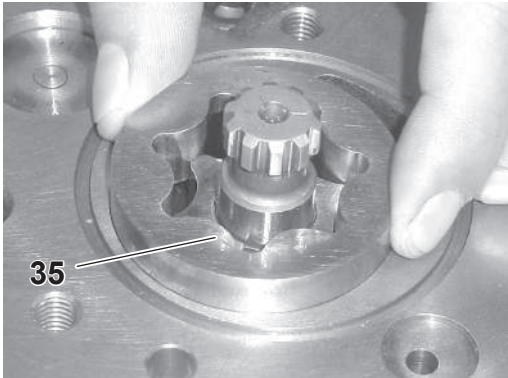
6. HYDRAULIC SYSTEM

Procedure	
(23)Install the power piston 24 to the stopper bolt 25 after applying grease.	
(24)Apply grease to the back face of the valve plate 20, align it to the positioning pin 22 and the outside cylindrical surface of the needle bearing 21 and install it to the port block 1.	
(25)Install the spring press A 28 to the step 27. Note: <i>Apply grease to the spring press A.</i>	
(26)Install the tilt spring 30 to the spring press A 28.	

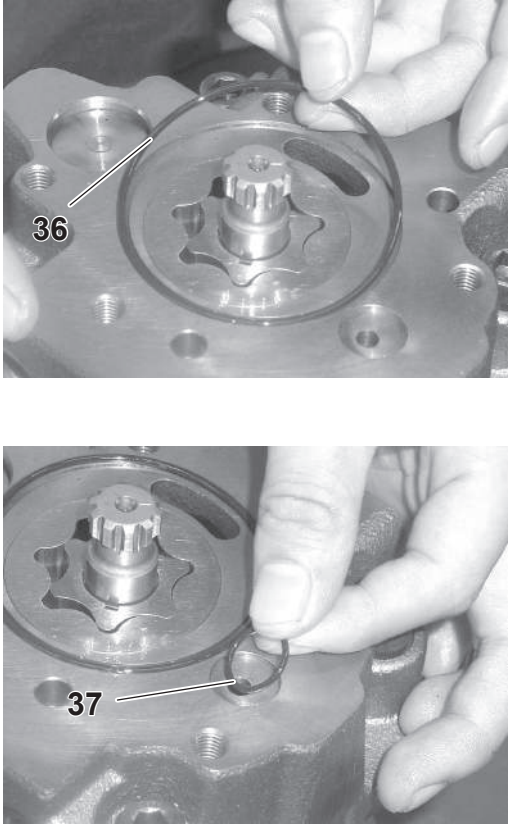
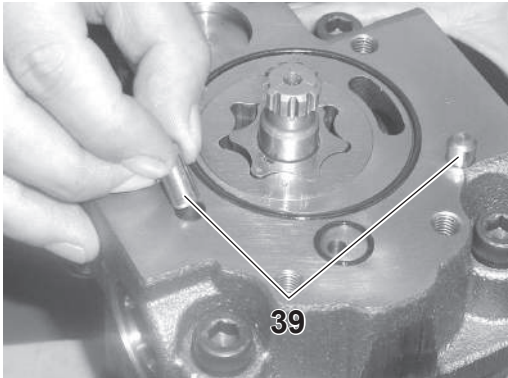
6. HYDRAULIC SYSTEM

Procedure	
(27) Install the packing 3 to the port block fitting face of the housing 2.	
(28) Install the port block 1 in parallel to the fitting face of the housing 2. Note: • Take care not to drop the valve plate and the piston. • Ensure that the port block is not stranded on the tile spring 30.	
(29) Install the spring press B 29 (with the O-ring 31) to the port block 1. Note: Apply grease to the O-ring 31 before installation.	
(30) Tighten the four hexagon socket head bolts 38 to the port block 1. Tightening torque: 29.9 to 36.5 ft·lbf (40.5 to 49.5 N·m)	

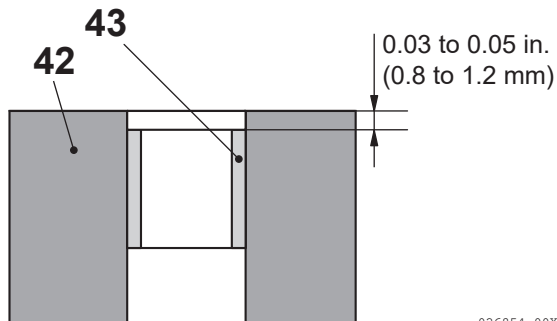
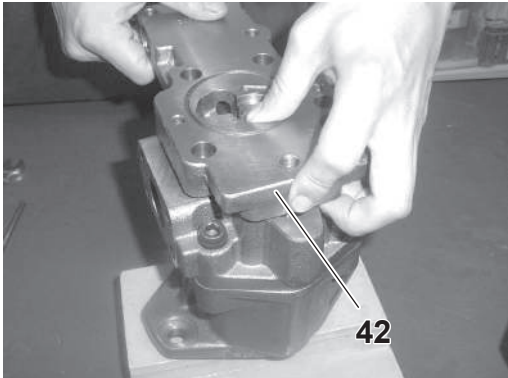
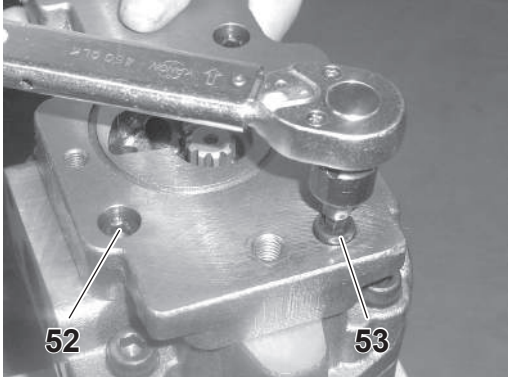
6. HYDRAULIC SYSTEM

Procedure	
(31) Install the key 32 to the shaft 4. Note: <i>Apply grease before the installation to prevent it from dropping.</i>	
(32) Install the inner rotor 34 of the rotor SET 33 to the shaft 4 and insert the outer rotor 35 to the rotor hole of the port block 1. Note: <i>Take care not to drop the key 32 to the inside of the piston pump at the time of the inner rotor installation.</i>	 

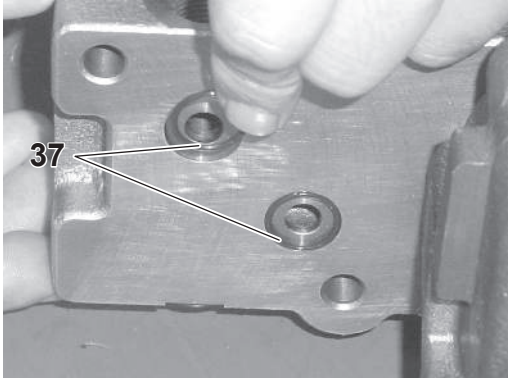
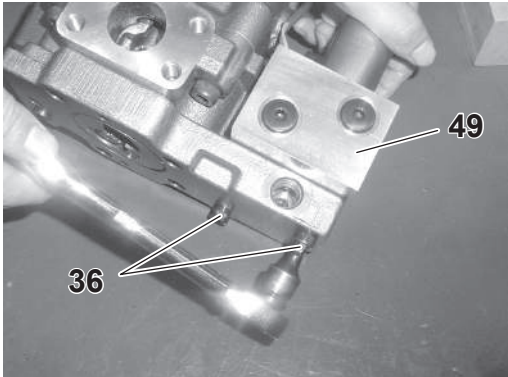
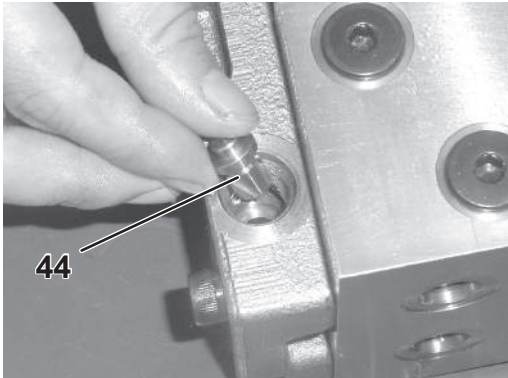
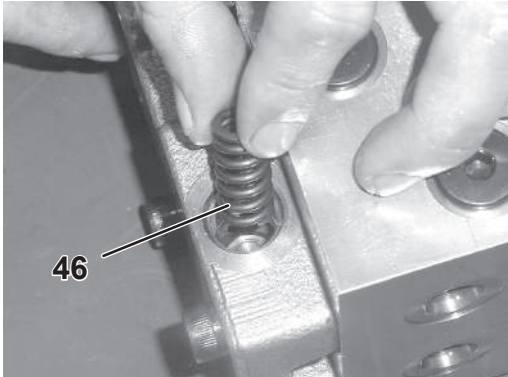
6. HYDRAULIC SYSTEM

Procedure	
(33) Install the O-rings 36 and 37 (one piece each) to the port block.	 The top photograph shows a hand installing O-ring 36 into a groove on a port block. The bottom photograph shows a hand installing O-ring 37 into a different groove on the same port block.
(34) Install the parallel pin 39 to the port block 1.	 The photograph shows a hand inserting a parallel pin 39 into a hole in a port block.

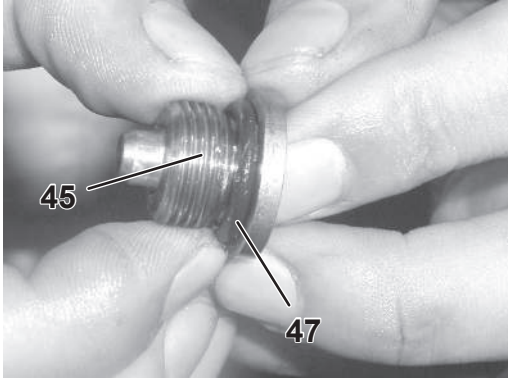
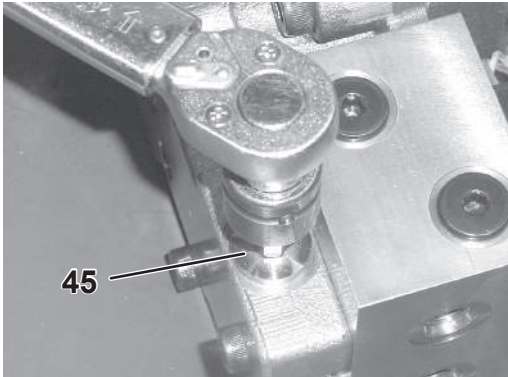
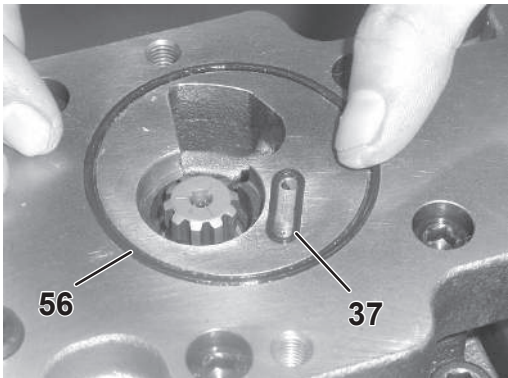
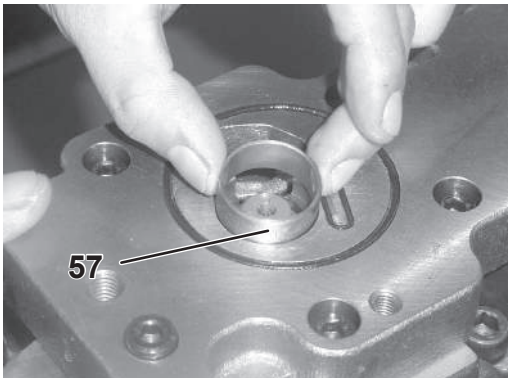
6. HYDRAULIC SYSTEM

Procedure	
(35) Press-fit the bush 43 vertically with a hand press from the port block 1 fitting face side of the control block 42. Note: <i>Ensure that the bush does not fly out from the fitting face.</i> Injection height: 0.03 to 0.05 in. (0.8 to 1.2 mm) from the fitting face	  0.03 to 0.05 in. (0.8 to 1.2 mm) 026854-00X
(36) Install the control block 42. Note: <i>Confirm that the O-ring is fitted in the O-ring groove of the port block.</i>	
(37) Tighten the port block 42 with the four hexagon socket head bolts 52 and the one hexagon socket head bolt 53. Tightening torque: 16.6 to 20.3 ft·lbf (22.5 to 27.5 N·m)	

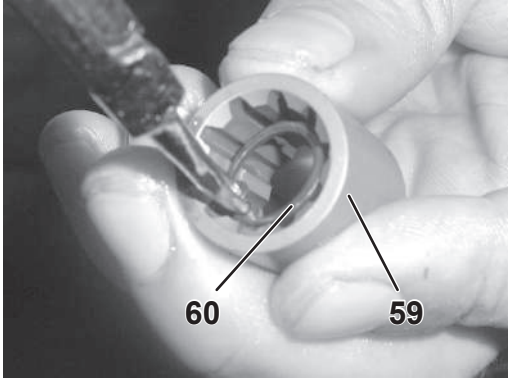
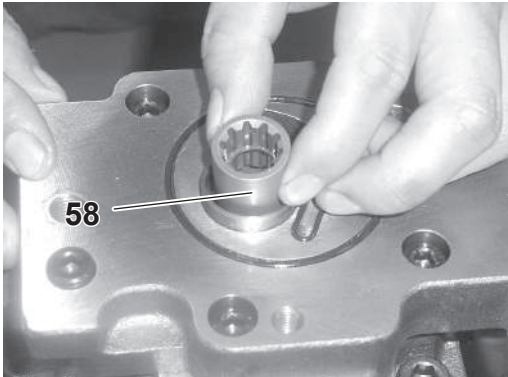
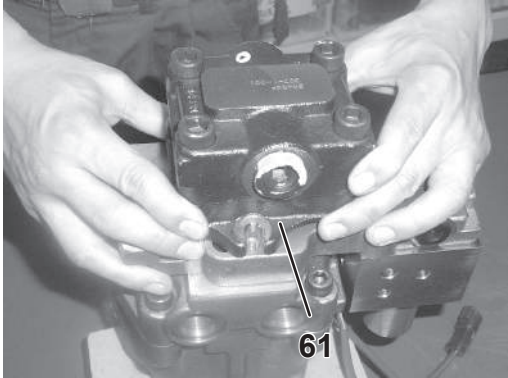
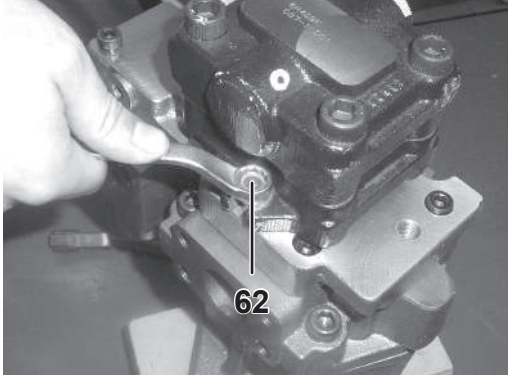
6. HYDRAULIC SYSTEM

Procedure	
(38) Install the two O-rings 37 to the O-ring groove in the solenoid valve CMP 49 fitting face side of the control block after applying grease.	
(39) Install the solenoid valve CMP 49 and tighten it with the two hexagon head bolts 53. Note: <i>Take care not to drop the O-rings at this time.</i> Tightening torque: 16.6 to 20.3 ft·lbf (22.5 to 27.5 N·m)	
(40) Install the relief valve 44 to the control block 42. Note: <i>Care must be taken for the direction of the valve.</i>	
(41) Install the spring 46 to the control block 42. Note: <i>Confirm that the height of the relief valve is fitted in the inside diameter of the spring.</i>	

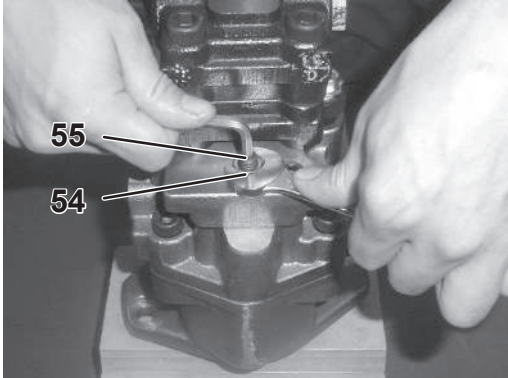
6. HYDRAULIC SYSTEM

Procedure	
(42) Install the plug 45 (with the O-ring 47) to the control block 42. Note: <i>Confirm that the height of the relief valve is fitted in the inside diameter of the spring.</i> Tightening torque: 22.6 to 27.6 ft·lbf (30.6 to 37.4 N·m)	 
(43) Install the two O-rings 36 and 56 (one piece each) to the O-ring grooves in the gear pump CMP 61 fitting face side of the control block.	
(44) Install the collar 57 to the control block 42.	

6. HYDRAULIC SYSTEM

Procedure	
(45) Install the C-shaped snap ring 60 to the assembly coupling 59 of the coupling SET 58 .	
(46) Install the coupling SET 58 to the shaft 4 .	
(47) Install the gear pump CMP 61 by aligning the spline of the gear pump and the spline of the coupling.	
(48) Tighten the gear pump CMP 61 with the two flange hexagon head bolts 62 . Tightening torque: 16.6 to 20.3 ft·lbf (22.5 to 27.5 N·m)	

6. HYDRAULIC SYSTEM

Procedure	
(49) Install the set screw with hexagon socket 55 (adjustment bolt) and tighten it with the hexagon nut 54 after adjusting to the same protrusion as before the disassembly. Note: • <i>Do not disassemble unless necessary.</i> • <i>Fix the set screw with hexagon socket with a hexagon wrench and tighten.</i> Tightening torque: 29.9 to 36.5 ft·lbf (40.5 to 49.5 N·m)	

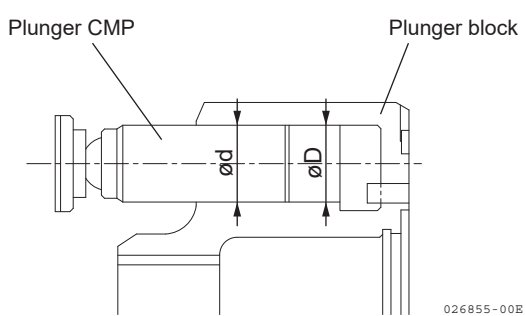
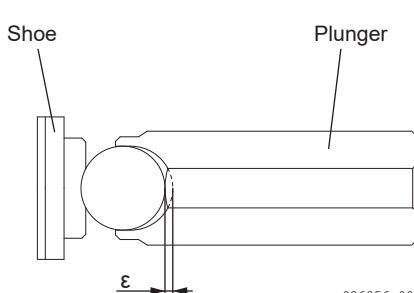
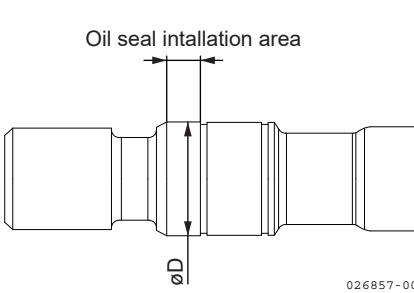
6. HYDRAULIC SYSTEM

6. Service Standards

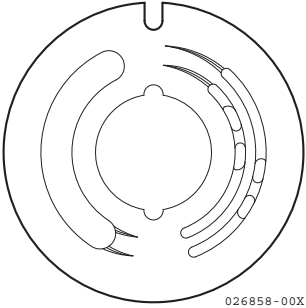
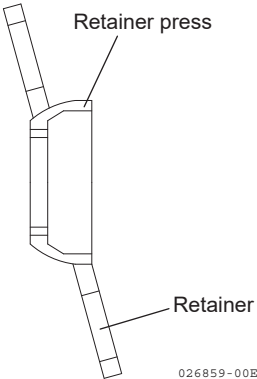
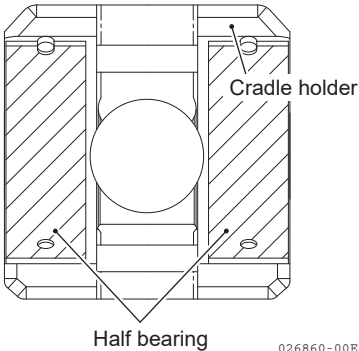
Clean the parts to be checked and completely dry them

Check the major parts carefully and replace any ones on which excessive wear or damage that may cause malfunction is found.

Be sure to replace the packings and seals with the new ones at the time of reassembly, even when they are not clearly deformed or damaged.

Procedure	
(1) Piston assembly and cylinder barrel - Perform visual inspections for any flaws, scuffing or excessive wear (especially on the sliding parts). - Check the clearance between the outside diameter of each piston and the inside diameter of the cylinder barrel. $D - d \leq 0.00197 \text{ in. (0.05 mm)}$	 026855-00E
(2) Piston shoes and pistons Check the axial play of each and shoe. $\varepsilon \leq 0.00787 \text{ in. (0.2 mm)}$	 026856-00E
(3) Drive shaft Check the oil seal installation area. Wear $\leq 0.00098 \text{ in. (0.025 mm)}$ (Difference between contact and noncontact parts with oil seal in radius.)	 026857-00E

6. HYDRAULIC SYSTEM

Procedure	
(4) Valve plate • Check the slide face for any damages. Replace it with a new one, if it is damaged.	 026858-00X
(5) Retainer and retainer press • Check for scuffing and stepwise wear, and replace the set if can be corrected. • Small scuffing and damage are corrected together by the lap. Clean the lapping sufficiently.	 Retainer press Retainer 026859-00E
(6) Cradle holder and half bearing • Check the front face of the bearing portion for scuffing and stepwise wear. • Replace the cradle holder CMP with a new set, if it is damaged or has wear.	 Cradle holder Half bearing 026860-00E

6. HYDRAULIC SYSTEM

7. Troubleshooting

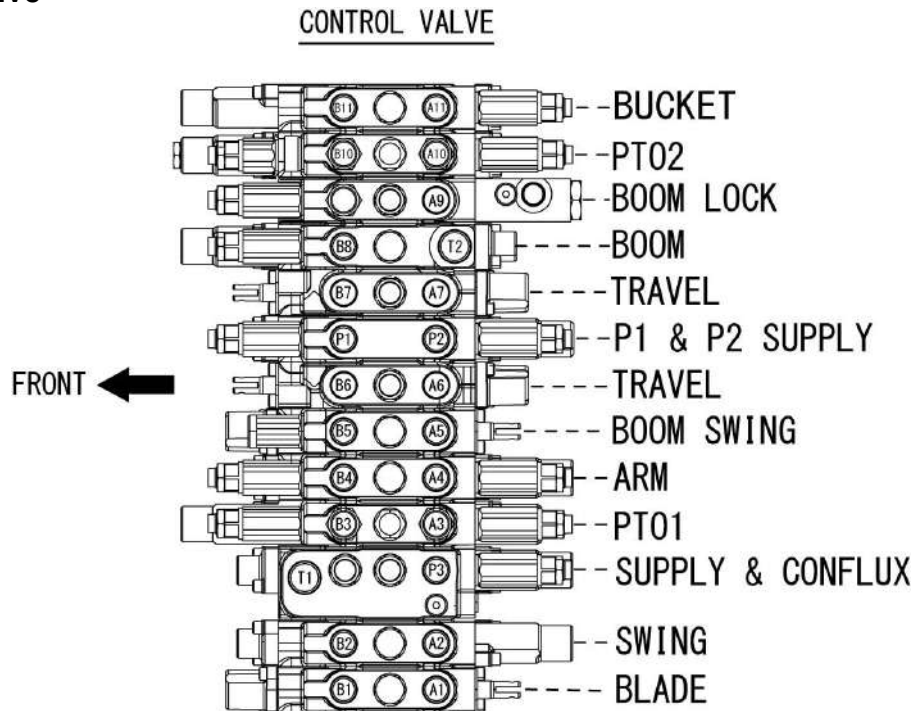
Trouble	Cause	Measure
1. No oil discharge from pump	(1) Wrong turning direction	Correct to normal turning direction
	(2) Closed strainer or suction pipe	Clean strainer and open suction pipe
	(3) Suction pipe tip above tank internal oil level	Increase tank internal oil level or put suction pipe tip to oil level
	(4) Breakage of pump main partsAbnormality of input shaft or coupling	Disassemble and replace parts and reassemble after cleaning all parts
2. Extremely low pump discharge volume or discharge pressure not increased	(1) Pressure not increased due to hydraulic motor besides pump or each control valve, or insufficient specified flow rate	Replace hydraulic equipment, repair or check
	(2) Large amount of high-pressure oil leak due to wear of pump sliding area	Disassemble pump and regrind or repair by lap-ping in case slide face is damagedDisassemble if unrepairable and replace parts and reassemble after cleaning all parts
	(3) Air sucked from pump suction side	Check and replace suction pipe, packing or the like or check and retighten tightening portion
	(4) Clogged strainer or air sucked due to low oil level	Clean or replace strainer
	(5) Cavitation caused by excessive suction resistance due to abnormal oil temperature, abnormal hydraulic oil viscosity	Decrease suction resistance
3. Abnormal sound or vibration (Cavitation)	(1) Air sucked due to low oil level in tank	Replenish hydraulic oil and conduct air-bleeding with no load
	(2) Large suction resistance due to inappropriate thickness or length of suction pipe	Decrease suction resistance
	(3) Cavitation of pump due to clogged strainer	Clean strainer. Brush circuit if tank is still clogged and replace hydraulic oil
	(4) Insufficient capacity of strainer	Select twice or three times larger max. discharge volume
	(5) Low oil temperature or cavitation of pump due to high viscosity	Follow instruction manual for oil selection and oil temperature
	(6) Coupling failure	Check for core oscillation
	(7) Resonance with exterior	Check loosening of bolts in installation area
4. Engine overload (Extremely reduced engine speed or engine stall)	(1) High set torque of horsepower control	Readjust adjustment bolt
	(2) Clogged pilot oil passage in pump or orifice, seizure or scuffing of parts	Disassemble and check pump, if no change after readjusting adjustment bolt
	(3) Seizure or wear of pump internal parts	Repair pump
5. Oil leak	(1) Oil leak or breakage of oil seal due to increased drain flow rate and internal pressure of pump case (oil seal withstand pressure	Replace oil seat with new ones.In this case, take care not to damage lip at the time of oil seal insertion

6. HYDRAULIC SYSTEM

Trouble	Cause	Measure
6. Valve malfunction, no oil flow, and unstable pressure	(1) Low set pressure of relief valve	Set specified valve
	(2) Dust in poppet of relief valve	Disassemble and clean pump and valve, and replace hydraulic oil
	(3) Damage or wear in poppet of relief valve	Replace poppetReplace pump, if pump case side is damaged
	(4) Valve cannot be switched due to no current flow to solenoid	Check current
	(5) Dust in spool of solenoid valve	Disassemble and clean pump and valve, and replace hydraulic oil
	(6) Damage or wear in spool of solenoid valve	Replace solenoid valve CMP

6. HYDRAULIC SYSTEM

6-4 Control Valve



6-4-1 Introduction

1) Outline

This manual contains safety instructions for the subject product.

Before using the product, you must first thoroughly read this manual to fully understand the configuration, disassembly, and assembly.

Save this manual so that you can read it immediately when necessary.

If you do not follow the instructions, there could be serious accidents.

6. HYDRAULIC SYSTEM

6-4-2 Safety

1) Safety Precautions

- The maintenance personnel must read this manual carefully before carrying out the inspection and/or maintenance work of this product and observe the instructions mentioned here.
- Do not carry out any maintenance work such as disassembly and assembly until you fully understand the instructions in the manual.
- Since the product is being improved continuously, there could be some difference between the product and the contents in this manual. If you have any questions in this manual, please feel free to contact us.
- If you modify the shape or performance of the product from the shipment condition, there could be degradation, failure, or breakage in it.
- Do not modify the product. We assume no responsibility for any accident after modification. Also, if you feel the necessity of modification, contact us first of all.
- If you use the product under conditions not mentioned in the Specification and Drawings, there could be degradation, failure, or breakage in it. Keep the working conditions as described in the specifications.
- Be more careful handling the product during or immediately after the operation, the surface of the product can be high temperature.

To help you understand this manual easily, there are several kinds of safety precautions.

2) Safety Instructions

Please pay a particular attention to the signals of the safety alerts and special instructions in this manual. They are indicated in the following manner:



Indicates information or instructions which must be followed to guarantee your safety during operations.

CAUTION :

Warning against possible equipment damage.

Note :

Useful information.

6. HYDRAULIC SYSTEM

6-4-3 Specifications

1) Use of Product

This product is designed as a directional control valve for excavator. This directional control valve is used to operate the blade, swing, PTO1, arm, boom swing, travels, boom, PTO2, and bucket of an excavator.

2) Specifications

Specifications of Control Valve:

Rated Pressure : 24.5 MPa (250 kgf/cm²)
Rated Flow : 35L/min

For the other specifications, refer to the Specifications and Drawings.

Note

- Do not use the Control Valve at a pressure exceeding the rated pressure; There is a possibility of breakage in the Control Valve.
- Use the Control Valve within the rated flow; There could be malfunction or a deterioration in heat balance. If it is necessary to use the Control Valve at a level exceeding the rated flow unavoidably, carry out various confirmatory tests and then use it within the verified range. If the Control Valve is used under a condition beyond the verified range, we assume no responsibility for any accidents occurred as a result of the use.
- The conditions beyond the scope of the assumption or operation mistake could result in the unexpected operation of each attachment (hereafter called ATT), Swing, and Travels. Check the safety of the Excavator and its surroundings before operation to keep people away from the moving range of ATT.
- Using low-cleanliness hydraulic fluid could cause seal failure or damage to the seal part, resulting in operation failure, the holding failure of ATT, or operation mistake of the machine; The customer is requested to control the cleanliness of hydraulic fluid without fail.

【Degree of contamination in hydraulic fluid: Be controlled within Grade 9 in NAS】

6. HYDRAULIC SYSTEM

6-4-4 Usage Precautions

1) Installation

Before installation, remove Masking Plugs in the ports, and check whether there is abnormality.

When installing this Control Valve in the Excavator, observe the following precautions.

1. When unpacking or installing the Control Valve, make sure not to let it fall or hit it on any places.
2. When handling the Control Valve, be careful not hold the Pilot Covers of the Spools or Accessory Valves such as Main Relief Valves and Overload Relief Valves.
3. Mount the Control Valve securely to a flat surface; at that time, do not use a hammer for positioning by hitting.
4. Clean piping materials sufficiently before use.
5. Make sure to prevent dust or foreign matters from entering into the port openings.
6. Fasten the port connectors surely with the recommended fastening torque shown in 4-2.
7. Arrange the piping so that the backpressure on T ports are to be 0.98 MPa (10 kgf/cm²) or less.

Caution

- Falling or hitting the Control Valve could cause a bend in the Spool, resulting in an accident due to an operation failure.
- If the Control Valve is mounted on an uneven surface, the Control Valve Body could be deformed, which results in a malfunction or external leakage.
- If there are foreign matters in each port, the Control Valve operation could fail, resulting in an accident.
- Do not fasten connectors with torque more than the recommended value.
There could be strains or damage to Control Valve and/or connectors, resulting in a serious accident such as the falling of ATT.
- If there is a mistake in piping between the ports, unintentional movement could result in an accident.

6. HYDRAULIC SYSTEM

2) Port symbols and recommended fastening torque

Port Symbol	Port Position	Use	Port Size	Recommended Fastening Torque
P1	P1,P2 Inlet Comp.	Pump Port	G3/8	39.2~49.0N・m [4.0~5.0kgf・m]
P2				
P3				
T1	P3 Inlet Comp.	Tank Port	G1/2	58.8~68.6N・m [6.0~7.0kgf・m]
T2	Boom Comp.			
A1	Blade Comp.	Actuator Port	G3/8	39.2~49.0N・m [4.0~5.0kgf・m]
B1				
A2	Swing Comp.			
B2				
A3	PTO1 Comp.			
B3				
A4	Arm Comp.			
B4				
A5	Boom Swing Comp.			
B5				
A6	Travel Comp.			
B6				
A7				
B7				
B8	Boom Comp.			
A9	Boom Lock Valve Comp.			
A10	PTO2 Comp.			
B10				
A11	Bucket Comp.			
B11				
Pa2	Swing Comp.	Spool Pilot Port	G1/4	24.5~29.4N・m [2.5~3.0kgf・m]
Pb2				
Pa3	PTO1 Comp.			
Pb3				
Pa4	Arm Comp.			
Pb4				
Pa8	Boom Comp.			
Pb8				
Pa10	PTO2 Comp.			
Pb10				
Pa11	Bucket Comp.			
Pb11				
Pp1	P3 Inlet Comp.	Pilot Signal Input Port	G1/4	24.5~29.4N・m [2.5~3.0kgf・m]
Pp2	P1,P2 Inlet Comp.			
Pb8'	Boom Lock Valve Comp.	Boom Lock Valve Release Port	G1/4	24.5~29.4N・m [2.5~3.0kgf・m]
Dr1		Drain Port for Boom Lock Valve		

6. HYDRAULIC SYSTEM

6-4-5 Disassembly

1) Precautions for disassembly

Observe the following precautions and carry out the work at a factory where there are engineers with sufficient technique for hydraulic devices.

1. Since hydraulic devices are all machined precisely with clearances being very little, carry out the disassembly and assembly work at a clean place and make sure to prevent the device from being entered with dust, sand, and the like.
2. Before disassembly work, check that there is no dust on the outside of the control valve and then place it on a workbench with actuator ports facing upward.
3. Before disassembly work, prepare necessary material such as the structural drawing for valves to fully understand the structure and others.
4. When removing the control valve from the machine, put a dustproof cap on each port and then clean the outside of assembly after checking the installation of caps.
Furthermore, prepare a suitable workbench with clean paper or rubber mat on it for the work.
5. Since there is a possibility of rust when the disassembled parts are left, apply anti-corrosive oil to the parts and seal them.
6. When carrying or moving the control valve, hold the body. Especially, after removing a pilot cover from the control valve, never hold the exposed spool.
7. Even if a control valve does not move smoothly, never hit it.
8. It is recommended to carry out various tests (relief valve setting, leak test, internal pressure loss check, etc.) after the disassembly and assembly of the control valve, which requires a hydraulic test device.
Accordingly, when the disassembly might be possible technically but the test and/or adjustment might be impossible, do not carry out the work.



Before removing the pipes, attach suitable indications on them to be able to locate their positions later. If there is a mistake between the ports, unintentional movement could result in an accident.

Falling or hitting the control valve could bend the spool, which could result in an accident.

If foreign matter enters any port, there could be a control valve malfunction, resulting in an accident.

Since the load side port could hold an empty weight or enclosed pressure, release the inside pressure before loosening the piping. If not, there could be a fall of attachments or a jet of high temperature hydraulic fluid, and it is dangerous.

CAUTION :

The control valve becomes hot after operating the machine. Start the work once the temperature is sufficiently low.

The control valve has complicated connections and seals through the internal passages, which means that there could be enclosed pressure, resulting in an oil jet after disassembly. Wear safety goggles during disassembly work.

6. HYDRAULIC SYSTEM

2) Necessary tools and others

Before disassembling the control valve, prepare the following tools.

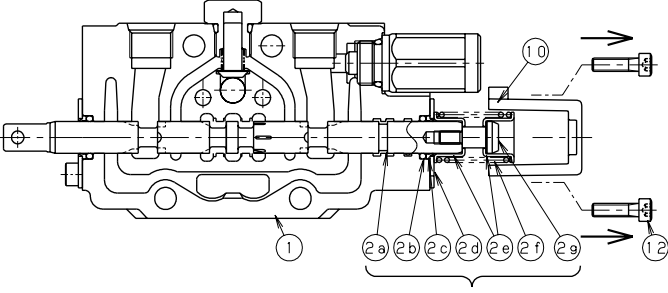
The tools below are used to disassemble the control valve only. Tools for disassembling the ports fittings are not included.

Name	Quantity	Application
Hexagonal wrench	Each 1	0.16 in (4mm) - 0.20 in (5mm) 0.24 in (6mm) - 0.31 in (8mm)
Screw wrench	Each 1	0.51 in (13mm) - 0.55 in (14mm) 0.75 in (19mm) - 0.83 in (21mm) 0.87 in (22mm) - 1.02 in (26mm)
Socket wrench	Each 1	0.51 in (13mm) - 0.55 in (14mm) 0.75 in (19mm) - 0.83 in (21mm) 0.87 in (22mm) - 1.02 in (26mm)
Torque wrench	1	1.4 lbf.ft ~ 14.5 lbf.ft (1.96N.m ~ 19.6N.m)
Torque wrench	1	14.5 lbf.ft ~ 72.4 lbf.ft (19.6N.m ~ 98.1N.m)
Magnets	1	
Pliers	1	
Slotted screwdriver	1	
Tweezers	1	

Prepare clean wash, hydraulic fluid, grease, tag paper, oil marker pen, and others before work.

6. HYDRAULIC SYSTEM

3) Spool draw-out

Procedure																							
Manual operation type: Taking the boom swing spool as an example, the extraction procedures are as follows: 1) Remove 2 Hex. socket head bolts (10) by using 4mm hexagonal wrench. 2) Remove the pilot cover (9). 3) With spring in the Swing Spool exposed, pull out Spool Ass'y from the Control Valve slowly and horizontally (parallel to Spool Sleeve) by holding Spring. 4) The other Spools can also be pulled out in the same manner. •At this time, check O-ring (7) is on the bottom of body side flange. <table border="1"> <thead> <tr> <th>No.</th><th>DESCRIPTION</th></tr> </thead> <tbody> <tr> <td>1</td><td>BODY-WORK "fk"</td></tr> <tr> <td>2a</td><td>SPOOL(Swing)</td></tr> <tr> <td>2b</td><td>O-RING 1AP12</td></tr> <tr> <td>2c</td><td>DUST WIPER</td></tr> <tr> <td>2d</td><td>SEAL PLATE</td></tr> <tr> <td>2e</td><td>SPRING SEAT</td></tr> <tr> <td>2f</td><td>SPRING</td></tr> <tr> <td>2g</td><td>END-SPOOL</td></tr> <tr> <td>10</td><td>COVER</td></tr> <tr> <td>12</td><td>HEX SOCKET HEAD BOLT WITH WASHER</td></tr> </tbody> </table>	No.	DESCRIPTION	1	BODY-WORK "fk"	2a	SPOOL(Swing)	2b	O-RING 1AP12	2c	DUST WIPER	2d	SEAL PLATE	2e	SPRING SEAT	2f	SPRING	2g	END-SPOOL	10	COVER	12	HEX SOCKET HEAD BOLT WITH WASHER	
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6. HYDRAULIC SYSTEM

Procedure																							
Hydraulic pilot type: Taking the Swing spool as an example, the draw-out procedures are as follows: 1) Remove 2 Hex. socket bolts with washers (10) by using 4-mm hexagonal wrench. 2) Remove the pilot cover (9). At this time, check whether the O-ring (3) falls off from the bottom of body side flange. 3) With a spring in Swing spool exposed, pull out Spool Ass'y from the contral valve slowly and horizontally (parallel to the spool hole) by holding the spring. 4) The other hydraulic pilot type spools can also be pulled out in the same way.																							
<table border="1"> <thead> <tr> <th>No.</th><th>DESCRIPTION</th></tr> </thead> <tbody> <tr> <td>1</td><td>BODY-WORK"GE"</td></tr> <tr> <td>2a</td><td>SPOOL(Swing)</td></tr> <tr> <td>2b</td><td>SPRING SEAT</td></tr> <tr> <td>2c</td><td>SPRING</td></tr> <tr> <td>2d</td><td>SPRING SEAT</td></tr> <tr> <td>2e</td><td>END-SPOOL</td></tr> <tr> <td>7</td><td>O-RING 1B S22</td></tr> <tr> <td>8</td><td>PILOT COVER "B1"</td></tr> <tr> <td>9</td><td>PILOT COVER "A1"</td></tr> <tr> <td>10</td><td>HEX SOCKET HEAD BOLT WITH WASHER</td></tr> </tbody> </table>	No.	DESCRIPTION	1	BODY-WORK"GE"	2a	SPOOL(Swing)	2b	SPRING SEAT	2c	SPRING	2d	SPRING SEAT	2e	END-SPOOL	7	O-RING 1B S22	8	PILOT COVER "B1"	9	PILOT COVER "A1"	10	HEX SOCKET HEAD BOLT WITH WASHER	
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6. HYDRAULIC SYSTEM

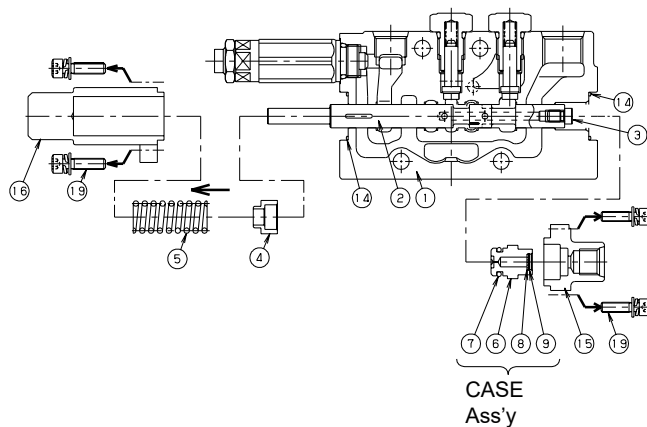
Procedure

P3 Inlet and Connecting Comp.

The draw-out procedures for the connecting spool are as follows:

- 1) Remove 2 Hex. socket head bolts with washers (19) with 4mm hexagonal wrench.
- 2) Remove pilot cover (16).
- 3) With spring in the connecting spool exposed, pull out Spool Ass'y from the control valve slowly and horizontally (parallel to spool sleeve) by holding spring.
 - At this time, check O-Ring (14) is on the bottom of body side flange.

No.	DESCRIPTION
1	BODY-WORK "UJ"
2	SPOOL(CONFLUX)
3	PLUG
4	SPRING SEAT
5	SPRING
6	CASE
7	O-RING 1B P10A
8	FILTER
9	RETAINING RING-C
14	O-RING 1B S22
15	PILOT COVER B1
16	PILOT COVER A2
19	HEX SOCKET HEAD BOLT WITH WASHER



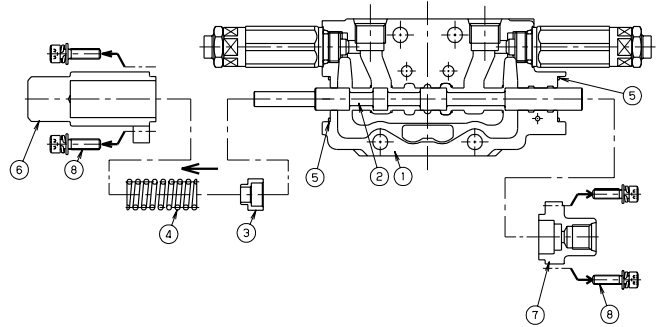
6. HYDRAULIC SYSTEM

Procedure

P1/P2 inlet Comp.:

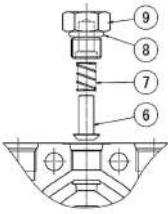
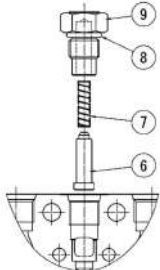
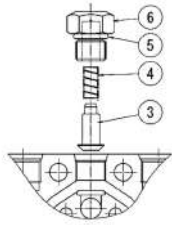
- 1) Remove 2 Hex. socket head bolts with washers (8) with 5mm Hexagonal Wrench.
- 2) Remove the pilot cover (6).
- 3) Remove the spring (4) and the spring seat (3).
- 4) Pull out the spool from the control valve slowly and horizontally (parallel to the spool sleeve). At this time, check the O'ring (5) is on the bottom of body side flange.

No.	DESCRIPTION
1	BODY-WORK "AN"
2	SPOOL(SUPPLY)
3	SPRING SEAT
4	SPRING
5	O-RING 1B S22
6	PILOT COVER A2
7	PILOT COVER B1
8	HEX SOCKET HEAD BOLT WITH WASHER



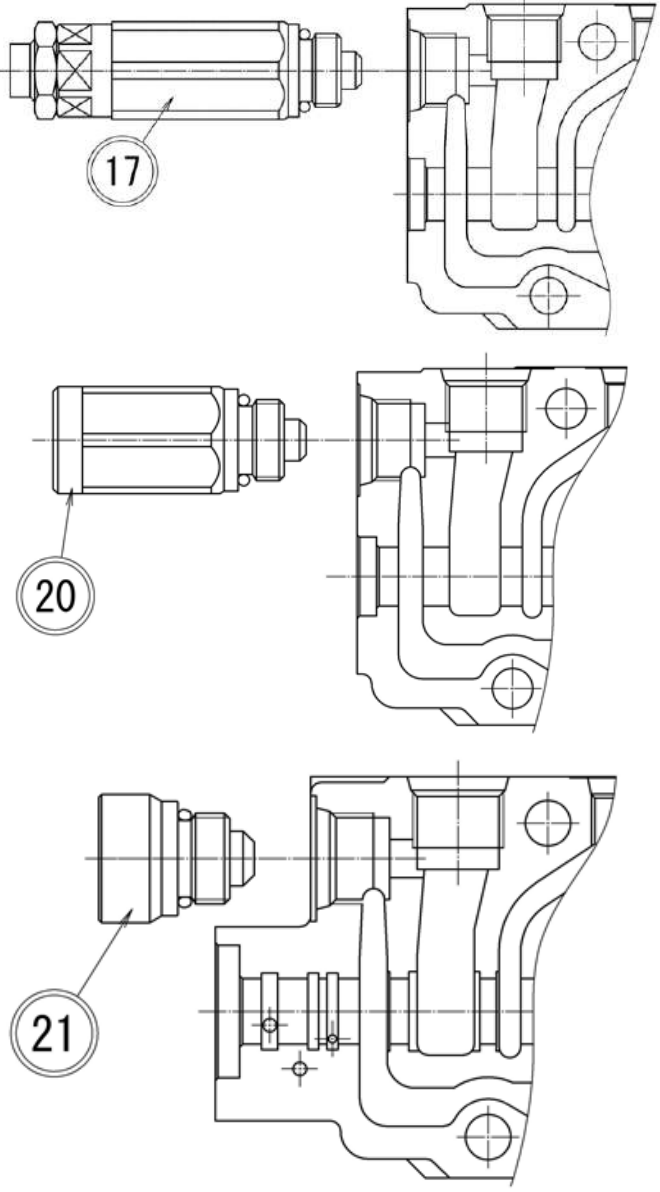
6. HYDRAULIC SYSTEM

4) Check valve (load check valve) disassembly procedure

Procedure	
1) Hold the control valve body at workbench or hold it by two or more people. 2) Loosen and remove the check valve plug (9) at the center of the control valve upper surface with a 19mm screw wrench or a socket wrench. When it is hard to loosen the plug because the O-ring (8) bites the screw, do not loosen forcibly; refasten it once and then try to loosen again. 3) From the hole where the check valve plug has been removed, remove the check valve spring (7) and the check valve (6) with tweezers or a magnet.	 Check valve  Check valve (P3 inlet, travel, boom lock valve)  Check valve (PTO1, PTO2)

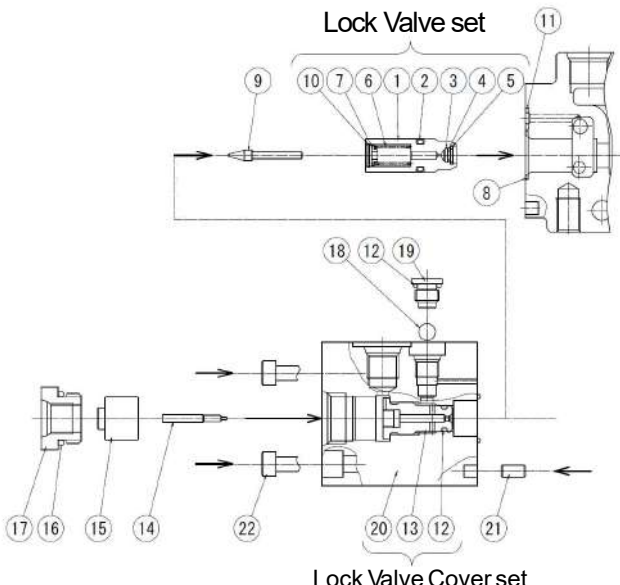
6. HYDRAULIC SYSTEM

5) Accessory valve removal procedures

Procedure	
Main relief valve (MRV) and Overload relief valve (ORV): Loosen and remove MRV and ORV (17) by using 22mm spanner or socket wrench. - Put screw wrench to 22mm hexagonal part of pressure regulating body. - If there is no 22mm screw wrench, it is also possible to loosen and remove by putting 19mm screw wrench to the hexagonal part as shown in the figure. CAUTION : <i>Be careful not to damage the seat of the socket that sticks out above the tip.</i> <i>If the seat is damaged, there could be internal leakage, resulting in the malfunction of holding attachment.</i> Anticavitation valve : As for the ORV, loosen and remove anticavitation valve (20) by using 22mm spanner or socket wrench. CAUTION : <i>Do not use a 8mm hexagonal wrench to remove. Only plug part is loosened, which could result in the degradation in performance or damage.</i> Relief plug Loosen and remove relief plug(21) by using 8mm hexagonal wrench.	

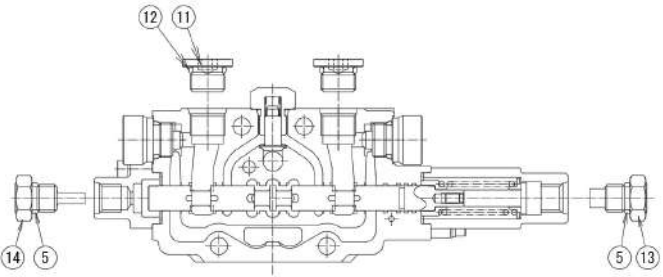
6. HYDRAULIC SYSTEM

6) Boom lock valve disassembly procedures

Procedure	
If there is a malfunction, replace the lock valve Ass'y with a new one. Disassembly procedures are shown here as reference for investigating malfunction: 1) Remove 2 hexagonal socket bolts (22) by using a 5-mm hexagonal wrench. 2) Remove the lock valve lid (20). Be careful not to fall or lose the 2 locating pins (21) on the lock valve body side. Be careful to handle it to protect the pin from being damaged. 3) When the lock valve (1) and the needle valve (9) are exposed, pull them out. Since the needle valve is easy to fall out, take out it first to store. The lock valve is not to be disassembled but to be stored as a lock valve set (1~7 , 9 ,10). 4) Hold the lock valve cover in a vise bench or the like, and loosen and remove the bush (5) by using a 26-mm screw wrench. Hold any two sides except port side in a vise bench or the like. 5) From the hole that has been used to pull out the bush, pull out the piston B (15) and the Piston A1 (14) by using tweezers or a magnet. For piston B and piston A1, arrange them so that their assembled direction can be recognized. Piston guide (13) is not to be disassembled but to be stored in a combination with the lock valve cover. 6) Loosen and remove the plug (16) by using a 4-mm Hexagonal Wrench. 7) From the hole that has been used to pull out the plug, pull out the Steel Ball7 (18) by using a magnet.	 The diagram illustrates the disassembly of the boom lock valve. It is divided into two main sections: the 'Lock Valve set' and the 'Lock Valve Cover set'. The 'Lock Valve set' includes components 1 through 11, with 1 being the lock valve and 9 being the needle valve. The 'Lock Valve Cover set' includes components 12 through 21, with 20 being the lid and 21 being locating pins. A separate view shows the removal of bolts 22. Arrows indicate the direction of removal for various parts.

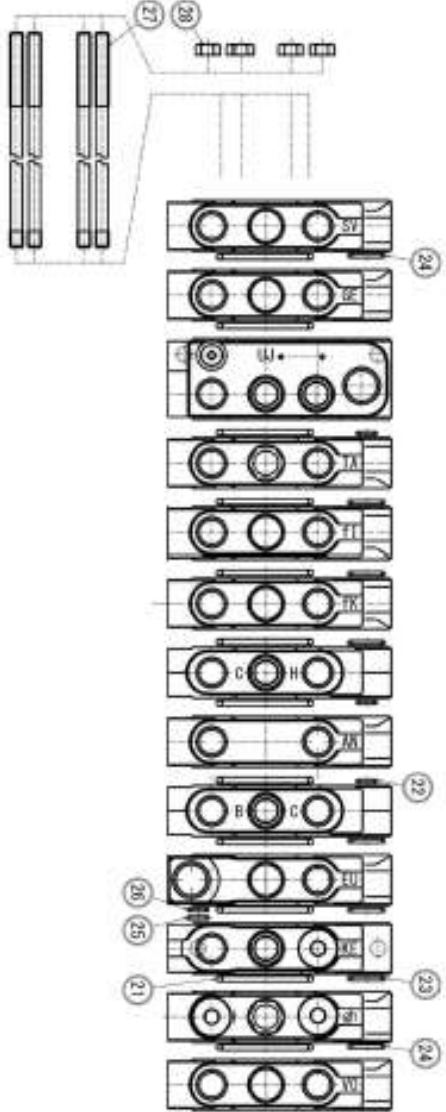
6. HYDRAULIC SYSTEM

7) Removing parts when using PTO2

Procedure	
When using the PTO2 Comp., remove the plugs of the actuator port and pilot port, and pipe the actuator to be connected. 1. Loosen and remove the plug (11) by using a 8-mm hexagonal wrench 2. Loosen and remove the plug (13, 14) by using a 19-mm socket wrench	 The diagram shows a top-down view of a hydraulic valve assembly. It features a central body with various ports and internal components. Five specific parts are highlighted with numbered circles: 11 and 12 are at the top, pointing to small plug-like components. 13 and 14 are at the bottom left and right, pointing to larger plug-like components. 5 is shown twice, once on the left and once on the right, pointing to the main body of the plugs.

6. HYDRAULIC SYSTEM

8) Comp. Body disassembly procedure

Procedure	
1) Loosen and remove the 4 M8 hexagonal nuts (28) for assembling Comp. bodies on the dozer (Body-Work "SV") side with a 13mm screw wrench or a socket wrench. 2) When the 4 tie bolts (27) are pulled out from the Blade side, each Comp. body can be removed. Be careful not to drop or lose O-rings (21-26) mounted on mating surfaces of each Comp. Body.	 The diagram illustrates the disassembly procedure for the hydraulic system. It shows a side view of the blade assembly with tie bolts (27) and nuts (28). Below this, a detailed view of the component bodies (21-26) is shown, highlighting the O-rings (21-26) and their mating surfaces. The components are labeled with numbers 21 through 26, and the O-rings are labeled with numbers 21 through 26.

6. HYDRAULIC SYSTEM

9) Accessory valves disassembly procedures



Accessory valves are the most important parts for performance and safety, in particular, the relief valve is very difficult to readjust the setting so that Assy's replacement is recommended if any malfunction occurs.

Procedure	
Main relief valve MRV: 1. Lightly hold any two surfaces of the body (5) in a vise bench, whose intervals are 22 mm. 2. Loosen and remove the nut M14 (8) by using a 19mm screw wrench. 3. Loosen and remove the adjustable screw (7) by using a 4mm hexagonal wrench. 4. Take out the regulating valve spring (9) by using tweezers or the like. 5. Loosen and remove the valve seat (4) by using a 19mm screw wrench. 6. The other parts can also be removed in the following order: Socket (1) - Piston (3) - Spring (10) - Valve (2)	

No.	DESCRIPTION
1	Socket
2	Poppet-MAIN VALVE
3	PISTON
4	VALVE SEAT-PILOT
5	BODY
6	POPPET-PILOT
7	ADJUSTABLE SCREW
8	NUT M14
9	SPRING-PILOT
10	SPRING-MAIN VALVE
11	O-RING 1B P15
12	O-RING 1B S10
13	O-RING 1A P7
14	BACK-UP RING
15	O-RING 1B P14

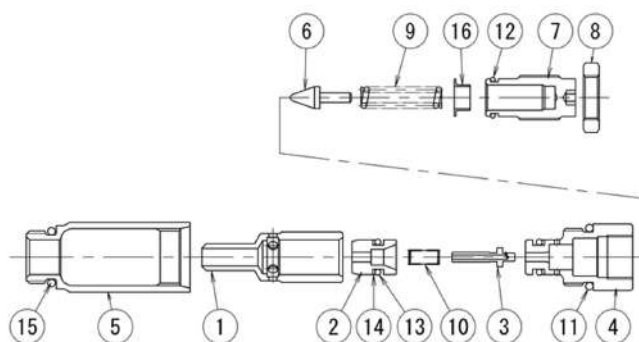
6. HYDRAULIC SYSTEM

Procedure

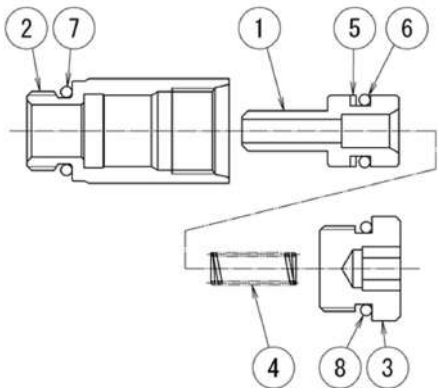
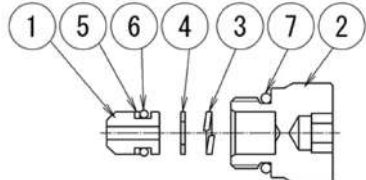
Overload relief valve (ORV):

1. Lightly hold any two surfaces of hexagonal body (5) in a vise bench, whose intervals are 22 mm.
2. Loosen and remove the nut M14 (8) by using a 19mm screw wrench.
3. Loosen and remove the adjustable screw (7) by using a 4mm hexagonal wrench.
4. Take out the regulating valve spring (9) by using tweezers or the like.
5. Loosen and remove the valve seat (4) by using a 19mm screw wrench.
6. The other parts can also be removed in the following order:
Socket (1) - Piston (3) - Spring (10) - Valve (2)

No.	DESCRIPTION
1	Socket
2	Poppet-MAIN VALVE
3	PISTON
4	VALVE SEAT-PILOT
5	BODY
6	POPPET-PILOT
7	ADJUSTABLE SCREW
8	NUT M14
9	SPRING-PILOT
10	SPRING-MAIN VALVE
11	O-RING 1B P15
12	O-RING 1B S10
13	O-RING 1A P7
14	BACK-UP RING
15	O-RING 1B P14
16	SPRING GUIDE



6. HYDRAULIC SYSTEM

Procedure																			
Anticavitation valve: 1. Lightly hold any two surfaces of hexagonal body (2) in a vise bench, whose intervals are 22 mm. 2. Loosen and remove the plug (3) by using a 8mm hexagonal wrench. 3. Take out the spring (4) by using tweezers, a magnet or the like. 4. Remove the valve (1) from the body (2). <table border="1"> <thead> <tr> <th>No.</th><th>DESCRIPTION</th></tr> </thead> <tbody> <tr><td>1</td><td>VALVE</td></tr> <tr><td>2</td><td>BODY</td></tr> <tr><td>3</td><td>PLUG</td></tr> <tr><td>4</td><td>SPRING</td></tr> <tr><td>5</td><td>BACK-UP RING</td></tr> <tr><td>6</td><td>O-RING 1A P10A</td></tr> <tr><td>7</td><td>O-RING 1B P14</td></tr> <tr><td>8</td><td>O-RING 1B P15</td></tr> </tbody> </table>	No.	DESCRIPTION	1	VALVE	2	BODY	3	PLUG	4	SPRING	5	BACK-UP RING	6	O-RING 1A P10A	7	O-RING 1B P14	8	O-RING 1B P15	
No.	DESCRIPTION																		
1	VALVE																		
2	BODY																		
3	PLUG																		
4	SPRING																		
5	BACK-UP RING																		
6	O-RING 1A P10A																		
7	O-RING 1B P14																		
8	O-RING 1B P15																		
Relief plug: 1. Remove the plug (1) by air-pressuring it into hole part. 2. After removing the plug (1), the inner plain washer (4) and the spring washer (3) can be taken out. <table border="1"> <thead> <tr> <th>No.</th><th>DESCRIPTION</th></tr> </thead> <tbody> <tr><td>1</td><td>PLUG</td></tr> <tr><td>2</td><td>BODY</td></tr> <tr><td>3</td><td>SPRING LOCK WASHER</td></tr> <tr><td>4</td><td>PLAIN WASHER</td></tr> <tr><td>5</td><td>BACK-UP RING</td></tr> <tr><td>6</td><td>O-RING 1B P7</td></tr> <tr><td>7</td><td>O-RING 1B P14</td></tr> </tbody> </table>	No.	DESCRIPTION	1	PLUG	2	BODY	3	SPRING LOCK WASHER	4	PLAIN WASHER	5	BACK-UP RING	6	O-RING 1B P7	7	O-RING 1B P14			
No.	DESCRIPTION																		
1	PLUG																		
2	BODY																		
3	SPRING LOCK WASHER																		
4	PLAIN WASHER																		
5	BACK-UP RING																		
6	O-RING 1B P7																		
7	O-RING 1B P14																		

6. HYDRAULIC SYSTEM

10) Precautions after disassembly

CAUTION :

For the parts already removed in the work, store and/or transport them with attention on flaws and dirt.

When carrying out another work, storage, or transportation with the parts removed, apply caps or plastic tape to the holes from which the parts have been taken out, protecting the holes from being entered with dust or the like.

6. HYDRAULIC SYSTEM

6-4-6 Assembly

1) Precautions for assembly

Observe the following precautions and carry out the work at a factory where there are engineers with sufficient technique for hydraulic devices.

1. Be careful that the unevenness of tightening torque and the contamination of dust during assembly work could result in malfunction.

In addition, observe tightening torque values specified in the delivery specifications.

2. During assembly work, compare valves with valve structural drawing and check the number of parts to check whether there is any improper assembly and/or the omission of parts.

3. For the parts to be used in assembly, dip in fluid oil as the need arises to reassemble after washing well in washing oil and being dried.

4. After cleaning and degreasing the surface sufficiently, apply Loctite to 2 threads of the screw from the tip. (Too much Loctite could result in malfunction after squeezing out.)

5. For the part to be attached or assembled with two or more bolts and nuts, tighten them evenly and alternately for several times, not once with the specified torque.

If not, the unevenness of tightening torque could result in the leakage of hydraulic fluid to the outside and/or malfunctions.

2) Precautions for assembling seal parts

1. All seals are to be renewed at assembly.

2. Check seals for defects in molding and flaws in handling.

Do not use seals with defect and/or flaw.

3. The seals used on sliding surfaces and the places to be installed with seals are to be applied with grease or hydraulic fluid for sufficient lubrication where not specially noted.

4. Never make seals longer up to permanent deformation.

5. O-rings are not to be twisted during assembly.

Kinked O-rings could cause oil leakage after installation because kinks are hard to restore.

6. HYDRAULIC SYSTEM

3) Necessary tools and others

Before assembling the control valve, prepare the following tools.

The tools below are used to assemble the control valve only. Tools for assembling the ports fittings are not included.

Name	Quantity	Application
Hexagonal wrench	Each 1	0.16 in (4mm) - 0.20 in (5mm) 0.24 in (6mm) - 0.31 in (8mm)
Screw wrench	Each 1	0.51 in (13mm) - 0.55 in (14mm) 0.75 in (19mm) - 0.83 in (21mm) 0.87 in (22mm) - 1.02 in (26mm)
Socket wrench	Each 1	0.51 in (13mm) - 0.55 in (14mm) 0.75 in (19mm) - 0.83 in (21mm) 0.87 in (22mm) - 1.02 in (26mm)
Torque wrench	1	1.4 lbf.ft ~ 14.5 lbf.ft (1.96N.m ~ 19.6N.m)
Torque wrench	1	14.5 lbf.ft ~ 72.4 lbf.ft (19.6N.m ~ 98.1N.m)
Magnets	1	
Pliers	1	
Slotted screwdriver	1	
Tweezers	1	

Prepare clean wash, hydraulic fluid, grease, tag paper, oil marker pen, and others before work.

6. HYDRAULIC SYSTEM

4) Comp. Body assembly

Procedure

1) On a surface plate with clean rubber plates on it, place Comp. bodies with actuator port surface facing downward in the order shown on the figure.

CAUTION :

Then, check the matching 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.

2) Put and fasten 4 tie bolts (27) through the bodies from the side of dozer Comp. (Body "SV" side), and fasten 4 M8 hexagonal nuts (28) to the bolts **by hand**.

3) Check that all the body surfaces are in alignment in this condition.

If not, make all the body surfaces in alignment by hitting them with plastic hammers or the like.

Since the bottom surfaces (the opposite side of actuator port surfaces) of the control valve are not in alignment, place the bodies with actuator port facing downward to align actuator port surfaces when arranging the body surfaces.

Before aligning the body surfaces, remove the rubber plates and others that have been laid at 1. However, check that there is no dust or no unevenness on the surface from which the above rubber plates have been removed.

CAUTION :

Do not hit hard when using a plastic hammer.

Hard hitting could cause displacements in the portion that has been aligned.

Check the alignment with a flat plate or the like after aligning.

If there is large displacement in any Comp., bad connection between internal passages could cause a malfunction.

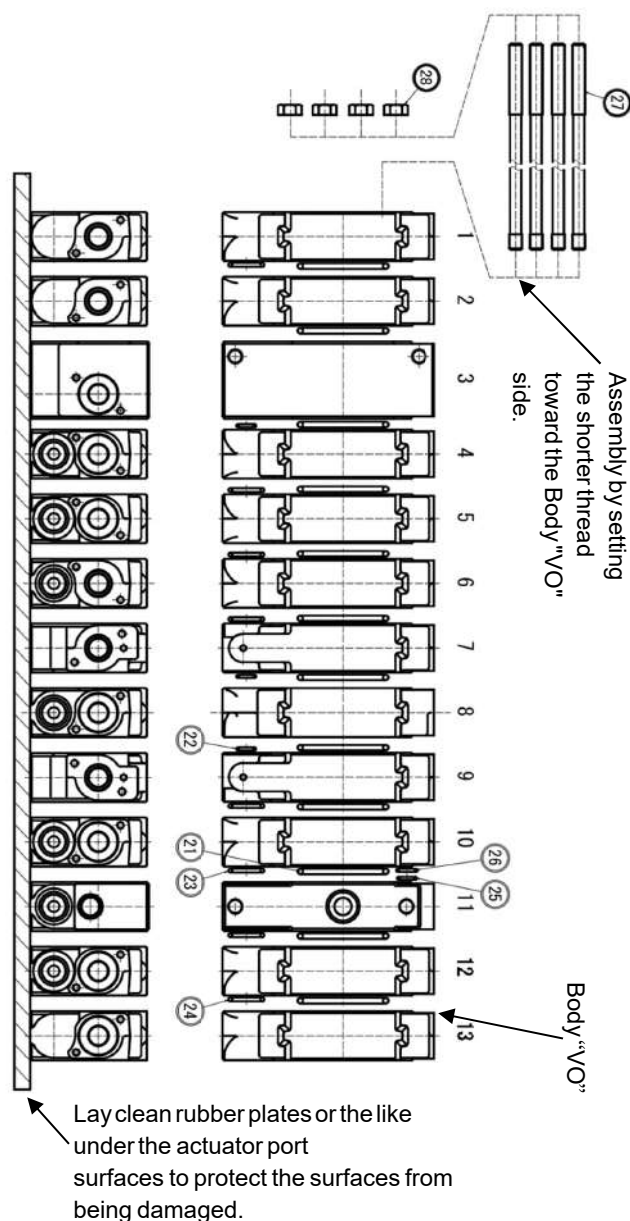
If any seal position overlaps the passage, there could be a leakage of hydraulic fluid to the outside

4) After checking that the surfaces are in alignment, fasten 4 M8 hexagonal nuts (28) that have been put on in 2.

Orders of Assembling Bodies

No.	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	SV	GE	UJ	TA	fl	fK	CH	AN	BC	EU	KE	gh	VO

Note: Identifications (ID) are engraved on the top (actuator port side) of the Body.

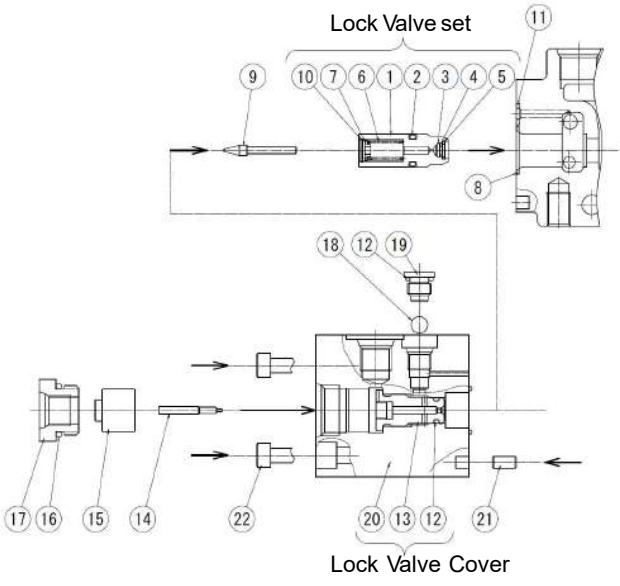


6. HYDRAULIC SYSTEM

Procedure	
Fasten 4 M8 Hex. Nuts evenly and little by little in several times. Uneven fastening makes the Body Ass'y curve easily, which could result in leakage or malfunction after installation on the machine. If you find any curve in the Body Ass'y, it is necessary to reassemble or to correct it by pressing machine or the like.	

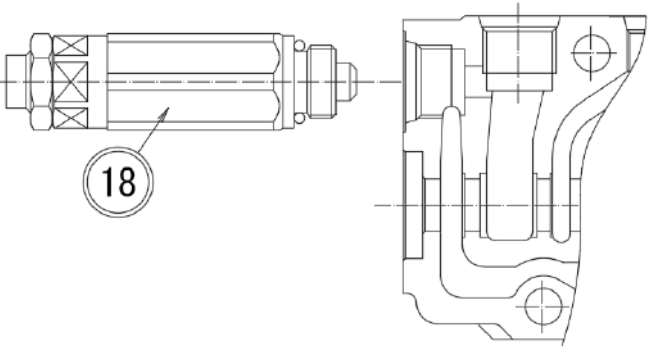
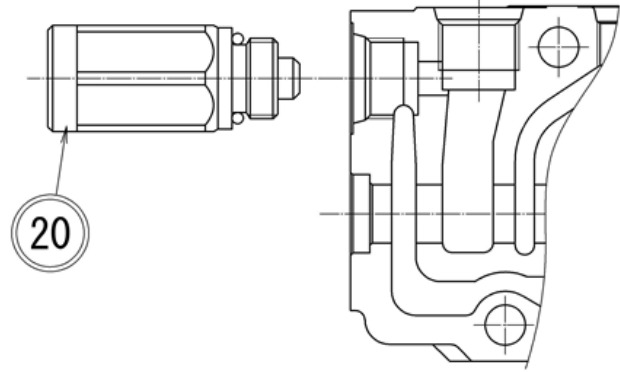
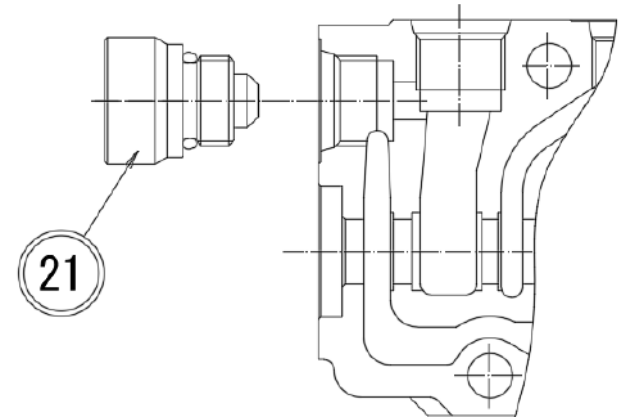
6. HYDRAULIC SYSTEM

5) Boom lock valve assembly procedures

Procedure	
1) Hold the lock valve cover set (20, 12, 13) in a vise bench or the like. 2) Put the steel ball (18) into a hole on top surface of the lock valve cover set. 3) Check that the O-ring (12) is securely installed and then tighten the plug (19) with specified torque by using a 4-mm hexagonal wrench. 4) Insert the piston A1 (14) and the piston B (15) in sequence from a hole on the lock valve cover set side (screw machined). CAUTION : <i>Then, check the direction of those pistons. If the direction of the piston A1 (14) is wrong, the lock valve will not be released. If the direction of piston B (15) is wrong, the lock valve will be left being released. In addition, since the bush (17) cannot be tightened to the end, there will be a leakage of hydraulic fluid to the outside.</i> 5) Check that the bush (17) is securely installed with the O-ring (16) and then screw the bush (17) to the hole, into which the piston has been inserted, with specified torque by using a 26-mm screw wrench (or socket wrench). 6) Install the O-rings (8, 11) securely into the O-ring grooves on the lock valve body. 7) Insert the lock valve set (1~7, 10) into a hole for the lock valve. 8) Insert the needle valve (9) into the lock valve set from the rear of the lock valve set. 9) Install the 2 positioning pins (21) to the surface facing the body of the lock valve cover set. 10) Pressing the lock valve cover set to the body, screw in 1-2 threads of the 2 hexagonal socket bolts 22) by hand. CAUTION : <i>Then, make sure that the needle valve (9) is settled in the seat of the piston guide (13) in the lock valve cover set. If not, the needle valve will not be seated so that the lock valve will also be released. To check the settlement, under the condition 10., loosen the force that is used to press the lock valve cover set to the body and then check whether the lock valve cover set can depart from the body by the force of the spring inside the lock valve set. If there is no feel of spring reaction, remove the unit once and then carry out the assembly again.</i> 11) Tighten the hexagonal socket bolts 22) with specified torque by using an hexagonal wrench.	 The diagrams illustrate the assembly of the boom lock valve. The top diagram, labeled 'Lock Valve set', shows a cross-section of the valve body with components 1 through 11. Component 9 is a needle valve, 10 is a piston guide, 11 is an O-ring, and 1 through 7 are internal valve components. The bottom diagram, labeled 'Lock Valve Cover', shows the cover assembly with components 12 through 22. Component 12 is an O-ring, 13 is a piston guide, 14 and 15 are pistons A1 and B, 16 is an O-ring, 17 is a bush, 18 is a steel ball, 19 is a plug, 20 is the lock valve cover set, 21 are positioning pins, and 22 are hexagonal socket bolts. Arrows indicate the direction of assembly and fluid flow.

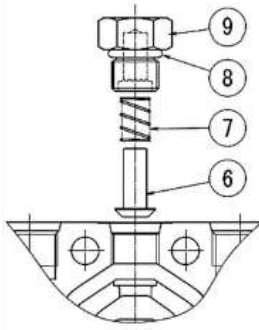
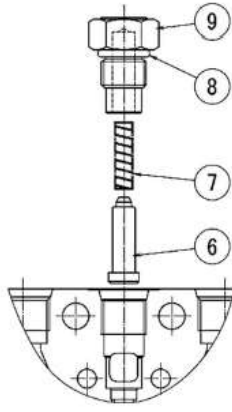
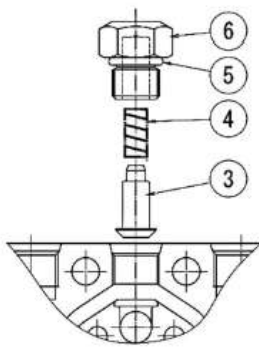
6. HYDRAULIC SYSTEM

6) Accessory valves installation procedures

Procedure	
Main Relief valve (MRV) and overload relief valve (ORV): 1. Tighten the MRV and the ORV with specified torque by using a 22mm screw wrench or a deep socket wrench. Put Screw Wrench (or Deep Socket Wrench) to 22mm hexagonal part of Pressure Regulating Body. Screw Wrench to put the hexagonal part as shown in the Fig beside. CAUTION : <i>Be carefeul not to damage the seat of the socket that sticks out above the tip when installing the MRV and ORV to the body. If the seat is damaged, there could be internal leakage, resulting in the malfunction of holding attachment.</i> <i>Do not put a 19mm screw wrench to the lock nut part when installing. Lock nut turns with adjustable screw free turning, resulting in the degradation in performance or damage.</i>	
Anticavitation valve: 1. As well as ORV, fit anticavitation valve by using a 22mm screw wrench or socket wrench. CAUTION : <i>Be careful not to damage the seat of the socket that sticks out above the tip when installing the anticavitation valve to the body. If the seat is damaged, there could be internal leakage, resulting in the malfunction of holding attachment.</i> <i>Do not use a 8mm hexagonal wrench to install.</i>	
Relief plug: 1. Tighten relief plug by using a 8mm hexagonal wrench. CAUTION : <i>When installing a relief plug to the body, be careful not to damage the seat of socket that projects out above the tip. If the seat is damaged, there will be internal leakage, resulting in the malfunction of holding attachment.</i>	

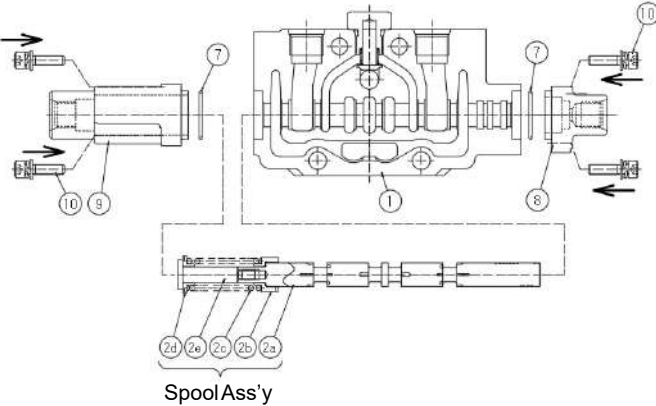
6. HYDRAULIC SYSTEM

7) Check valves assembly procedure

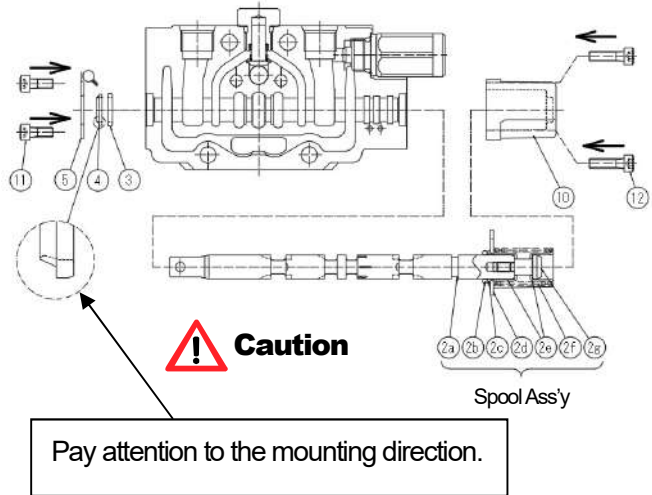
Procedure	
1) Hold the control valve body at a workbench or hold it by two or more people. 2) Assemble the check valve (6) and the check valve spring (7) in sequence at the center of the control valve top surface. Then, set the check valve (6) vertically. (Check that the check valve is in nearly at the center of the hole.) 3) Check that the O-ring (8) is securely installed with the check valve plug (9) and then screw it into the part where the check valve has been assembled. 4) Fasten the check valve plug (9) with specified torque with a 19mm screw wrench or a socket wrench. The other check valves can be assembled in the same manner; use suitable parts in the drawing. CAUTION : <i>If assembly is mistaken, the check valve could not function or there could be damage.</i>	 Standard check valve  P3 inlet, travel, boom lock check valve  PTO1, PTO2 check valve

6. HYDRAULIC SYSTEM

8) Spool assembly procedures

Procedure	
Hydraulic Operation Taking the swing spool as an example, the assembly procedures are as follows: 1) After checking whether there is no dust or the like in the Spool Sleeve of the Body and/or Spool Ass'y and O-Ring (7) is securely installed with that the flange bottom of the Body, insert the Dozer Spool Ass'y into Spool Sleeve of the Body with attention to the position and direction. - Then, apply little hydraulic fluid to the Spool before insertion  Carefully insert it into the spool hole horizontally. If it is hard to insert, forcible insertion could cause impressions on spool holes and/or spools, resulting in malfunction. If you feel a feeling of wrongness such as catches or strong resistance, pull it out once to check whether there is the adhesion of dust or the development of flaw or burr. If there are flaws or burrs, there could be malfunction so that it is recommended to replace it together with the body in a set. - When there is no feeling of wrongness, move it slowly several times checking the movement and no feeling of wrongness again. 2) Press Pilot Cover (9) in a direction from the spring side of Spool Ass'y to the flange of the Body. Fasten 2 Hex. Socket Head Bolts with Washers (10) with specified torque with 4mm Hexagonal Wrench. 3) The other spools can be assembled in the same manner.	

6. HYDRAULIC SYSTEM

Procedure	
Mechanic pilot type: Taking the sBoom Swing Spool as an example, the assembly procedures are as follows 1) After checking that there is no adhesion of dust on each Spool Ass'y or each comp. body's spool hole, insert each Spool Ass'y into spool hole of Comp. Body. - At this time, use caution not to mistake the insertion position and direction. - Before insertion, apply little hydraulic oil to spools.  If it is hard to insert, forcible insertion could cause impressions on spool holes and/or spools, resulting in malfunction. If you feel a feeling of wrongness such as catches or strong resistance, pull it out once to check whether there is the adhesion of dust or the development of flaw or burr. If there are flaws or burrs, there could be malfunction so that it is recommended to replace it together with the body in a set. - When there is no feeling of wrongness, check for any heavy movement or a feeling of catches. 2) Put Spring Cover (11) over the spring of Spool Ass'y, and tighten 2 Hex. Socket Head Bolt (12) with specified torque by using 4-mm Hexagonal Wrench. - At this time, tighten 2 Hex. Socket Head Bolt (12) little by little and alternately to push Spring Cover 11 forward evenly, not all at once with specified torque. 3) Then, put O-ring (3), Dust Wiper (4), and Seal Plate (5) over the spool projected from the opposite side of Comp. Body in order, and then tighten them with Hex. Socket Head Bolt (10) by using Screwdriver for cross with specified torque. - Tighten the two screws little by little and alternately to push Seal Plate (5) forward evenly, not all at once with specified torque.	 Caution Pay attention to the mounting direction.

6. HYDRAULIC SYSTEM

Procedure

P3 inlet and conflux comp.:

1) After checking whether there is no dust or the like in the spool sleeve of the body and/or spool ass'y and O-ring (14) is securely installed with that the flange bottom of the Body, insert the conflux spool ass'y into the spool sleeve of the body with attention to the position and direction.

Apply little hydraulic fluid to the spool before the insertion. When there is no feeling of wrongness, move it slowly several times checking the movement and no feeling of wrongness again.



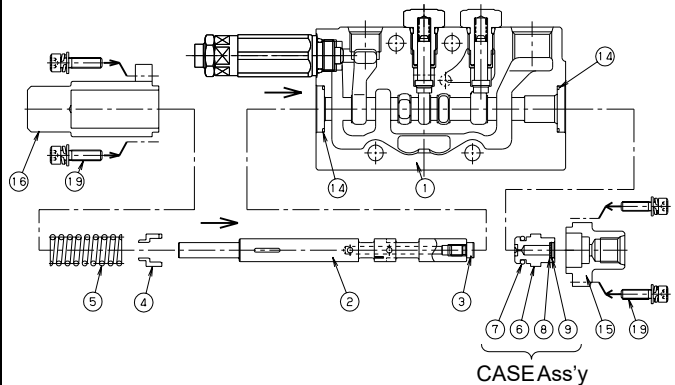
Carefully insert it into the spool hole horizontally.

If it is hard to insert, forcible insertion could cause impressions on spool holes and/or spools, resulting in malfunction.

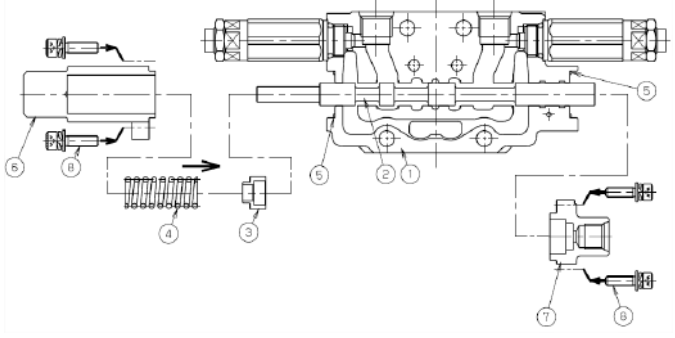
If you feel a feeling of wrongness such as catches or strong resistance, pull it out once to check whether there is the adhesion of dust or the development of flaw or burr. If there are flaws or burrs, there could be malfunction so that it is recommended to replace it together with the body in a set.

2) Press the pilot cover (16) in a direction from the spring side of the spool ass'y to the flange of the body. Fasten 2 hexagonal socket head bolts with washers (19) with specified torque with a 4mm hexagonal wrench.

No.	DESCRIPTION
1	BODY-WORK "UJ"
2	SPOOL(CONFLUX)
3	PLUG
4	SPRING SEAT
5	SPRING
6	CASE
7	O-RING 1B P10A
8	FILTER
9	RETAINING RING-C
14	O-RING 1B S22
15	PILOT COVER B1
16	PILOT COVER A2
19	HEX SOCKET HEAD BOLT WITH WASHER

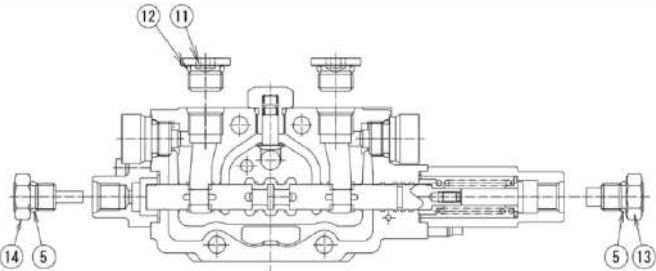


6. HYDRAULIC SYSTEM

Procedure	
P1/P2 supply: 1) After checking whether there is no dust or the like in the spool sleeve of the body and/or spool ass'y insert the conflux spool ass'y into the spool sleeve of the body with attention to the position and direction. Apply little hydraulic fluid to the spool before the insertion. When there is no feeling of wrongness, check for any heavy movement or a feeling of catches. 2) Assemble the spring seat (3) and the spring (4). 3) Press the pilot cover (6) in a direction from the spring side of the spool ass'y to the flange of the body. Fasten 2 hexagonal socket head bolts with washers (8) with specified torque with a 4mm hexagonal wrench.	 The diagram illustrates the assembly of a hydraulic valve. It shows a main valve body with a central spool sleeve. To the left, a spool assembly is shown with a spring seat (3) and a spring (4) being assembled. To the right, a pilot cover (6) is shown being pressed onto the spool assembly. Two hexagonal socket head bolts (8) with washers (7) are shown being fastened to the pilot cover. The diagram includes numbered callouts for each component: 1 (spool assembly), 2 (spring seat), 3 (spring), 4 (spring seat), 5 (pilot cover), 6 (pilot cover), 7 (hexagonal socket head bolt), and 8 (washer).

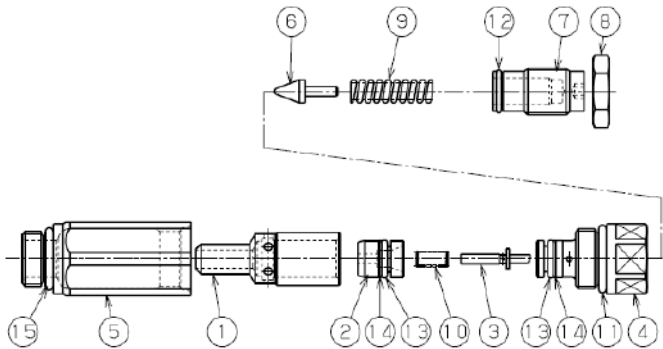
6. HYDRAULIC SYSTEM

9) Assembling parts when not using PTO2

Procedure	
When not using the PTO2 comp, plug the actuator port. 1) Check that the plug (11) is securely installed with O-ring (12). 2) Tighten the plug (11) with specified torque by using a 8mm hexagonal wrench. 3) Check that the plugs (13, 14) are securely installed with O-ring (5). 4) Tighten the plugs (13, 14) with specified torque by using a 19mm socket wrench.	 The diagram shows a top-down view of a hydraulic valve assembly. It features a central body with several ports. Callout 11 points to a top plug, and callout 12 points to its O-ring. Callout 13 points to a right-side plug, and callout 14 points to a left-side plug. Callout 5 points to the O-rings on these side plugs. The assembly includes various internal components like spools and springs, and external ports for fluid connection.

6. HYDRAULIC SYSTEM

10) Assembling accessory valves

Procedure	
 Accessory valves are the most important parts for performance and safety; in particular, the relief valve is very difficult to readjust the setting so that replace in Ass'y if any malfunction occurs. Assembly procedures are shown here as reference for investigating malfunction: The accessory valve assembled according to the procedures below should not be used practically. Main Relief valve (MRV): 1) After checking that the O-ring (12) is securely installed into grooves on the top of the adjustable screw (7), assemble the regulating valve spring (9) and the regulating valve (6) into the hole of the adjustable screw (7). 2) After checking that the back-up ring (14) and O-rings (13,11) are installed into the regulating body (4), put the screw hole side of the regulating body (4) on the ass'y that has been assembled in 1. and then fasten them with screws. CAUTION : <i>Pay attention to the positional relationship between the O-ring (13) and the back-up ring (14). (back-up ring is installed on the screw machined side of the regulating body)</i> <i>If it is installed oppositely, there would be the squeezing out of the O-ring or the like, resulting in internal leakage, malfunction, or damage to other hydraulic devices at worst. Then, look in the inside from a small-diameter hole of the regulating body (4) to check that the regulating valve (6) is settled in the seat of the regulating body (4).</i> <i>If the regulating valve is not settled, there will be no rise in pressure, resulting in malfunction.</i> 3) Attach M14 nut (8) to the adjustable screw (7) sticking out from ass'y that has been assembled in 2. 4) After checking that the O-ring (13) and back-up ring (14) are securely installed into grooves on the peripheral of the regulating valve (2), insert the regulating valve (2) into the socket (1).	

6. HYDRAULIC SYSTEM

Procedure

CAUTION :

Pay attention to the positional relationship between the O-ring (13) and the back-up ring (14). (back-up ring is installed on the screw machined side of the regulating body)

If it is installed oppositely, there would be the same malfunction as in 2.

5) Assemble the piston (3) and the regulating valve spring (10) in sequence into a small-diameter hole of the ass'y that has been assembled until 3. .

Be careful of the direction to install the piston. (The side machined with drill hole is to be the outside.)

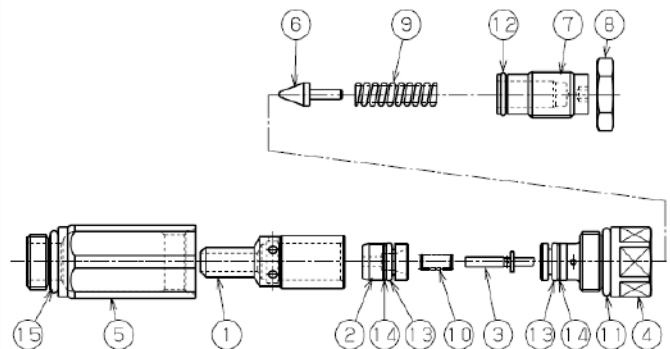
If it is inserted oppositely, the following assembly work cannot be done.

6) Assemble the ass'y that has been assembled in 5. with the ass'y that has been assembled in 4. .

7) Insert the ass'y that has been assembled in 6. into the regulating body (5) by turning the regulating body.

8) Lightly hold any two surfaces of the body (5) in a vise bench or the like and then fasten the regulating body (4) with specified torque by using a 19mm screw wrench.

9) Check the installation of the O-ring (15).



No.	DESCRIPTION
1	SOCKET
2	POPPET - MAIN VALVE
3	PISTON
4	VALVE SEAT - PILOT
5	BODY
6	POPPET - PILOT
7	ADJUSTABLE SCREW
8	NUT M14
9	SPRING - PILOT
10	SPRING - MAIN VALVE
11	O-RING 1B P15
12	O-RING 1B S10
13	O-RING 1A P7
14	BACK-UP RING
15	O-RING 1B P14

6. HYDRAULIC SYSTEM

Procedure	
Overload Relief valve (ORV): 1) After checking that the O-ring (12) is securely installed into grooves on the top of the adjustable screw (7), assemble the spring guide(16), the regulating valve spring (9) and the regulating valve (6) into the hole of the adjustable screw (7). 2) After checking that the back-up ring (14) and O-rings (13,11) are installed into the regulating body (4), put the screw hole side of the regulating body (4) on the ass'y that has been assembled in 1. and then fasten them with screws. CAUTION : <i>Pay attention to the positional relationship between the O-ring (13) and the back-up ring (14). (back-up ring is installed on the screw machined side of the regulating body)</i> <i>If it is installed oppositely, there would be the squeezing out of the O-ring or the like, resulting in internal leakage, malfunction, or damage to other hydraulic devices at worst.</i> <i>Then, look in the inside from a small-diameter hole of the regulating body (4) to check that the regulating valve (6) is settled in the seat of the regulating body (4).</i> <i>If the regulating valve is not settled, there will be no rise in pressure, resulting in malfunction.</i> 3) Attach M14 nut (8) to the adjustable screw (7) sticking out from ass'y that has been assembled in 2. 4) After checking that the O-ring (13) and back-up ring (14) are securely installed into grooves on the peripheral of the regulating valve (2), insert the regulating valve (2) into the socket (1). CAUTION : <i>Pay attention to the positional relationship between the O-ring (13) and the back-up ring (14). (back-up ring is installed on the seat side of the regulating valve)</i> <i>If it is installed oppositely, there would be the same malfunction as in 2.</i>	

6. HYDRAULIC SYSTEM

Procedure

5) Assemble the piston (3) and the regulating valve spring (10) in sequence into a small-diameter hole of the ass'y that has been assembled until 3. .

Be careful of the direction to install the piston.(The side machined with drill hole is to be the outside.)

If it is inserted oppositely, the following assembly work cannot be done.

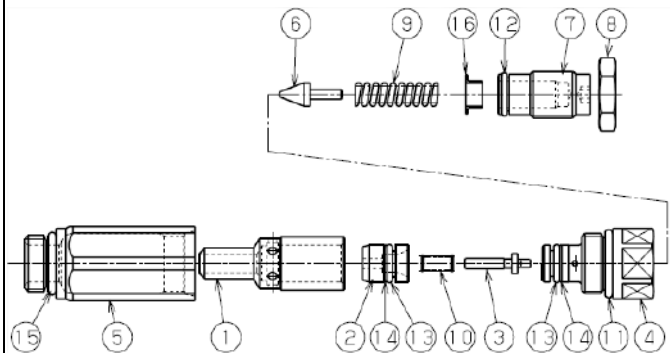
6) Assemble the ass'y that has been assembled in 5. with the ass'y that has been assembled in 4. .

7) Insert the ass'y that has been assembled in 6. into the regulating body (5) by turning the regulating body.

8) Lightly hold any two surfaces of the body (5) in a vise bench or the like and then fasten the regulating body (4) with specified torque by using a 19mm screw wrench.

9) Check the installation of the O-ring (15).

No.	DESCRIPTION
1	Socket
2	Poppet-MAIN VALVE
3	PISTON
4	VALVE SEAT-PILOT
5	BODY
6	POPPET-PILOT
7	ADJUSTABLE SCREW
8	NUT M14
9	SPRING-PILOT
10	SPRING-MAIN VALVE
11	O-RING 1B P15
12	O-RING 1B S10
13	O-RING 1A P7
14	BACK-UP RING
15	O-RING 1B P14
16	SPRING GUIDE



6. HYDRAULIC SYSTEM

Procedure

Anticavitation valve:

- 1) Install the back-up ring (5) and the O-ring (6) on the regulating valve (1).
- 2) Insert the regulating valve (1) into the regulating body (2).

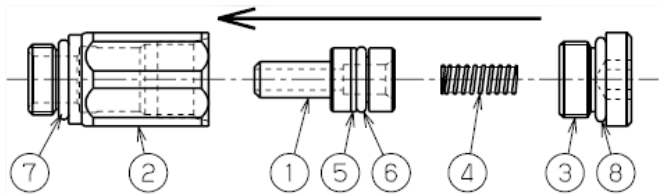
CAUTION :

Pay attention to the positional relationship between the O-ring (6) and the back-up ring (5). (back-up ring is installed on the small diameter side of the valve)

If it is installed oppositely, there would be the squeezing out of the O-ring or the like, resulting in internal leakage, malfunction, or damage to other hydraulic devices at worst.

- 3) Insert the spring (4) into the hole of the regulating valve (1).
- 4) After checking that the plug (3) is installed with the O-ring (8), tighten the plug (3) with specified torque by using a 8mm hexagonal wrench.

No.	DESCRIPTION
1	VALVE
2	BODY
3	PLUG
4	SPRING
5	BACK-UP RING
6	O-RING 1A P10A
7	O-RING 1B P14
8	O-RING 1B P15



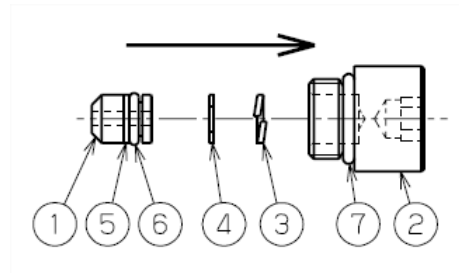
6. HYDRAULIC SYSTEM

Procedure

Relief plug:

- 1) Assemble the spring washer (3) and the plain washer (4) in sequence into the hole of the relief plug body (2).
- 2) Install the O-ring (6) and back-up ring (5) to the relief plug (1) securely.
- 3) Insert the relief plug (1) into the relief plug body (2) with the seat side of the relief plug (1) facing you.

No.	DESCRIPTION
1	PLUG
2	BODY
3	SPRING LOCK WASHER
4	PLAIN WASHER
5	BACK-UP RING
6	O-RING 1B P7
7	O-RING 1B P14



6. HYDRAULIC SYSTEM

6-4-7 Storage

To protect control valve from deteriorating, do not store them in the following places:

- A place with high temperature, high humidity.
- A place subject to direct weather.
- A place near medicines such as organic solvent, acids, and alkali, or affected by vaporized gas.
- A place with great temperature difference and in danger of condensation.

6-4-8 Disposal

When disposing of the control valve, first drain the hydraulic fluid completely and dispose of it as industrial waste.

6. HYDRAULIC SYSTEM

6-5 Pilot Valve

6-5-1 Remote Control Valve

Pilot valve unit for arm rest installation

Type 4TH5

Maintenance Instructions



1) Foreword

This manual deals with the instructions relative to servicing and maintenance operations for the hydraulic pilot control unit 4TH5 for the inspections and servicing operations associated with the hydraulic system of the machine to which they are connected. Please consult the maintenance manual supplied by the equipment manufacture.

It is recommended that only qualified personnel perform the installation, connection and maintenance of this device, and that all operations shall be carried out in compliance with the technical standards in force and the cleanliness regulations specific to this type of installation.

To ensure maximum performance and safety during maintenance operations we advise
you to **Read this manual thoroughly**

All information, illustrations, instructions and characteristics contained in this document are based on the latest product information available at the time of publication. In its attempts to maintain a high-quality product, MANNESMANN REXROTH reserves the right to make design or technical modifications at any time and without prior notification.

2) Safety Instructions

Please pay a special attention to the signals of safety alerts and special instructions in this manual. They are indicated in the following manner:



Indicates information or instructions which must be followed to guarantee your safety during operations.

CAUTION :

*Warning against possible equipment damage. **Note :***

Useful information.

6. HYDRAULIC SYSTEM

6-5-2 Troubleshooting

CAUTION :

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

Abnormal operation of equipment connected to the hydraulic pilot unit

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

Abnormal Hydraulic Pilot Unit Operation

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

Visual Defects

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

6. HYDRAULIC SYSTEM

6-5-3 Fundamental Rules

1) General Information Concerning Pilot Control Unit Connection

When removing the pilot control unit, all openings must be plugged immediately to prevent any contamination of the hydraulic system.

When replacing the pilot control unit, remove the plastic plugs from the openings and lines just before making the connections.

Do not tighten connectors to a torque greater than that specified in the assembly instructions.

Check the hydraulic installation's oil quality and filtration capacity during all servicing/maintenance operations. The use of teflon tape, hemp and joint filler is prohibited.

Hydraulic lines and connections must not be under any strain whatsoever.

6-5-4 Removal / Installation of the Pilot Control Unit Connection

1) General Recommendations

CAUTION :

Before removing the pilot control unit from the machine, the block and its surroundings must be thoroughly cleaned with a high-pressure cleaner.

No impurities must enter the hydraulic system. Plastic plugs are to be fitted on lines and orifices immediately following their removal.



Wear protective clothing and use suitable equipment to prevent accidents, particularly concerning the hydraulic fluid.

Set all actuators connected to the machine in neutral position (on the ground, at lower limit...) to avoid accidents which could result from uncontrolled movements of the equipment when the hydraulic system is disconnected.

With the machine off, release the pressure remaining in the system by manipulating all of the distribution spools. This is performed by moving the handle in all directions.

2) Pilot Control Unit Removal

Immediately after disconnecting the lines from the control device, fit the sealing plugs. Make sure to collect any possible oil leakage in a suitable receptacle.

Unscrew the mounting screws and remove the control device.

3) Installation of the Hydraulic Pilot Control Unit

Contact faces must be perfectly clean.

Check the evenness of the support area on the machine (tolerance : 0.5 mm).

Check the condition of the line connector seals.

Clean the pilot control unit if it has been in storage for a long period of time.

Correctly place and secure the pilot control unit onto the machine with the mounting screw (maxi torque : 10 N·m).

Connect the lines to the control unit as per the connecting diagram and tighten to the torque specification (maxi torque : 30 N·m).

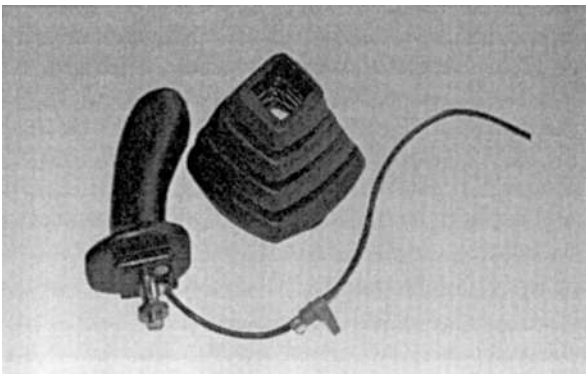
Ensure that the hoses are not twisted or rubbed.

Once correctly installed, the unit can be placed into operation.

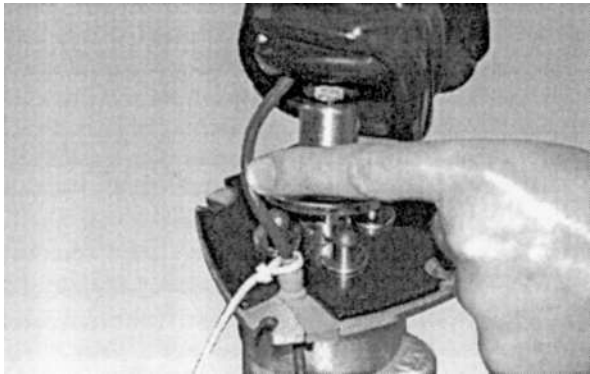
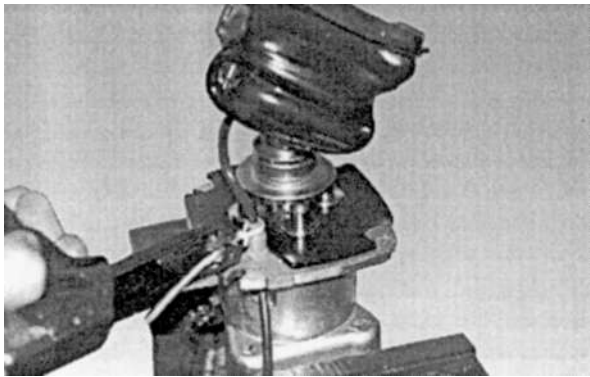
6. HYDRAULIC SYSTEM

6-5-5 Pilot Control Unit Repair Procedures

1) Boot or Handle Replacement

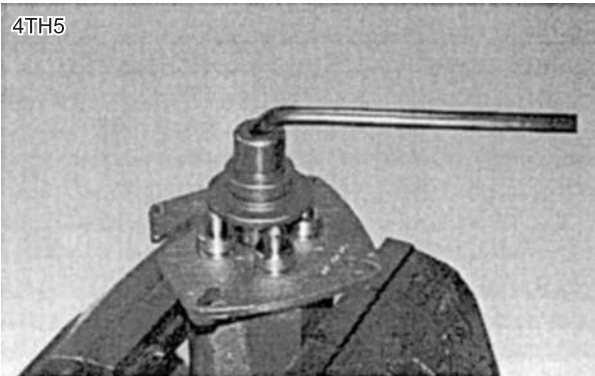
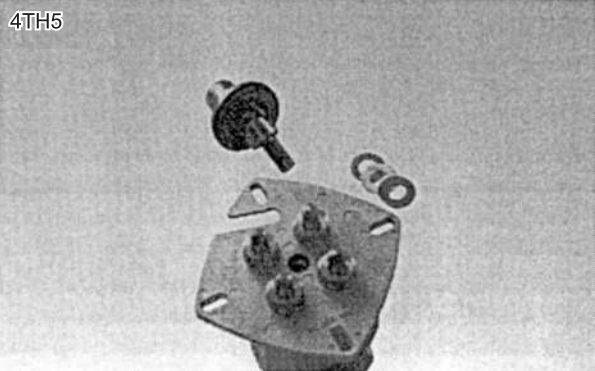
Procedure	
Preliminary operations Remove the pilot control unit from the machine's arm rest of free the unit by unscrewing the 4 screws fixing the plate in order to release the electrical cable. Hold the pilot control unit using a vice or a vice-grip wrench (clamp onto the body above the arm rest, 65 opening). Note : <i>The pilot control unit does not need to be removed from the machine to release the cable. However, it is recommended to lift the control unit by undoing the 4 fixing screws on the arm rest.</i> <i>It is unnecessary to remove the units without electrical function.</i>  Machine off : - place all of the machine's equipment connected to the pilot control unit in neutral position, - release stored pressure by operating all of the pilot unit's control valves by moving the handle in all directions. Handle removal Lift and turn the boot inside out. Remove the grommet from its emplacement to free the cable. Loosen the handle mounting nut (19 mm open-end wrench). Reassembly : torque : 30±3 N·m Unscrew and remove the handle.	 
Boot replacement Remove the faulty boot and replace it with a new boot. Replace the handle following the disassembly instructions in reverse order.	

6. HYDRAULIC SYSTEM

Procedure	
Handle replacement Clamp the threaded section of the bent lever in a vice fitting with V-shaped vice clamps. Remove the pin (5 mm pin driver)	
Remove : - pin, - bent lever, - handle. Replace the bent lever onto the new handle and secure it with the pin (5 mm pin driver) Note : <i>Respect the position of the bent lever to ensure that the handle is correctly oriented as indicated by the machine's technical specifications.</i> Replace the nut on the threaded section and replace the boot.	
Screw the handle onto the pilot control unit and tighten the nut (19 mm open-end wrench). Connect the new handle's electrical wiring to the machine's electric system. Fit the grommet into its emplacement while leaving enough cable length so as to enable the correct handle operation.	
Secure the cable to the grommet with a cable clamp. Fold down the boot.	

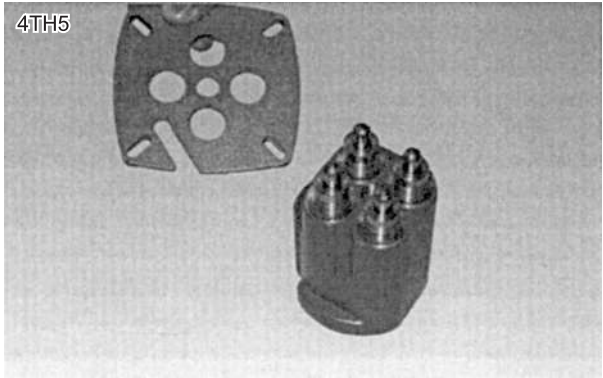
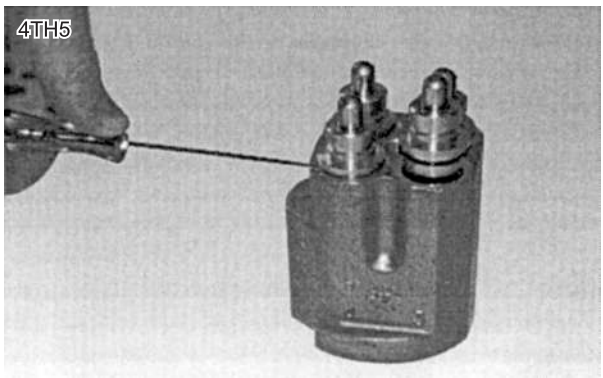
6. HYDRAULIC SYSTEM

2) Cardan Replacement

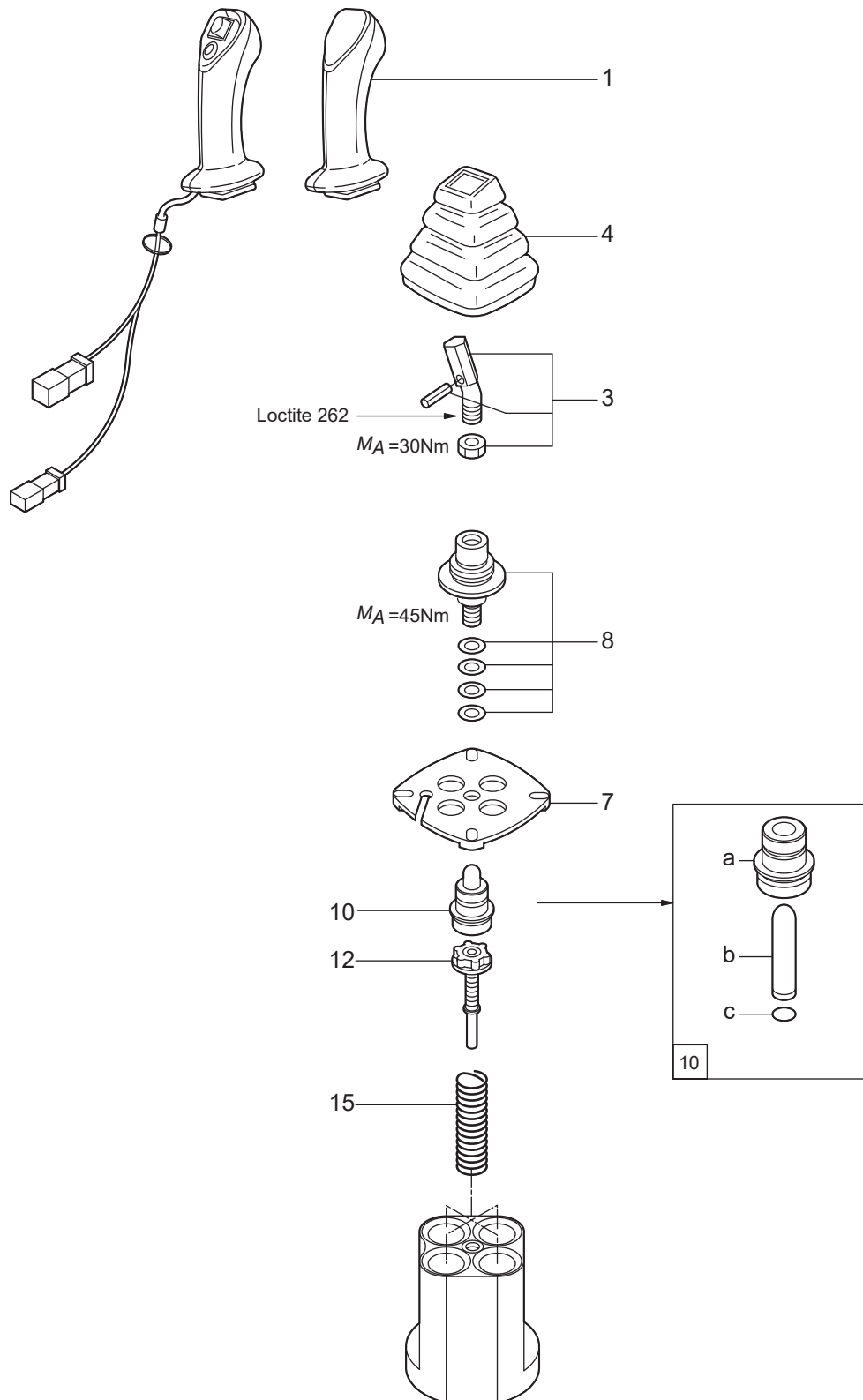
Procedure	
Preliminary operations Remove the pilot control unit from the machine's arm rest. Secure the pilot control unit in a vice (clamp onto the body). Remove the handle. Note : <i>It is recommended to remove the pilot control unit from the machine. Nevertheless, the servicing on machine is possible by securing the unit into a vice-grip wrench (65 opening). This is performed by extracting the body from the arm rest so as to clamp the vice-grip wrench onto the body in order to hold it above the arm rest.</i> Removal of the cardan Fit an Allen wrench into the assembly screw and unscrew it (8 mm Allen wrench). Reassembly : torque : 45 ± 4 N·m Remove : - the cardan, - the shim (s) Reassembly : Adjust the pre-depression of the cardan by selecting the shims necessary to obtain play-free contact between the switch-plate and the plungers. In neutral position, the depression of the plungers must not exceed 0.2 mm. In order to check this value, observe the displacement of the plunger located opposite to the one being pressed. Note : <i>The pre-depression may be difficult to achieve on site. Could be necessary to readjust it after reassembly and system working control.</i>	 

6. HYDRAULIC SYSTEM

3) Guide / Plunger and Regulation Unit Replacement

Procedure	
Preliminary operations Remove the pilot control unit from the machine's arm rest. Remove the handle. Remove the cardan. Note : <i>It is recommended to remove the pilot control unit from the machine. Nevertheless, the servicing on machine is possible by securing the unit into a vice-grip wrench (65 opening). This is performed by extracting the body from the arm rest so as to clamp the vice-grip wrench onto the body in order to hold it above the arm rest.</i>	
Removal Secure the pilot control unit to a vice. Remove the retaining plate. Reassembly : Line up the notches for the grommet in both the plate and the body.	
Insert the end of a thin screwdriver between the guide and the body, carefully lift the guide to remove it from the body. Note : <i>Hold the guide with the other hand during the extraction operation to limit the effect of the return spring.</i> Remove the guide / plunger assembly. Repeat the operation for the other 3 sub-assemblies. Reassembly : Use the retaining plate to insert the 4 guides into the body simultaneously and perpendicularly. Reassemble in reverse order.	
Regulation unit verification Extract the regulation units from the body (using flat nose pliers). Visually check that the guides / plungers are in good condition. If defects are present, replace the 4 sub-assemblies. Inspect the regulation units and particularly their spring. If defects are detected, replace the 4 units.	

6. HYDRAULIC SYSTEM



6. HYDRAULIC SYSTEM

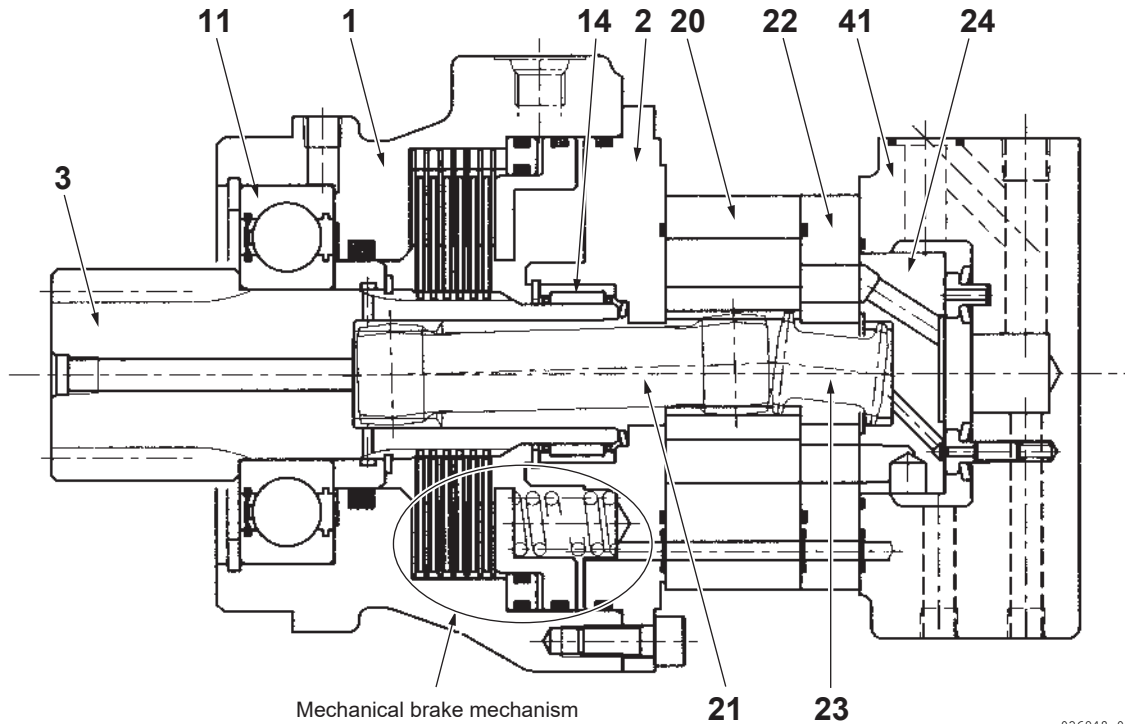
Item	Description
1	Handle TT
3	Lever kit
4	Rubber boot
7	Retaining plate
8	Cardan kit composed of : 1 cardan + shims
10	Plunger kit composed of : a. 4 plunger guides b. 4 plain plungers c. 4 spring rings
12	Regulating kit
15	Set of 4 return springs

Item	Description
1	Handle SH1 PRAH + Deutsch connectors 2 & 6 pins
3	Lever kit
4	Rubber boot
7	Retaining plate
8	Cardan kit composed of : 1 cardan + shims
10	Plunger kit composed of : a. 4 plunger guides b. 4 plain plungers c. 4 spring rings

6. HYDRAULIC SYSTEM

6-6 Swing Motor

6-6-1 Structure and Functions



This hydraulic swing motor consists of an orbit motor and a pinion gear assembly.

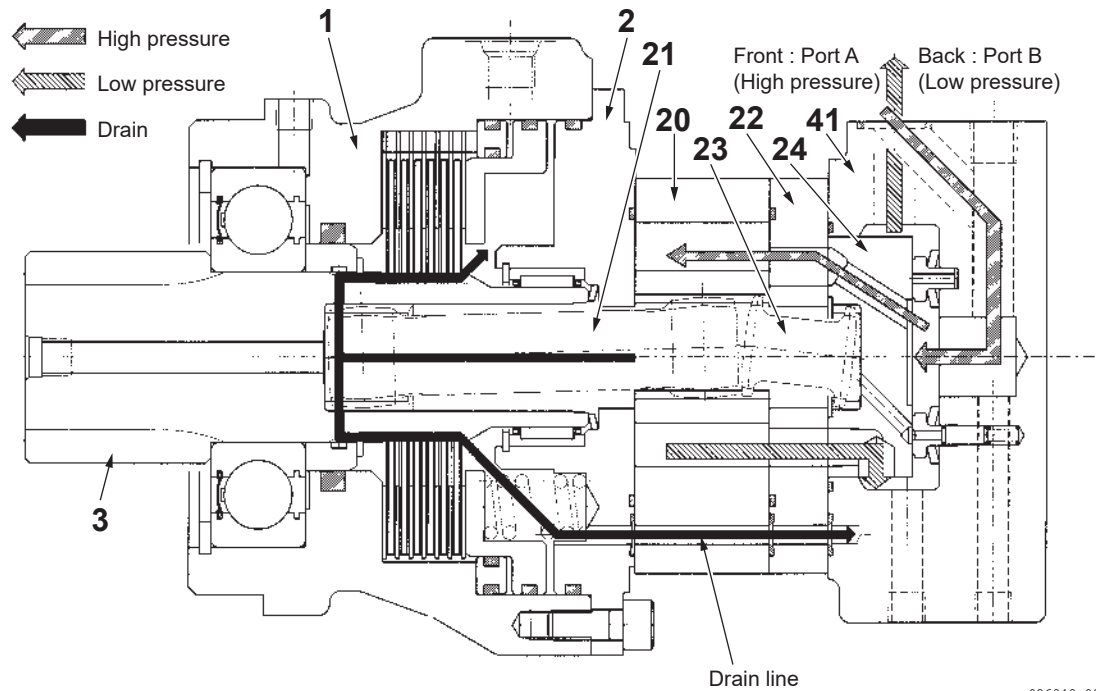
The swing motor with a mechanical brake has friction plates splined to the pinion gear **3** and steel plates splined to the bearing housing **1**. In this structure, the brake is operated under the brake torque which is produced by frictional force generated by the piston ring and the coil springs.

The hydraulic motor has six holes in the valve **24** and seven holes in the valve plate **22**, and the displacement per revolution is 14.9 cu. in. (244 cu. cm).

The pinion gear assembly consists of the pinion gear **3** and the two bearings **11** and **14** supporting the pinion gear. The hydraulic oil which flows in through the brake valve is fed to the valve housing **41**.

No.	Part
1	Bearing housing
2	Flange mounting
3	Pinion gear
11	Front bearing
14	Rear bearing
20	Roller
21	Drive
22	Valve plate
23	Valve drive
24	Valve
41	Valve housing

6. HYDRAULIC SYSTEM



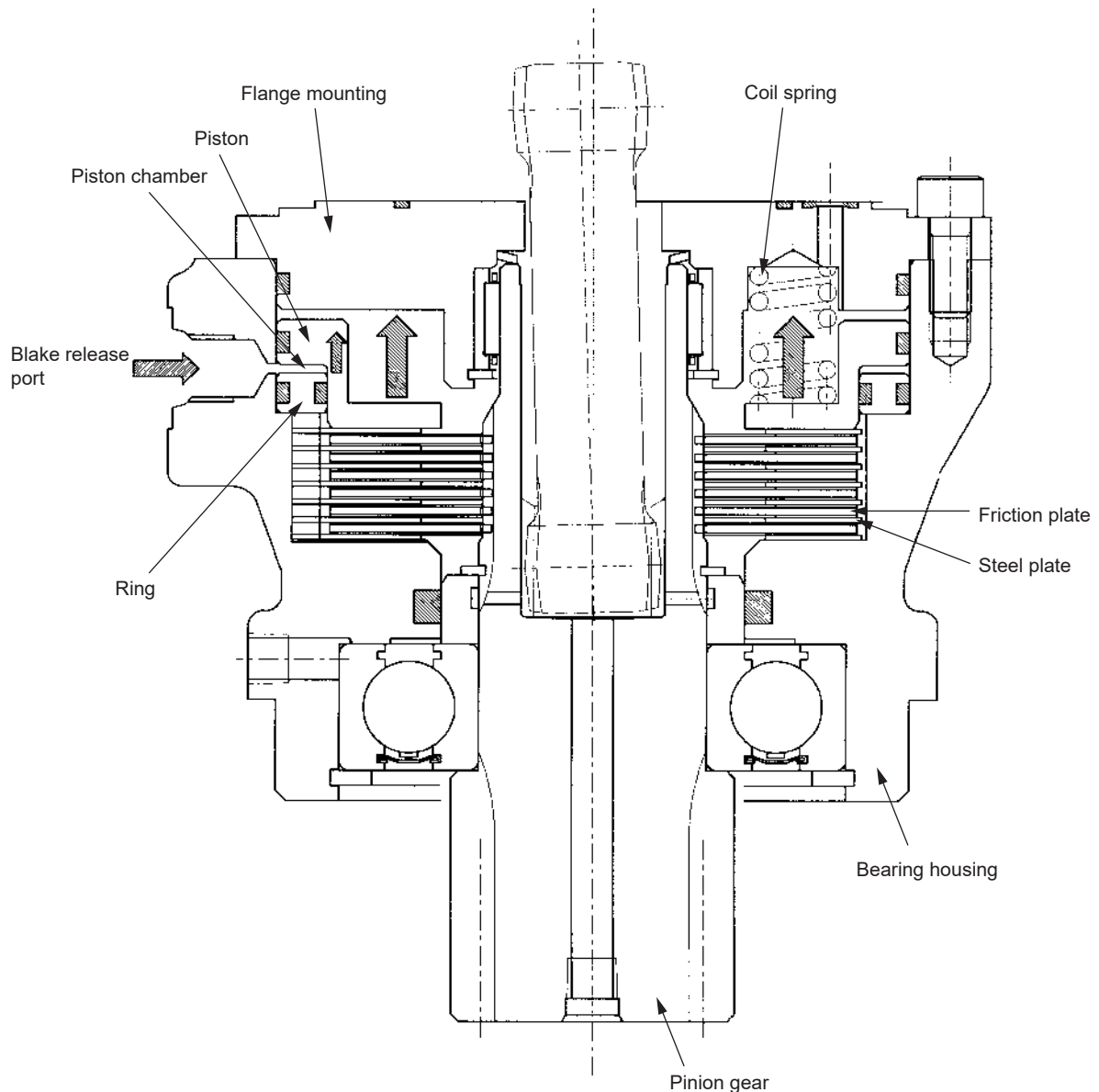
When hydraulic oil is fed to the port A, the oil flows into the oil hole in the valve **24** corresponding to the port A and runs through the oil hole in the valve plate **22** to rotate the roller **20**. When the valve **24** is rotated via the valve drive **23**, the positional relation between the six holes in the valve **24** and the seven holes in the valve plate **22** is changed and, in turn, the relative position of the hydraulic oil which flows into the roller **20** is shifted successively. The oil flow is converted into rotational force and outputted to the drive **21** splined to the roller **20**. Then, the rotational force is transmitted to the pinion gear **3**.

The oil which has leaked in the motor lubricates the parts, and then, is drained from the drain port.

6. HYDRAULIC SYSTEM

6-6-2 Mechanical Brake

The friction plates are splined to the pinion gear and the steel plates are splined to the bearing housing. When no hydraulic oil flows into the brake release port, the springs press the piston against the end face of the bearing housing through the steel plates and the friction plates which causes the pinion gear (output shaft) to be locked. When hydraulic oil flows into the piston chamber through the brake release port, the piston is moved up against the springs to the bottom of the flange mounting and the friction plates and the steel plates are disengaged, which causes the mechanical brake to be released.



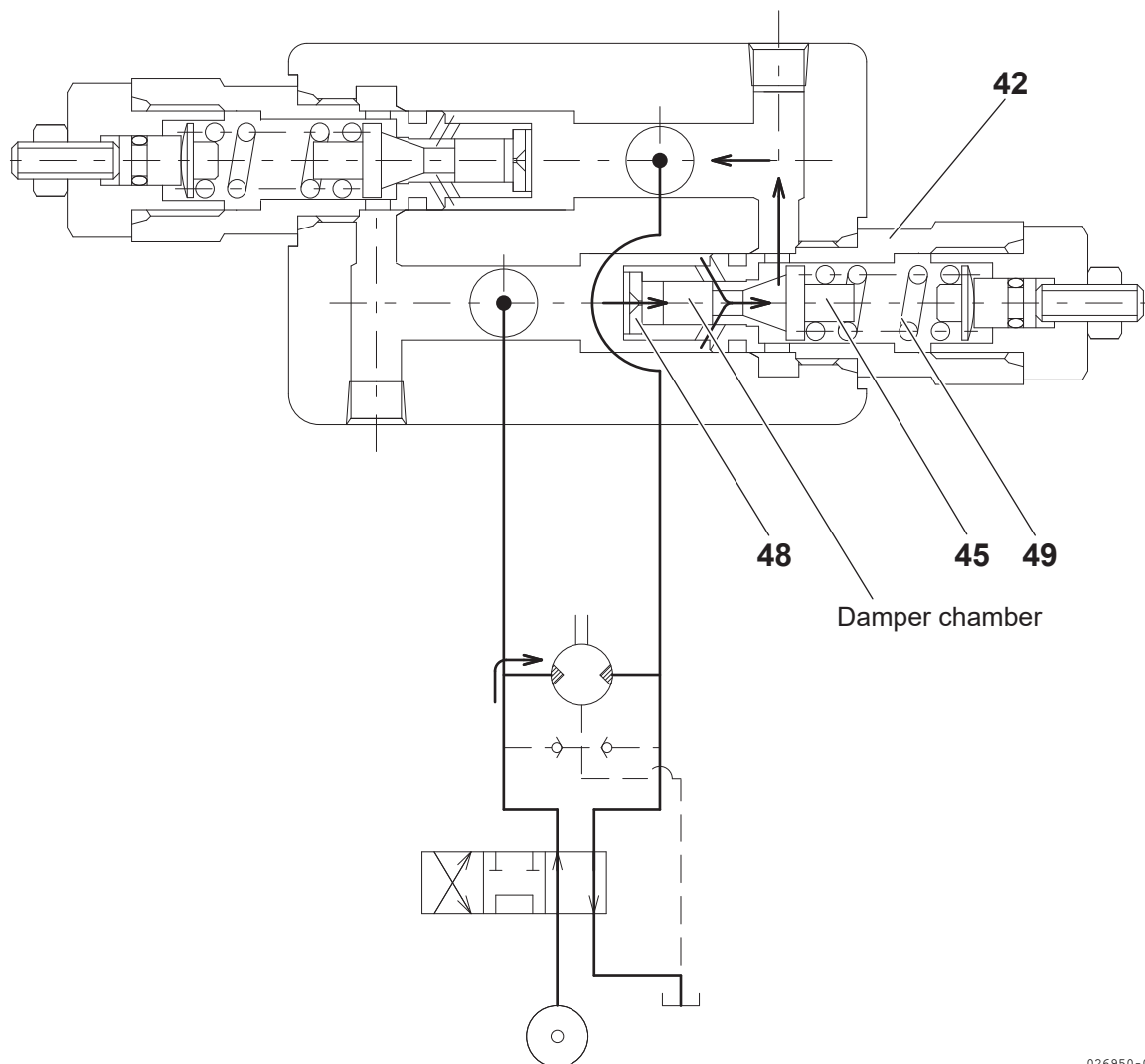
6. HYDRAULIC SYSTEM

6-6-3 Theory of Operation for Brake Valve

Normally, the needle valve 45 is seated on the seat portion of the cartridge 42 and both the high pressure (port A) and the low pressure (port B) are shutoff.

At starting or stopping, high pressure oil flows through the orifice of the orifice plug 48 into the damper chamber and when the pressure is greater than the set pressure of the spring 49, the needle valve 45 opens and high pressure oil flows to the low pressure side.

When the passage opens and the pressure decreases, the needle valve 45 is pushed back by the spring 49 and seated again to shutoff the high pressure and low pressure..



026950-00B

No.	Part
42	Cartridge
45	Needle valve
48	Orifice plug
49	Spring

6. HYDRAULIC SYSTEM

6-6-4 Disassembly and Reassembly

1) Precautions for Disassembly and Reassembly

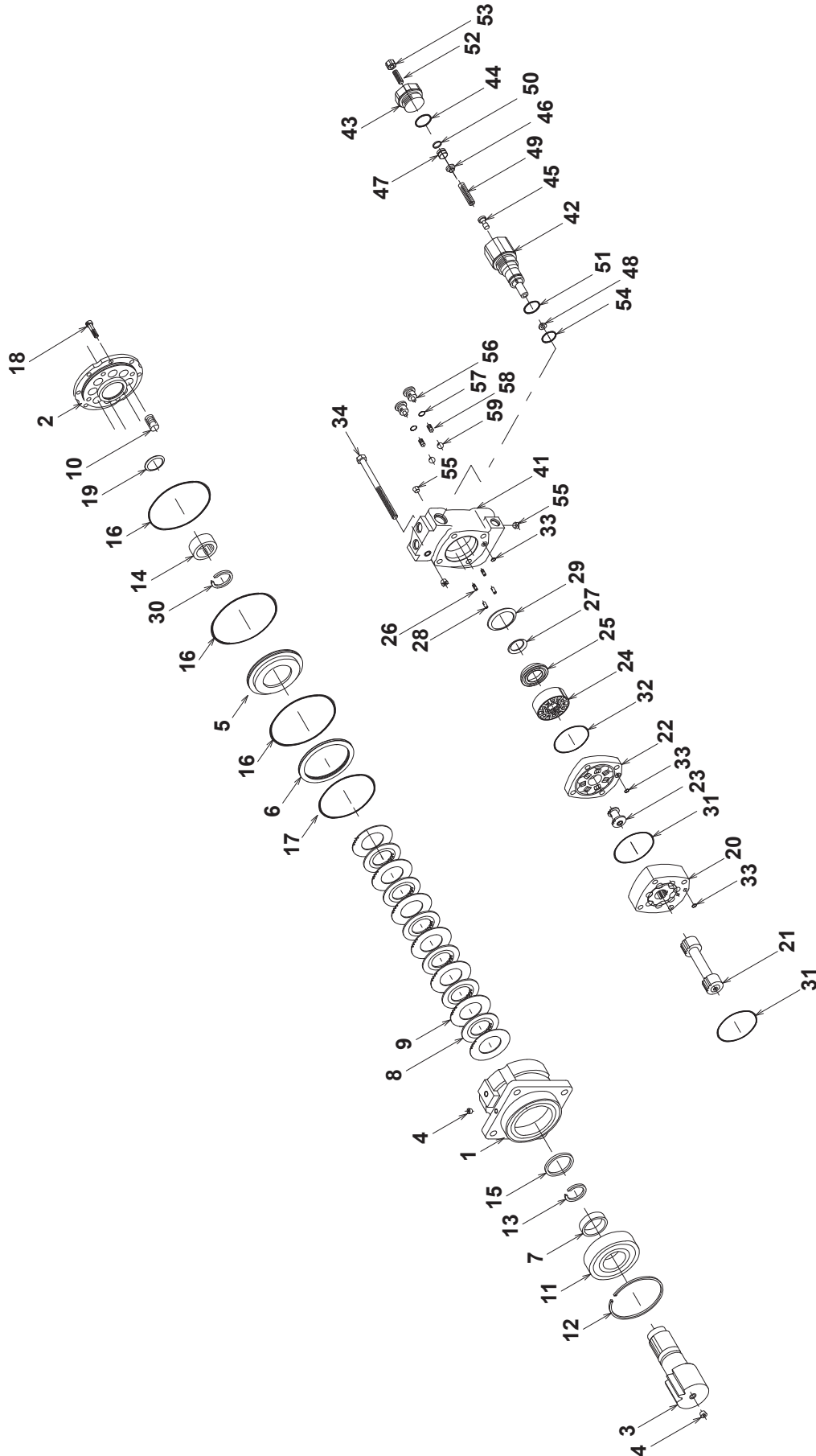
- (1) Since the parts of the hydraulic equipment are precision-made for tight clearances, be sure to perform disassembly and reassembly in a clean area that is free from dust.
- (2) Prepare clean tools and treated oil and handle the parts carefully.
- (3) First clean the external surface of the removed assemblies.
- (4) Before beginning disassembly, review the drawings of the internal construction and prepare the required parts according to the purpose and extent of the disassembly.
- (5) After disassembly, replace the removed seals and O-rings with new ones in principle. As some replacement parts are available only as subassemblies, see the parts catalogue to prepare the necessary subassemblies in advance.
- (6) Handling of O-rings
 - [1] Lubricate the O-rings and the O-ring fitting seats with clean grease or hydraulic oil.
 - [2] The O-rings may not be damaged in handling or distorted by heat.
 - [3] Do not extend any O-rings with such great force as to permanently deform them.
 - [4] Avoid rolling the O-rings when fitting them.A distorted O-ring may not return to its original shape, and therefore, may cause oil leak.

2) Tools for Disassembly

Tool	Remarks
Torque wrench	Capacity : 7.2 to 72.3 ft•lbf (9.8 to 98.0 N•m)
Socket	Width across flats : 0.55 in. (14 mm)
Hexagon sockets	Width across flats : 0.20 in. (5 mm) Width across flats : 0.31 in. (8 mm)
Retaining pliers	Internal snap ring : Ø1.85 in. (47 mm), Ø4.72 in. (120 mm) External snap ring : Ø1.77 in. (45 mm)
Screw driver	
Plastic hammer	
Press	~3 ton
Vice	

6. HYDRAULIC SYSTEM

3) Exploded View and Parts Names



6. HYDRAULIC SYSTEM

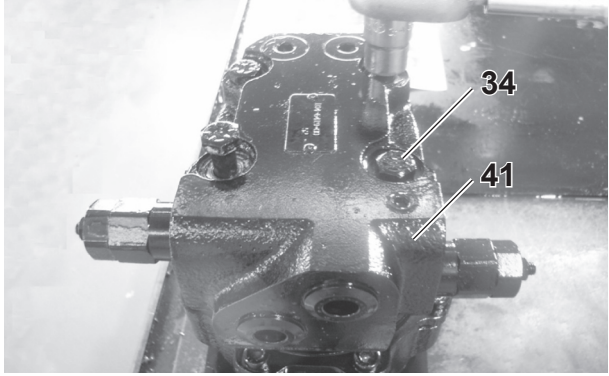
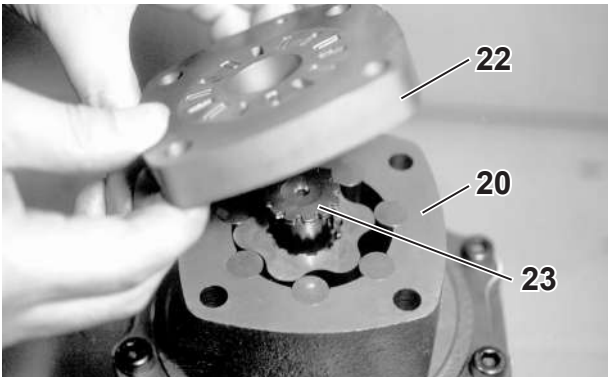
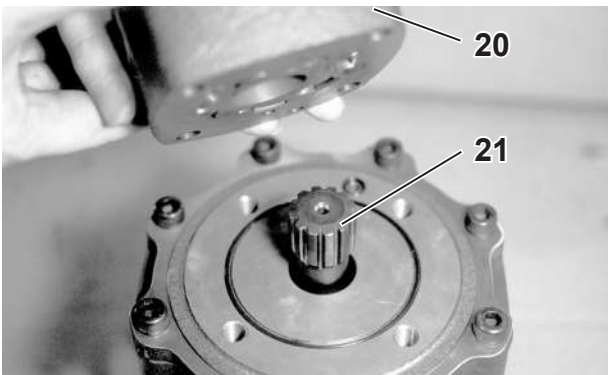
No.	Parts	Q'ty	No.	Parts	Q'ty
1	Bearing housing	1	31	O-ring	2
2	Flange mounting	1	32	O-ring	1
3	Pinion gear	1	33	O-ring	3
4	Plug	2	34	Hexagon head bolt	4
5	Piston	1	40	Valve housing assembly	1
6	Ring	1	41	Valve housing	(1)
7	Collar	1	42	Cartridge	(2)
8	Friction plate	6	43	Thread guide	(2)
9	Opposite plate	7	44	O-ring	(2)
10	Spring	8	45	Needle valve	(2)
11	Front bearing	1	46	Spring seat	(2)
12	C-shaped snap ring for hole	1	47	Spring press	(2)
13	C-shaped snap ring for shaft	1	48	Orifice plug	(2)
14	Rear bearing	1	49	Spring	(2)
15	X-ring	1	50	O-ring	(2)
16	O-ring	3	51	O-ring	(2)
17	O-ring	1	52	Hexagon socket set screw	(2)
18	Hexagon socket head bolt (M8 x 20)	8	53	Hexagon nut	(2)
19	Shaft face seal	1	54	O-ring	(2)
20	Roller	1	55	Plug	(2)
21	Drive	1	56	Plug	(2)
22	Valve plate	1	57	O-ring	(2)
23	Valve drive	1	58	Spring	(2)
24	Valve	1	59	Steel ball	(2)
25	Balancing ring	1			
26	Spring	2			
27	Inner face seal	1			
28	Pin	2			
29	Outer face seal	1			
30	Snap ring	1			

[Note]

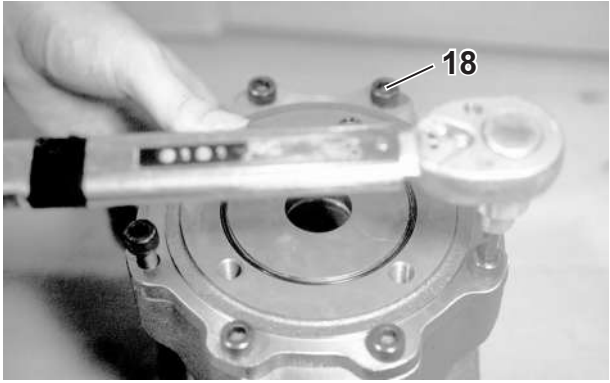
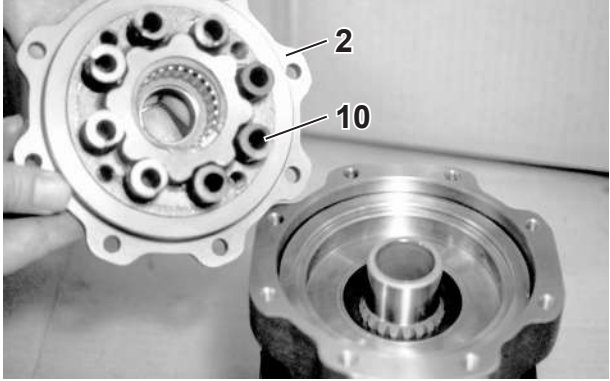
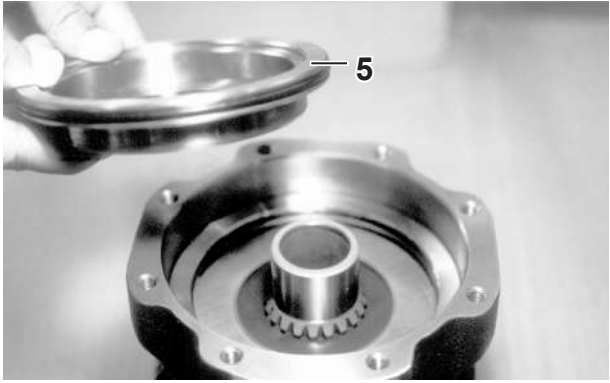
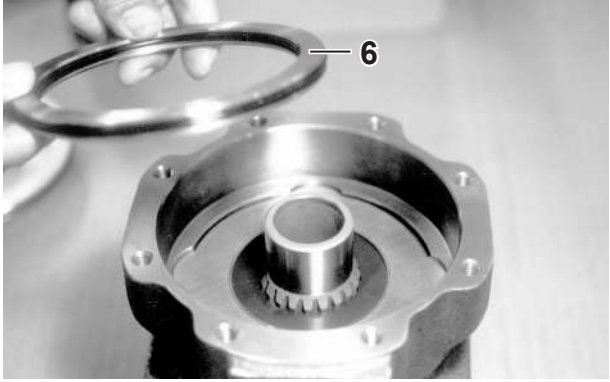
The valve housing assembly 40 include No.41-59.

6. HYDRAULIC SYSTEM

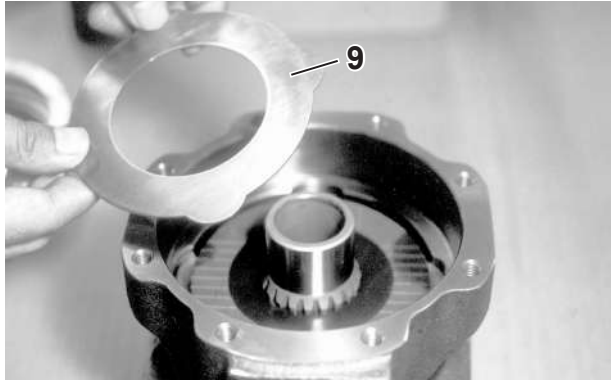
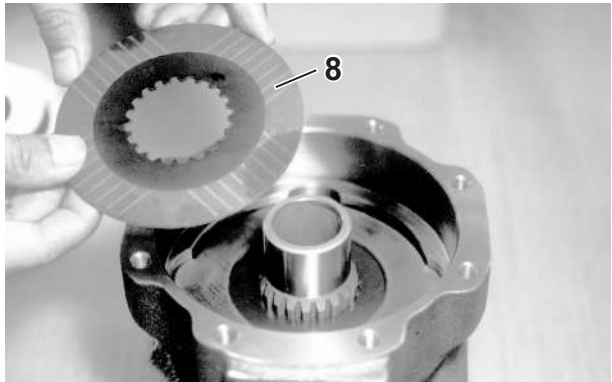
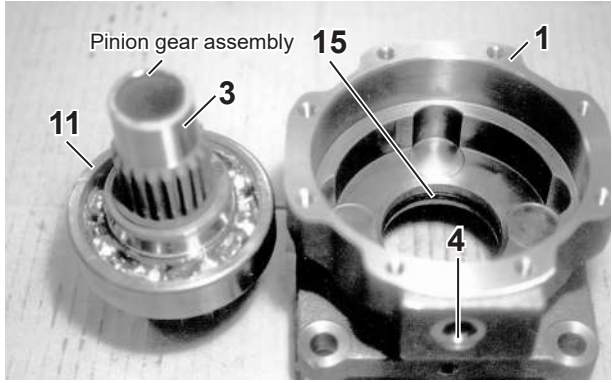
4) Disassembly

Procedure	
(1) Hold the flange part in a vice with the pinion gear 3 side down. Remove the hexagon head bolts 34 .	
(2) Remove the valve housing 41 . When removing it, take care not to lose pins 28 and springs 26 . Note : <i>Do not disassemble the valve housing 41 if not required.</i>	
(3) Remove the balancing ring 25 , the valve 24 , the valve plate 22 and the valve drive 23 .	
(4) Remove the roller 20 and the drive 21 .	

6. HYDRAULIC SYSTEM

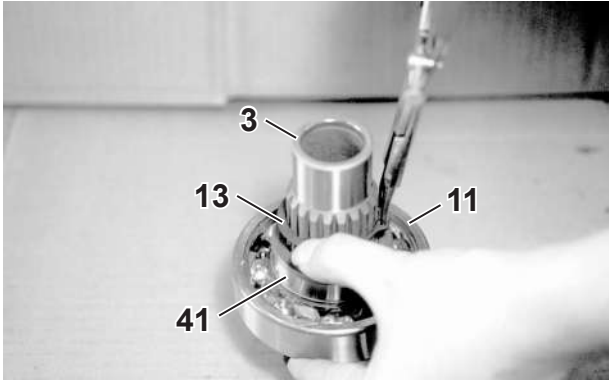
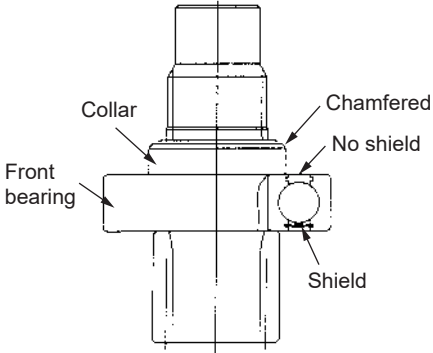
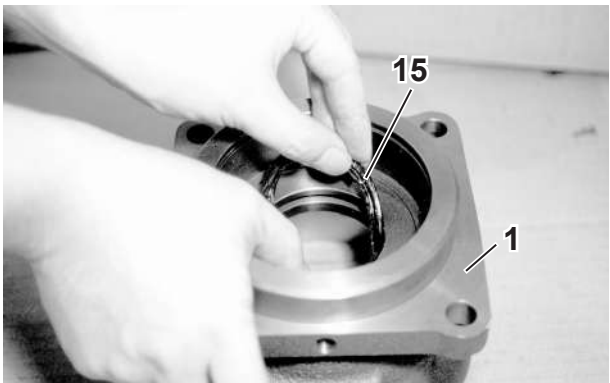
Procedure	
(5) Remove the hexagon socket head bolts 18.	
(6) Remove the flange mounting 2, and then remove the springs 10. Note : <i>Do not remove the shaft face seal 19, the rear bearing 14 and the internal snap ring 30, if not required.</i>	
(7) Remove the piston 5.	
(8) Remove the ring 6.	

6. HYDRAULIC SYSTEM

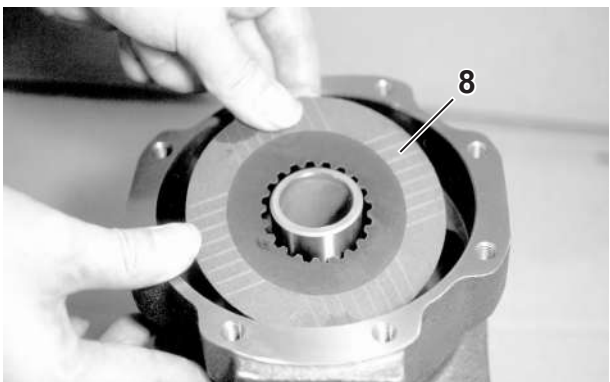
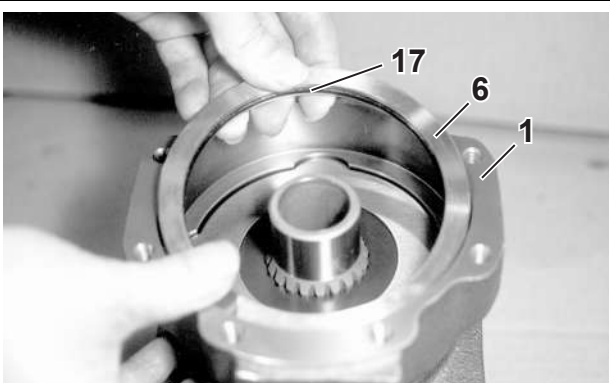
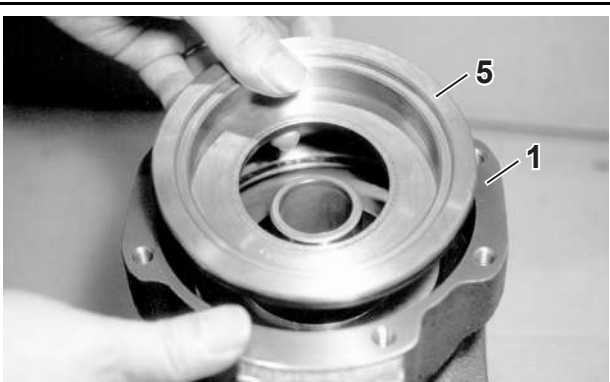
Procedure	
(9) Remove one of the steel plates 9.	
(10) Remove one of the friction plates 8. Alternately remove the rest of the steel plates 9 and the friction plates 8.	
(11) Remove the internal snap ring 12 to remove the pinion gear assembly such as the bearing from the bearing housing 1. Remove the blind plug 4 and the X-ring 15 from the bearing housing 1.	
(12) Remove the external snap ring 13 from the pinion gear 3 to remove the collar 7 and the front bearing 11. Note : <i>Do not remove them, if not required.</i>	

6. HYDRAULIC SYSTEM

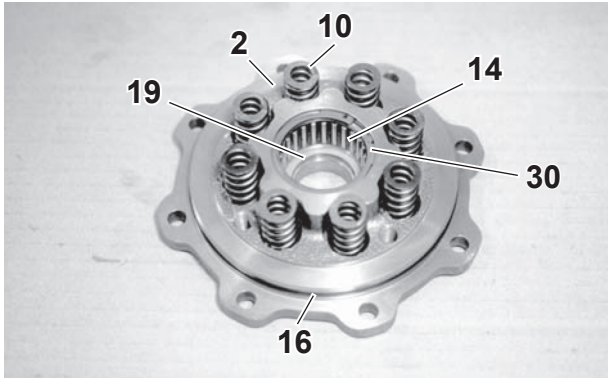
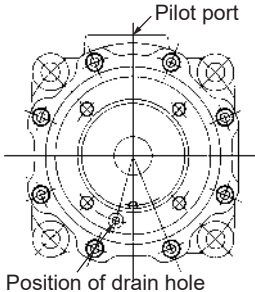
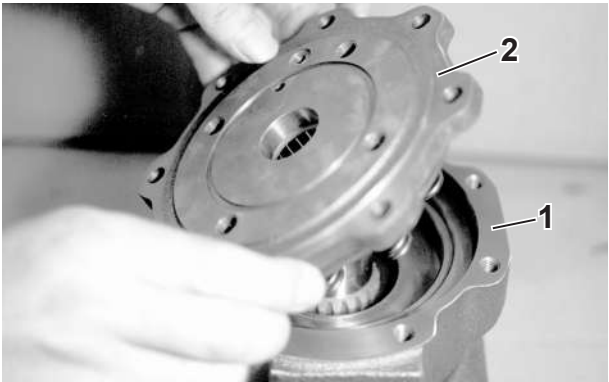
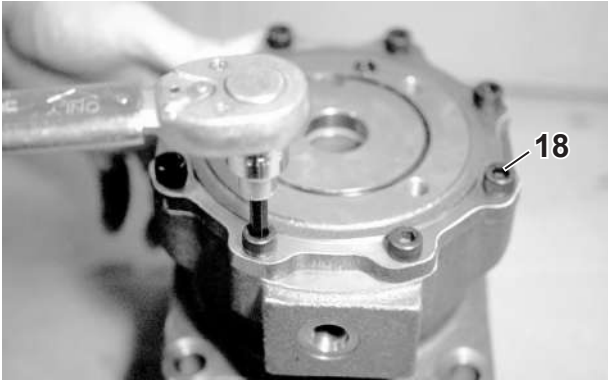
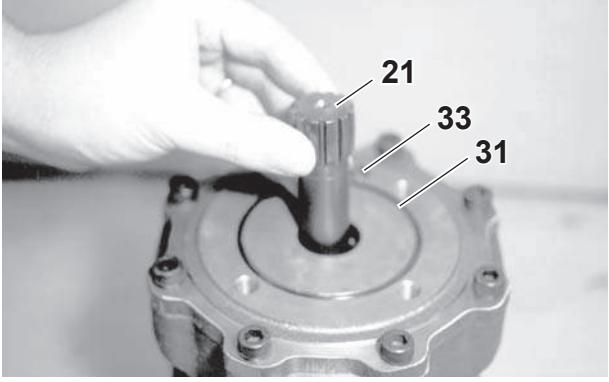
5) Reassembly

Procedure	
(1) Press-fit the front bearing 11 and the collar 41 into the pinion gear 3. At this time, pay attention to the direction of press-fitting. (2) Install the external snap ring 13.	 
(3) Install the X-ring 15 into the bearing housing 1.	
(4) Install the pinion gear assembly into the bearing housing 1. After installation, install the internal snap ring 12, and then tighten the blind plug 4 into the bleeder. Tightening torque : 7.2 ft·lbf (9.8 N·m)	

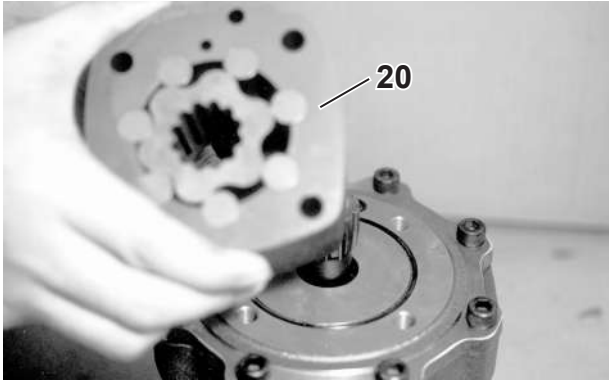
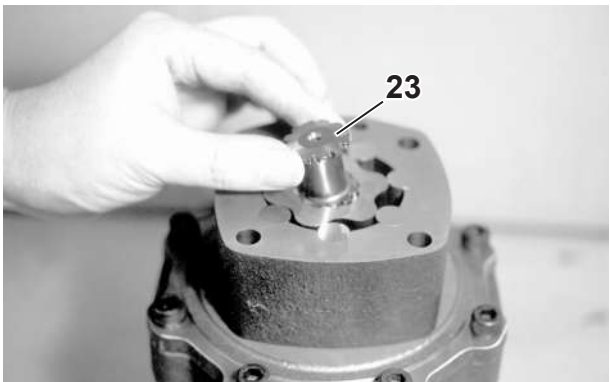
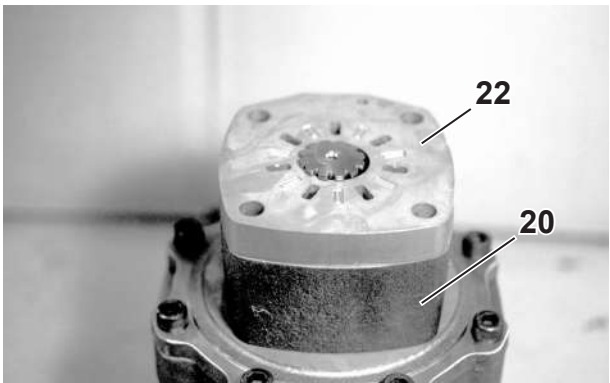
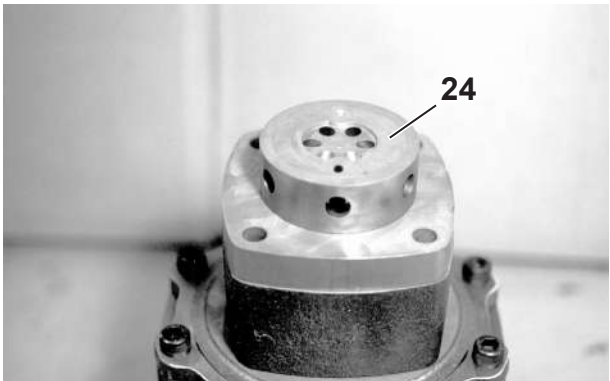
6. HYDRAULIC SYSTEM

Procedure	
(5) Insert one of the seven steel plates 9 into the bearing housing 1.	 A black and white photograph showing a hand placing a circular steel plate (9) into the bearing housing (1). The housing has a central bore with a gear-like inner surface. The plate is being positioned around this central part.
(6) Insert one of the six friction plates 8 into the bearing housing 1. Note : <i>Alternately install the steel plates and the friction plates. Finally, the steel plate should be seen on the top.</i>	 A black and white photograph showing a hand placing a circular friction plate (8) into the bearing housing (1). The plate has a textured, ribbed surface. It is being positioned over the central gear-like part of the housing.
(7) Install the O-rings (for inner and outer faces) 17 and 16 onto the ring 6. (8) Insert the ring 6 with O-rings into the bearing housing 1.	 A black and white photograph showing a hand installing O-rings (17 and 16) onto a ring (6) inside the bearing housing (1). The ring is being positioned within the housing, and the O-rings are being placed on its inner and outer faces.
(9) Install the O-ring (for outer face) 16 onto the piston 5. (10) Insert the piston 5 into the bearing housing 1.	 A black and white photograph showing a hand inserting a piston (5) into the bearing housing (1). The piston is a cylindrical component with a flange, and it is being placed into the housing's bore.

6. HYDRAULIC SYSTEM

Procedure	
(11) Install the shaft face seal 19 into the flange mounting 2. (12) Insert the rear bearing 14 and fasten it with the internal snap ring 30. (13) Apply grease to the springs 10, and install them into the flange mounting 2. (14) Install the O-ring 16 into the flange mounting 2.	
(15) Install the flange mounting 2 on the bearing housing 1. Notes : • Take care not to drop the springs 10. • The drain hole should be positioned as shown in the figure at the right. 	
(16) Tighten the hexagon socket head bolts 18. Note : Apply Loctite #242 or its equivalent to the hexagon socket head bolts 18. Tightening torque : 25.3 ft·lbf (34.3 N·m)	
(17) Install the two types of O-rings 31 and 32 into the O-ring grooves in the flange mounting 2. (18) Insert the drive 21.	

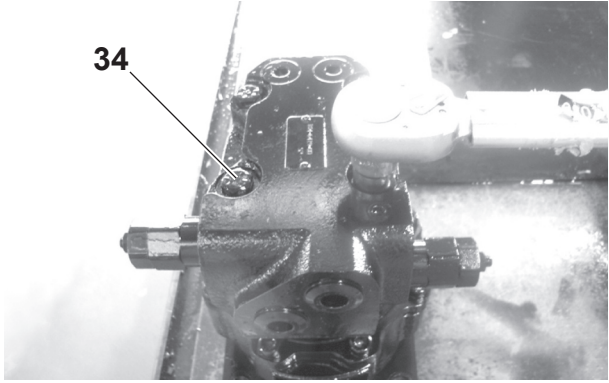
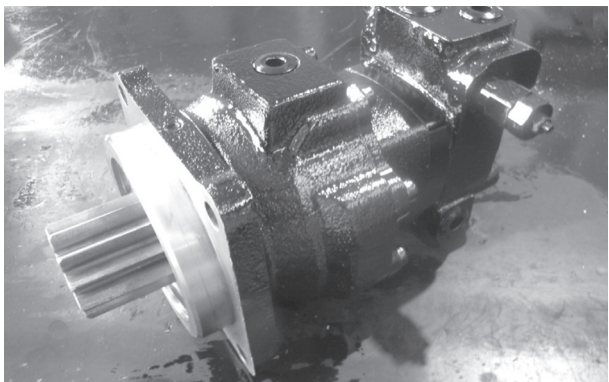
6. HYDRAULIC SYSTEM

Procedure	
(19) Install the roller 20. Note : <i>The drain hole in the roller 20 must be aligned with the drain hole in the flange mounting 2.</i>	 A black and white photograph showing a hand holding a circular roller with a central gear-like pattern and multiple small holes. The roller is being positioned over a flange mounting which has a central hole and several smaller holes around its perimeter. A label '20' with a pointer indicates the roller.
(20) Insert the valve drive 23 into the roller.	 A black and white photograph showing a hand inserting a small, cylindrical valve drive into the central hole of the roller. A label '23' with a pointer indicates the valve drive.
(21) Install the two types of O-rings 31 and 33 into the O-ring grooves in the valve plate 22. (22) Install the valve plate 22 on the roller 20. Note : <i>The drain hole in the valve plate 22 must be aligned with the drain hole in the roller 20.</i>	 A black and white photograph showing the valve plate (22) installed on top of the roller (20). The valve plate has a central hole and several smaller holes around its perimeter. A label '22' with a pointer indicates the valve plate, and a label '20' with a pointer indicates the roller.
(23) Install the valve 24.	 A black and white photograph showing the valve (24) installed on top of the roller assembly. The valve has a central hole and several smaller holes around its perimeter. A label '24' with a pointer indicates the valve.

6. HYDRAULIC SYSTEM

Procedure	
Note : The installation of the valve is important because the position of the valve determines the revolving direction of the motor. Refer to the right figure for the installation of the valve.	Valve drive 15° Roller star 15° External gear tooth Valve Horizontal hole 15° 050285-00EN00
(24) Install the steel balls 59, the springs 58 and the plugs 56 into the valve housing 41. Tightening torque : 43.4 ft·lbf (58.8 N·m)	41 58 59 56
(25) Install the springs 26 and the pins 28 into the valve housing 41. (26) Install the outer face seal 29 and the inner face seal 27 into the balancing ring 25. Note : When installing the balancing ring 25 into the valve housing 41, the notches in the balancing ring 25 must be aligned with the pins 28.	Outer face seal 29 Valve housing 41 Inner face seal 27 Spring 26 Pin 28 Balancing ring 25 026952-00E
(27) Install the two types of O-rings 32 and 33 into the O-ring grooves in the valve housing 41. (28) Insert a slender bar such as a driver into the port B side of the valve housing 41, and install the valve housing 41 on the valve 24 while holding the balancing ring 25 to prevent it from coming off. Note : The drain hole in the valve housing 41 must be aligned with the drain hole in valve 24.	33 24

6. HYDRAULIC SYSTEM

Procedure	
(29) Tighten the hexagon head bolts 34. Note : <i>Apply Loctite #242 or its equivalent to the bolts 34.</i> Tightening torque : 39.1 ft•lbf (53 N•m)	 A close-up photograph of a hydraulic component, likely a swing motor, showing a hexagon head bolt labeled 34. The bolt is being tightened. A white hose is connected to the side of the component.
(30) The procedure for reassembling the swing motor is completed. Make sure that the swing motor rotates in the correct direction before being installed to the actual device. Rotation direction viewed from the pinion shaft side : When pressure is applied to the port A : Clockwise When pressure is applied to the port B : Counterclockwise	 A photograph of a swing motor with a pinion shaft. The motor is shown from a side angle, highlighting the pinion shaft and the housing. The motor is mounted on a surface.

6. HYDRAULIC SYSTEM

5. Troubleshooting

Trouble	Cause	Measure
1. Motor does not rotate	(1) Insufficient hydraulic oil volume in hydraulic oil tank.	Supply hydraulic oil to the specified level.
	(2) Breakage of pump.	Replace the pump.
	(3) Malfunction of relief valve or low set pressure of it.	Disassemble and clean the relief valve and set the pressure to the specified value.
	(4) Excessive wear or scuffing of motor.	Disassemble the motor to check the parts. Replace any damaged parts.
	(5) Short-circuit inside motor.	The face seals or other parts may be damaged. Disassemble the motor to check the parts. Replace any damaged parts.
	(6) Insufficient brake release pressure.	Apply a pilot pressure of 145 PSI (1.0 MPa) to the brake release port.
2. Unstable rotation	(1) Low relief set pressure.	Check whether the specified volume of hydraulic oil is fed to the motor suction side. Then, check and repair each part.
	(2) Air in pump on the suction side.	Check the piping of the suction side. Tighten the piping if necessary.
3. Reverse rotation	(1) Reversed piping.	Correct the piping.
	(2) Reversed valve timing of motor.	Correct the valve timing.
4. Oil leak from joint	(1) Loosened bolt.	Tighten the bolt at the specified tightening torque.
	(2) Caught or damaged O-ring.	Replace the O-ring.
5. Low brake torque	(1) Worn friction plates.	Replace the friction plates.
	(2) Pressure remaining in pilot line.	Check the piping of the pilot line.

6. HYDRAULIC SYSTEM

6-7 Travel Motor

6-7-1 Outline

The travel motor on this machine is a kind of orbit motor, and consists of the followings units.

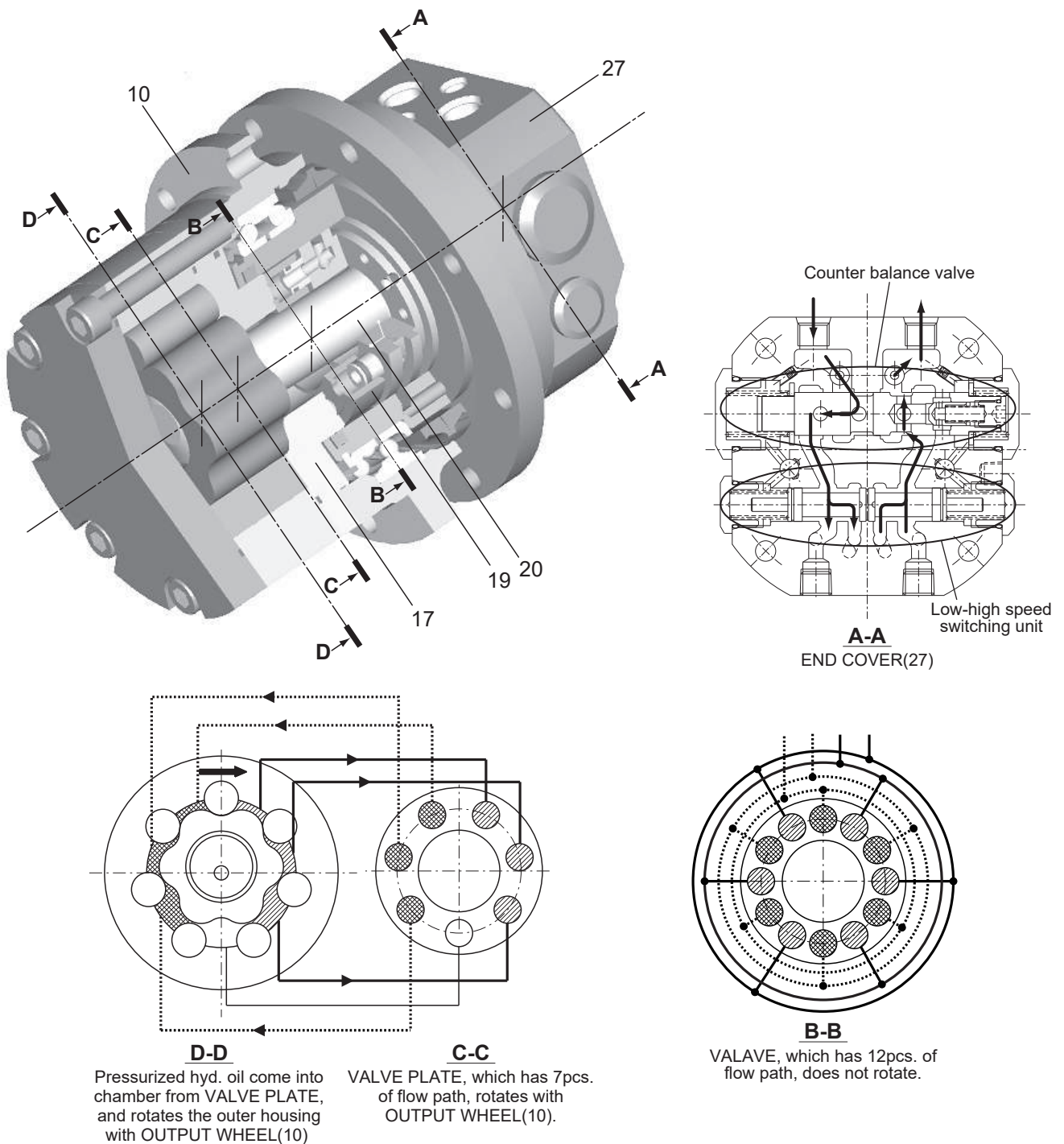
(1) HYDRAULIC MOTOR unit with OUTPUT WHEEL (10).

The motor units includes VALVE(19) which has 12 holes of oil flow paths and VALVE PLATE (17) which has 7 holes of oil flow paths.

DRIVE SHAFT (20) moves precessional rotation, but not rotate itself. The rotation of the DRIVE SHAFT(20) is fixed with END COVER(27) on the track frame. The OUTPUT WHEEL(10) is rotated by hydraulic power.

(2) END COVER UNIT (27) with counter balance valve.

End cover units includes low-high speed switching units and counter balance valve.



6. HYDRAULIC SYSTEM

6-7-2 Theory of Operation

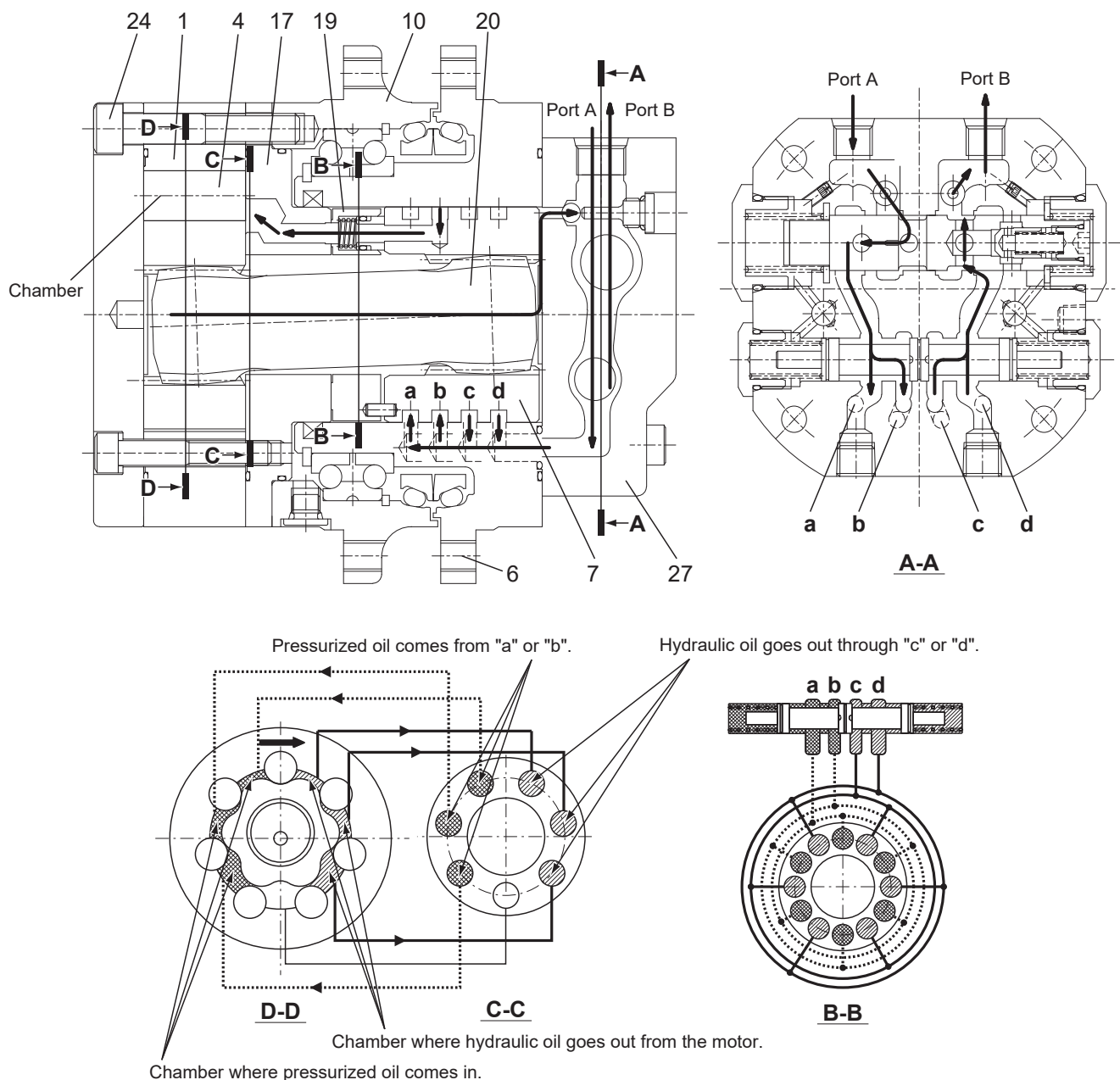
1) Motor (Low speed)

High pressurized hydraulic oil comes in Port A or B and the low pressure hydraulic oil goes out from the other port. It depends on the traveling direction. In this section, a case where high pressurized oil comes in Port A is described.

The high pressurized hydraulic oil from port A on END COVER UNIT(27) goes into VALVE(19) through counter balance valve, low-high speed switching unit and VALVE SLEEVE(7).

And the hydraulic oil goes into chambers via VALVE PLATE(17), Then the hydraulic oil turn RING (1). After that, hydraulic oil goes out from port B via VALVE PLATE(17), VALVE(19) and VALVE SLEEVE(7).

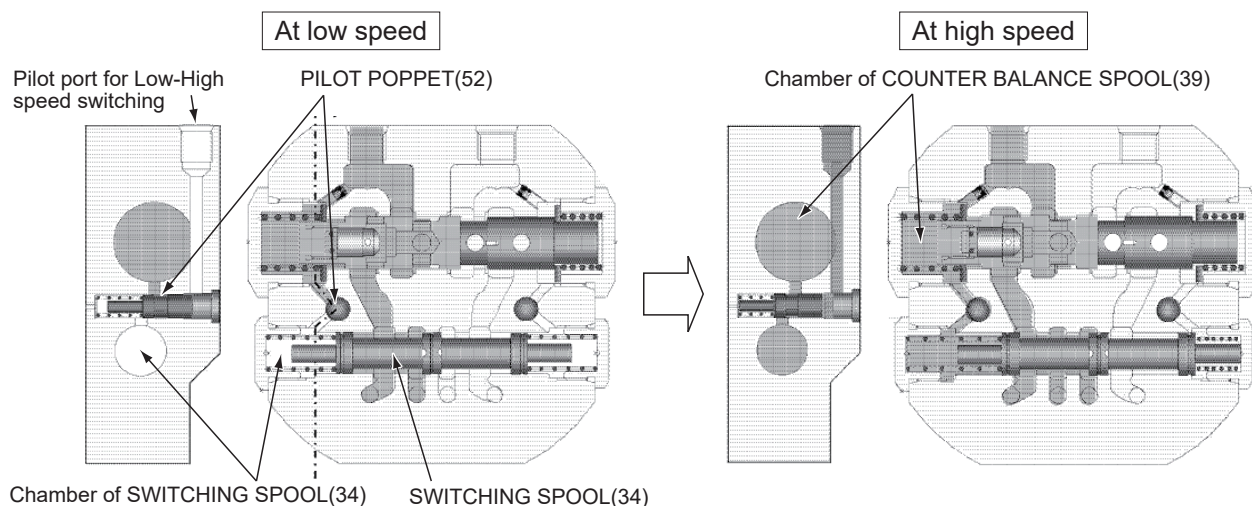
DRIVE SHAFT(20) moves precessional rotation, but not rotate itself, because rotation of the DRIVE SHAFT(20) is fixed with FLANGE(6) on track frame. Then OUTER WHEEL(10) which is fixed on RING(1) and VALVE PLATE(17) rotates. Sprocket is fixed on OUTER WHEEL(10).



6. HYDRAULIC SYSTEM

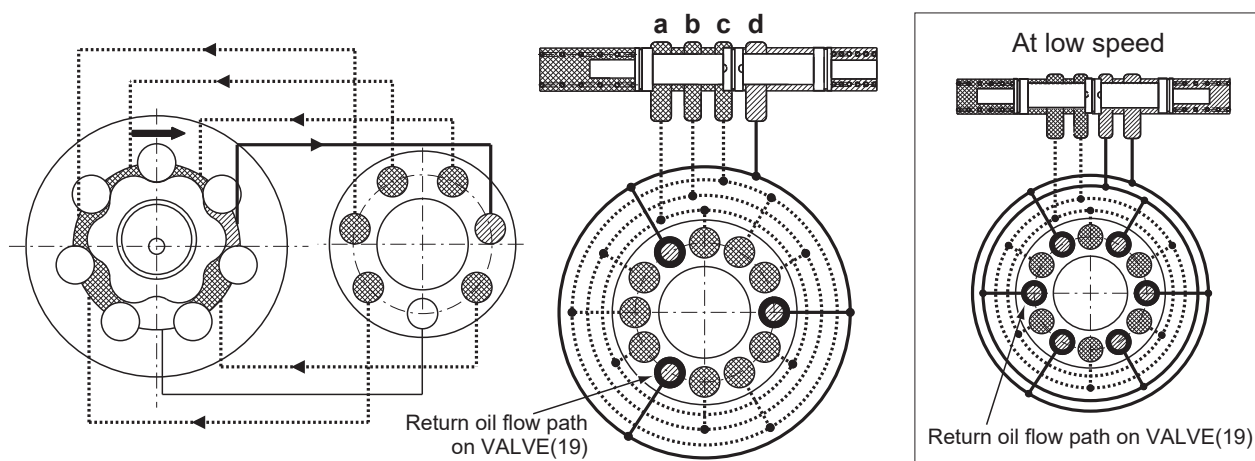
2) Low-High speed switching scheme

When the pilot oil, that switches high speed, comes in pilot port, Pilot oil pushes PILOT POPPET(52). And path, which is from COUNTER BALANCE SPOOL(39) chamber to SWITCHING SPOOL(34) chamber, is open. Then pressurized hydraulic oil goes to chamber of SWITCHING SPOOL(34) and pushes SWITCHING SPOOL(34). As the result, three paths(a, b and c) of hydraulic oil are open. Hydraulic oil from counter balance goes to orbit motor via three oil paths(a, b and c), and return oil goes out via only one path(d).



Though number of the hydraulic oil flow paths is increased at high speed, amount of supplied hydraulic oil flow at high speed is same as at low speed. Rotation speed is controlled by capacity of returned oil flow.

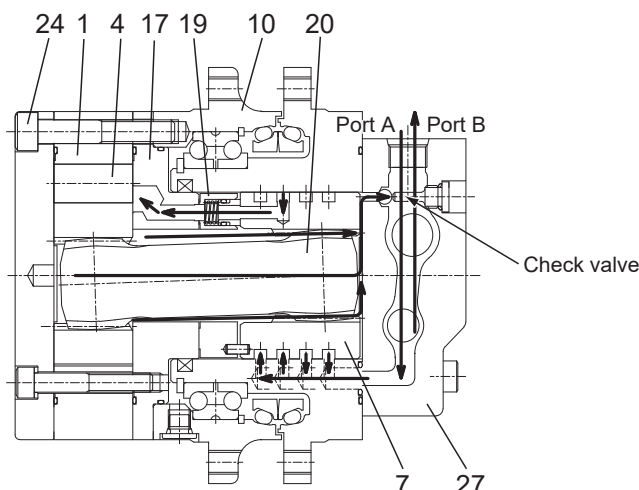
At high speed, oil returns/goes out via flow path "d", and flow path "d" is connected to three paths on VALVE(19). Capacity of returned oil flow is actually determined by number of flow path on VALVE(19). Number of returned oil flow path on VALVE(19) is six at low speed. The capacity of returned oil flow at high speed is half of the capacity at low speed. Because same amount of hydraulic oil is fed to the orbit motor, the motor must rotate at double speed to discharge same amount of oil from the motor.



6. HYDRAULIC SYSTEM

3) Return flow of normal inner leakage

Inner leaked oil goes through clearance between DRIVE SHAFT(20) and it's housing to END COVER(27). When the pressure of inner leakage rises up higher than check valve, the oil goes out from the motor and returns through drain hoses to reservoir tank.



4) Counter balance valve

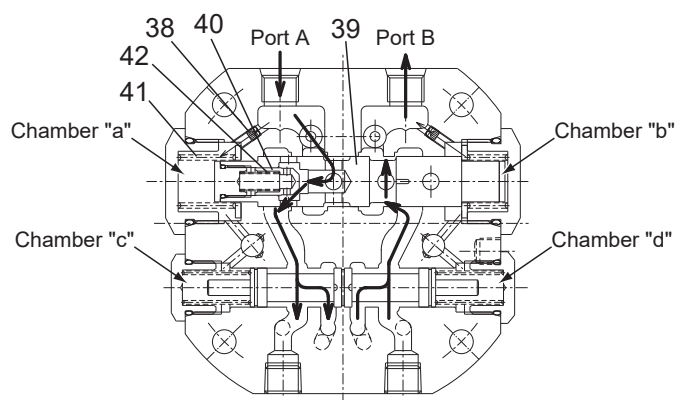
When traveling levers are at neutral positions, COUNTER BALANCE SPOOL(39) is kept at neutral position by two pcs. of SPRING(41) on both sides. COUNTER BALANCE SPOOL(39) at neutral position prevents hydraulic oil to flow out. Then motor does not rotate.

Hydraulic oil, which is fed to Port "A", goes chamber "a" through ORIFICE(38). At the same time, POPPET(38) starts open, and hydraulic oil starts to go into motor. But ORIFICE on opposite side is still closed. Then hydraulic oil is not goes out from the motor via Port "B" and motor does not rotate.

When hydraulic oil pressure in Camber "A" rises up more than cracking pressure, COUNTER BALANCE SPOOL(39) moves to right hand. Then oil flow path on Port "B" is open and hydraulic oil goes out from the motor. Oil in chamber "b" goes out via ORIFICE, when the COUNTER BALANCE SPOOL(39) moves to right hand. But amount of oil flow is small due to ORIFICE, moving speed of COUNTER BALANCE SPOOL is slow.

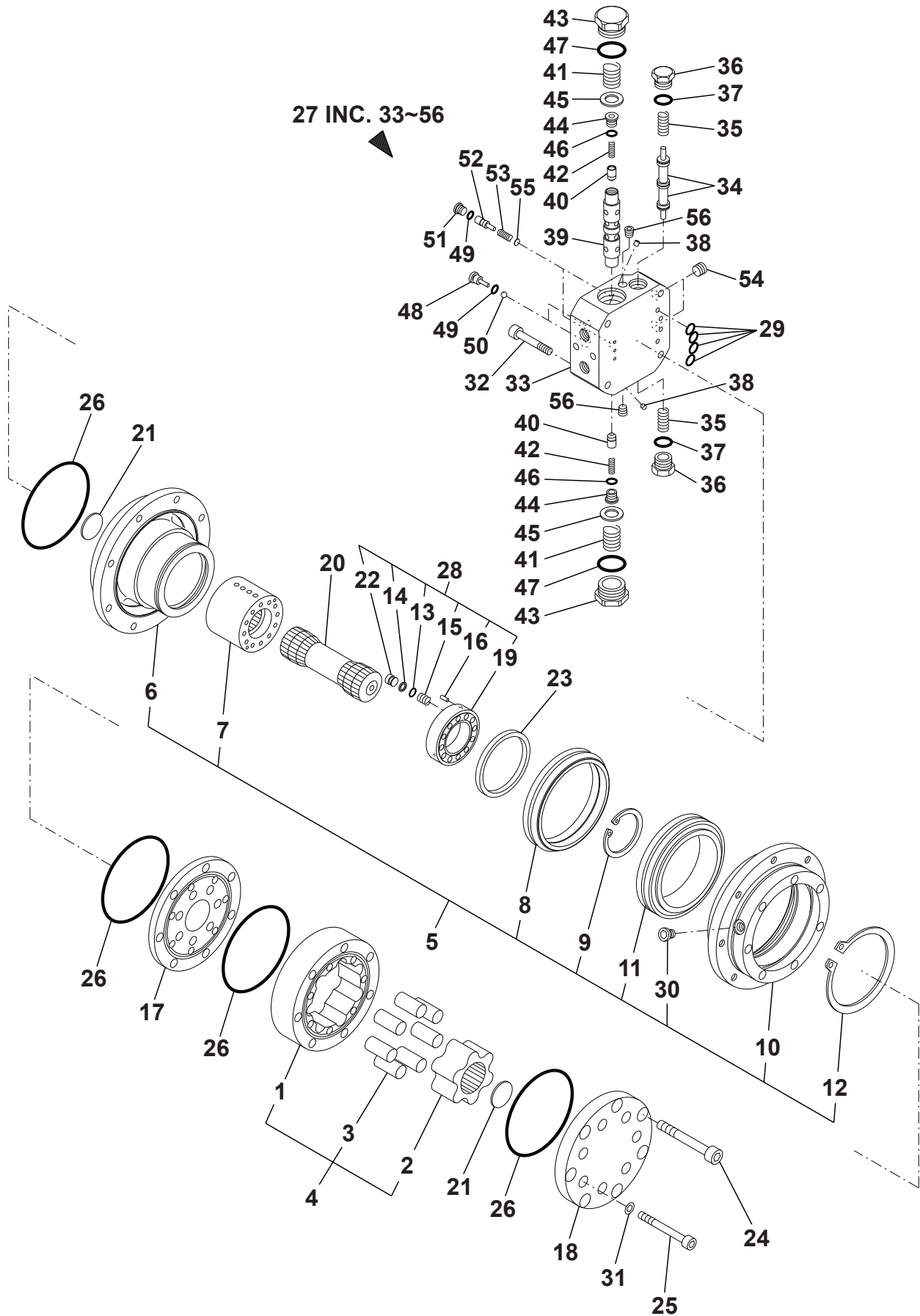
In a case where the motor speed rise up higher than rated speed due to outer load, amount of supplied hydraulic oil is insufficient to rotate such high speed. Hydraulic oil pressure in chamver "a" falls down, and COUNTER BALANCE SPOOL return back to balanced position. Then the oil flow path is reduced and the hydraulic oil flow is reduced and rotation speed is also reduced.

Depend on this function, travel speed is kept at rated speed even on steep grade.



6. HYDRAULIC SYSTEM

6-7-3 Exploded View and Parts Comprised



6. HYDRAULIC SYSTEM

No	Part	Q'ty	No	Part	Q'ty
1	Ring	1	31	Washer	7
2	Star	1	32	Hexagon socket head bolt	4
3	Roller	7	33	Valve housing	1
4	Roller assy	1	34	Low high switching spool	2
5	Spindle/wheel assy	1	35	Spring	2
6	Flange/spindle	1	36	Plug	1
7	Valve sleeve	1	37	O-ring	2
8	Floating seal	1	38	Orifice	2
9	Retaining ring	1	39	Counter balance spool	1
10	Output wheel	1	40	Counter balance poppet	2
11	Ball bearing	1	41	Spring	2
12	Retaining ring	1	42	Spring	2
13	O-ring	12	43	Plug	2
14	Backup ring	12	44	Check plug	2
15	Coil spring	12	45	Washer	2
16	Pin	2	46	O-ring	2
17	Valve plate	1	47	O-ring	2
18	Roller cover	1	48	Check plug	2
19	Valve	1	49	O-ring	4
20	Drive shaft	1	50	Ball	2
21	Spacer	2	51	Pilot plug	2
22	Sleeve	12	52	Pilot poppet	2
23	X-ring	1	53	Spring	2
24	Hexagon socket head bolt	7	54	Plug	2
25	Hexagon socket head bolt	7	55	Orifice plate	2
26	O-ring	4	56	Plug	2
27	End cover assy	1			
28	Valve assy	1			
29	O-ring	4			
30	Plug	1			

6. HYDRAULIC SYSTEM

6-7-4 Disassembly and Reassembly

1) Precautions for Disassembly and Reassembly

- (1) Since the parts of the hydraulic equipment are generally precision-made for tight clearances, be sure to perform disassembly and reassembly in a clean place that is free from dust.
- (2) Prepare clean tools and treated oil, and handle the parts carefully.
- (3) First clean the external surface of the removed assemblies.
- (4) Before beginning disassembly, review the drawings of the internal structure and prepare the required parts according to the purpose and extent of the disassembly.
- (5) In principle, replace the removed seals and O-rings with new ones. Since some replacement parts are available only as subassemblies, refer to the parts catalog to prepare the necessary subassemblies in advance.
- (6) Handling of O-rings
 - [1] Lubricate the O-rings and the O-ring fitting seats with clean grease or hydraulic oil.
 - [2] The O-rings may not have any defects in molding or be damaged in handling or distorted by heat.
 - [3] Do not extend any O-rings with such great force as to permanently deform them.
 - [4] Avoid rolling the O-rings when fitting them.

[A distorted O-ring may not return to its original shape, and therefore, may cause oil leakage.]
- (7) Before beginning reassembly, check that there is no treated oil or hydraulic oil on the outer surface of the O-ring groove in the mating face of each section.

[If reassembly is performed without cleaning such oil, it may be mistaken for oil leakage.]

2) Tools for Disassembly and Reassembly

No.	Tool	Remarks
1	Torque wrench	Capacity 66.4ft-lbf (90N-m)
2	Hexagon socket	Hexagon width across flat 8mm, 6mm
3	Wire brush	
4	Flathead screwdriver	
5	Eye bolt	For M8, 1 or 2 pieces
6	Screw locking	Locktite#242 or equivalent
7	Gear oil	Shell Spirax EP90 55cm ³
8	Grease	Small amount

6. HYDRAULIC SYSTEM

3) Disassembly Procedure

At the time of disassembly, clean the worksites and prepare the clean plastic case for storing parts. Clean around the port of the motor before removal of the piping and bolts, and remove the paint film and dirt from each joint with the wire brush.

Note :

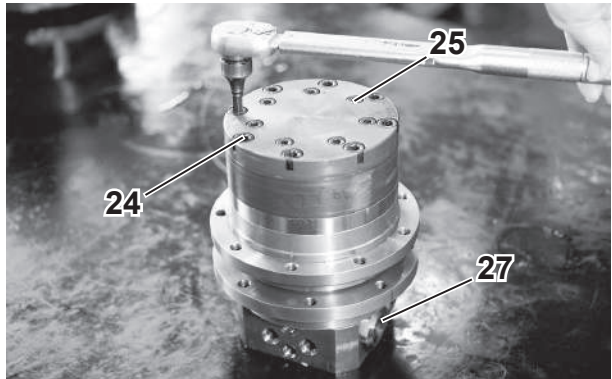
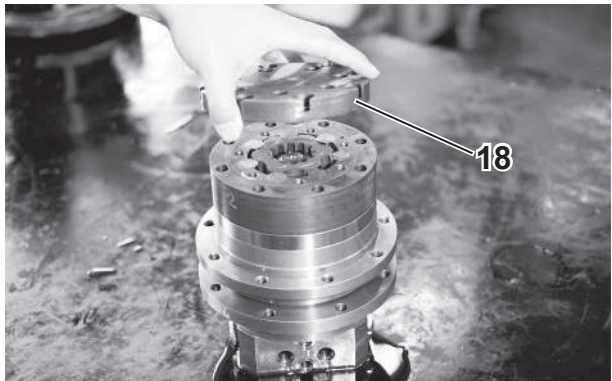
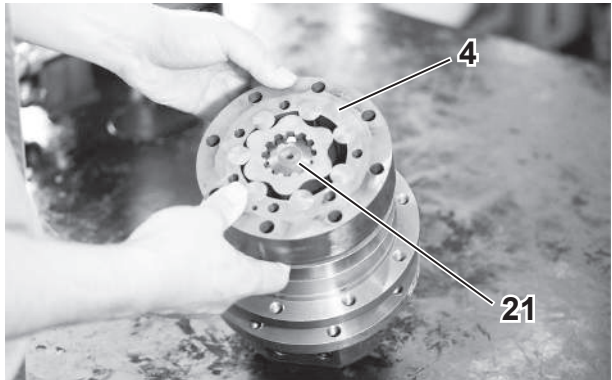
Do not disassemble the following assy except when required:

Roller assy 4

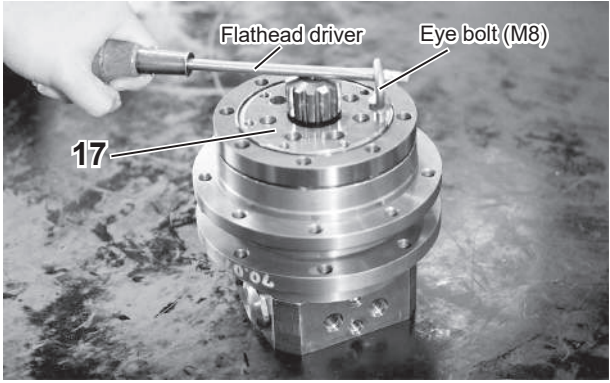
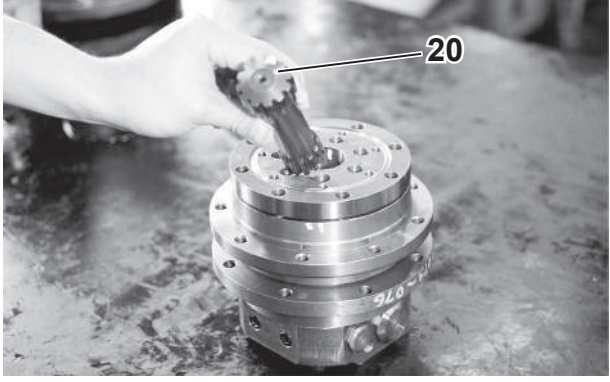
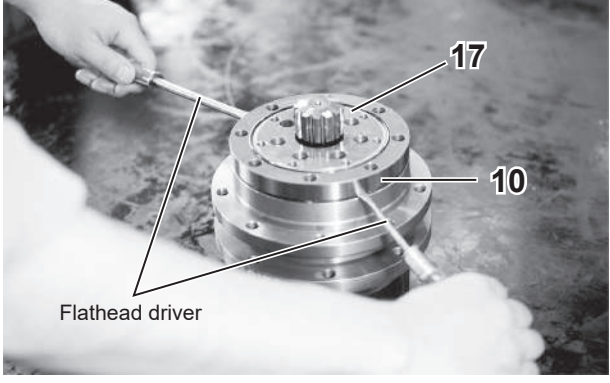
Spindle/wheel assy 5

End cover assy 27

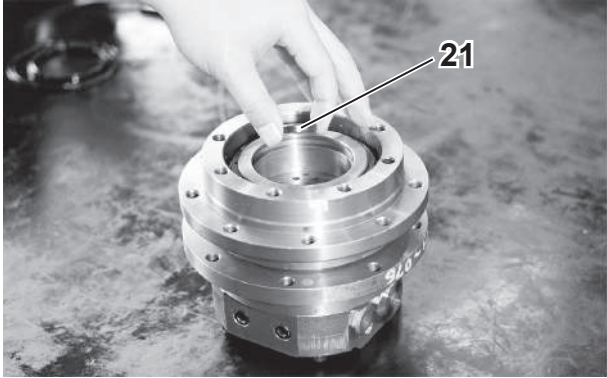
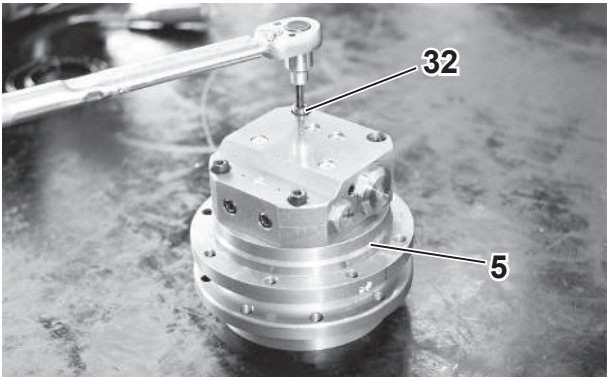
Valve assy 28

Procedure	
(1) Place the wheel side as the top surface, fix the body by pinching the end cover assy 27 with a vise. (2) Loosen 7 pieces of the M10 bolts 24 and 7 pieces of the M8 bolts 25 to remove them. Note : <i>The Locktite residue is adhered in the bolts and tap holes. Remove the Locktite residue cleanly before assembly.</i>	
(3) Remove the roller cover 18.	
(4) Remove the spacer 21. (5) Remove the roller assy 4.	

6. HYDRAULIC SYSTEM

Procedure	
(6) Attach the eye bolt (M8) in the valve plate 17, and lift the valve plate 17 up with the flathead screwdriver.	
(7) Remove the drive 20.	
(8) Remove the valve plate 17 by inserting the flathead screwdriver between the valve plate 17 and the wheel 10.	
(9) Remove the valve assy 28.	

6. HYDRAULIC SYSTEM

Procedure	
(10) Remove the spacer 21. Note : <i>Take care not to lose the spacer, as it drops at the time of turning upside down.</i>	 A black and white photograph showing a hand reaching into a cylindrical metal component to remove a spacer. A label '21' points to the spacer being removed. The component has several bolt holes around its circumference.
(11) Place the end cover side as the top surface by fixing the wheel side with a vise. Note : <i>When turned up side down, gear oil flows out from the spindle/wheel assy 5. Receive it with the oil pan.</i> (12) Loosen 4 pieces of the M8 bolts 32 to remove them.	 A black and white photograph showing a hydraulic assembly (5) being worked on. A tool (32) is being used to loosen bolts. The assembly is mounted on a surface, and a label '5' points to the main body of the assembly. The tool '32' is a long-handled screwdriver or similar tool.

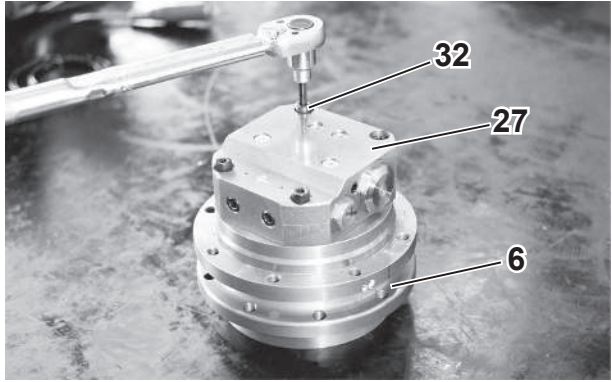
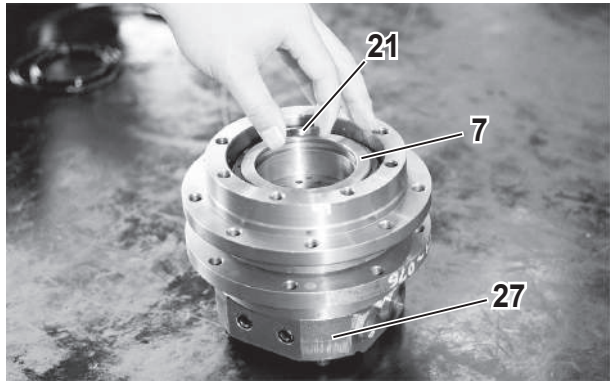
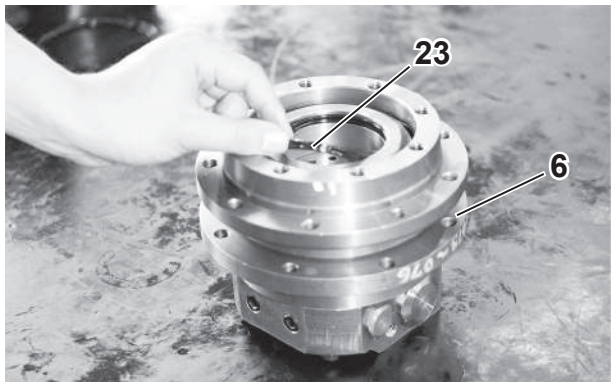
6. HYDRAULIC SYSTEM

4) Reassembly Procedure

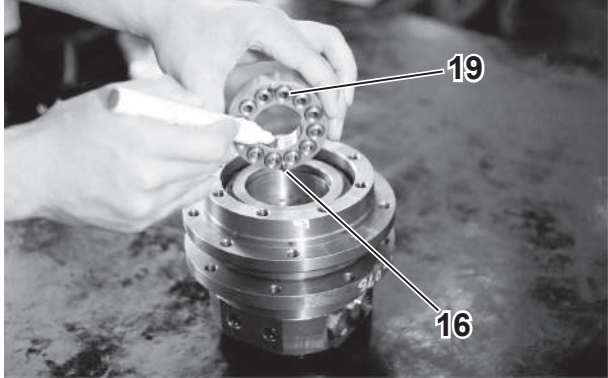
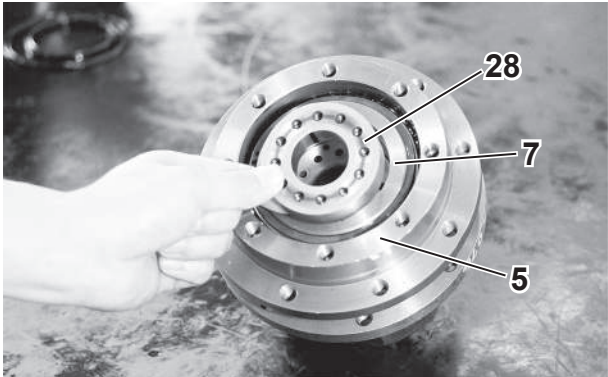
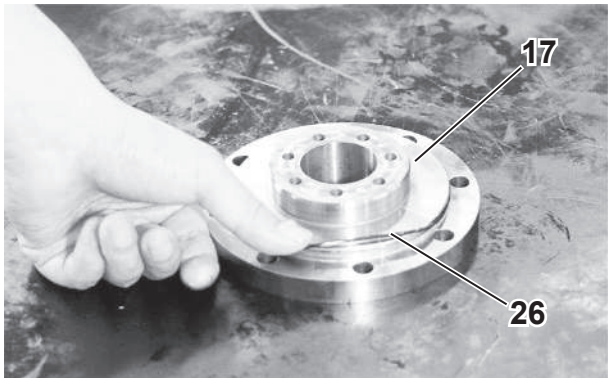
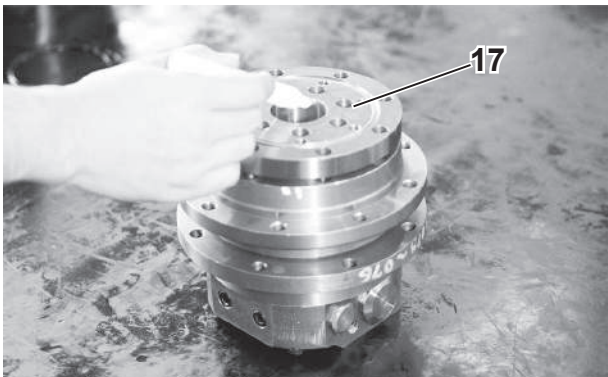
Wash all the parts using clean fuel and remove grease by air blow.

Handle all the parts with care so that they are free from dust, damage or dent.

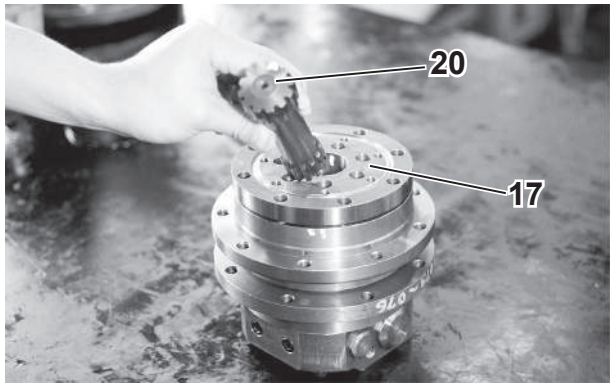
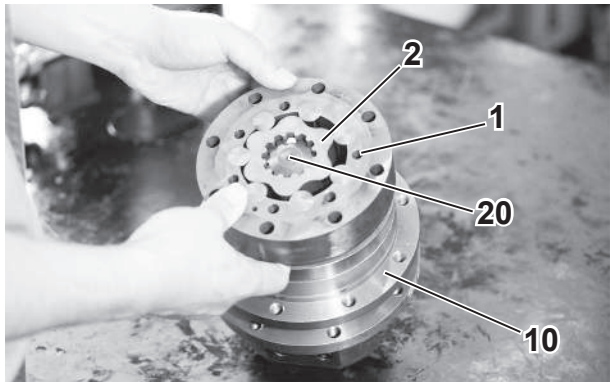
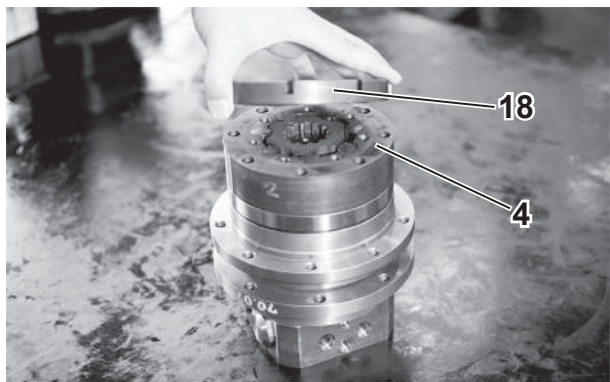
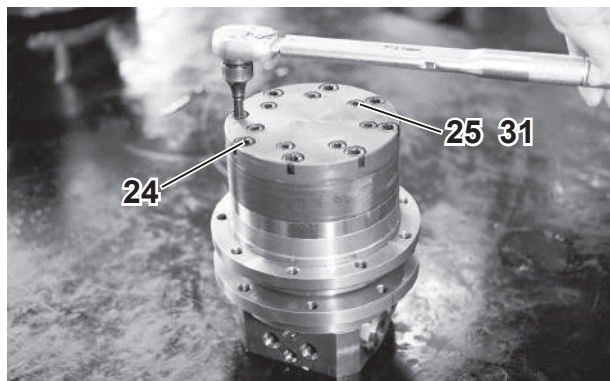
Replace the removed O-rings with new ones and apply grease in advance.

Procedure	
(1) Fix the wheel side with a vise, place the O-rings 26 on the spindle 6, and tighten the end cover assy 27 with 4 pieces of the M8 bolts 32. • Tightening torque 25.3ft-lbf (34.3N-m)	
(2) Place the wheel side as the top surface, fix the body by pinching the end cover assy 27 with a vise. (3) Insert the spacer 21 in the back of the valve sleeve 7.	
(4) Apply grease to the X-ring 23 and mount it in the spindle 6.	

6. HYDRAULIC SYSTEM

Procedure	
(5) When the parallel pins 16 are mounted on the valve 19, apply grease to the pins so that they don't drop in the upside down position. (6) Mark inside the position of the parallel pins 16 in the valve 19 with a magic marker in advance (either position in the two positions).	 A black and white photograph showing a hand using a grease applicator to apply grease to a parallel pin (16) that is mounted on a valve (19). The valve is a complex metal component with multiple ports and a central opening. The pin is a small, cylindrical component that fits into a hole in the valve. The hand is holding the grease applicator and is applying the grease to the pin. The valve is labeled 19 and the pin is labeled 16.
(7) Mount the valve assy 28 on the valve sleeve 7. Align the phases to accommodate the pins.	 A black and white photograph showing a hand mounting a valve assembly (28) onto a valve sleeve (7). The valve sleeve is part of a larger spindle/wheel assembly (5). The hand is holding the valve assembly and is aligning it with the sleeve. The valve assembly is labeled 28, the sleeve is labeled 7, and the spindle/wheel assembly is labeled 5.
(8) Put gear oil in the spindle/wheel assy 5. • Shell Spirax EP90 55cm³ Note : <i>Fill gear oil slowly in the part where the bearing is seen.</i> (9) Mount the O-rings 26 on the valve plate 17.	 A black and white photograph showing a hand mounting O-rings (26) onto a valve plate (17). The valve plate is a circular metal component with a central hole and several smaller holes around the perimeter. The O-rings are small, circular components that fit into grooves in the valve plate. The hand is holding the O-rings and is placing them into the grooves. The valve plate is labeled 17 and the O-rings are labeled 26.
(10) Mount the valve plate 17. Note : <i>Mount it horizontally so that the O-rings 26 don't bite.</i>	 A black and white photograph showing a hand mounting a valve plate (17) onto a valve assembly. The valve assembly is a complex metal component with multiple ports and a central opening. The valve plate is a circular metal component that fits into the central opening of the valve assembly. The hand is holding the valve plate and is placing it into the opening. The valve plate is labeled 17.

6. HYDRAULIC SYSTEM

Procedure	
(11) Mark one position of the teeth without the claw mark on the end face of the drive 20. (12) Place the side with the claw mark on the end face of the drive 20 as the lower side, align the phases of the mark of the drive 20 and the inside mark position of the valve 19 to insert the drive 20 to the spline part of the valve sleeve 7. Note : <i>When there is a gap in the phases, the motor rotates in a reverse direction, which could cause serious injury, so be cautious.</i>	
(13) Put the O-rings 26 on the valve plate 17. (14) Align the phases of one position of the six ridges of the roller star 2 and the mark of the drive 20 to mount. Note : <i>when there is a gap in the phases, the motor rotates in a reverse direction, which could cause serious injury, so be cautious.</i> (15) To align the phases of the bolt hole of the roller ring 1 and the tap hole of the valve plate 17, it is necessary to rotate the wheel 10.	
(16) Put the O-rings 26 on the roller assy 4. (17) Put the G roller cover 18 on the roller assy 4.	
(18) Mount the seal washers 31 on 7 pieces of the M8 bolts 25. (19) Apply Locktite#242 or equivalent to 7 pieces of the M10 bolts 24 and 7 pieces of the M8 bolts 25 and tighten them. • Tightening torque: M8 22.1ft-lbf (30N-m) M10 41.3ft-lbf (56N-m)	

6. HYDRAULIC SYSTEM

6-7-5 Failure Cause and Measure

Trouble	Cause	Measure
Motor does not rotate	• Insufficient hydraulic oil volume in the hydraulic oil tank. • Breakage of pump. • Malfunction of relief valve or low set pressure of it. • Excessive wear or scuffing of motor. • Short-circuit inside motor, dust in the valve and valve plate.	• Supply hydraulic oil to the specified level. • Replace the pump. • Disassemble and clean the relief valve and set the pressure to the specified value. • Disassemble the motor to check the parts. Replace any damaged parts. • Disassemble and clean.
Unstable rotation	• Low relief set pressure. • Air in pump on the suction side.	• Set the relief valve at the specified pressure.
Reverse rotation	• Reversed piping. • Reversed valve timing of motor.	• Correct the piping. • Correct the valve timing.
Oil leak from joint	• Loosened bolt. • Caught or damaged O-ring. • Wear or damage of floating seal.	• Tighten the bolt at the specified tightening torque. • Replace the O-ring. • Replace the floating seal.
Abnormal sound during rotation	• Occurrence of flaking, peeling off, and indentation in bearing. • Gear oil is completely empty.	• Replace the bearing. • Replace the floating seal and refill the gear oil.
Speed cannot be shifted	• Dual speed spool, stick in pilot poppet, or large leakage. • Dust choking in orifice plate. • Insufficient dual speed pilot pressure. • High drain pressure.	• Replace the end cover assy. • Clean the orifice plate. • Increase the pilot pressure to 19kgf/cm² and above the drain pressure. • Conduct the drain piping or increase the pilot pressure.

CHAPTER 7

ADJUSTMENT AND REPAIR

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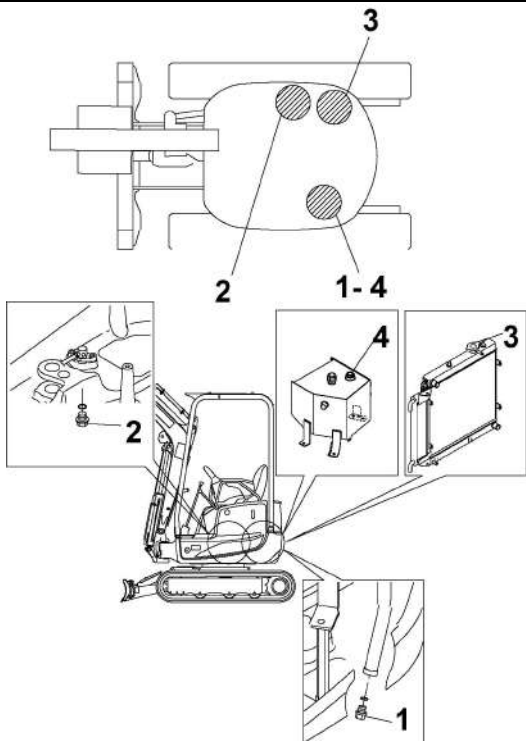
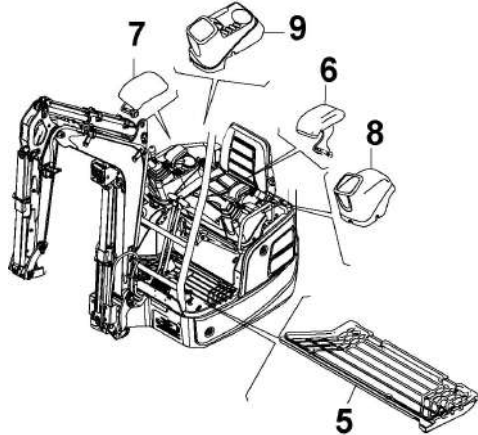
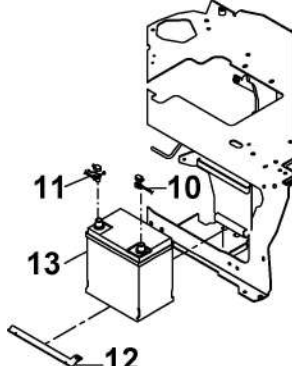
7. ADJUSTMENT AND REPAIR

7. Adjustment and Repair

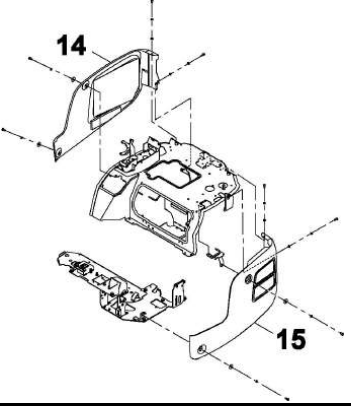
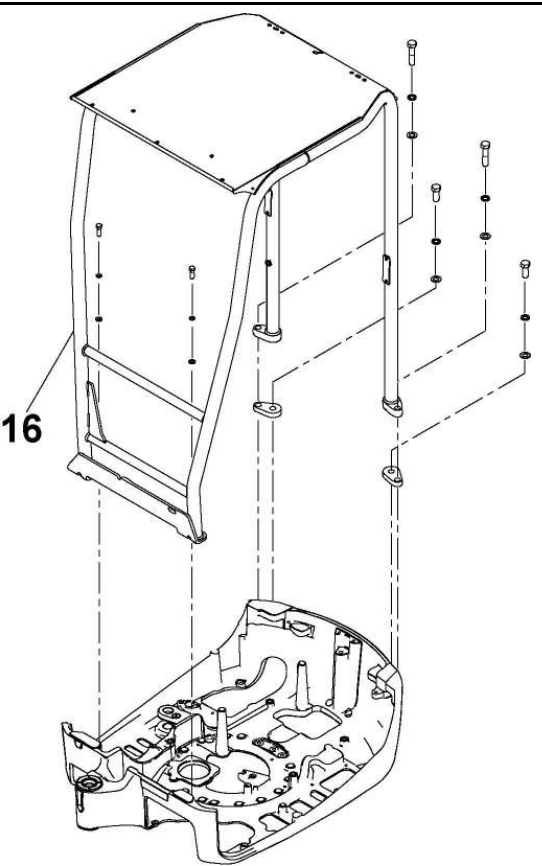
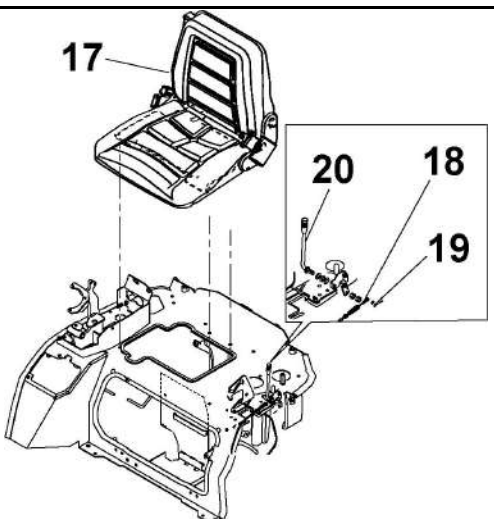
7-1 Engine and Electric Equipment

7-1-1 Removal and Reinstallation of Engine

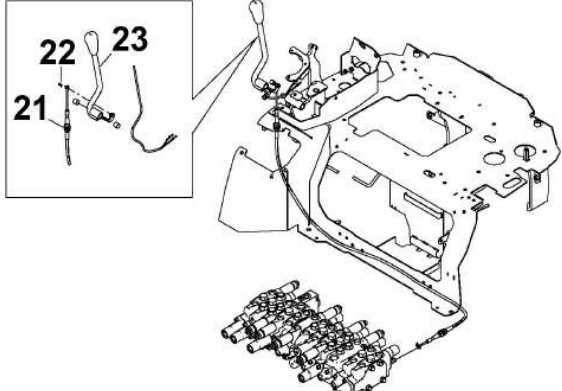
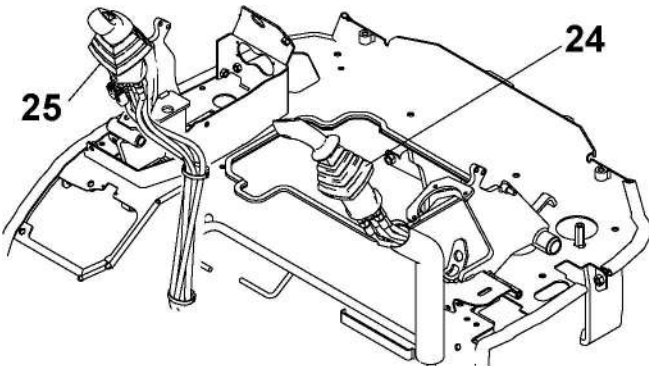
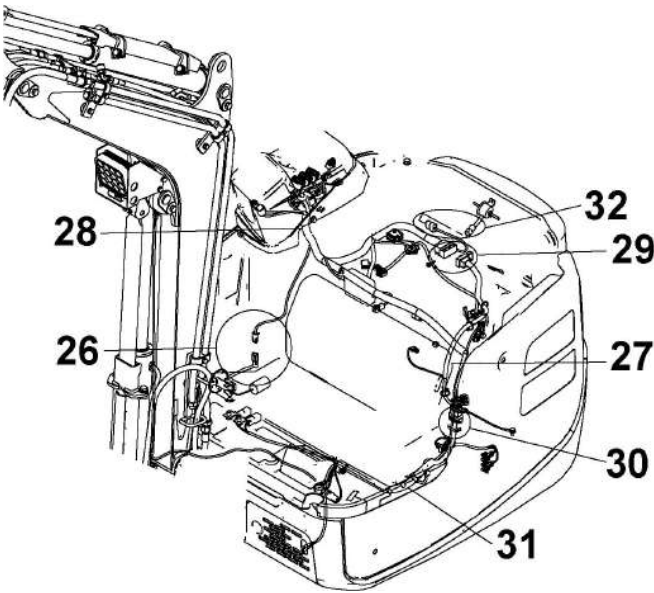
1) Removal

Procedure							
(1) Lower the bucket to the ground and stop the engine, and remove the drain plug 1 and the fill plug 4 from the hydraulic oil tank and drain the hydraulic oil. <table><tr><td>Type</td><td>YANMAR SUPER HYDRO OIL (VG 46 class or its equivalent)</td></tr><tr><td>Quantity</td><td>4.4 Gals. (16.5 L)</td></tr></table> (2) Remove the drain plug 2 and the fill plug 3 from the two-way cock for cooling water and drain the cooling water. <table><tr><td>Cooling water quantity</td><td>2.9 Qts. (2.7 L)</td></tr></table>	Type	YANMAR SUPER HYDRO OIL (VG 46 class or its equivalent)	Quantity	4.4 Gals. (16.5 L)	Cooling water quantity	2.9 Qts. (2.7 L)	
Type	YANMAR SUPER HYDRO OIL (VG 46 class or its equivalent)						
Quantity	4.4 Gals. (16.5 L)						
Cooling water quantity	2.9 Qts. (2.7 L)						
(3) Remove the step 5, the armrest L 6, the armrest R 7 the panel L 8, and the panel R 9. (4) Then disconnect the harness connectors of the left and right Joysticks.							
(5) Disconnect the battery cable (negative) 10 and the battery cable (positive) 11 and remove the battery clamp 12, and then remove the battery 13.							

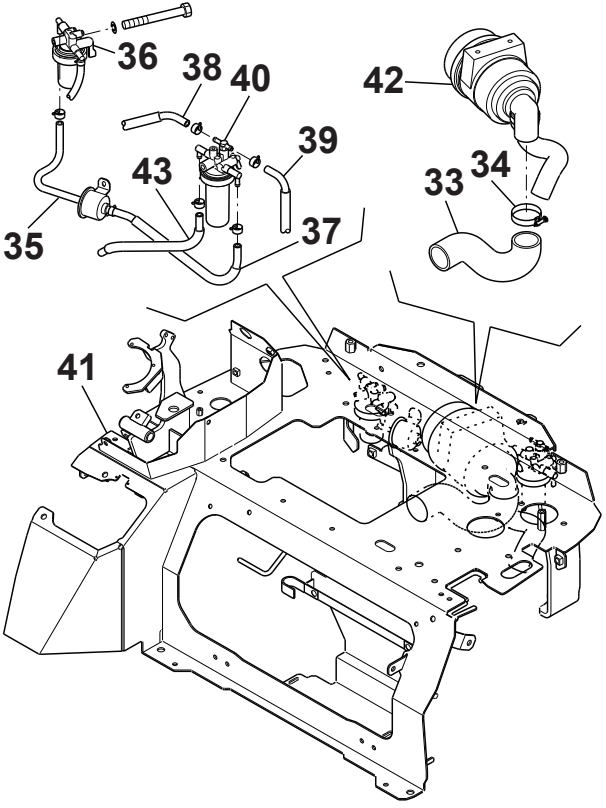
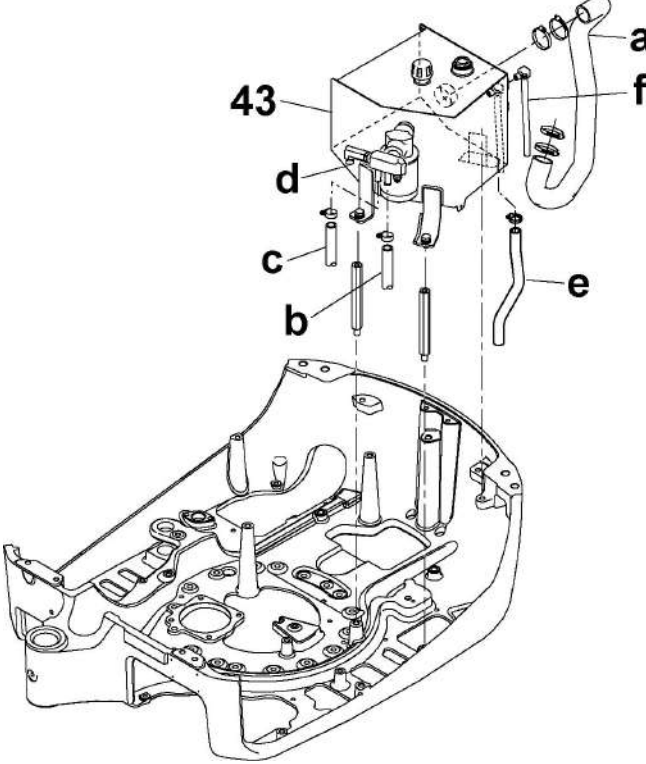
7. ADJUSTMENT AND REPAIR

Procedure	
(6) Remove the cover R 14 and the cover L 15.	 The diagram illustrates the removal of two covers, labeled 14 and 15, from the operator's seat area. Cover 14 is shown being lifted away from the seat, while cover 15 is shown being removed from the base of the seat. Dashed lines indicate the original positions of the covers.
(7) Unplug the canopy harness and remove the canopy 16. Note : <i>Take care that the harnesses and clamps do not catch on any other parts when lifting up the operator's seat mount.</i>	 The diagram shows the canopy, labeled 16, being lifted away from the operator's seat area. The canopy is shown in a partially detached state, with dashed lines indicating its original position. The operator's seat and base are visible below the canopy.
(8) Unplug the seat harness and remove the operator's seat with the operator's seat plate 17. (9) Remove the snap pin 19 and disconnect the accelerator cable 18 from the accelerator lever 20.	 The diagram illustrates the removal of the operator's seat, labeled 17, and the disconnection of the accelerator cable, labeled 18, from the accelerator lever, labeled 20. The seat is shown being lifted away from the base. A close-up view shows the accelerator lever (20) and the snap pin (19) being removed from the accelerator cable (18).

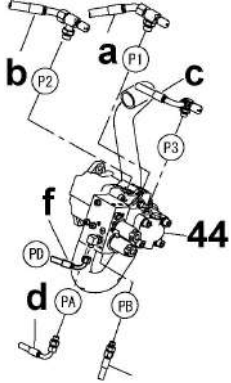
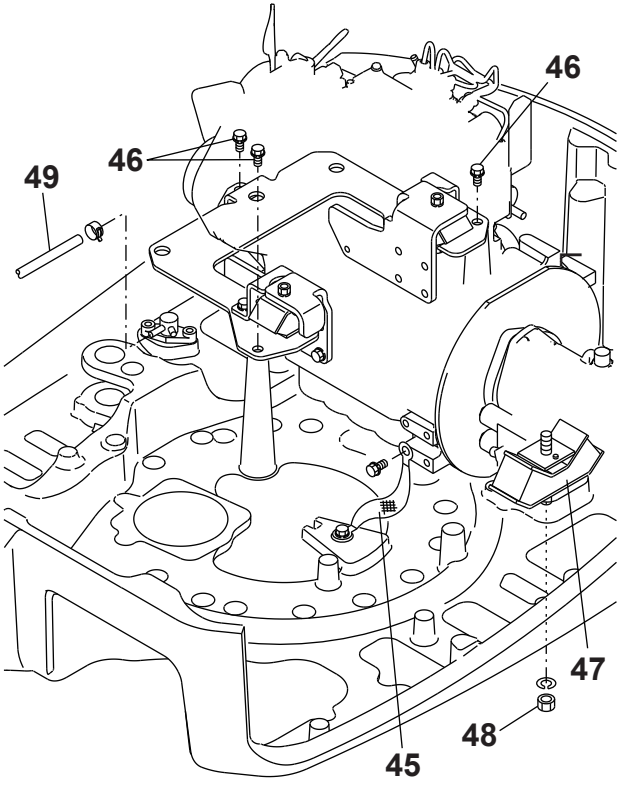
7. ADJUSTMENT AND REPAIR

Procedure	
(10) Remove the snap pin 22 and disconnect the blade cable 21 from the blade lever 23 by loosen the nut and the lock nut. Then disconnect the cable from the control valve.	
(11) Remove the pilot valve 24 and 25 in the left and right with the hydraulic hose attached.	
(12) Disconnect the harness 26 from the fuel gauge unit. (13) Disconnect the connecting coupler 29 of the harness A 27 and harness B 28. (14) Disconnect the body coupler 30 of the harness B 28 and harness D 31. (15) Disconnect the fuel pump connector 32.	

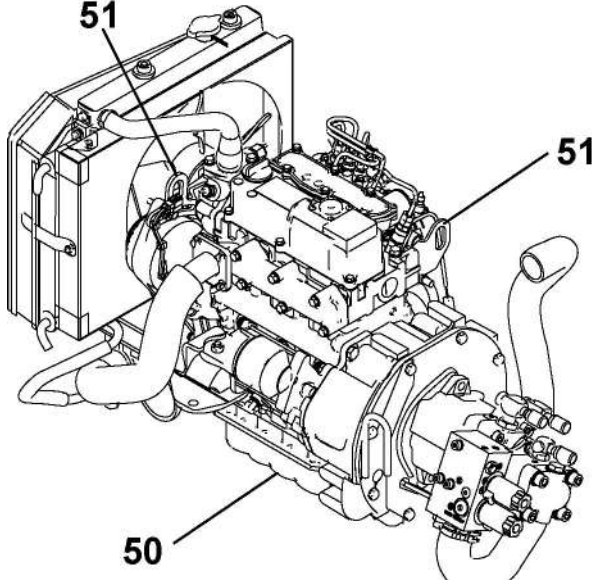
7. ADJUSTMENT AND REPAIR

Procedure	
(16) Remove the air cleaner hose B 33 by loosen the collar 34 (17) Remove the water separator 36 from the operator's seat mount 41 and disconnect the fuel hose 35 on the water separator 36 side. (18) Remove the fuel hose 37, 38, 39 and 43 on the fuel filter 40 side. (19) Rope the operator's seat mount 41 (with the bonnet and the air cleaner 42) and lift it up, to remove it. Note : Take care that the harnesses and clamps do not catch on any other parts when lifting up the operator's seat mount.	
(20) Remove the hoses connected to the reservoir tank 43. a. Suction hose b. Return hose (control valve to reservoir tank) c. Return hose (cooler to reservoir tank) d. Return hose (PTO1) e. Drain hose f. Drain hose (21) Remove the reservoir tank 43.	

7. ADJUSTMENT AND REPAIR

Procedure	
(22) Remove the hydraulic hoses from the hydraulic pump 44. a. Hose P1 b. Hose P2 c. Hose P3 d. Hose PA e. Hose PB f. Hose from accumulator	 The diagram shows a hydraulic pump assembly labeled 44. Six hoses are connected to it: P1 (top left), P2 (top left, below P1), P3 (top right), PA (bottom left), PB (bottom right), and f (middle left, connected to an accumulator). Each hose is labeled with its corresponding letter in a circle.
(23) Remove the engine ground cable 45. (24) Remove the bolts 46. (25) Remove the nuts 48 from the vibroisolating rubbers. (26) Remove the radiator drain hose 49.	 The diagram shows a detailed view of the engine and radiator assembly. Component 45 is the engine ground cable. Component 46 is a bolt. Component 47 is a nut. Component 48 is a nut. Component 49 is the radiator drain hose. The diagram shows the engine block, radiator, and various mounting points and hoses.

7. ADJUSTMENT AND REPAIR

Procedure	
(27) Rope the engine 50 using its lifting lugs 51 and lift it up, to remove it.	 The diagram shows a detailed line drawing of an engine assembly, labeled 50. Two lifting lugs, labeled 51, are attached to the top of the engine. One lug is on the left side, and the other is on the right side. The engine is shown from a side-on perspective, with various components like the cylinder head, intake manifold, and exhaust pipe visible. The lifting lugs are designed for hoisting the engine.

7. ADJUSTMENT AND REPAIR

2) Reinstallation

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

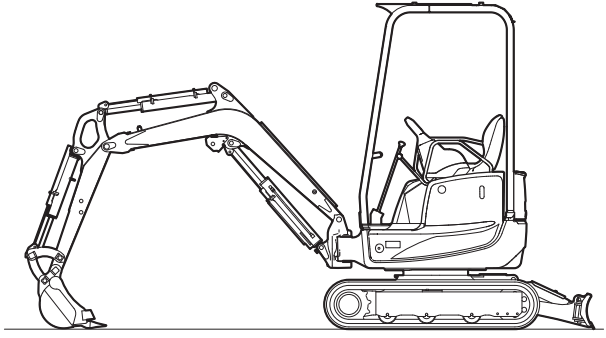
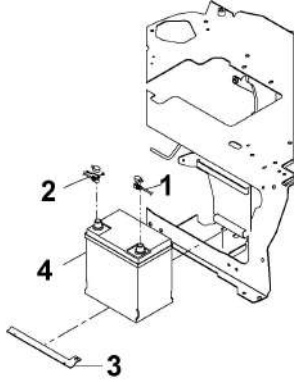
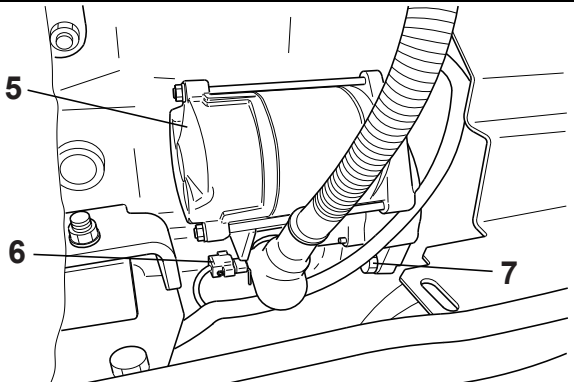
Adhesive and tightening torque

No.	Parts	Size	Adhesive	Tightening torque
1	Drain plug 14	M14	—	43.4 ft•lbf (59.0 N•m)
8	Battery holding rod	M6 nut	—	1.45 to 2.17 ft•lbf (2.0 to 2.9 N•m)
8	Battery holding rod (Lock nut)	M6 nut	—	3.62 to 4.34 ft•lbf (4.9 to 5.88 N•m)
34	Canopy pole (front)	M12×35	—	57.9 to 72.3 ft•lbf (78.4 to 98.0 N•m)
34	Canopy pole (Rear) M20×50	M12×35	—	238.8 to 296.6 ft•lbf (323.8 to 402.2 N•m)
34	Canopy pole (Joint 21)	M20×28	—	238.8 to 296.6 ft•lbf (323.8 to 402.2 N•m)
36	Hose clip	60	—	1.6 to 1.8 ft•lbf (2.2 to 2.5 N•m)
46-a	Hose clip	41	—	3.62 to 43.4 ft•lbf (4.9 to 5.9 N•m)
46-b 46-c 46-d	Hose clip	16	—	1.85 to 2.52 ft•lbf (2.5 to 3.4 N•m)
50	Engine mount	M10×25	Apply Three Bond 1324 or its equivalent.	32.6 to 43.4 ft•lbf (44.1 to 58.8 N•m)
52	Engine vibroisolating rubber	M14 nut	—	50.6 to 61.5 ft•lbf (68.6 to 83.4 N•m)

7. ADJUSTMENT AND REPAIR

7-1-2 Removal and Reinstallation of Starter Motor

1) Removal

Procedure	
(1) Lower the bucket to the ground and stop the engine.	
(2) Disconnect the battery cable (negative) 1 and the battery cable (positive) 2 and remove the battery clamp 3 . Then remove the battery 4 .	
(3) Disconnect the wire harness 6 connected to the starter motor 5 . (4) Remove the mounting bolts 7 and remove the starter motor 5 .	

2) Reinstallation

Reinstall the starter motor in the reverse order of the removal procedure.

Note :

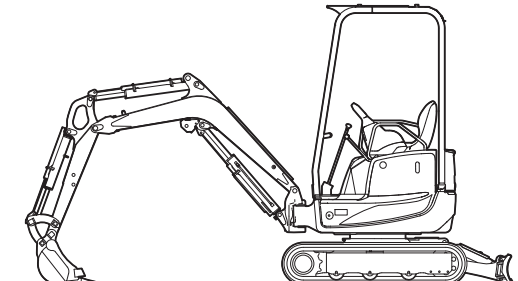
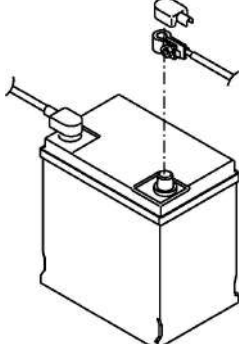
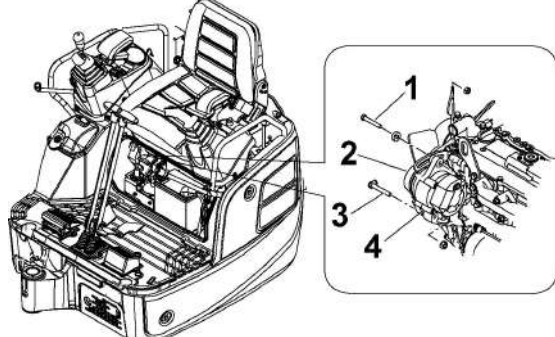
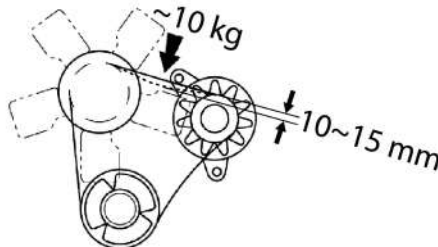
Secure the harness with a band.

Starter motor mounting bolt (M10)	
Tightening torque	32.5 to 43.4 ft•lbf (44.1 to 58.8 N•m)

7. ADJUSTMENT AND REPAIR

7-1-3 Removal and Reinstallation Generator

1) Removal

Procedure	
(1) Lower the bucket to the ground and stop the engine.	
(2) Open the cover under the seat to access to the battery cable, then disconnect the battery cables. Always disconnect the negative (-) cable first. Note : Place a MAINTENANCE IN PROGRESS label on the machine.	
(3) Remove the harness, bolt, collar and nut 1 then remove the belt 2 . (4) Remove the bolt and nut 3 , then remove the generator 4 .	
(5) Adjustment of tension belt: a) Check that the pulleys, the V-groove, the fan belt are not damaged. b) Check that the fan belt is not touching the lower part of the V-groove. c) Adjust the belt tension by unscrewing the bolt 1 , pulling on the alternator and tightening the bolt 1 . d) Check the belt tension so that the setting matches the value in the illustration opposite. Repeat the adjustment if necessary.	

2) Reinstallation

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

Note :

- Secure the harness with a band.
- For bolts Tightening torque value, refer to Section "List of Tightening Torque" on page 3-7-1
- For fittings Tightening torque value, refer to Section "Hydraulic Fitting" on page 3-7-6

7. ADJUSTMENT AND REPAIR

7-1-4 Removal and Reinstallation of Fuel Injection Pump

1) Removal

Procedure	
(1) Remove the water separator 1. (2) Remove the fuel feed pump 2. (3) Remove the air cleaner assembly 3. (4) Remove the hose connector bolt 4, and remove the hose (the fuel filter to the fuel pump). (5) Remove the steady retainer 5, and then remove the fuel injection pipes (No.1, No.2 and No.3) 6.	The diagram illustrates the removal of various fuel system components. It shows a water separator (1) being detached from a fuel line. A fuel feed pump (2) is shown being removed from its mounting. An air cleaner assembly (3) is shown being removed from the engine. A hose connector bolt (4) is shown being removed from a hose. A steady retainer (5) is shown being removed from a fuel injection pipe. Fuel injection pipes (6) are shown being removed from the fuel injection pump (8). The fuel injection pump (8) is shown being removed from the engine block.
(6) Remove the keps (with washer 8) 7 and remove the fuel injection pump 8.	The diagram shows the fuel injection pump (8) being removed from the engine block. A key (7) and washer (8) are shown being used to remove the pump from the block.

7. ADJUSTMENT AND REPAIR

2) Reinstallation

Reinstall the fuel injection pump in the reverse order of the removal procedure.

3) Checking of Fuel Injection Timing

(1) Check the fuel injection timing in the FID method.

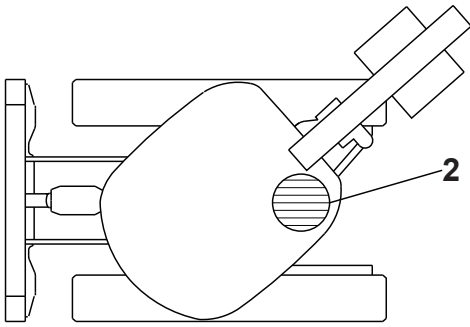
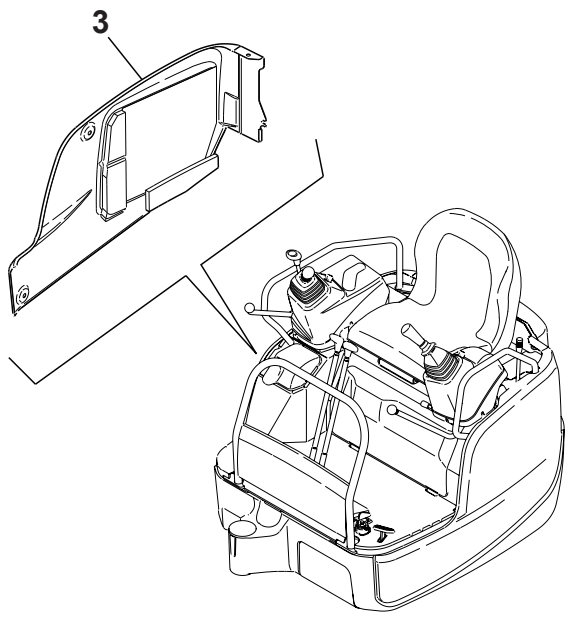
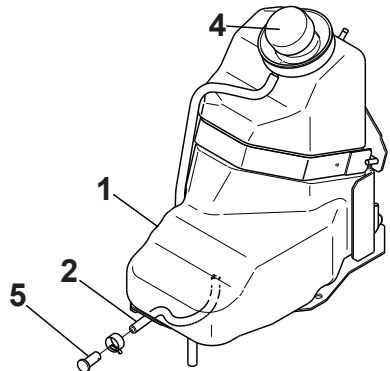
Note :

For the proper fuel injection timing, refer to the specification on page 2-1-5.

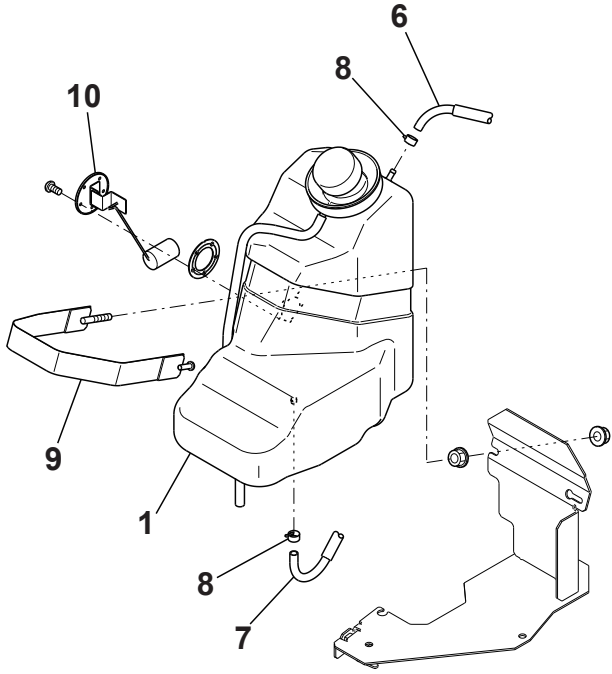
7. ADJUSTMENT AND REPAIR

7-1-5 Removal and Reinstallation of Fuel Tank

1) Removal

Procedure (1) Swing the upperstructure so that the drain cock 2 of the fuel tank 1 is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine.			
(2) Remove the bonnet R 3.			
(3) Remove the pin 5 on the tip of the drain cock 2, the plug 4 and drain the fuel. <table border="1"> <tr> <td>Fuel quantity</td><td>5.3 Gals. (20 L) (when the tank is filled up)</td></tr> </table>	Fuel quantity	5.3 Gals. (20 L) (when the tank is filled up)	
Fuel quantity	5.3 Gals. (20 L) (when the tank is filled up)		

7. ADJUSTMENT AND REPAIR

Procedure	
(4) Remove the hose clips 8 of the fuel hose (the fuel filter to the fuel tank) 6, and the fuel hose (the fuel tank to the water separator) 7, and remove the hoses. (5) Remove the fuel tank clamp 9 and fuel gauge unit 10, and then remove the fuel tank 1.	 The diagram is an exploded view of a fuel tank assembly. It shows the following components and their relative positions: 1: The main fuel tank, a rectangular container with a fuel filter on top. 6: A fuel hose connecting the fuel filter to the fuel tank. 7: A fuel hose connecting the fuel tank to the water separator. 8: Two hose clips, one on hose 6 and one on hose 7. 9: A fuel tank clamp, a strap with a buckle used to secure the tank. 10: A fuel gauge unit, shown as a separate component with a mounting bracket. Dashed lines indicate the assembly alignment and the removal path for the components.

7. ADJUSTMENT AND REPAIR

2) Reinstallation

Reinstall the fuel tank in the reverse order of the removal procedure.

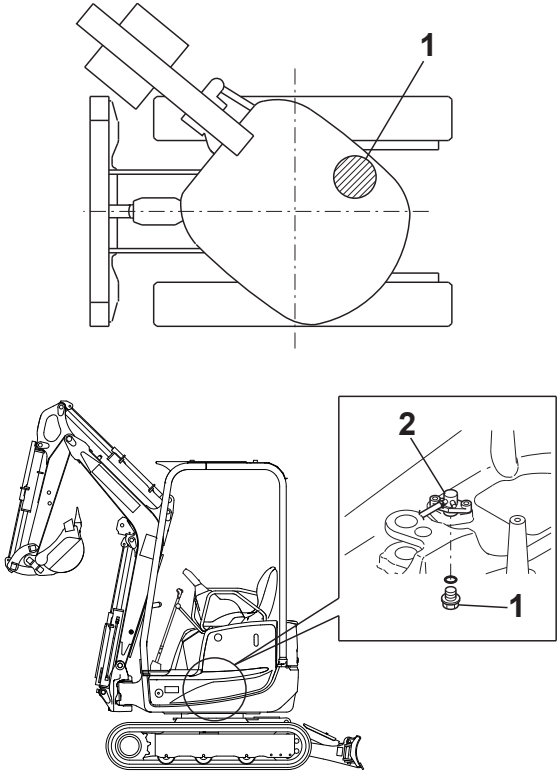
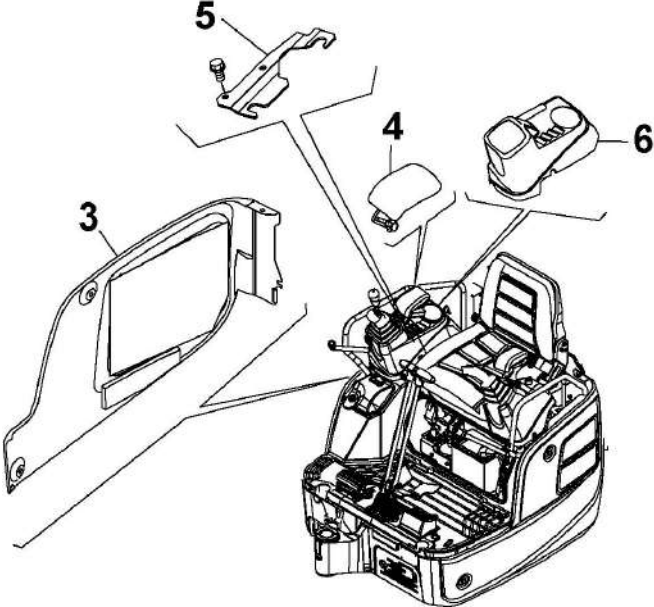
Note :

Before reinstalling the fuel tank, clean up the inside of it. In particular, remove the deposits on the bottom of the fuel tank completely.

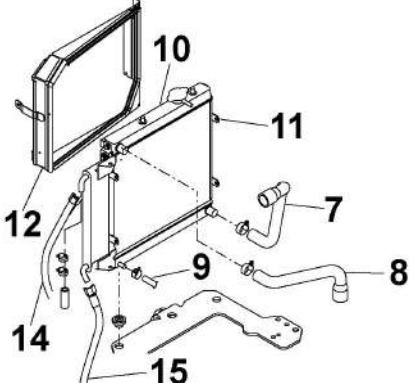
7. ADJUSTMENT AND REPAIR

7-1-6 Removal and Reinstallation of Radiator

1) Removal

Procedure	
(1) Swing the upperstructure so that the cooling water drain plug 1 is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine. (2) Remove the drain plug 1 from the two-way cock 2 for cooling water and drain the cooling water. Cooling water quantity : 3.3 Qts. (3.1 L) (including the cooling water in the sub-tank)	
(3) Remove the bonnet R 3, the armrest 4, the bracket 5 and the panel R 6.	

7. ADJUSTMENT AND REPAIR

Procedure	
(4) Remove the hoses A 7 and C 8 from the engine. (5) Remove the cooling water drain hose 9, 14 and 15. (6) Remove the radiator 10 (with the shroud 11 and the duct 12).	 The diagram shows an exploded view of the radiator and shroud assembly. The radiator (10) is a rectangular unit with a fan shroud (11) attached to its top. A duct (12) is connected to the bottom of the radiator. Various hoses are shown: hose 7 is connected to the top of the radiator; hose 8 is connected to the bottom of the radiator; hose 9 is connected to the side of the radiator; hose 14 is connected to the bottom of the radiator; and hose 15 is connected to the bottom of the radiator. The hoses are labeled with their respective numbers: 7, 8, 9, 10, 11, 12, 14, and 15.

7. ADJUSTMENT AND REPAIR

2) Reinstallation

Reinstall the fuel tank in the reverse order of the removal procedure.

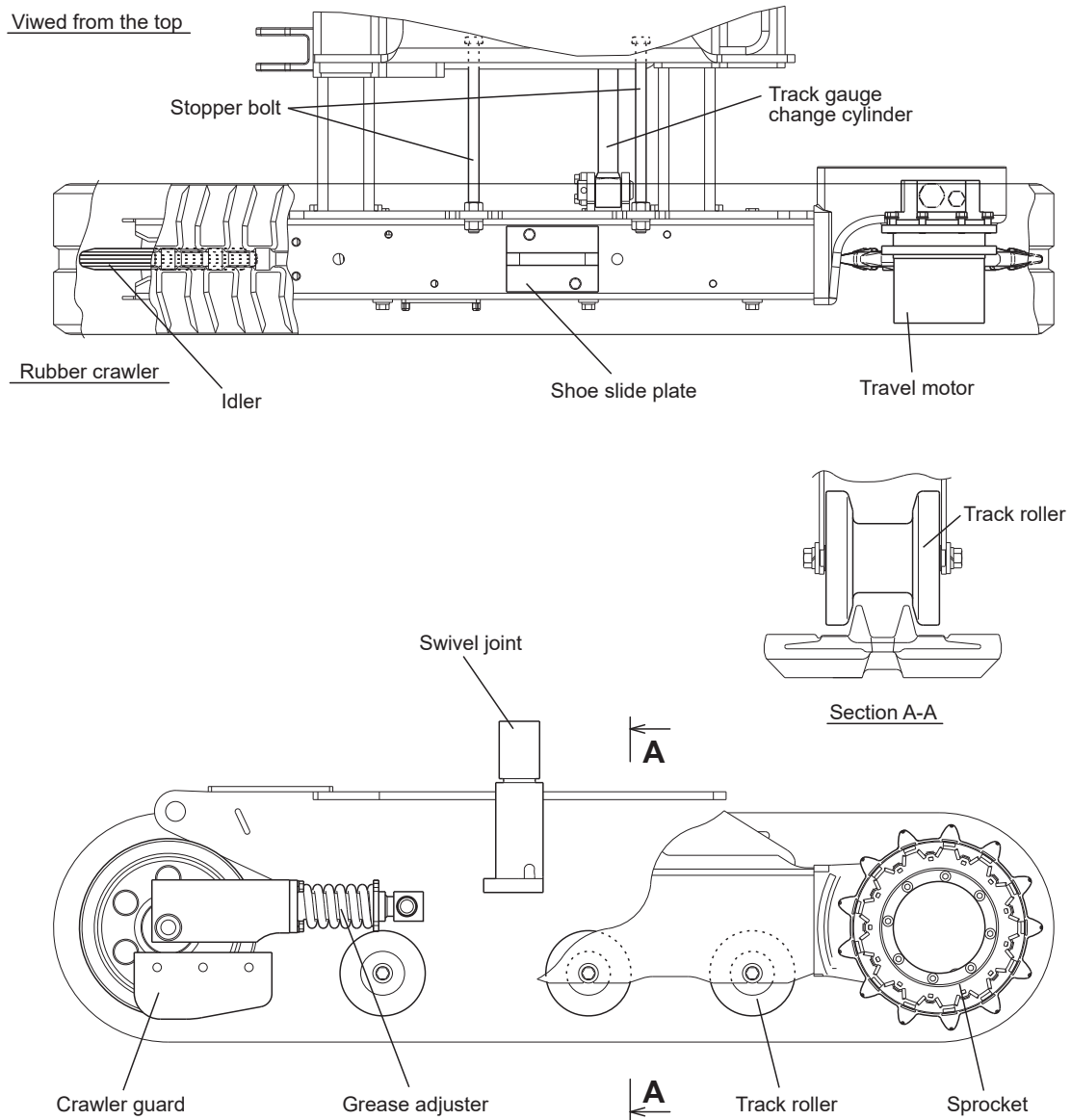
Hose clip 25	
Tightening torque	1.4 to 2.2 ft•lbf (2.16 to 2.45 N•m)

7. ADJUSTMENT AND REPAIR

7-2 Undercarriage

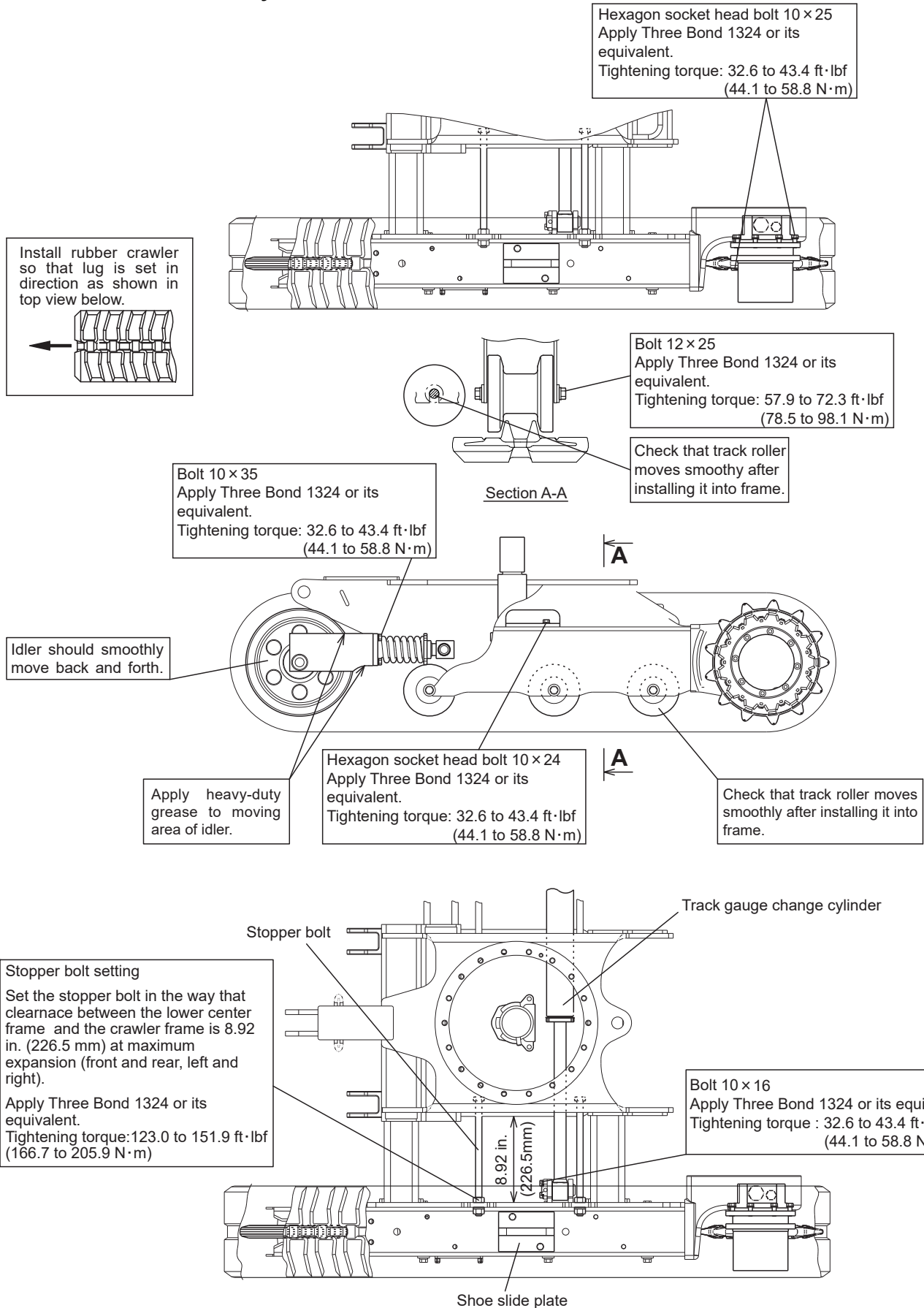
7-2-1 Outline

The undercarriage consists of travel motors, a track frame (crawler frames and a lower center frame), track rollers, front idlers, rubber crawlers and other parts. Hydraulic oil fed through the control valve and the swivel joint from the hydraulic pump causes the travel motors to rotate, so that the power is transmitted to the crawlers via the sprockets. The track frame can be widened and narrowed by the track gauge change cylinder.



7. ADJUSTMENT AND REPAIR

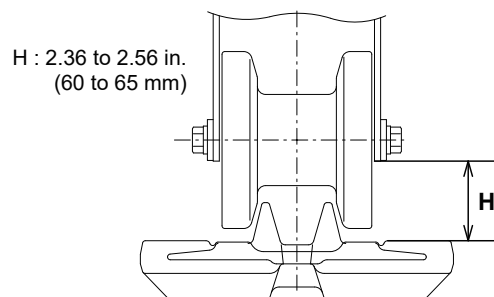
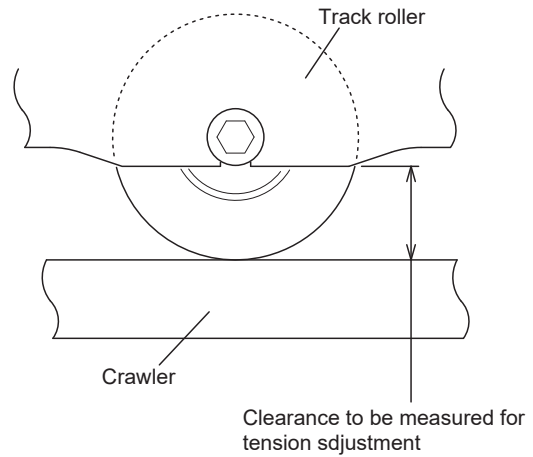
7-2-2 Points of Reassembly



7. ADJUSTMENT AND REPAIR

7-2-3 Crawler Tension Adjustment Procedure

- (1) Raise one crawler using the boom.
- (2) Position the  mark on the inside surface of the rubber crawler on the slide plate.
- (3) Measure the clearance **H** shown in the figures below, and adjust the crawler tension so that the clearance H will be within the specified range.



7. ADJUSTMENT AND REPAIR

7-2-4 Removal and Reinstallation of Crawler



When rasing the machine, support it with safety blocks of sufficient strength.



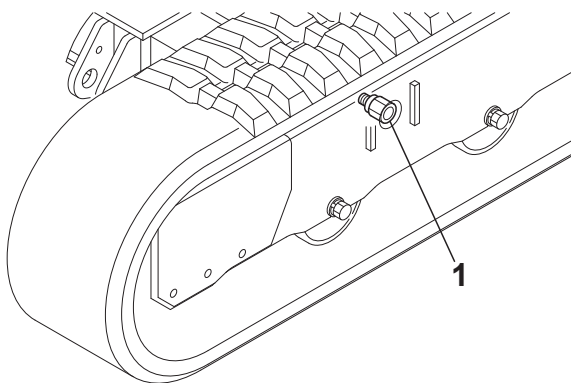
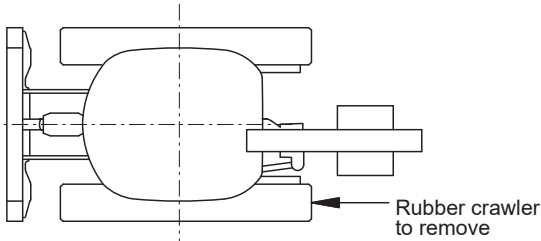
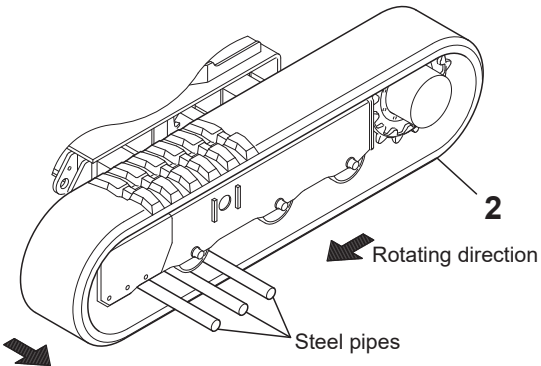
When loosening or removing the nipple valve 1, the high internal pressure could cause grease to eject or the nipple valve to blow. Do not bring your face close to the nipple valve 1.

1) Removal of Rubber Crawler



Handle the rubber crawlers with great care, as they are heavy.

Rubber crawler : 129 lbs. (58 kg) each

Procedure	
(1) Lower the bucket to the ground, and remove the nipple valve 1 to loosen the rubber crawler tension. Note : <i>Move the machine back and forth if the grease is not discharged smoothly.</i>	
(2) Swing the upperstructure to position the implement in the direction opposite to the blade, and raise the machine slightly with the implement.	
(3) Insert steel pipes between the crawler frame and the rubber crawler 2, as shown in the figure at the right, and turn the sprocket in the reverse direction. Slide the rubber crawler off when the rubber crawler is separated from the idler by the steel pipes.	

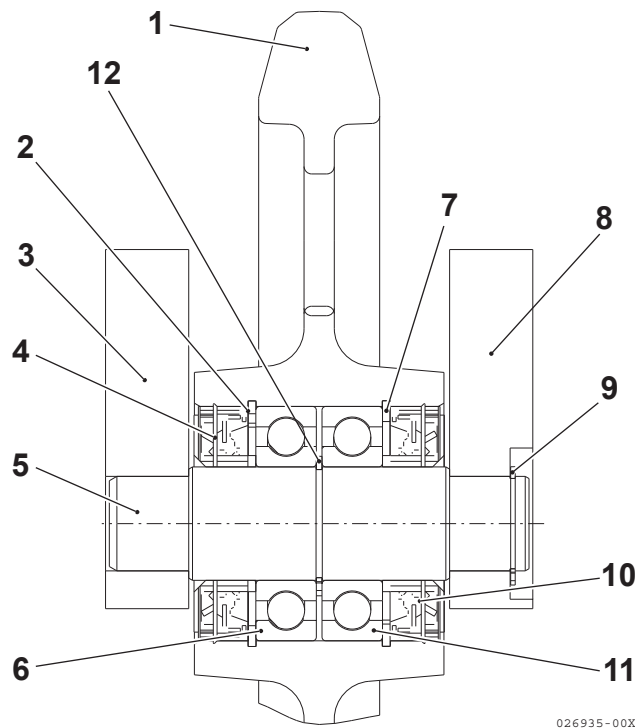
2) Reinstallation of Rubber Crawler

Install the rubber crawler in the reverse order of the removal procedure.

7. ADJUSTMENT AND REPAIR

7-2-5 Disassembly and Reassembly of Idler

1) Structure and Component Parts



No.	Part	Q'ty	No.	Part	Q'ty
1	Idler	1	7	Internal snap ring C62	1
2	Internal snap ring C62	1	8	Idler fork R	1
3	Idler fork L	1	9	External snap ring C25	1
4	Seal QLN306213.2	1	10	Seal QLN306213.2Y	1
5	Shaft	1	11	Bearing 6206	1
6	Bearing 6206	1	12	External snap ring C30	1

2) Disassembly

Procedure	
(1) Remove the idler assembly from the crawler frame.	Diagram illustrating the removal of the idler assembly from the crawler frame. The components are labeled: - Track frame - Idler ass'y 026953-00B

7. ADJUSTMENT AND REPAIR

Procedure			
(2) Remove the mounting bolts to remove the crawler adjusting spring. (3) Remove the snap ring C 9 and then remove the idler fork R 8, the seal 10 and the snap ring C 7. (4) Drain the lube oil inside the idler. Then, pull out the shaft 5 (with the bearing 11) using a press. <table border="1"> <tr> <td>Oil quantity</td><td>0.026 Qts. (25 mL)</td></tr> </table> (5) Remove the seal 4, and then remove the snap ring C 2, the bearing 6 and the snap ring C12. Note : The shaft 5 is press-fitted into the idler fork L 3.	Oil quantity	0.026 Qts. (25 mL)	026954-00B
Oil quantity	0.026 Qts. (25 mL)		

3) Reassembly

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

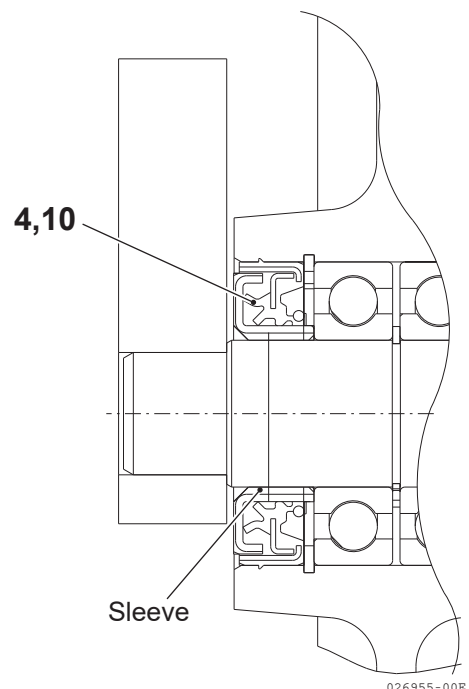
Notes :

- [1] Clean all the parts and check them for damage or defects.
- [2] Replace the seals with new ones.
- [3] Apply multipurpose grease to the lips of seals **4** and **10**.
- [4] When installing the seal **10**, to release air from the inside of the idler, remove the sleeve from the seal and install the seal, then install the sleeve.

Crawler adjusting spring mounting bolt (M10)	
Adhesive	Three Bond 1324 or its equivalent.
Tightening torque	32.6 to 43.4 ft•lbf (44.1 to 58.8 N•m)

[5] Oil to be used for idler:

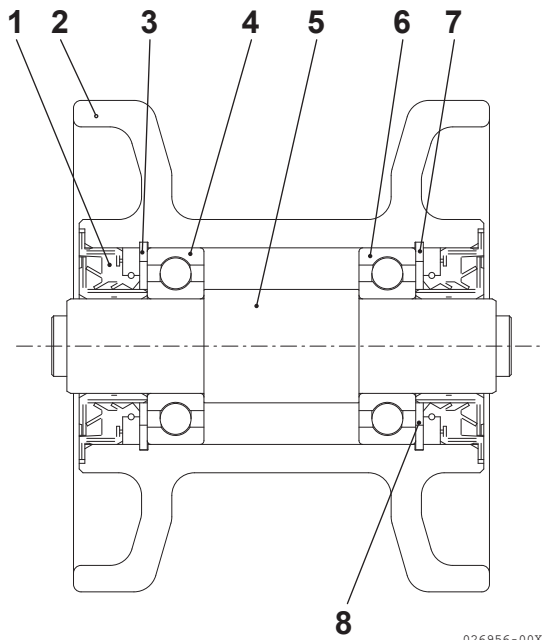
Type	Engine oil SAE 30
Quantity	0.026 Qts. (25 mL)



7. ADJUSTMENT AND REPAIR

7-2-6 Disassembly and Reassembly of Track Roller

1) Structure and Component Parts



026956-00X

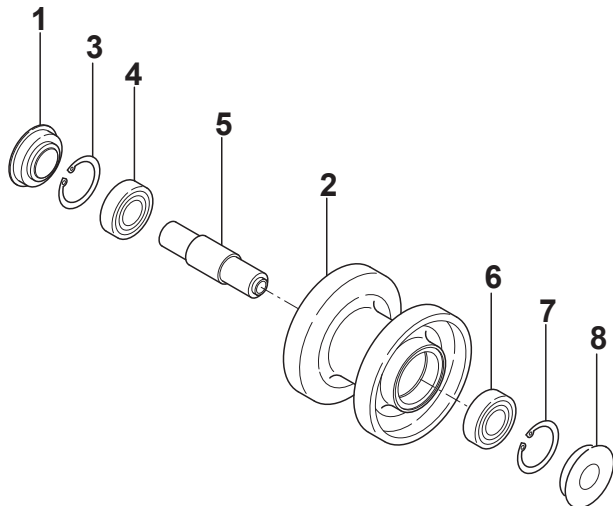
No.	Part	Q'ty	No.	Part	Q'ty
1	Seal TW 25 52 18	1	5	Shaft	1
2	Roller	1	6	Bearing 6205	1
3	Internal snap ring C52	1	7	Internal snap ring C52	1
4	Bearing 6205	1	8	Seal TW 25 52 18	1

2) Disassembly

Procedure	
(1) Remove the mounting bolts and remove the track roller from the crawler frame.	An exploded view diagram showing the disassembly of a track roller from a track frame. The diagram labels the 'Mounting bolt', 'Track roller', and 'Track frame'. It illustrates the process of removing the mounting bolts to detach the roller from the frame.

026957-00E

7. ADJUSTMENT AND REPAIR

Procedure			
(2) Remove the seal 1 from the track roller 2 and drain the lube oil. <table border="1"><tr><td>Oil quantity</td><td>0.042 Qts. (40 mL)</td></tr></table>	Oil quantity	0.042 Qts. (40 mL)	
Oil quantity	0.042 Qts. (40 mL)		
(3) Remove the snap ring C 3 and pull out the shaft 5 (with the bearing 4) using a press.			
(4) Remove the seal 8, and then remove the snap ring C 7 and the bearing 6.			

3) Reassembly

Reassemble the track roller in the reverse order of the disassembly procedure.

Notes :

[1] Clean all the parts and check them for damage or defects.

[2] Replace the seals with new ones.

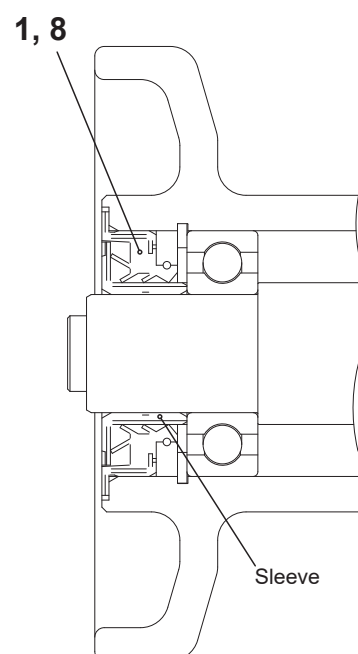
[3] Apply multipurpose grease to the lips of seals **1** and **8**.

[4] When installing the seal **1**, to release air from the inside of the track roller, remove the sleeve from the seal and install the seal, then install the sleeve.

Track roller mounting bolt (M12)	
Adhesive	Three Bond 1324 or its equivalent.
Tightening torque	57.9 to 72.3 ft•lbf (78.5 to 98.1 N•m)

[5] Oil to be used for track rollers :

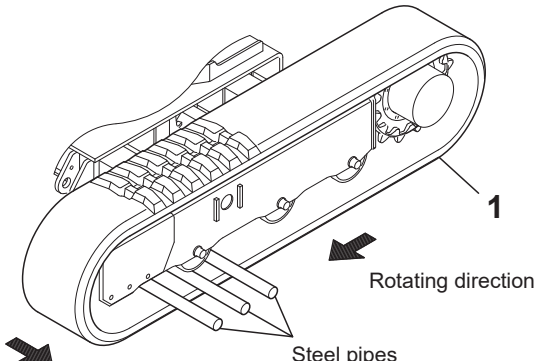
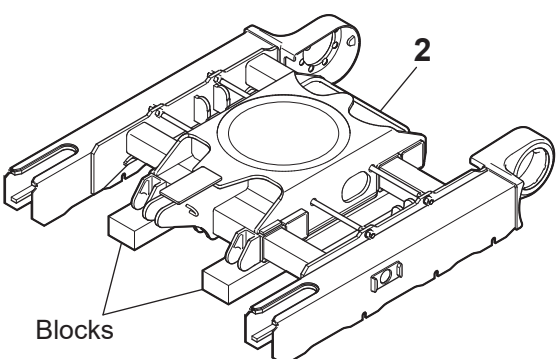
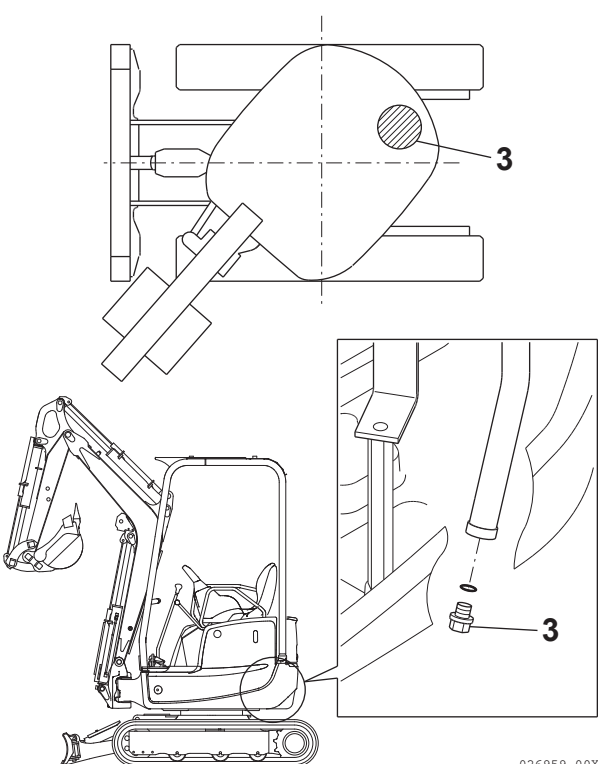
Type	Engine oil SAE 30
Quantity	0.042 Qts. (40 mL)



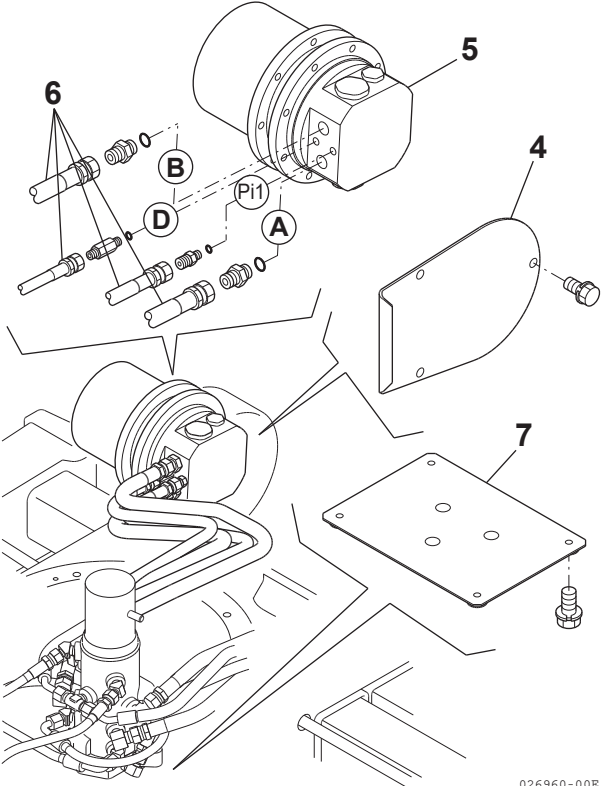
7. ADJUSTMENT AND REPAIR

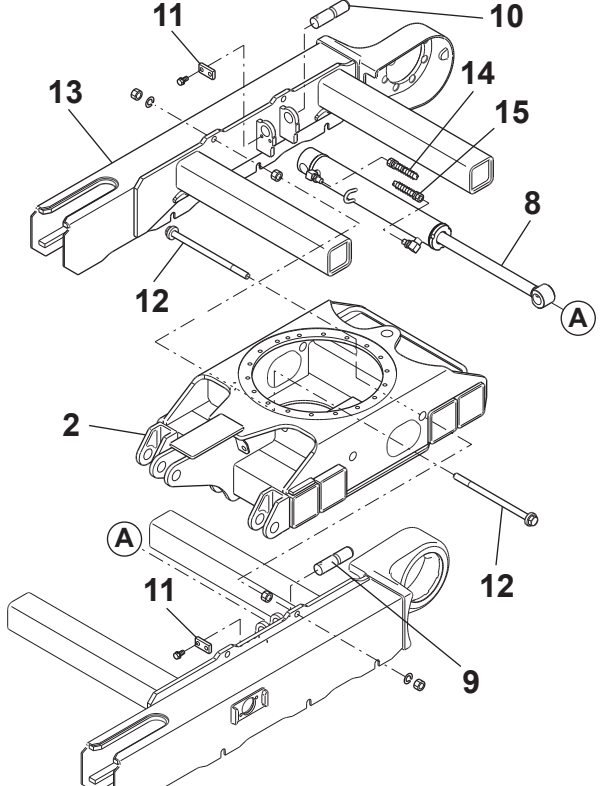
7-2-7 Removal and Reinstallation of Track Gauge Change Cylinder

1) Removal of Track Gauge Change Cylinder

Procedure			
(1) Widen the track frame fully by operating the track gauge change cylinder, and then remove the right rubber crawler 1. Note : Refer to Section "7-2-5 Removal and Reinstallation of Crawler".	 Rotating direction Steel pipes		
(2) Raise the machine using the implement and the blade, and then place blocks under the lower center frame 2. Note : Place blocks which have sufficient height to allow work under the lower center frame 2.	 Blocks 026958-00B		
(3) Swing the upperstructure so that the drain plug 3 of the hydraulic oil tank is positioned halfway between the right and left crawlers, and then stop the engine. (4) Remove the drain plug 3 from the hydraulic oil tank and drain the hydraulic oil. <table border="1"> <tr> <td>Hydraulic oil quantity</td> <td>4.4 Gals. (16.5 L)</td> </tr> </table>	Hydraulic oil quantity	4.4 Gals. (16.5 L)	 3 3 026959-00X
Hydraulic oil quantity	4.4 Gals. (16.5 L)		

7. ADJUSTMENT AND REPAIR

Procedure	
(5) Remove the motor cover 4, and then remove the hydraulic hoses 6 from the right travel motor 5. Note : Mark the hydraulic hoses 6 to identify their respective fitting positions. (6) Remove the under cover (SJ) 7.	

(7) Remove the plates 11 for the pin 9 at the rod end and the pin 10 at the bottom end of the track gauge change cylinder 8, and pull out the pins. (8) Remove the right stopper bolt 12, and then pull out the crawler frame (R) 13 from the lower center frame 2. (9) Pull out the track gauge change cylinder 8 and remove the hydraulic hose 14 on the bottom side. (10) Turn the track gauge change cylinder 8 about 90 degrees, and then remove the hydraulic hose 15 on the rod side of the cylinder from the lower part of the lower center frame 2. (11) Remove the track gauge change cylinder 8 from the lower center frame 2.	
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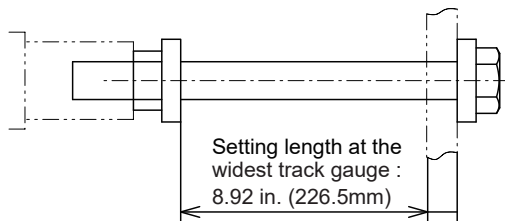
7. ADJUSTMENT AND REPAIR

2) Reinstallation of Track Gauge Change Cylinder

Reinstall the track gauge change cylinder in the reverse order of the removal procedure.

Notes :

- [1] Clean the square pipes of the crawler frames and the square pipe holes of the lower center frame.
- [2] Apply heavy-duty grease to the four sides of each square pipe hole of the lower center frame over 7.9 in. (200 mm) from the entrance.
- [3] Stopper bolt setting procedure:
After fully screwing the stopper nut onto the stopper bolt, loosen the nut one turn. Then tighten the bolt.

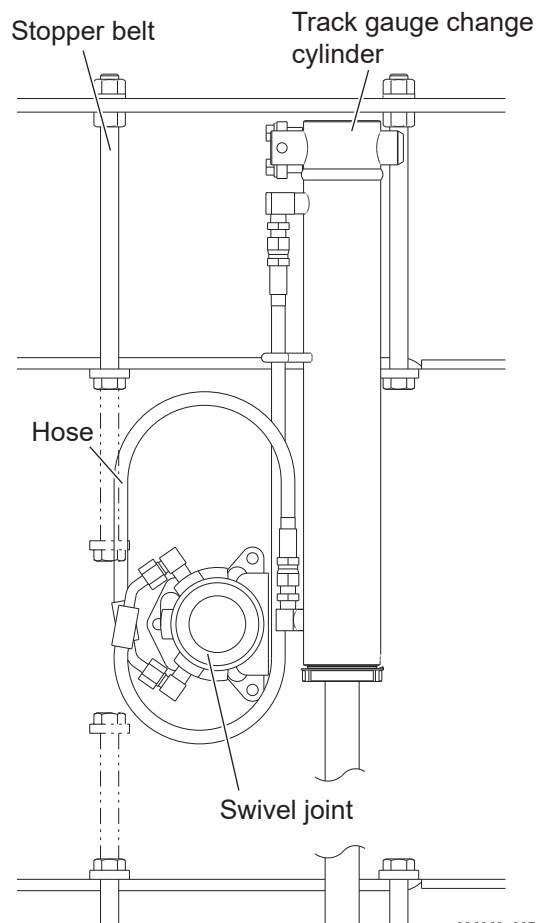


Stopper bolt and stopper nut (M16)	
Adhesive	Three Bond 1324 or its equivalent.
Tightening torque	123.0 to 151.9 ft•lbf (166.7 to 205.9 N•m)

- [4] Place the hoses for the track gauge change cylinder in the outermost and undermost position of all the hoses connected to the swivel joint.
(This prevents the hoses from catching on any other hose when narrowing the track frame.)
- [5] Make sure that the clearance between the stopper bolt head and the hose fitting when the track frame is narrowed fully.

- [6] Hydraulic oil to be used :

Type	YANMAR SUPER HYDRO OIL (VG 46 class) or its equivalent
Quantity	4.4 Gals. (16.5 L)



026962-00E

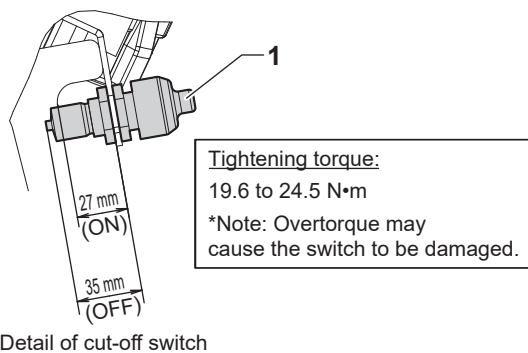
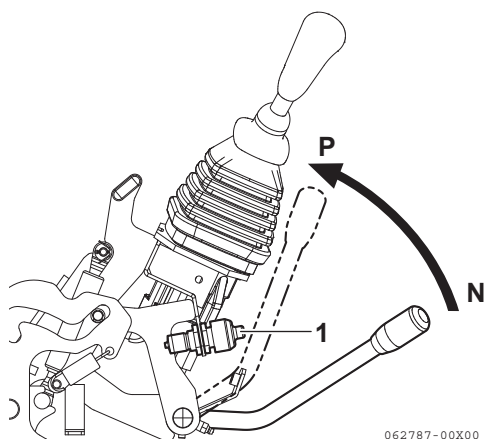
7. ADJUSTMENT AND REPAIR

7-3 Controls

7-3-1 Adjustment of Lock Lever Switch

1) Operation of Lock Lever

- (1) The operating force for moving the lock lever from **N** to **P** should be 53 N +/- 5 N.
- (2) The lock lever switch **1** should not allow the implements to operate when the lock lever is in **N** position.

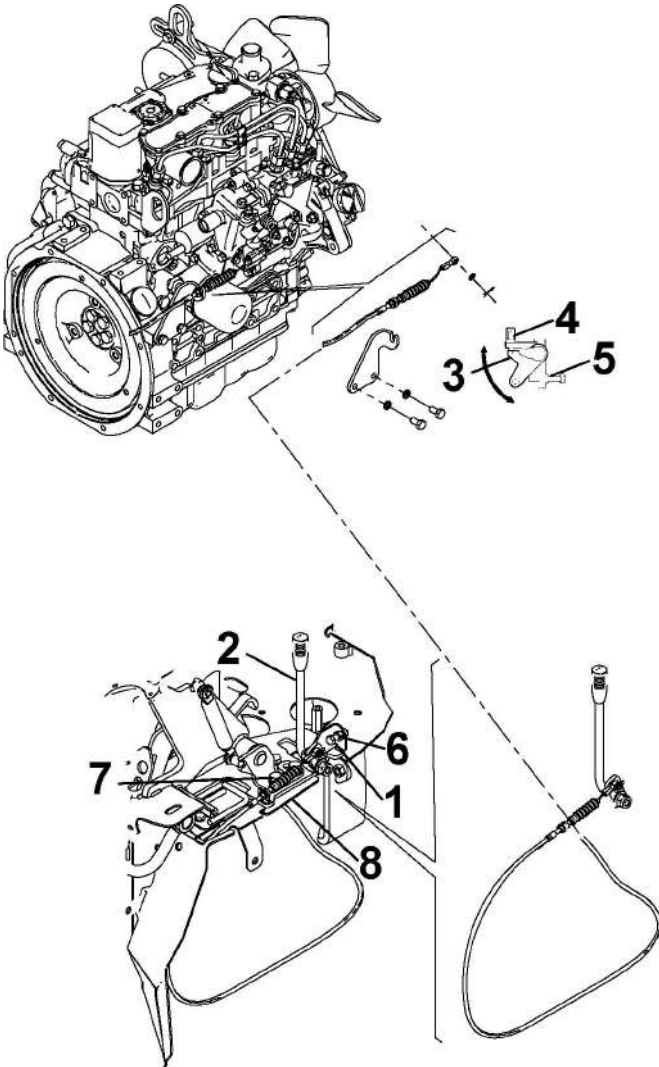


Lock lever switch operation

Lever position	Switch condition	Switch circuit	Cut-off valve operation	Implement operation
P	Pushed 	ON	Operate	Operate
N	Normal 	OFF	Stop	Can not operate

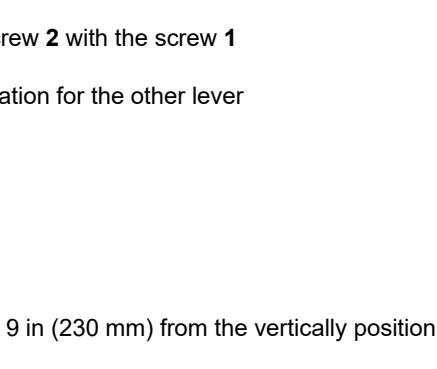
7. ADJUSTMENT AND REPAIR

7-3-2 Adjustment of Accelerator Lever

Procedure	
Adjustment of Maximum Idling Speed (1) Loosen the stopper bolt 1, and then move the accelerator lever 2 back until the regulator handle 3 on the engine side touches the adjusting bolt 4 for the maximum idling speed in the governor case. (2) Check that the maximum idling speed is within a specified range (2325 to 2375 rpm). (3) After the adjustment of the maximum idling speed, screw in the stopper bolt 1 until the bolt end touches the accelerator arm 2 and fix it with the nut 6. Adjustment of Minimum Idling Speed (1) Loosen the stopper bolt 7, and then move the accelerator lever 2 forward. (2) When the regulator handle 3 on the engine side touches the stopper bolt 5 for the minimum idling speed, check whether the minimum idling speed is within a specified range (1200 to 1250 rpm). (3) If the minimum idling speed is not within the range, make adjustments to the speed by tightening or loosening the stopper bolt 5. (4) After the adjustment of the minimum idling speed, screw in the stopper bolt 7 until the bolt end touches the accelerator arm 2 and fix it with the nut 8.	

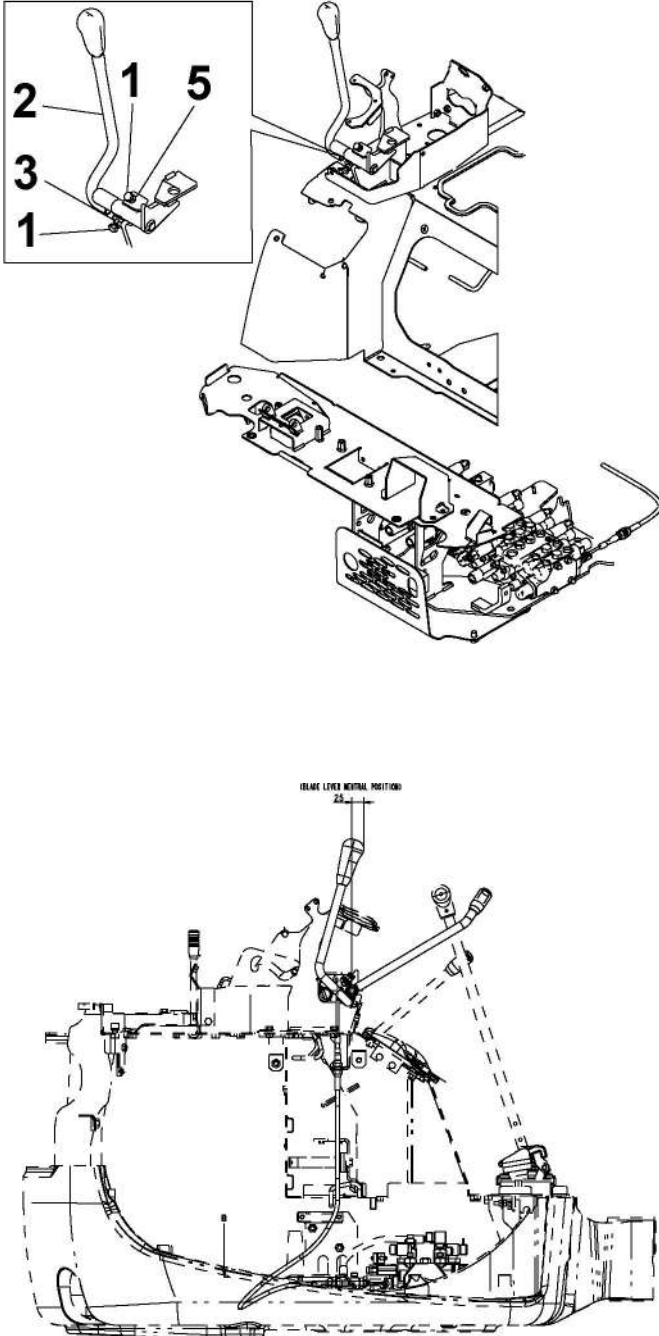
7. ADJUSTMENT AND REPAIR

7-3-3 Adjustment of Travel Levers

Procedure	 (1) Loosen the screw 1. (2) Adjust the travel lever with the screw 2. (3) Block the screw 2 with the screw 1 Repeat the operation for the other lever Neutral position: 9 in (230 mm) from the vertically position

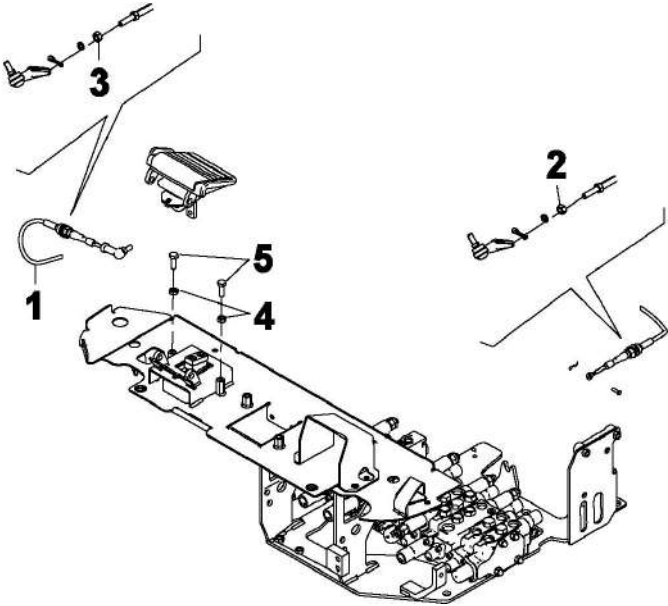
7. ADJUSTMENT AND REPAIR

7-3-4 Adjustment of Blade Lever

Procedure	
Adjustment of blade lift movement (1) Loosen the stopper bolt 1, and then move the blade lever 2 back until the blade lift. (2) After the adjustment of the blade lift movement, screw in the stopper bolt 1 until the bolt end touches the blade lever 2 and fix it with the nut 3. Adjustment of blade down movement (1) Loosen the stopper bolt 4, and then move the blade lever 2 back until the blade down. (2) After the adjustment of the blade down movement, screw in the stopper bolt 4 until the bolt end touches the blade lever 2 and fix it with the nut 5. Neutral position: 1 in (25 mm) from the standby position	

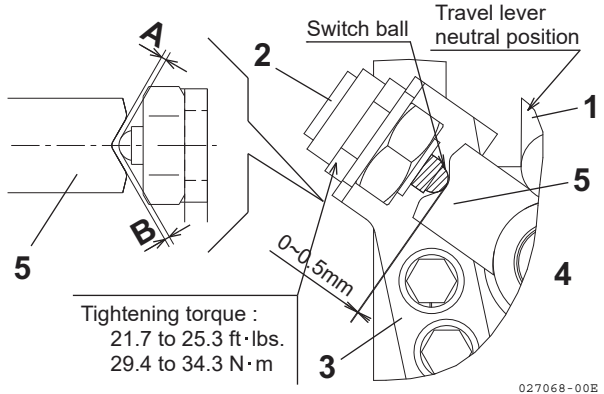
7. ADJUSTMENT AND REPAIR

7-3-5 Adjustment of Boom Swing Pedal

Procedure	
1) Setting Pedal Level from pedal side Remove the step and side cover L. (1) Loosen the nut 3 of the cable 1. (2) Adjust the cable 1 so that the pedal will be level. (3) Tighten the nut 3 of the cable 1. 2) Setting Pedal Level from control valve side Remove the step and side cover L. (1) Loosen the nut 2 of the cable 1. (2) Adjust the cable 1 so that the pedal will be level. (3) Tighten the nut 2 of the cable 1. 3) Adjustment of Stopper Bolts (For Right and Left Boom Swing) (1) Loosen the lock nuts 3 and screw in the stopper bolts 4 so that they will not touch the boom swing pedal. (2) Move the boom swing pedal to its stroke end, and loosen the stopper bolt 4 until the bolt head touches the pedal (for each stopper bolt). (3) Loosen the stopper bolt 4 half-turn further and tighten the lock nut 3 to fix it.	

7. ADJUSTMENT AND REPAIR

7-3-6 Adjustment of Travel Alarm Switch (Left and Right)

Procedure	
(1) Set the travel lever 1 to the neutral position. (2) Loosen bolt 4 (2 pcs.) of bracket 3 of travel alarm switch 2. (3) Adjust the distance between the travel lever arm 5 and the travel alarm switch 2 to 0.02 in. (0.5 mm) or less. Note : <i>Make the clearances A and B equal.</i> (4) Check that the alarm sounds without fault when each travel lever on either side is operated in forward and reverse.	 The diagram illustrates the adjustment of the travel alarm switch. It shows a side view of the travel lever arm (5) and the travel alarm switch (2) mounted on a bracket (3). The travel lever (1) is shown in its neutral position. Two bolts (4) are used to secure the bracket. The distance between the travel lever arm (5) and the travel alarm switch (2) is indicated as 0~0.5mm. The diagram also shows the switch ball and the travel lever neutral position. The tightening torque for the bolts is specified as 21.7 to 25.3 ft·lbs. (29.4 to 34.3 N·m). The diagram is labeled 027068-00E.

7. ADJUSTMENT AND REPAIR

7-4 Swing Bearing

1) Removal and Reinstallation of Swing Bearing

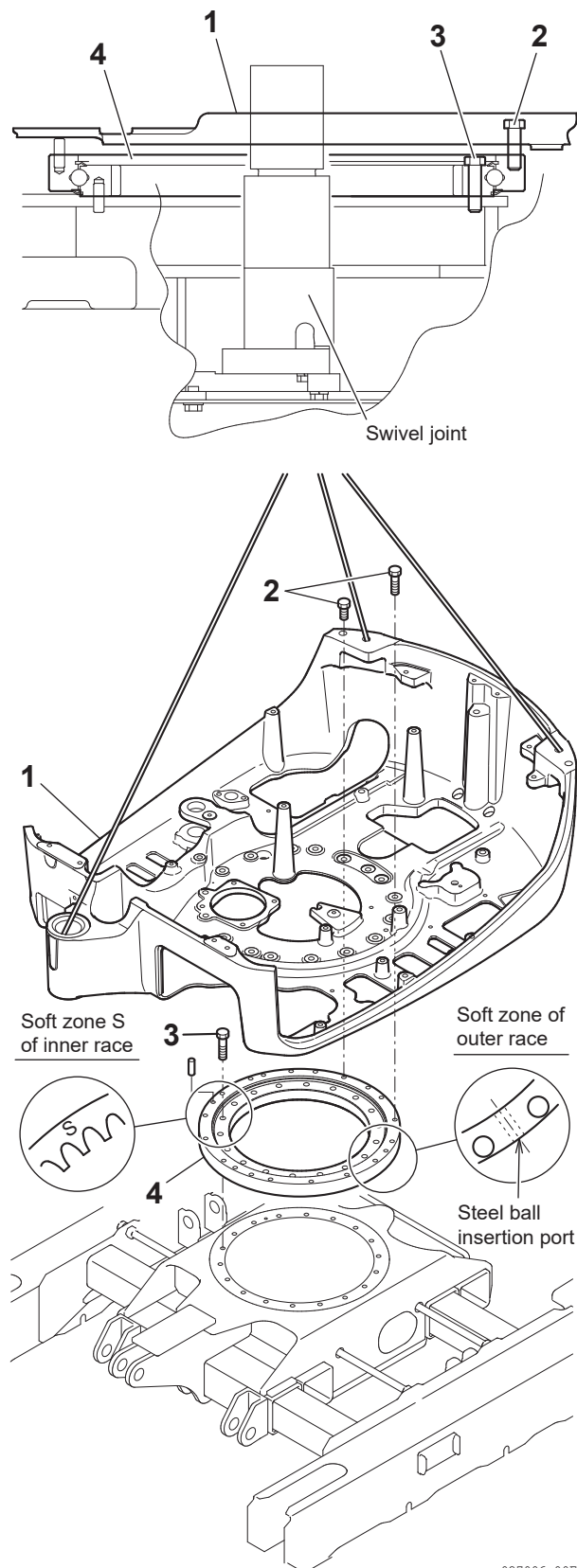
- (1) Remove the implement.
Refer to Section "7-6-1 Removal and Reinstallation of Implement".
- (2) Remove the engine.
Refer to Section "7-1-1 Removal and Reinstallation of Engine".
- (3) Remove the swing motor.
Refer to Section "7-5-3 Removal and Reinstallation of Swing Motor".
- (4) Remove the hydraulic hoses from the swivel joint.
Refer to Section "7-5-4 Removal and Reinstallation of Swivel Joint".
- (5) Rope the turning frame **1** at three points and suspend it temporarily.
- (6) Remove the seventeen mounting bolts **2** with which the turning frame **1** is mounted on the outer race of the swing bearing.
- (7) Lift up the turning frame **1**.
- (8) Remove the eighteen mounting bolts **3** with which the inner race of the swing bearing is mounted on the track frame.
- (9) Remove the swing bearing **4**.

2) Points of Installation

The inner and outer races of the swing bearing have a soft zone, and the soft zone of the inner race is marked with "S".

The soft zone of the outer race is located at the steel ball insertion port.

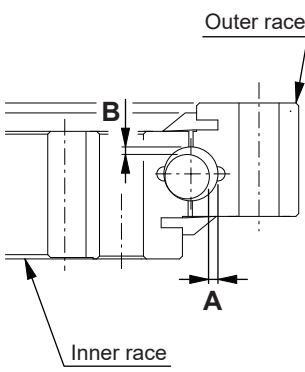
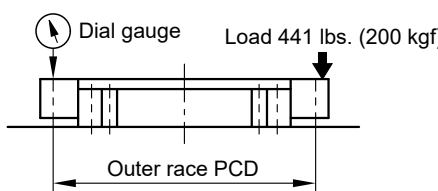
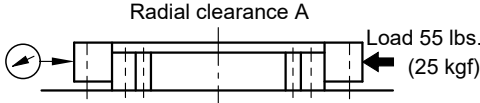
To reduce the load to be applied to the soft zones, as shown in the figure at the right, install the swing bearing with the "S" mark on the right side of the track frame and the steel ball insertion port on the left side of it.



027006-00E

7. ADJUSTMENT AND REPAIR

3) Service Standards

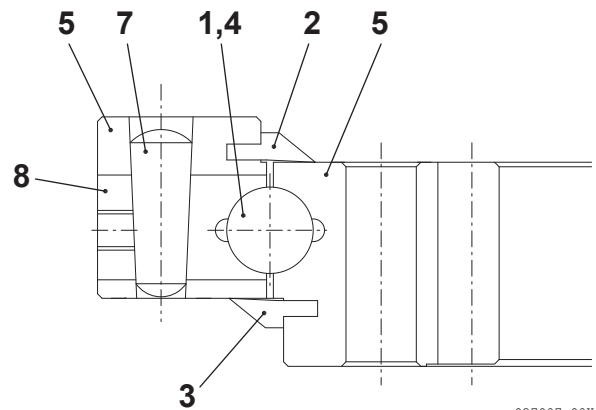
			Standard	Wear limit
			0.0012 to 0.0059 in. (0.03 to 0.15 mm)	0.0157 in. (0.4 mm)
				
Steel ball diameter			Ø0.6946 in. (Ø17.6425 mm)	—
Tightening torque (10.9 T)	Tuning frame×outer race Track frame×inner race	M12×25 M12×40 M12×45	79.6 to 94.0 ft·lbf (107.9 to 127.5 N·m)	Apply Loctite 262 or its equivalent.

Note :

Put multipurpose grease into the swing bearing.

4) Parts of Swing Bearing

No.	Part	Q'ty
1	Steel ball	66
2	Seal A	1
3	Seal B	1
4	Support	66
5	Outer race	1
6	Inner race	1
7	Taper pin	1
8	Plug	1



027007-00X

5) Inspection

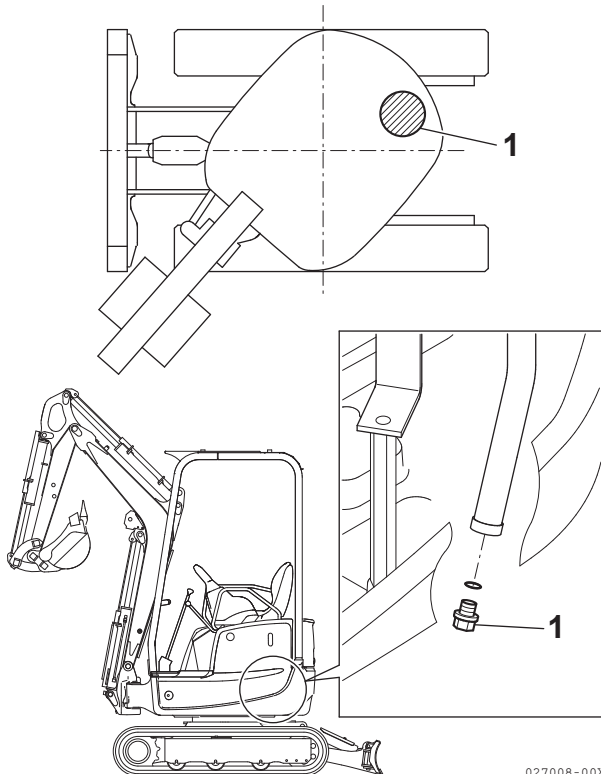
- (1) Check the gear teeth surfaces for nicks, flaws, cracks, wear and breakage. Replace the swing bearing if the damage is excessive.
- (2) Check for abnormal sound. Clean, grease or replace the swing bearing if necessary.
- (3) Check the inner and outer races for play and irregular rotation. Refer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

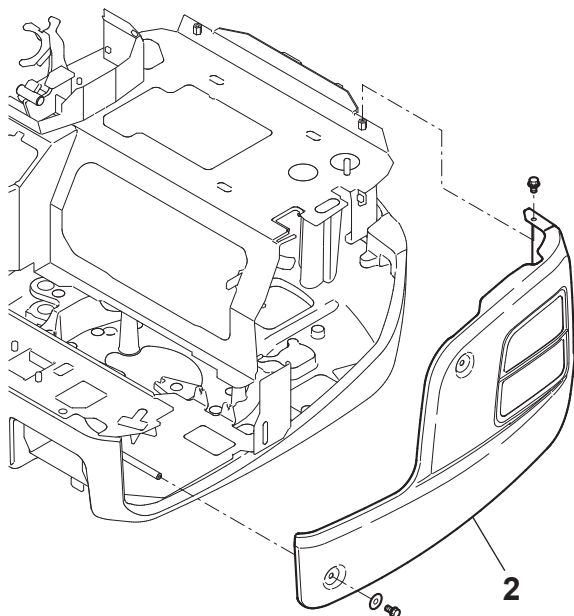
7. ADJUSTMENT AND REPAIR

7-5 Hydraulic Equipment

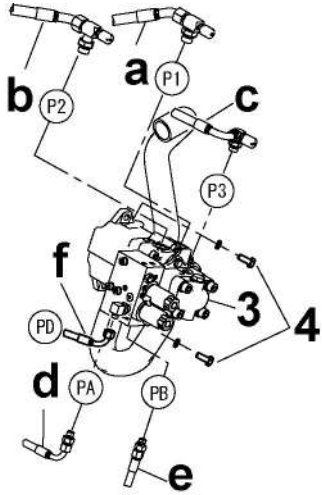
7-5-1 Removal and Reinstallation of Hydraulic Pump

1) Removal

Procedure			
(1) Swing the upperstructure so that the drain plug 1 of the hydraulic oil tank is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine. (2) Remove the drain plug 1 from the hydraulic oil tank and drain the hydraulic oil. <table><tr><td>Hydraulic oil quantity</td><td>4.36 Gals. (16.5L)</td></tr></table>	Hydraulic oil quantity	4.36 Gals. (16.5L)	 027008-00X
Hydraulic oil quantity	4.36 Gals. (16.5L)		

(3) Remove the cover 2.	 027009-00X
---------------------------------------	--

7. ADJUSTMENT AND REPAIR

Procedure	
(4) Remove the hydraulic hoses from the hydraulic pump 3. a. Hose P1 b. Hose P2 c. Hose P3 d. Hose PA e. Hose PB f. Hose (Accumulator) (5) Disconnect the harness connector of the cut-off valve. (6) Remove the mounting bolts 4 and remove the hydraulic pump 3.	 The diagram illustrates a hydraulic pump assembly with various hoses and mounting bolts. The pump is labeled 3. Mounting bolts are labeled 4. Hoses are labeled with letters and codes: a (P1), b (P2), c (P3), d (PA), e (PB), and f (Accumulator). A cut-off valve is labeled PD. The diagram shows the pump connected to a network of hoses and a cut-off valve, with mounting bolts securing the pump to a base.

7. ADJUSTMENT AND REPAIR

2) Reinstallation

Reinstall the hydraulic pump in the reverse order of the removal procedure.

Notes :

- *Apply heavy-duty grease to the spline shaft of the hydraulic pump.*

Hydraulic pump installation bolt M12	
Tightening torque	57.9 to 72.3 ft•lbf (78.5 to 98.1 N•m)

- *Hydraulic oil to be used :*

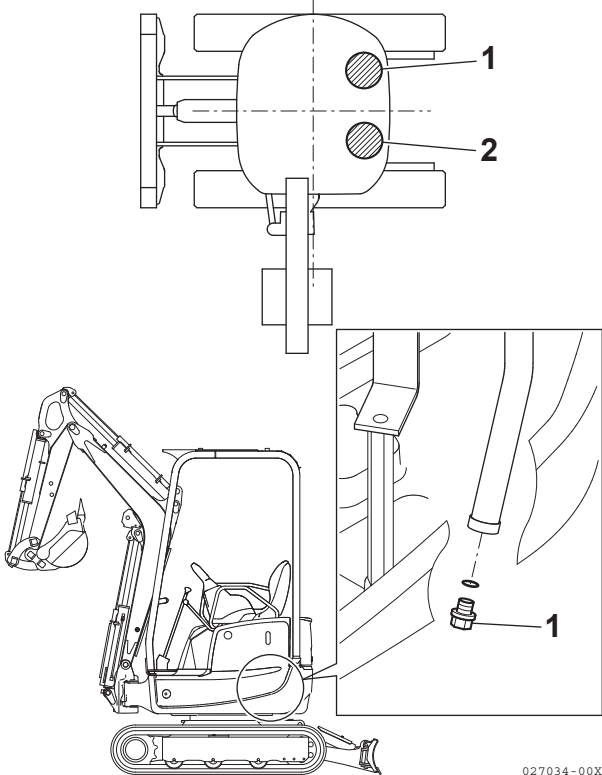
Type	YANMAR SUPER HYDRO OIL (VG 46 class) or its equivalent
Quantity	4.36 Gals. (16.5 L)

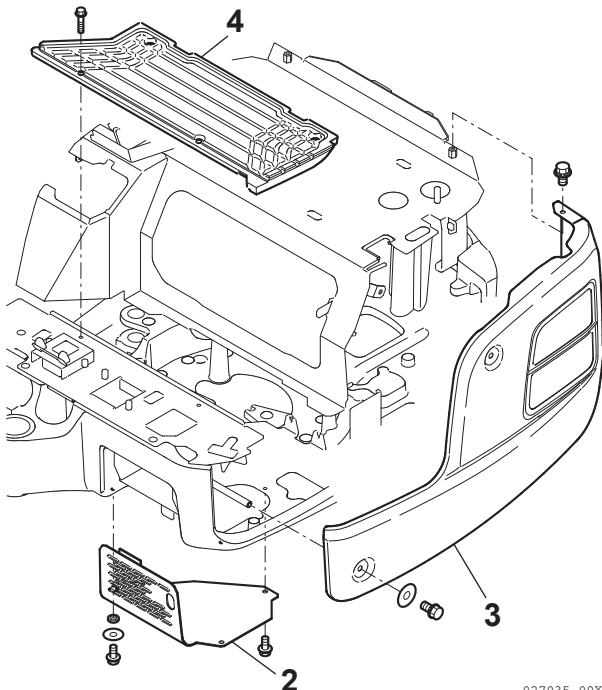
- *After the installation of the hydraulic pump, make a test run and operate the relief valves to check for oil leak or other abnormality.*

7. ADJUSTMENT AND REPAIR

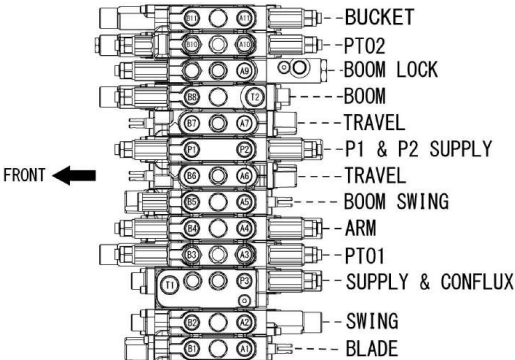
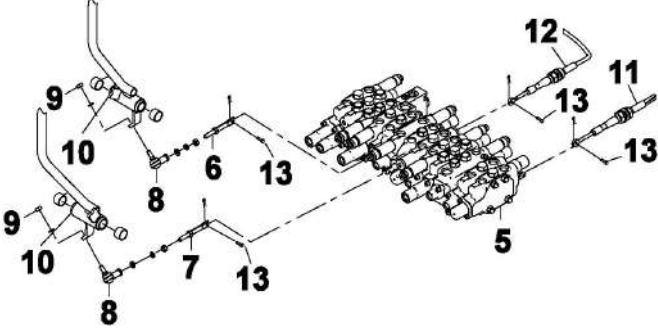
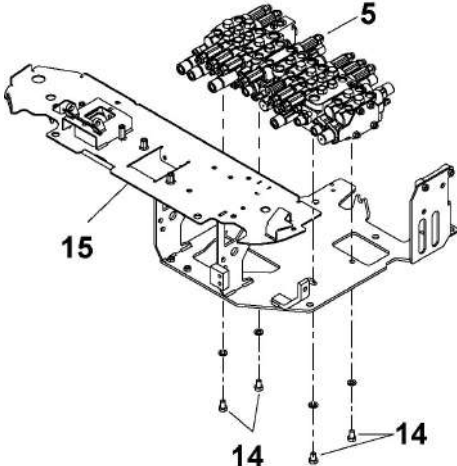
7-5-2 Removal and Reinstallation of Control Valve

1) Removal

Procedure			
(1) Swing the upperstructure so that the drain plug 1 of the hydraulic oil tank and the under cover (CV) 2 are positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine. (2) Remove the drain plug 1 from the hydraulic oil tank and drain the hydraulic oil. <table border="1"><tr><td>Hydraulic oil quantity</td><td>4.36 Gals. (16.5L)</td></tr></table>	Hydraulic oil quantity	4.36 Gals. (16.5L)	 027034-00X
Hydraulic oil quantity	4.36 Gals. (16.5L)		

(3) Remove the cover (CV)2, the cover L 3 and the step 4.	 027035-00X
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7. ADJUSTMENT AND REPAIR

Procedure	
(4) Remove the hydraulic hoses and the pilot hoses from the control valve 5. Notes : - Remove the hydraulic hoses and the pilot hoses from the control valve in left-to-right order. - Mark the removed hoses to identify their respective fitting positions.	CONTROL VALVE  Diagram showing the control valve assembly with labels for various ports and components: - BUCKET - PT02 - BOOM LOCK - BOOM - TRAVEL - P1 & P2 SUPPLY - TRAVEL - BOOM SWING - ARM - PT01 - SUPPLY & CONFLUX - SWING - BLADE FRONT ←
(5) Remove the nuts 9 from the L-balls 8 connected to the travel (R) section 6, and the travel (L) section 7, to disconnect those sections from the links 10. (6) Remove the pins 13 to disconnect the cable 11 connected to the blade lever and the cable 12 connected to the boom swing pedal from the spools of the control valve 5.	 Diagram showing the disconnection of travel sections and cables from the control valve. Labels include: 9, 10, 8, 6, 13, 7, 11, 12, 13, 5.
(7) Remove the mounting bolts 14, and then remove the control valve 5 from the valve plate 15.	 Diagram showing the removal of the control valve from the valve plate. Labels include: 5, 15, 14, 14.

7. ADJUSTMENT AND REPAIR

2) Reinstallation

Reinstall the control valve in the reverse order of the removal procedure.

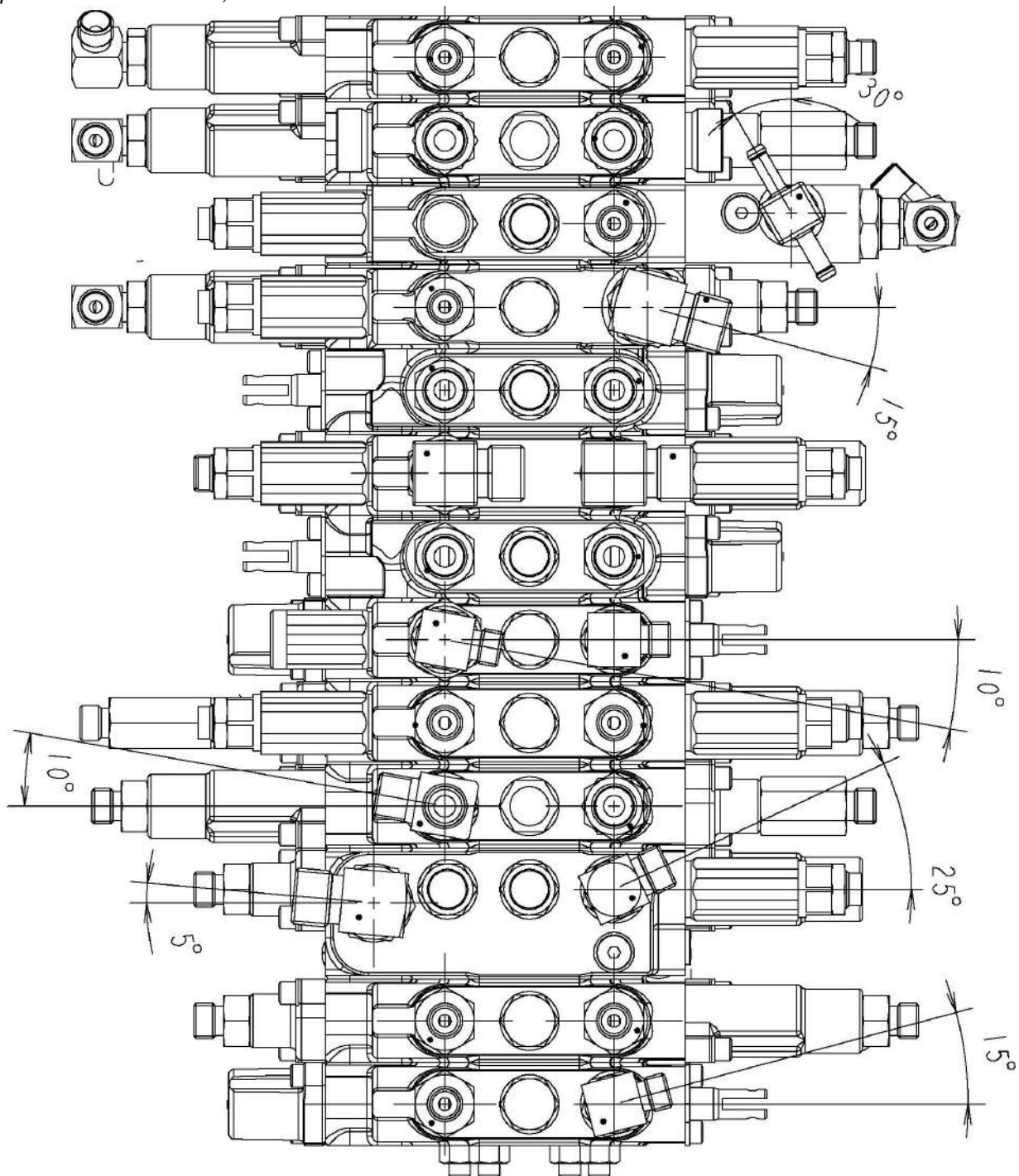
Notes :

[1] Install the hoses so that each of them is not in contact with any other hoses or parts.

[2] Hydraulic oil to be used :

Type	YANMAR SUPER HYDRO OIL (VG 46 class) or its equivalent
Quantity	4.36 Gals. (16.5 L)

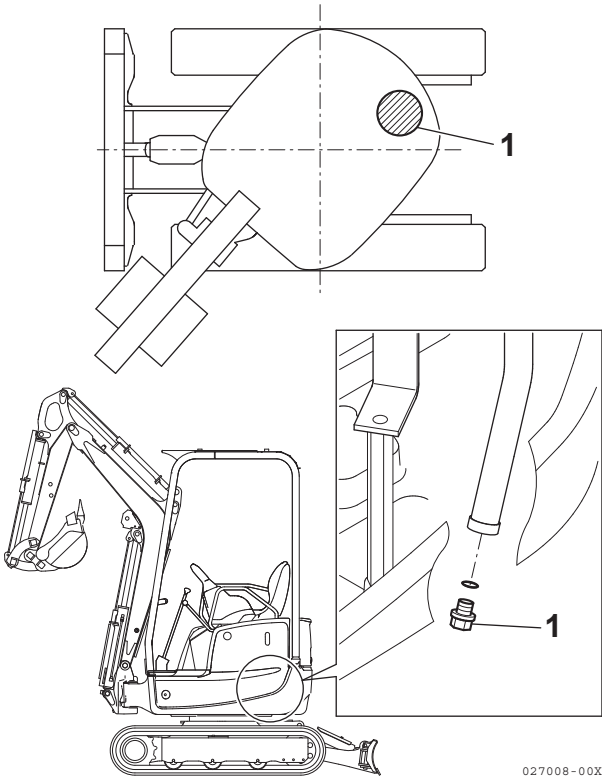
[3] After the installation of the control valve, raise the hydraulic oil temperature to 122 to 140 °F (50 to 60 °C) and operate the relief valves, to check for oil leak.

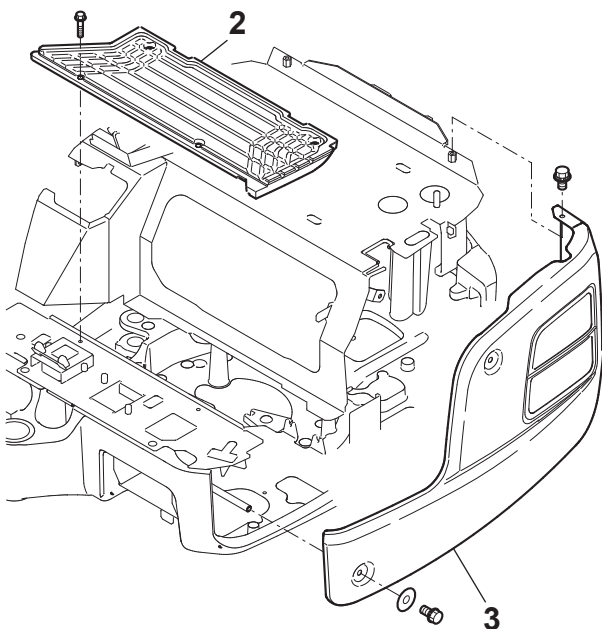


7. ADJUSTMENT AND REPAIR

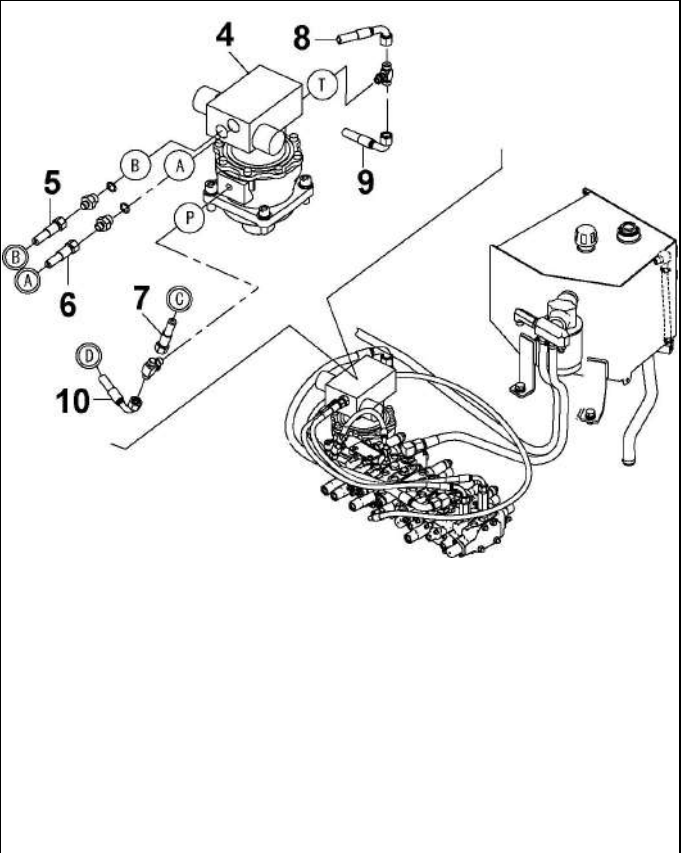
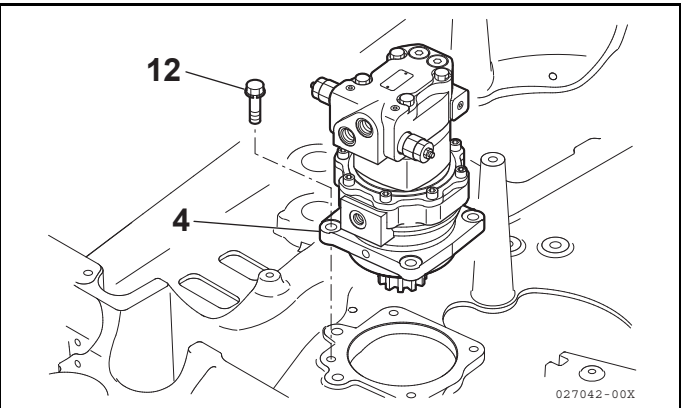
7-5-3 Removal and Reinstallation of Swing Motor

1) Removal

Procedure			
(1) Swing the upperstructure so that the drain plug 1 of the hydraulic oil tank is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine. (2) Remove the drain plug 1 from the hydraulic oil tank and drain the hydraulic oil. <table border="1"><tr><td>Hydraulic oil quantity</td><td>4.36 Gals. (16.5L)</td></tr></table>	Hydraulic oil quantity	4.36 Gals. (16.5L)	 027008-00X
Hydraulic oil quantity	4.36 Gals. (16.5L)		

(3) Remove the step 2 and the cover L 3	 027040-00X
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7. ADJUSTMENT AND REPAIR

Procedure	
(4) Remove the hydraulic hoses from the swing motor 4. * Hose 5 (control valve to swing motor) * Hose 6 (control valve to swing motor) * Hose 7 (block drain to swing motor) * Hose 10 (control valve drain PP2 to swing motor) (5) Remove the drain hose 8 and 9.	
(6) Remove the mounting bolts 12 and remove the swing motor 4.	 027042-00X

7. ADJUSTMENT AND REPAIR

2) Reinstallation

Reinstall the swing motor in the reverse order of the removal procedure.

Notes :

Swing motor mounting bolt (M12)	
Adhesive	Apply three bond 1324 or its equivalent.
Tightening torque	57.9 to 72.3 ft•lbf (78.5 to 98.1 N•m)

[1] *Install the hoses so that each of them is not in contact with any other hoses or parts.*

[2] *Hydraulic oil to be used :*

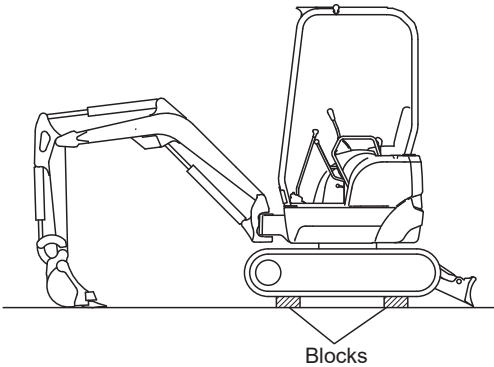
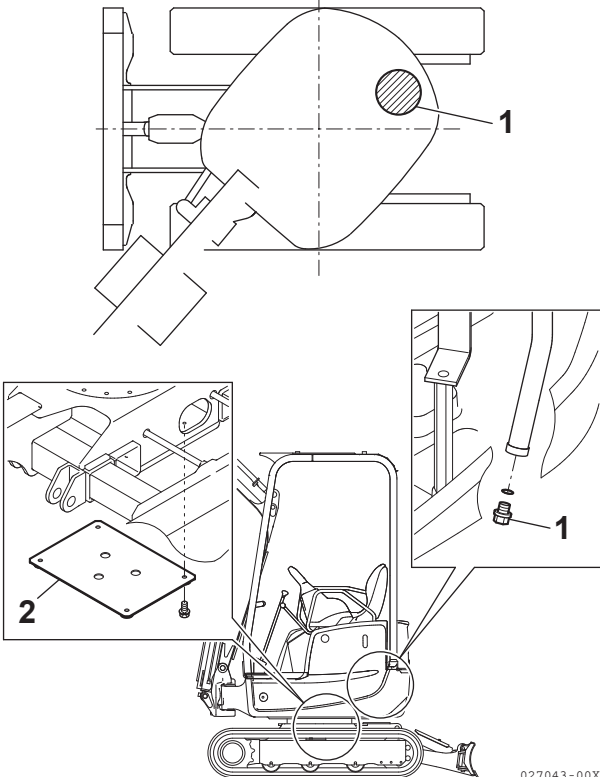
Type	YANMAR SUPER HYDRO OIL (VG 46 class) or its equivalent
Quantity	4.36 Gals. (16.5 L)

[3] *After the installation of the swing motor, raise the hydraulic oil temperature to 122 to 140 °F (50 to 60 °C) and operate the relief valves, to check for oil leak.*

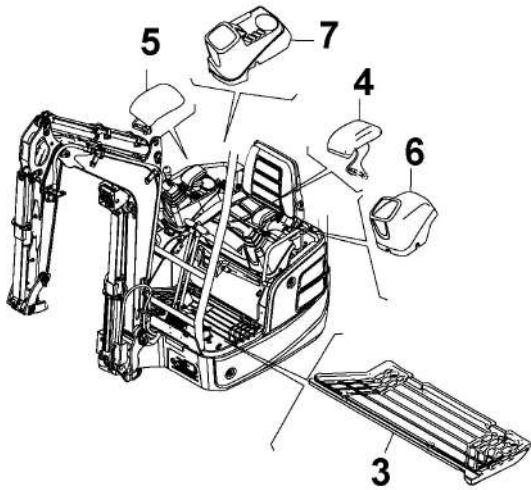
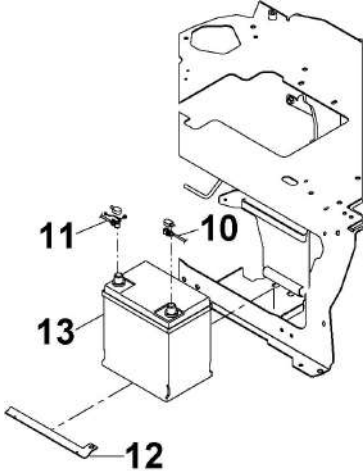
7. ADJUSTMENT AND REPAIR

7-5-4 Removal and Reinstallation of Swivel Joint

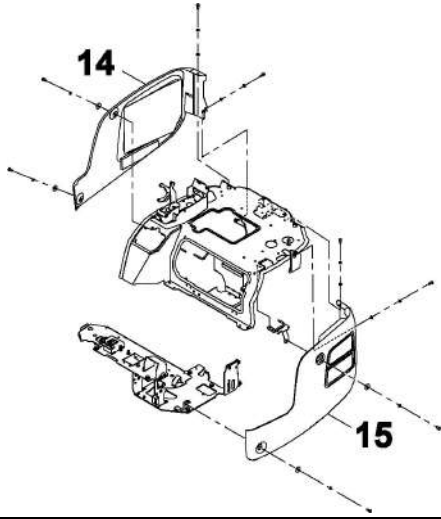
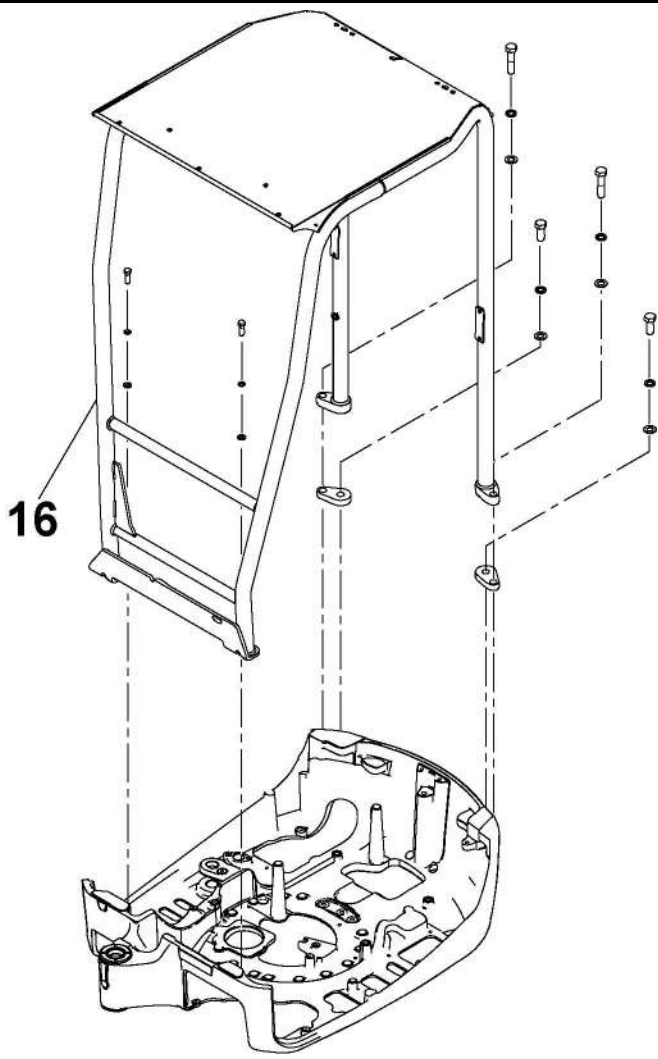
1) Removal

Procedure			
(1) Operate the implement and the blade to raise the machine. (2) After raising the machine, place blocks under the machine. Notes : • To prevent the machine from dropping down, be sure to place blocks under it. • Place blocks which have sufficient height to allow work under the machine.	 Blocks		
(3) Swing the upperstructure so that the drain plug 1 of the hydraulic oil tank is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine. (4) Remove the under cover (SJ) 2. (5) Remove the drain plug 1 from the hydraulic oil tank and drain the hydraulic oil. <table border="1"><tr><td>Hydraulic oil quantity</td><td>4.36 Gals. (16.5L)</td></tr></table>	Hydraulic oil quantity	4.36 Gals. (16.5L)	 027043-00X
Hydraulic oil quantity	4.36 Gals. (16.5L)		

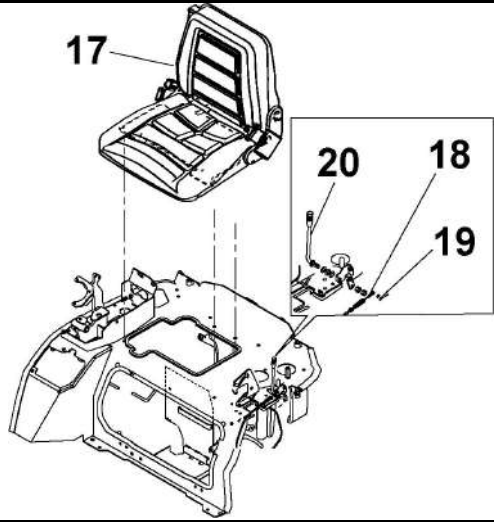
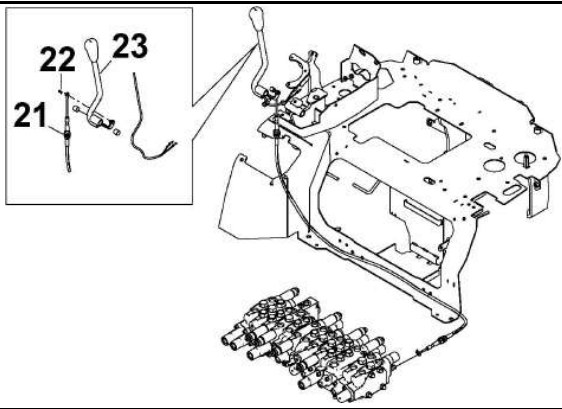
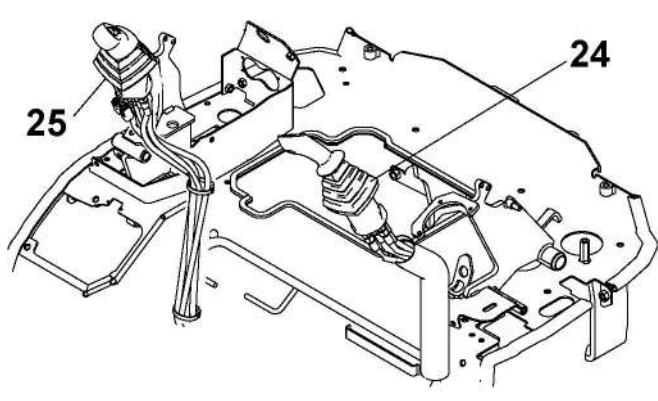
7. ADJUSTMENT AND REPAIR

Procedure	
(6) Remove the step 3, the armrest L 4, the armrest R 5 the panel L 6, and the panel R 7. (7) Then disconnect the harness connectors of the left and right Joysticks.	 The diagram illustrates the removal of several components from the excavator's operator's seat area. Component 3 is a rectangular step plate located at the base of the seat. Component 4 is the left armrest, and component 5 is the right armrest. Component 6 is the left joystick panel, and component 7 is the right joystick panel. The diagram shows these components being detached from the main seat structure.
(8) Disconnect the battery cable (negative) 10 and the battery cable (positive) 11 and remove the battery clamp 12, and then remove the battery 13.	 The diagram shows the battery (13) and its associated components. Component 10 is the negative battery cable, and component 11 is the positive battery cable. Component 12 is a battery clamp. The diagram illustrates the process of disconnecting the cables and removing the clamp from the battery.

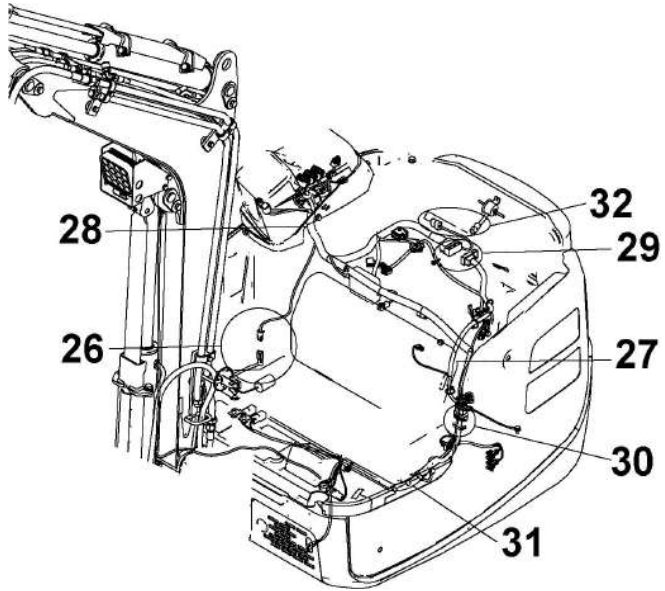
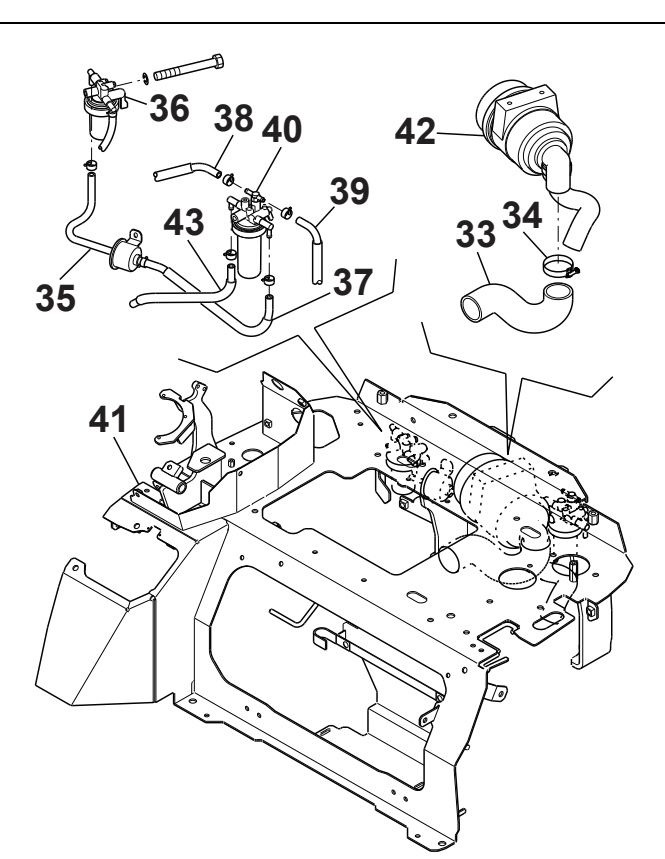
7. ADJUSTMENT AND REPAIR

Procedure	
(9) Remove the cover R 14 and the cover L 15.	 This diagram shows an exploded view of the operator's seat mount. Two covers, labeled 14 and 15, are shown being removed from the main seat assembly. Cover 14 is on the left and cover 15 is on the right. Dashed lines indicate the removal path for each cover.
(10) Unplug the canopy harness and remove the canopy 16. Note : <i>Take care that the harnesses and clamps do not catch on any other parts when lifting up the operator's seat mount.</i>	 This diagram shows an exploded view of the canopy, labeled 16, being removed from the seat mount. The canopy is shown above the seat mount, with dashed lines indicating its removal path. The seat mount is shown below, with various components and fasteners visible. The canopy has a flat top and side panels. The seat mount has a complex base with various mounting points and fasteners.

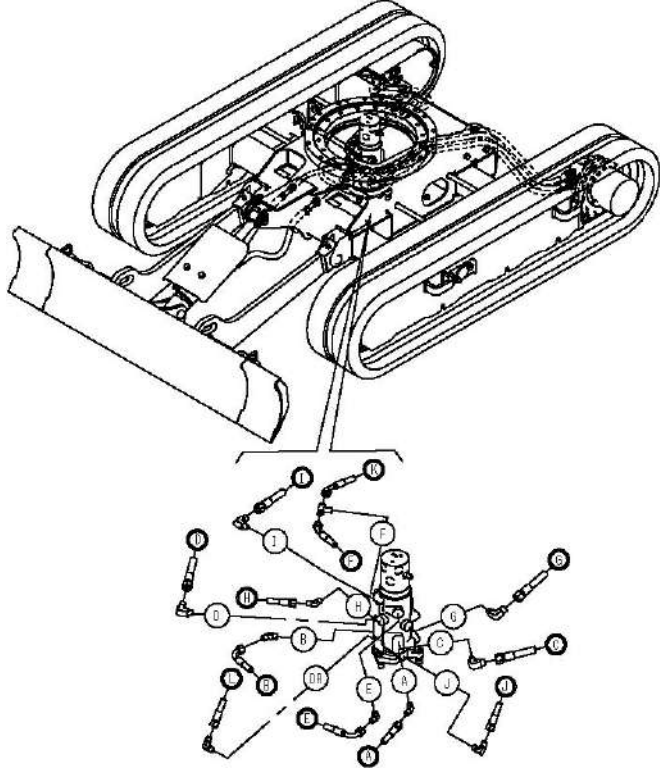
7. ADJUSTMENT AND REPAIR

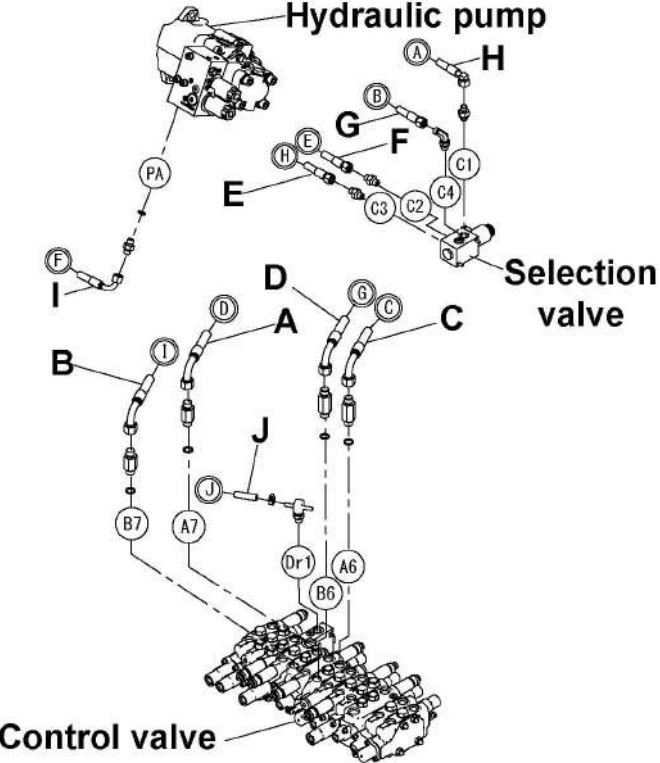
Procedure	
(11) Remove the snap pin 7 and disconnect the accelerator cable 6 from the accelerator lever 8. (12) Unplug the seat harness and remove the operator's seat with the operator's seat plate 5.	
(13) Remove the snap pin 22 and disconnect the blade cable 21 from the blade lever 23 by loosen the nut and the lock nut. Then disconnect the cable from the control valve.	
(14) Remove the pilot valve 24 and 25 in the left and right with the hydraulic hose attached.	

7. ADJUSTMENT AND REPAIR

Procedure	
(15) Disconnect the harness 26 from the fuel gauge unit. (16) Disconnect the connecting coupler 29 of the harness A 27 and harness B 28. (17) Disconnect the body coupler 30 of the harness B 28 and harness D 31. (18) Disconnect the fuel pump connector 32.	 This diagram shows the operator's seat and surrounding components. Numbered parts include: 26 (harness), 27 (harness A), 28 (harness B), 29 (connecting coupler), 30 (body coupler), 31 (harness D), and 32 (fuel pump connector). The diagram illustrates the locations of these components and the points where they are disconnected.
(19) Remove the air cleaner hose B 33 by loosen the collar 34 (20) Remove the water separator 36 from the operator's seat mount 41 and disconnect the fuel hose 35 on the water separator 36 side. (21) Remove the fuel hose 37, 38, 39 and 43 on the fuel filter 40 side. (22) Rope the operator's seat mount 41 (with the bonnet and the air cleaner 42) and lift it up, to remove it. Note : Take care that the harnesses and clamps do not catch on any other parts when lifting up the operator's seat mount.	 This diagram shows the operator's seat mount (41) and the fuel system components. Numbered parts include: 35 (fuel hose), 36 (water separator), 37 (fuel hose), 38 (fuel hose), 39 (fuel hose), 40 (fuel filter), 41 (operator's seat mount), 42 (air cleaner), 43 (fuel hose), and 44 (fuel hose). The diagram illustrates the locations of these components and the points where they are disconnected.

7. ADJUSTMENT AND REPAIR

Procedure	
(23) Remove the hydraulic hoses from the swivel hub of the swivel joint. A : For track gauge change cylinder (rod side) B : For track gauge change cylinder (bottom side) C : For travel motor (L) (reverse) D : For travel motor (R) (reverse) E : For blade cylinder (rod side) F : For travel motor (L) (2nd speed) G : For travel motor (L) (forward) H : For blade cylinder (bottom side) I : For travel motor (R) (forward) J : For travel motor (R) (drain) K : For travel motor (R) (2nd speed) L : For travel motor (L) (drain) Notes : - Remove the hydraulic hoses from the swivel hub in bottom-to-top order. - Mark the removed hoses to identify their respective fitting positions. (24) Remove the mounting bolts for the swivel joint.	

(25) Remove the hydraulic hoses from the control valve. A : For travel motor (R) (reverse) B : For travel motor (R) (forward) C : For travel motor (L) (reverse) D : For travel motor (L) (forward) J : For travel motor (L and R) (drain) (26) Remove the hydraulic hoses from the selection valve. E : For blade cylinder (bottom side) F : For blade cylinder (rod side) G : For track gauge change cylinder (bottom side) H : For track gauge change cylinder (rod side) Note : Mark the removed hoses to identify their respective fitting positions. (27) Remove the hydraulic hose from the pump. I for high-speed (L and R) (28) Take down the swivel joint (with the hydraulic hoses connected to the swivel shaft) to the lower center frame and remove it.	
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7. ADJUSTMENT AND REPAIR

2) Reinstallation

Reinstall the swivel joint in the reverse order of the removal procedure.

Notes :

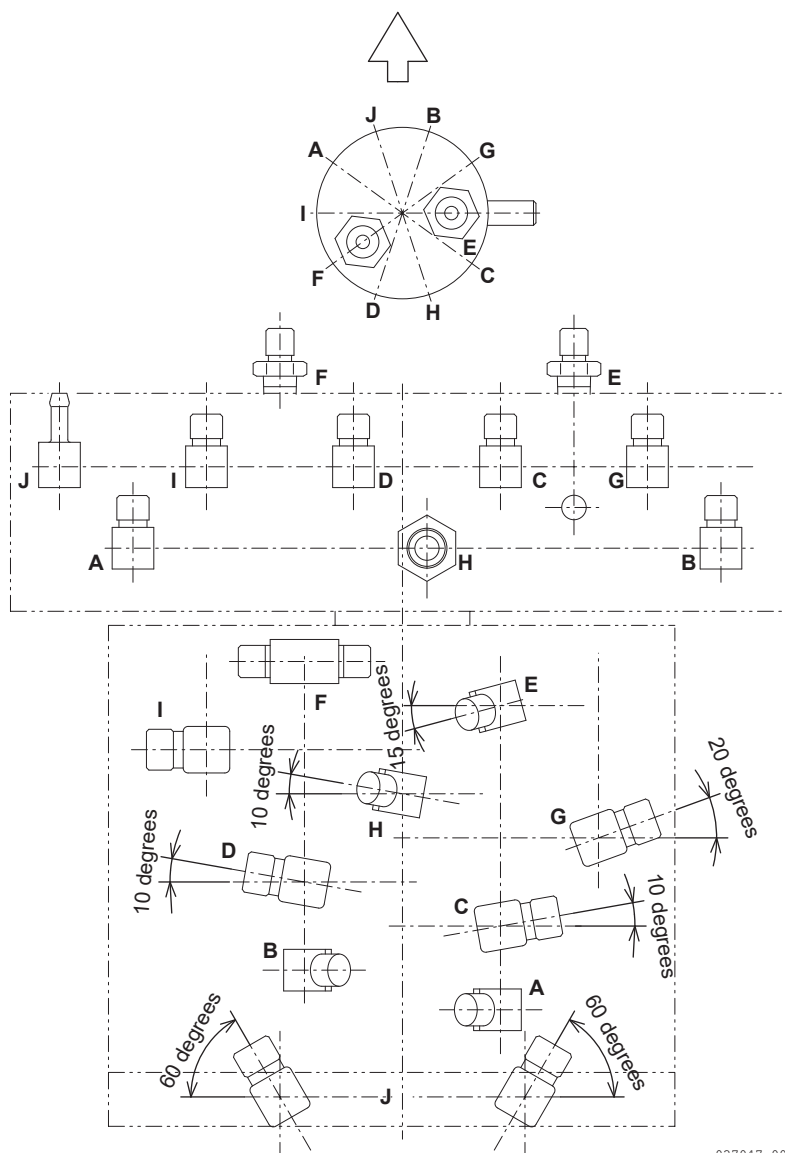
[1] Wrap seal tape around the connectors before installing them.

[2] Install each connector at a specified mounting angle.

Swivel joint mounting bolt (M10)	
Adhesive	Apply Three Bond 1324 or its equivalent.
Tightening torque	32.6 to 43.4 ft•lbf (44.1 to 58.8 N•m)

[3] Hydraulic oil to be used :

Type	YANMAR SUPER HYDRO OIL (VG 46 class) or its equivalent
Quantity	4.36 Gals. (16.5 L)



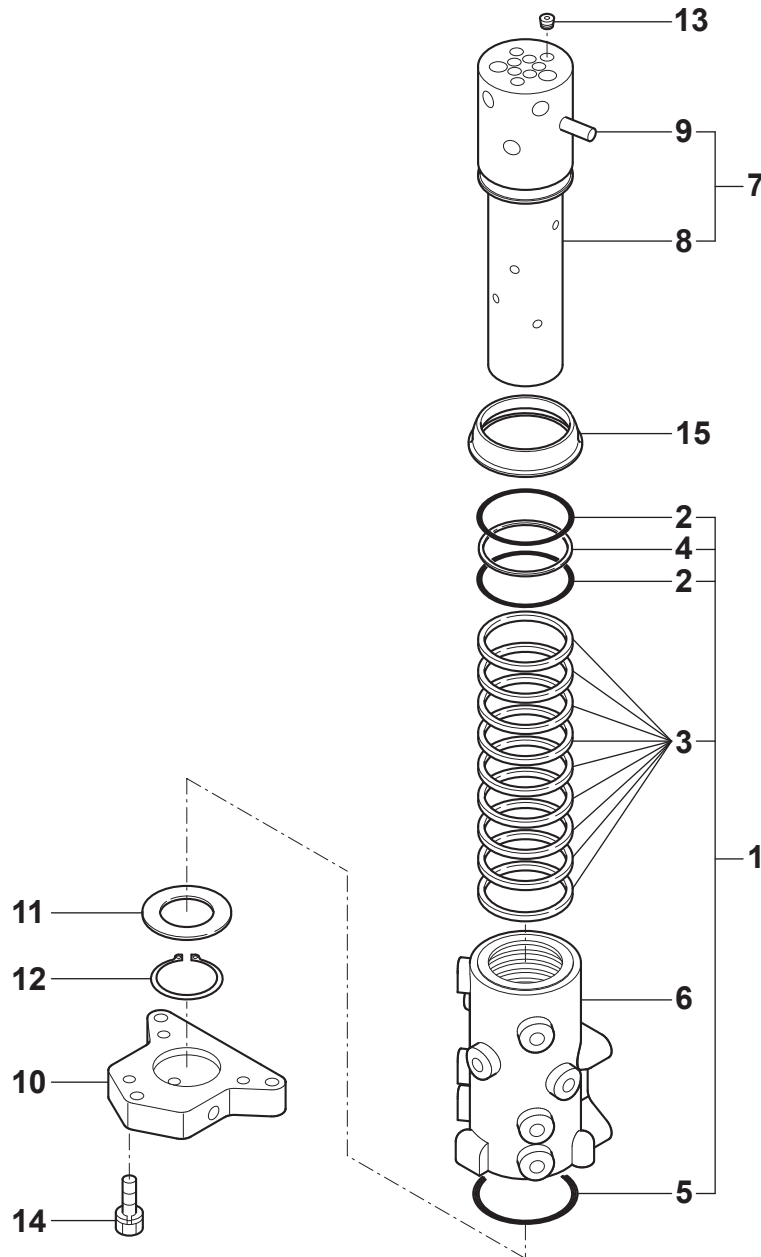
027047-00B

7. ADJUSTMENT AND REPAIR

7-5-5 Disassembly and Reassembly of Swivel Joint

1) Structure and Component Parts

The swivel joint is used to prevent the hydraulic piping from twisting when the upperstructure swings. The swivel joint consists of a shaft, a hub, a seal kit and other parts. The shaft and hub have holes and grooves, and the oil which flows in from the port of the shaft, passing through the hub groove, is fed to the actuators of the undercarriage.



027048-00X

No.	Part	Q'ty	No.	Part	Q'ty
1	Swivel seal kit	1	9	Dowel pin 10×25	1
2	O-ring 55.76×5.7	2	10	Swivel flange	1
3	Swivel seal	9	11	Thrust washer 40×66×2.5	1
4	Back-up ring EL	1	12	External snap ring C40	1
5	O-ring 1A G70.0 NBR	1	13	Screw plug R (PT) 1/8	8
6	Swivel hub	1	14	Bolt (with spring washer) 8×35	3
7	Swivel shaft	1	15	Dust cover	1
8	Swivel shaft	1			

7. ADJUSTMENT AND REPAIR

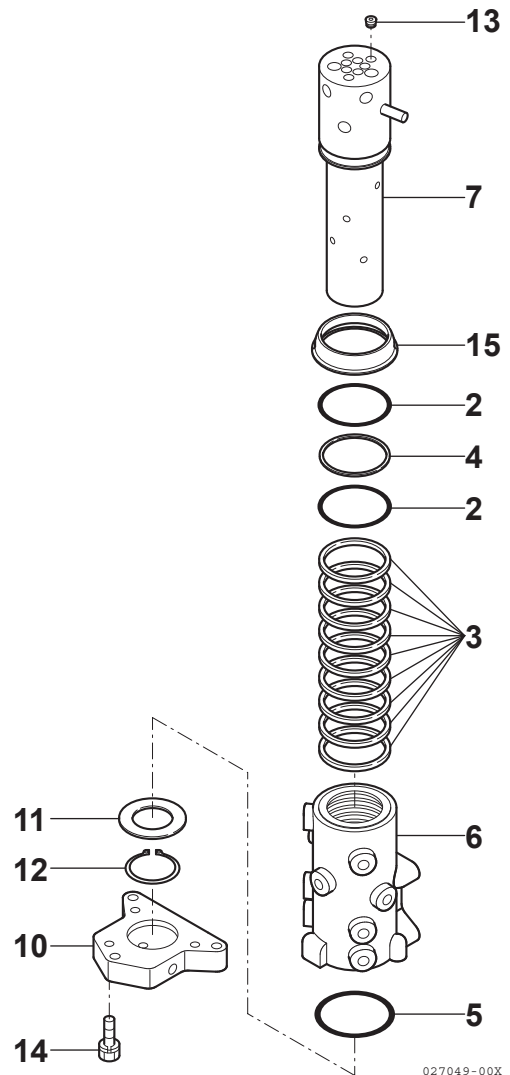
2) Disassembly and Reassembly of Swivel Joint

• Disassembly

- (1) Remove the bolts **14**.
- (2) Remove the swivel flange **10** and the O-ring **5**.
- (3) Remove the external snap ring C **12** and the thrust washer **11** from the swivel shaft **7**.
- (4) Pull the swivel shaft **7** out of the swivel hub **6** and remove the O-ring **2** and the dust cover **15**.
- (5) Remove the swivel seals **3**, O-ring **2** and back-up ring **4** from the swivel hub **6**.

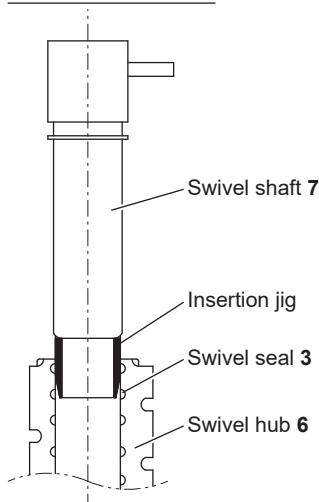
• Reassembly

- (1) Install the swivel seals **3**, O-ring **2** and back-up ring **4** into the swivel hub **6**.
- (2) Apply multipurpose grease to the inner surface of the swivel hub **6**.
- (3) Install the O-ring **2** and the dust cover **15** onto the swivel shaft **7** and insert the shaft into the swivel hub **6** slowly.
 - Use a jig (E-004 B).
 - Apply multipurpose grease to the outer surface of the shaft.
- (4) Install the thrust washer **11** and the external snap ring C **12** to the swivel shaft **7**.
- (5) Install the O-ring **5** and then the swivel flange **10** on the swivel hub **6**, and install and tighten and bolts **14**.



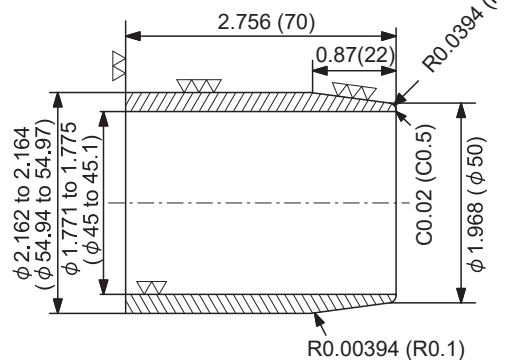
027049-00X

Insertion of shaft



Shaft insertion jig No.E-004B

Unit : in. (mm)



Note : The ▽▽▽ areas must be hard chromium plated.

027050-00E

7. ADJUSTMENT AND REPAIR

3) Precautions for Handling and Storing Seals

- (1) Seals are packed in the package that is suitable for storage.
- (2) Do not leave seals outside the packages.
- (3) For storing, put seals in the packages and place them in a dark and cool place (in a parts box or cardboard box) under 104°F (40°C) to avoid direct sunlight. If the storage condition is proper, they can be stored for four or five years.
- (4) Do not put anything on swivel seals, or they may be distorted.

4) How to Fit Seals (for Inner Side)

• Fitting

- (1) It is not abnormal to have a clearance (within approx. 3% of the shaft diameter) between the seal ring and the back ring.
- (2) Check that there is no failure including distortion and scarring in the seal ring and the back ring prior to installation.
- (3) Use lithium soap base multipurpose grease (cone penetration No.1 or No.2).
- (4) To fit a swivel seal, make it heart-shaped as shown in the figures at the right and press one end of it into the groove. Then, fit the whole swivel seal, pressing it with your finger (Figs. 1 and 2).
- (5) When using a jig for fitting swivel seals, use a jig with round edges to avoid damaging the seals. (Fig. 3)
- (6) If the swivel seal is distorted after fitted, correct the distortion with a jig before assembly. (Fig. 4)

5) Repair and Replacement of Parts

- (1) Disassemble and reassemble the swivel joint at a place free from dust.
- (2) Completely remove the contamination, foreign matter (sludge), etc. from the removed parts.
- (3) Check the seal surface of the shaft for flaws and nicks.
Repair or replace the shaft when necessary.
- (4) Replace the shaft if it is worn.
- (5) Replace all seals in reassembly.

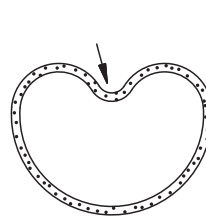
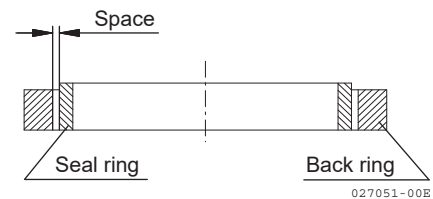


Fig. 1

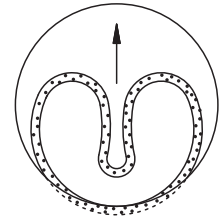


Fig. 2

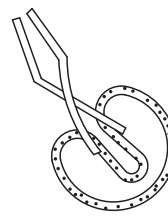


Fig. 3

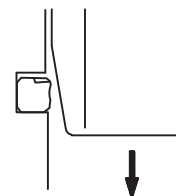
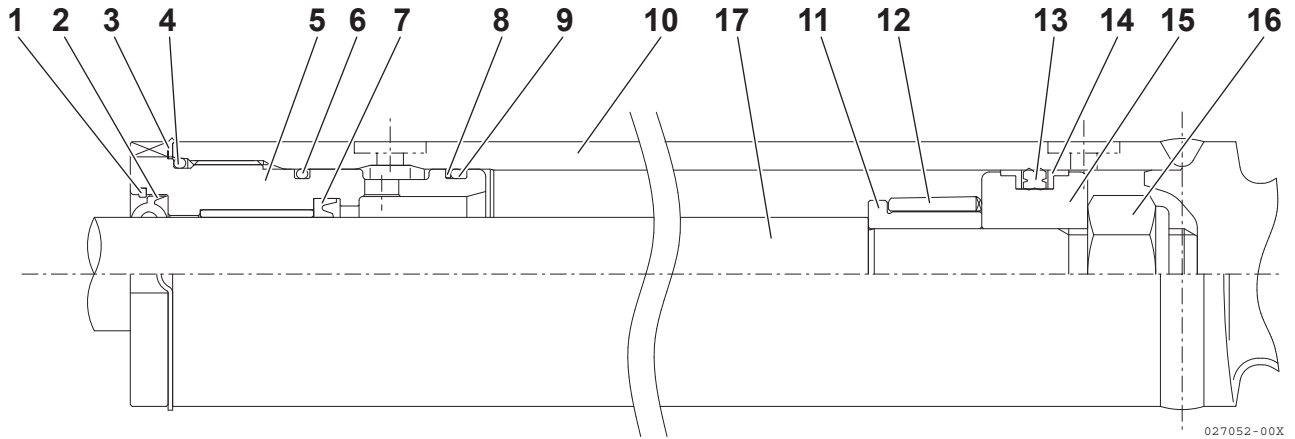


Fig. 4

7. ADJUSTMENT AND REPAIR

7-5-6 Disassembly and Reassembly of Hydraulic Cylinders

1) Sectional View and Component Parts



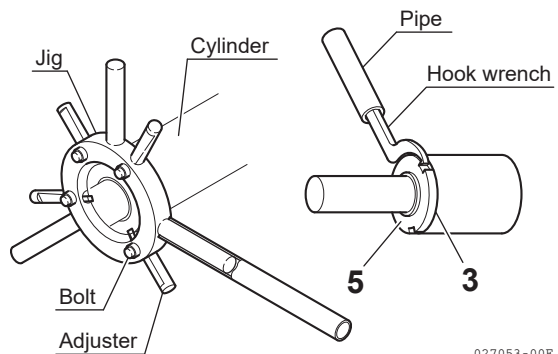
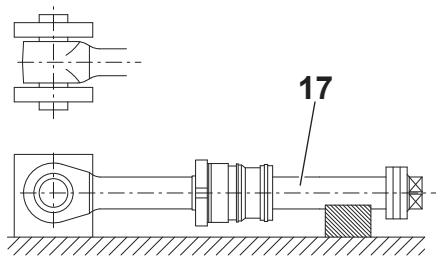
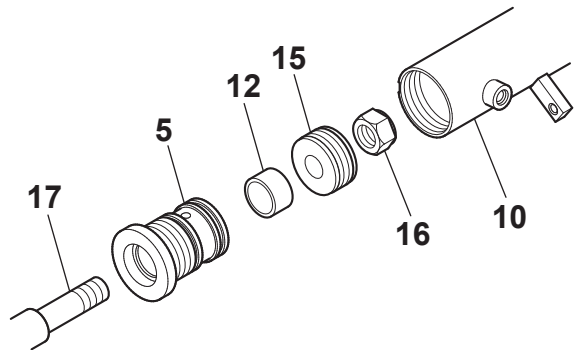
No.	Part	Boom cylinder	Arm cylinder	Bucket cylinder	Boom swing cylinder	Blade cylinder	Track gauge change cylinder
1	spring ring	○	—	—	—	—	—
2	Dust seal	○	○	○	○	○	○
3	Lock washer	—	—	—	—	—	—
4	O-ring	○	○	○	○	○	○
5	Head	○	○	○	○	○	○
6	O-ring	○	○	○	○	○	○
7	ISI packing	○	○	○	○	○	○
8	Back-up ring	—	—	—	—	—	—
9	O-ring	—	—	—	—	—	—
10	Cylinder tube	○	○	○	○	○	○
11	Cushion collar	—	—	—	—	—	—
12	Cushion plunger	—	—	—	—	—	—
13	RGU packing	○	○	○	○	○	○
14	RWL bearing	○	○	○	○	○	○
15	Piston	○	○	○	○	○	○
16	U-nut	○	○	○	○	○	—
17	Rod	○	○	○	○	○	○
18	Screw	—	—	—	—	—	○

7. ADJUSTMENT AND REPAIR

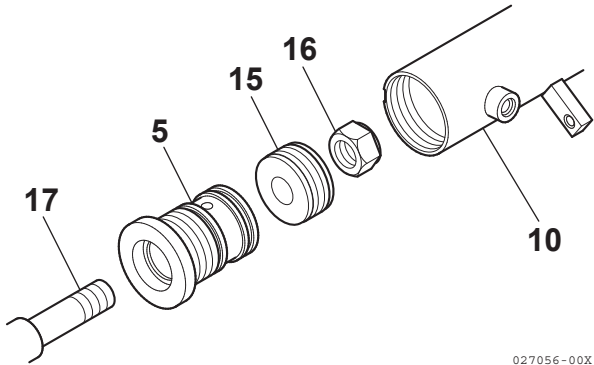
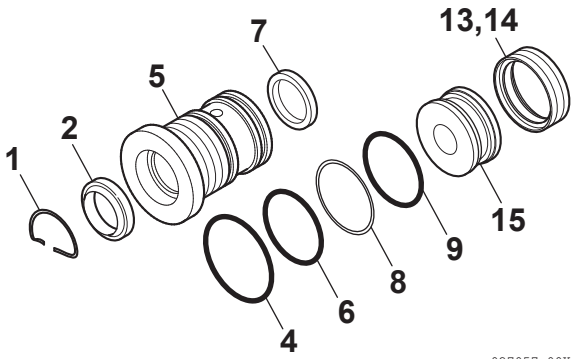
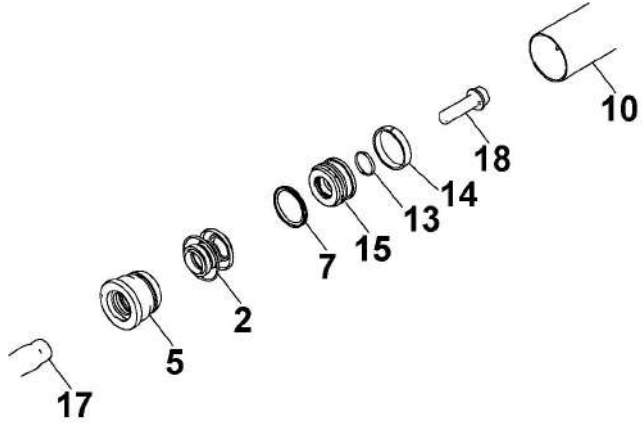
2) Precautions for Disassembly and Reassembly

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

3) Disassembly

Procedure	
(1) Drain the oil from the hydraulic cylinder. (2) Hold the cylinder at the bottom end or using the pin hole at the bottom end, and put the rod side of the cylinder on a block. (3) Raise the pawl of the lock washer 3 on the head 5 and loosen the head 5. Note : Use a hook wrench or a jig to loosen the head 5.	 027053-00E
(4) Pull out the rod assembly 17 from the cylinder tube 10, and then hold the cylinder rod assembly at the rod end or using the pin hole at the rod end.	 Hold cylinder rod assembly 027054-00E
(5) Disassembly of boom cylinder Remove the U-nut 16, and then the piston 15, the cushion plunger 12, and the head 5 in that order.	 027055-00X

7. ADJUSTMENT AND REPAIR

Procedure	
(6) Disassembly of bucket, arm, boom swing, and blade cylinders Remove the U-nut 16, and then the piston 15 and the head 5 in that order.	 027056-00X
(7) Remove the O-rings 4, 6 and 9, the spring ring 1 the dust seal 2, the ISI packing 7, the RGU packing 14 and the PWL bearing 14. Note : • Use a sharp tool to raise each of the O-rings, the ISI packing, the RGU packing or the PWL bearing, and then insert a spatula to remove it. • The spring ring 1 is only for the boom cylinder.	 027057-00X
(8) Disassembly of track gauge change cylinders Remove the screw 18 from the rod 17, and then the piston 15 and the head 5 in that order. (9) Remove the O-ring 13, the piston seal 7 the bearing 14, the bearing 2 from the rod guide 5. Note : • Use Loctite 270 to glue the screw 18 to the rod 17. • Use an hammer to engage the rod guide 5 in the cylinder 10.	

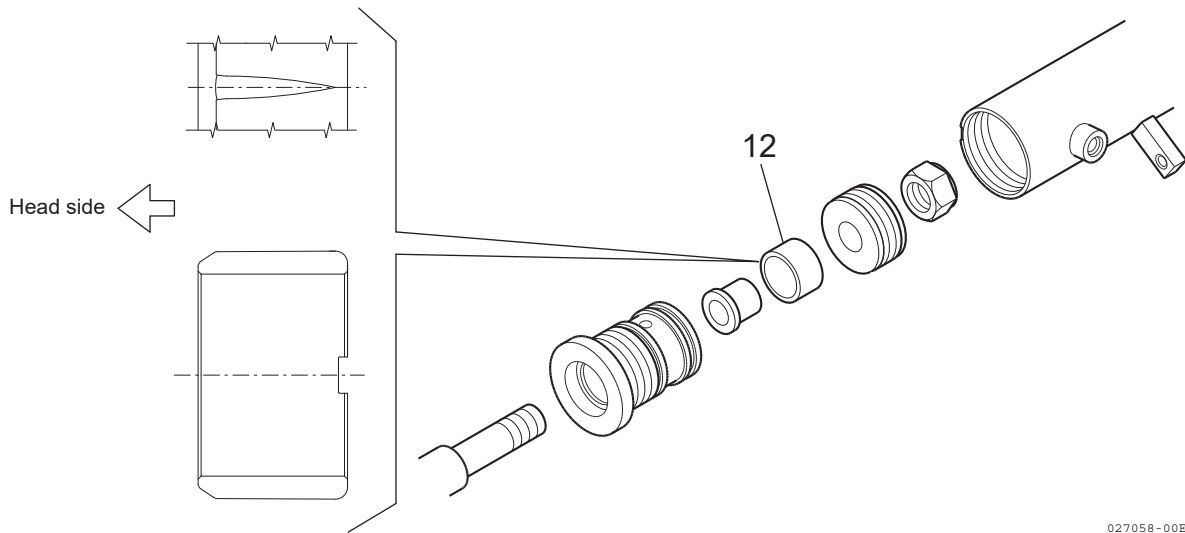
7. ADJUSTMENT AND REPAIR

4) Reassembly

Reassemble the hydraulic cylinder in the reverse order of the disassembly procedure.

Notes :

- Take care not to install the cushion plunger **12** of the boom cylinder in the wrong direction.
- Replace the O-rings, packings and seals with new ones.



U-nut Size end Tightening Torque

No.	Cylinder	U-nut size	U-nut tightening torque	Adhesive
1	Boom	M24	152.7 to 186.6 ft•lbf (207 to 253 N•m)	Loctite L270
2	Arm	M22	86.3 to 105.5 ft•lbf (117 to 143 N•m)	
3	Bucket	M22	86.3 to 105.5 ft•lbf (117 to 143 N•m)	
4	Boom swing	M27	199.1 to 243.4 ft•lbf (270 to 330 N•m)	
5	Blade	M24	152.7 to 186.6 ft•lbf (207 to 253 N•m)	

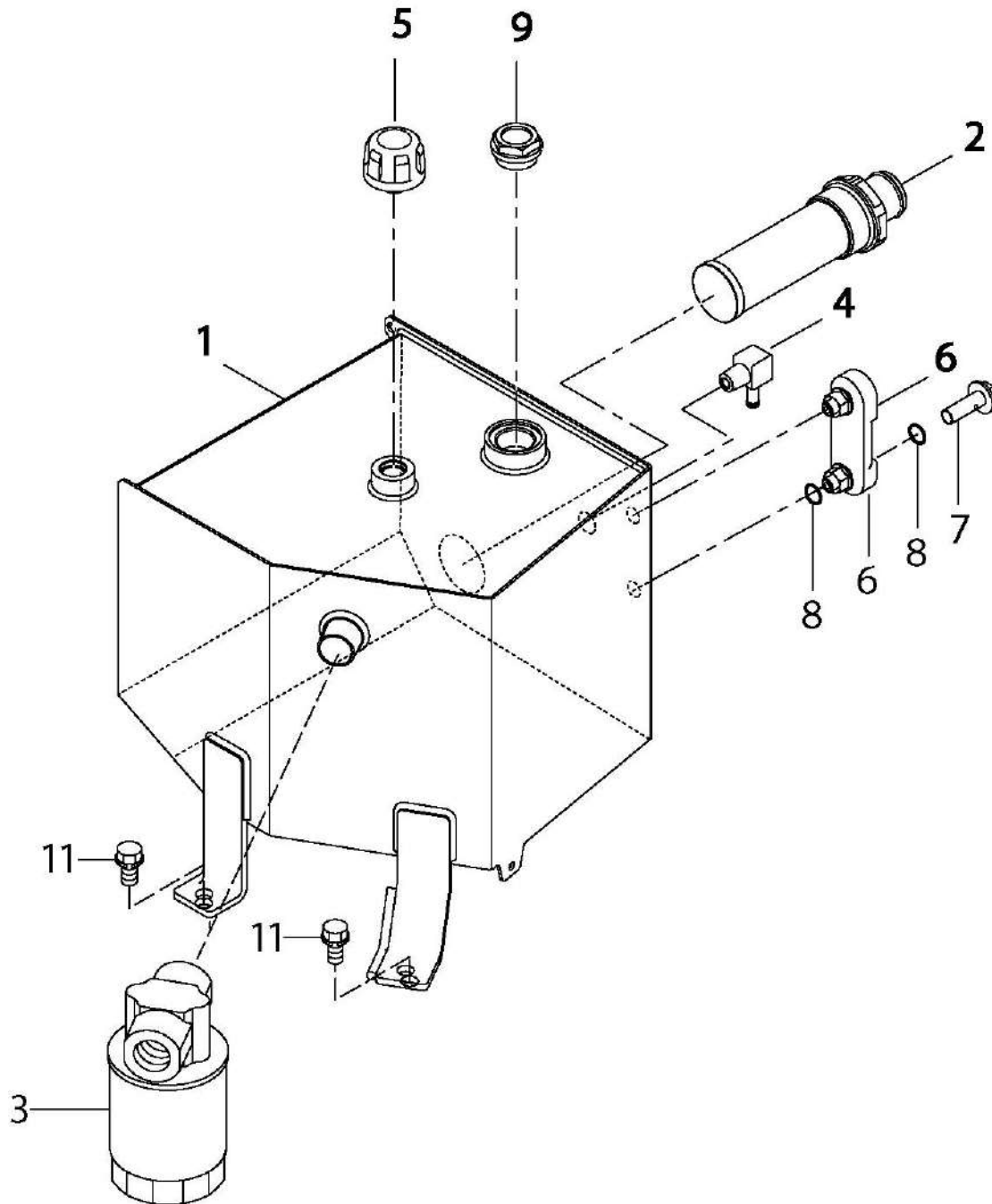
U-screw Size end Tightening Torque

No.	Cylinder	U-screw size	U-screw tightening torque	Adhesive
1	Track gauge change	M16	159.3 to 194.7 ft•lbf (216 to 264 N•m)	

7. ADJUSTMENT AND REPAIR

7-5-7 Hydraulic Oil Tank

1. Structure and Component Parts

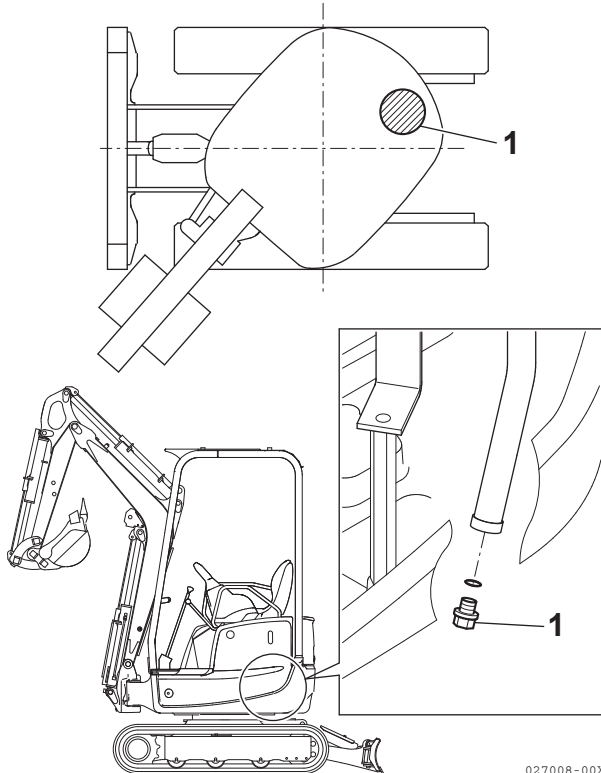


No.	Part	Q'ty	No.	Part	Q'ty	No.	Part	Q'ty
1	Reservoir tank	1	6	Oil level gauge	1	11	Bolt (spring 12 x 25)	3
2	Strainer	1	7	Bolt M10 (oil)	2			
3	Return filter	1	8	O-ring	4			
4	Elbow	1	9	Plug	1			
5	Reservoir cap	1	10	O-ring	1			

7. ADJUSTMENT AND REPAIR

2. Removal and Reinstallation of Hydraulic Oil Tank

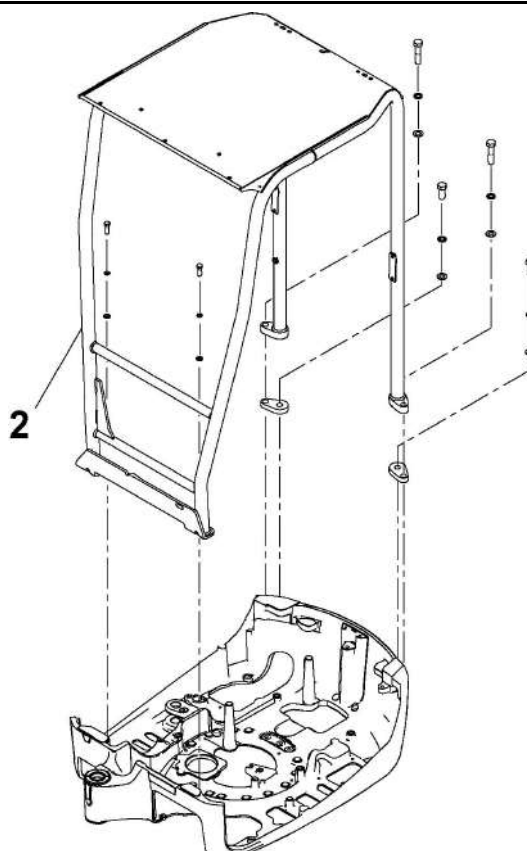
1) Removal

Procedure			
(1) Swing the upperstructure so that the drain plug 1 of the hydraulic oil tank is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine. (2) Remove the drain plug 1 from the hydraulic oil tank and drain the hydraulic oil. <table border="1"><tr><td>Hydraulic oil quantity</td><td>4.36 Gals. (16.5L)</td></tr></table>	Hydraulic oil quantity	4.36 Gals. (16.5L)	 027008-00X
Hydraulic oil quantity	4.36 Gals. (16.5L)		

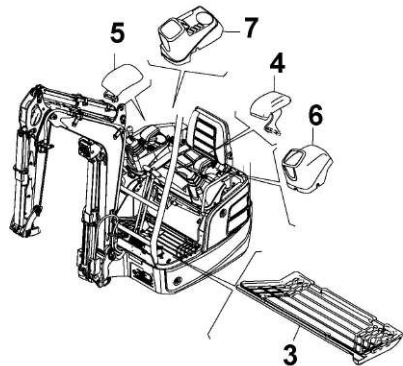
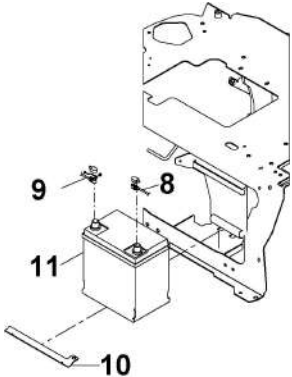
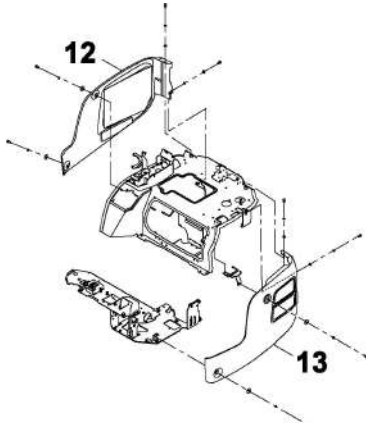
(3) Remove the canopy **2**.

Note :

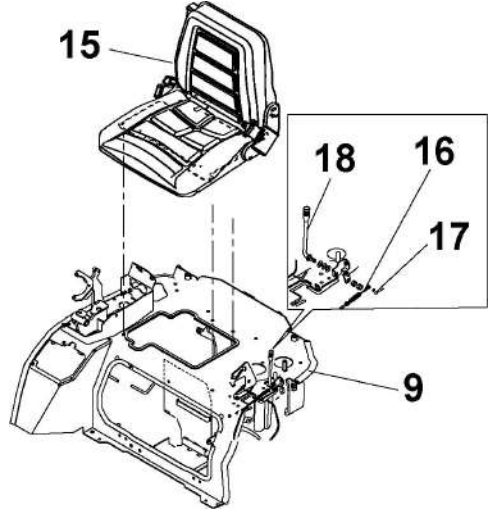
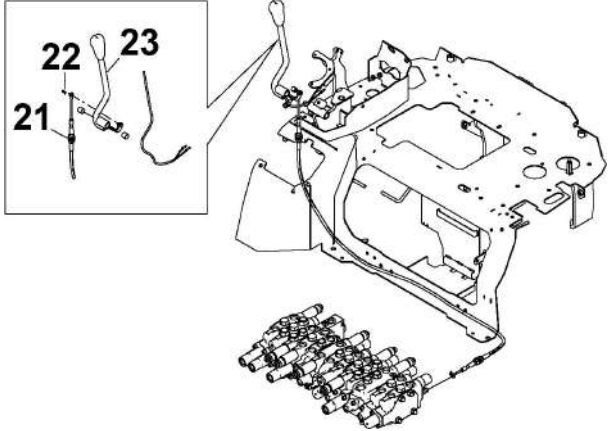
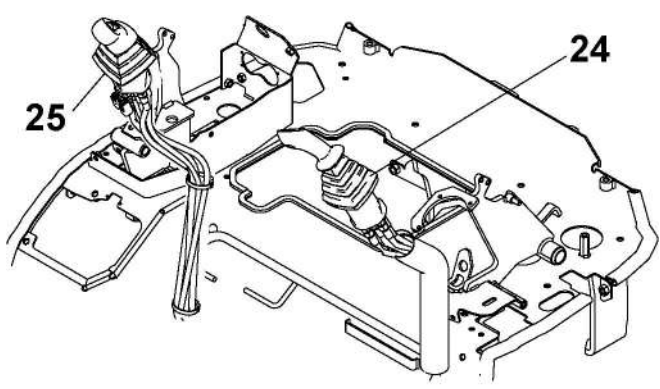
Take care that the harnesses and clamps do not catch on any other parts when lifting up the operator's seat mount.



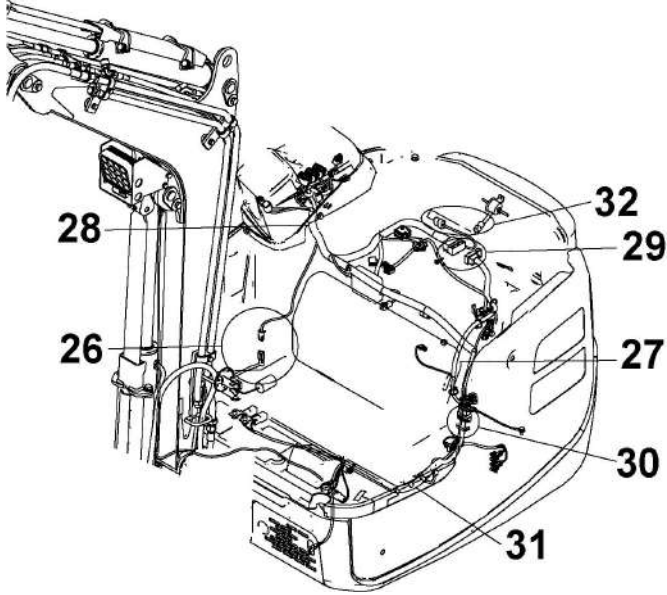
7. ADJUSTMENT AND REPAIR

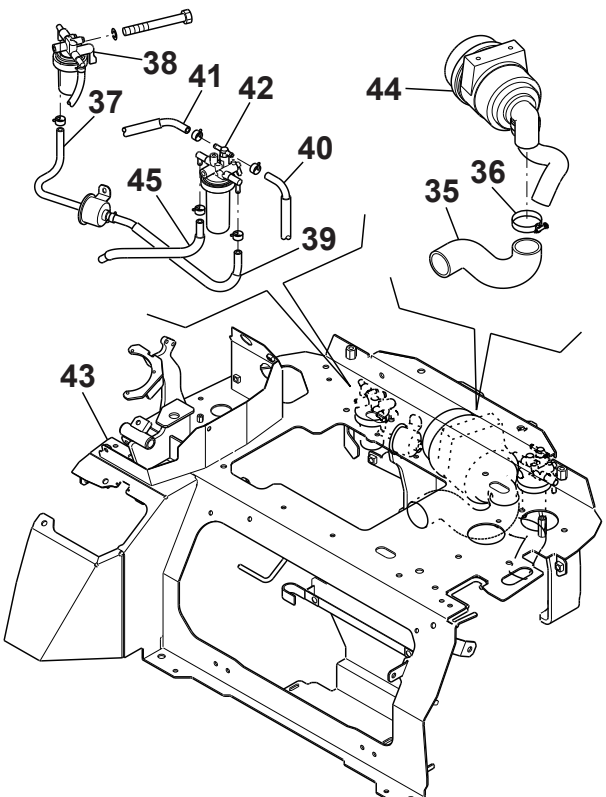
Procedure	
(4) Remove the step 3, the armrest L 4, the armrest R 5 the panel L 6, and the panel R 7. (5) Then disconnect the harness connectors of the left and right Joysticks.	
(6) Disconnect the battery cable (negative) 8 and the battery cable (positive) 9 and remove the battery clamp 10, and then remove the battery 11.	
(7) Remove the cover R 12 and the cover L 13.	

7. ADJUSTMENT AND REPAIR

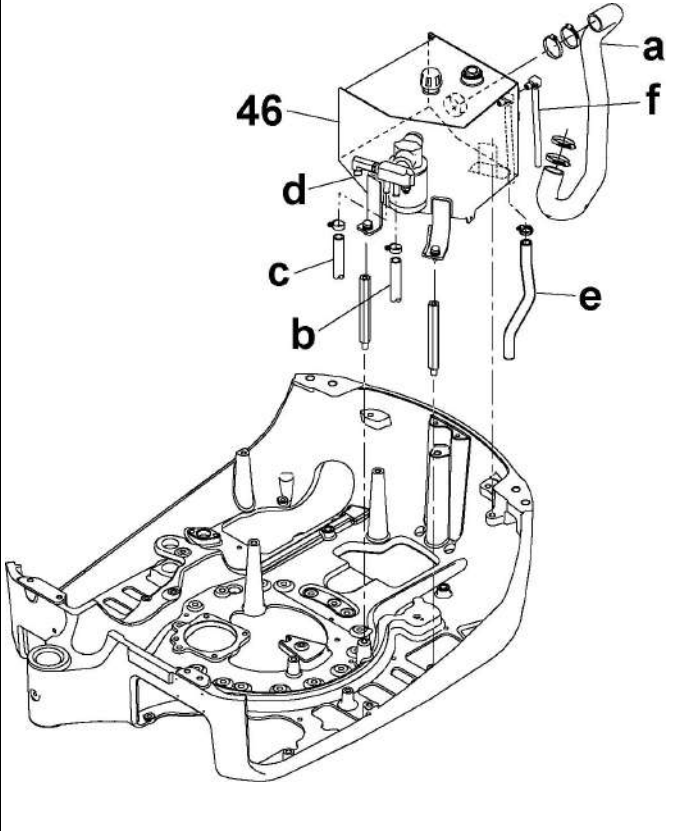
Procedure	
(9) Unplug the seat harness and remove the operator's seat with the operator's seat plate 15. (10) Remove the snap pin 17 and disconnect the accelerator cable 16 from the accelerator lever 18.	 The diagram illustrates the removal of the operator's seat and the disconnection of the accelerator cable. The main view shows the seat assembly (15) being lifted away from the chassis (9). An inset provides a close-up of the accelerator lever (18) where the snap pin (17) is located, and the accelerator cable (16) is shown being disconnected from the lever.
(11) Remove the snap pin 22 and disconnect the blade cable 21 from the blade lever 23.	 The diagram shows the blade lever (23) and the blade cable (21) being disconnected. An inset shows a close-up of the snap pin (22) that secures the cable to the lever. The main view shows the lever (23) and cable (21) being removed from the chassis.
(12) Remove the pilot valve 24 and 25 in the left and right with the hydraulic hose attached.	 The diagram shows the pilot valves (24 and 25) being removed from the chassis. The valves are shown with their respective hydraulic hoses attached. The main view shows the valves (24 and 25) being removed from the chassis.

7. ADJUSTMENT AND REPAIR

Procedure	
(14) Disconnect the harness 26 from the fuel gauge unit. (15) Disconnect the connecting coupler 29 of the harness A 27 and harness B 28. (16) Disconnect the body coupler 30 of the harness B 28 and harness D 31. (17) Disconnect the fuel pump connector 32.	

(18) Loosen the hose clip 36 on the air cleaner side and remove the air cleaner hose B 35. (19) Remove the water separator 38 from the operator's seat mount 43 and disconnect the fuel hose 37 on the water separator 38 side. (20) Remove the fuel hose 39, 40, 41, 45 on the fuel filter 42 side. (21) Rope the operator's seat mount 43 (with the bonnet and the air cleaner 44) and lift it up, to remove it. Note : Take care that the harnesses and clamps do not catch on any other parts when lifting up the operator's seat mount.	
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7. ADJUSTMENT AND REPAIR

Procedure	
(22) Remove the hoses connected to the reservoir tank 46. a. Suction hose b. Return hose (control valve to reservoir tank) c. Return hose (control valve to reservoir tank) d. Return hose (PTO1) e. Drain hose f. Drain hose (23) Remove the reservoir tank 46.	 The diagram shows an exploded view of the reservoir tank assembly. At the top is the reservoir tank, labeled 46. Below it are various hoses and components labeled with letters: a (suction hose), b (return hose from control valve to tank), c (return hose from control valve to tank), d (return hose from PTO1 to tank), e (drain hose), and f (drain hose). The bottom part of the diagram shows the main hydraulic housing with various ports and internal components. Dashed lines indicate the alignment and removal path of the hoses and the tank itself.

7. ADJUSTMENT AND REPAIR

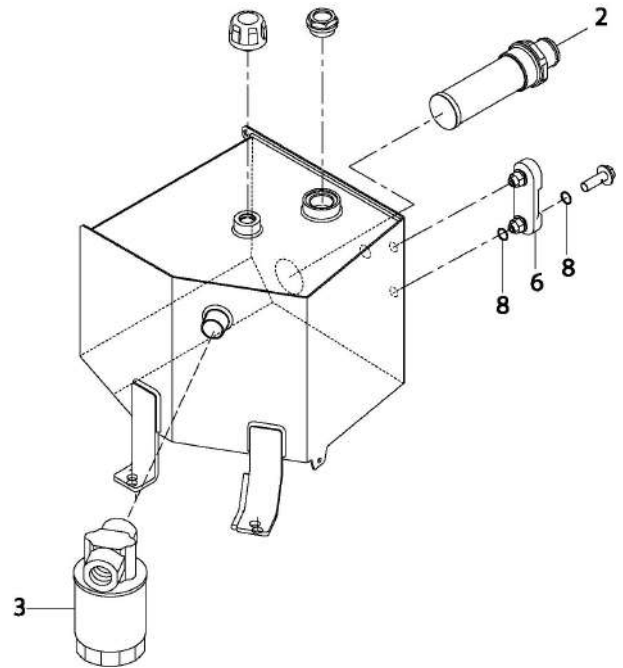
2) Reinstallation

Reinstall the hydraulic oil tank in the reverse order of the removal procedure.

Notes :

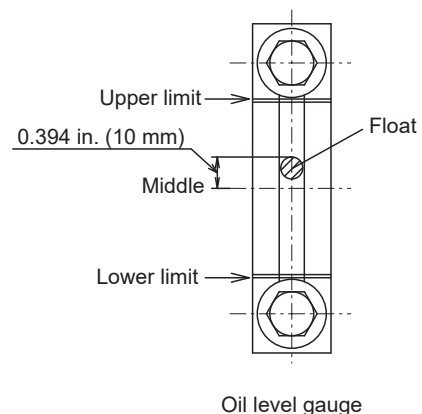
- [1] Completely drain the oil from the hydraulic oil tank and wipe off the deposits from the bottom of the tank.
- [2] Replace the return filter **3** with a new one.
- [3] Clean the strainer **10**. Replace it if the wire gauze is damaged.
- [4] Replace the oil when it reaches the replacement time or it has been deteriorated. If reusing the oil, maintain the oil quality so that it has no impurities.
- [5] Check the O-rings **8** of the oil level gauge **6** for oil leak. If any oil leak is found, replace the O-ring.
- [6] Hydraulic oil to be used :

Type	YANMAR SUPER HYDRO OIL (VG 46 class) or its equivalent
Quantity	4.36 Gals. (16.5 L)



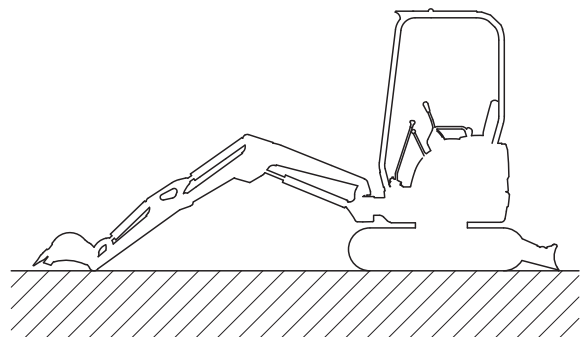
3) Oil Level Check

- (1) Place the machine on firm and flat ground when checking the hydraulic oil level.
- (2) Check the hydraulic oil level with the oil level gauge when the oil temperature is between 32 °F (0°C) and 86°F (30°C).
- (3) The proper oil level is 0.394 in. (10 mm) above the middle of the oil level gauge. The hydraulic oil level increases or decreases depending on the hydraulic oil temperature due to its nature; therefore, check it when the oil is cooled.



4) Machine Position for Oil Level Check

- (1) Retract the bucket and arm cylinder rods fully to lower the bucket to the ground.
- (2) Lower the blade to the ground.



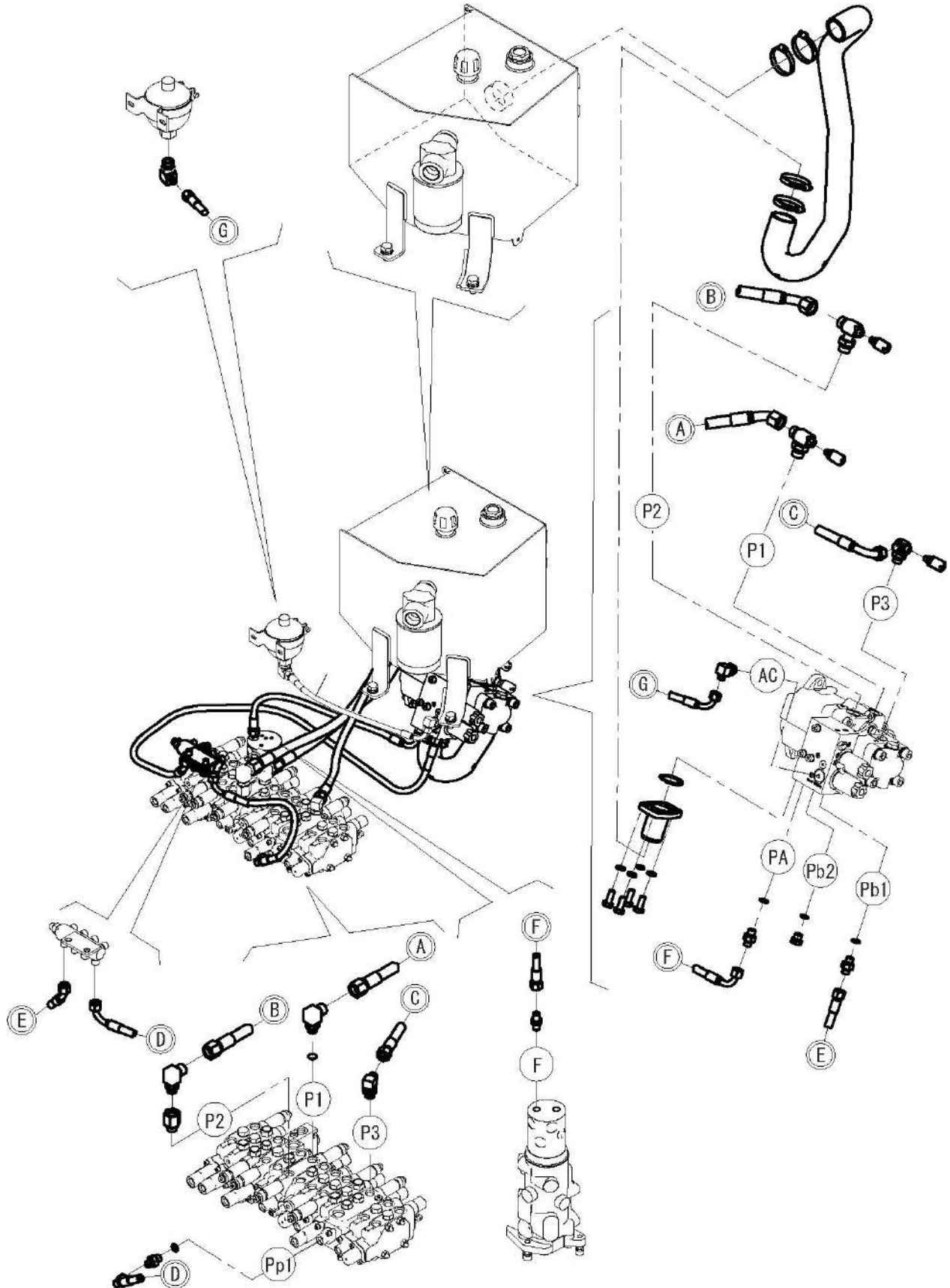
Machine position

7. ADJUSTMENT AND REPAIR

7-5-8 Piping Layout

1) Upperstructure

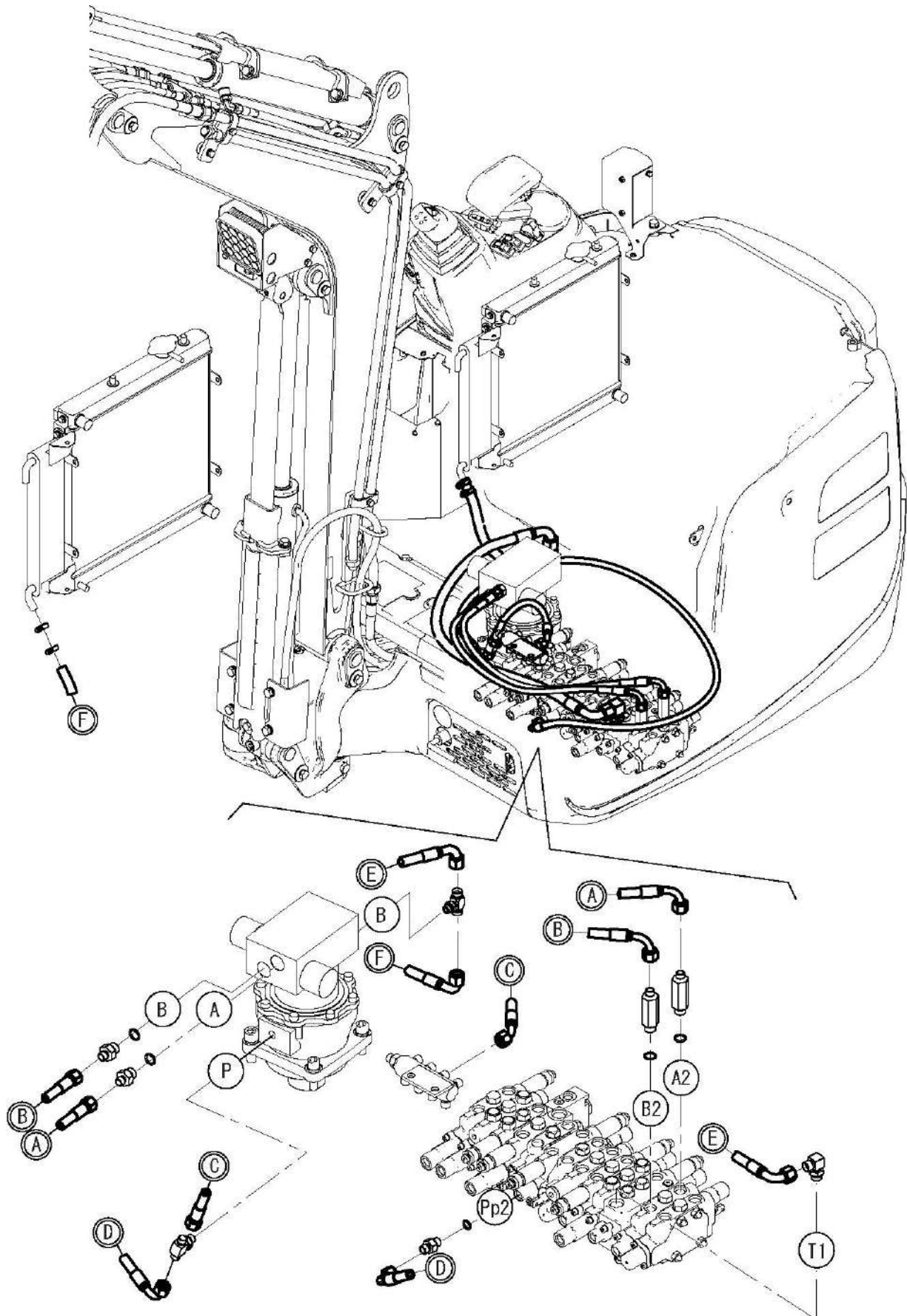
(Hydraulic oil tank → Hydraulic pump → Control valve)



7. ADJUSTMENT AND REPAIR

2) Swing motor

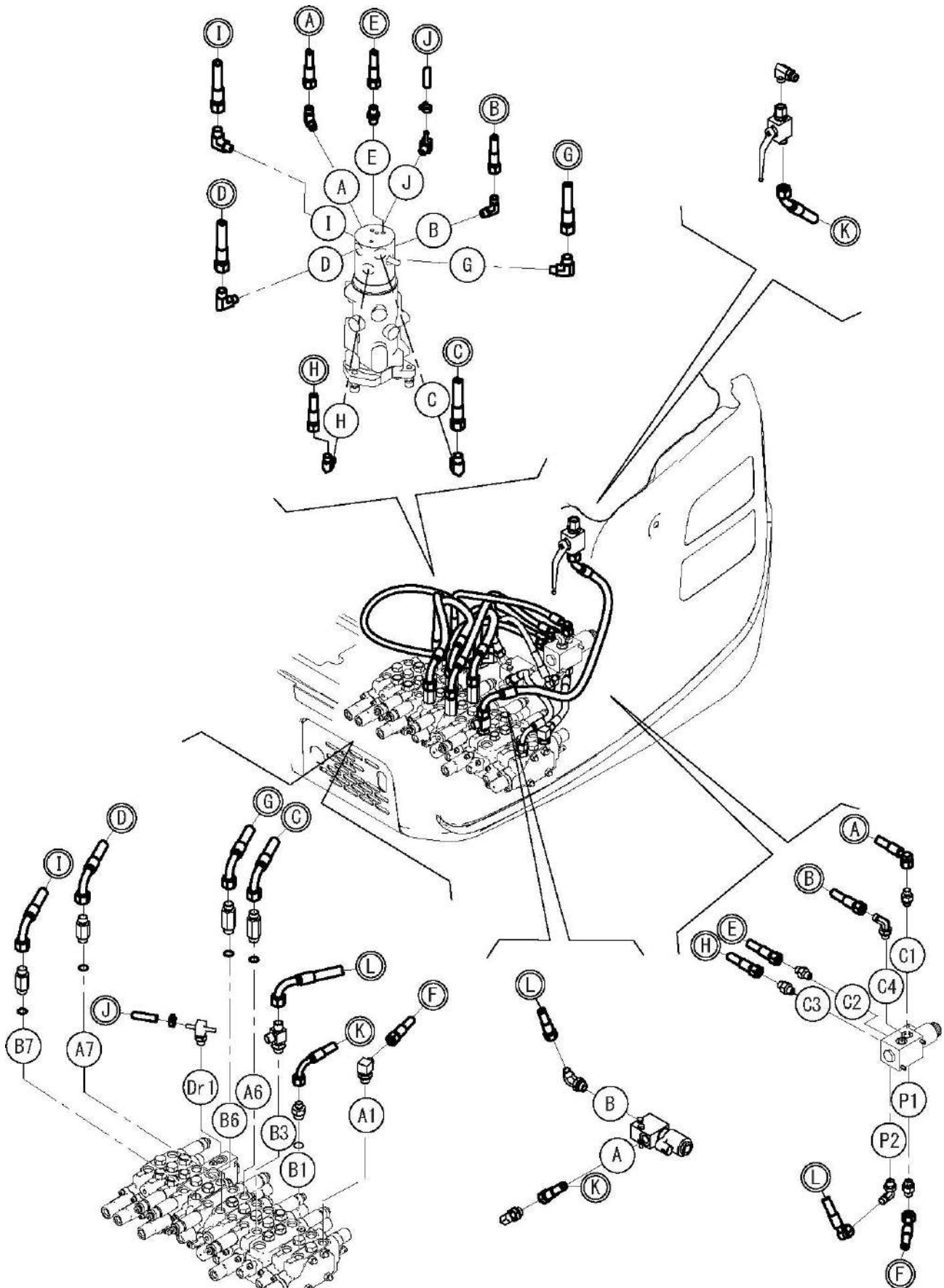
(Control valve $\longleftrightarrow$ Swing motor)



7. ADJUSTMENT AND REPAIR

3) Swivel joint

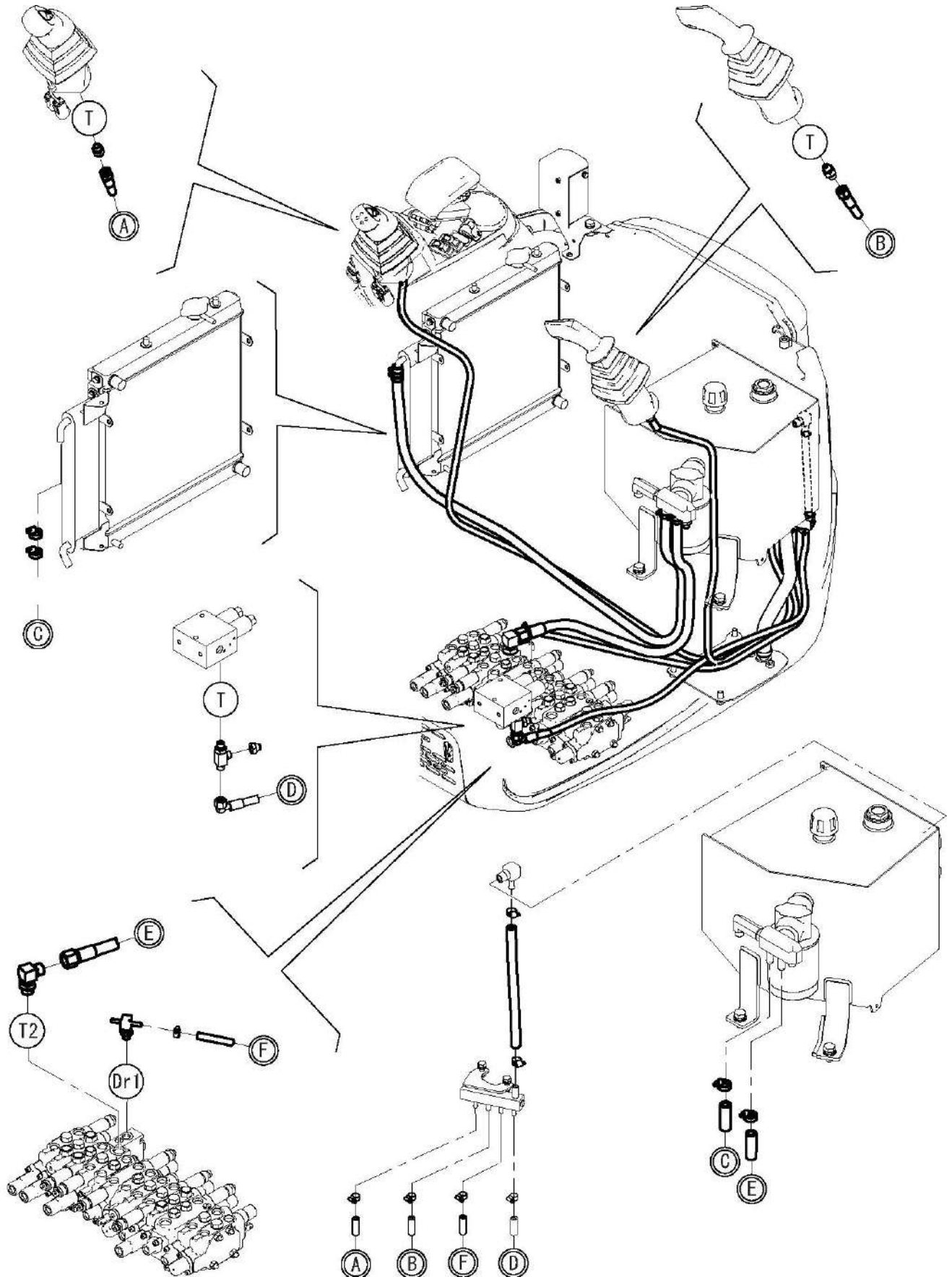
(Control valve → Selector valve → Swivel joint)



7. ADJUSTMENT AND REPAIR

4) Return lines

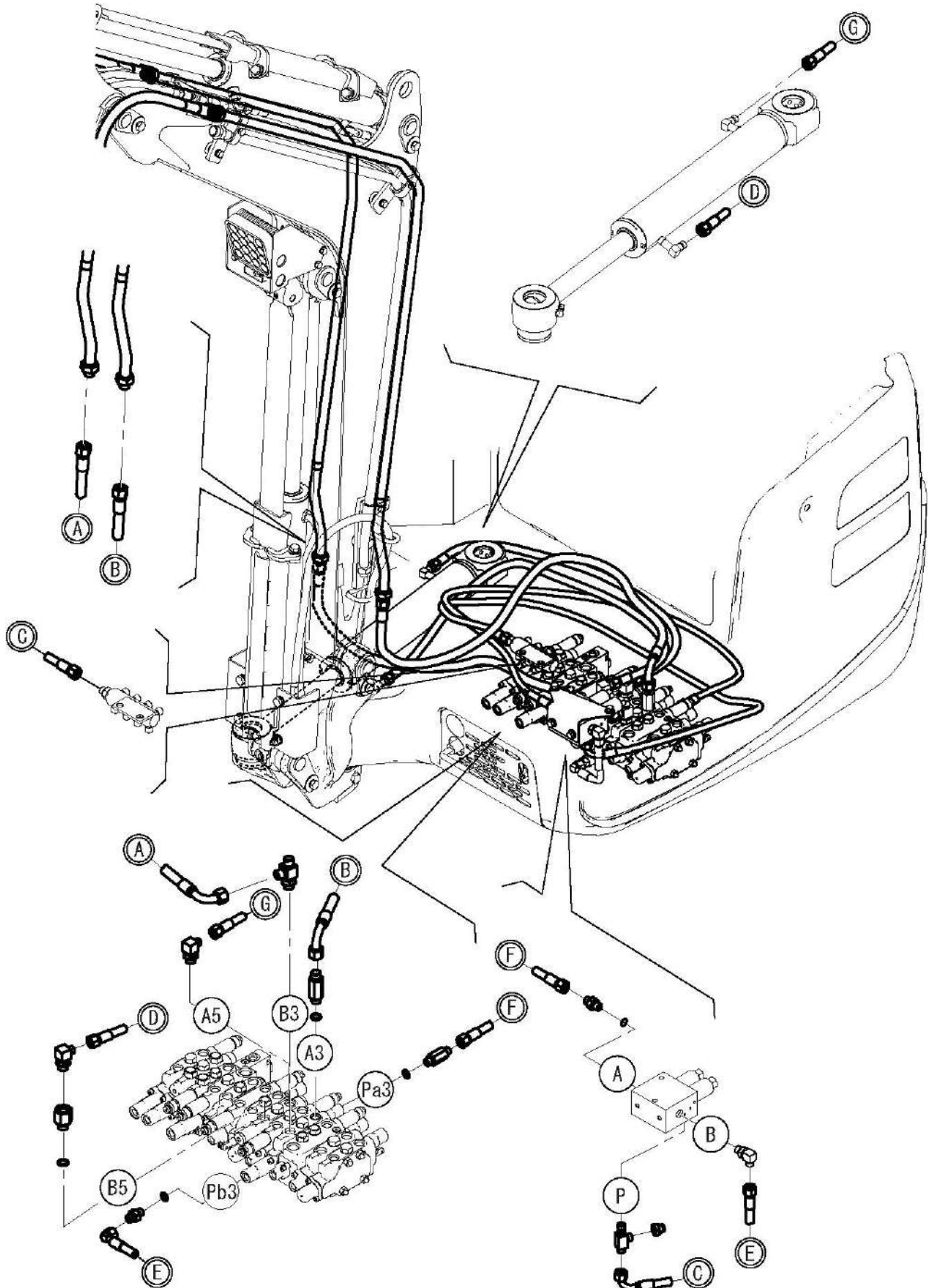
(Joystick, PTO valve, Control valve, → Hydraulic oil tank)



7. ADJUSTMENT AND REPAIR

5) PTO/Boom swing

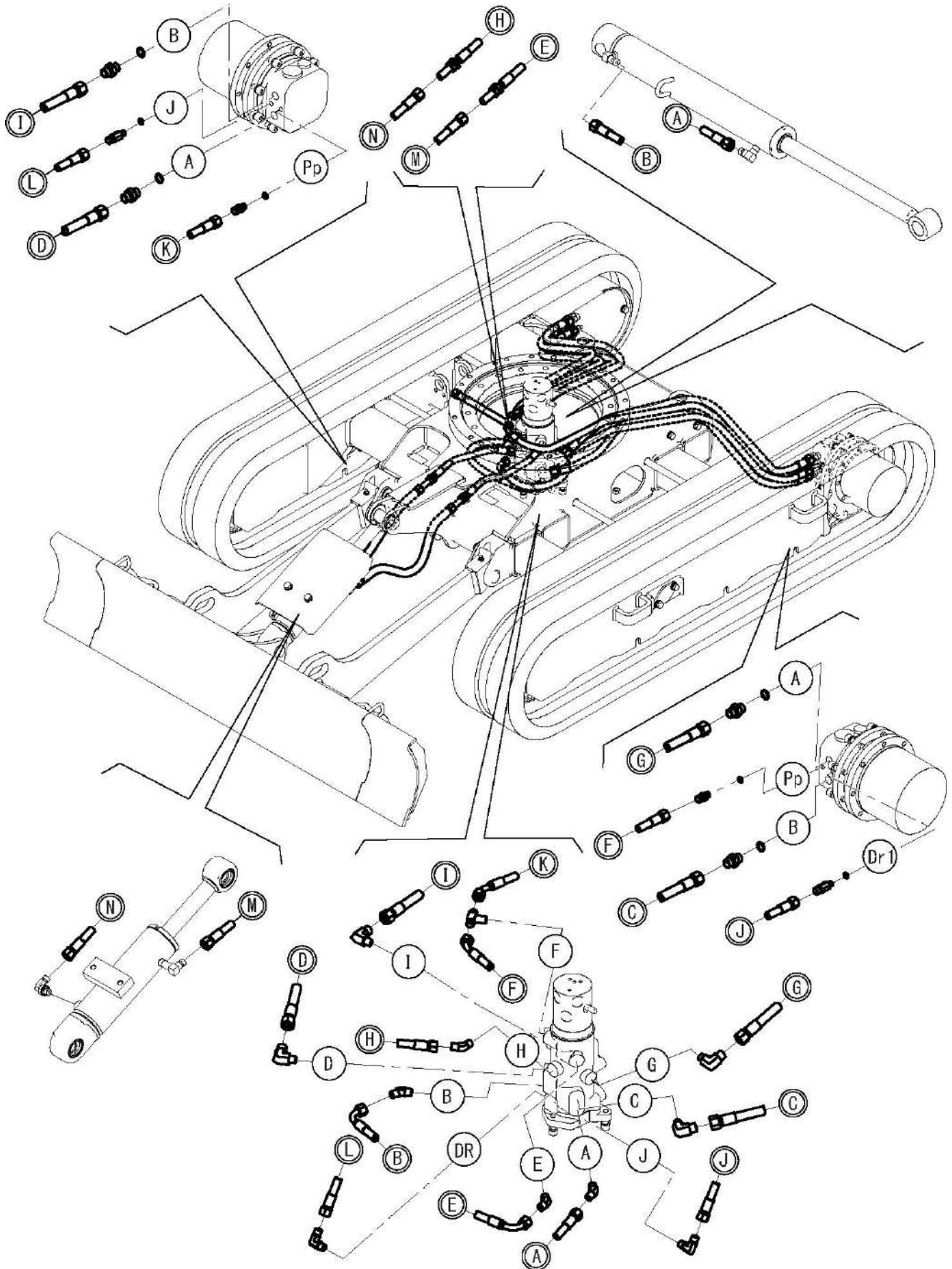
(Boom swing cylinder, PTO circuit, PTO valve → Control valve)



7. ADJUSTMENT AND REPAIR

6) Lower structure

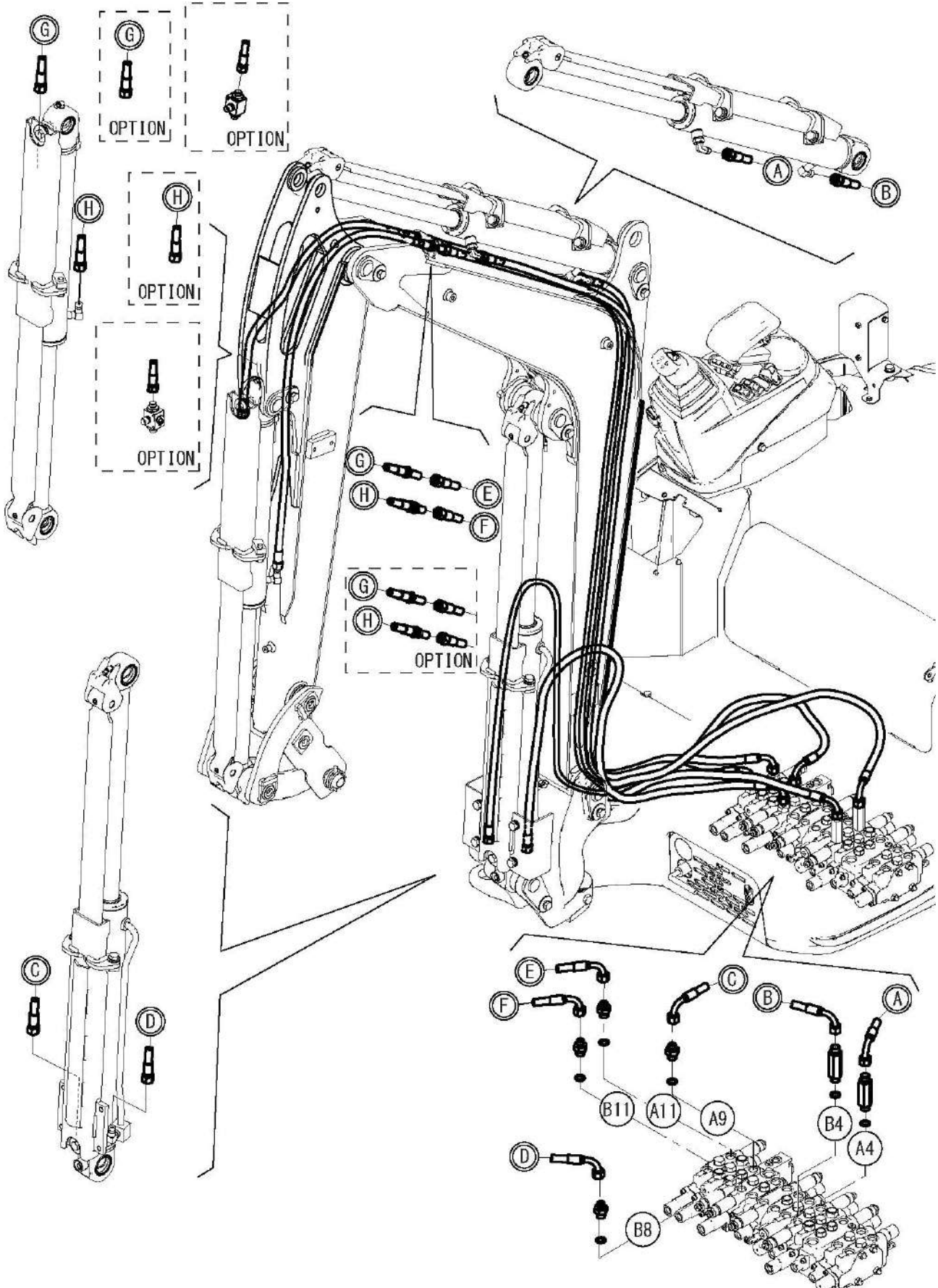
(Swivel joint→ Travel motors, Track gauge cylinder, Blade cylinder)



7. ADJUSTMENT AND REPAIR

7) Kinematics

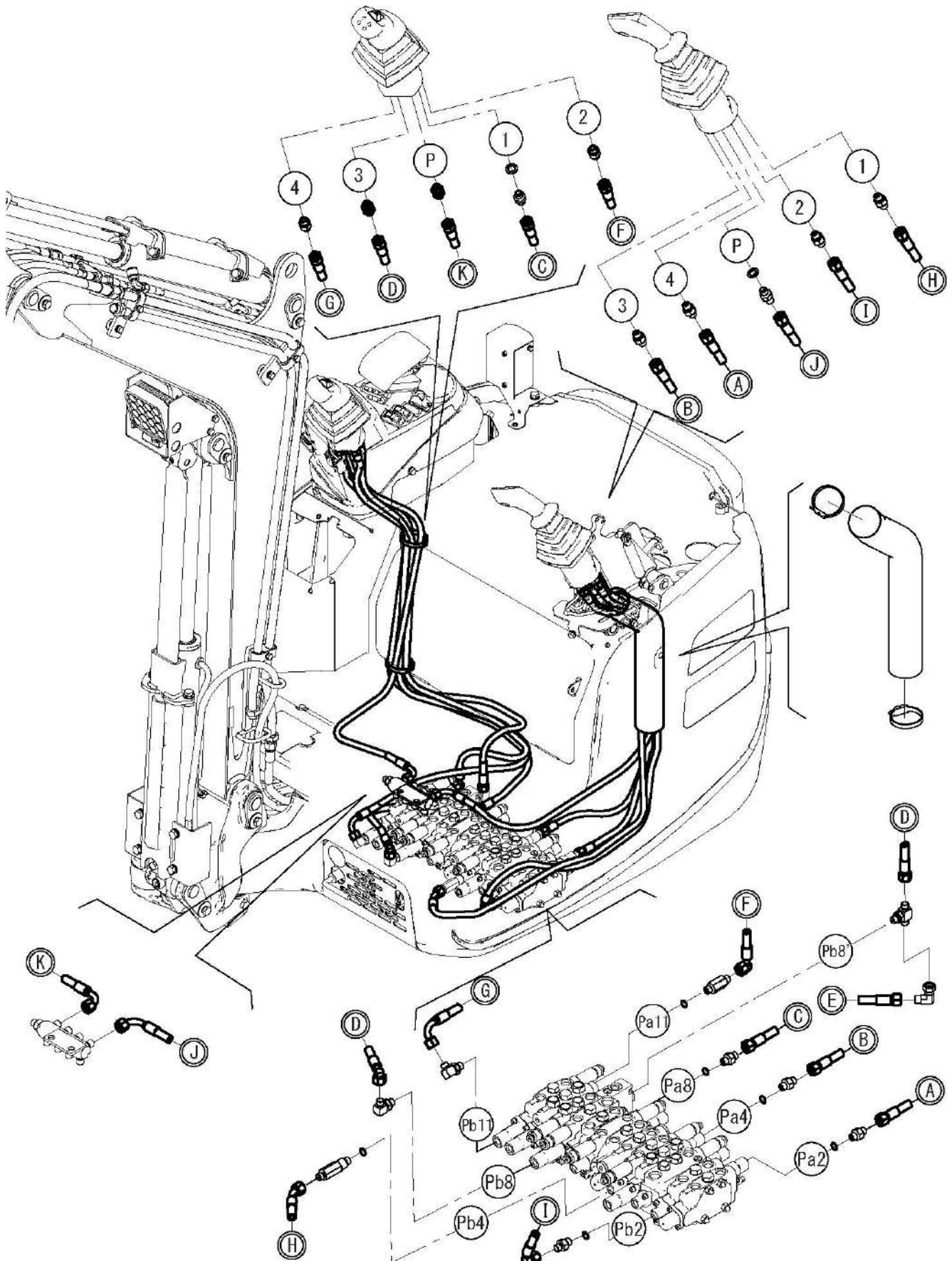
(Control valve → Bucket cylinder, Arm cylinder, Boom cylinder)



7. ADJUSTMENT AND REPAIR

8) Control levers

(Joysticks → Control valve)



7. ADJUSTMENT AND REPAIR

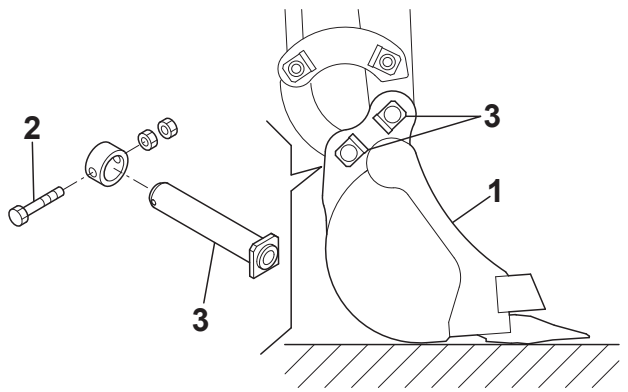
7-6 Implement

7-6-1 Removal and Reinstallation of Implement

Notes :

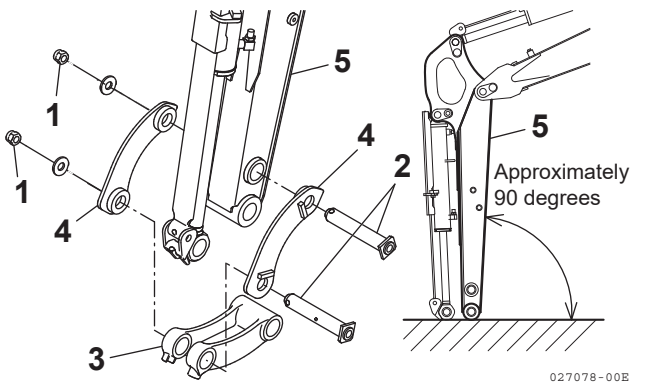
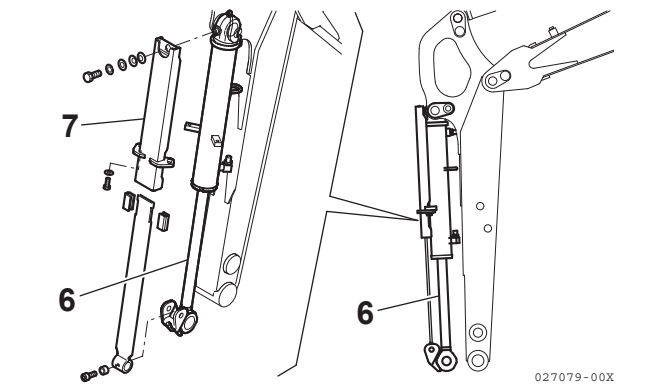
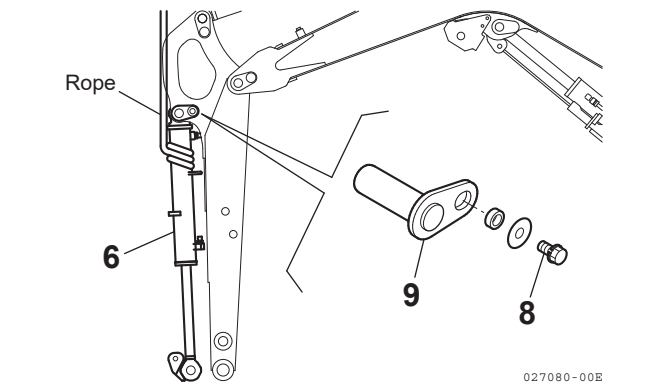
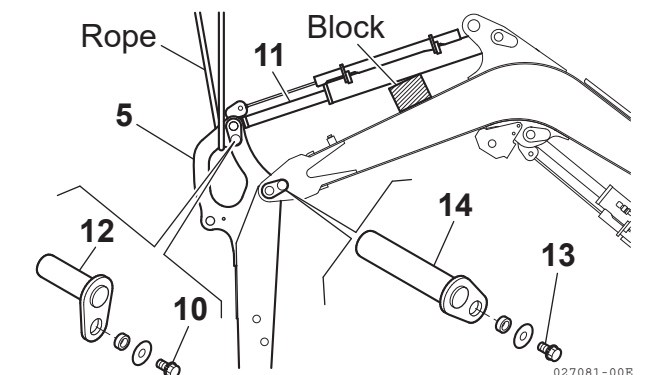
- When removing a pin, check the number of shims installed and their positions.
- When removing a hose, put a plug into the hose connection port to keep the oil from flowing out.

1) Removal of Bucket

Procedure	
(1) Lower the bucket 1 to the ground with its back face down. (2) Remove the bolts 2 (M10) and remove the pins 3. (3) Remove the bucket 1.	

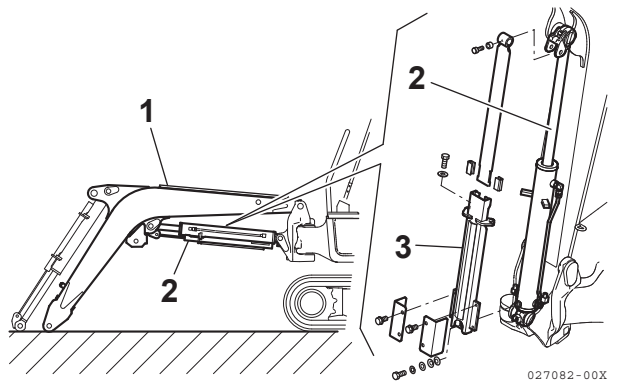
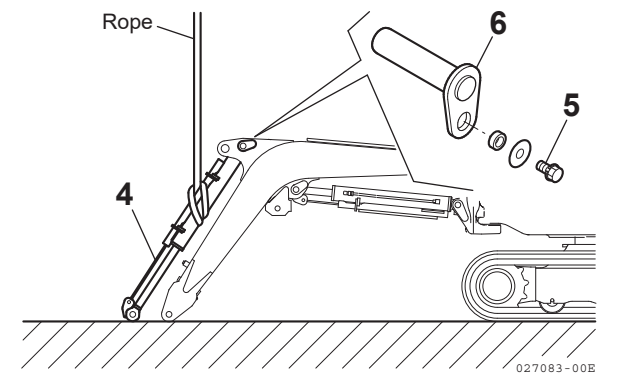
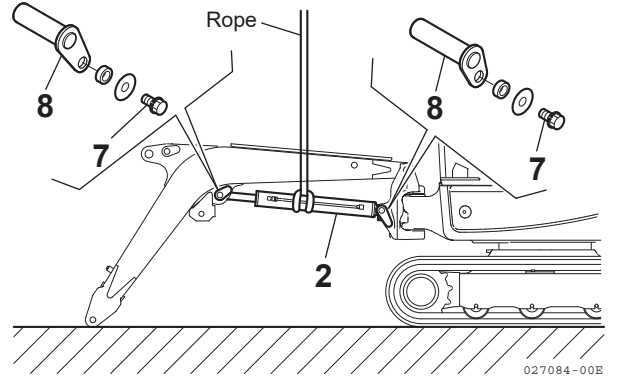
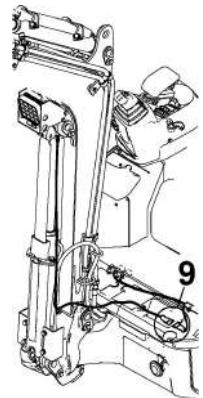
7. ADJUSTMENT AND REPAIR

2) Removal of Arm

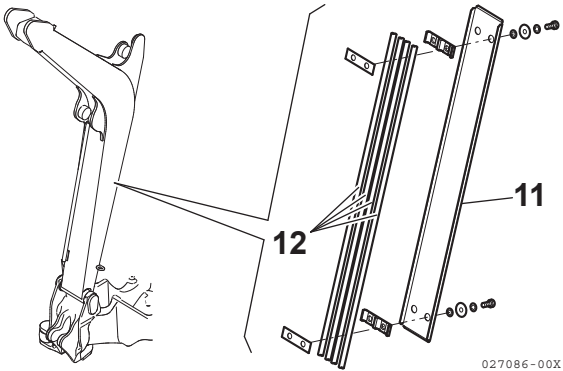
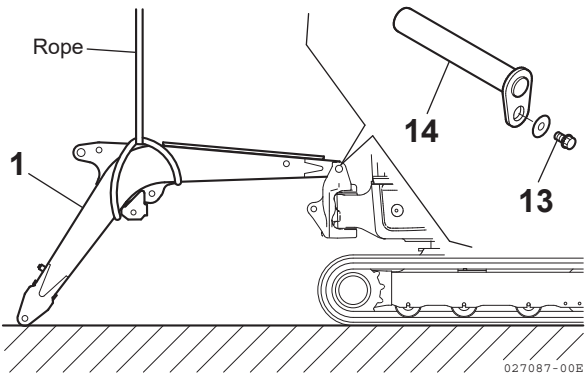
Procedure	
(1) Remove the bucket. (2) Remove the nuts 1 (M16) and pull out the pins 2. Then remove the bucket link 3 and the bucket arms 4. (3) Lightly place the top end of the arm 5 on the ground perpendicularly to the ground.	 027078-00E
(4) Remove the thrust cover 7 from the bucket cylinder 6.	 027079-00X
(5) Remove the hydraulic hoses from the bucket cylinder 6, and remove the bolt 8 (M10) to pull out the pin 9. Then remove the bucket cylinder 6. Note : Rope the bucket cylinder and remove it using a lifting device.	 027080-00E
(6) After roping the arm 5, remove the bolt 10 (M10) and remove the pin 12 from the arm cylinder 11 (on the rod side). Note : Place a block under the arm cylinder. (7) Remove the bolt 13 (M10) and pull out the arm pin 14. Then remove the arm 5 using a lifting device.	 027081-00E

7. ADJUSTMENT AND REPAIR

3) Removal of Boom

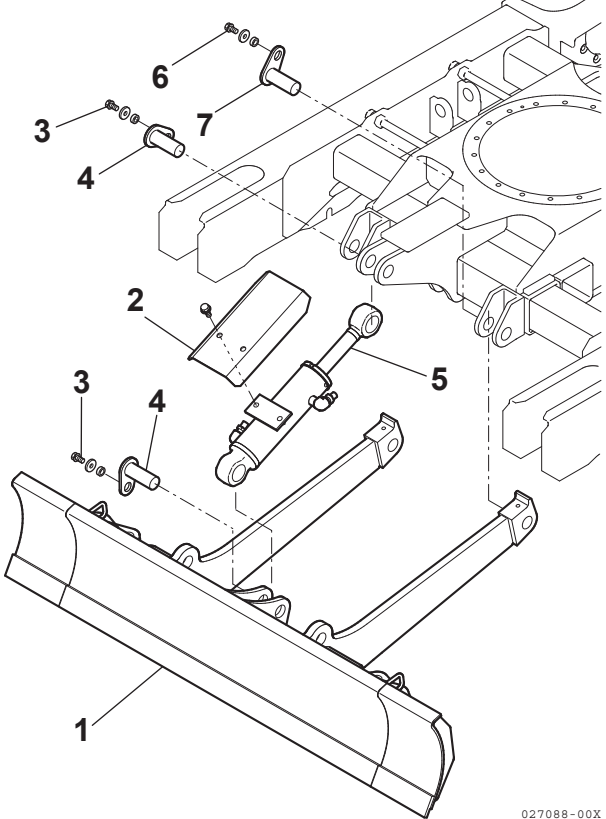
Procedure	
(1) After raising the boom 1 fully, remove the slide cover 3 from the boom cylinder 2. (2) Place the top end of the boom 1 on the ground. Note : Install an expansion plug to the connector from which the hydraulic hose has been removed and start the engine.	
(3) After roping the arm cylinder 4, remove the hydraulic hoses from the arm cylinder. (4) Remove the bolt 5 (M10) and pull out the pin 6. Then remove the arm cylinder 4. Note : Remove the arm cylinder using a lifting device.	
(5) After roping to the boom cylinder 2, remove the hydraulic hoses from the boom cylinder. (6) Remove the bolts 7 (M10) and pull out the pins 8. Then remove the boom cylinder 2. Note : Remove the boom cylinder using a lifting device.	
(7) Disconnect the connectors 9 of the boom light wiring harness.	

7. ADJUSTMENT AND REPAIR

Procedure	
(8) Remove the hose cover 11. Then remove the hydraulic hoses 12 from the boom.	 The diagram illustrates the removal of the hose cover (11) and hydraulic hoses (12) from the boom. A callout shows a detailed view of the hoses (12) being disconnected from the boom structure. The boom is shown in a vertical position. The reference number 027086-00X is located at the bottom right of the diagram.
(9) After roping the boom 1, remove the bolt 13 (M10) and pull out the pin 14. Then remove the boom 1. Notes : • Remove the boom using a lifting device. • Take care that the hoses do not catch on any other parts.	 The diagram illustrates the removal of the boom (1) using a rope. A rope is attached to the boom (1) and is being pulled upwards. The boom is shown in a horizontal position. A bolt (13) and a pin (14) are shown being removed from the boom. The boom is resting on a surface. The reference number 027087-00B is located at the bottom right of the diagram.

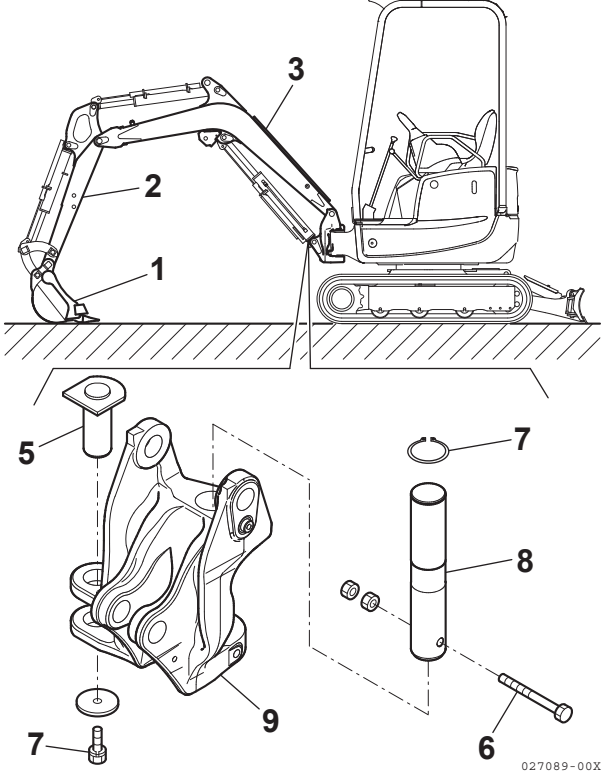
7. ADJUSTMENT AND REPAIR

4) Removal of Blade

Procedure	
(1) Turn the implement to the blade side, lower the bucket and the blade 1 to the ground and stop the engine. (2) Remove the protector 2 and remove the hydraulic hoses. (3) Remove the bolts 3 (M10) and pull out the pins 4. Then remove the blade cylinder 5. (4) After roping the blade 1, remove the bolts 6 (M10) and pull out the pins 7. Then remove the blade. Note : <i>Remove the blade using a lifting device.</i>	 027088-00X

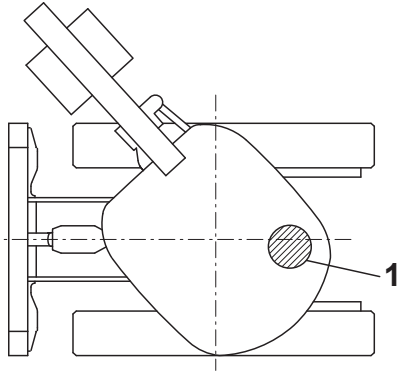
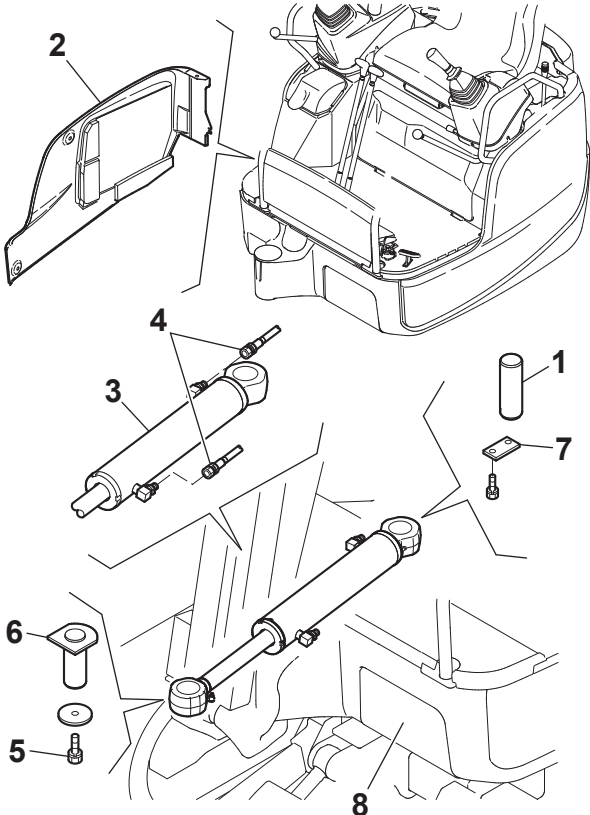
7. ADJUSTMENT AND REPAIR

5) Removal of Boom Bracket

Procedure	
(1) Remove the bucket 1. Refer to Section "7-6-1 1) Removal of Bucket". (2) Remove the arm 2. Refer to Section "7-6-1 2) Removal of Arm". (3) Remove the boom 3. Refer to Section "7-6-1 3) Removal of Boom". (4) Remove the bolt 4 (M12) and pull out the pin 5 (for the boom swing cylinder). (5) Remove the bolt 6 (M12) and the snap ring C 7, and pull out the pin 8. Then remove the boom bracket 9. Note : <i>Rope the boom bracket and remove it using a lifting device.</i>	 027089-00X

7. ADJUSTMENT AND REPAIR

6) Removal of Boom Swing Cylinder

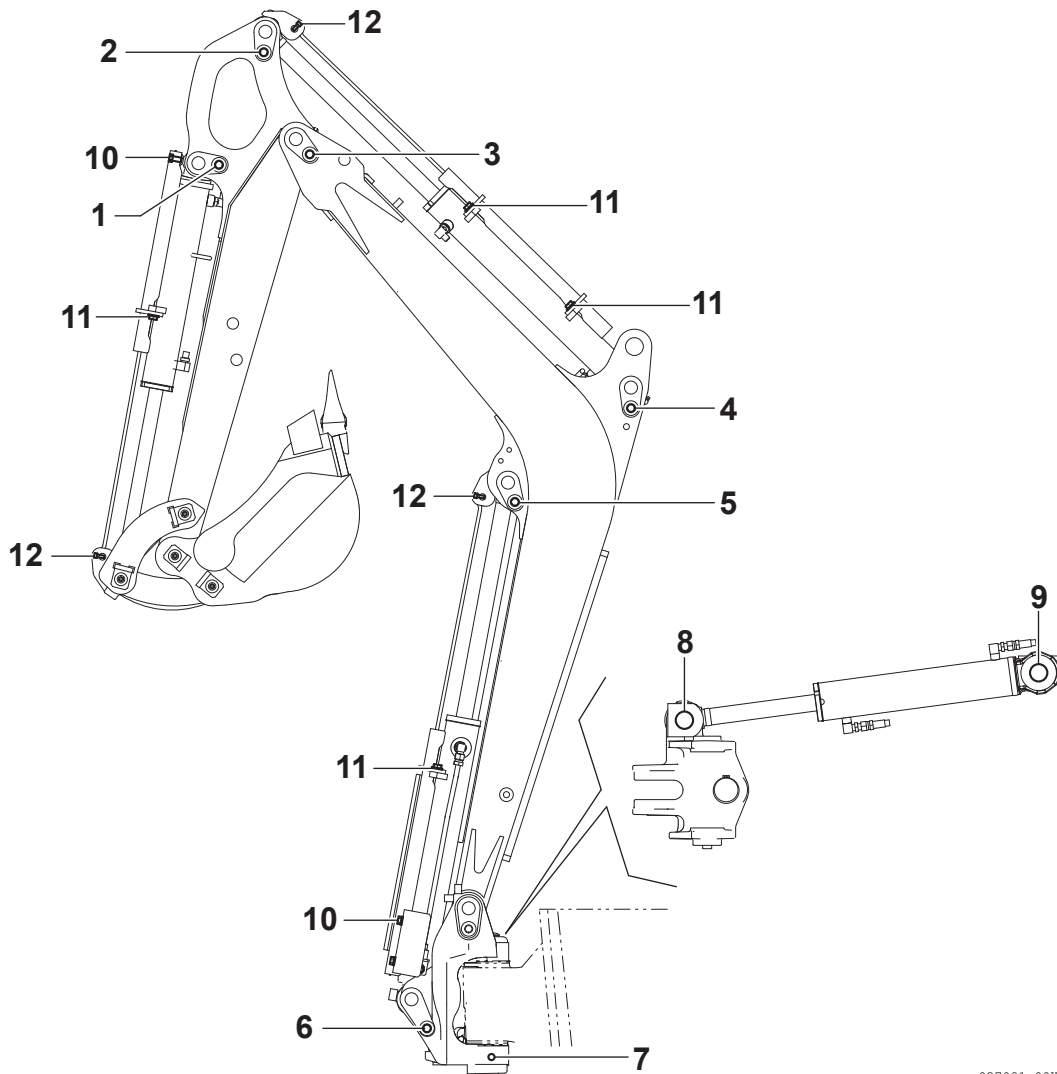
Procedure	
(1) Swing the upperstructure so that the pin 1 at the bottom end of the boom swing cylinder is positioned halfway between the right and left crawlers. Then, lower the bucket to the ground and stop the engine.	
(2) Remove the frame R cover 2, and then remove the hydraulic hoses 4 from the boom swing cylinder 3. (3) Remove the bolt 5 (M12) and pull out the pin 6 at the rod end of the boom swing cylinder 3. (4) Remove the plate 7 and pull out the pin 1 at the bottom end of the boom swing cylinder 3. (5) Remove the boom swing cylinder 3 from the turning frame 8.	

027090-00X

7. ADJUSTMENT AND REPAIR

7) Reinstallation

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



027091-00X

Tightening Torque and Adhesive

No.	Size	Tightening torque	Adhesive
1	M10	32.6 to 43.4 ft·lbf (44.1 to 58.8 N·m)	Apply Three Bond 1324 or its equivalent.
2	M10		
3	M10		
4	M10		
5	M10		
6	M10		
7	M12	57.9 to 72.3 ft·lbf (78.5 to 98.1 N·m)	
8	M12		
9	M10	32.6 to 43.4 ft·lbf (44.1 to 58.8 N·m)	
10	M10		
11	M10(Hexagon socket)	7.2 to 8.7 ft·lbf (9.8 to 11.8 N·m)	
12	M6(Hexagon socket)		

CHAPTER 8

TROUBLESHOOTING

8-1 Non-Breakdowns	8-1-1
8-1-1 Natural Release of Bucket	8-1-1
8-1-2 Discontinuous Arm Movement	8-1-1
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8-1-4 Thermal Shock of Travel Motor	8-1-3
8-1-5 Time Lag on Travel Speed Switching	8-1-4
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8-2-1 Machine and Engine	8-2-1
8-2-2 Machine and Engine	8-2-22

8. TROUBLESHOOTING

8. Troubleshooting

8-1 Non-Breakdowns

8-1-1 Natural Release of Bucket

Phenomenon

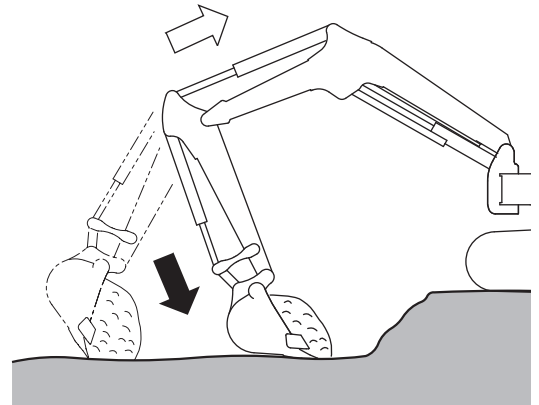
When the arm is extended while scooping with the bucket, the scooping side of the bucket is restricted by the arm and causes back pressure because oil cannot be supplied to the bucket cylinder in time.

When the boom is raised immediately in this condition, the bucket is released naturally because of the back pressure in the piston side of the cylinder

Operation

This problem can be solved by using a sequence of three actions of bucket scooping, arm extension and boom raising.

(For the models that cannot make the triple sequence actions, extend the arm after raising the boom.)



8-1-2 Discontinuous Arm Movement

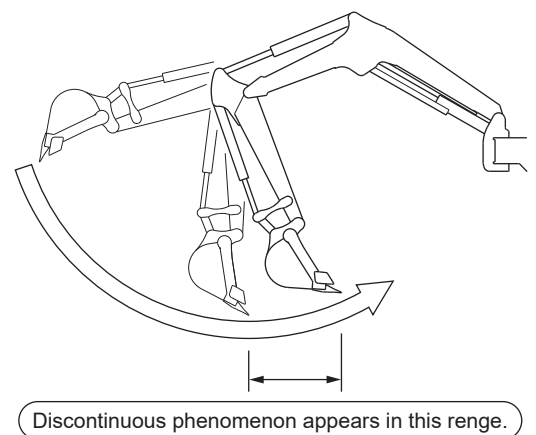
When scooping with the arm, the arm tends to move slower as it draws near to the perpendicular and it may stop momentarily.

Reason

This may happen because the oil supply cannot catch up with the cylinder extension speed. This is a characteristic of hydraulic equipment.

Specifically, this phenomenon appears when the engine speed is in the low to medium speed range.

Advise your users fully that this will happen in hydraulic equipment and that this is not a breakdown.

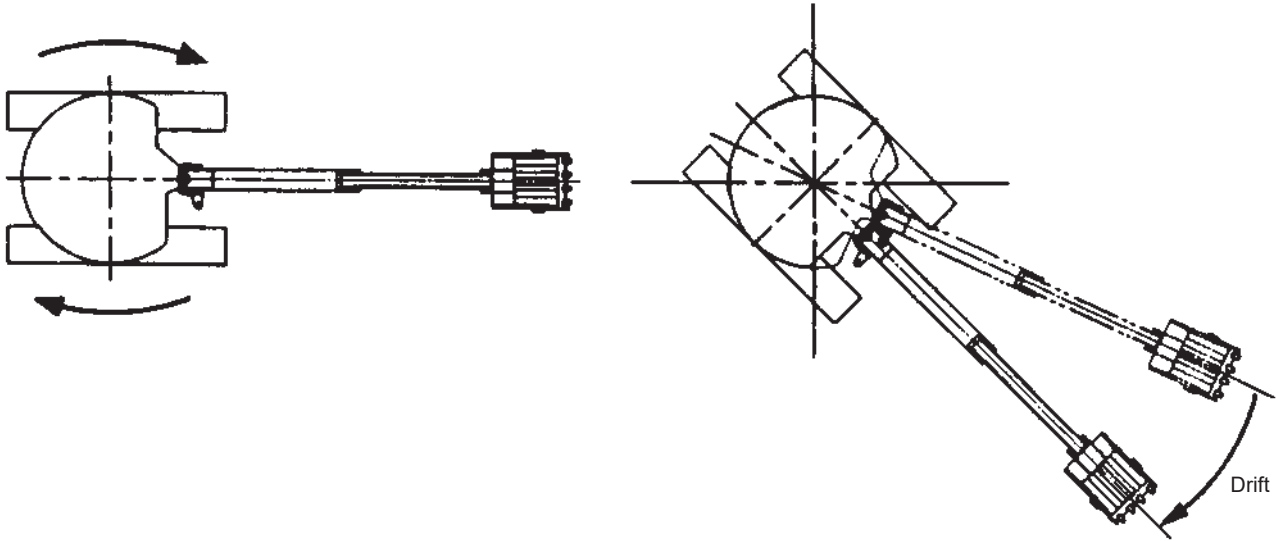


8. TROUBLESHOOTING

8-1-3 Drifting of Upperstructure on Quick Travel Operation

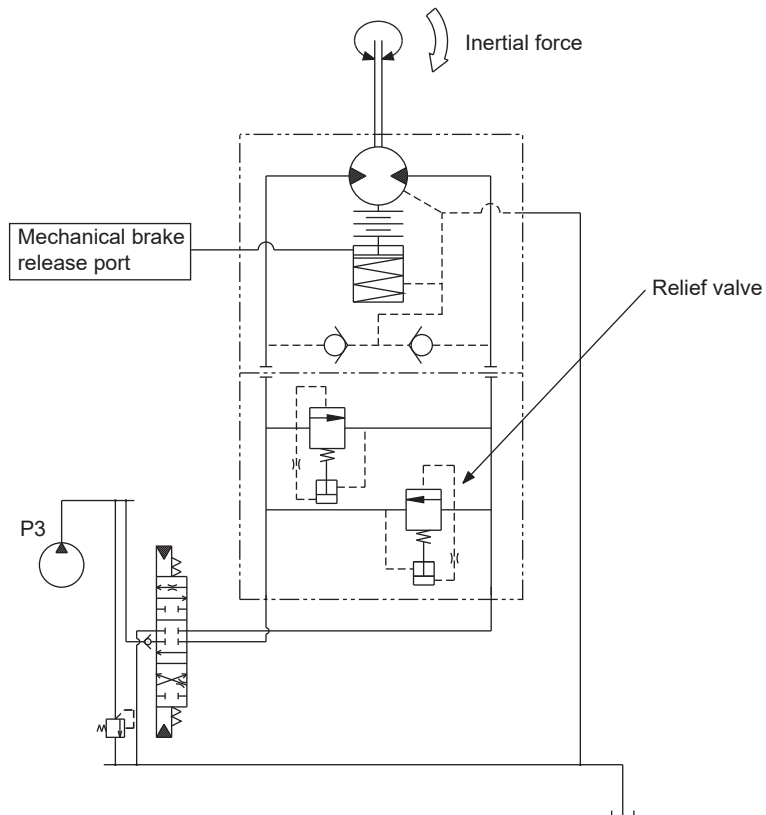
Phenomenon

The upperstructure drifts on quick travel operation (especially, on spin-or pivot-turning).



Reason

Inertial force is given to the upperstructure through the quick operation of the undercarriage, and high pressure is applied to the swing motor. The relief valve is activated to turn the swing motor.

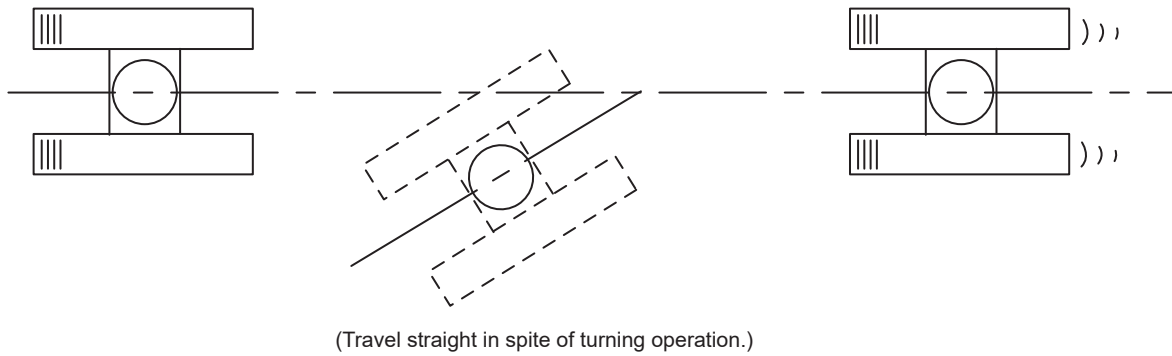


8. TROUBLESHOOTING

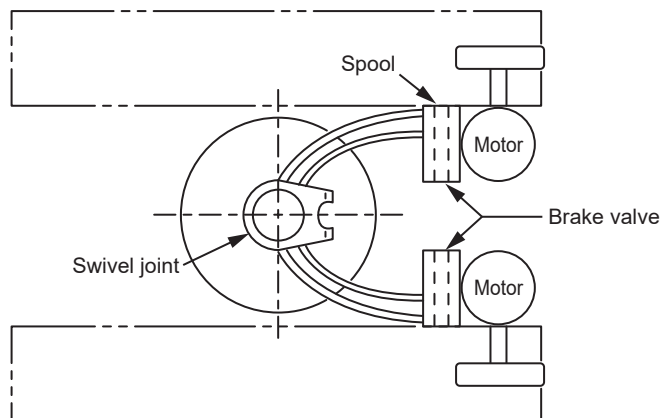
8-1-4 Thermal Shock of Travel Motor

Phenomenon

When the traveling operation is made for pivot turning in cold temperatures after raising the hydraulic oil to more than 140°F (60°C) higher than the ambient temp. through relief valve operation, etc., without traveling after starting the engine, the machine may travel straight instead of making a pivot turn.



Reason



When the hot hydraulic oil is suddenly fed to the cold brake valve and motor, the spool in the brake valve sticks momentarily due to thermal expansion, canceling the braking force.

Evaluation

Since the phenomenon disappears in 20 to 30 seconds and this situation is generally rare, this phenomenon presents no problem.

8. TROUBLESHOOTING

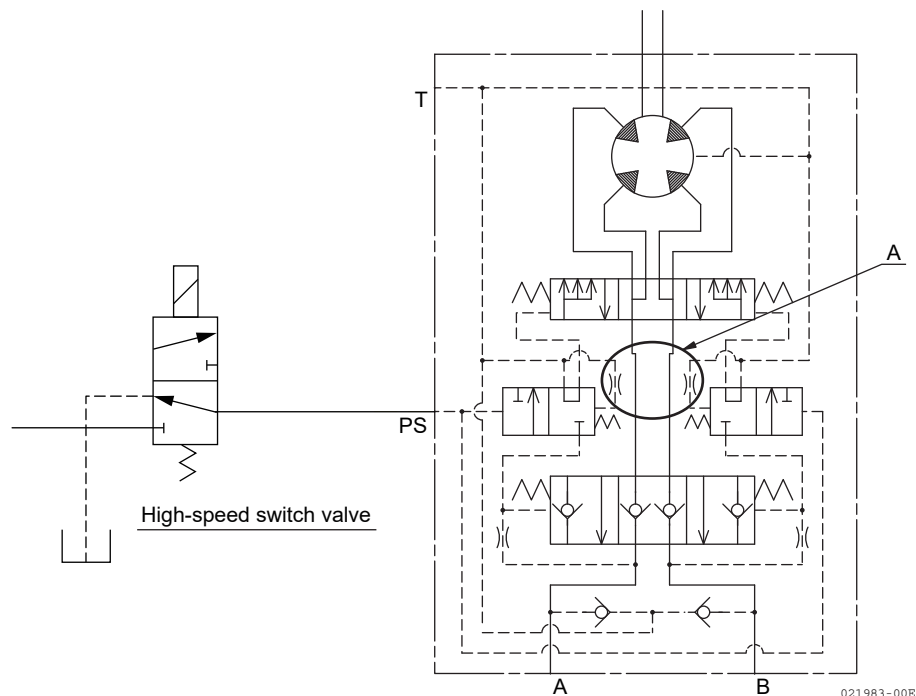
8-1-5 Time Lag on Travel Speed Switching

Phenomenon

In cold temperatures, there is a time lag in switching from the high-travel speed to low-travel speed (with the high-speed pedal released).

Reason

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

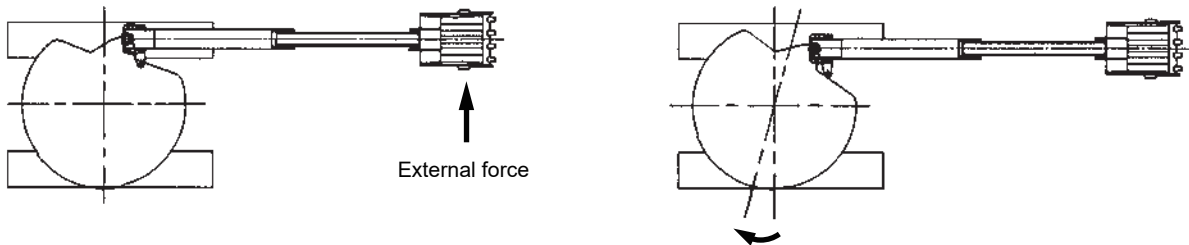


8. TROUBLESHOOTING

8-1-6 Elongation of Boom Swing Cylinder on 65 degrees Swing

Phenomenon

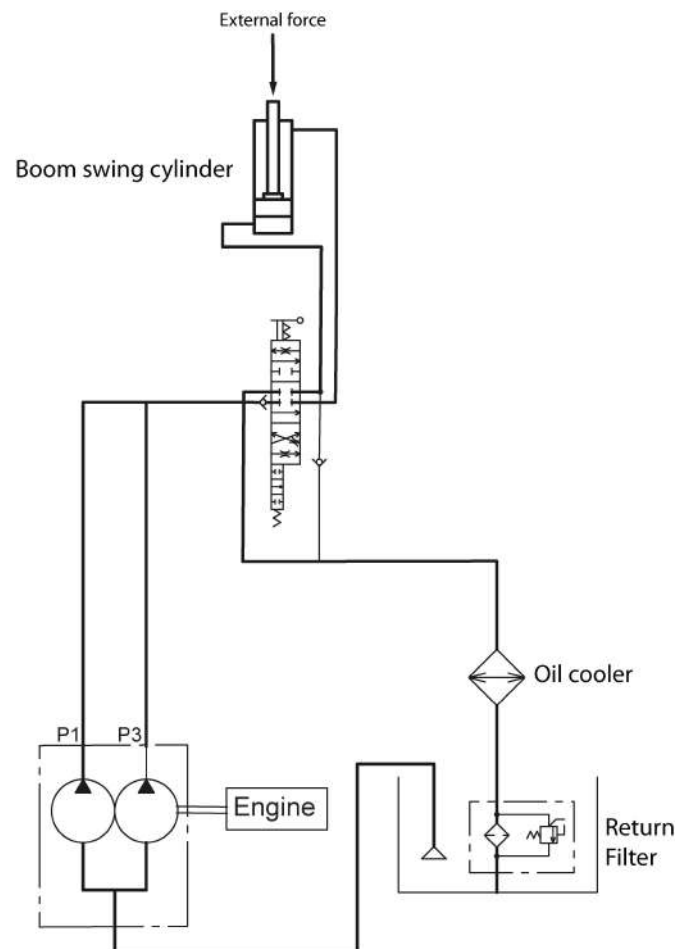
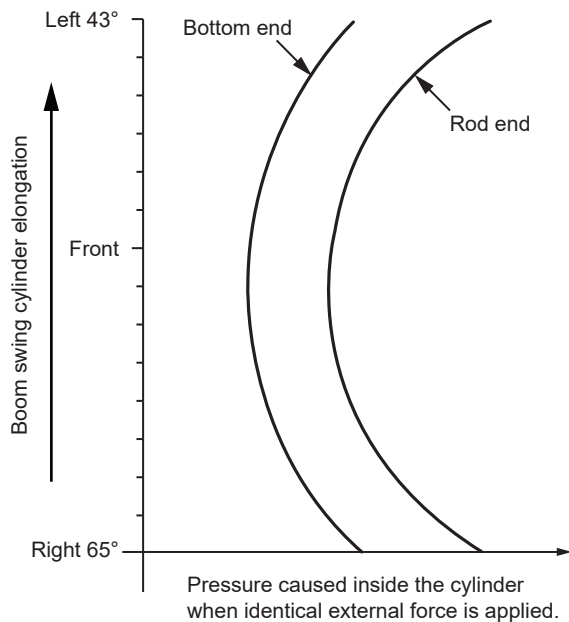
The boom swing cylinder elongates in digging operation at a 65 degrees swing.



Reason

When an outside sideways force is applied to the bucket, the force extends (retracts) the boom swing cylinder. At the 65 degrees swing position, however, the cylinder's internal pressure is higher than in other positions due to the link ratio. Remaining air in boom swing hydraulic circuit may elongate the boom swing cylinder.

If necessary operate several time the boom swing fully to bleed the air off the circuit.

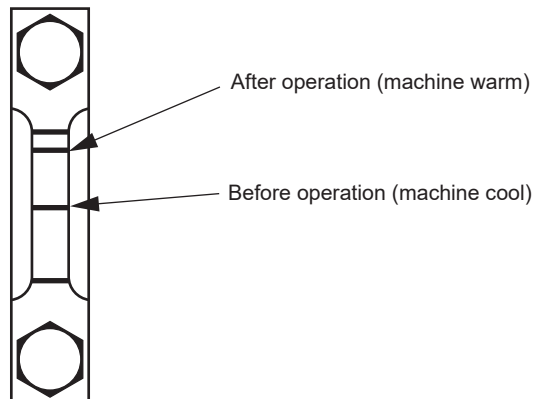


8. TROUBLESHOOTING

8-1-7 Fluctuation in Oil Level of Hydraulic Oil Tank Due to Temperature Change

Phenomenon

The oil level of the hydraulic oil tank varies between before operation (the machine is cool) and after operation (the machine is warm).



Reason

The oil level changes because the thermal expansion factor of oil is far larger (about 20 times) than that of steel.

1. Linear thermal expansion factor of steel : 11.7×10^{-6}
2. Cubical thermal expansion factor of steel : 3.51×10^{-5}
3. Cubical thermal expansion factor of hydraulic oil : 7.7×10^{-4}

(Example)

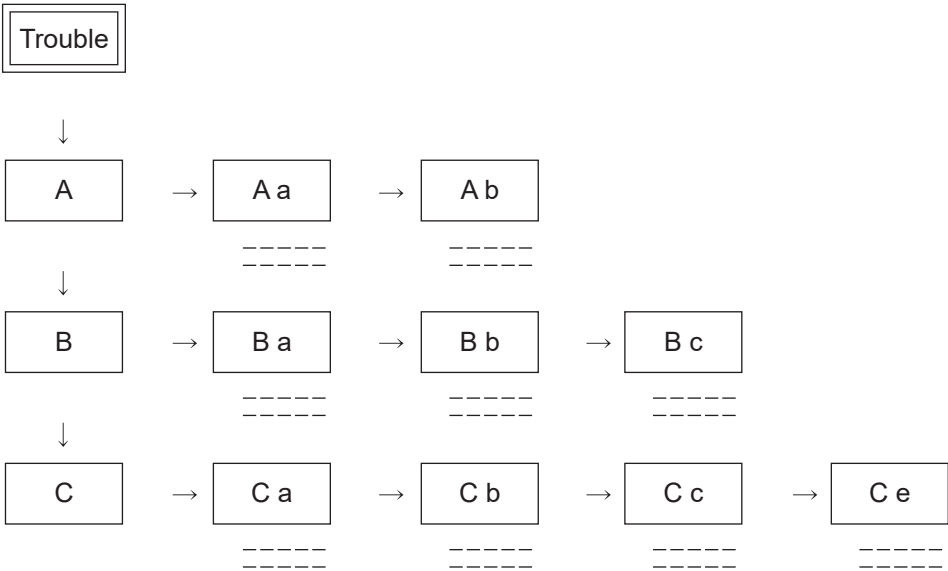
Hydraulic oil	68°F (20°C) 4.4 Gals. (16.5 L)	158°F (70°C) 4.4 Gals. (16.5 L)	Expansion by temp. rise 0.17 Gals. (0.6353 L)
Hydraulic oil tank (Steel)	68°F (20°C) 4.4 Gals. (16.5 L)	158°F (70°C) 4.4 Gals. (16.5 L)	Expansion by temp. rise 0.008 Gals. (0.029 L)

8. TROUBLESHOOTING

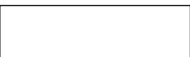
8-2 Troubleshooting

8-2-1 Machine and Engine

(How to use the charts)

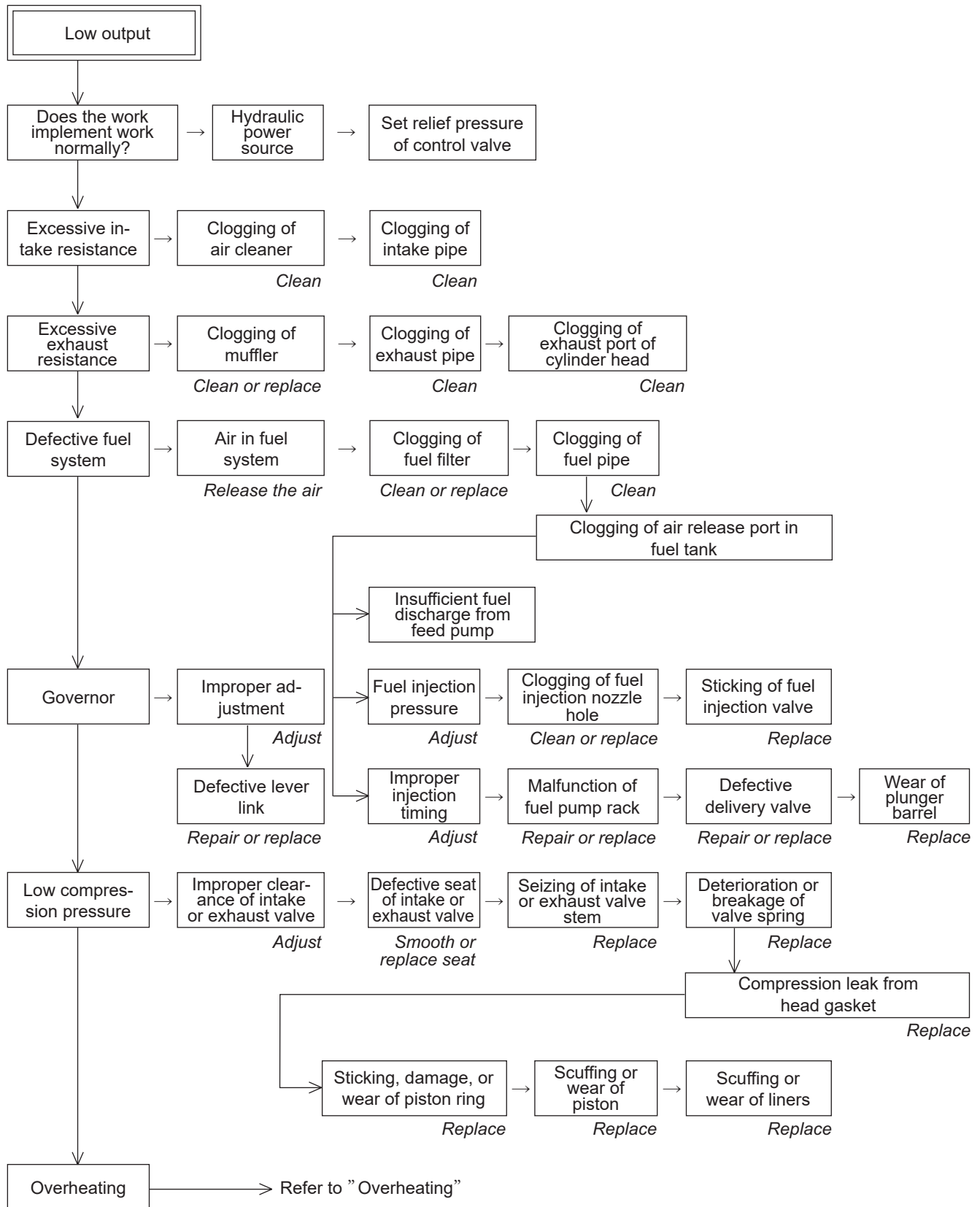


Factors related to the trouble are enumerated in the columns and instructions for corrective procedures are given below. It is recommended that the troubles be inspected and corrected one by one according to the chart.

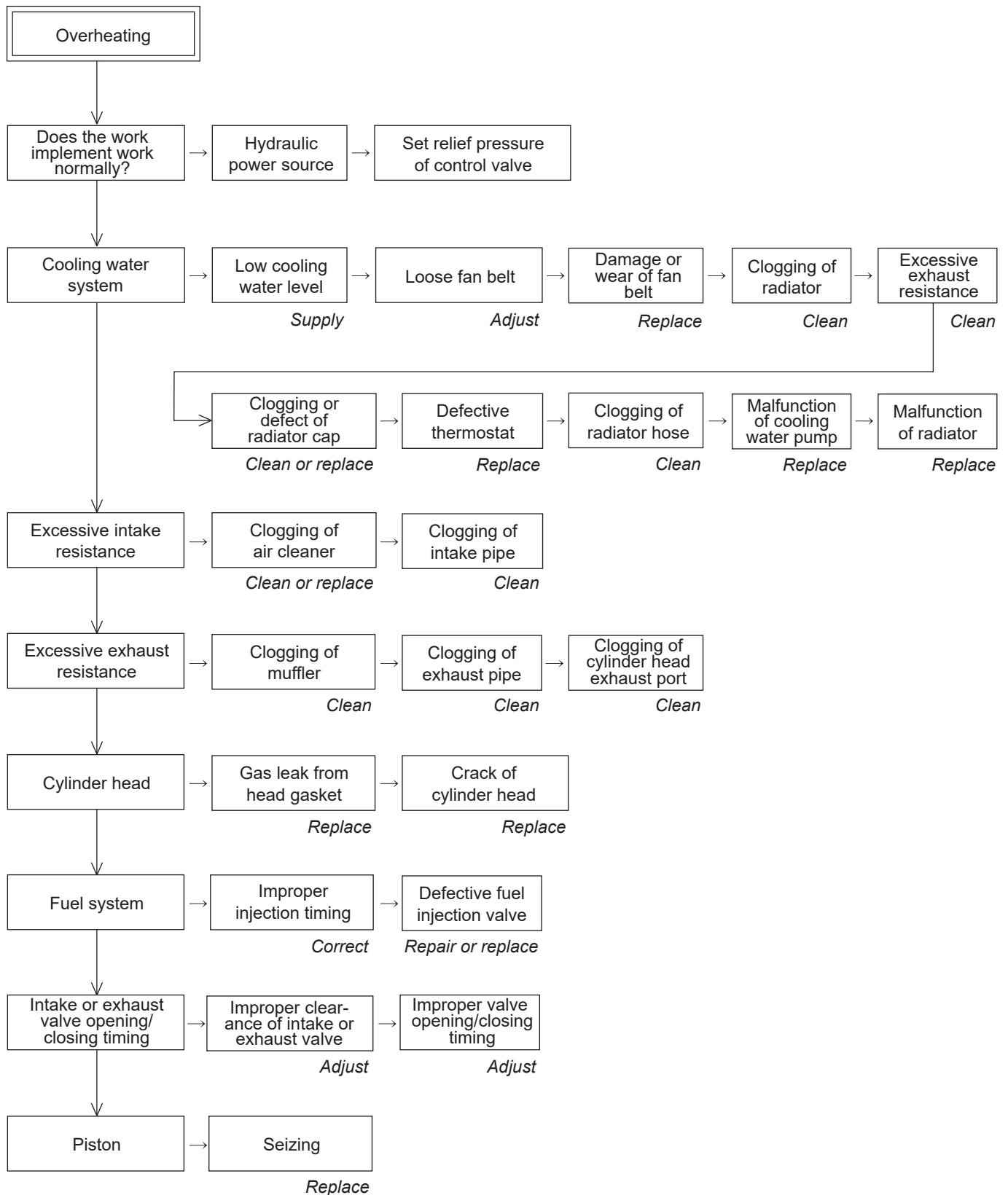
 ← Inspection item

----- ← Remedy for failure

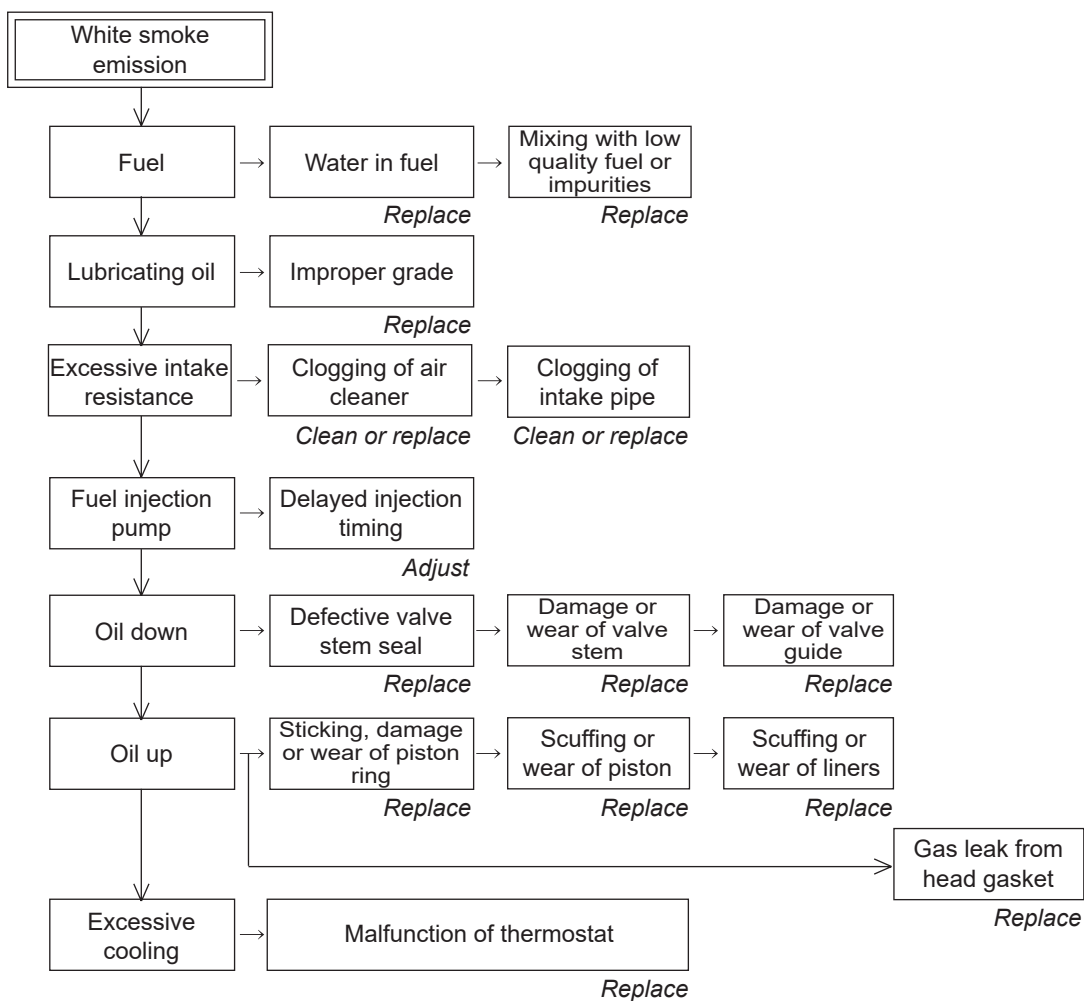
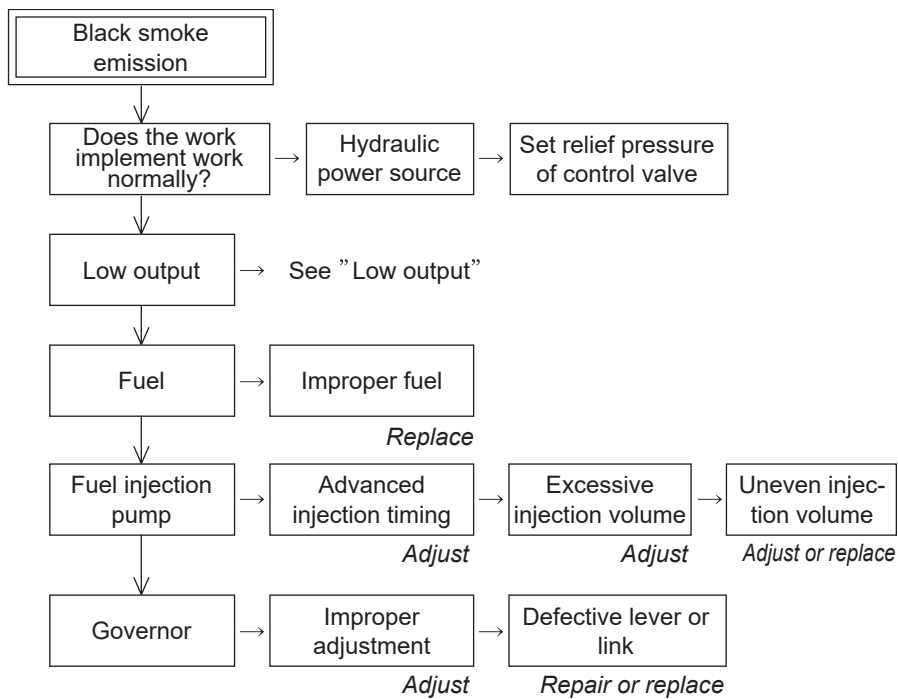
8. TROUBLESHOOTING



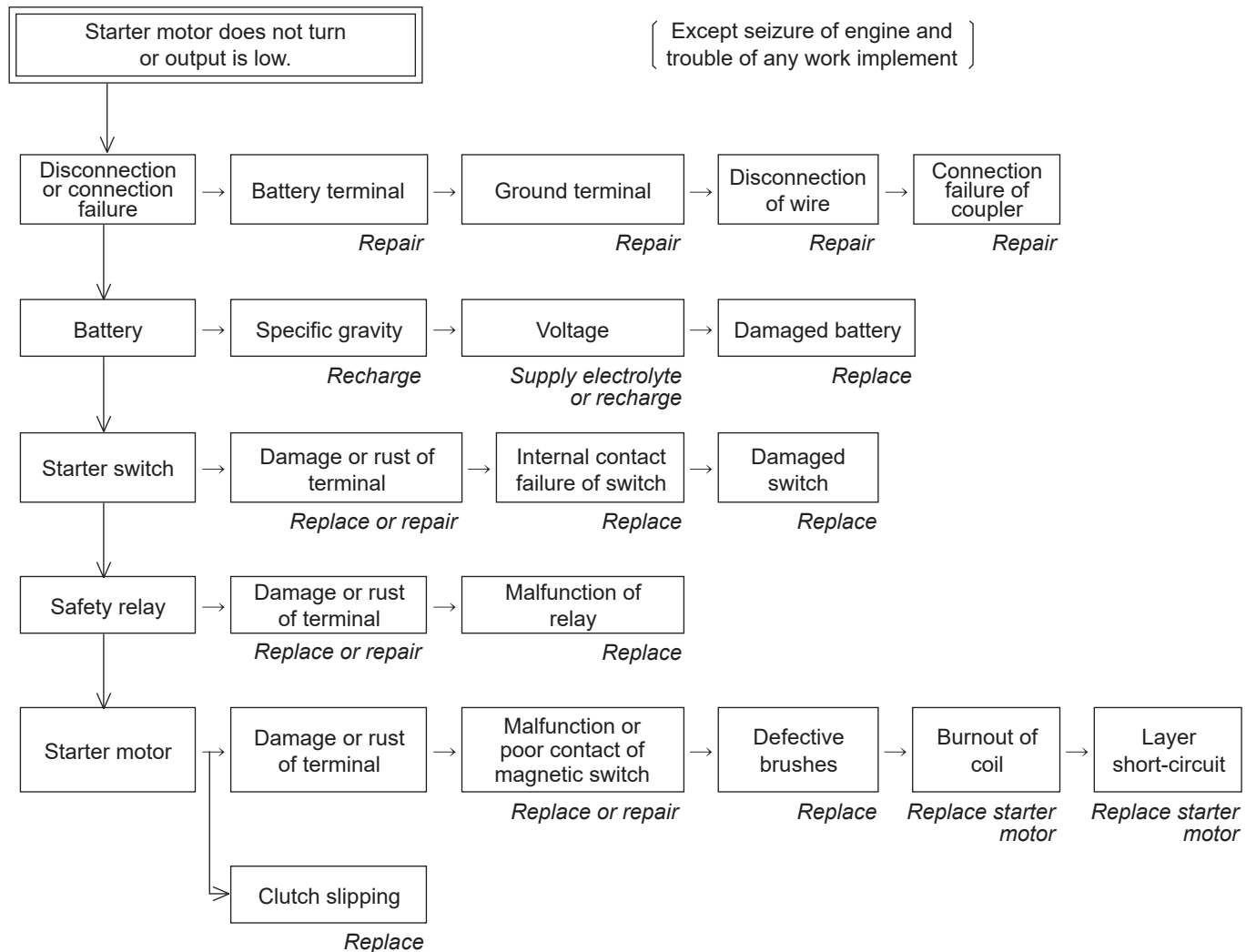
8. TROUBLESHOOTING



8. TROUBLESHOOTING



8. TROUBLESHOOTING



Inspection procedures

When the starter motor cannot be started by turning the starter switch on, check it as follows.

(Battery, starter switch and wiring assumed to be normal.)

(1) Safety relay & starter motor magnetic switch

Connect the S-and B-terminals of the starter motor directly.

[1] When the starter motor turns : The safety relay is faulty.

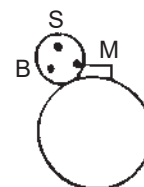
[2] When the starter motor does not turn : Either the starter motor magnetic switch or the starter motor is faulty.

(2) Starter motor

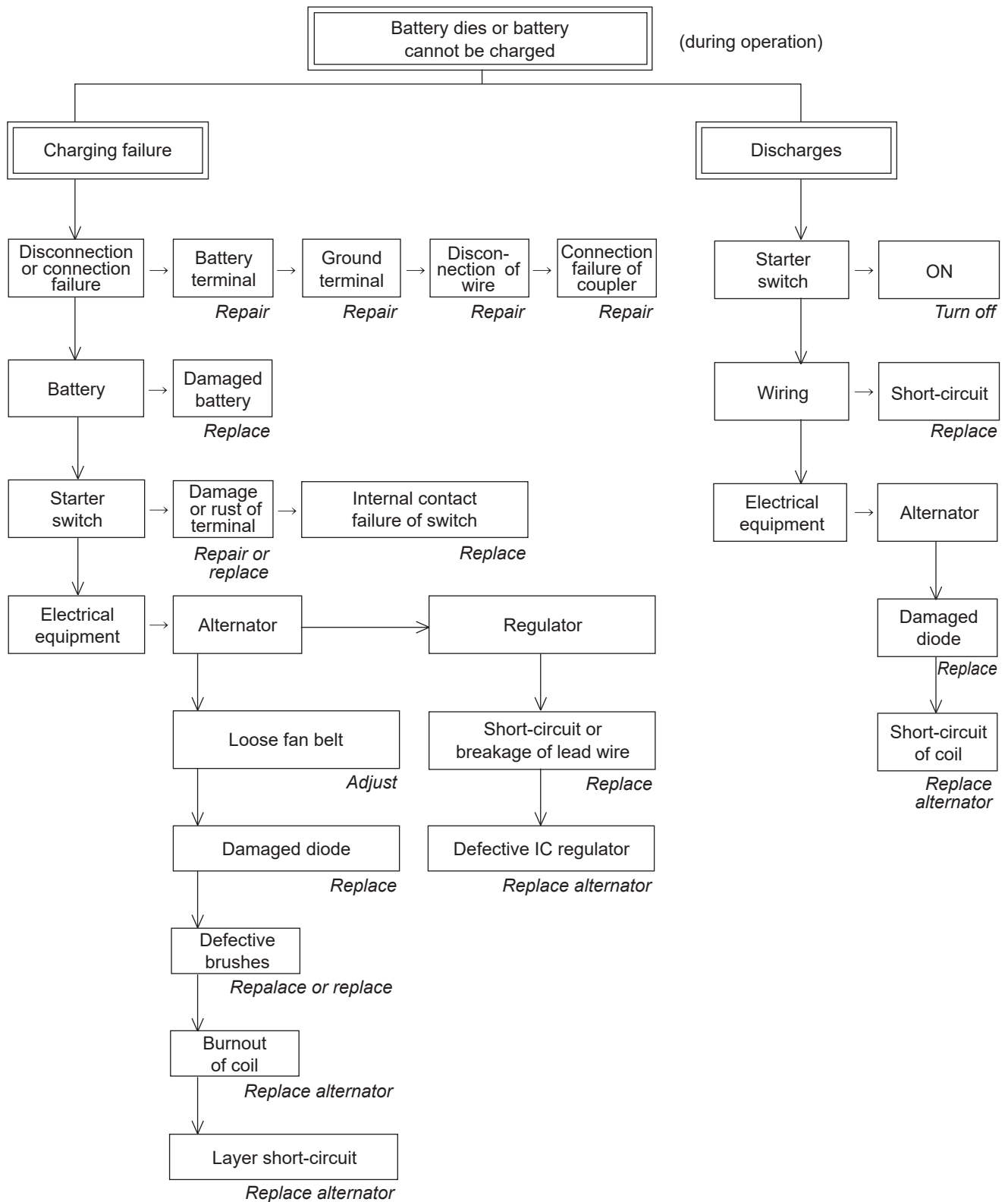
Connect the B-and M-terminals of the starter motor directly.

[1] When the starter motor turns : Magnetic switch is faulty.

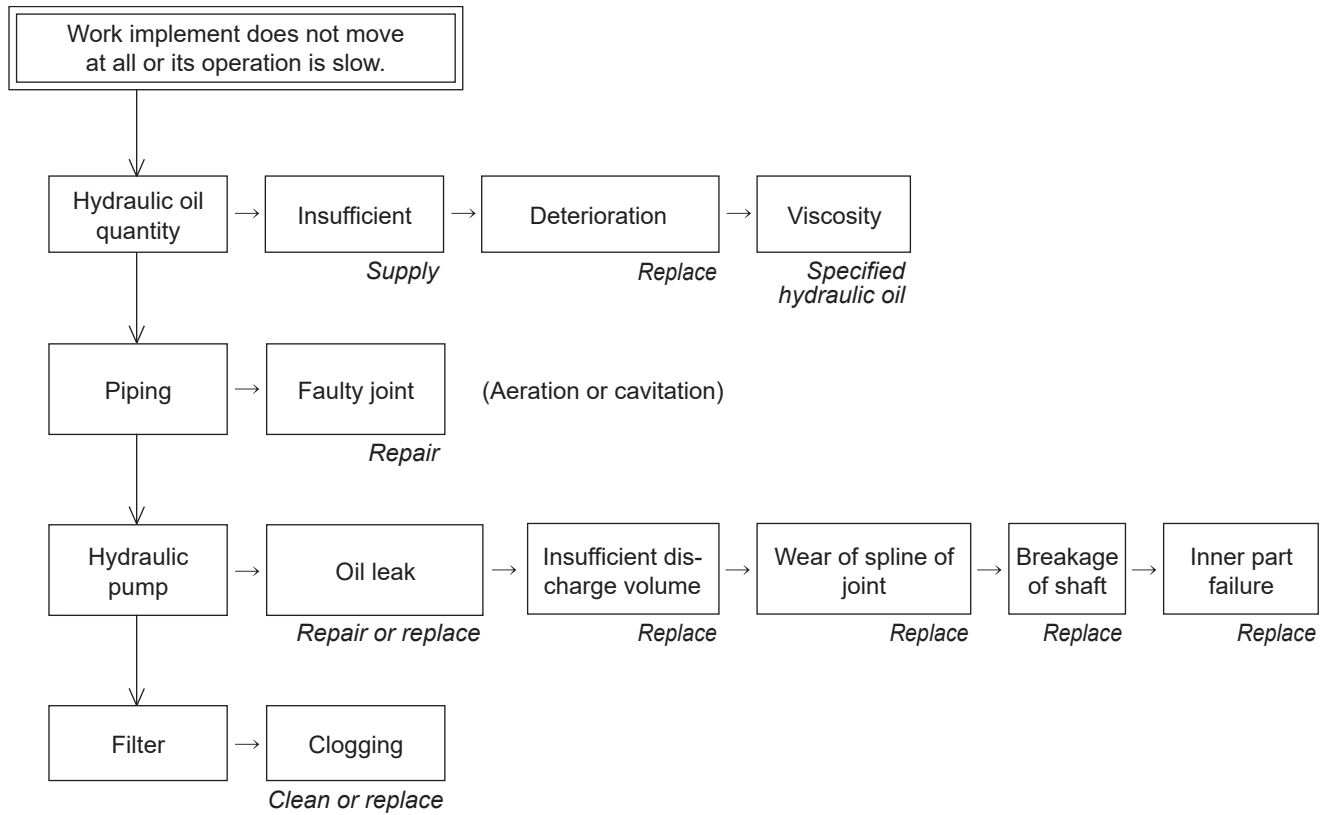
[2] When the starter motor does not turn : Starter motor is faulty.



8. TROUBLESHOOTING

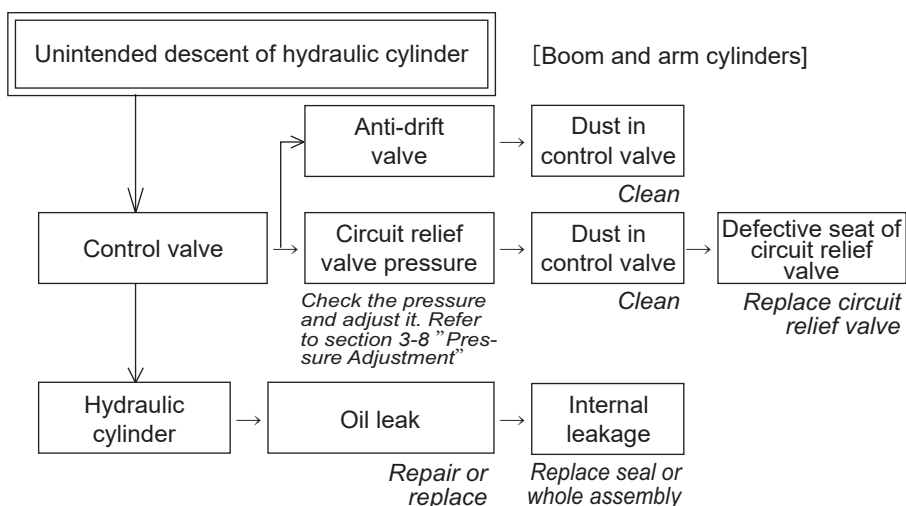
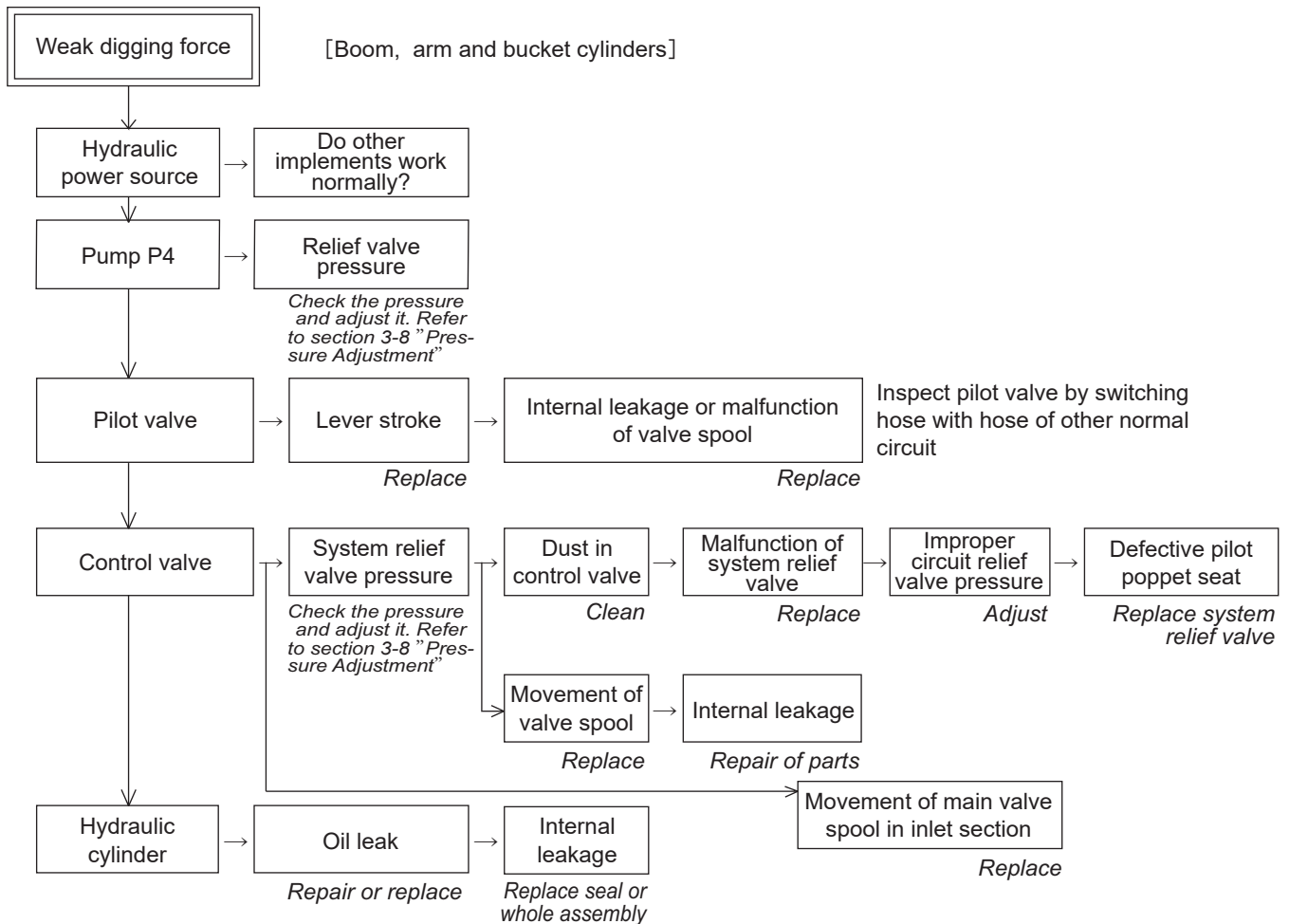


8. TROUBLESHOOTING



8. TROUBLESHOOTING

Work Implements



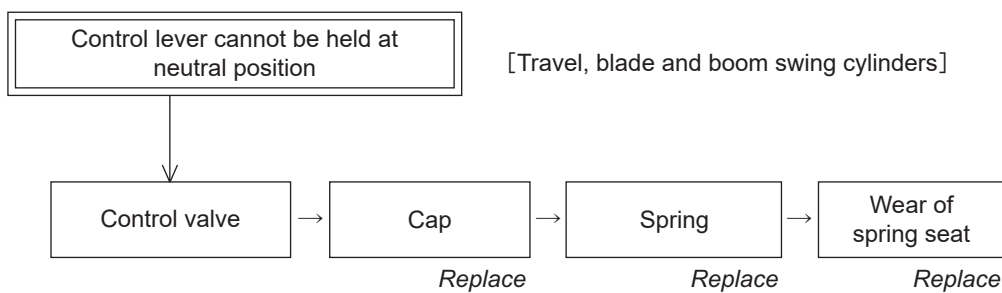
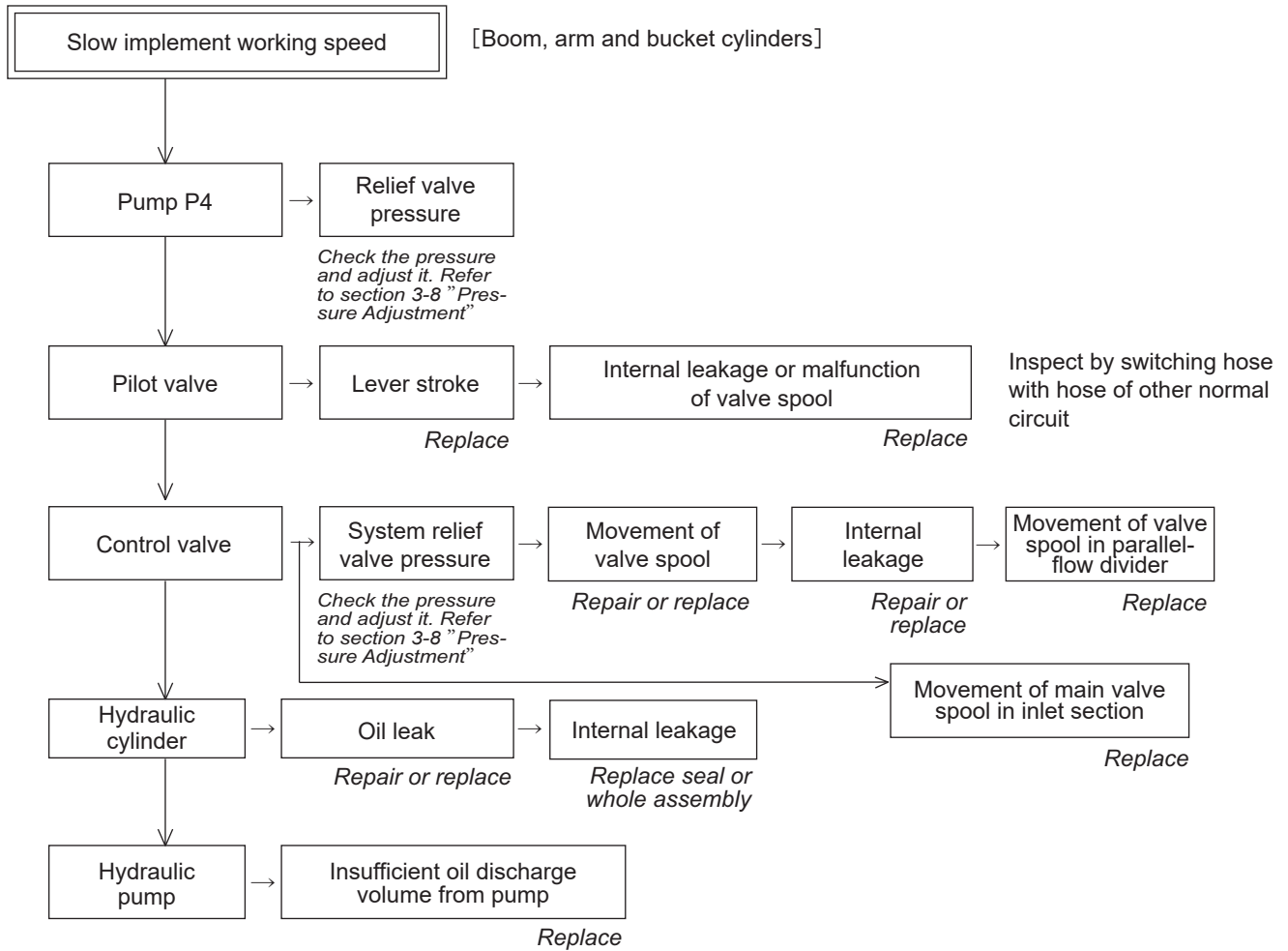
Inspection procedure

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

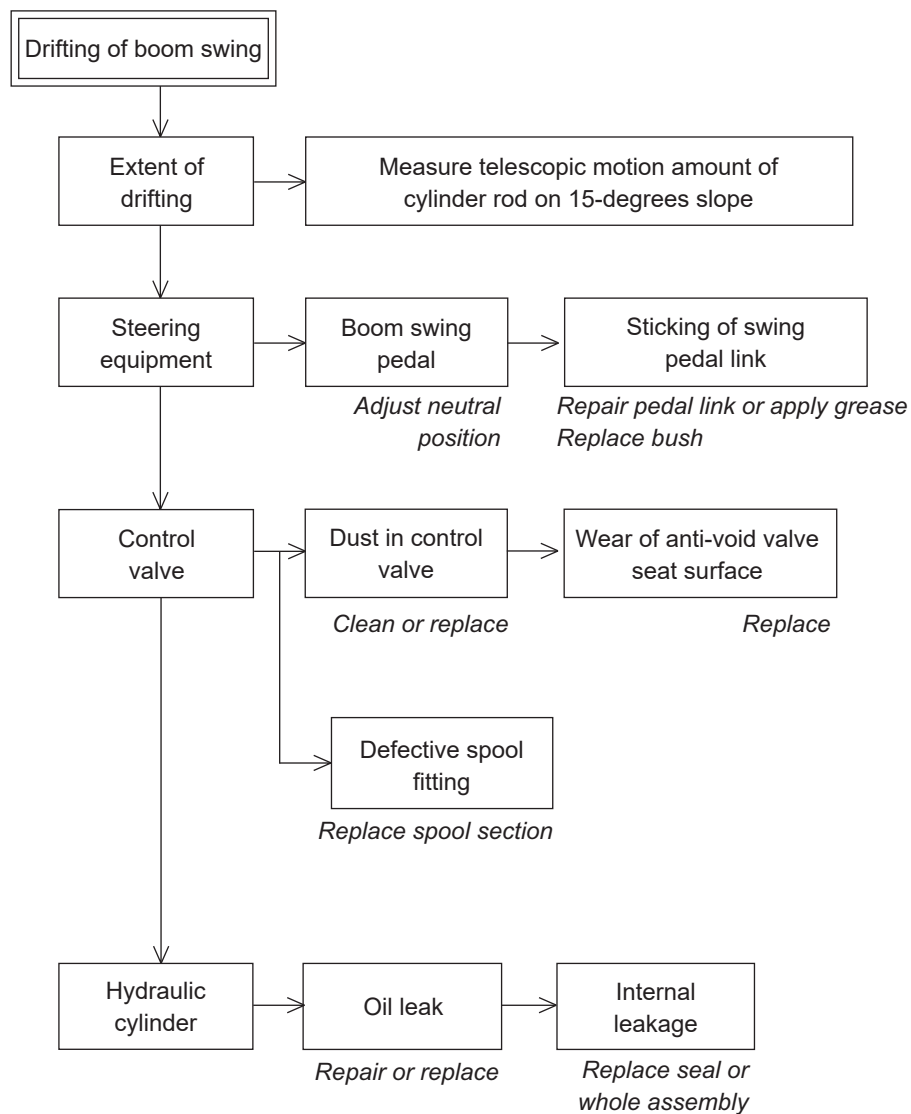
[1] No descent : Control valve is faulty.

[2] Descent : Cylinder is faulty.

8. TROUBLESHOOTING



8. TROUBLESHOOTING



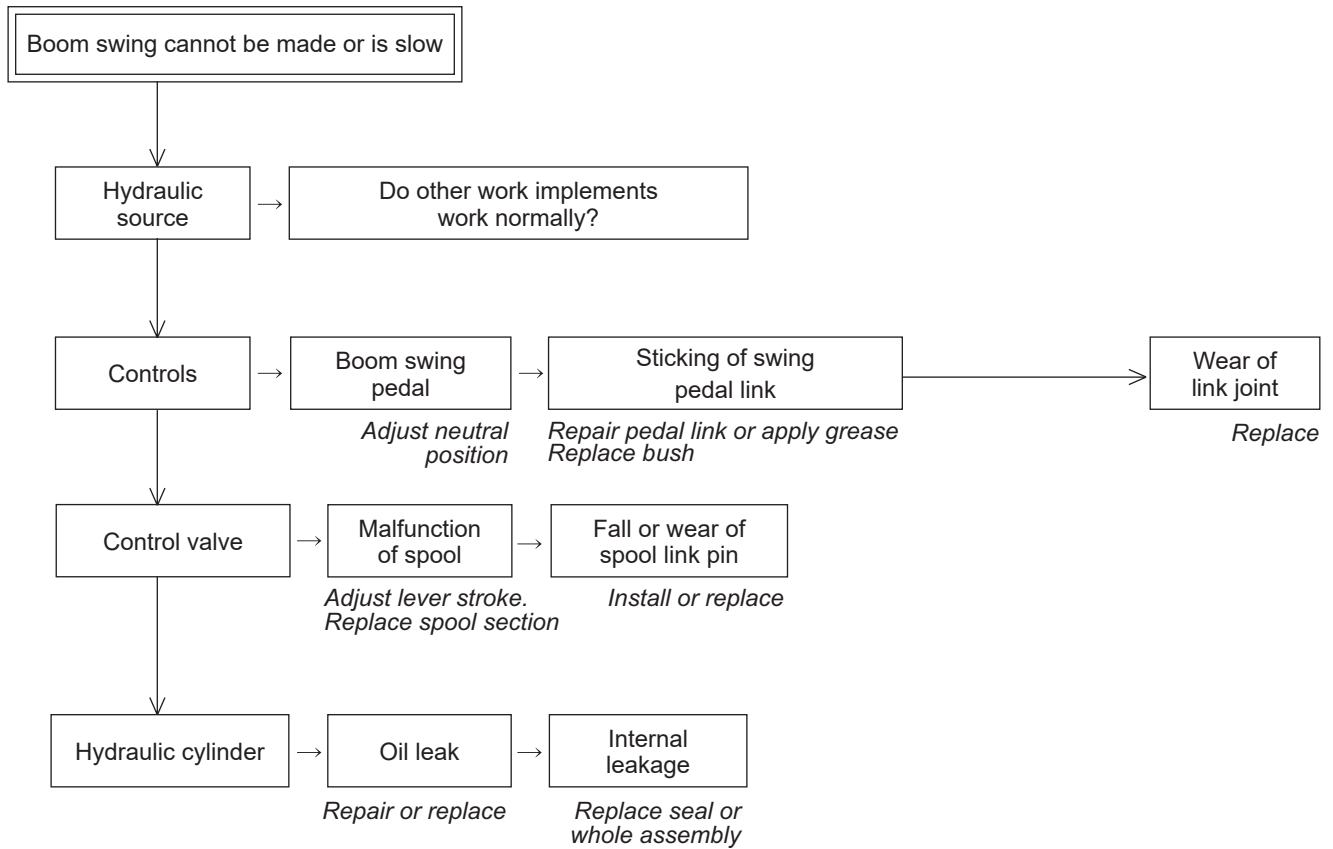
Inspection procedure

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

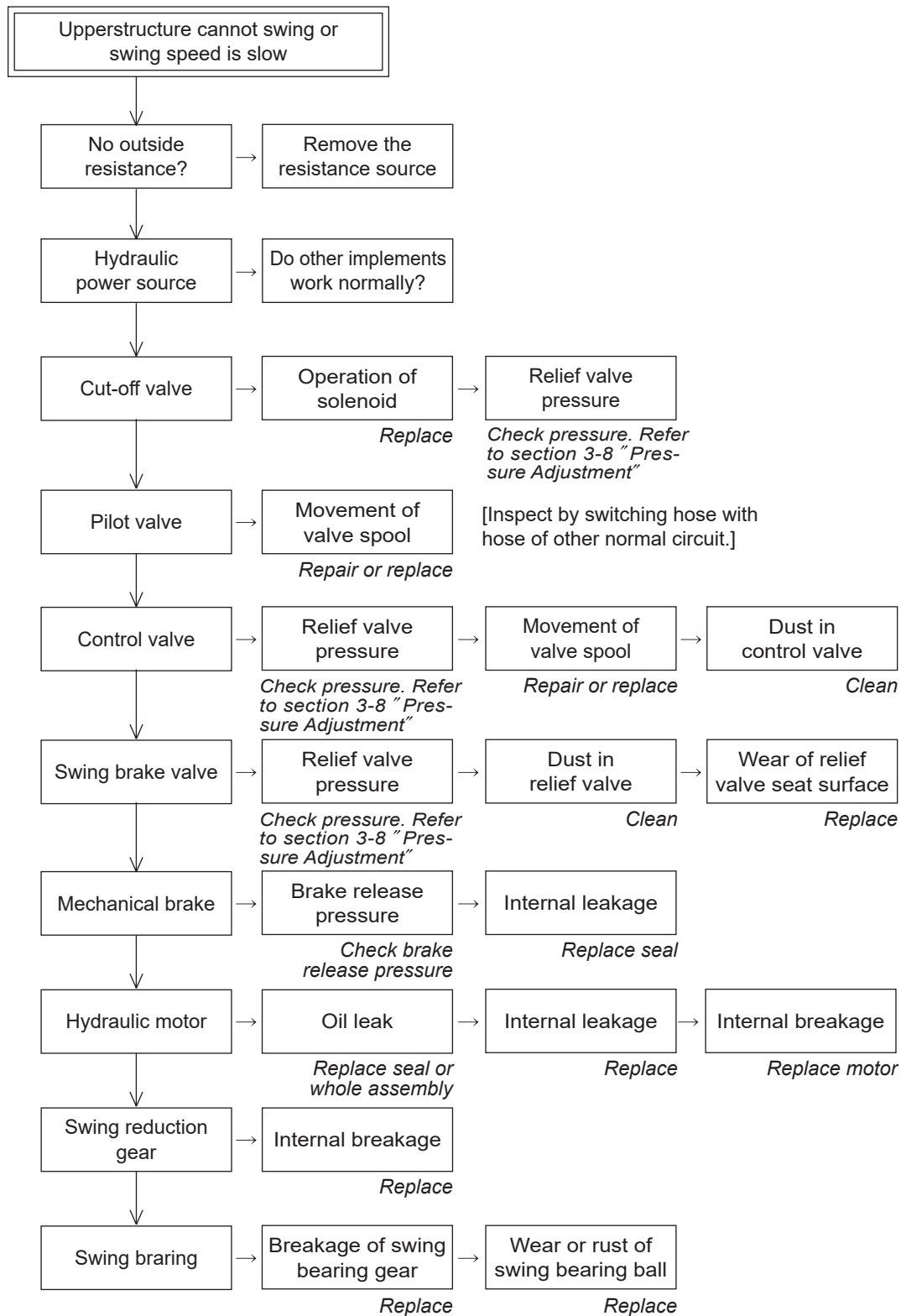
[1] No boom swing drifting : Control valve is faulty.

[2] Boom swing drifting : Hydraulic cylinder is faulty.

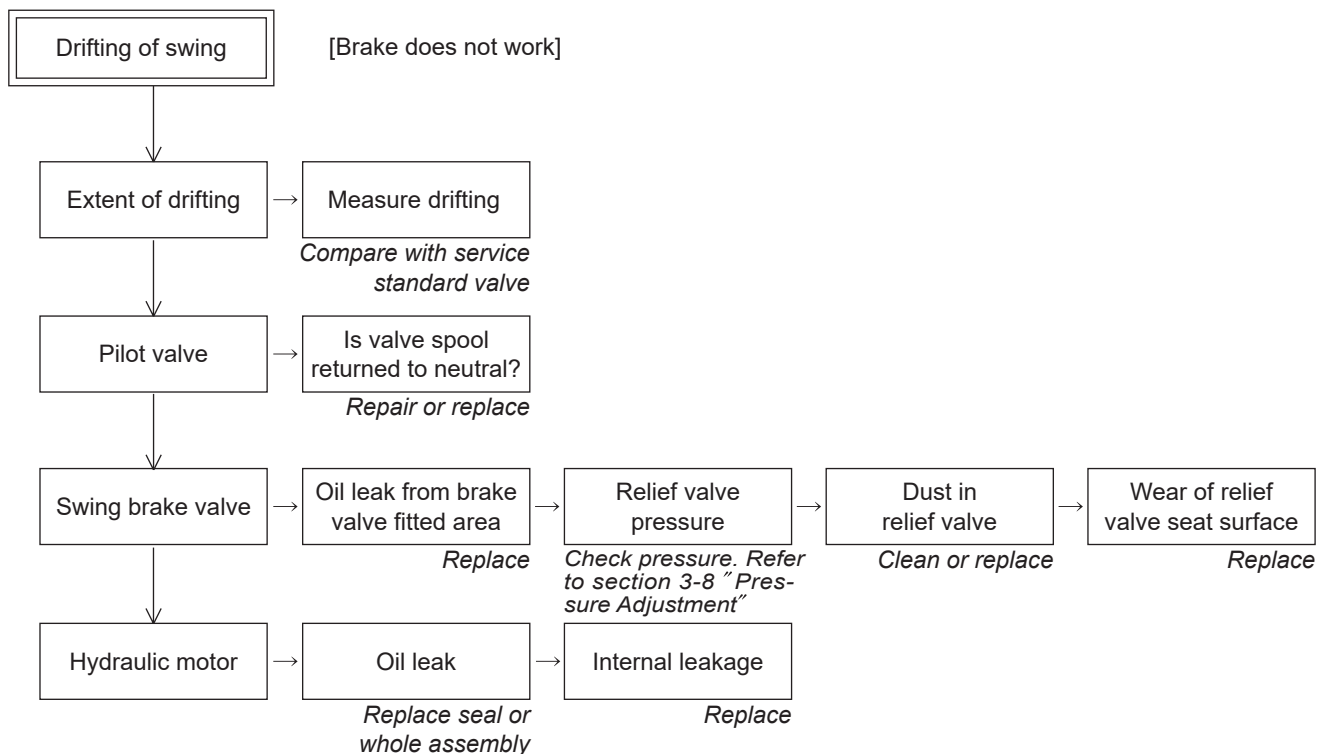
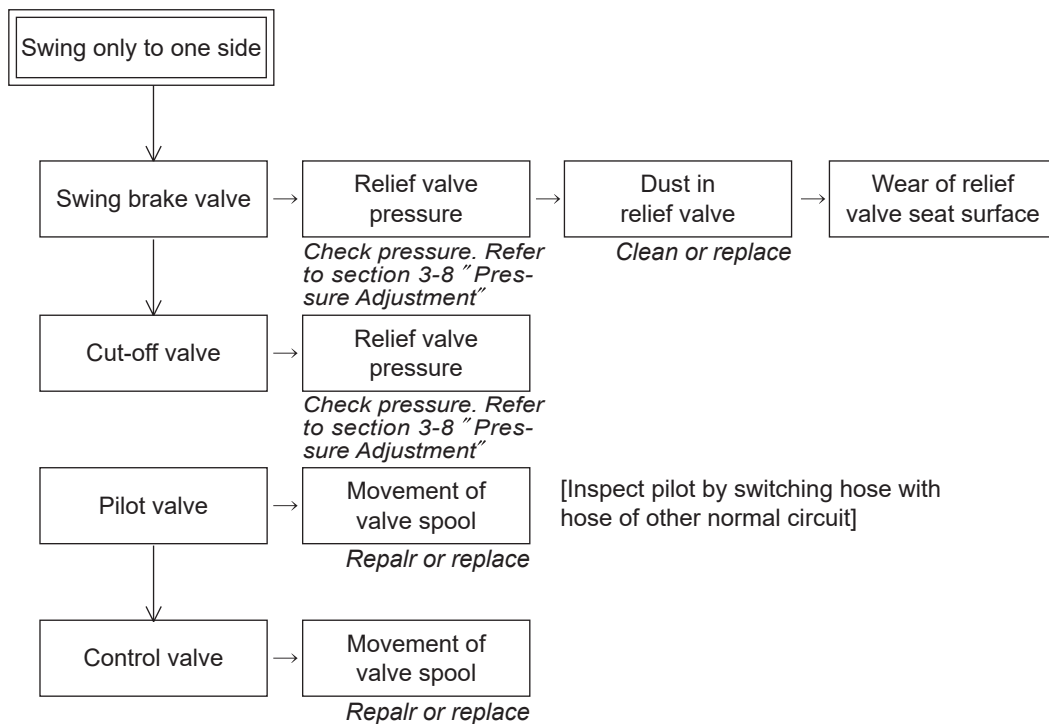
8. TROUBLESHOOTING



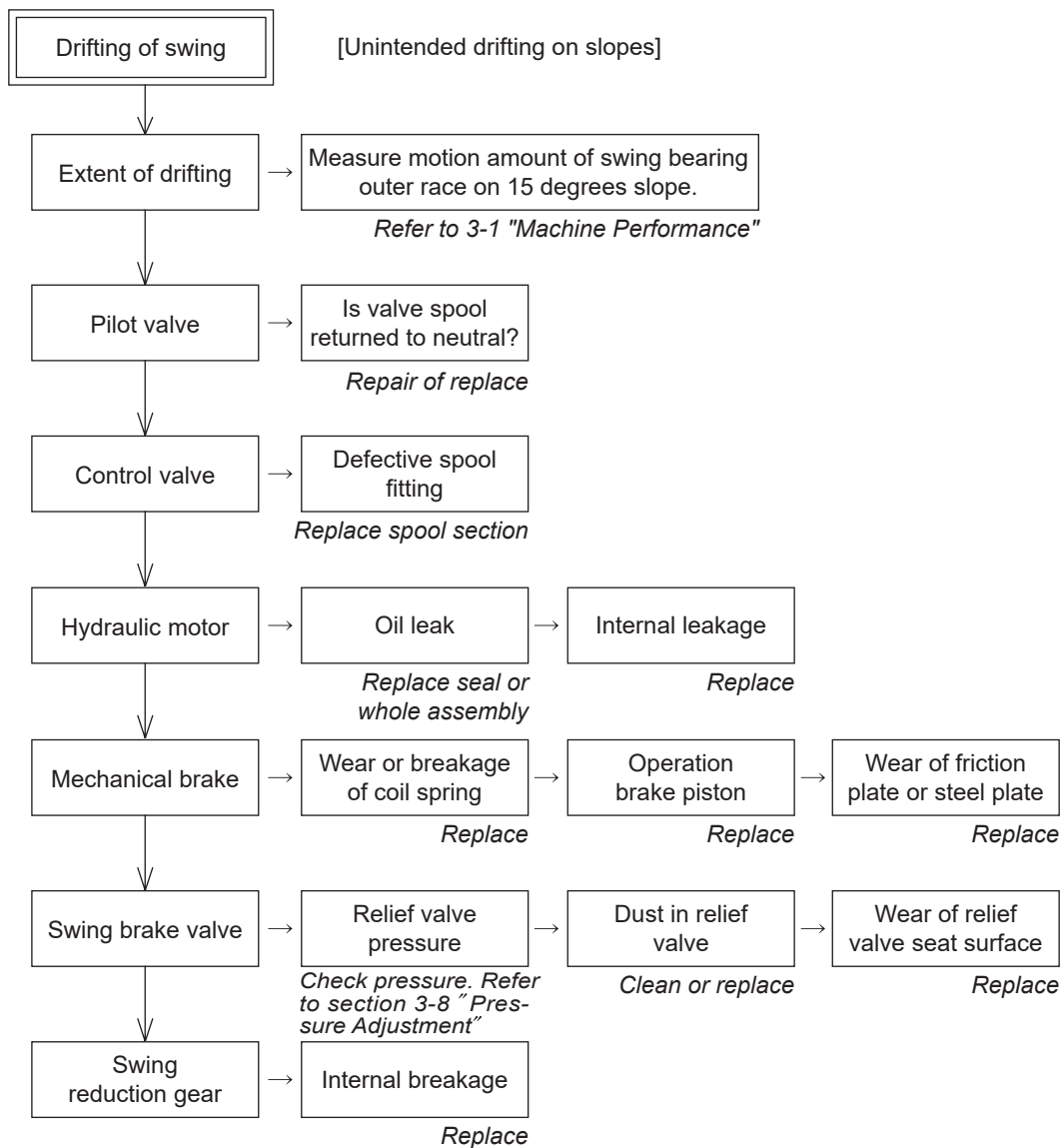
8. TROUBLESHOOTING



8. TROUBLESHOOTING

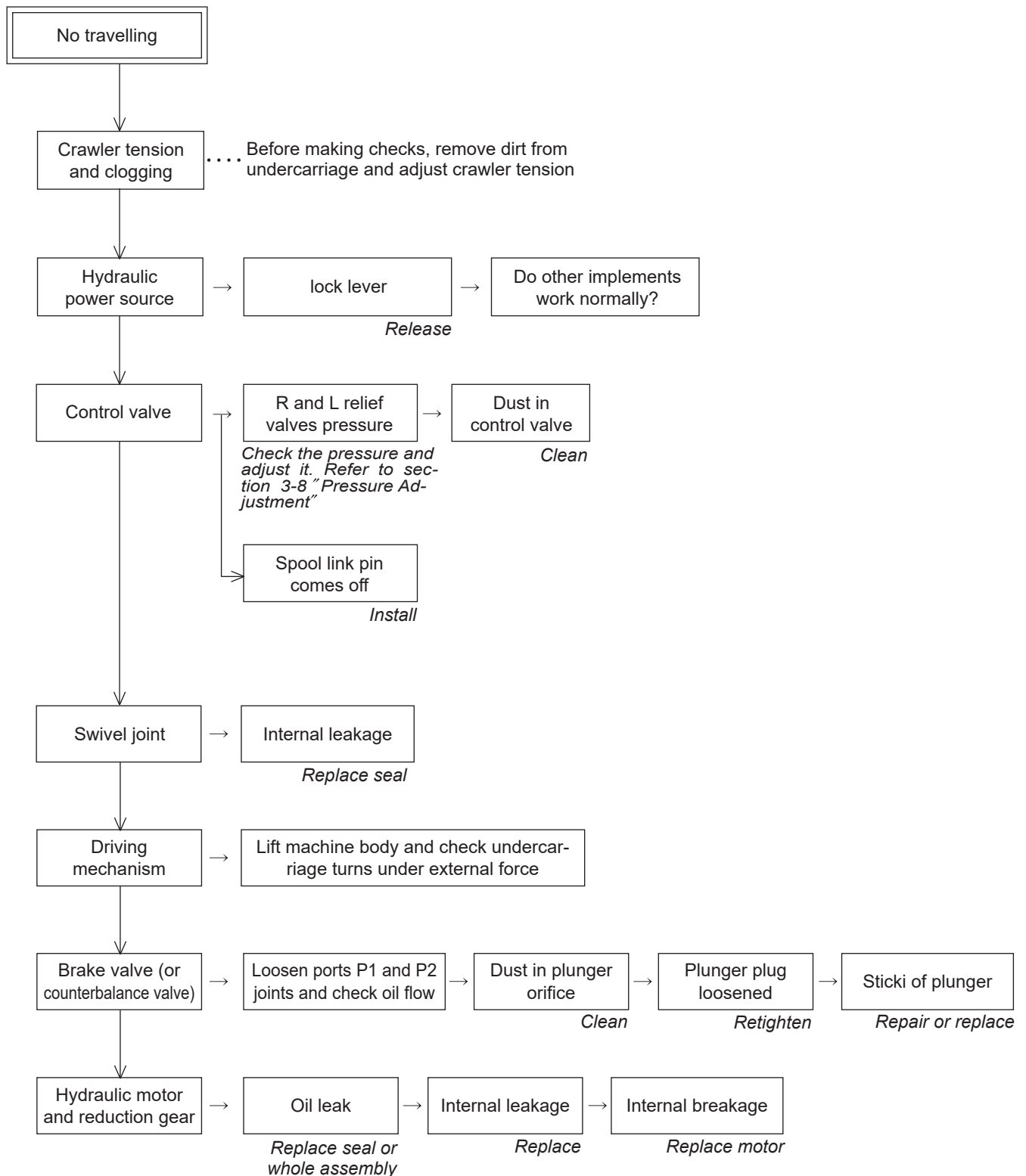


8. TROUBLESHOOTING

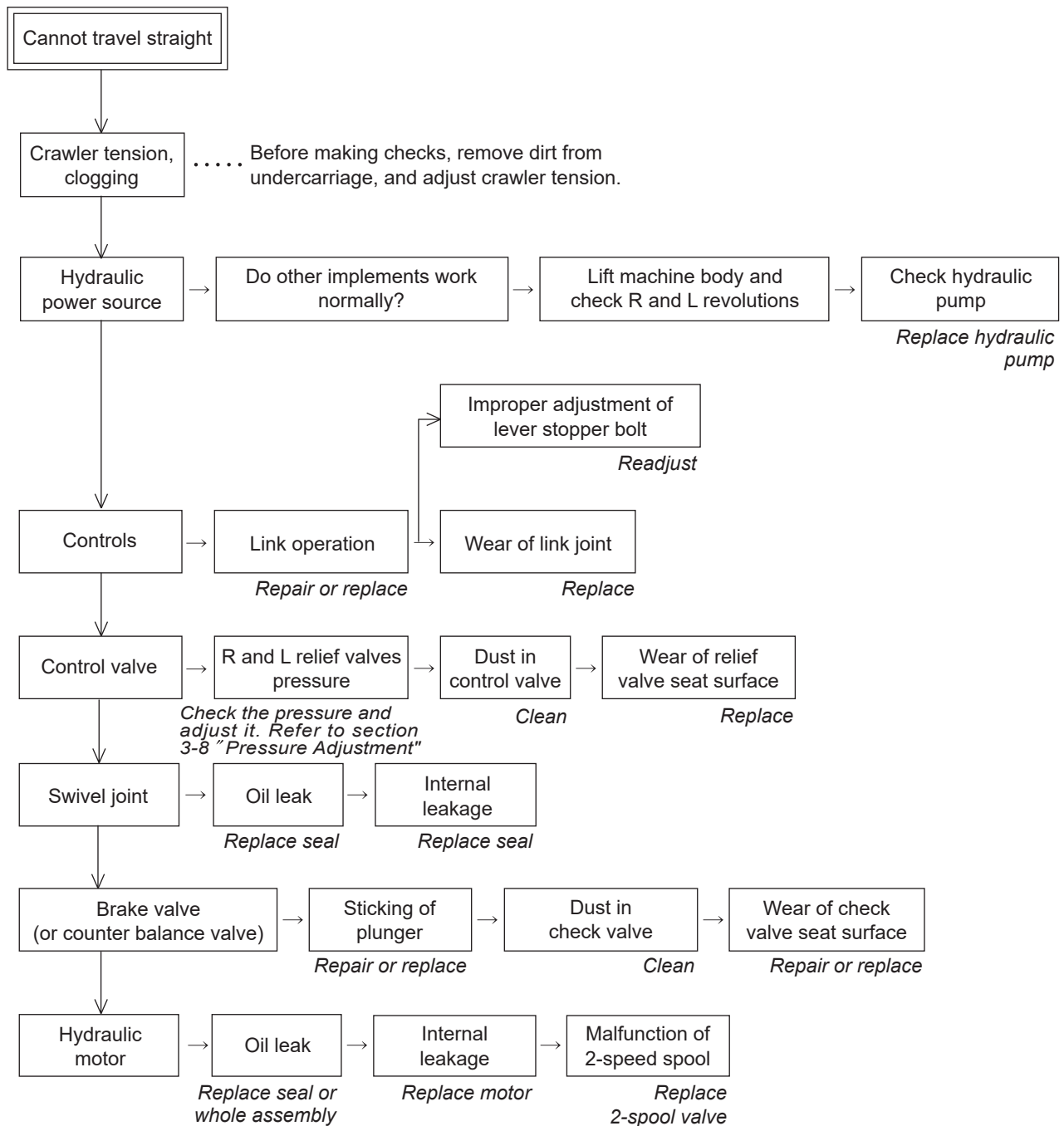


8. TROUBLESHOOTING

Travel Equipment



8. TROUBLESHOOTING



8. TROUBLESHOOTING

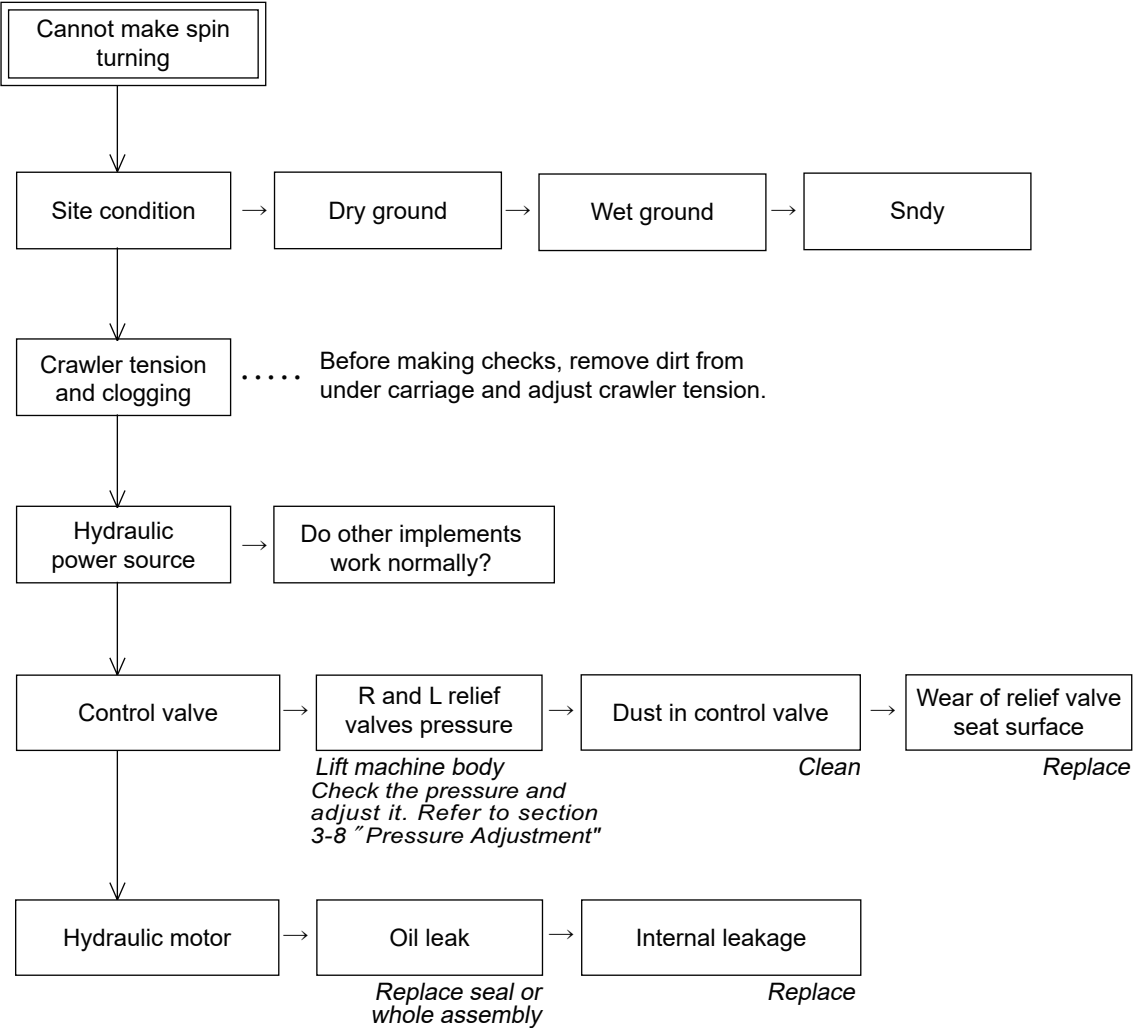
Inspection procedures

1. When the hydraulic tester is not used :
 - (1) Reverse the hoses of the hydraulic pumps P1 and P2.
Phenomenon : Reversed Replace the hydraulic pump.
 - (2) Reverse the hoses between the control valve and the swivel joint.
Phenomenon : Reversed Overhaul or replace the control valve.
 - (3) Reverse the hoses between the swivel joint and the brake valve (or counter balance valve).
Phenomenon : Reversed Overhaul or replace the swivel joint.
 - (4) Reverse the left and right hydraulic motors.
Phenomenon : Reversed Replace the counter balance valve (or counter balance valve) or the motor.
2. When the hydraulic tester is used :
 - (1) Flow volume at no load (Check the difference between the right and left motors.)
 - (2) Flow volume when loaded (Check the difference between the right and left motors.)

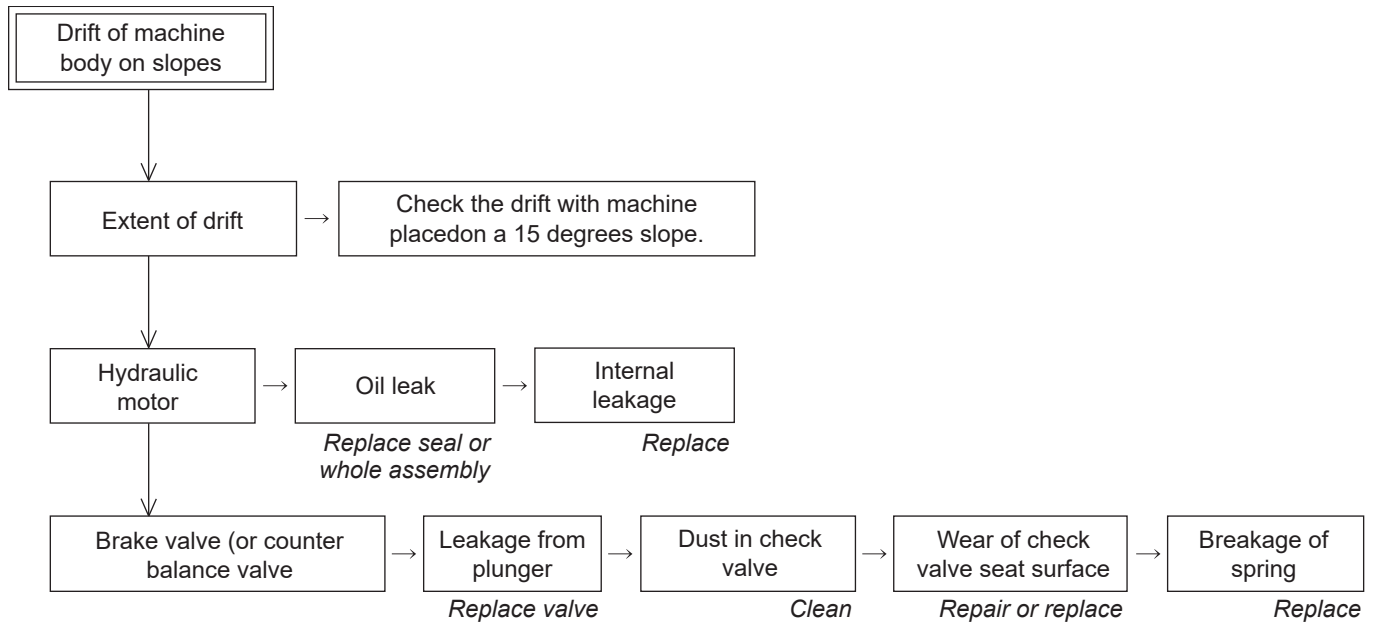
Conditions :

- (1) Discharge volume at no load
 - (2) Discharge volume when loaded
 - (3) Engine at rated speed.
 - (4) Hydraulic oil temp. at 122 to 140°F (50 to 60°C)
- } Make judgment by reading the difference between the right and left motors.

8. TROUBLESHOOTING



8. TROUBLESHOOTING



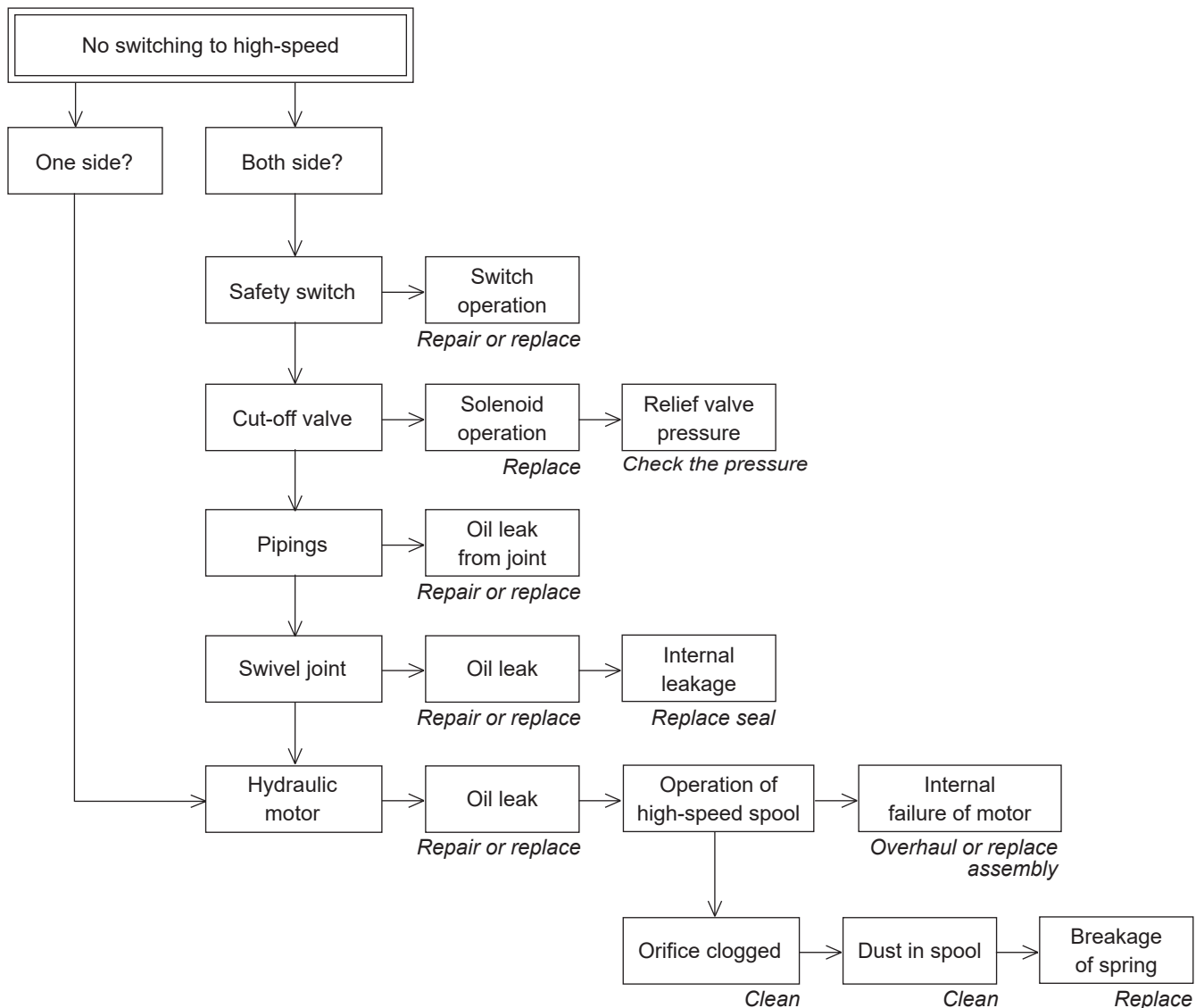
Inspection procedures

Check the drift with the machine placed on a slope with an inclination angle below 15 degrees.

[1] Continuous drift : Brake valve (or counter balance valve) is faulty.

[2] Discontinuous drift : Hydraulic motor is faulty.

8. TROUBLESHOOTING

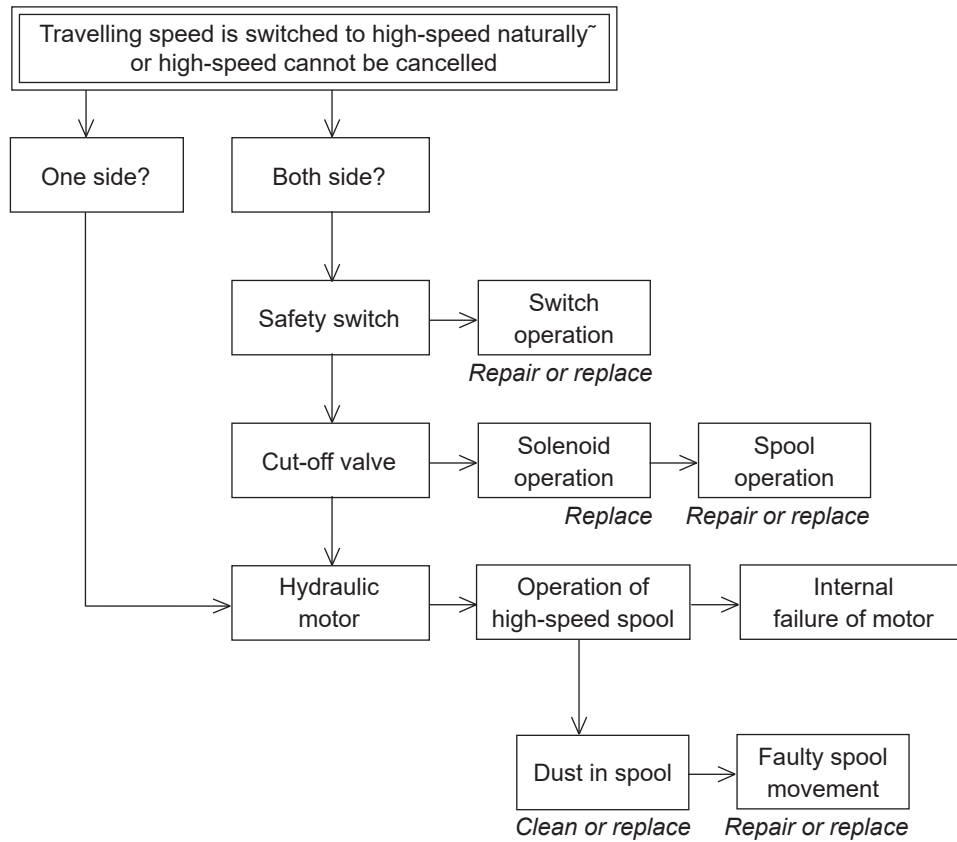


Note :

When the oil temp. is still very low, switching to high-speed may not be made immediately when treading on the high-speed pedal. This problem disappears as the oil temperature rises.

(Refer to Section "10-1-7 Time Lag on Travel Speed Switching".)

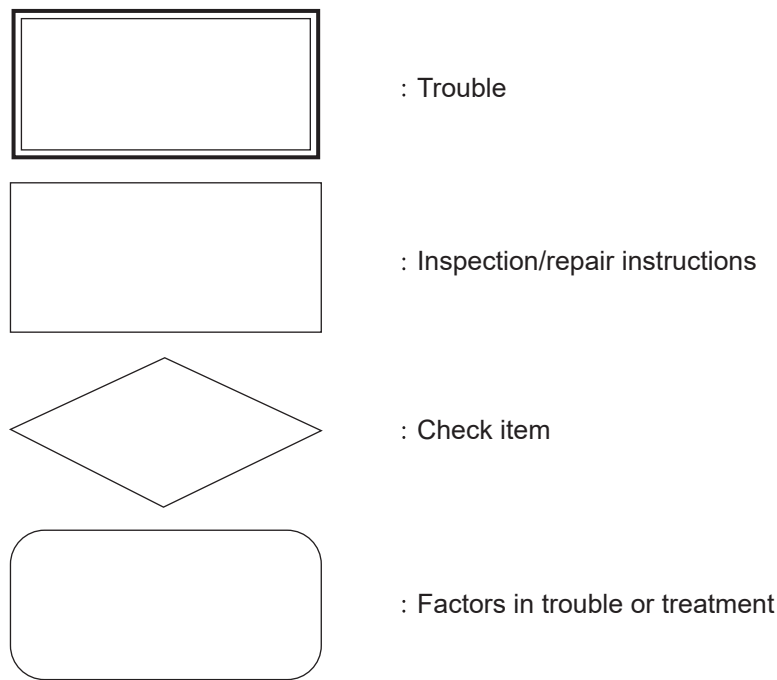
8. TROUBLESHOOTING



8. TROUBLESHOOTING

8-2-2 Electrical Equipment on Panel

(1) How to read the chart

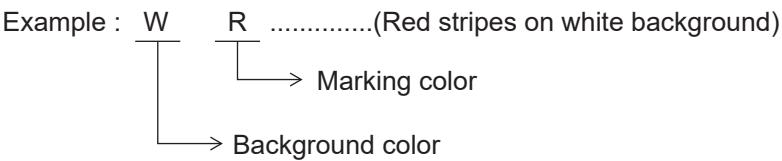


(2) Refer to the wiring diagram for the number of the connector terminal and lead wire color.

(3) Color marks of leads

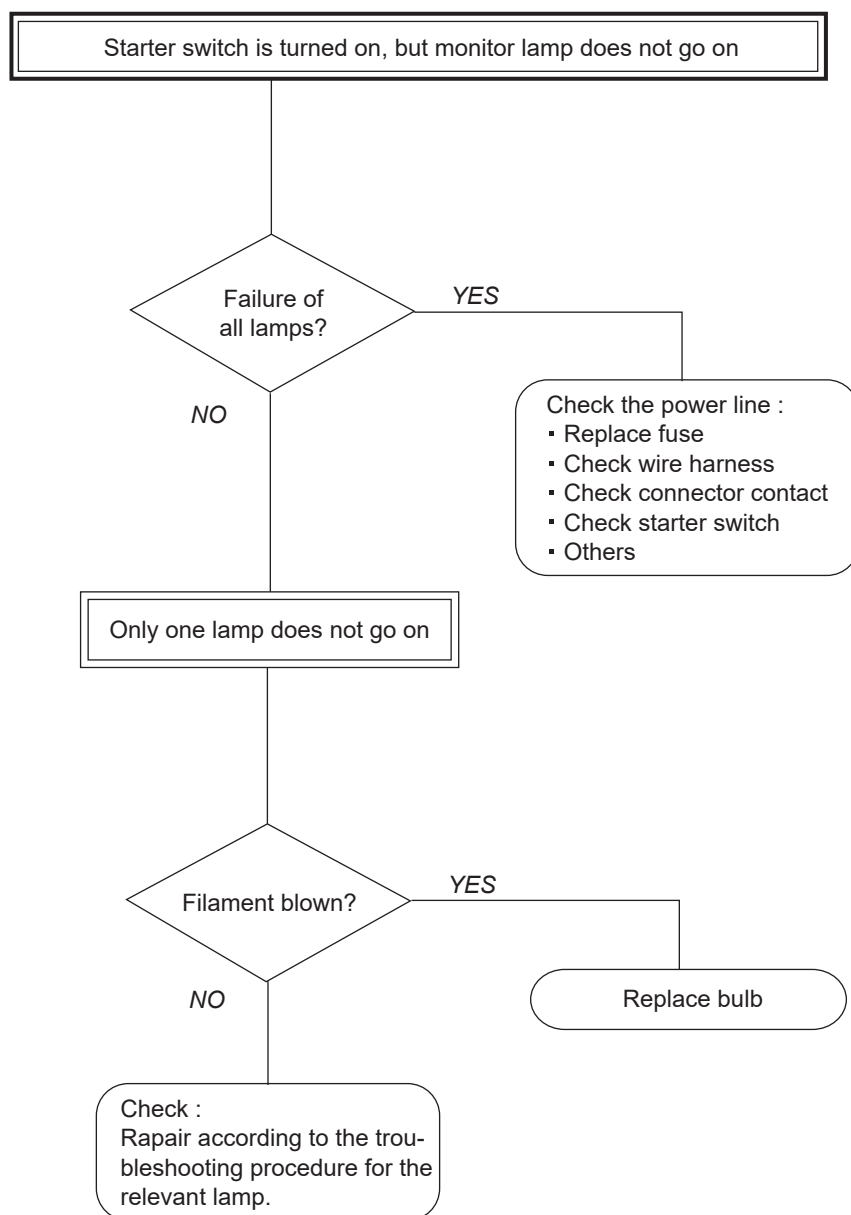
W (White)	B(Black)	R (Red)	Y (Yellow)
G (Green)	L (Blue)	Br (Brown)	Lg (Light green)
O (Orange)	Gr (Grey)		

Combination of colors



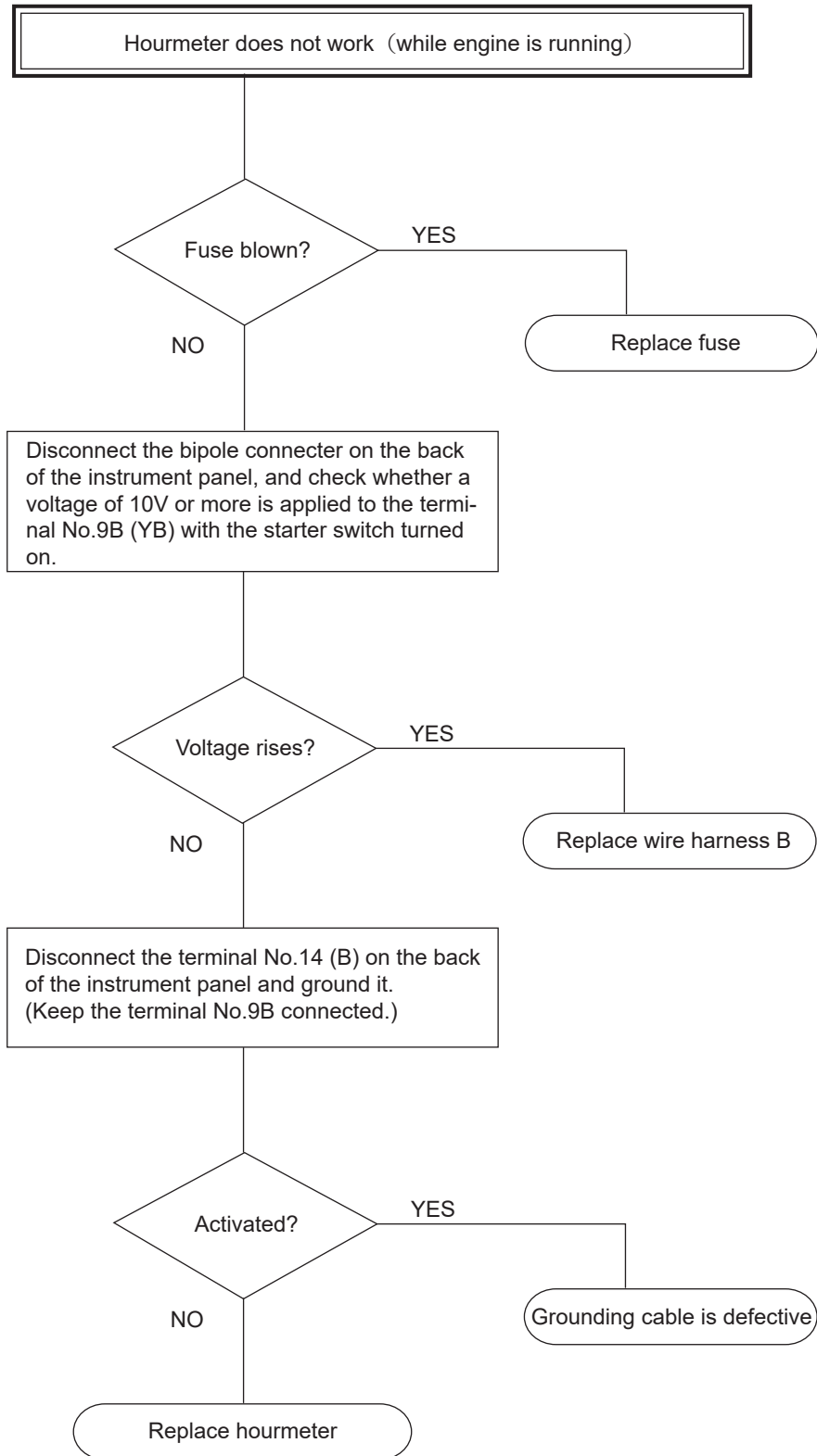
8. TROUBLESHOOTING

Monitor Lamps



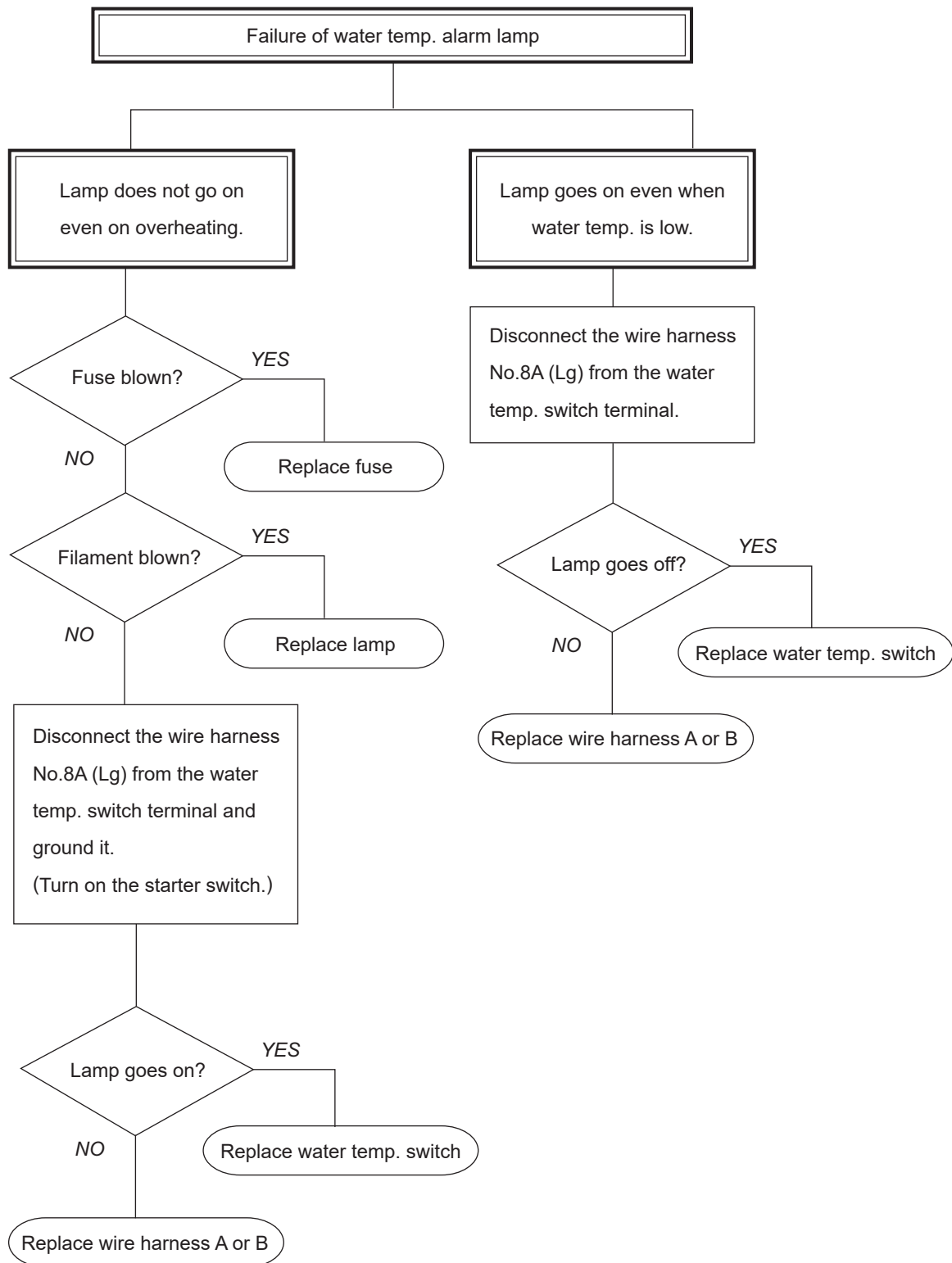
8. TROUBLESHOOTING

Hourmeter



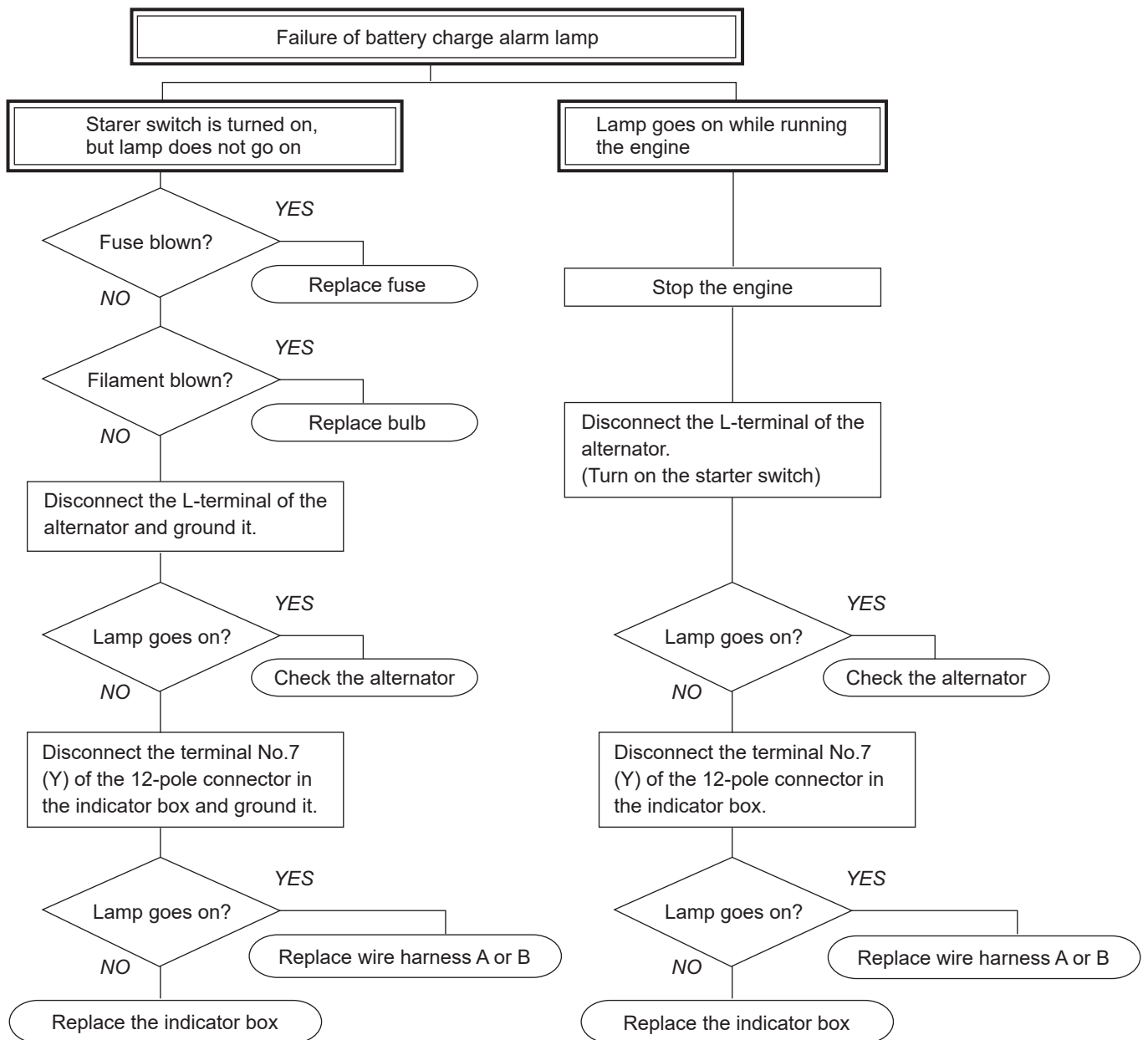
8. TROUBLESHOOTING

Water Temp. Alarm Lamp



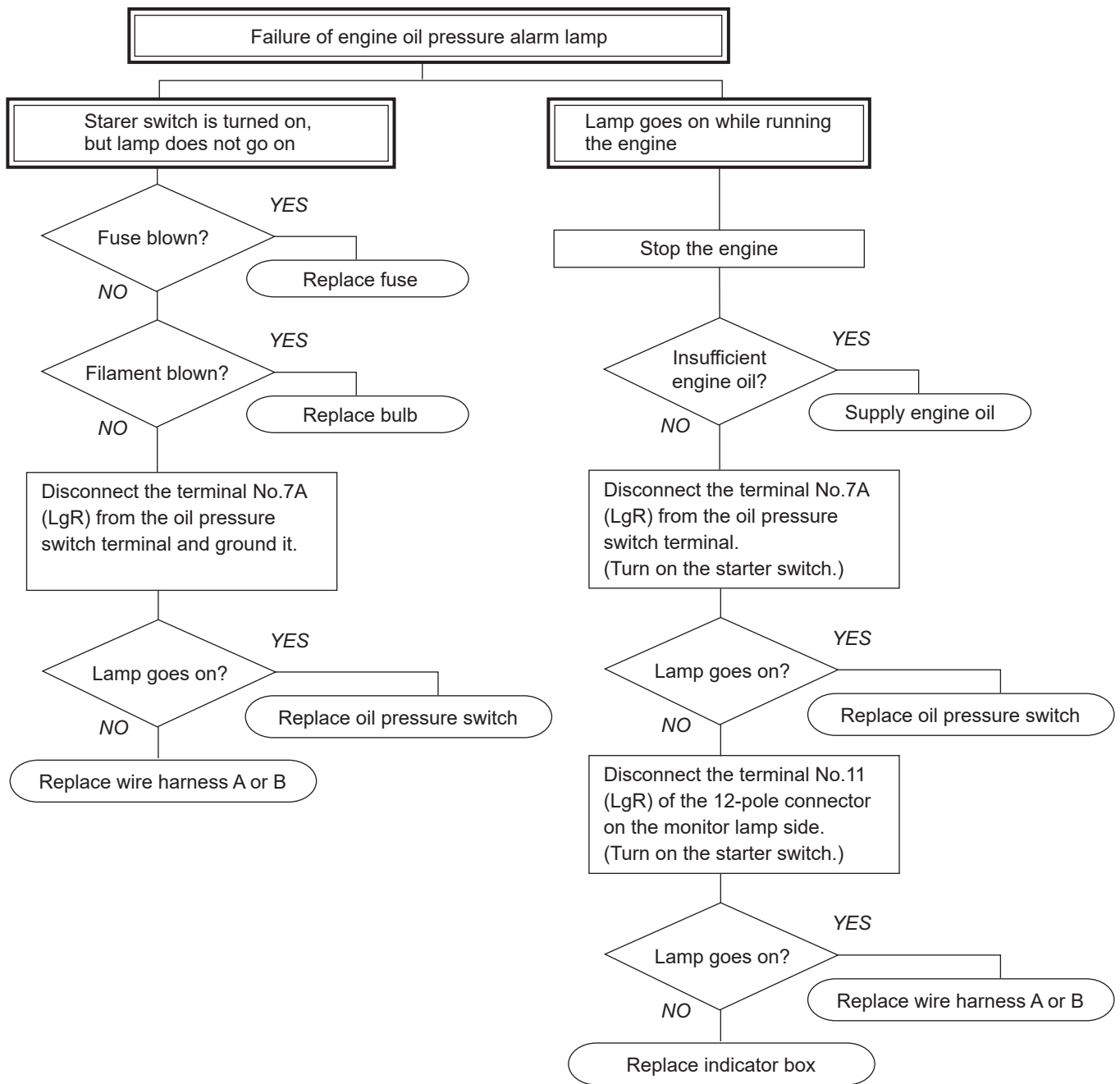
8. TROUBLESHOOTING

Battery Charge Alarm Lamp



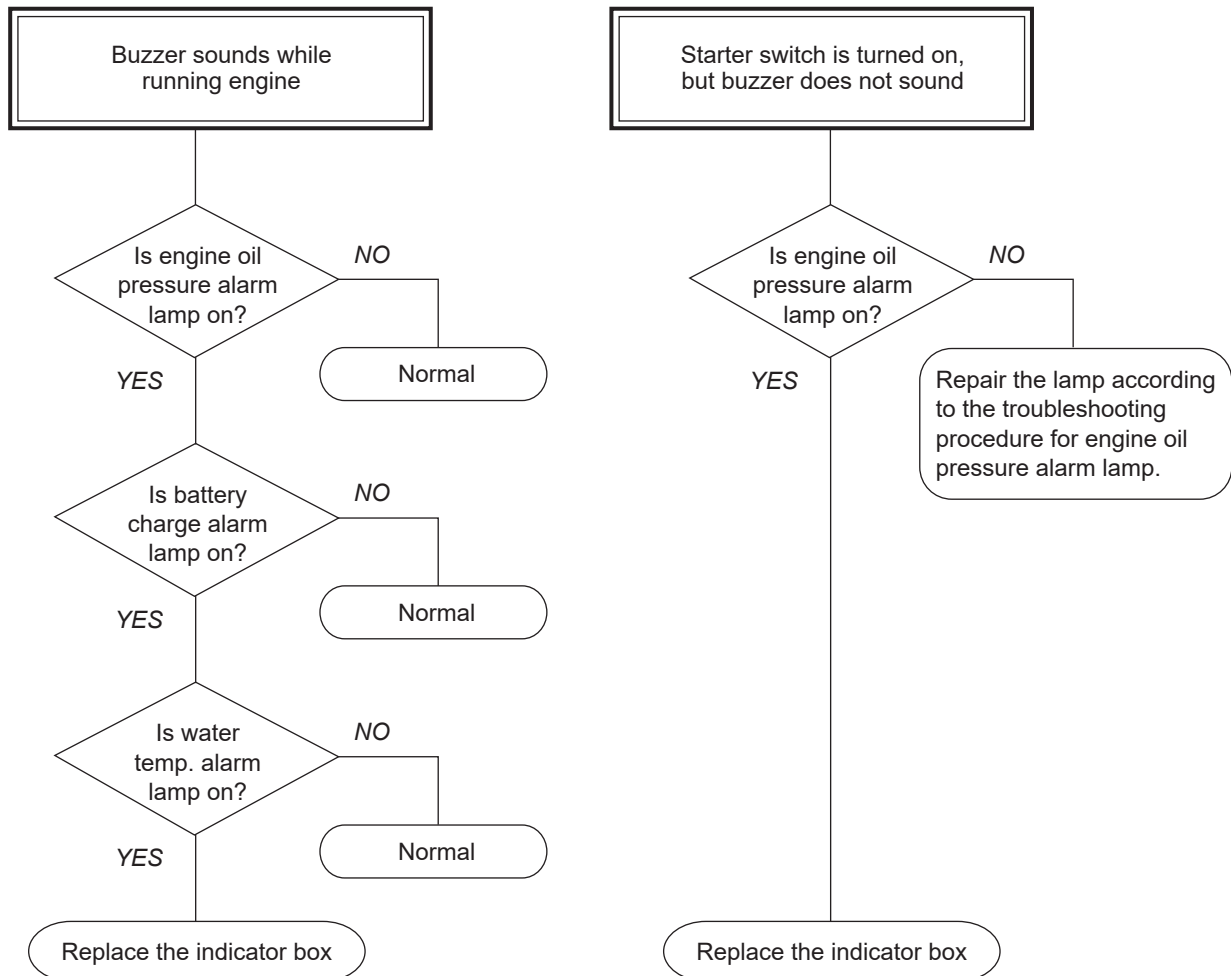
8. TROUBLESHOOTING

Engine Oil Pressure Alarm Lamp



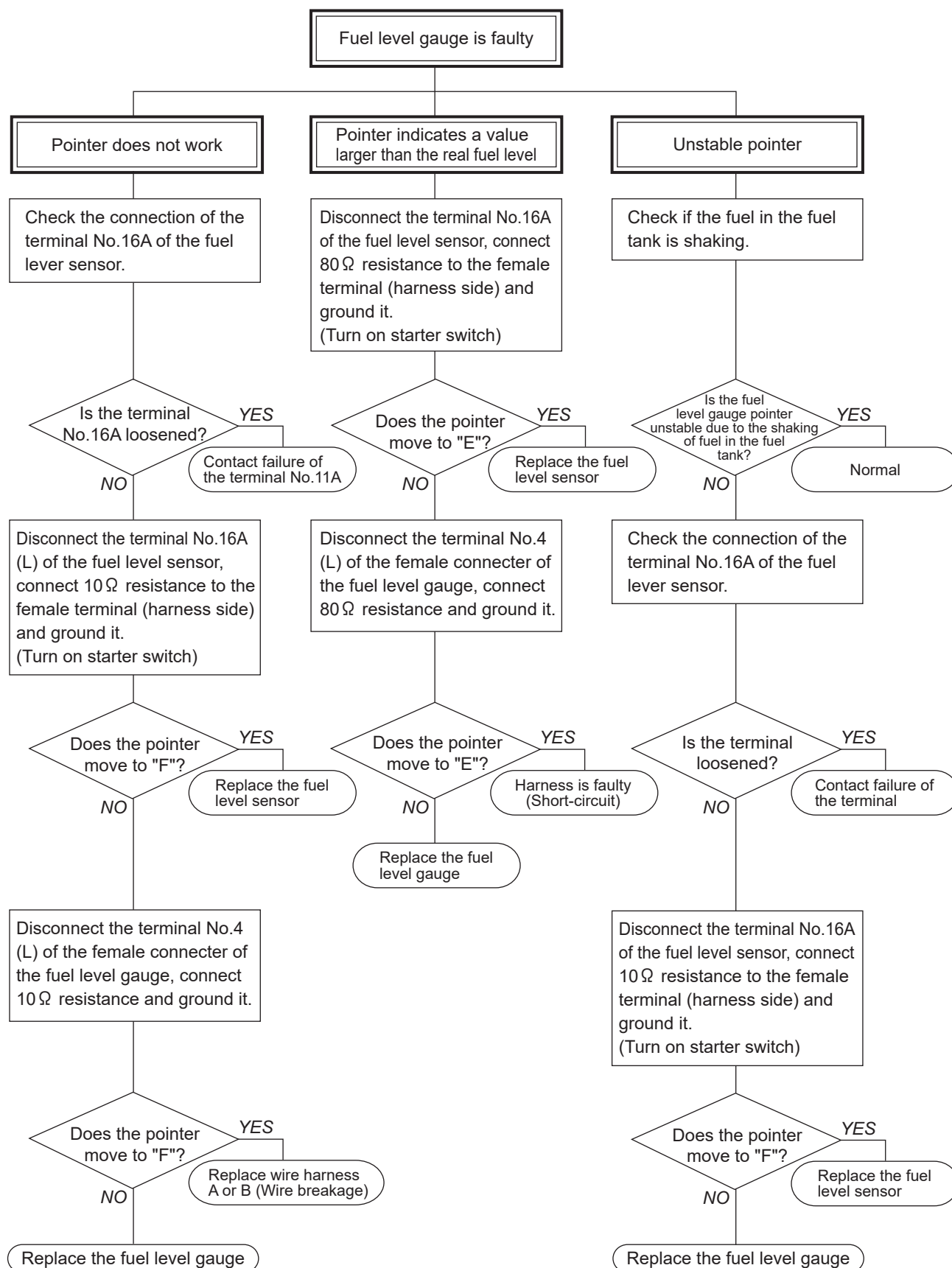
8. TROUBLESHOOTING

Warning Buzzer



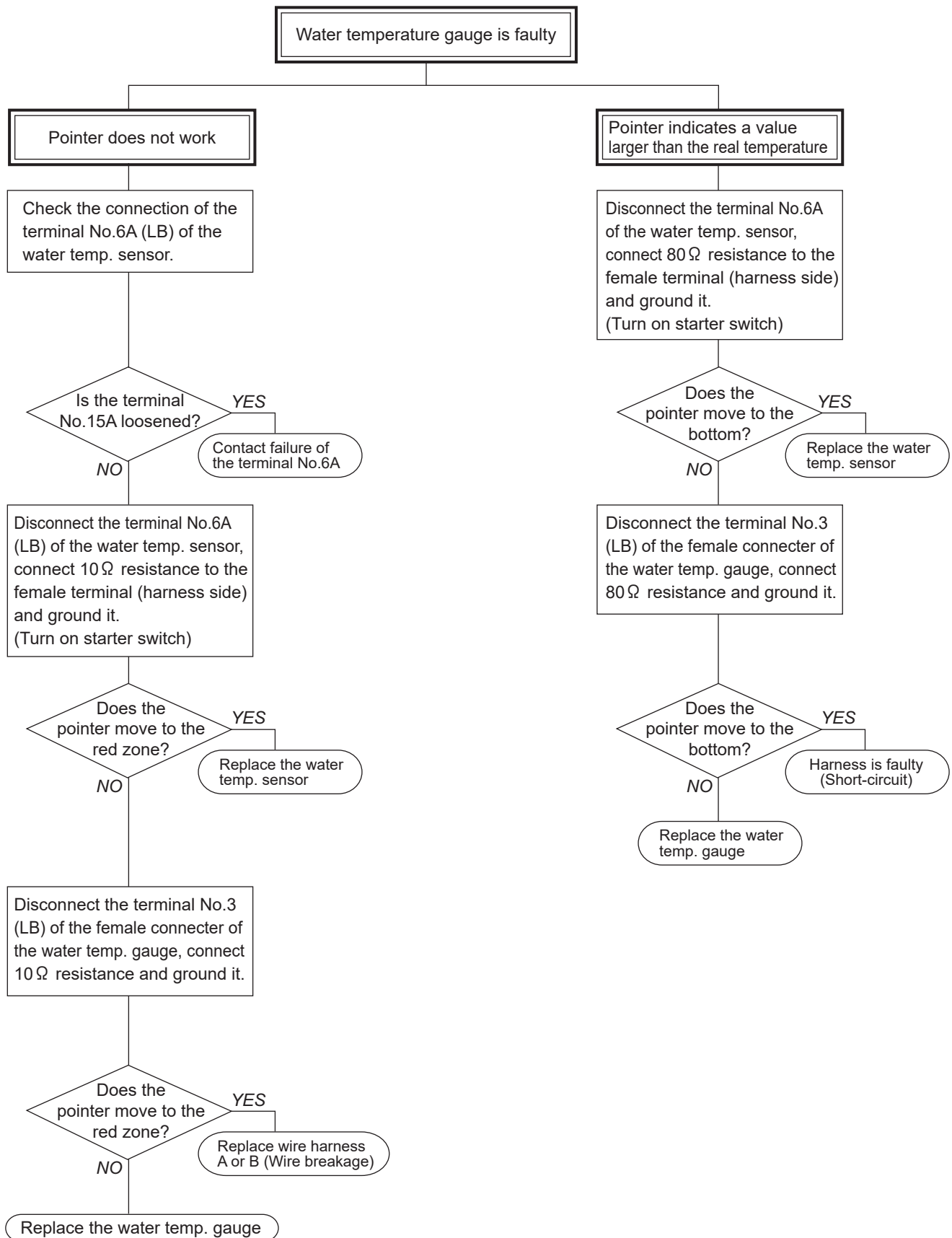
8. TROUBLESHOOTING

Fuel Level Gauge



8. TROUBLESHOOTING

Water Temperature



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