



SERVICE MANUAL

MINI EXCAVATOR

SV08-1A
SV08-1A(S)
SV08-1C

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.

In case of exporting this product and providing the related technical material to non-residents in Japan or residents overseas, it is required to comply with the export and trade control laws and regulations of Japan and other relevant countries.

Please be sure to follow the necessary procedure.

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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

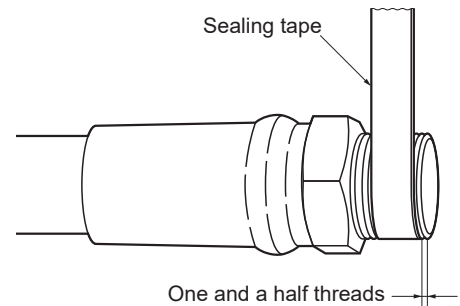
- (1) Check the service record of the machine. (That is, check how many months or hours the machine has been used since the preceding overhaul, what was the trouble then and what parts were replaced.)
- (2) Have all servicing tools ready, i.e., tools, measuring devices (which have received periodic maintenance), 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 0.4 in. (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 2.0 to 3.9 in. (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.

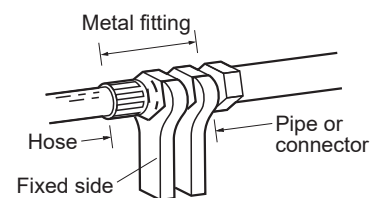
1-6 Cautions for Removal and Installation of Hydraulic Piping

- (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.

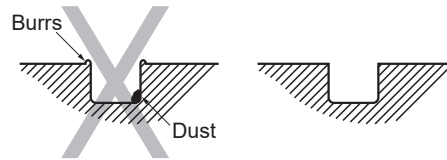
- (2) When installing hoses, first tighten to the specified torque and then loosen them a little. Then retighten to the specified torque.
 - Break in the installed parts before tightening (except those using seal tapes).
- (3) When installing pipes, turn the nuts more 1/4 to 1/2 turn after they reach 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.



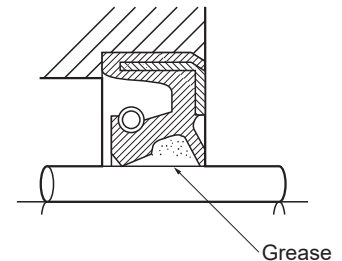
1. GENERAL CAUTIONS FOR MAINTENANCE WORK

1-7 Cautions for Handling Seals

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



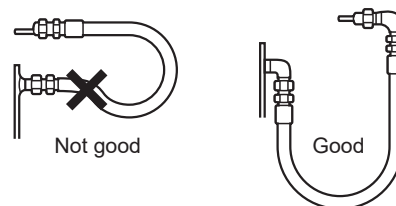
- (2) Take care not to twist O-rings. Correct by your finger if it is twisted.
- (3) Take care not to damage seals when inserting.
- (4) Handling of floating seals :
- Completely wipe off all the oil from the O-ring and housing after detaching the floating seals.
 - Before installing, apply a little 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.



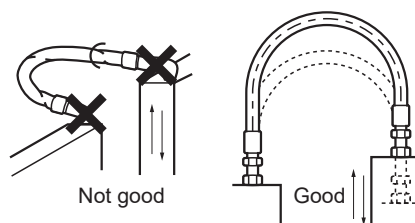
1-8 Correct Installation of Hydraulic Hose

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.

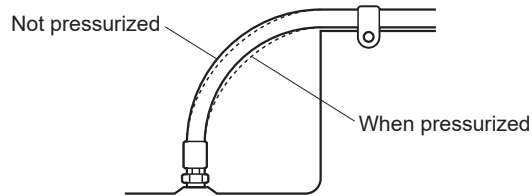


- (2) To prevent twisting, the hose should be bent in the same direction as it moves.

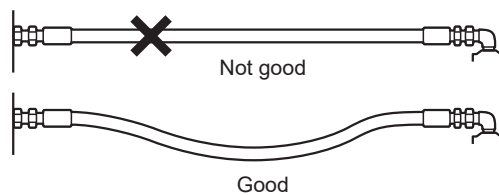


1. GENERAL CAUTIONS FOR MAINTENANCE WORK

- (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.



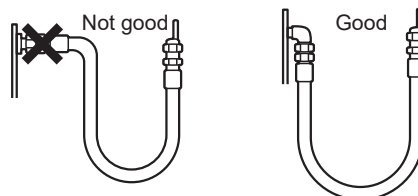
- (4) It is necessary for the hose to have ample slackness for elongation and contraction, because its length will change by +2 % to -4 % when used at high pressure.



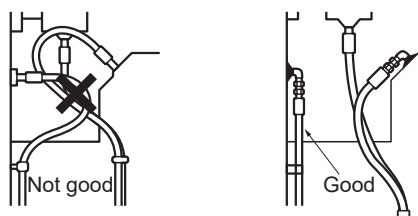
- (5) Use the proper adapters, not pipes, in order to reduce the number and length of joints and improve the external appearance.



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

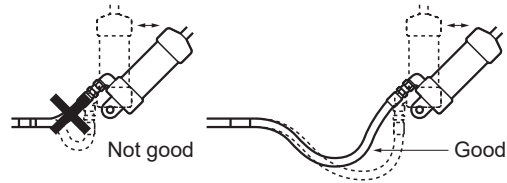


- (7) Use adapters to make the hose as straight as possible. The outside appearance can be improved by avoiding the use of hoses that are too long.

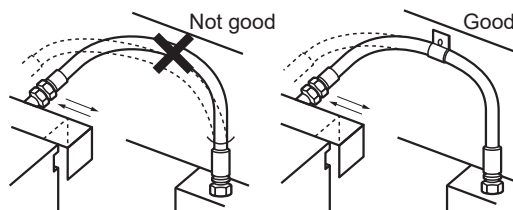


1. GENERAL CAUTIONS FOR MAINTENANCE WORK

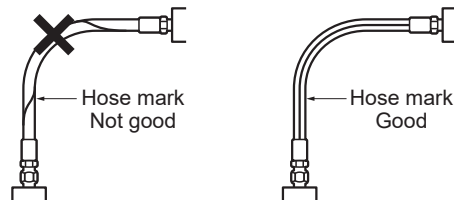
- (8) The hose should be slightly longer than is absolutely necessary. The extra allows smoother movement of the hose and prevents sharp bending.



- (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.

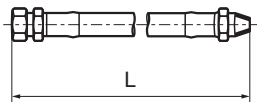


1. GENERAL CAUTIONS FOR MAINTENANCE WORK

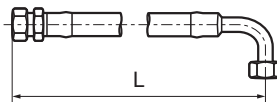
1) Type of Hose (Hose Dia. & Recommended Working Pressure)

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)

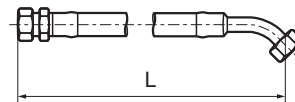
2) Total Length of Hose [Unit : in. (cm)]



3 digit indication in. (cm)



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



3) Hose Dia. (Unit : inch)

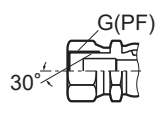
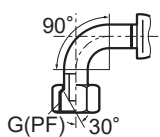
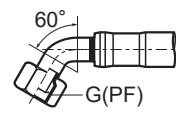
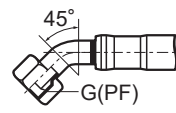
02....1/4"	05....5/8"	12....1 1/4"
03....3/8"	06....3/4"	14....1 1/2"
04....1/2"	10....1	

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)
3	A·E		
4	B·B	B	 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		
		D	 60 degrees bent type. 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

(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

(2) Special Parts

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

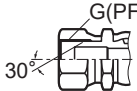
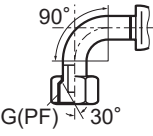
3 Recommended working pressure PSI(Mpa)

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

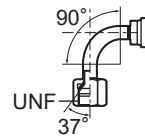
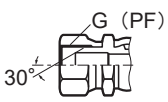
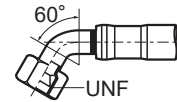
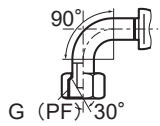
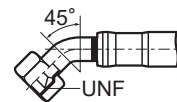
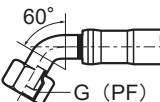
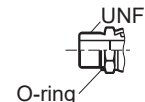
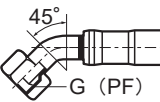
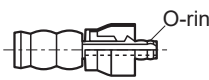
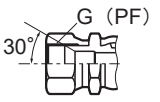
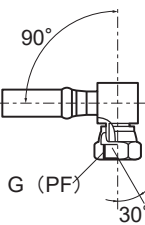
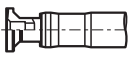
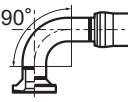
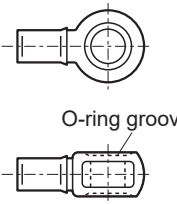
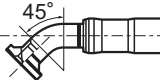
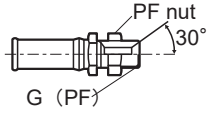
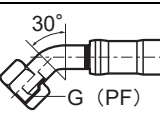
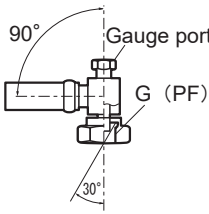
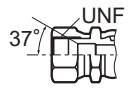
The example hose, P 2 06 AB 075 W stands for :

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
 R (PT) Taper pipe thread R (PT)	A	 90° UNF 37° 90 degrees bent type. UNF thread with female 37 degrees seat	P
 G (PF) 30° Straight pipe thread G (PF) with male 30 degrees seat	B	 60° UNF 60 degrees bent type. UNF thread with female 37 degrees seat	Q
 90° G (PF) 30° 90 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	C	 45° UNF 45 degrees bent type. UNF thread with female 37 degrees seat	R
 60° G (PF) 60 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	D	 UNF O-ring UNF, thread with O-ring groove	S
 45° G (PF) 45 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	E	 O-ring One-touch fitting (male)	T
 G (PF) 30° Straight pipe thread G (PF) with male 30 degrees seat	F	 90° G (PF) 30° 90 degrees elbow straight pipe thread male 30 degrees seat	V
 O-ring flange type	G		
 90° 90 degrees bent O-ring flange type	H	 O-ring groove Eyejoint with O-ring groove	W
 45° 45 degrees bent O-ring flange type	J		
 G (PF) 30° Straight pipe thread, female 30 degrees seat with O-ring groove	K	 PF nut 30° G (PF) Straight pipe thread with jam nut female 30 degrees seat	X
 30° G (PF) 30 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	L	 90° Gauge port G (PF) 30° 90 degrees elbow straight pipe thread with gauge port plug male 30 degrees seat	Z
 NPTF Taper pipe thread NPTF	M		
 UNF 37° 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.

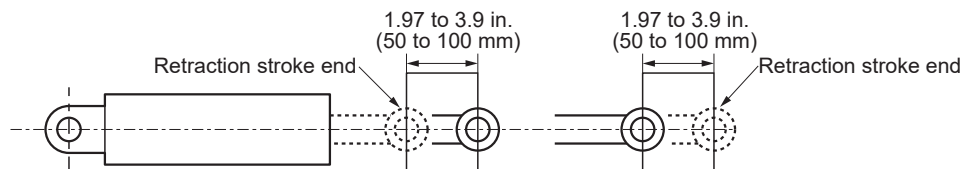
1. Air Release of Each Hydraulic Component

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

2. 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.

CHAPTER 2

TECHNICAL DATA

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2-2 Outline Drawing and Working Area	2-2-1
2-3 Weight List of Main Parts	2-3-1
2-4 Lifting Capacity List.....	2-4-1
2-5 Specifications for Attachment	2-5-1
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2. TECHNICAL DATA

2. Technical Data

2-1 Specifications

Note : < > : at minimum track gauge

Item			Unit	SV08-1A, SV08-1A(S), SV08-1C	
				Link track gauge change type SV08-1A	Slide track gauge change type SV08-1A(S), SV08-1C
Main specifications of machine					
Dimensions					
Overall length (Transportation position)			in. (mm)	102.4 (2600)	
Canopy	Overall height	Transportation position	in. (mm)	86.6 (2200) <90.6 (2300)>	86.6 (2200)
		Traveling position	in. (mm)	86.6 (2200) <90.6 (2300)>	86.6 (2200)
	Overall width	Full machine width	in. (mm)	33.1 (840) <26.8 (680)>	
Cabin	Overall height	Transportation position	in. (mm)	-	
		Traveling position	in. (mm)	-	
	Overall width	Full machine width	in. (mm)	-	
Tumbler center distance			in. (mm)	35.4 (900)	
Track gauge			in. (mm)	26.0 (660) <19.7 (500)>	
Minimum ground clearance			in. (mm)	5.1 (130) <9.1 (230)>	5.1 (130)
Traveling performance					
Travel speed	Steel crawler	Low speed (Forward/Reverse)	MPH (km/hr)	-	
		High speed (Forward/Reverse)	MPH (km/hr)	-	
	Rubber crawler	Low speed (Forward/Reverse)	MPH (km/hr)	1.12 (1.8) / 1.12 (1.8)	
		High speed (Forward/Reverse)	MPH (km/hr)	-	
Climbing ability			degrees	-	
Permissible water depth limit			in. (mm)	11.4 (290)	
Work performance					
Bucket	Width (Standard)		in. (mm)	13.8 (350)	
	(Standard. JIS heaped capacity)		cu.ft. (cu.m)	0.78 (0.022)	
	Number of teeth / Installation method		pcs.	3 / Weld	
Maximum digging depth	With blade raised		in. (mm)	59.1 (1500)	
	With blade on the ground		in. (mm)	63.8 (1620)	
Maximum depth of vertically digging			in. (mm)	49.6 (1260)	
Maximum dumping height			in. (mm)	76.8 (1950) <80.7 (2050)>	76.8 (1950)
Minimum front swing radius (with boom in front)			in. (mm)	46.5 (1180)	
Minimum front swing radius (at 90 degrees right boom swing)		Canopy	in. (mm)	37.4 (950)	
		Cabin	in. (mm)	-	
Rear swing radius			in. (mm)	28.0 (710)	

2. TECHNICAL DATA

Note : < > : at minimum track gauge

Item	Unit	SV08-1A, SV08-1A(S), SV08-1C		
		Link track gauge change type SV08-1A	Slide track gauge change type SV08-1A(S), SV08-1C	
Main specifications of machine				
Work performance				
Boom swing angle	Canopy	Left	degrees	45
		Right	degrees	90
	Cabin	Left	degrees	-
		Right	degrees	-
Maximum digging force	Bucket		lbs. (kN)	2360 (10.5)
	Arm		lbs. (kN)	1390 (6.2)
Maximum tractive force (Oil pressure force)			lbs. (kN)	1550 (6.9)
Maximum swing inclination angle (with standard bucket and load)			degrees	20
Swing speed			rpm	8.4
Fuel consumption in practical operation			Gals. (L) / h	0.28 (1.05)
Blade				
Blade	Width×Height		in. (mm)	33.1 (840) <26.8 (680)>×7.1 (180)
	Capacity		cu.ft. (cu.m)	0.989 (0.028) <0.777 (0.022)>
	Lift above ground level		in. (mm)	7.1 (180) <11.0 (280)>
	Digging depth		in. (mm)	8.3 (210)
Mean contact pressure				
JIS	Steel crawler	Canopy	PSI (KPa)	-
		Cabin	PSI (KPa)	-
	Rubber crawler	Canopy	PSI (KPa)	4.15 (28.4)
		Cabin	PSI (KPa)	4.18 (28.8)
Mass				
Operating mass	Steel crawler	Canopy	lbs. (kg)	-
		Cabin	lbs. (kg)	-
	Rubber crawler	Canopy	lbs. (kg)	2348 (1065)
		Cabin	lbs. (kg)	2282 (1035)
Base machine dry mass	Steel crawler	Canopy	lbs. (kg)	-
		Cabin	lbs. (kg)	-
	Rubber crawler	Canopy	lbs. (kg)	1555 (705)
		Cabin	lbs. (kg)	1488 (675)
Hydraulic equipment				
Hydraulic pump				
Drive method				Engine → CF Coupling → Pump (Direct drive)
Type of main pump				External gear pump
Number of pumps			pcs.	2
Theoretical discharge volume			cu.in. (cu.cm) / rev	0.249 (4.08)
Maximum allowable pressure			PSI (MPa)	2625 (18.1)

2. TECHNICAL DATA

Note : < > : at minimum track gauge

Item			Unit	SV08-1A, SV08-1A(S), SV08-1C		
				Link track gauge change type SV08-1A	Slide track gauge change type SV08-1A(S), SV08-1C	
Hydraulic equipment						
Control valve						
Number of connected valves			pcs.	10		
System relief set pressure			PSI (MPa)	2625 (18.1)		
Circuit relief set pressure	Boom (at rod end)		PSI (MPa)	3263 (22.5)		
	Boom (at bottom end)		PSI (MPa)	-		
	Arm (at rod end)		PSI (MPa)	-		
	Arm (at bottom end)		PSI (MPa)	3263 (22.5)		
	Bucket (at rod end)		PSI (MPa)	-		
	Bucket (at bottom end)		PSI (MPa)	-		
	Boom swing / offset (at rod end)		PSI (MPa)	-		
	Boom swing / offset (at bottom end)		PSI (MPa)	-		
	Blade (at rod end)		PSI (MPa)	-		
	Blade (at bottom end)		PSI (MPa)	-		
	Swing brake (Right)		PSI (MPa)	1001 (6.9)		
	Swing brake (Left)		PSI (MPa)	1001 (6.9)		
Cylinder						
Boom	Stroke		in. (mm)	13.2 (335)		
	Inside diameter		in. (mm)	1.97 (50)		
	Piston rod diameter		in. (mm)	0.98 (25)		
	Speed	Up (Ground → Max.)		sec.	2.4	
		Down (Max. → Ground)		sec.	2.4	
Arm	Stroke		in. (mm)	11.1 (281)		
	Inside diameter		in. (mm)	1.97 (50)		
	Piston rod diameter		in. (mm)	0.98 (25)		
	Speed	Full stroke for digging		sec.	3.2	
		Full stroke for dumping		sec.	2.4	
Bucket	Stroke		in. (mm)	10.6 (270)		
	Inside diameter		in. (mm)	1.77 (45)		
	Piston rod diameter		in. (mm)	0.98 (25)		
	Speed	Full stroke for digging		sec.	2.5	
		Full stroke for dumping		sec.	1.8	
Blade	Stroke		in. (mm)	3.5 (88)		
	Inside diameter		in. (mm)	1.97 (50)		
	Piston rod diameter		in. (mm)	0.98 (25)		
	Speed	Up (Ground → Max.)		sec.	1.1	
		Down (Max. → Ground)		sec.	0.9	
Boom swing	Stroke		in. (mm)	11.1 (283)		
	Inside diameter		in. (mm)	2.17 (55)		
	Piston rod diameter		in. (mm)	1.18 (30)		
	Speed	Full stroke to the right		sec.	3.1	
		Full stroke to the left		sec.	4.2	

2. TECHNICAL DATA

Note : < > : at minimum track gauge

Item				Unit	SV08-1A, SV08-1A(S), SV08-1C	
					Link track gauge change type SV08-1A	Slide track gauge change type SV08-1A(S), SV08-1C
Hydraulic equipment						
Cylinder						
Track gauge change	Stroke		in. (mm)	2.8 (72)	6.3 (160)	
	Inside diameter		in. (mm)	1.97 (50)		
	Piston rod diameter		in. (mm)	0.98 (25)		
	Speed	Max. track gauge		sec.	1.7	2.0
		Min. track gauge		sec.	1.3	1.8
Swivel joint						
Swivel joint port diameter×Number			inch×pcs.	1/4×9		
Motor						
Swing motor	Type			Orbit motor		
	Displacement		cu.in. (cu.cm) / rev	*Refer to the bottom note.		
	Brake valve	Type		-		
		Relief set pressure		PSI (MPa)	-	
Travel motor	Type			Variable displacement piston motor		
	Displacement (Low/High)		cu.in. (cu.cm) / rev	0.69 / 0.35 (11.35 / 5.67)		
	Brake valve	Type		Counterbalance valve		
		Relief set pressure		PSI (MPa)	-	
	Type of reduction gear			Planetary gear (with double-reduction mechanism)		
Hydraulic oil tank						
Tank capacity			Gals. (L)	2.83 (10.7) [tank: 1.51 (5.7)]		
Suction filter	Type			Wire gauze		
	Filtration area		sq.in. (sq.cm)	25.26 (163)		
	Filtration accuracy		Meshes	150		
Return filter	Type			Cartridge (filter type)		
	Filtration area		sq.in. (sq.cm)	220.1 (1420)		
	Filtration accuracy		μ	10		
	By-pass valve opening pressure		PSI (MPa)	21.32 (0.147)		
Locking device						
Lever lock				Link fastening		
Boom swing lock				-		
Swing lock				Pin type		
Swing device						
Swing bearing				-		
Power transmission				Swing motor shaft → Pinion gear → Swing gear		
Type of brake				-		
Brake mounting position				-		

* The motor displacement has been changed for design changes of the swing motor
 11.50 (188.5)[S/N 14001 to 17475] → 11.58 (189.8)[S/N 17476 to 19874] → 11.90 (195)[S/N 19875 to 19999, 1A000 and above]

2. TECHNICAL DATA

Note : < > : at minimum track gauge

Item			Unit	SV08-1A, SV08-1A(S), SV08-1C	
				Link track gauge change type SV08-1A	Slide track gauge change type SV08-1A(S), SV08-1C
Undercarriage					
Steel crawler	Shoe width		in. (mm)	-	
	Grouser	Type		-	
		Height	in. (mm)	-	
	Shoe and link mounting method			-	
	Link pitch		in. (mm)	-	
	Number of shoes (One side)		pcs.	-	
	Crawler drive method			-	
Rubber crawler	Shoe width		in. (mm)	7.1 (180)	
	Lug height		in. (mm)	0.7 (17)	
	Core metal pitch		in. (mm)	2.8 (72)	
Carrier roller (Upper roller)	Manner of support			-	
	Quantity (One side)		pcs.	-	
	Bearing			-	
	Sealing			-	
Number of shoe slide plates (One side)			pcs.	1	
Track roller (Lower roller)	Quantity (One side)		pcs.	2	
	Bearing			Ball bearing	
	Sealing			TW seal (Shaft seal w/sleeve)	
Idler	Quantity (One side)		pcs.	1	
	Bearing			Ball bearing	
	Sealing			QLN seal (Shaft seal w/sleeve)	
Number of sprocket teeth	Steel crawler		pcs.	-	
	Rubber crawler		pcs.	12	
Crawler tension adjustment				Adjusting bolt	
Engine					
Main specifications					
Engine model				2TE67L-BV3, 402J-05 IG84555R	
Type				Vertical type series water-cooled 4 cycle diesel engine	
Combustion system				Swirl pre-combustion chamber	
Number of cylinders - Bore×Stroke			pcs. - in. × in. (mm × mm)	2 - 2.64 × 2.83 (67 × 72)	
Total displacement			cu.in. (cu.cm)	30.9 (507)	
Rated output / engine speed			HP (kW)/rpm	10.3 (7.7)/2400	
Maximum torque / engine speed			ft•lbf (N•m) /rpm	23.2 (31.5)/2000	
Specific fuel consumption			lbs./HP•h (g/kW•h)	0.480 (292) or less	
Maximum idling speed			min ⁻¹ (rpm)	2575 to 2625	
Minimum idling speed			min ⁻¹ (rpm)	1175 to 1225	
Engine dry mass (excluding air cleaner and silencer)			lbs. (kg)	132 (60)	
Lubricating method				Forced lubrication by trochoid pump	

2. TECHNICAL DATA

Note : < > : at minimum track gauge

Item			Unit	SV08-1A, SV08-1A(S), SV08-1C	
				Link track gauge change type SV08-1A	Slide track gauge change type SV08-1A(S), SV08-1C
Engine					
Main specifications					
Specific lubricating oil consumption			lbs./HP•h (g/kw•h)	0.0002 to 0.0013 (0.1 to 0.8)	
Compression pressure			PSI (MPa)	420.6 (2.9) at 300 rpm	
Cylinder head					
Intake valve	Open	bTDC	degrees	13	
	Close	aBDC	degrees	43	
Exhaust valve	Open	bBDC	degrees	43	
	Close	aTDC	degrees	13	
Intake valve clearance (Cold engine)			in. (mm)	0.0079 (0.2)	
Exhaust valve clearance (Cold engine)			in. (mm)	0.0079 (0.2)	
Intake valve seat angle			degrees	90	
Exhaust valve seat angle			degrees	90	
Piston					
First compression ring	Ring shape			Barrel face	
	Ring quantity	pcs.		2	
Second compression ring	Ring shape			Inner cut	
	Ring quantity	pcs.		2	
Oil-ring	Ring shape			I type (with coil expander)	
	Ring quantity	pcs.		2	
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			sq.in. (sq.cm)	66.96 (432)	
Oil/water separator				Mesh filter screen	
Feed pump				Mechanical, diaphragm	
Lubrication system					
Lubrication pump				Trochoid pump	
LO pressure regulating valve opening pressure			PSI (kPa)	51.2 to 65.4 (353 to 451)	
LO filter				Full flow filter	
LO filter filtration area			sq.in. (sq.cm)	11.63 (75)	
Filter valve opening pressure			PSI (kPa)	11.6 to 17.4 (80 to 120)	
Operating pressure of alarm switch			PSI (kPa)	5.7 to 8.5 (39.2 to 58.8)	
Cooling device					
Cooling system				Forced circulation radiator cooling system	
Fan belt size				HM28 cogged	
Thermostat opening temperature			°F (°C)	163.4 to 170.6 (73 to 77)	
Thermostat full-open temperature			°F (°C)	188.6 (87) or more	

2. TECHNICAL DATA

Note : < > : at minimum track gauge

Item		Unit	SV08-1A, SV08-1A(S), SV08-1C	
			Link track gauge change type SV08-1A	Slide track gauge change type SV08-1A(S), SV08-1C
Engine				
Cooling device				
Radiator cap pressure		PSI (kPa)	12.79 (88.2)	
Radiator fan		pcs.×Ømm	7×Ø230	
Operating temperature of water temperature alarm switch		°F (°C)	224.6 to 235.4 (107 to 113)	
Air cleaner				
Type			Cyclone type	
Filtration area		sq.ft. (sq.m)	2.89 (0.44)	
Fuel injection pump				
Injection pump type			ND-PFR 2NC55A 2ND 857	
Injection pump plunger diameter		in. (mm)	0.2165 (5.5)	
Injection pump cam lifting height		in. (mm)	0.2559 (6.5)	
Fuel injection timing (FID)		degrees	13 to 15	
Firing order			1→2	
Nozzle				
Type			ND10PD41	
Nozzle hole diameter×Number of holes		Øin. (mm) ×pcs.	Ø0.0394 (Ø1.0)×1	
Spray angle		degrees	10	
Fuel injection pressure		PSI (MPa)	1734.65 to 1847.78 (11.96 to 12.74)	
Turbocharger				
Type			-	
Revolution speed		min ⁻¹ (rpm)	-	
Turbocharging pressure		mmHg	-	
Starting device				
Cold starting aids			Glow plug	
Starting aids capacity		V-A	11-8.5	
Battery type			44B-19L	
Battery voltage - 5 hrs rate capacity		V-Ah	12-30	
Electrical equipment				
Alternator	Type		GP8146	
	Nominal output	V-A	12-14	
	Rated speed	min ⁻¹ (rpm)	5200	
Current limiter	Type		RS5161	
	Regulation voltage	V	14 to 15	
Starter motor	Type		Direct current type	
	Nominal output	V-kW	12-1.2	
	Engagement		Magnet shift	
Stop motor	Type	-	-	
	Nominal output	V-A	-	
Stop solenoid	Regular	V-W	12-0.566	
	Moment	V-W	12-3.75	

2. TECHNICAL DATA

Note : < > : at minimum track gauge

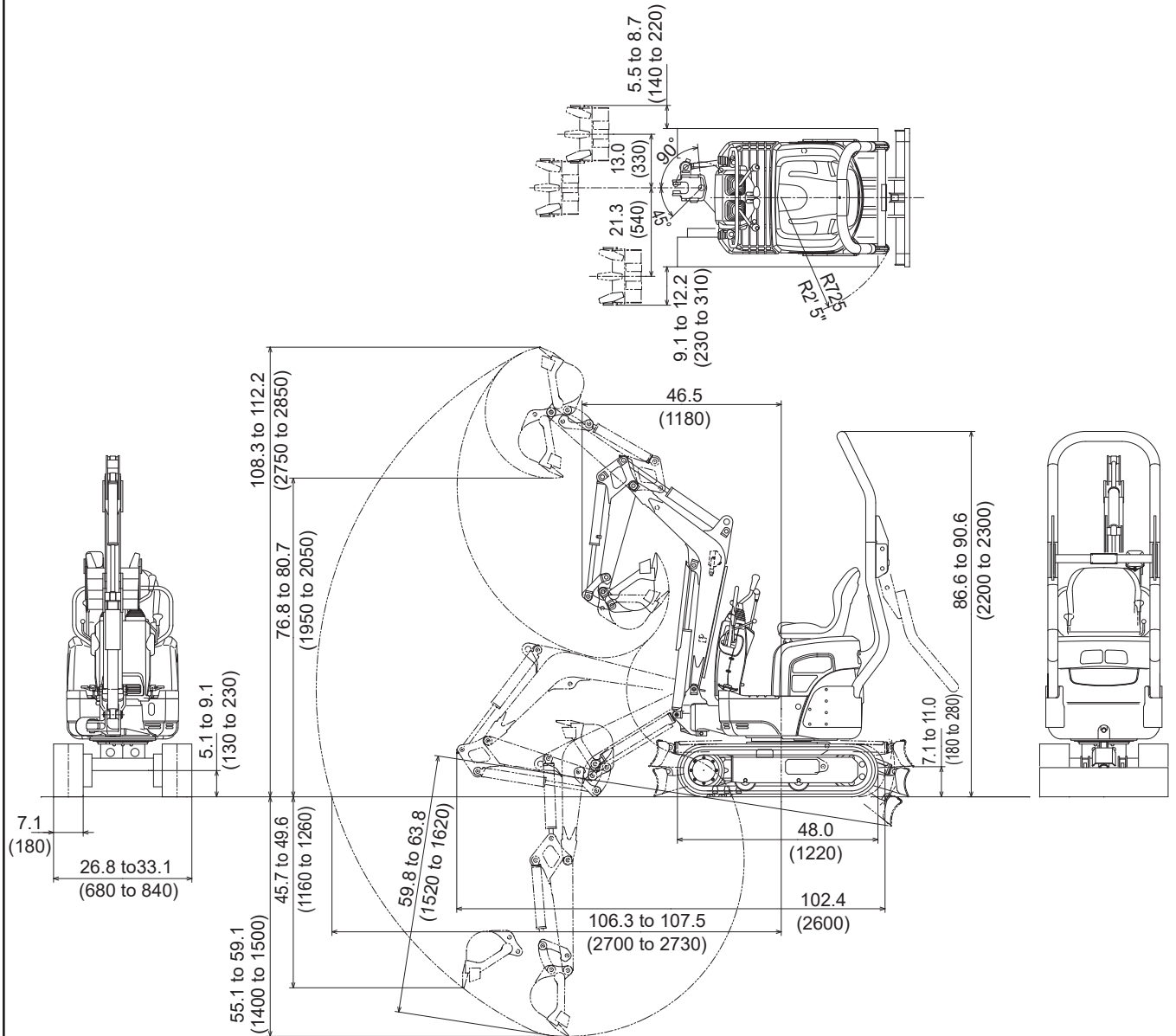
Item		Unit	SV08-1A, SV08-1A(S), SV08-1C	
			Link track gauge change type SV08-1A	Slide track gauge change type SV08-1A(S), SV08-1C
Electrical equipment				
Hour meter		V-W	12-0.18	
Horn		V-W	12-30	
Fuse		A×pcs.	10×2	
Monitor lamps	Battery charge alarm lamp	V-W	12-3	
	Engine oil pressure alarm lamp	V-W	12-3	
	Water temperature alarm lamp	V-W	12-3	
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

in. (mm)

Outline of SV08-1A (Link track gauge change type)

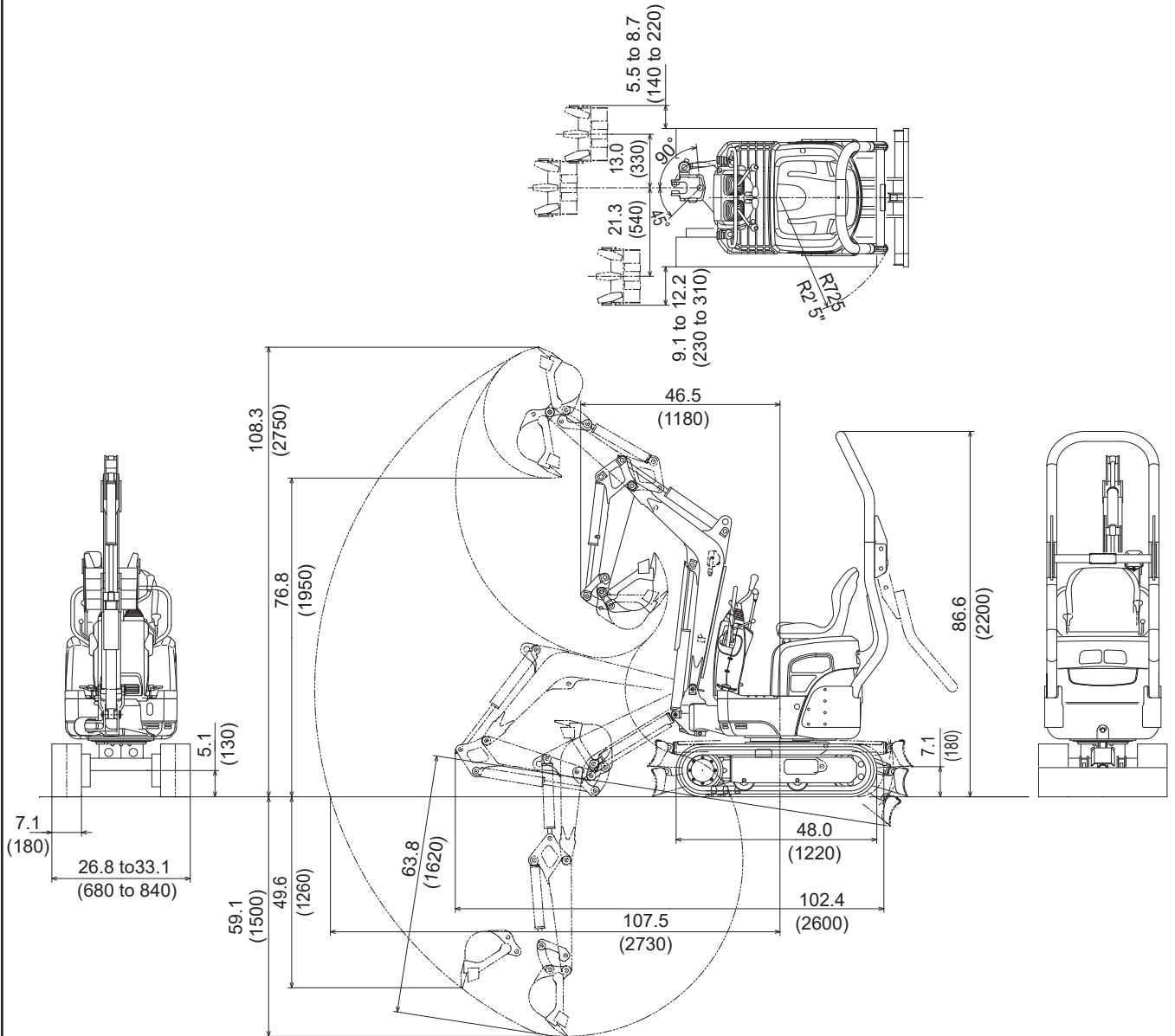


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2. TECHNICAL DATA

in. (mm)

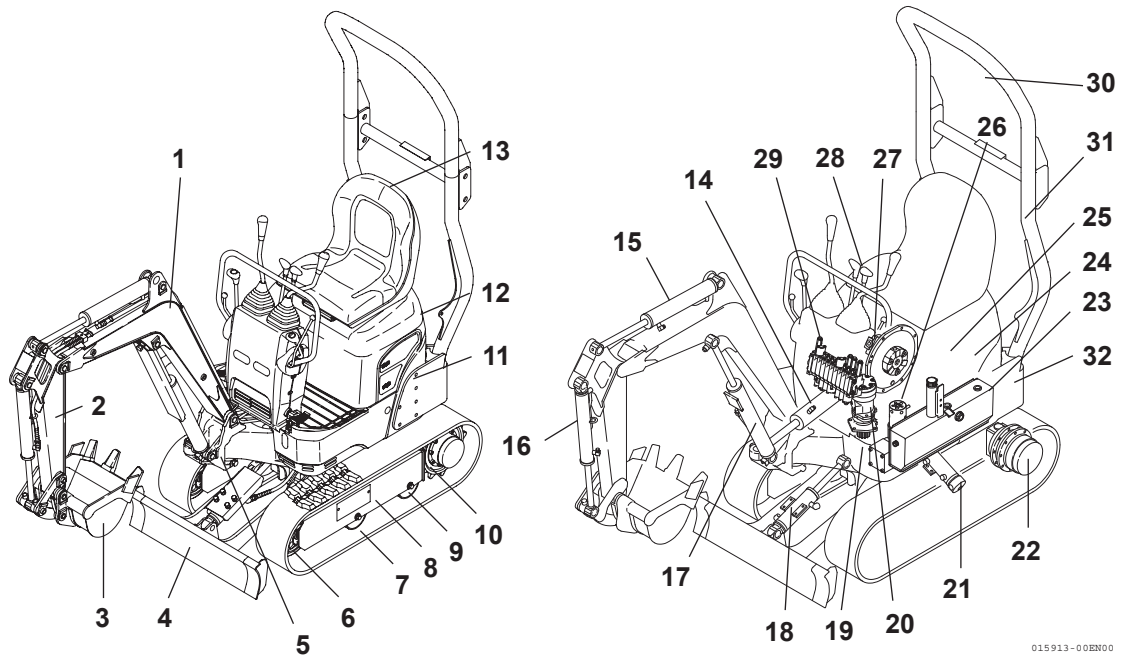
Outline of SV08-1A(S), SV08-1C (Slide track gauge change type)



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2. TECHNICAL DATA

2-3 Weight List of Main Parts



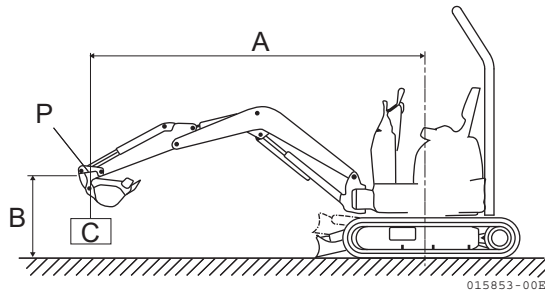
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Unit : lbs. (kg)

No.	Part	Weight	No.	Part	Weight
1	Boom Ass'y	56.9 (25.8)	17	Boom cylinder Ass'y	20.3 (9.2)
2	Arm Ass'y	29.8 (13.5)	18	Blade cylinder Ass'y	12.1 (5.5)
3	Bucket Ass'y	40.6 (18.4)	19	Swing bearing Ass'y	28.2 (12.8)
4	Blade Ass'y	67.7 (30.7)	20	Swing motor + Swing pinion Ass'y	24.0 (10.9)
5	Boom bracket Ass'y	43.7 (19.8)	21	Track gauge change cylinder Ass'y (Link track gauge change type) SV08-1A	10.1 (4.6)×2
				Track gauge change cylinder Ass'y (Slide track gauge change type) SV08-1A(S), SV08-1C	13.7 (6.2)×1
6	Front idler Ass'y	23.4 (10.6)×2	22	Travel motor	35.3 (16)×2
7	Rubber crawler Ass'y	63.7 (28.9)×2	23	Hydraulic oil tank (Excluding oil)	17.6 (8.0)
8	Track frame crawler Ass'y	275.6 (125.0)	24	Radiator	3.3 (1.5)
9	Track roller Ass'y	6.4 (2.9)×4	25	Engine + Hydraulic pump mount	178.6 (81.0)
10	Sprocket	15.9 (7.2)×2	26	Swivel joint + Fitting	35.9 (16.3)
11	Turning frame	487.3 (221)	27	Hydraulic pump	8.0 (3.65)
12	Engine hood	33.1 (15.0)	28	Battery + Battery cable	22.1 (10.0)
13	Operator's seat	16.3 (7.4)	29	Control valve + Hose	43.2 (19.6)
14	Boom swing cylinder Ass'y	20.3 (9.2)	30	ROPS bar top	30.9 (14.0)
15	Arm cylinder Ass'y	20.9 (9.5)	31	ROPS bar bottom	88.2 (40.0)
16	Bucket cylinder Ass'y	13.0 (5.9)	32	Bracket Ass'y	63.5 (28.8)

2. TECHNICAL DATA

2-4 Lifting Capacity List



With:

(□ Cabin ■ Canopy) Type

(□ Steel ■ Rubber) Crawler

Bucket width : 13.8 in. (350 mm)

W/O Bucket

Track gauge : Maximum

A : Reach from swing center line [in. (m)]

B : Load point height [in. (m)]

C : Lifting load [lbs. (kg)]

P : Load point



: Rating over front



: Rating over side or 180 degrees

Blade on ground

Unit : lbs. (kg)

A in. (m)	Max.		78.7 (2.0)		59.1 (1.5)		Min.	
B in. (m)								
78.7 (2.0)	—	*485 (220)	—	—	—	—	—	—
59.1 (1.5)	—	*485 (220)	—	*485 (220)	—	*595 (270)	—	—
39.4 (1.0)	—	*507 (230)	—	*573 (260)	—	*772 (350)	—	*1080 (490)
19.7 (0.5)	—	*529 (240)	—	*662 (300)	—	*1036 (470)	—	*1301 (590)
0 (0)	—	*529 (240)	—	*706 (320)	—	*1058 (480)	—	*1389 (630)
-19.7 (-0.5)	—	*573 (260)	—	*617 (280)	—	*948 (430)	—	—
-39.4 (-1.0)	—	*507 (230)	—	—	—	—	—	—

2. TECHNICAL DATA

Blade above ground

Unit : lbs. (kg)

A in. (m)	Max.		78.7 (2.0)		59.1 (1.5)		Min.	
B in. (m)								
78.7 (2.0)	353 (160)	419 (190)	—	—	—	—	—	—
59.1 (1.5)	265 (120)	331 (150)	331 (150)	375 (170)	441 (200)	*529 (240)	—	—
39.4 (1.0)	243 (110)	287 (130)	309 (140)	375 (170)	507 (230)	617 (280)	662 (300)	838 (380)
19.7 (0.5)	221 (100)	287 (130)	287 (130)	375 (170)	463 (210)	573 (260)	573 (260)	706 (320)
0 (0)	243 (110)	309 (140)	287 (130)	375 (170)	463 (210)	573 (260)	595 (270)	750 (340)
-19.7 (-0.5)	287 (130)	375 (170)	287 (130)	353 (160)	463 (210)	595 (270)	—	—
-39.4 (-1.0)	*463 (210)	*507 (230)	—	—	—	—	—	—

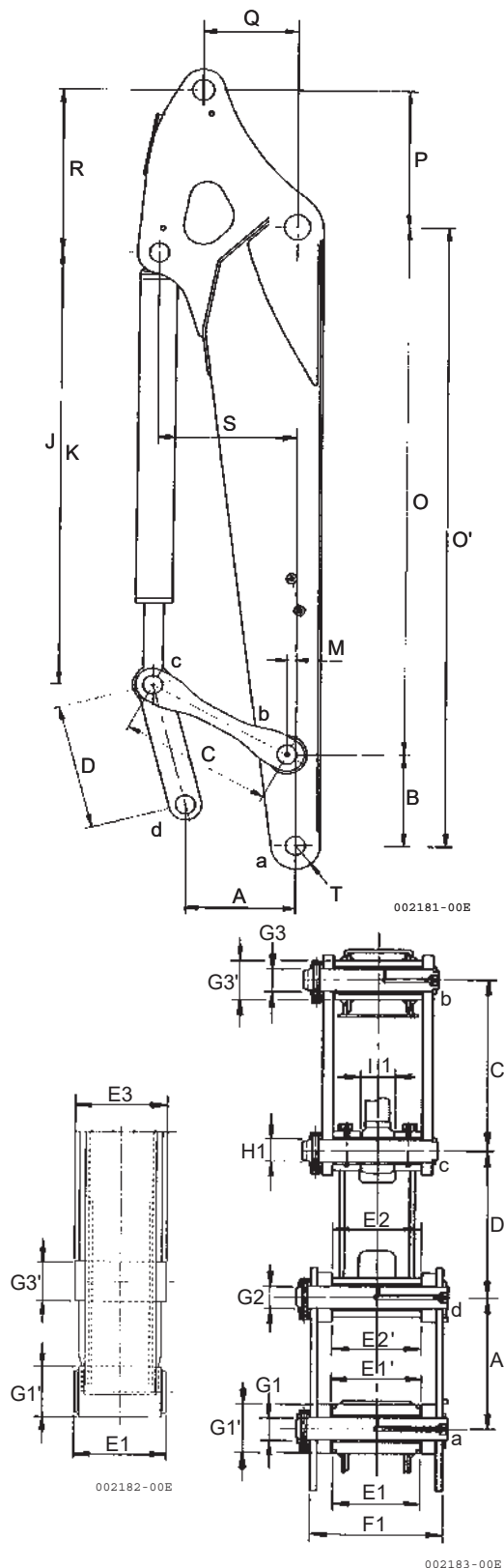
Note :

The lifting load with the asterisk (*) mark is limited by hydraulic lifting capacity rather than tipping. The lifting capacity shown in the above list is based on the ISO Standard No. 10567 and represents either 87 % of hydraulic lifting capacity or 75 % of tipping load, which is smaller.

2. TECHNICAL DATA

2-5 Specifications for Attachment

Unit : in. (mm)



Model		SV08-1A, SV08-1A(S), SV08-1C
Dimensions		
A		3.94 (100)
B		3.54 (90)
C		6.30 (160)
D		6.10 (155)
E 1 ; External width of arm end boss		3.78 (96)
E 1' ; Internal width of bucket pin boss		3.82 (97)
E 2 ; External width of bucket link boss		3.78 (96)
E 2' ; Internal width of bucket pin boss		3.82 (97)
E 3 ; External width of bucket arm pivot pin boss		3.78 (96)
F 1 ; External width of bucket arm		4.76 (121)
G 1 ; Bucket pin diameter		ø0.98 (ø25)
G 1' ; Arm end boss diameter		ø2.17 (ø55)
G 2 ; Bucket pin diameter		ø0.98 (ø25)
G 3 ; Bucket arm pivot pin diameter		ø0.98 (ø25)
G 3' ; Bucket arm pivot pin boss diameter		ø1.97 (ø50)
H 1 ; Bucket cylinder rod end pin diameter		ø0.98 (ø25)
I 1 ; Bucket cylinder rod end boss thickness		1.38 (35)
H 2 ; Bucket cylinder bottom pin diameter		ø0.98 (ø25)
I 2 ; Bucket cylinder bottom boss thickness		1.38 (35)
J ; Cylinder length when it is fully retracted		18.15 (461)
K ; Cylinder length when it is fully extended		28.78 (731)
M		0.20 (5)
O		22.84 (580)
O'		26.38 (670)
P		5.22 (132.5)
Q		3.94 (100)
R		5.24 (133)
S		7.70 (195.5)
T		R1.08 (R27.5)
Oil pressure specifications		
Hydraulic pump discharge volume GPM (L/min)	P1	2.59 (9.8)
	P2	2.59 (9.8)
	P3	—
Total oil flow for P.T.O. GPM (L/min)		5.18 (19.6)
Set pressure of system relief valve [PSI (MPa)] P1, P2		2625 (18.1)
Set pressure of system relief valve [PSI (MPa)] P3		—
Set pressure of bucket circuit relief valve [PSI (MPa)]		—

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		■	■	■	■	■	■
	Moving parts of the chassis and track spacing jack.		■	■	■	■	■	■
	Bearing rollers and bearings, idler wheels	◇			■(2)	■	■	■
Engine	Diesel filter		●(1)		●	●	●	●
	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)	●	●	●
	External air cleaner element					●	●	●
	Safety cartridge element (if equipped)					●	●	●
	Intake and exhaust valves							◇
	Injectors and injection pressure							□+◇
	Crankcase breather system							◇
	Engine silent-bloc & bracket		◇	◇	◇	◇	◇	◇
Travel	Oil for travel gears		●(1)	◇(2)	◇/●(2)	●	●	●
	Tracks, rubber tracks & pads	◇						
	Track tension	◇						
	Play of travel lever		◇(1)			◇	◇	◇
	Performance of travel		◇(1)			◇	◇	◇
Hydraulic	Oil	◇	◆(1)			◆/●(4)	◆	◆
	Aspiration filter					□/●(4)	□/●(4)	□/●(4)
	Ventilation filter						●	●
	Hydraulic oil return filter		●(1)		●(4)	●	●	●
	Other filter				●(4)	●	●	●
	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	◇	◇	◇	◇	◇	◇	◇
	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

2-7 Fuel, Lube Oil and Grease

Cooling fluid

Temperatures °C								Quantity prescribed (L)
-40	-20	0	20	40	60	80	100	
Long-life cooling fluid YANMAR POWER COOLANT B-6								1,6 Radiator (SV08-1A, SV08-1A(S))
								1,1 Radiator (SV08-1C)
								0,4 Expansion flask

Engine oil

Temperatures °C								Quantity prescribed (L)
-30	-20	-10	0	10	20	30	40	
5W30								1,7
10W30								
15W40								

Fuel

Temperatures °C							Quantity prescribed (L)
-20	-10	0	10	20	30	40	
No. 1-D / No. 2-D							9,7

Hydraulic oil

Temperatures °C							Quantity prescribed (L)
-20	-10	0	10	20	30	40	
VG46							5,7 in the tank
VG68							5,0 the rest

Gear oil

Temperatures °C							Quantity prescribed (L)
-20	-10	0	10	20	30	40	
75W90LS							0,33 by reducer
80W90LS							

CHAPTER 3

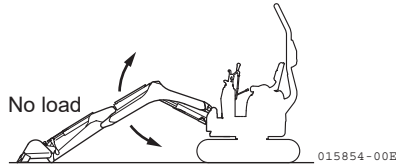
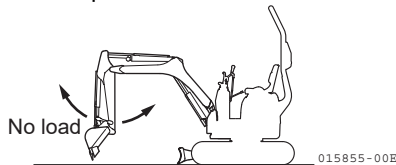
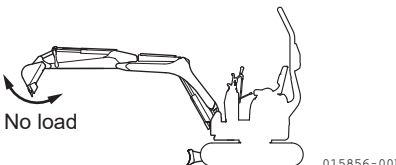
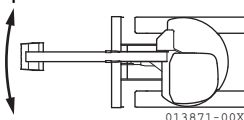
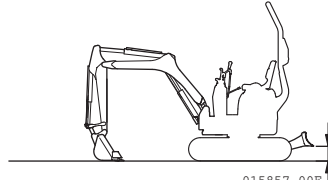
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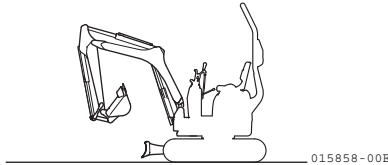
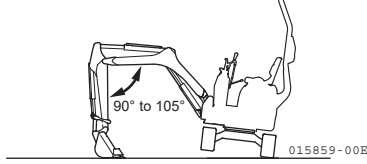
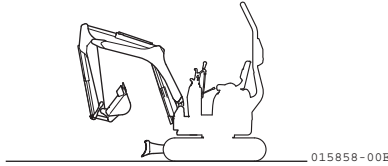
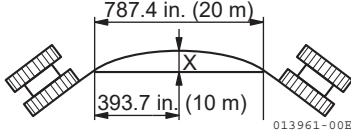
3. SERVICING STANDARDS

3. Service Standards

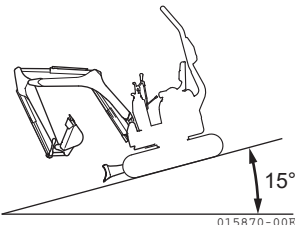
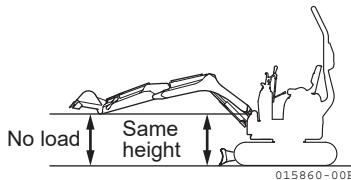
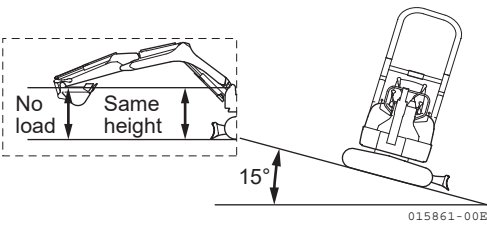
3-1 Machine Performance

Applicable model			SV08-1A, SV08-1A(S) SV08-1C		
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 • Maximum track gauge	Up	sec.	2.4	2.6
Bucket teeth grounded		Down		2.4	2.6
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.	2.4	2.6
Max. cylinder extension		Retract		3.2	3.5
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.	1.8	2.1
Max. cylinder extension		Curl		2.5	2.7
Boom swing 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.	3.1	3.3
Max. cylinder extension		Left swing		4.2	4.4
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 • Maximum track gauge	Up	sec.	1.1	1.3
Blade grounded		Down		0.9	1.1

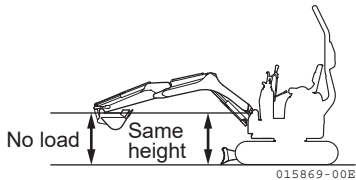
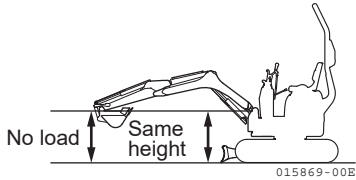
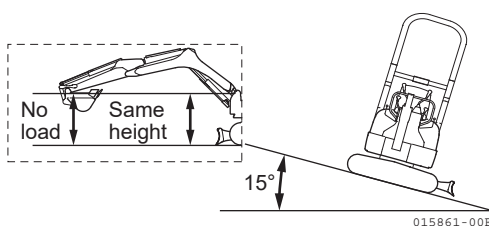
3. SERVICING STANDARDS

Applicable model			SV08-1A, SV08-1A(S) SV08-1C	
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./ 65.6 ft. (20 m)	40.0	46.0
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 idling the floating crawler side more than once at full throttle, measure the time needed for 3 turns of the crawler.	sec./ 3 rev.	16.9	19.4
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) / 65.6 ft. (20 m)	11.8 (300) or less	14.2 (360)

3. SERVICING STANDARDS

Applicable model			SV08-1A, SV08-1A(S) SV08-1C	
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.	in. (mm) / 10 min.	0.31 (8) or less	0.47 (12)
Arm drift (Cylinder rod extension)			0.31 (8) or less	0.47 (12)
Bucket drift (Cylinder rod extension)			0.20 (5) or less	0.30 (7.5)
Blade drift (Cylinder rod extension)			0.20 (5) or less	0.30 (7.5)
Boom swing 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, 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.	0.20 (5) or less	0.30 (7.5)

3. SERVICING STANDARDS

Applicable model			SV08-1A, SV08-1A(S) SV08-1C	
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	2.17 (55) or less, 20° or less	3.15 (80) 30°
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	36.5	42.0
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 between both marks after 5 min. after machine is parked on the slope.	in. (mm) degrees / 5 min.	1.18 (30.0) 10 or less	1.57 (40.0) 15

3. SERVICING STANDARDS

3-2 Engine

1) Nominal and Allowable Values

Applicable model			2TE67L-BV3, 402J-05 IG84555R		
Item		Unit	Standard	Allowable limit	
Cylinder head					
Cylinder head distortion		in. (mm)	0.0020 (0.05) or less	0.0047 (0.12)	
Valve seat angle	Intake	degrees (°)	90	—	
	Exhaust		90	—	
Valve seat width	Intake	in. (mm)	0.0626 to 0.0709 (1.59 to 1.8)	0.0984 (2.5)	
	Exhaust		0.0626 to 0.0709 (1.59 to 1.8)	0.0984 (2.5)	
Intake valve	Stem outside diameter	in. (mm)	0.2346 to 0.2352 (5.960 to 5.975)	0.2323 (5.9)	
	Guide inside diameter		0.2362 to 0.2367 (6.000 to 6.012)	0.2394 (6.08)	
	Oil clearance		0.0009 to 0.0020 (0.025 to 0.052)	0.0079 (0.2)	
Exhaust valve	Stem outside diameter	in. (mm)	0.2339 to 0.2344 (5.940 to 5.955)	0.2323 (5.9)	
	Guide inside diameter		0.2362 to 0.2367 (6.000 to 6.012)	0.2394 (6.08)	
	Oil clearance		0.0018 to 0.0028 (0.045 to 0.072)	0.0079 (0.2)	
Valve sinkage	Intake	in. (mm)	0.0276 to 0.0354 (0.7 to 0.9)	0.0709 (1.8)	
	Exhaust		0.0276 to 0.0354 (0.7 to 0.9)		
Valve head thickness	Intake	in. (mm)	0.0305 to 0.0423 (0.775 to 1.075)	0.0197 (0.5)	
	Exhaust		0.0305 to 0.0423 (0.775 to 1.075)		
Intake valve operating timing	Open	b. TDC	degrees (°)	13	—
	Close	a. BDC		43	—
Exhaust valve operating timing	Open	b. BDC	degrees (°)	43	—
	Close	a. TDC		13	—
Valve spring	Free length	in. (mm)	1.2992 (33)	—	
	Inclination	in. (mm)	0.0394 (1.0)	0.0472 (1.2)	
	Tension [1.11in. (28.3 mm) compressed]	lbs. (kg)	15.21 (6.9)	14.33 (6.5)	
Intake / exhaust valve clearance		in. (mm)	0.0079 (0.2)	0.0197 (0.5)	
Cylinder block					
Cylinder bore diameter		in. (mm)	2.6378 to 2.6385 (67.000 to 67.019)	2.6457 (67.2)	
Roundness of cylinder			0 to 0.0004 (0 to 0.01)	0.0012 (0.03)	
Cylindricity of cylinder			0 to 0.0004 (0 to 0.01)	0.0012 (0.03)	
Upper surface distortion			0.0020 (0.05) or less	0.0047 (0.12)	

3. SERVICING STANDARDS

Applicable model			2TE67L-BV3, 402J-05 IG84555R		
Item		Unit	Standard	Allowable limit	
Valve rocker arm					
Rocker arm for Intake / exhaust valve	Shaft outside diameter		in. (mm)	0.3917 to 0.3924 (9.95 to 9.968)	0.3878 (9.85)
	Bush inside diameter			0.3937 to 0.3943 (10.000 to 10.015)	0.3957 (10.050)
	Oil clearance			0.0013 to 0.0026 (0.032 to 0.065)	0.0079 (0.2)
Push rod bend		0.0012 (0.03) or less		—	
Tappet	Stem outside diameter			0.7073 to 0.7079 (17.965 to 17.980)	0.7059 (17.93)
	Guide hole inside diameter			0.7087 to 0.7094 (18.000 to 18.018)	0.7106 (18.05)
	Oil clearance			0.0008 to 0.0021 (0.02 to 0.053)	0.0047 (0.12)
Piston					
Piston outside diameter		in. (mm)	2.6354 to 2.6359 (66.938 to 66.953)	2.6732 (67.90)	
Minimum clearance between piston and cylinder			0.0019 to 0.0032 (0.047 to 0.081)	—	
Projection of piston from the upper surface of cylinder block			0.0197 to 0.0236 (0.5 to 0.6)	Thickness of gasket 0.0472 (1.2)	
			0.0236 to 0.0276 (0.6 to 0.7)	Thickness of gasket 0.0512 (1.3)	
Piston pin	Outside diameter		0.7479 to 0.7481 (18.996 to 19.002)	0.7472 (18.98)	
	Bush hole inside diameter		0.7480 to 0.7482 (18.998 to 19.004)	—	
	Oil clearance		0.0002 to 0.0003 (0.004 to 0.008)	0.0007 (0.02)	
Piston ring					
Top ring	Ring groove width	in. (mm)	0.0610 to 0.0618 (1.550 to 1.570)	—	
	Ring width (B)		0.0579 to 0.0587 (1.470 to 1.490)	—	
	Clearance between groove and ring		0.0024 to 0.0039 (0.060 to 0.100)	0.0098 (0.25)	
	End gap		0.0051 to 0.0110 (0.130 to 0.280)	0.0394 (1.0)	
Second ring	Ring groove width		0.0606 to 0.0614 (1.540 to 1.560)	—	
	Ring width (B)		0.0579 to 0.0587 (1.470 to 1.490)	—	
	Clearance between groove and ring		0.0020 to 0.0035 (0.050 to 0.090)	0.0098 (0.25)	
	End gap		0.0039 to 0.0098 (0.100 to 0.250)	0.0394 (1.0)	

3. SERVICING STANDARDS

Applicable model			2TE67L-BV3, 402J-05 IG84555R	
Item		Unit	Standard	Allowable limit
Piston ring				
Oil ring	Ring groove width	in. (mm)	0.1185 to 0.1193 (3.010 to 3.030)	—
	Ring width (B)		0.1169 to 0.1177 (2.970 to 2.990)	—
	Clearance between groove and ring		0.0008 to 0.0024 (0.020 to 0.060)	0.0059 (0.15)
	End gap		0.0039 to 0.0118 (0.100 to 0.300)	0.0394 (1.0)
Connecting rod				
Crank pin side	Crank pin metal inside diameter	in. (mm)	1.4961 to 1.4965 (38.000 to 38.011)	—
	Crank pin metal thickness		0.0584 to 0.0602 (1.484 to 1.503)	—
	Crank pin outside diameter		1.3765 to 1.3770 (34.964 to 34.975)	1.3740 (34.90)
	Oil clearance		0.0012 to 0.0031 (0.031 to 0.079)	0.0059 (0.15)
Piston pin side	Bush hole inside diameter		0.7486 to 0.7491 (19.015 to 19.026)	0.7913 (20.10)
	Piston pin outside diameter		0.7479 to 0.7481 (18.996 to 19.002)	0.7472 (18.98)
	Oil clearance		0.0007 to 0.0012 (0.017 to 0.030)	0.0079 (0.2)
Twist and parallelism			0.0031 (0.08) or less for 3.9370 (100)	0.0079 (0.2)
Cam				
Cam shaft bend		in. (mm)	0.0008 (0.02) or less	0.0020 (0.05)
Cam height	Intake / Exhaust		1.0459 to 1.0480 (26.565 to 26.620)	1.0276 (26.1)
	Injection pump		1.3575 to 1.3591 (34.480 to 34.520)	1.3504 (34.3)
	Fuel pump		1.0984 to 1.1024 (27.90 to 28.00)	1.0630 (27.0)
Crank shaft				
#1, 2 Journal	Crank shaft	in. (mm)	1.6915 to 1.6919 (42.964 to 42.975)	1.5709 (39.90)
	Oil clearance		0.0015 to 0.0036 (0.039 to 0.092)	—
#3 Journal	Crank shaft		1.8090 to 1.8094 (45.948 to 45.959)	—
	Oil clearance		0.0014 to 0.0035 (0.035 to 0.088)	0.0079 (0.2)
Bend			0.0012 (0.03) or less	0.0024 (0.06)

3. SERVICING STANDARDS

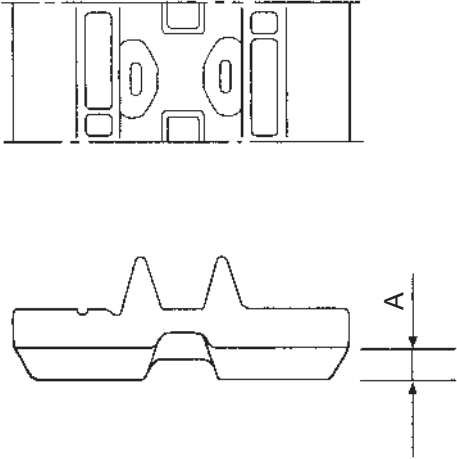
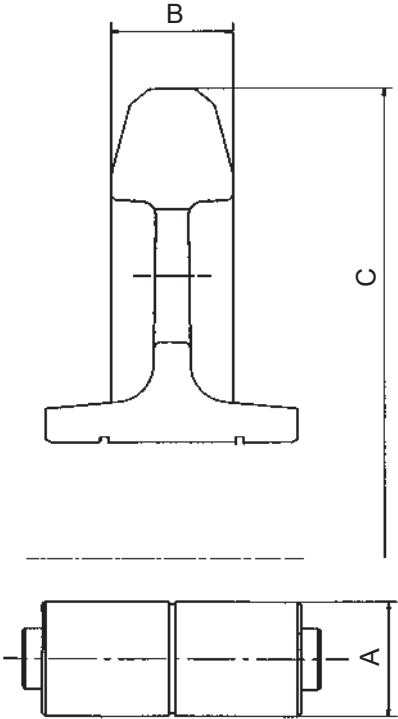
Applicable model			2TE67L-BV3, 402J-05 IG84555R	
Item		Unit	Standard	Allowable limit
Side gap	Crank shaft	in. (mm)	0.0039 to 0.0118 (0.1 to 0.3)	—
	Oil pump		0.0039 to 0.0059 (0.1 to 0.15)	—
	Connecting rod		0.0039 to 0.0118 (0.1 to 0.3)	—
Backlash	Crank gear	in. (mm)	0.0016 to 0.0047 (0.04 to 0.12)	—
	Cam gear			
	Idle gear			
Lubrication oil pump (Trochoid pump)				
Tip clearance		in. (mm)	0.0012 to 0.0071 (0.03 to 0.18)	0.0098 (0.25)
Side clearance		in. (mm)	0.0039 to 0.0059 (0.10 to 0.15)	0.0079 (0.20)
Others				
Lube oil pump discharge volume	High speed	GPM (L/min)	3.6 (13.7) at 3000 min ⁻¹ (rpm)	—
	Low speed		1.2 (4.6) at 1000 min ⁻¹ (rpm)	—
Oil pressure regulating valve opening pressure		PSI (kPa)	55.46 to 61.24 (382.4 to 422.2)	—
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)	7.00 (26.5) at 3000 min ⁻¹ (rpm)	—
Thermostat valve opening temperature	Temperature	°F (°C)	163 to 170 (73 to 77)	—
	Lift at opening	in. (mm)	0.2 (6.0) or more at 188°F (87°C) or higher	—
Thermo-switch operating temperature	ON	°F (°C)	225 to 235 (107 to 113)	—
	OFF		217 (103) or more	—
Compression pressure at 300 rpm (Reference values)		PSI (MPa)	426 (2.94)	355 (2.45)
Variations of compression pressure among cylinders		PSI (MPa)	29 to 44 (0.2 to 0.3)	—

3. SERVICING STANDARDS

3-3 Undercarriage

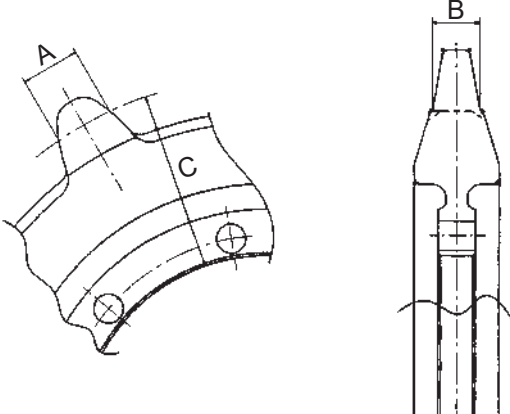
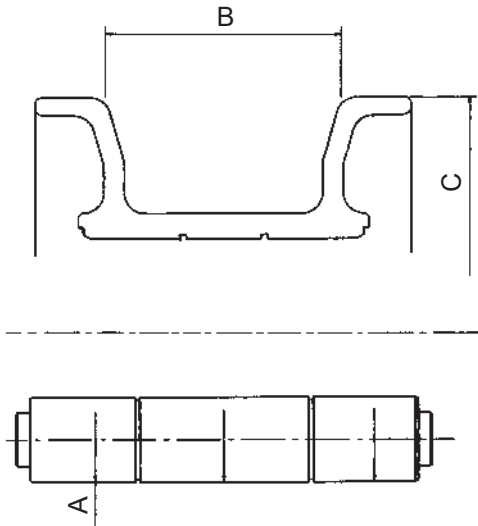
3-3-1 Rubber Crawler Specifications

[Unit : in. (mm)]

Applicable model	SV08-1A, SV08-1A(S), SV08-1C		
Part	Measuring position	Standard	Wear limit
(1) Rubber crawler 	A	0.67 (17)	0.31 (8)
(2) Idler & shaft 	A	Ø1.18 (Ø30)	—
	B	1.26 (32)	1.02 (26)
	C	Ø9.80 (Ø249)	Ø9.61 (Ø244)

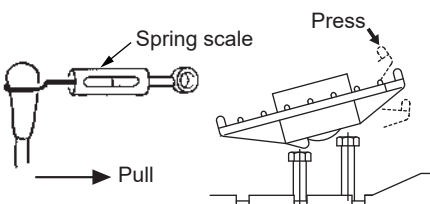
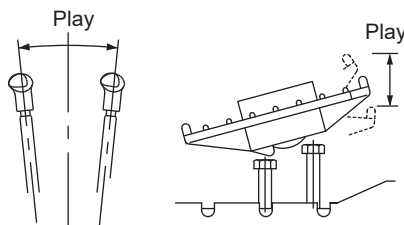
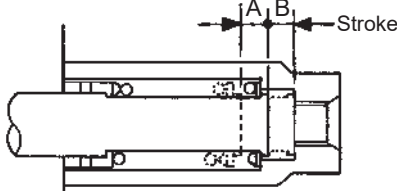
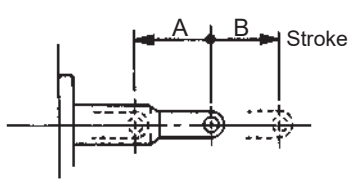
3. SERVICING STANDARDS

[Unit : in. (mm)]

Applicable model	SV08-1A, SV08-1A(S), SV08-1C		
Part	Measuring position	Standard	Wear limit
(1) Sprocket 	A	0.87 (22)	0.47 (12)
	B	0.71 (18)	0.51 (13)
	C	2.66 (67.5)	—
(2) Track roller & shaft 	A	Ø0.98 (Ø25)	—
	B	2.72 (69)	2.48 (63)
	C	Ø5.12 (Ø130)	Ø4.88 (Ø124)

3. SERVICING STANDARDS

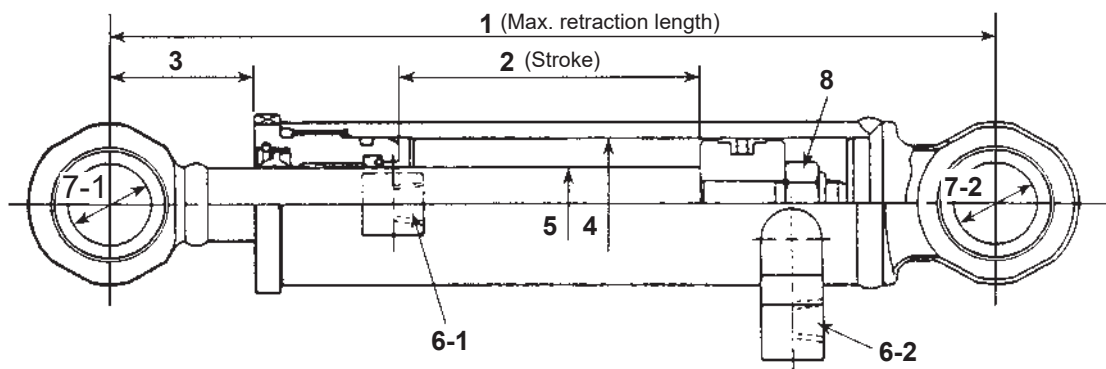
3-4 Controls

Applicable model		SV08-1A, SV08-1A(S), SV08-1C		
Item	Measuring conditions	Unit	Standard	Allowable limit
Controls				
Operating force				
Right control lever (Boom)	• 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. (kgf)	2.43 (1.1)	3.09 (1.4)
Right control lever (Bucket)				
Left control lever (Arm & Swing)				
Blade lever			4.41 (2.0)	5.51 (2.5)
Travel levers			3.31 (1.5)	3.97 (1.8)
Track gauge change lever			5.51 (2.5)	7.72 (3.5)
Boom swing pedal			13.23 (6.0)	14.33 (6.5)
P.T.O. pedal			11.03 (5.0)	13.23 (6.0)
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)	0.79 (20)	—
Left control lever (Front & rear / left & right)			0.79 (20)	—
Blade lever			0.39 (10)	—
Travel levers			0.39 (10)	—
Boom swing pedal			0.20 (5)	—
P.T.O. pedal			0.20 (5)	—
Track gauge change lever			0.20 (5)	—
Control valve				
Spool stroke				
Boom		in. (mm)	0.24 (6)	—
Bucket				
Arm				
Swing				
Right travel		in. (mm)	0.24 (6)	—
Left travel				
Blade				
Boom swing				
P.T.O.				
Track gauge change				

3. SERVICING STANDARDS

3-5 Hydraulic Equipment

3-5-1 Hydraulic Cylinders



Unit : in. (mm)

Cylinder	No.	1	2	3	4	5	6-1 / 6-2	7-1 / 7-2		8	
								Standard	Allowable limit	Nut size	Tightening torque ft•lbf (N•m)
Boom		22.80 (579)	13.19 (335)	2.26 (57.5)	Ø1.97 (Ø50)	Ø0.98 (Ø25)	G1/4	Ø0.98 (Ø25)	Ø1.00 (Ø25.5)	M18	151.9 to 173.3 (206 to 235)
Arm		18.82 (478)	11.06 (281)	2.03 (51.5)	Ø1.97 (Ø50)	Ø0.98 (Ø25)	G1/4	Ø0.98 (Ø25)	Ø1.00 (Ø25.5)	M18	151.9 to 173.3 (206 to 235)
Bucket		18.15 (461)	10.63 (270)	1.77 (45)	Ø1.77 (Ø45)	Ø0.98 (Ø25)	G1/4	Ø0.98 (Ø25)	Ø1.00 (Ø25.5)	M18	151.9 to 173.3 (206 to 235)
Boom swing		20.51 (521)	11.14 (283)	2.56 (65)	Ø2.17 (Ø55)	Ø1.18 (Ø30)	G1/4	Ø1.18 (Ø30)	Ø1.20 (Ø30.5)	M20	217.0 to 253.0 (294 to 343)
Blade		15.51 (394)	3.46 (88)	5.87 (149)	Ø1.97 (Ø50)	Ø0.98 (Ø25)	Rc1/4	Ø0.98 (Ø25)	Ø1.00 (Ø25.5)	M18	151.9 to 173.3 (206 to 235)
Track gauge change (Link track gauge change type) SV08-1A		9.53 (242)	2.68 (68)	1.50 (38)	Ø1.97 (Ø50)	Ø0.98 (Ø25)	Rc1/4	Ø0.98 (Ø25)	Ø1.00 (Ø25.5)	M18	151.9 to 173.3 (206 to 235)
Track gauge change (Slide track gauge change type) SV08-1A(S), SV08-1C		15.75 (400)	6.30 (160)	2.52 (64)	Ø1.97 (Ø50)	Ø0.98 (Ø25)	Rc1/4	Ø1.30 (Ø33)	Ø1.32 (Ø33.5)	M18	151.9 to 173.3 (206 to 235)

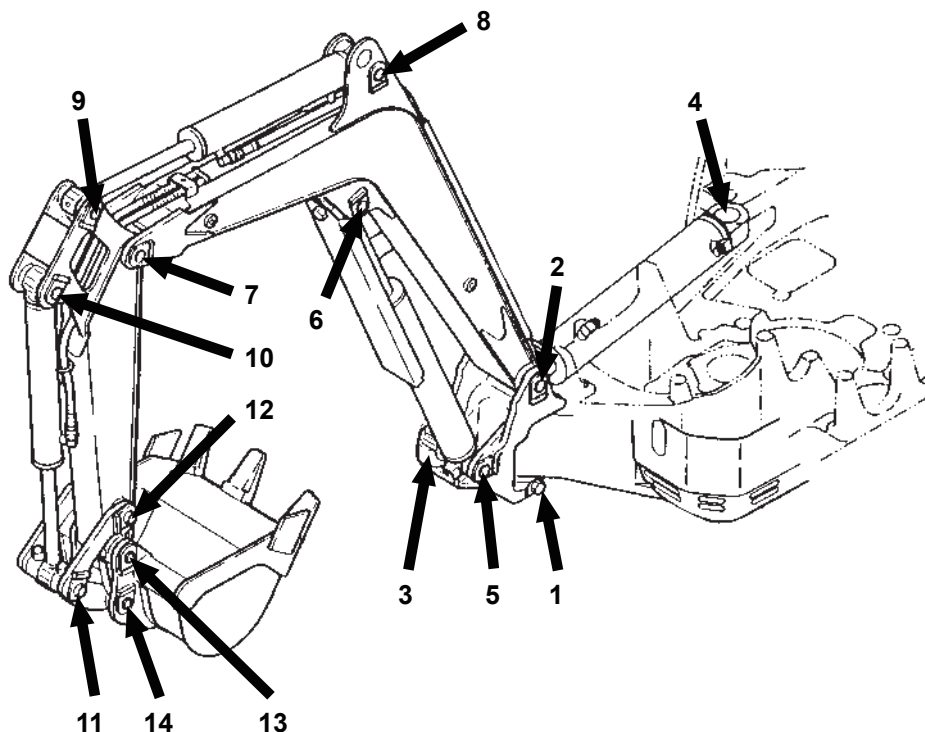
Nut for pipe

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

3. SERVICING STANDARDS

3-6 Implement

3-6-1 Front Attachments



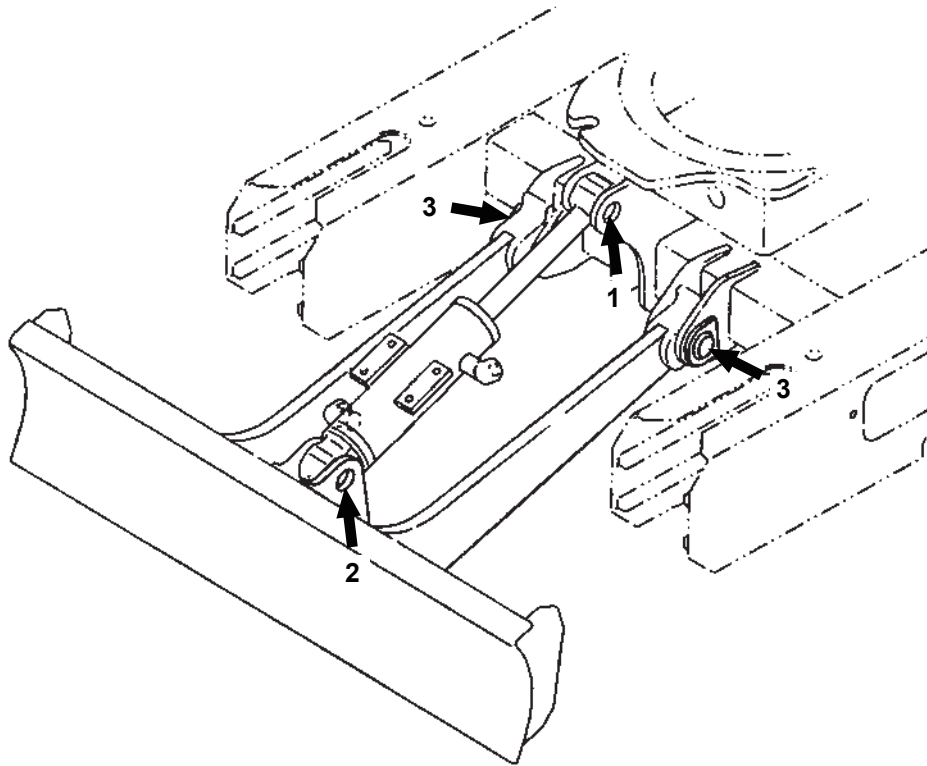
Unit : in. (mm)

No.	Applicable model : SV08-1A, SV08-1A(S), SV08-1C	Standard	Wear limit	
	Measuring point		Pin	Bore of bush or hole
1	Boom bracket fulcrum	Ø1.38 (Ø35)	-0.02 (-0.5)	+0.02 (+0.5)
2	Boom fulcrum	Ø0.98 (Ø25)		
3	Boom swing cylinder, rod	Ø1.18 (Ø30)		
4	Boom swing cylinder, bottom	Ø1.18 (Ø30)		
5	Boom cylinder, bottom	Ø0.98 (Ø25)		
6	Boom cylinder, rod	Ø0.98 (Ø25)		
7	Arm fulcrum	Ø0.98 (Ø25)		
8	Arm cylinder, bottom	Ø0.98 (Ø25)		
9	Arm cylinder, rod	Ø0.98 (Ø25)		
10	Bucket cylinder, bottom	Ø0.98 (Ø25)		
11	Bucket cylinder, rod	Ø0.98 (Ø25)		
12	Bucket arm	Ø0.98 (Ø25)		
13	Bucket fulcrum	Ø0.98 (Ø25)		
14	Bucket link	Ø0.98 (Ø25)		

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

3. SERVICING STANDARDS

3-6-2 Blade Moving Device (Link track gauge change type SV08-1A)



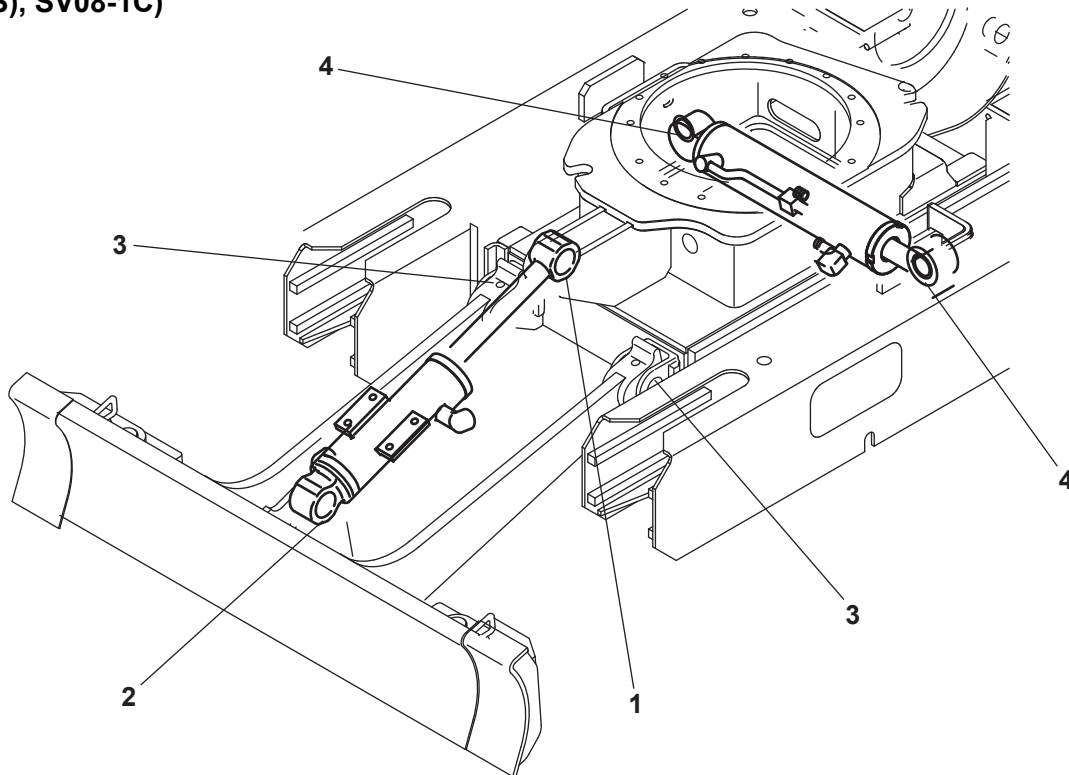
Unit : in. (mm)

No.	Applicable model : SV08-1A	Standard	Wear limit	
	Measuring point		Pin	Bore of bush or hole
1	Blade cylinder, rod	Ø0.98 (Ø25)	-0.02 (-0.5)	+0.02 (+0.5)
2	Blade cylinder, bottom	Ø0.98 (Ø25)		
3	Blade fulcrum	Ø0.98 (Ø25)		

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

3. SERVICING STANDARDS

3-6-3 Variable Track Gauge Type and Blade Moving Device (Slide track gauge change type SV08-1A(S), SV08-1C)



008364-00X

Unit : in. (mm)

No.	Applicable model : SV08-1A(S), SV08-1C	Standard	Wear limit	
	Measuring point		Pin	Bore of bush or hole
1	Blade cylinder, rod	Ø0.98 (Ø25)	-0.02 (-0.5)	+0.02 (+0.5)
2	Blade cylinder, bottom	Ø0.98 (Ø25)		
3	Blade fulcrum	Ø0.98 (Ø25)		
4	Track gauge change cylinder	Ø1.30 (Ø33)		

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

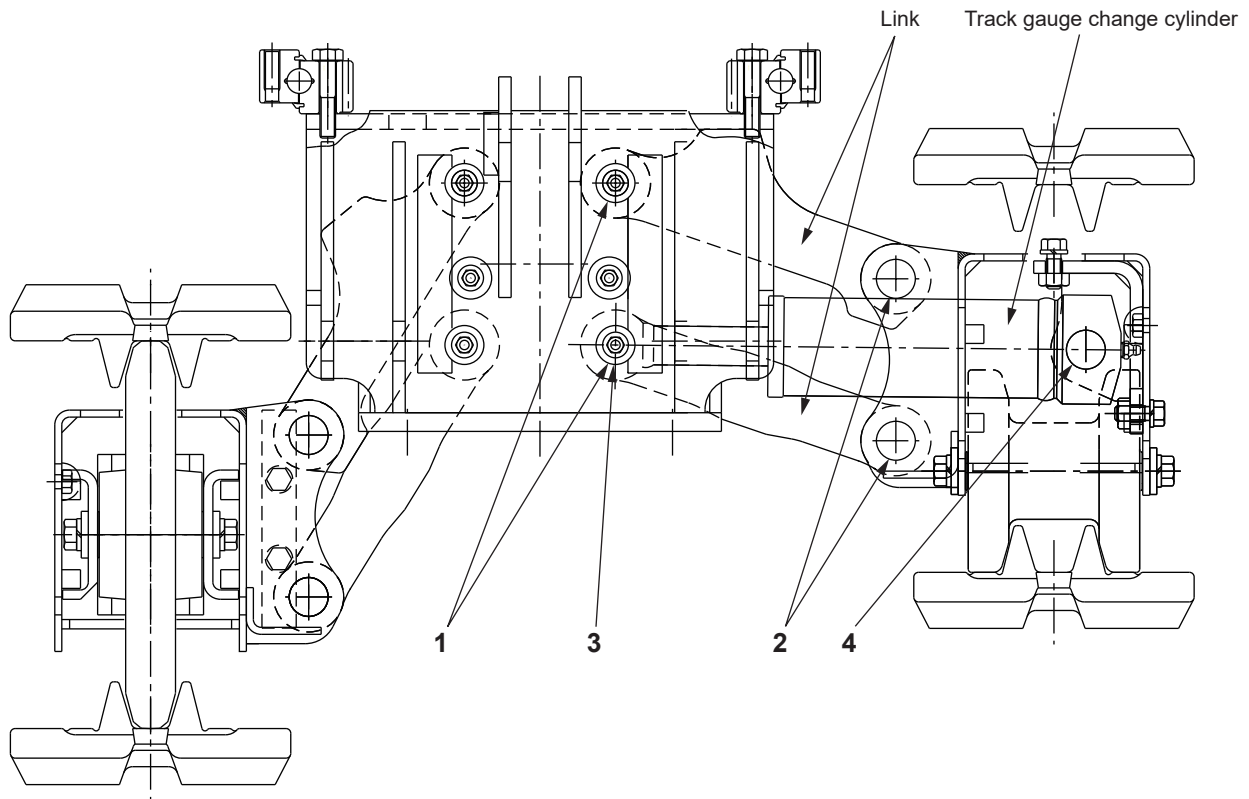
3-6-4 Bucket Teeth

Unit : in. (mm)

Measuring point	Standard	Wear limit	Measure
	5.91 (150)	4.72 (120)	Replace

3. SERVICING STANDARDS

3-6-5 Variable Track Gauge Type (Link track gauge change type SV08-1A)



Unit : in. (mm)

No.	Applicable model : SV08-1A,	Standard	Wear limit	
	Measuring point		Pin	Bore of bush or hole
1	Link fulcrum (center frame side)	Ø0.98 (Ø25)	-0.02 (-0.5)	+0.02 (+0.5)
2	Link fulcrum (crawler frame side)	Ø0.98 (Ø25)		
3	Track gauge change cylinder, rod	Ø0.98 (Ø25)		
4	Track gauge change cylinder, bottom	Ø0.98 (Ø25)		

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

3. SERVICING STANDARDS

3-7 List of Tightening Torque

3-7-1 Machine

Unit : ft•lbf (N•m)

Applicable model:			SV08-1A, SV08-1A(S), SV08-1C			
Equipment			Thread size	Tightening torque ft•lbf (N•m)	Adhesive	Remarks
No.	Tightening part					
Engine						
1	Engine mount L, R		M10× 25	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	
2	Engine vibration proof rubber		Nut M10	18.1 to 23.8 (24.5 to 32.3)		Fan side
3	Engine vibration proof rubber		Nut M14	50.6 to 61.4 (68.6 to 83.3)		Pump side
4	Plate A, Stopper FL and Stopper FR		M10 × 30	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	Tighten plate A together with stopper
5	Radiator hose band		Hose band 35	1.8 to 2.2 (2.45 to 2.94)		Engine side
6	Radiator hose band		Hose clip 25	1.8 to 2.2 (2.45 to 2.94)		Radiator side
7	Air cleaner hose (2 pcs)		Hose clip 54	1.6 to 1.8 (2.16 to 2.45)		
8	Accelerator cable		Cable fixed nut	3.0 to 3.6 (4.0 to 4.9)		
Fuel oil tank						
1	Fuel oil tank clamp (Lock side)		Nut M10	18.1 to 21.7 (24.5 to 29.4)		
2	Fuel oil tank clamp (For tank fixing)		Nut M10	1.8 to 2.2 (2.45 to 2.94)		Tank clamp side
Electric equipment						
1	Battery clamp (Battery fixing side)		Nut M8	1.4 to 2.2 (1.96 to 2.94)		Lower side
2	Battery clamp (Lock side)		Nut M8	3.6 to 4.3 (4.9 to 5.88)		Upper side
Undercarriage						
1	Inner race of swing bearing		M10 × 45	50.7 to 57.9 (68.7 to 78.5)	Loctite 262 or its equivalent	
2	Track roller		M12 × 25	57.9 to 72.4 (78.5 to 98.1)	Three Bond 1324 or its equivalent	
3	Sprocket		Hexagon socket bolt M10 × 25	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	
4	Idler		M12 × 25	57.9 to 72.4 (78.5 to 98.1)	Three Bond 1324 or its equivalent	
5	Nut (Stopper) (Slide track gauge change type only) SV08-1A(S), SV08-1C		M16	159.1 to 195.3 (215.7 to 264.8)	Three Bond 1324 or its equivalent	
6	Plate (For track gauge change cylinder stopper) (Slide track gauge change type only) SV08-1A(S), SV08-1C		M10	32.5 to 43.4 (44.1 to 58.8)	Three Bond 1324 or its equivalent	
7	Adjusting bolt		Nut M20	159.1 to 195.3 (215.7 to 264.8)		
8	Under cover		M10 × 20	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	

3. SERVICING STANDARDS

Unit : ft•lbf (N•m)

Applicable model:		SV08-1A, SV08-1A(S), SV08-1C			
Equipment		Thread size	Tightening torque ft•lbf (N•m)	Adhesive	Remarks
No.	Tightening part				
Controls					
1	Control lever grip L, R	binding screw M4 × 6	1.3 to 1.9 (1.76 to 2.55)	Three Bond 1324 or its equivalent	
2	Boss in blade lever shaft fulcrum	M8 × 45	21.7 to 25.3 (29.4 to 34.3)	Three Bond 1324 or its equivalent	
3	L-ball 8 (male screw) Link-ball 8 (male screw)	M8	9.4 to 12.3 (12.74 to 16.66)		
4	L-ball 8 (female screw) Link-ball 8 (female screw)	M8	5.8 to 7.2 (7.84 to 9.8)		
5	Link ball 6 (male screw)	M6	3.6 to 5.1 (4.9 to 6.9)		
6	Link ball 6 (female screw)	M6	3.6 to 5.1 (4.9 to 6.9)		
7	Accelerator lever locking nut	Locking nut M12	18.1 to 23.8 (24.5 to 32.3)		
8	Support	M10 × 20	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	
Turning frame					
1	Outer race of swing bearing	M10 × 35 M10 × 70	50.6 to 57.8 (68.6 to 78.4)	Loctite 262 or its equivalent	
2	Swivel plate	M12 × 20	57.9 to 72.4 (78.5 to 98.1)	Three Bond 1324 or its equivalent	
Rigging					
1	Stand cover R Stand cover F	Binding screw M6 × 16	2.1 to 2.9 (2.9 to 3.9)		
2	Cylinder key	Nut M10	14.5 to 21.7 (19.6 to 29.4)		
Hydraulic equipment					
1	Coupling CF-8	Hexagon socket bolt M30 × 30	36.1 to 43.4 (49.0 to 58.8)	Three Bond 1324 or its equivalent	
2	Suction filter	G1 1/2	72.4 to 86.8 (98.1 to 117.7)		
3	Hydraulic oil level gauge	G3/4	10.8 to 14.5 (14.7 to 19.6)		
4	Hydraulic oil tank drain	Drain plug M14	43.5 (59)		
5	Swing motor	M12 × 35	57.9 to 72.4 (78.5 to 98.1)	Three Bond 1324 or its equivalent	
6	Bearing retainer	M10 × 25	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	
7	Travel motor	Hexagon socket bolt M10 × 25	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	
8	Drain hose	Hose clip 13	1.6 to 1.8 (2.16 to 2.45)		
9	Suction hose	Hose clip 41	1.8 to 2.5 (2.5 to 3.4)		
10	Swivel	M10 × 30	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	

3. SERVICING STANDARDS

Unit : ft•lbf (N•m)

Applicable model:			SV08-1A, SV08-1A(S), SV08-1C			
Equipment			Thread size	Tightening torque ft•lbf (N•m)	Adhesive	Remarks
No.	Tightening part					
Implements						
1	Boom bracket vertical pin		M12	18.1 to 23.8 (24.5 to 32.3)		
2	Boom cylinder slide cover		M10	32.5 to 43.4 (44.1 to 58.9)	Three Bond 1324 or its equivalent	

3. SERVICING STANDARDS

3-7-2 Engine

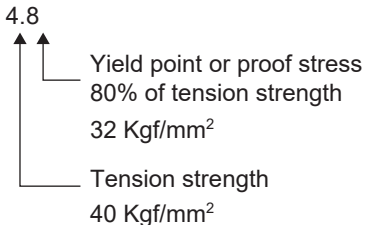
Tightening torque for major bolts and nuts

No.	Item	Thread size × Pitch	Tightening torque [Unit : ft•lbf (N•m)]	Lubricating oil
1	Cylinder head bolt	M8 × 1.25	25.1 to 28.8 (34 to 39)	Yes
2	Connecting rod nut	M7 × 1.0	15.5 to 18.4 (21 to 25)	No
3	Flywheel mounting bolt	M10 × 1.25	53.8 to 57.5 (73 to 78)	No
4	Bearing holder upper and lower tightening	M8 × 1.25	14.8 to 18.4 (20 to 25)	No
5	Bearing holder and cylinder block	M8 × 1.25	18.4 to 21.4 (25 to 29)	No
6	Crankshaft pulley tightening nut	M18 × 1.5	64.9 to 72.3 (88 to 98)	No
7	Fuel injection nozzle tightening	M20 × 1.5	43.5 to 50.9 (59 to 69)	No
8	Glow plug	M8 × 1.0	5.9 to 11.1 (8 to 15)	No

Tightening Torque for General Bolts and Nuts (Engine)

Thread size	Class	Coarse thread			Fine thread		
		Thread pitch	Tightening torque		Thread pitch	Tightening torque	
			ft•lbf	N•m		ft•lbf	N•m
M5	4T, 4.8	0.8	2.07 - 2.95	2.8 - 4.0	—	—	—
	7T, 8T, 8.8		3.61 - 5.09	4.9 - 6.9			
	10T, 11T		4.94 - 6.93	6.7 - 9.4			
M6	4T, 4.8	1.0	3.61 - 5.09	4.9 - 6.9	—	—	—
	7T, 8T, 8.8		6.12 - 8.33	8.3 - 11.3			
	10T, 11T		8.85 - 11.8	12 - 16			
M8	4T, 4.8	1.25	9.59 - 12.5	13 - 17	1.0	11 - 15	15 - 20
	7T, 8T, 8.8		17.0 - 20.7	23 - 28		19 - 25	26 - 34
	10T, 11T		20.7 - 26.6	28 - 36		22 - 30	30 - 40
M10	4T, 4.8	1.5	18.4 - 24.3	25 - 33	1.25	21 - 27	28 - 36
	7T, 8T, 8.8		32.5 - 41.3	44 - 56		36 - 46	49 - 63
	10T, 11T		39.8 - 51.6	54 - 70		43 - 55	58 - 74
M12	4T, 4.8	1.75	27.3 - 34.7	37 - 47	1.25	32 - 41	43 - 55
	7T, 8T, 8.8		48.7 - 61.2	66 - 83		55 - 69	75 - 94
	10T, 11T		67.9 - 85.6	92 - 116		73 - 94	99 - 127
M14	4T, 4.8	2.0	46.5 - 59.0	63 - 80	1.5	52 - 64	70 - 87
	7T, 8T, 8.8		76.7 - 97.4	104 - 132		86 - 109	117 - 148
	10T, 11T		103 - 129	139 - 175		110 - 136	149 - 184
M16	4T, 4.8	2.0	63.5 - 81.1	86.1 - 110	1.5	67 - 84	91 - 114
	7T, 8T, 8.8		110 - 136	149 - 185		116 - 142	157 - 192
	10T, 11T		151 - 188	205 - 255		163 - 198	221 - 269
M18	4T, 4.8	2.0	83.3 - 104	113 - 141	1.5	97.4 - 119	132 - 162
	7T, 8T, 8.8		145 - 174	196 - 236		170 - 206	231 - 279
	10T, 11T		203 - 246	275 - 333		220 - 271	298 - 367
M20	4T, 4.8	2.5	106 - 133	144 - 180	1.5	127 - 155	172 - 210
	7T, 8T, 8.8		177 - 214	240 - 290		203 - 246	275 - 333
	10T, 11T		268 - 325	363 - 441		293 - 358	397 - 485

3. SERVICING STANDARDS

Bolt head mark	Strength class	Description of Strength class
	4.8	Description of Strength class (Example) 
	8.8	
	10.9	

3-7-3 Tightening Torque for General Bolts and Nuts (Machine)

Item	Thread size × Pitch	Tightening torque [Unit : N•m (kgf•m)]	Remarks
Hexagon head bolt (7T) Nut	M6 × 1	7.23 to 8.70 (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	16.67 to 20.95 (22.6 to 28.4)	
	M10 × 1.5	32.53 to 43.44 (44.1 to 58.9)	
	M12 × 1.75	57.90 to 72.35 (78.5 to 98.1)	
	M14 × 2	83.20 to 104.88 (112.8 to 142.2)	
	M16 × 2	123.03 to 151.94 (166.8 to 206.0)	
	M18 × 2.5	173.70 to 209.84 (235.5 to 284.5)	
	M20 × 2.5	238.8 to 296.6 (323.8 to 402.2)	
	M14 × 1.5	94.04 to 108.5 (127.5 to 147.1)	
	M16 × 1.5	155.55 to 177.24 (210.9 to 240.3)	
R (PT) plug	1/8	7.23 (9.8)	
	1/4	14.46 (19.6)	
	3/8	21.68 (29.4)	
	1/2	43.44 (58.9)	
Pipe joint bolt	M8	9.37 to 12.32 (12.7 to 16.7)	
	M12	18.07 to 25.30 (24.5 to 34.3)	
	M14	28.91 to 36.14 (39.2 to 49.0)	
	M16	36.21 to 43.44 (49.1 to 58.9)	

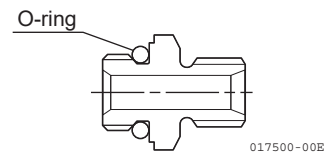
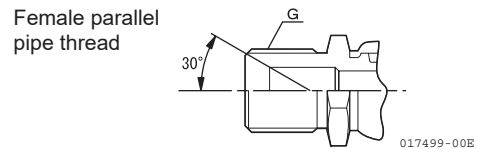
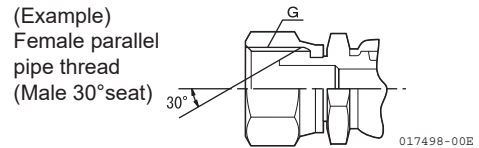
3. SERVICING STANDARDS

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)

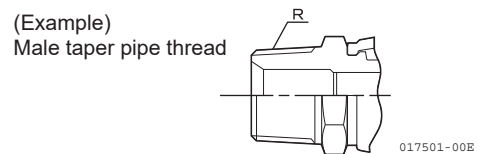
Nominal designation of screw thread G (PF)	Tightening torque
	Material of the other side: copper, cast iron
1/8	10.1 to 12.3 (13.7 to 16.7)
1/4	16.7 to 20.3 (22.6 to 27.5)
3/8	32.6 to 39.8 (44.1 to 53.9)
1/2	39.1 to 47.8 (53.0 to 64.7)
3/4	78.2 to 95.2 (106 to 129)
1	91.5 to 111.5 (124 to 151)
1 1/4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



- (2) Tightening torque for taper pipe thread
(Application of seal tape)

Unit : ft•lbf (N•m)

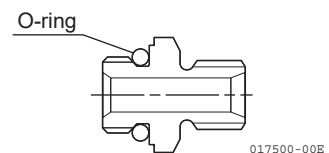
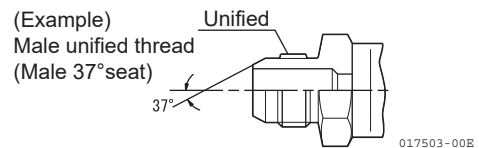
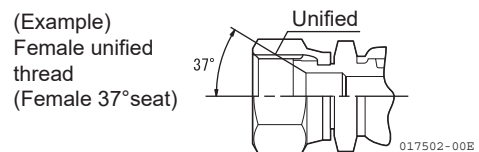
Nominal designation of screw thread R (PF)	Tightening torque
	Material of the other side: copper, cast iron
1/8	5.09 to 6.50 (6.9 to 8.8)
1/4	7.23 to 10.9 (9.8 to 14.7)
3/8	21.7 to 28.9 (29.4 to 39.2)
1/2	28.9 to 36.2 (39.2 to 49.0)
3/4	36.2 to 47.0 (49.0 to 63.7)
1	50.6 to 65.2 (68.6 to 88.3)
1 1/4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



- (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)



CHAPTER 4

Engine

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4. Engine

4-1 Disassembly of Engine

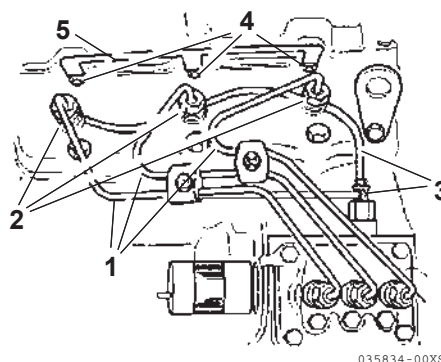
The following disassembly procedures apply to both two-cylinder and three-cylinder engines.

4-1-1 Removing the Nozzle and Glow Plug

Note:

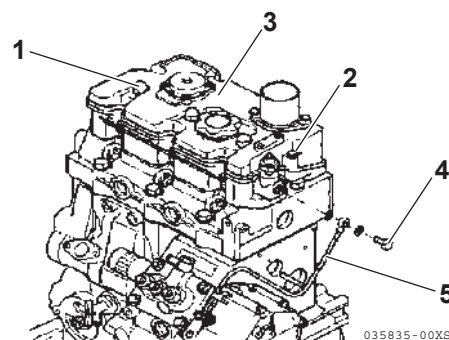
Clean the engine to remove dirt and debris before disassembly.

- (1) Remove the high pressure pipes **1**.
- (2) Disconnect the fuel return pipes **3**.
- (3) Remove the injection nozzle assemblies **2**.
- (4) Disconnect the connector **5** and remove the glow plugs **4**.



4-1-2 Removing the Cylinder Head Cover

- (1) Remove the cap nuts **1** and bolts **2** and then remove the cylinder head cover **3**.
- (2) Remove the eyebolt **4**.

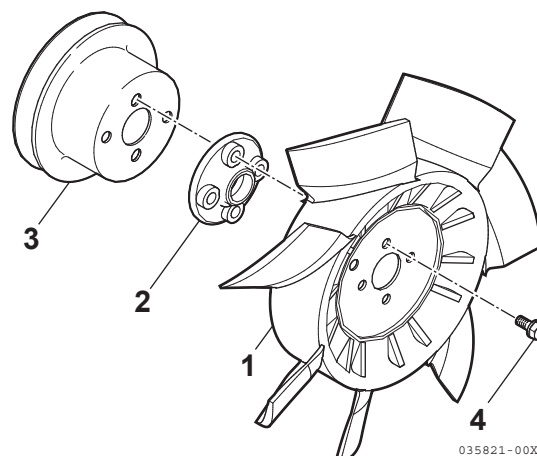


4-1-3 Removing the Oil Pipe

Remove the oil pipe **5** and the two gaskets.

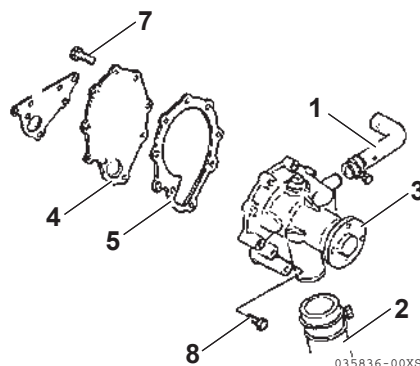
4-1-4 Removing the Water Pump Assembly

- (1) Remove the bolts **4** and then remove the fan **1**, holder **2** and pulley **3**.



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- (2) Remove the bypass hose **1** and lower hose **2** from the water pump **3**.
- (3) Remove the bolts **8** and then remove the water pump **3** from the engine.
- (4) Remove the bolts **7** and then remove the plate **4** and gasket **5** from the water pump **3**.

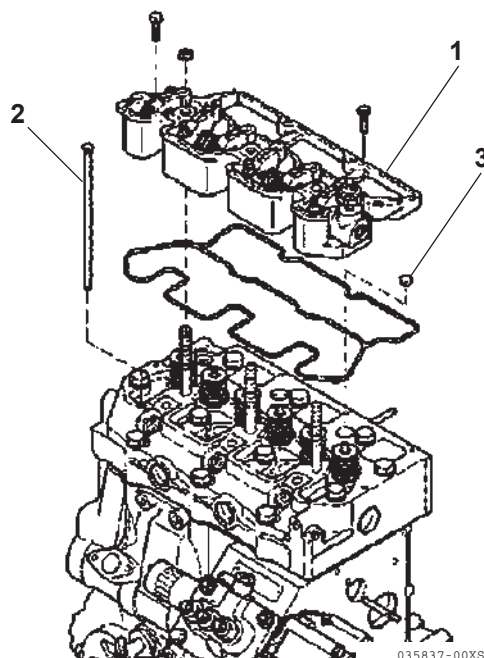


4-1-5 Removing the Rocker Arm and Push Rods

- (1) Remove the bolts and nuts and then remove the rocker arm assembly **1**.
*Be sure to check the length of each bolt.
- (2) Pull the push rods **2** from the cylinder head.

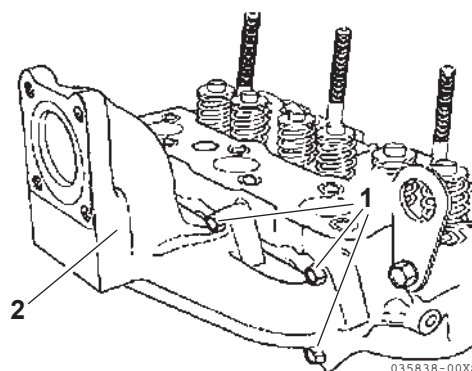
Note:

Be careful not to lose the caps **3** on the top of the valves.
Remove the caps and keep them in a proper place.



4-1-6 Removing the Exhaust Manifold

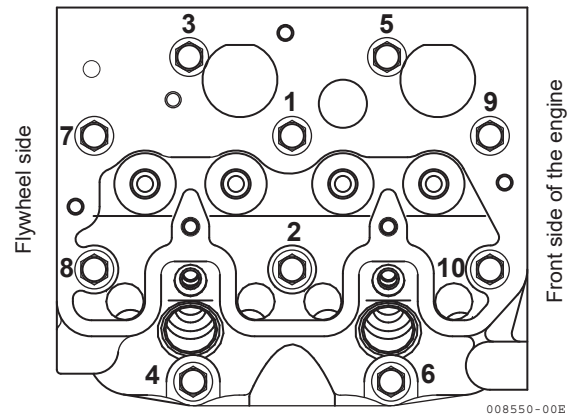
Remove the nuts **1** and then remove the exhaust manifold **2**.



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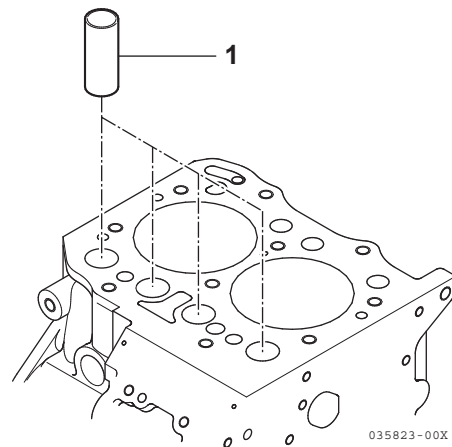
4-1-7 Removing the Cylinder Head

Uniformly loosen and remove the bolts **1** to **10** gradually in two or three passes in the numerical order shown in the figure at the right. Then remove the cylinder head.



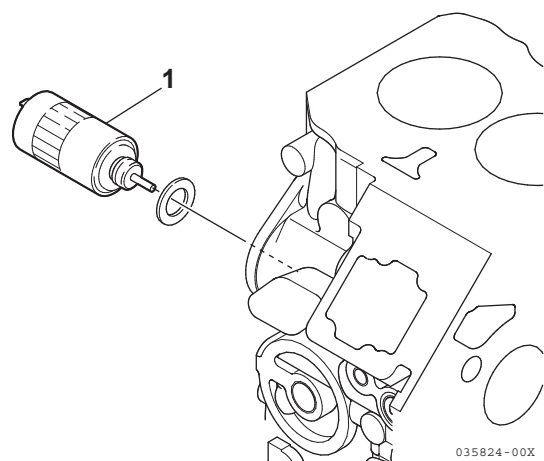
4-1-8 Removing the Tappets

Pull out the tappets **1** upward from the cylinder block.



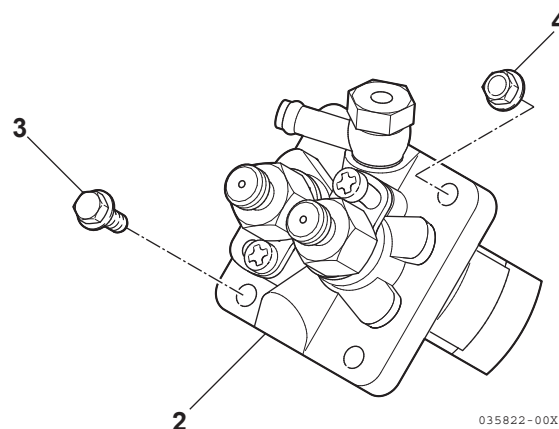
4-1-9 Removing the Injection Pump Assembly

(1) Remove the engine stop solenoid **1**.



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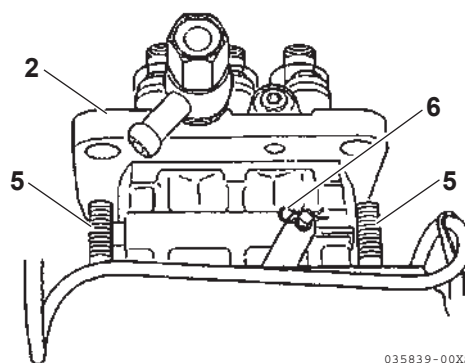
- (2) Remove the two bolts **3** and two nuts **4** securing the injection pump **2**.



- (3) Slowly lift the injection pump **2** up along the length of the stud bolts **5**, remove the snap pin **6** to separate the pump from the link and then remove it.

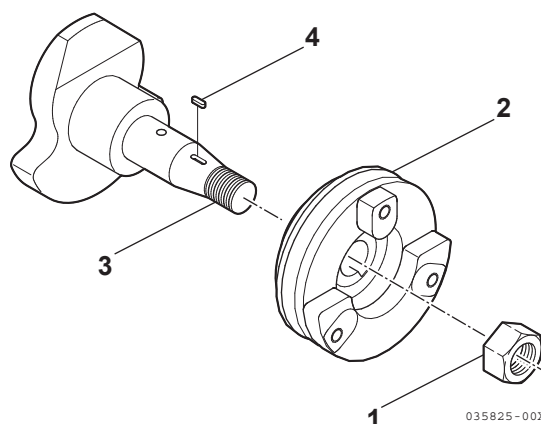
Note:

- Be sure to check the number and thickness of the injection timing adjustment shims installed between the injection pump and the mounting surface.
- Be careful not to let the pump rack get caught in the cylinder block when removing the injection pump. (Pull out the pump while moving the stop lever or the rack through the solenoid mounting hole.)



4-1-10 Removing the Crankshaft Pulley

- (1) Remove the nut **1** and then remove the crankshaft pulley **2**.
- (2) Remove the key **4** from the crankshaft **3**.



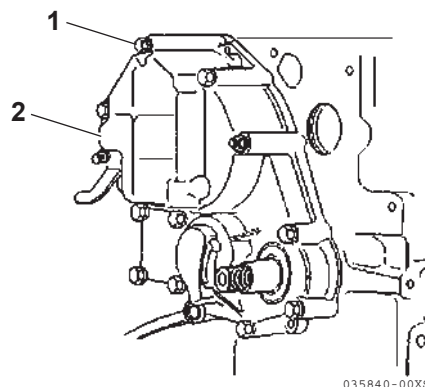
4. ENGINE

4-1-11 Removing the Timing Gear Case Assembly

Remove the bolts **1** and then remove the timing gear case **2**.

Note:

Do not damage the oil seal lip by catching it in the key groove.

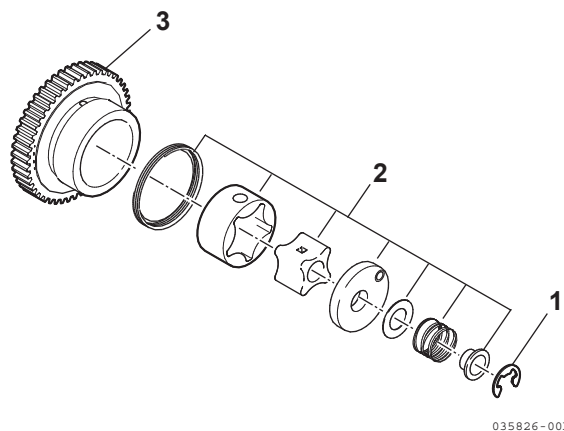


4-1-12 Removing the Idle Gear and Oil Pump Assembly

Remove the E-shape clip **1** and then remove the oil pump assembly **2** and idle gear **3**.

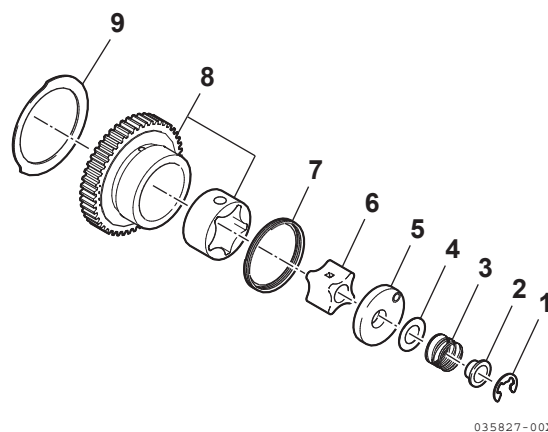
Note:

- *Be careful when removing the E-shape clip because the spring can fly out.*
- *Be careful not to lose shims in the oil pump assembly.*



<<Oil Pump Component Parts>>

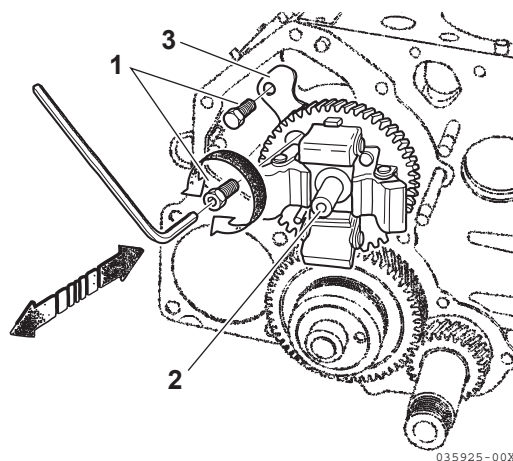
No.	Parts
1	E-shape clip
2	Collar
3	Spring
4	Shim
5	Oil pump cover
6	Inner rotor
7	Spring
8	Idle gear
9	Thrust washer



4. ENGINE

4-1-13 Removing the Camshaft Assembly

- (1) Remove the bolts **1** securing the plate **3**.
*The bolt behind the gear must be removed after aligning the hole in the gear with the bolt.
- (2) Pull the camshaft **2** out of the cylinder block.

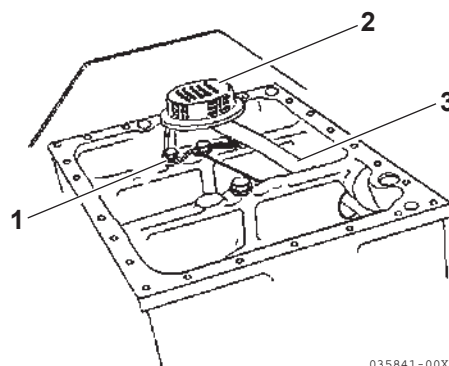


4-1-14 Removing the Suction Filter and Pipe

- (1) Remove the oil pan.
- (2) Remove the bolts **1** and then remove the suction filter **2** and pipe **3**.

Note:

Check to make sure that the O-ring is not damaged.

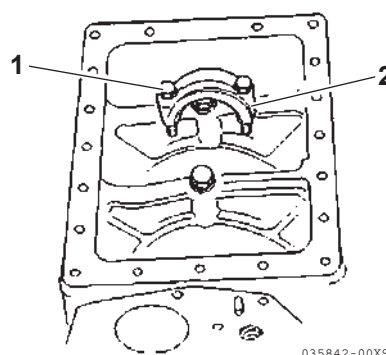


4-1-15 Removing the Connecting Rods and Pistons

- (1) Remove the bolts **1** and then remove the rod cap **2**.
- (2) Pull out the connecting rod and piston together from the cylinder head side and temporarily install the rod cap on the connecting rod while aligning the match-marks for temporary storage.

Note:

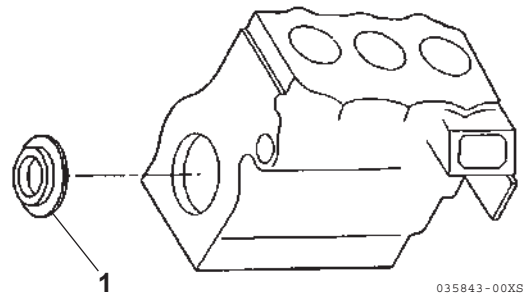
- *Before removing the connecting rod and piston, remove carbon deposits from inside the cylinder around the top dead center.*
- *Keep the removed connecting rods and pistons in order of cylinder placement [so that they will be installed in their correct position during reassembly].*



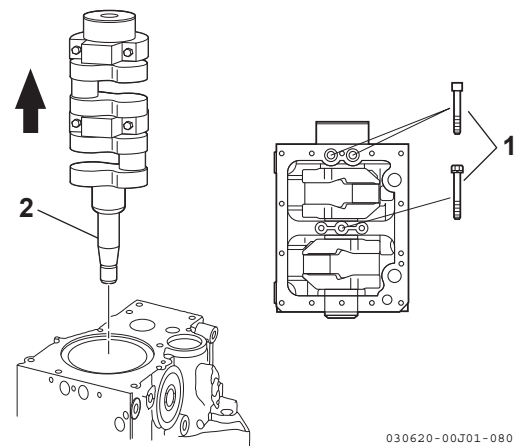
4. ENGINE

4-1-16 Removing the Crankshaft Assembly

(1) Remove the flywheel cover and rear oil seal **1**.



(2) Remove the bolts **1** securing the bearing holder to the cylinder block and then slide out crankshaft assembly **2** from the flywheel side.

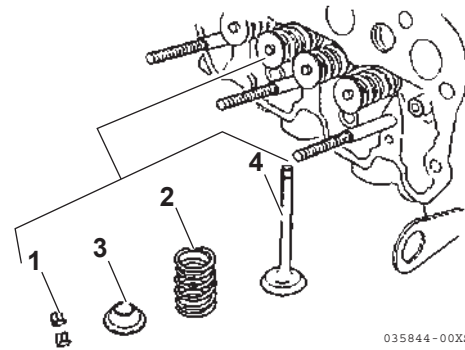


4. ENGINE

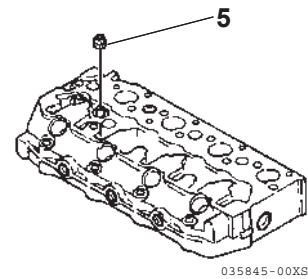
4-2 Disassembly, Inspection and Reassembly of Main Component Parts

4-2-1 Cylinder Head

- (1) Compress the valve spring with a valve spring replacer and remove a pair of valve cotters **1**, retainer **3**, spring **2** and valve **4**.

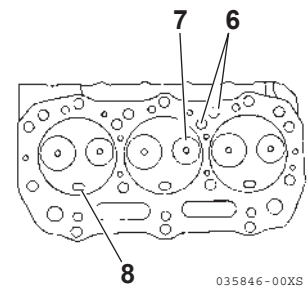
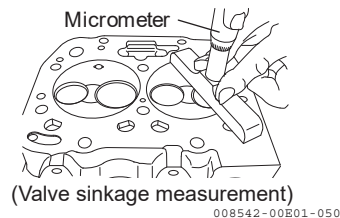


- (2) If necessary, remove the valve guide seal **5**.



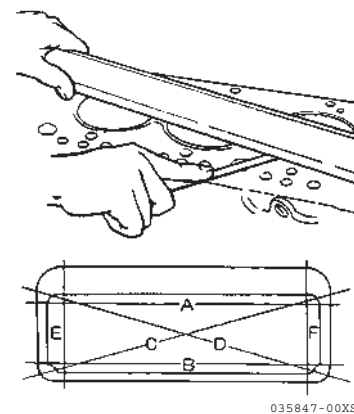
- (3) Check the following portions of the cylinder head for cracks and other damage.

- Valve stem passages
- Water jacket (water passages) **6**
- Valve seats **7** (Check for sinkage)
- Combustion chambers **8**



- (4) Check the bottom surface of the cylinder head for distortion as follows.

Place a straight edge across the bottom surface of the cylinder head and use a thickness gauge to measure the clearances at six points A to F between the straight edge and the bottom surface. If the measured value exceeds the allowable distortion limit, use a surface grinder or a similar tool to restore the flatness of the bottom surface of the cylinder head.



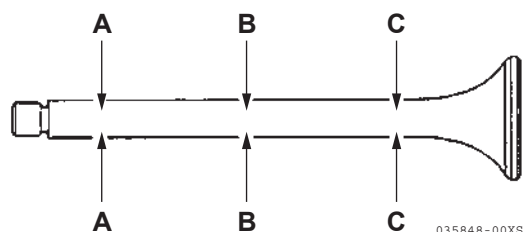
Cylinder head bottom surface distortion [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	

4. ENGINE

(5) Inspect and check the valve as follows.

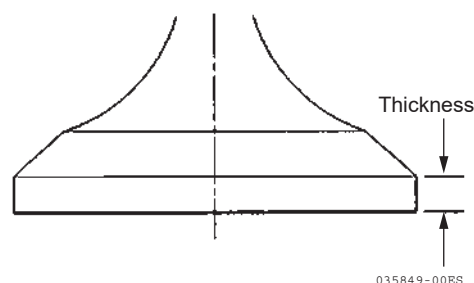
- Check the valve head and stem for damage and if considerable seizing, wear or deformation is observed, replace the valve.
- Measure the outside diameter of the valve stem at points A, B and C shown in the figure at the right with a micrometer and if the measured value at any of the points is less than the allowable limit, replace the valve.

Valve stem outside diameter [in. (mm)]			
Intake valve		Exhaust valve	
Standard	Allowable limit	Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3			



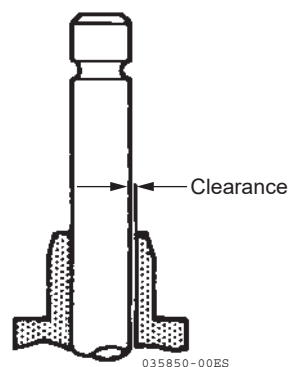
- If the thickness of the valve head is less than the allowable limit, replace the valve.

Valve head thickness [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	



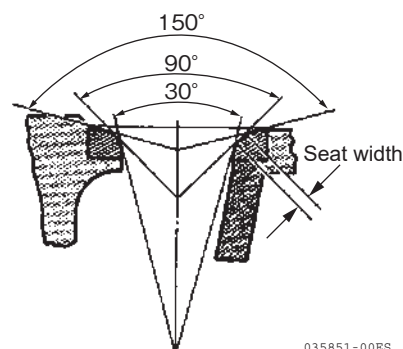
- If the clearance between the valve stem and valve guide exceeds the allowable limit, replace the valve and/or the valve guide.

Clearance between valve stem and valve guide [in. (mm)]			
Intake valve		Exhaust valve	
Standard	Allowable limit	Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3			



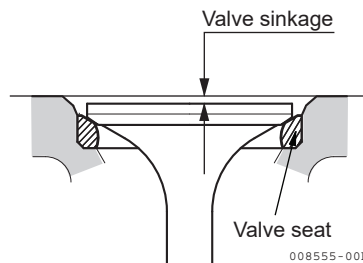
- Use a 15, 45 or 75 degree seat cutter to correct the valve seat so that the valve seat width and valve sinkage are within their standard range.

Valve seat width [in. (mm)]	
Standard	Allowable limit
Intake	Refer to Section 3-2-2 of Chapter 3
Exhaust	



4. ENGINE

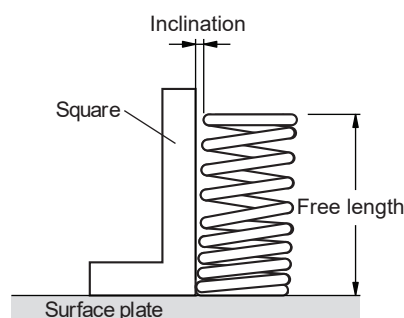
Valve sinkage [in. (mm)]		
Standard		Allowable limit
Intake	Refer to Section 3-2-2 of Chapter 3	
Exhaust		



(6) Inspect and check the valve spring as follows.

- Visually check the valve spring for damage.
- Measure the valve spring squareness and if the inclination exceeds the allowable limit, replace the valve spring.
- Check the free length and force of the valve spring and if any of the measured values exceeds the allowable limit, replace the valve spring.

	Standard	Allowable limit
Squareness (Inclination) [in. (mm)]	Refer to Section 3-2-2 of Chapter 3	
Free length [in. (mm)]		
Installed load [lbf (N)]		

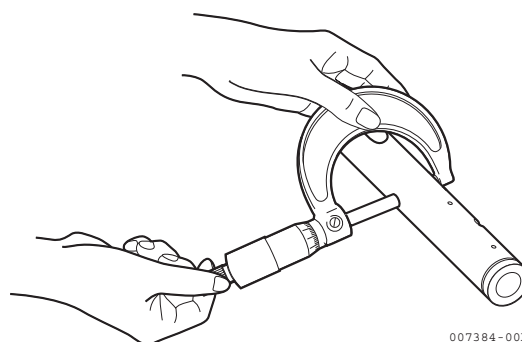


(Measuring the inclination of the valve spring)

4-2-2 Rocker Arm

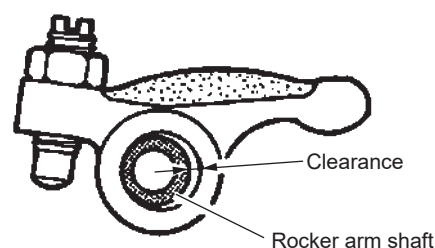
(1) Measure the outside diameter of the rocker arm shaft and if the measured value exceeds the allowable limit, replace the rocker arm shaft.

Rocker arm shaft outside diameter [in. (mm)]		
Standard		Allowable limit
Refer to Section 3-2-2 of Chapter 3		



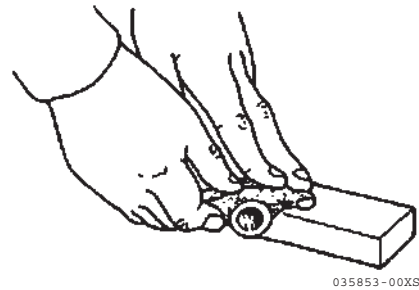
(2) Measure the inside diameter of the rocker arm and if the clearance between the rocker arm and the rocker arm shaft exceeds the allowable limit, replace the rocker arm.

Clearance between rocker arm and rocker arm shaft [in. (mm)]		
Standard		Allowable limit
Refer to Section 3-2-2 of Chapter 3		



4. ENGINE

- (3) Check the rocker arm for stepped wear on the contact surface with the valve stem and if there is slight wear on the surface, correct the curved surface using an oil stone or a grinder.



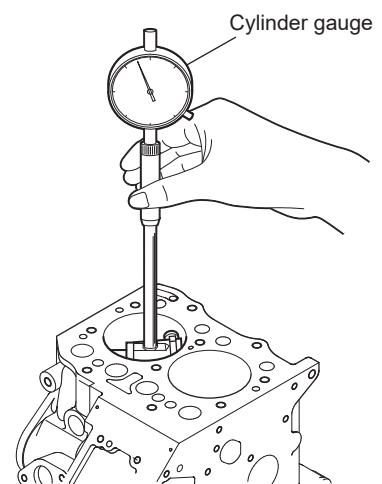
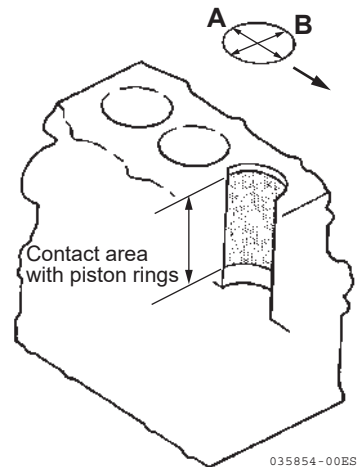
4-2-3 Cylinder Block

- (1) Check the cylinder block for cracks, top surface distortion and other damage according to the same procedures as those for the cylinder head.

Cylinder block top surface distortion [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	

- (2) Visually check the cylinder bores for scratches, rust, corrosion and other damage.
- (3) Measure the diameter of each cylinder bore at the top, middle and bottom with a cylinder gauge placed parallel (A) and perpendicular (B) to the crankshaft. [Cylinder bore measurements should be performed within the contact area of the bore with piston rings.] If any of the measured values exceeds the allowable limit or if any damage like flaws is found, replace the cylinder block.

Cylinder block bore diameter [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	



(Measuring the cylinder bore diameter)

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4. ENGINE

4-2-4 Piston and Piston Rings

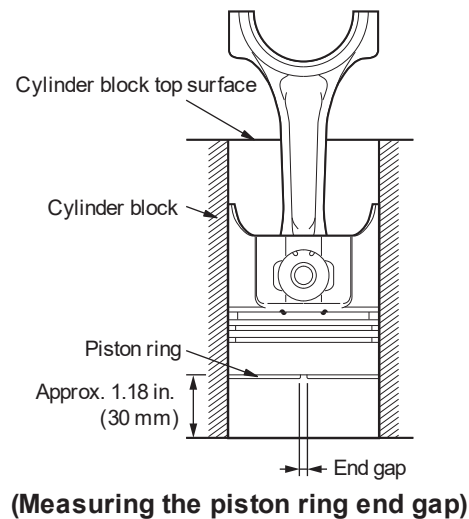
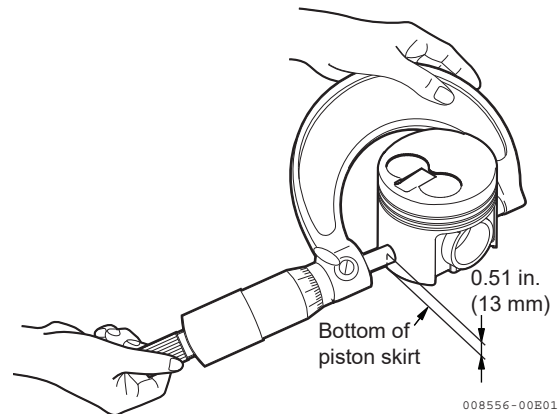
- (1) Check the outside surface of the piston for cracks, scratches and burnout and if any significant crack, scratch or burnout is found, replace the piston.
- (2) Measure the piston skirt diameter (major diameter) and the cylinder bore diameter in the thrust direction and if the clearance between the piston skirt and the cylinder bore exceeds the allowable limit, replace the piston.

[Measure the skirt diameter at a point 0.51 in. (13 mm) from the bottom of the piston skirt.]

Piston skirt diameter [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	

- (3) Check the piston rings for wear and damage and if excessive wear or damage is found, replace the piston ring.
 - Put the piston ring into the cylinder bore so that it is located perpendicular to the bore at the point shown in the figure at the right. Measure the piston ring end gap and if the measured value exceeds the allowable limit, replace the piston ring.

Piston ring end gap [in. (mm)]		
Top ring	Standard	Refer to Section 3-2-2 of Chapter 3
	Allowable limit	
Second ring	Standard	
	Allowable limit	
Oil ring	Standard	
	Allowable limit	

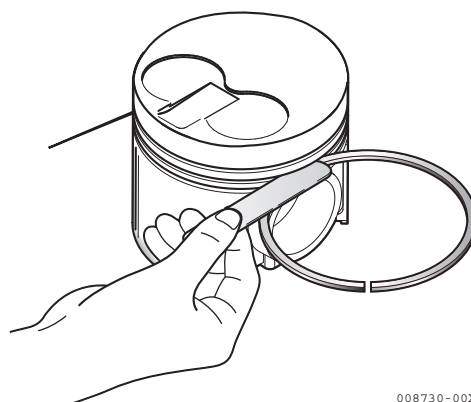


(Measuring the piston ring end gap)

4. ENGINE

- (4) Measure the clearance between each of the piston rings and its piston ring groove and if the measured value exceeds the allowable limit, replace the piston ring.

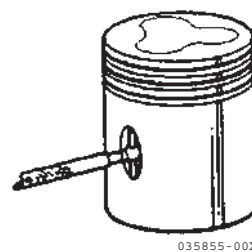
Clearance between piston ring and piston ring groove [in. (mm)]		
Top ring	Standard	Refer to Section 3-2-2 of Chapter 3
	Allowable limit	
Second ring	Standard	
	Allowable limit	
Oil ring	Standard	
	Allowable limit	



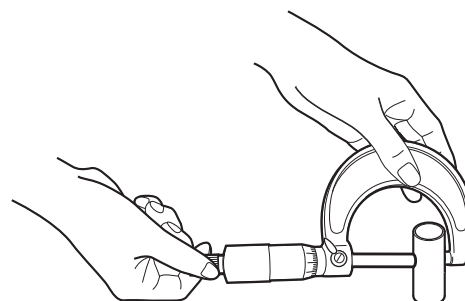
008730-00X

- (5) Measure the piston pin hole diameter and the piston pin outside diameter and if the clearance between the piston pin hole and the piston pin exceeds the allowable limit, replace the piston and the piston pin.

Clearance between piston pin hole and piston pin [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	



035855-00XS



(Measuring the piston pin outside diameter)

030614-00E01

4. ENGINE

4-2-5 Connecting Rod

(1) Check each connecting rod for twist, parallelism and damage as follows.

- Measure the twist and parallelism of the connecting rod using a connecting rod aligner and if any of the measured values exceeds the allowable limit, replace the connecting rod.

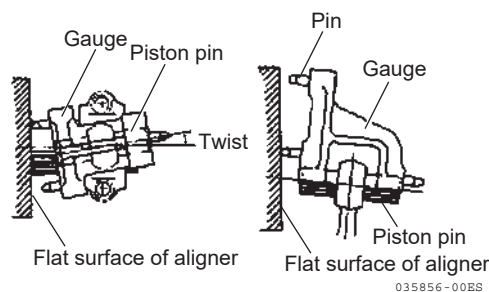
Connecting rod twist and parallelism [in. (mm)]		
	Standard	Allowable limit
Twist per 3.937 in. (100 mm)	Refer to Section 3-2-2 of Chapter 3	
Parallelism per 3.937 in. (100 mm)		

(2) Measure the inside diameter of the connecting rod small end bush and if the clearance between the connecting rod small end bush and the piston pin exceeds the allowable limit, replace the connecting rod.

Clearance between small end bush and piston pin [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	

(3) Install the connecting rod onto the crankshaft and check the play between the connecting rod and the crank pin. If the play exceeds the standard, replace the connecting rod.

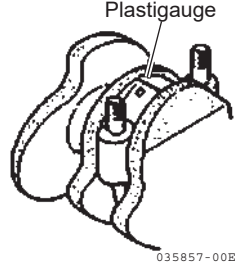
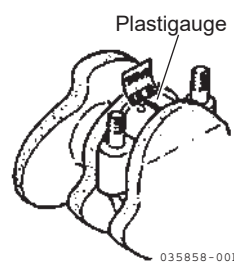
Play between connecting rod and crank pin [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	



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4-2-6 Connecting Rod Metal

- (1) Check the metal of each connecting rod for abrasion, melting, stepped portions, inadequate contact and other abnormalities. If any abnormality is found, replace the metal.
- (2) Measure the clearance between the crank pin and the metal using a plastigauge.
 - Before measurement, remove dirt and oil from the metal and the crank pin.
 - Cut the plastigauge to the same length as the width of the metal and place it parallel to the crankshaft, being careful not to overlap the oil groove.
 - Tighten the connecting rod cap to the specified torque, then remove the connecting rod cap and check the clearance.

Clearance between crank pin and connecting rod metal [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	
Set the plastigauge.  035857-00ES	Measure the clearance.  035858-00ES

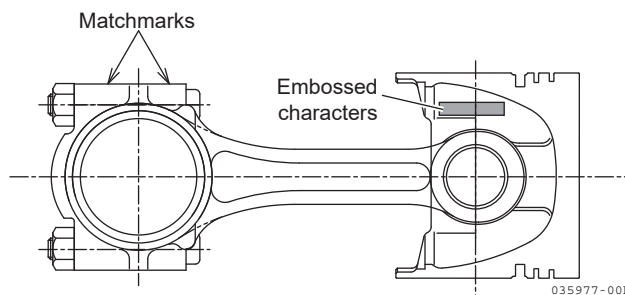
Tightening torque	Refer to Section 3-7-2 of Chapter 3
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Note:

Do not turn the crankshaft when measuring the clearance.

Assembling the Pistons, Connecting Rods and Piston Rings

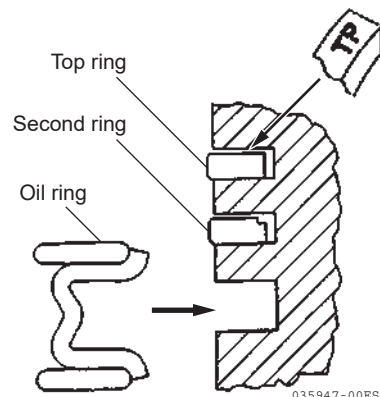
- (1) Heat each piston to approximately 212°F (100°C) with a piston heater or any other appropriate heater and install the piston onto the connecting rod so that the embossed characters on the inner surface of the piston and the matchmarks on the connecting rod are aligned as shown in the figure below.



- (2) Install each piston ring with the stamp on one end of the piston ring facing up as shown in the figure at the right.

[The piston ring gaps should be evenly distributed around the circumference, staggered at intervals of 120° and should not be positioned parallel or perpendicular to the piston pin.]

- (3) The differences in weight between the pistons must be within 0.022 lbs. (10 g).



4. ENGINE

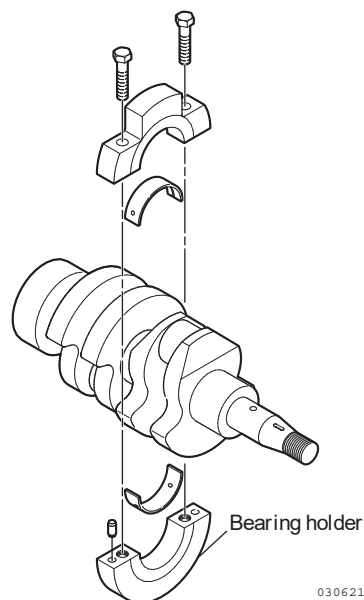
4-2-7 Bearing Holder

<<Center Bearing>>

- (1) Remove the bearing holder and check the metal for abrasion, melting, stepped portions, inadequate contact and other abnormalities. If any abnormality is found, replace the metal.
- (2) Measure the clearance between the center journal and the metal using a plastigauge.
- (3) If the measured value exceeds the allowable limit, replace the metal.

Clearance between center journal and metal [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	

Bearing holder tightening torque	Refer to Section 3-7-2 of Chapter 3
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Precautions for Installation of Bearing Holders

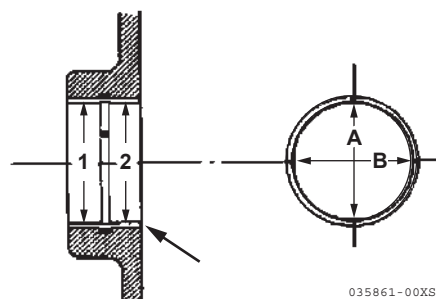
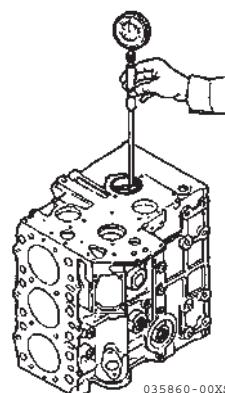
- (1) The lower half of the metal on the lower bearing holder side has no oil groove.
- (2) The upper half of the metal on the upper bearing holder side has oil groove.
- (3) The aluminum bearing holders are on the flywheel side.
- (4) Place the embossed mark "F" of the bearing holder to front side (crankshaft pulley side).
Install the bearing holder without the embossed mark "F" facing its chamfered side to front side (crankshaft pulley side).

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4-2-8 Crankshaft Bearing

- (1) Check the bearing (bush) for abrasion, melting, seizing, inadequate contact and other abnormalities. If any abnormality is found, replace the bearing (bush).
- (2) Measure the inside diameter of the bearing (bush) at locations **1** and **2** in directions **A** and **B** as shown in the figure at the right and calculate the differences (clearances) between the measured values and the largest outside diameter of the crankshaft journal.
- (3) If any of the calculated values exceeds the allowable limit, replace the bearing (bush).

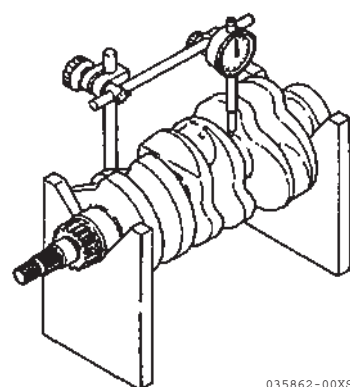
Clearance between crankshaft journal and bearing (bush) [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	



4-2-9 Crankshaft

- (1) Support the crankshaft at both ends, as shown in the figure at the right, and place a dial gauge on the crankshaft journal. Then, measure the amount of crankshaft runout and if the measured value exceeds the allowable limit, replace the crankshaft.

Crankshaft runout [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	



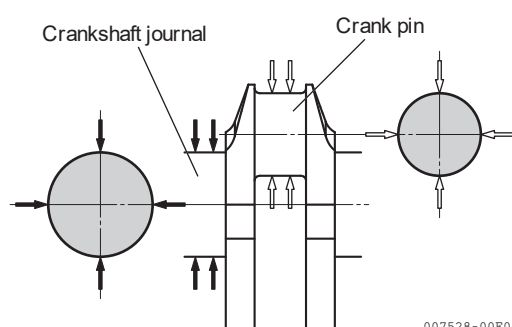
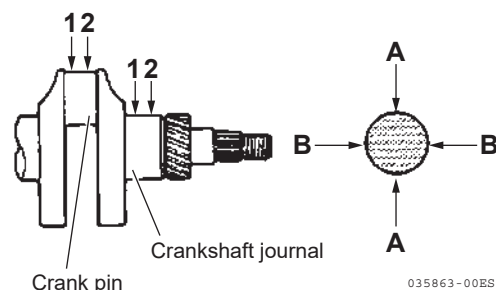
4. ENGINE

- (2) Check the crankshaft journals and crank pins for damage and wear (ovality and conicality) and measure the crankshaft journal diameters and crank pin diameters. If any of the measured values exceed the allowable limit, replace the crankshaft.

Crankshaft journal diameter [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	
Crank pin diameter [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	

Note:

The above values for #1, #2 and #3 apply to the diameters of the crankshaft journals in order starting from the crankshaft pulley side.

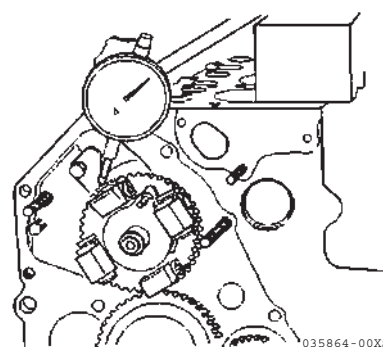


(Measuring points of the crank pin and crankshaft journal)

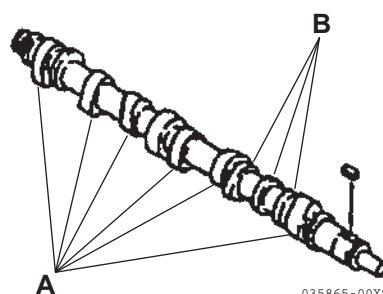
4-2-10 Timing Gears and Camshaft Assembly

- (1) Check each timing gear for tooth wear and if excessive wear is found, replace the timing gear.
- (2) Measure the backlash of each timing gear and if the measured value exceeds the allowable limit, replace the timing gear.

Timing gear backlash [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	



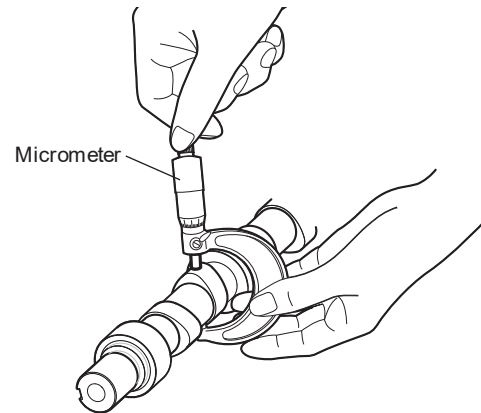
- (3) Check the camshaft journals and cams for wear and damage and if wear or damage exceed the allowable limit, replace the camshaft assembly.



4. ENGINE

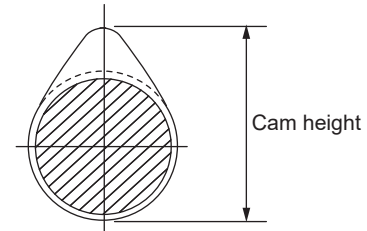
- (4) If the cam surface is damaged and slightly stepped, use an oil stone or a similar tool to restore the smooth surface.

Cam height [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	



(Measuring the cam height)

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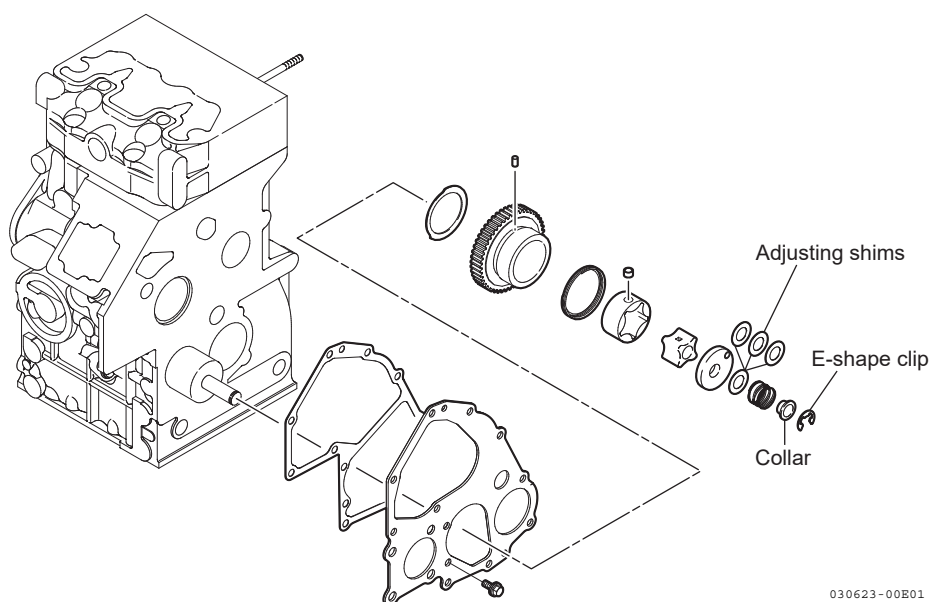
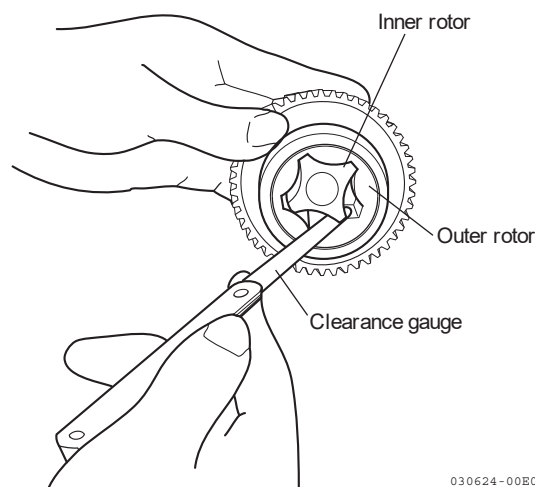
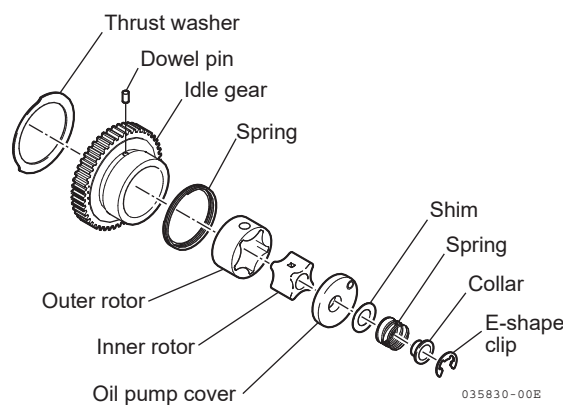
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4. ENGINE

4-2-11 Lubrication Oil Pump

- (1) Check the oil pump cover, inner rotor and outer rotor for wear and damage and if excessive wear or damage is found, replace the oil pump.
- (2) Measure the clearance between the inner and outer rotors and if the measured value exceeds the allowable limit, replace the oil pump.

Tip clearance between inner and outer rotors [in. (mm)]	
Standard	Allowable limit
Refer to Section 3-2-2 of Chapter 3	

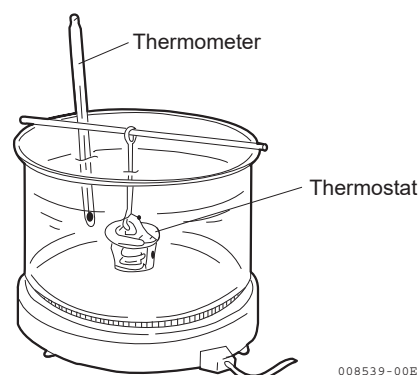


4. ENGINE

4-2-12 Thermostat

- (1) If the thermostat is open even slightly at ordinary temperatures, replace it.
- (2) Put the thermostat into water and gradually increase the water temperature to check the thermostat opening temperature.

Specifications [°F (°C)]	
Thermostat opening temperature	163 to 170 °F (73 to 77 °C)
Thermostat full-open temperature	188 °F (87°C)

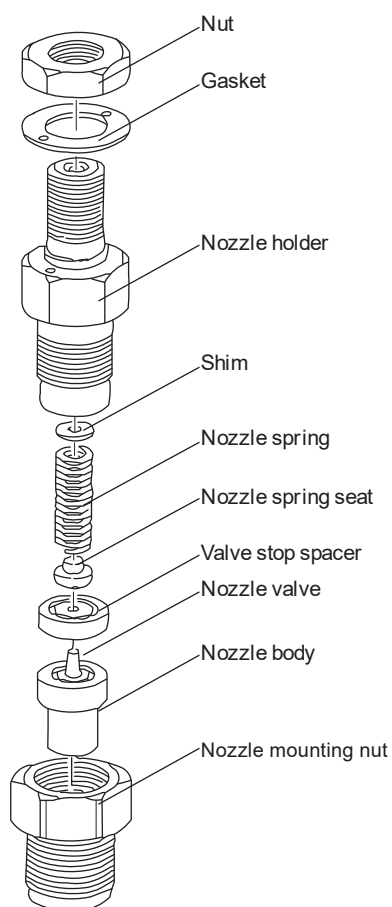


4-2-13 Nozzle and Holder Assembly

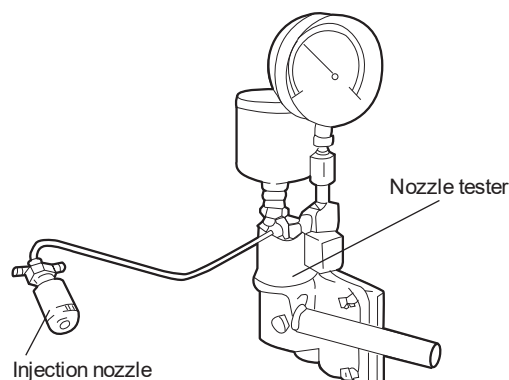
Check the nozzle for seizing, sticking and fuel leaks on the seating surface and if any damage or oil leak is found, replace the nozzle.

- As a basic rule, do not disassemble the nozzle.
Replace the whole nozzle with a new one if necessary.

Nozzle injection pressure [PSI (MPa)]	1740.4 to 1841.9 PSI (12.0 to 12.7 MPa)
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(Nozzle structure) 008541-00E01



(Measuring the injection pressure
with a nozzle tester)

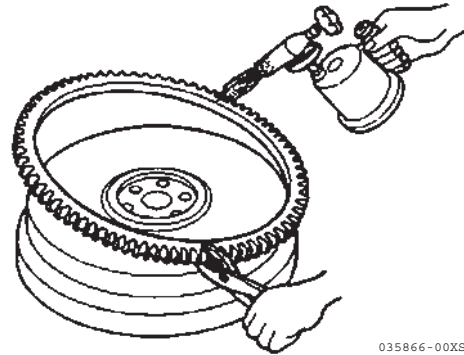
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4. ENGINE

4-2-14 Flywheel and Ring Gear

- Check the ring gear and if breakage or excessive wear is found, replace it.
- If just a small portion of the ring gear is worn, by removing the ring gear, then shifting it approximately 90 degrees and shrink-fitting it onto the flywheel, the ring gear can be still used.

To shrink-fit the ring gear onto the flywheel, heat it to 248 to 302°F (120 to 150°C) to cause it to expand.



4. ENGINE

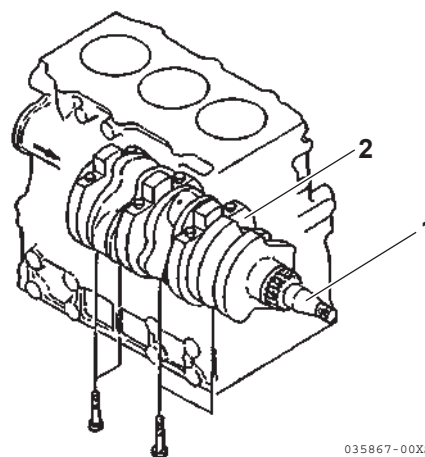
4-3 Reassembly of Engine

4-3-1 Crankshaft and Bearing Holder Assembly

- (1) Install the bearing holders **2** onto the crankshaft **1** and insert them into the bush on the front side of the cylinder block.
- (2) Align the bolt holes at the bottom of the cylinder block and the tapped holes in the bearing holders, then install and tighten the bolts.

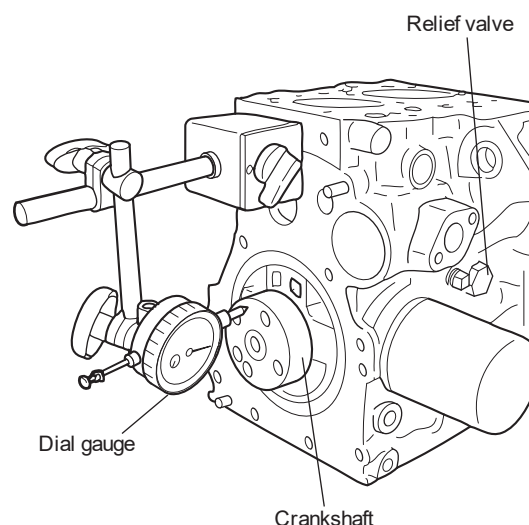
[Hexagon socket head bolts should be used on the fly-wheel side.]

Bearing holder bolt tightening torque	Refer to Section 3-7-2 of Chapter 3
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- (3) Measure the axial play in the crankshaft.

Crankshaft axial play [in. (mm)]	Refer to Section 3-2-2 of Chapter 3
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4-3-2 Oil Seal and Flywheel Cover (Rear Plate)

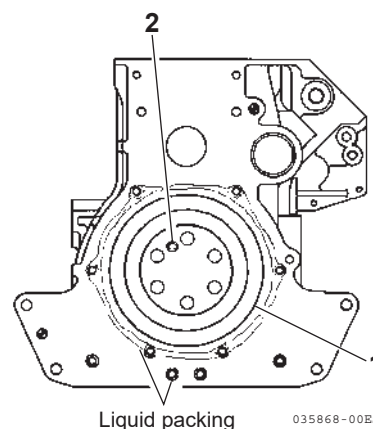
- (1) Install the oil seal **1** on the flywheel side of the crankshaft.
- (2) Apply liquid packing to the area around the tapped holes in the flywheel cover mounting surface of the cylinder block and install the flywheel cover.

Flywheel cover (rear plate) bolt tightening torque	Refer to Section 3-7-2 of Chapter 3
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4-3-3 Flywheel

Secure the flywheel with bolts, paying attention to the location of the roll pin **2**.

Flywheel bolt tightening torque	Refer to Section 3-7-2 of Chapter 3
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4. ENGINE

4-3-4 Pistons and Connecting Rods

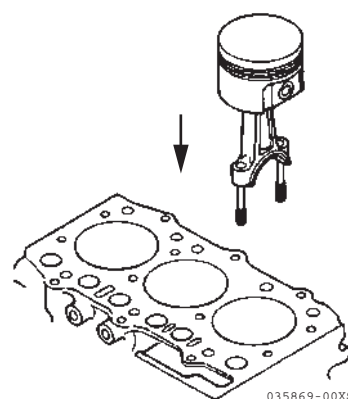
- (1) Apply engine oil to the metal surface, piston and piston rings.
- (2) Turn the piston rings, letting the oil enter the ring grooves, so that they are evenly distributed around the circumference, staggered at intervals of 120°.
- (3) Use piston ring pliers to insert the connecting rod into the cylinder bore with the matchmarks on the connecting rod facing the injection pump side.

Note:

Install the connecting rods in order of the matchmark number from smallest to largest, from the front side of the cylinder block.

- (4) Install and tighten the connecting rod cap to the specified torque and check the axial play in the crankshaft.

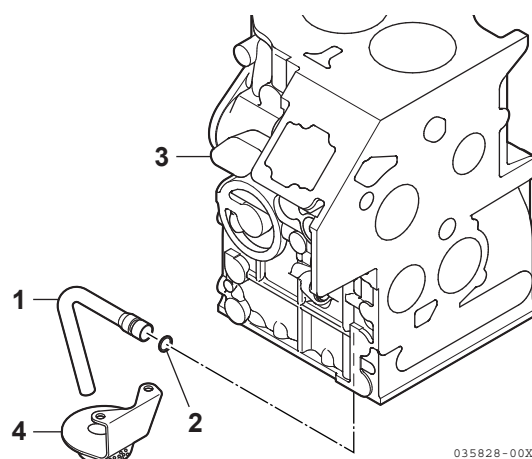
Connecting rod bolt tightening torque	Refer to Section 3-7-2 of Chapter 3
Crankshaft axial play [in. (mm)]	Refer to Section 3-2-2 of Chapter 3



4-3-5 Suction Pipe and Suction Filter

- (1) Install the O-ring 2 onto the suction pipe 1 and insert the suction pipe into the cylinder block 3.
- (2) Put the end of the suction pipe 1 into the hole in the suction filter 4 and secure the filter with the bolts.

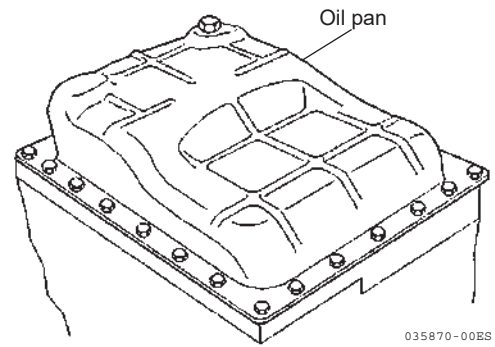
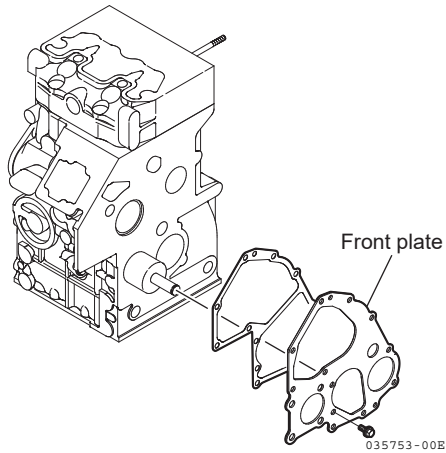
Suction filter mounting bolt tightening torque	Refer to Section 3-7-2 of Chapter 3
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4. ENGINE

4-3-6 Oil Pan and Front Plate

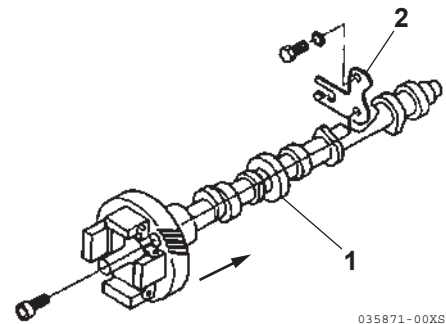
Install the oil pan and the front plate and alternately tighten the bolts diagonally.



4-3-7 Camshaft Assembly and Plate

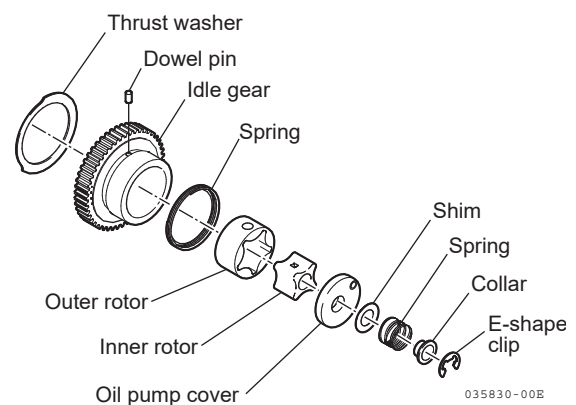
- (1) Install the camshaft assembly 1.
- (2) Secure the camshaft assembly 1 with the plate 2.

Plate tightening torque	Refer to Section 3-7-2 of Chapter 3
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4-3-8 Idle Gear and Oil Pump Assembly

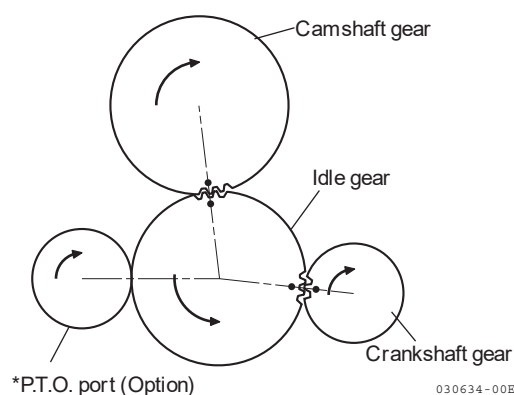
- (1) Install the thrust washer onto the idle gear shaft.
- (2) Install the outer rotor, dowel pin and the spring to the idle gear.



4. ENGINE

- (3) Align the matchmarks on the idle gear and those on the crankshaft gear and on the camshaft gear and install the idle gear onto the idle gear shaft.
- (4) Install the inner rotor.

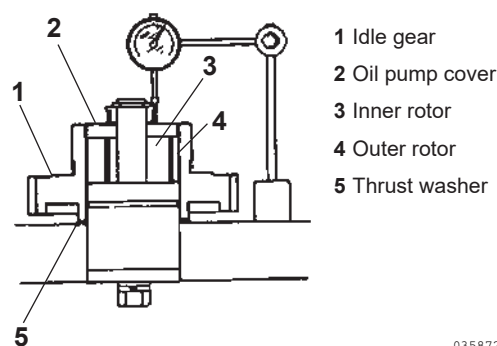
(Viewed from the gear case side)



- (5) Install the oil pump cover, shims, spring and collar and secure them with the E-shape clip.
- (6) Use shims to adjust the side clearance between the inner and outer rotors of the oil pump to 0.0039 to 0.0059 in. (0.10 to 0.15 mm).

Note:

- Before installing the inner and outer rotors, apply grease to the contact surfaces of both rotors.
- Do not rotate the crankshaft before installing the timing gear case because the dowel pin of the timing gear case is put into the hole in the oil pump cover.

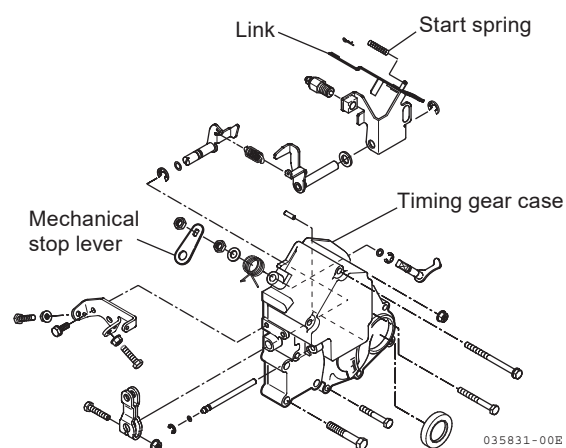


4-3-9 Timing Gear Case

- (1) Install the start spring.
- (2) Install the timing gear case on the cylinder block, being careful not to damage the oil seal, while inserting the link into the hole in the cylinder block.

Note:

Turn the mechanical stop lever clockwise and hold it in the position, then install the timing gear case.



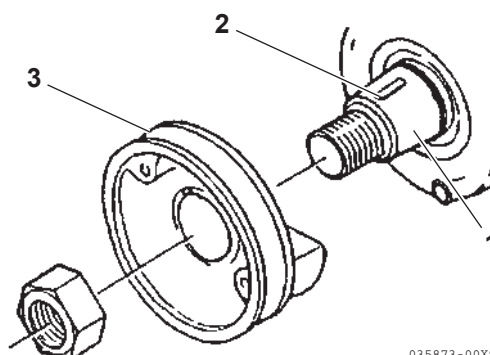
4. ENGINE

4-3-10 Crankshaft Pulley

Install the key **2** into the key groove in the crankshaft **1** and then install the crankshaft pulley **3** onto the crankshaft.

Be careful when installing the crankshaft pulley because the crankshaft is a tapered shaft.

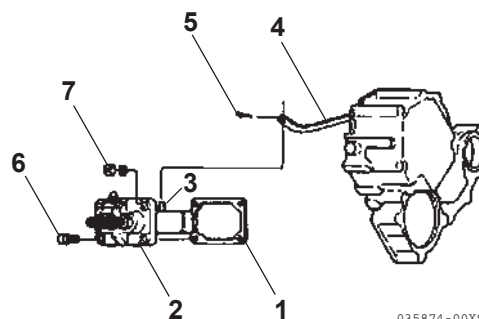
Crankshaft pulley nut tightening torque	Refer to Section 3-7-2 of Chapter 3
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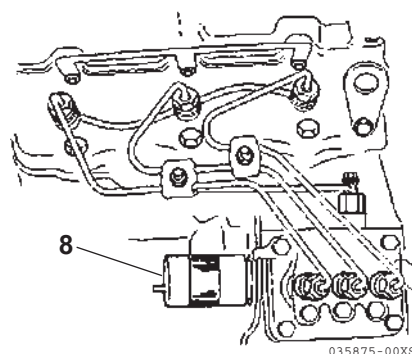
4-3-11 Injection Pump Assembly

- (1) Install the shims **1** which were removed during disassembly and connect the control rack **3** and link **4** of the injection pump **2**, then secure them with the snap pin **5**.
- (2) Secure the injection pump assembly with bolts **6** and nuts **7**.

Injection pump mounting bolt and nut tightening torque	Refer to Section 3-7-2 of Chapter 3
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- (3) Install the engine stop solenoid **8**.



4. ENGINE

Adjusting the Injection Timing

In cases where the injection pump, camshaft assembly or the cylinder block is replaced, adjust the injection timing in accordance with the following procedures.

- (1) Install a shim with 0.019 in. (0.5 mm) thickness and assemble the injection pump in accordance with the procedure described in the preceding section.
- (2) Remove the delivery holder on the front side (radiator side) of the injection pump.
(Be careful not to allow dust or other foreign matter to enter the injection pump.)

- (3) Remove the delivery valve (IN) from the delivery holder and install the delivery holder to the injection pump.

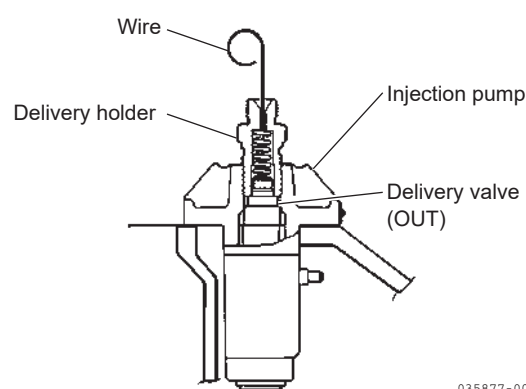
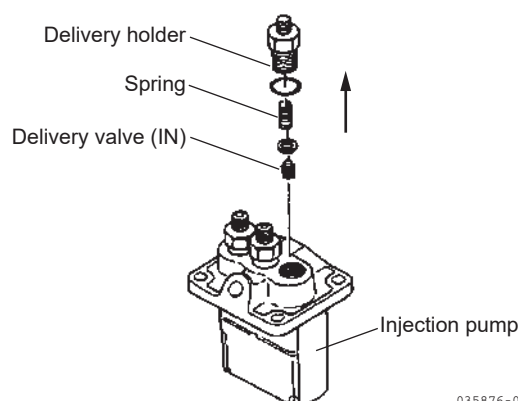
Delivery holder tightening torque	Refer to Section 3-7-2 of Chapter 3
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Note:

When installing the delivery holder, use wire to adjust the position of the delivery valve (OUT) so that it is set to the correct position.

(Note that depending on the injection pump type, the diameter of the hole in the delivery holder is so small that the wire cannot be put through the hole.)

- (4) Move the governor lever to the fuel increasing side to set the No. 1 piston (on the front side) at about 25 degrees before top dead center on its compression stroke and allow fuel to flow through the delivery holder.
- (5) Slowly rotate the crankshaft clockwise to stop fuel flowing through the delivery holder.
When fuel stops flowing, measure the position of the piston relative to top dead center. If the measured position is lagging, decrease the thickness of shims and if it is advanced, increase the thickness of shims.
- (6) After completing the adjustments, install the delivery valve (IN) in the same location where it was removed.



4. ENGINE

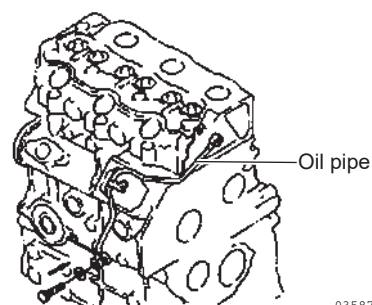
4-3-12 Oil filter and Oil Pipe

- (1) After applying oil to the oil filter mounting surface of the cylinder block, install the oil filter and manually tighten it.
- (2) Install the oil pipe and temporarily tighten the eye-bolt on the cylinder block side only.

Note:

After installing the cylinder head, tighten both eyebolts to the specified torque.

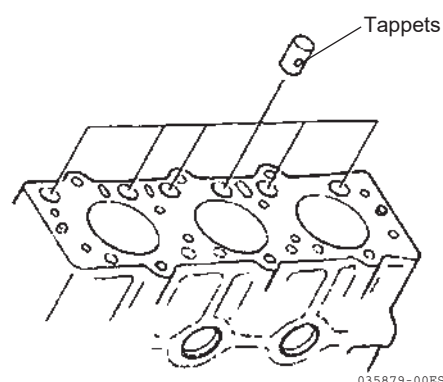
Tightening torque: Refer to Section 3-7-2 of Chapter 3



4-3-13 Tappets

Apply oil to the tappets and install them into the hole in the cylinder block.

Number of tappets: 4



4-3-14 Cylinder Head Assembly and Cylinder Head Gasket

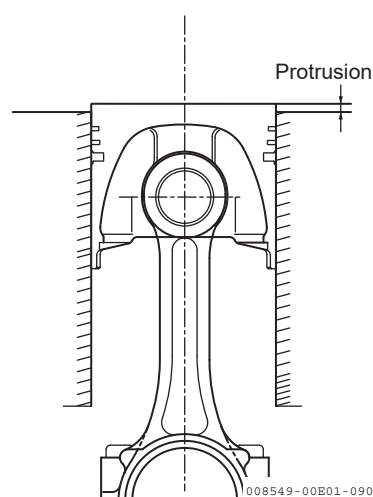
- (1) Set each piston at top dead center and measure the piston protrusion from the cylinder block.

Note:

- Measure the piston protrusion while lightly pressing the piston.
- The cylinder with largest piston protrusion value should be used as the reference.

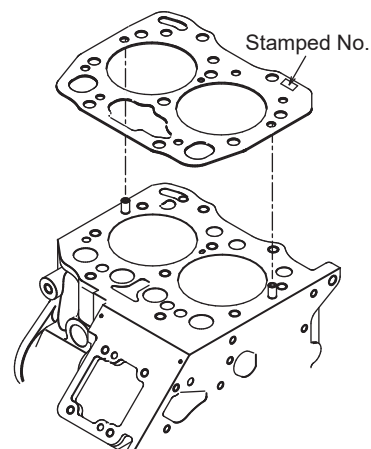
- (2) Select a gasket based on the measured value.

Measured value [in. (mm)]	Stamped No.	Tightening thick- ness [in. (mm)]
0.0197 to 0.0236 (0.50 to 0.60)	7600	0.0472 (1.2)
0.0236 to 0.0276 (0.60 to 0.70)	7610	0.0512 (1.3)



4. ENGINE

- (3) Install the glow plug and the connector.



(Installing the cylinder head gasket)

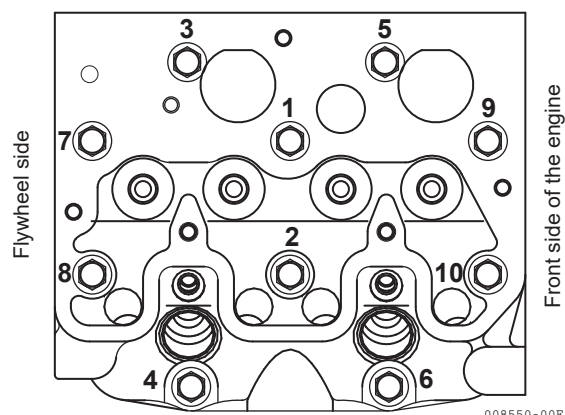
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- (4) Install the cylinder head and uniformly tighten the bolts **1** to **10** gradually in several passes in the numerical order shown in the figure at the right, finally to the specified torque.

Cylinder head bolt tightening torque	Refer to Section 3-7-2 of Chapter 3
--------------------------------------	-------------------------------------

Note:

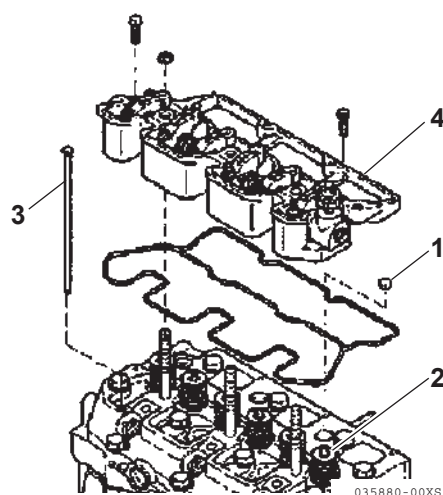
Apply molybdenum disulfide grease to the threaded portion of each bolt.



4-3-15 Caps, Push Rods and Rocker Arm Assembly

- (1) Install caps **1** on valve stem ends **2**.
 (2) Install push rods **3** and rocker arm assembly **4**.

Rocker arm assembly mounting bolt tightening torque	Refer to Section 3-7-2 of Chapter 3
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4. ENGINE

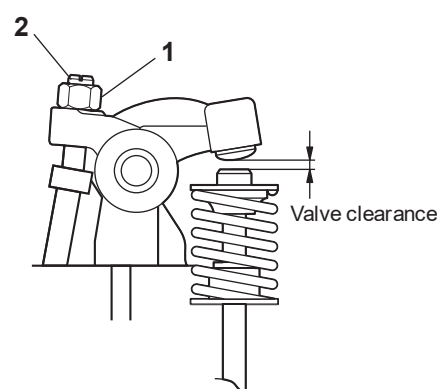
4-3-16 Adjusting the valve clearance

After loosening the lock nut **1**, turn the adjust screw **2** to adjust the valve clearance to 0.0079 in. (0.2 mm) for the intake and exhaust valves.

Lock nut tightening torque	Refer to Section 3-7-2 of Chapter 3
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Note:

Adjust the valve clearance in cold state.



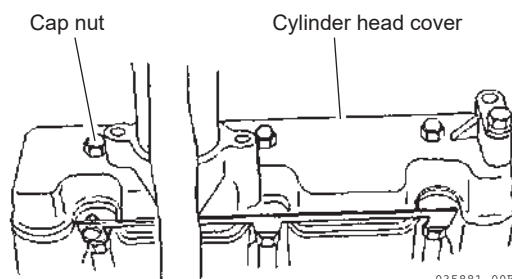
(Adjusting the valve clearance)

030549-00E01

4-3-17 Cylinder Head Cover

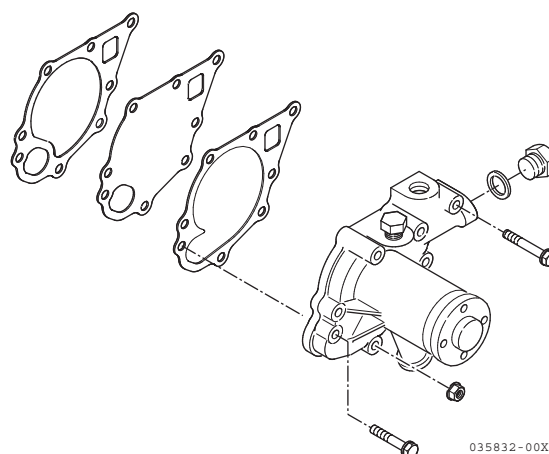
Install the cylinder head cover and uniformly tighten the cap nuts, paying attention to the packing.

Cylinder head cover cap nut tightening torque	Refer to Section 3-7-2 of Chapter 3
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035881-00ES

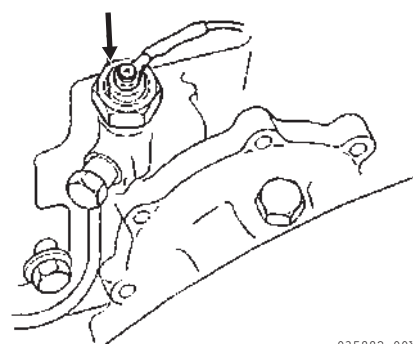
4-3-18 Water Pump Assembly



035832-00X

4-3-19 Oil Pressure Switch

Oil pressure switch tightening torque	Refer to Section 3-7-2 of Chapter 3
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035882-00XS

4. ENGINE

4-3-20 Nozzle and Holder Assembly

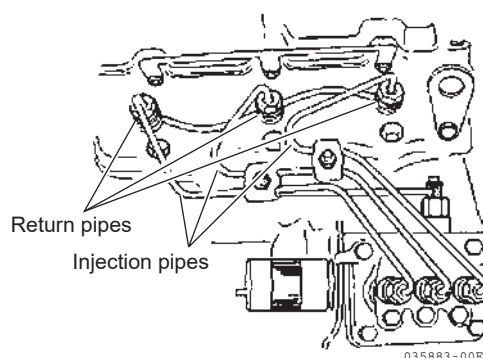
Insert the gasket and install the nozzle and holder assembly. Then, tighten it to the specified torque.

Nozzle and holder assembly tightening torque	Refer to Section 3-7-2 of Chapter 3
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4-3-21 Return Pipes and Injection Pipes

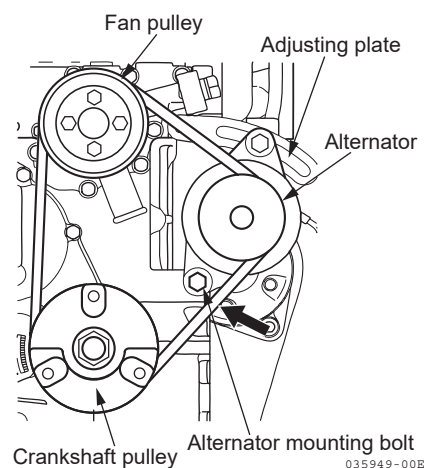
Install the return pipe and then install the injection pipes.

Injection pipe tightening torque	Refer to Section 3-7-2 of Chapter 3
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4-3-22 V-belt

Press on the V-belt midway between the crankshaft pulley and the alternator with a finger (pressing force of 11.02 lbf [49 N]) and adjust the slack to 0.2 to 0.4 in. (5 to 10 mm).



4. ENGINE

4-4 Electrical Equipment

4-4-1 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 and Service Data

Yanmar code			165000-47590
Applicable model			2TE67L-BV(3), 402J-05 IG84555R
Starter motor model			MITSUBISHI M000T84281
Nominal output / Weight		kW / lbs. (kg)	1.2 / 5.8 (2.65)
Rotation direction (viewed from pinion side)			Clockwise
Engagement method			Magnetic shift
No load	Terminal voltage / Current	V / A	11 / Less than 90
	Speed	rpm	More than 2800
Load characteristics	Terminal voltage / Current	V / A	4.0 / Less than 650
	Torque / speed	ft•lbf / (N•m) / rpm	11.6 (15.7)
Pinion DP or module / Number of pinion teeth			DP10 / 12

4. ENGINE

1. Structure

The starter is 4-P direct drive type motor and the overrunning clutch is activated by the solenoid.

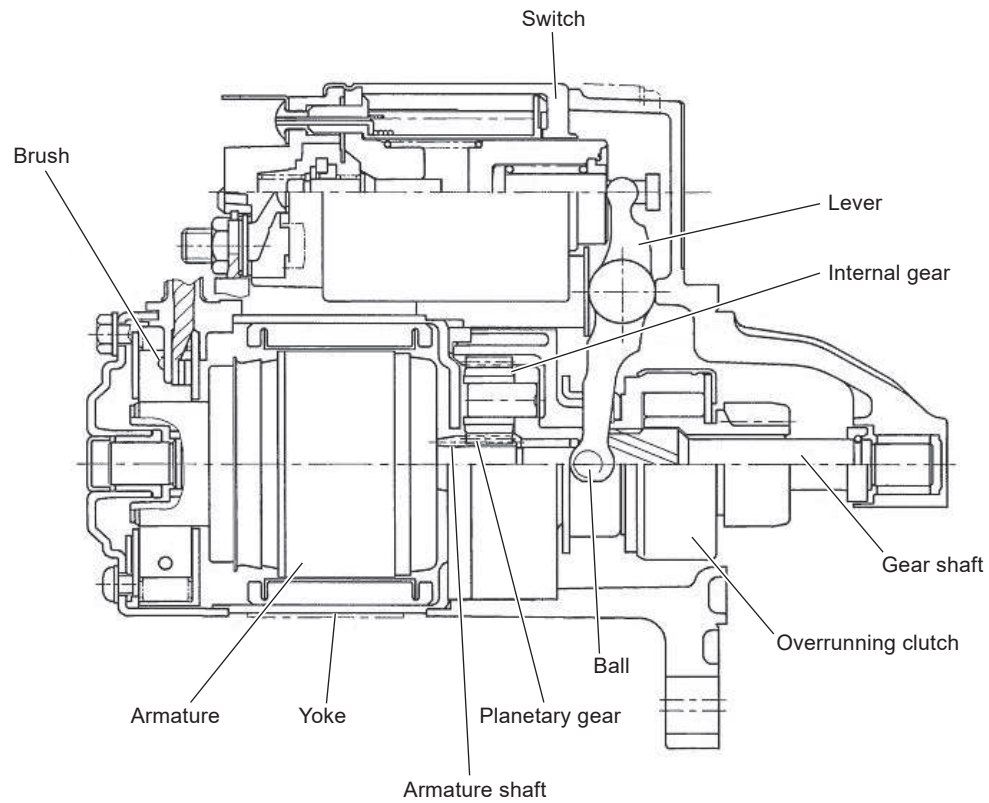


Fig.1

4. ENGINE

2. Disassembly

Note :

Put two matching marks on the switch and yoke before disassembling.

- (1) Remove the terminal nuts of the magnet switch to remove connector.
Remove switch holding screws to remove the switch and plunger.
- (2) Remove the brush holding screws and through screws.
Remove the rear bracket but do not remove the brush holders.
- (3) Slip in a socket [OD 1.16 in. (29.4 mm)] or something between the commutator and brush holder for inspection and reassembly.
- (4) Remove the armature and the yoke.
- (5) Remove the planetary gear and packing.
Remove the gear shaft assembly and lever at the same time.

Note :

For easy reassembling, line up the lever, plate and packing according to disassembling order.

- (6) Remove the overrunning clutch
 - [1] Drive a pipe that matches the snap ring with a hammer to remove the stop ring and snap ring.
 - [2] Remove the overrunning clutch from the armature shaft. If the snap ring is damaged, replace it with a new one.

3. Inspection

- (1) Armature
 - [1] Check the coil for short circuit. If any, replace the armature.
 - [2] Check the coil for ground. If it grounds, replace the armature.
 - [3] Check the commutator for wear. If it is too much, replace the armature.
 - [4] Check the commutator for insulation depth. Repair if it is inadequate.
- (2) Gears
Check for excessive wear or damage.
- (3) Brush
 - [1] Check brushes for wear. If it is too much, replace them with new ones.
 - [2] Check if the brushes smoothly move in the holder to verify the springs work well.
 - [3] Check the brush holder plate and brush holder insulated for connection. If any, replace the brush holder assembly with a new one.
- (4) Overrunning Clutch and Pinion Gear
Rotate the pinion gear with holding the clutch housing.
It should rotate one way only. If something is wrong, replace the overrunning clutch.
If any wear and burrs in the pinion gear, replace the overrunning clutch.

Note :

Never wash the overrunning clutch not to remove lubrication grease in it.

- (5) Front Bracket / Rear Bracket
Check metals of them for wear. If it is too much, replace metals with new ones.
- (6) Switch
Check the terminal M and body of the switch for connection. Unless they are connected, replace the switch with a new one.

4. ENGINE

4. Reassembly and Adjustment

Reassemble in the reverse order of the disassembly procedures with observing the following instructions.

(1) Fill or coat grease on the following parts.

Greasing points		Grease
a	Front sleeve bearing	MULTEMP #6129
b	Rear sleeve bearing	MULTEMP #6129
c	Reduction device (Armature shaft gear, Internal gear, Planetary gear)	MULYKOTE RAG-650
d	Overrunning clutch and lever friction part	MULTEMP #6129
e	Gear shaft spline and pinion friction part	MULYKOTE RAG-650
f	Ball	MULYKOTE RAG-650

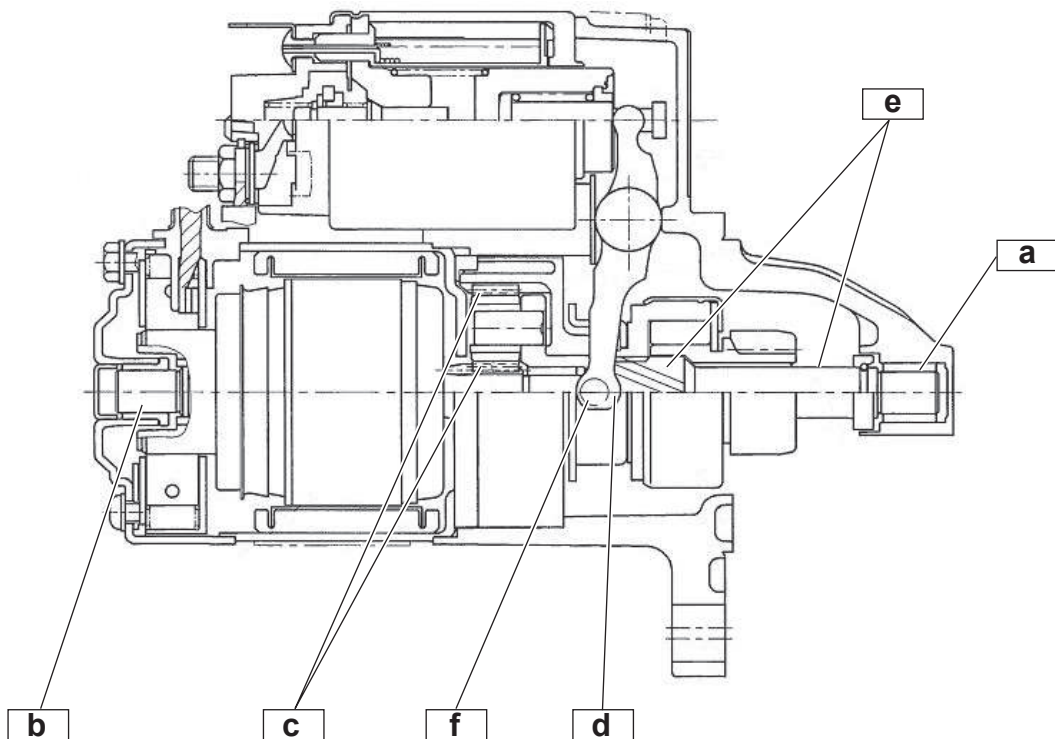


Fig.2

4. ENGINE

5. Non Load Testing

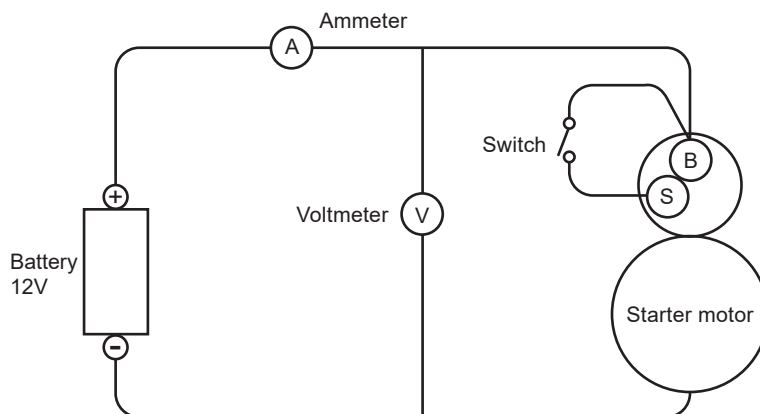


Fig.5

003422-00B

(1) Arrange the test circuit with the voltmeter and ammeter as shown in Fig.5.

Note :

Use as bold wire as possible and securely connect all terminals.

(2) Close the switch and compare RPM, ammeter and voltmeter readings with the service data.

(3) If anything is not within the standard, repeat the inspection mentioned above.

6. Service Data

		Standards or limit
Non load performance	V	11.0
	A	Less than 90
	RPM	2800
Commutator	O.D.	1.16 in. (29.4 mm)
	Limit	1.13 in. (28.8 mm)
Brush	Length	0.484 in. (12.3 mm)
	Limit	0.276 in. (7.0 mm)
Brush spring	Pressure	4.11 to 5.58 lbf (18.3 to 24.8 N)
	Limit	1.32 lbf (5.88 N)
Pinion gap		0.020 to 0.276 in. (0.5 to 2.0 mm)

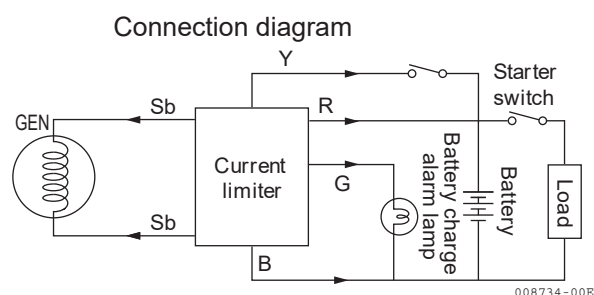
4. ENGINE

4-4-2 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.

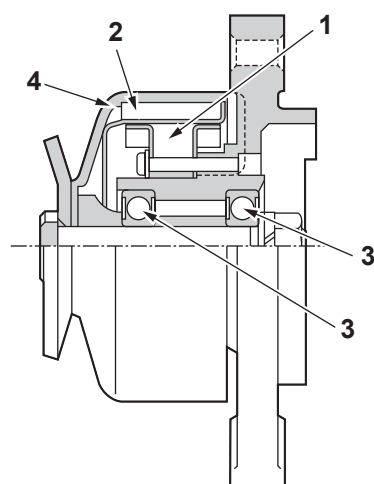
Specification

Nominal output voltage (Full-wave rectification)	V / A	14 / 14
Alternator model		GP8146
Yanmar code		165000-15580
Operating speed	RPM	1600 to 5200
Maximum speed	RPM	5600
Nominal output current	A / V	15 or less / 14 (at 5200 RPM)
Operating ambient temperature	°F (°C)	-40 to 176 (-40 to 80)
Pulley diameter / V-belt size	in. (mm)	2.5591 (65), FM28
Ground polarity		Negative



(Disassembly procedures)

- (1) Remove the alternator from the engine.
- (2) Remove the cap and the M10 hexagon nut.
Hold the end of the shaft securely. (Do not hold the flywheel 4.)
- (3) Tap the threaded end (M10) of the shaft with a wooden hammer or a similar tool and pull out the flywheel 4.
- (4) Remove the M4 screw for the coil plate lead-wire clamp and disconnect the coupler.
- (5) Remove the two M4 screws and then remove the stator coil 1 from the coil plate.



- 1 Stator coil
- 2 Rotor
- 3 Ball bearing
- 4 Flywheel

030633-00B

4. ENGINE

(Reassembly procedures)

(1) Perform reassembly in the reverse order of the disassembly procedures.

Tightening Torque	21.68 to 25.30 ft•lbf (29.4 to 34.3 N•m)
-------------------	--

(Inspection)

1. Combination of the alternator and regulator

	Normal	Not normal	Cause
Battery charge current and battery terminal voltage (when alternator motor speed is 5200 RPM)	1. 14 A or more at 14 V or less 2. 14 A to 0.5 A at 14 to 15 V	14 A or more at 15 V or more	Malfunction of regulator
		Battery charge current : 0 A	Malfunction of alternator or regulator, or wiring connection failure
		Battery charge current flows but battery voltage is low.	Battery failure (over discharging)

2. Alternator

(1) Performance

		Normal	Abnormal	Cause
Tester reading of no load voltage (between two sky blue wires) when running (at about 5200 RPM)		Above 28 V AC	Less than 28 V AC	Breakage of flywheel demagnetization coil or wire harness
Continuity	Between two sky blue wires	Continuity exists.	No continuity exists.	Coil breakage
Insulation resistance (between a lead wire and coil plate)		3 MΩ or more	Below 3 MΩ	Insulation failure of coil

(2) Rotation of flywheel

	Normal	Abnormal	Cause
Manually rotate flywheel.	Repulsion by magnetic force occurs 12 times per turn but flywheel smoothly rotates.	Noise occurs while rotating.	Bearing failure Foreign materials caught
		No rotation resistance without repulsion	Magnet demagnetization

4. ENGINE

4-4-3 Glow Plug

The glow plug installed on the cylinder head serves as a starting aid in cold weather and warms the air in the combustion chamber to start the engine easily at low ambient temperature.

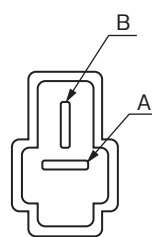
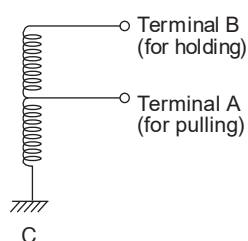
The glow plug is operated to warm the air in the combustion chamber by setting the starter switch key to "HEAT" and supplying electricity for approximately 6 seconds.

(1) Specifications

Yanmar code	165000-47870
Rated voltage	DC 11V / 1.0 Ω (At ordinary temp.)
Temperature rise	Temperature 6 second after applying rated DC 11V: 1472 to 1742 °F (800 to 950 °C)

Tightening torque	Body: 5.9 to 11.1 ft•lbf (8 to 15 N•m) Terminal mounting nut: 0.7 to 1.1 ft•lbf (1.0 to 1.5 N•m)
-------------------	---

4-4-4 Stop Solenoid



Terminals of solenoid

008735-00B

Inspection

- (1) The stop solenoid is normal as long as the plunger is pulled into the body when the positive and negative terminals of the battery are connected to the terminal A and the body, respectively.
- (2) The stop solenoid is normal as long as the plunger is held in the body when the plunger is released after connecting the positive and negative terminals of the battery are connected to the terminal B and the body, respectively, while pressing in the plunger with a finger.

Note :

Complete the pulling test in a short time to prevent wire breakage.

4. ENGINE

4-5 Troubleshooting

Trouble	Cause	Measure
Engine does not start.	Malfunction of starter switch	Repair defective connection or contact point.
	Battery shortage or discharged	Charge battery.
	Out of fuel	Refuel.
	Air in fuel system	Repair defective portion where air is sucked in.
	Clogging of fuel filter	Replace fuel filter.
	Instable or insufficient fuel supply	Injection pump is defective. Repair it in specified repair plant or specialty shop.
	Malfunction of glow plug	Glow plug is disconnected. Replace it.
	Improper viscosity lubrication oil	Check and change lubrication oil.
	Clogging of air cleaner	Clean or replace air cleaner.
	No compression pressure	Check and repair parts if necessary.
Engine speed is not stable.	Air in fuel system	Release air from fuel.
	Uneven injection volume	Injection pump is defective. Repair it in specified repair plant or repair shop.
	Clogging of fuel filter	Replace fuel filter.
	Governor failure	Check and adjust governor.
	Malfunction of engine body	Check and repair parts if necessary.
Engine stops during operation.	No fuel in fuel tank	Refuel.
	Clogging of fuel filter	Replace fuel filter.
	Air in fuel system	Repair defective portion where air is sucked in.
	Malfunction of engine body	Check and repair parts if necessary.
Engine is overheated.	Low cooling water level	Resupply cooling water. Check for water leakage and repair if necessary.
	Loose or slipping fan belt	Clean oil, remove dust or other foreign matter and adjust fan belt tension.
	Clogging of radiator	Clean radiator.
	Clogging of radiator fin	Clean radiator fin.
	Dust or water stain in cooling water passages	Wash out.
	Malfunction of thermostat	Check and replace if necessary.
	Low lubrication oil level	Resupply lubrication oil.
	Overload	Reduce load.
Exhaust smoke color is abnormal. (White or blue)	Too high engine oil level	Check and adjust engine oil volume to the proper level.
	Low viscosity engine oil	Check and replace if necessary
	Improper injection timing	Injection timing is too late. Correct it.

CHAPTER 5

HYDRAULIC SYSTEM

5-1 Outline	5-1-1
5-1-1 Control Valve Operation.....	5-1-4
5-2 Hydraulic Circuit Schematic.....	5-2-1
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5-3-1 Boom.....	5-3-1
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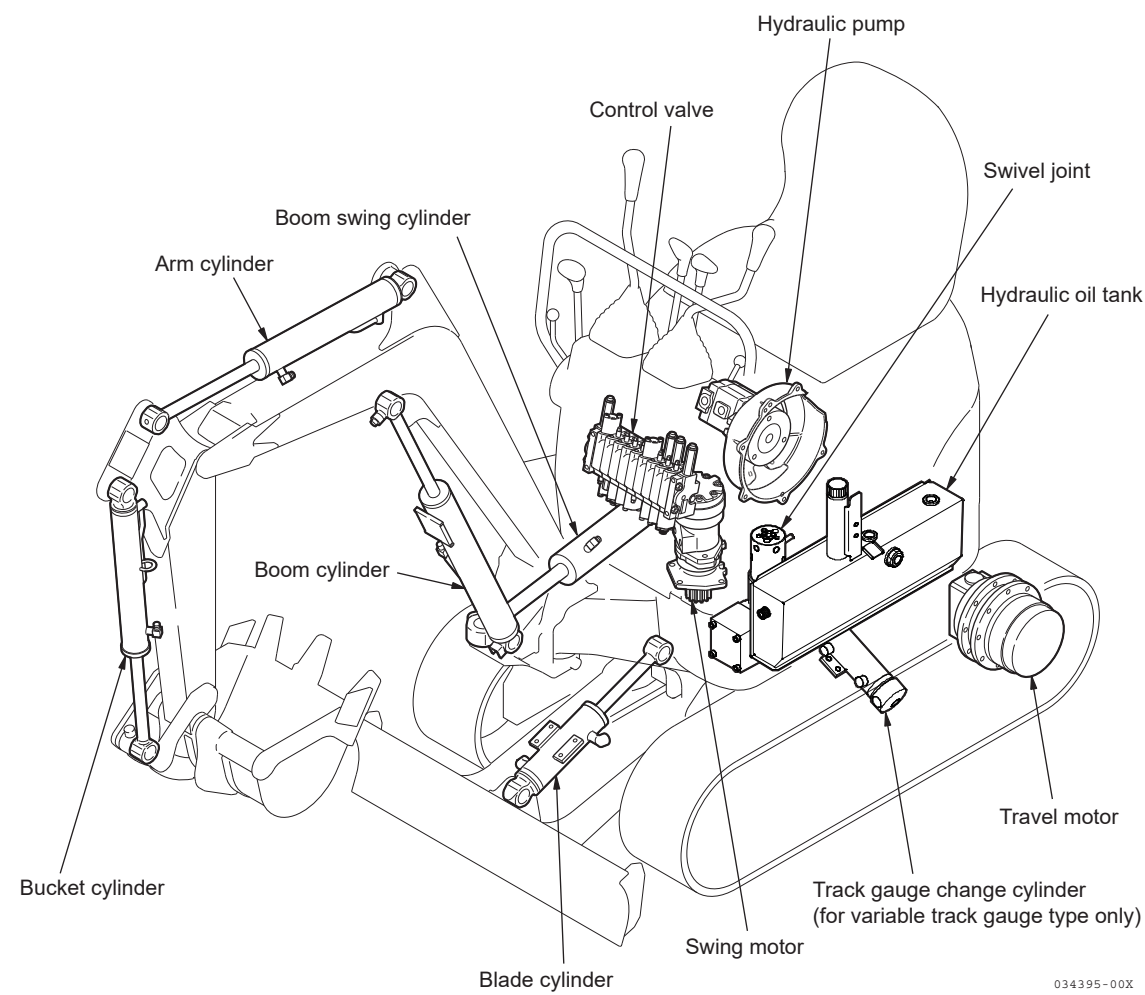
5. HYDRAULIC SYSTEM

5. Hydraulic System

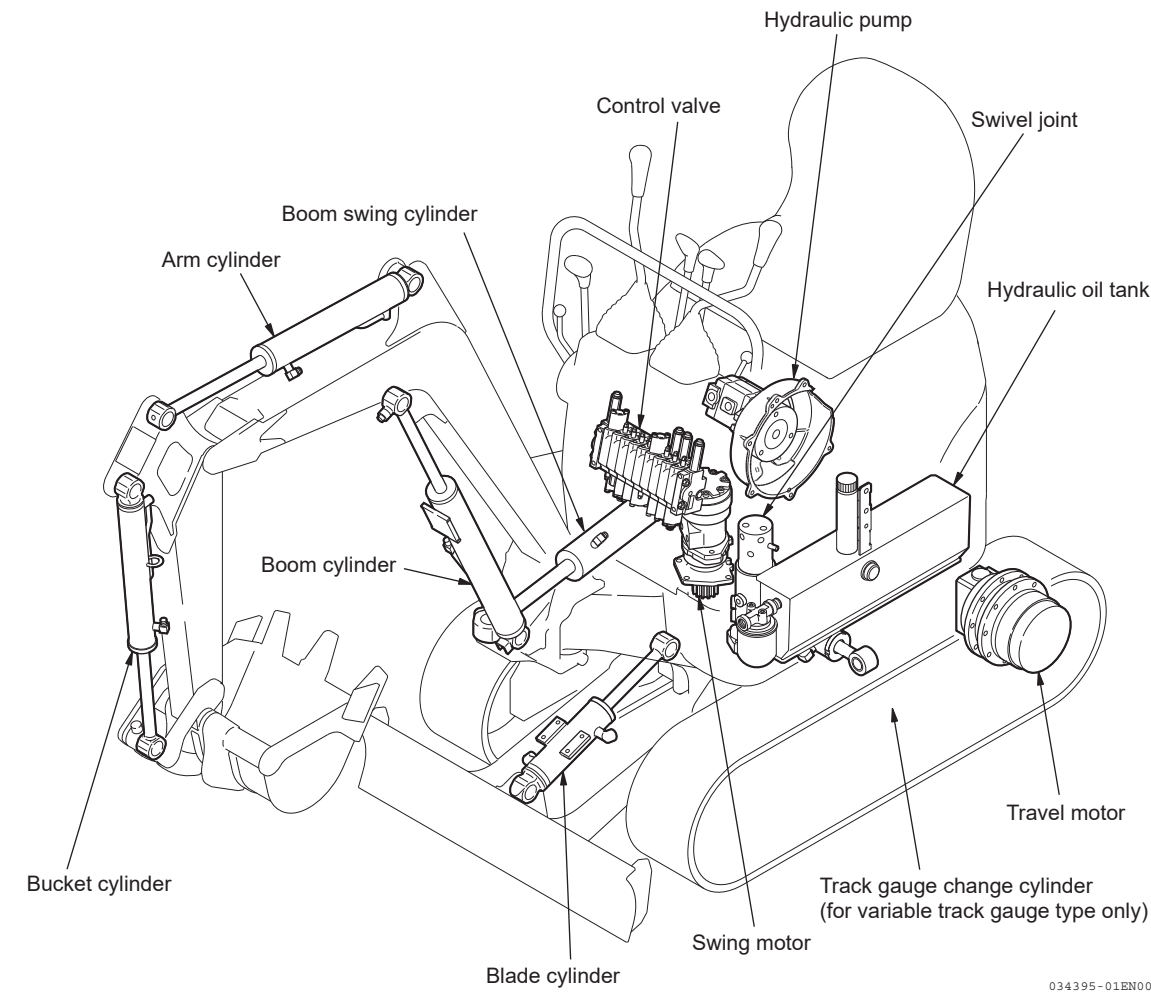
5-1 Outline

The hydraulic system consists of an engine, a double hydraulic pump, a control valve, a boom cylinder, an arm cylinder, a bucket cylinder, a blade cylinder, a boom swing cylinder, two track gauge change cylinders (for the link track gauge change type) or one track gauge change cylinder (for the slide track gauge change type), a pilot check valve CMP (for the link track gauge change type only), a swing motor, a swivel joint, two travel motors and a hydraulic oil tank. The oil discharged from the double hydraulic pump flows to the actuators through the control valve.

Link track gauge change type SV08-1A



Slide track gauge change type SV08-1A(S) , SV08-1C



5. HYDRAULIC SYSTEM

1) Hydraulic Pump

The double hydraulic pump is linked to the flywheel of the engine through the coupling. The number of revolutions of each pump is identical to the engine speed.

Discharge volume of each pump

cu.in. (cu.cm)			
No.	Pump		Discharge volume
1	Hydraulic pump	P1	0.250 (4.1)
2	Hydraulic pump	P2	0.250 (4.1)

2) System Relief Valve

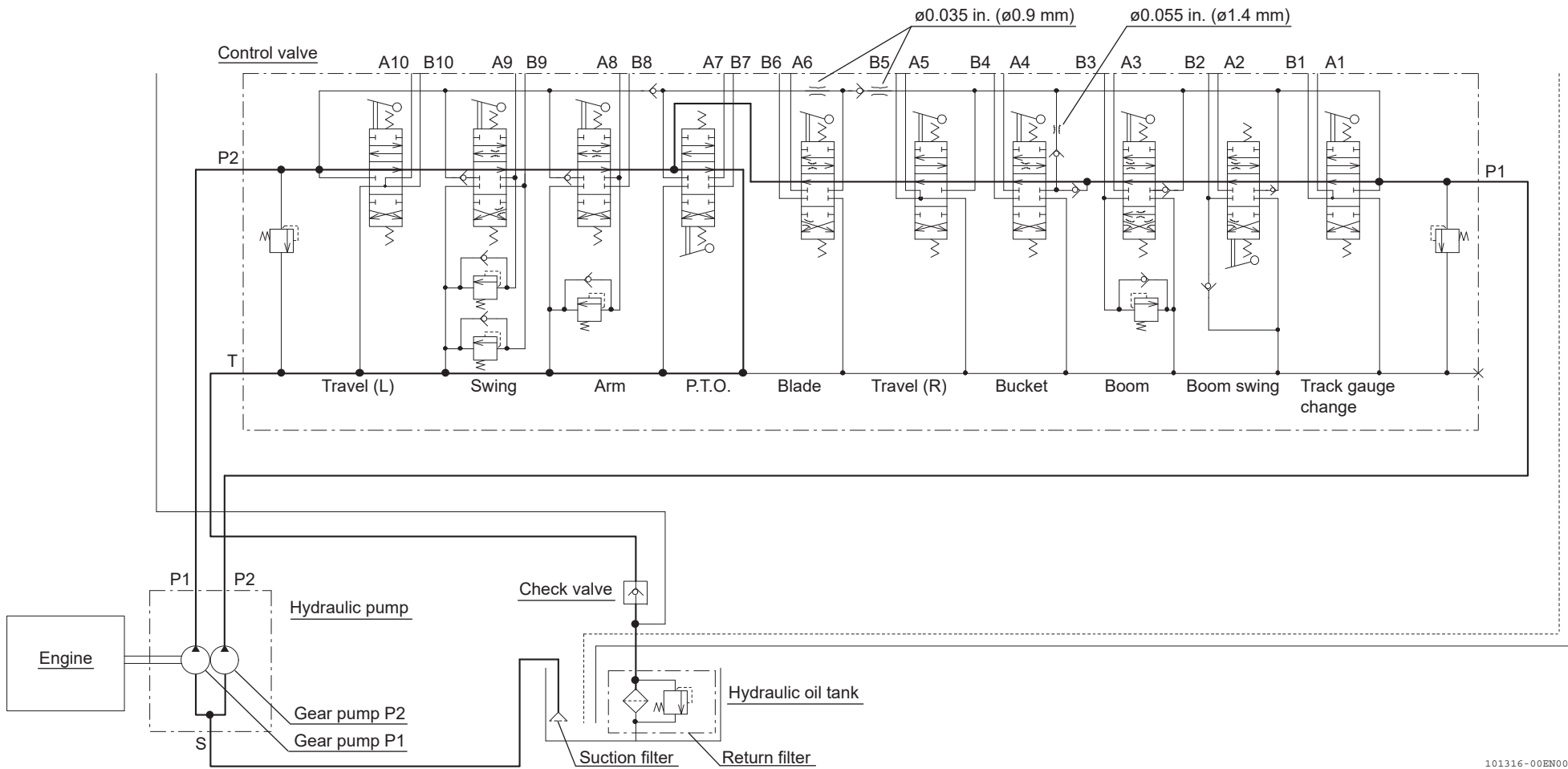
The system relief valves installed in the control valve control the discharge pressure of the pumps.

System relief valve set pressure and actuator

PSI (MPa)		
No.	Pump	Relief pressure
		SV08-1A, SV08-1A(S), SV08-1C
1	P1	2625 (18.1)
2	P2	2625 (18.1)

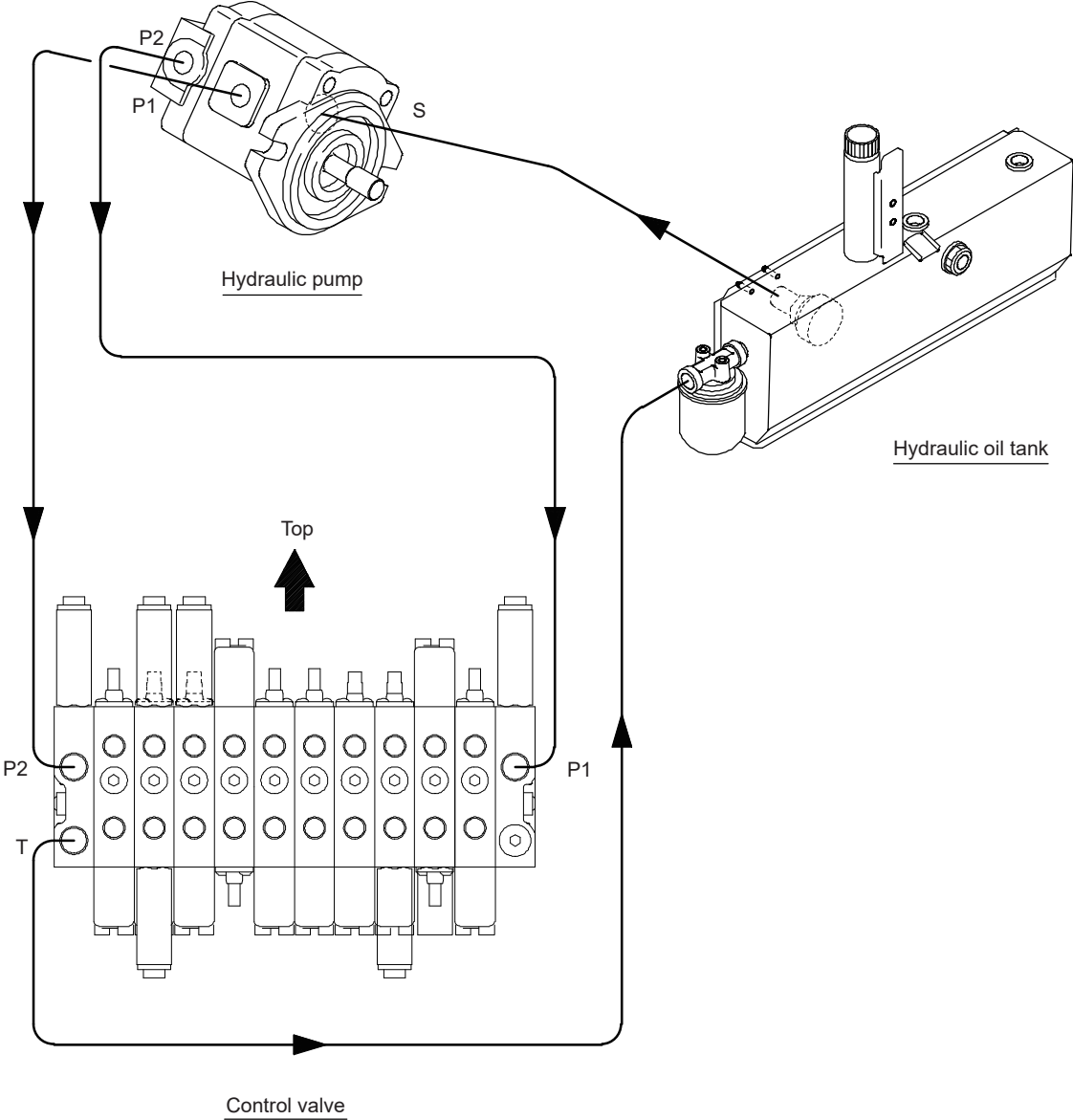
3) Oil Flow from Hydraulic Pumps P1 and P2

The pumps take in oil through the suction filter from the hydraulic oil tank and discharge it. The discharged oil flows to the ports P1 and P2 of the control valve and returns to the hydraulic oil tank through the check valve and the return filter from the port T of the control valve. This circulation is repeated.
The bypass valve in the return filter opens at a differential pressure of 21.3 PSI (0.147 MPa).



101316-00EN00

5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-1-1 Control Valve Operation

1) Oil Flow from Hydraulic Pump

(1) Oil flow from hydraulic pump P1

The oil from the hydraulic pump P1 flows to the sections through the port P2 of the control valve and the parallel passage.

The travel (L) section is positioned the most upstream in the control valve, and then the swing, arm and P.T.O. sections are arranged in that order.

The P.T.O. section is supplied with the oil from both the hydraulic pumps P1 and P2.

(2) Oil flow from hydraulic pump P2

The oil from the hydraulic pump P2 flows to the sections through the port P1 of the control valve and the parallel passage.

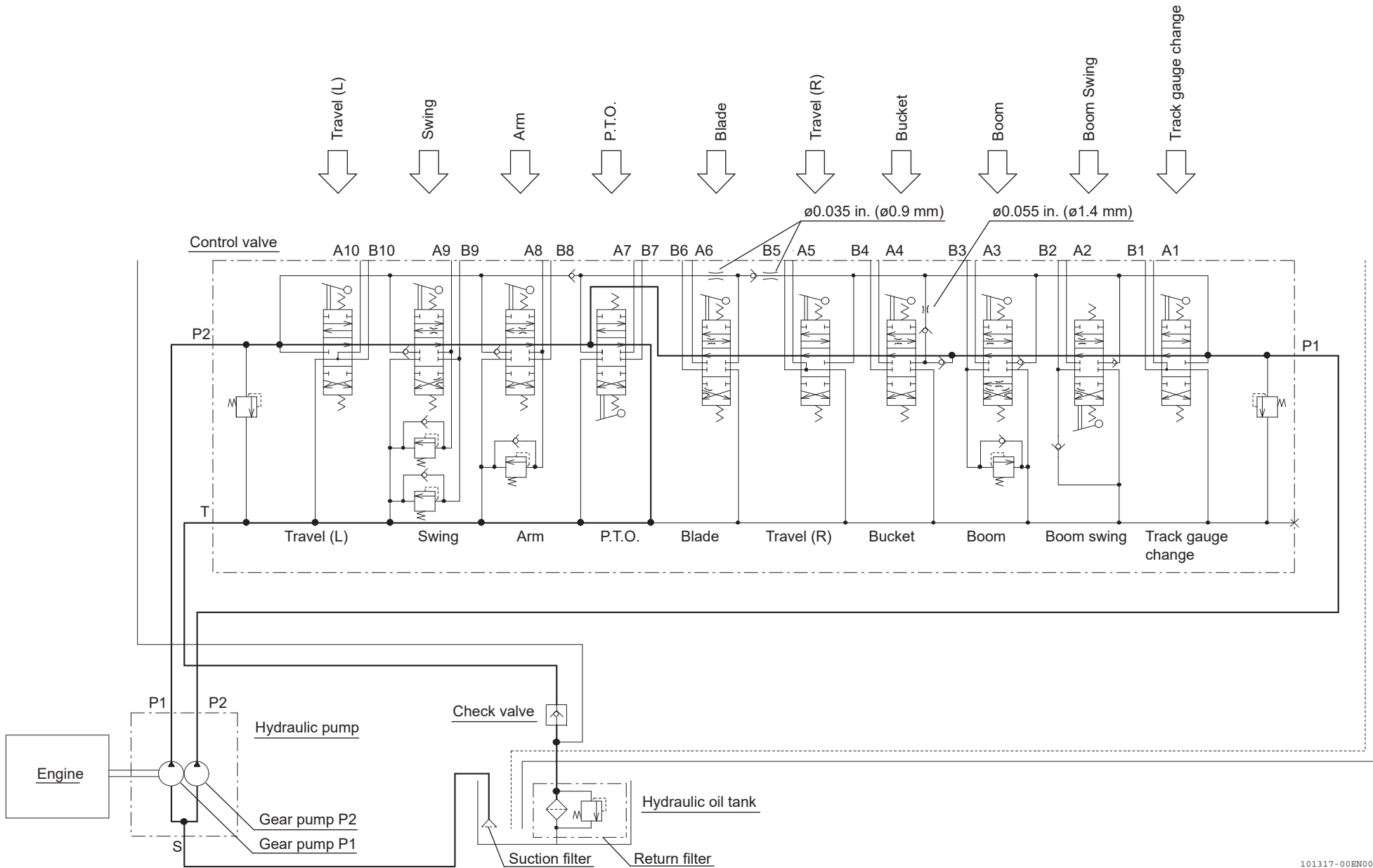
The track gauge section is positioned the most upstream in the control valve, and then boom swing section, the boom, bucket, travel (R) and blade sections are arranged in that order.

2) Simultaneous Operation of Boom and Bucket

The parallel passage in the bucket section has a throttle [Ø0.055 in. (Ø1.4 mm)] so that the oil can flow to the boom section more smoothly than to the bucket section even when the boom is given a heavy load. Therefore, the boom and the bucket can be operated simultaneously.

3) Simultaneous Operation of Blade and Travel

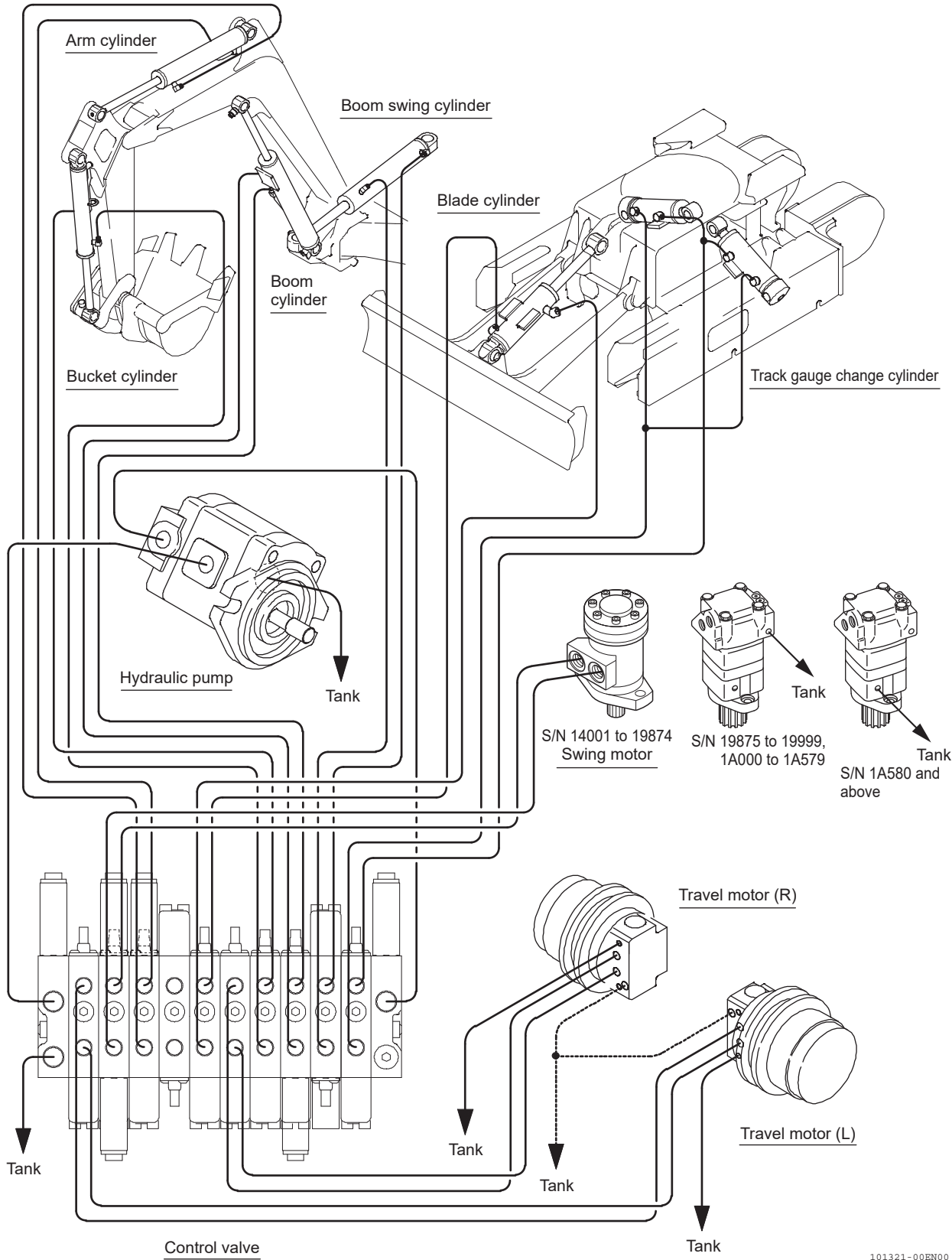
When the blade is operated while the machine is traveling, the blade cylinder is supplied with the same quantity of oil from the hydraulic pumps P1 and P2 through the throttles in the parallel passage. Therefore, the blade can be operated while the machine is traveling, with no travel deviation. However, the travel speed is slowed down.



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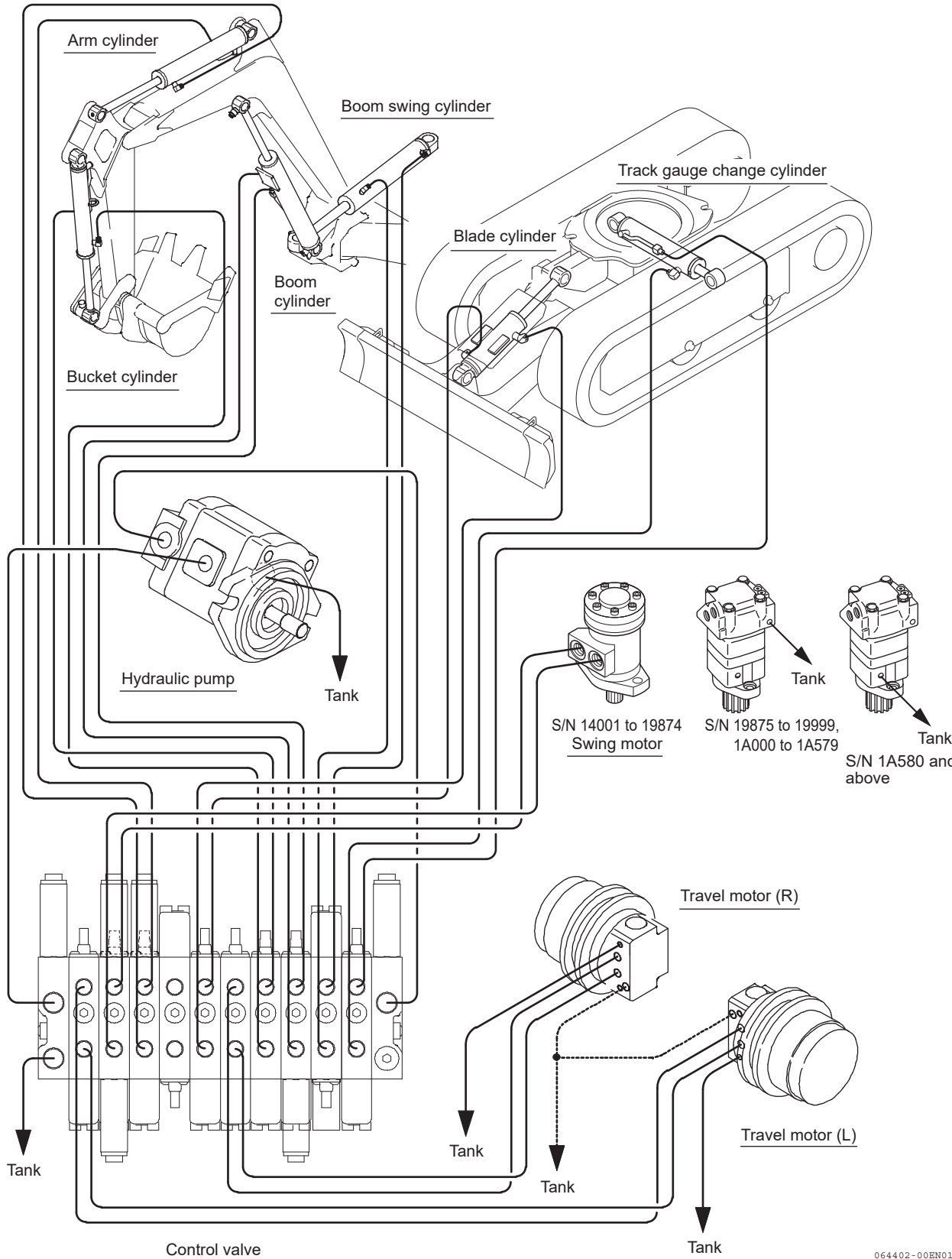
5. HYDRAULIC SYSTEM

Link track gauge change type SV08-1A



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Slide track gauge change type SV08-1A(S), SV08-1C

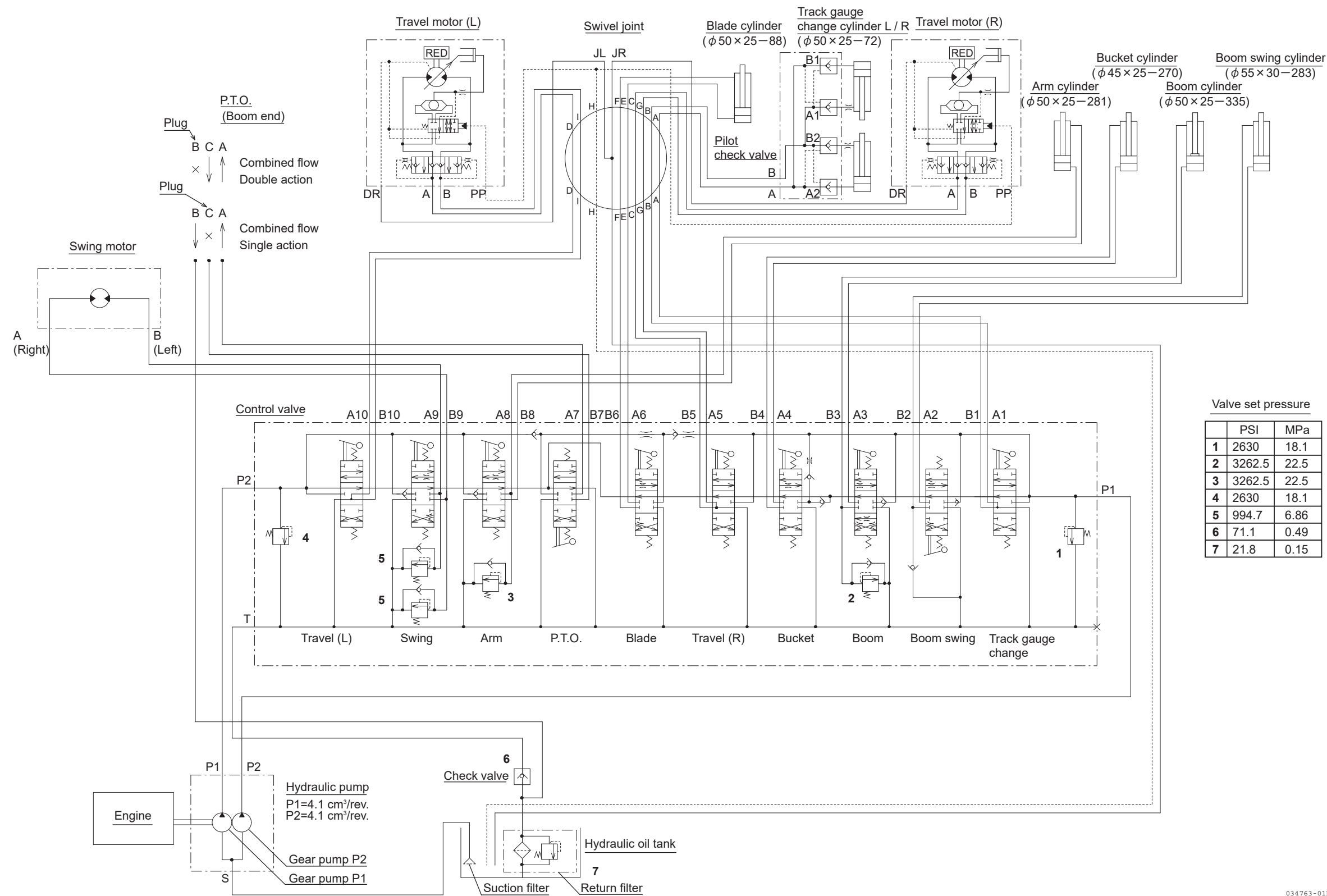


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5. HYDRAULIC SYSTEM

5-2 Hydraulic Circuit Schematic

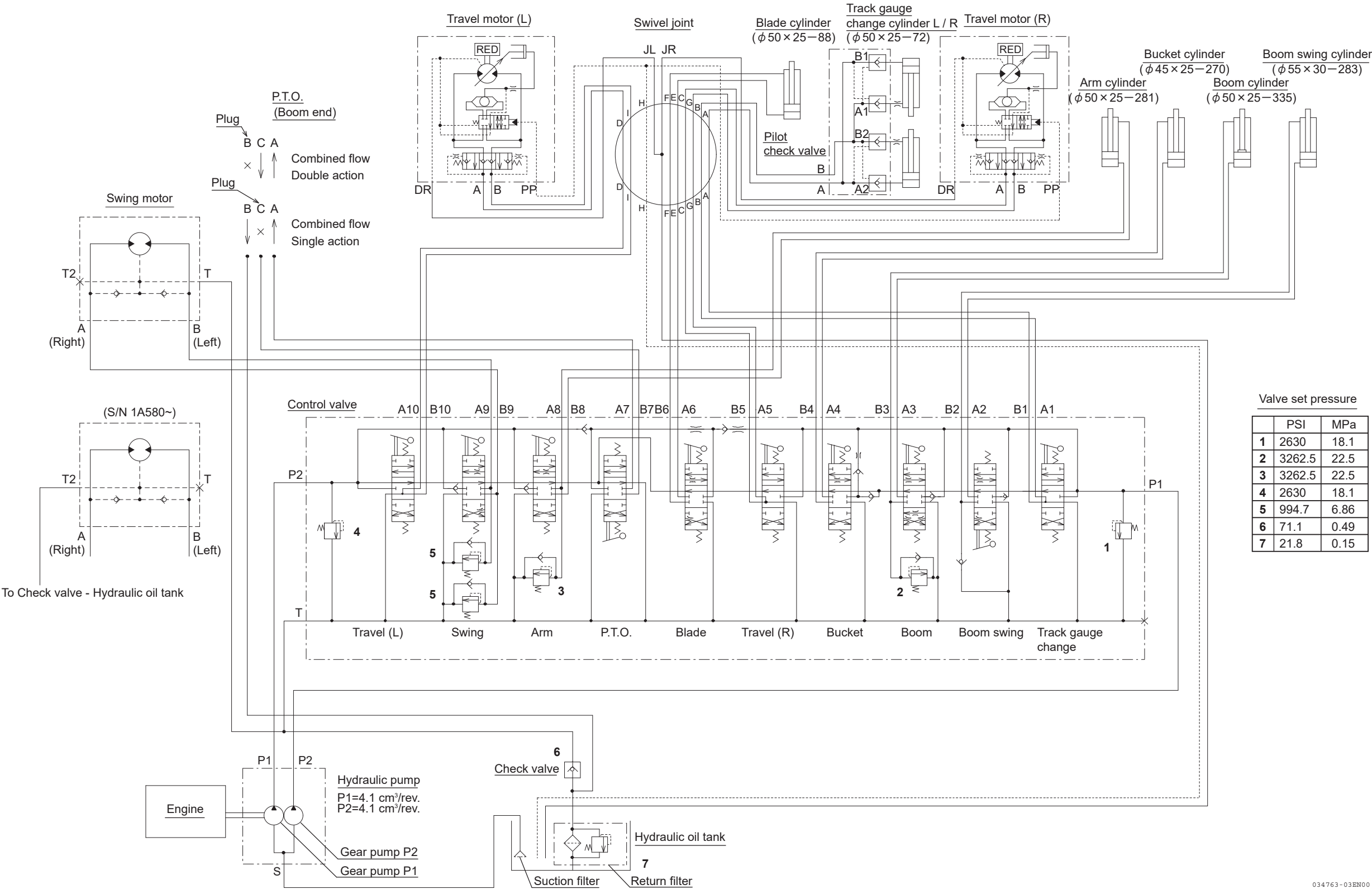
Link track gauge change type SV08-1A
S/N 14001 to 19874



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5. HYDRAULIC SYSTEM

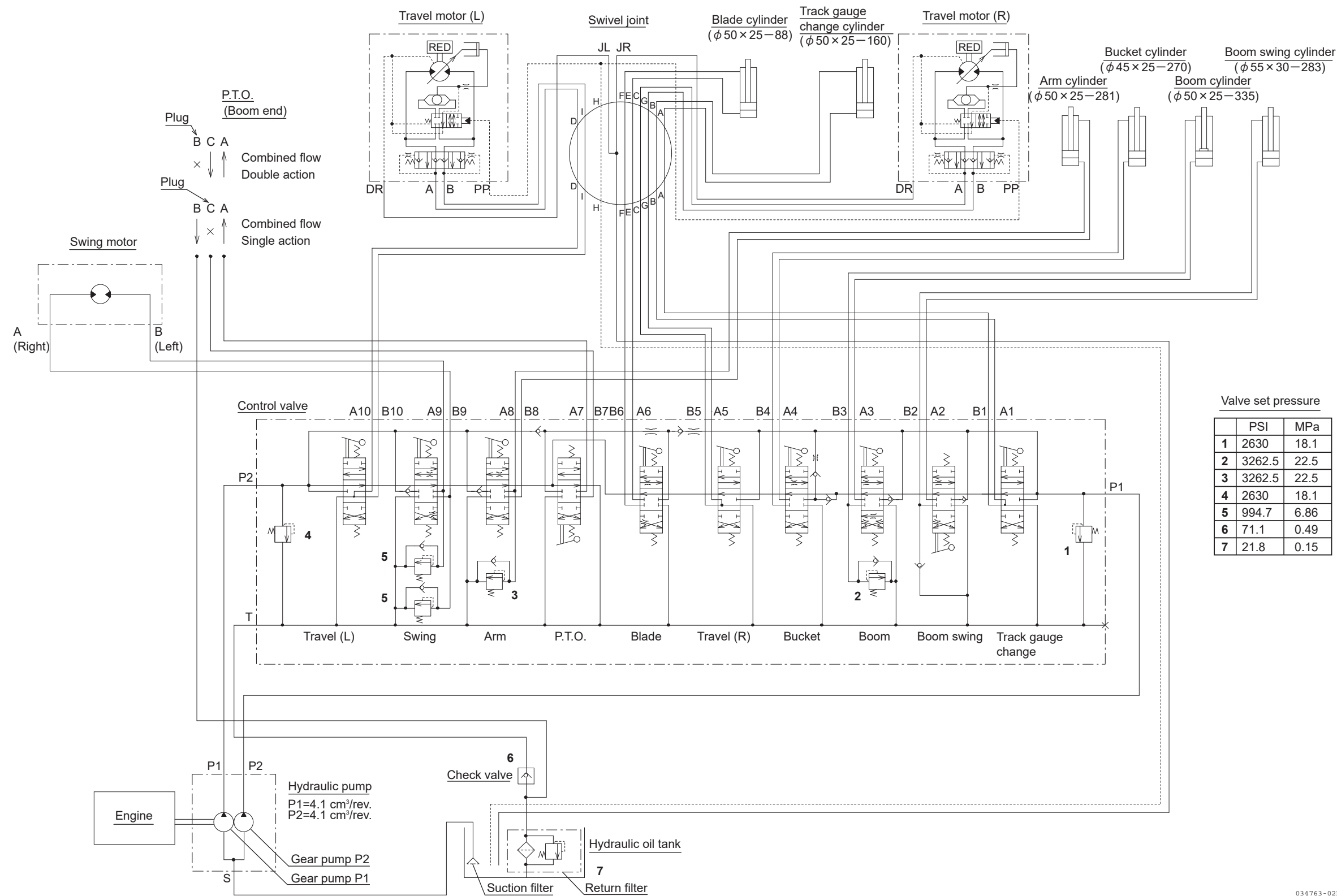
S/N 19875 to 19999, 1A000 and above



034763-03EN00

5. HYDRAULIC SYSTEM

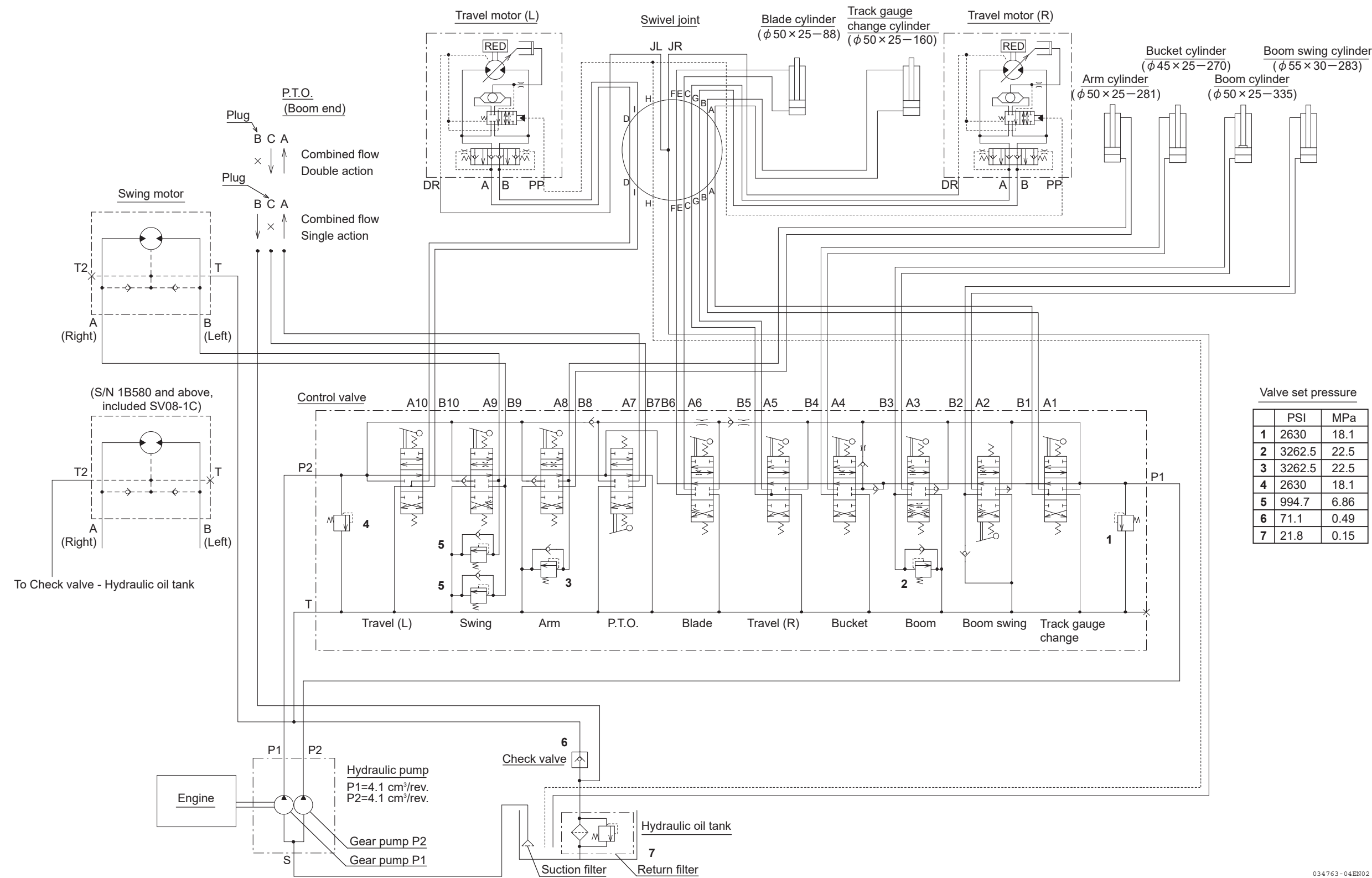
Slide track gauge change type SV08-1A(S)
S/N 14001 to 19874



034763-02EN00

5. HYDRAULIC SYSTEM

S/N 19875 to 19999, 1A000 and above



034763-04EN02

5. HYDRAULIC SYSTEM

5-3 Circuit Operation

5-3-1 Boom

1) Boom “Up”

Oil Flow from Hydraulic Pump

When the boom control lever is pulled back to raise the boom, the spool is pressed.

The oil discharged from the hydraulic pump P2 flows through the port P1 of the control valve, the parallel passage and the port A3 of the boom section to BU of the boom cylinder to extend its cylinder rod, raising the boom.

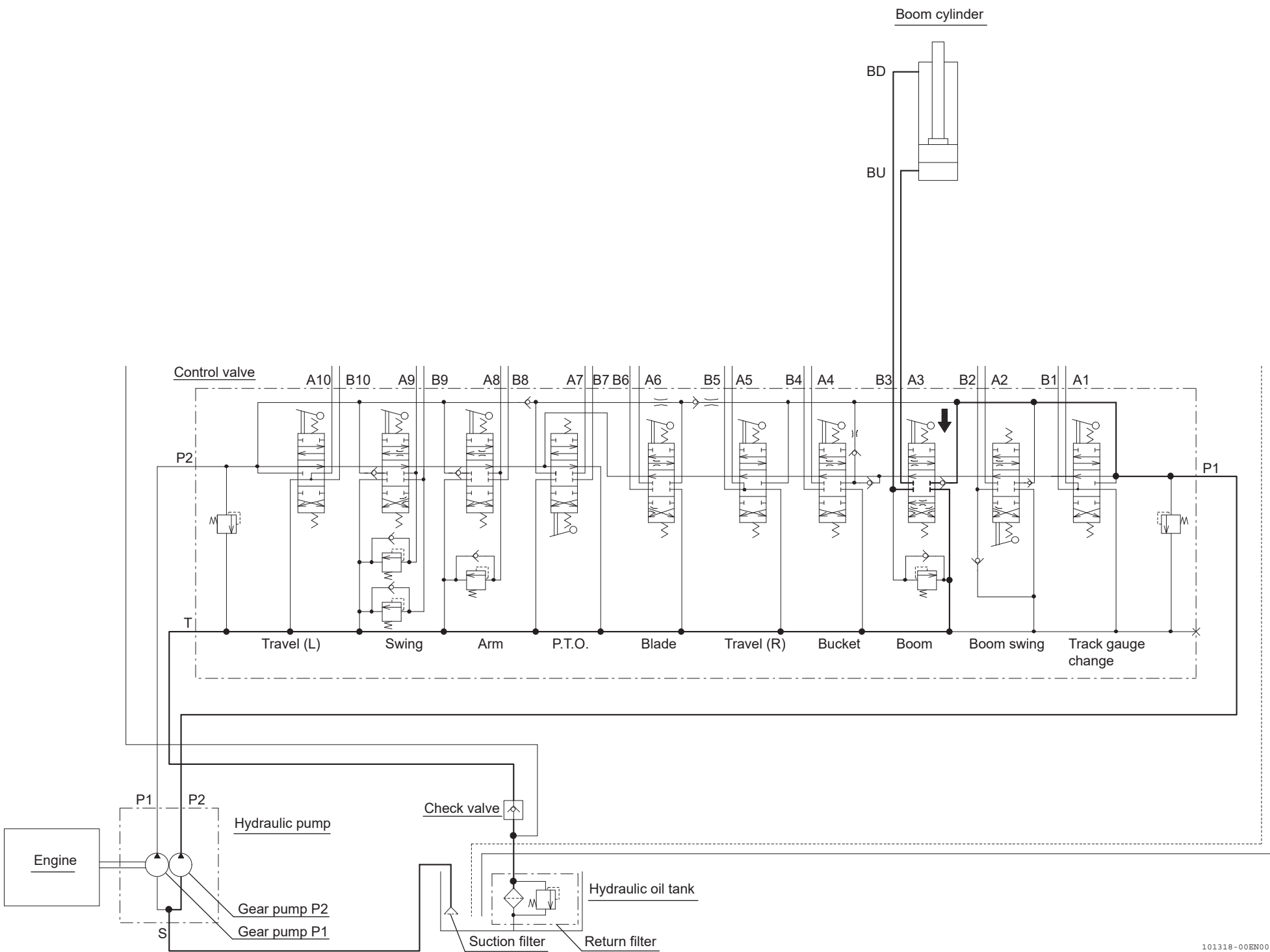
The return oil from BD of the boom cylinder flows back to the hydraulic oil tank through the port B3 of the boom section, the port T of the control valve and the check valve.

2) Boom "Down"

Oil Flow from Hydraulic Pump

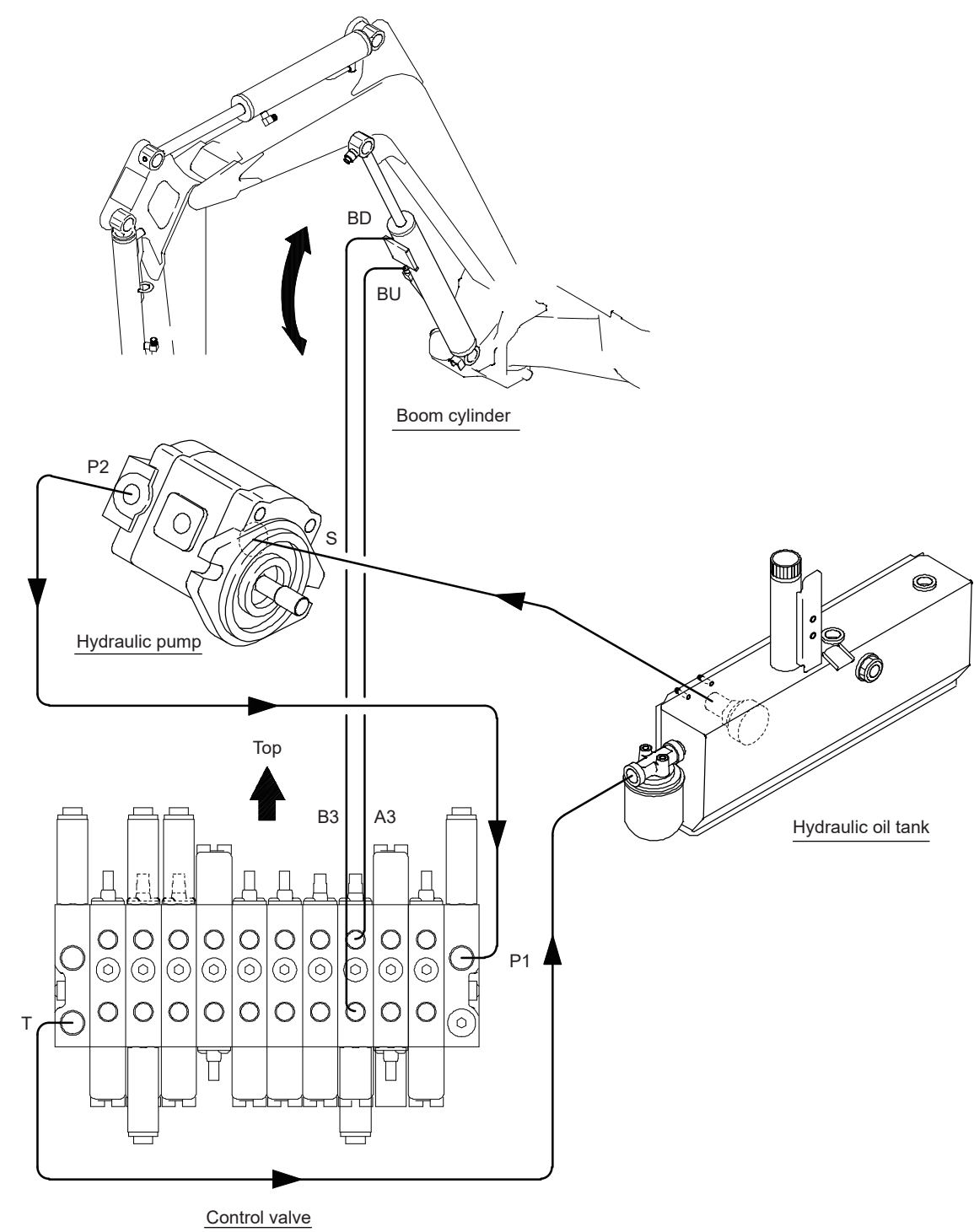
When the boom control lever is pushed forward to lower the boom, the spool is pulled.

The oil flows in the opposite direction to the oil flow in the boom up operation with regard to the boom cylinder.



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5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-3-2 Arm

1) Arm "Retract"

Oil Flow from Hydraulic Pump

When the arm control lever is pulled back to retract the arm, the spool is pressed.

The oil from the hydraulic pump P1 flows through the port P2 of the control valve, the parallel passage and the port A8 of the arm section to A1 of the arm cylinder to extend its cylinder rod.

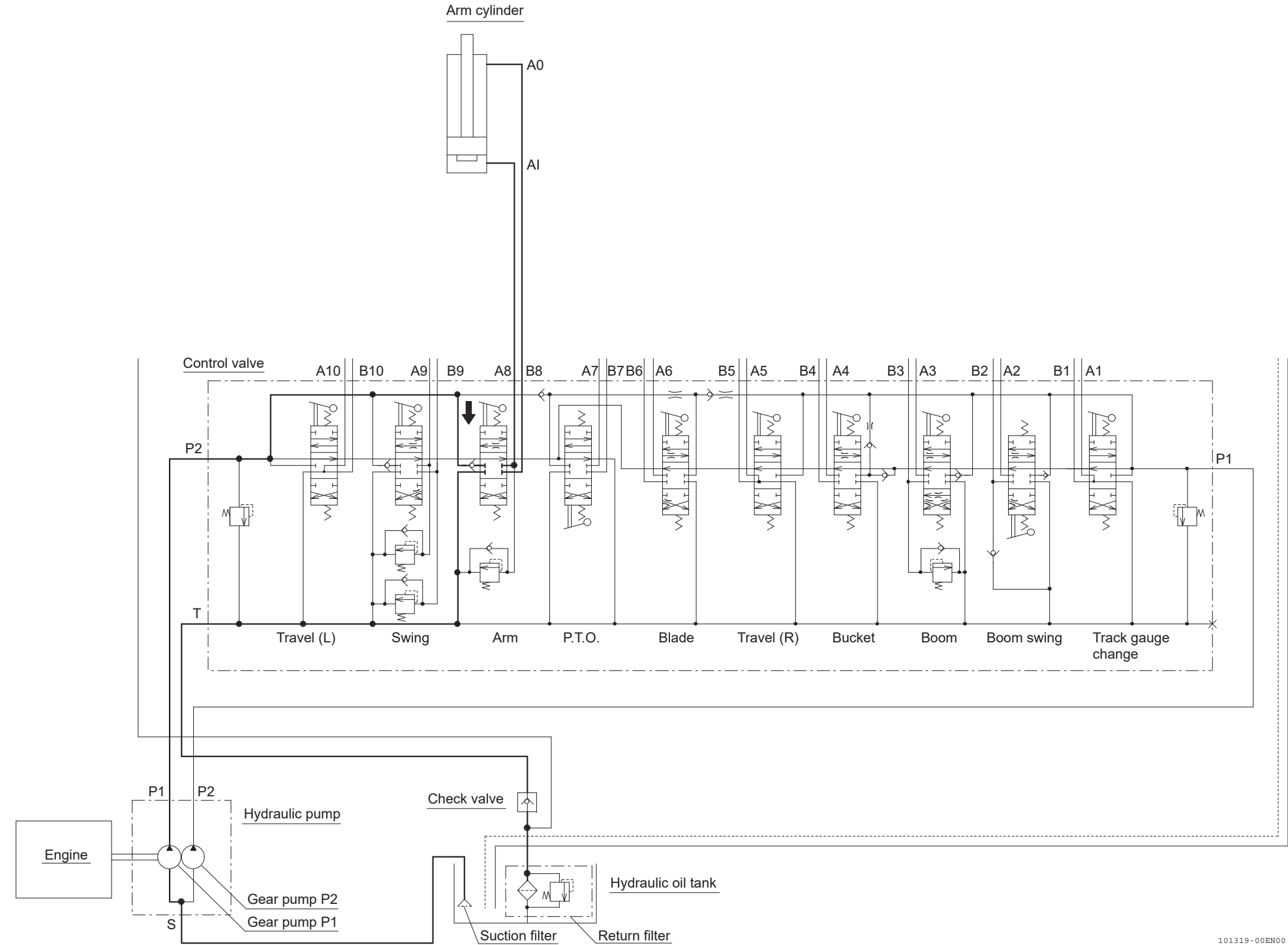
The return oil from A0 of the arm cylinder flows back to the hydraulic oil tank through the port B8 of the arm section, the port T of the control valve and the check valve.

2) Arm "Extend"

Oil Flow from Hydraulic Pump

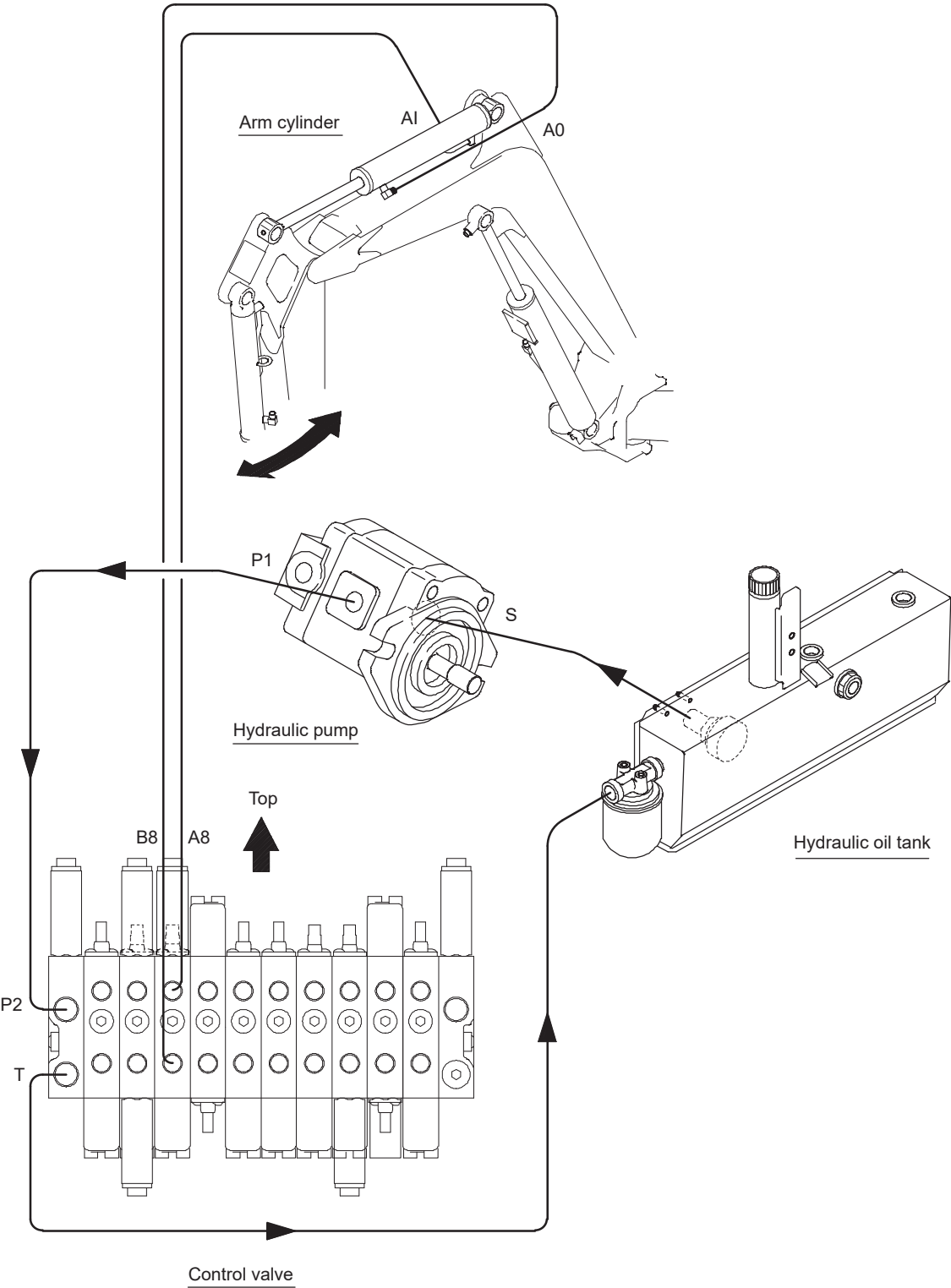
When the arm control lever is pushed forward to extend the arm, the spool is pulled.

The oil flows in the opposite direction to the oil flow in the arm retract operation with regard to the arm cylinder.



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5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-3-3 Bucket

1) Bucket "Curl"

Oil Flow from Hydraulic Pump

When the bucket control lever is moved to the left to curl the bucket, the spool is pressed.

The oil from the hydraulic pump P2 flows through the port P1 of the control valve and the A4 port of the bucket section to BKI of the bucket cylinder to extend its cylinder rod.

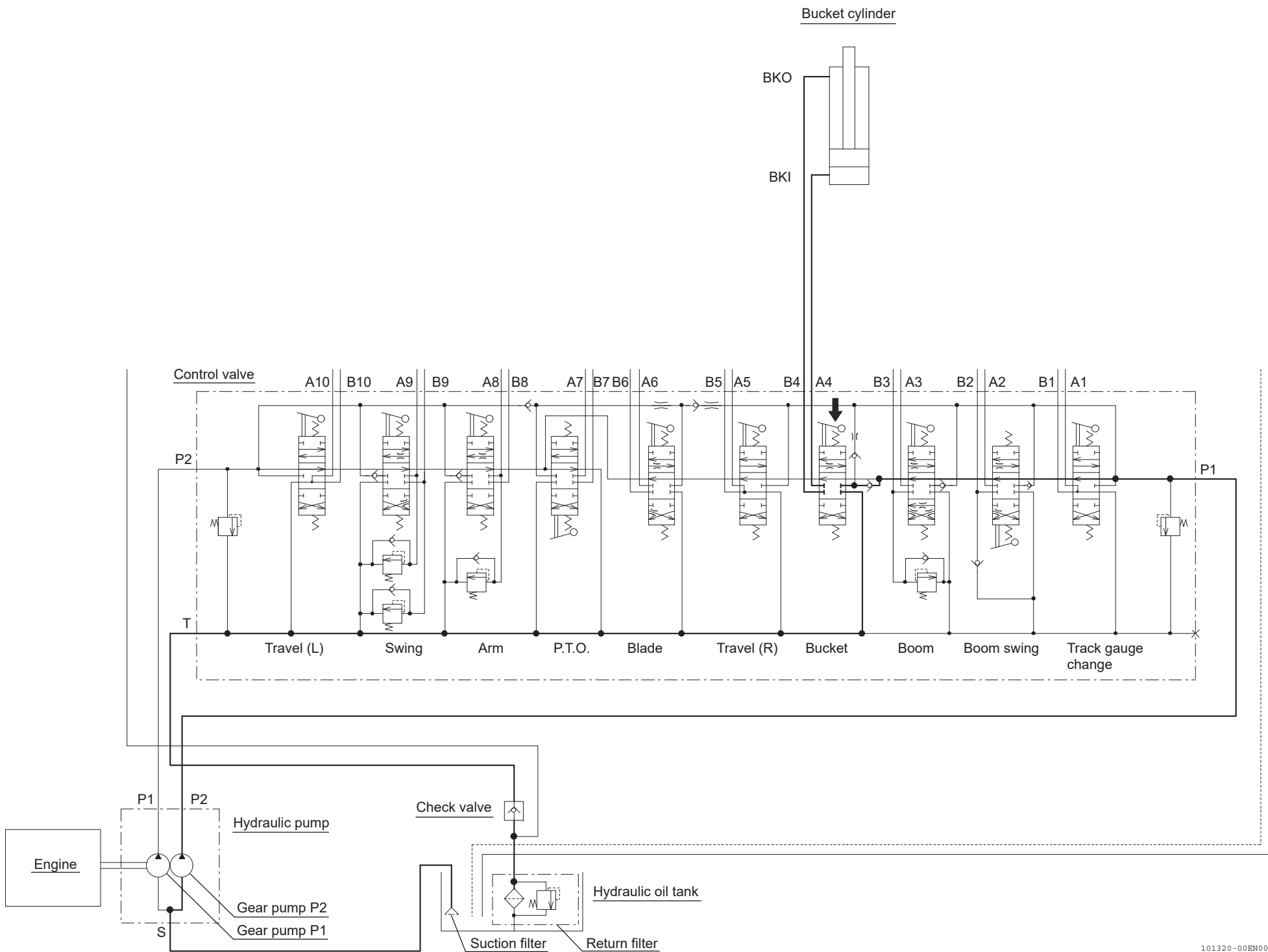
The return oil from BKO of the bucket cylinder flows back to the hydraulic oil tank through the port B4 of the bucket section, the port T of the control valve and the check valve.

2) Bucket "Dump"

Oil Flow from Hydraulic Pump

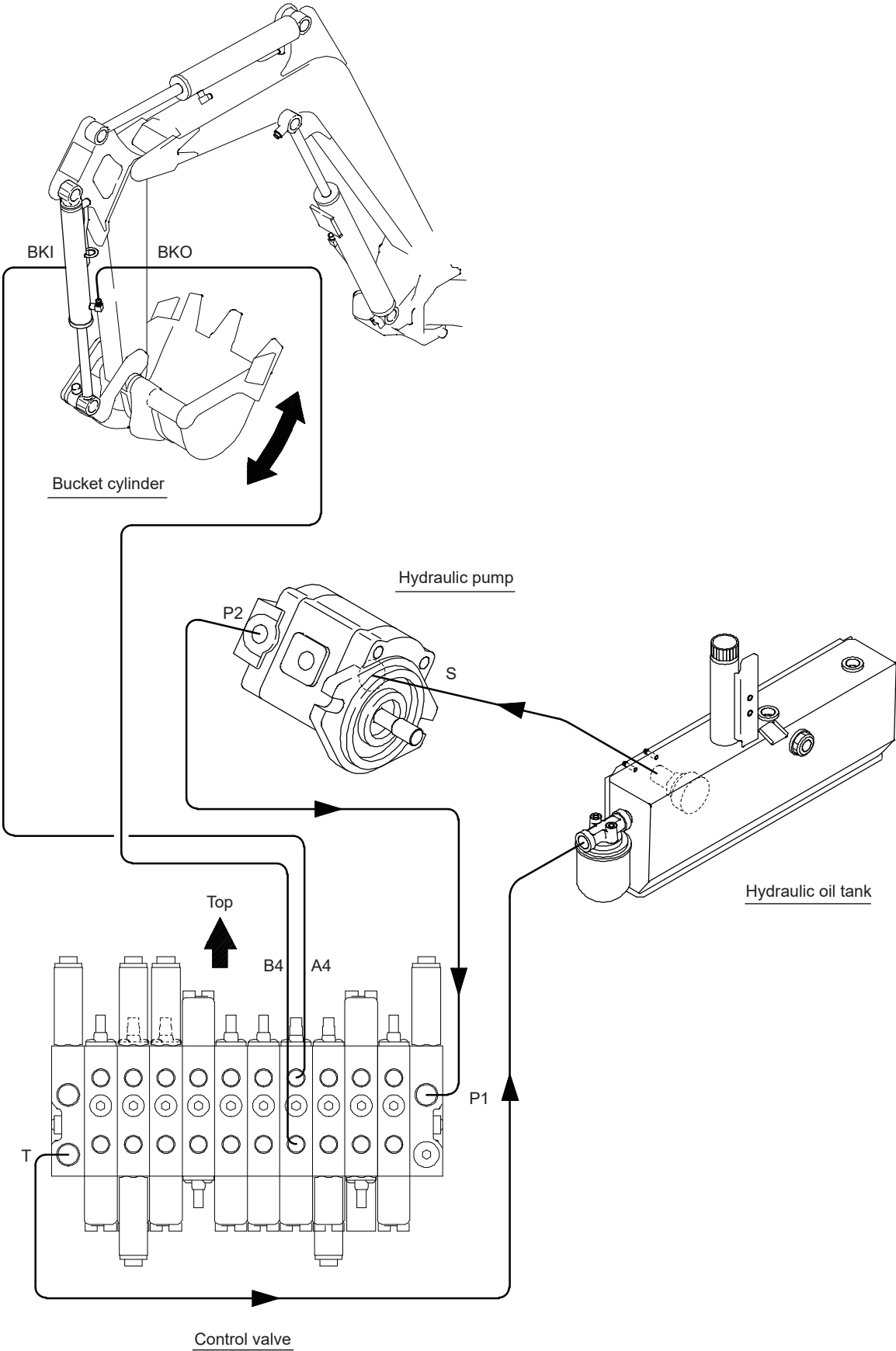
When the bucket control lever is moved to the right to dump the bucket, the spool is pulled.

The oil flows in the opposite direction to the oil flow in the bucket curl operation with regard to the bucket cylinder.



101320-00EN00

5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-3-4 Swing

1) Right Swing

Oil Flow from Hydraulic Pump

When the swing control lever is moved to the right, the spool is pulled.

The oil from the hydraulic pump P1 flows through the port P2 of the control valve, the parallel passage and the port B9 of the swing section to the port A of the swing motor, so that the swing motor is rotated.

The return oil from the port B of the swing motor flows back to the hydraulic oil tank through the port A9 of the swing section, the port T of the control valve and the check valve.

2) Left Swing

Oil Flow from Hydraulic Pump

When the swing control lever is moved to the left, the spool is pressed.

The oil flows in the opposite direction to the oil flow in the right swing operation with regard to the swing motor.

3) Swing Motor Brake Function (Combination Valve)

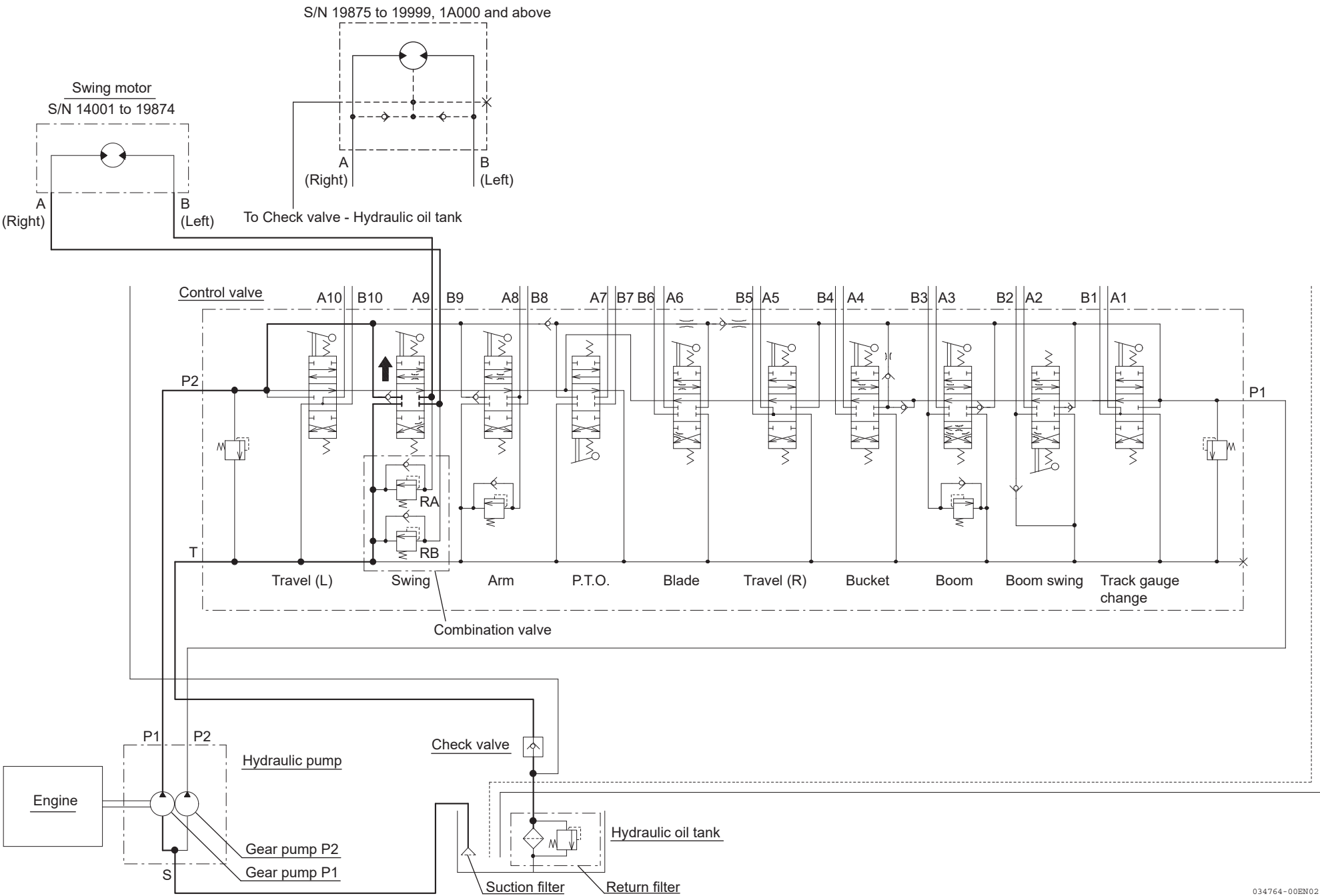
When the swing control lever is released (i.e., returned to the neutral position), the oil flow to the swing motor is blocked. However, the swing motor continues to rotate in a short time under its own inertia. This causes the motor to act like a pump and increases the circuit pressure on the port B (A) side. The increased pressure operates RA (RB) of the combination valve to let the oil on the lower pressure side escape to the port A (B) side, so that the circuit pressure on the port B (A) side is absorbed and cavitation on the port A (B) side is prevented.

So that negative pressure can be prevented in the swing motor, the return passage from the port T of the control valve to the hydraulic oil tank has the check valve which serves to give back pressure to the swing motor circuit to allow the oil returned from the swing motor to flow to the port A (B) of the motor easily.

4) Function of Swing Motor Check Valves (For S/N 19875 to 19999, 1A000 and above)

As mentioned in "3) Swing Motor Brake Function" above, the combination valves on the swing section have swing braking and cavitation prevention functions.

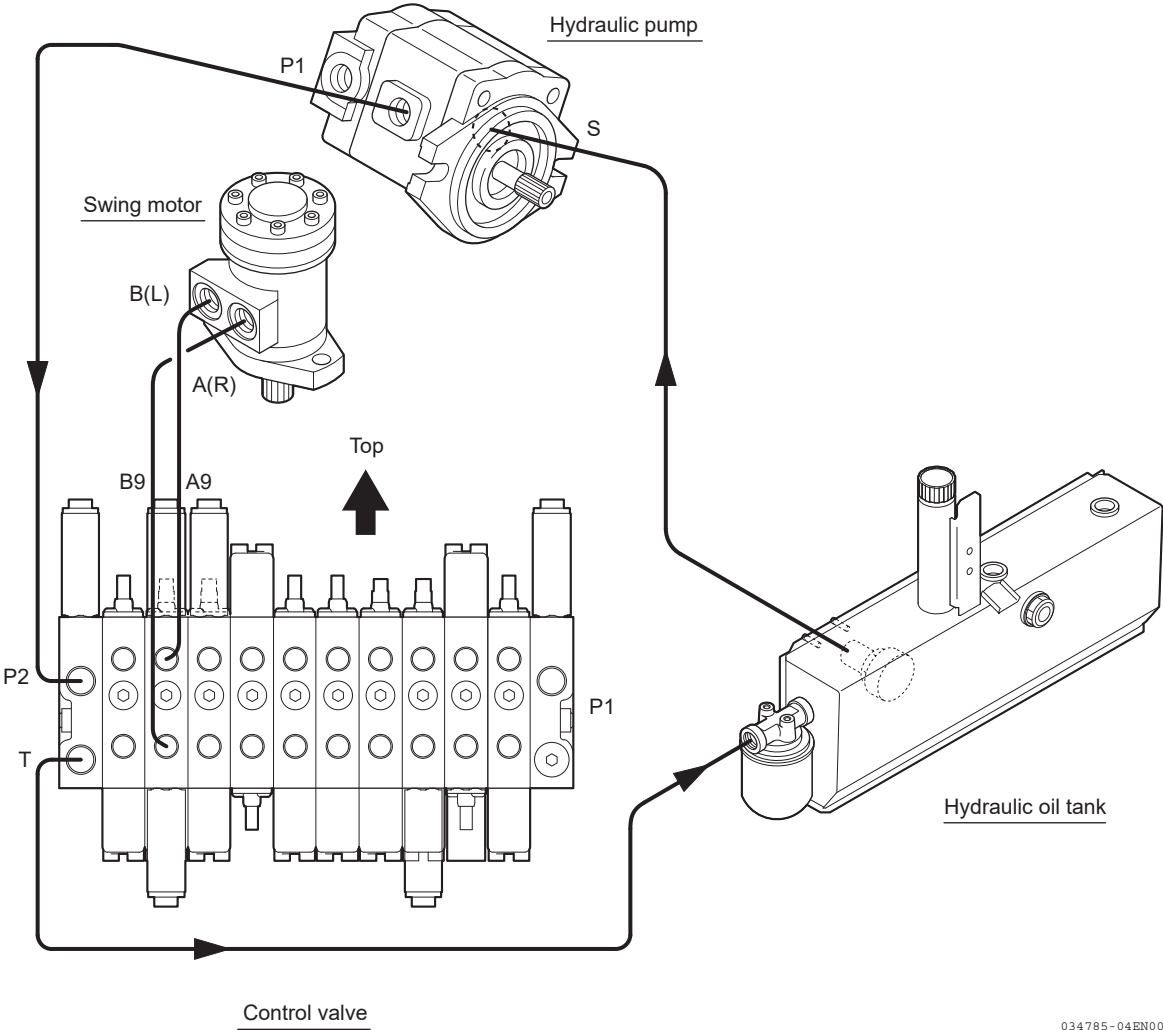
These check valves send oil in the swing motor case and its hydraulic oil pipings to the lower pressure circuit in port A or port B of the swing motor in order to reduce the motor case pressure.



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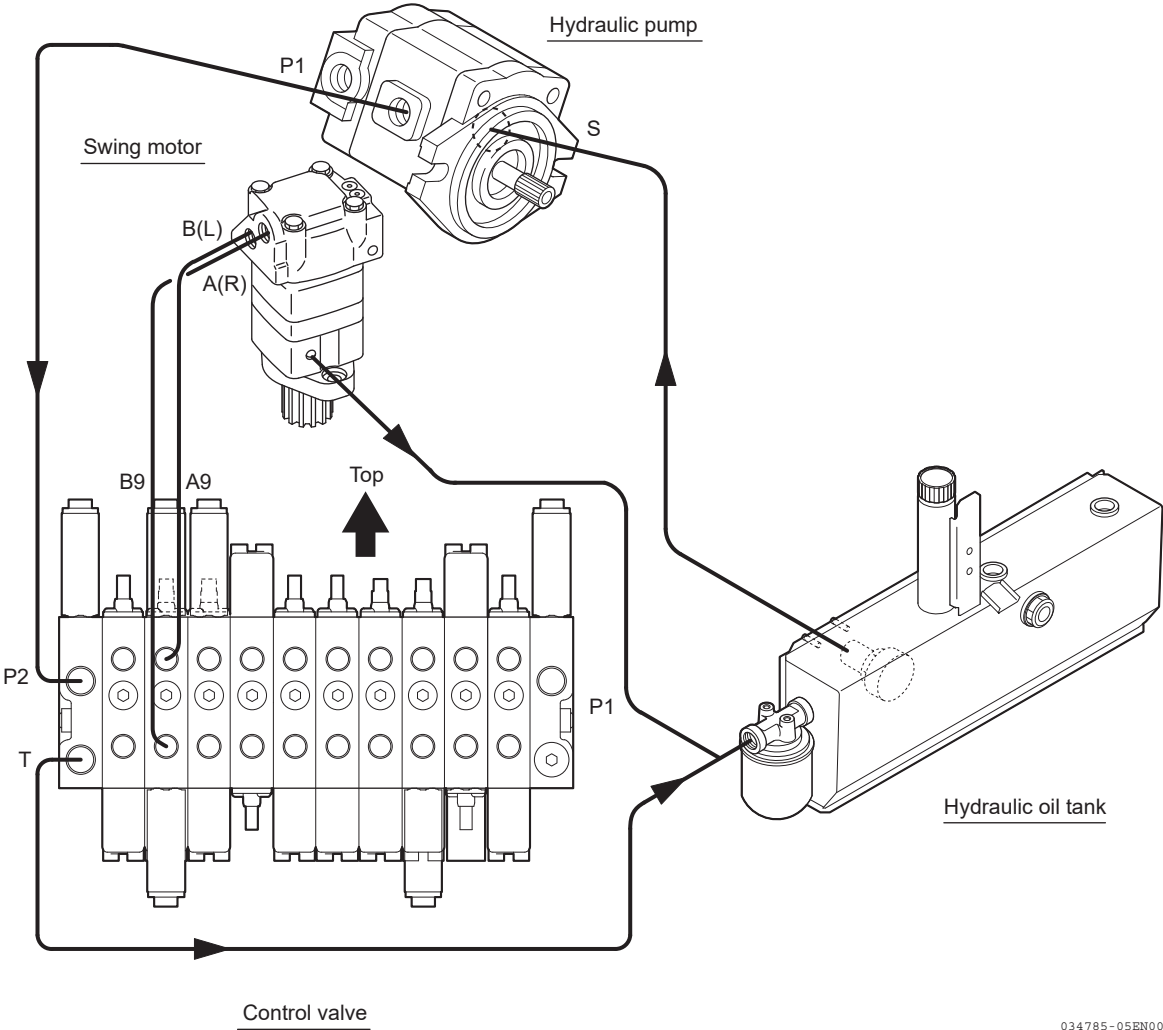
5. HYDRAULIC SYSTEM

S/N 14001 to 19874



034785-04EN00

S/N 19875 to 19999, 1A000 and above



034785-05EN00

5. HYDRAULIC SYSTEM

5-3-5 Boom Swing

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

1) Right Boom Swing

Oil Flow from Hydraulic Pump

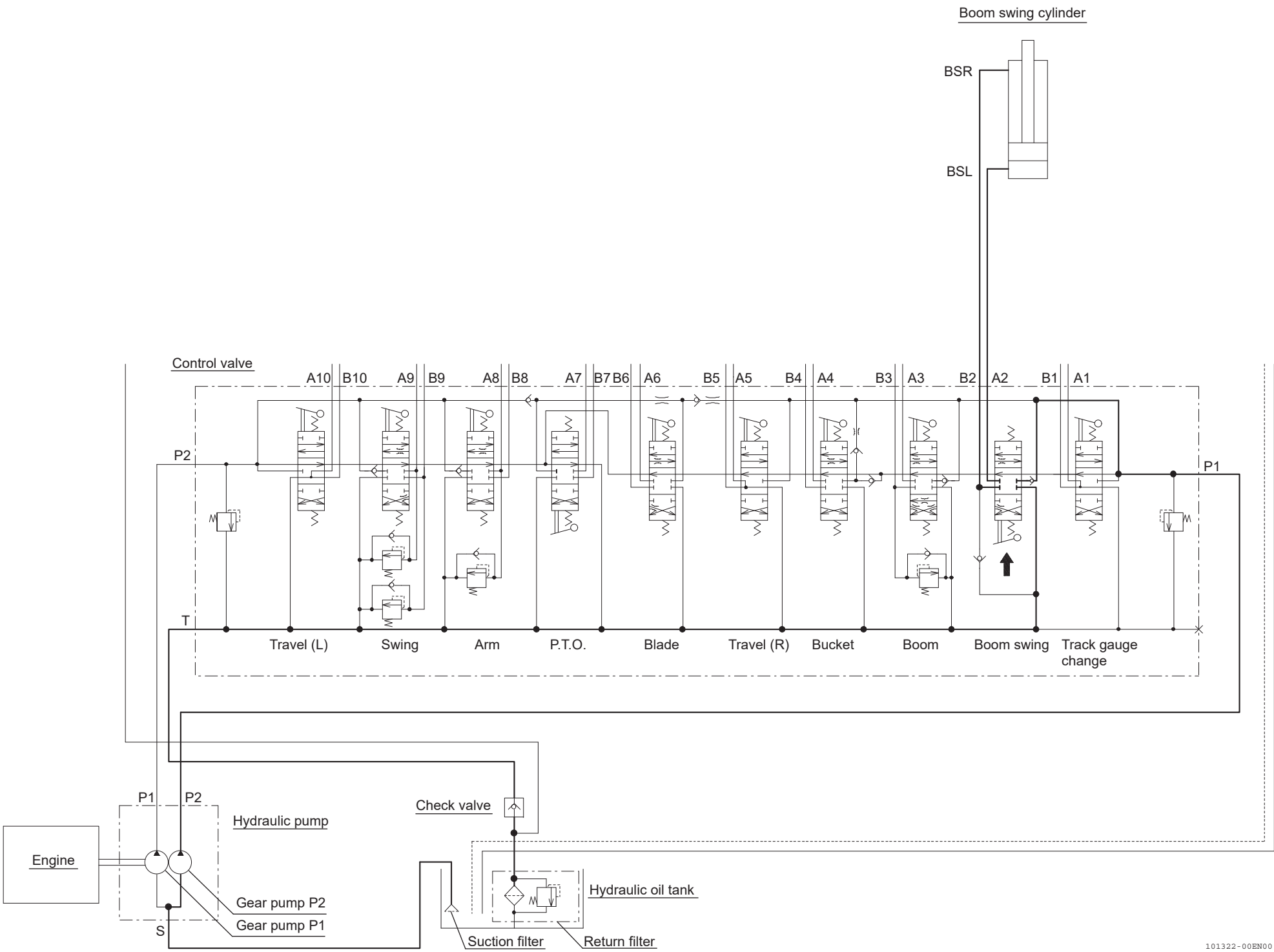
When the boom swing pedal is moved on the right, the spool is pressed. The oil from the hydraulic pump P2 flows through the port P1 of the control valve, the parallel passage to the boom swing section and the port B2 of the boom swing section to BSR of the boom swing cylinder to retract its cylinder rod.

The return oil from BSL of the boom swing cylinder flows back to the hydraulic oil tank through the port A2 of the boom swing section, the port T of the control valve and the check valve.

2) Left Boom Swing

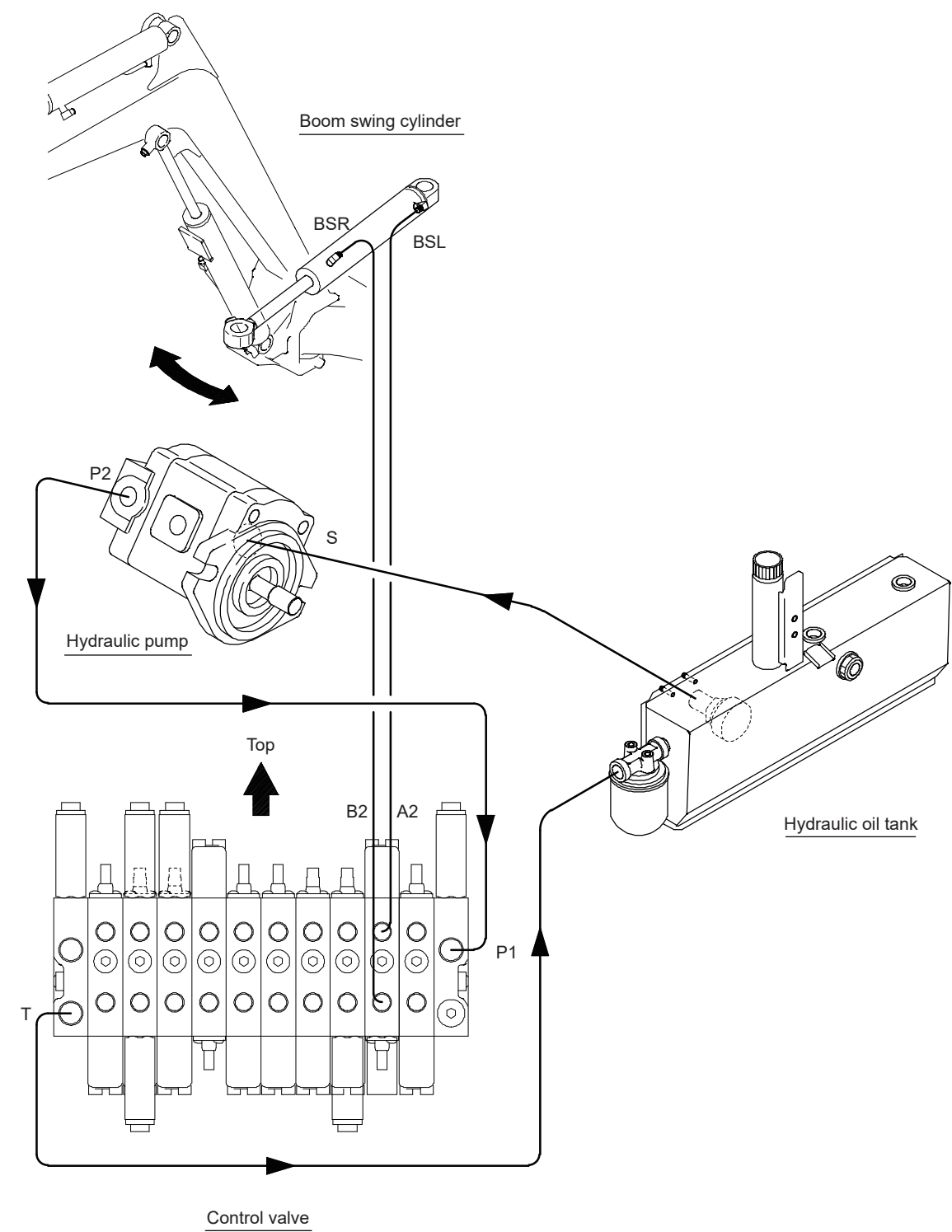
Oil Flow from Hydraulic Pump

When the boom swing pedal is moved on the left, the spool is pulled. The oil flows in the opposite direction to the oil flow in the right boom swing operation with regard to the boom swing cylinder.



101322-00EN00

5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-3-6 Blade

The blade lever is linked to the spool of the control valve through L-balls and a blade cable.

1) Blade "Down"

Oil Flow from Hydraulic Pump

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

The oil from the hydraulic pump P2 flows through the port P1 of the control valve, the parallel passage, the port A6 of the blade section and the port E of the swivel joint to BLD of the blade cylinder to extend its cylinder rod, lowering the blade.

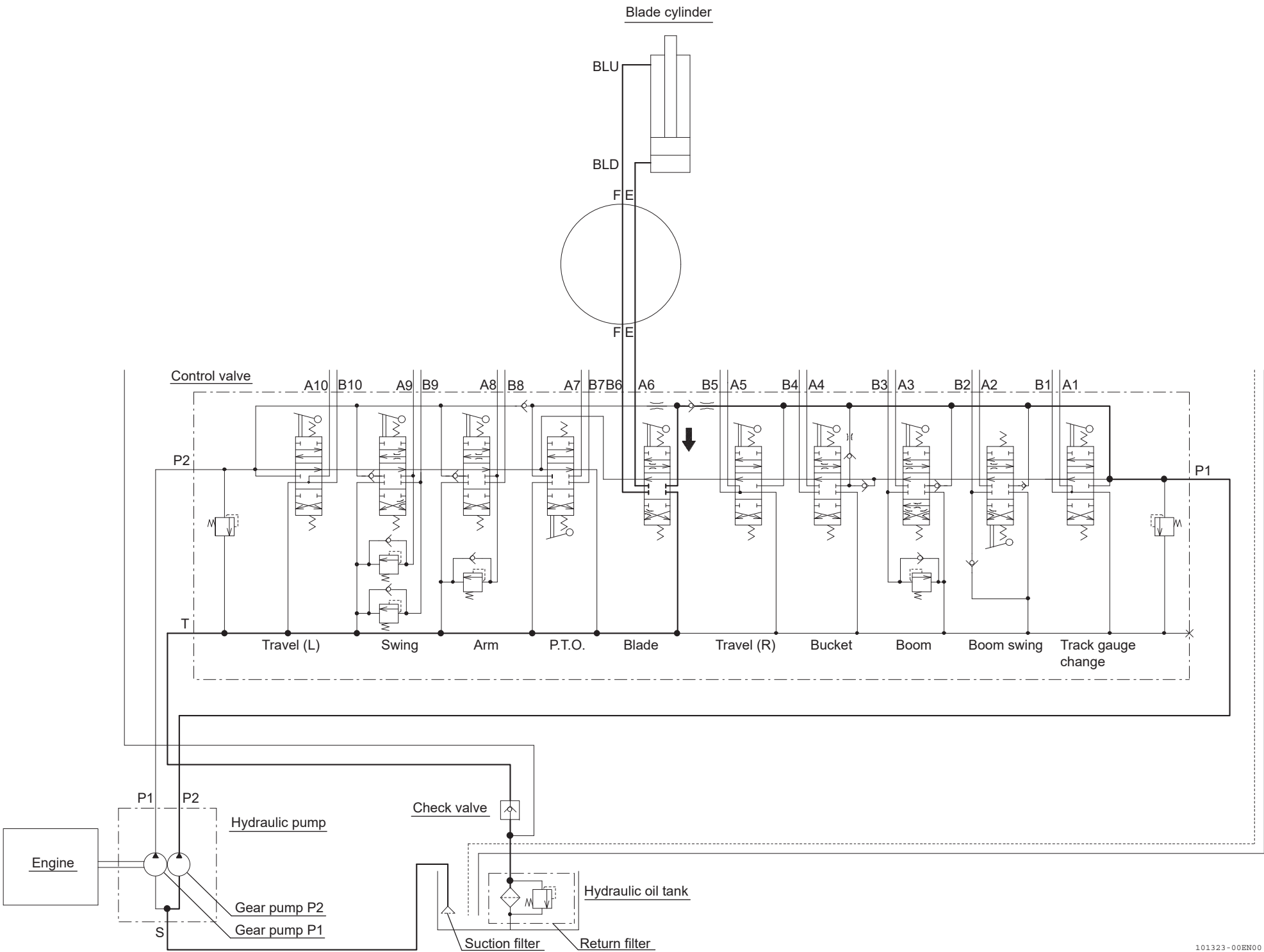
The return oil from BLU of the blade cylinder flows back to the hydraulic oil tank through the port F of the swivel joint, the port B6 of the blade section, the port T of the control valve and the check valve.

2) Blade "Up"

Oil Flow from Hydraulic Pump

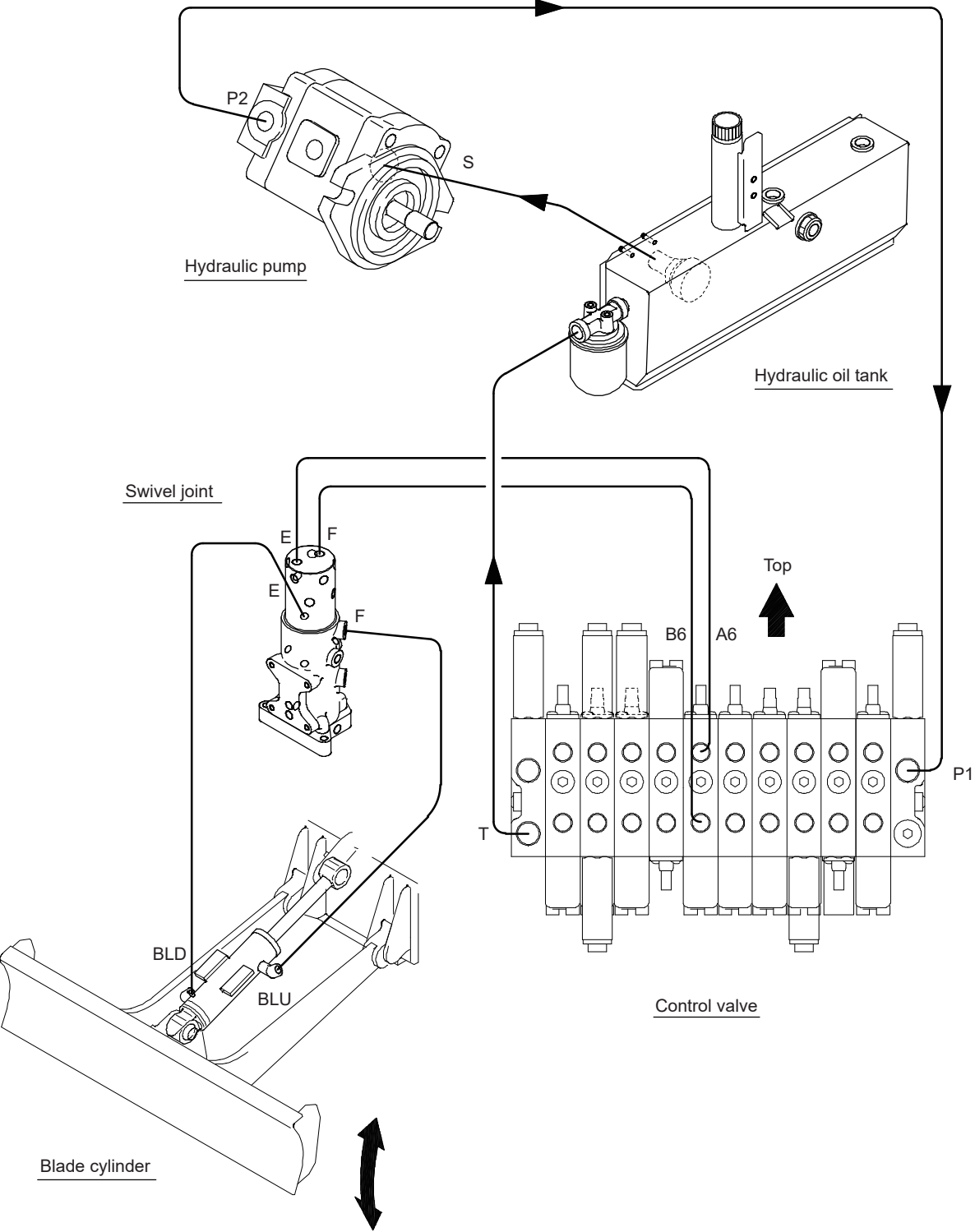
When the blade lever is pulled back to raise the blade, the spool is pulled.

The oil flows in the opposite direction to the oil flow in the blade down operation with regard to the blade cylinder.



101323-00EN00

5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-3-7 Travel

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

1) Forward Travel (Right)

Oil Flow from Hydraulic Pump

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

The oil from the hydraulic pump P2 flows through the port P1 of the control valve, the parallel passage, the port A5 of the right travel section and the port G of the swivel joint to the port B of the right travel motor, so that the travel motor is rotated.

The return oil from the port A of the right travel motor flows back to the hydraulic oil tank through the port C of the swivel joint, the port B5 of the right travel section, the port T of the control valve and the check valve.

2) Forward Travel (Left)

Oil Flow from Hydraulic Pump

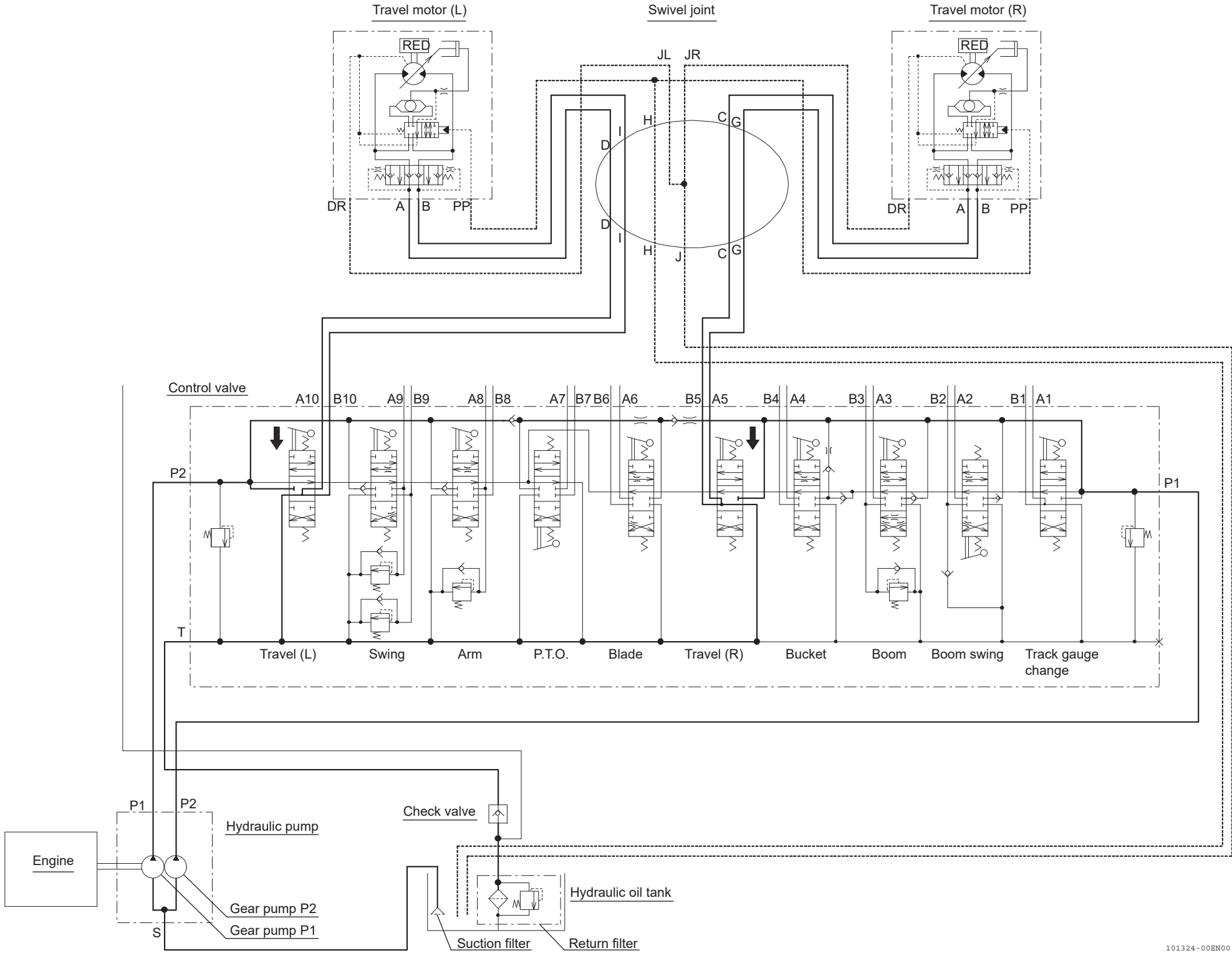
The oil from the hydraulic pump P1 flows through the port P2 of the control valve, the port A10 of the left travel section and the port D of the swivel joint to the port A of the left travel motor, so that the travel motor is rotated. The return oil from the port B of the left travel motor flows back to the hydraulic oil tank through the port I of the swivel joint, the port B10 of the left travel section, the port T of the control valve and the check valve.

3) Reverse Travel (Right and Left)

Oil Flow from Hydraulic Pump

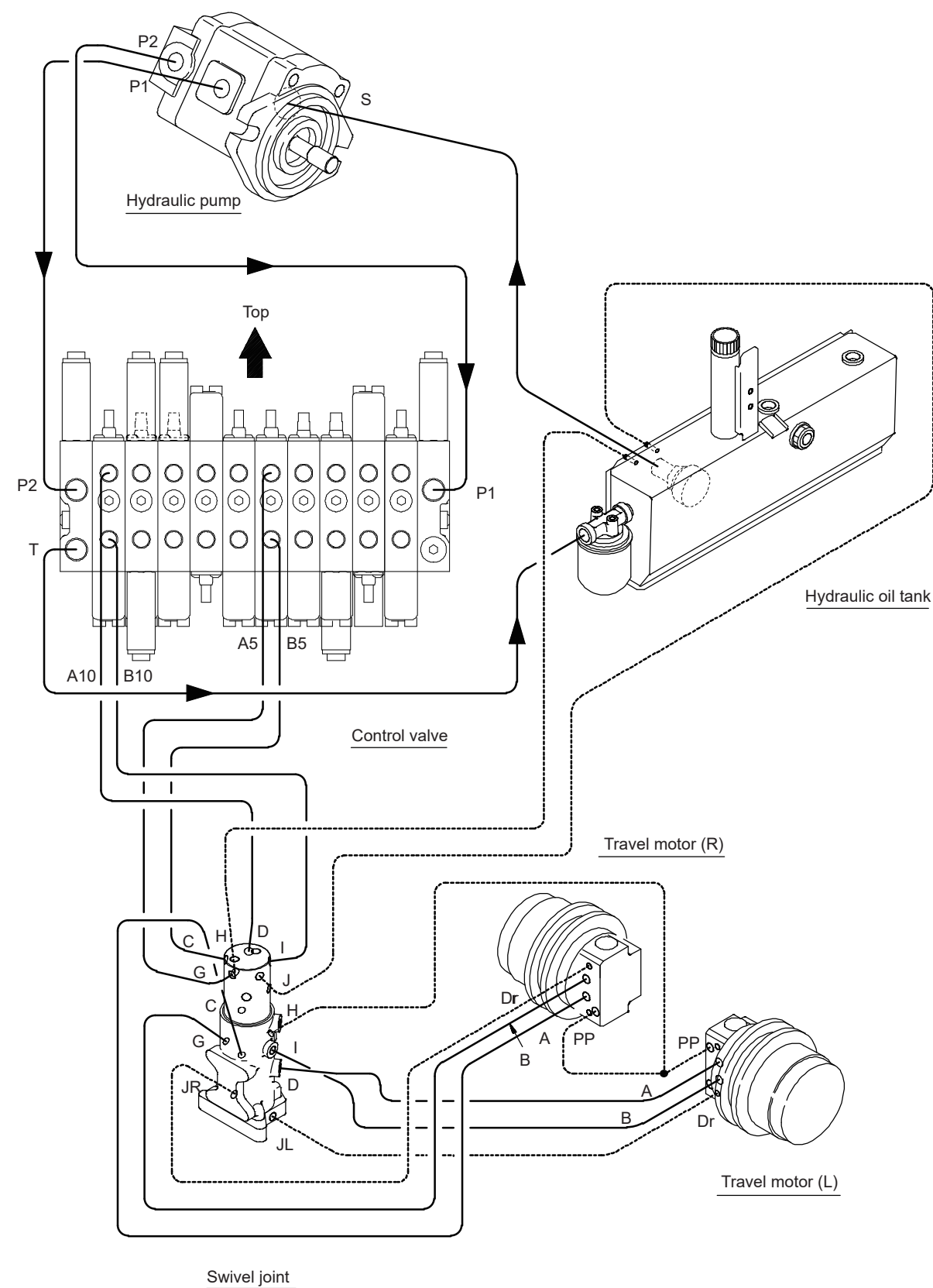
When the right or left travel lever is pulled back, the spool of the travel section is pulled.

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.



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5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-3-8 Simultaneous Operation of Travel and Blade

Oil Flow from Hydraulic Pump

When the blade is operated while the machine is traveling, the oil from the hydraulic pump P1 and that from the hydraulic pump P2 flow to the control valve in which they are each divided between the left or right travel section and the blade section.

1) Travel Sections

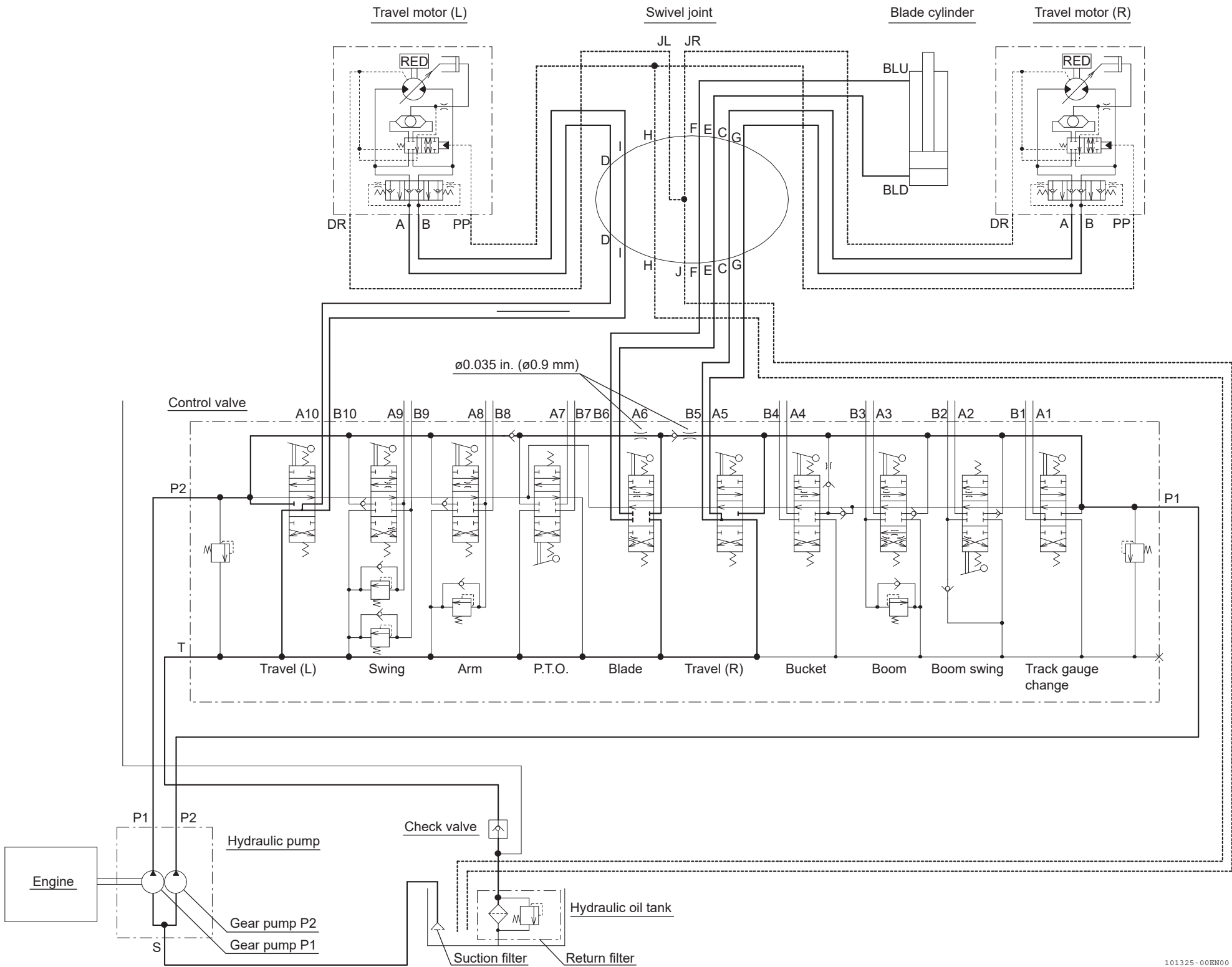
The right travel section is supplied with the oil from the hydraulic pump P2 through the parallel passage, and the left travel section is supplied with the oil from the hydraulic pump P1.

2) Blade section

The oil divided between the travel section and the blade section flows through the parallel passage. The divided oil for the blade section is regulated to the specified quantity by the throttle in the parallel passage. The regulated quantity of oil from the hydraulic pump P1 and that from the hydraulic pump P2 combine in the blade section and flow to the blade cylinder.

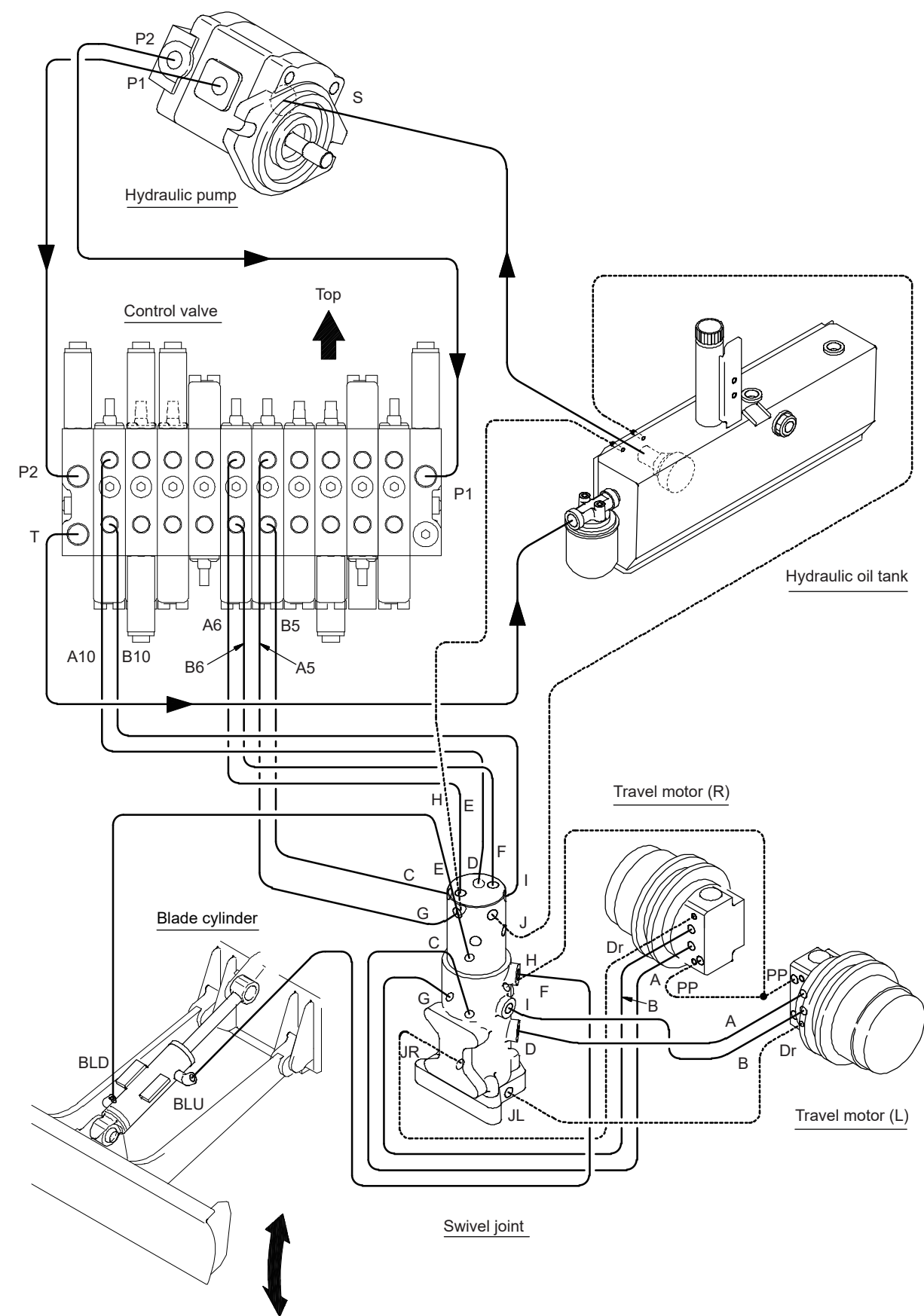
Accordingly, the machine can travel with no deviation even when the blade is operated while the machine is traveling, although the travel speed is slowed down.

Refer to Section "5-3-6 Blade" and Section "5-3-7 Travel" for the oil flow with regard to the blade cylinder and the travel motors.



101325-00EN00

5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-3-9 Hydraulic P.T.O.

The P.T.O. pedal is linked to the spool of the P.T.O. section through L-balls and a rod.

1. P.T.O. Combined Flow / Single Acting Actuator

Oil Flow from Hydraulic Pump

When the P.T.O. pedal is moved on its front side, the spool of the P.T.O. section is pulled.

The oil from the hydraulic pump P1 and that from the hydraulic pump P2 each flow through the parallel passage to the P.T.O. section, in which they are combined. The combined oil flows through the port A7 of the P.T.O. section to A of the P.T.O..

The return oil from B of the P.T.O. flows back to the hydraulic oil tank through the return filter.

2. P.T.O. Combined Flow / Double Acting Actuator

To use the double acting actuator, exchange the hose connection between B (blue) and C (white) at frame end.

Oil Flow from Hydraulic Pump

When the P.T.O. pedal is moved on its front side, the spool of the P.T.O. section is pulled.

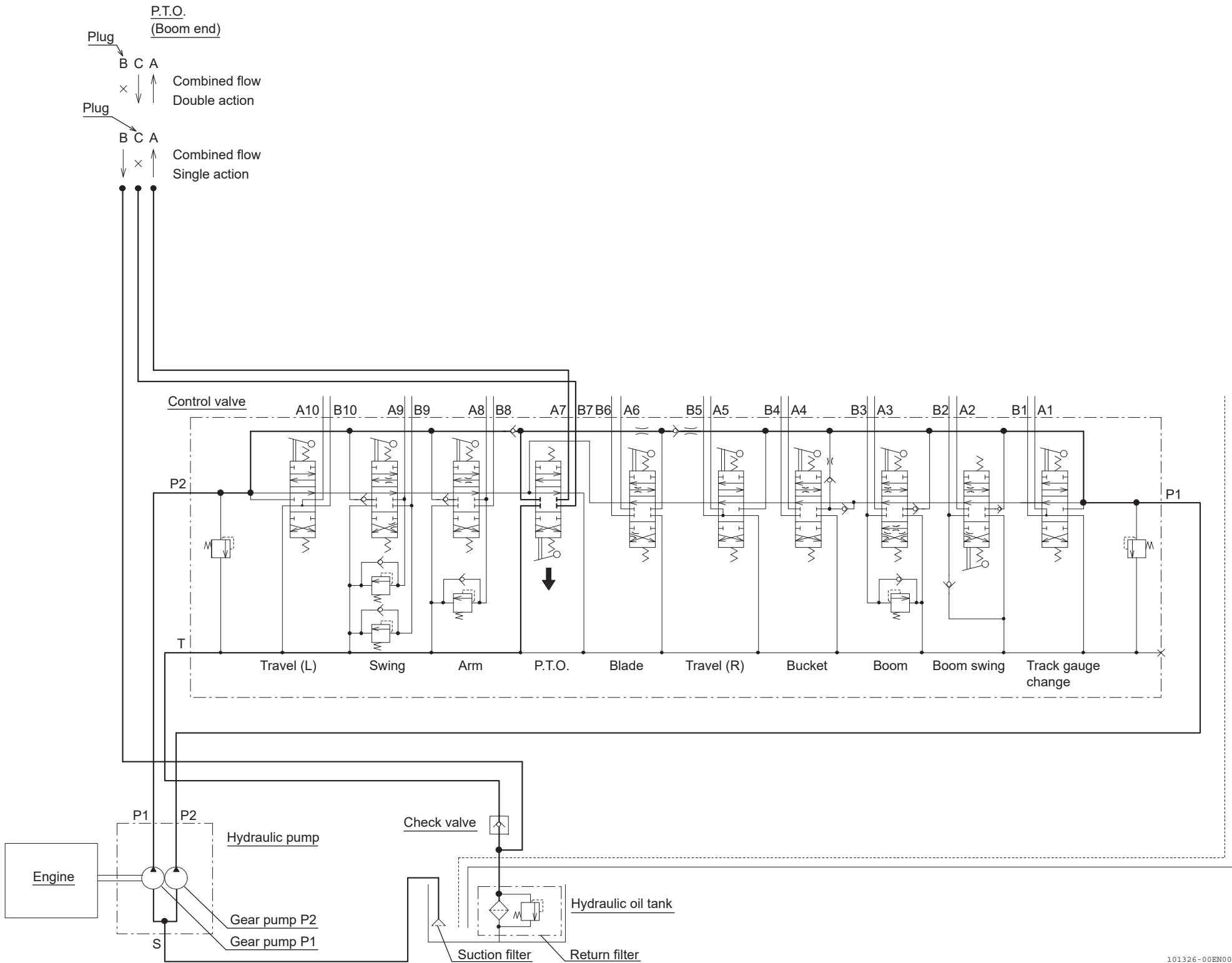
The oil from the hydraulic pump P1 and that from the hydraulic pump P2 each flow through the parallel passage to the P.T.O. section, in which they are combined. The combined oil flows through the port A7 of the P.T.O. section to A of the P.T.O..

The return oil from C of the P.T.O. flows back to the hydraulic oil tank through the ports B7 and T of the control valve, and returns to the hydraulic oil tank through the check valve and return filter.

When the P.T.O. pedal is moved on its back side, the spool of the P.T.O. section is pressed.

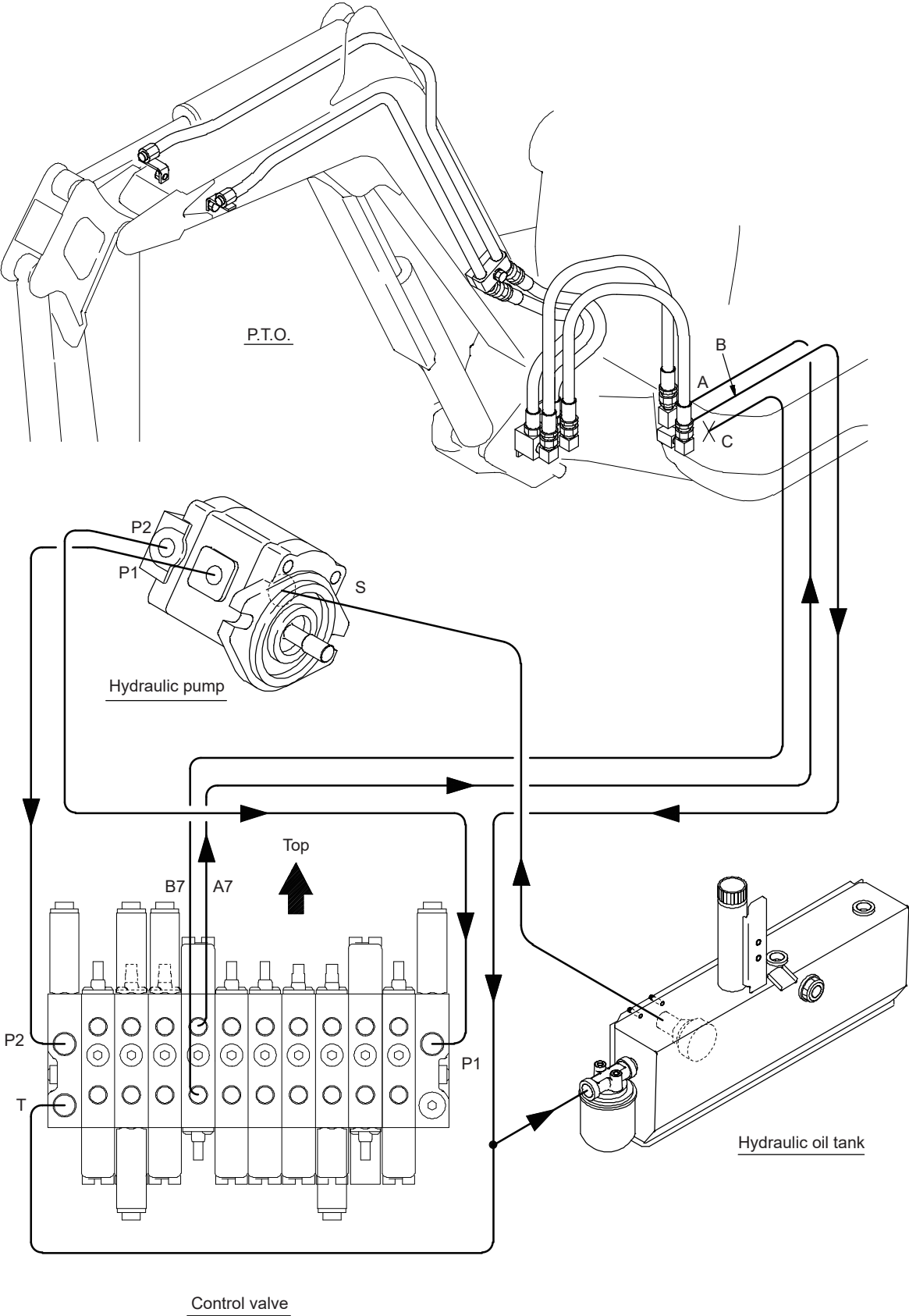
The oil from the hydraulic pump P1 and that from the hydraulic pump P2 each flow through the parallel passage to the P.T.O. section, in which they are combined. The combined oil flows through the port B7 of the P.T.O. section to A of the P.T.O..

The return oil from A of the P.T.O. flows back to the hydraulic oil tank through the ports A7 and T of the control valve, and returns to the hydraulic oil tank through the check valve and return filter.



101326-00EN00

5. HYDRAULIC SYSTEM



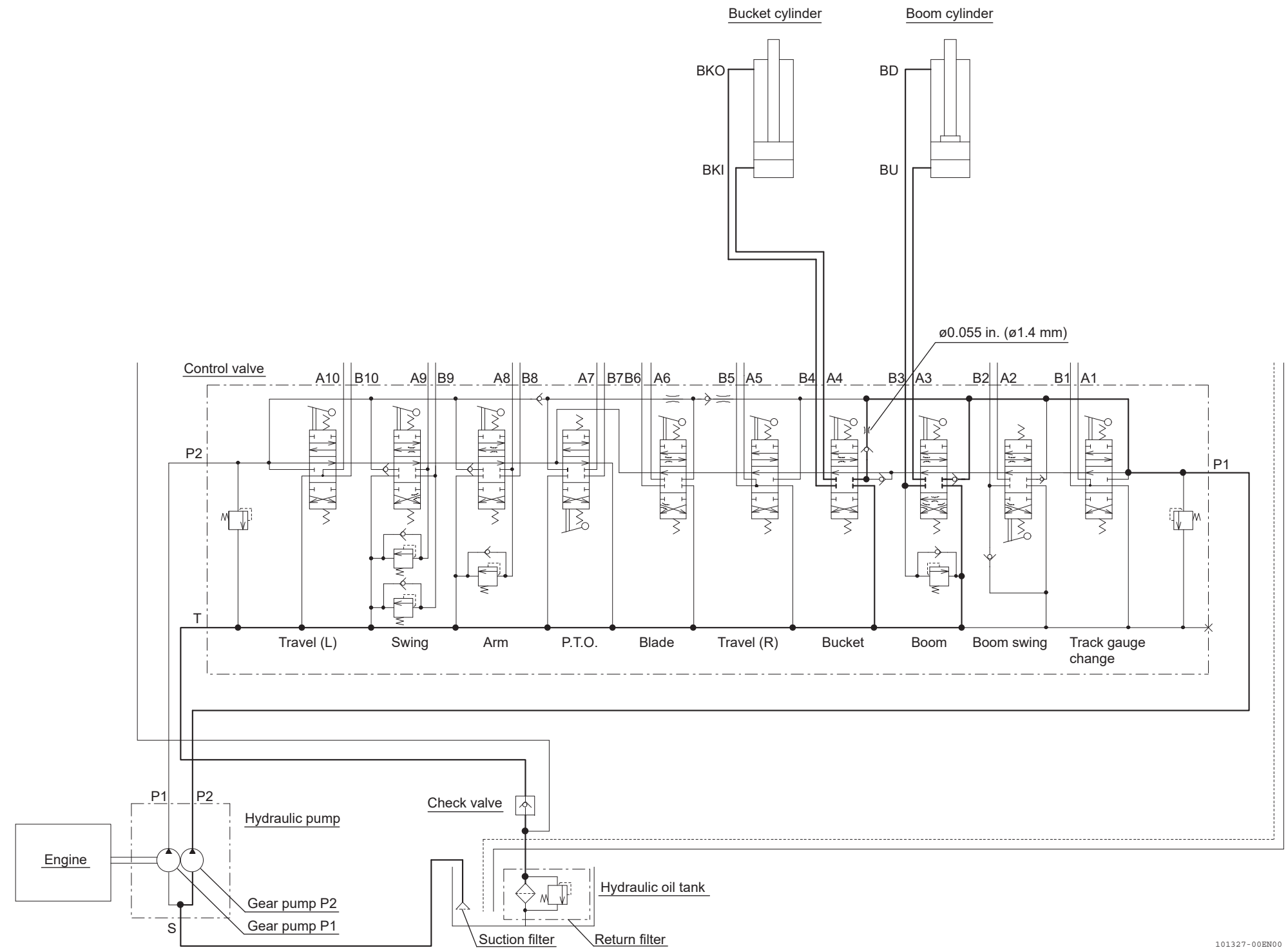
5. HYDRAULIC SYSTEM

5-3-10 Simultaneous Operation of Boom Up and Bucket

Oil Flow from Hydraulic Pump

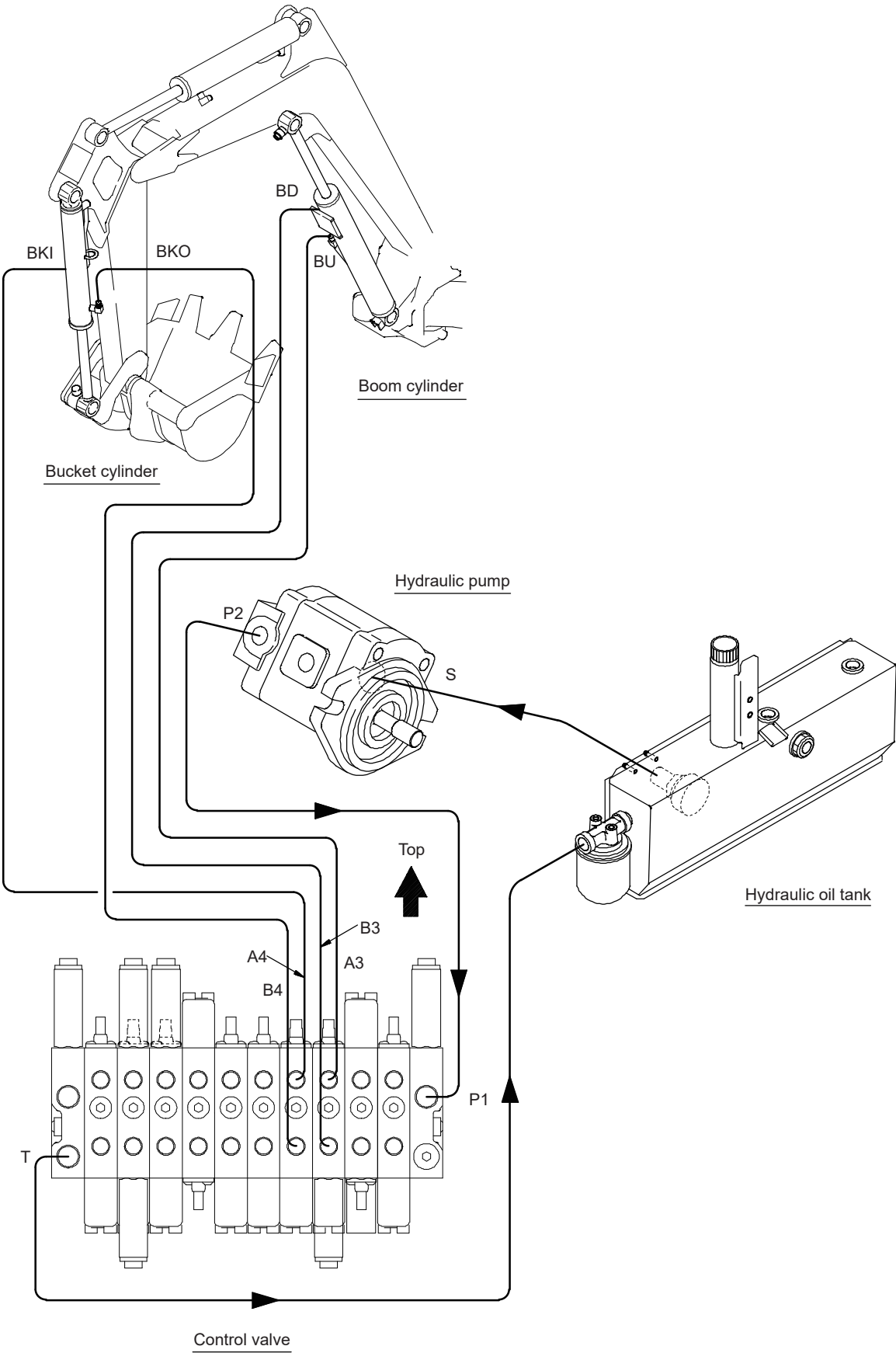
A throttle [Ø0.055 in. (Ø1.4 mm)] is installed in the parallel passage in the bucket section so that the oil can flow more smoothly to the boom section when the bucket control lever is moved while the boom with a heavy load is being raised. Therefore, the boom and the bucket can be operated simultaneously.

Refer to Section "5-3-1 Boom" and Section "5-3-3 Bucket" for the oil flow with regard to the boom and bucket cylinders.



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5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-3-11 Track Gauge Change

Link track gauge change type SV08-1A

The track gauge change lever is connected to the spool of the control valve through linkage.

1) Widening

When the track gauge change lever is pushed forward to widen the track gauge of the crawler, the spool of the track gauge change section is pushed.

Oil Flow from Hydraulic Pump

The oil from the hydraulic pump P2 flows through the port P1 of the control valve, the port B1 of the track gauge change section and the port A of the swivel joint to the port A of the pilot check valve, in which the oil is divided into two flows.

The two divided oil flows each open the pilot check valve and flow to the port A2 of the right track gauge change cylinder and the port B1 of the left track gauge change cylinder to extend the respective cylinder rods.

At this time, the pilot pressure is given to the return circuit to open the pilot check valve so that the return oil can flow. The pilot check valve opens at a differential pressure of 49.3 PSI (0.34 MPa).

The return oil from the port B2 of the right track gauge change cylinder and that from the port A1 of the left track gauge change cylinder flow through the pilot check valves, the port B of the swivel joint, the port A1 of the track gauge change section and the check valve to the hydraulic oil tank.

2) Narrowing

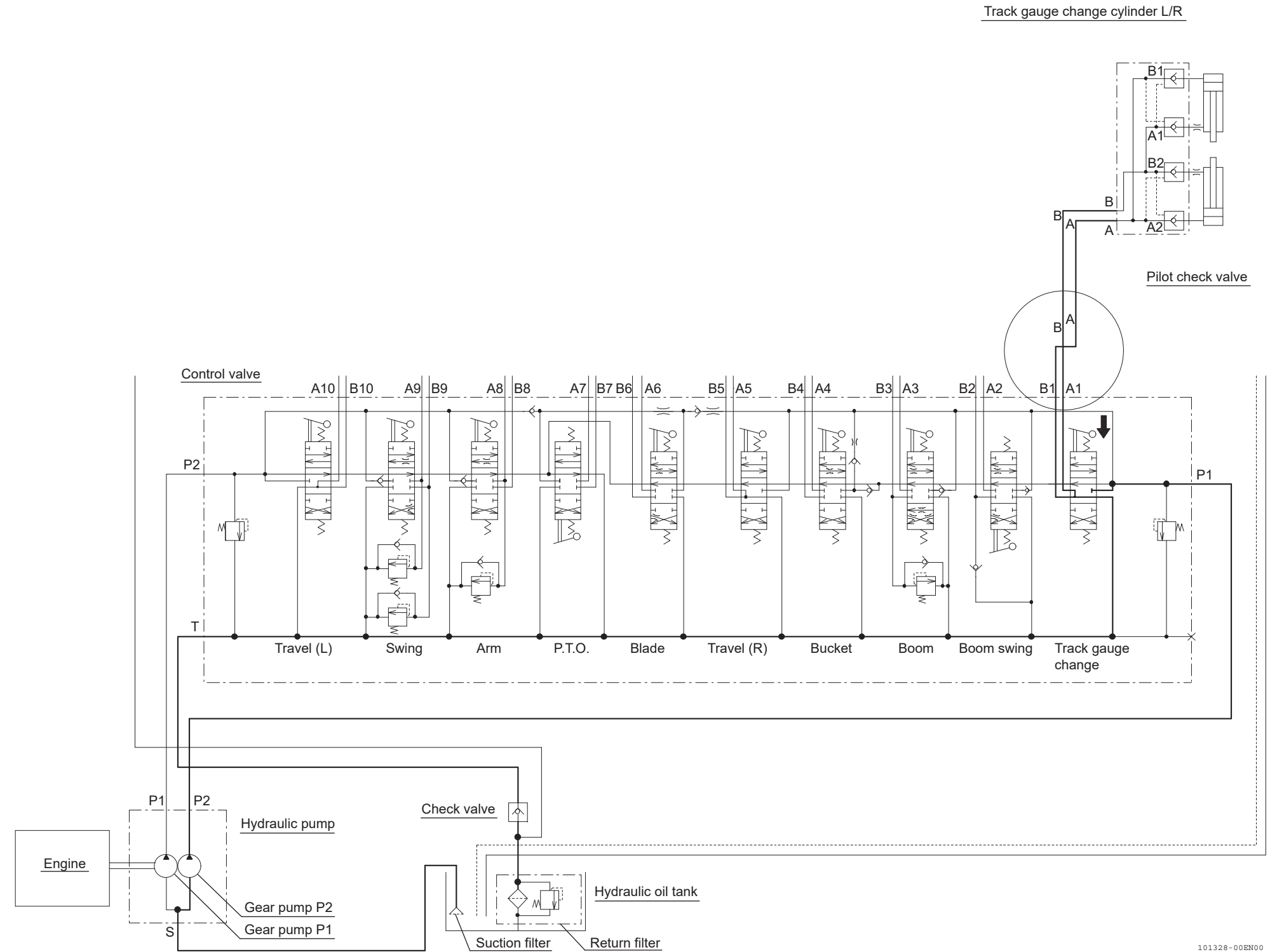
When the track gauge change lever is pulled back to narrow the track gauge of the crawler, the spool of the track gauge change section is pulled.

Oil Flow from Hydraulic Pump

The oil flows in the opposite direction to the oil flow in the track gauge widening operation with regard to the track gauge change cylinders.

3) Track Gauge Change of Crawler on One Side

The right and left track gauge change cylinders are connected in parallel. To widen or narrow the track gauge of the crawler on one side, raise the crawler on that side and give a load to the other side.



5. HYDRAULIC SYSTEM

Slide track gauge change type SV08-1A(S), SV08-1C

The track gauge change lever is connected to the spool of the control valve through linkage.

1) Widening

When the track gauge change lever is pushed forward to widen the track gauge of the crawler, the spool of the track gauge change section is pushed.

Oil Flow from Hydraulic Pump

The oil from the hydraulic pump P2 flows to the bottom side of the track gauge change cylinder through the port P1 of the control valve, the port B1 of the track gauge change section and the port A of the swivel joint to extend its cylinder rod, widening the track gauge.

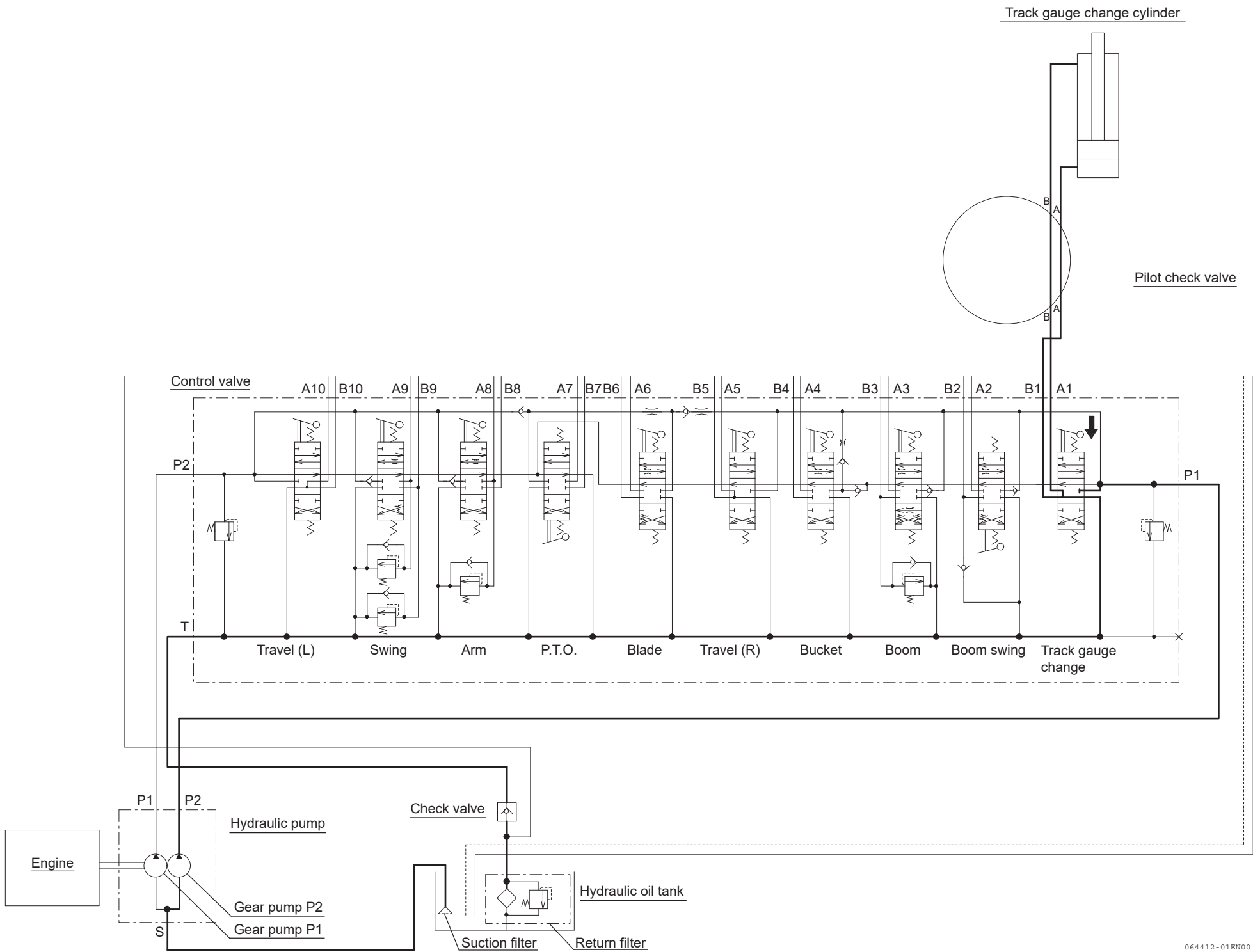
The return oil from the rod side of the track gauge change cylinder flows back to the hydraulic oil tank through the port B of the swivel joint, the port A1 of the track gauge change section and the check valve.

2) Narrowing

When the track gauge change lever is pulled back to narrow the track gauge of the crawler, the spool of the track gauge change section is pulled.

Oil Flow from Hydraulic Pump

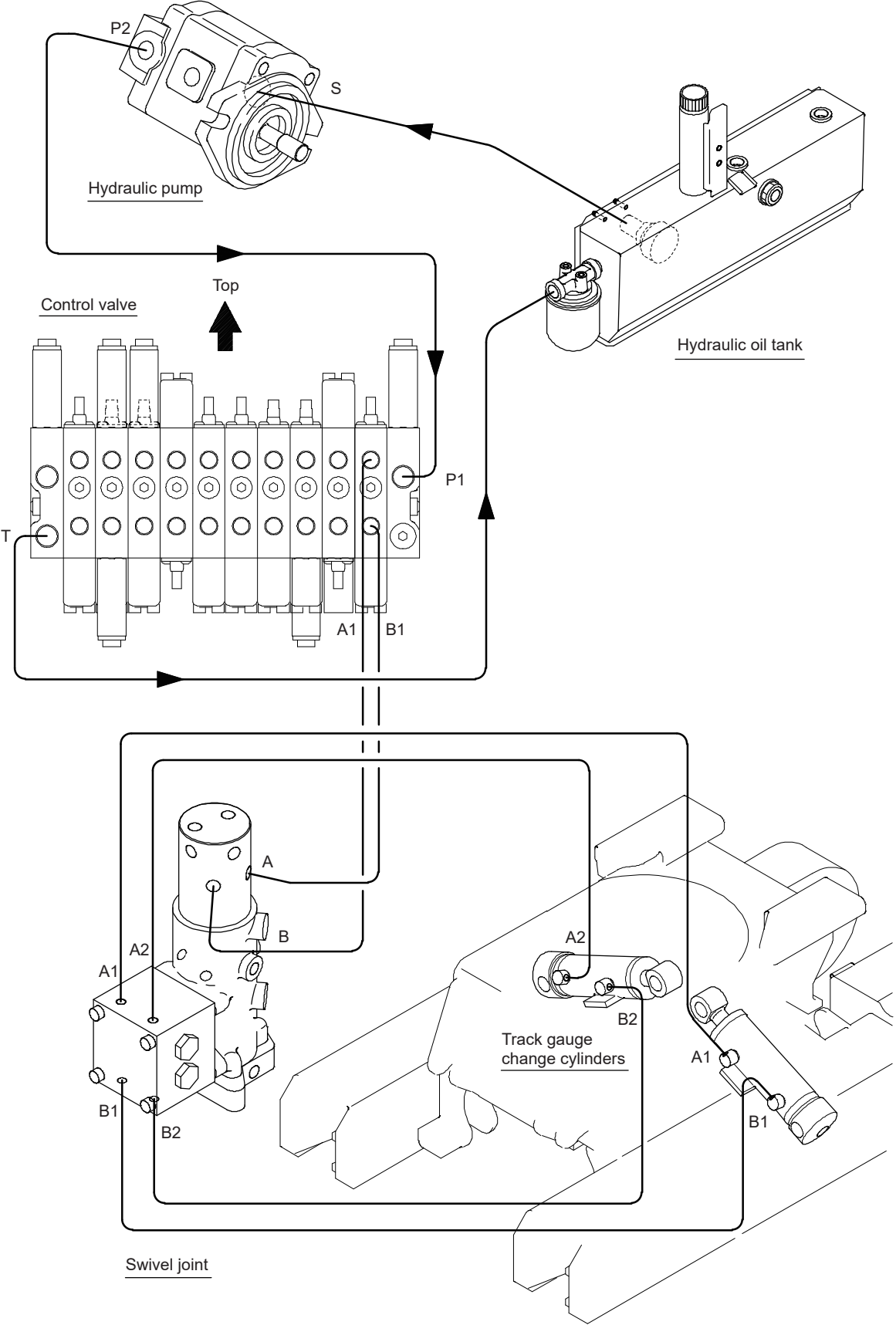
The oil flows in the opposite direction to the oil flow in the track gauge widening operation with regard to the track gauge change cylinder.



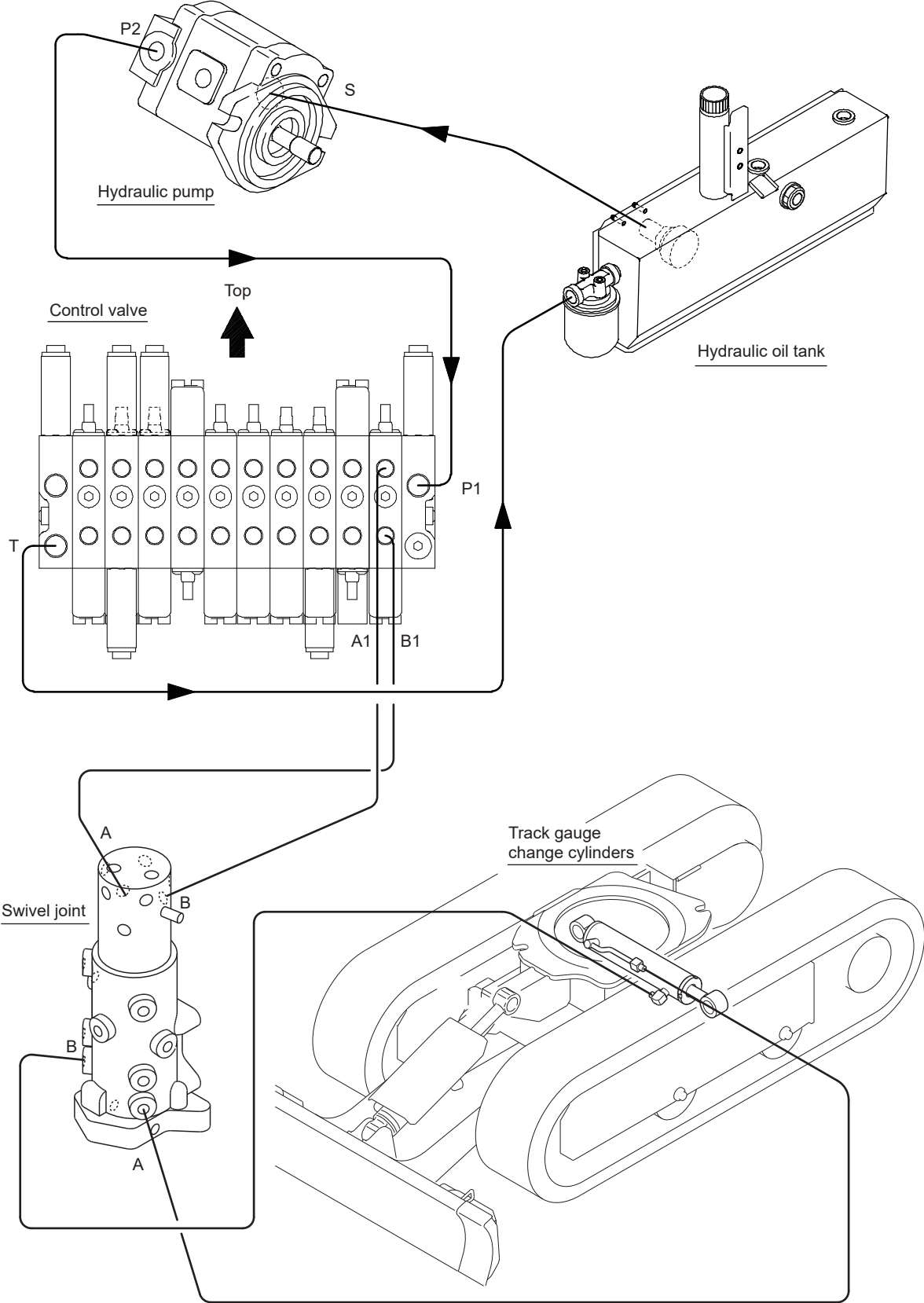
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5. HYDRAULIC SYSTEM

Link track gauge change type SV08-1A



Slide track gauge change type SV08-1A(S), SV08-1C



5. HYDRAULIC SYSTEM

5-4 Pressure Adjustment

5-4-1 Relief Valves

1) Conditions

- (1) Engine : rated speed
- (2) Hydraulic oil temperature : 122 to 140 °F (50 to 60 °C)
- (3) Pressure gauge capacity : 4977.1 PSI (34.3 MPa)

2) Relief Valve Specifications

Valve		Pump	Set pressure	Flow rate
			PSI (MPa)	GPM (L / min)
System relief valve	No.1	Piston pump P2	2630.0 (18.1)	at 2.64 (10)
	No.2	Piston pump P1	2630.0 (18.1)	
Circuit relief valve	Boom (rod end)	Hydraulic pump P2	3262.5 (22.5)	at 1.32 (5)
	Arm (bottom end)	Hydraulic pump P1	3262.5 (22.5)	
Combination valve	Swing (right and left)	Hydraulic pump P1	994.7 (6.86)	at 2.64 (10)

3) Measurement Procedure

- (1) Remove the step 1.
- (2) Remove the grips **2** of the right and left travel levers, and then remove the stand cover R **3**.
- (3) Remove the plug (PT1/8) from the connector of the hydraulic hose (from the hydraulic pump to the control valve) to install the pressure gauge **4**.

4) Adjustment Procedure

(1) System relief valve

- Relief valve No.2 (Pump P1)

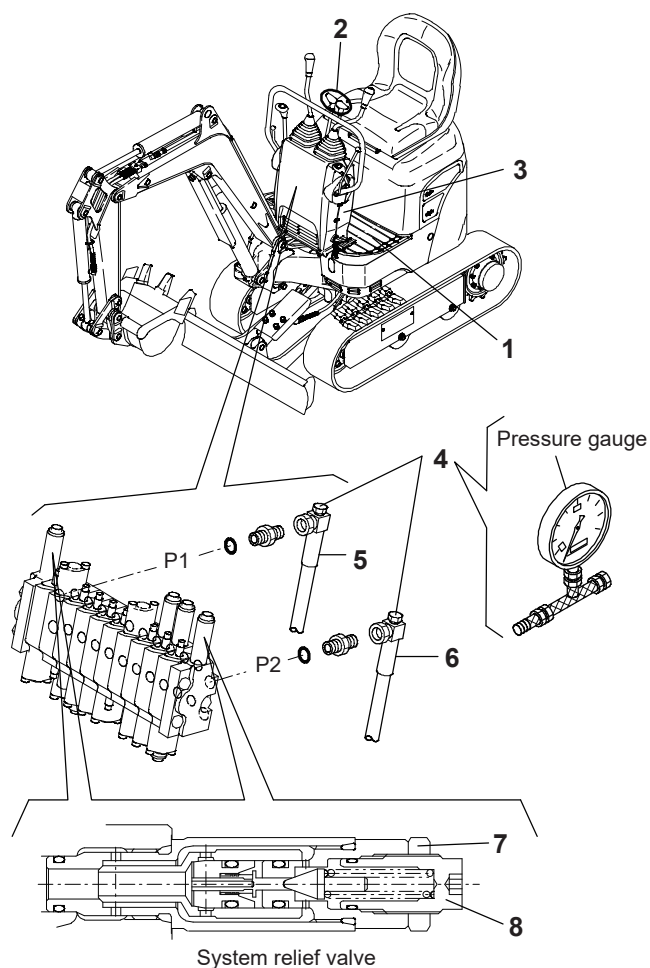
Retract the arm cylinder to its stroke end and hold the control lever in that position, then read the gauge.

- Relief valve No.1 (Pump P2)

Retract the bucket cylinder to its stroke end and hold the control lever in that position, then read the gauge.

- If the measured value is not that of the set pressure, loosen the nut (M14) **7** of the relief valve and turn the adjust screw **8** to adjust the pressure to the set value while reading the gauge.

Pressure change by one turn of adjust screw	Tightening torque for nut (M14)
1763.3 PSI (12.2 MPa)	14.47 ft·lbf (19.6 N·m)



5. HYDRAULIC SYSTEM

(2) Circuit relief valve

• Arm cylinder bottom 1

Extend the arm cylinder to its stroke end and hold the control lever in that position, then read the gauge.

• Boom cylinder rod 2

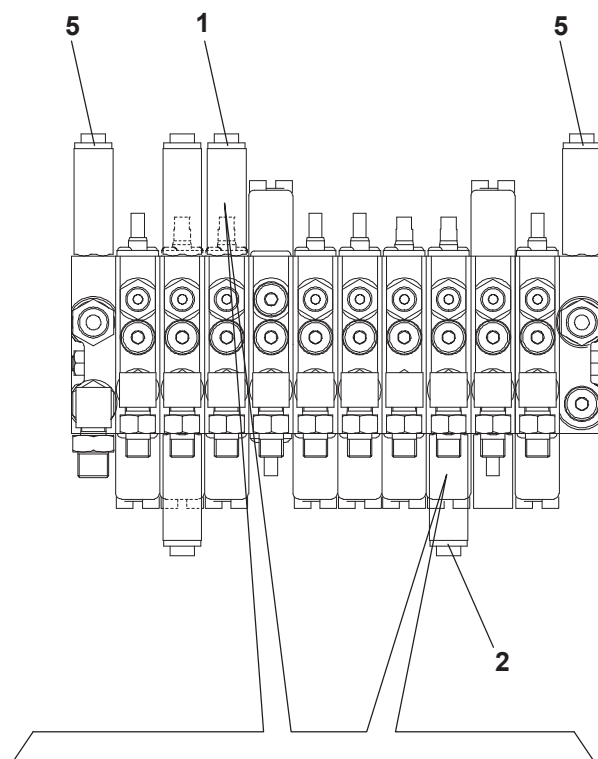
Retract the boom cylinder to its stroke end and hold the control lever in that position, then read the gauge.

- If the relief pressure of the circuit relief valve is lower than that of the system relief valve, adjust the pressure.

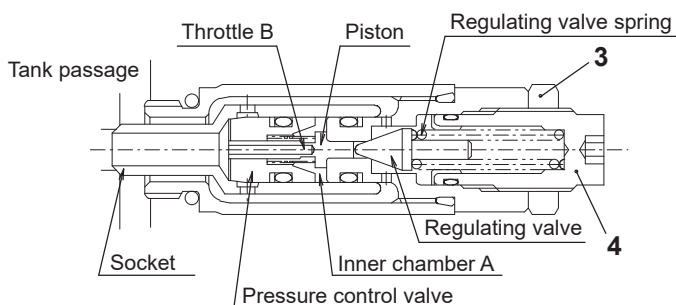
Increase the pressure of the system relief valve and that of the circuit relief valve by turns, and lock the adjust screw when the specified pressure of the circuit relief valve is obtained. Then, lower the pressure of the system relief valve to the specified value and lock the adjust screw.

(3) After adjustment, be sure to tighten the nut (M14) 7.

Pressure change by one turn of adjust screw	Tightening torque for nut (M14)
1763.3 PSI (12.2 MPa)	14.47 ft·lbf (19.6 N·m)



Circuit relief valve (Arm cylinder bottom)
(Boom cylinder rod)



5. HYDRAULIC SYSTEM

5-4-2 Swing Combination Valve (Brake Valve)

1) Conditions

- (1) Engine : rated speed
- (2) Hydraulic oil temperature : 122 to 140 °C (50 to 60 °C)
- (3) Pressure gauge capacity : 2842.0 PSI (19.6 MPa)
- (4) Set pressure : 994.7 PSI (6.86 MPa)

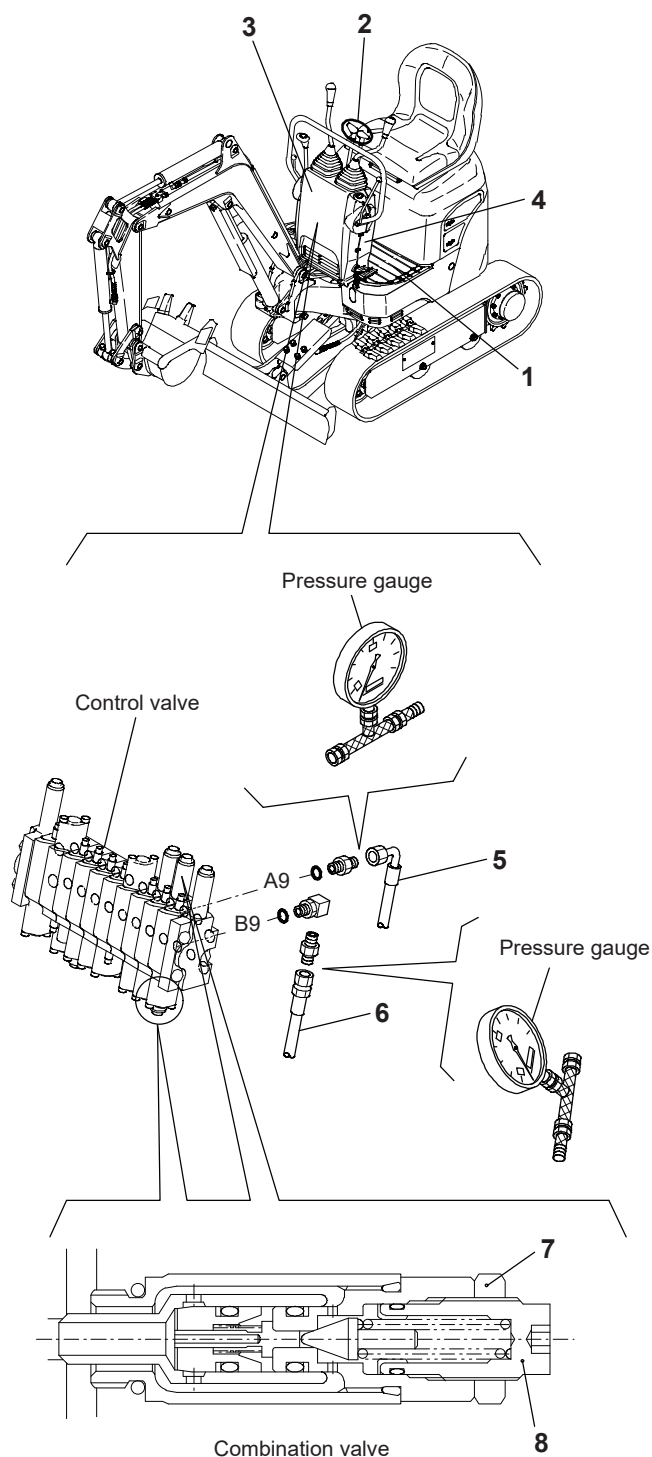
2) Measuring Procedure

- (1) Remove the step 1.
- (2) Remove the grips 2 of the right and left travel levers, and then remove the stand cover F 3 and the stand cover R 4.
- (3) Remove the hydraulic hoses 5 and 6 for the swing motor at the connectors on the control valve side, and then install the pressure gauge.
- (4) After fixing the upperstructure (by inserting the swing lock pin), move the control lever to the right and the left to increase the pressure in the circuit to the relief pressure and read the gauge.

3) Adjustment Procedure

- (1) Loosen the nut (M14) 7 of the combination valve.
- (2) Turn the adjust screw 8 to adjust the pressure to the set value while reading the gauge.
- (3) After adjustment, be sure to tighten the nut (M14) 7.

Pressure change by one turn of adjust screw	Tightening torque for nut (M14)
1769.0 PSI (12.2 MPa)	14.47 ft·lbf (19.6 N·m)



CHAPTER 6

HYDRAULIC EQUIPMENT

6-1 Hydraulic Pump 6-1-1

6-2 Control Valve 6-2-1

6-3 Swing motor..... 6-3-1

 6-3-1 S/N 14001 to 19874 6-3-1

 6-3-2 S/N 19875 to 19999, 1A000 and above..... 6-3-19

6-4 Valve Block (Link track gauge change type)..... 6-4-1

6-5 Travel Motor..... 6-5-1

6. HYDRAULIC EQUIPMENT

6. Hydraulic Equipment

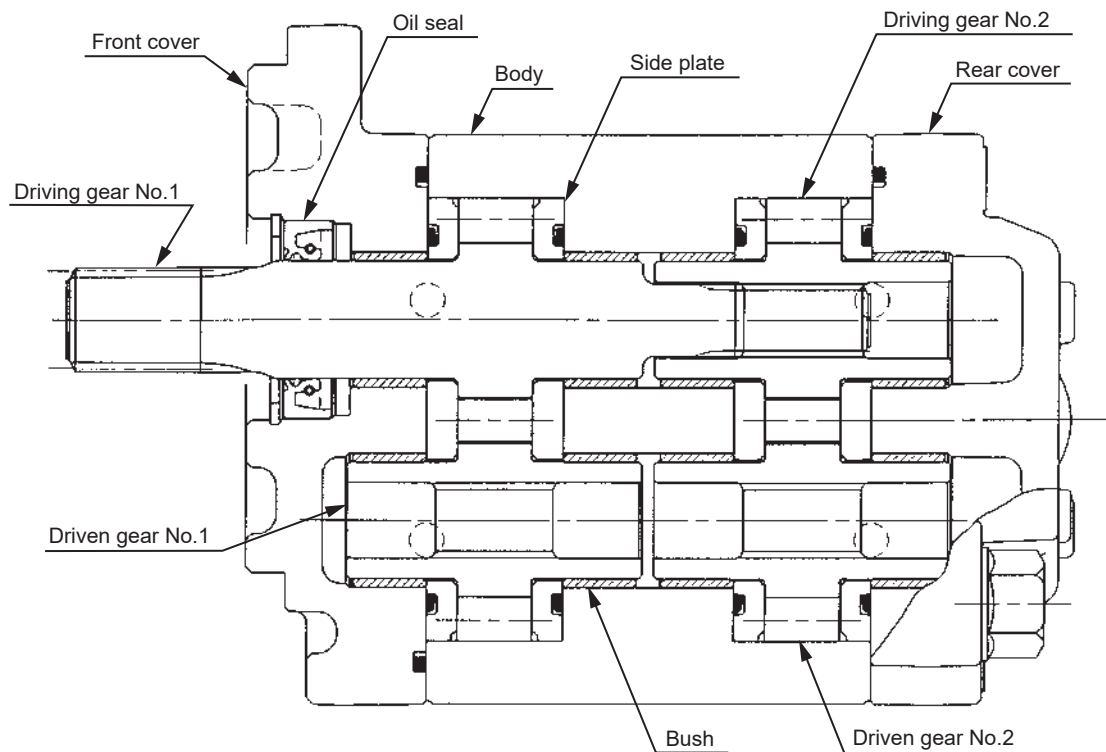
6-1 Hydraulic Pump

1. Outline

The hydraulic pump is a double gear pump consisting of a front cover, side plates, bushes, driving gears, driven gears, an oil seal and a rear cover as main parts. (Refer to the figure below.)

The front cover and the rear cover are made of aluminum alloy. The driving gears are rotated clockwise when seen from the front cover side.

The driving gear of the hydraulic pump P1 and that of the hydraulic pump P2 are directly splined to each other.



6. HYDRAULIC EQUIPMENT

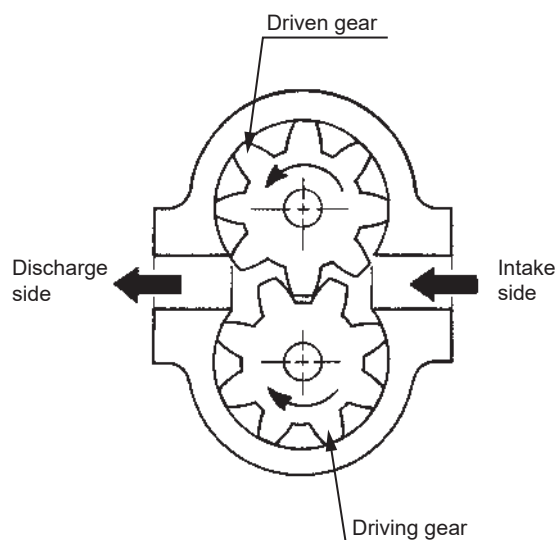
2. Theory of Operation

1) Pump Function

A combination of a driving gear and a driven gear is installed in each of the hydraulic pumps P1 and P2.

The driving gear is connected to the output shaft of the power source.

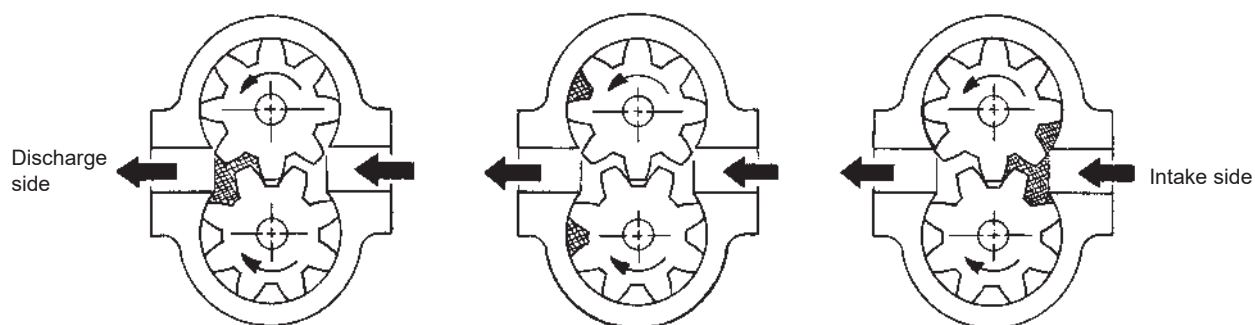
The driven gear is rotated in the opposite direction to the rotation of the driving gear.



The hydraulic oil which comes into the intake side is shut in the grooves between the teeth of the driving and driven gears, and the oil in the grooves is carried to the discharge side by the rotations of the gears.

When the teeth of the driving and driven gears reach the chamber on the discharge side, they start engaging with each other again. The oil in the groove between the teeth of one of the gears is discharged to the chamber on the discharge side by the tooth of the other gear put in the groove.

The oil in the chamber is pushed out to the discharge port by the oil discharged from the following groove between the teeth. The pressure in the chamber on the discharge side rises in proportion to the load applied to the hydraulic circuit.

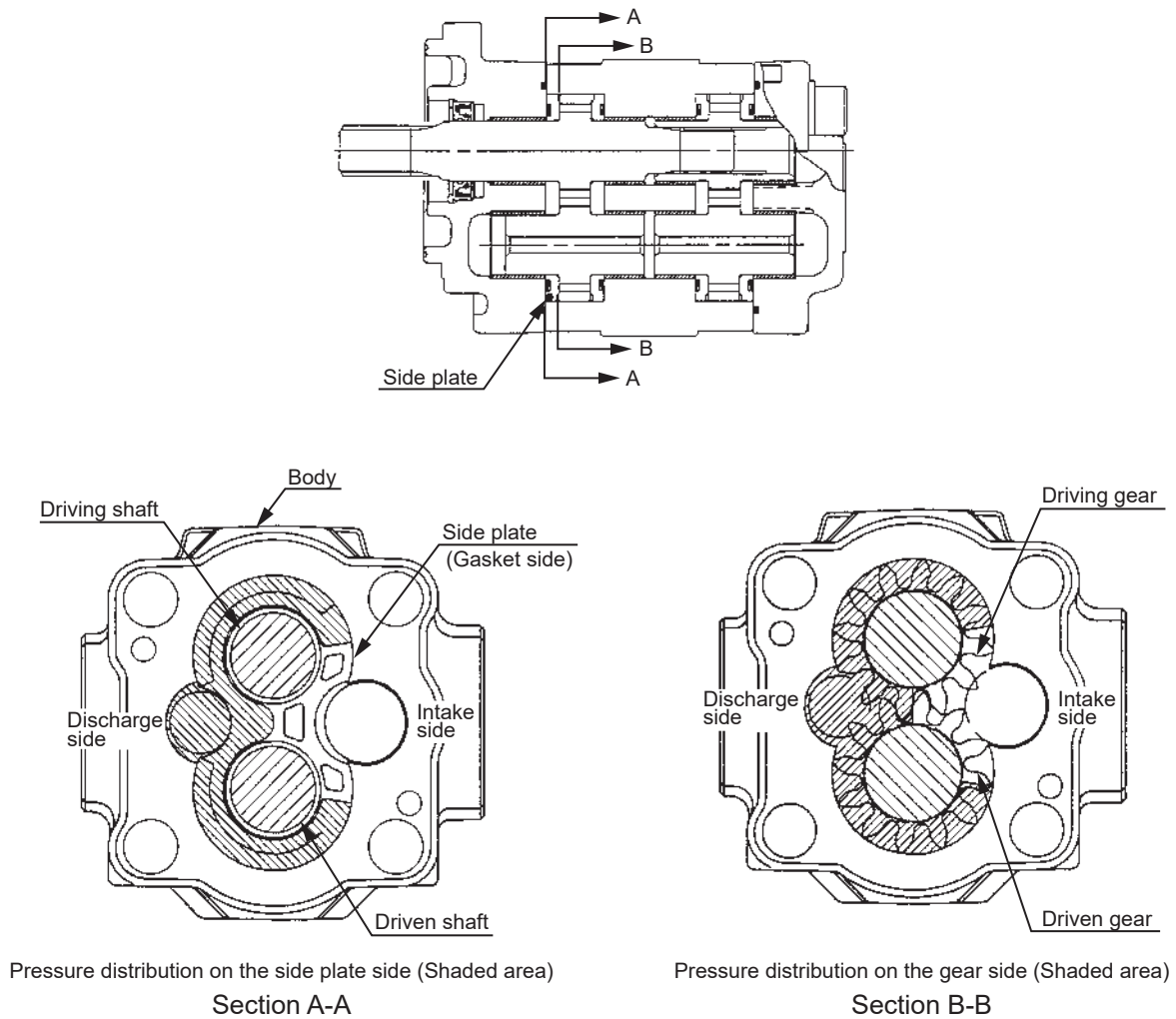


6. HYDRAULIC EQUIPMENT

2) Pressure Balance

When the hydraulic pump is not operating or the discharge pressure is low, the side plate is pressed against the side faces of the gears by the elastic force of the rubber gasket.

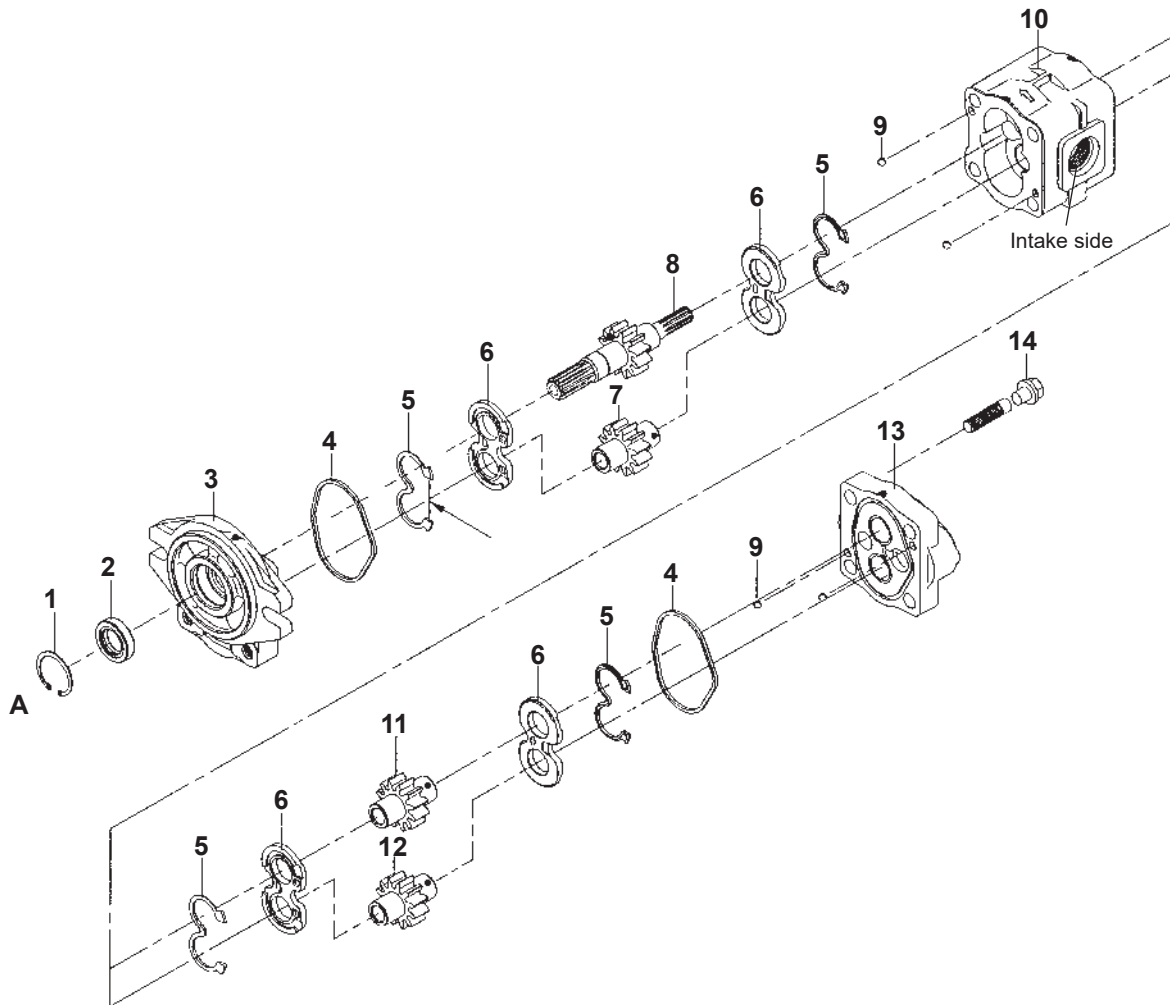
When the discharge pressure rises, the force pushing back the side plate (the shaded area in the section B-B) is applied between the side plate and the gears. However, the pressure corresponding to that force is applied to the back of the side plate (the shaded area in the section A-A) to maintain the pressure balance, so that the side plate is always pressed against the side faces of the gears by the elastic force of the rubber gasket.



6. HYDRAULIC EQUIPMENT

3. Exploded View and Component Parts

This exploded view is for the hydraulic pump which rotates counterclockwise when viewed from the side A.



No.	Part	Q'ty	No.	Part	Q'ty
1	Internal snap ring C	1	8	Driving gear No.1	1
2	Oil seal	1	9	Steel ball	4
3	Front cover (with bushes)	1	10	Body (with bushes)	1
4	Gasket	2	11	Driving gear No.2	1
5	3-shaped gasket	4	12	Driven gear No.2	1
6	Side plate	4	13	Rear cover (with bushes)	1
7	Driven gear No.1	1	14	Washer faced hexagon head bolt	4

6. HYDRAULIC EQUIPMENT

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 surfaces 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) In principle, replace the removed seals and rings with new ones. As some replacement parts are available only as a subassembly, 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] Do not damage the O-rings in handling or distort them by heat.
 - [3] Do not stretch the O-rings so strongly as to deform them permanently.
 - [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.
- (7) Before beginning reassembly, check that the mating surfaces of each section have no treated oil or hydraulic oil on the outer surface of the O-ring grooves in them. If reassembly is performed without removing such oil, it may be mistaken for oil leak.
- (8) Use a torque wrench to tighten the bolts at the tightening torque for them.

2) Tools for Disassembly and Reassembly

Unit : in. (mm)

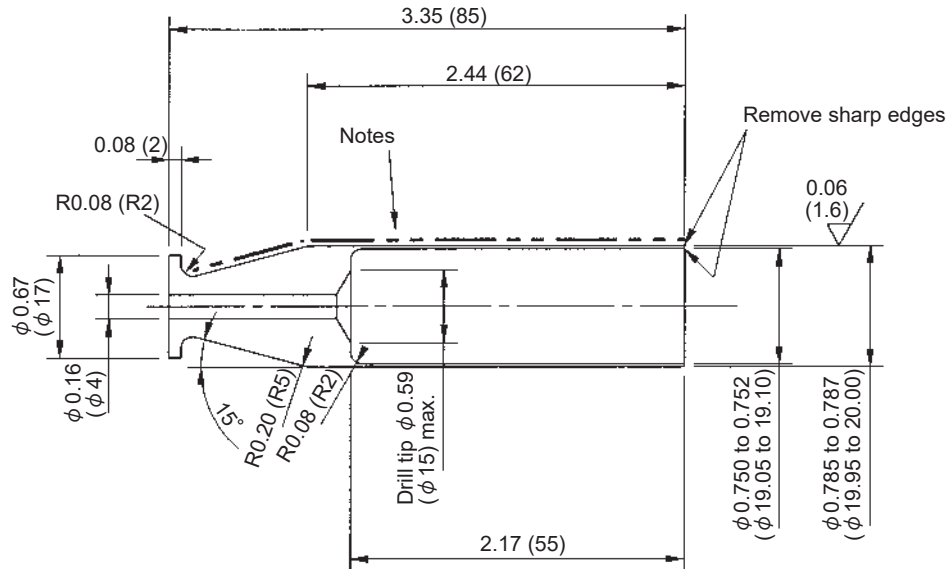
No.	Tool	
1	Preset torque wrench	Nominal size : 31.50 (800)
2	Hexagon socket screw key	Width across flats : 0.39 (10)
3	Screwdriver	Width : 0.24 to 0.39 (6 to 10)
4	Snap ring pliers	For Ø1.57 (Ø40) hole
5	Plastic hammer	
6	Others	Lithium grease
		Specified hydraulic oil
		Pump holding jig

6. HYDRAULIC EQUIPMENT

3) Special Tools

Oil seal guide

Unit : in. (mm)



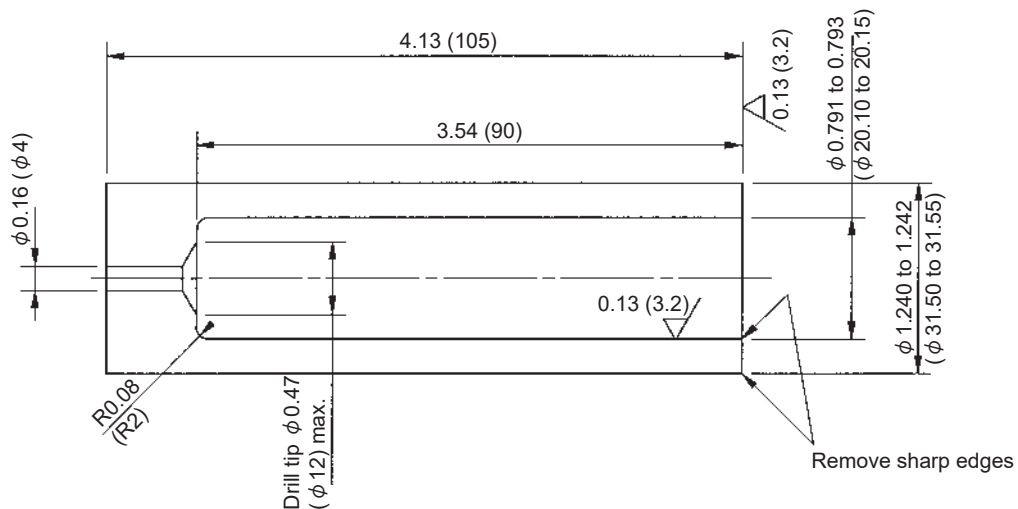
Material : SS400 or its equivalent

Notes :

- Finish the outer surface with an emery paper to make it smooth.
(Buffing is not permitted, as it may cause thermal strain.)
- Since the material is thin, take care not to deform it.

Oil seal snap

Unit : in. (mm)



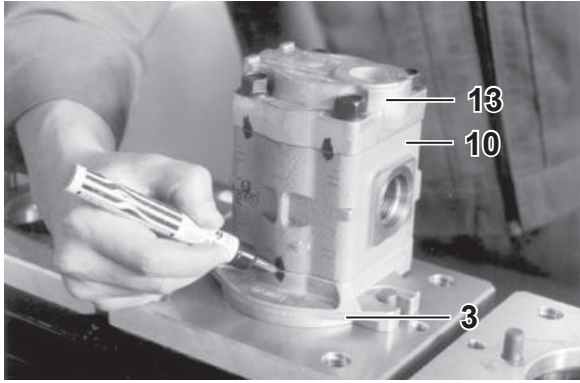
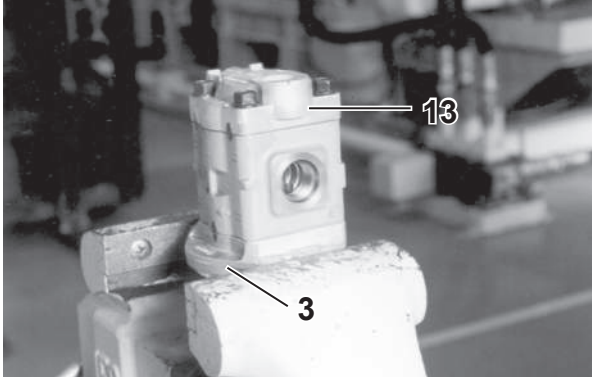
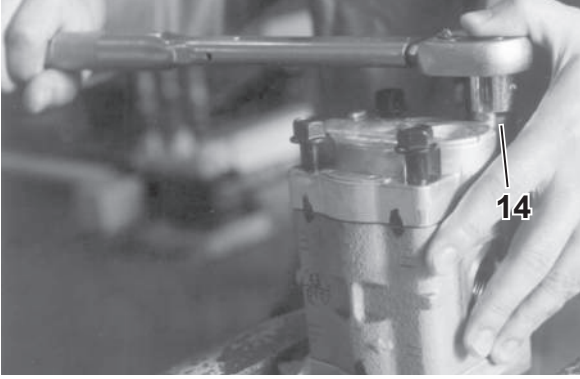
Material : SS400 (JIS G3101) or its equivalent

6. HYDRAULIC EQUIPMENT

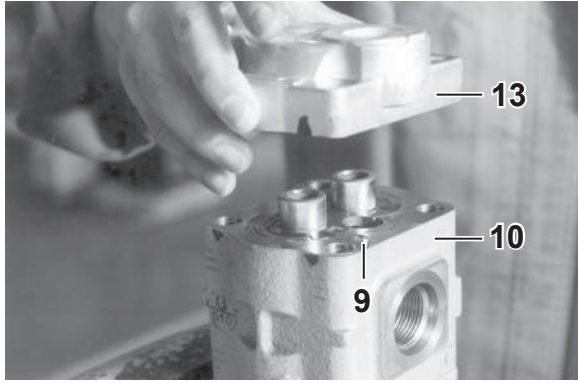
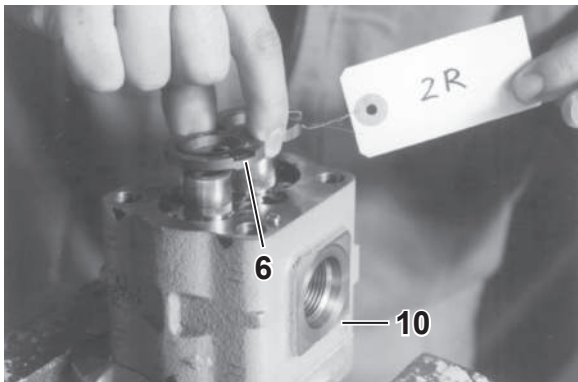
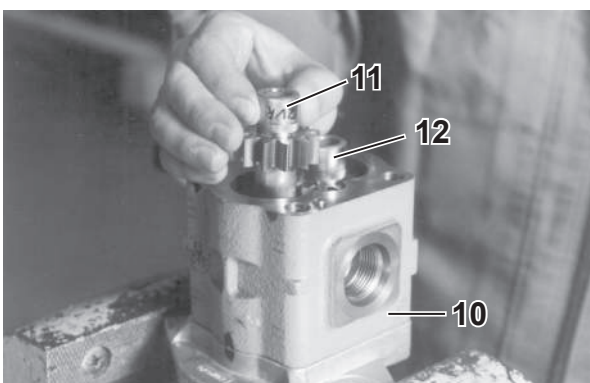
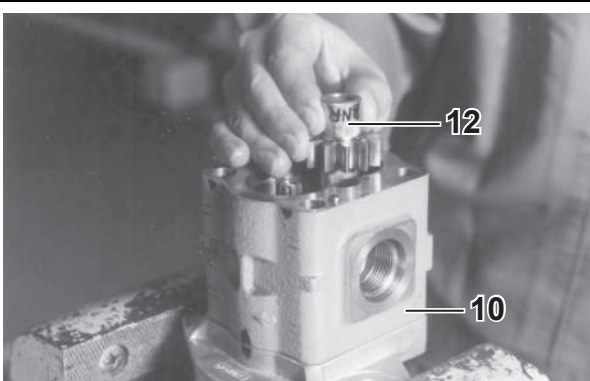
4) Disassembly

Notes :

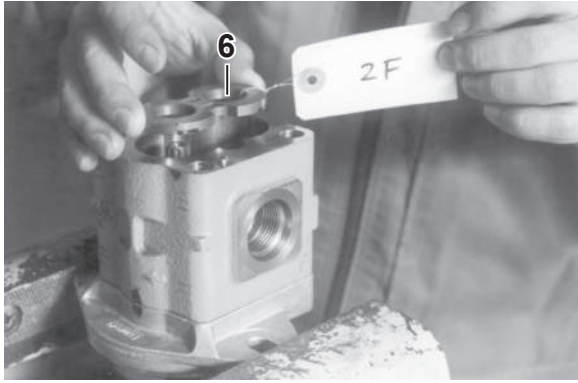
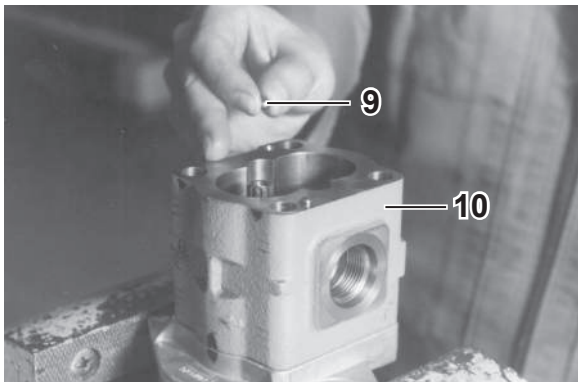
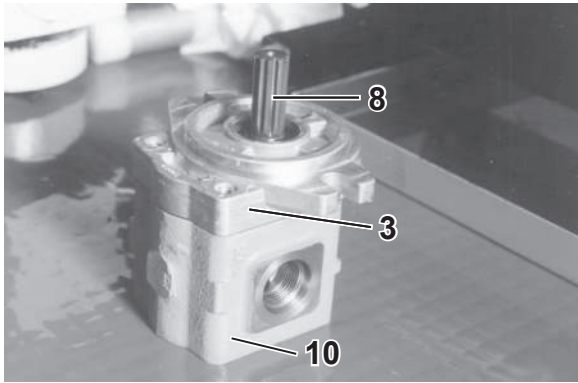
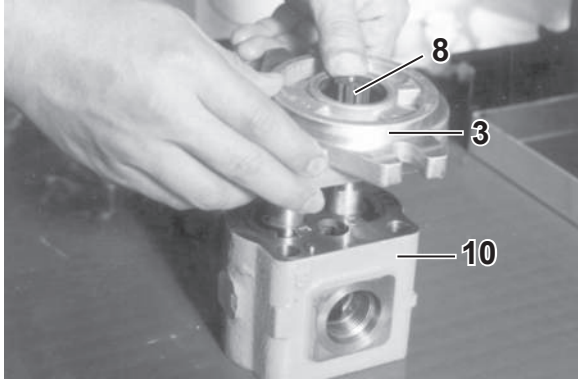
- Mark the parts for identification so that they can each be reinstalled in their correct position and direction.
- This procedure is for the hydraulic pump which rotates counterclockwise (when viewed from the input shaft).

Procedure	
(1) Put match marks. Before disassembly, put a match mark on the joint of the front cover 3 and the body 10, and that of the body 10 and the rear cover 13.	
(2) Hold the hydraulic pump. Hold the front cover 3 of the pump with a vice or an anchor block, with the rear cover 13 up.	
(3) Remove the hexagon head bolts. Turn the four hexagon head bolts 14 each counterclockwise with a torque wrench to remove them. Note : Check whether each of the bolts has been loosened when removing them, since it is an important factor to identify the cause of a failure.	

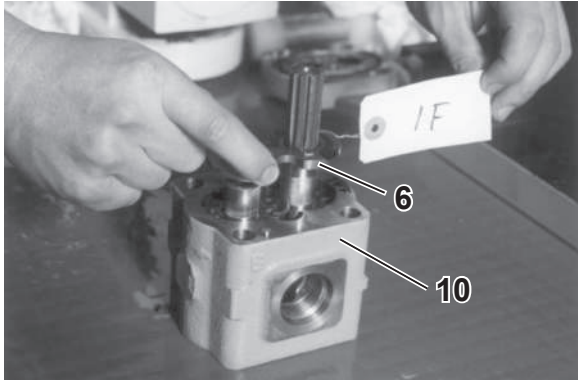
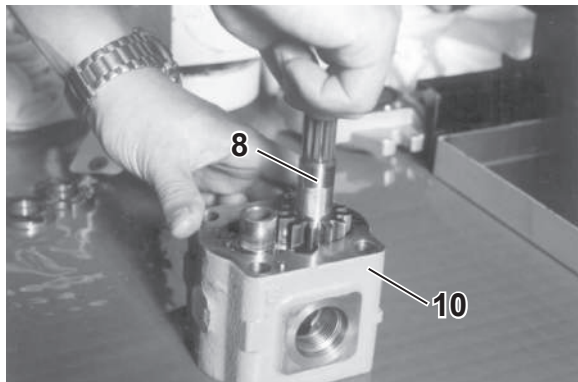
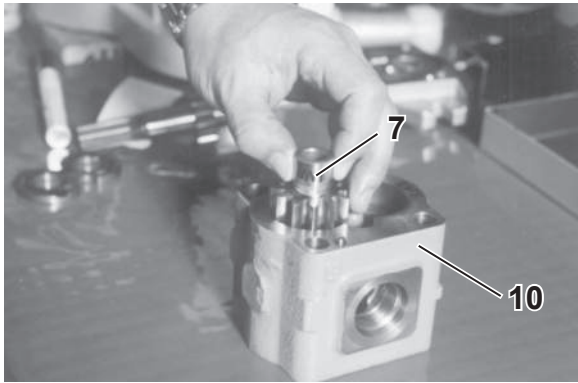
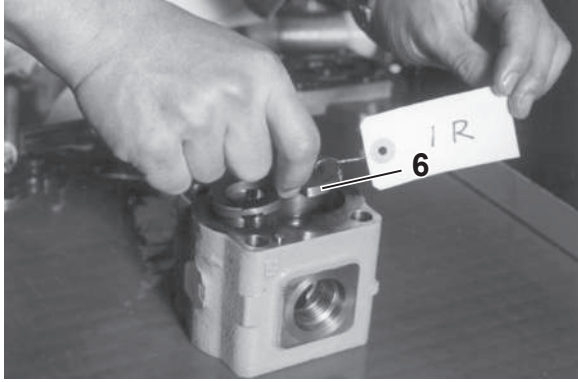
6. HYDRAULIC EQUIPMENT

Procedure	
(4) Remove the rear cover. Hold the sides of the rear cover 13 and lift it up perpendicularly. Note : <i>The steel balls 9 for positioning are installed between the rear cover 13 and the body 10. Take care not to lose them during disassembly.</i>	
(5) Pull the side plate on the rear side of the hydraulic pump P2 out of the body. Hold the 3-shaped gasket 5 and the side plate 6 in their center and pull it up perpendicularly. Note : <i>Put a tag marked with "2 R" on the side plate 6 and the 3-shaped gasket 5 so that they can be identified as the parts on the rear side of the hydraulic pump P2.</i>	
(6) Pull the driving gear No.2 of the hydraulic pump P2 out of the body. Hold the shaft of the driving gear No.2 11 connecting to the driving gear No.1 8 via the spline of the hollow shaft, and pull it up perpendicularly. Note : <i>Mark the shaft on the rear side of the driving gear No.2 11 with "2 VR" for identification with a marker or the like.</i>	
(7) Pull the driven gear No.2 of the hydraulic pump P2 out of the body. Hold the shaft of the driven gear No.2 12 and pull it up perpendicularly. Note : <i>Mark the shaft on the rear side of the driven gear No.2 12 with "2 NR" for identification with a marker or the like.</i>	

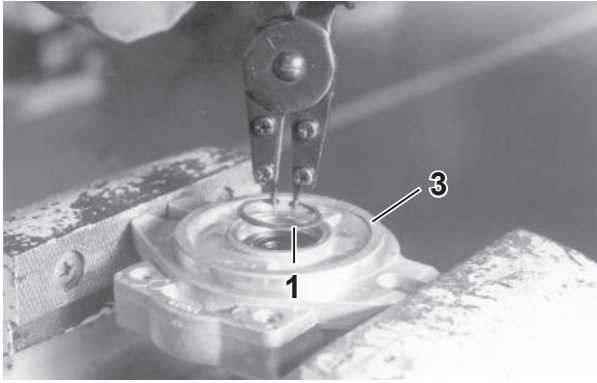
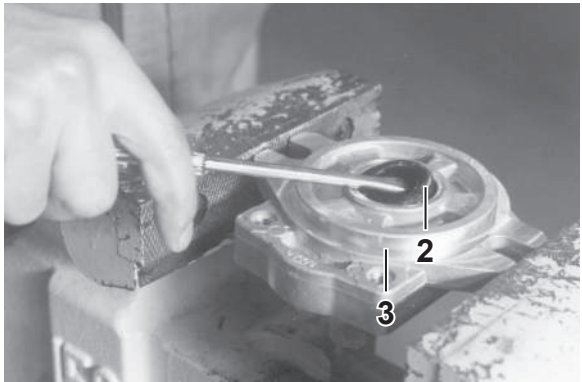
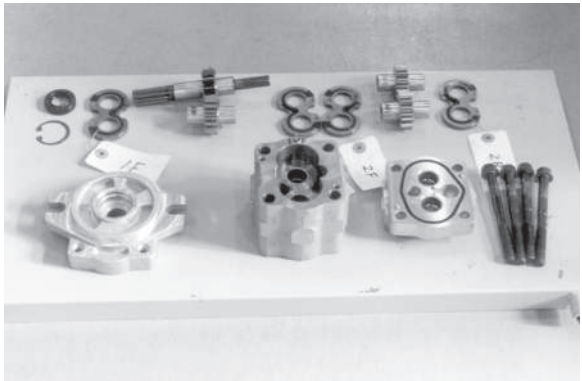
6. HYDRAULIC EQUIPMENT

Procedure	
(8) Pull the side plate on the front side of the hydraulic pump P2 out of the body. Hold the 3-shaped gasket 5 and the side plate 6 in their center and pull them up perpendicularly. Note : <i>Put a tag marked with "2 F" on the side plate 6 and the 3-shaped gasket 5 so that they can be identified as the parts on the front side of the hydraulic pump P2.</i>	
(9) Remove the steel balls. Remove the steel balls 9 for positioning from the body 10.	
(10) Turn the hydraulic pump upside down. Turn the body 10 with the front cover 3 installed upside down and put it with the front cover up on the workbench.	
(11) Remove the front cover from the body. Hold the sides of the front cover 3 and pull it out perpendicularly while pushing the shaft of the driving gear No.1 8 down so that the gear does not come out with the cover. Notes : • The steel balls 9 for positioning are installed between the front cover 3 and the body 10. Take care not to lose them during disassembly. • Mark the end face of the body 10 on the driving gear No.1 side with "1 VF" for identification.	

6. HYDRAULIC EQUIPMENT

Procedure	
(12) Pull the side plate on the front side of the hydraulic pump P1 out of the body. Hold the 3-shaped gasket 5 and the side plate 6 in their center and pull them up perpendicularly. Note : <i>Put a tag marked with "1 F" on the side plate 6 and the 3-shaped gasket 5 so that they can be identified as the parts on the front side of the hydraulic pump P1.</i>	
(13) Pull the driving gear No.1 of the hydraulic pump P1 out of the body. Hold the shaft of the driving gear No.1 8 and pull it up perpendicularly.	
(14) Pull the driven gear No.1 of the hydraulic pump P1 out of the body. Hold the shaft of the driven gear No.1 7 and pull it up perpendicularly. Note : <i>Mark the shaft on the front side of the driven gear 7 with "1 NF" for identification with a marker or the like.</i>	
(15) Pull the side plate on the rear side of the hydraulic pump P1 out of the body. Hold the 3-shaped 5 gasket and the side plate 6 in their center and pull them up perpendicularly. Note : <i>Put a tag marked with "1 R" on the side plate 6 and the 3-shaped gasket 5 so that they can be identified as the parts on the rear side of the hydraulic pump P1.</i>	

6. HYDRAULIC EQUIPMENT

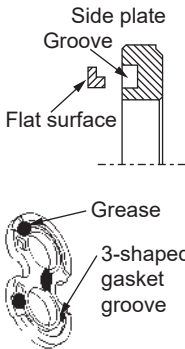
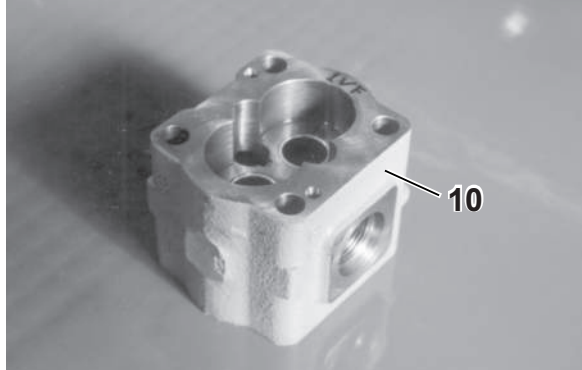
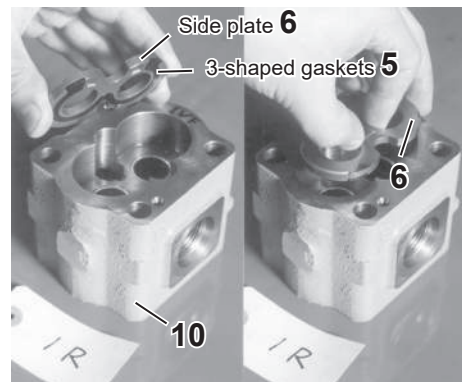
Procedure	
(16) Remove the internal snap ring C for the oil seal from the front cover. Remove the internal snap ring C 1 with snap ring pliers.	
(17) Remove the oil seal. Insert the tip of a screwdriver inside the lip of the oil seal 2 and take the oil seal out using the screwdriver with the boss around the oil seal hole in the front cover as a fulcrum. Notes : • Before removing the oil seal 2, carefully see how the oil seal is installed in the front cover. • Take care not to damage the surface around the oil seal hole with the tip of the screwdriver.	
(18) All parts after disassembly of the hydraulic pump.	

6. HYDRAULIC EQUIPMENT

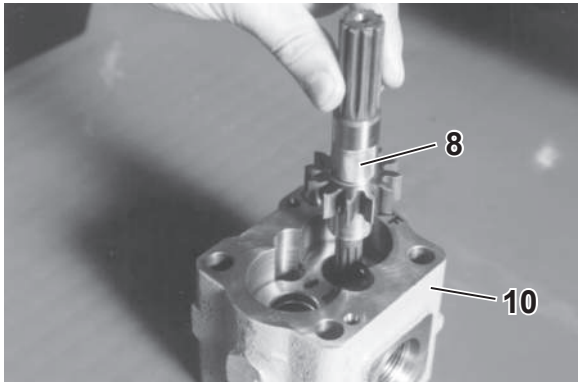
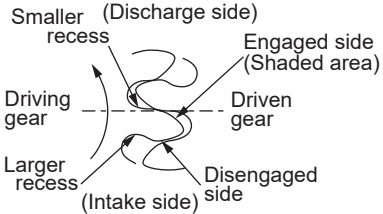
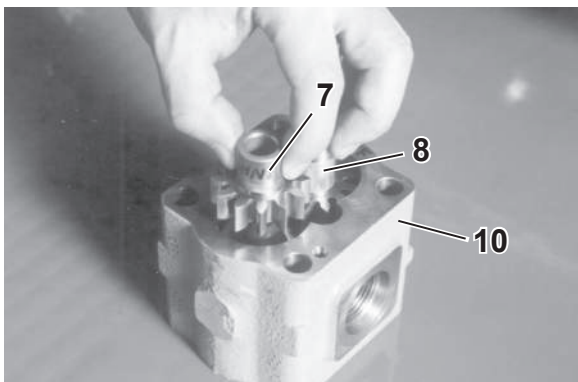
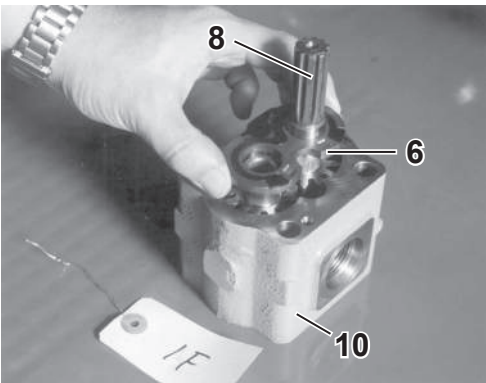
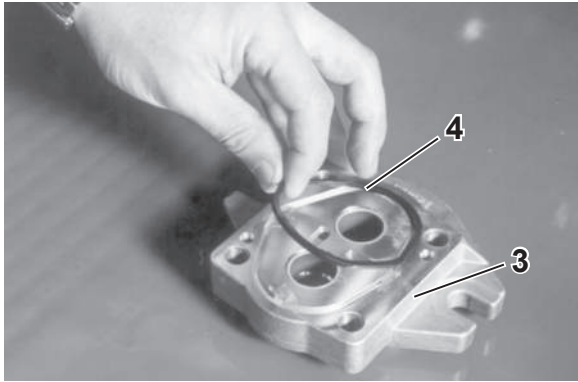
5. Reassembly

Notes :

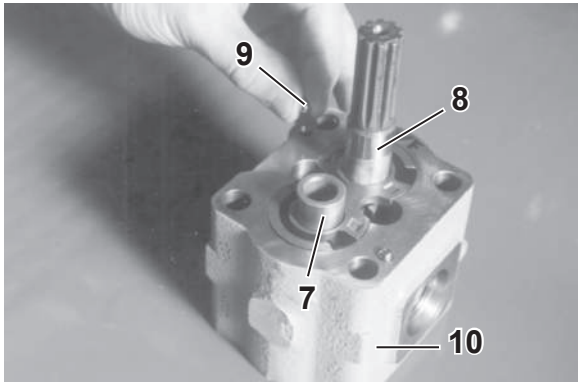
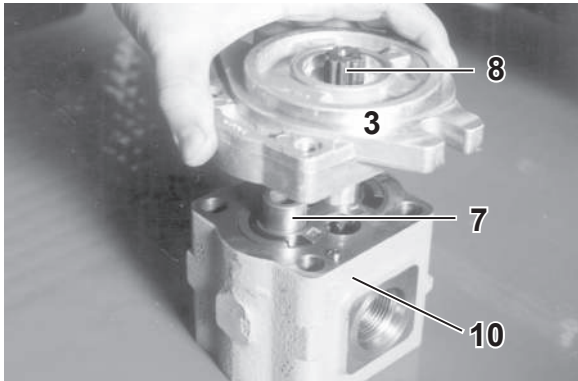
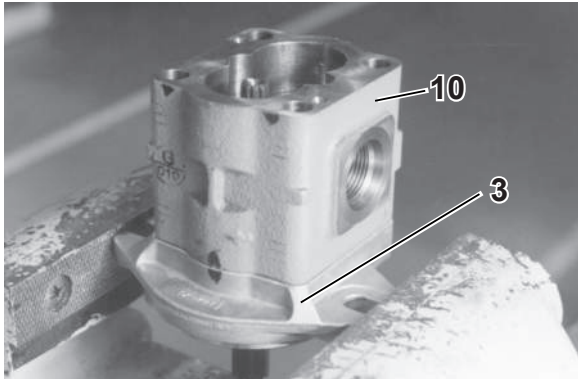
- This hydraulic pump includes many parts which have to be installed on the specified sides such as the intake, discharge, front and rear sides. Reinstall the parts in their correct positions according to the match marks put during disassembly and this reassembly procedure.
- This procedure is for the hydraulic pump which rotates counterclockwise (when viewed from the input shaft).

Procedure	
(1) Install the 3-shaped gaskets. Insert the 3-shaped gasket 5 along the gasket groove in the side plate 6. Do this for all the side plates before going on to the next step. Notes : • Insert the 3-shaped gasket 5 in the gasket groove with its flat surface outside. • Apply grease to the 3-shaped gasket groove at two or three points to prevent the gasket from falling off.	 The diagram shows a cross-section of a side plate with a groove. A 3-shaped gasket is being inserted into the groove. Labels indicate 'Side plate Groove', 'Flat surface', 'Grease', and '3-shaped gasket groove'. A photo shows a hand inserting a 3-shaped gasket (labeled 5) into a side plate (labeled 6).
(2) Put the body 10 on the workbench. Put the body 10 on the workbench with the hydraulic pump P1 side (with the arrow indicating the direction of rotation cast on the side face) up. Put the body with its intake side to the right when viewed from the operator.	 A photo of the hydraulic pump body (labeled 10) on a workbench. The body is a cast metal part with several ports and a side face with an arrow indicating rotation direction.
(3) Insert the side plate 6 into the body on the rear side of the hydraulic pump P1. Insert the side plate 6 with the 3-shaped gasket into the 8-shaped hole in the body 10 with the gasket side down, and lower it to the bottom of the hole. Notes : • Apply grease thinly to the contact surface of the side plate 6 with the gears. • Align the intake side of the side plate 6 (the open side of the 3-shape gasket 5) with that of the body 10.	 A photo showing the side plate (labeled 6) being inserted into the body (labeled 10). The side plate has 3-shaped gaskets (labeled 5) on its surface. Labels indicate 'Side plate 6', '3-shaped gaskets 5', and '10'. The photo shows the side plate being lowered into the body.

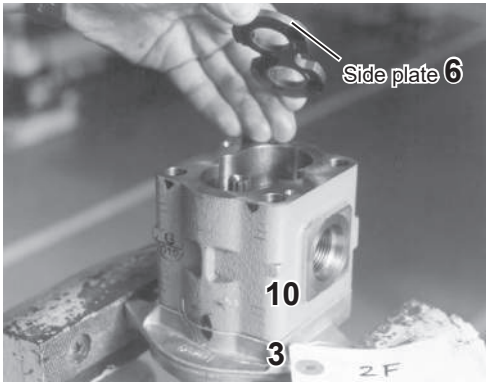
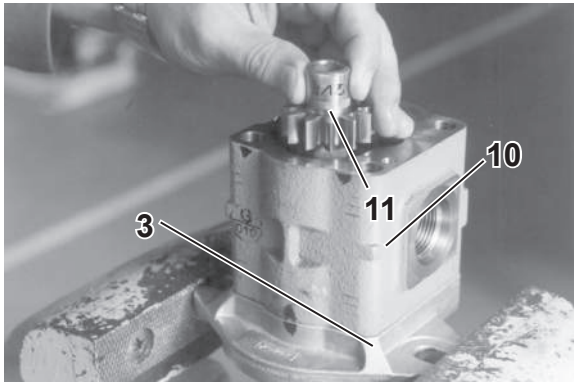
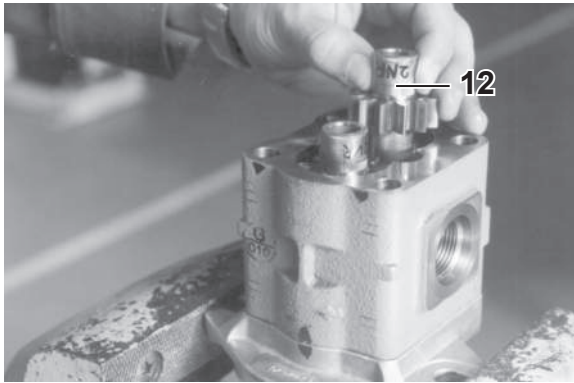
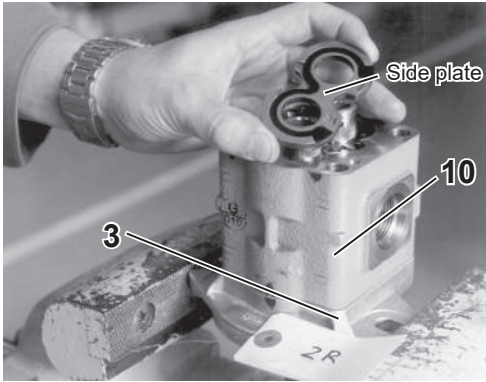
6. HYDRAULIC EQUIPMENT

Procedure	
(4) Insert the driving gear No.1 of the hydraulic pump P1 into the body. With the input shaft side up, insert the driving gear No.1 8 perpendicularly into the far side of the 8-shaped hole when viewed from the operator (on the end face side marked with "1 VF" of the body 10).	
(5) Insert the driven gear No.1 of the hydraulic pump P1 into the body. With the shaft side marked with "1 NF" up, insert the driven gear No.1 7 perpendicularly into the other side of the 8-shaped hole in the body. Note : <i>The gears of this pump are asymmetrical in the shape of the gear teeth. The teeth of both gears are engaged with each other on the smaller recess side of the dedendum.</i> 	
(6) Insert the side plate into the body on the front side of the hydraulic pump P1. Insert the side plate 6 with the 3-shaped gasket into the 8-shaped hole in the body 10 with the gasket side up, and lower it to the side faces of the gears. Notes : • Apply grease thinly to the contact surface of the side plate 6 with the gears. • Align the intake side of the side plate (the open side of the 3-shape gasket) with that of the body.	
(7) Install the gasket for preventing external leakage in the front cover. Install the gasket 4 into the gasket groove in the front cover 3 while taking care not to twist it. Note : <i>Apply grease thinly to the gasket 4 to prevent it from falling off even when the front cover 3 is turned upside down.</i>	

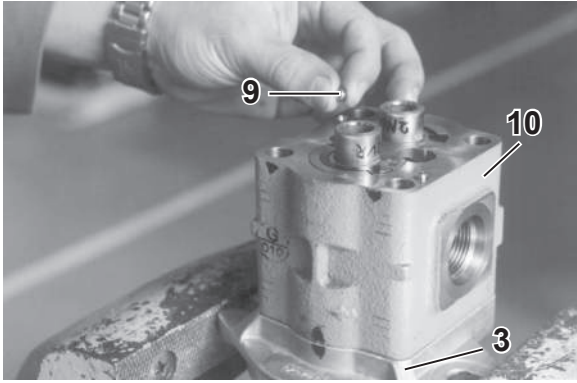
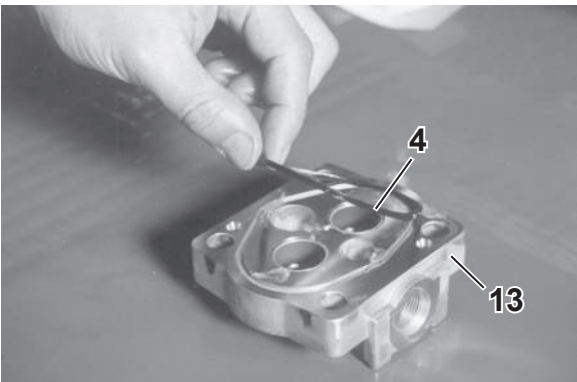
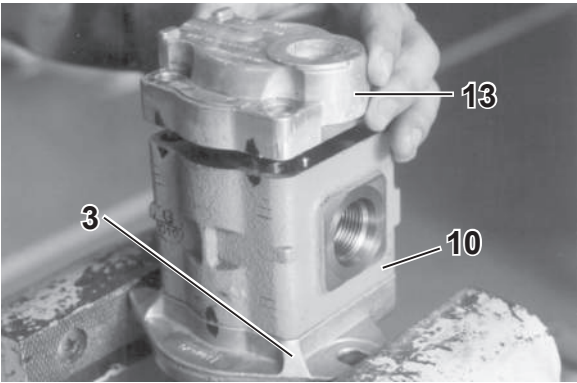
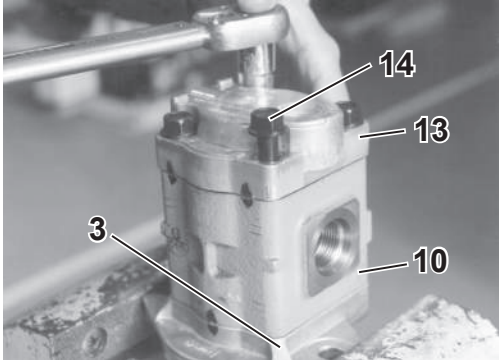
6. HYDRAULIC EQUIPMENT

Procedure	
(8) Install the steel balls for positioning in the body. Put the two steel balls 9 into the two steel ball hollows in the end face of the body 10.	
(9) Apply grease to the side face around the oil seal hole in the front cover. Apply grease thinly to the side face around the oil seal hole in the front cover 3 so that the oil seal 2 can be inserted smoothly.	
(10) Install the front cover onto the body. With the gasket for preventing external leakage of the front cover 3 down, install the front cover 3 onto the body 10 perpendicularly while aligning the shafts of the driving gear No.1 8 and the driven gear No.1 7 with the axes of the bushes press-fitted into the front cover 3. Note : <i>When the driving gear and the driven gear are correctly positioned, the steel balls for positioning are fitted into the steel ball hollows in the front cover.</i>	
(11) Turn the hydraulic pump upside down. Turn the front cover 3 and the body 10 together upside down, and hold them with a vice with the front cover 3 side down.	

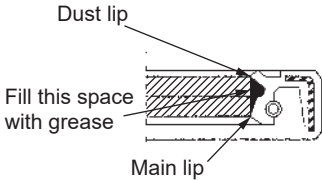
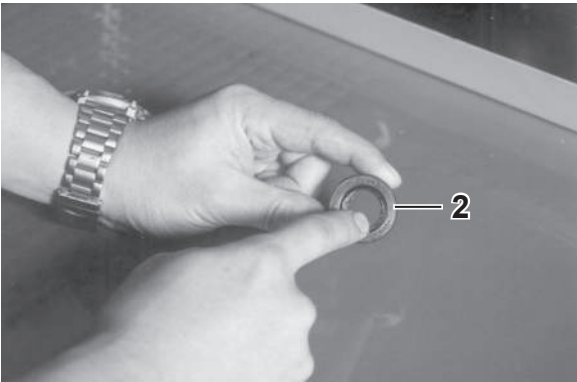
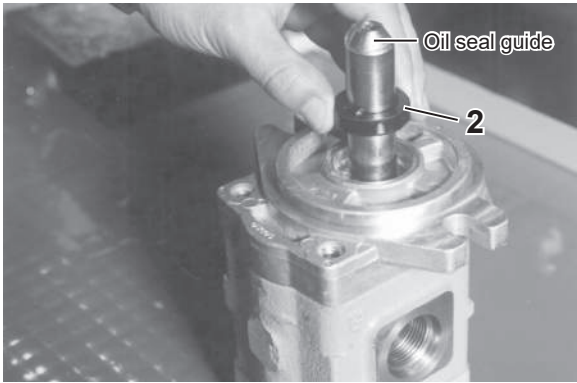
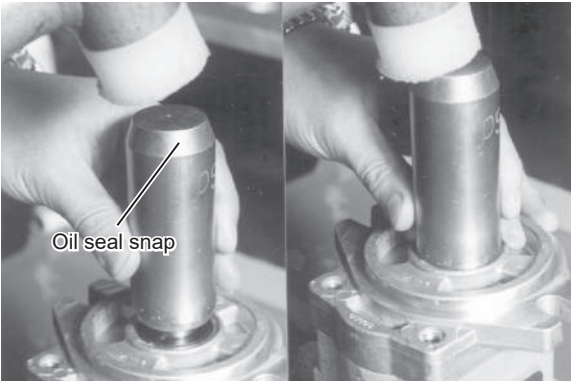
6. HYDRAULIC EQUIPMENT

Procedure	
(12) Insert the side plate into the body on the front side of the hydraulic pump P2. Insert the side plate 6 (tagged with "2 F") with the 3-shaped gasket 5 into the 8-shaped hole in the body 10 with the gasket side down, and lower it to the bottom of the hole. Notes : • Apply grease thinly to the contact surface of the side plate with the gears. • Align the intake side of the side plate (the open side of the 3-shape gasket) with that of the body 10.	
(13) Insert the driving gear No.2 of the hydraulic pump P2 into the body. With the shaft side marked with "2 VR" up, insert the driving gear No.2 11 along the spline of the driving gear No.1 8 perpendicularly into the body 10. Note : If the mark is not on the driving gear 11, determine the installation direction of the driving gear from the relation between the positions of the intake and discharge sides of the body 10 and the engagement of the driving and driven gears. Refer to the note in the step (5) of the reassembly procedure.	
(14) Insert the driven gear No.2 of the hydraulic pump P2 into the body. With the shaft side marked with "2 NR" up, insert the driven gear No.2 12 perpendicularly into the other side of the 8-shaped hole in the body 10. Note : If the mark is not on the driven gear 12, install it in the direction where the driving and driven gears are engaged with each other on the smaller recess side of their gear teeth. Refer to the note in the step (5) of the reassembly procedure.	
(15) Insert the side plate into the body on the rear side of the hydraulic pump P2. Insert the side plate 6 (tagged with "2 R") with the 3-shaped gasket into the 8-shaped hole in the body 10 with the gasket side up, and lower it to the side faces of the gears. Notes : • Apply grease thinly to the contact surface of the side plate with the gears. • Align the intake side of the side plate (the open side of the 3-shape gasket) with that of the body 10.	

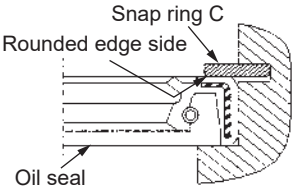
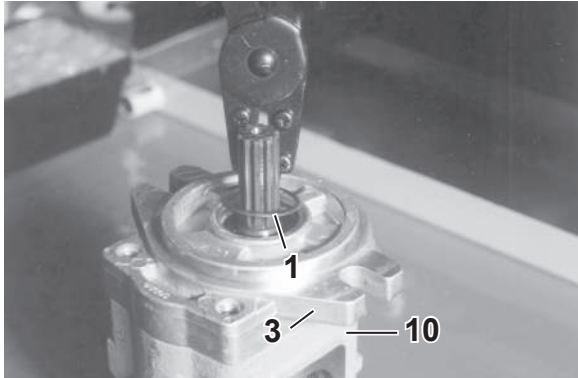
6. HYDRAULIC EQUIPMENT

Procedure	
(16) Install the steel balls for positioning in the body. Put the two steel balls 9 into the two steel ball hollows in the end face of the body 10.	
(17) Install the gasket for preventing external leakage in the rear cover. Install the gasket 4 into the gasket groove in the rear cover 13 while taking care not to twist it. Note : <i>Apply grease thinly to the gasket 4 to prevent it from falling off even when the rear cover 13 is turned upside down.</i>	
(18) Install the rear cover onto the body. With the gasket for preventing external leakage of the rear cover 13 down, install it onto the body 10 while aligning the match marks put during disassembly.	
(19) Install the hexagon head bolts, and tighten them at a specified torque. Tighten the four hexagon head bolts 14 evenly with a torque wrench. Tightening torque : 35.5 to 37.6 ft·lbf (48.1 to 51.0 N·m)	

6. HYDRAULIC EQUIPMENT

Procedure	
(20) Put the hydraulic pump upside down on the workbench, and install the oil seal guide. Put the oil seal guide on the driving gear No.1.	
(21) Fill the space between the lips of the oil seal with grease. Fill the space between the dust and main lips of the oil seal 2 with grease. 	
(22) install the oil seal. With the main lip side of the oil seal 2 down (i.e., to the hydraulic pump side), push the oil seal down along the oil seal guide from the top of the guide to the mouth of the oil seal hole with the hand.	
(23) Drive the oil seal into the oil seal hole. Install the oil seal 2 snap onto the oil seal guide, and tap the snap with a plastic hammer to install the oil seal 2 into the oil seal hole with the end face of the seal contacted with the bottom of the hole.	

6. HYDRAULIC EQUIPMENT

Procedure	
(24) Install the internal snap ring C. Install the internal snap ring C 1 into the snap ring groove along the inside of the oil seal hole with snap ring pliers. Note : <i>Install the snap ring C 1 into the groove with its rounded edge on the oil seal side.</i> 	

6. HYDRAULIC EQUIPMENT

6. Service Standard

Clean the parts to be checked and completely dry them. Check the major parts carefully and replace them with new ones if they are excessively worn or damaged and may cause malfunction. Replace any obviously deformed or damaged seal with new one.

1) Check Item

- (1) Check the gasket for preventing external leakage for damage.
- (2) Check the press-fitted bushes for seizure and wear.
- (3) Check the side faces of the gear and gear shafts for seizure and wear.
- (4) Check the 3-shaped gasket for damage.
- (5) Check the contact surface of the side plate with the gears for seizure and wear.
- (6) Check the journal of the shaft for seizure and wear.
- (7) Check the edges of the gear teeth for roughness and wear.
- (8) Check the spline of the hollow shaft for seizure and wear.
- (9) Check whether the lips of the oil seal are reversed, damaged or worn.

6. HYDRAULIC EQUIPMENT

7. Troubleshooting

Trouble	Cause	Measure
1. Oil leak from oil seal	(1) Reverse rotation (2) Too high pressure on the intake side (3) Broken oil seal lip due to dust or the like (4) Damaged or worn shaft in the area contacted with the seal (5) Incorrect centering of the shaft	(1) Find the cause of the reverse rotation or the too high pressure on the intake side to remove it. (2) Replace the oil seal. (3) Center the shaft correctly. (4) Replace the pump.
2. Oil leak from joint of cover, body or other parts	(1) Loosened bolt, or broken cover or body (2) Deteriorated sealing performance or damage of the seal due to the external leakage prevention gasket hardened by heat	(1) Remove vibration or too high pressure that causes looseness of the bolt or breakage of the cover or the body. (2) Replace the gasket. (3) Replace the pump.
3. Oil leak from port	(1) Loosened or broken port joint (2) Broken joint sealing member (3) Broken port	(1) Remove vibration or too high pressure that causes looseness or breakage of the joint. (2) Replace the joint sealing member. (3) Replace the pump.
4. Decrease in oil discharge volume or insufficient oil pressure	(1) Insufficient oil quantity in hydraulic oil tank (2) Increased internal leakage due to too high temperature or improper viscosity of the hydraulic oil (3) Deteriorated pump performance due to contaminated hydraulic oil (4) Cavitation due to excessive negative pressure (5) Broken internal part (6) Reverse rotation	(1) Supply the specified kind of hydraulic oil to the proper level or replace the cooling system. (2) Replace the contaminated hydraulic oil. (3) Review the length and thickness of the intake pipes or replace the filter to prevent excessive negative pressure. (4) Replace the pump.
5. Abnormal temperature rise of pump or hydraulic oil	(1) Abnormal heat due to frequent operation of relief valve (2) Inadequate capacity or failure of the cooling system (3) Broken internal part	(1) Adjust the set pressure to a proper value. (2) Replace the cooling system. (3) Replace the pump.
6. Abnormal sound and vibration	(1) Improper installation (2) Cavitation (3) Air sucked in (4) Resonance of the piping, the mounting flange or others (5) Chattering of the relief valve	(1) Correct the centering or retighten the mounting parts. (2) Review the length and thickness of the intake pipes or replace the filter to prevent excessive negative pressure. (3) Find the cause of the shortage of oil quantity or the air mixed in the piping to remove it. (4) Reinforce the piping or the mounting flange to prevent resonance. (5) Replace the relief valve.

6. HYDRAULIC EQUIPMENT

6-2 Control Valve

1. Outline

This control valve is a mono-block valve comprising nine-series (variable track type : ten-series) connected three-position directional control valves which control the operation of the actuators by switching the circuit, system relief valves which control the circuit pressure, circuit relief valves, an anti-cavitation valve, load check valves, throttles and others.

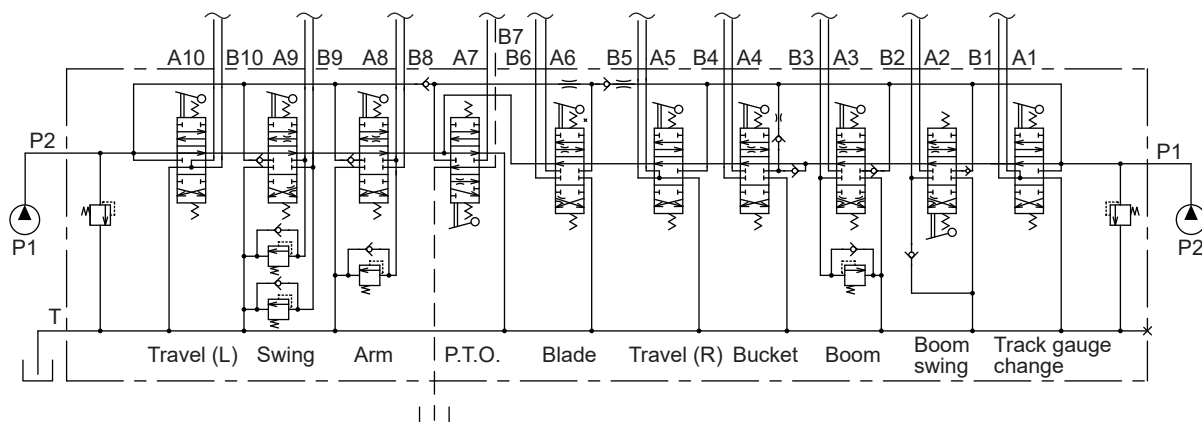
1) Circuit Configuration

There are two pump ports at both right and left ends of the circuit. Oil from the port P2 flows to the left travel, swing, arm and P.T.O. spool sections, which are connected via parallel passages.

The parallel passage allows simultaneous operation of more than one spool, however, they cannot always operate in the same motion. Specifically, due to the differences in load and capacity between the actuators, pressures to be generated vary and the spool with a smaller load pressure operates earlier.

To allow the simultaneous operation of the spools in the same motion as a single operation, the spool stroke of the spool section with a heavier load needs to be adjusted to the full stroke while that of the spool section with a lighter load needs to be adjusted to half a stroke or smaller.

Oil from the port P1 flows to the track gauge change, the boom swing, boom, bucket, right travel and blade spool sections, which are also connected via parallel passages.

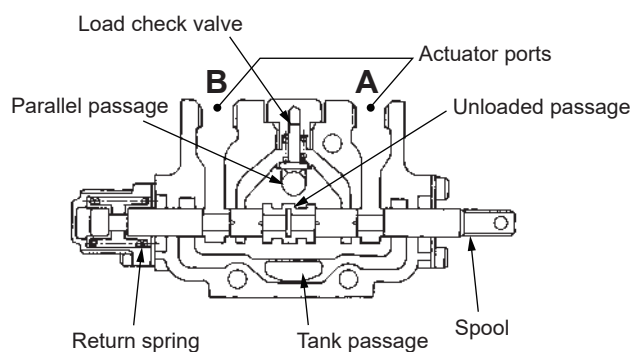
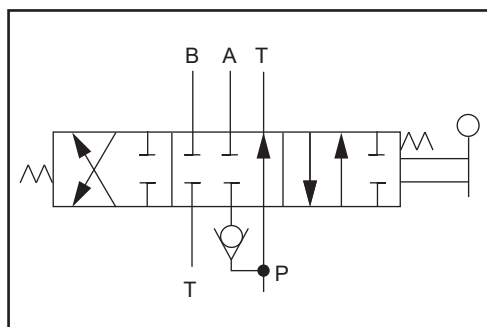


6. HYDRAULIC EQUIPMENT

2. Operation of Directional Control Valves (Pilot Controlled Directional Control Valves)

1) Spool in Neutral

When the spool is in neutral, the oil fed by the pump flows through the unloaded passage and returns to the tank through the tank passage. (Unloaded state) The actuator ports A and B are blocked.

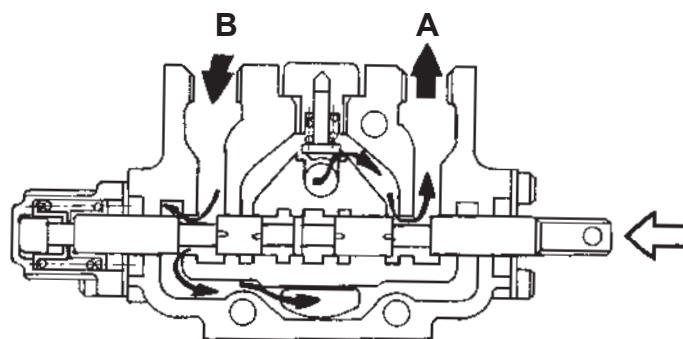


2) Pushing Spool In

The unloaded passage is closed, and the oil fed by the pump passes through the parallel passage, opens the load check valve and flows to the actuator port A.

The return oil from the actuator port B returns to the tank through the tank passage.

The spool is returned to the neutral position by the return spring.

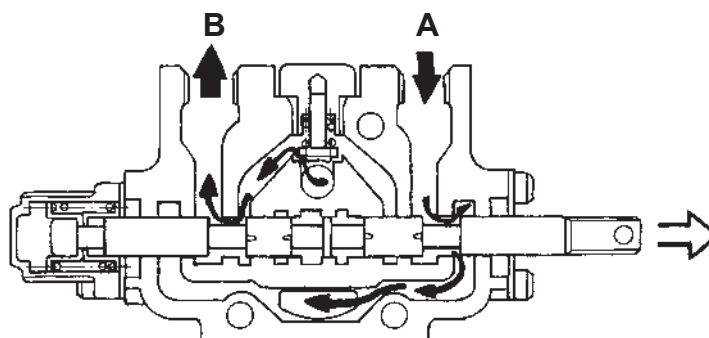


3) Pulling Spool Out

The unloaded passage is closed, and the oil fed by the pump passes through the parallel passage, opens the load check valve and flows to the actuator port B.

The return oil from the actuator port A returns to the tank through the tank passage.

The spool is returned to the neutral position by the return spring.



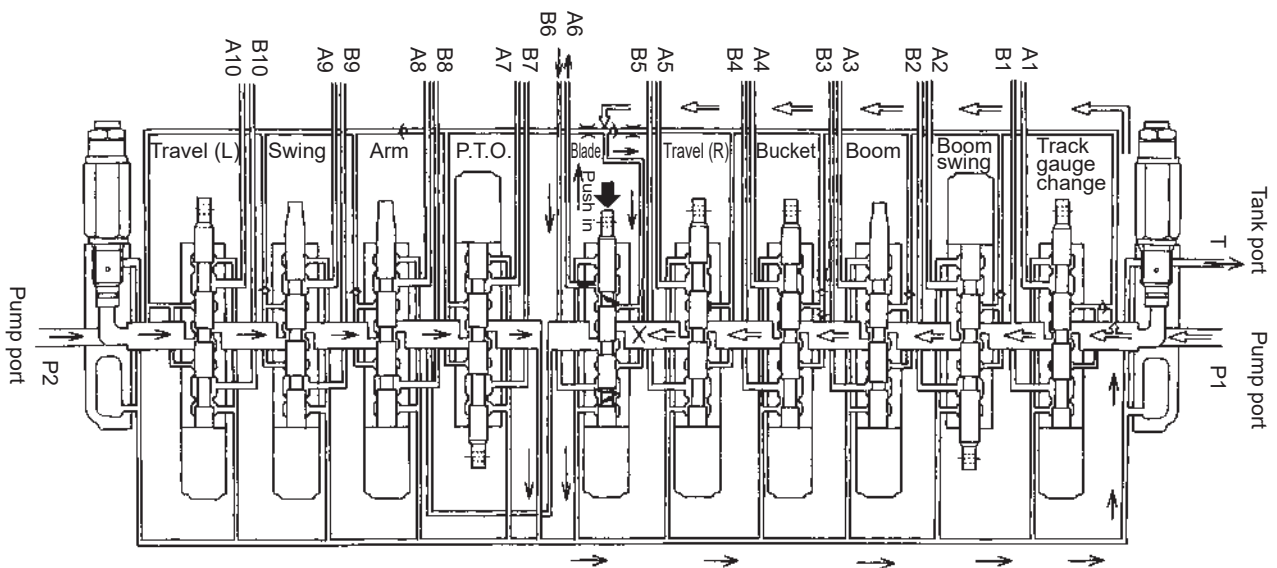
6. HYDRAULIC EQUIPMENT

4) Single Operation of Blade

When the blade spool is pushed in, the oil from the port P1 is regulated to a specified quantity through the throttle and the specified quantity of oil flows to the port A6 through the load check valve. The return oil from the port B6 returns to the tank through the tank passage.

The oil from the port P2 returns to the tank through the tank passage because the unloaded passage for the pump port P2 is open.

When the blade spool is pulled out, the specified quantity of oil flows to the port B6 and returns from the port A6 to the tank.



6. HYDRAULIC EQUIPMENT

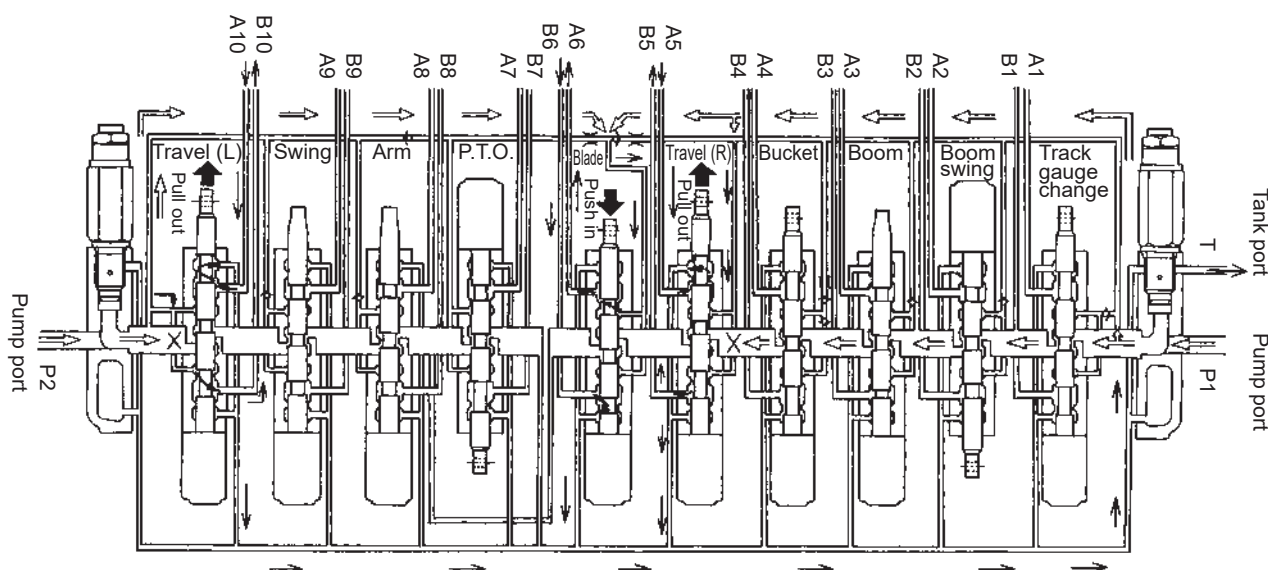
5) Simultaneous Operation of Blade and Travel

When the both travel spools are pulled out and the blade spool is pushed in, the oil from the port P1 and that from the port P2 flow to the travel section ports B5 and B10 respectively, while some of each oil flow is regulated to a specified quantity through the throttle and the specified quantity of oil flows to the blade section. These divided oil flows which have come into the blade section are combined after passing through the load check valve, and the combined oil flows to the port A6.

The return oil from the port B6 returns to the tank through the tank passage.

The blade section is supplied with the same specified quantity of divided oil from the ports P1 and P2 : therefore, the both travel sections are also supplied with the same quantity of oil. Thus, the machine can travel without deviation even when the blade is operated during traveling.

When the travel spools are pushed in and the blade spool is pulled out, the oil from the port P1 and that from the port P2 flow to the travel section ports A5 and A10 respectively and the specified quantity of divided oil flows through the blade section to the port B6. Then, the oil returns from the port A6 to the tank through the tank passage.

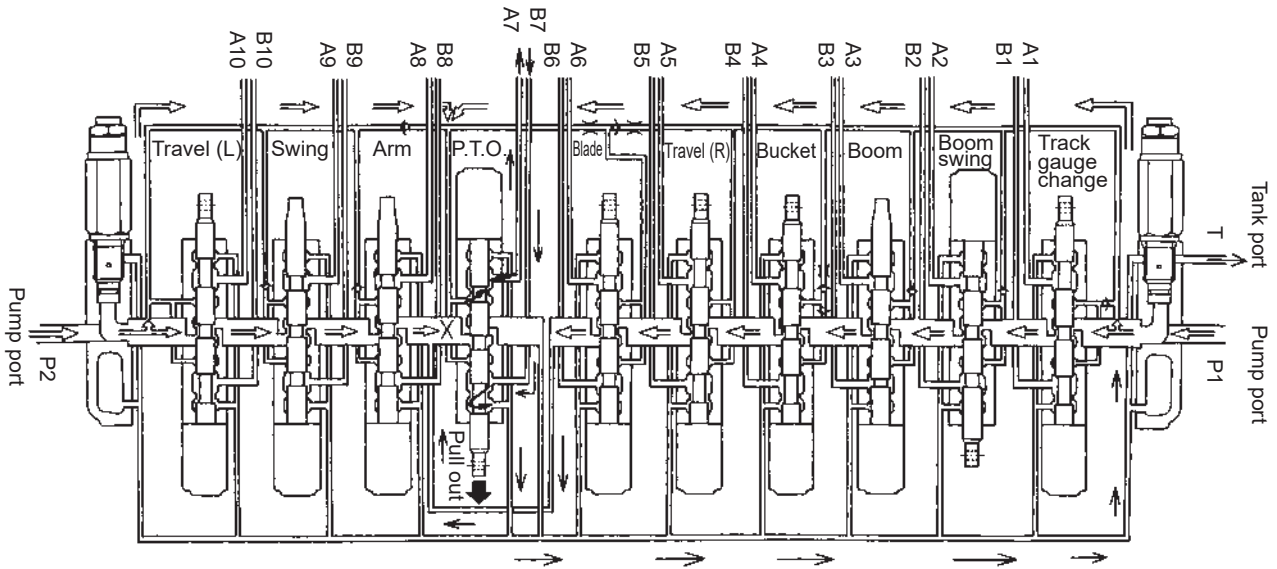


6. HYDRAULIC EQUIPMENT

6) Pulling P.T.O. Spool Out

The oil from the port P1 and that from the port P2 are combined and the combined oil flows to the port A7. The port B7 is open to the drain side.

When the spool is pushed in, the oil from the port P1 and that from the port P2 are combined and the combined oil flows to the port B7.



6. HYDRAULIC EQUIPMENT

3. System Relief Valves

These relief valves are of a balance piston type and also a cartridge type.

The relief valves are located between the pump ports P1 and P2 in the inlet sections, and the tank port T in the P1 inlet section. They operate as follows :

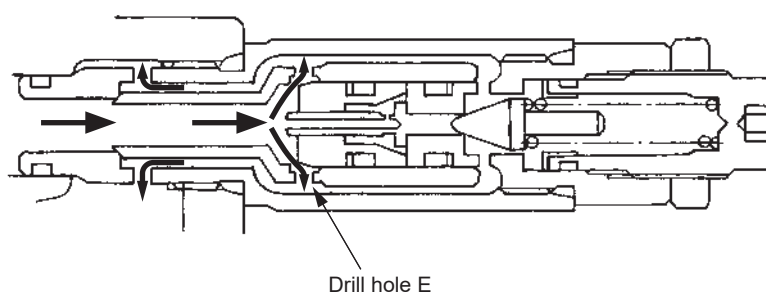
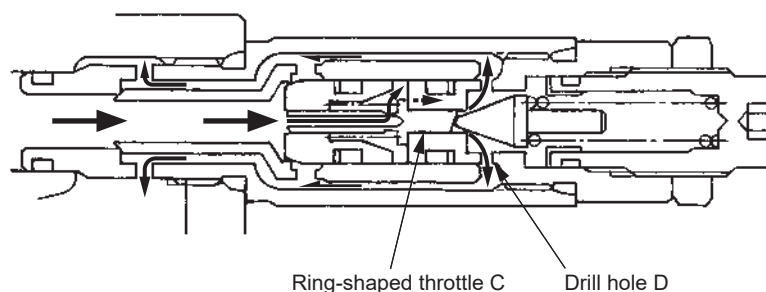
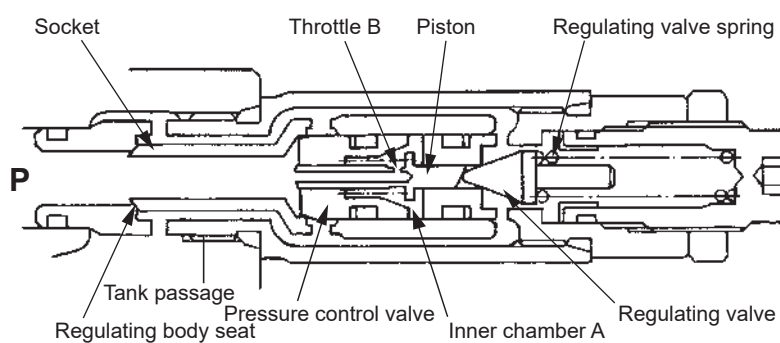
1) Relief Operation

(1) Pressure oil flows through the inside of the piston installed in the pressure control valve (the parent valve) and the throttle B to the inner chamber A, so that it is filled with oil. The pressure control valve and the socket are securely seated, and so are the socket and the regulating body seat.

(2) When the oil pressure in the port P reaches the set pressure of the regulating valve spring, the pressure oil flows through the piston to the regulating valve to open it. At this time, the pressure oil passes through the inside of the piston, the throttle B, the inner chamber A, the ring-shaped throttle C and the drill hole D in sequence, and flows outside the socket to the tank passage.

(3) When the regulating valve opens, the pressure in the inner chamber A is lowered, and consequently, the pressure control valve is opened and the pressure oil in the port P flows directly to the tank passage through the drill hole E.

(4) When the pressure in the port P lowers to less than the set pressure of the regulating valve spring, the regulating valve is pressed on the seat with the force of the regulating valve spring and the pressure in the inner chamber A becomes equal to that in the port P. Therefore, the pressure control valve is also pressed on the seat portion of the socket and returned to the original state.



6. HYDRAULIC EQUIPMENT

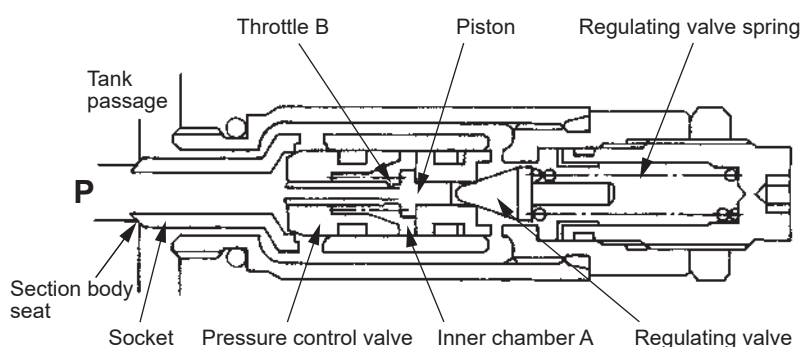
4. Circuit Relief Valves

These circuit relief valves are of a balance piston type and also cartridge type. The circuit relief valves are located between the cylinder port P and the tank port T in the section. It operates as follows :

(It is installed at the rod end of the boom cylinder, at the bottom end of the arm cylinder and swing motor.)

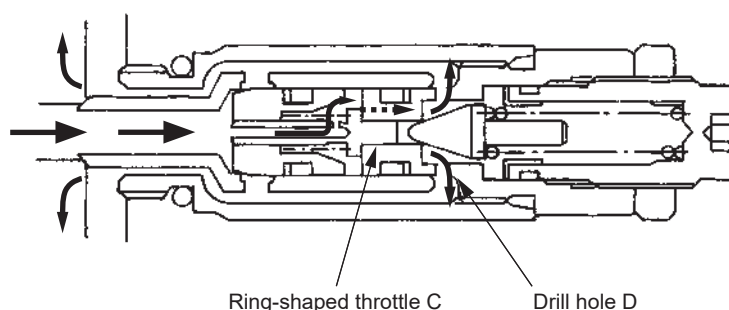
1) Relief Operation

- (1) Pressure oil flows through the inside of the piston installed in the pressure control valve (the parent valve) and the throttle B to the inner chamber A, so that it is filled with oil. The pressure control valve and the socket are securely seated, and so are the socket and the section body seat.

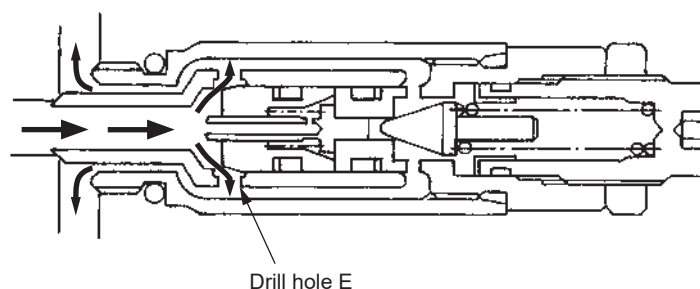


- (2) When the oil pressure in the port P reaches the set pressure of the regulating valve spring, the regulating valve is opened.

At this time, the pressure oil passes through the inside of the piston, the throttle B, the inner chamber A, the ring-shaped throttle C and the drill hole D in sequence, and flows outside the socket to the tank passage.



- (3) When the regulating valve opens, the pressure in the inner chamber A is lowered, and consequently, the pressure control valve is opened and the pressure oil in the port P flows directly to the tank passage through the drill hole E.



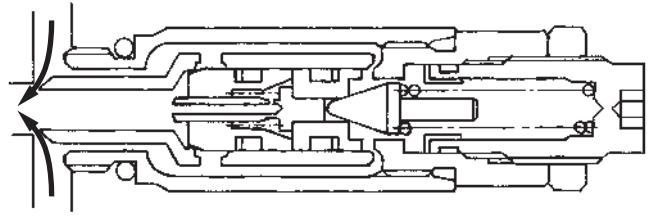
- (4) When the pressure in the port P lowers to less than the set pressure of the regulating valve spring, the regulating valve is pressed on the seat with the force of the regulating valve spring and the pressure in the inner chamber A becomes equal to that in the port P. Therefore, the pressure control valve is also pressed on the seat portion of the socket and returned to the original state.

6. HYDRAULIC EQUIPMENT

2) Suction Operation

When the pressure in the tank passage exceeds that in the port P, upward force is applied to the socket. This creates an opening between the section body seat and the socket and oil flows from the tank passage to the port P, so that the space in the port P is filled with oil.

Thus, when negative pressure is generated in the port P, the port P is supplied with oil from the tank passage to prevent negative pressure.



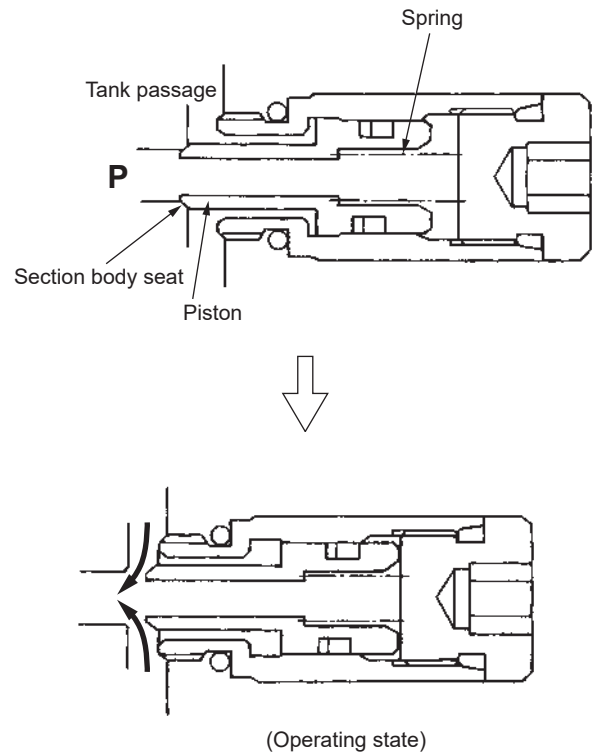
6. HYDRAULIC EQUIPMENT

5. Anti-Cavitation Valve

(It is installed at the rod end of the boom swing cylinder.)

This anti-cavitation valve consists of a body, a piston and a spring. The valve is located between the actuator port P and the tank port T in the section. It operates as follows :

- (1) The pressure oil in the port P flows through the inside of the piston to the piston chamber, so that it is filled with oil. The balance is kept with the spring force in the piston chamber and the oil flow to the tank passage is being blocked.
- (2) When the pressure in the tank passage exceeds that in the port P, upward force is applied to the piston. This creates an opening between the section body seat and the valve and oil flows from the tank passage to the port P, so that the space in the port P is filled with oil.



6. HYDRAULIC EQUIPMENT

6. Disassembly and Reassembly

1) Precautions for Disassembly and Reassembly

• Precautions for disassembly

- (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.

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.

• Precautions for reassembly

- (1) 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.

- (2) 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.

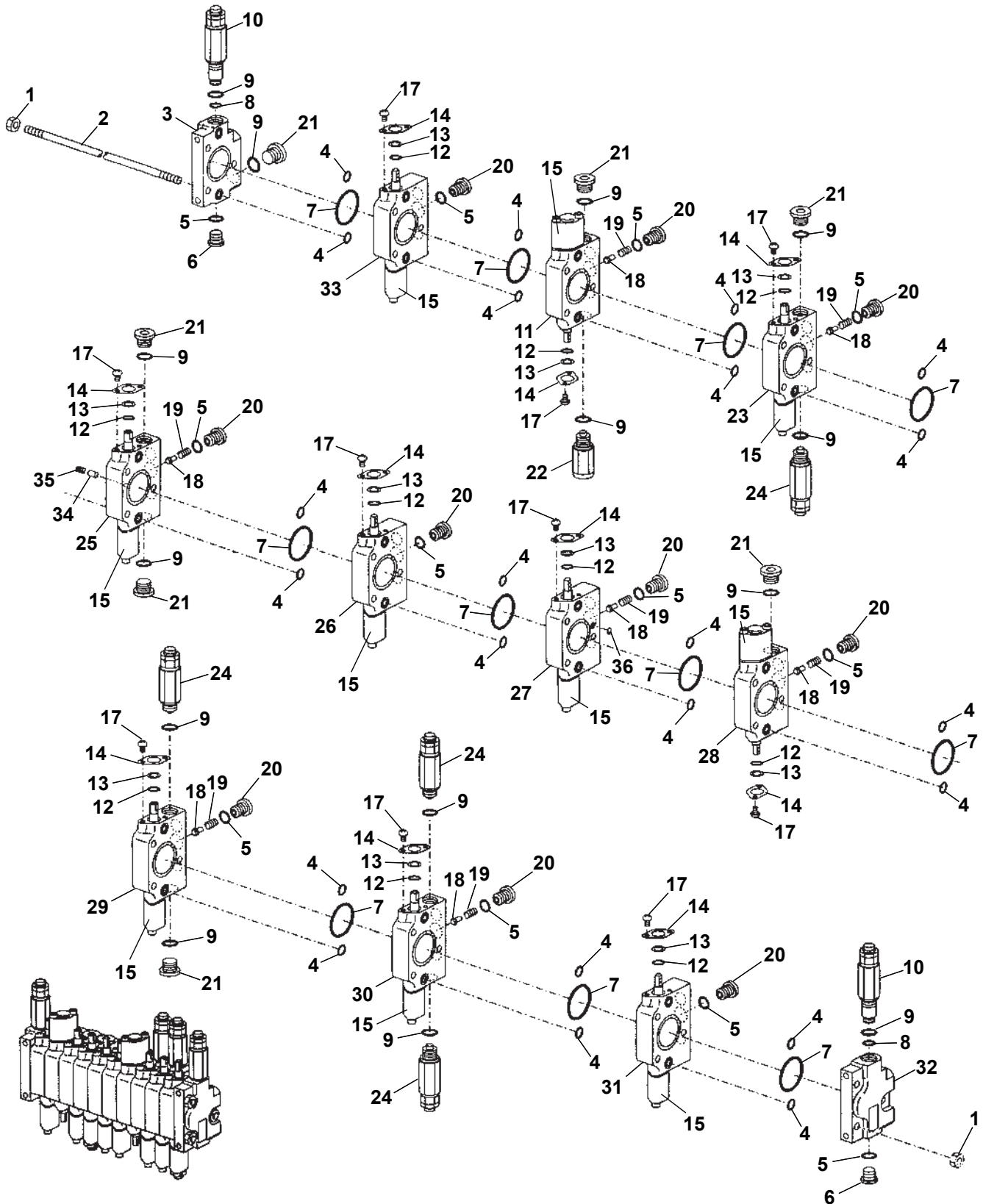
2) Tools for Disassembly and Reassembly

Tool	Nominal size	Remarks
Hexagon screw socket key [in. (mm)]	0.12 (3)	For hexagon socket set screw M6.
	0.16 (4)	For hexagon socket head bolt M5.
	0.20 (5)	For hexagon socket head plug R (PT) 1 / 8.
	0.24 (6)	For hexagon socket head plug G (PF) 1 / 4.
	0.31 (8)	For hexagon socket head plug G (PF) 3 / 8.
Wrench or box wrench [in. (mm)]	0.31, 0.39, 0.51, 0.83 and 0.87 (8, 10, 13, 21 and 22)	
Screwdriver for cross recessed head screws		For cross recessed pan-head screw M5.
Torque wrench [ft·lbf (N·m)]	14.5 to 72.4 (19.6 to 98.1) Smaller than 14.5 (19.6)	For nut M8. For system and circuit relief valves and spring cases.

6. HYDRAULIC EQUIPMENT

3) Exploded View and Component Parts

Exploded View



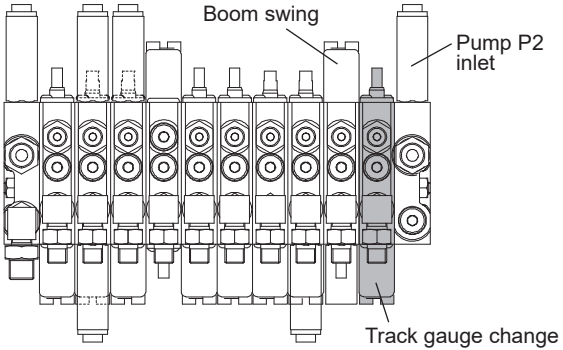
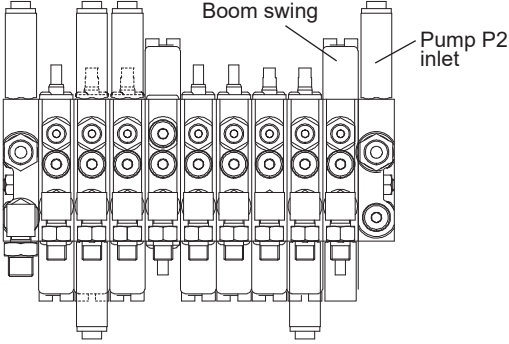
6. HYDRAULIC EQUIPMENT

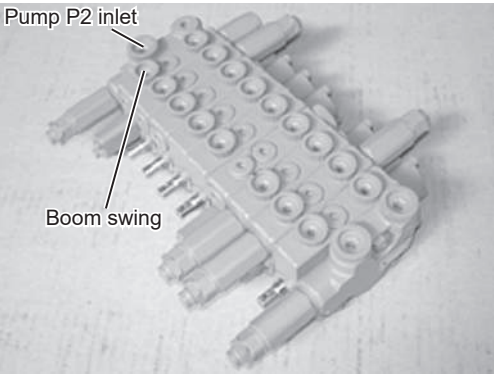
Component Parts

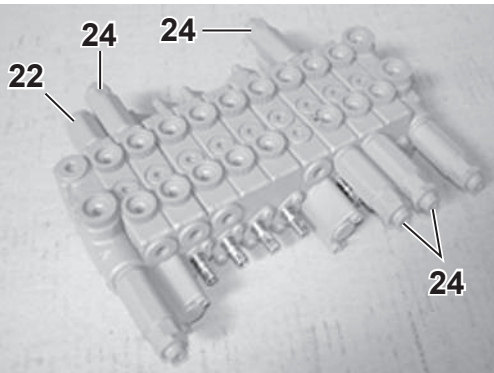
No.	Part	Q'ty		No.	Part	Q'ty	
		Standard type	Variable type			Standard type	Variable type
1	Nut M8	6		19	Check valve spring	7	
2	Bolt	3		20	Check valve holder	9	10
3	P1 section	1		21	Plug G3 / 8	7	
4	O-ring 1BP10.0	20	22	22	Anti-cavitation valve	1	
5	O-ring 1BP11.0	11	12	23	Boom section	1	
6	Plug G1 / 4	2		24	Circuit relief valve	4	
7	O-ring ARP127	10	11	25	Bucket section	1	
8	O-ring 1BP10.0	2		26	Travel section (R)	1	
9	O-ring 1BP14.0	14		27	Blade section	1	
10	System relief valve	2		28	P.T.O. section	1	
11	Boom swing section	1		29	Arm section	1	
12	O-ring 1BP10A	18	20	30	Swing section	1	
13	Backup ring T3 P13A	18	20	31	Travel section (L)	1	
14	Seal plate	18	20	32	P2 section	1	
15	Spring case	9	10	33	Variable track section	—	1
16	Hexagon socket head bolt M5 × 45	18	20	34	Check valve (Bucket section)	1	
17	Pan head screw M5 × 10	18	20	35	Check valve spring (Bucket section)	1	
18	Check valve	7		36	O-ring AS1 A016	1	

6. HYDRAULIC EQUIPMENT

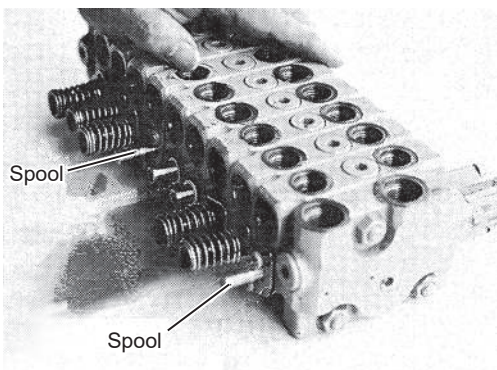
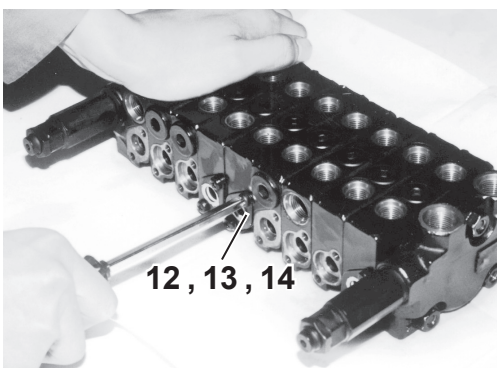
4) Disassembly

Procedure	
Note : All photos indicate fixed track gauge type. For the variable track gauge type, the track gauge change section is installed between boom swing section and inlet section of pump P2.	Variable track gauge type  Fixed track gauge type 

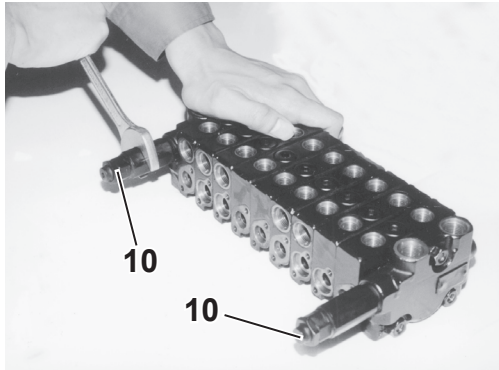
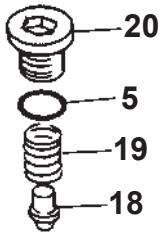
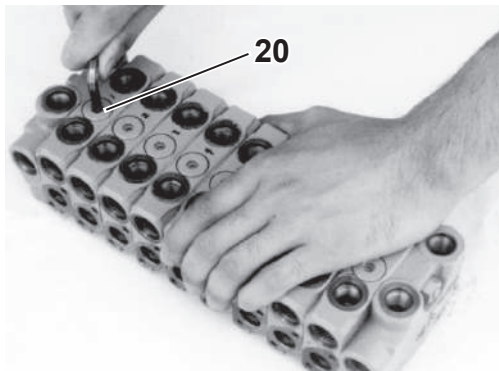
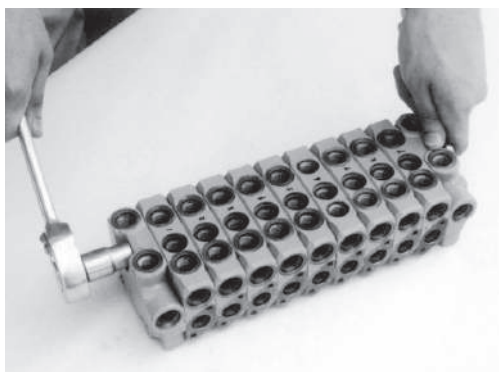
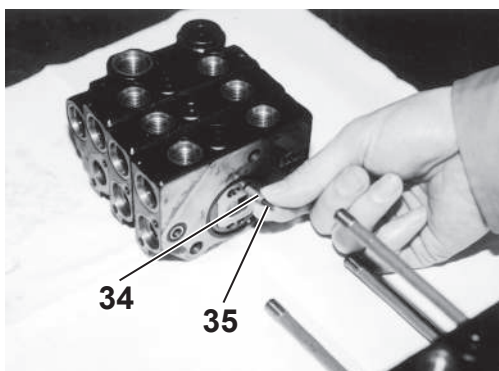
(1) Put the control valve assembly on a clean working table.	
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(2) Remove circuit relief valves 24 and anti-cavitation valve 22.	
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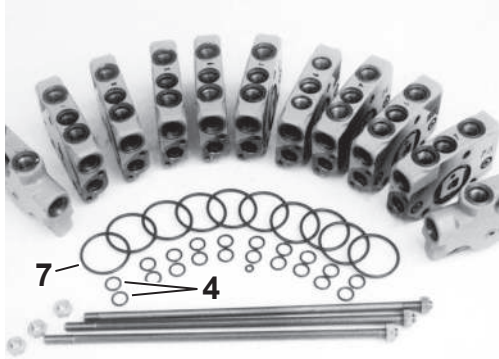
6. HYDRAULIC EQUIPMENT

Procedure	
(3) Remove plug G3 / 8 21 on the side of each section.	 A black and white photograph showing a person's hands in gloves using a hex key to remove a plug labeled '21' from the side of a hydraulic valve body.
(4) Remove spring case 15 of each section.	 A black and white photograph showing a person's hands in gloves using a hex key to remove a spring case labeled '15' from the side of a hydraulic valve body.
(5) Remove all spools. Note : <i>Each spool is installed into the valve body with a specified clearance between them. Make matchmarks on them so that each spool can be reinstalled in its original position.</i>	 A black and white photograph showing a close-up of a hydraulic valve body. Two spools are visible, each labeled 'Spool' with a leader line. The spools are installed into the valve body.
(6) Remove seal plates 14 , backup rings 13 and O-rings 12 on the spool link side.	 A black and white photograph showing a person's hands in gloves using a screwdriver to remove seal plates labeled '14', backup rings labeled '13', and O-rings labeled '12' from the spool link side of a hydraulic valve body.

6. HYDRAULIC EQUIPMENT

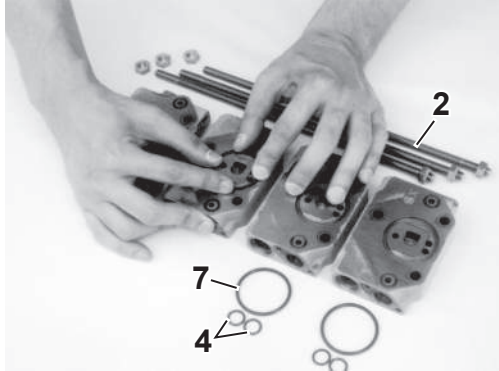
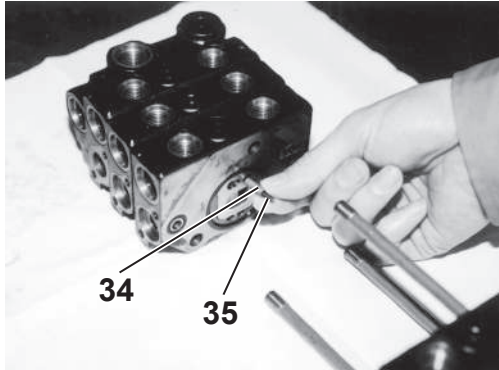
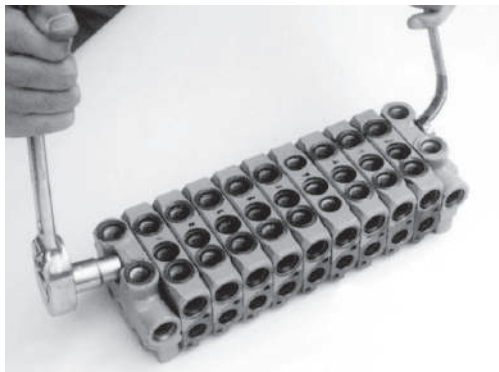
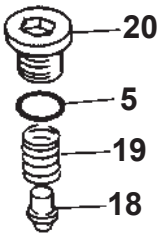
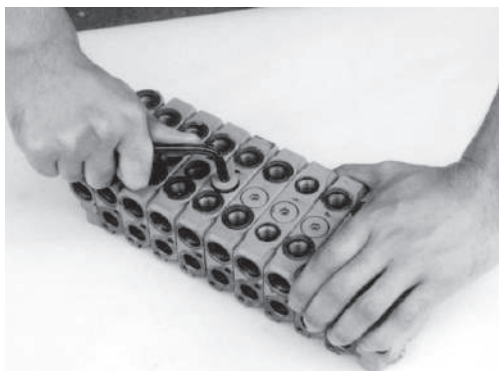
Procedure	
(7) Remove system relief valves 10. Note : <i>Make matchmarks on the valves and the control valve body before removing the valves.</i>	
(8) Remove check valve holder 20 (with O-ring 5), check valve spring 19 and check valve 18 of each section. 	
(9) While holding the nut on one inlet section side, loosen the nut on the other inlet section side to separate the sections from each other.	
(10) Remove check valve 34 and check valve spring 35 of the bucket section.	

6. HYDRAULIC EQUIPMENT

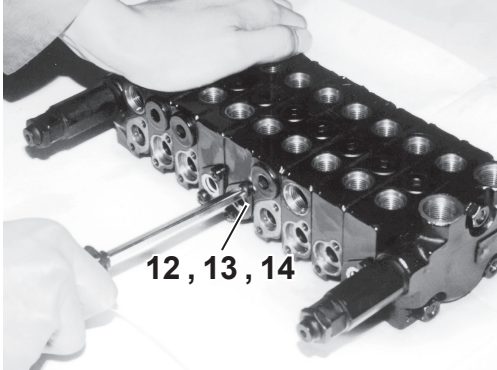
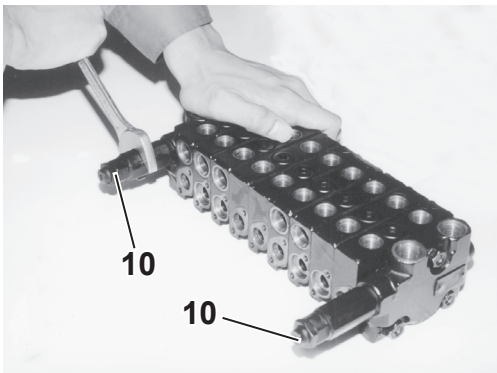
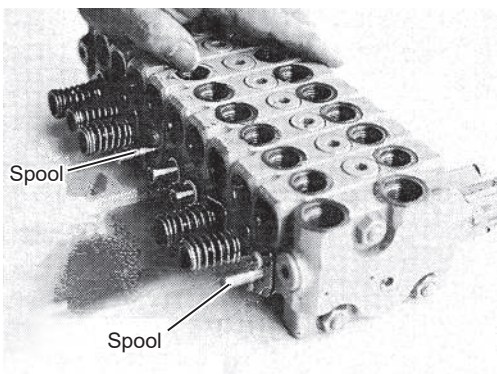
Procedure	
(11) Remove O-rings 4 and 7 from the mating face of each section. Note : <i>Put all the sections in order for reassembly.</i>	

6. HYDRAULIC EQUIPMENT

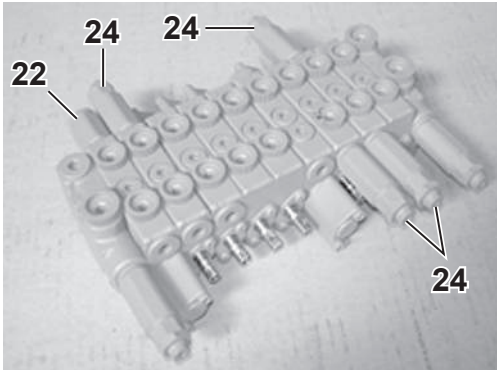
5) Reassembly

Procedure (1) After installing O-rings 4 and 7 to each section, put the sections in the specified order and insert bolts 2 into them. Note : Do not apply grease to the O-rings.	
(2) Install check valve 34 and check valve spring 35 into the bucket section.	
(3) Put all the sections together and tighten the nuts at a specified tightening torque. Tightening torque : 10.1 to 10.9 ft·lbf (13.7 to 14.7 N·m)	
(4) Install check valve 18, check valve spring 19 and check valve holder 20 (with O-ring 5) to each section, and tighten the check valve holder at a specified tightening torque. Tightening torque : 18.1 to 21.7 ft·lbf (24.5 to 29.4 N·m) Note : Both travel sections have no check valve 18 or check valve spring 19. 	

6. HYDRAULIC EQUIPMENT

Procedure	
(5) Install O-rings 12, backup rings 13 and seal plates 14 on the spool link side. Tightening torque : 1.5 to 2.2 ft·lbf (2.0 to 3.0 N·m)	
(6) Install system relief valves 10. Tightening torque : 28.9 ft·lbf (39.2 N·m) Note : <i>Apply grease thinly to O-rings 8 and 9.</i>	
(7) Install all spools to each original section.	
(8) Install spring cases 15. Tightening torque : 4.4 to 5.1 ft·lbf (5.9 to 6.9 N·m)	

6. HYDRAULIC EQUIPMENT

Procedure	
(9) Install circuit relief valves 24 and anti-cavitation valve 22. Tightening torque : 28.9 ft·lbf (39.2 N·m) Note : <i>Apply grease thinly to O-rings 9.</i>	
(10) Install plug G3 / 8 21 (with O-ring 9) on the side of each section. Tightening torque : 28.9 to 36.2 ft·lbf (39.2 to 49.0 N·m) Note : <i>Apply grease thinly to O-rings 9.</i>	

6. HYDRAULIC EQUIPMENT

6) Troubleshooting

Trouble	Cause	Measure
1. Oil leak from spool	(1) Damaged oil seal (2) Damaged spool surface	(1) Replace oil seal. (2) - 1. Flaw ... Replace spool. (3) - 2. Foreign substances ... Remove.
2. Spool does not work smoothly or return to neutral position	(1) Foreign substances caught inside (2) Bent spool (3) Off-center of control valve linkage (4) Excessive tightening of tie rod (5) Distortion of valve contact face (6) Too high temperature of hydraulic oil	(1) Clean hydraulic circuit and valves. (2) Replace spool. (3) Check linking condition of linkage. (4) Retighten tie rod at specified tightening torque. Tightening torque : 10.1 to 10.9 ft·lbf (13.7 to 14.7 N·m) (5) Repair distortion of contact face. (6) Keep oil temperature within specified range.
3. Actuator does not operate or operates slowly (at low pressure)	(1) Spool stroke is not full (2) Foreign substances caught between regulating valve and seat surface (3) Improper set pressure, or sticking or breakage of relief valve	(1) Check spool linked portion. (2) Disassemble and clean parts. (3) Adjust set pressure or disassemble and clean parts.
4. Actuator does not operate or operates slowly (at high pressure)	(1) Overload (2) High resistance of piping	(1) Check load applied. (2) Replace piping with proper sized one.
5. Oil pressure can not be maintained in neutral position of spool	(1) Neutral position of spool is not in right place (2) Oil leak from clearance between spool and body (3) Internal leakage of hydraulic cylinder	(1) Adjust neutral position of spool. (2) Replace spool or valve section. (3) Repair or replace hydraulic cylinder.
6. Oil pressure lowers when spool is moved from neutral position	(1) Dust or foreign substances caught between load check valve and seat surface (2) Sticking or breakage of poppet (3) Damaged seat surface	(1) Disassemble and clean parts. (2) Replace poppet. (3) Replace valve section.

6. HYDRAULIC EQUIPMENT

6-3 Swing motor

6-3-1 S/N 14001 to 19874

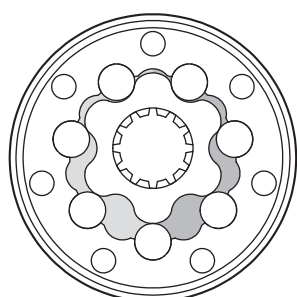
1. Outline

The swing motor is hydraulic motor with a displacement of 11.5 cu.in. (188.5 cc) for S/N 14001 to 17475 or that of 11.58 cu.in (189.8 cc) for S/N 17476 to 19874.

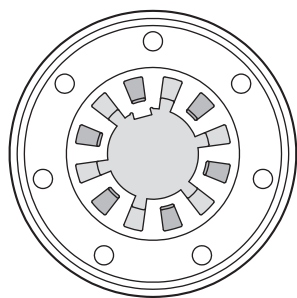
The main component parts of the motor are a rotor set, a shaft, a rotary valve, a drive shaft, a housing, a flange and an end cover.

2. Theory of Operation

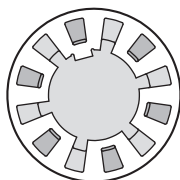
When high pressure oil is supplied to the port A of the housing, the high pressure oil flows into the rotary valve through the bearing housing. Then, high pressure oil flows into the rotor set through the oil holes in the rotary valve and the valve plate to rotate the rotor. The oil discharged from the rotor flows out of the port B of the housing through the valve plate and rotary valve.



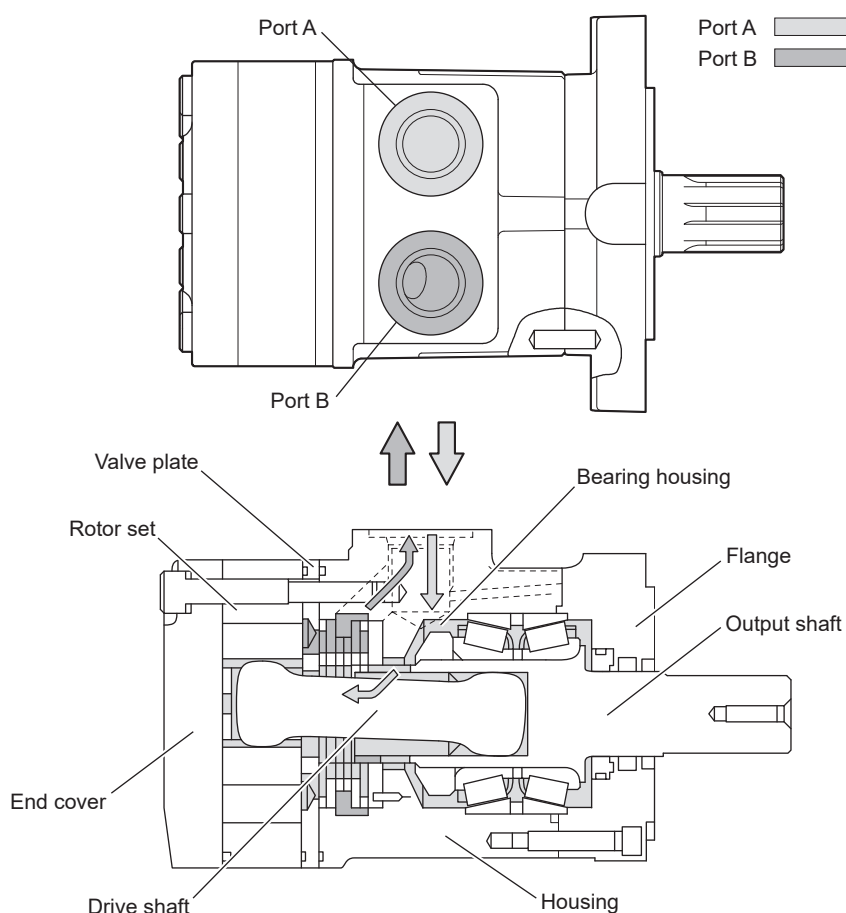
Sectional view of rotor set



Sectional view of valve plate



Rotary valve

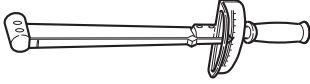
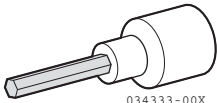
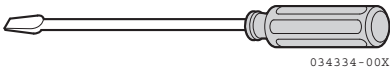
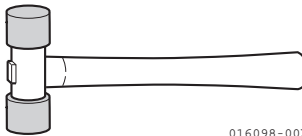


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6. HYDRAULIC EQUIPMENT

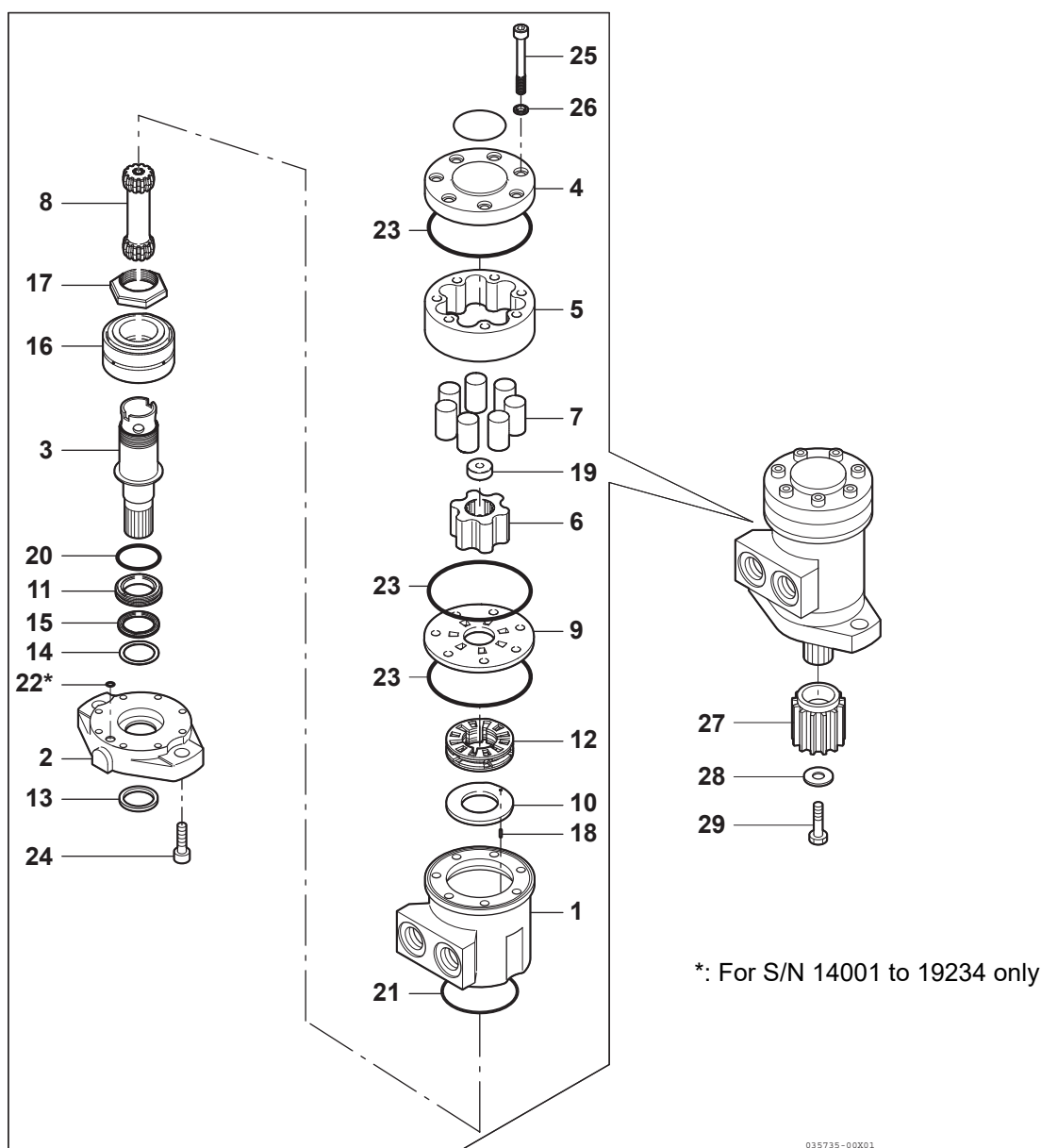
3. Disassembly and Reassembly

1) Tools for Disassembly and Reassembly

Tool	Appearance	Remarks
Torque wrench	 001427-00X	32.5 ft•lbf (44.1 N•m)
Hexagon socket	 034333-00X	Width across flats: 0.24 in. (6 mm) 0.31 in. (8 mm)
Screwdriver	 034334-00X	A long and slender one
Plastic hammer	 016098-00X	

6. HYDRAULIC EQUIPMENT

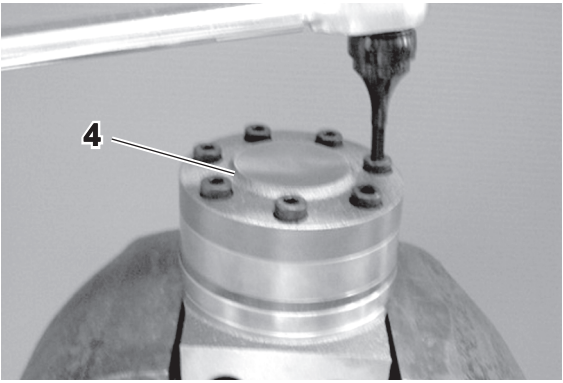
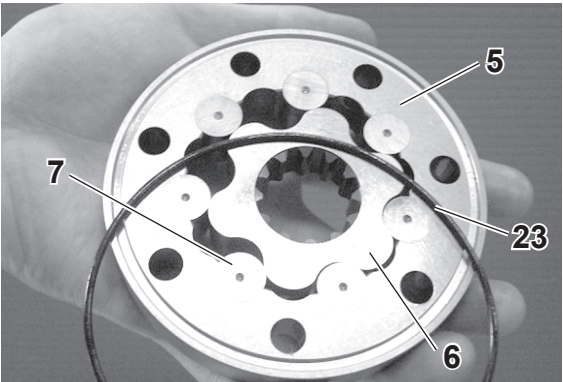
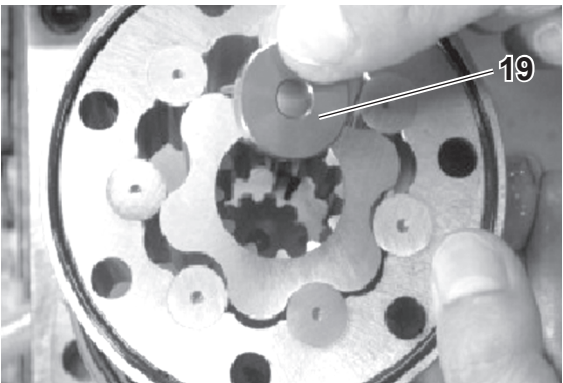
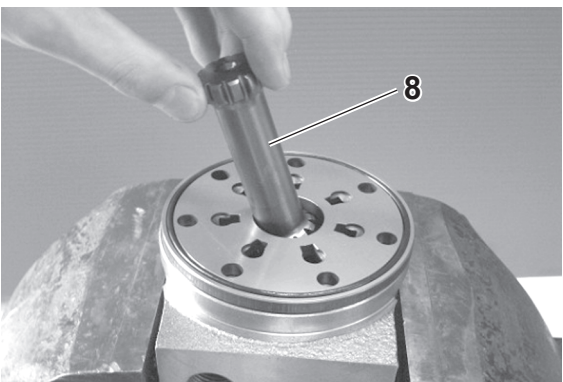
2) Exploded View and Component Parts (S/N 14001 to 19874)



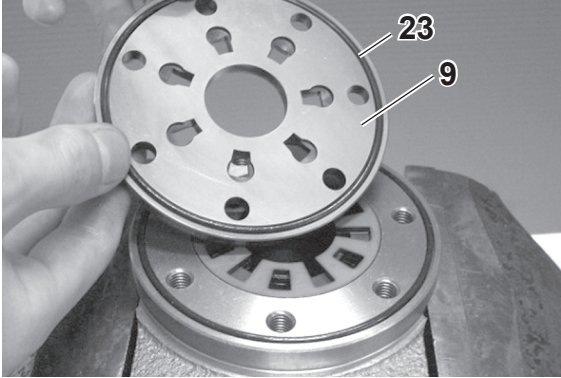
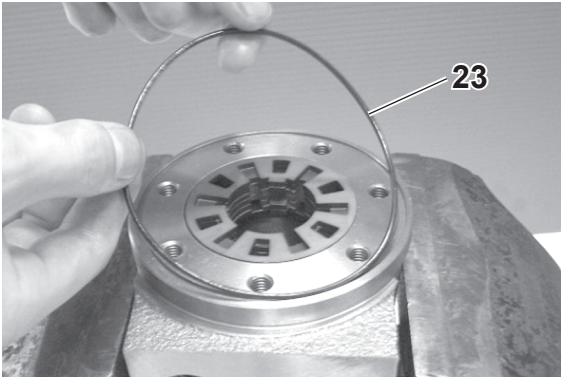
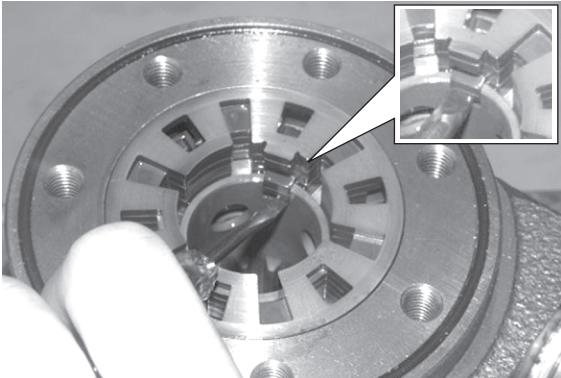
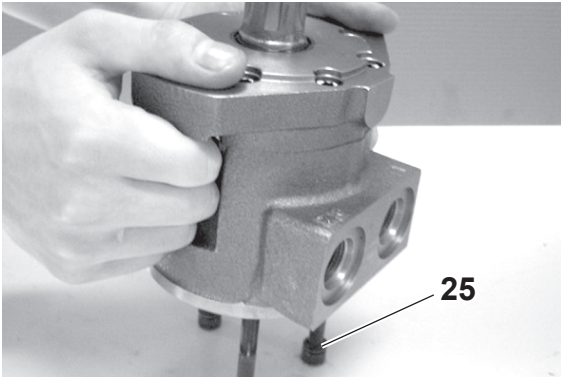
No.	Part	Q'ty	No.	Part	Q'ty
1	Housing	1	16	Tapered roller bearing	1
2	Flange	1	17	Nut	1
3	Output shaft	1	18	Pin (Ø2mm)	1
4	End cover	1	19	Spacer	1
5	Outer rotor	1	20	O-ring	1
6	Inner rotor	1	21	O-ring (S67)	1
7	Roller	7	22	O-ring (S6)*	1
8	Drive shaft	1	23	O-ring (S91.5)	3
9	Valve plate	1	24	Hexagon socket head bolt (M6 X 30)	8
10	Fixed plate	1	25	Hexagon socket head bolt (M8 X 60)	7
11	Seal collar	1	26	Seal washer	7
12	Rotary valve	1	27	Pinion 13T	1
13	Oil seal	1	28	Washer (M10)	1
14	Back-up ring	1	29	Hexagon socket head bolt (M10 X 20)	1
15	X ring	1			

6. HYDRAULIC EQUIPMENT

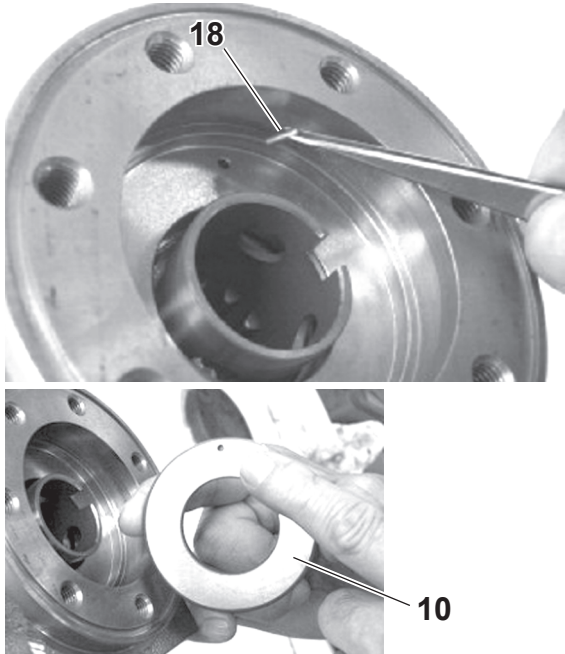
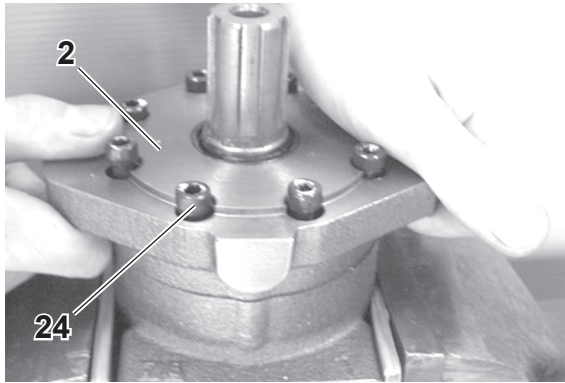
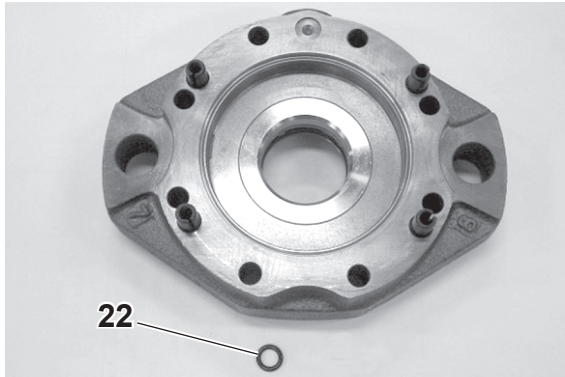
3) Disassembly

Procedure	
(1) Loosen hexagon socket head bolts 25 and remove them with seal washers 26 .	
(2) Remove end cover 4 and rotor set 5 , 6 and 7 , and then remove O-ring 23 from the rotor set.	
*Remove spacer 19 from the spline hole of the inner rotor.	
(3) Pull out drive shaft 8 .	

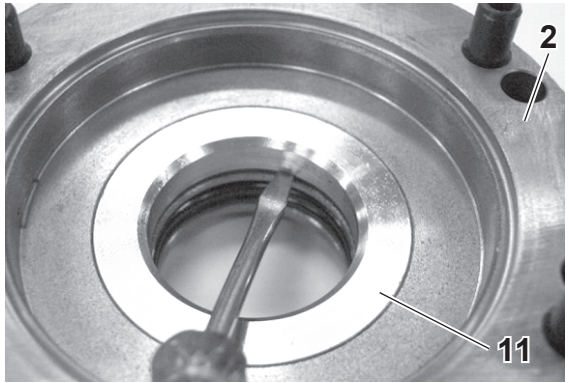
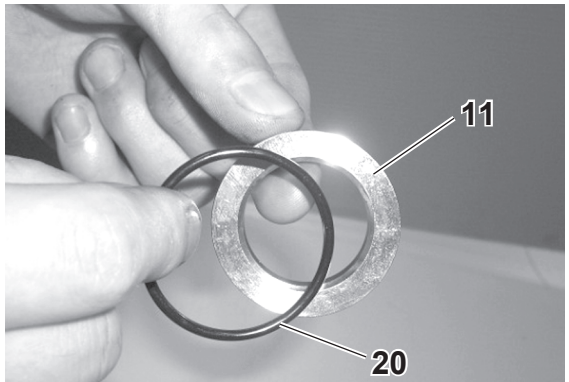
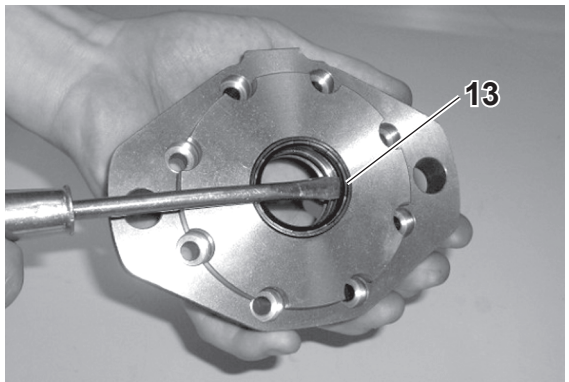
6. HYDRAULIC EQUIPMENT

Procedure	
(4) Remove valve plate 9, and then remove O-ring 23 from the valve plate.	
(5) Remove O-ring 23 from the housing.	
(6) Gently pry up the protrusion of rotary valve 12 engaged with the notch in the output shaft and remove rotary valve 12. *When removing the rotary valve, put a pad like a cloth on the floor and be sure to take care not to damage the parts.	
(7) Screw two or three hexagon socket head bolts 25 into tapped holes appropriate to keep balance and remove the fixed plate by tapping them against the floor as shown in the photograph on the right.	

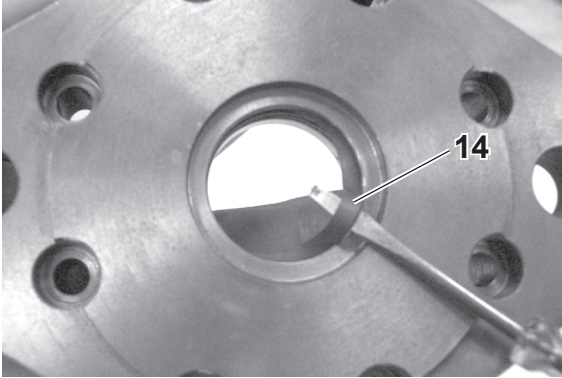
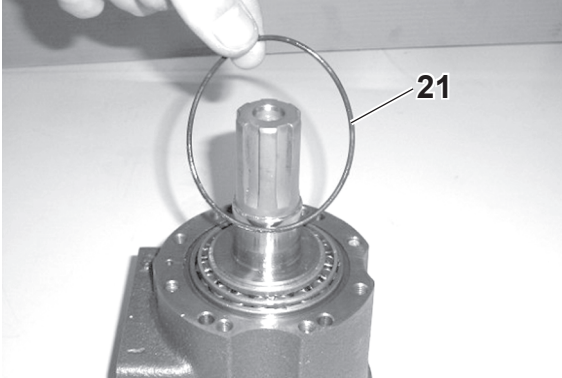
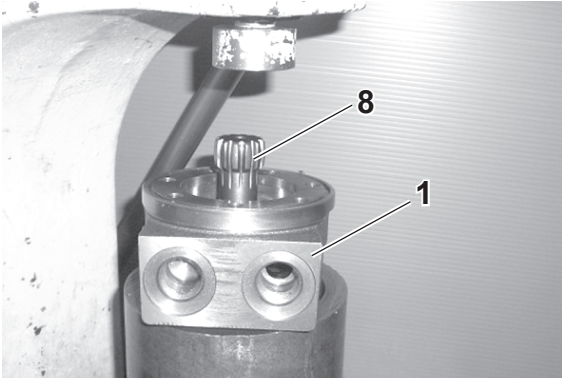
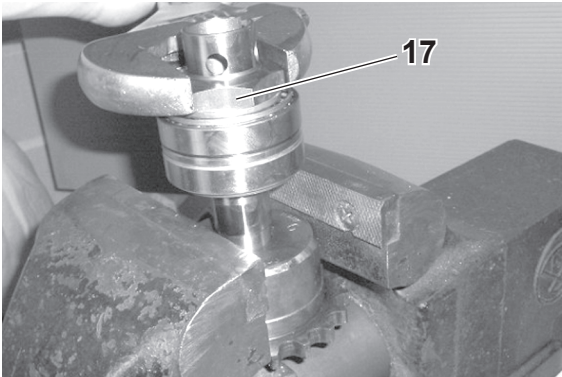
6. HYDRAULIC EQUIPMENT

Procedure	
(8) Remove Ø0.079 in (Ø2 mm) pin 18 from fixed plate 10 or the housing, whichever the pin remains.	
(9) Remove hexagon socket head bolts 24. (10) Remove flange 2 from the housing. *When removing the flange, pull it straight upward with both hands without twisting it to prevent damage to the shaft hole.	
(11) Remove O-ring 22. Note: For S/N 14001 to 19234 only.	

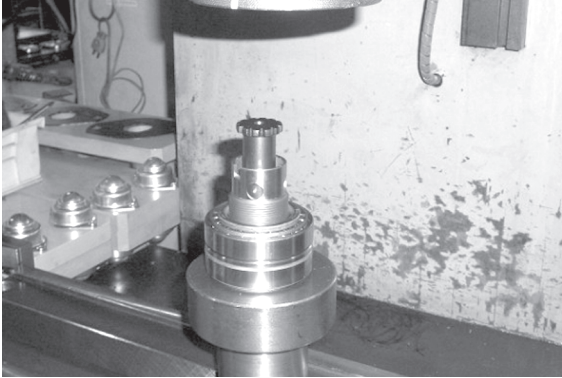
6. HYDRAULIC EQUIPMENT

Procedure	
(12) Hold flange 2 with a vice and remove seal collar 11 .	
(13) Remove O-ring 20 from seal collar 11 .	
(14) Remove oil seal 13 .	
(15) Remove X-ring 15 .	

6. HYDRAULIC EQUIPMENT

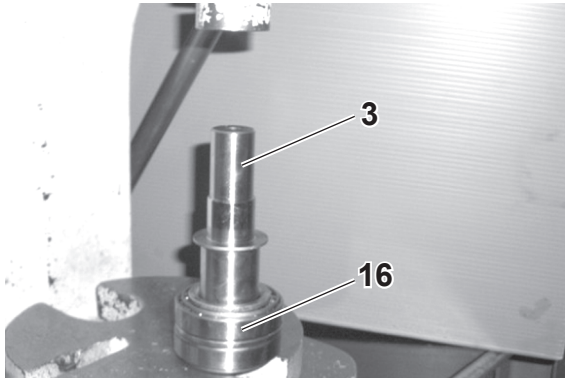
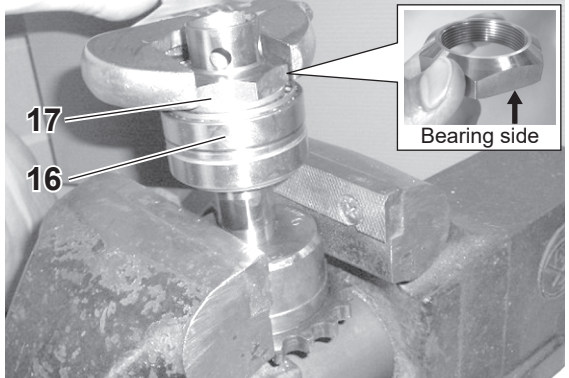
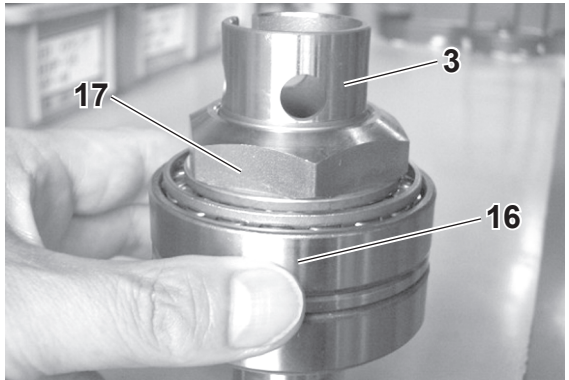
Procedure	
(16) Remove back-up ring 14 .	
(17) Remove O-ring 21 .	
(18) Put drive shaft 8 into the hole in output shaft 3 , then press the end of drive shaft 8 using a press and push output shaft 3 out of housing 1 .	
(19) Hold output shaft 3 securely with a vice and a coupling or a similar tool to prevent damage to the shaft, and loosen bearing holder nut 17 .	

6. HYDRAULIC EQUIPMENT

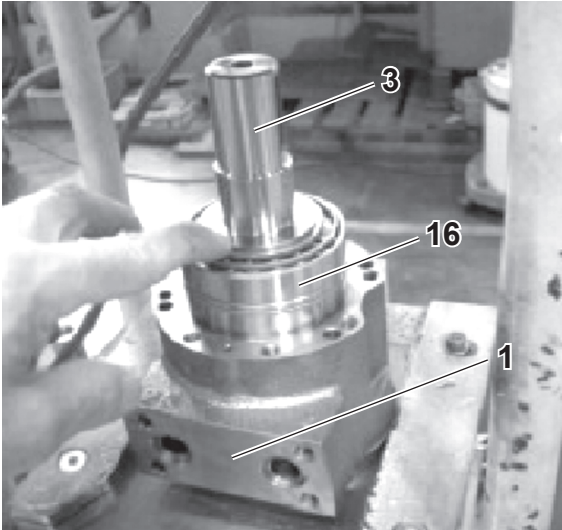
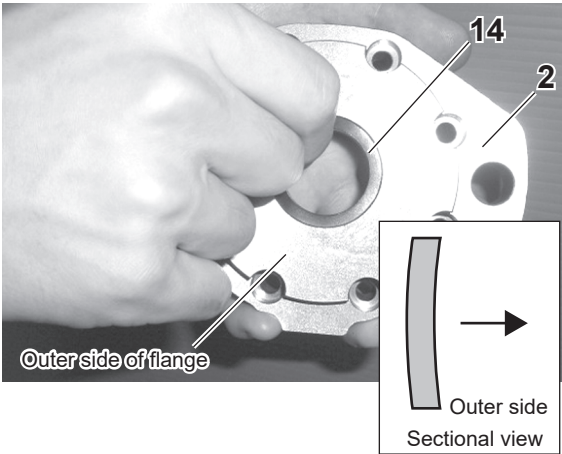
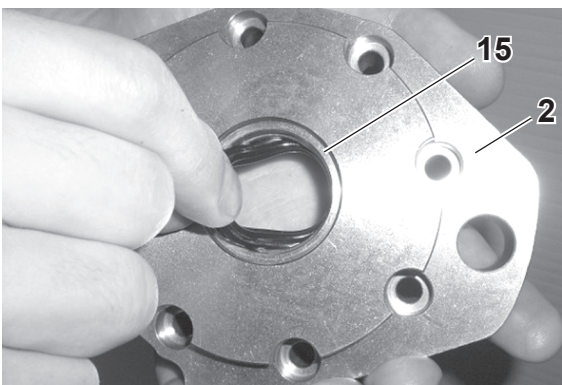
Procedure	
(20) Remove tapered roller bearing 16 with a bearing removal jig and a press.	
(21) Remove dents, scratches or any other damages from the parts with sandpaper #600 or equivalent. Clean all the parts with clean wash oil and dry them by air blowing.	

6. HYDRAULIC EQUIPMENT

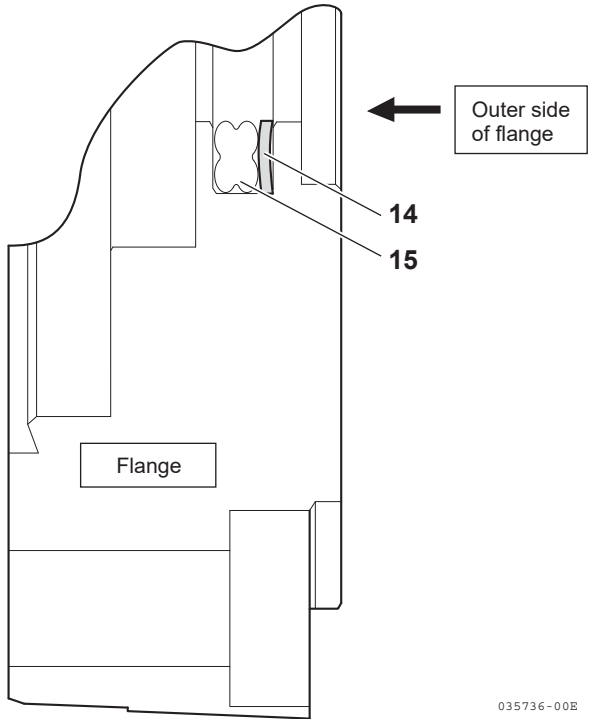
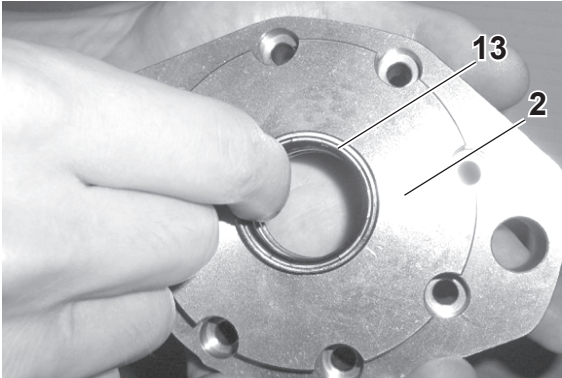
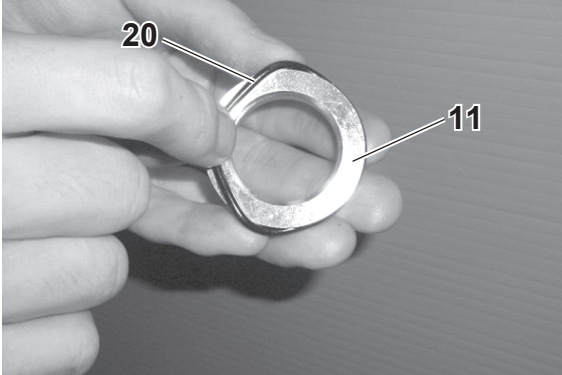
4) Reassembly

Procedure	
(1) Press fit tapered roller bearing 16 onto output shaft 3 with a press.	
(2) Degrease the threaded portion of output shaft 3 and bearing holder nut 17 with a cleaner. Apply Loctite #277 to nut 17 and tighten it.	
*Tighten nut 17 to the specified tightening torque while rotating the bearing. Tightening torque: 147.5 ft•lbf (200 N•m) Notes: <i>If the nut is tightened without rotating the bearing, irregular rotation of the bearing may occur, resulting in malfunction.</i>	

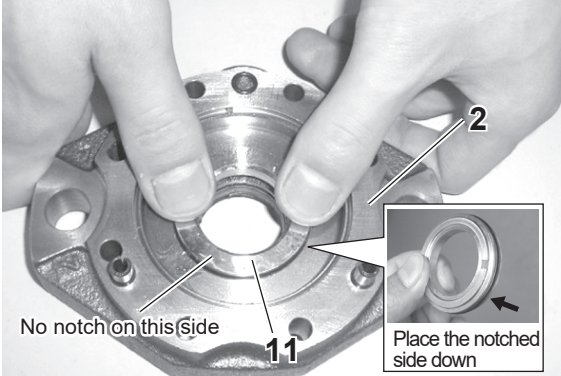
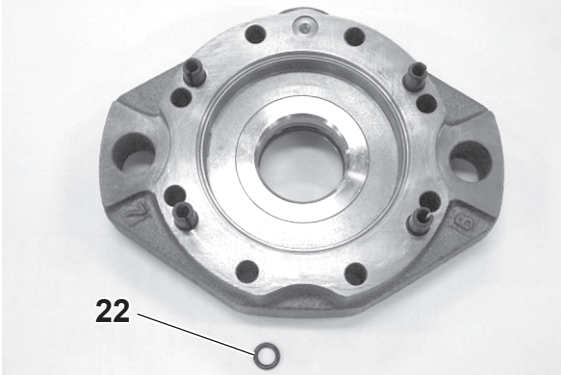
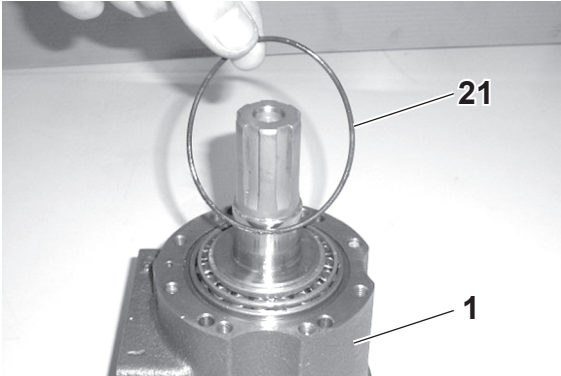
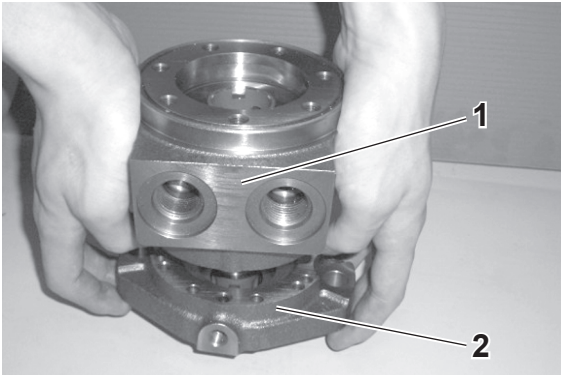
6. HYDRAULIC EQUIPMENT

Procedure	
(3) Check that tapered roller bearing 16 rotates smoothly, and then press fit it into housing 1 with a bearing press-fitting jig and a press.	
(4) Install back-up ring 14 into the groove of flange 2.	
(5) Install X-ring 15 into the groove of flange 2. Apply grease thinly to the shaft sliding surface of the X-ring.	

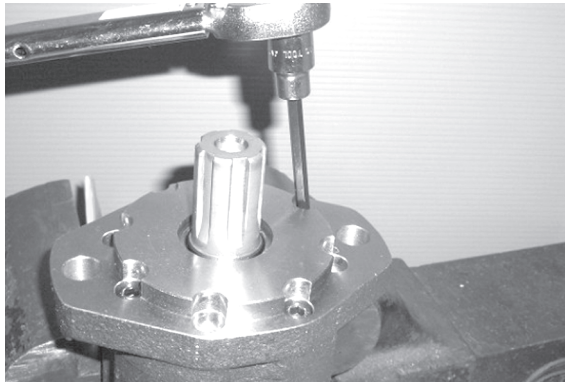
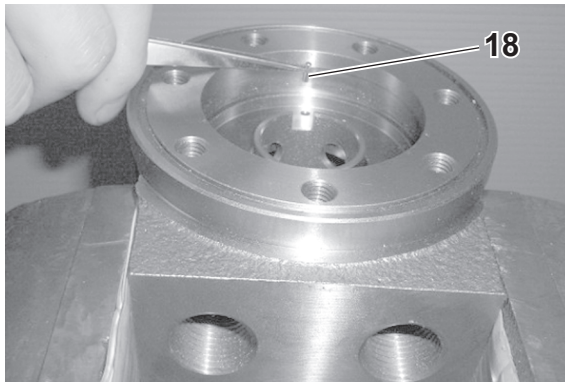
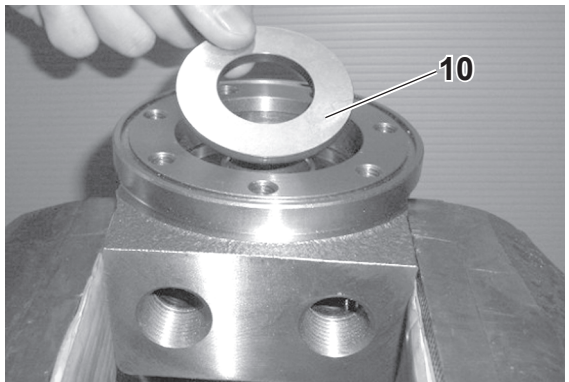
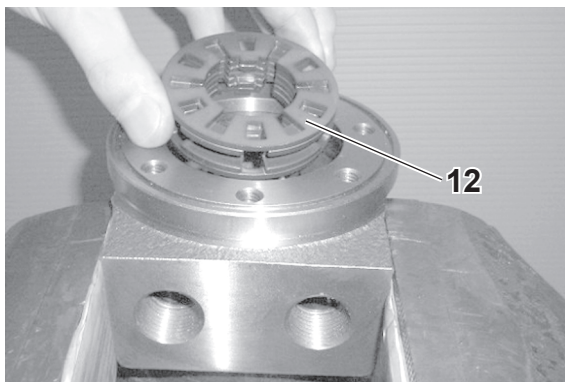
6. HYDRAULIC EQUIPMENT

Procedure	
*Positions of X-ring 15 and back-up ring 14 in flange 2	 035736-00B
(6) Install oil seal 13 onto flange 2.	
(7) Install O-ring 20 onto seal collar 11.	

6. HYDRAULIC EQUIPMENT

Procedure	
(8) Fit seal collar 11 in the hole in the middle of flange 2.	
(9) Install O-ring 22 onto flange 2. Note: For S/N 14001 to 19234 only.	
(10) Install O-ring 21 onto housing 1. When installing the O-ring, apply a small amount of grease to it and securely fit it into the groove so that it does not fall out event when the housing is turned upside down.	
(11) Install the housing assembly to flange 2 by putting housing 1 on flange 2.	

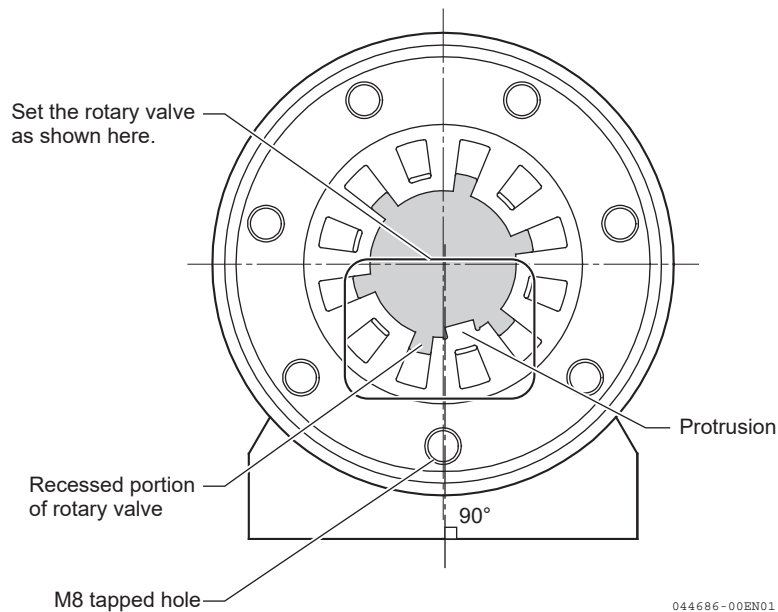
6. HYDRAULIC EQUIPMENT

Procedure	
(12) Install four hexagon socket head bolts 24 in tapped holes not next to each other and temporarily tighten them. Then, after applying Loctite #262 to the remaining four bolts, install them and tighten all the eight bolts to the specified tightening torque. Tightening torque: 9.59 ft•lbf (13 N•m).	
(13) Insert Ø0.079 in (Ø2 mm) pin 18 into the pin hole in the housing. Turn the motor upside down and hold it lightly with a vice.	
(14) Install fixed plate 10 while aligning its pin hole with pin 18.	
(15) Install rotary valve 12 while engaging its protrusion with the notch in output shaft 3.	

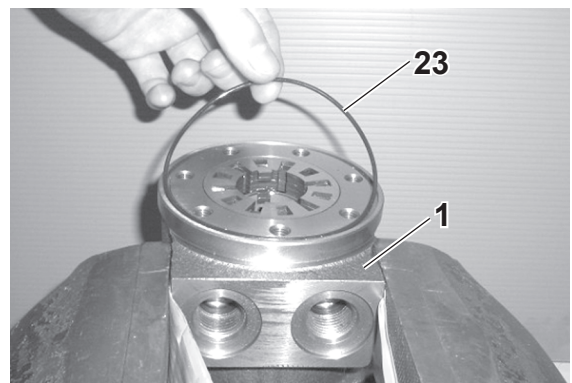
6. HYDRAULIC EQUIPMENT

Procedure

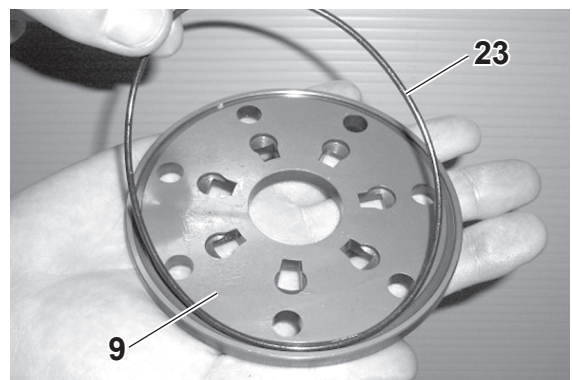
*By tapping the rotary valve lightly with a plastic hammer, secure it with its end face aligned with the end face of the housing.
 *Set the rotary valve so that the line extending perpendicularly toward the port face through the center of the M8 tapped hole passes through the middle between the recessed portion and protrusion of the rotary valve as shown in the figure below.
 (The position of the rotary valve is a factor in determining the direction of the motor rotation.)



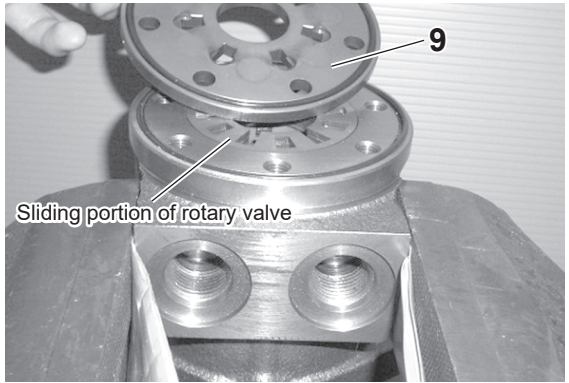
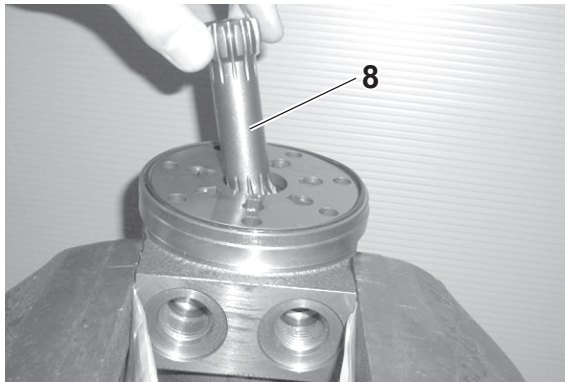
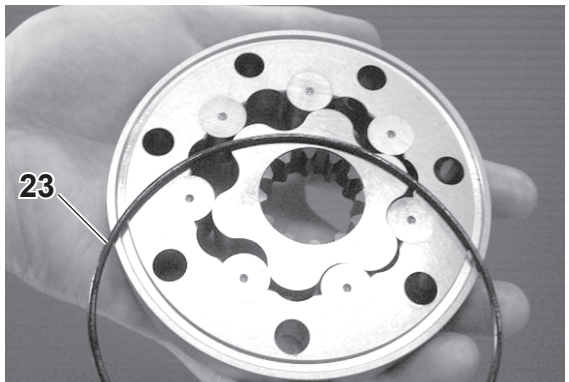
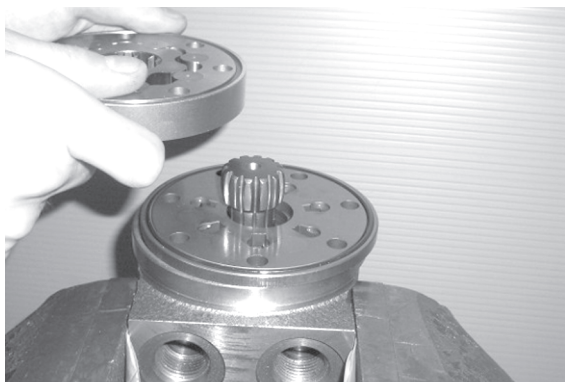
(16) Install O-ring **23** into the groove of housing **1**.



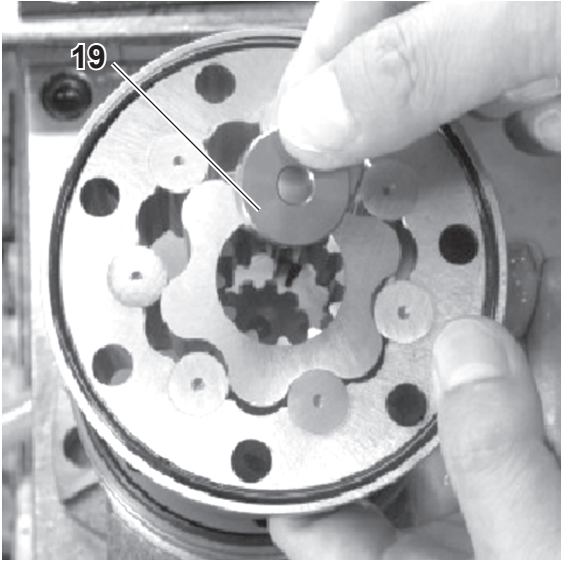
(17) Install O-ring **23** into the groove of valve plate **9**.



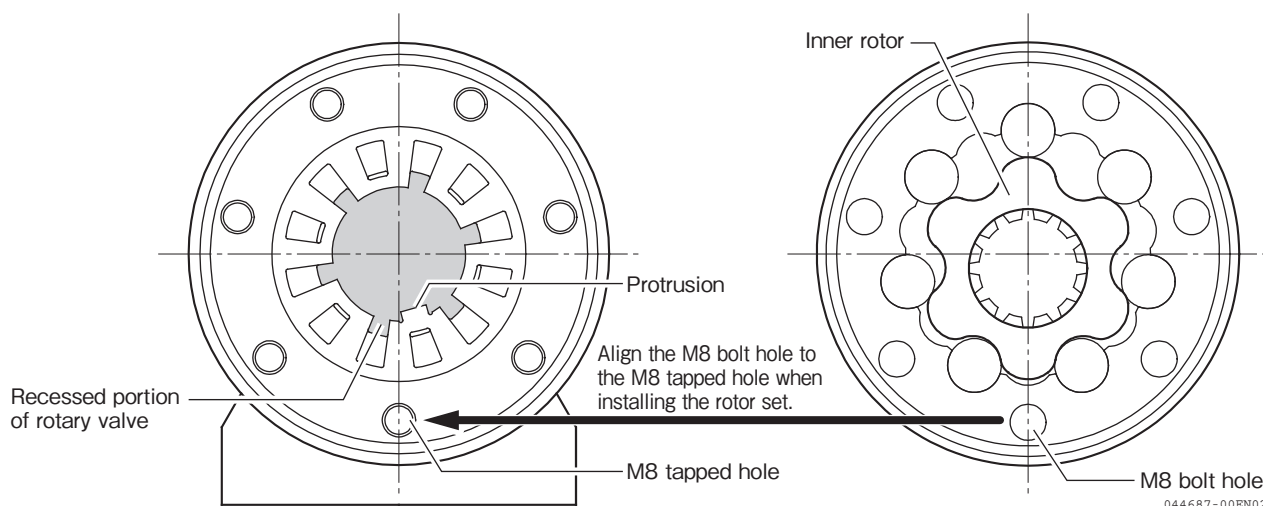
6. HYDRAULIC EQUIPMENT

Procedure	
(18) Apply a small amount of machine oil to the sliding portion of rotary valve 12 and put valve plate 9 on it.	
(19) Insert drive shaft 8 into the shaft hole.	
(20) Install O-ring 23 into the groove of the rotor set.	
(21) Install the rotor set.	

6. HYDRAULIC EQUIPMENT

Procedure	
(22) Install spacer 19 into the spline hole of the inner rotor. (23) Apply a small amount of machine oil to the rotor set and put end cover 4 on it.	

*Set the rotary valve and the rotor set in the positions as shown in the figures below as the motor rotation direction is determined by their positions.



*Set the tapped hole, the recessed portion and protrusion of the rotary valve in their positions shown in the figure above.

*Set the inner rotor symmetrically with regard to the line passing through the center of the M8 bolt hole.

(24) Install seal washers **26** onto hexagon socket head bolts **25** and temporarily tighten two of them. Then, after applying Loctite to the remaining bolts, install them and tighten all the seven bolts.

Tightening torque: 25.81 to 29.50 ft·lbf (35 to 40 N·m)



6. HYDRAULIC EQUIPMENT

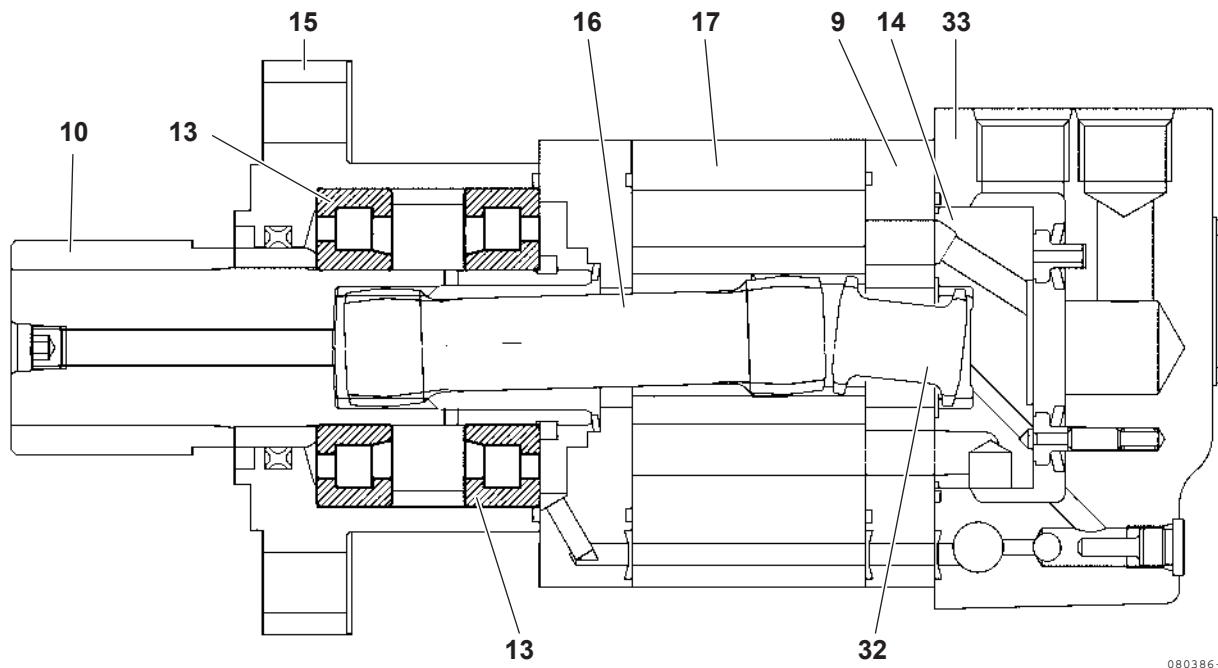
4. Troubleshooting

Trouble	Cause	Measure
1. Motor does not rotate.	(1) Foreign substances mixed in hydraulic oil get into rotor set section.	Check that motor rotates after removed from machine. If motor does not rotate with an oil pressure of 356 to 427 PSI (2.45 to 2.94 MPa) applied, overhaul it.
	(2) No oil flow	Check hydraulic circuit, especially control valve.
	(3) Pressure does not rise.	Check hydraulic circuit, especially regulator valve.
	(4) Load is higher than rated load.	Remove motor and check load condition.
2. Motor speed is lower than the rated speed.	(1) Insufficient amount of hydraulic oil fed to motor	Check pump discharge rate, engine speed and all valves.
	(2) Higher temperature and lower viscosity of hydraulic oil	Run motor at proper hydraulic oil temperature.
	(3) Improper type of hydraulic oil used	Use proper type of hydraulic oil.
3. Motor rotates in the wrong direction.	(1) Incorrect piping	Correct piping.
	(2) Incorrect timing	Disassemble motor and check drive shaft, spline portion of inner rotor and spline portion inside shaft. Replace excessively worn parts, then reassemble them correctly.
4. Oil leak from shaft seal	(1) Worn or damaged seal	Replace X-ring with new one. Polish shaft with sandpaper #600.
5. Oil leak between flange and housing	(1) Loosen flange bolts M6x1.0	Apply a small amount of Loctite to threaded portions and tighten bolts.
	(2) Broken or damaged O-ring between flange and housing	Replace O-ring S67 with new one.
6. Oil leak between housing and valve plate	(1) Loosen M8 hexagon socket head bolts	Retighten seven M8 hexagon socket head bolts.
	(2) Broken or damaged O-ring	Replace O-ring S91.5 with new one.
7. Breakage of flange	(1) Flange broken by external force	Replace flange with new one. Put it on housing and press flange face using a press. Check that there is no clearance between flange and housing and fasten them with M6 hexagon socket head bolts with Loctite applied.
8. Oil leak from ports	(1) Improper joint	Replace joint.
	(2) Broken screw for piping	Replace housing.
	(3) Broken housing	Replace housing.
9. Abnormal sound	(1) Improper installation of motor	Center shaft correctly.
	(2) Air remaining inside circuit and motor	Remove air completely. Run motor with no load until air bubbles inside tank are gone.
	(3) Pump cavitation	Clean clogged suction filter. Replace pump suction hose with larger one. Increase pump boost pressure.
	(4) Motor cavitation	When motor is rotated at load with high inertia, negative pressure occurs and causes cavitation, resulting in motor breakage. Apply proper boost pressure to avoid negative pressure.
	(5) Air caught in suction system	Apply oil or grease to joints while checking sound during operation and retighten joints where sound is softened.

6. HYDRAULIC EQUIPMENT

6-3-2 S/N 19875 to 19999, 1A000 and above

1. Structure and theory of operation



080386-00X00

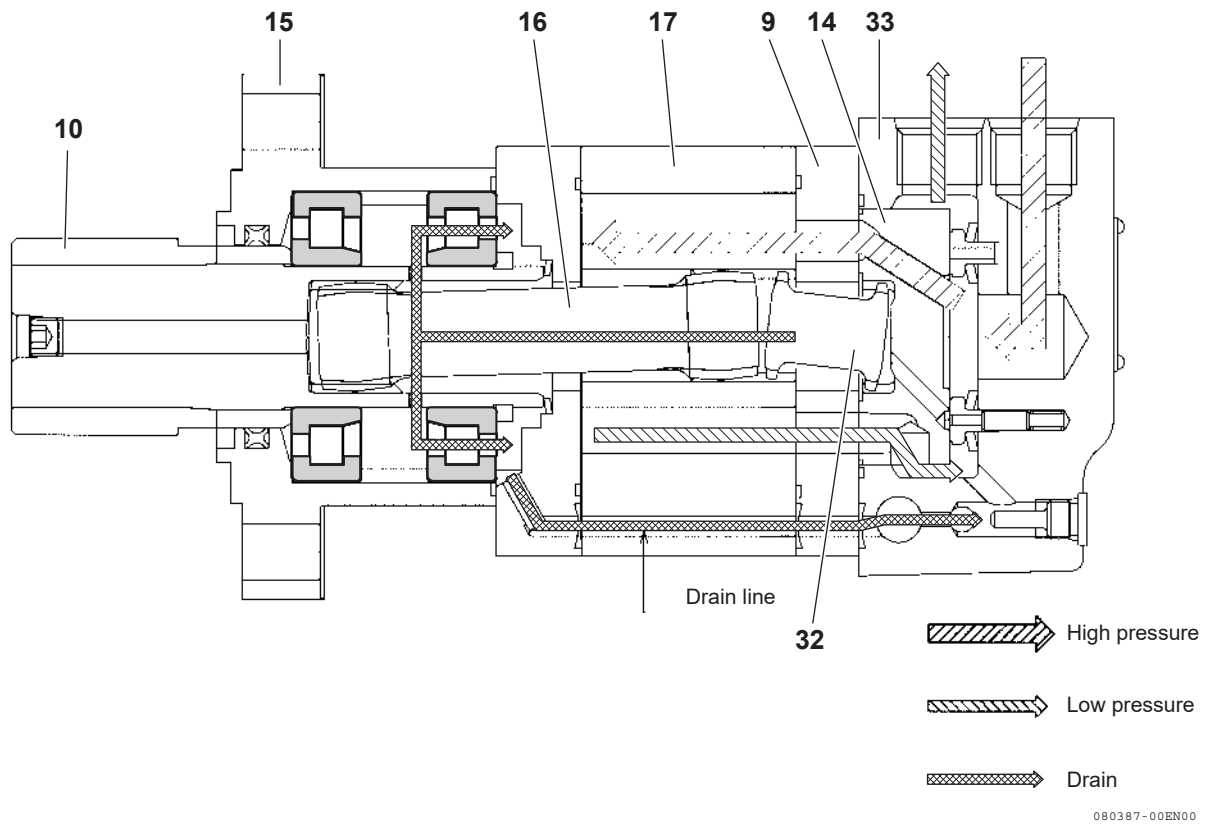
This hydraulic swing motor consists of an orbit motor section and a pinion gear assembly section.

The hydraulic motor has six holes in the valve **14** and seven holes in the valve plate **9**, and the displacement per revolution is 11.9 cu.in (195 cu.cm). The pinion gear assembly comprises the pinion gear **10** and the two roller bearings **13** supporting the pinion gear.

The hydraulic oil is fed to the valve housing **33**.

No.	Part
9	Valve plate
10	Pinion gear
13	Roller bearing
14	Valve
15	Bearing housing
16	Drive
17	Geroller
32	Valve drive
33	Valve housing

6. HYDRAULIC EQUIPMENT



When hydraulic oil is fed to the port A, the oil flows into the oil holes in the valve **14** corresponding to the port A and runs through the oil holes in the valve plate **9** to rotate the geroller **17**. When the valve **14** is rotated via the valve drive **32**, the positional relation between the six holes in the valve **14** and the seven holes in the valve plate **9** is changed and, in turn, the relative position of the hydraulic oil which flows into the geroller **17** is shifted successively. The oil flow is converted into torque and outputted to the drive **16** splined to the geroller **17**. Then, the torque is transmitted to the pinion gear **10**.

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

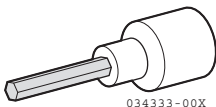
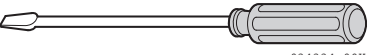
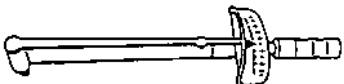
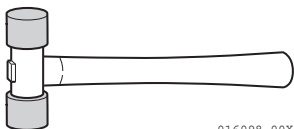
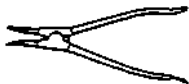
6. HYDRAULIC EQUIPMENT

2. Disassembly and Reassembly

1) Precautions for disassembly and reassembly

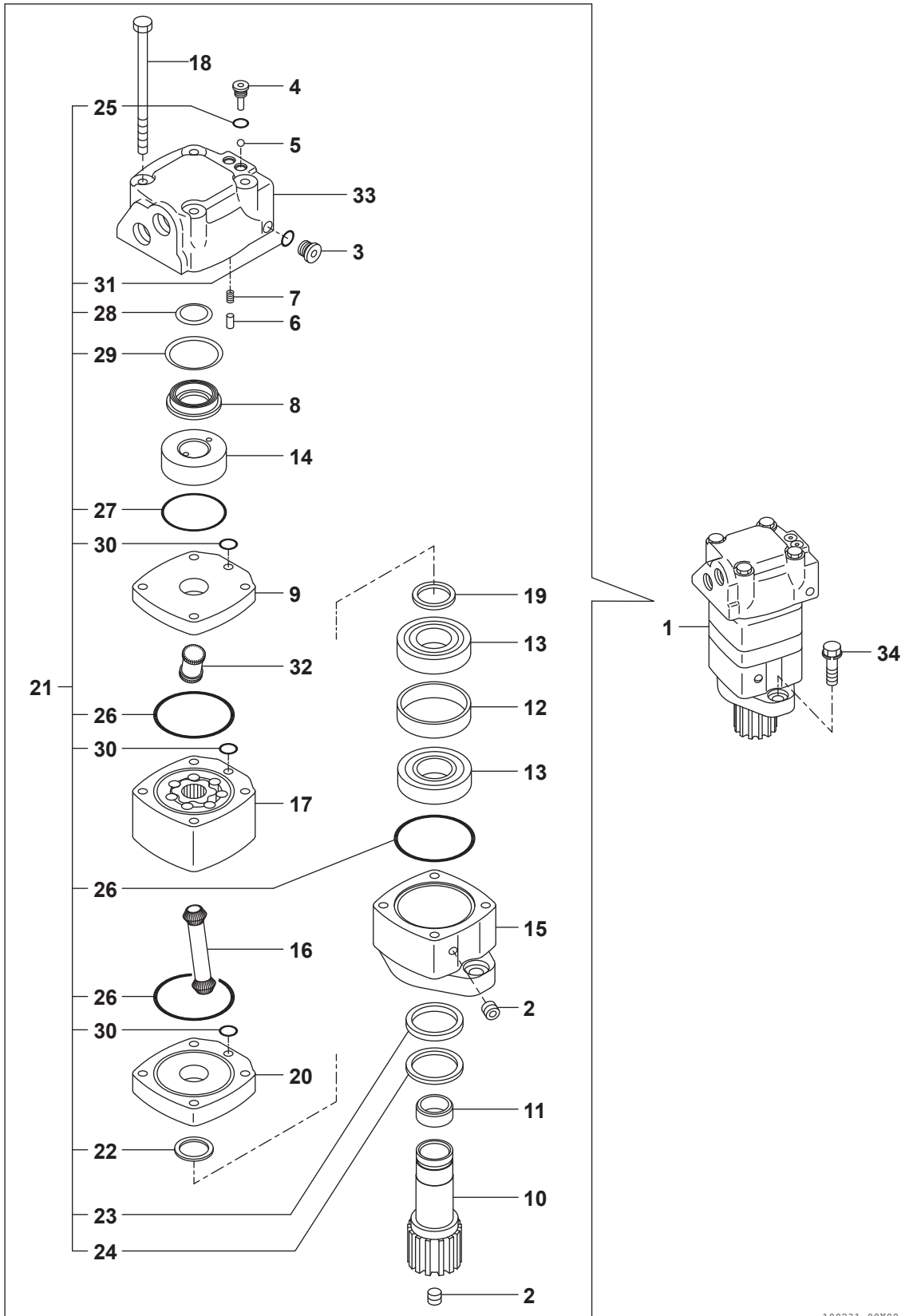
- (1) Since the parts of the hydraulic equipment are precision-made for tight clearances, be sure to perform disassembly and reassembly in a clean place that is free from dust.
- (2) Prepare clean tools and treated oil, and handle the parts carefully.
- (3) First clean the external surface of the removed 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 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 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.

2) Tools for disassembly and reassembly

Tool	Appearance	Remarks	Tool	Appearance	Remarks
Hexagon socket		Width across flats: 0.20 in. (5 mm) 0.24 in. (6 mm)	Screwdriver		
Torque wrench		Capacity: 7.2 to 72.3 ft·lbf (9.8 to 98 N·m)	Plastic hammer		
Socket		Width across flats: 9 / 16 in.	Press		Approx. 3 ton
Retaining pliers		Ø1.38 in. (35 mm) for external snap ring	Vice		

6. HYDRAULIC EQUIPMENT

3) Exploded view and component parts



100231-00X00

6. HYDRAULIC EQUIPMENT

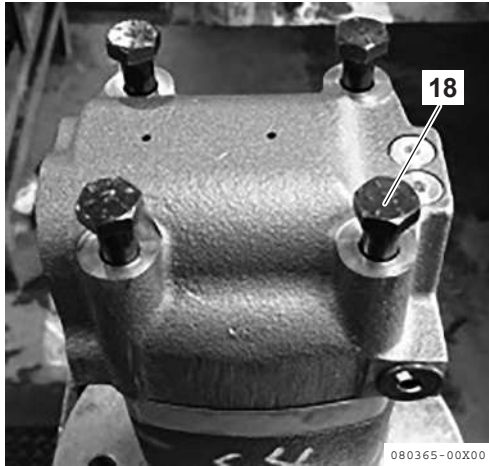
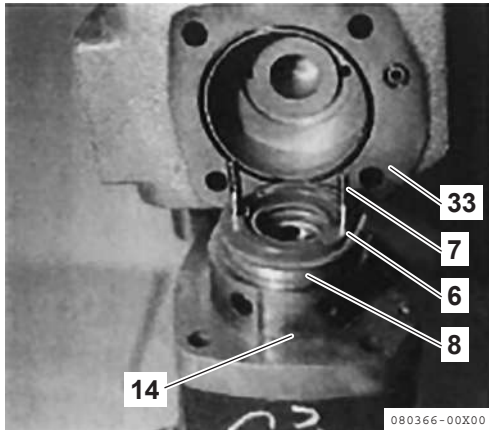
No.	Part	Q'ty	No.	Part	Q'ty	No.	Part	Q'ty
1	Swing motor assembly	1	13	Roller bearing	2	25	O-ring	2
2	Plug	2	14	Valve	1	26	O-ring	3
3	Plug	1	15	Bearing housing	1	27	O-ring	1
4	Plug	2	16	Drive	1	28	Inner face seal	1
5	Ball	2	17	Geroller	1	29	Outer face seal	1
6	Pin	2	18	Bolt 12×40	4	30	O-ring	3
7	Spring	2	19	Retaining ring	1	31	O-ring, 1BP11.0	1
8	Balancing ring	1	20	Wear plate	1	32	Valve drive	1
9	Valve plate	1	21	Seal kit	1	33	Valve housing	1
10	Pinion gear	1	22	Shaft face seal	1	34	Bolt, M12×35	2
11	Collar	1	23	X ring	1			
12	Spacer Bearing	1	24	Dust seal	1			

6. HYDRAULIC EQUIPMENT

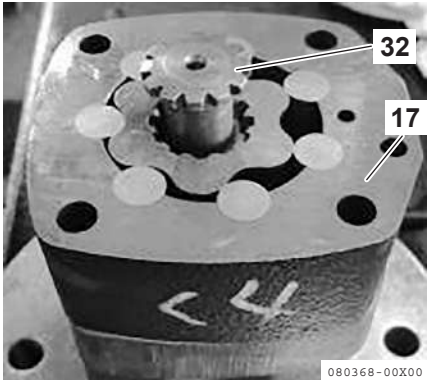
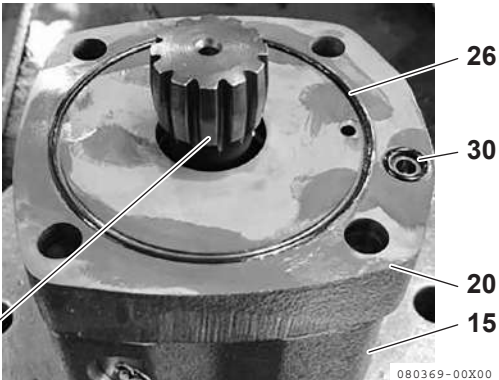
4) Disassembly

The motor should not be disassembled unless necessary.

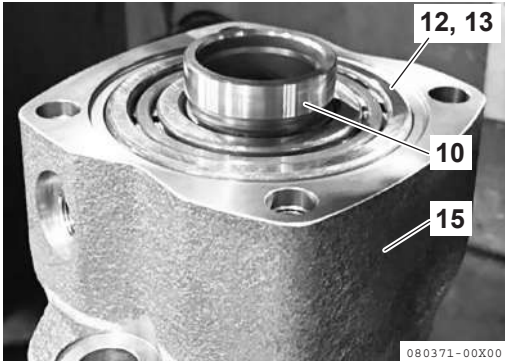
If it needs to be disassembled, clean the work area and prepare a container such as a plastic box to keep parts in before starting disassembly. Then, clean out dirt and debris from the motor. Carefully clean the areas around the ports and remove all dirt and paint residue from the connecting areas with a wire brush or similar means.

Procedure	
(1) With pinion gear 10 facing down, hold the flange of bearing housing 15 in a vice. (2) Loosen hexagon head bolts 18.	
(3) Remove valve housing assembly 33. Notes: • When doing this, be careful not to lose springs 7 and pins 6. • Do not disassemble valve housing assembly 33 unless necessary. Remove springs 7, pins 6, balancing ring 8 and valve 14. Separate inner face seal 28 and outer face seal 29 from balancing ring 8. Note: Make sure that inner face seal 28 and outer face seal 29 are reassembled in the same direction.	

6. HYDRAULIC EQUIPMENT

Procedure	
(4) Remove valve plate 9 .	
(5) Remove valve drive 32 and geroller 17 .	
(6) Remove drive 16 and wear plate 20 . Note: <i>Be careful with shaft face seal 22 as it may fall off drive 16.</i>	
(7) Remove retaining ring 19 .	

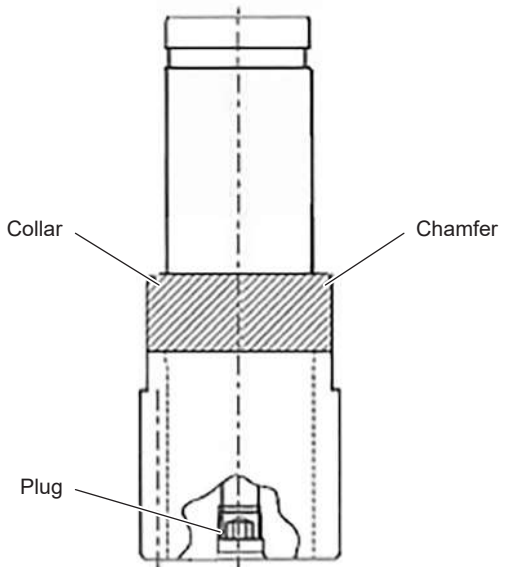
6. HYDRAULIC EQUIPMENT

Procedure	
(8) Remove pinion gear 10, bearings 13 and bearing spacer 12 from bearing housing 15. Notes: • Push pinion gear 10 from the inner spline side to remove it. • Push bearings 13 from the pinion side to remove them.	 080371-00X00
(9) Remove X-ring 23 and dust seal 24 from bearing housing 15. Note: Do not disassemble the collar 11 from the pinion gear 10 unless necessary because doing so may damage the shaft surface. This completes the disassembly procedure.	 080372-00X00

5) Reassembly Procedure

Before reassembly, clean all the parts with clean wash oil to remove dust and dirt. In addition, be very careful not to scratch or dent any of them.

Replace the seals with new ones. In addition, apply grease to the new seals before installation.

Procedure	
(1) Install collar 11 and plug 2 to the pinion gear 10 (when necessary). Notes: • Make sure the collar 11 is installed in the right direction as shown in the figure at the right. • Make sure not to damage the surfaces of pinion gear 10 shaft and collar 11 when installing.	 080373-00EN00

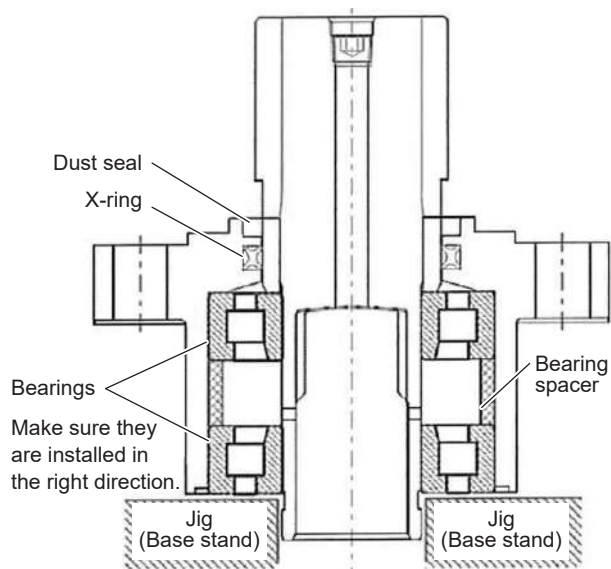
6. HYDRAULIC EQUIPMENT

Procedure

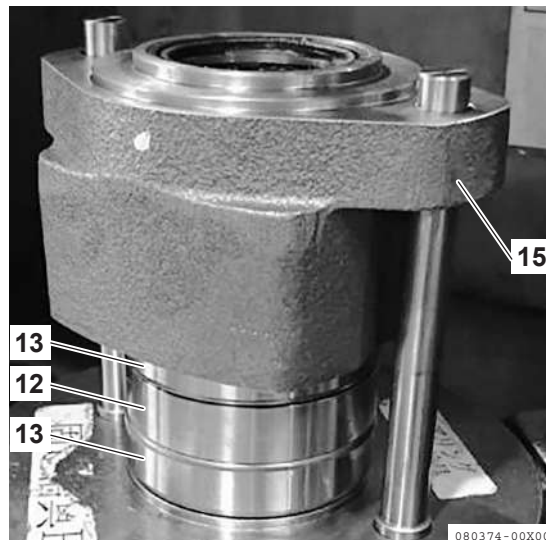
- (2) Install X-ring **23** and dust seal **24** to bearing housing **15** and then install bearings **13** and bearing spacer **12**.

Note:

Make sure the bearings are installed in the right direction as shown in the figure below.



080375-00EN00



- (3) Install pinion gear **10** into bearing housing **15**.

Notes:

To install the pinion gear **10**, put and hold the bearing housing **15** on a jig (base stand with a hole) and insert the pinion gear **10** into the hole in the bearing housing **15** until it reaches the specified position. When doing this, the bearing housing **15** and bearing (inner and outer races) **13** should be supported by the jig (base stand).

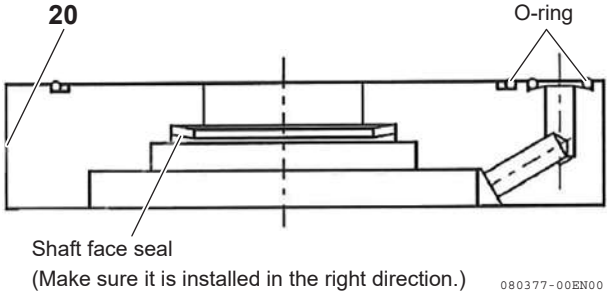
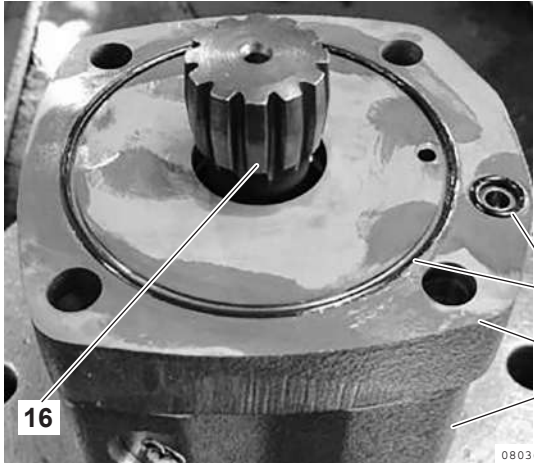
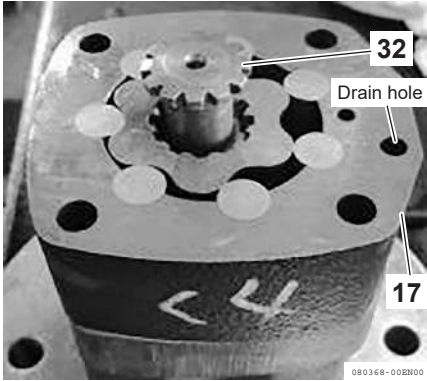
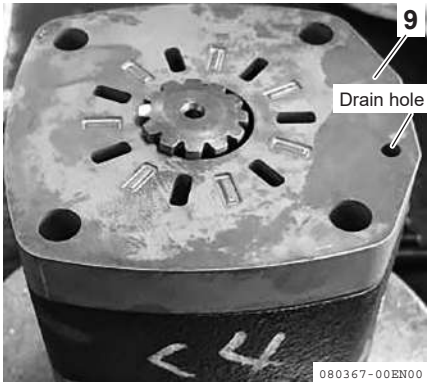
Incorrect installation of the pinion gear **10** may cause damage to the bearing housing **15**.



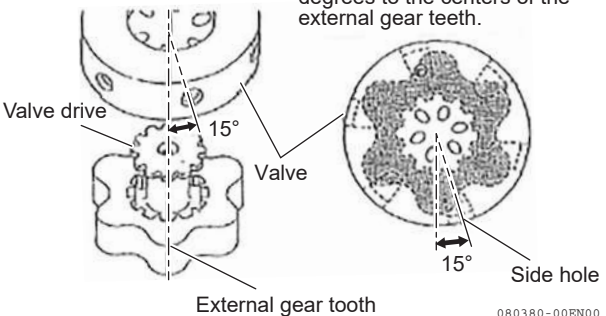
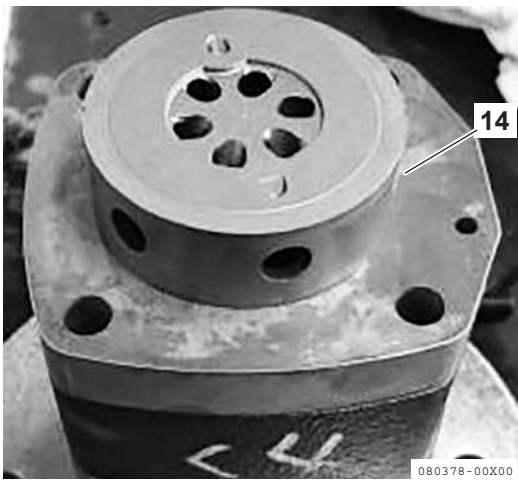
- (4) Install retaining ring **19** onto pinion gear **10**.

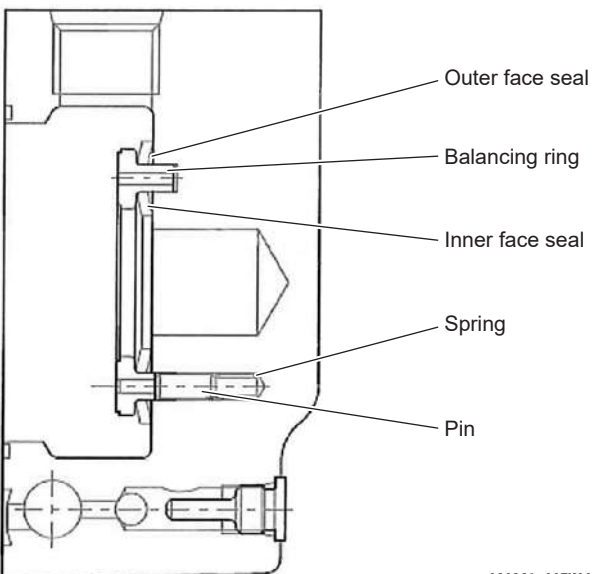
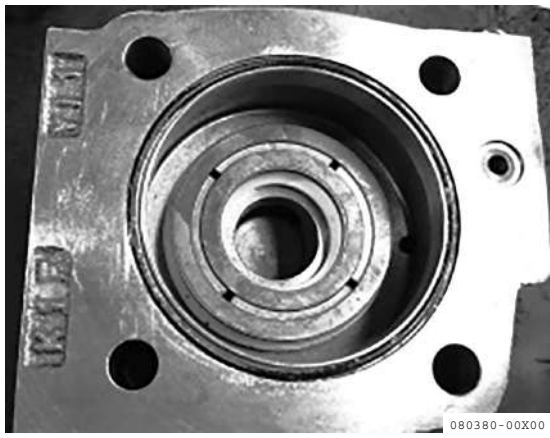


6. HYDRAULIC EQUIPMENT

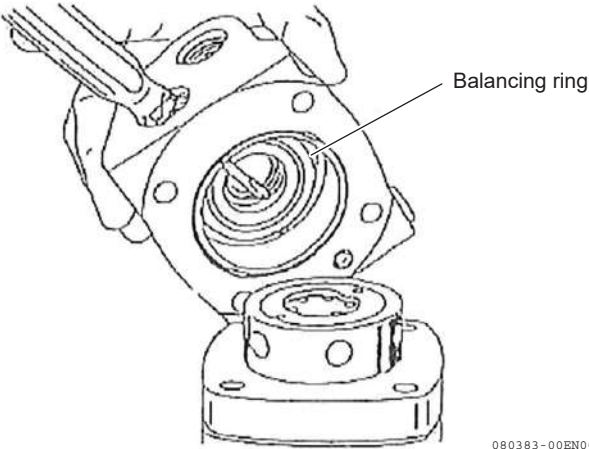
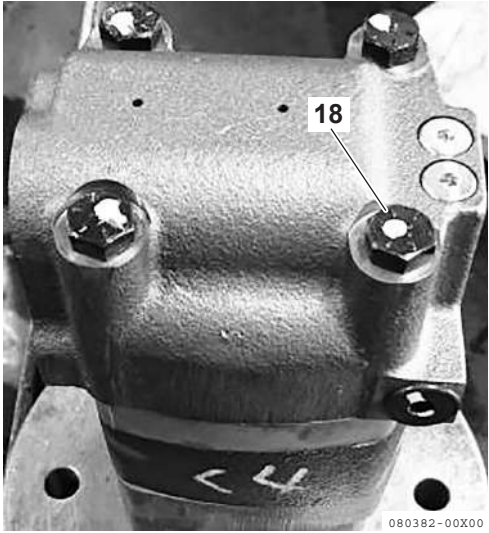
Procedure	
(5) Install O-ring 26 into the groove in bearing housing 15. Install shaft face seal 22 in wear plate 20 and then install wear plate 20 on bearing housing 15. (6) Install the O-rings (two types) 26, 30 into their grooves in wear plate 20 and install drive 16 into pinion gear 10 through hole of wear plate 20.  080377-00EN00	 080369-00EN00
(7) Install geroller 17 on wear plate 20 and install valve drive 32 in geroller rotor. Note: When installing geroller 17, make sure its drain hole is aligned with that of wear plate 20.	 080368-00EN00
(8) Install the O-rings (two types) 26, 30 into their grooves in valve plate 9 and then install valve plate 9 on geroller 17. Note: When installing valve plate 9, make sure its drain hole is aligned with that of geroller 17.	 080367-00EN00

6. HYDRAULIC EQUIPMENT

Procedure	
(9) Install valve 14 on the valve plate 9. Note: <i>Because installation of the valve is a crucial step in determining the direction of rotation of the motor, make sure the valve is installed correctly as shown in the figures below. Incorrect valve timing may cause the motor to rotate in the reverse direction, resulting in serious injury or equipment damage.</i> The centers of the side holes in the valve must be shifted by 15 degrees to the centers of the external gear teeth.  Valve drive 15° Valve 15° Side hole External gear tooth 080380-00EN00	 14 080378-00X00

(10) Install springs 7 and then pins 6 into two holes in valve housing assembly 33. Install O-rings (two types) 27, 30 into their grooves in valve housing assembly 33. Install inner and outer face seals 28, 29 onto balancing ring 8 and then install the balancing ring in valve housing assembly 33 while aligning notches in balancing ring 8 with pins 6 in valve housing assembly 33. Note: <i>Make sure the inner and outer face seals 28, 29 are installed in the right direction as shown in the figure below.</i>  Outer face seal Balancing ring Inner face seal Spring Pin 080381-00EN00	 080380-00X00
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6. HYDRAULIC EQUIPMENT

Procedure	
(11) Install valve housing assembly 33. Notes: • When doing this, insert a long thin bar like a screwdriver through a port in valve housing assembly 33 and hold balancing ring 8 with the bar against the inside of valve housing assembly 33 to prevent it from falling off, as shown in the figure below. • Make sure the drain port in valve housing assembly 33 is aligned with the drain port in the valve plate. (12) Align the bolt holes and then install and tighten hexagon bolts 18. Tightening torque: 40 ft•lbf (54 N•m)  080383-00EN00	 080382-00X00

This completes the reassembly procedure.

Before installing the motor on the machine, be sure to check for oil leaks and whether the motor rotates in the correct direction.

If the direction of rotation is not correct, disassemble and reassemble the motor again with correct valve timing achieved.

If any oil leaks are observed, disassemble the motor again, replace damaged seals and then perform reassembly.

6. HYDRAULIC EQUIPMENT

6) Troubleshooting

Trouble	Cause	Measure
1. Motor does not rotate.	(1) Insufficient hydraulic oil quantity in hydraulic oil tank.	Supply hydraulic oil to a specified level.
	(2) Broken 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 a specified value.
	(4) Excessive wear or scuffing of motor section	Disassemble the motor section to check the parts. Replace any damaged parts.
	(5) Short-circuit inside motor	The face seals or other parts would be damaged. Disassemble the motor to check the parts. Replace any damaged parts.
2. Unstable rotation	(1) Low relief set pressure	Adjust the pressure of the relief valve to a specified value.
	(2) Air in pump on the suction side	Check the piping on 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 leakage from joint	(1) Loosened bolt	Tighten the bolt at a specified tightening torque.
	(2) Caught or damaged O-ring	Replace the O-ring.

6. HYDRAULIC EQUIPMENT

6-4 Valve Block (Link track gauge change type) SV08-1A

1. Structure and Theory of Operation

The oil flows freely from the port A to the ports A2 and B1, and from the port B to the ports A1 and B2, while the opposite oil flow is blocked.

1) Oil Flow from Port A to Ports A2 and B1

■ Refer to the sectional view of A-A

When the oil is flowing from the port A to the port A2, pressure is applied to the piston. If the pilot pressure from the port A to the port A2 is higher than one third of the pressure at the port A1, the piston is moved to the left to open the left check valve and consequently the oil flows from the port A1 to the port B.

As shown in the symbol below, when the oil flows from the port A to the port A2, the oil also flows from the port A to the port B1.

■ Refer to the sectional view of B-B

Just like the case of the section A-A, if the pilot pressure from the port A to the port B1 is higher than one third of the pressure at the port B2, the piston is moved to the right to open the right check valve and consequently the oil flows from the port B2 to the port B.

2) Oil Flow from Port B to Ports A1 and B2

The theory of operation is the quite same as that for the above 1).

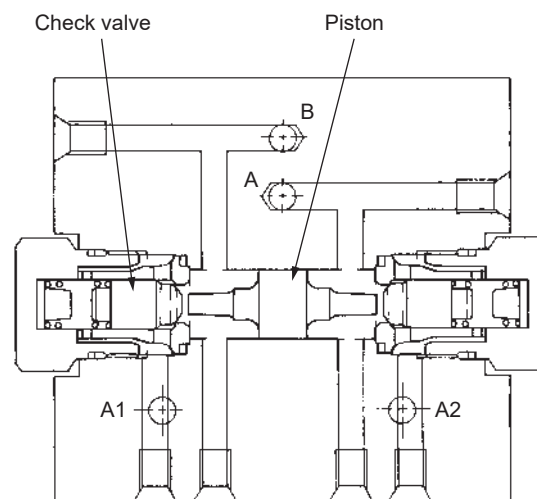
■ Refer to the sectional view of A-A

When the oil is flowing from the port B to the port A1, pressure is applied to the piston. If the pilot pressure from the port B to the port A1 is higher than one third of the pressure at the port A2, the piston is moved to the right to open the right check valve and consequently the oil flows from the port A2 to the port A.

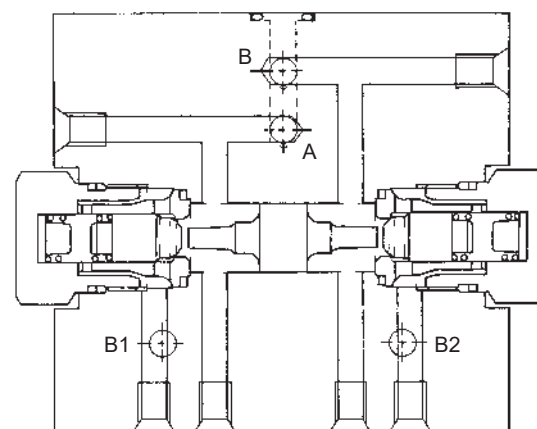
As shown in the symbol below, when the oil flows from the port B to the port A1, the oil also flows from the port B to the port B2.

■ Refer to the sectional view of B-B

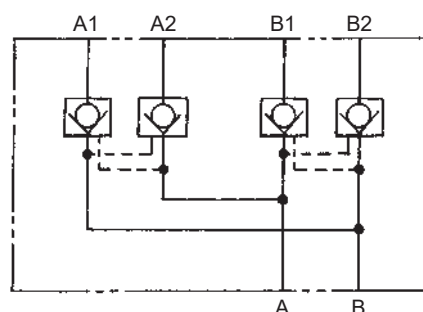
Just like the case of the section A-A, if the pilot pressure from the port B to the port B2 is higher than one third of the pressure at the port B1, the piston is moved to the left to open the left check valve and consequently the oil flows from the port B1 to the port A.



A - A



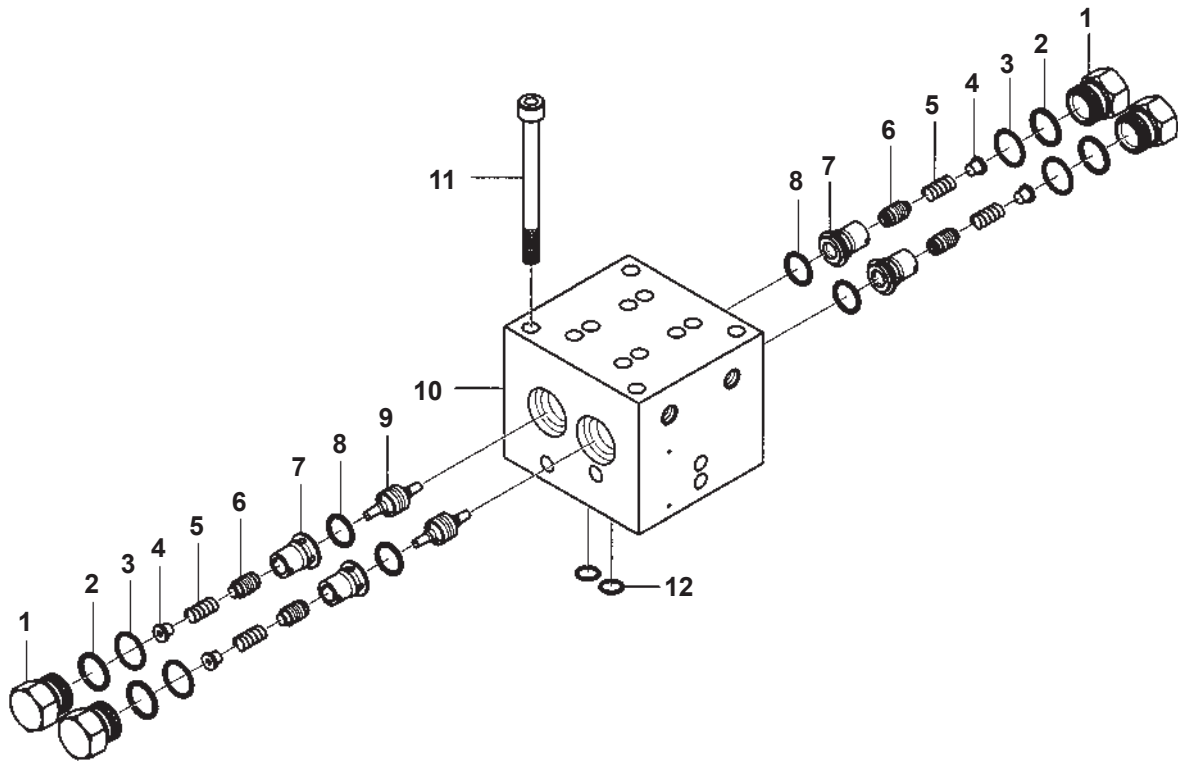
B - B



Symbol

6. HYDRAULIC EQUIPMENT

2. Exploded View and Component Parts



No.	Part	Q'ty
1	Plug	4
2	Backup ring (17.91×1.35)	4
3	O-ring (17.0×1.5)	4
4	Spring seat	4
5	Spring (7.5 / 1×15.5 / 5.5)	4
6	Plunger	4
7	Valve seat	4
8	O-ring 015 (14.00×1.78)	4
9	Piston	2
10	Body	1
11	Hexagon socket head bolt M8×90	4
12	O-ring 012 (9.25×1.78)	2

6. HYDRAULIC EQUIPMENT

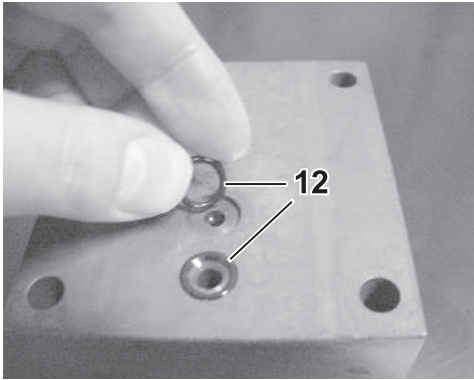
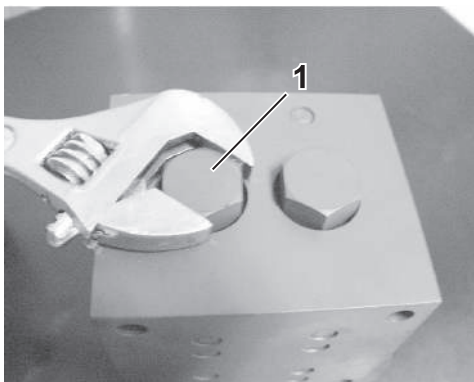
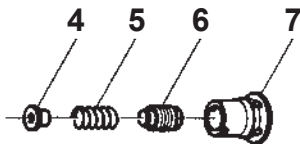
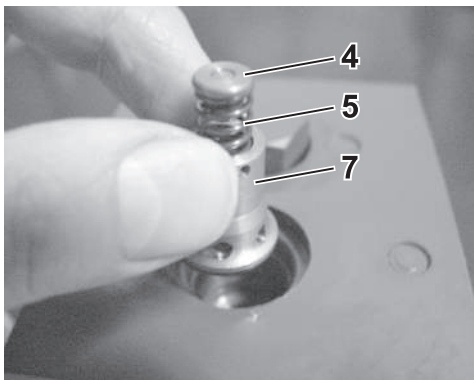
3. Disassembly and Reassembly

1) Precautions for Disassembly and Reassembly

- Take care not to damage the surfaces of the parts during disassembly and reassembly work. When reassembling the parts, clean them with a washing agent and keep them free from dust and the like.
- Replace the removed O-rings with new ones in principle.

6. HYDRAULIC EQUIPMENT

2) Disassembly

Procedure	
(1) Remove the O-rings 12 from the contact surface with the gasket.	 A close-up photograph showing a hand using a finger to peel an O-ring, labeled with the number 12, off the contact surface of a metal block.
(2) Remove the plug 1 of the check valve assembly on one side of the body 10 . [Width across flats : 0.87 in. (22 mm)]	 A photograph showing a wrench being used to turn and remove a hexagonal plug, labeled with the number 1, from a metal block.
(3) Take out the internal parts of the check valve assembly.	  The left image is an exploded view diagram of four small components labeled 4, 5, 6, and 7. Component 4 is a small O-ring, 5 is a spring, 6 is a small washer or spacer, and 7 is a larger cylindrical part. The right image is a photograph showing a hand removing these internal components from a metal block.
(4) Take out the piston 9 from the body 10 .	 A photograph showing a hand using a finger to push a piston, labeled with the number 9, out of a hole in a metal block.

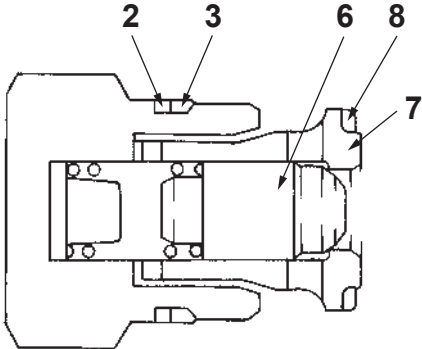
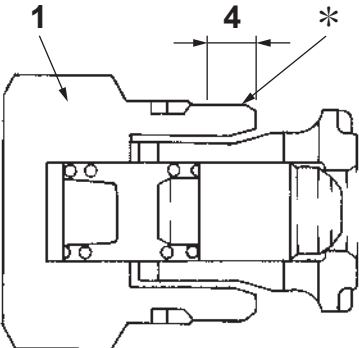
6. HYDRAULIC EQUIPMENT

Procedure	
(5) Remove the check valve assemblies on the other side of the body 10 according to the steps (2) and (3).	

6. HYDRAULIC EQUIPMENT

3) Disassembly and Reassembly

Reassemble the valve block in the reverse order of the disassembly procedure.

Procedure	
(1) Wash the parts cleanly and dry them up.	
(2) Inspect the moving surface of each piston, and the valve seat and the plunger of each check valve carefully. If any of them is excessively worn or damaged, replace it with a new one.	
(3) Check that the plunger 6 moves smoothly inside the valve seat 7. Apply grease thinly to the backup ring 2 and the O-rings 3 and 8.	
(4) Remove grease and oil from the check valve assembly and the valve hole in the valve block body, and then apply Loctite #572 or its equivalent to the area marked with the asterisk (*) of the plug shown in the figure below. Tightening torque : 18.1 to 22.4 ft·lbf (24.5 to 30.4 N·m)	

6. HYDRAULIC EQUIPMENT

4. Troubleshooting

Trouble	Cause	Measure
Check valve does not open	Foreign matter caught	Disassemble the valve to clean the parts.
	Defective piston	Check the moving surface of the piston. If it is damaged, replace the piston.
Check valve does not operate as a check	Foreign matter caught	Disassemble the valve to clean the parts.
	Defective valve seat	Replace the check valve assembly.

6. HYDRAULIC EQUIPMENT

6-5 Travel Motor

1. Structure

The travel motor consists of a swash plate type axial piston motor, a hydraulic valve, a two-speed switching mechanism, a reduction gear and other parts.

The swash plate type axial piston motor has 7 pistons and a 2-speed (low and high) switching mechanism.

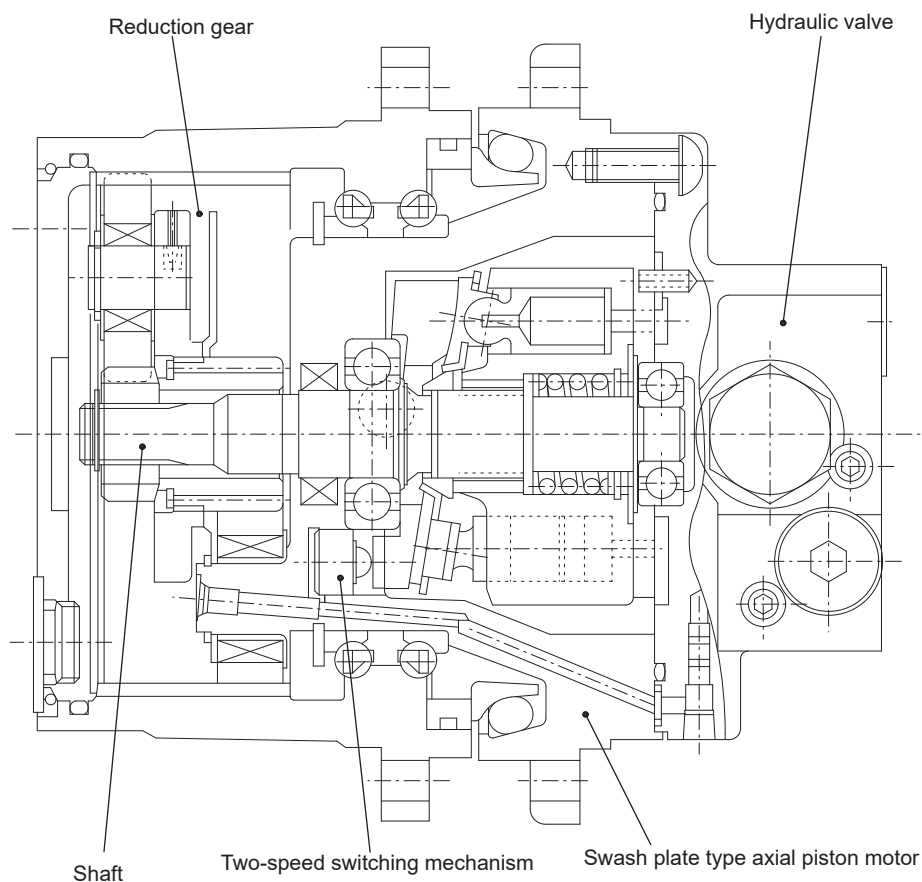
The hydraulic valve is integrated with the piston motor which is housed in the reduction gear.

The reduction gear reduces the output speed of the piston motor through the planetary double-reduction mechanism to increase the output torque and transmit it to the sprocket.

Note :

Although this travel motor has a 2-speed switching mechanism, pilot line for it is connected with tank line.

Accordingly, high speed cannot be used.



6. HYDRAULIC EQUIPMENT

2. Theory of Operation

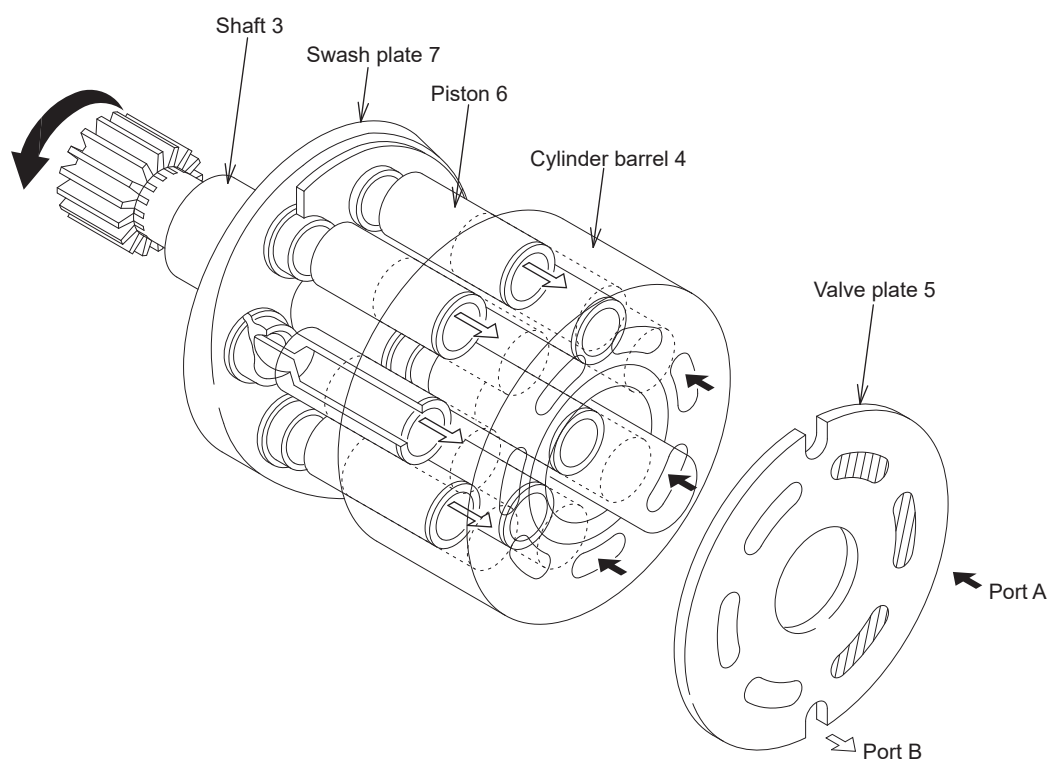
1) Motor

When the travel section of the control valve is switched to "Travel", the pressure oil which has flown in through the hydraulic valve flows to the valve plate 5. Then, the pressure oil flows from the valve plate 5 into the cylinder ports, which correspond to the port A, in the cylinder barrel 4 and presses the pistons 6. This pressing force is applied to the sliding surface of the swash plate 7, and the shoes installed to the pistons slide on the sliding surface of the swash plate toward the circumference of the plate. That motion of more than one piston on the high pressure side is converted into the rotational motion of the cylinder barrel 4.

The rotational motion is transmitted to the shaft 3 splined to the cylinder barrel 4.

When those pistons move to the low pressure side, the oil in the cylinder ports is pushed out by the pistons. The discharged oil flows through the port B of the valve plate 5 to the tank passage.

When the travel section of the control valve is switched to the opposite side, the pressure in the port B becomes high and the pressure in the port A becomes low, so that the rotation of the shaft 3 is reversed.



6. HYDRAULIC EQUIPMENT

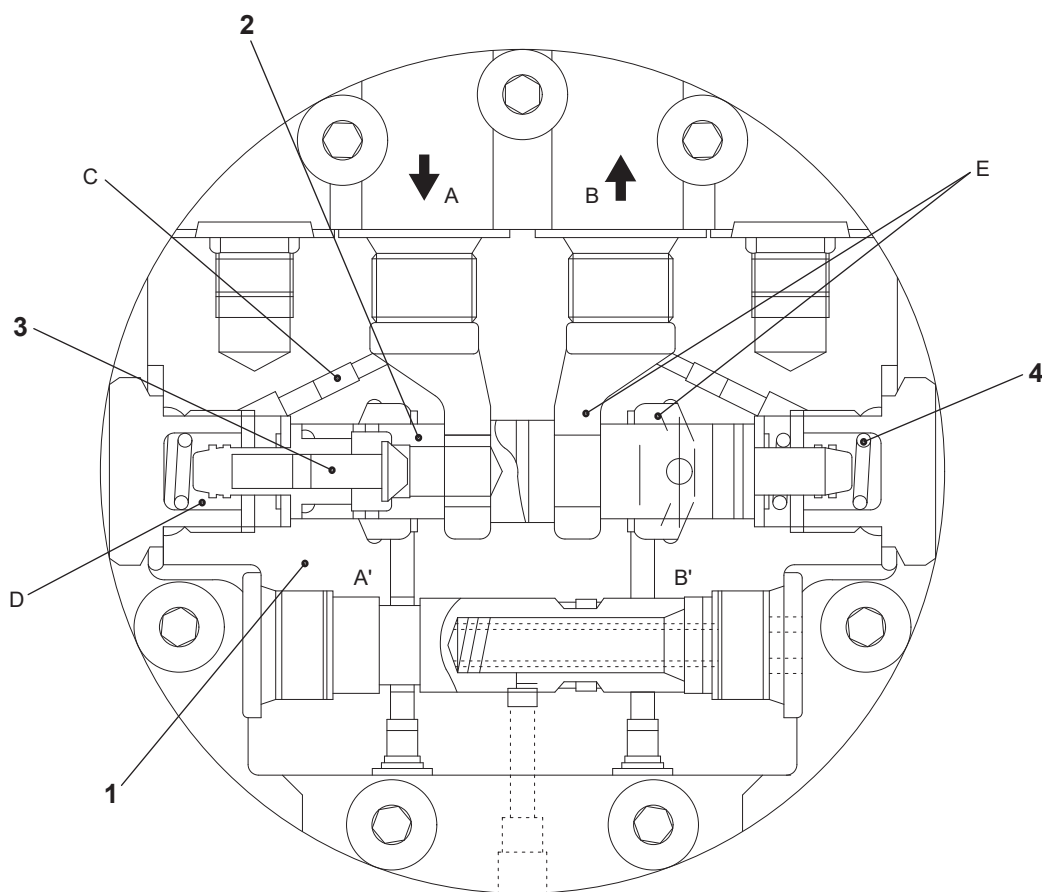
2) Hydraulic Valve (Counterbalance Valve)

When pressure oil is fed from the port A, it presses and opens the check valve **3** and then flows into the port A' on the inlet side of the hydraulic motor; while the pressure oil flows into the chamber D through the choke C and exceeds the force of the spring **4** to slide the spool valve **2** to the right. This causes the oil on the return side of the hydraulic motor to flow in from the port B' and return to the port B through the opening E in the spool valve **2**, so that the hydraulic motor is rotated.

When pressure oil is fed from the port B, the above parts operate in the opposite way and the hydraulic motor is rotated in reverse.

When the pressure oil from the port A is blocked, the spool valve **2** which has moved to the right starts to be returned to the left by the force of the spring **4**. At this time, the oil in the chamber D starts to flow out to the port A through the choke C. However, the throttling of the choke C controls the speed at which the spool valve **2** returns to the left.

The hydraulic motor keeps rotating due to inertial force even after the pressure oil from the port A is blocked. In this condition, the controlled return speed and notched shape of the spool valve **2** allows smooth stop of the hydraulic motor through gradual reduction of return oil.



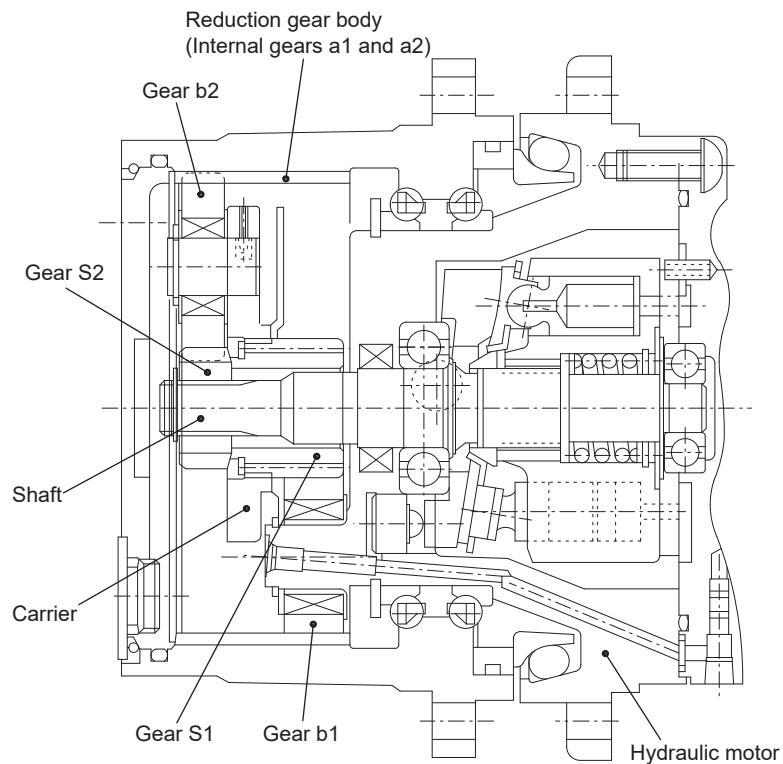
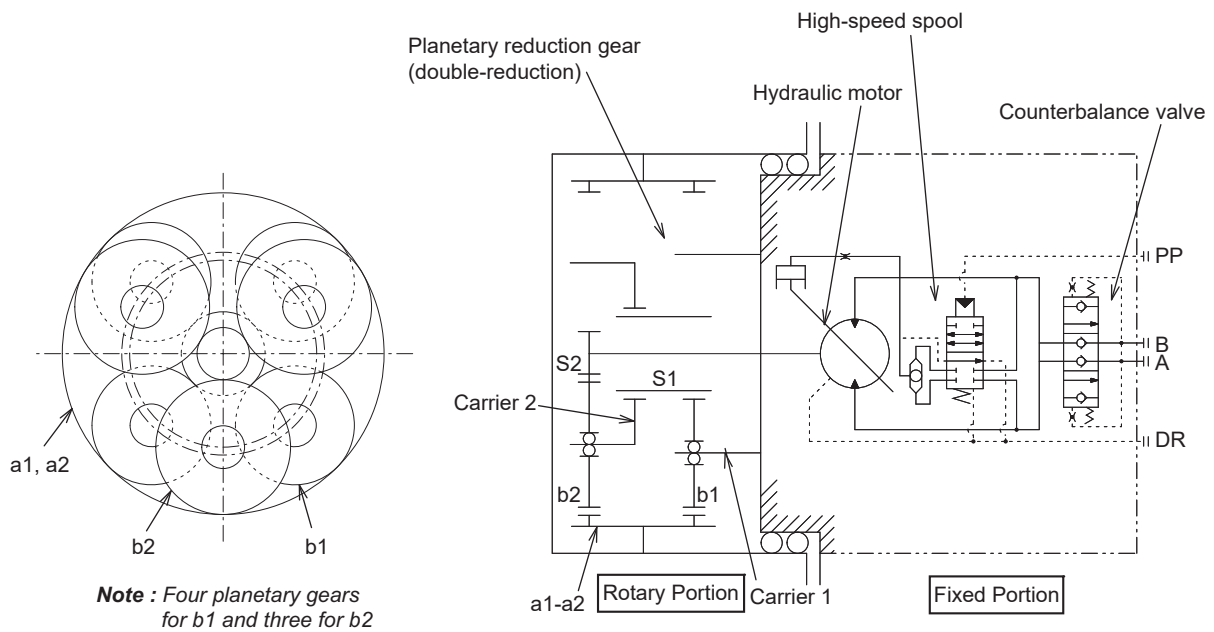
6. HYDRAULIC EQUIPMENT

3) Reduction Gear

The reduction gear has a planetary double-reduction mechanism. It reduces the speed of the high-speed rotational motion transmitted from the hydraulic motor to convert the rotational motion into large low-speed torque, so that the gear case can be rotated.

The gear S2 is splined to the output shaft of the hydraulic motor, so that the rotational speed of the gear S2 is reduced to the first level between the gears S2, b2 and a2.

This one level-reduced rotational speed is reduced to the second level between the gear S1 splined to the carrier 2, the gears b1 and a1. This rotation is transmitted to the reduction gear body via the internal gears a1 and a2 and converted to travel driving force.



6. HYDRAULIC EQUIPMENT

3. Disassembly and Reassembly

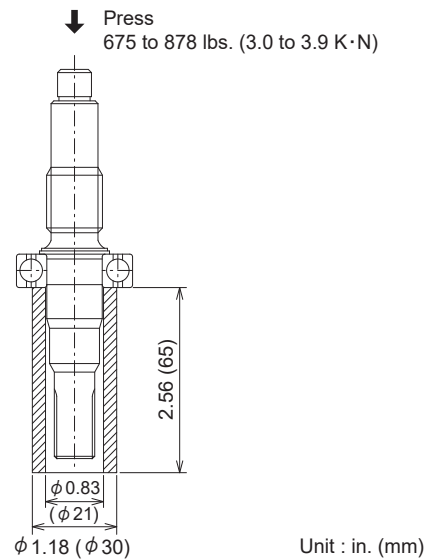
1) Precautions for Disassembly and Reassembly

- (1) Since the parts of the hydraulic equipment are precision-made for tight clearances, be sure to perform disassembly and reassembly in a clean 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 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 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.

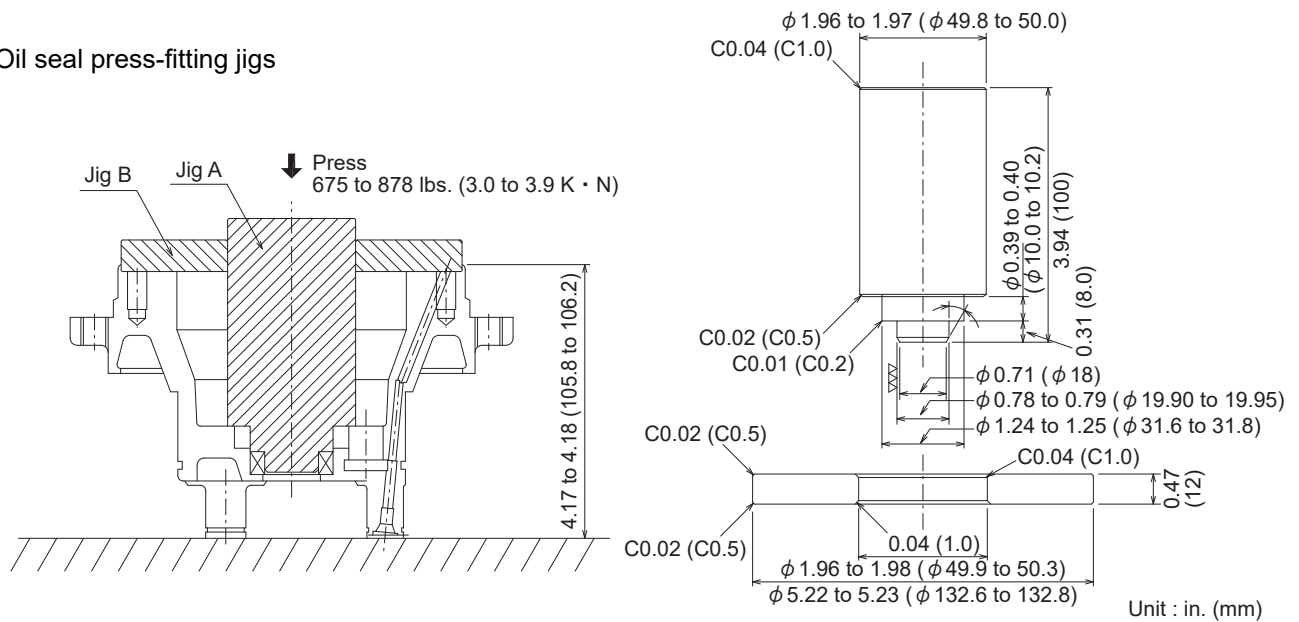
6. HYDRAULIC EQUIPMENT

2) Special Tools

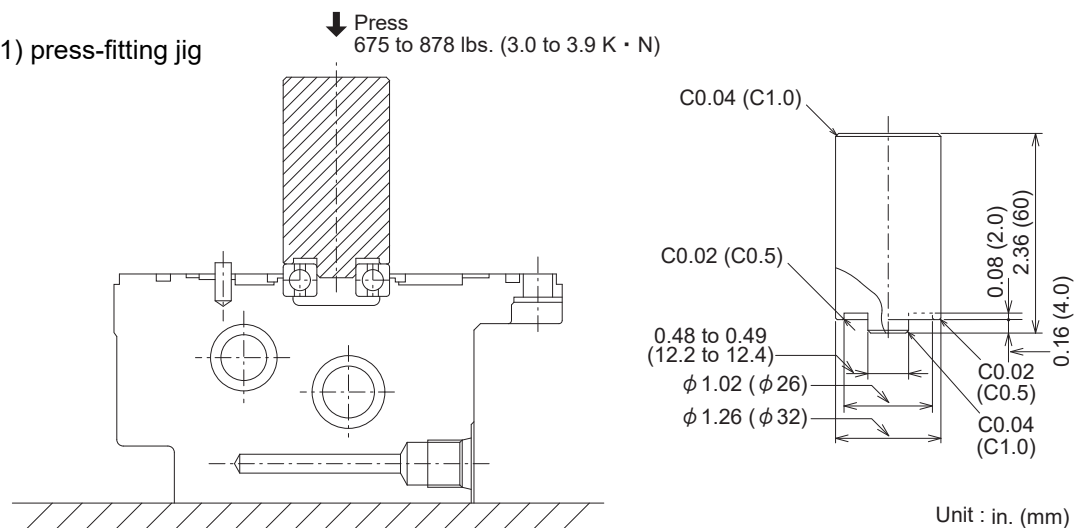
1. Bearing (for shaft) press-fitting jig



2. Oil seal press-fitting jigs

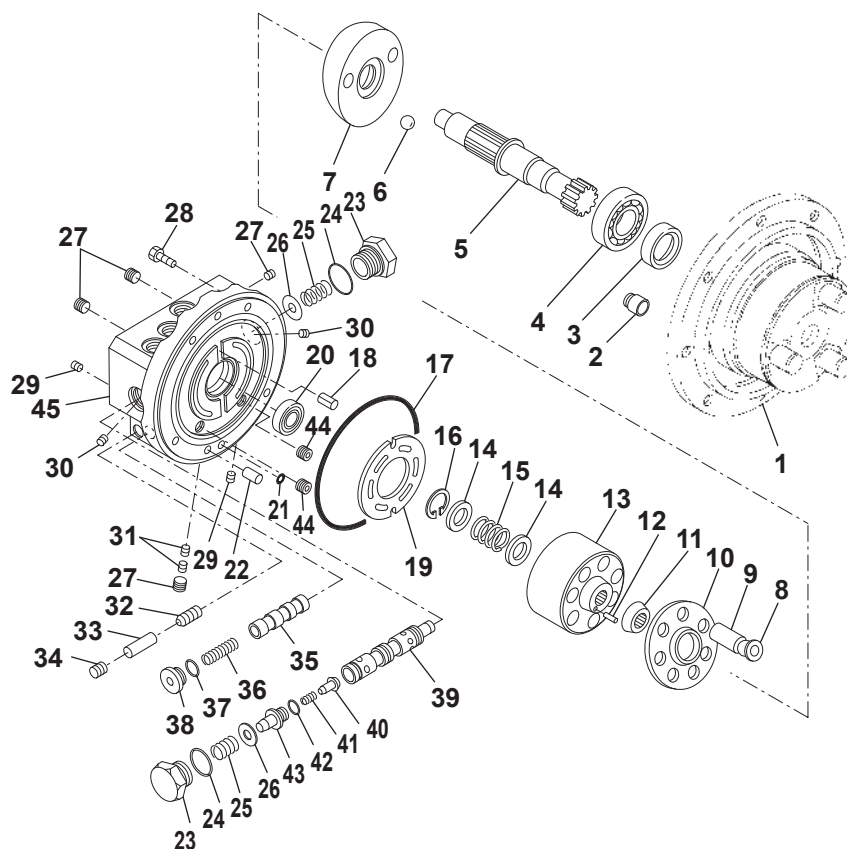


3. Bearing (for body 1) press-fitting jig



6. HYDRAULIC EQUIPMENT

3) Exploded View and Component Parts (Motor Section and Valve Section)

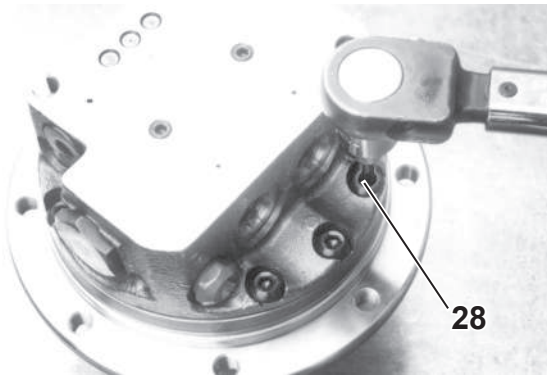
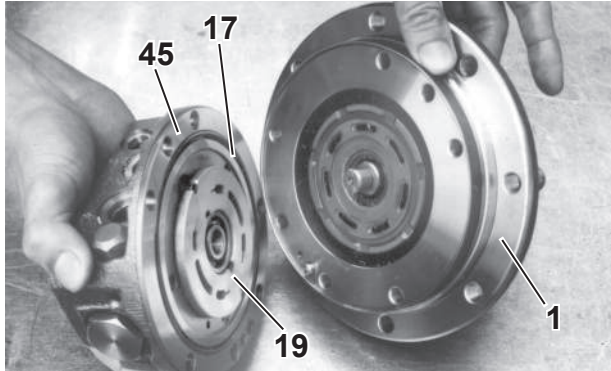
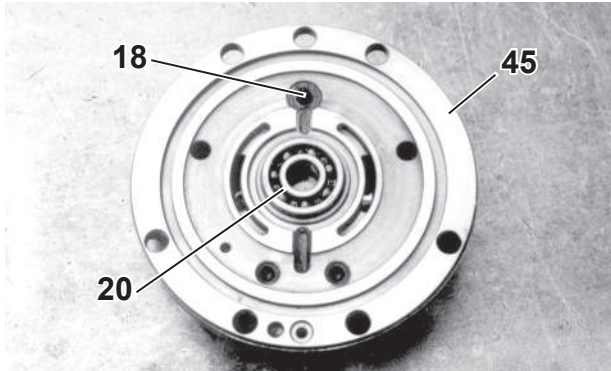
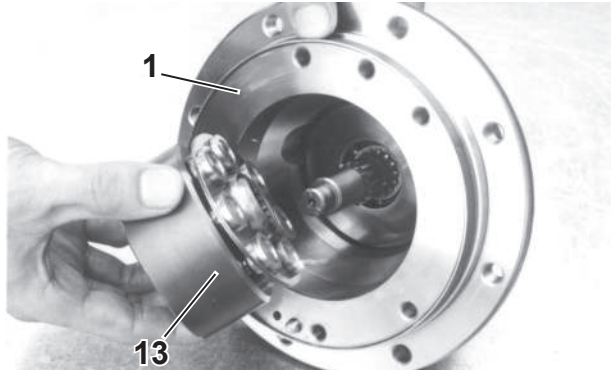


No.	Part	Q'ty	No.	Part	Q'ty
1	Body 2	1	24	O-ring 1BP18	2
2	Control piston	1	25	Spring V2	2
3	Oil seal	1	26	Ring	2
4	Bearing 6004	1	27	Plug 1 / 16	4
5	Shaft	1	28	Hexagon socket head bolt	7
6	Ball	2	29	Plug	6
7	Swash plate	1	30	Choke 0.4	2
8	Shoe	7	31	Choke 0.5	2
9	Piston	7	32	Shuttle spool	1
10	Shoe holder	1	33	Pin	2
11	Barrel holder	1	34	Plug 1 / 16	2
12	Pin	3	35	High-speed spool	1
13	Cylinder barrel	1	36	Spring V3	1
14	Retainer	2	37	O-ring 1BP14	2
15	Spring C	1	38	Plug	2
16	Internal snap ring 28	1	39	Spool	1
17	O-ring 1B105	1	40	Check valve	2
18	Spring pin	1	41	Spring V1	2
19	Valve plate	1	42	O-ring 1A10	2
20	Bearing 6201	1	43	Spring guide	2
21	O-ring 1BP6	1	44	Plug 1 / 8	2
22	Pin 6 × 14	1	45	Body 1	1
23	Plug	2			

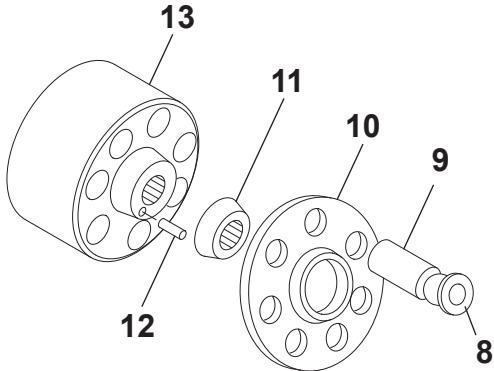
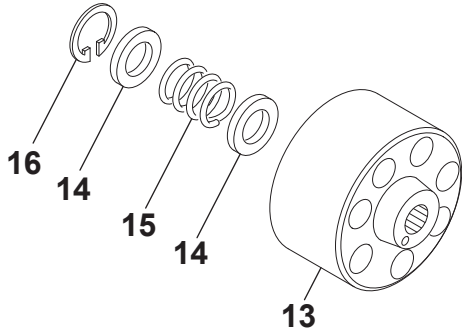
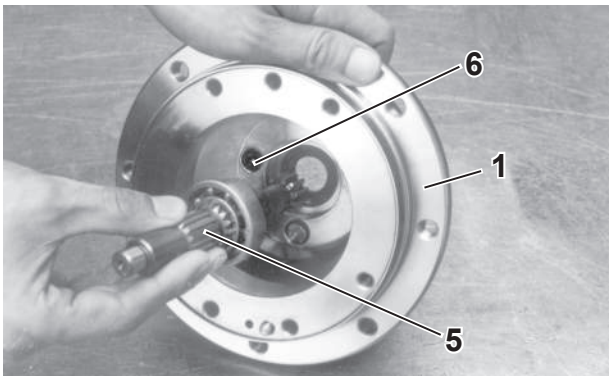
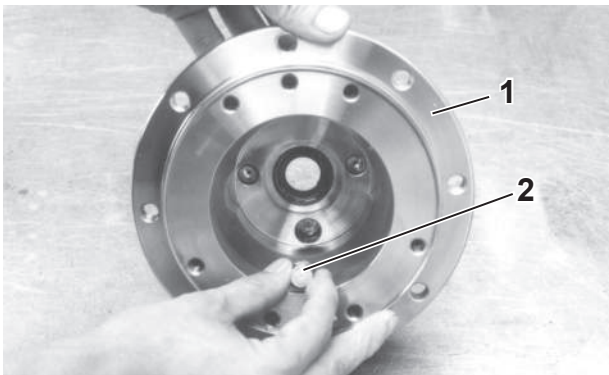
6. HYDRAULIC EQUIPMENT

4) Disassembly and Reassembly

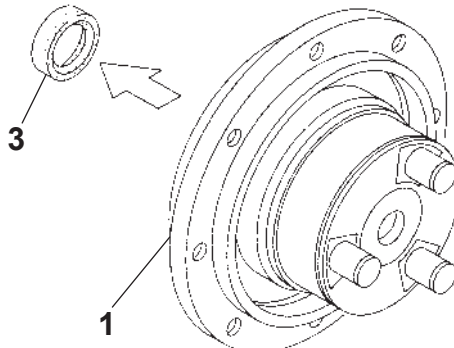
4)-1 Disassembly of Motor Section Procedure

Procedure	
(1) Hold the hydraulic motor with a vice to remove hexagon socket head bolts 28. Note : <i>Put aluminum plates or the like between the hydraulic motor and the vice to prevent damage to the outside surface of the body 2.</i> [Width across flats : 0.20 in. (5 mm)]	
(2) Remove body 1 45 from body 2 1. Notes : • Take care not to drop valve plate 19. • The oil in the case might flow out. Take care about the oil.	
(3) Remove valve plate 19 and O-ring 17 from body 1 45. Note : <i>Spring pin 18 and bearing 20 cannot be removed from body 1 45, because they are press fitted into body 1 45.</i>	
(4) Remove cylinder barrel assembly 13 from body 2 1.	

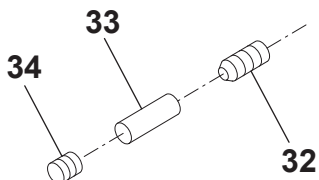
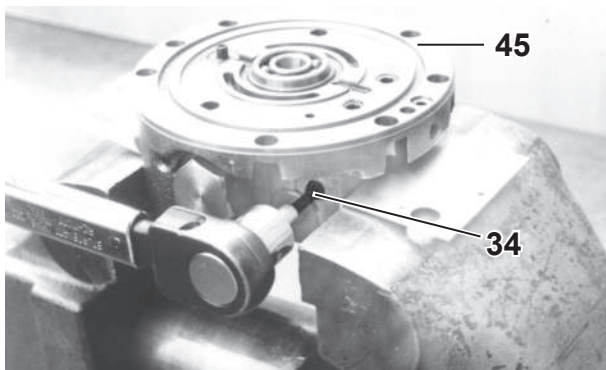
6. HYDRAULIC EQUIPMENT

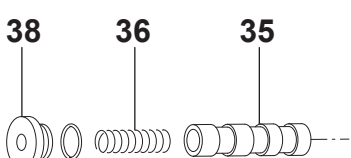
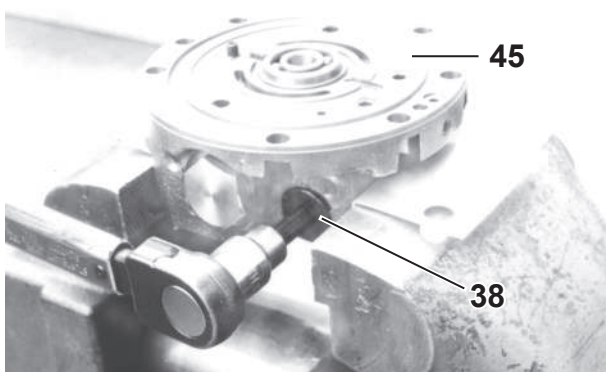
Procedure	
(5) Remove the piston shoe assemblies (pistons 9 and shoes 8), shoe holder 10, barrel holder 11 and pins 12 from cylinder barrel 13. Note : <i>Each piston shoe assembly cannot be disassembled because the piston and the shoe are caulked.</i>	
(6) Remove internal snap ring 16 from cylinder barrel 13, and remove retainers 14 and spring 15.	
(7) Remove swash plate 7, shaft 5 and balls 6 from body 2 1. Notes : • If the shaft cannot be removed easily, tap the shaft on the other end face with a plastic hammer to remove it. • Take care not to damage the oil seal with the shaft.	
(8) Remove control piston 2 from body 2 1.	

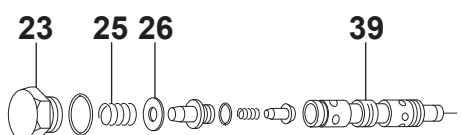
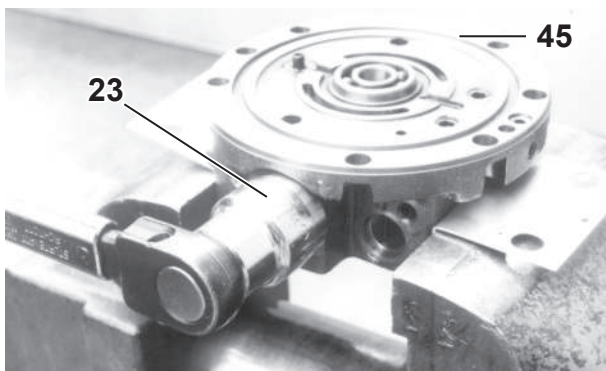
6. HYDRAULIC EQUIPMENT

Procedure	
(9) Remove oil seal 3 from body 2 1 .	

4)-2 Disassembly of Hydraulic Valve Section

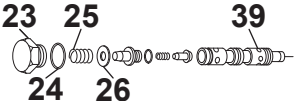
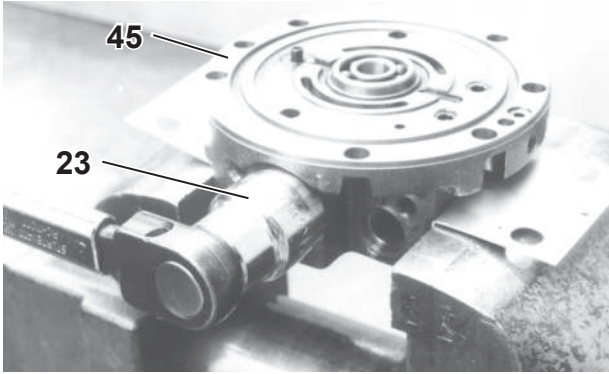
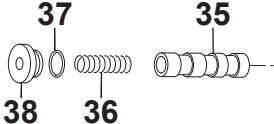
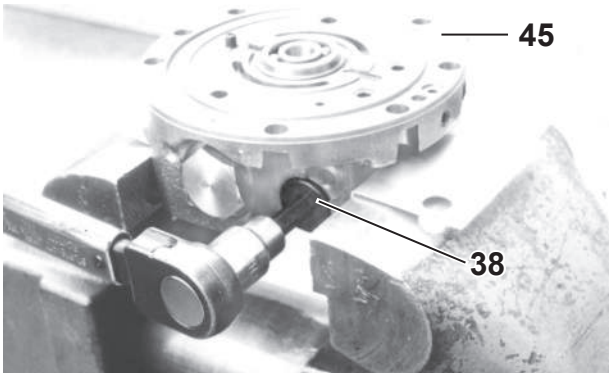
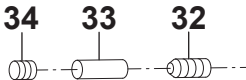
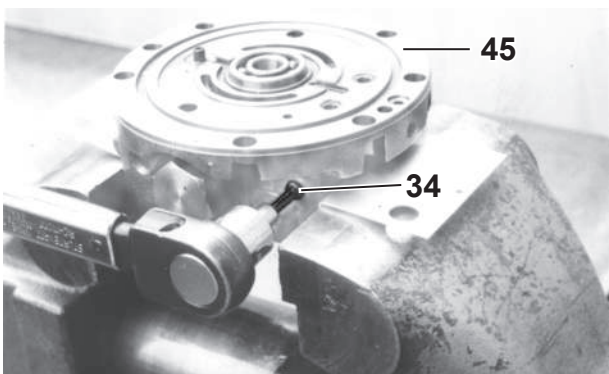
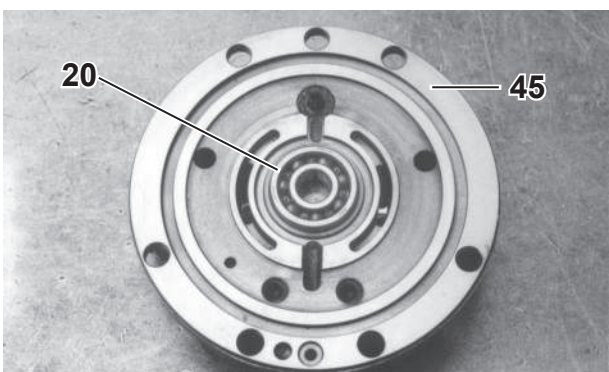
(1) Loosen plugs 34 (on both sides) to remove shuttle spool 32 and pins 33 (on both sides) from body 1 45. [Width across flats : 0.20 in. (5 mm)] 	
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(2) Loosen plugs 38 (on both sides) to remove high-speed spool 35 and spring 36 from body 1 45. [Width across flats : 0.31 in. (8 mm)] 	
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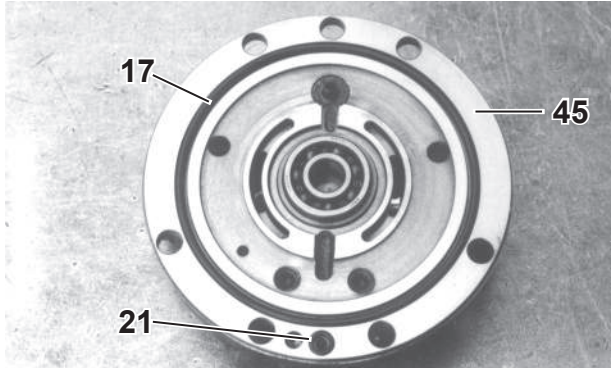
(3) Loosen plugs 23 (on both sides) to remove spool assembly 39, rings 26 (on both sides) and springs 25 (on both sides) from body 1 45. Note : <i>The spool assembly cannot be disassembled because the parts of the assembly are put together with adhesive.</i>  [Width across flats : 1.06 in. (27 mm)]	
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6. HYDRAULIC EQUIPMENT

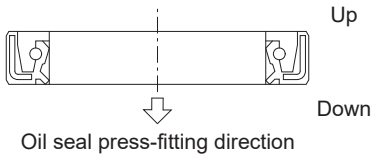
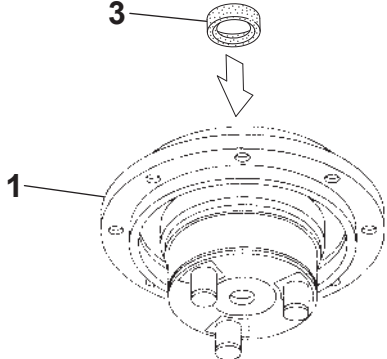
4)-3 Reassembly of Hydraulic Valve Section Procedure

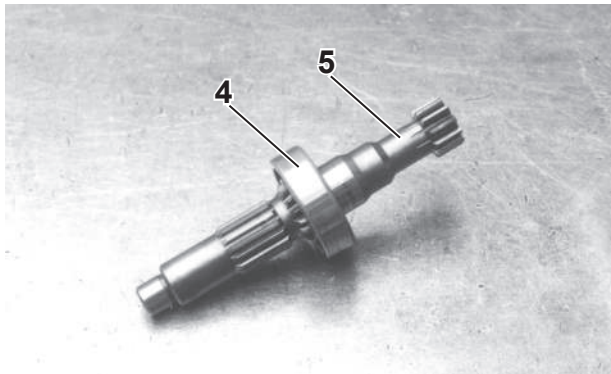
Procedure	
(1) Install spool assembly 39, rings 26 (on both sides) and springs 25 (on both sides) in this order into body 1 45, and install and tighten plugs 23 with O-rings 24 installed (on both sides). Note : <i>The spool assembly cannot be disassembled.</i> Tightening torque : 123.1 to 144.8 ft·lbf (166.7 to 196.1 N·m) (In two places)  [Width across flats : 1.06 in. (27 mm)]	
(2) Install high-speed spool 35 and spring 36 into body 1 45, and install and tighten plugs 38 with O-rings 37 installed (on both sides). Tightening torque : 34.0 to 38.4 ft·lbf (46.1 to 52.0 N·m) (In two places)  [Width across flats : 0.31 in. (8 mm)]	
(3) Install shuttle spool 32 and pins 33 (on both sides) into body 1 45, and install and tighten plugs 34 (on both sides). Tightening torque : 4.4 ft·lbf (5.9 N·m) (In two places)  [Width across flats : 0.20 in. (5 mm)]	
(4) Press fit bearing 20 into body 1 45.	

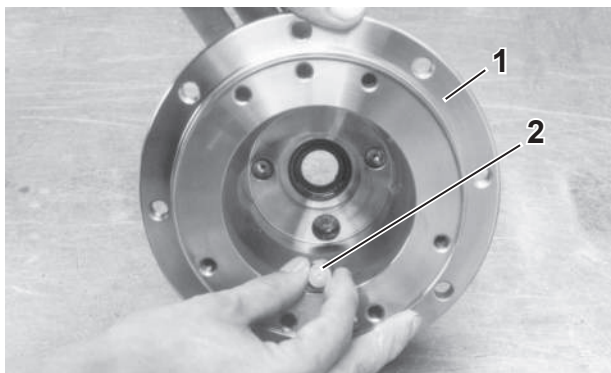
6. HYDRAULIC EQUIPMENT

Procedure	
(5) Install O-rings 17 and 21 to body 1 45 .	

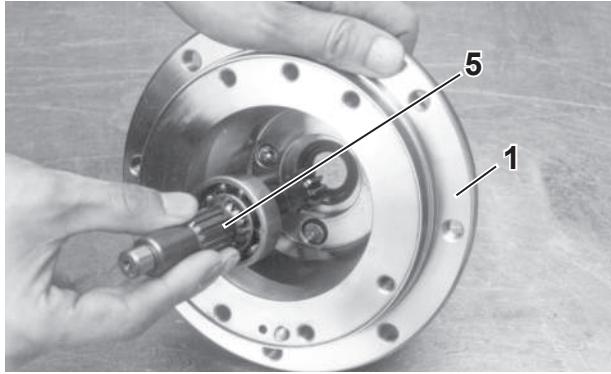
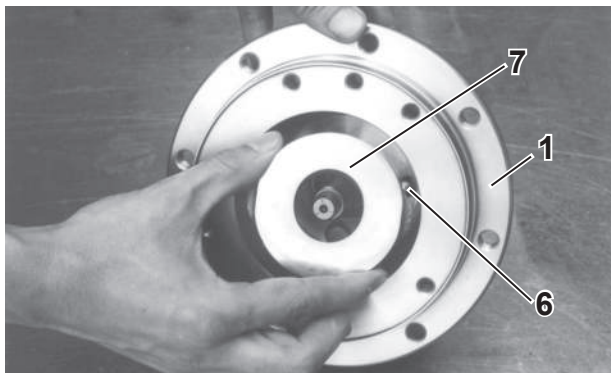
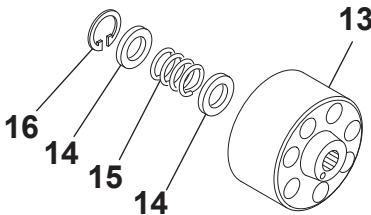
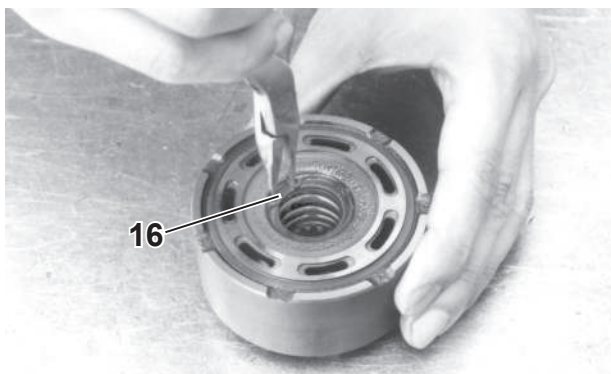
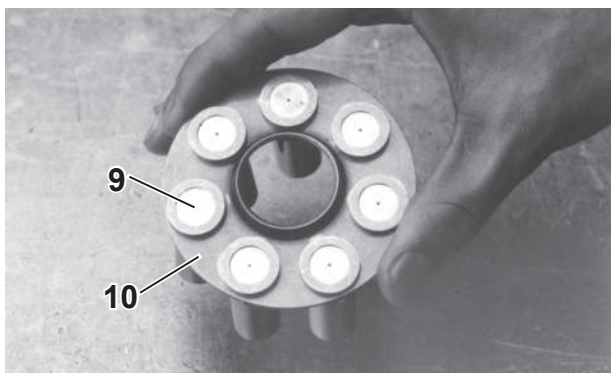
4)-4 Reassembly of Motor Section

(1) Press fit oil seal 3 into body 2 1. Notes : • Fill the space between the lips of the oil seal with grease. • Press fit the oil seal into the body 2 in the direction as shown in the figure below. 	
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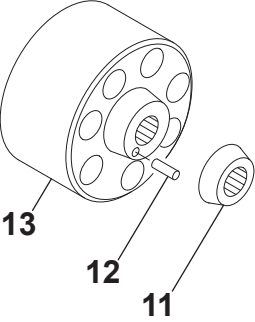
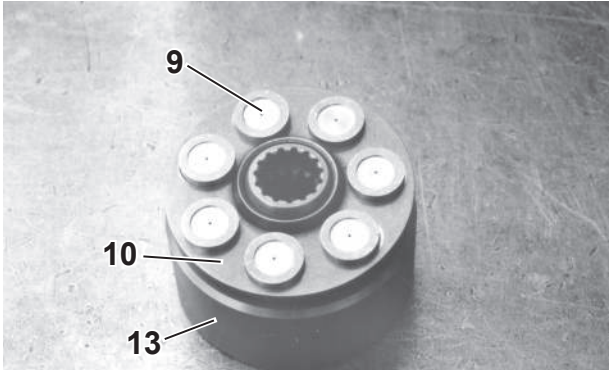
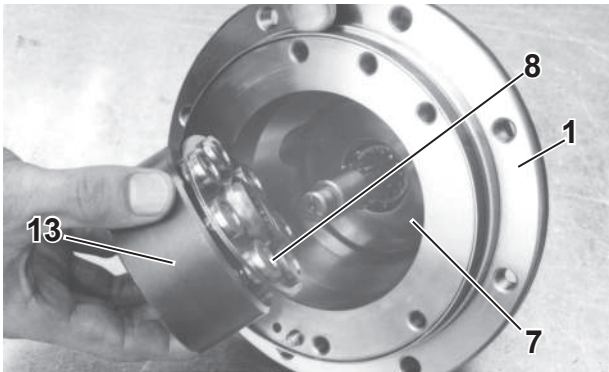
(2) Press fit bearing 4 onto shaft 5.	
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(3) Install control piston 2 into body 2 1.	
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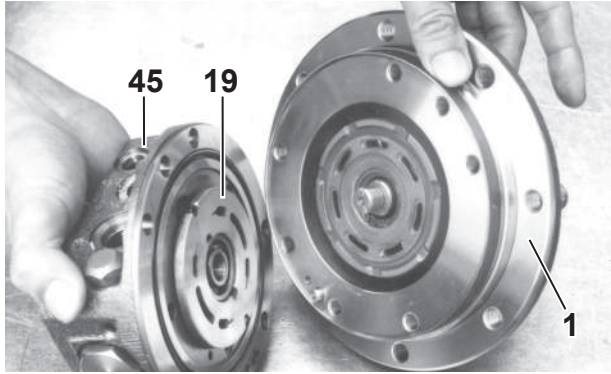
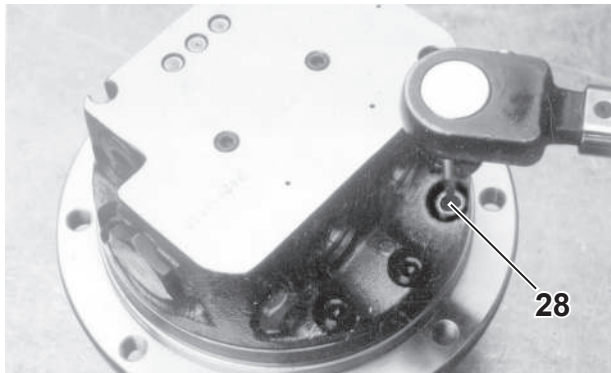
6. HYDRAULIC EQUIPMENT

Procedure	
(4) Install shaft 5 into body 2 1. Note : Take care not to damage the oil seal with the shaft.	
(5) Install two balls 6 and swash plate 7 to body 2 1. Notes : • Apply hydraulic oil to the sliding surface of the swash plate. • If the swash plate is likely to fall off when installed, apply grease to the other side of the swash plate.	
(6) Install retainer 14, spring 15 and retainer 14 in this order into the cylinder barrel 13, and fasten them with internal snap ring 16. 	
(7) Install piston shoe assemblies (pistons 9 and shoes 8) to shoe holder 10 to make the shoe holder assembly.	

6. HYDRAULIC EQUIPMENT

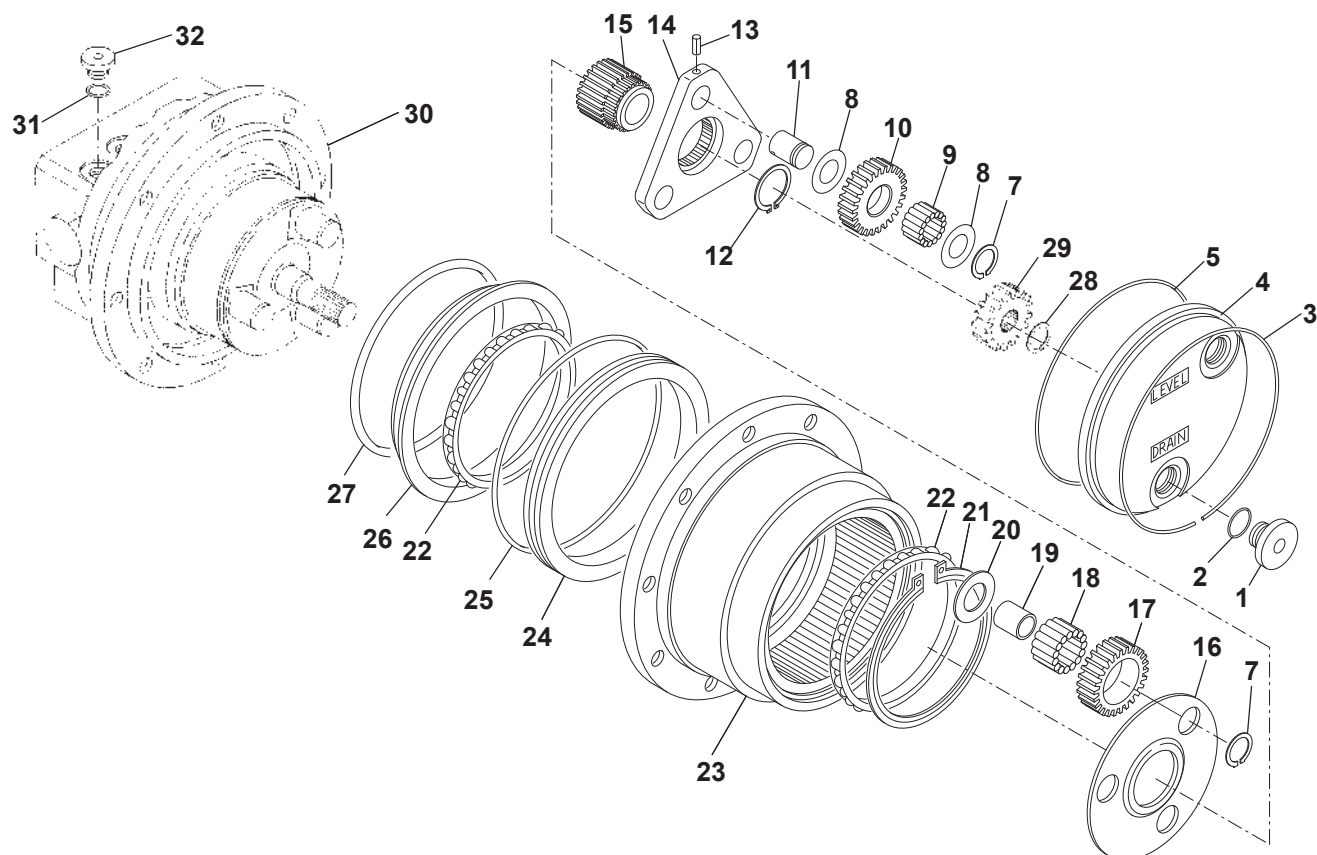
Procedure	
(8) Insert three pins 12 into cylinder barrel 13 , and then, install barrel holder 11 to the cylinder barrel.	
(9) Install the shoe holder assembly to cylinder barrel 13 .	
(10) Insert the cylinder barrel assembly into body 2 1 until shoes 8 contact with swash plate 7 .	
(11) Put hydraulic oil [approx. 0.026 Gals. (0.1 L)] into body 2 1 .	

6. HYDRAULIC EQUIPMENT

Procedure	
(12) Install valve plate 19 to body 1 45, and combine body 1 45 and body 2 1. Notes : • Install the valve plate with its copper face up (toward the cylinder barrel side). • Apply hydraulic oil to the sliding surface (the copper face) of the valve plate. • Apply grease to the rear face (the iron face) of the valve plate to prevent it from falling off.	
(13) Install and tighten seven hexagon socket head bolts 28. Note : Protect the motor body with aluminum plates or the like when holding it with a vice. Tightening torque : 20.3 to 22.4 ft·lbf (27.5 to 30.4 N·m) [Width across flats : 0.20 in. (5 mm)]	

6. HYDRAULIC EQUIPMENT

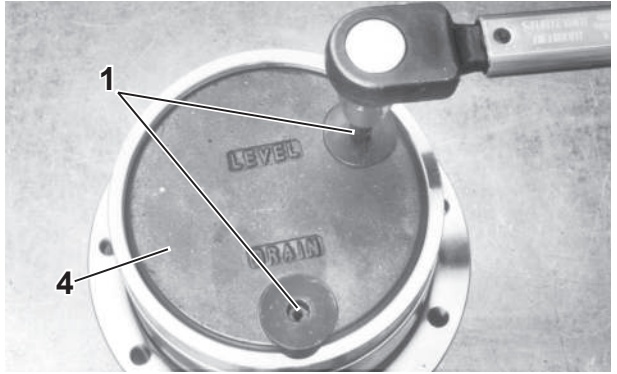
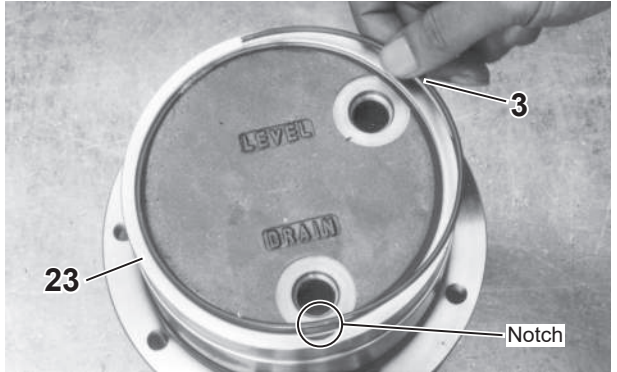
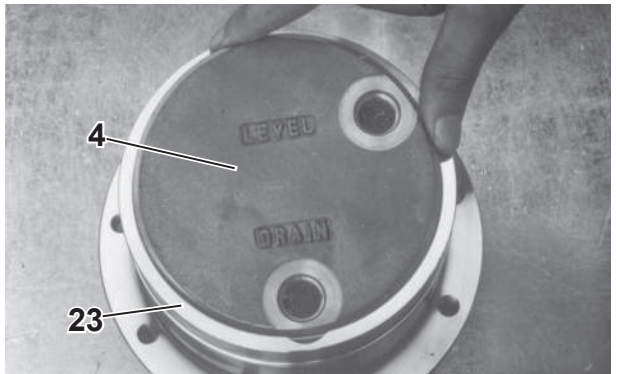
4)-5 Exploded View and Component Parts (Reduction Gear Section)



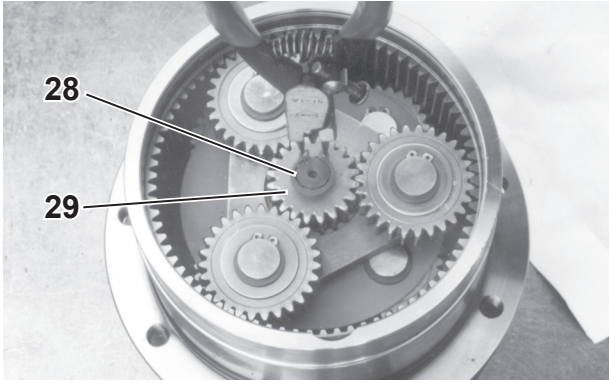
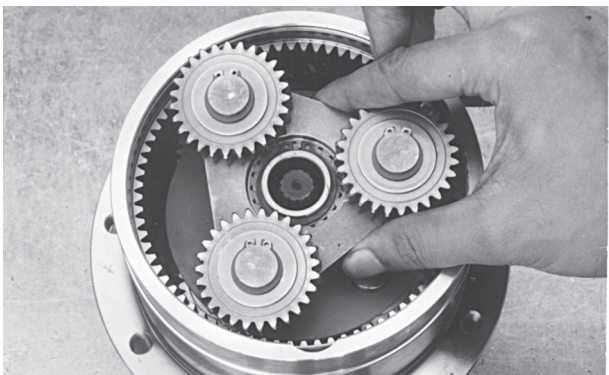
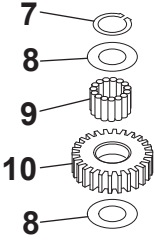
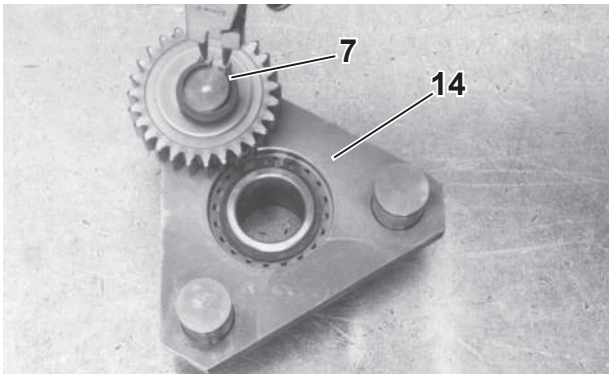
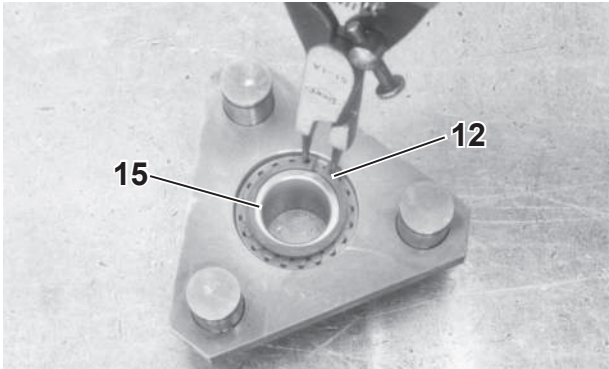
No.	Part	Q'ty	No.	Part	Q'ty
1	Plug	2	17	Gear b1	3
2	O-ring 1BP14	2	18	Needle bearing	3
3	O-snap ring	1	19	Ring	3
4	Cover	1	20	Thrust washer	3
5	O-ring AS568-248-70 or its equivalent	1	21	Snap ring	1
6	-	-	22	Angular bearing 90BVV11S2G	2
7	Snap ring	6	23	Body	1
8	Thrust washer	6	24	Seal ring	1
9	Needle bearing	3	25	O-ring 1AG130	1
10	Gear b2	3	26	Floating seat	1
11	b2 pin	3	27	O-ring	1
12	External snap ring 26	1	28	External snap ring	—
13	Spring pin 3 × 12	3	29	Gear S2	—
14	Carrier 2	1	30	Body 2 (Hydraulic motor)	1
15	Gear S1	1	31	O-ring 1BP11	1
16	Thrust plate	1	32	Plug	1

6. HYDRAULIC EQUIPMENT

4)-6 Disassembly of Reduction Gear Section Procedure

Procedure	
(1) Remove plugs 1 from cover 4 to drain the lubricating oil. [Width across flats : 0.20 in. (5 mm)]	
(2) Put a screwdriver or the like in the notch of body 23 to remove O-snap ring 3 .	
(3) Remove cover 4 from body 23 .	
(4) Remove O-ring 5 from body 23 .	

6. HYDRAULIC EQUIPMENT

Procedure	
(5) Remove external snap ring 28, and then remove gear S2 29. Note : Replace external snap ring 28 with a new one in reassembly.	
(6) Remove the carrier 2 assembly from the body.	
(7) After removing snap ring 7 from carrier 2 14, - remove thrust washer 8, - needle bearing 9, - gear b2 10 and thrust washer 8 in this order. 	
(8) Remove external snap ring 12, and then, remove gear S1 15. Notes : - The b2 pins, which are press fitted into the carrier 2, cannot be removed. - Replace the external snap ring 12 with a new one in reassembly.	

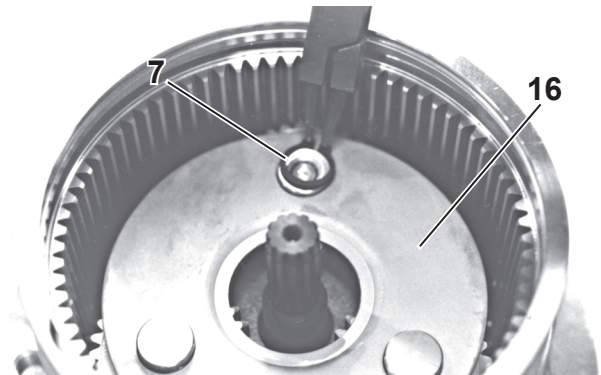
6. HYDRAULIC EQUIPMENT

Procedure

- (9) Remove snap rings **7** from the b1 pin portions, and then, remove thrust plate **16**.

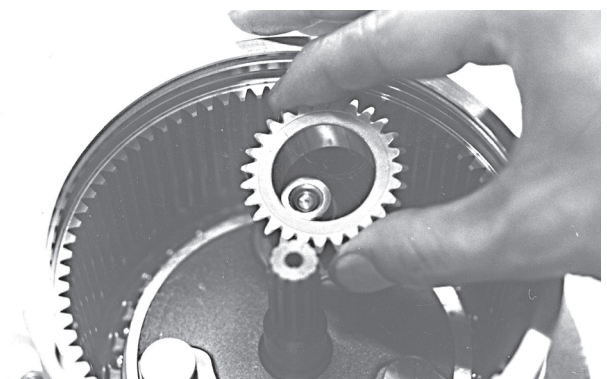
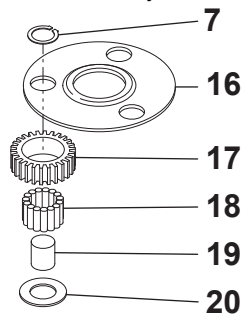
Notes :

- Number of snap rings : 4 pcs.
- Replace the snap rings **7** with new ones in reassembly.

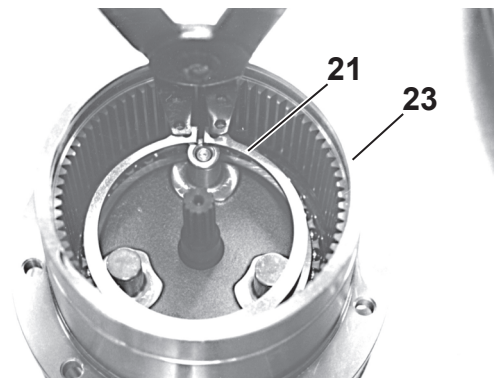
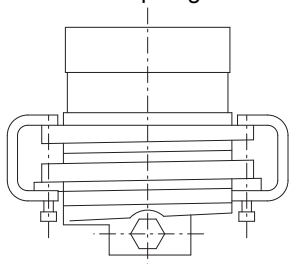


- (10) Remove gear b1 **17**, needle bearing **18**, thrust washer **20** and ring **19** from each b1 pin portion of the body **2**.

	SV08-1
Ring	3 pcs.
Thrust washer	3 pcs.
Gear b1	3 pcs.



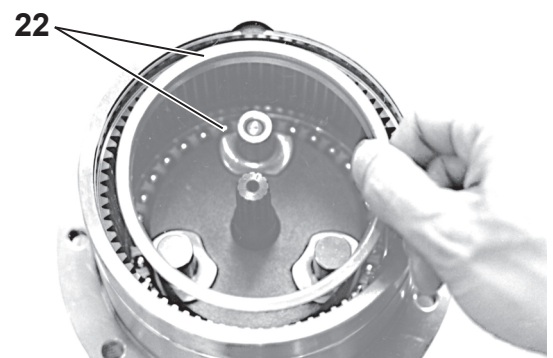
- (11) Compress the flanges of body **23** and body **2 30** with a squill vice or an oil hydraulic press, as shown in the figure below, to remove snap ring **21**.



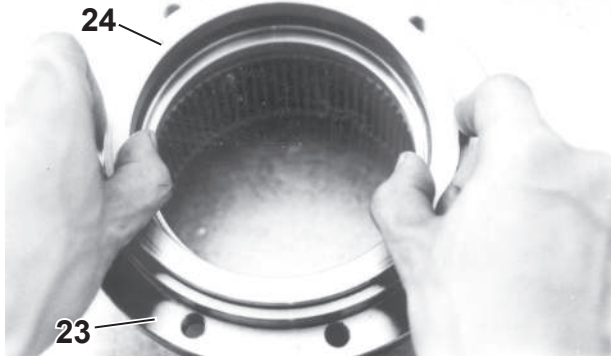
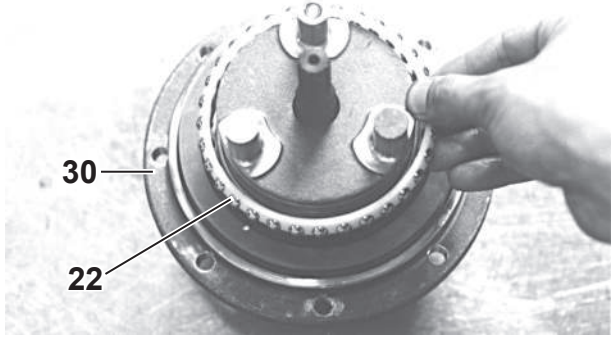
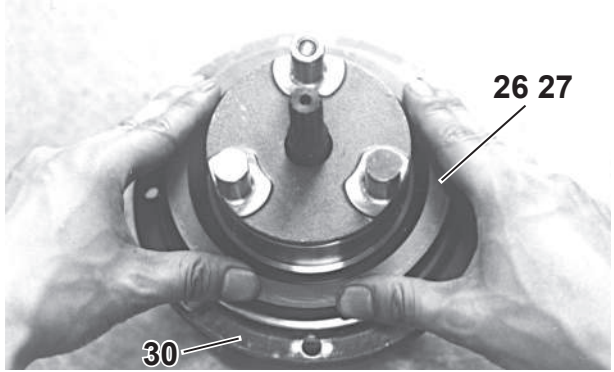
- (12) Pull out the body with angular bearing **22** (one set) to remove it from the hydraulic motor.

Note :

Angular bearing **22** can be disassembled into an inner race and a retainer.

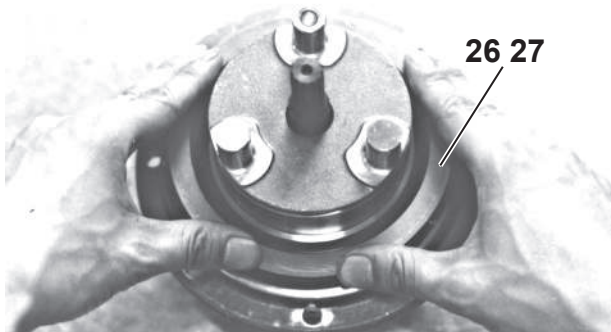
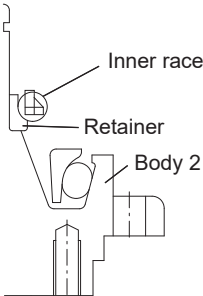
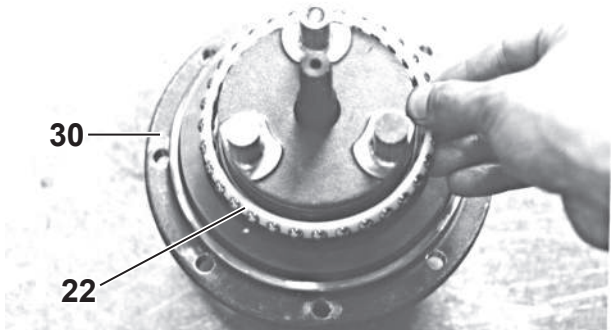
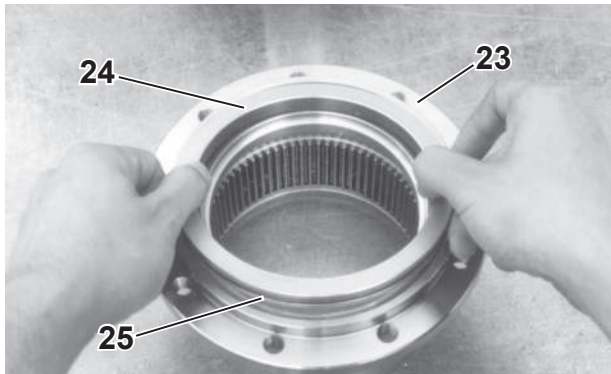
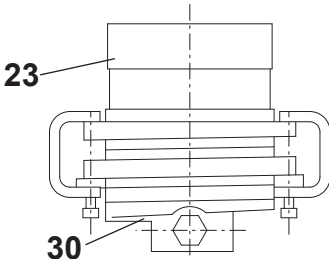
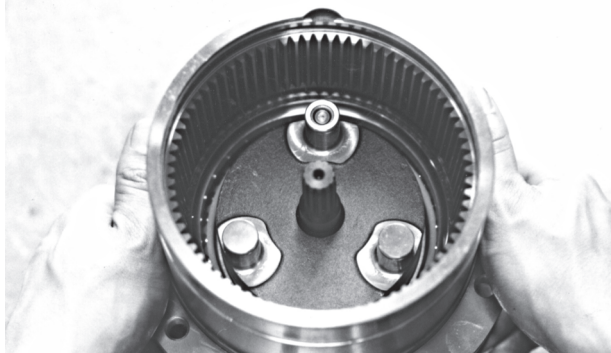


6. HYDRAULIC EQUIPMENT

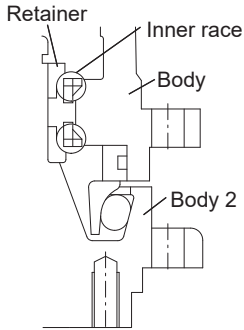
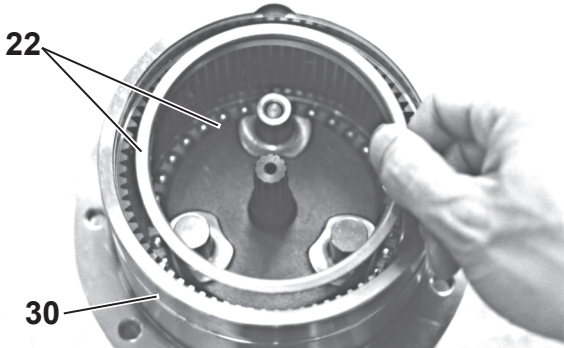
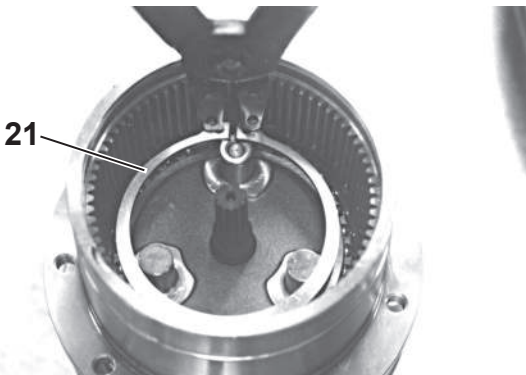
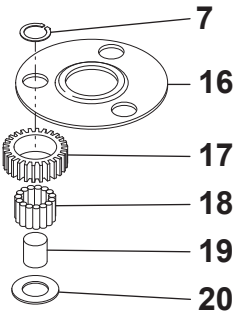
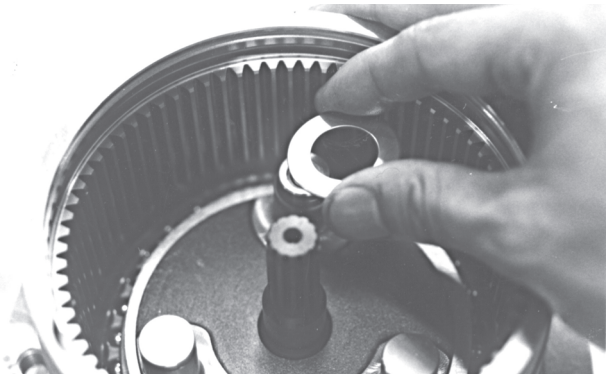
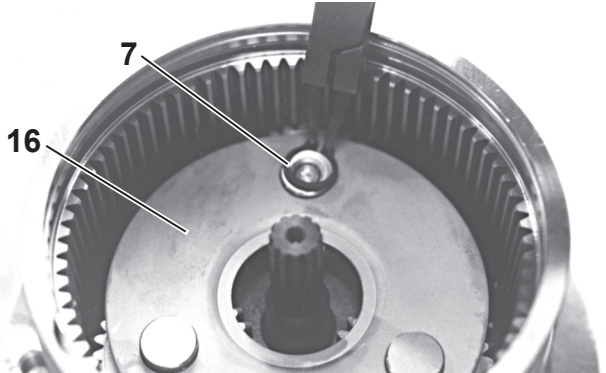
Procedure	
(13) Remove seal ring 24 from body 23 .	
(14) Remove angular bearing 22 from body 30 . Note : <i>Angular bearing 22 can be disassembled into an inner race and a retainer.</i>	
(15) Remove floating seat 26 and O-ring 27 together from body 30 .	

6. HYDRAULIC EQUIPMENT

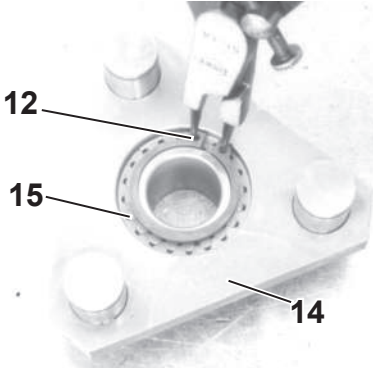
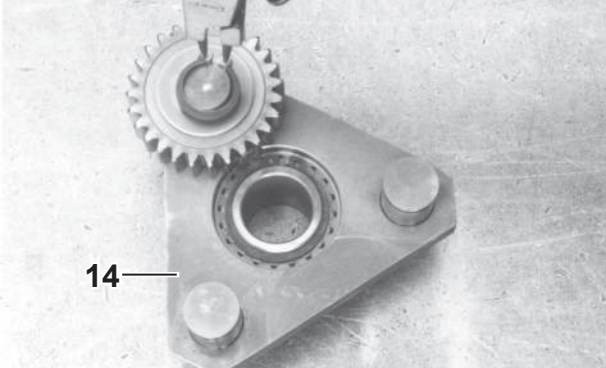
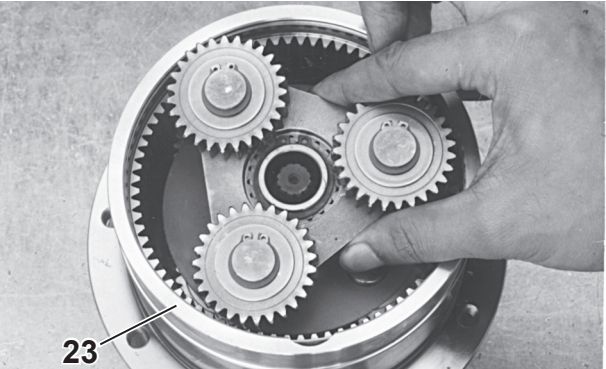
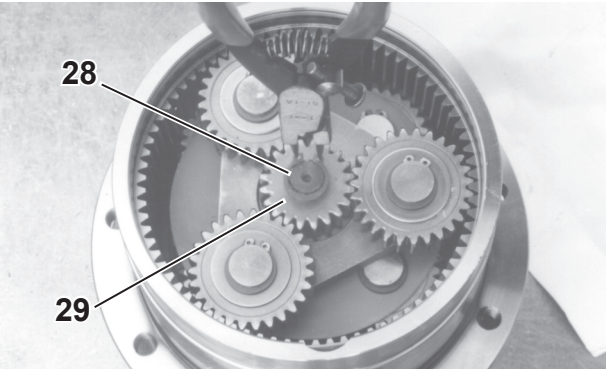
4)-7 Reassembly of Reduction Gear Section Procedure

Procedure	
(1) Install floating seat 26 and O-ring 27 to body 2 30. Notes : • Apply grease to the O-ring in advance for easy installation. • Number of b1 pin portions : 4 places	
(2) Install angular bearing 22 (one set) to body 2 30. Note : Since the angular bearing can be disassembled into an inner race and a retainer, take care that the retainer is installed in the correct direction. 	
(3) Insert seal ring 24 with O-ring 25 installed, into body 23. Notes : • Apply grease to the O-ring. • Install the seal ring with the sealing surface up.	
(4) Install body 2 30 to body 23. Note : Compress the flanges of body 23 and body 2 30 with a squill vice or an oil hydraulic press. 	

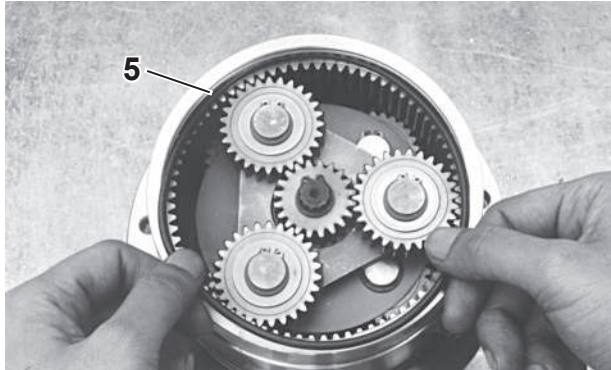
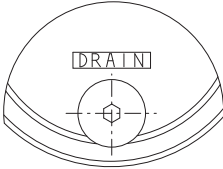
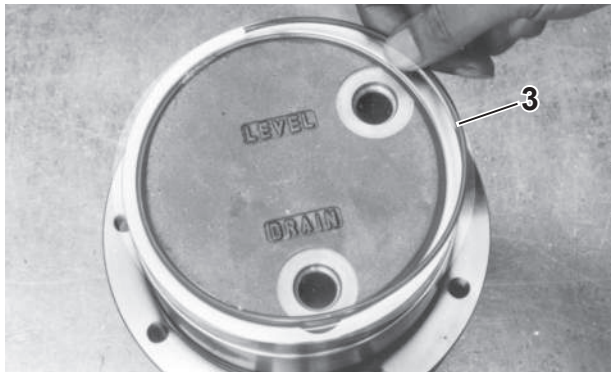
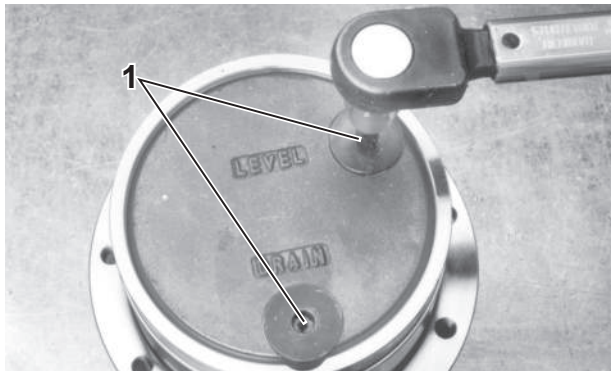
6. HYDRAULIC EQUIPMENT

Procedure (5) Install angular bearing 22 (another set) to body 2 30. Note : <i>Since the angular bearing can be dis-assembled into an inner race and a retainer, take care that the retainer is installed in the correct direction.</i> 									
(6) Fasten the bearing with snap ring 21. Note : <i>Adjust the pre-load of the bearing by the thickness of the snap ring.</i>									
(7) Install ring 19, thrust washer 20, gear b1 17 and needle bearing 18 in this order to each b1 pin portion of the body 2. <table border="1"> <tr> <td></td><td>SV08-1</td></tr> <tr> <td>Ring</td><td>3 pcs.</td></tr> <tr> <td>Thrust washer</td><td>3 pcs.</td></tr> <tr> <td>Gear b1</td><td>3 pcs.</td></tr> </table> 		SV08-1	Ring	3 pcs.	Thrust washer	3 pcs.	Gear b1	3 pcs.	
	SV08-1								
Ring	3 pcs.								
Thrust washer	3 pcs.								
Gear b1	3 pcs.								
(8) Install thrust plate 16 and fasten it with snap rings 7. Notes : • Install the thrust plate with the convex surface up. • Number of snap rings : 4 pcs. • The snap ring has the front and back sides. Install it with the edge side up (toward the cover side). • Do not expand the snap ring too much when installing it, or it will be deformed.									

6. HYDRAULIC EQUIPMENT

Procedure	
(9) Insert gear S1 15 into carrier 2 14 and fasten it with external snap ring 12. Notes : • The snap ring has the front and back sides. Install it with the edge side up (toward the cover side). • Do not expand the snap ring too much when installing it, or it will be deformed.	
(10) Install the thrust washer 8, the gear b2 10, the needle bearing 9 and the thrust washer 8 in this order to carrier 2 14 in each of the three places, and fasten them with snap rings 7 to make the carrier 2 assembly. Notes : • The snap ring has the front and back sides. Install it with the edge side up (toward the cover side). • Do not expand the snap ring too much when installing it, or it will be deformed.	
(11) Install the carrier 2 assembly into body 23.	
(12) Install the gear S2 29 and fasten it with external snap ring 28. Notes : • The snap ring has the front and back sides. Install it with the edge side up (toward the cover side). • Do not expand the snap ring too much when installing it, or it will be deformed.	

6. HYDRAULIC EQUIPMENT

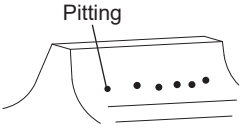
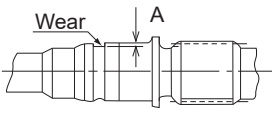
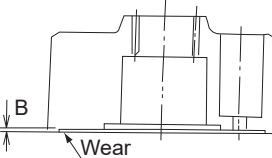
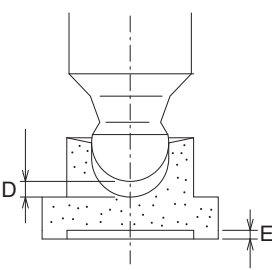
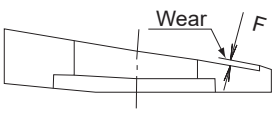
Procedure	
(13) Install O-ring 5 onto the body. Note : Apply grease to the O-ring. (14) Put lubricating oil into the body. - Type : Gear Oil 90 (GL-4) - Quantity : 0.087 Gals. (0.33 L)	
(15) Install the cover on the body. Notes : - Take care not to damage the O-ring. - Install the cover on the body with the letters "DRAIN" on the cover put above the notch of the body. 	
(16) Install O-snap ring 3 to fasten the cover. Note : Put a screwdriver or the like on the end face of the snap ring and install the snap ring by tapping the grip end of the screwdriver.	
(17) Install and tighten two socket head plugs 1 (G3 / 8). Note : First tighten the plug on the letters "DRAIN" side to stop the cover from turning with its flange. Tightening torque : 34.0 to 37.6 ft-lbf (46.1 to 51.0 N·m) [Width across flats : 0.31 in. (8 mm)]	

6. HYDRAULIC EQUIPMENT

4. Service Standards

(Hydraulic Motor Section)

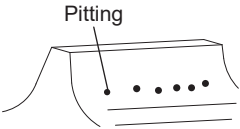
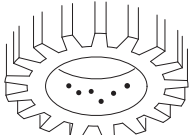
If any of the parts of the hydraulic motor is defective, replace the whole hydraulic motor assembly with a new assembly in principle.

Part	Inspection item	Inspection standard		Measure
Shaft	Excessive wear of gear and damage to teeth	Pitting area rate : 5 % or more		Replace the hydraulic motor assembly.
	Shear droop or damage of splined portion	Visible dents		
	Wear of oil seal portion (A)	Wear : 0.0010 in. (0.025 mm) or more		
Cylinder barrel	Wear of surface contacted with valve plate (B)	Wear : 0.0008 in. (0.020 mm) or more		Replace the cylinder barrel kit.
Valve plate	Wear of sliding surface contacted with cylinder barrel (C)	Wear : 0.0008 in. (0.020 mm) or more		
Pistons and shoes	Looseness (D) in caulked portion of shoe	Play : 0.0118 in. (0.3 mm) or more		Replace the cylinder barrel kit.
	Wear (E) of surface contacted with swash plate	Difference : 0.0008 in. (0.02 mm) or under		
Swash plate	Wear of sliding surface contacted with shoes (F)	Wear : 0.0008 in. (0.020 mm) or more		Replace the swash plate kit.

6. HYDRAULIC EQUIPMENT

(Reduction Gear Section)

If any of the parts listed below is worn or damaged, replace it with a new one.

Part	Inspection Item	Inspection Standard		Measure
Gear body (Internal gear a)	Excessive wear of gear and damage to teeth	Pitting area rate : 5 % or more	Rate of pitting area to tooth surface area 	Replace the gear body.
Hydraulic motor body	Shear droop or damage of splined portion	Visible dents		Replace the hydraulic motor assembly or the carrier 2 kit.
Carrier 2	Play of b1 pin (Hydraulic motor body) Play of b2 pin (Carrier 2)	Play by manual check : 0.0002 in. (0.005 mm) or more		
Gears S1 and b2	Excessive wear of gears and damage of teeth	Pitting area rate : 5 % or more		Replace the carrier 2 kit.
	Wear of surfaces contacted with needles	Visible flaking or pitting		
Pins and needles	Wear of contact surface of needles	Visible flaking or pitting		Replace the carrier 2 kit.
	Pitting on needles			
Main bearing	Dent by steel balls. Pitting on contact surfaces of inner and outer races.	Visible dents. Visible flaking or pitting		Replace the bearing.

6. HYDRAULIC EQUIPMENT

5. Troubleshooting

Trouble	Cause	Measure
1. Motor does not rotate	1) Malfunction of any hydraulic equipment other than travel motor	Check the inlet pressure of the motor. Then, check and repair or replace the other equipment.
	2) Malfunction of hydraulic motor (1) Pressure oil leakage due to excessively worn sliding portion of internal part	Replace the excessively worn part.
	(2) Broken internal part	Replace the broken part or kit.
	3) Malfunction of counterbalance valve (Improper stroke of counterbalance valve) (1) Foreign matter caught in the valve (2) Clogged choke	Remove the foreign matter, and repair or replace the damaged part. Clean the choke.
	4) Malfunction of reduction gear (1) Broken internal part	Replace the broken part or kit.
2. Travel speed is low or machine cannot travel straight	1) Malfunction of any hydraulic equipment other than travel motor	Check and repair or replace the equipment.
	2) Malfunction of hydraulic motor (1) Lowered volumetric efficiency due to excessive worn	Replace the excessively worn part in the sliding section.
3. Motor does not stop or takes time to stop	1) Malfunction of counterbalance valve (Counterbalance valve does not return normally.) (1) Foreign matter caught in the valve (2) Clogged choke	Remove the foreign matter, and repair or replace the damaged part. Clean the choke.
	(3) Broken spring	Replace the spring.
4. Travel speed cannot be changed between low speed and high speed	1) Malfunction of high-speed spool (1) Foreign matter caught in the valve (2) Broken spring	Remove the foreign matter, and repair or replace the damaged part. Replace the spring.
5. Oil leakage	1) Damaged O-ring	Replace the O-ring.
	2) Flaw in sealing surface of O-ring	Repair the sealing surface or replace the O-ring.
	3) Broken oil seal	Replace the oil seal.
	4) Excessively worn mechanical seal	Replace the floating seat and the seal ring.
	5) Loosened bolt or plug	Retighten the bolt or the plug.
6. Machine slips excessively on a slope	1) Excessive oil leakage from hydraulic motor	Replace the excessively worn part in the sliding section.
	2) Excessive oil leakage from counterbalance valve	Replace the excessively worn part in the sliding section.

ADJUSTMENT AND REPAIR

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7-1-2 Monitor and Alarm Systems	7-1-2	7-5-6 Disassembly and Reassembly of	
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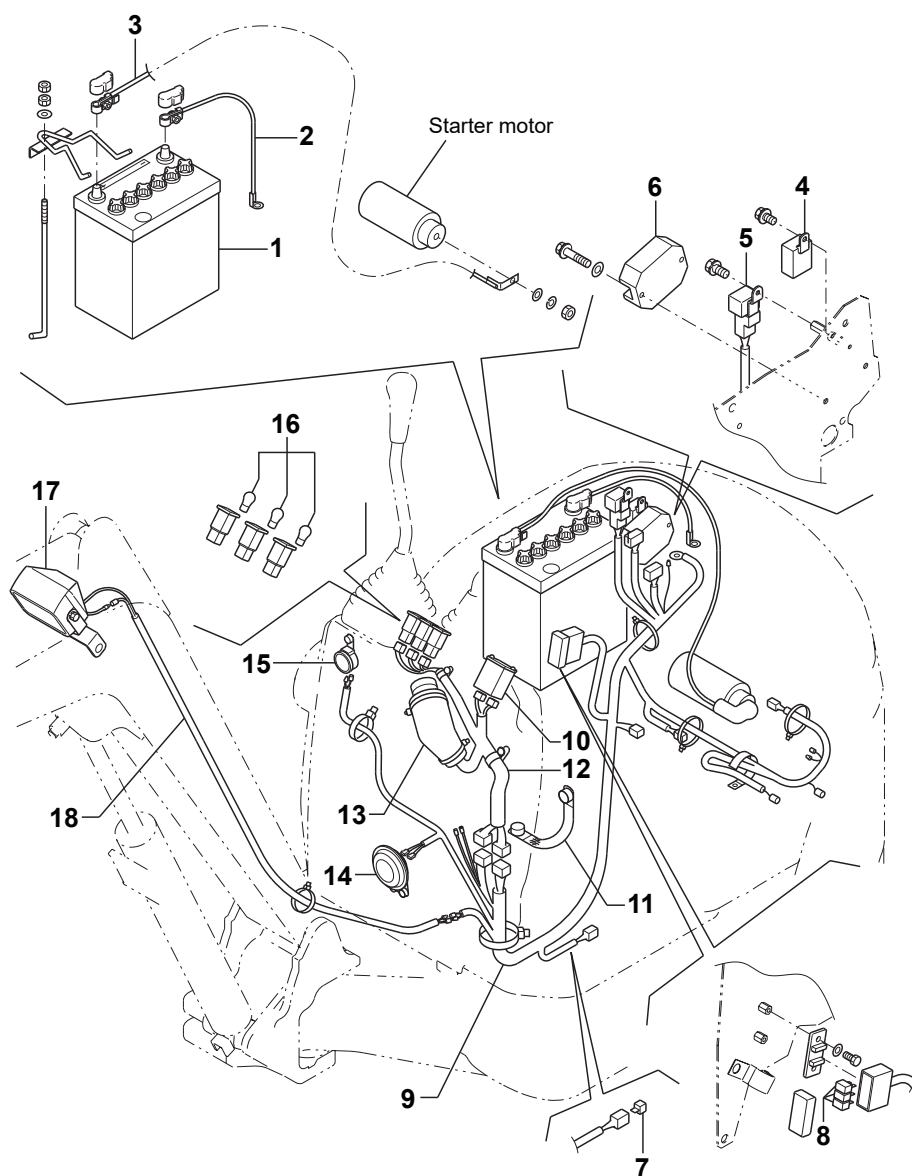
7. ADJUSTMENT AND REPAIR

7. Adjustment and Repair

7-1 Electrical Equipment of Machine

7-1-1 Parts Layout of Electrical Equipment

1) Electrical Equipment and Electric Wiring



No.	Part	No.	Part	No.	Part
1	Battery (44B19L)	7	Diode (1.5-2P)	13	Starter switch
2	Battery harness (Negative)	8	Fuse B 10	14	Horn
3	Battery cable (Positive)	9	Wire harness A	15	Buzzer
4	Safety relay	10	Hour meter	16	Alarm lamp (Battery charge, engine oil pressure, water temp)
5	Slow blow fuse 40A	11	Engine ground cable	17	Work lamp
6	Current limiter	12	Wire harness (Stand)	18	Wire harness (Work lamp)

7. ADJUSTMENT AND REPAIR

7-1-2 Monitor and Alarm Systems

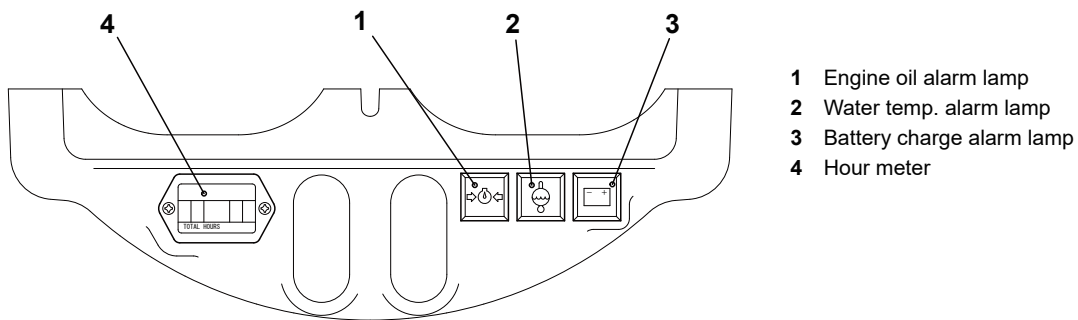
For safer machine operation, the operator needs to have a clear understanding of the machine's condition. However, it is difficult for the operator to keep an eye on every aspect of the machine he/she is operating.

Therefore, gauges and alarms are installed to warn the operator of any trouble of the machine at the early stage.

Note :

The monitors do not give a full assurance of the machine's condition. The indications shown on them should be used as a guide for daily check and periodic maintenance according to the operation and maintenance manual.

1) Part Name



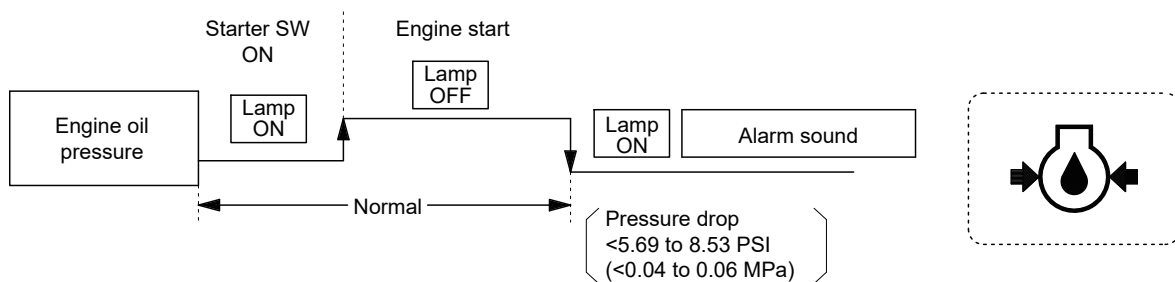
2) Function of Alarm Sensor

- All the lamps should go on for a few seconds when the starter switch is turned on.
- All the lamps should go off when the engine is running.
- The engine oil pressure and battery charge alarm lamps should go on when the engine is stopped.
- The buzzer should sound when a lamp goes on while the engine is running.

3) Alarm Sensor Operation

(1) Lube oil pressure drop monitoring (Engine oil pressure switch)

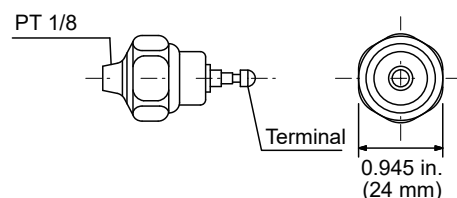
When the engine oil pressure falls, the lamp goes on and the buzzer sounds.



The switch monitors the lube oil pressure drop of the engine and causes the engine oil pressure alarm lamp to go on and the alarm buzzer to sound.

Working pressure : 5.69 to 8.53 PSI (0.04 to 0.06 MPa)

Installation position : Engine block



7. ADJUSTMENT AND REPAIR

When the alarm buzzer sounds, check the following items.

- [1] Degeneration of engine oil.
- [2] Clogging of oil filter element.
- [3] Malfunction of engine oil pressure switch.

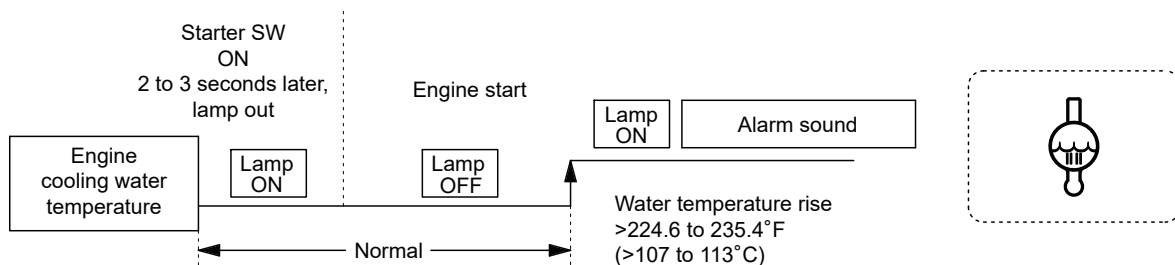
Refer to Section 4-3-19 in the chapter "4. Engine" for the checking procedure of the engine oil pressure switch.

- [4] Malfunction of pressure control valve.
- [5] Wear or breakage of lube oil pump.

(2) Overheating sensor (Water temperature switch)

The water temp. meter indicates the engine cooling water temperature.

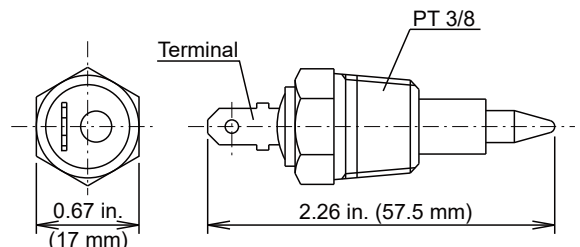
If the pointer goes up to the set water temperature of the water temperature switch while the engine is running, the engine is overheating.



Turned on : Set water temp. : 224.6 to 235.4°F (107 to 113°C)

Turned off : Set water temp. : 212°F (100°C) or less

Installation position : Cooling water pump on engine

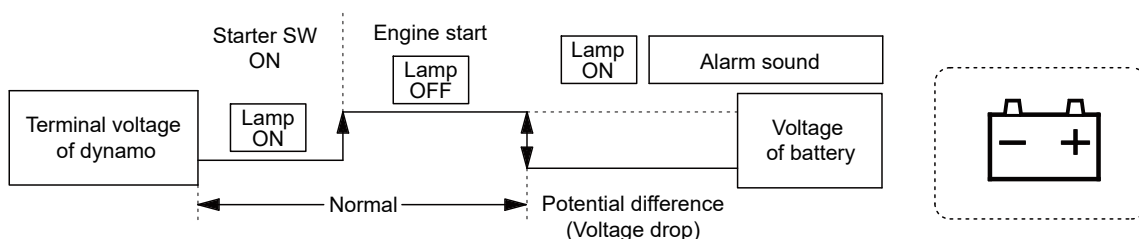


When the alarm buzzer sounds, check the following items.

- [1] Refer to Section 4-1-7 in the chapter "4. Engine" and the chapter "10. Troubleshooting".

(3) Battery charge

When there occurs a potential difference between the output voltage of the dynamo and the voltage of the battery, the lamp goes on and the buzzer sounds.



When the alarm buzzer sounds, check the following items.

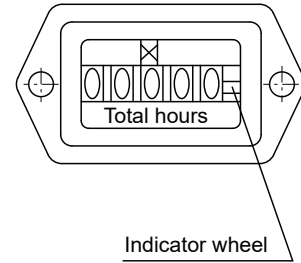
- [1] Degeneration or malfunction of battery.
- [2] Refer to Section "7-1-4 Circuit Description of Engine Start and Stop" and the Section "7-1-5 Circuit Description of Battery Charging".

7. ADJUSTMENT AND REPAIR

(4) Hour meter

When the starter switch is turned on, the hour meter starts to work.

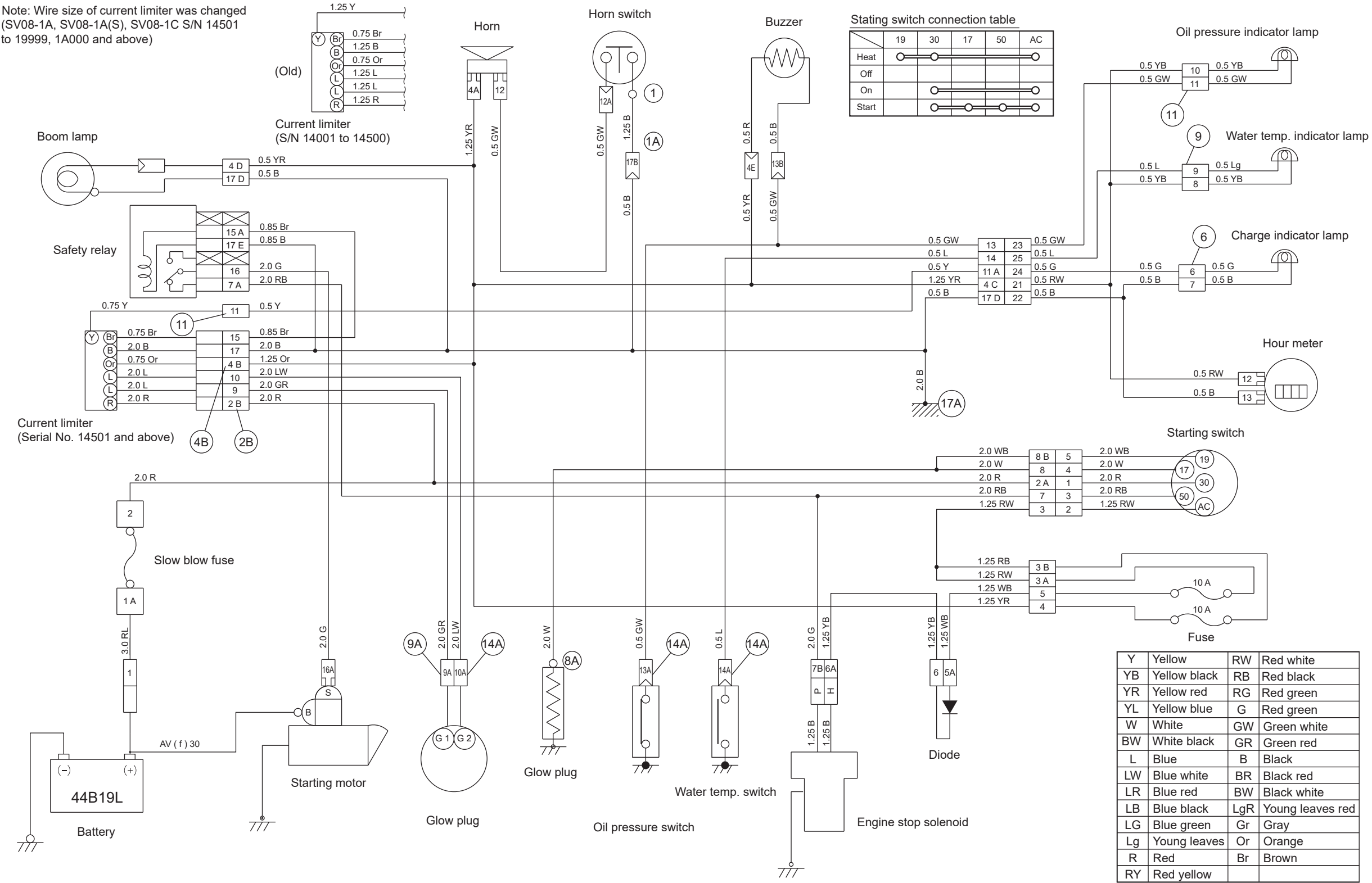
While the hour meter is working, the indicator wheel at the right end of the indicator rotates; otherwise, the hour meter or the lead wire for the hour meter can be defective.



7. ADJUSTMENT AND REPAIR

7-1-3 Wiring Diagram

Note: Wire size of current limiter was changed (SV08-1A, SV08-1A(S), SV08-1C S/N 14501 to 19999, 1A000 and above)

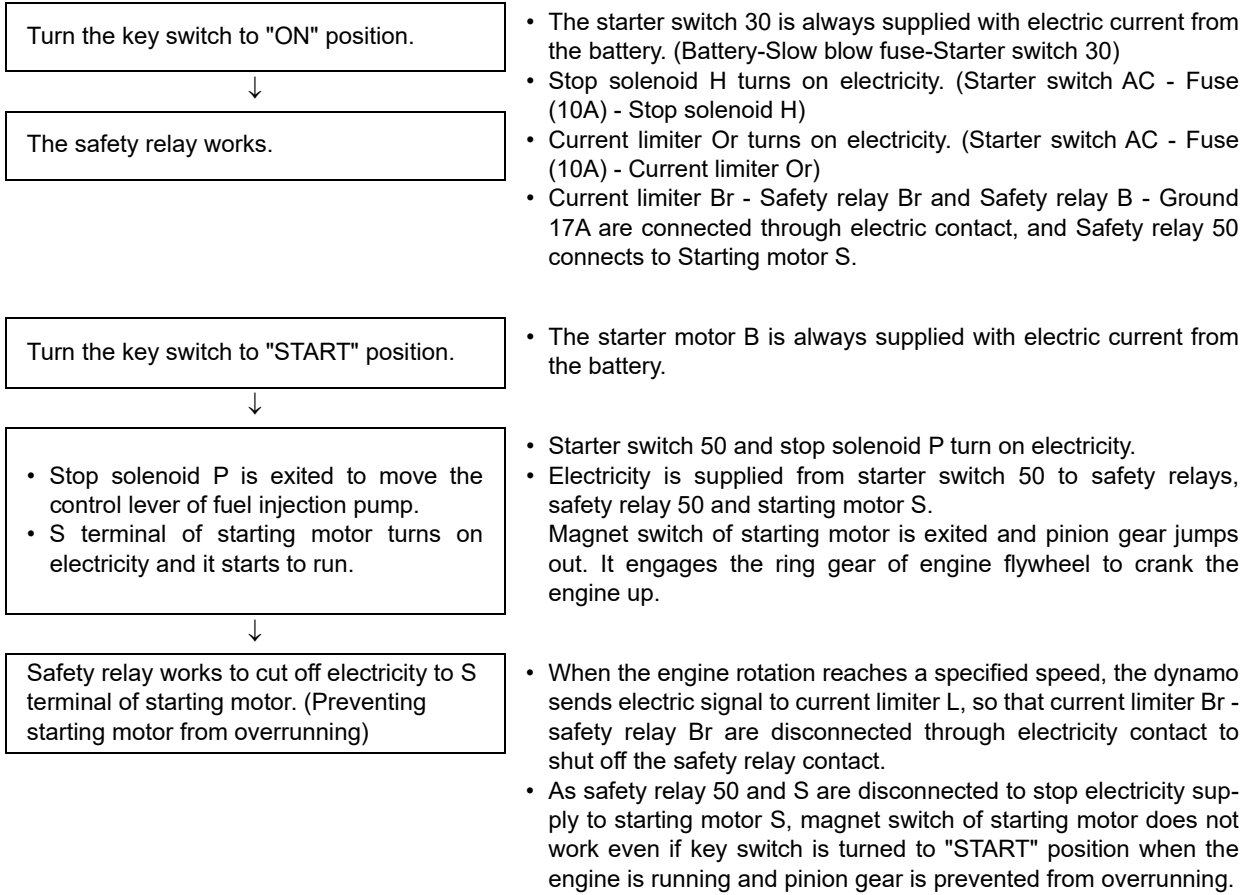


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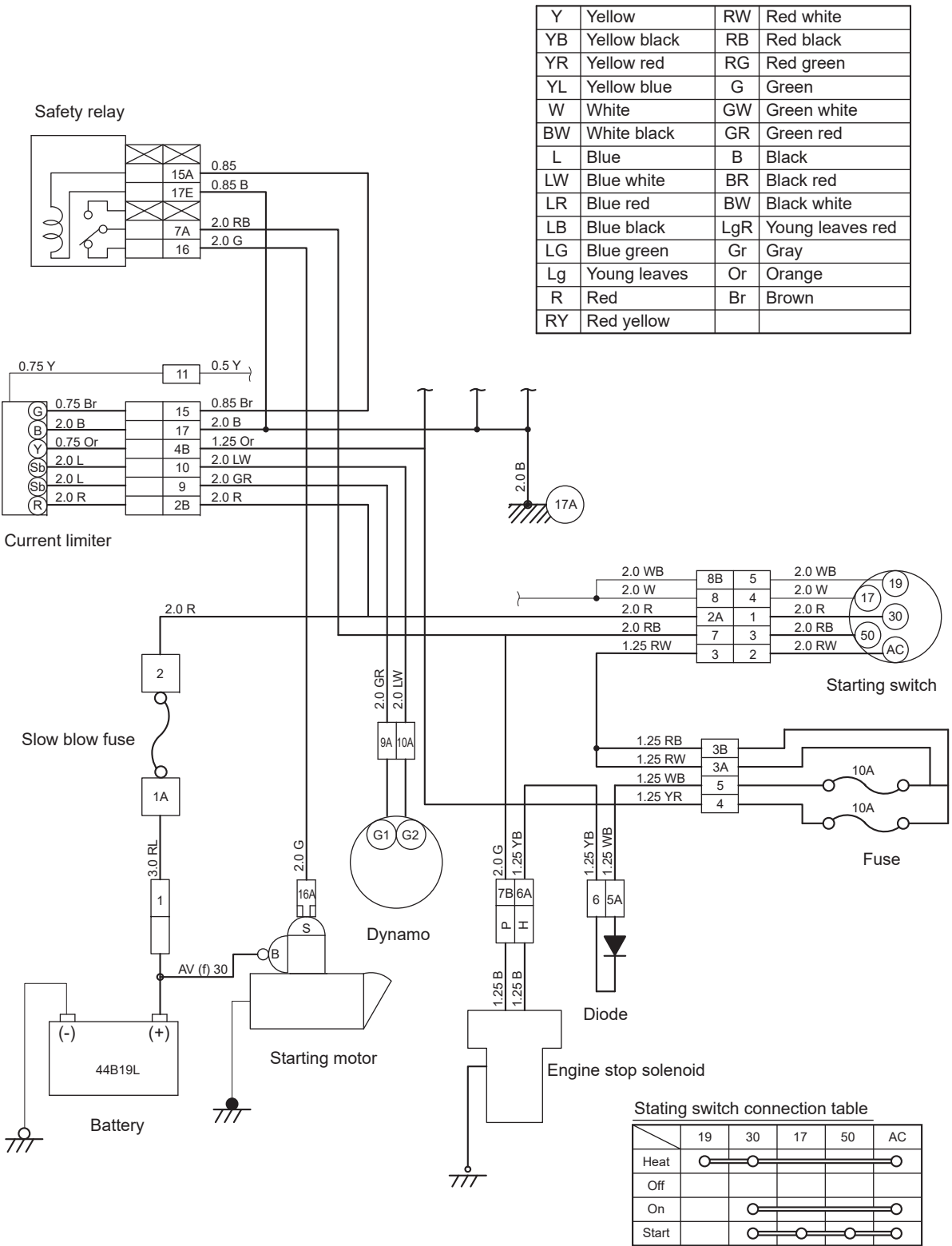
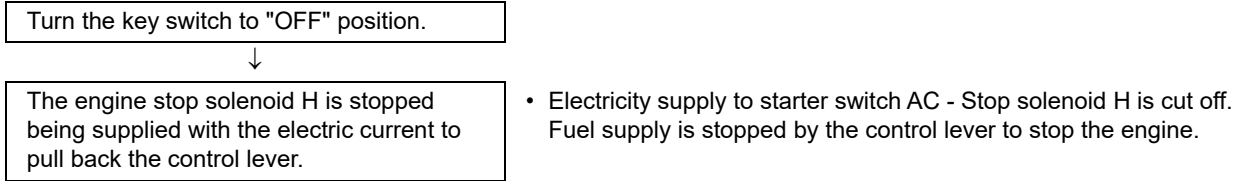
7. ADJUSTMENT AND REPAIR

7-1-4 Circuit Description of Engine Start and Stop

1) Start Engine



2) Engine Stop



7. ADJUSTMENT AND REPAIR

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7. ADJUSTMENT AND REPAIR

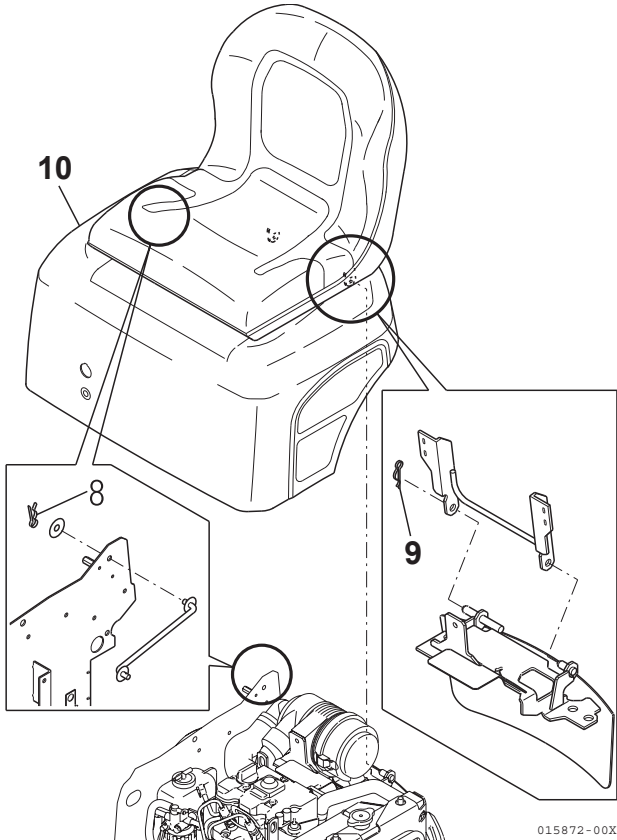
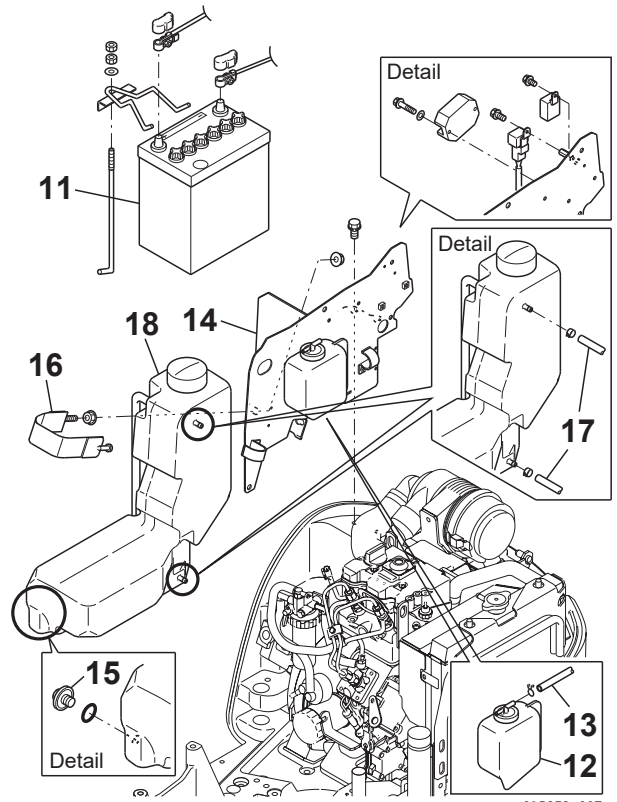
7-1-6 Removal and Reinstallation of Engine

1) Removal

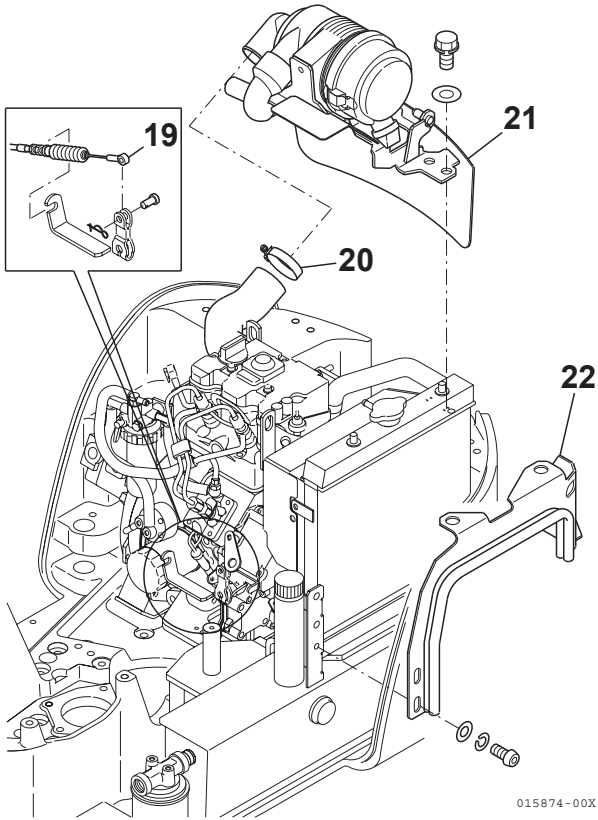
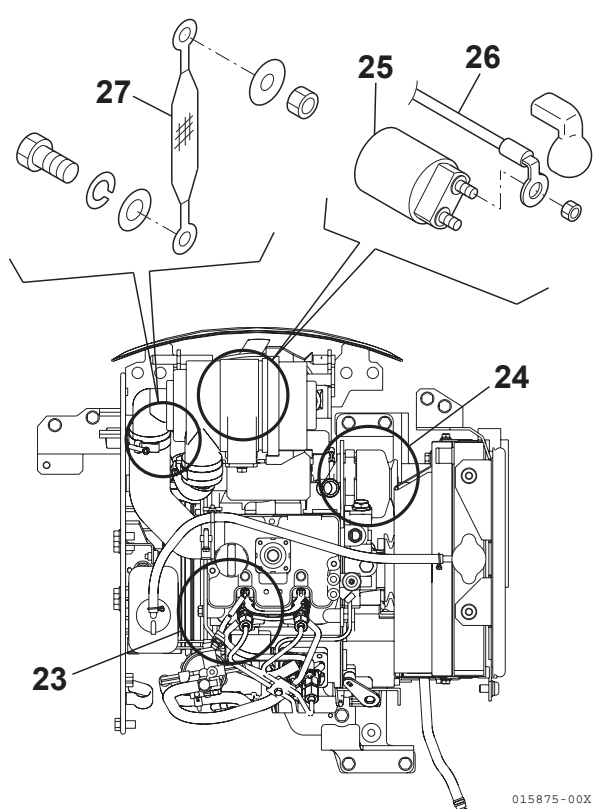
Procedure	
(1) Swing the upperstructure so that the drain plug 2 of the hydraulic oil tank 1 and drain cock of the radiator is positioned halfway between the right and left crawlers. Lower the bucket to the ground and stop the engine. Note : Make sure the nut 4 under the vibroisolating rubber 3 of the engine mount (pump side) is accessible. (2) Remove the drain plug 2 of hydraulic oil tank 1 to drain hydraulic oil. Type : YANMAR SUPER HYDRO OIL (VG 46 or its equivalent) Q'ty : 1.5 Gals. (5.7 L)	015870-00X

(3) Remove the floor plate 5. (4) Remove the frame side covers R 6 and L 7.	015871-00X
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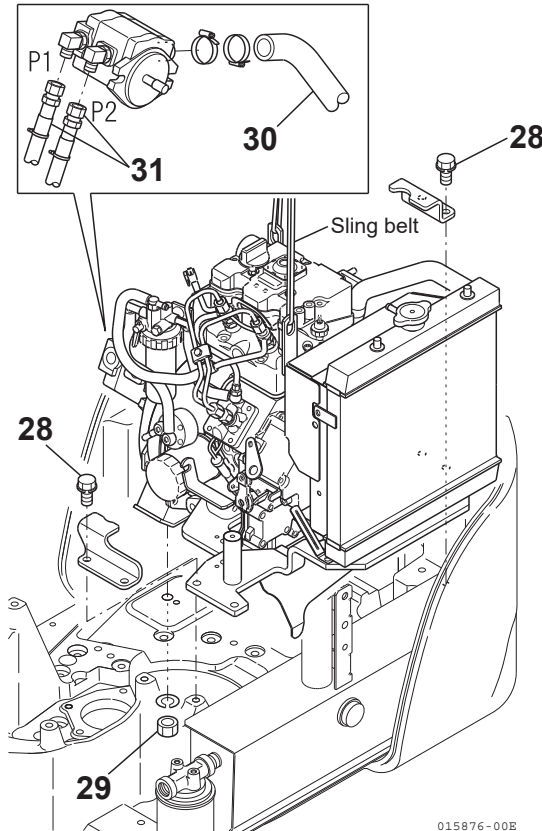
7. ADJUSTMENT AND REPAIR

Procedure	
(5) Remove the spring lock pins 8 and 9 to remove the engine hood 10 with the operator seat.	 015872-00X
(6) Remove the battery 11. (7) Remove the hose 13 of coolant container 12. (8) Disconnect the wirings from the electric parts on the partition panel 14. (9) Remove the plug 15 to drain fuel in the tank. (10) Remove the clamp 16. (11) Remove the two hoses 17. (12) Remove the fuel tank 18. (13) Remove the partition panel 14.	 015873-00E

7. ADJUSTMENT AND REPAIR

Procedure	
(14) Disconnect the engine speed control cable 19 from the engine. (15) Loosen the hose band 20 to separate the air cleaner from the engine. (16) Remove the engine hood mount 21 with the air cleaner. (17) Remove the radiator mount 22.	 015874-00X
(18) Disconnect wiring harness A couplers for the glow plug 23, dynamo 24 and S terminal of the starting motor. (19) Disconnect the starting motor wiring 26 and the engine ground cable 27. (20) Remove or disconnect other wiring clamps, fuel hoses and their clamps as required.	 015875-00X

7. ADJUSTMENT AND REPAIR

Procedure	
(21) Remove four cap screws 28 of the engine mounts (cooling fan side) and the nut 29 under the vibroisolating rubber. (22) Install sling belt or wire on the engine and lift it up with radiator and pump. Disconnect the suction hose 30 and pump outlet hoses 31.	 The diagram illustrates the engine removal process. It shows the engine mounted on a chassis. Four cap screws, labeled 28, are shown being removed from the engine mounts. A nut, labeled 29, is shown being removed from the vibroisolating rubber. A sling belt is shown being installed around the engine. An inset diagram shows the engine being lifted up with the radiator and pump. The suction hose, labeled 30, and pump outlet hoses, labeled 31, are shown being disconnected. The pump outlet hoses are labeled P1 and P2. The diagram is labeled with the part number 015876-00B.

7. ADJUSTMENT AND REPAIR

2) Reinstallation

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

Tightening torque

No.	Item	Fastener size	Q'ty	Lock agent	Tightening torque
-	Engine mount L, R	M10×25	6	Three Bond 1324	33 to 43 ft·lbf (44.1 to 58.9 N·m)
28	Vibro isolating rubber nut (Fan side)	M10	4	-	19 to 23 ft·lbf (24.5 to 32.3 N·m)
29	Vibro isolating rubber nut (Pump side)	M14	2	-	51 to 61 ft·lbf (68.6 to 83.3 N·m)
-	Plate A Cmp. Stoppers FL, FR	M10×30	4	Three Bond 1324	33 to 43 ft·lbf (44.1 to 58.9 N·m)
-	Stand support	M14	2	Three Bond 1324	58 to 72 ft·lbf (78.5 to 98 N·m)
-	Radiator hose (Engine side)	Ø35	2	-	1.8 to 2.0 ft·lbf (2.45 to 2.94 N·m)
-	Radiator hose (Radiator side)	Ø25	2	-	1.8 to 2.0 ft·lbf (2.45 to 2.94 N·m)
20	Air cleaner hoses clip	Ø54	3	-	1.6 to 1.8 ft·lbf (2.16 to 2.45 N·m)
-	Engine speed control cable nut	-	2	-	2.9 to 3.6 ft·lbf (4.0 to 4.9 N·m)
16	Fuel tank clamp nut (Tank holding)	M10	1	-	19 to 21 ft·lbf (24.5 to 29.4 N·m)
16	Fuel tank clamp nut (Lock side)	M10	1	-	19 to 21 ft·lbf (24.5 to 29.4 N·m)
-	Battery clamp nut	M8	2	-	1.9 ft·lbf (2.5 N·m)

Hydraulic oil reservoir capacity	1.5 Gals. (5.7 L)
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Coolant	2.11 Qts. (2.0 L) [including sub-tank]
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7. ADJUSTMENT AND REPAIR

7-1-7 Removal and Reinstallation of Starter motor

1) Removal

Procedure	
(1) Remove the spring lock pins 1 and 2 to remove the engine hood 3 with the operator seat. (2) Loosen the hose clip 5 of the air cleaner hose A 4 to disconnect it from the air intake manifold. (3) Remove the engine hood mount 6 with the air cleaner. (4) Disconnect the engine ground cable 8 from the battery 7.	015877-00X

(5) Disconnect the battery cable and the terminal S after cutting a tie strap. (6) Loosen the cap screws to remove the starting motor Note : Fasten the battery cable and the terminal S harness down to the original position by a tie strap.	Cap screw Battery cable and terminal S Starting motor 015878-00E
--	--

7. ADJUSTMENT AND REPAIR

2) Reinstallation

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

Notes :

- *Replace the gasket to new one.*
- *Cover the rubber cap to the terminal of the starter motor surely*

Starter motor installation bolt (M10)	
Tightening torque	33 to 43 ft·lbf (44.1 to 58.8 N·m)

7. ADJUSTMENT AND REPAIR

7-2 Undercarriage

7-2-1 Outline

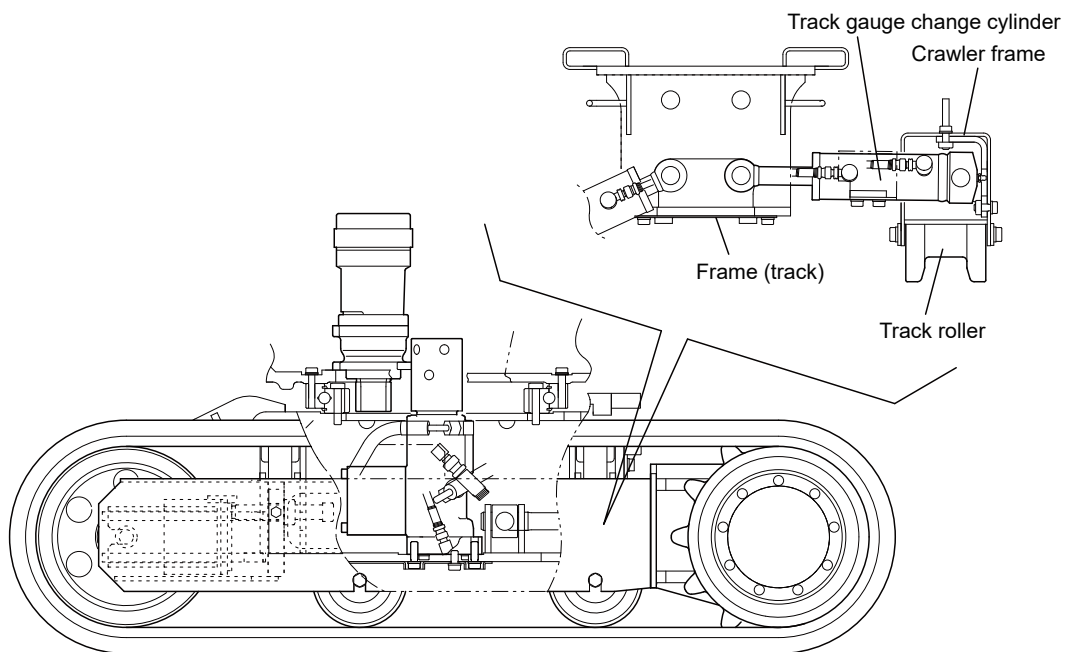
Undercarriage mainly consists of a frame (track), crawlers, idlers, track rollers, travel motors and two track gauge change cylinders (for the link track gauge change type) or one track gauge change cylinder (for the slide track gauge change type).

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 sprocket.

The track rollers and the idlers are installed to scatter the machine weight on the ground equally and rotate the crawlers smoothly while the machine is travelling.

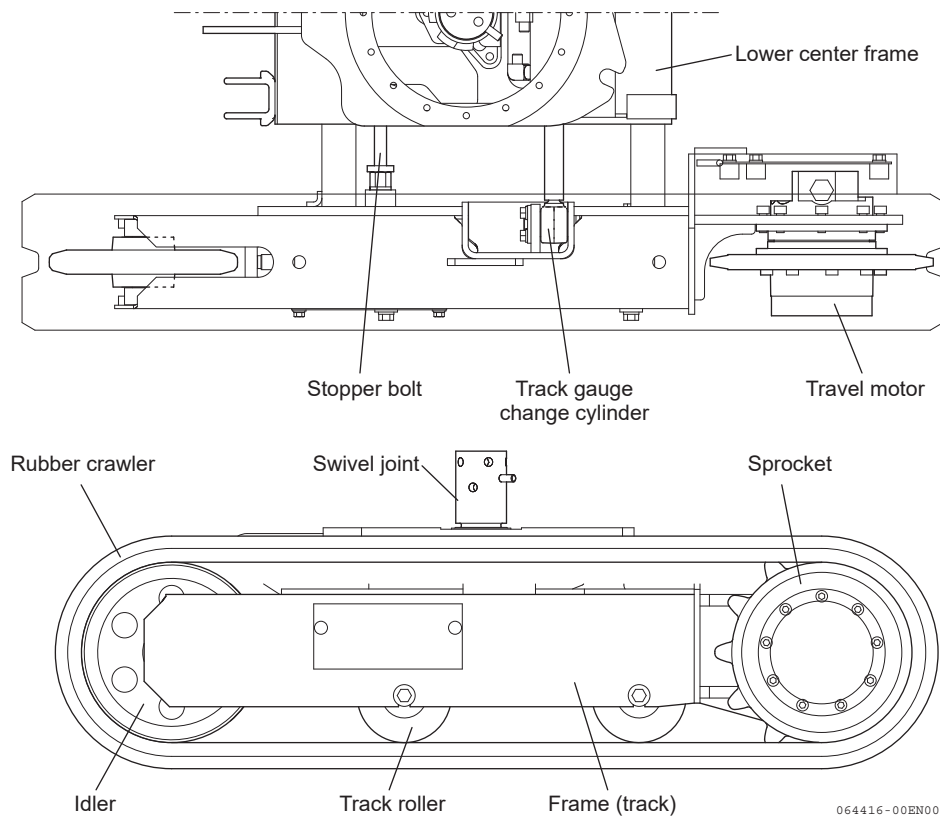
1) Component Drawing

Link track gauge change type SV08-1A



7. ADJUSTMENT AND REPAIR

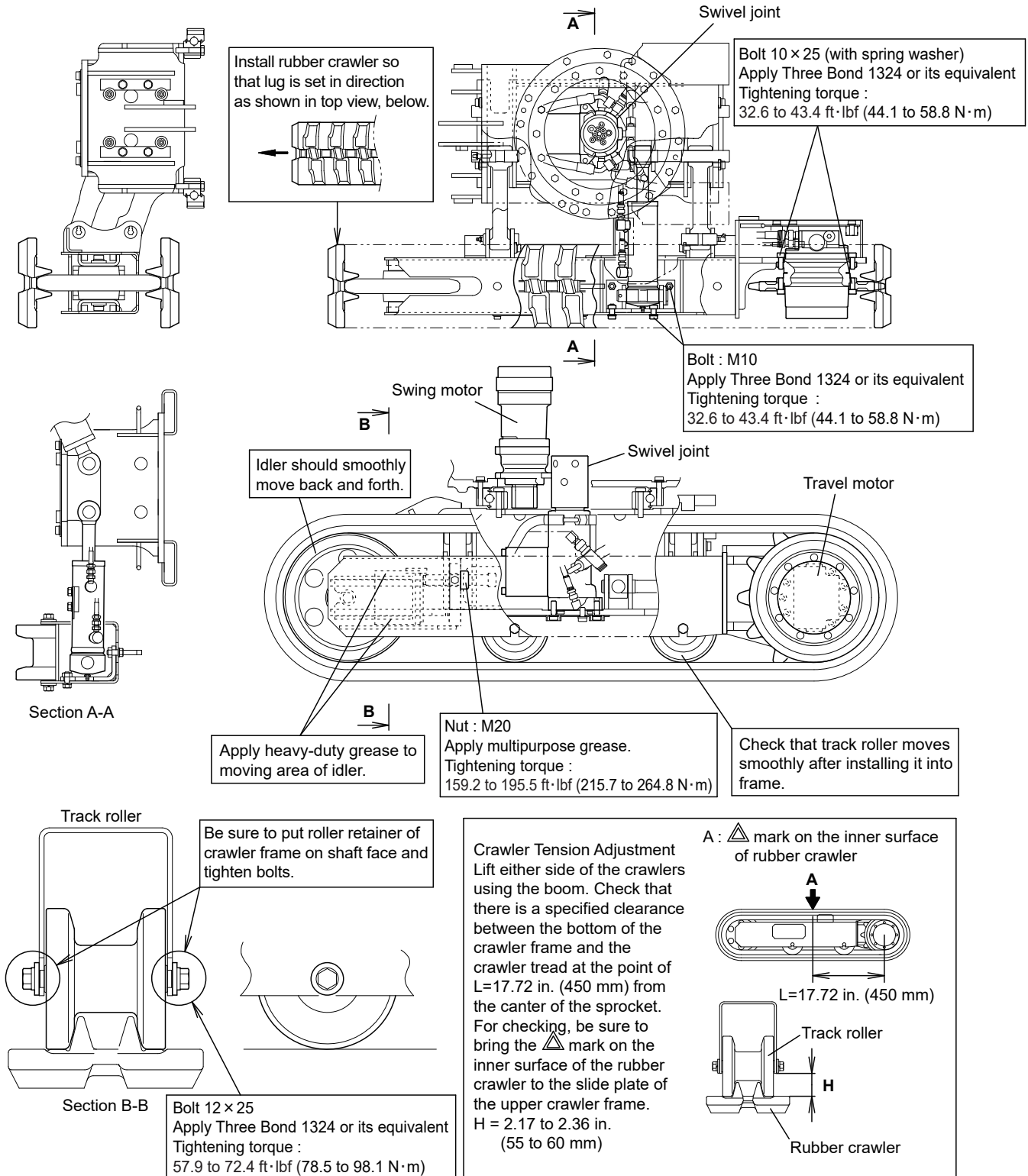
Slide track gauge change type SV08-1A(S), SV08-1C



7. ADJUSTMENT AND REPAIR

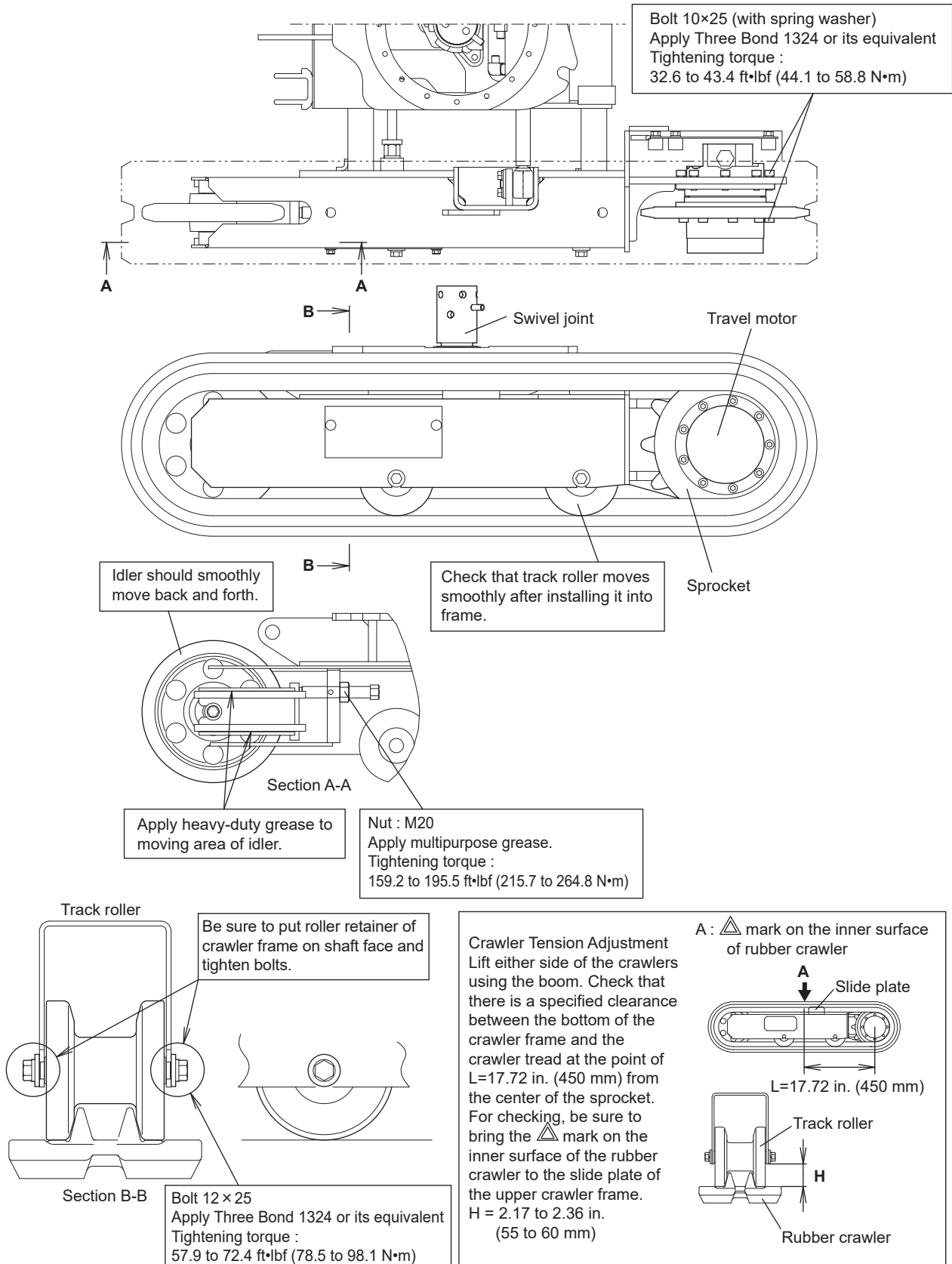
7-2-2 Points of Reassembly

Link track gauge change type SV08-1A



7. ADJUSTMENT AND REPAIR

Slide track gauge change type SV08-1A(S), SV08-1C

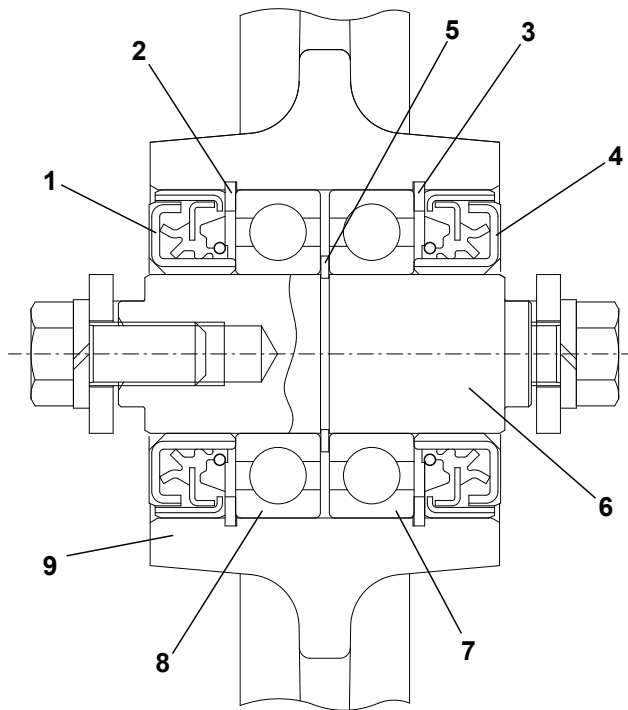


064417-00EN00

7. ADJUSTMENT AND REPAIR

7-2-3 Disassembly and Reassembly of Idler

1) Structure and Part Names

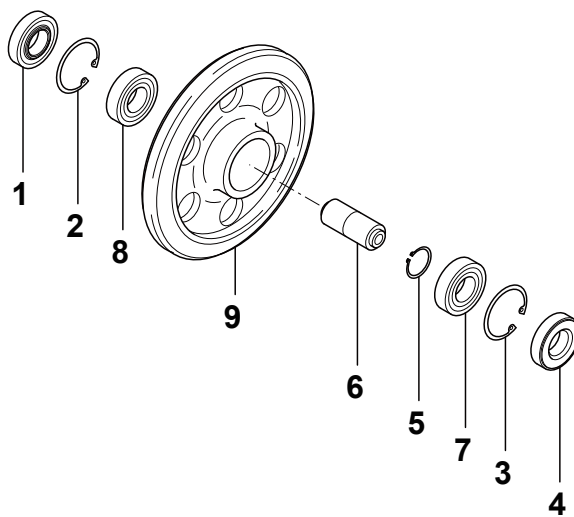


No.	Part	Q'ty	No.	Part	Q'ty
1	Oil seal QLN306213.2Y	1	6	Shaft	1
2	Internal snap ring C 62	1	7	Bearing 6206	1
3	Internal snap ring C 62	1	8	Bearing 6206	1
4	Oil seal QLN306213.2Y	1	9	Idler	1
5	External snap ring C 30	1			

2) Disassembly

Procedure	
(1) Remove the rubber crawler. (2) Remove the idler assembly from the crawler frame. (3) Remove the idler 9 from the slider.	The diagram illustrates the disassembly process. It shows the idler assembly (9) being removed from the slider. The crawler frame is shown with the idler assembly attached. The installation bolt (M12) is shown being removed from the idler assembly. The slider is shown with the idler assembly attached.

7. ADJUSTMENT AND REPAIR

Procedure	
(4) Remove the seal 1 from the idler 9 to drain the oil. Type : Gear Oil 90 (GL-4) Q'ty : 0.026 Qts. (25 cc) (5) Remove the seal 4, the internal snap rings C 2 and 3, and then the shaft 6 (with the bearings 7 and 8) from the idler 9 using a press. (6) Remove the bearings 7 and 8 and the external snap ring C 5 from the shaft 6.	

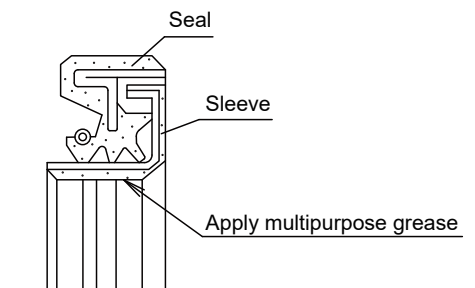
3) Reassembly

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

Notes:

- Clean all the parts, and check for defective parts.
- Replace the seals with new ones.
- Apply multipurpose grease to the lip surface of the seals.
- When installing the seal **1**, remove the sleeve, insert the seal, and then reinstall the sleeve to release the air inside the idler.

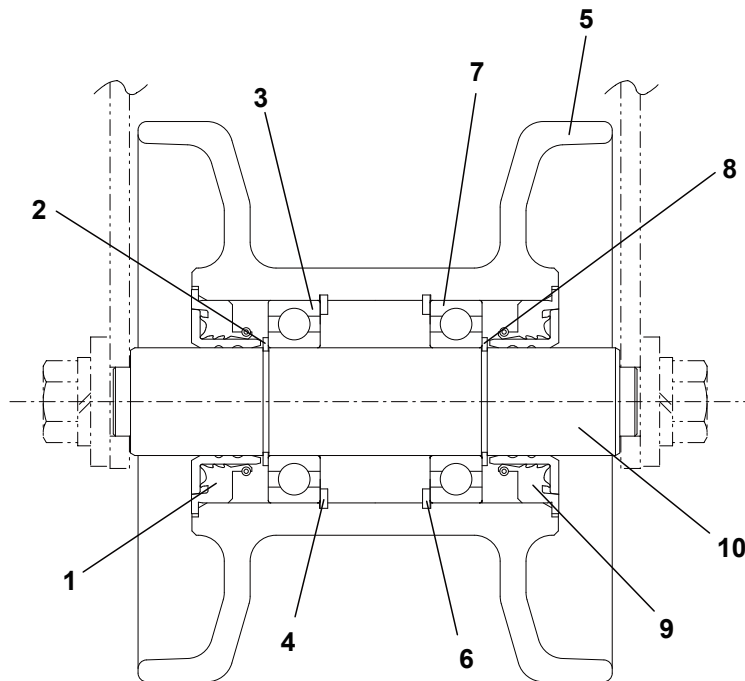
Installation bolt : M12
Apply Three Bond 1324 or its equivalent
Tightening torque :
57.9 to 72.4 ft·lbf (78.5 to 98.1 N·m)



7. ADJUSTMENT AND REPAIR

7-2-4 Disassembly and Reassembly of Track Roller

1) Structure and Part Names

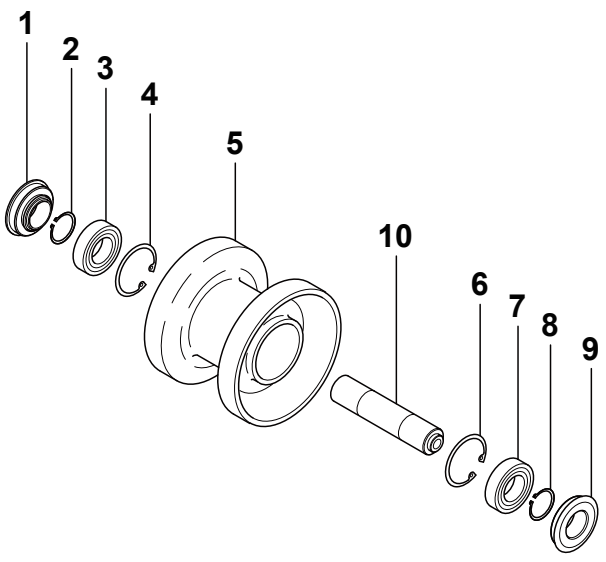


No.	Part	Q'ty	No.	Part	Q'ty
1	Seal TW25 47 16	1	6	Internal snap ring C 47	1
2	External snap ring C 25	1	7	Bearing 6005	1
3	Bearing 6005	1	8	External snap ring C 25	1
4	Internal snap ring C 47	1	9	Seal TW25 47 16	1
5	Track roller	1	10	Shaft	1

2) Disassembly

Procedure	
(1) Loosen the adjust bolt to loosen the rubber crawler. (2) Remove the track roller from the crawler frame.	The diagram illustrates the removal of a track roller from a crawler frame. It shows the track roller (labeled 'Track roller') being pulled away from the frame (labeled 'Crawler frame'). An 'Installation bolt (M12)' is shown being used to secure the roller to the frame. The roller is shown in two positions: one where it is being removed and one where it is being installed.

7. ADJUSTMENT AND REPAIR

Procedure	
(3) Remove the seal 1 from the track roller 5 to drain the oil. Type : Gear Oil 90 (GL-4) Q'ty : 0.042 Qts. (40 cc) (4) Remove the seal 9 from the track roller 5, and then remove the external snap rings C 2 and 8. (5) Pull out the shaft 10 from the track roller 5 using a press. (6) Remove the bearings 3 and 7 and the internal snap rings C 4 and 6.	

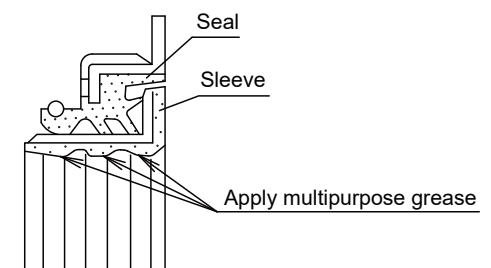
3) Reassembly

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

Notes:

- Clean all the parts, and check for defective parts.
- Replace the seals with new ones.
- Apply multipurpose grease to the lip surface of the seals.
- When installing the seal **1**, remove the sleeve, insert the seal, and then reinstall the sleeve to release the air inside the idler

Installation bolt : M12
Apply Three Bond 1324 or its equivalent
Tightening torque :
57.9 to 72.4 ft·lbf (78.5 to 98.1 N·m)

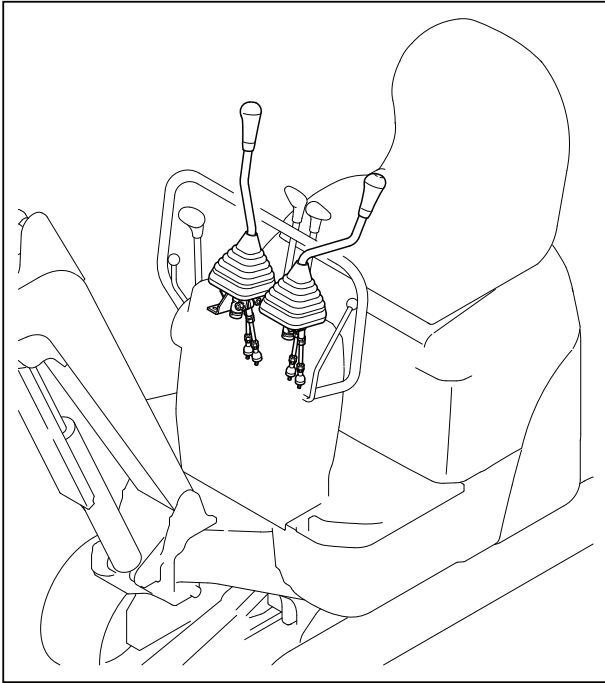


7. ADJUSTMENT AND REPAIR

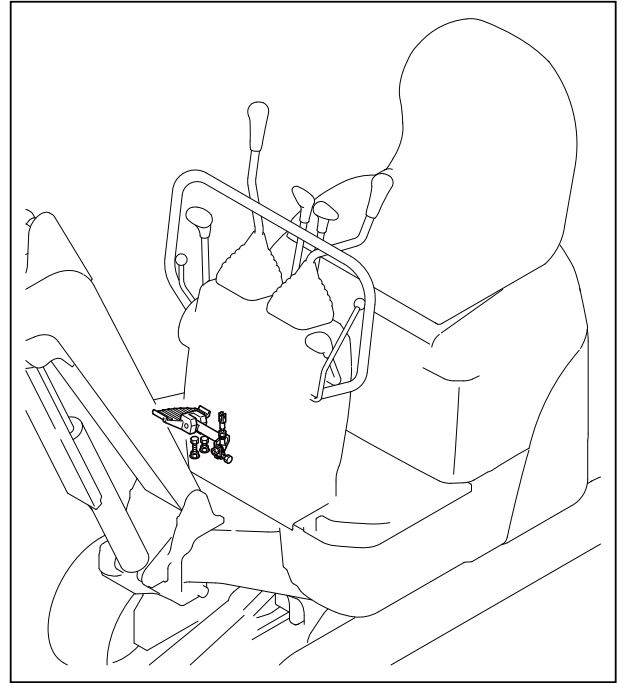
7-3 Controls

7-3-1 Control Train

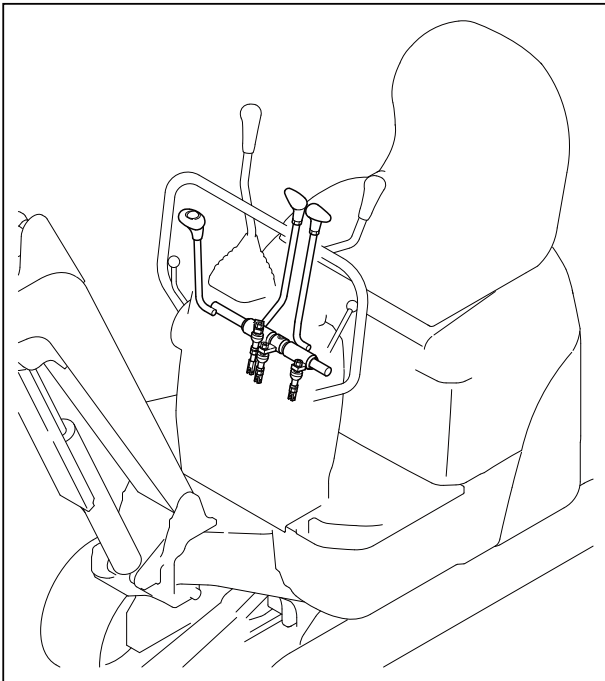
- 1) Control Lever (R) : Boom and Bucket
Control Lever (L) : Arm and Swing



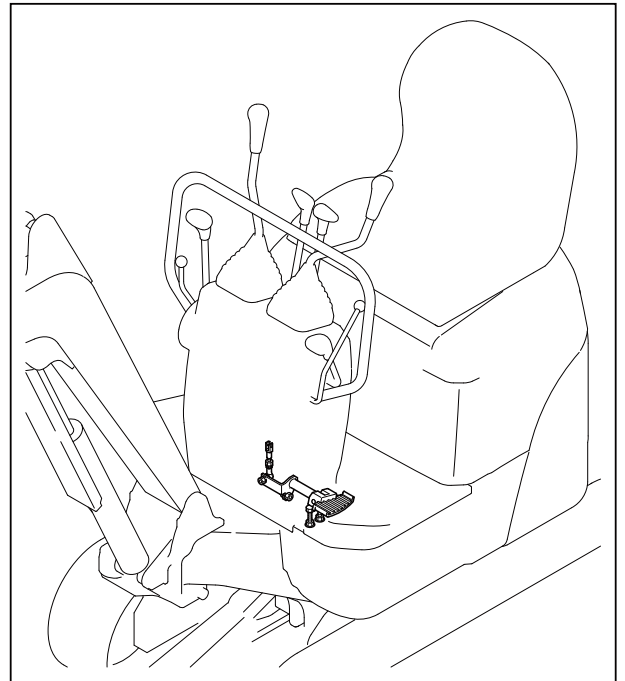
- 3) Boom Swing Pedal



- 2) Travel and Blade Levers



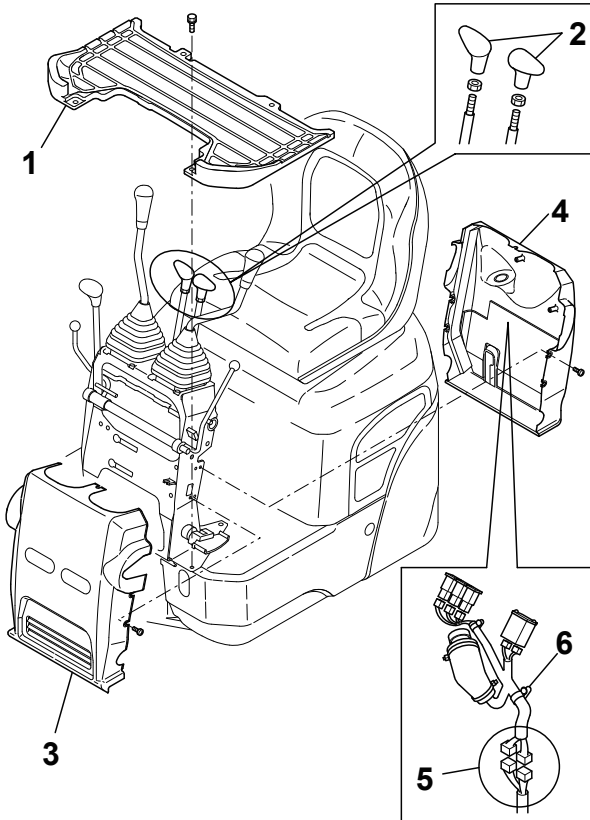
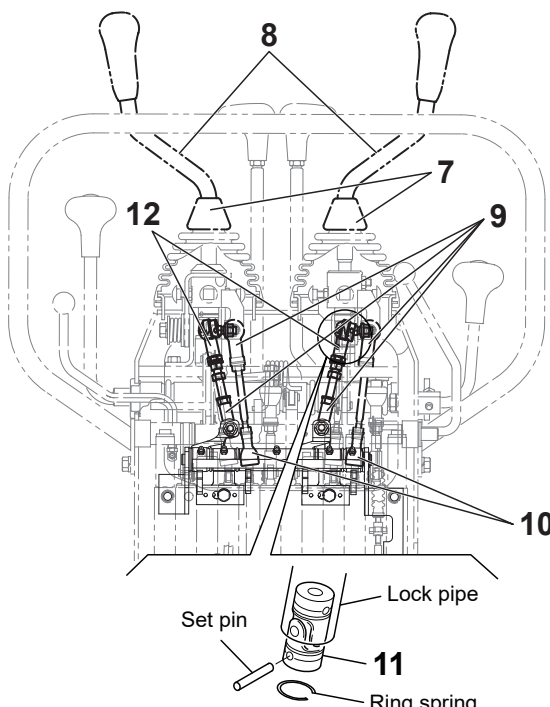
- 4) P.T.O. Pedal



7. ADJUSTMENT AND REPAIR

7-3-2 Removal and Reinstallation of Control Levers

1) Removal

Procedure	
(1) Remove the step 1, and then remove the grips 2 of the travel levers. (2) Remove the stand cover F 3 and the stand cover R 4. Notes : • When removing the stand cover R 4, disconnect the couplers 5 of the wire harness (for the stand), and then remove the band 6. • Fasten the wire harness to the hydraulic hose with the band in reinstallation.	
(3) Remove the lever boot 7 to move it up along the control lever 8. (4) Remove the rod ends (L-balls 8 9, link balls 6 10 and link balls 8L 12) connecting to the control levers 8. (5) Disconnect the connector of the lead wire for the horn switch. (6) Disconnect the lock lever link from the rock pipe side. (7) Move the lock pipe upward to remove the ring spring and set pin from the joint 11. (8) Remove the control lever CMP 8 from the lever stand.	 016016-00E

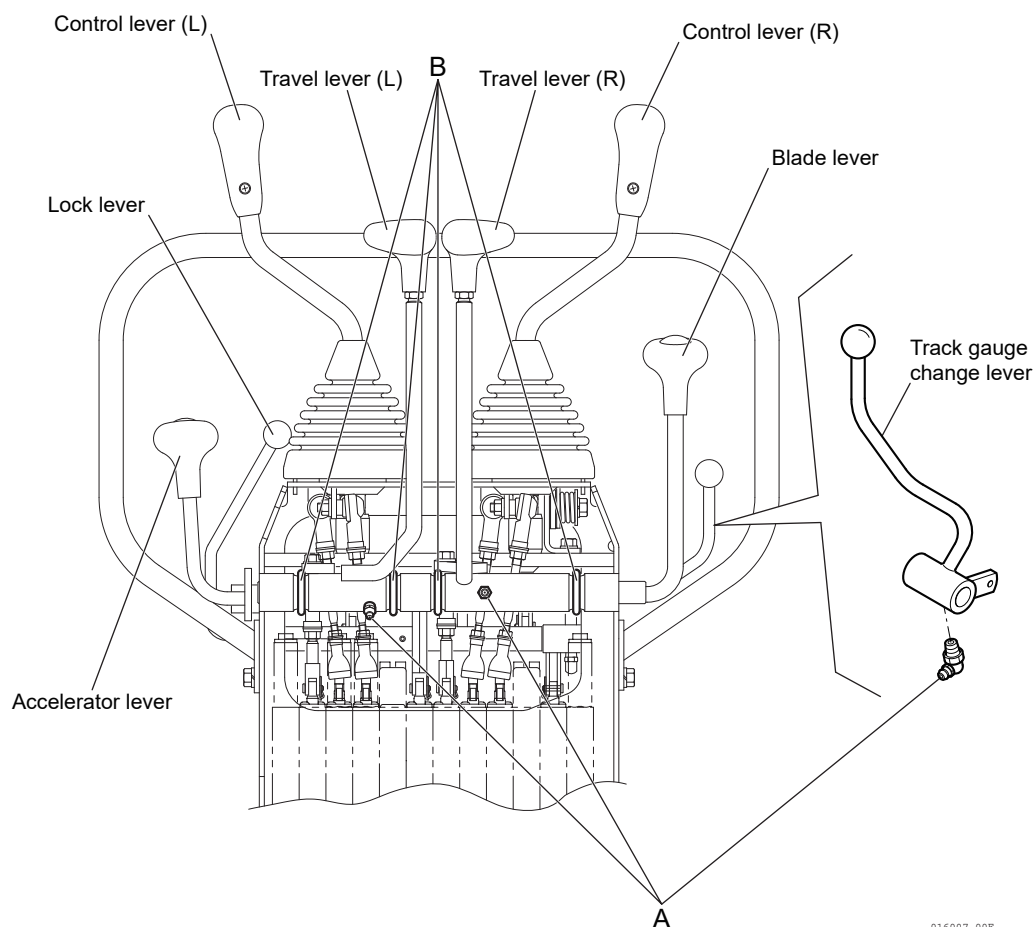
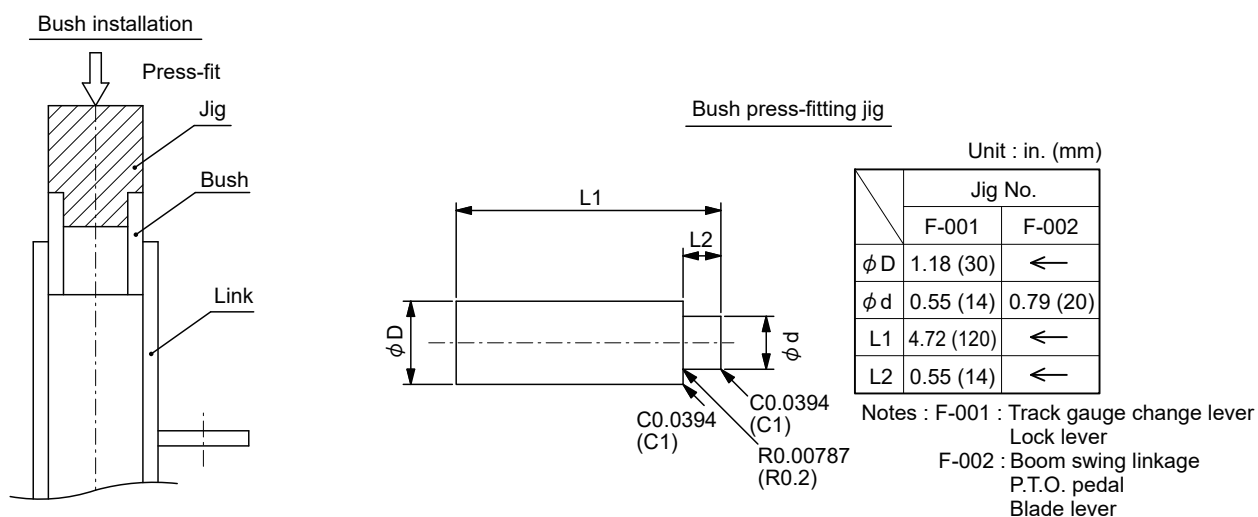
7. ADJUSTMENT AND REPAIR

2) Reinstallation

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

(1) Points of reassembly

- [1] Use a jig to install the bush into the link.
- [2] Apply grease to the links and take care not to damage the O-rings B when installing the links.
- [3] Fill the nipples A with grease after installation.



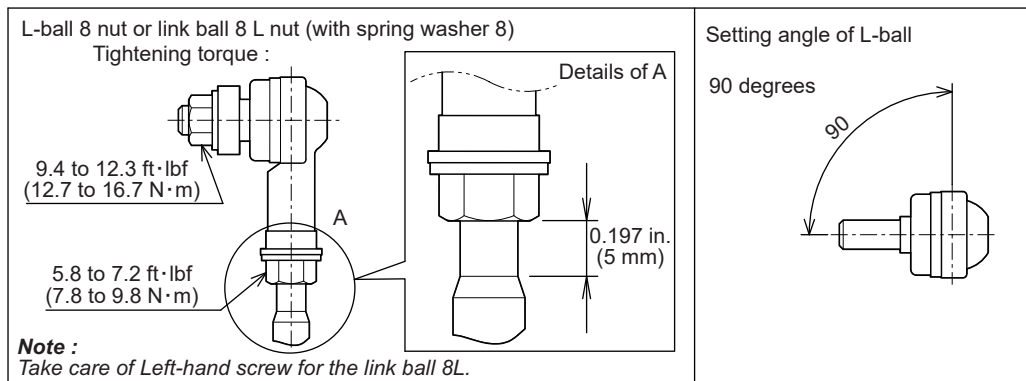
016007-00E

7. ADJUSTMENT AND REPAIR

3) Reinstallation of Link Balls and L-balls

Note :

Screw the rod into the link ball and the L-ball according to the specified values in the details of A and B.

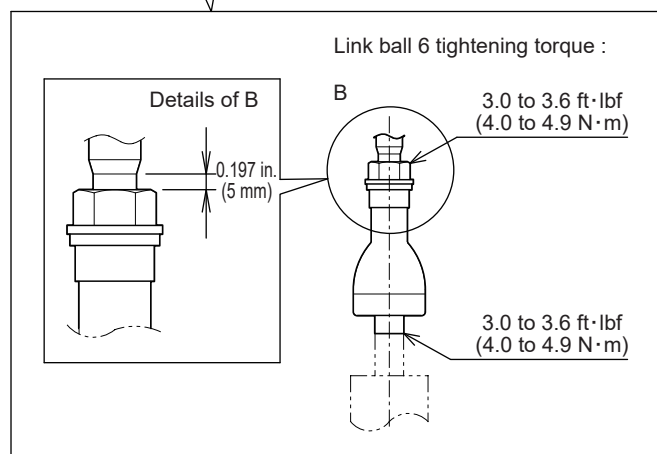
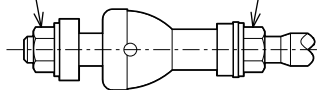


Binding head screw (cross recessed head 4×6)	
Tightening torque	3.0 to 3.6 ft·lbf (4.0 to 4.9 N·m)

Link ball 8 nut (with spring washer 8)
Tightening torque :

5.8 to 7.2 ft·lbf
(7.8 to 9.8 N·m)

9.4 to 12.3 ft·lbf
(12.7 to 16.7 N·m)



016008-00B

7. ADJUSTMENT AND REPAIR

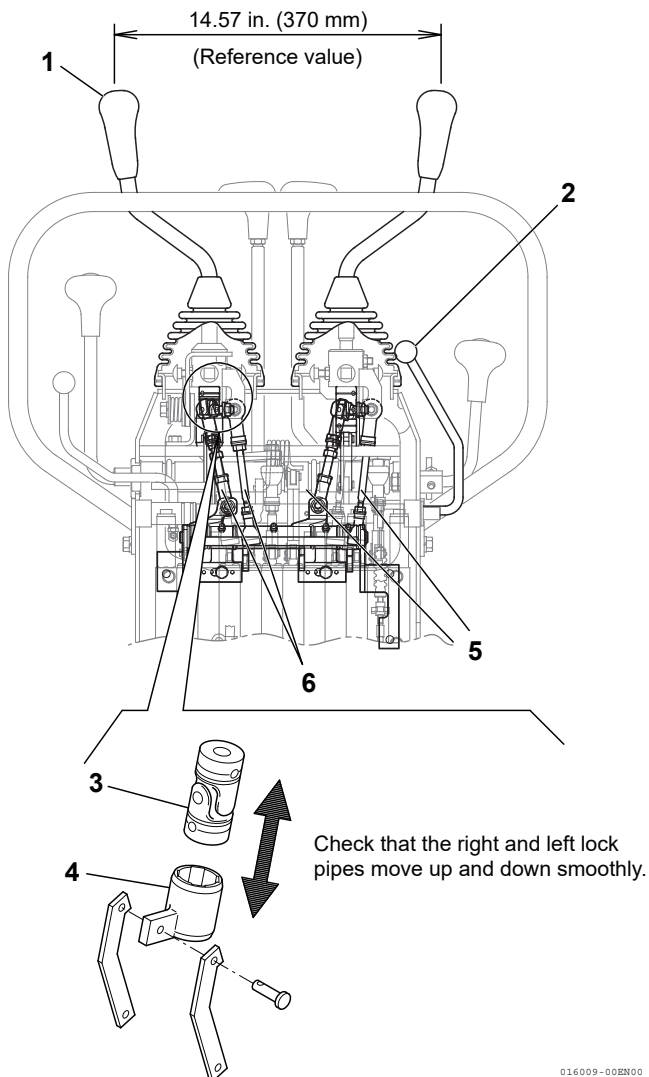
7-3-3 Adjustment of Control Levers

1) Adjustment of Control Levers

- (1) Check if the lock lever **2** can be moved to the "LOCK" and "UNLOCK" positions smoothly when the control levers **1** are in the neutral position.
- (2) Move the lock lever **2** to check if the lock pipe **4** smoothly moves on the joint **3** up and down for each control lever. If not, turn the rods **5** and **6** to adjust the movement of the lock pipe.
- (3) After adjustment, tighten the lock nuts for the L-balls and the link balls.

Note :

The distance between the right and left control levers shown in the figure is a reference value. Give priority to the adjustment of the lock lever over the distance adjustment.



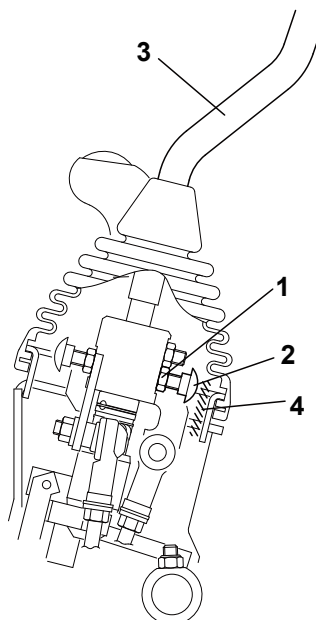
016009-00EN00

2) Adjustment of Stopper Bolts

- (1) Loosen the lock nut **1** and screw in the stopper bolt **2** to the limit.
- (2) Move the control lever **3** to its stroke end and loosen the stopper bolt **2** until its head contacts with the inside wall **4** of the support.
- (3) Move the control lever **3** back to the "NEUTRAL" position, loosen the stopper bolt **2** half a turn further and tighten the lock nut **1** to hold it.

Note :

After adjusting the stopper bolts on the front, rear, right and left sides, apply grease to the stopper bolt heads and the contact areas of the support inside wall with them.



7. ADJUSTMENT AND REPAIR

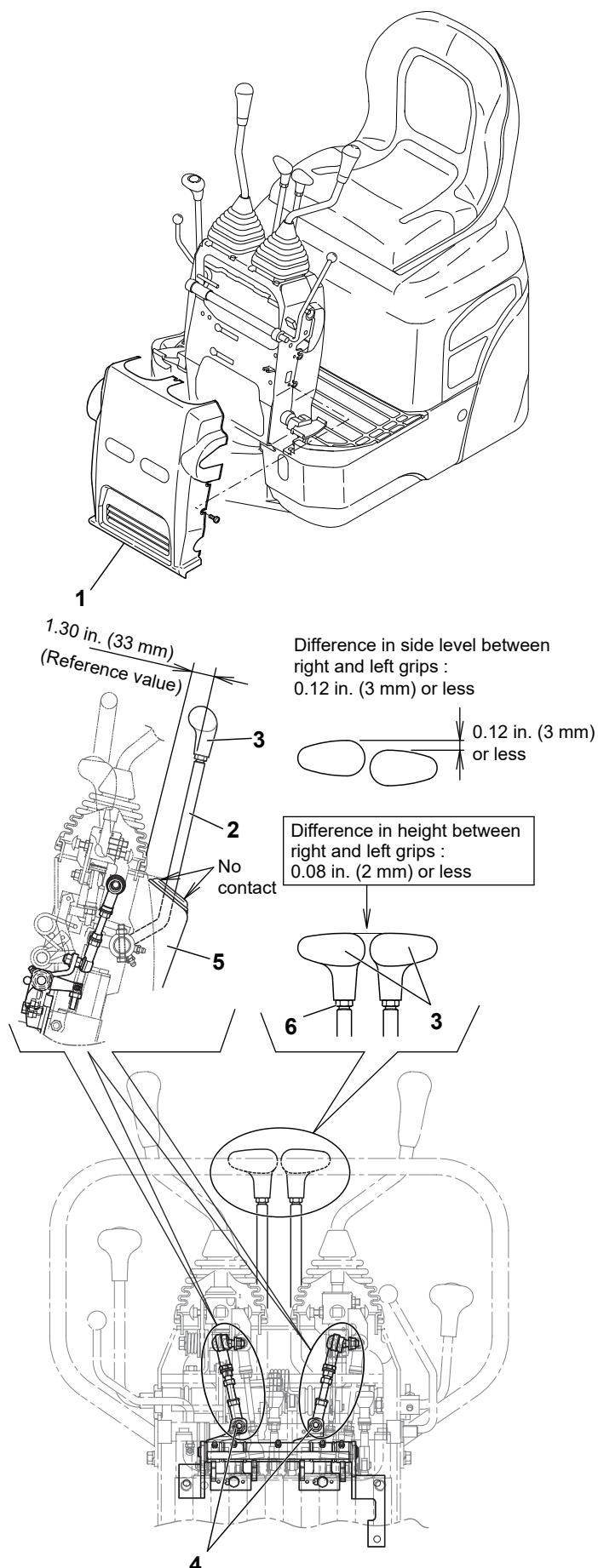
7-3-4 Adjustment of Travel Levers

- (1) Remove the stand cover F 1.
- (2) Check the difference in side level between the grips 3 of the right and left travel levers 2.
- (3) Loosen the lock nuts 4 and turn the rods to adjust the difference in side level between the right and left grips to a value within the specified range.

Note :

Check that the travel levers 2 are not in contact with the stand cover R 5 around the lever openings.

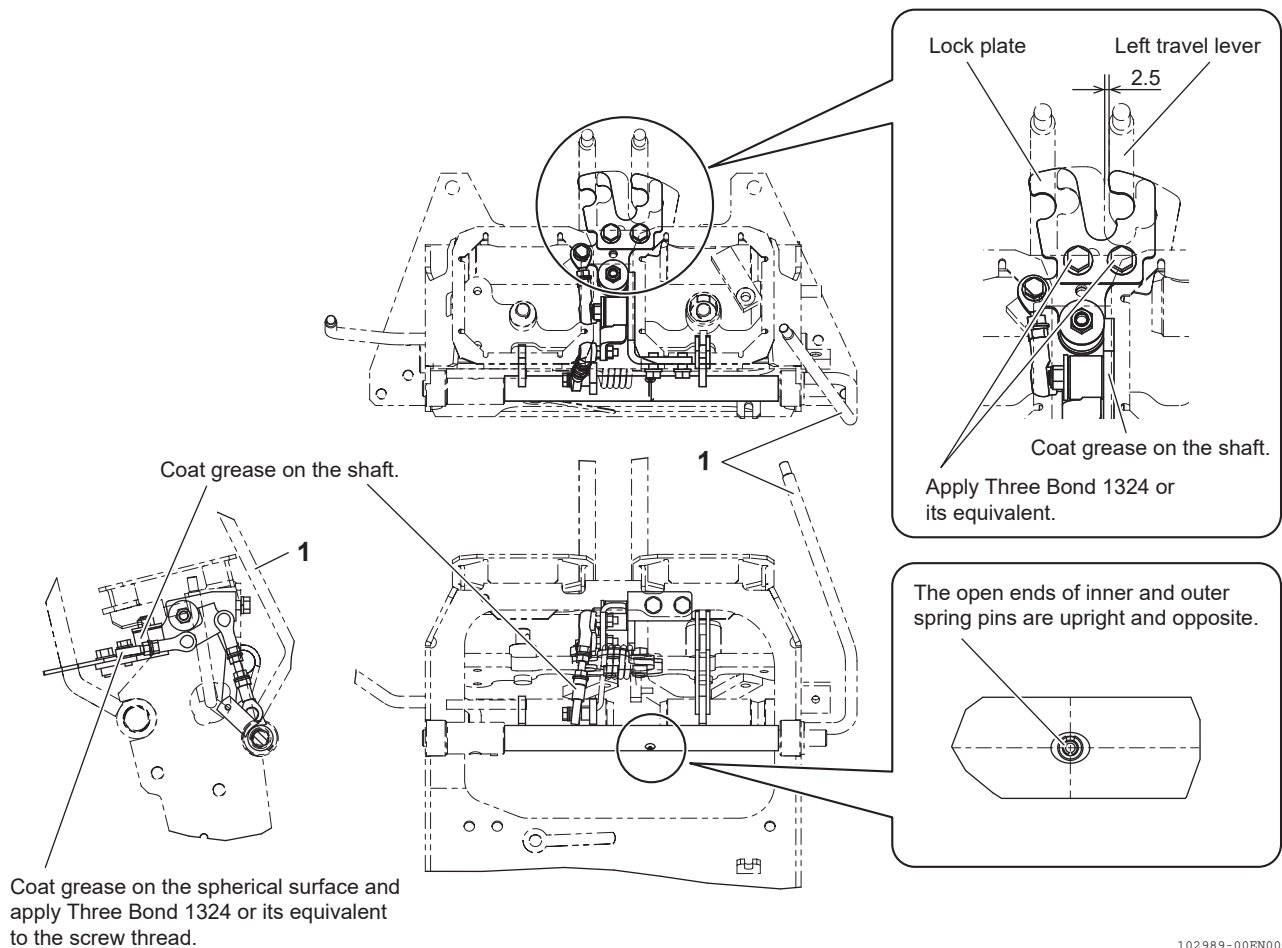
- (4) Check the difference in height between the right and left grips 3.
- (5) Loosen the lock nuts 6 and turn the grips 3 to adjust the difference in height between the right and left grips to a value within the specified range.



7. ADJUSTMENT AND REPAIR

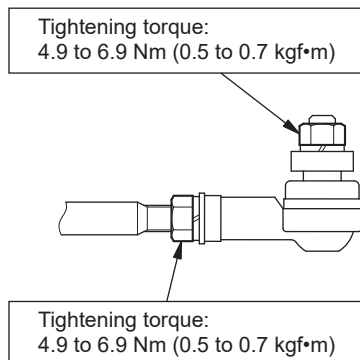
7-3-5 Adjustment of Travel Lever Lock (YCEE spec. S/N 19919 and above)

- (1) Confirm that the left and right tracks do not move when the travel lever grips are pushed or pulled with 44 N (4.5 kgf) of power.
- (2) Adjust the clearance between the lock plate and left travel lever shown in the figure to approximate 2.5 mm when the lock lever **1** is in the unlock position.



102989-00EN00

Tightening torque of Linkage ball 6 nut

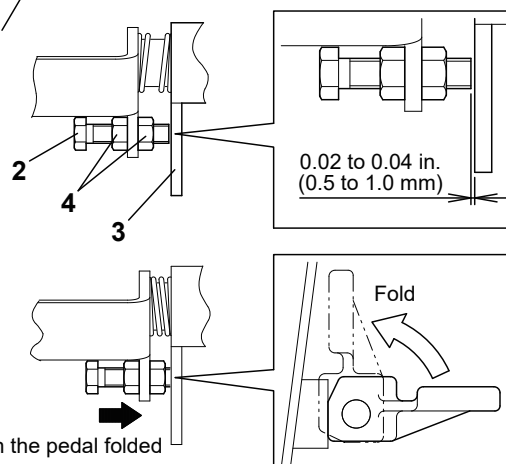
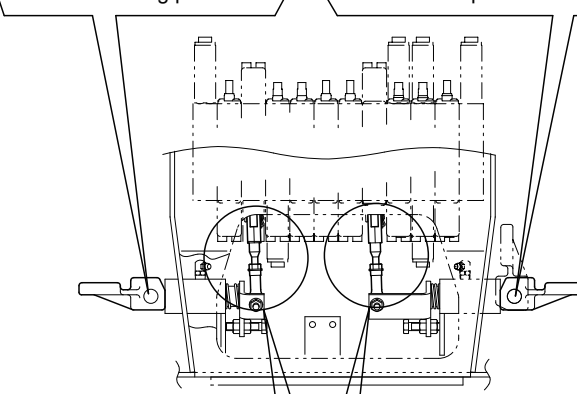
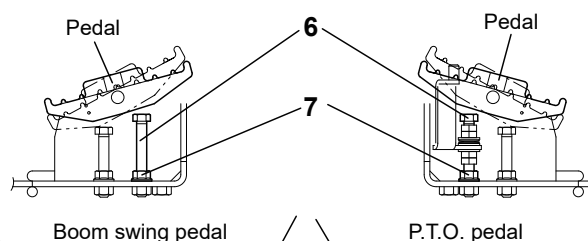
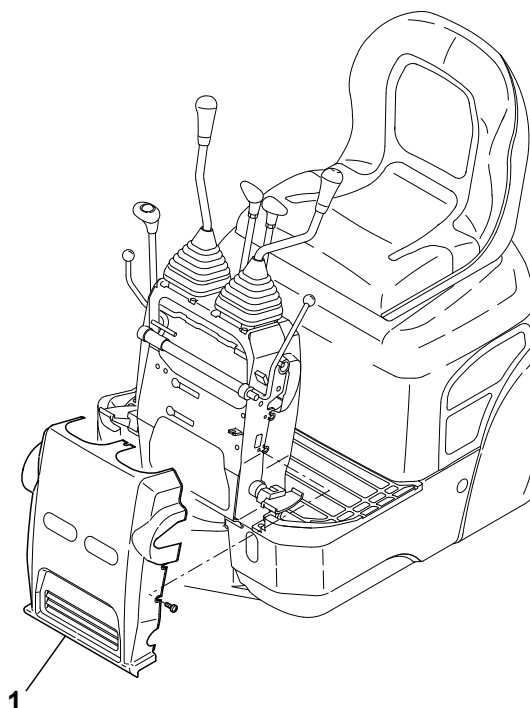


079281-00EN00

7. ADJUSTMENT AND REPAIR

7-3-6 Adjustment of P.T.O. Pedal

- (1) Remove the stand cover F 1.
- (2) Check if the clearance between the end of the lock bolt 2 and the plate 3 is within the range from 0.02 to 0.04 in. (0.5 to 1.0 mm).
- (3) If not, adjust the clearance by loosening the lock nuts 4.
- (4) Check if the end of the lock bolt 2 is inserted into the hole in the plate 3 smoothly when the pedal is folded.
- (5) If not, make adjustments by loosening the lock nut and turning the rod 5.
- (6) Loosen the lock nut 7 of the stopper bolt 6 for the pedal and screw in the stopper bolt 6 to the limit, and then move the pedal to its stroke end.
- (7) While keeping the pedal in that position, loosen the stopper bolt 6 until its head contacts with the pedal. Then, loosen the bolt half a turn further and tighten the lock nut 7.



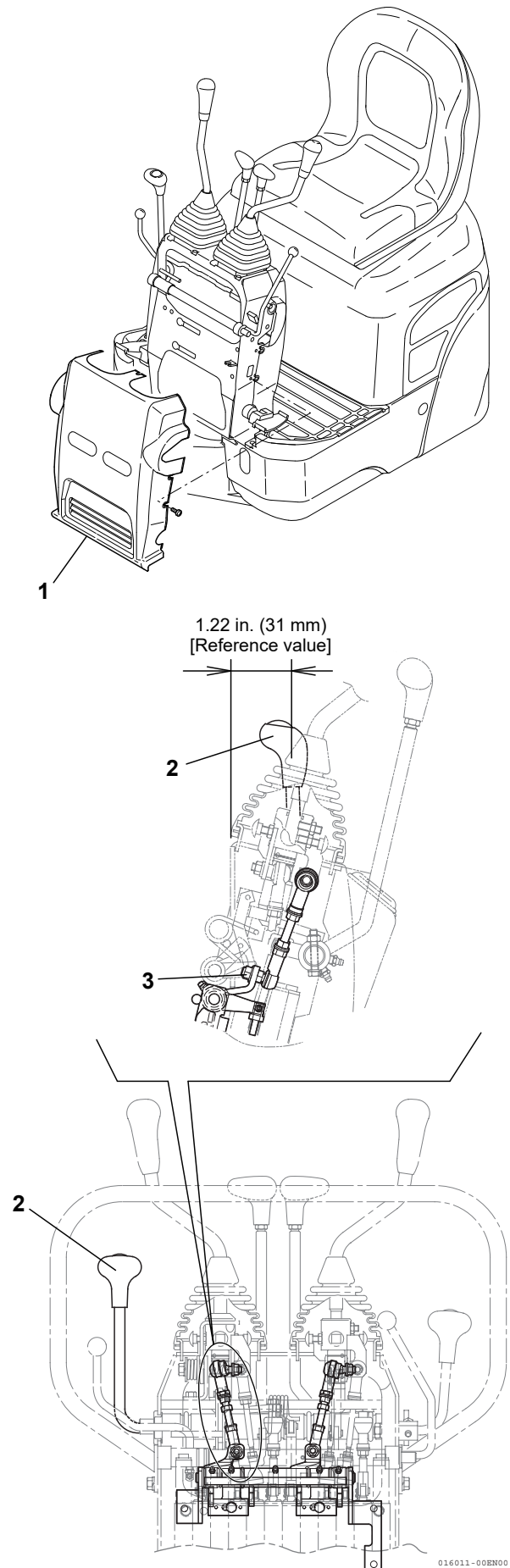
7-3-7 Adjustment of Boom Swing Pedal

Adjust the boom swing pedal according to the same procedure as the steps (1) to (7) in Section 7-3-5 "Adjustment of P.T.O. Pedal".

7. ADJUSTMENT AND REPAIR

7-3-8 Adjustment of Blade Lever

- (1) Remove the stand cover F 1.
- (2) Check if the blade lever 2 is perpendicular to the floor plate.
- (3) If not, loosen the lock nut 3 and turn the rod to make the blade lever 2 perpendicular.



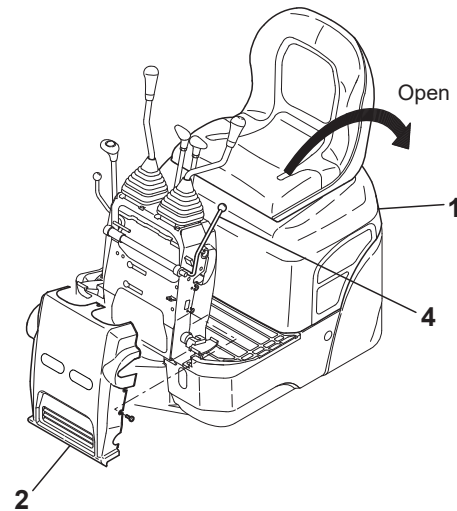
7. ADJUSTMENT AND REPAIR

7-3-9 Adjustment of Accelerator Lever (Adjustment of Engine Idling Speed)

- (1) Open the engine hood **1**.
- (2) Remove the stand cover F **2**.
- (3) Adjust the length of the fitting part of the accelerator cable **3** in the details A to 0.4 in. (10 mm) and fix the cable in that state.
- (4) Start the engine.

Note :

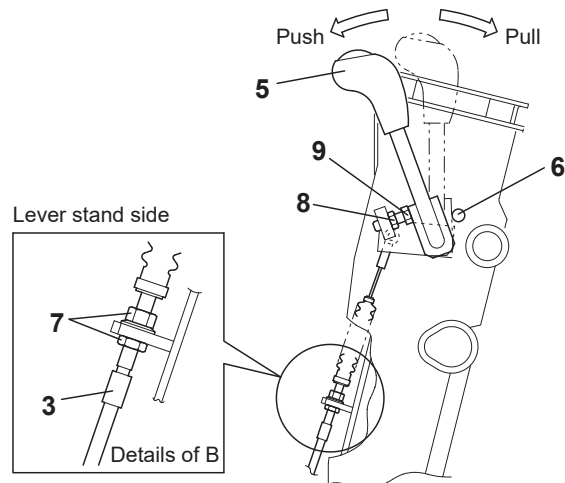
Set the lock lever **4** in the "LOCK" position.



1) Adjustment of High Idling Speed

- (1) Pull the accelerator lever **5** back to the high idling speed position where the lever contacts with the stopper **8**.
- (2) Check if the engine speed is 2400 rpm.
- (3) If not, readjust it with the lock nuts **7** in the details B.

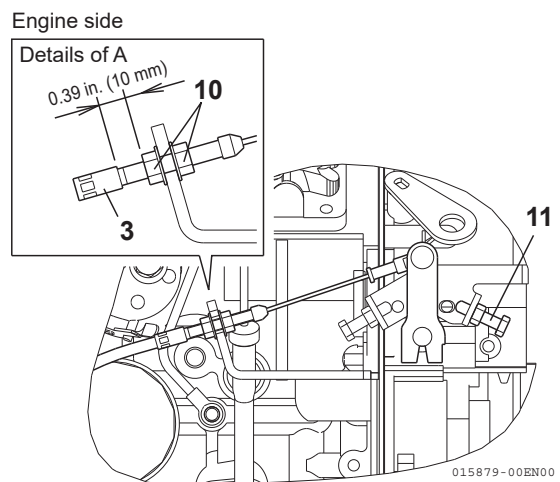
Tightening torque of the lock nut 7 (M12):
18.1 to 23.8 ft·lbf (24.6 to 32.3 N·m)



2) Adjustment of Low Idling Speed

- (1) Loosen the lock nut **8** of the stopper bolt **9** and fully screw in the bolt.
- (2) Push the accelerator lever **5** forward to the low idling speed position.
- (3) Check if the minimum idling speed is 1175 to 1225 rpm.
- (4) If not, readjust it with the lock nuts **10** in the details A or low idle adjusting screw **11**.
- (5) Loosen the stopper bolt **9** until the bolt head contacts with the accelerator lever **5**, and then tighten the lock nut **8**.

Tightening torque of the lock nut 10 (M12):
18.1 to 23.8 ft·lbf (24.6 to 32.3 N·m)

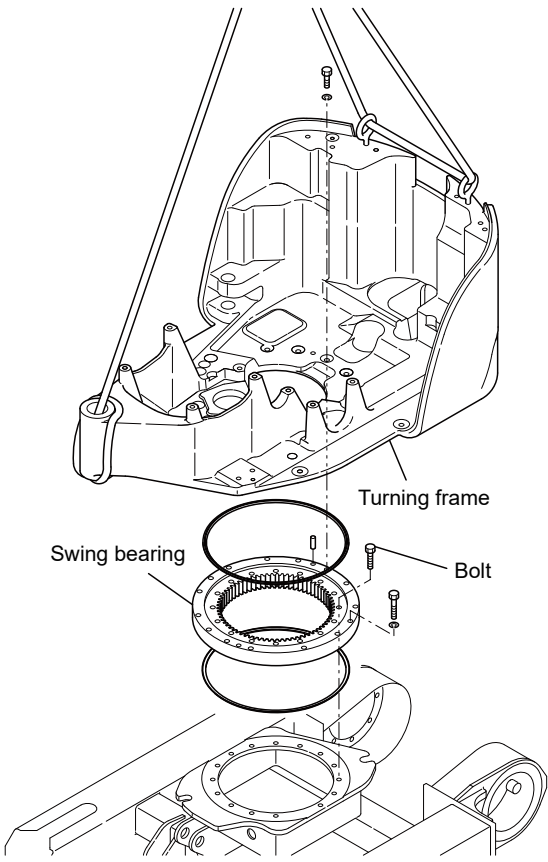


7. ADJUSTMENT AND REPAIR

7-4 Swing Bearing

7-4-1 Removal and Reinstallation of Swing Bearing

1) Removal

Procedure	
(1) Remove the turning frame. Refer to Section "7-5-4 Removal and Reinstallation of Swivel Joint" for the turning frame removal procedure. (2) Remove the installation bolts on the track frame side to remove the swing bearing.	 The diagram illustrates the removal of the swing bearing in three stages. The top stage shows the turning frame being lifted away from the track frame. The middle stage shows the swing bearing being removed from the track frame, with a bolt being used to secure it. The bottom stage shows the track frame with the swing bearing removed. Labels in the diagram: - Turning frame - Swing bearing - Bolt

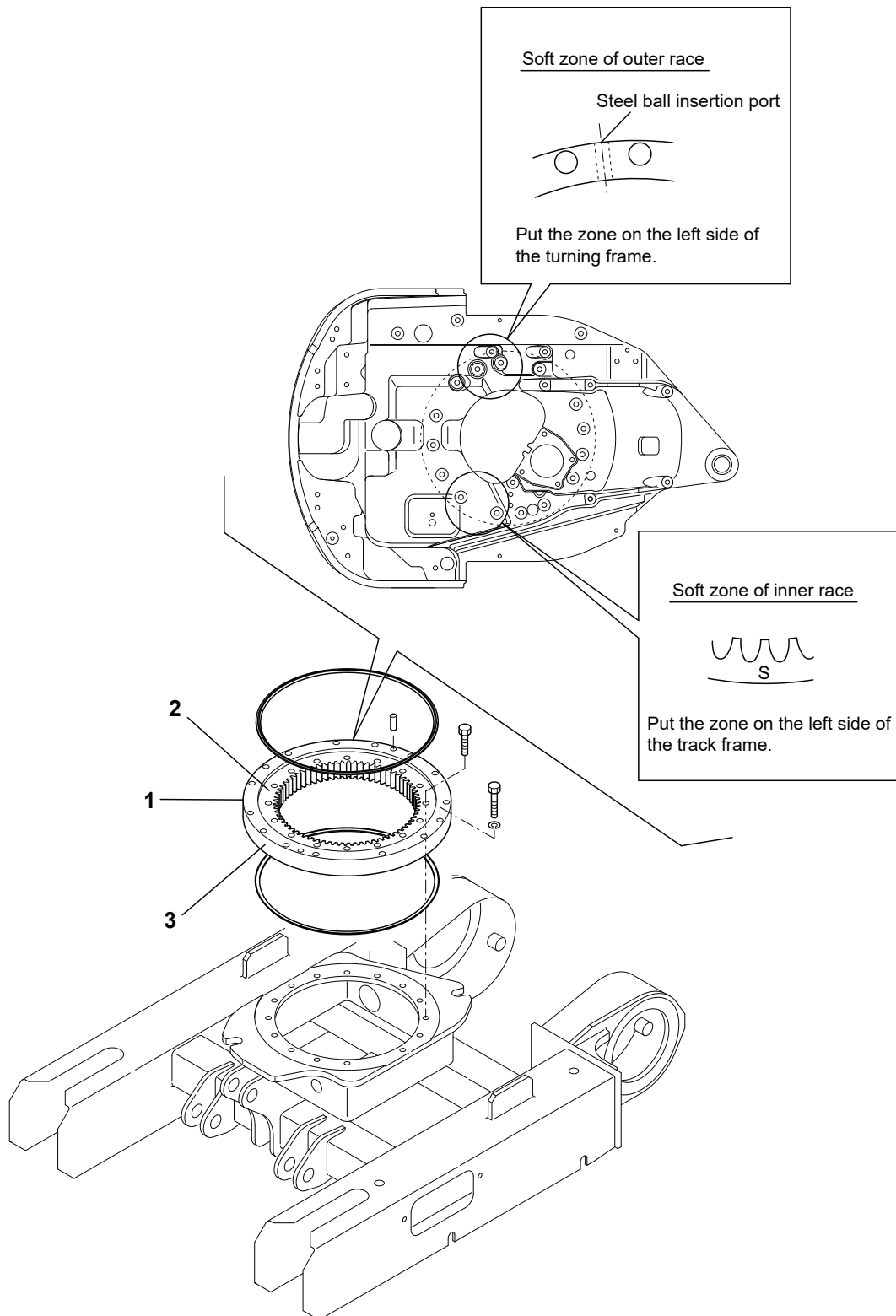
7. ADJUSTMENT AND REPAIR

2) Reinstallation

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

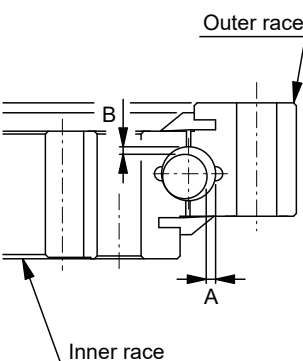
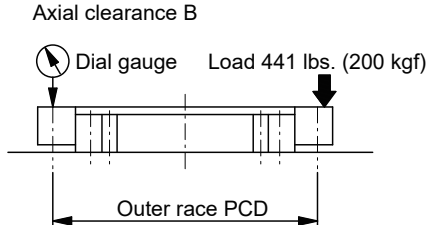
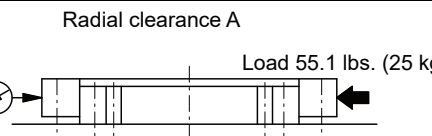
Note :

The inner race 2 and the outer race 3 of the swing bearing 1 each have a soft zone. Install the swing bearing with the soft zones in place.



7. ADJUSTMENT AND REPAIR

3) Service Standards

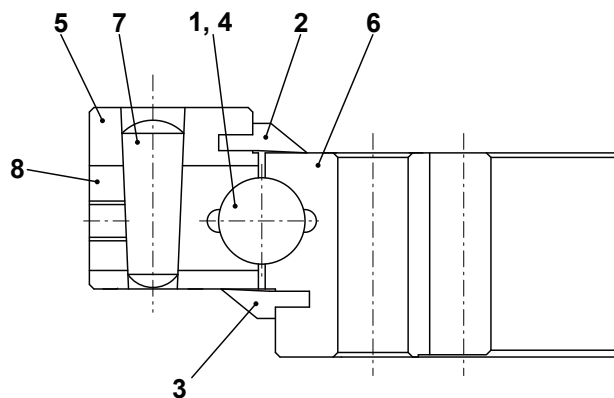
			Standard	Wear limit
	Axial clearance B 		0.0020 to 0.0098 in. (0.05 to 0.25 mm)	0.0157 in. (0.4 mm)
	Radial clearance A 		0.0020 to 0.0130 in. (0.05 to 0.33 mm)	0.0197 in. (0.5 mm)
Steel ball diameter			Ø0.625 in. (Ø15.875 mm)	—
Tightening torque	Upperstructure×outer race Undercarriage×inner race	M10	50.6 to 57.9 ft·lbf (68.6 to 78.4 N·m)	Apply Loctite 262 or its equivalent

Note :

Supply multi purpose grease to the swing bearing.

4) Parts

No.	Part	Q'ty
1	Steel ball	47
2	Seal A	1
3	Seal B	1
4	Support	47
5	Outer race	1
6	Inner race	1
7	Taper pin	1
8	Plug	1

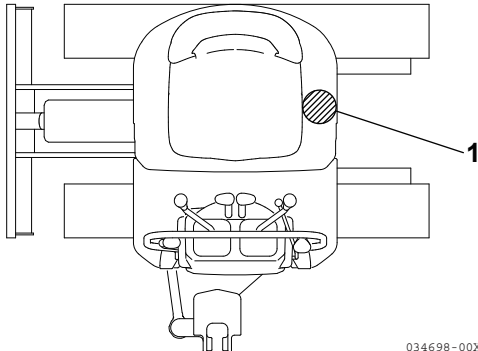
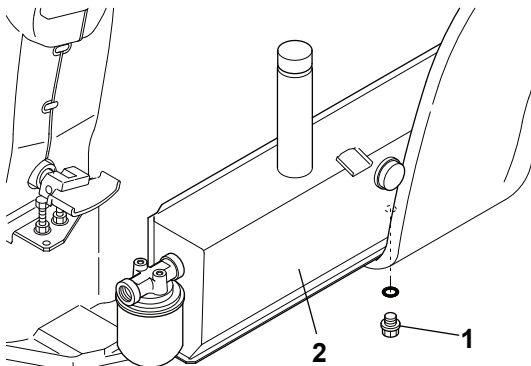
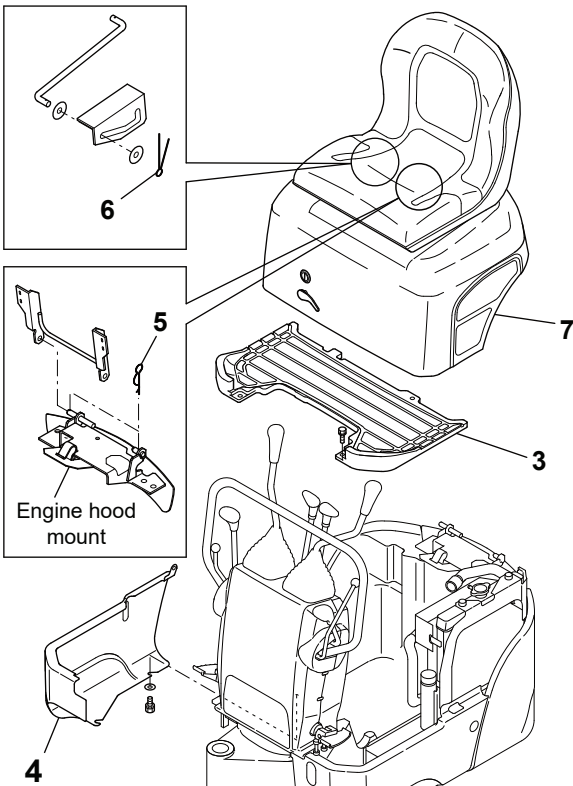


7. ADJUSTMENT AND REPAIR

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. Lower the bucket to the ground and stop the engine.	 034698-00X
(2) Remove the drain plug 1 from the hydraulic oil tank 2 to drain the hydraulic oil. Type : YANMAR SUPER HYDRO OIL (VG 46 or its equivalent) Q'ty : 1.74 Gals. (6.6 L)	 034699-00X
(3) Remove the step 3 and the side cover R 4. (4) Remove the snap rings 5 on the engine hood mount and the split pin 6 of the link to remove the engine hood (with the operator's seat) 7.	 034700-00E

7. ADJUSTMENT AND REPAIR

Procedure	
(5) Remove the battery 8. (6) Remove the hose 10 of coolant container 9. (7) Disconnect the wirings from the electric parts on the partition panel 11. (8) Remove the plug 12 to drain fuel in the tank. (9) Remove the clamp 13. (10) Remove the two hoses 14. (11) Remove the fuel tank 15. (12) Remove the partition panel 11.	015917-00B

(13) Loosen the hose clips 16 to remove the suction hose 17. (14) Remove the hydraulic hoses P1 18 and P2 19. (15) Remove the installation bolts 20 to remove the hydraulic pump 21.	015921-00X
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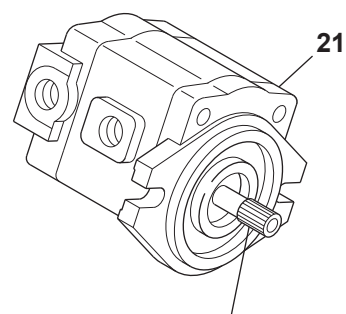
2) Reinstallation

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

Hose clip 41	
Tightening torque	1.8 to 2.5 ft·lbf (2.5 to 3.4 N·m)

Note :

Apply heavy-duty grease to the spline shaft of the hydraulic pump **21**.



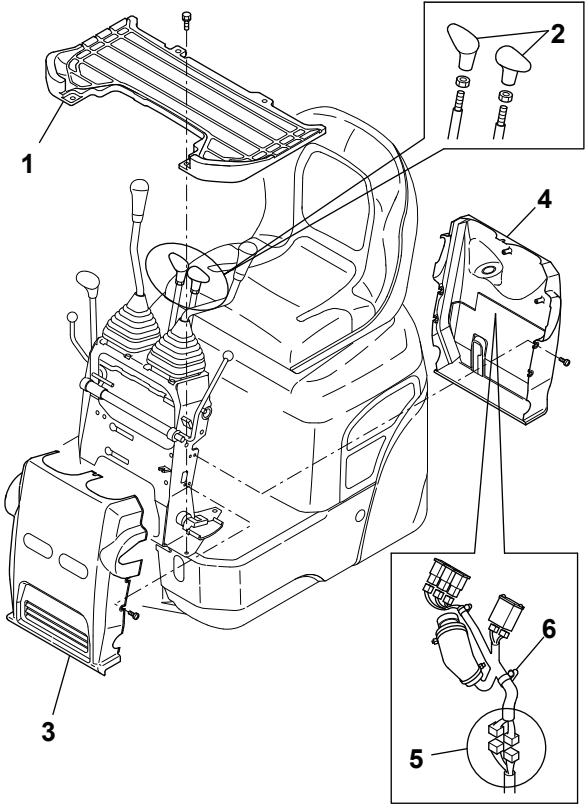
Apply heavy-duty grease

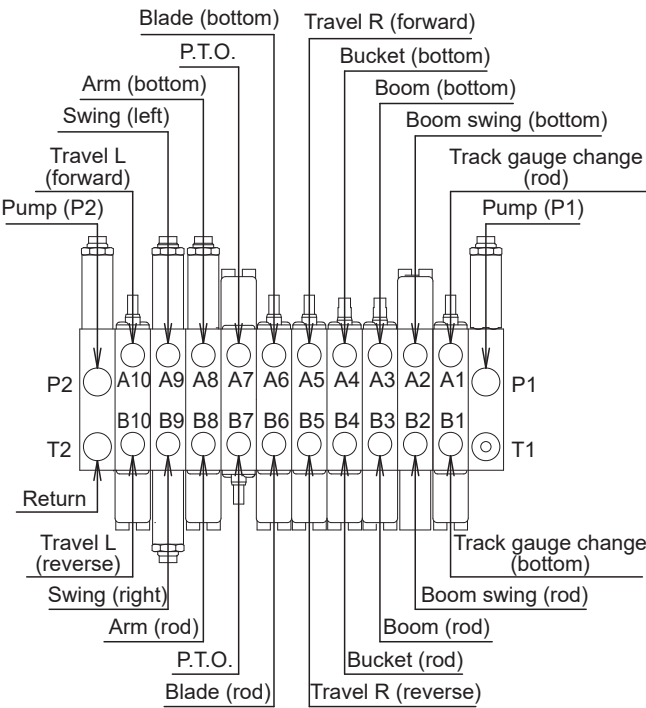
015922-00B

7. ADJUSTMENT AND REPAIR

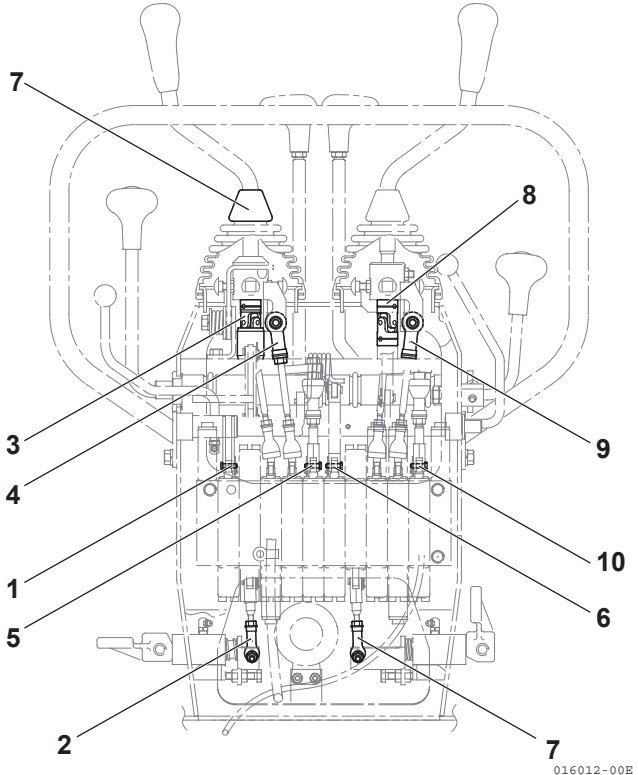
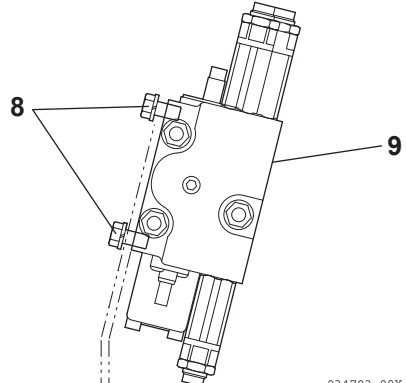
7-5-2 Removal and Reinstallation of Control Valve

1) Removal

Procedure	
(1) Remove the step 1, and then remove the grips 2 of the travel levers. (2) Remove the stand cover F 3 and the stand cover R 4. Notes : - When removing the stand cover R 4, disconnect the couplers 5 of the wire harness (for the stand), and then remove the band 6. - Fasten the wire harness to the hydraulic hose with the band in reinstallation.	 034701-00X

(3) Remove the hydraulic hoses from the control valve. Notes : - Remove all the hydraulic hoses in order of section arrangement from the pump P2 side. - Put an identification mark on each of the removed hoses so that they can be reinstalled in the correct order. - Reinstall the band in the specified position in reinstallation.	 (Variable track gauge type) 034702-00E01
---	---

7. ADJUSTMENT AND REPAIR

Procedure	
(4) Remove the lever boot 7 to move it up along the control lever. (5) Remove the L-balls, the link balls and the pins connecting to the spools of the control valve. 1. Track gauge change section→Pin 2. Boom swing section→Link ball 6 3. Boom section→Link ball 8 L 4. Bucket section→L-ball 8 5. Travel R section→Pin 6. Blade section→Pin 7. P.T.O. section→Link ball 6 8. Arm section→Link ball 8 L 9. Swing section→L-ball 8 10. Travel L section→Pin	 016012-00E
(6) Remove the installation bolts (M8) 8 to remove the control valve 9.	 034703-00X

7. ADJUSTMENT AND REPAIR

2) Reinstallation

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

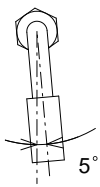
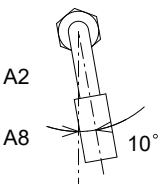
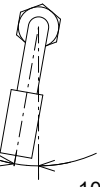
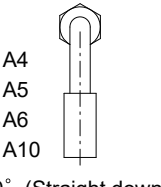
(1) Tightening torque

L-ball 8 (for the boom, bucket, arm, and swing sections)	
Tightening torque	9.4 to 12.3 ft·lbf (12.7 to 16.7 N·m)

L-ball 6 (for the boom swing and P.T.O. sections)	
Tightening torque	5.8 to 7.2 ft·lbf (7.8 to 9.8 N·m)

(2) Setting angles of hydraulic hoses (connecting to ports A of control valve)

Setting angles of hoses connecting to ports A

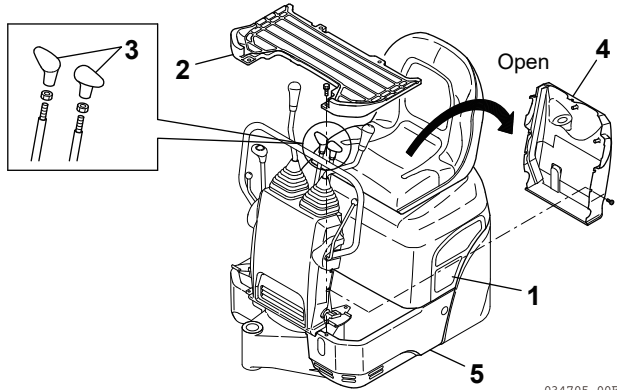
 A1 5°	 A2 A8 10°
 A3 A9 10°	 A4 A5 A6 A10 0° (Straight down)

034704-00B

7. ADJUSTMENT AND REPAIR

7-5-3 Removal and Reinstallation of Swing Motor

1) Removal

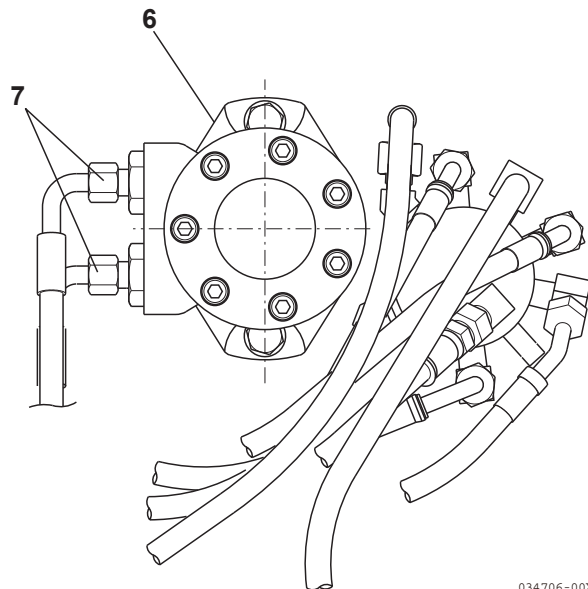
Procedure	
(1) Open the engine hood 1 and remove the step 2, the grips 3 of the travel levers and then the stand cover R 4. (2) Remove the side cover L 5.	 034705-00E

(3) Remove the hydraulic hoses **7** from the swing motor **6**.

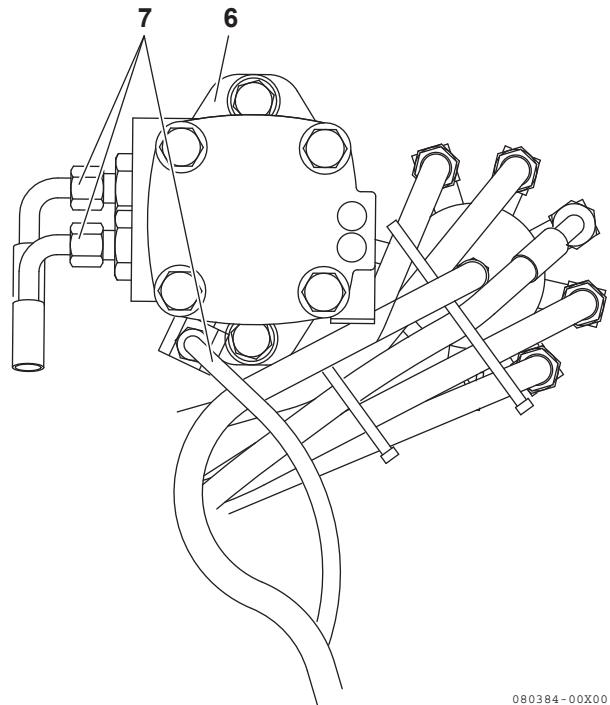
Note :

Reinstall the band in the specified position in reinstallation.

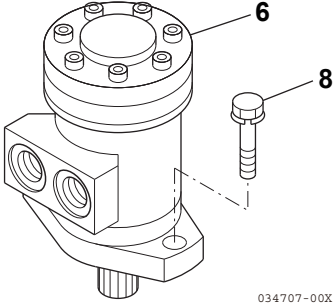
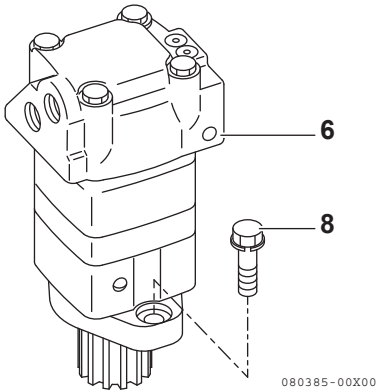
S/N 1B501 to 1B537



S/N 19875 to 19999, 1A000 and above



7. ADJUSTMENT AND REPAIR

Procedure	
(4) Remove the bolts (M12) 8 to remove the swing motor 6 .	S/N 14001 to 19874  S/N 19875 to 19999, 1A000 and above 

2) Reinstallation

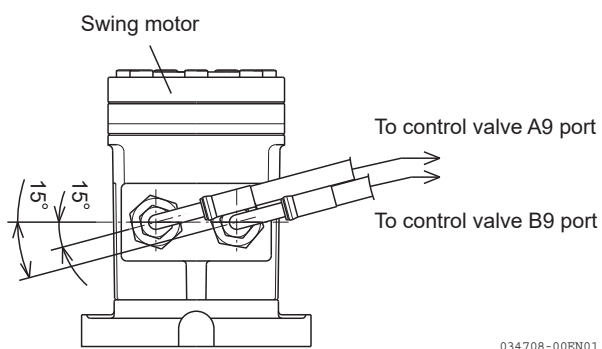
Reinstall the swing motor in the reverse order of the removal procedure.

Swing motor installation bolt (M12)	
Adhesive	Apply Three Bond 1324 or its equivalent
Tightening torque	57.9 to 78.5 ft·lbf (78.5 to 98.1 N·m)

Pinion assembly installation 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)

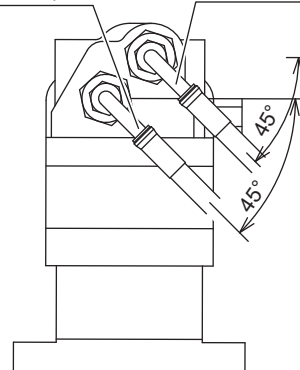
Setting angles of hydraulic hoses (for swing motor)

S/N 14001 to 19874



S/N 19875 to 19999, 1A000 and above

To control valve A9 port To control valve B9 port

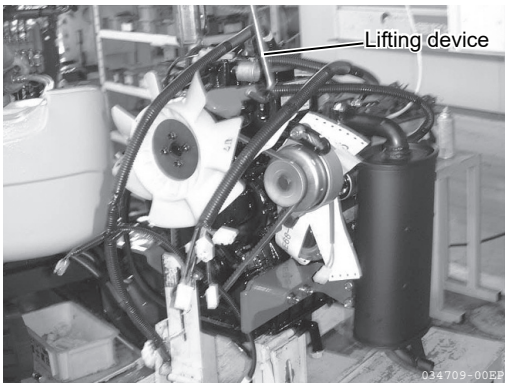
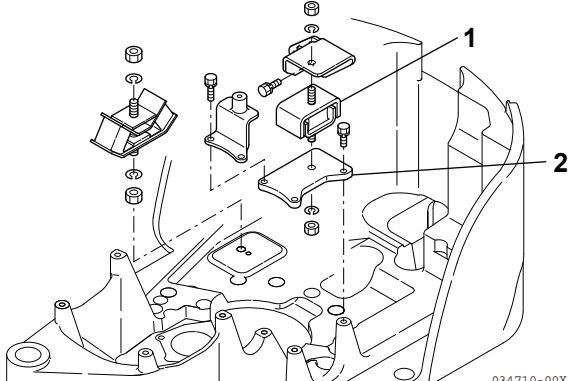
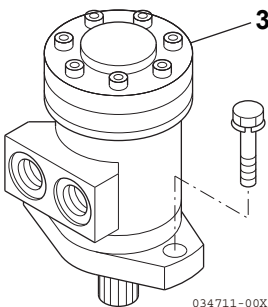
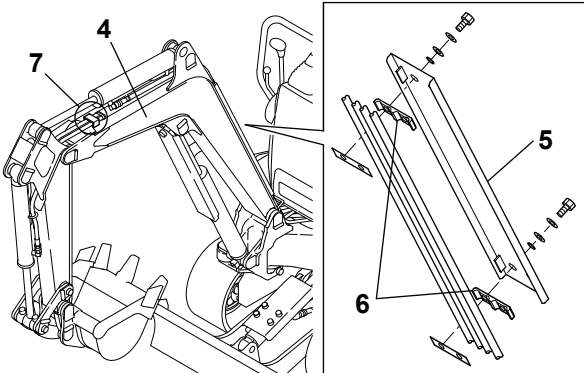


7. ADJUSTMENT AND REPAIR

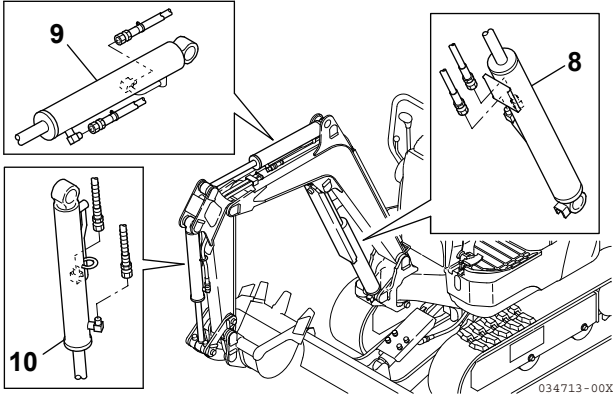
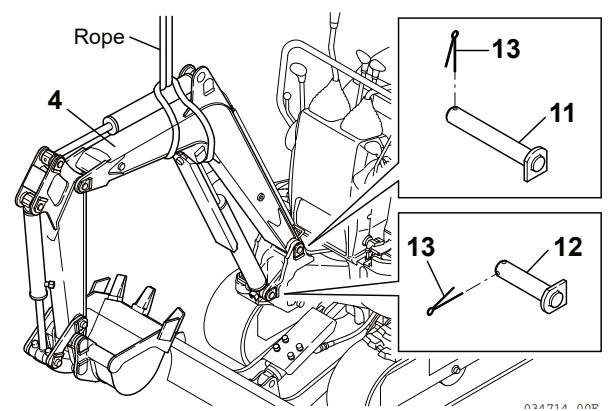
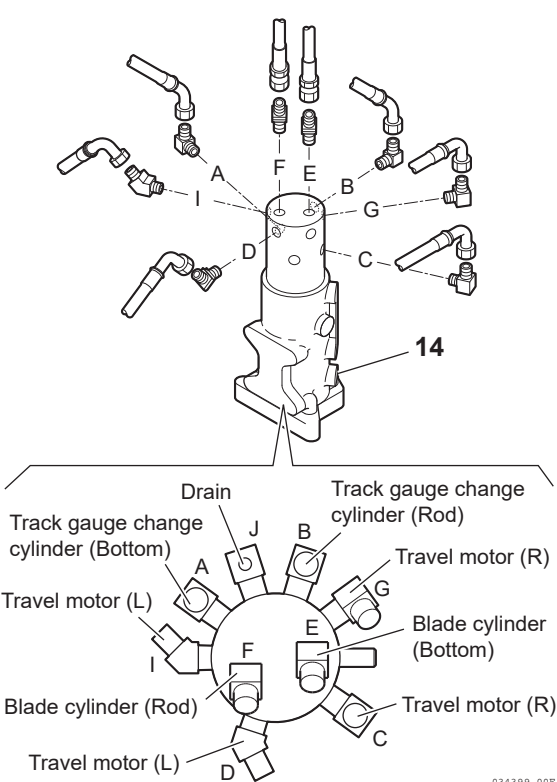
7-5-4 Removal and Reinstallation of Swivel Joint

Link track gauge change type SV08-1A

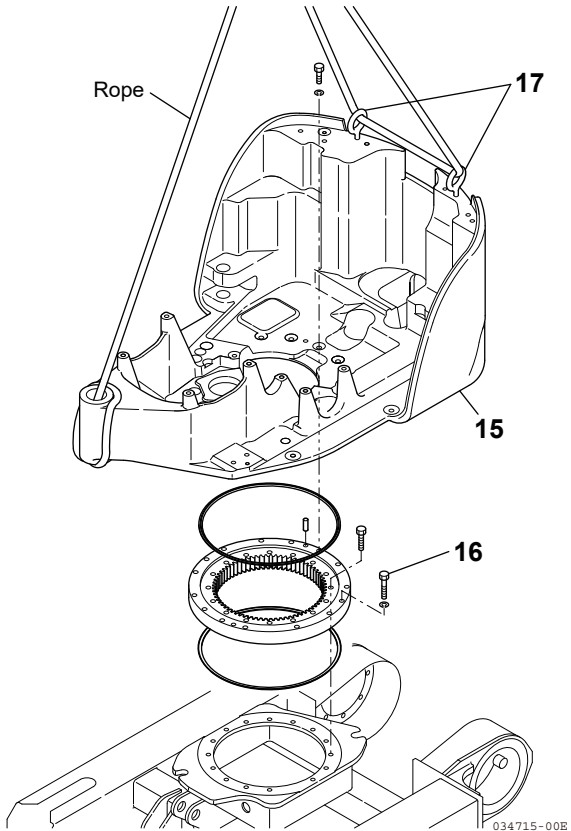
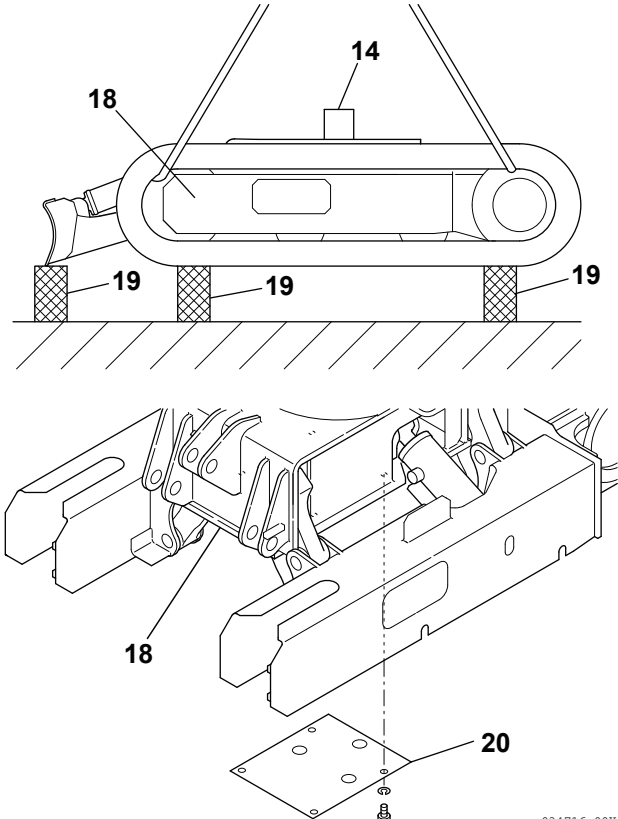
1) Removal

Procedure	
(1) Remove the engine. Refer to Section "7-1-6 Removal and Reinstallation of Engine".	 Lifting device 034709-00ER
(2) Remove the stay FR 2 for the vibroisolating rubber 1 of the engine. Note : <i>Remove the stay FR in advance so that the tool can be used to remove the installation bolts for the turning frame (the swing bearing).</i>	 034710-00X
(3) Remove the swing motor 3. Refer to Section "7-5-3 Removal and Reinstallation of Swing Motor".	 034711-00X
(4) Remove the hose cover 5, the hose supports 6 and the hose clamps 7 from the boom 4.	 034712-00X

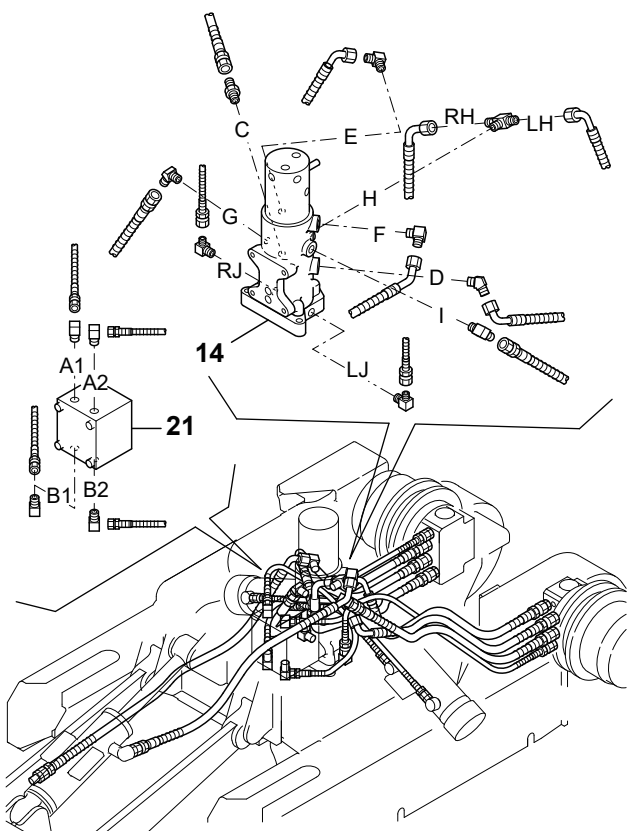
7. ADJUSTMENT AND REPAIR

Procedure	
(5) Disconnect the joints of the hydraulic hoses for the boom cylinder 8, the arm cylinder 9 and the bucket cylinders 10.	 034713-00X
(6) After putting rope round the boom 4, remove the split pins 13 from the pin (25×161) 11 and the pin (25×98) 12 to pull out the pins. (7) Lift the front implement up to remove it. Note : When removing the front implement, take care not to catch the hydraulic hoses on other parts.	 034714-00B
(8) Remove the hydraulic hoses on the turning frame side from the swivel joint 14. A : For track gauge change cylinder (Bottom) B : For track gauge change cylinder (Rod) C : For travel motor (R) D : For travel motor (L) E : For blade cylinder (Bottom) F : For blade cylinder (Rod) G : For travel motor (R) I : For travel motor (L) J : For drain Note : Mark the removed hydraulic hoses so that they can be reinstalled in the correct positions.	 034399-00B

7. ADJUSTMENT AND REPAIR

Procedure	
(9) After putting rope onto the turning frame 15, remove the bolts 16 to remove the turning frame 15. Notes : • Install the eyebolts 17 into the tapped holes (M10) in the rear part of the turning frame to put rope through them. • Put blocks on the flat ground and place the removed turning frame on them.	
(10) Lift the track frame 18 up and put blocks 19 under it to keep it at a height that allows working under it. Note : Put stable and firm blocks on the flat ground to prevent the track frame from falling down. (11) Remove the under cover 20.	

7. ADJUSTMENT AND REPAIR

Procedure	
(12) Remove the hydraulic hoses on the track frame side from the swivel joint 14. C : For travel motor (R) I : For travel motor (L) RH : For travel motor (R) RJ : For drain (R) LH : For travel motor (L) LJ : For drain (L) D : For travel motor (L) E : For blade cylinder (Bottom) F : For blade cylinder (Rod) G : For travel motor (R) (13) Remove the hydraulic hoses from the check valve 21. A1 : For track gauge change cylinder (Left rod) B1 : For track gauge change cylinder (Left bottom) A2 : For track gauge change cylinder (Right rod) B2 : Track gauge change cylinder (Right bottom) Note : Mark the removed hydraulic hoses so that they can be reinstalled in the correct positions. (14) Remove the bolts and lift the swivel joint 14 up to remove it from the track frame.	 034717-00X

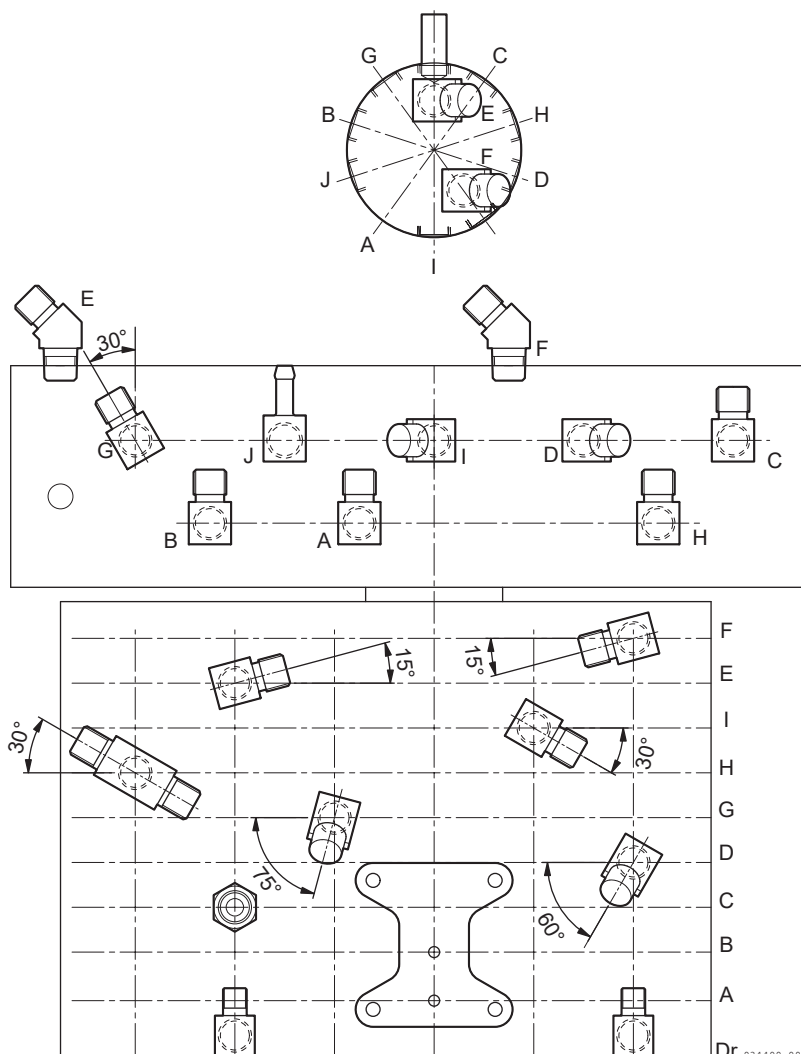
7. ADJUSTMENT AND REPAIR

2) Reinstallation

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

List of adhesive and tightening torque

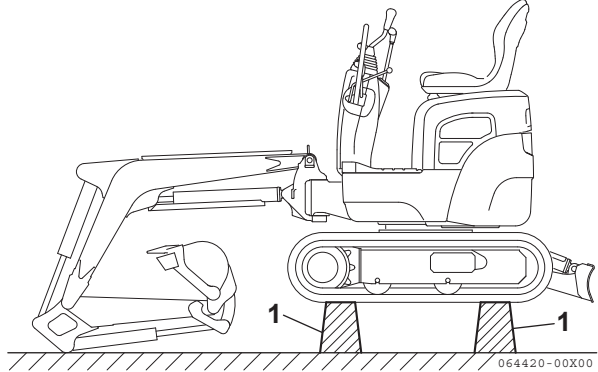
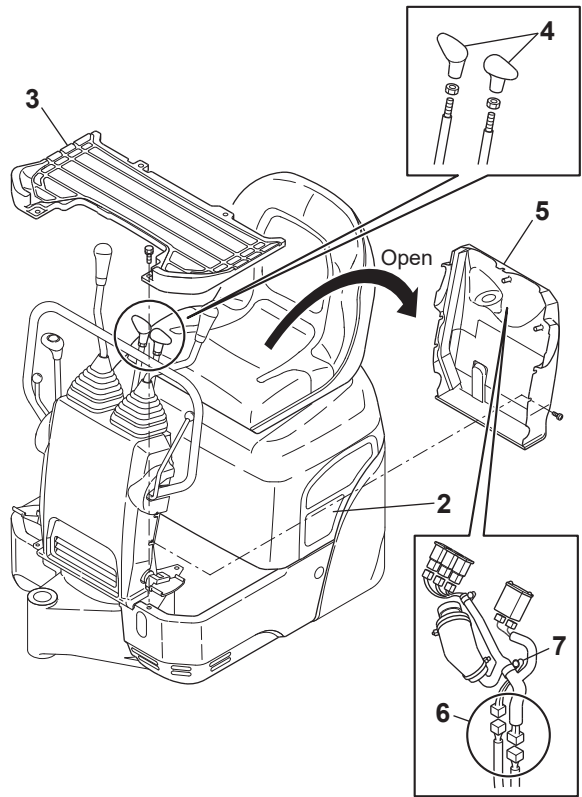
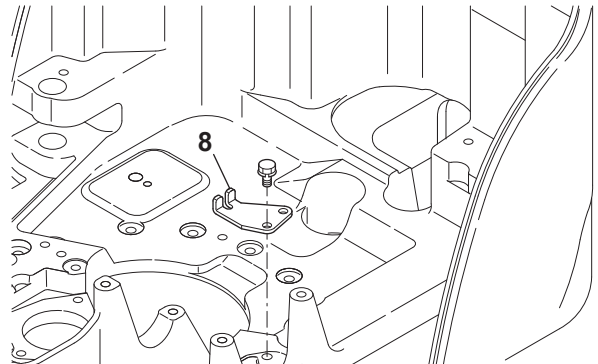
Step No.	Part	Size	Adhesive	Tightening torque
(9)	Swing bearing (Turning frame)	M10	Apply Three Bond 1324 or its equivalent	50.6 to 57.9 ft·lbf (68.6 to 78.5 N·m)
(1)	Vibroisolating rubber	Nut M12	—	32.6 to 43.4 ft·lbf (44.1 to 58.8 N·m)
		Nut M14 (fine)	—	50.6 to 61.6 ft·lbf (68.6 to 83.4 N·m)
(2)	Engine stay (stopper)	10×25 10×35	Apply Three Bond 1324 or its equivalent	32.6 to 43.4 ft·lbf (44.1 to 58.8 N·m)
(14)	Swivel joint	10×30 (10.9T)	Apply Three Bond 1324 or its equivalent	50.6 to 57.9 ft·lbf (68.6 to 78.5 N·m)
(3)	Swing motor	10×25	Apply Three Bond 1324 or its equivalent	32.6 to 43.4 ft·lbf (44.1 to 58.8 N·m)
(11)	Under cover	10×20	Apply Three Bond 1324 or its equivalent	32.6 to 43.4 ft·lbf (44.1 to 58.8 N·m)



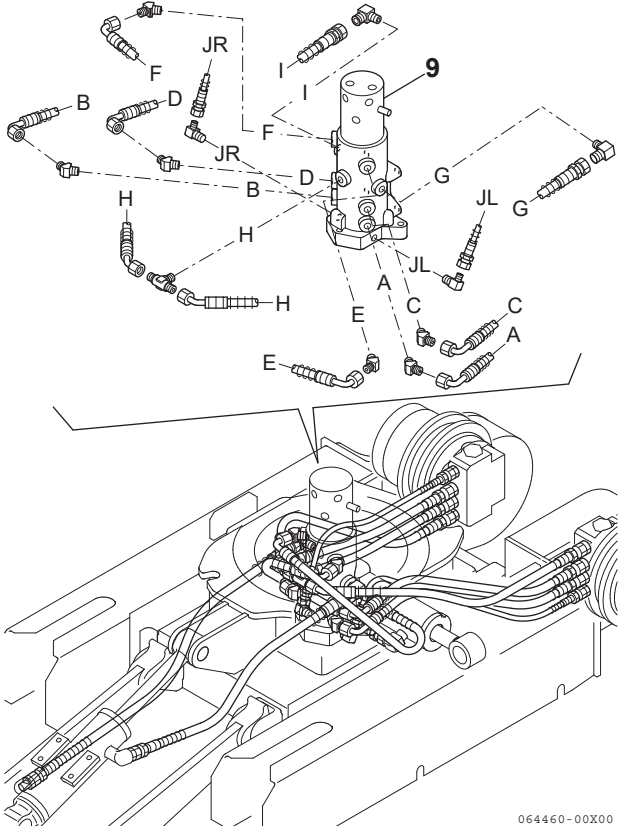
7. ADJUSTMENT AND REPAIR

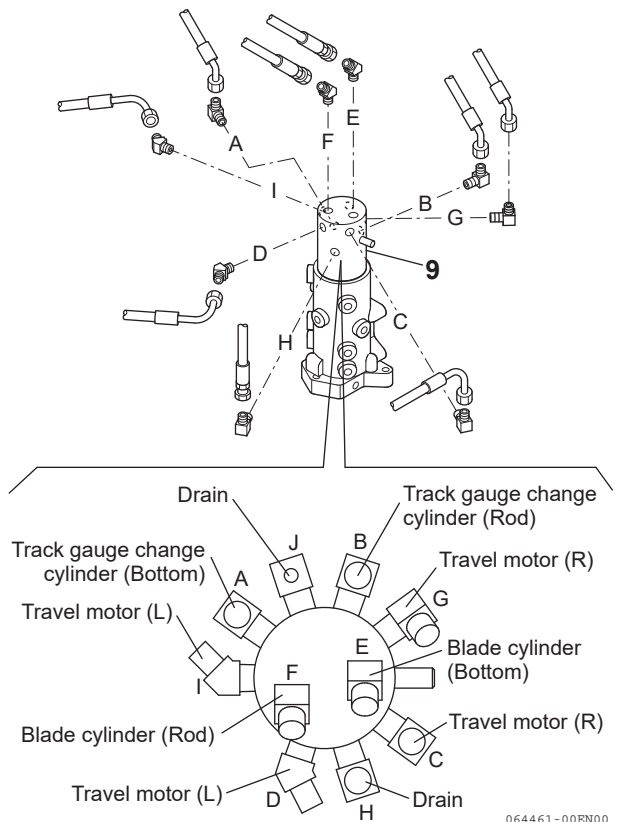
Slide track gauge change type SV08-1A(S), SV08-1C

1) Removal

Procedure	
(1) After raising the machine, place blocks 1 under the machine. Notes: • To prevent the machine from dropping down, be sure to place stable blocks 1 under the flat surface. • Place blocks 1 which have sufficient height to allow work under the machine.	 064420-00X00
(2) After opening the bonnet 2, remove the step 3, the travel lever grip 4, and then the stand cover R 5. Notes: • When removing the stand cover R 5, remove the couplers 6 of the wire harness (Stand) and then the clamp 7. • When reinstalling, fix it to the hydraulic hose with the clamp. (3) Remove the engine. Refer to Section "7-1-6 Removal and Reinstallation of Engine".	 064455-00EN00
(4) Remove the swivel plate 8.	 064459-00X00

7. ADJUSTMENT AND REPAIR

Procedure	
(5) Remove the hydraulic hoses on the track frame side from the swivel joint 9. A: For track gauge change cylinder (Bottom) B: For track gauge change cylinder (Rod) C: For travel motor (R) D: For travel motor (L) E: For blade cylinder (Bottom) F: For blade cylinder (Rod) G: For travel motor (R) H: For travel motor (L, R) I: For travel motor (L) JR, JL: For drain Notes: • If necessary, remove the bolts and turn the swivel joint over to remove the hydraulic hoses. • Mark the removed hydraulic hoses so that they can be reinstalled in the correct positions.	 064460-00X00

(6) Remove the hydraulic hoses on the turning frame side from the swivel joint 9. A: For track gauge change cylinder (Bottom) B: For track gauge change cylinder (Rod) C: For travel motor (R) D: For travel motor (L) E: For blade cylinder (Bottom) F: For blade cylinder (Rod) G: For travel motor (R) H: For travel motor (L, R) I: For travel motor (L) J: For drain (7) Remove the bolts and lift the swivel joint 9 up to remove it from the track frame. Notes: • Make match marks on the track frame and the swivel joint so that the swivel joint can be reinstalled correctly. • Make match marks on the swivel joint shafts so that they can be reinstalled in their correct direction.	 064461-00EN00
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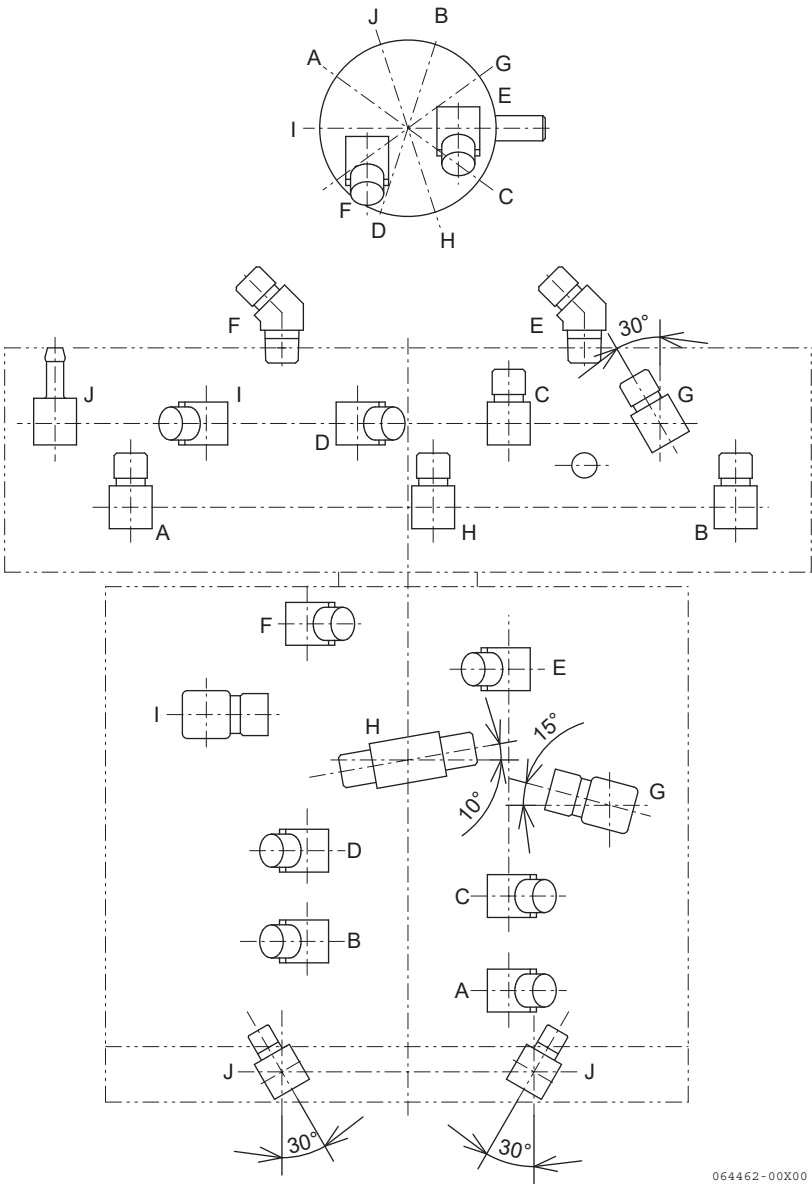
7. ADJUSTMENT AND REPAIR

2) Reinstallation

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

List of adhesive and tightening torque

Step No.	Part	Size	Adhesive	Tightening torque
-	Swivel joint	10×30 (10.9T)	Apply Three Bond 1324 or its equivalent	32.6 to 43.4 ft·lbf (44.1 to 58.8 N·m)
(4)	Swivel plate	12×20	Apply Three Bond 1324 or its equivalent	57.9 to 72.3 ft·lbf (78.5 to 98.0 N·m)



064462-00X00

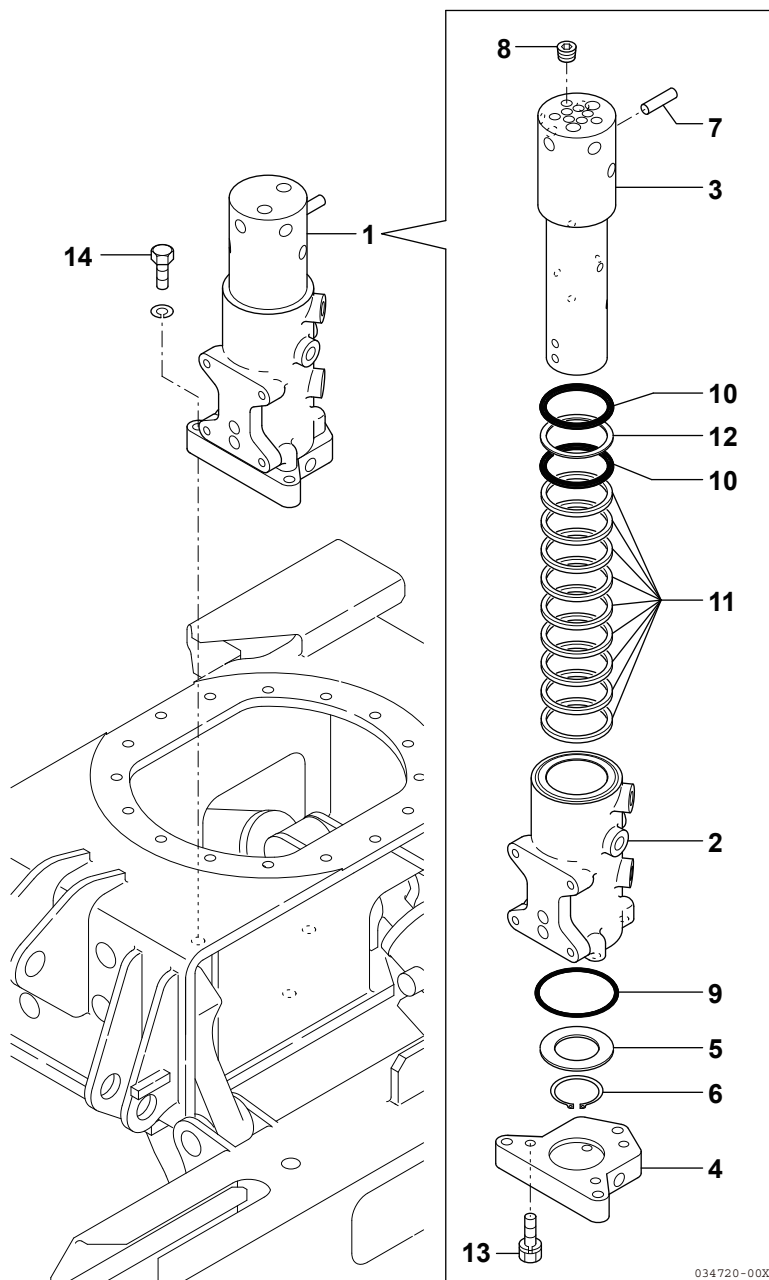
7. ADJUSTMENT AND REPAIR

7-5-5 Disassembly and Reassembly of Swivel Joint

Link track gauge change type SV08-1A

1) Swivel Joint

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 has specified number of holes and the hub has specified number of holes and grooves. The oil which flows in from a port in the shaft passes through the hub groove connected to the port and is fed to the actuator of the undercarriage.



No.	Part	Q'ty	No.	Part	Q'ty	No.	Part	Q'ty
1	Swivel joint assembly	1	6	External snap ring 40	1	11	Seal (Back ring + Seal ring)	9
2	Swivel hub	1	7	Dowel pin 10×32	1	12	Backup ring	1
3	Swivel shaft	1	8	Screw plug (PT) 1/8	8	13	Bolt M8×35	3
4	Swivel flange	1	9	O-ring 1A G70.0	1	14	Bolt M10×30 (10.9T)	4
5	Thrust washer	1	10	O-ring 55.76×5.7	2			

7. ADJUSTMENT AND REPAIR

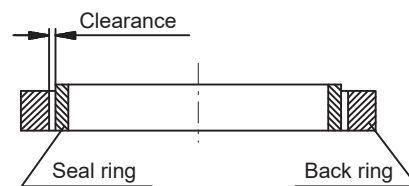
3) Cautions for Handling and Storing Seals

- (1) O-rings are packed in the package that is suitable for storage.
- (2) Do not leave the O-rings outside the package.
- (3) For storing, put the O-rings 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.
- (4) Do not put anything on the O-rings, or they may be distorted.

4) How to Fit O-rings (for inner side)

• Before fitting

- (1) There may be a clearance (within 3% of the shaft dia.) between the seal ring and the back ring.
This is normal condition.
- (2) Check that there is no distortion, flaw or other abnormality on the seal ring and the back ring.



• Fitting

- (1) Dry the seal groove. Push an end of the seal ring into the groove and fit the whole part while pressing the seal ring with your fingers.
Take care not to twist the seal ring.
- (2) Use lithium soap group multipurpose grease.
- (3) For fitting a seal ring, 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 seal ring while pressing it with your finger (Figs. 1 and 2).
- (4) When using jigs for fitting seal rings, use the jigs with round edges to avoid damaging the seal rings. (Fig. 3)
- (5) If the seal ring is distorted after fitting, correct the distortion with the jig before assembly. (Fig. 4)

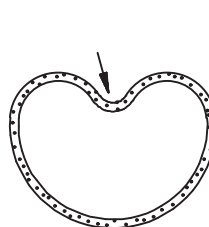


Fig. 1

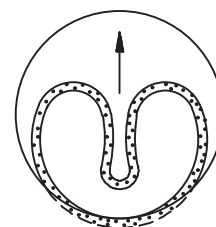


Fig. 2

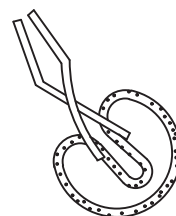


Fig. 3

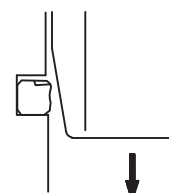


Fig. 4

034723-00B

5) Repair and Replacement of Parts

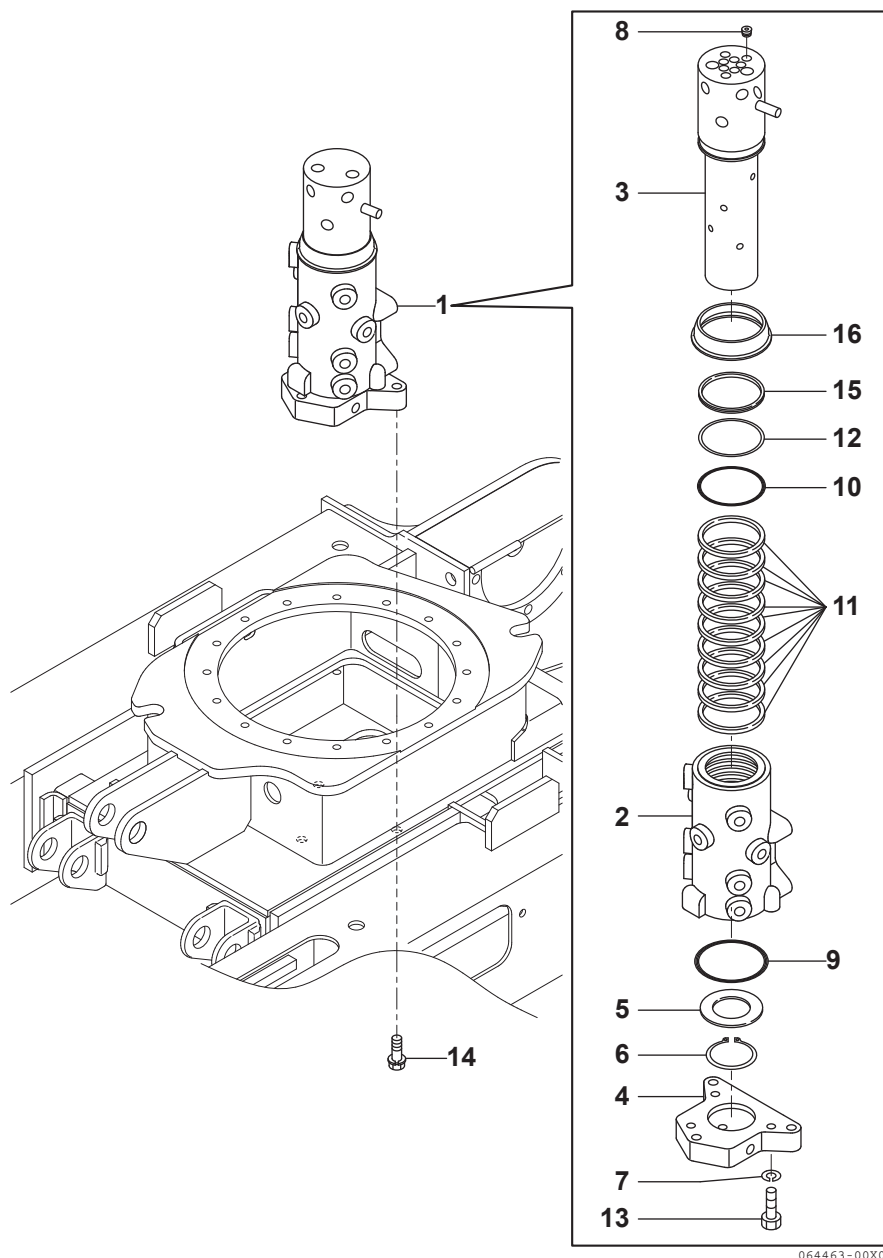
- (1) Disassemble and reassemble at a place free from dust.
- (2) Completely remove the contamination, foreign matter (sludge), etc. from the disassembled parts.
- (3) Check for flaws or nicks on the seal surface of the shaft.
Repair or replace the part when necessary.
- (4) Replace the shaft if it is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

7. ADJUSTMENT AND REPAIR

Slide track gauge change type SV08-1A(S), SV08-1C

1) Swivel Joint

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 has specified number of holes and the hub has specified number of holes and grooves. The oil which flows in from a port in the shaft passes through the hub groove connected to the port and is fed to the actuator of the undercarriage.



No.	Part	Q'ty	No.	Part	Q'ty	No.	Part	Q'ty
1	Swivel joint assembly	1	7	Spring washer	1	13	Bolt M8×40	3
2	Swivel hub	1	8	Screw plug (PT) 1/8	8	14	Bolt M10×30 (10.9T)	4
3	Swivel shaft	1	9	O-ring 1A G70.0	1	15	V ring	1
4	Swivel flange	1	10	O-ring 55.76×5.7	2	16	Dust cover	1
5	Thrust washer	1	11	Seal (Back ring + Seal ring)	9			
6	External snap ring 45	1	12	Backup ring	1			

7. ADJUSTMENT AND REPAIR

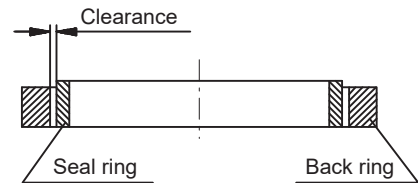
3) Cautions for Handling and Storing Seals

- (1) O-rings are packed in the package that is suitable for storage.
- (2) Do not leave the O-rings outside the package.
- (3) For storing, put the O-rings 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.
- (4) Do not put anything on the O-rings, or they may be distorted.

4) How to Fit O-rings (for inner side)

• Before fitting

- (1) There may be a clearance (within 3% of the shaft dia.) between the seal ring and the back ring.
This is normal condition.
- (2) Check that there is no distortion, flaw or other abnormality on the seal ring and the back ring.



• Fitting

- (1) Dry the seal groove. Push an end of the seal ring into the groove and fit the whole part while pressing the seal ring with your fingers.
Take care not to twist the seal ring.
- (2) Use lithium soap group multipurpose grease.
- (3) For fitting a seal ring, 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 seal ring while pressing it with your finger (Figs. 1 and 2).
- (4) When using jigs for fitting seal rings, use the jigs with round edges to avoid damaging the seal rings. (Fig. 3)
- (5) If the seal ring is distorted after fitting, correct the distortion with the jig before assembly. (Fig. 4)

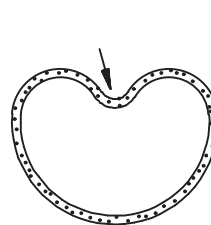


Fig. 1

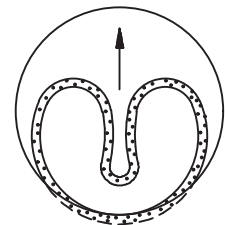


Fig. 2

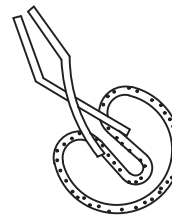


Fig. 3

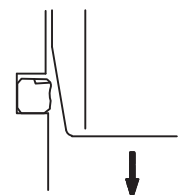


Fig. 4

034723-00B

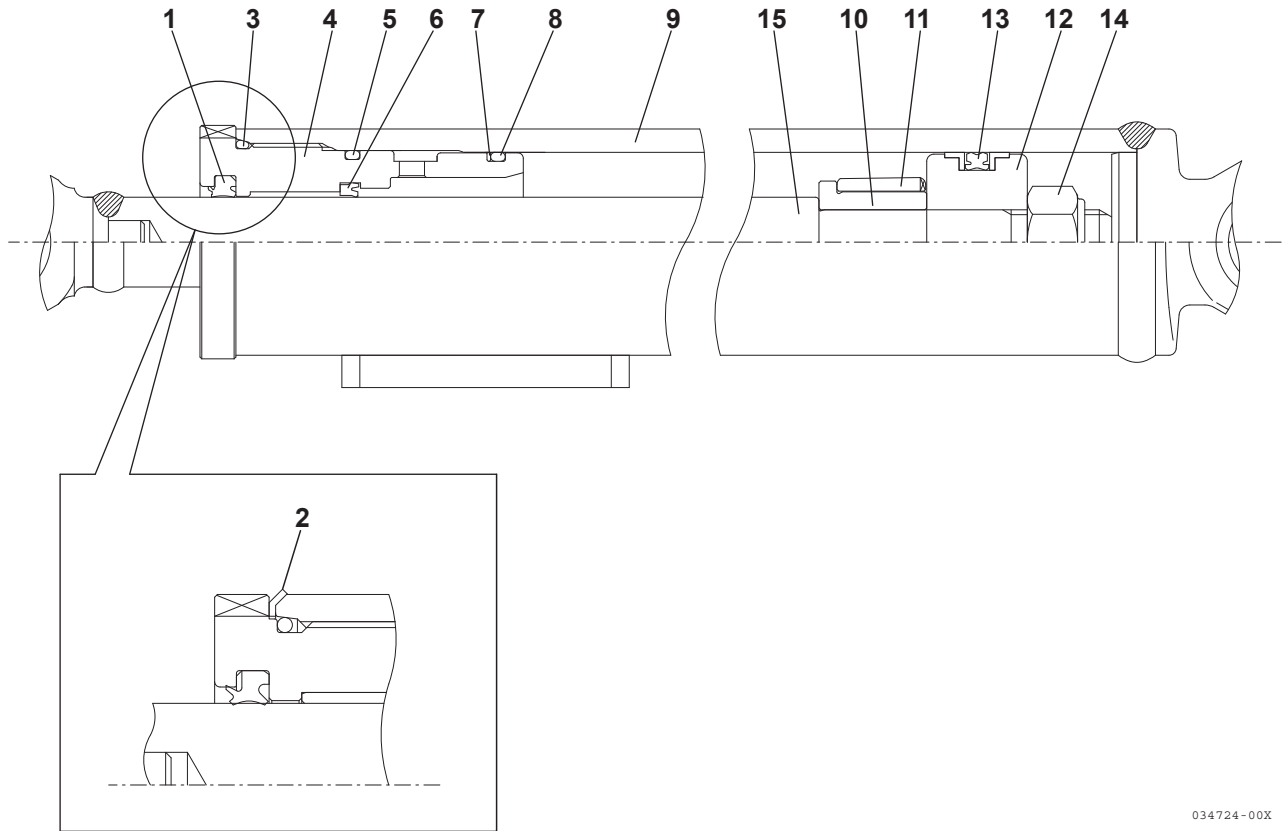
5) Repair and Replacement of Parts

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

7. ADJUSTMENT AND REPAIR

7-5-6 Disassembly and Reassembly of Hydraulic Cylinders

1) Sectional View and Parts



034724-00X

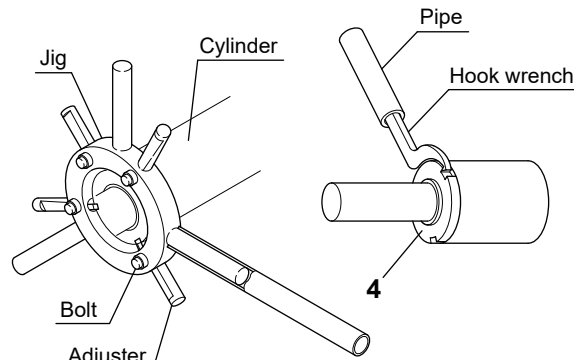
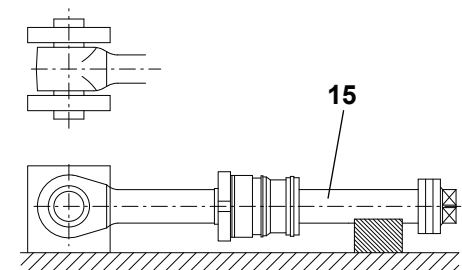
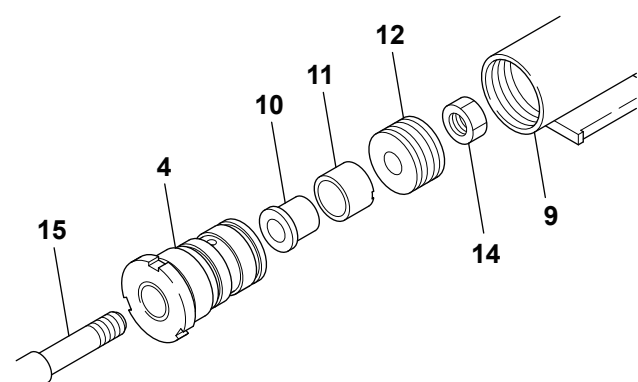
No.	Part	Boom cylinder	Arm cylinder	Bucket cylinder	Boom swing cylinder	Blade cylinder	Track gauge change cylinder
1	Dust seal	○	○	○	○	○	○
2	Lock washer	—	—	—	○	—	—
3	O-ring	○	○	○	○	○	○
4	Head	○	○	○	○	○	○
5	O-ring	○	○	○	○	○	○
6	ISI packing	○	○	○	○	○	○
7	Backup ring	○	—	—	—	—	—
8	O-ring	○	—	—	—	—	—
9	Cylinder tube	○	○	○	○	○	○
10	Cushion collar	○	—	—	—	—	—
11	Cushion ring	○	—	—	—	—	—
12	Piston	○	○	○	○	○	○
13	Piston packing	○	○	○	○	○	○
14	U-nut	○	○	○	○	○	○
15	Rod	○	○	○	○	○	○

7. ADJUSTMENT AND REPAIR

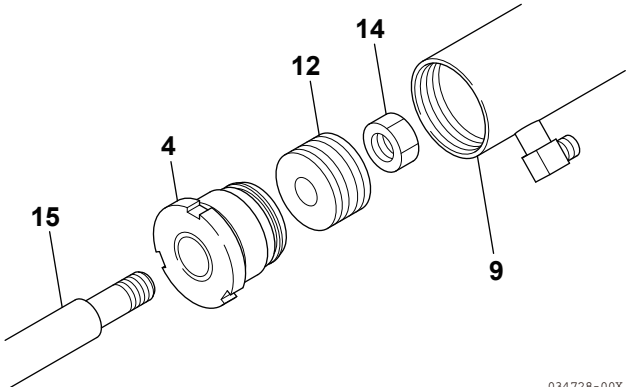
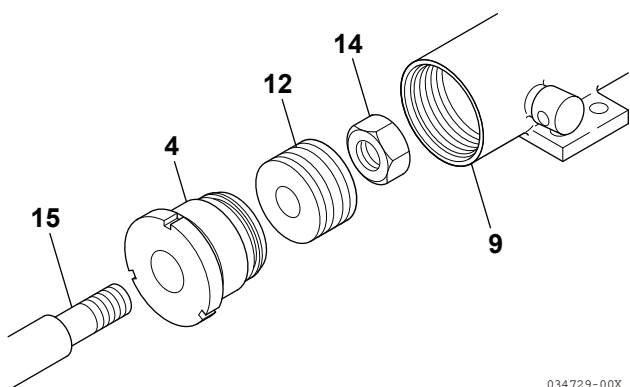
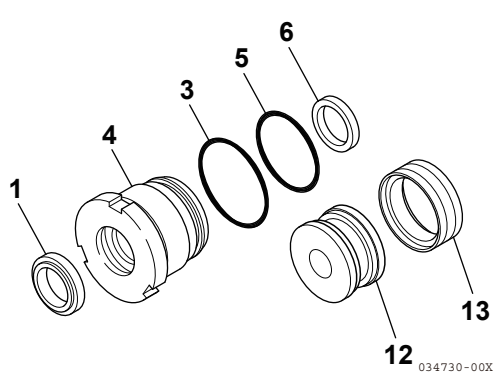
2) Cautions for Disassembly and Reassembly

- (1) The cylinder parts are precision-made. For disassembly and reassembly, be careful not to damage any parts by dropping them or knocking them together when handling them.
- (2) Remove any burrs or flashes in the seal mounting area and the O-ring groove.
- (3) Do not re-use the lock washer once it is removed.
- (4) Replace the seals and O-rings once removed with new ones.
- (5) Clean all parts and dry them by air blow before reassembly.

3) Disassembly

Procedure	
(1) Drain the oil from the hydraulic cylinder. (2) Hold the cylinder by using the bottom end or the pin hole on the bottom side, and put the rod side of the cylinder on a block. (3) Raise the pawl of the lock washer 2 on the head 4 to loosen the head 4. Note : Use a hook wrench or a jig to loosen the head 4.	 034725-00B
(4) Pull out the rod assembly 15 from the cylinder tube 9, and then hold the cylinder rod assembly by using the rod end or the pin hole on the rod side.	 Hold cylinder rod assembly. 034726-00B
(5) Disassembly of boom cylinder. Remove the U-nut 14, then the piston 12, the cushion collar 10 (with the cushion ring 11), and the head 4 in that order from the rod 15.	 034727-00X

7. ADJUSTMENT AND REPAIR

Procedure	
(6) Disassembly of arm, bucket, boom swing and blade cylinders. Remove the U-nut 14, then the piston 12 and the head 4 in that order from the rod 15.	 034728-00X
(7) Disassembly of track gauge change cylinder. Remove the U-nut 14, then the piston 12 and the head 4 in that order from the rod 15.	 034729-00X
(8) Remove the O-rings 3 and 5, the dust seal 1, the ISI packing 6 and the piston packing 13. Note : Use a sharp tool to raise the O-ring, seal or packing, and then insert a spatula or the like to remove it.	 034730-00X

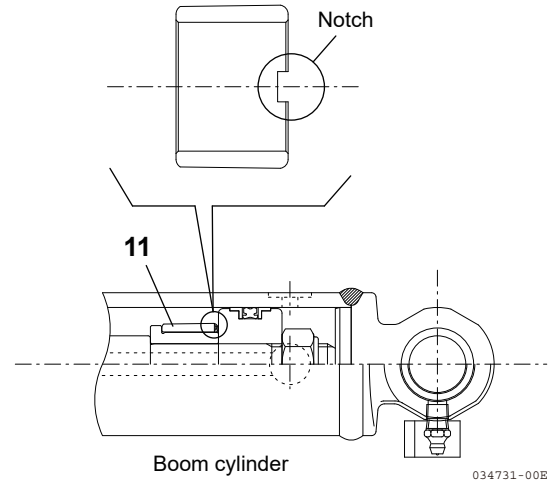
7. ADJUSTMENT AND REPAIR

4) Reassembly

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

Notes :

- Take care not to install the cushion ring **11** of the boom cylinder in the wrong direction.
- Replace the O-rings, packings and seals with new ones.



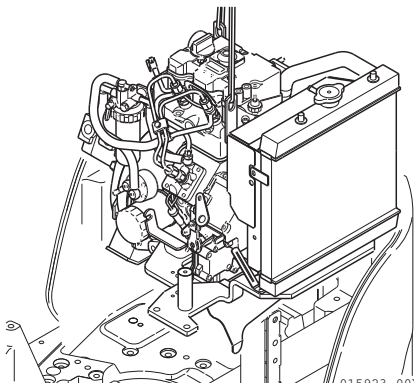
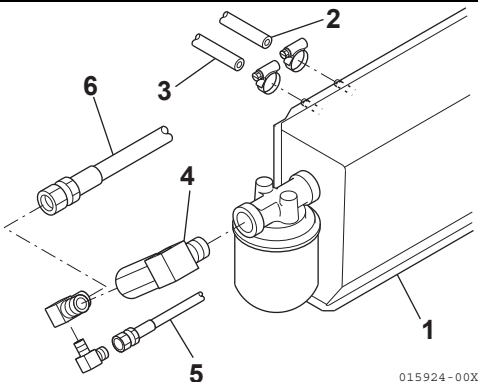
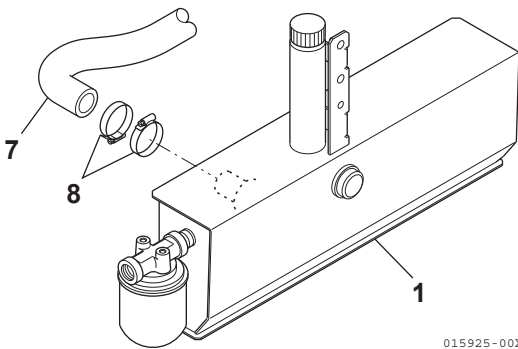
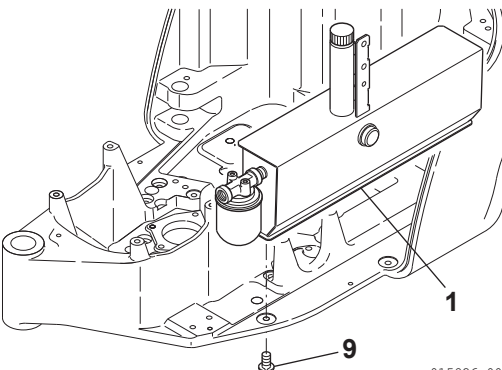
List of tightening torque for U-nut

Item	U-nut size	U-nut tightening torque	Adhesive	
Boom	M18	152.1 to 173.5 ft·lbf (206 to 235 N·m)	Three bond 1324 or its equivalent	
Arm				
Bucket				
Boom swing	M20	217.0 to 253.2 ft·lbf (294 to 343 N·m)		
Blade	M18	152.1 to 173.5 ft·lbf (206 to 235 N·m)		
Track gauge change				

7. ADJUSTMENT AND REPAIR

7-5-7 Removal and Reinstallation of Hydraulic Oil Tank

1) Removal

Procedure	
(1) Remove the engine according to the instruction in 7-1-6.	 015923-00X
(2) Remove the return hoses from the hydraulic oil tank 1. - Return hose from swivel joint to hydraulic oil tank : 2. - Return hose from control valve (P.T.O.) to hydraulic oil tank : 3. (3) Remove the return hoses connecting to the return filter and the check valve 4. - Return hose from swing motor to check valve : 5. - Return hose from port T of control valve to check valve : 6.	 015924-00X
(4) Loosen the hose clips 8 to pull the suction hose 7 out of the hydraulic oil tank 1.	 015925-00X
(5) Remove the bolts 9 to remove the hydraulic oil tank 1 from the turning frame.	 015926-00X

7. ADJUSTMENT AND REPAIR

2) Reinstallation

Reinstall the hydraulic oil tank in the reverse order of the removal procedure.

Hydraulic oil tank installation bolt (M10)	
Tightening torque	32.6 to 43.4 ft·lbf (44.1 to 58.8 N·m)

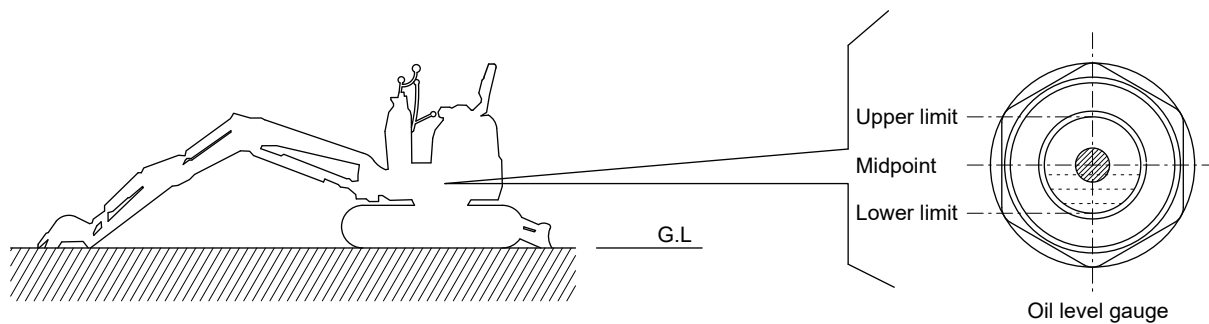
Oil level gauge	
Tightening torque	10.9 to 14.5 ft·lbf (14.7 to 19.6 N·m)

Drain plug (14)	
Tightening torque	43.4 ft·lbf (58.8 N·m)

3) Oil Level Check

Place the machine on the firm and flat ground. Retract the bucket and arm cylinder rods to the maximum and lower the bucket and the blade to the ground, as shown in the figure below. Check that the oil level is at the midpoint between the upper limit and the lower limit of the oil level gauge.

[Oil temperature : 32 to 86°F (0 to 30°C)]



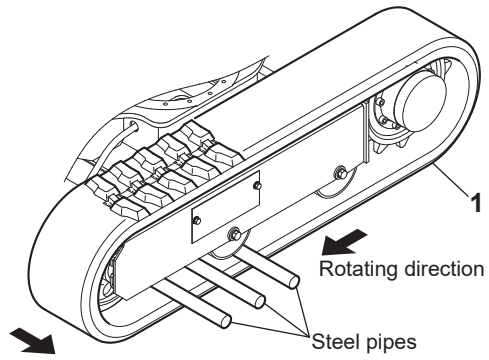
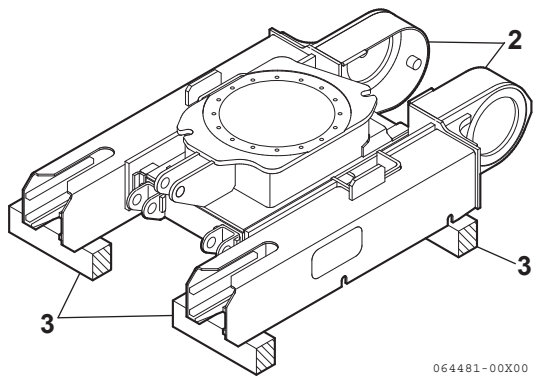
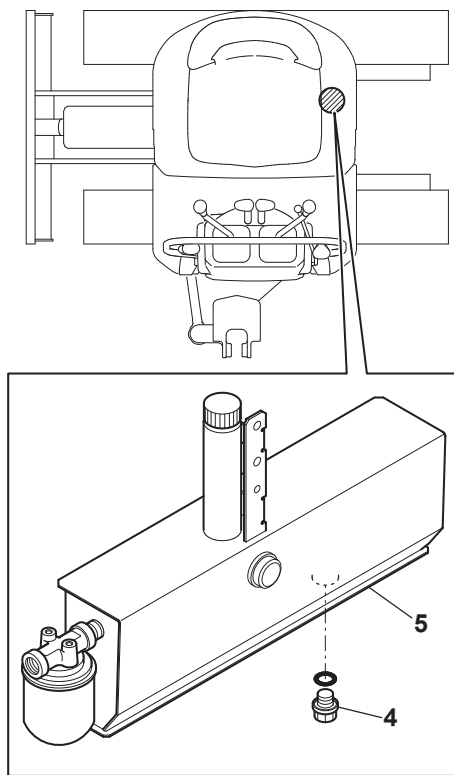
034732-00E

7. ADJUSTMENT AND REPAIR

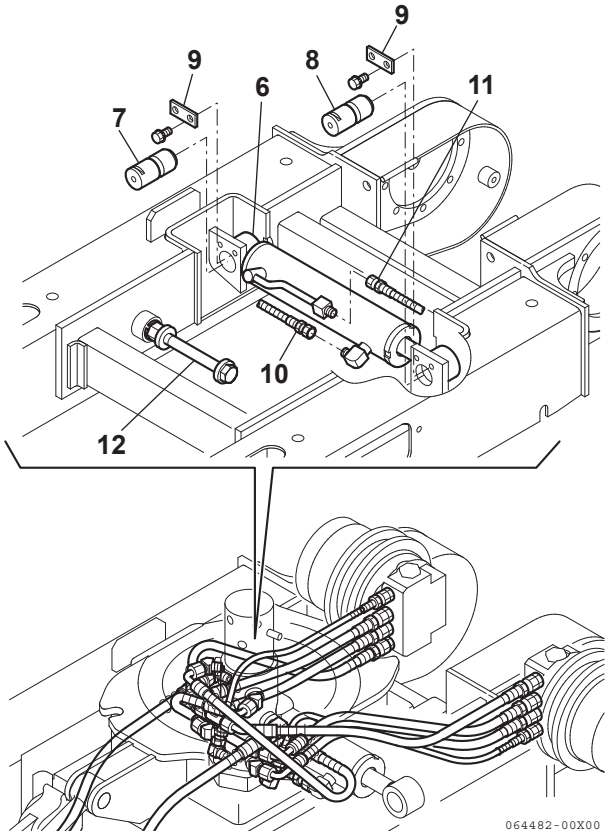
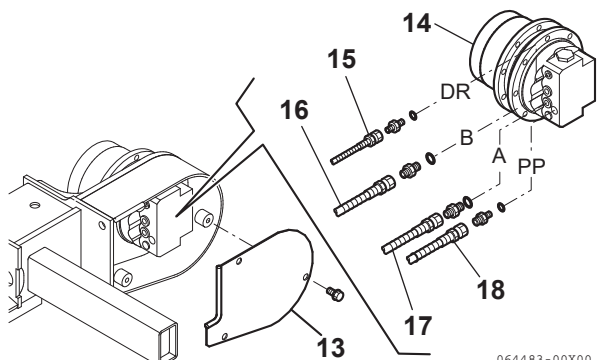
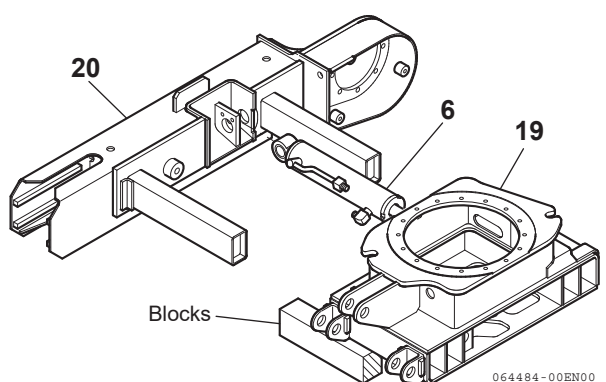
7-5-8 Removal and Reinstallation of Track Gauge Change Cylinder

1) Removal of Track Gauge Change Cylinder

Slide track gauge change type SV08-1A(S), SV08-1C

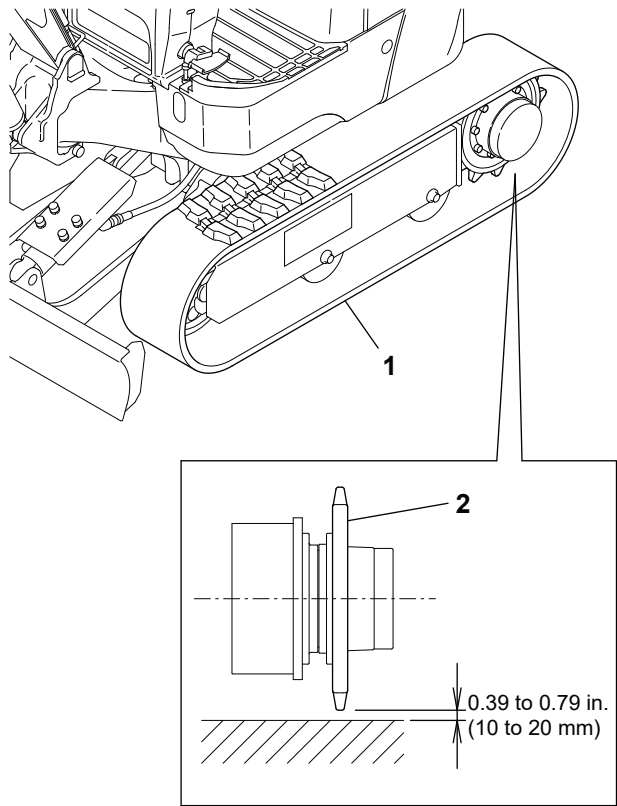
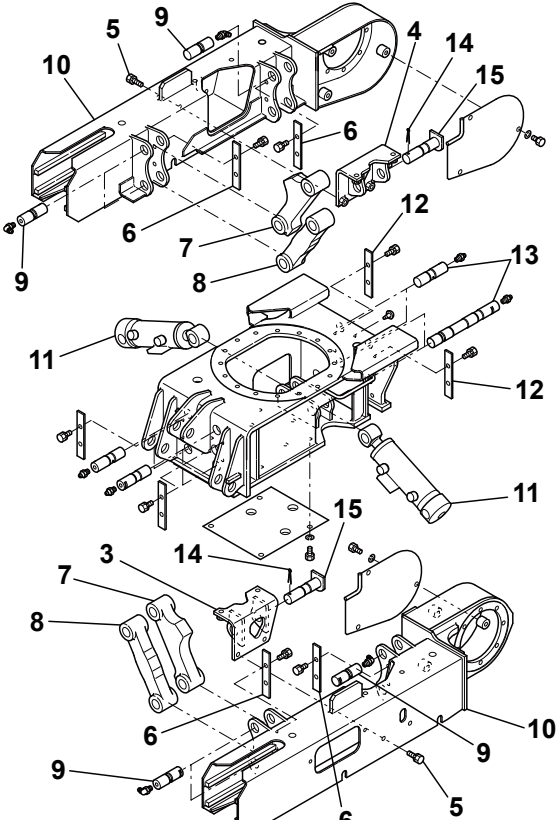
Procedure					
(1) Widen the crawler frames fully by operating the track gauge change cylinder, and then remove the rubber crawler 1 for the right side.	 Rotating direction Steel pipes 064480-00EN00				
(2) Raise the machine using the implement and the blade, and then place blocks 3 under the lower center frame 2. Note: Place blocks 3 which have sufficient height to allow work under the lower center frame.	 064481-00X00				
(3) Connect the vacuum compressor and vacuum the air in the hydraulic oil tank or, swing the upperstructure so that the drain plug 4 of the hydraulic oil tank 5 is positioned halfway between the right and left crawlers on the opposite side of the blade. Then, lower the bucket to the ground and stop the engine. (4) Remove the drain plug 4 from the hydraulic oil tank 5 and drain the hydraulic oil. <table border="1"> <tr> <td>Oil type</td><td>YANMAR SUPER HYDRO. OIL (ISO VG46)</td></tr> <tr> <td>Amount of oil</td><td>5.7 L</td></tr> </table>	Oil type	YANMAR SUPER HYDRO. OIL (ISO VG46)	Amount of oil	5.7 L	 064419-00X01
Oil type	YANMAR SUPER HYDRO. OIL (ISO VG46)				
Amount of oil	5.7 L				

7. ADJUSTMENT AND REPAIR

Procedure	
(5) Remove the plates 9 for the pin 7 at the bottom end and the pin 8 at the rod end of the track gauge change cylinder 6, and pull out the pins. (6) Remove the hoses 10 and 11 from the track gauge change cylinder 6. (Move the track gauge change cylinder left and right so that the hoses can be removed easily.) (7) Remove the right stopper bolt 12.	 064482-00X00
(8) Remove the motor cover 13, and then remove the hydraulic hoses from the travel motor 14. • Hose 15 (swivel joint to travel motor A) • Hose 16 (swivel joint to travel motor B) • Hose 17 (swivel joint to travel motor Dr) • Hose 18 (swivel joint to travel motor PP)	 064483-00X00
(9) Pull out the crawler frame (R) 20 from the lower center frame 19. Note: Move the position of the blocks at the right side under the lower center frame. (10) Remove the track gauge change cylinder 6 from the lower center frame 19.	 064484-00EN00

7. ADJUSTMENT AND REPAIR

Link track gauge change type SV08-1A

Procedure	
(1) With the crawler frames in the widened track gauge, retract the front idler to remove the rubber crawler 1 for each side. (2) Lift the machine body up and put blocks under the track frame to keep a space of approx. 0.39 to 0.79 in. (10 to 20 mm) between the end face of the sprocket 2 and the ground.	 The diagram illustrates the initial adjustment step. The top part shows a side view of the crawler assembly with the rubber crawler (1) being retracted. The bottom part is a detailed cross-sectional view of the sprocket (2) and the track frame. It shows a gap between the sprocket and the ground, dimensioned as 0.39 to 0.79 in. (10 to 20 mm).
(3) Remove the bolts 5 for the brackets L 3 and R 4. (4) Remove the lock plates 6 to pull out the pins 9 for the track gauge change links A 7 and B 8, and remove the crawler frame 10. (For each side) Note : Move the crawler frames allowing for the length of the hydraulic hoses for the travel motors. (5) Remove the hydraulic hoses from the track gauge change cylinders 11. (6) Remove the lock plates 12 to pull out the pins 13, and remove the track gauge change cylinders 11. (7) Remove the split pins 14 to pull out the pins 15, and remove the brackets L 3 and R 4 from the respective track gauge change cylinders 11.	 The diagram is an exploded view of the track gauge change assembly. It shows the following components: 3 (Bracket L), 4 (Bracket R), 5 (Bolts), 6 (Lock plates), 7 (Link A), 8 (Link B), 9 (Pins), 10 (Crawler frame), 11 (Track gauge change cylinders), 12 (Lock plates), 13 (Pins), 14 (Split pins), and 15 (Pins). The components are shown in their relative positions as they would be assembled.

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 for Slide track gauge change type (SV08-1A(S), SV08-1C):

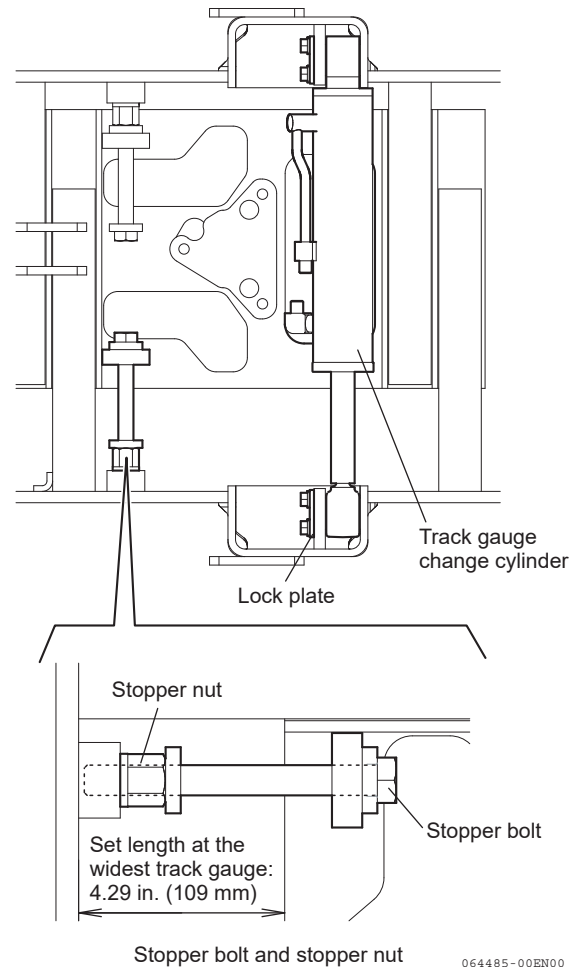
- [1] Clean the square pipes of the crawler frames and the square pipe holes of the lower center frame.
- [2] Apply heavy-duty grease to the four sides of each square pipe hole of the lower center frame over 7.9 in. (200 mm) from the entrance.
- [3] Stopper bolt setting procedure:
After fully screwing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

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

Lock plate (M10)	
Adhesive	Apply Three Bond 1324 or its equivalent.
Tightening torque	32.6 to 44.1 ft•lbf (44.1 to 58.8 N•m)

Hydraulic oil to be used :

Type	YANMAR SUPER HYDRO OIL (VG 46 class) or its equivalent
Oil quantity	1.51 Gals. (5.7 L)



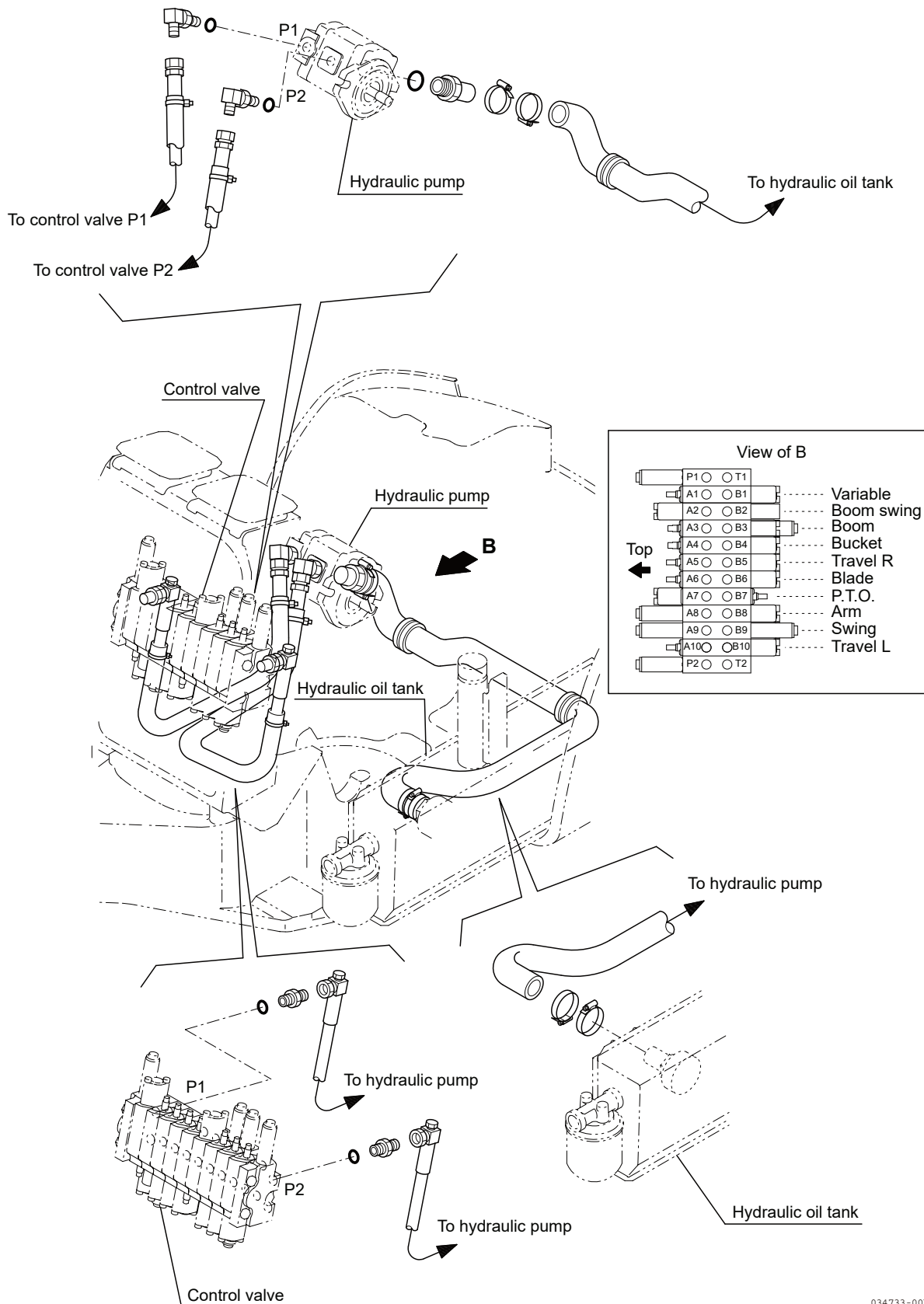
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7. ADJUSTMENT AND REPAIR

7-5-9 Piping Layout

1) Upperstructure

(Hydraulic oil tank → Hydraulic pump → Control valve)



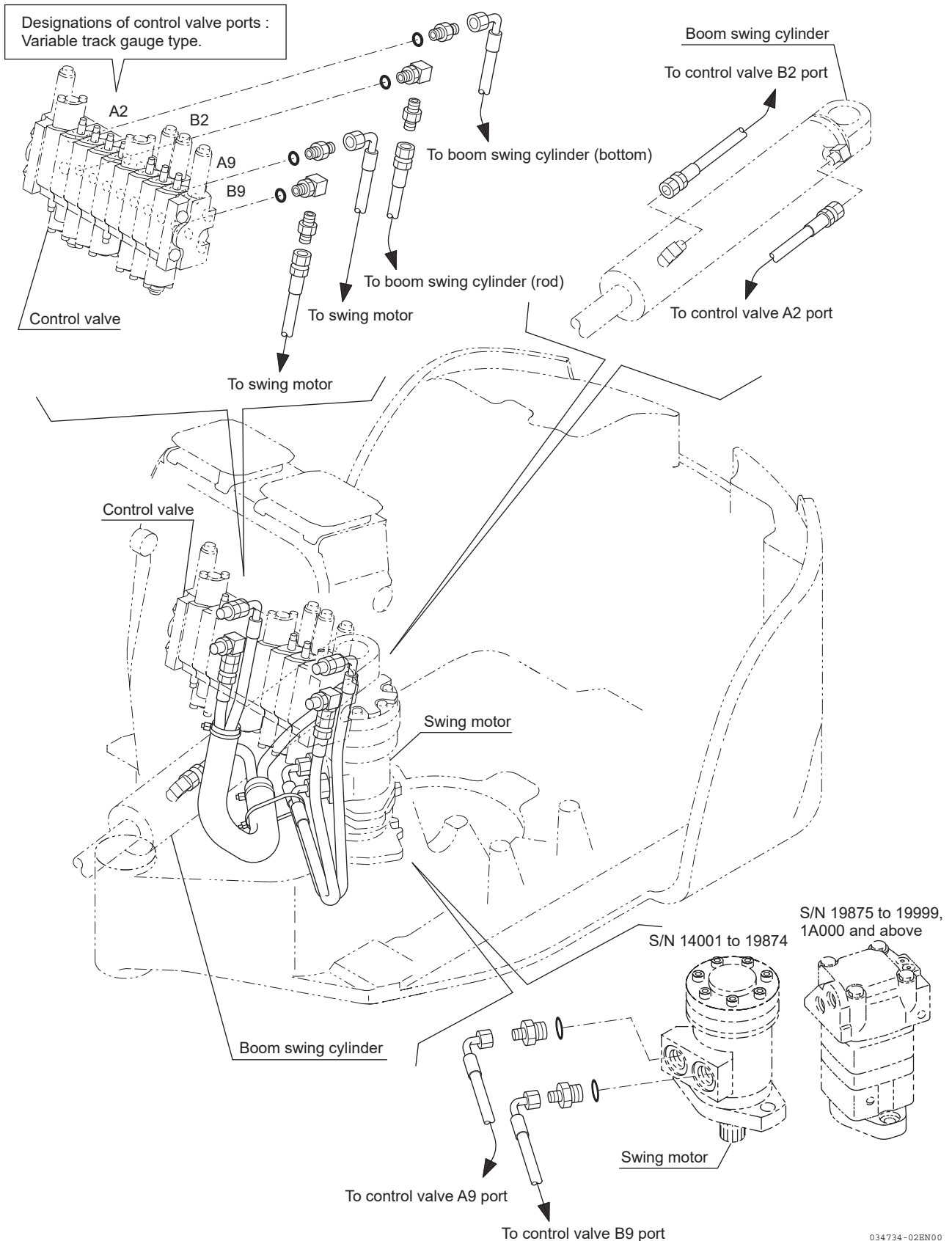
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7. ADJUSTMENT AND REPAIR

2) Upperstructure

(Control valve $\longleftrightarrow$ Swing motor)

(Control valve $\longleftrightarrow$ Boom swing)



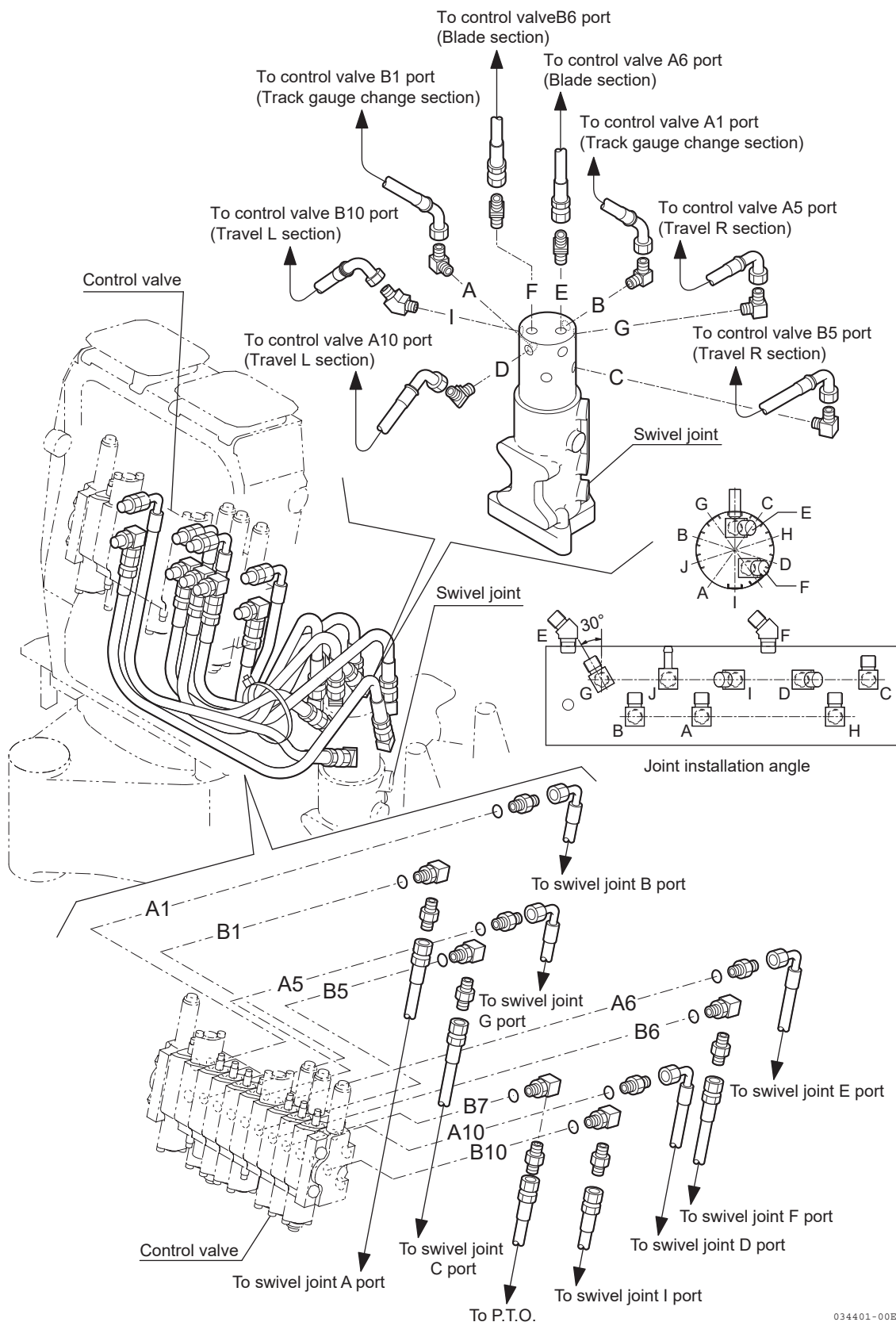
034734-02EN00

7. ADJUSTMENT AND REPAIR

3) Upperstructure

(Control valve ↔ Swivel joint)

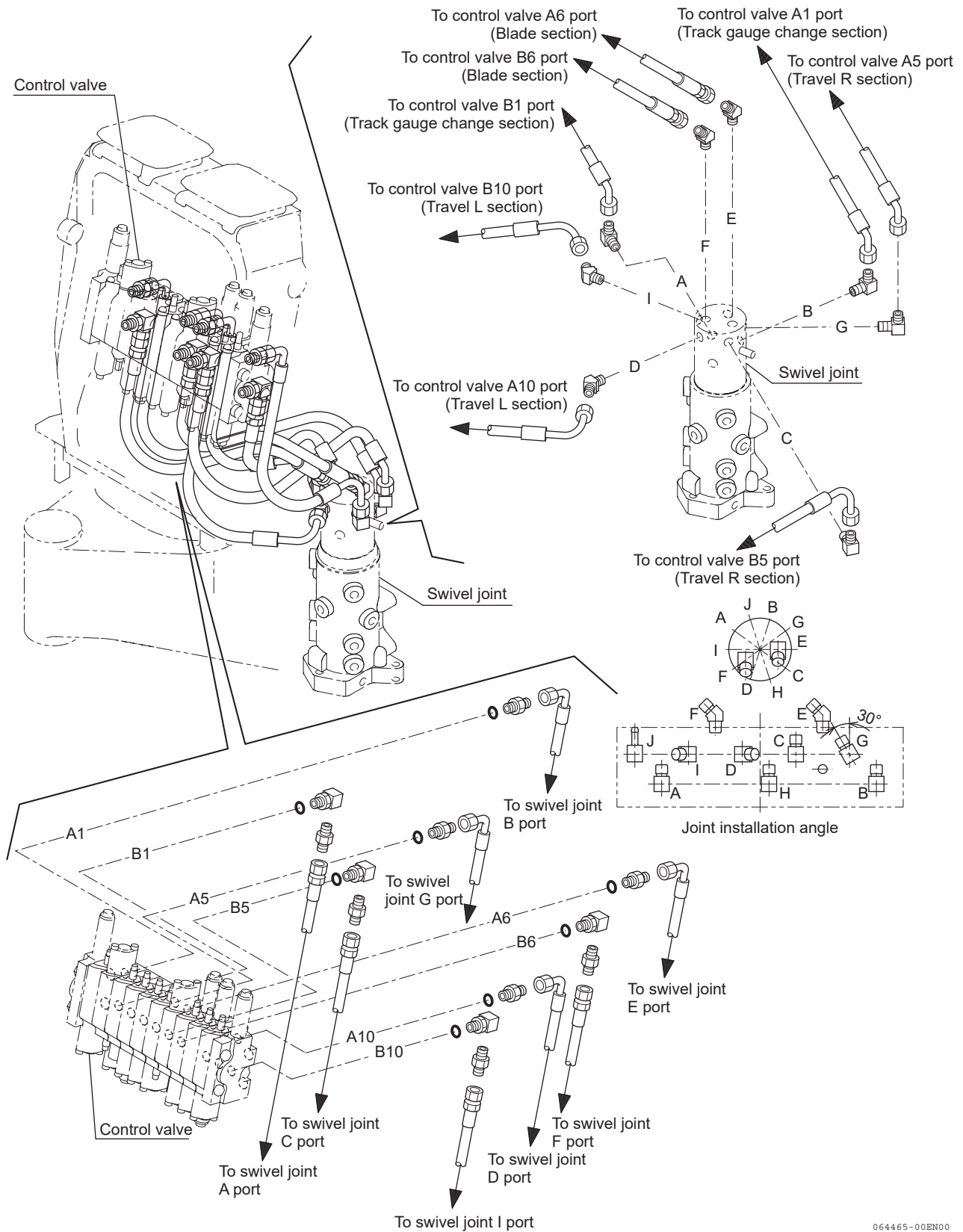
Link track gauge change type SV08-1A



034401-00B

7. ADJUSTMENT AND REPAIR

Slide track gauge change type SV08-1A(S), SV08-1C



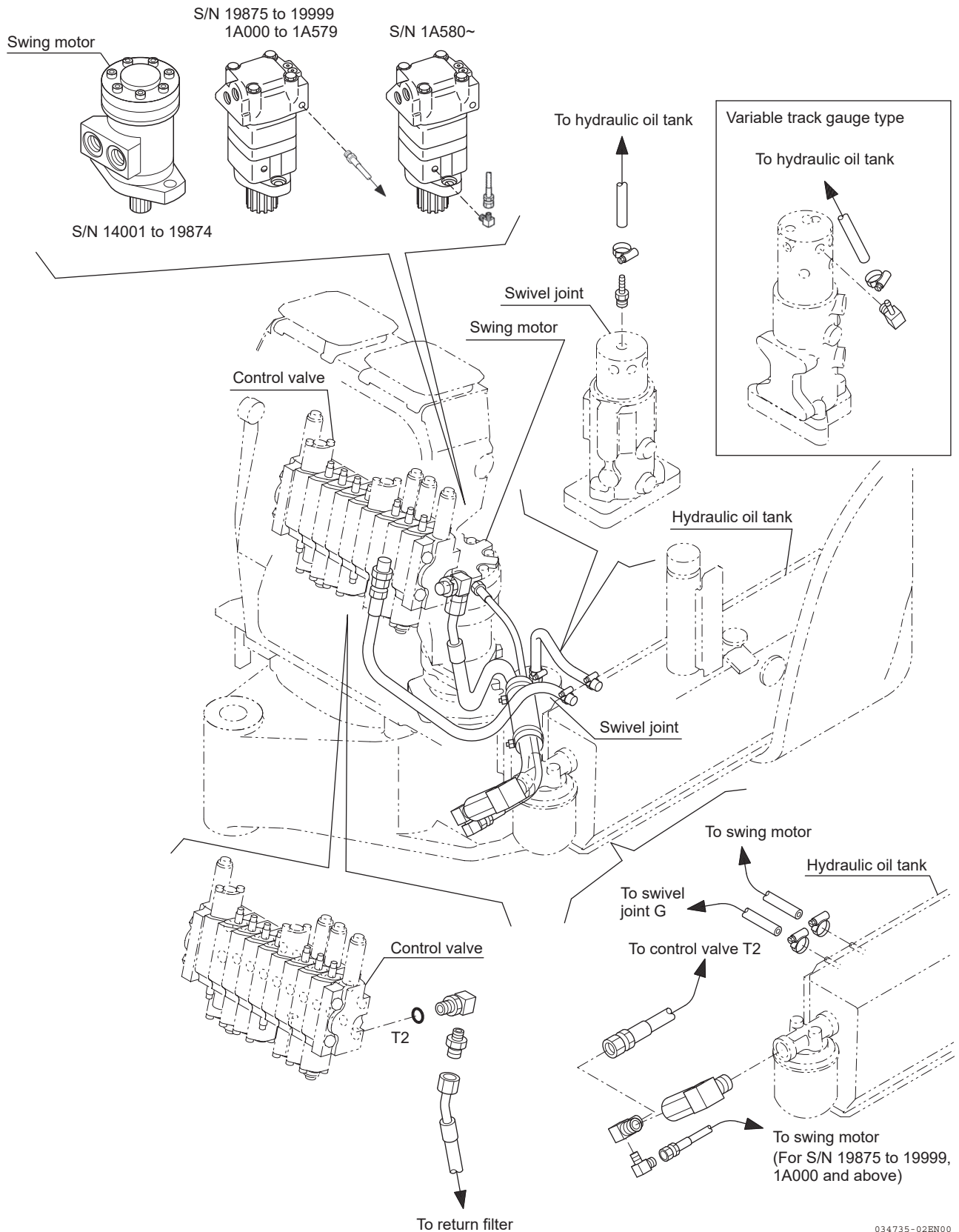
064465-00EN00

7. ADJUSTMENT AND REPAIR

4) Upperstructure

(Control valve → Hydraulic oil tank)

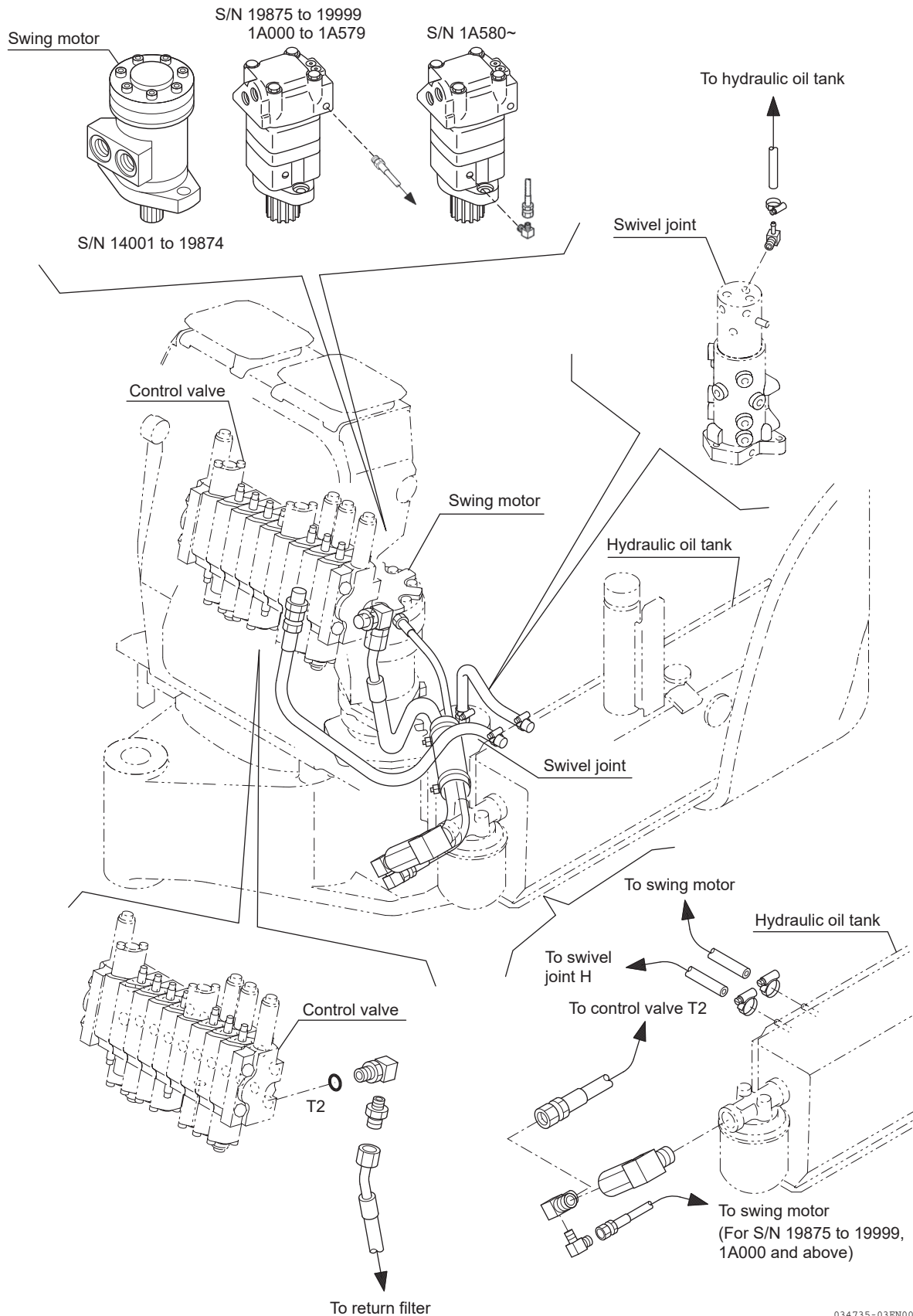
Link track gauge change type SV08-1A



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7. ADJUSTMENT AND REPAIR

Slide track gauge change type SV08-1A(S), SV08-1C



034735-03EN00

7. ADJUSTMENT AND REPAIR

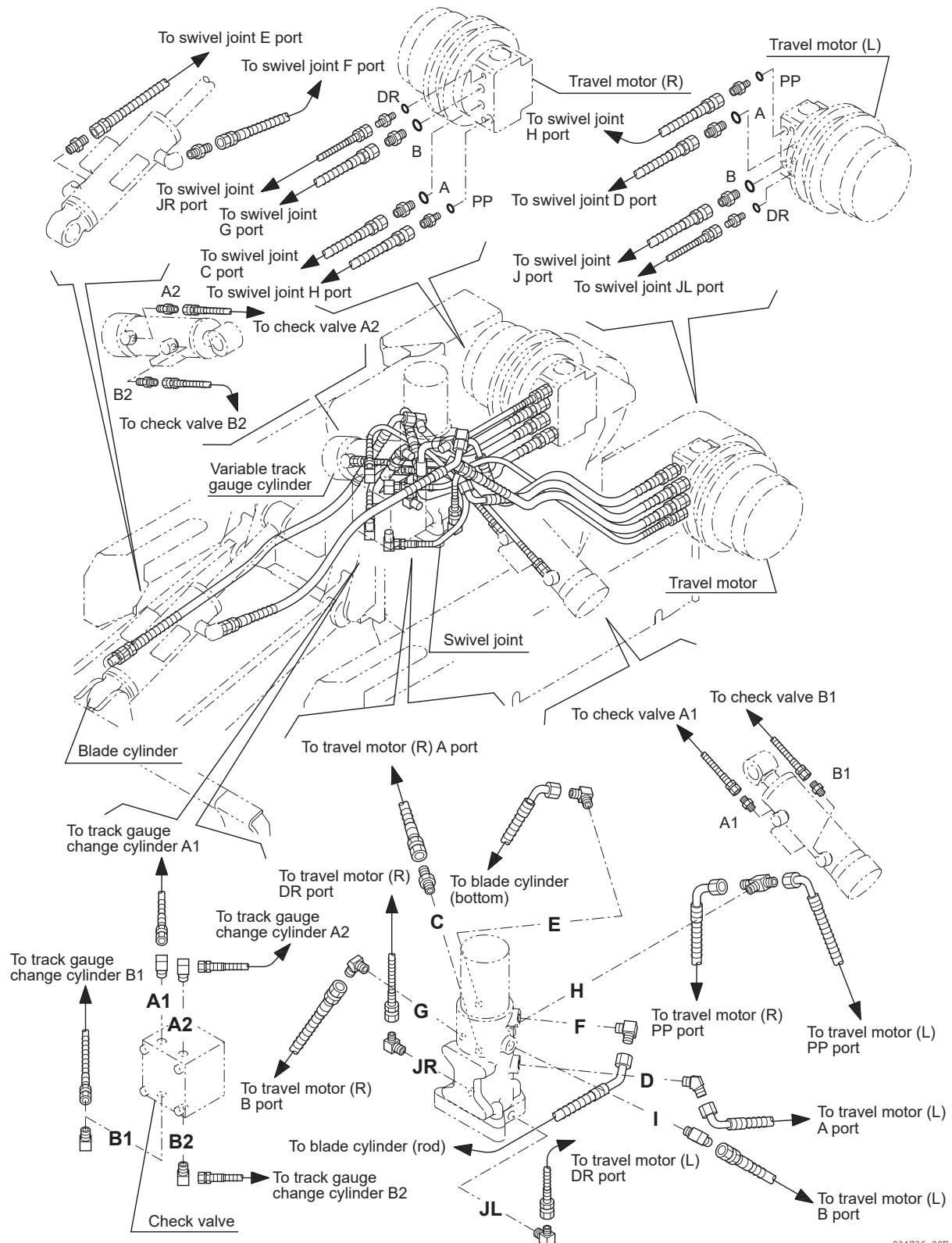
5) Undercarriage

(Swivel joint $\longleftrightarrow$ Travel motor)

(Swivel joint $\longleftrightarrow$ Blade cylinder)

(Swivel joint $\longleftrightarrow$ Track gauge change cylinder)

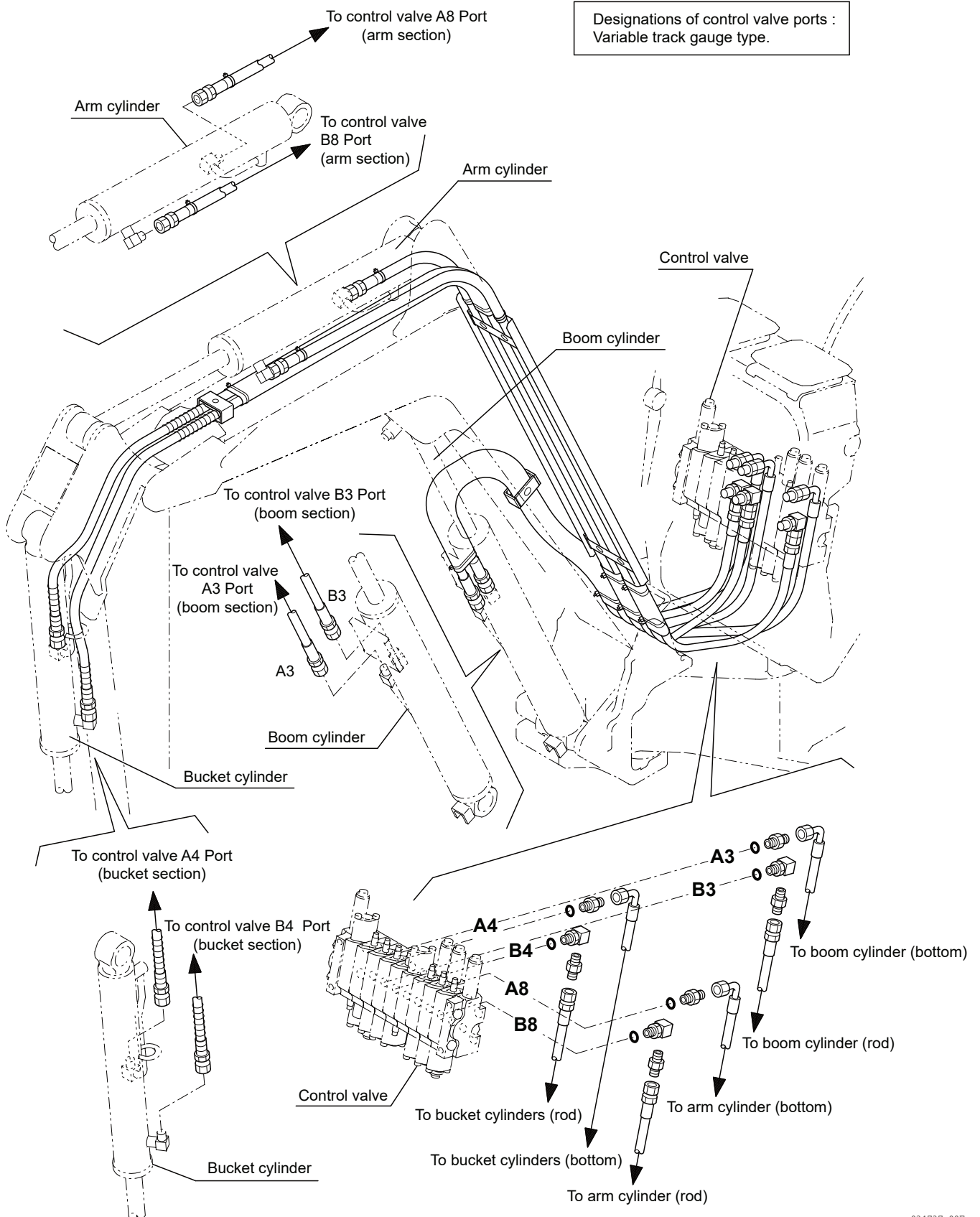
Link track gauge change type SV08-1A



034736-00B

7. ADJUSTMENT AND REPAIR

6) Pilot control for Implements



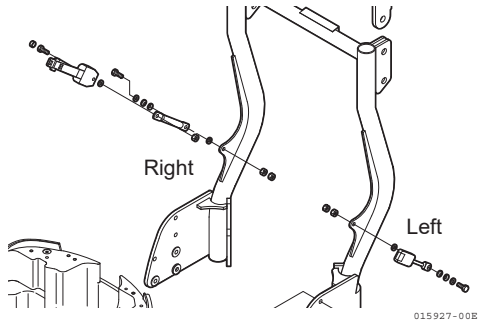
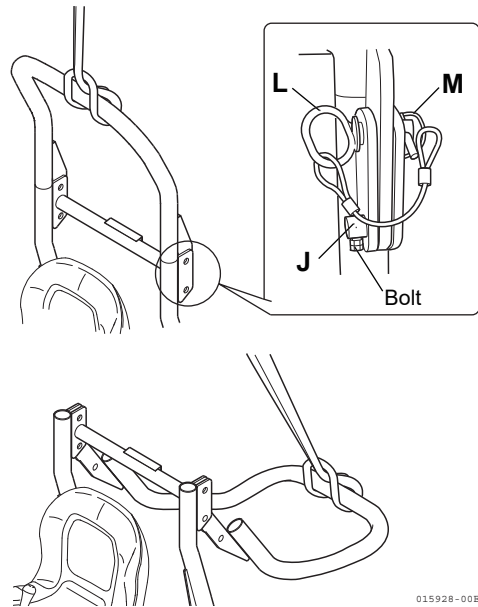
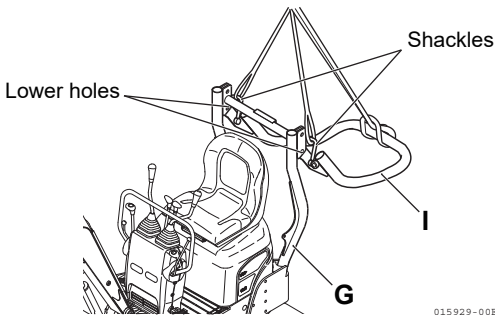
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7. ADJUSTMENT AND REPAIR

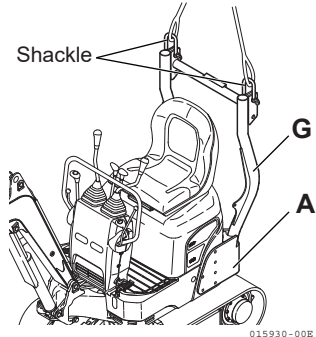
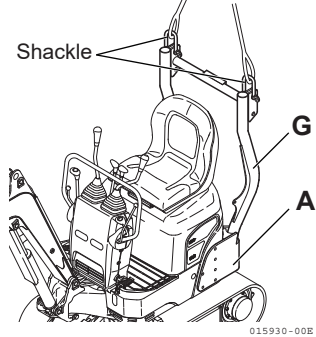
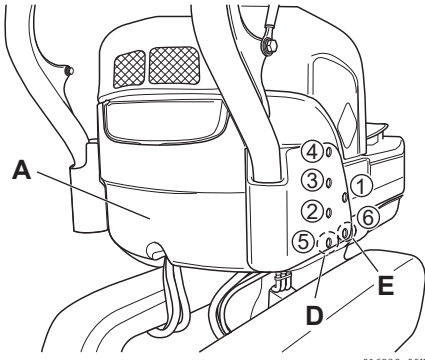
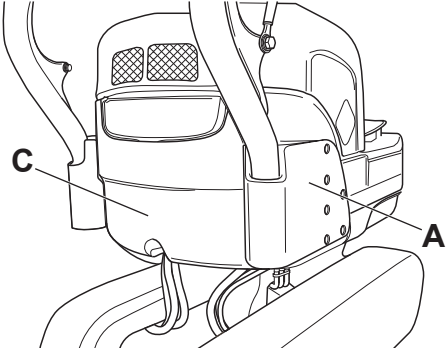
7-6 ROPS Bar

7-6-1 Removal and Reinstallation of ROPS bar

1) Removal

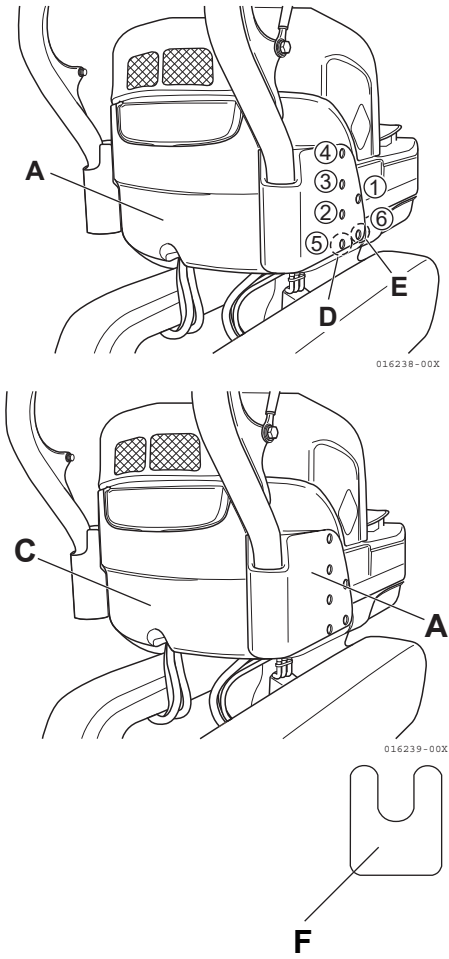
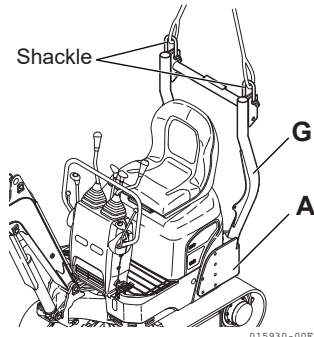
Procedure	
(1) Remove the bolts to take the seat belt off.	
(2) Using rope, support the ROPS bar top I with a crane, as shown in the figure at the right. (3) Remove the linchpin M to pull the linchpin L out. Follow the step (3) for each side. (4) Fold the ROPS bar top I back while supporting it with a crane.	
(5) Use shackles and rope to support the ROPS bar top I with a crane again, as shown in the figure at the right. (6) Remove the bolt to pull the pivot pin J out. Follow the step (6) for each side. (7) Lift the ROPS bar top I up with a crane to remove it.	

7. ADJUSTMENT AND REPAIR

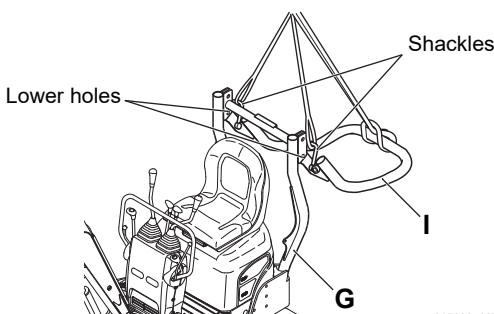
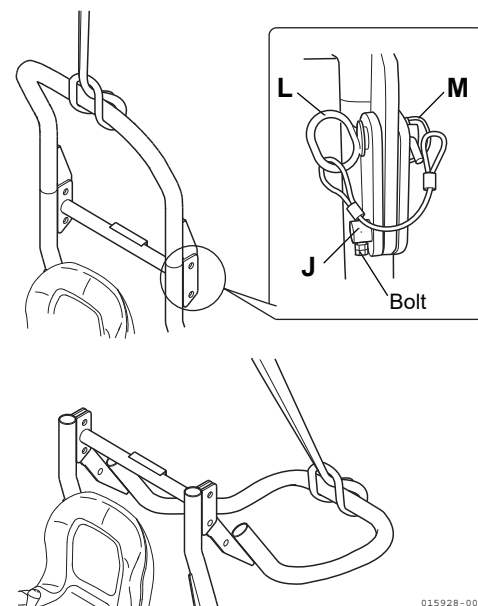
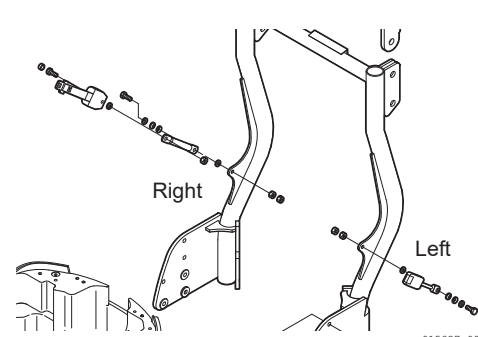
Procedure	
(8) Using shackles and rope, support the ROPS bar bottom G with a crane, as shown in the figure at the right.	 Shackle G A 015930-00E
(9) Lift the ROPS bar bottom G up with a crane to remove it.	 Shackle G A 015930-00E
(10) Install the rope to the bracket Ass'y A securely enough for the rope not to get out of position.	 A ① ② ③ ④ ⑤ ⑥ D E 016238-00X
(11) Use a crane to support the bracket Ass'y A. (12) Remove the M12×35 bolts to take the bracket Ass'y A off.	 C A 016239-00X

7. ADJUSTMENT AND REPAIR

2) Reinstallation

Procedure	
(1) Install the rope to the bracket Ass'y A securely enough for the rope not to get out of position. (2) Use a crane to align the mounting holes in the bracket Ass'y A with those in the counterweight C. (3) Apply adhesive (Three Bond 1324 or its equivalent) to the M12×35 bolts. Note: Be sure to apply adhesive to the bolts to prevent them from loosening. (4) Temporarily tighten those bolts with a spring washer and a plain washer installed on them on the right and left sides. (5) If there is a gap of 0.079 in. (2 mm) or more in the part D or E on each side, put the shim F in the gap to reduce it to less than 0.079 in. (2 mm). Note : With a gap of 0.079 in. (2 mm) or more, excessive force will be applied to the bracket Ass'y A when tightening the bolts. (6) Tighten the bolts in the order as shown in the figure at the right. Bolt : M12×35×12 Tightening torque : 57.9 to 72.3 ft•lbf (78.5 to 98.1 N•m) (7) Remove rope and pull the vertical hinge pins B out. (fig 1)	
(8) Use shackles and rope to lift the ROPS bar bottom G up with a crane. (9) Align the mounting holes in the bracket Ass'y A and in the ROPS bar bottom G on each side.	

7. ADJUSTMENT AND REPAIR

Procedure	
(10) Use shackles and rope to lift the ROPS bar top I up with a crane. (11) Align the lower holes in the ROPS bar bottom G and in the ROPS bar top I on each side.	 015929-00E
(12) Insert the pivot pin J. (13) Install the bolt for keeping the pivot pin J from falling out. Bolt : M6×35×1 Nut : M6×2 Tightening torque : 7.5 to 8.5 ft•lbf (9.8 to 11.8 N•m) Follow the steps (13) and (14) for each side. (14) Using rope, support the ROPS bar top I with a crane again to erect it, as shown in the figure at the right. (15) Insert locking pin complete with wire and linchpin L and lock it with the linchpin M to each side.	 015928-00E
(16) Install the seat belt with the bolts, spacers, "star" washers and nuts, as shown in the figure at the right, and tighten the bolts and nuts. Bolt : 7/16 UNF×20×2 Nut : 7/16 UNF×2 Tightening torque : 18.5 to 22.0 ft•lbf (25 to 30 N•m)	 015927-00E

7. ADJUSTMENT AND REPAIR

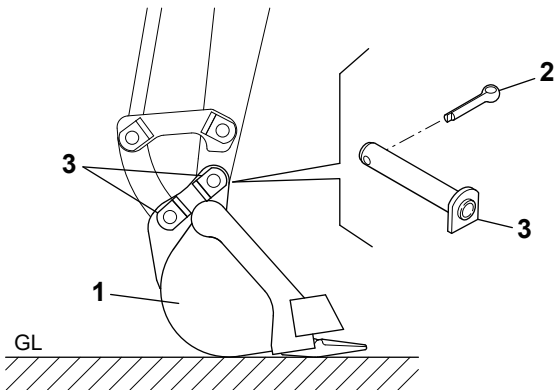
7-7 Work Implements

7-7-1 Removal and Reinstallation of Work Implements

Notes :

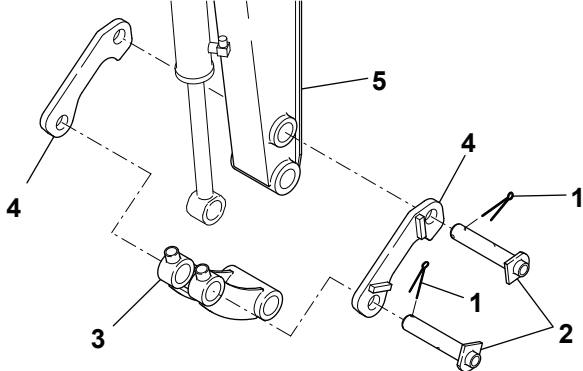
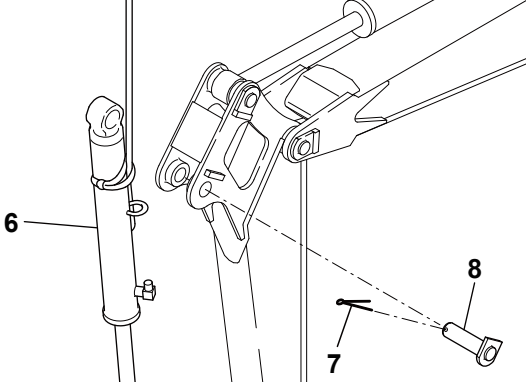
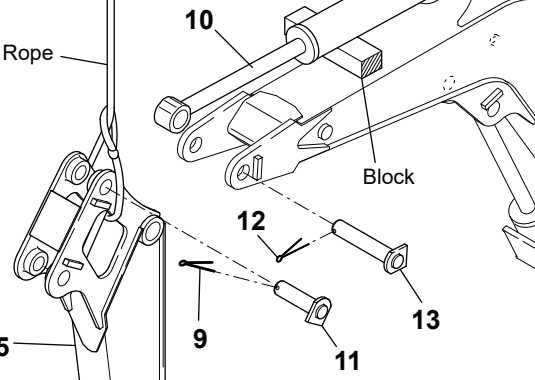
- When removing a pin, check the number of shims installed onto it and their positions.
- When removing a hydraulic hose, put a plug into the hose connection port to keep the oil from flowing out.

1) Removal of Bucket

Procedure	
(1) Lower the bucket 1 to the ground with its back side down and stop the engine. (2) Remove the split pin 2 to remove the pin 3. (3) Remove the bucket 1.	

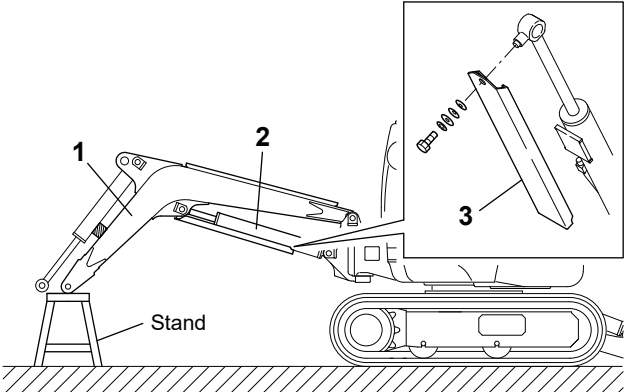
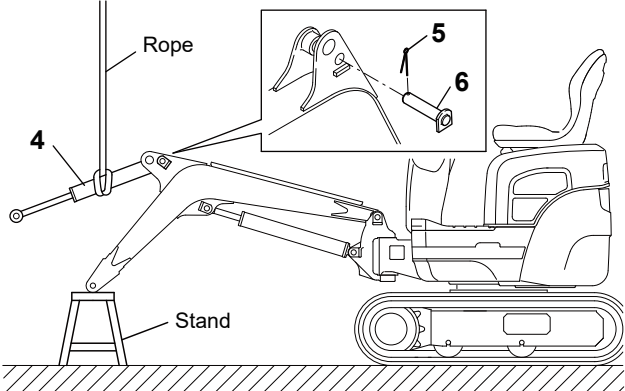
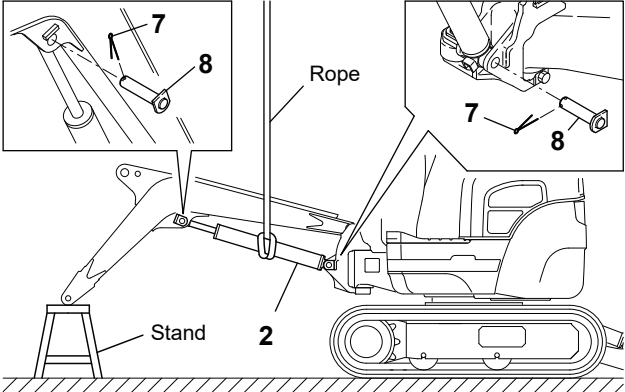
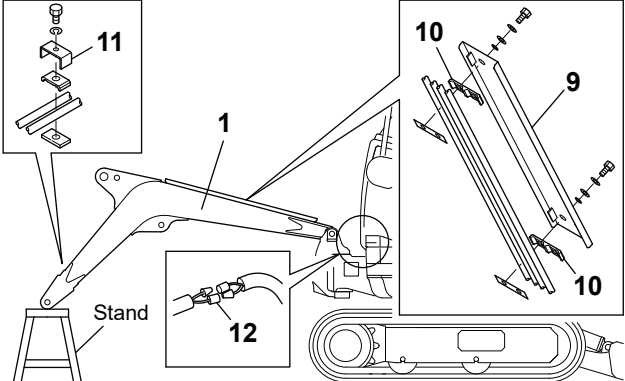
7. ADJUSTMENT AND REPAIR

2) Removal of Arm

Procedure	
(1) Remove the bucket. (2) Remove the split pins 1 and pull out the pins 2 to remove the bucket link 3 and the bucket arms 4. (3) Place the top end of the arm 5 lightly on the ground perpendicularly (at approx. 90 degrees) to the ground.	
(4) Remove the hydraulic hoses from the bucket cylinder 6, and remove the split pin 7 to pull out the pin 8. Then remove the bucket cylinder 6. Note : Put rope round the bucket cylinder to remove it using a lifting device.	
(5) After putting rope to the arm 5, remove the split pin 9 and remove the pin 11 for the arm cylinder 10 (on the rod side). Note : Put a block under the arm cylinder. (6) Remove the split pin 12 to pull out the pin 13 (for the arm) and remove the arm 5.	

7. ADJUSTMENT AND REPAIR

3) Removal of Boom

Procedure	
(1) Remove the bucket. (2) Remove the arm. (3) After raising the boom 1 to the maximum, remove the slide cover 3 from the boom cylinder 2. Note : Install an expansion plug into the joint of the removed hydraulic hose and start the engine. (4) Place the top end of the boom 1 on a stand.	
(5) After putting rope round the arm cylinder 4, remove the hydraulic hoses from the arm cylinder. (6) Remove the split pin 5 to pull out the pin 6, and remove the arm cylinder 4. Note : Use a lifting device and rope to remove the arm cylinder.	
(7) After putting rope round the boom cylinder 2, remove the hydraulic hoses from the boom cylinder. (8) Remove the split pin 7 to pull out the pin 8, and remove the boom cylinder 2. Note : Use a lifting device and rope to remove the boom cylinder.	
(9) Remove the hose cover 9, the hose supports 10 and the hose clamps 11 from the boom 1. (10) Remove the step and the stand cover R to disconnect the connectors 12 of the wire harness.	

7. ADJUSTMENT AND REPAIR

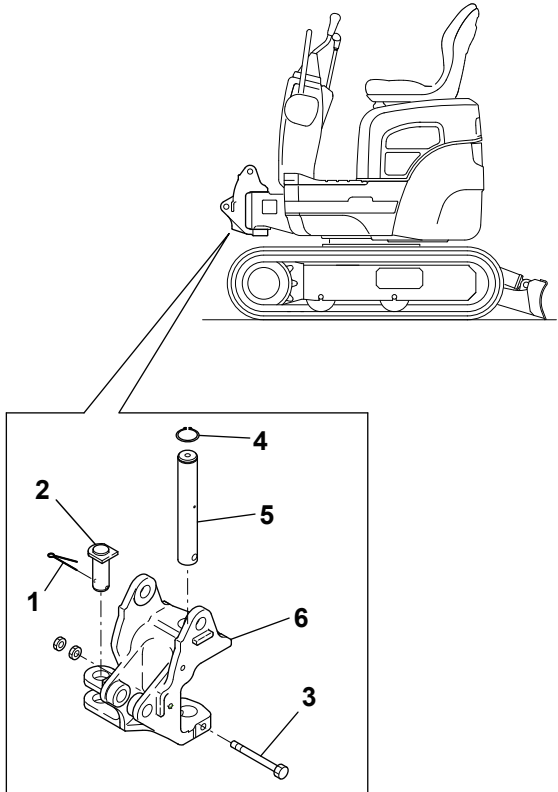
Procedure	
(11) After putting rope round the boom 1, remove the split pin 13 to pull out the pin 14 and remove the boom 1. Notes : • Use a lifting device and rope to remove the boom. • Take care that none of the hoses are caught.	

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 blade cover 2 to remove the hydraulic hoses. (3) After putting rope round the blade cylinder 5, remove the split pin 3 to pull out the pin 4 and remove the cylinder 5. (4) After putting rope onto the blade 1, remove the split pins 6 to pull out the pins 7 and remove the blade. Note : Use a lifting device and rope to remove the blade cylinder and the blade.	

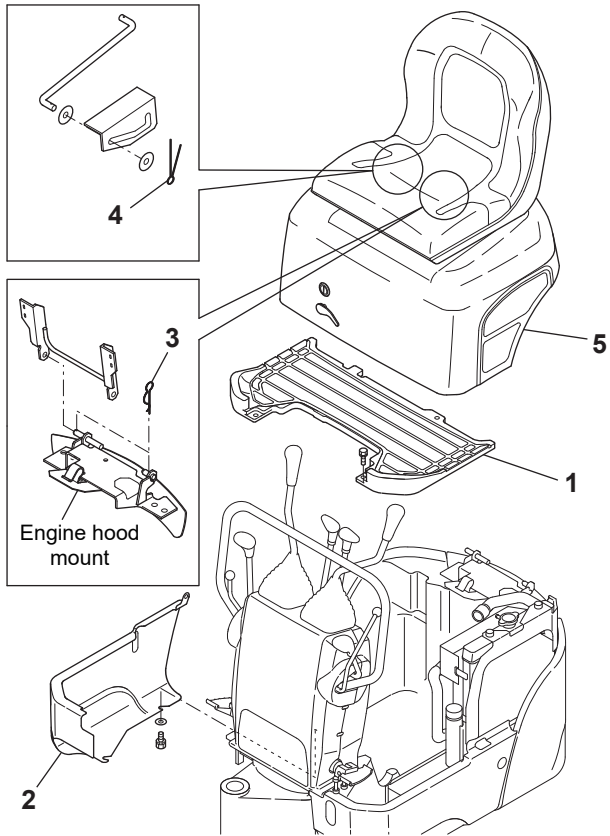
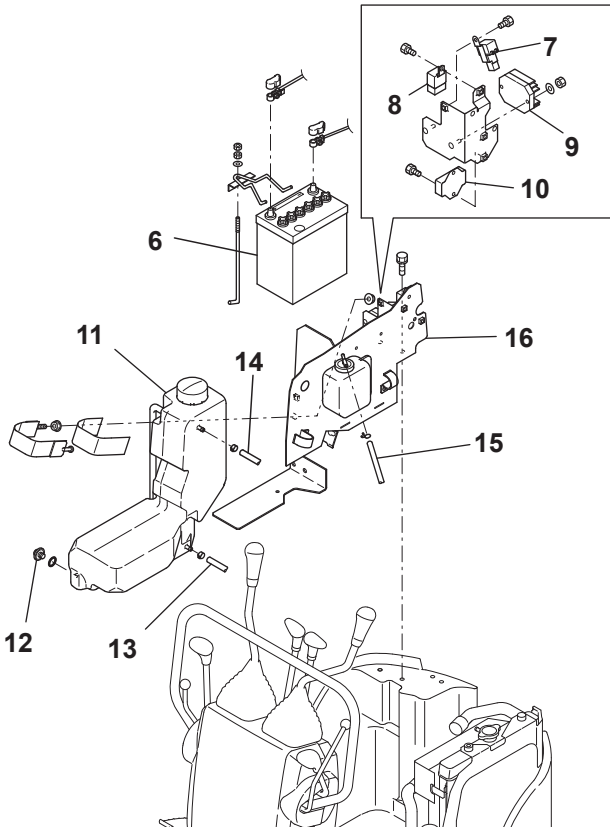
7. ADJUSTMENT AND REPAIR

5) Removal of Boom Bracket

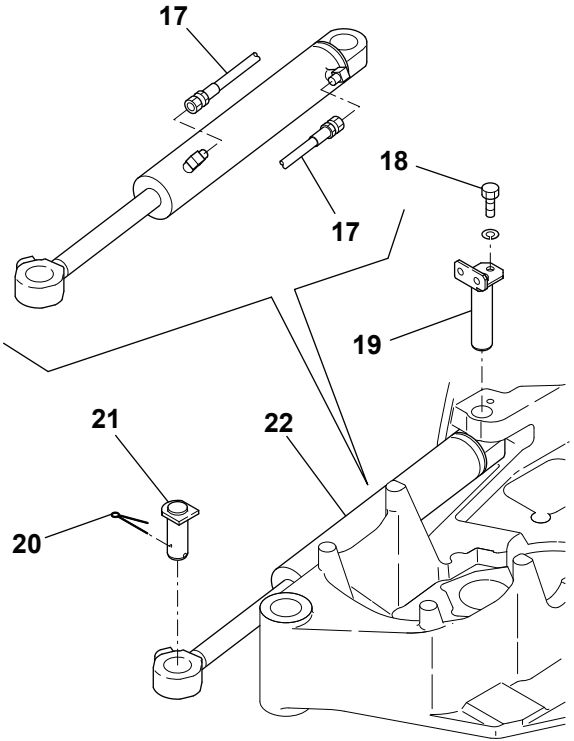
Procedure	
(1) Remove the bucket. Refer to Section "7-6-1 1) Removal of Bucket". (2) Remove the arm. Refer to Section "7-6-1 2) Removal of Arm". (3) Remove the boom. Refer to Section "7-6-1 3) Removal of Boom". (4) Remove the split pin 1 to pull out the pin 2 (for the boom swing cylinder). (5) Remove the bolt 3 (M12) and the snap ring C 4 to pull out the pin 5, and then remove the boom bracket 6. Note : <i>Put rope onto the boom bracket to remove it using a lifting device.</i>	

7. ADJUSTMENT AND REPAIR

6) Removal of Boom Swing Cylinder

Procedure	
(1) Remove the step 1 and the side cover R 2. (2) Remove the snap rings 3 on the engine hood mount and the split pins of the link 4 to remove the engine hood (with the operator's seat) 5.	
(3) Remove the battery 6. (4) Disconnect the connectors of the electrical equipment including the slow blow fuse 7, the safety relay 8, the current limiter 9 and the resistor 10. (5) Remove the drain plug 12 from the fuel tank 11 to drain the fuel. (6) Remove the fuel hose 13 (the fuel tank to the fuel prefilter) and the fuel return hose 14 (the fuel filter to the fuel tank), and then remove the fuel tank 11. (7) Remove the rubber hose 15 for the sub tank to remove the partition plate 16.	

7. ADJUSTMENT AND REPAIR

Procedure	
(8) Remove the hydraulic hoses 17. (9) Remove the bolt 18 to pull out the pin 19. (10) Remove the split pin 20 to pull out the pin 21. (11) Remove the swing cylinder 22.	 The diagram is an exploded view of a hydraulic assembly. It shows a main hydraulic cylinder (22) with two ports. One port is connected to a hydraulic hose (17) which has a bolt (18) and a pin (19) attached to it. The other port is connected to a split pin (20) which is attached to a pin (21). The cylinder (22) is shown in a partially extended position. The components are labeled with numbers 17, 18, 19, 20, 21, and 22.

7. ADJUSTMENT AND REPAIR

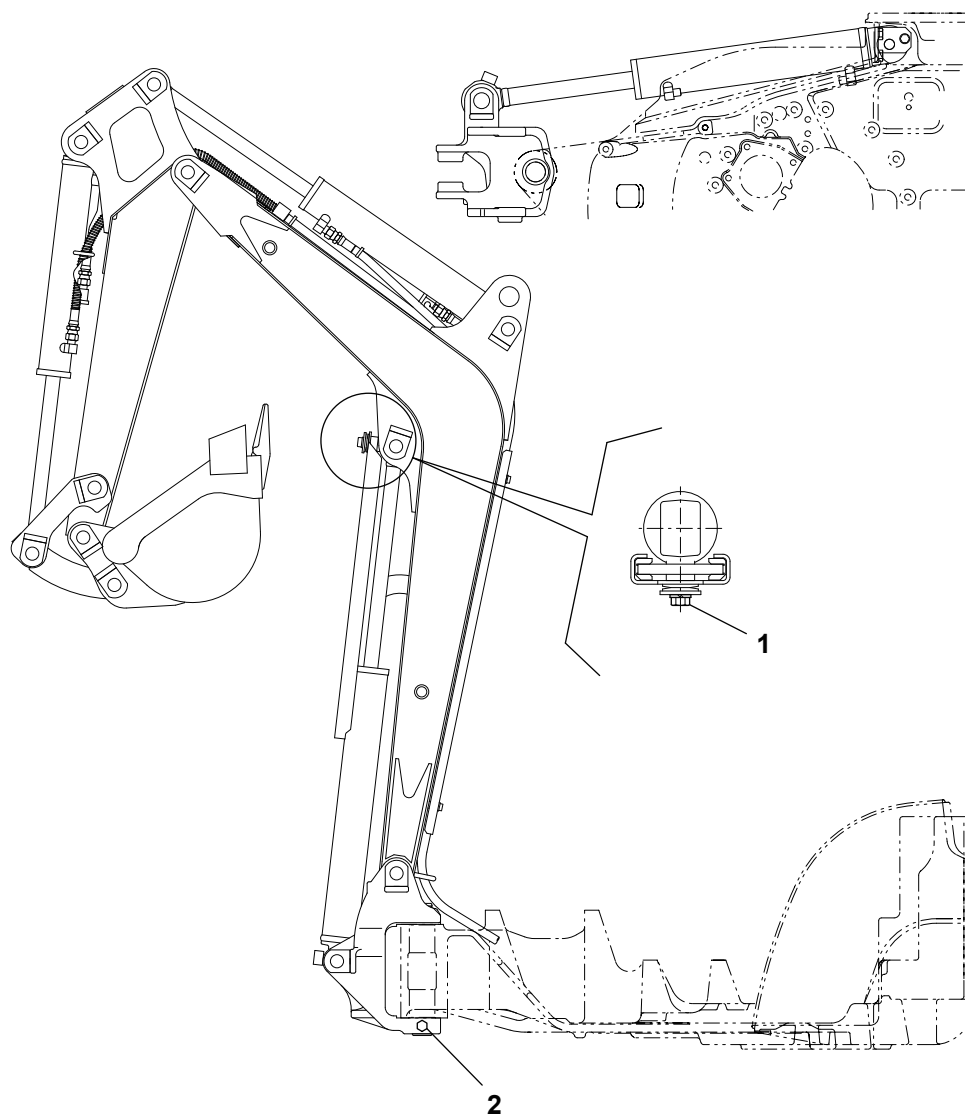
7) Reinstallation

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

Note :

Apply multipurpose grease to the pins.

Tightening torque and adhesive



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	Nut M12	18.1 to 23.9 ft·lbf (24.5 to 32.4 N·m)	—

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
8-1-3 Drifting of Upperstructure on Quick Travel Operation	8-1-2
8-1-4 Thermal Shock of Travel Motor	8-1-3
8-1-5 Fluctuation in Oil Level of Hydraulic Oil Tank Due to Temperature Change	8-1-4
8-2 Troubleshooting	8-2-1
8-2-1 Machine and Engine	8-2-1
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8. TROUBLESHOOTING

8. Troubleshooting

8-1 Non-Breakdowns

8-1-1 Natural Release of Bucket

Phenomenon

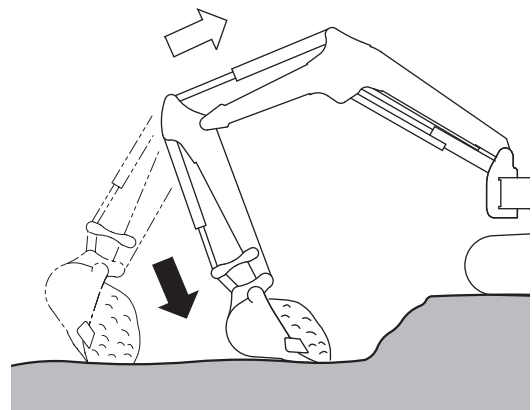
When the arm is extended while scooping with the bucket, the scooping side of the bucket is restricted by the arm and causes back pressure because oil cannot be supplied to the bucket cylinder in time.

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.)



013929-00X

8-1-2 Discontinuous Arm Movement

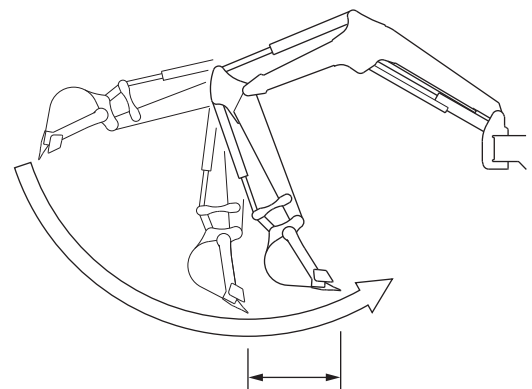
When scooping with the arm, the arm tends to move slower as it draws near to the perpendicular and it may stop momentarily.

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.



Discontinuous phenomenon appears in this range.

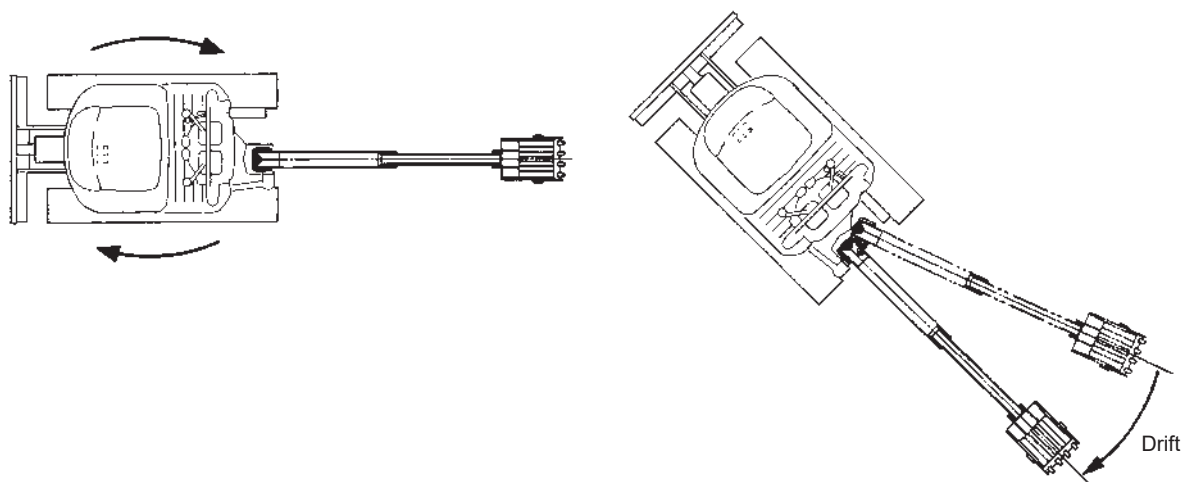
013930-00B

8. TROUBLESHOOTING

8-1-3 Drifting of Upperstructure on Quick Travel Operation

Phenomenon

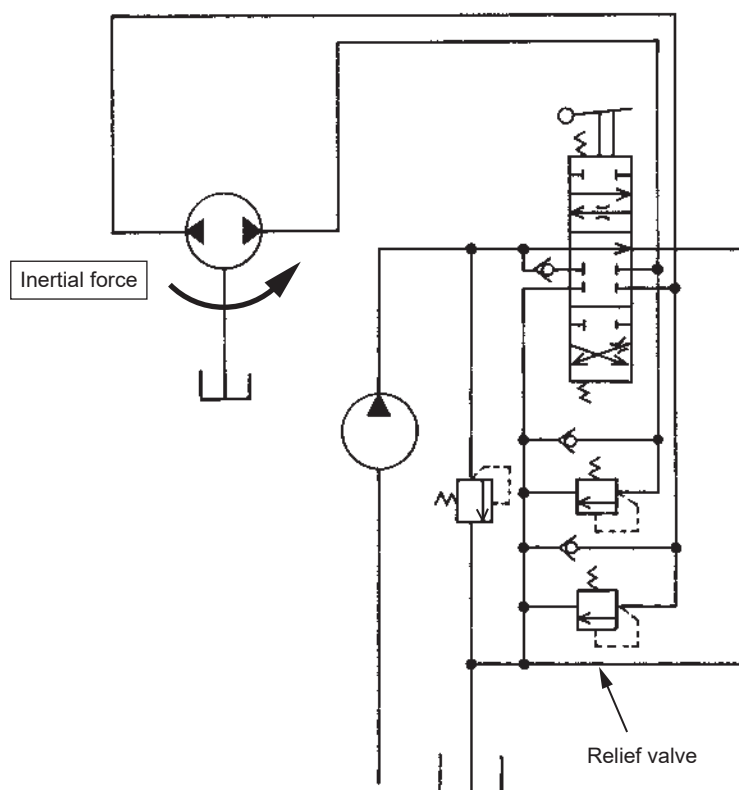
The upperstructure drifts on quick travel operation (especially, on spin-or pivot-turning).



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.

(The mechanical brake is released when the engine is running.)

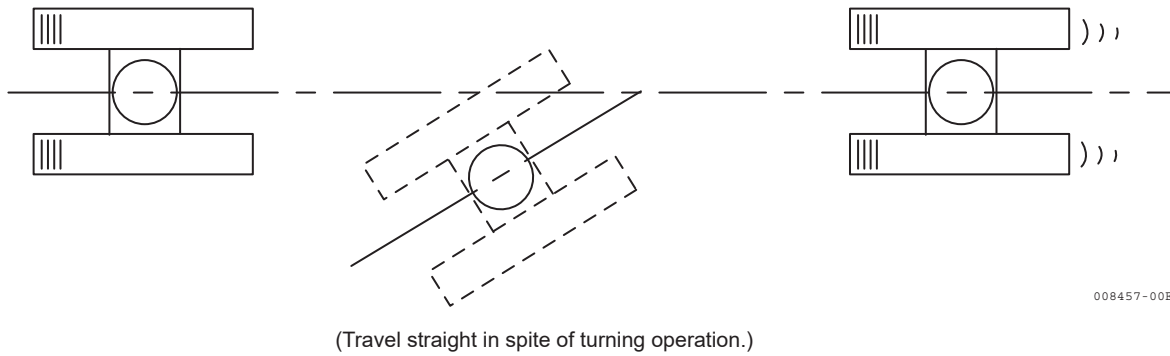


8. TROUBLESHOOTING

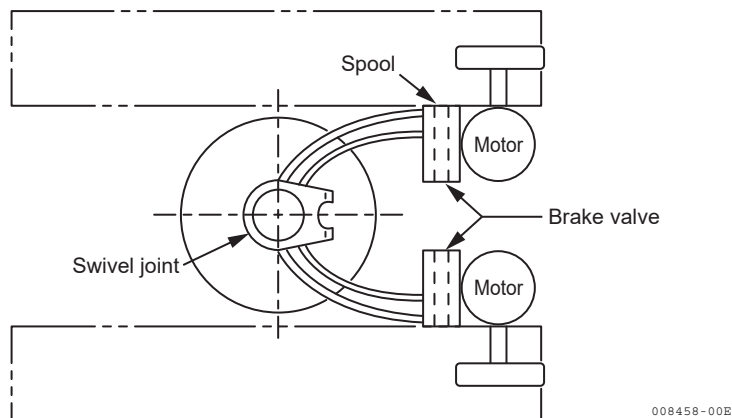
8-1-4 Thermal Shock of Travel Motor

Phenomenon

When the travelling 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 travelling 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

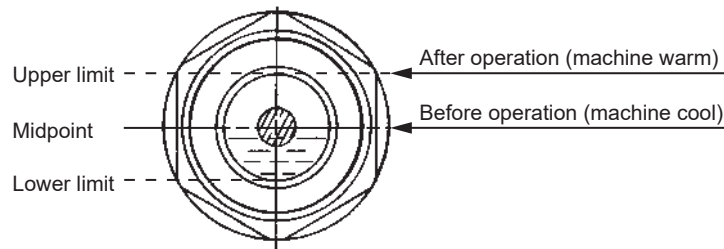
Since the phenomenon disappears in 20 to 30 seconds and this situation is generally rare, this phenomenon presents no problem.

8. TROUBLESHOOTING

8-1-5 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).

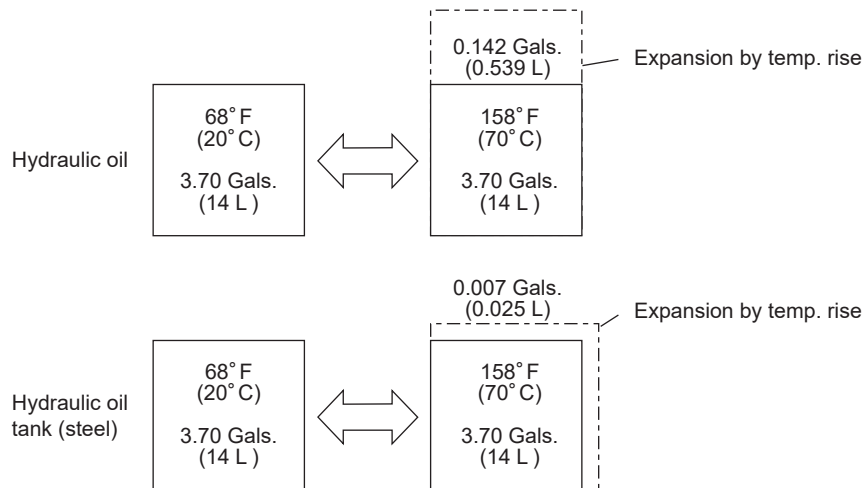


Reason

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)

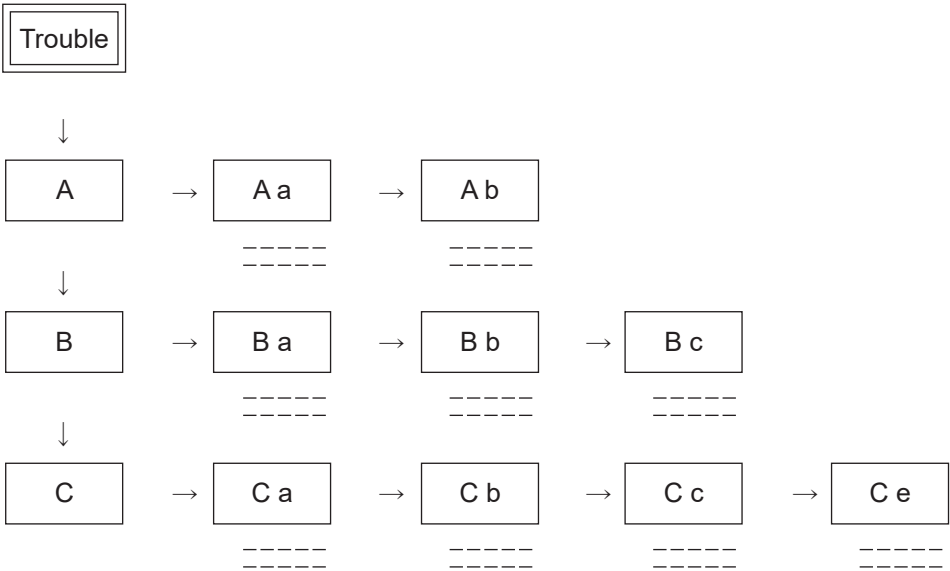


8. TROUBLESHOOTING

8-2 Troubleshooting

8-2-1 Machine and Engine

(How to use the charts)

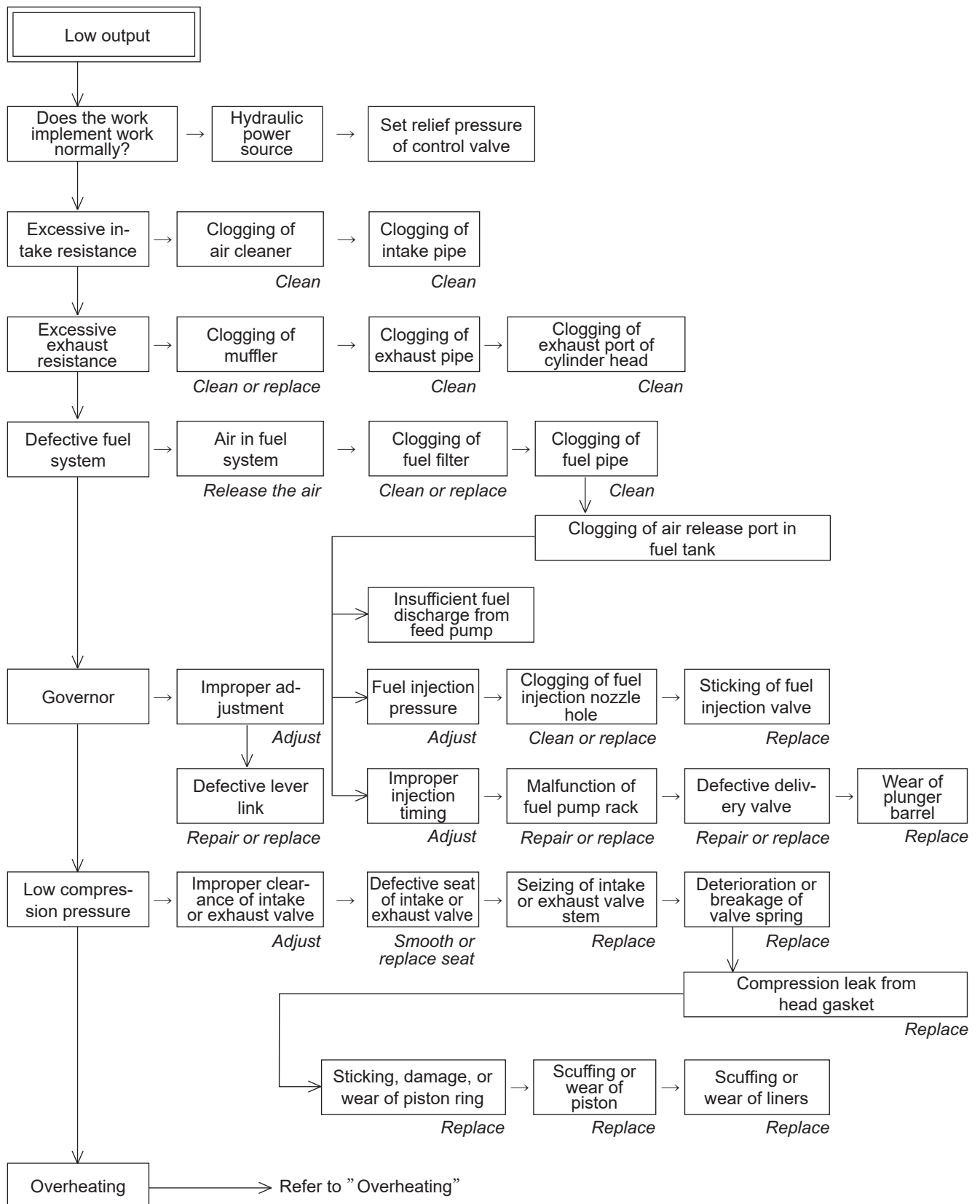


Factors related to the trouble are enumerated in the columns and instructions for corrective procedures are given below. It is recommended that the troubles be inspected and corrected one by one according to the chart.

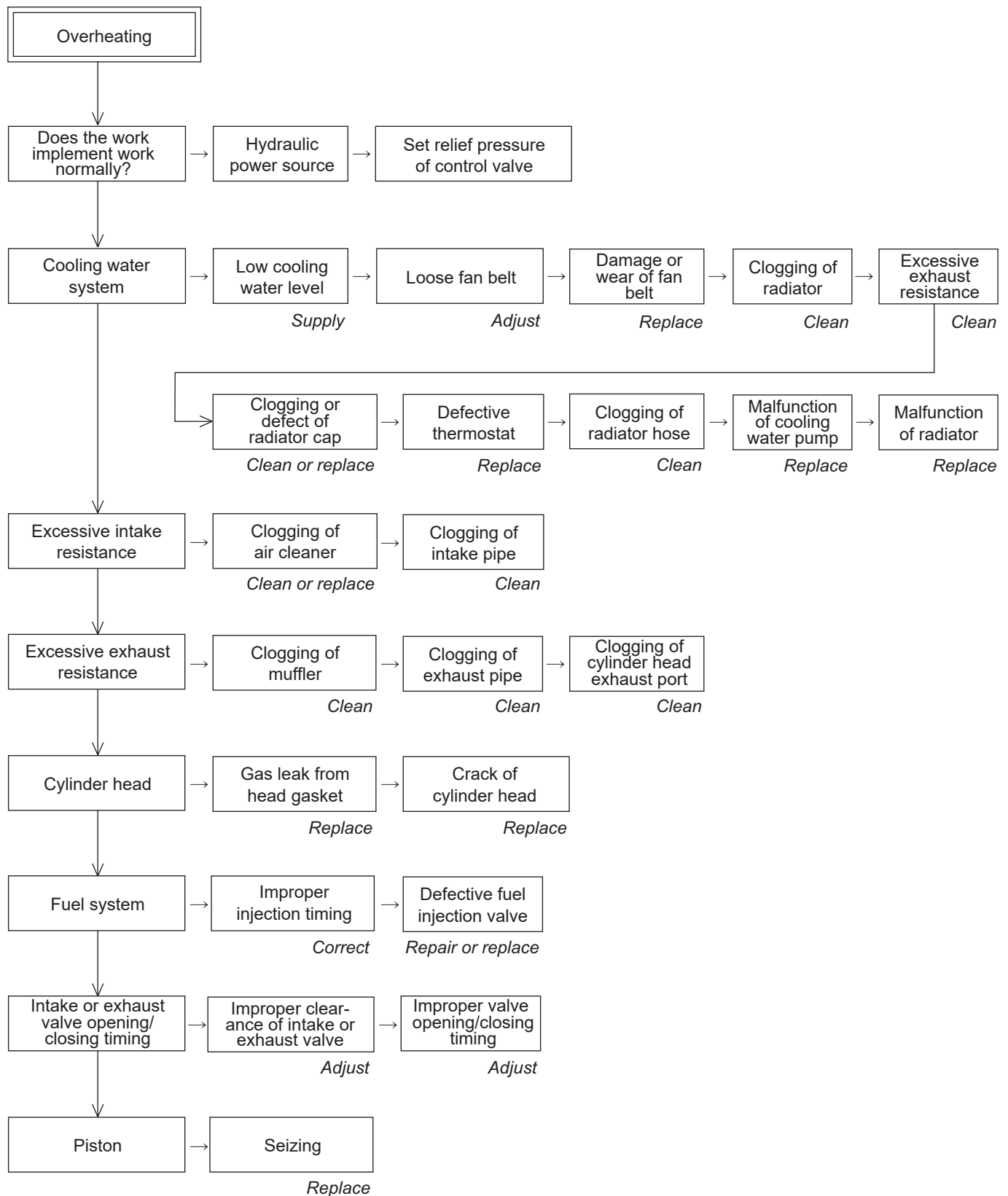
← Inspection item

----- ← Remedy for failure

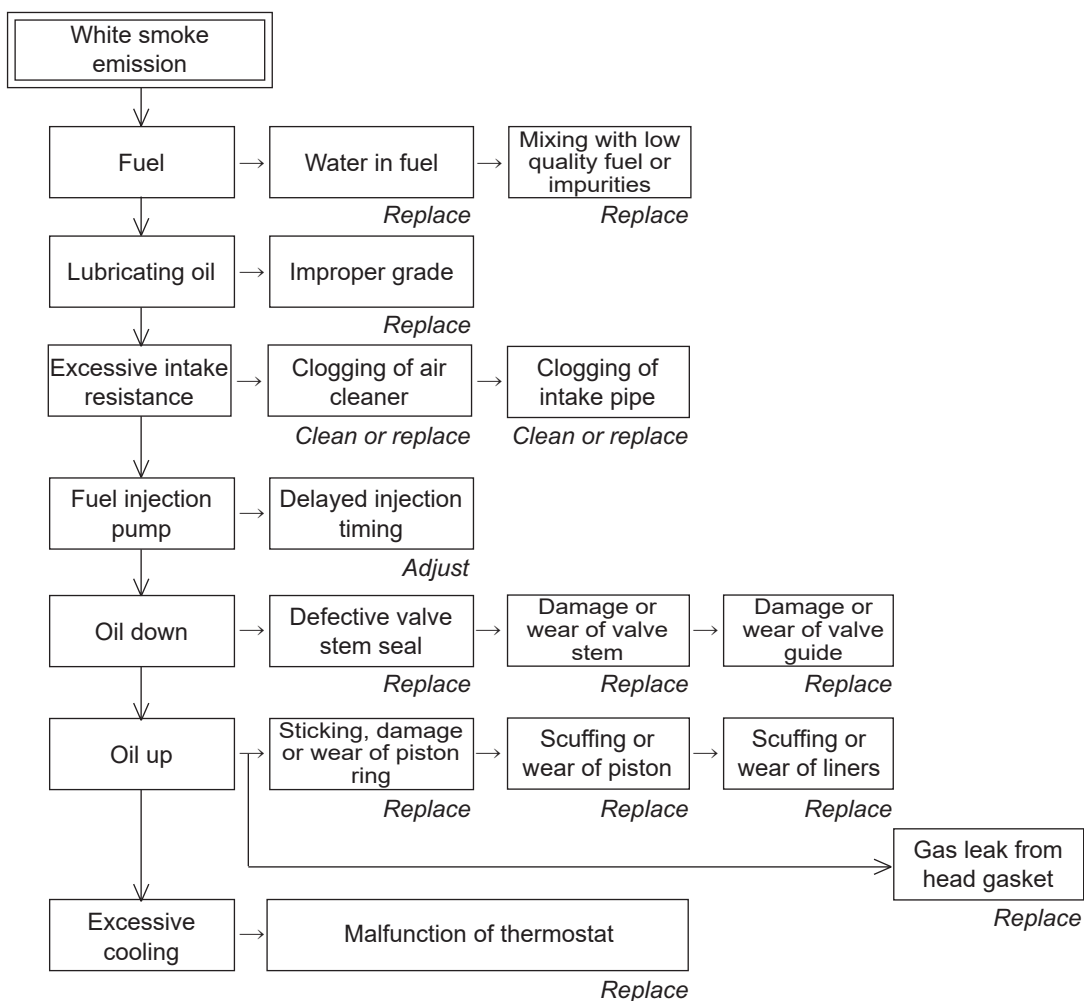
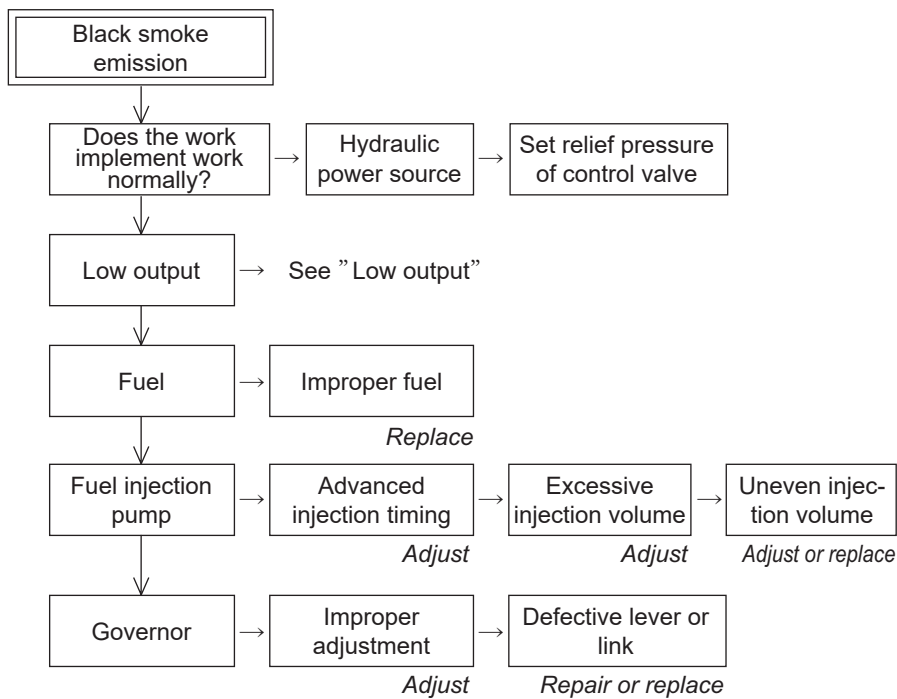
8. TROUBLESHOOTING



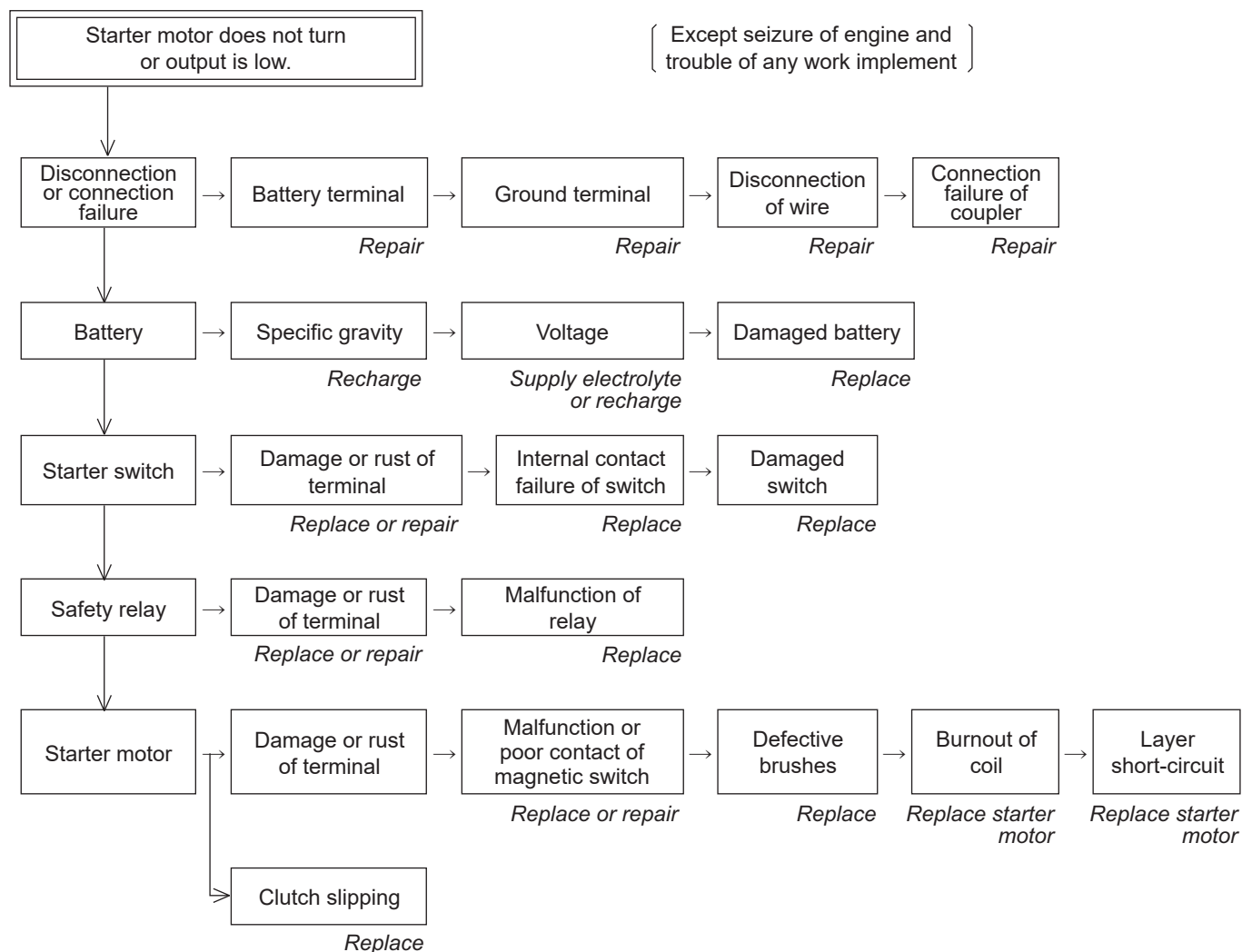
8. TROUBLESHOOTING



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.

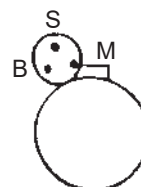
[2] When the starter motor does not turn : Either the starter motor magnetic switch or the starter motor is faulty.

(2) Starter motor

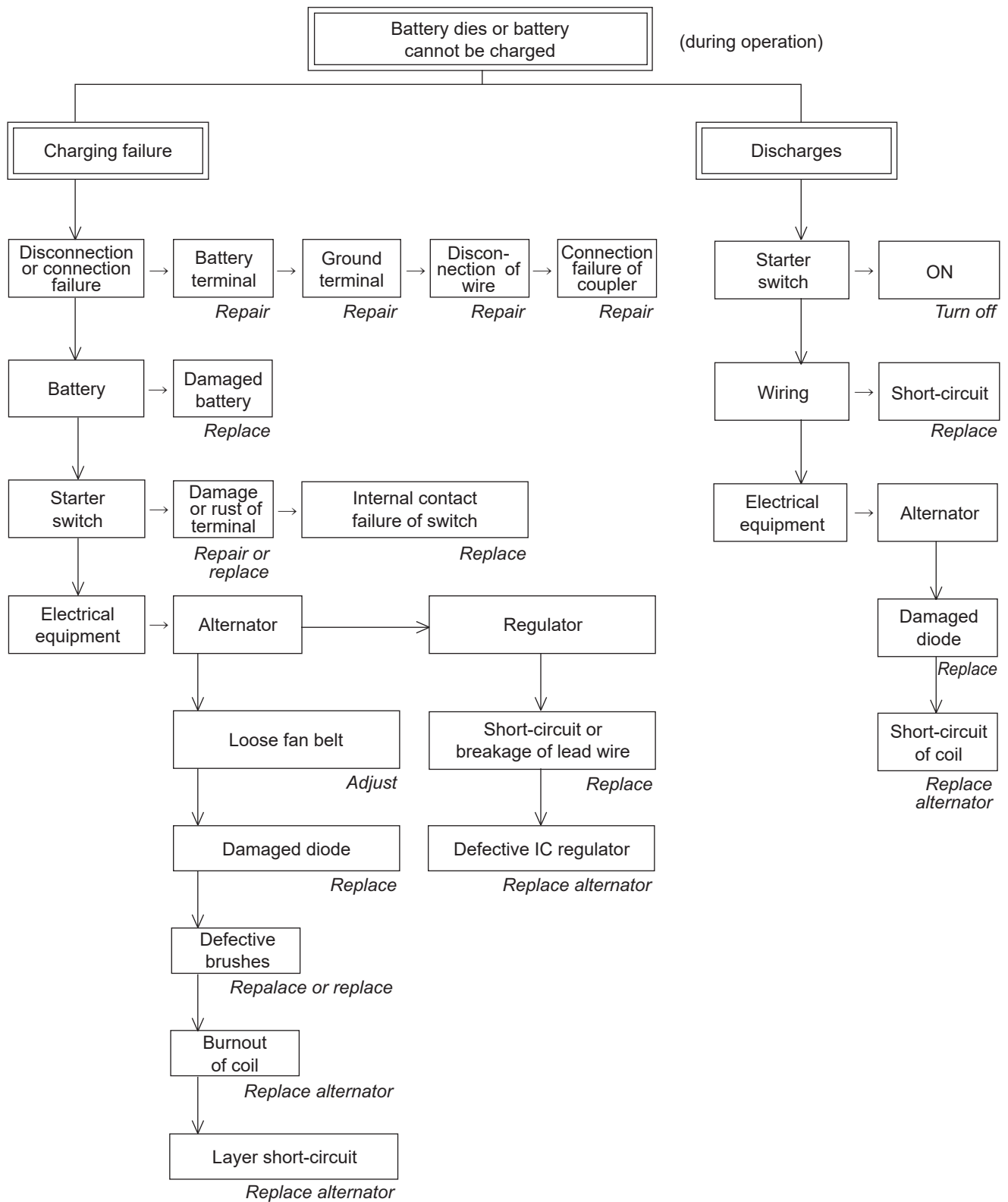
Connect the B-and M-terminals of the starter motor directly.

[1] When the starter motor turns : Magnetic switch is faulty.

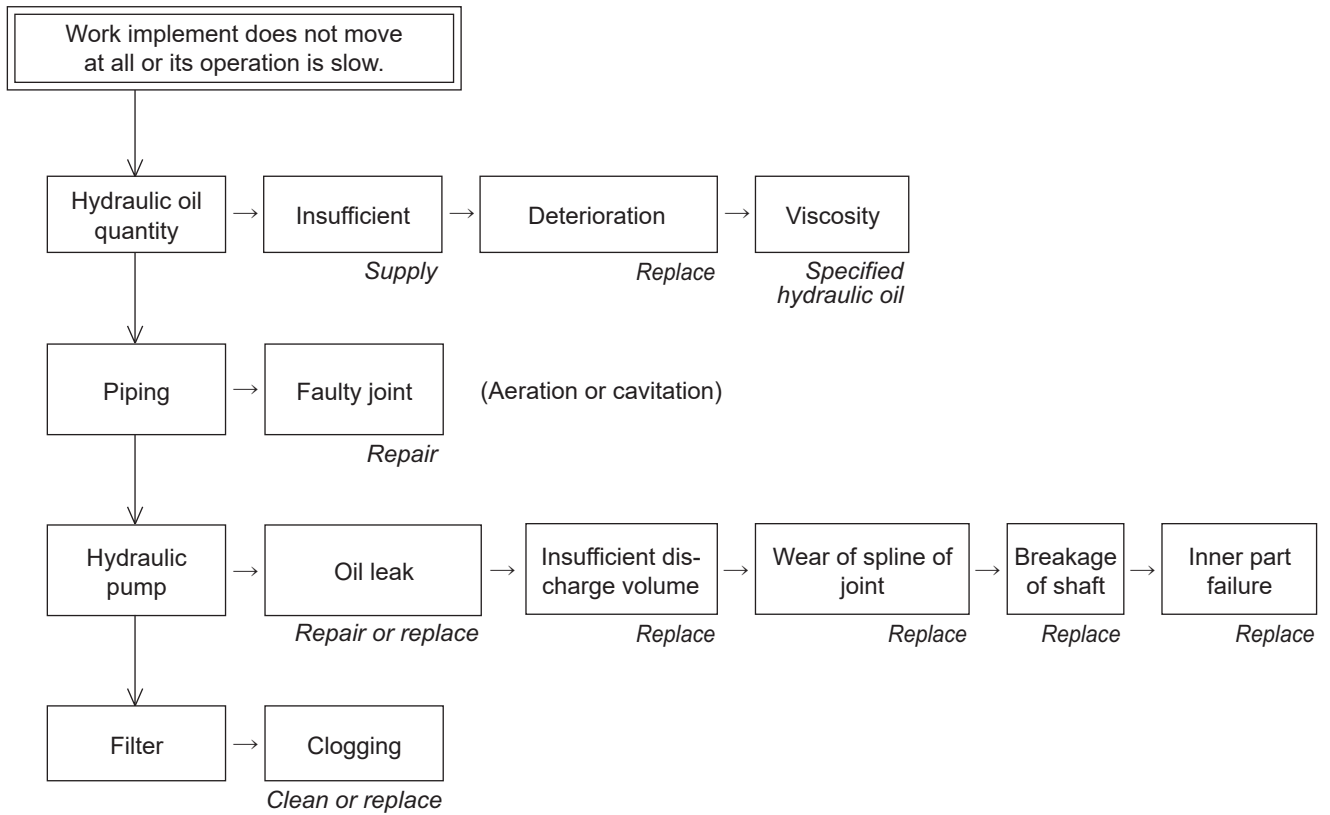
[2] When the starter motor does not turn : Starter motor is faulty.



8. TROUBLESHOOTING

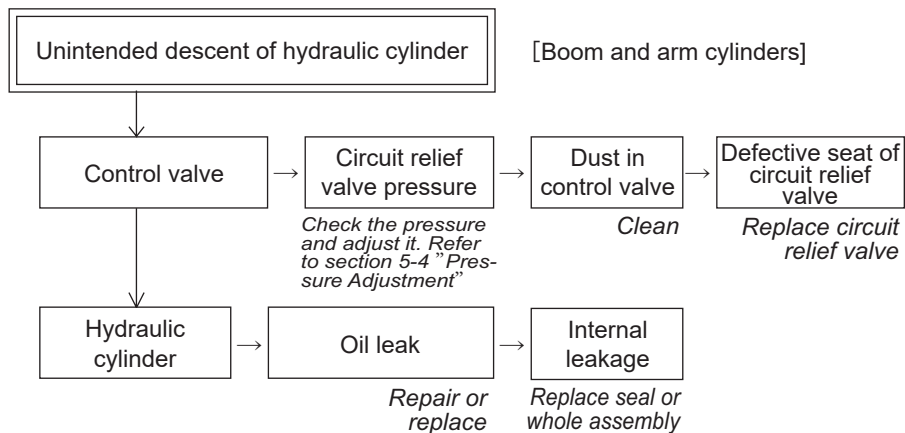
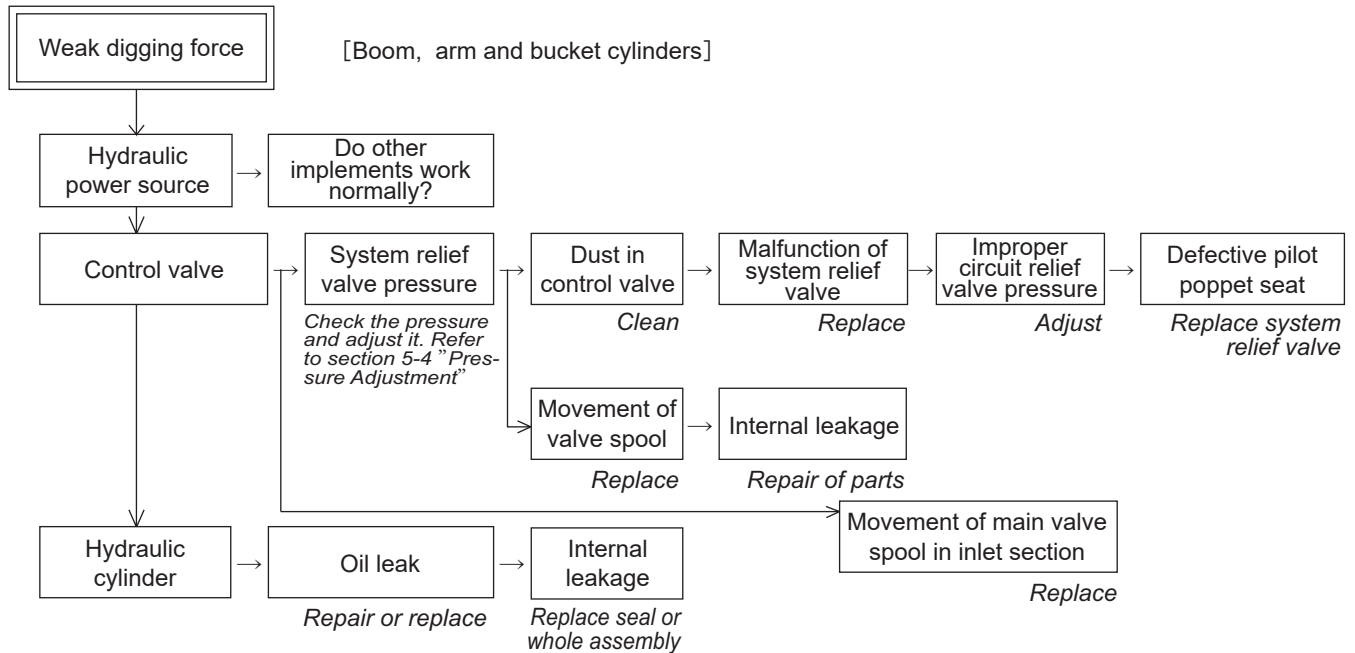


8. TROUBLESHOOTING



8. TROUBLESHOOTING

Work Implements



Inspection procedure

Switch the hose with the hose of the other circuit using the control valve.

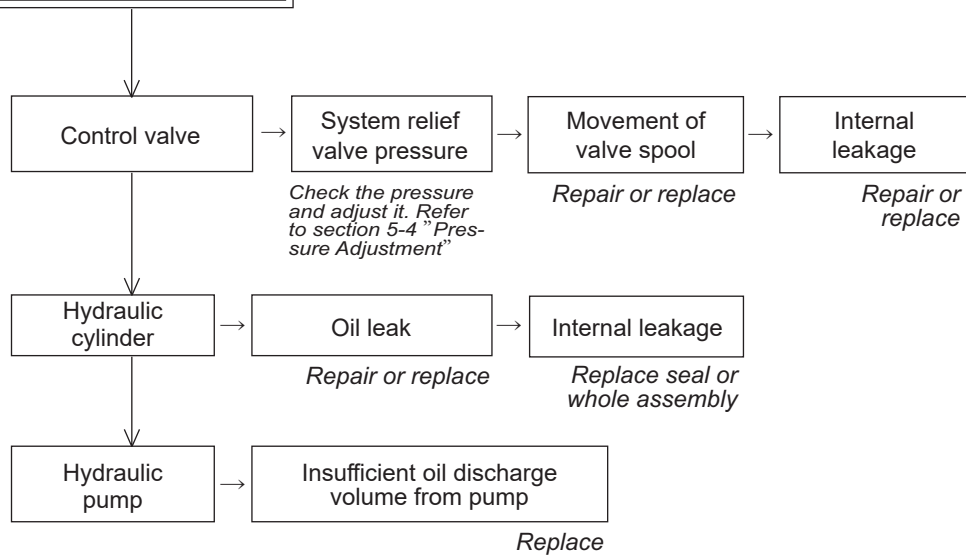
[1] No descent : Control valve is faulty.

[2] Descent : Cylinder is faulty.

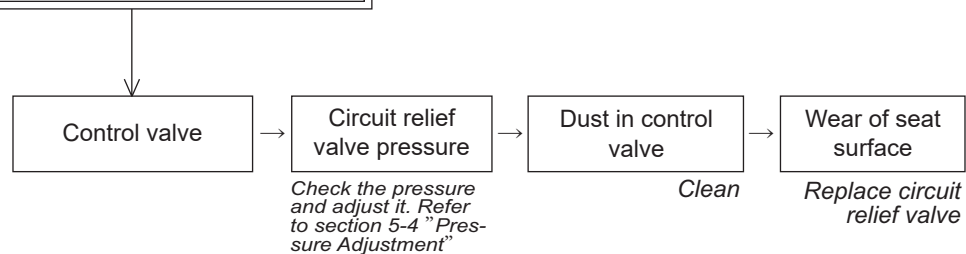
8. TROUBLESHOOTING

Slow work performance

[Boom, Arm and Bucket Cylinders]

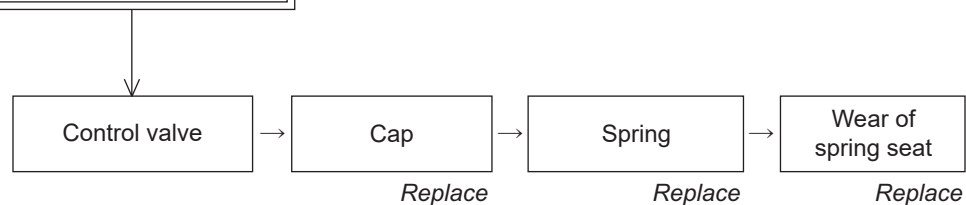


Unintended rise of boom or
unintended extension of arm
while digging

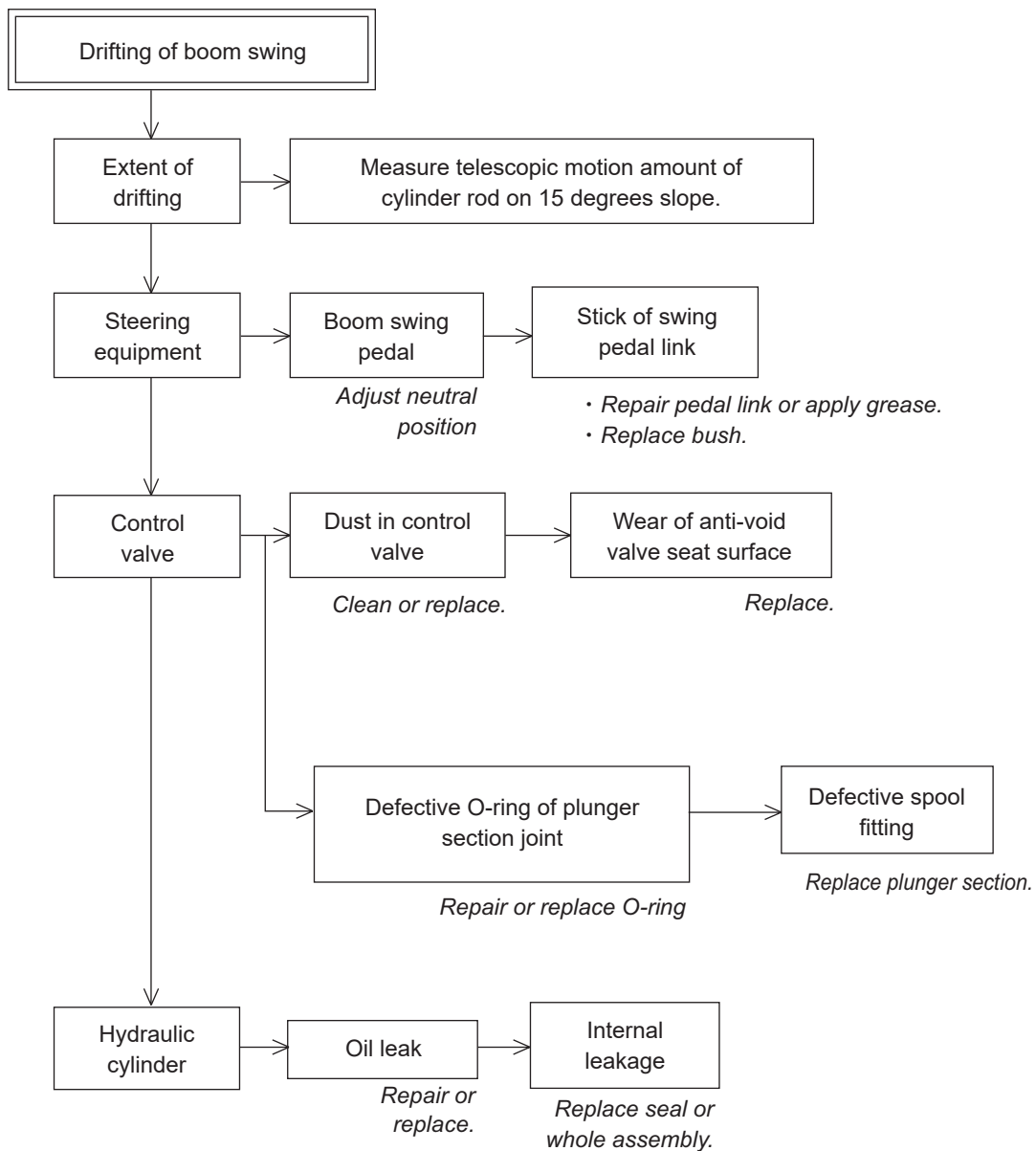


Control lever cannot be
held at neutral position

[Travel, Blade and Boom swing Cylinders]



8. TROUBLESHOOTING

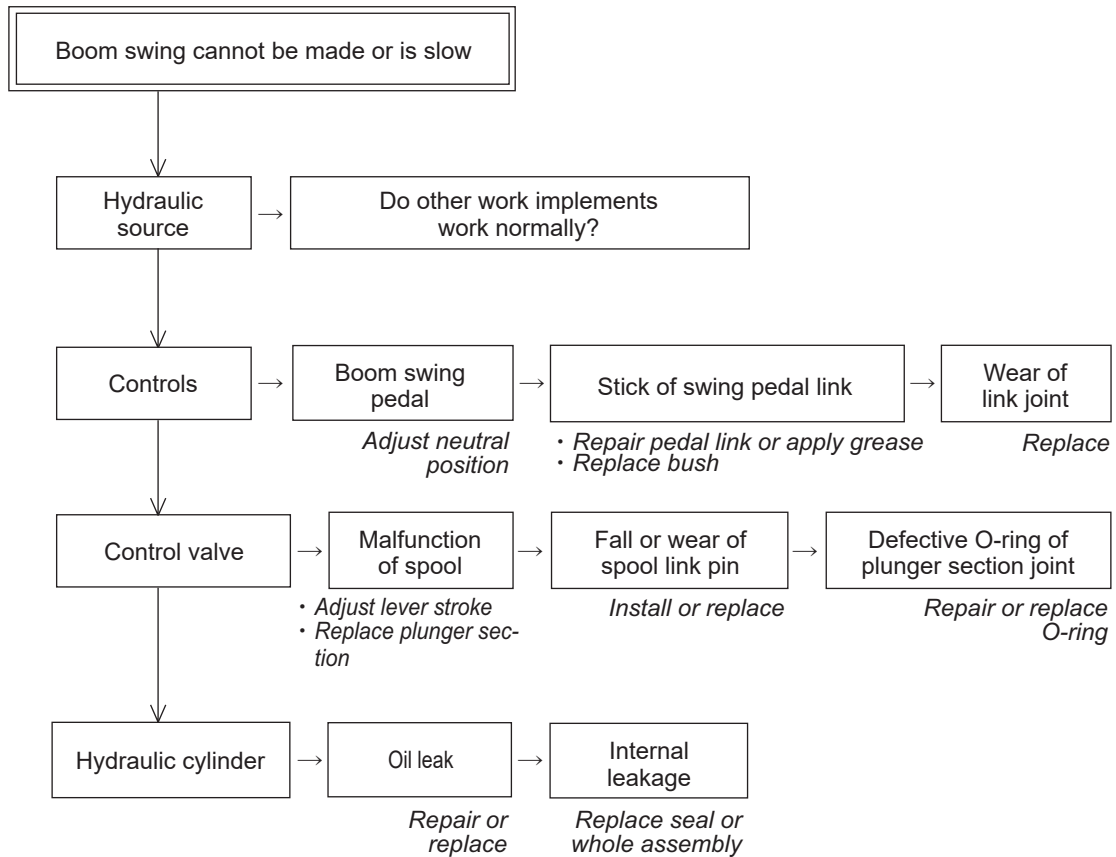


Inspection procedure

Switch the hose with the hose of the other circuit using the control valve.

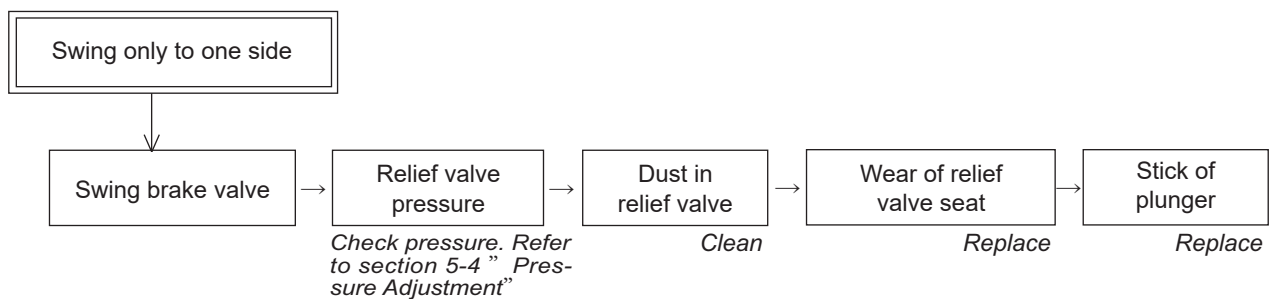
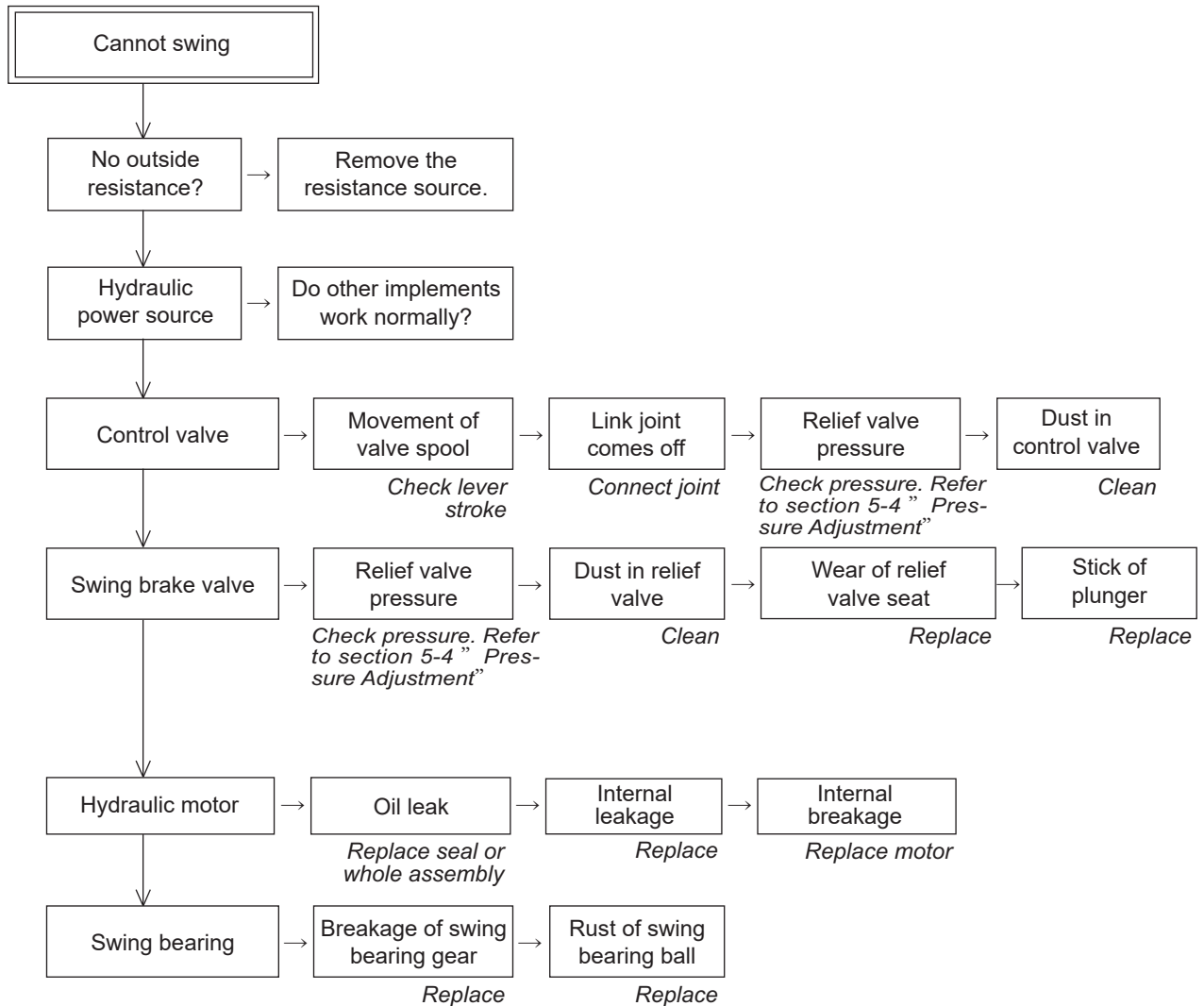
- a) No descent : Control valve is faulty.
- b) Descent : Cylinder is faulty.

8. TROUBLESHOOTING

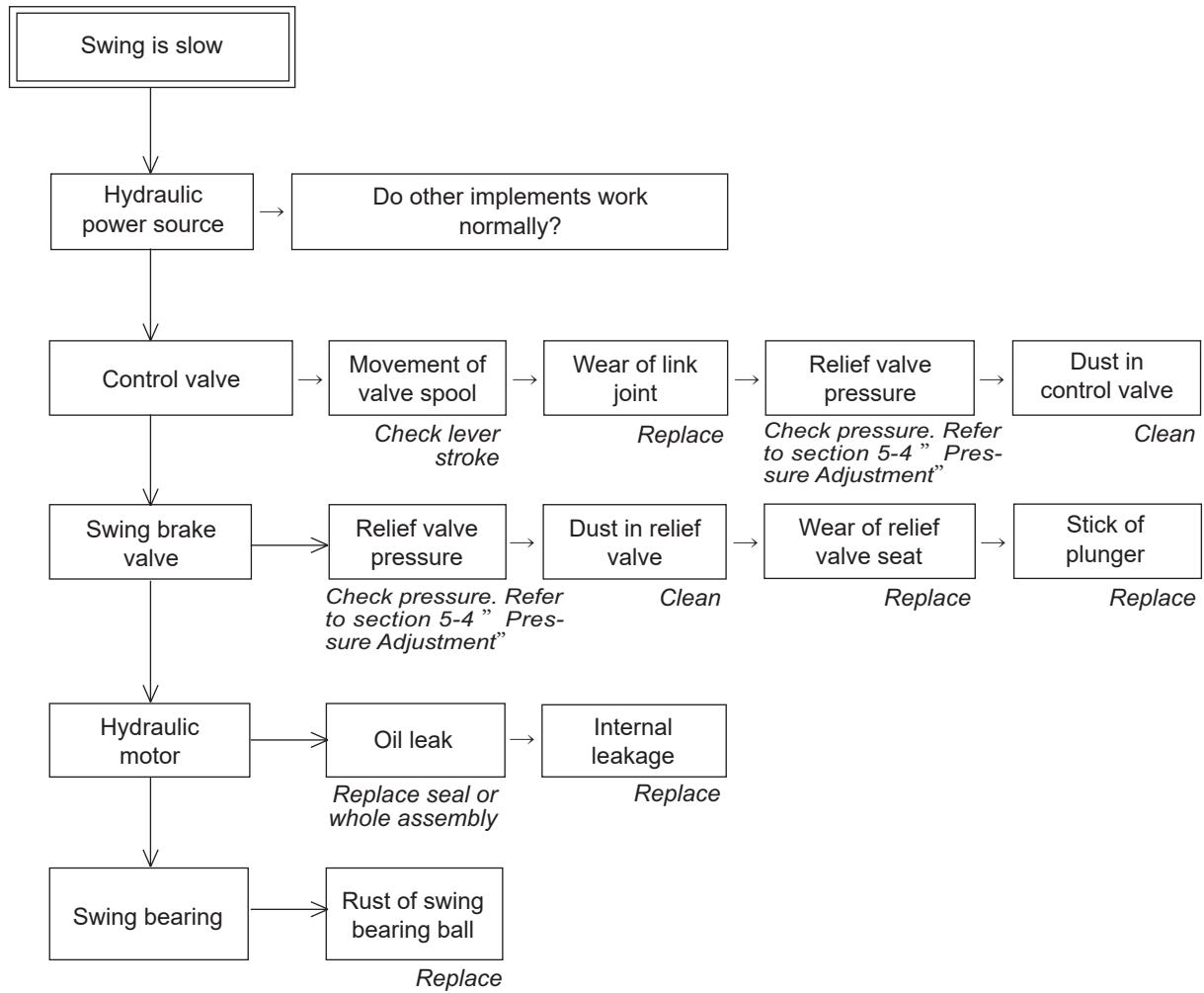


8. TROUBLESHOOTING

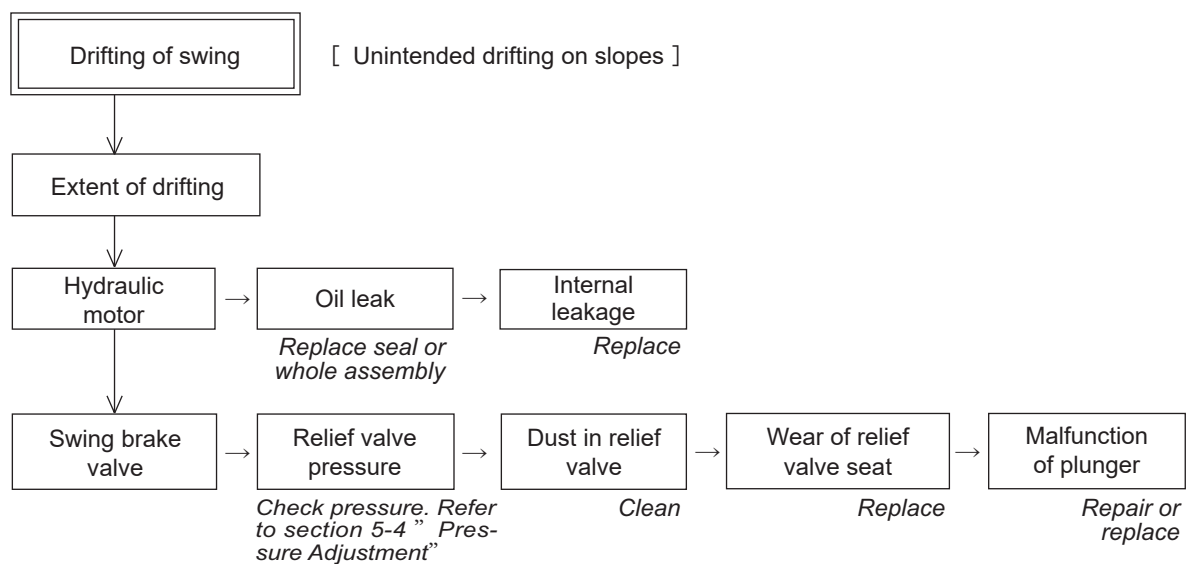
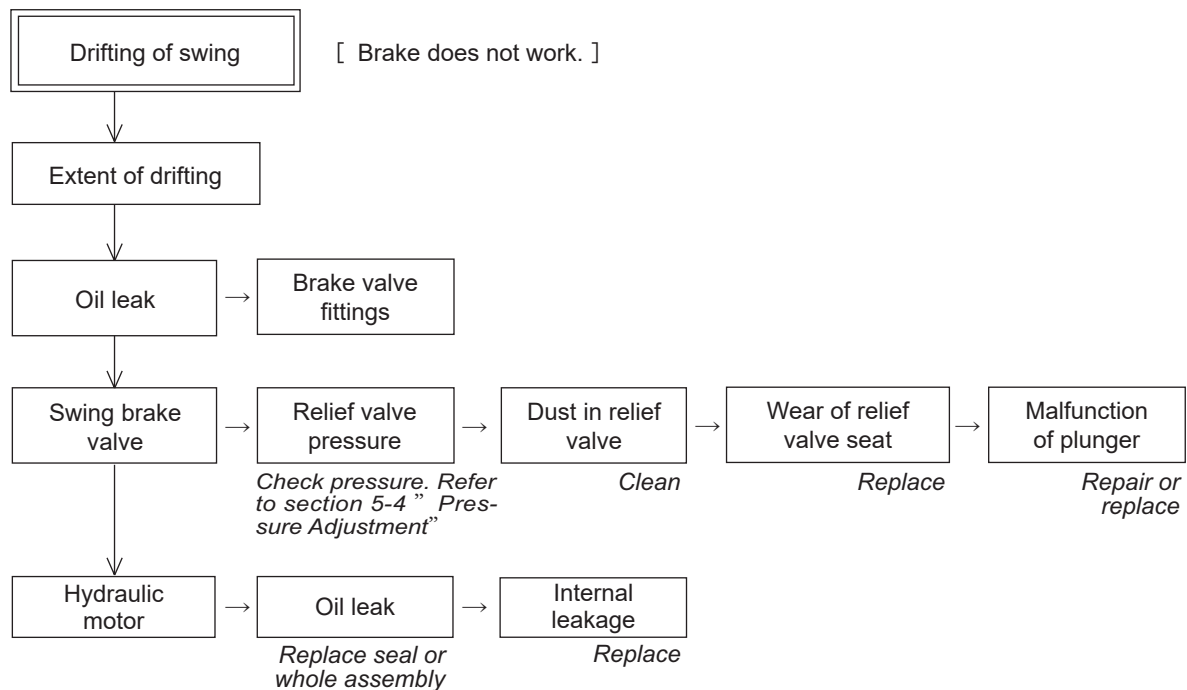
Swing Mechanism



8. TROUBLESHOOTING



8. TROUBLESHOOTING



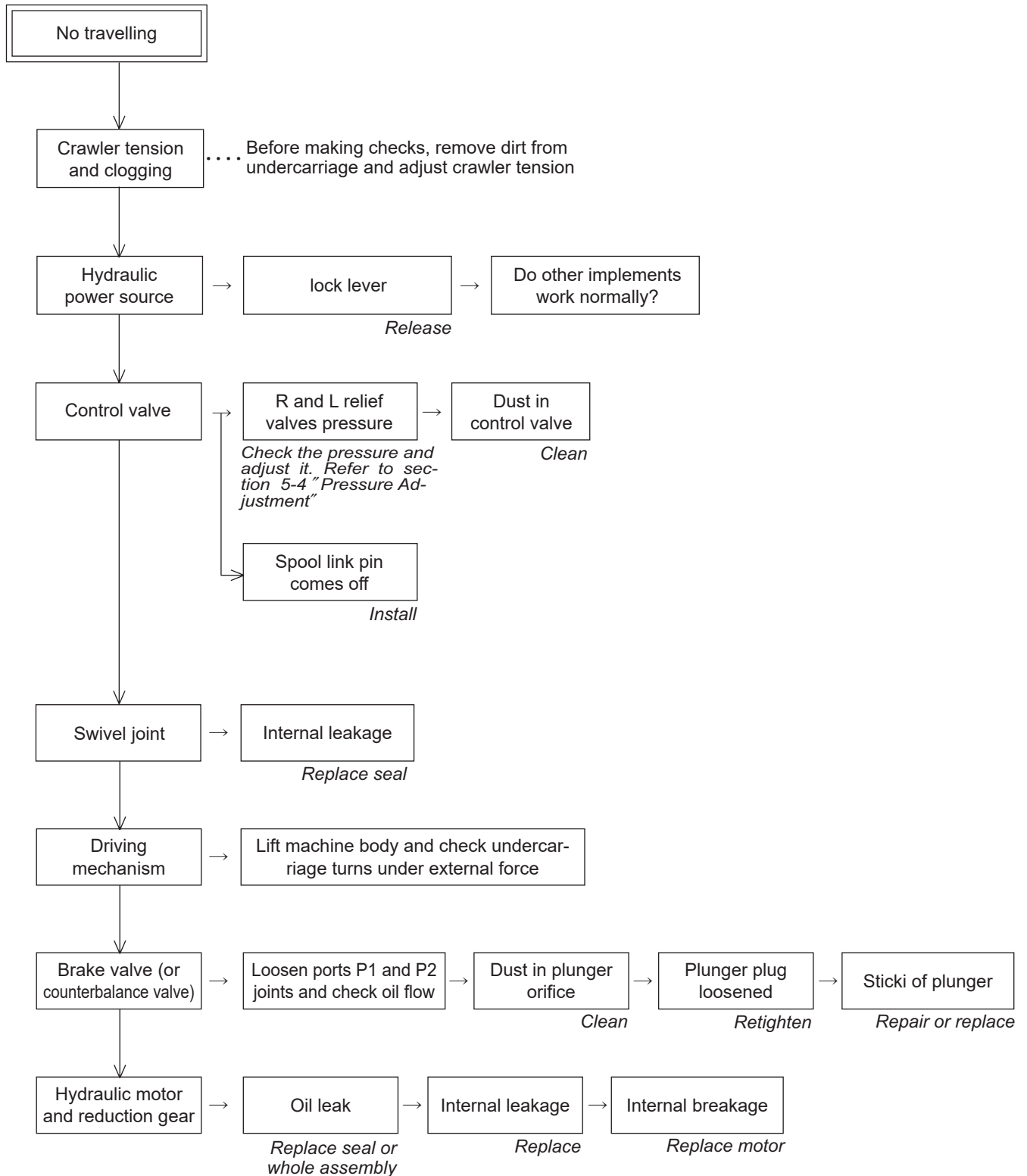
Inspection Procedure

Check the drifting pattern when the machine is placed on a slope with 15 degrees in slope angle. Phenomena :

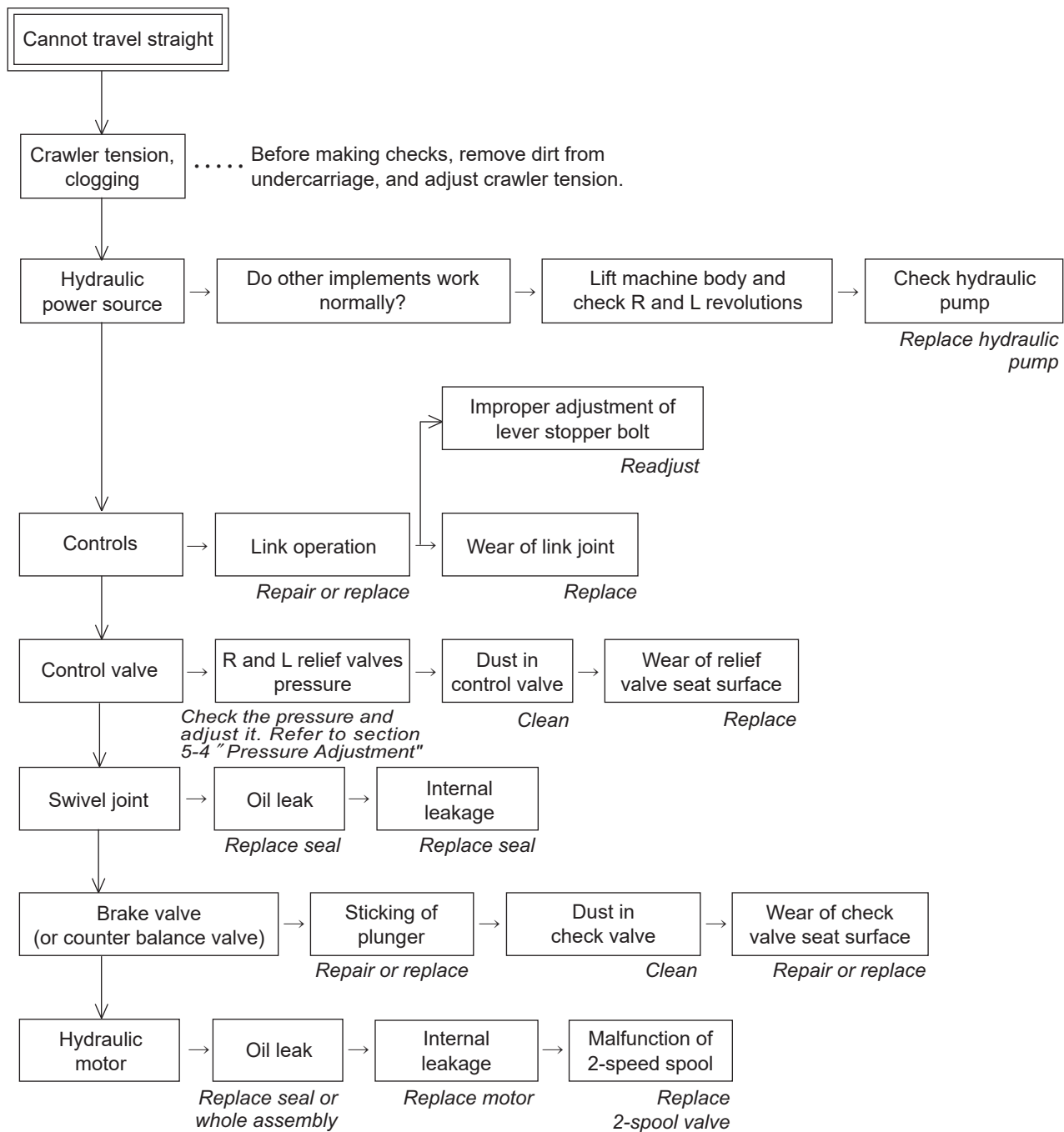
- (1) Continuous drifting : The swing brake valve is faulty.
- (2) Discontinuous drifting : The hydraulic motor is faulty.

8. TROUBLESHOOTING

Travel Equipment



8. TROUBLESHOOTING



8. TROUBLESHOOTING

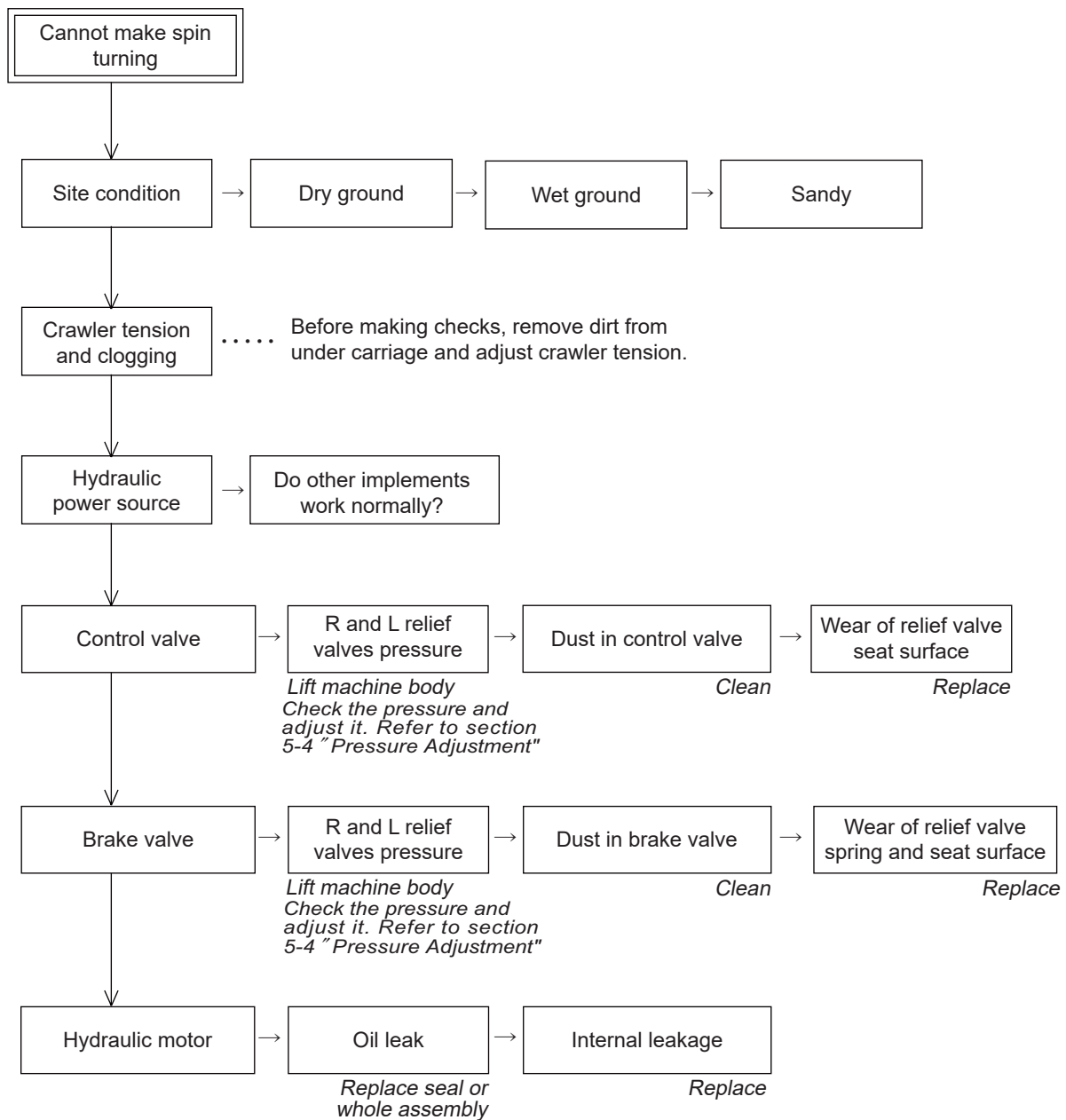
Inspection procedures

1. When the hydraulic tester is not used :
 - (1) Reverse the hoses of the hydraulic pumps P1 and P2.
Phenomenon : ReversedReplace the hydraulic pump.
 - (2) Reverse the hoses between the control valve and the swivel joint.
Phenomenon : ReversedOverhaul or replace the control valve.
 - (3) Reverse the hoses between the swivel joint and the brake valve (or counter balance valve).
Phenomenon : ReversedOverhaul or replace the swivel joint.
 - (4) Reverse the left and right hydraulic motors.
Phenomenon : ReversedReplace 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.)

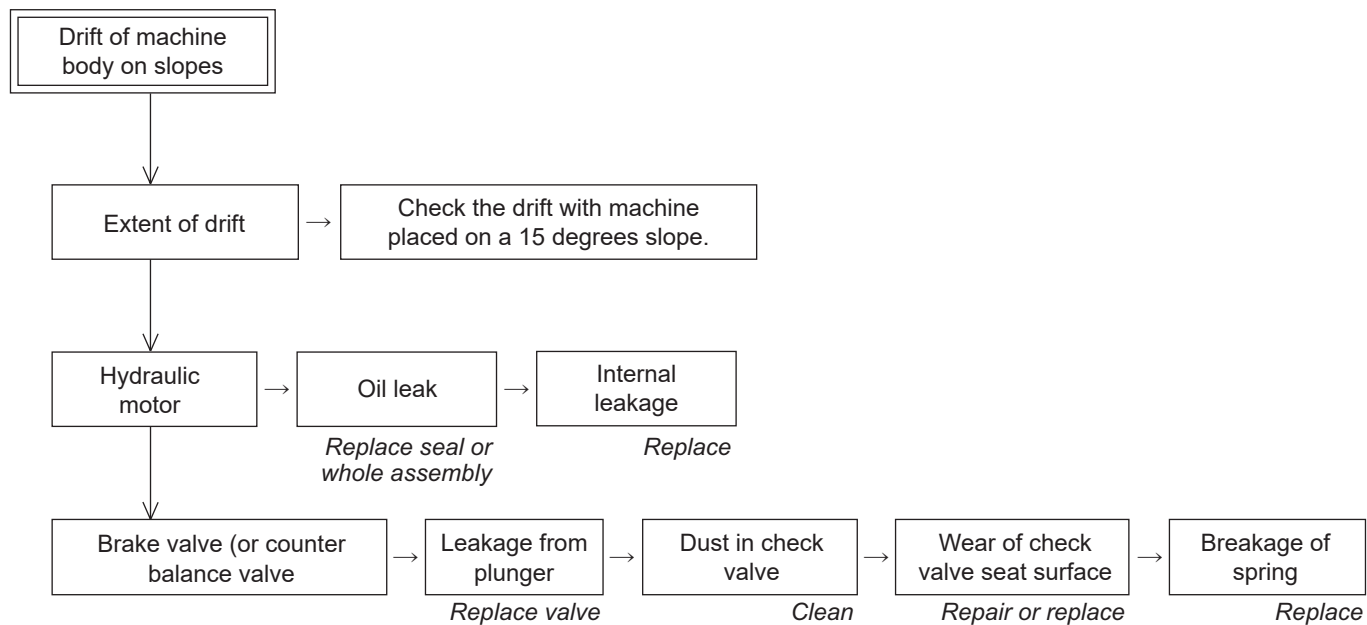
Conditions :

- (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.

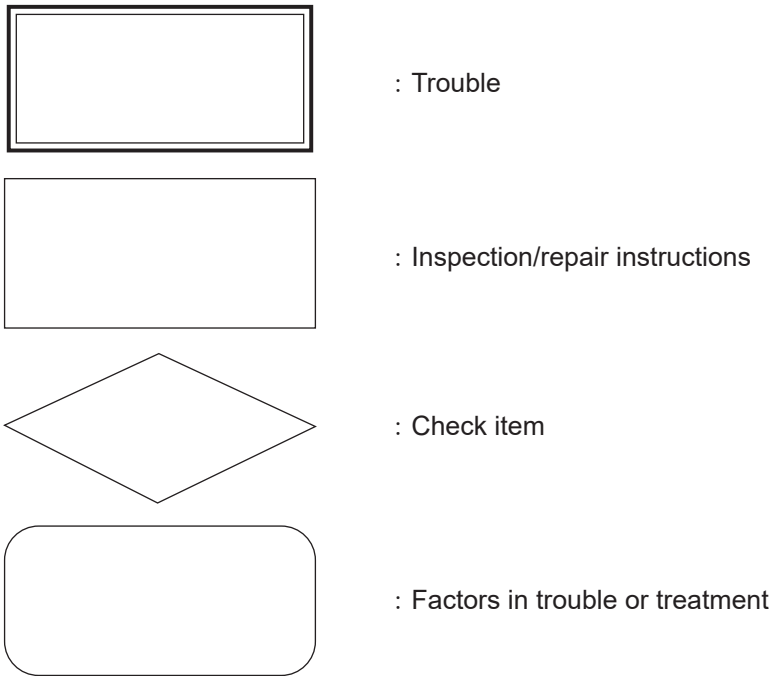
[1] Continuous drift : Brake valve (or counter balance valve) is faulty.

[2] Discontinuous drift : Hydraulic motor is faulty.

8. TROUBLESHOOTING

8-2-2 Electrical Equipment on Panel

(1) How to read the chart

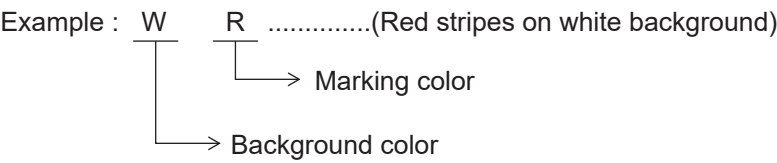


(2) Refer to the wiring diagram for the number of the connector terminal and lead wire color.

(3) Color marks of leads

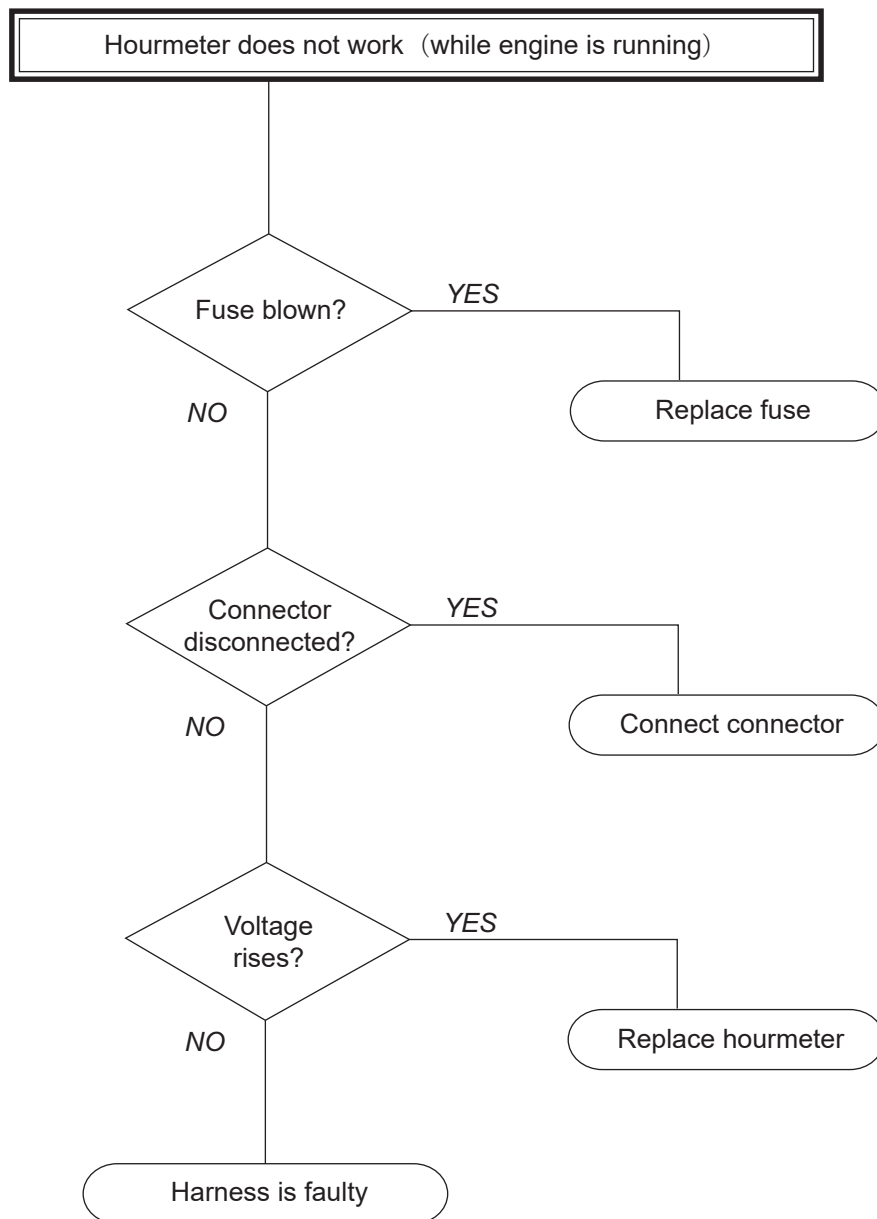
W (White)	B (Black)	R (Red)	Y (Yellow)
G (Green)	L (Blue)	Br (Brown)	Lg (Light green)
O (Orange)	Gr (Grey)		

Combination of colors



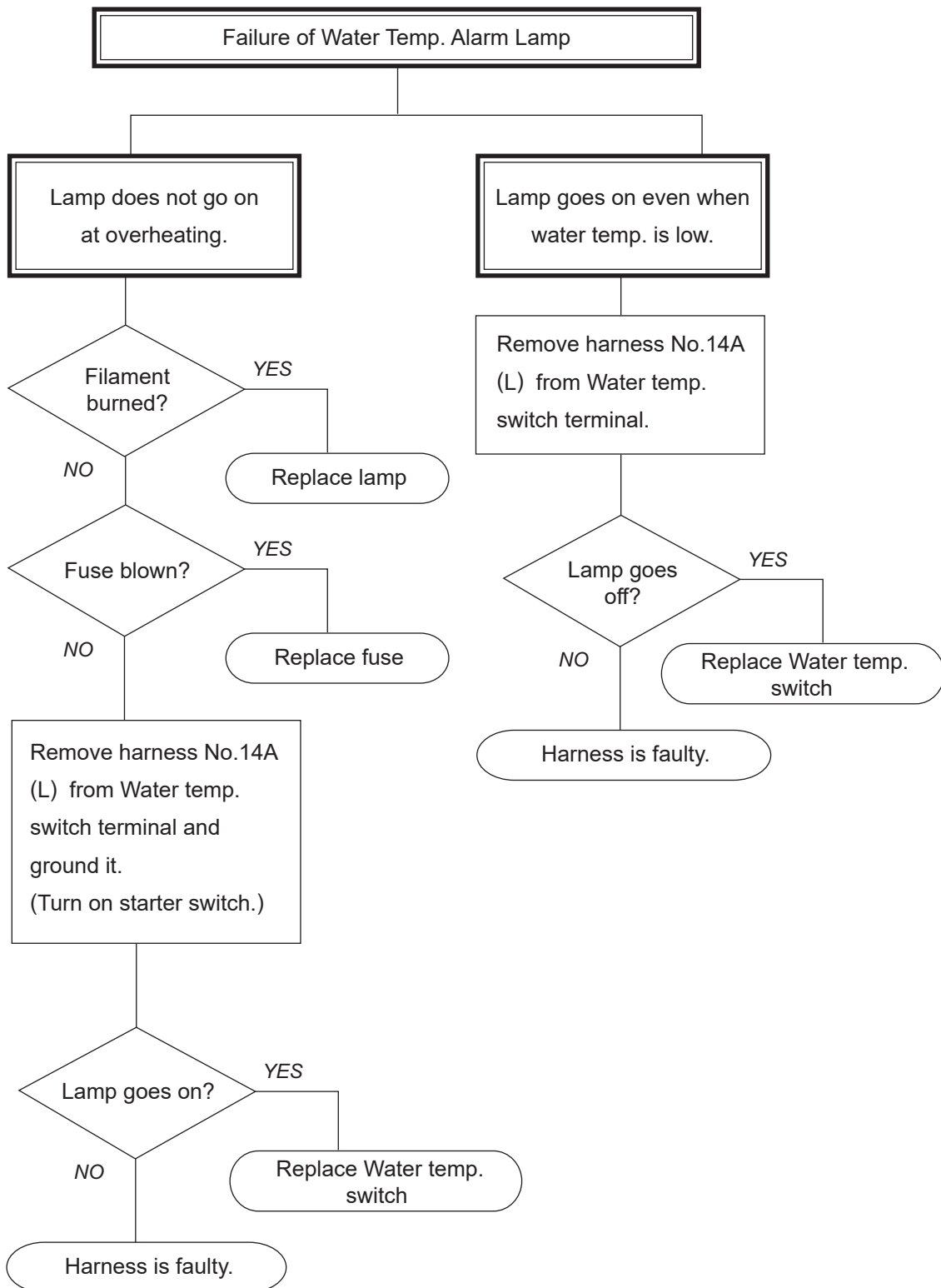
8. TROUBLESHOOTING

Hourmeter



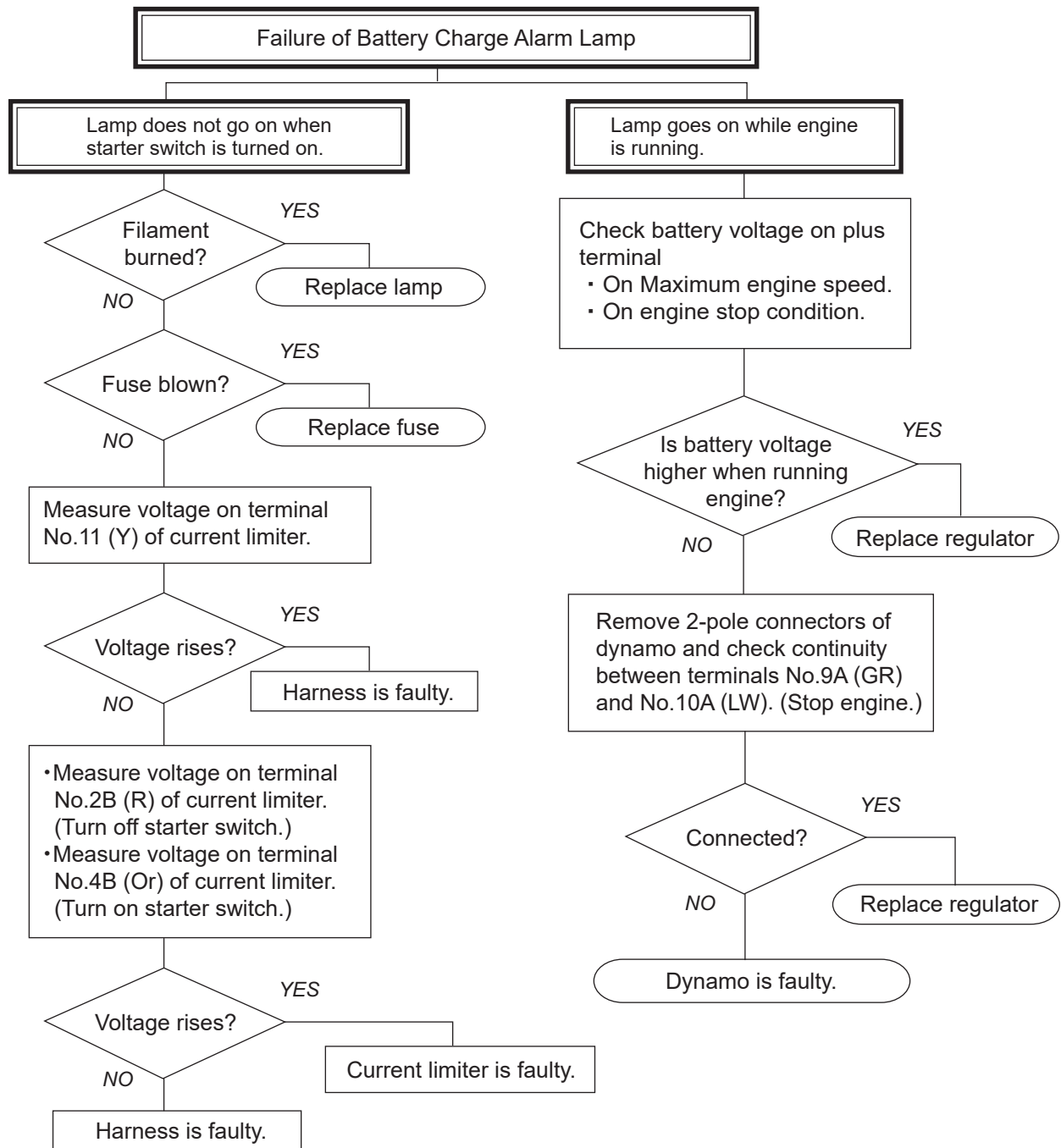
8. TROUBLESHOOTING

Water Temp. Alarm Lamp



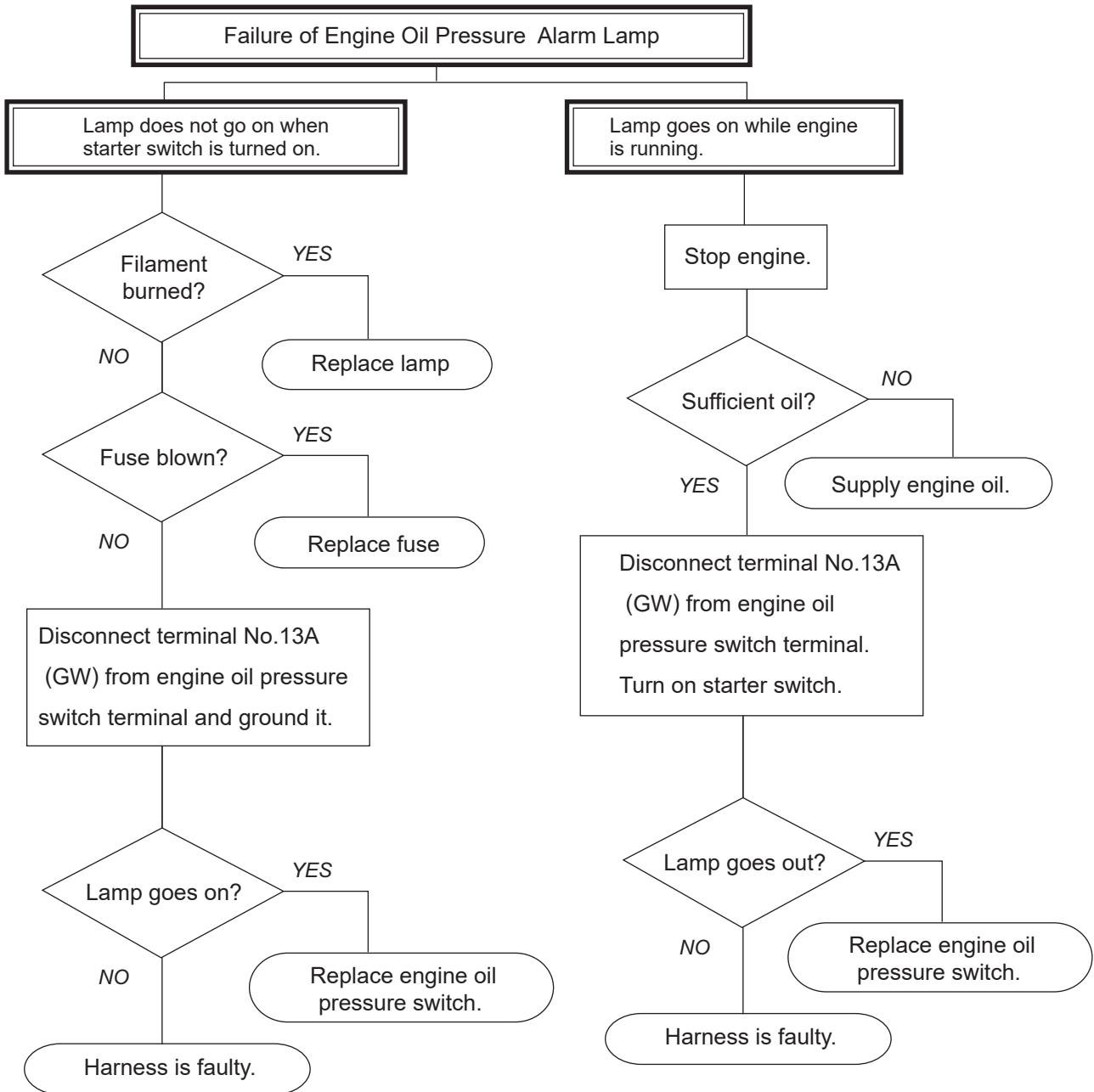
8. TROUBLESHOOTING

Battery Charge Alarm Lamp



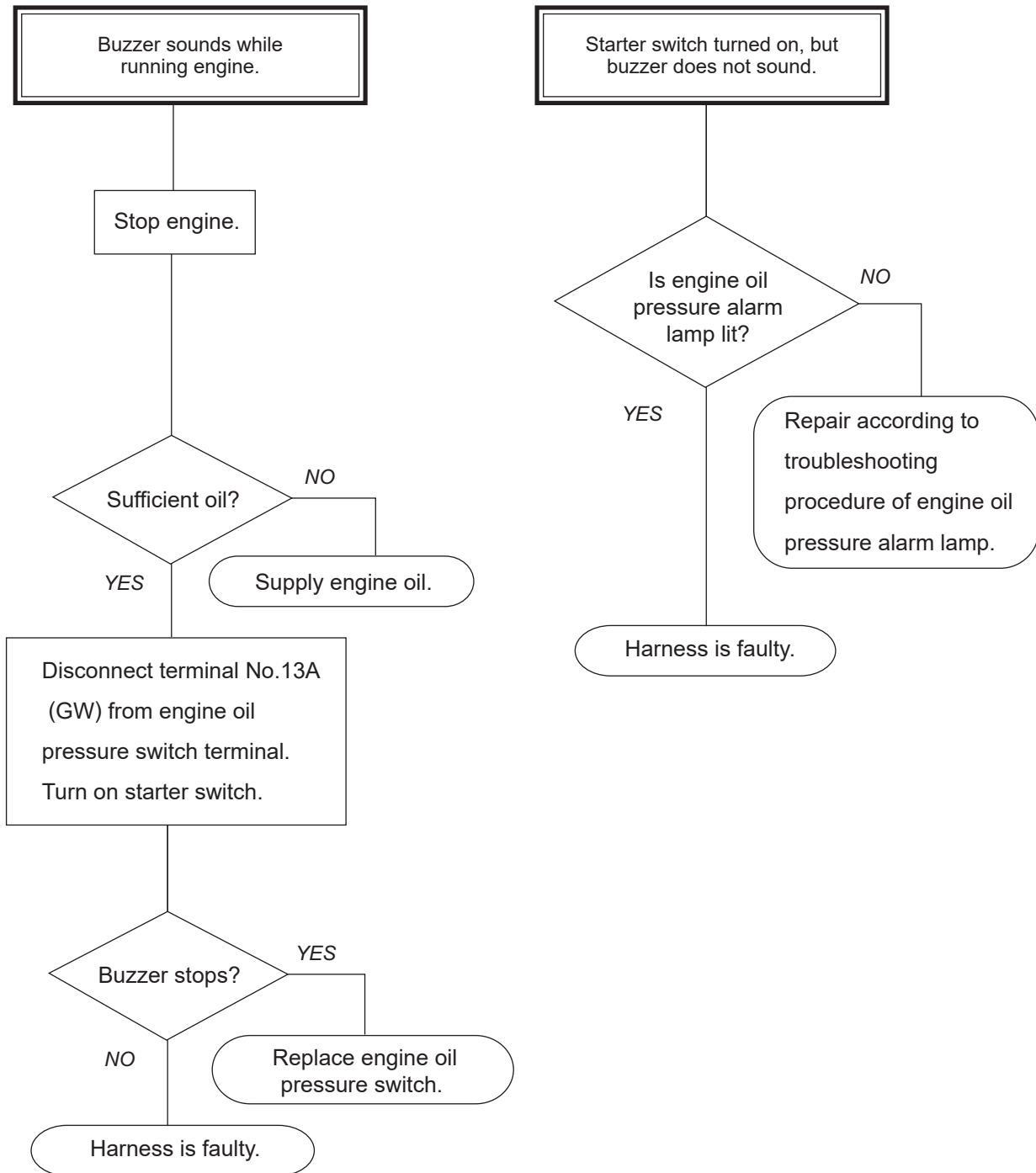
8. TROUBLESHOOTING

Engine Oil Pressure Alarm Lamp



8. TROUBLESHOOTING

Warning Buzzer



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