WSM

WORKSHOP MANUAL
KUBOTA EXCAVATOR

K008-3
U10-3

Kubota

Code No.97899-60730

Record of Revisions

Symbol	Date	Main Revised Points & Corrective Measures	Person-in-charge
△1			
△2			
△3			
△4			

CONTENTS

I. General

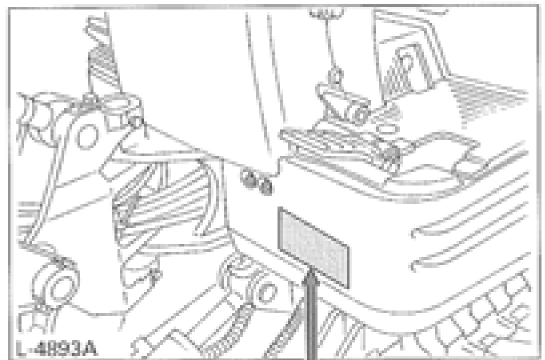
A.Body and engine identification marks

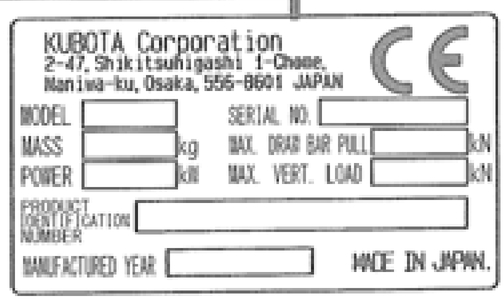
K008-3, U10-3 EU-Version

Your KUBOTA dealer is always ready to help so that your excavator offers the best performance. After having carefully read this manual, you will realize that much of the routine maintenance can be done by yourself. Your KUBOTA dealer is responsible for servicing and the derivery of sopare parts. When orderring spare parts from your KUBOTA dealer, always mention the serial number of the excavator and the engine.
Note these numbers right away in the supplied lines.

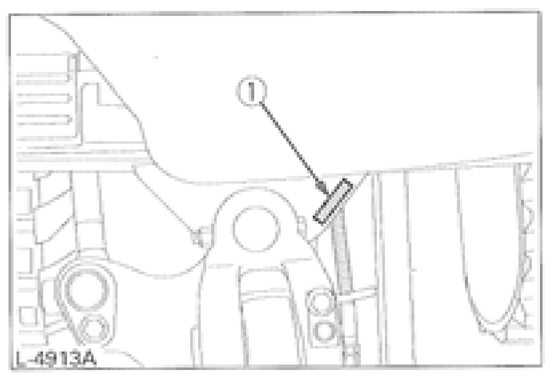
	Excavator	Excavator
Excavator	______________	______________
Engine	______________	______________

Dealer's name
(To be filled in through the owner)

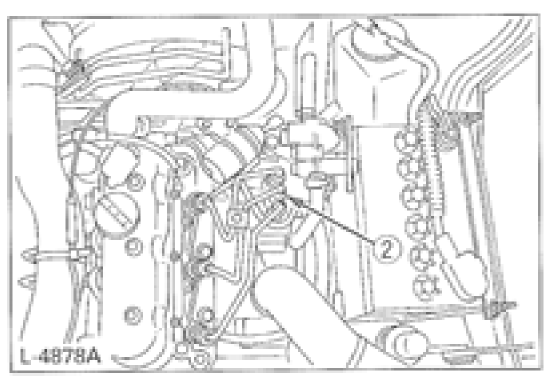



KUBOTA Corporation
2-47, Shikitsuhigashi 1-Chome,
Naniwa-ku, Osaka, 556-8601 JAPAN
CE
MODEL
SERIAL NO.
MASS kg
MAX. DRAW BAR PULL kN
POWER kW
MAX. VERT. LOAD kN
PRODUCT IDENTIFICATION NUMBER
MANUFACTURED YEAR
MADE IN JAPAN.

L-4865



(1) Serial No.



(2) Engine serial No.

K008-3 KTC, KCL, KTA-Version

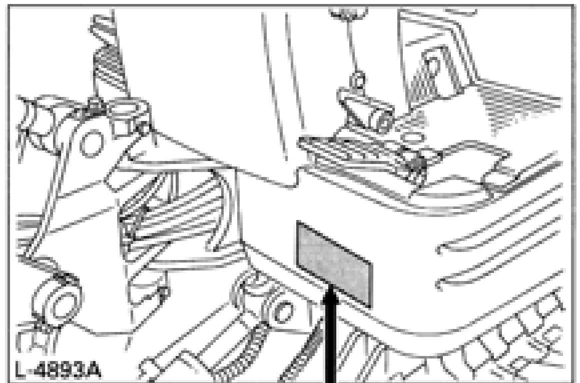
The model name, machine number and engine number of this product are described in their respective positions, as shown below. Note that their positions may be different depending on the specifications. Chech the specification of the product.

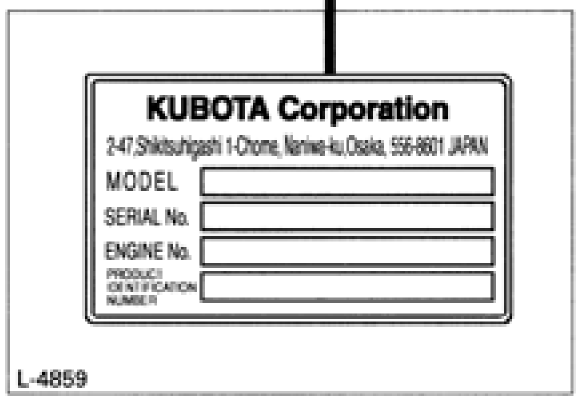
	Excavator	Excavator
Excavator	______________	______________
Engine	______________	______________

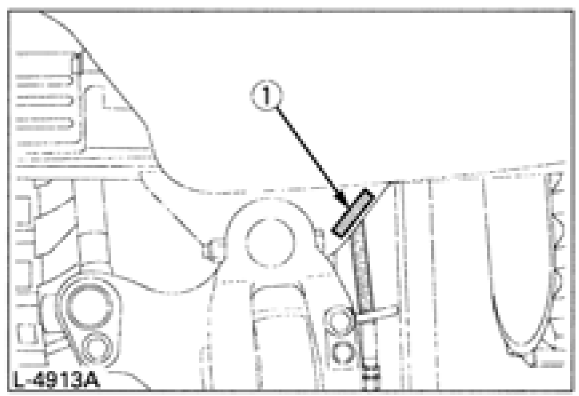
Date of Purchase ____________________________

Name of Dealer ____________________________

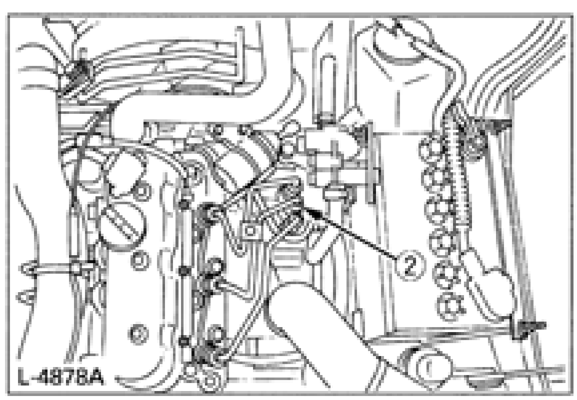
(To be filled in by purchaser)







(1) Serial No.



(2) Engine serial No.

B.Safty precautions for servicing, disassembly and reassembly

Safty precautions for servicing

Most accidents during servicing arise from carelessness. Please remember that safty involves both the welfare of the employees and improved work efficiency.

Safty precautions for Disassembly and reassembly

Machines must be diassembled and assembled efficiently and safely.
It is very important to thoroughly understand the construction and function of the machine, to make all appropriate preparations, and start operations according to the specified working procedures.

a. Safty measures before starting work

(1) Work clothes

1. Wear specified work cap and clothed. (Under no circumstances may workers wear undershirts only.)
   Cuffs must be kept buttoned, and any tears must be mended.)
2. Wear safety shoes.
3. Do not wear cotton gloves when working on the internal section of engine, reduction gears or hydrauricunits for repair or others, or when using a hammer. Wear leather gloves, however, when hoisting wires.

(2) Inspecting equipment and tools

1. Prepare equipment (cranes, fork lifts, tool, etc.) required for servicing and inspect for any problems before starting work.
2. Hammer heads (metal parts) must be firmly secured to their handles.
3. Check hosting tools (wire ropes, hoisting chains, etc.) before use.

(3) Keep workshop in order

1. Secure appropriate space needed for disassembly to the job.
2. Secure a clean, safe place for arranging disassembled parts.
3. Store volatile substances (gasoline, light oil, thinner, oily articles, etc.) in appropriate containers at selected locations to prevent fire hazards.

b. Safty measures during work

(1) Protectors

1. Wear goggles when using chisels for chipping.
2. Use appropriate protectors during welding.
3. Wear a helmet when working with a crane or at elevated locations.

(2) Team work

1. When working with two or more people, divide the work and maintain close communication.
2. Clane work must be carried out using predetermined signals.

(3) Disassembly and assembly

1. Do not wear gloves when using hammers.
2. Use rods of the specified soft material for removing pins. Do not use a hammer as a pad.
3. Do not place fingers in holes when centering.
4. Heavy parts must be adequately supported before removingbolts.

(4) Cranes

1. In principle, use a crane for objects heavier than 44lb (20kg).
2. Crane operation and hoisting must be performed only by qualified personal.
3. Pay careful attention to the center of gravity when hoisting, and do not stand under the lifted objects.

(5) Others

1. To work under a jacked-up carrier, be sure to place wood pieces under it.
2. When charging batteris, make sure there are no open flames in the immediate vicinity.
3. All electric tools must be grounded.
4. Before welding the machine, remove the battery.
   - When removing the battery, be sure to disconnect negative (-) cord first.
   - When mounting the battery, be sure tp connect the positive (+) cord first.

c. Preparation for disassembly

(1) Cleaning

Remove mud and dirt from the body before disassembly.

(2) Acceptance inspection

The machine must be checked before it is disassembled to record existing conditions, such as those listed below.

Model, serial number, and hourmeter reading

- Reason for repair and repair history
- Element stains
- Fuel and oil condition
- Parts damage *(Take photographs if nessesary.)

(3) Equipment and tools

prepare equipment, tools, cranes and parts storage racks as required.

d. Precautions for disassembly and reassembly

(1) Disassembly

1. Follow the specified disassembly procedures.
2. Make alignment marks to insure correct reassembly.
3. Arrange disassembled parts in an orderly way, and attach identification tags or put marks if needed.

(2) Reassembly

1. Clean all parts before assembly. Repair any scratches or dents. Take special precautions against dirt and dust.
2. Parts with rust-preventive coatings must be assembles only after removing the corting.
3. Separated parts must be correctly reassembled using alignment marks.
4. As a rule, use a press to reassembled bearings, bushing and oil seals. Use pads when using a hammer.

C.IMPORTANT SAFTY PROCESS AND CRITICAL FUNCTIONAL PROCESS

The following instructions are related to essential adhesives, important safety process $\boxed{S}$ and critical functional process $\boxed{A}$ .Pay special attention in servicing these process. (Pay also close attention in reconnecting the electrical cables.)

a. Essential Adhesives

Type of screw adhesive

- Unless otherwise specified, use Three-Bond 1324 adhesive (medium-duty type).
  Keep the screw threads free of oil and water.

Type of instantaneous adhesive

- Use Three-Bond 1733 or Three-Bond 1741E adhesive.
  Keep the bond areas free of oil and water.

b. Important Safety Process $\boxed{S}$.

1. Reconnecting the fuel hose (clearance, hose routes, clamps, etc.)
2. Electrical cabling (engine, instrument panal, controls, etc.) (wiring routes, clamps and couplers)

c. Important Critical Functional Process $\boxed{A}$.

1. Setting up the travel wheel motor (tightening torque)
2. Reassembling the rotary joints (joint direction and shaft set-up)
3. Installing the swivel base bearing and the swivel motor (tightening torque)
4. Fitting the pump couplings (tightening torque)
5. Installing the counter weight.

D.IMPORTANT INSPECTION ITEMS AFTER REASSEMBLING

a Operate the Machine and check for Unusual Noise and Vibrations.

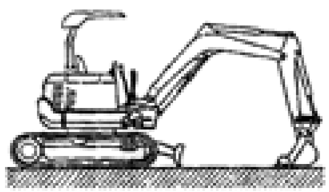
b Make Sure the Safety decals and Wireharness Clamps are in their Specified Positions.

c With the Machine Front in a Specified Posture, Check the Amount of Hydrauric Oil

Checking the oil level (For further datails, refer to the Operator’s Manual of each model.)

1) Park the machine on a level ground.
2) Make sure the hydrauric oil temperature is in the range of 10-30°C (50-86°F) and see if the oil level is within the specified zone of the oil level gauge.
3) Keep the machine front as shown as following posture.

Posture: Extend the rods of the arm and bucket cylinders nealy half. Place the bucket on the ground, the offset swing at the center, and the dozer also on the ground.

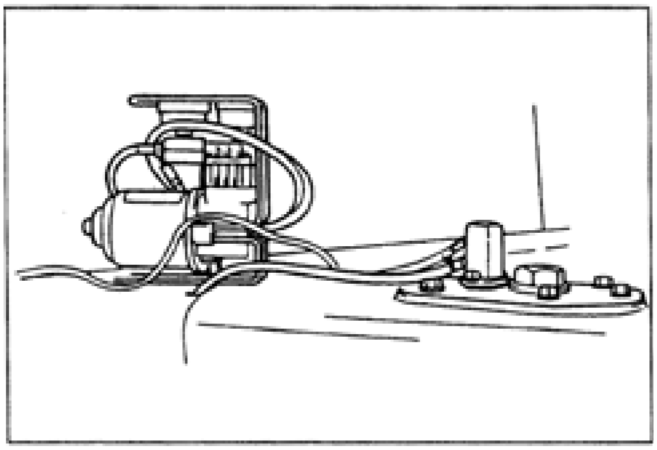


E.SERVICING FUNDAMENTALS

a.Items for Servicing

Locking adhesive

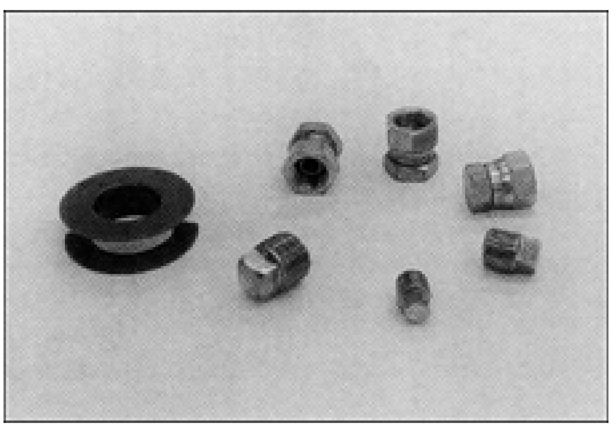
1) Tighten bolts, nuts, adapters,and similar parts to their specified torques which are given in the list of tightening torques and adhesive as well as in this manual. Be sure to observe the specified torques for important tightened parts and components.
2) Wipe out water, oil and grease off the screws on which loctite adhesive is to be applied. Be sure to apply the adhesive to specified locations.



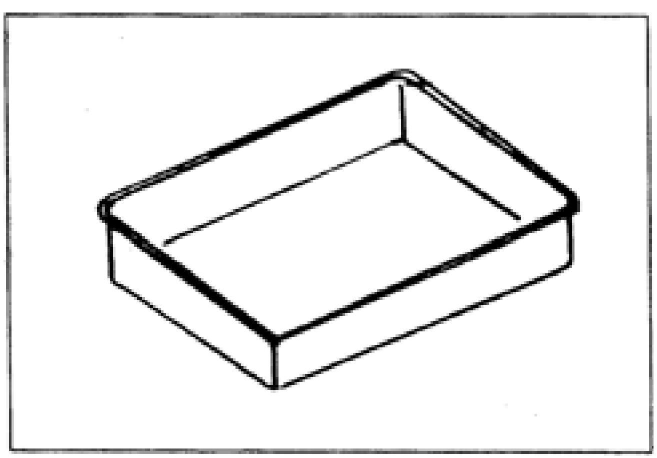
Types of screw adhesive
Equivalent to LOCTITE 271 (Heavy-duty) Equivalent to THREE-BOND 1305P (Heavy-duty) Equivalent to THREE-BOND TB1401B (Light-duty) Unless specified otherwise, use THREE-BOND 1324 (Medium-duty).

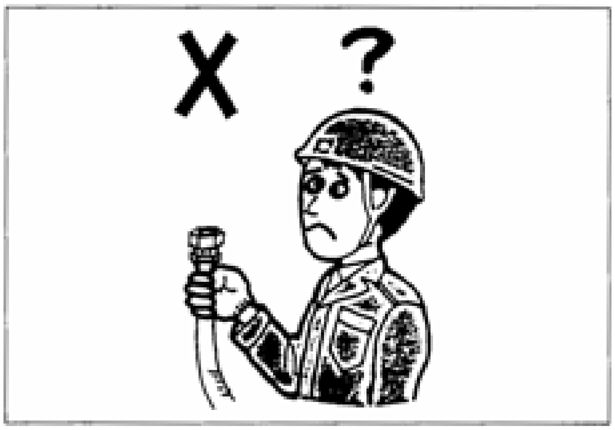
Type of instantaneous adhesive
Use THREE-BOND 1733 or 1741E

The word “LOCTITE“ in this manual denotes the red-color type.

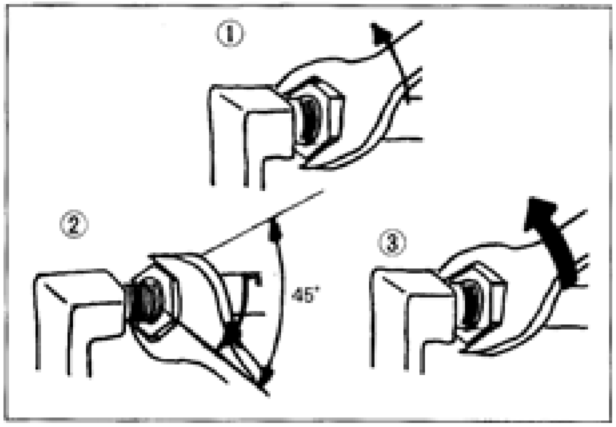


3) Precautions in disassembling the hydraulic equipment
   - Use a vacuum pump, pulgs, oil pans, waste cloth and the like to prevent oil from running out or splashing.
   - Wipe out leaking oil completely first and then add oil as required.
   - Protect the openings with plugs, covers or the like to keep off foreign matters. Most of hydraulic system troubles are caused by the entry of foreign matters.
   - Before reassembling, clean up the parts and components and apply hydraulic oil on them.
   - The system consists of precision parts. Be careful not to scratch them and apply excessive force on them.

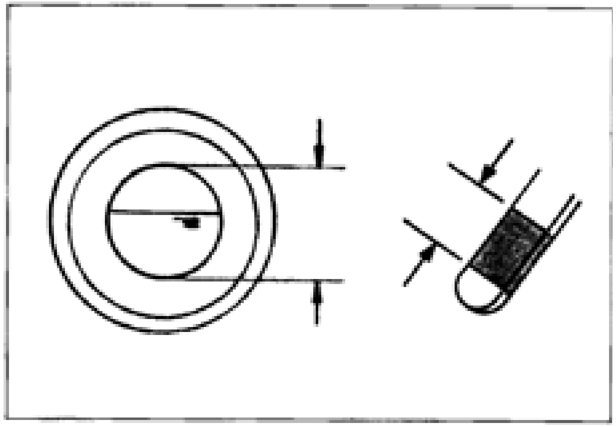




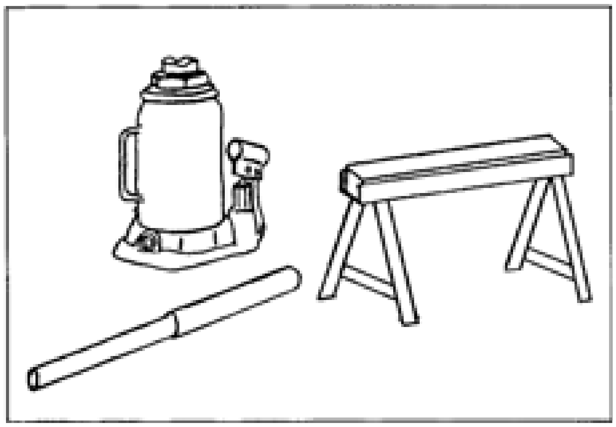
4) Precautions in tightening hoses and pipes.
   - Flexible hoses have a slight natural bend of their own. Utilize the natural bend. Be also careful not to twist them.
   - Be careful not to confuse the routes of the hoses.
   - Do not hold the hoses in tight contact with their adjacent parts and surfaces.



   - Tightening steps
     ① First tighten the nut to its specified torque.
     ② Then loosen the nut by about 45° to fit the seat of the joint to the connection.

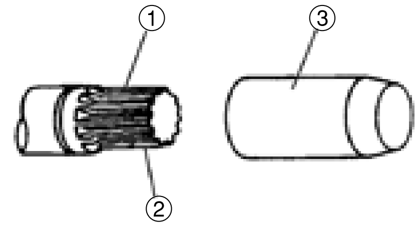


5) The quantities of oil, fuel, water and others, except for the oil to be filled in the track rollers and idlers, are listed just as reference. Fill up the fluid up to the specified center level of a level gauge if it is provided.

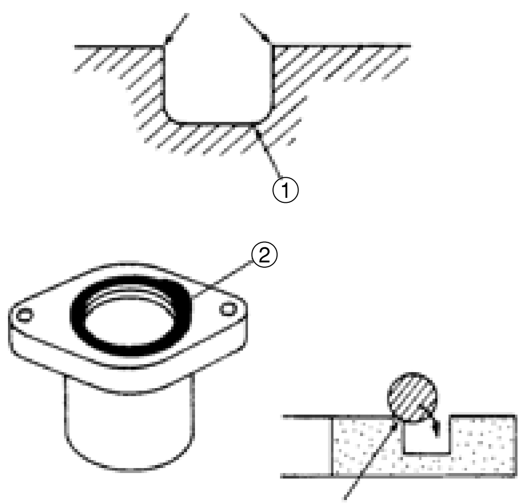


6) Security support the machine with a jack and a supporting jig when it is jacked up for servicing.
7) Be sure to use a crane in disassembling and reassembling heavy parts and components (frame, front attachment, crawler, etc.).

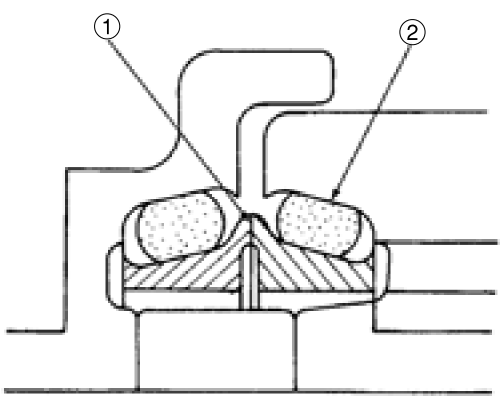
b.O-ring, Oil seal, Circlip and Roll Pin



①O-ring
②Spline
③Guide



①O-ring groove
②O-ring



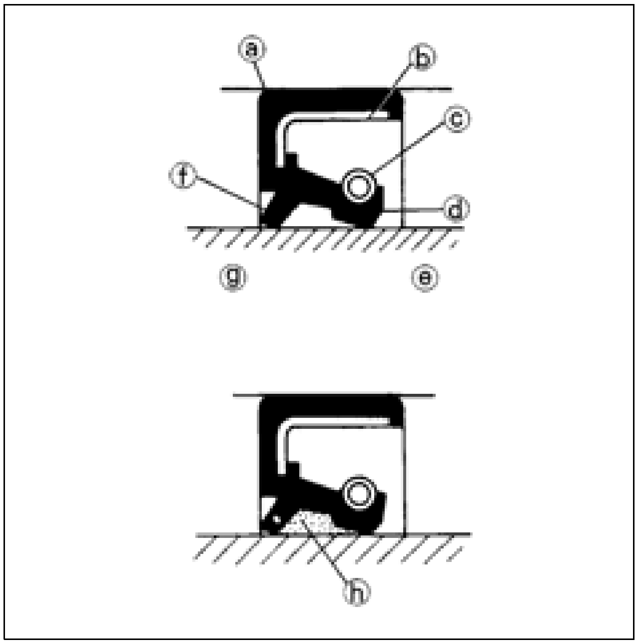
①Sliding surface
②O-ring

(1) General precautions
- Make sure the O-ring and the oil seal are free of anything unusual (uneven surface, scratches, chipping, etc.).
- Check the O-ring groove for burrs. Correct, if any, using an oil stone or the like.
- When putting a part past a sharp edge into position, protect such edge with a cover or get the part chamfered.

(2) O-ring
- Clean up the O-ring groove and deburr its edge as required.
- Before installing the ring, be sure to apply lubricant (grease) over it. (Do not do this to the floating seal.)
- Fit the O-ring into its groove without twist. With your fingertip, push the ring gently and evenly into the final position. Otherwise the ring would easily get twisted in contact with the inner edge of the groove.

(3) Floating seal
- Be sure to wipe oil off the O-ring and the O-ring contact surface. (Note, however, that oil must be applied thinly over those of the wheel motor.)
- In fitting the O-ring into the floating seal, be careful not to twist the O-ring.
- Before installing the floating seal together with the O-ring, apply sealing oil thinly over the sliding surface. Be careful to keep the sliding surface and O-ring in alignment with the housing.
- Finally turn hte floating seal 2 or 3 times by hand in order to form an oil film over the sliding surface as well as to get the sealing surface well it.

(4) Oil seal

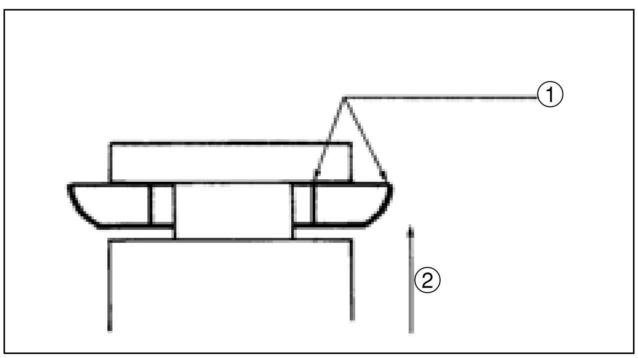


- Do not confuse the orientation of the oil seal lips. Direct the main lip toward the oil chamber; in other word, toward what is to be sealed.

ⓐ	Packing	ⓕ	Dustproof lip
ⓑ	Metal ring	ⓖ	Atmosphere (outside)
ⓒ	Spring	ⓗ	Grease
ⓓ	Main lip		
ⓔ	Oil chamber (inside)		

- If in dry state, the oil seal may wear out when running in the machine. To prevent this, be sure to apply lubricant (grease) over the lip sliding surface. If provided also with a dustproof lip, fill the space between this lip and the main lip with grease.
- As a rule, use a press to press-fit the oil seal. If not available, allpy a suitable tool and tap it evenly without allowing any tilt. Press-fit the oil seal deep down to the bottom of the oil seal fitting boss.

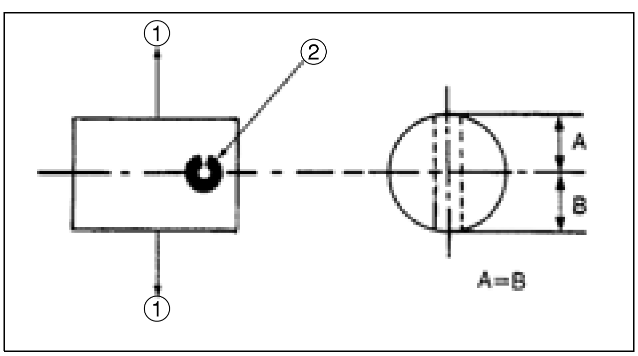
(5) Mounting the circlip



①Edge:Outside
②Force direction

- Place the circlip with its sharp edge facing outward (in the locking direction).
- Fit the circlip securely in the groove. For the hole circlip in particular, install and turn it slightly to make sure it fits well.

(6) Tapping the roll pin (spring pin)



①Revolving
②Spring pin

- Place the roll pin (spring pin) with its opening perpendicular to the load.
- Place the roll pin (spring pin) with its opening in the turning direction.
- Evenly tap the roll pin (spring pin) into position.

c. Piping

(1) General precautions

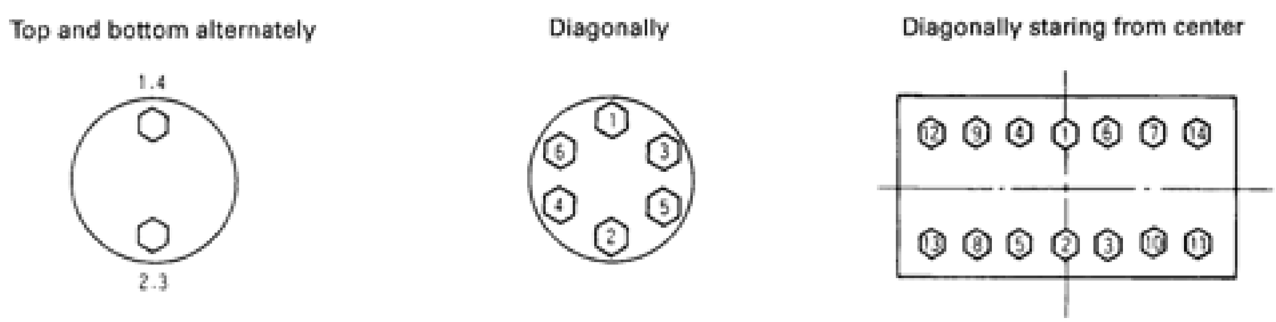
- Tightening the pipe socket to the specified torque. If too tight, the socket itself or a hydraulic component may get damaged. It too loose, an oil leak may result.
- In connecting a new hose or pipe, tighten its nut first to the specified torque and then turn it back (about 45°). Then tighten it again to the specified torque. (Do not this to the sealing tape-applied hose or pipe.)
- When disconnecting a vertical hose or pipe, separate its bottom connection first.
- In desconnecting and reconnecting the hose and pipe, be sure to use two wrenches. With one wrench, restrain the mating part to allow no twist.
- Check the mating connector’s sleeve and the hose’s taper for dust deposits and scratches.
- When the pipe socket has been tightened up, wipe the joint clean. Apply the maximum operating pressure 2 or 3 times to make sure there is no oil leak.

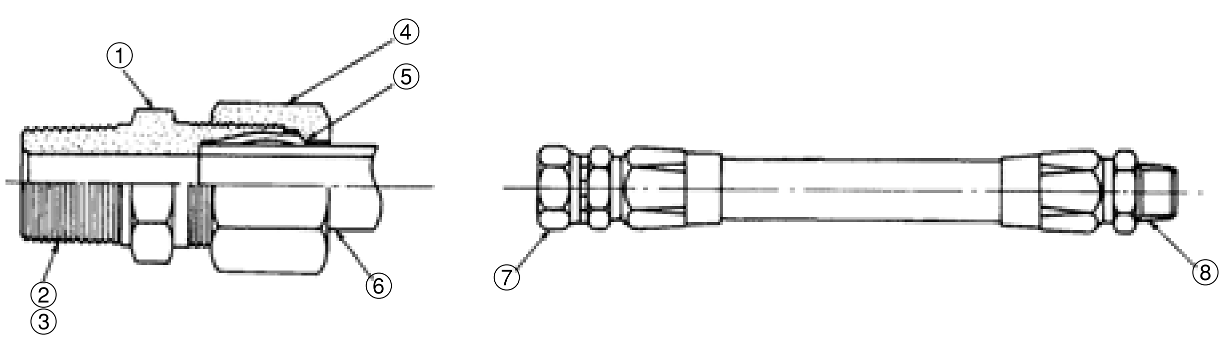
(2) Hydraulic hose

Check the hydraulic hose for too tight a connect or twist.
* Excessivly tight contact
Let’s suppose that a hose is in contact with another hose or other part. If the hose is pulled away by a force of 2 kg but still in contact, it means the contact is too tight.

(3) Precautions in tightening the bolts and nuts

- Use bolts of specified length.
- Do not over tighten the bolts: Its threads may get deformed or the fixed part may get damaged. Do not undertighten the bolt either: It may get loose.
- In other words, tighten the bolt to the specified torqoe.
- Tighten the bolts and nuts diagonally for even tightness.





①Joint body
②R (Tapered thread)
③G (Straight thread)
④Nut
⑤Sleeve
⑥Steel pipe
⑦Union nut
⑧Tapered thread

(4) Hose screw

Thread size (piping screw)	Tightening torque N·m kgf·m ft·lbf		Wrench size (reference)
	Union nut section	Taper thread section	
1/8”	7.8 ~ 11.8 N·m 0.8 ~ 1.2 kgf·m 5.8 ~ 8.7 ft·lbf	14.71 ~ 19.61 N·m 1.5 ~ 20 kgf·m 10.85 ~ 14.47 ft·lbf	17 mm 0.67 in
1/4”	24.5 ~ 29.4 2.5 ~ 3.0 18.1 ~ 21.7	36.3 ~ 44.1 3.7 ~ 4.5 26.8 ~ 32.5	19 mm 0.75 in
3/8”	49.0 ~ 53.9 5.0 ~ 5.5 36.2 ~ 39.8	49.0 ~ 68.6 5.0 ~ 7.0 36.2 ~ 50.6	22 mm 0.87 in
1/2”	58.8 ~ 63.7 6.0 ~ 6.5 43.4 ~ 47.0	83.4 ~ 88.3 8.5 ~ 9.0 61.5 ~ 65.1	27 mm 1.06 in
3/4”	117.7 ~ 127.5 12.0 ~ 13.0 86.8 ~ 94.0	127.5 ~ 147.1 13.0 ~ 15.0 94.0 ~ 108.5	36 mm 1.42 in
1”	137.3 ~ 147.1 14.0 ~ 15.0 101.3 ~ 108.5	147.1 ~ 166.7 15.0 ~ 17.0 108.5 ~ 123.0	41 mm 1.61 in

Metric Size Hose

Thread size (piping screw)	Torque N·m kgf·m ft·lbf
M12 × 1.5	20 ~ 30 2.0 ~ 3.1 14.75 ~ 22.13
M14 × 1.5	20 ~ 30 2.0 ~ 3.1 14.75 ~ 22.13
M16 × 1.5	30 ~ 50 3.1 ~ 5.1 22.13 ~ 36.9
M18 × 1.5	30 ~ 50 3.1 ~ 5.1 22.13 ~ 36.9
M22 × 1.5	40 ~ 60 4.1 ~ 6.1 29.5 ~ 44.25

(5) Joint bodies

Thread size (piping screw)	Tightening torque N·m kgf·m ft·lbf		Spanner size (reference)	Remarks Steel pipe (OD)	
	R (tapered thread)	G (straight thread)			
1/8”	19.6 ~ 29.4 N·m 2.0 ~ 3.0 kgf·m 14.5 ~ 21.7 ft·lbf	-	17 mm 0.67 in	When in steel pipe is in use.	8 mm 0.31 in
1/4”	36.3 ~ 44.1 3.7 ~ 4.5 26.8 ~ 32.5	W/O-ring *Joint Torque* 58.8 ~ 78.5 6 ~ 8 43.4 ~ 57.9	19 mm 0.75 in		12 mm 0.47 in
3/8”	39.2 ~ 49.0 4.0 ~ 5.0 28.9 ~ 36.2	W/O-ring *Joint Torque* 78.5 ~ 98.1 8 ~ 10 57.9 ~ 72.3	23 mm 0.91 in		15 mm 0.59 in
1/2”	49.0 ~ 68.6 5.0 ~ 7.0 36.2 ~ 50.6	W/O-ring *Joint Torque* 117.7 ~ 137.3 12 ~ 14 86.8 ~ 101.3	26 mm 1.02 in		16 mm 0.63 in

(6) Tightening torque table for hose clamp (Screw type)

No.	Dia. (mm)	Code No.	Tightening torque N·m kgf·m ft·lbf
1	Ø12 ~ 16	09318-89016	2.5 ~ 3.4 25 ~ 35 1.84 ~ 2.51
2	Ø19 ~ 25	09318-89024	
3	Ø31 ~ 40	09318-89039	
4	Ø36 ~ 46	09318-89045	
5	Ø15 ~ 25	RC101-64580	4.9 ~ 5.9 50 ~ 60 3.61 ~ 4.35
6	Ø26 ~ 38	68311-72820	
7	Ø13 ~ 20	RB101-63630	3.4 ~ 4.4 35 ~ 45 2.58 ~ 3.31
8	Ø40 ~ 55	RC411-63180	4.9 ~ 5.9 50 ~ 60 3.61 ~ 4.35
9	Ø77 ~ 95	69284-63170	
10	Ø50 ~ 60	RC401-63190	
11	Ø32 ~ 44	RD411-63820	

(7) Nuts for piping

Steel pipe size (O.D. × I.D. × Thickness)	Tightening torque N·m kgf·m ft·lbf	Spanner size (reference)	Remarks
8 × 6 × 1 mm 0.31 × 0.24 × 0.04 in	29.4 ~ 39.2 3.0 ~ 4.0 21.7 ~ 28.9	17 mm 0.67 in	When sleeve nut is in use.
10 × 7 × 1.5 mm 0.39 × 0.28 × 0.06 in	39.2 ~ 44.1 4.0 ~ 4.5 28.9 ~ 32.5	19 mm 0.75 in	
12 × 9 × 1.5 mm 0.47 × 0.35 × 0.06 in	53.9 ~ 63.7 5.5 ~ 6.5 39.7 ~ 47.0	21 mm 0.83 in	
16 × 12 × 2 mm 0.63 × 0.47 × 0.08 in	88.3 ~ 98.1 9.0 ~ 10.0 65.1 ~ 72.3	29 mm 1.14 in	
18 × 14 × 2 mm 0.71 × 0.55 × 0.08 in	127.5 ~ 137.3 13.0 ~ 14.0 94.0 ~ 101.3	32 mm 1.26 in	
27.2 × 21.6 × 2.8 mm 1.07 × 0.85 × 0.11 in	235.4 ~ 254.97 24.0 ~ 16.0 173.6 ~ 188.1	41 mm 1.61 in	

(8) Tightening torque of bolts and nuts

Refer to the tightness torque table below.

Bolts, Nuts / Nomial Dia.	4T 4	7T 7	9T 9
	SS41	S40C, S45C	SCr4
M6	7.8 ~ 9.3 N·m 0.80 ~ 0.95 kgf·m 5.8 ~ 6.9 ft·lbf	9.8 ~ 11.3 N·m 1.00 ~ 1.15 kgf·m 7.2 ~ 8.3 ft·lbf	12.3 ~ 14.2 N·m 1.25 ~ 1.45 kgf·m 9.0 ~ 10.5 ft·lbf
M8	17.7 ~ 20.6 N·m 1.80 ~ 2.10 kgf·m 13.0 ~ 15.2 ft·lbf	23.5 ~ 27.5 N·m 2.40 ~ 2.80 kgf·m 17.4 ~ 20.3 ft·lbf	29.4 ~ 34.3 N·m 3.00 ~ 3.50 kgf·m 21.7 ~ 25.3 ft·lbf
M10	39.2 ~ 45.1 N·m 4.00 ~ 4.60 kgf·m 28.9 ~ 33.3 ft·lbf	48.0 ~ 55.9 N·m 4.90 ~ 5.70 kgf·m 35.4 ~ 41.2 ft·lbf	60.8 ~ 70.6 N·m 6.20 ~ 7.20 kgf·m 44.8 ~ 52.1 ft·lbf
M12	62.8 ~ 72.6 N·m 6.40 ~ 7.40 kgf·m 46.3 ~ 53.5 ft·lbf	77.5 ~ 90.2 N·m 7.90 ~ 9.20 kgf·m 57.1 ~ 66.5 ft·lbf	103.0 ~ 117.7 N·m 10.50 ~ 12.00 kgf·m 75.9~ 86.8 ft·lbf
M14	107.9 ~ 125.5 N·m 11.00 ~ 12.80 kgf·m 79.6 ~ 92.6 ft·lbf	123.6 ~ 147.1 N·m 12.60 ~ 15.0 kgf·m 91.1 ~ 108.5 ft·lbf	166.7 ~ 196.1 N·m 17.00 ~ 20.00 kgf·m 123.0 ~ 144.7 ft·lbf
M16	166.7 ~ 191.2 N·m 17.00 ~ 19.50 kgf·m 123.0 ~ 141.0 ft·lbf	196.1 ~ 225.6 N·m 20.00 ~ 23.00 kgf·m 144.7 ~ 166.4 ft·lbf	259.9 ~ 304.0 N·m 26.50 ~ 31.00 kgf·m 191.7 ~ 224.2 ft·lbf
M18	245.2 ~ 284.4 N·m 25.00 ~ 29.0 kgf·m 180.8 ~ 209.7 ft·lbf	274.6 ~ 318.7 N·m 28.00 ~ 32.50 kgf·m 202.5 ~ 235.1 ft·lbf	343.2~ 402.1 N·m 35.00 ~ 41.00 kgf·m 253.2 ~ 296.5 ft·lbf
M20	333.4~ 392.2 N·m 34.00 ~ 40.00 kgf·m 245.9 ~ 389.3 ft·lbf	367.7 ~ 431.5 N·m 37.50 ~ 44.0 kgf·m 271.2 ~ 318.2 ft·lbf	519.8 ~ 568.8 N·m 53.00 ~ 58.00 kgf·m 383.3 ~ 419.5 ft·lbf

(9) Types and materials of bolts and nuts

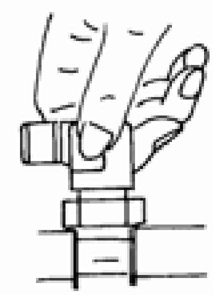
[ex. bolts]

Types	Material	Tensile strength	Hardness	Bolt head marking	
4T	SS41	Over 392 MPa 4000 kgf/cm^2 56892 lbf/in^2	H_RB 62 ~ 98	4	No mark or marked 4
7T	S40C S45C	Over 686 MPa 7000 kgf/cm^2 99561 lbf/in^2	H_RC 20 ~ 28	7	Marked 7
9T	SCr4	Over 882 MPa 9000 kgf/cm^2 128007 lbf/in^2	H_RC 28 ~ 34	9	Marked 9

(10)Washer-equipped elbow

Tightening torque

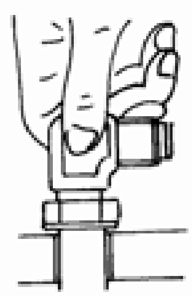
Size	N·m	kgf·m	ft·lbs
G1/4	25 ~ 30	2.5 ~ 3.0	18 ~ 22
G3/8	49 ~ 54	5.0 ~ 5.5	36 ~ 40
G1/2	59 ~ 64	6.0 ~ 6.5	43 ~ 47
G3/4 G1	118 ~ 127	12.0 ~ 13.0	87 ~ 94



Tightening procedure

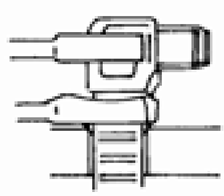
1) Connecting with the valve
   - Screw in the elbow by hand until the washer comes into contact.

Note: Clean up hte mating seal boforehand.



2) Positioning
   - Turn the elbow back to its set position.

Note: Do not make any more than one turn back.



3) Fixing
   - Tighten up the lock nut with a wrench.
   - Lock nut tightening torque
     G1/4:25 ~ 30 N·m (2.5 ~ 3.0 kgf·m, 18 ~ 22 ft·lbs)
     G3/8:50 ~ 55 N·m (5.0 ~ 5.5 kgf·m, 36 ~ 40 ft·lbs)
     G1/2:60 ~ 65 N·m (6.0 ~ 6.5 kgf·m, 43 ~ 47 ft·lbs)
     G3/4:118 ~ 127 N·m (12.0 ~ 13.0 kgf·m, 87 ~ 94 ft·lbs)
     G1:118 ~ 127 N·m (12.0 ~ 13.0 kgf·m, 87 ~ 94 ft·lbs)

F Machine Quality Specifications

a. K008-3, U10-3 EU-Version

Machine specification:Service port, Wrist rest, STD-arm, KBT-cab, KBT-bucket

No		Specifications Items			Unit	K008-3	U10-3	Remarks
Q1	Main Spec. JIS A8404							
1	1	Machine size	Total length (Trans-port)		mm	2750 ± 55	2985 ± 60	
	2		Total width [Track extended]		mm	860 ± 17	990 ± 20	
	3		Total width [Track retracted]		mm	700 ± 14	750 ± 28	
	4		Total height		mm	1420 ± 28	1380 ± 28	
2	1	Weight	Machine weight		kg	880 ± 18	980 ± 20	Fuel tank
3	1	Performance	Swivel speed	L	rpm	8.3 ± 0.8	8.3 ± 0.8	
	2			R	rpm	8.3 ± 0.8	8.3 ± 0.8	
	3		Travel speed	Rubber F1	km/h	2.0 ± 0.2	2.0 ± 0.2	
	4			Rubber F2	km/h	-	4.0 ± 0.4	
	5		Gradeability		deg	30<	30<	
4	1	Rear end min. turn-ing radius			mm	750 ± 15	500 ± 10	
	2	Swivel frame rear ground clearance			mm	350 ± 7	350 ± 7	
	3	Tambler center dis-tance			mm	900 ± 27	1010 ± 30	
	4	Crawler total length			mm	1230 ± 37	1340 ± 40	
	5	Crawler total width [retracted]			mm	700 ± 14	750 ± 15	
	6	Crawler total width [extended]			mm	860 ± 17	990 ± 20	
	7	Min. ground clear-ance			mm	140 ± 8	130 ± 7	
5	1	Front attachment	Bucket heaped capacity	CECE	m^3	0.022	0.024	
	2			SAE, JIS	m^3	0.019	0.019	
	3		Bucket width		mm	350 ± 7	350 ± 7	Without side cutter
	4		Swing angle	Canopy L	deg	52 ± 3	55 ± 3	
	5			Canopy R	deg	62 ± 3	55 ± 3	
	6		Max. digging radius		mm	3075 ± 46	3380 ± 51	
	7		Ground level Max. digging radius		mm	3025 ± 45	3335 ± 50	
	8		Ground level Min. finish radius		mm	905 ± 18	1105 ± 22	Bucket bottom horizontal
	9	Front attachment	Max. digging depth		mm	1715 ± 34	1790 ± 36	
	10		Max. vertical dig-ging depth		mm	1375 ± 28	1550 ± 31	
	11		Max. digging height	Conopy	mm	2870 ± 57	3055 ± 61	
	12		Max. dump height	Conopy	mm	2035 ± 41	2215 ± 44	
	13		Mini. turning radius	Conopy	mm	1120 ± 34	1245 ± 37	
	14		Mini. turning radius (Left swing)	Conopy	mm	945 ± 47	1075 ± 54	
6	1	Dozer	Width		mm	700-860	750-990	
	2		Height		mm	200 ± 10	200 ± 10	
	3		Max. lift above GL		mm	200 ± 10	195 ± 10	
	4		Max. below GL		mm	180 ± 13	200 ± 14	

The figures in parentheses are for the KTC, KCL and KTA versions.

No		Specifications Items			Unit	K008-3	U10-3	Remarks
Q2	Main Specs JIS A8404							
1	1	Bucket tooth slag-gish			mm	50>	50>	F - 30 kgf
	2	Front digger's tilt-down			mm	10>	10>	
	3	Dozer's declination			mm	5>	5>	
2	1	Min. clearance between boom and backet teeth			mm	50 ± 25	47 ± 25	
3	1	Approach angle			deg	29 ± 3	29 ± 3	
4	1	Max. crawler height			mm	325 ± 7	325 ± 7	Include grouser on the spocket
Q3	Engine performance							
1	1	Max, engine rpm	no load		rpm	2350>	2350>	
	2		1 pump relief		rpm	-	-	
	3		2 pump relief		rpm	-	-	
2	1	Idler			rpm	1200 ± 100	1200 ± 100	
Q4	Travelling performance							
1	1	Travel motor block performance	L		mm	300>	300>	20 deg, 10 min Engine stop Oil temp. 50 ± 5°C
	2	Travel motor block performance	R		mm	300>	300>	
2	1	Max, Traction force	F1		kgf	460<	786<	On the center
					kN	45<	7.7<	
	2		F2		kgf	-	-	
					kN	-	-	
3	1	Travel straightness	F1		mm	1000>	1000>	10m distance
4	1	Track shoe sag dis-tance	Rubber		mm	8 ~ 13	8 ~ 13	
Q5	Work performance							
1	1	Boom lifting capacity			kgf	92<	122<	Front end, Arm extend bucket crowd, dozer down.
					kN	0.9<	1.2<	
	2	Arm digging force			kgf	439<	561<	Bucket tooth root
					kN	4.3<	5.5<	
	3	Bucket digging force			kgf	950<	1010<	Machine stance to JIS bucket tooth root
					kN	9.3<	9.9<	
	4	Dozer force		down	kgf	1030<	1071<	Cutting edge down force at ground level
					kN	10.1<	10.5<	
2	1	Boom speed	Canopy	up 1st	sec	2.5 ± 0.3	2.5 ± 0.3	Oil temp. 50 ± 5 °C (122 ± 41 °F) 1st : Ground to max.up or Max. up to Ground. 2nd : Max.down to Max.up or Max. up to Max. down.
	2			up 2nd	sec	3.7 ± 0.3	3.7 ± 0.3	
	3			down 1st	sec	2.8 ± 0.3	2.8 ± 0.3	
	4			down 2nd	sec	4.0 ± 0.3	4.0 ± 0.3	
3	1	Arm speed		crowd	sec	3.0 ± 0.3	4.0 ± 0.3	
	2			extend	sec	2.2 ± 0.3	2.8 ± 0.3	
4	1	Bucket speed		crowd	sec	2.9 ± 0.3	2.9 ± 0.3	Oil temp. 50 ± 5 °C (122 ± 41 °F)
	2			dump	sec	2.0 ± 0.3	2.0 ± 0.3	
5	1	Dozer speed		up 1st	sec	-	-	Ground to max. up
	2			up 2nd	sec	1.6 ± 0.3	1.6 ± 0.3	Max. down to max. up
	3			down 1st	sec	-	-	Max.up to ground
	4			down 2nd	sec	1.2 ± 0.3	1.2 ± 0.3	Max. up to max. down
6	1	Arm cylinder cavita-tion			mm	5>	5>	Oil temp. 1300 rpm 95 ± 5 °C (203 ± 41 °F) Bucket heaped.

No		Specifications Items			Unit	K008-3	U10-3	Remarks
7	1	Max. digging height radius	Canopy		mm	1302 ± 130	1468 ± 146	
	2	Max. dump height radius	Canopy		mm	1183 ± 71	1619 ± 162	at bucket pin
	3	Bucket wrist angle			degree	186 ~ 192	186 ~ 192	
Q6	Swivel, swing performance							
1	1	Swivel torque		L	kgf·m	118<	127<	Arm extend,show/ Quick
					N·m	1159<	1250	
				R	kgf·m	118<	127<	
					N.m	1159<	1250	
2	1	Swivel angle		L	deg	27<	20<	Bucket load=JIS heaped×1.8
				R	deg	27<	20<	
3	1	Swivel block perfor- mance		L	deg	20>	30>	
				R	deg	20>	30>	
4	1	Swivel start-up speed		L	sec	2.1 ± 0.3	2.2 ± 0.3	0~90 deg swivel
				R	sec	2.1 ± 0.3	2.2 ± 0.3	
5	1	Swing speed	Canopy	L	sec	4.2 ± 0.3	4.2 ± 0.3	
				R	sec	4.1 ± 0.3	4.1 ± 0.3	
6	1	Swing Lock		Swivel R&L	mm	7.0>	7.0>	90 deg-swivel, 100 times actual digging cylinder dislocation
Q7	Hydraulic performance							
1	1	Relief pressure set- ting		P1	kgf/cm^2	170 ± 5.1	180 ± 5.1	At pump deliery 50 ± 5 °C
					MPa	16.7 ± 0.5	17.7 ± 0.5	
					bar	167 ± 5	177 ± 5	
	2			P2	kgf/cm^2	170 ± 5.1	180 ± 5.1	
					MPa	16.7 ± 0.5	17.7 ± 0.5	
					bar	167 ± 5	177 ± 5	
	3			P3	kgf/cm^2	-	30^{+5}_{0}	
					MPa	-	$2.9^{+0.5}_{0}$	
					bar	-	29^{+5}_{0}	
2	1	Cylinder oil sealing capacity	Boom	50 ± 5 °C (122 ± 41°F)	mm	20 >	20 >	Arm extend, bucket
	2			95 ± 5 °C (203 ± 41°F)	mm	20 >	20 >	
	3		Arm	50 ± 5 °C (122 ± 41°F)	mm	11>	11>	height 1m, 10 min.
	4		Bucket	50 ± 5 °C (122 ± 41°F)	mm	10 >	10 >	Bucket load=JIS heaped×1.8
	5		Dozer	50 ± 5 °C (122 ± 41°F)	mm	20 >	20 >	
3	1	Boom cushioning performance		30 °C(86 °F)	sec			
				50 °C(122 °F)	sec	0.4~0.7	0.4~0.7	
				80 °C(176 °F)	sec			
Q8	Lever operating force & stroke							
1	1	Boom lever operat- ing force		up	kgf	1.5 ± 0.5	1.5 ± 0.5	
					N	14.7 ± 5	14.7 ± 5	
				down	kgf	1.5 ± 0.5	1.5 ± 0.5	
					N	14.7 ± 5	14.7 ± 5	
	2	Arm lever		crowd	kgf	1.5 ± 0.5	1.5 ± 0.5	Extend & crowd
					N	14.7 ± 5	14.7 ± 5	
				extend	kgf	1.5 ± 0.5	1.5 ± 0.5	
					N	14.7 ± 5	14.7 ± 5	

No		Specifications Items			Unit	K008-3	U10-3	Remarks
1	3	Bucket lever		crowd	kgf	1.5 ± 0.5	1.5 ± 0.5	Dump & crowd
					N	14.7 ± 5	14.7 ± 5	
				extend	kgf	1.5 ± 0.5	1.5 ± 0.5	
					N	14.7 ± 5	14.7 ± 5	
	4	Swivel (Swing) lever		R	kgf	1.5 ± 0.5	1.5 ± 0.5	Left & right
					N	14.7 ± 5	14.7 ± 5	
				L	kgf	1.5 ± 0.5	1.5 ± 0.5	
					N	14.7 ± 5	14.7 ± 5	
	5	Dozer lever		up	kgf	2.0 ± 0.5	2.0 ± 0.5	Up & down
					N	19.6 ± 5	19.6 ± 5	
				down	kgf	2.0 ± 0.5	2.0 ± 0.5	
					N	19.6 ± 5	19.6 ± 5	
	6	Travel lever	L	Forward	kgf	1.1 ± 0.5	0.8 ± 0.5	
					N	10.8 ± 5	7.8 ± 5	
				Back	kgf	1.1 ± 0.5	0.8 ± 0.5	
					N	10.8 ± 5	7.8 ± 5	
			R	Forward	kgf	1.1 ± 0.5	0.8 ± 0.5	
					N	10.8 ± 5	7.8 ± 5	
				Back	kgf	1.1 ± 0.5	0.8 ± 0.5	
					N	10.8 ± 5	7.8 ± 5	
	7	Accelerator lever		up	kgf	-	-	
					N	-	-	
				down	kgf	2.5 ± 1	2.5 ± 1	
					N	24.5 ± 9.8	24.5 ± 9.8	
	8	Swing pedal		R	kgf	5.0 ± 1	5.0 ± 1	
					N	49.0 ± 9.8	49.0 ± 9.8	
				L	kgf	5.0 ± 1	5.0 ± 1	
					N	49.0 ± 9.8	49.0 ± 9.8	
	9	Safety lock lever		up	kgf	2.0 ± 0.2	2.0 ± 0.2	Up & down
					N	19.6 ± 1.5	19.6 ± 1.5	
				down	kgf	2.0 ± 0.2	2.0 ± 0.2	
					N	19.6 ± 1.5	19.6 ± 1.5	
2	1	Boom lever stroke		up	mm	80 ± 10	81 ± 10	
				down	mm	80 ± 10	81 ± 10	
	2	Arm lever stroke		crowd	mm	80 ± 10	81 ± 10	
				extend	mm	80 ± 10	81 ± 10	
	3	Bucket lever stroke		crowd	mm	70 ± 10	81 ± 10	
				extend	mm	70 ± 10	81 ± 10	
	4	Swivel, Swing lever stroke		R	mm	70 ± 10	81 ± 10	
				L	mm	70 ± 10	81 ± 10	
	5	Dozer lever stroke		up	mm	37 ± 10	32 ± 10	
				down	mm	37 ± 10	32 ± 10	
	6	Travel lever stroke	L	Forward	mm	55 ± 10	58 ± 10	
				Back	mm	55 ± 10	58 ± 10	
			R	Forward	mm	55 ± 10	58 ± 10	
				Back	mm	55 ± 10	58 ± 10	

No		Specifications Items			Unit	K008-3	U10-3	Remarks
Q9	Stability							
1	1	Standard arm, static limited load [track frame : extended]	Bucket load to tip fully	Side	kgf	83<	85<	Arm extend, bucket crowd oil temp.50 ± 5 °C (122 ± 41 °F)
					N	812<	833<	
	2			Front	kgf	108<	104<	
					N	1059<	1015<	
	3	[track frame : retracted]	Bucket load to tip fully	Side	kgf	56<	68<	
					N	547<	671<	
	4			Front	kgf	108<	79<	
					N	1059<	777<	
Q10	Comfortability							
1	1	Noise level	At operator's ear LPA	Canopy	db(A)	78>	73	
	2		Noise source;LWA		db(A)	92.9>	90	

b. K008-3 KTC KCL, KTA - Version

Machine specification: Service port, Wrist rest, STD-arm, KBT-cab, KBT-bucket

No		Specificatios Items			Unit	K008-3		Remarks
Q1	Main Speed JIS A8404							
1	1	Machine size	Total length (Transport)		mm	2750 ± 55		
					inch	108.3 ± 2.2		
	2		Total width [Track extended]		mm	860 ± 17		
					inch	33.9 ± 0.7		
	3		Total width [Track retracted]		mm	800 ± 14		
					inch	31.5 ± 0.6		
	4		Total height		mm	2230 ± 45		
					inch	87.8 ± 1.77		
2	1	Weight	Machine weight		kg	920 ± 18		Fuel tank
					lbs	2028 ± 40		
3	1	Performance	Swivel speed	L	rpm	8.3 ± 0.8		
	2			R	rpm	8.3 ± 0.8		
	3		Travel speed	Rubber F1	km/h	2.0 ± 0.2		
					mph	1.25 ± 0.13		
	4			Rubber F2	km/h	4.0 ± 0.4		
					mph	2.5 ± 0.25		
	5		Gradeability		deg	30<		
4	1	Rear end min. turning radius			mm	880 ± 18		
					inch	34.6 ± 0.7		
	2	Swivel frame rear ground clearance			mm	350 ± 17		
					inch	13.8 ± 0.7		
	3	Tambler center distance			mm	900 ± 27		
					inch	35.4 ± 1.1		
	4	Crawler total length			mm	1230 ± 37		
					inch	48.4 ± 1.5		
	5	Crawler total width [Retracted]			mm	700 ± 14		
					inch	27.6 ± 0.6		
	6	Crawler total width [Extended]			mm	860 ± 17		
					inch	33.9 ± 0.7		
	7	Min. ground clearance			mm	140 ± 8		
					inch	5.5 ± 0.3		
5	1	Front attachment	Bucket heaped capacity	CECE	m^3	0.022		
					yd^3	0.029		
	2			SAE, JIS	m^3	0.019		
					yd^3	0.025		
	3		Bucket width		mm	350 ± 7		Without side cutter
					inch	13.8 ± 0.3		
	4		Swing angle	L	deg	52 ± 3		
	5			R	deg	62 ± 3		
	6		Max. digging radius		mm	3075 ± 46		
					inch	121 ± 1.8		
	7		Ground level Max. digging radius		mm	3025 ± 45		
					inch	119.1 ± 1.8		
	8		Ground level Min. finish radius		mm	905 ± 18		Bucket bottom horizontal
					inch	35.6 ± 0.7		
	9		Max. digging depth		mm	1715 ± 34		
					inch	67.5 ± 1.3		

No		Specificatios Items			Unit	K008-3		Remarks
5	10	Front attachment	Max. vertical digging depth		mm	1375 ± 28		
					inch	54.1 ± 1.1		
	11		Max. digging height		mm	2870 ± 57		
					inch	113.0 ± 2.2		
	12		Max. dump height		mm	2035 ± 57		
					inch	80.1 ± 1.6		
	13		Mini. turning radius		mm	1120 ± 34		
					inch	44.1 ±1.3		
	14		Mini. turning radius (Left swing)		mm	945 ± 47		
					inch	37.2 ± 1.9		
6	1	Dozer	Width		mm	700-860		
					inch	27.6-33.9		
	2		Height		mm	200 ± 10		
					inch	7.9 ± 0.4		
	3		Max. lift above GL		mm	200 ± 10		
					inch	7.9 ± 0.4		
	4		Max. below GL		mm	180 ± 13		
					inch	7.1 ± 0.5		
Q2	Main Specs JIS A8404							
1	1	Bucket tooth slaggish			mm	50>		F-50N
					inch	2.0>		
	2	Front digger's tilt-down			mm	10>		
					inch	0.4>		
	3	Dozer's declination			mm	5>		
					inch	0.2>		
2	1	Min. clearance between boom and backet teeth			mm	50 ± 25		
					inch	1.97 ± 0.98		
3	1	Approach angle			deg	29 ± 3		
4	1	Max. crawler height			mm	325 ± 7		Include grouser on the spocket
					inch	12.80 ± 0.28		
Q3	Engine performance							
1	1	Max, engine rpm	no load		rpm	2350>		
	2		1 pump relief		rpm	-		
	3		2 pump relief		rpm	-		
2	1	Idler			rpm	1200 ± 100		
Q4	Travelling performance							
1	1	Travel motor block performance	L		mm	300>		20 deg, 10 min Engine stop Oil temp. 50 ± 5 °C
					inch	11.81>		
	2		R		mm	300>		
					inch	11.81>		
2	1	Max, Traction force	F1		kgf·m	460<		On the center
					kN·m	4.5<		
					ft·lbf	3320		
	2		F2		kgf·m	-		
					kN·m	-		
					ft·lbf	-		
3	1	Travel straightness	F1		mm	1000>		10m distance
					inch	39.37>		
4	1	Track shoe sag distance	Rubber		mm	8 ~ 13		Between treads
					inch	0.31 ~ 0.51		

No		Specificatios Items			Unit	K008-3		Remarks
Q5	Work performance							
1	1	Boom lifting capacity			kgf	91.8<		Front end, Arm extend bucket crowd, at tooth"
					kN	0.9<		
					lbf	202<		
	2	Arm digging force			kgf	505		Bucket tooth root
					kN	4.3<		
					lbf	1113		
	3	Bucket digging force			kgf	1000		Machine stance to JIS bucket tooth root
					kN	9.3<		
					lbf	2205		
	4	Dozer force		down	kgf	1089		Cutting edge down force at ground level
					kN	10.1<		
					lbf	2400		
2	1	Boom speed	Canopy	up 1st	sec	2.5 ± 0.3		Oil temp. 50 ± 5 °C(122 ± 41 °F) Ground to max. height (exculude cushioning)
	2			up 2nd	sec	3.7 ± 0.3		
	3			down 1st	sec	2.8 ± 0.3		
	4			down 2nd	sec	4.0 ± 0.3		
3	1	Arm speed		crowd	sec	3.0 ± 0.3		
	2			extend	sec	2.2 ± 0.3		
4	1	Bucket speed		crowd	sec	2.9 ± 0.3		Oil temp. 50 ± 5 °C(122 ± 41 °F)
	2			dump	sec	2.0 ± 0.3		
5	1	Dozer speed		up 1st	sec	-		
	2			up 2nd	sec	1.6 ± 0.3		Max. down to max. up
	3			down 1st	sec	-		
	4			down 2nd	sec	1.2 ± 0.3		Max. up to max. down
6	1	Arm cylinder cavita- tion			mm	5>		Oil temp. 95 ± 5 °C (203 ± 41 °F) 1300 rpm. heaped.
					inch	0.2>		
7	1	Max. digging height radius			mm	1302 ± 130		
					inch	51.26 ± 5.12		
	2	Max. dump height radius			mm	1183 ± 71		at bucket pin
					inch	46.575 ± 2.8		
	3	Bucket wrist angle			degree	189		
Q6	Swivel, swing performance							
1	1	Swivel torque		L	kgf·m	118<		Arm extend,show/ Quick
					kN·m	1159<		
					ft·lbf	855<		
	2			R	kgf·m	118<		
					kN·m	1159<		
					ft·lbf	855<		
2	1	Swivel angle		L	deg	27<		Bucket load=JIS heaped×1.8
				R	deg	27<		
3	1	Swivel block perfor- mance		L	deg	20>		Engine stop, 1 min. 20 degree slop Engine idle, Load condition.
	2			R	deg	20>		
4	1	Swivel start-up speed		L	sec	2.1 ± 0.3		0~90 deg swivel
				R	sec	2.1 ± 0.3		
5	1	Swing speed		L	sec	4.2 ± 0.3		
				R	sec	4.1 ± 0.3		
6	1	Swing Lock		Swivel R&L	mm	7.0>		90 deg-swivel, 100 times actual digging cylinder dislocation
					inch	0.28>		

No		Specificatios Items			Unit	K008-3		Remarks
Q7	Hydraulic performance							
1	1	Relief pressure setting		P1	kgf/cm^2	170 ± 5.0		At pump delivery 50 ± 5 °C
					MPa	16.7 ± 0.5		
					psi	2418 ± 71		
	2			P2	kgf/cm^2	170 ± 5.0		
					MPa	16.7 ± 0.5		
					psi	2418 ± 71		
2	1	Cylinder oil sealing capacity	Boom	50 ± 5 °C (122 ± 41 °F)	mm	20>		Arm extend, bucket
					inch	0.79>		
	2			95 ± 5 °C (203 ± 41 °F)	mm	20>		
					inch	0.79>		
	3		Arm	50 ± 5 °C (122 ± 41 °F)	mm	11>		height 1m, 10 min.
					inch	0.43>		
	4		Bucket	50 ± 5 °C (122 ± 41 °F)	mm	10>		Bucket load=JIS heaped×1.8
					inch	0.39>		
	5		Dozer	50 ± 5 °C (122 ± 41 °F)	mm	20>		
					inch	0.79>		
3	1	Boom cushioning performance		30°C(86°F)	sec	-		
	2			50°C(122°F)	sec	0.4 ~ 0.7		
	3			80°C(176°F)	sec	-		
Q8	Lever operating force & stroke							
1	1	Boom lever operating force		up	kgf·m	1.5 ± 0.5		
					N·m	14.7 ± 5.0		
					ft·lbs	10.8 ± 3.6		
				down	kgf·m	1.5 ± 0.5		
					N·m	14.7 ± 5.0		
					ft·lbs	10.8 ± 3.6		
	2	Arm lever		crowd	kgf·m	1.5 ± 0.5		Extend & crowd
					N·m	14.7 ± 5.0		
					ft·lbs	10.8 ± 3.6		
				extend	kgf·m	1.5 ± 0.5		
					N·m	14.7 ± 5.0		
					ft·lbs	10.8 ± 3.6		
	3	Bucket lever		crowd	kgf·m	1.5 ± 0.5		Dump & crowd
					N·m	14.7 ± 5.0		
					ft·lbs	10.8 ± 3.6		
				extend	kgf·m	1.5 ± 0.5		
					N·m	14.7 ± 5.0		
					ft·lbs	10.8 ± 3.6		
	4	Swivel (Swing) lever		R	kgf·m	1.5 ± 0.5		Left & right
					N·m	14.7 ± 5.0		
					ft·lbs	10.8 ± 3.6		
				L	kgf·m	1.5 ± 0.5		
					N·m	14.7 ± 5.0		
					ft·lbs	10.8 ± 3.6		

No		Specificatios Items			Unit	K008-3		Remarks
1	5	Dozer lever		up	kgf·m	2.0 ± 0.5		Up & down
					N·m	19.6 ± 5.0		
					ft·lbs	14.5 ± 3.6		
				down	kgf·m	2.0 ± 0.5		
					N·m	19.6 ± 5.0		
					ft·lbs	14.5 ± 3.6		
	6	Travel lever	L	Forward	kgf·m	1.1 ± 0.5		
					N·m	10.8 ± 0.5		
					ft·lbs	8.0 ± 3.6		
				Back	kgf·m	1.1 ± 0.5		
					N·m	10.8 ± 0.5		
					ft·lbs	8.0 ± 3.6		
			R	Forward	kgf·m	1.1 ± 0.5		
					N·m	10.8 ± 0.5		
					ft·lbs	8.0 ± 3.6		
				Back	kgf·m	1.1 ± 0.5		
					N·m	10.8 ± 0.5		
					ft·lbs	8.0 ± 3.6		
	7	Accelerator lever		up	kgf·m	-		
					N·m	-		
					ft·lbs	-		
				down	kgf·m	2.5 ± 1.0		
					N·m	24.5 ± 9.8		
					ft·lbs	18.1 ± 7.2		
	8	Swing pedal		R	kgf·m	5.0 ± 1.0		
					N·m	49.0 ± 9.8		
					ft·lbs	36.2 ± 7.2		
				L	kgf·m	5.0 ± 1.0		
					N·m	49.0 ± 9.8		
					ft·lbs	36.2 ± 7.2		
	9	Safety lock lever		up	kgf·m	2.0 ± 0.2		Up & down
					N·m	19.6 ± 1.5		
					ft·lbs	14.5 ± 1.4		
				down	kgf·m	2.0 ± 0.2		
					N·m	19.6 ± 1.5		
					ft·lbs	14.5 ± 1.4		

No		Specificatios Items			Unit	K008-3		Remarks
2	1	Boom lever stroke		up	mm	80 ± 10		
					inch	3.15 ± 0.39		
				down	mm	80 ± 10		
					inch	3.15 ± 0.39		
	2	Arm lever stroke		crowd	mm	80 ± 10		
					inch	3.15 ± 0.39		
				extend	mm	80 ± 10		
					inch	3.15 ± 0.39		
	3	Bucket lever stroke		crowd	mm	70 ± 10		
					inch	2.76 ± 0.39		
				extend	mm	70 ± 10		
					inch	2.76 ± 0.39		
	4	Swivel, swing lever stroke		R	mm	70 ± 10		
					inch	2.76 ± 0.39		
				L	mm	70 ± 10		
					inch	2.76 ± 0.39		
	5	Dozer lever stroke		up	mm	37 ± 10		
					inch	1.46 ± 0.39		
				down	mm	37 ± 10		
					inch	1.46 ± 0.39		
	6	Travel lever stroke	L	Forward	mm	55 ± 10		
					inch	2.17 ± 0.39		
				Back	mm	55 ± 10		
					inch	2.17 ± 0.39		
			R	Forward	mm	55 ± 10		
					inch	2.17 ± 0.39		
				Back	mm	55 ± 10		
					inch	2.17 ± 0.39		
Q9	Stability							
1	1	Standard arm, static limited load [track frame : extended]	Bucket load to tip fully	Side	kgf·m	82.8<		Arm extend, bucket crowd oil temp.50 ± 5 °C (122 ± 41 °F)
					N·m	812<		
					ft·lbf	600<		
	2			Front	kgf·m	108<		
					N·m	1059<		
					ft·lbf	781<		
	3	[track frame : retracted]	Bucket load to tip fully	Side	kgf·m	55.8<		
					N·m	547<		
					ft·lbf	403<		
	4			Front	kgf·m	108<		
					N·m	1059<		
					ft·lbf	781<		
Q10	Comfortability							
1	1	Noise level	At operator's ear LPA		db(A)	78>		
	2		Noise source;LWA		db(A)	92.9>		

G.Maintenance intervals

No.	Checkpoints	intervals	Hour meter indicator														Consequently
			50	100	150	200	250	300	350	400	450	500	550	600	1000	2000	
1	Fuel	check	Daily check														
2	Engine oil	check	Daily check														
		change	○		○		○		○		○		○				every 100 hrs
3	Hydraulic oil**	check	Daily check														
		change													○		every 1000 hrs
4	Coolant	check	Daily check														
		change															every 2 years
5	Lubrication points	check	Daily check														
6	Lubrication of the pins for backet	check		○		○		○		○		○		○	○	○	every 100 hrs
7	Radiator	check	Daily check														
8	Battery condition	check	○	○	○	○	○	○	○	○	○	○	○	○	○	○	every 50 hrs
9	Electrical lines	check	Daily check, Annual servicing														
10	Greasing of swing bearing teeth	—	○	○	○	○	○	○	○	○	○	○	○	○	○	○	every 50 hrs
11	Fan belt tension	adjust				○				○				○	○	○	every 200 hrs
12	Radiator hoses and clamps	check				○				○				○	○	○	every 200 hrs
		change															every 2 years
13	Air filter element*	clean				○				○				○	○	○	every 200 hrs
		change													○	○	every 1000 hrs
14	Greasing of swing ball bearings	—				○				○				○	○	○	every 200 hrs
15	Fuel pipes and hoses	check				○				○				○	○	○	every 200 hrs
		change															every 2 years
16	Engine oil filter	change	○				○				○				○	○	every 200 hrs
17	Fuel filter	check	○	○	○	○	○	○	○	○	○	○	○	○	○	○	every 50 hrs
		change										○			○	○	every 500 hrs
18	Hydraulic return filter element	change													○	○	every 1000 hrs
19	Hydraulic suction filter element	change													○	○	every 1000 hrs
20	Front idler and track roller oil	change														○	every 2000 hrs
21	Dynamo and starter motor	check														○	every 2000 hrs
22	Radiator system	rinse															every 2 years

IMPORTANT:

- * Clean the air filter more frequently if used in dusty conditions. With heavy soiling, replace the filter.

  ** When using a hydraulic breaker, change hydraulic oil and return filter according to the table on "Hydraulic Oil Change (Including Exchange of the Suction Filter in the Hydraulic Tank) under "EVERY 1000 SERVICE HOURS" in "REGULAR CHECKS AND MAINTENANCE WORK".

Periodic replacement of important component parts

To ensure safty in operation, you are strongly required to inspect and service the machine at regular intervals. For added safety, ask your KUBOTA dealer to replace the following impotant component parts.
These parts are prone to degradation in material or subject to wear and tear with time. It is difficult to judge how much they have been affected at regular inspection. It is therefore nessesary to replace them with new ones, whether waer is visible or not after a specified time of use.
If any of them is found worn even before the specified use, it must be repaired or replaced the same way as other parts.
If any of the hose clamps is found deformed or checked, the hose clamp must also be replaced. For the hydraulic hoses other than the ones to be replaced periodically, inspect them for the following points. If found unusual, tighten them up, replace them.
When replacing the hydraulic hoses, change their O-rings and sealings with new ones.
For replacement of the impotant parts, contact your KUBOTA dealer.

- At the following periodic inspections, check the fuel hoses and hydraulic hoses as well.

Inspection Interval	Check Points
Daily Checks	Oil leak at fuel and hydraulic hose connections and points.
Every month	Oil leak at fuel and hydraulic hose connections and points. Damages at fuel and hydraulic hose (cracks, chafing)
Every year	Oil leak at fuel and hydraulic hose connections and points. Interface, deformation, degradation, twist and other damages (cracks, chafing) of fuel and hydraulic hoses.

List of impotant component partrs

No	Component parts	Used Place	Q'ty	Period
1	Fuel hose	Fuel tank - Fuel filter	2	Every 2 years or 4000 hours
		Fuel filter - Fuel pump	1	
		Fuel pump - Fuel filter	1	
		Fuel filter - Fuel nozzle	2	
		Fuel nozzle - Fuel tank	1	
2	Hydraulic hose (suction)	Tank - Main pump	1	
3	Hydraulic hose (delivery)	Main pump - Control valve	2	
4	Hydraulic hose (Boom cylinder)	Control valve - Boom cylinder	2	
5	Hydraulic hose (Arm cylinder)	Control valve - Arm cylinder	2	
6	Hydraulic hose (Bucket cylinder)	Control valve - Bucket cylinder	2	
7	Hydraulic hose (Swing cylinder)	Control valve - Swing cylinder	2	
8	Hydraulic hose (Dozer cylinder & Track cylinder	Control valve - Rotary joint	4	
		Rotary joint - Dozer cylinder	4	
		Rotary joint - Track cylinder	2	
9	Hydraulic hose (Service port)	COntrol valve - Joint	1	
		Joint - Return pipe	1	
10	Hydraulic hose (Swivel motor)	Control valve - Swivel motor	2	

To prevent serious damage to the hydraulic system, use only a KUBOTA genuine hydraulic hose.

a. Hydraulic Oil Check for machines with Hydraulic Breakers

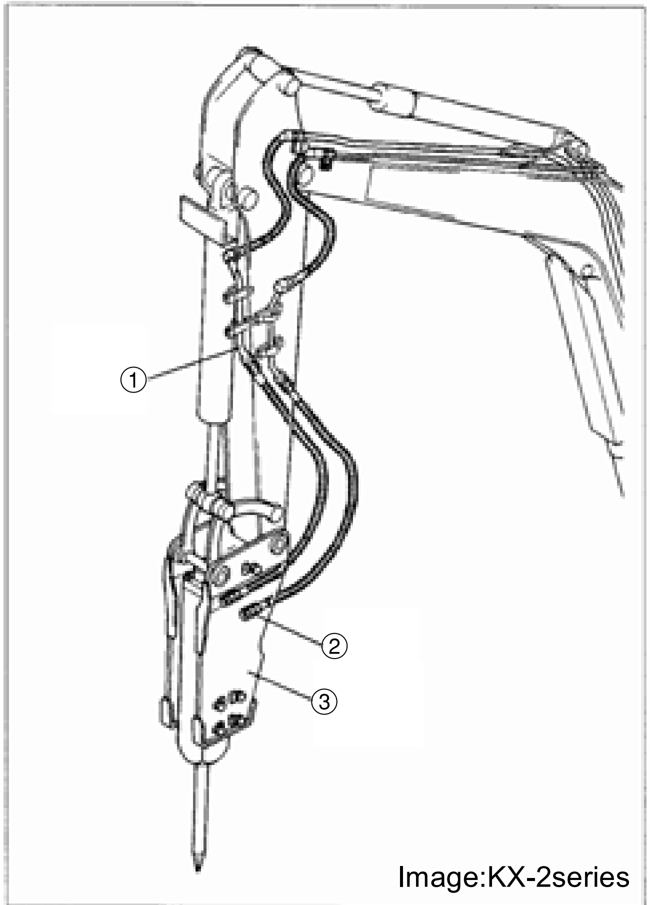


Image:KX-2series

①Return
②P port
③Breaker

The Hydraulic oil change after 1000 operating hours in the operator’s manual is based on the type of work done. Following inspection measure are valid when hydraulic breakers are used:

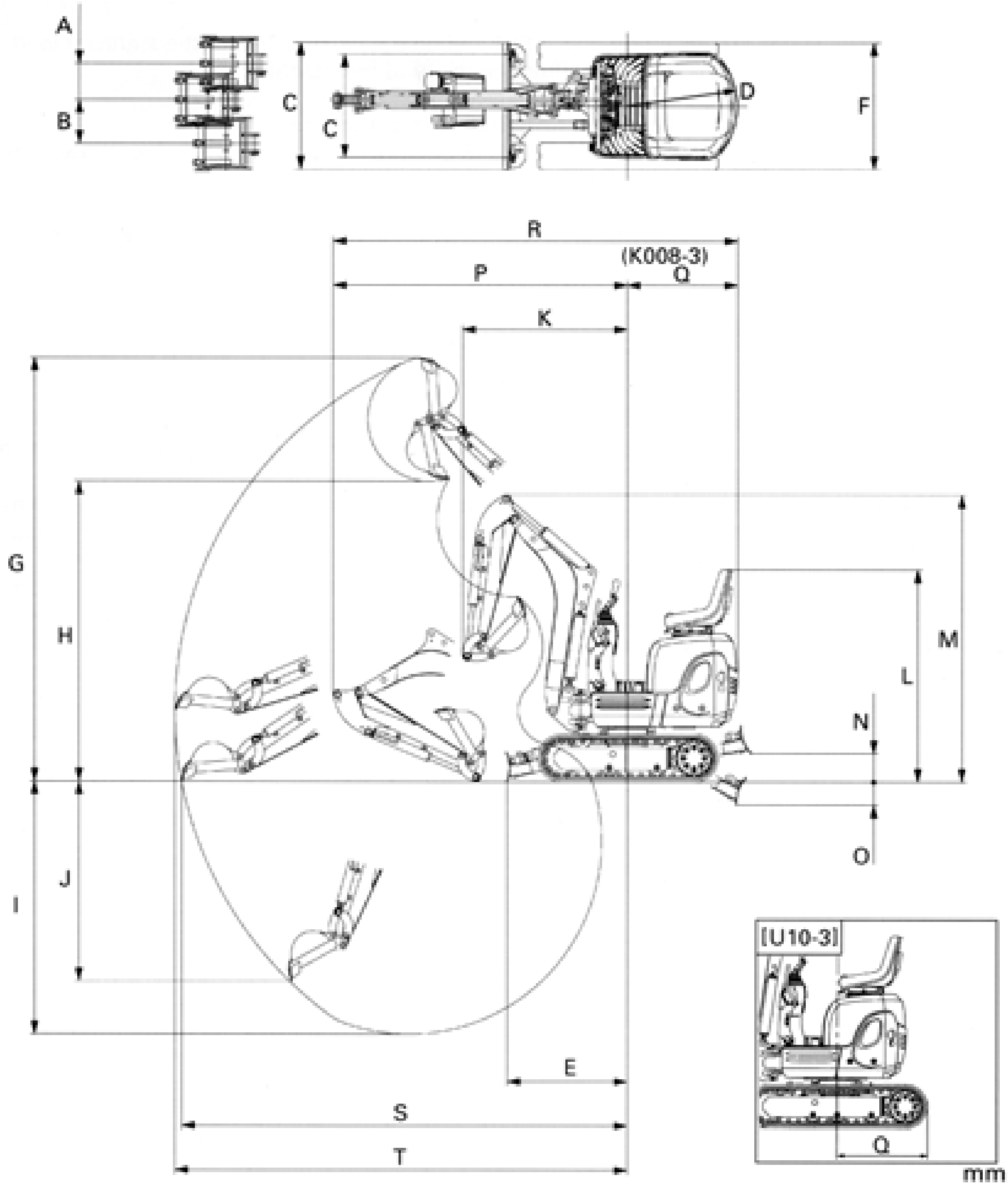
1. Changing and filling up of hydraulic oil
   1) The hydraulic oil must be changed more often when breakers are used because the machine is subject to harder conditions than at normal excavating work.
   2) Use only the recommended oils mentioned in the operator’s manual when changing or fill oil.
   3) When filling up oil, never mix oils of different makes.
2. Changing the return filter and oil
   1) The filter must be changed more often because of contamination resulting from the frequent assembly and disassembly of the hoses.
   2) Use the correct replacement filter.
   3) Oil change according to operating hours.

<table>
<tr><th colspan="2"></th><th>Hydraulic oil</th><th>Return Filter</th><th>Suction Filter</th></tr>
<tr><td colspan="2">Normal excavator work</td><td>every 1000 Hrs.</td><td>500 Hrs.</td><td rowspan="5">1000 Hrs.</td></tr>
<tr><td rowspan="4">Breaker work portion</td><td>20%</td><td>every 800 Hrs.</td><td rowspan="2">300 Hrs.</td></tr>
<tr><td>40%</td><td>every 400 Hrs.</td></tr>
<tr><td>60%</td><td>every 300 Hrs.</td><td rowspan="2">100 Hrs.</td></tr>
<tr><td>More than 80%</td><td>every 200 Hrs.</td></tr>
</table>

II. Machine body(Mechanism section)

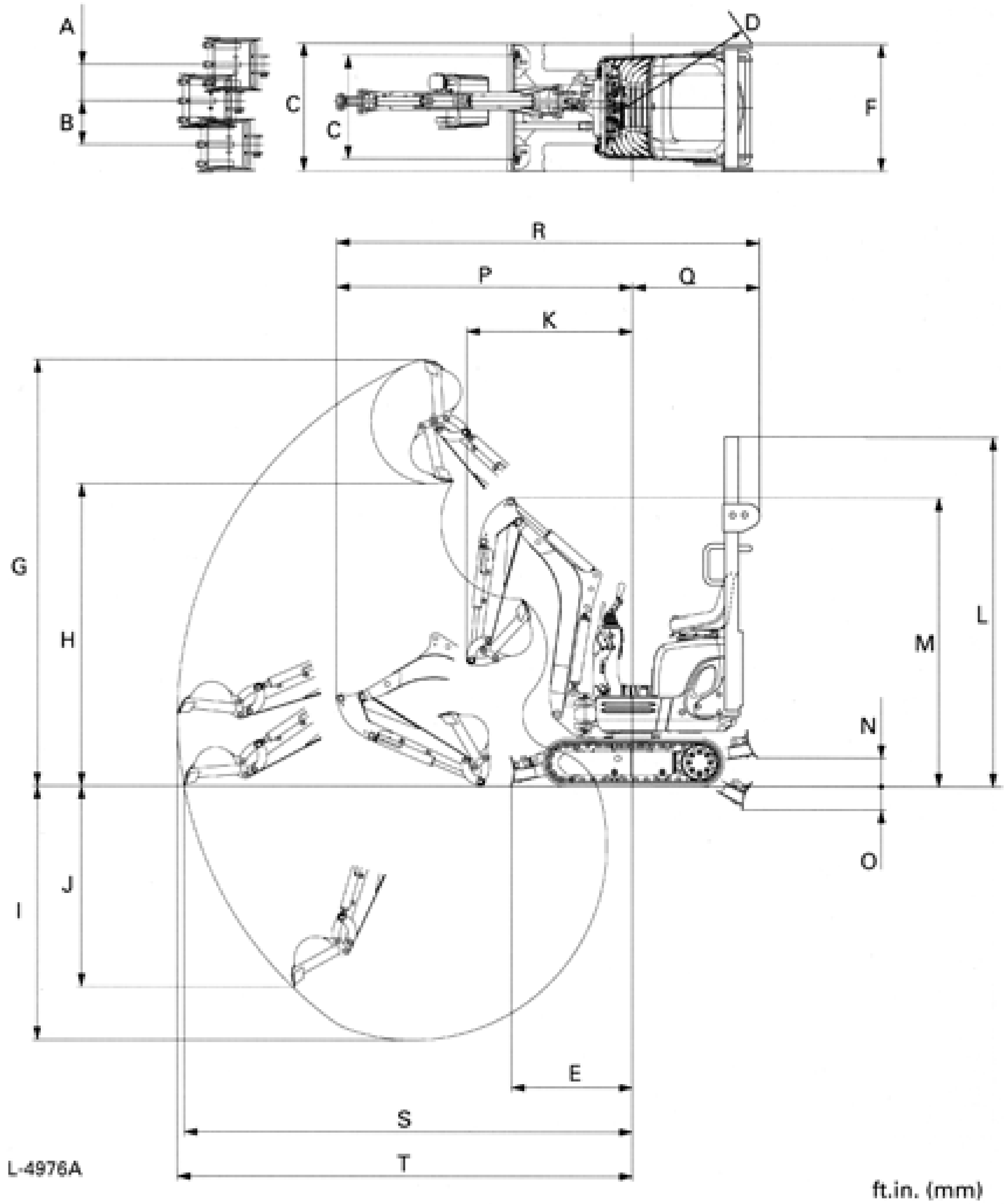
A.Specifications

a. EU - version



	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ	Ⓖ	Ⓗ	Ⓘ	Ⓙ	Ⓚ	Ⓛ	Ⓜ	Ⓝ	Ⓞ	Ⓟ	Ⓠ	Ⓡ	Ⓢ	Ⓣ
K008-3	245	300	700/ 860	750	820	700/ 860	2870	2030	1720	1380	1120	1420	1940	200	180	2000	750	2750	3020	3070
U10-3	355	435	750/ 990	500	900	750/ 990	3050	2210	1800	1550	1250	1420	2100	215	190	2310	670	2980	3330	3380

b. KTC, KCL, KTA - version



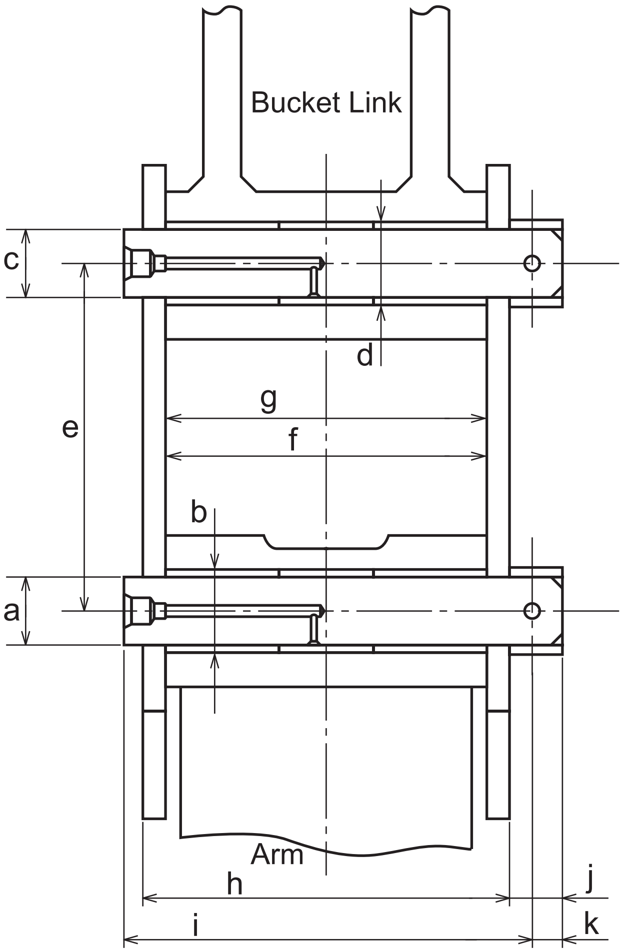
	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ	Ⓖ	Ⓗ	Ⓘ	Ⓙ	Ⓚ	Ⓛ	Ⓜ	Ⓝ	Ⓞ	Ⓟ	Ⓠ	Ⓡ	Ⓢ	Ⓣ
K008-3	0.8' (2450)	1' (300)	2'4" 3' (700/ 860)	2'11'' (880)	2'8'' (825)	2'7'' (800)	9'5'' (2870)	6'8'' (2035)	5'8'' (1715)	4'6'' (1375)	3'8'' (1120)	7'4'' (2230)	6'5'' (1945)	0.7' (200)	0.6' (180)	6'7'' (2000)	2'7'' (790)	9'2" (2790)	9'11" (3025)	10'1' '(3075)

B.Component interchangeability

a. Bucket

Bucket can be mounted between K-008 and K008-3new series in each local bucket as shown in the below table. Also below dimensions are for your reference to process local bucket in your place. Still bucket size and weight should be considered for safety, stability and performance.

	K-008		K008-3
Bucket	•	↔	•



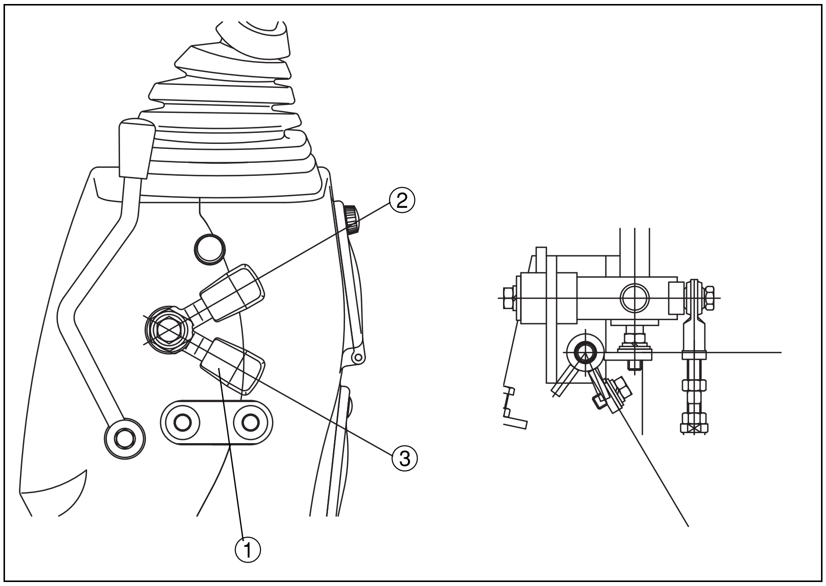
Unit:mm

	K008	K008-3
a(Bush) inner dia.	$\phi 25^{+0.13}_{+0.10}$	←
b(Arm) boss inner dia.	$\phi 33^{+0.025}_{0}$	←
c(Bucket) boss inner dia.	$\phi 25^{+0.13}_{+0.10}$	←
d(Link)	$\phi 33^{+0.025}_{0}$	←
e	85.1	←
f(Arm)	100	←
g(Bucket)	55^{+1}_{0}	←
h(Bucket)	124	←
i(Bucket)	20	←
j	149	←
k	11	←
l(pin dia.)	$\phi 25^{-0.05}_{-0.08}$	←

C.Machine structure

a. Control linkage

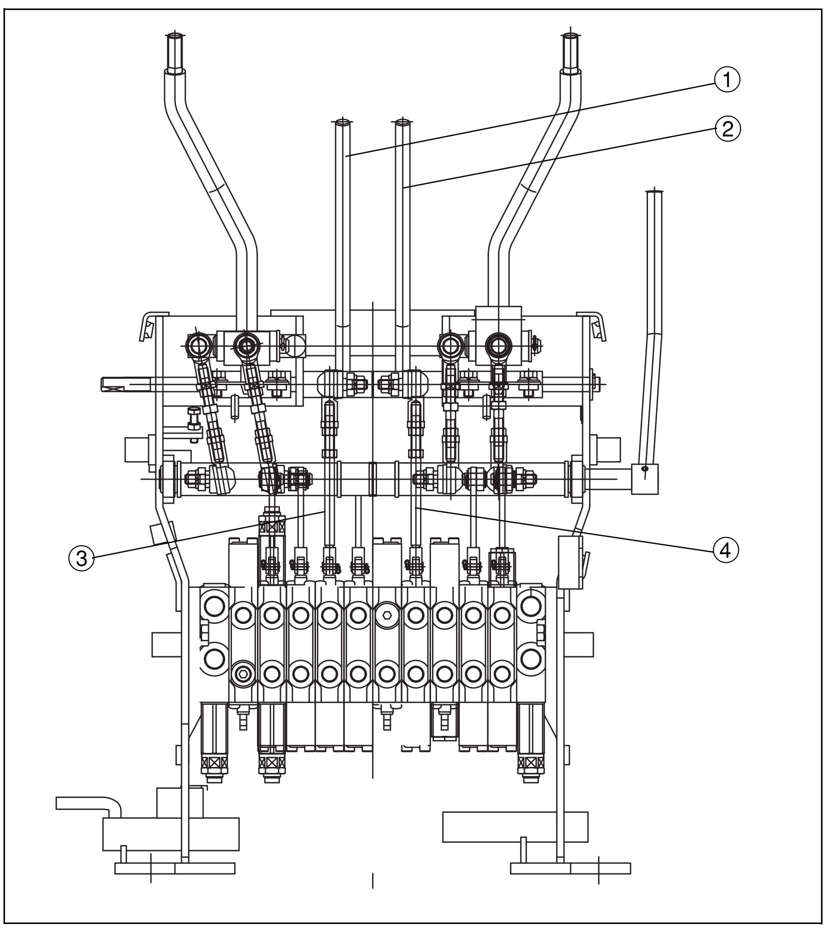
(1) Operating lever lock (K008-3)



① Operating lever lock
② Unlock position
③ Lock position

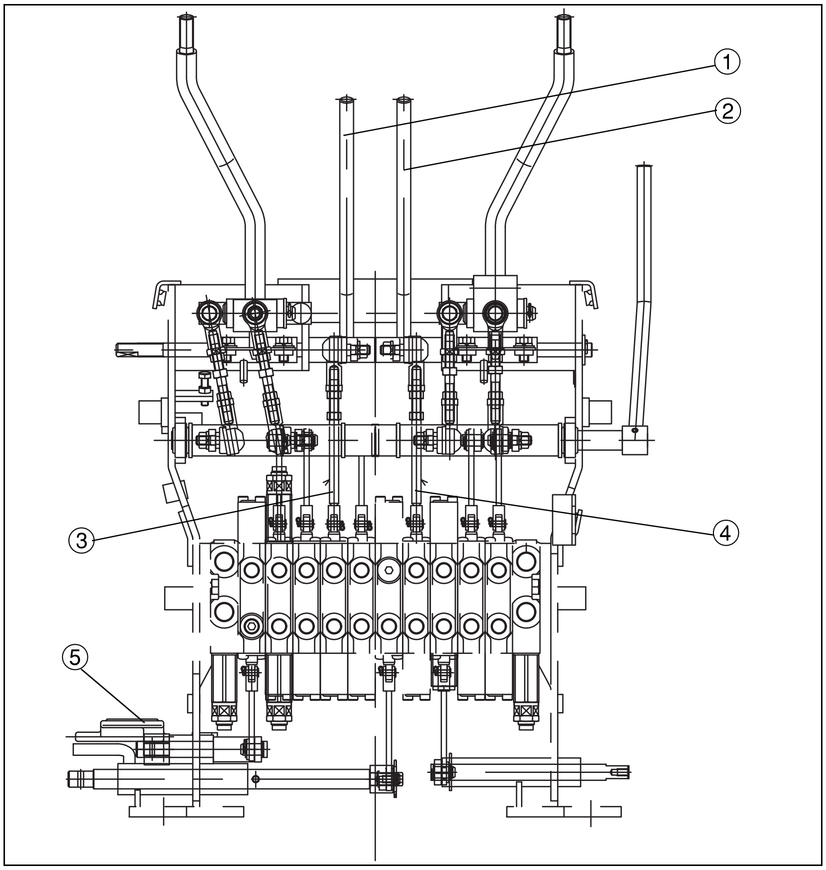
(2) Traveling lever

1. Single speed system (K008-3:EU version)



① Traveling lever LH
② Traveling lever RH
③ Rod for traveling LH
④ Rod for traveling LH

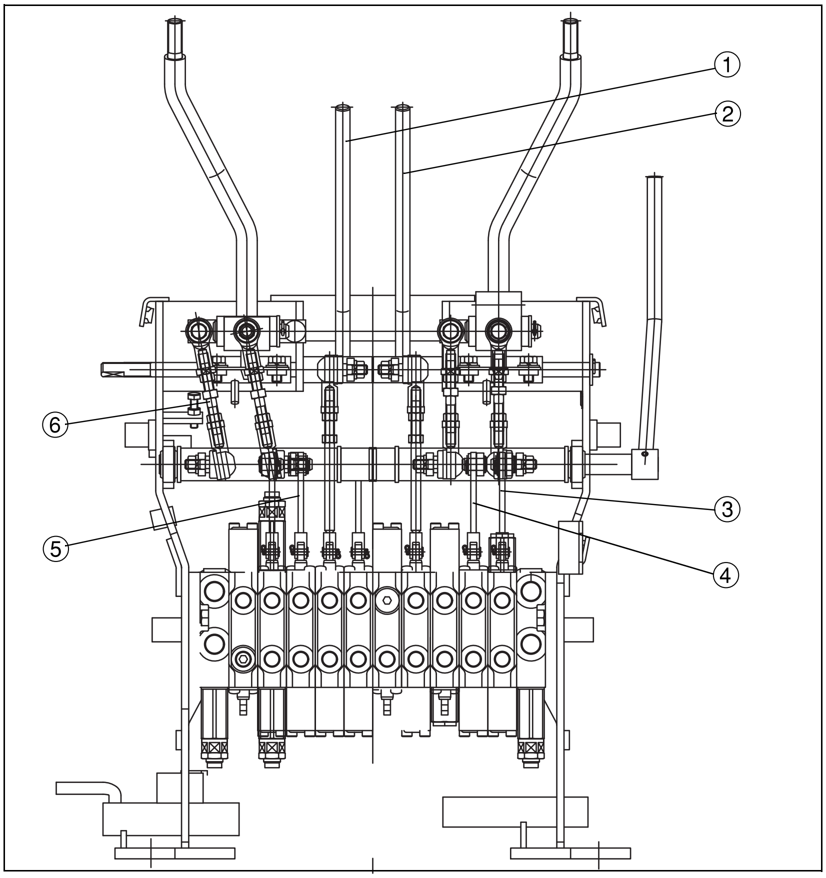
2. Too speed system (K008-3:KTC, KCL, KTA version)



① Traveling lever LH
② Traveling lever RH
③ Rod for traveling LH
④ Rod for traveling LH
⑤ High traveling speed pedal

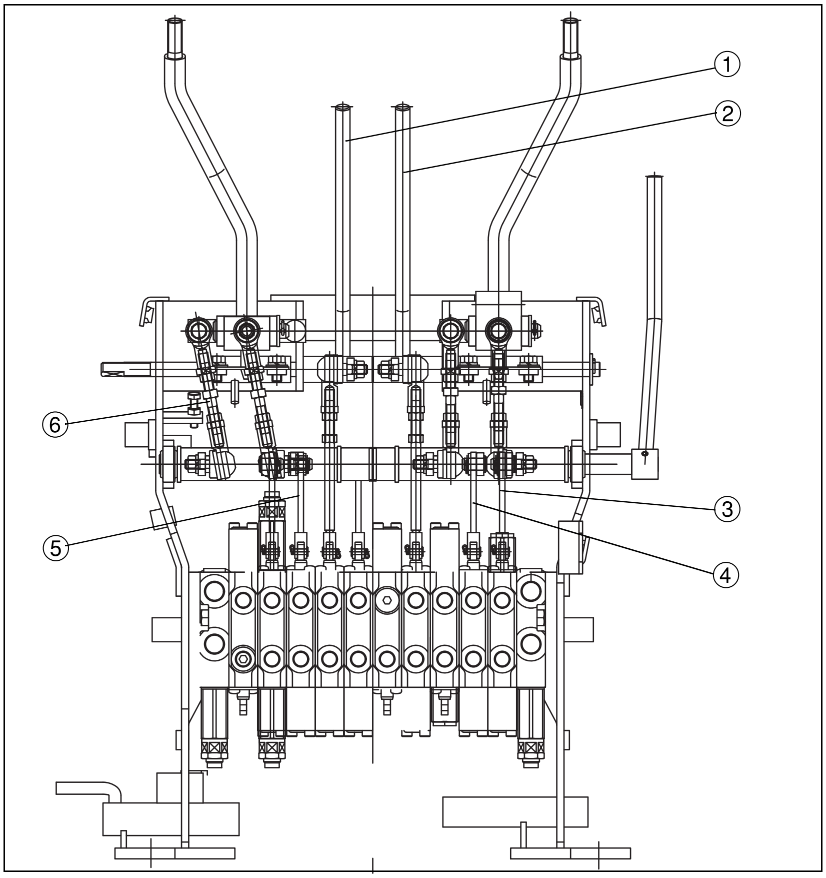
(3) Operating lever

1. K008-3:EU version



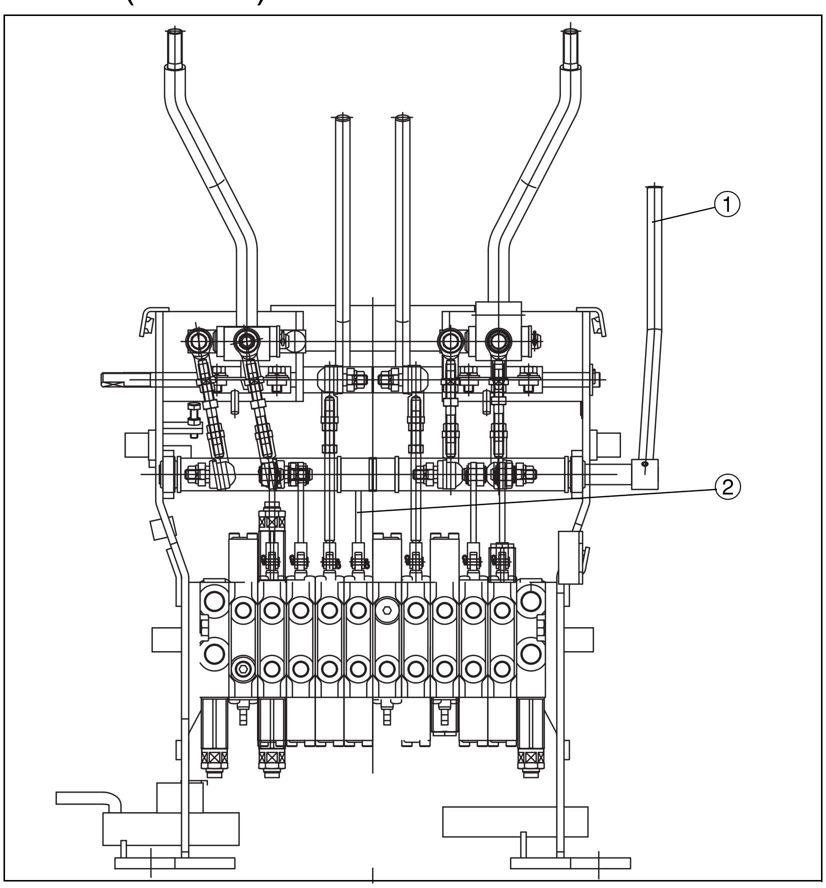
① Operating lever LH
② Operating lever RH
③ Boom
④ Bucket
⑤ Arm
⑥ Swivel

2. K008-3:KTC, KCL, KTA version



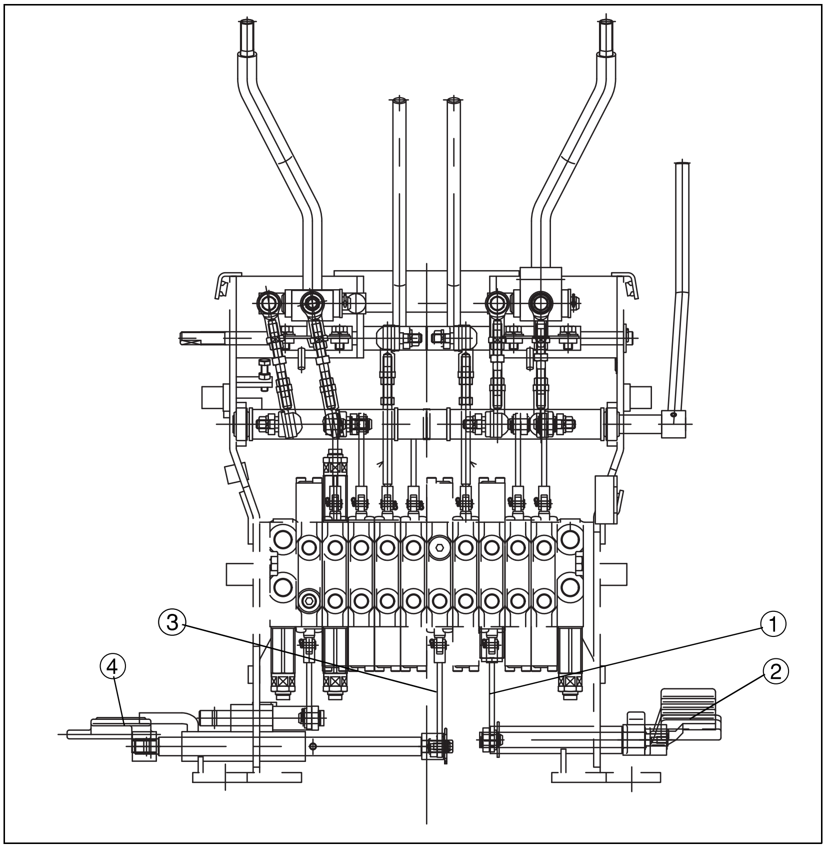
①Operating lever LH
②Operating lever RH
③Arm
④Bucket
⑤Boom
⑥Swivel

(4) Dozer (K008-3)



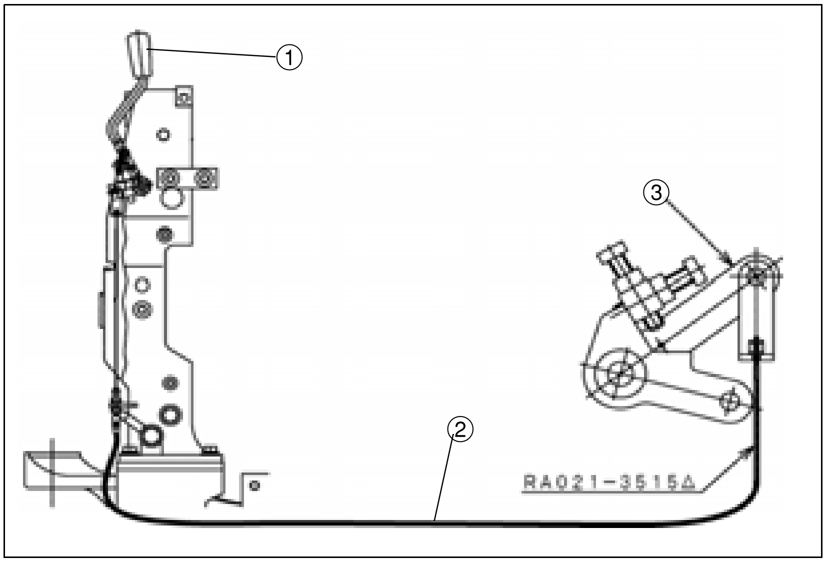
①Dozer lever
②Rod

(5) Swing and Service port (K008-3)



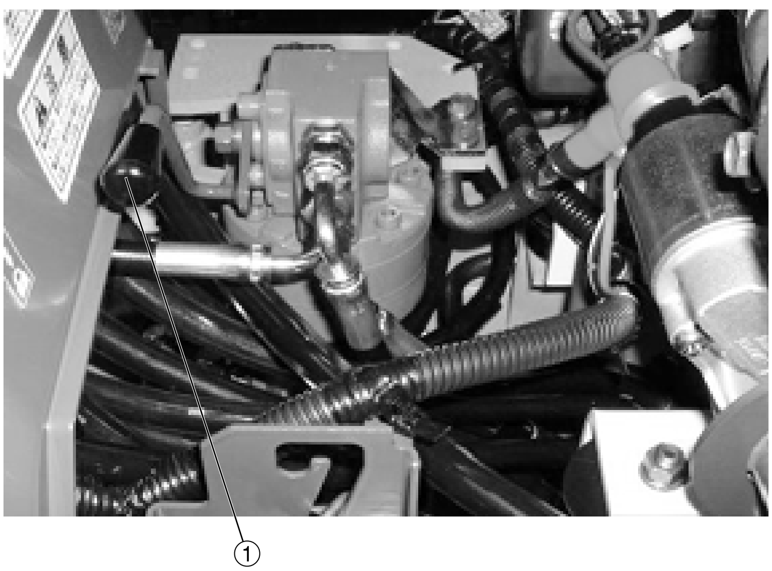
①Rod for swing
②Swing pedal
③Rod for service port
④Service port pedal

(6) Accelerator lever



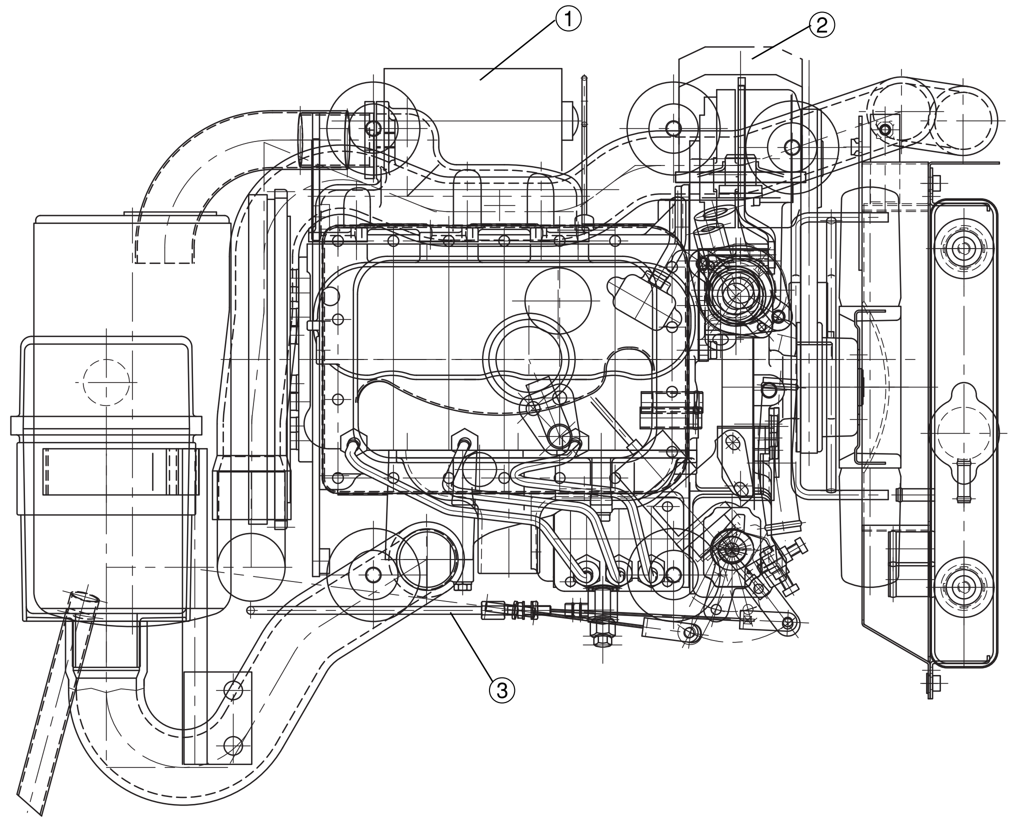
① Accelerator lever
② Accelerator Cable
③ Governor lever

(7) Change lever for retracting track frame

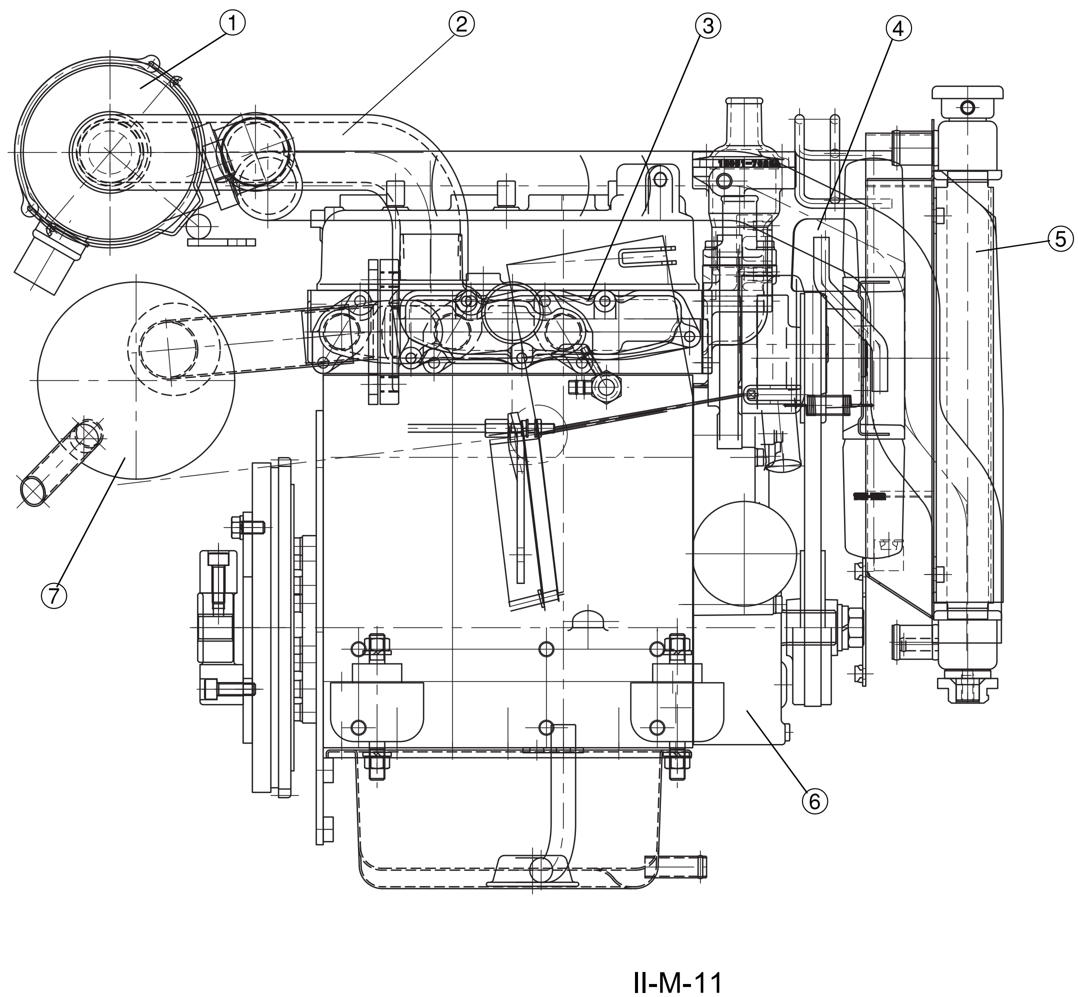


① Change lever

b. Engine mount



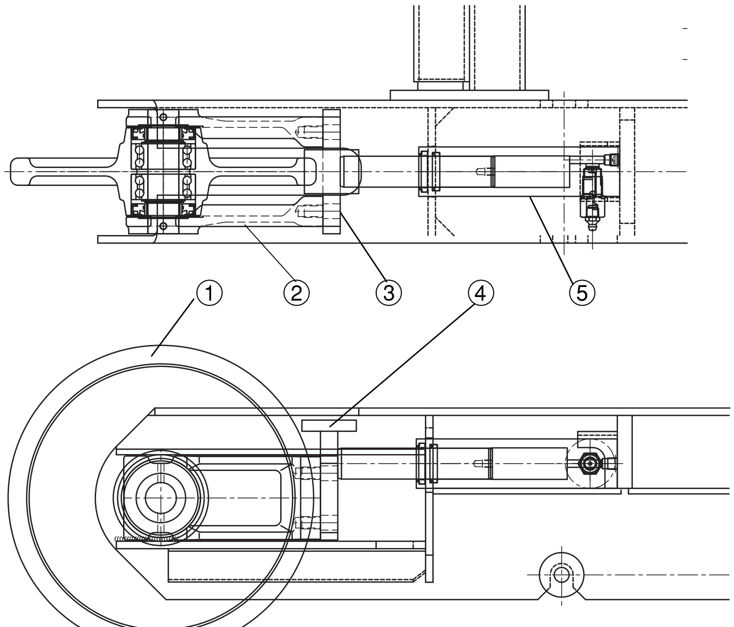
① Starter moter
② Alternator
③ Accelerator cable



① Air clearner
② Inlet hose
③ Exhaust manifold
④ Fan
⑤ Radiator
⑥ Rubber mount
⑦ Muffler

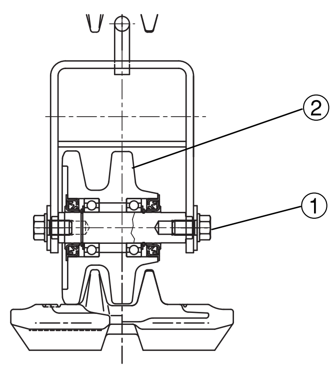
c. Under carriage

(1) Crawler Tension



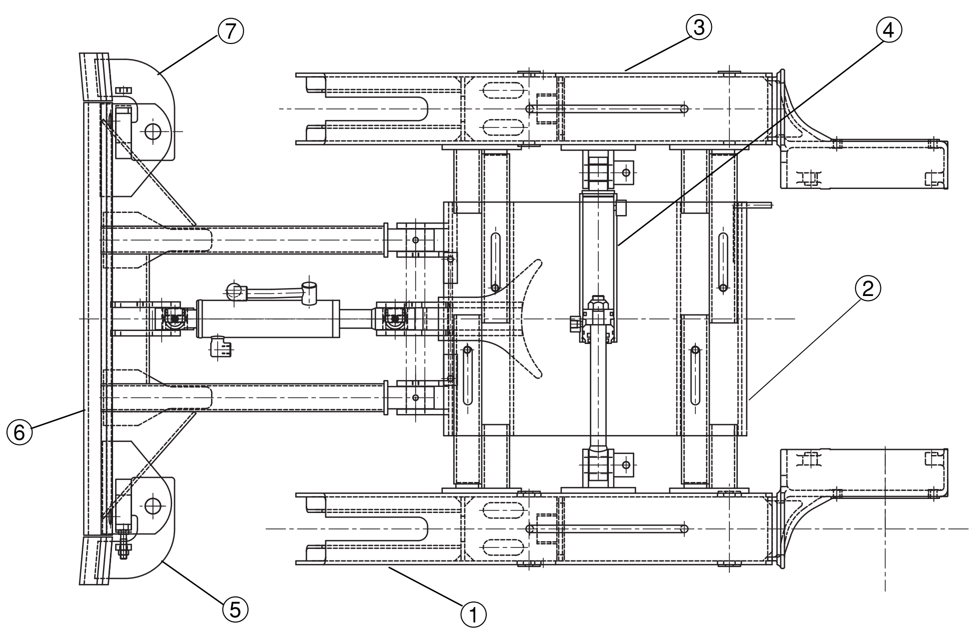
①Idler
②Idler support
③Bolt
④Plate
⑤Cylinder, grease

(2) Track roller



①Track roller
②Bolt

(3) Retractable undercarriage



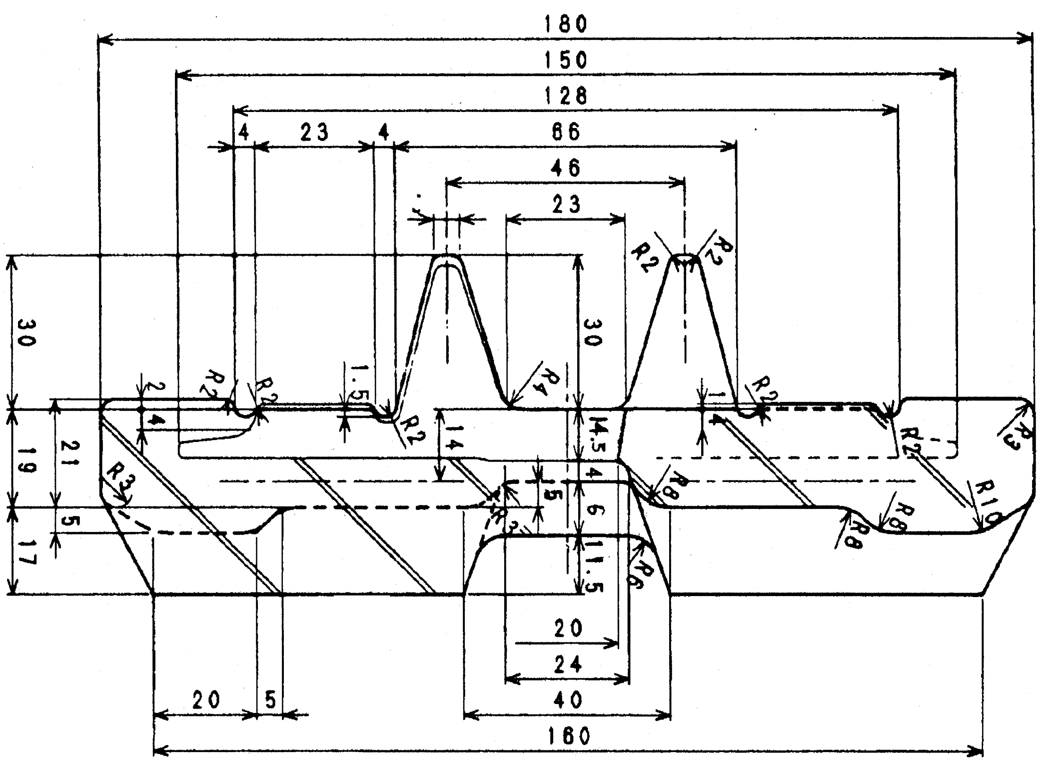
①Track, LH
②Track, Center
③Track, RH
④Track, Cylinder
⑤Blade, LH
⑥Blade, Center
⑦Blade, RH

(4) Rubber Crawler

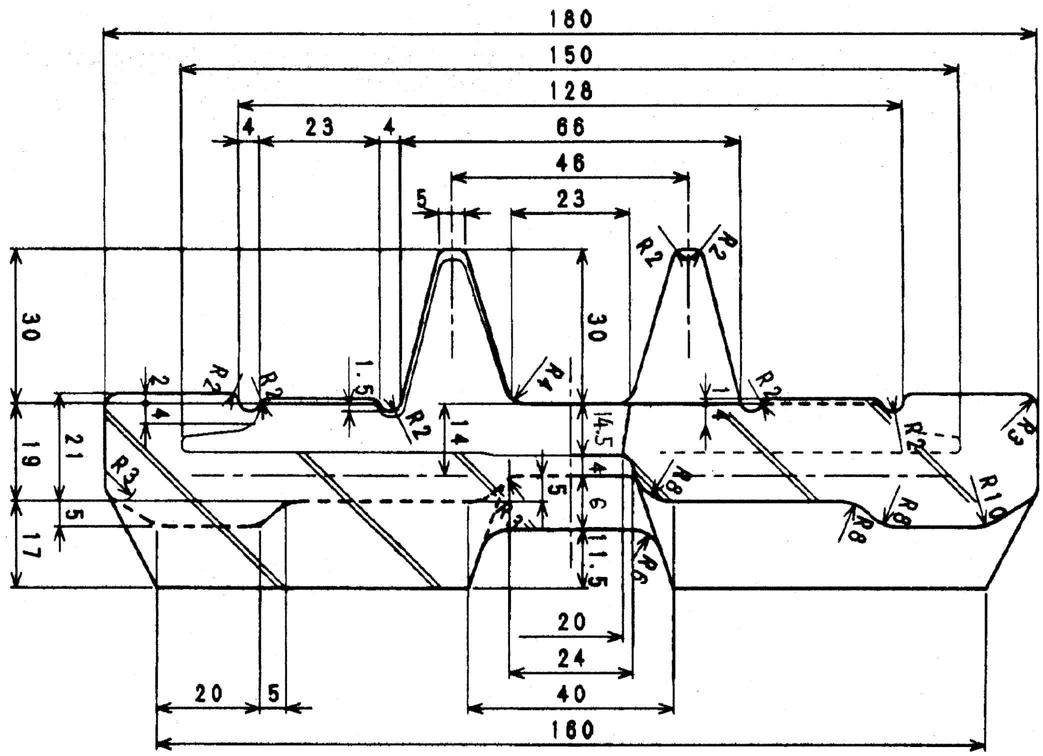
1. Specifications

Model	K008-3	U10-3
Part No.	RA021-2221△	RA131-2221△
Norminal size (Core length × No. of core × pitch)	180 mm × 37 × 72 mm 7.09 in. × 37 × 2.83 in.	180 mm × 40 × 72 mm
Center circumference	2664 mm ± 8 mm 104.88 in. ± 0.84 in.	2880 mm ± 8 mm
Steel code strength	3900 N 400 kgf 822 lbf	3900 N 400 kgf
Steel code number	37	40
Rubber thickness / Endress	19 mm / 22.5 mm 0.75 in. / 0.89 in.	19 mm / 22.5 mm
Robber Strength	13.7 MPa 140 kg / cm^2 1990 psi	13.7 MPa 140 kg / cm^2

2. K008-3



3. U10-3


180
150
128
4
23
4
66
46
5
23
R2
R2
30
30
R2
R2
1.5
R2
R4
R2
1
4
R3
2
4
14
14.5
19
21
R3
5
4
6
5
R3
R8
R10
R8
R8
17
11.5
R6
20
24
20
5
40
160

II. Machine body(Service section)

A.Specifications

a. Machine Weight

(1)K008-3, U10-3 EU - version

	unit	K008-3	U10-3
Machine weight	kg	850	980

(2)K008-3 KTC, KCL , KTA - version

	unit	K008-3	
Machine weight	kg lbs	920 2028	

b. Machine specifications

(1) K008-3, U10-3 EU version

			KUBOTA EXCAVATOR	
Model name			K008-3	U10-3
Type			Rubber tracks	
Machine weight		kg	850	980
Standard bucket	Volume	(CECE) m^3	0.022	0.024
	Width	mm	350	380
Engine	Type		Water cooled 3 cylinder Diesel	
	Model name		KUBOTA D722-BH-3	KUBOTA D722-BH-4
	Total displacement	cm^3	719	
	Engine power	kW (PS)	7.4 (10.2)	
	Rated speed	rpm	2050	
Performance	Swing speed	rpm	8.3	
	Travel speed	km/h	2.0	
	Ground pressure	kPa (kgf/cm^2)	22.5 (0.23)	24.5 (0.25)
	Climbing angle	% (deg)	27 (15)	
Dozer (width & height)		mm	700 x 200, 860 x 200	750 x 200, 990 x 200
Boom swing angle	Left	rad (deg)	0.96 (55)	
	Right	rad (deg)	1.05 (60)	0.96 (55)
Pressure connection for attachments	Displacement	L/min	21.0	
	Max. pressure	MPa (kgf/cm^2)	16.7 (170)	17.7 (180)
Fuel tank capacity		L	12	

NOTE:

- Above dimensions are based on the machine with JPN bucket.
  JPN = made in Japan

(2) K008-3 KTC, KCL, KTA version

			KUBOTA EXCAVATOR
Model name			K008-3
Type			Rubber tracks
Machine weight		lbs (kg)	2028 (920)
Standard bucket	Volume (CECE)	cu.in. (m^3)	1340 (0.022)
	Width	in. (mm)	13.8 (350)
Engine	Type		Water cooled 3 cylinder Diesel
	Model name		KUBOTA D722-EBH-3
	Total displacement	cu.in. (m^3)	44 (719)
	Engine power	HP (kW)	10.2 (7.4)
	Rated speed	rpm	2050
Performance	Swing speed	rpm	8.3
	Travel speed	mph (km/h)	1.2/2.5 (2.0/4.0)
	Ground pressure	psi (kgf/cm^2)	3.41 (0.24)
	Climbing angle	% (deg)	27 (15)
Dozer (width & height)		ft.in. (mm)	2 ft. 3.6 in. (700) x 7.9 in. (200), 2ft. 9.9 in. (860) x 7.9 in. (200)
Boom swing angle	Left	rad (deg)	0.96 (55)
	Right	rad (deg)	1.05 (60)
Pressure connection for attachments	Displacement	GPM (L/min)	5.55 (21.0)
	Max. pressure	psi (kgf/cm^2)	2420 (170)
Fuel tank capacity		gal (L)	3.2 (12)

NOTE:
- Above dimensions are based on the machine with JPN bucket.
  JPN = made in Japan

c. Lever stroke and operating force
(1) K008-3, U10-3 EU version

		Unit	K008-3	U10-3	Remarks
Boom	Stroke	mm	80	81	Up / Down
	Force	N kgf	14.7 / 14.7 1.5 / 1.5	14.7 / 14.7 1.5 / 1.5	Up / Down
Arm	Stroke	mm	80	81	Crowd / Dump
	Force	N kgf	14.7 / 14.7 1.5 / 1.5	14.7 / 14.7 1.5 / 1.5	Crowd / Dump
Bucket	Stroke	mm	70	81	Crowd / Dump
	Force	N kgf	14.7 / 14.7 1.5 / 1.5	14.7 / 14.7 1.5 / 1.5	Crowd / Dump
Swivel	Stroke	mm	70	81	Right / Left
	Force	N kgf	14.7 / 14.7 1.5 / 1.5	14.7 / 14.7 1.5 / 1.5	Right / Left
Travel	Stroke	mm	55	58	F / R
	Force	N kgf	10.8 / 10.8 1.1 / 1.1	7.8 / 7.8 0.8 / 0.8	F / R
Dozer	Stroke	mm	37	32	Up / Down
	Force	N kgf	19.6 / 19.6 2.0 / 2.0	19.6 / 19.6 2.0 / 2.0	Up / Down
Acceleration	Force	N kgf	24.5 2.5	24.5 2.5	
Swing pedal	Force	N kgf	4.9 5.0	4.9 5.0	Up / Down
Safety lock lever	Force	N kgf	19.6 2.0	19.6 2.0	

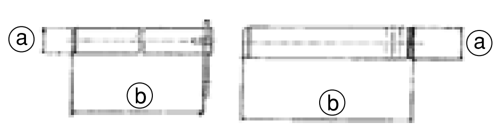
(2)K008-3 KTC, KCL, KTA version

		Unit	K008-3	Remarks
Boom	Stroke	mm in.	80 3.1	Up / Down
	Force	N kgf lbs	14.7 / 14.7 1.5 / 1.5 3.3 / 3.3	Up / Down
Arm	Stroke	mm in.	80 3.1	Crowd / Dump
	Force	N kgf lbs	14.7 / 14.7 1.5 / 1.5 3.3 / 3.3	Crowd / Dump
Bucket	Stroke	mm in.	70 2.8	Crowd / Dump
	Force	N kgf lbs	14.7 / 14.7 1.5 / 1.5 3.3 / 3.3	Crowd / Dump
Swivel	Stroke	mm in.	70 2.8	Right / Left
	Force	N kgf lbs	14.7 / 14.7 1.5 / 1.5 3.3 / 3.3	Right / Left
Travel	Stroke	mm in.	55 2.2	F / R
	Force	N kgf lbs	10.8 / 10.8 1.1 / 1.1 2.4 / 2.4	F / R
Dozer	Stroke	mm in.	37 1.5	Up / Down
	Force	N kgf lbs	19.6 / 19.6 2.0 / 2.0 4.4 / 4.4	Up / Down
Acceleration	Force	N kgf lbs	24.5 2.5 5.5	
Swing pedal	Force	N kgf lbs	4.9 5.0 11	Up / Down
Safety lock lever	Force	N kgf lbs	19.6 2.0 4.4	

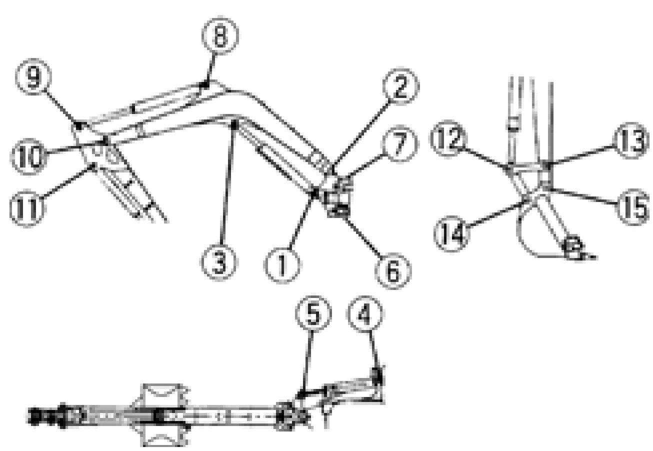
d. Dimensions of Parts

(1) Front pins

No.		Unit	K008-3	U10-3	Allowable wear limit
①	Pin diameter × length	mm in.	30 × 98.5 1.18 × 3.88	←	
②	Pin diameter × length	mm in.	30 × 218 1.18 × 8.58	←	
③	Pin diameter × length	mm in.	30 × 106 1.18 × 4.17	←	
④	Pin diameter × length	mm in.	30 × 103 1.18 × 4.06	←	
⑤	Pin diameter × length	mm in.	30 × 101 1.18 × 3.98	←	
⑥	Pin diameter × length	mm in.	30 × 82 1.18 × 3.23	←	
⑦	Pin diameter × length	mm in.	35 × 95 1.38 × 3.74	←	
⑧	Pin diameter × length	mm in.	30 × 98.5 1.18 × 3.88	←	
⑨	Pin diameter × length	mm in.	30 × 111 1.18 × 4.37	←	
⑩	Pin diameter × length	mm in.	30 × 173 1.18 × 6.81	←	
⑪	Pin diameter × length	mm in.	30 × 111 1.18 × 4.37	←	
⑫	Pin diameter × length	mm in.	30 × 150 1.18 × 5.91	←	
⑬	Pin diameter × length	mm in.	25 × 160 0.98 × 6.3	←	
⑭	Pin diameter × length	mm in.	25 × 160 0.98 × 6.3	←	
⑮	Pin diameter × length	mm in.	25 × 160 0.98 × 6.3	←	



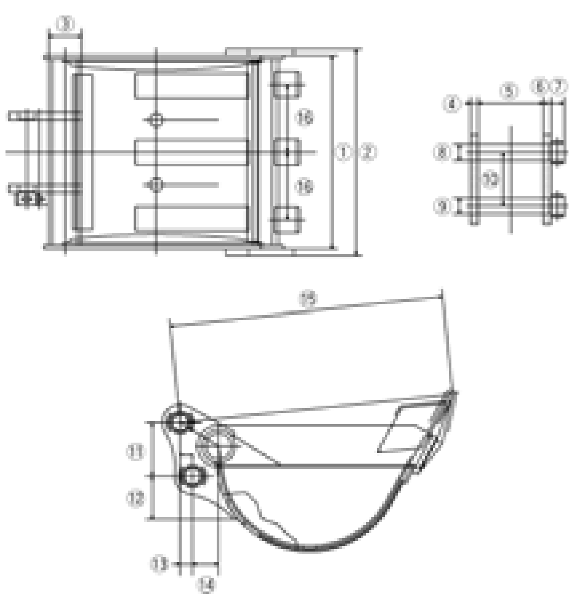
ⓐO.D.
ⓑLength



(2) Bucket

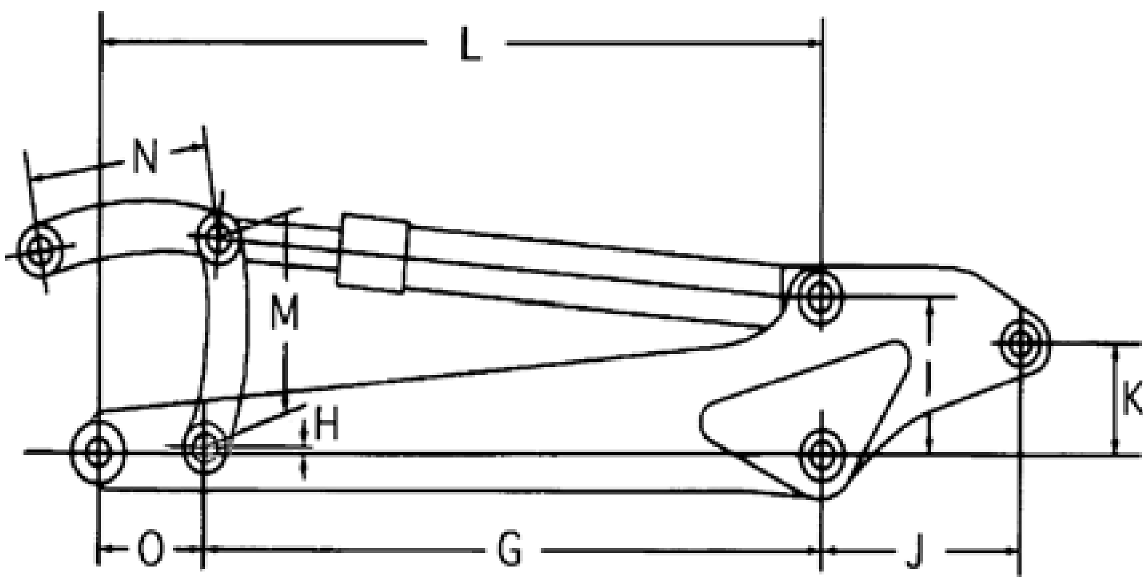
1) Bucket dimensions

No.	Unit	K008-3	U10-3	Remarks
①	mm in.	300 11.8	350 13.8	Lip outer width
②	mm in.	318 12.5	368 14.5	Side cutter outer width
③	mm in.	51 × 6 3.01 × 0.24	51 × 6 2.01 × 0.24	ϕ × t
④	mm in.	12 0.47	12 0.47	
⑤	mm in.	100 3.9	100 3.9	
⑥	mm in.	12 0.47	12 0.47	
⑦	mm in.	20 0.79	20 0.79	
⑧	mm in.	25 0.98	25 0.98	
⑨	mm in.	25 0.98	25 0.98	
⑩	mm in.	83 3.3	83 3.3	
⑪	mm in.	83 3.3	83 3.3	
⑫	mm in.	67 2.64	67 2.64	
⑬	mm in.	19 0.75	19 0.75	
⑭	mm in.	40 1.57	40 1.57	
⑮	mm in.	422 16.6	422 16.6	
⑯	mm in.	105 4.1	130 5.1	



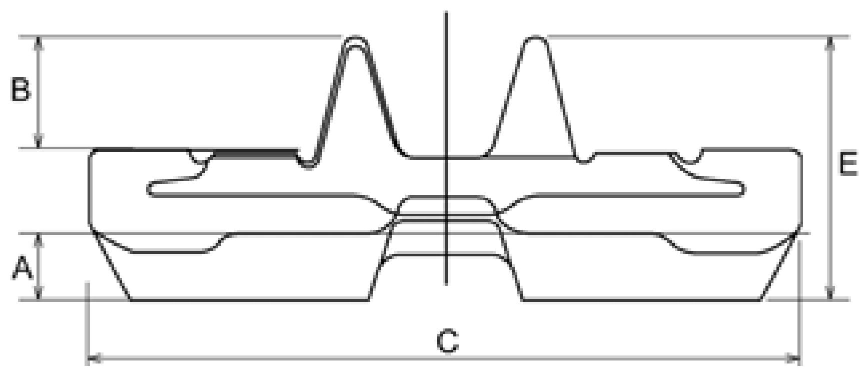
2. Bucket installation relevant dimensions

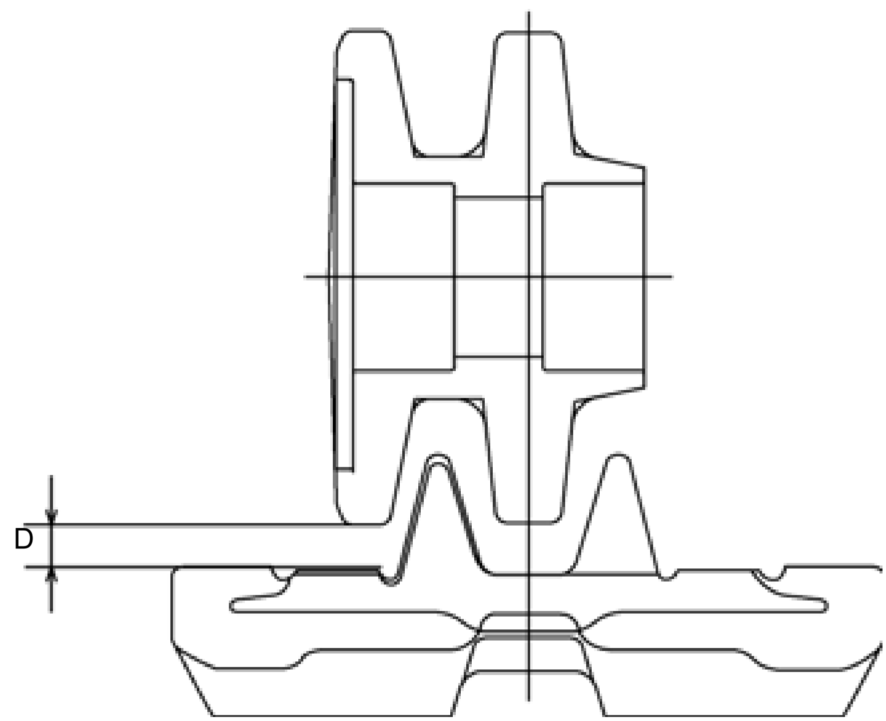
No.	Unit	K008-3	U10-3	Remarks
G	mm in	700 27.6	820 32.3	
H	mm in	0 0	←	
I	mm in	191 7.5	191.5 7.5	
J	mm in	118 4.6	145 5.7	
K	mm in	88 3.5	90 3.5	
L	mm in	702 27.6	←	
M	mm in	170 6.7	←	
N	mm in	165 6.5	←	
O	mm in	70 2.8	←	



(3) Rubber crawler

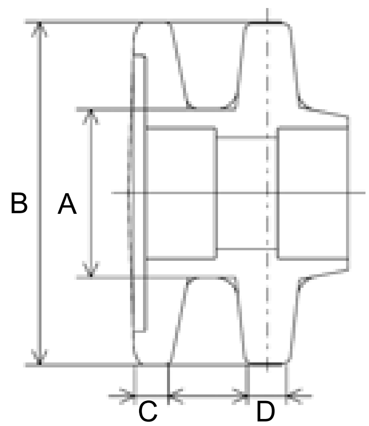
	Unit	K008-3	U10-3	Remarks
Crawler assy code No.		RA021-2221	RA131-2221	
Identification mark (Core steel rapping position)		∞	∞	
A : Lug height	mm in	17 0.7	←	
B : Link height	mm in	30 1.2	←	
C : Crawler width	mm in	180 7.1	←	
D : Crawler sag distance	mm in	10 ~ 15 0.4 ~ 0.6	←	
E : Crawler height	mm in	6.6 2.6	←	
Number of Core Iron				FCD450T
Rubber crawler center round length	mm in	2664 104.9	2880 113.4	
Core Iron pitch	mm in	72 2.8	←	





(4) Track toller, idler, sprocket

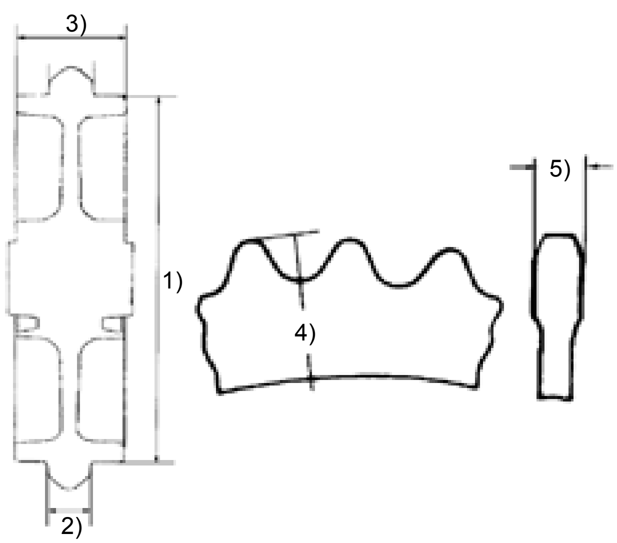
	Unit	K008-3	U10-3		Remarks
A : Guide width (A)/(B)	mm in	60.5 / 56.5 2.4 / 2.2	←		
B : Outer diameter (A)/(B)	mm in	124 / 120 4.9 / 4.7	←		
C : Roller width (A)/(B)	mm in	11 / 7 0.4 / 0.3	←		
D : Roller Width (A)/(B)	mm in	16 / 12 0.6 / 0.5	←		



(A)New machine reference value
(B)Allowable limit

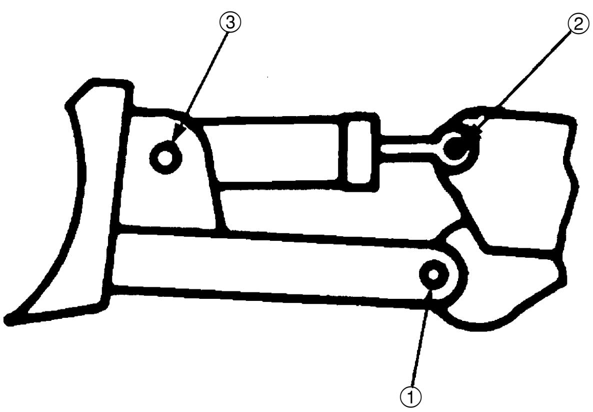
	Unit	K008-3	U10-3		Remarks
1) Idler O.D. (A)/(B)	mm in	225 / 217 8.91 / 8.5	←		
2) Guide width (A)/(B)	mm in	20 / 16 0.8 / 0.6	←		
3) Idler width (A)/(B)	mm in	64 /56 2.5 / 2.2	←		
4) Sprocket wheel O.D.. (A)/(B)	mm in	290 11.4	←		
5) Sprocket wheel width (A)/(B)	mm in	20 0.8	←		

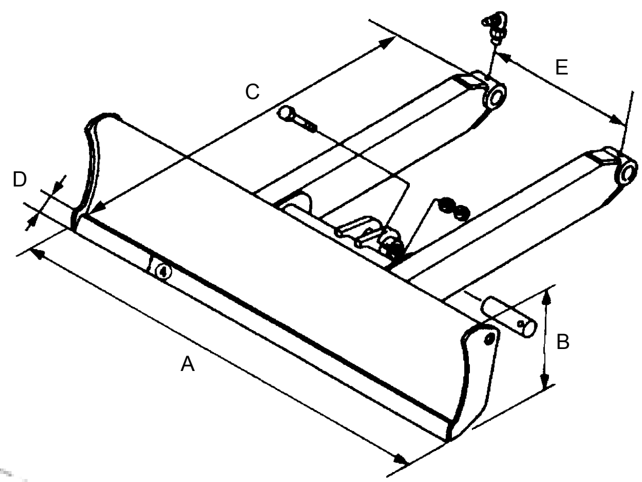
(A)New machine reference value
(B)Allowable limit

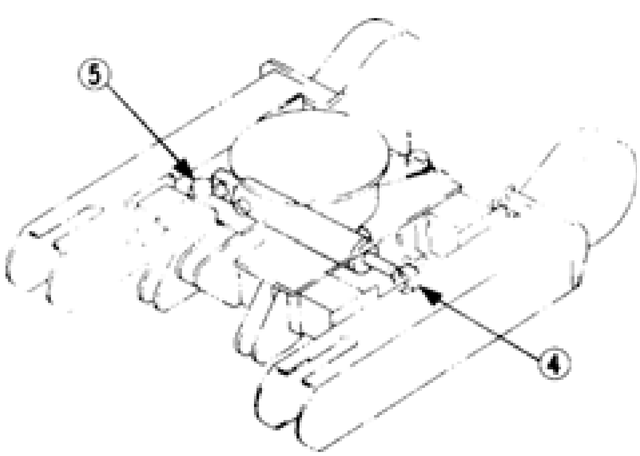


(6) Dozer

	Unit	K008-3	U10-3		Remarks
Assy code No					
① : Pin diameter × length	mm in	30 × 70 1.2 × 2.8	30 × 70 -		
② : Pin diameter × length	mm in	30 × 70 1.2 × 2.8	30 × 70 -		
③ : Pin diameter × length	mm in	30 × 70 1.2 × 2.8	30 × 70 -		
④ : Pin diameter × length	mm in	25 × 84 1.0 × 3.3	25 × 118 -		
⑤ : Pin diameter × length	mm in	25 × 84 1.0 × 3.3	25 × 118 -		
A : Dozer width	mm in	700 / 860 27.6 × 33.9	750 / 1000 -		
B : Dozer height	mm in	200 7.9	200 -		
C : Dozer length	mm in	499.8 19.7	612.2 -		
D : Dozer tip plate height × thickness	mm in	-	-		
E : Length between dozer arms	mm in	255 10.0	263 -		







(7) Parts weight

1) K008-3, U10-3 EU version

	Unit	K008-3	U10-3	Remarks
Track frame	kg	32	43	wide (left)
		32	43	wide (right)
		47	63	Track frame center
Swivel frame	kg	82	82	
Boom	kg	40	43	
Arm	kg	17	21	
Bucket	kg	16	17	
Dozer	kg	30	34	
Weight (rear)	kg	74	74	
Weight (left)	kg	29	30	
Weight (right)	kg	28	30	
Gear pump	kg	4	4	
Control valve	kg	12	12	
Swivel motor	kg	8	8	
Travel motor	kg	20	20	
Swivel bearing	kg	15	15	
Swing bracket	kg	13	13	
Oil tank	kg	13	13	
Swivel joint assy	kg	4	4	
Bonnet	kg			
Rubber crawler	kg	30	32.4	

2) K008-3 KTC, KCL, KTA version

	Unit	K008-3	Remarks
Track frame	kg lbs	32 14.5	Side (left)
	kg lbs	32 14.5	Side (right)
	kg lbs	47 21.3	Center
Swivel frame	kg lbs	82 37.2	
Boom	kg lbs	70 18.1	
Arm	kg lbs	17 7.7	
Bucket	kg lbs	16 7.3	
Dozer	kg lbs	30 13.6	
Weight (rear)	kg lbs	74 33.6	
Weight (left)	kg lbs	29 13.2	
Weight (right)	kg lbs	28 12.7	
Gear pump	kg lbs	4 1.8	
Control valve	kg lbs	12 5.4	
Swivel motor	kg lbs	8 3.6	
Travel motor	kg lbs	20 9.1	
Swivel bearing	kg lbs	15 6.8	
Swing bracket	kg lbs	13 5.9	
Oil tank	kg lbs	13 5.9	
Swivel joint assy	kg lbs	4 1.8	
Bonnet	kg lbs		
Rubber crawler	kg lbs	30 13.6	
Sprocket	kg lbs	4 1.8	
Idler assy	kg lbs	8 3.6	
Boom cylinder	kg lbs	12 5.4	
Arm cylinder	kg lbs	9 4.1	

	Unit	K008-3	Remarks
Bucket cylinder	kg lbs	9 4.1	
Swing cylinder	kg lbs	8 3.6	
Dozer cylinder	kg lbs	6 2.7	
Rotary joint	kg lbs	4 1.8	

The weights listed above are based on calculations and slightly different from actual ones.

(7) Water and Oil Quantity

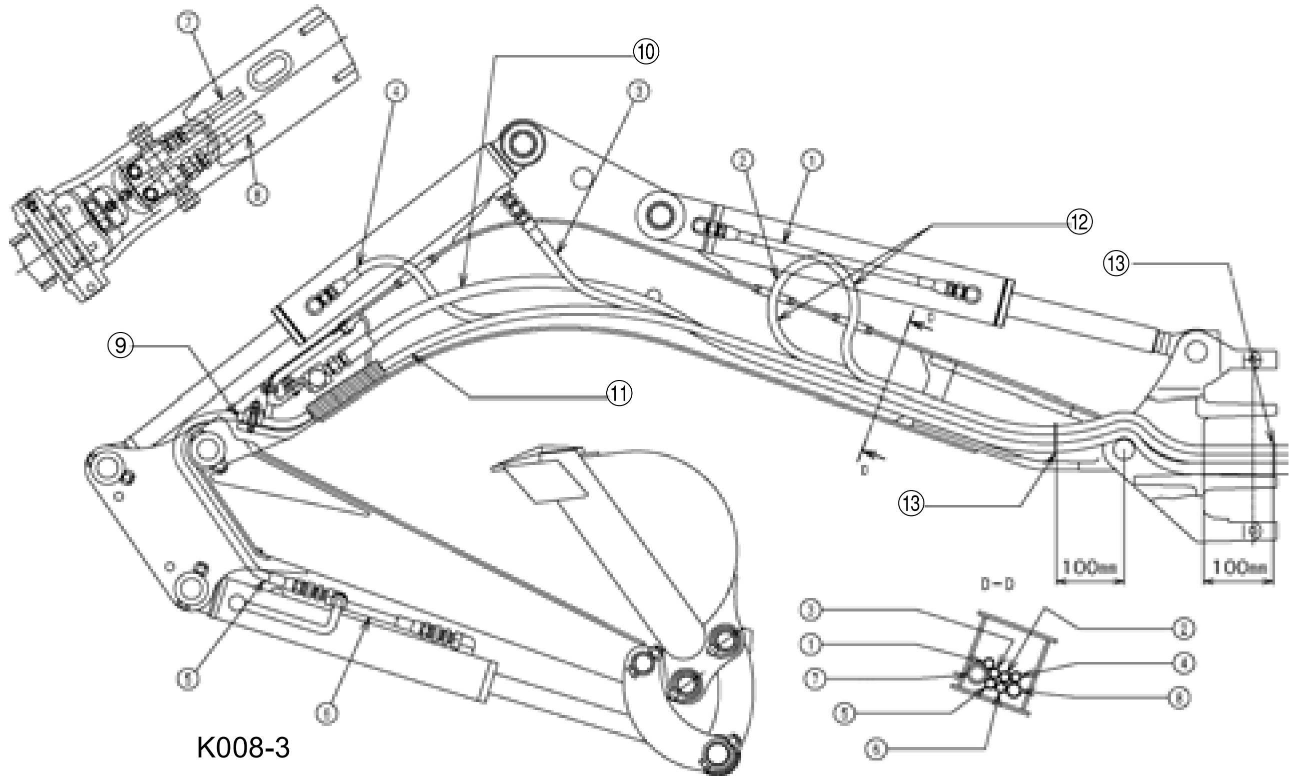
	Unit	K008-3	U10-3		Remarks
Radiator Canopy / Cab	L gal	2.8 0.74	←		Kubota LLC-N-50F 50%
Reserve tank	L gal	0.5 0.13	←		
Engine Crank case	L gal	2.2 0.58	←		SAE10W30(CD)
Hydraulic oil Full	L gal	18 4.73	←		ISO 46
Hydraulic oil Tank	L gal	13.5 3.54	←		ISO 46
Wheel motor	L gal	-	-		
Track roller	cc gal	8 2.1	←		Grease
Upper roller	cc gal	-	-		
Front idler	cc gal	11 2.89	←		Grease
Fuel tank	L gal	11 2.89	←		

B.Front attachment

a. Front attachment assembly procedure

1) Apply grease sparingly to pins before assembling them (ALBANIA EP2, MOBIL PLEX or equivalent)
2) Tightening torque of pin lock bolts : 48~56N·m (4.9~5.7kgf·m)
3) Do not tighten the lock nuts firmly.

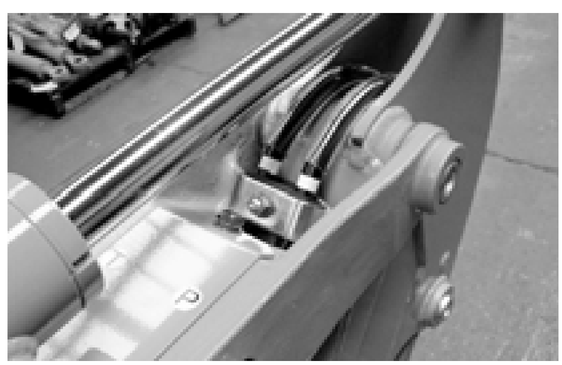
Front hose : K008-3



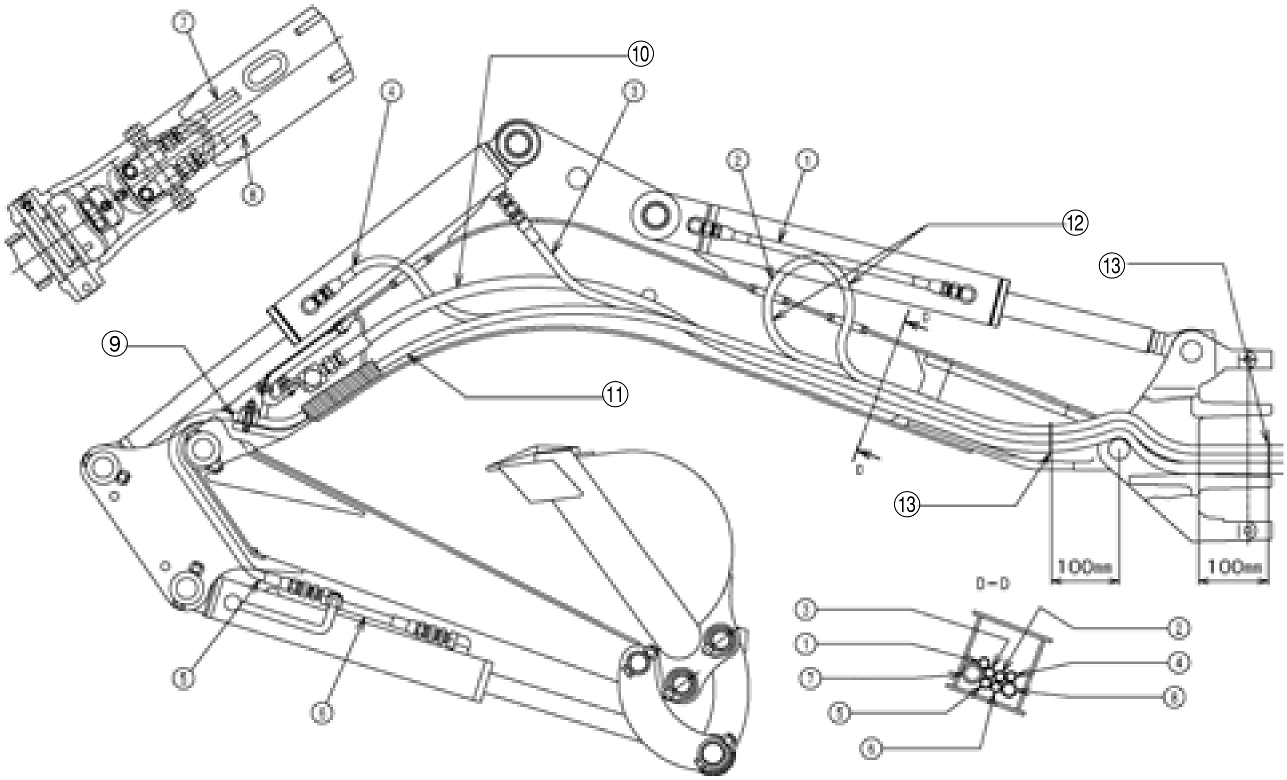
K008-3

SP specification only

No.	Parts name	Q'ty
①	Hose (High pressure, 1/4)	1
②	Hose (High pressure, 1/4)	1
③	Hose (High pressure, 1/4)	1
④	Hose (High pressure, 1/4)	1
⑤	Hose (High pressure, 1/4)	1
⑥	Hose (High pressure, 1/4)	1
⑦	Hose (High pressure, 3/8)	1
⑧	Hose (High pressure, 1/2)	1
⑨	White tape attached	
⑩	Service port hose to be lowermost for SP spec. only	
⑪	Bucket cylinder hose to be lowermost for standard spec. only	
⑫	Boom cylinder hose to be uppermost	
⑬	Vinyl clamp	



Front hose : U10-3

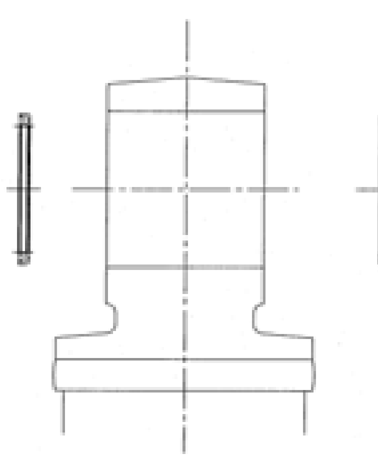


U10-3

SP specification only (⑦, ⑧)

No.	Parts name	Q'ty
①	Hose (High pressure, 1/4)	1
②	Hose (High pressure, 1/4)	1
③	Hose (High pressure, 1/4)	1
④	Hose (High pressure, 1/4)	1
⑤	Hose (High pressure, 1/4)	1
⑥	Hose (High pressure, 1/4)	1
⑦	Hose (High pressure, 3/8)	1
⑧	Hose (High pressure, 1/2)	1
⑨	White tape attached	
⑩	Service port hose to be lowermost for SP spec. only	
⑪	Bucket cylinder hose to be lowermost for standard spec. only	
⑫	Boom cylinder hose to be uppermost	
⑬	Vinyl clamp	

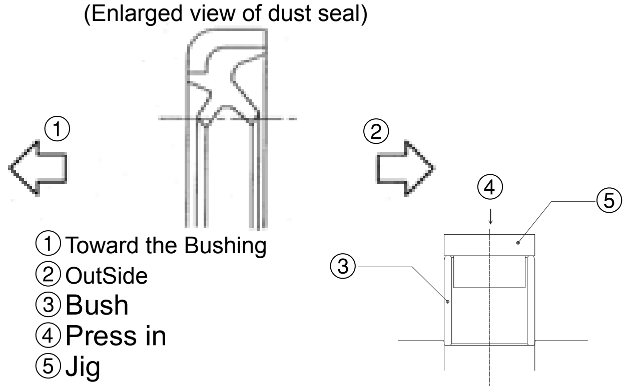
Installing direction of dust seal



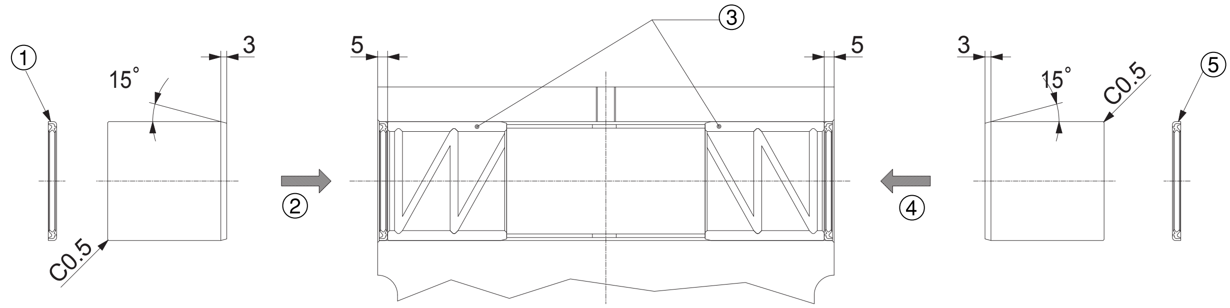
①Bush
②Dust Seal

Install the dust seals in the direction as shown at left. If in the wrong direction, the sealing effect is adversely affected, which may get the pins worn out earlier.

(Enlarged view of dust seal)

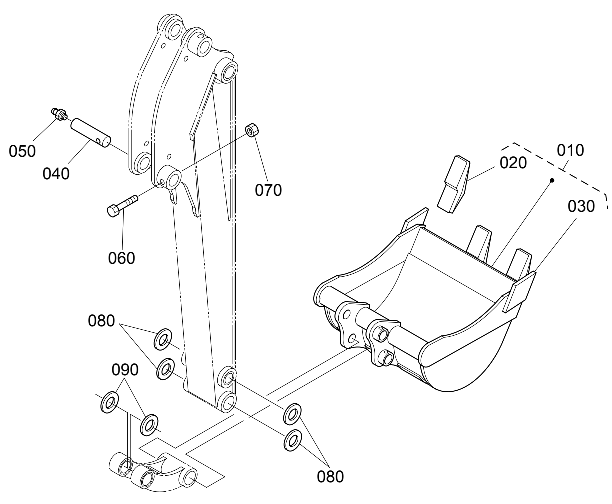


①Toward the Bushing
②OutSide
③Bush
④Press in
⑤Jig

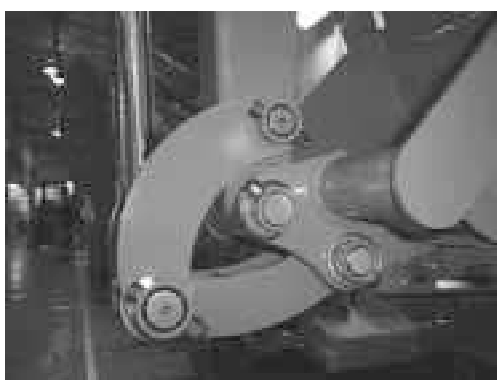


①Dust seal ②Bush direction ③Bush ④Bush direction ⑤Dust seal

Installing local bracket



RA028-033-10



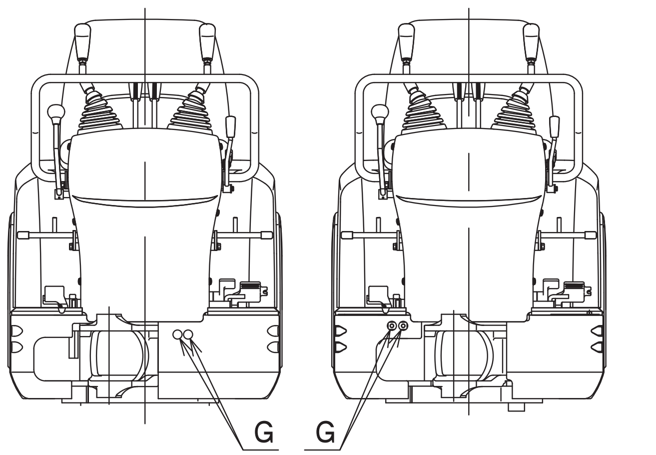
010	Assy, Bucket	
020	Teeth	
030	Cutter, Side	
040	Pin	
050	Nipple, Grease	
060	Bolt	
070	Nut, Lock	
080	Shim	As required 0.5mm
080	Shim	As required 1.0mm
080	Shim	As required 1.5mm
090	Shim	As required 0.5mm
090	Shim	As required 1.0mm
090	Shim	As required 1.6mm

b. Greasing points

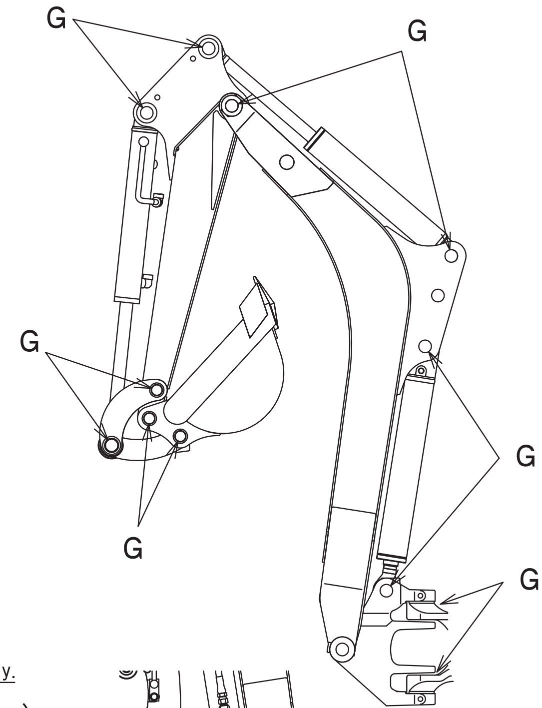
G : Greasing points

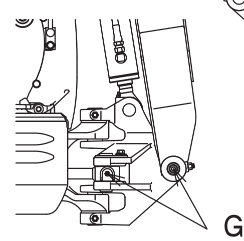
(Apply grease to such an extent that it should not run off the pins.)

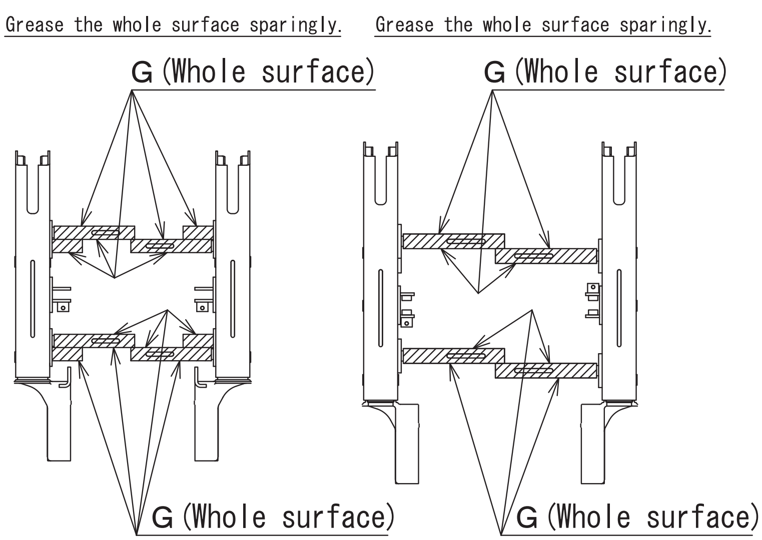
*Note: Balls and teeth of the swivel bearing may be greased before assembly.

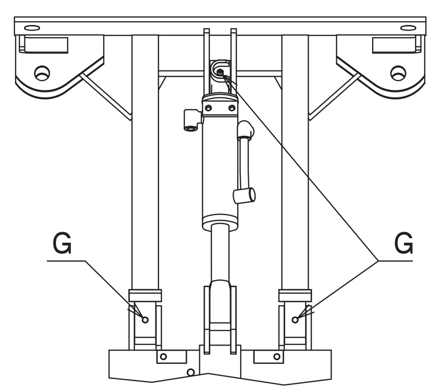


K008-3 U10-3





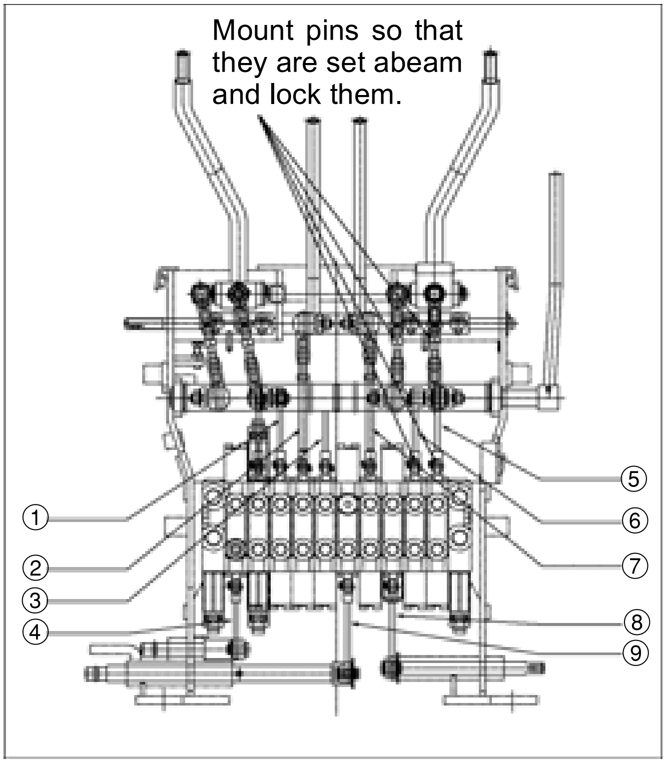




C.Upper Structure

a. Operating unit

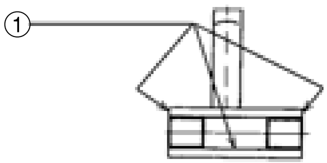
(1) K800-3 mechanical operating unit



①Arm ⑥Bucket
②Travel (L) ⑦Travel (R)
③Dozer ⑧Swivel
④2-speed ⑨Service
⑤Boom

■ Assembly procedure

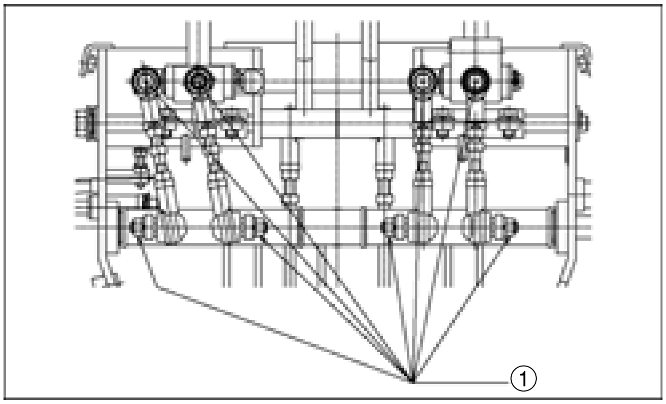
1) Mount the pins so that they are set abeam to the connection of rod and valve spool and tighten them with lock nuts.
2) Adjustment of lever (control, right & left) and lever (travel, right & left)
   1. Levers should be set vertically (at right angle) to the valve and stand frame.
   2. Rod length (Reference value)
      Travel (R) 152 mm
      (L) 152 mm



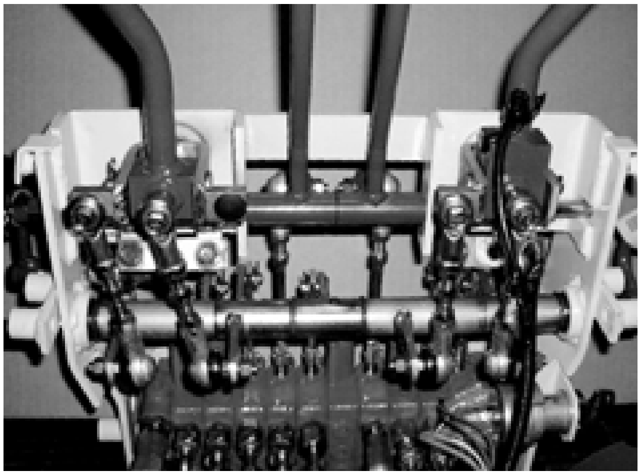
①Apply grease.

   3. Apply grease to the lever (travel right & left).
3) Tightening torque of operating pattern selecting section assembling bolts and nuts:
   * Apply screw lock agent.

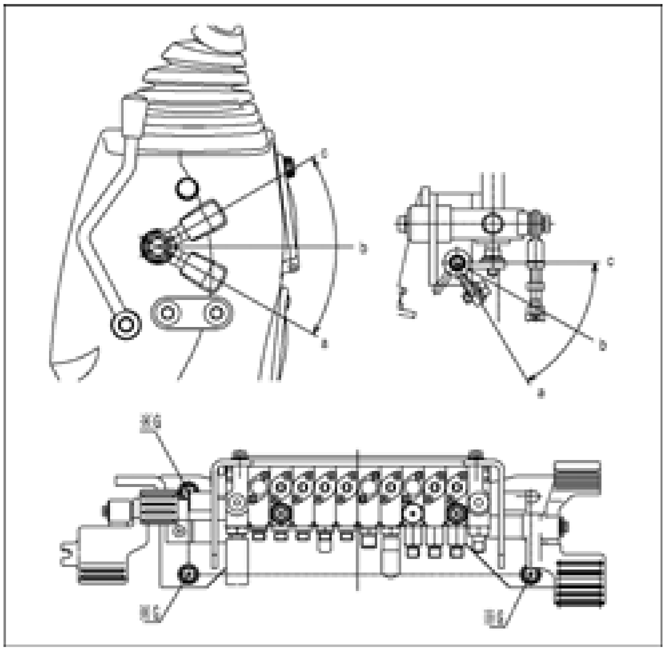
Operating pattern selecting section



①Apply screw lock agent.

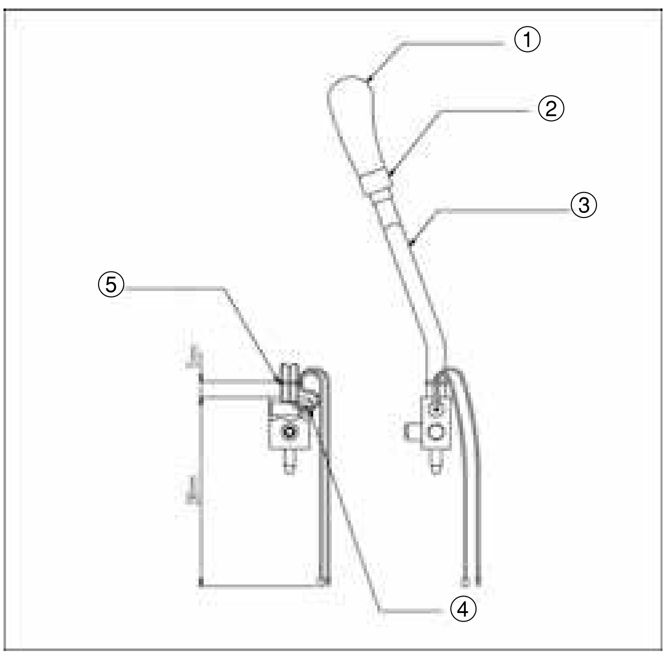


Assembling the lever (lock) and bracket (operation)



4) Adjustment of lever lock operation
   Lever should be engaged securely and lightly.
   a. Free state
      14.7~24.5N·m (1.5~2.5kgf·m)
   b. At lever engaged
      Up to 50N·m (5kgf·m)
   c. At lever locked
      Front attachment should not be operated even when 50N·m (5kgf·m) load is applied.
5) Assembling the bracket
   Tightening torque bolts at G
   : 48.1~55.9N·m (4.9~5.7kgf·m)
   * Apply screw lock agent.

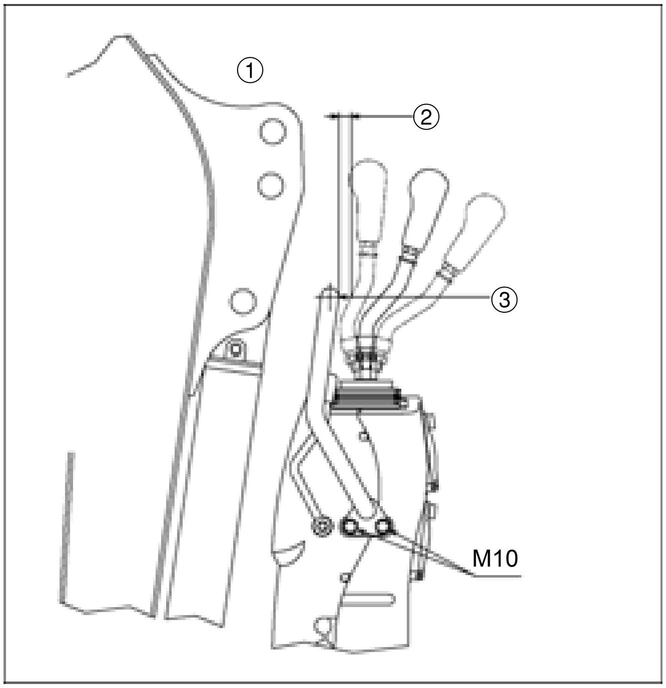
Assembling the grip (R)(K008-3)



①Grip (R)
②Tube (1)
③Lever (operating, right)
④Grommet
⑤Vinyl clamp

6) Assembling the grip (R)
   1. Assemble the grip (R) after turning it counterclockwise 8 or 9 times.
   2. Assemble the wire harness so that wires inside should not be tensed.
   3. Mount the terminal at a position 290 mm from the vinyl clamp.

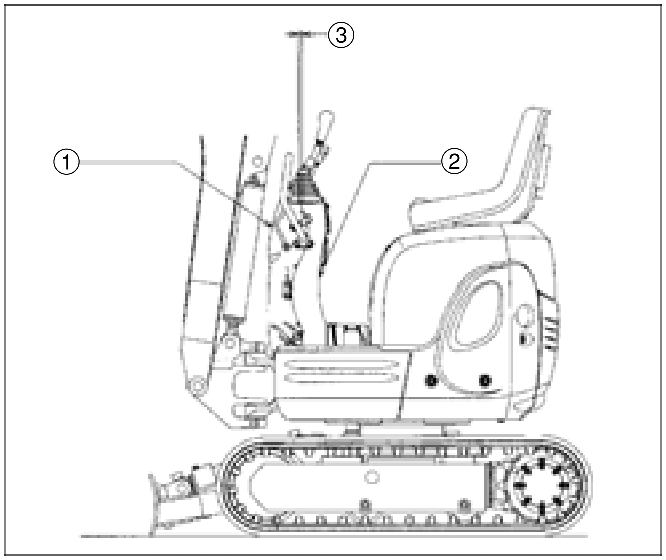
Assembling the handrail



①Provide clearance.
②More than 10 mm
③Assemble it, reclining forward.

7) Assembling the hand rail
   1. Assemble the handrail, reclining it forward and tighten.
   2. Tightening torque of hand rail: 48~56N·m (4.9~5.7kgf·m)

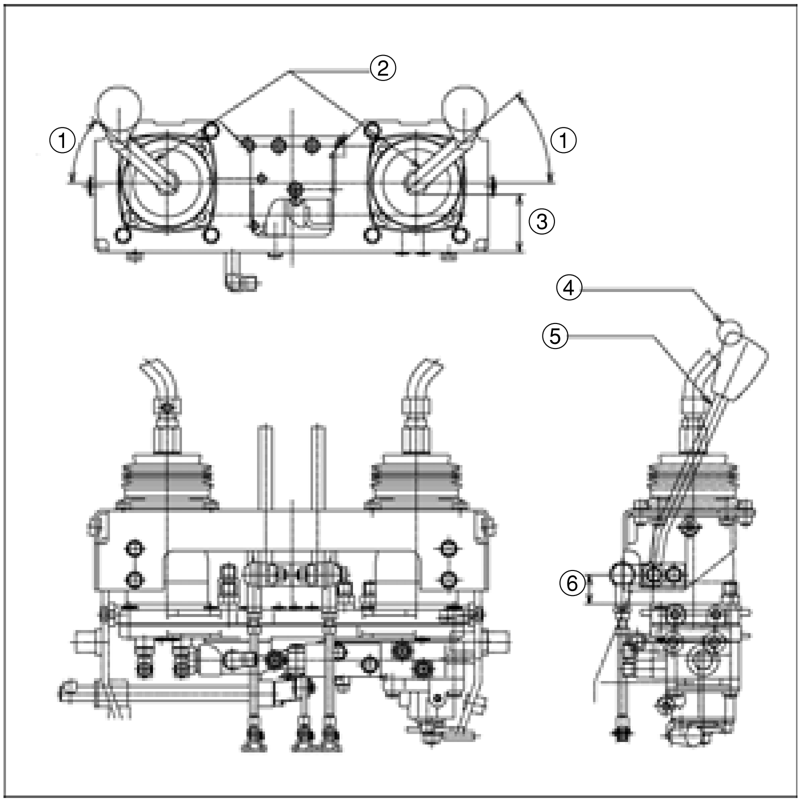
Assembling the covers (front) and (rear)



①Cover (front)
②Cover (rear)
③Parallelism and clearance should be less than 2 mm.

8) Assembling the covers (front) and (rear)
   1. Parallelism and clearance should be less than 2 mm.
   2. Tightening torque of mounting bolt (for resin) M8:10~12N·m (1.0~1.2kgf·m)
   3. Tighten the mounting bolt with round part of plain washer M8 facing to cover.

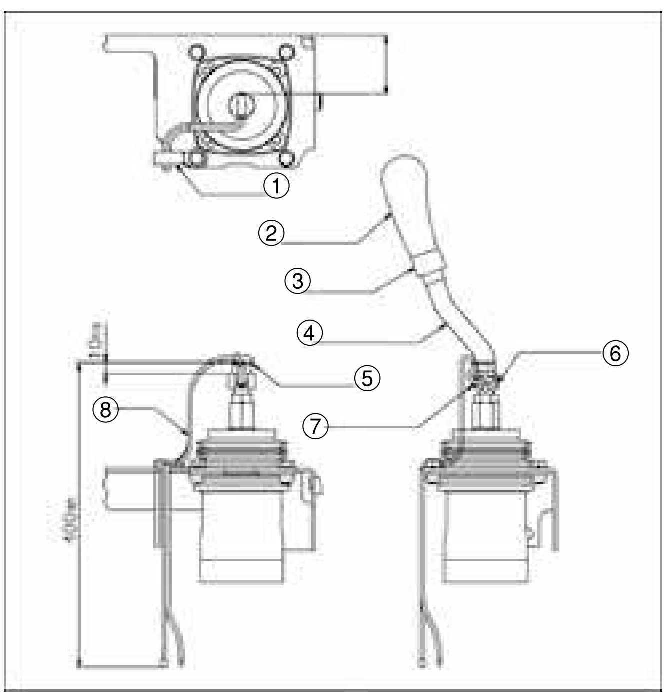
Adjusting the operating levers and lever (travel) (U10-3)



①Approx. 45 deg.
②Operating lever
③Nut is parallel to bracket (operating lever, P).
④Direct sharp angle part forwards.
⑤Travel lever
⑥Parallel to manifold

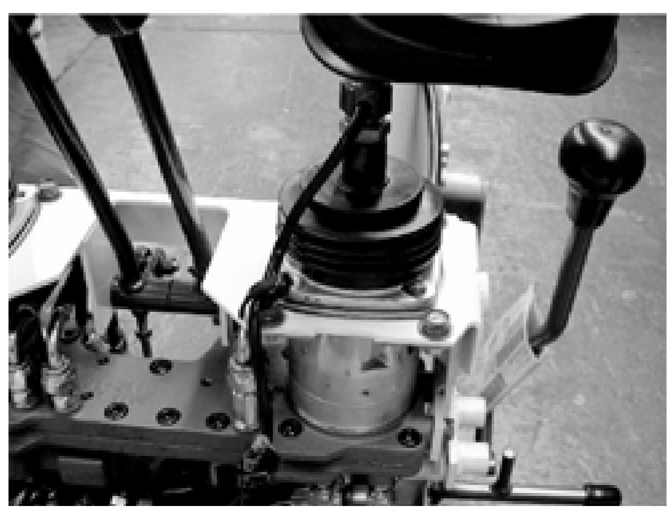
9) Adjusting the operating levers and lever (travel)
1. Adjusting the operating levers
   Assemble the operating levers so that the lever holes should be parallel to the front side of the operating panel and that the left lever should be set at approx. 45 deg. behind and the right lever at approx. 45 deg. behind.
   Operating lever operating torque
   :50N·m (5kgf·m)
   Front: The front part of the lever should not contact the handrail.
   Side: The lever should not contact other lever(s) at side(s).
2. Adjusting the lever (travel)
   Assemble the lever so that the linked portion of the lever (travel) should be parallel to the upper surface of the manifold.
   Travel lever operating torque
   :50N·m (5kgf·m)
   Front: The front part should not contact the handrail.
   Rod lengths: Right 152 mm
   (Reference value) Left 152 mm

Assembling the grip (R) (U10-3)

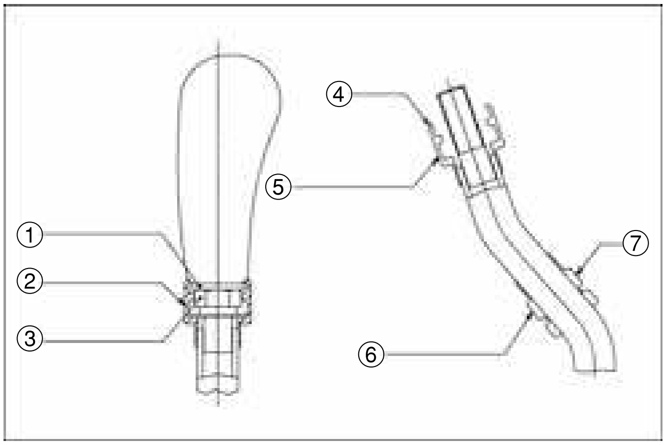


①Cord clamp
②Grip (R)
③Tube (1)
④Lever (operating, right)
⑤Vinyl clamp
⑥Direct the holes to the front and rear.
⑦Cover the edge with protection tube.
⑧Protection tube

10) Grip mounting direction
    Mount the grip so that the projection should face forward.



Assembling the grip (U10-3)

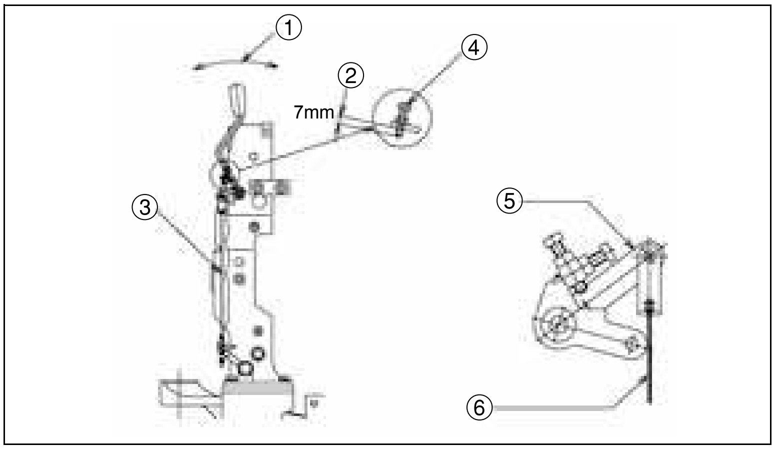


①Plain washer
②Tube (1)
③Nut
④Larger opening
⑤Tube (1)
⑥Tube (2)
⑦Larger opening

11) Mounting direction of the grip lock nut
Direct the dented part (by processing) downward. Lock nut tightening torque:

(2) Accelerator lever

Adjusting the accelerator

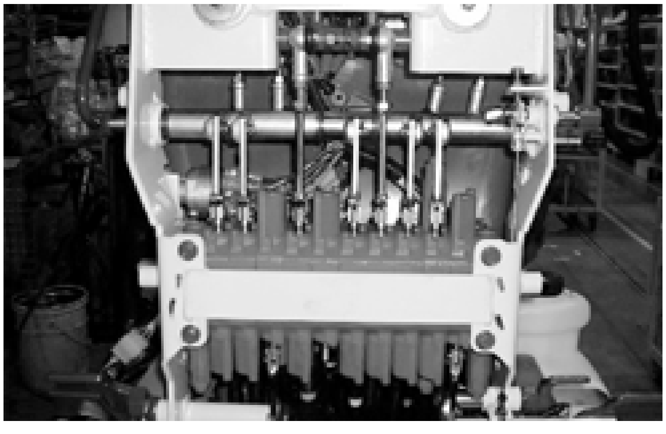


① Operating force : 20 ~ 30N (2 ~ 3kgf·m)
② Reference value
③ When the lever is inclined forward in idling operation, there should be no undue force applied to the lever and no slack.
④ Set the engine governor lever so that the engine rotates at maximum speed and set it so that the adjusting bolt lightly comes in contact with the lever.
⑤ Governor lever
⑥ Wire (accelerator)

■ Assembly procedure

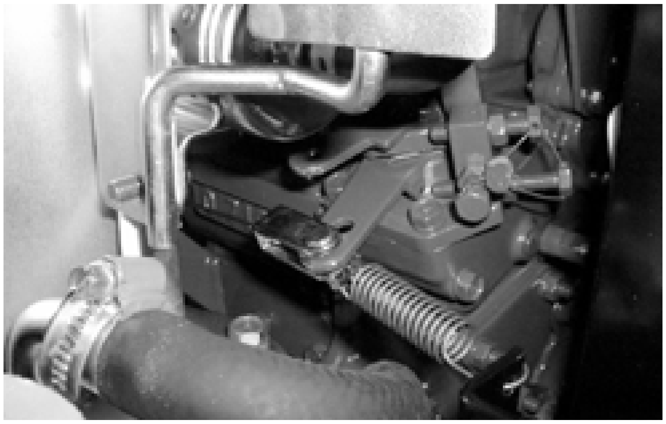
1) Adjusting to the maximum rotating speed
Adjust the engine governor so that the engine rotating speed should be surely at the maximum.
Set the governor so that the adjusting bolt comes lightly in contact and lock it.
2 Adjusting the idling speed
When the lever (accelerator) is inclined forward, wire should be free. (No force should be applied to it.)

Accelerator lever side

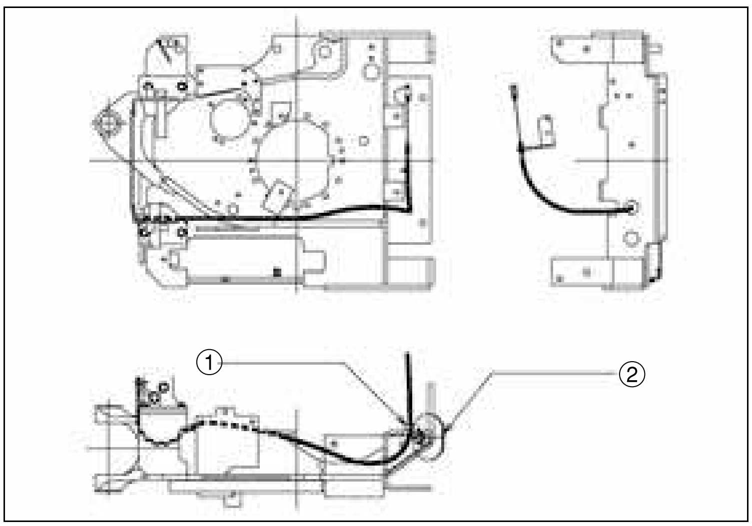


3) Accelerator operating force
Set the torque to 20~30 N (2~3 kgf·m).

Governor lever side



Routing of accelerator wire



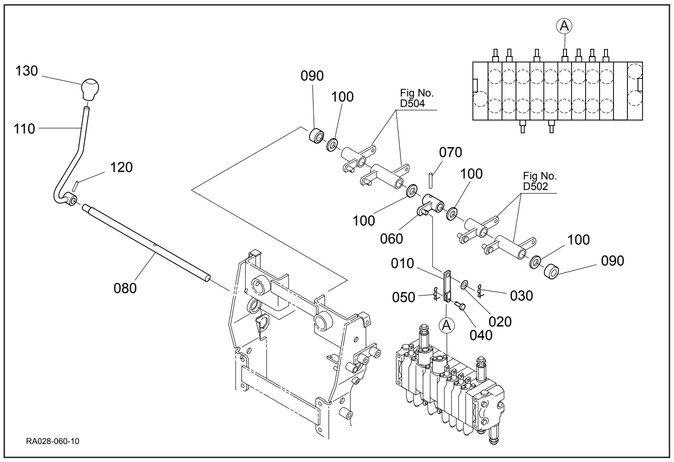
①Cord clamp
②Cover (suction tank)

4) Connection with engine
Connect the lever with engine governor at its outside.

5) Routing of accelerator wire
Pass the wire along the route shown in the left figure.

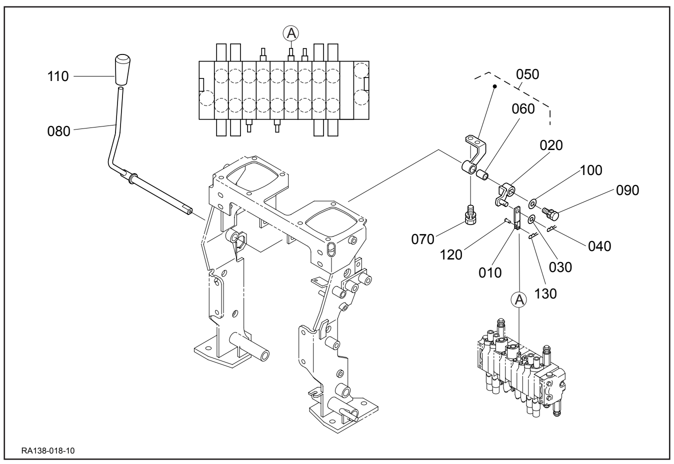
b. Dozer lever

K008-3

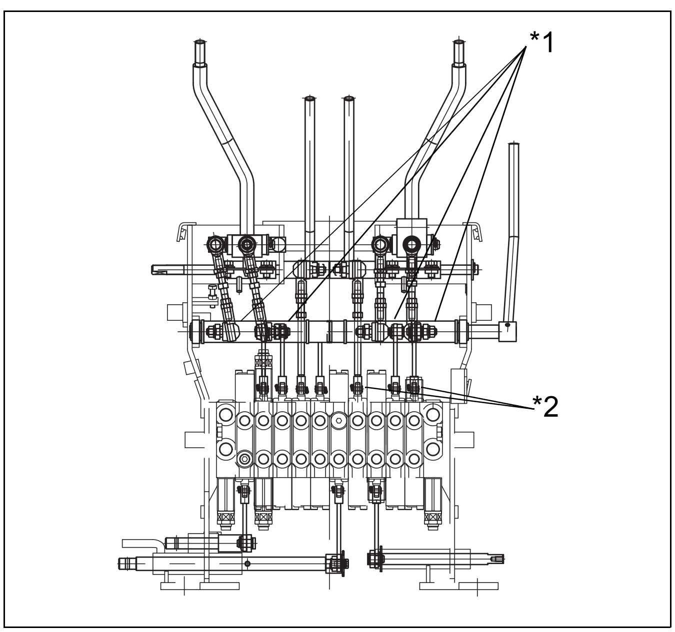


010	Link	070	Pin, Spring
020	Washer, Plain	080	Shaft, Brade
030	Pin, Snap	090	Bush
040	Pin, Joint	100	Washer, Plane
050	Pin, Snap	110	Lever, Blade
060	Lever, Blade	120	Pin, Spring
		130	Grip

U10-3



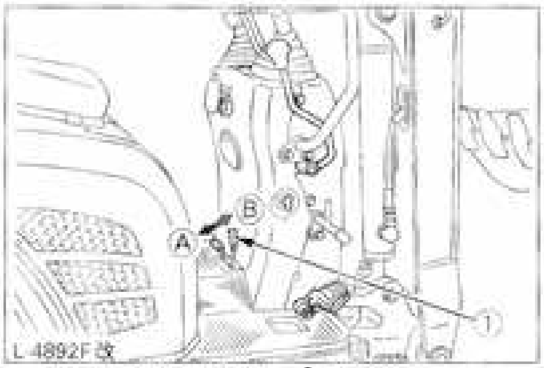
010	Link, Blade	070	Bolt
020	Plate, Blade	080	Lever, Blade
030	Washer, Pin	090	Bolt
040	Pin, Snap	100	Washer, Plane
050	Assy bracket, Blade	110	Grip
060	Bush	120	Pin, Joint
		130	Pin, Snap



■ Assembly procedure

1) Apply grease to the *1-marked points.
2) Put the pins just from side and lock them at the *2-marked points.

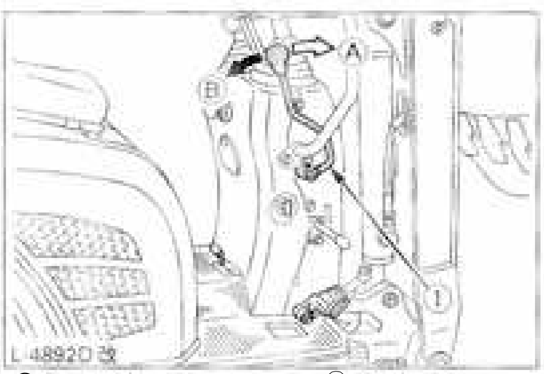
■ Track width change/dozer select lever



① Track width change / ② dozer select lever   Ⓐ "Dozer"   Ⓑ "Track width change"

■ Track width change/dozer select lever

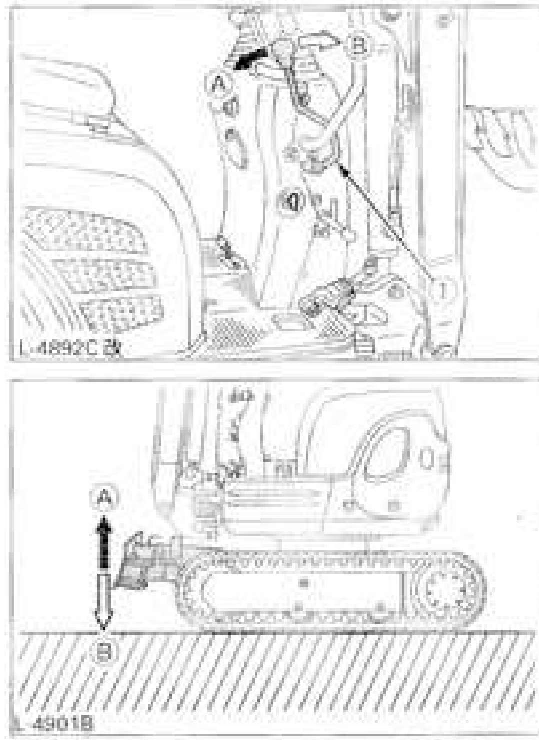
Push the control lever forward.
.....The track width reduces [from 860mm to 700mm]
Push the control lever backward.
.....The track width increases [from 700mm to 860mm]



① Control lever   Ⓐ "Reduce"   Ⓑ "Increase"

■ Operation of the Dozer

1. To raise the dozer, pull back the control lever. Pushing the control lever forwards, lowers the dozer.

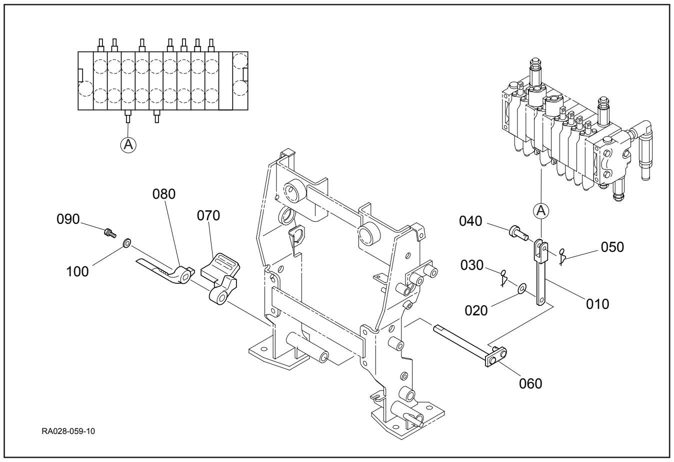


① Control lever   Ⓐ "Raise"   Ⓑ "Lower"

2. While undertaking earth moving work, control both drive levers with the left hand and the control lever with the right hand.

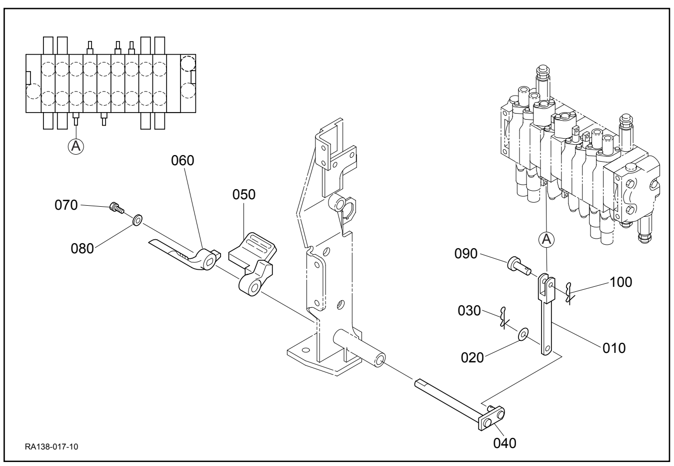
c. Swing pedal

K008-3

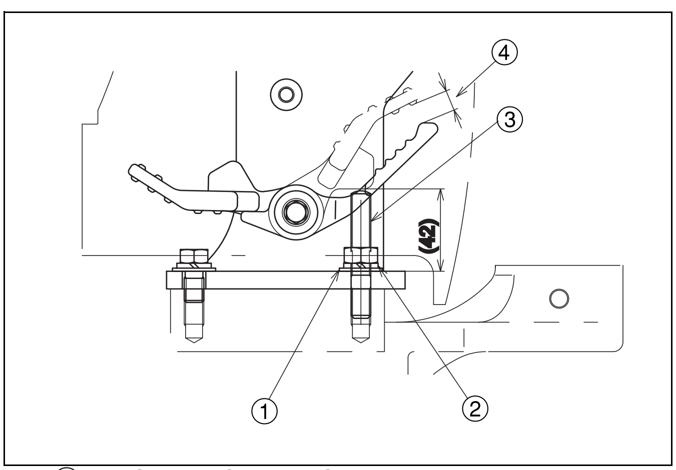


010	Link	060	Shaft, Swing
020	Washer, Plain	070	Pedal, Swing
030	Pin, Snap	080	Pedal, Swing
040	Pin, Joint	090	Bolt
050	Pin, Snap	100	Washer, Plain

U10-3



010	Link	060	Pedal, Swing
020	Washer, Plain	070	Bolt
030	Pin, Snap	080	Washer, Plain
040	Shaft, Swing	090	Pin, Joint
050	Pedal, Swing	100	Pin, Snap



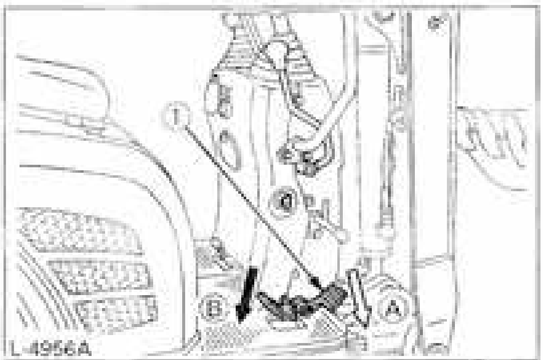
① WASHER SPPIING
② NUT
③ Stud Bolt
④ Provide clearance of 5 ~ 15 mm.

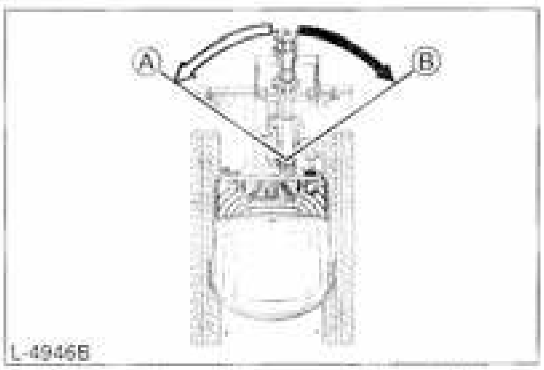
■ Assembly procedure

1) Adjust the stopper bolt length so that the swing spool stays neutral even when the swing 1 pedal is locked and stepped on.

■ Boom swing operation

1. Step on the front of the pedal to swing the boom to the left.
2. Step on the rear of the pedal to swing the boom to the right.





① Boom swing pedal Ⓐ Swing to left
Ⓑ Swing to right

WARNING

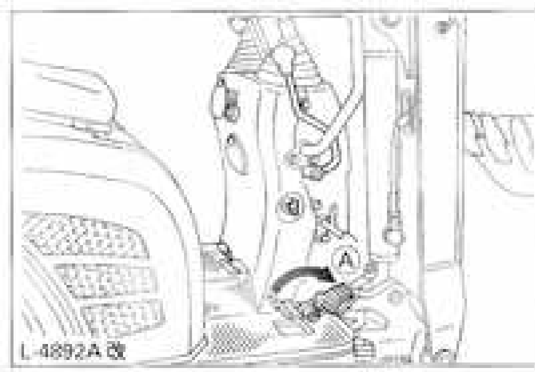
To avoid personal injury or death:

- **Always keep your toes within the edge of foot step; otherwise there is a possibility that your toes will be caught between swing frame and boom cylinder.**

CAUTION

To avoid personal injury:

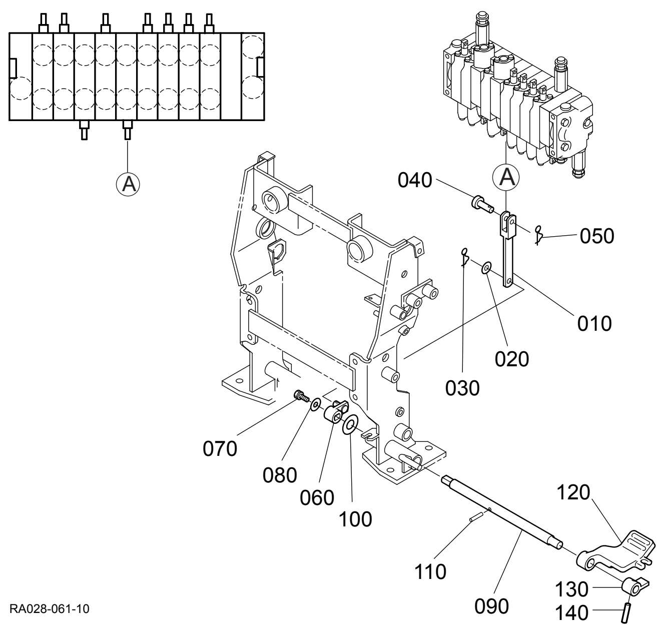
- **When boom swing operation is not in use, fold the boom swing pedal formard to fix the pedal from unexpected moves.**



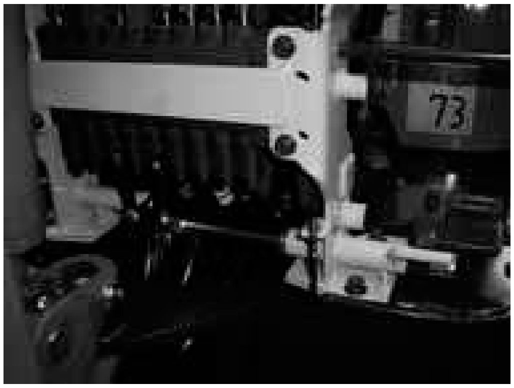
Ⓐ "Fix"

d. Service port pedal

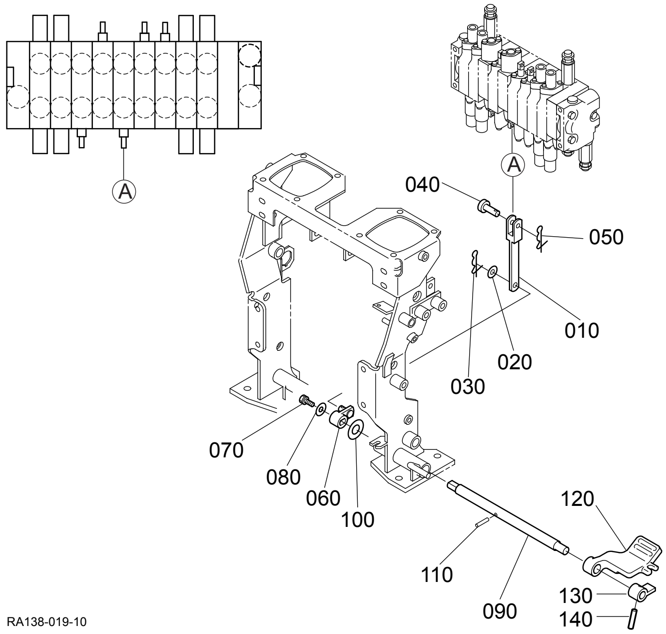
K008-3



010	Link	080	Washer, Plain
020	Washer, Plain	090	Shaft
030	Pin, Snap	100	Washer, Plain
040	Pin, Joint	110	Pin, Spring
050	Pin, Snap	120	Pedal, SP
060	Lever, SP	130	Holder
070	Bolt	140	Pin, Spring



U10-3



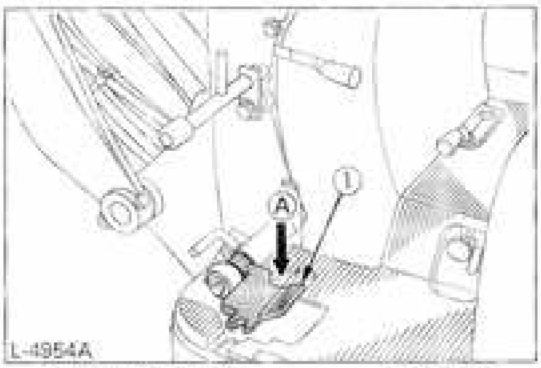
010	Link	080	Washer, Plain
020	Washer, Plain	090	Shaft
030	Pin, Snap	100	Washer, Plain
040	Pin, Joint	110	Pin, Spring
050	Pin, Snap	120	Pedal, SP
060	Lever, SP	130	Holder
070	Bolt	140	Pin, Spring

■ Service port operation

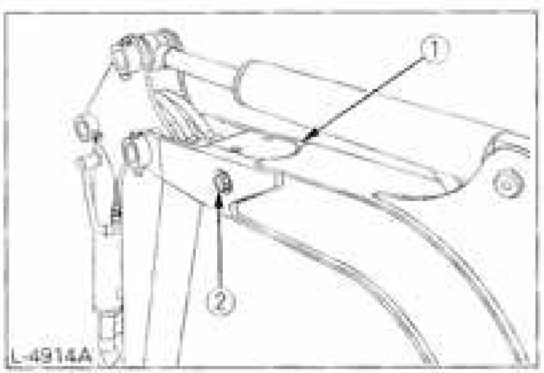
This pedal is used to operate attachments such as breakers.

Service port pedal

Step on the service port pedal and pressured oil starts following through the "P" port from the control valve. The oil then return through the "T" port into the tank.



①Service port pedal Ⓐ"Operate"



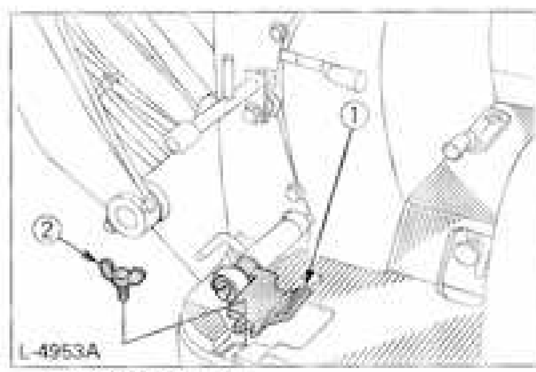
①"P" (Pressure) port
②"T" (Return) port

NOTE:

- When the service port is not use, put the cover on the pedal. The pedal gets fixed and can be used as footrest.

Locking the service port padal

The service port pedal can be locked downward in oder to use an attachment such as hand breakerand hand auger. Please make hole to pass the bolt through the floor mat with a knife etc. when you lock the service port pedal. The bolt which fixes the pedal is in the tool kit. Please tighten the bolt until you are able to depress the service port pedal.



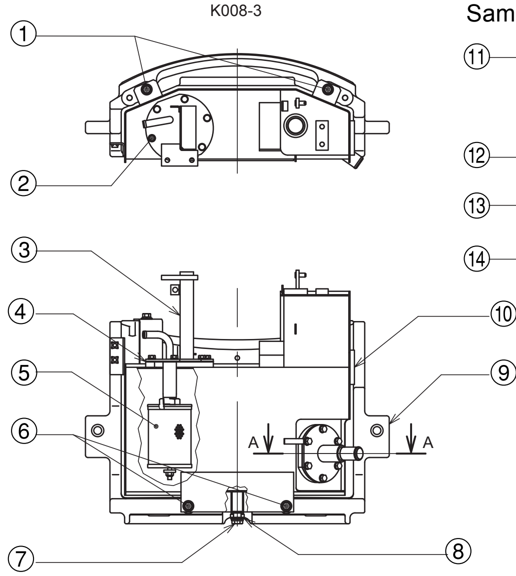
①Service port pedal
②Bolt

IMPORTANT:

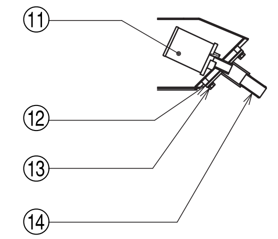
- When the service port is not used, be careful not to lock the pedal.
  Because the hydraulic oil temperature will rise abnormally, causing problems with the hydraulic components.

e. Tank
(1) Oil tank

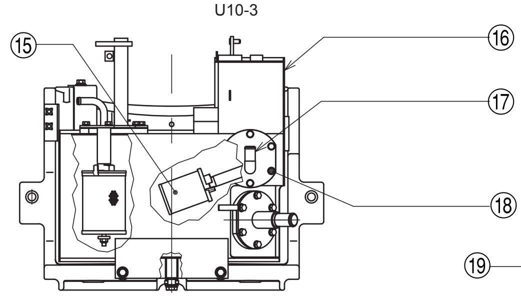
K008-3

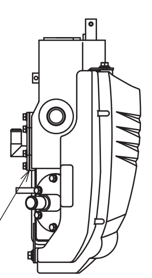


A - A
Same also for U10-3



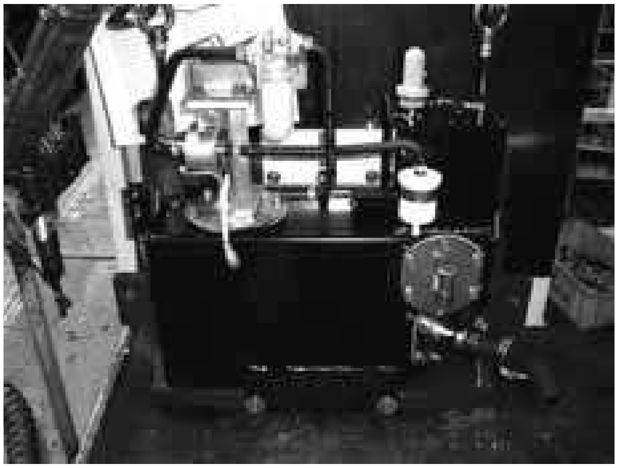
U10-3

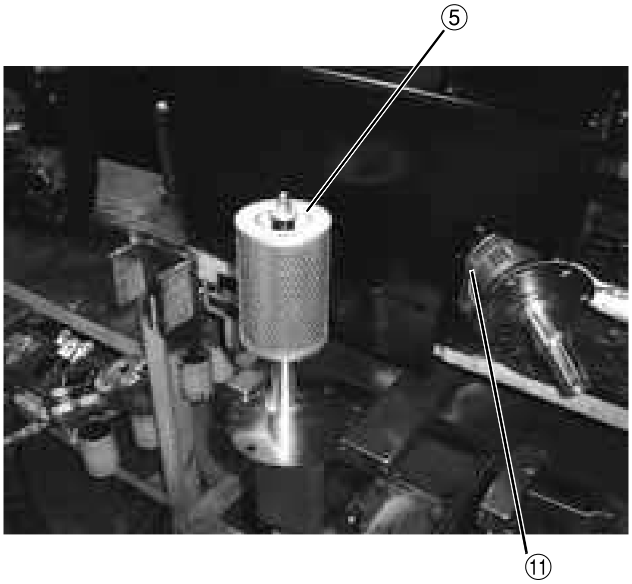




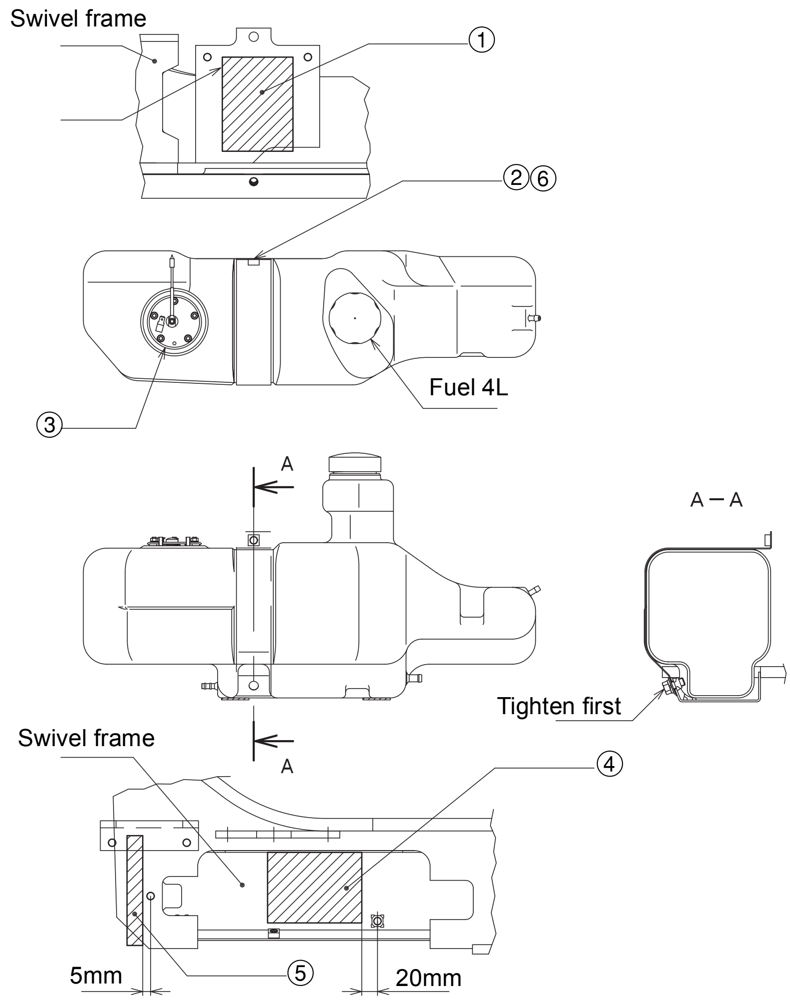
Assembly procedure

1) Assembling packings
   Apply bond (THREE BOND 1215 or equivalent) between packings and covers (suction tanks).
   Tightening torque:
   24~28 N·m (2.4~2.8 kgf·m)
2) Assembling the oil tank and weights
   Tightening torque:
   48.1~55.9 N·m (4.9~5.7 kgf·Em)
   * Apply screw lock agent
3) Assembling the suction strainer and filter (return oil)
   Tightening torque:
   19.6~29.4 N·m (2.0~3.0 kgf·m)
4) Parts list
   ① Bolt
   ② Bolt
   ③ Tank, Oil
   ④ Gasket
   ⑤ Filter return
   ⑥ Bolt
   ⑦ Plug
   ⑧ Washer with rubber
   ⑨ Protector, Rear (K008-3) weights, Rear
   ⑩ Gauge, Oil level
   ⑪ Filter, Suction
   ⑫ Gasket
   ⑬ Bolt
   ⑭ Cover, Tank suction
   ⑮ Filter, Suction
   ⑯ Gauge, Oil level
   ⑰ Cover, Tank, 2, suction
   ⑱ Bolt
   ⑲ Gasket



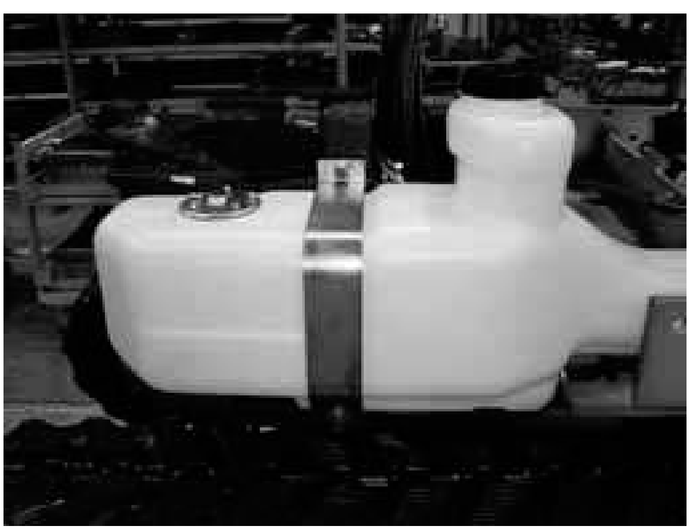


(2)Tank fuel



Assembly procedure

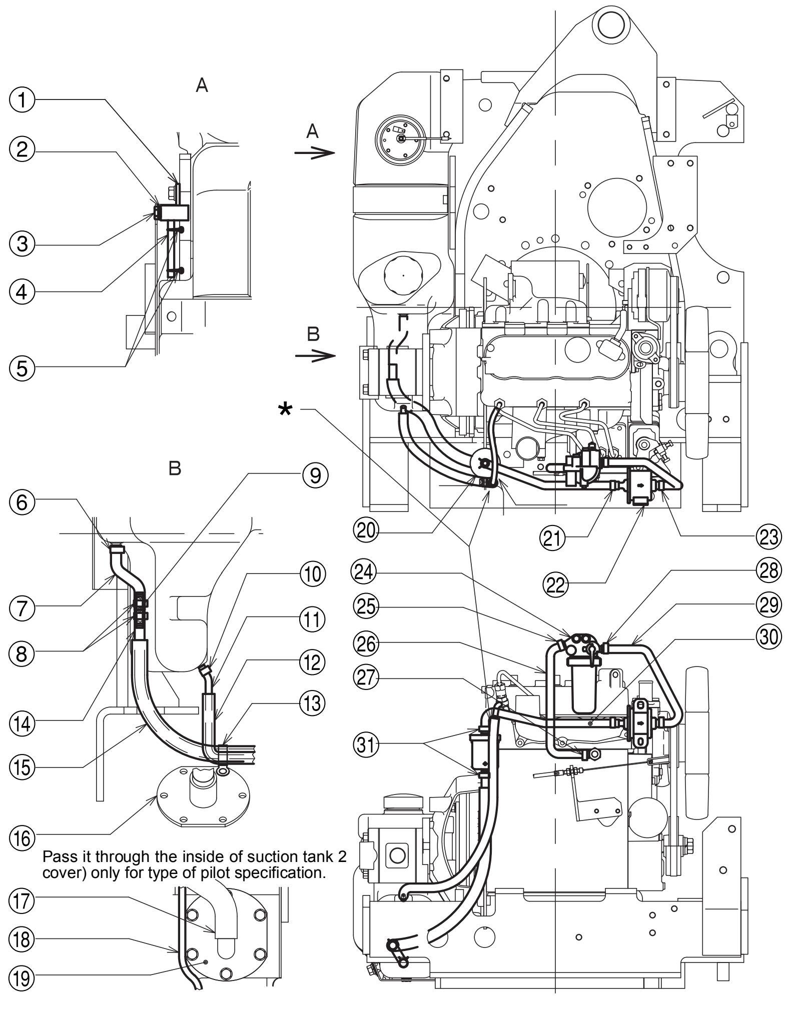
1) Assembling the band (fuel tank)
   When tightening the band, press the fuel tank to the right side, temporarily tighten it and tighten it securely using care not to twist the band.
   Band (fuel tank) tightening torque:
   48~56 N·m (4.9~5.7 kgf·m)
2) Sensor (fuel) tightening torque:
   3~4 N·m (0.3~0.4 kgf·m)
3) Parts list
   ① Cushion
   ② Band, Fuel tank
   ③ Sensor, Fuel
   ④ Cushion
   ⑤ Cushion
   ⑥ Cushion



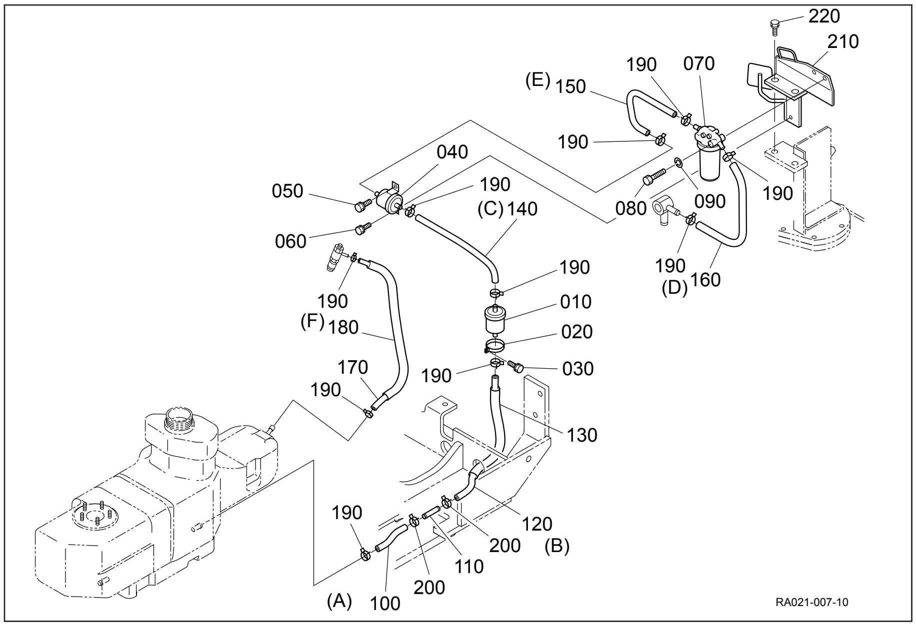
Routing the fuel hose

CAUTIONS!

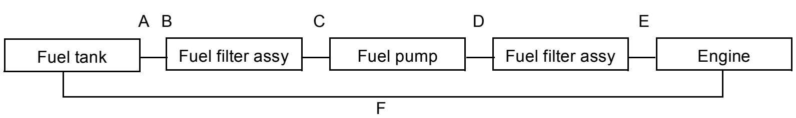
- **Clamp the fuel hose securely. Do not move the hose after clamped. (Tighten the cord clamp (34150-2939△) together with the cover (suction tank) (RA021-6213△).**
- **The fuel hose should not come in contact with sharp edge, high-temperature part or rotating part.**
- **Do not clamp the fuel hose together with electric wire.**
- **There should be no undue tension nor local looseness and do not flatten the hose.**



① Joint (fuel drain)
② Rubber-lined washer
③ Plug
④ Fuel tube
⑤ Hose clamp (spring type)
⑥ Pipe clip
⑦ Fuel tube
⑧ Pipe clip
⑨ Straight tag joint
⑩ Pipe clip
⑪ Fuel tube
⑫ Fuel tube
⑬ Cord clamp
(Tighten together with accelerator wire.)
⑭ Fuel tube
⑮ Fuel tube
⑯ Cover (suction tank)
⑰ Hose (2 suction)
⑱ Fuel drain
⑲ Cover (2 suction tank)
⑳ Fuel filter
㉑ Pipe clip
㉒ Fuel pump
㉓ Pipe clip
㉔ Fuel filter
㉕ Pipe clip
㉖ Fuel tube
㉗ Pipe clip
㉘ Pipe clip
㉙ Fuel tube
㉚ Fuel tube
㉛ Pipe clip
* Fuel return tube should be passed between filter and hydraulic oil tank.

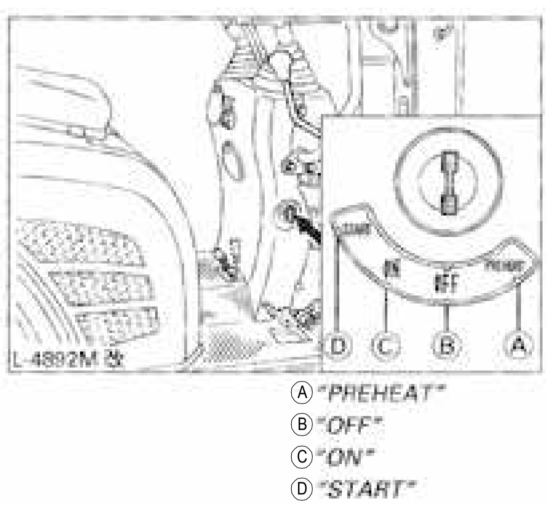


010	Assy filter, Fuel
020	Band, Filter
030	Bolt
040	Assy pump, Fuel
050	Bolt
060	Bolt
070	Assy filter, Fuel
080	Bolt
090	Washer, Spring
100	Tube, Fuel
110	Joint, Pipe
120	Tube, Fuel
130	Tube
140	Tube, Fuel
150	Tube, Fuel
160	Tube, Fuel
170	Tube, Fuel
180	Tube
190	Clip, Pipe
200	Clip, Pipe
210	Bracket
220	Bolt



Hose		Protection hose length
A	Molded hose	-
B	Hose length 480mm	400mm
C	Molded hose	-
D	Molded hose	-
E	Molded hose	-
F	Hose length 580mm	480mm

■ Purging of the fuel system

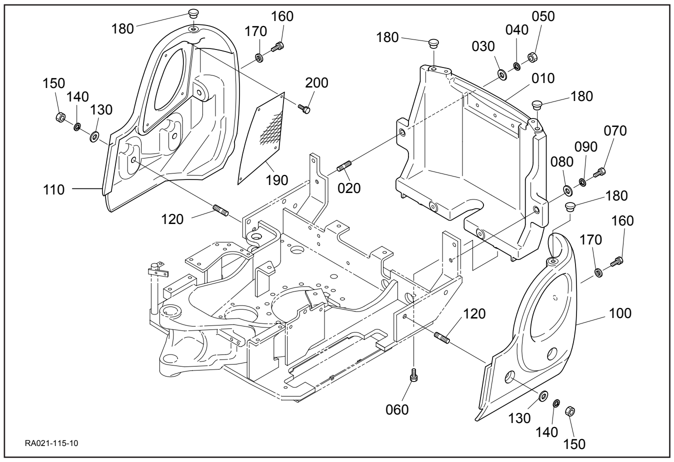


1. Fill up the excavator with fuel.
2. Turn the starter key to the position “ON”.
3. The air in the fuel system will be purged wothin one minute.

IMPORTANT:
- If the purging was insufficient, and the engine dies immediately arter starting. In this case repeat steps (2) to (3) again.

f. Weight

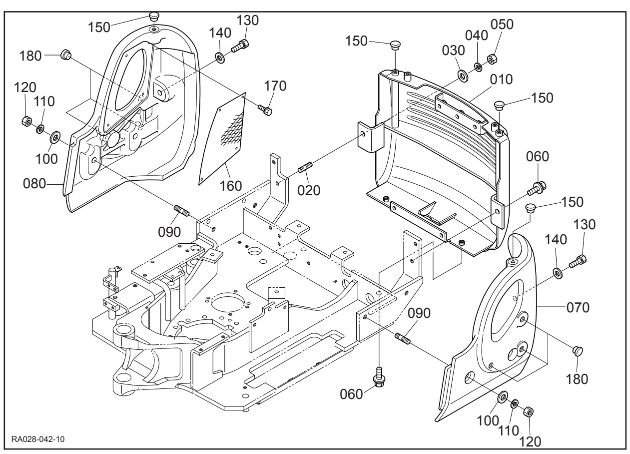
Exploded view of U10-3 weights (right, left and center)



010	Weight,Rear	110	Weiight RH
020	Stud	120	Stud
030	Washer, Plain	130	Washer, Plain
040	Washer, Spring	140	Washer, Spring
050	Nut	150	Nut
060	Bolt	160	Bolt
070	Bolt	170	Washer, Plain
080	Washer, Plain	180	Plug
090	Washer, Spring	190	Cover
100	Weight LH	200	Bolt

Assembling torque of weights (right, left and center)
Tightening torque of 060 and 130 bolts
77.5~90.2 N·m (7.9~9.2 kgf·m)
Tightening torque of 050 nut
62.8~72.6 N·m (6.4~7.4 kgf·m)
Tightening torque of 150 nut
107.9~125.5 N·m (11.0~12.8 kgf·m)

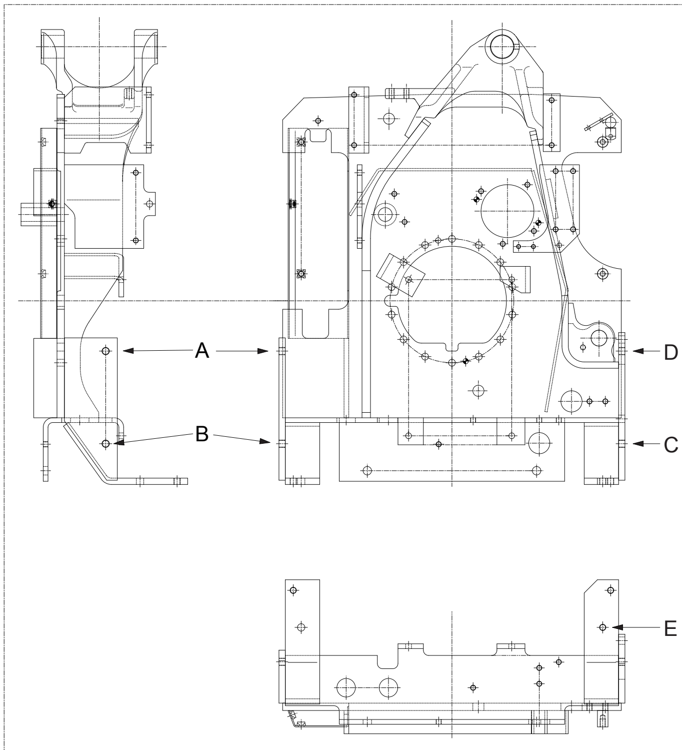
Exploded view of K008-3 weights (right, left and center)

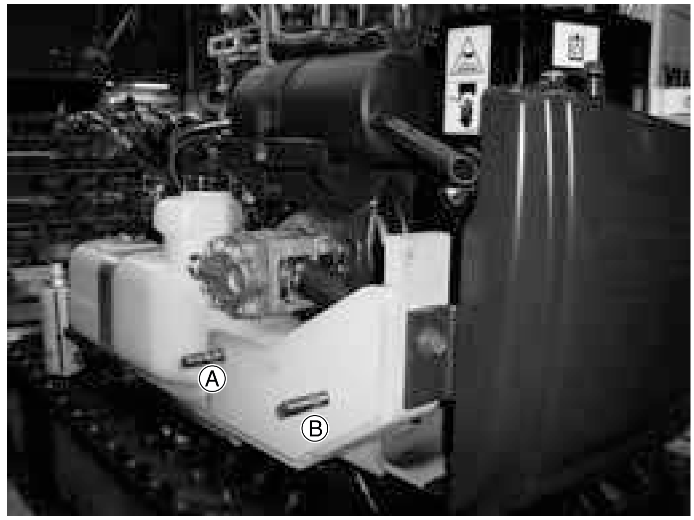


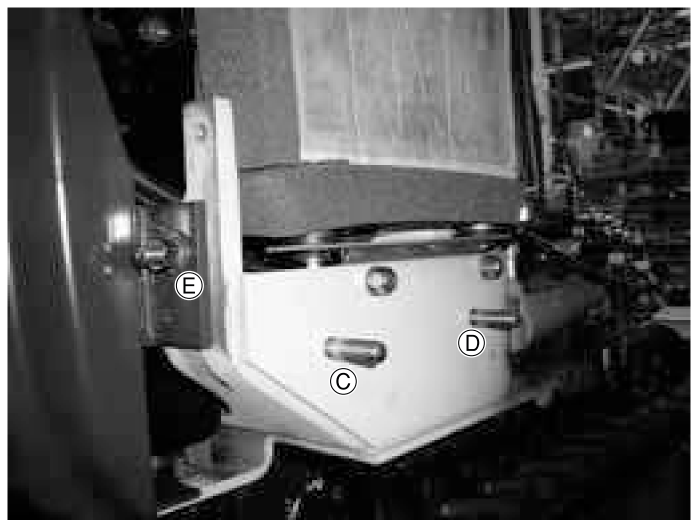
010	Link	080	Washer, Plain
020	Washer, Plain	090	Shaft
030	Pin, Snap	100	Washer, Plain
040	Pin, Joint	110	Pin, Spring
050	Pin, Snap	120	Pedal, SP
060	Lever, SP	130	Holder
070	Bolt	140	Pin, Spring
060	Lever, SP		
070	Bolt		

Assembling torque of weights (right, left and center)
Tightening torque of 070 and 160 bolts
77.5~90.2 N·m (7.9~9.2 kgf·m)
Tightening torque of 050 nut
62.8~72.6 N·m (6.4~7.4 kgf·m)
Tightening torque of 150 nut
107.9~125.5 N·m (11.0~12.8 kgf·m)

Assembly sketch of studs for weights







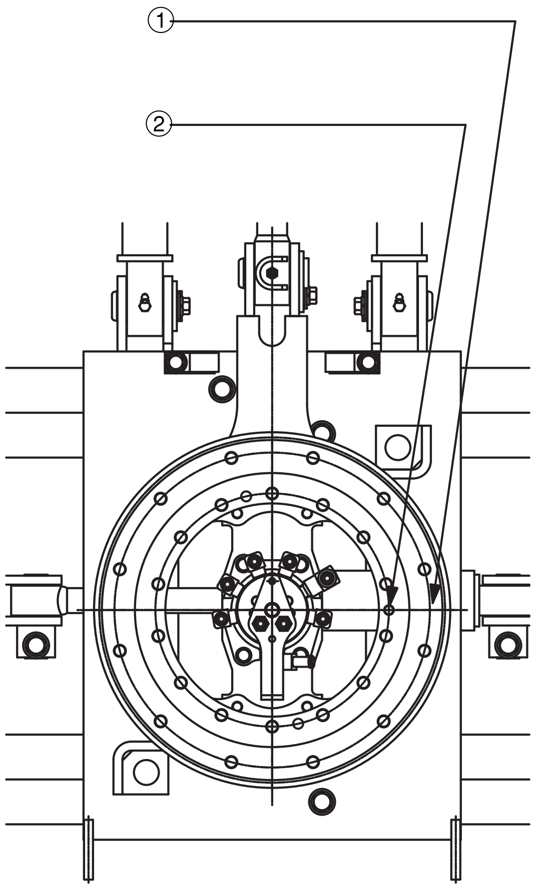
■ Assembling of stud for weights
Studs should be mounted at A, B, C, D and E in above Fig..
Apply screw lock agent.

■ Assembling weights
Nut tightening torque
A, B, C, D:107.9 ~ 125.5 N·m
11.0 ~ 12.8 kgf·m
E :62.8 ~ 72.6 N·m
6.4 ~ 7.4 kgf·m

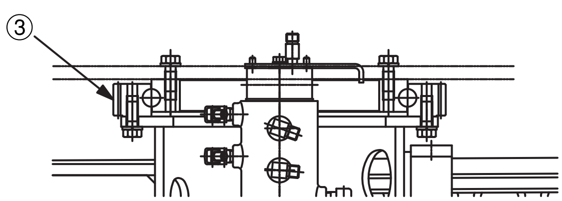
D.Under carriage

a. Swivel bearing

(1) Assembly sketch of swivel bearing (K008-3)



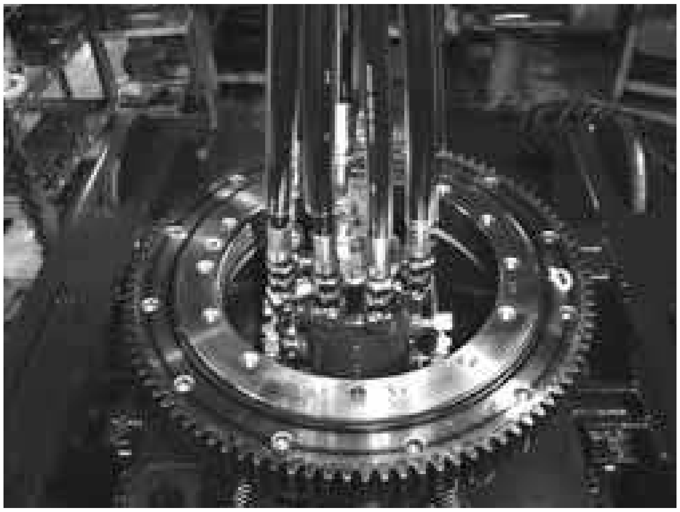
① Attach the mark "S" to the right side of the track frame. (Front rotary lock hole side)
② Set the screw hole the grease nipple to the right side of the rotary frame.



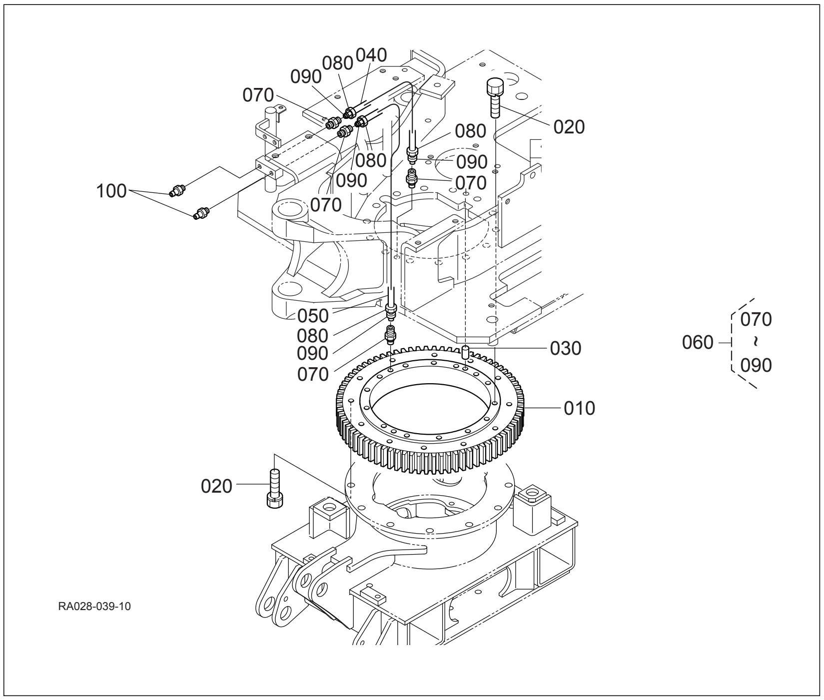
③ Apply grease the whole surface of the teeth. (DYNAMAX EP-2 or equivalent)

■ Assembly procedure

1) Set the screw hole the grease nipple to the right side and attach the stamp mark "S" to the right side.
   Bolt tightening torque:
   107~117.7N·m (10.5~12 kgf·m)
2) Apply and inject grease to the surface of teeth and between balls. (DYNAMAX EP-2 or equivalent)



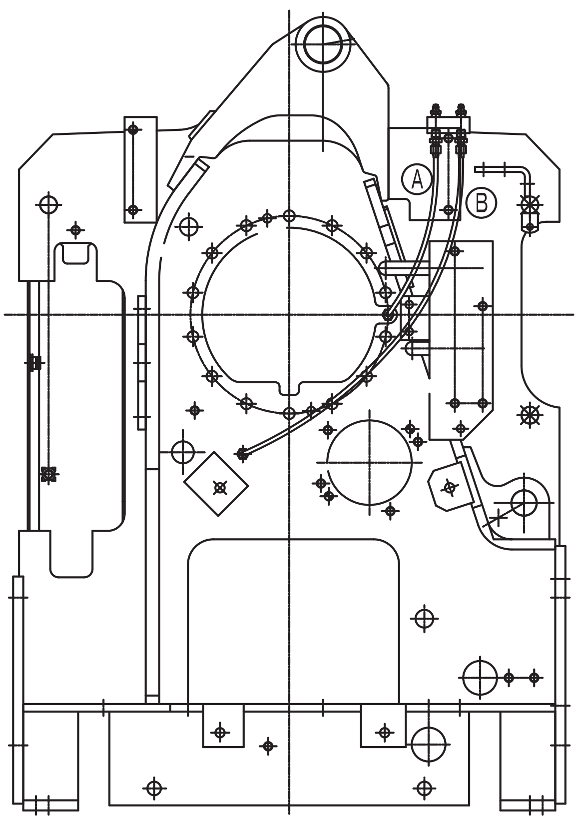
(2) Exploded view of swivel bearing (K008-3)



3) Parts list

010	Bearing, Swivel
020	Bolt
030	Pin, Straight
040	Tube, Grease
050	Tube, Grease
060	Connector
070	Body, Connector
080	Nut
090	Sleeve
100	Nipple, Grease

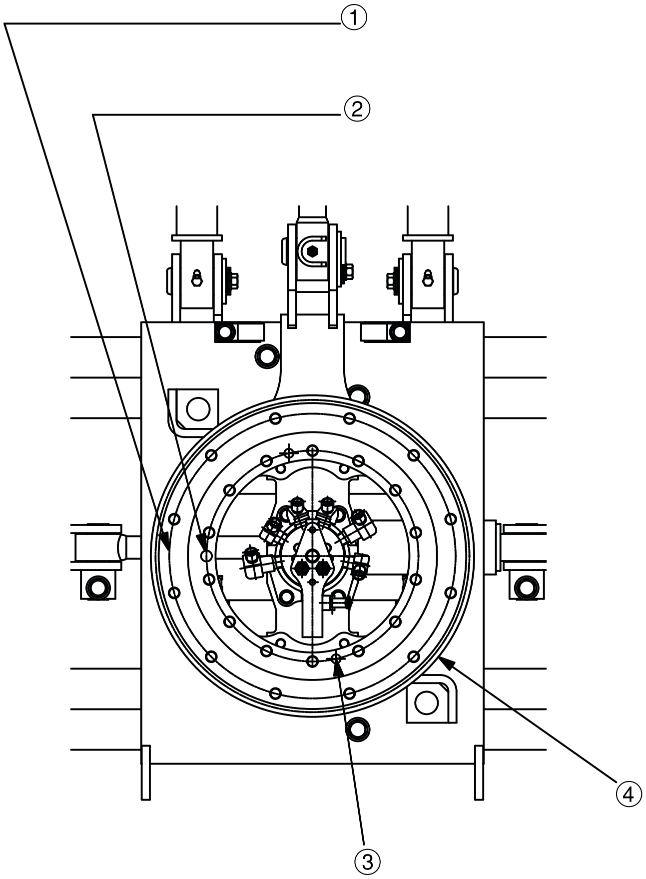
Grease tube length



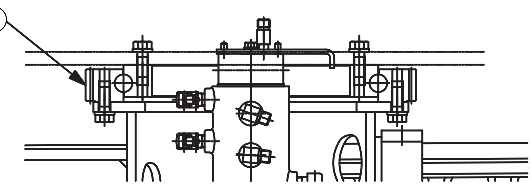
Grease tube length

Ⓐ	540mm
Ⓑ	310mm

(3) Assembly sketch of swivel bearing (U10-3)



① Attach the mark "S" to the left side of the track frame.
② Set the screw hole the grease nipple to the left side.
③ Parallel pin
④ Bearing (swivel)

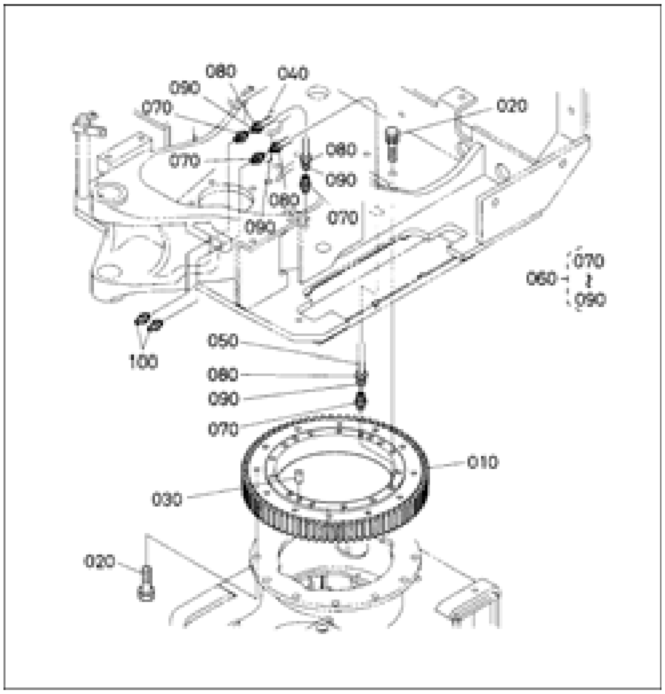


⑤ Apply grease the whole surface of the teeth. (DYNAMAX EP-2 or equivalent)

Assembly procedure

1) Set the screw hole the grease nipple to the left side and attach the stamp mark "S" to the left side.
   Bolt tightening torque:
   107~117.7N·m (10.5~12 kgf·m)
2) Apply and inject grease to the surface of teeth and between balls. (DYNAMAX EP-2 or equivalent)

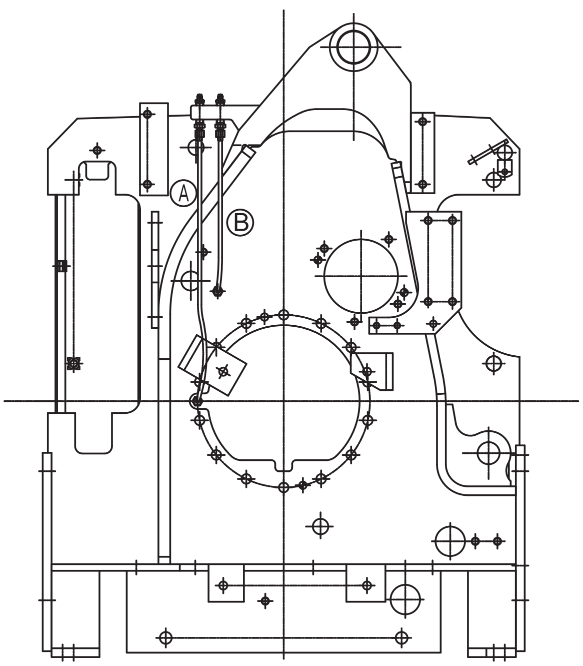
(4) Exploded view of swivel bearing (U10-3)



3) Parts list

010	Bearing, Swivel
020	Bolt
030	Pin, Straight
040	Tube, Grease
050	Tube, Grease
060	Connector
070	Body, Connector
080	Nut
090	Sleeve
100	Nipple, Grease

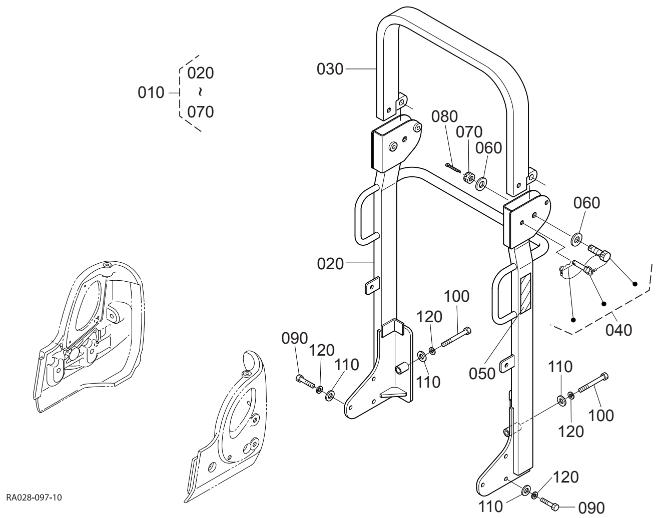
Grease tube length



Grease tube length

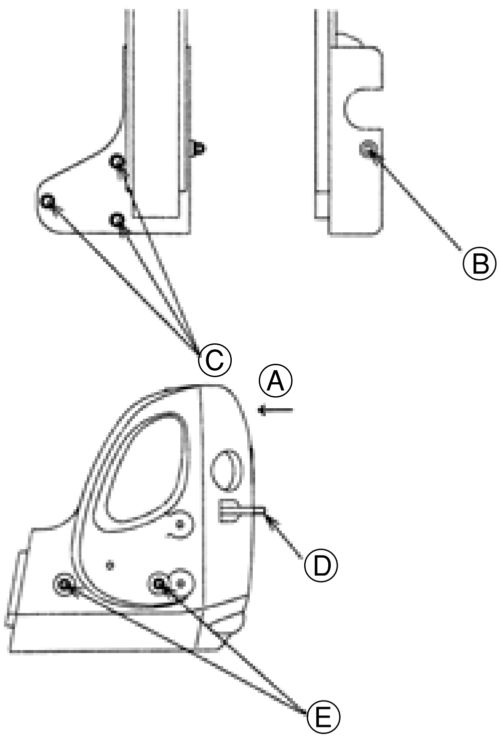
Ⓐ	425mm
Ⓑ	290mm

b. ROPS



Frame (ROPS, top)

010	ASSY FRAME, ROPS
020	FRAME
030	FRAME
040	ASSY PIN
050	LABEL, ROPS WARNING
060	WASHER, PLAIN
070	NUT, SELF-LOCKING
080	PIN, SPLIT
090	BOLT
100	BOLT
110	WASHER, PLAIN
120	WASHER, SPRING



Fitting the frame (ROPS, top)

Pressing the part Ⓐ, tighten up the two bolts Ⓔ (for both sides).
Tightening torque (7T):
123.6~147.1 N·m (12.6~15.0 kgf·m)

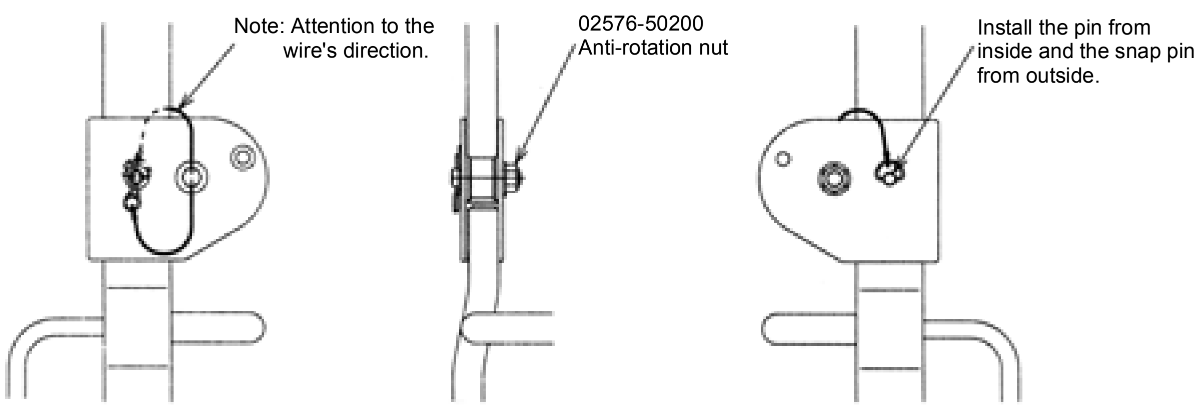
Install the ROPS onto the stud bolt Ⓓ. (Keep the three bolts (090) at Ⓑ.) (For both sides, not to be tightened up yet)
Tighten up the nut Ⓑ (for both sides).
Then tighten up the three bolts Ⓒ (for both sides).

Tightening torque of nut Ⓑ (9T):
103.0~117.7 N·m (10.5~12.0 kgf·m)

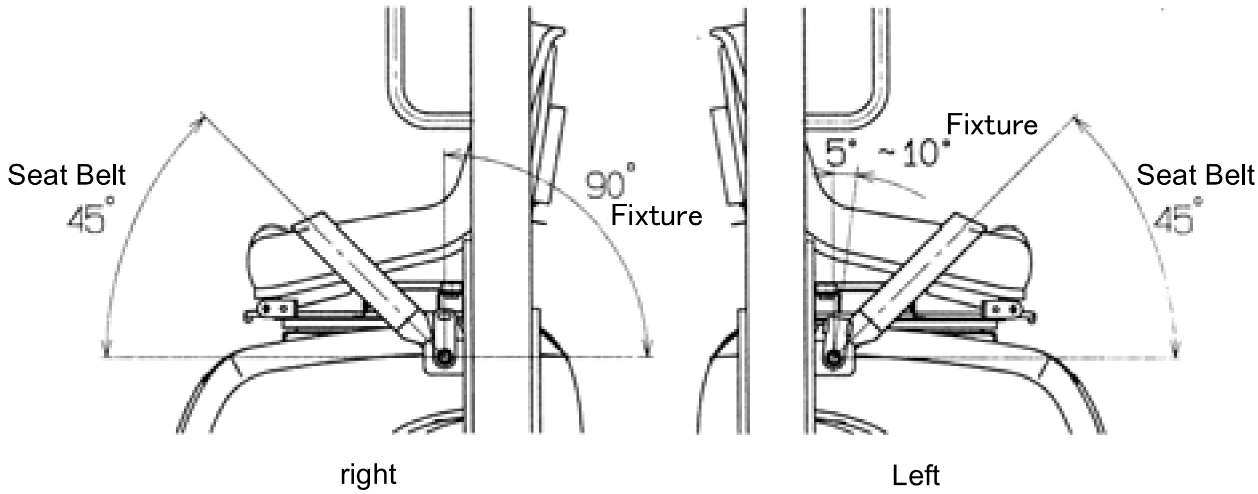
Tightening torque of bolt Ⓒ (4T):
62.8~72.6 N·m (6.4~7.4 kgf·m)

Outside

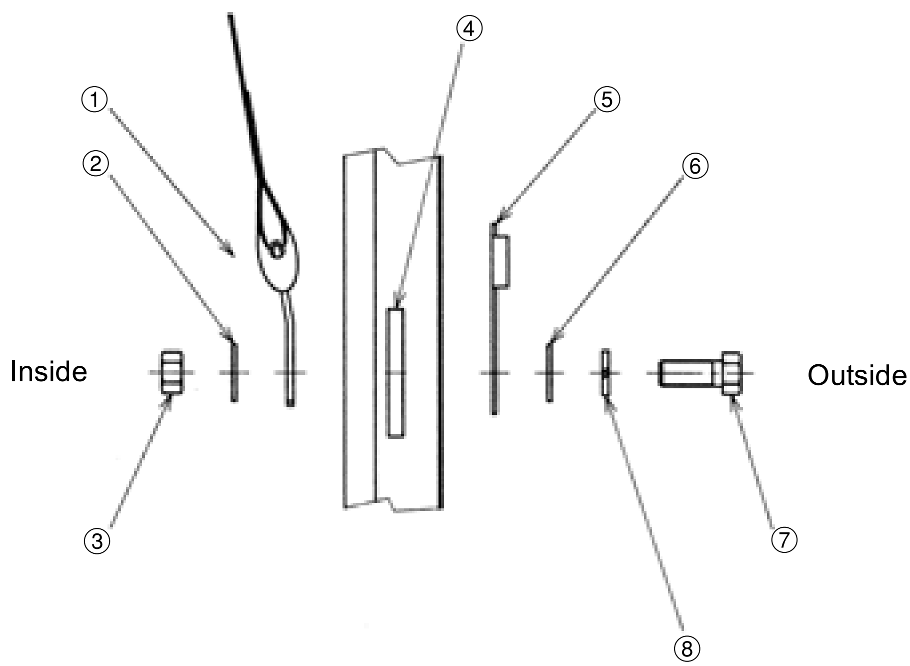
Inside



c. Seat belt setup angle

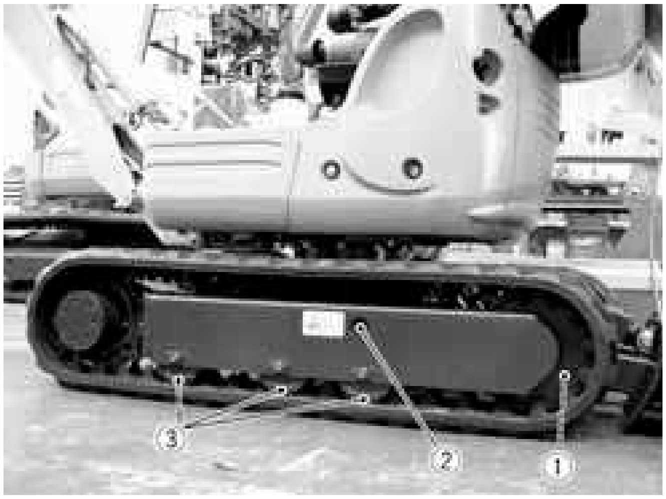


Assembling the seat belt



① Seat belt
② Plain washer
③ Nut
④ Frame (rops)
⑤ Fixture
⑥ Plain washer
⑦ Bolt : Tightening Torque 60.8~70.6 N·m (6.2~7.2 kgf·m)
⑧ Spring washer

d. Take-up Unit



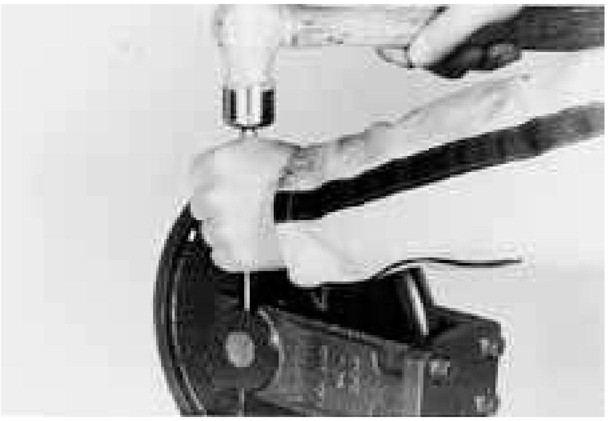
Component parts
① Idler assembly
② Track roller
③ Grease cylinder

Machine front side

(1) Idler assembly

Front idler disassembly procedure

1) Remove the rubber rollers and dismount the frond idler in assembly.



2) Pull out the spring pin by means of pin puller.
   <<At assembly>>
   • Idler assembly should be rotated smoothly after assembling.

3) Remove the plate and dismount the idler support by gear puller.
<<At assembly>>
Plate tightening torque:
48.0~55.9N·m (4.9~5.7 kgf·m)
Apply screw lock agent.

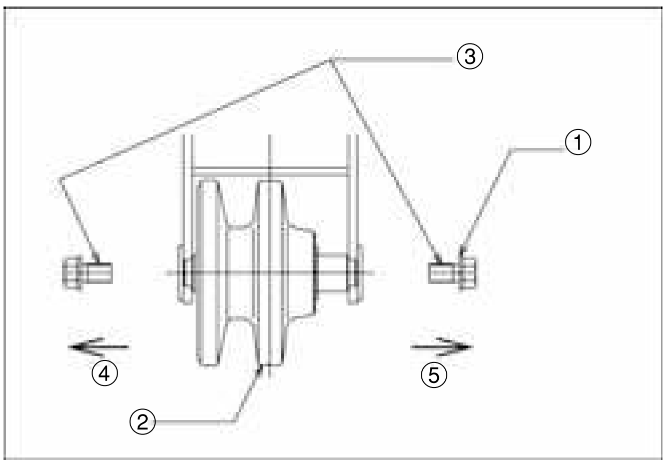
4) Remove the oil seal by screwdriver.
<<At assembly>>
Apply grease to the lip of oil seal.

5) Remove the circlip.

6) Pull out the idler shaft downward.
<<At assembly>>
Inject grease into the bearing.

No.	Parts Name
①	Idler
②	Idler shaft
③	Idler support
④	Plate
⑤	Oil seals
⑥	Ball bearing
⑦	Collar
⑧	Circlip
⑨	Spring pin
⑩	Bolts

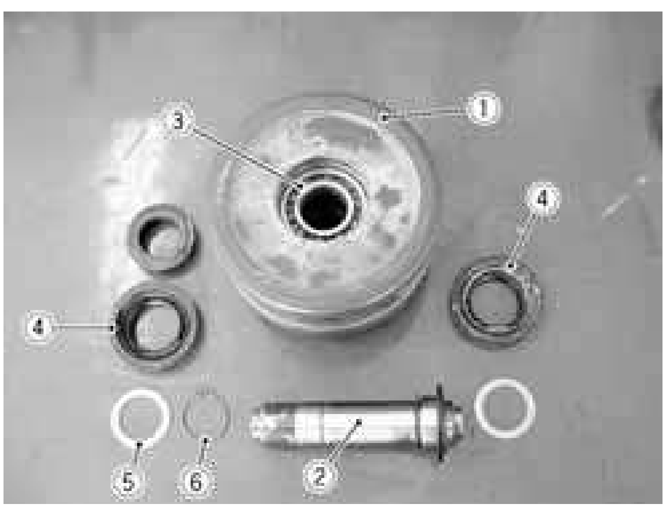
(2) Track roller



Assembly procedure

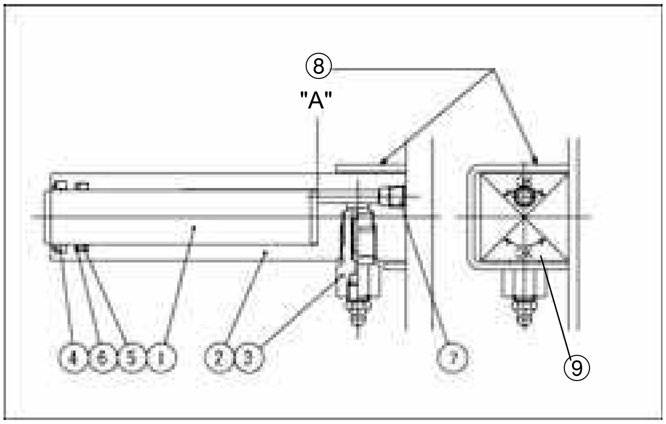
1) Bolt (01774-61220) tightening torque:
   78.0~90.0N·m (7.9~9.2 kgf·m)
   * Apply screw lock agent.

①Bolt
②Track roller
③Apply screw lock agent
④Machine outside
⑤Machine inside

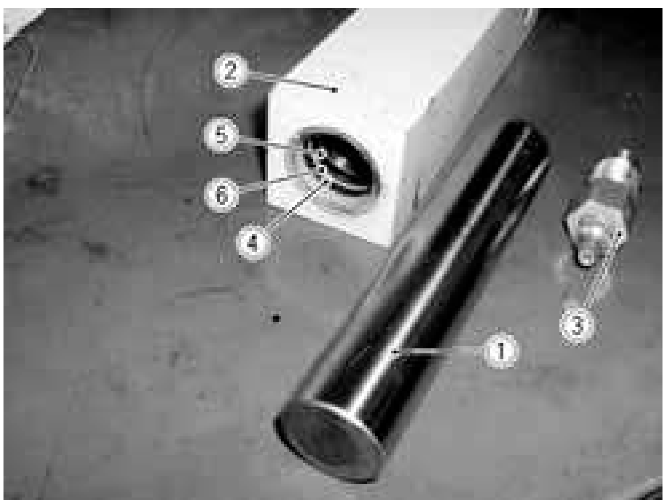


No.	Parts Name	Q'ty
①	Track roller	1
②	Shaft (track roller)	1
③	Ball bearing	2
④	Oil seal	2
⑤	Collar	2
⑥	Circlip	2

(3) Grease cylinder



⑧Guide of track frame side
⑨Mating face of backup ring should be directed in OK direction.



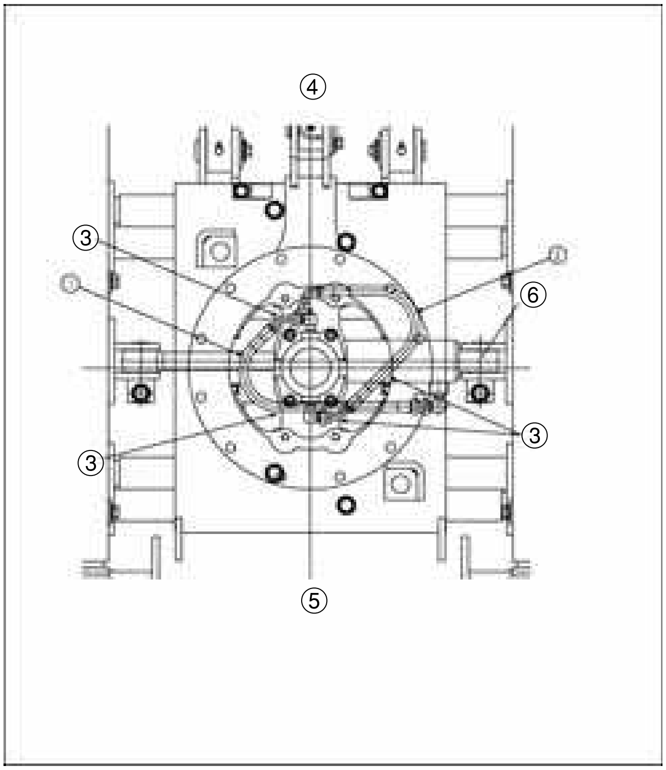
Assembly procedure

1) Nipple assembly tightening torque:
   103.0~108.0N·m (10.0~11.0 kgf·m)
   * Tighten it twice.
2) Apply oil (NEW UDT, M80B or equivalent) to dust seal, O-ring and backup ring when assembling them.
   *Mount the backup ring so that its mating face should be horizontal.
3) Grease injection
   Push the shim up to "A" and inject grease.
   * DYNAMAX EP2 or equivalent
4) Tension of crawler (rubber crawler specification)
   8~13 mm (Dimension between the track roller and the core of rubber crawler)
5) Parts list

No.	Parts Name	Q'ty
①	Cylinder tube	1
②	Rod	1
③	Nipple, assembly	1
④	Dust seal	1
⑤	O-ring	1
⑥	Ring (backup	1
⑦	Plug (PT1/8)	1

e. Track Frame (Adjustable Leg Specification)

(1) Route of adjustable leg hose



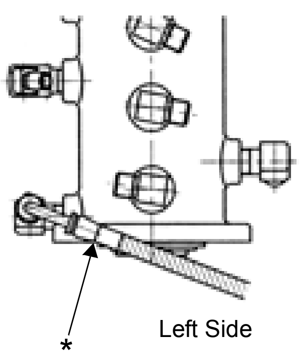
No.	Parts Name	Q'ty
①	Hose (High pressure, 1/4)	1
②	Hose (High pressure, 1/4)	1

③ Provide clearance.
④ Machine front side
⑤ Machine rear side
⑥ Be sure to connect the track cylinder bottom side directly to the frame (track, right).

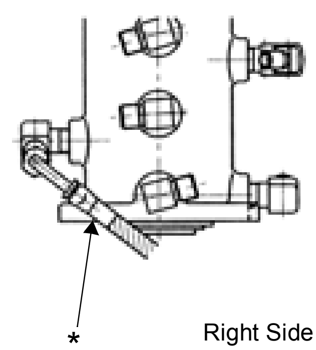
■Assembly procedure

1) Connection of adjustable leg hose
   - Pay attention to wrong connection of the hose.
   - Provide a clearance between the track frame and the hose.
   - Align the swivel joint lower part with the hose sleeve lower side together with rod and bottom hose of the track frame.

Machine bottom side



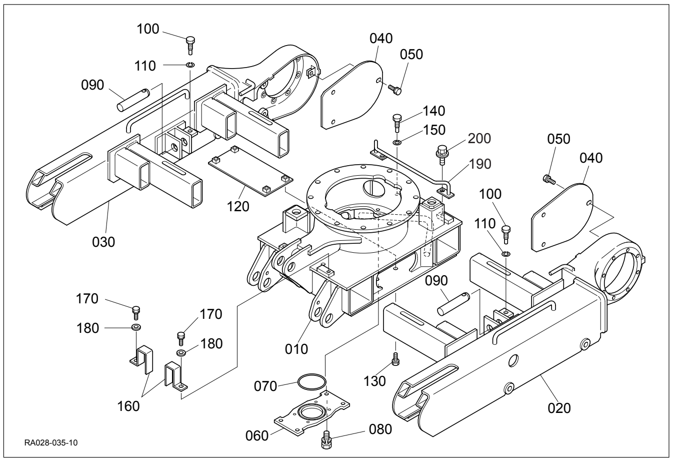
Left Side



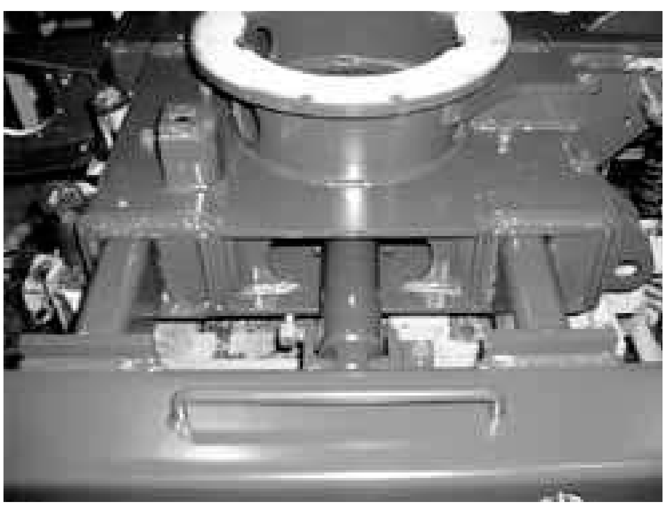
Right Side

* Center of metal fittings of hose should be located at same line of bottom of Rotary joint.

(2) Exploded view of track frame



No.	Parts Name	Q'ty
010	Frame, Center	1
020	Frame, Track LH	1
030	Frame, Track RH	2
040	Cover	2
050	Bolt	6
060	Base	1
070	O-ring	1
080	Bolt	4
090	Pin	2
100	Bolt	2
110	Washer, Spring	2
120	Cover	1
130	Bolt	4
140	Bolt	4
150	Washer, Spring	4
160	Guide	2
170	Bolt	2
180	Washer, Pin	2
190	Guide, Hose	1
200	Bolt	2



3) Mounting the track cylinder
- Be sure to connect the track cylinder bottom side to the frame (track, right).

4) Mounting the track frames (right, left)
- Apply grease (ALBANIA EP2 or equivalent) when mounting the track frames (right, left).

(3) Adjustment of crawlers

- To loosen the crawlers, follow the following procedure:

CAUTION

To avoid personal injury:

- **Do not loosen the grease nipple comletely or too quickly. Otherwise grease under high pressure in the tension cylinder could squirt out.**
- **Do not crawl under the excavator.**

1. Using a socket wrench, loosen the grease nipple a few turns.
2. When grease oozes out from the thread, rotate the crawler and loosen the crawler in the lifted position (see illustration).

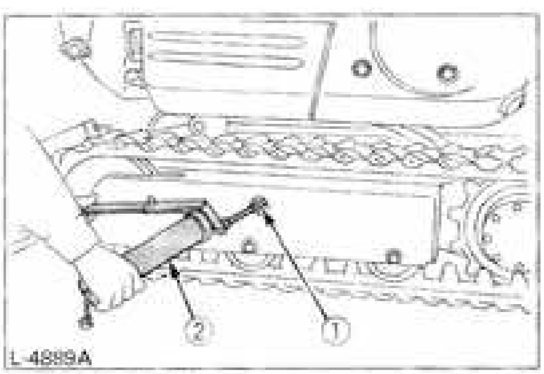
After adjustmentis completed:
Using the socket wrench, tighten the grease nipple.
Tightening torque must be between 72.3 to 79.6 ft·lbs (98 to 108 N·m, 10 to 11 kgf·m)

IMPORTANT:

- **If the crawlers are too tight, wear is increased.**
- **If the crawlers are too loose, the crawler shoes may collide with the sprocket, and wear is increased.**
  The crawler may dislocate or come off.
- **Clean the crawler after every use.**
- **Should the crawler tension be heightend due to mud sicking, lift the crawler with the help of the boom, arm and bucket, idle the engine and remove the mud from the crawler, especially from the opening og the link plate, carefully.**

◆ **Tension the crawlers as specified:**

1. Appli grease ② to the grease nipple ①.



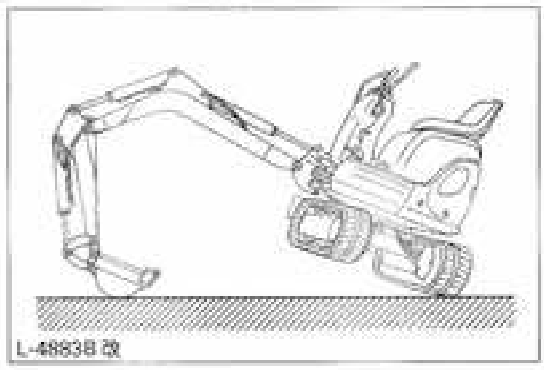
①*Grease nipple*
②*Grease gun*

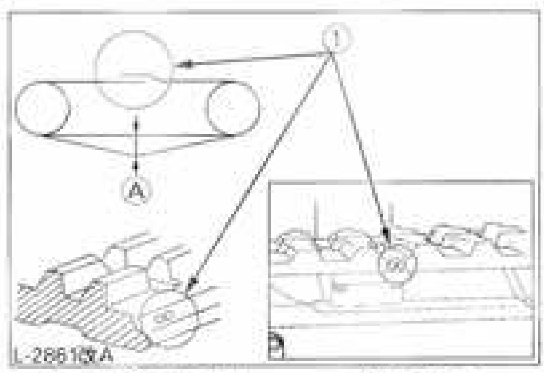
2. Tension the crawler in the lifted position, so that the distance "A" (clearance between the track roler and the inside surface of the crawler) is 10 to15 mm (see illustration) , (In this case, the crawler seam is positioned on the top centre between the idler and the sprocket.

DANGER

To avoid personal injury or death:

- **Do not work under the machine in this condition.**
- **For your safety do not rely on hydraulically supported devices, they may leak down suddenly drop or be accidentally lowered.**





① *Seam (Mark "=")* Ⓐ *10 to 15 mm*

IMPORTANT:

- **Make sure that no obstacles, such as stones, are caught in the crawler. Remove such obstacles before adjusting the crawler tension.**
- **Crawler seam**
  The ends of the rubber crawler are joined witha seam. When adjusting the crawlers, the seam must be positioned on the top centre between the idler and the sprocket.
  If the seam is positioned incorrectly, the crawlers will be tensioned to loosely, and a further re-adjustmentwill be necessary.
- **Rotate the crawler after adjustment one to two times to check the tension.**

- **Additionally the following points are to be observed when adjusting rubber crawlers.**
  1. If the crawler slackens more than 25 mm, readjust them.
  2. Check crawler tansion 30 hours after inistial use and readjust if necessary. Check and adjust there after every 50 service hours.

■ Special information when using rubber crawlers

1. When turning, preferably make a slow swing turn. Avoid spin turns to lessen lug wear and ingress of dirt.
2. The relief valve may be activated if too much dirt and sand clog the crawlers. In this case move the machine for a short distance straight backwards to let the earth and sand fall off, then a turn can be made.
3. Avoid using rubber crawler on riverbeds, stonly underground, ferro-concrete and iron plates. The rubber can be damaged as well as crawler wear increasing.

III.Engine(Mechanism section)

Note: Following pages are missing page.
Even-numbered pages from page M1 to M43.

TO THE READER

The following engine WSM has been compiled after minor changing of original 68 mm stroke series engine WSM by eliminating some pages which doesn't apply to construction machinery model of K008-3, U10-3 series.
Still some pages contain common specifications on -68 mm stroke series engine.
Therefore, some data may differ from the engine mounted on construction machinery.
In that case, please come to B. Engine specifications for construction machinary.
****

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of KUBOTA Diesel Engine 03-M Series. It is divided into two parts, "Mechanism" and "Servicing" for each section.

■ Mechanism

Information on the Features and New Mechanisms are described. This information should be understood before proceeding with troubleshooting, disassembling and servicing.

■ Servicing

The heading "General" includes general precautions, check and maintenance and special tools. There are troubleshooting, checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

All information illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. The right is reserved to make changes in all information at any time without notice.

Due to covering many models of this manual, illustration being used, have not been specified as one model.

April 2003

A.Safety first

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and decals on the engine itself to warn of the possibility of personal injury. Read these instructions carefully.
It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.

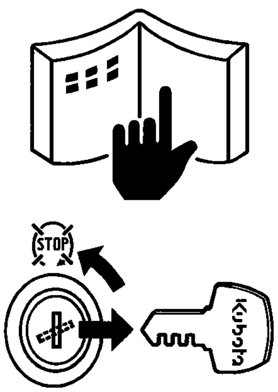
DANGER Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

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

CAUTION Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

■ **IMPORTANT** Indicates that equipment or property damage could result if instructions are not followed.

■ **NOTE** Gives helpful information.



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BEFORE SERVICING AND REPAIRING

(1) Read all instructions and safety instructions in this manual and on your engine safety decals.
(2) Clean the work area and engine.
(3) Place the engine on a firm and level ground.
(4) Allow the engine to cool before proceeding.
(5) Stop the engine, and remove the key.
(6) Disconnect the battery negative cable.

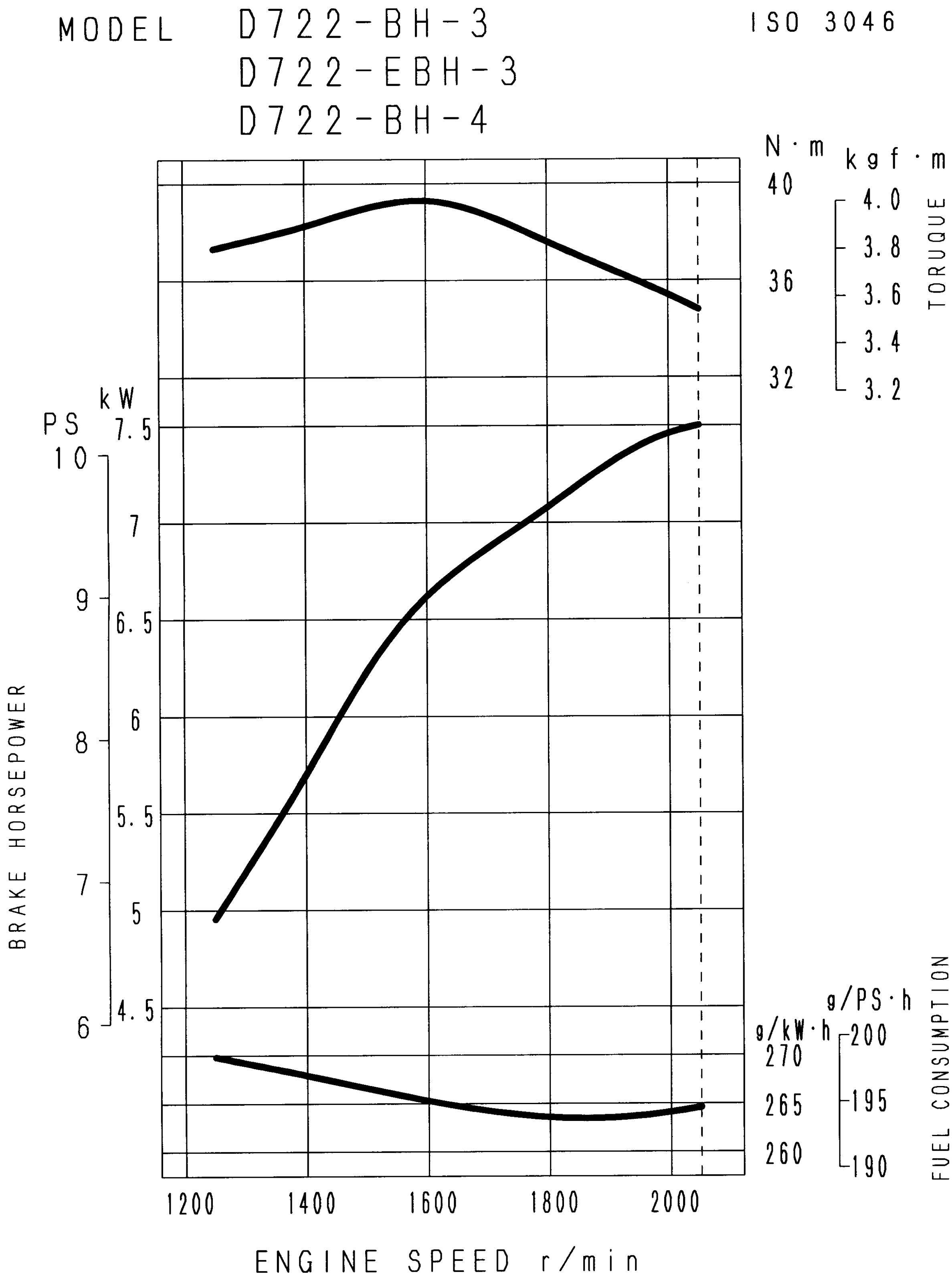
B.Engine specifications for construction machinery

		K008-3US	K008-3EU	U10-3EU
Model		D722-EBH-3	D722-BH-3	D722-BH-4
No. of cylinder		3	←	←
Bore × Stroke	mm in	67 × 68 2.64 × 2.68	←	←
Displacement	cc in^3	719 43.9	←	←
Max. output/rpm	kW/rpm PS/rpm HP/rpm	7.5/2050 10.2/2050 10.1/2050	←	←
Compression ratio		23	←	←
Max.torque	N·m kgf·m ft·lbf	39.3 4.01 29	←	←
Dimensions : L × W × H	mm in	396 × 389 × 520 15.6 × 15.3 × 20.5	←	←
Dri weight	kg lbs	73 161	←	←
Valve clearance	mm in	0.145 - 0.185 0.0057 - 0.0073	←	←
Firing sequence		1-2-3	←	←
Compression pressure (A)/(B)	MPa kgf/cm^2 psi	2.84 - 3.23/2.25 29 - 33/23 412 - 469/327	←	←
Fan belt		Bando RPF2320	←	←
Fuel consumption ratio	g/kWh g/Psh lbs/Hph	286 210 0.47	←	←
Fuel consumption	l/h gal/h	2.4 0.63	←	←
Max. speed without load	rpm	2400 ≧	←	←
Speedwith 2 pumps relief	rpm	2200 ≧	←	←
Speed with idling	rpm	1100 - 1300	←	←
Engine oil pressure with rated engine rpm	kPa kgf/cm^2 psi	196 - 441/10 2.0 - 4.5/1.0 28.4 - 64.0/14.2	←	←
Injection pressure	MPa kgf/cm^2 psi	13.7 140 1991	←	←
Engine oil consumption ratio	g/kWh g/Psh lbs/Hph	0.95 0.7 0.71	←	←

C.Engine electric components

		K008-3US	K008-3EU	U10-3EU
Model		D722-EBH-3	D722-BH-3	D722-BH-4
Fuel injection pump type		BoschMDtype mini-pump	←	←
Nozzle type		DN4PD62 mini-nozzle	←	←
Injection pressure	MPa kgf/cm^2 psi	13.7 140 1991	←	←
Dynamo		12V 150W	←	←
Manufacturer P/N		15531-6401△	←	←
Regulator adjusting voltage	V	12V 14A	←	←
Battery type		44B19R	←	←
Normal capacity of 5 hrs rating	Ah	30	←	←
Specific gravity of electrolite		1.28≦	←	←
Starter motor		12V 0.95kW	←	←
Manufacturer P/N		16853-6301△	←	←
Grow plug	Ω	0.9	←	←

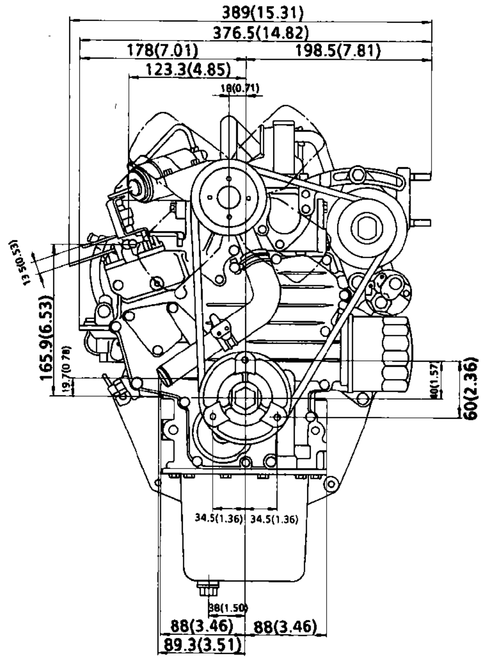
D.Performance Curve



E.Dimensions

■ Z442-B (E), Z482-B (E)

Unit, Unité, Einheit: mm (in.)



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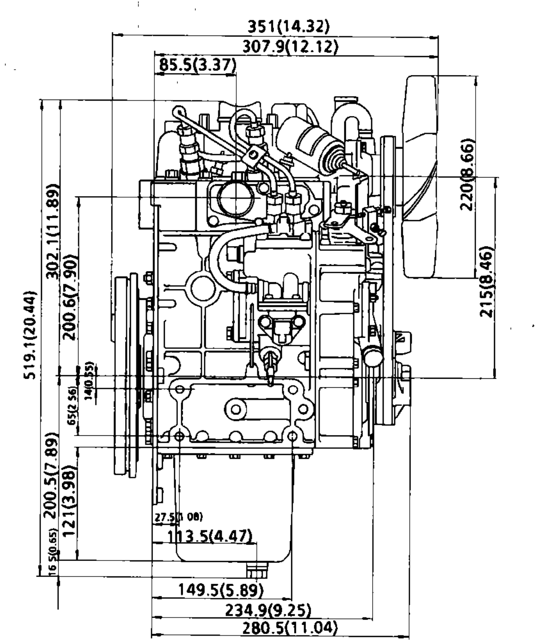

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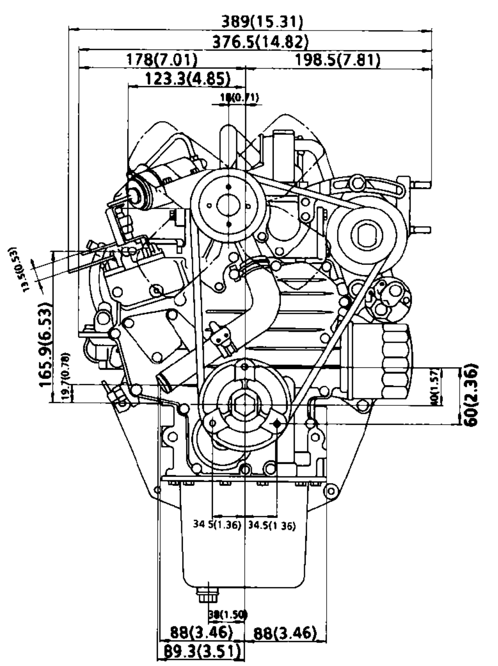
■ D662-B (E), D722-B (E)



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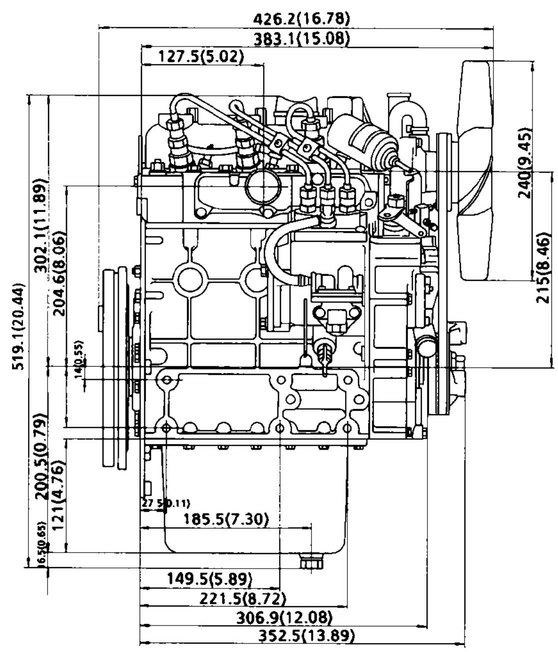

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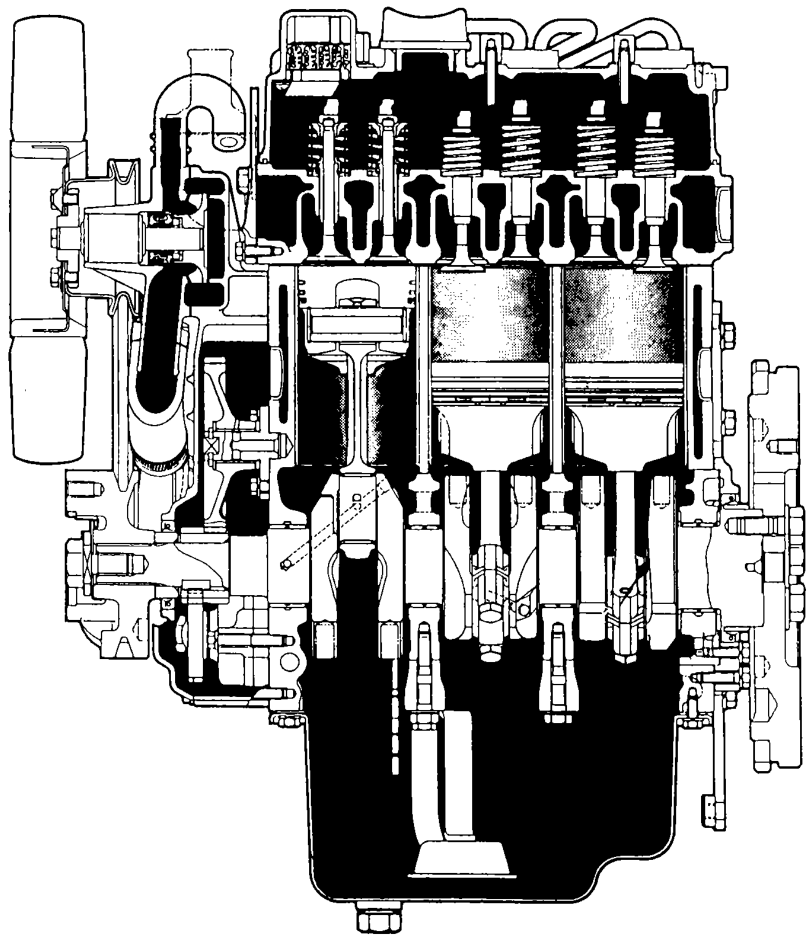
F FEATURE



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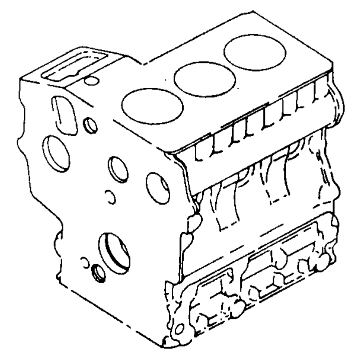
The Z442-B, Z482-B, D662-B, D722-B are vertical, liquid-cooled, 4-cycle diesel engines.
They incorporate KUBOTA's foremost technologies. With KUBOTA's the "NTVCS" (New Three Vortex Combustion System), well-known Bosch MD mini type injection pump and the well-balanced design, they give greater power, low fuel consumption, little vibration and quiet operation.

■ **NOTE**

- Since January **1994, E-TVCS** has been used for the combustion chamber of our products instead of traditional **N-TVCS.**
  E-TVCS was developed with an eye toward clean exhaust gas which is more environmentally friendly.
  The combustion chamber models mentioned hereinafter refers to **E-TVCS.**
  Model of combustion chamber :
  N-TVCS (Engine Serial Number ; 489290 or lower)
  E-TVCS (Engine Serial Number ; 489291 or higher)

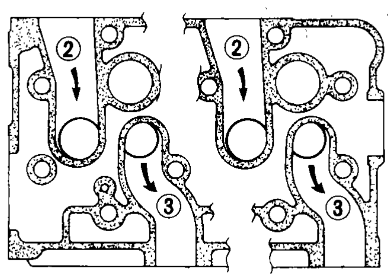
1 ENGINE BODY

[1] CYLINDER BLOCK


0172F007

The engine has a high durability tunnel-type cylinder block in which the crank bearing component is a constructed body. Furthermore, liner less type, allow effective cooling, less distortion, and greater wear-resistance. The noise level is reduced to a minimum because each cylinder has its own chamber.

[2] CYLINDER HEAD



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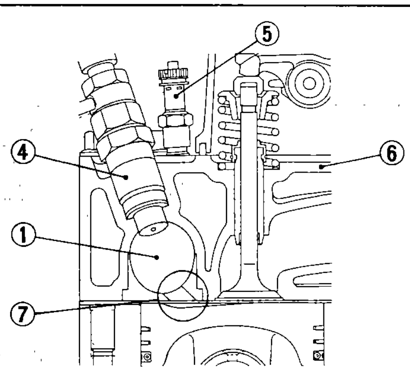

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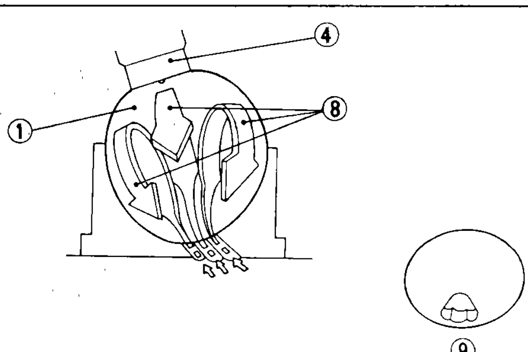

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The cross-flow type intake/exhaust ports in this engine have their openings at both sides of the cylinder head. Because overlaps of intake/exhaust ports are smaller than in ports of other types which have openings on one side, the suction air can be protected from being heated and expanded by heated exhaust air. The cool, high density suction air has high volume efficiency and raises the power of the engine. Furthermore, distortion of the cylinder head by heated exhaust gas is reduced because intake ports are arranged alternately. The combustion chamber is of KUBOTA's exclusive New TVCS combustion chamber type. Suction air is whirled to be mixed effectively with fuel, prompting combustion and reducing fuel consumption.

In the combustion chamber are installed throttle type injection nozzle and rapid heating sheathed type glow plug. This glow plug assures easier than ever engine starts even at −15°C (5°F).

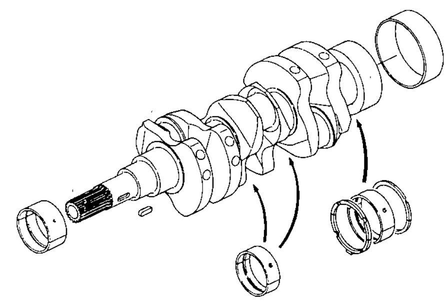
(1) Combustion Chamber
(2) Intake Port
(3) Exhaust Port
(4) Nozzle Assembly
(5) Glow Plug
(6) Cylinder Head
(7) Fan-shaped Concave
(8) Stream
(9) Air Inlet

■ Combustion System

These engine use the "NTVCS" (New Three Vortex Combustion System) to achieve perfect combustion for maximum power. The NTVCS combustion system provides unique shape of throat in the air inlet (9) for combustion chamber, to produce three streams (8) of air in the chamber (1) when compressing, giving an ideal mixture of air and fuel.

In addition, a fan-shaped concave (7) is provided on top of the piston to allow a smooth ejection of the exhaust gas, offering highly efficient combustion.

[3] CRANKSHAFT



0087F011

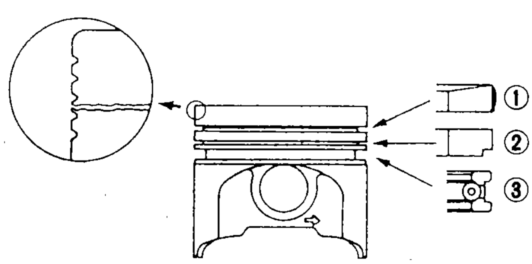
The crankshaft with the connecting rod converts the reciprocating motion of the piston into the rotating motion.

The crankshaft is made of tough special alloy steel, and the journals, pins and oil seal sliding portions are induction hardened to increase the hardness for higher wear resistance.

The front journal is supported by a solid type bearing, the intermediate journal by a split type, and the rear journal by a split type with thrust bearings.

The crankshaft is provided with an oil gallery, through which engine oil is fed to the crank pin portion, and lubricate it.

[4] PISTON AND PISTON RINGS



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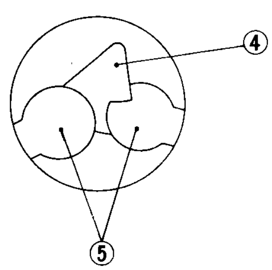


0087F013

The piston is made of aluminum alloy.

Two recesses for the valves are provided on top of the piston. A fan-shaped depression is also given atop the piston in order to allow combustion gas to jet smoothly. The piston pin is slightly out of the center of the piston. In this design, the run-out of the piston at the top and bottom dead points can be reduced, thereby resulting in lower operating noise.

The piston has a slightly oval shape when cold (in consideration of thermal expansion) and a concave head.

Three rings are installed in grooves in the piston.

The top ring (1) is a keystone type, which can stand against heavy loads, and the barrel face on the ring fits well to the cylinder wall.

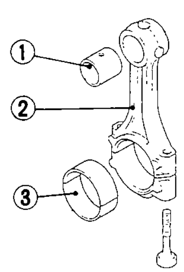
The second ring (2) is an undercut type, which effectively prevents the oil from being carried up.

The oil ring (3) has chamfered contact faces and an expander ring, which increase the pressure of the oil ring against the cylinder wall.

Several grooves are cut on the topland to help heat dissipate and to prevent scuffing.

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Fan-Shaped Concave
(5) Valve Recess

[5] CONNECTING ROD



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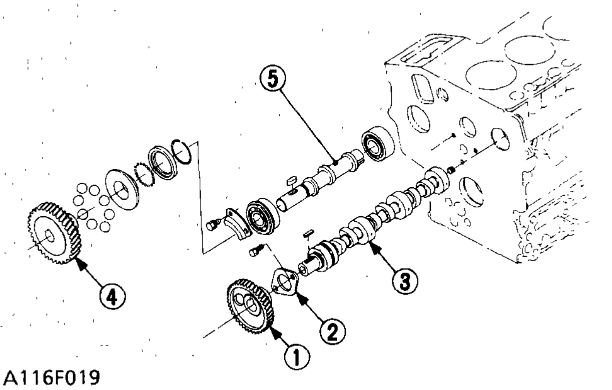
Connecting rod (2) is used to connect the piston with the crankshaft. The big end of the connecting rod has a crank pin bearing (3) (split type) and the small end has a small end bushing (1) (solid type).

(1) Small End Bushing
(2) Connecting Rod
(3) Crank pin Bearing

[6] CAMSHAFT



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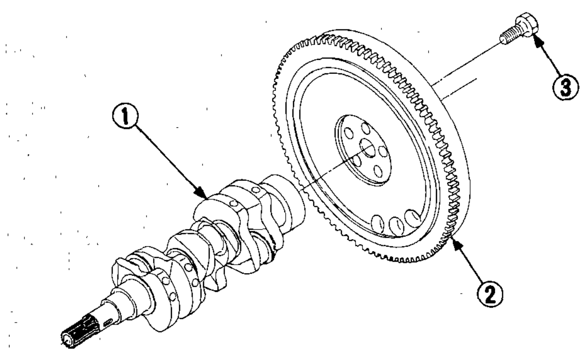
The camshaft (3) is made of special cast iron and the journal and cam sections are chilled to resist wear. The journal sections are force-lubricated. The fuel camshaft (5) controls the reciprocating movement of the injection pump. The fuel camshaft is made of carbon steel and the cam sections are quenched and tempered to provide greater wear resistance.

(1) Cam Gear
(2) Camshaft Stopper
(3) Camshaft
(4) Injection Pump Gear
(5) Fuel Camshaft

[7] FLYWHEEL



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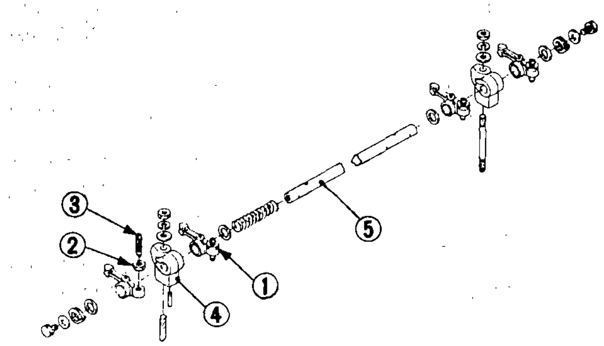
The flywheel stores the rotating force in the combustion stroke as inertial energy, reduces crankshaft rotating speed fluctuation and maintains the smooth rotating conditions.

The flywheel periphery is inscribed with the marks showing top dead center mark **TC**.

The flywheel has gear teeth around its outer rim, which mesh with the drive pinion of the starter.

(1) Crankshaft
(2) Flywheel
(3) Flywheel Screw

[8] ROCKER ARM



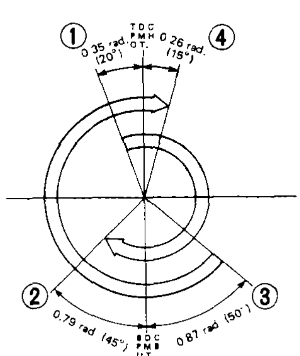
0109F021

The rocker arm assembly includes the rocker arms (1), rocker arm brackets (4) and rocker arm shaft (5) and converts the reciprocating movement of the push rods to an open/close movement of the inlet and exhaust valves.

Lubricating oil is pressurized through the bracket to the rocker arm shaft, which serves as a fulcrum so that the rocker arm and the entire system are lubricated sufficiently.

(1) Rocker Arm
(2) Lock Nut
(3) Adjusting Screw
(4) Rocker Arm Bracket
(5) Rocker Arm Shaft

[9] VALVE TIMING



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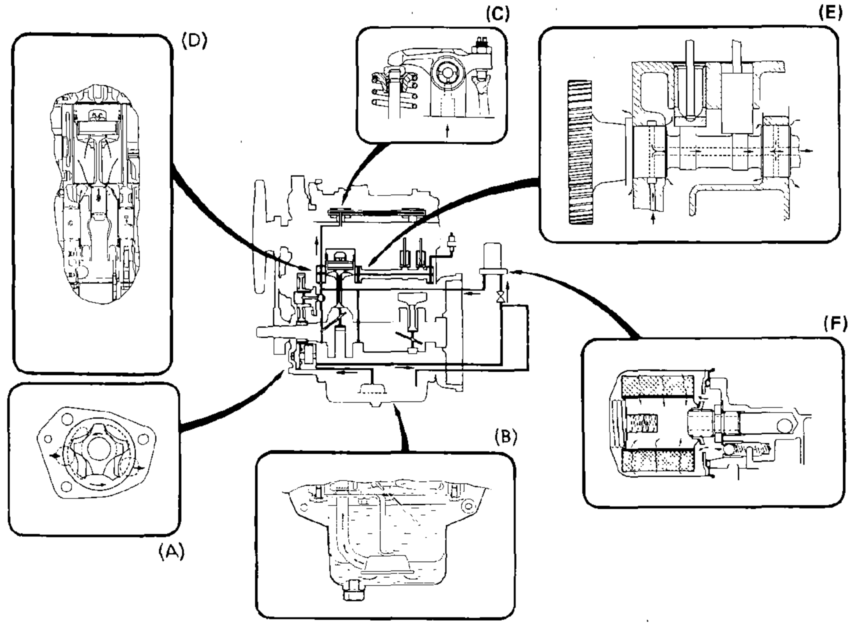
The timing for opening and closing the valve is extremely important to achieve effective air intake and sufficient gas exhaust.

The appropriate timing can be obtained by aligning the marks on the crank gear and the cam gear when assembling.

Inlet valve open ①	0.35 rad. (20°) before T.D.C.
Inlet valve close ②	0.79 rad. (45°) after B.D.C.
Exhaust valve open ③	0.87 rad. (50°) before B.D.C.
Exhaust valve close ④	0.26 rad. (15°) after T.D.C.

2 LUBRICATING SYSTEM

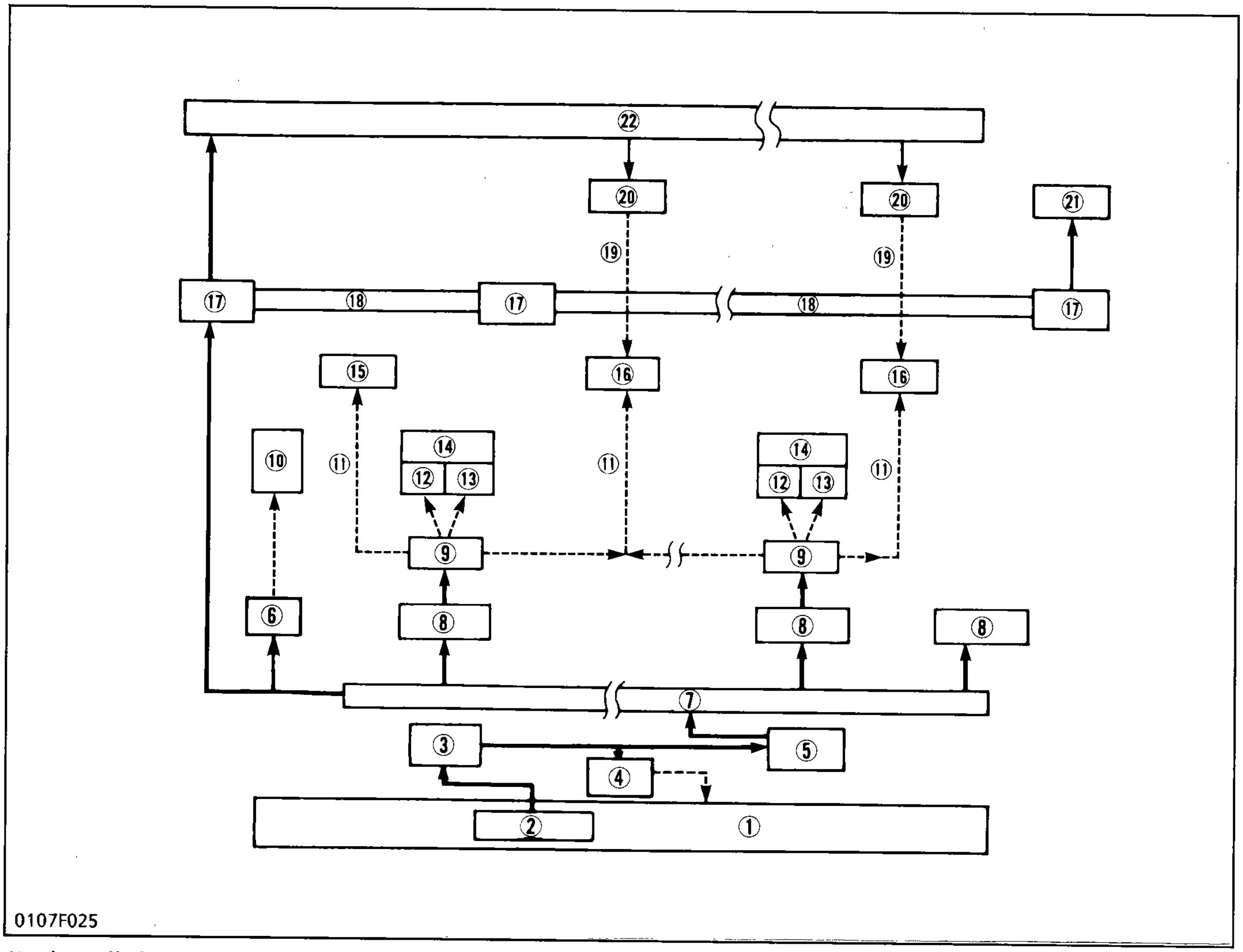
[1] GENERAL



0109F024

[A] Oil Pump
[B] Oil Strainer
[C] Rocker Arm and Rocker Arm Shaft
[D] Piston
[E] Camshaft
[F] Oil Filter Cartridge and Relief Valve

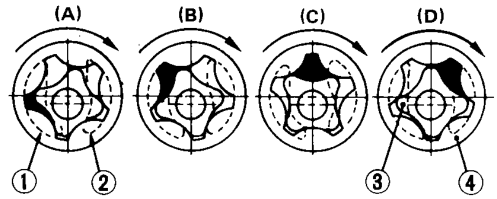
This engine's lubricating system consists of oil strainer, oil pump, relief valve, oil filter cartridge and oil switch. The oil pump sucks lubricating oil from the oil pan through the oil strainer and the oil flows down to the filter cartridge, where it is further filtered. Then the oil is forced to crankshaft, connecting rods, idle gear, camshaft and rocker arm shaft to lubricate each part. Some part of oil, splashed by the crankshaft or leaking and dropping from gaps of each part, lubricates these parts: pistons, cylinders, small ends of connecting rods, tappets, pushrods, inlet and exhaust valves and timing gears.



Engine Oil Flow

(1) Oil Pan
(2) Oil Strainer
(3) Oil Pump
(4) Relief Valve
(5) Oil Filter Cartridge
(6) Idle Gear
(7) Main Oil Gallery
(8) Main Bearing
(9) Big End
(10) Timing Gear
(11) Splash
(12) Bore
(13) Small End
(14) Piston
(15) Fuel Camshaft
(16) Tappets
(17) Camshaft Bearing
(18) Camshaft
(19) Drain
(20) Rocker Arm
(21) Oil Switch
(22) Rocker Arm Shaft

[2] OIL PUMP



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(1) Inlet Port
(2) Outlet Port
(3) Inner Rotor
(4) Outer Rotor

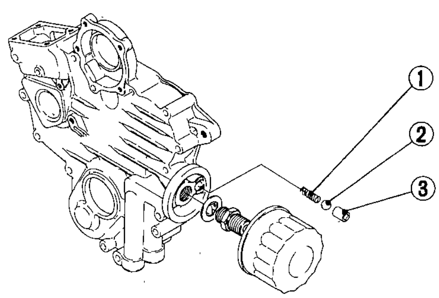
The oil pump is a trochoid pump, whose rotors have trochoid lobes. The inner rotor (3) has 4 lobes and the outer rotor (4) has 5 lobes, and they are eccentrically engaged with each other. The inner rotor, which is driven by the crankshaft through the gears, rotates the outer rotor in the same direction, varying the space between the lobes.

While the rotors rotate from (A) to (B), the space leading to the inlet port increases, which causes the vacuum to suck in the oil from the inlet port.

When the rotors rotate to (C), the space between both rotors switches from the inlet port to the outlet port.

At (D), the space decreases and the sucked oil is discharged from the outlet port.

[3] RELIEF VALVE



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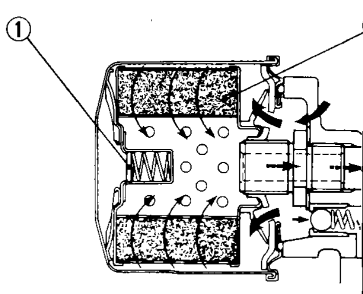
The relief valve prevents the damage to the lubricating system due to the high pressure of the oil.

The relief valve is ball direct acting type, and is best suited for low pressures.

When the pressure of the oil, forced by the pump, exceeds the specified value, the oil pushes back the ball (2) and escapes to the oil pan.

(1) Spring
(2) Ball
(3) Valve Seat

[4] OIL FILTER CARTRIDGE



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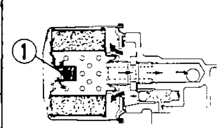


0109F029

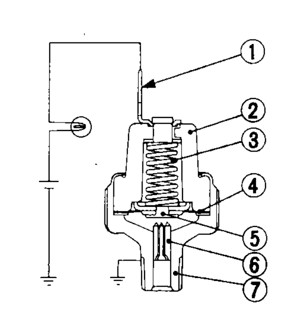
After lubricating, the lubricating oil brings back various particles of grit and dirt to the oil pan. Those particles and the impurities in the lubricating oil can cause wear or seizure of the engine parts. It may also impair the physical and chemical properties of the oil itself.

The lubricating oil which is force-fed by the pump, is filtered by the filter cartridge with the filter element (2). When the filter element accumulates on excessive amount of dirt and the oil pressure in the inlet line builds up by 98 kPa (1.0 kgf/cm^2, 14 psi) more than the outlet line, the bypass valve (1) opens to allow the oil to flow from the inlet into the outlet line, bypassing the filter element.

(1) Bypass Valve
(2) Filter Element

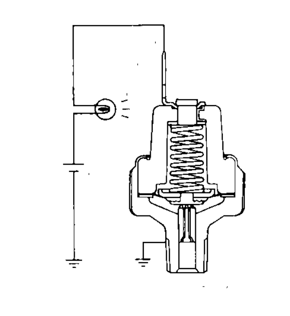
[5] OIL PRESSURE SWITCH

[A]



0107F029

[B]



0107F030

The oil pressure switch is mounted on the cylinder block and is led to the lubricating oil passage.

When the oil pressure falls below the specified value, the oil pressure warning lamp lights.

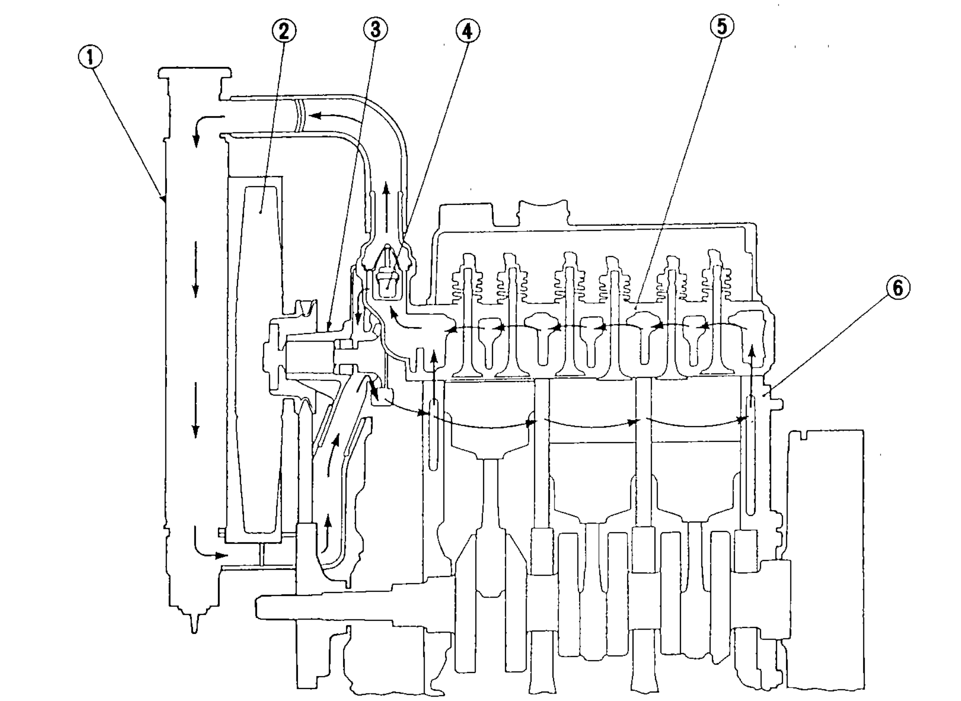
[A] At the proper oil pressure

[B] At lower oil pressure, 49 kPa (0.5 kgf/cm², 7 psi) or less

(1) Terminal
(2) Insulator
(3) Spring
(4) Rubber gasket
(5) Contact rivet
(6) Contact
(7) Oil Switch Body

3 COOLING SYSTEM

[1] GENERAL



B083F248

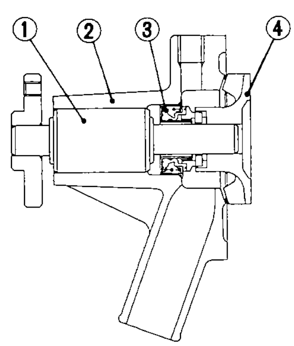
(1) Radiator
(2) Suction Fan
(3) Thermostat
(4) Water Pump
(5) Cylinder Head
(6) Cylinder Block

The cooling system consists of a radiator (1) (not included in the basic engine), centrifugal water pump (4), suction fan (2) and thermostat (3).

The water is cooled through the radiator core, and the fan set behind the radiator pulls cooling air through the core to improve cooling.

The water pump sucks the cooled water, forces it into the cylinder block and draws out the hot water. Then the cooling is repeated. Furthermore, to control temperature of water, a thermostat is provided in the system. When the thermostat opens, the water moves directly to radiator, but when it closes, the water moves toward the water pump through the bypass between thermostat and water pump. The opening temperature of thermostat is approx. 71°C (160°F).

[2] WATER PUMP

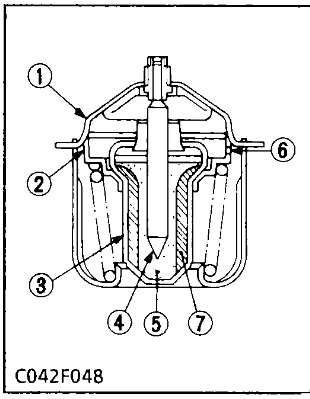


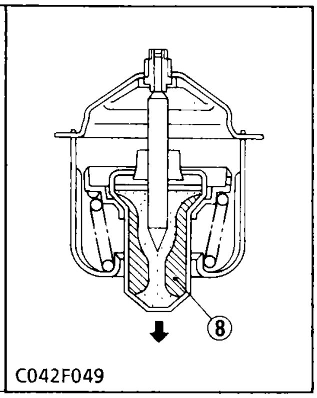
0109F031

The water pump is driven by the crankshaft via a V-belt. Water cooled in the radiator is sucked into the water pump from its lower portion and is sent from the center of the water pump impeller (4) radially outward into the water jacket in the crankcase.

(1) Bearing Unit
(2) Water Pump Body
(3) Mechanical Seal
(4) Water Pump Impeller

[3] THERMOSTAT





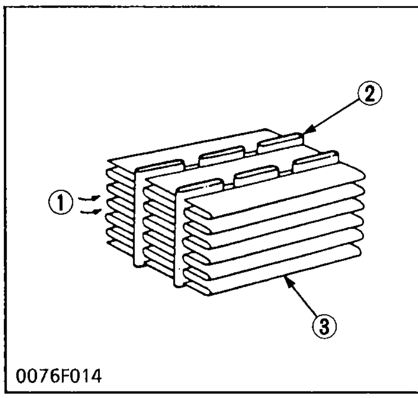
(1) Seat
(2) Valve
(3) Pellet
(4) Spindle
(5) Synthetic Rubber
(6) Leak Hole
(7) Wax (solid)
(8) Wax (liquid)

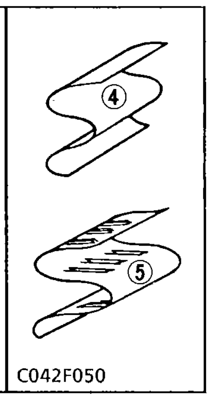
The thermostat maintains the cooling water at correct temperature. KUBOTA's engine uses a wax pellet type thermostat. Wax is enclosed in the pellet. The wax is solid at low temperatures, but turns liquid at high temperatures, expands and opens the valve.

(A) At low temperatures (lower than 71°C (160°F)).
As the thermostat is closed, cooling water circulates in the engine through the water return pipe without running to the radiator. Air in the water jacket escapes to the radiator side through leak hole (6) of the thermostat.

(B) At high temperatures (higher than 71°C (160°F)).
When the temperature of cooling water exceeds 71°C (160°F), wax in the pellet turns liquid and expands. Because the spindle (4) is fixed, the pellet (3) is lowered, the valve (2) is separated from the seat (1), and then cooling water is sent to the radiator.

[4] RADIATOR (not included in the basic engine)

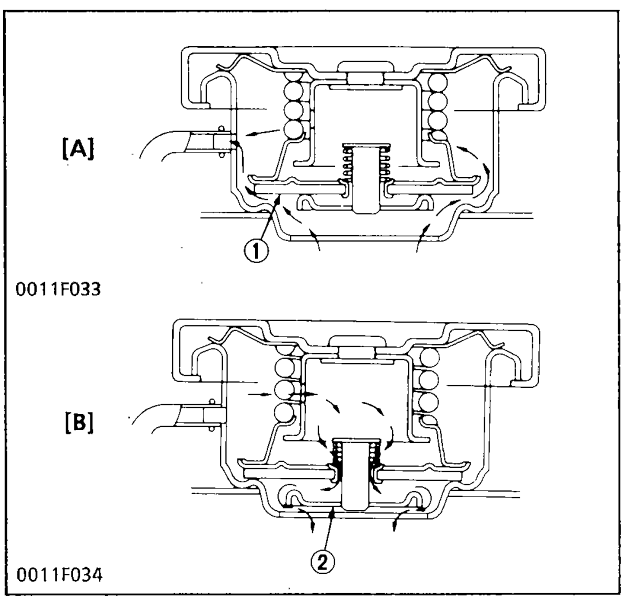




The radiator core consists of water carrying tubes and fins (3) at a right angle to the tubes (2). Heat of hot water in the tubes is radiated from the tube walls and fins. KUBOTA's engine uses corrugated fin type core which has a light weight and high heat transfer rate. Clogging is minimized by the louverless corrugated fins.

(1) Cooling Air
(2) Tube
(3) Fin
(4) Louverless Corrugated Fin
(5) Louvered Corrugated Fin

[5] RADIATOR CAP



The radiator cap is for sustaining the internal pressure of the cooling system at the specified level 88 kPa (0.9 kgf/cm^2, 13 psi) when the engine is in operation. The cap consists of a pressure valve (1) a vacuum valve (2), valve springs, gasket, etc.

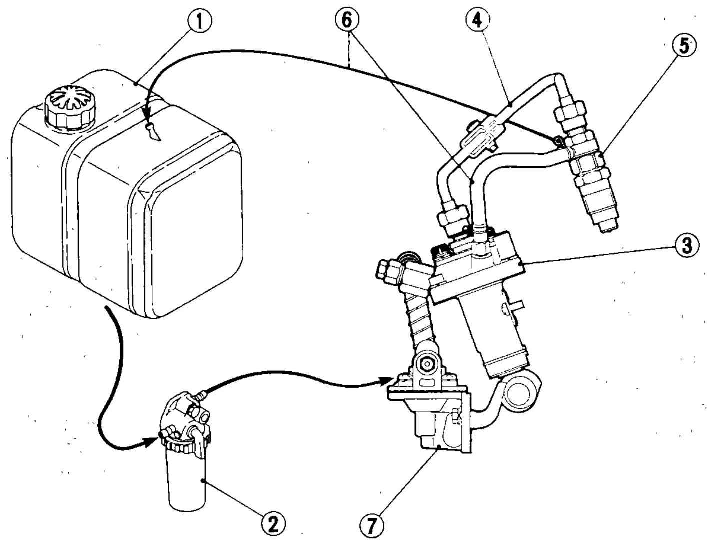
Cooling water is pressurized by thermal expansion of steam, and as its boiling temperature rises, generation of air bubbles will be suppressed. (Air bubbles in cooling water lowers the cooling effect.)

[A] When radiator internal pressure is high
[B] When radiator internal pressure is negative

(1) Pressure Valve
(2) Vacuum Valve

4 FUEL SYSTEM

[1] GENERAL



0109F032

*(1) Fuel Tank
(2) Fuel Filter
(3) Injection Pump
(4) Injection Pipe
(5) Injection Nozzle
(6) Fuel Overflow Pipe
**(7) Fuel Feed Pump

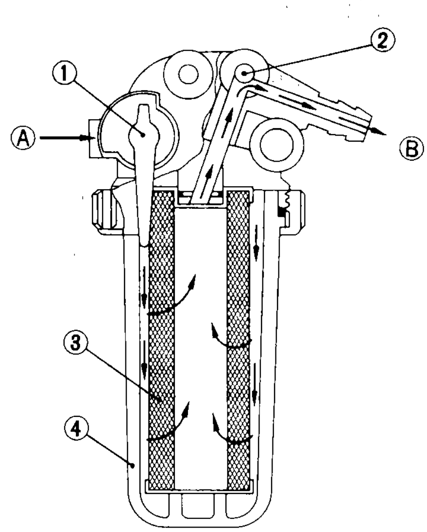
Fuel from the fuel tank (1) passes through the fuel filter (2), and then enters the injection pump (3) after impurities such as dirt, water, etc. are removed.

The fuel pressurized by the injection pump to the opening pressure (13.73 to 14.71 MPa, 140 to 150 kgf/cm^2, 1991 to 2062 psi), of the injection nozzle (5) is injected into the combustion chamber.

Part of the fuel fed to the injection nozzle (5) lubricates the moving parts of the plunger inside the nozzle, then returns to the fuel tank through the fuel overflow pipe (6) from the upper part of the nozzle holder.

■ **NOTE**
- **Component marked * is not included in the basic model.**
- **Component marked ** is included only in the basic model.**

[2] FUEL FILTER (not included in the basic model)



0109F053

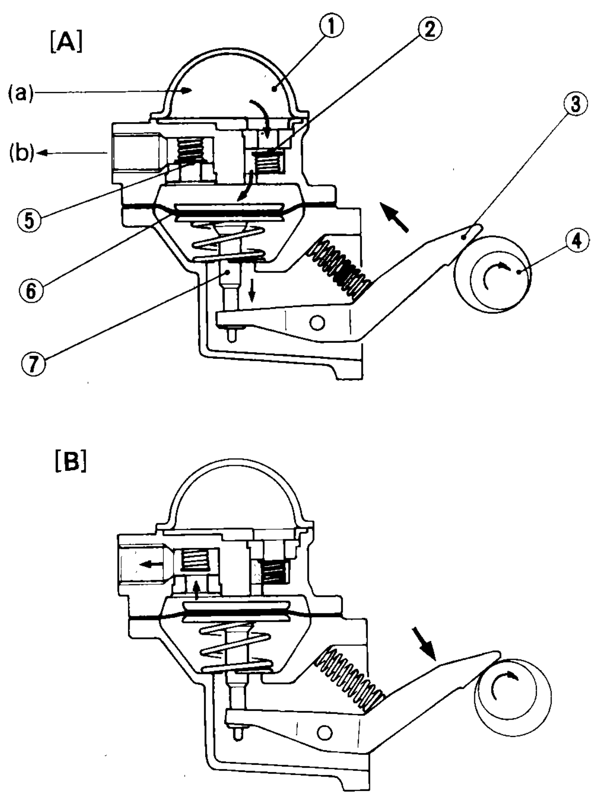
Each moving part of the injection pump and nozzle is extremely precision machined, and clearances of their sliding parts are extremely small. Fuel itself serves as lubricating oil. For this reason, it is extremely important to completely remove water and dirt contained in fuel.

This fuel filter, which uses very fine filter paper, serves to separate and filter dirt in fuel and water accumulated in the tank.

Air vent plug is fitted to the cock body. Before starting or after disassembling and reassembling, loosen this plug and bleed the air in the fuel system.

(A) Inlet
(B) Outlet
(1) Fuel Cock
(2) Air Vent Plug
(3) Filter Element
(4) Filter Cup

[3] FUEL FEED PUMP



0109F033

The filtered fuel is fed to the injection pump by the fuel fed pump.

The chamber (1) is enclosed with the inlet valve (2), the outlet valve (5) and the diaphragm (6), which is linked to the rocker arm with the pull rod (7). The rocker arm is swinged by the eccentric cam on the fuel camshaft (4).

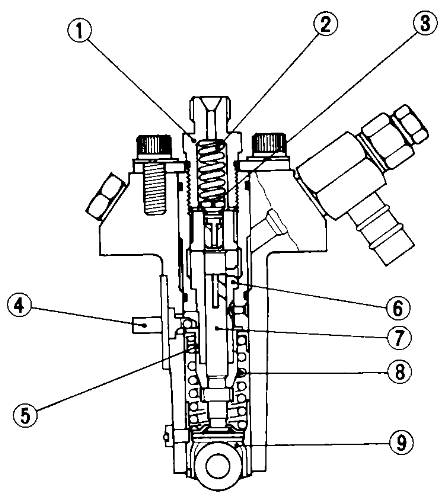
When the diaphgram is pulled down, vaccum in the chamber (1) causes the outlet valve (5) to close and the atomospheric pressure in the fuel tank to force the fuel into the chamber, opening the inlet valve (2).

When the diaphragm is pushed up by the cam, the pressure in the chamber causes the inlet valve to close and forces out the fuel, opening the outlet valve.

(A) Inlet Stroke
(a) from fuel filter
(1) Chamber
(2) Inlet Valve
(3) Rocker Arm
(4) Fuel Camshaft

(B) Discharge Stroke
(b) to injection pump
(5) Outlet Valve
(6) Diaphragm
(7) Pull Rod

[4] INJECTION PUMP



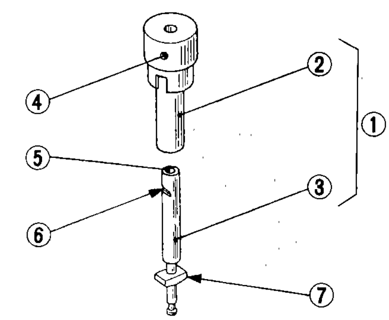
0109F034

A Bosch MD type mini pump is used for the injection pump. It is small, lightweight and easy to handle.

The plunger (7) with a right-hand lead reciprocates via the tappet roller (9) by means of the camshaft fuel cam, causing the fuel to be delivered into the injection nozzle.

(1) Delivery Valve Holder
(2) Delivery Valve Spring
(3) Delivery Valve
(4) Control Rod
(5) Control Sleeve
(6) Cylinder
(7) Plunger
(8) Plunger Spring
(9) Tappet

(1) Pump Element



0011F043

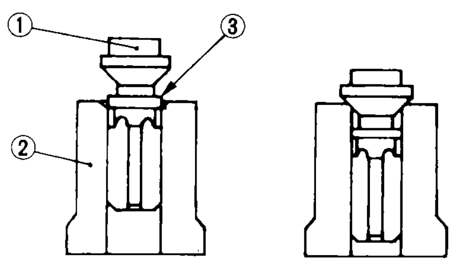
The pump element (1) is consist of the plunger (3) and cylinder (2).

The sliding surfaces are super-precision machined to maintain injection pressure at engine low speeds. Since the driving face (7) fits in the control sleeve, the plunger (3) is rotated by the movement of the control rack to increase or decrease of fuel delivery.

As described above, the plunger (3) is machined to have the slot (5) and the control groove (6).

(1) Pump Element
(2) Cylinder
(3) Plunger
(4) Feed Hole
(5) Slot
(6) Control Groove
(7) Driving Face

(2) Delivery Valve



0011F042

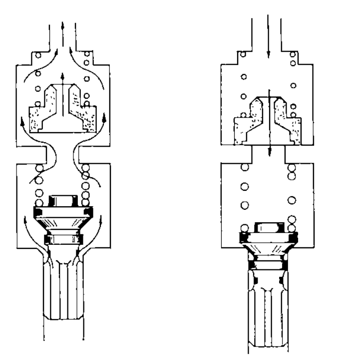
The delivery valve consists of the valve (1) and the Valve seat (2).

The delivery valve prevents the fuel from flowing back into the delivery chamber through the injection pipe. It also prevents the fuel from dribbling at the injection nozzle.

When the delivery stroke ends the relief plunger moves into the bore of the valve seat and seals the delivery line from the delivery chamber. The relief plunger lowers further until the valve seats suck back the fuel to prevent dribbling at the injection nozzle.

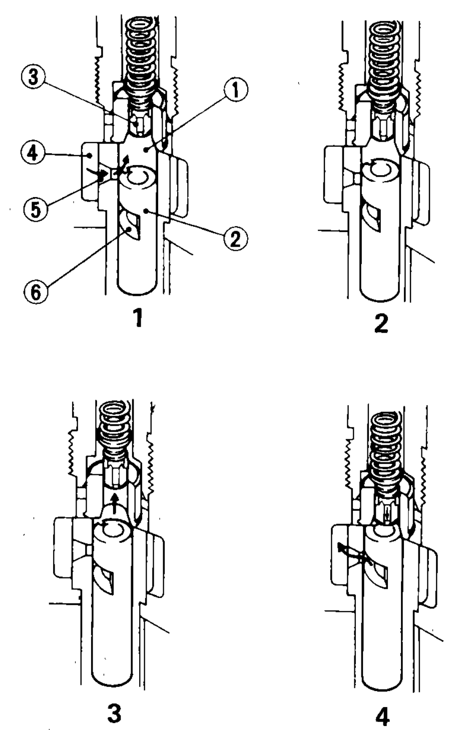
(1) Valve
(2) Valve Seat
(3) Relief Plunger

(3) Dumping Valve


0087F025

1. **At fuel injection**
   Since dumping valve is pushed up to press the spring, fuel is pressure-fed to injection nozzle the same as without dumping valve.
2. **At suck-back**
   At suck-back by delivery valve after fuel injection fuel returns through dumping valve orifice Generally second injection is apt to occur by reflex pressure due to reaction of sudden pressure drop when changing into suck-back by delivery valve from high injection pressure. As a result of preventing this second injection perfectly by dumping valve and dissolving nozzle clogging, durability of injection nozzle is improved.

(4) Operation of Pump Element

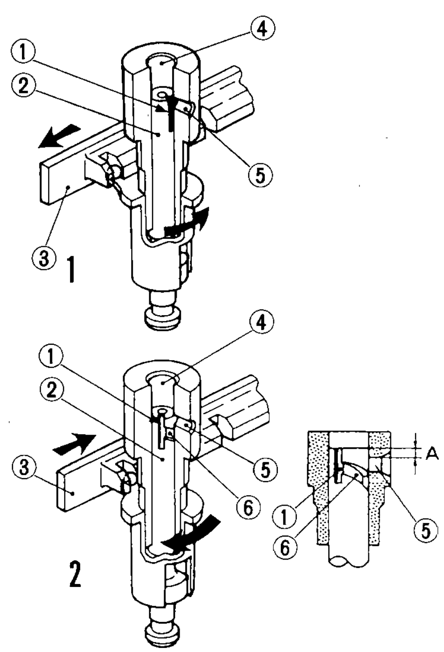


0011F044

1. **Before delivery**
   As the tappet lowers, the plunger (2) also lowers and fuel is drawn into the delivery chamber (1) through the feed hole (5) from the fuel chamber (4).
2. **Beginning of delivery**
   When the plunger is pushed up by the cam and the head of the plunger closes the feed hole, the pressure in the delivery chamber rises to push the relief plunger (3) open.
   Fuel is then force-fed into the injection pipe.
3. **Delivery**
   While the plunger is rising, the delivery of fuel continues.
4. **End of delivery**
   When the plunger rises further and the control groove (6) on its periphery meets the feed hole,the fuel returns to the fuel chamber from the delivery chamber through the control groove and the feed hole.

(1) Delivery Chamber
(2) Plunger
(3) Relief Plunger
(4) Fuel Chamber
(5) Feed Hole
(6) Control Groove

(5) Injection Control

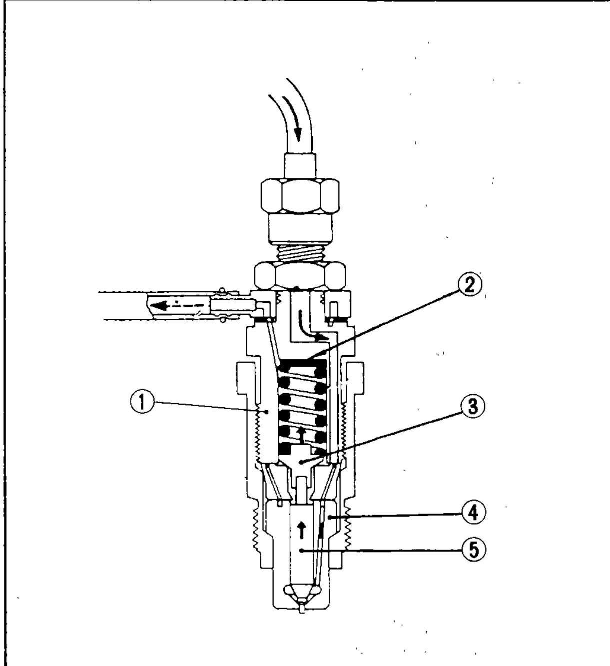


0109F304

1. **No fuel delivery**
   At the engine stop position of the control rod (3), the lengthwise slot (1) on the plunger (2) aligns with the feed hole (5). And the delivery chamber (4) is led to the feed hole during the entire stroke of the plunger.
   The pressure in the delivery chamber does not build up and no fuel can be forced to the injection nozzle.
2. **Fuel delivery**
   The plunger (2) is rotated (See figure) by the control rod (3). When the plunger is pushed up, the hole (5) is closed. The pressure in the delivery chamber (4) builds up and forcefeeds the fuel to the injection nozzle until the control groove (6) meets the feed hole (5).
   The amount of the fuel corresponds to the distance "**A**".

(1) Slot
(2) Plunger
(3) Control Rod
(4) Delivery Chamber
(5) Feed Hole
(6) Control Groove

[5] INJECTION NOZZLE



A116F012

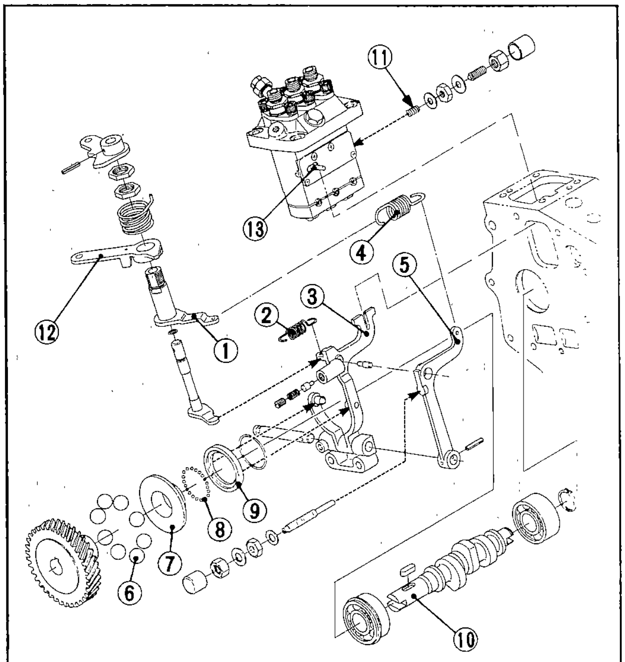
This nozzle is throttle-type. The needle valve (5) is pushed against the nozzle body (4) by the nozzle spring via the push rod (3). Fuel pressurized by the injection pump pushes the needle valve up and then is injected into the sub-combustion chamber.

Excessive flow passes from nozzle holder center through the eye joint and the fuel overflow pipe to the fuel tank.

The injection pressure is 13.73 to 14.71 MPa (140 to 150 kgf/cm^2, 1991 to 2133 psi), and is adjusted with adjusting washers (2).

(1) Nozzle Holder Body
(2) Adjusting Washer
(3) Push Rod
(4) Nozzle Body
(5) Needle Valve

[6] GOVERNOR



0109F035

(1) Governor Lever
(2) Start Spring
(3) Fork Lever 1
(4) Governor Spring
(5) Fork Lever 2
(6) Steel Ball
(7) Governor Sleeve
(8) Steel Ball
(9) Governor Ball Case
(10) Fuel Camshaft
(11) Idling Ajust Spring
(12) Speed Control Lever
(13) Control Rod

The governor controls the amount of the fuel to be fed in the entire speed range to prevent the engine from changing its speed according to the load.

The fork lever 1 (3) is held where two forces on it are balanced. One is the force that fork lever 2 pushes, which is caused by the tension of the governor spring (4) between the governor lever (1) and fork lever 2 (5). Another is the component of the centrifugal force produced by the steel balls (6) which are rotated by the fuel camshaft (10).

■ **At start**

The steel ball (6) has no centrifugal force.

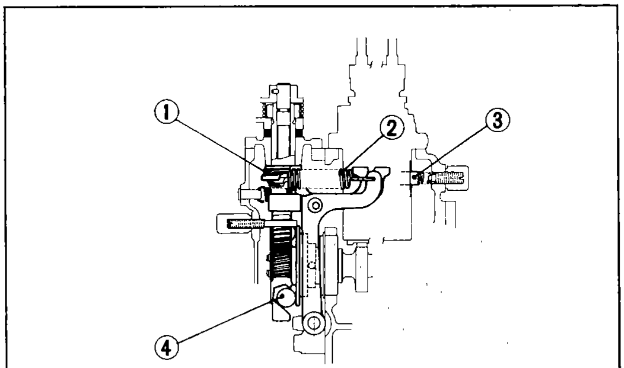
Fork lever 1 (3) is pulled by the start spring (2) and the control rod (13) moves to the maximum injection position for easy starting.

■ **At idling**

When the speed control lever (12) is set at the idling position, the governor spring (4) is pulled slightly.

As the camshaft rotates, the steel ball (6) increase their centrifugal force and push the governor sleeve (7). Fork lever 1 (3) pushed by the governor sleeve, pushes the control rod (13) and the control rod compresses the idling adjust spring (11).

The control rod is kept at a position where the centrifugal force is balanced with the spring tensions on the control rod, providing stable idling.



0109F038

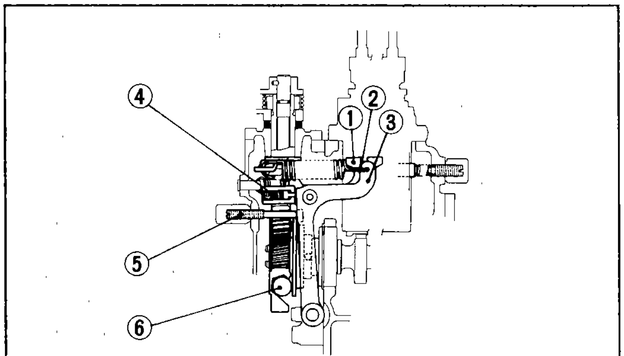
■ **At medium or high speed running**

When the speed control lever (1) is turned further, the governor spring (2) increases the tension and the control rod (3) is pulled to increase the engine speed.

The steel ball (4) increase their centrifugal force and the control rod is pushed, decreasing the engine speed, until the centrifugal force and the spring tension are balanced.

When the engine speed is dropped (A→B) with the increase of the load (a→b), the centrifugal force of the steel ball decreases and the control rod is pulled. The amount of the fuel to the injection nozzle is increased to produce a higher engine torque required for the load.

(1) Speed Control Lever
(2) Governor Spring
(3) Control rod
(4) Steel Ball



0109F039

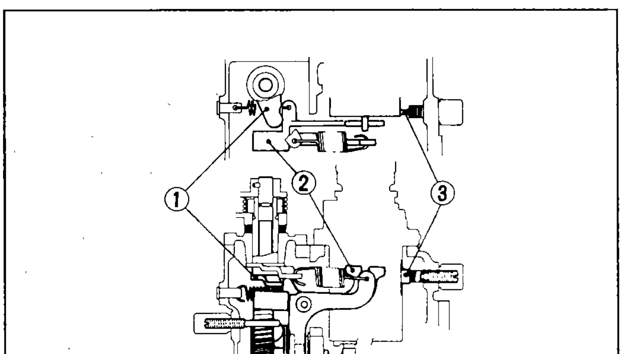
■ **At maximum speed running with an overload**

When the engine is overloaded at the high speeds and the engine speed drops, the centrifugal force of the steel ball (6) decreases and the governor spring (2) pulls fork lever 1 (1) and 2 (3).

When fork lever 2 contacts the adjusting screw (5), the spring (4) which is built in fork lever 1 begins to push the fork lever 1 to pull the control rod.

The fuel to the injection nozzle is increased to run the engine at high speed and torque.

(1) Fork Lever 1
(2) Governor Spring
(3) Fork Lever 2
(4) Spring
(5) Adjusting Screw
(6) Steel Ball



0109F040

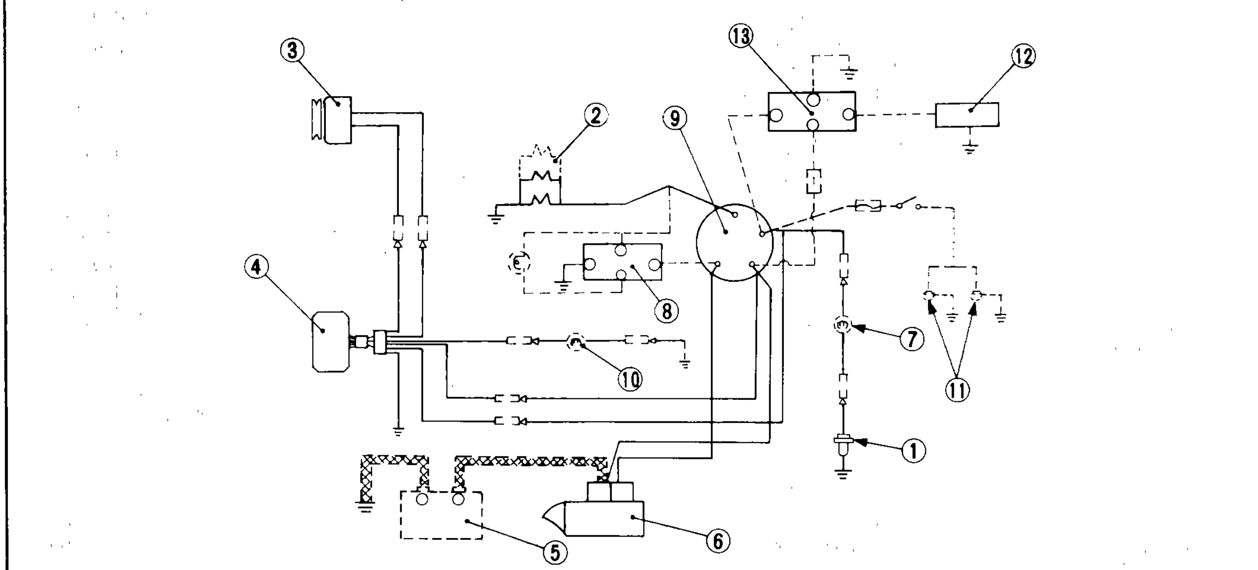
■ **To stop the engine**

When the stop lever (1) is moved to the stop position, fork lever 1 (2) is pushed and the control rod (3) is moved to stop the fuel injection.

(1) Stop Lever
(2) Fork Lever 1
(3) Control Rod

5 ELECTRICAL SYSTEM

Z442-B·Z482-B·D662-B·D722-B



A116P013

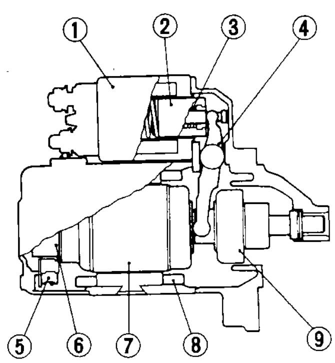
The electrical system of the engine consists of a starting system (including a starter, glow plugs and others), a charging system (including an AC dynamo, a regulator and others), a battery and an oil switch.

■ NOTE
- **Components marked * are not included in the basic model.**

(1) Oil Pressure Switch
(2) Glow Plug
(3) AC Dynamo
(4) Regulator
*(5) Battery
(6) Starter
*(7) Oil Lamp
*(8) Lamp Timer
*(9) Key Switch
*(10) Charge Lamp
*(11) Light
*(12) Solenoid
*(13) Timer

[1] STARTING SYSTEM

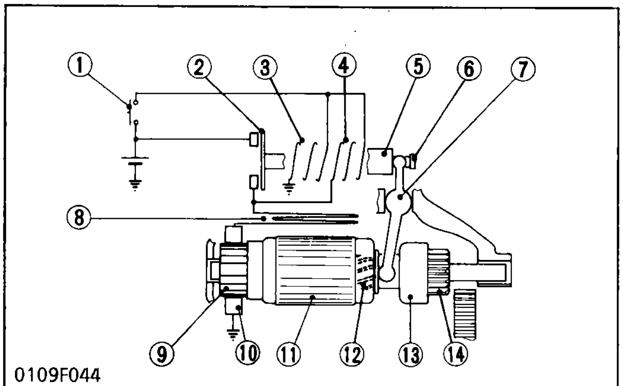
(1) Starter



0109F043

The starter is of the electromagnetic drive type.
It is composed of a starting motor and a solenoid switch.

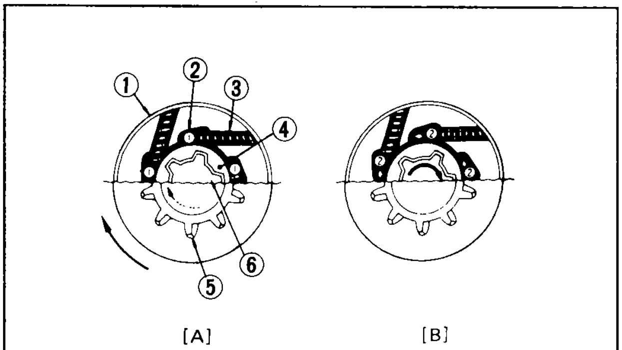
(1) Solenoid Switch
(2) Plunger
(3) Spring
(4) Shift Lever
(5) Brush
(6) Commutator
(7) Armature
(8) Field Coil
(9) Overrunning Clutch



0109F044

1. Schematic Circuit

(1) Key Switch	(8) Field Coil
(2) Solenoid Switch	(9) Commutator
(3) Holding Coil	(10) Brush
(4) Pull-in Coil	(11) Armature
(5) Plunger	(12) Spiral Spline
(6) Rod	(13) Overrunning Clutch
(7) Shift Lever	(14) Pinion



D007F088

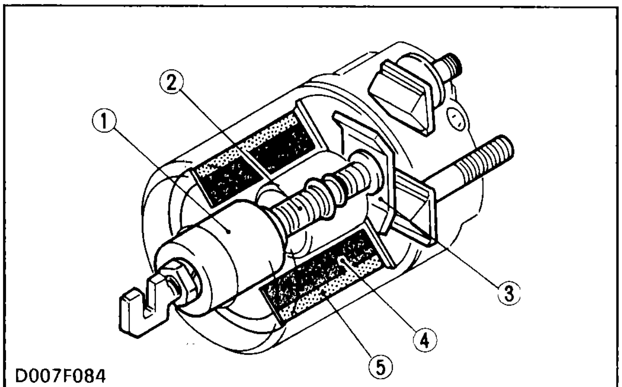
2. Overrunning Clutch

The overrunning clutch is so constructed that the power transmission relationship is automatically severed when the clutch pinion shaft (6) speed exceeds the clutch gear outer (1) speed at increased engine speeds. Therefore, the armature drives the ring gear and is never driven by the engine.

[A] When power is transmitted

[B] Idling rotation with clutch pinion shaft speed exceed that of clutch gear outer

(1) Clutch Gear outer	(4) Spline Tube Inner
(2) Roller	(5) Pinion Gear
(3) Roller Spring	(6) Clutch Pinion Shaft



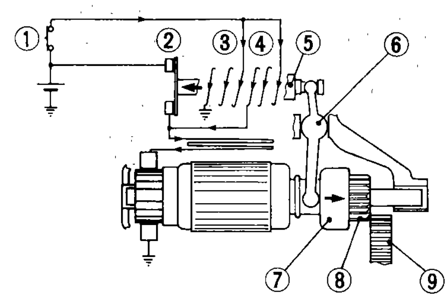
D007F084

3. Solenoid Switch

The solenoid switch forces out the pinion for engaging with the ring gear, and operates as a relay to drive the armature.

It consists of a pull-in coil, a holding coil and a plunger.

(1) Plunger	(4) Pull-in Coil
(2) Spring	(5) Holding Coil
(3) Contact Plate	



0109F045

4. Operating of Starter

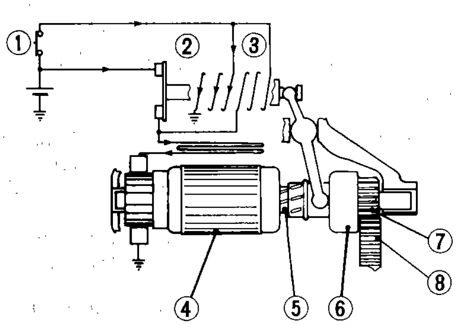
■ When Main Switch Is Turned to "START" Position

The contacts of main switch (1) close and the holding coil (3) is connected to the battery to pull the plunger (5).

The pull-in coil (4) and the starting motor are also connected to the battery.

The pinion (8) is pushed against the ring gear (9) with the overrunning clutch (7) by the drive lever (6) and the solenoid switch (2) is closed.

(1) Main Switch
(2) Solenoid Switch
(3) Holding Coil
(4) Pull-in Coil
(5) Plunger
(6) Drive Lever
(7) Overrunning Clutch
(8) Pinion
(9) Ring Gear



0109F046

■ When Solenoid Switch Is Closed

The current from the battery flows through the solenoid switch (2) to the starting motor.

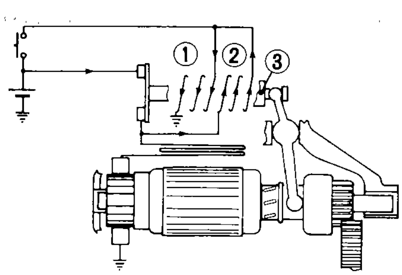
The pinion (7), which is pushed against the ring gear (8) and rotated along the spline (5), meshes with the ring gear to crank the engine.

The engine starts and increases its speed.

While the pinion spins faster than the armature, the overrunning clutch (6) allows the pinion to spin independently from the armature.

The pull-in coil (3) is short-circuited through the solenoid switch (2) and the main switch (1).

(1) Main Switch
(2) Solenoid Switch
(3) Pull-in Coil
(4) Armature
(5) Spiral Spline
(6) Overrunning Clutch
(7) Pinion
(8) Ring Gear



0109F047

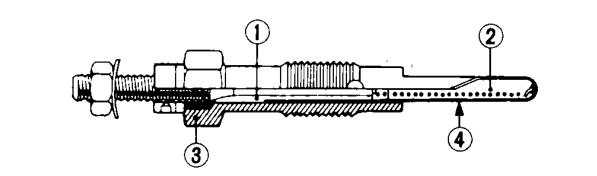
■ When Main Switch Is Released

The current from the battery flows to the holding coil (1) through the pull-in coil (2) to diminish the magnetism between them.

The plunger (3) is pushed by the spring to pull in the pinion.

(1) Holding Coil
(2) Pull-in Coil
(3) Plunger

(2) Glow Plug

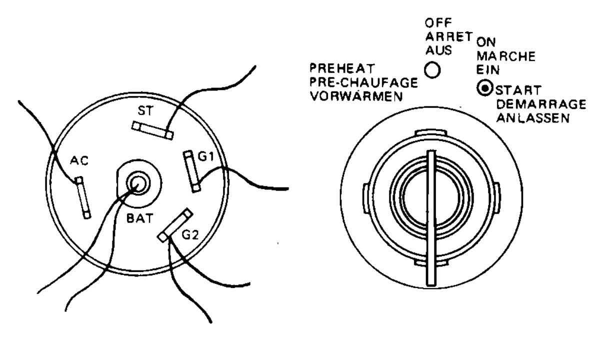


0011F177

Each sub-combustion chamber has a glow plug for easy starting. The glow plug is of the quick-heating type.

(1) Insulating Powder
(2) Metal Tube
(3) Housing
(4) Heat Coil

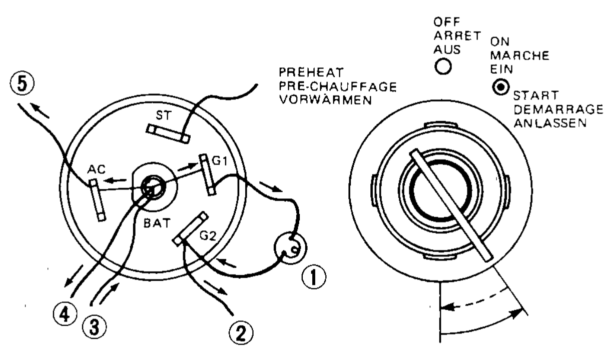
(3) Key Switch (not included in the basic model)



0109F307

The key switch has 4 positions. The terminal "BAT" is connected to the battery.

The key released at the "PREHEAT" position returns to the "OFF" position. And it released at the "START" position returns to the "ON" position.

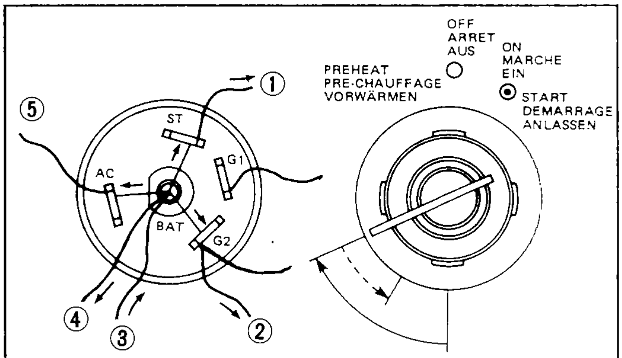


0314F016

■ PREHEAT

While the key switch is turned and held at the "PREHEAT" position, the current is supplied to the glow plugs through the lamp timer.

(1) Lamp Timer
(2) To Glow Plugs
(3) From Battery
(4) To Regulator
(5) To Oil Pressure Lamp and Accessory

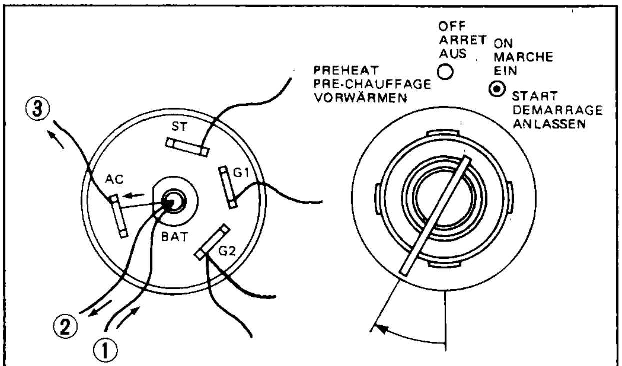


0314F017

■ START

When the key is turned to the "START" position, through the "ON" position the current is supplied to the starter.

(1) To Starter
(2) To Glow Plug
(3) From Battery
(4) To Regulator
(5) To Oil Pressure Lamp and Accessory



0314F018

■ **ON**

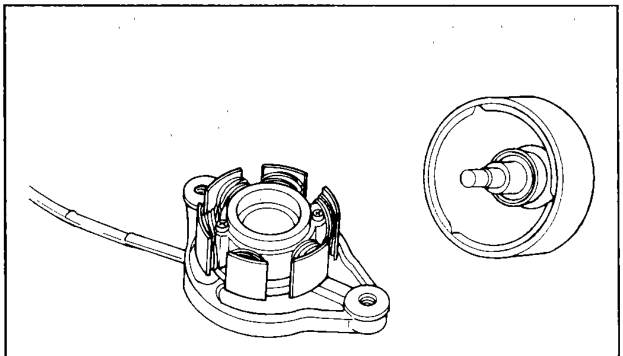
Only the terminal "AC" is connected to the battery.

At any position of the key except the "OFF" position, the terminal "AC" is connected to the "BAT" terminal.

(1) From Battery
(2) To Regulator
(3) To Oil Pressure Lamp and accessory

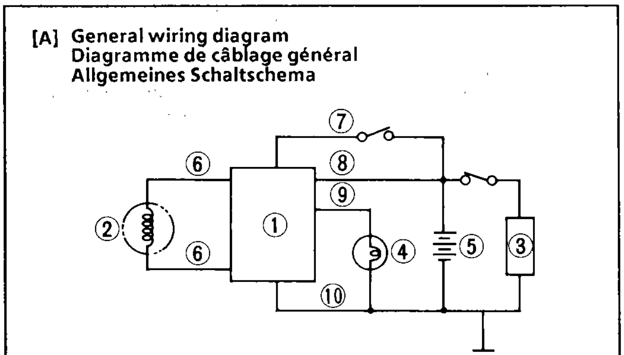
[2] CHARGING SYSTEM

(1) Dynamo


0339F516

This dynamo is an 8-8 pole rotating magnet type generator. It is simple in construction, consisting of a stator and rotor. The rotor is made up of eight permanent magnet pole pieces assembled on a shaft and rotates on the center of the stator around which eight electromagnetic coils are provided for. This dynamo produces higher voltage in slow speed rotation, and charges electric current to the battery during engine idling.

(2) Regulator

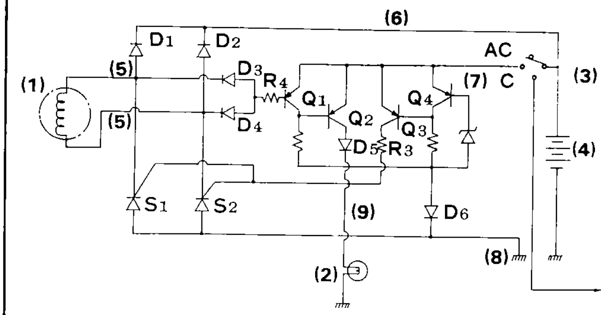


0203F013

The regulator performs rectification and voltage regulation. The regulator converts AC into DC which flows through the power consuming circuits and the battery, and also charges the battery. If however, the battery voltage exceeds a certain level. The DC current is cut off from the charging circuit to prevent overcharging.

(1) Regulator
(2) Dynamo
(3) Load
(4) Charge Lamp
(5) Battery
(6) Blue Lead Wire
(7) Yellow Lead Wire
(8) Red Lead Wire
(9) Green Lead Wire
(10) Black Lead Wire

(3) Charging Mechanism



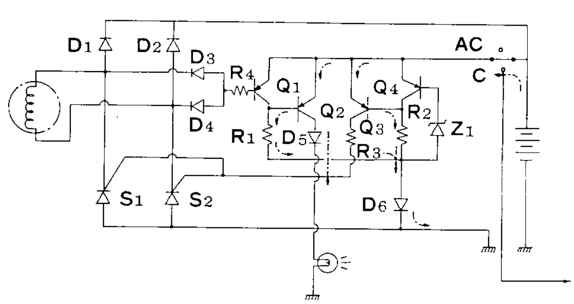
0172F051

The charging mechanism is described in four sections:

1) When key switch is ON
2) At starting
3) In charging
4) Over-charge protection

(1) GEN: Magnet type AC generator
(2) LAMP: Charge indication lamp (not included in the basic engine)
(3) KEY SW: Key switch (not included in the basic engine)
(4) BATT: Battery (not included in the basic engine)
(5) Blue: GEN connecting terminal
(6) Red: BATT + connecting terminal
(7) Yellow: BATT voltage test terminal
(8) Black: BAT – connecting terminal
(9) Green: LAMP connecting terminal

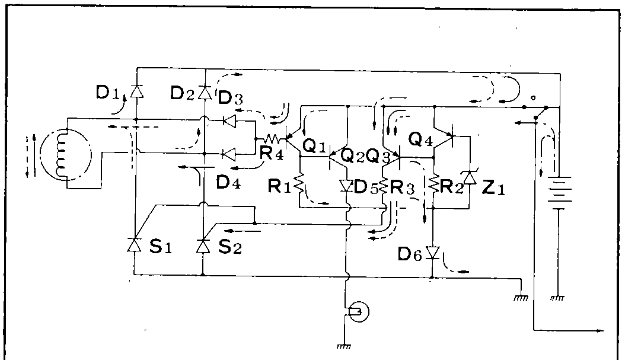
S_1, S_2: Output control/rectification thyristor (SCR)
D_1, D_2: Output rectifying diode
D_3, D_4: GEN generation detecting diode
D_5, D_6: Protection diode for wrong connecting of BATT
Z_1: BATT terminal voltage setting diode
Q_1: GEN generation detecting transistor
Q_2: LAMP on/off transistor
Q_3: Gate current control transistor
Q_4: BATT voltage detecting transistor



0172F052

1) When Key Switch is "ON"

When the engine is at standstill with key switch set at position 1, the circuit functions to light LAMP, as shown in Fig. 1. With key switch at position 1, current flows to base of Q_2 through the route of BATT → emitter/base of Q_2 → R_1 → D_6 → BATT and collector of Q_2 is then turned on. As a result, current also flows to LAMP though the route of BATT → emitter/collector of Q_2 → D_5 → LAMP → BATT lighting LAMP to indicate that charging is not carried out. At this time, though current flows to base of Q_3 through the route of BATT → emitter/base of Q_3 → R_2 → D_6 → BATT, collector of Q_3 has no current because GEN is stationary.

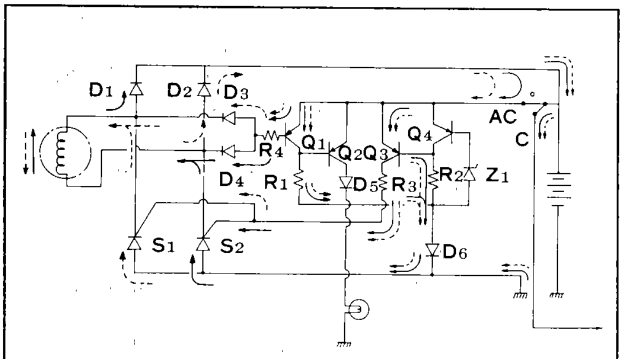


0172F053

2) At Starting

When key switch is turned to position 2, coil of starter relay is energized and starter starts engine. GEN also starts generation for charging and LAMP is turned off.

In detail, with GEN starting, current flows to base of Q_1 through the route of GEN → D_1 → emitter/base of Q_1 → R_4 → D_4 → GEN, or GEN --→ D_2 --→ emitter/base of Q_1 --→ R_4 --→ D_3 --→ GEN, and therefore current also flows through Q_1, short-circuiting emitter and base of Q_2. As a result, base current of Q_2 is interrupted, Q_2 is turned off and accordingly current to LAMP is also interrupted.



0172F054

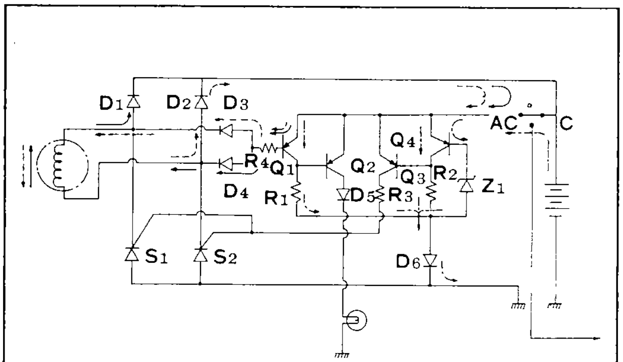
3) In Charging

Because BATT terminal voltage just after engine start is lower than setting value (14 to 15V), or lower than zener lever of Z_1, current is not supplied to base of Q_4 and Q_4 is off, as shown in Fig. 2. Q_3 is on with base current which flows through the route of BATT --→ emitter/base of Q_3 --→ R_2 --→ D_6 --→ BATT, and gate current is supplied to S_1 or S_2 through the route of GEN → D_1 → emitter/collector of Q_3 → R_3 → gate/cathode of S_2 → GEN, or GEN --→ D_2 --→ emitter/collector of Q_3 --→ R_3 --→ gate/cathode of S_1 --→ GEN.

When engine speed is increased so that GEN generation voltage becomes higher than BATT terminal voltage S_1 or S_2 is turned on and, as shown in Fig. 3, charge current is supplied to BATT through the route of GEN → D_1 → BATT → anode/cathode of S_2 → GEN, or GEN --→ D_2 --→ BATT --→ anode/cathode of S_1 --→ GEN.

After S_1 or S_2 is turned on, collector current of Q_1 and base current of Q_3 are supplied by GEN, not BATT.

When key switch is returned to position 1 after engine is started, BATT is charged, if BATT terminal voltage is lower than the setting value, or zener level of Z_1.



0172F055

4) Over-Charge Protection

When BATT terminal voltage is higher than the setting value or zener level of Z_1, BATT is not charged by the function of circuit as shown in Fig. 4. That is, Q_4 is on with base current which flows through the route of BATT --→ emitter/base of Q_4 --→ Z_1 --→ D_6 --→ BATT, shortcircuiting emitter and base of Q_3. Therefore, Q_3 is off with no base current and gate current is not supplied to S_1 and S_2. Consequently S_1 and S_2 are off and BATT is not charged.

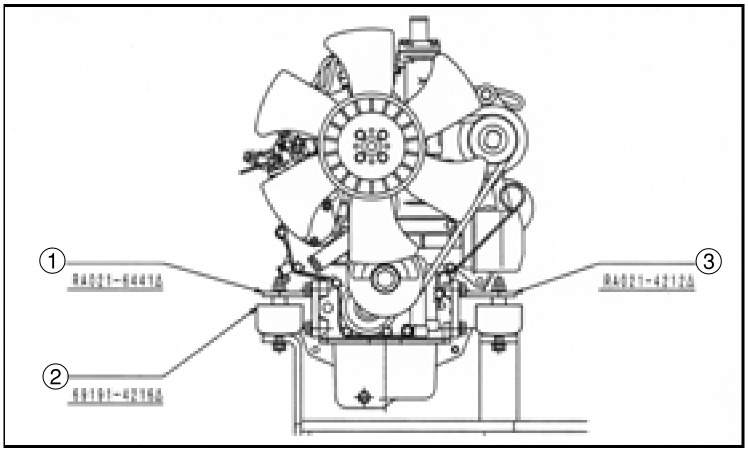
III.Engine(Service section)

Note: Folowing pages are missing page.

1. **From page S1 to S7.**
2. **From page S10 to S15.**
3. **From page S22 to S31.**
4. **From page S33 to S34.**
5. **Even-numbered pages from pages S35 to S141.**

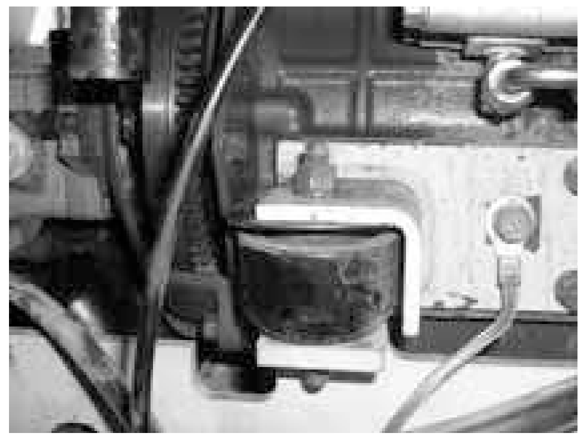
A.Engine mount on the machine

(1)Engine bracket, vibrationproof rubber

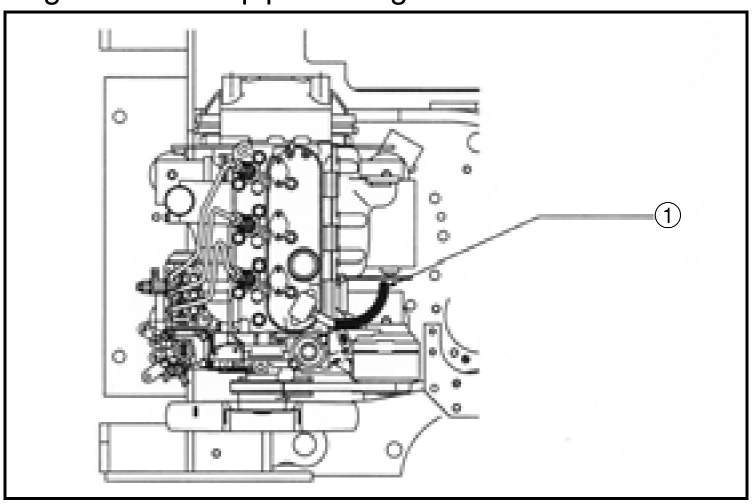


Assembly procedure
1) Bracket tightening torque:
   * Apply screw lock agent.
2) Vibrationproof rubber tightening torque:
   * Apply screw lock agent.

①Bracket (rear, engine)
②Vibrationproof rubber
③Bracket (front, engine)



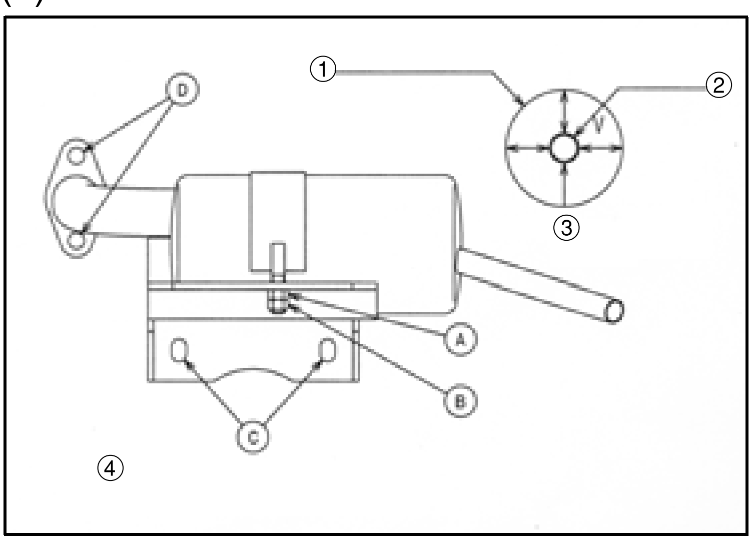
Engine breather pipe routing



3) Pass the engine breather pipe through this position.

①Pass the breather pipe through this position.

(2)Muffler



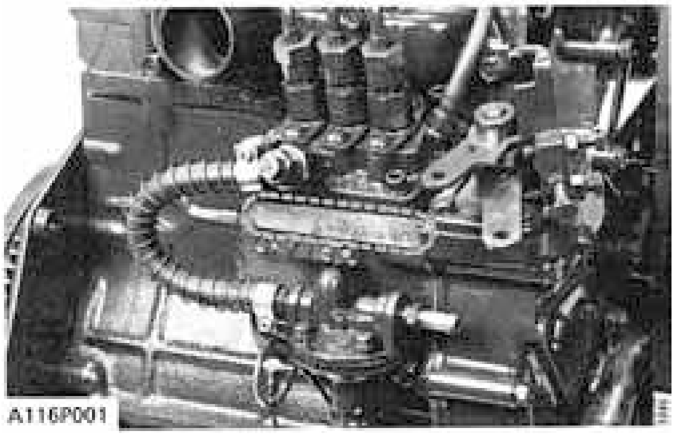
①Weight, left (muffler hole)
②Tail pipe
③Provide clearance of more than 15 mm.
④Tighten the parts in the order of Ⓐ→Ⓑ→Ⓒ→Ⓓ.

Assembly procedure
1) Band (Muffler) tightening torque:
   * Tighten the parts in the order of →Ⓐ→Ⓑ→Ⓒ→Ⓓ.
2) Provide a clearance of more than 15 mm between the tail pipe and the weight.

B.GENERAL

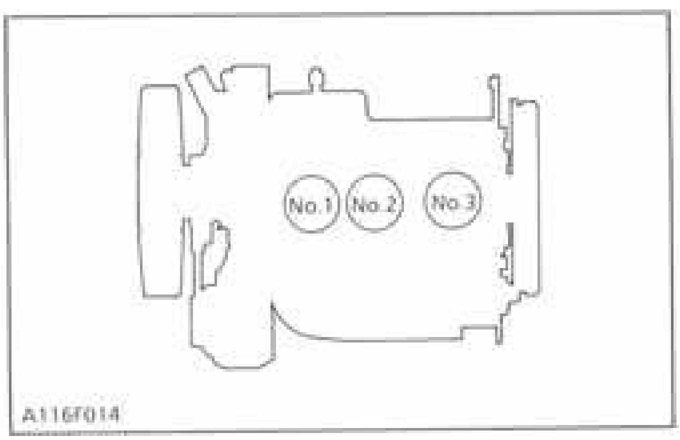
[1]ENGINE IDENTIFICATION

Model Name and Engine Serial Number



When contacting the manufacturer, always specify your engine model name and serial number.

Cylinder number



The cylinder numbers of 68 mm STROKE SERIES diesel engine are designated as shown in the figure. The sequence of cylinder numbers is given as No.1, No.2, No.3 starting from the gear case side.

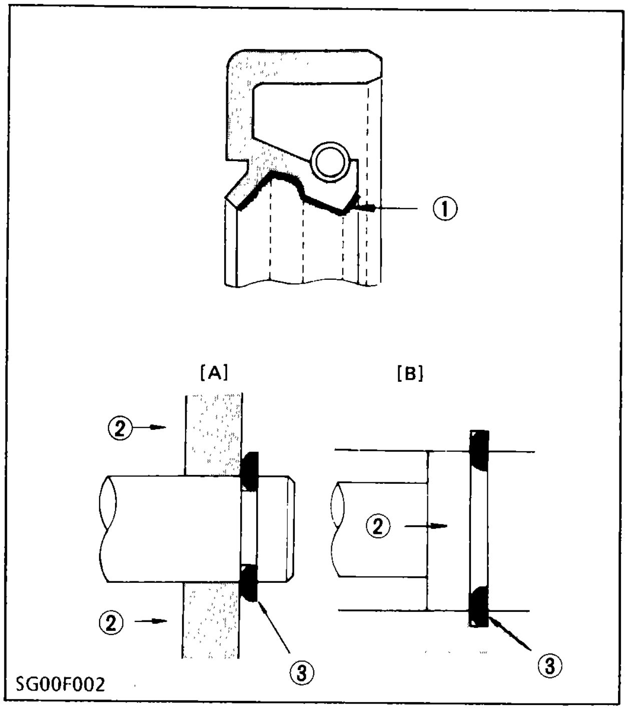
[2]GENERAL PRECAUTION

Model Name and Engine Serial Number

■ Precaution at overheating

Take the following actions in the event the coolant temperature be nearly or more than the boiling point, what is called “Overheating”.

(1) Stop the machine operation in a safe place and keep the engine unloaded idling.
(2) Don’t stop the engine suddenly, but stop it after about 5 minutes of unloaded idling.
(3) Keep yourself well away from the machine for further 10 minutes or while the steam spout out.
(4) Checking that there gets no danger such as burn, get rid of the causes of overheating according to the manual. And then, start agein the engine.



- During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws, bolts and nuts should be replaced in their original position to prevent reassembly errors.
- When special tools are required, use Kubota's genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.
- Before disassembling or servicing live wires, make sure to always disconnect the grounding cable from the battery first.
- Remove oil and dirt from parts before measuring.
- Use only Kubota genuine parts for parts replacement to maintain engine performance and to ensure safety.
- Gaskets and O-rings must be replaced during reassembly. Apply grease to new O-rings or oil seals before assembling.
- When reassembling external or internal snap rings, position them so that the sharp edge faces against the direction from which force is applied.
- Be sure to perform run-in the serviced or reassembled engine. Do not attempt to give heavy load at once, or serious damage may result to the engine.

CAUTION

- **Certain components used in this engine (cylinder head-gasket, exhaust gasket, etc.) contain asbestos. Handle with care according to safety regulation.**

(1) Grease
(2) Force
(3) Place the Sharp Edge against the Direction of Force

[A] **External Snap Ring**
[B] **Internal Snap Ring**

[3]TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench, Several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and at the proper torque.

(1) Tightening torques for special use screws, bolts and nuts

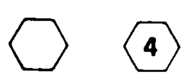
■ Note

- In removing and applying the bolts and nuts marked with “*”, pneumatic wrench or similar pneumatic tool, if employed, must be used with enough care not to get them sized.
- For “*” marked screwsm bolts and nuts on the table, apply engine oil to their threads and seats before tightening.

Item	Size × Pitch	N·m	kgf·m	ft·lbs
* Head cover cap nuts	M6 × 1.0	3.9 to 5.9	0.4 to 0.6	2.9 to 4.3
* Head bolts	M8 × 1.25	39.2 to 44.1	4.0 to 4.5	28.9 to 32.5
* Bearing case bolts 1	M6 × 1.0	12.7 to 15.7	1.3 to 1.6	9.4 to 11.6
* Bearing case bolts 2	M7 × 1.0	26.5 to 30.4	2.7 to 3.1	19.5 to 22.4
* Flywheel bolts	M10 × 1.25	53.9 to 58.8	5.5 to 6.0	39.8 to 43.4
* Connecting rod bolts	M7 × 0.75	26.5 to 30.4	2.7 to 3.1	19.5 to 22.4
* Rocker arm bracket nuts	M6 × 1.0	9.81 to 11.28	1.00 to 1.15	7.23 to 8.32
* Idle gear shaft bolts	M6 × 1.0	9.81 to 11.28	1.00 to 1.15	7.23 to 8.32
Glow plugs	M8 × 1.0	7.8 to 14.7	0.8 to 1.5	5.8 to 10.8
Nozzle holder assembly	M20 × 1.5	49.0 to 68.6	5.0 to 7.0	36.2 to 50.6
Oil switch taper screw	PT 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Injection pipe retaining nuts	M12 × 1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3
Starter’s terminal B mounting nut	M8	8.8 to 11.8	0.9 to 1.2	6.5 to 8.7

(2) Tightening torques for general use screws, bolts and nuts

When the tightening torques are not specified, tighten the screws, bolts and nuts according to he table below.

Grade / Nominal Diameter / Unit	Standard Screw and Bolt  SG00F004			Special Screw and Bolt 		
	N·m	kgf·m	ft·lbs	N·m	kgf·m	ft·lbs
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
M8	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
M10	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
M12	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5

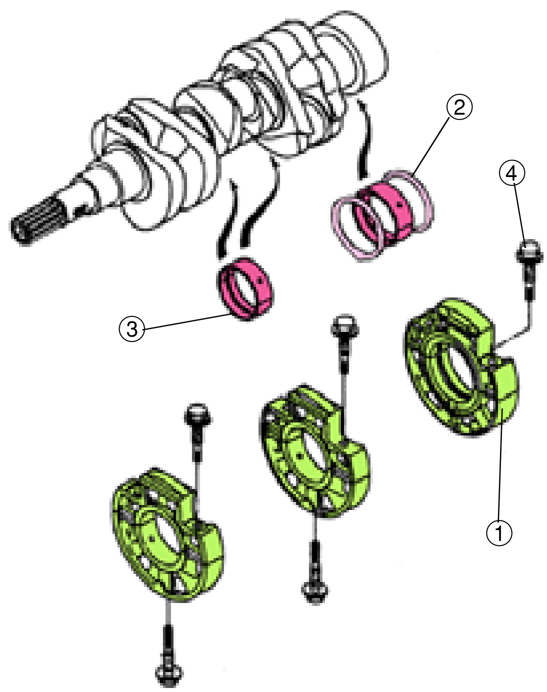
Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below.

Punched Number	Screw and Bolt Material Grade
None or 4	Standard screw and bolt SS41, S20C
7	Special screw and bolt S43C, S48C(Refined)

■ Note:From engine S/N WE 0364 and on, bearing case bolts / have two types, which are different part number. Tightening torque is different as follows.
No.1 and 2 bearing case bolt 1 : Code No. 15841-04540, M6 × 1.0, 12.7 ~ 15.7 N·m(1.3~1.6kgf·m)9.4~11.6ft·lbs
No.3 bearing case bolt 1 : Code No. 01754-50840, M8 × 1.25, 7T, 23.5 ~ 27.5 N·m(2.4~2.8kgf·m)17.4~20.3ft·lbs

(3) Main bearing case assembly - Type 1

* The main bearing case and thrust bearing are divided.



* This bearing is adopted for the OEM engines (Z482/D662/D722/D782)

Tightening torque of main bearing case bolt-1
  12.7 to 15.7 N·m/1.3 to 1.6 kg·m

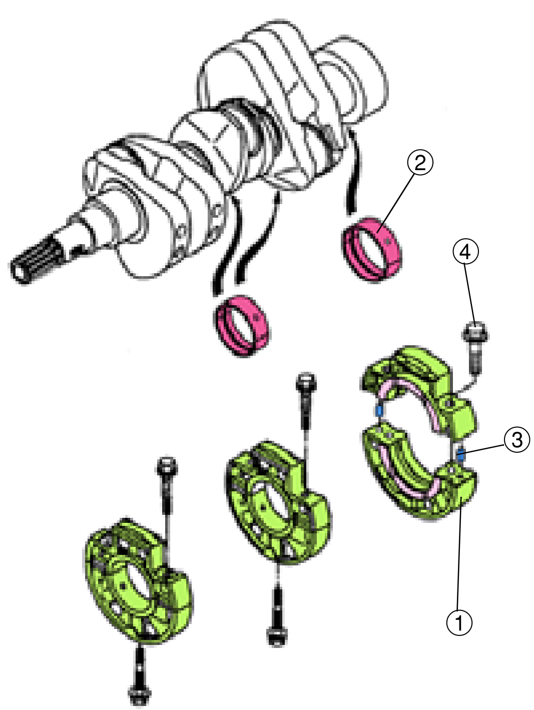
Crankshaft side clearance
  Factory specification:0.15 to 0.31 mm/0.006 to 0.012 in
  A/Limit: 0.5 mm/0.02 in

An oversize thrust bearing is adopted.

① Main bearing case assembly
② Thrust bearing
③ Main bearing
④ Main bearing case bolt-1(Special bolt)

(4) Main bearing case assembly - Type 2

* The main bearing case which adheres thrust bearing function.



* This bearing is adopted for the engines (Z482/D662/D722) of the KBT product.

Tightening torque of main bearing case bolt-1
  23.6 to 27.4 N·m/2.4 to 2.8 kg·m

Crankshaft side clearance
  Factory specification:0.15 to 0.25 mm/0.006 to 0.01 in
  A/Limit: 0.5 mm/0.02 in

An oversize thrust bearing is not adopted.

① Main bearing case
② Main bearing
③ Dowel pin
④ Main bearing case bolt-1(Flanged bolt)

[4] TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	• No fuel	Replenish fuel	–
	• Air in the fuel system	Bleed air	S-37
	• Water in the fuel system	Replace fuel and repair or replace fuel system	–
	• Fuel pipe clogged	Clean	–
	• Fuel filter clogged	Replace	S-41
	• Excessively high viscosity of fuel or engine oil at low temperature	Use the specified fuel or engine oil	S-39
	• Fuel with low cetane number	Use the specified fuel	–
	• Fuel leak due to loose injection pipe retaining nut	Tighten nut	S-63
	• Incorrect injection timing	Adjust	S-123
	• Fuel cam shaft worn	Replace	–
	• Injection nozzle clogged	Clean	S-121
	• Injection pump defective	Repair or replace	S-125
	• Fuel pump defective	Repair or replace	–
	• Seizure of crankshaft, camshaft, piston or bearing	Repair or replace	–
	• Compression leak from cylinder	Replace head gasket, tighten cylinder head bolt, glow plug and nozzle holder	S-57
	• Improper valve seat alignment, valve spring broken, valve seized	Repair or replace	S-87
	• Improper valve timing	Adjust	S-123
	• Piston ring worn	Replace	S-77
	• Excessive valve clearance	Adjust	S-47
[Starter Does Not Work]	• Battery discharged	Charge	–
	• Starter defective	Repair or replace	S-133
	• Main switch defective	Repair or replace	–
	• Wiring disconnected	Connect	–
Engine Revolution Is Not Smooth	• Fuel filter clogged or dirty	Replace	S-41
	• Air cleaner clogged	Clean or replace	S-39
	• Fuel leak due to loose injection pipe retaining nut	Tighten nut	S-37
	• Injection pump defective	Repair or replace	S-125
	• Incorrect nozzle opening pressure	Adjust	S-121
	• Injection nozzle suck or clogged	Repair or replace	S-121
	• Fuel over flow pipe clogged	Clean	–
	• Governor defective	Repair	–
Either White Or Blue Exhaust Gas Is Observed	• Excessive engine oil	Reduce to the specified level	–
	• Piston ring worn or stuck	Replace	S-77
	• Incorrect injection timing	Adjust	S-123
	• Deficient compression	Check the compression pressure	S-57
Either Black Or Dark Gray Exhaust Gas Is Observed	• Overload	Lessen the load	–
	• Low grade fuel used	Use the specified fuel	–
	• Fuel filter clogged	Replace	S-41
	• Air cleaner clogged	Clean or replace	S-39
Deficient Output	• Incorrect injection timing	Adjust	S-123
	• Engine's moving parts seem to be seizing	Repair or replace	–
	• Uneven fuel injection	Repair or replace the injection pump	–
	• Deficient nozzle injection	Repair or replace the nozzle	S-121
	• Compression leak	Replace head gasket, tighten cylinder head bolt, glow plug and nozzle holder	S-57

Symptom	Probable Cause	Solution	Reference Page
Excessive Lubricant Oil Consumption	• Oil ring worn or stuck • Piston ring groove worn • Valve stem and guide worn • Crankshaft bearing, and crank pin bearing worn	Replace Replace the piston Replace Replace	S-77 S-95 S-85 S-105, 107, 109
Fuel Mixed Into Lubricant Oil	• Injection pump's plunger worn	Replace pump element or pump	–
Water Mixed Into Lubricant Oil	• Head gasket defective • Crank case or cylinder head flawed	Replace Replace	S-65 S-83
Low Oil Pressure	• Engine oil insufficient • Oil strainer clogged • Oil filter cartridge clogged • Relief valve stuck with dirt • Relief valve spring weaken or broken • Excessive oil clearance of crankshaft bearing • Excessive oil clearance of rocker arm boss. • Oil passage clogged • Different type of oil • Oil pump defective	Replenish Clean Replace Clean Replace Replace Replace Clean Use the specified type of oil Repair or replace	– S-73 S-41 – – S-105, 107, 109 S-91 – S-39 S-113, 115
High Oil Pressure	• Different type of oil • Relief valve defective	Use the specified type of oil Replace	S-39 –
Engine Overheated	• Engine oil insufficient • Fan belt broken or tensioned improperly • Coolant insufficient • Radiator net and radiator fin clogged with dust • Inside of radiator corroded • Coolant flow route corroded • Radiator cap defective • Radiator hose damaged • Thermostat defective • Water pump defective • Overload running	Replenish Replace or adjust Replenish Clean Clean or replace Clean or replace Replace Replace Replace Replace Loosen the load	– S-39 – – S-43 S-43 S-117 S-41 S-119 S-119 –
Battery Quickly Discharge	• Battery electrolyte insufficient • Fan belt slips • Wiring disconnected • Regulator defective • AC dynamo defective • Battery defective	Replenish distilled water and charge Adjust belt tension or replace Connect Replace Replace Replace	– S-117 – – S-131 –

[5] SERVICING SPECIFICATIONS

(1) ENGINE BODY

Cylinder Head

Item		Factory Specification	Allowable Limit
Cylinder Head Surface Flatness		–	0.05 mm 0.0020 in.
Top Clearance		0.50 to 0.70 mm 0.0197 to 0.0276 in.	–
Cylinder Head Gasket Thickness (Grommet Section)	Free	1.15 to 1.30 mm 0.04153 to 0.0512 in.	–
	Tightened	1.05 to 1.15 mm 0.0413 to 0.0453 in.	–
Compression Pressure		2.84 to 3.24 MPa 29 to 33 kgf/cm2 412 to 469 psi	2.26 MPa 23 kgf/cm2 327 psi

Valves

Valve Clearance (Cold)	0.145 to 0.185 mm 0.0057 to 0.0073 in.	–
Valve Seat Width	2.12 mm 0.0835 in.	–
Valve Seat Angle	0.785 rad. 45°	–
Valve Face Angle	0.785 rad. 45°	–
Valve Recessing	-0.10 to 0.10 mm -0.0039 to 0.0039 in.	0.30 mm 0.0118 in.
Clearance between Valve Stem and Valve Guide	0.030 to 0.057 mm 0.00118 to 0.00224 in.	0.10 mm 0.0039 in.
Valve Stem O.D.	5.968 to 5.980 mm 0.23496 to 0.23543 in.	–
Valve Guide I.D.	6.010 to 6.025 mm 0.23661 to 0.23720 in.	–

Valve Timing

Inlet Valve	Open	0.35 rad. (20°) before T.D.C.	–
	Close	0.79 rad. (45°) after B.D.C.	–
Exhaust Valve	Open	0.87 rad. (50°) before B.D.C.	–
	Close	0.26 rad. (15°) after T.D.C.	–

Valve Spring

Item	Factory Specification	Allowable Limit
Free Length	31.6 mm 1.244 in.	28.4 mm 1.118 in.
Setting Load/Setting Length	64.7 N/27 mm 6.6 kgf/27 mm 14.6 lbs/1.063 in.	54.9 N/27 mm 5.6 kgf/27 mm 12.3 lbs/1.063 in.
Tilt	–	1.2 mm 0.047 in.

Rocker Arm

Clearance between Rocker Arm Shaft and shaft Hole	0.016 to 0.045 mm 0.00063 to 0.00177 in.	0.15 mm 0.0059 in.
Rocker Arm Shaft O.D.	10.473 to 10.484 mm 0.41232 to 0.41276 in.	–
Rocker Arm Shaft Hole I.D.	10.500 to 10.518 mm 0.41339 to 0.41410 in.	–

Tappet

Clearance between Tappet and Guide	0.016 to 0.052 mm 0.00063 to 0.00205 in.	0.10 mm 0.0039 in.
Tappet O.D.	17.966 to 17.984 mm 0.70732 to 0.70803 in.	–
Tappet Guide I.D.	18.000 to 18.018 mm 0.70866 to 0.70937 in.	–

Camshaft

Camshaft Side Clearance	0.15 to 0.31 mm 0.0059 to 0.01220 in.	0.5 mm 0.020 in.
Camshaft alignment	–	0.01 mm 0.0004 in.
Cam height (IN., EX.)	26.88 mm 1.0583 in.	26.83 mm 1.0563 in.
Oil clearance of camshaft	0.050 to 0.091 mm 0.0020 to 0.0036 in.	0.15 mm 0.0059 in.
Camshaft journal O.D.	32.934 to 32.950 mm 1.2966 to 1.2972 in.	–
Camshaft bearing I.D.	33.000 to 33.025 mm 1.2992 to 1.3002 in.	–

Timing Gear

Item	Factory Specification	Allowable Limit
Timing gear backlash Crank gear – Oil Pump Drive Gear	0.041 to 0.123 mm 0.00161 to 0.00484 in.	0.15 mm 0.0059 in.
Idle gear – Cam gear	0.047 to 0.123 mm 0.00185 to 0.00484 in.	0.15 mm 0.0059 in.
Idle gear – Injection pump gear	0.046 to 0.124 mm 0.00181 to 0.00488 in.	0.15 mm 0.0059 in.
Idel gear – Crank gear	0.043 to 0.124 mm 0.00169 to 0.00488 in.	0.15 mm 0.0059 in.
Idle gear Side clearance	0.20 to 0.51 mm 0.0079 to 0.0201 in.	0.60 mm 0.0236 in.
Clearance between idle gear shaft and idle gear bushing	0.020 to 0.084 mm 0.00079 to 0.00331 in.	0.10 mm 0.0039 in.
Idle Gear shaft O.D.	19.967 to 19.980 mm 0.78610 to 0.78661 in.	–
Idle Gear Bushing I.D.	20.000 to 20.051 mm 0.78740 to 0.78941 in.	–

Cylinder Liner

Cylinder liner I.D.	Z442-B (E) D662-B (E)	64.000 to 64.019 mm 2.51968 to 2.52043 in.	64.169 mm 2.52634 in.
	Z482-B (E) D722-B (E)	67.000 to 67.019 mm 2.63779 to 2.63854 in.	67.169 mm 2.64444 in.
Oversized cylinder liner I.D.	Z442-B (E) D662-B (E)	64.250 to 64.269 mm 2.52953 to 2.53028 in.	64.419 mm 2.53618 in.
	Z482-B (E) D722-B (E)	67.250 to 67.269 mm 2.64764 to 2.64839 in.	67.419 mm 2.65429 in.

Crankshaft

Crankshaft alignment	–	0.02 mm 0.0031 in.
Oil clearance between crankshaft and crankshaft bearing 1	0.034 to 0.106 mm 0.00134 to 0.00417 in.	0.20 mm 0.0079 in.
Crankshaft O.D.	39.934 to 39.950 mm 1.57221 to 1.57284 in.	–
Crankshaft bearing 1 I.D.	39.984 to 40.040 mm 1.57418 to 1.57638 in.	–
Oil clearance between crankshaft and crankshaft bearing 2	0.034 to 0.092 mm 0.00134 to 0.00362 in.	0.20 mm 0.0079 in.
Crankshaft O.D.	43.934 to 43.950 mm 1.72969 to 1.73032 in.	–
Crankshaft bearing 2 I.D.	43.984 to 44.026 mm 1.73166 to 1.73331 in.	–

Crankshaft

Item	Factory Specification	Allowable Limit
Oil clearance between crankshaft and crankshaft bearing 3	0.034 to 0.092 mm 0.00134 to 0.00362 in.	0.20 mm 0.0079 in.
Crankshaft O.D.	39.934 to 39.950 mm 1.57221 to 1.57284 in.	–
Crankshaft bearing 3 I.D.	39.984 to 40.026 mm 1.57418 to 1.57583 in.	–
Oil clearance between crank pin and crank pin bearing	0.019 to 0.081 mm 0.00075 to 0.00319 in.	0.15 mm 0.0059 in.
Crankshaft O.D.	33.959 to 33.975 mm 1.33697 to 1.33759 in.	–
Crank pin bearing I.D.	33.994 to 34.040 mm 1.33835 to 1.34016 in.	–
Crankshaft side clearance	0.15 to 0.31 mm 0.0059 to 0.0122 in.	0.5 mm 0.0197 in.

Connecting Rod

Connecting rod alignment	–	0.05 mm 0.0020 in.
Clearance between piston pin and small end bushing	0.014 to 0.038 mm 0.00055 to 0.00150 in.	0.10 mm 0.0039 in.
Piston pin O.D.	20.002 to 20.011 mm 0.78748 to 0.78783 in.	–
Small end bushing I.D.	20.025 to 20.040 mm 0.78839 to 0.78897 in.	–

Piston/Piston Ring

Piston pin hole I.D.		20.000 to 20.013 mm 0.78740 to 0.78791 in.	20.05 mm 0.7894 in.
Piston ring clearance	Second compression ring 2	0.085 to 0.115 mm 0.0033 to 0.0045 in.	0.15 mm 0.0059 in.
	Oil ring	0.02 to 0.06 mm 0.0008 to 0.0024 in.	0.15 mm 0.0059 in.
Ring gap	Top compression ring and oil ring	0.15 to 0.30 mm 0.0059 to 0.0118 in.	1.2 mm 0.0472 in.
	Second compression ring	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.2 mm 0.0472 in.
Oversize of piston rings		+ 0.25 mm + 0.0098 in.	–

(2) LUBRICATING SYSTEM

Oil Pump

Item		Factory Specification	Allowable Limit
Engine oil pressure	At idle speed	98 kPa 1.0 kgf/cm2, 14 psi	–
	At rated speed	196 to 441 kPa 2.0 to 4.5 kgf/cm2 28 to 64 psi	98 kPa 1.0 kgf/cm2 14 psi
Clearance between inner rotor and outer rotor		0.03 to 0.14 mm 0.012 to 0.0055 in.	–
Clearance between outer rotor and pump body		0.07 to 0.15 mm 0.0028 to 0.0059 in.	–
End clearance between inner rotor and cover		0.075 to 0.135 mm 0.0029 to 0.0053 in.	–

(3) COOLING SYSTEM

Thermostat

Thermostat's valve opening temperature	69.5 to 72.5°C 157.1 to 162.5°F	–
Temperature at which thermostat completely opens	85°C 185°F	–

Radiator

Radiator water tightness	Water tightness at specified pressure 157 kPa 1.6 kgf/cm2, 23 psi	–
Radiator cap air leakage	10 seconds or more 88 → 59 kPa 0.9 → 0.6 kgf/cm2 13→9 psi	–
Fan belt tension	Approx. 10 mm/10 kgf 0.39 in./10 kgf (22.1 lbs.)	–

(4) FUEL SYSTEM

Injection Pump

Injection timing	0.35 to 0.38 rad. before T.D.C. (20° to 22°)	–
Fuel tightness of pumpe element	–	14.71 MPa 150 kgf/cm2, 2133 psi
Fuel tightness of delivery valve	–	5 seconds 14.7 → 13.7 MPa 150 → 140 kgf/cm2 2133 → 1990 psi

Injection Nozzle

Item	Factory Specification	Allowable Limit
Fuel Injection pressure	13.73 to 14.71 MPa 140 to 150 kgf/cm2 1991 to 2133 psi	–
Fuel tightness of nozzle valve seat	When the pressure is 12.75 MPa (130 kgf/cm2, 1849 psi), the valve seat must be fuel tightness.	–

(5) ELECTRICAL SYSTEM

Starter

Commutator O.D.	28.0 mm 1.102 in.	27.0 mm 1.063 in.
Mica undercut	0.5 to 0.8 mm 0.020 to 0.031 in.	0.2 mm 0.008 in.
Brush length	16.0 mm 0.630 in.	10.5 mm 0.413 in.

Dynamo

No-load voltage	AC20V or more at 5200 rpm	–

Glow Plug

Glow plug resistance	Approx. 0.9 Ω	–

[6] MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

Item	Service Interval								
	Every 50 hrs	Every 100 hrs	Every 200 hrs	Every 400 hrs	Every 500 hrs	Every 800 hrs	Every 1000 hrs	Every one year	Every two years
Checking fuel pipes and clamps	o								
Changing engine oil *		o							
Cleaning air filter element		o							
Cleaning fuel filter		o							
Checking fan belt tension and damage		o							
Checking water pipes and clamps			o						
Changing oil filter cartridge *			o						
Changing fuel filter element				o					
Cleaning radiator interior					o				
Changing radiator cleaner and coolant									o
Changing air filter element								o	
Checking valve clearance						o			
Checking nozzle injection pressure							o		
Changing water pipes and clamps									o
Changing fuel pipes and clamps									o

*** Change engine oil and oil filter cartridge at the first 50 hours of operation.**

CAUTION

- **When changing or inspecting, be sure to level and stop the engine.**

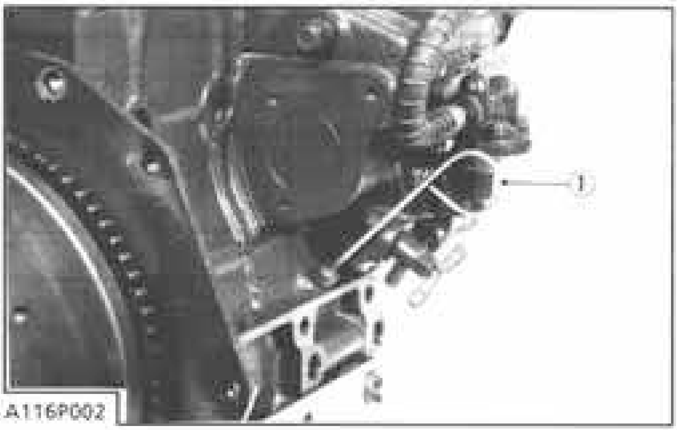
■ NOTE

- **Change interval of engine oil and oil filter cartridge.**

<table>
<tr><td rowspan="2"></td><td colspan="2">Oil pan depth</td></tr>
<tr><td>101 mm (3.98 in.)</td><td>121 mm (4.76 in.)</td></tr>
<tr><td rowspan="2">Engine oil</td><td colspan="2">50 Hrs (Intial)</td></tr>
<tr><td>75 Hrs</td><td>100 Hrs</td></tr>
<tr><td>Oil filter cartridge</td><td>150 Hrs</td><td>200 Hrs</td></tr>
</table>

[7] CHECK AND MAINTENANCE

(1) Daily Check Points



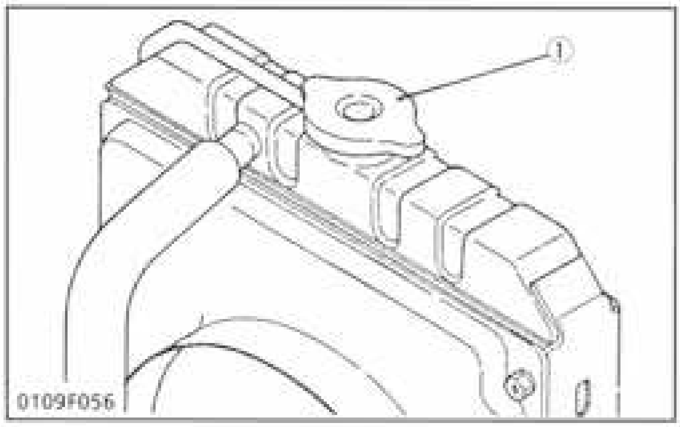
Checking Engine Oil Level

1. Level the engine.
2. To check the oil level, draw out the dipstick, (1) wipe it clean, reinsert it, and draw it out again. Check to see that the oil level lies between the two notches.
3. If the level is too low, add new oil to the specified level.

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous one, drain old oil. Never mix two different types of oil.**

(1) Dipstick



Checking and Replenish Cooling Water

1. Remove the radiator cap (1) and check to see that the cooling water level is just bellow the port.
2. If low, add clean water and antifreeze.

CAUTION

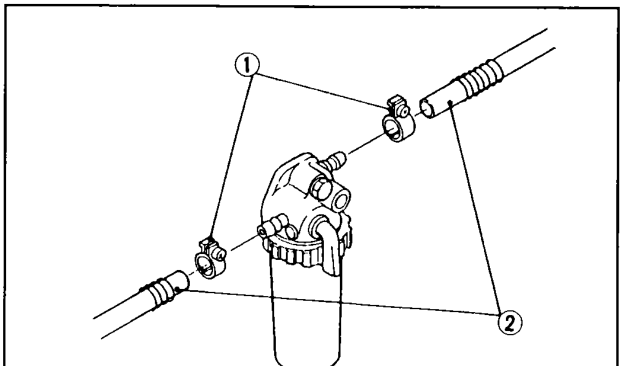
- **Do not remove the radiator cap (1) until cooling water temperature is below its boiling point. Then loosen the cap slightly to relieve any excess pressure before removing the cap completely.**

■ **IMPORTANT**

- **Be sure to close the radiator cap securely. If the cap is loose or improperly closed, water may leak out and the engine could overheat.**
- **Do not use an antifreeze and scale inhibitor at the same time.**

(1) Radiator Cap

(2) Check Point of Every 50 hours



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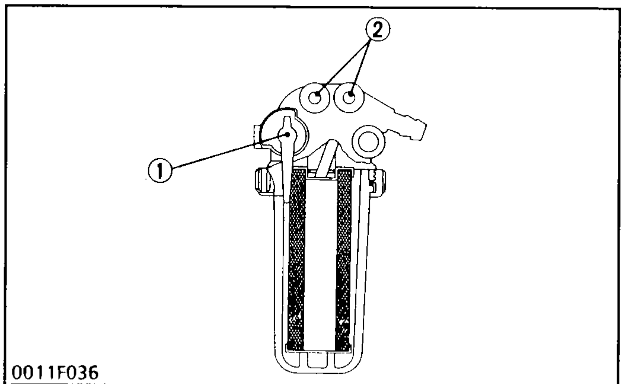
Checking Fuel Pipe

1. If the clamp (1) is loose, apply oil to the threads and securely retighten it.
2. The fuel pipe (2) is made of rubber and ages regardless of the period of service.
   Change the fuel pipe together with the clamp every two years.
3. However, if the fuel pipe and clamp are found to be damaged or deteriorate earlier than two years, then change or remedy.
4. After the fuel pipe and the clamp have been changed, bleed the fuel system.

CAUTION

- **Stop the engine when attempting the check and change prescribed above.**

(1) Clamp
(2) Fuel Pipe



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(When bleeding fuel system)

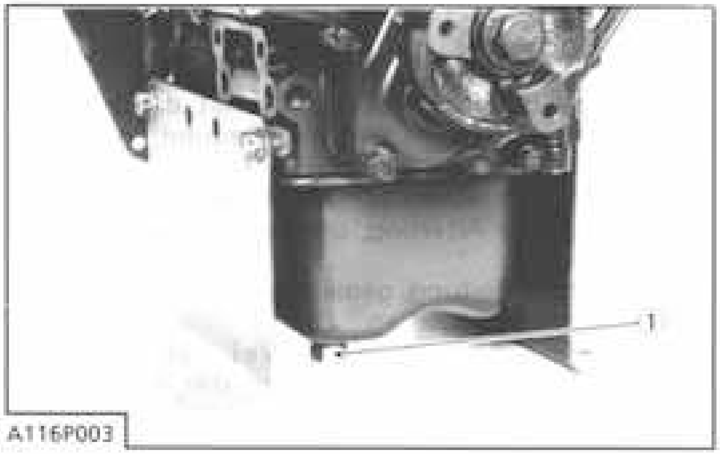
1 Fill the fuel tank with fuel, and open the fuel cock (1).
2. Loosen the air vent plug (2) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent cock on top of the fuel injection pump.
5. Retighten the plug when bubbles do not come up any more.

■ **NOTE**

- **Always keep the air vent plug on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.**

(1) Fuel Cock
(2) Air Vent Plug

(3) Check Point of Every 100 hours



Changing Engine Oil

1. After warming up, stop the engine.
2. To change the used oil, remove the drain plug at the bottom of the engine and drain off the oil completely.
3. Reinstall the drain plug.
4. Fill the new oil up to the upper notch on the dipstick.

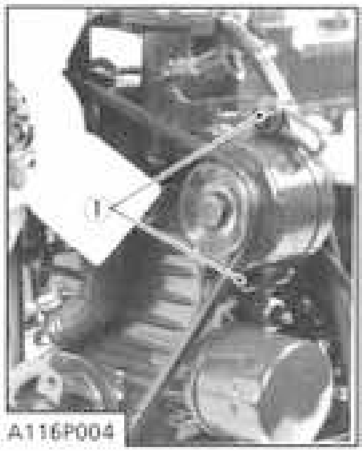
■ **IMPORTANT**

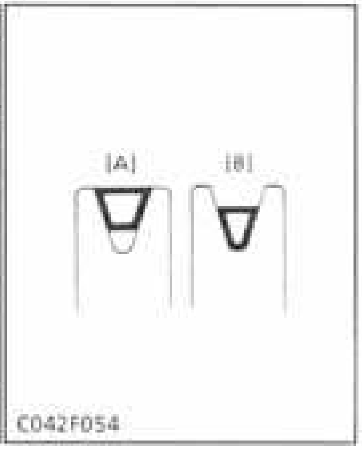
- **Change the type of engine oil according to the ambient temperature.**
  Above 25°C (77°F)---------------- SAE 30 or 10W-30
  0°C to 25°C (32°F to 77°F)------ SAE 20 or 10W-30
  Below 0°C (32°F)------------------ SAE 10 W or 10W-30

(1) Drain Plug

Cleaning Air Filter Element

- **When dry dust adheres**
  Use clean dry compressed air on the inside of the element.
  Air pressure at the nozzle must no exceed 690 kPa (7kgf/cm², 100 psi).
  Maintain reasonable distance between the nozzle and the filter.



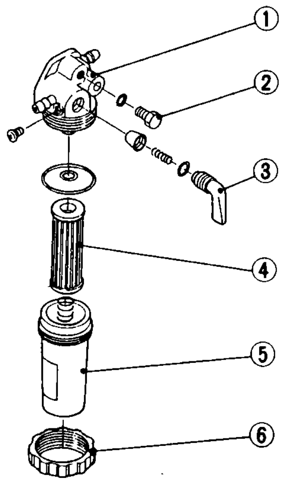


Checking Fan Belt Tension

1. Measure the deflection, depressing the belt halfway between the fan drive pulley and the AC dynamo pulley at 98 N (10kgf, 22 lbs) of force.
2. If the measurement is not the specified value, loosen the bolts and the nuts, and relocate the AC dynamo to adjust.

Fan belt tension	Factory spec.	approx. 10 mm 0.39 in.

[A] Good
[B] Bad
(1) Tension Pulley Adjusting Bolts



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Cleaning Fuel Filter

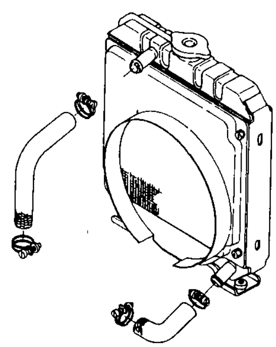
1. Close the fuel filter cock (3).
2. Unscrew the screw ring (6) and remove the cup (5), and rinse the inside with kerosene.
3. Take out the element (4) and dip it in the kerosene to rinse.
4. After cleaning, reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

■ **IMPORTANT**

- **If dust and dirt enter the fuel, the fuel injection pump and injection nozzle will wear quickly. To prevent this, be sure to clean the fuel filter cup periodically.**

(1) Cock Body
(2) Air Vent Plug
(3) Filter Cock
(4) Filter Element
(5) Filter Cup
(6) Screw Ring

(4) Changing of Every 200 hours



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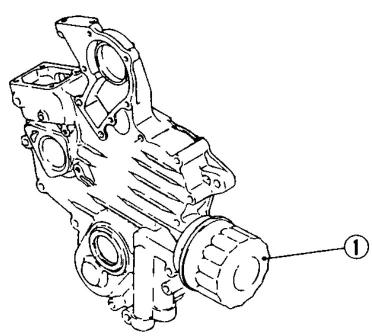
Checking radiator hoses (water pipes)

1. Check to see if the water pipes are properly fixed every 200 hours of operation or every six months, whichever comes first.
2. If clamp bands are loose or water leaks, tighten bands securely. Replace hoses and tighten clamp bands securely, if radiator hoses are swollen, hardened or cracked.
3. Replace hoses and clamp bands every 2 years or ealier if checked and found that hoses are swollen, hardened or cracked.



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Changing Engine Oil Filter Cartridge

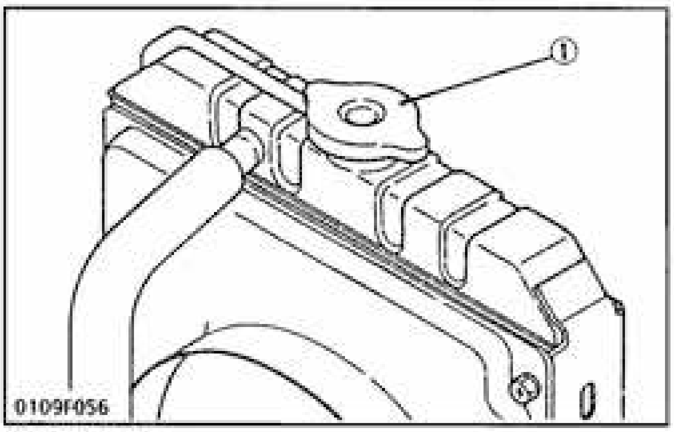
1. Remove the oil filter cartridge with a filter wrench.
2. Apply engine oil to the rubber gasket on the new cartridge.
3. Screw the new cartridge in by hand.

■ **NOTE**

- **Over-tightening may cause deformation of rubber gasket.**
- **After cartridge has been replaced, engine oil normally decreases a little.**
  Check the oil level and add new oil to the specified level.

(1) Filter Cartridge

(5) Check Point of Every 500 hours



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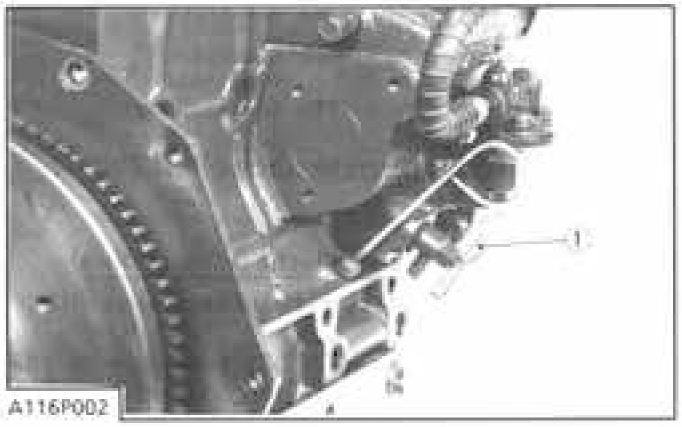
(1) Radiator Cap



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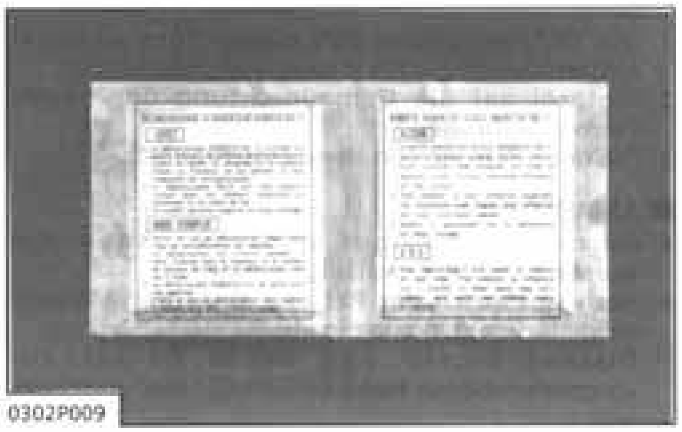

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Cleaning of water jacket (radiator interior)

1. The cooling system should be cleaned on the following occasions:
   - Every 500service hours.
   - When adding antifreeze.
   - When changing from water containing antifreeze to pure water.
2. When cleaning the cooling system, Kubota Detergent No. 20 is recommended to effectively wash away the rust build-up.

CAUTION

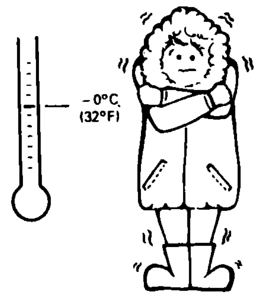
- **Do not remove the radiator cap until cooling water temperature is enoughly cooled. Then loosen the cap sightly to relieve any excess pressure before removing the cap completely.**

IMPORTANT

- **Use clean, fresh water to fill the radiator.**
- **To drain the used coolant completely, open the radiator drain cocks and remove the radiator cap.**
- **Do not use the antifreeze during hot weather to maintain engine performance since the boiling point of coolant rises.**
- **The radiator should be filled with part antifreeze and part water at all times as recommended by the antifreeze manufacturer.**
- **Do not use an antifreeze and scale inhibitor at the same time.**

Kubota Scale Inhibitor No. 11

1. Kubota Scale Inhibitor No.11 prevents scale formation in the cooling water. Scale build-up in either hard or soft water sharply reduces cooling efficiency.
2. The Scale Inhibitor is effective for 3 months so cooling water must be completely changed every 3 months.



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Antifreeze

If the cooling water freezes, the engine cylinder block, cylinder head and radiator may crack. In cold weather, before the temperature drops below 0°C (32°F), drain out the water after operating or add a proper amount of antifreeze.

- There are two types of antifreeze solutions: permanent type (PT) and semi-permanent type (SPT). For the KUBOTA engines, be sure to use the permanent type.
- When antifreeze is used for the first time, fill and drain clean water twice or three times so as to completely clean the inside of the radiator.
- The procedure for mixing water and antifreeze differs according to the make of the antifreeze and the ambient temperature. Basically, it should be refered to SAE J1034 standard, more specifically also to SAE J814c.
- Mix the antifreeze and water, then pour the mixture into the radiator.

Vol % antifreeze	Freezing point		Boiling point	
	°C	°F	°C	°F
40	–24	–12	106	222
50	–37	–34	108	226
60	–52	–62	111	232
70	–64	–84	114	238

*At 760mmHg pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

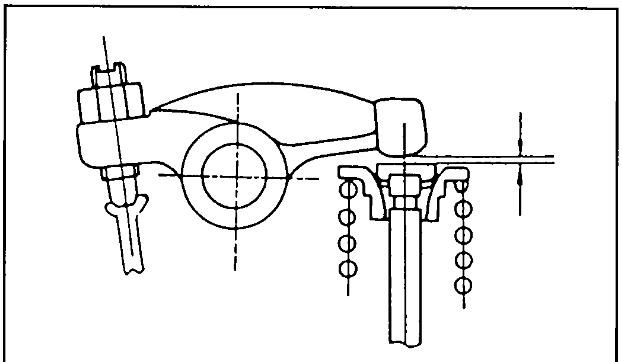
■ **IMPORTANT**

- **When the anti-freeze is mixed with water, the anti-freeze mixing ratio must be less than 50%.**
- **Do not use antifreeze during hot weather to keep the engine performance since the cooling water boiling point rises.**

■ **NOTE**

- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated antifreeze.**
- **When the cooling water level drops due to evaporation, add water only. In case of leakage, add antifreeze and water in the specified mixing ratio.**
- **Antifreeze absorbs moisture. Keep unused antifreeze in a tightly sealed container.**
- **Do not use radiator cleaning agents when antifreeze has been added to the cooling water. (Antifreeze contains an anticorrosive agent, which will react with the radiator cleaning agent forming sludge which will affect the engine**

(6) Check Point of Every 800 hours



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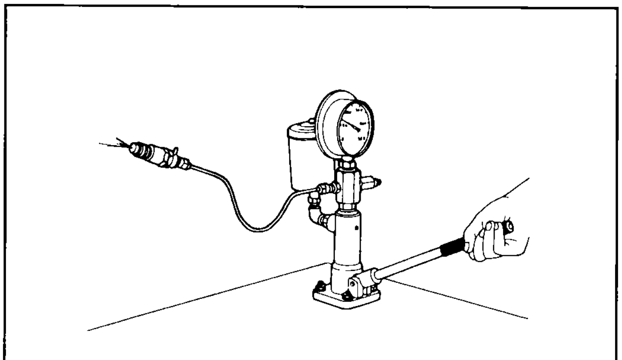
Valve Clearance

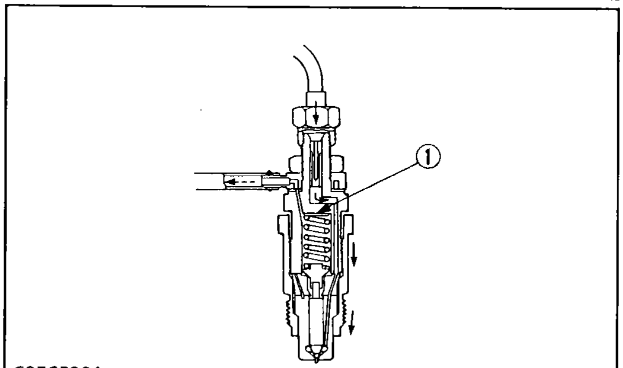
See page S-59.

Valve clearance	Factory spec.	0.145 to 0.185 mm 0.0057 to 0.0073 in.

(7) Check Points of 1000 hours (Serial No. : ~489290)



C019F032



C056F021

Checking Nozzle Injection Pressure

1. Set the injection nozzle to the nozzle tester (Code No: 07909-31361).
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, disassemble the injection nozzle, and change adjusting washer (1) until the proper injection pressure is obtained.
4. If the spraying condition is defective, replace the nozzle piece.

(Reference)

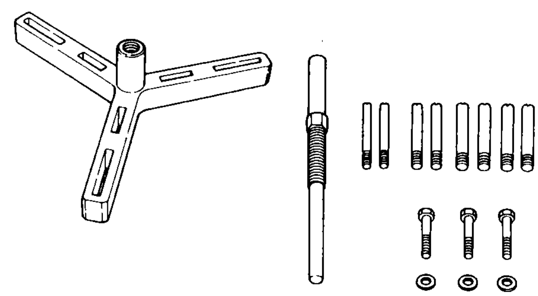
- Pressure variation with 0.025 mm (0.001 in.) difference of adjusting washer thickness. Approx. 59 kPa (6 kgf/cm^2, 85 psi)

CAUTION

- **Check the nozzle injection pressure and condition after confirming that there is nobody standing in the direction the fume goes. If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.**

(1) Adjusting Washer

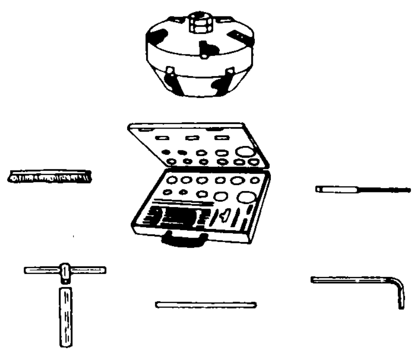
[8] SPECIAL TOOLS



0107F074

Flywheel Puller (For vertical type diesel engines)

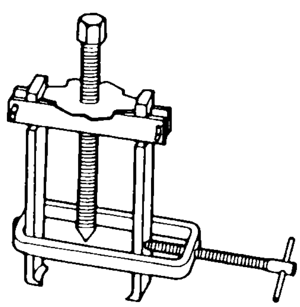
Code No: 07916-32011
Application: Use exclusively to take off the flywheel of all vertical type diesel engines safely and easily.



ST11F012

Valve Seat Cutter Set

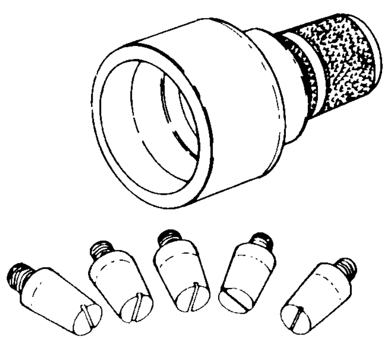
Code No: 07909-33102
Application: Use for correcting valve seats.



ST11F006

Special-use Puller Set

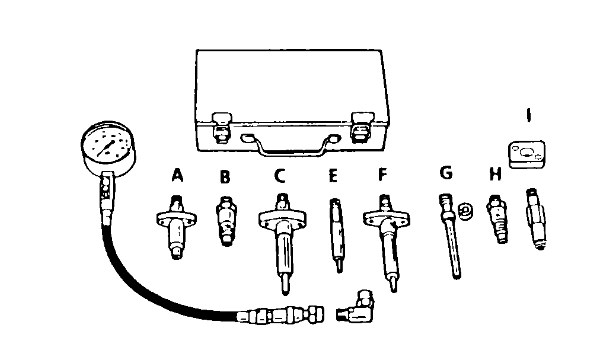
Code No: 07916-09032
Application: Use for pulling out bearings, gears and other parts.



ST10F115

Crank Sleeve Setter

Code No: 07916-34041
Application: Use to fix the crankshaft sleeve of the engine models Z442-B (E), Z482-B (E), D662-B (E), D722-B (E).

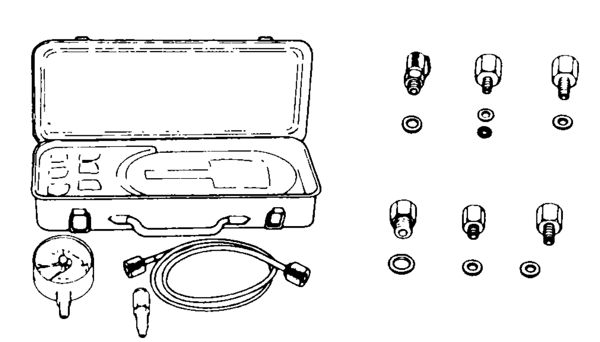


ST11F024

Diesel Engine Compression Tester

Code No: 07909-30208 (Assembly)
07909-30934 (A to F)
07909-31211 (E and F)
07909-31251 (G)
07909-31231 (H)
07909-31271 (I)

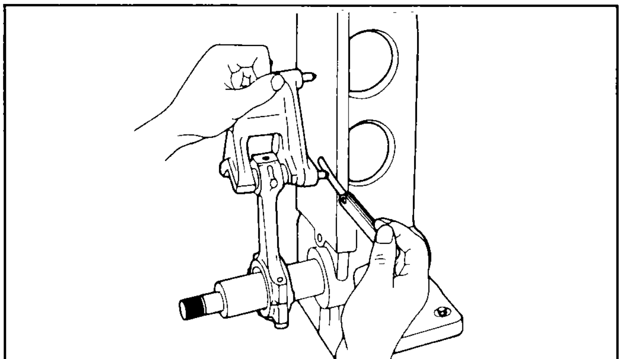
Application: Use for measuring diesel engine compression pressure.


ST11F025

Oil Pressure Tester

Code No: 07916-32032

Application: Use for measuring lubricating oil pressure.

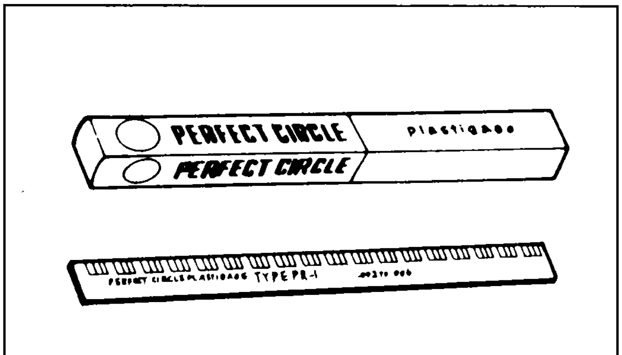

ST10F040

Connecting Rod Alignment Tool

Code No: 07909-31661

Application: Use for checking the connecting rod alignment.

Applicable range: Connecting rod big end I.D. 30 to 75 mm (1.18 to 2.95 in. dia.) Connecting rod length 65 to 330 mm (2.56 to 12.99 in.)



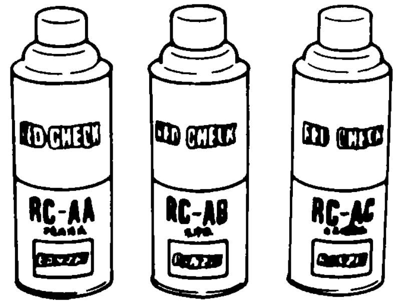
ST11F002

Plastigage

Code No: 07909-30241

Application: Use for checking the oil clearance between crankshaft and bearing, etc.

Measuring range:
Green —— 0.025 to 0.076 mm (0.001 to 0.003 in.)
Red —— 0.051 to 0.152 mm (0.002 to 0.006 in.)
Blue —— 0.102 to 0.229 mm (0.004 to 0.009 in.)



ST11F001

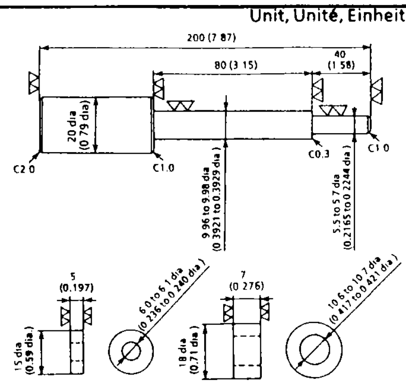
Red Check (Crack check liquid)

Code No: 07909-31371

Application: Use for checking cracks on cylinder head, cylinder block, etc.

■ **NOTE**

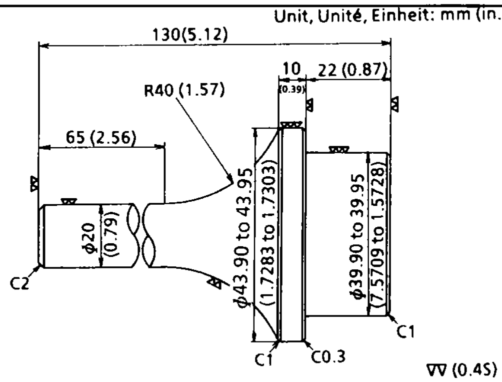
- **The following special tools are not provided, so make them referring to the figures.**



B008F052

Valve Guide Replacing Tool

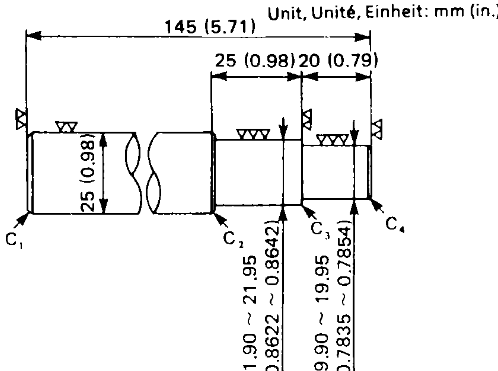
Application: Use to press out and press fit the valve guide.



ST11F312

Crankshaft Bearing 1 Replacing Tool

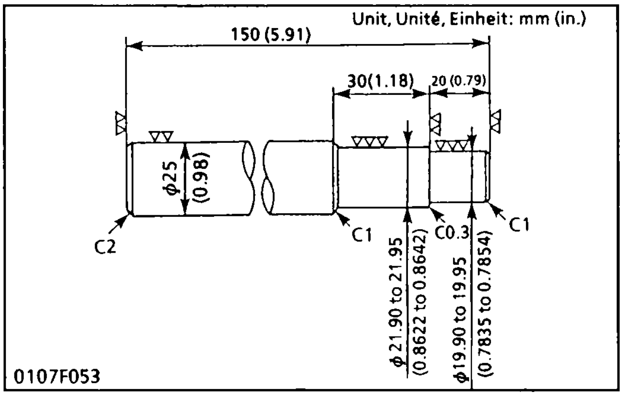
Application: Use to press out and press fit the crankshaft bearing 1.



010F053

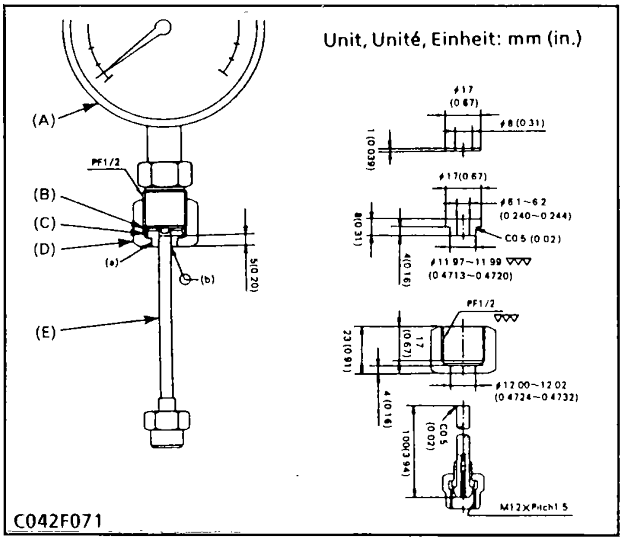
Connecting Rod Small End Bushing Tool

Application: Use to press out and press fit the connecting rod small end bushing.



Idle Gear Bushing Replacing Tool

Application: Use to press out and press fit the idle gear bushing.



Injection Pump Pressure Tester

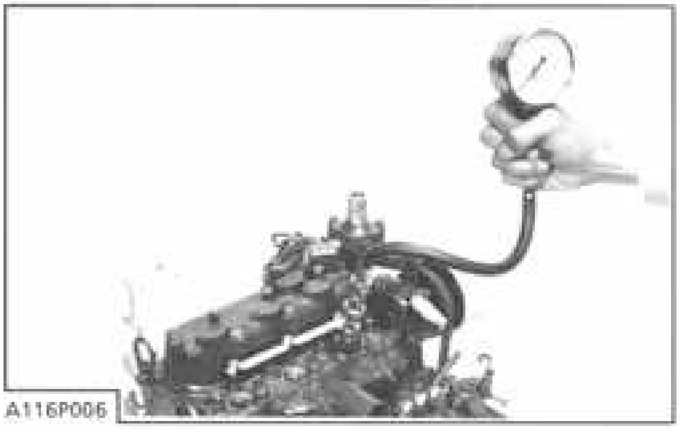
Application: Use to check the fuel tightness.

[A] Pressure Gauge, Full scale: more than 24.9 MPa (300 kgf/cm², 4267 psi)
[B] Copper Gasket
[C] Flange (Material: Steel)
[D] Hex. Nut, 27 mm (1.06 in.) across the flat (Material: Steel)
[E] Injection Pipe

(a) Adhesive application
(b) Fillet welding on the enter circumference

1 ENGINE BODY

CHECKING AND ADJUSTING

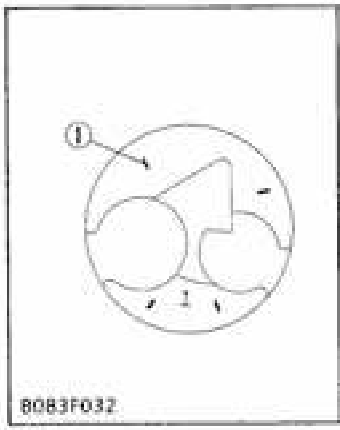

A116P006

Compression Pressure

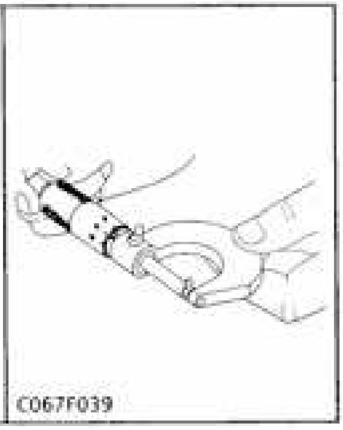
1. After warming up the engine, stop it and remove the air cleaner, the muffler and all nozzle holders.
2. Install a compression tester (Code No: 07909-30208) for diesel engines to nozzle holder hole.
3. After making sure that the speed control lever is set at the stop position (Non-injection), run the engine at 200 to 300 r.p.m. with the starter.
4. Read the maximum pressure. Measure the pressure more than twice.
5. If the measurement is below the allowable limit, check the cylinder, piston ring, top clearance, valve and cylinder head.

■ **NOTE**
- **Variances in cylinder compression values should be under 10%.**

Compression pressure	Factory spec.	2.84 to 3.24 MPa 29 to 33 kgf/cm² 412 to 469 psi
	Allowable limit	2.26 MPa 23 kgf/cm² 327 psi



B083F032


C067F039

(1) Fuse

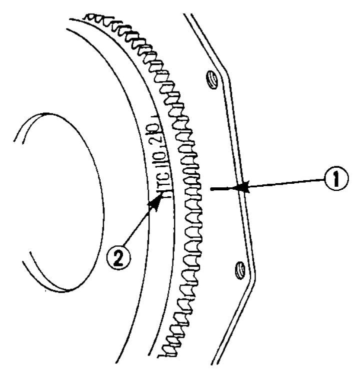
Top Clearance

1. Remove the cylinder head (then don't attmpt to remove the cylinder head gasket).
2. Bring the piston to its top dead center fasten 1.5 mm dia. 5 to 7 mm long fuse wires to 3 to 4 spots on the piston top with grease so as to avoid the intake and exhaust valves and the combustion chamber ports.
3. Bring the piston to its bottom dead center, install the cylinder head, and tighten the cylinder head bolts to specification.
4. Turn the crank shaft until the piston exceeds its top dead center.
5. Remove the cylinder head, and measure squeezed fuse wires for thickness.
6. If the measurement is not within the specified value, check the oil clearance of the crankpin journal and the piston pin.

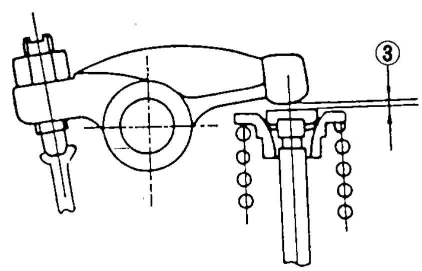
Top clearance	Factory spec.	0.50 to 0.70 mm 0.0197 to 0.0276 in.

Tightening torque	Cylinder head mounting bolts	39.2 to 44.1 N·m 4.0 to 4.5 kgf·m 28.9 to 32.5 ft-lbs

■ **NOTE**
- **Head gasket must be changed to new one.**



A125F002



0158F016

(1) Punch Mark
(2) TC Mark Line
(3) Valve Clearance

Checking Valve Clearance

■ **IMPORTANT**
- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the head cover.
2. Align the **"1TC"** mark on the flywheel and punch mark (1) on the plate so that the No. 1 piston comes to the compression or overlap top ded dead center.
3. Check the following valve clearance marked with "o" using a feeler gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory spec.	0.145 to 0.185 mm 0.0057 to 0.0073 in.

■ **NOTE**
- **The "TC" making on the flywheel is just for No. 1 cylinder. There is no "TC" marking for the other cylinders.**
- **No. 1 piston comes to the T.D.C. position when the "TC" marking is aligned with the punch mark of the rear end plate. Turn the flywheel 0.26 rad. (15°) clockwise and counter-clockwise to see if the piston is at the compression top dead center or the overlap position. Now referring to the table below, readjust the valve clearance. (The piston is at the top dead center when both the In. and EX valves do not move; it is at the overlap position when both the valves move.**
- **Finally turn the flywheel 6.28 rad. (360°) to make sure the "TC" marking and the punch mark are perfectly aligned. Adjust all the other valve clearances as required.**
- **After turning the flywheel counterclockwise twice or three times, recheck the valve clearance.**
- **After adjusting the valve clearance, firmly tighten the lock nut of the adjusting screw.**

Engine Model Valve arrengement Adjustable cylinder Location of piston		Z442-B (E), Z482-B (E)		D662-B (E), D722-B (E)	
		IN.	EX.	IN.	EX.
When No. 1 piston is compression top dead center	1st	o	o	o	o
	2nd		o		o
	3rd			o	
When No. 1 piston is overlap position	1st				
	2nd	o		o	
	3rd				o

DISASSEMBLING AND ASSEMBLING

■ **NOTE**
- **The cylinder heads with serial numbers 489291 and on are partially modified in configuration because of the introduction of the nozzle heat seal.**
  For replacing the cylinder head, see the Parts List and choose the right one in reference to its serial number.

[1] DRAINING WATER AND OIL

Draining Cooling Water and Engine Oil

⚠ **CAUTION**
- **Never remove radiator cap until cooling water temperature is below its boiling point. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Prepare a bucket. Open the drain cock to drain cooling water.
2. Prepare an oil pan. Remove the drain plug to drain engine oil in the pan.

[2] EXTERNAL COMPONENTS

Air Cleaner and Muffler

1. Remove the air cleaner.
2. Remove muffler retaining nuts to remove the muffler.

(When reassembling)
- Install the muffler gasket so that its steel side face the muffler.

A116P004

Dynamo and Fan Belt

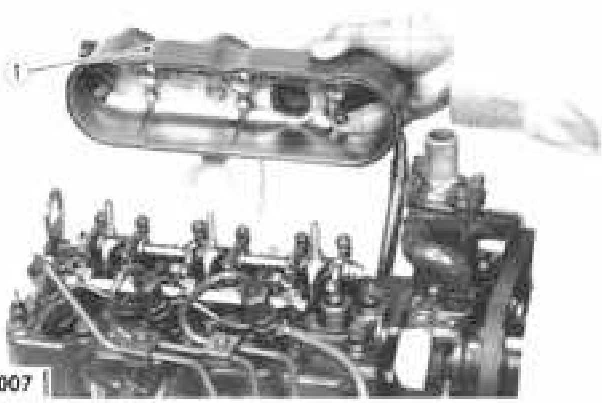
1. Remove the Dynamo (1).
2. Remove the fan belt (2).

(When reassembling)
- Check to see that there are no cracks on the belt surface.

■ **IMPORTANT**
- **After reassembling the fan belt, be sure to adjust the fan belt tension.**

(1) Dynamo (2) Fan Belt

[3] CYLINDER HEAD AND VALVES



A116P007

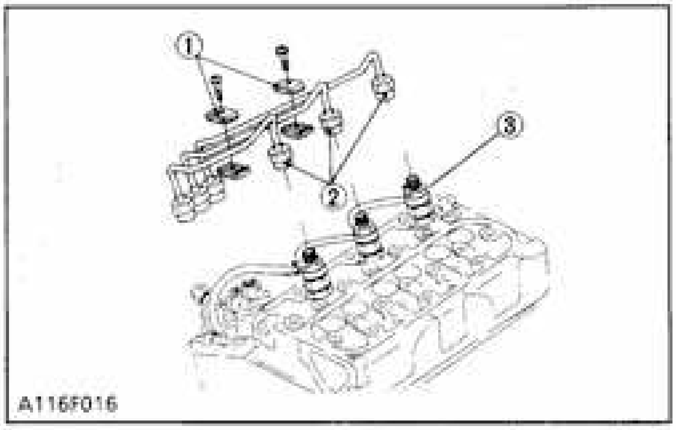
Cylinder Head Cover

1. Remove the cylinder head cover cap nuts.
2. Remove the cylinder head cover (1).

(When reassembling)
- Check to see that the cylinder head cover gasket is not defective.

Tightening torque	Head cover nut	3.9 to 5.9 N·m 0.4 to 0.6 kgf·m 2.9 to 4.3 ft-lbs

(1) Head Cover



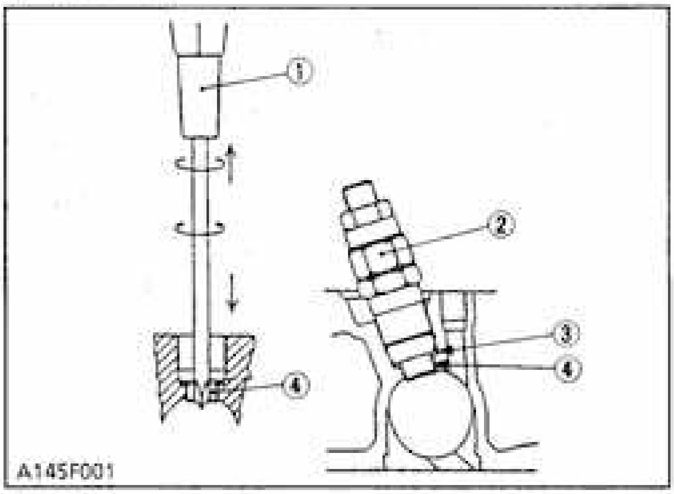
A116F016

(1) Pipe Clamps
(2) Injection Pipes
(3) Nozzle Holder Assembly

Injection Pipe and Nozzle Holder Assembly

1. Loosen the pipe clamps (1).
2. Remove the injection pipes (2).
3. Remove the fuel overflow pipe.
4. Loosen the lock nuts, and remove the nozzle holder assemblies (3).
5. Remove the copper gaskets on the seats.
6. Remove the nozzle heat seal. (Serial No.: 489291~)

Tightening torque	Injection pipe retaining nuts	24.5 to 34.3 N·m 2.5 to 3.5 kgf·m 18.1 to 25.3 ft-bs
	Nozzle holder assembly	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 ft-lbs



A145F001

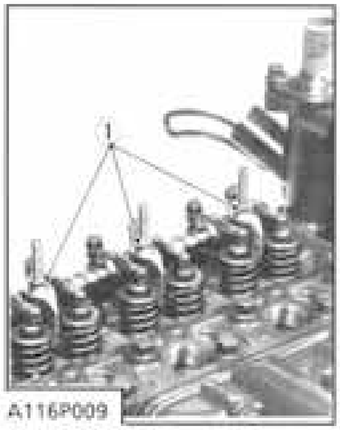
(1) Plus Screw Driver
(2) Injection Nozzle
(3) Injection Nozzle Packing
(4) Heat Seal

Nozzle Heat Seal Service Removal Procedure (Engine Serial Number : 489291 and beyond)

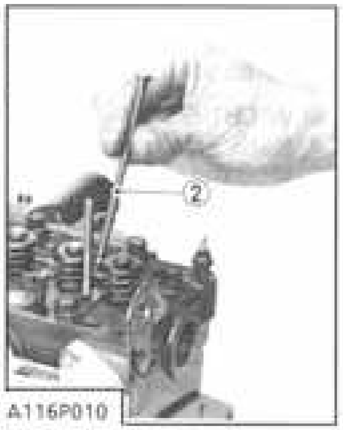
■ **IMPORTANT**
- **Use a plus (phillips head) screw driver that has a Dia. which is bigger than the heat seal hole. (Approx. 6 mm) 1/4 in.**

1. Drive screw driver lightly into the heat seal hole.
2. Turn screw driver three or four times each way.
3. While turning the screw driver, slowly pull the heat seal out together with the injection nozzle gasket.

   If the heat seal drops, repeat the above procedure. Heat seal and injection nozzle gasket must be changed when the injection nozzle is removed for cleaning or for service.



A116P009



A116P010

Rocker Arm and Push Rod

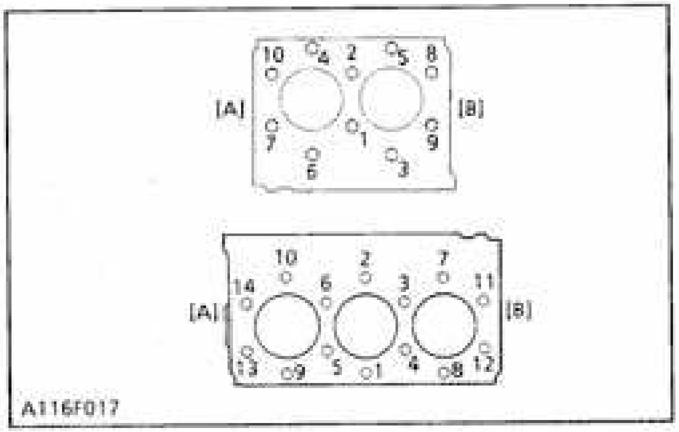
1. Remove the rocker arm bracket mounting nuts (1).
2. Remove the rocker arm as a unit.
3. Remove the push rods (2).

■ **IMPORTANT**
- **After reassembling the rocker arm, be sure to adjust the valve clearance.**

Tightening torque	Rocker arm brakcet nut	9.81 to 11.28 N·m 1.00 to 1.15 kgf·m 7.23 to 8.32 ft-lbs

Valve clearance	Factory spec.	0.145 to 0.185 mm 0.0057 to 0.0073 in.

■ **NOTE**
- **When putting the push rods (2) onto the tappets, check to see if their ends are properly engaged with the grooves.**



Cylinder Head

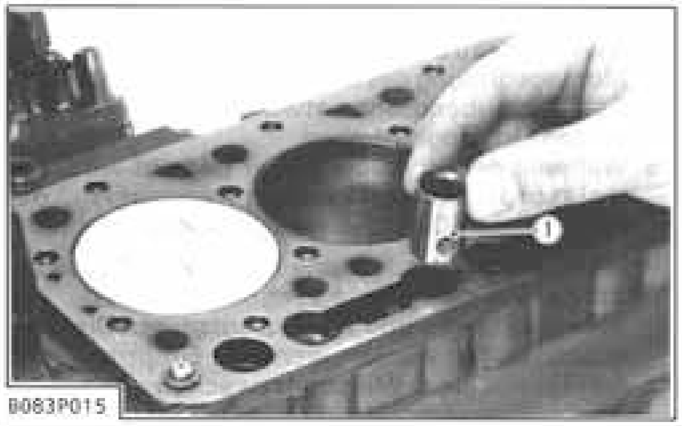
1. Loosen the pipe band, and remove the water return pipe.
2. Remove the cylinder head bolts in the order of (⑩, ⑭) to (①), and remove the cylinder head.

(When reassembling)

- Replace the head gasket with a new one.
- Install the cylinder head, using care not to damage the O-ring.
- Tighten the cylinder head bolts and nuts gradually in the order of (①) to (⑩, ⑭) after applying engine oil.
- Retighten the cylinder head screws and nuts after running the engine for 30 minutes.

Tightening torque	Glow plug	7.8 to 14.7 N·m 0.8 to 1.5 kgf·m 5.8 to 10.8 ft-lbs
	Cylinder head screw	39.2 to 44.1 N·m 4.0 to 4.5 kgf·m 28.9 to 32.5 ft-lbs

[A] Gear case side
[B] Flywheel side



Tappets

1. Remove the cylinder head gasket and O-ring.
2. Remove the tappets from the crankcase.

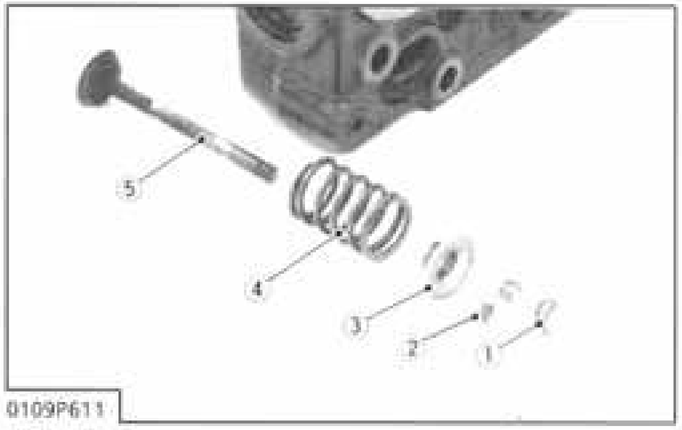
(When reassembling)

- Before installing the tappets, apply engine oil thinly around them.

■ **NOTE**

- **Mark the cylinder number to the tappets to prevent interchanging.**

(1) Tappet



Valves

1. Remove the valve cap (1).
2. Remove the valve spring collet (2) with a valve lifter.
3. Remove the valve spring retainers (3), valve spring (4) and valve (5).

■ **IMPORTANT**

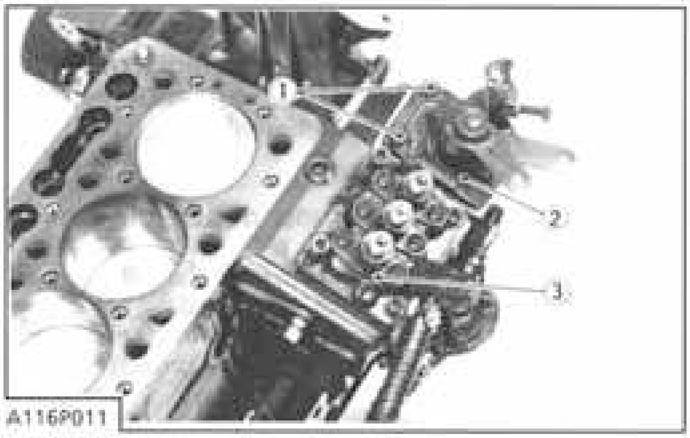
- **Don't change the combination of the valve and valve guide.**

(When reassembling)

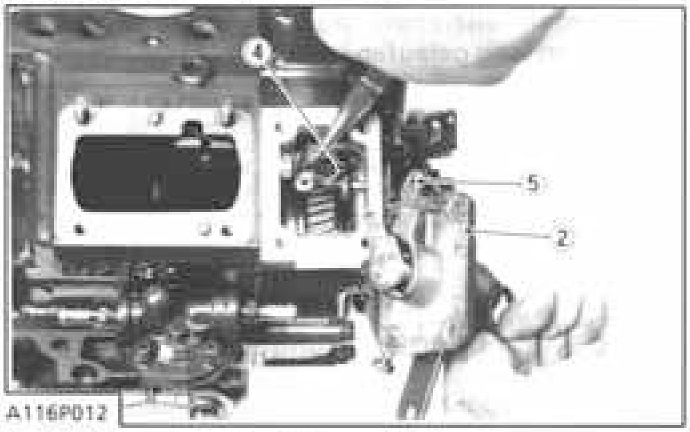
- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

(1) Valve Cap
(2) Valve Spring Collet
(3) Valve Spring Retainer
(4) Valve Spring
(5) Valve

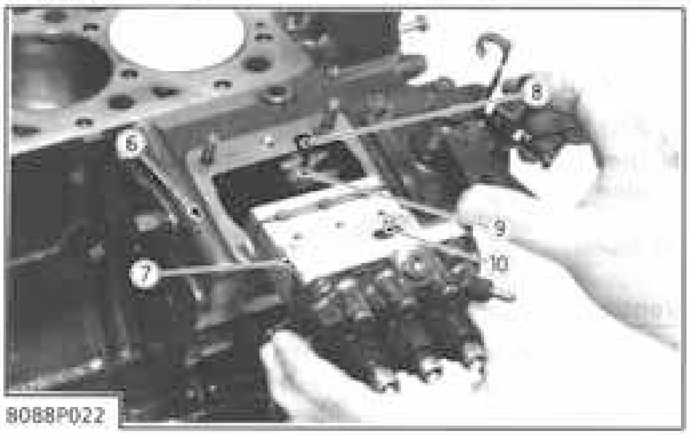
[4] TIMING GEARS AND CAMSHAFT



A116P011



A116P012



8088P022

Injection Pump and Speed Control Plate

1. Remove the socket head screws and nuts, and remove the injection pump (3).
2. Remove the screws and separate the speed control plate (2), taking care not to damage the spring (4).
3. Disconnect the spring (4) and remove the speed control plate (2).

(When reassembling)

- Hook the spring (4) to the lever (5) first and install the speed control plate (2).
- Be sure to place the copper washers underneath two screws (1) (See photo).
- Position the slot (9) on the fork lever just under the slot (8) on the crankcase.
- Insert the injection pump so that the control rod (7) should be pushed by the spring (6) at its end and the pin (10) on the rod engages with the slot (9) on the fork lever (See photo).

■ NOTE

(Engine serial number : ~489290)

- **Insert the same number of shims as used before between crank case and pump.**
- **Addition or reduction of shim (0.15 mm, 0.0059 in.) delays or advances the injection timing by approx. 0.026 rad (1.5°).**
- **Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of the injection pump shim before reassembling.**

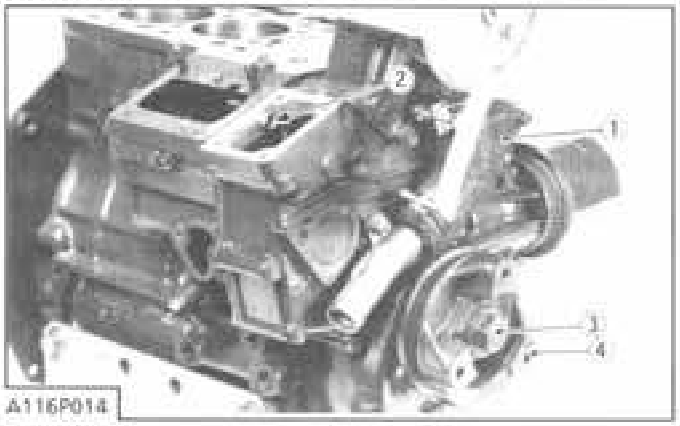
(Engine serial number : 489291~)

- **The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.**
- **Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5°).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**

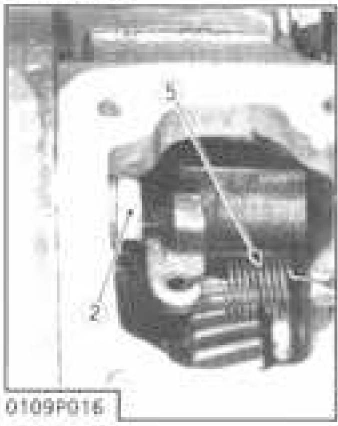
Tightening torque	Injection pump retaining screw and nut	9.81 to 11.28 N·m 1.00 to 1.15 kgf·m 7.23 to 8.32 ft-lbs

(1) Screws and Copper Washers
(2) Speed Control Plate
(3) Injection Pump
(4) Spring
(5) Lever
(6) Spring
(7) Control Rod
(8) Slot (Crankcase Side)
(9) Slot (Fork Lever Side)
(10) Pin

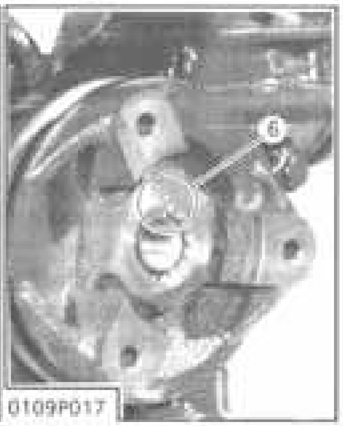
A116P013



A116P014



0109P016



0109P017

Pulley and Gear Case

1. Remove the fuel feed pump (7).
2. Unscrew the fan drive pulley mounting screw (3) and remove the fan drive pulley (4).
3. Unscrew the screw (2) and disconnect the start spring (5) in the speed control plate mounting hole.
4. Unscrew the retaining screws and remove the gear case (1).

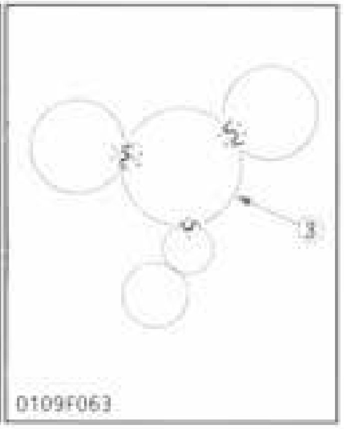
(When reassembling)

- Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of the gear case packing.
- Be sure to set three O-rings inside the gear case.
- Install the pulley to the crankshaft, aligning the marks (6) on them. (See photo)

Tightening torque	Fan drive pulley retaining screw	117.7 to 127.5 N·m 12.0 to 13.0 kgf·m 86.80 to 94.03 ft-lbs
	Gear case screw	9.81 to 11.28 N·m 1.0 to 1.15 kgf·m 7.23 to 8.32 ft-lbs

(1) Gear Case
(2) Screw
(3) Fan Drive Pulley Retaining Screw
(4) Fan Drive Pulley
(5) Start Spring
(6) Aligning Mark
(7) Fuel Feed Pump

8088P024



0109F063

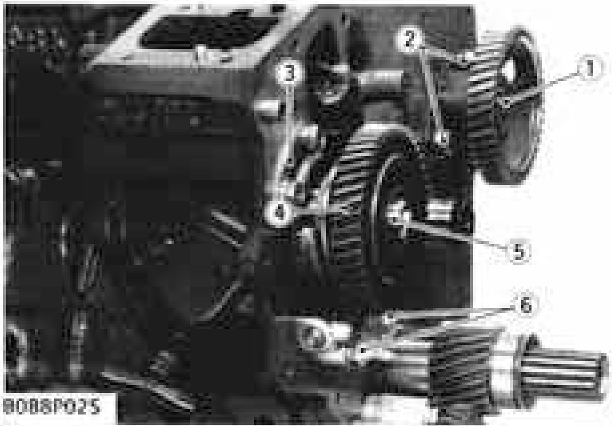
Idle Gear

1. Remove the external snap ring (1), the collar (2) and the idle gear (3).

(When reassembling)

- Install the idle gear, aligning the marks on the gears referring to the figure.

(1) External Snap Ring
(2) Idle Gear Collar
(3) Idle Gear



B088P025

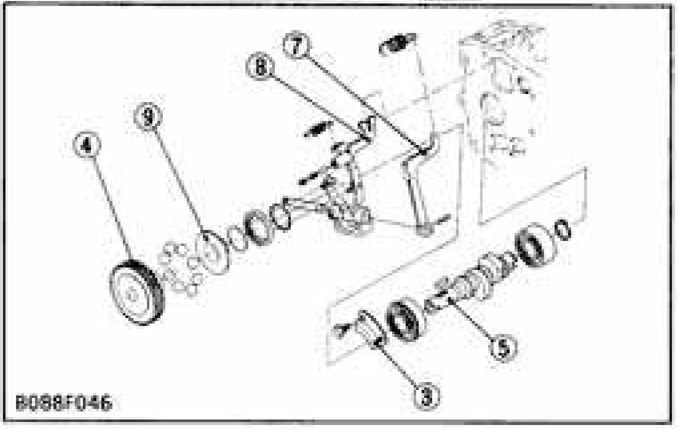
Fuel Camshaft

1. Remove the screws (2) and draw out the camshaft (1) with the gear on it.
2. Remove the retaining plate (3).
3. Remove the screws (6), then draw out the injection pump gear (4) and fuel camshaft (5) with the governor fork assembly.

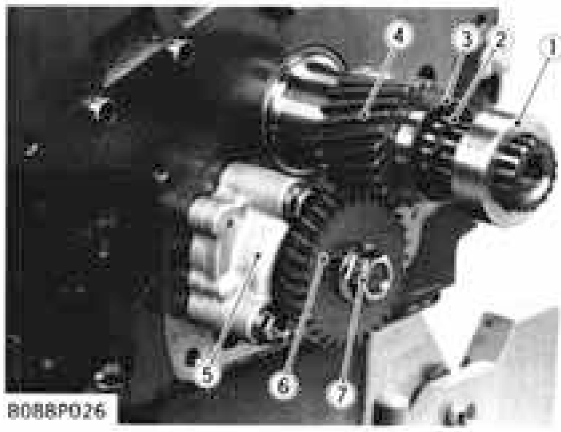
(When reassembling)

- Hook the spring to the fork lever 2 (7) as shown in the figure before installing the fork lever assembly to the crankcase.

(1) Camshaft
(2) Screw
(3) Retaining Plate
(4) Injection Pump Gear
(5) Fuel Camshaft
(6) Screw
(7) Fork Lever 2
(8) Fork Lever 1
(9) Governor Sleeve



B088F046



B088P026

Oil Pump and Crankshaft Gear

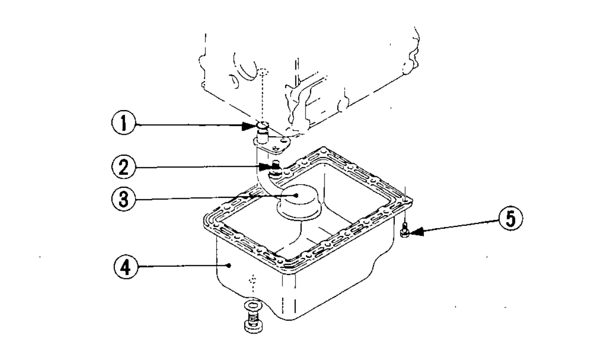
1. Unscrew the flange nut (7) and remove the oil pump gear (6).
2. Unscrew the retaining screws and remove the oil pump (5).
3. Remove the collar (1), O-ring (2) and oil slinger (3).
4. Remove the crankshaft gear (4) with a puller.

(When reassembling)

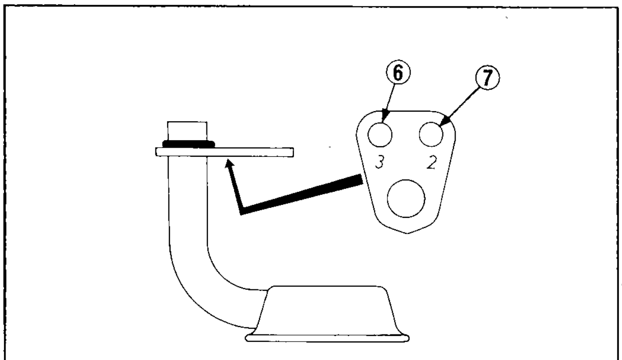
- Install the collar after aligning the marks on the gears. (See the figure at "Idle Gear")

(1) Crankshaft Collar
(2) O-ring
(3) Crankshaft Oil Slinger
(4) Crankshaft Gear
(5) Oil Pump
(6) Oil Pump Gear
(7) Flange Nut

[5] PISTON AND CONNECTING ROD



A116F018



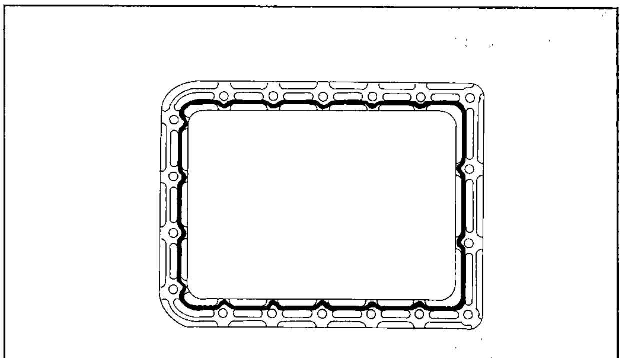
B083F042

Oil Pan and Oil Strainer

1. Unscrew the oil pan mounting screws (5), and remove the oil pan (4).
2. Unscrew the oil strainer mounting screw (2), and remove the oil strainer (3).

(When reassembling)

- Install the oil strainer, using care not to damage the O-ring (1).
- Using the hole (6) numbered "3", install the oil strainer by mounting screw (D662-B, D722-B).
- Using the hole (7) numbered "2", install the oil strainer by mounting screw (Z442-B, Z482-B).
- Apply liquid gasket (Three Bond 1270D or 1270C) to the oil pan as shown in the figure.

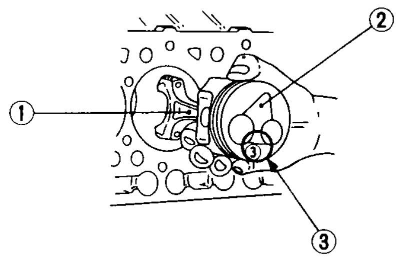


A116F019

■ **IMPORTANT**

- **Scape off the old adhesive completely. Wipe the sealing surface clean using waste cloth soaked with gasoline. Now apply new adhesive 3~5 mm thick all over the contact surface. Apply the adhesive also on the center of the flange as well as on the inner wall of each bolt hole.**
- **Cut the nozzle of the "fluid sealant" container at its second notch. Apply "fluid sealant" about 5 mm thick.**
  Within 20 minutes after the application of fluid sealant, reassemble the components. Wait then for about 30 minutes, and pour oil in the crankcase.

(1) O ring
(2) Screw
(3) Oil Strainer
(4) Oil Pan
(5) Oil Pan Mounting Screws
(6) Hole
(7) Hole



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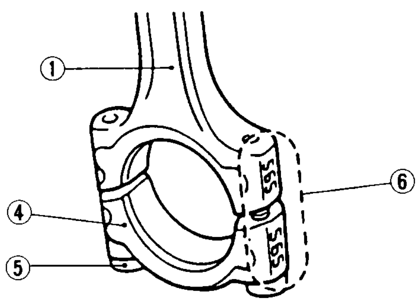


0203F021

Piston and Connecting Rod

1. Unscrew the connecting rod screws (5), and remove the connecting rod cap (4).
2. Turn the crankshaft to bring the piston to top dead center.
3. Push the connecting rod from the bottom of the cylinder block with a hummer grip, and pull out the piston (2) and connecting rod (1).

■ **IMPORTANT**

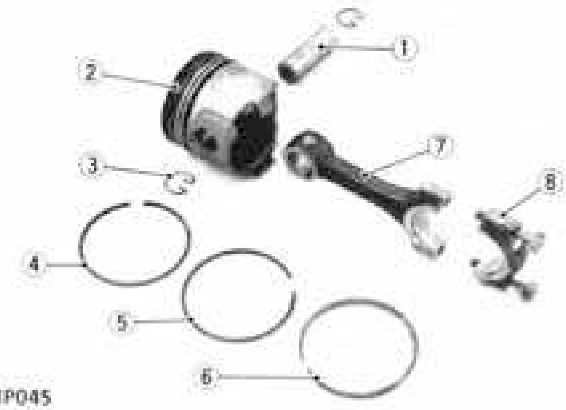
- **Do not change the combination of cylinder and piston.**

(When reassembling)

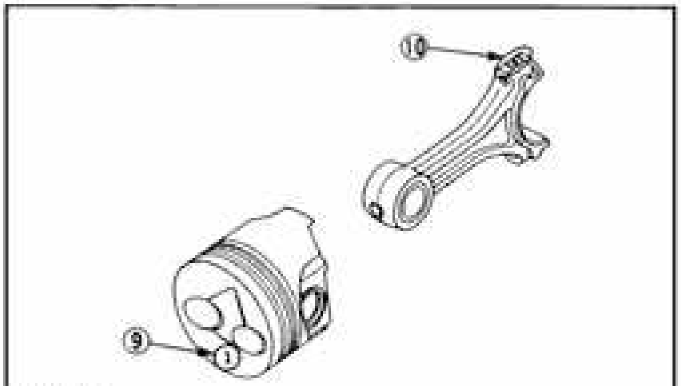
- Before inserting the piston into the cylinder, apply enough engine oil to the inside surface of the cylinder.
- Apply engine oil to the crank pin bearings and connecting rod screws.
- Be sure to install the piston and connecting rod into the cylinder so that the number (3) on the piston head opposite side of the injection pump.
- Align the alignment marks (6) on the connecting rod (1) and connecting rod cap (4).
- When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump.

Tightening torque	Connecting rod screw	26.5 to 30.4 N·m 2.7 to 3.1 kgf·m 19.5 to 22.4 ft-lbs

(1) Connecting Rod
(2) Piston
(3) Number
(4) Connecting Rod Cap
(5) Connecting Rod Screw
(6) Alignment Mark



B083P045



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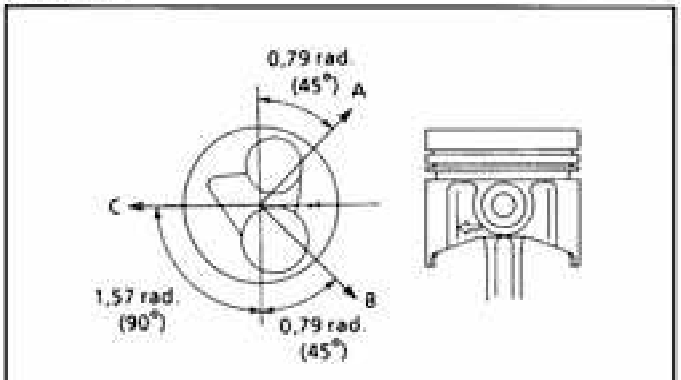

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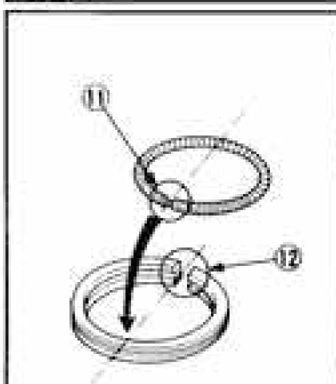

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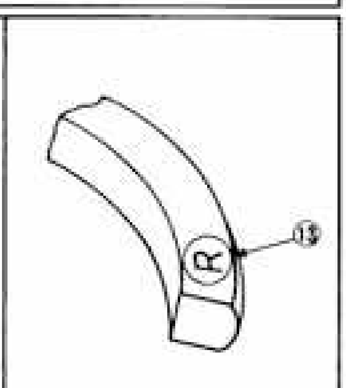


B083F046

Piston Ring and Connecting Rod

1. Remove the piston rings using a piston ring tool.
2. Put the alignment mark (9) on the piston as shown in figure.
3. Remove the piston pin (1), and separate the connecting rod (7) from the piston (2).

(When reassembling)

- When installing the ring, assemble the rings so that the manufacturer's mark (13) near the gap faces the top of the piston.
- When installing the oil ring onto the piston, place the expander joint (11) on the opposite side of the oil ring gap (12).
- Apply engine oil to the piston pin and small end bushing.
- When installing the piston pin, immerse the piston in 80°C (176°F) oil for 10 to 15 minutes and insert the piston pin to the piston.
- Install the connecting rod (7) to the piston (2) so that the alignment mark (10) on the connecting rod positions the opposite side of the number (9) on the piston head. (See figure)

■ IMPORTANT

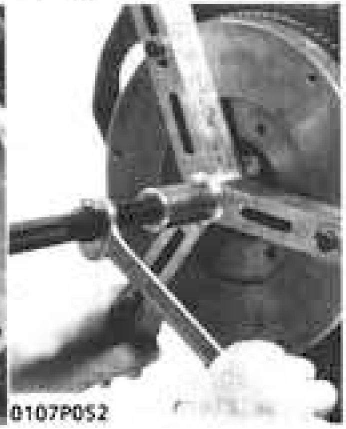
- **Mark the same number on the connecting rod and the piston so as not to change the combination.**
- **When inserting the piston into the cylinder, place the gap of the compression ring 1 on the opposite side of the combustion chamber and stagger the gaps of the compression ring 2 and oil ring making a right angle from the gap of the compression ring 1.**
- **Carefully insert the pistons using a piston ring compressor. Otherwise, their chrome-plated section may be scratched, causing trouble inside the liner.**

[A] Top Compression Ring Gap
[B] Second Compression Ring Gap
[C] Oil Ring Gap

(1) Piston Pin
(2) Piston
(3) Piston Pin Snap Ring
(4) Compression Ring 1
(5) Compression Ring 2
(6) Oil Ring
(7) Connecting Rod
(8) Connecting Rod Cap
(9) Alignment mark (Number)
(10) Mark
(11) Expander Joint
(12) Oil Ring Gap
(13) Manufacturer's Mark

[6] FLYWHEEL AND CRANKSHAFT

0107P051



0107P052

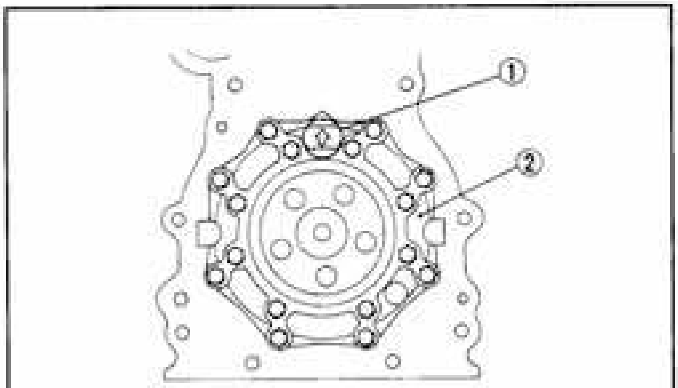
Flywheel

1. Lock the flywheel not to turn using the flywheel stopper.
2. Remove the flywheel bolts, except for two which must be loosened and left as they are.
3. Set a flywheel puller (Code No: 07916-32011), and remove the flywheel.

(When reassembling)

- Apply engine oil to the flywheel bolts.

Tightening torque	Flywheel bolts	53.9 to 58.8 N·m 5.5 to 6.0 kgf·m 39.8 to 43.4 ft-lbs



A116F023

Bearing Case Cover

1. Unscrew the bearing case cover mounting screws.
2. Remove the bearing case cover (2).

(When reassembling)

- Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of a new bearing case cover gasket.
- Install the bearing case cover to position the casting mark " ↑ " (1) on it upward.
- Tighten the bearing case cover mounting screws with even force on the diagonal line.

Tightening torque	Bearing case cover mounting screw	9.81 to 11.28 N·m 1.00 to 1.15 kgf·m 7.23 to 8.32 ft-lbs

(1) Mark
(2) Bearing Case Cover

B088P030

A116P016

Crankshaft

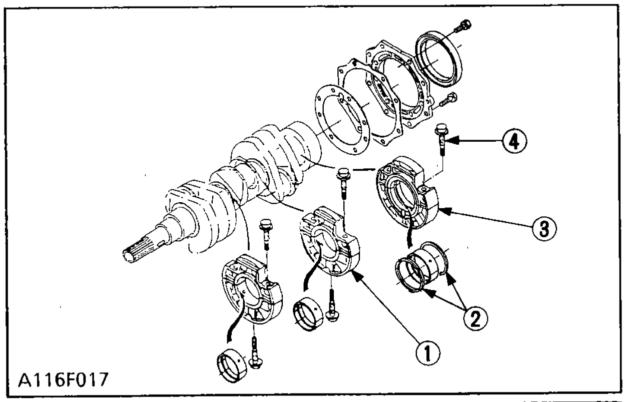
1. Unscrew the bearing case screws 2 (1), and draw out the crankshaft.

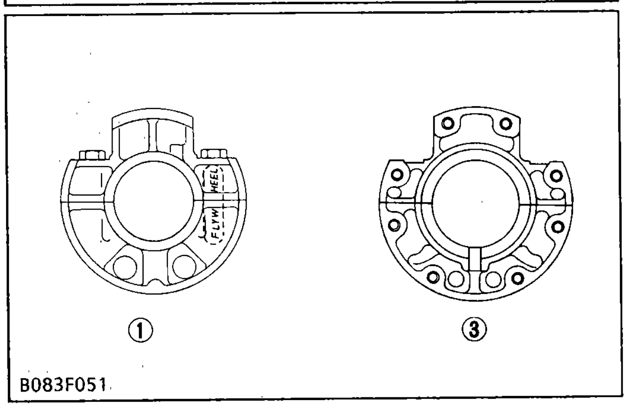
(When reassembling)

- Install the crankshaft sub assembly, aligning the screw hole of main bearing case 2 with the screw hole of cylinder block.
- Apply engine oi to the seat and thread of bearing case screw 2. After tightening it.

Tightening torque	Bearing case screw 2	26.5 to 30.4 N·m 2.7 to 3.1 kgf·m 19.5 to 22.4 ft-lbs

(1) Bearing Case Screw 2





Main bearing case assembly

1. Remove the two bearing case screws 1 (4), and remove the main bearing case assembly 1 (3), being careful with the thrust bearing (2) and crank-shaft bearing 2.

2.Remove the main bearing case assembies 2, 3.

(When reassembling)

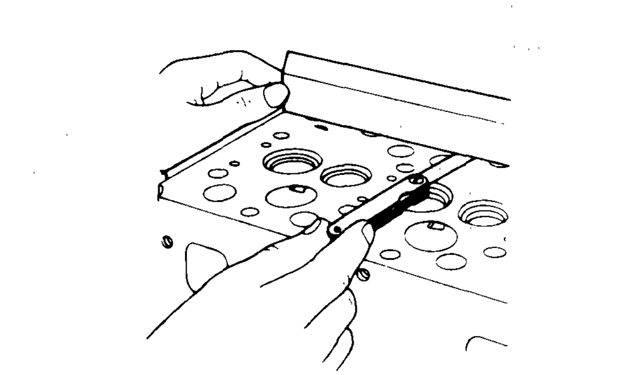
- Clean the oil passage in the main bearing case.
- apply clean engine oil on the crankshaft bearing 2 and thrust bearings.
- Install the main bearing case assemblies n the original positions. Since diameters of main bearing case vary, install them in order of makings (1,2) from the gear case side.
- When installing the main bearing case assemblies 2, 3, face the mark “FLYWHEEL” to the flywheel.
- Be sure to install the thrust bearing with its oil groove facing outward.

①Main bearing case assembli 2
②Thrust bearing
③Main bearing case assembli 1
④Bearing case screw 1

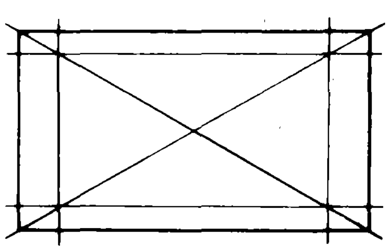
■ Note:From engine S/N WE 0364 and on, bearing case bolts / have two types, which are different part number. Tightening torque is different as follows.
No.1 and 2 bearing case bolt 1 : Code No. 15841-04540, M6 × 1.0, 12.7 ~ 15.7 N·m(1.3~1.6kgf·m)9.4~11.6ft·lbs
No.3 bearing case bolt 1 : Code No. 01754-50840, M8 × 1.25, 7T, 23.5 ~ 27.5 N·m(2.4~2.8kgf·m)17.4~20.3ft·lbs

SERVICING

[1] CYLINDER HEAD AND VALVES



0109F067



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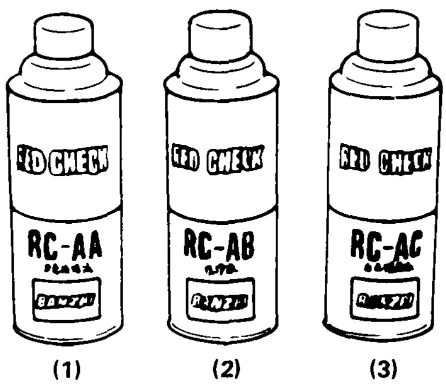


ST11F011

(1) Detergent
(2) Red Permeative Liquid
(3) White Developer

Cylinder Head Surface Flatness

1. Thoroughly clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal as shown in the figure.
3. Measure the clearance with a feeler gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ **NOTE**

- **Do not place the straightedge on the combustion chamber.**

■ **IMPORTANT**

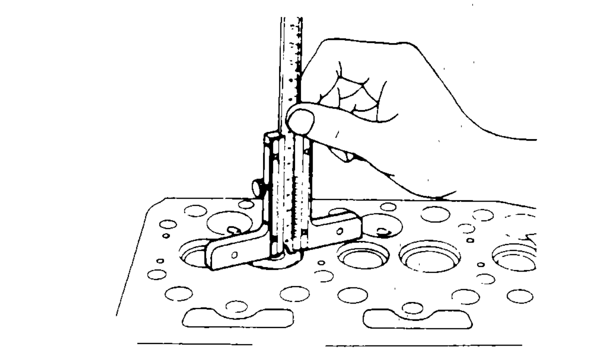
- **Be sure to check the valve recessing after correcting.**

Cylinder head surface flatness	Allowable limit	0.05 mm 0.0020 in.

Finishing	8 μR max ▽▽	8 (320) unit: μm (μin.)

Cylinder Head Flaw

1. Prepare an air spray red check (Code No. 07909-31371).
2. Clean the surface of the cylinder head with detergent (1).
3. Spray the cylinder head surface with the red permeative liquid (2).
   Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with white developer (3).
   If flawed, it can be identified as red marks.

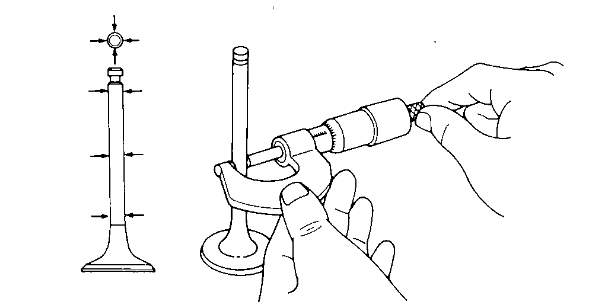


0109F070

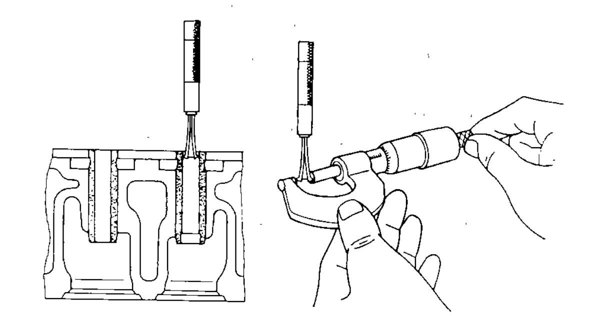
Valve Recessing

1. Clean the cylinder head, the valve face and valve seat.
2. Insert the valve into the valve guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement exceeds the allowable limit, replace the valve.
5. If it still exceeds the allowable limit after replacing the valve, correct the valve seat face of the cylinder head with a valve seat cutter (Code No. 07909-33102) or valve seat grinder.
   Then, correct the cylinder head surface with a surface grinder, or replace the cylinder head.

Valve recessing (Intake and exhaust)	Factory spec.	−0.10 to 0.10 mm −0.0039 to 0.0039 in.
	Allowable limit	0.30 mm 0.0118 in.



0347F029



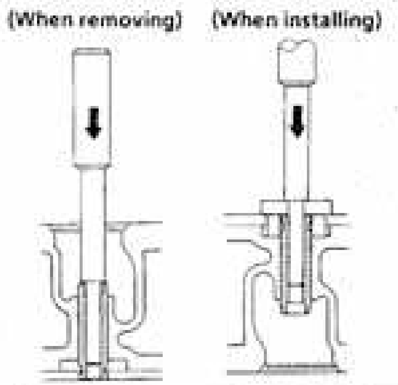
B083F052

Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. with a small hole gauge, and calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valve guide or valve.

Clearance between valve stem and valve guide	Factory spec.	0.030 to 0.057 mm 0.00118 to 0.00224 in.
	Allowable limit	0.10 mm 0.0039 in.

Valve stem O.D.	Factory spec.	5.968 to 5.980 mm 0.23496 to 0.23543 in.
Valve guide I.D.	Factory spec.	6.010 to 6.025 mm 0.23661 to 0.23720 in.



B088F051

Replacing Valve Guide

(When removing)

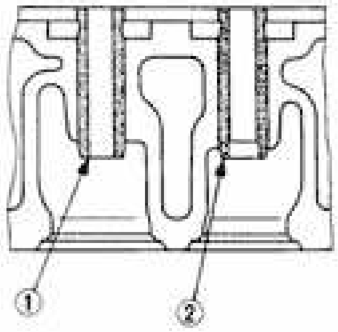
1. Using a valve guide replacing tool (see page S-53), press out the used valve guide.

(When installing)

1. Clean a new valve guide, and apply engine oil to it.
2. Using a valve guide replacing tool, press in a new valve guide until it is flush with the cylinder head as shown in the figure.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

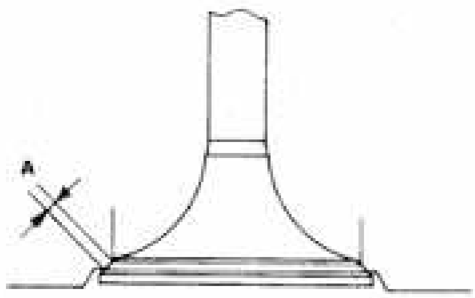
Valve guide I.D. (Intake and exhaust)	Factory spec.	6.010 to 6.025 mm 0.23661 to 0.23721 in.

■ IMPORTANT
- **Do not hit the valve guide with a hammer, etc. during replacement.**



B088F053

(1) Intake Valve Guide (2) Exhaust Valve Guide

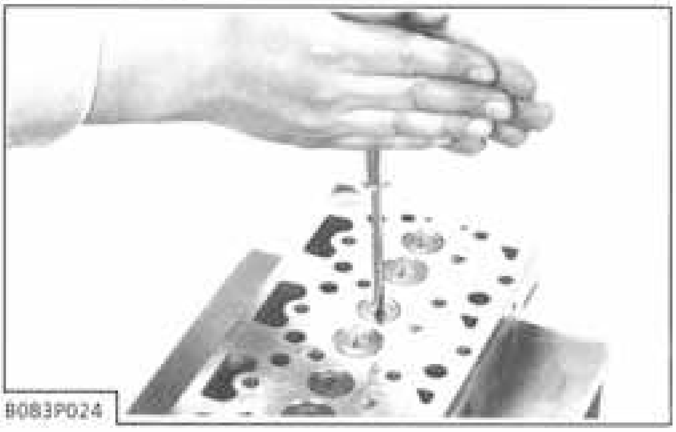


C066F044

Width of Contact between Valve and Valve Seat

1. Check the contact between the valve face and valve seat.
2. If the contact is uneven or the width of contact (A) is excessively large, correct the valve and valve seat referring to "**Correcting Valve and Valve Seat**".

Valve seat width	Factory spec.	2.12 mm 0.0835 in.

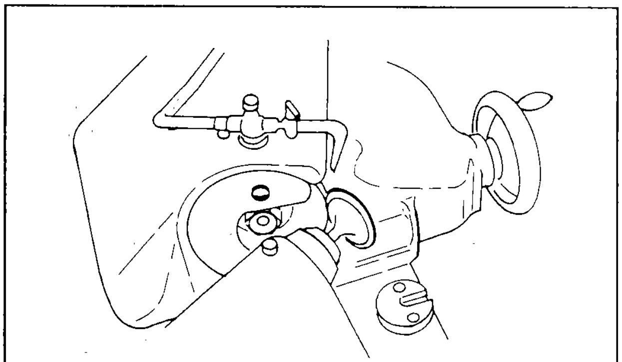


B083P024

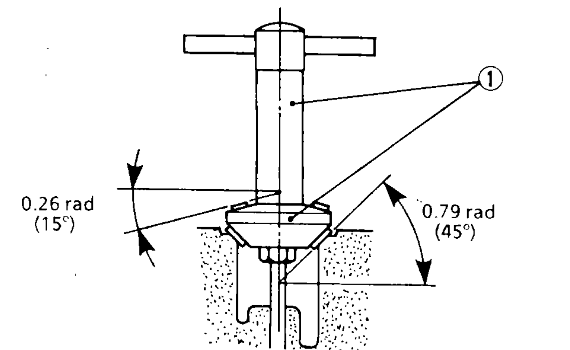
Valve Lapping

1. Apply compound evenly to the valve lapping surface.
2. Insert the valve into the valve guide. Lap the valve onto its seat with a valve flapper or screwdriver.
3. After lapping the valve, wash the compound away and apply oil, then repeat valve lapping with oil.
4. Apply red lead or prussian blue to the contact surface to check the seated rate. If it is less than 70%, repeat valve lapping again.

■ IMPORTANT
- **When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve. (See page S-47)**

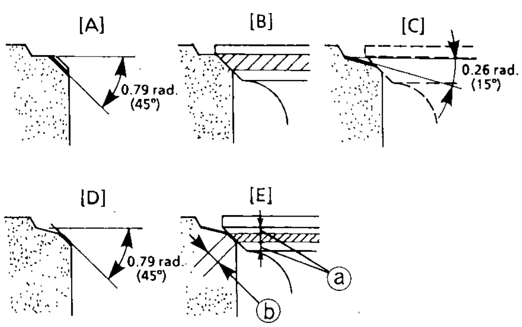


C066F050



C056F038

(1) Valve Seat Cutter



C056F039

(A) Slightly Correct
(B) Check Contact
(C) Correct Seat Width
(D) Correct Seat Surface
(E) Check Contact

(a) Identical Dimensions
(b) Valve Seat Width

Correcting Valve and Valve Seat

■ **NOTE**

- **Before correcting the valve and seat, check the valve stem and the I.D. of the valve guide section, and repair them if necessary.**
- **After correcting the valve seat, be sure to check the valve recessing.**

1) Correcting Valve

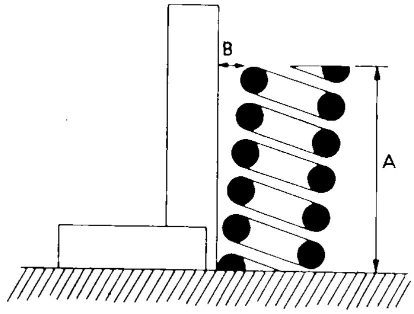
1. Correct the valve with a valve refacer.

Valve face angle	Factory spec.	0.785 to 0.794 rad. 45.0° to 45.5°

2) Correcting Valve Seat

1. Slightly correct the seat surface with a 0.79 rad. (45°) valve seat cutter (1) (Code No. 07909-33102).
2. Fitting the valve, check the contact position of the valve face and seat surface with red lead. (Visual check) [If the valve has been used for a long period, the seat tends to come in contact with the upper side of the valve face.]
3. Grind the upper surface of the valve seat with a 0.26 rad. (15°) valve seat cutter until the valve seat touches to the center of the valve face (so that a equals **b** as shown in the figure).
4. Grind the seat with a 0.79 rad. (45°) valve seat cutter again, and visually recheck the contact between the valve and seat.
5. Repeat steps 3 and 4 until the correct contact is achieved.
6. Continue lapping until the seated rate becomes more than 70% of the total contact area.

Valve seat angle	Factory spec.	0.785 rad. 45.0°

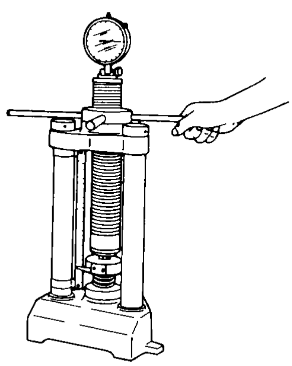


C019F021

Free Length and Tilt of Valve Spring

1. Measure the length **A** with varnier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the spring on a surface plate, place a square on the side of the spring.
3. Check to see if the entire side is in contact with the square. Rotate the spring and measure the maximum **B**.
   If the measurement exceeds the allowable limit, replace it.
4. Check the entire surface of the spring for scratches. Replace it, if any.

Free length **A**	Factory spec.	31.6 mm 1.244 in.
	Allowable limit	28.4 mm 1.118 in.
Tilt **B**	Allowable limit	1.2 mm 0.047 in.

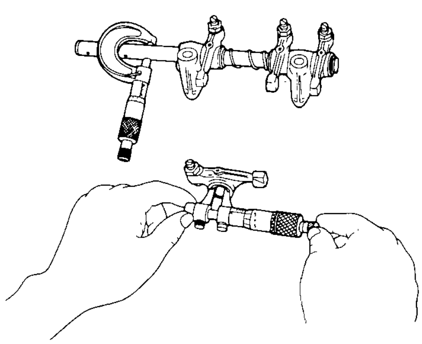


C019F022

Valve Spring Setting Load

1. Place the spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.

Setting load	Factory spec.	64.7 N / 27 mm 6.6 kgf / 27 mm 14.6 lbs / 1.063 in.
Setting length	Allowable limit	54.9 N / 27 mm 5.6 kgf / 27 mm 12.3 lbs / 1.063 in.



C019F023

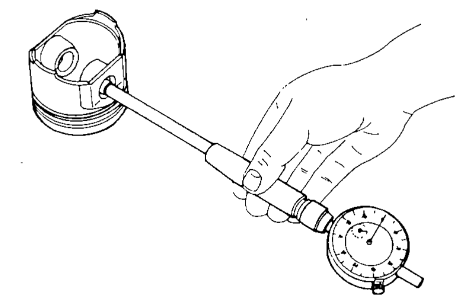
Oil Clearance between Rocker Arm and Rocker Arm Shaft

1. Measure the rocker arm I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

Oil clearance between rocker arm and rocker arm shaft	Factory spec.	0.016 to 0.045 mm 0.00063 to 0.00177 in.
	Allowable limit	0.15 mm 0.0059 in.

Rocker arm shaft O.D.	Factory spec.	10.473 to 10.484 mm 0.41232 to 0.41276 in.
Rocker arm I.D.	Factory spec.	10.500 to 10.518 mm 0.41339 to 0.41410 in.

[2] PISTON AND CONNECTING ROD

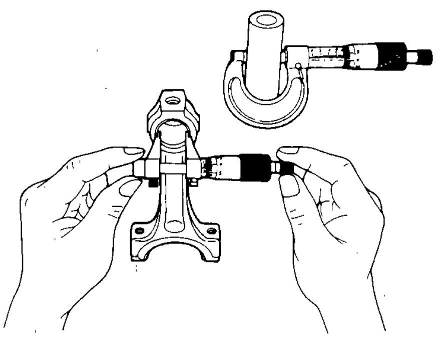


C083F040

Piston Pin-Bore I.D.

1. Measure the I.D. of the piston pin-bore in both the horizontal and vertical directions with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

Piston pin-hole I.D.	Factory spec.	20.000 to 20.013 mm 0.78740 to 0.78791 in.
	Allowable limit	20.05 mm 0.7894 in.



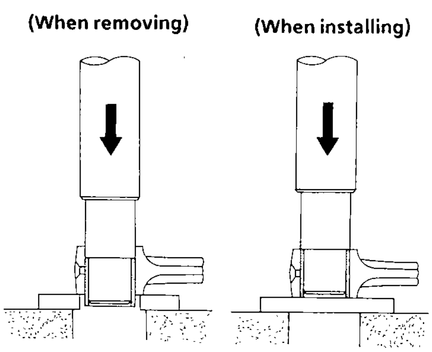
C019F053

Oil Clearance between Piston Pin and Small End Bushing

1. Measure the O.D. of the piston pin where it contacts the bushing with an outside micrometer.
2. Measure the I.D. of the small end bushing with an inside micrometer, and calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the piston pin.

Oil clearance between piston pin and small end bushing	Factory spec.	0.014 to 0.038 mm 0.00055 to 0.00150 in.
	Allowable limit	0.10 mm 0.0039 in.

Piston pin O.D.	Factory spec.	20.002 to 20.011 mm 0.78748 to 0.78783 in.
Small end bushing I.D.	Factory spec.	20.025 to 20.040 mm 0.78839 to 0.78897 in.



B083F054

Replacing Small End Bushing

(When removing)

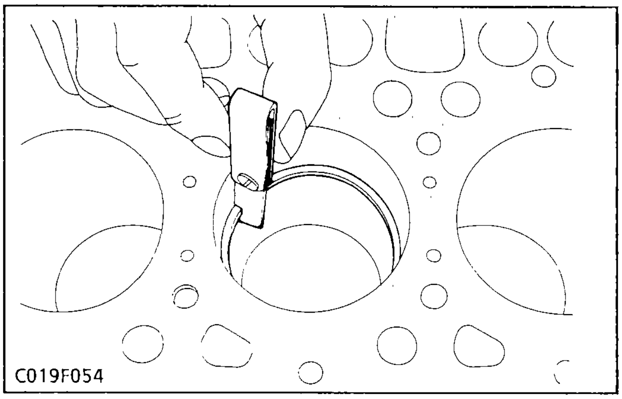
1. Using a small end bushing replacing tool (see page S-53), press out the used bushing.

(When installing)

1. Clean a new small end bushing and small end hole, and apply engine oil to them.
2. Using a small end bushing replacing tool, press in a new bushing (service parts) taking due care to see that the connecting rod hole matches the bushing hole.

[Service parts dimension]

Oil clearance between piston pin and small end bushing	Factory spec.	0.015 to 0.075 mm 0.00059 to 0.00295 in.
	Allowable limit	0.10 mm 0.0039 in.

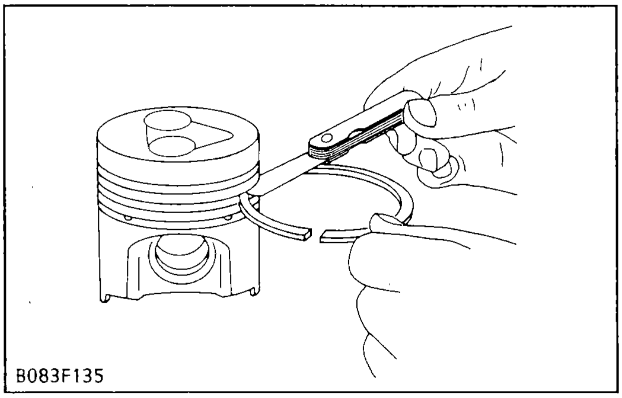


C019F054

Piston Ring Gap

1. Insert the piston ring into the lower part of the cylinder (the least worn out part) with a piston ring compressor and piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the piston ring.

Piston ring gap	Top compression ring and oil ring	Factory spec.	0.15 to 0.30 mm 0.0059 to 0.0118 in.
		Allowable limit	1.2 mm 0.0472 in.
	Second compression ring	Factory spec.	0.30 to 0.45 mm 0.0118 to 0.0177 in.
		Allowable limit	1.2 mm 0.0472 in.

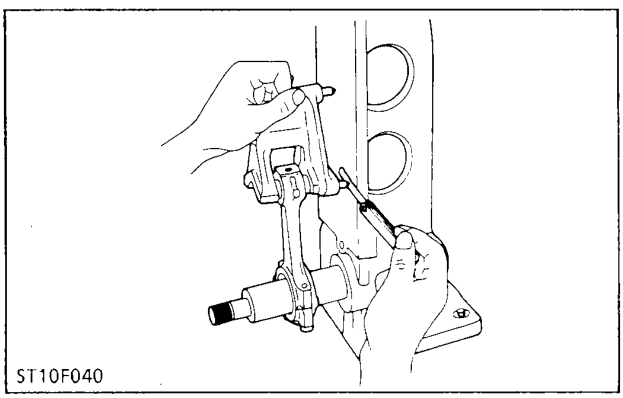


B083F135

Clearance between Piston Ring and Groove

1. Remove carbon from the ring grooves.
2. Place the ring into each ring groove, and measure the clearance at several points around the ring groove with a feeler gauge.
3. If the clearance exceeds allowable limit, replace the piston ring since compression leak and oil shortage result.
4. If the clearance still exceeds the allowable limit after replacing the piston ring, replace the piston.

Clearance between piston ring and groove	Second compression ring	Factory spec.	0.085 to 0.115 mm 0.0033 to 0.0045 in.
		Allowable limit	0.15 mm 0.0059 in.
	Oil ring	Factory spec.	0.02 to 0.06 mm 0.0008 to 0.0024 in.
		Allowable limit	0.15 mm 0.0059 in.



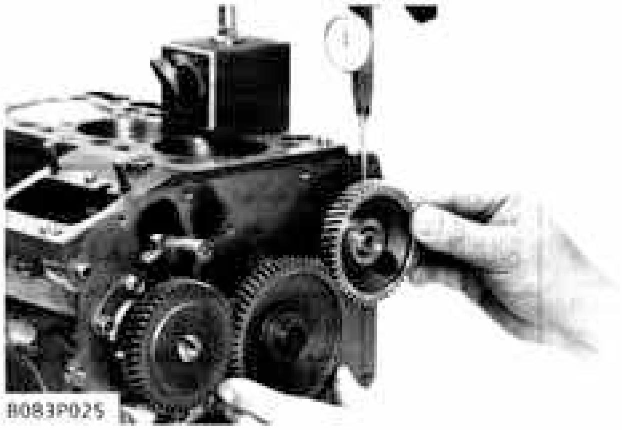
ST10F040

Connecting Rod Alignment

1. Remove the connecting rod crank pin bearing, and install the connecting rod cap.
2. Set the connecting rod to the connecting rod alignment tool (Code No. 07909-31661).
3. Install the piston pin into the connecting rod. Set the gauge on the piston pin.
4. Measure three point's gaps between the pins of the gauge and flat surface of the alignment tool. If the measurement exceeds the allowable limit, replace it.

Bend of connecting rod	Allowable limit	0.05 mm 0.0020 in. (gauge pin span at 100 mm, 3.94 in.)

[3] TIMING GEAR AND CAMSHAFT

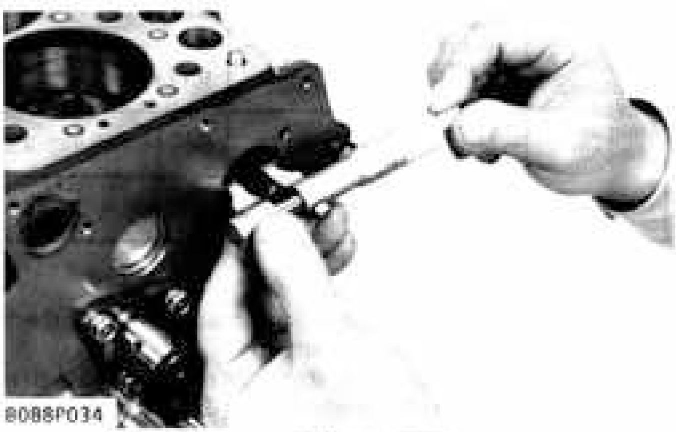


B083P025

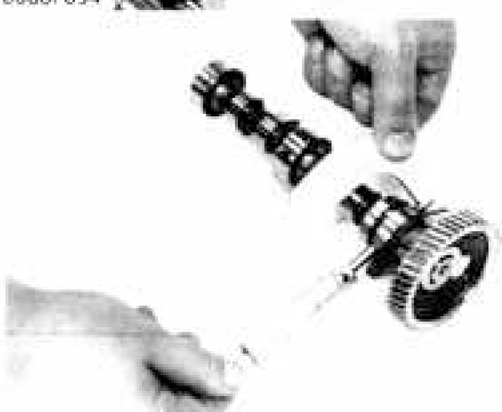
Timing Gear Backlash

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shaft and gear.
4. If the oil clearance is proper, replace the gears.

Backlash between idle gear and crank gear	Factory spec.	0.043 to 0.124 mm 0.00169 to 0.00488 in.
	Allowable limit	0.15 mm 0.0059 in.
Backlash between idle gear and cam gear	Factory spec.	0.047 to 0.123 mm 0.00185 to 0.00484 in.
	Allowable limit	0.15 mm 0.0059 in.
Backlash between idle gear and injection pump gear	Factory spec.	0.046 to 0.124 mm 0.00181 to 0.00488 in.
	Allowable limit	0.15 mm 0.0059 in.
Backlash between oil pump gear and crank gear	Factory spec.	0.041 to 0.123 mm 0.00161 to 0.00484 in.
	Allowable limit	0.15 mm 0.0059 in.



B088P034



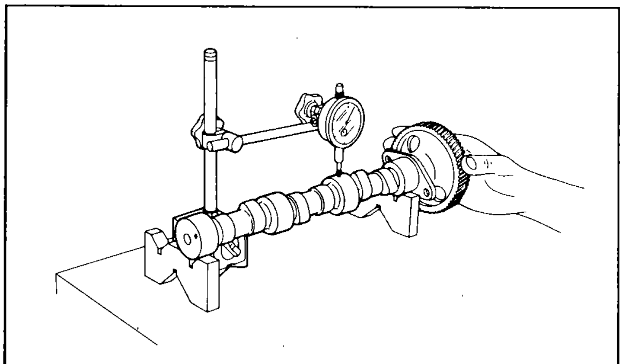
0109P031

Oil Clearance of Camshaft Journal

1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the camshaft.

Oil clearance of camshaft journal	Factory spec.	0.050 to 0.091 mm 0.0020 to 0.0036 in.
	Allowable limit	0.15 mm 0.0059 in.

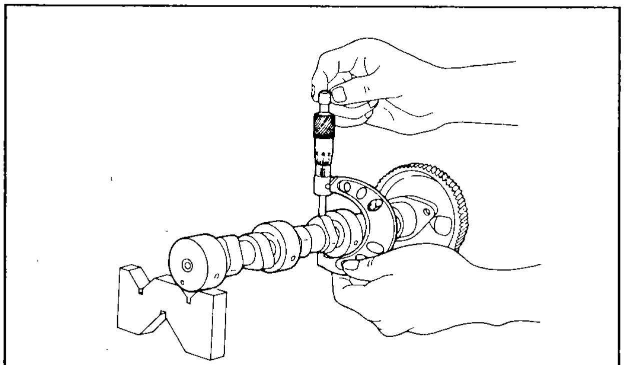
Camshaft journal O.D.	Factory spec.	32.934 to 32.950 mm 1.2966 to 1.2972 in.
Cylinder block bore I.D. (Bearing portion)	Factory spec.	33.000 to 33.025 mm 1.2992 to 1.3002 in.


C019F043

Camshaft Alignment

1. Support the camshaft with V-blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the camshaft on the V-blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the camshaft.

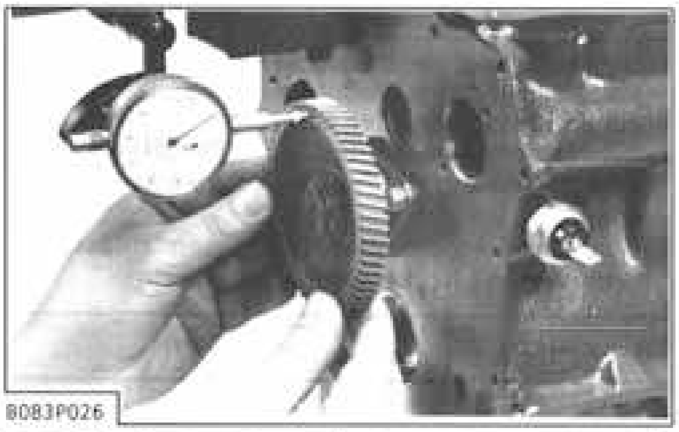
Misalignment	Allowable limit	0.01 mm 0.0004 in.


C019F044

Intake and Exhaust Cam Heights

1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

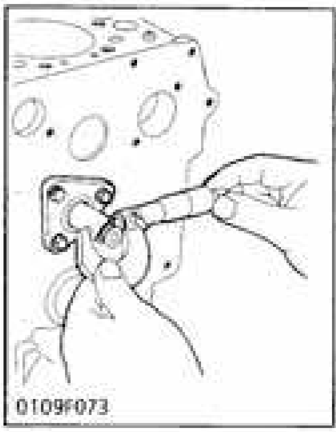
Intake and exhaust cam heights	Factory spec.	26.88 mm 1.0583 in.
	Allowable limit	26.83 mm 1.0563 in.

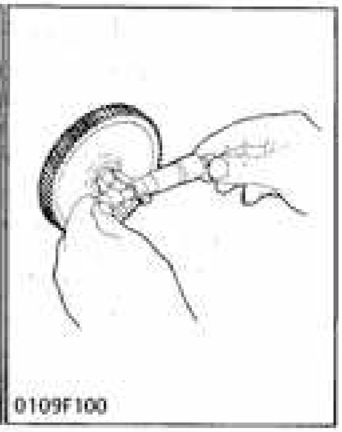

B083P026

Idle Gear Side Clearance

1. Set a dial indicator with its tip on the idle gear.
2. Measure the side clearance by moving the idle gear to the front and rear.
3. If the measurement exceeds the allowable limit, replace the idle gear or idle gear shaft.

Idle gear side clearance	Factory spec.	0.20 to 0.51 mm 0.0079 to 0.0201 in.
	Allowable limit	0.60 mm 0.0236 in.


0109F073

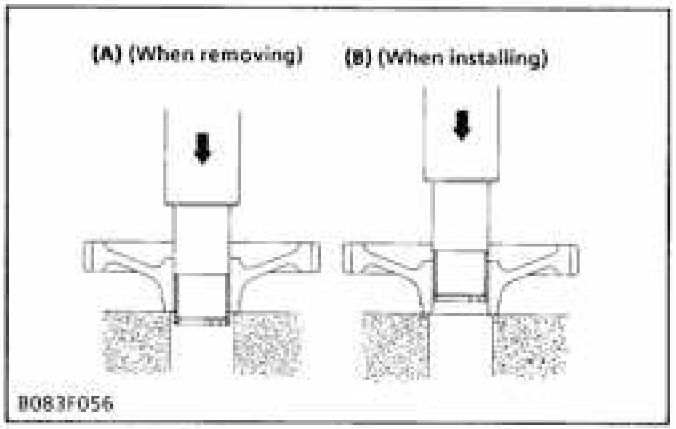

0109F100

Oil Clearance between Idle Gear Shaft and Idle Gear Bushing

1. Measure the I.D. of the idle gear bushing with an inside micrometer.
2. Measure the O.D. of the idle gear shaft with an outside micrometer, and calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the idle gear shaft.

Oil clearance between idle gear shaft and idle gear bushing	Factory spec.	0.020 to 0.084 mm 0.00079 to 0.00331 in.
	Allowable limit	0.10 mm 0.0039 in.

Idle gear shaft O.D.	Factory spec.	19.967 to 19.980 mm 0.78610 to 0.78661 in.
Idle gear bushing I.D.	Factory spec.	20.000 to 20.051 mm 0.78740 to 0.78941 in.



B083F056

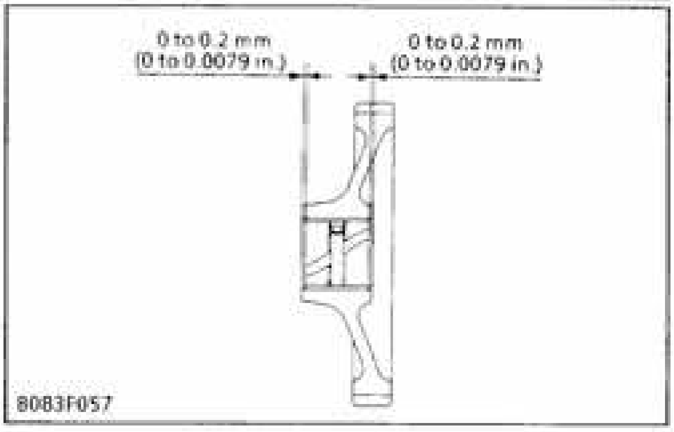
Replacing Idle Gear Bushing

(A) (When removing)

1. Using an idle gear bushing replacing tool (see page S-55), press out the used bushing.

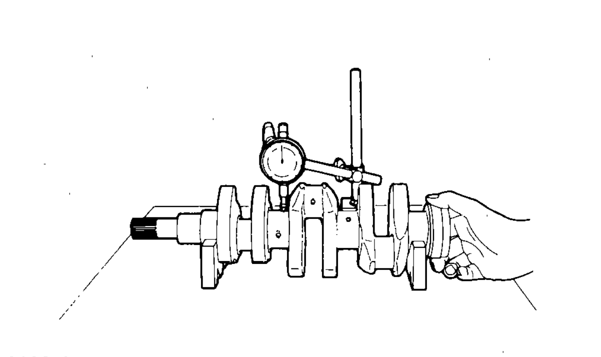
(B) (When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Using an idle gear bushing replacing tool, press in a new bushing (service parts) to the specified dimension. (See figure)



B083F057

[4] CRANKSHAFT

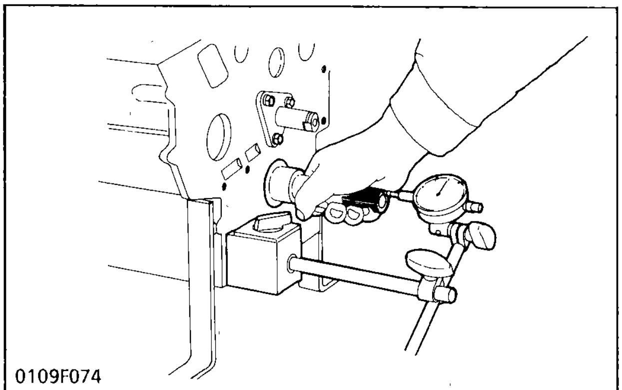


0109F075

Crankshaft Alignment

1. Support the crankshaft with V-blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the crankshaft on the V-blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

Misalignment	Allowable limit	0.02 mm 0.0008 in.

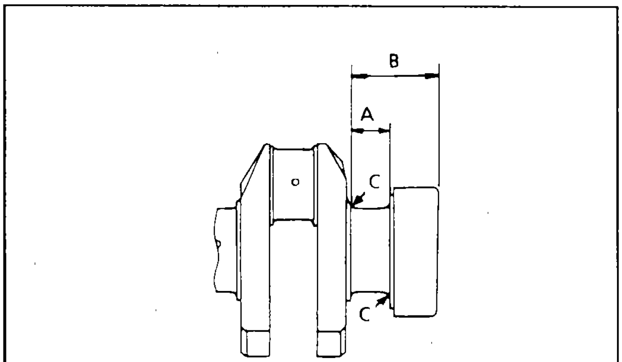


0109F074

Crankshaft Side Clearance

1. Set a dial indicator with its tip on the end of the crankshaft.
2. Measure the side clearance by moving the crankshaft to the front and rear.
3. If the measurement exceeds the allowable limit, replace the thrust bearings.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an oversize one referring to the table and figure.

Crankshaft side clearance	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit	0.5 mm 0.0197 in.



0071F006

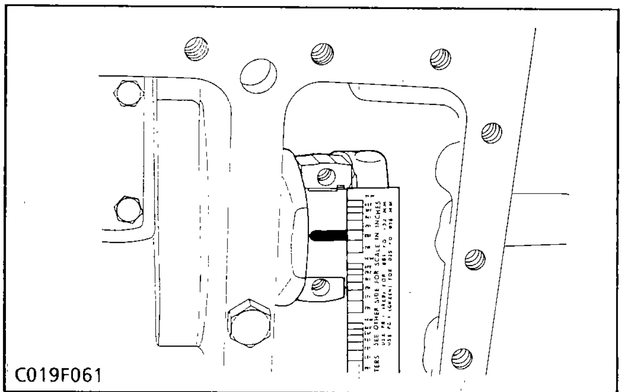
(Reference)

- Oversize thrust bearing

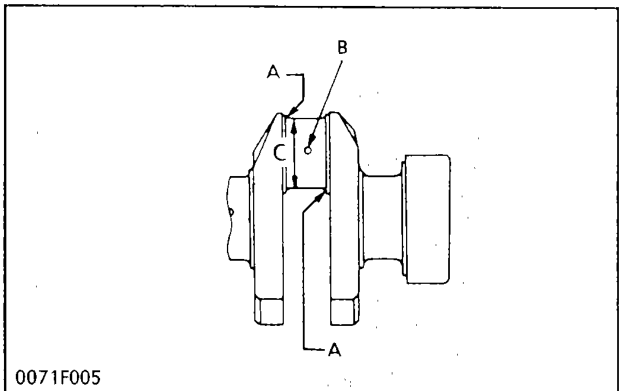
Oversize	Bearing	Code Number	Marking
0.2 mm 0.008 in.	Thrust bearing 1 02	15261-23951	020 OS
	Thrust bearing 2 02	15261-23971	020 OS
0.4 mm 0.016 in.	Thrust bearing 1 04	15261-23961	040 OS
	Thrust bearing 2 04	15261-23981	040 OS

- Oversize dimensions of crankshaft journal

Oversize / Dimension	0.2 mm 0.008 in.	0.4 mm 0.016 in.
A	23.40 to 23.45 mm 0.9134 to 0.9154 in.	23.80 to 23.85 mm 0.9213 to 0.9232 in.
B	46.1 to 46.3 mm 1.815 to 1.823 in.	46.3 to 46.5 mm 1.823 to 1.831 in.
C	1.8 to 2.2 mm radius 0.071 to 0.087 in. radius	1.8 to 2.2 mm radius 0.071 to 0.087 in. radius
The crankshaft journal must be fine-finished to higher than ∇∇∇∇ (0.4S).		



C019F061



0071F005

Oil Clearance between Crank Pin and Crank Pin Bearing

1. Clean the crank pin and crank pin bearing.
2. Put a strip of plastigage (Code No. 07909-30241) on the center of the crank pin.

■ **IMPORTANT**

- **Never insert the press gauge into the crank pin oil hole.**

3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque (26.5 to 30.4 N·m, 2.7 to 3.1 kgf·m, 19.5 to 22.4 ft-lbs), and remove the cap again.

■ **NOTE**

- **Be sure not to move the crankshaft while the connecting rod screws are tightened.**

4. Measure the amount of the flattening with the scale, and get the oil clearance.
5. If the oil clearance exceeds the allowable limit, replace the crank pin bearing.
6. If the same size bearing is useless because of the crank pin wear, replace it with an undersize one referring to the table and figure.

Oil clearance between crank pin and crank pin bearing	Factory spec.	0.019 to 0.081 mm 0.00075 to 0.00319 in.
	Allowable limit	0.15 mm 0.0059 in.

Crank pin O.D.	Factory spec.	33.959 to 33.975 mm 1.33697 to 1.33759 in.
Crank pin bearing I.D.	Factory spec.	33.994 to 34.040 mm 1.33835 to 1.34016 in.

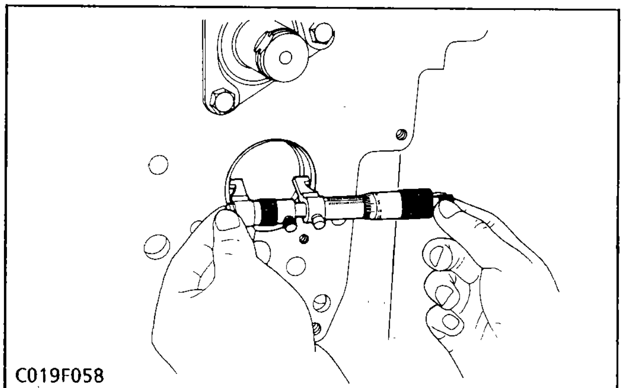
(Reference)

- Undersize crank pin bearing

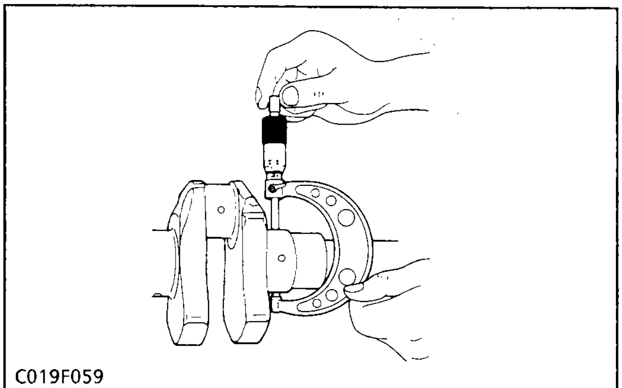
Undersize	Bearing	Code Number	Marking
0.2 mm 0.008 in.	Crank pin bearing 02	15861-22971	020 US
0.4 mm 0.016 in.	Crank pin bearing 04	15861-22981	040 US

- Undersize dimensions of crank pin

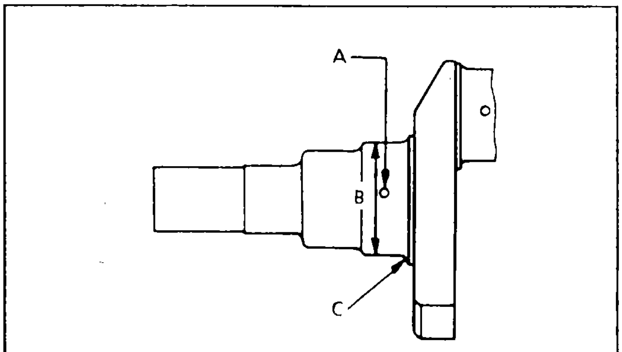
Undersize / Dimension	0.2 mm 0.008 in.	0.4 mm 0.016 in.
A	2.3 to 2.7 mm radius 0.091 to 0.106 in. radius	2.3 to 2.7 mm radius 0.091 to 0.106 in. radius
B	4 mm dia. 0.16 in. dia.	4 mm dia. 0.16 in. dia.
C	33.759 to 33.775 mm 1.32910 to 1.32973 in.	33.559 to 33.575 mm 1.32122 to 1.32185 in.
The crank pin must be fine-finished to higher than ▽▽▽▽ (0.4S).		



C019F058



C019F059



0071F003

Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer.
2. Measure the O.D. of the crankshaft front journal with an outside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the crankshaft bearing 1.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table .

Oil clearance between crank shaft journal and crankshaft	Factory spec.	0.034 to 0.106 mm 0.00134 to 0.00417 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D.	Factory spec.	39.934 to 39.950 mm 1.57221 to 1.57284 in.
Crankshaft bearing 1 I.D.	Factory spec.	39.984 to 40.040 mm 1.57418 to 1.57638 in.

(Reference)

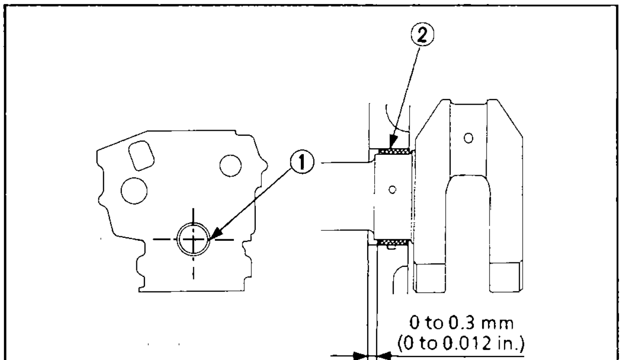
- Undersize crank shaft bearing 1

Undersize	Bearing	Code Number	Marking
0.2 mm 0.008 in.	Crankshaft bearing 1 02	15861-23911	020 US
0.4 mm 0.016 in.	Crankshaft bearing 1 04	15861-23921	040 US

- Undersize dimensions of crank shaft journal

Undersize / Dimension	0.2 mm 0.008 in.	0.4 mm 0.016 in.
A	5 mm dia. 0.20 in. dia.	5 mm dia. 0.20 in. dia.
B	39.734 to 39.750 mm 1.56433 to 1.56496 in.	39.534 to 39.550 mm 1.55646 to 1.55709 in.
C	1.8 to 2.2 mm radius 0.071 to 0.087 in. radius	1.8 to 2.2 mm radius 0.071 to 0.087 in. radius

- The crankshaft journal must be fine-finished to higher than ▽▽▽▽ (0.4S).
- Chamfer the oil hole with an oilstone.



B083F058

(1) Seam (2) Crankshaft Bearing 1

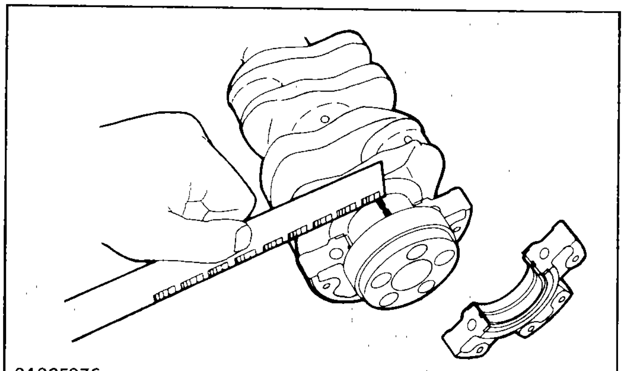
Replacing Crankshaft Bearing 1

(When removing)

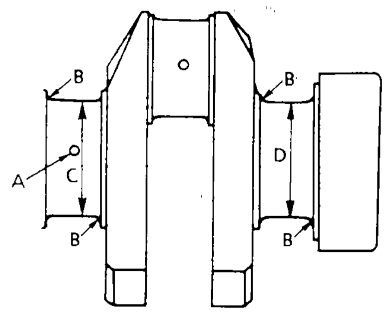
1. Using a crankshaft bearing 1 replacing tool (see page S-53), press out the used crankshaft bearing.

(When installing)

1. Clean a new crankshaft bearing 1 and crankshaft journal, and apply engine oil to them.
2. Using a crankshaft bearing 1 replacing tool, press in a new bearing 1 (2) so that its seam (1) directs toward the exhaust side in the cylinder block. (See figure)



0109F076



0071F004

Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2 and 3

1. Put a strip of plastigage (Code No. 07909-30241) on the center of the journal.
2. Install the bearing case and tighten the bearing case screws 1 to the specified torque (12.7 to 15.7 N·m, 1.3 to 1.6 kgf·m, 9.4 to 11.6 ft-lbs), and remove the bearing case again.

■ **NOTE**

- **Be sure not to move the crankshaft while the bearing case screws are tightened.**

3. Measure the amount of the flattening with the scale, and get the oil clearance.
4. If the oil clearance exceeds the allowable limit, replace the crankshaft bearing 2 or 3.
5. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

Oil clearance between crankshaft journal and crankshaft bearing 2 and 3	Factory spec.	0.034 to 0.092 mm 0.00134 to 0.00362 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D. (Flywheel side)	Factory spec.	43.934 to 43.950 mm 1.72969 to 1.73032 in.
Crankshaft bearing 2 I.D.	Factory spec.	43.984 to 44.026 mm 1.73166 to 1.73331 in.
Crankshaft journal O.D. (Intermediate)	Factory spec.	39.934 to 39.950 mm 1.57221 to 1.57284 in.
Crankshaft bearing 3 I.D.	Factory spec.	39.984 to 40.026 mm 1.57418 to 1.57583 in.

(Reference)

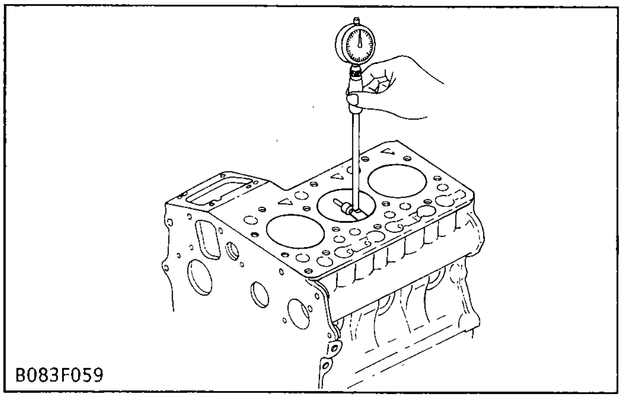
- Undersize crankshaft bearing 2 and 3

Undersize	Bearing	Code Number	Marking
0.2 mm 0.008 in.	Crankshaft bearing 2 02	15694-23931	020 US
	Crankshaft bearing 3 02	15861-23861	020 US
0.4 mm 0.016 in.	Crankshaft bearing 2 04	15694-23941	040 US
	Crankshaft bearing 3 04	15861-23871	040 US

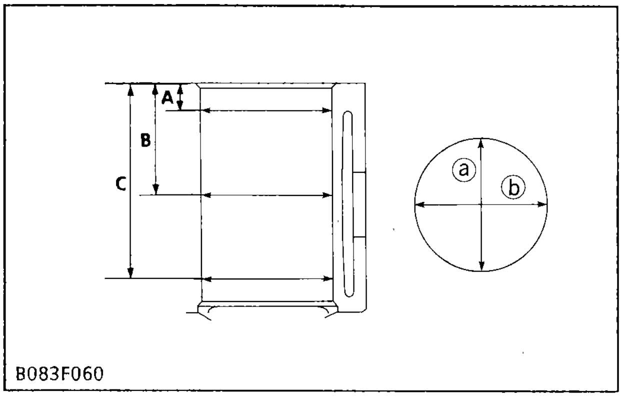
- Undersize dimensions of crankshaft journal

Undersize / Dimension	0.2 mm 0.008 in.	0.4 mm 0.016 in.
A	3 mm dia. 0.12 in. dia.	3 mm dia. 0.12 in. dia.
B	1.8 to 2.2 mm radius 0.071 to 0.087 in. radius	1.8 to 2.2 mm radius 0.071 to 0.087 in. radius
C	39.734 to 39.750 mm 1.56433 to 1.56496 in.	39.534 to 39.550 mm 1.55646 to 1.55709 in.
D	43.734 to 43.750 mm 1.72181 to 1.72244 in.	43.534 to 43.550 mm 1.71394 to 1.71457 in.
The crank pin jounrnal must be fine-finished to higher than ∇∇∇∇ (0.4S).		

[5] CYLINDER



B083F059



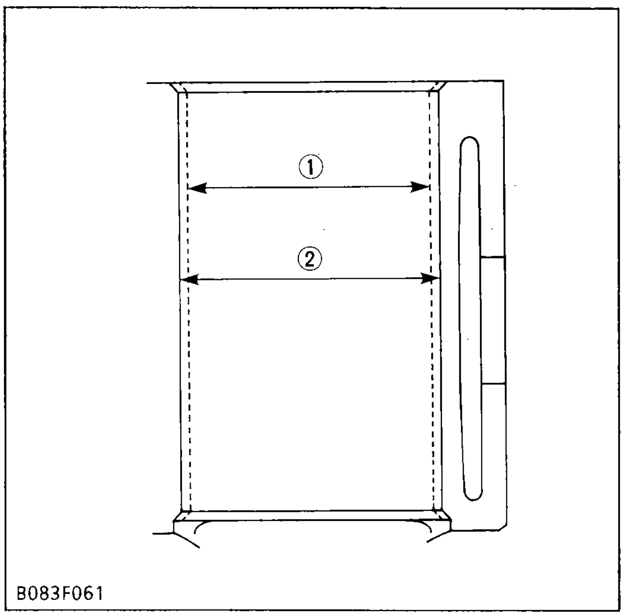
B083F060

Cylinder Wear

1. Measure the I.D. of the cylinder at the six positions (See figure) with a cylinder gauge to find the maximum and minimum I.D.'s.
2. Get the difference (Maximum wear) between the maximum and the minimum I.D.'s
3. If the wear exceeds the allowable limit, bore and hone to the oversize dimension. (Refer to **"Correcting Cylinder"**)
4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder should be bored. (Refer to **"Correcting Cylinder"**)

Cylinder I.D.	Factory spec.	Z442-B D662-B	64.000 to 64.019 mm 2.51968 to 2.52043 in.
		Z482-B D722-B	67.000 to 67.019 mm 2.63779 to 2.63854 in.
Maximum wear	Allowable limit		0.15 mm 0.0059 in.

A : Approx. 10 mm (0.394 in.)
B : Approx. 45 mm (1.771 in.)
C : Approx. 95 mm (3.740 in.)
a : Right-angled to Piston Pin
b : Piston Pin Direction



B083F061

(1) Cylinder I.D. (Before Correction)
(2) Oversize Cylinder I.D.

Correcting Cylinder

1. When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

Oversize cylinder I.D.	Factory spec.	Z442-B D662-B	64.250 to 64.269 mm 2.52953 to 2.53028 in.
		Z482-B D722-B	67.250 to 67.269 mm 2.64764 to 2.64839 in.
Maximum wear	Allowable limit		0.15 mm 0.0059 in.

2. Replace the piston and piston rings with oversize ones.

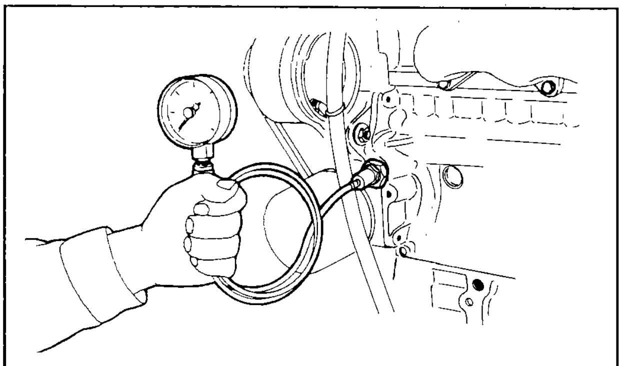
Oversize	Model	Part Name	Code Number	Marking
0.25 mm 0.0098 in.	Z442-B D662-B	Piston	16861-21900	0.25 OS
		Piston ring assembly	16861-21090	0.25 OS
	Z482-B D722-B	Piston	16851-21900	0.25 OS
		Piston ring assembly	16851-21090	0.25 OS

■ **NOTE**

- **When the oversize cylinder is worn beyond the allowable limit, replace the cylinder block with a new one.**

2 LUBRICATING SYSTEM

CHECKING



0109F079

Engine Oil Pressure

1. Remove the oil pressure switch, and install the engine oil pressure tester (Code No. 07916-32032). (Adaptor screw size: PT1/8).
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.

- Engine oil insufficient
- Oil pump defective
- Oil strainer clogged
- Oil filter cartridge clogged
- Oil gallery clogged
- Excessive oil clearance
- Foreign matter in the relief valve

Engine oil pressure	At idle speed	Factory spec.	98 kPa 1.0 kgf/cm² 14 psi
	At rated speed	Factory spec.	196 to 441 kPa 2.0 to 4.5 kgf/cm² 28 to 64 psi
		Allowable limit	98 kPa 1.0 kgf/cm² 14 psi

(When reassembling)

- After checking the engine oil pressure, tighten the oil pressure switch to the specified torque.

Tightening torque	Oil pressure switch	14.7 to 19.6 N·m 1.5 to 2.0 kgf·m 10.8 to 14.5 ft-lbs

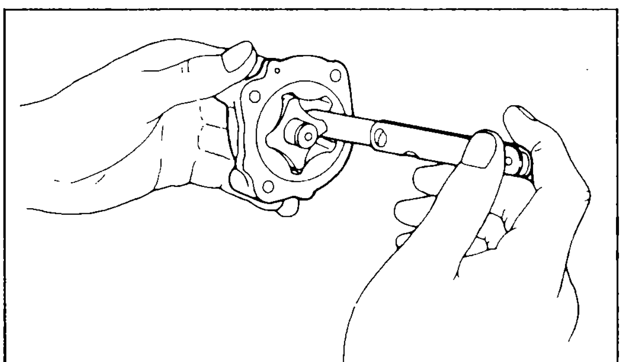
DISASSEMBLING AND ASSEMBLING

Oil Pump

1. See page S-71.

SERVICING

[1] OIP PUMP

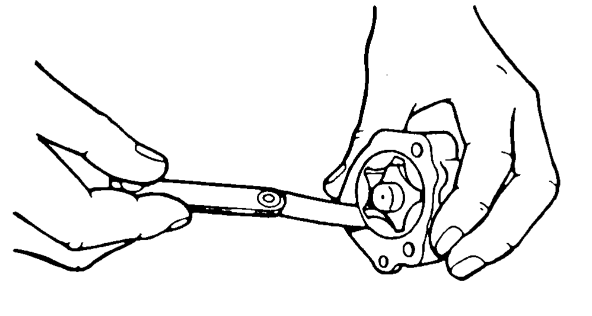


0109F081

Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Rotor lobe clearance	Factory spec.	0.03 to 0.14 mm 0.012 to 0.0055 in.

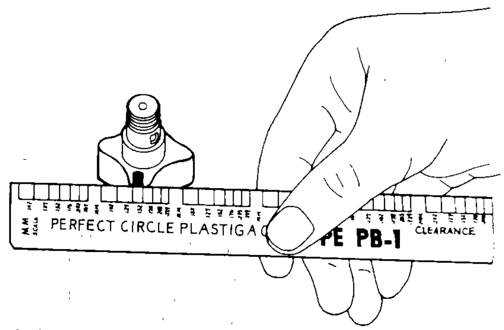


C019F049

Clearance between Outer Rotor and Pump Body

1. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between outer rotor and pump body	Factory spec.	0.07 to 0.15 mm 0.0028 to 0.0059 in.



C019F050

Clearance between Rotor and Cover

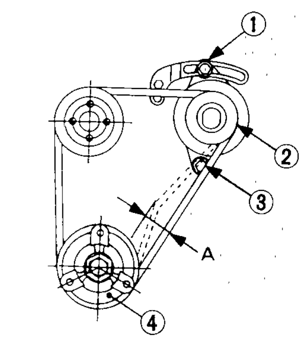
1. Put a strip of press gauge (Code No. 07909-30241) onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the width of the press gauge with a sheet of gauge.
4. If the clearance exceeds the allowable limit, replace oil pump rotor assembly.

Clearance between rotor and cover	Factory spec.	0.075 to 0.135 mm 0.0029 to 0.0053 in.

3 COOLING SYSTEM

CHECKING AND ADJUSTING

[1] FAN BELT



B083F062

Fan Belt Tension

1. Measure the deflection (A), depressing the belt halfway between the fan drive pulley (4) and dynamo pulley (2) at specified force (98 N, 10 kgf, 22 lbs).
2. If the measurement is not the factory specification, loosen the dynamo mounting screws (1), (3) and relocate the dynamo to adjust.

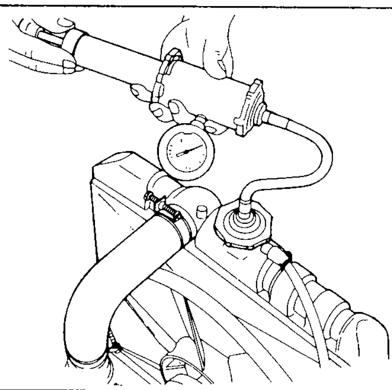
Fan belt tension (Deflection A)	Factory spec.	Approx. 10 mm/ 10 kgf Approx. 0.39 in./10 kgf (22.1 lbs)

(1) Dynamo Mounting Screw
(2) Dynamo Pulley
(3) Dynamo Mounting Screw
(4) Fan Drive Pulley

[2] RADIATOR

CAUTION

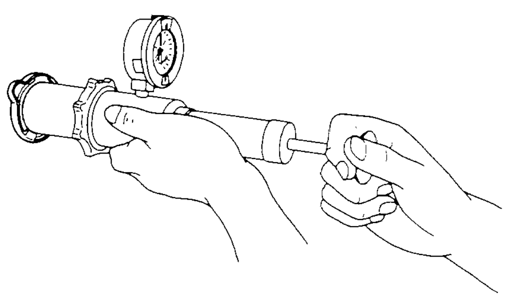
- Never remove the radiator cap while operating or immediately after stopping. Otherwise, hot water will spout out from the radiator. Wait for more than ten minutes to cool the radiator, before opening the cap.


0109F082

Radiator Water Tightness

1. Pour a specified amount of water into the radiator.
2. Warm up the engine and stop it.
3. Set a radiator tester (Code No. 07909-31551) and raise the water pressure to the specified pressure.
4. Check the radiator for water leaks.
5. For water leak from the pinhole, repair with the radiator cement. When water leak is excessive, replace the radiator.

Radiator leakage test pressure	Factory spec.	157 kPa 1.6 kgf/cm^2 23 psi

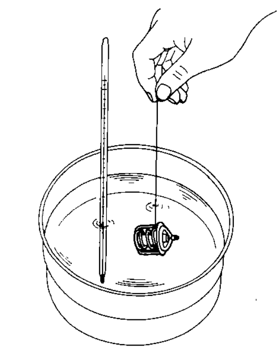

C019F068

Radiator Cap Tightness

1. Set a radiator tester on the radiator cap.
2. Apply the pressure of 88 kPa (0.9 kgf/cm^2, 13 psi) and measure the time for the pressure to fall to 59 kPa (0.6 kgf/cm^2, 9 psi).
3. If the measurement is less than the factory specification, replace the radiator cap.

Radiator cap tightness (Pressure falling time)	Factory spec.	More than 10 seconds for pressure fall from 88 to 59 kPa (from 0.9 to 0.6 kgf/cm^2, from 13 to 9 psi)

[3] THERMOSTAT



0109F069

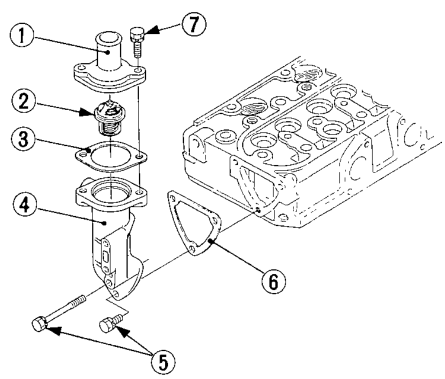
Thermostat Valve Opening Temperature

1. Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
2. Heating the water gradually, read the temperature when the valve opens and leaves the string.
3. Continue heating and read the temperature when the valve opens approx. 6 mm (0.236 in.).
4. If the measurement is not within the factory specifications, replace the thermostat.

Thermostat's valve opening temperature	Factory spec.	69.5 to 72.5 °C 157.1 to 162.5 °F
Temperature at which thermostat completely opens	Factory spec.	85 °C 185 °F

DISASSEMBLING AND ASSEMBLING

[1] THERMOSTAT AND WATER PUMP



B083F063

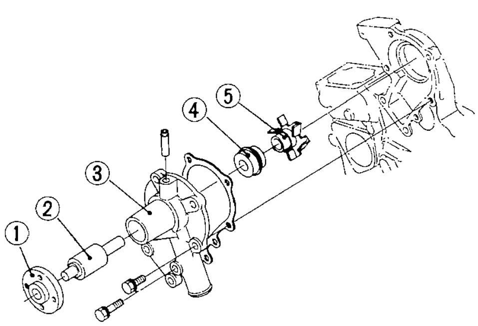
Thermostat and Water Flange

1. Unscrew the thermostat cover mounting screws (7), and remove the thermostat cover (1).
2. Remove the thermostat (2).
3. Unscrew the water flange mounting screws (5), and remove the water flange (4).

(When reassembling)

- Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of a new thermostat cover gasket (3).
- Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of a new water flange gasket (6).

(1) Thermostat Cover
(2) Thermostat
(3) Thermostat Cover Gasket
(4) Water Flange
(5) Water Flange Mounting Screw
(6) Water Flange Gasket
(7) Thermostat Cover Mounting Screw



B083F064

Water Pump

1. Unscrew the water pump mounting screws, and remove the water pump from the gear case cover.
2. Remove the water pump flange (1).
3. Press out the water pump shaft (2) with the impeller (5) on it.
4. Remove the impeller (5) from the water pump shaft (2).
5. Remove the mechanical seal (4).

(When reassembling)

- Apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of a new water pump gasket.
- Replace the mechanical seal (4) with a new one.

(1) Water Pump Flange
(2) Water Pump Shaft
(3) Water Pump Body
(4) Mechanical Seal
(5) Impeller

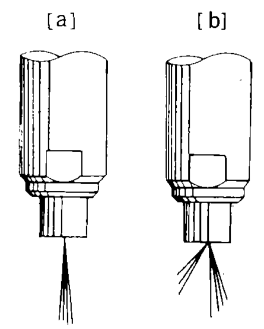
4 FUEL SYSTEM

CHECKING AND ADJUSTING

[1] INJECTION NOZZLE

CAUTION

- **Check the nozzle injection pressure and condition after confirming that there is nobody standing in the direction the fume goes.**
  If the fume from the nozzle directly contacts the human body, cells may be destoroyed and blood poisoning may be caused.

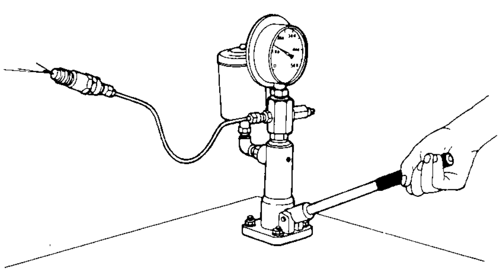


C019F038

Nozzle Spraying Condition

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the nozzle piece.

[a] **Good**
[b] **Bad**



C019F032

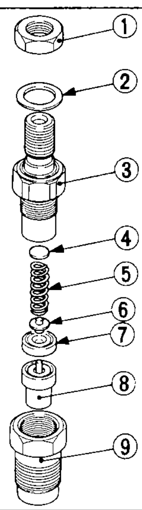
Fuel Injection Pressure

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the adjusting washer (4) in the nozzle holder to adjust it.

Fuel injection pressure	Factory spec.	13.73 to 14.71 MPa 140 to 150 kgf/cm² 1991 to 2133 psi

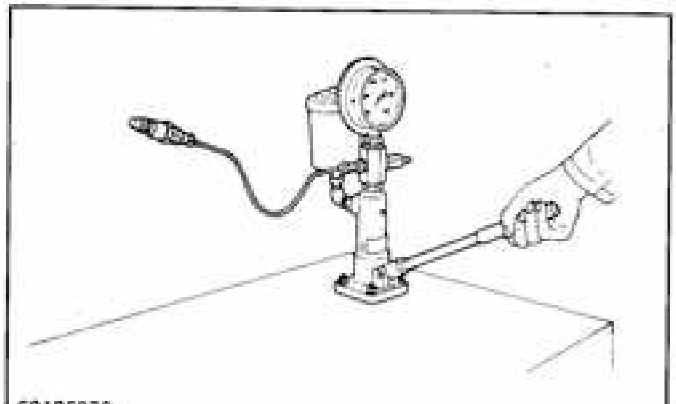
(Reference)

- Adjusting washer is provided every 0.025 mm (0.00098 in.) of thickness from 0.900 mm (0.03543 in.) to 1.950 mm (0.07677 in.). [Adjusting washer assembly : Code No. 15841-98101]



C095F145

(1) Fuel Overflow Pipe Nut
(2) Plain Washer
(3) Nozzle Holder
(4) Adjusting Washer
(5) Nozzle Spring
(6) Push Rod
(7) Distance Piece
(8) Nozzle Piece
(9) Nozzle Retaining Nut



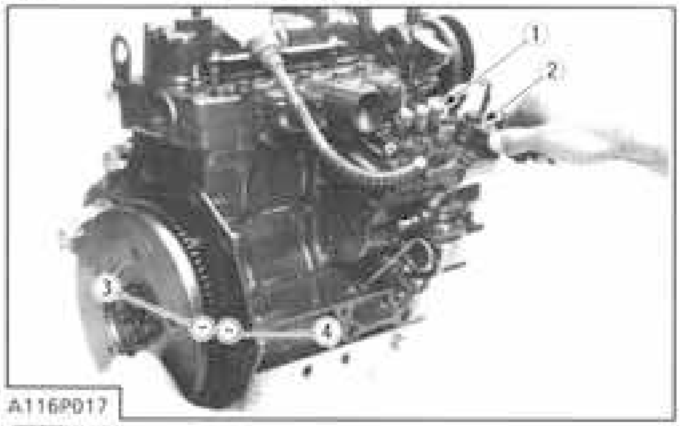
C019F030

Valve Seat Tightness

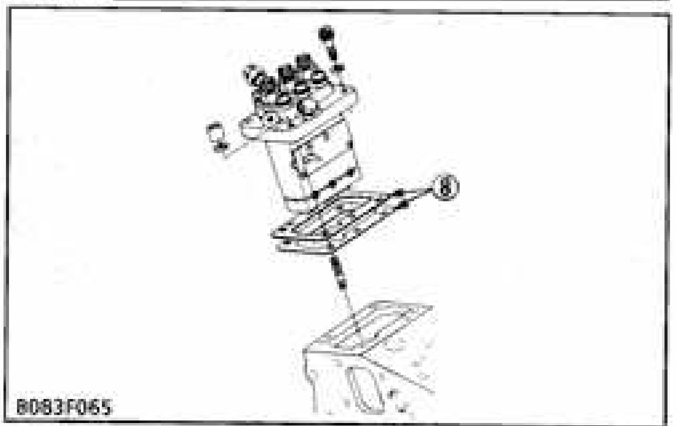
1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 12.75 MPa (130 kgf/cm², 1849 psi) for 10 seconds.
3. If any fuel leak is found, replace the nozzle piece.

Valve seat tightness	Factory spec.	No fuel leak at 12.75 MPa (130 kgf/cm², 1849 psi)

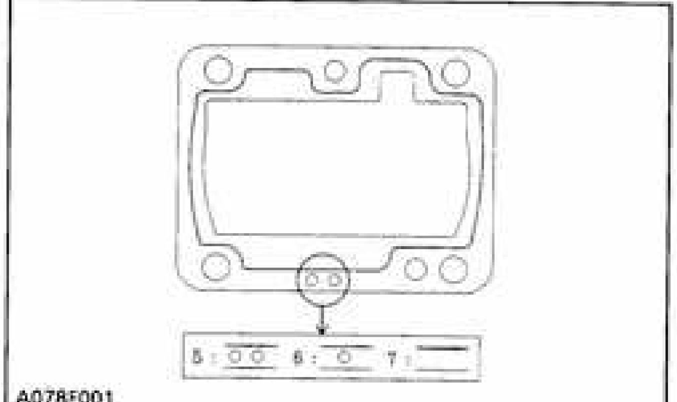
[2] INJECTION PUMP



A116P017



B083F065



A078F001

Injection Timing

1. Remove the injection pipes.
2. Set the speed control lever (2) to the maximum fuel discharge position.
3. Turn the flywheel until the fuel fills up to the hole of the delivery valve holder (1).
4. Turn the flywheel further to check the injection timing, and stop turning when the fuel begins to flow over again.
5. Check to see if the mark or timing angle lines (3) on the flywheel is aligned with the punch mark (4).
6. If the timing is out of adjustment, readjust the timing with shims (8).

■ **NOTE**

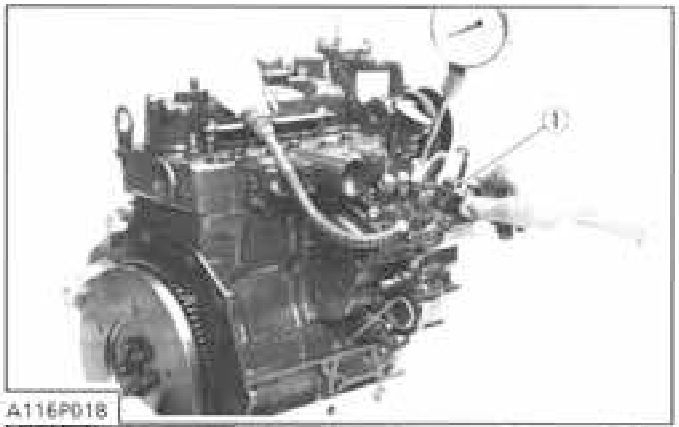
(Engine serial number : ~489290)

- **Shims are available in thickness of 0.15 mm, 0.30 mm. Combine these shims for adjustments.**
- **Addition or reduction of shim (0.15 mm, 0.0059 in.) delays or advances the injection timing by approx. 0.026 rad (1.5°).**
- **After adjusting the injection timing, apply liquid-type gasket (Three Bond 1215 or its equivalent) to both sides of the injection pump shim before reassembling.**

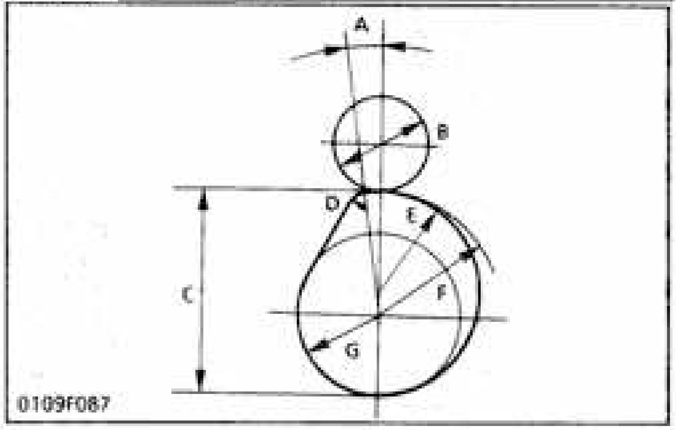
(Engine serial number : 489291~)

- **The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.**
- **Shims are available in thickness of 0.20 mm, 0.25 mm and 0.30 mm. Combine these shims for adjustments.**
- **Addition or reduction of shim (0.05 mm, 0.0020 in.) delays or advances the injection timing by approx. 0.0087 rad (0.5°).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**

(1) Delivery Valve Holder
(2) Speed Control Lever
(3) Mark
(4) Mark
(5) 2-holes : 0.20 mm
(6) 1-hole : 0.25 mm
(7) Without hole : 0.30 mm
(8) Shim



A116P018



0109F087

(1) Speed Control Lever

(A) 0.35 rad. (20°)
(B) 14 mm (0.551 in.)
(C) 30 mm (1.181 in.)
(D) 3 mm (0.118 in.)
(E) 15 mm (0.591 in.)
(F) 18 mm (0.709 in.)
(G) 12 mm (0.472 in.)

Pump Element Fuel Tightness

1. Remove the injection pipes and injection nozzles.
2. Install the pressure tester (see page 5-55) to the injection pump.
3. Set the speed control lever (1) to the maximum fuel discharge position.
4. Turn the flywheel counterclockwise to raise the fuel pressure.
5. If the fuel pressure can not reach the allowable limit, replace the pump element or injection pump assembly.

Pump element fuel tightness (Fuel pressure)	Allowable limit	14.71 MPa 150 kgf/cm² 2133 psi

■ IMPORTANT

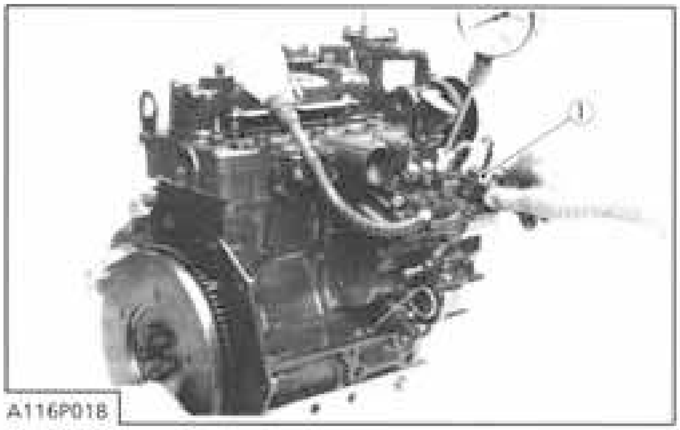
- **After replacing the pump element, be sure to adjust the amount of the fuel injection using a pump tester and a test bench [DIESEL KIKI CO.LTD : Code No. 105760-0010 (50 Hz) or 105760-0020 (60Hz)].**

[Test Condition]

Driving stand	Code No. 105781-4160 [DIESEL KIKI CO.LTD]
Nozzle	DN4PD62
Opening pressure	11.77 MPa, 120 kgf/cm², 1707 psi
Injection pipe	6 mm dia. x 1.6 mm dia. x 255 mm long 0.24 in. dia. x 0.08 in. dia. x 23.62 in. long
Fuel feed pressure	49 kPa, 0.2 kgf/cm², 7 psi
Test fuel	Diesel fuel No.2-D
Pre-stroke	0.5 to 1.5 mm (with valve) 0.0728 to 0.0768 in. (with valve)
Cam profile	PFM-TE-00 (See figure)

[Data for Adjustment]

Control rack position (from stop position)	Camshaft speed	Amount of fuel
5.0 mm 0.1969 in.	1800 rpm	1.17 to 1.23 cc / 100 st. 0.0714 to 0.0751 cu.in. / 100 st.
1.5 mm 0.0591 in.	1800 rpm	less than 0.1 cc / 100 st. less than 0.006 cu.in. / 100 st.



(1) Speed Control Lever

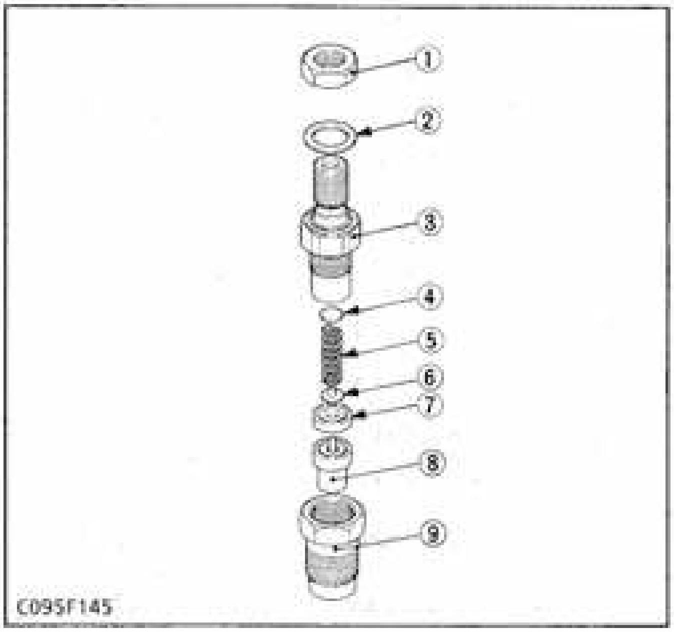
Delivery Valve Fuel Tightness

1. Remove the injection pipes and injection nozzles.
2. Install the pressure tester (see page S-55) to the injection pump.
3. Set the speed control lever (1) to the maximum fuel discharge position.
4. Turn the flywheel counterclockwise to raise the fuel pressure to 14.71 MPa (150 kgf/cm², 2133 psi).
5. Set the plunger of the injection pump at the bottom dead center to reduce the delivery chamber pressure to zero.
6. Measure the falling time of the fuel pressure from 14.71 to 13.73 MPa (from 150 to 140 kgf/cm², from 2133 to 1991 psi).
7. If the measurement is less than the allowable limit, replace the delivery valve or injection pump assembly.

Pressure falling time	Allowable limit	5 seconds

DISASSEMBLING AND ASSEMBLING

[1] INJECTION NOZZLE



(1) Fuel Overflow Pipe Nut
(2) Plain Washer
(3) Nozzle Holder
(4) Adjusting Washer
(5) Nozzle Spring
(6) Push Rod
(7) Distance Piece
(8) Nozzle Piece
(9) Nozzle Retaining Nut

Injection Nozzle

1. Remove the injection nozzle from the cylinder head.
2. Secure the nozzle retaining nut (9) in a vise.
3. Remove the nozzle holder (3), and take out the adjusting washer (4), nozzle spring (5), push rod (6), distance piece (7) and nozzle piece (8).

(When reassembling)

- Assemble the injection nozzle in clean fuel.
- Install the push rod (6), noting its direction.

Tightening torque	Fuel overflow pipe nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Nozzle holder (3) to nozzle retaining nut (9)	34.3 to 39.2 N·m 3.5 to 4.0 kgf·m 25.3 to 28.9 ft-lbs
	Injection nozzle to cylinder head	49.0 to 68.6 N·m 5.0 to 7.0 kgf·m 36.2 to 50.6 ft-lbs

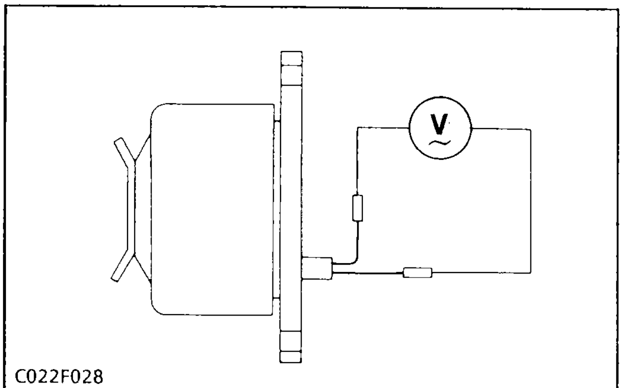
■ **IMPORTANT**

- **The nozzle piece is precisely finished. Do not use a piece of metal but a piece of wood to remove the carbon deposits.**
- **After assembling the nozzle, be sure to adjust the injection pressure. (See "Fuel Injection Pressure")**

5 ELECTRICAL SYSTEM

CHECKING

[1] DYNAMO AND REGULATOR

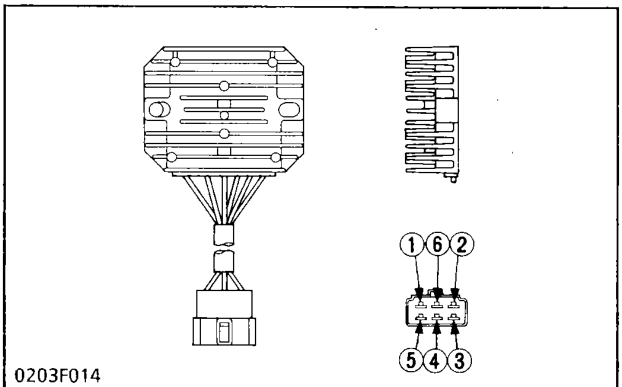


C022F028

Dynamo No-load Voltage

1. Disconnect the lead wire from the Dynamo.
2. Start the engine and measure the voltage generated by the Dynamo
3. Measur the output voltage with a voltmeter. If the measumrement is not within the factory specifications, replace the dynamo.

No load dynamo voltage	Factory spec.	AC20V or more at 5200 rpm



0203F014

(1) Blue
(2) Blue
(3) Red
(4) Yellow
(5) Green
(6) Black

Continuity across Regulator's Terminals

1. Measure with a circuit tester according to the list below.

■ **NOTE**

- **For this test, use only Analog Meter and do not use a high voltage tester such as a MΩ meter.**
- **This check sheet shows the results of the test conducted by using the "Sanwa-made testers SP-10 and SP-15D" (Analog Meter).**
- **Use of other testers than those above may show different measured results. Ω shall be used as the unit for the measuring range.**
- **The judgment shold be as below table. "ON" if the indicator moves, otherwise "OFF".**

■ Check Table

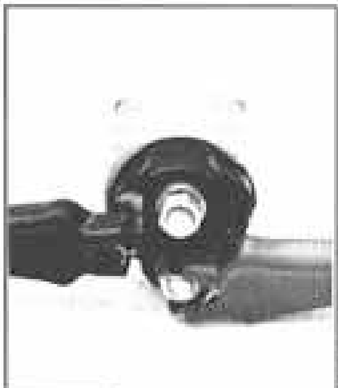
+ terminal Tester / Tester		Cord colors					
		blue	blue	red	yellow	green	black
Cord colors	blue		OFF	**ON**	OFF	OFF	OFF
	blue	OFF		**ON**	OFF	OFF	OFF
	red	OFF	OFF		OFF	OFF	OFF
	yellow	**ON**	**ON**	**ON**		OFF	**ON**
	green	OFF	OFF	OFF	OFF		OFF
	black	OFF	OFF	OFF	OFF	OFF	

[2] STARTER

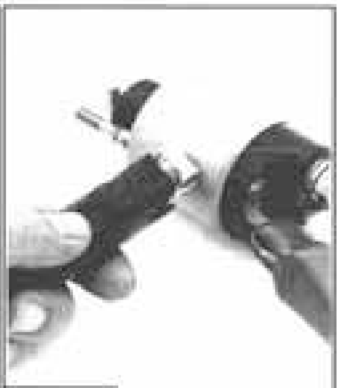
0302P151

Motor Test

1. Disconnect the connecting lead from the "C" terminal of the starter and connect a jumper lead from the connecting lead to the positive battery terminal.
2. Connect a jumper lead momentarily between the starter body and the negative battery terminal.
3. If the motor does not run, check the motor.



0302P158



0302P159

Magnet Switch

■ NOTE

- **Each test should be carried out for a start time (3 to 5 seconds), and at half of the rated voltage (6V).**

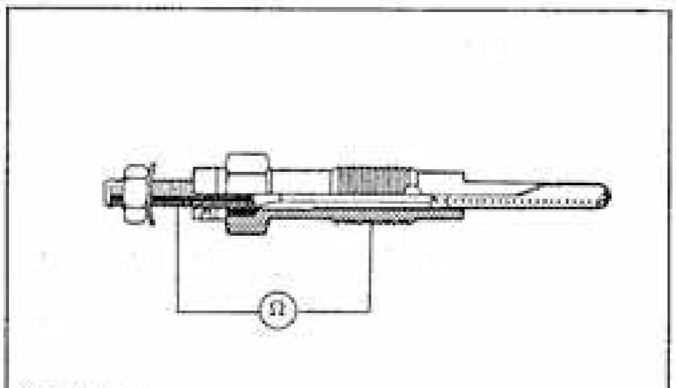
1) Checking Pull-in Coil

1. Connect jumper lead from the battery's negative terminal post to the **C** terminal.
2. The plunger should be attracted strongly when a jumper lead is connected from the battery positive terminal to the **S** terminal.

2) Checking Holding Coil

1. Connect jumper leads from the battery's negative terminal post to the body and the battery's positive terminal post to the **S** terminal.
2. Push the plunger in by hand and release it. Then, the plunger should remain being attracted.

[3] GLOW PLUG



0011F177

Glow Plug

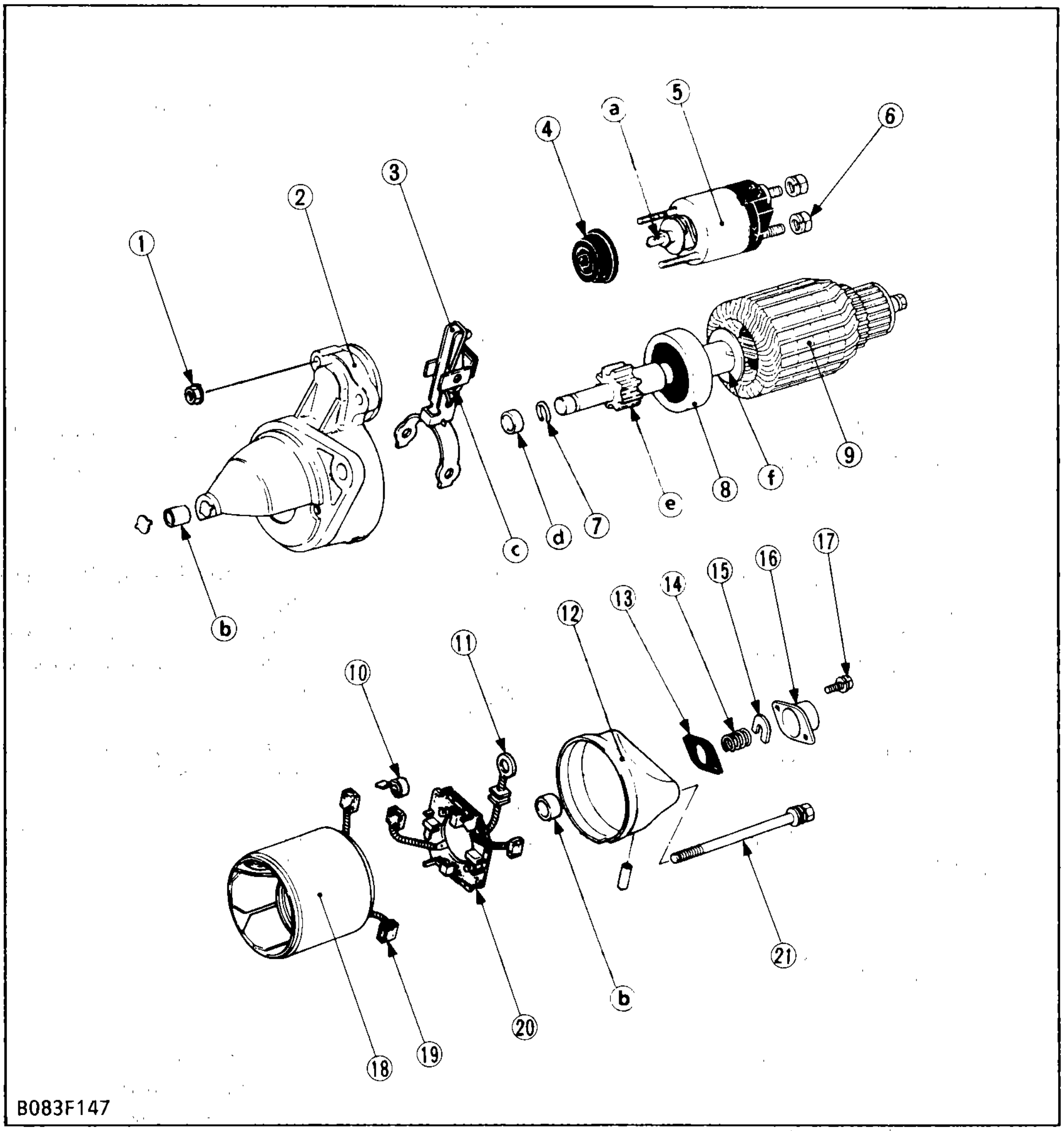
1. Disconnect the leads from the glow plugs.
2. Measure the resistance with circuit tester across the glow plug terminal and the housing.
3. If 0 ohm is indicated, the screw at the tip of the glow plug and the housing are short-circuited. If the reference value is not indiacated, the glow plug is faulty, replace the glow plug.

Glow plug resistance	Factory spec.	Approx. 0.9 Ω

DISASSEMBLING AND ASSEMBLING

[1] STARTER

Disassembling Starter



(1) Solenoid Switch Mounting Nut
(2) Starter Drive Housing
(3) Drive Lever
(4) Gasket
(5) Solenoid Switch
(6) Nut
(7) Snap Ring
(8) Overrunning Clutch
(9) Armature
(10) Brush Spring
(11) Connecting Lead
(12) Rear End Frame
(13) Gasket
(14) Brake Spring
(15) Brake Shoe
(16) End Frame Cap
(17) Screw
(18) Yoke
(19) Brush
(20) Brush Holder
(21) Through Bolt

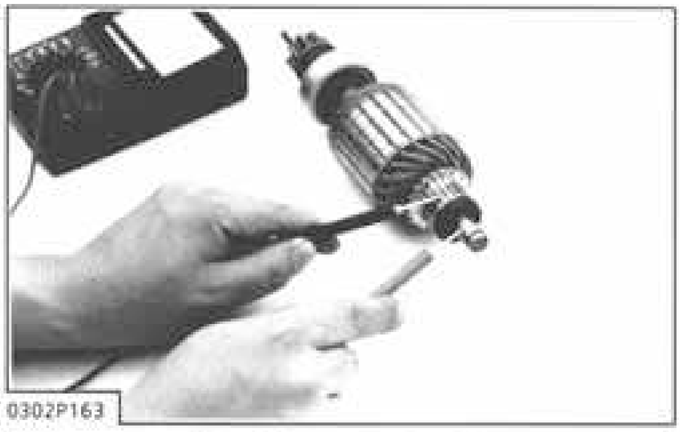
1. Unscrew the mounting nut (6), and disconnect the connecting lead (11).
2. Unscrew the solenoid switch mounting nuts (1), and remove the solenoid switch (5).
3. Remove the end frame cap (16).
4. Remove the brake shoe (15), brake spring (14) and gasket (13).
5. Unscrew the through bolts (21), and remove the rear end frame (12).
6. Remove the brush from the brush holder while holding the spring up.
7. Remove the brush holder (20).
8. Draw out the yoke (18) from the starter drive housing (2).
9. Draw out the armature (9) with the drive lever (3).

■ **NOTE**
- **Do not damage to the brush and commutator.**

(When reassembling)
- Apply grease (NIPPONDENSO No.50 or its equivalent) to the parts indicated in the figure.
  - Joint of solenoid switch (a)
  - Bushing (b)
  - Drive lever (c)
  - Collar (d)
  - Teeth of pinion gear (e)
  - Armature shaft (f)

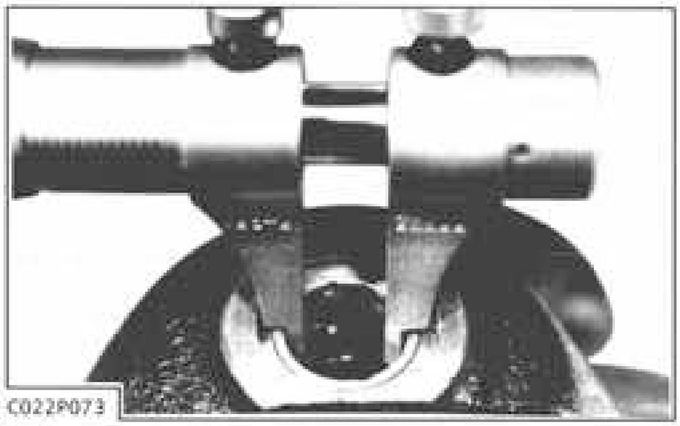
SERVICING

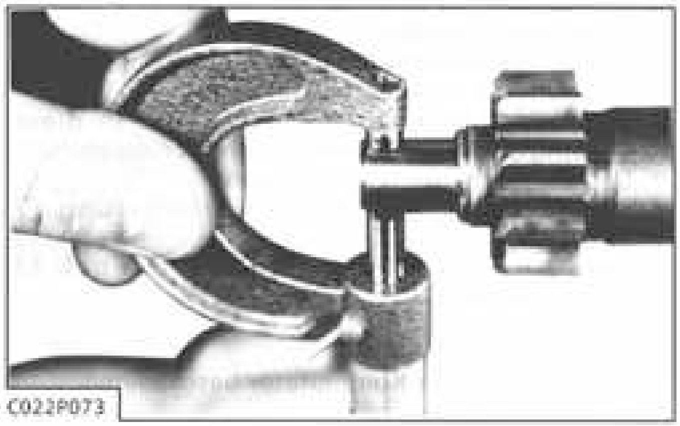
[1] STARTER


0302P163

Armature Coil

1. Check the continuity across the commutator and armature shaft with an ohmmeter.
2. If it conducts, replace the armature.


C022P073

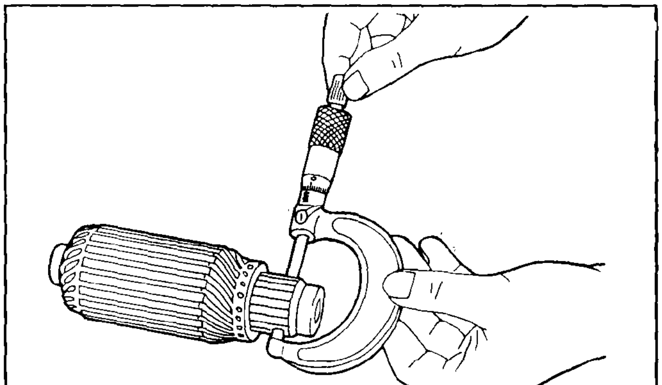

C022P073

Clearance between Armature Shaft and Bushing

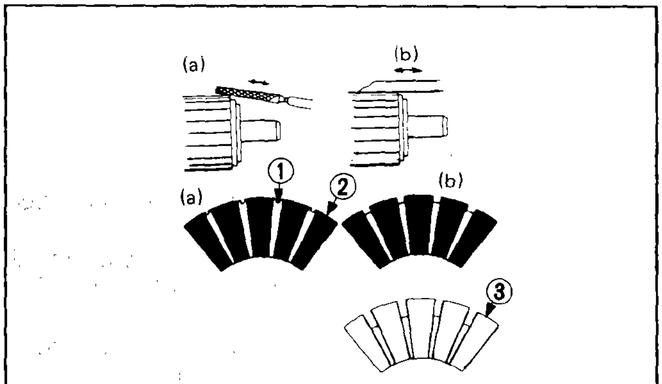
1. Measure the bushing I.D. of the drive side and commutator side.
2. Measure the armature shaft O.D. of the drive side and commutator side, and calculate the clearance.
3. If the clearance exceeds the allowable limit, replace the bushing.

Clearance between armature shaft and bushing	Factory spec.	Commu-tator side	0.03 to 0.10 mm 0.0012 to 0.0039 in.
		Drive side	0.05 to 0.10 mm 0.0020 to 0.0039 in.
	Allowable limit		0.20 mm 0.0079 in.

Armature shaft O.D.	Factory spec.	12.50 mm 0.4921 in.
Bushing I.D. (Commutator side)	Factory spec.	12.53 to 12.60 mm 0.4933 to 0.4961 in.
Bushing I.D. (Drive side)	Factory spec.	12.55 to 12.60 mm 0.4941 to 0.4961 in.



0109F310



0087F088

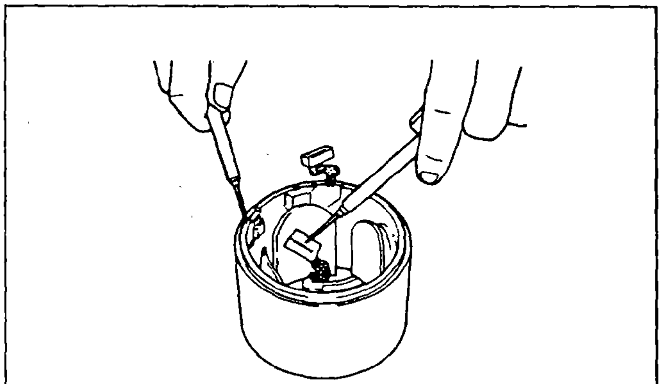
(a) Bad **(b) Good**

(1) Mica (3) Depth of Mica
(2) Segment

Commutator and Mica

1. If the commutator surface is dirty or dusty, clean it with a sandpaper.
2. Measure the commutator O.D. with vernier calipers at several points.
3. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
4. If the minimum O.D. is less than the allowable limit, replace the armature.
5. Measure the mica undercut depth.
6. If the undercut is less than the allowable limit, correct with a saw blade and chamfer the segment edges.

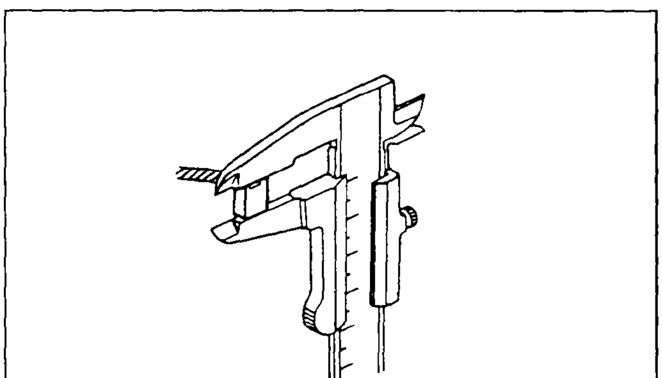
Commutator O.D.	Factory spec.	28.0 mm 1.102 in.
	Allowable limit	27.0 mm 1.063 in.
Difference of O.D.'s	Factory spec.	Less than 0.05 mm 0.002 in.
	Allowable limit	0.4 mm 0.016 in.
Mica undercut	Factory spec.	0.5 to 0.8 mm 0.020 to 0.031 in.
	Allowable limit	0.2 mm 0.008 in.



0347F095

Field Coil

1. Check the continuity across the yoke and brush with an ohmmeter.
2. If either are not conducting, replace the yoke assembly.

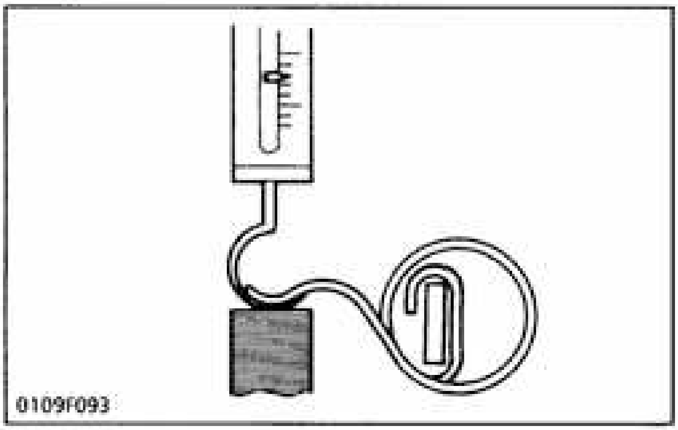


0610F069

Brush Wear

1. If the contact face of the brush is dirty or dusty, clean it with sand paper.
2. Measure the brush length with vernier calipers.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder.

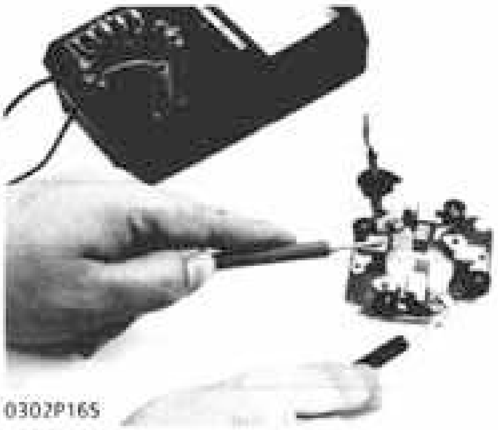
Brush length	Factory spec.	16.0 mm 0.630 in.
	Allowable limit	10.5 mm 0.413 in.


0109F093

Brush Spring

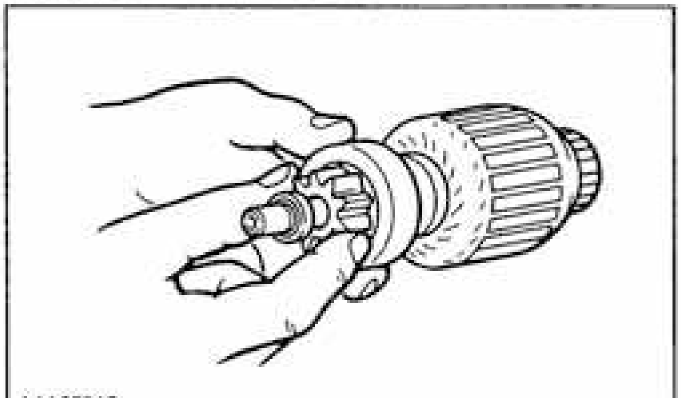
1. Pull the brush in the brush holder with a spring scale.
2. Measure the brush spring tension required to raise the spring from contact position with the commutator.
3. If the tension is less than the allowable limit, replace the spring.

Spring tension	Factory spec.	13.7 to 25.5 N 1.4 to 2.6 kgf 3.1 to 5.7 lbs
	Allowable limit	8.8 N 0.9 kgf 2.0 lbs


0302P165

Brush Holder

1. Check the continuity across the brush holder and holder support with an ohmmeter.
2. If it conducts, replace the brush holder.


A116F018

Overrunning Clutch

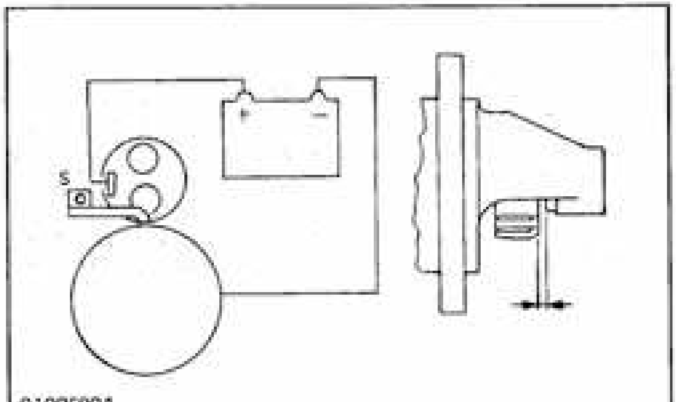
1. Inspect the pinion for wear or damage.
2. If there is any defect, replace it.
3. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
4. If the pinion slips or does not turn in both directions, replace the overrunning clutch assembly.

0109P045

0109P046

Solenoid Switch

1. Check the continuity across "B" and "M" terminals with an ohmmeter, pushing in the plunger.
2. If not continuous or if a certain value is indicated, replace the solenoid switch.
3. Pull the pull-rod to check the spring built in the plunger.



0109F094

Pinion Clearance

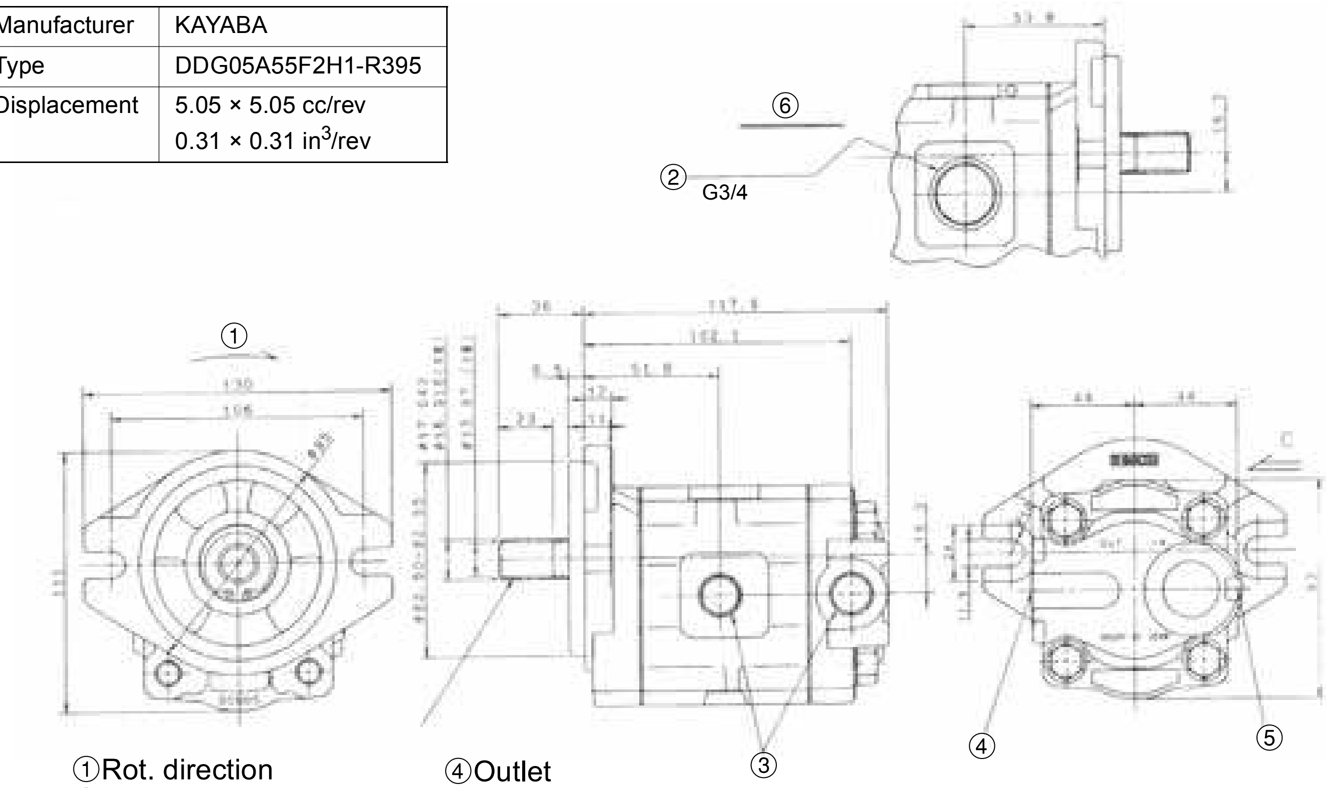
1. Reassemble the starter with connecting leads unconnected.
2. Connect a cable from the negative terminal of the battery to the starter body and a cable from "S" terminal of the starter to the positive terminal of the battery to force out the pinion.
3. Push back the pinion slightly to kill the play, and measure the pinion clearance.
4. If the clearance is not within the specified values, add or remove the washer between the solenoid switch and front end frame.

Pinion clearance	Factory spec.	0.5 to 2.0 mm 0.020 to 0.079 in.

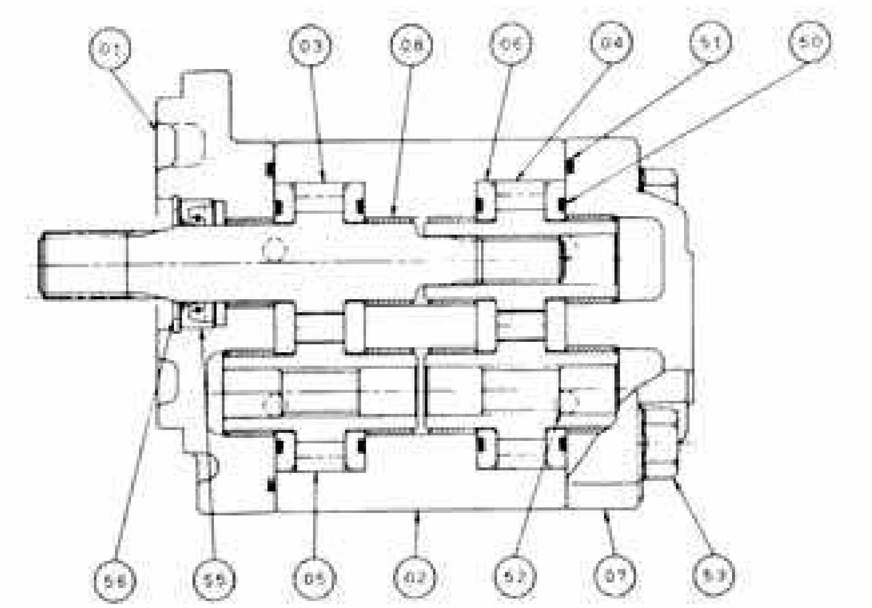
IV.Hydraulic system(Mechanism section)

A.Main pump(K008-3, U10-3)

Manufacturer	KAYABA
Type	DDG05A55F2H1-R395
Displacement	5.05 × 5.05 cc/rev 0.31 × 0.31 in^3/rev

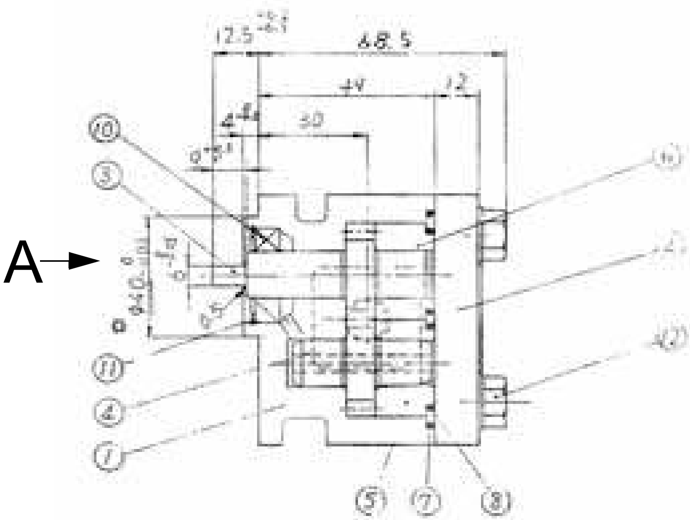


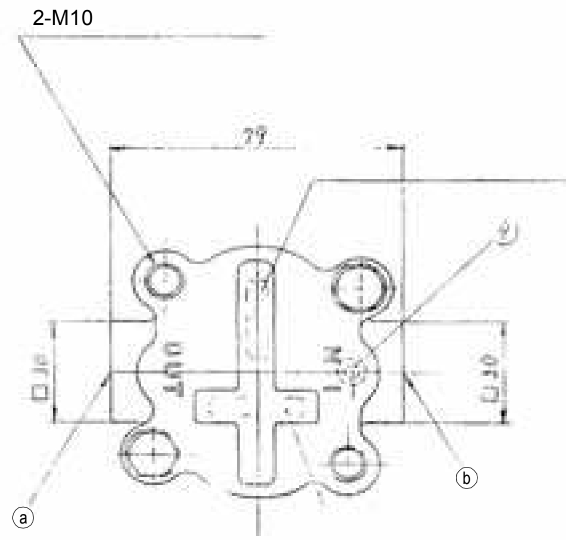
①Rot. direction
②Inlet
③Pump 1, 2
④Outlet
⑤Inlet
⑥View C

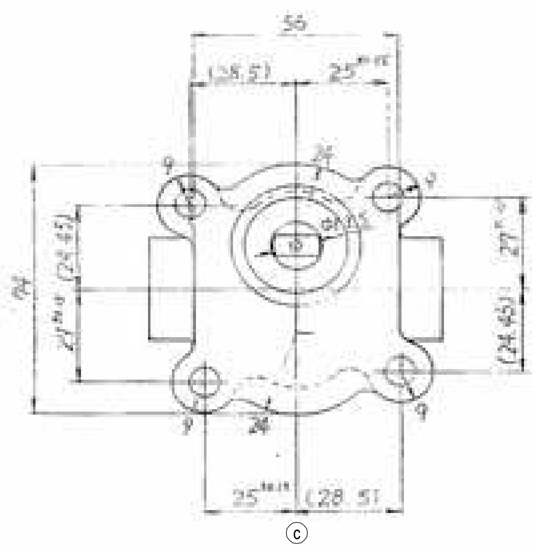


No.	Parts Name	Q'ty
01	Front cover	1
02	Body	1
03	Drive Gear, 1st	1
04	Drive Gear, 2nd	1
05	Driven Gear	2
06	Side Plate	4
07	Rear Cover	1
08	Bush	8
50	Gasket	4
51	Gasket	2
52	Ball	4
53	Bolt	4
55	Oil, Seal	1
56	Circlip	1

B.Pilot pump(U10-3)







ⓐOutport
ⓑInport
ⓒView A

No.	Parts Name	Q'ty
①	Case	1
②	Cover	1
③	Gear, Drive	1
④	Gear	1
⑤	METAL, A	1
⑥	METAL, B	1
⑦	O-ring	1
⑧	O-ring	2
⑨	O-ring	1
⑩	Oil Seal	1
⑪	Circlip, Internal	1
⑫	Bolt	2

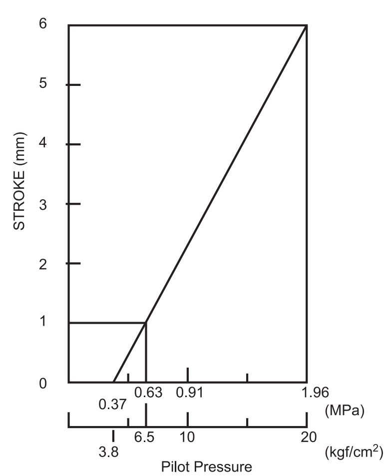
Manufacturer	KUBOTA
Type	56900-26201
Displacement	(3.15 l/min)

C.Control valve

a. Specifications

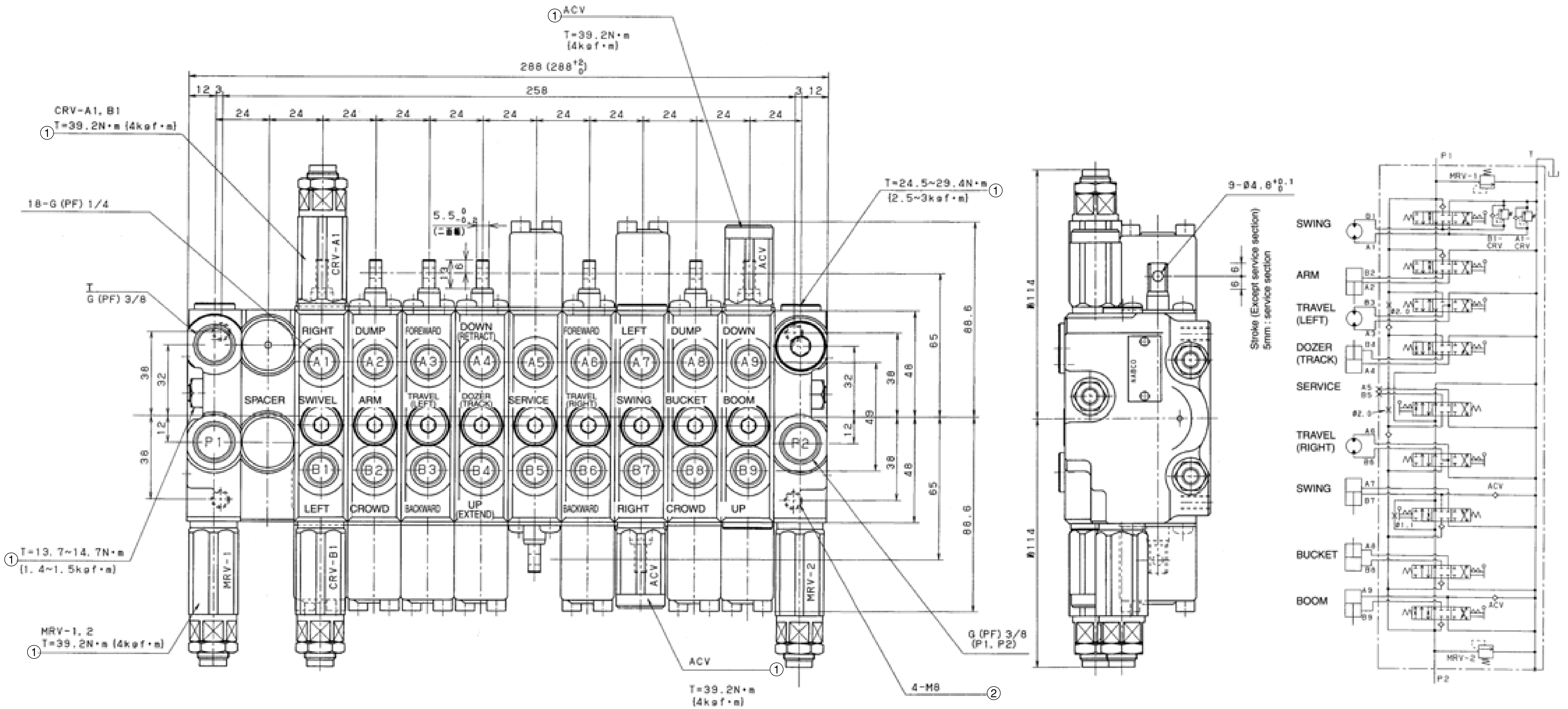
			K008-3		U10-3	
Control valve			NSC10		NSC10	
Section width			24mm 0.94in		24mm	
Total length			280mm 11.02in		280mm	
Spool stroke	Service port		5mm 0.20in		5mm	
	Except service port		6mm 0.24in		6mm	
Spool operating force	Dozer, Travel 2nd	at neutral	58.8N 6.0kgf 13.23lbf		58.8N 6.0kgf	
		at full stroke	78.5N 8.0kgf 17.64lbf		78.5N 8.0kgf	
	Except Dozer and Travel 2nd	at neutral	68.6N 7.0kgf 15.43lbf		68.6N 7.0kgf	
		at full stroke	93.2N 9.5kgf 20.94lbf		93.2N 9.5kgf	
Main relief pressure setting		P_1	$17.5^{+0.49}_{0}$ MPa $175^{+0.5}_{0}$ kgf/cm^2 2489Psi	at 12l/min 3.17gal/min	$17.5^{+0.49}_{0}$ MPa $175^{+0.5}_{0}$ kgf/cm^2	at 12l/min
		P_2	$17.5^{+0.49}_{0}$ MPa $175^{+0.5}_{0}$ kgf/cm^2 2489Psi	at 12l/min 3.17gal/min	$17.5^{+0.49}_{0}$ MPa $175^{+0.5}_{0}$ kgf/cm^2	at 12l/min
Overload relief pressure setting		Swivel left right	$6.86^{+0.49}_{0}$ MPa $70^{+0.5}_{0}$ kgf/cm^2 2418Psi	at 12l/min	$6.86^{+0.49}_{0}$ MPa $70^{+0.5}_{0}$ kgf/cm^2	at 12l/min
Engine rated speed			2050rpm		2050rpm	
Pump displacement			5.05cc/rev 0.31in^3		5.05cc/rev	
Service port oil flow		P_1+P_2	20.7l/min 5.47gal/min		20.7l/min	

U10-3 Pilot pressure



b. General view of Control valve

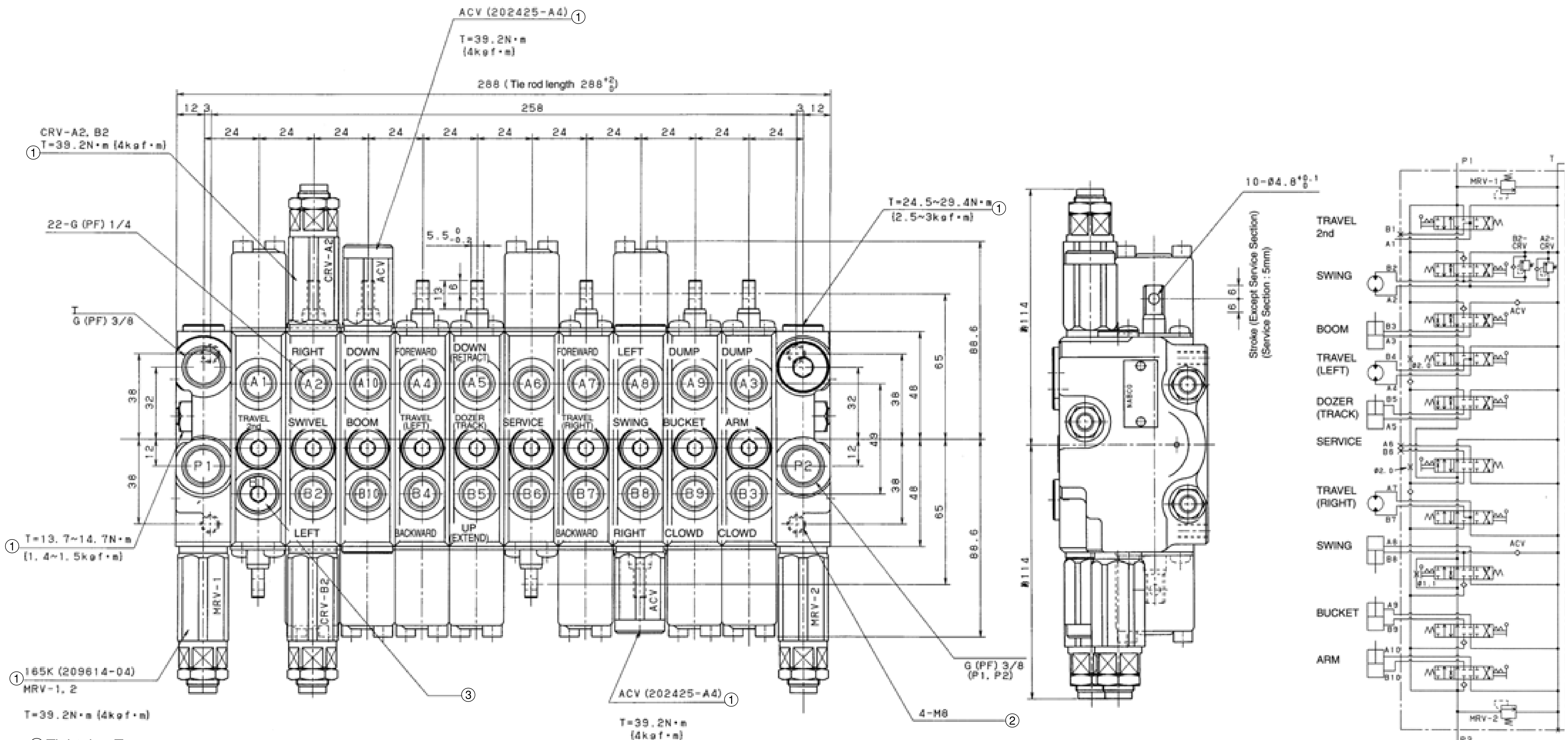
K008-3 EU - version : P/N RA021-61160



①Tightning Torgue
②Thread depth 2

MRV=Main relief valve
CRV=Overload relief valve
ACV=Antiboid valve

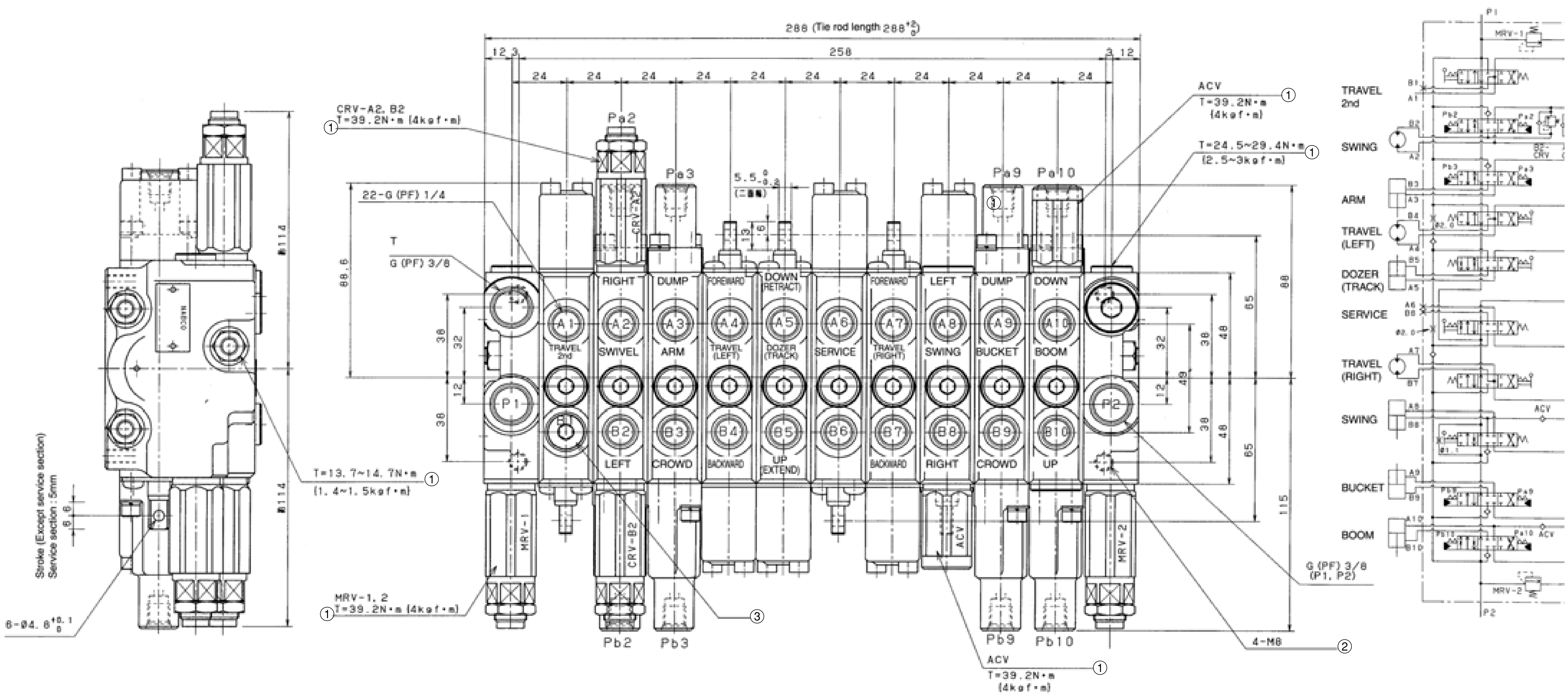
K008-3 KTC, KCL, KTA - version : P/N RA021-61130



①Tightning Torgue
②Thread depth 12
③Plug

MRV=Main relief valve
CRV=Overload relief valve
ACV=Antiboid valve

U10-3 : P/N RA131-61160

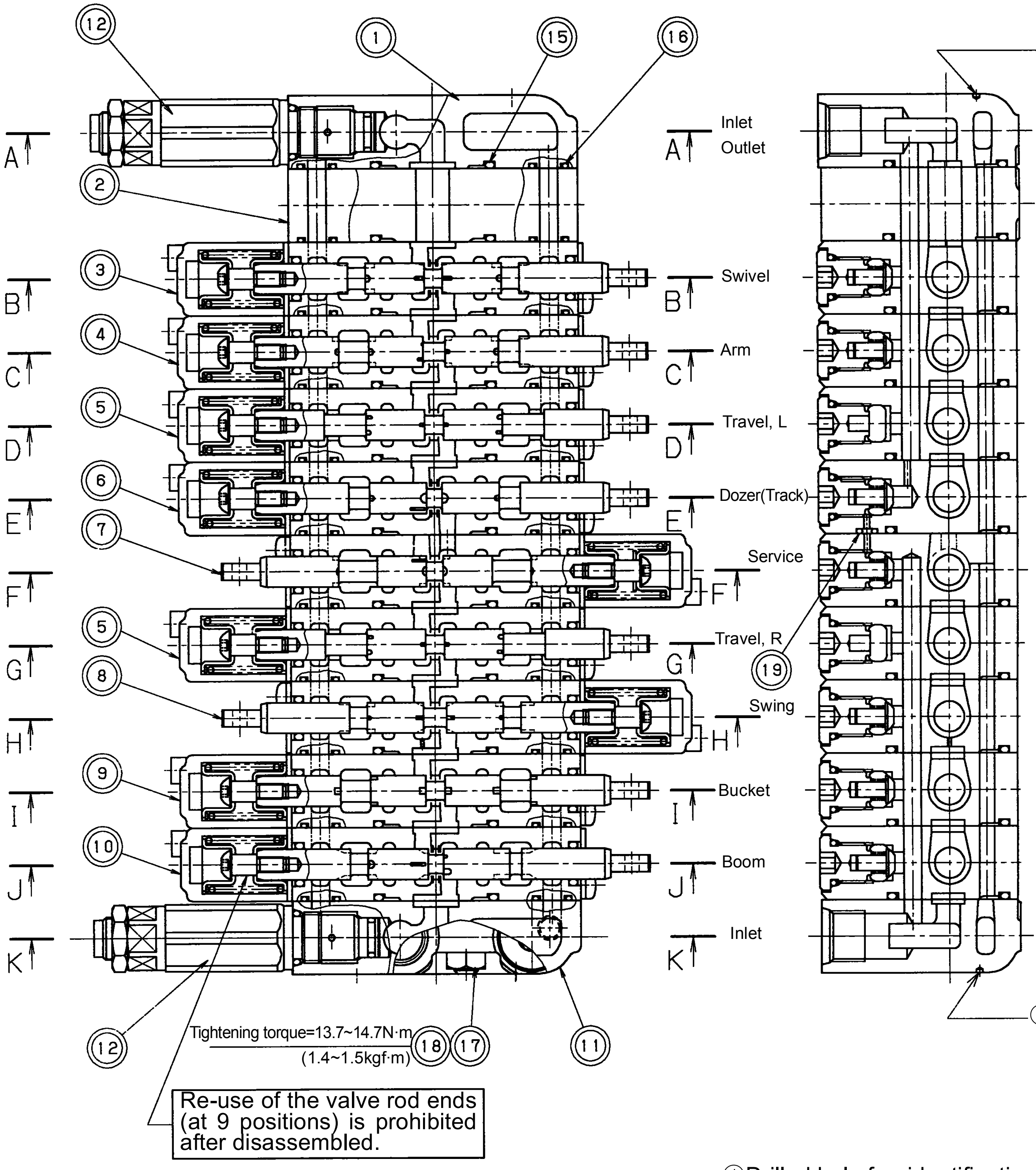


①Tightning Torgue
②Thread depth 12
③Plug

MRV=Main relief valve
CRV=Overload relief valve
ACV=Antiboid valve

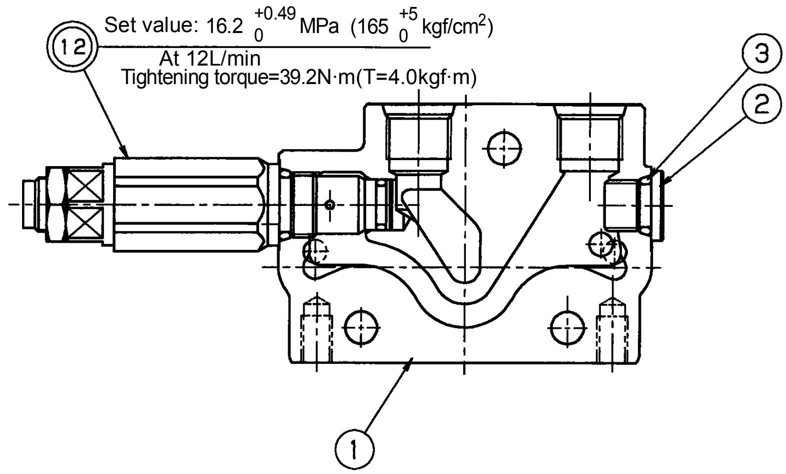
c. Sectional view

(1) K008-3 EU - version : P/N RA021-61160

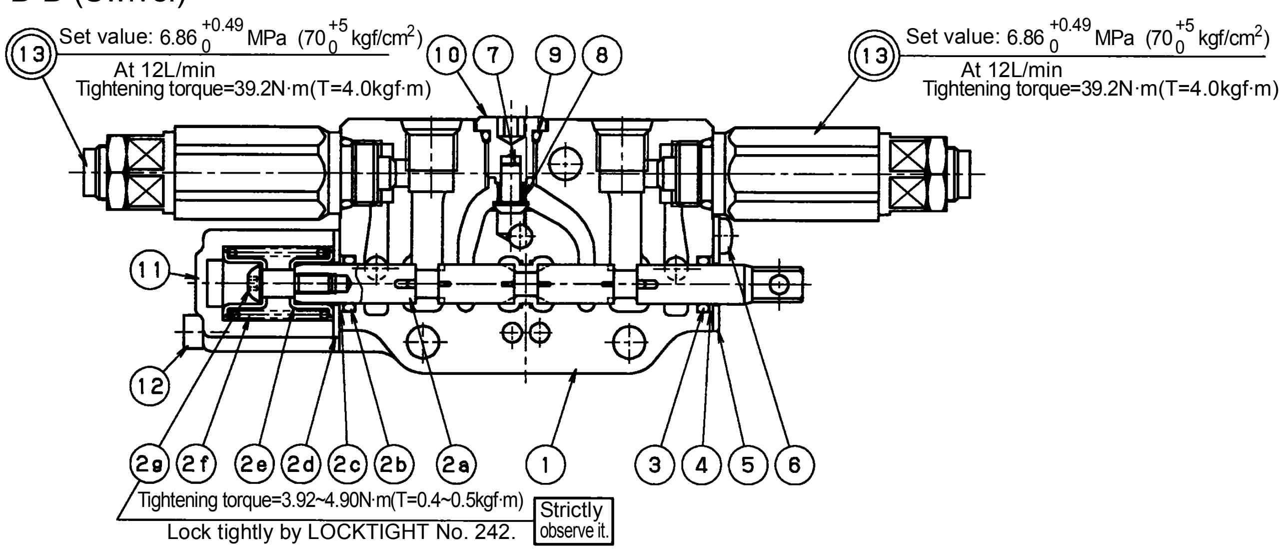


①Drilled hole for identification

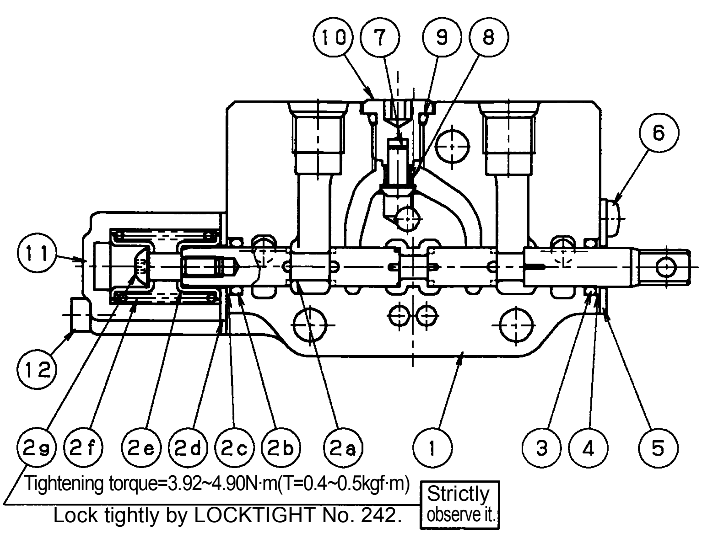
Section A-A (Inlet, Outlet)



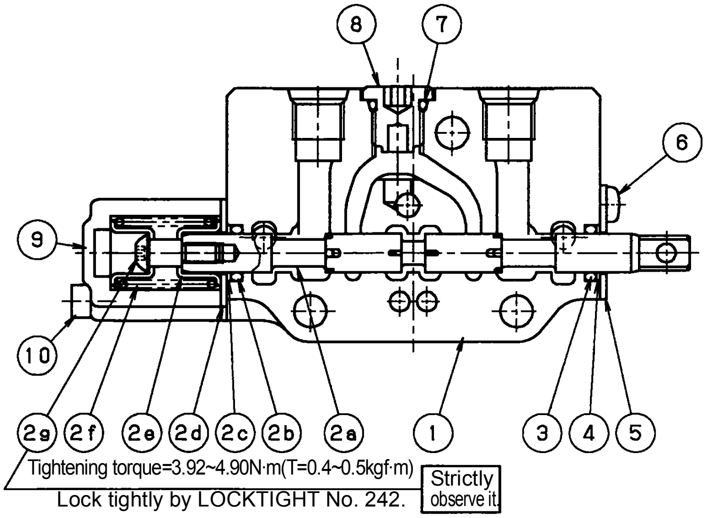
Section B-B (Swivel)



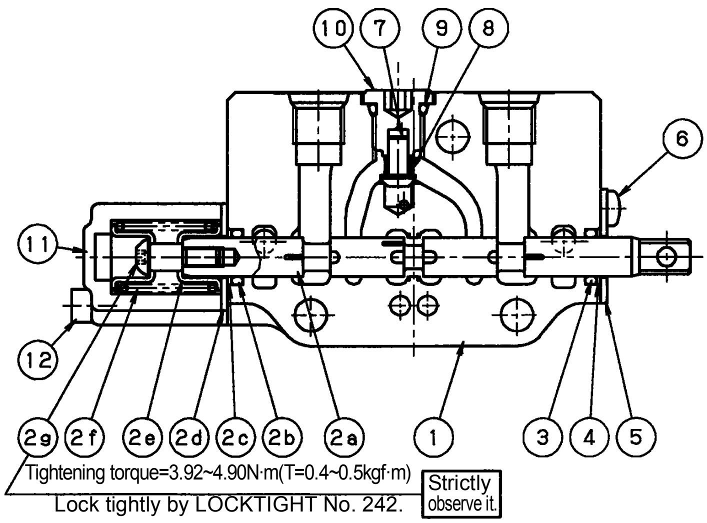
Section C-C (Arm)



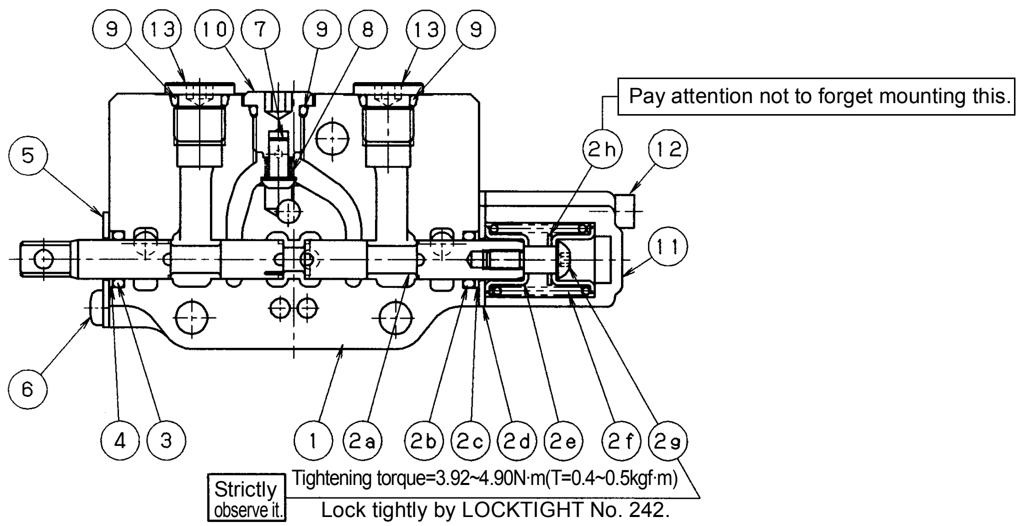
Section D-D (Travel, Left)



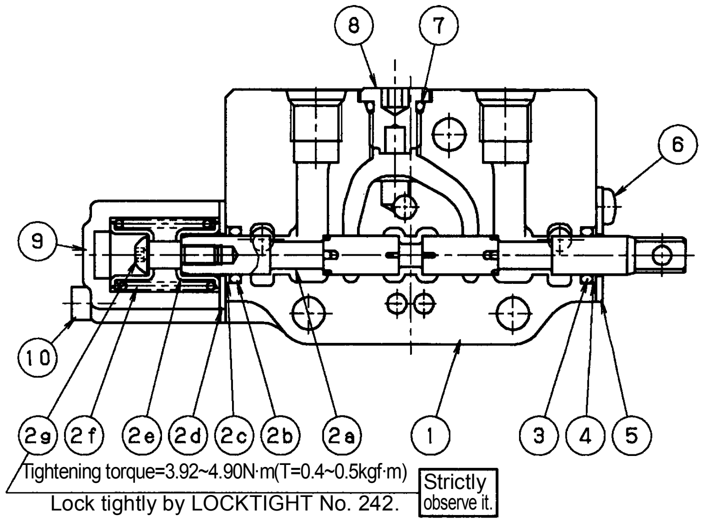
Section E-E (Dozer or track)



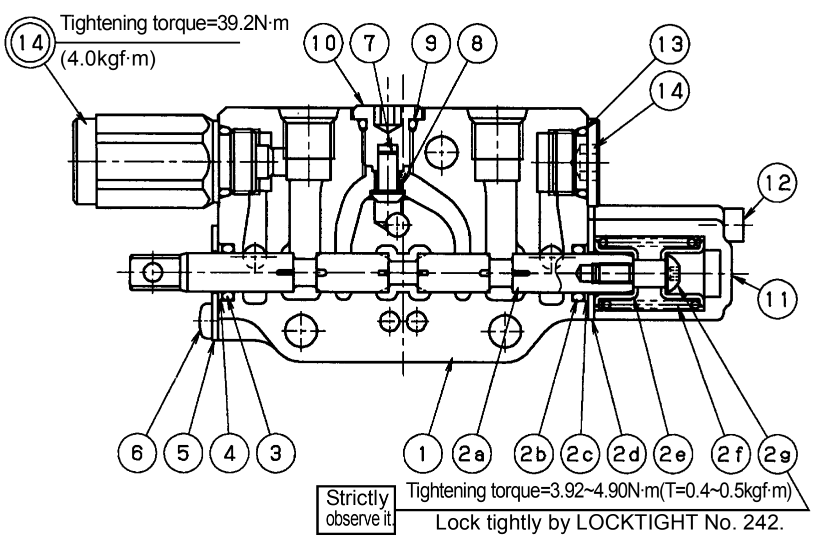
Section F-F (Service)



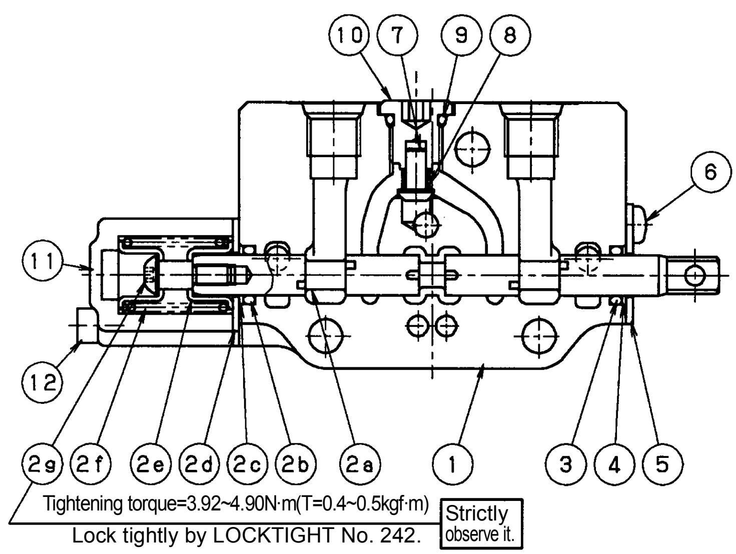
Section G-G (Travel, Right)



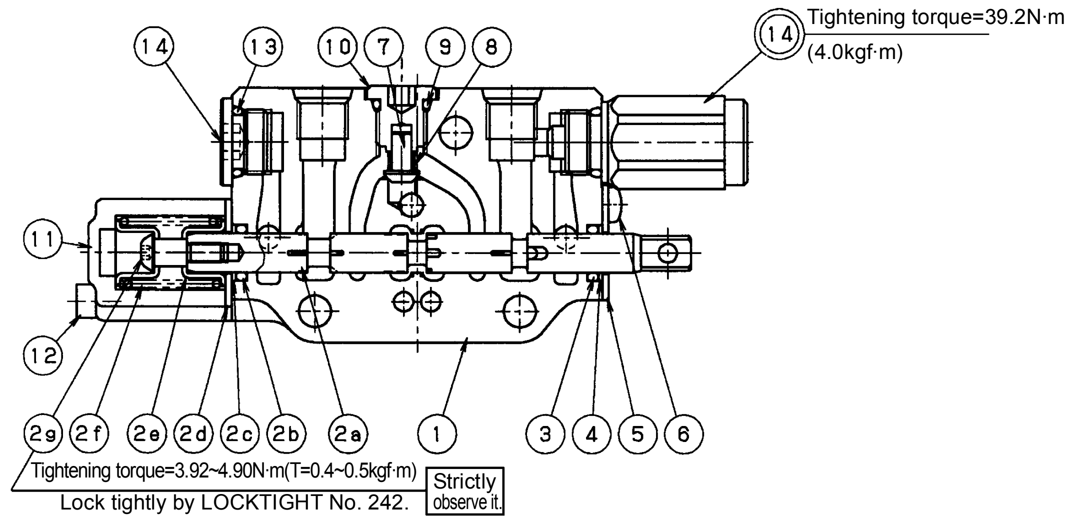
Section H-H (Swing)



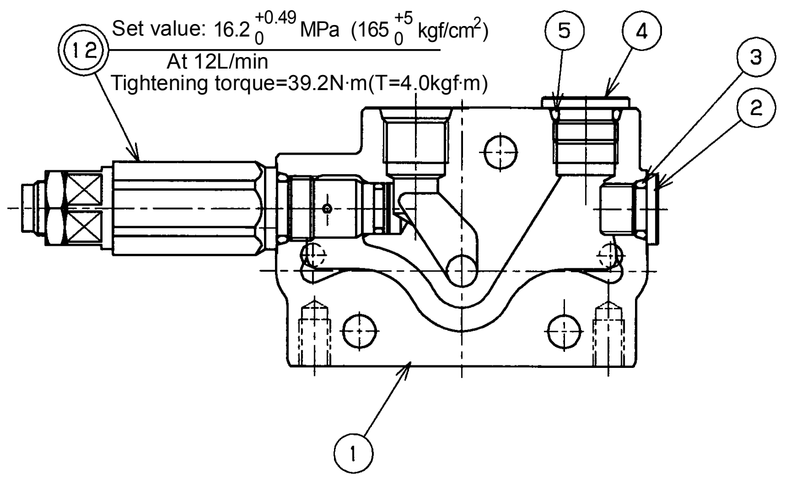
Section I-I (Bucket)



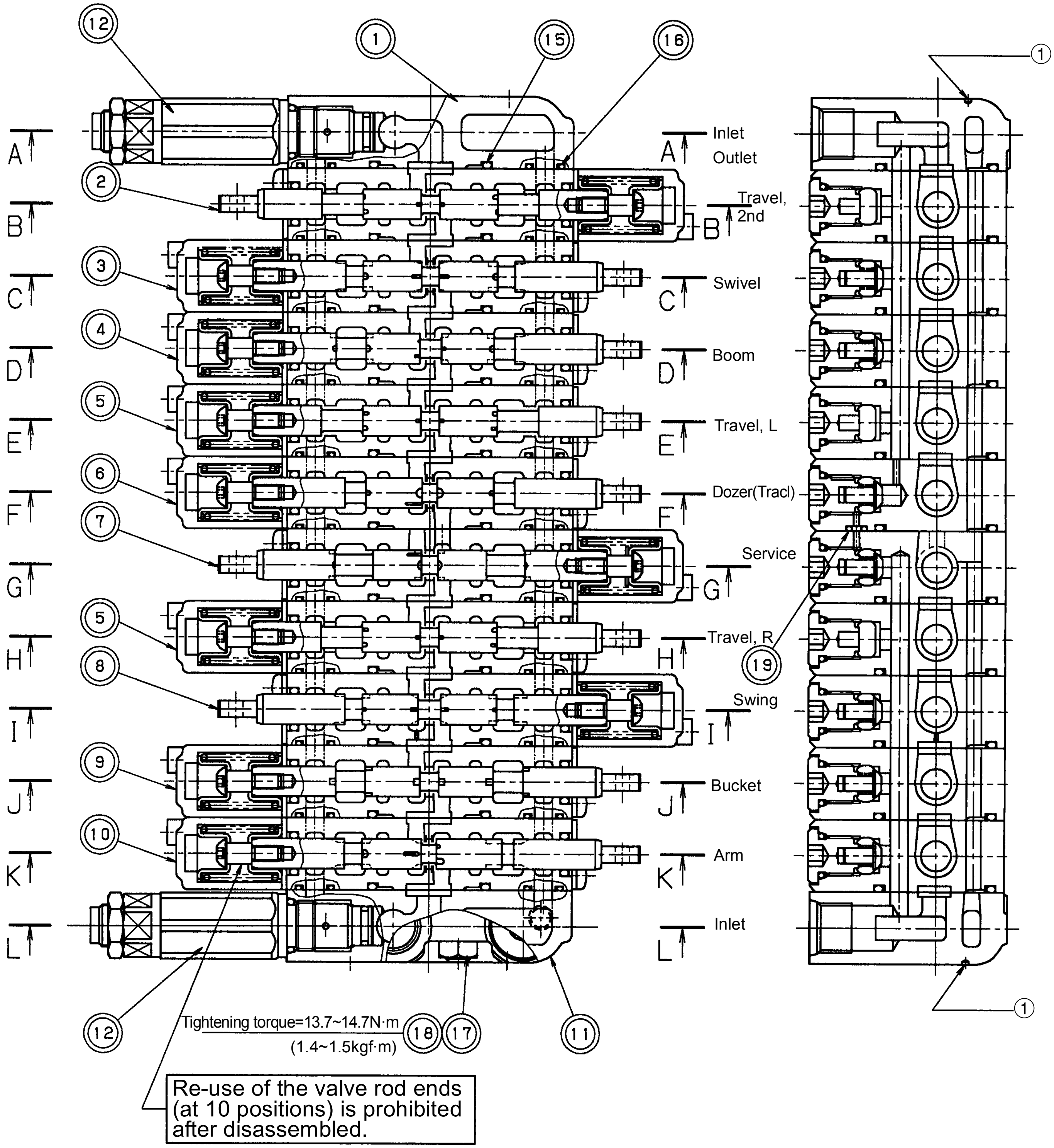
Section J-J (Boom)



Section K-K (Inlet)



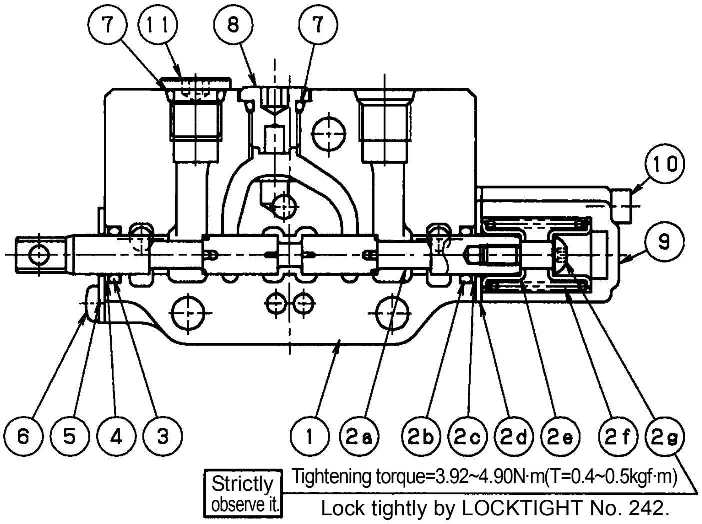
(2) K008-3 KTC, KCL, KTA - version : P/N RA021-61130



①Drilled hole for identification

Section A-A (Inlet, Outlet)
Refer Section A-A page.IV-S-12

Section B-B (Travel, 2nd)



Section C-C (Swivel)
Refer Section B-B page.IV-S-12

Section D-D (Boom)
Refer Section J-J page.IV-S-15

Section E-E (Travel, Left)
Refer Section D-D page.IV-S-13

Section F-F (Dozer or track)
Refer Section E-E page.IV-S-13

Section G-G (Service)
Refer Section F-F page.IV-S-13

Section H-H (Travel, Right)
Refer Section G-G page.IV-S-14

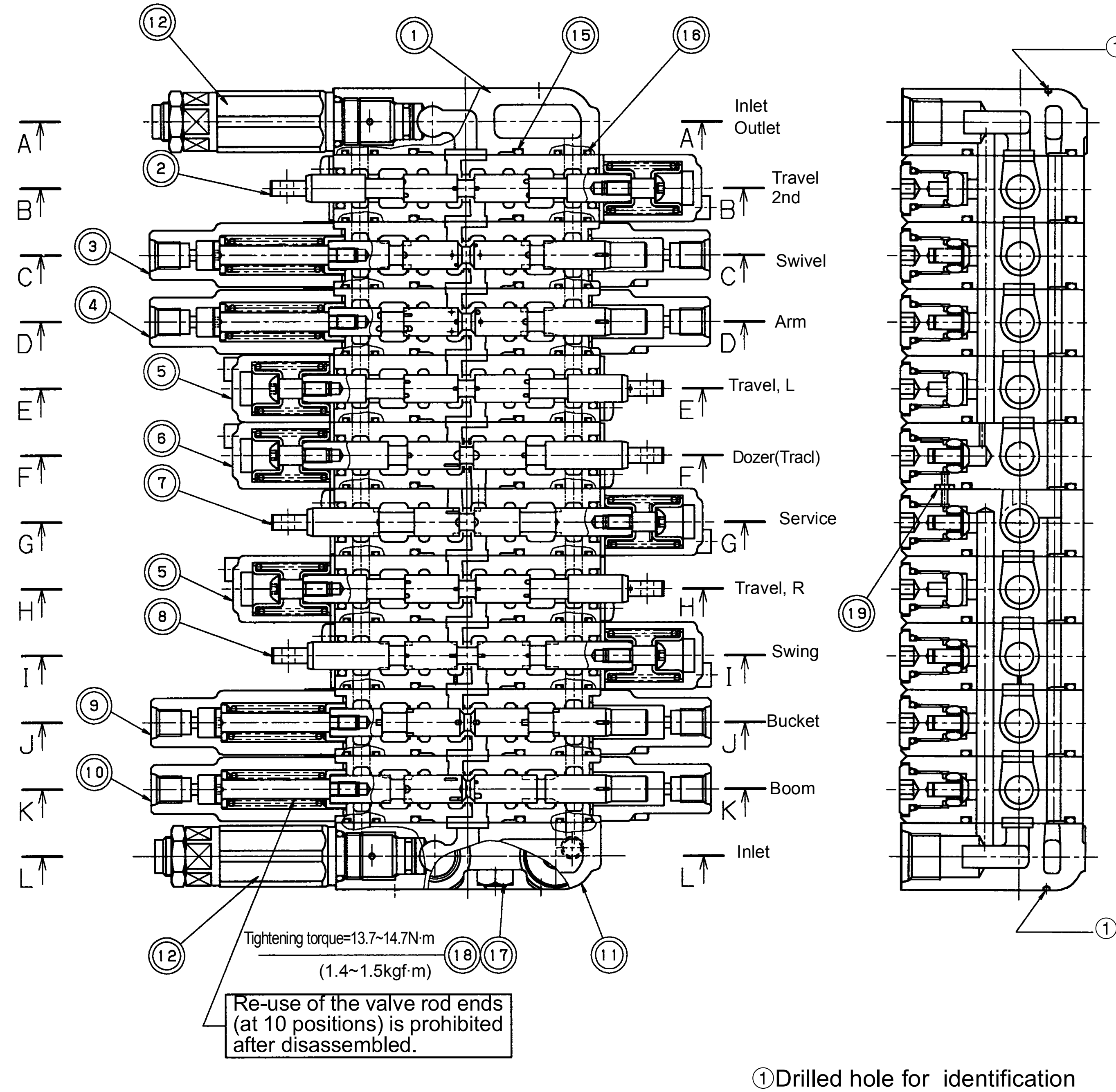
Section I-I (Swing)
Refer Section H-H page.IV-S-14

Section J-J (Bucket)
Refer Section I-I page.IV-S-14

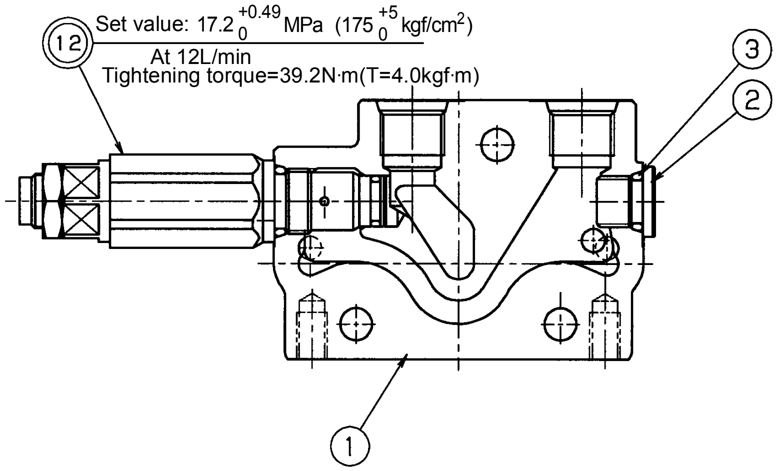
Section K-K (Arm)
Refer Section C-C page.IV-S-12

Section L-L (Inlet)
Refer Section K-K page.IV-S-15

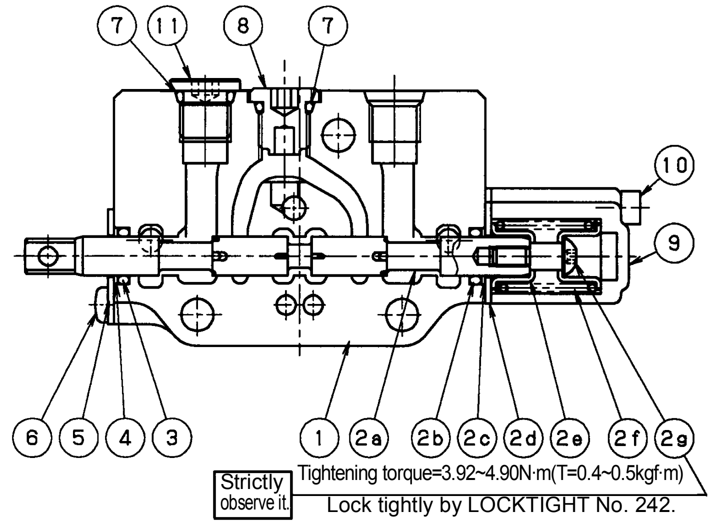
(3)U10-3 : P/N RA131-61160



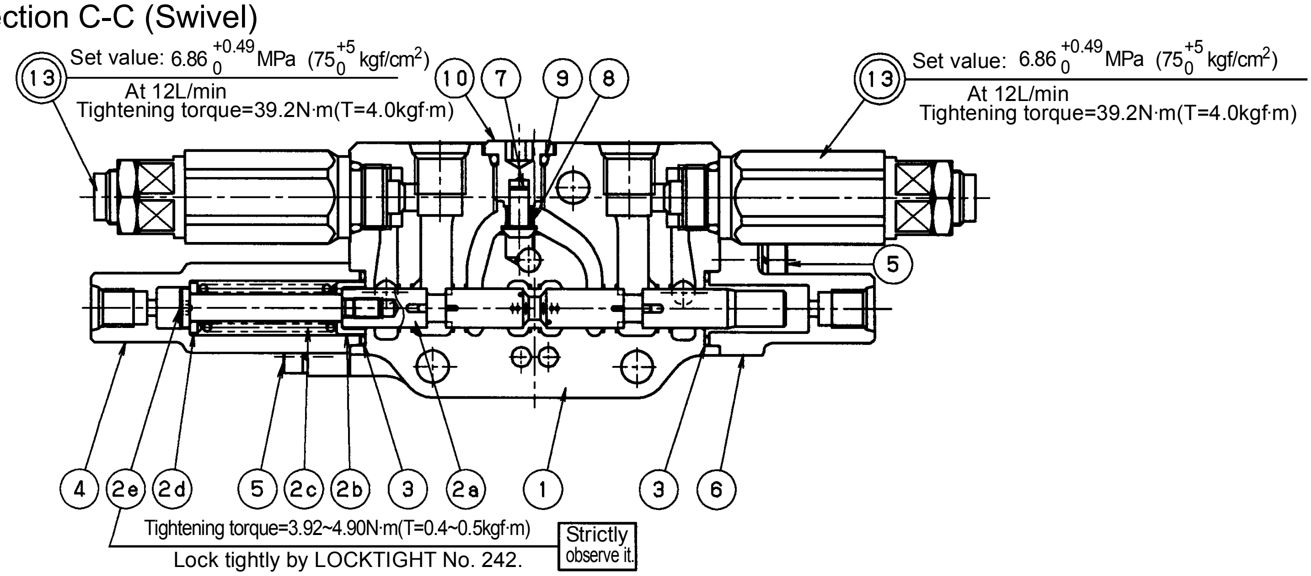
Section A-A (Inlet, Outlet)



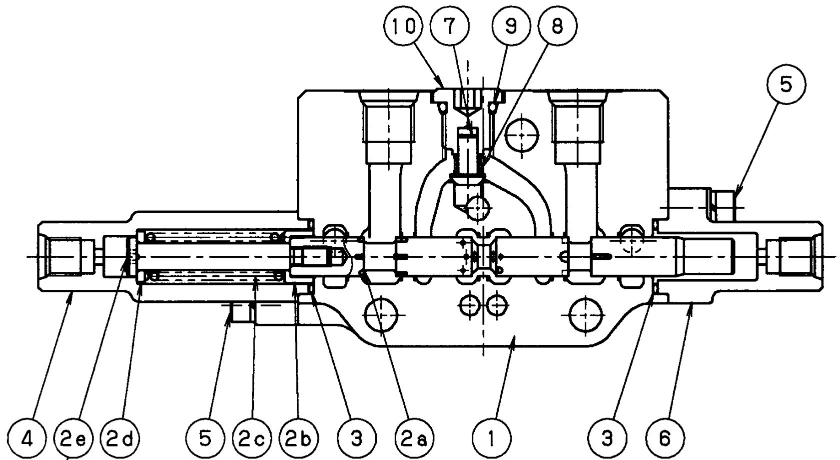
Section B-B (Travel, 2nd)



Section C-C (Swivel)



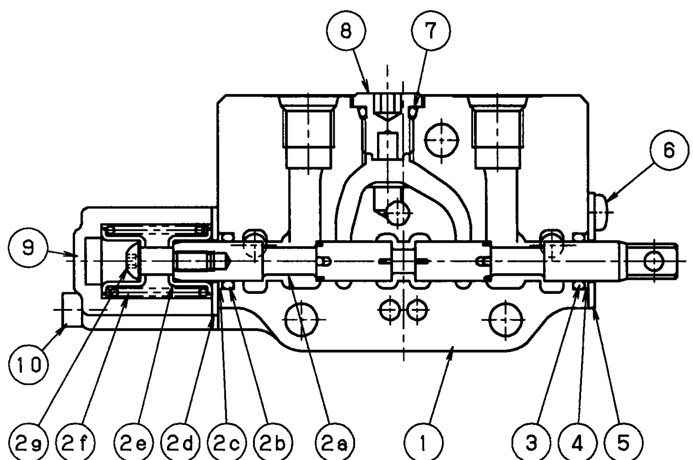
Section D-D (Arm)



Tightening torque=3.92~4.90N·m(T=0.4~0.5kgf·m) Strictly observe it.

Lock tightly by LOCKTIGHT No. 242.

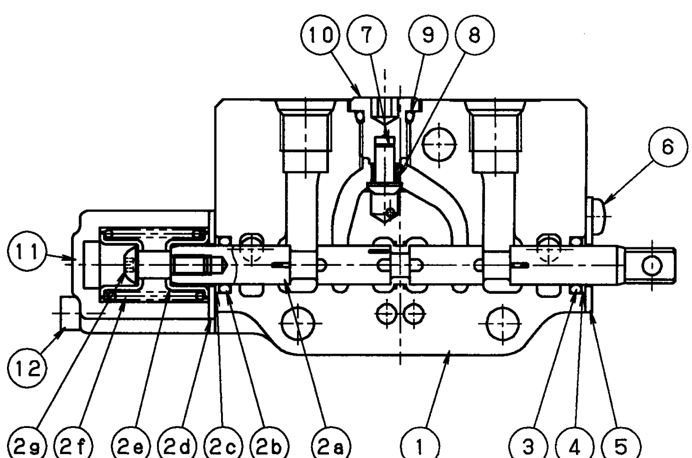
Section E-E (Travel, Left)



Tightening torque=3.92~4.90N·m(T=0.4~0.5kgf·m) Strictly observe it.

Lock tightly by LOCKTIGHT No. 242.

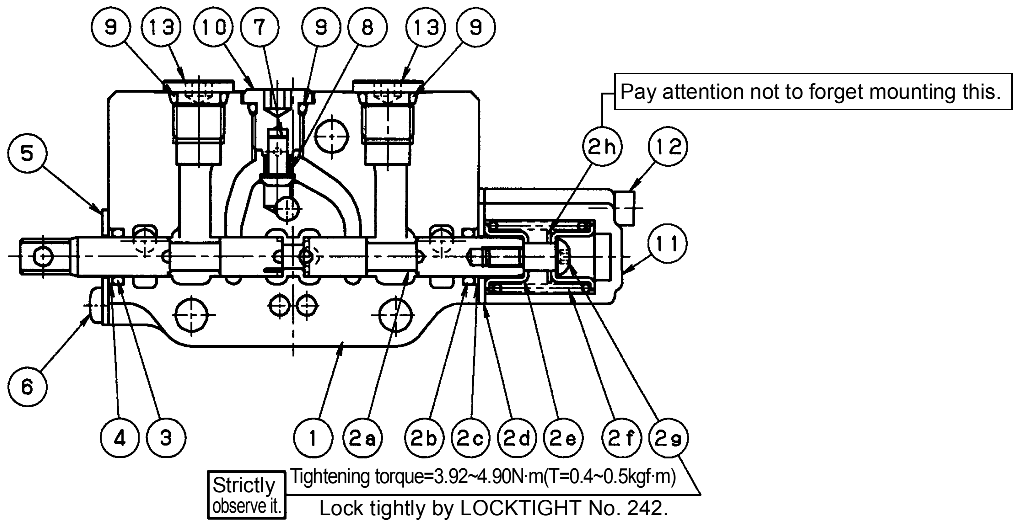
Section F-F (Dozer or Track)



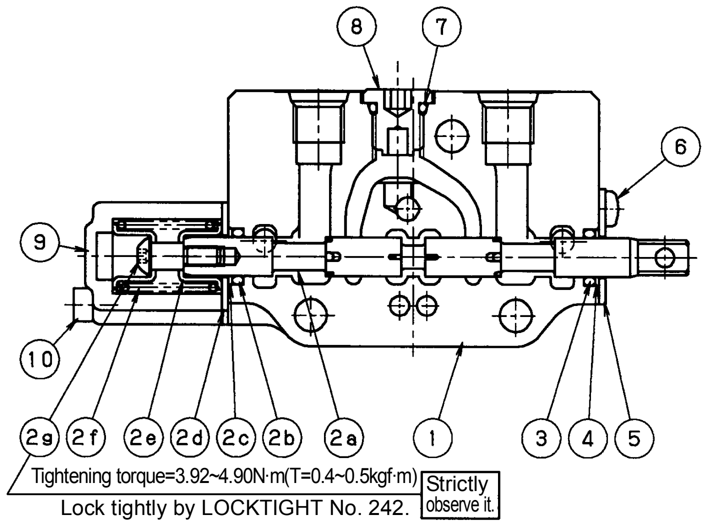
Tightening torque=3.92~4.90N·m(T=0.4~0.5kgf·m) Strictly observe it.

Lock tightly by LOCKTIGHT No. 242.

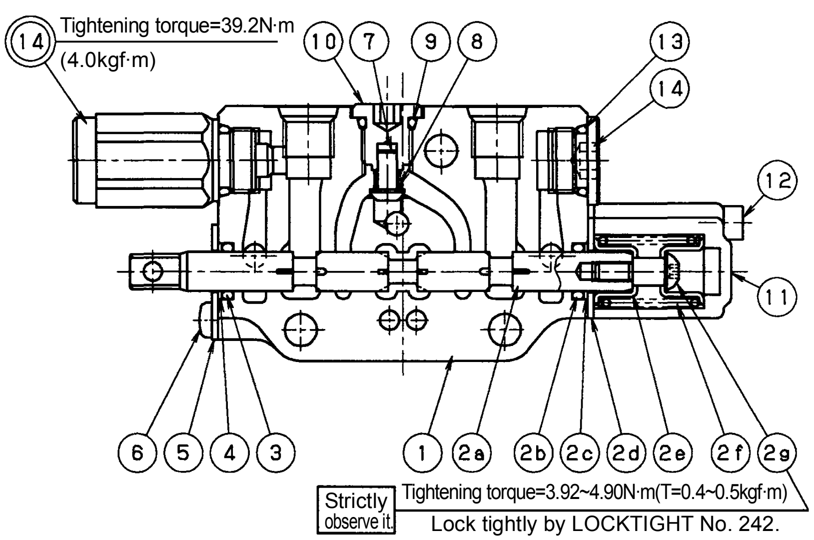
Section G-G (Service)



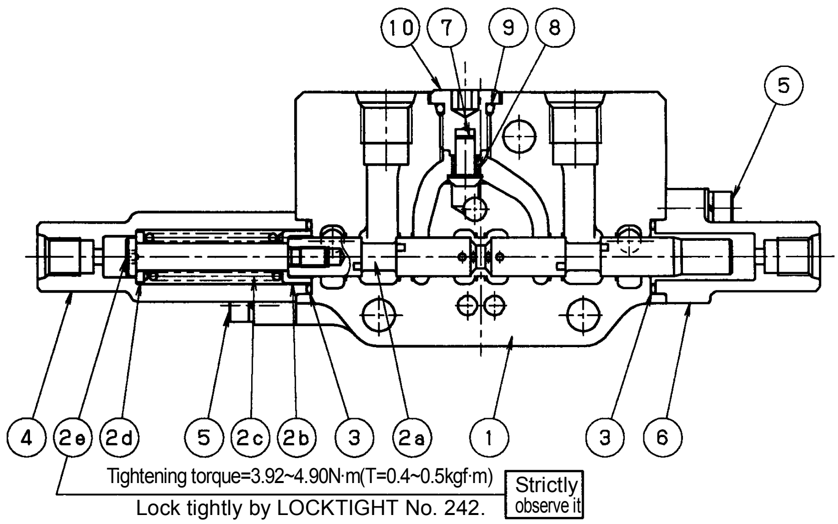
Section H-H (Travel, Right)



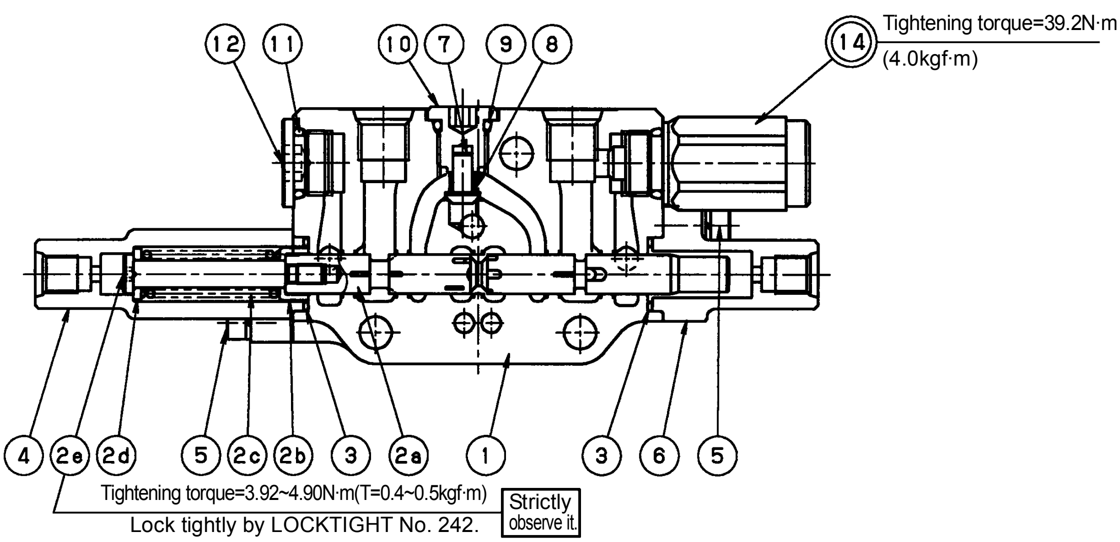
Section I-I (Swing)



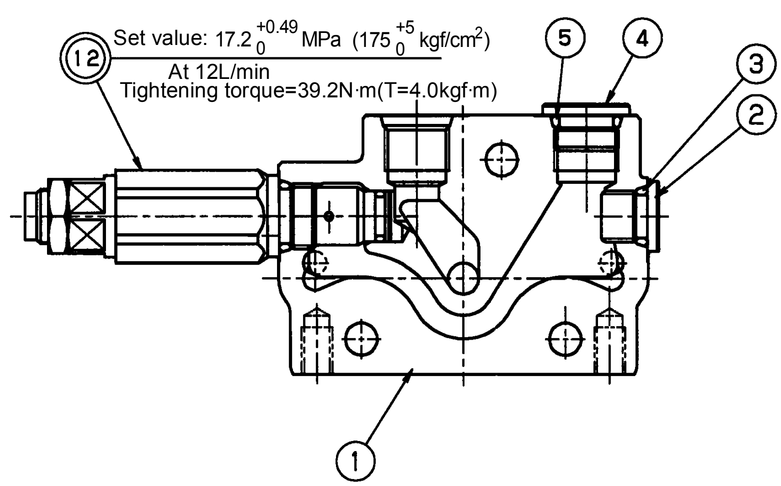
Section J-J (Bucket)



Section K-K (Boom)

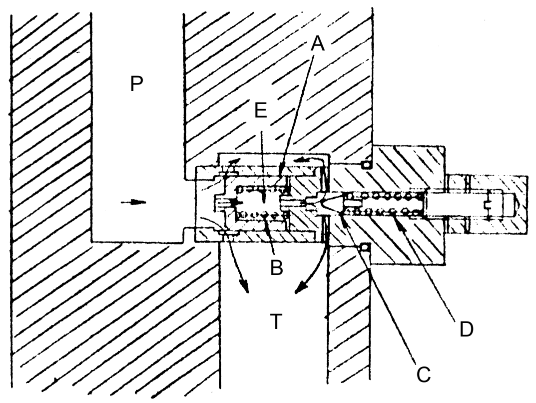


Section L-L (Inlet)



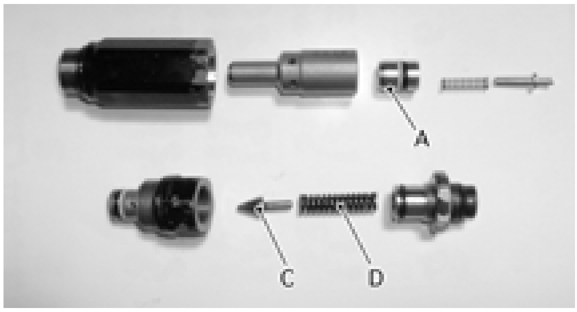
d. Structure and function

(1) Relief valve function



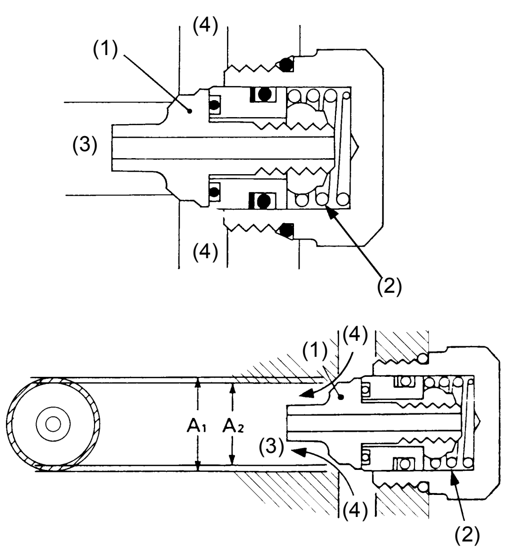
(Operating mechanism of the relief valve)
The higher the working load rises, the higher the circuit pressure goes up. At a preset pressure level, however, the relief valve gets activated. When the sircuit pressure has reached the setting of the pilot valve spring (D), the oil flows through the orifice of the main poppet (A) into the main poppet spring chamber (E). This pushes up the pilot poppet (C) and lets the oil flow into the tank. Now a pressure difference takes place across the orifice of the main poppet (A), and the main poppet (A) gets released the seat. In this way, the pressure oil starts flowing out of the circuit to the tank, which keeps the circuit pressure at a preset level.

Inner parts, relief valve



Check point
(1) To seeif the relief valve itself is in trouble, replace it with new one of the same pressure level and check for similar sympom.
(2) The relief valve malfunctions probably due to foreign matters that are caught in between the poppet (A to C) and the seat. Carefully check these parts for dust, metal chippings and the like. Check also the seat for dents and repair it as required.
(3) Check the springs for looseness and the seals for degrading.

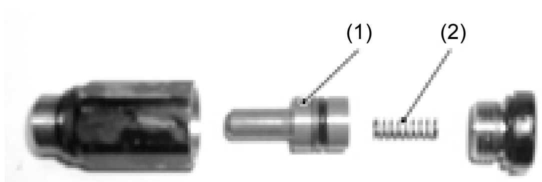
(2) Anti cavitations valve function



If the pressure (3) at the cylinder causes cavitation, the anti-void valve opens itself, feeding the oil from the tank and filling the space.

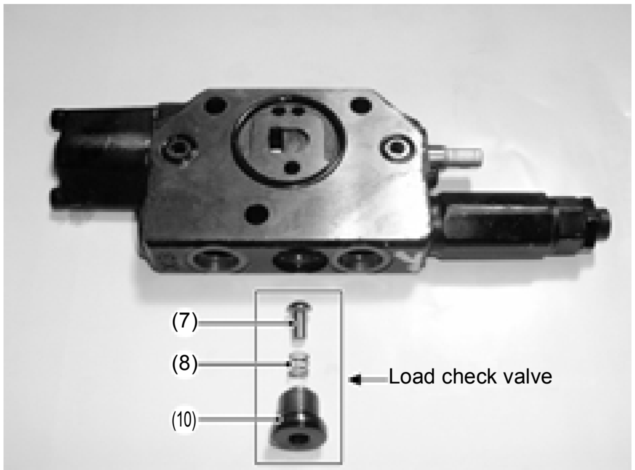
(1) The cylinder port pressure (3) is applied over the large area at the back of the O-ring, which activates the poppet (3) and its seat.
(2) When the pressure (3) drops below the atmosphiric pressure, the tank pressure (4) applies upon the circular area between A1 and A2. This pressure will overcome the cylinder port pressure and the force of the spring (2), thereby opening the poppet (1).
(3) With the space full of oil, the spring forces back the poppet and the cylinder port presure (3) works tightly upon the seat.

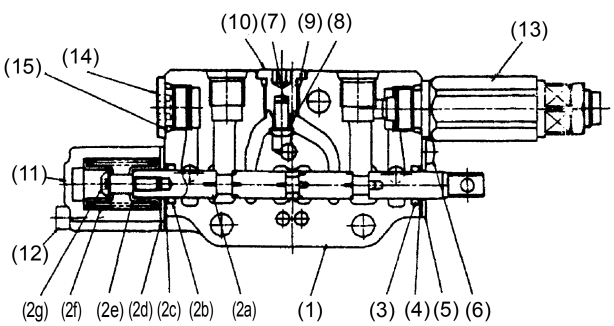
Inner parts, anti-void valve



Check point
(1) Check the poppet seat for scratches, the spring for looseness and the seals for degrading.

(3) Load check valve function





For smooth movement and easy inching adjustment of the spool, the passages of the hydraulic source, working section and tank are all inter connected while the spool is switched over.

Let's suppose that there is no check valve installed and taht the working load keeps on forcing the working section in the opposite direction. In such situation, the working section passage, pump passage and tank passage are all interconnected while the spool is switched over. This causes a pressure drop and the working load invites a back flow. This is very hazardous.

With this reason, the check valve is added in halfway along the working section passage. Even if the passage pressure drops too low, the woking section's oil is blocked by the check valve and the working load is safety maintained.

This function therefore provides for same advantages. The spool switched over smoothly, and the working section does not suffer any reverse motion. What's more, if the spools are activated at once with different-working section pressure, the oil flows back from the high-pressure side to the low-pressure one.This design leads to ease of operation.

(1) Valve body
(2a) Spool
(7) Check valve
(8) Spring
(9) O-ring
(10) Retainer
(11) Cap
(13) Overload relief valve

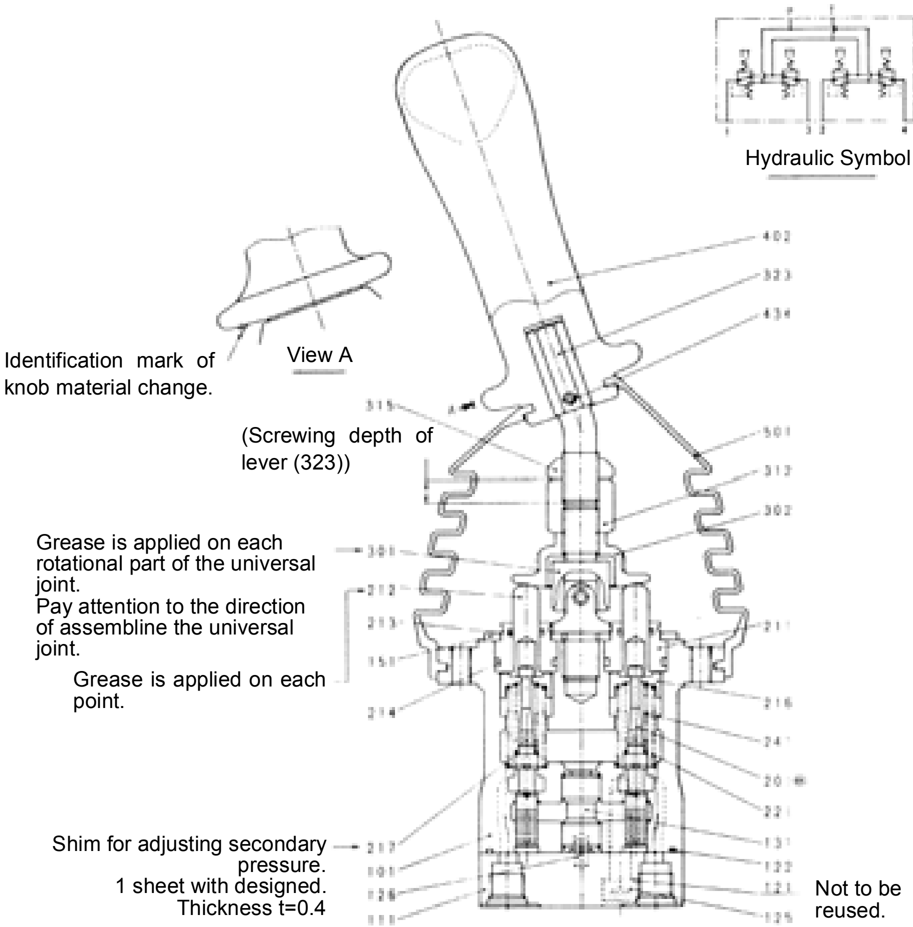
D.Pilot valve

a. Structure

The construction of the pilot valve is as shown in the figure. The casing has a vertical hole where a pressure reducing valve is assembled.

The pressure reducing valve is composed of spool (201), secondary pressure setting spring (241), spring seat (216) and washer (217). The spring for secondary pressure setting (241) is set so that the secondary pressure conversion should be 0.5 ~ 1 Mpa (This value varies depending on the type). The spool (201) is pressed to the push rod (212) by return spring (221).

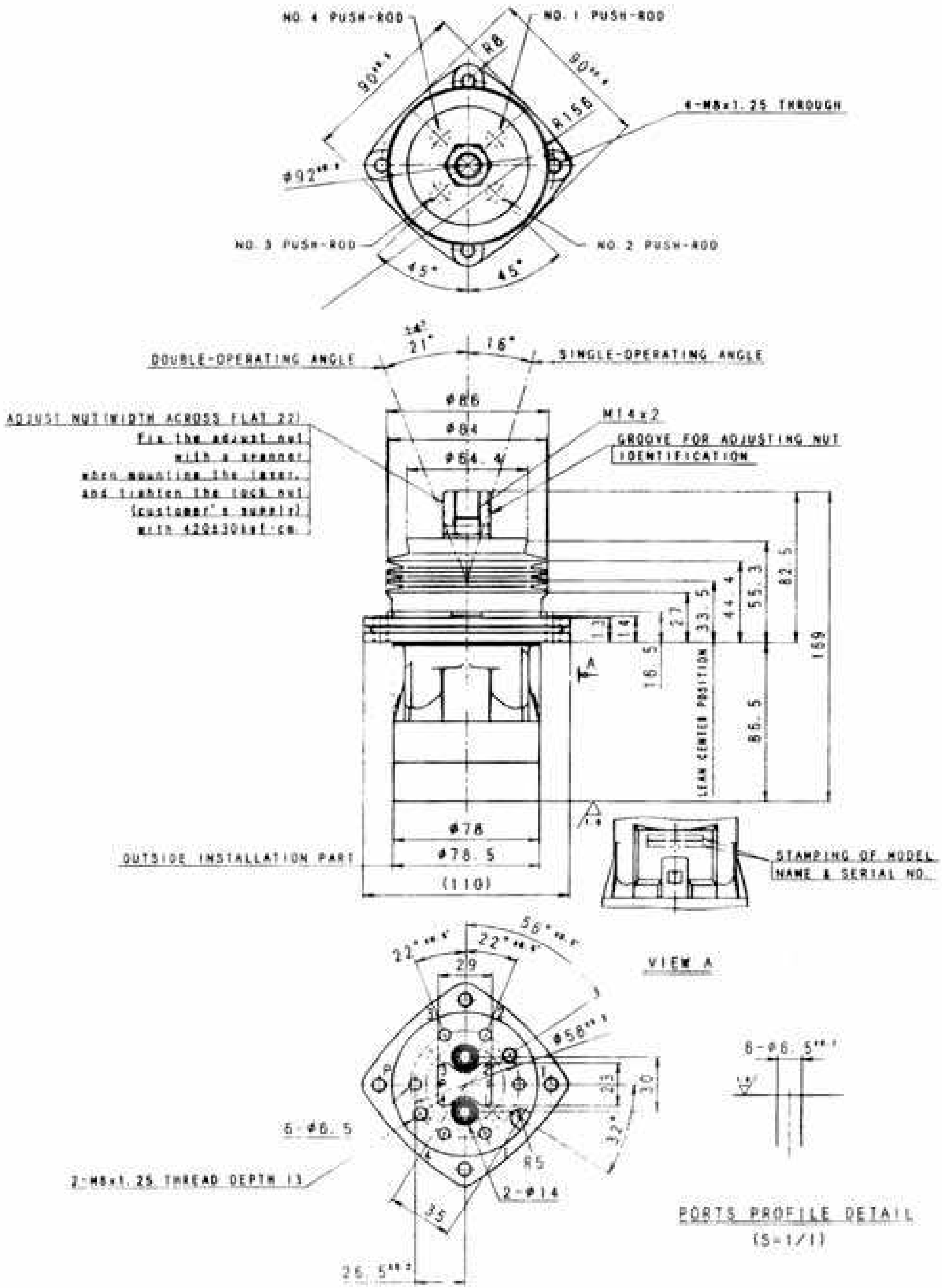
When the push rod is pressed down by inclination of operating section including steering wheel etc., the spring seat comes down at the same time to change the setting of the spring for secondary pressure setting. The casing (101) and the port plate (111) have oil inlets (primary pressure) port and outlet (tank) ports. From the ports 1, 2, 3 and 4, secondary pressure is taken out.



No.	Part Name	Q'ty
101	Casing	1
111	Plate, Port	1
121	Washer, Seal	2
122	O-ring	1
125	Screw, hex, S.M.C.	2
126	Pin, Spring	1
131	Bush	1
151	Plate	1
201	Spool	4
211	Plug	4
212	Rod, Bush	4
213	Seal	4
214	O-ring	4
216	Seat1, Spring	4
217	Washer2	4
221	Spring	4
241	Spring	4
301	Joint	1
302	Plate, Circulator	1
312	Nut, Adjusting	1
315	Nut, Lock	1
323	Lever	1
434	Pin, Spring	1
501	Bellows	1

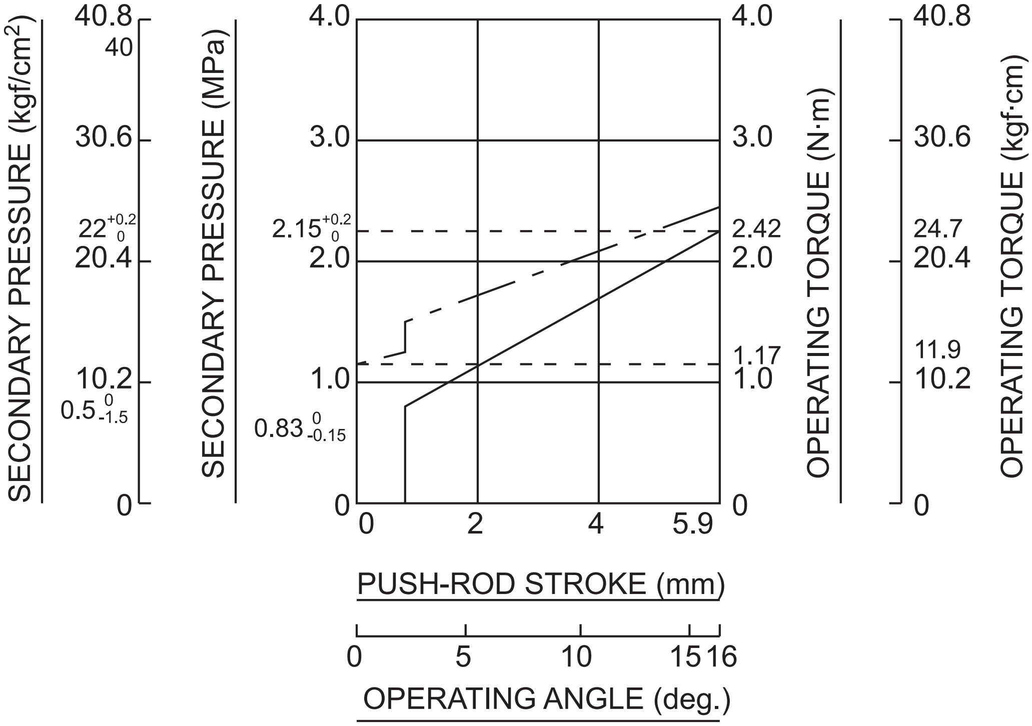
Tightening torque List

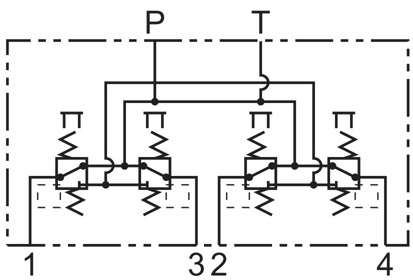
No.	Screw size	tightening torque
125	M8	20.6 1.5 Nm (210 15 kgfcm)
301	M14	47.1 2.9 Nm (480 30 kgfcm)
302.312	M14	68.6 4.9 Nm (700 50 kgfcm)
315	M14	49 3.4 Nm (500 35 kgfcm)



NO. 4 PUSH-ROD
NO. 1 PUSH-ROD
NO. 3 PUSH-ROD
NO. 2 PUSH-ROD
4-M8x1.25 THROUGH
DOUBLE-OPERATING ANGLE
SINGLE-OPERATING ANGLE
ADJUST NUT(WIDTH ACROSS FLAT 22)
Fix the adjust nut
with a spanner
when mounting the lever,
and tighten the lock nut
(customer's supply)
with 420±30kgf·cm.
M14x2
GROOVE FOR ADJUSTING NUT
IDENTIFICATION
LEAN CENTER POSITION
OUTSIDE INSTALLATION PART
STAMPING OF MODEL
NAME & SERIAL NO.
VIEW A
6-ϕ6.5
2-M8x1.25 THREAD DEPTH 13
2-ϕ14
PORTS PROFILE DETAIL
(S=1/1)

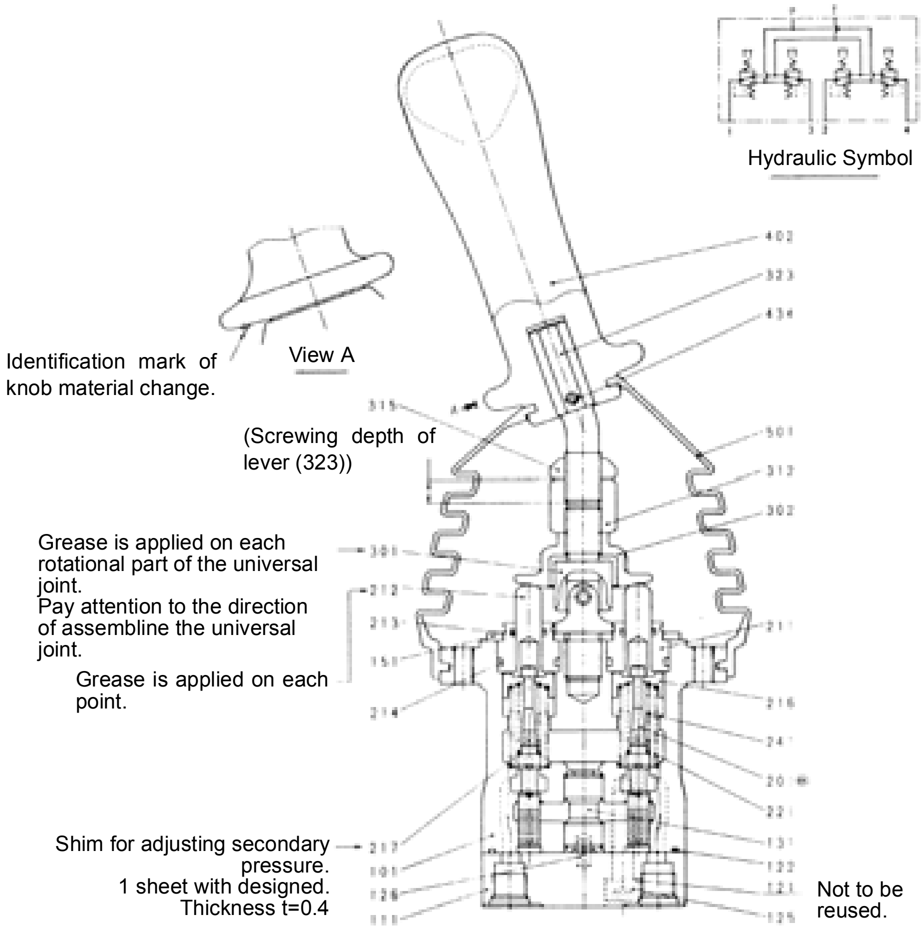
b. Pilot valve control diagram





HYDRAULIC SYMBOL

c. Function



(1) Basic function

The pilot valve is the valve to control the stroke, direction etc. of the spool of the control valve. This is done by actuating the output pressure of the pilot valve to the control valve's spool end.
To meet this function, the pilot valve is comprised of the following elements.
(1) Inlet port (P) through which oil is supplied from the hydraulic pump.
(2) Plural output ports (1, 2, 3 and 4) to actuate the pressure supplied from the inlet port to the control valve's spool end.
(3) Tank port (T) which becomes necessary for controlling the aforesaid output pressure.
(4) Spool to connect the output port with the input port or the tank port.
(5) Mechanical means including spring to act on the aforesaid spool for controlling the output pressure.

(2) Functions of major parts

The function of the spool (201) is such that the oil pressure supplied form the hydraulic pump is received by P port and it changes over the oil path whether the P port hydraulic pressure is guided to the output ports (1, 2, 3 and 4) or the hydraulic pressure is guided to T port. That is the secondary pressure setting spring (241) which acts on this spool (201) to decide the output pressure.
In order to change the flexure of the secondary pressure setting spring (241), the push rod (212) is inserted in the plug (211) in such manner that the rod moves smoothly.
Return spring (221) acts on the casing (101) and the spring seat (216) to return the push rod (212) in the direction of zero displacement, regardless of the output pressure, thus ensuring return of the spring to neutral. Besides, it has an effect as reactive spring to give the operator an adequate operating feeling.

(3) Operation

The operation of the pilot valve is explained hereunder based on the hydraulic pressure circuit diagram (Fig. 1) and the illustrations of operation (Fig. 2 - Fig. 4).
Fig. 1 shows a typical example of use of the pilot valve.

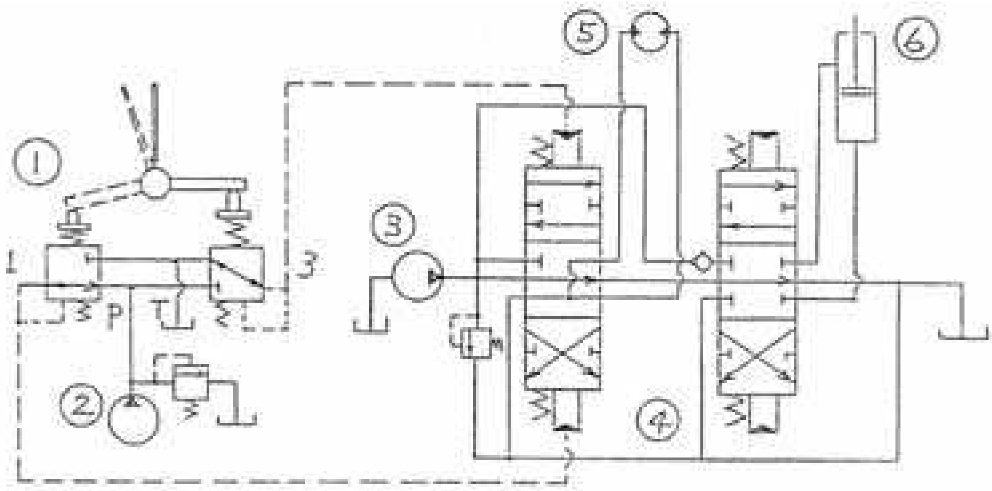
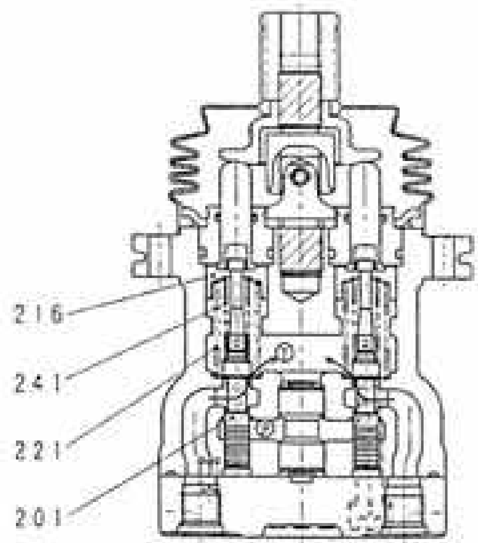


Fig. 1 Example of Use of Pilot Valve

①	Pilot valve	③	Main pump	⑤	Hydraulic motor
②	Pilot pump	④	Control valve	⑥	Hydraulic cylinder

1) When the steering wheel is at neutral position (See Fig. 2.)
   Force of the secondary pressure setting spring (241) which determines the output pressure of the pilot valve does not act on the spool (201). Accordingly, the spool is pushed up by the return spring (221) (spring seat (216)) to communicate the output ports (2, 4) with the T port. Therefore, the output pressure becomes same at the tank pressure.



Ports (2, 4)
Fig. 2 Steering Wheel Being at Neutral Position

2) When the steering wheel is inclined (See Fig. 3.)
When the steering wheel is inclined to stroke the push rod (212), the (spring seat (216)) spool (201) moves downward, the P port communicates with the ports (2, 4) and oil supplied from the pilot pump flows to the ports (2, 4) to generate pressure.

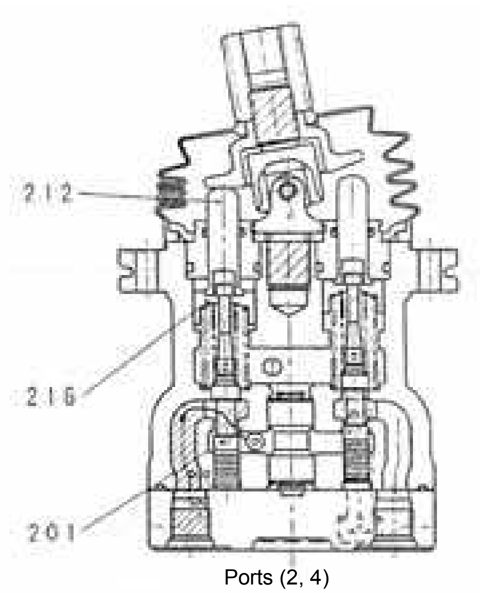


Fig. 3 Steering Wheel Being Inclined

3) When the steering wheel is held. (See Fig. 4.)
When the pressure is raised up to the value equivalent to the force of the spring (241) which has been set by inclination of the steering wheel, balance is kept between the hydraulic pressure force and the spring force. When the pressure of the ports (2, 4) exceeds the set pressure, the ports (2, 4) and the P port close, and the ports (2, 4) and the T port open. When the pressure of the ports (2, 4) drops lower than the set pressure, the ports (2, 4) and the P port open, and the ports (2, 4) and the T port close, thus to keep the secondary pressure constant.

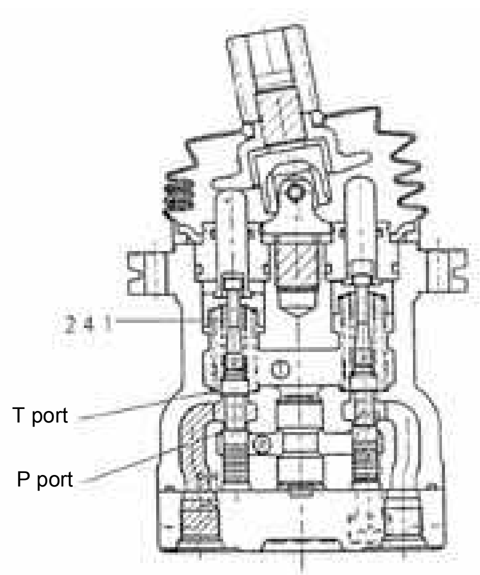
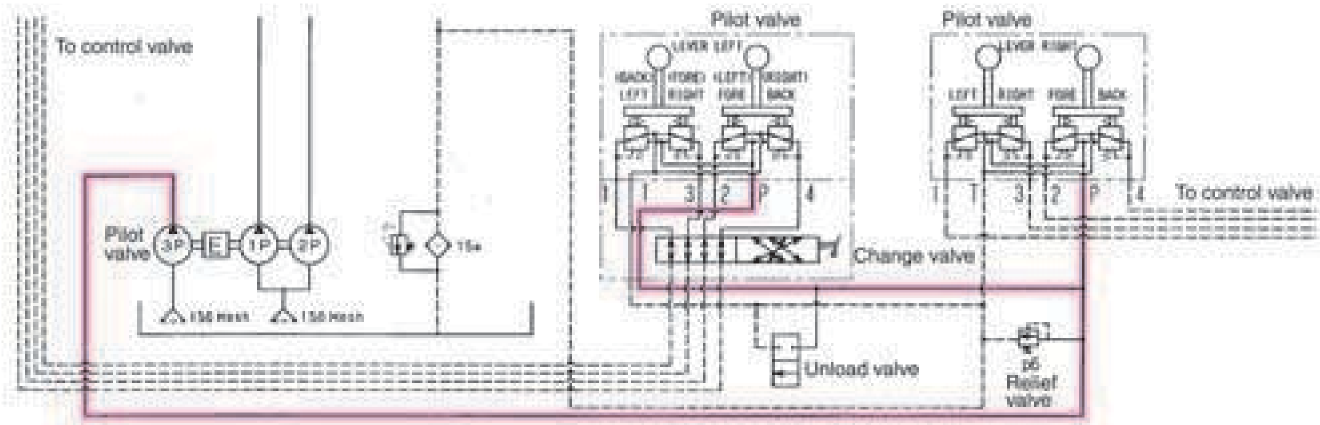


Fig. 4 Steering Wheel Being Held (when the secondary pressure is higher than the set pressure)

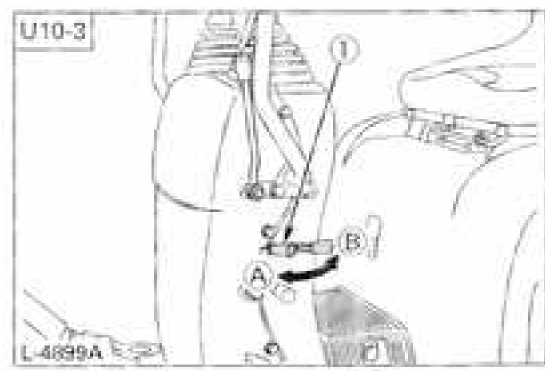
4) Operation in a wide range of steering wheel inclination (which varies depending on the type)
In some types, when the steering wheel is inclined at a certain angle, the spool top end comes in contact with the bottom of push rod inner diameter and the output pressure is in the state of being connected with the P port pressure.
Moreover, in a type which has such a construction that spring seat and spring are assembled in the push rod, when the steering wheel is inclined at an certain angle, the bottom of push rod inner diameter comes in contact with the spring, and the secondary pressure gradient is changed by this spring force. Then, the bottom of push rod inner diameter comes in contact with the spring seat upper end and the output pressure is in the state of being connected with the P port pressure.

E.Hydraulic pilot circuite

Oil supplied from the pilot pump is guided to the right and left pilot valves. Unload valve and relief valve are installed between them.
When the operating lever is manipulated, oil from the right pilot valve is guided directly to the control valve, while the oil from the left pilot valve is guided to the control valve via the change valve.



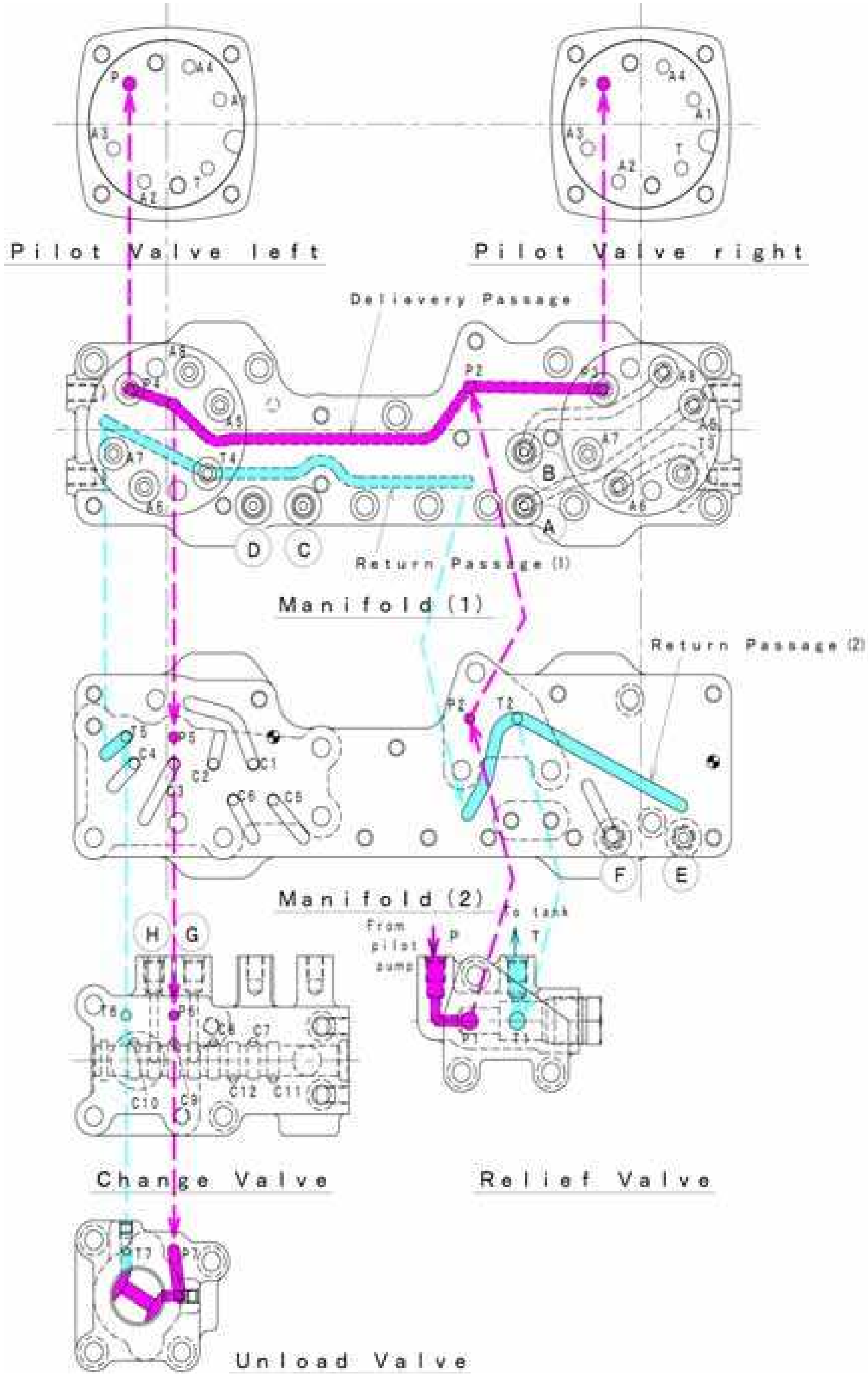
a. Flow of oil at the time when the control lever lock is at lock position (A)



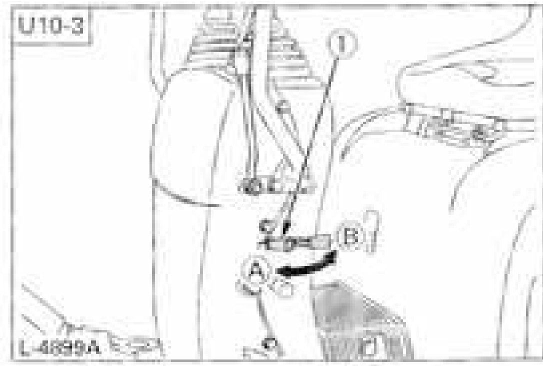
① Lock levers Ⓐ "Lock" Ⓑ "Unlock"

1. Hydraulic oil from the pilot pump passes the P port of the relief valve and P1 port, and guided from the P2 port of the manifold (2) to the delivery passage of the manifold (1).
2. Oil coming to this passage is guided partly to the P port of the left pilot valve through the P3 port, while another part of oil is guided to the P port of the left pilot valve through the P4 port.
3. Hydraulic oil running through the delivery passage is also guided to the P7 port of the unload valve through the P5 port of the manifold (2) and the P6 port of the change valve.
4. Hydraulic oil is blocked in the P port of the pilot valve as long as the control lever is not operated. On the other hand, when the control lever lock is at lock position, the P7 port and the T7 port of the unload valve communicate with each other.
5. Therefore, hydraulic oil which has been guided to the P7 port passes through the P7 port of the unload valve, the T6 port of the change valve and the T5 port of the manifold (2), and flows into the return passage (1) of the manifold (1).
6. Oil at the return passage (1) of the manifold (1) passes through the return passage (2) of the manifold (2), T2 port, the T1 port and T port of the relief valve and returns to the tank.

a. Control lever lock being at lock position



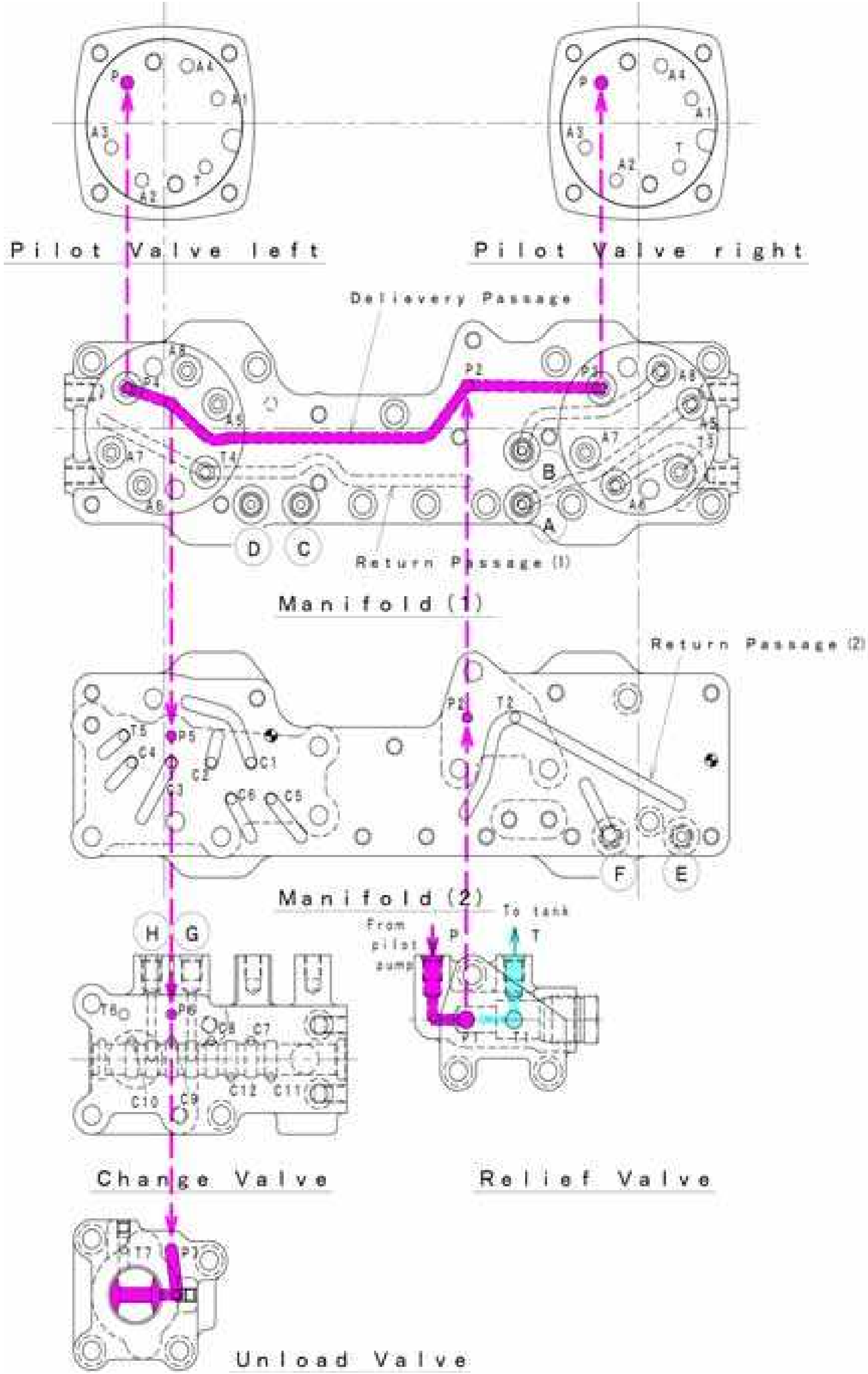
b. Flow of oil at the time when the control lever lock is at unlock position (B)



① Lock levers Ⓐ "Lock" Ⓑ "Unlock"

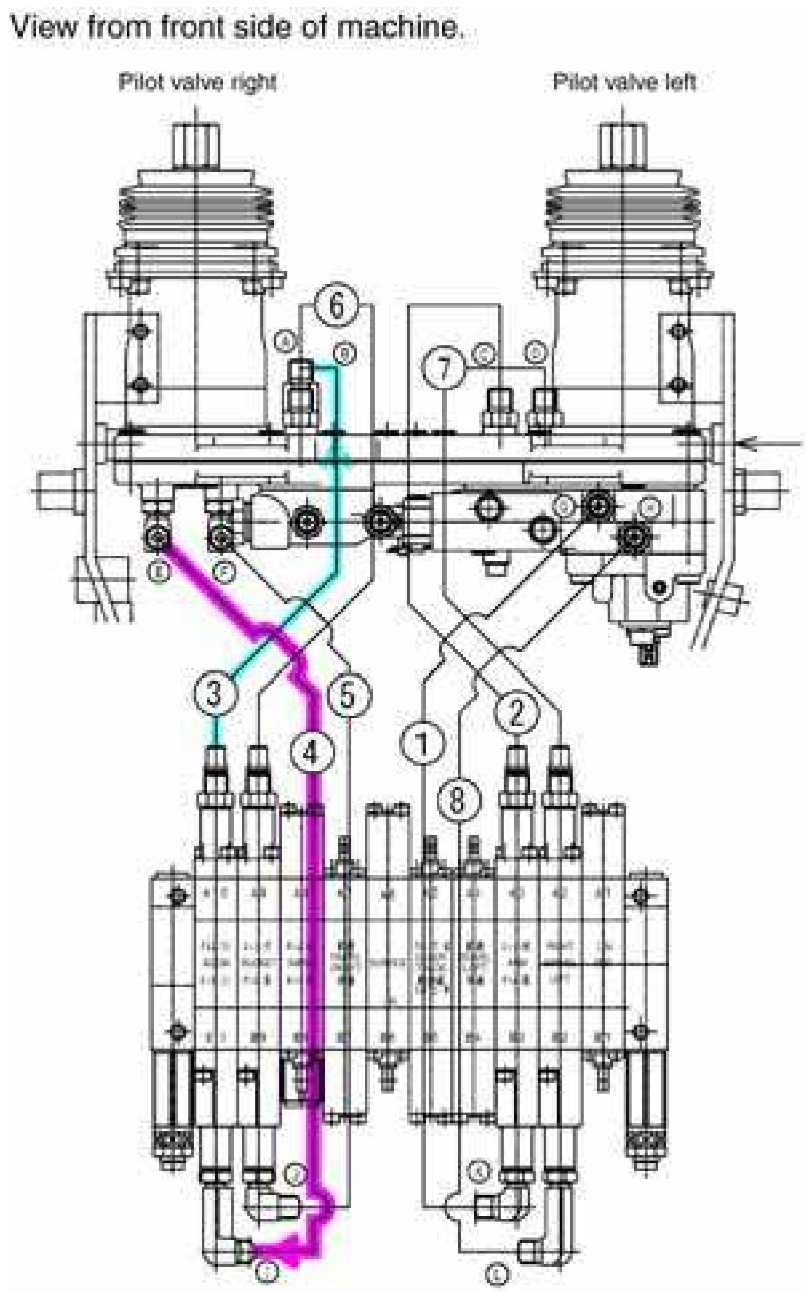
1. Hydraulic oil running from the pilot pump passes through the P port and P1 port of the relief valve and guided to the delivery passage of the manifold (1) through the P2 port of the manifold (2).
2. A part of oil is guide from the delivery passage to the P port of the right pilot valve through the P3 port, while the other part of oil is guided to the P port of the left pilot valve through the P4 port.
3. Hydraulic oil running through the delivery passage is also guided to the P7 port of the unload valve through the P5 port of the manifold (2) and the P6 port of the change valve.
4. Hydraulic oil is blocked in the P port of the pilot valve as long as the control lever is not operated. On the other hand, when the control lever lock is at unlock position, the P7 port the T7 port of the unload valve and t are blocked.
5. Therefore, since hydraulic oil running from the pilot pump is stopped in the pilot valve and unload valve, the hydraulic oil pressure increases. When this pressure rises higher than 2.9Mpa, the value set at the relief valve, the relief valve starts to work and hydraulic oil from the pilot pump returns to the tank.

b. Control lever lock being at unlock position

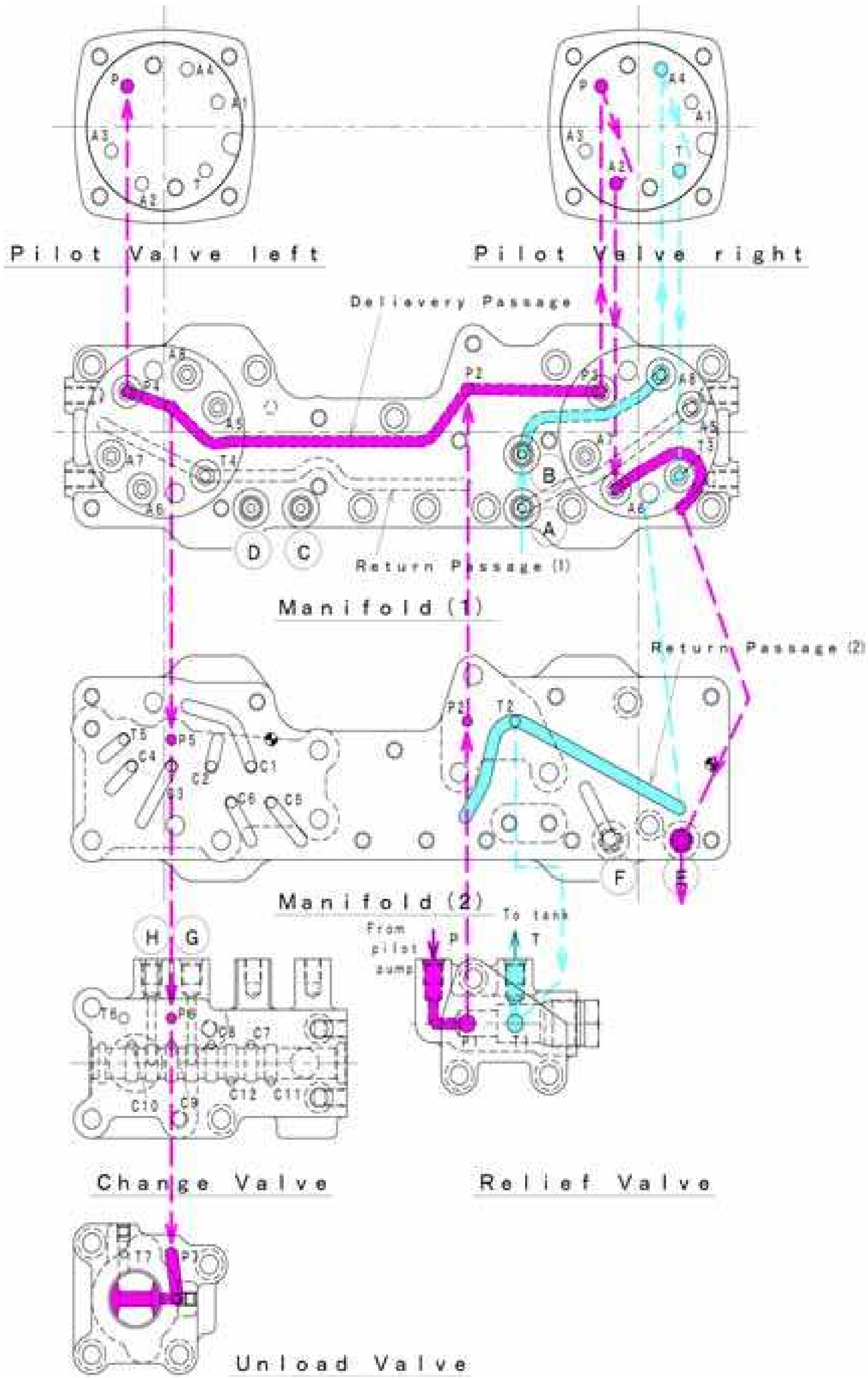


c. Flow of oil in boom lifting operation

1. Oil from the pilot pump passes through the relief valve and the manifold is guided up to the P port of the right pilot valve.
   (Refer to the flow of oil at the times when the control lever lock is locked and when it is unlocked as explained in 1 and 2.)
2. When the boom lifting operation is performed, hydraulic oil passes through the P port of the right pilot valve, A2 port, and the A6 port of the manifold (1) and flows from the E port of the manifold (2) to the pilot port of the B10 section side of the control valve.
3. When the pressure at the B10 section side increases, the main spool starts to move and oil at the B10 section side is pressed out and passes through the B port of the manifold (1), A8 port, and the A4 port of the right pilot valve and T port, and then returns to the tank from the T3 port of the manifold (1) through the return passage (2) of the manifold (2), T2 port, the T1 port of the relief valve and the T port.
4. When oil at the A10 section side is depleted, the main spool is completely changed over to boom lifting side to lift the boom.
5. The flow of oil at the time when the boom is lowered is reverse to that of boom lifting operation.

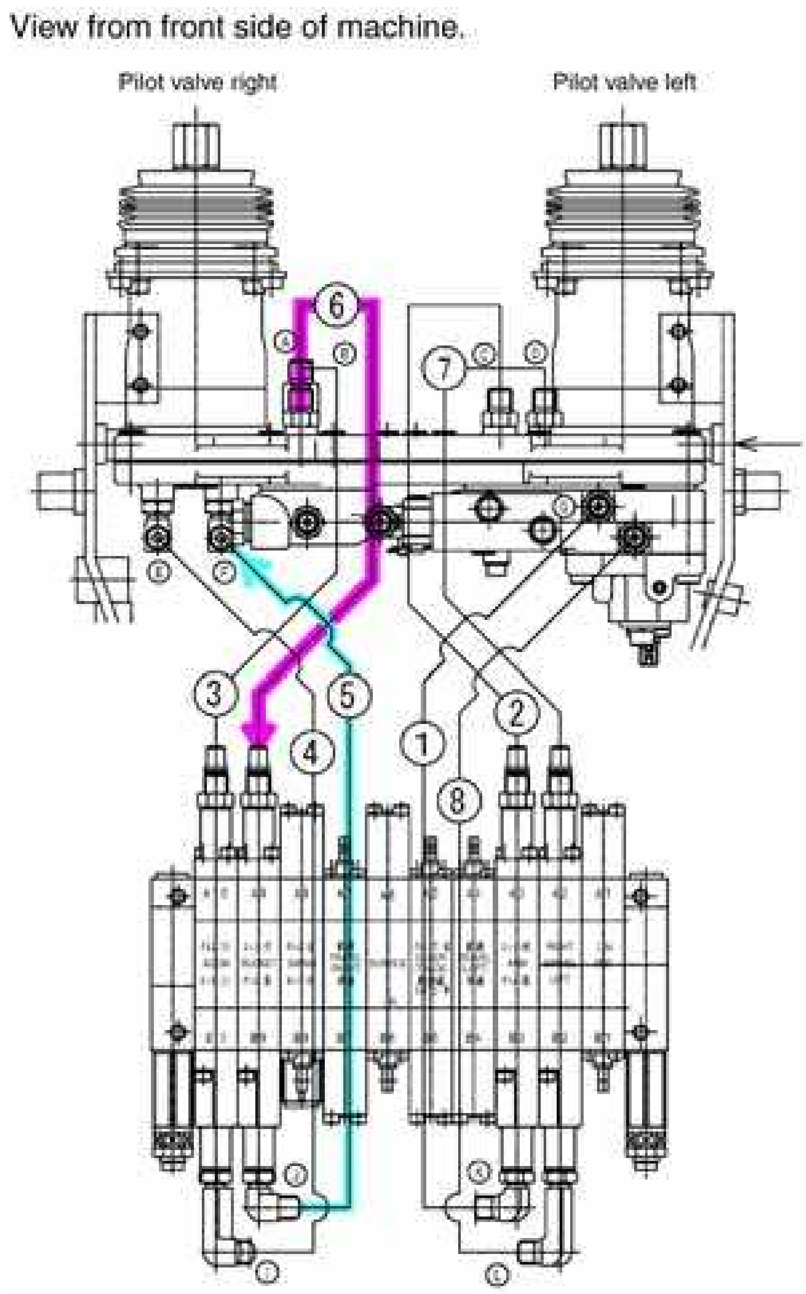


c. Flow of oil in boom lifting operation

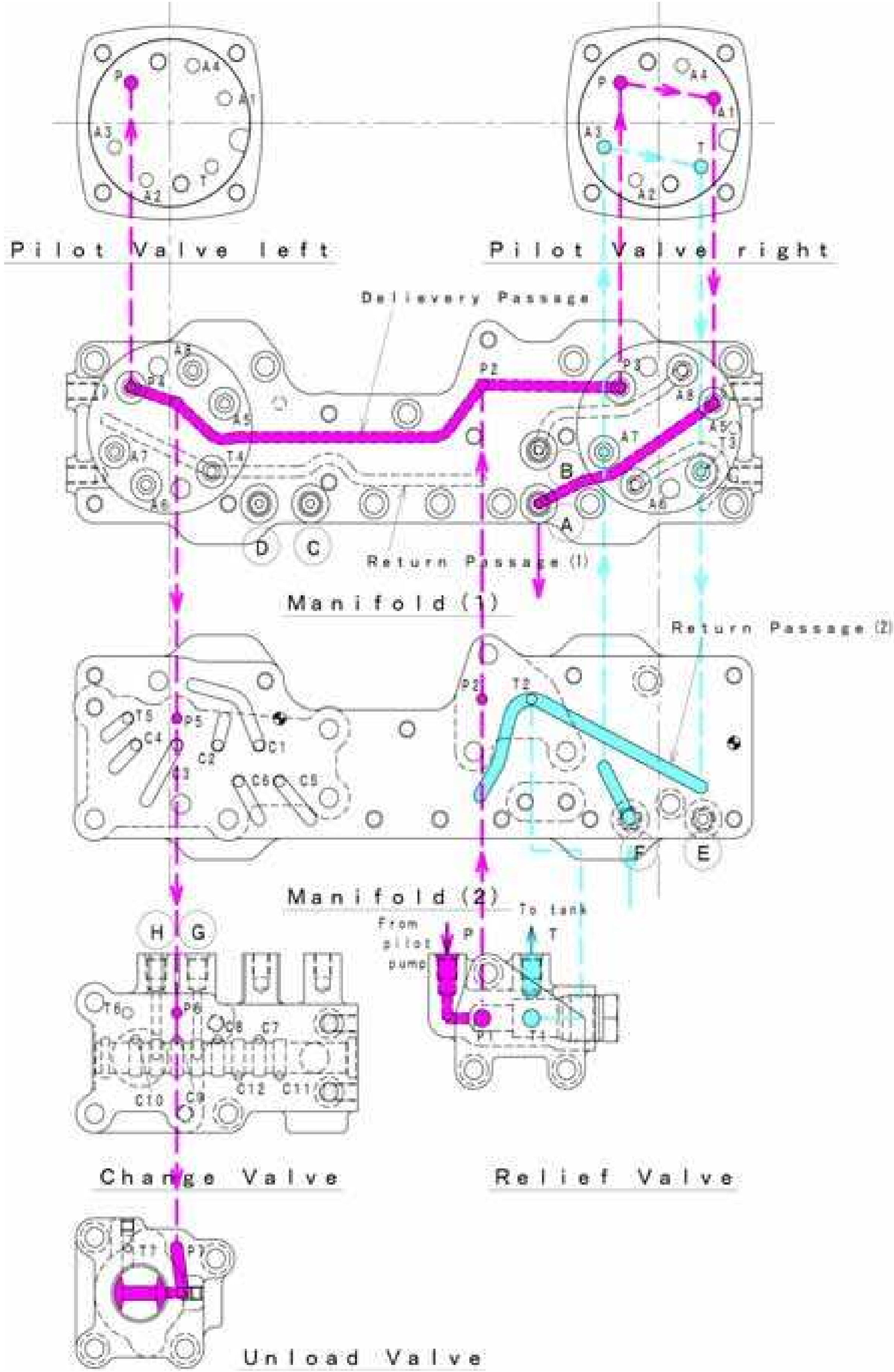


d. Flow of oil in bucket dumping operation

1. Hydraulic oil running from the pilot pump flows through the relief valve and manifold up to the P port of the right pilot valve.
   (Refer to the flow of oil at the times when the control lever lock is locked and when it is unlocked as explained in 1 and 2.)
2. When the bucket dumping operation is performed, hydraulic oil passes through the P port of the right pilot valve, A1 port, and the A5 port of the manifold (1) and flows from the A port to the pilot port of the A9 section side of the control valve.
3. When the pressure at the A9 section side increases, the main spool starts to move and oil at the A9 section side is pressed out and passes through the F port of the manifold (2), A7 port, and the A3 port of the right pilot valve and T port, and then returns to the tank from the T3 port of the manifold (1) through the return passage (2) of the manifold (2), T2 port, the T1 port of the relief valve and the T port.
4. When oil at the B9 section side is depleted, the main spool is completely changed over to boom lifting side to dump the bucket.
5. The flow of oil in bucket raking operation is reverse to that of bucket dumping operation.

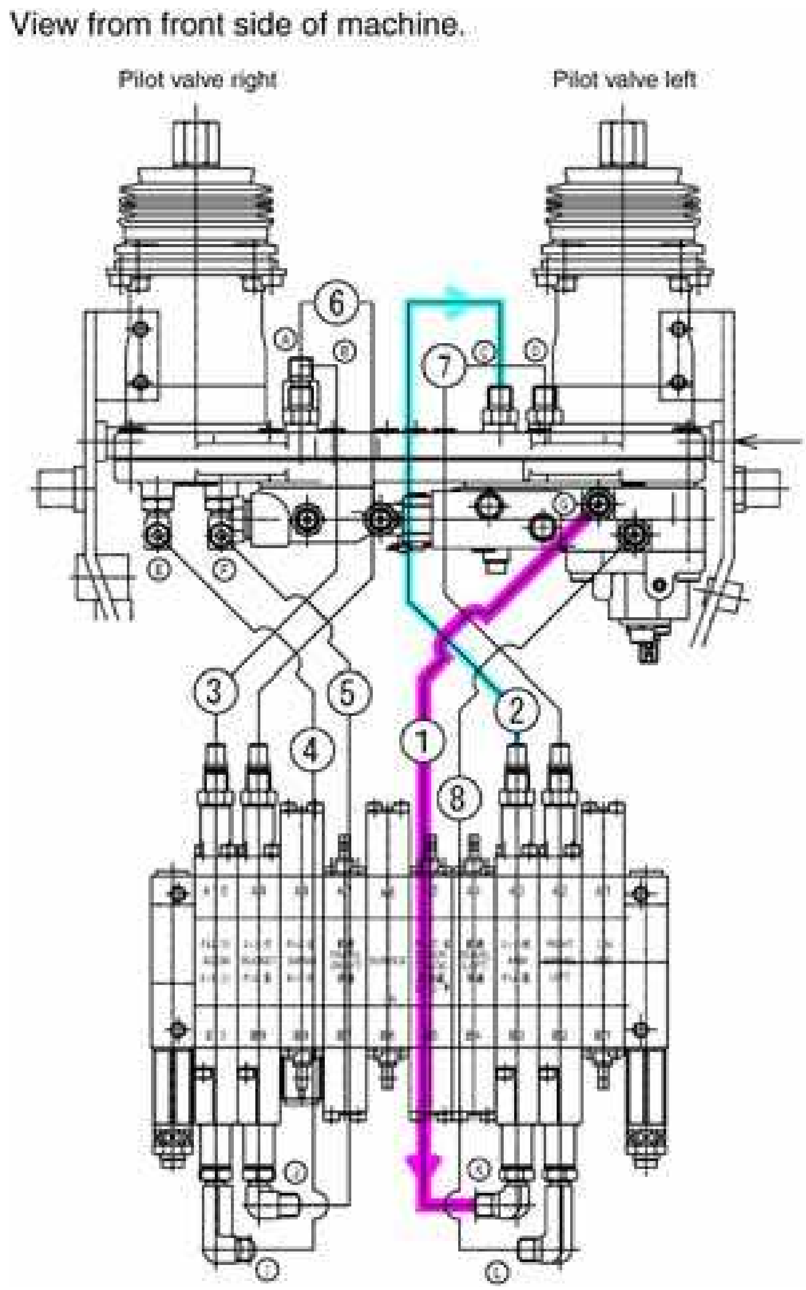


d.Flow of oil in bucket dumping operation

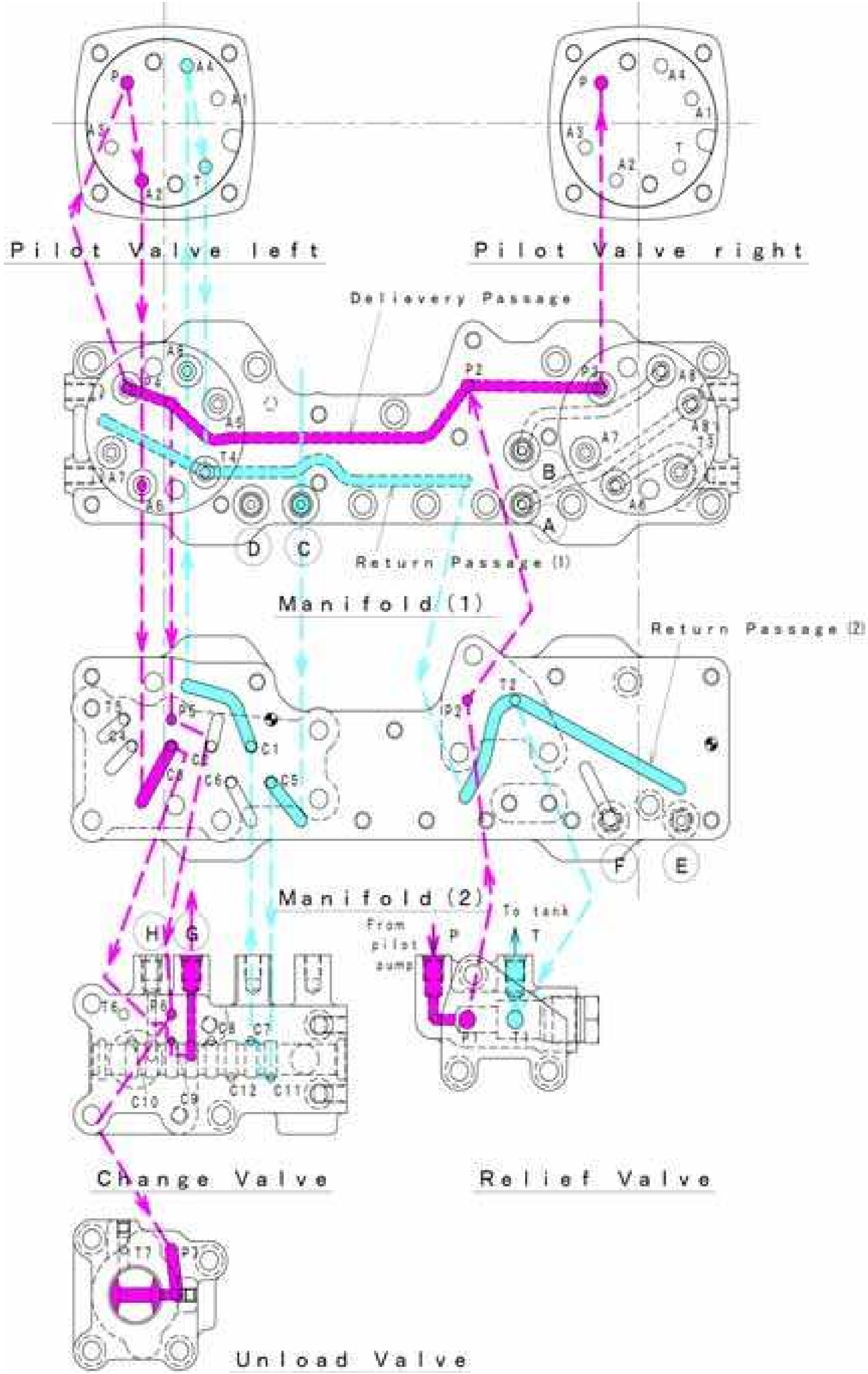


e. Flow of oil in arm crowding operation

1. Hydraulic oil running from the pilot pump flows through the relief valve and manifold up to the P port of the left pilot valve.
   (Refer to the flow of oil at the times when the control lever lock is locked and when it is unlocked as explained in 1 and 2.)
2. When the arm crowding operation is performed, hydraulic oil passes through the P port of the left pilot valve, A2 port, and the A6 port of the manifold (1) and is guided from the C3 port to the manifold (2), C9 port of the change valve and G port to the pilot valve of the B3 section side of the control valve.
3. When the pressure at the B3 section side increases, the main spool starts to move and oil at the A3 section side is pressed out and passes through the C port of the manifold (1), the C5 port of the manifold (2), the C11 port of the change valve, C7 port, the C1 port of the manifold (2), the A8 port of the manifold (1), the A4 port of the left pilot valve, T port, and the T4 port of the manifold (1), and is guided from the return passage of the manifold (1), the return passage of the manifold (2) and the T2 port to the relief valve, and then returns from the T1 port of the relief valve and the T port to the tank.
4. When oil at the A3 section side is depleted, the main spool is completely changed over to arm crowding side to crowd the arm.
5. The flow of oil in arm dumping operation is reverse to that of arm crowding operation.

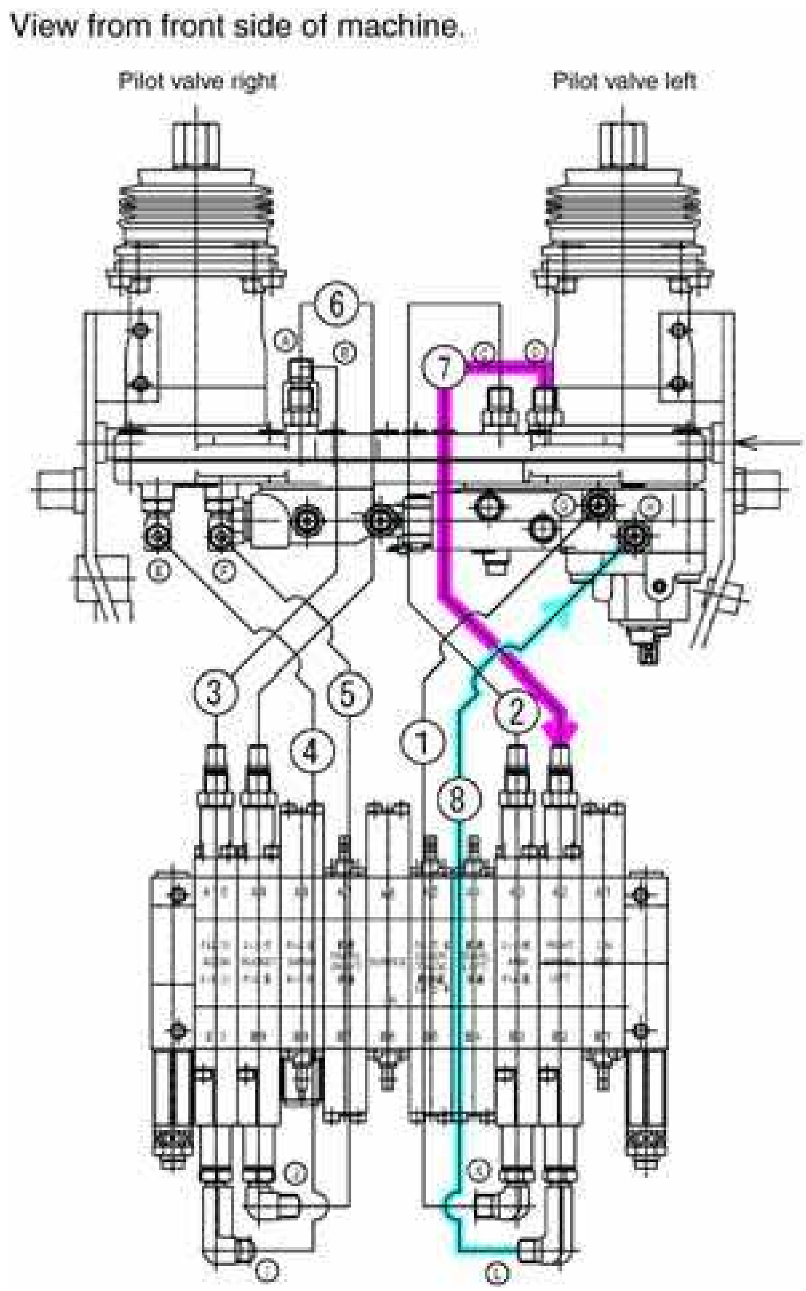


e.Flow of oil in arm crowding operation

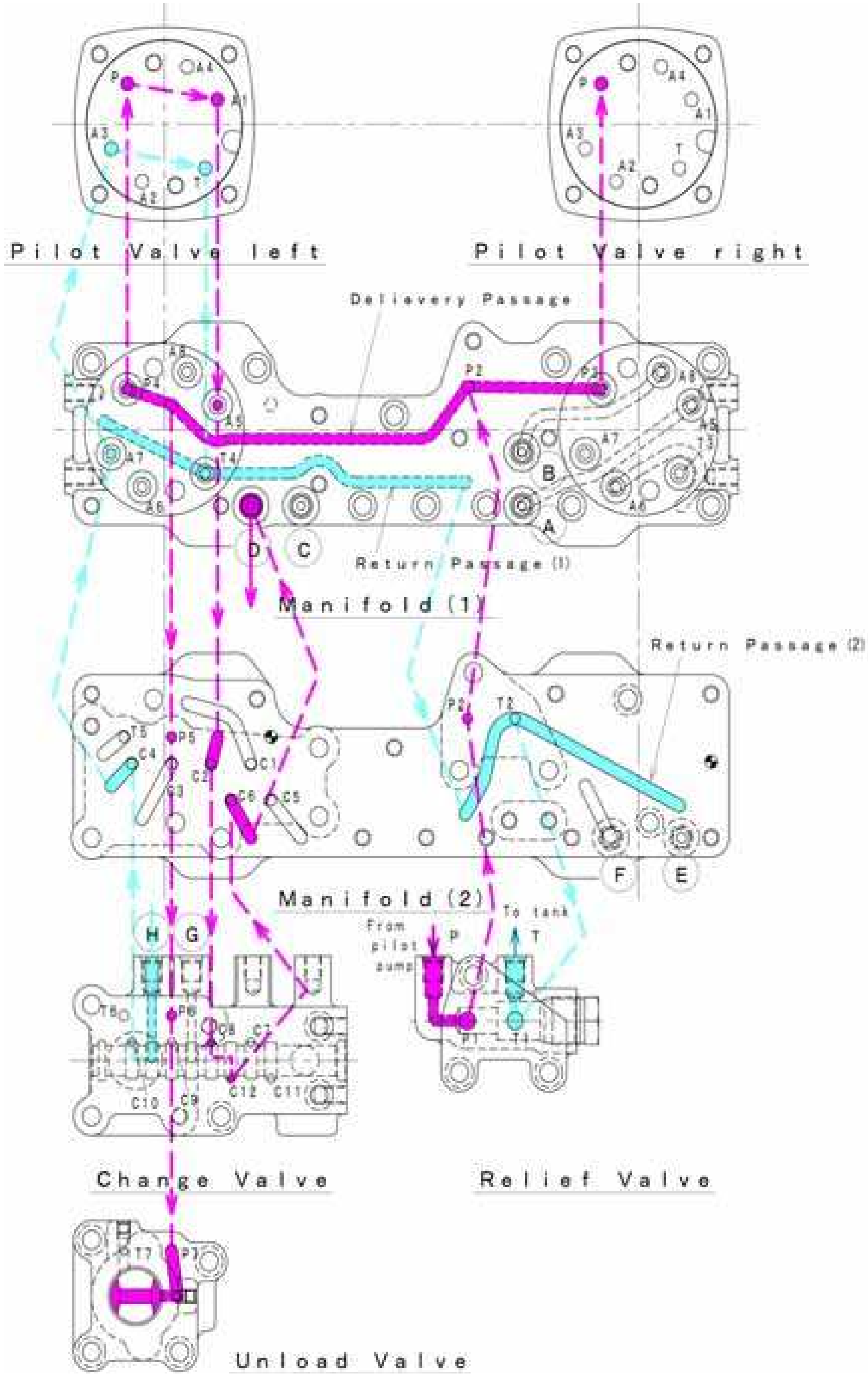


f. Flow of oil in right swivel operation

1. Hydraulic oil running from the pilot pump flows through the relief valve and manifold up to the P port of the left pilot valve.
   (Refer to the flow of oil at the times when the control lever lock is locked and when it is unlocked as explained in 1 and 2.)
2. When the right turning operation is performed, hydraulic oil passes through the P port of the right pilot valve, A1 port and the A5 port of the manifold (1) and flows from the C2 port to the manifold (2), the C8 port of the change valve, C12 port, the C6 port of the manifold (2) and is guided from the D port of the manifold (1) to the pilot port of the A2 section side of the control valve.
3. When the pressure at the A2 section side increases, the main spool starts to move and oil at the B2 section side is pressed out and passes through the H port of the change valve, C10 port, the C4 port of the manifold (2), the A7 port of the manifold (1), the A3 port of the right pilot valve, T port, and the T4 port of the manifold (1) and is guided from the return passage of the manifold (1), the return passage of the manifold (2) and the T2 port, and returns from the T1 port of the relief valve and the T port to the tank
4. When oil at the B2 section side is depleted, the main spool is completely changed over to right turning side to start right turning operation.
5. The flow of oil in left turning operation is reverse to that of right turning operation.

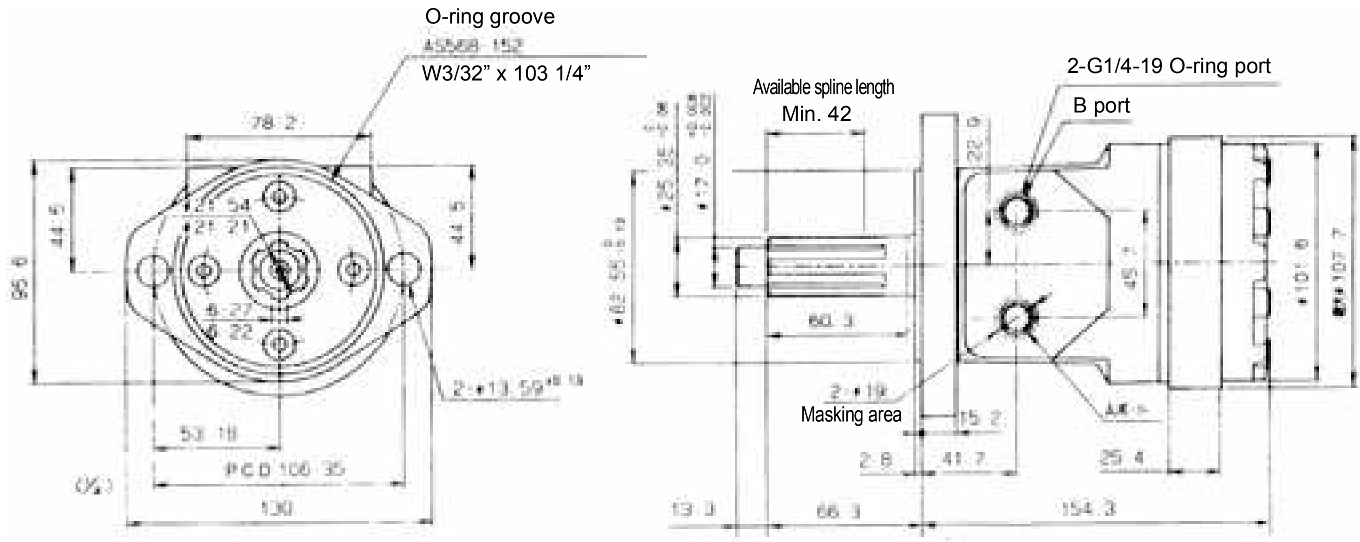


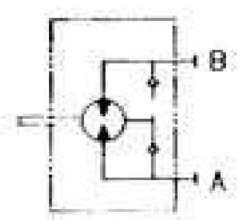
f.Flow of oil in right swivel operation



F. Swing motor (K008-3, U10-3)

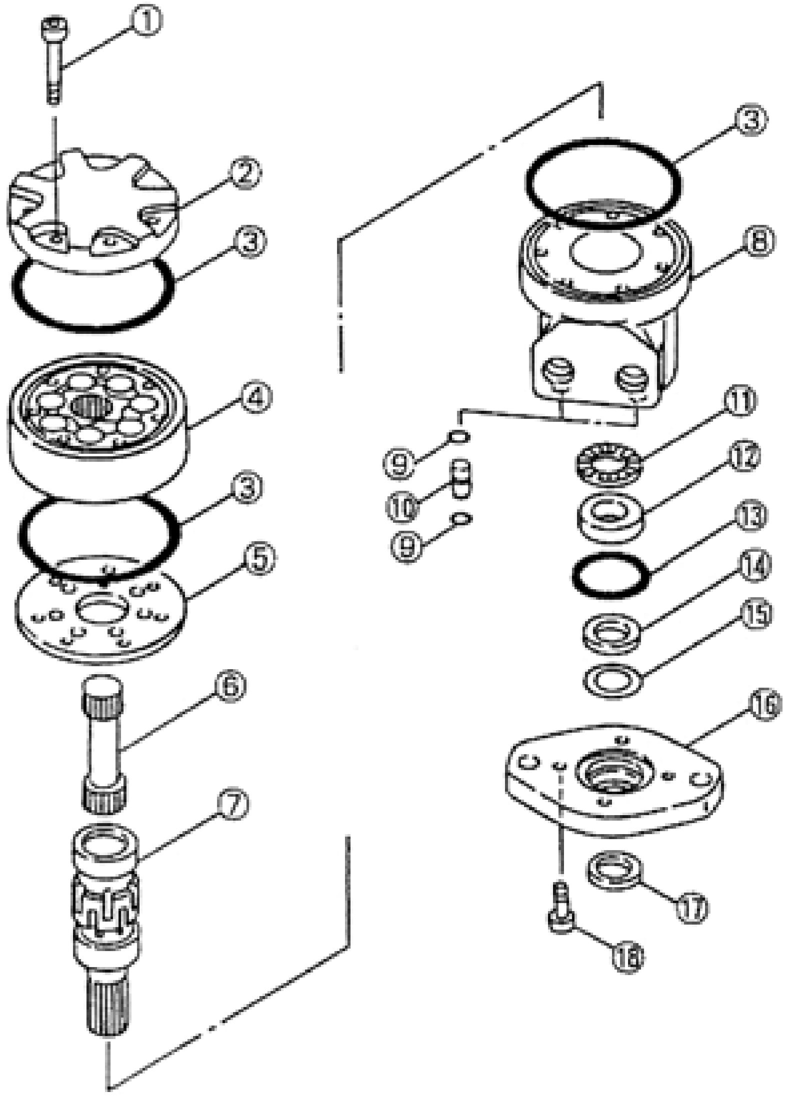
a. Structure and specifications





Specifications

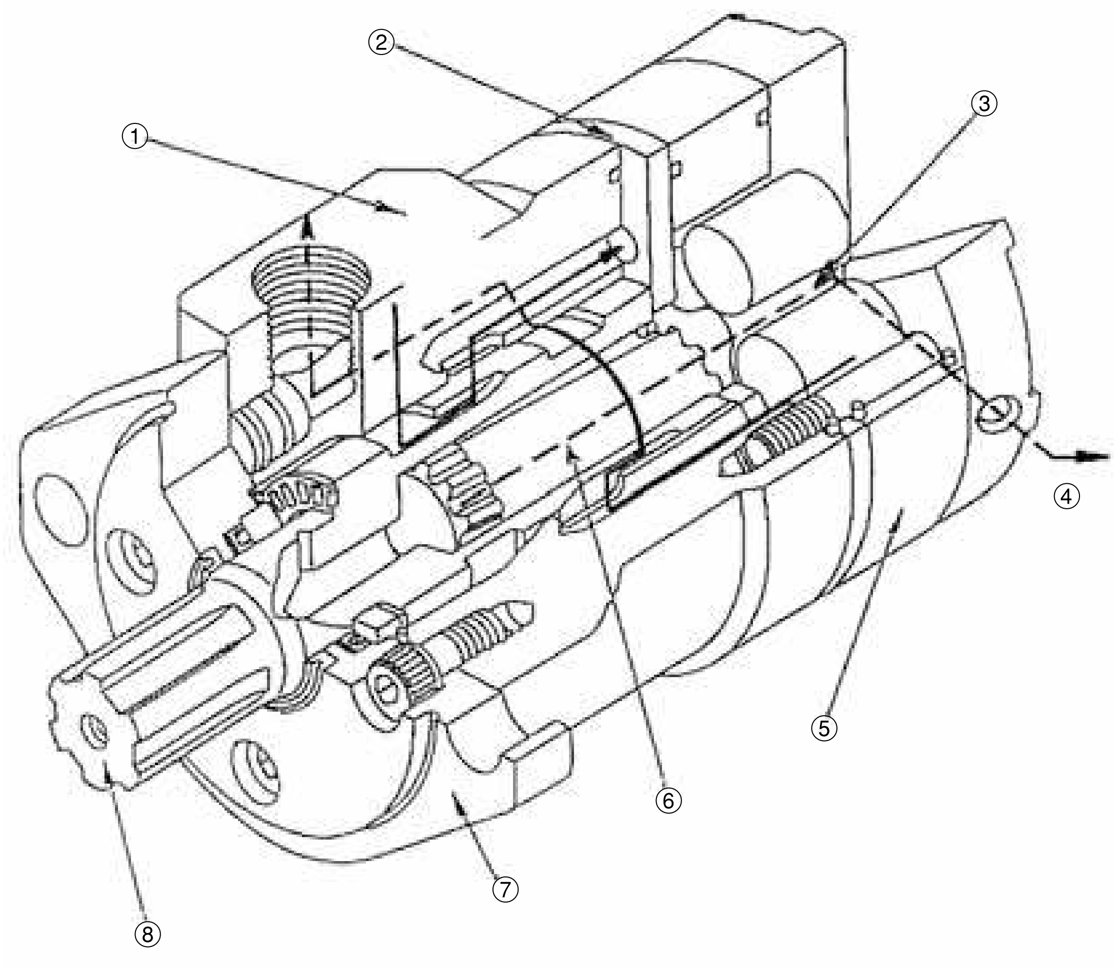
Model	S-190SS2S-K2880	
Displacement	184cc/rev 11.5in^3/rev	
Rotaiting direction (To see from output shaft side)	A port	right
	B port	left
Torque	73% 147N·m 15.0kgf·m 108.2ft·lbf	at 6.87Mpa 70kgf/cm^2 996Psi n=150rpm
Volmetric efficiency	over 95%	



No.	Part Name	Q'ty	No.	Part Name	Q'ty	No.	Part Name	Q'ty
①	Hex. socket head bolt	7	⑦	Shaft output	1	⑬	O-ring	1
②	End gap metal	1	⑧	Housing	1	⑭	Oil seal	1
③	O-ring	3	⑨	O-ring	4	⑮	Backup washer	1
④	Geroller bearing assembly	1	⑩	Ball check sub-assembly	2	⑯	Flange	1
⑤	Spacer plate	1	⑪	Needle bearing	1	⑰	Dust seal	1
⑥	Drive	1	⑫	Bearing race	1	⑱	Hex. socket head bolt	4

b. Operating principle

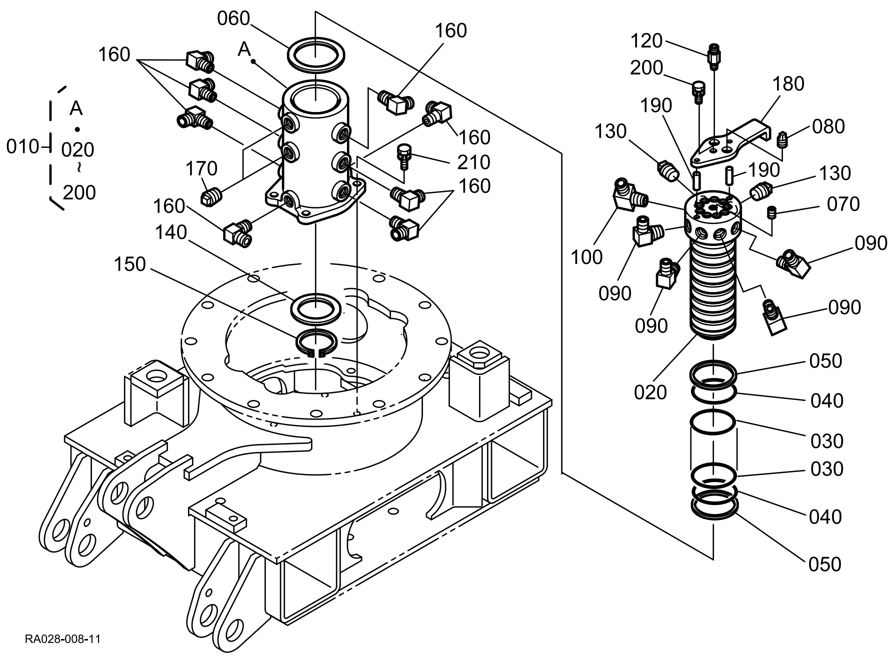
When high-pressure oil is supplied to the A port side of the housing, this high-pressure oil passes through the oil hole provided in the housing and flows into the flange side groove selectively among the grooves provided around the shaft output periphery.
This high-pressure oil enters the geroller through the oil groove of the housing and the oil hole of the spacer plate and turns the geroller star. From this turning, only rotation is taken out, discarding revolution (turning around the geroller star) and turns the shaft output.
Positions of the grooves of the shaft output periphery and the grooves of the housing inner surface are changed at the same time with this turning and the position of oil flow to the geroller is displaced repeatedly in sequence.
Oil discharged from the geroller passes through the oil hole of the spacer plate and the oil groove of the housing, flows into the groove at geroller side among the grooves of the shaft output periphery and runs out of the B port through the oil hole provided at the housing.
As for the rotating speed of the shaft output, the rotating speed of the geroller star becomes 1/the number of teeth of the geroller star, namely, 1/6.
Oil overflowing inside the motor flows, rubricating parts along the dotted line shown in the figure and runs out of the drain port. Accordingly, the pressure inside the case is equal to the pressure of the outside drain line.



①Housing
②Spacer plate
③Geroller shaft
④Drain
⑤Geroller
⑥Drive
⑦Flange
⑧Shaft output

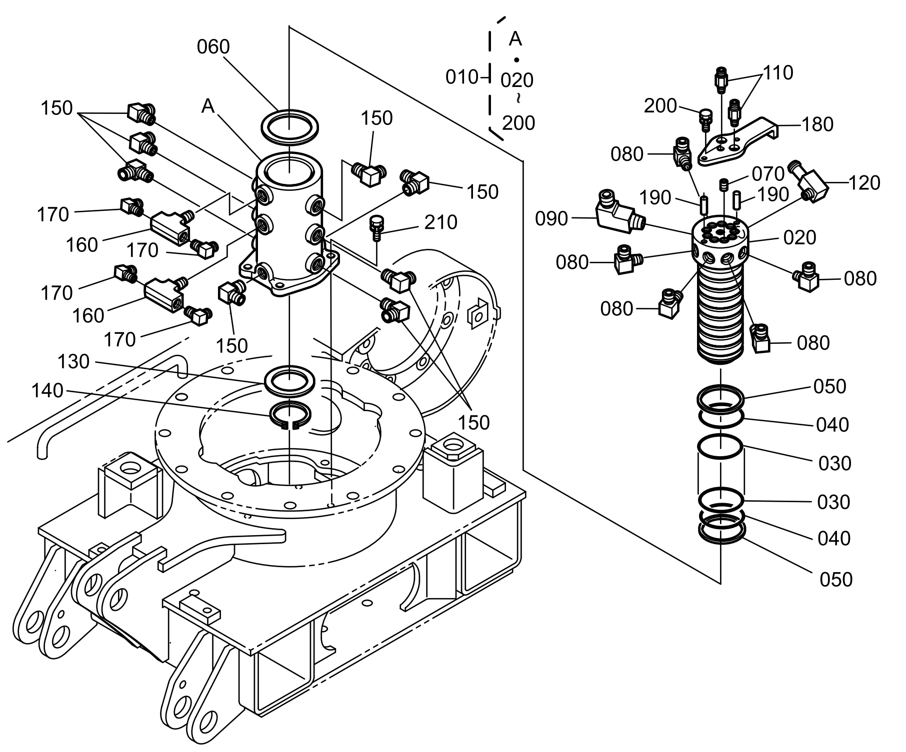
G.Rotary joint (Swivel Joint)

K008-3 Single speed travel (Retractable track)



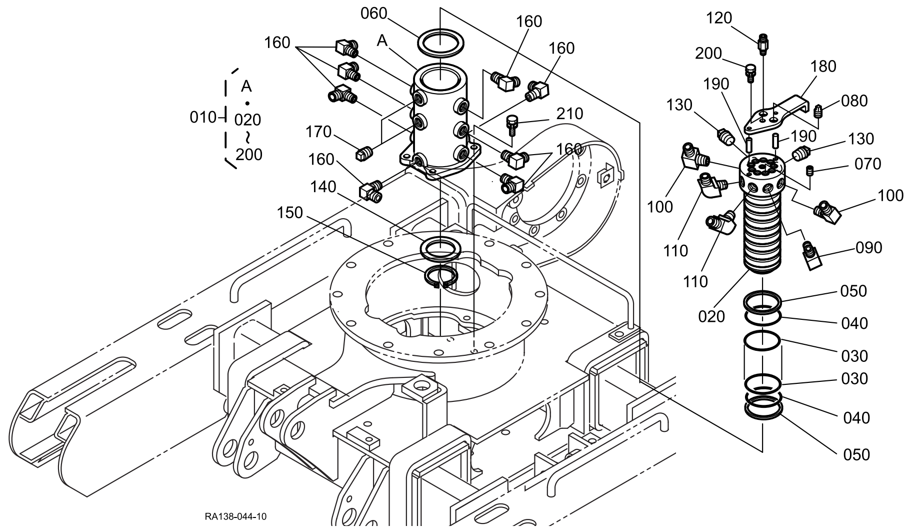
No.	Part Name.	Q'ty
010	Assy joint, Swivel	1
020	Shaft, Swivel joint	1
030	O-ring	8
040	O-ring	2
050	Rng, Backup	2
060	Collar	1
070	Plug	7
080	Plug	1
090	Joint	4
100	Joint, Pipe	1
110	brank	-
120	Joint	1
130	Plug	2
140	Collar	1
150	Circlip, External	1
160	Joint	8
170	Plug	2
180	Stopper	1
190	Pin, Straight	2
200	Bolt	1
210	Bolt	4

K008-3 Two speed travel (Retractable track)

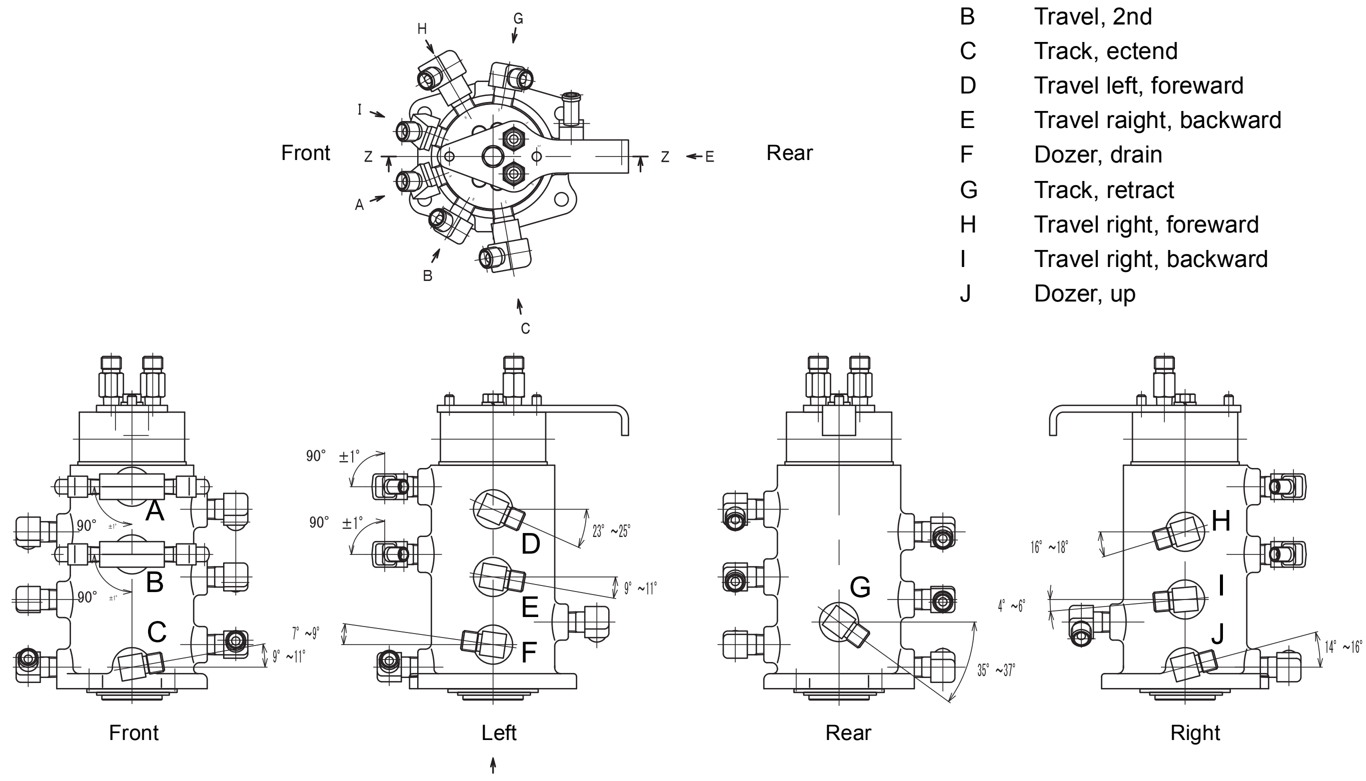


No.	Part Name.	Q'ty
010	Assy joint, Swivel	1
020	Shaft, Swivel joint	1
030	O-ring	8
040	O-ring	2
050	Rng, Backup	2
060	Collar	1
070	Plug	7
080	Joint	5
090	Joint, Pipe	1
100	brank	-
110	Joint	2
120	Joint, Pipe	1
130	Collar	1
140	Circlip, External	1
150	Joint	8
160	Joint	2
170	Joint	4
180	Stopper	1
190	Pin, Straight	2
200	Bolt	1
210	Bolt	4

U10-3 Two Speed travel (Retractable Track)



No.	Part Name.	Q'ty
010	Assy joint, Swivel	1
020	Shaft, Swivel joint	1
030	O-ring	8
040	O-ring	2
050	Rng, Backup	2
060	Collar	1
070	Plug	7
080	Joint	2
090	Joint	2
100	Joint	2
110	Joint	2
120	Joint	1
130	Collar	1
140	Circlip, External	1
150	Joint	8
160	Joint	2
170	Joint	4
180	Stopper	1
190	Pin, Straight	2
200	Bolt	1
210	Bolt	4

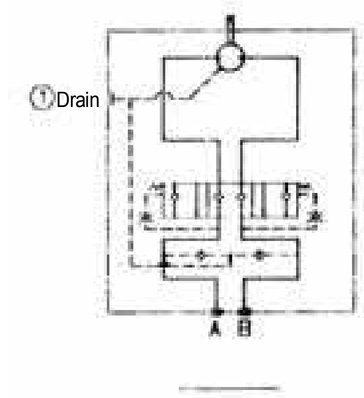


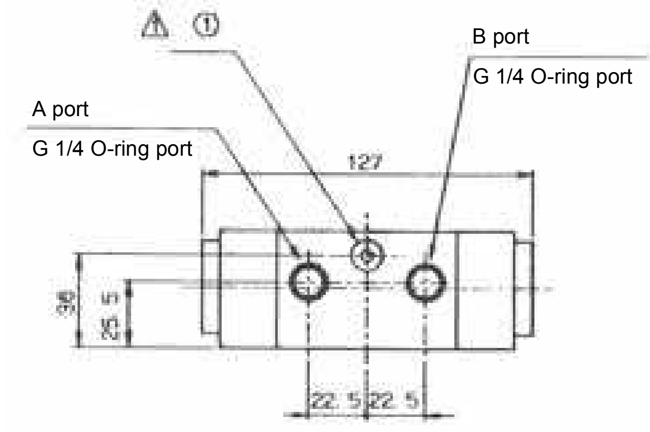
A	Travel, drain
B	Travel, 2nd
C	Track, ectend
D	Travel left, foreward
E	Travel raight, backward
F	Dozer, drain
G	Track, retract
H	Travel right, foreward
I	Travel right, backward
J	Dozer, up

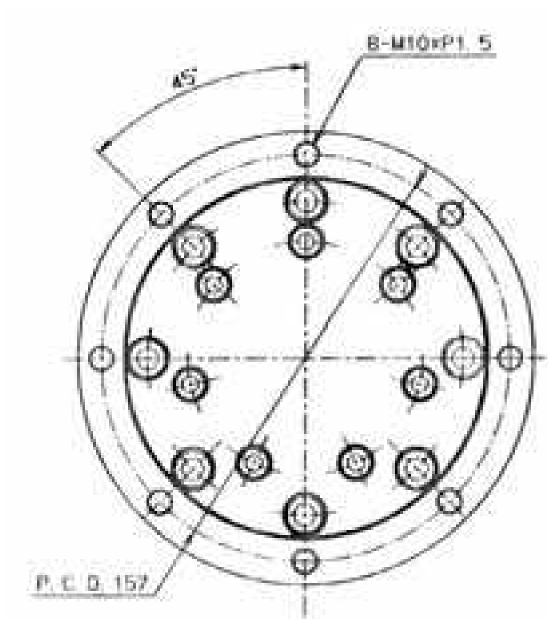
H.Travel motor

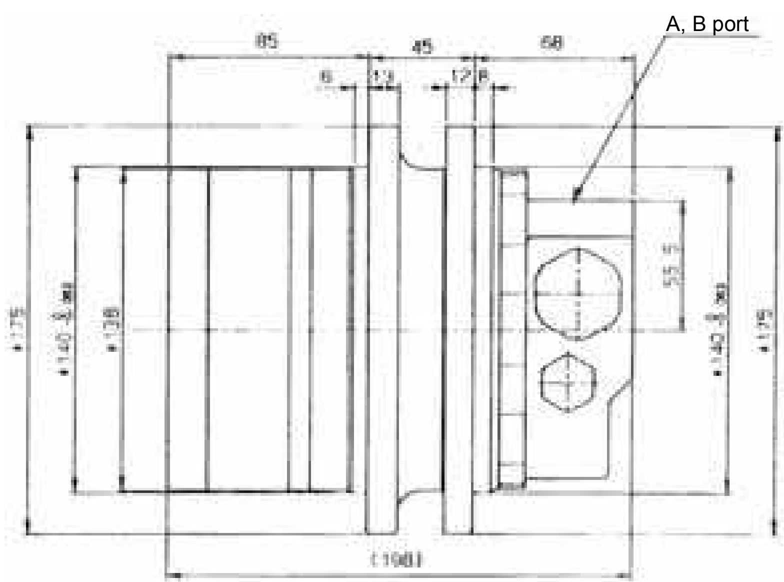
a. Single speed motor (K008, Eu-version)

(1) Structure & Specifications



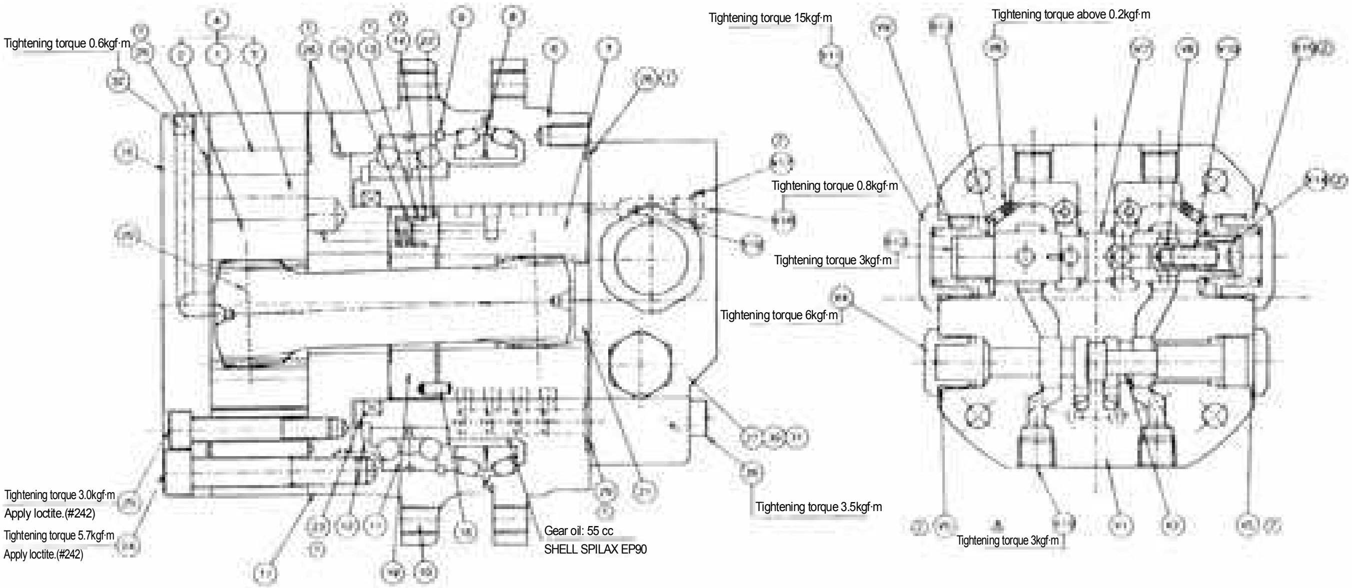






(2) Specifications

		K008-3	
		EU - version	
Speed Range		1	
Model		TR BF31C1101-A	
Displacement		311 cc/rev	
Theoretical max. output torque		874N·m 89.1kgf·m	
Theoretical max. rotating speed	1F	36.0rpm	
	2F	-	
Rotaiting direction (To see from output shaft side)		A port	left
		B port	right
Torque efficiency	at 10.3MPa 105kgf/cm^2 1493Psi	over 75%	
Volmetric efficiency	11.2l/min 2.96gal/min	over 85%	

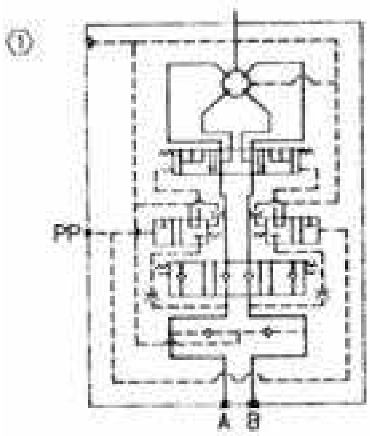


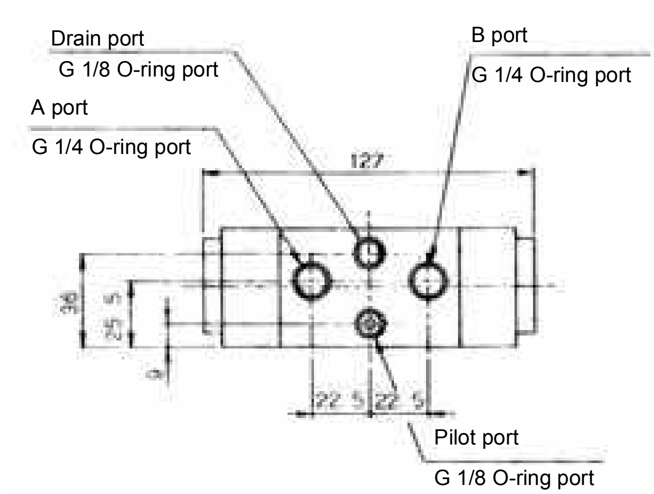
No.	Part Name	Q'ty	Part Number	Remarks	Customer's part number
1	Ring	1			
2	Star	1			
3	Roller	7			
4	Geroller assembly	1	AF0108C-001		RA021-70211
5	Spindle wheel assembly	1	AF0107B-1	Including Item Nos. 1~6	RA021-70221
6	Spindle	1			
7	Valve sleeve	1			
8	Floating seal	1 set			
9	Circlip for hole	1			
10	Wheel	1			
11	Angular ball bearing	1	ϕ 90		
12	Circlip for shaft	1			
13	O-ring	12		1BP8 HS90	
14	Backup ring	12		T3-P8	
15	Coil spring	12			
16	Parallel pin	2	AF0116A		RA021-70231
17	Valve plate	1	AF0101C		RA021-70241
18	Geroller cover	1	AF0100B		RA021-70251
19	Valve	1	AF0103B		RA021-70261
20	Drive	1	AF0102C-001		RA021-70271
21	Spacer	1	AF0117A		RA021-70281
22	Sleeve	12	AF0104A		RA021-70291
23	X-ring	1		R70	
24	Hex. socket head bolt	8	DW0024A-060	M10 × 60	01311-11060
25	Hex. socket head bolt	7	AA0033A-50	M8 × 50	01311-10850
26	O-ring	4		S105 HS70	
27	End cover assembly	1	AF0129C	(Including Item Nos. V1 - V19)	RA021-70301

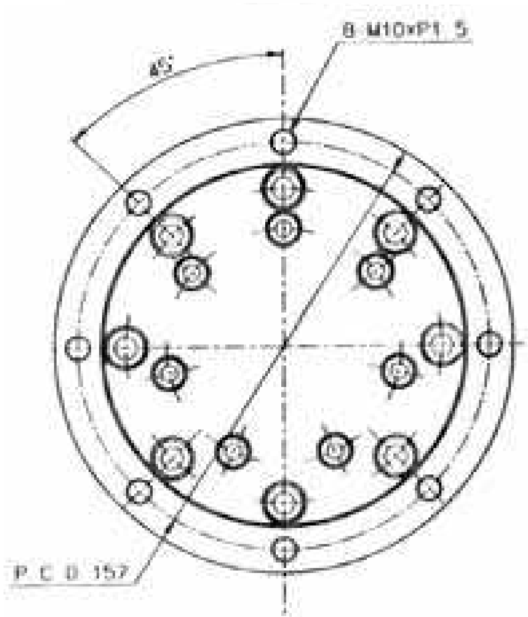
No.	Part Name	Q'ty	Part Number	Remarks	Customer's part number
28	Hex. socket head bolt	4	AA0033A	M8 × 50	01311-10850
29	O-ring	4		1BP 10A HS90	
30	Name plate	1			
31	Rivet	2			
32	Plug	1	DW0128A		RA021-70311
V1	Valve housing	1			
V2	Single connector	1			
V4	2-speed plug	2			
V5	O-ring	2		AS568-908, HS90	
V6	Orifice	2		M4 (ϕ 0.4 orifice)	
V7	Spool	1			
V8	Poppet	2			
V9	Main spring	2			
V10	Check spring	2			
V11	Plug	2			
V12	Check plug	2			
V13	Washer	2			
V14	O-ring	2		AS568-904, HS90	
V15	O-ring	2		AS568-914, HS90	
V16	Check plug	2			
V17	O-ring	2		AS568-903, HS90	
V18	Ball	2		1/4	
V19	Pilot plug	2		R1/4(Seal tape)	

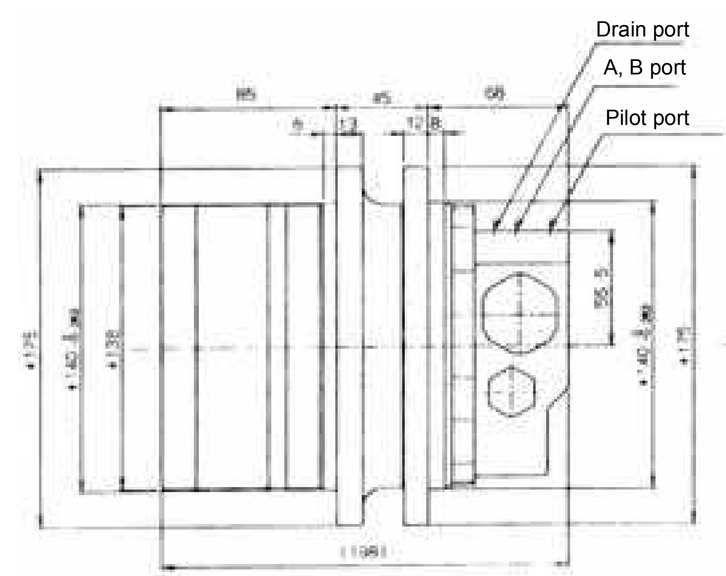
b. Two speed motor

(1) Structure & Specifications



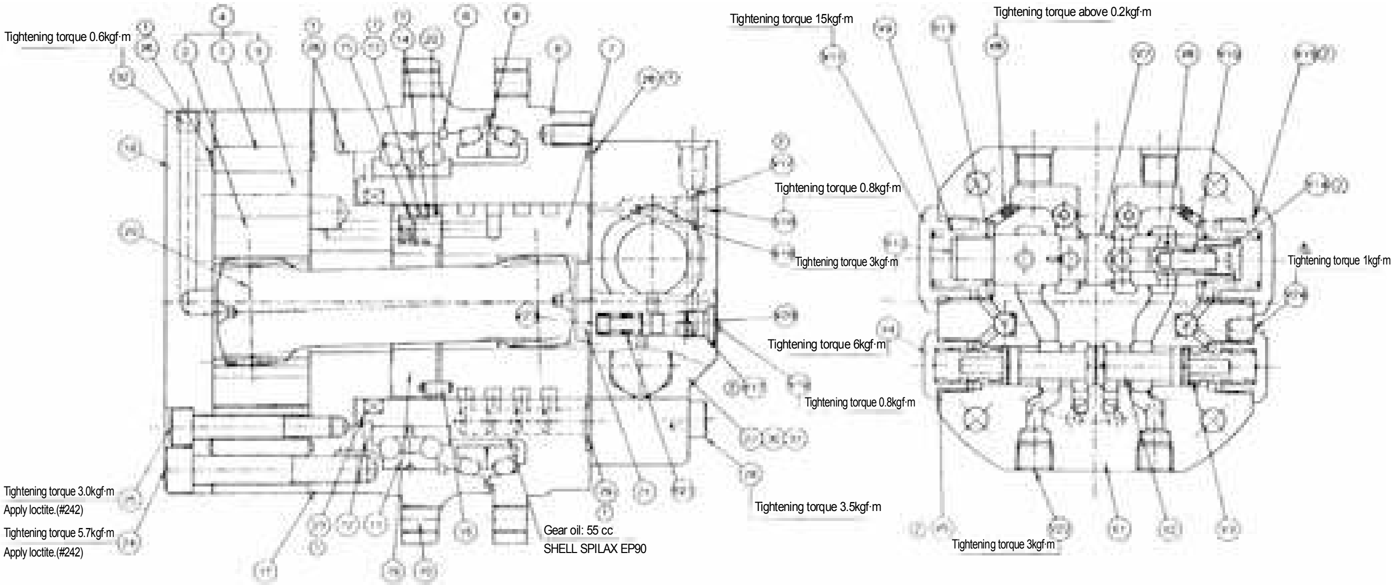






(2) Specifications

		K008-3	U10-3
		KTC, KCL, KTA version	EU - version
Speed Range		2	2
Model		TR BV31C1101-A	
Displacement		311 cc/rev 19.0in^3/rev	
Theoretical max. output torque		874N·m 89.1kgf·m 644.3ft·lbf	
Theoretical max. rotating speed	1F	36.0rpm	
	2F	72.0rpm	
Rotaiting direction (To see from output shaft side)		A port	left
		B port	right
Torque efficiency	at 10.3MPa 105kgf/cm^2 1493Psi	over 75%	
Volmetric efficiency	11.2l/min 2.96gal/min	over 85%	

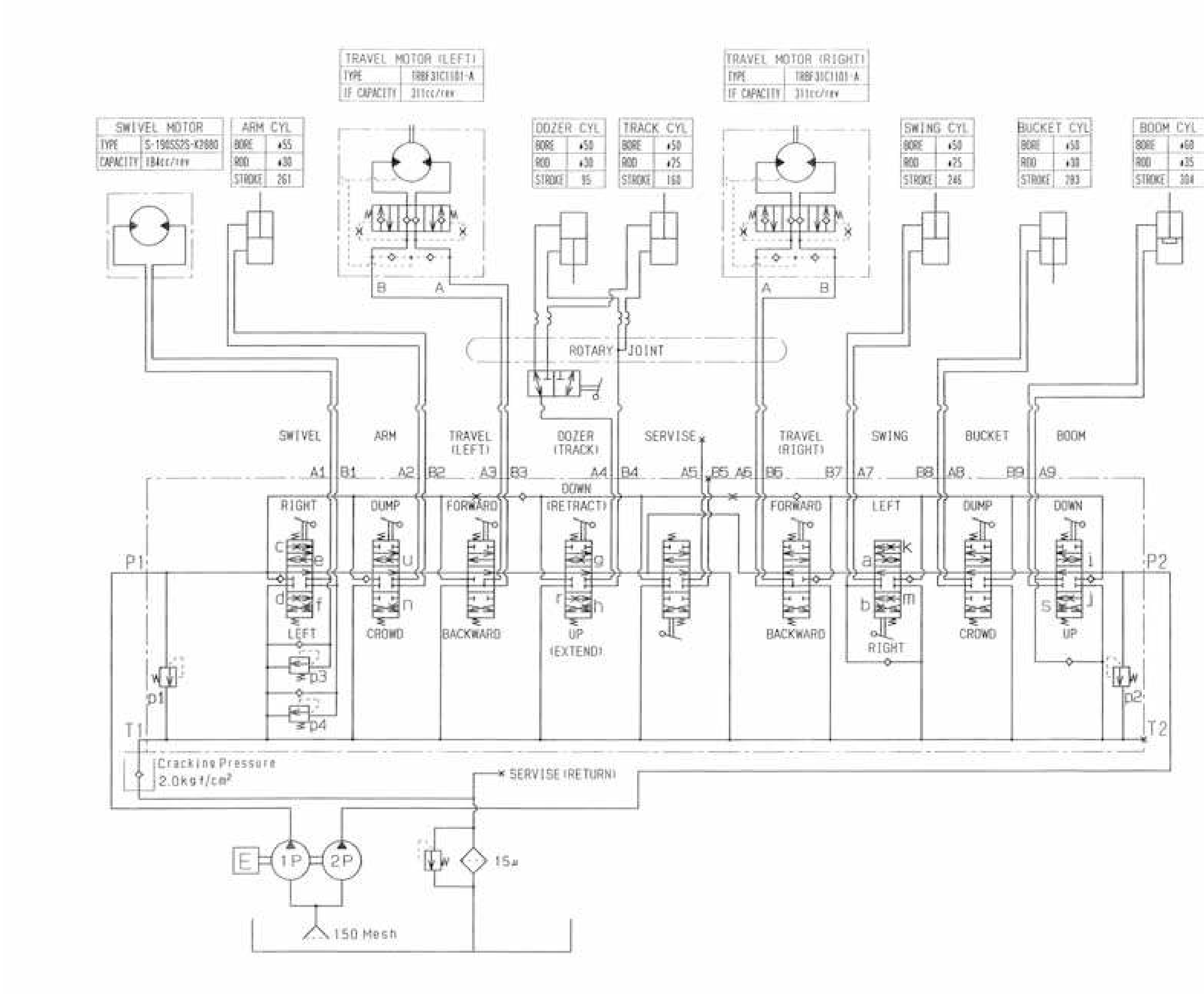


		Q'ty	Part Number	Remarks	Customer's part number
1	Ring	1			
2	Star	1			
3	Roller	7			
4	Geroller assembly	1	AF0108C-001		RA021-70211
5	Spindle wheel assembly	1	AF0107B-1	Including Item Nos. 1~6	RA021-70221
6	Spindle	1			
7	Valve sleeve	1			
8	Floating seal	1 set			
9	Circlip for hole	1			
10	Wheel	1			
11	Angular ball bearing	1	ϕ 90		
12	Circlip for shaft	1			
13	O-ring	12		1BP8 HS90	
14	Backup ring	12		T3-P8	
15	Coil spring	12			
16	Parallel pin	2	AF0116A		RA021-70231
17	Valve plate	1	AF0101C		RA021-70241
18	Geroller cover	1	AF0100B		RA021-70251
19	Valve	1	AF0103B		RA021-70261
20	Drive	1	AF0102C-001		RA021-70271
21	Spacer	1	AF0117A		RA021-70281
22	Sleeve	12	AF0104A		RA021-70291
23	X-ring	1		R70	
24	Hex. socket head bolt	8	DW0024A-060	M10 × 60	01311-11060
25	Hex. socket head bolt	7	AA0033A-50	M8 × 50	01311-10850
26	O-ring	4		S105 HS70	
27	End cover assembly	1	AF0129C	(Including Item Nos. V1 - V24)	RA021-70301

		Q'ty	Part Number	Remarks	Customer's part number
28	Hex. socket head bolt	4	AA0033A	M8 × 50	01311-10850
29	O-ring	4		1BP 10A HS90	
30	Name plate	1			
31	Rivet	2			
32	Plug	1	DW0128A		RA021-70311
V1	Valve housing	1			
V2	2-speed spool	1			
V3	2-speed spring	2			
V4	2-speed plug	2			
V5	O-ring	2		AS568-908, HS90	
V6	Orifice	2		M4 (ϕ 0.4 orifice)	
V7	Spool	1			
V8	Poppet	2			
V9	Main spring	2			
V10	Check spring	2			
V11	Plug	2			
V12	Check plug	2			
V13	Washer	2			
V14	O-ring	2		AS568-904, HS90	
V15	O-ring	2		AS568-914, HS90	
V16	Check plug	2			
V17	O-ring	2		AS568-903, HS90	
V18	Ball	2		1/4	
V19	Pilot plug	2			
V20	Pilot poppet	2			
V21	Pilot poppet spring	2			
V22	Plug	2		R1/4(Seal tape)	
V23	Orifice plate	2			
V24	Plug	1		R1/8(Seal tape)	

I. Hydraulic circuit

a. K008-3 : EU - version

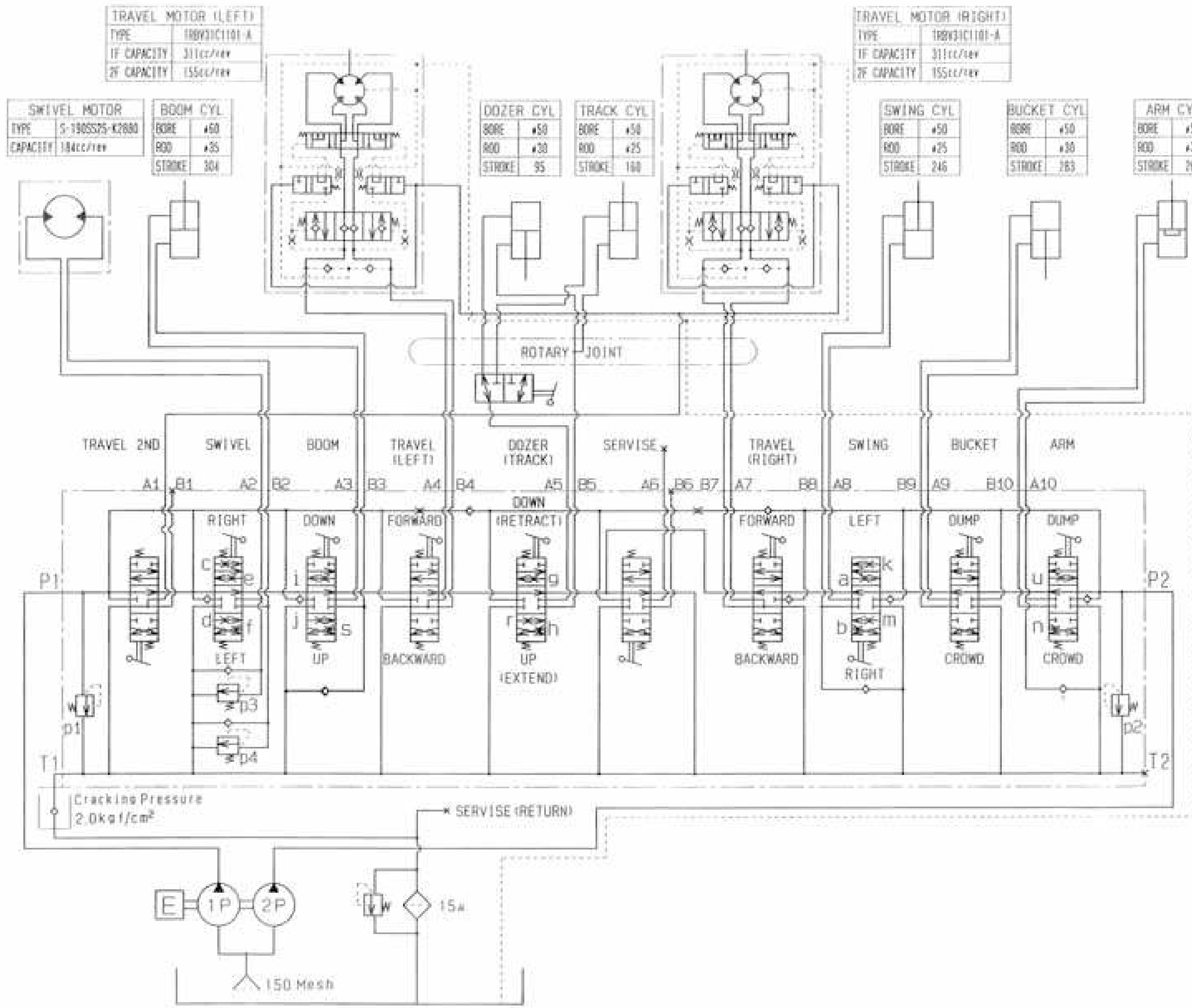


	P1	P2
ENGINE SPEED (rpm)	2050	2050
DISPLACEMENT (cc/rev)	5.05	5.05
DISCHARGE CAPACITY (l/min)	10.35	10.35

RELIEF PRESSURE (MPa)	
p1	16.7
p2	16.7
p3	6.86
p4	6.86

SIZE OF NOTCHES AND ORIFICES	
a	ø1.3 equiv
b	ø1.6 equiv
c	ø0.6 equiv
d	ø0.6 equiv
e	ø2.0 equiv
f	ø2.0 equiv
g	ø1.5 equiv
h	ø1.7 equiv
i	ø1.5 equiv
j	ø0.8 equiv
k	ø1.1 equiv
m	ø1.1 equiv
n	ø2.0 equiv
r	ø1.0 equiv
s	ø3.3 equiv
u	ø1.4 equiv

b. K008-3 : KTC, KCL, KTA - version

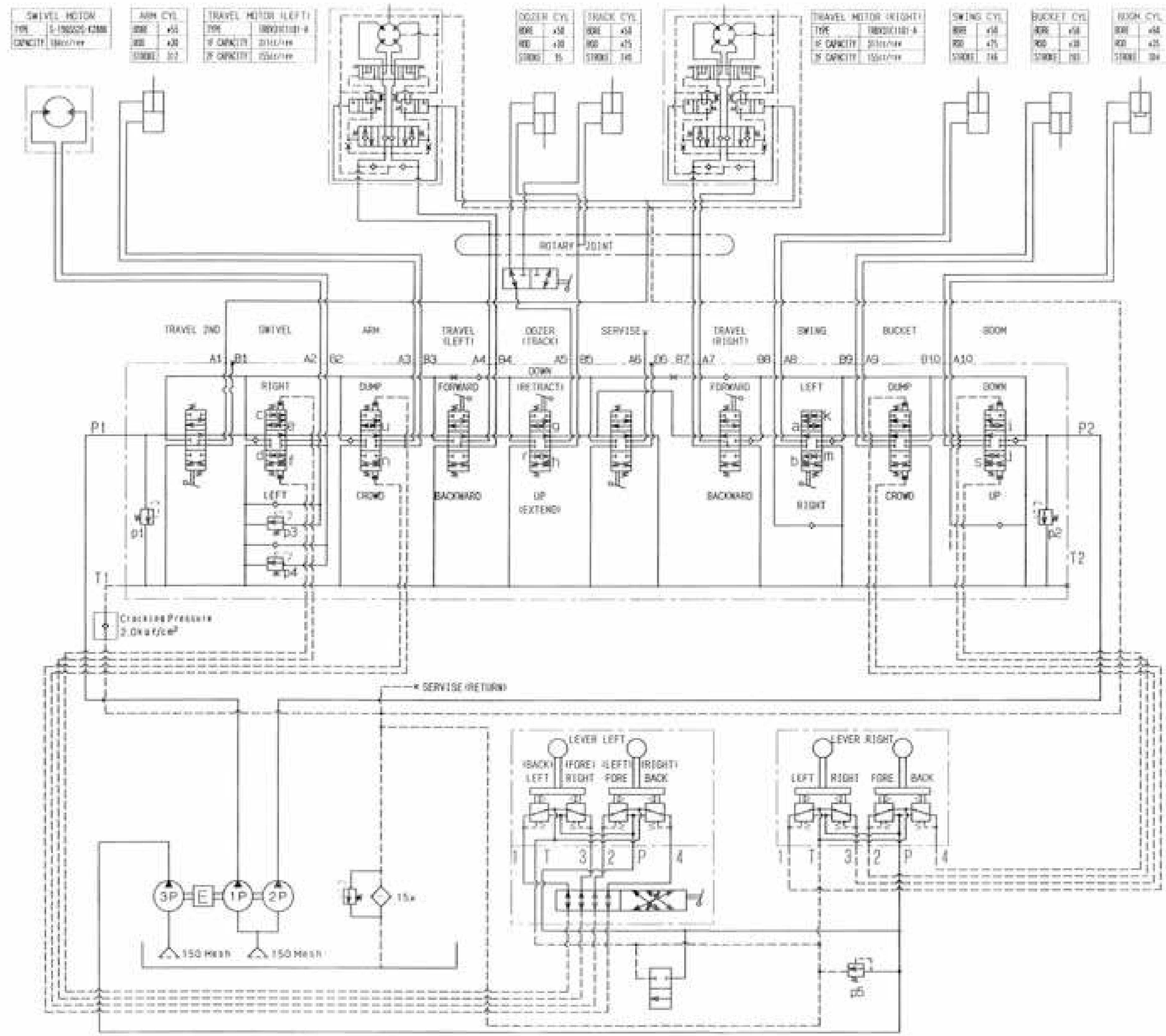


	P1	P2
ENGINE SPEED (rpm)	2050	2050
DISPLACEMENT (cc/rev)	5.05	5.05
DISCHARGE CAPACITY (l/min)	10.35	10.35

RELIEF PRESSURE (MPa)	
p1	16.7
p2	16.7
p3	6.86
p4	6.86

SIZE OF NOTCHES AND ORIFICES	
a	ø1.3 equiv
b	ø1.6 equiv
c	ø0.6 equiv
d	ø0.6 equiv
e	ø2.0 equiv
f	ø2.0 equiv
g	ø1.5 equiv
h	ø1.7 equiv
i	ø1.5 equiv
j	ø0.8 equiv
k	ø1.1 equiv
m	ø1.1 equiv
n	ø2.0 equiv
r	ø1.0 equiv
s	ø3.3 equiv
u	ø1.4 equiv

c. U10-3 : EU - version

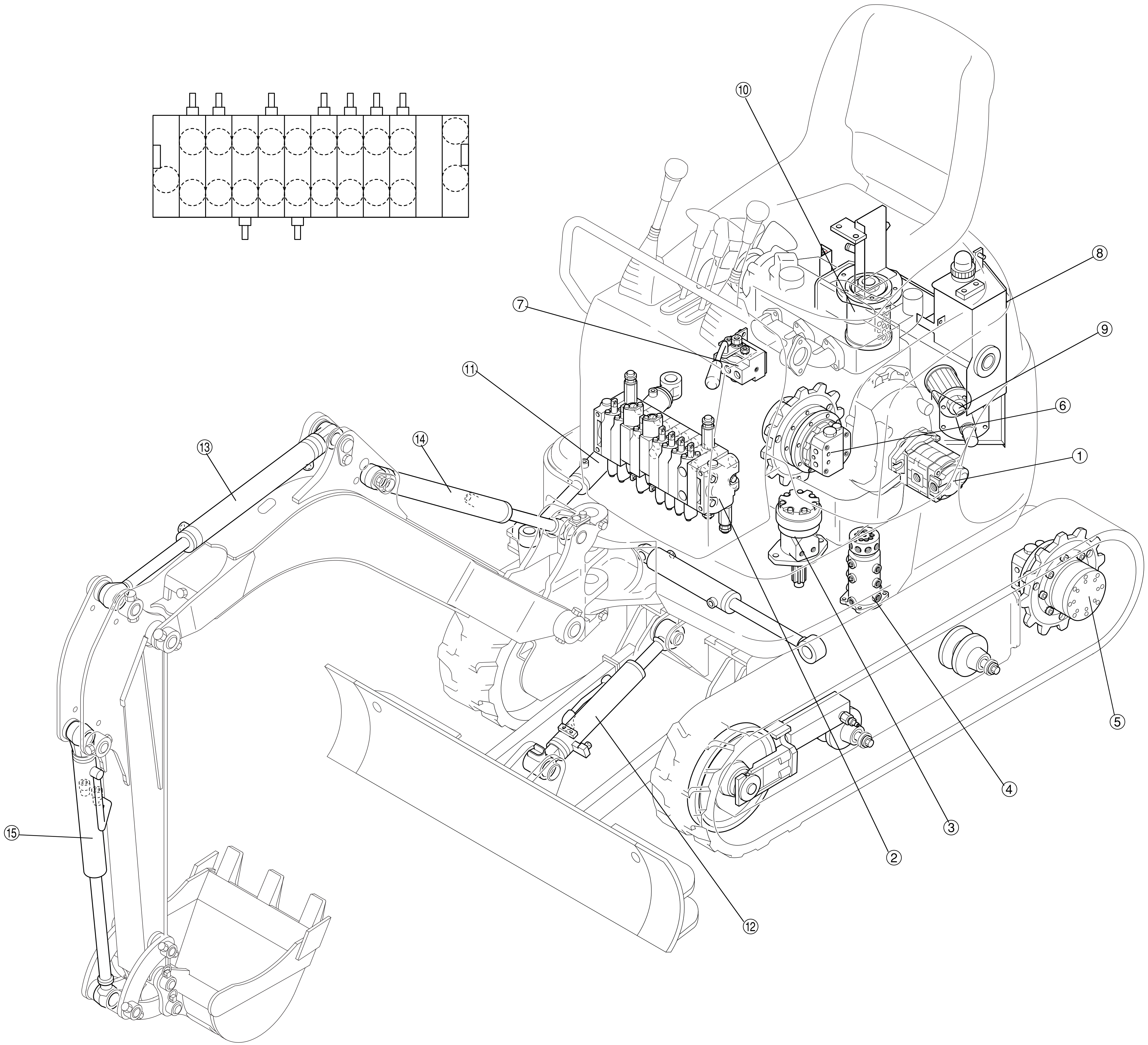


	P1	P2	P3
ENGINE SPEED (1/min)	2050	2050	1825
DISPLACEMENT (cc/rev)	5.05	5.05	[illegible]
DISCHARGE CAPACITY (L/min)	10.35	10.35	3.15

RELIEF	PRESSURE (MPa)
p1	17.65
p2	17.65
p3	6.86
p4	6.86
p5	2.94

SIZE OF NOTCHES AND ORIFICES	
a	ø1.3 equiv
b	ø1.6 equiv
c	ø0.6 equiv
d	ø0.6 equiv
e	ø2.0 equiv
f	ø2.0 equiv
g	ø1.5 equiv
h	ø1.7 equiv
i	ø1.5 equiv
j	ø0.8 equiv
k	ø1.1 equiv
m	ø1.1 equiv
n	ø2.0 equiv
r	ø1.0 equiv
s	ø3.3 equiv
u	ø1.4 equiv

d. Hydraulic components layout : K008-3



① Main pump
② Control valve
③ Swivel motor
④ Rotary joint
⑤ Travel motor (L)
⑥ Travel motor (R)
⑦ Charge valve (Track <-> Dozer)
⑧ Hydraulic Tank
⑨ Suction filter
⑩ Return filter
⑪ Swing cylinder
⑫ Dozer cylinder
⑬ Boom cylinder
⑭ Arm cylinder
⑮ Bucket cylinder

IV.Hydraulic system(Service section)

A.Troubleshooting

a. Machine general

Engine System

- Engine does not start.
  - Starter does not rotate normally. → Check electric system.
  - Starter rotates normally but engine does not start. → Check engine system. / Check hydraulic system.
- Engine starts but not normally.
  - Engine does not stop.
  - Engine rotation is irregular.
  - White or bluish exhaust gas is emitted.
  - Black or dark gray exhaust gas is emitted.
  - Poor output
  - Oil is consumed too much.
  - Fuel mixes in oil.
  - Water mixes in oil.
  - Oil pressure is low.
  - Oil pressure is high.
  - Engine is overheated.
    - → Check engine system.
  - Battery discharges too much. (Battery is completely discharged.)
  - Grow lamp does not light up.
  - Charge lamp does not light up.
  - Charge lamp does not go out.
    - → Check electric system
  - Engine rotating speed drops or engine rotation stops when load is applied. → Check engine system. / Check hydraulic system.

Hydraulic system

Engine starts but whole hydraulic system does not operate.	Whole hydraulic system does not operate.	Check hydraulic system.
	Cylinder of any of boom, arm, bucket, Swing or dozer does not work.	Check front attachment.
	Swivel operation is impossible.	Check swivel bearing system.
	Traveling operation is impossible.	Check traveling system.
Operating speed of hydraulic equipment is slow or its output power is weak.	Max. engine rotating speed is abnormal.	Check engine system.
	Operating speed of whole hydraulic system is slow or its output power is weak.	Check hydraulic system.
	Operating speed of cylinder of any of boom, arm, bucket, Swing or dozer is slow or its output power is weak.	Check front attachment.
	Swivel speed is slow or turning power is weak.	Check swivel bearing system.
	Traveling speed is slow or traveling power is weak.	Check traveling system.
	Traveling speed selection is impossible.	Check traveling system
	Track travels askew.	Check traveling system
Free-fall of hydraulic system is severe, does not stop or becomes out of control.	Free-fall of cylinder of any of boom, arm, bucket, Swing or dozer is severe.	Check front attachment.
	Turning does not stop or becomes severely out of control.	Check swivel bearing system
	Travel does not stop or track runs away on a slop.	Check traveling system.

Hydraulic system(cont.)

Symptom	Cause	Remedy
Temperature of hydraulic oil tank rises.	Trouble with engine system: cooling water, oil or combustion system	Check engine system.
	Loose application of heat insulating material to engine hood	Check application and attaching of heat insulating material and covers.
	Operator’s operation is wrong.	Educate and train operator.
	Attachment is not conforming to working conditions within the recommended range.	Check specifications of attachment and the machine.
	Hydraulic oil of recommended quality or amount is not used.	Use recommended hydraulic oil.
	Trouble with hydraulic oil system	Check hydraulic system.
Abnormal noise is heard during operation.	Bolt of cover mounting bolt near the source of noise is loosened.	Check mounting condition of covers.
	Pipe or hose near the source of noise comes in contact with other part(s).	Check mounting condition of pipes and hoses.
	Abnormal noise is generated from pin or bush.	Check pipes and hoses for seizure.
	Abnormal noise is generated from hydraulic system.	Check hydraulic system.
	Abnormal noise is generated from engine system.	Check engine system.
	Abnormal noise is generated from around the legs.	Check mounting condition of crawler, idler or track roller.

b. Hydraulic System

(1) Hydraulic system

Troubles	Causes	Remedies	Remarks
Total hydraulic system does not operate. Speed is slow. Output power is weak.	(1) Amount of hydraulic oil in the tank is decreased or oil quality is not good.	Supply or replace hydraulic oil.	
	(2) Suction line (Suction filter) is clogged.	Check suction line or replace suction filter.	
	(3) Coupling for mounting the pump is defective.	Repair or replace pump coupling.	
	(4) Pump drive shaft is broken.	Replace shaft.	
	(5) Pump internal parts are seized or broken.	Repair or replace pump.	
Boom, arm, bucket or Swivel system does not operate.	(1) Hydraulic oil pilot filter or hydraulic oil line filter is clogged.	Clean or replace pilot filter.	
	(2) Change valve is defective.	Disassemble or replace change valve.	
	(3) Pilot pump internal parts are seized or broken.	Replace pilot pump.	
Boom, swivel system or travel to left does not operate. Speed is slow. Output power is weak.	(1) Main relief valve (P1) is not set at specified pressure.	Check and adjust main relief valve (P1).	
	(2) In case arm or swivel system does not operate, the right pilot valve is defective (U10-3).	Check secondary pressure. Check pilot valve.	
Boom, bucket, Swing or travel to right does not operate. Speed is slow. Output power is weak.	(1) Main relief valve (P2) is not set at specified pressure.	Check and adjust main relief valve (P2).	
	(2) In case boom or bucket does not operate, the left pilot valve is defective (U10-3).	Check secondary pressure. Check pilot valve.	
Only boom does not operate. Speed is slow. Output power is weak.	(1) Boom lever link system is sticking or removed. (K008-3).	Adjust or replace link system.	
	(2) Malfunction of control valve or spool of boom section.	Check and repair spool.	
	(3) Pilot valve is defective. (U10-3)	Check secondary pressure and pilot valve.	
	(4) Packing of boom cylinder rod is broken.	Disassemble cylinder. Replace seal.	
Only arm does not operate. Speed is slow. Output power is weak.	(1) Arm lever link system is sticking or removed. (K008-3).	Adjust or replace link system.	
	(2) Malfunction of control valve or spool of arm section.	Check and repair spool.	
	(3) Pilot valve is defective. (U10-3)	Check secondary pressure and pilot valve.	
	(4) Packing of arm cylinder rod is broken.	Disassemble cylinder. Replace seal.	
Only bucket does not operate. Speed is slow. Output power is weak.	(1) Bucket lever link system is sticking or removed. (K008-3).	Adjust or replace link system.	
	(2) Malfunction of control valve or spool of bucket section.	Check and repair spool.	
	(3) Pilot valve is defective.	Check secondary pressure and pilot valve.	
	(4) Packing of bucket cylinder rod is broken.	Disassemble cylinder. Replace seal.	

Troubles	Causes	Remedies	Remarks
Only Swing does not operate. Speed is slow. Output power is weak.	(1) Maladjustment of Swing pedal and link	Check and adjust pedal and link.	
	(2) Malfunction of control valve or spool of swivel section.	Check and repair spool.	
	(3) Anti-void valve is defective.	Check and adjust anti-void valve.	
	(4) Packing of Swing cylinder rod is broken.	Disassemble cylinder. Replace seal.	
Only dozer does not operate. Speed is slow. Output power is weak.	(1) Maladjustment of dozer lever and cable.	Check and adjust lever and cable.	
	(2) Malfunction of control valve or spool of dozer section.	Check and repair spool.	
	(3) Packing of dozer cylinder rod is broken.	Disassemble cylinder. Replace seal.	
Free-fall of boom cylinder is severe.	(1) Spool of control valve is damaged. Spring is broken.	Check and repair spool.	
	(2) Packing of boom cylinder rod is broken.	Disassemble cylinder. Replace seal.	
Free-fall of bucket cylinder and arm cylinder is severe.	(1) Spool of control valve is damaged. Spring is broken.	Check and repair spool.	
	(2) Packing of bucket cylinder or arm cylinder rod is broken.	Disassemble cylinder. Replace seal.	
Swing cylinder moves even when it is returned to neutral position.	(1) Maladjustment of Swing pedal link system	Check and adjust link system	
	(2) Spool of control valve is sticking or broken. Spring is broken.	Check and repair cylinder.	
	(3) Packing of Swing cylinder rod is broken.	Disassemble cylinder. Replace seal.	
Free-fall of dozer cylinder is severe.	(1) Maladjustment of dozer lever and cable	Check and adjust lever cable.	
	(2) Spool of control valve is damaged. Spring is broken.	Check and repair spool.	
	(3) Packing of dozer cylinder rod is broken.	Disassemble cylinder. Replace seal.	
Temperature of hydraulic oil tank rises.	(1) Return filter is clogged.	Check and replace return filter.	
	(2) Low pressure line is blocked with foreign matter.	Check low pressure line.	

(2) Swivel system

Prior to checking, confirm that trouble lies only in the swivel system.

Troubles	Causes	Remedies	Remarks
Both right and left swivels do not operate.	(1) Malfunction of charge valve (U10-3)	Check operation, and disassemble or replace.	
	(2) Malfunction of spool of pilot valve (U10-3)	Check operation, and disassemble and clean.	
	(3) Malfunction or sticking of spool stick of control valve	Check operation, and disassemble and clean.	
	(4) Secondary pressure of pilot valve is poor. (U10-3)	Check pressure.	
	(5) Swivel relief valve pressure is poor.	Check pressure, and disassemble, clean and adjust.	
	(6) Internal wear or breakage of motor	Disassemble and clean or replace.	
	(7) Internal breakage of control valve	Disassemble and clean or replace.	
Swivel system at one side does not operate.	(1) Malfunction of charge valve (U10-3)	Check operation, and disassemble or replace.	
	(2) Malfunction of spool of pilot valve (U10-3)	Check operation, and disassemble and clean.	
	(3) Malfunction or sticking of spool of control valve	Check operation, and disassemble and clean.	
	(4) Secondary pressure of pilot valve is poor. (U10-3)	Check pressure.	
	(5) Swivel relief valve pressure is poor.	Check pressure, and disassemble, clean and adjust.	
	(6) Internal wear or breakage of motor	Disassemble and clean or replace.	
	(7) Internal breakage of control valve	Disassemble and clean or replace.	
Output power is weak. Speed is slow.	(1) Malfunction of spool of pilot valve (U10-3)	Check operation, and disassemble or replace.	
	(2) Malfunction or sticking of spool of control valve	Check operation, and disassemble and clean.	
	(3) Secondary pressure of pilot valve is poor. (U10-3)	Check pressure.	
	(4) Swivel relief valve pressure is poor.	Check pressure, and disassemble, clean and adjust.	
	(5) Action and seating property of brake valve is defective.	Disassemble and clean.	
	(6) Internal wear or breakage of motor	Disassemble and clean or replace.	
	(7) Internal breakage of control valve	Disassemble and clean or replace.	
Swivel action does not stop. Swivel action becomes severely out of control.	(1) Malfunction of spool of pilot valve (U10-3)	Check operation, and disassemble and clean.	
	(2) Malfunction or sticking of spool of control valve	Check operation, and disassemble and clean.	
	(3) Swivel relief valve pressure is poor.	Check pressure, and disassemble, clean and adjust.	
	(4) Internal wear or breakage of motor	Check drain volume.	

Troubles	Causes	Remedies	Remarks
Shock at start and stop is remarkable. Inching operation is impossible.	(1) Malfunction of spool of pilot valve (U10-3)	Check operation, and disassemble and clean.	
	(2) Malfunction or sticking of spool of control valve	Check pressure, and disassemble and clean.	
	(3) Internal wear or breakage of motor	Check operation, and disassemble and clean.	
Track sways when pushed by hand.	(1) Malfunction of spool of pilot valve	Check operation, and disassemble and clean.	
	(2) Internal wear or breakage of motor	Check pressure, and disassemble and clean.	

(3) Travel system

Prior to checking, confirm that trouble lies only in the travel system.

Troubles	Causes	Remedies	Remarks
Track does not travel.	(1) Travel lever link system is sticking or removed.	Adjust and replace link system.	
	(2) Stick of spool of control valve	Disassemble and clean or replace control valve.	
	(3) Internal leak at rotary joint	Disassemble rotary joint. Replace seal.	
	(4) Sticking of spool of counter balance valve	Disassemble and clean or replace counter balance valve.	
	(5) Motor internal wear or breakage	Disassemble or replace motor.	
Traveling speed is slow. No traveling power.	(1) Malfunction of travel lever link system	Adjust and replace link system.	
	(2) Malfunction of spool of control valve	Disassemble and clean or replace control valve.	
	(3) Internal leak at swivel joint	Disassemble swivel joint. Replace seal.	
	(4) Malfunction of spool of counter balance valve	Disassemble and clean or replace counter balance valve.	
	(5) Internal wear or breakage of motor	Disassemble or replace motor.	
	(6) Malfunction of travel 2-speed spool	Disassemble and clean or replace.	
Travel is skewed. (Independent travel operation)	(1) Operation of right and left travel levers link system is uneven.	Adjust and replace link system.	
	(2) Operation of spools of right and left control valves link system is uneven.	Disassemble and clean or replace control valve.	
	(3) Internal leak of swivel joint at one side	Disassemble swivel joint. Replace seal.	
	(4) Sticking of spool of counter balance valve	Disassemble and clean or replace counter balance valve.	
	(5) Internal wear or breakage of motor at one side	Disassemble or replace motor.	
	If any difference is found in the flowrate and pressure between the pumps for right travel and left travel, or it delivery hose at one side is in trouble, track will travel askew. In this case, other operations will be troubled also.		
Travel does not stop.	(1) Travel lever link system is defective or sticking.	Adjust link system.	
	(2) Return of spool of control valve is defective or sticking	Disassemble and clean or replace control valve.	
	(3) Return of spool of counter balance valve is defective or sticking	Disassemble and clean or replace counter balance valve.	
Traveling speed stage cannot be changed over.	Malfunction of high-low speed changeover spool in travel motor is defective.	Disassemble and clean or replace high-low speed changeover valve.	

B.Specifications

a. Pump System

(1) Discharge

		Unit	K008-3	U10-3	Remarks
P1, P2 Maker's Type No.			DDG05A55F2H1-R395(S)	DDG05A55F2H1-R395(S)	
Pp Maker's Type No.			-	56900-26201(K)	
Rated rotating speed	P1, P2/Pp	rpm	2050/1025	2050/1025	
Rated load pressure	P1, P2/Pp	MPa kgf/cm^2 psi	16.7 170 2421	17.7 / 3.4 180 / 35	
Theoretical discharge	P1, P2/Pp	cc/rev	5.05/-	5.05/3.07	
Theoretical discharge at rated output	P1, P2	L/min(gal\min)	10.5(2.8)	10.5	
	Pp	L/min(gal\min)	-	3.1	
85% of theoretical discharge	P1, P2	L/min(gal\min)	8.93(2.4)	8.93	
	Pp	L/min(gal\min)	-	2.64	
80% of theoretical discharge	P1, P2	L/min(gal\min)	8.4(2.2)	8.4	
	Pp	L/min(gal\min)	-	2.48	

(S) SHIMAZU CORPORATION, (K) KUBOTA CORPORATION

(2) List of pressures

		Unit	K008-3	U10-3	Remarks
Main relief valve					
P	Actual measured value	MPa kgf/cm^2 psi	16.7 170 2421	17.7 180 -	
	Operating part		Arm	Arm	
	Independent set pressure	MPa kgf/cm^2 psi	16.7 170 2421	17.7 180 -	
P 2	Actual measured value	MPa kgf/cm^2 psi	16.7 170 2421	17.7 180 -	
	Operating part		Bucket	Bucket	
	Independent set pressure	MPa kgf/cm^2 psi	16.7 170 2421	17.7 180 -	
P 3	Actual measured value	MPa kgf/cm^2 psi	-	-	
	Operating part		-	-	
	Independent set pressure	MPa kgf/cm^2 psi	-	-	

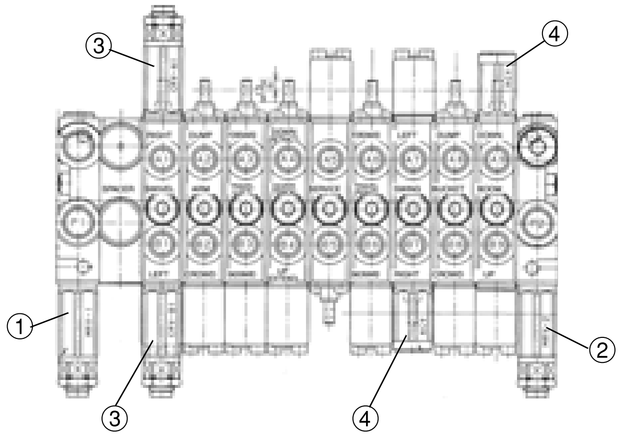
		Unit	K008-3	U10-3	Remarks
Pp	Actual measured value	MPa kgf/cm^2 psi	-	3.4 35 -	
	Operating part		-		
	Independent set pressure	MPa kgf/cm^2 psi	-	3.4 35 -	
	Secondary pressure	MPa kgf/cm^2 psi	-	2.2 22.5 -	
Overload relief valve					
Boom rod/Bottom		MPa kgf/cm^2 psi	-	-	
Arm rod/Bottom		MPa kgf/cm^2 psi	-	-	
Dozer rod/Bottom		MPa kgf/cm^2 psi	-	-	
Swivel system		MPa kgf/cm^2 psi	6.9 70 996	6.9 70 -	
Bucket rod/Bottom		MPa kgf/cm^2 psi	-	-	

b. List of Relief Valves

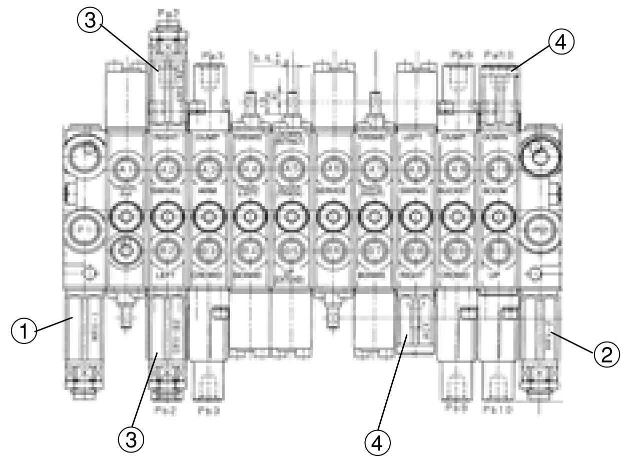
(1) Mounting position:K008-3
Valve type:CP CV NSC-K110
Name of maker: Nabco Ltd.

(1) Mounting position:U10-3
Valve type:CP CV NSC-K110
Name of maker: Nabco Ltd.

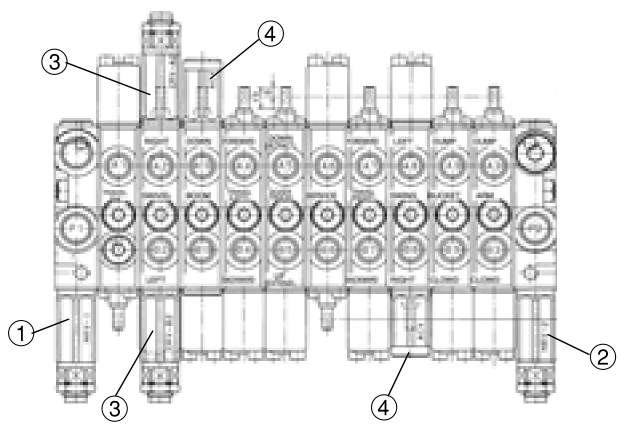
K008-3 EU version



U10-3



K008-3 KTC, KCL, KTA version

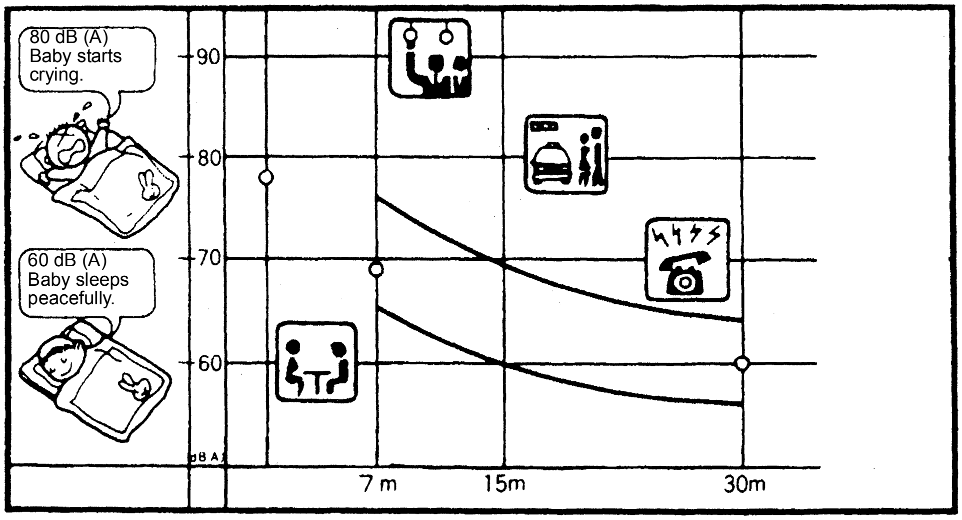


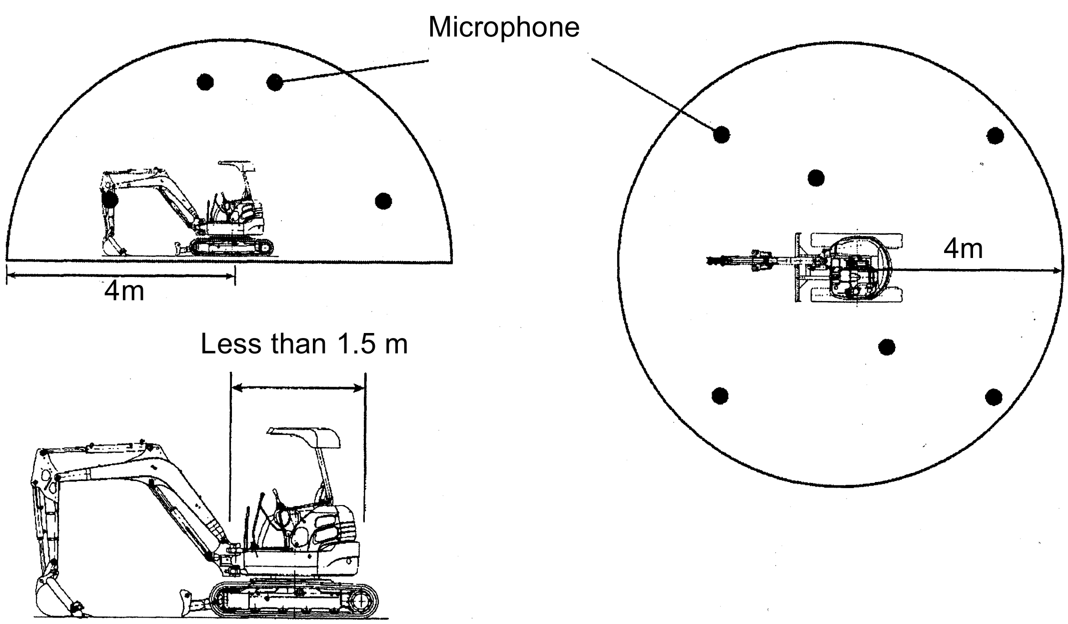
No.	Part Name	Unit	K008-3	U10-3	Remarks
①	Main relief valve	MPa kgf/cm^2 psi	16.7 170 2418	17.7 180 -	
②	Main relief valve	MPa kgf/cm^2 psi	16.7 170 2418	17.7 180 -	
③	Port relief valve	MPa kgf/cm^2 psi	6.9 70 997	6.9 70 -	
④	Anti-void valve				

c. Noise

	Unit	K008-3	U10-3	Remarks
Noise near ears	dB(A)	78	78	
Sound power level		93	93	

(Noise near ears is represented by actual mean energy value measured at max. engine rotating speed without load.





Sound power level
Measure the noise level within the area of 4 m radius around the machine (machine body length = Virtual hemisphere of less than 1.5 m) while engine is operated at maximum rotating speed for simulated excavation.

d. Swivel system

(A) Standard values for new vehicles

		Unit	K008-3	U10-3	Remarks
Maker			Eaton Fluid Power Ltd.	Eaton Fluid Power Ltd.	
Type			S-190SS2S-K2880	S-190SS2S-K2880	
Capacity		cc/rev	184	184	
Brake V pressure		MPa kgf/cm^2 psi	6.9 70 997	6.9 70	
Standard value of drain volume	At locking	L/min gal/min			
	At rotating	L/min gal/min			
Swiveling speed		rpm	8.3	8.3	
Swiveling speed in 3 turns		sec.			
Swivel startup		mm/min in./min	2.1 ± 0.3 0.08± 0.01	2.1 ± 0.3	Front level, Bucket heaped. Eng. max, 90°
Swivel blocking performance		mm/min in./min	93.4 3.68	93.4	Front level, Bucket heaped. Slope 15°, Engine stop.
Turnable angle on slop		degree(kg)	17≦	17≦	Front level, Bucket heaped. Eng. max
Bucket end play		mm in.	50≦ 19.7≦	50≦	

(How to measure the bucket end play)
1. Extend the arm and make the bucket rake in. The height of the bucket should be 1 m from the ground.
2. Press the bucket end by 5 kgf force. Take this position as zero and press it by 30 kgf in opposite direction.
3. Measure the distance of move of the bucket end.
4. Repeat each operation more than 5 times without swiveling.
5. Performance of the rotary block should be of hydraulic oil temperature of 50± 5 deg. on a slop of 15 deg.

e. Traveling system

		Unit	K008-3	U10-3	Remarks
Whole type			TRBV31C1101-A	TRBV31C1101-A	
Maker			Eaton Fluid Power Ltd.	Eaton Fluid Power Ltd.	
Gradability		Deg. (Angle)	30	30	
Max. tractive force		kN(kgf)	5.0(505)	8.5(870)	1F
Traveling block performance		mm/10min in./10min	300 ≧ 11.8 ≧	300 ≧	Traveling posture, 20 deg., for 10 min., engine stopped, no-load
Traveling speed		km/h	2.0/4.0	2.0/4.0	1F/2F G
			-	-	1F/2F Iron
1-speed		sec/10min	19 ±	19 ±	G
2-speed		sec/10min	10 ±	10 ±	G
Crawler rotating speed		sec./turn	5.0 ± /2.6 ±	5.5 ± /2.7 ±	1F/2F
Straight traveling performance		mm/10min in./10min	1000 ≧ 39.4 ≧	1000 ≧	Traveling posture, 10 m interval, engine at max. speed
Standard value of drain volume	At lock	L/min gal/min	-	-	1F/2F
	At rotation	L/min gal/min	-	-	1F/2F

1. Measuring procedure

Temperature of hydraulic oil: 50± 5 °C Bring the front attachment into traveling posture.

(1) Measuring procedure of traveling block performance

1) Carry out traveling operation on 20 deg. slop more than thrice.
2) Put marks to the under carriage and the crawler, and measure the displacement generated for 10 min.
3) Measure the displacement more than twice, and indicate the largest value.

(2) Crawler rotating speed

1) Lift up the machine, put a mark to the crawler, perform traveling about a half turn and conduct measurement more than twice.

Note:

The K008-3's 2-speed type is available only on the KTC, KCL and KTA versions.

f. Cylinder system

(1) Cylinder speed

(A) Standard values for new vehicle
(B) Limit value of uses

		Unit	K008-3	U10-3	Remarks
Boom cylinder cushion(Boom)	Extension (A/B)	Sec.	1.9~2.5/3.0	2.2~2.8/3.4	Ground to top
	Retraction (A/B)	Sec.	2.4~3.0/3.6	2.5~3.1/3.7	Top to ground
	50°	Sec.	0.4~0.7/0.9	0.4~0.7/0.9	Empty bucket, raking-in
Arm cylinder	Extension (A/B)	Sec.	2.7~3.3/4.0	3.7~4.3~5.2	Raking-in
	Retraction (A/B)	Sec.	1.9~2.5/3.0	3.7~4.3/5.2	Arm extension
Bucket cylinder	Extension (A/B)	Sec.	2.6~3.2/3.8	2.6~3.2/3.8	Raking-in
	Retraction (A/B)	Sec.	1.7~2.3/2.8	1.7~2.3/2.8	Dumping
Swing (offset) cylinder	Extension (A/B)	Sec.	3.7~4.3/5.2	3.9~4.5/5.4	Left
	Retraction (A/B)	Sec.	3.4~4.0/4.8	3.8~4.4/5.3	Right
Dozer cylinder (Total stroke)	Extension (A/B)	Sec.	0.9~1.5/1.8	1.2~1.8/2.2	Dozer down
	Retraction (A/B)	Sec.	1.3~1.9/2.3	1.7~2.3/2.8	Dozer up

(2) Degree of free-fall

		Unit	K008-3	U10-3	Remarks
(Bucket load weight)		kg			Full bucket
Boom cylinder	(A)/(B)	mm in.	20≧/100≧ 0.79≧/394≧	20≧/100≧	
Arm cylinder	(A)/(B)	mm in.	11≧/55≧ 0.43≧/2.17≧	11≧/55≧	
Bucket cylinder	(A)/(B)	mm in.	10≧/50≧ 0.39≧/1.97≧	10≧/50≧	
Swing block	90 deg. swiveling 100 times	mm in.	7≧/35≧ 0.3≧/1.4≧	7≧/35≧	90 deg. swiveling 100 times
Dozer cylinder	(A)/(B)	mm in.	20≧/100≧ 0.79≧/3.94≧	20≧/100≧	Machine body lifting
(Bucket without load)					
Boom cylinder	(A)/(B)	mm in.			
Arm cylinder	(A)/(B)	mm in.			
Bucket cylinder	(A)/(B)	mm in.			
Swing block	(A)/(B)	mm in.			90 deg. swiveling 100 times
Dozer cylinder	(A)/(B)	mm in.			

(Measuring procedure)

1. Equipped with standard front attachment and standard bucket.
2. Conduct air purge of each cylinder.
3. Measure the amount of downward movement for 10 min.

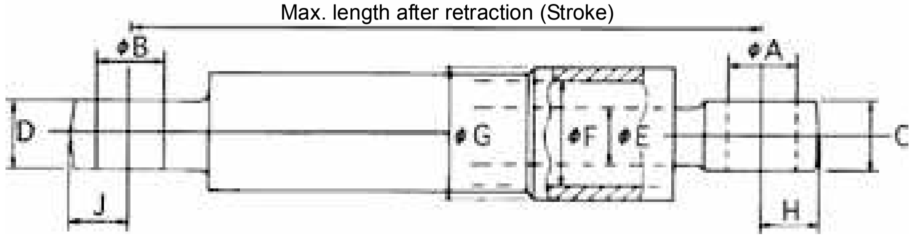
(3) Boom/Arm/Bucket/Swing/Blade Specification

		Unit	K008-3	U10-3	Remarks
Boom	Tube O.D. × I.D. × rod O.D.	mm in.	70 × 60 × 35 2.76 × 2.36 × 1.37	70 × 60 × 35	
	Stroke	mm in.	304 11.97	304	
	Max. length after retraction	mm in.	589 23.19	589	
	Part No. of seal kit		69191-72302	69191-72302	
	Piston tightening torque	N·m kgf·m ft·lbf	343 ~ 392 35 ~ 40 252 ~ 288	343 ~ 392 (35 ~ 40)	
	Piston screw size		M22 × 1.5	M22 × 1.5	
	Width across flats of piston spanner	mm in.	41 1.61	41	
Arm	Tube O.D. × I.D. × rod O.D.	mm in.	65× 55 × 30 2.56× 2.17 × 1.18	65× 55 × 30	
	Stroke	mm in.	261 10.28	312	
	Max. length after retraction	mm in.	499 19.65	546	
	Part No. of seal kit		69191-72501	69191-72501	
	Piston tightening torque	N·m kgf·m ft·lbf	343 ~ 392 35 ~ 40 252 ~ 288	343 ~ 392 (35 ~ 40)	
	Piston screw size		M22 × 1.5	M22 × 1.5	
	Width across flats of piston spanner	mm in.	32 1.26	32	
Bucket	Tube O.D. × I.D. × rod O.D.	mm in.	60 × 50 × 30 2.56× 1.97 × 1.18	60 × 50 × 30	
	Stroke	mm in.	283 11.14	283	
	Max. length after retraction	mm in.	513 20.2	513	
	Part No. of seal kit		69191-72401	69191-72401	
	Piston tightening torque	N·m kgf·m ft·lbf	343 ~ 392 35 ~ 40 252 ~ 288	343 ~ 392 (35 ~ 40)	
	Piston screw size		M22 × 1.5	M22 × 1.5	
	Width across flats of piston spanner	mm in.	32 1.26	32	
Swing	Tube O.D. × I.D. × rod O.D.	mm in.	60 × 50 × 25 2.56× 1.97 × 0.98	60 × 50 × 25	
	Stroke	mm in.	246 9.69	246	
	Max. length after retraction	mm in.	451 17.76	451	
	Part No. of seal kit		69191-72202	69191-72202	
	Piston tightening torque	N·m kgf·m ft·lbf	137.2 ~ 18)	137.2 ~ 18)	
	Piston screw size		M18 × 1.5	M18 × 1.5	
	Width across flats of piston spanner	mm in.	27	27	

		Unit	K008-3	U10-3	Remarks
Blade	Tube O.D. × I.D. × rod O.D.	mm in.	60 × 50 × 30 2.36 × 1.97 × 1.18	60 × 50 × 30	
	Stroke	mm in.	95 3.74	95	
	Max. length after retraction	mm in.	356 14.02	356	
	Part No. of seal kit		69191-72401	69191-72401	
	Piston tightening torque	N·m kgf·m ft·lbf	343 ~ 392 35 ~ 40 252 ~ 288	343 ~ 392 35 ~ 40	
	Piston screw size		M22 × 1.5	M22 × 1.5	
	Width across flats of piston spanner	mm in.	32 1.26	32	
Leg extension/retraction	Tube O.D. × I.D. × rod O.D.	mm in.	60× 50 × 25 2.36 × 1.97 × 0.98	60× 50 × 25	
	Stroke	mm in.	160 6.3	240	
	Max. length after retraction	mm in.	313 12.32	394	
	Part No. of seal kit		69191-72101	69191-72101	
	Piston tightening torque	N·m kgf·m ft·lbf	137.2 ~ 176.4 14 ~ 18 101 ~ 130	137.2 ~ 176.4 14 ~ 18	
	Piston screw size		M18 × 1.5	M18 × 1.5	
	Width across flats of piston spanner	mm in.	27 1.06	27	

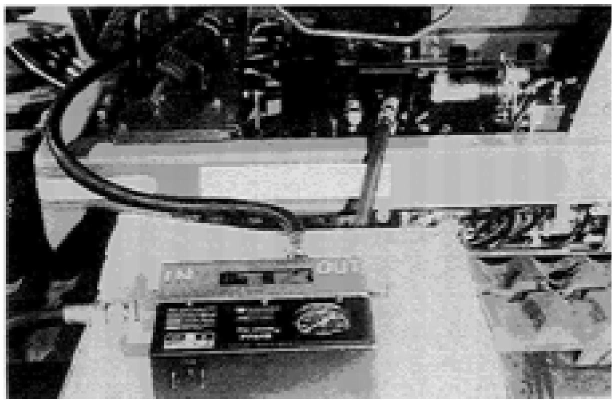
(4) Table of dimensions of cylinder parts

Model		unit	A	B	C	D	E	F	G	H	J	Port screw dia.	Remarks
K008-3	Boom	min in.	30	30	35	35	35	60	70	32	35	R1/4	KUBOTA SEIKI
	Arm	min in.	30	30	35	35	30	55	65	30	32	R1/4	KUBOTA SEIKI
	Bucket	min in.	30	30	35	35	30	50	60	32	32	R1/4	KUBOTA SEIKI
	Swing	min in.	30	30	35	35	25	50	60	29	32	R1/4	KUBOTA SEIKI
	Dozer	min in.	30	30	35	35	30	50	60	32	32	R1/4	KUBOTA SEIKI
U10-3	Boom	min	30	30	35	35	35	60	70	32	35	R1/4	KUBOTA SEIKI
	Arm	min	30	30	35	35	30	55	65	32	32	R1/4	KUBOTA SEIKI
	Bucket	min	30	30	35	35	30	50	60	32	32	R1/4	KUBOTA SEIKI
	Swing	min	30	30	35	35	25	50	60	29	32	R1/4	KUBOTA SEIKI
	Dozer	min	30	30	35	35	30	50	60	32	32	R1/4	KUBOTA SEIKI
	Track Cylinder	min	25	25	30	30	25	50	60	25	25	R1/4	KUBOTA SEIKI

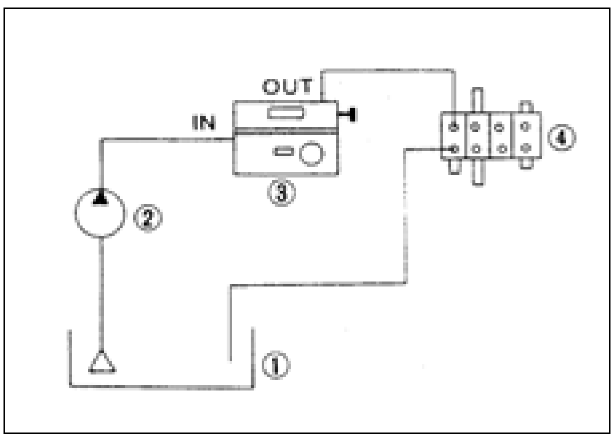


C.Testing

a. Pump flow test



1. Connect the tester to the pump discharge side. Be careful not to connect the wrongpipes.
2. Open the loading valve of the tester to start the engine.
3. increase the engine speed to the maximum speed.
4. While slowly closing the loading valve, apply the rated load pressure (test pressure) to the pump.
5. Measure the discharge and pump rpm (engine rpm).
6. Calculate the volumetric efficiency and judge the usability of the pump.
7. Perform steps 1 to 6 above for each pump.



[Procedure for pump performance test]

The pump performance test proceeds as follows: apply the specified hydraulic load to the pump discharge side, measure the discharge at the specified revolutions, and determine the volmetric efficiency.

$$\text{Volumetric efficiency} = \frac{\text{Discharge at the rated load}}{\text{Theoretical discharge}} \times 100(\%)$$

[Caution]

1. The volumetric efficiency of the pump is proportional to its revolutions and is inversely proportional to the load pressure. The test should thereforebe made with the engine revolutions increased to a maximum.
2. The volumetric efficiency is the ratio of theoretical discharge (Caluculated value) to discharge per revolution of pump (c.c./rev) with the rated load. The rated load shall be the main relief setting pressure.
3. Because the pump revolutions are usually descreased, be sure to convert the measured value of discharge with the rated load into rpm.

$$\text{Discharge at the rated load (c.c./rev)} = \frac{\text{Measured discharge(l/min)}\times 100(\%)}{\text{Measured pump speed}}$$

4. The criterion for judging pump performance shall satisfy the standards of volmetric coefficiency.
5. Hydraulic oil temperature must be 45 ± 5°C

①Tank
②Pump
③Tester
④Control valve

b. Pilot pressure (U10-3)

(1) Primary pressure

[Measuring procedure]

1. Remove the cover (front).
2. Disconnect the hose, which connected between the pilot pump and the changeover valve, at the changeover valve side.
3. Mount T-joint and set the pressure gauge.
4. Unlock the operating lever lock (to operating position).
5. Start the engine and measure the pressure at max. rotating speed.
6. Conduct measurement thrice, obtain mean value and take it as measured value.
   *Conduct measurement at oil temperature of 50 ± 5°C, 122±41F°

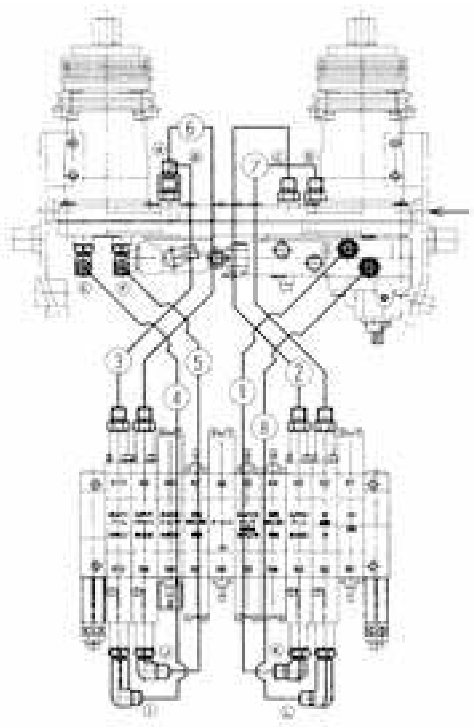
(2) Secondary pressure

[Measuring procedure]

(In the case of swiveling operation)

1. Remove the cover (front).
2. Disconnect the hose, which connected between the pilot pump and the control valve, at the control valve side.
3. Mount T-joint and set the pressure gauge.
4. Start the engine and lock the operating lever by swivel lock pin.
5. Start the engine rpm to maximum, do the swivel operation and measure the pressure.
6. Conduct measurement thrice, obtain mean value and take it as measured value.
   *Conduct measurement at oil temperature of 50 ± 5°C, 122±41F°

Routing of pilot valve hose



No.	Mounting Position	Q'ty	Discrimination
⑧	Swivel (L)	1	Red
⑦	Swivel (R)	1	Yellow
⑥	Bucket rod	1	Brown
⑤	Bucket bottom	1	Pink
④	Boom (Upper)	1	Sky blue
③	Boom (Lower)	1	Gray
②	Arm rod	1	Blue
①	Arm bottom	1	Green

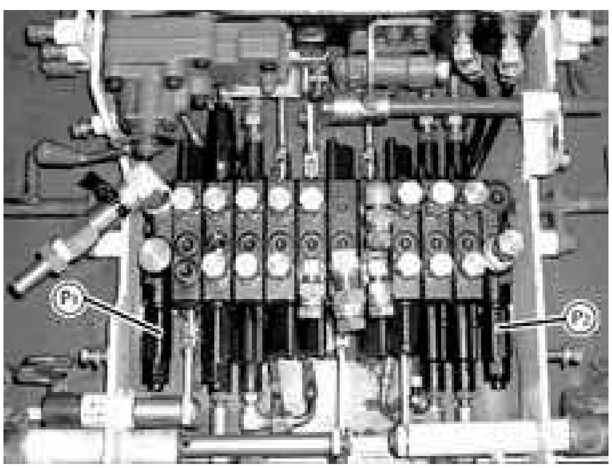
(3) Main relief valve pressure

P1 measurement port

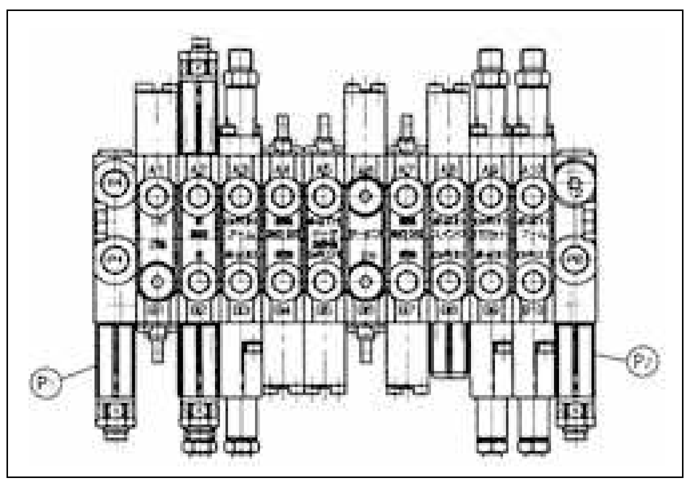
P2 measurement port

[Measuring procedure]

1. Remove the plug (1/8) of the main pump discharge side, and set the pressure gauge.
   P1 Arm, swivel, travel (L), dozer, leg retraction and service
   P2 Boom, bucket, swing and travel (R)
2. Start the engine. Check the circuit to be measured for any oil leak.
3. Operate the lever while the engine is rotated at the maximum speed, and relieve the cylinder.
4. Conduct measurement thrice, obtain mean value and take it as measured value.
   *Conduct measurement at oil temperature of 50 ± 5°C.



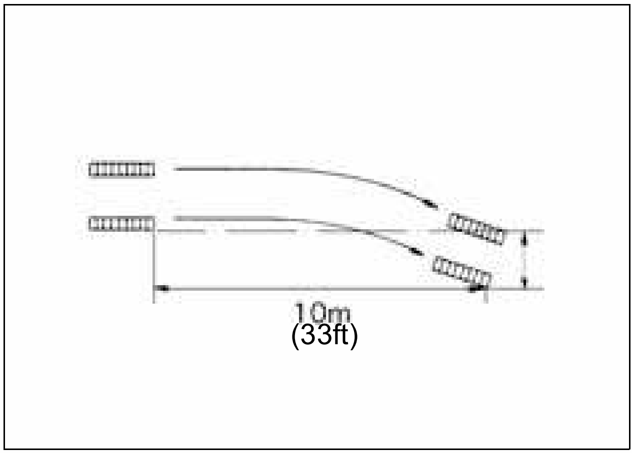
Arrangement of control valve section



[Measuring procedure]

1. Loosen the lock nut of the relief valve.
2. Set the pressure by turning the adjusting screw with use of hexagon wrench. When the pressure is set, tighten the lock nut.
   *Clockwise turning increases the pressure, and counterclockwise turning decreases it.
3. Operate the lever while the engine is rotated at the maximum speed, and check the set pressure.

Travel straightness measurement test



1. With the engine at full speed, throw the travel control lever by its full stroke, and run the vehicle by 10 m (33ft.).
2. Measure the trace error from the straight line.
3. When not within the reference value range, check and repair ad discribed under “Travel circuit” (Oblique traveling) in the Trouble-shooting table.

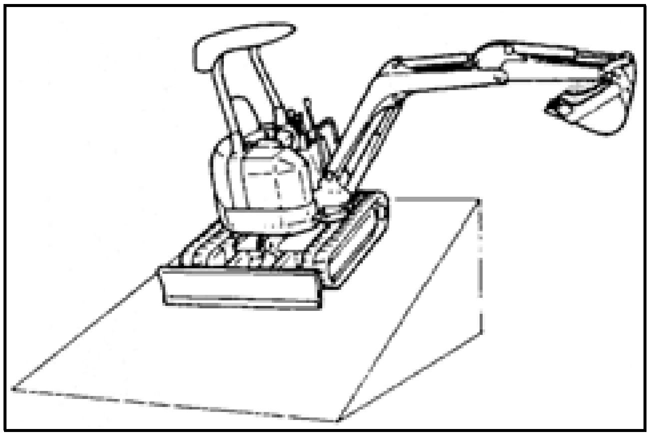
1.Trace error

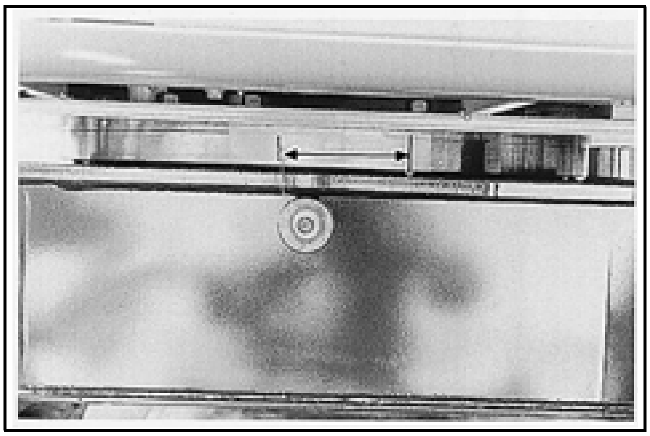
• Reference value: 23.6 in>,(600mm>)

4. As for troubleshooting, swap P_1, P_2 delivery hoses and test the symptom.
   For example: Ordinally, oblique travel to left, then after exchange the hoses,
   • In case oblique travel to right;
     (Suspected causes are control valve or rotary joint, travel motor’s failure)
   • In case oblique travel to left;
     (Suspected causes could be pump itself.)

ⓐ P_1 delivery hose
ⓑ P_2 delivery hose

c. Swivel motor block performance



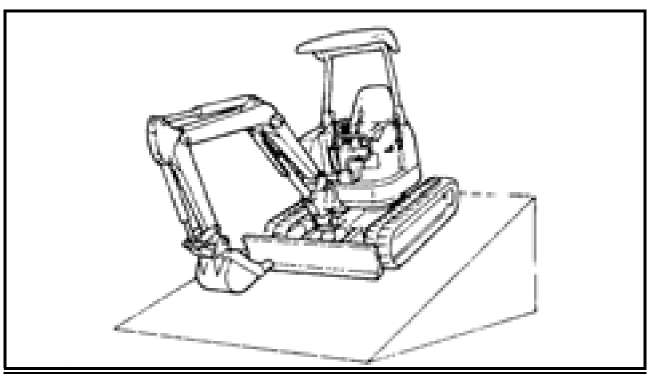


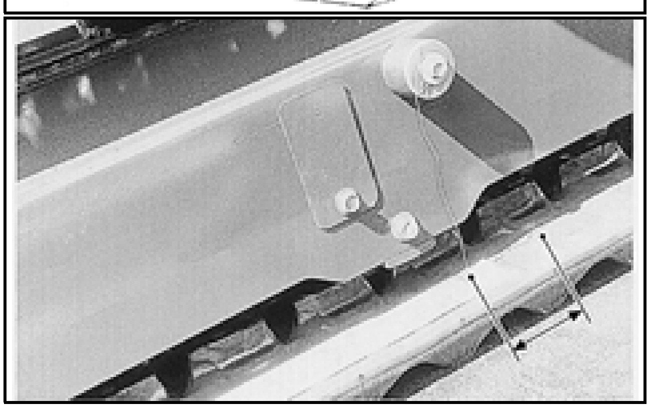
1. Locate the machine on the 15 deg. slope.
2. The front position is of arm dump and bucket crowd. Keep the boom so that the boom end pin is alignedwith the bucket pin.
3. Mark the outer ring of swivel bearing and truck frame.
4. Unlock the safety lock lever, and measure the one minute shifting distance between them with engine idling rpm.
5. Load on the bucket should be as follows.

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	Brake applied	K008-3	5 mm / min	5 mm / min 0.2 in. / min
	Brake released	U10-3	30 mm / min 1.18 in. / min	-

6. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 41°F.

d. Traveling motor block performance





1. Park the machine on a 20deg. slope. Keep front at traveling position.
2. Put marks on the truck frame and the crawler.
3. Measure 10 minutes slip-distance without engine running.
4. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 41°F.

Reference Value	300 mm/10 min 0.98 ft/10 min

e. Operating speed

(1) Checking each operating speed.

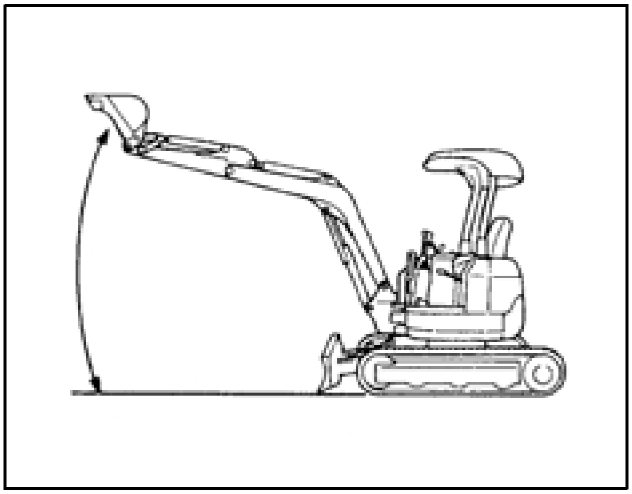
[Important points]

1. Measure full stroke operating time with no load on the standard bucket.
2. Make several mesurement and use average time for judgement.
3. Two different measurements are expected for the forward and backward movements as well as the right and left swivelings.
   Obtain their respective measurements. Do not calculate for their average.
4. Before operation, make sure nobody is around the machine.

[Measurement conditions]

1. Engine rpm is max..
2. Hydraulic temperature is 50 ± 5°C, 122 ± 41°F.
3. Ground is flat.
4. Measure time after several pre-operation.

(2) Boom cylinder



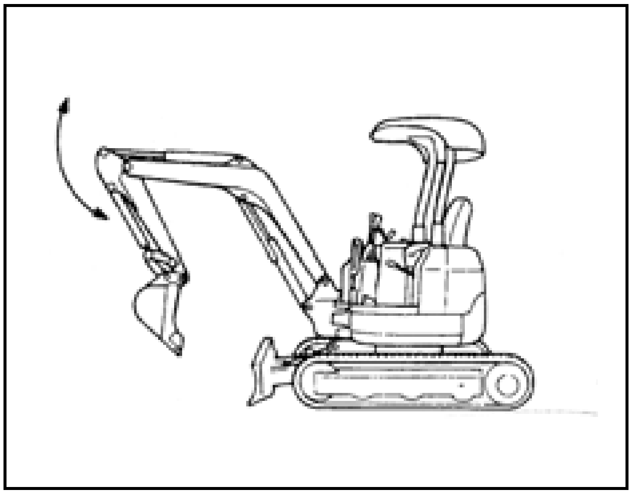
1. Arm and bucket cylinder shouls be most shorted position.
2. Measure the time from the bucket is on the ground to the boom highest position, and from the boom highest position to the ground.

Note:The cushioning time is not included.

[sec]

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	K008-3	Up	2.5	←
		Down	2.8	←
	U10-3	Up	2.5	-
		Down	2.8	

(3) Arm cylinder

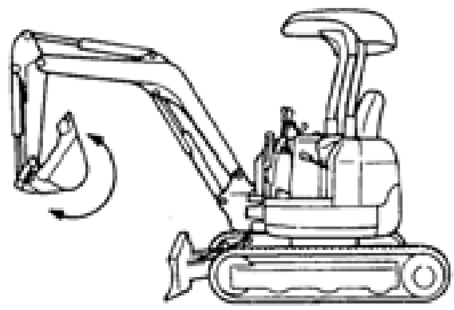


1. Position the boom and arm as showm at left.
2. Measure the arm cylinder full stroke operating time.

[sec]

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	K008-3	Crowd	3.0 ± 0.3	←
		Dump	2.2 ± 0.3	←
	U10-3	Crowd	4.0 ± 0.3	-
		Dump	2.8 ± 0.3	

(4) Bucket cylinder

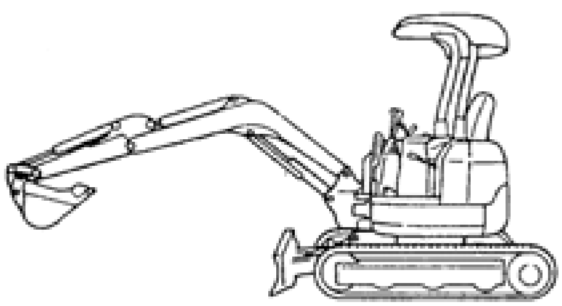


1. Position the boom and arm as showm at left.
2. Measure the bucket cylinder full stroke operating time.

[sec]

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	K008-3	Crowd	2.9 ± 0.3	←
		Dump	2.0 ± 0.3	←
	U10-3	Crowd	2.9 ± 0.3	-
		Dump	2.0 ± 0.3	

(5) Swing cylinder

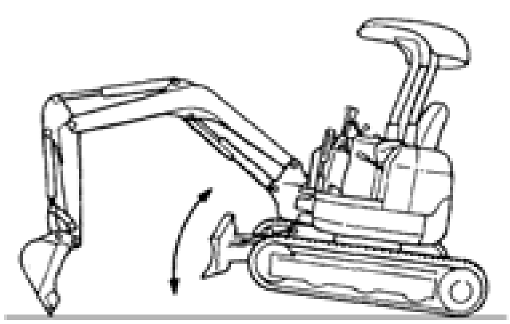


1. Position the boom, arm and bucket as showm at left. (with the bottom of the bucket about 1 m (33 ft) above from the ground.)
2. Measure the swing cylinder full stroke operating time. (right to left and left to right)

[sec]

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	K008-3	Left	4.2 ± 0.3	←
		Right	4.1 ± 0.3	←
	U10-3	Left	4.2 ± 0.3	-
		Right	4.1 ± 0.3	

(6) Dozer cylinder

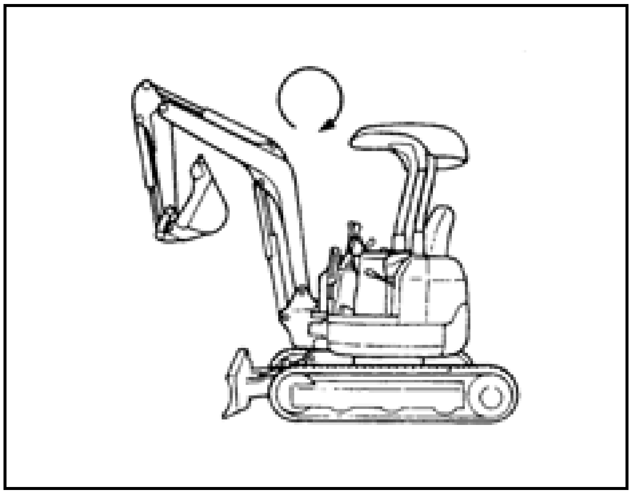


1. Place the bucket on the ground. Position the machine as shown at left for the dozer to make a full stroke.
2. Measure the dozer cylinder full stroke operating time.

[sec]

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	K008-3	Up	1.6 ± 0.3	←
		Down	1.2 ± 0.3	←
	U10-3	Up	1.6 ± 0.3	-
		Down	1.2 ± 0.3	

(7) Swivel speed

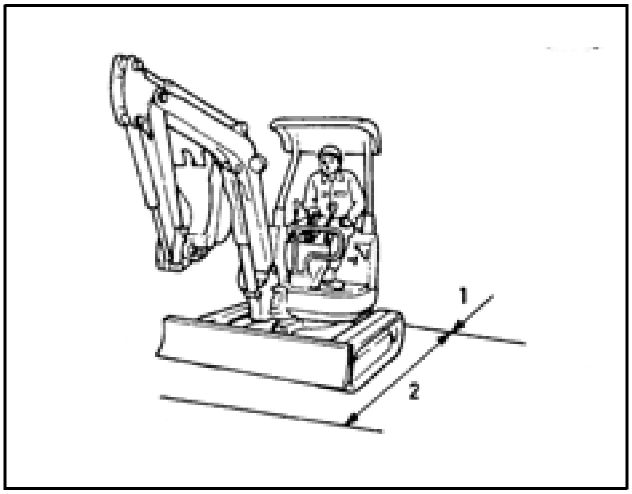


1. Position the boom, arm and bucket as showm at left.
2. Measure three times rotation time.

[sec/three turns]

		KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	K008-3	19.8 ~ 24.0	19.8 ~ 24.0
	U10-3	19.8 ~ 24.0	-

(8) Traveling speed

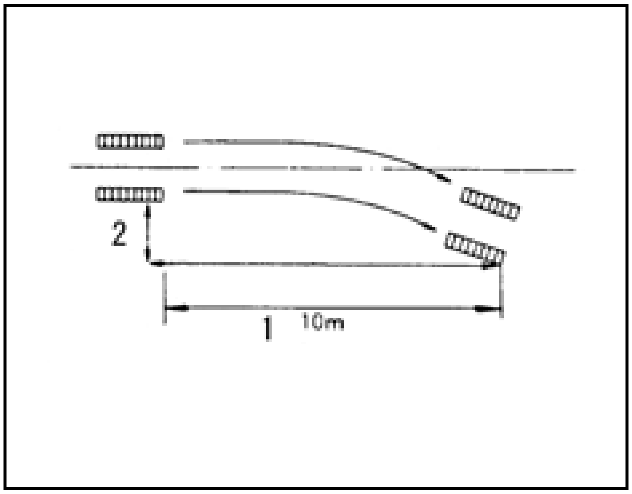


1. Travel the machine untill getting max. speed.
2. After getting max. speed, measure the 10 mm (33 ft) traveling time.

km/h

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value (Rubber)	K008-3	1F	2.0 ± 0.2	2.0 ± 0.2
		2F	-	4.0 ± 0.4
	U10-3	1F	2.0 ± 0.2	-
		2F	4.0 ± 0.4	-

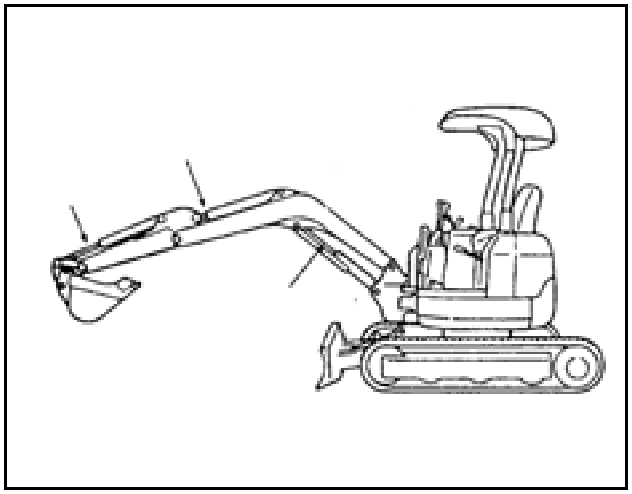
f. Straight travel performance



1. Travel the machine untill getting max. speed.
2. Measure the vertical distance from the traveling line.

Reference Value	Under 600 mm/10 m 1.97 ft/32.8 ft

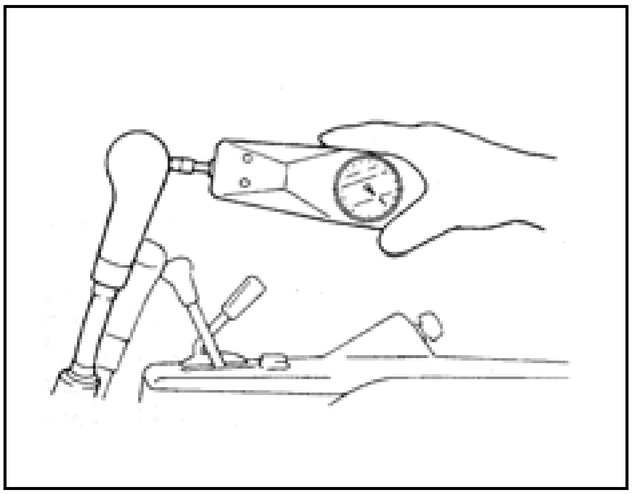
g. Cylinder natural fall amount



1. Locate the machine on the flat ground, and put the load the bucket.
   Load on the bucket should be as follows.
   K008-3: 29kg(64lbs) - exclude bucket weight
   U10-3: 35kg(77lbs) - exclude bucket weight
2. Arm cylinder must be fully retracted. Bucket cylinder must be fully extended.
3. Locate the bottom of bracket about 1 m above from the ground. Stop the engine.
4. Mark on the rod of each cylinder.
5. Measure the fall distance after 10 min.

Reference Value	See page IV-S-17

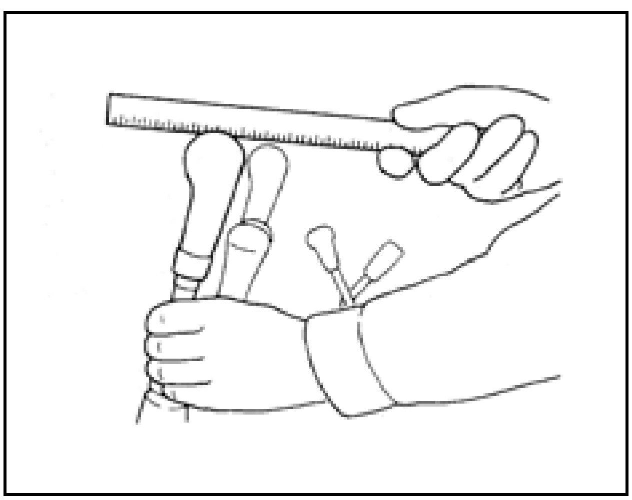
h. Control and Traveling lever operating force



1. Stop the engine.
2. Measure force of right and left control and traveling levers.
3. Start the engine, operate the control lever or traveling lever for a full stroke, and measure the max. operating force.
4. Make three measurements and take their average.
5. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

Reference Value	See page II-S-6, 7

i. Lever stroke



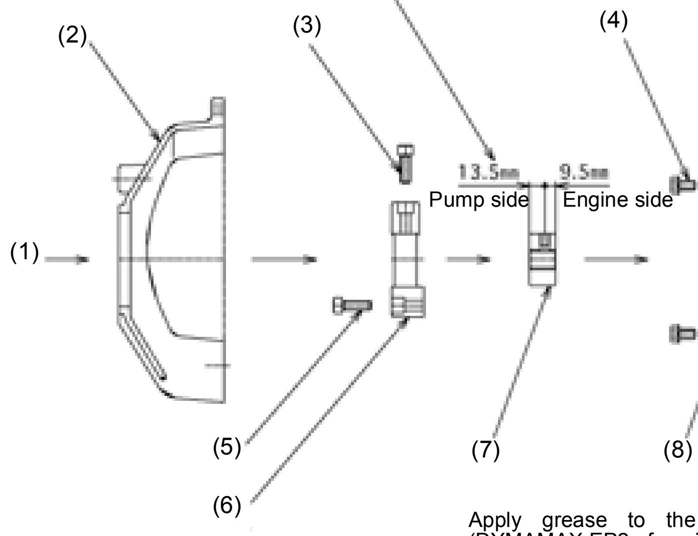
1. Stop the engine.
2. Move each lever from neutral to full stroke end, and measure each stroke with respect to the top center of the each lever glip.
3. If any lever is loose at its neutral position, measure the stroke from each loose end.
4. Make three measurements and take their average.

Reference Value	See page II-S-6, 7

D.Disassembling and Assembling

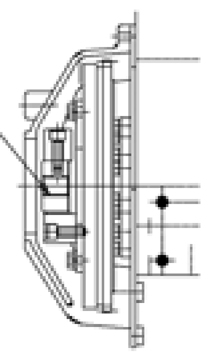
a. Pump coupling

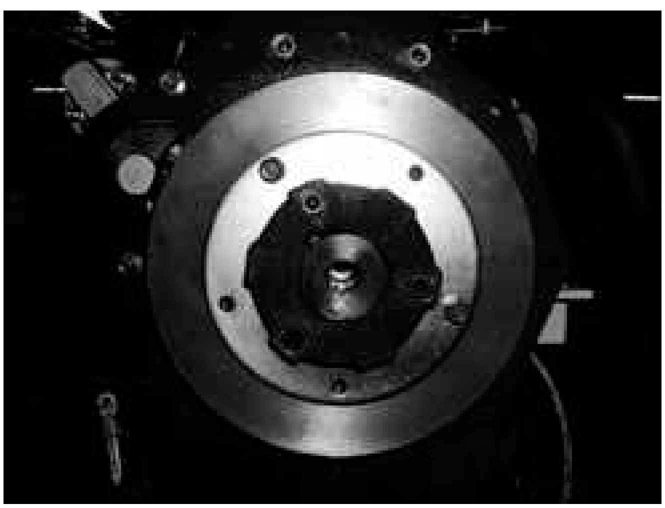
Mount the boss having long threaded hole from pump side, and mount the boss having short threaded hole from engine side.



(1) Pump assembly (Gear)
(2) Flange (Pump)
(3) Hex. socket head bolt
(4) Bolt
(5) Hex. socket head bolt
(6) Rubber coupling
(7) Boss (Inner)
(8) Plate

Apply grease to the spline. (DYMAMAX EP2 of equivalent)





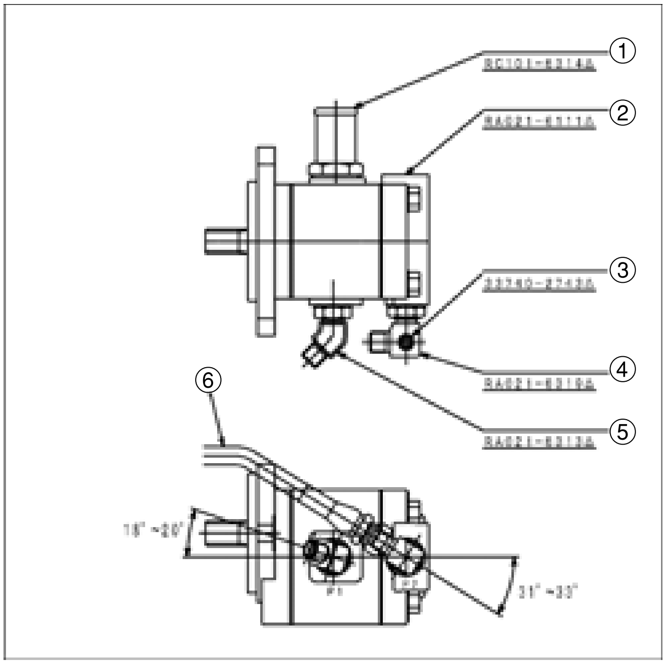
■ Assembly procedure

1) Tightening torque of plate (8):
   * Apply screw lock agent.
2) Assembling the boss (inner)(7)
   1. Mount the boss having long threaded hole from pump side, and mount the boss having short threaded hole from engine side.
      * Apply grease (DYNAMAX EP2) to the hole.
   2. Tightening torque of tightening bolt (hex. socket head bolt)(3):
      * Apply screw lock agent.
3. Tightening torque of rubber coupling (6)
   * Apply screw lock agent.

Pay attention not to allow excessive screw lock agent to stick to rubber.

b. Pump

(1) Pump (Main) assembly drawing

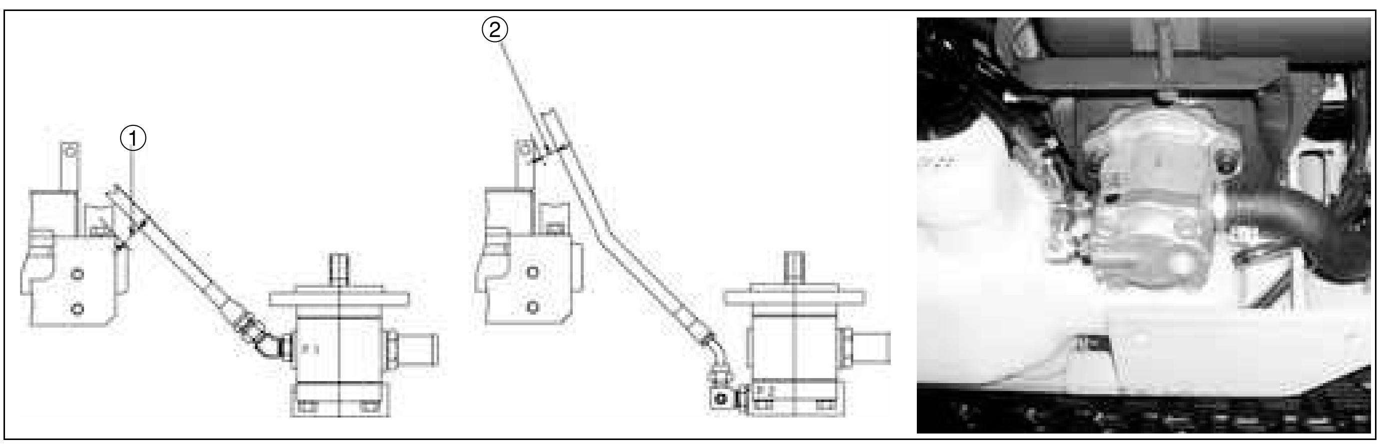


■ Assembly procedure

1) Pump assembly (gear) mounting torque:
   39.2 ~ 45.1 N·m(4.0 ~4.6 kgf·m)
   * Apply screw lock agent.
2) Mount the adaptor of No.1 pump side 18 deg.-20 deg. upwards and the adaptor of No. 2 pump side 31 deg.- 33 deg. upwards.
   Adaptor tightening torque:
   37.2 ~ 42.1 N·m(3.8 ~ 4.3 kgf·m)
3) Pipe joint mounting torque:
   58.8 ~ 63.7 N·m(6.0 ~ 6.5 kgf·m)
4) Plug (Seal) tightening torque:
   15 ~ 16.5 N·m(1.5 ~ 1.7 kgf·m)

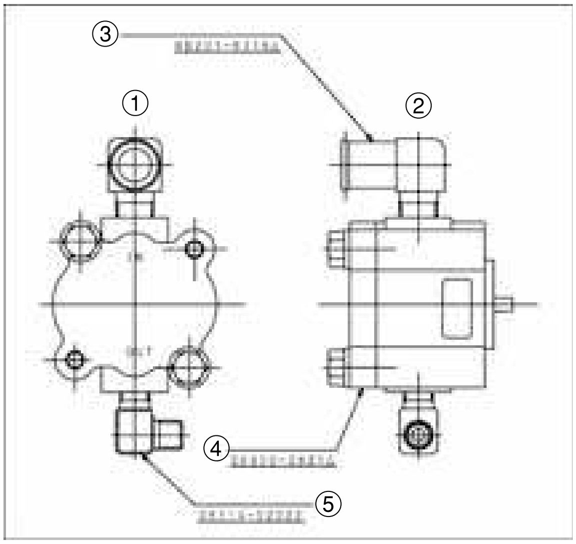
①Pipe joint (Inlet, 2)
②Pump, assembly (Gear)
③Plug (Seal)
④P2 elbow joint (G3-G2)
⑤P1 elbow joint (G3-G2)
⑥Provide a clearance of more than 5 mm at the wire harness clamp of the bracket (step).

(2) Route of delivery hose



①Provide a clearance of more than 5 mm between the bolt and the support (step).
②Provide a clearance of more than 5 mm at the support (step).

(3) Pump (Pilot) assembly drawing



■ Assembly procedure

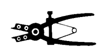
1) IN side port pipe joint (L, T3/8-22) tightening torque: 48 ~ 51.5 N·m(4.9 ~ 5.3 kgf·m)
   OUT side port pipe joint tightening torque :15.1 ~ 30.9 N·m(2.6 ~ 3.2 kgf·m)

①As viewed from left
②As viewed from rear
③Pipe joint(L, T3/8-22)
④Hydraulic pump assembly
⑤Elbow pipe joint

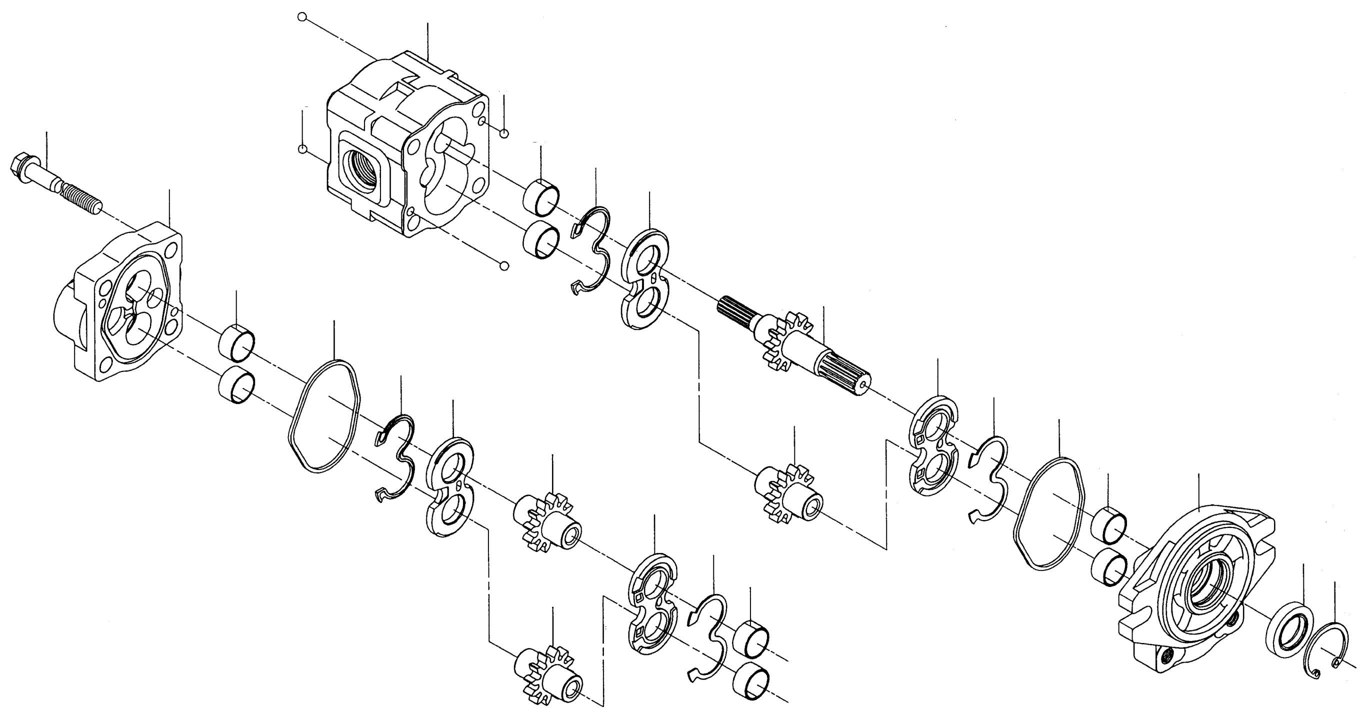
(4) Disassembly and reassembly

1) Tools

Required tools are as shown below. Get ready before repair work. Clean tools, working table and the surrounding to prevent foreign materials from getting into pump.

Tool Name	Fig.	Remarks
Torque wrench		
Socket wrench		
Socket		14mm (0.55 inch)
Snap ring plier (Hole)		
Resin hammer		
Minus driver		

2) Figure of disassembled parts

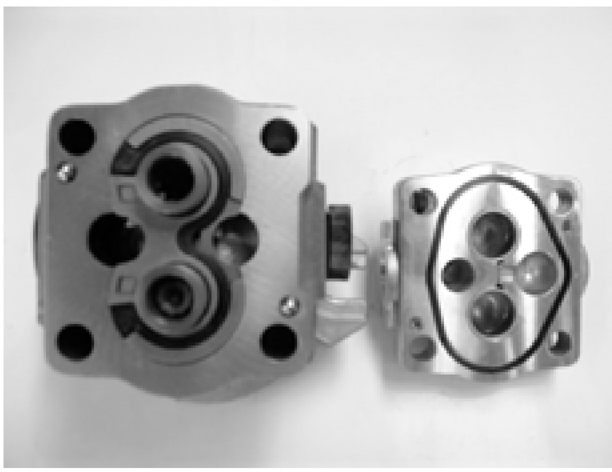


No.	Part Name	Q'ty	No.	Part Name	Q'ty
01	Front cover	1	50	Gasket	4
02	Body	1	51	Gasket	2
03	First drive gear	1	52	Steel ball	4
04	2nd drive gear	1	53	Bolt	4
05	3rd drive gear	2	55	Oil seal	1
06	Side plate	4	56	C-circlip	1
07	Rear cover	1			
08	Bush	8			

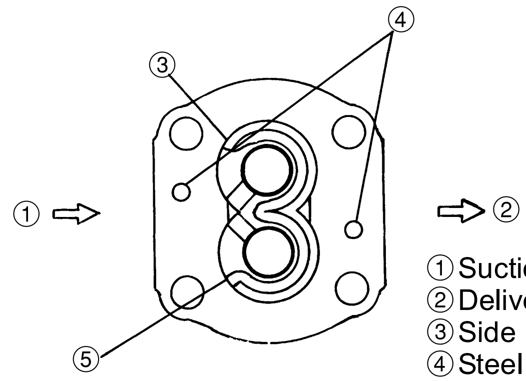
3) Procedure

(1) Before disassemble, put alignment mark on front cover, body and rear cover and remove bolts.

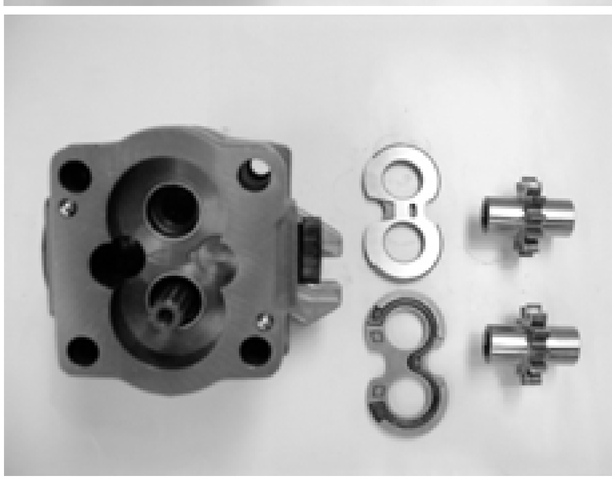
Bolt tightening torque : 48.1 ~ 51.0 N·m (4.9 ~ 5.2 kgf·m) , 35.5~37.6 ft·lbs

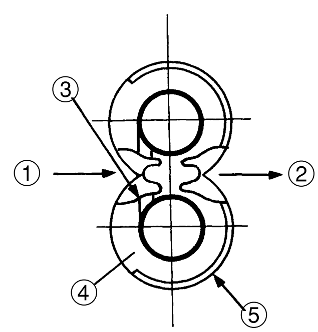


(2) Remove rear cover, gasket, side plate, 2nd drive gear, 2nd driven gear and steel ball.
Bush cannot come out.
* Watch steel ball not to loose.



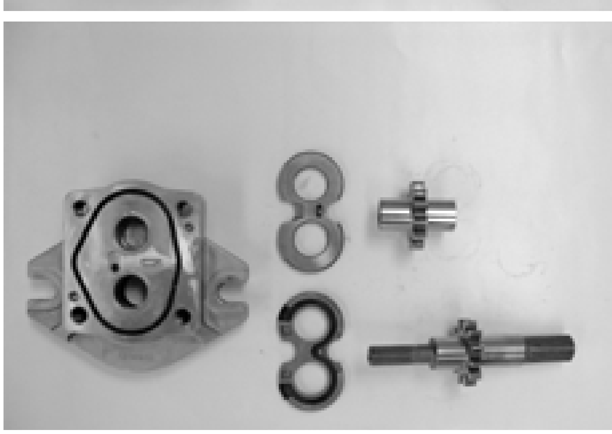
① Suction side
② Delivery side
③ Side plate
④ Steel ball
⑤ Gasket



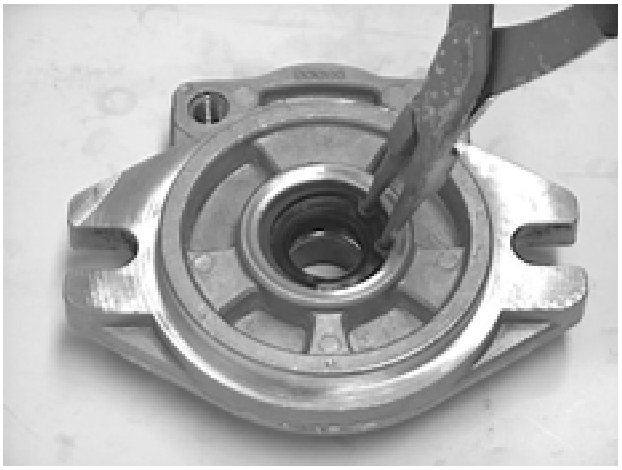


① Inlet port
② Delivery port
③ This groove is inlet side.
④ Gear side sliding face
⑤ Chamfer is in delivery side.

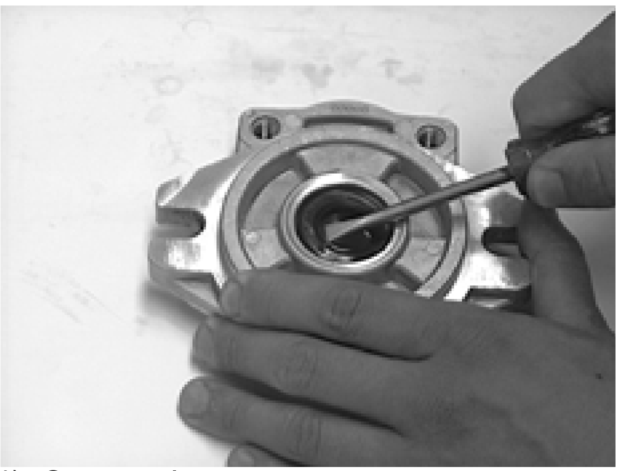
[Renew seal]
When replacing seals, apply grease on seals and fit them in the groove.



(3) Remaining oil seal and C-circlip in the front cover, remove gaskets, side plate, 1st drive gear, 1st driven gear and steel balls.



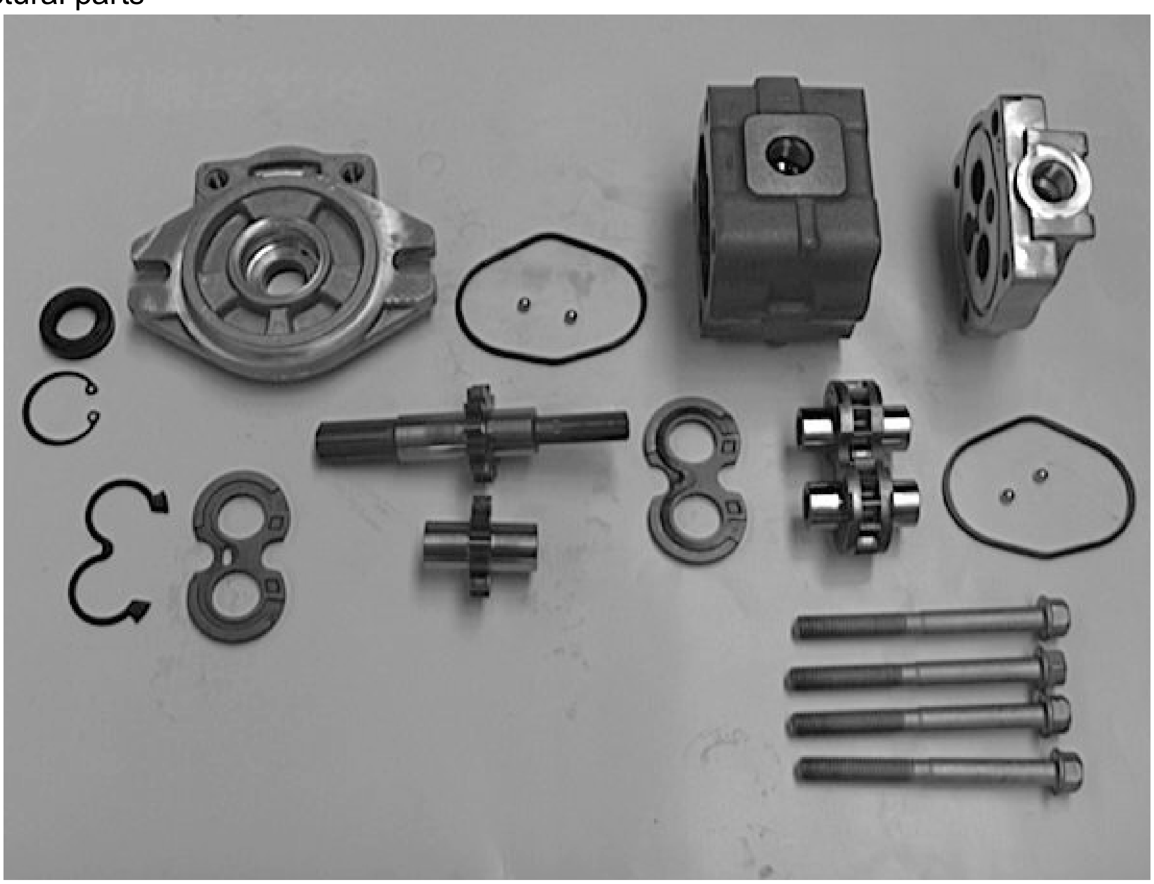
(4) Remove C-circlip and oil seal.
Oil seal is difficult to remove, care should be taken not to damage machining surface.



(5) Apply grease on oil seal housing.

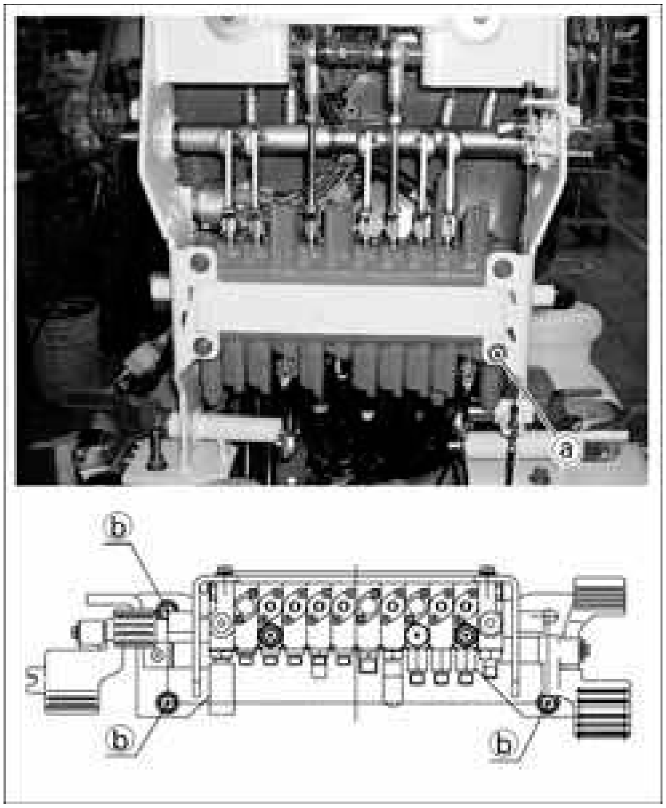
[Replacement of oil seal]
Apply grease on lips of oil seal.
Wound vinyl tape around spline of 1st drive gear.
Apply gease on the tape to smooth the oil seal.
Press fit the oil seal and set the C-circlip.

4) Structural parts



(5) Control valve

Assembling the control valve (K008-3)

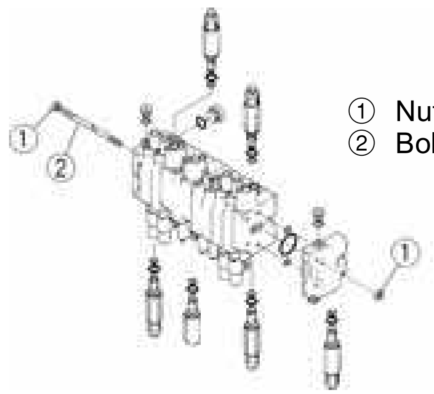


■ Assembly procedure

1) Tightening torque of control valve:
   23.5 ~ 27.5 N·m (2.4 ~ 2.8 kgf·m)(a)
   * Apply screw lock agent.

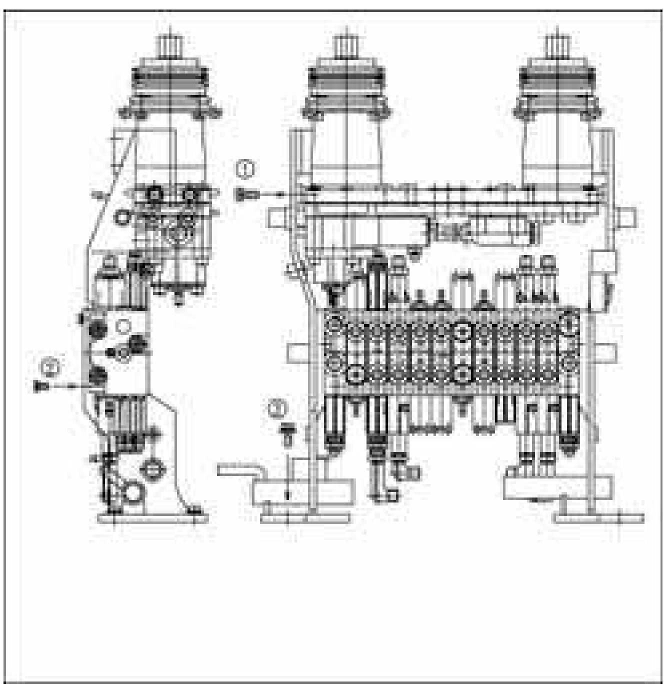
2) Tightening torque of bracket (operating):
   48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m)(b)
   * Apply screw lock agent.

3) Tightening torque of nut (1)
   13.7 ~ 14.7 N·m (1.4 ~ 1.5 kgf·m)



① Nut (RA011-7067△)
② Bolt (RA121-7066△)

Assembling the control valve (U10-3)



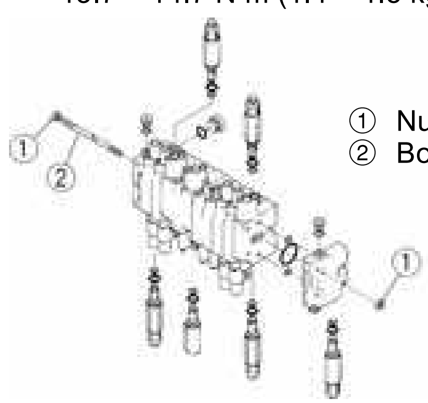
■ Assembly procedure

1) Tightening torque of valve and sub-unit:
   23.5 ~ 27.5 N·m (2.4 ~ 2.8 kgf·m)
   * Apply screw lock agent.

2) Tightening torque of control valve:
   23.5 ~ 27.5 N·m (2.4 ~ 2.8 kgf·m)
   * Apply screw lock agent.

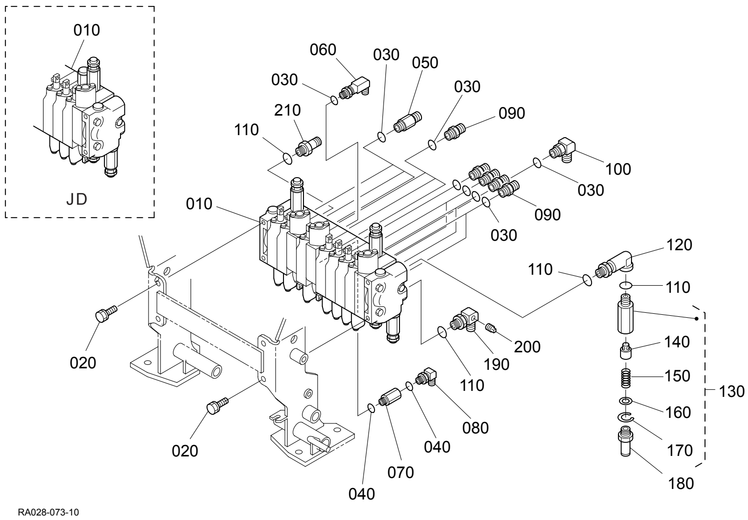
3) Tightening torque of bracket (operating):
   48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m)
   * Apply screw lock agent.

4) Tightening torque of nut (1)
   13.7 ~ 14.7 N·m (1.4 ~ 1.5 kgf·m)



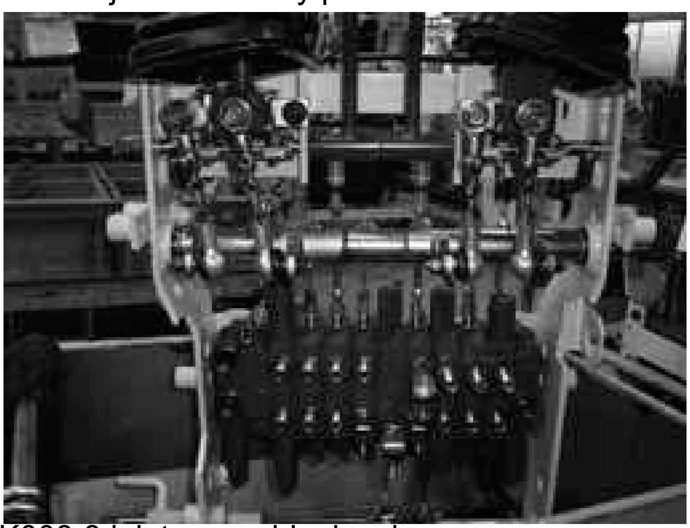
① Nut (RA011-7067△)
② Bolt (RA121-7066△)

(6) Control valve joint

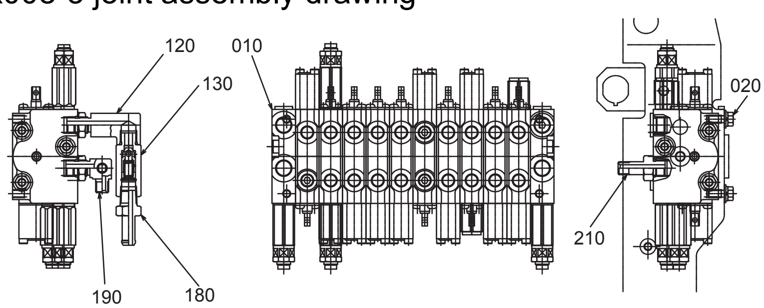


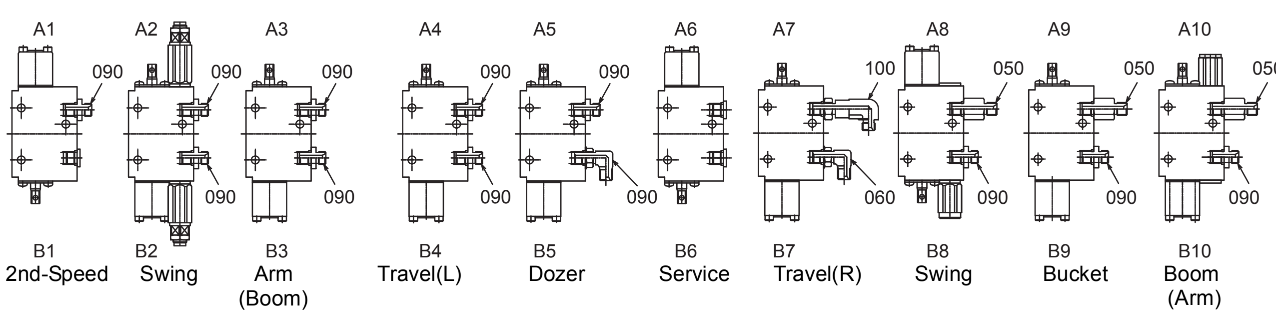
010	Assy valve, Control
020	Bolt
030	O-ring
040	O-ring
050	Joint, Pipe
060	Joint, Elbow
070	Joint, Pipe
080	Joint
090	Joint, Pipe
100	Joint
110	O-ring
120	Joint, Pipe
130	Assy valve, Check
140	Poppet
150	Spring
160	Washer
170	Circlip, Internal
180	Joint, Pipe(ST/-)
190	Joint, Pipe
200	Plug
210	Joint, Pipe

K008-3 joint assembly photo



K008-3 joint assembly drawing





The figures in parentheses are for the KTC, KCL and KTA versions.

■ Assembly procedure

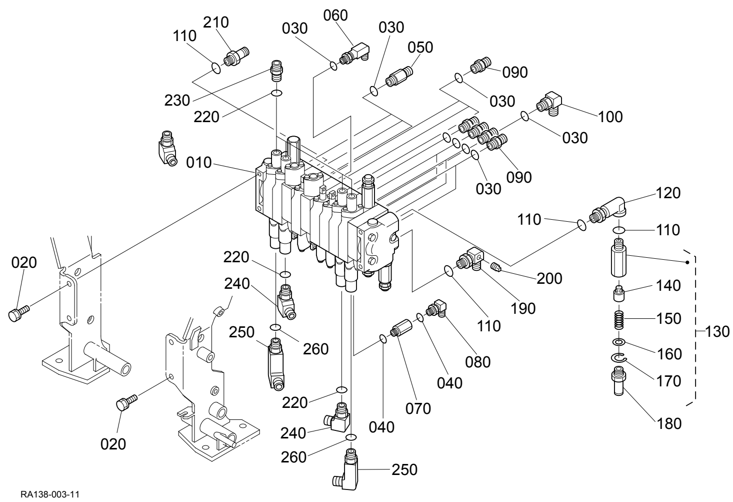
Assembling method and tightening torque of the valve adaptor

* Apply oil (NEW UDT or M80B, or equivalent) to O-rings.

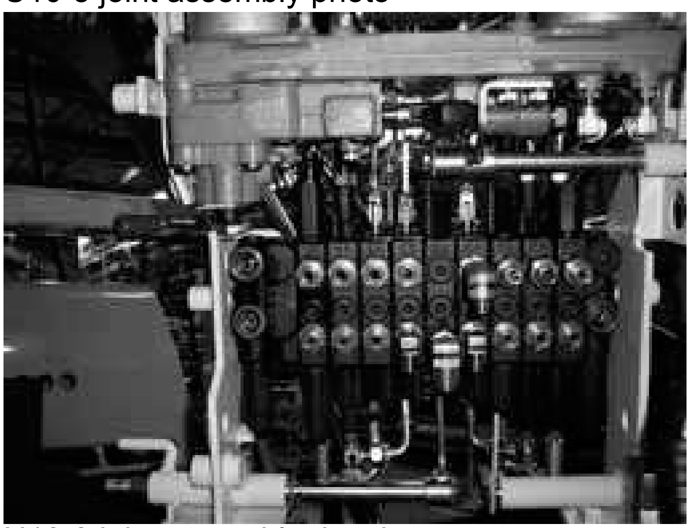
■ Tightening torque

G 1/4 adaptors (A1-A10, B1-B10):
24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m)
G 3/8 adaptors (P1, P2, T):
37.2 ~ 42.1 N·m (3.8 ~ 4.3 kgf·m)
Plug (seal):
15 ~ 16.5 N·m (1.5 ~ 1.7 kgf·m)

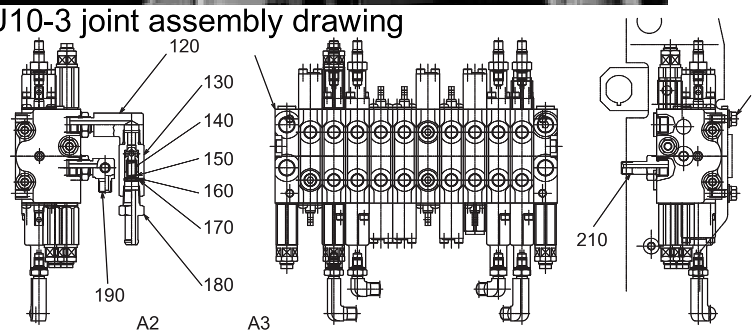
Exploded view of U10-3

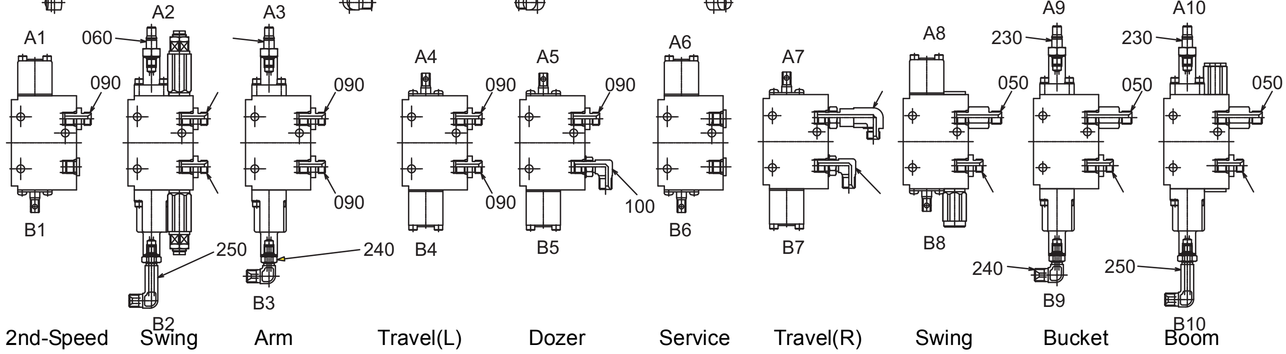


U10-3 joint assembly photo



U10-3 joint assembly drawing





010	Assy valve, Control
020	Bolt
030	O-ring
040	O-ring
050	Joint, Pipe
060	Joint, Elbow
070	Joint, Pipe
080	Joint
090	Joint, Pipe
100	Joint
110	O-ring
120	Joint, Pipe
130	Assy valve, Check
140	Poppet
150	Spring
160	Washer
170	Circlip, Internal
180	Joint, Pipe(ST/-)
190	Joint, Pipe
200	Plug
210	Joint, Pipe
220	O-ring
230	Joint, Pipe
240	Joint
250	Joint
260	O-ring

■ Assembly procedure

Assembling method and tightening torque of the valve adaptor

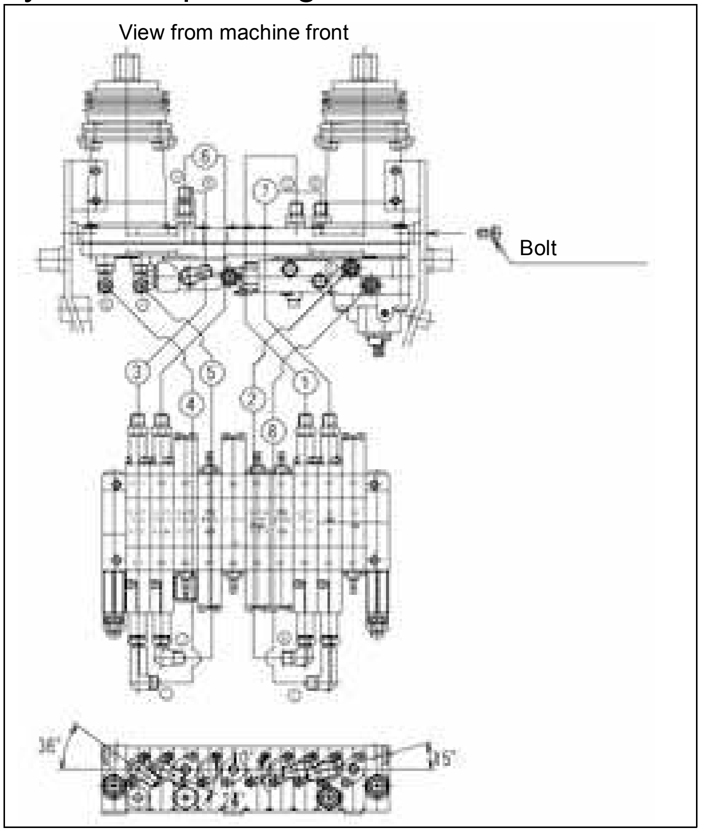
* Apply oil (NEW UDT or M80B, or equivalent) to O-rings.

■ Tightening torque

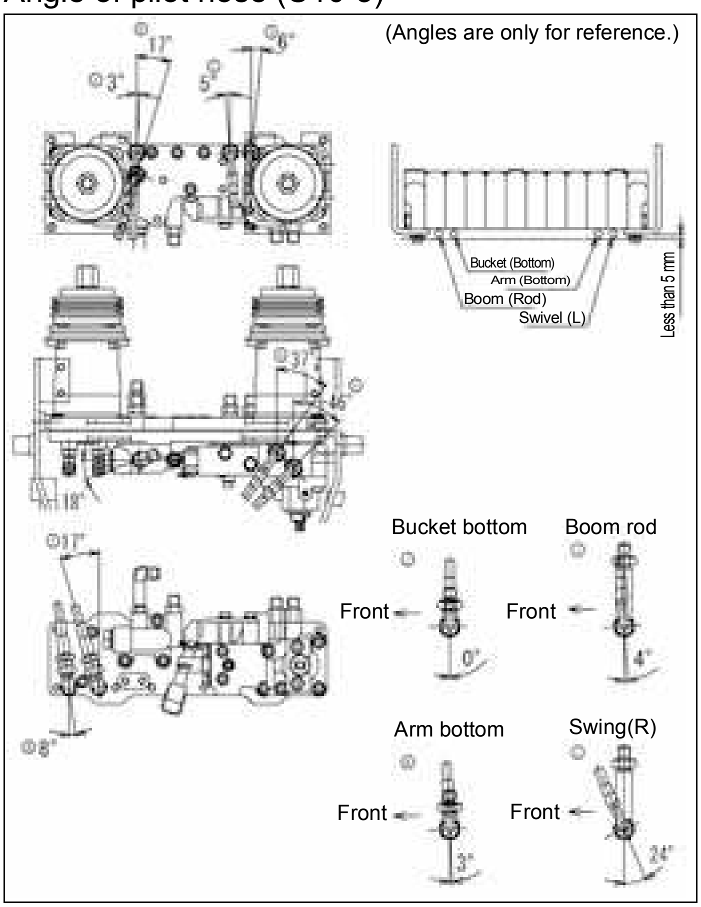
G 1/4 adaptors (A1-A10, B1-B10):
24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m)
G 3/8 adaptors (P1, P2, T):
37.2 ~ 42.1 N·m (3.8 ~ 4.3 kgf·m)
G 1/8 adaptors (A2, A3, A9, A10, B2, B3, B9, B10):
15 ~ 16.5 N·m (1.5 ~ 1.7 kgf·m)

c. Pilot valve

Hydraulic operating unit



Angle of pilot hose (U10-3)



■ Assembly procedure

1) Cautions for routing of pilot hose
   1. Hose should not be in tight contact with the cover (front).
   2. There should be no tightly contacting parts such as edge near the hose.
   3. Clamp the hose which passes through the swivel frame.
2) List of pilot hoses

No.	Part Name	Q'ty	Color
①	Hose(1/8)	1	green
②	Hose(1/8)	1	blue
③	Hose(1/8)	1	gray
④	Hose(1/8)	1	lightblue
⑤	Hose(1/8)	1	pink
⑥	Hose(1/8)	1	brown
⑦	Hose(1/8)	1	yellow
⑧	Hose(1/8)	1	red

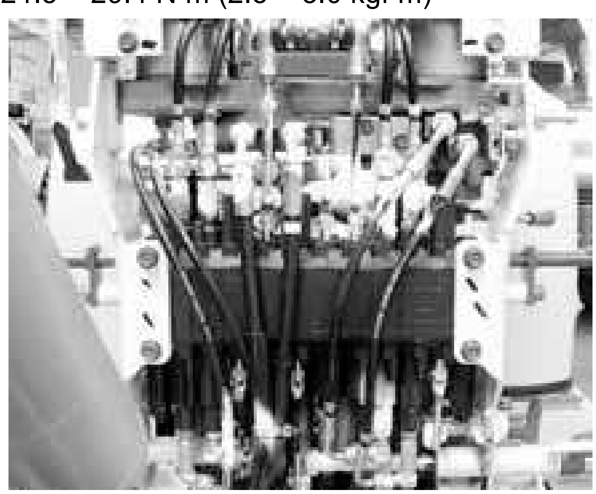
Connect the side of hose, where discrimination tape is applied, to the control valve.

3) Angle of pilot hose adaptor (See the figure left below.)
   Tightening torque of adaptor:
   15.0 ~ 16.5 N·m (1.5 ~ 1.7 kgf·m)

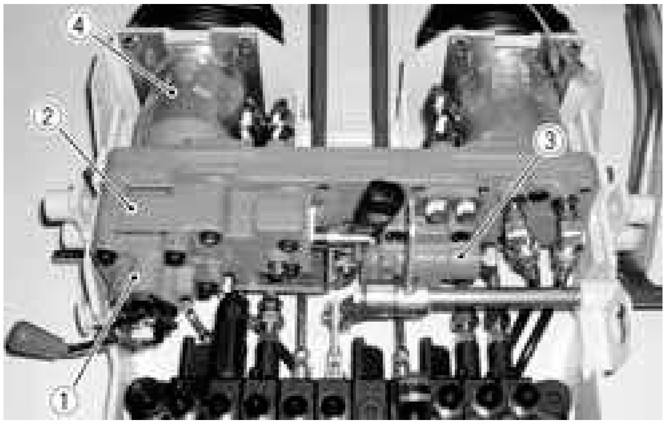
CAUTION

- **1/8 adaptor is mounted to the control valve side and 1/4 adaptor is mounted to the hose side. Be careful not to bend or break the adaptor when tightening the hose.**

4) Angle of pilot hose (See the figure left below.)
   Tightening torque of pilot hose:
   24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m)



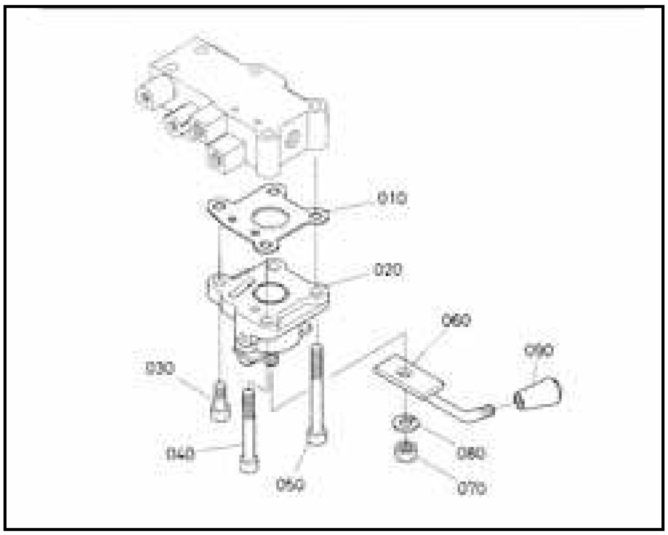
d. U10-3 Component parts of hydraulic operating unit



① Unload valve
② Super change calve
③ Valve assembly (Relief)
④ Pilot valve

(1) Unload valve

Unload valve assembly drawing

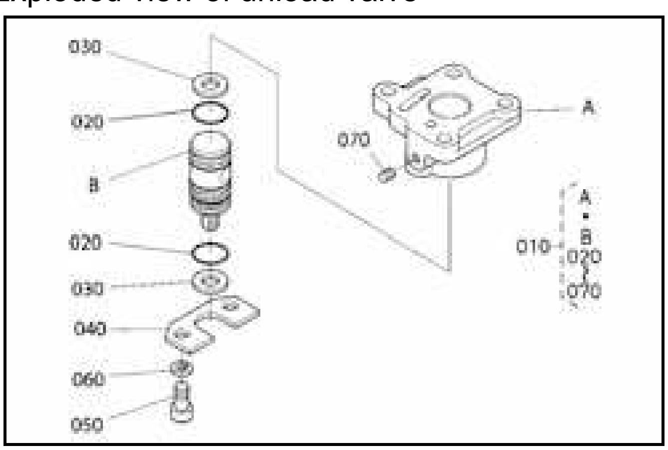


■ Assembly procedure

1) Tightening valve of hex. socket head bolt (M8 x 1.25):
   29.4 N·m (3.0 kgf·m)
2) Parts list

No.	Part Name
010	Packing (3)
020	Valve assembly (Unload)
030	Hex. socket head bolt
040	Hex. socket head bolt
050	Hex. socket head bolt
060	Lever (Unload)
070	Nut
080	Spring washer
090	Grip (Unload)

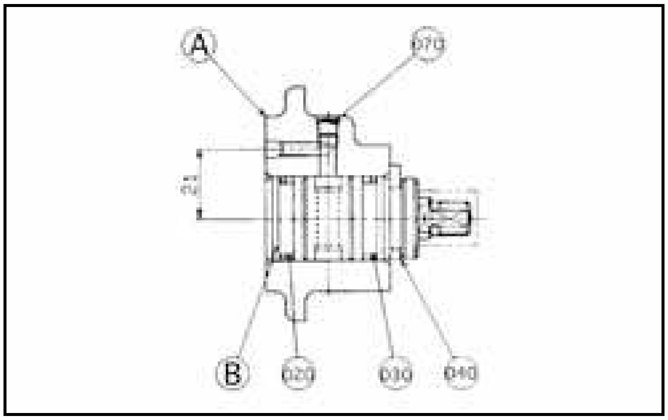
Exploded view of unload valve



3) Parts list

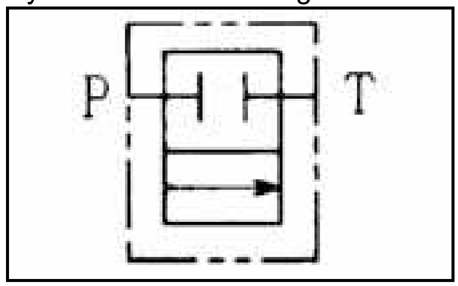
No.	Part Name
010	Valve assembly (Unload)
020	O-ring
030	Ring (Backup)
040	Spacer
050	Hex. socket head bolt
060	Spring washer
070	Thread plug

Unload valve structural drawing



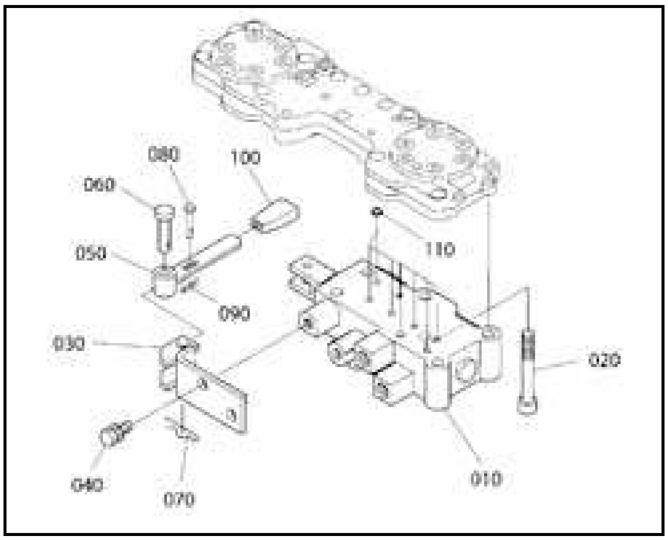
4) Cautions in assembly
Unload valve inside (oil passage) should be especially clean.
When assembling the valve, apply antirust LPS-32 or equivalent to the part which comes in contact with spools provided at both sides of machine.

5) Hydraulic oil circuit diagram



(2) Super change valve

Super change valve assembly drawing

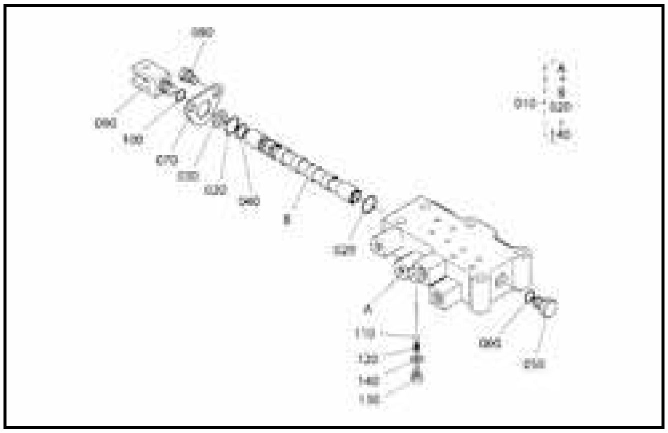


■ Assembly procedure

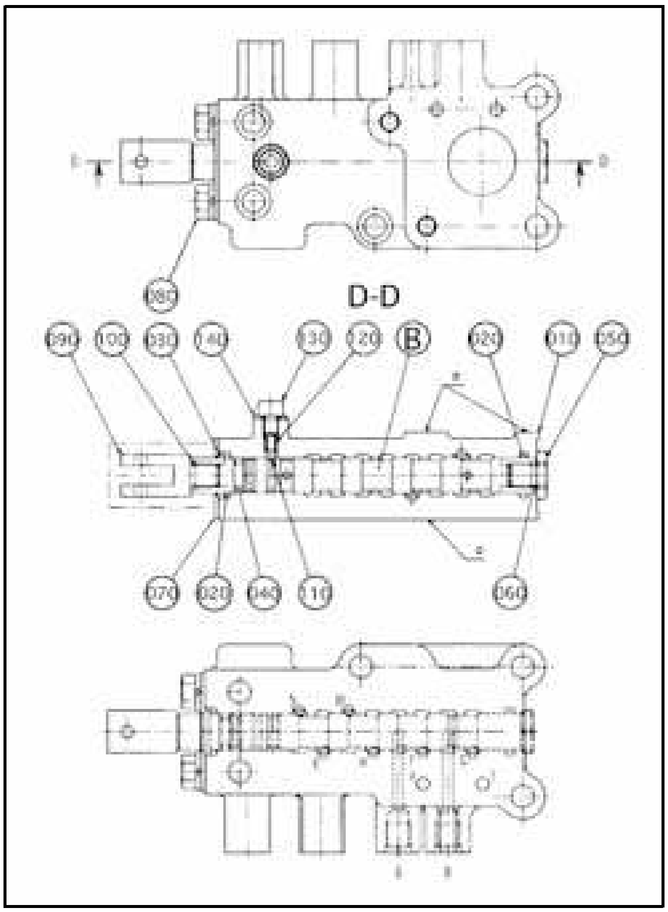
1) Tightening torque of hex. socket head bolt (M8 x 1.25):
29.4 N·m (3.0 kgf·m)
2) Parts list

No.	Part Name
010	Valve assembly (SC)
020	Hex. socket head bolt
030	Bracket
040	Bolt
050	Lever (SC)
060	Head bolt
070	Snap pin
080	Head bolt
090	Snap pin
100	Lever grip
110	O-ring

Exploded view of super change valve



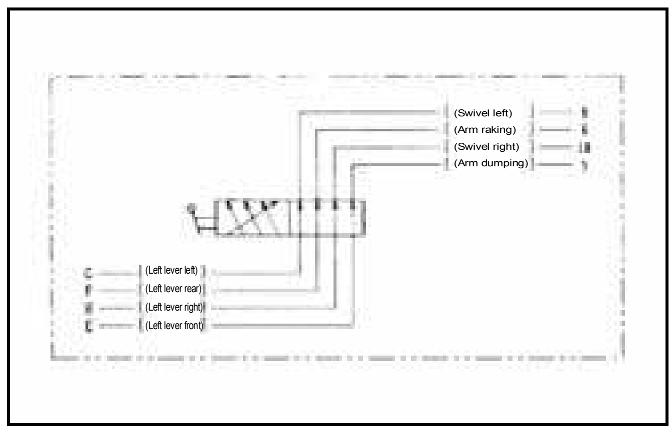
Super change valve structural drawing



3) Parts list

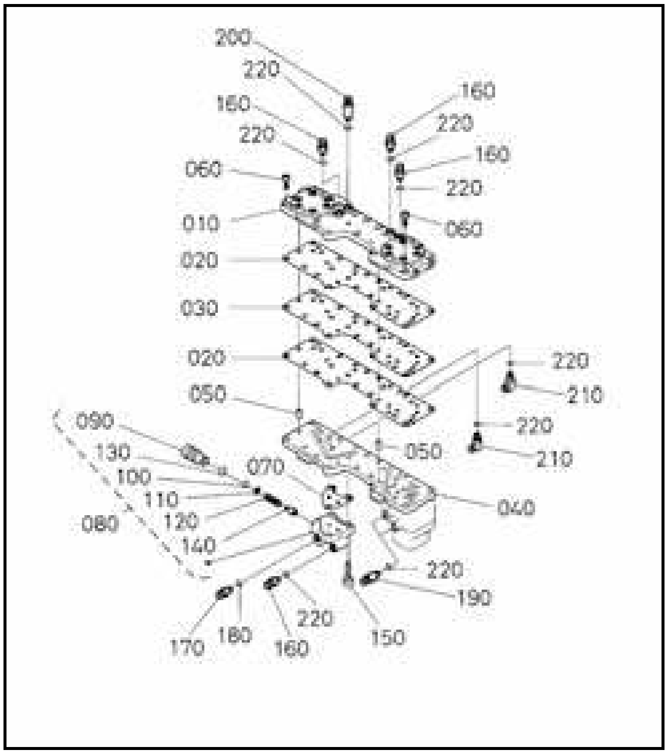
No.	Part Name
010	Valve assembly (SC)
020	O-ring
030	Ring (Backup)
040	O-ring
050	Plug (1)
060	O-ring
070	Plate
080	Bolt
090	Rod (2)
100	O-ring
110	Ball
120	Spring
130	Plug
140	Rubber-lined washer

4) Hydraulic oil circuit diagram

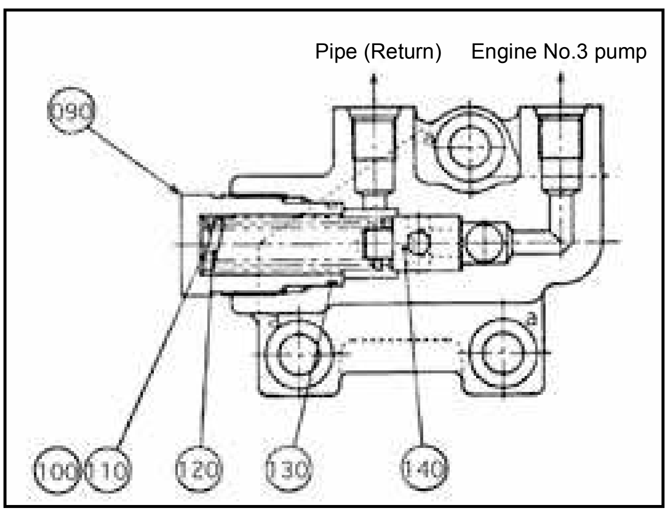


(3) Valve assembly (Relief)

Valve assembly (Relief) drawing



Valve assembly (Relief) structural drawing



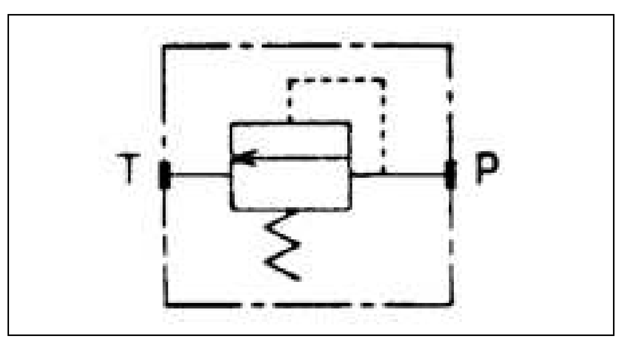
■ Assembly procedure

1) Parts list

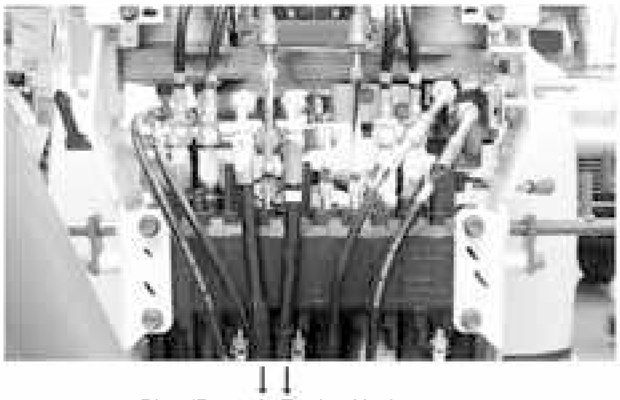
No.	Part Name
010	Manifold (1)
020	Packing (1)
030	Plate (1)
040	Manifold (2)
050	Parallel pin
060	Hex. socket head bolt
070	Packing (4)
080	Valve assembly (Relief)
090	Plug (Relief)
100	Shim 0.4 (Relief)
100	Shim 0.2 (Relief)
100	Shim 0.1 (Relief)
110	Plain washer
120	Spring(Relief)
130	O-ring
140	Spool (Relief)
150	Hex. socket head bolt
160	Straight pipe joint
170	Pipe joint (L, G1/8-G1/4)
170	Straight pipe joint
180	O-ring
190	Pipe joint (S, G1/4-G1/8)
200	Pipe joint (S, G1/4-G1/8)
210	Pipe joint (L, G1/8-G1/4)
220	O-ring
230	Bolt

3) Relief valve setting pressure:
$2.9^{+0.5}_{0}$ MPa (30^{+5}_{0} kgf/cm^2)

4) Hydraulic oil circuit diagram



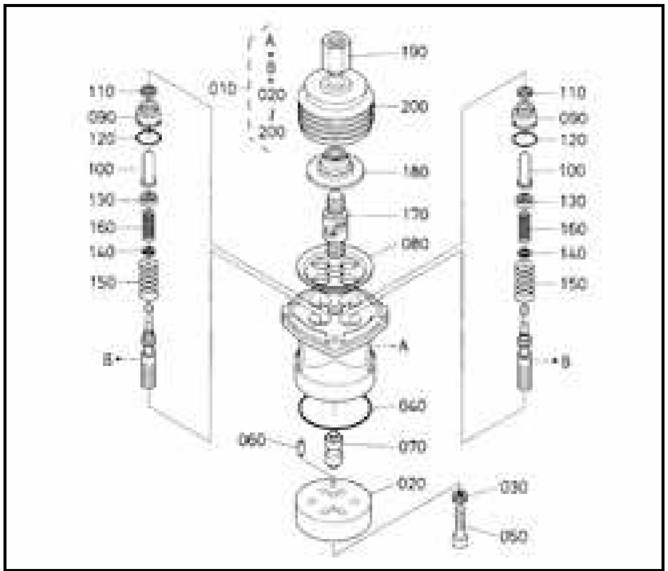
Route of hydraulic hose



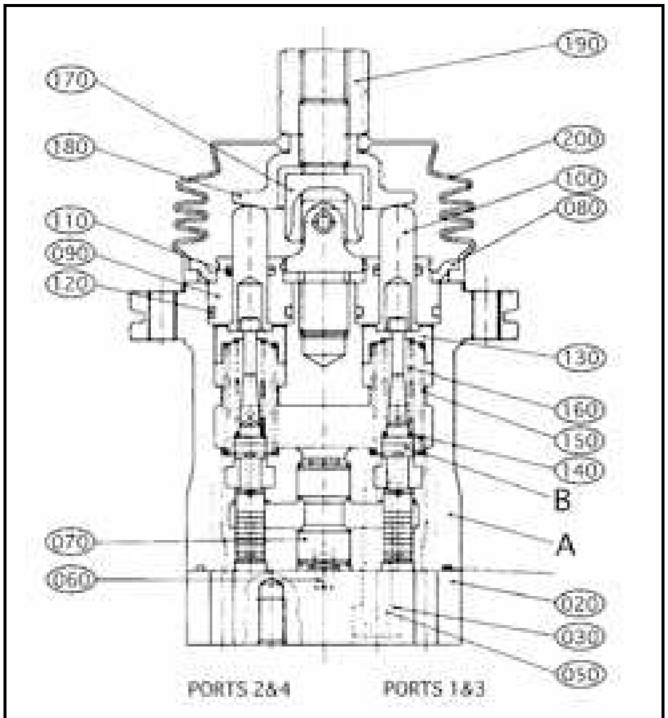
2) Joint mounting
- Apply oil (NEW UDT or M80B, or equivalent) to O-rings.
- Tightening torque:
  15 ~ 16.5 N·m (1.5 ~ 1.7 kgf·m)

(4) Pilot valve

Exploded view of pilot valve



Pilot valve structural drawing



■ Assembly procedure

1) Parts list

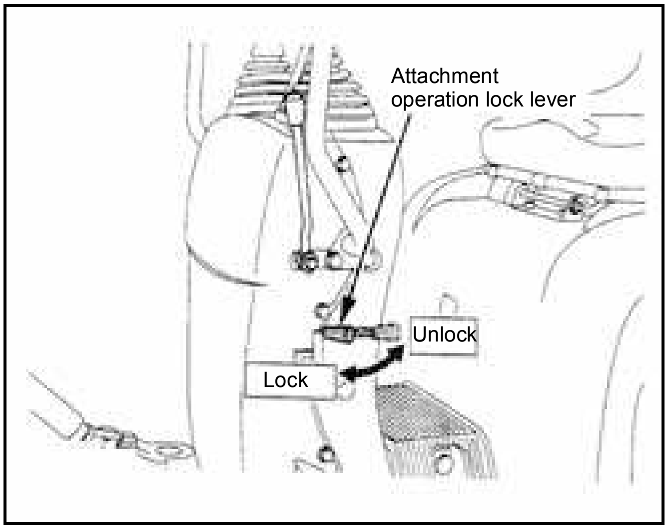
No.	Part Name
010	Valve assembly (Pilot)
020	Plate (Port)
030	Seal washer
040	O-ring
050	Hex. socket head bolt
060	Spring pin
070	Bush
080	Plate
090	Plug
100	Push rod
110	Seal
120	O-ring
130	Spring(Relief)
140	Washer 2
150	Spring
160	Spring
170	Joint
180	Nut (Disk)
190	Nut (Adjusting)
200	Bellows

2) List of tightening torques

Dwg. No.	Thread size	Tightening torque
050	M4	20.6 ± 1.5 N·m (2.1 ± 0.15 kgf·m)
170	M14	47.1 ± 2.9 N·m (4.8 ± 0.3 kgf·m)
190	M14	68.6 ± 4.9 N·m (7.0 ± 0.5 kgf·m)

*Apply grease the rotating part of the joint (170) and the head of the push rod (100).

e. U10-3 hydraulic operating unit bleeding procedure



When air enters the hose for pilot valve or the manifold, the attachment may not be operated even when the engine is started and the operating lever is manipulated.
If that is the case, bleed the unit in the procedure as follows.
(1) Set the attachment operating lock lever to "Lock" position.
(2) Rotate the engine at full speed for 1 - 2 min.
(3) Set the attachment operating lock lever to "Unlock" position and operate the attachment by manipulating the operating lever.
Perform the above operations of (1) - (3). If the attachment will not be operated even by these operations, repeat the operations of (1) - (3) twice or thrice.

f. Disassembling and assembling

1) Tools and tightening torque

Tool	Size (mm)	Part No.	Part name	Screw size	Tightening torque (N·m)
Hex wrench	6	125	Hex socket bolt	M8	20.6 ± 1.5
Money wrench	22	312	Adjusting nut	M14	68.6 ± 4.9
	32	302	Disc	M14	
Special tool (Drawing on page 17)	24	301	Joint	M14	47.1 ± 2.9

Others
- Vapor phase inhibitor
- Kerosene
- Heat-resistant grease
- Sandpaper (#1000, #2000)
- Oilstone
- Vise

2) Maintenance standard

Checkpoints	Criteria	Remarks
Leak amount	Replace the pilot valve assembly with new one if the oil leak exceeds 1000 cc/min with the steering wheel at neutral or 2000 cc/min while in operation.	Conditions: Primary pressure: 2.95 MPa Oil viscosity: 23 mm^2/s
Spool	If the sliding face is worn over 10 μ more than the non-sliding one, replace the pilot valve assembly with new one.	This amount of wear corresponds to the above leak amount. The same conditions as above are expected.
Push rod	If the tip is worn 1 mm or more, replace the push rod with new one.	
Loose control elements	If the disc (302) or joint (301) is worn out and loose 2 mm or more, replace it with new one.	If the shakiness is caused by a loose fixture, tighten it up.
Stable operation	If unusual noise, hunting, primary pressure drop, etc, occurs and it cannot be corrected according to "Chapter 8 Troubleshooting", replace the pilot valve assembly with new one.	

Note 1: It is advisable to replace the O-rings and other sealing elements at every disassembly. They may be reused when they are found not damaged.

Note 2: When the hex socket bolt (125) has been loosened, be sure to replace the sealing washer (121).

3) Disassembling

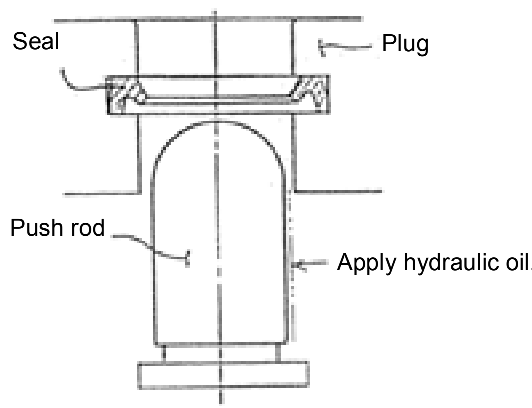
1. Preparations
   (1) Prepare a workbench that is spacious enough for the parts handled and strong and stable enough to keep the parts in place.
   (2) Also have the tools and jigs, discussed in Item 7-1, at hand.
2. General precautions
   (1) The parts are precision-machined. Handle them with enough care not to hit them against each other or drop them.
   (2) Even if any part is hard to remove, do not strike it out or pry out forcibly. Such handling may cause burrs or damages, which may invite oil leak or poor performance later. Try to do the job with patience.
   (3) Do not leave the taken-out or exposed parts unprotected. Moisture or dust may get stuck on them, causing rust. If unavoidably the job is interrupted halfway, be careful to protect such parts against rust and dust.
3. Disassembling procedure

	Procedure	Precautions
1	Clean up the pilot valve with kerosene.	* Apply blind plugs to all the open ports.
2	Fix the pilot valve on a vise using copper (or lead) sheets.	
3	Remove the bellows (501). [Photo 7-1]	* Be careful not to break the bellows (501).
4	Apply a wrench across the adjusting nut (312) and disc (302). Loosen and remove the adjusting nut and disc. [Photos 7-2, 7-3 and 7-4]	
5	With the specified jig, turn the joint (301) counterclockwise to get it loose. [Photos 7-5 and 7-6]	* Photo 7-5 shows the jig in its specified position. **CAUTION:** * When the return spring (221) is strong in force, take care in loosening and drawing out the joint (301). The plate (151), plug (211) and push rod (212) may pop out together when taking out the joint.
6	Remove the plate (151). (When the return spring (221) is strong in force) [Photo 7-7] (When the return spring (221) is weak in force) [Photo 7-8]	
7	When the return spring (221) is weak in force, the sliding resistance of the O-ring holds the plug (211) inside the casing (101). Using a bladed screwdriver, draw out the plug. [Photo 7-9]	* Using its outer groove, draw out the plug (211) with care not to get it damaged by an unbalanced load. **CAUTION:** * Keep in mind that when the plug (211) may pop out by the force of the return spring (221).
8	Pull the push rod (212), plug (211), reducing valve assembly, and return spring (221) out of the casing (101). [Photo 7-10]	* Keep record of the positional relation with the casing hole.
9	Fix the pilot valve, with its port plate (111) upward, in the vise.	
10	Using the specified hex wrench, loosen and remove the hex socket bolt (125). [Photo 7-11]	
11	Detach the port plate (111) and O-ring (122) from the casing (101). [Photos 7-12 and 7-13] Draw the bushing (131) out of the casing (101).	
12	To disassemble the reducing valve, do the following. Press in the spring seat (216) to get the secondary-pressure spring (241) warped. Then slide this spring seat sideways and pass it through the larger hole and out of the spool (201). [Photo 7-14] Next separate the following parts: spool (201), spring seat (216), secondary-pressure spring (241) and washer 2 (217). [Photo 7-15]	* Be careful not to scratch the surface of the spool (201). * Do not allow the spring seat (216) 6 mm or lower than specified. * Handle this group of parts as an assembly.

	Procedure	Precautions
13	Remove the folding-purpose spring (246) and spring seat (218) from the push rod (212). [Photo 7-16]	
14	Draw the push rod (212) out of the plug (211). [Photo 7-17]	
15	Remove the O-ring (214) and seal (213) from the plug (211). Use a small bladed screwdriver or the like to take out the seal (213). [Photos 7-18 and 7-19]	
16	Clean up the parts. 1) Put the parts one by one in a rough-washing container with kerosene. (Rough washing) 2) Put the parts one by one in a finish-washing container with kerosene. Slowly turn them and wipe them clean thoroughly inside and out. (Finish washing) Using clean waste cloth, wipe kerosene away from the parts.	* Do not wipe dirty parts in kerosene from the beginning because otherwise they might get scratched. Keep them dipped until dirt, fat and grease become loose enough off the parts. * Be attentive to keep the kerosene clean enough. Otherwise the parts may get scratched, leading to poor performance when reassembled. * Do not dry up the parts with compressed air. Dust and moisture in the air may damage the parts or get them rusty later.
17	Keep the parts against rust. Apply rust-preventive to the specified parts.	* Do not leave the parts without rust-preventive. Rust may build up, causing malfunction later.

4) Assembling

1. Preparations
   (1) As in the case of disassembling, prepare the specified workbench, tools and materials.
2. General precautions
   (1) Take the same general precautions as in disassembling.
   (2) Before reassembling, remove metal chippings and foreign matters from all the parts. Make sure the parts are free of burrs, hit marks and other problems. If a burr or hit mark is found, get rid of it with an oilstone.
   (3) In principle, replace the O-rings and backup rings with new ones.
   (4) When fitting the O-rings and backup rings, handle them with care not to damage it. (Apply a small amount of grease for smooth fitting.)
   (5) When fitting the parts in place, preferably use grease to avoid accidental drop.
   (6) Tighten the bolts and the like to the their specified torques listed in "7-1 Tightening Torque Chart". Measure the tightening torques with a torque wrench.
   (7) Finally apply blind plugs to all the open ports to avoid entry of dust.
3. Reassembling procedure

	Procedure	Precautions
1	Fit the bushing (131) and O-ring (122) to the casing (101). [Photo 7-20]	
2	Install the port plate (111), with the hex socket bolt (125) and seal washer (121) in between, on the casing (101). [Photos 7-21 and 7-22]	* Carefully position the spring pin (126) in the casing hole. * Replace the seal washer (121) with new one.
3	Tighten the hex socket bolt (125) to the specified torque. [Photo 7-23]	* Alternately tighten the two bolts.
4	Install the washer 2 (217), secondary-pressure spring (241) and spring seat (216) in this order on the spool (201). [Photo 7-24] Then press in the spring seat (216) to get the secondary-pressure spring (241) warped. Now slide this spring seat sideways and pass it through the larger hole and onto the spool (201). [Photo 7-25]	* Do not allow the spring seat (216) 6 mm or lower than specified.
5	Fit the return spring (221) in the casing (101). Also fit the reducing valve assembly to the casing (101). [Photo 7-26]	* Place these parts back in their original positions.
6	Fit the O-ring (214) to the plug (221). [Photo 7-27]	
7	Fit the seal (213) to the plug (211). [Photo 7-28]	* Place the seal (213) with its lip positioned as shown below.
8	Fit the push rod (212) into the plug (211). [Photo 7-29] Fit the folding-purpose spring (246) and spring seat (218) into the push rod (212). [Photo 7-30]	* Apply hydraulic oil over the surface of the push rod. 

	Procedure	Precautions
9	Fit the plug assembly to the casing (101). When the return spring (221) is weak in force, this assembly is kept in place by the sliding resistance of the O-ring. [Photo 7-31] When the return spring (221) is strong in force, fit all the four plugs at once using the plate (151). Apply and temporarily tighten the joint (301). [Photo 7-32]	* Be careful not to pry the spool (201) too hard. Otherwise the casing hole (101) may get damaged. **CAUTION:** * Keep in mind that the plug assembly and plate (151) may pop out.
10	Place the plate (151) in position.	
11	Using the specified jig, tighten the joint (301) to the casing (101) by the specified torque. [Photos 7-33 and 7-34]	* Photo 7-33 shows the jig in its specified position.
12	Fit the disc (302) to the joint (301). [Photo 7-35]	* Screw in the disc until it comes into even contact with the four push rods (212). **WARNING:** * Carefully adjust the final position of the disc (302). If it is screwed in too much, the secondary pressure with the lever at neutral may be wrongly applied, causing the machine to malfunction.
13	Apply the adjusting nut (312) and fix it by applying the specified wrench across the disc (302). Tighten the adjusting nut to the specified torque. [Photo 7-36]	* In tightening the nut, keep the disc (302) in position.
14	Apply grease to the turning portion of the joint (301) and the top of the push rod (212). [Photo 7-37]	
15	Fit the bellows back into position. [Photo 7-38]	* Be careful not to break the bellows (501).
16	Pour vapor phase inhibitor from the ports and apply the blind plugs.	

Photo 7-1

Photo 7-2

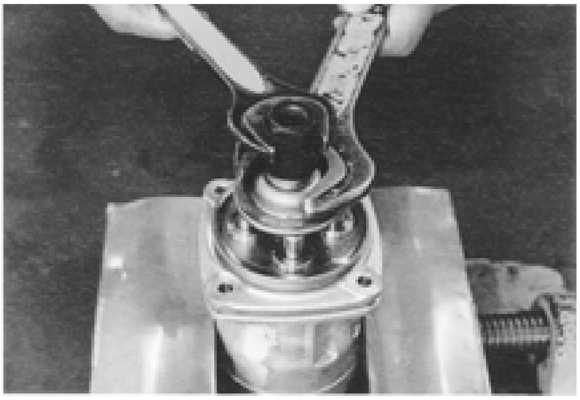


Photo 7-3

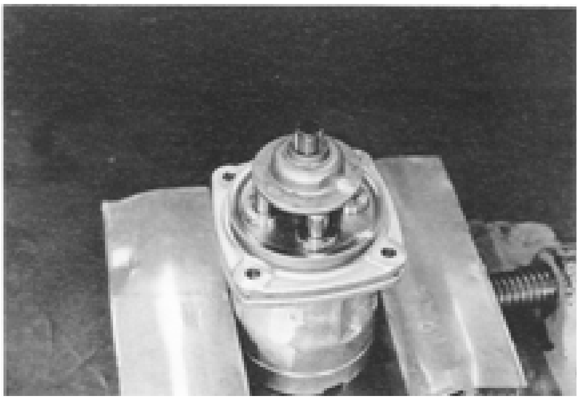


Photo 7-4

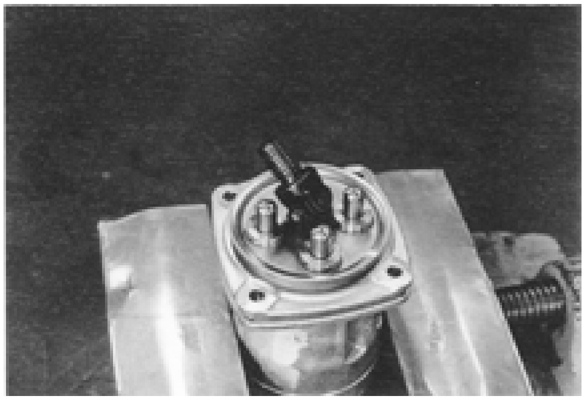


Photo 7-5

Photo 7-6

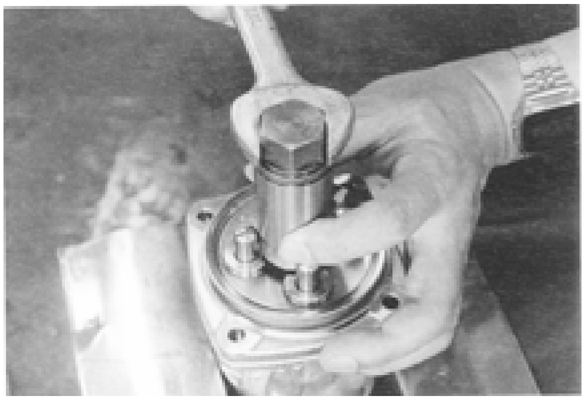


Photo 7-7

Photo 7-8

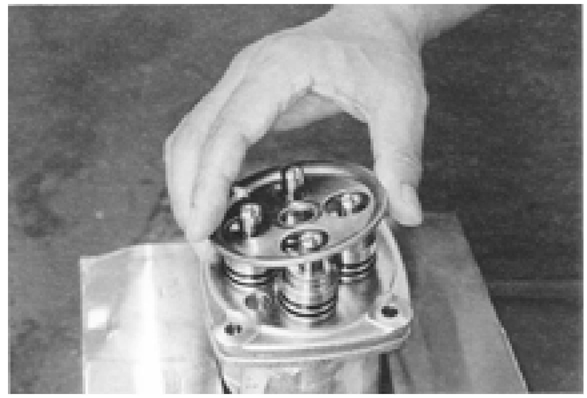


Photo 7-9

Photo 7-10

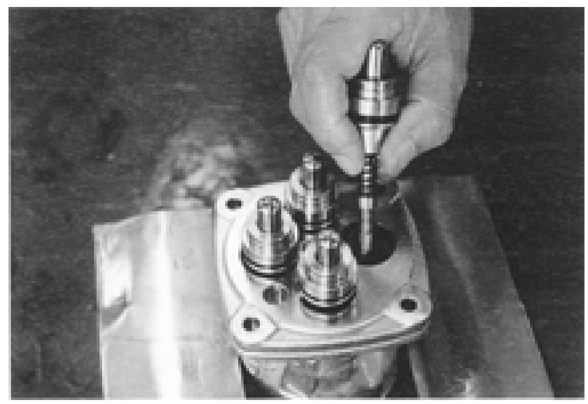


Photo 7-11

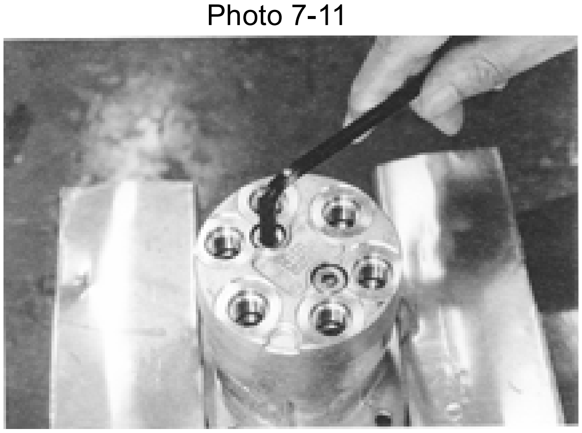


Photo 7-12

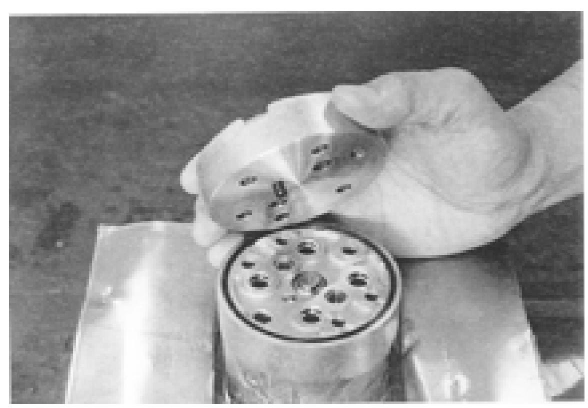


Photo 7-13

Photo 7-14

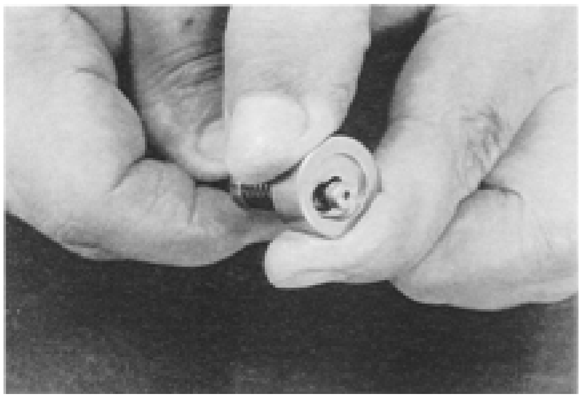


Photo 7-15

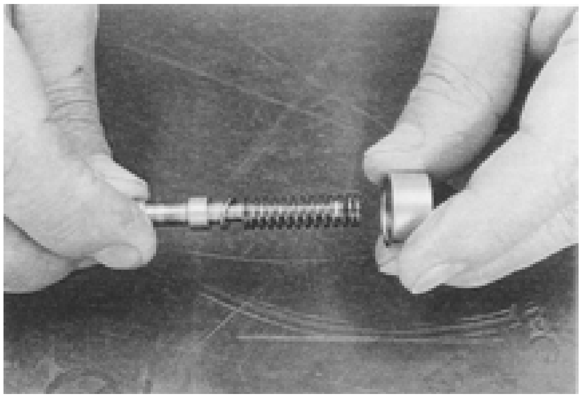


Photo 7-16

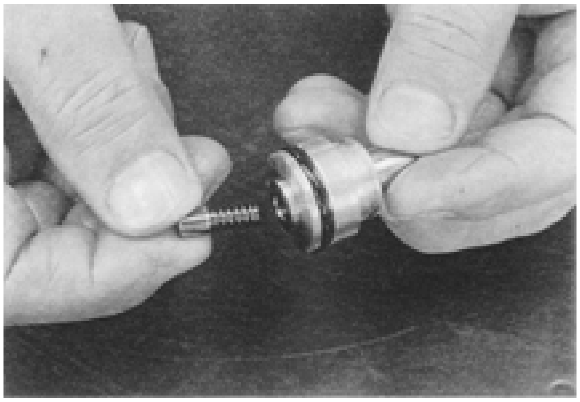


Photo 7-17

Photo 7-18

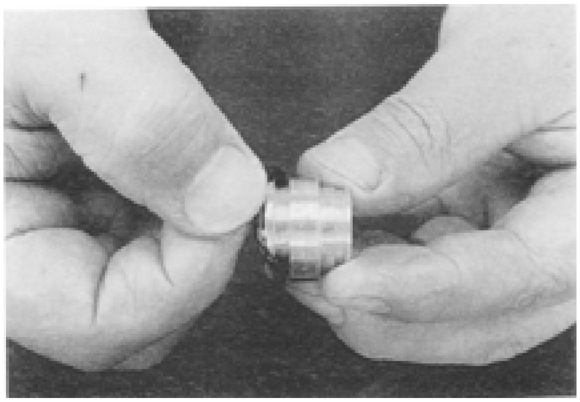


Photo 7-19

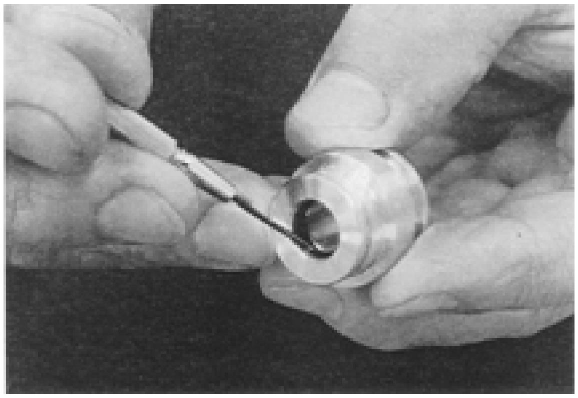


Photo 7-20

Photo 7-21

Photo 7-22

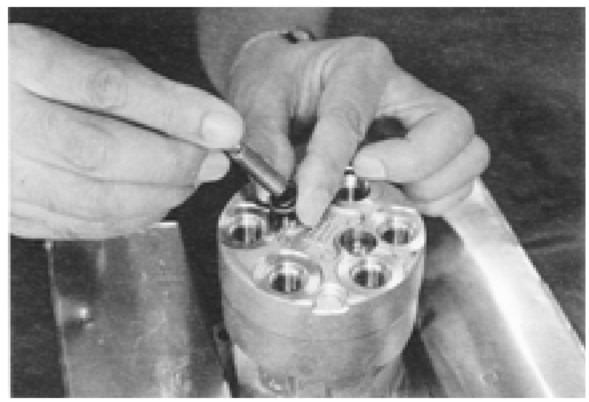


Photo 7-23

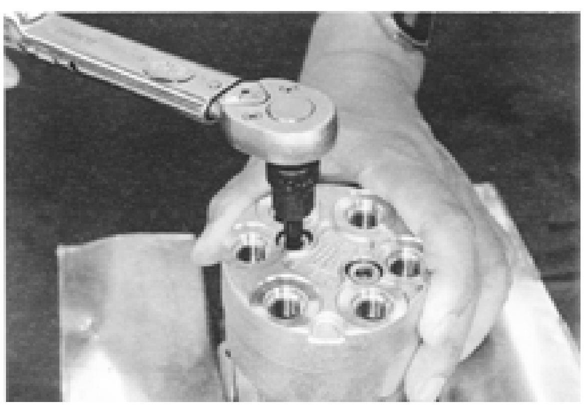


Photo 7-24

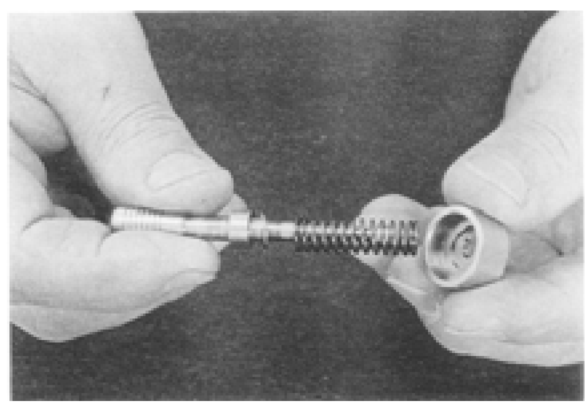


Photo 7-25

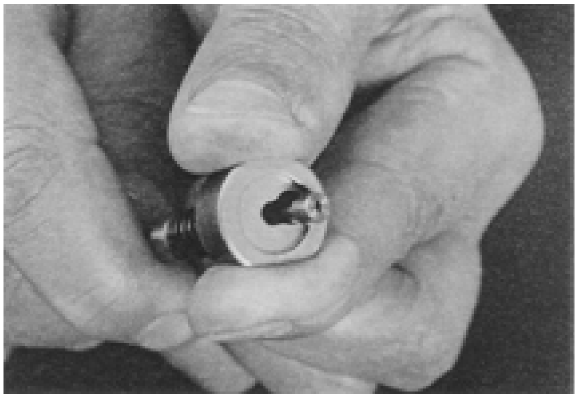


Photo 7-26

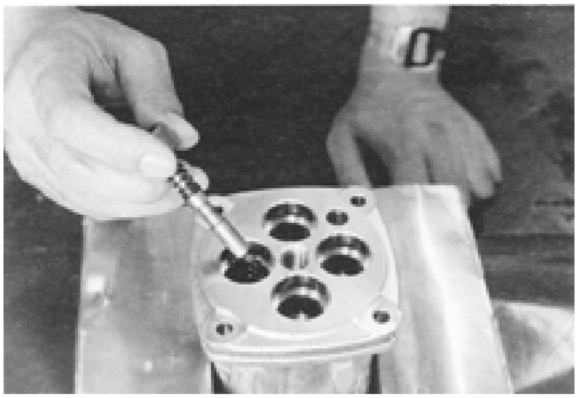


Photo 7-27

Photo 7-28

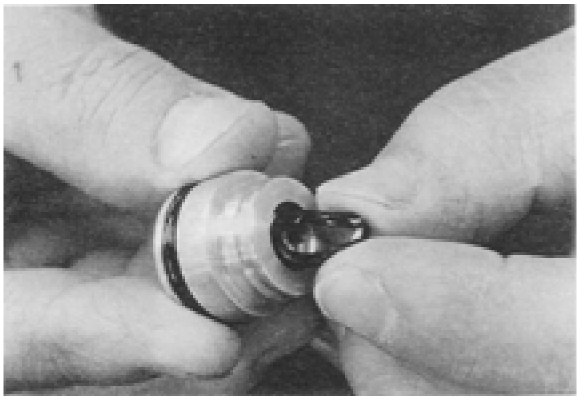


Photo 7-29

Photo 7-30

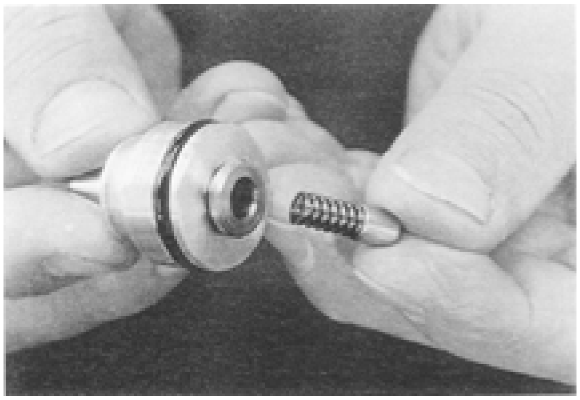


Photo 7-31

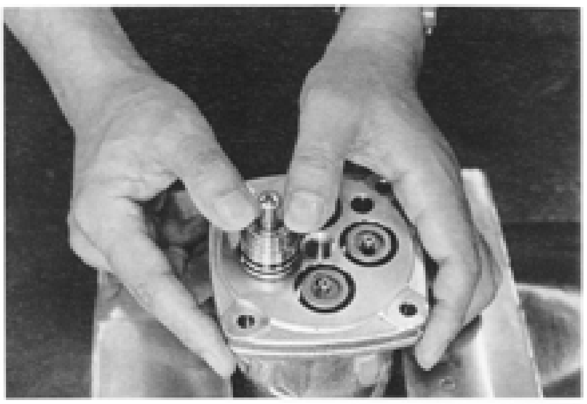


Photo 7-32

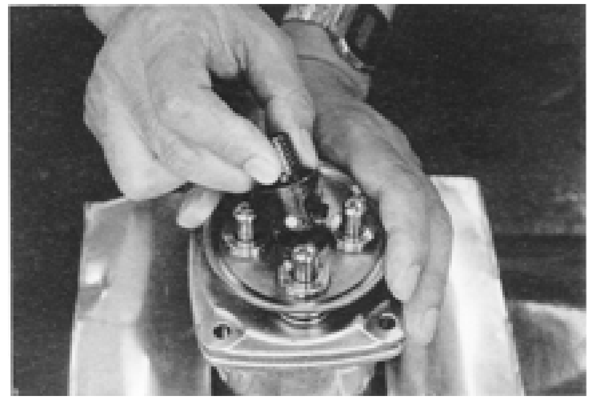


Photo 7-33

Photo 7-34

Photo 7-35

Photo 7-36

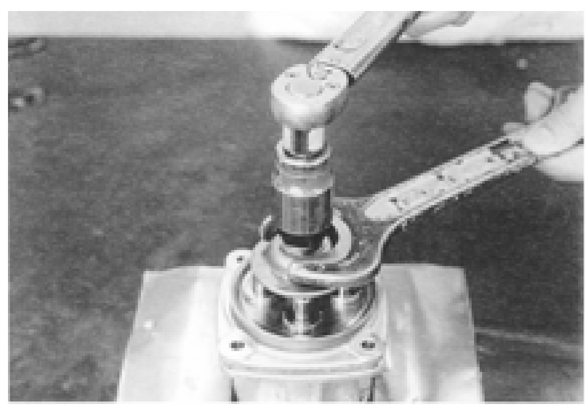


Photo 7-37

Photo 7-38

(4) Trouble shooting

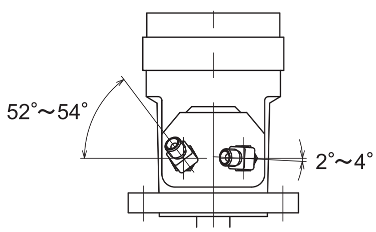
It is not easy to pinpoint trouble spots. The table below lists some typical problems, their possible causes and corrections. Before starting repair jobs, refer to the table below.
A machine trouble is not necessarily caused by just one part, but by come different parts combined. It should be noted that the corrections listed below might not be enough and additional measures might be needed.
This chart does not cover all possible causes and corrections. Whenever necessary, it is therefore essential for the repair supervisor to look further into the problem and cause in question.

Problem	Causes	Corrections
Secondary pressure failure to rise	(1) Primary pressure too low. (2) Secondary-pressure spring (241) broken or worn out. (3) Too large a gap between the spool (201) and casing (101). (4) Steering wheel too loose.	(1) Ensure the specified primary pressure. (2) Replace the spring with new one. (3) Replace the remotely operated valve with new one. (4) Disassemble and reassemble the related section. Or replace the steering wheel as required.
Secondary pressure unstable	(1) Sliding parts stuck. (2) Tank line pressure fluctuating too much. (3) Air sucked in the piping.	(1) Correct the stuck spot. (2) Return the oil direct to the oil tank. (3) Operate the machine to let out the air.
Secondary pressure too high	(1) Tank line pressure too high. (2) Sliding parts stuck.	(1) Correct the stuck spot. (2) Return the oil direct to the oil tank.

g. Swivel motor

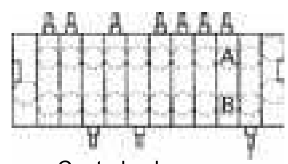
(1) K008-3 mounting position

Adaptor mounting angle



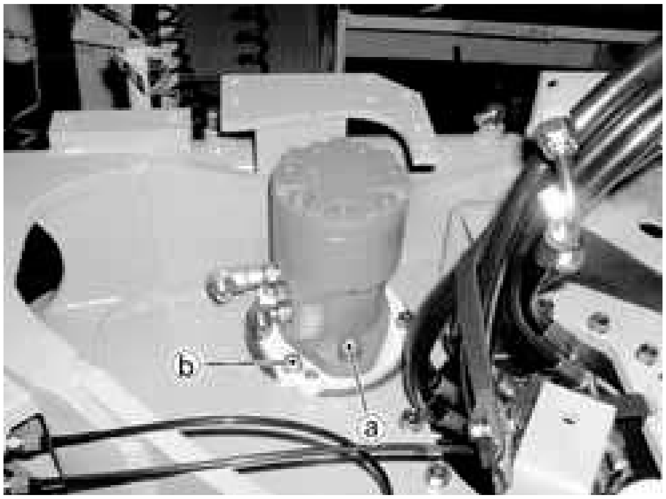
■ Assembly procedure (K008-3)

1) Tightening torque of case (swivel) mounting bolt:60.8 ~ 70.6 N·m (6.2 ~ 7.2 kgf·m)
   * Apply screw lock agent.
2) Tightening torque of motor assembly (swivel) mounting bolt (b):
   78.0 ~ 90.0 N·m (7.9 ~ 9.2 kgf·m)
   * Apply screw lock agent.
3) Mounting the adaptor
   1. Angle
      See the left figure.
   2. Tightening torque:
      24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m)
      *Apply grease to O-rings (NEW UDT or M80B or equivalent).
4) Route of hydraulic hose
   (1) Swivel motor right side - control valve (A) side
   (2) Swivel motor left side - control valve (B) side (Color of hose: Pink)

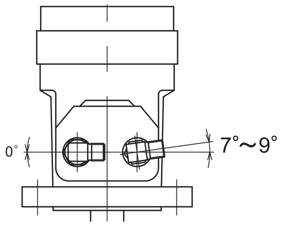


Control valve

(2) U10-3 mounting position

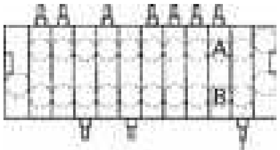


Adaptor mounting angle



■ Assembly procedure (U10-3)

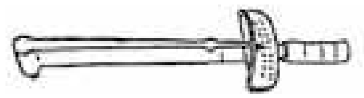
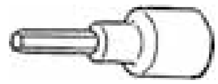
1) Tightening torque of case (swivel) mounting bolt:60.8 ~ 70.6 N·m (6.2 ~ 7.2 kgf·m)
   * Apply screw lock agent.
2) Tightening torque of motor assembly (swivel) mounting bolt (b):
   78.0 ~ 90.0 N·m (7.9 ~ 9.2 kgf·m)
   * Apply screw lock agent.
3) Mounting the adaptor
   1. Angle
      See the left figure.
   2. Tightening torque:
      24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m)
      *Apply grease to O-rings (NEW UDT or M80B or equivalent).
4) Route of hydraulic hose
   (1) Swivel motor right side - control valve (A) side
   (2) Swivel motor left side - control valve (B) side
       (Color of hose: Pink)



Control valve

(3) Swivel motor disassembly and assembly procedure.

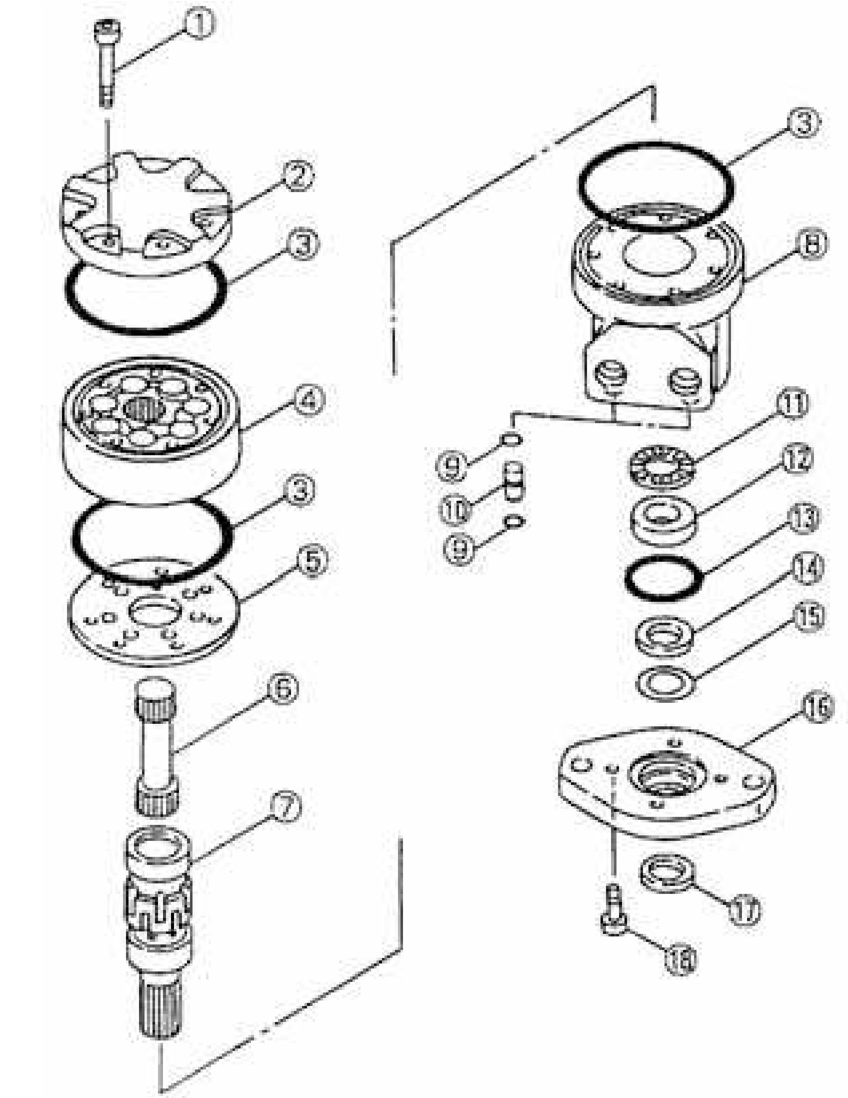
[1] Disassembly and reassembly tools

Name of Tool	Shape	Remarks
Torque wrench		44 N·m capacity
Hexagon socket wrench		Width across flats: 6 mm
Screwdriver		Slim screwdriver
Plastic hammer		

[2] Preparations for disassembly

(1) Place for disassembling the motor should be dust-free and clean. Prepare a plastic parts box.
(2) Wash tools and parts necessary for disassembly in advance.
(3) Clean the outside surface of the motor completely.
(4) Remove dust, soil, oil, etc. around the motor shaft and oil seal.
(5) Clean around the port of the motor before disconnecting the piping hose.

[3] Exploded view and names of parts

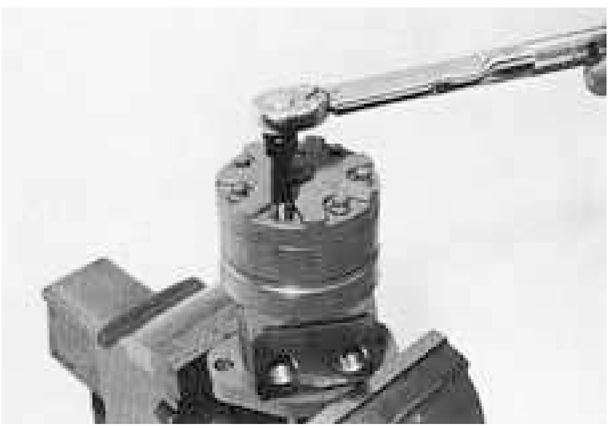


No.	Parts Name	Q'ty	No.	Parts Name	Q'ty	No.	Parts Name	Q'ty
①	Hex. socket head bolt	7	⑦	Shaft output	1	⑬	O-ring	1
②	End cap	1	⑧	Housing	1	⑭	Oil seal	1
③	O-ring	3	⑨	O-ring	4	⑮	Backup washer	1
④	Geroller assembly	1	⑩	Ball check sub assembly	2	⑯	Flange	1
⑤	Spacer plate	1	⑪	Needle bearing	1	⑰	Dust seal	1
⑥	Drive	1	⑫	Bearing race	1	⑱	Hex. socket head bolt	4

[4]Disassembiy Procedure

1. Before disassembling orbitrol (swivel motor), clean working area and necessary tools should be come to order. Get ready plastic box for removed parts,
2. Before disconnecting hoses, wipe and clean around joint section.

(1) Tap out shaft key.
Remove bur around shaft key groove by using sand paper or oil stone.



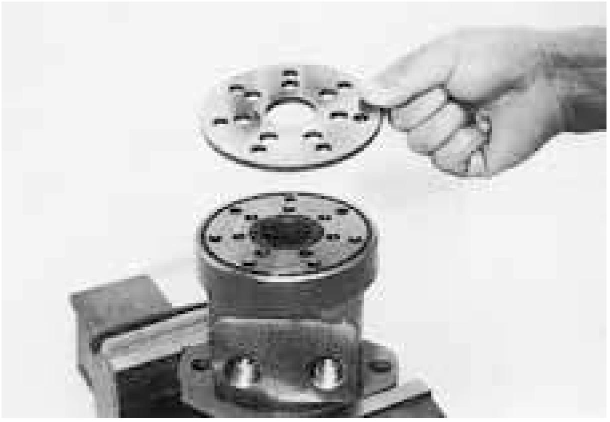
(2) Remove 7 pieces of end cap bolts and seal washer.
When mounting on vice, clamp at flange part not, not housing.
(Only S-70 and S-100 have seal washer.)

(3) Take out end cap.

(4) Take out geroler set and spacer.
Care should be taken not to drop rollers.

(5) Take out O-ring (Two in both sides) from geroler.

(6) Take out drive.

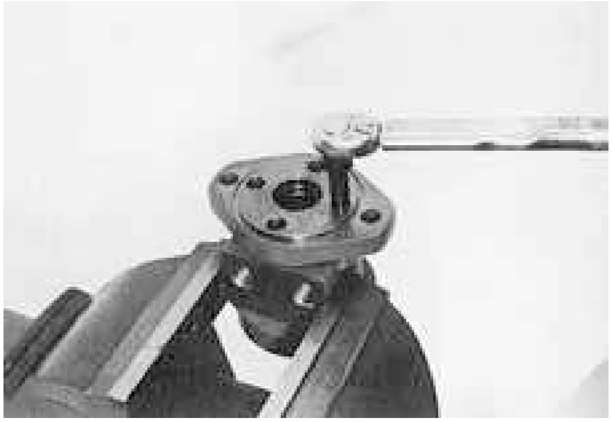


(7) Take out spacer plate.

(8) Take out O-ring from housing.

(9) Dismount motor from vise and push out output shaft.

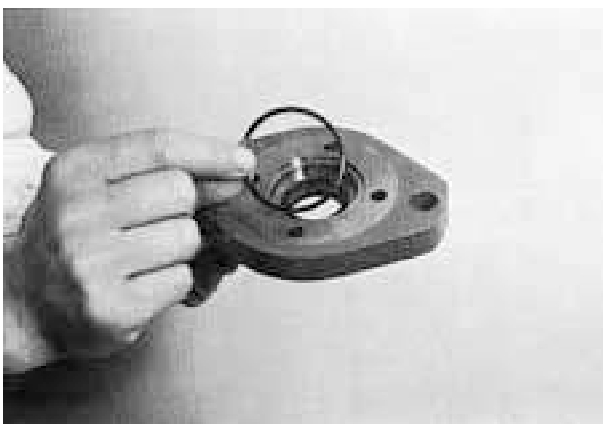
(10) Take out needle bearing from output shaft.



(11) Mount the motor housing by vise as shown in photo, remove 4 pieces of flange mounting bolts.
As this bolt was tightened with screw locktite, removing torque shold be 33.3 ~ 49.0N·m (3.4 ~ 5.0kgf·m).
Care should be taken not to ship the socket and damage the bolt head.
(Models S-280 S-380 use spring pin instead of screw locktite.)

(12) Take out flange. In case of S-280 and S-380, 4 pieces of spring pins are installed, Therefore, remove flange by slightly topping the flange by plastic hammer, then pull out spring pins.

(13) Take out bearing.

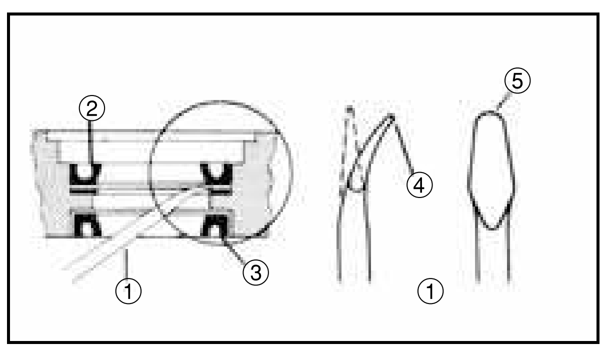


(14) Remove O-ring.

(15) Remove oil seal.

(16) Remove dust seal.

When removing oil seal and dust seal, never get the flange damaged.
Use special tool when removing oil seal and dust seal.



① Special tool
② Oil seal
③ Dust seal
④ Bend tip end of driver
⑤ Round

(17) Take out two plugs from housing.
Inserting throush port hole, push up the plugs. If not in need, never remove check plug.

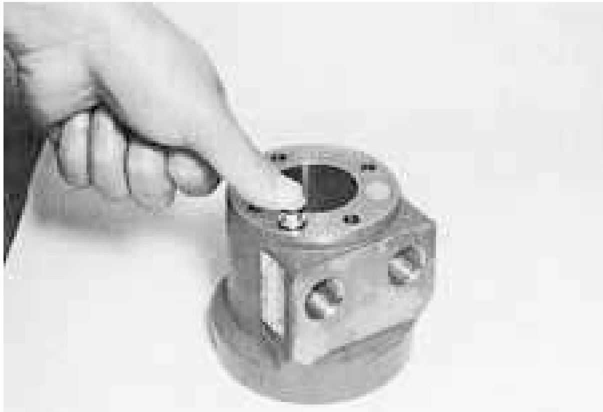
(18) Remove O-ring (4 pieces) from the check plugs. When reassembling, check the plug, securely replace O-rings with new ones.

(19) After removing, securely inspect no scratch or burs on mating surface of each part.
Found any burs or scratch, smooth with sand paper(#600).
Wash each part with clean solvent and dry.
Never wipe out, or fiber nap remains on part and causes oil leakage or other troubles.

[5]Reassembly Procedure

1. remove dirt, scratch, or burr or each part.
2. Clean every part. Remove screw locktite in screw hole with tap. Remove grease.
3. When reassembling, replace all soft materials, like oil seal, O-ling.

(1) Fit O-ring(Code No.15007) in check plug.



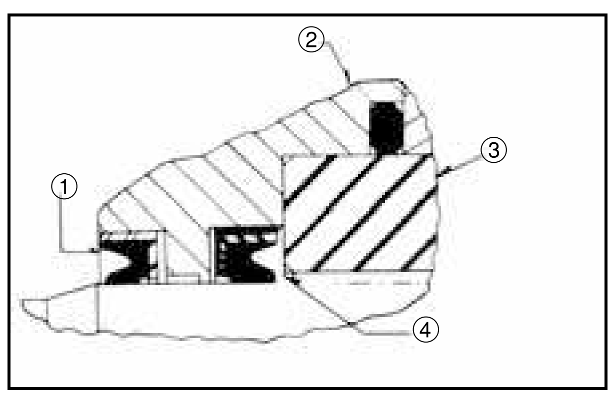
(2) Apply grease on O-ring of check plug and push in the housing.

(3) Install output shaft in housing.

(5) Install oil seal in flange as shown in Fig.

(3) Insert needle bearing and bearing race into output shaft.

(4) Fit dust seal in flange.
Use appropriate jig not to damage seal or distort metal plate.
Apply hydraulic oil on outer side of seal.
Fit seal on flange and press fit.
This seal contains metal plate in rubber.
Case should be taken ont to damage seal or distort metal plate.



① Dust seal
② Flange mounting
③ Race bearing
④ This rip should be motor inward.

When press fit the dust seal and oil seal, use socket ans tap in with hammer.

(7) Fit O-ring in flange.

(8) Thoroughly clean flange mounting screw holes of housing, remove grease and apply screw-locktite slightly. (S-280 and S-380 dose not require this job.)

(9) Mount flange into housing saay.
Care should be taken not to damage seal with shaft key.

(10) Clamp at housing with vise and tighten 4 bolts. (Tightening torque 25.5 ~ 31.4N·m (2.6 ~ 3.2kg·m))

(11) Clamp with vise at flange and put O-ring on housing.

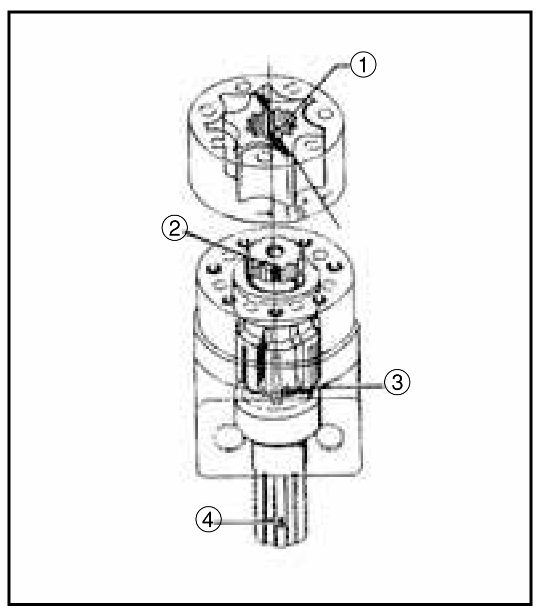
(12) Attach spacer plate.

(13) Insert drive.

(14 Fit O-ring (2 pieces) onto geroler.
Apply grease on O-ring and securely fit.

(15) Install geroler.
Care should be taken on the position of output shaft, geroler and geroler set.
Refer to the figure below.

(16) Insert spacer.

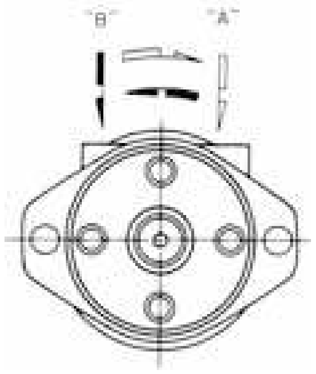


① Teeth of spline
② Drive
③ Front valve groove
④ Align key groove or spline in front

(17) Put end cap onto geroler set, aligning to bolt holes.

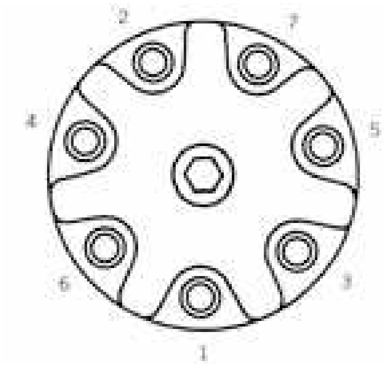
(18) Tighten 7 pieces of end cap mounting bolts. Model S-380 requires screw locktite #262.

(19) Tap in shaft key.
Securely check the rotating direction.
See the figure below.



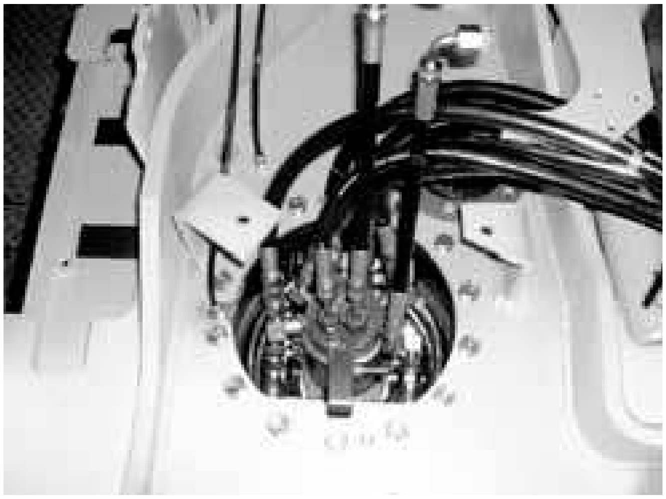
(Motor rotating direction)
Viewed from output shaft
When delivering pressure oil to A port, motor rotates clockwise.
When delivering pressure oil to B port, motor rotates counterclockwise.

<u>Tightening torque</u>
S-70, S-100 19.6 ~ 22.5N·m (2.0 ~ 2.3kgf·m)
(Need seal washer)
S-160 ~ S-380 31.4 ~ 34.3N·m (3.2 ~ 3.5kgf·m)
<u>Bolt tightening sequence</u>



E.Swivel Joint

a. Assembly and Disassembly



■ Assembly procedure

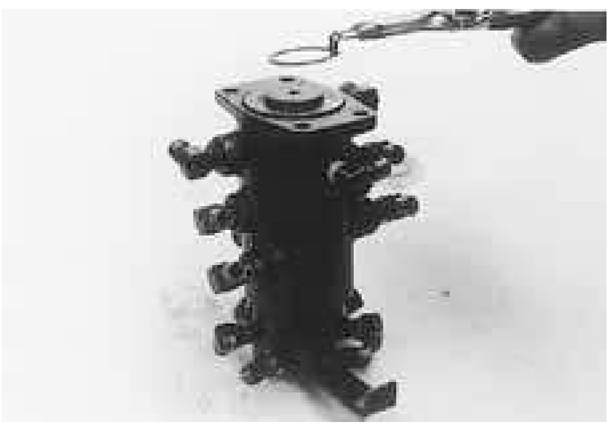
1) Tightening torque of swivel joint assembly mounting bolt:
   24.0 ~ 28.0 N·m (2.4 ~ 2.8 kgf·m)
   * Apply screw lock agent.
2) Tightening torque of stopper mounting bolt:
   24.0 ~ 28.0 N·m (2.4 ~ 2.8 kgf·m)
   * Apply screw lock agent.

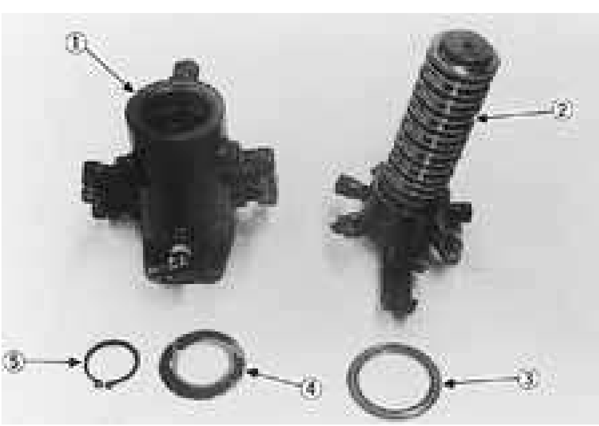
CAUTION

- **Mount the stopper so that bending direction should be downward.**

3) Mounting the plug (R1/8)
   After tightening, check that the plug comes below the upper surface of the shaft (swivel joint).

(1) Disassembly and assembly of swivel joint





[1] Disassembly procedure

1) Remove the circlip for shaft and the shim.
2) Remove the shaft by means of a plastic hammer and soft-iron bar.
3) Remove the collar.

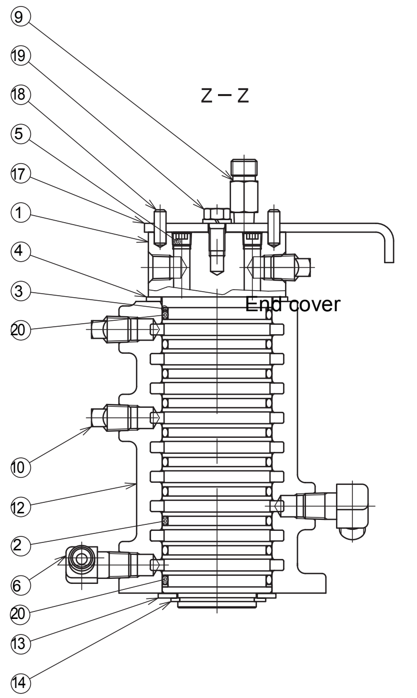
[2] Assembly procedure

1) When mounting the shaft to the body, apply grease to O-rings and backup rings. Mount the shaft using care not to damage O-rings and backup rings.
2) Mount the backup rings to the outside of O-rings only for the top and bottom.

[3] Component parts

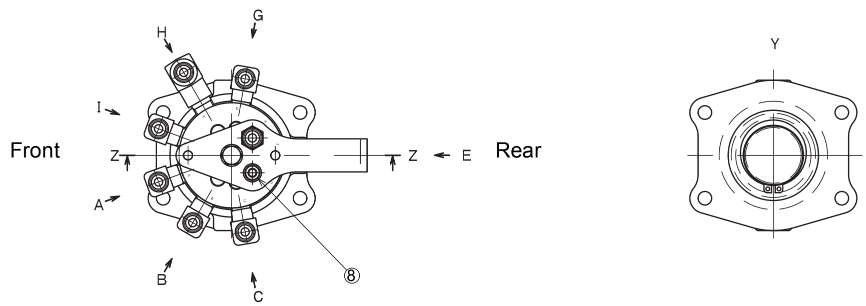
① Body
② Shaft
③ Collar
④ Collar
⑤ Circlip for shaft

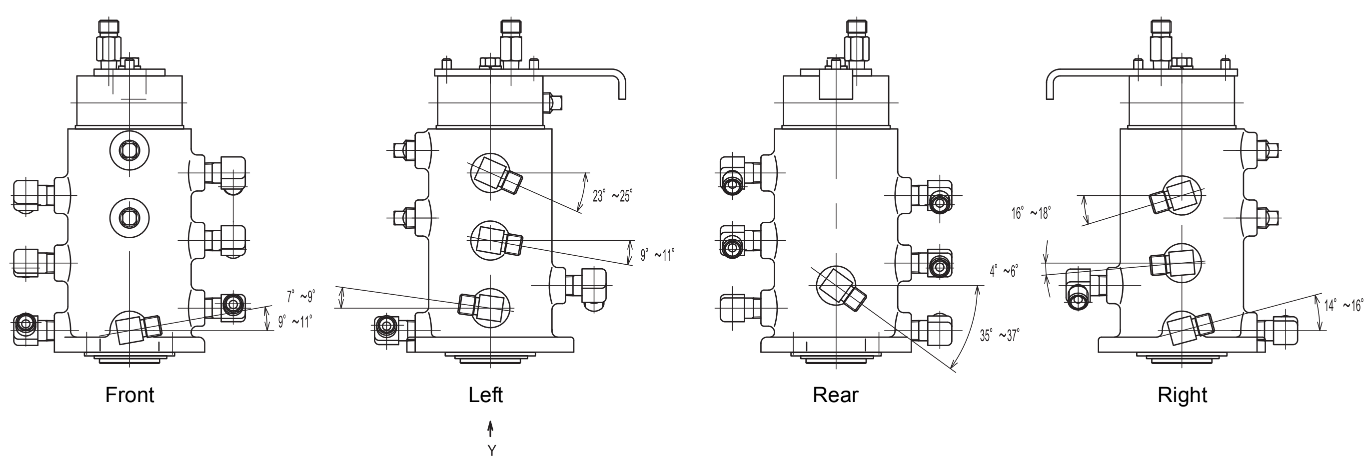
Specifications of K008-3 fixed leg 1 - speed

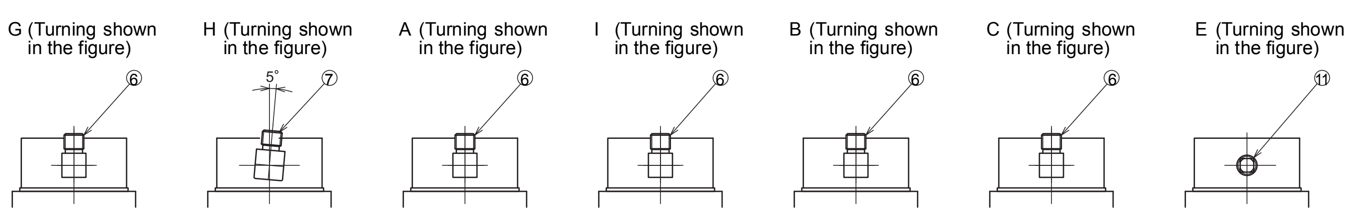


①	Shaft (Swivel joint)
②	O-ring
③	Ring (Backup)
④	Collar
⑤	Plug (R1/8)
⑥	Elbow pipe joint
⑦	Pipe joint (L, R2-G2)
⑨	Pipe joint (S, R1/8-G1/4)
⑪	Pipe joint (L, R1/4-10)
⑫	Body (Swivel joint)
⑬	Collar
⑭	Circlip for shaft
⑮	Pipe joint (T, R1/4-R1/8)
⑯	Pipe joint (L, R1/8-R1/8)
⑰	Stopper
⑱	Parallel pin
⑲	Bolt
⑳	O-ring

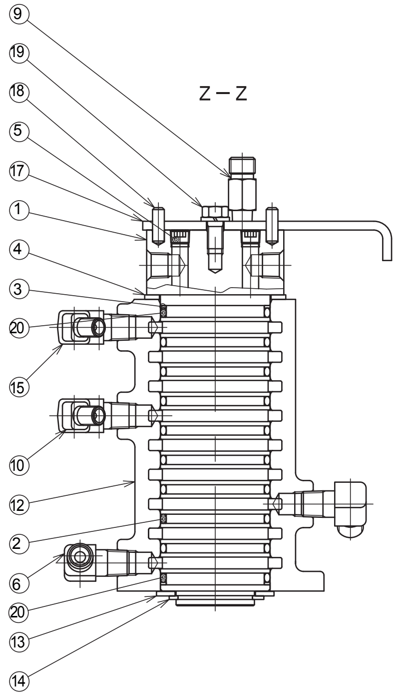
Swivel joint's adaptor mounting angle should be within the range shown in the drawing.





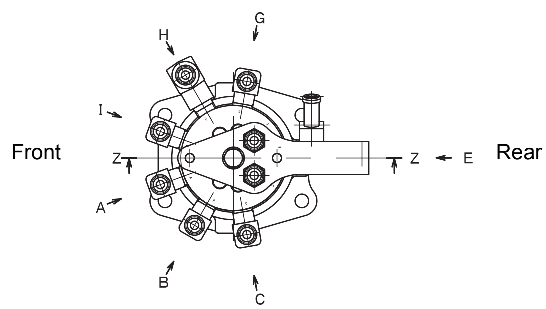


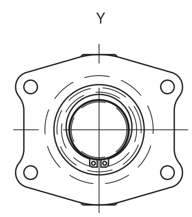
Specifications of K008-3 retractable leg 2 - speed

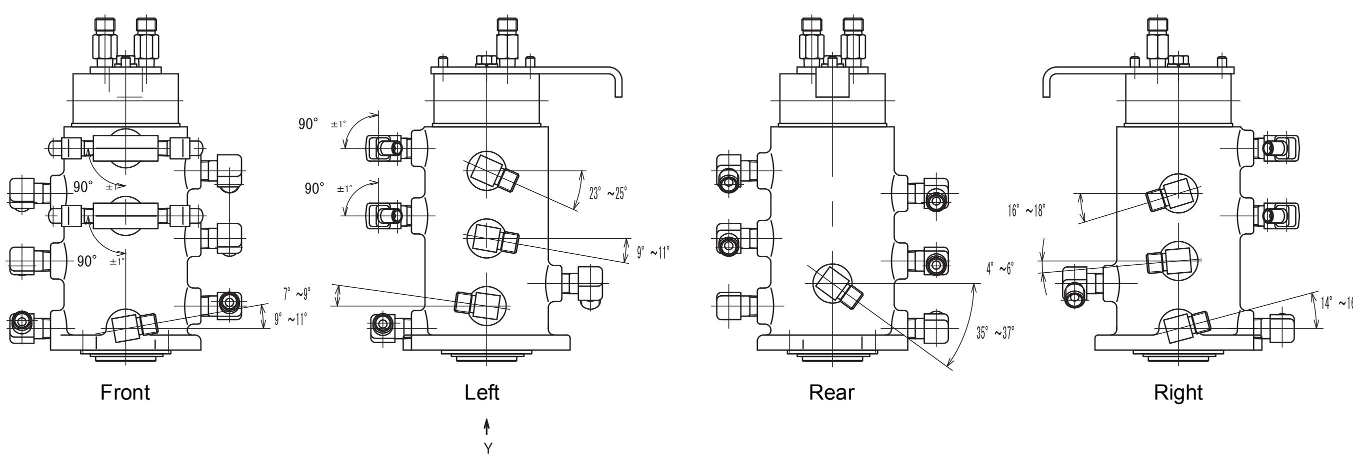


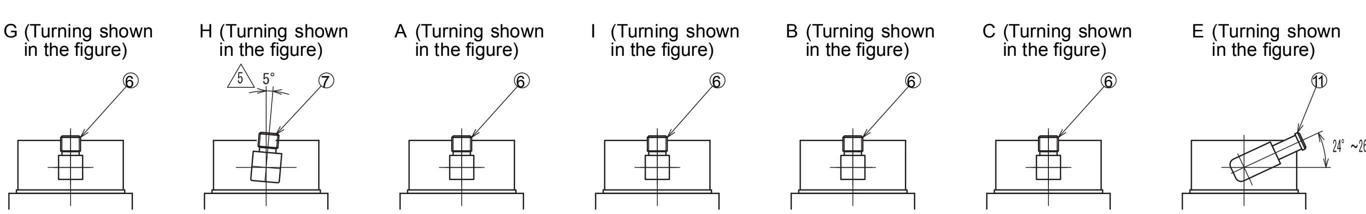
①	Shaft (Swivel joint)
②	O-ring
③	Ring (Backup)
④	Collar
⑤	Plug (R1/8)
⑥	Elbow pipe joint
⑦	Pipe joint (L, R2-G2)
⑧	Plug (Seal)
⑨	Pipe joint (S, R1/8-G1/4)
⑩	Plug (PT1/4)
⑪	Plug (PT1/4)
⑫	Body (Swivel joint)
⑬	Collar
⑭	Circlip for shaft
⑰	Stopper
⑱	Parallel pin
⑲	Bolt
⑳	O-ring

Swivel joint's adaptor mounting angle should be within the range shown in the drawing.

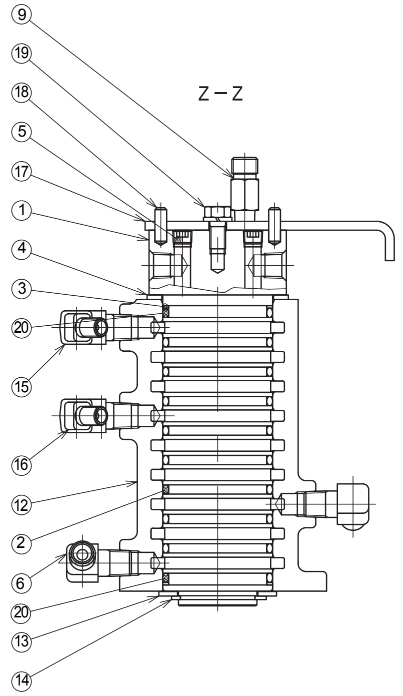






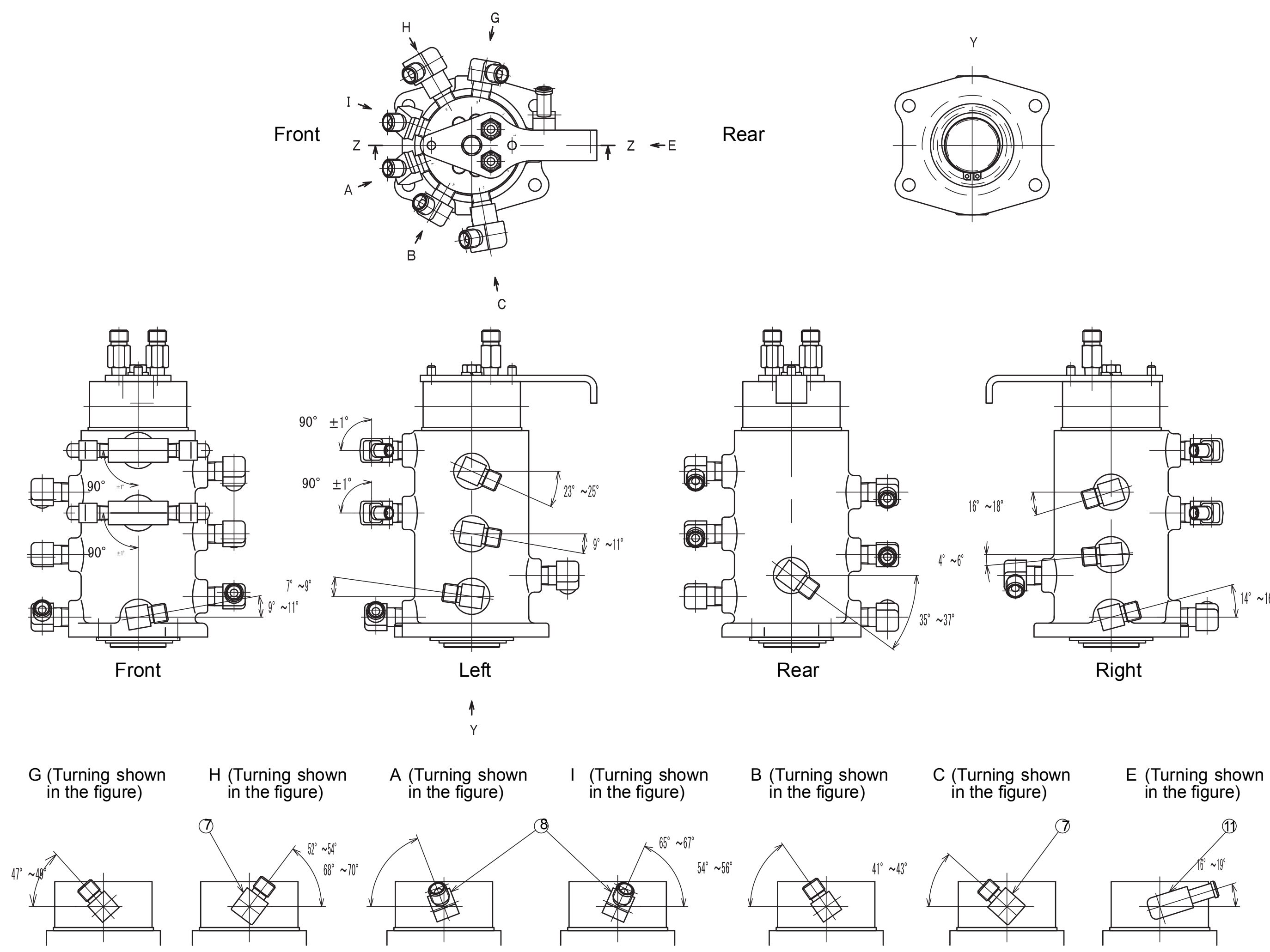


Specifications of U10-3 retractable leg

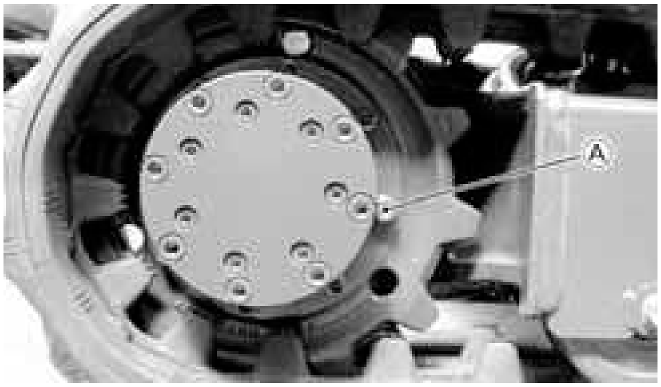


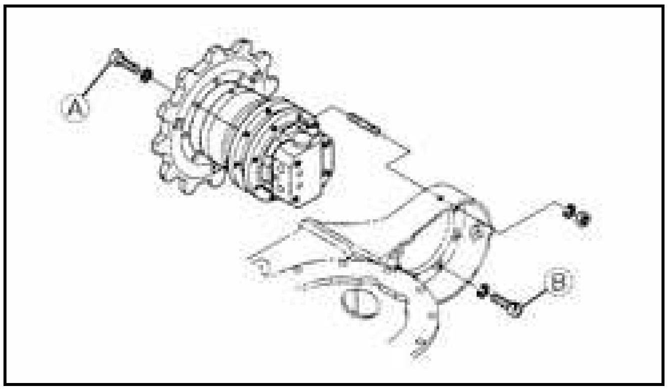
①	Shaft (Swivel joint)
②	O-ring
③	Ring (Backup)
④	Collar
⑤	Plug (R1/8)
⑥	Elbow pipe joint
⑦	Pipe joint (L, R2-G2)
⑧	Adaptor 10
⑨	Pipe joint (S, R1/8-G1/4)
⑪	Plug (L, R1/4-10)
⑫	Body (Swivel joint)
⑬	Collar
⑮	Circlip for shaft
⑯	Pipe joint (T, R1/4-R1/8)
⑰	Pipe joint (L, R1/8-Q1/8)
⑰	Stopper
⑱	Parallel pin
⑲	Bolt
⑳	O-ring

Swivel joint's adaptor mounting angle should be within the range shown in the drawing.



b. Wheel Motor

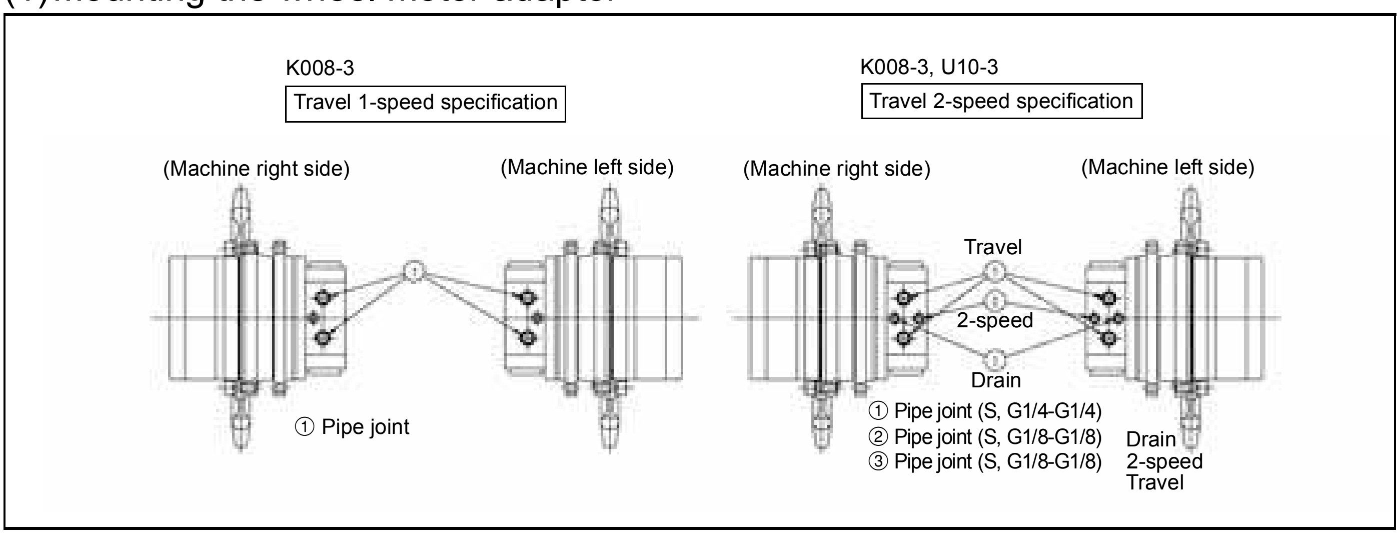




Assembly procedure

1) Tightening torque of sprocket fixing bolt (01311-11025):
   48.0 ~ 56.0 N·m (4.9 ~ 5.7 kgf·m)
   * Apply screw lock agent.(8 bolts for "A")
2) Tightening torque of motor-frame fixing bolt:
   48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m)
   * Apply screw lock agent.(8 bolts for "B")

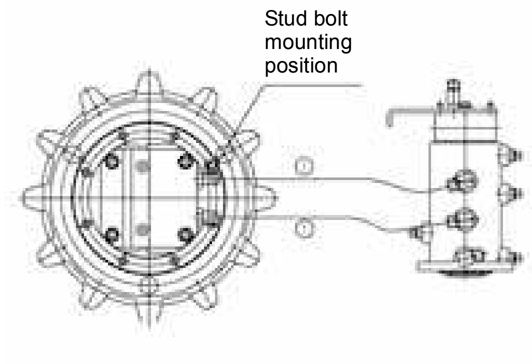
(1) Mounting the wheel motor adaptor



(2) Route of wheel motor hose

Route of hose
(Machine right side)

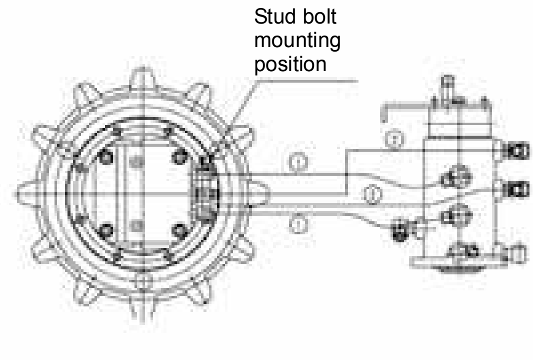
K008-3
① Hose (high pressure, 1/4)



Route of hose
(Machine right side)

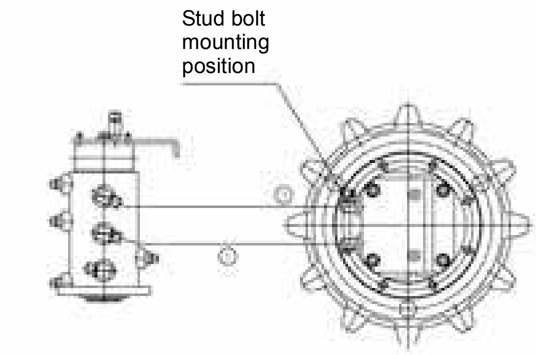
K008-3
① Hose (high pressure, 1/4)
② Hose (high pressure, 1/8)
③ Hose (high pressure, 1/8)

U10-3
① Hose (high pressure, 1/4)
② Hose (high pressure, 1/8)
③ Hose (high pressure, 1/8)



(Machine left side)

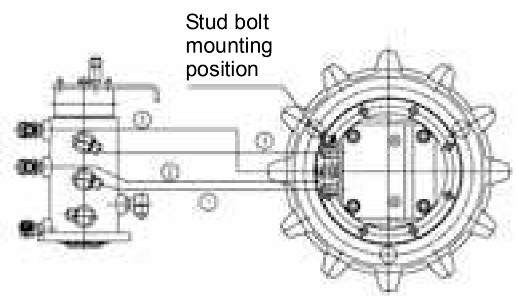
K008-3
① Hose (high pressure, 1/4)



(Machine left side)

K008-3
① Hose (high pressure, 1/4)
② Hose (high pressure, 1/8)
③ Hose (high pressure, 1/8)

U10-3
① Hose (high pressure, 1/4)
② Hose (high pressure, 1/8)
③ Hose (high pressure, 1/8)



c. Wheel Motor (made by Eaton Equipment Co. Ltd.)

(1) Wheel motor disassembly and assembly procedure

[1] Introduction

This instruction manual describes the handling method with a view to prevent possible trouble in handling and maintain the full performance for long period of time when you use this product as mini-shovel travel motor.
Please refer to the attached documents.
Sectional and structural drawing AZ7275B

[2] Precautions for handling

2.1 Check
Check the following points before mounting the motor.

a) Isn't there any part which was broken during transportation?
b) Isn't there any looseness at connections?

2.2 Checking before and after operation

a) Isn't there any looseness at connections?
b) Isn't there any oil leak?
   Isn't there any abnormal noise, vibration or heating?

[3] Maintenance and check

Unless any trouble is found in operation, check only the following points.

a) Check bolts for looseness.
b) Check parts for oil leak.

[4] Tools for disassembly and assembly

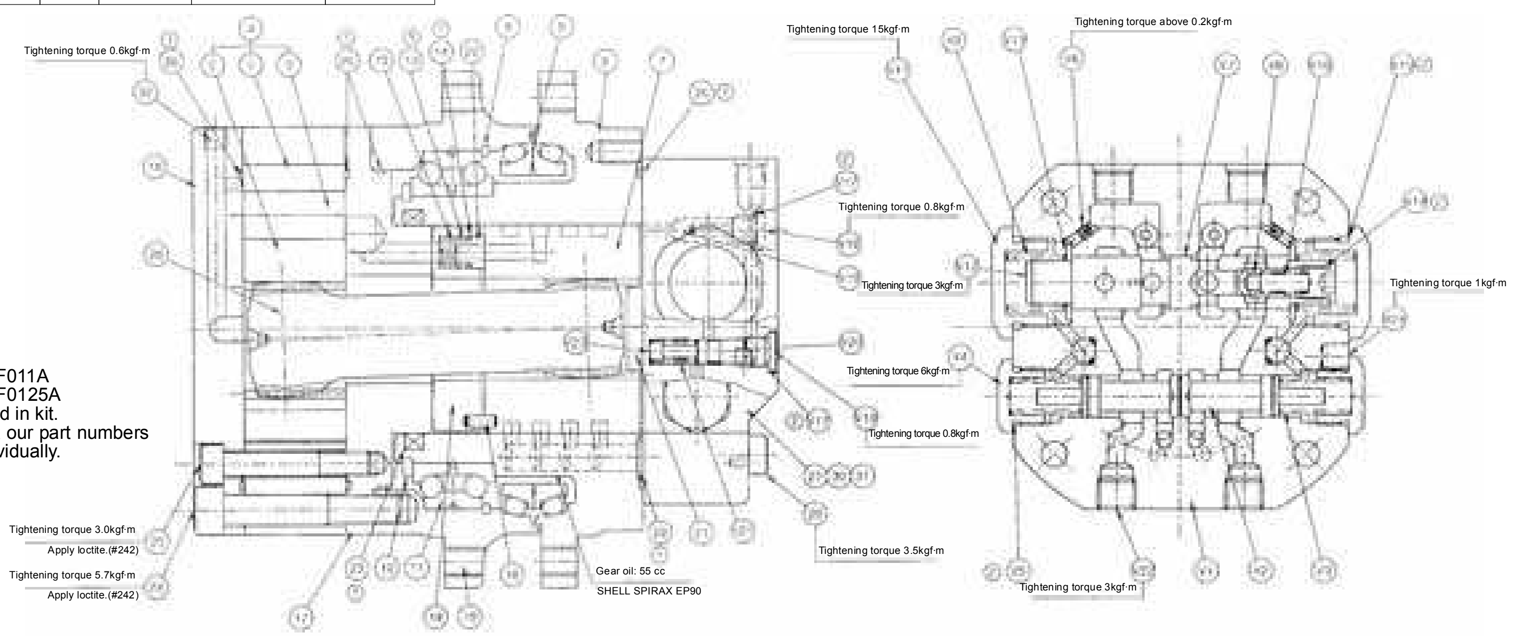
The table below shows the tools necessary for disassembly and assembly of motor. Prepare them before work.

Name of Tool	Remarks
Torque wrench	Capacity:3, 3.5, 5.7 kgf·m
Wire brush	
Screwdriver	
Screw lock agent	LOCTITE No.242
Gear oil	SHELL SPIRAX EP90
Grease	
Hexagon socket wrench	Width across flats 8, 6, 4
Hexagon wrench	Width across flats 2
Socket wrench	Width across flats 36, 22

No.	Part Name	Q'ty	Part number	Remarks	Customar's Part number
1.	Ring	1			
2.	Star	1			
3.	Roller	7			
4.	Geroller assembly	1	AF108C001		
5.	Spindle/Wheel assembly	1	AF0107B-1	Including Item Nos. 6 ~12	
6.	Spindle	1			
7.	Valve sleeve	1			
8.	Floating seal	1set			
9.	Circlip for hole	1			
10.	Wheel	1			
11.	Angular ball bearing	1			
12.	Circlip for shaft	1		ϕ90	
13.	O-ring	12	1BP8 HS90		
14.	Backup ring	12		T3-P8	
15.	Coil spring	12			
16.	Parallel pin	2	AF0116A		
17.	Valve plate	1	AF0101C		
18.	Geroller cover	1	AF0100B		
19.	Valve	1	AF0103B		
20.	Drive	1	AF0102C-001		
21.	Spacer	1	AF0104A		
22.	Sleeve	12	AF0104A		

No.	Part Name	Q'ty	Part number	Remarks	Customar's Part number
23.	X-ring	1		R70	
24.	Hex. socket head bolt	8	DW0024A-060	M10 × 60	
25.	Hex. socket head bolt	7	AA0033A-50	M8 × 50	
26.	O-ring	4		S105 HS70	
27.	End cover assembly	1	AF0126	Including Item Nos. V1 ~V24	
28.	Hex. socket head bolt	4	AA0033A-50	M8 × 50	
29.	O-ring	4		1BP10A HS90	
30.	Name plate	1			
31.	Rivet	2			
32.	Plug	1	DW0128A		
V1.	Valve housing	1			
V2.	2-speed spool	1			
V3.	2-speed spring	2			
V4.	2-speed plug	2			
V5.	O-ring	2		AS568-908 HS90	
V6.	Orifice	2		M4(ϕ0.5 orifice)	
V7.	Counter-balance spool	1			
V8.	Counter-balance poppet	2			
V9.	Counter-balance main spring	2			

No.	Part Name	Q'ty	Part number	Remarks	Customar's Part number
V10.	Counter-balance check spring	2			
V11.	Plug for counter-balance	2			
V12.	Counter-balance check plug	2			
V13.	Washer	2			
V14.	O-ring	2		AS568-904 HS90	
V15.	O-ring	2		AS568-914 HS90	
V16.	Check plug	2			
V17.	O-ring	4		AS568-903 HS90	
V18.	Ball	2		1/4	
V19.	Pilot plug	2			
V20.	Pilot poppet	2			
V21.	Pilot poppet spring	2			
V22.	Plug	2		R1/4(Seal tape)	
V23.	Orifice plate	2			
V24.	Plug	2		R1/8(Seal tape)	



Notes):
(1) Oil seal kit AF011A
(2) Oil seal kit AF0125A
(3) Seals are sold in kit.
(4) Parts without our part numbers are not sold individually.

[redacted]

[6] Motor disassembly procedure

Disassembly procedure

Prior to starting disassembly work, clean around the work place and prepare clean plastic box as parts box. Before disconnecting piping hose, clean around the motor and remove paint sticking to connections by means of wire brush.

[Caution]

Do not disassemble the following assembly.
Spindle/Wheel assembly.

1) Set the end cover assembly (21) to vice and fix it firmly.
   Loosen and remove eight M10 bolts (24) and seven M8 bolts (25).

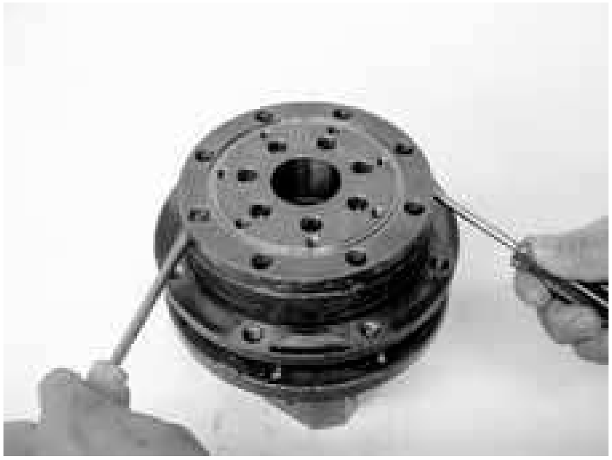
2) Remove the geroller cover (18).

3) Remove the geroller (4).

4) Fit an eye bolt to the valve plate (17), hook it on screwdriver and lift the valve plate (17) from the wheel (10)

M8 × 1.25

5) Pull out the drive (20).

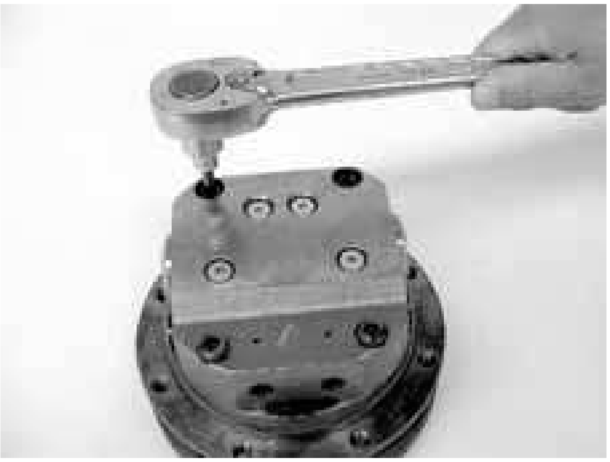


6) Dismount the valve plate (17) by inserting a screwdriver between the valve plate (17) and the wheel (10).

7) Pull out the valve (19).

8) Insert the plastic bar into the valve hole and push the sleeve (22) out of the valve (19), and remove the spring.

9) Take out the spacer (21).



10) Fix the wheel and remove four M8 bolts (28) by which the end cover assembly is mounted.

    48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m)

End cover assembly disassembling procedure

[Caution]

When clamping the assembly by vice etc., use care not to pinch the copper plate and give damage to the machine finished surface. Do not tighten it excessively.

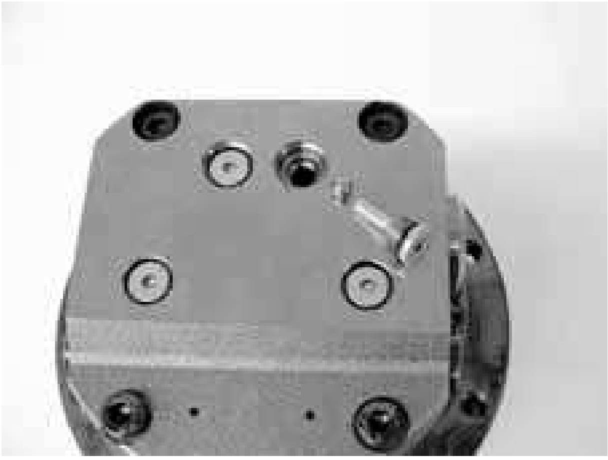
11) Remove the plug (V11), and then remove the spring (V9), washer (V13) and spool (V7).
    Do not use spanner but use socket wrench.

12) Remove the plug (V12) which is fitted to the spool (V7), and remove the spring (V10) and Counter-balance poppet (V8).

13) Remove the orifice (16) which is fitted to the housing.

14) Remove the plug (V4), spring (V3) and spool (V2). (Do not use spanner but use socket wrench.)
In TRBF (1-speed motor) this procedure is needed for plug only but not for spool and spring.

15) Remove the plug (V19), and then remove the pilot poppet (V20), spring (V21) and orifice plate (V23). Use care not to confuse right and left combination of the pilot poppets.
This procedure is not needed for TRBF (1-speed motor).



16) Remove the check plug (V16) and take out the ball (V18).

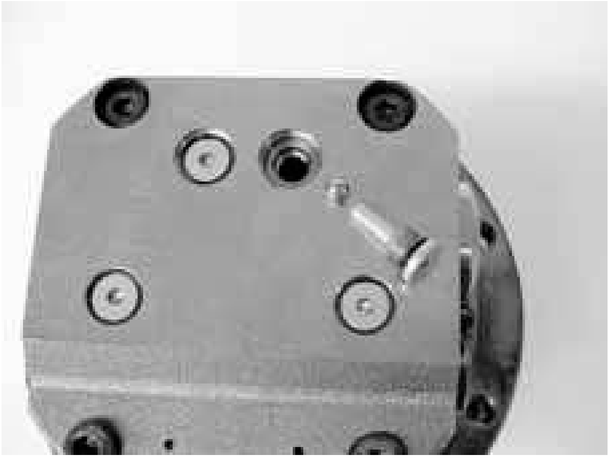
48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m)

[7] Motor assembly procedure

Assembly procedure

[Cautions]

1. Remove dents, scratches, burrs, etc. from parts.
2. Wash parts clean. Remove loctite sticking to the threaded holes by tapping tool and degrease parts completely with trichloroethylene.S
3. When re-assembling the motor, replace oil seals, O-rings etc. with new ones.



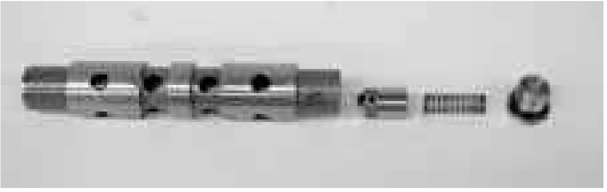
1) Put in the ball (V18) and tighten the check plug (V16) with specified tightening torque.
   • Tightening torque: 0.8 kgf·m

2) Mount the orifice plate (V23), spring (V21) and pilot poppet (V20), and tighten the plug (V19) with specified tightening torque.
   • Tightening torque: 0.8 kgf·m
   Use care not to confuse right and left combination of the pilot poppets.
   This procedure is not needed for TRBF (1-speed motor).

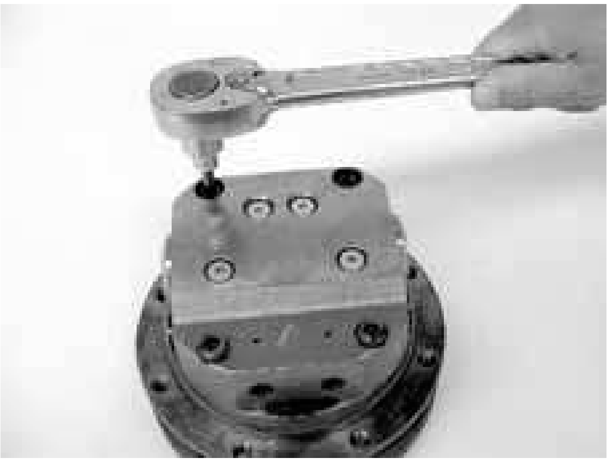
3) Insert the spool (V2) and spring (V3), and tighten the plug (V4). (Mounting direction is free.)
   • Tightening torque: 6 kgf·m
   Do not use spanner but use socket wrench.
   Since TRBF (1-speed motor) has not spool and spring, tighten only the plug.

4) Mount the orifice (V6) to the housing.
   • Tightening torque: More than 0.2 kgf·m

5) Insert the Counter-balance poppet (V8) and spring (V10) into the spool (V7), and tighten the plug (V12).
   • Apply loctite No.242 to threads.
   • Tightening torque: 3 kgf·m



6) Insert the spool (V7), washer (V13) and spring (V9) (Mounting direction is free) one by one, and tighten the plug (V11).
   • Tightening torque: 15 kgf·m
   Do not use spanner but use socket wrench.



7) Fix the wheel and tighten the end cover assembly with four M8 bolts (28).
   • Tightening torque: 3.5 kgf·m

Motor assembly procedure

8) Put in the spacer (21).

9) Apply grease to the X-ring (23) put it in.

10) Insert the spring (15) in the valve and fit in the sleeve (22). If frictional force of sleeve's O-ring is large and the spring which is elongated up to the bottom will not return, push the sleeve slightly out of the valve hole.

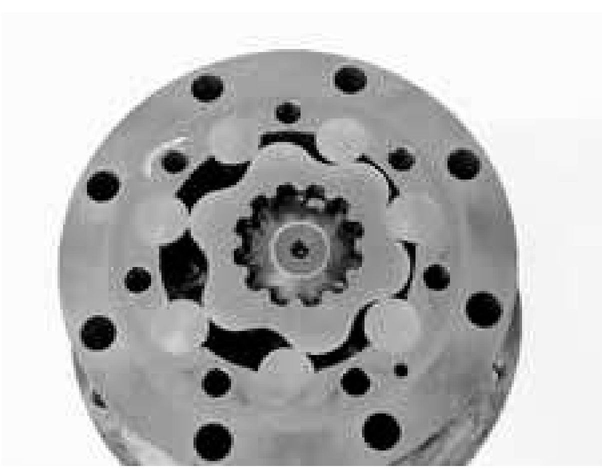
11) Mount the parallel pin (16) to the valve (19). (2 locations)
Apply grease to it and put it upside down so that the pin should not drop.
Put a mark beforehand by felt pen to the inner side of the position where the pin is mounted to the valve. (Either one of the two locations)

12) Fit the valve in the valve sleeve (7). Align the phase position so that pins are fitted in.

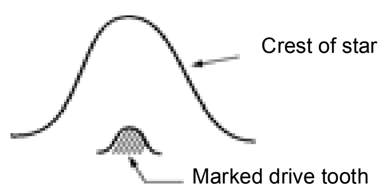
13) Fit the O-ring (20) to the valve plate (17).

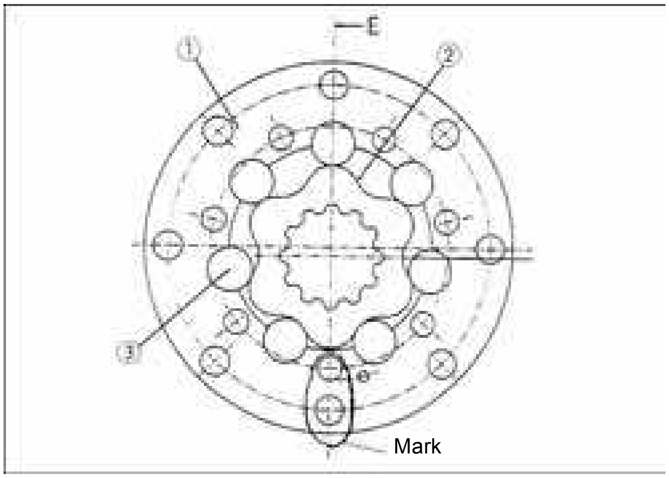
14) Mount the valve plate (17). Phase position can be aligned by matching with the wheel hole. Put a mark by felt pen to the same phase position as the position where the valve is marked.

15) Put a mark to one of the teeth of the drive (20) and fit it in by matching to the mark of aforesaid hole side.



16) Mount the O-ring (26) onto the valve plate (17). Align the phase with one of the six crests of the star (2) and mount the geroller (4).





17) Clamp and fix the end cover assembly (27) and turn the wheel and valve plate to align it with the bolt holes of the geroller. (There is only one phase position to be able to match all the bolt holes.)
Phases of the inside bolts and outsides bolts are matched at one position. Mark there to facilitate matching.

18) Fit the O-ring (26) to the geroller cover (18) and mount the motor.

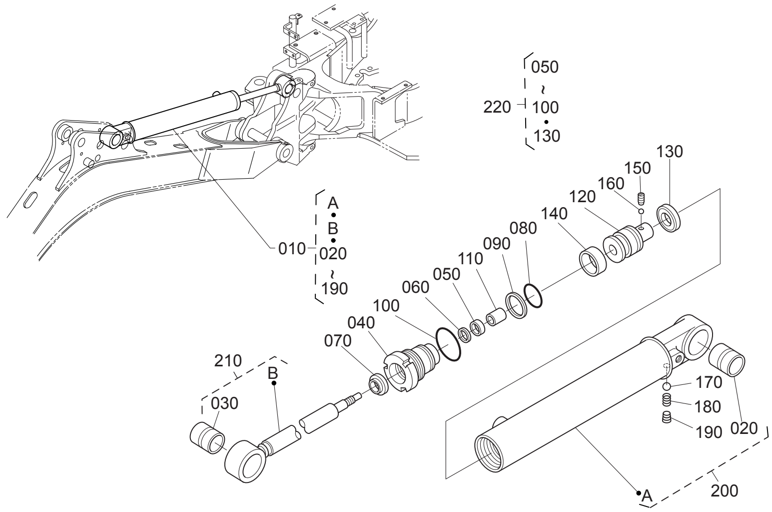
19) Tighten eight M10 bolts (24) and seven M8 bolts.
Tightening torque M8: 3 kgf·m
M10: 5.7 kgf·m

(2) Troubleshooting

Troubles	Causes	Remedies
Motor does not rotate.	• Oil volume in tank is insufficient. • Pump is broken. • Malfunction of relief valve or low set pressure • Abnormal wear or scuffing of motor • Shortcircuit in motor, entry of dust in valve or valve plate	• Supply hydraulic oil up to appropriate level. • Replace pump. • Disassembly and wash relief valve, and set it at appropriate pressure. • Disassemble and check motor, and replace parts. • Disassemble and wash.
Unstable rotation	• Relief valve is set at low pressure. • Air mixes in pump suction side.	• Set the relief valve at appropriate pressure.
Reverse rotating direction	• Reverse pipe connection • Reverse motor valve timing	• Connect pipe correctly. • Set correct valve timing.
Oil leak from connections	• Bolts are loosened. • O-ring is bitten or broken. • Floating valve seal is worn or damaged.	• Tighten bolts with appropriate tightening torques. • Replace O-ring. • Replace floating valve seal.
Noise is heard during rotation.	• Flaking, peeling or indentation is generated at bearing. • Gear oil is depleted.	• Replace bearing. • Replace floating seal and supply gear oil.
Speed is not changed over.	• Sticking of 2-speed spool or pilot poppet, or severe leak from them • Orifice plate is clogged with dust. • 2-speed pilot pressure is insufficient. • Drain pressure is high.	• Replace end cover assembly. • Wash orifice plate. • Raise pilot pressure higher than 10 kgf/cm^2 + drain pressure. • Connect drain pipe or raise pilot pressure.

d. Cylinder

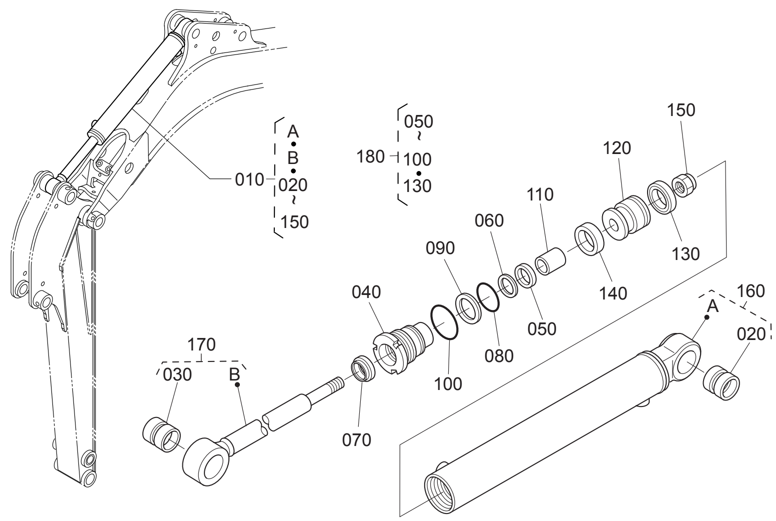
Boom cylinder and component parts



RA028-024-10

010	Assy cylinder, Boom
020	Bush, Pin
030	Bush, Pin
040	End
050	Gasket
060	Ring, Backup
070	Scaraper
080	O-ring
090	Ring, Buckup
100	O-ring
110	Bush
120	Piston
130	SPG Seal
140	Wearing
150	Screw, Set
160	Ball
170	Ball
180	Spring
190	Plug, Screw
200	Kit tube, Cylinder
210	Kit rod, Cylinder
220	Kit seal

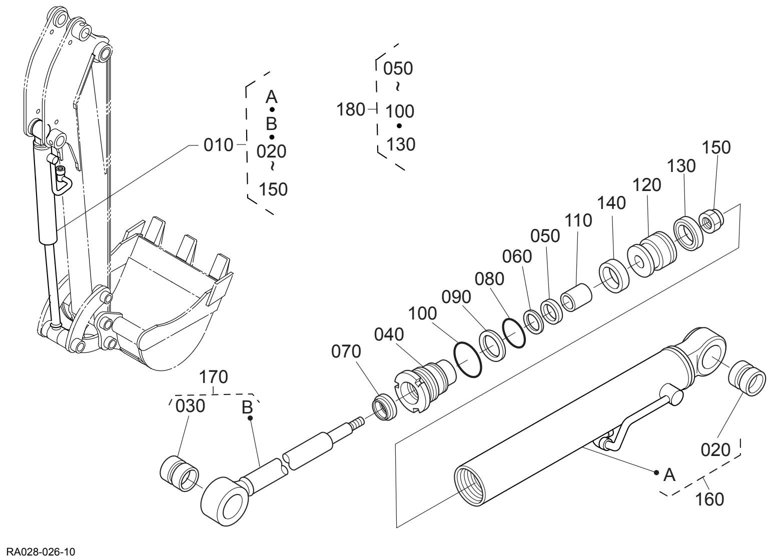
Arm cylinder and component parts



RA028-025-10

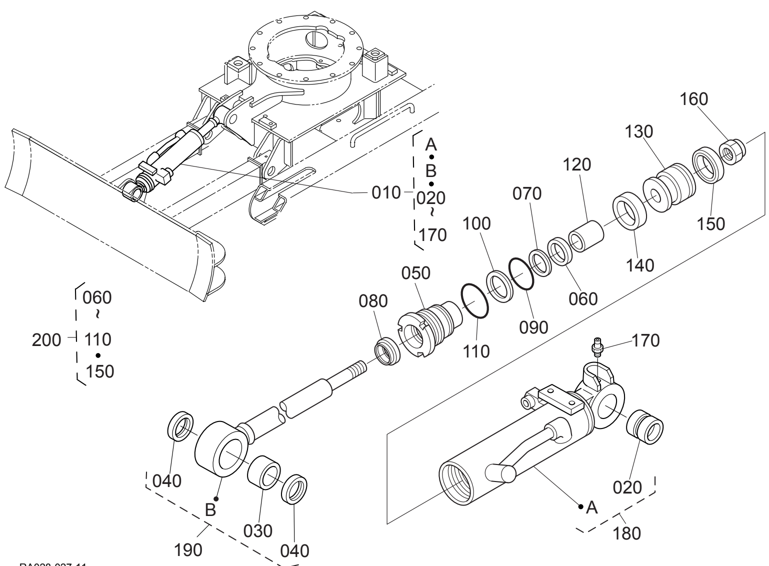
010	Assy cylinder, Arm
010	Assy cylinder, Arm
020	Bush, Pin
030	Bush, Pin
040	End
050	Gasket
060	Ring, Backup
070	Scaraper
080	O-ring
090	Ring, Buckup
100	O-ring
110	Bush
120	Piston
130	ST Seal
140	Wearing
150	Nut
160	Kit tube, Cylinder
160	Kit tube, Cylinder
170	Kit rod, Cylinder
170	Kit rod, Cylinder
180	Kit seal

Bucket cylinder and component parts



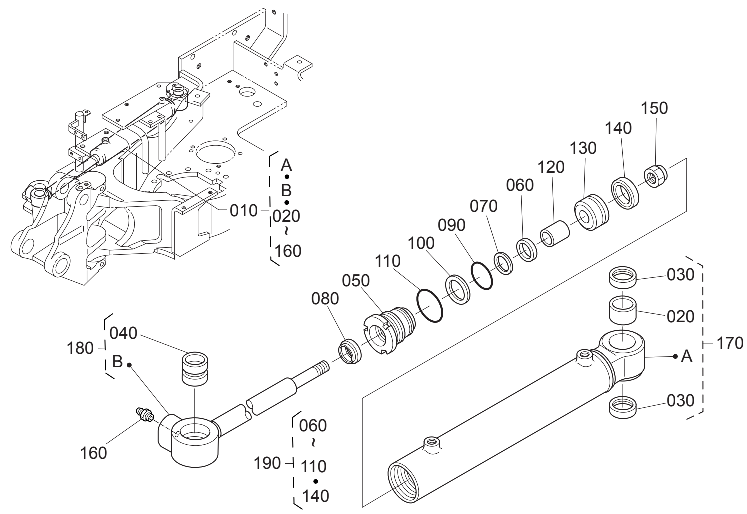
010	Assy cylinder, Bucket
020	Bush, Pin
030	Bush, Pin
040	End
050	Gasket
060	Ring, Backup
070	Scaraper
080	O-ring
090	Ring, Buckup
100	O-ring
110	Bush
120	Piston
130	ST Seal
140	Wearing
150	Nut
160	Kit tube, Cylinder
170	Kit rod, Cylinder
180	Kit seal

Blade cylinder and component parts



010	Assy cylinder, Blade
020	Bush, Pin
030	Bush
040	Seal, Dust
050	End
060	Gasket
070	Rung, Backup
080	Scraper
090	O-ring
100	Ring, Backup
110	O-ring
120	Bush
130	Piston
140	Wearing
150	ST seal
160	Nut
170	Nipple, Grease
180	Kit tube, Cylinder
190	Kit rod, Cylinder
200	Kit seal

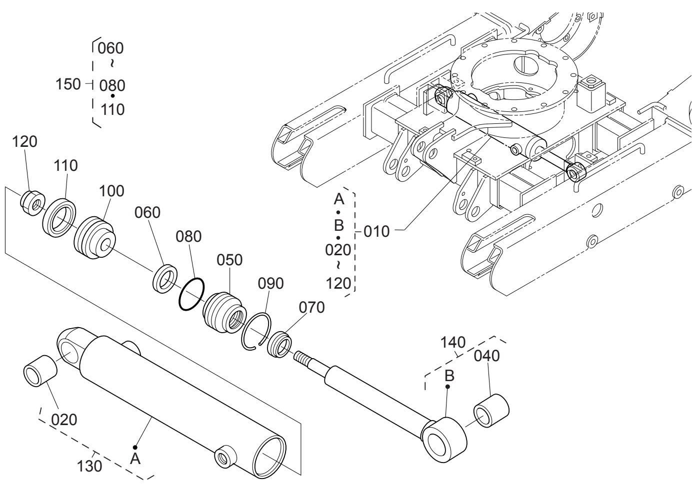
Swing cylinder and component parts



RA028-028-10

010	Assy cylinder, Swing
020	Bush
030	Seal, Dust
040	Bush, Pin
050	End
060	Gasket
070	Rung, Backup
080	Scraper
090	O-ring
100	Ring, Backup
110	O-ring
120	Bush
130	Piston
140	ST seal
150	Nut
160	Nipple, Grease
170	Kit tube, Cylinder
180	Kit rod, Cylinder
190	Kit seal

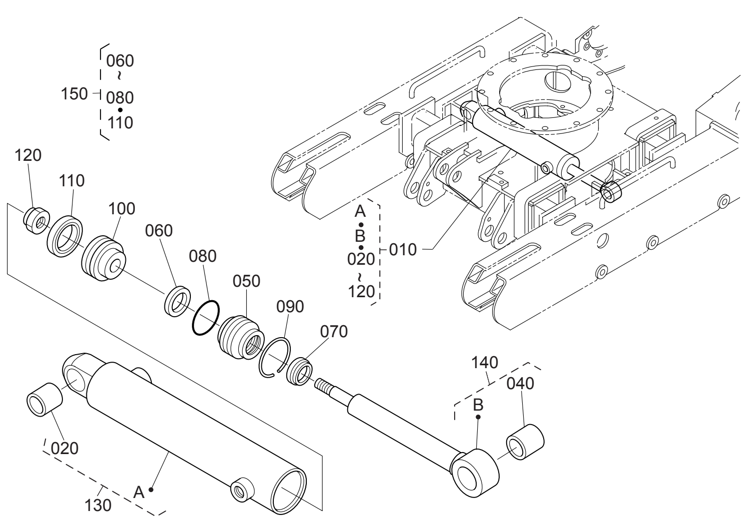
Track cylinder and component parts



RA028-029-11

010	Assy cylinder, Track
020	Bush
030	Blank
040	Bush
050	End
060	Gasket
070	Scraper
080	O-ring
090	Circlip
100	Piston
110	ST seal
120	Nut
130	Kit tube, Cylinder
140	Kit rod, Cylinder
150	Kit seal

Track cylinder and component parts

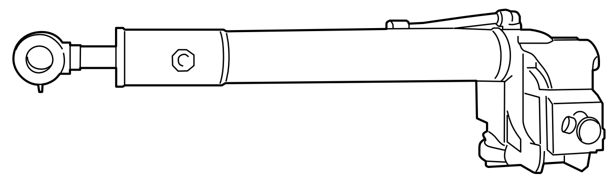


RA138-034-11

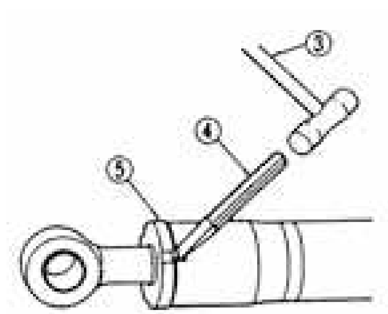
010	Assy cylinder, Track
020	Bush
030	Blank
040	Bush
050	End
060	Gasket
070	Scraper
080	O-ring
090	Circlip
100	Piston
110	ST seal
120	Nut
130	Kit tube, Cylinder
140	Kit rod, Cylinder
150	Kit seal

(2) Disassembling and assembling

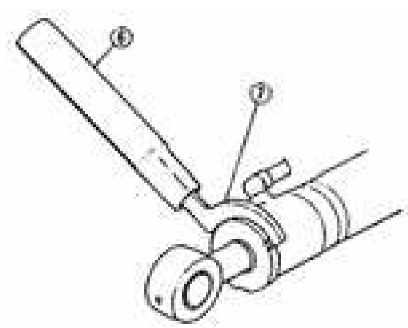
1) Disassembling



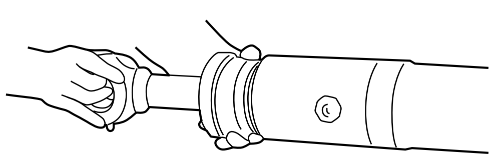
1. Place the cylinder on a vise.
2. Let hydraulic oil out of the cylinder.



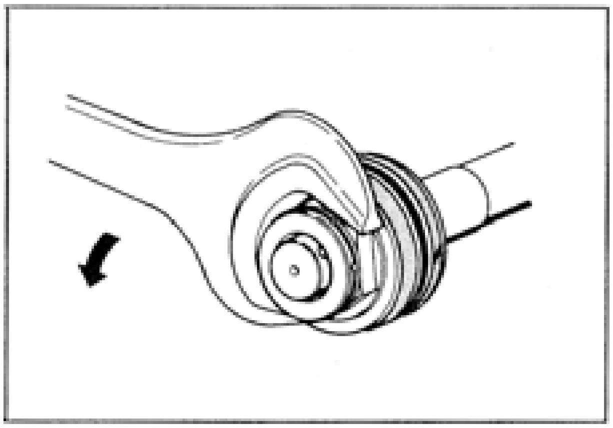
3. Undo the lock washer.
   ③ Hammer
   ④ Chisel
   ⑤ Lock washer



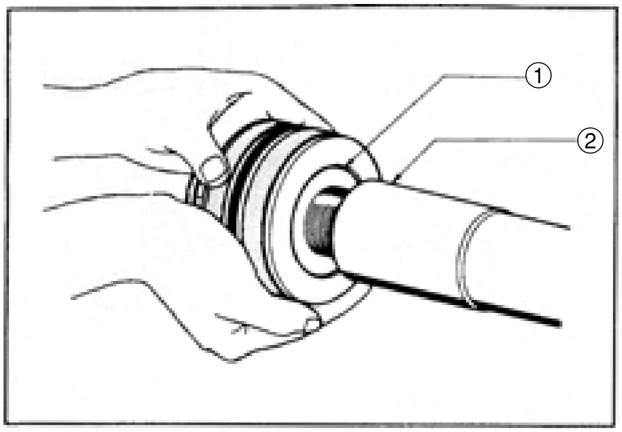
4. Loosen the cylinder head screw and detach the cylinder head.
   ⑥ Pipe
   ⑦ Hook wrench



5. Draw out the piston rod together with the cylinder head.
 * If the pipe ports are open, place an oil pan below the port at the retracting-side cylinder head.

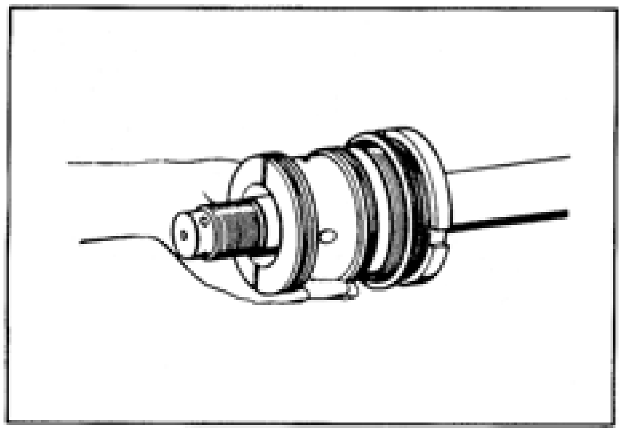


6. Apply a wrench to the hex nut of the piston. Loosen the nut.



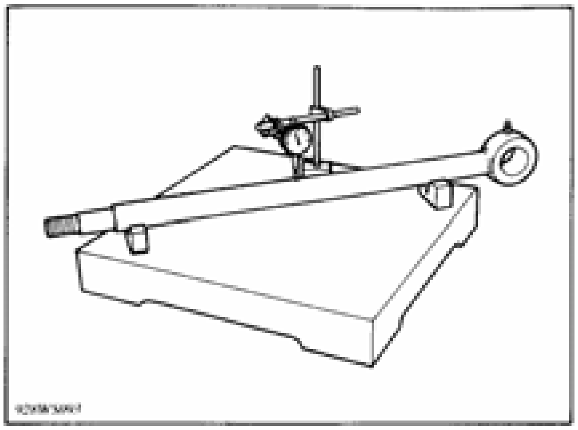
7. Draw out the piston and remove the shim
8. Remove the cushion bearing.

① Shim
② Cushion bearing



9. Draw out the cylinder head.
10. Release the piston rod from the vise.

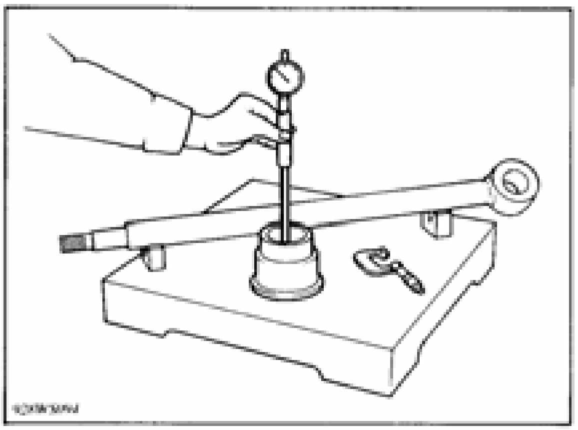
(3) Inspection



1.Piston rod warp

① Mount the piston rod on a V-block.
② Set a dial indicator at the center of the rod.
③ Rotate the piston rod and read the indicator. Warp is one-half of the difference between the maximum and the minimum readings.
④ If the valve exceeds the allowable limit, replace the piston rod.

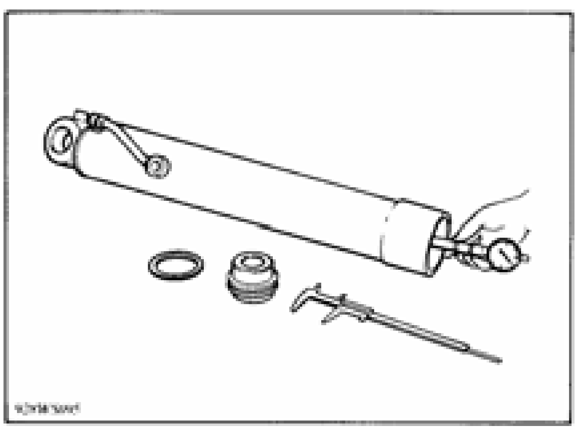
- Reference value .. warp within 0.05 mm, 0.002in.
- Allowable value ... warp within 0.5 mm, 0.0197in.



2.Clearance between piston rod and bushing

① Measure the piston rod O.D. and cylinder head bushing I.D. and determin the clearance.

	Rod size	Clearance
Reference value	ϕ25 to ϕ40 mm	less than 0.25 mm
	ϕ45 to ϕ75 mm	less than 0.30 mm
Allowable limit	ϕ25 to ϕ40 mm	0.4 mm
	ϕ45 to ϕ75 mm	0.5 mm
Reference value	ϕ0.9843 to 1.5748 in	less than 0.010 in
	ϕ1.7717 to 2.9528 in	less than 0.012 in
Allowable limit	ϕ0.9843 to 1.5748 in	0.0158 in
	ϕ1.7717 to 2.9528 in	0.0197 in



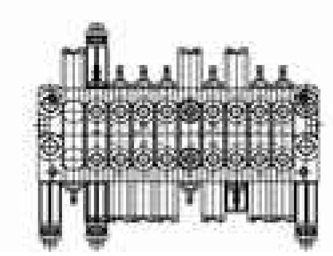
3.Clearance between cylinder tube I.D. and Piston ring O.D.

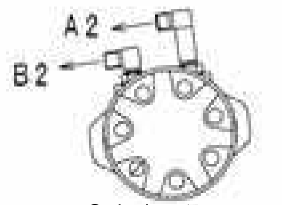
① Measure the cylinder tube I.D.
② Calculate the piston ring thickness plus piston ring groove O.D. determin the clearance.

	Rod size	Clearance
Reference value	less than ϕ60 mm	0.05 to 0.30 mm
	ϕ65 to ϕ115 mm	0.05 to 0.35 mm
	more than ϕ120 mm	0.05 to 0.40 mm
Allowable limit	less than ϕ60 mm	0.60 mm
	ϕ65 to ϕ115 mm	0.70 mm
	more than ϕ120 mm	0.80 mm
Reference value	ϕ2.3622 in less	0.0020 to 0.0118 in
	ϕ2.5590 to 4.5276 in	0.0020 to 0.0138 in
	ϕ4.7244 in more	0.0020 to 0.0157 in
Allowable limit	ϕ0.9843 to 1.5748 in	0.0236 in
	ϕ1.7717 to 2.9528 in	0.0276 in
	ϕ4.7244 in more	0.0315 in

F. Route of Hydraulic Hose

(1) Route of control valve hydraulic hose (Fixed leg, 1-speed)





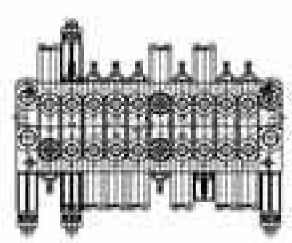
Swivel motor

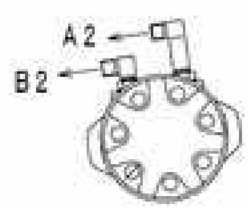
A2	→	Swivel motor right side (No tape)
A3	→	Arm rod side (Red) * Boom bottom side (white)
A4	→	Swivel joint C port (Shaft side) (Green)
A5	→	Swivel joint F port (Shaft side) (No tape)
A7	→	Swivel joint H port (Shaft side) (Red)
A8	→	Swing bottom side (White)
A9	→	Bucket rod side (Green)
A10	→	Boom bottom side (White) * Arm rod side (Red)

B2	→	Swivel motor left side (Pink)
B3	→	Arm bottom side (Blue) * Boom rod side (No tape)
B4	→	Swivel joint B port (Shaft side) (Yellow)
B5	→	Swivel joint A port (Shaft side) (Sky blue)
B7	→	Swivel joint I port (Shaft side) (Blue)
B8	→	Swing rod side (No tape)
B9	→	Bucket bottom side (Yellow)
B10	→	Boom rod side (No tape) * Arm bottom side (Blue)

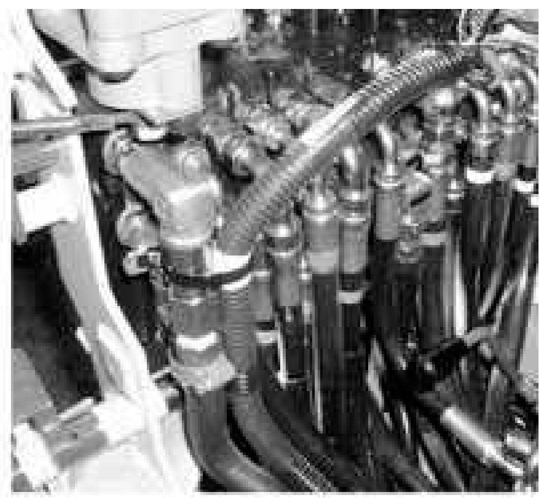
* KTC, KCL, KTA Version.

Route of control valve hydraulic hose (Retractable leg, 2-spped)





Swivel motor

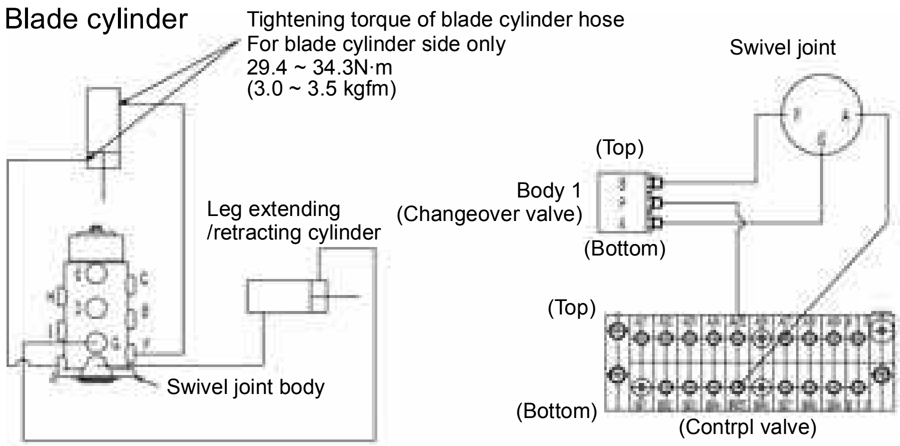


A1	→	Swivel joint D port (Shaft side) (No tape)
A2	→	Swivel motor right side (No tape)
A3	→	Arm rod side (Red) * Boom bottom side (white)
A4	→	Swivel joint C port (Shaft side) (Green)
A5	→	Changeover valve P port (No tape)
A7	→	Swivel joint H port (Shaft side) (Red)
A8	→	Swing bottom side (White)
A9	→	Bucket rod side (Green)
A10	→	Boom bottom side (White) * Arm rod side (Red)

B1	→	Plug
B2	→	Swivel motor left side (Pink)
B3	→	Arm bottom side (Blue) * Boom rod side (No tape)
B4	→	Swivel joint B port (Shaft side) (Yellow)
B5	→	Swivel joint A port (Shaft side) (Sky blue)
B7	→	Swivel joint I port (Shaft side) (Blue)
B8	→	Swing rod side (No tape)
B9	→	Bucket bottom side (Yellow)
B10	→	Boom rod side (No tape) * Arm bottom side (Blue)

* KTC, KCL, KTA Version.

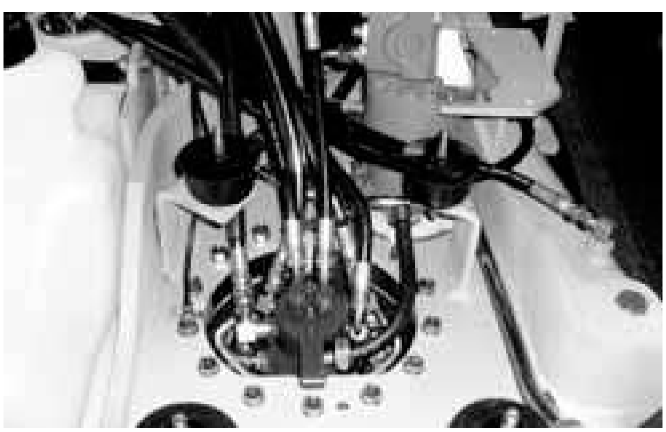
Leg extending/retracting cylinder bottom side → Swivel joint, A (Body side) (No tape)
Leg extending/retracting cylinder bottom side →Swivel joint, G (Body side) (No tape)



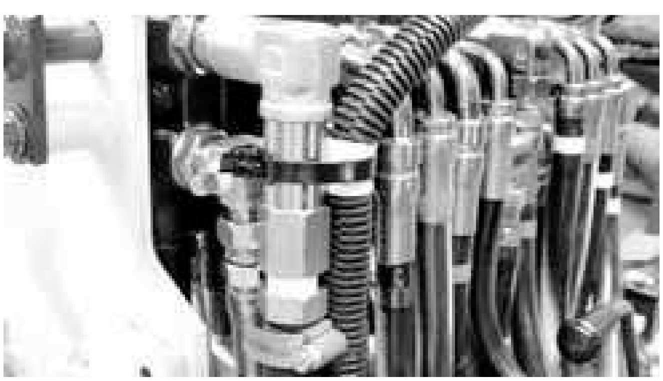
B:Straight pipe joint
P:Pipe joint
A:Straight pipe joint

(2) Route of return hose

1) Connection of the hose (return 1) and hose (return 3).
   - Provide a clearance of more than 5 mm between the hose and the oil tank.
   - Tightening torque of hose clamp (15-24): 4.4 ~ 73.5 N·m (7.0 ~ 7.5 kgf·m)



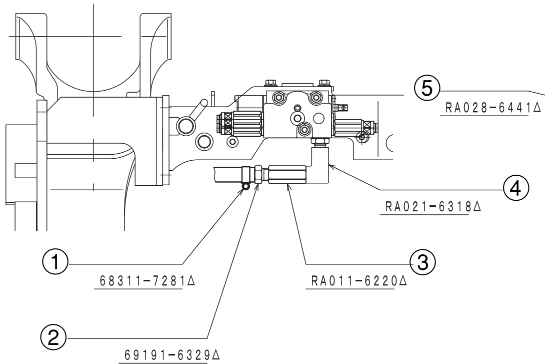
2) Connection of the hose (return 2)
   Tightening torque of hose clamp (10-22):
   2.9 ~ 3.9 N·m (3.0 ~ 4.0 kgf·m)

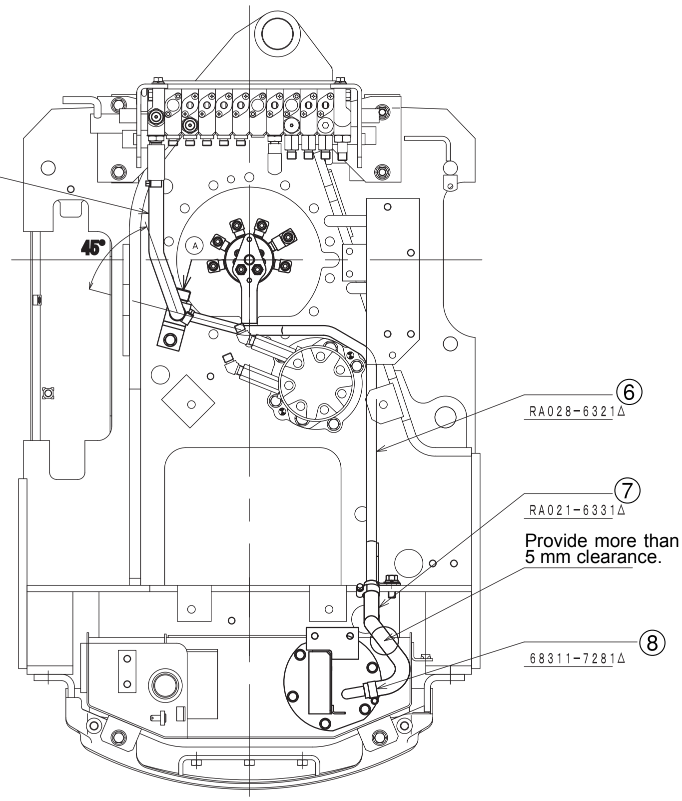


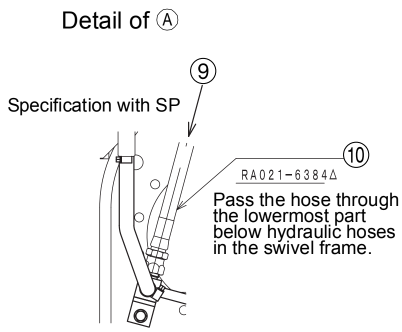
3) Tightening torque of the valve assembly (check) and pipe joint:
   68.6 ~ 73.5 N·m (7.0 ~ 7.5 kgf·m)
   Tightening torque of the elbow pipe joint to be mounted to the valve assembly (check):
   37.2 ~ 42.1 N·m (3.8 ~ 4.3 kgf·m)
   * Apply oil (M80B or equivalent) to O-rings.

4) Tightening torque of the plug:
58.8 ~ 63.7 N·m (6.0 ~ 6.5 kgf·m)

Route of K008-3 return hose (1-speed)

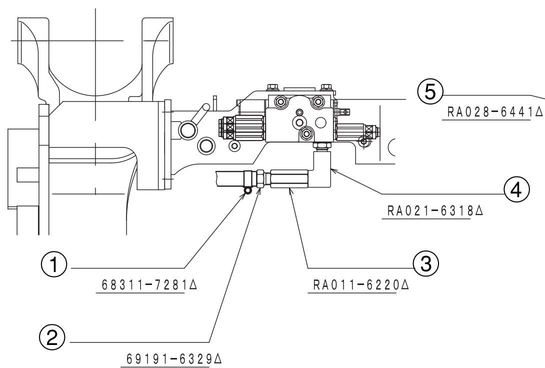


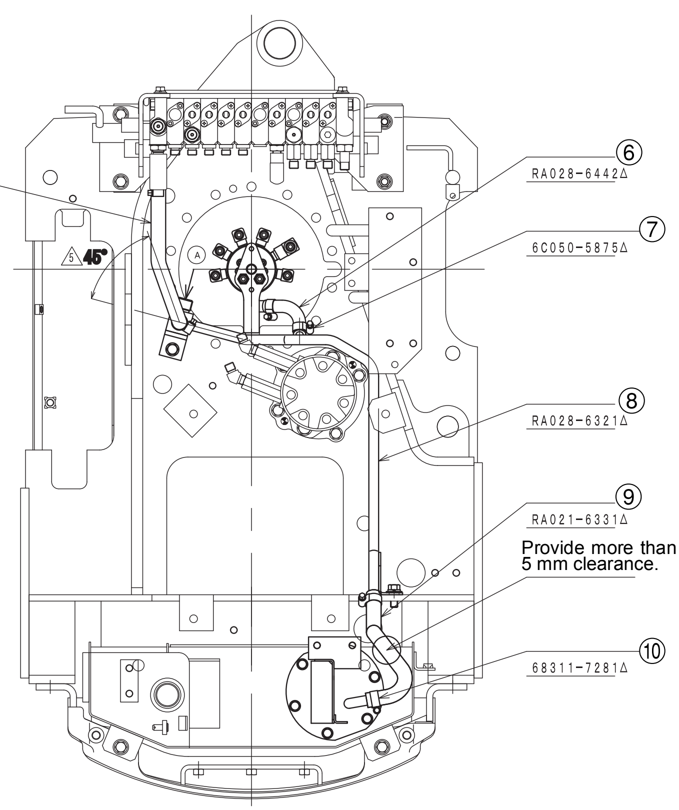


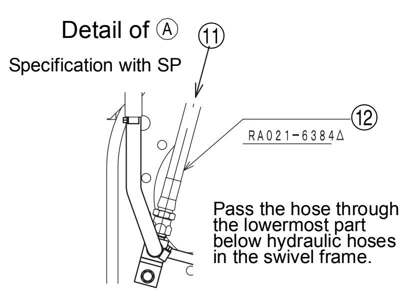


① Hose clamp (15-24)
② Pipe joint (S, T3/8-13.8)
③ Valve ass'y (Check)
④ Elbow pipe joint (G3-G3)
⑤ Hose (Return, 3)
⑥ Pipe (Return)
⑦ Hose (Return, 1)
⑧ Hose clamp (15-24)
⑨ SP adaptor in arm (T port)
⑩ Hose (High pressure, 1/2)

Route of K008-3 return hose (2-speed)

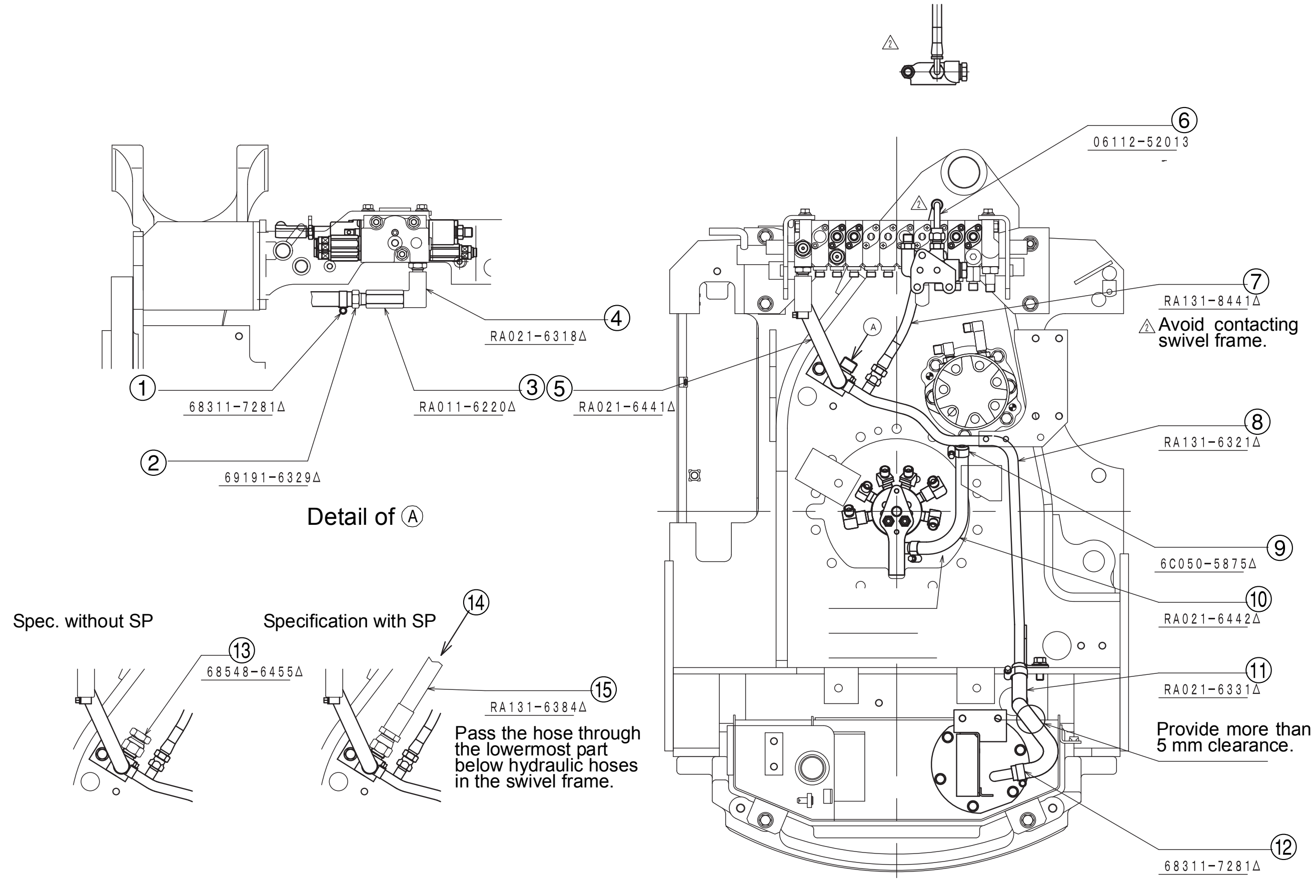






① Hose clamp (15-24)
② Pipe joint (S, T3/8-13.8)
③ Valve ass'y (Check)
④ Elbow pipe joint (G3-G3)
⑤ Hose (Return, 3)
⑥ Pipe (Return, 2)
⑦ Hose clamp (10-22)
⑧ Pipe (Return)
⑨ Hose (Return, 1)
⑩ Hose clamp (15-24)
⑪ SP adaptor in arm (T port)
⑫ Hose (High pressure, 1/2)

Route of U10-3 return hose (2-speed)



① Hose clamp (15-24)
② Pipe joint (S, T3/8-13.8)
③ Valve ass'y (Check)
④ Elbow pipe joint (G3-G3)
⑤ Hose (Return, 3)
⑥ Straight pipe joint
⑦ Hose (1/4)
⑧ Pipe (Return)
⑨ Hose clamp (10-22)
⑩ Hose (Return, 2)
⑪ Hose (Return, 1)
⑫ Hose clamp (15-24)
⑬ Plug
⑭ SP adaptor in arm (T port)
⑮ Hose (High pressure, 1/2)

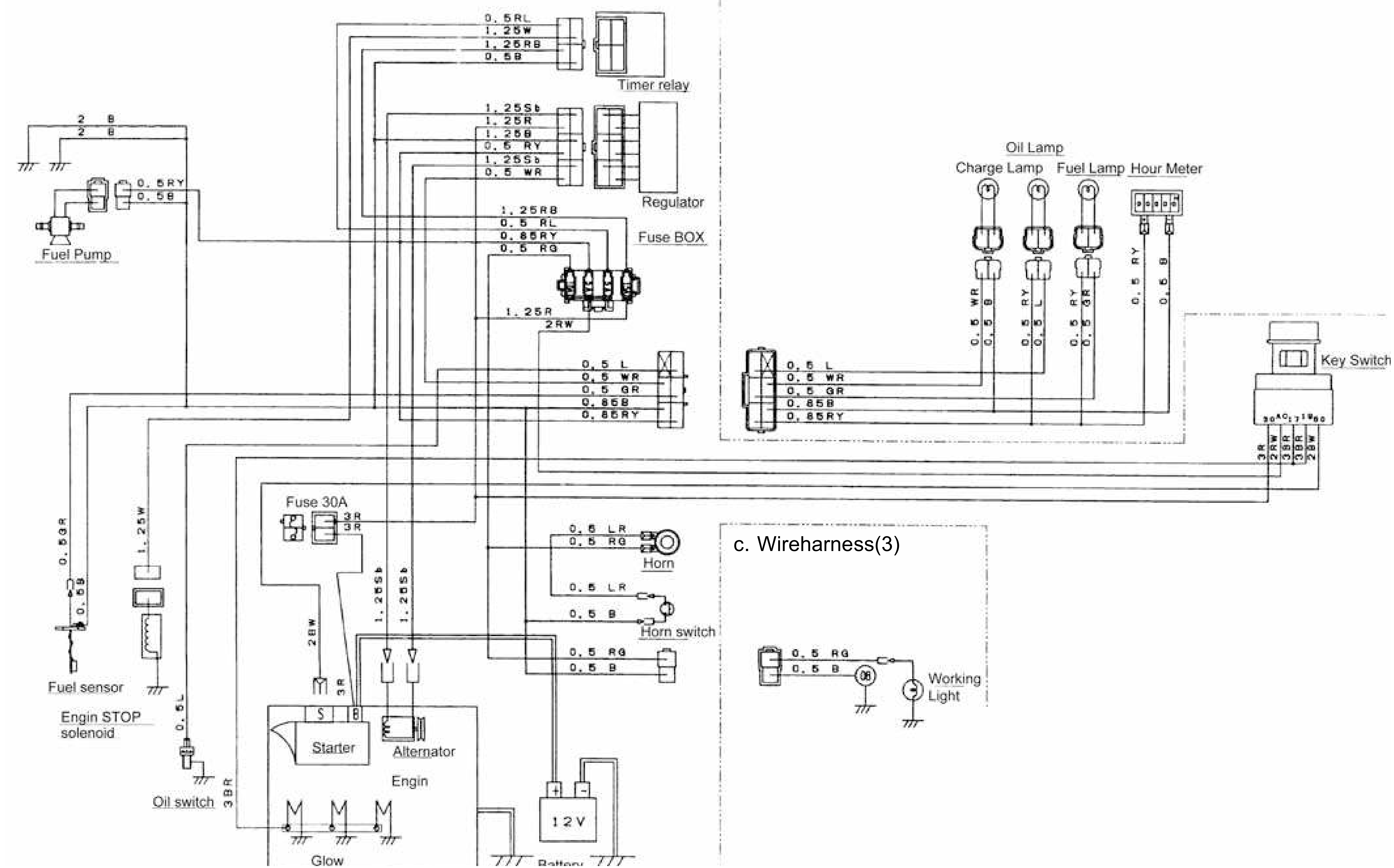
V. Electrical system(Service section)

A.Wireharness

a. Wireharness(1)

b. Wireharness(2)

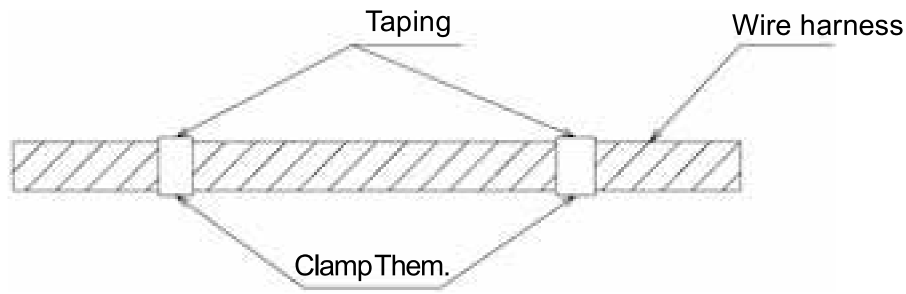
c. Wireharness(3)



B. Electric Wiring

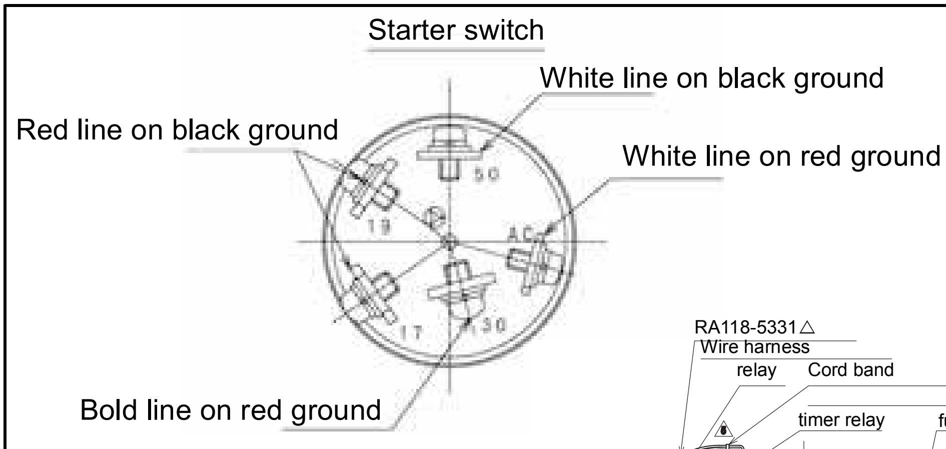
a. Cautions on electric wire clamping method

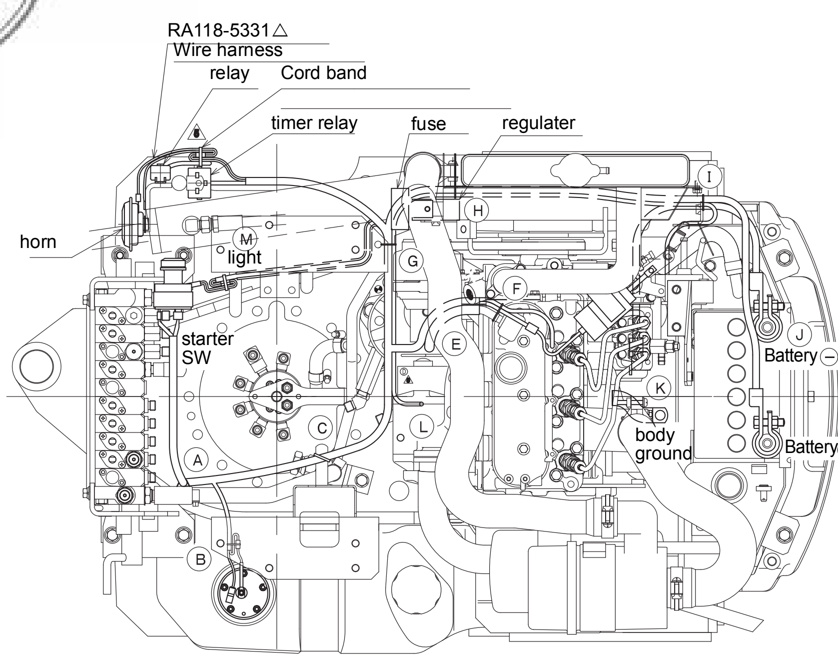
1. There should be no contact or possible contact with surroundings of wire.
   There should be no contact of wire at a place where no protective material is provided.
2. Do not clamp electric wire together with fuel hose.
3. Connect couplers, terminals etc. securely so that they should not be removed when they are pulled by rather strong force.
4. Clamp wire harness surely to clamping position. (Clamp the portion of white tape)



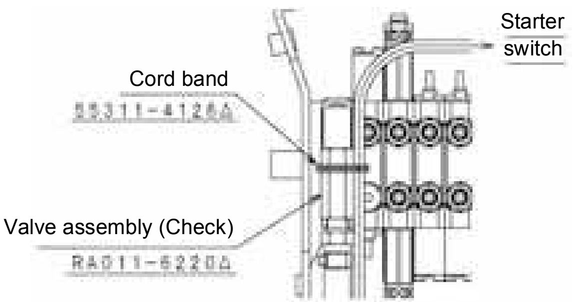
1) Clamp the wire harness at the positions which are indicated by taping on the wire harness.
2) Clamp the wire harness securely so that it should not be displaced nor move.

* Wire harness should not be extruded from the slit of corrugated tube.
* Clamp the cord over the wound corrugated tube.



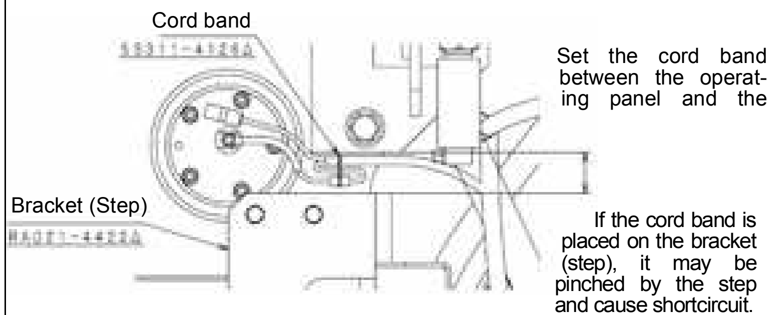


(A)Clamp to valve assembly (check)



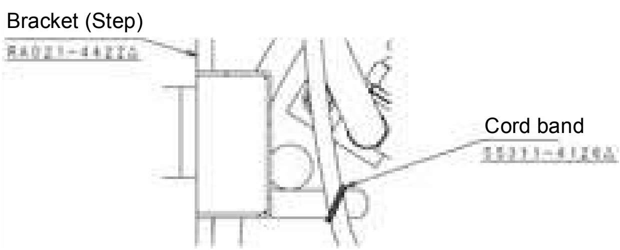
* Pass the wire harness through the inside of the valve assembly (check) and clamp it securely.

(B) Wiring to fuel sensor



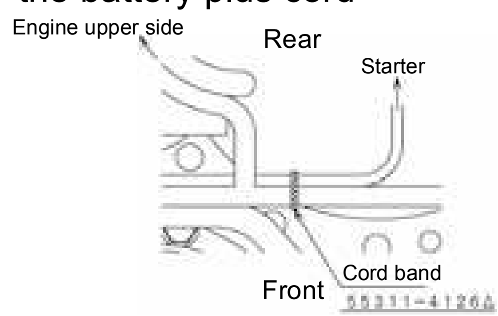
* Insert the clamped wire harness between the operation panel and the bracket of step.

(C) Clamping to bracket (step)



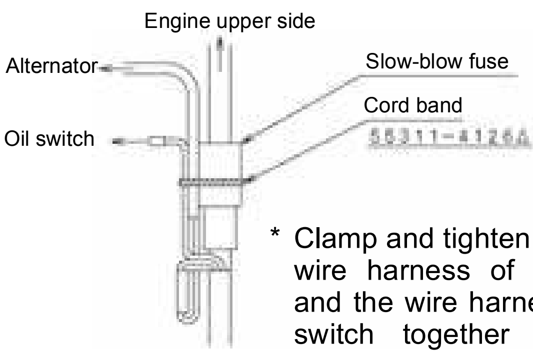
* Clamp the cord band securely to the bracket (step).

(D) Clamping of wire harness (1) and the battery plus cord



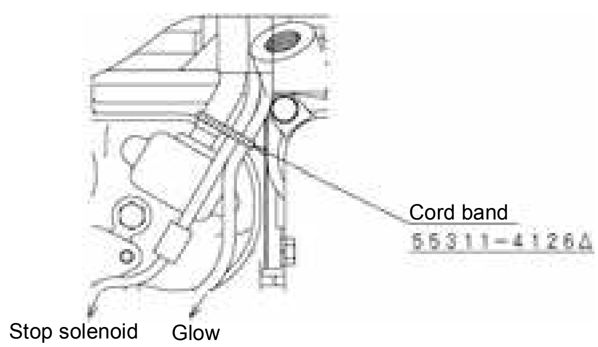
* Securely clamp the wire harness (1) and the battery.

(E) Clamping of wire harness for alternator, oil switch and slow-blow fuse



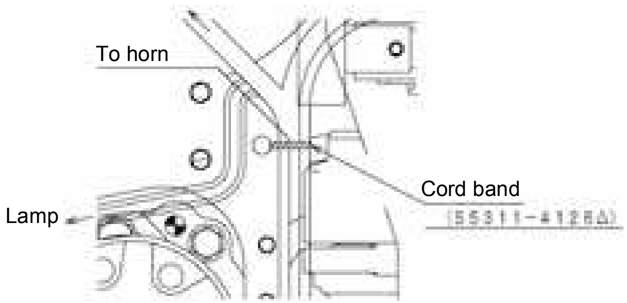
* Clamp and tighten the loose wire harness of alternator and the wire harness for oil switch together with the slow-blow fuse.

(F) Clamping to the engine breather



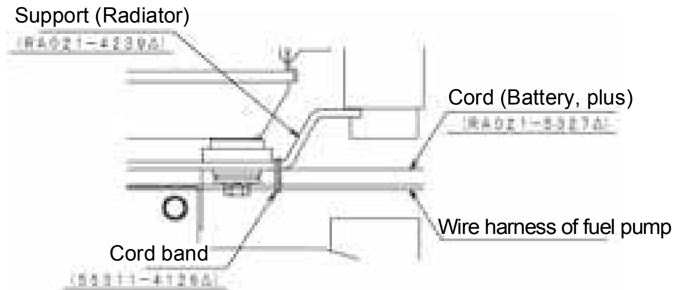
* Clamp the wire harness to the engine breather' iron part.

(G) Clamping of the battery plus cord and the wire harness (1) to the swivel frame.



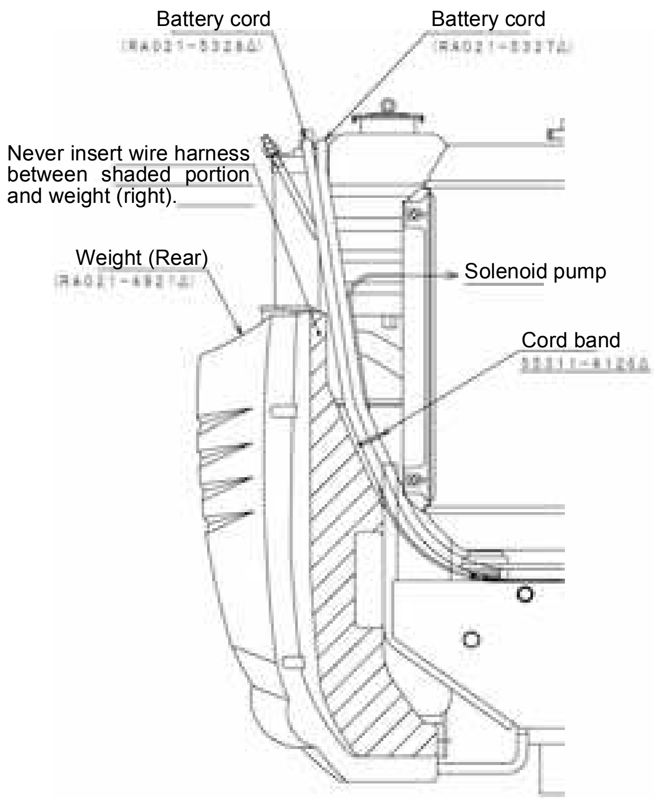
* Clamp the battery plus cord and the wire harness (1) to the swivel frame.

(H) Clamping to the support (radiator)

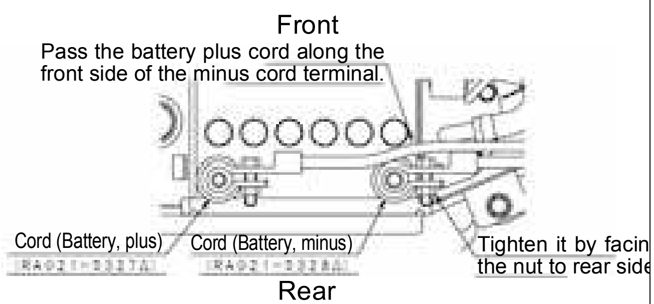


* Clamp the battery plus cord and the wire harness of solenoid pump to the support (radiator).

(I) Clamping of the cord (battery plus) and the cord (battery minus) to the wire harness for solenoid pump

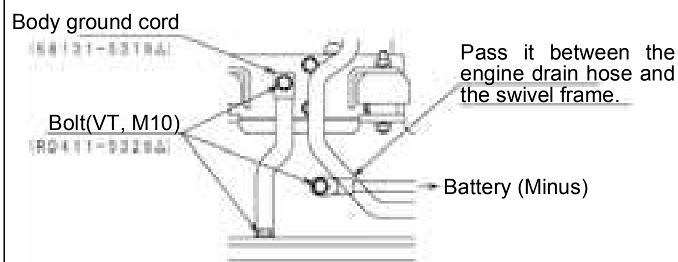


(J) Assembling the cord (battery)



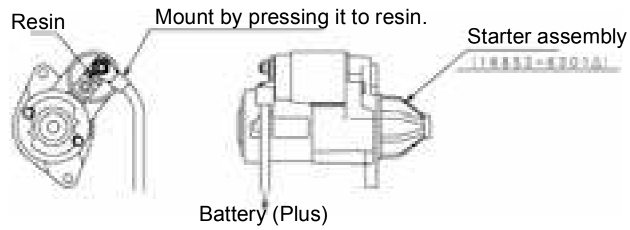
* Tighten the cord (battery, minus) so that the nut comes to the rear side.

(K) Assembling the body ground and the battery minus cord



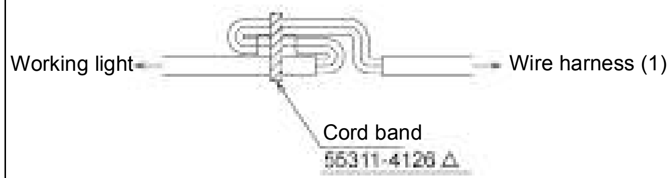
* Pass the battery minus cord between the engine water drain hose and swivel.

(L) Assembling the cord (battery plus)



* Starter terminal tightening torque

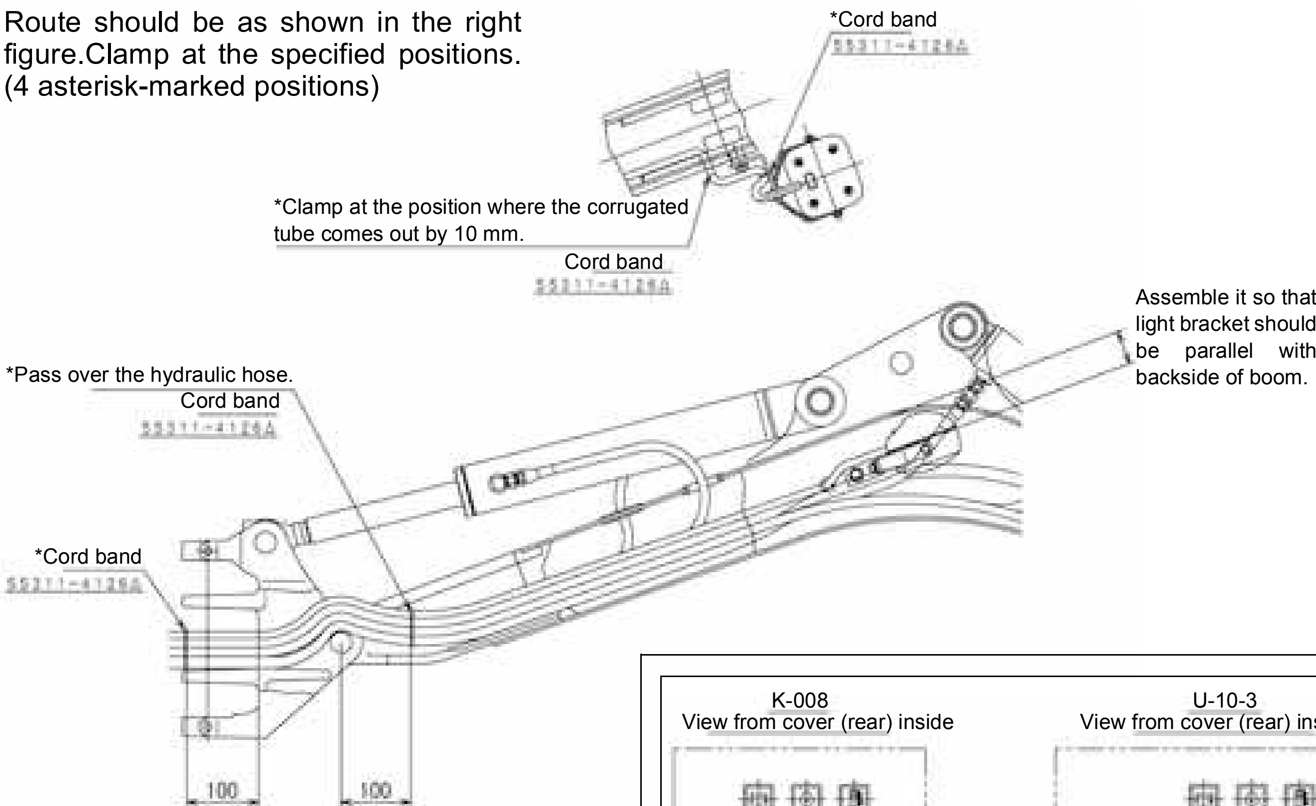
(M)Wiring to working light

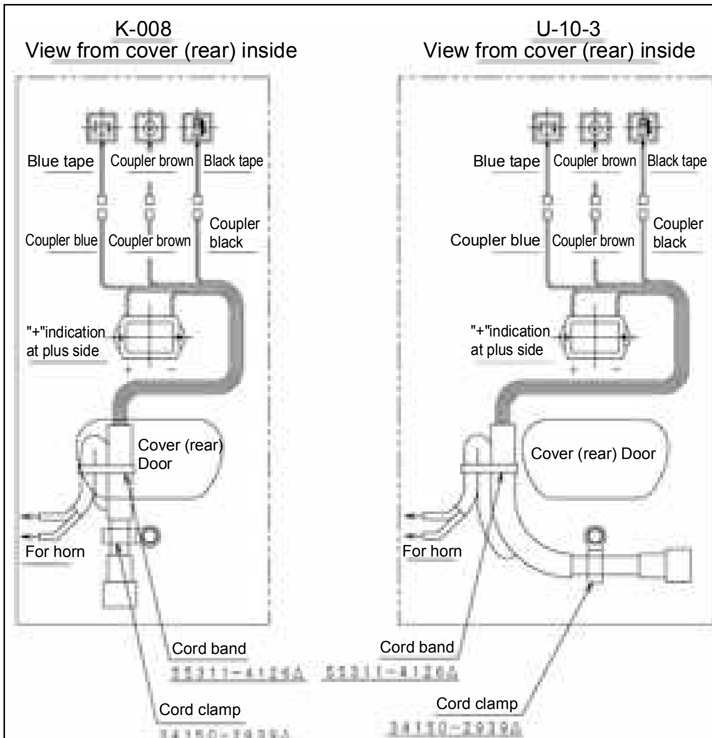


* Clamp the wire harness of the working light securely.

Front

Route should be as shown in the right figure.Clamp at the specified positions. (4 asterisk-marked positions)





C.Troubleshooting of Electric System

a. Outline pf troubleshooting

(1)Procedure

The most important thing in conducting troubleshooting is "to estimate the cause". It is also essential to narrow down the checking points and cut out excess checking work by estimation of the cause. The estimation of cause must require the theory and the proof based on facts and must not lean on intuition.
If you try to remove trouble without going through with due procedure in troubleshooting, the trouble may be complicated all the more, resulting in misunderstanding of the cause of trouble to lead to wrong repair. Consequently, it is necessary to consider the following four steps as the procedure of troubleshooting.

1	Procedure of troubleshooting	Observe trouble correctly. Check whether the trouble occurs locally or also elsewhere.
2	Estimation of cause of trouble	In the estimation of cause of trouble, it is vital to understand the circuit as a system by circuit diagram. It is also necessary to estimate the causes of trouble more extensively, such as the cause of trouble similar to that which was remedied in the past, needless to say, in order to acquire the knowledge about operation of switches, relays etc.
3	Checking of specified points and discovery of cause.	The objective of troubleshooting lies in accumulation of the facts obtained by checking work and approaching a true cause step by step. Proceed to the checking work while always considering what checking should be made and where should be checked for more effective result.
4	Confirmation after remedy	After remedy of trouble, be sure to confirm that the system operates normally. Also, check whether a new trouble is generated or not.

This document includes the total wiring diagram and the circuit diagrams for each system as the information required for conducting troubleshooting, see to it that troubleshooting can be made easily.

1. Wiring diagram includes the connector arrangement and the wiring and routing of wire harness in actual machine.
2. Circuit diagram includes the circuitry of the system and shows all types of switches in normal (non-operating) state.
3. Operation is explained on the basis of the circuit diagram where the flow of electricity at the time when switch is manipulated is shown. How equipments work is also included.
4. As for discovery of trouble, information which can be a clue to find out the cause of trouble in common-sense terms from plural symptoms of trouble. As for the troubles whose cause can not be found out, perform troubleshooting in pursuit of circuits of each system.

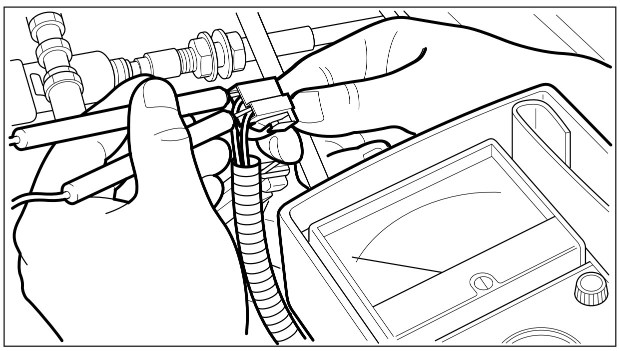
b. Cautions in general

(1) Checking of conductivity and voltage at coupler

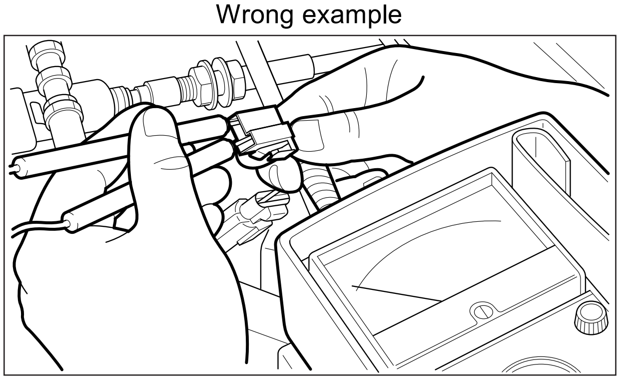
In order to prevent loose connection of coupler and deterioration of waterproofing property of coupler, perform checking of conductivity and voltage at coupler in the procedure as follows.

Checking of ordinary (non-waterproof) coupler

Correct example



Wrong example

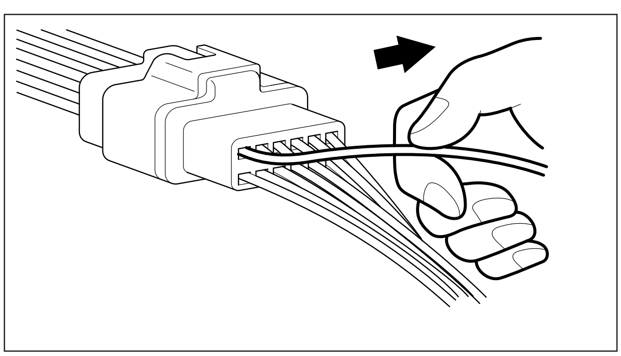


1) Ordinary (Non-waterproof) coupler

Carry out checking by inserting the test lead from the wire harness side. Since the terminal is broken particularly in the case of female terminal, be sure to insert the test lead from the wire harness side.
When it is impossible to insert the test lead in the case of control unit having small connectors, do not insert it forcedly but use special tool.

2) Waterproof coupler

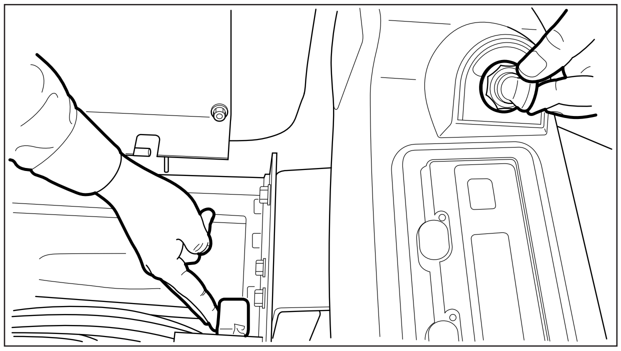
1. When checking after bringing the circuit to be conductive, undue insertion of the test lead from the wire harness side deteriorates waterproofing property and cause corrosion. Strictly avoid insertion by force in this case.
2. When the object to be checked is male pin, contact the test lead directly to the pin. In this case, use care not to causes shortcircuit between couplers.



(2) Checking procedure for removal of pin

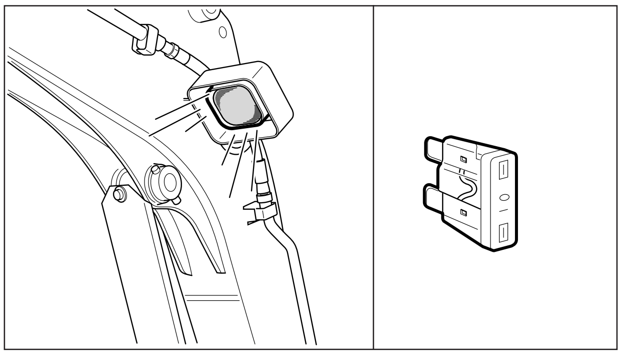
1. Checking procedure for removal of coupler
2. When the pin stopper of coupler is broken, coupler can be connected in coupler connection, but connection of terminals (male, female, pin) becomes incomplete and pin may be removed to the back side of coupler. Therefore, lightly pull wire harnesses one by one and make sure that pin will not be removed from coupler.

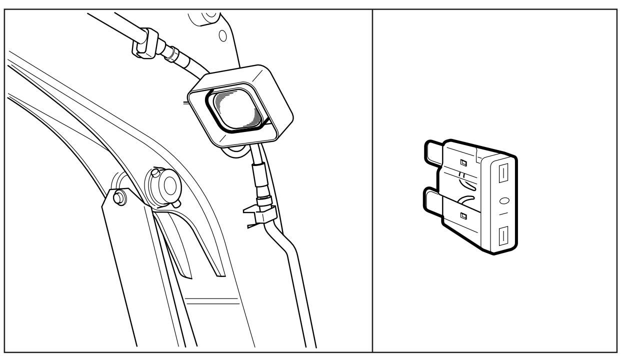
(3) Checking method



1) Visual checking and checking by sound

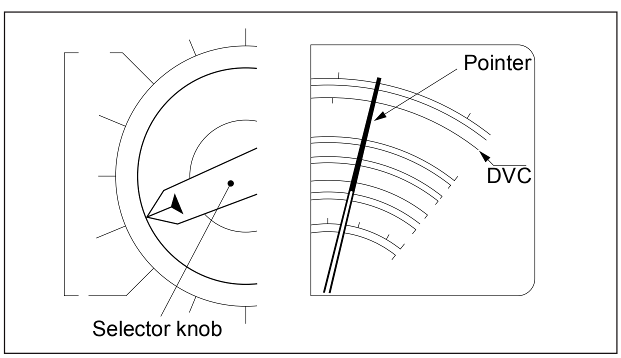
Trouble with the machine can be checked by operation of invisible parts such as by operating sound of relay, motor rotating sound and lamp lighting though the flow of electricity is invisible.





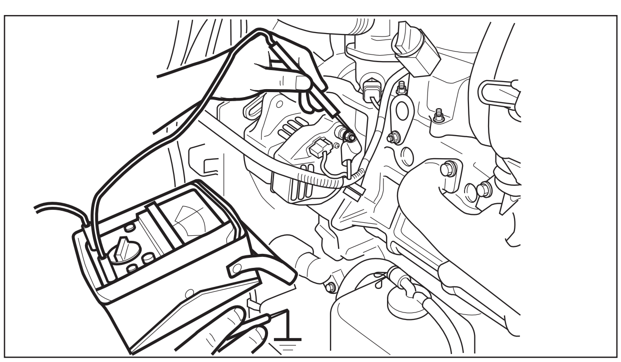
2) Summary checking

For example, when there is such a trouble that the head lamp does not light up and fuse is considered to be the cause, replace the fuse with new one having same capacity. Or, when poor grounding is considered to be the cause of trouble, establish a ground by special tool (wire harness for checking) between the lamp and the machine frame. Position of trouble can be estimated by these measures.



3) Checking by measuring and test equipment

Use an appropriate measuring equipment and select an appropriate range. When the measuring range has been changed, be sure to do measurement after making zero adjustment. It is essential to be well versed in handling of the equipment to be used.



4) Voltmeter

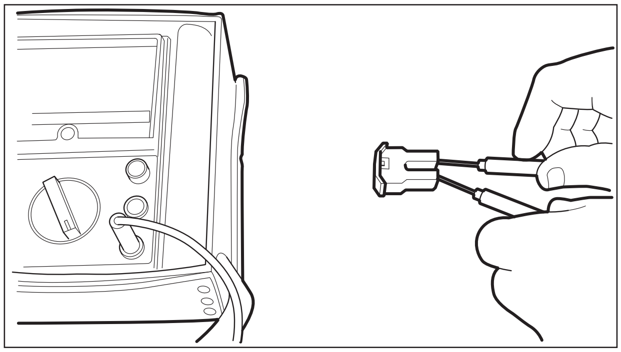
When measuring the circuit voltage, connect the plus side of test lead (red lead) to the position where voltage is to be measured, and ground the minus side (black lead) to the machine frame.

(4) Checking of fuse

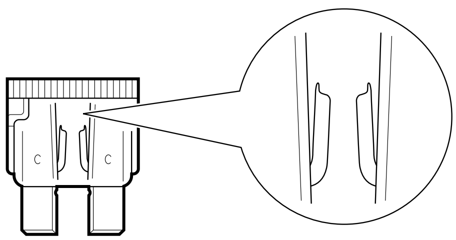
1) Cautions at blowing of fuse

When fuse is blown, two causes are considered. One is the case where fuse is blown by overcurrent of higher than rated value, and the other is the case where fuse is blown by repetition of intermittent current.

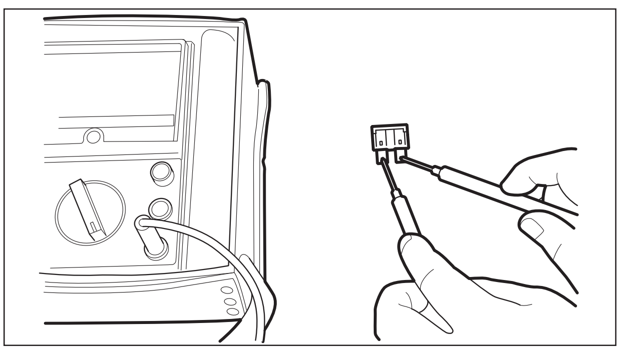
These two cases can be confirmed by visual checking. When fuse is blown, pay attention to the following points.



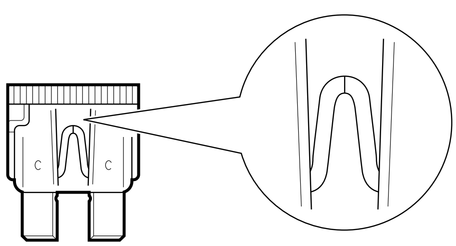
Case where fuse is blown by overcurrent



1. Case where fuse is blown by overcurrent of higher than rated value
   The figure shows the case where fuse is blown by overcurrent. In such case, do not replace the fuse immediately with new one.
   Since so high overcurrent as to blow fuse has run, check first the circuit or electric equipment for any abnormality and after repair, mount new fuse of same capacity.
   Mounting of a fuse having larger capacity than the previous one for allowance sake is strictly prohibited.
   Mounting of a fuse having larger capacity may arise such a danger that abnormality is caused at electric equipment or wiring before blow of fuse when overcurrent runs.

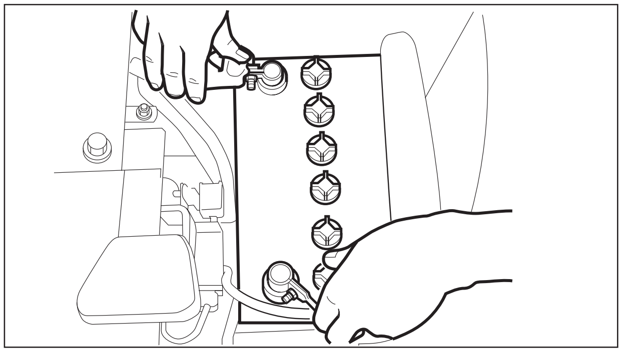


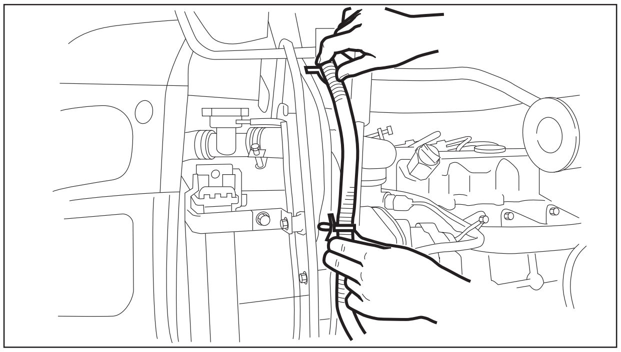
Case where fuse is blown by thermal fatigue



2. Case where fuse is blown by repetition of intermittent current
   The figure shows the case where fuse is blown by repetition of intermittent current. Generally speaking, such blowing of fuse is caused after a long elapse of time and the frequency is low.
   In the case of such blowing of fuse, replace the blown fuse with new one.

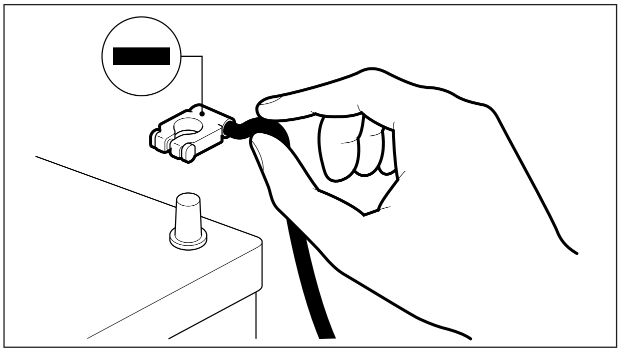
(5) Checking of wire harness





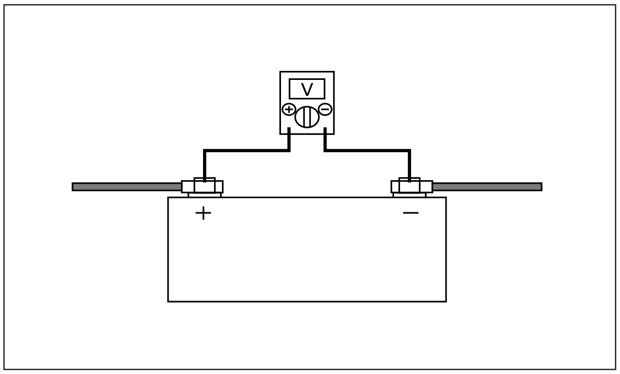
1. There should be no looseness, rust nor taint damage at connections.
2. Terminals or wires should not be corroded by battery electrolyte.
3. There should be no breakage nor half-breakage of terminals and wires.
4. There should be no breakage, crack nor deterioration of insulation material of wire.
5. Terminal of conductive part should not be in contact with metal parts (machine body and other parts).
6. Grounding parts to be mounted should have complete conductivity between the mounting bolts and the machine body.
7. There should be no wrong connection.
8. Wires should be clamped securely so that they should not contact a sharp edge like machine frame and high-temperature parts (such as exhaust manifold and pipe.
9. Wire harness should be clamped securely, being kept sufficiently away fro rotating parts including fan pulley, fan belt etc
10. Allowance should be given to the length of wires connected between the fixed part like machine body and vibrating part.

(6) Handling and checking of battery



Battery

When the power supply from mounted battery is not needed for checking and servicing, disconnect the cable of minus terminal from the battery without fail.
This is for prevention of trouble due to shortcircuit of the circuit. Always disconnect the minus terminal first and connect it last.

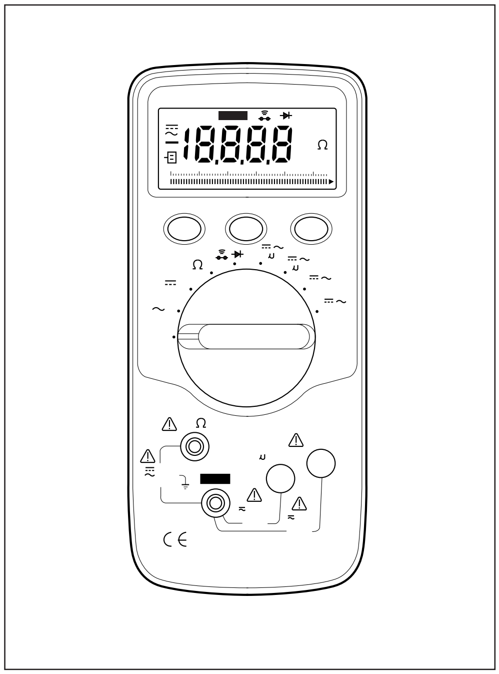


1. Start the engine.
2. Connect the circuit tester to the battery plus terminal and minus terminal and measure the voltage.
   Higher than 10.5 V: Battery is normal

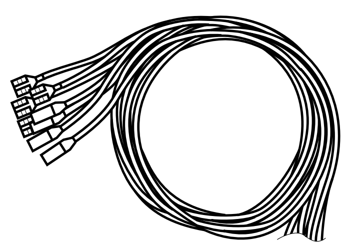
(7) Measuring instrument and special tools

In proceeding to checking work, use of the tester and special tools will be helpful for safe and speedy work.

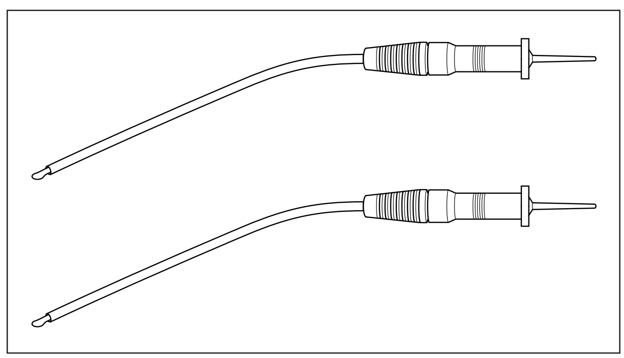
- HIOKI Digital Hi-tester (3256-01)
  Characteristics: Measurable of frequency (Hz)



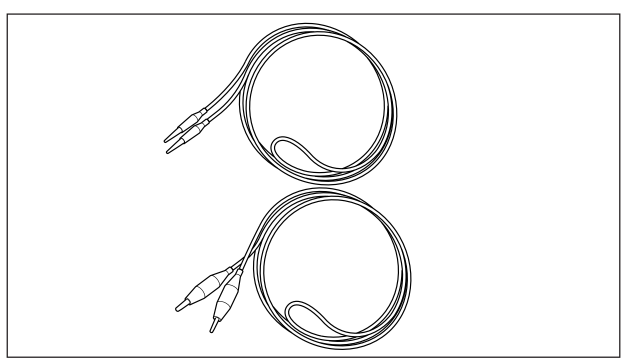
- Special tools
  Use these tools when test lead can not be connected to coupler or connector, or fixed to it.



Name of item; Tester lead set
Item No.: KS000-00340



Pins



Clips

c. Troubleshooting

(1) Engine system

Troubles	Checking points	Remedies	Remarks
1) Starter does not rotate.	1. Isn't slow-blow fuse (30A) blown? 2. Isn't battery terminal loosened? 3. Is voltage is higher than 10.5 V at battery both ends ((+), ( )) in start position? 4. Isn't starter M terminal loosened? 5. Is voltage is higher than 9 V at starter 50 terminal in start position? 6. Is key switch normal?	Check or replace. Re-tighten. Charge or replace. Re-tighten. Repair or replace. Check or replace.	
2) Starter rotates but engine does not start.	1. Does fuel overflow to tank when key switch is turned ON? 2. Is fuel pump moved by hand when key switch is turned ON? 3. Isn't fuel pump fuse (5A) blown? 4. Is there voltage at fuel pump couplers 1 and 2? 5. Does engine start when stop solenoid is dismounted? 6. Is there voltage at engine stop solenoid coupler when key is turned ON?	Visually check. Replace. Replace. Repair or replace. Repair or replace. Repair of replace.	
3 Engine is hard to start at low temperature.	1. Is battery voltage normal? 2. Is there voltage at glow plug? 3. Is glow plug normal?	Charge or replace. Repair or replace. Replace.	

(2) Panel (key switch: ON)

Troubles	Checking points	Remedies	Remarks
1) Charge lamp does not light up.	1. Isn't fuse (5A) blown? 2. Isn't coupler of dynamo or of regulator removed? 3. Isn't coupler at meter side removed? 4. Isn't lamp dead?	Replace. Repair or replace. Repair of replace. Replace.	
2) Oil lamp does not light up.	1. Isn't fuse (5A) blown? 2. Isn't coupler of oil switch removed? 3. Is there voltage at coupler of oil switch? 4. Does oil lamp light up when wire harness terminal of oil switch is removed and grounding is established to machine body? 5. Measure engine oil pressure.	Replace. Repair or replace. Repair or replace. Repair.	
3) Fuel remaining amount warning lamp does not light up.	1. Isn't fuse (5A) blown? 2. Are charge lamp and oil lamp lighted up? Lighted: Normal No lighted: Trouble 3. Ground wire harness terminal of fuel sensor to machine body. Lights up: Normal Not light up: Wire harness is broken. 4. Isn't bulb of panel lamp dead?	Replace. Repair or replace. Repair or replace. Replace.	

(3) Panel (Engine start)

Troubles	Checking points	Remedies	Remarks
1) Charge lamp does not go out.	1. Isn't fuse (5A) blown? 2. Isn't output terminal or coupler of dynamo removed? 3. Does dynamo work normally?	Replace. Repair or replace. Repair or replace.	
2) Oil lamp does not go out.	1. Is oil filled at specified amount? 2. Isn't coupler of oil switch removed? 3. Is there voltage at coupler of oil switch? 4. Measure engine oil pressure.	Supply oil. Repair or replace. Replace. Repair.	
3) Fuel remaining amount warning lamp does not light up.	1. Is fuel filled? 2. Is fuel sensor normal?	 Replace.	

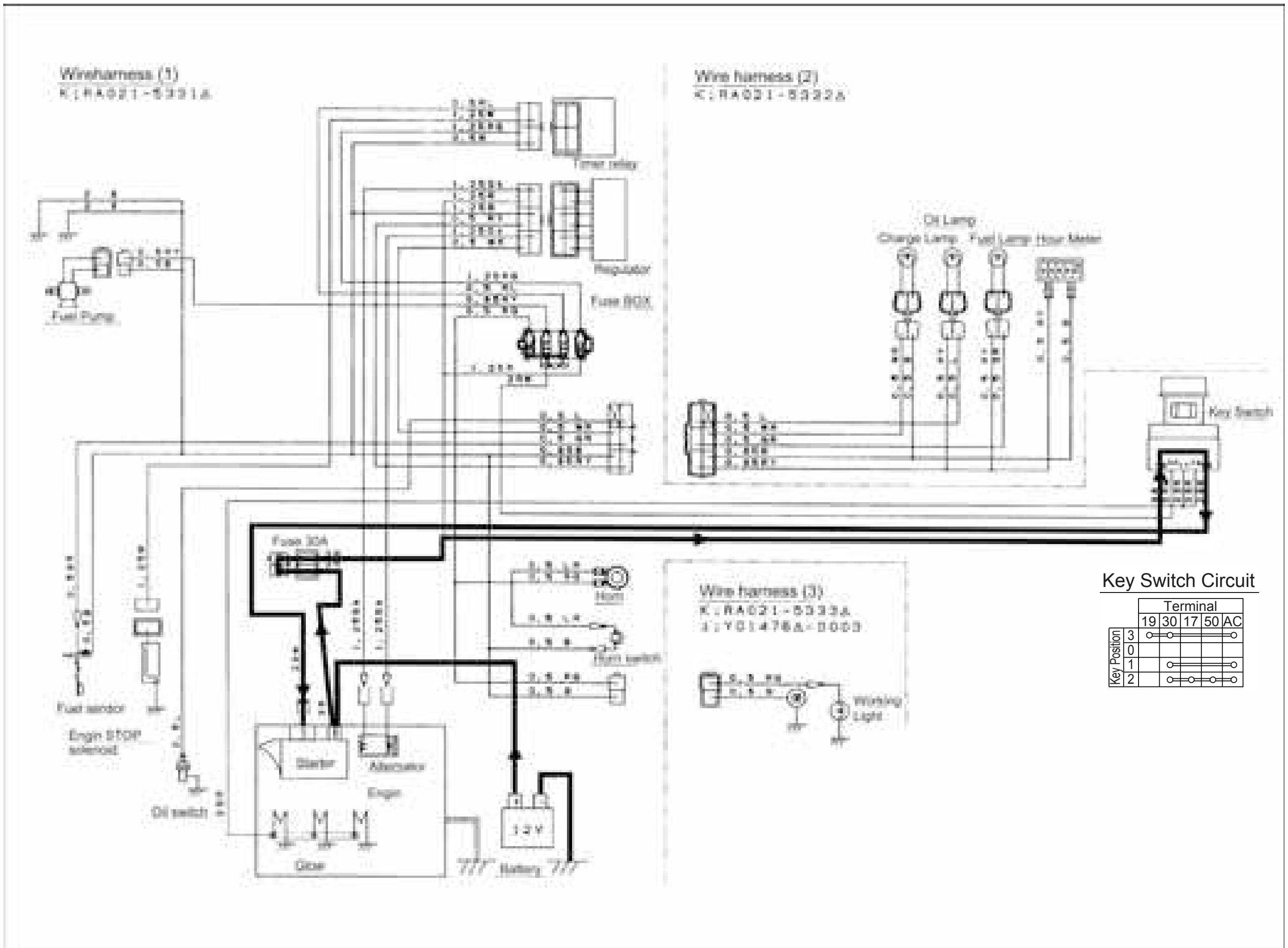
(4) Others

Troubles	Checking points	Remedies	Remarks
1) Horn does not sound even when horn switch is pressed.	1. Isn't fuse (10A) blown? 2. Isn't wire harness running from grip (horn switch) broken? 3. Isn't horn coupler or grip (horn switch) coupler removed? 4. Is there voltage at horn terminal? 5. Is horn switch normal? 6. Is horn normal?	Replace. Repair or replace. Repair or replace. Replace. Replace. Replace.	
2) Working light does not light up even when working light switch is pressed.	1. Isn't fuse (10A) blown? 2. Are working light terminal and switch coupler removed? 3. Is there voltage at working light terminal? 4. Isn't lamp dead?	Replace. Repair or replace. Replace. Replace.	

d. Checking procedure

(1) Starter

1) Flow of electricity



2) Starting principle

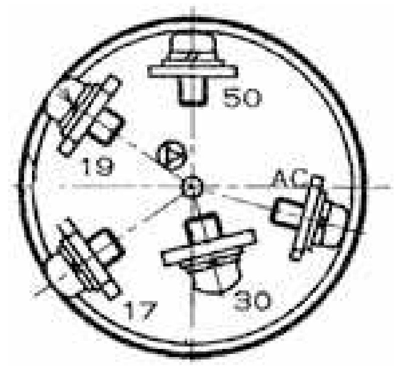
1. Starter switch OFF
   Voltage from the battery is applied at all times to the starter B, slow-blow fuse and starter switch 30 terminal.
2. Starter switch ON
   Starter switch 30 terminal (Photo 2) and 50 terminal are connected, electric current flows to the starter S terminal, pinion gear turns and engine is rotated.

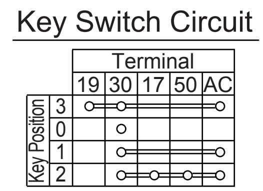
3) Checking at the time when starting is impossible

When starter switch is at start position, check whether battery voltage is applied to the starter S terminal (1) or not. (Photo 4)

- When voltage is not applied:
  1. Slow-blow fuse is blown (Photo 3)
     (Visually check to see whether or not shortcircuit occurs between wires.)
  2. Poor conductivity of starter switch
     (Turn ON the starter switch and check the conductivity between the 30 terminal and 50 terminal for.)
  3. Poor contact of coupler, wire etc.
  4. Wire breakage(Check for conductivity by circuit tester.)
- When voltage is applied:
  1. Poor contact of starter S terminal(Check the starter S terminal and body for conductivity.)
  2. Poor grounding of starter and body(Check the starter and machine body for conductivity.)
  3. Breakage of the starter PC coil and HC coil(Check the starter S terminal and body for conductivity.)

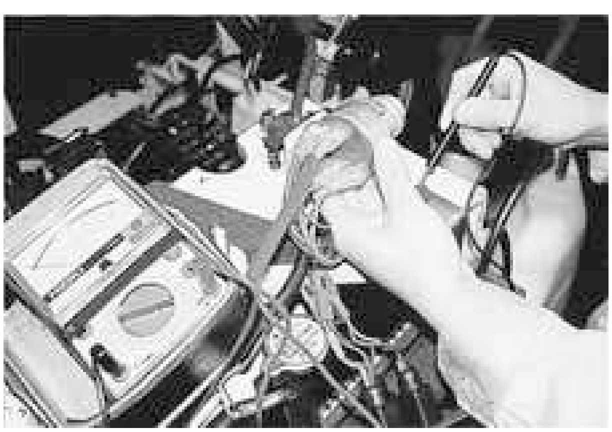
(Photo 2)





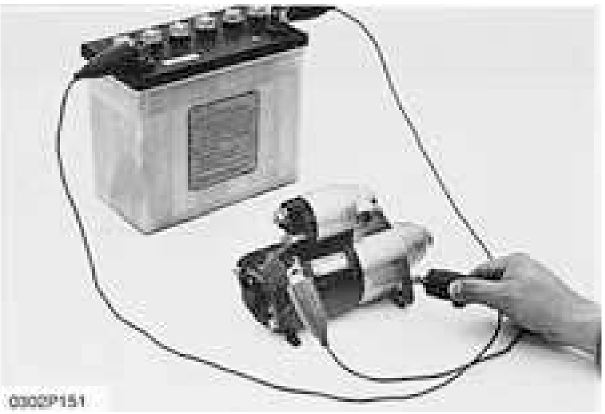
1. Checking slow-low fuse for breakage (Photo 3)

2. Is battery voltage applied to the self-starting motor in starter switch ON position? (Photo 4)



2. Check if battery voltage is applied to the 50 terminal in starter switch ON position.

Starter



4) Testing the motor

[Cautions]

- Starter moves by reaction when it is rotated. Therefore, be sure to fix it firmly by vice.
- Use connection cable of diameter large enough for flowing of large electric current (several hundred amperes).

1. Remove the connecting lead from the C terminal of the magnet switch and connect it by cable directly to the battery plus terminal.
2. Bring the cable extending from the battery minus terminal into contact with the starter body for short period of time.
3. If the starter rotates, it is considered that the motor is normal but the magnet is defective. If the motor does not rotate, it means that the motor is defective. In this case, disassemble and check the motor.

5) Magnet switch

[Cautions]

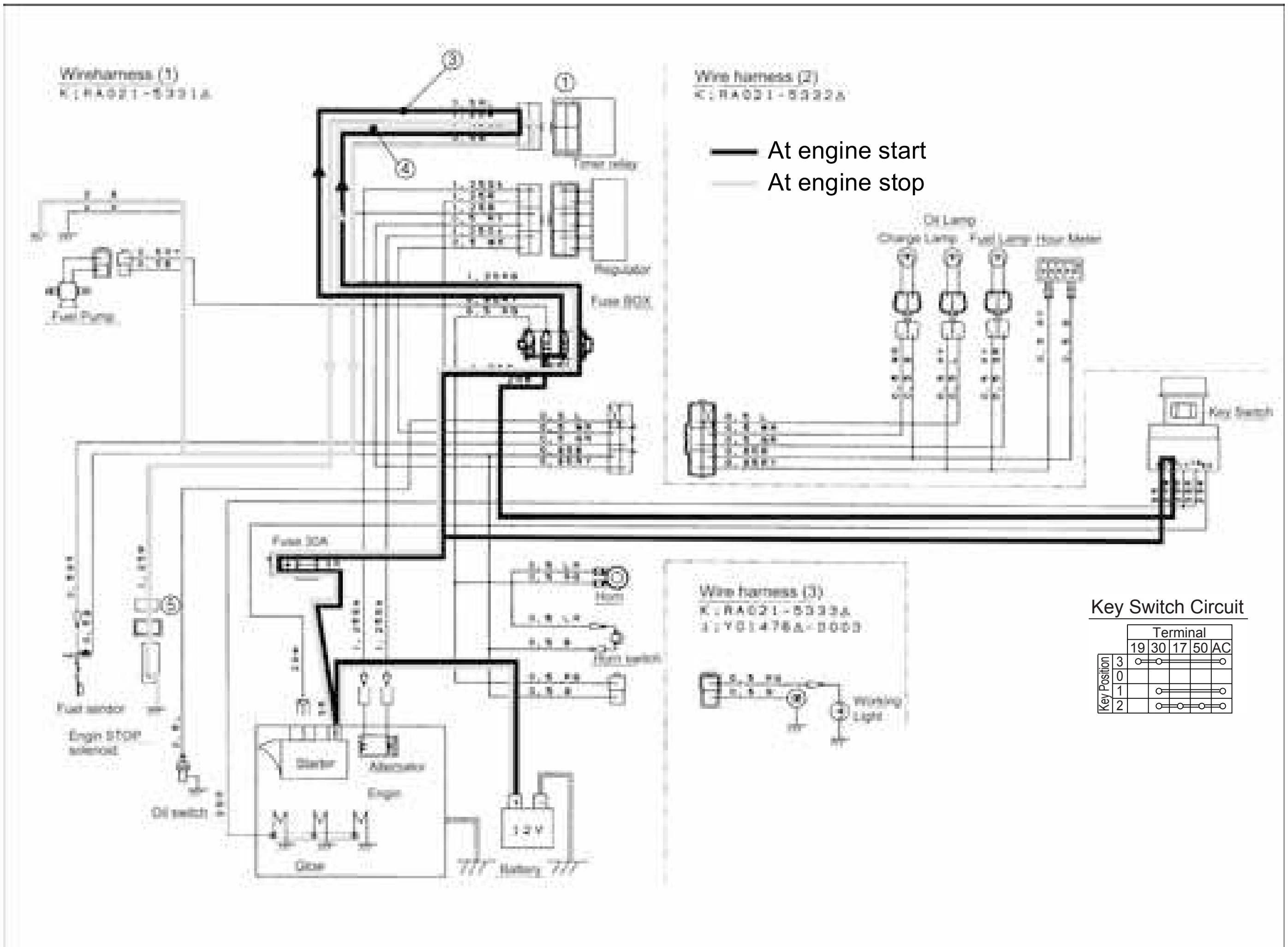
- Conduct the tests within a short time (3 - 5 sec.)
  Conduct the test at 1/2 of the rated voltage (6 V)

- Checking of pull-in coil
  1. Connect the battery minus terminal with the C terminal of the magnet switch body.
  2. Then, connect the battery plus terminal to the S terminal. At this time, if the pinion gear sticks out, it means that the pull-in coil is normal.

- Checking of holding coil
  1. The holding coil is normal if the pinion gear stays out after removal of the C terminal cable from the state after checking of the pull-in coil.

(2) Engine stop

1) Flow of electricity



2) Engine stop principle

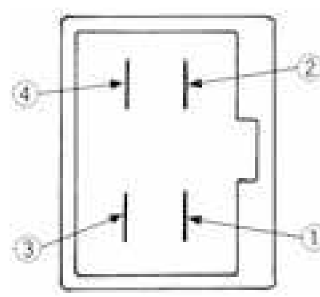
At starter SW ON	Battery voltage is applied to the timer relay terminal (4) (Photo 1) at all times regardless of operation of the starter switch. When starter switch is turned ON, electric current flows to the timer relay terminal (3) and electricity is accumulated in the capacitor of the timer relay.
At starter SW OFF	AC power supply is shut down and no electricity from (3) comes to be accumulated in the capacitor of the timer relay. Then, the capacitor discharges electricity to operate the relay for 10 sec. of discharging time, (1) and (4) are connected and electric current flows to the engine stop solenoid to stop engine operation.

3) Checking to be done when engine does not stop

- At (Immediately after) starter SW OFF, check to see if voltage (12) is applied to the engine stop solenoid terminal for 10 sec.
  (Photo 3)

When voltage is not applied	1. 15A fuse for timer relay is blown (Photo 4). (Visually check the fuse and check to see whether or not wires are shortcircuited. 2. Defective timer relay (Apply voltage to (3) and (4), and check to see whether or not voltage is applied to (1) for 10 sec. when (3) is turned OFF.) Since interval between terminals is small, pay attention so as not to cause shortcircuit. 3. Wire breakage of (1) and (5) (Check them for conductivity by circuit tester.) 4. Poor contact of coupler and wire
When voltage is applied	1. Engine stop solenoid is defective (Photo 5). (Check the solenoid for conductivity and check it by applying 12V voltage to see if it operates. 2. Poor contact of the engine stop solenoid coupler 3. Defective grounding of the engine stop solenoid body (Check the solenoid body for conductivity at the engine stop solenoid terminal.)

(Photo 1)



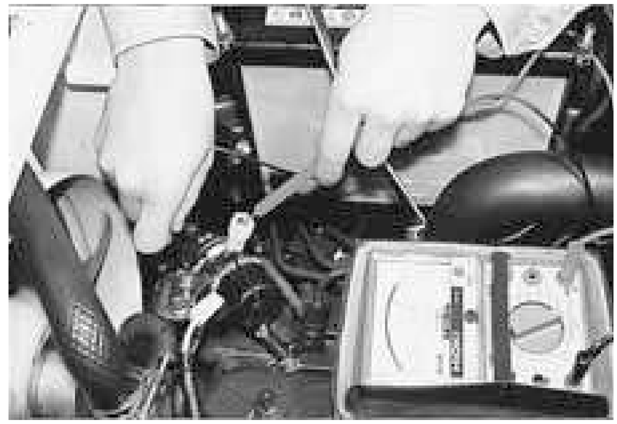
Timer relay coupler terminal

④	Fuse (AC)	RL
③	Fuse	RB
①	Stop solenoid	W
②	Ground	B

Is voltage applied for about 10 sec. when the starter switch is OFF? (Photo 3)

Isn't the fuse blown? (Photo 4)

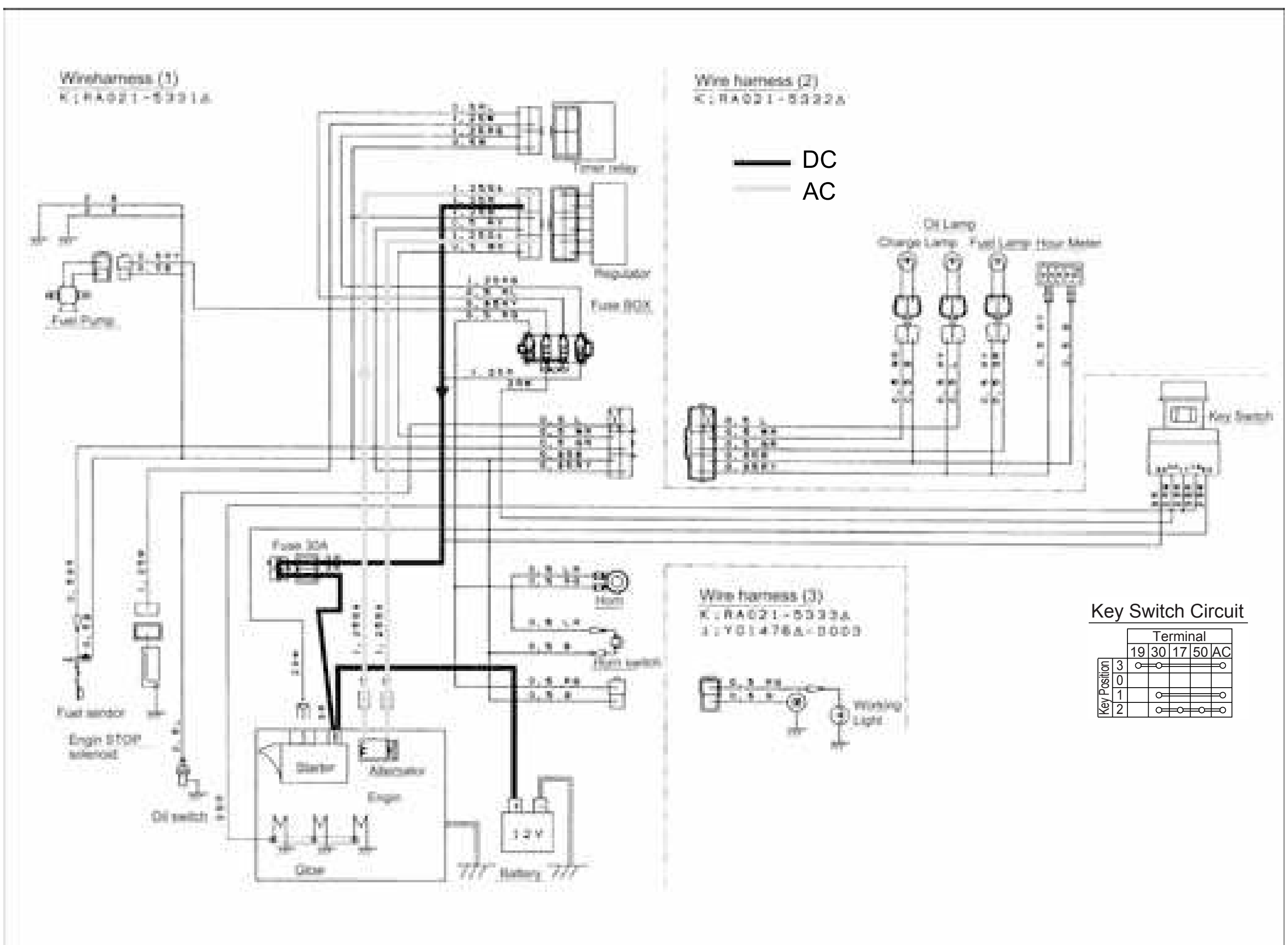
Apply battery voltage to the engine stop solenoid and check to see whether or not the injection rubber is drawn in and the rack bar returns when the application of voltage is stopped. (Photo 5)

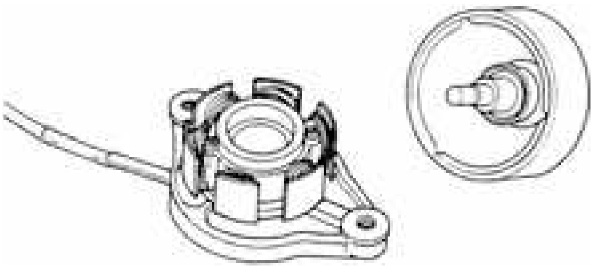


Check conductivity between the solenoid terminal and the body ground. (Photo 6)

(3) Charger

1) AC dynamo





This AC dynamo is so designed as to mount a cooling fan at the shaft end and composed of a rotor and stator.
The stator has six magneto coils around which the rotor having (six) permanent magnets rotates to generate alternating current at the stator coils.

2) Regulator

The regulator is equipped with rectifying and voltage regulating functions. It converts the alternating current generated by the AC dynamo to direct current and works for supplying electric current when battery is charged and light is loaded. When the battery voltage exceeds 14.5 V, the regulator prevents overcurrent. Besides, when the AC dynamo does not generate alternating current, the charge lamp lights up to so inform the operator.

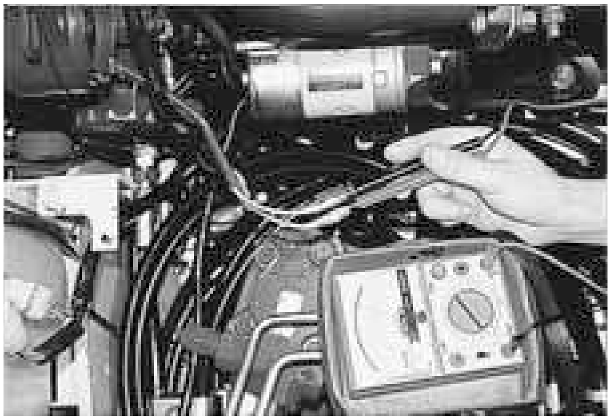
Principle of electric power generation

When engine is rotating	The permanent magnets of the dynamo is rotated in the coil by fan belt to generate alternating current. Generated alternating current is rectified and regulated for voltage by the regulator and charged to the battery.
When engine is stopped	Since the dynamo is not rotated, no electric power is generated.

Checking to be done when power generation is impossible (Carry out checking, paying attention to rotating parts.)

Connect the AC tester to the dynamo terminal and check to see whether or not alternating current of about higher than 20V is generated when the engine is rotated at max. speed. (Photo 1))

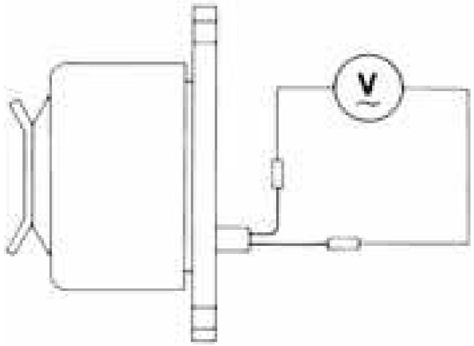
When no electricity is generated	1. Decrease in magnetic power of dynamo permanent magnets 2. Breakage of dynamo coils (Connect the tester to the dynamo terminal and check conductivity.) (Photo 1)
When electricity is generated	1. Damage to regulator (Photo 2) 2. Breakage of wire(s) (Check conductivity.) 3. Poor contact of coupler, wire etc.

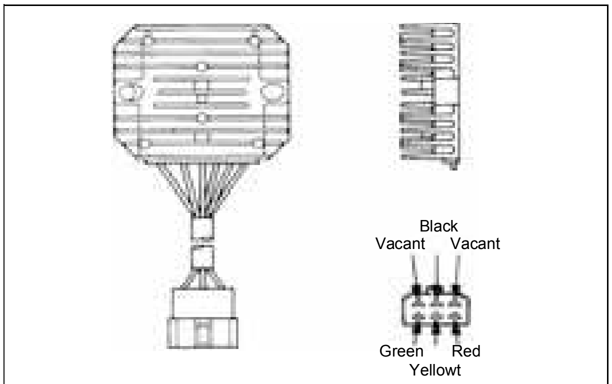


(Photo 1)

3) Regulated voltage without load

1. Start the engine and gradually raise the rotating speed.
2. Raise the engine rotating speed gradually while checking the voltage and check to see if the voltage rises higher than the standard value.
3. If the voltage stays lower than the standard value, replace the dynamo.
   Generated voltage without load
   Standard value: Higher than AC 20 V





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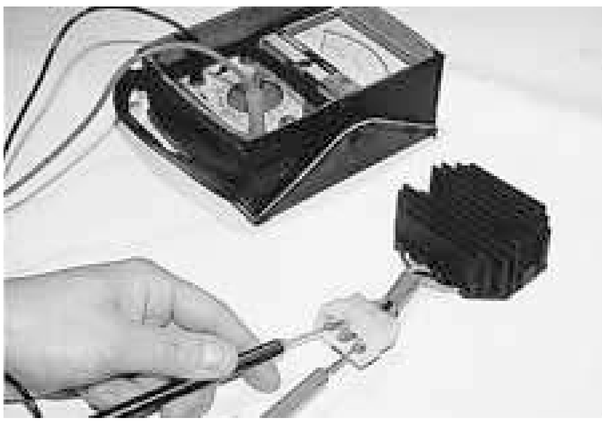



(Photo 2)

4) Conductivity of regulator

[Cautions]

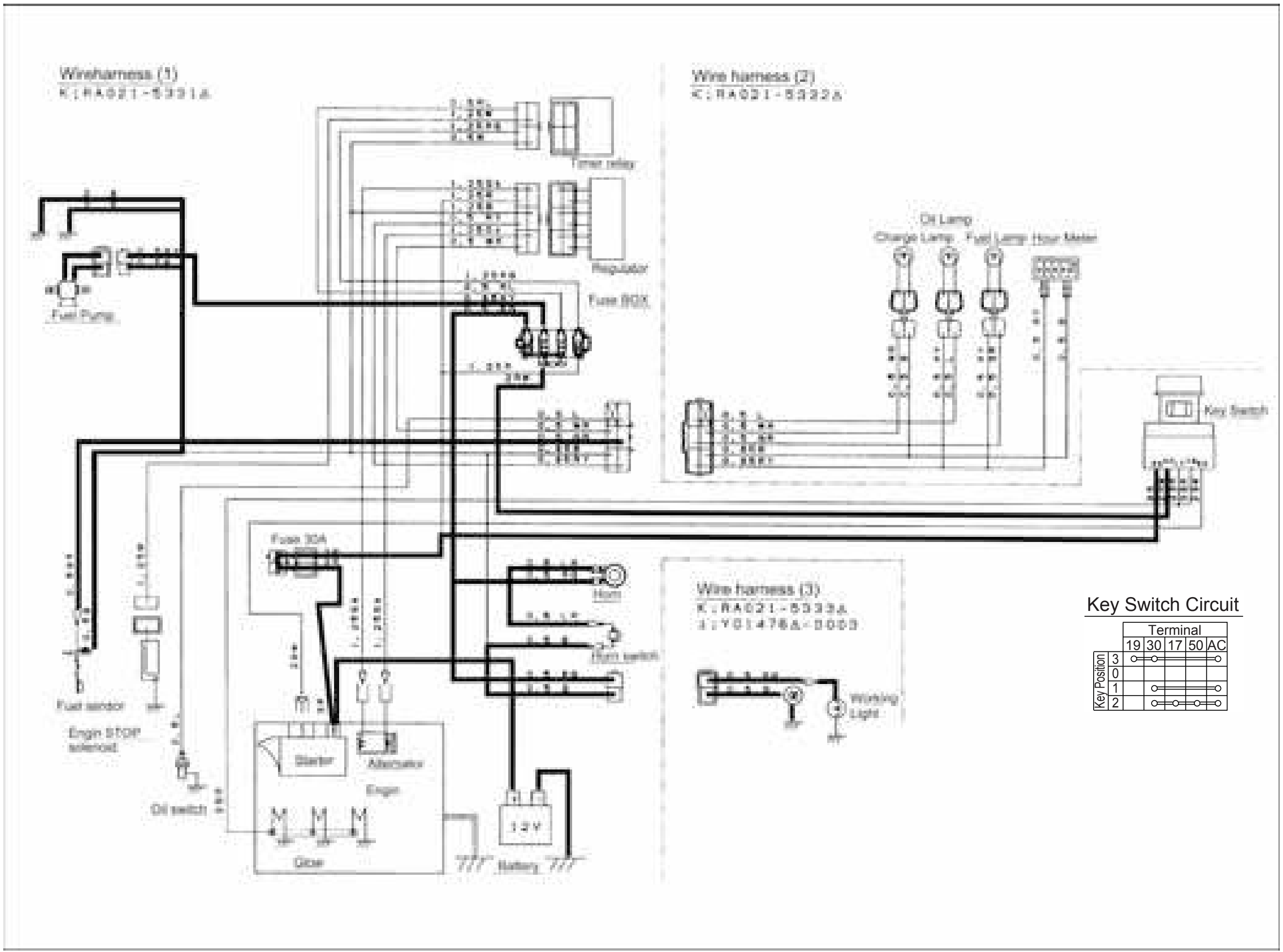
Check the conductivity between the connector terminals by using resistance range of circuit tester according to the table. "ON" stands for "Conductive", while "OFF" for "Non-conductive". This regulator is not always normal even if all the items are normal. However, should any one of them be abnormal, the regulator becomes defective.

		Plus terminals of tester					
		Vacant	Vacant	Red	Black	Yellow	Green
Minus terminals of tester	Vacant		OFF	ON	OFF	OFF	OFF
	Vacant	OFF		ON	OFF	OFF	OFF
	Red	OFF	OFF		OFF	OFF	OFF
	Black	OFF	OFF	OFF		OFF	OFF
	Yellow	ON	ON	ON	ON		OFF
	Green	OFF	OFF	OFF	OFF	OFF	

① Regulator
② Fuse box

(4) Horn, fuel pump and working light

1) Flow of electricity



2) Operating principle of horn, fuel pump and working light

At starter SW ON	Battery voltage is applied by the starter switch AC terminal to the working light switch and horn switch, and current flows to the fuel pump. Thus, they are operated. When the working light internal switch is pressed, electric current flows to the working light and horn to operate them.

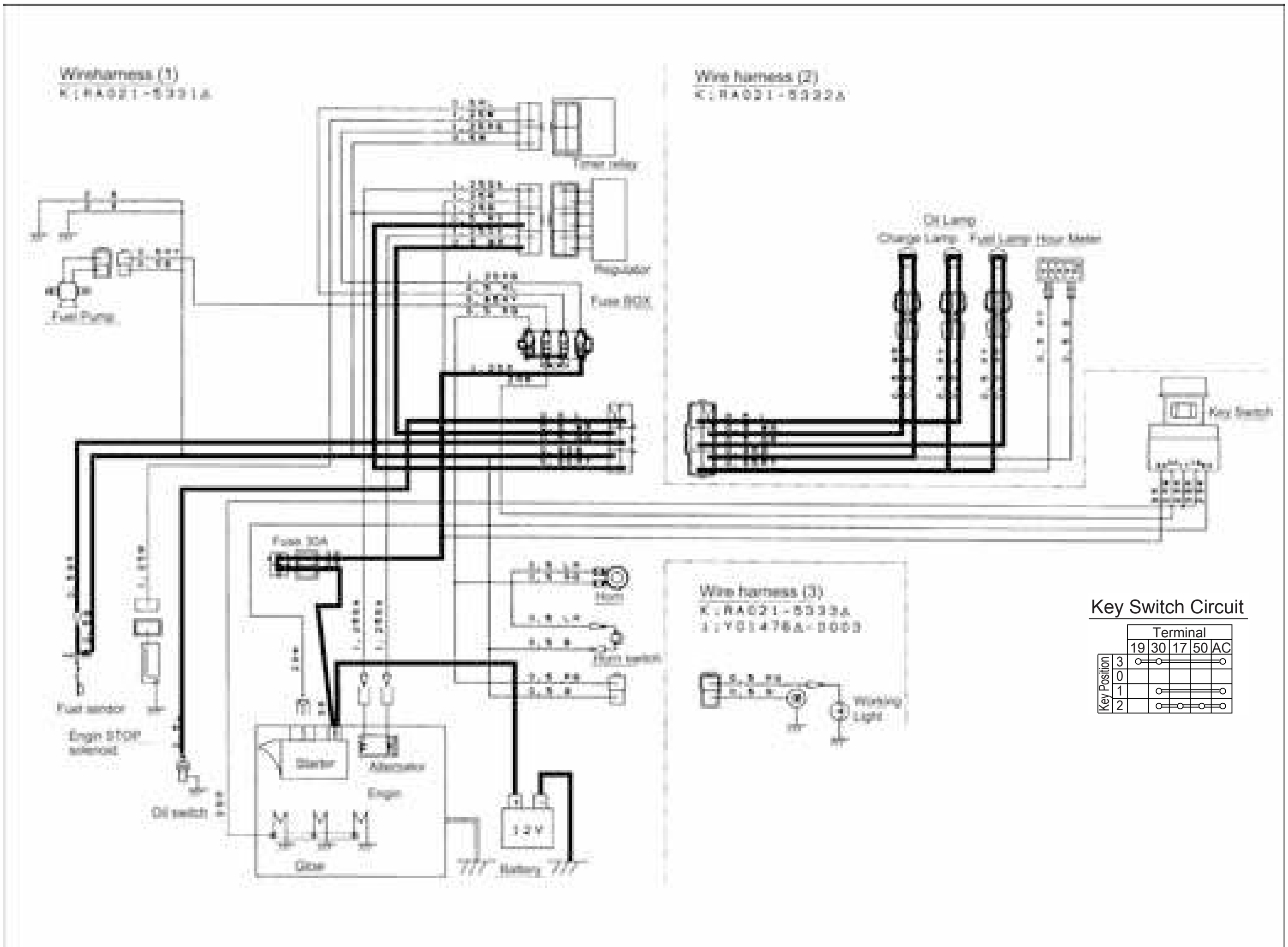
3) Checking to be done when they do not operate

Check if battery voltage is applied to the fuel pump and horn switch when the starter switch is ON.

When no voltage is applied	1. Fuse is blown. (10A fuse for the working light and horn. 5A fuse for the fuel pump) 2. Poor conductivity of starter switch (Check the starter switch 30 terminal and AC terminal for conductivity.) 3. Slow-blow fuse is blown. (Visually check if wires are shortcircuirted.) 4. Wire breakage or incomplete insertion of wiring coupler 5. Poor grounding

(5) Charge lamp, oil lamp and fuel lamp

1) Flow of electricity



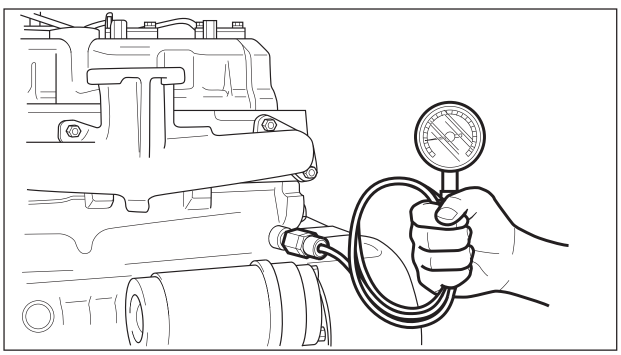
2) Operating principle of charge lamp, oil lamp and fuel lamp

At engine stop	1. Since the dynamo does not rotate, no electricity is generated and the regulator feeds electric current to the charge lamp to light it up. 2. Since engine oil pressure is not applied either to the oil switch, the contact remains closed and the ground of the oil lamp is connected to light up the lamp. 3. The thermistor mounted to the fuel sensor self-generates heat by extremely small electric current, and such self-heat generation decreases the internal resistance of the thermistor, thus permitting large electric current to flow. The internal resistance of the thermistor is decreased by cooling the termistor, thus restricting the flow of electric current. By utilizing this function, the thermistor generates heat and permits the electric current from the fuel lamp to flow to light up the lamp when it is out of fuel. Since it loses heat and is cooled when it is in fuel, the internal resistance is increased and the fuel lamp goes out.

3) Checking to be done when the lamps do not light up

Check the charge lamp and oil lamp when the engine is stopped, and check the fuel lamp after depleting the fuel tank to see if the bulb of the lamp is dead. In addition, check to see it voltage is applied to every coupler of the lamps.

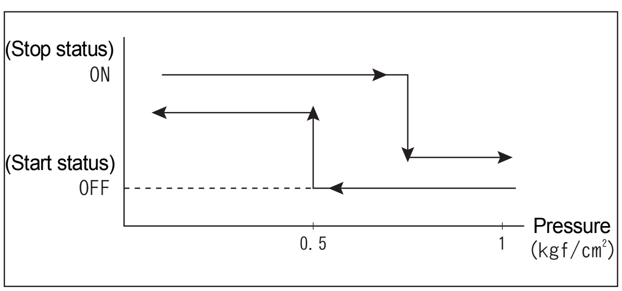
When voltage is not applied (Charge lamp)	1. Regulator is defective. 2. Poor contact of couplers, wires etc. 3. Wire breakage related to charge lamp (Check the conductivity from the charge lamp up to the regulator.)
(Oil lamp)	1. Fuse (5A) is blown. (Visually check if wires are shortcircuirted.) 2. Oil switch is defective. (Check the oil switch itself for conductivity.) (Photo 4) 3. Wire breakage related to the oil lamp (Check the conductivity from the starter switch AC terminal up to oil switch terminal.)
(Fuel lamp)	1. Fuse (5A) is blown. (Visually check if wires are shortcircuirted.) 2. Fuel sensor (thermistor) is defective. (Measure the electric current values at the times when fuel is filled and when fuel is depleted.) (Photo 2) 3. Wire breakage related to the fuel lamp (Check the conductivity from the starter switch AC terminal up to the fuel sensor terminal.)



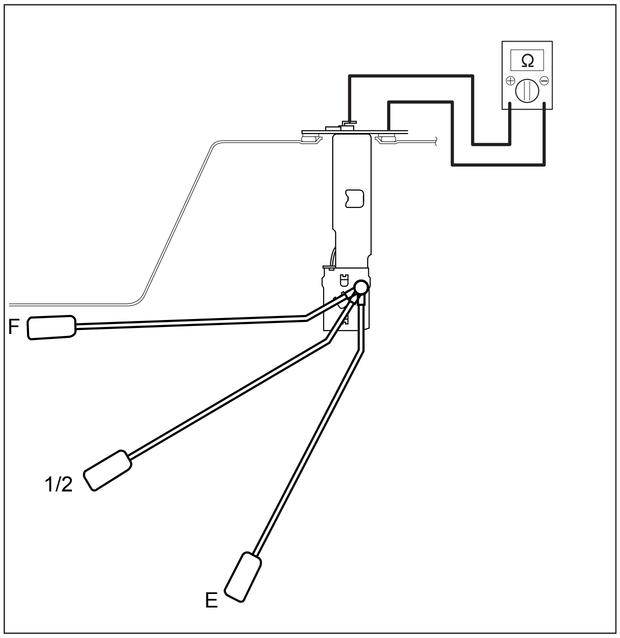
4) Measurement of engine oil pressure

Measure the engine oil pressure.

Idling	0.4MPa(4kgf/cm^2)
MAX	0.6MPa(6kgf/cm^2)



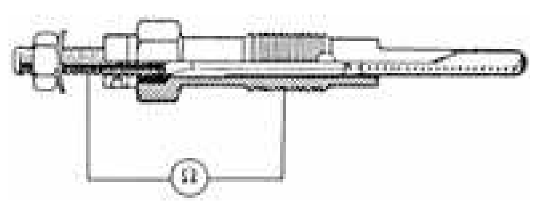
* Oil switch operating pressure
Standard value: 0.05 ± 0.01Mpa (0.5 ± 0.1kgf/cm2)



5) Checking of fuel sensor

- Dismount the fuel sensor from the fuel tank for checking.
- Bring the plus test read into contact with the coupler CN23 [3].
- Bring the minus test lead into contact with the plated part to measure the resistance.
- Standard value

Float position	F	1/2	E
Resistance value (Ω)	3±2	32.5±4	110±7



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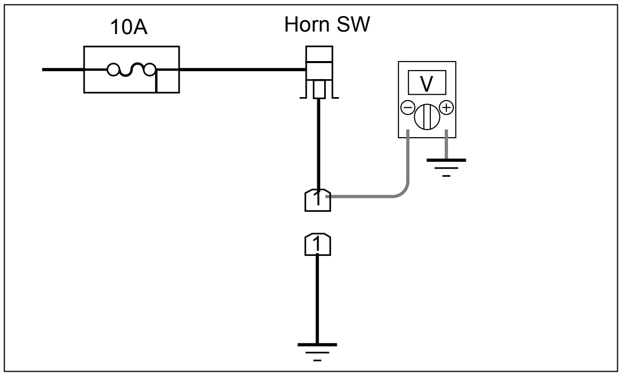
6) Glow plug

1. Remove the lead from the glow plug.
2. Measure the resistance between the thread of the glow plug end and the housing.
3. If the resistance is 0 Ω, it means shortcircuiting. Then, replace the glow plug. If the resistance is infinite, it means coil breakage. Then, replace the glow plug.
   Resistance of glow plug Standard value: Approx. 0.9 Ω (at normal temp.)

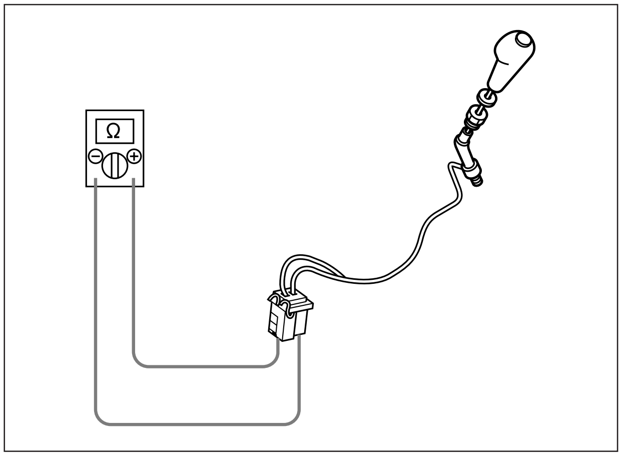


(6) Others

1) Checking of horn

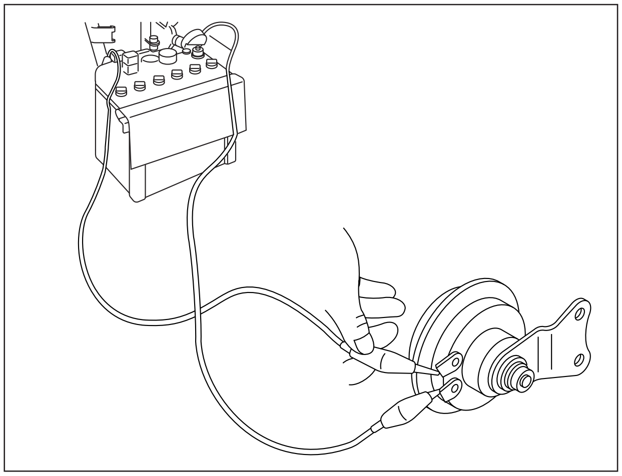
1. Measurement of voltage at horn terminal
   - Key switch: ON
   - Horn switch: ON

     12 V: Normal Check the horn.
     Other than 12 V: Check the conductivity.
     Check the horn.



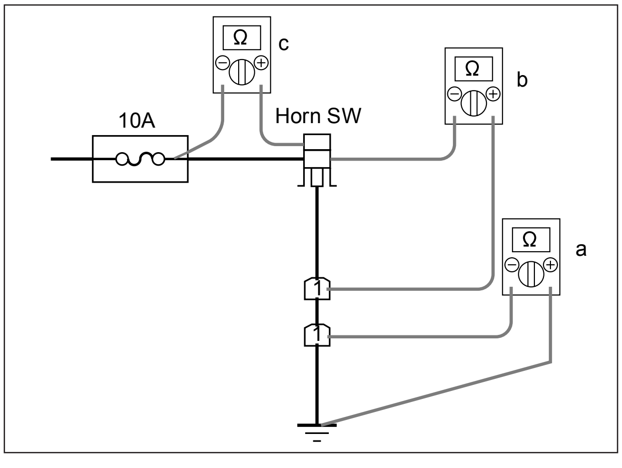
2. Checking of horn switch
   - Turn ON and OFF the horn switch to see whether or not the tester pointer swings.

     It swings: Normal
     It does not swing: Defective



3. Checking of horn
   - Apply 12V voltage between the horn terminals to see whether or not the horn sounds

     It sounds: Normal
     It does not sound: Defective



4. Checking of conductivity
   - Remove couplers.
   - Key switch: OFF

     a: Check the conductivity between the horn coupler [1] and the body ground.
     b: Check the conductivity between the horn coupler [1] and the horn switch coupler 2.
     c: Check the conductivity between the horn switch coupler [1] and the 10 A fuse box.

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